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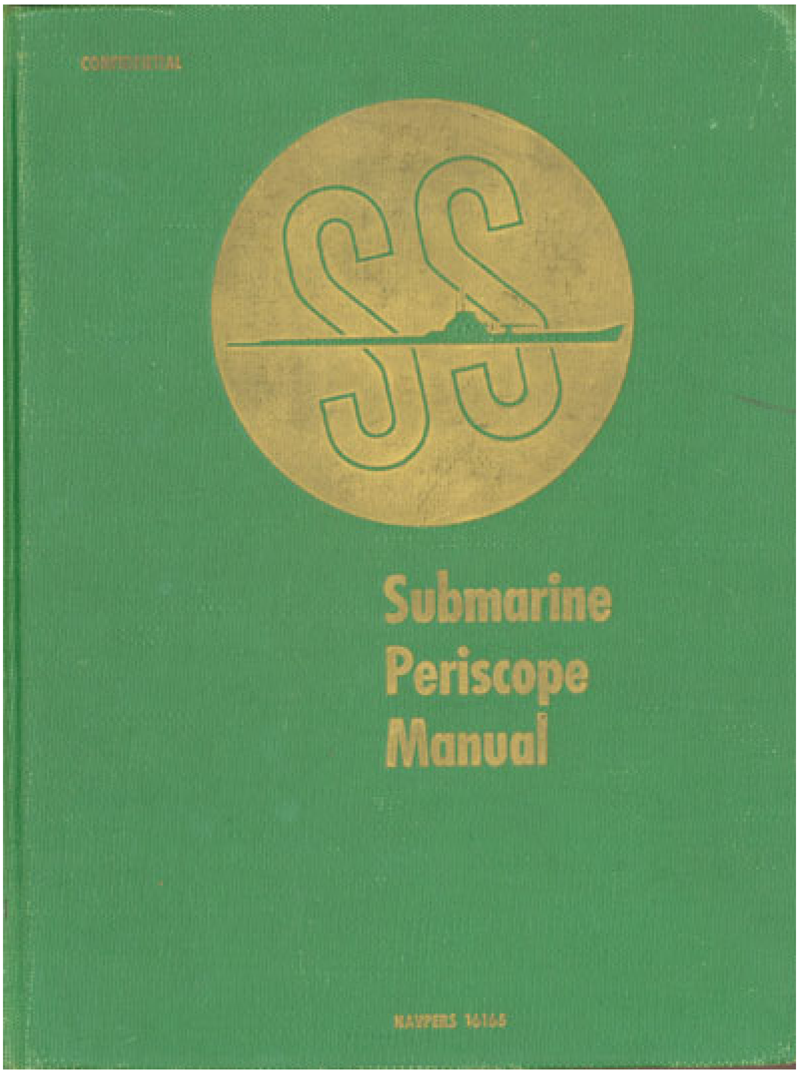
Submarine Periscope Manual



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Submarine Periscope Manual, Navpers 16165, is one of a series of submarine training manuals that was completed just after WW II. The series describes the peak of WW II US submarine technology.

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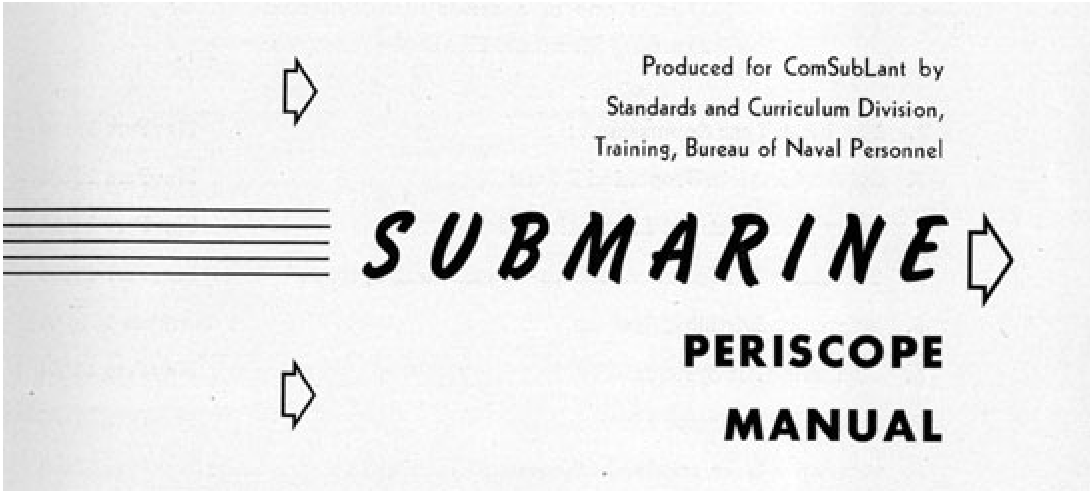
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SUBMARINE

PERISCOPE MANUAL

June 1946

~~CONFIDENTIAL~~

This is one of a series of Submarine Training Manuals. The series includes:

1.	The Fleet Type Submarine	NavPers 16160
2.	Submarine Main Propulsion Diesels	NavPers 16161
3.	Submarine Electrical Installations	NavPers 16162
4.	Submarine Refrigerating and Air-Conditioning Systems	NavPers 16163
5.	Submarine Distilling Systems	Navpers 16163A
6.	Submarine Air Systems	NavPers

		16164
7.	Submarine Periscope Manual	NavPers 16165
8.	Submarine Trim and Drain Systems	NavPers 16166
9.	Submarine Sonar Operator's Manual	NavPers 16167
10.	Submarine Underwater Log Systems	NavPers 16168
11.	Submarine Hydraulic Systems	NavPers 16169
12.	Torpedo Tubes, 21-Inch submerged, Mks 32 to 39	O.P. 1085

PREFACE

The Submarine School, Submarine Base, New London, Connecticut, and other activities of Submarines, Atlantic Fleet, have collaborated in the preparation of this manual. It is designed as both an instruction and service manual. The purpose of this manual is to describe, illustrate, and explain the details of construction and basic procedure for the maintenance of periscopes in submarines of modern classes.

A thorough knowledge of theory and maintenance of submarine periscopes is a requisite to operational effectiveness and the fulfillment of the submarine's mission the destruction of the enemy's ships wherever and under whatever conditions they may be encountered. The accomplishment of this mission necessitates that optical maintenance personnel be trained to maintain these delicate instruments in reliable operating condition.

Detailed descriptive information is given on disassembly, reassembly, and collimation of the three types of periscopes used in submarines.

The manual is presented in seven chapters:

Chapter 1.	Description.
Chapter 2.	Servicing of Periscopes.
Chapter 3.	Reflection-Reducing Films.
Chapter 4.	Design Designation 91KA40T/1.414HA Periscope.
Chapter 5.	Boresighting Submarine Torpedo Tubes.

Chapter 6.	Design Designation 92KA40T/1.99 Periscope.
Chapter 7.	Design Designation 93KN36 Periscope.

Each chapter presents the theory of each assembly, disassembly, and reassembly procedure in chronological order for the successful elimination of the more common maintenance and service problems.

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Key to Hydraulic Hoist System

Ill. No.	Nomenclature
1	Bottom casting
2	Union nut
3	Gland
4	Union nut
5	Plastic gasket
6	Tail piece
7	Piston rod
8	Chevron packing
9	Cylinder
10	Gasket
11	Hull casting
12	Hull casting gasket

13	Cylinder thrust retaining ring
14	Gasket
15	Thrust collar
16	Periscope bearing
17	Stud
18	Nut
19	Grease manifold
20	Valve plug
21	Ground key cock
22	Male connector
23	Copper tubing
24	Push rod
25	Push rod collar
26	Sleeve
27	Spring
28	Leather washer
29	Leather pad
30	Extension ring (2 halves)
31	Azimuth circle support
32	Stud bolt
33	Stud nut
34	Azimuth circle
35	Azimuth circle screws
36	Retaining ring
37	Machine screw
38	Leather wiper
39	Conning tower structure
40	Periscope
41	Drain pipe
42	Hydraulic line
43	Machine screws
44	Stuffing box packing chevron (see Figure 47)

1
DESCRIPTION

A. INTRODUCTION

1A1. Historical note. The periscope is the eye of the submarine. It was invented and developed solely for the purpose of providing a means to view the surface without fear of detection by surface craft. While it is primarily simple in principle, actually it is a complicated piece of apparatus. It is probable that all the navies of the world have similar instruments with only minor variations.

The earliest submarines were built without provision for periscopes and therefore, when submerged, were forced to grope their way blindly.

In 1854 Marie Davey, a Frenchman, designed a sight tube for a submarine. This tube contained two mirrors, one above the other, held at a 45 degree angle and facing in opposite directions. These, while providing some degree of sight to the submerged vessel, were faulty at best and, in 1872, prisms were substituted for mirrors.

Before the War Between the States, the submarine had not had a place among the ships of naval warfare. An American, Thomas H. Doughty, USN, was the inventor of the original periscope. Doughty's invention when the boat was traveling at a low rate of speed but, with increased speed, the pressure was apt to bend the tube and throw the image out of line. Improved design resulted in a double tube, the outer to resist pressure and the inner to house the lens systems.

One of the biggest difficulties with the periscope in its infancy was that the rotation of the upper prism caused the image to be seen upside down. This has been corrected in the design of the instrument.

The Germans were responsible in large measure for the improvement of the modern periscope but, in spite of the advances made in the development of the instrument, the basic principle is still the same, the reflection of objects through mirrors or prisms arranged in a tube.

1A2. Periscope function. The essential function of a periscope is to give an officer conning a submarine a view of the surrounding horizon while his vessel remains submerged. To accomplish this, it is necessary that the periscope be long enough to extend beyond the surface, and that means be provided to deflect

was not the result of study and research but rather the result of necessity. During the campaign of the Red River, while he was serving aboard the monitor Osage, Confederate cavalry, from the banks of the river, kept up a steady series of surprise attacks upon the Union vessels which had no way of seeing over the banks. This led Doughty to seek some new method of watching the shores. He took a piece of lead pipe, fitted it with mirrors at either end, and ran it up through the turret. This makeshift periscope provided sight for the crew of the Osage, enabled them to annihilate approaching Confederates, and practically freed her from further attack.

The earliest periscope, other than a collapsible one designed late in the nineteenth century by Simon Lake and known as an omniscope or skalomniscope, was a fixed tube. Soon, however, provision was made to allow the tube to be raised and turned by hand. This was fairly satisfactory

the horizontal rays of light first in a downward direction, and then horizontally to the eye of the observer. In addition, the part of the periscope which is to be above water must be as inconspicuous and streamlined as possible; for this reason the periscope is made in the form of a long narrow tube.

1A3. Periscope nomenclature. To insure a uniform method of designating periscopes on submarines, a standard system of nomenclature is used in all correspondence, specifications, and plans relating to such instruments.

The periscope nearest the bow is called No. 1 Periscope, regardless of whether it is of the altiscope type or whether it is installed in the conning tower. The next periscope aft of No. 1 Periscope is called No. 2 Periscope, and the next periscope aft of No. 2 is called No. 3 Periscope. The terms forward, middle, and after periscopes or 1st, 2nd, and 3rd periscopes are not used.

1A4. Useful definitions. The term periscope is used generally to designate all types of instruments. However, it is used specifically to designate instruments that are designed for horizontal view only.

The term altiscope is applied to a periscope from which the upper prism has been omitted and the view is directly upward toward the zenith.

Letter	Manufacturer
K	Kollmorgen
E	Keuffel & Esser
B	Bausch & Lomb
S	Barr & Stroud
Z	Nederlandsche Instrumentim Compagnie (Nedinsco)

3. A letter indicating the type of periscope. Letter Type.

Letter	Type

The term altiperiscope is applied to instruments having the combined qualities of altiscopes and periscopes, sometimes called altiscope-periscopes and sometimes alti-azimuth instruments.

The terms unifocal and bifocal are used to refer to instruments of single and double power, respectively.

The term night periscope is used to designate a periscope having both high light transmission and an exit pupil of large diameter.

The term attack periscope is applied to a periscope with a minimum diameter of head at the sacrifice of light transmission and diameter of exit pupil.

The term metrescope is used to designate a periscope designed primarily for determining ranges of objects.

The term azimuth circle refers to the graduated circle used for taking bearings with the periscope.

The term stabilized azimuth device refers to a device in which a vertical wire in the field of the periscope is held gyroscopically in a fixed position in azimuth. The device is used in estimating the speed of an enemy ship.

1A5. Design designations of periscopes. Each separate or modified design of periscope is assigned a design designation, which is used in all correspondence relating to the periscope, in addition to the registry number of the periscope. The design designation is

A	Bifocal altiperiscope
H	High-power altiperiscope
N	Night or low visibility periscope

4. A number indicating the optical length of the instrument in feet to the nearest foot.

5. For a period, the letter T was added to indicate that the optics of the instrument had been treated to increase light transmission and improve definition. Since all periscopes in service have been so treated and new periscopes are furnished treated, this letter is not being included in recent design designations.

6. If the outer diameter of the upper portion of the reduced head section is less than 2 inches, a number representing the outer diameter of the upper part of the reduced head section in inches is added, separated from the preceding character by a diagonal mark.

7. If the instrument is an altiperiscope designed to permit view at any angle from the zenith to a point below the horizon, the letters HA are added.

8. As an example the following is quoted:

91	(serial number)
K	(Kollmorgen)
A	(bifocal altiperiscope)
40	(optical length in feet to nearest foot)
T	(treated optics)
1.414	(outside diameter of

assigned by the Bureau of Ships and consists of the following parts in the order given:

1. A serial number for each design, assigned by the Bureau.

2. A letter indicating the manufacturer.

upper part of reduced head section in inches)

HA (high angle)

Combined, this design designation reads as follows:

91KA40T/1.414HA

1A6. Marking of periscopes. The registry number of the periscope is conspicuously cut, or impress stamped, on the eyepiece end of each

periscope. It is also stamped on detachable external fittings, such as the training handles.

An etched or engraved name plate of suitable corrosion-resistant material is secured by screws to the eyepiece box of each periscope, and contains the following data:

U.S.N. BU. OF SHIPS
SUBMARINE PERISCOPE

DESIGN ________________

REGISTRY NO. ___________

	H.P.	L.P.
MAGNIFICATION FIELD OF VIEW	_____	____
SMALL DIVISION OF RETICLE EQUALS (ELEV.)	_____	____
LINE OF SIGHT (DEP.)	_____	____
INSPECTOR		

MFG. ________ by
Manufacturer's Name
Manufacturer's Address

two telescope systems enable the periscope to attain sufficient length, for example, 27, 30, 34, or 40 feet.

If the periscope is to magnify the image, it is necessary either to decrease the reduction of the image by the upper telescope or to increase the magnification of the lower telescope. For example, if a magnification of 2x is desired, the upper telescope may be so changed that the field angle is reduced to only 1/10 of the original field angle, while the lower telescope remains unchanged; the magnification would then be 1/10 X 20, or 2x. Or the upper telescope may remain unchanged at 1/20 and the magnification of the lower may be increased to 40x: Then the final magnification is 1/20 X 40, or 2x, as before. However, the latter plan has the disadvantage of reducing the illumination. Since the size of the exit pupil is equal to the diameter of the objective divided by the magnification, the exit

The inspector's stamp appears on the name plate.

1A7. Principles of modern periscopes. Everyone has looked through the wrong end of a telescope, that is, an inverted telescope, and viewed a normal scene much reduced in apparent size. This apparent reduction takes place because the inverted telescope takes a wide angle of vision and reduces it into a narrower one in the eyepiece. This principle is employed in periscopes. Essentially, a periscope consists of a vertical tube with a head prism inclined to the horizon at an angle of 45 degrees, a reducing telescope, and, at the bottom of the tube, an enlarging telescope and a lower prism facing the head prism and parallel to and below it. The objectives of the two telescopes face each other.

Suppose that a periscope is to be constructed with a field of 40 degrees. If, at the upper end of the tube, a telescope is installed with a reduction of 20x, or 1/20, the field angle is narrowed by lenses to 2 degrees. This field angle passes through a 5-inch tube for a distance of 12 feet. Now, if at the lower end a magnifying telescope of 20x is installed, the lenses of this telescope take the field angle of 2 degrees and expand it to 40 degrees.

If astronomical telescopes are used, the upper telescope inverts the image and the lower telescope reinverts it, so that the image appears erect to the observer. The distance between pupil is reduced if the magnification is increased.

1A8. Limits of periscope design. It is seen from the preceding section that there are definite limits in periscope design. The vital factors, as in a telescope, are: 1) length of tube, 2) diameter, 3) illumination, 4)magnification, and 5) size of field. If a periscope favoring any one of these factors is to be produced, such favoring can be only at the expense of the other factors; hence, the final design generally is a compromise.

1A9. Examples of periscope design. The following requirements are for periscopes which have been used in submarines: field, at least 40 degrees to 45 degrees; magnification, between 1.2x and 1.5x; exit pupil, at least 5 millimeters in diameter; length, not specified; external diameter, 5 inches; thickness of walls, about 1/4 inch. Let us find possible periscope lengths under these conditions for the two magnifications given, 1.2x and 1.5x. The inside diameter of the tube is 5 inches minus 1/2 inch, or 4 1/2 inches. The lens, lens-holding ring, supporting tube, and so forth take up another 1/2 inch of diameter, leaving about 4 inches free for the objective.

4 inches = 101.6 mm, which is close to 100 mm

In order to obtain an exit pupil of 5 millimeters, the magnification of the telescope must be:

Diameter of objective / Diameter of exit pupil =
100 / 5 = 20x

the objectives, about 12 feet, plus the lengths of the

3

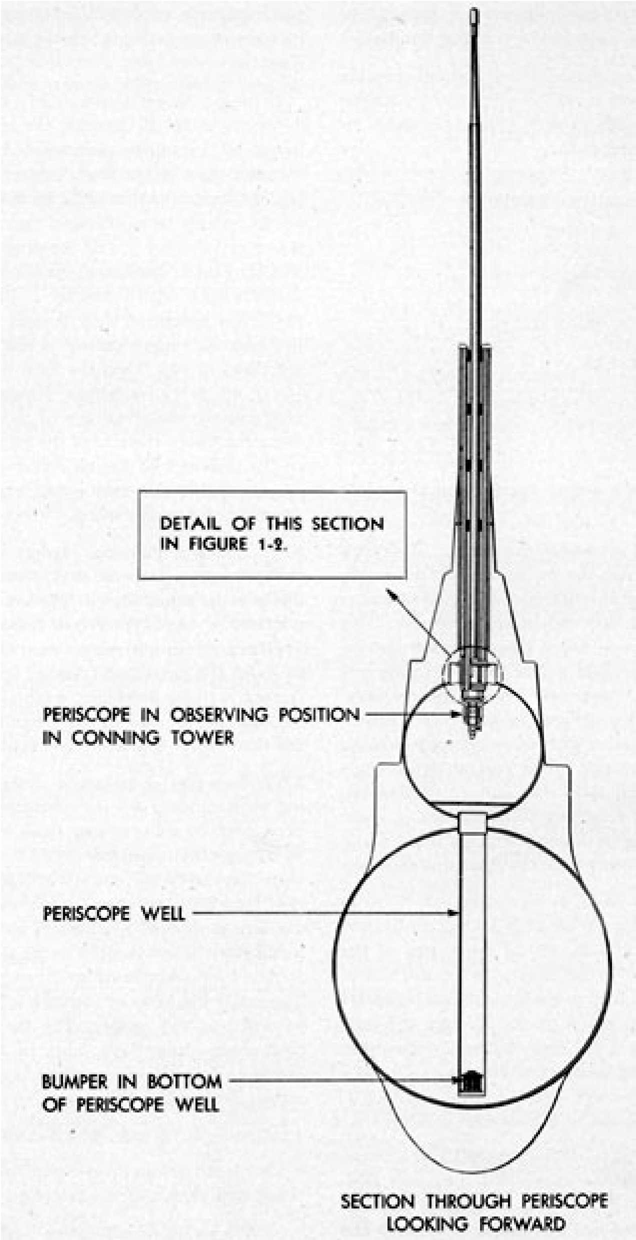

Figure 1-1. Section through submarine with periscope elevated.

4

If the magnification of the final periscope is to be 1.2x, the reduction of the upper telescope must be:

20 / 1.2 = 16.67, or 16.67x

Since the field must be 40 degrees / 16.67, or 2.4 degrees = 2 degrees 24', this limits the diameter of the lower objective lens in inches and θ is half the angle of beam. θ equals 2 degrees 24' / 2, or 1 degrees 12'.

log 2 = 10.30103 - 10

log tan 1 degree 12' = (8.32112 / 1.97991) - 10

length between the objectives of the two telescopes, since the entire beam of light must fall on the lower objective.

From Figure 1-3, it can be seen that the permissible length equals 2 / tan θ, where 2 is half the

antilog 1.97991 = 95.58 inches = 7 feet 11 1/2 inches

The upper and lower telescope systems enter into the total length, and if it were possible to increase the focal length of their objective lenses

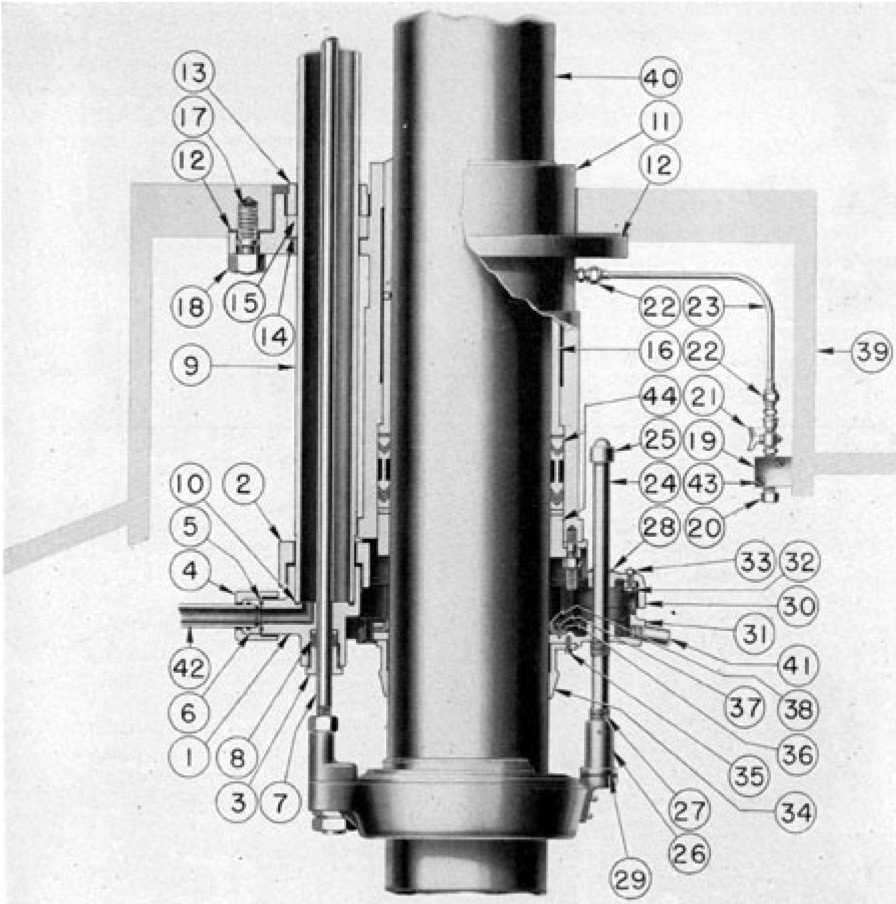

Figure 1-2. Detail of encircled section in Figure 1-1.

indefinitely, the periscope could be lengthened. Increasing this is limited, however, by the same considerations of diameter and cannot exceed the same length; that is, about 7 feet 11 1/2 inches for each telescope system. Hence, the total possible length is roughly 3 times 7 feet 11 1/2 inches, or about 23 feet 10 1/2 inches. Since this length is greater than is required, the diameter of the periscope may be reduced, the magnification

The total length possible is 3 times 6 feet 4.4 inches, or 19 feet 1.2 inches.

To increase the length of tube beyond these limits, more telescopes may be placed in the tube. If astronomical telescopes are used, two more must be employed to keep the image erect, making a total of four telescope systems. One Galilean telescope could be used. The objection to adding more telescopes lies in the

increased, or the size of the exit pupil increased without sacrifice.

If the magnification is to be 1.5x, the reduction of the upper telescope must be:

20 / 1.5 = 13 1/3x

For a field of 40 degrees, the angle of beam is:

40 / 13 1/3 = 30 degrees

The inter-objective distance is:

log 2 = 10.30103 - 10

log tan 1 degrees 30' = (8.41807 / 1.88296) - 10

antilog 1.88296 = 76.37 inches = 6 feet 4.4 inches

fact that each lens through which the beam must pass absorbs light, and if more are added, the illumination is seriously reduced.

Figure 1-4 shows a periscope designed as a straight instrument, and Figure 1-5 shows it with prisms introduced. The prisms may be placed at any point where the angle of the rays does not exceed the critical angle which results in total reflection. In this particular case, the prisms are placed at the focal planes. Both periscopes produce an erect image, since the two astronomical telescopes and the two prisms counteract each other in inverting the object. Prisms should not be placed exactly in a focal plane. Doing so is faulty design, since any minute imperfections

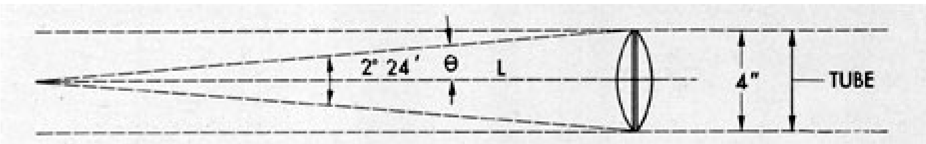

Figure 1-3. Example of periscope design.

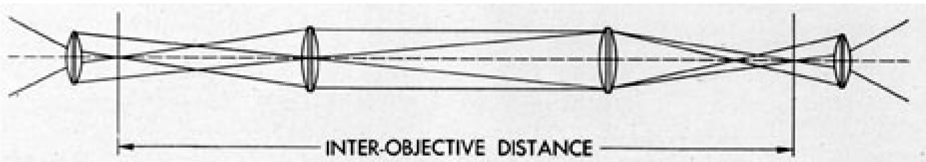

Figure 1-4. Example of periscope design.

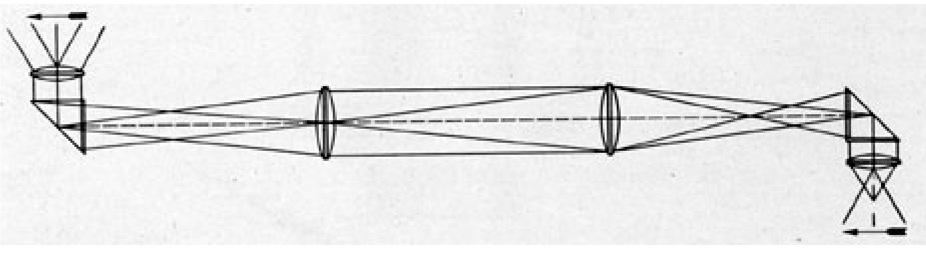

Figure 1-5. Example of periscope design.

that may be present in or on the reflecting surface are reproduced as part of the final image, whereas a lens or glass plate which is not in a focal plane, or near one, may be dirty without

is the Type II design (Design Designations 89KA40T/1.414HA, 91KA40T/1.414HA, and 92KA40T/1.4HA built by the Kollmorgen Optical Corp., Brooklyn, N.Y., which is of the

affecting the resulting image. Periscope specifications often state that no lens or glass plate should be in or near a focal plane except the crosswire reticle, which must of necessity be placed in a focal plane.

Since the backs of the prisms, which are the reflecting surfaces, are silvered, the critical angle for reflection is raised to more than 20 degrees; thus the two eyepieces may be placed between the prisms and the objectives. Both forms of construction are used in various periscopes. However, the best position for a prism is at a point at which the rays are approximately parallel; in erecting telescopes, this point lies between the two erecting lenses.

The chief function of a telescope system in a periscope is to take an object appearing from the point of vision under narrow angular view, and produce it to the eye at a wide angle. The ratio of these two angles is the magnification of the telescope.

1A10. Altiscopes. The only difference between a periscope and an altiscope is that in an altiscope the upper prism is omitted and the view is directly upward toward the zenith. The field of an altiscope is 100 degrees. To obtain this field, some sacrifice must be made in other characteristics. The magnification is necessarily less than unity.

The only type of periscope used in the Navy today which permits observation of the zenith high-angle type. The prism has a maximum elevation of the line of sight above horizontal of 74.5 degrees. The entire sky is observed with the line of sight set respectively at 14 degrees, 44 degrees, and 74.5 degrees or full elevation, giving complete zenith at the edge of the field in low power. The periscope is rotated 360 degrees in each zone with a minimum of overlap between the zones.

1A11. Types of periscopes. Periscopes under Bureau of Ships Specifications R20 P5 of 15 June 1940, are of the following types:

1. Type I. Outer diameter of taper section, 1.414 inches. The line of sight can be moved through all angles between 10 degrees depression and 45 degrees elevation.

2. Type II. Outer diameter of taper section, 1.414 inches. The line of sight can be moved through all angles between 10 degrees depression and 74 degrees elevation.

3. Type III. Outer diameter of taper section, 1.99 inches. The line of sight can be moved through all angles between 10 degrees depression and 45 degrees elevation.

4. Type IV. Outer diameter of taper section, 3.750 inches. The line of sight can be moved through all angles between 10 degrees depression and 45 degrees elevation. The periscope is designed for night use with an installed antenna array and waveguide for the attachment of an electronic range device.

B. MATERIALS AND WORKMANSHIP

1B1. General description. a. The materials and workmanship of both mechanical and optical features of Navy periscopes are the best throughout. Particular attention is devoted to the accuracy, durability, ruggedness, especially as regards ability to withstand excessive vibration, and finish of the periscope and of each of its component parts. In deciding whether to reject flawed, improperly or inaccurately finished, or otherwise defective optical parts in which the flaws or defects are of such nature that they do not offer any possibility of more than very slightly reducing optical efficiency and durability of the instrument, the state of advancement of the manufacturing of optical parts at the time the parts in question were manufactured is taken into consideration. However, the final decision always rests with the Navy Department.

b. Metals used in the construction of periscopes, except where otherwise specified, are brass, bronze, nickel-copper alloy, or corrosion-resisting steel. The balls of the hoisting yoke are made of stainless or corrosion-resisting steel. Carbon steel may be used for ball-bearing races and balls, springs, and small parts which must be

hardened. Carbon steel is not used for parts exposed to salt water. Carbon steel parts external to the sealed portion of the periscope are cadmium plated. Aluminum or aluminum alloys are used only in parts where lightness is essential, provided such parts are within the sealed portion of the periscope, and specific approval has been given by the Bureau of Ships.

c. The highest standards of mechanical construction are required, especially with respect to the hermetical tightness of the instrument and the arrangements for rangefinding, changing the magnification, operating the altiscope attachment, and focusing. Sharp work. A part that shows signs of porosity on this test is rejected, unless, after effective steps have been taken by brazing, peening, and tinning or other means to remedy permanently the porous condition, and after the defective part has passed a successful internal pressure test, the acceptance of such part is specifically authorized by the Navy Department.

c. Cracking of metal under stress. In the selection of the material and method of manufacture of the various parts of the external casing, due regard is given to the danger of the development of porosity as a result of minute cracks that may occur in the metal when it is subjected to the stresses

corners or points which might be sources of chips or metal shavings during assembly and adjustment, or from vibration of the periscope, are avoided.

d. The construction of the periscope is such that the optics and internal mechanism may be easily disassembled and correctly reassembled, and the hermetical tightness of the instrument may be maintained.

1B2. General requirements for periscopes. When delivered to the Government, periscopes are completely assembled, including all parts and fittings. By means of the tests described below and by such other tests as the Government representative may require or conduct during the manufacture and after completion of the periscope, it must be demonstrated that the periscope meets the provisions of the specifications set up for its manufacture. The following requirements apply to all types of periscopes:

a. Hermetical tightness. The complete optics of the periscope, except rayfilters, are contained in a hermetically sealed tubular casing. Only the first surface of the head window and the last surface of the eyepiece window used in the optical system, are external to the hermetically sealed easing. The external casing is, in so far as possible, capable of withstanding without leakage the shocks, vibrations, and bending to which the instrument is subjected in service.

and vibrations encountered in service.

d. Joints in the external casing. All joints, in the external casing for the passage of moving parts, such as the operating gear for the power shift, altiscope, and focusing mechanism, are located below the hoisting yoke. All joints in the external casing which must be broken for overhaul, cleaning, or renewal of the optics or internal mechanism of the periscope, or for drying out the periscope, are located below the hoisting yoke, except in the Type I and Type II periscopes where one such joint is permitted at the upper end of the taper section.

1. The joints between the main body tube and the eyepiece box casting and taper section, and the joint between the taper section and head section are in accordance with Bureau of Ships Plans Nos. 306508 and 318815. Special provision is made in the case of screwed joints or joints held by screws to insure that the joint is not loosened by continued vibration. Setscrews and tap bolts, with lock washers or other locks, are used as necessary for this purpose. In installing such setscrews or tap bolts, special care must be taken not to drill entirely through the wall of the external casing of the periscope.

2. If it is necessary to drill screw holes completely through the wall of the external casing, the screws used in such holes are fitted with the utmost accuracy and, when practicable, are tinned and sweated in place. The threads of such screws engage only in threads in the wall of the external

b. Tests of castings. The external casing and all castings forming part of the hermetically sealed portion of the periscope are given an internal air pressure test. When practicable, each casting is subjected separately to an internal air pressure test after the completion of all machine casing. However, this construction is avoided if possible. No holes are drilled through the main body tube or taper section.

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3. Permanent joints which are not broken for overhaul, cleaning, or renewal of the optics or internal mechanism of the periscope are screwed joints. Before setting up, the screw threads are coated with a mixture of litharge and glycerin. Screwed joints are designed to provide an external shoulder about 0.20 inch in width. Such a shoulder requires a true and smooth finish. Gaskets for permanent joints are usually of soft annealed copper 1/32 inch thick. At the joint between the lower end of the main body tube and the eyepiece box, there is a triangular annular ridge on the shoulder 1/64 inch in height and approximately 1/16 inch in width at the base. The angles, including the apex, of this ridge are filleted. There is a corresponding triangular annular groove in the other face of the joint. In addition to the threaded part of the overlap of the permanent screwed joint between the main body tube and the taper section of the external casing, there is an unthreaded overlapping part. The latter part is located farther from the external seam of the joint than the threaded part, and the exterior surface of the inner overlapping part and the interior taper section, in which the width of the shoulder and the gasket width may be less than 3/16 inch, and the faces of the joint may be normal to the axis instead of finished with triangular grooves. The use of any such joint is subject to the specific approval of the Bureau of Ships.

5. Cover plates and retaining rings of joints secured by screws are of such thickness and the screw spacing is sufficiently close to guard effectively against any possibility of lack of tightness of the joint caused by springing of the metal between securing screws. However, screwed cover plates and retaining rings are preferred to cover plates and retaining rings secured by screws, especially in the case of joints which must be broken for overhaul, cleaning, and removal of the optics and internal mechanism of the periscope.

6. In the case of each joint which must be broken for overhaul, cleaning, or renewal of the optics or internal mechanism of a periscope, provision as far as practicable is made to enable the joint to be broken without undue difficulty. To prevent seepage of water between the threads of

surface of the outer overlapping part are finish machined or bored to give the closest and tightest practicable fit. When practicable, these surfaces are slightly conical. This part of the joint is tinned and sweated, or coated with litharge and glycerin.

4. Joints which must be broken for overhaul, cleaning, or renewal of the optics or internal mechanism of the periscope are either screwed joints provided with a shoulder that seats against a gasket, or are secured by flush, fillister head screws of a noncorrosive material. The width of the shoulder of such a joint is at least 3/16 inch. Rubber gaskets of suitable thickness and at least 3/16 inch in width are inserted in all such joints. A triangular annular ridge is provided on one face of each such joint, and a corresponding triangular annular groove is provided in the opposite face of the joint. The faces of each such joint have a smooth and true finish, and a ground or scraped fit is preferred. In Type I and Type II periscopes, an exception to the foregoing may be made for one such joint at the upper end of the screwed joints of this character, the hermetically tight part of the joint is, when practicable, external to the threaded part. Special provision is made to guard against freezing of the threads of a screwed joint, resulting from corrosion of the metal caused by the seepage of salt water between the threaded parts of the joint. To provide for the easy removal of screwed cover plates, a hexagonal base is provided when practicable. This base conforms to the size of a United States standard hexagonal nut.

7. Joints in the eyepiece box casting of a periscope for the passage of moving parts, such as the operating gear for the power shift, altiscope, or focusing mechanism, are made in the form of stuffing boxes. Only motion of revolution is transmitted through a joint in the external casing.

8. Packed joints in the external casing of a periscope are thoroughly worked in before making the internal 150-pound test that must be made after assembly of the instrument. No further adjustments of these stuffing boxes are made after the successful completion of this test.

2
SERVICING OF PERISCOPES

A. DRYING

2A1. Gas drying. Suitable and adequate provision is made for drying out the interior of the periscope by circulation of dry nitrogen through the instrument. The drying gas enters the periscope through a drying inlet plug in the lower part of the eyepiece box casting, and exhausts from the periscope through a similarly located drying outlet plug.

2A2. Insuring circulation. To insure the complete circulation of the drying gas throughout the instrument, an internal circulating pipe is led to the lower end of a reduced tube section and, if practicable, to the extreme top of the instrument. Circulation of gas is upward through this pipe, which discharges upward, and then downward through the optical tube or tubes and the space between the optical tube or tubes and the external casing of the periscope. If the optical tube is made practically airtight, the circulation of gas is upward through the interior of the optical tube, discharging upward against the head window, then downward through the space between the optical tube or tubes and the external casing. A combination of these two methods may be used. at the most rapid rate permitted by the valve in the drying inlet plug when the drying gas in the external connection to the plug is under a pressure of 100 pounds per square inch (psi).

2A3. Circulation arrangements. Special care is taken in making arrangements for causing circulation of the drying gas to prevent undue difficulties and complications in the method of assembling and disassembling the periscope, and for cleaning, overhauling, renewing, and adjusting the optics and internal mechanisms.

2A4. Inlet and outlet plugs. A drying inlet plug and a drying outlet plug are located in the eyepiece box casting below the hoisting yoke. No other drying inlet or outlet plugs are provided. The preferred location of these plugs is on the side of the tube approximately diametrically opposite the eyepiece. These plugs are as specified in Bureau of Ships Plan No. 549601, Standard drying plug. A suitable lead washer is installed between each plug and its seat. The word inlet or outlet, as appropriate, is legibly stamped or cut in the external casing of the periscope in the immediate vicinity of each drying plug.

In cases in which the circulation of gas in the interior of the optical tube and between the optical tube and the external casing are in the same direction, suitably placed and fitted diaphragms or bearing collars are provided between the optical tube and the external casing at such points and in such manner that the drying gas is forced to circulate through the space between each successive pair of optical surfaces. Provisions are made to insure that there are no dead pockets in the interior of the instrument through which, the drying gas is not forced to circulate.

Diaphragms installed to produce circulation of drying gas are secured in the manner specified for securing bearing collars. The openings which permit circulation of the drying gas through each closed space in the interior of the periscope are of such dimensions that there is no danger of collapse of the optics, or structure forming the closed space, because of the admission of the drying gas

2A5. Drying gas. Nitrogen gas in accordance with Navy Department Specifications 51N3b dated 1 November 1941 (abstracted below), is used as the drying gas. Special care is taken to insure that the nitrogen used is free from moisture and from dust or other foreign matter.

Abstract from Navy Department Specifications 51N3b, 1 November 1941, Superseding 51N3a, 2 January 1929; Nitrogen For Use In Optical Instruments; and Cylinders Therefor:

1. a) Applicable specifications:

A-1. The following Navy Department specifications, of the issue in effect on date of invitation for bids, form a part of this specification, and bidders and contractors should provide themselves with the necessary copies:

General Specifications for Inspection of Material 51C31, - Cylinders, Compressed-Gas, ICC3A

Type (for pressures not exceeding 1,800 pounds per square inch).

2. b) Grade:

B-1 Nitrogen covered by this specification shall be of but one grade.

3. d) General requirements:

D-1. See Section E.

14 threads to the inch and the threaded portion shall be at least 5/8 inch long. The thread diameters shall be in accordance with original specification.

E-5. Cylinders furnished by the contractor or supplied by the Government shall be rated at 1,800 pounds normal pressure, and at this pressure shall contain approximately 184 cubic feet of gas at atmospheric pressure.

4. e) Detail requirements:

E-1. The nitrogen shall be at least 99.5 percent pure and free from acid, dust, and objectional impurities.

E-2. Cylinders: Nitrogen shall be shipped in cylinders which, unless otherwise specified in the contract or order will be furnished by the Government, and which will conform to Navy Department Specification 51C31, listed in Section A.

E-3. Marking: The cylinders charged with nitrogen shall be painted around the neck with two light gray bands, 3 inches wide, separated by a black band 2 inches wide. The remainder of the body of the cylinder shall be painted black. In addition, each cylinder shall be stencilled on the painted band with the notation Special for use in optical instruments. Painted bands and stencilled notation shall be clear and distinct at time of delivery.

E-4. When Government-owned cylinders are not furnished, the contractor shall furnish cylinders conforming to the latest issue of Interstate Commerce Commission Specification 3-A. The valve outlet shall be male and threaded with national form left-hand threads. There shall be

5. f) Methods of sampling, inspection, and tests:

F-1. Volume: A test shall be conducted on each cylinder to determine its volumetric contents as indicated by the pressure of the gas. Each cylinder shall contain not more than 5 percent by volume, in excess of the volume required by the contract or order. The entire volume required by the contract or order shall be considered as the cumulative volume of all cylinders required by the contract or order. Cylinders shall be at normal volume at 1,800 pounds at 70 degrees F, and a lesser volume shall be considered cause for rejection of the cylinders. Compensation for pressure shall be made as provided by Table I (not reproduced here).

F-2. Purity of gas: The gas from one cylinder shall be tested for compliance with the requirements of paragraph E-1.

F-3. Dewpoint: A dewpoint test of bottled nitrogen was taken in the New London Optical Shop. This test showed a dewpoint of -56 degrees centigrade. However, this does not hold true of every bottle, as there may be variance, either plus or minus.

B. FOGGING

2B1. Importance of watertightness. When periscopes are assembled at the factory, the greatest care is used to make sure that the contained nitrogen-air mixture is absolutely free of moisture. A periscope, deposited on them, and the field becomes clouded or completely obscured. If this should occur, the only remedy is to dry the contained nitrogen-air mixture.

when new, is charged with dry nitrogen-air mixture at a pressure of 7 1/2 psi and -50 degrees C to -69 degrees C dewpoint. Since the optical qualities of most of the periscopes presently in use are excellent, there is usually no reason for opening the periscope unless water enters.

If a periscope is reassembled with moisture in the contained nitrogen-air mixture, no trouble is experienced until the next submerged run. Sea water then cools the tube and optics, moisture is

The most frequent cause of periscope failure in normal service is fogging of the optics resulting from internal moisture. Internal moisture is caused chiefly by leakage of gas past the packing glands of the operating shafts, accompanied by the breathing action of the periscope during temperature changes.

2B2. Kinds of fogging. Fogging of periscopes is caused by condensation of water vapor on the

optics. There are two types of fogging, external and internal. External fogging is temporary, and can be readily identified and easily eliminated. Internal fogging is of a more serious nature and its elimination requires skilled techniques and special equipment.

2B3. External fogging. External fogging can take place on the outside of the eyepiece window or on the outside of the head window whenever the temperature of the glass is below the dewpoint of the air to which it is exposed. Temporary fogging of the outside of the eyepiece window may occur as a result of moisture in the observer's breath, or when the periscope is first raised after being housed in the cold periscope well over a long period of time when the air in the submarine is particularly humid. The condensation that forms on the outside of the

only by personnel who are skilled in the maintenance and care of submarine periscopes, and who are sufficiently familiar with each step of the correct procedure. It can be performed with the periscope installed in the submarine; however, when the temperature is under 50 degrees F it is preferable that it be done ashore or on a tender, to take advantage of higher temperature, and to maintain the safety factor. Using a vacuum pump, an absolute pressure of 4 mm-of-mercury is attained, thereby removing any significant amount of water present in the instrument. The instrument is then filled with nitrogen that has been passed through a silica-gel dryer and cotton filter, or through a cold trap of acetone-CO_2 mixture.

As a preliminary step, the periscope should first be tested for tightness with nitrogen under pressure. This obviates the

eyepiece under these conditions can be wiped off with lens paper. Continuation of this fogging ceases as the instrument becomes warmer.

External fogging of the outside of the head window rarely occurs, but is possible when the temperature of the sea water is appreciably lower than the dewpoint of the outside air. This kind of fogging can be recognized by the fact that when the periscope is first raised clear of the water and the outside surface of the window is still wet, there is no apparent fog, but as the surface dries, condensation slowly appears. This condensation can be rapidly eliminated by occasionally lowering the periscope and wetting the window.

2B4. Internal fogging. Internal fogging is caused by the presence, within the periscope, of water vapor which condenses on one or more optical surfaces whenever the temperature of the optics falls below the dewpoint. Obviously, the most practical remedy for this condition is to reduce the amount of water vapor to a point where condensation cannot take place at the temperatures likely to be met by the periscope in service. This can be accomplished by evacuating the assembled periscope to a low absolute pressure and then recharging it with dry nitrogen.

2B5. Elimination of internal fogging. A new method of servicing periscopes to eliminate internal fogging has been tested and is recommended for extremely difficult task of locating leaks while the periscope is under vacuum. The periscope is filled slowly, taking 2 hours to build up a pressure of 100 psi gage. Strong gas currents in the periscope should be avoided at all times to prevent the deposit of dust on the optical surfaces; too rapid building up of pressure may derange the optical system. After the pressure has been built up, the instrument is thoroughly checked with soap for leaks. When it has been made tight, the pressure is slowly released over another 2-hour period.

Before evacuating the periscope, the pump should be checked by attaching a mercury manometer to the suction side. The manometer reads in millimeters. It does not begin to register until a vacuum of 29 inches is reached. If the pump is operating properly, it pulls a flat vacuum, that is, the height of the mercury in both legs of the manometer becomes equalized. Care must be taken to keep the pump level to prevent loss of oil from the exhaust port.

Connections are made for evacuating as illustrated in Figures 2-1 and 2-2. All leads should be kept as short as possible. A sealing compound should be used to insure tight joints at the periscope air inlet and outlet valves and at other connections in the evacuating system. It may also be necessary to seal over the inlet and outlet air-valve screws. Sealing compound should not be used on any other part of the instrument.

adoption by periscope overhauling activities. It should, if possible, be undertaken

The periscope is then evacuated until a vacuum of preferably 2 mm absolute (and in no case more than 4 mm) is attained. The time required to reach this pressure is usually from three to six hours, depending on the amount of moisture present. When this pressure has been attained, the air outlet valve is closed and the pump secured. The vacuum is then held for three hours as a check on the tightness of the periscope and the removal of all water vapor. If a slight rise in pressure occurs, it will be caused by residual moisture and further pumping will be required.

The periscope is now ready for filling with nitrogen. The nitrogen bottle is connected to the instrument through a silica-gel dryer and filter,

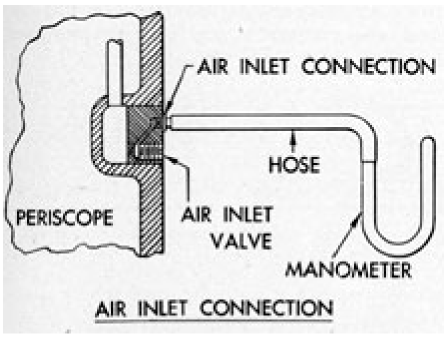

Figure 2-1. Cross-sectional view of air inlet valve body.

or cold trap of acetone-CO_2 mixture. A small amount of nitrogen should be bled to the atmosphere before making final connection at the periscope air inlet to remove any water vapor

servicing. The color test should not be used to determine the dryness of silica-gel. Reactivating can be accomplished by heating in a covered kettle or pan to a temperature of 480 degrees to 500 degrees F for 2 hours.

Where silica-gel is used, there is a possibility of introducing particles of the gel into the periscope and it is not possible to check the drying procedure by making a dewpoint test. For these reasons, the method of drying using the acetone-CO_2 (dry ice) mixture should be used wherever dry ice is available.

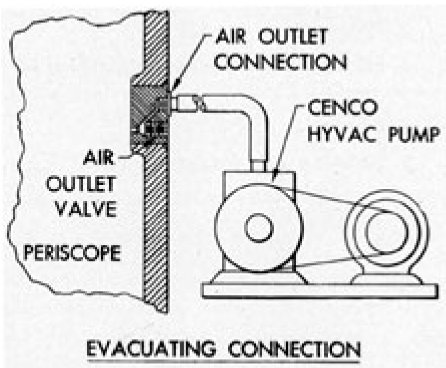

Figure 2-2. Cross-sectional view of air outlet valve body.

In making connections to the air inlet and air outlet valves on the periscope, the air-valve connection, supplied with the periscope tool and spare parts boxes is utilized.

The Bureau of Ships instructs the manufacturer of periscopes and the building yards to treat each new periscope by a process similar to that just described before installation in new submarines and

or dust in the line from the filter. The nitrogen is then slowly introduced, building the pressure up to 8 pounds. Nitrogen should not be taken from a bottle in which the pressure has fallen as low as 400 psi.

The Bureau of Ordnance Mark 3 Mod 0 Instrument Dryer, or the Bureau of Ships nitrogen dryer manufactured by the Navy Yard, Philadelphia, Pa., can be used for drying the nitrogen, provided they are modified. This equipment utilizes silica-gel. Tests have demonstrated that this material is satisfactory for periscope work, provided freshly reactivated gel is used for each to attach an appropriate tag to each instrument so treated. Under the following circumstances the Bureau requests that the forces afloat dry and recharge periscopes in service as just described and attach a tag to show date and pressure of recharging:

1. When the internal pressure of any periscope falls to 4 psi or less. If the pressure is found to be between 4 and 7 1/2 psi, it should be increased to 10 psi with nitrogen dried by a silica-gel dryer or by the cold trap method and bled down to 7 1/2 psi.

2. When a periscope is overhauled or disassembled.

3. When a periscope is reported to be fogging, if internal fogging is indicated.

C. INSTRUCTIONS FOR CYCLING

2C1. Cycling equipment. The following equipment is used in cycling (Figure 2-3).

1. Vacuum gage (Stokes-McLeod Flosdorf Mod. Manometer).

2. Vacuum gage fitting for inlet fitting.

3. Cenco Hyvac Pump.

4. Cenco Hyvac Pump outlet fitting.

5. Pressure gage, 0 to 150 psi.

6. Silica-gel dryer (Figure 2-17). (Note: Silica-gel should not be used where CO_2 is available.)

9. Apiezon soft wax.

10. Thermos jar of pyrex, 2 3/4 inches inside diameter, and 12 inches deep, properly insulated in a metal container having 1/2-inch cork insulation surrounding the flask, and a wax seal covering the joint between insulation and the flask.

11. Copper coil of 3/8-inch tubing, 15 feet long, coiled to 2 1/2 inches outside diameter and inserted in the flask.

11a. Wire screen.

12. Cuno air filter attached in the line between the nitrogen tank and the copper coil. (A filter using

7. Silica-gel.

8. Reducing valve for nitrogen flask.

a sintered bronze Porex disk may also be used.)

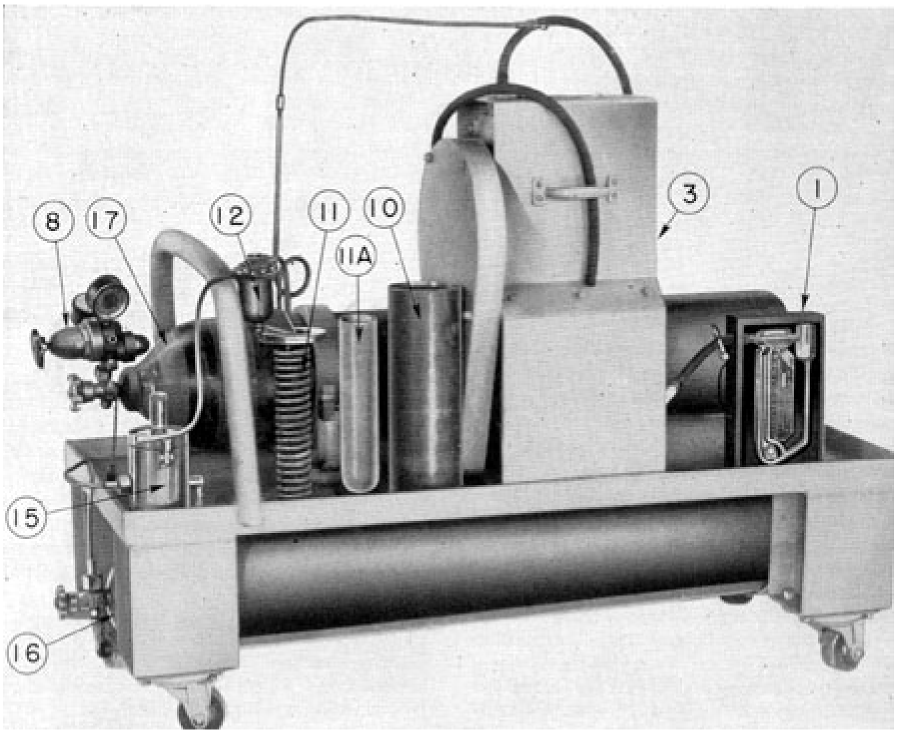

Figure 2-3. Cycling equipment.

13. 0.5 liter of liquid acetone, technical grade.

14. Three pounds of CO_2 to fill the flask.

15. Snow Man CO_2 machine.

16. CO_2 Supply (20 bottles).

17. Nitrogen bottle.

Note: In the cold trap method of drying, items 10, 11, 13, 14, 15, 16, and 17 are required and items 6 and 7 are not. If silica-gel drying is used, the reverse is true.

2C2. The Snow Man CO_2 machine. The Snow Man is a small, compact, automatic machine for producing solid carbon dioxide with a

7. As the volume of gas in the tank decreases, the time necessary to make additional cakes of dry ice increases.

2C3. Steps in cycling. Cycling a periscope should be accomplished as follows:

1. If the procedure is carried out on board a submarine, the periscope is first elevated from

temperature of 114 degrees F below zero. From one 50-pound bottle of CO_2 gas, the machine will make about ten 12-ounce solid CO_2 cakes. The machine is operated in the following manner:

1. Lay the bottle of CO_2 on its side and raise the bottom of the tank so that it is about 4 inches higher than the valve end. Connect one end of the copper tubing to the drum and the other to the valve on the side of the Snow Man, using the fiber washers attached to the machine.

2. Before turning on the gas, be sure that the cover of the Snow Man is clamped down tight, and the handle valve is closed. Then open the valve at the CO_2 bottle, and the machine is ready for operation.

3. Open the handle valve just slightly, until the gas is heard going into the machine. Hold this valve open for about 3 minutes or until the safety valve blows. When the safety valve blows, it indicates that the cavity is filled with dry ice. Close the handle valve and raise the cover. The cavity contains a cake of dry ice weighing 12 ounces.

4. Do not open the handle valve wide. Doing so only wastes gas, and does not form a solid cake of dry ice.

5. While the machine is in operation and a cake of dry ice is being formed, do not become alarmed at the escape of gas from the sides and bottom of the machine. This is the excess gas

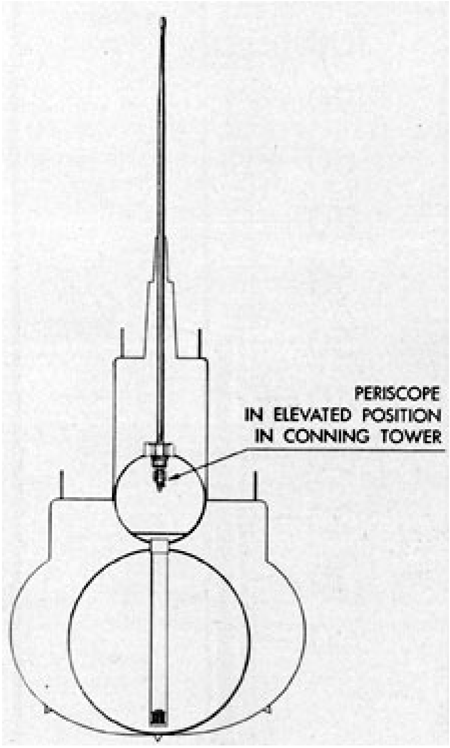

Figure 2-4. Periscope elevated.

the periscope well of the submarine to a height sufficient to give the repairman access to the air inlet and outlet connections (Figure 2-4).

2. In no case should the periscope be cycled at a temperature less than 50 degrees F as the partial pressure of the water vapor below this temperature is too low to insure complete drying (Figure 2-5). If the temperature is less than 50 degrees F, the periscope should be removed from the submarine and transported to a convenient building where

that escapes from the machine during and after the making of each cake of dry ice.

6. After making each cake, clean the opening leading to the safety valve.

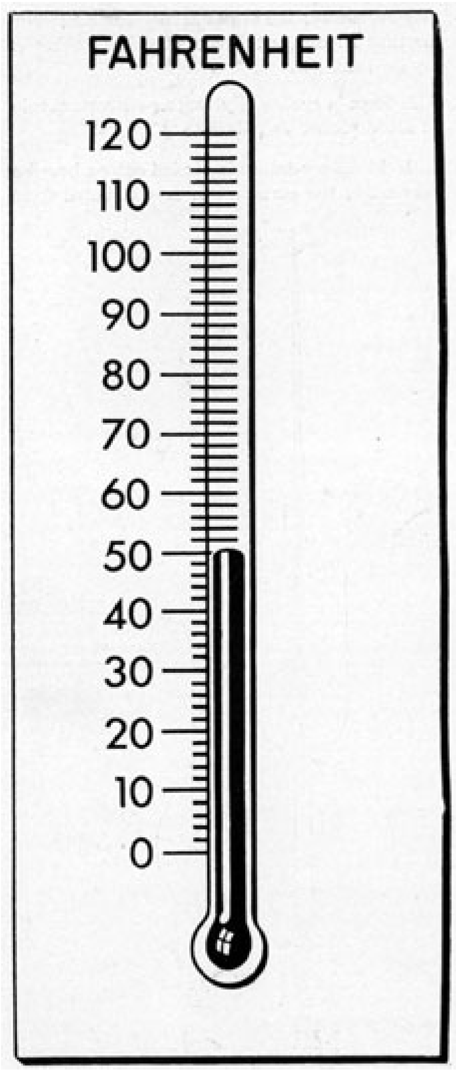

Figure 2-5. Safe cycling temperature.

cycling can be accomplished and where a temperature above 50 degrees is maintained.

3. Inspect the periscope by observing through it, checking first for external fogging on the head and eyepiece window (Figures 2-6, 2-7, 2-8).

Clean lens paper or a selvyt cloth should be used to wipe off any external fog.

4. Remove the OUTLET PLUG from the AIR OUTLET connection of the periscope (Figure 2-9).

5. On periscopes without a built-in pressure gage, place a 0 to 25 psi or 0 to 50 psi gage in this outlet connection (Figure 2-10).

6. Slowly open the AIR OUTLET valve. A pressure of 5 to 7 1/2 psi is normal, but one

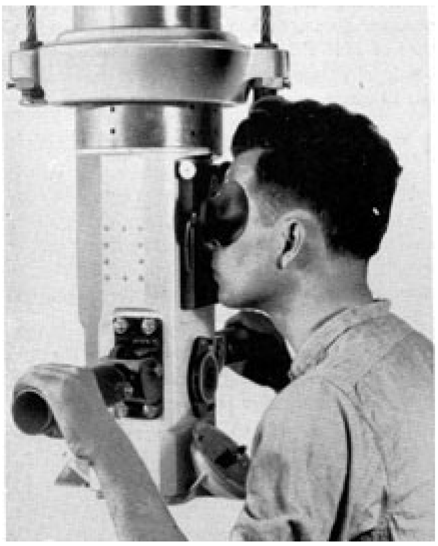

Figure 2-6. Observing through periscope.

between 2 and 5 psi indicates that the periscope should be recharged at the first opportunity. Pressure lower than 2 psi denotes a dangerous condition and may indicate that the periscope is breathing and hence likely to

become fogged internally without warning (Figure 2-11). Continued loss of pressure in the periscope, or the excessively free movement of any operating shaft in the eyepiece box, should be cause for an investigation into the tightness of the packing glands. When a periscope is cold, the observer's breath may cause temporary fogging of the outside of the eyepiece window. This condensation can be removed by opening the rayfilter housing

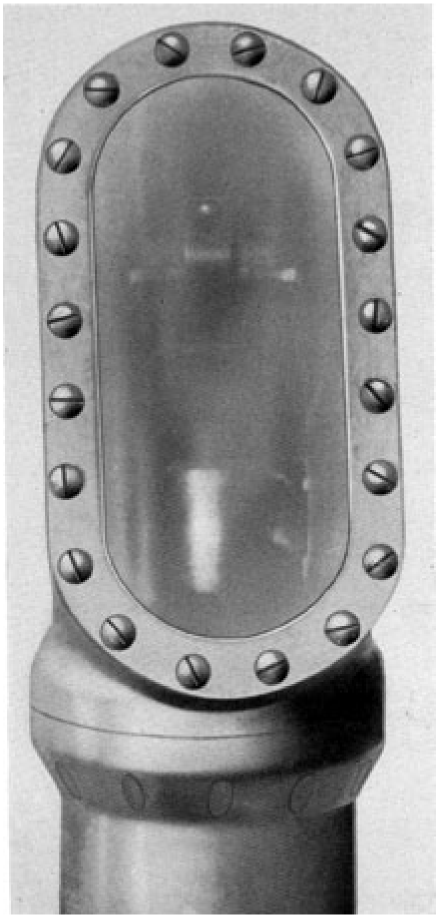

Figure 2-7. External fogging of head window.

and the condition ceases as the instrument becomes warmer.

7. Close the AIR OUTLET valve.

8. Remove the pressure gage from the outlet connection of

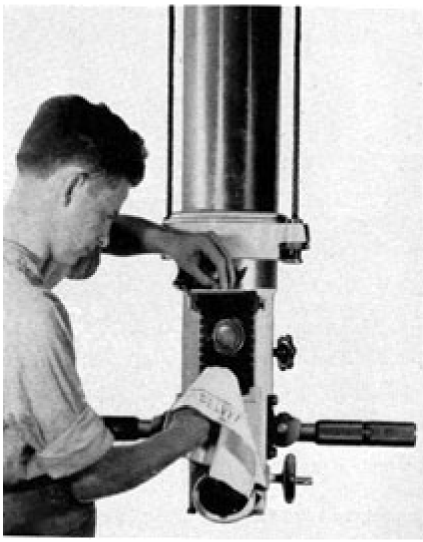

Figure 2-8. Wiping off external fog from eyepiece window.

and 8, Figures 4-24 and 6-8, respectively). The number 58 on the height scale dial (52) should appear approximately opposite the value 2.2 on the range scale dial (50, Figure 4-24). Opposite values of 58 and 2.2 are illustrated in Figure 2-12. In periscopes without the course angle, the number 15 on the height scale dial (13) should appear approximately opposite the value 220 on the range scale dial (14, Figure 6-8). This setting is shown in Figure 2-13. This will make possible

the periscope (on periscopes without a built-in pressure gage).

9. To remove the stadimeter housing assembly turn the stadimeter handwheel (12) to the observing position, as noted by the stamped numerals located on the stadimeter housing (67

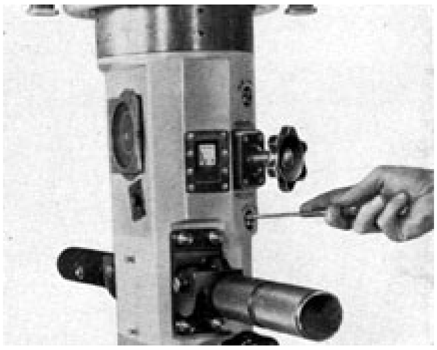

Figure 2-9. Removal of air outlet plug.

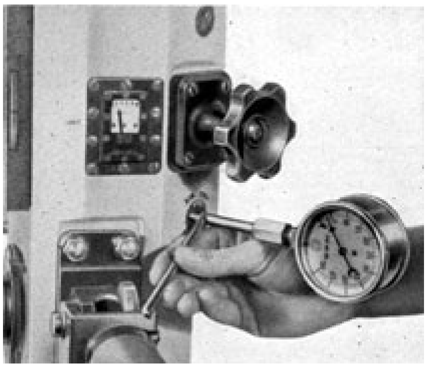

Figure 2-10. Insertion of 50 psi gage in outlet connection and opening outlet valve.

the rapid reassembly of the stadimeter housing assembly. Remove the four stadimeter housing bolts (30, Figure 4-24) and then takeoff the stadimeter housing assembly with care to avoid bending the stadimeter transmission shaft (22 and 12, Figures 4-27 and 6-10, respectively). An automatic stop prevents rotation of the stadimeter handwheel (12, Figure 4-24) when not in place.

10. If the periscope requires recycling, remove all the external projection fittings on the eyepiece box, such as the stadimeter housing, training handles, focusing knob, and rayfilter attachment. Access to the packing glands is thus given so that they may be tested for

Figure 2-12. Infinity setting of stadimeter dials of Type II periscope.

11. Release the internal gas pressure, if any, by opening the AIR OUTLET valve.

12. After the internal gas pressure is released, close the AIR OUTLET valve. 13. Remove the INLET PLUG from the AIR INLET connection (Figure 2-14).

14. Insert the hose fitting in the AIR INLET connection of the periscope. Steps 14 and 15 are illustrated in Figure 2-15.

leaks under a 100-psi nitrogen pressure. Testing is preferably done by immersion in water but an application of soapy water may be used.

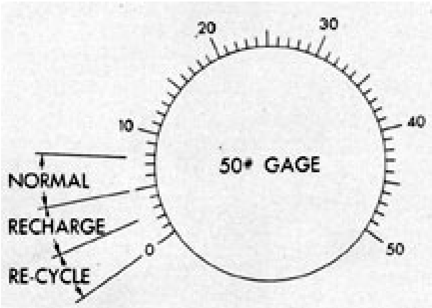

Figure 2-11. Internal nitrogen pressure ranges for servicing.

Figure 2-13. Infinity setting of stadimeter dials of Type III periscope.


Figure 2-14. Removal of air inlet plug.

15. Insert a 0 to 150 psi gage in the AIR OUTLET connection.

16. Open the AIR OUTLET valve (Figure 2-16).

17. The hose pressure from the reducing valve of the nitrogen bottle is reduced from high to low

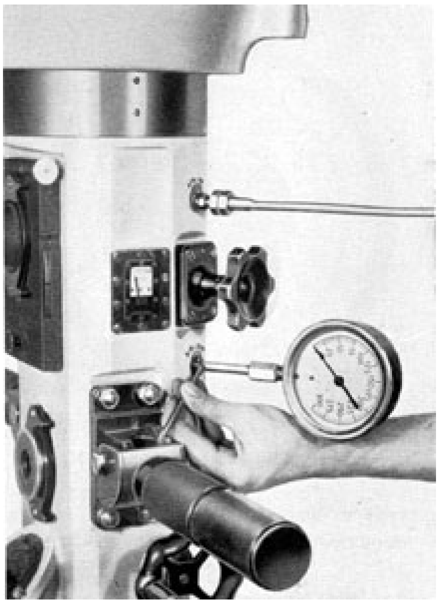
Figure 2-16. Opening the air outlet valve with an offset screwdriver.

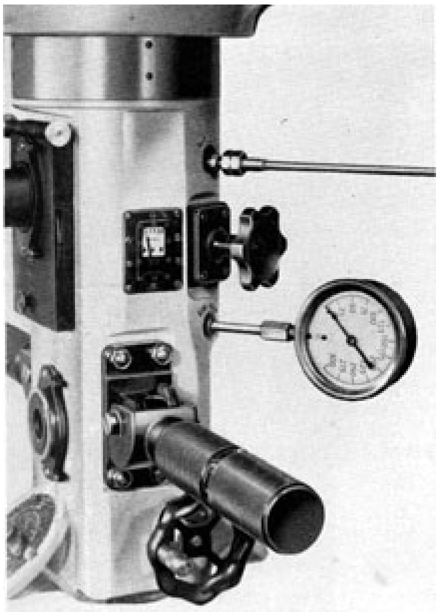

Figure 2-15. Insertion of nitrogen fitting in inlet connection and pressure gage In outlet connection. Figure 2-16. Opening the air outlet valve with an

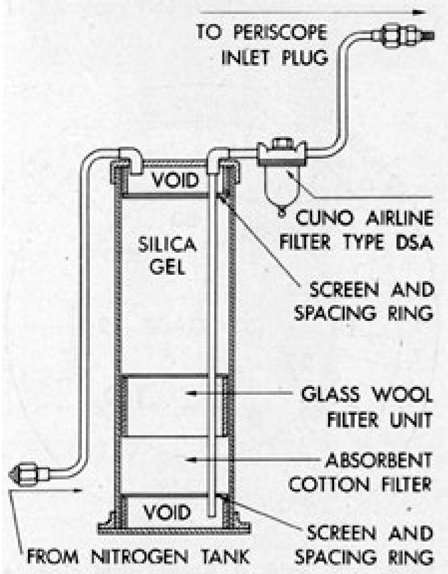

Figure 2-17. Silica-gel dryer.

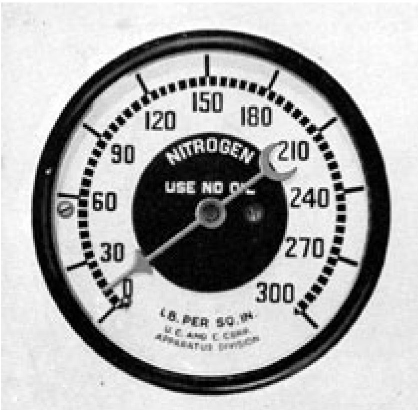

Figure 2-18. Nitrogen gage indicating 10 psi.

pressure so that in filling the periscope a low charging rate may be used.

18. Attach a silica-gel dryer and filter (Figure 2-17) or the cold trap acetone-CO_2 mixture (Figure 2-29) in the line connecting the reduced pressure nitrogen to the AIR INLET connection of the periscope.

19. Figure 2-17 shows a metal disk filter inserted in this line to pick up any dirt which may pass through the silica-gel dryer and filter.

20. Open the AIR INLET valve when the pressure on the charging line is 10 psi, as shown by the pressure gage (Figure 2-18).

21. Fill the periscope slowly, taking 2 hours to build up a pressure of 100 psi in a series of 4-pound steps (Figure 2-19), waiting about 5 minutes between steps. Strong gas currents in the periscope should be avoided at all times to prevent deposits of dust on the optical surfaces; too rapid building up of pressure may derange the optical system.

22. Close the AIR INLET valve when the pressure reaches 100 psi gage (Figure 2-20).

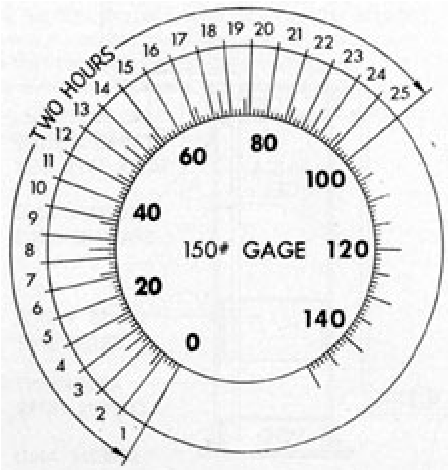

Figure 2-19. Series of 4-pound steps during a 2-hour period.

23. Close off the nitrogen pressure at the nitrogen bottle.

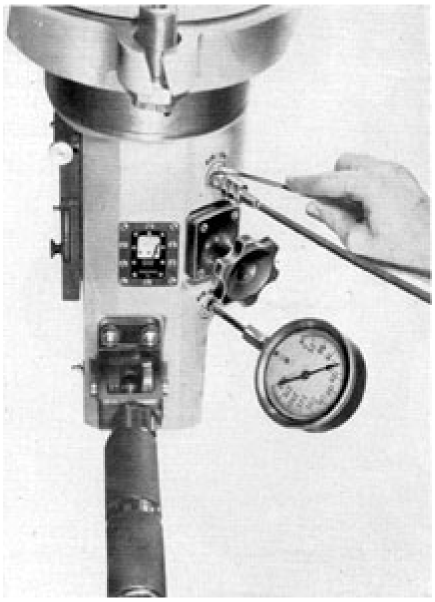

Figure 2-20. Closing air inlet valve.

24. Remove the charging line connection from the AIR INLET connection of the periscope.

25. Check the periscope thoroughly by means of soapy water (Figures 2-21, 2-22, 2-23, and 2-24), or preferably by immersion in water, and minutely examine it for leaks, particularly through the packing glands. All leaks must be eliminated; otherwise a high vacuum cannot be obtained. The renewal of packing, tightening of packing glands, and gaskets around the head and eyepiece windows must also be checked.

Figure 2-22. Pressure testing with soapy water.

Figure 2-21. Pressure testing outer head and head window with soapy water.

26. When the tightness of the periscope is insured, the pressure is slowly released over another 2-hour period.

27. Close the AIR INLET valve, and remove the pressure gage from the OUTLET connection.

28. Open the AIR OUTLET valve of the periscope to release the pressure as described in Step 26.

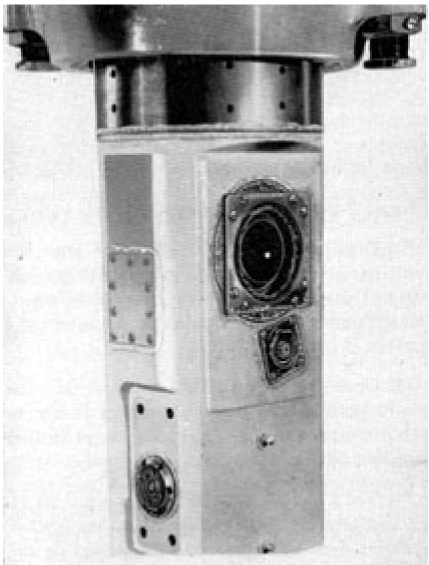

Figure 2-23. Pressure testing with soapy water.

29. When all gas pressure has been released, close the AIR OUTLET valve.

30. Connect the mercury manometer fitting to the AIR INLET connection (Figure 2-25).

31. Connect the evacuating fitting into the AIR OUTLET connection.

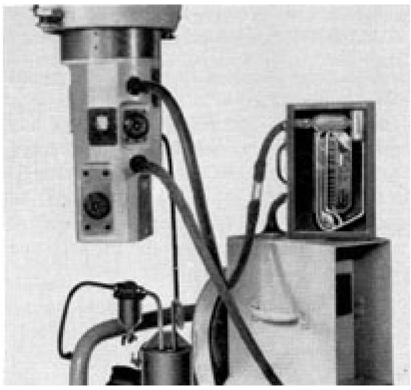

Figure 2-25. Mercury manometer fitting in air inlet connection and evacuating fitting in air outlet connection.

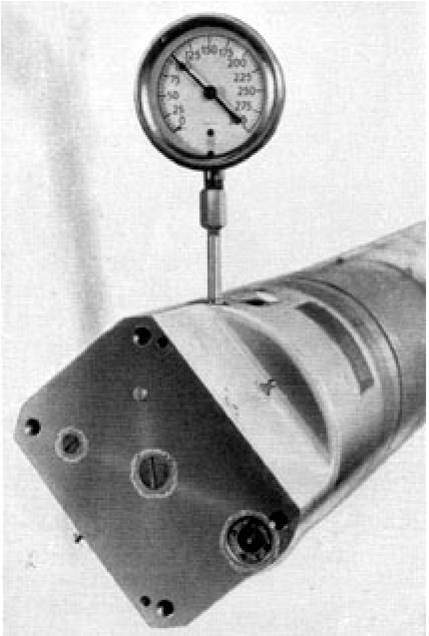

Figure 2-24. Pressure testing with soapy water.

32. Open the AIR OUTLET valve after the pump has been started, and proceed with evacuation of the periscope. All leads should be short, and with as few joints as possible, to reduce the number of possible leaks.

33. Open the AIR INLET valve so that the line to the mercury manometer gage is free to record the vacuum as the evacuating procedure is carried out.

34. The CENCO HYVAC pump must not be left unattended. If the pump should stop, oil or oil fumes may be sucked into the periscope and deposited on the optics, making necessary a major overhaul of the instrument. If the pump gives indication of stopping, the hose connection should be promptly kinked (Figure 2-26) and the AIR OUTLET valve closed.

35. Evacuate the periscope until the mercury manometer shows a reading of 4 mm or less (Figure 2-27).

36. When the vacuum has been attained, close the AIR OUTLET valve and secure the pump.

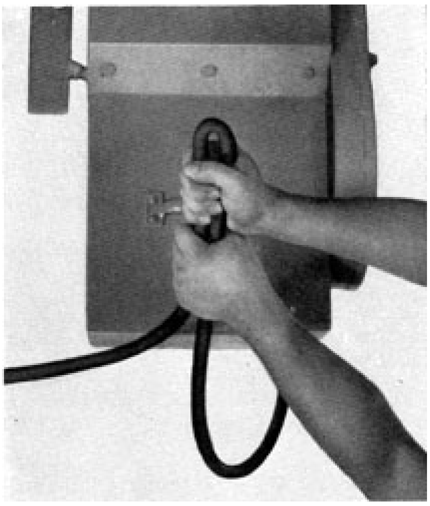

Figure 2-26. Kinking of evacuating hose.

7. Hold the vacuum for 3 hours as a check on the tightness of the periscope and the removal of all water vapor. If residual water is present, a slight rise in the line from the filter. (Navy Specified nitrogen has been tested at New London with the dewpoint testing equipment; readings of -56

pressure will occur and further pumping will be necessary.

38. Remove the evacuating connection from the AIR OUTLET connection.

39. Close the AIR INLET valve and remove the manometer from the AIR INLET connection.

40. The periscope is now ready for filling with nitrogen. Connect the nitrogen flask, or bottle, to the instrument through a silica-gel dryer and filter (Figure 2-17), or cold trap of acetone and dry ice (Figure 2-29). If the cold trap of acetone and dry ice is used, bleed off a small amount of nitrogen to the atmosphere before making final connection to the periscope AIR INLET connection. This removes any moisture or dust in

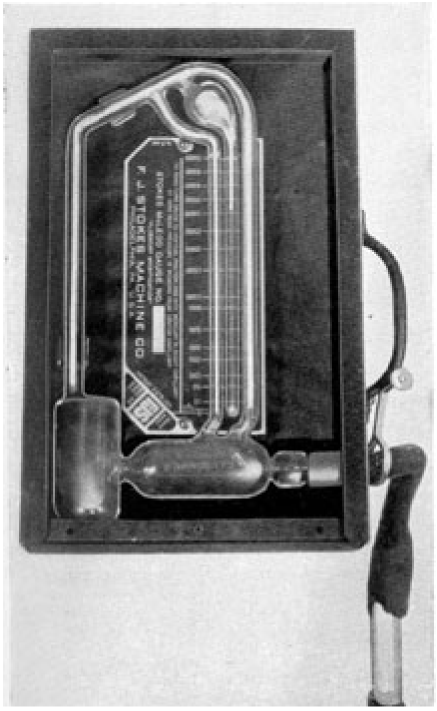

Figure 2-27. Mercury manometer reading less than 4 mm.

degrees C have been obtained direct from the nitrogen bottle.)

41. Insert the pressure gage in the AIR OUTLET connection.

42. Open the AIR OUTLET valve to allow free passage of gas to the pressure gage.

43. Connect the nitrogen hose fitting to the AIR INLET connection of the periscope.

44. Open the AIR INLET valve slowly, introducing nitrogen, and slowly build up the pressure to 10 psi.

45. Nitrogen should never be taken from a bottle in which the pressure has fallen to 400 psi (Figure 2-28). Moisture would thus be introduced in the periscope since all nitrogen contains some moisture.

46. Close the AIR INLET valve.

47. Secure the nitrogen pressure.

48. Disconnect the nitrogen INLET fitting from the AIR INLET connection,

49. Insert the INLET plug into the AIR INLET connection.

50. If acetone and dry ice are available, the following method is used for drying nitrogen:

a) Figure 2-29 shows the passage of nitrogen from the nitrogen bottle through a reducing valve into a metal disk filter and into the coil of copper tubing which is immersed in a bath of acetone and dry ice.

b) The dewpoint of the nitrogen passing through the bath is

lowered to a temperature of -69 degrees to -74 degrees C. The dewpoint of the nitrogen may be tested as it passes through the cold trap into the periscope, providing an outlet for this test is available.

c) Insert a filter made of metal disks between the nitrogen bottle and the dryer to prevent introduction of dirt, dust, scale, and lint into the periscope. A sintered bronze Porex filter may also be used.

d) In the cold trap, the acetone-CO_2 mixture serves to dry several periscopes if done consecutively. Additional dry ice may be added to keep

the temperature down. After several days, however, the acetone becomes polluted and should be distilled or thrown out, and a fresh mixture used.

51. The dewpoint test should now be made in accordance with the procedure described in Section 2C5. Upon completion of a satisfactory dewpoint test of -50 degrees C or lower, the periscope is bled down very slowly to 7 1/2 psi through the

soon as the temperature of the surface of the flask reaches that of saturation of the gas vapor under test, a film of the condensed vapor appears. A thermometer is provided to measure the temperature of the flask surface by measuring the temperature of the acetone-CO_2 mixture surrounding the immersed Erlenmeyer flask. The temperature at which this clouding appears is the dewpoint.

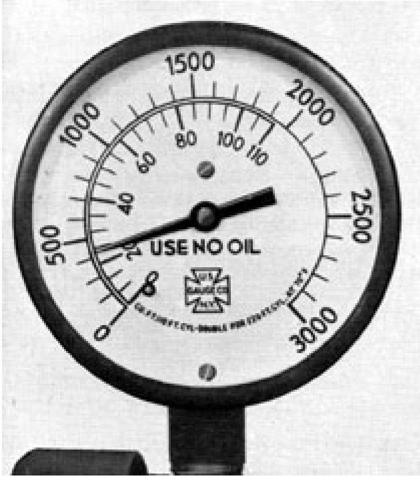

Figure 2-28. Nitrogen bottle reducing valve gage pressure at 400 psi.

AIR OUTLET valve. Secure the AIR OUTLET valve when the pressure on the mechanical pressure gage registers 7 1/2 psi. (With the built-in pressure gage type, it is only necessary to observe the pressure indicated.)

52. After evacuating and cycling procedure is completed, the AIR INLET and OUTLET plugs and external fittings are assembled in inverse order.

2C4. Dewpoint and testing equipment. Dewpoint is the temperature at which the water vapor in any mixture of a gas and water vapor becomes saturated or condenses. The dewpoint is found by cooling the mixture at a constant pressure until saturation occurs.

The dewpoint test equipment, consisting of a silvered surface on an Erlenmeyer flask in contact with the gas under test, is cooled by immersing the flask in an acetone-CO_2 mixture. As

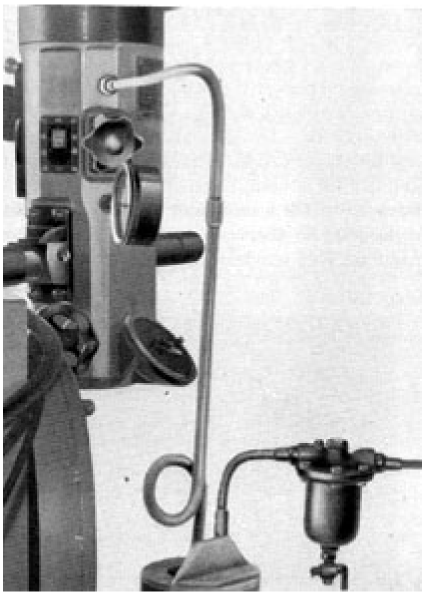

Figure 2-29. Nitrogen passing through cold trap.

Figure 2-30 shows the equipment necessary to complete the dewpoint test.

1. One centigrade thermometer, range -100 degrees to +50 degrees C.

2. Three 200-ml Erlenmeyer pyrex flasks, with bottom and part of sides silvered, copper-plated, and coated with acetone resisting enamel, or with the internal area silvered and lacquered.

3. 12 inches of glass tubing.

4. Four feet of rubber tubing.

5. Rubber stopper for Erlenmeyer flask.

6. 1/2 lb of CO_2

7. 1000-ml pyrex beaker, large with the centigrade thermometer.

enough to immerse a 200-ml Erlenmeyer flask in 2 inches of acetone-CO_2 mixture.

8. 0.5 liter of acetone.

9. Soft apiezon wax for sealing fittings.

10. Pressure gage, range 0 to 30 psi.

2C5. Steps in taking a dewpoint test. A dewpoint, test should be taken as follows:

1. Heat the Erlenmeyer flasks on a hot plate to drive out all moisture. This is done before assembly with a rubber stopper.

2. Bleed nitrogen from the AIR OUTLET connection of the periscope through rubber tubing connected to the glass tubing of the inlet of the 200-ml flask. Allow an extremely light flow of nitrogen to escape from the glass exhaust tube outlet. This light flow can be noted by placing the outlet tube to a moist lip and feeling the light exhaust flow of nitrogen.

3. Fill the glass beaker with 0.5 liter of liquid acetone.

4. Immerse the Erlenmeyer flask in the acetone in the glass beaker to about 1 inch above the silvered sides and take a temperature measurement Watch carefully for a clouding of the gas vapor, as the glass tubing is suspended to within 1/4 inch of the inner glass surface of the bottom of the flask.

5. Add powdered dry ice and continue to take successive measurements with the thermometer, stirring the acetone-CO_2 mixture.

6. Keep the thermometer raised from the bottom inner surface of the glass beaker (Figure 2-31). A false reading may occur if the thermometer comes in contact with the dry ice.

7. Watch closely for the clouding film on the inner bottom surface of the 200-ml flask (Figure 2-32); the silvered surface on the bottom of the flask aids in detecting this film.

8. When the clouded film of condensed gas vapor is observed, record the temperature. Although a temperature of -50 degrees to -69 degrees C is not likely to be encountered by a submarine in service, having the dewpoint in this range provides a factor of safety and will keep the periscope free from fogging for a longer period if minute leaks should occur.

9. A series of three complete tests is necessary. After each dewpoint test, be sure that the lines and flask are thoroughly dry for each succeeding test.

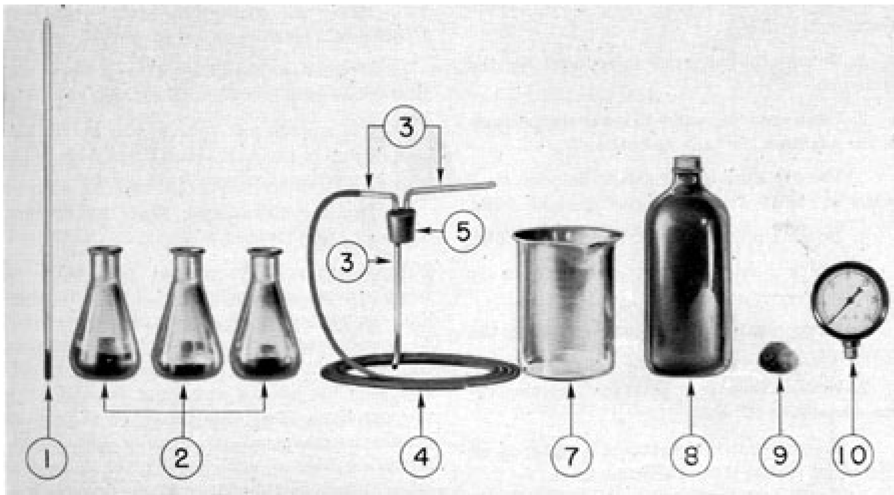

Figure 2-30. Viewpoint testing equipment.

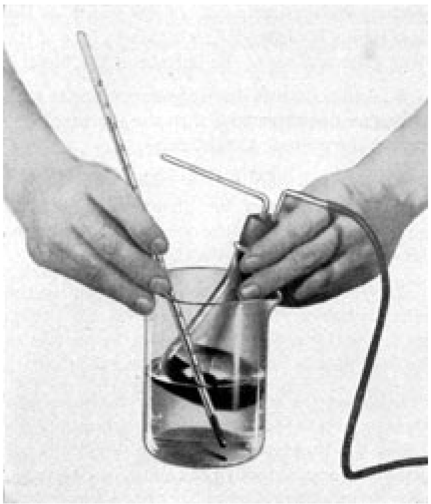

Figure 2-31. Thermometer raised from inner bottom surface of glass beaker.

10. Three Erlenmeyer flasks are used. This provides a dry container for each test, without any loss of time caused by warming and drying.

2C6. Safety precautions for cycling and evacuating periscopes. The following safety precautions should be observed in using the vacuum drying system:

1. Be sure that oil is not introduced into the periscope.

2. Use a reducing valve to lower the pressure of the gas from the tank or bottle.

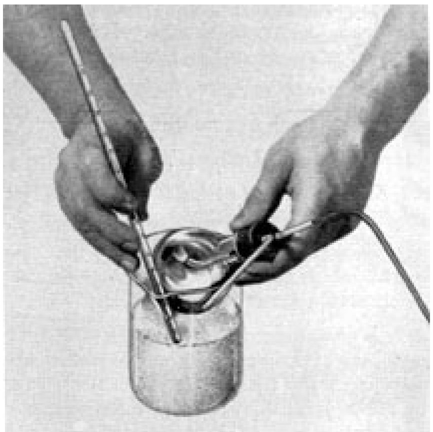

Figure 2-32. Clouding film on inner bottom surface of flask.

does not stop while pulling a vacuum. The pump must always be attended during the evacuating of the periscope.

10. Always take the dewpoint test from the AIR OUTLET connection.

11. Always charge the periscope using a series of 4-pound steps for approximately 2 hours.

12. Never use a nitrogen bottle which has dropped to a pressure as low as 400 psi.

13. Dry out the charging cold trap copper coil after completing every fourth charge.

3. Use dry silica-gel. It should be dried for 2 hours at 500 degrees F and must be of granular form.

4. Be certain that the filter is clean and tight.

5. Check to ascertain that all connections are tight.

6. Bleed out all lines before filling the periscope.

7. Never evacuate a periscope at temperatures less than 50 degrees F.

8. Be sure that the periscope is tight, as all efforts are useless if the periscope leaks.

9. Keep the vacuum pump in a horizontal position and watch carefully to see that the pump

14. Use apiezon soft vacuum wax around the hose fittings of the AIR INLET and AIR OUTLET connections to insure a complete seal.

15. Dry the Erlenmeyer flasks before each dewpoint test.

2C7. Cleanliness. The greatest care must be taken to avoid introducing dust, dirt, or moisture into the periscope. All apparatus must be kept clean and used for no other purpose. The cold trap and vacuum lines should be blown out before each use with a strong jet from the dry nitrogen flask. Hose lines should be as short as possible and the joints hermetically tight. If periscopes are dried or recharged in place on the vessel, all equipment should be available on board. Long lines for dry gas or vacuum should not be used under any circumstances.

D. CARE OF FLOODED PERISCOPE

2D1. Preservation of flooded periscopes. 1. A drain opening is provided in the base of the eyepiece box on the Type II and III periscopes. Opening this drain first requires the removal of the stadimeter housing assembly. A screw with a lead washer is secured in this tapped hole. Removal of this screw permits the repairman to drain the periscope.

2. When periscopes have been flooded and subsequently emptied of water, the resulting corrosion damages certain parts beyond repair unless prompt counter-measures are taken.

3. As soon as possible after flooding, flush with fresh water and dry thoroughly, if practicable. Then apply a rust preventive compound similar to Tectyl Grade III or No. 511 to internal parts.

4. If Tectyl is not available, the periscope should be sealed after flushing and left filled with fresh water until repairs are effected.

E. REMOVING AND INSTALLING A PERISCOPE

2E1. Removing a periscope. A periscope is removed as follows:

1. The precautions to be taken when elevating a periscope are:

a) Notify any men working around the vicinity to stand clear.

b) If a cover plate is provided remove the cover plate from the top steady bearing of the submarine.

2. The submarine is moored on either the starboard or port side of the tender (Figure 2-33). Generally it is moored on the side where the periscope is transported most easily to the optical shop.

3. Elevate the periscope to the height required, which should be high enough to accommodate two slings of sufficient length to clear the fragile head (Figure 2-34). Each sling is provided with a spreader bar to prevent contact with the relatively fragile head and taper section of a Type II periscope. The same procedure is followed for other types of periscopes.

4. Secure a suitable forged steel hoisting clamp (2, Figure 2-34) of ample proportion around the outer tube at least 12 inches below the joint between the outer tube and the taper section (Figure 2-24). The hoisting clamp should be lined with asbestos brake lining, or emery cloth placed with the smooth side to the outer tube. Special steel bolts must be used.

clamp. Under no circumstances are poorly fitting clamps or clamps containing setscrews to be used, nor should any clamp be directly over the joint between the body tube and the taper section, as severe damage to the periscope may result (Figure 2-34).

6. Place the hook of the lifting crane (4, Figure 2-34) in the hook opening of the spreader bar.

7. Raise the periscope to the observing position and transfer the weight of the periscope to the lifting crane (Figure 2-35). This gives the repairman access to all external parts.

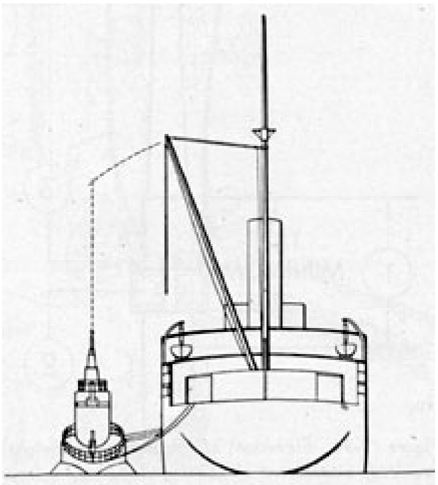

Figure 2-33. Submarine moored on port side of tender.

5. One or 2 safety clamps (3a Figure 2-34) (the brass clamps supplied with the shipping box will serve) should be secured above the hoisting

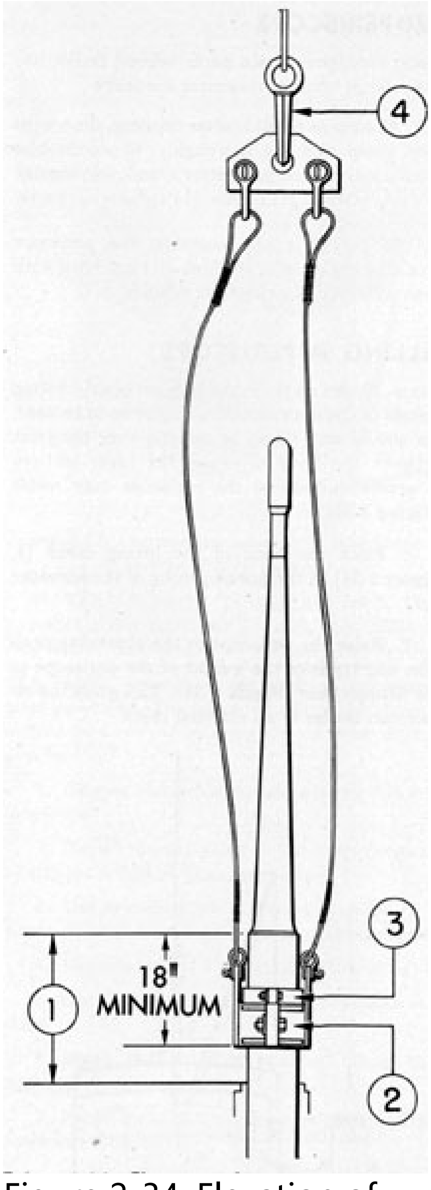

Figure 2-34. Elevation of periscope to height required; attachment of hoisting clamp and safety clamp; placement of the hook of the lifting crane in the spreader bar.

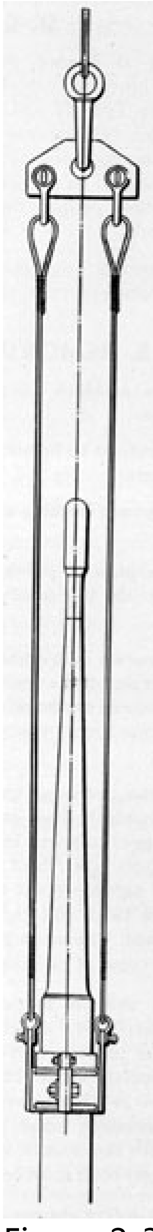

Figure 2-35. Raising the periscope to the observing position.

8. Remove all external parts which project beyond the circumference of the outer tube Figure 2-36). At the time of

Note the reference marks on the focusing knob assembly in a similar manner.

removal, note the position of the reference marks on the square ends of the training handle packing gland assembly shafts with corresponding reference marks on the training handles for proper reassembly.

a) Remove the training handles by taking out eight hinge, bracket bolts (19 and 21, Figures 4-43 and 4-44, respectively), for the left and right training handles of a Type II periscope.

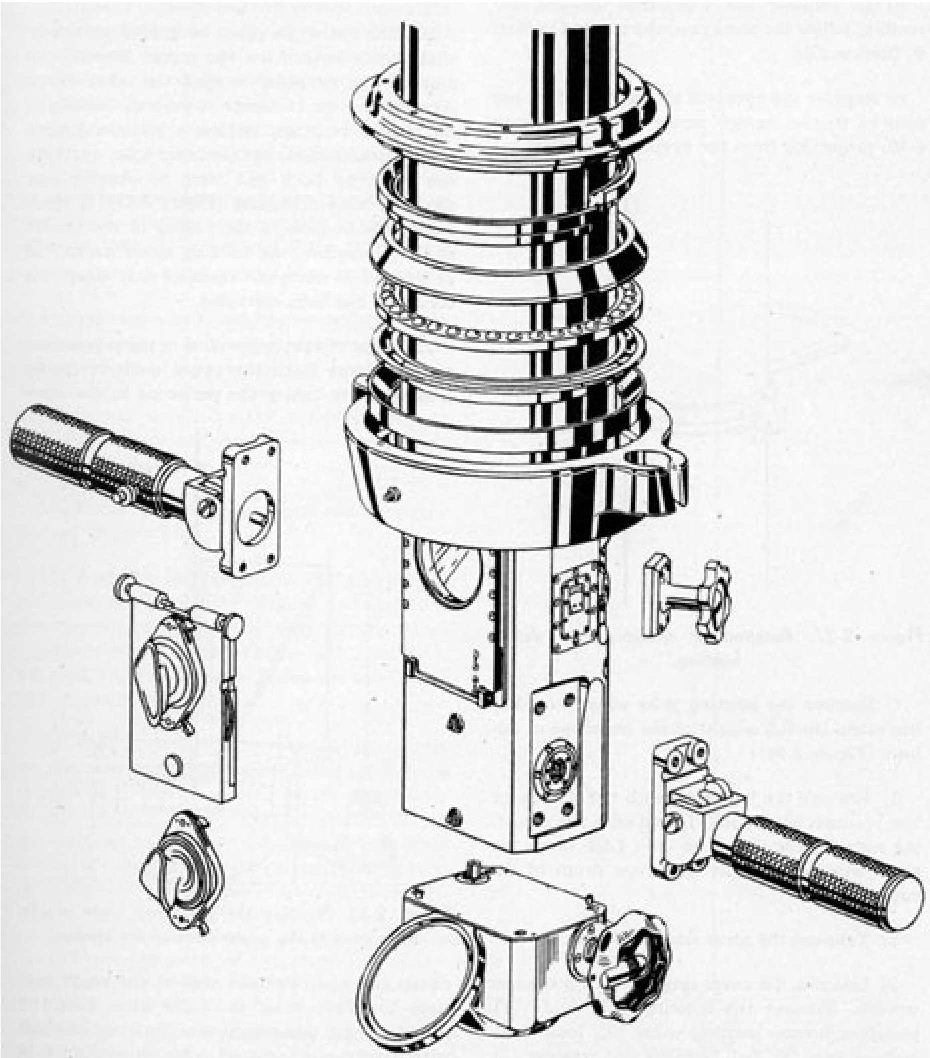

Figure 2-36. Removal of external parts of periscope.

b) Remove the focusing knob assembly by taking out four lockscrews (10, Figure 4-39).

c) Remove the rayfilter by pulling, outward on both spring-actuated plunger knobs (24, Figure 4-40).

d) To remove the stadimeter housing assembly, follow the same procedure stated in Step 9, Section 2B8.

4) Remove the split ring (3). All parts of the thrust bearing should be protected from dirt or grit.

5) Remove the cover ring (2).

9. Slack off the hull stuffing box gland of the submarine before removing the periscope.

10. The periscope must be guided vertically while being hoisted by the crane. Station one man on the fairwater to spot the crane boom

e) Remove the eyepiece attachments that are secured to the anchor screw pins (19, Figure 4-29) projecting from the eyepiece box itself.

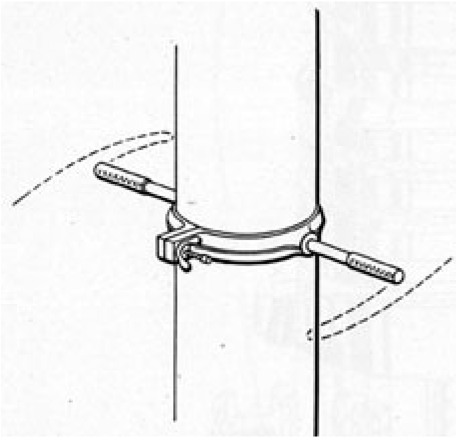

Figure 2-37. Rotation of periscope to detect binding.

f) Remove the hoisting yoke when the crane has taken the full weight of the periscope as follows (Figure 7-26):

1) Remove the wire rope with the sleeves for the 7/16-inch wire rope (11) and with the adjusting nuts for the wire rope (10). Lash down the slack wire rope to the wire rope drum of the submarine.

2) Take out the cover ring lockscrews (4).

3) Unscrew the cover ring (2) with a spanner wrench. Remove the hoisting yoke body (1), phosphor-bronze locating collar (9), lower ball bearing race (8), ball bearings and retainer (7), and the upper ball-bearing race (6).

directly over the periscope to prevent binding in the steady bearings. Attach a suitable hinged clamp with handles over the outer tube, to rotate the periscope back and forth to observe any tendency toward binding (Figure 2-37). If binding occurs because of the rolling of the tender or the submarine, the hoisting operation should be stopped at once, and resumed only when this condition has been corrected.

11. Hoist the periscope clear of the submarine, and transport it to the upper deck vertically (Figure 2-38). Lower the periscope in the open

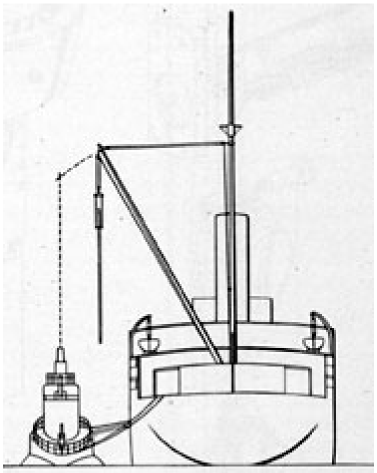

Figure 2-38. Hoisting the periscope clear of the submarine to the upper deck of the tender.

clamp cap and clearance wall of the hinge carriage to within 4 inches of the deck. Line the clamp cap and clamp section of the hinge carriage with emery cloth placed with its smooth side against the outer tube. Secure the clamp cap and

clamp section of the hinge carriage to the outer tube with two special bolts and nuts over the emery cloth. Insert the

toggle bolt in the lined-up holes of the supporting arm and clearance wall periphery projection after the clamp cap is secured (Figure 2-39).

12. Carry the lower end of the periscope and the hinge carriage toward the position in which it will lie, in the horizontal position (Figure 2-40), lowering the upper end of the crane. The large wheels of the hinge carriage roll the lower end of the periscope toward its proper horizontal position as the upper end is lowly lowered (Figure 2-41).

13. When the periscope is near the horizontal position, locate the clamp carriage in the proper position, with the upper half of the clamp hinge of the clamp carriage open. Lower the periscope to the lower half of the clamp carriage and close the upper clamp half, securing it with a swinging wing nut (Figure 2-42). The hinge carriage has clearance around the eyepiece box, and is secured to the outer tube just above the coupling, thus carrying the weight of the periscope as it is swung to the horizontal position, and preventing damage to the eyepiece box.

14. Remove the hoisting clamp and the safety clamps (Figure, 2-34).

15. Assemble two horizontal lifting clamps to the periscope outer tube (Figure 2-43) between the, clamp carriage and the hinge carriage. Two 3/4-inch steel bolts, not shown in Figure 2-43, are used on each clamp to

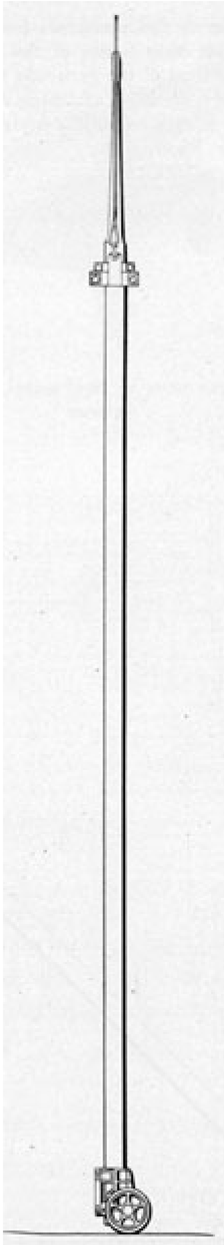

Figure 2-39. Attachment of hinge carriage.

fasten the two halves of the clamp together.

16. Roll the periscope by means of the wheels on the clamp carriage and the hinge carriage to the inboard transfer opening of the upper deck (Figure 2-44). Secure the horizontal lifting spreader bar to the plate extension of both horizontal lifting clamps with special bolts 3/4 inch in diameter. (These bolts are not shown in Figure 2-43.)

17. Place the hook of the chain fall of the overhead track in the hook opening in the horizontal lifting spreader bar, and carry the weight of the periscope by the chain hoist (Figure 2-45). Remove the hinge carriage and open the upper half of the clamp carriage.

18. Transport the periscope, lowering it to the overhead chain hoists of the main deck. Transfer the load of the periscope to the chain hoists of the main deck, attaching each hook in the shackle at each end of the horizontal lifting spreader bar (Figure 2-46).

19. Roll the periscope into the optical shop and lower it onto the separated channel optical benches.

20. Remove the horizontal lifting spreader bar and the horizontal lifting clamps.

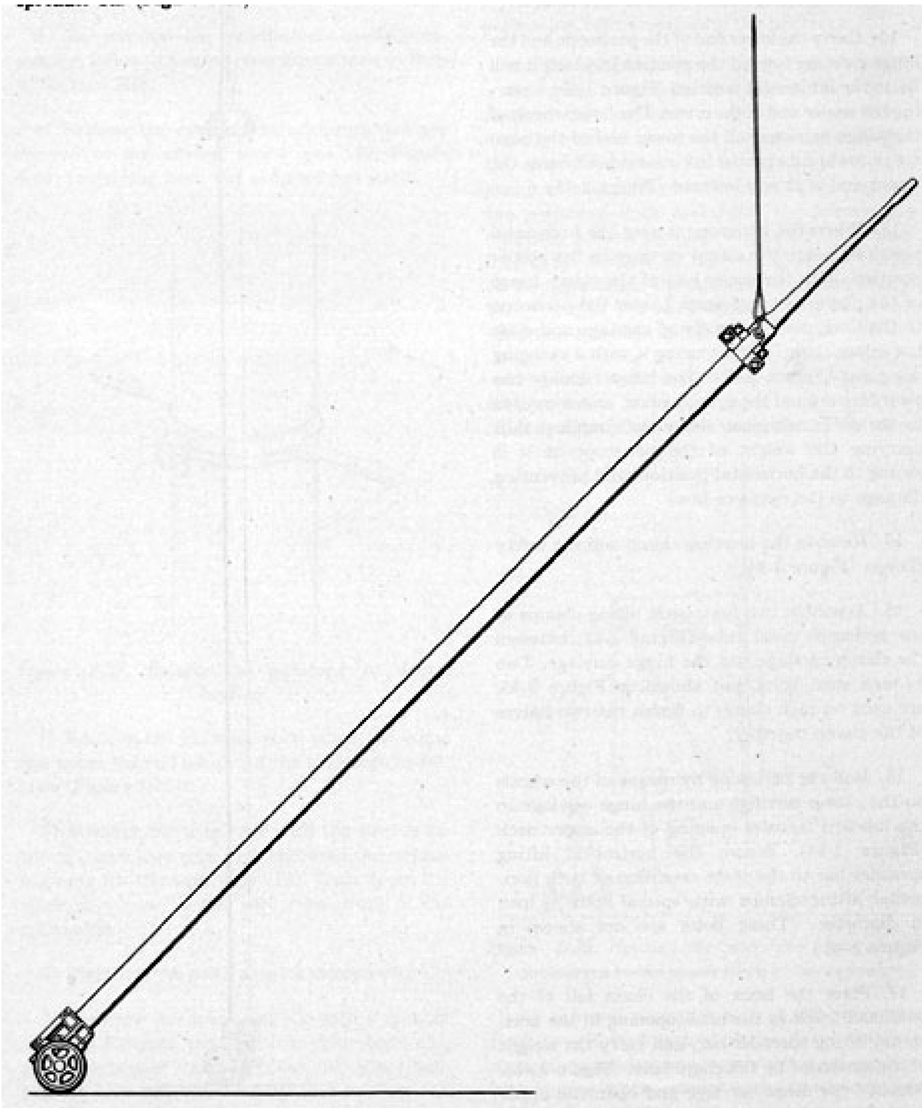

Figure 2-40. Periscope and hinge carriage at 45 degrees position.

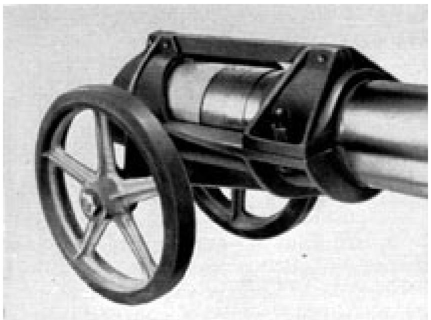

Figure 2-41. Hinge carriage at horizontal position.

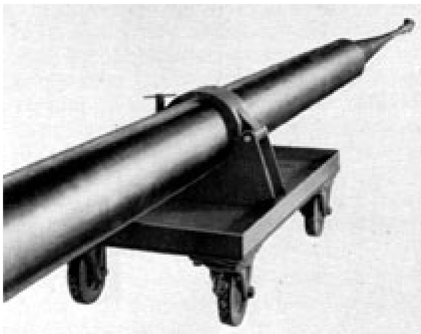

Figure 2-42. Upper part of periscope in clamp carriage.

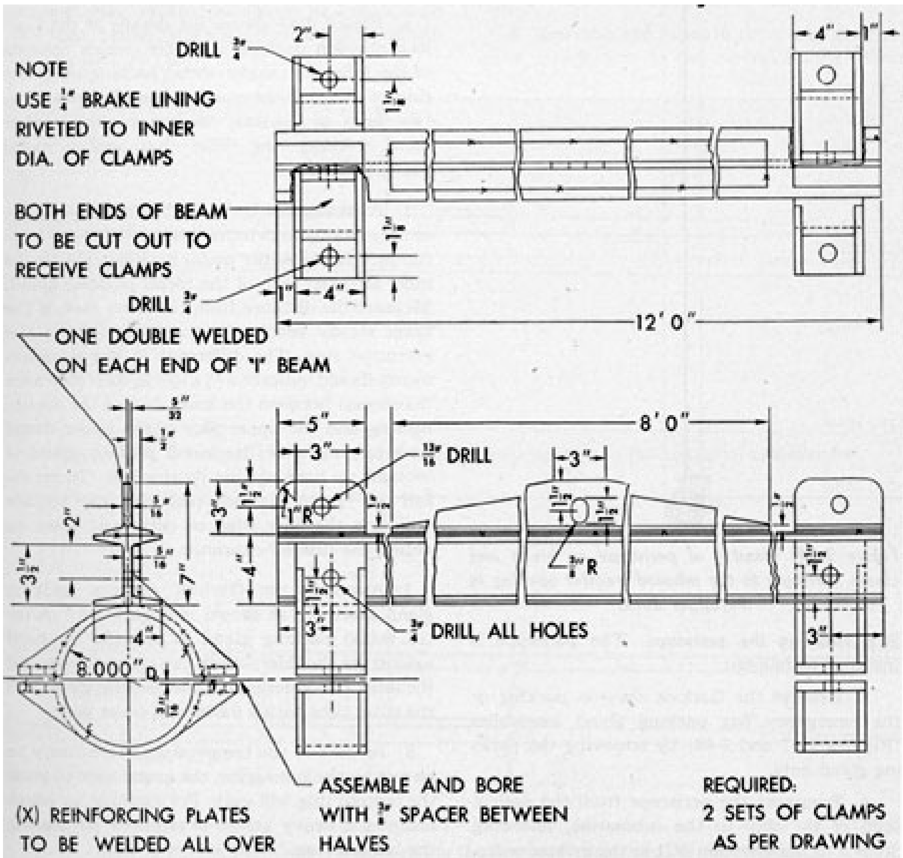

Figure 2-43. Details of horizontal lifting clamps and lifting spreader bar.

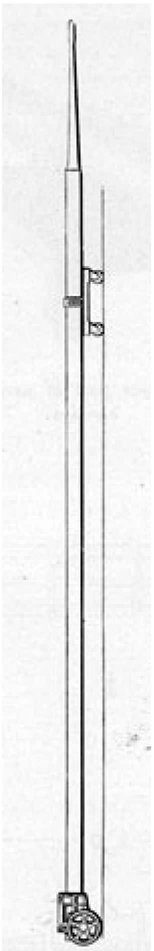

Figure 2-44. Transfer of

3. To effect smoother guidance, apply grease freely to the periscope as it enters the steady bearings of the submarine.

4. Replace the suitable hinged clamp with handles (Figure 2-37) over the outer tube, and rotate the periscope back and forth as it is lowered to observe any tendency toward binding. Follow precautions to prevent binding stated in Step 10 of Section 2C1.

5. Hull stuffing box packing. The hull stuffing box gland provides a water seal joint between the hull casting and the outer tube of the periscope. It may be made up of two types of packing: Garlock chevron packing or emergency flax packing assemblies.

a) Figure 2-47 shows the details of the Garlock chevron packing

periscope on hinge and clamp carriages to the inboard transfer opening in the upper deck.

2E2. Installing the periscope. The periscope is installed as follows:

1. Remove the Garlock chevron packing or the emergency flax packing gland assemblies (Figures 2-47 and 2-48) by removing the packing gland nuts.

2. Transport the periscope from the optical shop of the ship to the submarine, following Steps 3 to 20 of Section 2C1 in the inverse order.

assembly, which consists of the following: upper metal packing ring, one ring of Garlock chevron packing, lantern ring, two rings of Garlock chevron packing, lower metal packing ring, filler ring, and a metal packing gland.

1) Assemble the Garlock chevron packing assembly loosely to determine a measurement from the face of the upper metal packing ring to the inner shoulder face of the metal packing land. Measure the distance from the lower face of the lower steady bearing to the lower face of the extension ring. The difference in the measurements should indicate a 1/16 to 3/32-inch clearance (looseness) between the lower face of the steady bearing and the upper face of the upper metal packing ring after the metal packing gland is brought up hard against its shoulder. To establish the 1/6 to 1/32-inch clearance may require replacing the filler ring, or cutting it down to obtain the desired clearance.

2) Assemble the Garlock chevron packing gland assembly as shown in Figure 2-47. After the metal packing gland is brought up hard against its shoulder, check the clearance around the inner circumference of the packing gland and the outer tube with a .006-inch feeler gage.

3) In view of the temperature zones likely to be met by the submarine, the grease used to pack the lantern ring will vary. For example, in warm climates a heavy grease is required for sealing the lantern ring.

4) It is of prime importance that the angle of 75 degrees not be exceeded at the lower end of the lantern ring; this also applies to the lower end of the upper metal packing ring.

5) It is believed that in cases where leakage occurs with Garlock chevron packing, it can be attributed to a slight off-center condition existing between the periscope and the hull gland, which results in forcing the Garlock packing out of round and opening the seal between the periscope and the packing. Experience has shown that in most cases leakage can be eliminated by the addition of one or two rings of Garlock chevron packing, without any appreciable increase in effort required to train the periscope. Where additional rings of Garlock packing fail to stop leakage, flax packing as shown in Figure 2-48 will stop leakage, but some increase in effort will be necessary to train the periscope.

b) Figure 2-48 shows the details of the emergency flax packing assembly which consists of removing the Garlock chevron packing rings and the filler ring, and installing three flax packing rings. One ring of 5-inch flax packing is placed above the upper metal packing ring, and two rings of 5/8-inch flax packing below the lower metal packing ring. Cut each flax packing ring with square ends, and measure it to conform with the inner circumference of the hull casting, not the outer diameter of the periscope.

In taking up the packing gland, use a feeler gage around the periscope to insure equal clearance and proper tightening of the packing gland. This is essential as the shoulder of the packing gland is not brought up against the extension ring.

6. Assemble the azimuth circle and auxiliary circle attachment to the extension ring. Train

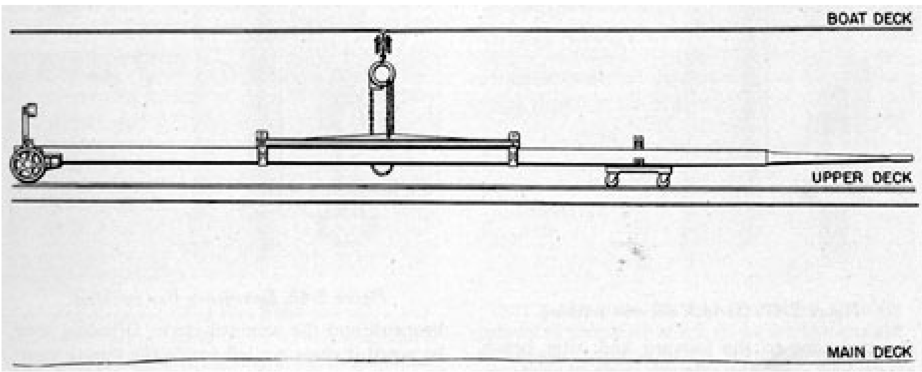

Figure 2-45. Overhead chain hoist hook placed in hook opening in the horizontal spreader bar.

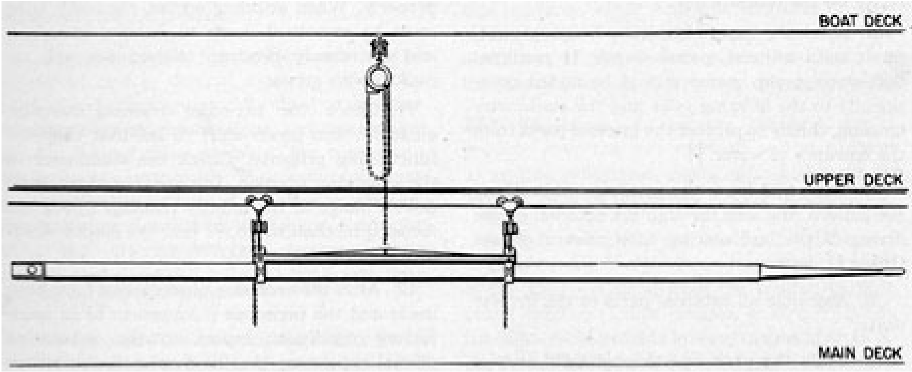

Figure 2-46. The periscope is transferred to the overhead chain hoists of the main deck.

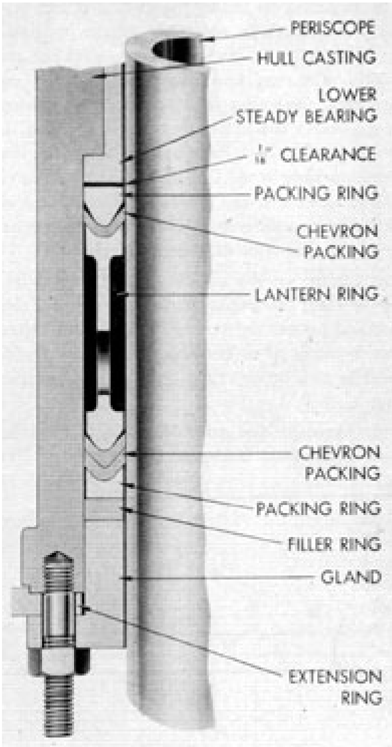

Figure 2-47. Garlock chevron packing.

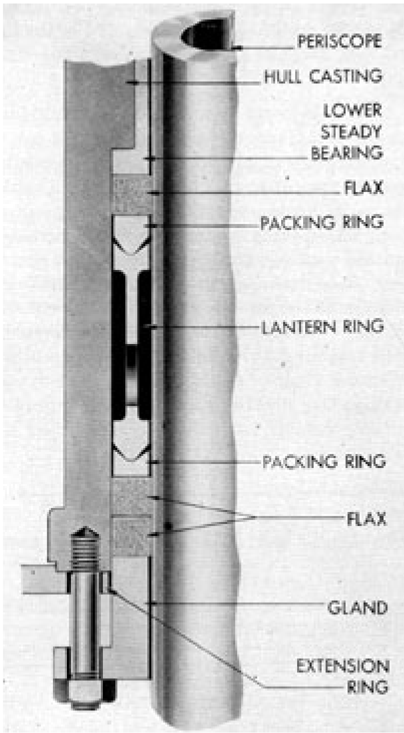

Figure 2-48. Emergency flax packing.

the periscope to the forward and after bench marks and check the azimuth circle to read correctly on the lubber's line.

7. After the assembly of the hoisting yoke, fill it with mineral grease Grade II medium. Soft-water pump grease should be added occasionally to the hoisting yoke and the stadimeter housing, chiefly to protect the internal parts from the entrance of water.

bearings and the azimuth circle. Grinding may be noted if chips are left inside the steady bearings, and the azimuth circle is not located properly. When grinding occurs, the outer tube must be smoothed down to remove scratches, and the steady bearings cleaned out and repacked with grease.

11. Check the periscope training handles, altiscope, and power shift to see that they are functioning properly. Check the stadimeter in the observing position, to note

8. Raise and lower the periscope while filling the lantern ring area through the external grease fitting of the hull casting with mineral grease Grade II medium.

9. Assemble all external parts in the inverse order.

10. Train the periscope through 360 degrees several times to observe the condition of the steady that there is no double image at the infinity reading. Check the focusing mechanism to see that the diopter readings are -3 and +1 1/2.

12. After the necessary observations have been made and the periscope is known to be in satisfactory condition, report to the submarine officer, requesting that he inspect the periscope for approval.

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3
REFLECTION-REDUCING FILMS

A. METALLIC FLUORIDE

3A1. Purpose. Standards of quality and performance have been set up for evaporated metallic fluoride or other similar films which are applied to optical elements to improve the quality of optical images by reducing reflection from, and increasing transmission through them.

3A2. Type of film. The reflection-reducing film discussed is the metallic fluoride film produced by evaporation in high vacuum. Other films include those produced by chemical bleaching, acid etching, or by any means other than evaporation.

3A3. General requirements. a. Film thickness. The optical thickness of the film on each treated surface should be 1/4 wavelength of green light (5461 Angstroms). This thickness may be considered as attained when a ray of light striking the treated surface at an angle of incidence between 0 degrees and 30 degrees appears purple in the reflected ray.

b. Color variations over a treated surface. Uniform graduations in the purple color-range from purple-red purple to purple-blue purple over the treated surface

f. Samples for approval. Before making deliveries under any contract, sample coatings on flat glass squares or disks 2 inches on the side or diameter, and not less than 1/8 inch thick are furnished to the Bureau of Ordnance for approval of quality and workmanship. The samples submitted are representative of the types of films for the range of indices of refraction of the glasses to be used in the contract.

3A4. Detail requirements. Films must be smooth and free from visible minute particles of solid coating material.

When the green light of wavelength 5461 Angstroms is incident upon a treated surface at an angle of incidence between 0 degrees and 30 degrees, the percentage of reflected light should not exceed the values shown in the following table:

Index of Refraction (nd) of Material to Be Coated	Percent Reflection
1.52	1.5
1.57	1.2
1.60	1.0
1.65	0.8
1.70	0.6

of an individual optical element are permissible.

c. Appearance. The film must not show evidence of crazing, spalling, or cloudiness which might result in the scattering of light. Blotches, spots, streaks, or other defects of dirty glass surfaces must not be present.

d. Durability. The film on each surface of an individual optical element must be sufficiently hard to withstand, without chemical or mechanical deterioration, the handling and cleaning required during the assembly or subsequent overhaul of an instrument. This requirement may be considered as fulfilled if the films remain unchanged after cleaning by washing in soap solutions and organic solvents (acetone, grain, alcohol, and so forth), followed by drying with lens tissue or a soft cloth.

e. Cemented surfaces. A glass surface which is to be cemented to another glass surface is not treated.

Pure magnesium fluoride is used for treating surfaces of elements which in an instrument are the exterior surfaces of the optical system. For treating elements which comprise the interior optical surfaces, other fluorides, mixtures of fluorides, or other materials may be used at the discretion of the manufacturer. All films are hardened by baking or other equivalent processes.

3A5. Inspections. To achieve the best results possible from the treatment of optical surfaces to reduce reflections, each optical element so treated must be inspected.

A lamp and shield are used as a light source in determining film thickness by noting the color of the light reflected from the treated surface. Small apertures (slits, crosses, or circles) cut in the light shield provide an easy means of separating the images reflected from the two surfaces of an optical element.

An optical element which, before treatment, meets the requirements of all other applicable specifications as to freedom from scratches or other imperfections, is not rejected after treatment if fine hairlines and minute specks become visible as a result of the coating process. However, scratches or other film defects which under conditions of normal use, are visible in the field of view of the assembled instrument, are sufficient cause for rejection of the element or elements involved.

B. HANDLING TREATED OPTICS

3B1. Detecting treated optics. The nonreflecting properties of treated optics are derived from a thin film of metallic fluoride deposited on the glass as a surface layer. This film is not so hard as the underlying glass, and since it is only four-millionths of an inch thick, it does not withstand rough treatment.

Before an optical instrument is disassembled, it is examined to determine whether any elements in the system have been treated with nonreflecting films. This is done by observing the elements of either the entrance or exit pupils of the instrument and noting whether the light reflected is a distinct blue or deep purple color. Such colors indicate that some of the elements, but not necessarily all, have been treated, and therefore require more care in handling.

3B2. Preventing damage. To prevent damage to these films, avoid handling or rubbing as far as possible. As the instrument is disassembled, place the elements on clean paper or cloth, not on dirty tables or benches which may be covered with minute, gritty, abrasive particles. As each element is removed from the instrument, examine it to determine whether it has been coated by noting the color of the light reflected from the surface. Ordinarily, there is a thin uncoated rim about 1 mm wide around the periphery of the lens, from which the reflected light is white and brilliant.

Treated optics must be handled carefully if the nonreflecting properties are to be retained. thereby exposing the underlying glass. No amount of rubbing or polishing can restore the film. In fact, efforts to remove these scratches only result in more scratches or even in complete removal of the film. Therefore, avoid rubbing and polishing coated lenses as much as possible. Scratches do not impair the usefulness of the instrument in service, as they are not noticeable to the observer.

3B3. Cleaning treated optics. Organic solvents such as alcohol, benzene, ether, and acetone do not injure the film, and can be used in cleaning if they are pure and do not leave a residue of gum or grease on evaporation. Cold water and cold dilute acids or salt solutions do not injure the film if the film is not soaked in such solutions for long periods. Do not boil the lenses in water or dilute acids since this treatment not only softens and sometimes removes the film, but may cause an uneven etching of the glass.

Surfaces which are to be cemented are never coated; only the outside air-to-glass surfaces are treated. Heat does not harm the film, and lenses therefore can be heated on hot plates for uncementing and again for recementing. Excess balsam from the cementing operation is removed with a clean cloth wet with a solvent. It is neither necessary nor desirable to scrub the lens vigorously to remove the balsam. If sufficient solvent is used, a few gentle sweeps across the surface cleans the lens.

Lenses are now appearing in service which have been cemented

Never use a rouge pad for cleaning because it completely removes the film; use only a soft, clean cloth wet with a solvent, or lens paper. Paper or cloth used previously and left on a table or bench must never be used, as grease and grit which have been picked up leave oil streaks across the lens and scratch the film.

Do not attempt to remove scratches. Scratches in the film mean that the film has been removed,

with a new type of cement that is thermosetting rather than thermoplastic. The procedure for uncementing these lenses is different from that for Canada balsam.

Equipment needed for uncementing these special lenses is a hot plate capable of attaining temperatures of 500 degrees F, special glass cloth, and a pair of chenille or heat-resistant gloves (asbestos glow are unwieldy and are not recommended).

The glass cloth as supplied is covered with invisible oil film. It is to be heated on the hot plate at about 500 degrees F until all the oil has been evaporated. The removal of oil is evidenced by the change in appearance of the cloth upon heating. A change from white to a scorched tan and thence to a greyish white is noticeable during the heating. The glass cloth and gloves are supplied to optical repair activities by the Naval Gun Factory.

Lenses to be uncemented are placed on the glass cloth on the hot plate after the latter has reached a temperature around 500 degrees F. After about 5 minutes, the cemented elements separate. The separation may be evidenced by the sound of the splitting or by reflection of light from the new interface. If the elements have not completely separated, a slight tap on a wooden surface completes the separation. Generally, the remaining cement may be

been too thick. Similar samples submitted by several Navy yards also were too thick. In terms of color, the films are too blue when viewed in reflected light. The tendency to make blue films is greatest when coating glasses which have low indices of refraction, such as common crown or plate glass, and borosilicate crown glass. Such low-index glasses are used as telescope windows, sealing plates, clear rayfilters, prisms, and the positive elements of doublets. Even highly skilled filming operators may overcoat low-index glasses. The error arises from the fact that the colors produced are not distinct and cannot be matched with any colors which appear in the Munsell Color Charts.

However, the colors produced on high-index glasses (commonly called flint glasses) are quite distinct and it is easy for a filming operator to follow the color changes as the film is being made. The negative elements of most

stripped by hand from the lens element. However, if this is not possible, the remaining cement may be removed by playing a stream of hot distilled water on the cement from a wash bottle. The uncemented lenses are recemented by standard procedures with Canada balsam.

SPECIAL PRECAUTIONS. If the hot elements are picked up with cold gloves, cracking may result. Therefore, the finger tips of the gloves should be laid on the surface of the hot plate for a few seconds before picking up the hot lenses. Also, air drafts are known to crack lenses, so all operations should be performed in relatively quiet air.

Stains from finger marks and Prussian blue do not injure the film and can be removed with solvent. It is best to remove such stains while they are fresh, since they are more difficult to eradicate without injury to the film when they have thoroughly dried.

In summary, the best way to preserve the nonreflecting properties of the film is to avoid handling and rubbing the elements. If rubbing is necessary, rub gently with little pressure. Use a clean cloth or lens paper, and rub no longer than necessary to clean the element.

3B4. Determining thickness of films. Samples of magnesium fluoride reflection-reducing films tested by the Naval Gun Factory for compliance with Ordnance Specification 1357 have invariably doublets are usually made from high-index glasses.

It is recommended that the following instructions be followed by naval activities engaged in the filming of optics to produce films which provide the greatest benefit:

1. When in doubt as to the proper color of film, always make the film too thin rather than too thick. In terms of color, this means that the film should be too red rather than too blue. This is in accordance with paragraph C-1 of Ordnance Specification 1357 which states that the most satisfactory films will fall in the color range (Munsell System) from purple to purple-red purple.

2. Since the colors are most pronounced on high-index glass, a rule should be made that at least one piece of high-index glass should always be placed under the bell jar for coating simultaneously with a group of low-index glass. The high-index sample is to be used as the test piece for judging the correct color. This can be done most conveniently by organizing the procedure so that a negative element of one of the lenses of the instrument itself is used as the test piece since they are invariably made of high-index glass.

3. Errors sometimes result in a lens being given a double coating. The color of the reflected light is then green. The reflection from

such a surface is almost as much as from an uncoated surface and the lens should not be used in this condition.

This condition may be remedied by coating the element a third time until the color returns to purple-red purple. Such a triply coated lens is less efficient in reducing reflection than one which has been coated properly. The procedure described is recommended for use by those activities which do not possess facilities for repolishing.

Do not attempt to remove a film by hand polishing with a rouge pad under any conditions.

4. Reports indicate that the outside surfaces of many coated binoculars have been badly scratched by the indiscriminate use of gritty cloth in cleaning. Do not recoat such binoculars unless all of the damaged film can be removed. Some benefit is obtained as long as any film remains. A second coating over the damaged film does not improve the appearance and the over-all reflection may actually be increased.

3B5. Removing damaged films of treated optics. No satisfactory field method of removing damaged films was known previous to the suggestion of the following method by the Navy Yard at Puget Sound, Washington.

The materials required are: 1) a hot plate, 2) any dish which is not attacked by hot concentrated sulfuric acid, such these materials should be available at repair activities.

A solution of 2 ounces of boric acid per liter of concentrated sulfuric acid is prepared. The optics from which the film is to be removed are immersed in the cold solution to prevent breakage. The solution is then heated to approximately 100 degrees to 110 degrees C and maintained at that temperature for 30 to 45 minutes, which is sufficient to remove the film completely.

Higher temperatures are not dangerous, but the proper temperature may be determined by observing white fumes which appear at approximately 100 degrees C. The fumes are slightly acidic but not sufficiently corrosive to require a fume hood for safety. At the end of the acid treatment, the lenses should be drained, cooled, and rinsed in methyl alcohol or denatured alcohol. Acetone, benzene, carbon tetrachloride, or other low boiling point alcohols, may be used in the absence of methyl or denatured alcohol. A thorough washing with water and subsequent drying should follow the alcohol rinse. If no organic liquids are available for the first rinse, the lenses are preferably left in the acid to cool. Each lens is then removed individually and rinsed quickly and thoroughly in a copious stream of cold water after which it is immediately dried. Care should be exercised in handling the highly corrosive solution to avoid burns resulting from spilling or breaking of containers.

as a Pyrex glass beaker, porcelain casserole, or nickel-chrome alloy dish, 3) sulfuric acid, concentrated, specific gravity approximately 1.84, and 4) boric acid. All of

The optics should be cooled gradually to prevent breakage. Water should never be allowed to come in contact with the concentrated sulfuric acid solution.

C. VACUUM COATING APPARATUS, MARK IV, TYPE II

3C1. Operation of vacuum coating apparatus, Mark IV, Type II. These instructions indicate the procedure used in the coating of optical elements in their correct order and are to be followed in the operation of the vacuum coating apparatus, Mark IV, Type II. The machine should be charged with clean optics and the bell jar secured in advance of the following operations:

1. Close the vacuum valve located between the diffusion pump and the mechanical pump.

2. Close the air intake valve.

3. Turn on the thermocouple gage switch and adjust the input meter (tower meter) to the value indicated for the instrument.

4. Note the reading of the output meter (upper 0-200 microammeter) while the system is at atmospheric pressure.

5. Start the mechanical pump.

6. Open the vacuum valve between the diffusion pump and the mechanical pump.

7. Observe the reading of the thermocouple output meter and turn on the diffusion pump

when this reading reaches plus 100 microamperes. (Diffusion pump switch: upper position is high heat; lower position is low heat.) If high heat is used, switch to low heat immediately upon obtaining a reading above 100 microamperes.

8. The heater switch is ON in the lower position and the temperature is controlled by the variac marked Heater Control. This operation should coincide with the starting of the diffusion pump. The heat control should vary directly with the length of time required to obtain a

12. Cool the diffusion pump, preferably with water, until the bottom of the pump is barely warm upon being touched.

13. Close the valve between the diffusion pump and the mechanical pump.

14. Turn off the mechanical pump.

15. Open the air inlet valve and admit air to the system gradually.

16. Precautions to be observed. a) Always heat and cool optics gradually. Sudden changes in temperature may cause breakage.

satisfactory vacuum. With average units requiring 1 hour to produce a vacuum, start the heater control at 20 and increase 20 units at intervals of 10 minutes until a reading of 80 is reached. The ultimate reading and rate of increase of settings is inversely proportional to the length of time required to reach a satisfactory vacuum.

9. Satisfactory vacuum is reached when the thermocouple output meter reaches its final value (usually 190 to 200 microamperes), and remains at that reading for 15 to 20 minutes. Then turn on the ion gage switch and carefully turn up the small variac control, watching the upper microammeter. The upper microammeter (plate) should not go off the scale and the lower milliammeter (grid) should not read beyond 5 milliamperes. When a reading on the microammeter of 3 1/2 or less is obtained with a reading of 5 on the milliammeter, the vacuum is satisfactory for coating.

10. Start the coating by turning the Heater Control variac to zero and the heater switch to the upper position. Watch the filament through the side port while the heat is gradually increased until a dull red color is obtained. Allow the filament to burn at this temperature for several minutes, unless it sputters, in which case decrease the heat input with the variac until the sputtering ceases. Then increase the heat until a light red color is obtained. Observe the optics by reflected light through the upper port and continue

Large optics should be heated and cooled more slowly than small optics.

b) Do not use the ion gage until the vacuum is sufficiently high. During normal operation, the ion gage is used as a checking gage and is turned on only while the reading is being taken. It is not designed for continuous operation and one or two checks per run should be sufficient.

c) Do not turn on the diffusion pump before a satisfactory high vacuum is reached. The pump oil (octoil) cracks if heated in too low a vacuum. It is then necessary to replace the oil, an expensive, time-consuming operation.

d) If the filament is heated too rapidly, hot particles of magnesium fluoride spatter from the filament and imbed themselves in the optics being coated.

e) Keep the entire inner surface of the coating chamber free of grease and dirt. Both the rate of obtaining a satisfactory vacuum and the hardness of the coating are adversely affected by the presence of dirt in this chamber.

f) Do not use castor oil on the bell jar gasket. It is not necessary and may contaminate the system.

g) The base plate and the rubber gasket on the bell jar should be absolutely free of small particles of foreign matter in order to assure a perfect seal when the bell jar is seated.

17. These instructions are for systems in which a vacuum-type valve is used. If a vacuum type

coating until the proper purple color is reached. Then turn the heat control to the OFF position.

11. Turn the filament and diffusion pump switch to the OFF position.

valve is no used, the air inlet valve should be opened before turning off the mechanical pump.

3C2. Cleaning optics for coating when afloat. When afloat optics may be cleaned for coating in the following manner:

1. Wash the optics in aerosol solution. A very low concentration of aerosol is effective.

2. Test the dried optics to determine whether water wets the entire surface.

3. If grease is difficult to remove, rub the surface of the optics with calcium carbonate and rewash in aerosol solution.

4. After the entire surface is wet with water, spray the surface with hot distilled water until the optics become hot.

5. Use a small hand-aspiration bulb to blow the remaining water from the surface.

6. If no water marks remain on the dry surface, the optics are ready for coating. Optics should be recleaned if water marks remain on the surfaces.

7. Precautions to be observed. a) This method is more difficult than methods which can be used ashore, but with practice the operators become proficient.

b) Never touch the surface with anything after it has been cleaned for coating.

c) Do not breathe on a surface after cleaning.

d) Water marks or grease spots lower the quality of the coating; consequently, it is advisable to reclean the optics if there is any doubt of their being absolutely clean.

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Figures 4-16 and 4-47. Inner Tube and Telescope Systems and Optical Arrangement Ray Diagrams

4
DESIGN DESIGNATION 91KA40T/1.414HA PERISCOPE

A. GENERAL DESCRIPTION

4A1. Principal characteristics. The submarine periscope Type II is a general purpose instrument of 40-foot nominal length and 7 1/2-inch outer diameter. It is equipped with a tilting head prism capable of elevating the line of sight 74.5 degrees above the horizontal and of correcting for the roll or pitch of the vessel. Its optical elements are treated to increase light transmission. The instrument is designed for high- and low-power observation, and is supplied with a built-in stadimeter for estimating the range and course angle of the target. The principal characteristics of the periscope are as follows:

Characteristic	Value
Magnification	Low power 1.5x High power 6.0x
True field of view	Low power 32 degrees High power 8 degrees
Maximum elevation of line	74.5 degrees
Net weight of periscope	2000 lb
Material of body tube	CRS
Material of taper section	CRS

4A2. Shipping, unpacking, and handling. A modern submarine periscope with a reduced section of small diameter is a fragile instrument, especially during handling and shipment. It is shipped in a box of sturdy construction, but to prevent needless stresses it is advisable that the box, whenever possible, be hoisted or supported at more than one point, preferably the quarter-points. During rail shipment, the box should be securely chocked in the car. A reach truck is desirable for highway movement, and in any case the box should be loaded so that the portion overhanging the truck contains the upper, lighter end of the periscope. The name plate of the shipping box is placed at the end containing the lower heavier portion of the periscope.

The periscope is secured in the box by chocks, with brass clamps provided to prevent endwise movement in the box. The clamps should remain with the box for reuse. The cover of the box when

of sight (above Horizontal)	
Maximum depression of line of sight (below Horizontal)	10 degrees
Maximum elevation of edge of field (above Horizontal)	Low power 90.5 degrees High power 78.5 degrees
Diameter of exit pupil (both powers)	4 mm
Over-all length of periscope	41 ft 6 5/8 in.
Optical length	40 ft
Outer diameter of reduced section	1.414 in.
Outer diameter of body tube	7.500 in.
Maximum diameter of hoisting yoke	14.750 in.
Maximum diameter of outer external projections	15.250 in.

inverted, serves as a convenient support for the instrument.

In case of reshipment of the periscope, care should be taken to see that the brass clamps are in place, and that all accessories are either mounted on the instrument or secured inside the box.

B. HEAD WINDOW AND OUTER HEAD

4B1. General description. The area of the head window is as small as practicable. Its bezel frame is secured by screws. These screws are of noncorrosive material. The head window and its bezel frame are of sufficient strength to withstand an internal 150 psi hydraulic test or an external 300 psi hydraulic test.

In order to be sure that the head window does not crack as a result of the temperatures to which the instrument is subjected in service, the upper 2 feet of the instrument are tested by being immersed in water and heated to a temperature of 150 degrees F. This temperature is maintained for at least one-half hour. The upper 2 feet of the instrument are then plunged into water of a temperature not more than 70 degrees F and allowed to remain for at least one-half hour. This test is made after the final installation of the head window,

but before the optics are in place. Any further adjustment of the head window necessitates a repetition of this test after such adjustment has been made. In Type II periscopes in which a joint between the head and the taper section must be broken when installing optics in the head, this test may be made upon the head only.

In view of the shocks to which this part of the periscope may be subjected in service, such as a depth-charge attack, an ample margin of strength beyond that necessary to withstand the specified test is most desirable. This is especially true of the head window itself.

The metallic seats for the head window, both in the head and in the bezel frame, should be scraped as necessary to give a true bearing. An approved gasket is inserted between the head window and its seat. Both in the design of the head window, its securing device, and their final assembly in the periscope, all possible precautions are taken to prevent setting up unequal strains in the glass caused by unevenness of the seat, bezel frame, or gaskets, or by uneven setting up of the securing device, or by other causes.

The inner circumference of the head window bezel frame is beveled outward and away from its line of contact with the glass. This increases the effect of wind in clearing drops of water from the glass and reduces the lodgment of water and the deposit of salt by evaporation on the glass near the inner circumference of the bezel frame.

4B2. Outer head assembly. The outer head assembly is composed of the following parts, as shown in Figure 4-1. All bubble numbers in Sections 4B2, 3, and 4 refer to Figure 4-1 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1389-2	12	Outer head seat lockscrews (lower)
2	P-1407-1	1	Outer head
3	P-1407-2	1	Head window bezel frame rubber gasket
4	P-1407-3	1	Head window seat rubber gasket
5	P-1407-4	1	Outer head seat rubber gasket
6	P-1409-	1	Head window

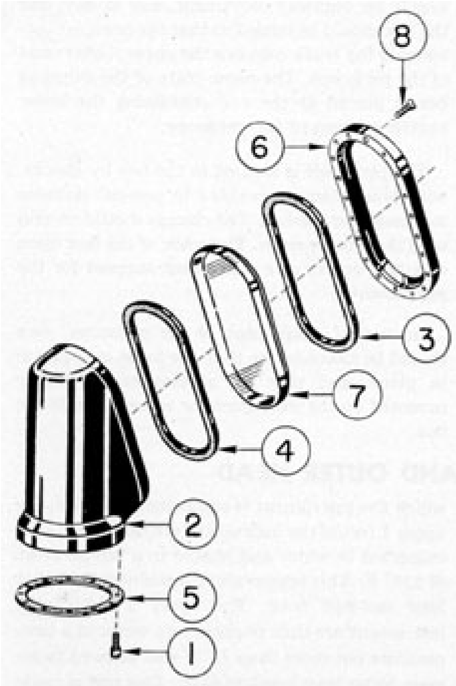


Figure 4-1. Outer head assembly.

	8		bezel frame
7	P-1418-1	1	Head window
8	P-1422-11	20	Head window bezel frame lockscrews

4B3. Description. a. Outer head. The outer head (2) is made of corrosion-resisting steel material. It is designed to meet the service requirements of a covering for the upper part of the skeleton head assembly. The bottom face is counterbored to a nominal depth to accommodate the outer head seat rubber gasket (5). The smaller counterbore is a push fit over a shoulder of the outer taper section (1, Figure 4-15). The machined recess in the outer head is at an angle of 22 degrees from the vertical centerline. This recess receives a head window seat rubber gasket (4) and the head window (7).

The outer face of the outer head has 20 proportionately spaced 6-40 tapped holes to accommodate the head window bezel frame (6). This frame is secured with 20 corrosion-resisting steel lockscrews (8).

The bottom face, or seat, of the outer head (2) has 12 equally spaced 4-48 tapped holes to receive the lockscrews (1).

A recess of nominal depth, 3/8-inch width, and 5/8-inch length is machined in the rear inner wall of the outer head to provide sufficient clearance for the movement of the skeleton head eccentric arm (21, Figure 4-17).

and preventing damage to the head prism (55). Check the right training handle; it should be set for low power.

2. Remove the AIR OUTLET plug (14, Figure 4-29) and open the AIR OUTLET valve (16) of the eyepiece box (11) to allow the internal gas pressure to be released slowly.

3. Remove the putty from the 12 countersunk holes at the upper part of the outer taper section flange (1,

The inside wall of the outer head is provided with approximately 0.010-inch clearance, so that it does not touch any part of the skeleton head mechanism when assembled to the outer taper section (1, Figure 4-15).

b. Head window bezel frame. The head window bezel frame (6) is made of phosphor-bronze material. Its lower face has a machined irregular recess to fit over the head window (7) with a 45 degrees angle. The 45 degrees angle of the beveled recess is to accommodate a head window bezel frame rubber gasket (3) which compresses to the angle of the head window to form an airtight seal.

The outer flange of the head window bezel frame has 20 proportionately spaced clearance holes with countersunk heads to accommodate the lockscrews (8). These lockscrews extend into tapped holes in the face of the outer head (2). The inner irregular circumference of the head window bezel frame is beveled outward at an angle of 22 degrees away from the line of contact with the glass.

c. Head window. The head window (7) is made of one crown optical glass element with parallel surfaces. It is molded with a 45 degrees angle edge to which a head window bezel frame rubber gasket (3) is applied. It provides a means of sealing without obstructing the entering light rays, and offers a transparent

Figure 4-15). This putty covers up the screw heads and permits only personnel familiar with the instrument to break the seal of the periscope.

4. After the nitrogen pressure is released, close the AIR OUTLET valve (16) and replace the AIR OUTLET plug (14, Figure 4-29).

5. Remove the 12 lockscrews (1) from the upper flange of the outer taper section (1, Figure 4-15).

6. Remove the outer head assembly from the outer taper section (1, Figure 4-15) by slowly pulling off the outer head.

7. Remove the outer head seat rubber gasket (5) from the outer taper section shoulder (1, Figure 4-15).

8. Slack off each of 20 head window bezel frame lockscrews (8) several turns.

9. Assemble the outer head seat rubber gasket (5) and the outer head (2) to a special jig with about six lockscrews (1). Apply an internal air pressure of 15 to 30 psi to the outer head assembly to break the seal of the head window (7).

10. Remove the outer head assembly from the special jig.

11. Remove the 20 head window bezel frame lockscrews (8).

12. Lift the head window bezel frame (6) off the outer head (2).

13. Push out the head window (7), placing a piece of clean lens tissue on its bottom face. The lens tissue is applied from the lower base opening of the outer head (2).

medium through which light is transmitted.

4B4. Disassembly of the outer head. The outer head is disassembled as follows;

1. Rotate the revolving grip of the left training handle assembly (2) so that the zero line of sight graduation of the index ring (6) corresponds to the stationary index line graduation of the fixed grip (29, Figure 4-43). This places the head prism at zero line of sight, offering no obstruction for the removal of the outer head,

14. Remove the head window seat rubber gasket (4) from the seat of the outer head (2) and destroy it.

4B5. Reassembly of the outer head. The outer head is reassembled as follows:

1. Scrape the seat of the-outer head, if necessary, to give a true bearing. Mark the head window (7) in the position it is scraped so that it cannot be turned end-for-end.

2. Insert the new head window seat rubber gasket (4) of crude rubber of specified drawing dimensions into the head window seat of the outer head (2).

3. Scrape the beveled seat of the head window bezel frame (6), if necessary, to provide a true bearing surface in conjunction with the beveled edge of the head window (7).

4. Clean the inner surface of the head window (7) with clean lens tissue, and use a small air bulb to blow off surface dust.

of the head window bezel frame (6) over the head window bezel frame rubber gasket (3). Place a C-clamp over the wooden block and the outer head to flatten the raised center portion of the rubber gasket. Use a wooden wedge on the opposite side of the outer head to tighten the clamp evenly. The flattening of the rubber gasket forces the outer edges to adhere to the inner beveled walls of the head window bezel frame (6), and utilizes the entire area of the beveled surface of the head window bezel frame to maintain the seal.

9. Lubricate the threads of the head window bezel frame lockscrews (8) lightly with a medium grease before insertion, and tighten them evenly. Take each lockscrew down equally in a series of all-around adjustments and use a feeler gage as a check around the head window bezel frame (6).

10. It is desirable to wet the head window bezel frame rubber gasket

5. Place the head window (7) in the head window seat of the outer head (2) on the head window seat rubber gasket (4).

6. The head window bezel frame rubber gasket (3) should be approximately 0.072 inch larger than the head window outer irregular circumference, except to comply to drawing dimension as to thickness. Place it in the head window bezel frame (6) in one solid piece. Punch a small hole in the center of the rubber gasket to enable the trapped air to escape.

7. Place the head window bezel frame (6) with the head window bezel frame rubber gasket (3) over the head window (7). Insert the four lockscrews (8) into the tapped holes in the flange of the outer head, and screw each lockscrew down flush with the head window bezel frame.

8. Place a flat wooden block 1 inch thick and slightly smaller than the inner circumference (3), thereby providing a lubricant for the brass knife-edge, when cutting the crude rubber gasket around the inner irregular circumference of the head window bezel frame (6). The brass blade does not scratch the head window surface.

11. Clean the outer surface of the head window in the same manner as outlined in Step 4 of this section,

12. Use a lens strain testing device to insure that unequal strain is not placed on the head window (7).

13. The outer head seat rubber gasket (5) and the outer head (2) are not assembled to the outer taper section (1, Figure 4-15) with lockscrews (1) until complete disassembly, assembly, and collimation of the instrument have been completed.

C. REMOVING INNER TUBE

4C1. Disassembly of the inner tube from the outer tube. The inner tube is removed from the outer tube as follows:

1. Place the periscope on V-blocks of the optical I-beam bench. Place it so that sufficient space remains to permit removal of the inner tube.

2. Remove the four axial alignment screws (48, Figure 4- of the upper part of the outer taper section (1, Figure 4-15). Unscrew them from the skeleton head (20, Figure 4-17) and the outer taper section. Place these lockscrews, in a small box.

3. Remove side plate and pressure gage lockscrews (5, Figure 4-29) from both sides of the eyepiece box (11). It may be necessary to tap out two diagonally opposite holes with an 32 tap in the side plate (9) and the pressure gage

17) located in the small shoulder

assembly (21) for the insertion of special lockscrews to break the seal of the rubber gaskets (10). Remove the two rubber gaskets (10).

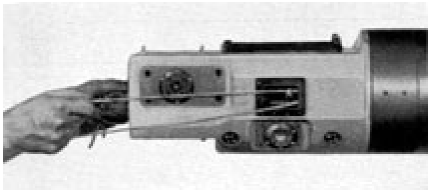


Figure 4-2. Special cord attached to shifting wire spindles and held with both hands.

4. Using two pieces of special cord of 3-foot length doubled, secure one end of each piece of cord to the spindles (1, Figure 4-28) of the power shifting side, and secure the other two loose ends to the spindles (1) of the prism shifting side. Take special care that the end of one cord is secured to the left spindle (1) of the power shifting side, while the other end is secured to the right spindle (1) of the prism shifting side (Figure 4-2). The second piece of cord is secured in like manner to permit one man to hold one set of shifting wire spindles (1) with one hand, while the other set of spindles (1, Figure 4-28) a held with the other hand, using the looped cords.

adapter to be carried over the shifting wire (38) up to the shifting wire spindle adjusting nuts (4). Each lower adjusting nut (4), when removed from the shifting wire spindle (1), is turned onto the short threaded stem of the adapter. This permits each adjusting nut (4) to be lifted out through the side plate (9) opening of the eyepiece box (11, Figure 4-29). The skeleton head assembly is to be withdrawn (Figure 4-4) sufficiently to expose the clamp blocks (16, Figure 4-17) and remove it from the outer taper section (1, Figure 4-15).

6. Remove the shifting wire tape (38, Figure 4-28) from the clamp blocks (16, Figure 4-17) removing and replacing the clamp blocks (16) and clamp block lockscrews (12) to the prism and cube shifting racks (40, 42, 17, and 18) of the skeleton head assembly.

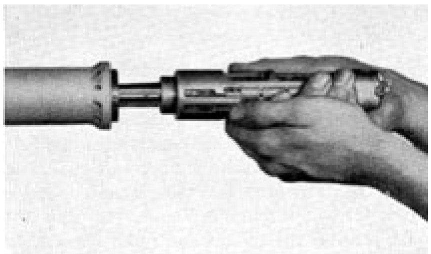


Figure 4-4. The skeleton head assembly is withdrawn.

7. Before proceeding, it is necessary to secure the tapes in place. This is done by using a special metal dowel 1 inch in diameter (Figure 4-5) to which the tapes are tightened sufficiently to pull the dowel into contact with the ninth reduced tube section. (1, Figure 4-18). A larger dowel will not pass through the

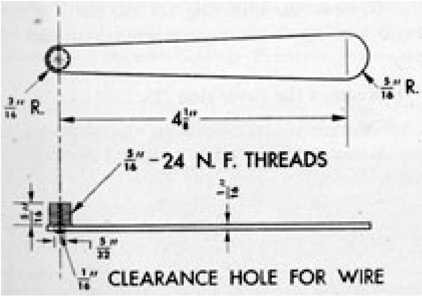


Figure 4-3. Special spindle adjusting nut adapter.

5. By means of a special spindle adjusting nut removal adapter (Figure 4-3) remove the four shifting wire spindle adjusting nuts (4, Figure 4-28) one by one. The adapter has a short threaded stem which has a clearance hole through its center axis. The clearance hole permits the

outer taper section (1, Figure 4-15) while a smaller one may rest on the auxiliary upper eyepiece lens (5, Figure 4-18), in the upper part of the ninth reduced tube section and damage it.

8. After the tapes (38, Figure 4-28) are tightened to the 1-inch metal dowel, and pulled down into contact with the ninth reduced tube section (1, Figure 4-18) by means of the looped cords, the shifting wire spindles (1, Figure 4-28) are free of the prism and power shifting racks (43, 44, 45, and 46) of the eyepiece skeleton assembly.

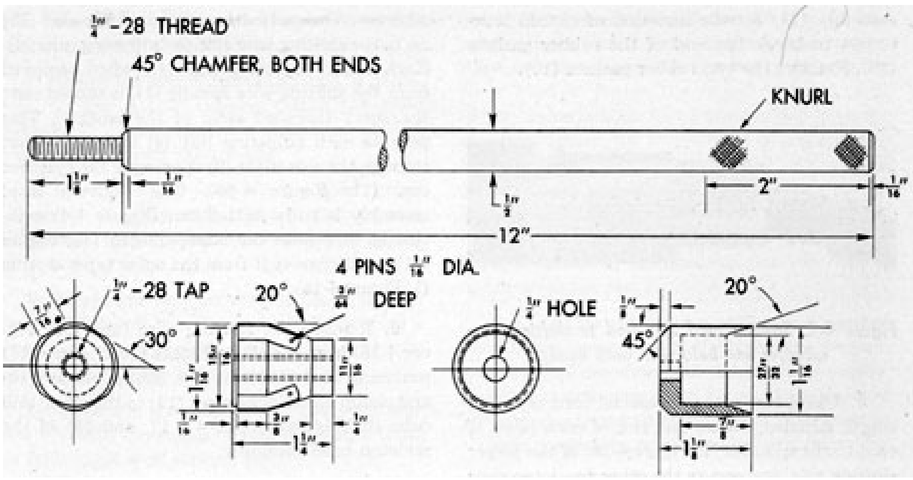


Figure 4-5. One-inch metal dowel, detail drawing.

9. Turn the stadimeter handwheel (12, Figure 4-24) to the observing position as noted by the stamped numerals on the stadimeter housing (67). The number 58 on the height scale dial (52) should appear approximately opposite the value 2.2 on the range scale dial (50). Values opposite 58 and 2.2 will be found in Figure 2-12. This will make possible the correct and rapid reassembly of the

14. The hoisting yoke assembly is disassembled in the following manner (Figure 7-26)

a. Remove the covering lockscrews (4).

b. Unscrew the cover ring (2) with a spanner wrench. Remove the hoisting yoke body (1), phosphor-bronze locating collar (9), lower ball-bearing race (8), ball bearings and retainer (7), and the upper ball-bearing race (6).

stadimeter housing assembly. Remove the four stadimeter housing bolts (30, Figure 4-24) and take off the stadimeter housing assembly with care to prevent bending the stadimeter transmission shaft (22, Figure 4-27). An automatic stop prevents rotation of the stadimeter handwheel (12, Figure 4-24) when not in place.

10. Remove the training handles by taking out the eight hinge bracket bolts (19 and 21, Figures 4-43 and 4-44, respectively) for the left and right training handle assemblies.

11. Remove the focusing knob assembly by taking out the four lockscrews (10, Figure 4-39).

12. Remove the rayfilter by pulling outward on both spring-actuated plunger knobs (24, Figure 4-40).

13. Remove the eyepiece attachments that are secured to the anchor screw pins (19, Figure 4-29) projecting from the eyepiece box itself.

c. Remove the split ring (3). All parts of the thrust bearing should be protected from dirt or grit.

d. Remove the cover ring (2).

15. Rotate the periscope on the V-blocks of the Optical I-beam bench so that the eyepiece end is down.

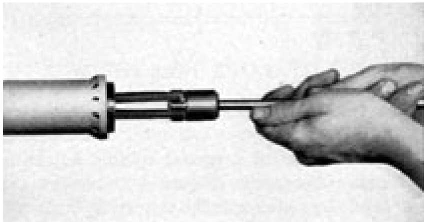


Figure 4-6. Shifting wire tapes attached to 1-inch metal dowel.

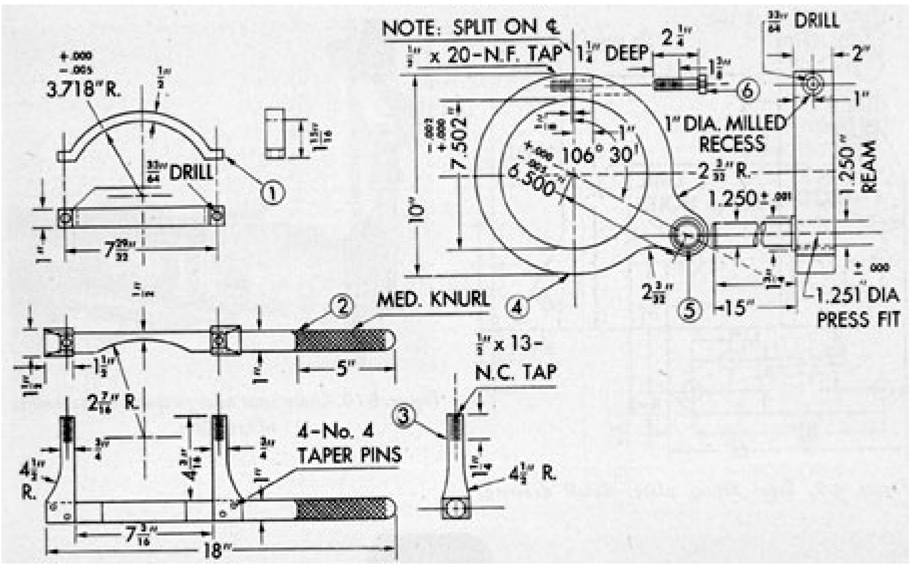


Figure 4-7. Eyepiece box and outer tube alignment guides.

16. Place the special outer tube alignment guide on the outer tube over the undercut section. Using a socket wrench, secure it so that the slotted section is lined up temporarily to the rear vertical azimuth line of the outer tube (Figure 4-7). Place the eyepiece box alignment guide over the two flat side portions of the eyepiece box (11, Figure 4-29), resting it on the front flat portion. Assemble the radius clamp (Figure 4-7) from the rear side of the eyepiece box (11, Figure 4-29) to the two bolt projections of the eyepiece box alignment guide. Check the outer tube and eyepiece box alignment guide handles to ascertain their contact (Figure 4-8). Should any separation be detected, loosen the outer tube alignment guide bolt with the socket wrench and rotate its handle in contact with the eyepiece box alignment guide handle and secure it. The purpose of this outer tube and the eyepiece box alignment guides is to establish correct entry and removal guidance for the angular alignment key (1) in the eyepiece box (11, Figure 4-29), with the keyway in the lower part of the outer tube (2, Figure 4-15).

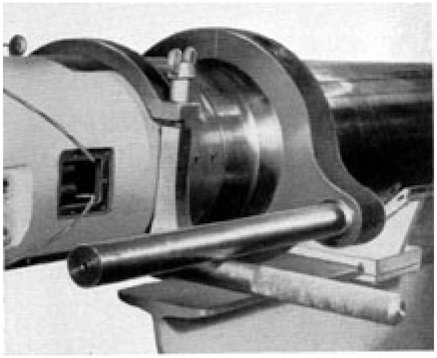


Figure 4-8. Eyepiece box and outer tube alignment guide handles in contact.

17. Remove the two lockscrews (7, Figure 4-29) in the main coupling (2) at the eyepiece box (11). Unscrew the main coupling (2), using a special spanner wrench. The main coupling (2) has a right-hand thread on the outer tube and a left-hand thread on the eyepiece box (11).

18. Attach a steel lifting plate (Figure 4-9) to the base of the eyepiece box (11, Figure 4-29) and insert four bolts in the clearance holes in the steel lifting plate and the tapped holes in the

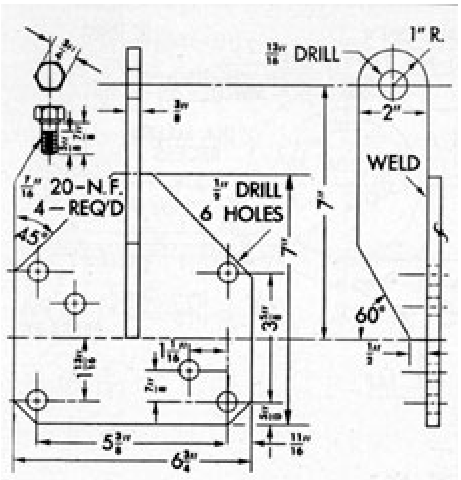


Figure 4-9. Steel lifting plate, detail drawing.

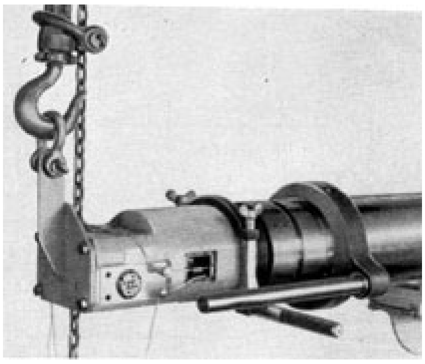


Figure 4-10. Chain hoist hook in shackle attached to lifting plate.

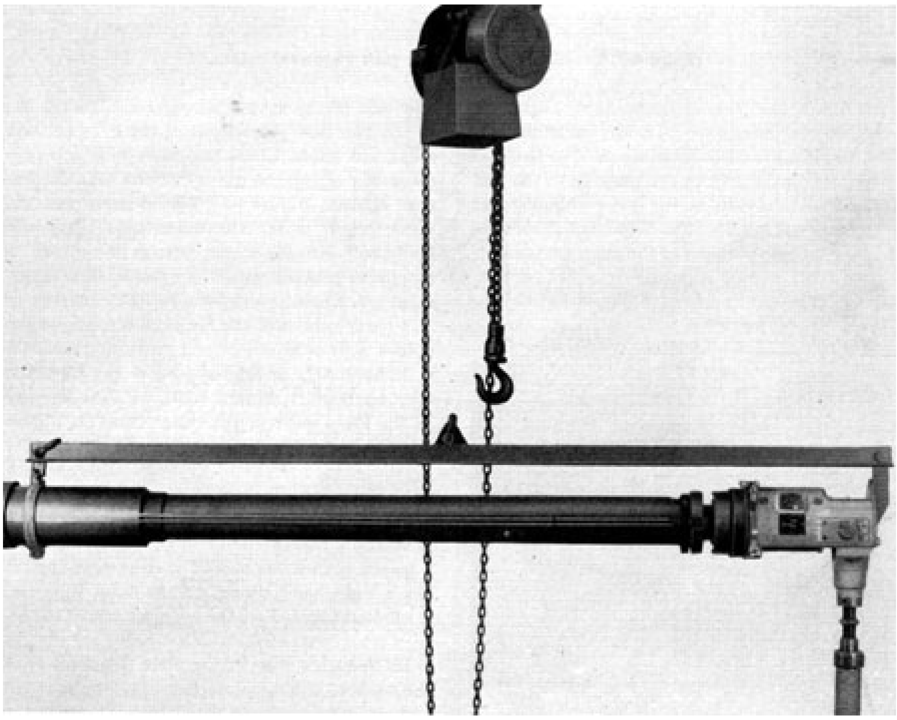


Figure 4-11. Adjustable roller stand placed under eyepiece box.

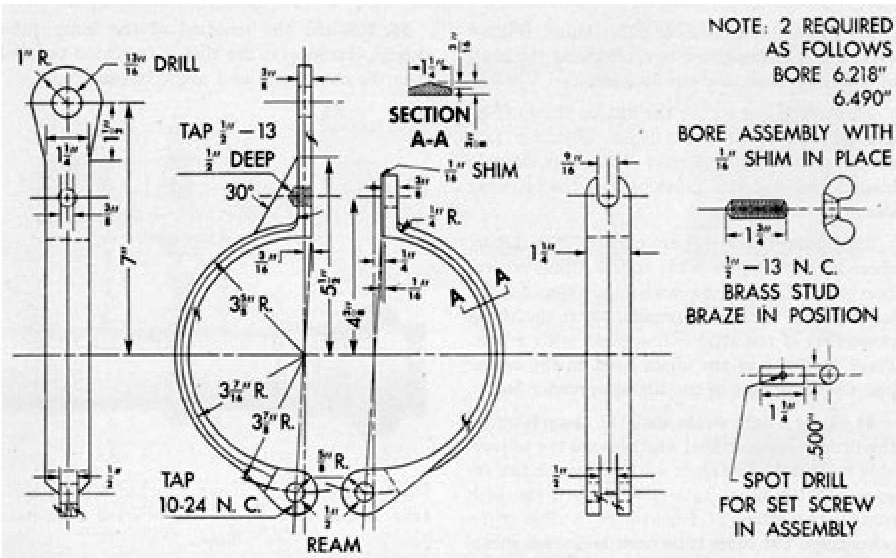


Figure 4-12. Hinged clamp, detail drawing.

eyepiece box. Secure the steel lifting plate to the eyepiece box base (11).

19. Attach a shackle to the lifting projection of the steel lifting plate, and insert the hook of the chain hoist (Figure 4-10). Apply a light lifting strain to this end of the eyepiece box.

20. Slowly pull the inner tube section out of the outer tube until the lower (split) objective lens coupling sleeve (34, Figure 4-23) is clear of the outer tube. The inner tube must be guided parallel to the outer tube and properly centered in it.

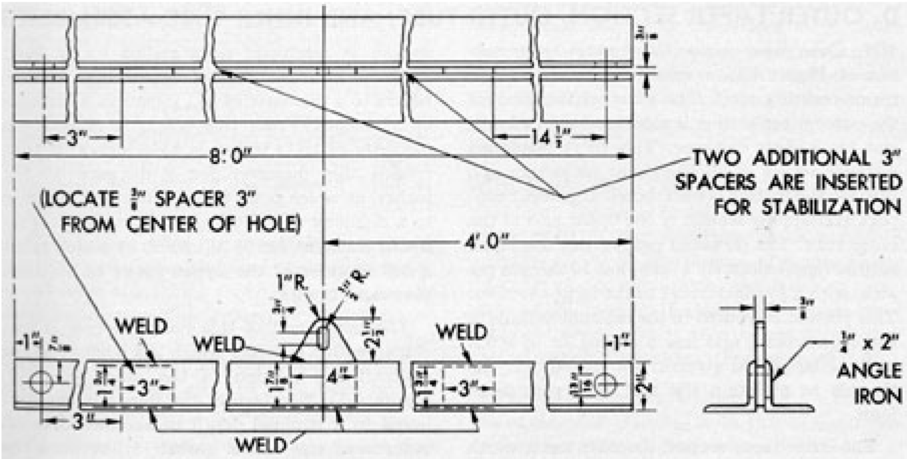


Figure 4-13. Lifting spreader bar, detail drawing.

21. Place the adjustable roller stand (Figure 4-11) under the eyepiece box, removing the hook of the chain hoist and the shackle.

22. Attach and secure the hinged clamp (Figure 4-12) over the lower (split) objective lens coupling sleeve (34, Figure 4-23). Locate this hinged clamp at the upper part of the coupling sleeve.

23. Connect the upper part of the lifting spreader bar (Figure 4-13) to the lifting projection of the hinged clamp with a bolt. Connect the lower part of the lifting spreader bar to the lifting projection of the steel lifting plate with a bolt. Place the hook of the chain hoist in the center

26. Resume the removal of the inner tube slowly, checking to see that it is guided parallel with the outer tube and properly centered.

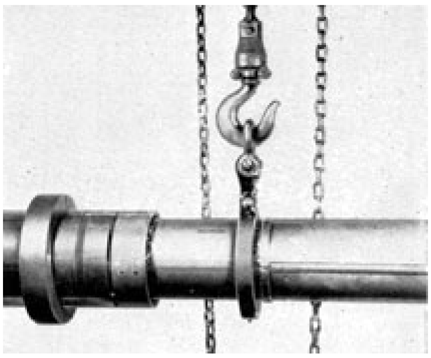


Figure 4-14. Hinged clamp attached to fifth inner tube section with shackle and inserted chain hoist hook.

27. Transport the inner tube to the V-blocks of the second I-beam bench. Remove both chain hoist hooks, hinged clamps, and the steel lifting plate.

pad clearance hole of the lifting spreader bar.

24. Take a light strain with the chain hoist on the lifting spreader bar, and remove the adjustable roller stand (Figure 4-11). Resume the removal of the inner tube slowly until the fifth inner tube section (34, Figure 4-20) is clear of the outer tube. The inner tube must be guided parallel with the outer tube and properly centered in it.

25. Attach and secure another hinged clamp (Figure 4-14) over the upper part of the fifth inner tube section (34, Figure 4-20). Attach a shackle in the hole of the lifting projection of the hinged clamp, and with the hook of the chain hoist placed in the shackle, take a light strain with the chain hoist.

28. Using canvas-covered galvanized cable slings, each wrapped once around the outer tube, remove the outer tube from the V-blocks of the Optical I-beam bench with both chain hoists and transport it to the periscope rack.

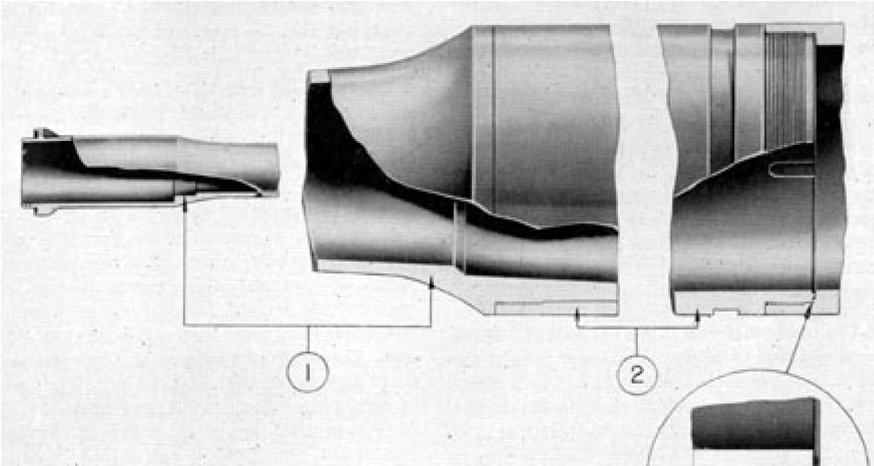
D. OUTER TAPER SECTION, OUTER TUBE, AND INNER TUBE ASSEMBLIES

4D1. Outer taper section. The outer taper section (1, Figure 4-15) is made of solid forged corrosion-resisting steel. The external diameter of the outer taper section is machined at the lower end for a short distance. This short machined distance serves as an alignment projection and fits into the mating counterbored alignment support overlapping section of the upper part of the outer tube. The threaded part of this machined section (approximately 1 inch) has 12 threads per inch, with a 1/16-inch relief to the large shoulder. This portion is secured in the internal threads of the counterbore, and has a section is machined at a radius for a short distance to a diameter of 5 5/8 inches. It then tapers to a diameter of 1 3/4 inches in a distance of 37 inches. From this point, it tapers to a diameter of 1.414 inches in 13 3/8 inches. It then retains this diameter for a distance of 8 1/8 inches, at which point it is machined at a radius to a diameter of 1.870 inches. This diameter remains constant for 3 3/16 inches, at which point a 30 degrees chamfer of the upper flange of 2/12-inch diameter remains.

The upper end of this flange section is machined with a shoulder which is a push fit in the

sliding fit of 0.004 inch. Litharge and glycerin are coated over the threads to maintain the seal as a permanent joint.

The outer taper section shoulder has a width of 1/2 inch. From this shoulder, the outer taper counterbored portion of the outer head (2, Figure 4-1). The face of the flange is counterbored to a nominal depth to accommodate an outer head seat rubber gasket (5), between the flange and the outer head (2). In this



ILL. NO.	DRAWING NUMBER	NUMBER REQUIRED	NOMENCLATURE
(1)	P-1383-1	(1)	OUTER TAPER SECTION
(2)	P-1206-1	(1)	OUTER TUBE

Figure 4-15. Outer taper section and outer tube, cross-sectional view.

counterbore, 12 equally spaced holes are provided to accommodate lockscrews (1). The clearance holes are countersunk from the lower end of the radius of the flange.

The upper end of the machined 1.414-inch section is counterbored a short distance with an additional counterbored section to receive the skeleton head assembly (Figure 4-17). A keyway, 0.032 inch deep and 0.124 inch wide, is provided a short distance in the upper part of the counterbored wall. This keyway receives the angular alignment key (19) of the skeleton head assembly and maintains its angular alignment.

point by more than +0.005 inch or -0.000 inch. The bore of the taper is concentric with the outside diameter within 0.005 inch.

The inside section of the lower end of the outer taper section is chamfered at its lower face at a 30 degrees angle. From this point, with a 6 3/8-inch diameter, it tapers upward to a diameter of 5.560 inches in a distance of 6.752 inches, with the shoulder chamfered to a diameter of 4.930 inches.

4D2. Outer tube. The outer tube (2, Figure 4-15) and the outer taper section (1) form the outer shell of the periscope. It is machined cylindrically to fit into a series of bronze steady bearings of the submarine, and is bored

Two tapped holes are provided on each side in the overlapping shoulder that projects upward from the flange face. These four tapped holes receive headless lockscrews (48), which retain the skeleton head assembly in the counterbore and extend into mating tapped holes in the cube bracket (45) and the gear train bracket (30) of the skeleton head assembly.

The inside diameter of the taper section does not vary from the calculated diameter at any cylindrically to receive the assembled inner tube sections, which consist of a series of five telescope system assemblies (Figure 4-16).

The outer tube is machined from a solid forging of corrosion-resisting steel. It is 34 feet 1 inch in length and finished to an outside diameter of 7.497 inches, plus 0.000 inch, minus 0.002 inch.

The upper part of the outer tube is counterbored a short distance, serving as an alignment overlapping support for the alignment projection of the outer taper section (1). The 1-inch threaded portion of the alignment overlapping support of 12 threads per inch has a 1/8-inch relief to provide the external threads of the alignment projection of the outer taper section easy entry without crossing the threads. The upper face is finished smooth to form a metal-to-metal contact with the lower shoulder face of the outer taper section (1, Figure 4-15) when assembled.

The inside diameter is ground to 6.375 inches for a distance of 26 feet. The lower part of the outer tube has a counterbore of 6 1/2-inch diameter for 7 feet, with a 15 degrees chamfer to the smaller diameter. This partially counterbored section provides sufficient clearance for the lower maintains the angular alignment with the eyepiece box (11) by means of the angular alignment key (1).

Two azimuth scale index lines are scribed on the outer tube. The second line is 180 degrees from the first line. Both lines lie in a plane passing through the axis of the outer tube and coinciding approximately with the plane of sight through the vertical centerline of the telemeter lens of the periscope. These lines are in the form of grooves of rectangular section with sides parallel to that radius of the tube which passes through the center of the groove. The width of each groove is not less than 0.015 inch nor more than 0.020 inch. The depth of each groove is not less than 0.010 inch nor more than 0.015 inch. The center of each groove does not, at any point, deviate more than 0.003 inch to either side of a straight line parallel to the axis of the outer tube of the periscope. The angle between the plane in which the

(split) objective lens coupling sleeve (34, Figure 4-23).

The external diameter at the lower part has a 5/8-inch undercut section to a depth of 5/32 inch on a side of the vertical centerline. This undercut section starts 2 inches from the bottom face and receives two split ring halves (3, Figure 7-26) of the hoisting yoke assembly. The entire weight of the periscope is carried by the hoisting yoke assembled over the halves of the split ring (3).

The lower external part of the outer tube has a turned shoulder with a threaded section of 12 threads per inch. The threaded section is relieved on each end with a slot, machined for a width of 0.125 inch.

On the lower face of the outer tube, there is a triangular annular ridge on the shoulder 1/64 inch in height and approximately 1/16 inch in width at the base. The angles, including the apex, are filleted. The triangular annular ridge detail is provided to compress a rubber gasket (8, Figure 4-29) into a corresponding triangular annular groove in the large upper face of the eyepiece box (11) joint shoulder. The compression of the rubber gasket (8) into the triangular annular groove of the eyepiece box (11) insures an airtight sealed joint.

A keyway of 3/8-inch width, 1/16-inch depth, and length of 1 1/8 inch is provided in the inner wall of the vertical centerline. This keyway grooves are situated and the plane of sight through the vertical centerline of the telemeter lens of the instrument is as small as practicable and does not in any case exceed 15 minutes. The grooves extend upward from the top of the hoisting yoke groove along the outer tube for a distance of 6 feet. In some periscopes the grooves have been extended to a length of 22 feet above the hoisting yoke groove.

Numbers are stamped or engraved on the eyepiece side of the outer tube at intervals of 1 foot for a distance of 6 feet above the hoisting yoke groove, showing the distance in feet from the axis of the line sight through the head window of the periscope to the position of the upper edge of each number. The left edge of the left digit of each number is located 1/2 inch to the right of the azimuth index line, each number is at least 3/8 inch high and is stamped or engraved to a sufficient width and depth as to be easily visible to a person standing 5 feet away from the periscope.

The steady bearings are placed in the submarine periscope supports at intervals to carry the periscope vertically, and also to provide vertical guidance. The periscope can be trained through 360 degrees of azimuth, and raised and lowered.

The raising and lowering are accomplished by one of two systems, electric or hydraulic. With the electric hoisting system, the wire ropes

are attached to the hoisting yoke. The wire ropes in turn are carried over pulleys to a cable drum, which is operated by an electric motor. Safety cutout switches are provided to cut off the power when the periscope is at the limit of the vertical travel at the observing position or at the lowered position.

With the hydraulic hoisting system, the plunger rods are attached to the bracket connectors secured to the hoisting yoke. The hydraulic control valve controls the raising and lowering of the periscope by means of the ship's hydraulic system under high pressure. A safety limit stop serves to cut off the hydraulic pressure when the periscope is at the limit of the vertical travel or the observing position. The weight of the periscope causes the hydraulic pistons to act on the volume of oil in the low-pressure side of the system, and the friction of the oil in the return piping to control the lowering of the periscope. No limit stop is provided in lowering the periscope. The precautions to be taken when elevating and lowering a periscope are:

1. Notify men working around the vicinity to stand clear.

2. Remove the cover plate (if fitted) over the top steady bearing of the submarine.

4D3. Inner tube assemblies. Figure 4-16 shows the inner tube of the periscope divided into five telescope systems. Each

3. Auxiliary lower telescope system: second, third, fourth, fifth, and sixth reduced tube sections.

4. Upper main telescope system.

Part I. First reduced tube section and fifth and sixth inner tube sections.

Part II. Second, third, and fourth inner tube sections.

5. Lower main telescope system.

a. Lower (split) objective lens and mount assembly.

b. Objective operating mechanism assembly.

c. First inner tube section assembly.

d. Eyepiece skeleton assembly.

e. Eyepiece box and miscellaneous assemblies.

1) One stadimeter transmission shaft packing gland assembly, and four spring-loaded packing gland assemblies.

2) Eyepiece window frame assembly.

f. External projections to the eyepiece box.

1) Stadimeter housing assembly.

2) Focusing knob assembly.

3) Rayfilter assembly.

4) Eye buffer and blinder assembly.

5) Variable density polaroid filter assembly.

6) Training handle assemblies.

telescope system is made up of assemblies as follows:

1. Galilean telescope system: skeleton head assembly.

2. Auxiliary upper telescope system: seventh, eighth, and ninth reduced tube sections.

7) Hoisting yoke assembly.

E. SEPARATION OF THE FIVE TELESCOPE SYSTEMS

4E1. Separation of the Galilean telescope system. 1. The Galilean telescope system is located in the skeleton head assembly. It has already been disassembled from the upper end of the outer taper section (1, Figure 4-15).

2. Remove the prism and power shifting tapes (38, Figure 4-28) by slacking off the four shifting wire clamps (2) of the eyepiece skeleton assembly. Remove them from the reduced tube and inner tube sections.

4E2. Separation of the auxiliary upper telescope system. This consists of the seventh, eighth, and ninth reduced tube section assembly.

1. Remove the four lockscrews (16, Figure 4-18) from the lower part of the seventh reduced tube section (14). These lockscrews are unscrewed from tapped holes in the upper part of the sixth reduced tube section (1, Figure 4-19).

2. Unscrew the lower part of the seventh reduced tube section (14, Figure 4-18) from the

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upper part of the sixth reduced tube section (1, Figure 4-19).

4E3. Separation of the auxiliary lower telescope system. This consists of the second, third, fourth, fifth, and sixth reduced tube section assembly.

1. Remove the two lockscrews (22, Figure 4-19) from the removable air line strap (21) and remove the air line strap. These lockscrews are unscrewed from tapped holes in the second reduced tube section (19).

from tapped holes in the fourth inner tube section upper end coupling (5, Figure 4-21).

5. Remove the fifth inner tube section (34, Figure 4-20) unscrewing it from the upper part of the fourth inner tube section upper end coupling (5, Figure 4-21).

6. Remove the two lockscrews (32) from the removable air line strap (30) and remove the air line strap from the lower part of the second inner tube section (22). These lockscrews are unscrewed from

2. Pull the air line section (18, Figure 4-20) outward to disconnect the air line coupling (14) and remove the air line section (18) from the air line adapter (11, Figure 4-19) and the attached coupling (14, Figure 4-20) from the bent air line section (17).

3. Remove the four lockscrews (8) from the upper part of the first reduced tube section (1). These lockscrews are unscrewed from tapped holes in the second reduced tube section (19, Figure 4-19).

4. Unscrew the second reduced tube section (19) from the first reduced tube section (1, Figure 4-20). The second, third, fourth, fifth, and sixth reduced tube sections are removed together.

4E4. Separation of the upper telescope system. This consists of two assemblies, Parts I and II.

1. Remove the two lockscrews (22, Figure 4-20) removing the removable air line strap (19) from the lower part of the first reduced tube section (1). Remove the bent air line (17) from this reduced tube section, carrying with it the air line coupling (15) and short air line section (16) from the upper opening of the soldered air line section (30) of the sixth inner tube section (23).

2. Remove the air line section (31) from the lower opening of the soldered air line section (30) of the sixth, inner tube section (23) and the upper opening of the soldered air line section (10) of the fourth inner tube section (1, Figure 4-21). tapped holes in the second inner tube section.

7. Remove the two lockscrews (24, Figure 4-27) from the removable air line strap (21) and remove the air line strap from the upper part of the first inner tube section (1).

8. Lift up both air line sections (29 and 18, Figures 4-21 and 4-27 respectively) sufficiently to remove the air line section (29, Figure 4-21) and the soldered air line coupling (28) from the air line section (18, Figure 4-27) of the first inner tube section (1), and remove the air line section (29, Figure 4-21) from its connection with the lower opening of the soldered air line section (20) of the third inner tube section (11).

9. Slide the air line section (18, Figure 4-27) upward to disconnect the air line coupling (17) from the bent air line section (16) located at the lower end of the first inner tube section (1).

10. Remove the two lockscrews (24) from the removable air line strap (19) and remove the air line strap from the lower part of the first inner tube section (1).

11. Remove the bent air line section (16) from its connection with the long air line coupling (15).

12. Unscrew the long air line coupling (15) from the flange of the eyepiece skeleton (42, Figure 4-28).

13. Remove the 15 lockscrews (27, Figure 4-23) from the lower part of the lower (split) objective lens coupling sleeve (34). These lockscrews are unscrewed from

3. Remove the air line section (21) pulling it outward to free it from the lower part of the soldered air line (10) of the fourth inner tube section (1) and removing it from the upper part of the soldered air line section (20) of the third inner tube section (11).

4. Remove the four lockscrews (35, Figure 4-20) from the lower part of the fifth inner tube section (34). These lockscrews are unscrewed tapped holes in the large flange section of the track sleeve (2).

14. Slide the lower telescope system assembly clear of the coupling sleeve (34) about a foot.

15. Remove the four lockscrews (22) from the upper part of the lower (split) objective lens coupling sleeve (34). These lockscrews are unscrewed from tapped holes in the lower part of

the second inner tube section lower end coupling (26, Figure 4-21).

16. Remove the split-objective lens coupling sleeve (34, Figure 4-23) unscrewing it from the lower part of the second inner tube section lower end coupling (26, Figure 4-21) and remove the second, third, and fourth inner tube section assembly.

4E5. Separation of the lower telescope system. The lower telescope system is broken into assemblies in the following manner:

1. Remove the two stadimeter collimating lockscrews (13, Figure 4-22) and washers (14) from each of the lower (split) objective lens and mount assembly halves. These lockscrews are unscrewed from tapped holes in each mounting plate half (5, Figure 4-23) of the objective operating mechanism assembly. The straight dowel pins (15, Figure 4-22) are carried out with the mounts (1 and 2)

8. Check reference marks on all four spring-loaded packing gland assemblies with corresponding reference marks of the eyepiece box (11, Figure 4-29).

9. Remove the six lockscrews (1, Figure 4-36) from the stuffing boxes (5) for the left and right training handle assemblies, and the six lock screws (3, Figure 4-35) from the stuffing box (6) for the eyepiece drive packing gland assembly.

10. Remove the four lockscrews (13, Figure 4-32) from the stuffing box (4) for the rayfilter packing gland assembly.

11. Remove the eyepiece drive and the left and right training handle packing gland assemblies (25 and 26, Figure 4-29) using a special packing gland wrench. Place this wrench over the square section of each shaft. Using a sideward thrust movement, remove the assemblies.

12. Remove the rayfilter drive actuating gear (11, Figure 4-32)

from the mounting plates (5, Figure 4-23).

2. Remove the taper pin (33) from the upper part of the stadimeter transmission shaft coupling (14).

3. Remove the two taper pins (10, Figure 4-27) from the two stadimeter transmission shaft thrust collars (4) located on the stadimeter transmission shaft (22) on each side of the spider (2) of the first inner tube section assembly.

4. Remove the stadimeter transmission shaft (22, Figure 4-27) sliding it out of the stadimeter transmission shaft coupling (14, Figure 4-23) and clear of the track sleeve (2). Remove this coupling from the operating gear pinion shaft (13).

5. Remove the four lockscrews (23) from the lower end of the track sleeve (2). These lockscrews are unscrewed from tapped holes in the upper part of the first inner tube section upper end coupling (11, Figure 4-27).

6. Remove the track sleeve (2, Figure 4-23), unscrewing it from the upper part of the first inner tube section upper end coupling (11, Figure 4-27) and remove the split-objective operating mechanism assembly (Figure 4-23).

7. Remove the stadimeter transmission shaft (22, Figure 4-27) from the first inner tube section assembly, also removing the two thrust collars (4) from each side of the spider bearing projection (2).

from the protruding square section of the rayfilter drive actuating shaft (10). Remove the rayfilter drive packing gland assembly by placing a pair of parallel pliers over the square section of this shaft, and, using a slight sideward thrust, pulling outward.

13. Disassembly of the spring type stadimeter transmission shaft assembly proceeds as follows:

a. Remove the lockscrew (1, Figure 4-30) from the spring retainer (3) and, using a special wrench, unscrew the spring retainer (3) from the stuffing box chamber in the eyepiece box base (11, Figure 4-29).

b. Remove the packing gland spring (4, Figure 4-30), packing, and packing gland (2) from the stuffing box chamber.

14. Where the modified stadimeter transmission shaft packing gland assembly is utilized, delete Step 13 and follow the disassembly procedure as follows:

a. Remove the lockscrew (1, Figure 4-31) from the packing retainer (2).

b. Unscrew the packing retainer from the stuffing box section in the eyepiece box (11, Figure 4-29) using a special wrench.

c. Remove the one packing retainer brass washer (6, Figure 4-31) the three separation brass washers (5), the four Hycar packing washers (4), and the one gland filler piece (3) from the stuffing box chamber in the eyepiece box base (11, Figure 4-29).

15. Remove the seven lockscrews (19, Figure 4-40) from each side of the rayfilter plate (2). These lockscrews are unscrewed from tapped holes in both rayfilter plate straps (3). Remove the rayfilter plate (2) and two rayfilter plate straps (3).

16. Remove the four short and eight long lockscrews (2 and 3, Figure 4-38) from the eyepiece window frame (7) of the eyepiece window assembly. These lockscrews are unscrewed from tapped holes in the counterbored recess face in the eyepiece box (11, Figure 4-29). Remove this assembly from the eyepiece box.

17. Remove the eyepiece lens mount (19, Figure 4-28) by unscrewing it from the eyepiece prism front retaining plate (24) attached to the eyepiece prism mount (20). The eyepiece lens mount (19) contains the eyepiece lens (52), eyepiece lens clamp ring (16), and its lockscrew (41).

18. Move the counterweight to its extreme upper position in order to have sufficient space for removal of the eight lockscrews (31). Remove these lockscrews from the upper face of the eyepiece skeleton flange. These lockscrews are unscrewed from the tapped holes of the upper face of the eyepiece box (11, Figure 4-29).

19. Remove the eyepiece box (11) from the eyepiece skeleton (42, Figure 4-28) carrying it off from the lower end.

20. Move the counterweight to its extreme lower position in order to remove the four lockscrews (37) from the cylindrical bearing surface in the upper part of the eyepiece skeleton (42). These lockscrews are unscrewed from tapped holes in the spider bearing (3, Figure 4-27) of the first inner tube section assembly.

21. Remove the upper part of the eyepiece skeleton (42, Figure 4-28), unscrewing it from the lower part of the spider bearing (3, Figure 4-27).

F. GALILEAN TELESCOPE SYSTEM

4F1. Description of the skeleton head assembly. Figure 4-17 shows the skeleton head assembly.

All bubble numbers in Sections 4F1, 2, and 3 refer to Figure 4-17 unless otherwise specified.

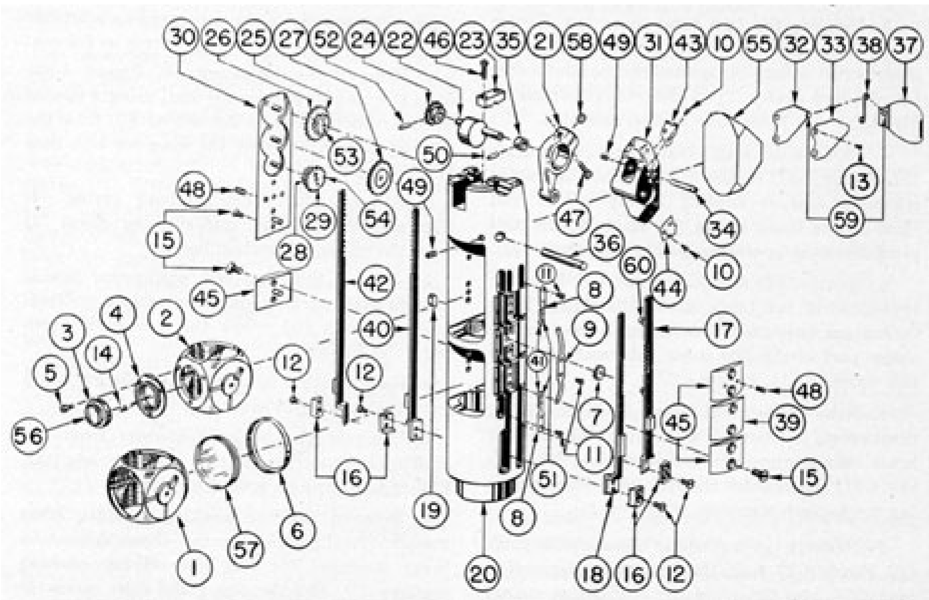

Figure 4-17. Skeleton head assembly.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1306-7	1	Galilean objective lens cube
2	P-1306-8	1	Galilean eyepiece lens cube
3	P-1306-9	1	Galilean eyepiece lens mount
4	P-1306-10	1	Galilean eyepiece lens mount housing
5	P-1306-11	3	Galilean eyepiece lens mount housing lockscrews
6	P-1306-12	1	Galilean objective lens retainer
7	P-1308-10	1	Power shift gear
8	P-1308-16	2	Pawl holders
43	P-1388-6	2	Head prism mounting clamps (left)
44	P-1388-7	2	Head prism mounting clamps (right)
45	P-1388-8	3	Cube brackets
46	P-1389-1	4	Split bearing cap lockscrews
47	P-1389-2	1	Eccentric arm adjusting screw
48	P-1389-3	4	Axial alignment lockscrews
49	P-1389-4	2	Eccentric arm pin lockscrew and head prism base shaft lockscrew
50	P-1389-175	1	Eccentric shaft collar

9	P-1308-17	1	Reinforcing spring
10	P-1310-5	8	Head prism mounting clamp lockscrews
11	P-1310-6	6	Pawl holder and reinforcing spring lockscrews
12	P-1310-7	8	Clamp block lockscrews
13	P-1310-8	4	Head prism side plate lockscrews
14	P-1310-12	1	Galilean eyepiece lens mount lockscrew
15	P-1310-37	12	Various bracket lockscrews
16	P-1315-3	4	Clamp blocks
17	P-1315-4	1	Cube shifting rack (right)
18	P-1315-5	1	Cube shifting rack (left)
19	P-1383-2	1	Angular alignment key
20	P-1385-1	1	Skeleton head
21	P-1386-1	1	Eccentric arm
22	P-1386-2	1	Eccentric shaft
23	P-1386-3	2	Bearing caps
24	P-1386-4	1	Head prism shift actuating gear
25	P-1386-5	1	Fourth intermediate

			taper pin
51	P-1389-176	4	Rivets for pawl holders and pawls
52	P-1389-177	1	Prism shift actuating gear taper pin
53	P-1389-178	2	Third and fourth intermediate prism shift gear rivets
54	P-1389-179	2	First intermediate and prism shift gear rivets
55	P-1418-2	1	Head prism
56	P-1418-3	1	Galilean eyepiece lens
57	P-1418-4	1	Galilean objective lens
58		1	Eccentric arm spacer washer
59		4	Head prism shade wire link, rivets, attached to head prism side plates and shade
60		2	Right cube shifting rack pins

a. Skeleton head frame. The skeleton head frame (20) is machined of phosphor-bronze material. It forms the necessary framework to carry the prism tilt mechanism, Galilean telescope, and change of power mechanism. The skeleton head is a push fit in the counterbored section in the upper

			head prism shift gear
26	P-1386-6	1	Third intermediate head prism shift gear
27	P-1386-7	1	Second intermediate head prism shift gear
28	P-1386-8	1	First intermediate head prism shift gear
29	P-1386-9	1	Head prism shift gear
30	P-1386-10	1	Gear train bracket
31	P-1387-1	1	Head prism mount
32	P-1387-2	1	Head prism side plate (left)
33	P-1387-3	1	Head prism side plate (right)
34	P-1387-4	1	Eccentric arm pin
35	P-1387-5	1	Eccentric shaft collar
36	P-1387-6	1	Head prism mount pivot shaft
37	P-1387-7	1	Head prism shade
38	P-1387-8	2	Head prism shade wire links
39	P-1388-1	1	Power shift gear bracket
40	P-1388-2	1	Head prism shifting rack (left)
41	P-1388-3	2	Power shift pawls

1.890-inch section of the outer taper section (1, Figure 4-15).

The prism tilt mechanism is composed of numerous mechanical parts in the upper and left hand side of the skeleton head to operate one optical element, the head prism (55).

b. Head prism. The head prism (55) is a right angle prism made of dense flint optical glass material. It is used to reflect the light rays at right angles. The light rays enter from any position of elevation between 90.5 degrees to 26 degrees depression in low power and from 78.5 degrees elevation to 14 degrees depression in high power, and are deflected downward into the instrument.

42	P-1388-4	1	Head prism shifting rack (right)

c. Head prism mount. The head prism mount (31) carries the head prism (55) with a suitable clamping arrangement. The base bearing provision of the mount fits between two machined shoulders of the upper part of the skeleton head and pivots over the head prism mount pivot shaft (36). Above the base bearing provision, a recess is provided for the insertion of the extended arm bearing section of the eccentric arm (21), attached to the mount with an eccentric arm pin (34) and secured to the mount with a headless lockscrew (49). The skeleton head frame is provided with recesses to allow clearance for the eccentric arm and the head prism mount (31) for all degrees of elevation and depression. The head prism (55) is retained from sideward movement with two head prism side plates left and right (32 and 33), and it is held to the head prism mount (31) with two pairs of head prism mounting clamps (43 and 44) secured with two lockscrews each (10).

d. Head prism side plates. The head prism side plates left and right (32 and 33) are attached to the head prism mount (31) with two lockscrews (13) each. These side plates retain the head prism (55) from sideward movement. Attached to each side plate are two head prism shade wire links (38) secured with rivets (59). The opposite ends of each wire link are secured to each bent-over side of the head prism shade (37), so that the shade is is provided with a spacer washer (58) fitted in the sawed slot. The front half of the stub section has a clearance hole with a countersunk section for the eccentric arm adjusting screw (47). This adjusting screw extends into the tapped hole in the opposite rear half of the stub section, and, with the assembled spacer washer, allows only a sufficient sliding clearance over the eccentric of the eccentric shaft (22). The eccentric arm (21) assembled to the eccentric shaft (22) actuates the head prism (55) by means of the extended arm bearing section assembled over the eccentric arm pin (34) between the two recessed walls of the head prism mount base (31) for elevation and depression.

g. Eccentric shaft. The eccentric shaft (22) is made of corrosion-resisting steel material. The centerline of the eccentric is offset from both shaft stems 0.179-inch. The offset provides the necessary cam movement for the manipulation of the head prism (55) to all the required degrees of elevation and depression. Both of the eccentric shaft stems fit into the lower reamed bearing halves of the skeleton head (20) and are secured radially with the upper two reamed bearing cap halves (23). These bearing caps are secured with two lockscrews (46) each. The axial displacement of the eccentric shaft stems is secured individually on each side. The right side has a thrust collar (35) secured with a taper pin (50), while the left side

carried vertically with the movement of the head prism mount (31).

e. Head prism shade. The head prism shade (37) is made of sheet brass material, and is constructed to conform with the contour of the skeleton head periphery. The sides are bent downward and again at 90 degrees to fit into a vertical recess groove in each of the inner side walls of the skeleton head. Wire links (38) are attached with rivets (59) to each bent side of the shade. As the head prism (55) is elevated or depressed, the head prism shade is carried vertically and is used principally in the elevated position to shade the lower 90 degrees face of the head prism (55), thus preventing a double image.

f. Eccentric arm. The eccentric arm (21) is made of cast phosphor-bronze material. The large section has a reamed hole with a stub section having a sawed slot, and fits over the eccentric of the eccentric shaft (22). The stub section accommodates a head prism shift actuating gear (24) which also is secured with a taper pin (52). Both the thrust collar (35) and the head prism shift actuating gear (24) are secured snugly against the bearings in the milled recesses of the skeleton head.

h. Head prism shift actuating gear. The head prism shift actuating gear (24) is made of phosphor-bronze material. The large diameter has 20 teeth of nominal width around the outer circumference, to mesh with the teeth of the fourth intermediate prism shift gear (25). The reamed hole of the actuating gear (24) is a push fit on the stem section of the eccentric shaft (22) and is secured with a taper pin (52) through the hub section.

i. Fourth intermediate head prism shift gear. The fourth intermediate head prism shift gear (25) is made of phosphor-bronze material and has 18 teeth around the outer circumference which mesh with the teeth of the head prism

shift actuating gear (24). This intermediate head prism shift gear (25) fits into a clearance hole of the left side of the skeleton head (20). The reamed hole in the center axis is a sliding fit over the first integral upper pin projection of the gear train bracket (30), with two number 60 drilled holes for the insertion of rivets (53) to secure it to the undercut shoulder side of the third intermediate head prism shift gear (26).

j. Third intermediate head prism shift gear. The third intermediate which mesh with the gear teeth of the head prism shifting racks left and right (40 and 42). This head prism shift gear (29) has a reamed hole in the center axis which is a sliding fit over the second integral lower pin projection of the gear train bracket (30) and sets inside the countersunk recess of the skeleton head between both the head prism shifting racks left and right (40 and 42). It also is provided with two number 60 drilled holes for the insertion of rivets (54) and is secured to the first intermediate

head prism shift gear (26) is made of phosphor-bronze material and has 32 teeth around the outer circumference which mesh with the teeth of the second intermediate head prism shift gear (27). This intermediate head prism shift gear (26) has a reamed hole in the center axis which is a sliding fit over the first integral upper pin projection and sets in the shallow counterbored section in the gear train bracket (30). It also is provided with two number 60 drilled holes for the insertion of rivets 53) and is secured to the fourth intermediate head prism shift gear (25) and riveted.

k. Second intermediate head prism shift gear. The second intermediate head prism shift ear (27) is identical to the third intermediate bead prism shift gear (26) except in the diameter of its undercut shoulder. The teeth mesh with the first intermediate head prism shift gear (28). The reamed hole in its center axis is a sliding fit over the second integral upper pin projection and sets in the countersunk recess of the gear train bracket (30).

1. First intermediate head prism shift gear. The first intermediate head prism shift hear (28) is made of phosphor-bronze material, and has 18 teeth around the outer circumference which mesh with the second intermediate head prism shift gear (27). This intermediate head prism shift gear (28) has a reamed hole in the center axis which is a sliding fit over the second integral lower pin projection and sets in the countersunk recess of the gear train bracket (30). It is also provided with two number 60 drilled holes for the insertion of rivets (54) and is secured to the head prism shift gear (28) and riveted.

n. Head prism shifting racks. The head prism shifting racks left and right (40 and 42) are made of blued, cold rolled steel, and operate in vertical recess grooves. The left shifting rack (40) is made of nominal width and thickness and is provided with 22 gear teeth in the upper part of the right side in a distance of 1.437 inches to mesh with the teeth of the head prism shift gear (29) on the left side. This shifting rack (40) is offset to the right, and stepped inward toward the center axis. The outer portion of the stepped section is provided with a radius contour of 0.607 inch, and the inside portion has a 0.550-inch radius contour to conform to the counterbore of the skeleton head. The lower end has a 45 degrees radius chamfer conforming to a similar mating radius chamfer of the clamp block (16). Two tapped holes are provided in the radius contour wall of the stepped section to accommodate clamp block lockscrews (12). The flat monel metal tape ends of the shifting wire tape (38, Figure 4-28) of the eyepiece skeleton assembly are secured to the outer radius contour of the stepped section with the clamp blocks (16) and the head prism shifting rack (40). This causes the shifting wire tape (38, Figure 4-28) to be stepped at 45 degrees bevel downward sufficiently to carry it free in the inside radius groove of the skeleton head. Above the stepped section on the outer surface of the head prism shifting rack (40) a protruding stop section of 0.375 inch is located a distance of 1.125 inches from the lower end, and its outer surface has a radius slightly below the contour of the skeleton head periphery. The stop

head prism shift gear (29) and riveted.

m. Head prism shift gear. The head prism shift gear (29) is made of phosphor-bronze material, and has 21 teeth around the outer circumference

section in contact with the cube bracket (45) restricts the movement of the head prism in the elevated position to the designed limits, thus preventing any damage to the head prism (55) and its operating mechanism.

The head prism shifting rack right (42) is similar to the left in design, except for the fact that it is constructed in opposite manner. Its teeth mesh with the teeth of the head prism shift gear (29) on the right side. The integral stop section of this head prism shifting rack (42) in contact with the cube bracket (45) restricts the movement of the head prism in the depressed position to its designed limit.

Both head prism shifting racks left and right (40 and 42) fit into two vertical slots on each side of the vertical centerline of the skeleton head left side wall. Two vertical elongated holes below the groove seats, and offset toward the vertical centerline, provide clearance for the stepped sections of both head prism shifting racks and allow for the attachment of the shifting wire tape (38, Figure 4-28).

o. Gear train bracket. The gear train bracket (30) is made of blued, cold rolled steel material, and serves various functions. It serves to carry the gear train of the first, second, third, and fourth intermediate head prism shift gears (28, 27, 26, 25) and the head prism shift gear (29) by means of four pin projections integral with the bracket. It provides a closed housing by means of countersunk recesses below the

shifting racks (40 and 42). The pin projection, an integral part of this cube bracket, serves as the pivot for the reamed hole axis in the Galilean objective lens cube (1). This integral pin projection is a sliding fit in the reamed hole in the vertical centerline and is secured with two lockscrews (15) which are also located in the centerline on each side of the integral pin projection securing the bracket to the fiat recess in the skeleton head. This bracket serves as a stop for each stop of the head prism shifting racks (40 and 42) for the elevation and depression position of the head prism (55).

q. Angular alignment key. The angular alignment key (19) is inserted in the vertical centerline in the left side of the skeleton head and is located in the center part. This key is a sliding fit in the vertical keyway in the upper part of the counterbore wall of the outer taper section, and maintains the angular alignment of the skeleton head (20).

The Galilean telescope system is composed of two lenses; namely, a negative Galilean eyepiece lens doublet and a positive Galilean objective lens doublet. It is used in reverse to effect a low power magnification and increase the true field of view.

three integral upper pin projections for the 1st, 2nd, and 3rd intermediate head prism shift gears (28, 27, and 26) and also serves as a retaining plate for the upper part of the head prism shifting racks left and right (40 and 42). The lower pin projection serves as a pivot for the reamed hole axis of the Galilean eyepiece lens cube (2). All four integral pin projections are a sliding fit into the reamed holes in the left side wall of the skeleton head. The bracket is secured to the flat recess face in the skeleton head with four lockscrews (15) located in the lower part. Two tapped holes are located in the periphery of this bracket on each side of the centerline in the lower part to coincide with the tapped holes of the overlapping section of the outer taper section (1, Figure 4-15) to maintain the axial alignment of the skeleton head with lockscrews (48). The periphery of the bracket when assembled on the skeleton head conforms to its periphery.

p. Cube bracket. The cube bracket (45) is made of blued, cold rolled steel material. It serves to retain the lower part of the head prism

r. Galilean eyepiece lens. The Galilean eyepiece lens (56) is made of two optical elements, one is a divergent meniscus flint element, cemented to the equi-concave crown element, forming a negative doublet. The divergent meniscus element cemented to the equi-concave element of the Galilean eyepiece lens corrects for spherical and chromatic aberration. It is mounted in a Galilean eyepiece lens mount (3) and burnished in place. The threaded mount can be screwed vertically in the threads of the Galilean eyepiece lens mount housing (4) by using a sharp pointed scribe inserted in any one of a series of eight shallow drilled recesses. This vertical movement provides a means of focusing for elimination of parallax.

s. Galilean eyepiece lens mount housing. The galilean eyepiece lens mount housing (4) is provided with an internal threaded bore to carry the mounted Galilean eyepiece lens (56) and mount (3) movement to eliminate parallax. The housing flange has three equally spaced clearance holes. One hole is used as a pivot hole, while the

other two are elongated for collimation. A tapped hole located in the outer undercut shoulder receives the lockscrew (14) used to secure the mounted Galilean eyepiece lens (56) and mount after parallax removal.

t. Galilean eyepiece lens cube. The Galilean eyepiece lens cube (2) is constructed of a suitable framework for holding the Galilean eyepiece lens mount housing (4). By means of

v. Galilean objective lens cube. The Galilean objective lens cube (1) is constructed similarly to the Galilean eyepiece lens cube (2). The lower part is counterbored a shallow depth to serve as a mount for the Galilean objective lens (57), while its outer shoulder is threaded to receive the internal threaded section of the Galilean objective lens retainer (6). The upper, front, and rear walls are bored and provided with antireflection threads, thus

integral pin projections of the cube bracket (45) and the gear train bracket (30) protruding in the reamed hole axis in opposite sides of the cube, it can be rotated for change of power. The undercut shoulder of 0.010-inch width and 0.437-inch diameter on each side face provides sufficient bearing wall. All corners are rounded off with a radius of 0.750 inch. The two 90 degrees V-grooves in the right side wall located at 90 degrees, receive the upper pawl (41) attached to the pawl holder (8) with rivets (51). The pawls are held in the grooves with a reinforcing spring (9) to maintain the cube in either the IN or OUT position (low or high power). The 90 degrees rotation of the cube is accomplished by the upper pin projection (60) of the right cube shifting rack (17), protruding into the elongated slot in the right side face. The clearance hole in the upper face of the cube allows the lower undercut shoulder sufficient free movement for collimation of the Galilean eyepiece lens (56). Three equally spaced tapped holes in the upper face receive lockscrews (5) to secure the Galilean eyepiece lens mount housing (4) after collimation. The lower wall is bored out and provided with antireflection threads, and also the front and rear walls, thus offering no obstruction for the entering light rays in either high or low power. The skeleton head (20) is machined out, leaving only the side walls and the center support to accommodate sufficient clearance for the assembly, disassembly, and manipulation of this cube.

u. Galilean objective lens. The Galilean objective lens (57) is made of two optical elements, consisting of a double convex flint element offering no obstruction for the entering light rays in either high or low power. The two 90 degrees V-grooves in the right side wall located at 90 degrees, receive the lower pawl (41) attached to the pawl holder (8) with rivets (51). The pawls held in the grooves with a reinforcing spring (9) to maintain the cube in either the IN or OUT position (low or high power). The 90 degrees rotation of the cube is accomplished by the lower pin projection (60) of the right cube shifting rack (17) protruding into the elongated slot in the right side face. The center support of the skeleton head is bored and provided with antireflection threads, and is machined out in the lower part in similar manner to the Galilean eyepiece lens cube (2), leaving only the side walls, to accommodate sufficient clearance for the assembly, disassembly, and manipulation of this cube.

The change of power mechanism is located on the right side wall of the skeleton head frame (20) and is composed of numerous parts to operate the Galilean telescope system.

w. Cube shifting racks. The cube shifting racks right and left (17 and 18) operate in vertical recess grooves, located in the right side wall of the skeleton head. These shifting racks are made of blued, cold rolled steel material, and are constructed similarly to the head prism shifting racks left and right (40 and 42). The right cube shifting rack (17) is wider than the left, and is provided with two assembled and riveted pins (60). These two pins protrude through two elongated slots in the wide vertical recess groove to the right of the vertical

cemented to a divergent meniscus dense crown element, forming a positive objective lens doublet. It is mounted in the Galilean objective lens cube (1) and secured with a Galilean objective lens retainer (6). The retainer is spot soldered to the Galilean objective lens cube (1) to prevent it from unscrewing.

centerline and into the elongated slot in the Galilean eyepiece lens and objective lens cubes (2 and 1). These protruding pins (60), by movement of the right or left cube shifting racks (17 and 18), shift the Galilean telescope system to the IN or OUT position. That is, each cube carrying one lens doublet each of the Galilean telescope is

shifted simultaneously to place the lenses in the line of sight for low power, or out of the line of sight to allow the light rays free passage through the cubes for high power.

The cubes (1 and 2) are maintained in either position by means of pawls (41) protruding through two elongated slots under spring tension into the 90 degrees V-groove in the right side wall of each cube. The right and left cube shifting racks (17 and 18) are provided with 10 teeth, each located 2 1/2 inches from the lower end in a distance of 11/16-inch, to engage the power shift gear (7) on opposite sides. The left cube shifting rack, (18) is narrower than any of the head prism shifting racks (40 and 42) and the right cube shifting rack (17).

This left cube shifting rack (18) operates in the vertical recess groove to the left of the vertical centerline. When it is pulled downward by the shifting wire tape (38, Figure 4-28) its teeth engage with the power shift gear (7) causing it to rotate. The power shift gear (7), also engaged with the teeth of the right cube shifting rack (17), causes it to be carried upward, and by means of the protruding pins (60) right side wall of the skeleton head (20). The gear teeth engage with the teeth of both cube shifting racks right and left (17 and 18). A reamed hole in the center axis of the gear is a sliding fit over the pin projection of the power shift gear bracket (39). This gear serves to provide movement to the opposite cube shifting rack, carrying it upward as one cube shifting rack is pulled downward and vice versa.

y. Power shift pawls. The two power shift pawls (41) are made from tool steel material with an over-all length of 0.375 inch. The detent section is constructed at a 90 degrees angle, to engage in the 90 degrees V-grooves of each Galilean objective lens and eyepiece lens cube (1 and 2) through the elongated slots in the outer left vertical recess groove in the right side wall of the skeleton head.

Each pawl is attached to a pawl holder (8) made of sheet bronze material with two rivets (51). The left vertical recess groove has three enlarged recess sections to accommodate the wider sections of the pawl holders (8) and the reinforcing spring (9) and are secured with two lockscrews (11) each. The reinforcing spring (9) is

extending through the elongated slots in the skeleton head (20) into the elongated slots of each cube, rotates the cubes to the OUT position and vice versa.

The integral stops of the cube shifting racks protruding outward in each vertical recess groove, contact the lower side face of the lower cube bracket (45) to restrict the movement of each cube beyond the 90 degrees V-groove engagement of both pawls (41).

Both cube shifting racks right and left (17 and 18) are stepped outward from the vertical centerline. The inward stepped sections that tend toward the center axis, for the attachment of the shifting wire tape (38, Figure 4-28) clamp blocks (16), and the clamp block lockscrews (12) are constructed identically to the stepped sections of the head prism shifting racks (40 and 42).

x. Power shift gear. The power shift gear (7) is made of corrosion-resisting steel material, and is provided with 12 teeth in the outer circumference. Both sides of the gear have undercut shoulders, and it sets in the countersunk recess in the vertical centerline and center part of the

made of clock spring material, bent to shape, with a wide center section for the insertion of two lockscrews (11). The upper and lower narrow sections of the reinforcing spring (9), overlapping the ends of the power shift pawls (41), provide sufficient spring tension to maintain the detent in the 90 degrees V-grooves for either the IN or OUT position of the cubes.

z. Cube brackets and power shift gear bracket. 1. Cube brackets. The three cube brackets (45) are made of blued, cold rolled steel material, and have integral pin projections. The integral pin projection of the upper bracket is a sliding fit in the reamed hole in the vertical centerline of the skeleton head, and protrudes further into the reamed hole axis of the right side of the Galilean eyepiece lens cube to serve as a pivot for this side. The bracket has a recessed section which fits over the upper part of the reinforcing spring (9) to allow clearance for this part of the spring when the detent pawl (41) lifts on the smooth area between the two 90 degrees V-grooves in the cubes. The bracket is secured on the flat milled recess over the upper part of the cube shifting racks right and left (17 and 18)

with two lockscrews (15). Two tapped holes are located in the periphery opposite the centerline, to coincide with the tapped holes of the overlapping section of the outer taper section (1, Figure 4-15) to maintain the axial alignment of the skeleton head with lockscrews (48).

3. Scrape the spot solder from the Galilean objective lens retainer (6), unscrew the retainer, and remove the Galilean objective lens (57). Wrap the lens doublet in clean lens tissue and store it in a box to prevent scratches and breakage.

4. Remove the four lockscrews (15) from the gear train bracket (30).

The lower cube bracket serves the same purpose as noted above for the Galilean eyepiece lens cube (2) except that it is used for the Galilean objective lens cube (1) minus the tapped holes in the periphery. The lower side of this cube bracket serves as a stop for the protruding stops integral sections of the cube shifting racks right and left (17 and 18), as they contact it alternately for the IN and OUT position of the cubes.

2. Power shift gear bracket. The power shift gear bracket (39) is similar in construction to the cube brackets (45) except for length. It is provided with a pin projection, an integral part of the bracket, which has a countersunk recess to accommodate sufficient clearance for part of the power shift gear (7). The pin projection serves as a pivot for the power shift gear (7) and is a sliding fit in the reamed hole in the vertical centerline of the skeleton head. It is secured over the cube shifting racks right and left (17 and 18) to the flat milled recess of the skeleton head with two lockscrews (15).

4F2. Disassembly of the skeleton head assembly. The skeleton head assembly is disassembled as follows:

1. Move the cube shifting racks right and left (17 and 18), shifting the Galilean telescope system to the OUT position or high power. This allows the Galilean objective lens (57), Galilean objective lens retainer (6), Galilean eyepiece lens (56), Galilean eyepiece lens mount (3), and the Galilean eyepiece lens mount housing (4) to be removed.

2. Remove the three lockscrews (5) from the flange of the Galilean These lockscrews are unscrewed from tapped holes in the left side wall of the skeleton head (20). Careful attention and skill are required to remove the gear train bracket. Since the gear train bracket (30) has four integral pin projections, it must be lifted evenly.

5. Remove the head prism shift gear (29) and the first intermediate head prism shift gear (28) together.

6. Remove the second intermediate head prism shift gear (27).

7. Remove the third and fourth intermediate head prism shift gears (26 and 25).

8. Remove the two lockscrews (15) from the cube bracket (45) on the left side of the skeleton head (20). These lockscrews are unscrewed from the tapped holes in the centerline of the skeleton head. This cube bracket (45) must be raised carefully in order not to break its integral pin projection.

9. Remove the head prism shifting racks left and right (40 and 42) carrying with them the assembled clamp locks (16) and lockscrews (12).

10. Remove the two lockscrews (15) from each of the two cube brackets (45) on the right side of the skeleton head (20). These lockscrews are unscrewed from the tapped holes in the skeleton head. Remove both cube brackets (45), raising each one carefully in order not to break the integral pin projection of each cube bracket.

11. Remove the two lockscrews (15) from the power shift gear bracket (39). These lockscrews are unscrewed from the tapped holes in

eyepiece lens mount housing (4). These lockscrews are unscrewed from tapped holes in the Galilean eyepiece lens cube (2). Remove the Galilean eyepiece lens mount housing (4) with the mounted Galilean eyepiece lens (56) and its mount (3). Remove the lockscrew (14), unscrewing it from the housing and the mounted Galilean eyepiece lens (56).

the right side wall of the skeleton head. Remove the power shift gear bracket (39), raising it carefully in order not to break the integral pin projection of the bracket.

12. Remove the cube shifting racks right and left (17 and 18), carrying with them the assembled clamp blocks (16) and lockscrews (12).

13. Remove the power shift gear (7).

14. Remove the Galilean objective lens and eyepiece lens cubes (1 and 2) sliding them out from the center and front of each opening in the skeleton head.

15. Remove the two lockscrews (11) from the reinforcing spring (9), and remove the reinforcing spring.

16. Remove the two lockscrews (11) from each upper and lower pawl holder (8) and remove the pawl holder (8) and pawls (41). All lockscrews (11) for (8 and 41) are unscrewed from the tapped holes in the enlarged recesses of this outer left vertical recess groove in the right side wall of the skeleton head (20).

17. Remove the two lockscrews (46) from each bearing cap (23), and remove the two bearing caps. These lockscrews are unscrewed from the tapped holes in the top face of the skeleton head.

18. Remove the lockscrew (49), unscrewing it from its contact with the head prism mount pivot shaft (36). Remove the head prism mount pivot shaft (36).

piece of lens tissue and store it in a box to prevent scratches and breakage.

24. Remove the taper pin (50) from the eccentric shaft collar (35), and remove the collar.

25. Release the eccentric arm adjusting lockscrew (47). Remove the eccentric shaft (22) with the head prism shift actuating gear (24). The lockscrew (47) is unscrewed from the tapped hole in the lower split stub section of the eccentric arm (21). The spacer washer (58) is also removed.

26. Remove the taper pin (52) from the hub section of the head prism shift actuating gear (24), and remove the gear from the eccentric shaft (22).

4F3. Reassembly of the skeleton head assembly. The skeleton head assembly is reassembled in the following manner:

1. Apply Lubriplate No. 110 lightly to all rotating parts as the assembly procedure is followed.

2. Place the head prism shift actuating gear (24) on the left side of the eccentric shaft stem section

19 Remove the head prism mount (31), head prism (55), head prism mounting clamps (43 and 44), head prism side plates (32 and 33), head prism shade wire links (38), eccentric arm (21), and eccentric shaft (22), in the assembled position, sliding out the head prism shade (37) from the upper part of the skeleton head (20).

20. Remove the lockscrew (49), unscrewing it from its contact with the eccentric arm pin (34), and remove the eccentric arm pin.

21. Remove the eccentric arm (21) from between the two recess side walls of the head prism mount base (31).

22. Remove the two lockscrews (13) from the left and right head prism side plates (32 and 33), and remove both side plates. The head prism shade wire links (38) and the head prism shade (37) are carried assembled with the side plates.

23. Remove the two lockscrews (10) from each of the upper two head prism mounting clamps (43 and 44). These lockscrews are unscrewed from tapped holes in the beveled side faces in the upper part of the head prism mount (31). Remove the head prism mounting clamps and the head prism (5,5). Wrap the head prism in a clean

(22). A reference scribed line on the left side of the eccentric designates the proper side for reassembling the above gear, with the hub section of the gear facing the eccentric. Insert the taper pin (52) in the shoulder of the hub section to secure the gear to the eccentric shaft stem section.

3. Assemble the eccentric shaft collar (35) on the right stem section of the eccentric shaft (22). Place the taper pin (50) in the collar to secure it to the eccentric shaft.

4. Place the eccentric arm (21) over the assembled collar (35) and rotate the eccentric shaft (22) sufficiently to slide the eccentric arm over the eccentric. Place the spacer washer (58) in the slot of the eccentric arm stub section, and insert the adjusting lockscrew (47) in the front stub section, tightening it sufficiently to provide a snug sliding fit. It is important to remember that any wear of the eccentric and the eccentric arm bearing surface decreases the designed limits of the head prism travel for elevation and depression.

5. Assemble the complete eccentric assembly into the lower bearing halves of the upper part of

the skeleton head (20). Assemble the two bearing caps (23) to their respective sides of the eccentric over the eccentric shaft stem sections (22). Insert two lockscrews (46) in each bearing cap to retain the eccentric shaft to the skeleton head. Check the eccentric assembly

skeleton head, then through the reamed hole in the base of the head prism mount (31) into the opposite side wall of the skeleton head. Secure the pivot shaft with a lockscrew (49) placed in the tapped hole in the rear wall located on the right side of the skeleton head. The

and observe its free operation in the skeleton head bearings.

6. Assemble the left and right side plates (32 and 33) to the head prism mount (31) on both sides. Secure the side plates with two lockscrews (13) each in the tapped holes in the head prism mount.

7. Clean the head prism (55) using clean lens tissue; also clean off the surface dust. Place the head prism with its hypothenuse face of the scraped head prism mount (31) sliding the lower part under the 60 degrees prongs of the two lower assembled head prism mounting clamps (43 and 44). Apply two head prism mounting clamps (43 and 44) to the upper beveled side faces of the head prism mount, securing each with two lockscrews (10). Take precautions to note that the 60 degrees prongs touch the 90 degrees faces of the head prism (55).

8. Swing the extended arm bearing of the eccentric arm (21) to the front of the skeleton head (20). Place the recess walls of the head prism mount base over the extended arm bearing section, and insert the eccentric arm pin (34) through the reamed hole in the recess wall into the reamed hole in the extended arm bearing section and through the opposite recess side wall. Secure this pin with a lockscrew (49) which screws into the right recess side wall tapped hole in the head prism mount base, and contacts the spotted recess in the eccentric arm pin (34).

9. Insert the prism shade (37) in the two vertical grooves cut in the inner side walls of the skeleton head (20). lockscrew extends into the spotted recess in the head prism mount pivot shaft (36).

12. Place the Galilean objective lens and eyepiece lens cubes (1 and 2) in their respective openings in the skeleton head (20). Check the cubes to ascertain that they are located for the IN position or low-power.

13. Place the pawl holders (8) and the assembled pawls (41) in the outer vertical recess groove in the right side wall of the skeleton head. The pawls fit in the elongated slots, and the pawl holders in the enlarged recesses in the upper and lower part of this vertical recess groove. Secure each pawl holder (8) with two lockscrews (11) which screw into the tapped holes in the enlarged recess face.

14. Place the reinforcing spring (9) over the pawls in the center enlarged recess of the above vertical recess groove and secure it with two lockscrews. The lockscrews are inserted in clearance holes in the spring and screwed into tapped holes in the enlarged recess face.

15. With the Galilean objective lens and eyepiece lens cubes (1 and 2) located in the IN position, apply the right cube shifting rack (17), placing the assembled protruding pins (60) through the elongated slots in the outer right vertical recess groove in the right side wall.

16. Place the left cube shifting rack (18) in the center of the three vertical recess grooves in the skeleton head, right side wall (20).

17. Assemble the two cube brackets (45) to the two flat recesses in the right side wall of the skeleton head over the cube shifting racks right

10. Check the reference scribed lines of the eccentric (22) and the eccentric arm (21) on the left side, and rotate them into coincidence. The coincidence of both scribed lines designates the full elevated position of the head prism (55).

11. With the position of the eccentric shaft (22) and the eccentric arm (21) as noted above, the head prism mount (31) is set in place. Insert the head prism mount pivot shaft (36) in the reamed hole in the outer right side wall of the

and left (17 and 18). Place the integral pin projection of each cube bracket in the reamed holes in the skeleton head and the reamed hole axis in each cube. Carefully push the integral pin projection of the cube bracket down into the reamed hole axis in each cube. Secure each cube bracket with two lockscrews (15). These lockscrews extend into tapped holes in the right sidewall of the skeleton head.

18. Place both head prism shifting racks left and right (40 and 42) in the vertical recess grooves in the left side wall of the skeleton head (20).

19. Assemble the cube bracket (45) over the head prism shifting racks (40 and 42). The integral pin projection of this cube bracket extends into the reamed hole in the skeleton head and into the reamed hole axis in the Galilean objective lens cube (1). Carefully push the integral pin projection of the cube bracket down into the reamed hole axis in the cube. Secure the bracket with two lockscrews (15) which extend into tapped holes in the recess face.

20. To align the gear train for the head prism shift mechanism, check the scribed line of the eccentric of the eccentric shaft (22) and the eccentric arm (21) for coincidence. This position places the head prism (55) in the full elevated position. In this position move the left head prism shifting rack (40) upward until its integral stop is in contact with the lower side face of the cube

meshes with the reference line tooth of the second intermediate head prism shift gear (27) on the skeleton head. The fourth intermediate head prism shift gear (25) assembled with the third intermediate head prism shift gear (26) engages with the head prism shift actuating gear (24) in the clearance hole in the left side wall of the skeleton head.

24. Make a careful check to see that all bearing holes of this gear train align with the reamed holes in the flat recess face of the skeleton head. Carefully place the integral pin projections of the gear train bracket (30) in the center bearing holes of the gear train and press downward slowly. The first lower integral pin projection enters first, and protrudes into the skeleton head and further into the reamed hole axis of the Galilean eyepiece lens cube (2), while the other three integral pin projections enter the gear train to protrude further into the skeleton head. Secure the gear train bracket (30) with four lockscrews (15) which extend into tapped holes in the skeleton head.

bracket (45). Move the right head prism shifting rack (42) downward and measure a distance of 0.875 inch from the lower side face of the cube bracket (45) to the upper shoulder of the stop integral with this head prism shifting rack. This distance is required to shift the head prism (55) to 74.5 degrees elevation and 10 degrees depression.

21. Reassembly of the gear train (Steps 20 to 23 inclusive) proceeds as follows: Place the head prism shift gear (29) and the assembled first intermediate head prism shift gear (28) in the countersunk recess in the skeleton head. Check the reference line on the face of the first intermediate head prism shift gear (28) and place it so that the reference line is in the upper centerline of the skeleton head. The head prism shift gear teeth (29) engage on opposite sides with the head prism shifting racks (40 and 42).

22. Place the second intermediate head prism shift gear (27) so that its reference line tooth meshes with the reference line tooth of the first intermediate head prism shift gear (28) on the flat recess of the skeleton head (20).

23. Place the third intermediate head prism shift gear (26) so that its reference line tooth

25. With the use of a surface gage and dial indicator attachment, stand the skeleton head on a surface plate. Measure the front and rear sides of the upper face of the Galilean eyepiece lens cube (2). Release the two lockscrews (11) and move the upper pawl holder (8) and pawl (41) axially to obtain a true horizontal measurement. Secure the two lockscrews (11) after the true horizontal measurement is ascertained.

Follow the same procedure for the Galilean objective lens cube (1), using the lower face of the cube for determining the true horizontal measurement. Release the two lockscrews (11) and move the lower pawl holder (8) and pawl (41) axially to obtain a true horizontal measurement. This measurement determination places the mechanical alignment of the Galilean telescope mechanism in a true horizontal position, so that upon the assembly of the lenses, the optical line of sight of this system is parallel to the optical line of sight of the remaining telescope systems. This procedure prevents a pronounced general aberration which results when the IN position of the pawl holders (8) and pawls (41) have a faulty alignment.

26. With the Galilean objective lens and eyepiece lens cubes (1 and 2) located in the IN

position, place the left cube shifting rack (18) with its integral stop against the lower side face of the lower cube bracket (45). In this position insert the power shift gear (7) to coincide its reference scribe

30. Clean the Galilean eyepiece lens (56), using clean lens tissue; also clean off the surface dust.

31. Assemble the mounted Galilean eyepiece lens (56) and mount (3) in

line with the mating scribe line of the right cube shifting rack (17) in the countersunk recess in the right side wall of the skeleton head. The teeth of the gear mesh with the gear teeth of the right and left cube shifting racks (17 and 18) on opposite sides.

27. Assemble the power shift gear bracket (39), placing its integral pin projection in the bearing hole of the power shift gear (7) and further into the reamed hole in the flat recess of the skeleton head. Slowly push the integral pin projection of this bracket into place in the flat recess, and secure it with two lockscrews (15) which screw into tapped holes in the recess of the skeleton head.

28. Check the movement of the Galilean objective lens and eyepiece lens cubes (1 and 2) in the IN and OUT positions to insure that a pronounced and distinct operation of the pawls is obtained.

29 Shift the Galilean objective lens and eyepiece lens cubes (1 and 2) to the OUT position.

the Galilean eyepiece lens mount housing (4). Attach the housing to the Galilean eyepiece lens cube (2), placing the pivot hole downward, and securing it with three lockscrews (5). These lockscrews extend into tapped holes in the face of the cube. Collimation of this lens doublet is accomplished in the final stage of collimation of the instrument.

32. Clean the Galilean objective lens (57), using clean lens tissue; also clean off any surface dust. Place this lens doublet in the Galilean objective lens cube (1). With the longest radius facing upward in the IN position, apply the retainer ring (6). Spot solder the retainer ring to the cube to prevent its backing off the threaded periphery of the cube.

33. Shift the head prism to the zero line of sight by eyesight and shift the Galilean telescope system to the IN position. Wrap the skeleton head assembly in clean lens tissue and store conveniently to preserve it from damage until the assembly is required for collimation.

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Chapter 4 Continued

G. AUXILIARY UPPER TELESCOPE SYSTEM

4G1. Description of the seventh, eighth, and ninth reduced tube sections. Figure 4-18 shows the auxiliary upper telescope system assembly. All bubble numbers in Section 4G1, 2, and 3 refer to Figure 4-18 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1306-2	1	Ninth reduced tube section
2	P-1310-11	1	Auxiliary upper eyepiece lens clamp ring lockscrew
3	P-1310-19	2	Ninth and eighth reduced tube section lockscrews
4	P-1314-7	1	Auxiliary upper eyepiece lens clamp ring
5	P-1418-5	1	Auxiliary upper eyepiece lens
6	P-1306-1	1	Eighth reduced tube section
7	P-1179-75	1	Circumferential alignment lockscrew
8	P-1306-3	1	Ninth reduced tube section clamp ring

Ill. No.	Drawing Number	Number Required	Nomenclature
9	P-1306-4	1	Telemeter lens mount
10	P-1306-5	1	Telemeter lens clamp ring
11	P-1310-19	5	Ninth reduced tube section clamp ring and seventh and eighth reduced tube section lockscrews
12	P-1310-20	2	Telemeter lens clamp ring lockscrews
13	P-1418-6	1	Telemeter lens
14	P-1305-7	1	Seventh reduced tube section
15	P-1305-5	2	Auxiliary upper objective lens clamp rings
16	P-1310-21	4	Sixth and seventh reduced tube section lockscrews
17	P-1310-	2	Auxiliary

	22		upper objective lens clamp ring lockscrews
18	P-1418-7	1	Auxiliary upper objective lens

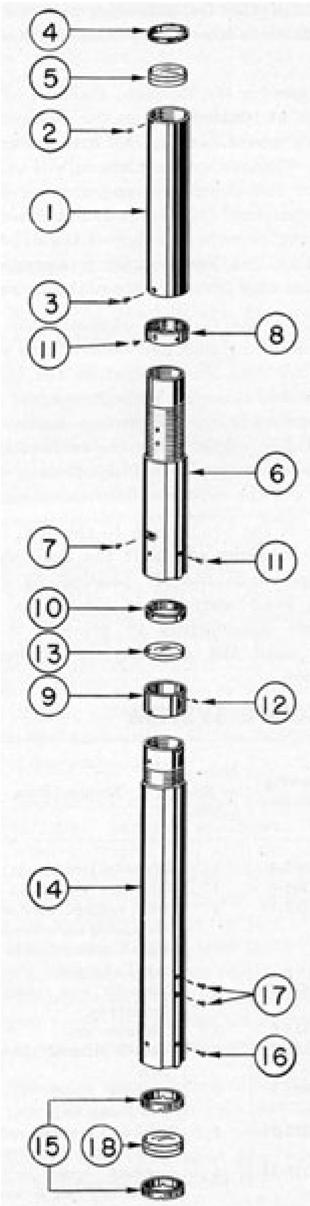

Figure 4-18. Auxiliary upper telescope system assembly.

a. Sections. The auxiliary upper telescope system consists of three reduced tube sections of a unit power telescope, making up the necessary length and carrying parts which locate the lenses in appropriate relation to their focal lengths. This system consists of the seventh, eighth, and ninth reduced tube sections.

b. Ninth reduced tube section. The ninth reduced tube section (1) is made of brass tubing and is 4 7/16 inches in length. Its upper part is a sliding fit into the bore of the lower part of the skeleton head (20, Figure 4-17). At assembly, four shallow vertical recess fiats are located on the periphery to provide clearance for the prism tilt and change of power shifting wire tapes (38, Figure 4-28). The inside diameter is bored for light transmission and is provided with anti-reflection threads.

The upper part is counterbored a short distance to serve as a mount for the auxiliary upper eyepiece lens (5). It has an additional counterbored section which is threaded to receive the auxiliary upper eyepiece lens clamp ring (4). The clamp ring is secured with a lockscrew (2) which screws into the tapped hole in the upper part of this reduced tube section.

The lower part of the ninth reduced tube section (1) is counterbored with an additional counterbored and internal threaded section of 1.125 inches in length. The smooth counterbored section is a sliding fit over the upper part of the eighth reduced tube section (6) and serves as an alignment support section. The threaded part of the additional counterbored section screws vertically on the threaded periphery of the eighth reduced tube section (6) to provide the necessary vertical focusing travel of the mounted auxiliary upper eyepiece lens (5). The necessary movement of this lens in atmospheric pressure to compensate for the introduction of nitrogen is explained under Section 4U8, Step 18, and Section 4V7. The lower part of the ninth reduced tube section (1) is secured with two lockscrews (3) which are inserted into tapped holes in the upper part of the eighth reduced tube section.

c. Auxiliary upper eyepiece lens. The auxiliary upper eyepiece lens (5) is made of two optical elements, consisting of a divergent meniscus flint element cemented to a double convex crown

element, forming a positive doublet. It is mounted in the upper part of the ninth reduced tube section (1) with the crown element resting in the seat of the counterbored section, and is secured with an auxiliary upper eyepiece lens clamp ring (4) secured with a lockscrew (2).

d. Auxiliary upper eyepiece lens clamp ring. The auxiliary upper eyepiece lens clamp ring (4) is threaded on its periphery to screw tapped hole in the telemeter lens mount (9), while the head of the lockscrew rests on the radial recess face. The lower part of the smooth counterbored section of this reduced tube section has an additional counterbored threaded section to screw on the threaded periphery in the upper part of the seventh reduced tube section (14). It is secured to the seventh reduced tube section with four lockscrew (11). These lockscrew are inserted

into the upper part of the ninth reduced tube section (1) to retain the auxiliary upper eyepiece lens with sufficient tension. It is kept from backing out by a lockscrew (2) protruding into the spotted recess in the threaded, periphery from the tapped hole in the ninth reduced tube section (1). The clamp ring has opposite slots in the upper face to permit it to be tightened or loosened.

e. Eighth reduced tube section. The eighth reduced tube section (6) is made of brass tubing and is 5.150 inches in length. Its inside diameter is bored for light transmission and is provided with anti-reflection threads. At assembly, the large periphery has four shallow vertical recess grooves to provide clearance for the prism tilt and change of power shifting wire tapes (38, Figure 4-28). The upper part is turned to a sliding clearance fit and serves as an alignment support in the ninth reduced tube section (1).

The threaded periphery of the eighth reduced tube section is threaded an ample distance to accommodate the ninth reduced tube section clamp ring (8) and to permit the vertical focusing adjustment of the ninth reduced tube section.

The lower part of the eighth reduced tube section has a smooth counterbored section to carry the telemeter lens mount (9) which is a sliding fit. It also serves as an alignment support section for the upper alignment support section of the seventh reduced tube section (14). Two opposite air channels are located in this counterbored section for the upward passage of nitrogen. A circumferential slot with an additional circumferential recess is into countersunk clearance holes in the lower part of this reduced tube section and screwed into tapped holes in the upper alignment support section of the seventh reduced tube section.

f. Ninth reduced tube section clamp ring. The ninth reduced tube section clamp ring (8) is made of nominal thickness and width. The inside diameter is threaded to screw on the threaded periphery of the upper part of the eighth reduced tube section, and is provided with two opposite drilled holes to accommodate a special spanner wrench. This clamp ring screws up tightly against the lower face of the ninth reduced tube section after its final adjustment and is secured with a lockscrew (11). This lockscrew extends into a tapped hole in the threaded periphery of the eighth reduced tube section. After assembly the clamp ring is provided with four shallow vertical flat faces to allow clearance for the prism tilt and change of power shifting tapes (38, Figure 4-28).

g. Telemeter lens. The telemeter lens (13) is made of one flint plano convex element. The plano surface is etched with vertical and horizontal calibrations in degrees of true field, and provides a means of measuring the angular size of a target. Refer to Section 4U7, Paragraph (a) for further detail.

The telemeter lens is placed in the image plane of the auxiliary upper telescope, and the first real image plane of the periscope, so that the graduations appear to vibrate in unison with the image and observation is easier.

provided a short distance from the lower end of this counterbored section to accommodate an angular alignment lockscrew (7). It is used to permit angular adjustment of the telemeter lens mount during collimation, so that the telemeter lens line lies in a true vertical plane. The circumferential alignment lockscrew extends through the circumferential slot into a

The telemeter lens periphery is provided with a stoned vertical recess groove for the protruding lockscrew of the telemeter lens mount (9), thus permitting it to be reassembled in its original position, and preventing any angular, shift of the telemeter lens in the mount. The plano surface of the lens is placed toward the seat of the mount

and is secured with a clamp ring (10) and lockscrew (17).

h. Telemeter lens mount. The telemeter lens mount (9) is made of brass tubing and is 0.562 inch in width. Its inside diameter is bored for light transmission and threaded for anti-reflection. The mount is a sliding fit in the smooth counterbored section in the lower part of the eighth reduced tube section (6), and is secured after collimation with the circumferential alignment lockscrew (7). The mount is counterbored to carry the telemeter lens (13) and the telemeter lens clamp ring (10). The mount is provided with a small screw located as a permanent fitting and filed off so that the protruding section of the screw allows the free disassembly and reassembly of the telemeter lens in the mount. This protruding section of the screw, when engaged in the stoned vertical recess groove of the telemeter lens periphery, prevents it from shifting angularly in the mount and also provides the original reassembly of the lens in the mount. Two opposite drilled holes are provided in the lower part of the mount to receive a special tool which is used to remove the mount from the eighth reduced tube section.

inserted into countersunk clearance holes in the lower part of the eighth reduced tube section, and screwed into tapped holes in the upper alignment support section of the seventh reduced tube section. Two opposite air holes of 0.060-inch diameter are located 0.060 inch from the upper end of the alignment support section in the upper part of this reduced tube section.

The inside diameter is bored for light transmission and threaded for anti-reflection. The lower part of the seventh reduced tube section has a counterbored threaded section of 1 1/16 inches. This counterbored threaded section serves as a mount for the auxiliary upper objective lens (18), and is secured with two auxiliary upper objective lens clamp rings (15). One clamp ring serves as a seat for the flint element of the lens doublet in the upper part of this section, while the second clamp ring secures snugly against the crown element of the lens doublet in the lower part of this section. Each clamp ring is secured with a lockscrew (17). Two opposite shallow vertical grooves in the threaded wall of this section provide for nitrogen passage.

i. Telemeter lens clamping. The telemeter lens clamp ring (10) is made of brass tubing and is of nominal thickness and width. It is a push fit in the counterbored section of the telemeter lens mount (9). This clamp ring fits snugly against the convex surface of the telemeter lens, and is secured with two opposite lockscrews (12). These lockscrews extend into tapped holes in the upper part of the telemeter lens mount and into the partially tapped hole of each clamp ring.

j. Seventh reduced tube section. The seventh reduced tube section (14) is made of brass tubing and is 8.161 inches in length. At assembly it is provided with four shallow vertical recess grooves the entire length to allow sufficient clearance for the prism tilt and change of power shifting wire tapes (38, Figure 4-28). The upper part is machine-turned to serve as an alignment support section, and is a sliding fit in the small counterbored section in the lower part of the eighth reduced tube section (6). The threaded periphery section in the upper part receives the counterbored threaded section in the lower part of the eighth reduced tube section (6) and is secured with four lockscrews (11). These lockscrews are

An additional counterbore of 1.157 inches in length is provided to serve as an alignment support section with the lower part of 0.340-inch length of this section threaded. This threaded section screws on the threaded periphery of the sixth reduced tube section (1, Figure 4-19) of the auxiliary lower telescope system and is secured with four lockscrews (16). These lockscrews extend into countersunk clearance holes and into tapped holes in the alignment support section of the sixth reduced tube section.

k. Auxiliary upper objective lens. The auxiliary upper objective lens (18) is made of two optical elements, consisting of a divergent meniscus flint element cemented to a double convex crown element, forming a positive doublet. It is mounted in the threaded counterbore section in the lower part of the seventh reduced tube section (14) with two auxiliary upper objective lens clamp rings (15) located on opposite sides of the lens.

l. Auxiliary upper objective lens clamp rings. The auxiliary upper objective lens clamp rings (15) are made of brass tubing and are of nominal thickness and width. Both clamp rings are identical, with the periphery threaded, and

each has opposite slots in one of the side faces to accommodate a special wrench.

One clamp ring is inserted into the threaded counterbore in the lower part of the seventh reduced tube section before insertion of the auxiliary upper objective lens (18).

lockscrew is unscrewed from the tapped hole in the threaded periphery of the eighth reduced tube section. Unscrew the clamp ring (8) from the eighth reduced tube section.

10. Remove the circumferential alignment lockscrew (7). This

The second clamp ring contacts the lower side of the objective lens. Each clamp ring is secured with a lockscrew (17), which extends into the countersunk clearance hole in the dower part of the seventh reduced tube section (14) and into the tapped hole in each clamp ring.

4G2. Disassembly of the seventh, eighth, and ninth reduced tube sections. The seventh, eighth, and ninth reduced tube sections are disassembled in the following manner:

1. Remove the two lockscrews (11) from the lower part of the eighth reduced tube section 6). These lockscrews are unscrewed from tapped holes in the upper part of the external alignment support section of the seventh reduced tube section (14).

2. Unscrew the seventh reduced tube section 14) from the eighth reduced tube section (6).

3. Remove the two lockscrews (17) from the lower part of the seventh reduced tube section. These lockscrews are unscrewed from tapped holes in the two auxiliary upper objective lens clamp rings (15).

4. Remove the lower clamp ring (15), unscrewing it with a special wrench from the lower part of the seventh reduced tube section.

5. The auxiliary upper objective lens (18) slides out easily. This is done by turning this reduced tube section on its lower end over clean lens tissue, and tapping, around the periphery with a light rawhide mallet. Make certain that the lens drops lightly on soft lens tissue.

lockscrew is unscrewed from the tapped hole in the telemeter lens mount (9), and is removed from the circumferential slot in the eighth reduced tube section.

11. Remove the telemeter lens mount (9) from the lower part of the eighth reduced tube section. This is done by means of a special pair of calipers. The two rounded ends of the calipers fit into opposite drilled holes in the lower part of the mount.

12. Remove the two lockscrews (12) from opposite sides of the telemeter lens mount (9). These lockscrews are unscrewed from tapped holes in the telemeter lens clamp ring (10).

13. Turn the telemeter lens mount (9) with its upper face on a piece of lens tissue. If necessary, using a piece of lens tissue, press downward on the upper side of the telemeter lens (13), removing both the lens and the clamp ring (10). Wrap the lens in clean lens tissue and store in a box to prevent scratches and breakage.

14. Remove the lockscrew (2) from the upper part of the ninth reduced tube section (1). This lockscrew is unscrewed from the tapped hole in the auxiliary upper eyepiece lens clamp ring (4).

15. Unscrew the auxiliary upper eyepiece lens clamp ring (4), using a special wrench.

16. Place the upper end of the ninth reduced tube section on a piece of lens tissue. If necessary, tap lightly on the periphery of this reduced tube section with a small rawhide mallet. The auxiliary upper eyepiece lens (5) should slide out easily.

6. Unscrew the upper clamp ring (15) in the same manner as noted under Step 4.

7. Remove the two lockscrews (3) from the lower part of the ninth reduced tube section (1).

8. Unscrew the ninth reduced tube section (1) from the eighth reduced tube section (6).

9. Remove the lockscrew (11) from the ninth reduced tube section clamp ring (8). This

17. Wrap all lenses in clean lens tissue and place to one side, to prevent scratches and breakage.

4G3. Reassembly of the seventh, eighth, and ninth reduced tube sections. The seventh, eighth, and ninth reduced tube sections are reassembled in the following manner:

1. Using an air line pressure hose, blow out the internal surfaces of the seventh reduced

tube section. If a circular brush is available, it should be used first. This procedure should be carried out with each succeeding reduced tube section, and with the clamp rings and lens mounts.

2. Place the upper clamp ring (15) in the threaded counterbored section in the lower part of the seventh reduced tube section and screw it in until the lockscrew holes coincide.

3. Insert and secure the lockscrew (17) in the countersunk clearance hole in the lower part of the seventh reduced tube section and screw it into a tapped hole in the upper clamp ring (15).

4. Clean the auxiliary upper objective lens (18) with clean lens tissue. Surface dust can be removed with a rubber air bulb and a camel's hair brush. A vacuum brush used with ether is also effective.

5. Place the objective lens of this system in the lower part of the seventh reduced tube section, turning the flint side of the lens

11. Slide the telemeter lens clamp ring (10) into the telemeter lens mount so that it coincides with the lockscrew holes in the mount.

12. Insert and secure the two lockscrews (12) in the tapped holes in the mount and clamp ring (10).

13. Slide the telemeter lens (13) with its mount (9) into the lower part of the eighth reduced tube section with the etched graduated surface facing the lower part of this reduced tube section and the curvature facing upward.

14. Insert the circumferential alignment lockscrew (7) through the circumferential slot in the lower part of the eighth reduced tube section. This lockscrew extends into the tapped hole in the telemeter lens mount (9).

15. Screw the lower part of the eighth reduced tube section (6) on the upper part of the seventh reduced tube section (14) until the lockscrew holes coincide. The upper face of the seventh reduced tube section almost contacts the lower

doublet toward the lower face of the upper clamp ring (15).

6. Place the lower clamp ring (15) in the same threaded counterbored section on the lower face or crown side of the objective lens. Screw this clamp ring tightly against the objective lens with a special wrench. The lockscrew holes should coincide when this lens is tightened sufficiently.

7. Insert and secure the lockscrew (17) in the countersunk clearance hole in the lower part of the seventh reduced tube section and screw it into a tapped hole in the lower clamp ring (15).

8. Place the ninth reduced tube section clamp ring (8) on the threaded periphery of the eighth reduced tube section (6), screwing it beyond its locking position.

9. Clean the telemeter lens (13) in similar manner to that outlined under Step 4.

10. Place the telemeter lens (13) in the telemeter lens mount (9) with the etched graduations resting against the shoulder of the mount, and the stoned vertical recess groove meshing with the inward protruding screw in the mount.

face of the telemeter lens mount, and prevents axial movement of the mount.

16. Secure the seventh and eighth reduced tube sections with four lockscrews (11). These lockscrews are inserted in countersunk clearance holes in the eighth reduced tube section and screwed into tapped holes in the upper part of the alignment support section of the seventh reduced tube section.

17. Clean the auxiliary upper eyepiece lens (5) in similar manner to that outlined in Step 4.

18. Place the auxiliary upper eyepiece lens in the seat of the upper part of the ninth reduced tube section with the crown side of the lens doublet against the seat of this section.

19. Screw the auxiliary upper eyepiece lens clamp ring (4) into and against the lens tightly to insure that the tapped holes coincide.

20. Place the lockscrew (2) in the tapped holes in both the ninth reduced tube section (1) and the clamp ring (4) for securement.

21. Place an auxiliary telescope at the lower part of the seventh reduced tube section. Set the auxiliary telescope diopter at infinity for the observer. (This setting should be based on

at least five observations of an infinity target which give consistent readings.) Check the definition on the telemeter lens through the auxiliary upper objective lens. It should correspond to the diopter

diopter to the observer's diopter reading. Check at this diopter reading to ascertain that the telemeter graduations are in sharp definition and that there is no

setting on the auxiliary telescope. Should the focusing of this lens doublet indicate that the previous factory setting is correct, the-auxiliary upper eyepiece lens is assembled.

22. Screw the lower part of the ninth reduced tube section (1) onto the upper part of the eighth reduced tube section (6).

23. With the use of an infinity target, primary collimation of this auxiliary upper telescope system is carried out in the following manner. The ninth reduced tube section is moved downward, focusing the auxiliary upper eyepiece lens until the image of the target is apparent on the telemeter lens. At this setting, the auxiliary telescope is focused from plus parallax apparent on the telemeter lens.

24. This auxiliary upper telescope system, being of unit power magnification, requires the use of an auxiliary telescope to set the system to zero diopter. This constitutes the primary collimation of this telescope system. Any error in this telescope system when assembled to the rest of the instrument is apparent when magnified at 6 power.

25. Keep the lockscrews (3) which secure the ninth reduced tube section (1) to the eighth reduced tube section (6) and the ninth reduced tube section clamp ring lockscrew (11) in a small box until the final collimation on a distance target of 1200 feet at atmospheric pressure is completed.

H. AUXILIARY LOWER TELESCOPE SYSTEM

4H1. Description of the second, third, fourth, fifth, and sixth reduced tube sections. Figure 4-19 shows the auxiliary lower telescope system assembly. All bubble numbers in Sections 4H1, 2, and 3 refer to Figure 4-19 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1305-6	1	Sixth reduced tube section
2	P-1305-2	1	Fifth reduced tube section
3	P-1305-5	1	Auxiliary lower objective lens clamp ring
4	P-1305-8	1	Taper guide

Ill. No.	Drawing Number	Number Required	Nomenclature
13	P-1305-3	1	Auxiliary lower eyepiece lens mount
14	P-1305-4	1	Auxiliary lower eyepiece lens clamp ring
15	P-1310-25	4	Third and fourth reduced tube section lockscrews
16	P-1310-26	1	Auxiliary lower eyepiece lens clamp ring lockscrew

5	P-1310-22	1	Auxiliary lower objective lens clamp ring lockscrew
6	P-1310-23	4	Fifth and sixth reduced tube section lockscrews
7	P-1310-24	4	Taper guide lockscrews
8	P-1418-7	1	Auxiliary lower objective lens
9	P-1305-1	1	Fourth reduced tube section
10	P-1310-24	4	Fourth and fifth reduced tube section lockscrews
11	P-1361-7	1	Air line adapter
12	P-1304-9	1	Third reduced tube section
17	P-1310-27	2	Auxiliary lower eyepiece lens mount lockscrews
18	P-1418-8	1	Auxiliary lower eyepiece lens
19	P-1304-8	1	Second reduced tube section
20	P-1310-28	4	Second and third reduced tube section lockscrews
21	P-1362-13	1	Air line strap
22	P-1422-1	2	Air line strap lockscrews

a. Sections. The auxiliary lower telescope system consists of five reduced tube sections of a unit power telescope which make up the necessary length and carry six parts which locate the lenses in appropriate relation to their focal lengths. The system consists of the second, third, fourth, fifth, and sixth reduced tube sections,

b. Sixth reduced tube section. The sixth reduced tube section (1) is made of brass tubing

and is 10.309 inches in length. It serves to provide only the necessary distance between the auxiliary upper and lower telescope systems. At assembly, four vertical shallow recess grooves are provided 3 1/2 inches from the upper part, to allow clearance for the prism tilt and change of power shifting wire tapes (38, Figure 4-28). Its inside diameter

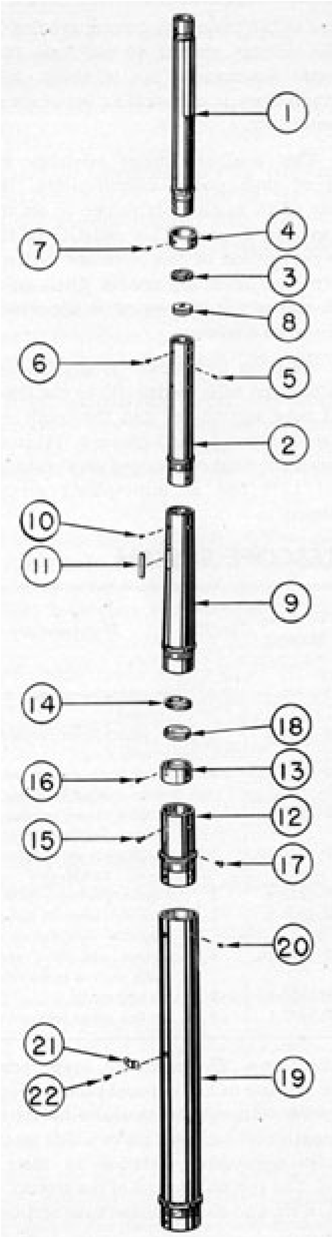

Figure 4-19. Auxiliary lower telescope system assembly.

is bored for light transmission and is provided with anti-reflection threads.

The upper part is turned a sliding fit and serves as an alignment support section in the counterbored alignment support section in the lower part of the seventh reduced tube section. The threaded periphery section in the upper part of this reduced tube section receives the counterbored threaded section in the lower part of the seventh reduced tube section (14, Figure 4-18) and is secured with four lockscrews (16) of the auxiliary upper telescope system assembly.

The lower part is turned a sliding fit and serves as an alignment support section in the counterbored alignment support section in the upper part of the fifth reduced tube section (2). The threaded periphery section in the lower part screws into the threaded counterbore in the upper part of the fifth reduced tube section, and is secured with four lockscrews (6) which are inserted into countersunk clearance holes in the upper part of the fifth reduced tube section (2) and screwed into tapped holes in the lower alignment support section of the sixth reduced tube section (1). The lower part has a shoulder 1/4 inch wide and its diameter coincides with the diameter of the upper part of the fifth reduced tube section.

c. Fifth reduced tube section. The fifth reduced tube section (2) is made of brass tubing, and is 7.187 inches in length. The upper part of its external wall is straight turned a distance of 4 inches. A taper guide is located on this surface with a center distance of approximately 2 1/4 inches from the upper face and

is secured to this reduced tube section with four lockscrews (7). From the 4-inch turned section, the lower part of this reduced tube section is tapered outward for 1 15/16 inches at which point there is a shoulder 1/8 inch wide. The diameter of this shoulder coincides with the diameter of the upper part of the fourth reduced tube section (9). The part below the large shoulder is straight turned a short

distance to serve as an alignment support section with a threaded periphery section above it. The alignment support section is a sliding fit into the counterbored alignment support section, while the threaded periphery screws into the threaded counterbored section in the upper part of the fourth reduced tube section. It is secured with four lockscrews (10) which are inserted in countersunk clearance holes in the lower part of the fourth reduced tube section and screwed into tapped holes in the upper alignment support section of the fifth reduced tube section.

This reduced tube section is bored to a diameter of 0.946 inch for light transmission. The lower part is counterbored with a taper, which tapers inward from the lower end and upward for a distance of 3 15/16 inches. From this point it remains a straight counterbored section for a distance of 2 3/16 inches. The tapered and straight counterbored sections are provided with anti-reflection threads. This reduced tube section tapers principally to allow sufficient space, and to form a wall around the marginal or oblique light ray bundles. These bundles diverge walls have four vertical shallow recess grooves, two opposite each other to provide clearance for the prism tilt and change of power shifting wire tapes (38, Figure 4-28). It is secured with four lockscrews (7) which extend into countersunk clearance holes in the taper guide and screw into tapped holes in the fifth reduced tube section. The taper guide provides a support for the reduced tube sections in the outer taper section (1, Figure 4-15).

e. Auxiliary lower objective lens. The auxiliary lower objective lens (8) is identical to the auxiliary upper objective lens (18, Figure 4-18) of the auxiliary upper telescope system. The flint element of this doublet is secured against the shoulder seat in the fifth reduced tube section by means of a threaded auxiliary lower objective lens clamp ring (3) which is secured with a lockscrew (5).

f. Auxiliary lower objective lens clamp ring. The auxiliary lower objective lens clamp ring (3) is identical to the auxiliary upper objective lens clamp rings (15, Figure 4-18) of the auxiliary upper telescope system. The clamp ring is

downward from the auxiliary lower objective lens (8), through the fourth reduced tube section (9) to the auxiliary lower eyepiece lens (18) of the third reduced tube section (12).

The upper part of the fifth reduced tube section is counterbored an appropriate distance to serve as a mount for the auxiliary lower objective lens (8) with an internal threaded section to accommodate the auxiliary lower objective lens clamp ring (3). Two opposite shallow air channels located in the inner wall of this mount section and protruding into the seat of the mount permit passage of the charging nitrogen. An additional counterbored section serves as an alignment support section with an internal threaded section above it to receive the upper alignment support section and the threaded periphery of the 6th reduced tube section (1).

d. Taper guide. The taper guide (4) is made of brass tubing, with a nominal wall thickness, and is 5/8 inch in width. The upper part is tapered slightly at assembly to allow about 0.005 inch clearance on the diameter with the inside wall of the outer taper section (1, Figure 4-15). The bore of the taper guide is a push fit on the upper part of the fifth reduced tube section (2). The inside inserted in the threaded counterbore in the lower part of the fifth reduced tube section, and contacts the crown element side of the auxiliary lower objective lens to secure the lens doublet snugly. The clamp ring is secured from unscrewing by the insertion of a lockscrew (5) which is inserted into a countersunk clearance hole in the lower part of the fifth reduced tube section and screwed into a tapped hole in the clamp ring.

g. Fourth reduced tube section. The fourth reduced tube section (9) is made of brass tubing, and is 7.937 inches in length. Its external diameter is tapered, with the inside diameter tapered in the same proportion allowing the wall a nominal thickness. It is provided with antireflection threads.

The lower part of the fourth reduced tube section has a shoulder 3/16 inch in width, located at the lower part of the taper. Its diameter coincides with the diameter in the upper part of the third reduced tube section (12). Below this shoulder, the lower part is turned straight, and is provided with an alignment support section and threaded periphery. The alignment support section is a sliding fit in the upper counterbored alignment section in the third reduced tube section, while

the threaded periphery screws into the threaded counterbored section of the same reduced tube section. It is secured with four lockscrews (15) which are inserted in countersunk clearance holes in the upper part of the third reduced tube section and screwed into tapped holes in the lower alignment support section of the third reduced tube section.

The center part of this reduced tube section has opposite axial slots of appropriate length in which the

screwed into tapped holes in the lower alignment support section of the fourth reduced tube section.

The upper part is counterbored straight a depth of 1.130 inches, to serve as an alignment support section with a portion threaded to receive the alignment support section and threaded periphery in the lower part of the fifth reduced tube section. In the upper part a 1/8-inch diameter hole is drilled through the wall and is located 1.571 inches from the upper end, for the assembly of an air line adapter (11).

h. Air line adapter. The air line adapter (11) consists of a piece of flat brass air line, with the upper end closed, provided with a 1/8-inch diameter drilled hole located 7/64 inch from the upper end. The adapter is soldered to the periphery in the upper part of the fourth reduced tube section (9) with 1/8-inch holes in coincidence. The lower opening of the adapter receives the air line section (18) shown on the upper telescope system Part I assembly (Figure 4-20).

i. Third reduced tube section. The third reduced tube section (12) is made of brass tubing and is 3.562 inches in length. It is bored straight for light transmission, and carries the auxiliary lower eyepiece lens mount (13) which is a sliding axial fit in its central part.

Its external diameter is a step larger than the preceding reduced tube section, and it has a large shoulder 1/8 inch in width. This shoulder forms a flange, with a diameter that coincides with the diameter of the upper part of the second reduced tube section (19). The part below the shoulder flange is turned straight, auxiliary lower eyepiece lens (18) and its mount (13) are focused in the primary and final collimation of the auxiliary upper and lower telescope system.

The bore of the upper part is provided with a partially threaded section to receive the threaded periphery of the lower part of the fourth reduced tube section, while the bore serves as an alignment support section for the lower alignment support section of the fourth reduced tube section.

The lower part is counterbored a depth of 1.125 inches upward to provide clearance for light transmission and to lighten the reduced tube section. The air line section (18) shown on the upper telescope system Part I (Figure 4-20) extends downward from the fourth reduced tube section over this reduced tube section.

j. Auxiliary lower eyepiece lens. The auxiliary lower eyepiece lens (18) is made of two optical elements, consisting of a double convex crown element cemented to a divergent meniscus flint element, forming a positive doublet. It is mounted in the auxiliary lower eyepiece lens mount (13) with the flint element resting in the seat of the counterbored section of the mount, and is secured with an auxiliary lower eyepiece lens clamp ring (14) which is secured with a lockscrew (16).

k. Auxiliary lower eyepiece lens mount. The auxiliary lower eyepiece lens mount (13) is made of brass tubing, and is 0.780 inch in length. It is bored for light transmission, and is provided with two counterbored sections. The small counterbored

with a threaded periphery and an alignment support section. The alignment support section is a sliding fit into the counterbored alignment support section in the upper part of the second reduced tube section, while its threaded periphery screws into the internal threaded section in the same counterbored section. It is secured with four lockscrews (20) which are inserted into countersunk clearance holes in the upper part of the second reduced tube section and section carries the auxiliary lower eyepiece lens (18), while the large counterbored section is threaded to receive the auxiliary lower eyepiece lens clamp ring (14) which is secured with a lockscrew (16). The mount is a sliding fit in the bore of the third reduced tube section, and is moved axially to focus the auxiliary lower eyepiece lens (18) for fine

adjustments for the removal of parallax at primary and final collimation.

Two opposite narrow air channels in the periphery permit passage of charging nitrogen. A tapped hole is provided to receive a screw which is inserted temporarily through the axial slot of the third reduced tube section during collimation, to focus the mount axially, thus carrying the auxiliary lower eyepiece lens (18) vertically for adjustments required.

The face of the mount is beveled inward at 45 degrees to prevent restriction to the light rays that are deflected downward. The mount is secured with two lockscrews (17) which are inserted into countersunk clearance holes in the third reduced tube section and screwed into tapped holes in the mount. Two opposite drilled holes are provided in the upper wall of the mount to receive a special tool which is used to remove the mount from the third reduced tube section.

l. Auxiliary lower eyepiece lens clamp ring. The auxiliary lower eyepiece lens clamp ring (14) is made of brass with the diameter of the upper part of the first reduced tube section shown in Figure 4-20 of the upper telescope system assembly Part I.

The lower part below the shoulder flange is turned to serve as an alignment support section and is a sliding fit in the counterbored alignment support section in the first reduced tube section (1, Figure 4-20). The threaded periphery screws into the threaded section of the same counterbore. It is secured with four lockscrews (8) which are inserted in countersunk clearance holes in the upper part of the first reduced tube section (1, Figure 4-20) and screwed into tapped holes in the lower alignment support section of the second reduced tube section (19).

The inside diameter is bored for light transmission and is provided with anti-reflection threads up to the upper alignment support section. The bore in the upper part serves as an alignment support section and is threaded above the upper part, to receive the lower alignment support section and the

tubing and is of nominal thickness and width. The periphery is threaded to screw into the threaded counterbore of the auxiliary lower eyepiece lens mount (13) to secure the lens. The upper face of the clamp ring is beveled at 30 degrees with a matching inside bevel from an undercut groove of the bore, thus providing a 1/64-inch upper wall to secure the lens sufficiently and a shock support to the crown element of the lens. The remaining bore is tapered outward. Two opposite slots are provided in the side face of the clamp ring for the insertion of a special wrench. The clamp ring is secured with a lockscrew (16) which is inserted in a countersunk hole in the mount and screwed into a tapped hole in the clamp ring.

m. Second reduced tube section. The second reduced tube section (19) is made of brass tubing, and is 16.300 inches in length. It serves to enclose the light rays to the designed clear aperture area, and to provide the necessary distance between the auxiliary lower telescope system and the upper telescope system assembly Part I. Its outside diameter is uniform for its entire length, with the exception of the lower part. This part has a shoulder flange 3/16 inch in width, the outside diameter coinciding threaded periphery of the third reduced tube section (12).

The air line section (18, Figure 4-20) of the upper telescope system assembly Part I, extends downward the entire length of this reduced tube section. It is secured to it with a removable air line strap (21) which is secured with two lockscrews (22). These lockscrews are inserted in clearance holes in the air line strap (21) and screwed into tapped holes in the wall of this reduced tube section.

4H2. Disassembly of the second, third, fourth, fifth, and sixth reduced tube sections. The second, third, fourth, fifth, and sixth reduced tube sections are disassembled in the following manner:

1. Remove the four lockscrews (6) from the upper part of the fifth reduced tube section (2). These lockscrews are unscrewed from tapped holes in the lower alignment support section of the sixth reduced tube section (1).

2. Unscrew the sixth reduced tube section (1) from the fifth reduced tube section (2).

3. Remove the lockscrew (5) from the upper part of the fifth reduced tube section (2). This

lockscrew is unscrewed from the tapped hole in the auxiliary lower objective lens clamp ring (3).

4. Using a special wrench, unscrew the clamp ring (3).

5. Place the upper end of the fifth reduced tube section (2) on a piece

15. Using a special wrench, unscrew the clamp ring (14) from the auxiliary lower eyepiece lens mount (13).

16. Place the upper end of the mount (13) on a piece of clean lens tissue. The auxiliary lower eyepiece lens (18) should drop out easily. If

of clean lens tissue, allowing the auxiliary lower objective lens (8) to slide out.

6. Remove the four lockscrews (7) from the taper guide (4). These lockscrews are unscrewed from tapped holes in the wall of the fifth reduced tube section (2).

7. Carry the taper guide (4) off the upper part of the fifth reduced tube section (2).

8. Remove the four lockscrews (10) from the upper part of the fourth reduced tube section. These lockscrews are unscrewed from the tapped holes in the lower alignment support section of the fifth reduced tube section (2).

9. Unscrew the fifth reduced tube section (2) from the upper part of the fourth reduced tube section (9).

10. Remove the four lockscrews (15) from the upper part of the third reduced tube section (12). These lockscrews are unscrewed from the tapped holes in the lower alignment support section of the fourth reduced tube section (9).

11. Unscrew the fourth reduced tube section (9) from the upper part of the third reduced tube section (12).

12. Remove the two lockscrews (17) from the central part of the third reduced tube section (12). These lockscrews are unscrewed from tapped holes in the auxiliary lower eyepiece lens mount (13).

13. Turn the assembled third and second reduced tube sections so that the third reduced tube section is facing downward. Tap lightly on the periphery of the third reduced tube section (12) with a light rawhide difficulty should be encountered, place a piece of clean lens tissue over the mount and push downward.

17. Remove the four lockscrews (20) from the upper part of the second reduced tube section (19). These lockscrews are unscrewed from tapped holes in the lower alignment support section of the third reduced tube section (12).

18. Unscrew the third reduced tube section (12) from the upper part of the second reduced tube section (19).

19. Place the lens doublets of this telescope system to one side, to prevent scratches or breakage.

4H3. Reassembly of the second, third, fourth, fifth, and sixth reduced tube sections. The second third, fourth, fifth, and sixth reduced tube sections are reassembled in the following manner:

1. Using an air hose, blow out the internal surface of the sixth reduced tube section. If a circular brush is available, it should be used before the air hose. This procedure is carried out with each reduced tube section of this assembly, and also with the clamp rings and lens mounts.

2. Clean the auxiliary lower objective lens (8) with clean lens tissue. Surface dust can be removed with a rubber air bulb and a camel's hair brush; a vacuum brush used with ether is also effective.

3. Place the objective lens of this system in the upper part of the fifth reduced tube section (2). The lens doublet should be placed so that

mallet. The assembled auxiliary lower eyepiece lens (18) and its mount (13) with the clamp ring (14) should slide out easily.

14. Remove the lockscrew (16) from the periphery of the auxiliary lower eyepiece lens mount (13), unscrewing it from the tapped hole in the clamp ring (14).

the flint element is resting against the seat of the mount section.

4. Place the clamp ring (3) in the threaded counterbored section of the upper part of the fifth reduced tube section (2). Screw the clamp ring tight against the crown element of the lens doublet. The lockscrew holes should coincide when this lens is tightened sufficiently.

5. Insert and secure the lockscrew (5) in the countersunk clearance hole in the upper part of the fifth reduced tube section (2) and screw it into the tapped hole in the clamp ring.

6. Assemble the taper guide (4) over the upper part of the fifth reduced tube section (2). Push this taper guide on, noting the reference numerals to determine its correct assembly with the lockscrew holes. The tapered part faces upward.

7. Insert and secure the four lockscrews (7). These lockscrews are inserted in countersunk clearance holes in the taper guide (4) and screwed into tapped holes in the periphery of the fifth reduced tube section (2).

8. Insert the threaded periphery of the lower part of the sixth reduced tube section (1) in the threaded counterbored section in the upper part of the fifth reduced tube section (2). Screw it tight until the lockscrew holes coincide.

9. Secure the sixth and fifth reduced tube sections with the four lockscrews (6). These lockscrews are inserted in countersunk clearance holes in the fifth reduced tube section and screwed into tapped holes should coincide when the lens is tightened sufficiently.

15. Insert and secure the lockscrew (16) in the countersunk clearance hole in the mount (13) and screw it into the tapped hole in the clamp ring (14).

16. Slide the mounted auxiliary lower eyepiece lens (18) with the mount (13) into place in the central part of the third reduced tube section (12). Place the mount so that the clamp ring side remains toward the upper part. Insert the one lockscrew (17) temporarily to hold the mount in place.

17. The auxiliary lower eyepiece lens mount (13) is not secured with the two lockscrews (17) during the primary collimation of the auxiliary lower telescope system. The lockscrews should be placed in a small box until the final collimation is completed.

18. Place the upper part of the third reduced tube section (12) on the lower alignment support section of the fourth reduced tube section (9), screwing it on the threaded periphery.

holes in the lower alignment support section of the sixth reduced tube section.

10. Insert the threaded periphery of the lower part of the fifth reduced tube section (2) in the threaded counterbored section in the upper part of the fourth reduced tube section (9). Screw it tight until the lockscrew holes coincide.

11. Secure the fifth and fourth reduced tube sections with four lockscrews (10). These lockscrews are inserted in countersunk clearance holes in the upper part of the fourth reduced tube section (9) and screwed into tapped holes in the lower alignment support section of the fifth reduced tube section (2).

12. Clean the auxiliary lower eyepiece lens (18) in similar manner to that described in Step 2.

13. Place the auxiliary eyepiece lens (18) in the mount (13) so that the flint element of this lens doublet rests in the seat of the mount.

14. Place the clamp ring (14) in the threaded counterbored section in the mount. Using a special wrench, screw the clamp ring tight against the crown element of this lens doublet. The lockscrew

19. Secure the fourth and third reduced tube sections (9 and 12) with four lockscrews (15). These lockscrews are inserted into countersunk clearance holes in the upper part of the third reduced tube section (12) and screwed into tapped holes in the lower alignment support section of the fourth reduced tube section.

20. Insert the threaded periphery of the lower part of the third reduced tube section (12) into the threaded counterbore of the upper part of the second reduced tube section (19).

21. Secure the third and second reduced tube sections (12 and 19) with four lockscrews (20). These lockscrews are inserted into countersunk clearance holes in the upper part of the second reduced tube section (19) and screwed into tapped holes in the lower alignment support section of the third reduced tube section.

22. Assemble the auxiliary lower telescope system assembly to the auxiliary upper telescope system assembly. Insert the threaded periphery of the upper part of the sixth reduced tube section (1) into the threaded counterbore of the lower part of the seventh reduced tube section (14, Figure 4-18).

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23. Secure the seventh and sixth reduced tube sections with four lockscrews (16). These lockscrews are inserted into countersunk clearance holes in the lower part of the seventh reduced tube section (14) and screwed into tapped holes in the upper alignment support section of the sixth reduced tube section (1).

When the target is sharply apparent on the telemeter lens there should be no parallax observed.

26. Focus the auxiliary telescope from plus to observe the diopter reading, taking a series of observations to determine the correct setting of the auxiliary lower eyepiece lens. This telescope

24. Place an auxiliary telescope at the lower end of the second reduced tube section. Set the auxiliary telescope diopter at infinity for the observer. (This setting should be based on at least five observations of an infinity target which give consistent readings.)

25. Move the auxiliary lower eyepiece lens in until the image of the infinity target is apparent on the telemeter lens. The movement of the auxiliary lower eyepiece lens requires fine movement, as the image is lost with very little movement.

system, being of unit power magnification, requires the use of an auxiliary telescope to set the system to zero diopter. This constitutes primary collimation of the auxiliary lower telescope system to the auxiliary upper telescope system.

27. Any error in the auxiliary lower telescope system, when assembled to the rest of the instrument, is apparent when magnified at 6 power. This error can be compensated during final collimation.

I. UPPER TELESCOPE SYSTEM

4I1. Part I of the upper telescope system. The upper telescope system is divided into two individual assemblies, namely: Part I: first reduced tube section, fifth, and sixth inner tube sections. Part II: second, third, and fourth inner tube sections.

The upper telescope system is divided principally to permit familiarization as to nomenclature, description, disassembly, and reassembly. It is composed of three lenses, namely: a positive upper eyepiece lens doublet, a plano convex collective, lens, and an air space upper objective lens doublet. This system is used in reverse to decrease the lower telescope system to a 6 power magnification.

Part I: a. First reduced tube section and fifth and sixth inner tube sections. Figure 4-20 shows the upper telescope system assembly Part I. All bubble numbers in Section 4I1, 3 and 4 refer to Figure 4-20 unless otherwise specified.

Ill.	Drawing	Num-	Nomenclature

Ill. No.	Drawing Number	Number Required	Nomenclature
4	P-1304-3	1	Collective lens clamp ring
5	P-1304-6	1	Upper eyepiece lens clamp ring
6	P-1304-7	1	Upper eyepiece lens mount
7	P-1310-7	2	Collective lens mount and diaphragm lockscrews
8	P-1310-29	4	First and second reduced tube section lockscrews
9	P-1310-30	1	Upper eyepiece lens clamp ring lockscrew
10	P-1310-31	2	Upper eyepiece lens

No.	Number	ber Re-quired	
1	P-1304-5	1	First reduced tube section
2	P-1304-1	1	Reducing coupling
3	P-1304-2	1	Collective lens mount

			mount lockscrews
11	P-1310-32	1	Collective lens clamp ring lockscrew
12	P-1310-33	4	Reducing coupling and first reduced tube section lockscrews
13	P-1314-14	1	Diaphragm
14	P-1362-3	1	Air line coupling
15	P-1362-6	1	Flat air line coupling
16	P-1362-7	1	Air line section (short)
17	P-1362-8	1	Air line section (bent)
18	P-1362-9	1	Air line section
19	P-1362-12	1	Air line strap
20	P-1418-9	1	Upper eyepiece lens
21	P-1418-10	1	Collective lens
22	P-1422-1	2	Air line strap lockscrews
23	P-1204-3	1	Sixth inner tube section
24	P-1179-24	8	Sixth inner tube section lower end lockscrews (soldered)

Ill. No.	Drawing Number	Num-ber Re-quired	Nomenclature
25	P-1179-	4	Sixth inner

into tapped holes in the lower alignment support section of the first reduced tube section (1).

	30		tube section and reducing coupling lockscrews
26	P-1204-2	1	Sixth inner tube section upper end coupling
27	P-1204-4	1	Sixth inner tube section lower end coupling
28	P-1310-34	8	Sixth inner tube section upper end coupling lockscrews (soldered)
29	P-1361-3	2	Tape straps
30	P-1362-7	1	Air line section (soldered)
31	P-1362-7	1	Air line section (short)
32	P-1362-13	1	Air line strap
33	P-1422-1	2	Air line strap lockscrews
34	P-1204-5	1	Fifth inner tube section
35	P-1179-23	8	Fifth inner tube section lockscrews, upper and lower ends
36	P-1179-23	6	Upper objective lens mount lockscrews
37	P-1179-35	1	Upper objective lens clamp ring lockscrew
38	P-1204-6	1	Upper objective lens mount

The upper part is counterbored straight for a depth of 3.062 inches and carries the mounted upper eyepiece lens (20) and mount (6). An axial slot of appropriate length is provided in the wall near the lower part of the counterbored section for the insertion of a screw in the tapped hole in upper eyepiece lens mount (6). The upper eyepiece lens (20) can be focused vertically with its mount during primary and final collimation of the upper and lower telescope systems.

An additional counterbore of 1.250 inches in length serves as an alignment support section to receive the alignment support section in the lower part of the second reduced tube section (19, Figure 4-19), while the threaded section of this counterbored section receives the threaded periphery of the second reduced tube section (19). It is secured with four lockscrews (8) which are inserted in countersunk clearance holes in the upper part of the first reduced tube section (1) and screwed into tapped holes in the lower alignment support, section of the second reduced tube section (19, Figure 4-19).

The internal diameter tapers upward from the counterbored section in the lower part to the small counterbored section in the upper part, and is provided with anti-reflection threads. The lower part is counterbored a depth of 1 5/16 inches, and is threaded to receive the collective lens mount (3) and the threaded section of the diaphragm (13).

The lower part of this reduced tube section is provided with an air line strap (19) to retain the bent air line

39	P-1204-7	1	Upper objective lens clamp ring
40	P-1417-5	1	Upper objective lens spacer
41	P-1418-11A	1	Upper objective lens flint element
42	P-1418-11B	1	Upper objective lens crown element

b. First reduced tube section. The first reduced tube section (1) is made of cast phosphor bronze, and is 18.750 inches in length. It serves to enclose the marginal or oblique light rays diverging downward from the upper eyepiece lens in the upper part to the collective lens in the lower part. The external diameter tapers from the upper part downward to the shoulder flange in the lower part.

The shoulder flange is 3/16 inch in width, with the outside diameter coinciding with the diameter of the upper part of the reducing coupling (2). In the lower part below the shoulder flange is a turned section serving as an alignment support section for insertion in the upper part of the reducing coupling (2). The threaded periphery screws into the threaded part of the same counterbored section and is secured with four lockscrews (12). These lockscrews are inserted in countersunk clearance holes in the upper part of the reducing coupling and screwed

(17). It is secured with two lockscrews (22) which are inserted in clearance holes in the air line strap and screwed into tapped holes in the wall of the first reduced tube section (1). The air line section (18) extends downward from the preceding reduced tube section to the lower part. At this point the soldered air line coupling (14) soldered to its lower part connects in the upper part of the bent air line (17).

The bent air line (17) extends over the reducing coupling (2) and has a soldered flat air line coupling (15) at its lower part. The flat air line coupling (15) has a short air line section (16) soldered to its lower part. This short air line

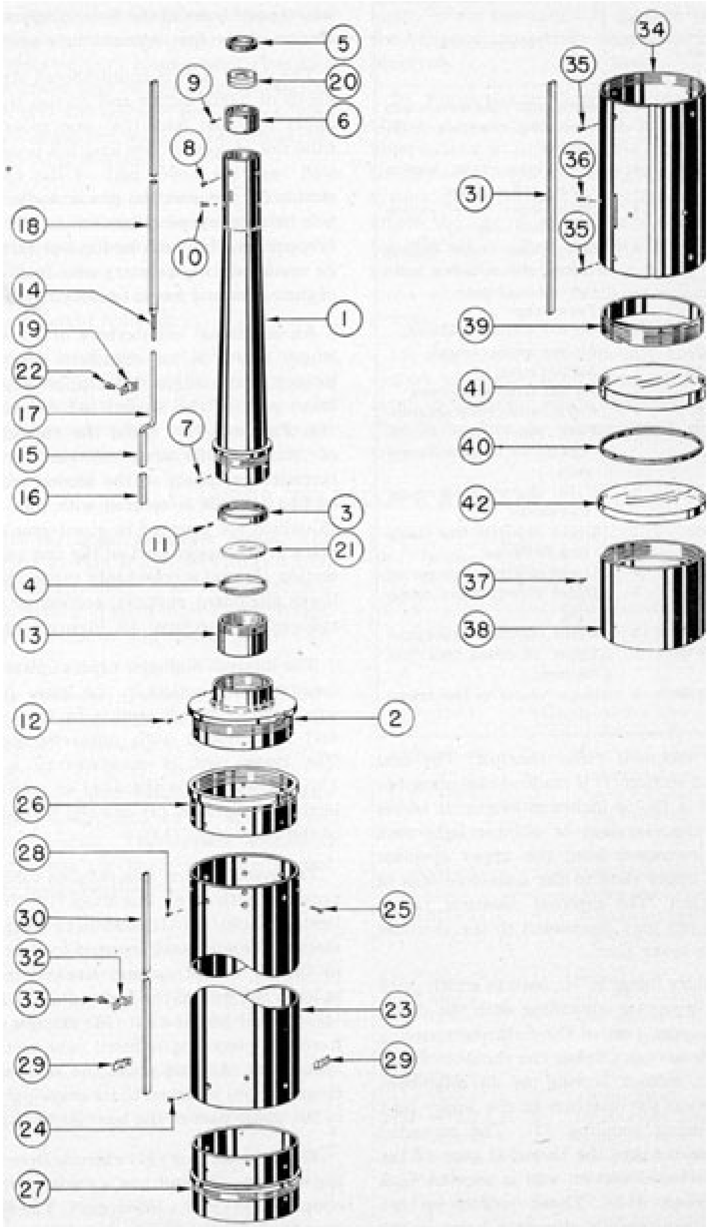

Figure 4-20. Upper telescope system assembly, Part 1.

section (16) fits into the upper opening in the soldered air line (30) of the sixth inner tube section (23).

c. Upper eyepiece lens. The upper eyepiece lens (20) is made of two optical elements, consisting of a plano concave flint element cemented to a double convex flint element, forming a positive doublet. It is mounted in the upper eyepiece lens mount (6) with the curvature surface of the doublet resting against the seat of the mount and is secured with an upper eyepiece lens clamp ring (5) and a lockscrew (9).

upper wall to secure the lens sufficiently and also provides a shock support to the plano surface of the flint element of the lens doublet. Two opposite slots are provided in the face of the clamp ring for the insertion of a special wrench. The clamp ring is secured with a lockscrew (9) which protrudes from the tapped hole in the mount into the partially tapped hole in the clamp ring.

f. Collective lens. The collective lens (21) is made of one plano convex crown optical element. Refer to

d. Upper eyepiece lens mount. The upper eyepiece lens mount (6) is made of brass tubing and is 1.120 inches in length. It has two counterbored sections. The smaller smooth turned counterbored section carries the upper eyepiece lens doublet (20). The larger counterbored section is threaded to receive the threaded periphery of the upper eyepiece lens clamp ring (5). The upper face is chamfered from the bore at a 45 degrees angle outward. The mount is a sliding fit in the small counterbored section in the upper part of the first reduced tube section (1). The mount is moved vertically during collimation by a temporarily inserted screw extending through the axial slot of the first reduced tube section into a tapped hole in the mount. This vertical focusing of the upper eyepiece lens (20) is necessary to obtain correct adjustment for definition and to eliminate parallax in the upper and lower telescope system during primary and final collimation. The mount is secured in the first reduced tube section (1) with two lockscrews (10). These lockscrews are inserted in countersunk clearance holes in the reduced tube section and screwed into tapped holes in the mount. Two opposite narrow vertical air channels are provided in the periphery of the mount to allow sufficient clearance for the passage of nitrogen.

e. Upper eyepiece lens clamp ring. The upper eyepiece lens clamp ring (25) is made of brass tubing, and is of nominal thickness and width. The periphery is threaded to screw into the threaded counterbored section in the upper eyepiece lens mount (6) to secure the lens doublet. The upper face of the clamp ring is Section 4U8 Step 10 for further detail. The plano side of the lens rests against the seat in the collective lens mount (3) and is secured with a collective lens clamp ring (4) which is secured with a lockscrew (11).

g. Collective lens mount. The collective lens mount (3) is made of brass tubing of nominal thickness and width. Its periphery is threaded to screw into the threaded counterbored section in the lower part of the first reduced tube section (1). The mount has two counterbored sections. The smaller counterbored section carries the collective lens (21) and the larger is threaded to carry the clamp ring (4). The upper face of the mount is chamfered at a 45 degrees angle outward from the bore. The mount is secured with a lockscrew (7). This lockscrew is inserted in a tapped hole in the lower alignment support section of the first reduced tube section (1) and screwed into the partially tapped hole in the mount. Two opposite narrow air channels are provided in the periphery of the mount to allow sufficient clearance for nitrogen passage.

h. Collective lens clamp ring. The collective lens clamp ring (4) is made of brass tubing material of nominal thickness and width. The periphery is threaded to screw into the larger threaded counterbored section in the collective lens mount (3) to secure the lens. The upper face of the clamp ring is chamfered at a 30 degrees angle outward from the bore, with a matching inside chamfer from the undercut groove of the bore. This provides a 1/64-inch upper wall to secure the lens sufficiently and also provides a shock support to the curvature face

chamfered at a 30 degrees angle outward from the bore, with a matching inside chamfer from the undercut groove of the bore. This provides a 1/64-inch of the collective lens. Two opposite slots are provided in the lower face of the clamp ring for the insertion of a special wrench. The clamp is secured in the mount with a lockscrew (11). This lockscrew is

inserted in a tapped hole in the mount and screwed into the partially tapped hole in the clamp ring.

i. Diaphragm. The diaphragm (13) is made of brass tubing and is 1.868 inches in length. It confines the light rays to the required aperture area, thus preventing any unwanted reflection of light which might result from striking the walls of the next inner tube section. The outer diameter is threaded a distance of 1/2 inch with the remaining section smooth turned below the root diameter of the threaded section.

It is bored for light transmission, with a counterbore provided with anti-reflection threads. The 0.060-inch shoulder in the lower part is chamfered at a 45 degrees angle outward from the bore.

j. Reducing coupling. The reducing coupling (2) is made of cast phosphor-bronze material. Its lower part is designed to fit in the sixth inner tube section upper end coupling (26), while its upper part has a reduction which carries the lower part of the first reduced tube section (1). It has a large bearing flange 1/16 inch wide, and its diameter is a few thousandths of an inch smaller than the inner diameter of the outer tube. This flange serves as a bearing to stabilize the reduced tube sections and the upper part of the bore of the sixth inner tube section upper end coupling (26), with the threaded periphery screwing into the internal threaded section in the upper part of the sixth inner tube section upper end coupling (26).

The bearing flange has four vertical slots, two opposite the others to provide clearance for the prism tilt and power shifting wire tapes (38, Figure 4-28). An air line slot is provided at right angles to, the tape slots at assembly in the bearing flange for the air line coupling (15).

k. Sixth inner tube section. The sixth inner tube section (23) is made of brass tubing and is 75 1/2 inches in length. Its inner and outer diameter are uniform the entire length. An air line section (30) of 71 3/8 inches in length is soldered on its periphery 2 inches from the upper end. Openings are provided on each end for the insertion of air line sections. The upper end receives the short air line section (16) while the lower end receives the air line section (31). The air line strap (32) is provided between the lower end of the soldered air line section (30) and the end of this inner tube section. It is secured over the air line section (31) after its assembly with two lockscrews (33). These lockscrews are inserted in clearance holes in the air line strap (32) and screwed into

the sixth inner tube section (23) in the outer tube (2, Figure 4-15). The reducing coupling is bored for light transmission, and has a threaded section in the upper part of the bore to receive the threaded periphery of the lower part of the first reduced tube section (1). The smooth part of the bore serves as an alignment support section for the lower alignment support section of the first reduced tube section (1). The reduced diameter of the upper part of this coupling has sufficient wall thickness for stabilization of the reduced tube sections above it. The first reduced tube section (1) and the reducing coupling (2) are secured with four lockscrews (12). These lockscrews are inserted in countersunk clearance holes in the upper part of the reducing coupling and screwed into tapped holes in the lower alignments support section of the first reduced tube section.

The lower part of the reducing coupling below the bearing flange is smooth turned to serve as an alignment support section with a threaded periphery in the upper part. It is a sliding fit in tapped holes in the inner tube section.

The upper part is a push fit and is soldered on the lower alignment support section of the sixth inner tube section upper end coupling (26) with eight lockscrews (28). These lockscrews are inserted in soldered countersunk clearance holes in the upper part of the sixth inner tube section and screwed into soldered tapped holes in the lower alignment support section in the sixth inner tube section upper end coupling (26) to form a permanent joint.

Two opposite tape straps (29) are soldered to the periphery of this inner tube section, located 3 3/4 inches from the lower end. These straps retain the shifting wire tapes (38, Figure 4-28) to the inner tube section and prevent them from binding and breaking as a result of looseness in the disassembly and reassembly of the inner tube in the outer tube (2, Figure 4-15).

The lower part of the inner tube section is a push fit and is soldered on the upper alignment

support section of the sixth inner tube section lower end coupling (27) with eight lockscrews (24). These lockscrews are inserted in soldered countersunk clearance holes in the lower part of the sixth inner tube section and screwed into soldered tapped holes in the upper alignment support section of the sixth inner tube section lower end coupling (27) to form a permanent joint.

coupling are secured with four lockscrews (25). These lockscrews are inserted in countersunk clearance holes in the upper part of the sixth inner tube section, and clearance holes in the lower alignment support section of the sixth inner tube section upper end coupling (26) and screwed into the tapped holes in the lower alignment support section of the reducing coupling (2).

l. Sixth inner tube section upper end coupling. The sixth inner tube section upper end coupling (26) is made of cast phosphor bronze, and is 2.750 inches in length. It forms a joint between the lower part of the sixth inner tube section and the upper part of the fifth inner tube section. The upper part has a large bearing flange 3/4 inch in width, and its diameter is a few thousandths of an inch smaller than the inner diameter of the outer tube. This flange serves as a bearing to stabilize the upper part of the sixth inner tube section (23) in the outer tube, providing sufficient clearance for the prism tilt and power shifting wire tapes (38, Figure 4-28) and also the air line sections (16, 30, and 31). The lower shoulder of the bearing flange is chamfered at a 30 degrees angle.

In the lower part below the chamfered flange, a straight turned section-serves as an alignment support section and fits in the upper part of the sixth inner tube section (23). This alignment support section is turned a push fit into the upper part of the sixth inner tube section and soldered to it with eight lockscrews (28). Two air ports opposite each other are provided through the upper part of the sixth inner tube section 1 inch from the upper end. These ports are a small hole in the coupling, with a larger hole in the inner tube section. A wire screen is placed in the large hole, with a brass bushing soldered into this hole against the wire screen. The bushing is filled down to conform to the contour of the inner tube section periphery.

The internal diameter of the coupling is bored for light transmission. The upper part has an Four tape slots are provided in the bearing flange of the coupling, two opposite the others. A radial cross slot 4 inch from the upper end intersects the two outside shoulders of the two opposite tape slots for the insertion of two 0.040-inch bronze wires. These wires are soldered in place, and serve as, retainers for the prism tilt and change of power shifting wire tapes (38, Figure 4-28) to hold them in the slots. An air line slot is provided at right angles to the tape slots at assembly for the air line coupling (1S).

m. Sixth inner tube section lower end coupling. The sixth inner tube section lower end coupling (27) is made of phosphor bronze and is 4.125 inches in length. In the upper part it has a straight turned section which serves as an alignment support section for the lower part of the sixth inner tube section (23). This alignment support section is soldered and tinned a push fit in the lower part of the sixth inner tube section and secured with eight lockscrews (24). These lockscrews are inserted in soldered countersunk clearance holes in the lower part of the sixth inner tube section and screwed into soldered tapped holes in the upper alignment support section of the sixth inner tube section lower end coupling (27) to form a permanent joint.

The central part is provided with a large bearing flange 5/8 inch in width, and its diameter is a few thousandths of an inch smaller than the inner diameter of the outer tube. This flange serves as a bearing to stabilize the lower part of the sixth inner tube section (23) and the upper part of the fifth inner tube section (34) in the outer tube,

internal threaded section to receive the threaded periphery of the lower part of the reducing coupling (2), while the alignment support section below the threaded periphery is a sliding fit in the bore of the coupling. The reducing coupling (2) and the sixth inner tube section upper end providing sufficient clearance for the prism tilt and change of power shifting wire tapes (38, Figure 4-28) as well as the air line sections (30 and 31). Four tape slots are provided in the bearing flange of the coupling, two opposite the others. A radial cross slot

located in the center intersects the two outside shoulders of the two opposite tape slots for the insertion of two 0.040-inch bronze wires. These wires are soldered in place, and serve as retainers for the prism tilt and change of power shifting wire tapes (38, Figure 4-28) to hold them in the slots. An air line slot is provided at right angles to the tape slots at assembly for the air line section (31). The inner diameter is bored for light transmission.

The lower part of the coupling is provided with a threaded periphery and an alignment support section to receive the smooth bore and threaded part in the upper part of the fifth inner tube section. It is secured to the fifth inner tube section (34) with four lockscrews. These lockscrews are inserted in countersunk clearance holes in the upper part of the fifth inner tube section (34) and screwed into tapped holes in the lower alignment support section of the sixth inner tube section lower end coupling.

n. Fifth inner tube section. The fifth inner tube section (34) is made of cast phosphor bronze and is 10 inches in length. The inner and outer diameters are uniform throughout the entire length. The upper part has an internal threaded

o. Upper objective lens. The upper objective lens is made of two optical elements. One is a plano concave flint element (41) separated with a spacer ring (40). The second is a double convex crown element (42) forming an air-space doublet. The doublet is mounted in the upper objective lens mount (38) and secured with a threaded clamp ring (39) and lockscrew (37).

p. Upper objective lens mount. The upper objective lens mount (38) is made of cast phosphor bronze and is 5 inches in length. The external diameter of this mount is a sliding fit in the bore of the fifth inner tube section (34). Its internal diameter is bored for light transmission. The upper part has two counterbored sections. The smaller counterbored section accommodates the upper objective lens flint element (41) and crown element (42) separated by a spacer ring. The seat of the small counterbored section has two opposite air channels to provide sufficient clearance for the passage of nitrogen. The crown element (42) of the air-space doublet having the shortest radius rests against the seat in the mount. The upper objective lens clamp ring screws into the threaded section of the large counterbored section in the mount, and screws against the piano side of

section 5/8 inch deep to screw on the threaded periphery of the lower part of the sixth inner tube section lower end coupling (27) which is secured with four lockscrews (35).

A 2-inch axial slot in the wall of this inner tube section located 2.625 inches from the lower end provides a means of axial movement for the upper objective lens mount (38). The axial focusing of this lens is necessary for primary and final collimation of the upper and lower telescope systems. The mount is secured, in this inner tube section with four lockscrews (36).

The lower part of this inner tube section has an internal threaded section 5/8 inch long to screw on the threaded periphery in the upper part of the fourth inner tube section upper end coupling (5). It is secured with four lockscrews (35).

A shallow vertical recess groove is provided at assembly the entire length of this inner tube section for the air line section (31). Four tape slots are provided in this inner tube section, two opposite the others for free movement of the prism tilt and change of power shifting wire tapes (38, Figure 4-28).

the flint element (41) which is secured with a lockscrew (37).

The lower part below the shoulder seat is counterbored and has anti-reflection threads. The lower part of the shoulder seat is chamfered to this counterbore at an angle of 8 degrees.

The mount is secured in the fifth inner tube section (34) with six lockscrews (36) after primary and final collimation. These lockscrews are inserted in countersunk clearance holes in the fifth inner tube section and screwed into tapped holes in the mount.

q. Upper objective lens spacer ring. The upper objective lens spacer ring (40) is made of aluminum tubing and is 0.062 inch wide. It is a sliding fit in the mount, and is placed between the concave surface of the flint element (41) and the longest radius surface of the crown element (42). The spacer ring is required between this doublet because lenses of large diameter cannot be cemented because of the difference in the thermal expansion coefficients of crown and flint glasses.

r. Upper objective lens clamp ring. The upper objective lens clamp ring (39) is made of cast phosphor bronze and is 1 inch long. Its periphery is threaded, with the internal diameter bored for light transmission, and is provided with anti-reflection threads. This clamp ring screws into the threaded section in the upper part of the upper objective lens mount (38), to

Ill. No.	Drawing Number	Number Required	Nomenclature
13	P-1179-24	8	Third inner tube section upper end coupling lockscrews soldered
14	P-1179-	8	Third inner

contact the plano flint surface of the upper objective lens with sufficient tightness. Two opposite slots are provided in the upper face for the insertion of a special wrench. The clamp ring is secured in the lens mount with a lockscrew (37) which is inserted in a countersunk clearance hole in the mount and screwed into a tapped hole in the clamp ring. The inside face of the clamp ring has two opposite air channels to provide sufficient clearance for the passage of nitrogen.

4I2. Part II: Upper telescope system. a. Description of the second, third, and fourth inner tube sections. These three inner tube sections have no lenses, but form the necessary inner tube bodies to enclose the inter-objective parallel light rays that are deflected downward to the magnifying lower telescope system. Figure 4-21 shows the upper telescope system assembly Part II. All bubble numbers in Sections 4I2, 5, and 6 refer to Figure 4-21 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1205-1	1	Fourth inner tube section
2	P-1179-24	8	Fourth inner tube section upper end coupling lockscrews soldered
3	P-1179-24	8	Fourth inner tube section lower end coupling lockscrews soldered
	24		tube section lower end coupling lockscrews soldered
15	P-1179-53	6	Diaphragm lockscrews
16	P-1205-2	1	Third inner tube section lower end coupling
17	P-1205-3	1	Third inner tube section upper end coupling
18	P-1207-6	2	Diaphragms
19	P-1361-3	2	Tape straps
20	P-1362-7	1	Air line section soldered
21	P-1362-7	1	Air line section short
22	P-1205-1	1	Second inner tube section
23	P-1179-24	8	Second inner tube section upper end coupling lockscrews soldered
24	P-1179-24	8	Second inner tube section lower end coupling lockscrews soldered
25	P-1205-3	1	Second inner tube section upper end coupling
26	P-1205-4	1	Second inner tube section lower end coupling

4	P-1179-24	4	Third and fourth inner tube section coupling lockscrews
5	P-1204-8	1	Fourth inner tube section upper end coupling
6	P-1205-2	1	Fourth inner tube section lower end coupling
7	P-1207-5	1	Diaphragm
8	P-1310-13	3	Diaphragm lockscrews
9	P-1361-3	2	Tape straps
10	P-1362-7	1	Air line section
11	P-1205-1	1	Third inner tube section
12	P-1179-24	4	Second and third inner tube section coupling lockscrews

27	P-1361-3	2	Tape straps
28	P-1362-3	1	Airline coupling
29	P-1362-5	1	Air line section
30	P-1362-13	1	Air line strap 31 P-1362-14 3 Air line straps soldered
32	P-1422-1	2	Air line strap lockscrews

b. Fourth inner tube section. The fourth inner tube section (1) is made of brass tubing and is 90.292 inches long. The inner and outer diameters are uniform throughout the entire length. An air line section (10) 86 1/2 inches long is soldered to the periphery of this inner tube section 1 5/8 inches from the upper end. The air, line section is open at both ends to, receive the air line section (31, Figure 4-20) in the upper opening, while in the lower opening it receives the short unsoldered air line section (21).

Two tape straps (9) are soldered to opposite sides on the periphery to retain the prism tilt and change of power shifting wire tapes (38, Figure 4-28) to their required vertical centerline position.

The internal diameter of this inner tube section carries a diaphragm (7) which is located in

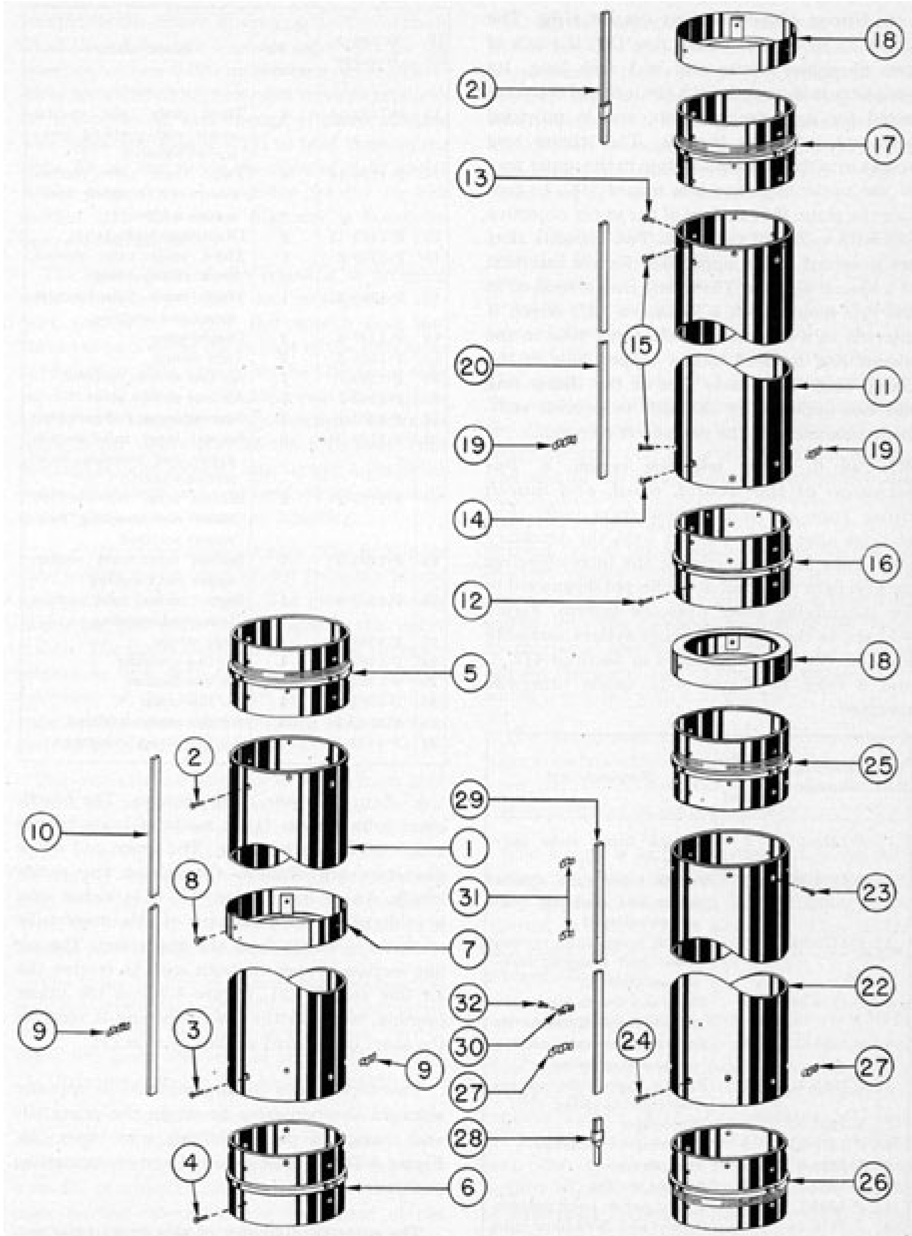

Figure 4-21. Upper telescope system assembly, Part II.

the central part and is secured with three lockscrews (8).

The upper part of the fourth inner tube section (1) is a push fit and is soldered on the alignment support section in the lower part of the fourth inner tube section upper end coupling (5) with eight lockscrews (2). These lockscrews are inserted into soldered countersunk clearance holes in the upper part of the fourth inner tube section (1) and screwed into soldered tapped holes in the lower alignment

Four tape slots are provided in the bearing flange of the coupling, two opposite the others. Two radial cross slots located in the center intersect the two outside shoulders of each opposite set of tape slots for the insertion of two, 0.040-inch bronze wires. These wires are soldered in place, and serve as retainers for the prism tilt and change of power shifting wire tapes (38, Figure 4-28) to hold them in the slots. An air line slot is provided at right angles to the tape slots at assembly for the air line section (10).

support section of the fourth inner tube section upper end coupling (5) to form a permanent joint.

The lower part of the fourth inner tube section (1) is a push fit and is soldered on the alignment support section in the upper part of the fourth inner tube section lower end coupling (6) with eight lockscrews (3). These lockscrews are inserted into soldered countersunk clearance holes in the lower part of the fourth inner tube section (1) and screwed into soldered tapped holes in the upper alignment support section of the fourth inner tube section lower end coupling (6).

c. Fourth inner tube section upper end coupling. The fourth inner tube section upper end coupling (5) is made of cast phosphor bronze and is 4.125 inches long. It forms a joint between the lower part of the fifth inner tube section and the upper part of the fourth inner tube section.

In the upper part, it is provided with a threaded periphery and-an alignment support section to receive the internal threaded section and smooth bore of the lower part of the fifth inner tube section which is secured with four lockscrews (35, Figure 4-20).

The central part is provided with a large bearing flange 5/8 inch wide, and its diameter is a few thousandths of an inch smaller than the inner diameter of the outer tube. This flange serves as a bearing to stabilize the upper part of the fourth inner tube section (1) and the lower part of

In the lower part it has a straight turned section which serves as an alignment support section to receive the upper part of the fourth inner tube section. This alignment support section is tinned a push fit in the upper part of the fourth inner tube section and is secured with eight lockscrews (2) and soldered. These lockscrews are inserted in soldered countersunk clearance holes in the upper part of the fourth inner tube section and screwed into tapped holes in the lower alignment support section of the fourth inner tube section upper end coupling (5) to form a permanent joint.

d. Diaphragm. The diaphragm (7) is made of 1/32-inch spun brass of light weight and is 2 inches in length. It is located in the central part of the fourth inner tube section. The side wall of the diaphragm has an opening sufficient to permit the necessary light transmission. The diaphragm restricts the light rays from striking the inner wall of the inner tube section and confines it to the necessary clear aperture required. Three equally spaced brass strips are soldered on the inner wall of the diaphragm. It is a push fit in the inner tube section and is secured with three lockscrews (8). These lockscrews are inserted in countersunk clearance holes in the fourth inner tube section and screwed into tapped holes in the soldered strips in the diaphragm.

e. Fourth inner tube section lower end coupling. The fourth inner tube section lower end coupling (6) is made of cast phosphor bronze 4.125 inches in length. It forms a joint between the lower part of the fourth inner tube

the fifth inner tube section (34, Figure 4-20) in the outer tube, and to provide sufficient clearance for the prism tilt and change of power shifting wire tapes (38, Figure 4-28) along with the air line sections (31 and 10, Figure 4-20). The inner diameter is bored for light transmission and has anti-reflection threads.

section (1) and the third inner tube section upper end coupling (17).

In the upper part it has a straight turned section which serves as an alignment support

section for the lower part of the fourth inner tube section (1). This alignment support section is tinned a push fit into the lower part of the fourth inner tube section and is secured with eight lockscrews (3) and soldered. These lockscrews are inserted into soldered countersunk clearance holes in the lower part of the fourth inner tube section and screwed into soldered tapped holes in the upper alignment support of the fourth inner tube section lower end coupling (6) to form a permanent joint.

Near the central part it is provided with a large bearing flange 5 inch in width, and its diameter is a few thousandths of an inch smaller than the inner diameter of the outer tube. This flange serves as a bearing to stabilize the lower part of the fourth inner tube section (1) in the outer tube, providing sufficient clearance for the prism tilt and change of power shifting wire tapes (38), the air line section (10), and the short air line section (21).

(6) and screwed into tapped holes in the upper alignment support section of the third inner tube section upper end coupling (17).

f. Third inner tube section. The third inner tube section (11) is made of brass tubing and is 90.292 inches in length. The inner and outer diameters are uniform throughout its length. An air line section (20), 86 1/2 inches long, is soldered to the periphery of this inner tube section two inches from the upper end. This air line section is open on both ends to receive air line sections over the joints. The short air line section (21) fits into the upper opening, while the air line section (29) fits into the lower opening. Two tape straps (19) are soldered to opposite sides on the periphery of this inner tube section near the lower part, to retain the prism tilt and change of power shifting wire tapes (38, Figure 4-28) to their required vertical centerline position.

The upper part is a push fit and is soldered on the alignment support section in the lower part of the third inner tube section upper end coupling (17) with eight lockscrews (13). These lockscrews

Four tape slots are provided in the bearing flange of the coupling, two opposite the others. Two radial cross slots located in the center intersect the two outside shoulders of each opposite set of tape slots, for the insertion of two 0.040-inch bronze wires. These wires are soldered in place, and serve as retainers for the prim tilt and change of power shifting wire tapes (38, Figure 4-28) to hold them in the slots. An air line slot is provided at right angles to the tape slots at assembly for the air line section (21). The inner diameter is bored for light transmission and has anti-reflection threads.

In the lower part below the large bearing flange it has a straight turned section which is larger in diameter than the alignment support section located in the upper part of the bearing flange. This section is counterbored and is threaded a depth of 5/8 inch. It serves as an alignment support section to receive the alignment support section in the upper part of the third inner tube section upper end coupling (17) and provides a removable joint between these couplings. It receives the threaded periphery of the third inner tube section upper end coupling (17) and is secured with four lockscrews (4). These lockscrews are inserted into countersunk clearance holes in the lower part of the fourth inner tube section lower end coupling

are inserted in soldered countersunk clearance holes in the upper part of the third inner tube section (11) and screwed into the soldered tapped holes in the lower alignment support section of the third inner tube section upper end coupling (17) to form a permanent joint.

The lower part of the inner tube section is a push fit and is soldered on the upper alignment support section of the third inner tube section lower end coupling (16).

g. Third inner tube section upper end coupling. The third inner tube section upper end coupling (17) is made of cast phosphor bronze and is 4.125 inches in length. It forms a joint between the fourth inner tube section lower end coupling (6) and the upper part of the third inner tube section (11).

It is similar to the fourth inner tube section upper end coupling (5) and is soldered to the upper part of the third inner tube section (11) with eight soldered lockscrews (13) to form a permanent joint.

The upper alignment support section is a sliding fit into the counterbore of the fourth

inner tube section lower end

j. Second inner tube section. The

coupling (6), while the threaded periphery screws into the threaded section in the same counterbore.

A diaphragm (18) is secured in the lower part of this coupling with the side wall facing downward, and is secured with three lockscrews (15).

h. Diaphragms. The two diaphragms (18) are similar to the diaphragm (7) of the fourth inner tube section (1) except for the outside diameter. One is secured in the bore in the lower part of the third inner tube section upper end coupling (17) with its side wall facing downward. It is secured with three lockscrews (15), which are inserted in countersunk clearance holes in the upper part of the third inner tube section (11) through clearance holes in the lower alignment support section of the third inner tube section upper end coupling (17) and screwed into tapped holes in the-diaphragm (18).

The second diaphragm (18) is secured in the bore in the upper part of the third inner tube section lower end coupling (16) with the side wall facing upward. It is secured with three lockscrews (15) which are inserted into countersunk clearance holes in the lower part of the third inner tube section (11) through clearance holes in the upper alignment support section of the third inner tube section lower end coupling (16) and screwed into tapped holes in the diaphragm (18).

second inner tube section (22) is made of brass tubing and is 43 1/4 inches in length. The inner and outer diameters are uniform throughout the entire length. An air line section (29) extends downward from the lower opening of the soldered air line section (20) of the third inner tube section (11) over the entire length of this inner tube section.

Four air line straps are spaced equally over the air line section (29) of the second inner tube section. Three of these air line straps (31) are soldered to the periphery while the removable air line strap (30) is secured with two lockscrews (32). These lockscrews are inserted into clearance holes in the air line strap (30) and screwed into tapped holes in the periphery wall.

Two tape straps (27) are soldered to opposite sides on the periphery of the lower part, to retain the prism tilt and change of power shifting wire tapes (38, Figure 4-28) to their required vertical centerline position.

The upper part of this inner tube section is a push fit and is soldered on the lower alignment support section of the second inner tube section upper end coupling (25) with eight lockscrews (23). These lockscrews are inserted in soldered countersunk clearance holes in the upper part of the second inner tube section and screwed into soldered tapped holes in the lower alignment support section of the second inner tube section upper end coupling (25) to form a permanent joint.

i. Third inner tube section lower end coupling. The third inner tube section lower end coupling (16) is identical to the fourth inner tube section lower end coupling (6). It forms a joint between the lower part of the third inner tube section (11) and the second inner tube section upper end coupling (25).

The alignment support section in the upper part is tinned a push fit and soldered in the lower part of the third inner tube section (11) with eight lockscrews (14) to form a permanent joint. The bore of this upper part carries the diaphragm (18) with the side wall of the diaphragm facing upward.

The bore and threaded section in the lower part of this coupling receives the upper alignment support section and threaded periphery of the second inner tube section upper end coupling (25) as a removable joint between these couplings.

The lower part of the second inner tube section (22) is a push fit on the tinned upper alignment support section of the second inner tube section lower end coupling (26). It is soldered at assembly with eight lockscrews (24). These lockscrews are inserted in soldered countersunk clearance holes in the lower part of the second inner tube section and screwed into soldered tapped holes in the upper alignment support of the second inner tube section lower end coupling (26) to form a permanent joint.

k. Second inner tube section upper end coupling. The second inner tube section upper end coupling (25) is identical to the third inner tube section upper end coupling (17) and similar to the fourth inner tube section upper end

coupling (5). It forms a joint between the third inner tube section lower end coupling (16) and the upper part of the second inner tube section.

It is soldered to the upper part of the second inner tube section (22) with eight soldered lockscrews (23) to form a permanent joint.

The upper alignment support section is a sliding fit into the counterbored section in the third inner tube section lower end coupling (16), while the threaded periphery screws into the the tape slots at assembly for the air line section (29).

In the lower part below the bearing flange, it has a straight turned section which is larger in diameter than the alignment support section in the upper part of the bearing flange, and is provided with a threaded periphery section. This alignment support section is a sliding fit in the bore in the upper part of the lower (split) objective lens coupling sleeve (34, Figure 4-23) while the threaded periphery screws into the internal threaded

threaded section of the same counterbored section.

1. Second inner tube section lower end coupling. The second inner tube section lower end coupling (26) is made of cast phosphor bronze and is 3.687 inches in length. It forms a joint between the lower part of the second inner tube section (22) and the upper part of the lower (split) objective lens coupling sleeve (34, Figure 4-23) of the lower telescope system.

In the upper part it has a straight turned section which serves as an alignment support section for the lower part of the second inner tube section (22). This alignment support section is tinned a push fit into the lower part of the second inner tube section and is soldered at assembly and secured with eight lockscrews (24). These lockscrews are inserted in soldered countersunk clearance holes in the lower part of the second inner tube section and screwed into soldered tapped holes in the upper alignment support section of the second inner tube section lower end coupling (26) to form a permanent joint.

Near the central part it is provided with a large bearing flange 3/8 inch in width, and its diameter is a few thousandths of an inch smaller than the inner counterbore of the lower part of the outer tube. This flange serves as a bearing to stabilize the lower part of the second inner tube section (22) in the counterbore of the outer tube, providing sufficient clearance for the prism tilt and change of section in the upper part of this coupling sleeve. It is secured with four lockscrews (22, Figure 4-23) which are inserted in countersunk clearance holes in the coupling sleeve and screwed into tapped holes in the lower alignment support section of this coupling. The inner diameter is bored for light transmission and provided with anti-reflection threads.

The lower part is counterbored a depth of 1 7/16 inches and provided with anti-reflection threads.

4I3. Disassembly of Part I. The first reduced tube section and the fifth and sixth inner tube sections are disassembled in the following manner:

1. Separate the lower part of the first reduced tube section (1) from the upper part of the reducing coupling (2) as follows:

2. Remove the four lockscrews (12) from the reducing coupling (2). These lockscrews are unscrewed from tapped holes in the first reduced tube section (1).

3. Unscrew the first reduced tube section (1) from the upper part of the reducing coupling (2).

4. Remove the lockscrew (7) from the diaphragm (13), unscrewing it from the tapped hole in the diaphragm (13).

5. Remove the diaphragm (13) by unscrewing it.

6. Remove the lockscrew (7) from the collective lens mount (3). This lockscrew is unscrewed from the tapped hole in the mount.

power shifting wire tapes (38, Figure 4-28) as well as the air line section (29).

Four tape slots are provided in the bearing flange of the coupling, two opposite the others. An air line slot is provided at right angles to

7. Unscrew the collective lens mount (3) and remove the assembled mount with the collective lens (21) and the clamp ring (4).

8. Remove the lockscrew (11), unscrewing it from the tapped hole in the mount (3) and the clamp ring (4).

9. Using a special wrench, unscrew the clamp ring (4). Remove the clamp ring from the mount (3).

10. Turn the collective lens mount (3) on a piece of lens tissue, placing it on its lower face. Using a piece of lens tissue on the opposite side, press downward on the lens tissue and the collective lens (21) for its removal.

11. Remove the two lockscrews (10) from the upper eyepiece lens mount (6). These lockscrews are unscrewed from tapped holes in the mount, and are carried out of countersunk clearance holes in the first reduced tube section (1).

12. Using a special pair of calipers inserted in opposite holes in the upper part of the upper eyepiece lens mount (6), slide the upper eyepiece lens mount (6) out from the upper part of the first reduced tube section (1), removing the mount, upper eyepiece lens (20), and clamp ring (5).

18. Remove the reducing coupling (2) from the sixth inner tube section upper end coupling (26) by unscrewing the reducing coupling.

19. Separate the fifth inner tube section (34) from the sixth inner tube section lower end coupling (27) as follows:

20. Remove the four lockscrews (35) from the upper part of the fifth inner tube section (34). These lockscrews are unscrewed from tapped holes in the lower alignment support section of the sixth inner tube section lower end coupling (27).

21. Remove the fifth inner tube section (34) from the lower part of the sixth inner tube section lower end coupling (27) by unscrewing the fifth inner tube section.

22. Remove the six lockscrews (36), unscrewing them from the tapped holes in the upper objective lens mount (38).

23. Remove the upper objective lens mount (38) from the fifth inner tube section (34). The mount can be slid out from either end. Remove the assembled mount (38) with the upper objective lens (41 and 42), upper objective lens

13. Remove the lockscrew (9) from the upper eyepiece lens mount (6) and clamp ring (5). This lockscrew is unscrewed from the tapped hole in the mount and the clamp ring.

14. Using a special wrench, unscrew the upper eyepiece lens clamp ring (5) and remove it from the mount (6).

15. Place the upper eyepiece lens mount (6) on a piece of lens tissue, turning it on its upper face. Using a piece of lens tissue on the opposite side, press downward on the lens tissue and the upper eyepiece lens (20) for its removal. Wrap the lens doublet in clean lens tissue and store it in a box to prevent scratches and breakage.

16. Separate the lower part of the reducing coupling (2) from the upper part of the sixth inner tube section upper end coupling (26) as follows:

17. Remove the four lockscrews (25) from the upper part of the sixth inner tube section (23). These lockscrews are unscrewed from tapped holes in the lower alignment support section of the reducing coupling (2).

spacer ring (40), and the upper objective lens clamp ring (39).

24. Remove the lockscrew (37) from the upper objective lens mount (38). This lockscrew is unscrewed from the tapped hole in the clamp ring (39).

25. Using a special wrench, unscrew the upper objective lens clamp ring (39) from the upper part of the lens mount (38).

26. Place the upper objective lens mount (38) over a special padded block. The mount slides down over the block, with the upper objective lens elements (41 and 42) and the, upper objective lens spacer ring (40) remaining on the padded part of the block.

27. Wrap the flint and crown elements of the upper objective lens doublet (41 and 42) with lens tissue and store them in a box to prevent scratches and breakage.

414. Reassembly of Part I. The reassembly of the first reduced tube section and the fifth and sixth inner tube sections is effected in the following manner:

1. Using an air hose, blow out the internal surfaces of the first reduced tube section. If a circular brush is available, it should be used first. This procedure should be carried out with each succeeding inner tube section, and with the clamp rings and lens mounts.

the collective lens (21) is tightened sufficiently by the clamp ring.

11. Insert and secure the lockscrew (11), screwing it into the tapped hole of the mount (3) and the partially tapped hole of the clamp ring (21).

2. Clean the upper eyepiece lens (20) with clean lens tissue. Surface dust can be removed with a rubber air bulb and a clean camel's hair brush or a vacuum brush used with ether.

3. Place the upper eyepiece lens (20) in the upper eyepiece lens mount (6). The convex face of this doublet is placed toward the seat of the mount.

4. Place the upper eyepiece lens clamp ring (5) in the threaded section in the upper part of the mount (6). Screw this clamp ring tight against the plano face of the upper eyepiece lens doublet. The lockscrew holes should coincide when the lens is tightened sufficiently.

5. Insert and secure the lockscrew (9), screwing it into the tapped hole in the mount (6) and the partially tapped hole in the clamp ring (5).

6. Slide the assembled upper eyepiece lens mount (6) into the upper part of the first reduced tube section (1). The clamp ring side of the assembled mount should be located upward.

7. The lockscrews (10) should not be inserted in the countersunk clearance holes in the first inner tube section (1) and the tapped holes in the mount (6) until completion of the primary and final collimation of both the upper and lower telescope systems. One lockscrew (10) should be inserted temporarily until ready for collimation. Place the remaining lockscrews in a small box until ready for the securement of the mount.

12. Place the assembled collective lens mount (3) in the threaded counterbore in the lower part of the first reduced tube section (1). The mount is placed with the clamp ring side facing downward. Screw the mount into this reduced tube section until the tapped hole in the mount coincides with the clearance hole in the reduced tube section.

13. Insert and secure the lockscrew (7), screwing it into the tapped hole in the mount (3).

14. During the primary collimation of the upper telescope system with the lower telescope system, it is necessary to install a temporary mechanical crossline adapter with attached crosswires (Figure 4-56). This requires that the replacement of the diaphragm (13) and its lockscrew (7) be deferred until after primary collimation.

15. The lower part of the temporary crossline adapter is angularly adjusted so that the repairman can square its crossline section for a temporary orientation. A lockscrew, inserted through the circumferential slot of the squaring mount into the tapped hole in the body of the adapter, enables the repairman to secure the crosswires at a fixed position.

16. The purpose of the mechanical crosswise is to establish a target on which the upper objective lens is focused, and also to provide a reference point from which the correct position of the collective lens is found. Refer to Section 4V4.

17. Place the diaphragm (13) and its lockscrew (7) to one side until after primary collimation.

8. Clean the collective lens (21) in similar manner to that outlined in Step 2.

9. Place the collective lens (21) in the collective lens mount (3). The plano face of the lens is placed toward the shoulder seat of the mount.

10. Place the collective lens clamp ring (4) in the threaded counterbore of the upper part of the mount. The lockscrew holes coincide when

18. Connect the lower part of the first reduced tube section (1) to the upper part of the reducing coupling (2) as follows:

19. Screw the lower part of the first reduced tube section (1) into the threaded section of the upper part of the reducing coupling (2).

20. Insert and secure the four lockscrews (12) screwing them into tapped holes in the lower alignment support section of the first reduced tube section (1).

21. Connect the lower part of the reducing coupling (2) in the upper part of the sixth inner tube section upper end coupling (26) as follows:

22. Screw the lower part of the reducing coupling (2) into the internal threaded section in the upper part of the sixth inner tube section upper end coupling (26).

23. Insert and secure the four lockscrews (25), inserting them in countersunk clearance holes in the upper part of the sixth inner tube section, thence through clearance holes in the sixth inner tube section upper end coupling alignment support section and screwing them into the tapped holes in the lower alignment support section of the reducing coupling (2).

28. Insert the lockscrew (37) in the clearance hole in the mount and secure it by screwing it into the tapped hole in the upper objective lens clamp ring (39).

29. Slide the upper objective lens mount (38) into the fifth inner tube section (34). The clamp ring side of the assembled mount should face upward.

30. The upper objective lens mount (38) is not secured until completion of primary and final collimation.

31. Insert and secure one of the six lockscrews (36) in the tapped hole in the mount; until ready for collimation. Place the remaining five lockscrews in a small box until ready for the securement of the mount.

32. Connect the fifth inner tube section to the lower part of the sixth inner tube section lower end coupling (27) as follows:

33. Screw the upper part of the fifth inner tube section (34) on the

24. Clean the upper objective lens flint element (41) and crown element (42) in similar manner to the procedure described under Step 2.

25. Place the plano side of the flint element (41) on the special padded surface wooden block. Place the upper objective lens spacer ring (40) on the concave surface of the flint element lace the longest radius of the double convex crown-element (42) on the spacer ring. Line up the periphery of both elements and the spacer ring.

26. Place the upper objective lens mount (38) with the clamp ring side facing downward over the assembled upper objective lens doublet and the padded wooden block. Turn the complete assembly with the padded block over so that the crown element (42) with the shortest radius is resting in the shoulder seat of the mount,

27. Place the clamp ring (39) in the internal threaded section in the upper part of the upper objective lens mount (38). Using a special wrench, screw this clamp ring tightly against the plano side of the flint element (41). The lockscrew holes should coincide when the lens is tightened sufficiently.

lower alignment support section and threaded periphery of the sixth inner tube section lower end coupling (27).

34. Insert and secure the four lockscrews (35) inserting them in countersunk clearance holes in the upper part of the fifth inner tube section (34) and screwing them into the tapped holes in the lower alignment section of the sixth inner tube section lower end coupling (27).

4I5. Disassembly of Part II. The second, third, and fourth inner tube sections are disassembled in the following manner:

1. Separate the fourth inner tube section lower end coupling (6) from the third inner tube section upper end coupling (17) as follows:

2. Remove the four lockscrews (4) from the fourth inner tube section lower end coupling (6). These lockscrews are unscrewed from the tapped holes in the upper alignment support section of the third inner tube section upper end coupling (17).

3. Unscrew the lower part of the fourth inner tube section lower end coupling (6) from the upper part of the third inner tube section upper end coupling (17). This removes the fourth inner tube section and its lower end coupling

from its connection with the third inner tube section and its upper end coupling. The diaphragm (7) should not be removed from the central part of

This procedure is also carried out with each succeeding inner tube section.

the fourth inner tube section (1) unless the periscope is known to be flooded with sea water. To remove it would require the removal of either the upper or lower end couplings which are soldered to form a permanent joint.

4. Separate the third inner tube section lower end coupling (16) from the second inner tube section upper end coupling (25) as follows:

5. Remove the four lockscrews (12) from the third inner tube section lower end coupling (16). These lockscrews are unscrewed from the tapped holes in the upper alignment support section of the second inner tube section upper end coupling (25).

6. Unscrew the upper part of the second inner tube section upper end coupling (25) from the lower part of the third inner tube section lower end coupling (16). This removes the second inner tube section and its upper end coupling from its connection with the third inner tube section and its lower end coupling.

7. If it is necessary to remove the two diaphragms (18) from the third inner tube section upper and lower end couplings (17 and 16), remove the three lockscrews (15) each from the upper and lower parts of the third inner tube section (11). These lockscrews are unscrewed from tapped holes in each diaphragm (18). The diaphragms can pulled out easily, as they are a push fit into these two couplings.

4I6. Reassembly of Part II. The second, third, and fourth inner

2. Place the two diaphragms (18) in the third inner tube section upper and lower end couplings (17 and 16). The side wall of each diaphragm should face inward toward the inner part of this inner tube section.

3. Insert and secure the three lockscrews (15) in each diaphragm (18). These lockscrews are inserted in countersunk clearance holes in the inner tube section thence through clearance holes in their respective coupling and screwed into tapped holes in each diaphragm.

4. Screw the upper part of the second inner tube section upper end coupling (25) into the internal threaded section of the third inner tube section lower end coupling (16).

5. Secure the third inner tube section lower end coupling (16) to the second inner tube section upper end coupling (25) with four lockscrews (12). These lockscrews are inserted in countersunk clearance holes in the third inner tube section lower end coupling and screwed into tapped holes in the upper alignment support section of the second inner tube section upper end coupling (25).

6. Screw the upper part of the third inner tube section upper end coupling (17) into the internal threaded section in the lower part of the fourth inner tube section lower end coupling (6).

7. Secure the fourth inner tube section lower end coupling (6) to the third inner tube section upper end coupling (17) with four lockscrews (4). These lockscrews are inserted into countersunk

tube sections are reassembled in the following manner:

1. Using an air hose, blow out the internal surfaces of the second inner tube section. If a circular brush is available, it should be used first.

clearance holes in the fourth inner tube section lower end coupling and screwed into tapped holes in the upper alignment support section of the third inner tube section upper end coupling (17).

Chapter 4 Continued

J. RANGE AND COURSE-ANGLE FINDER

4J1. General description. The periscope has an internal range finding device of the stadimeter type capable of giving both ranges and course angles. The change from direct observation to range reading or course measuring is quickly and positively effective.

The range and course-angle finding device is of the duplicate image type; the distance between the images may be varied at will, so that, for example, the water line of one image may be brought into contact with the masthead or funnel top of the other image. If the length

of the vessel is known or estimated and set on the length of the target scale dial, the angle subtended is indicated in yards on the range scale dial, against the known height of the vessel on the height scale dial.

The device may be rotated 90 degrees in a plane normal to the optical axis of the periscope. This is done by continuing the clockwise motion of the operating gear beyond the limit of the vertical position of the separating mechanism; thus the whole divided lens unit rotates 90 degrees. In this position, the two images of the target are at opposite edges of the field and the mechanism is in contact with its stops. Turning the handwheel counterclockwise makes the two images approach each other. Since the known length of the target has

Counterclockwise rotation of the handwheel then causes the two images to approach each other until the two halves of the objective supplement each other and produce a single image. Further counterclockwise rotation of the handwheel causes the divided lens unit to rotate and return to the ordinary observing position, ready for the next range and course angle finding operation.

The device gives readings independent of the focus setting of the individual observer. It is capable of bringing into coincidence two points of the image that subtend an angle of from 0 degrees to not more than 2 degrees of the field at high power. It is provided with duplicate scale dials of Bakelite attached to the outside of the periscope so that range and course angle data may be read by an assistant, if desired. One set of scale dials is located under the eyepiece at the lower end of the eyepiece

been set on the length of target scale dial opposite the stationary index mark on the bottom of the stadimeter housing, when the bow of one image touches the stern of the other, the course angle is indicated on the length of target scale dial against the previously found range on the range scale dial.

The duplicate images are obtained in the following manner: The lower objective lens is divided into two substantially equal parts and mounted in such a manner that the parts may be moved against each other in a plane normal to the vertical optical axis of the periscope and also may be rotated in the same plane through 90 degrees.

The mechanism for these movements is operated by a handwheel on the right-hand side of the lower end of the periscope at a height convenient for the operator.

Ordinary observation is obtained when each half of the divided lens supplements the other and thus forms a complete circle; then a single image is visible in the eyepiece, and the joint between the two halves of the lens lies in the vertical centerline. The stops of the mechanism are in contact in this position.

When the lens halves are in the position for ordinary observation, clockwise rotation of the handwheel causes the halves to slide against each other in opposite directions; box, and the other set diametrically opposite on the back of the periscope. Such scale dials are not less than 2-inch outer diameter in the case of the smallest scale dial, and so located as to be easily readable. The graduations and numbering on each scale dial are clear and legible and each scale dial occupies as great an angular portion on the dial on which it is engraved as is practicable. The angular movement of the scale dial or scale dials connected to the handwheel is directly proportional to the angular movement of the handwheel.

Each device is adjusted to suit the exact magnification of the periscope in which it is incorporated.

The indicating scale dials are circular, arranged concentrically, and engraved in Arabic numerals as follows:

1. Outer ring. Outside graduated 100 to 1,000 feet and inscribed Length of Target in Feet; inside graduated 30 minutes to 85 degrees and inscribed Course angle.

2. Intermediate ring. Outside and inside graduated 2.2 to 110 and inscribed Range in 100 Yards.

3. Inner ring. Outside graduated 15 to 130, feet and inscribed Height in Feet.

The range and course-angle finder consists chiefly of three main assemblies:

this causes duplicate images to appear in the eyepiece. The separation of the images increases until a maximum is reached, when further clockwise rotation causes the divided lens unit to rotate through 90 degrees.

1. Lower (split) objective lens and mount assembly (Figure 4-22).

2. Objective operating mechanism assembly (Figure 4-23).

3. Stadimeter housing assembly (Figure 4-24). These three assemblies are not in contact with each other for actuation in direct series. The objective operating mechanism assembly and the lower (split) objective lens and mount assembly connect directly with each other. However, the three assemblies are so connected by shafts and couplings that they act as a unit. Three other assemblies are placed between the objective operating mechanism assembly and the stadimeter housing assembly for mechanical and optical reasons. These three assemblies are:

1. First inner tube section assembly (Figure 4-27).

2. Eyepiece skeleton assembly (Figure 4-28).

3. Eyepiece box and miscellaneous assemblies (Figure 4-29).

mechanism assembly by means of four stadimeter collimating screws (13, Figure 4-22). The stadimeter housing assembly (Figure 4-24) is secured to the eyepiece box (11, Figure 4-29) by means of four stadimeter housing bolts (30, Figure 4-24).

4J2. Description of the lower (split) objective lens and mount assembly. Figure 4-22 shows the

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1158-1	1	Right mount half
2	P-1158-2	1	Left mount half
3	P-1158-9	4	Tension plugs
4	P-1158-10	4	Tension plug springs
5	P-1158-13	2	Half ring clamps
6	P-1158-13A	12	Variable thickness washers
7	P-1159-7	2	Large side clamps
8	P-1159-8	2	Small side clamps
9	P-1159-	4	Mount keys

The stadimeter housing assembly contains gearing which is connected to the internal mechanism of the eyepiece box (11, Figure 4-29) and eyepiece skeleton assembly by a female tang coupling (68, Figure 4-24) that projects upward from the stadimeter housing assembly and engages on a milled tang at the lower end of the stadimeter transmission shaft (22, Figure 4-27) in the eyepiece box 11, Figure 4-29).

The stadimeter housing assembly, by means of the stadimeter transmission shaft (22, Figure 4-27) and the stadimeter transmission shaft coupling (14, Figure 4-23), is coupled with the operating gear pinion shaft (13) of the objective operating mechanism assembly. The stadimeter transmission shaft (22, Figure 4-27) extends through a bearing hole in the spider (2) where its thrust is restrained by two thrust collars (4) secured with taper pins (10). These two thrust collars (4) restrain the axial thrust of the shaft on either side of the spider (2), thereby restricting axial movement of the shaft. The eyepiece skeleton (42, Figure 4-28) has a clearance hole in its large shoulder flange to accommodate the stadimeter transmission shaft (22, Figure 4-27).

The lower (split) objective lens and mount assembly is secured to the objective operating

	9		
10	P-1179-25	12	Half ring clamp lockscrews,
11	P-1179-26	12	Large and small clamp lockscrews
12	P-1179-31	8	Tension plug spring lockscrews
13	P-1179-34	4	Stadimeter collimating screws
14	P-1179-34A	4	Washers for stadimeter collimating screws
15	P-1179-189	4	Mount dowel pins
16	P-1418-12A	2	Crown halves
17	P-1418-12B	2	Flint halves
18	P-1418-12C	6	0.001 inch tin foil, to separate the lower objective split lens halves

lower (split) objective lens and mount assembly. All bubble numbers in Sections 4J2, 3, and 4 refer to Figure 4-22 unless otherwise specified.

a. Lower (split) objective lens. The lower (split) objective lens is made of two optical elements; one is a double convex crown element (16) while the other is a concave plano flint element (17) separated with 0.001-inch tin foil (18) forming an air-space doublet.

Both elements are split individually and when assembled in the mount

halves have an approximate gap of 0.055 inch between the split. The lens halves are carried by the objective operating mechanism to a maximum displacement of both halves of 9/16 to 5/8 inch.

Each half is separated with three strips of 0.001-inch tin foil (18) equally spaced and placed

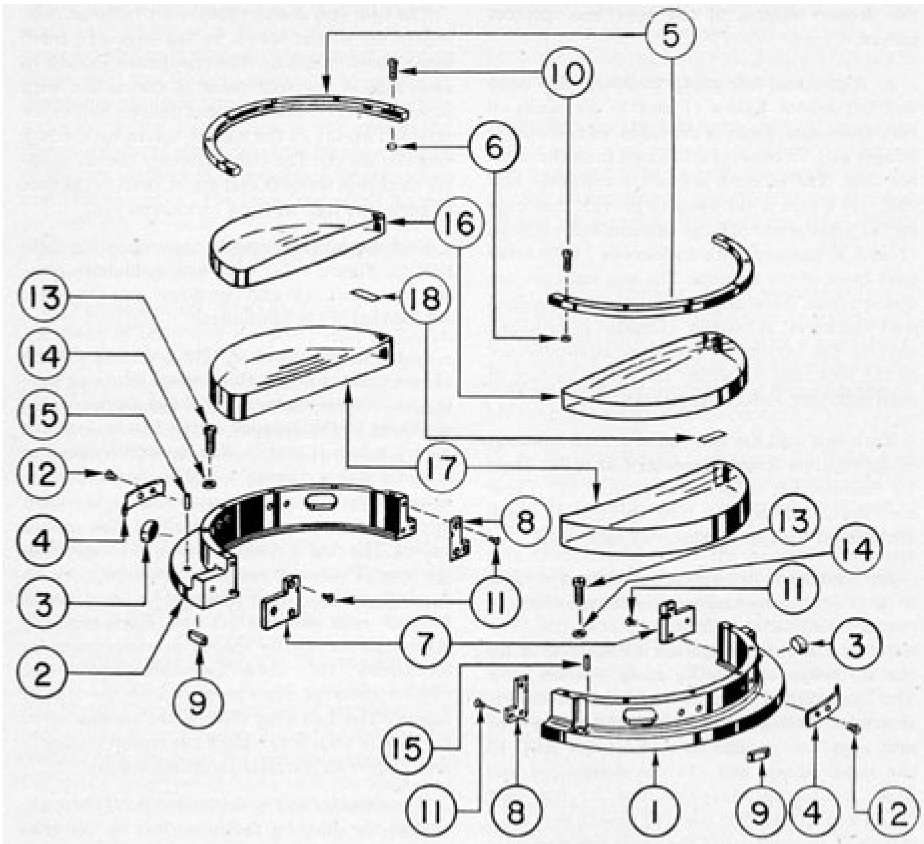

Figure 4-22. Lower (split) objective lens and mount assembly.

near the periphery. This provides spacing sufficiently uniform to keep color constant over the outer surface where the lens halves are separated, thereby preventing newton rings. Lenses of large diameter cannot be cemented because of the difference in the thermal expansion coefficients of crown and flint glasses.

The plano surface of the flint element rests against the lower shoulder seat of each mount, by the scraped 45 degrees angle contact seats of the large and small side clamps (7 and 8).

The split lens doublet of each assembled mount is clamped snugly, without restricting the movement of the lens under constant spring pressure applied to the tension plugs. Changes in the relative position of the split halves of the doublet caused by expansion and contraction of the lens mount are sufficient to destroy its collimation. Therefore, the angle of

while the inner circumference is scraped to a true bearing seat with the periphery of the lens doublet. The opposite corners of the split section of the doublet halves are beveled at a 45 degrees angle. These beveled faces are clamped sufficiently radially the beveled contact surfaces of the lens and their angular relation to the movement of the tension plugs, centralizes the split halves of the doublet against the 45 degrees angle contact seats of the side clamps, thus maintaining

the proper, relation of the split lens doublet halves.

b. Right and left mount halves. The right and left mount halves (1 and 2) are made of cast aluminum. Each is provided with eccentric flanges with an offset of 0.197 inch from the original axis. The mounts are not a complete half circle, as a part is cut away to provide clearance for the attachment of large and small side clamps (7 and 8) secured with lockscrews (11) to the split faces of the mounts. The lens walls project upward from the eccentric flange with a nominal wall thickness. A narrow shoulder is provided next to the bottom of the inner circumference of the lens wall, to which the plano surface of each split flint element is retained.

Each lens wall has two radial slotted openings of appropriate length, separated at a 90 degrees angle for the insertion of two tension plugs (3). These are retained by tension plug springs (4) which are secured with two lockscrews each (12).

Each eccentric flange has two elongated holes to provide the The split lens doublet halves are retained radially in the mount halves by the large and small side clamps (7 and 8). The clamps are secured to each side of the split faces of the mount with lockscrews (11). The split lens doublet halves are retained axially in the mount halves by the half ring clamps (5). The clamps fit over the six variable thickness washers and are secured to the face of each lens wall with six lockscrews (10).

Each mount is secured to each mounting plate half (5, Figure 4-23) with two stadimeter collimating screws (13) and two dowel pins (15) after collimation of the stadimeter.

e. Half ring clamps. The half ring clamps (5) are made of brass tubing of one solid ring having an outside diameter of 4.900 inches which conforms to the contour of the lens wall of the mount halves (1 and 2). The inner circumference is bored with a counterbore of shallow depth, its counterbored diameter conforming to the inner circumference of the lens wall of the mount halves. The ring is chamfered at a 30 degrees angle from the bore. The ring is split after machining with a 3/16-inch cutter, thus forming a half ring clamp for each split lens doublet half. Each half ring clamp

necessary adjustment over the inserted stadimeter collimating screws (13). The outer face of each elongation is countersunk for the stadimeter collimating screw washers (14). The lower face of each eccentric has two key recesses for the mount keys (9). The elongations and keys are parallel in each mount half. In the right mount half (1) the elongations and keys are located perpendicular to the split of the lens halves. The inserted mount keys are a sliding fit in keyways of the same perpendicular location in the right mounting plate (5, Figure 4-23) of the objective operating mechanism assembly. This mount half can be adjusted at perpendicular plane to the split of the lens halves, moving it away from the axis and increasing the gap between the split lens halves, or moving it toward the axis and decreasing the gap.

The left mount half (2) has the elongations and keys located parallel to the split of the lens halves. The inserted mount keys are a sliding fit in keyways of the same parallel location in the left mounting plate (5, Figure 4-23) of the objective operating mechanism assembly. This mount half can be adjusted parallel to the split lens halves, moving it to either side of the axis as is necessary.

has six equally spaced clearance holes for lockscrews (10). These lockscrews screw into tapped holes of each lens wall of the mount halves. The half ring clamps are assembled to the face of each lens wall of the mount halves (1 and 2) over six variable thickness washers (6).

The shoulder face of the counterbore fits snugly against the shortest radius surface of the split crown element of the doublet half. The adjustment of these half ring clamps is of sufficient tension only to allow the tension plugs under spring pressure to centralize the split lens doublet halves against each beveled contact surface of the large and small side clamps (7 and 8).

d. Large and small side clamps. The large and small side clamps (7 and 8) are made of phosphor bronze 0.125 inch thick. These clamps are shaped to conform to each part of the split contact faces of each mount half and are secured with three lockscrews each (11). The lockscrews are inserted into countersunk clearance holes in the clamps and screwed into tapped holes in their large and small split contact faces respectively. Each side clamp projects 1/8 inch inward of the inner circumference of the lens wall. The lower

face of this projecting section is beveled at a 45 degrees angle and serves as a contact seat for the 45 degrees angle beveled

assembled lower (split) objective lens and mount carefully, as the two dowel pins (15) are a push fit in the mounting plates (5, Figure 4-23) of

split face of the right and left side of the split lens doublet halves. A 1/32-inch slot of nominal depth in the beveled 45 degrees angle seat is provided at the intersection of the crown and flint elements, to allow clearance for the variance of thermo coefficients of expansion of the crown and flint elements. The large and small clamps on each side of the split lens doublet halves retain the lens from radial displacement in the mount halves (1 and 2).

e. Tension plugs. The four tension plugs (3) are made of brass and are 0.625 inch in length and 5/16 inch in width. Both ends of each tension plug have the corners rounded off. Two tension plugs are inserted in the radial slotted openings of the lens wall of each mount half (1 and 2) and fit loosely. The inner face of each tension plug conforms to the contour of the periphery of the split lens doublet halves. They are held against the periphery of the lens doublet halves by the spring pressure of tension plug springs (4) mounted to the periphery of the lens walls of the mount halves (1 and 2) and are secured with lockscrews (12).

f. Tension plug springs. The tension plug springs (4) are made of spring steel of 22 gage, and blued. The contact surface of each spring is bent with a 38-inch radius inward to contact the tension plug (3) from the remaining contour of the spring a distance of 0.093 inch. Each has two clearance

the objective operating mechanism assembly.

2. Remove the two lockscrews (12) from the two tension plug springs (4). These lockscrews are unscrewed from tapped holes in the lens wall of each mount half (1 and 2). Remove the four tension plug springs (4) and the four tension plugs (3).

3. Before removing the six lockscrews (10) of each mount half, construct a wooden fixture with six wire nails with reference marks. This is necessary for each mount half (1 and 2) because of the variable thickness washers, and it enables the repairman to assemble them correctly.

4. Remove the six lockscrews (10) from each of the half ring clamps (5). These lockscrews are unscrewed from tapped holes in each lens wall of the mount halves (1 and 2). Lift away the half ring clamps and place the variable thickness washers on the wire nails of each wooden fixture in their respective order.

5. Remove the three lockscrews (11) from the small side clamp (8). These lockscrews are unscrewed from tapped holes in the split center con tact face of the small section of the mount half. Remove the small side clamp.

6. Carefully remove the split lens doublet half by pressing downward radially on the lens next to the large side clamp (7) on the split center section rotating the lens out of the mount half. This permits the lens halves to be freed. Handle the split lens doublet half with lens tissue.

7. Place pencil marks on the periphery of the split lens doublet halves and on the inner

holes to accommodate lockscrews (12) securing the two tension plug springs to the lens wall of each mount half (1 and 2). These to screws are inserted into clearance holes in each spring and screwed into the tapped holes in the lens wall. The springs have sufficient applied tension on the tension plugs to centralize the split lens doublet halves, with their contacting 45 degrees beveled seats against the 45 degrees beveled seat faces of the large and small side clamps (7 and 8).

4J3. Disassembly of the lower (split) objective lens and mount assembly. The lower (split) objective lens and mount assembly is disassembled in the following manner:

1. Remove the four stadimeter collimating screws (13), holding each lower, (split) objective lens and mount assembled half while unscrewing the two collimating screws (13). Remove each

circumference of the mount half to provide a proper reference for reassembly. Place the three strips of 0.001-inch tin foil (18) in a small box to prevent damage or loss. Place the crown and flint elements of this half to one side to prevent scratches or breakage.

8. Follow the procedure stated in Steps 5, 6, and 7 for the other mount half.

9. Remove the three lockscrews (11) from each large side clamp (7) of both mount halves

(1 and 2). These lockscrews are unscrewed from tapped holes in the split center contact face of the large section of each mount half, removing the large side clamps.

10. Check the lacquered split center flat sections of each split lens doublet half, and re-lacquer them if necessary. Slack lacquer is used to prevent light from entering or escaping from the split flat center section of

tight. The lapped 45 degrees angle contact surface of the small side clamp (8) to the 45 degrees angle contact beveled face of the split lens doublet halves should be fitted to allow only 1/8-turn of the lockscrews (11), to prevent angular movement, and to allow sufficient clamping without placing any strain in the crown and flint elements.

6. Follow the procedure stated in Steps 4 and 5 for the mount half (2).

7. Place the six variable thickness washers (6) from the reference

the split lens doublet halves (16 and 17).

4J4. Reassembly of the lower (split) objective lens and mount assembly. The lower (split) objective lens and mount assembly is reassembled in the following manner:

1. Assemble the large side clamps (7) to their respective mount halves. Insert and secure the lockscrews (11), screwing them into the tapped holes of the large section of the split contact surfaces of each mount half.

2. Clean the crown and flint elements (16 and 17) of the split lens doublet halves with clean lens tissue. All surface dirt, grease, or foreign matter must be removed with alcohol. Wipe each surface dry with a clean untouched lens cloth or lens tissue. Specks of dirt which have a tendency to adhere may be removed with a sable brush which has been cleaned with ether. A vacuum brush with ether is also effective. All lens elements must be cleaned in the same careful manner. A rubber air bulb removes most of the surface dust.

3. Place the three strips of 0.001-inch tin foil (18) at three equally spaced places near the periphery, to separate the crown and flint elements. The strips of tin foil are placed on the concave surface of the flint element, and the crown element having the longest radius is place on the three strips of tin foil.

fixture at their respective places on the face of the lens wall of the mount half (1). Place the half ring clamp (5) over the variable thickness washers (6) and line up the holes of the half ring clamp and the washers. Insert the six lockscrews (10) through the clearance holes in the half ring clamp and the washers, and screw them into tapped holes in the lens wall of the mount half. Using a 0.001-inch piece of shim stock, tighten the lockscrews maintaining 0.001-inch clearance between the half ring clamp and the face of the crown element. The half ring clamp prevents axial displacement of the split lens doublet halves, and is tightened sufficiently that it does not restrict the free movement of the tension plugs (3). A strain testing device using polarized light should be used to ensure that there is no strain in the assembled lens element.

8. Follow the procedure stated in Step 6, for the opposite mount half (2).

9. Insert the four tension plugs (3) in the two radial slotted openings of each mount half, placing the concave surface of the tension plug to ward the periphery of the split lens doublet halves. Assemble the tension plug springs (4) securing each with two lockscrews (12) placing the tension plugs (3) under spring pressure. The lockscrews are inserted into clearance holes in the tension plug spring and screwed into tapped holes in the lens wall of each mount half.

10. Assemble both mount halves (1 and 2) to the mounting plates (5, Figure 4-23) after the 90 degrees rotation is adjusted and checked.

4. Holding the split lens do let halves (crown and flint) together with lens tissue, place them in the mount half (1), with the large side clamp (7) in place. Press downward from the split flat center section on the opposite side until the lens is rotated up tight against the 45 degrees angle contact seat face of the large side clamp.

5. Proceed to fit the small side clamp (8) until the lockscrews (11) inserted in the tapped holes in the small section of the split contact face of the mount half are within 1/8-turn of being

4J5. Description of the objective operating mechanism assembly. This mechanism consists of the necessary parts which transmit the displacement of the lower (split) objective lens and

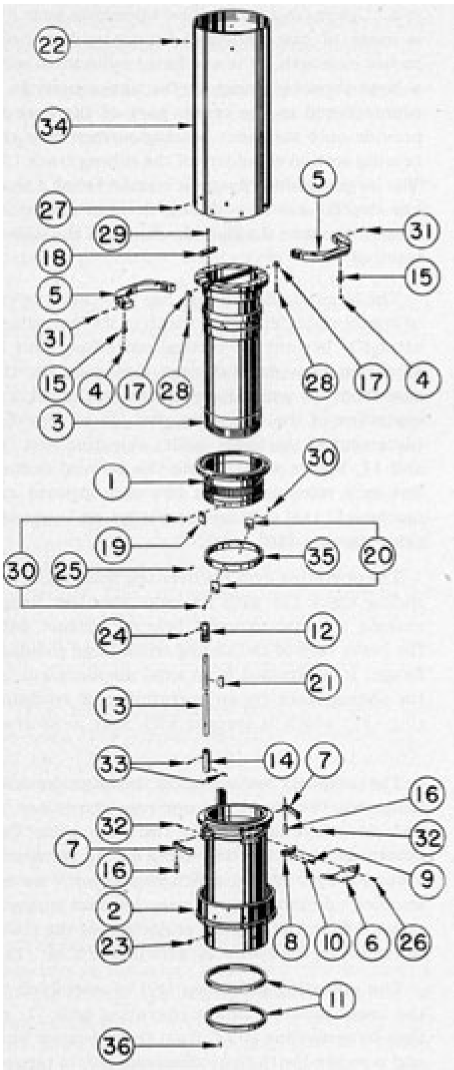

Figure 4-23. Objective

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1156-1	1	Operating gear
2	P-1156-2	1	Track sleeve
3	P-1156-3	1	Sliding track
4	P-1156-4	2	Cam shoes
5	P-1158-3	2	Mounting plates
6	P-1158-5	1	Detent pawl spring
7	P-1158-6	2	Detent pawls
8	P-1158-7	1	Detent pawl rest
9	P-1158-8(a)	2	Long detent pawl rest lockscrews
10	P-1158-	2	Short detent

operating mechanism assembly.

mount assembly, and is described in the following manner: Figure 4-23 shows the objective operating mechanism assembly. All bubble numbers in Section 4J5, 6, and 7 refer to Figure 4-23 unless otherwise specified.

	8(b)		pawl rest lockscrews
11	P-1158-12	2	Sliding track lock rings
12	P-1159-1	1	Operating gear pinion
13	P-1159-2	1	Operating gear pinion shaft
14	P-1159-3	1	Stadimeter transmission shaft coupling
15	P-1159-4	2	Mounting plate guide key with integral shafts
16	P-1159-5	2	Detent pawl shafts
17	P-1159-6	2	Mounting plate guide keys
18	P-1159-10	2	Mounting plate guides
19	P-1163-4	1	Operating gear stop
20	P-1163-5	2	Maximum displacement stop and observation position stop
21	P-1172-15	1	Operating gear pinion key
22	P-1179-23	4	Coupling sleeve lockscrews (upper end)
23	P-1179-24	4	First inner tube section upper end coupling lockscrews
24	P-1179-27	2	Operating gear pinion lock screws

25	P-1179-28	4	Operating gear retaining ring lockscrews
26	P-1179-29	6	Detent pawl spring lockscrews
27	P-1179-30	15	Coupling sleeve lockscrews (lower end)
28	P-1179-32	2	Mounting plate guide key lockscrews
29	P-1179-33	6	Mounting plate guide lockscrews
30	P-1179-73	6	Operating gear stop, observation position stop and maximum displacement stop lockscrews
31	P-1179-177	2	Mounting plate guide key shaft taper pins
32	P-1179-178	2	Detent pawl shaft taper pins
33	P-1179-179	2	Stadimeter transmission shaft coupling taper pins
34	P-1205-5	1	Coupling sleeve
35	P-1205-8	1	Operating gear retaining ring
36	P-1310-15	1	Sliding track lock ring lockscrew

a. Sliding track. The sliding track (3) is made of cast phosphor bronze and is 12.574 inches in length. It is machined cylindrical, with a large shoulder flange of nominal thickness at the upper part. Its internal diameter is machined for light transmission and has anti-reflection threads throughout.

A brass plate spacer 1/16 inch thick and 1/4 inch wide is inserted and soldered in the slots cut directly in the centerline in each side of the bore of the large shoulder flange. The spacer when assembled is flush with the face of the large shoulder flange. It prevents stray light from entering the gap between the two split lens doublet halves of the lower (split) objective lens (16 and 17, Figure 4-22).

Two longitudinal T-slots are milled parallel to the horizontal centerline, at an appropriate center distance from the vertical centerline on each side; there are two more 180 degrees apart on the opposite side in the large shoulder flange. These longitudinal T-slots project inward horizontally on each side an appropriate distance, to correspond to an appropriate center distance from the vertical centerline, to receive two mounting plate guide keys with integral shafts (15) and mounting plate guide keys (17). The large shoulder flange face has two shallow recesses 1 5/16 inches wide located an

b. Operating gear. The operating gear (1) is made of cast phosphor bronze and is 2.687 inches in length. It is machined cylindrical with a large shoulder flange in the upper part. It is counterbored in the center part of the bore to provide only sufficient bearing surface over the bearing section shoulders of the sliding track (3). The large shoulder flange is counterbored a shallow depth, and is a sliding fit over the small shoulder next to the shoulder flange of the sliding track (3).

The large shoulder flange has two cam grooves of appropriate depth and width in its face, which extend 1 degree beyond the vertical centerline. This 1 degree extension provides sufficient clearance for the cam shoes (4) which have centers in the vertical centerline of the operating gear (1) at zero displacement of the lower (split) objective lens (16 and 17, Figure 4-22). Using the vertical centerline as a reference, these two cam grooves are machined 153 degrees circumferentially on opposite sides starting 180 degrees apart.

The operating gear fits over the bearings of the sliding track (3) with its large shoulder flange making a metal-to-metal bearing contact with the lower face of the sliding track large shoulder flange. It is retained from axial displacement on the sliding track by an operating gear retaining ring (35) which is secured with four lockscrews (25).

The periphery section below the large shoulder flange has two shoulders, one near the center inch wide and the other at the lower part. The center shoulder has 160

appropriate distance from the horizontal centerline, and parallel with it. The remaining part of the face serves as a bearing for the lower surfaces of two mounting plates (5) retained with two mounting plate guides (18). The mounting plate guides are mounted parallel to the horizontal centerline, on opposite sides, and are secured with three lockscrews (29) each. The mounting plates (5) are moved against each other over the bearing faces of the large shoulder flange of this sliding track with their sides under the mounting plate guides (18).

The sliding track has a cylindrical tube section of about 1 foot below the large shoulder flange. Next to the large shoulder flange is a small shoulder to receive the small counterbored section in the operating gear (1). Sections of the external diameter are undercut to provide only the necessary bearing surface for the operating gear (1) and the track sleeve (2) over this tube section. The lower part is threaded a short distance to receive two lock rings (11).

teeth of 32 pitch cut around its periphery, which engage with an assembled operating gear pinion (12) that projects upward from the bearing projection of the track sleeve (2) on the operating gear pinion shaft (13).

The operating gear stop (19) is assembled to the lower shoulder of the operating gear (1) so that its centerline is 22 degrees from the reference line, and is secured with two lockscrews (30) in tapped holes in the lower shoulder of the operating gear (1). When the cam shoes (4) are at the limit of their travel, the operating gear is reversed 0.125 inch. At this position of the operating gear (1), a line is scribed on the operating gear retaining ring (35). At this line, the maximum displacement stop (20) is secured to the retaining ring with two lockscrews (30). The scribed line is the

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point of contact of the operating gear stop (19) and the maximum displacement stop (20).

The observation position stop (20) is secured during the process of collimation. (Refer to Section 4V11 Step, 25.)

and the threaded periphery of the first inner tube section upper end coupling (11, Figure 2-27) and is secured with four lockscrews (23). These lockscrews are inserted into countersunk clearance holes in the lower part of the track sleeve (2) and screwed into tapped holes in the upper alignment support

c. Track sleeve. The track sleeve (2) is made of cast phosphor bronze and is 11.827 inches in length. The upper part has a cast rectangular bearing projection that extends upward from the shoulder flange, and is provided with a reamed hole in its center axis which serves as a bearing for the operating gear pinion shaft (13).

The main body is machined cylindrical with two cast hinge projections located 180 degrees apart, a short distance from the upper shoulder flange. One raised section of appropriate size, at a perpendicular plane to the two hinge projections, serves as a mount for the detent pawl spring (6). A circumferential slot 128 degrees long and 3/8 inch wide is located in the center of this raised section, with the slot running 64 degrees on each side of the vertical centerline. This circumferential slot receives the detent pawl rest (8) attached to the sliding track (3) with two long and short lockscrews (9 and 10), secured in tapped holes in the sliding track.

The hinge projections have a 1/4-inch slot through their center located in the same plane as the 128 degrees circumferential slot, and reamed holes perpendicular to this slot through the center of the hinge projections on both sides of the 1/4-inch slot. The hinge projections receive the hinge section of two detent pawls (7), with two detent pawl shafts (16) forming the hinge section of the first inner tube section upper end coupling (11).

The lower external part of the track sleeve (2) has a cylindrical shoulder flange, which projects upward with a cored inner wall 1 1/2 inches in length. This wall section is turned to serve as an alignment support section or the lower part of the lower (split) objective lens coupling sleeve (34) fitting up to a shoulder in the lower part. The coupling sleeve is secured to this alignment support section with 15 lockscrews (27). These lockscrews are inserted into countersunk clearance holes in the coupling sleeve and screwed into tapped holes in the alignment support section. A section of the cored section is solid with a reamed hole, having its centerline in the same axis as the extended projection of the upper cast bearing flange, located 180 degrees opposite to the centerline of the raised mount and the radial slot for the detent pawl spring; this reamed hole serves as a bearing for the operating gear pinion shaft (13).

Four tape slots are provided in the bearing flange of the track sleeve (2), two opposite the others, for the prism tilt and change of power shifting wire tapes (38, Figure 4-28). An air line slot is provided at assembly at a perpendicular plane to the tape slots, for the air line section (29, Figure 4-21) extending downward from the second inner tube section (22).

d. Mounting plates. The two mounting plate halves left and right (5) are made of cast phosphor bronze and are 1/2 inch wide. Each is of eccentric design with the inner circumference 0.197 inch offset from the outer diameter, and is bored for

pins, secured with a taper pin (32) each.

The track sleeve is bored and ground with bearings in the upper and lower internal part, a sliding fit over the bearings on the periphery of the sliding track tube section (3). One inch from the upper face it has a counterbore of shallow depth a distance of 6 3/8 inches, allowing a 1-inch bearing in the lower part near the lower end and also in the upper part. The track sleeve is counterbored below the lower bearing a distance of 2.187 inches, to accommodate two sliding track lock rings (11) that secure the sliding track axially. It serves as an alignment support section also with the lower end threaded a 3/4-inch distance, to receive the alignment support section

light transmission. The design of each complies to the eccentric flange and lower face of the right and left mount halves (1 and 2, Figure 4-22). Each half has a 50 degrees minor chord section removed from the outer circumference and is provided with a narrow shoulder to slide on the bearing face of the sliding track large shoulder flange under the parallel shoulder of the mount guide (18) which is secured with three

lockscrews (29) in the large shoulder flange of the sliding track (3).

The mounting plates are assembled to the bearing faces of the large shoulder flange of the sliding track (3) for operation with the operating gear (1) in the following manner: The large part of the right mounting plate has a reamed hole to receive the integral long shaft section of the mounting plate guide key (15) inserted from the lower face, and is secured with a taper pin (31) from the periphery of this part. The T design of the mounting plate

to the vertical centerline, INWARD and OUTWARD of the horizontal centerline, for collimation of this mounting plate half.

The left mounting plate half is assembled and secured to the sliding track (3) and operates in similar manner in the opposite direction with the use of the second cam groove of the operating gear (1).

e. Mounting plate guide keys and integral shafts. The two mounting plate guide keys and integral shafts (15) are made of monel metal and are 1.031 inches in length. The long shaft section is integral with the milled T-shaped section. This shaft

guide fits in the elongated T-slot in the sliding track large shoulder flange. The integral stub shaft located in the lower part of the mounting plate guide key (15)fits into the reamed hole in the cam shoe (4) located in the cam groove of the operating gear (1) to provide for operation of this half.

The narrow eccentric part of this mounting plate half located on the opposite side, has a tapped hole to receive the lockscrew (28). This lockscrew is inserted into the countersunk clearance hole in the mounting plate guide key (17) and screwed into the tapped hole in this narrow eccentric part. The mount guide keys (15 and 17) located in the sliding track large shoulder flange elongated T-slots provide parallel guidance for this mounting plate half.

The upper face of this mounting plate has two horizontal keyways at a perpendicular plane to vertical movement of this mounting plate to receive the two inserted mount keys (9) of the right mount half (1, Figure 4-22) a sliding fit in the keyways. These keyways provide a positive movement in two directions of the axis, INWARD and OUTWARD, for collimation of the right half of the lower (split) objective lens and mount assembly. This mounting plate half has two tapped holes to receive the stadimeter collimating screws (13) securing the above assembled lens half also with two drilled holes for section fits into each reamed hole in the large part of each eccentric mounting plate and is secured with a taper pin (31). The T-shaped section is 3/8 inch in length and is a sliding fit in the elongated T-slots on opposite sides in the sliding track large shoulder flange.

The stub shaft section is an integral part of the lower part of the T-shaped section and fits into the reamed hole in the cam shoe (4) assembled in the cam groove of the operating gear. The cam shoes on the mounting plate guide keys and integral shafts operating in the cam grooves in the operating gear (1) displace the mounting plate halves laterally.

f. Mounting plate guide keys. The two mounting plate guide keys (17) are made of monel metal and are 3/8 inch in length. They are milled of a T-shape with a countersunk clearance hole in their axis for a lockscrew (28). The lockscrew secures them to the narrow eccentric part of the eccentric mounting plate, extending into the tapped hole in this narrow eccentric part. These guide keys are a sliding fit in the elongated T-slots in the sliding track large shoulder flange and by means of the operating guide keys (15) provide a parallel guidance to the mounting plate halves (5) which carry the lower (split) objective lens and mount assembly halves (Figure 4-22) in the same vertical plane for displacement from minimum to maximum displacement and vice versa.

g. Mounting plate guides. The mounting plate guides (18) are made of monel metal and are 1.750 inches in length. It is a step design with the narrow shoulder having a

two dowel pins (15, Figure 4-22) after collimation. The dowel pins provide the factory collimation setting of this collimated lens half.

The upper face of the left mounting plate has one vertical keyway located in the same plane as its movement, to receive the two inserted mount keys (9, Figure 4-22) of this mounting plate half (2) a sliding fit in the keyway. This keyway provides a positive movement in two directions parallel

nominal fit on the shoulder section of each mounting plate

half (5). They are held to the large shoulder flange face of the sliding track (3) with three lockscrews (29) each. These lockscrews are inserted into countersunk clearance holes in the mounting plate guides (18) and screwed into three tapped holes in opposite sides of the sliding track large shoulder flange (3). These guides allow free movement to each mounting plate half and retain them axially.

h. Cam shoes. The two cam shoes (4) are made of hardened drill rod steel and are 5/16 inch in length. The ends are rounded off to conform to the width of 0.218 inch. A reamed hole in their axis accommodates the integral stub shaft section of the mounting plate guide keys and integral shafts (15). The cam shoes are a sliding fit in each cam groove in the operating gear large shoulder flange (1).

gear (1) for the necessary additional torque required to rotate the sliding track (3) simultaneously with the operating gear (1) for the 90 degrees rotation from the range position to the course angle position. It also serves to overcome the locking device of the sliding track (3), namely, the detent pawl (7) engaged in the 90 degrees V-groove in the detent pawl rest (8).

k. Observation position stop. The observation position stop (20) is identical to the maximum displacement stop, and is located on the retaining ring (35) during collimation. It serves to relieve the torque from the two cam shoes (4) in the ends of the cam grooves in the operating gear (1) for the necessary additional torque required to rotate the sliding track (3) simultaneously with the operating gear (1) for the 90 degrees rotation from the course angle position back to the range position. It is fitted during collimation (refer to Section 4V11

The cam shoes operate the mounting plate guide keys (15)-for displacement of the assembled lower (split) objective lens and mount assembly halves (Figure 4-22).

i. Operating gear retaining ring. The operating gear retaining ring (35) is made of old rolled steel and is 1/2 inch in width. It is cylindrical with a nominal wall thickness, and fits over the sliding track tube section (3) up to the lower face of the operating gear (1) and is secured with four lockscrews (25). These lockscrews are inserted into countersunk clearance holes in the retaining ring and screwed into tapped holes in the sliding track (3). It serves to retain the operating gear (1) axially and also serves as a stationary support for the maximum displacement and observation position stops (20) secured with two lockscrews (30).

j. Maximum displacement stop. The maximum displacement stop (20) is made of cold rolled steel 3/4 inch wide and 7/8 inch long. It is a step radius design, with the seat of the stop conforming to the contour of the operating gear retaining ring (35) and secured to it with two lockscrews (30). These lockscrews are inserted in countersunk clearance holes in the thick section of the stop and screwed into tapped holes in the retaining ring (35) and the sliding track. The radius step projects over the lower shoulder of the operating gear with sufficient clearance. Step 25) to restrict the movement of the lens halves to zero displacement, that is, to form a single image.

l. Operating gear stop. The operating gear stop (19) is of similar design and material to the maximum displacement and observation position stops (20). The seat of the stop conforms to the contour of the lower shoulder of the operating gear (1) and is secured with two lockscrews (30). These lockscrews are inserted into countersunk clearance holes in the thick section of the stop and screwed into tapped holes in the lower shoulder of the operating gear. The radius step projects over the operating gear retaining ring (35) with sufficient clearance. This stop is secured to the operating gear with its centerline located 22 degrees from the reference line of the cam groove. This allows sufficient movement of the operating gear for minimum and maximum displacement of the lower (split) objective lens. This stop overlaps the maximum displacement stop (20) for clockwise rotation to carry the sliding track (3) simultaneously with the operating gear (1) through the 90 degrees rotation from the range position to the course angle position. It overlaps the observation position stop (20) for the counterclockwise rotation to carry the sliding track (3) simultaneously with the operating gear (1) through the 90 degrees rotation from the course angle position back to the range position.

m. Operating, gear pinion. The operating gear pinion (12) is made of phosphor bronze and

The maximum displacement stop serves to relieve the torque from the two cam shoes (4) in the ends of the cam grooves in the operating

is 1.531 inches in length. It is cylindrical in design with a large hub section in the upper part which is filleted at a radius of 1.750 inches in a distance of 5/16 inch to conform to the circumference of the gear cutter used in cutting the teeth in the lower large diameter. The large diameter of the pinion section has 20 teeth of 32 diametral pitch, cut in a pinion section 0.718 inch long. The lower part of this pinion section is undercut to the root of the gear teeth and chamfered.

The axis is provided with a reamed hole, a push fit over the upper part of the operating gear pinion shaft (13). The reamed hole has an undercut groove 1/16 inch wide located above the upper end of the pinion section, to serve as a relief for the insertion of a keyseat 0.063 inch wide and 0.036 inch deep. This keyseat allows the pinion to slide over the inserted woodruff key (21) in the upper part of the operating gear pinion shaft (13). The hub section is provided with two tapped holes directly on opposite sides for two lockscrews (24). These lockscrews are inserted in tapped holes in the pinion and extend into spotted recesses in the operating gear pinion shaft upper part is reamed to fit on the lower part of the operating gear pinion shaft (13) and is secured with a taper pin (33). The lower part is reamed to receive the upper part of the stadimeter transmission shaft (22, Figure 4-27) and is secured with a taper pin (33) during collimation. The lower part is provided with three irregular tapped holes at assembly for the insertion of 8-36 setscrews used primarily to secure the coupling to the stadimeter transmission shaft (22, Figure 4-27) during collimation, and the taper pin provision is made upon completion of collimation.

p. Detent pawl rest. The detent pawl rest (8) is made of tool steel and is 1 5/8 inches in length. Its bottom face conforms to the contour of the sliding track periphery (3), while the upper faces on each side of the horizontal centerline are beveled to 27 1/2 degrees. It is a sliding fit in the milled 128 degrees circumferential slot in the track. sleeve (2). A 90 degrees V-groove is provided in the horizontal centerline to a depth of 0.407 inch, for the engagement of the detent pawls (7) for the range and course angle positions. The opposite ends of the detent pawl rest are finished to approximately 38 degrees or 19 degrees on each side of the horizontal centerline to contact each end in the 128 degrees circumferential slot, when the operating gear (1) and the sliding

(13) at assembly to secure the pinion.

The operating gear pinion teeth mesh with the teeth in the operating gear (1) for its operation.

n. Operating gear pinion shaft. The operating gear pinion shaft (13) is made of cold rolled steel rod and is 14.625 inches in length and 5/16 inch in diameter. It is provided with a woodruff keyseat located near the upper end, for a number 10 woodruff key (21). The operating gear pinion (12) with a keyseat is a push fit on the upper part of this shaft and is secured with two lockscrews (24). This shaft fits through the reamed hole in the cast projection located in the upper part of the track sleeve (2) and the reamed hole in the solid section in the cored alignment support section of the lower part.

The lower part of the shaft receives the upper part of the stadimeter transmission shaft coupling (14) secured with a taper pin (33) during collimation.

o. Stadimeter transmission shaft coupling. The stadimeter transmission shaft coupling (14) is made of phosphor bronze and is 1.812 inches in length. It is 5/8 inch in diameter, with the axis provided with two reamed holes. The

track (3) have rotated 90 degrees. The opposite ends of the detent pawl rest are finished off at assembly and the collimation procedure of the 90 degrees rotation. A dowel pin of a body fit is inserted in the hole in the center of the 90 degrees V-groove and fitting into the snug hole in the sliding track, is inserted for proper location of the four tapped holes. The detent pawl rest is secured to the periphery of the sliding track (3) through the circumferential slot with two long and short lockscrews (9 and 10). These lockscrews are inserted into countersunk clearance holes in the detent pawl rest (8) and screwed into tapped holes of the sliding track (3).

q. Detent pawls. The detent pawls (7) are made of tool steel and are 2 1/2 inches in length. The arms of each detent pawl are 1/4 inch wide and 5/32 inch thick. The detent section is enlarged to 3/8 inch in width and inclined at an angle of 22 degrees of the arm section. Its engaging detent section of 90 degrees engages in the 90 degrees V-groove in the detent pawl rest (8), to maintain it at the 90 degrees rotation position under spring tension.

The lower part of the detent pawl arm section is enlarged

clearance of the sliding track (3) in the track sleeve (2). Each is provided

inward, thus forming a partial circle of 7/16-inch diameter, with a reamed hole to receive the detent pawl shaft (16). The circle section fits in the milled slot between both hinge projections, with the shaft inserted in the reamed holes in the hinge projections and the circular section. Each of the two shafts is secured with a taper pin (32) in the lower hinge projections.

The detent pawls for the range and course angle positions are retained in the 90 degrees V-groove under spring pressure by the detent pawl spring secured to the raised mount section on each side of the 128 degrees circumferential slot with six lockscrews (26).

r. Detent pawl shafts. The detent pawl shafts (16) are made of cold rolled steel and are 0.812 inch in length. These shafts fit into reamed holes in the two sets of hinge projections of the track sleeve (3) and are secured with a taper pin (32) after assembly. These shafts serve as a pivot pin on which the circular section of the detent pawls pivot for engagement and disengagement in the detent pawl rest (8).

s. Detent pawl spring. The detent pawl spring (6) is made of 17-gage blued spring steel. The center part is 1 inch in width, to extend over the width of the raised mount section on each side of the circumferential slot. Each side of the spring starting from 3/4 inch of the center is filleted to 14 inch

with opposite slots in the lower side face for insertion of a special wrench. The lower of the two lock rings (11) is secured against the upper by a lockscrew (36). This lockscrew screws into the tapped hole in the threaded intersection of the lower face of the lock ring and the sliding track, and thus prevents axial displacement of the sliding track (3) in the track sleeve (2).

u. Coupling sleeve. The coupling sleeve (34) is made of brass tubing material 14.875 inches in length. The inner and outer diameters of this coupling sleeve are uniform throughout its length. This sleeve section forms the outer wall to enclose the lower (split) objective lens and mount assembly (Figure 4-22) and the objective operating mechanism assembly. It also connects the upper telescope system assembly Part II (Figure 4-21) with the lower main telescope system. Connection is made after primary and final collimation of the periscope.

The upper part has an internal threaded section 1 1/4 inches in length to screw on the threaded periphery and lower alignment support section of the second inner tube section lower end coupling (26, Figure 4-21) and is secured with four lockscrews (22). These lockscrews are inserted in, countersunk clearance holes in the upper part of the coupling sleeve (34) and screwed into tapped holes in the lower alignment support section of the second inner tube section lower end coupling (26, Figure 4-21).

The inner wall is provided with an 11-inch axial recess groove with a 3/4-inch radius. This axial recess

width, a proportional amount on each side. The spring is bent from the filleted point inward to a radius of 1.500 inch, on each side with an outward radius bend of 3/16 inch. It is oil hardened in this form, and when assembled it overlaps to contact the 22 degrees angle outer section of both detents. It is secured on this section of the detent pawls (7) to the raised mounts on each side of the circumferential slot with three lockscrews (26). These lockscrews are inserted in clearance holes in this spring and screwed into tapped holes in the raised mount on opposite sides of the 128 degrees circumferential slot.

t. Sliding track lock rings. The two sliding track lock rings (11) are made of cast phosphor bronze 5/16 inch wide. The rings are cylindrical, and are a sliding fit in the counterbore of the track sleeve. The inner surface is threaded to screw can the threaded periphery of the sliding track (3). These rings preserve the axial thrust

groove starts at the lower end of the coupling sleeve. The center of the radius is located 19 degrees 30' from the horizontal centerline of the prism tilt shifting wire tape slots. The radius is cut to a depth of 0.050 inch in the inner wall. This axial recess groove provides clearance for the operating gear pinion (12) which is necessary to permit the lower telescope system to be pulled axially clear of the coupling sleeve for disassembly or vice versa.

Four vertical tape slots are provided in the outer circumference, two opposite the others for the entire length, for the prism tilt and change of power shifting wire tapes (38, Figure 4-28). An air line slot is provided its entire length at a

perpendicular plane to the tape slots for the air line section (29, Figure 4-21) extending downward from the second inner tube section (22).

The lower part is a push fit over the alignment support section of the lower shoulder flange of the track sleeve (2) and is secured with 15 lockscrews (27). These lockscrews are inserted into countersunk

6. Remove the two lockscrews (24) from opposite sides of the operating gear pinion (12). Pull the operating gear pinion off the operating gear pinion shaft (13). The woodruff key (21) remains in the shaft.

7. Remove the two lockscrews (30) from the maximum displacement stop (20). These lockscrews are unscrewed from tapped holes in the

clearance holes in the lower part of the coupling sleeve and screwed into tapped holes in the alignment support section of the lower shoulder flange of the track sleeve (2).

4-16. Disassembly of the objective operating mechanism assembly. The objective operating mechanism is disassembled in the following manner:

1. Remove the six lockscrews (26) from the detent pawl spring (6). These lockscrews are unscrewed from tapped holes in the raised mount of the track sleeve (2). Remove the detent pawl spring.

2. Remove the taper pins (32) from the lower two hinge projection sets of the track sleeve (2) to free the detent pawl shafts (16). Drive these shafts upward through the clearance hole in the upper shoulder flange of the track sleeve, removing the detent pawl shafts (16) and the detent pawls (7).

3. Remove the two long and two short lockscrews (9 and 10) from the detent pawl rest (8) and remove the detent pawl rest from its insertion in the circumferential slot of the track sleeve (2). The lockscrews are unscrewed from tapped holes in the periphery wall of the sliding track (3).

4. Remove the lockscrew (36) from the tapped hole in the threaded intersection of the lower face of the lower sliding track lock ring (11) and the sliding track (3). Unscrew the operating gear retaining ring (35) and the sliding track (3).

8. Remove the two lockscrews (30) of shorter length from the observation position stop (20). These lockscrews are unscrewed from tapped holes in the operating gear retaining ring (35).

9. Remove the four lockscrews (25) from the operating gear retaining ring (35). These lockscrews are unscrewed from tapped holes in the sliding track (3). Remove the retaining ring.

10. Remove the operating gear (1) from the tube section of the sliding track (3).

11. Remove the two lockscrews (30) from the operating gear stop (19). These lockscrews are unscrewed from tapped holes in the lower shoulder of the operating gear (1).

12. Remove the two cam shoes (4) from the stub shaft of the two mounting plate guide keys and integral shafts (15), or lift them from the cam grooves in the operating gear (1).

13. Remove the two lockscrews (29) from each, of the two mounting plate guides (18). These lockscrews are unscrewed from tapped holes in the large shoulder flange on opposite sides of the sliding track (3). Remove the two mounting plate guides.

14. Remove the two lockscrews (28) from the two mounting plate guide keys (17). These lockscrews are unscrewed from tapped holes in the narrow eccentric section of the two mounting plate halves (5). Remove the mounting plate guide keys from

lower lock ring (11) which is a tap fit, using a special wrench. Then unscrew the upper of the two lock rings (11) in the same manner.

5. Remove the sliding track (3) from the track sleeve (2). At the same time, remove the assembled operating gear pinion (12) and shaft (13). The operating gear pinion and shaft must be removed with the sliding track to prevent damage to these parts.

the T-slots on opposite sides of the sliding track (3).

15. Carefully slide out each mounting plate half (5) with the mounting plate guide keys and integral shafts (15), moving them outward in opposite directions from the T-slots on opposite sides of the sliding track (3).

16. Remove the two taper pins (31) from the large eccentric section of the two mounting plate halves (5). Drive out the two mounting plate guide keys and integral shafts (15) from both mounting plate halves.

4J7. Reassembly of the objective operating mechanism assembly. The objective operating mechanism is reassembled in the following manner:

1. Apply Lubricate No. 110 lightly to all rotating parts as the reassembly procedure is followed.

2. Assemble the mounting plate guide keys and integral shafts (15) in the reamed holes in the large eccentric art of the two mounting plate halves (5) checking their corresponding reference marks for proper assembly. The long section of the integral shaft sections is inserted from the lower face. Each is secured with a taper pin (31).

7. Place the operating gear (1) over the tube section of the sliding track (3). The upper face of the operating gear large shoulder flange contacts the lower face of the sliding track large shoulder flange, and the two cam shoes (4) are fitted into the cam grooves in the operating gear (1). The proper position of the operating gear (1) for its contact with the sliding track shoulder large flange (3) is obtained from corresponding reference marks on the sliding track.

8. Place the operating gear retaining ring (35) on the tube section of the sliding track (3). Check to ascertain that the 10 degrees rotation scribe lines coincide with similar scribe lines on the operating gear shoulder, and that lockscrew holes coincide. Secure the retaining ring with four lockscrews (25) which screw into tapped, holes in the sliding track (3).

9. Assemble the operating gear stop (19) to the operating gear lower shoulder section and secure it with two lockscrews (30). These

3. Stand the sliding track (3) in a vertical position resting it on its lower face. Place one and then the other of the two mounting plate halves on the large shoulder flange face of the sliding track (3). Carefully slide the mounting guide keys of the assembled integral shafts into the elongated T-slots in opposite directions, noting the reference marks for correct reassembly.

4. Assemble one and then the other of the mounting plate guide keys (17) in the elongated T-slots on opposite sides of the sliding track large shoulder flange face (3). Secure each with a lockscrew (28) screwing them into the tapped holes in the narrow eccentric part of the two mounting plate halves (5).

5. Place one and then the other of the two mounting plate guides (18) over the side shoulder of each mounting plate half (5), noting their reference marks on the sliding track large shoulder flange face (3). Secure each with three lockscrews (29) screwing them into tapped holes in the large shoulder flange on opposite sides. The mounting plate guides are placed 180 degrees apart.

6. Place the two cam shoes (4) on the two mounting plate guide keys and integral stub shafts (15), placing the thinner wall of the cam shoe outward on each side.

lockscrews are screwed into tapped holes in this lower shoulder section.

10. To assemble the maximum displacement stop (20) to the retaining ring (35), first rotate the operating gear (1) until the cam shoes (4) are at the limit of their travel; scribe a line on the operating gear lower shoulder section and the retaining ring (35). Reverse the operating gear 0.125 inch and note the tapped holes in the retaining ring (35). Secure this stop with two lockscrews (30) screwing them into the tapped holes in the retaining ring (35) and the sliding track (3).

11. The observation position stop (20) is located and secured to the retaining ring (35) during the procedure of collimation. (Refer to Section 4VII, Step 25.)

12. Place the operating gear pinion (12) on the operating gear pinion shaft (13) sliding it over the inserted woodruff key (21) located in the upper part of this shaft. Secure the pinion with two lockscrews (24), screwing them into tapped holes in opposite sides of the pinion and into spotted recesses in the shaft.

13. Check the reference marks of the operating gear pinion teeth (12) for corresponding reference marks on the operating gear teeth (1) and engage the pinion in mesh with the teeth of the

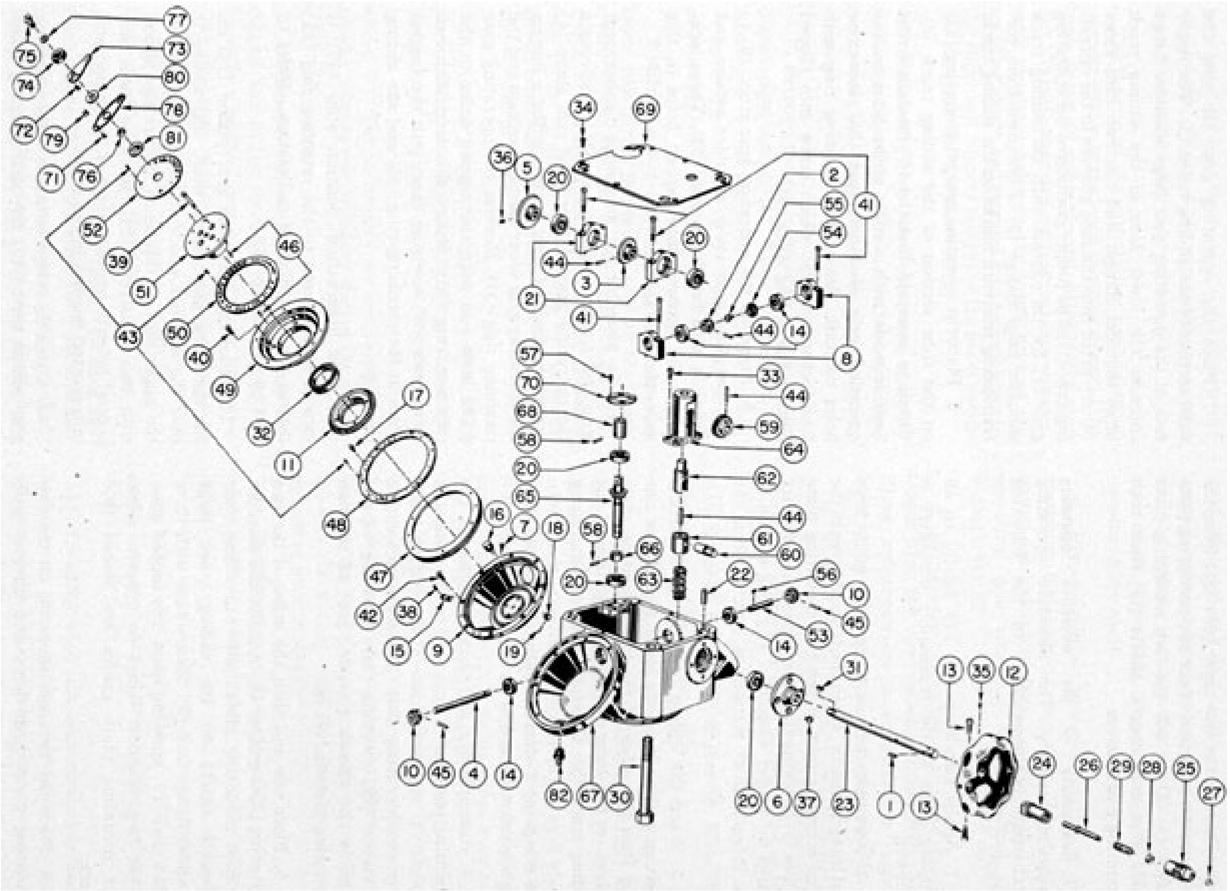

Figure 4-24. Stadimeter housing assembly.

operating gear. Holding, the pinion in mesh, place the operating gear (1) and the operating gear pinion (12) together in the track sleeve (2). The operating gear pinion shaft enters the reamed hole of the bearing projection before the tube section of the sliding track enters the track sleeve. This method permits correct alignment for the assembly of the stadimeter transmission shaft coupling (14) so that the taper pins (33) can be inserted correctly in relation to the position of the upper part of the stadimeter transmission shaft (22, Figure 4-27).

14. Place the sliding track lock rings (11) in the counterbore of the track sleeve. The upper ring has a slight counterbore. Screw this lock ring on the threaded periphery of the sliding track (3) and between the with a taper pin (32) inserted in the lower part of each set of hinge projections.

17. Place the detent pawl spring (6) over both detent pawls (7). Secure it with six lockscrews (26), screwing three of these lockscrews into tapped holes in each raised mount on opposite sides of the circumferential slot.

18. Check the 90 degrees rotation before reassembly of the lower (split) objective lens and mount assembly halves (Figure 4-22) to the objective operating mechanism assembly.

4J8. Description of the stadimeter housing assembly. The stadimeter housing assembly is constructed as follows. (Figure 4-24 shows the stadimeter housing assembly.) All bubble numbers in Sections 4J8, 9,

overlapping section of the track sleeve (2) using a special wrench until it comes up tight. Tap it lightly. Place the lower lock ring (11) on in the same manner. When this lock ring is tightened sufficiently against the upper lock ring, the tapped recesses of the lock ring and sliding track intersection (3) should coincide, forming a tapped hole. Insert the lockscrew (36) in this tapped hole in the threaded intersection. If the tapped recesses do not coincide, the upper ring requires further tightening.

15. Place the detent pawl rest (8) in the 128 degrees circumferential slot. A dowel pin fits into its aligning hole in the sliding track (3) and will fit only one way. Secure the detent pawl rest to the periphery of the sliding track (3) with two long and two short lockscrews (9 and, 10). These lockscrews are inserted into countersunk clearance holes in the detent pawl rest and screwed into tapped holes in the sliding track. The true 90 degrees rotation of this objective operating mechanism assembly must be checked on the V-blocks of an optical I-beam bench before collimation.

16. Place the detent pawls (7) which have reference marks to correspond to hinge projections of the track sleeve (2) at their respective places. Insert the detent pawl shafts with similar reference marks, through the reamed holes in the track sleeve shoulder flange, and carry them into the reamed holes in the hinge projections and the detent pawls. Secure each shaft

and 10 refer to Figure 4-24 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1159-11	1	Handwheel key
2	P-1159-12	1	Transmission gear pinion
3	P-1159-13	1	Handwheel shaft bevel gear
4	P-1159-14	1	Long transmission shaft
5	P-1159-17	1	Transmission shaft bevel gear
6	P-1159-18	1	Handwheel bracket
7	P-1163-10	8	Length of target scale mount retaining screws
8	P-1169-2	2	Scale ball bearing housings
9	P-1169-3	2	Scale housings
10	P-1169-4	2	Range scale actuating bevel gear pinions (front and rear)
11	P-1169-8	2	Range scale actuating bevel gears (front and rear)
12	P-1170-2	1	Handwheel
13	P-1170-13	2	Spring handle hinge screws

14	P-1171-1	4	Scale and transmission ball bearings
15	P-1171-16	2	Index line plates
16	P-1171-17	2	Length of target scale clamp screws
17	P-1171-18	4	Length of target scale knobs
18	P-1172-1	2	Length of target scale clamp screw retaining collars
19	P-1172-2	2	Length of target scale clamp screw retaining collar rivets
20	P-1172-3	5	Transmission ball bearings
21	P-1172-4	2	Transmission ball bearing housings
22	P-1172-5	2	stadimeter housing dowel pins
23	P-1172-6	1	Handwheel shaft

Ill. No.	Drawing Number	Number Required	Nomenclature
24	P-1172-7	1	Spring handle stud
25	P-1172-8	1	Spring handle
26	P-1172-9	1	Spring handle plunger
27	P-1172-	1	Spring handle

Ill. No.	Drawing Number	Number Required	Nomenclature
60	P-1316-2	1	Star wheel key
61	P-1316-3	1	Star wheel key holder
62	P-1316-4	1	Star wheel lock plunger
63	P-1316-	1	Star wheel

	10		plunger nut
28	P-1172-11	1	Spring retaining nut
29	P-1172-12	1	Plunger spring
30	P-1172-13	4	Stadimeter housing bolts
31	P-1172-15	1	Transmission shaft pinion bevel gear key
32	P-1172-17	2	Front and rear range scale actuating bevel gear ball bearings
33	P-1179-37	4	Star wheel lock plunger housing lockscrews
34	P-1179-46	6	Stadimeter housing cover plate lockscrews
35	P-1179-50	1	Handwheel lockscrew
36	P-1179-60	1	Transmission shaft pinion bevel gear lockscrew
37	P-1179-68	4	Handwheel bracket lockscrews
38	P-1179-69	4	Index line plate lockscrews
39	P-1179-70	8	Height scale mount lockscrews
40	P-1179-71	8	Range scale mount lockscrews
41	P-1179-72	8	Ball bearing housing lockscrews
	5		lock plunger spring
64	P-1316-6	1	Star wheel lock plunger housing
65	P-1316-7	1	Transmission shaft pinion
66	P-1316-10	1	Transmission shaft pinion thrust collar
67	P-1404-1	1	Stadimeter housing
68	P-1409-6	1	Female tang coupling
69	P-1409-9	1	Housing cover plate
70	P-1409-10	1	Ball bearing retainer
71	P-1422-3	2	Lower pointer knob lockscrews
72	P-1422-10	6	Upper pointer lockscrews
73	P-1429-1	2	Upper pointers
74	P-1429-2	2	Upper pointer knobs
75	P-1429-3	2	Pointer shoulder screws
76	P-1429-4	2	Lower pointer collars
77	P-1429-5	2	Spring washers
78	P-1429-6	2	Lower pointers
79	P-1429-7	2	Lower pointer knobs
80	P-1429-8	2	Brass friction washers
81	P-1429-9	2	Felt friction washers
82	P-1448-7	2	Alemite fittings

42	P-1179-73	16	Scale housing lockscrews
43	P-1179-74	32	Various dial lockscrews
44	P-1179-197	4	Transmission gear pinion, handwheel shaft bevel gear, star wheel, and star wheel key taper pins
45	P-1179-198	2	Front and rear range scale actuating gear pinion taper pins
46	P-1179-200	8	Scale dowel pins
47	P-1184-1	2	Length of target scale mounts
48	P-1184-2	2	Length of target scale dials
49	P-1184-3	2	Range scale mounts
50	P-1184-4	2	Range scale dials
51	P-1184-5	2	Height scale mounts
52	P-1184-6	2	Height scale dials
53	P-1264-2	1	Short transmission shaft
54	P-1264-3	1	Transmission gear pinion
55	P-1264-4	1	Transmission gear pinion lockscrew
56	P-1264-5	1	Transmission gear pinion
57	P-1310-37	4	Pinion ball bearing

a. Stadimeter housing. The stadimeter housing (67) is made of cast phosphor bronze. It consists of a cored rectangular box section called the center section, with front and rear projections forming a part of the casting. These are called the front and rear scale housings. The center section carries the transmission mechanism to operate the scale dial mechanisms of the front and rear housings simultaneously with the various interconnecting shafts and couplings to operate the objective operating mechanism assembly (Figure 4-23) and the lower (split) objective lens and mount assembly (Figure 4-22) as a single unit called the stadimeter.

The walls of the center section are of rectangular design and have their outer four corners beveled. The inner four corners of this section are filleted inward sufficiently to accommodate clearance holes for the four stadimeter housing bolts (30). These bolts, inserted from the four spot faced corners of the base, secure the stadimeter housing to the eyepiece box (11, Figure 4-29). There are two dowel pins (22) inserted in the upper wall face which are located

			retainer lockscrews
58	P-1310-202	2	Transmission shaft pinion thrust collar and female tang coupling taper pins
59	P-1316-1	1	Star wheel

diagonally to insure a rapid reference for reassembly of this housing. These dowel pins are a force fit into the reamed holes in the eyepiece box base (11, Figure 4-29).

An inward projecting semi-circular lug of sufficient thickness provides the necessary support for the transmission shaft pinion (65) and its perpendicular, supporting parts, for interconnection with the stadimeter transmission shaft (22, Figure 4-27), of the first inner tube section assembly. Directly below this semicircular lug, in the base of the center section, a semi-circular raised section accommodates the lower supporting parts of the transmission shaft pinion (65).

A raised section shaped like the letter G, 0.937 inch in height, is supported by a narrow rib from the front filleted corner, extending forward from the inner rear wall of the center section. This part, having ample wall thickness, accommodates the three way interconnection of the transmission, by means of four mounted ball bearings (14 and 20).

The lower part of the stadimeter housing is cored inward to the

This assembly is swung vertically or horizontally at will by the observer, and is locked in either position by means of a plunger under spring pressure, extending into clearance holes in the inner wall of the remaining wall of the machined scallop. This spring handle when swung horizontally, provides the observer with a means for rapid turning of the handwheel if desired. One scallop opposite the spring handle assembly is solid to balance the handwheel for the increased weight.

The inner wall of the handwheel is scored with four flat spokes which project inward to the hub section and have a square appearance. The hub section is filleted toward its diameter, and has a reamed hole and a keyseat to receive the outer part of the handwheel shaft (23) with an inserted key (1). The handwheel is secured to the handwheel shaft with a lockscrew (35). This lockscrew is inserted into a tapped hole in the handwheel hub section and extends into a spotted recess, thus preventing the handwheel from coming off the shaft.

The center of the three solid scallops is machined out to receive

center part, with supporting ribs to the front and rear scale housing section walls. The center section and lower face are bored, faced, and threaded. The lower fate of this section contacts the bumper located in the well of the submarine. At various times it is necessary, because of the construction of a submarine, to insert a filler piece in the threaded section in the lower center part of the stadimeter housing base.

The front, rear, and right side walls of the center section have openings to accommodate ball bearings for the operation of the transmission and the front and rear scale housing mechanisms. The lower wall of each scale housing section has a tapped hole to receive alemite fittings (82) for the introduction of grease.

b. Handwheel. The handwheel (12) is made of cast phosphor bronze. It is of sufficient. diameter to permit easy operation of the stadimeter, with the periphery scalloped. The inner scalloped circumference is cored and allows only sufficient wall thickness for six of the scallops. Three of the scallops of one section are solid for the assembly of a spring handle.

the hinge section of the spring handle stud (24) and its cylindrical shoulder. This milled out section is provided with sufficient clearance to allow the spring handle stud (24) to rotate 90 degrees. It is secured in the handwheel by two spring handle hinge screws (13). These screws fit into countersunk tapped holes located on opposite sides of the machined scallop in the periphery, with their centerline offset from the scalloped periphery wall 1/16 inch. Two clearance holes are provided in this machined scallop, located 90 degrees apart, for the spring handle plunger (26). This allows the spring handle assembly to be locked in either the extended or folded position.

c. Spring handle stud, plunger, plunger spring, spring retaining nut, and spring handle. 1. Spring handle stud. The spring handle stud (24) is made of rolled bronze and is nickel plated. The hinge section is square with the corners rounded off to provide 90 degrees rotation in the milled section of the handwheel (12). Two opposite reamed holes in this section serve as pivot bearings for the spring handle hinge screws (13) which extend from countersunk tapped holes in the scalloped periphery

into reamed holes in each wall of the hinge section. The undercut section of the screws fits into the reamed holes. The outer surface of the main body carries the spring handle (25) up to "the narrow shoulder. The diameter of the shoulder conforms to the diameter of the contacting part of the spring handle.

1/8-inch thick. It is cylindrical and has a threaded periphery to screw into the threaded outer part of the spring handle stud (24). It has a reamed hole in its axis to allow the long section of the plunger a sliding fit. Two shallow drilled holes are provided in the side face for a special wrench. The retaining nut compresses the plunger spring (29)

The inner surfaces are provided with two reamed holes, the smaller of which receives the shorter stem of the spring handle plunger (26), and the larger receives the narrow shoulder section of the spring handle plunger and the plunger spring (29). The outer part of the large reamed hole is threaded 1/8 inch deep to receive the spring retaining nut (28) to compress the plunger spring.

2. Spring handle plunger. The spring handle plunger (26) is made of monel metal and is 2 5/8 inches long. The shorter stem which is 1 5/16 inch long is rounded off at the end; this section extends from the reamed hole in the spring handle stud (24) under tension of the plunger spring (29) to snap into either of the 90 degrees clearance holes in the handwheel (12) to retain the assembled spring handle in the extended or folded position.

The narrow shoulder section of the handle is a sliding fit in the large reamed hole in the spring handle stud (24) with the plunger spring (29) fitting over the long stem section against the narrow shoulder section. The plunger spring under tension carries this shoulder to the bottom of the large reamed hole. The outer part of the long stem section is undercut and threaded, and carries the small reamed and countersunk outer part of the spring handle, securing it with a plunger nut (27).

3. Plunger spring. The plunger spring (29) is made of No. 16 gage music wire and is 3/4-inch free length. The spring fits over the long section of the spring handle plunger (26) and is placed under a nominal tension by the spring retaining nut normally and is secured tightly in the bottom of the threaded outer part of the spring handle stud.

5. Spring handle. The spring handle (25) is made of rolled bronze and is nickel plated. It is of sufficient length with the outer corners rounded off. The outer surface has a 1/2-inch knurled band to offer a firm grip to the observer.

The inner surface has a reamed hole which is countersunk in the outer part. The reamed hole is a sliding fit over the long section of the spring handle plunger (26). It is counterbored a sliding fit over the main body of the spring handle stud (24), and is secured with nominal clearance by a plunger nut (27). The plunger nut is a sliding fit in the outer countersunk reamed hole in the outer part, and is slotted in its side face for a special wrench. The upward movement of the spring handle against spring tension causes its countersunk face to contact the plunger nut (27) which is attached to the spring handle plunger (26) thus carrying the plunger outward, compressing the plunger spring (29), and removing the short stem section of the plunger from its locked position in the handwheel (12). Once the plunger is released from its locked position, it automatically snaps into the opposite locked position upon rotation and when lined up for proper engagement.

d. Handwheel bracket and shaft. 1. Handwheel bracket. The handwheel bracket (6) is made of phosphor bronze and is 5/8 inch in length. The large diameter of the shoulder flange is of nominal thickness and is filleted to the hub section. It is secured to the right side wall of the

(28) to retain the narrow shoulder section of the plunger against the bottom shoulder of the large reamed hole. Sufficient compression of the spring allows the short section of the plunger to be released from the locking clearance holes in the handwheel (12).

4. Spring retaining nut. The spring retaining nut (28) is made of rolled bronze and is stadimeter housing center section with four lockscrews (37). These lockscrews are inserted in countersunk clearance holes and screwed into tapped holes in the center section wall. The inner surface has a reamed hole for the handwheel shaft (23) and a shallow counterface to allow clearance over the ball bearing (20) extending from the alignment counterface

of the center section wall. The small raised alignment shoulder of the bracket is a push fit into the alignment counterface. The bracket serves as a support for the weight of the handwheel (12) and the protruding part of the handwheel shaft (23). It also prevents foreign matter from entering the ball bearing (20).

2. Handwheel shaft. The handwheel shaft (23) is made of corrosion-resisting steel rod and is 7 1/8 inches in length. The outer part of the shaft is provided with a keyway for the insertion of a handwheel key (1), and receives the handwheel (12) which is secured with a lockscrew (35) that protrudes from the tapped hole in the handwheel hub and extends into a spotted recess in the shaft. This shaft is mounted in three ball bearings (20), with the first ball bearing in the right side wall of the center section. The shaft protrudes into the center section from the right side wall of the stadimeter housing. In the center section, a nominal distance from the inner right wall, a star wheel (59) is secured to the handwheel shaft (23) with a taper pin (44) inserted through the hub section. This Directly outward of this ball bearing on the opposite end of the handwheel shaft, a woodruff keyway is cut in this stub section, to accommodate a No. 10 woodruff key (31). This woodruff key is inserted in the stub section to receive the transmission shaft bevel gear (5). This bevel gear is secured to the handwheel shaft (23) by means of a lockscrew (36). The lockscrew is inserted into a tapped hole in the bevel gear hub section and extends into a spotted recess in the shaft.

The handwheel shaft mounted in three ball bearings, operates the front and rear scale housing mechanisms by means of the handwheel shaft bevel gear (3) which engages with the front and rear transmission gear pinions (2 and 54). It also operates the objective operating mechanism assembly by means of the transmission shaft bevel gear (5) which engages with the transmission gear pinion (65). Both of the scale housing mechanisms and the transmission shaft pinion are rotated simultaneously as the handwheel (12) operates the

section faces the inner wall. A star wheel lock plunger housing (64) is provided between the star wheel (59) and the next ball bearing (20).

The second ball bearing (20) is a push fit over the handwheel shaft (23) and is mounted in a transmission ball bearing housing (21). The housing is secured to the lower part of the raised G-wall in the center section with two lockscrews (41). These lockscrews are inserted into countersunk clearance holes in the housing and screwed into tapped holes in the raised G-wall section.

Directly inward of this mounted ball bearing (20), a handwheel shaft bevel gear (3) is attached to the handwheel shaft with a taper pin (44) inserted through the hub section. This section faces the second ball bearing (20).

The shaft is mounted a push fit in the third ball bearing (20) mounted in a housing (21) which is secured to the upper part of the raised G-wall section in the center section. The housing is secured to this wall face with two lockscrews (41). These lockscrews are inserted into countersunk clearance holes in the housing and screwed into tapped holes in this raised G-wall section face.

handwheel shaft (23) for clockwise or counterclockwise rotation.

e. Transmission shaft pinion. The transmission shaft pinion (65) is made of corrosion resisting steel and is 2.933 inches in length. The pinion is cut as an integral part of the shaft. It has 26 bevel teeth of 32 diametral pitch which mesh at right angles with 54 bevel teeth of the transmission shaft bevel gear (5). This transmission shaft pinion is mounted vertically in the center section at right angles to the handwheel shaft (23) and parallel to its centerline.

A part of the long section of the pinion shaft is undercut below the pinion to allow clearance for cutting of the bevel teeth. The lower part of the pinion shaft is a push fit in a ball bearing (20) which in turn is a push fit in the raised semicircular section in the lower wall of the center section. The upper part of the stub shaft section above the pinion is mounted a push fit in a ball bearing (20), which in turn is mounted a push fit into the semicircular lug section of the center section projecting inward. The face of this semicircular lug section is provided with a ball bearing retainer (70) secured with four lockscrews (57).

The upper part of the stub shaft section is cut away a depth of 3/8 inch forming a male tang

section far the assembly of a female tang coupling (68) secured snugly against the race of the ball bearing with a taper pin (58). This stub shaft section projects upward with the assembled female tang coupling

of phosphor bronze with a reamed hole in its center axis, and is provided with a keyseat. It is a push fit over the inserted woodruff key (31) on the stub section of the handwheel shaft (23). The large

from the upper face of the stadimeter housing center section.

The lower part of the long shaft section of the pinion shaft is provided with a thrust collar (66). This thrust collar is secured to this part of the shaft in contact with the lower ball bearing race with a taper pin (58). The thrust collar is adjusted before securing, so that the pinion teeth are engaged with the transmission shaft pinion bevel gear (5) at operating depth, with no lost motion in the pinion or its mating bevel gear.

f. Star wheel. The star wheel (59) is made of corrosion-resisting steel 1/2 inch wide. It is provided with a large shoulder section in which 22 teeth of non-standard design are cut for the engagement of a star wheel key (60). The inner surface has a reamed hole which is a sliding fit on the handwheel shaft (23). It is secured to this shaft with a taper pin (44) inserted through the hub section of the star wheel, with the hub section facing the inner right side wall of the stadimeter housing center section. The face of the star wheel is fitted close to the star wheel lock plunger housing (64), and receives the star wheel key (60) which is secured in a star wheel key holder (61) with a taper pin (44) under tension of a star wheel lock plunger spring (63).

g. Handwheel and transmission shaft bevel gears. 1. Handwheel shaft bevel gear. The handwheel shaft bevel gear (3) is made of phosphor bronze with a reamed hole in its center axis, a sliding fit on the handwheel shaft (23). The large diameter is provided with 40 bevel teeth of 32 diametral pitch, which mesh at right angles with a diameter is provided with 54 bevel teeth of 32 diametral pitch, which mesh with the 20 bevel teeth of the transmission shaft pinion (65) located vertically at right angles. It is provided with a hub section which faces the shoulder of the handwheel shaft (23) and is secured with a lockscrew (36). This lockscrew is inserted in a tapped hole in the hub section of this bevel gear and extends into a spotted recess in the handwheel shaft (23).

h. Transmission ball bearing housings, ball bearing retainer, and ball bearings. 1. Transmission ball bearing housings. The transmission ball bearing housings (21) are made of cast phosphor bronze and are 1 5/8 inches long. They are of proportional thickness to provide a rigid foundation for the ball bearings (20) and actuation of the transmission. Each is bored to accommodate the handwheel shaft (23) and to permit the rapid removal of each ball bearing. A counterbore 1/4 inch deep is provided in each housing for the assembly of two ball bearings (20), a press fit in each of the counterbores. The height of the housings is proportional to the establishment of a parallel transmission centerline, with each upper part having a radius to accommodate sufficient wall thickness. Each housing is provided with two dowel pins, for rapid alignment upon reassembly. These dowel pins fit into shallow holes in the face of the raised G-wall section face. Each housing is secured to this raised G-wall section face with two lockscrews (41) located in tapped holes in the wall. These lockscrews are inserted in countersunk clearance holes of appropriate center distance in the housing and screwed into tapped holes in the

transmission gear pinion (2) of 20 beveled teeth on the front side of the handwheel shaft (23). It also meshes with a transmission gear pinion (54) on the opposite (or rear) side for actuation of the front and rear scale housing mechanisms. This bevel gear is provided with a hub section into which the taper pin (44) is secured, with this section facing away from its mating pinions.

2. Transmission shaft bevel gear. The transmission shaft bevel gear (5) is made

raised G-wall section. The bored holes in the assembled housings face each other at assembly.

2. Ball bearing retainer. The ball bearing retainer (70) is made of 1/16-inch thick brass. It is cylindrical with a clearance hole in the center axis. It is secured in contact with the ball bearing (20) to the face of the semi-circular lug section with four lockscrews (57). These lockscrews are inserted in four equally spaced countersunk clearance holes in the retainer and

screwed into tapped holes in the semi-circular lug section. This retainer prevents the transmission shaft pinion (65) from being displaced axially. A recess is provided in the periphery, where it overlaps the clearance holes for the stadimeter housing bolt (30).

3. Ball bearings. The ball bearings (20) for the transmission shaft pinion (65) are mounted a push fit in the bored holes of the semicircular lug section and the semicircular raised section, a part of the lower base wall of the center section. Each ball bearing is a push fit over the lower part of the long shaft section of the transmission shaft pinion (65) and also over the stub section of the upper part.

i. Female tang coupling. The female tang coupling (68) is made of phosphor bronze- and is 0.812 inch in length. The outer surface is cylindrical with a broached hole of a partially circular design in the center axis. This broached hole fits over the transmission shaft pinion (65) male tang to contact the ball bearing (20)

rectangular base is secured to the machined center section boss over the handwheel shaft (23) with four lockscrews (33). These lockscrews are inserted into counterfaced clearance holes in the housing flanges and screwed into tapped holes in the center section boss. The periphery of the housing on the slotted sides is filed off for clearance between the ball bearing housing (21) and the star wheel (59).

2. Star wheel lock plunger. The star wheel lock plunger (62) is made of phosphor bronze and is 1 1/2 inches in length. It is cylindrical, with a small undercut section a loose fit in the reamed hole in the plunger housing (64), while the large periphery is a loose fit in the small counterbored section in the same housing. The larger diameter is slotted to a distance of 3/4 inch, to allow its free vertical movement over the handwheel shaft in the housing. The lower part rests in the counterfaced upper part of the keyholder (61). This plunger, in contact with the keyholder (61) under tension by the plunger spring,

and is secured with a taper pin (58). The remaining part of the coupling receives the stadimeter transmission shaft male tang section (22, Figure 4-27) for actuation, and is a sliding fit in this part. The coupling projects above the face of the stadimeter housing center section and is connected to the stadimeter transmission shaft tang section (22, Figure 4-27) upon assembly of the stadimeter housing assembly to the base of the eyepiece box (11, Figure 4-29).

j. Star wheel lock plunger housing, plunger, key holder, and key. 1. Star wheel lock plunger housing. The star wheel lock plunger housing (64) is made of cast phosphor bronze and is 2 3/4 inches in length. The outer surface is cylindrical, with a rectangular flange in the lower part. The inner surface has a reamed hole and two counterbored sections; the small counterbored section and reamed hole receive the lock plunger (62) which is a loose fit. The large counterbored section receives the keyholder (61) which is also a loose fit. Both sides of the housing perpendicular to the narrow rectangular part of the flange are slotted to allow the protruding parts of the star wheel key (60) vertical guidance and also to fit over the handwheel shaft (23). The is carried to its upper extreme position, and the star wheel key (60) is engaged with the star wheel (59) locking the handwheel shaft (23) and the transmission.

3. Star wheel key holder. The star wheel key holder (61) is made of phosphor bronze and is 0.781 inch in length. Its outer surface is cylindrical, a loose fit in the large counterbore of the lock plunger housing (64). The upper part is counterfaced a shallow depth to provide a seat for the lower part of the lock plunger (62), while the lower part is counterbored 3/16 inch to provide clearance and guidance for the plunger spring (63). A reamed hole is provided perpendicular to its axis a short distance from the upper part to receive the star wheel key (60) which is secured with a taper pin (44) in its center axis. The rear side of the key extends beyond the periphery 1/32 inch to provide vertical guidance of the assembled key holder and key in the vertical slots of the plunger housing (64).

4. Star wheel key. The star wheel key (60) is made of corrosion-resisting steel material and is 1 1/8 inches in length. The key section is 0.281 inch in length and is a true profile of the star wheel non-standard teeth. The supporting body of the key is a push fit in the

reamed hole in the key holder (61) and is secured with a taper pin (44).

k. Automatic stop. The automatic stop prevents rotation of the handwheel (12) when the stadimeter housing is not in place, and insures (45). This shaft operates the front scale housing mechanism by means of the attached pinions.

2. Transmission gear pinion. The transmission gear pinion (2) is made of phosphor bronze with a reamed

correct reassembly. The locking device consists of a star wheel (59) mounted on the handwheel shaft (23) which is secured with a taper pin (44), and with the following parts enclosed in a star wheel lock plunger housing (64): star wheel lock plunger (62), star wheel key (60), its holder (61), and a plunger spring (63).

The star wheel key (60) in the locked position is engaged in the teeth of the star wheel (59) by means of the tension placed against the key holder (61) by the plunger spring (63). In this position the lock plunger (62) is carried to its upward position by the key holder (61). When the stadimeter housing assembly is attached to the base of the eyepiece box (11, Figure 4-29) and secured with four stadimeter housing bolts (30), the screw head (6, Figure 4-29) projecting from the base of the eyepiece box (11, Figure 4-29) contacts the lock plunger (62) and pushes it downward, disengaging the star wheel key (60) from the star wheel (59) compressing the plunger spring (63). This automatic device locks the handwheel (12) and the transmission that the broached tang hole of the female tang coupling (68) couples with the stadimeter transmission shaft male tang section (22, Figure 4-27) for proper relation to the proper position of the lower (split) objective lens and the stadimeter dials.

l. Long transmission shaft and gear pinion. 1. Long transmission shaft. The long transmission shaft (4) is made of corrosion-resisting steel and is 3 3/8 inches in length. It is mounted in two ball bearings (14). One is located in the center section front wall, while the other is located hole in its center axis a push fit on the inner end of the long transmission shaft (4). The large diameter is provided with 20 bevel teeth of 32 diametral pitch, to mesh at right angles with the 54 bevel teeth of the handwheel shaft bevel gear (3). It is provided with a hub section which faces toward the mounted ball bearing (14) in the scale ball bearing housing (8) and is secured with a taper pin (44). This gear pinion transmits motion to the long transmission shaft (4) for actuation of the front scale housing mechanisms.

m. Short transmission shaft and gear pinion. 1. Short transmission shaft. The short transmission shaft (53) is made of corrosion-resisting steel and is 1 1/2 inches in length. It is mounted in two ball bearings (14). One is located in the center section rear wall, while the other is located in the scale ball bearing housing (8) located on the face of the raised G-wall section and perpendicular to the transmission ball bearing housings (21). The inner part of this shaft is provided with a keyway for the insertion of a key (56). It is provided with a tapped hole in the center axis of this end for a lockscrew (55).

On the inner end of this shaft a transmission gear pinion (54) is secured over the inserted key (56) by means of a lockscrew (55). The lockscrew screws into the tapped hole in the center axis of the shaft. The opposite end of this shaft extends into the rear scale housing section to receive the range scale actuating gear pinion (10) secured with a taper pin (45). This shaft operates the rear scale mechanism by means of attached pinions.

in the scale ball bearing housing (8) located on the face of the raised G-wall sections and perpendicular to the ball bearing housings (21). On the inner end of this shaft a transmission gear pinion (2) is secured with a taper pin (44), while the opposite end extends into the front scale housing section to receive the range scale actuating bevel gear pinion (10) which is secured with a taper pin

2. Transmission gear pinion. The transmission gear pinion (54) is made of phosphor bronze with a reamed hole in its center axis, and is provided with a keyseat. This pinion is a push fit over the inserted key (56) located in the inner end of the short transmission shaft (53) and is secured against the race of the ball bearing (14) snugly by means of the lockscrew (55). This lockscrew screws into the tapped hole in the inner end of the shaft. The large diameter

of this pinion is provided with 20 bevel teeth of 32 diametral pitch which mesh at right angles with the 54 bevel teeth of the handwheel shaft bevel gear (3) for actuation of the rear scale housing mechanism.

n. Scale ball bearing housings and ball bearings. 1. Scale ball bearing housings. The scale ball bearing housings (8) are similar to the two transmission ball bearing housings (21) except for the diameter of the clearance holes, the counterbored sections, and the radius of the upper wall. They are used to mount each ball bearing (14) a press fit into each counterbored, section. Both of these housings are located on the raised G-wall section and perpendicular to the two transmission ball bearing housings. They are secured with two lockscrews (41) each, which are inserted into countersunk clearance holes in the housing and screwed into tapped holes in the raised G-wall section. Both housings provide a rigid support for the transmission gear pinions (2 and 54) for their actuation with the handwheel shaft bevel gear (3).

transmission shaft (4 and 53) and are secured with a taper pin (45). Both pinions operate the range scale actuating bevel gears (11) of the front and rear scale housing mechanisms.

p. Scale housings. The scale housings (9) are made of cast phosphor bronze and are 1 13/16 inches in length. Both housings are provided for the front and rear scale housing sections of the stadimeter housing (67). The outer and inner walls are beveled at 45 degrees forming a conical shape, and have equal wall thickness. This conical wall is undercut on the outer surface to form a shoulder flange, and is a sliding fit in the bored and counterbored section of the scale housing section. It is secured with eight lockscrews (42) which are inserted in countersunk clearance holes in the scale housing shoulder flange and screwed into tapped holes in the counterbored face of the scale housing section.

The lower part of the conical wall is flat with a diameter of 2 9/16 inches, with the conical wall and lower part

2. Ball bearings. The four ball bearings (14) provide smooth actuation to the long and short transmission shafts (4 and 53) in the center section mounted in scale ball bearing housings (8) for the inner parts of these shafts. Two ball bearings are mounted, a press fit into the counterbored sections in the front and rear walls of the scale housing sections. They are inserted from the scale housing side with a clearance hole of sufficient size for their removal. These two ball bearings support the outer part of the long and short transmission shafts (4 and 53) for the free actuation of each scale housing mechanism.

o. Range scale actuating bevel gear pinions. The two range scale actuating bevel gear pinions (10) are made of phosphor bronze with a reamed hole in each center axis. The large diameter of each is provided with 20 bevel teeth of 32 diametral pitch, with a pitch cone line angle of 17 degrees 4', which mesh with 80 bevel teeth of a range scale actuating bevel gear (11) having a pitch cone line angle of 72 degrees 56'. Each is provided with a hub section which faces toward the assembled ball bearing (14) located in the wall of each scale housing section. The gear pinions are a push fit on each long and short conforming to the inner cored conical and flat walls of the scale housing section. A clearance hole of sufficient size is provided in the conical wall to accommodate the long transmission shaft (4) and the range scale actuating gear pinion (10) of the front scale housing section. The same provision allows clearance for the protrusion of the short transmission shaft (53) and the range scale actuating gear pinion (10) of the rear scale housing section.

The inner lower wall face is provided with two raised shoulders of varying diameter, wall thickness, and depth. The space between the two shoulders allows clearance for the small chamfered shoulder of the range scale actuating bevel gear (11) and serves as a grease cell. The large shoulder is a contact face with the inner side face of the range scale actuating bevel gear (11), thereby providing the height or thrust adjustment to this bevel gear. The counterbored section of the small shoulder receives the lower face of the height scale mount (51), and is secured with four equally spaced lockscrews (39). These screws are inserted in countersunk clearance holes in the height scale mount (51) and screwed into tapped holes in this counterbored face. A tapped hole in the center axis of this counterbored face is provided for the insertion of a jacking screw for the removal of the scale housing.

The inner surface of the shoulder flange section has two counterbored sections to carry the length of target scale mount (47). The smaller of the two counterbored the inside shoulder. The mount face carries a length of target scale dial (48) secured with six. lockscrews (43) and two lengths of target scale knobs (17). The lockscrews are

sections has four equally spaced tapped holes, countersunk in the periphery to receive four length of target scale mount retaining screws (7), thus retaining, the length of target scale mount (47). These screws project into an undercut groove in the mount periphery, to retain it in the scale housing and also to allow its free actuation.

The shoulder flange of this scale housing is provided with a clamp screw (16) which screws into the countersunk tapped hole in the shoulder flange. It is secured from backing out of the tapped hole with a retaining collar (18) which in turn is secured with a rivet (19). The clamp screw shoulder (16), when in contact with the assembled length of target scale dial (48), clamps it with the mount at any desired length of target suitable for obtaining the course angle of an enemy ship by the observer. The counterbored shoulder of each scale housing section is slotted to provide clearance for the clamp screw assembly located in the right side of the scale housing outer face, at right angles to the conical wall clearance hole.

An index line plate (15) is attached to the scale housing face located opposite the conical wall clearance hole and is secured with two lockscrews (38).

q. Length of target scale mounts. The two length of target scale mounts (47) are made of cast phosphor bronze, and are provided for the stadimeter housing front and rear scale housing sections. The mounts are cylindrical, of single step design, with small and large diameter shoulders which are a sliding fit in the small and large equally spaced and are inserted in countersunk clearance holes in the scale dial and screwed into tapped holes in the mount. The knobs are located on opposite sides and are secured in tapped holes in the mount. They serve to allow the observer to rotate and set the assembled mount to the reference line of the index line plate (15) to any desired length of an enemy ship.

r. Range scale actuating bevel gears, ball bearings, and mounts. 1. Range scale actuating bevel gears. The two range scale actuating bevel gears (11) are made of phosphor bronze and are used for the front and rear scale housing mechanisms. The large diameter has 80 bevel teeth of 32 diametral pitch, with a pitch cone line angle of 72 degrees 56' which mesh with a range scale actuating gear pinion (10) of 20 bevel teeth having a pitch cone angle of 17 degrees 4'.

The lower face has a chamfered shoulder which forms a sufficient wall for the counterbored section to receive the ball bearing (32), a press fit in this part against the inner shoulder seat. The shoulder is bored for the protrusion of the lower part of the height scale mount (51). The large lower face revolves in contact with the large raised shoulder of the scale housing (9) to maintain its axial height adjustment.

The upper face has a shallow counterfaced recess serving as an alignment seat for the range scale mount (49) which is secured with four lockscrews (40). The lockscrews are inserted into clearance holes located in the small counterbored face of the range scale mount and screwed into tapped holes in this

counterbores in the scale housings (9). The small periphery shoulder is provided with an undercut groove to accommodate the protrusion of four retaining screws (7). These screws extend inward from four equally spaced countersunk tapped holes in the scale housings (9) for their protrusion in this groove, to retain the mount in its seat, and to offer free actuation to the mount.

The inner surface is bored for operational clearance over the range scale mount (49), and is provided with a chamfer to break off

bevel gear. The bevel gear carries the range scale mount (49) and its attached range scale dial (50) for all ranges of its engraved graduations.

2. Range scale actuating bevel gear ball bearings. The two range scale actuating bevel gear ball bearings (32) are of a torque tube type. Both ball bearings are used for the front and rear scale housing mechanisms. They are mounted a press fit into the counterbored sections in each range scale actuating bevel gear (11) and the other races rest against the counterbored shoulder seat The height scale mount

(51) lower part is a push fit in its center race. These ball bearings offer smooth actuation to the range scale actuating bevel gears.

3. Range scale mounts. The two range scale mounts (49) are made of cast phosphor bronze and are used for the front and rear scale housing mechanisms. The mounts are cylindrical with a large diameter shoulder flange section of nominal thickness. The outer surface of the shoulder flange is chamfered at 30 degrees, while the remaining outer wall is beveled conical. The lower part of the conical wall is provided with a small shoulder, which serves as an alignment support section and is a push fit into the alignment recess seat in the range scale actuating bevel gear (11).

The inner surface is a three step design; it has a bore of sufficient size for operational clearance of the ball bearing center race (32), and the protrusion of the height scale mount lower part (51). It has small

center race. The mount is secured to the ball bearing race with four lockscrews (39). The mount does not actually touch the small counterbored face of the scale housing (9), but is a sliding fit in the small counterbored section in the scale housing raised shoulder.

Four equally spaced countersunk clearance holes extend the entire length of this mount for the lockscrews (39). These lockscrews secure the mount to the ball bearing race by their protrusion into tapped holes in the scale housing lower wall. The outer face of the mount is provided with two dowel pins (46), a drive fit into opposite drilled holes, which are not both located in the centerline for reassembly alignment of the height scale dial (52). This outer face carries the height scale dial (52) secured with four lockscrews (43).

In the center axis of both mounts tapped holes are provided for pointer shoulder screws (75) to

and large counterbored sections. The smaller counterbored section lightens the mount with sufficient clearance to carry the four lockscrews (40). These lockscrews are inserted into four equally spaced clearance holes in the lower shoulder and screwed into tapped holes in the range scale actuating bevel gear (11).

The large counterbored section provides clearance for the large periphery of the height scale mount (51) and also lightens it. The outer face of the mount is provided with two dowel pins (46), a drive fit into opposite drilled holes, which are not both located in the centerline for reassembly alignment of the range scale dial (50). This outer face carries the range scale dial secured with six lockscrews (43). These lockscrews are inserted into equally spaced countersunk clearance holes in the range scale dial and screwed into tapped holes in the range scale mount flange.

s. Height scale mount. The two height scale mounts (51) are made of phosphor bronze and are used for the front and rear scale housing mechanisms. The periphery of the mount is a solid shoulder of nominal thickness and serves to carry the height scale dial (52). It is provided with two small shoulders, the smaller a push fit in the ball bearing (32) with the larger shoulder seat resting against the face of the ball bearing retain pointer assemblies. These mounts are stationary in the scale housings (9).

t. Length of target scale dials, index line plates, range and height scale dials. 1. Length of target scale dials. The two lengths of target scale dials (48) are made of 1/16-inch bakelite and are cylindrical. These dials are provided for the front and rear scale housing mechanisms. The inner and outer surfaces conform with their mounts, to which they are secured with six lockscrews (43) each. These lockscrews are inserted into equally spaced countersunk clearance holes and screwed into tapped holes in the length of target scale mounts (47).

Two clearance holes directly opposite are provided for each set of length of target scale knobs (17) which extend into tapped holes in the mount. It is graduated as before mentioned.

2. Index line plates. The two index line plates (15) are made of brass and are 5/8 inch in length. They are used for the front and rear scale housings (9). The width is proportional to the scale housing outer face, with the inner and outer radius conforming to the contour of its inner circumference and periphery. The inner radius is chamfered at 45 degrees and is provided with an index line 0.025 inch deep. The plates are secured with two lockscrews (38) to the

scale housing outer faces with the index line located in the centerline opposite the conical wall clearance hole.

dials (52), while the upper is used for the course angle graduation of the length of target scale dials (48).

3. Range scale dials. The two range scale dials (50) are made of 1/16-inch bakelite and are cylindrical. These dials are provided for the front and rear scale housing mechanism. The inner and outer surfaces conform to their mounts, to which they are secured with six lockscrews (43) each. These lockscrews are inserted into equally spaced countersunk clearance holes in the scale dials and screwed into tapped holes in each range scale mount (49).

Two opposite clearance holes in each dial not directly in the centerline fit over inserted dowel pins (46) in each mount for proper reassembly. Both dials are graduated as before mentioned.

4. Height scale dials. The two height scale dials (52) are made of 1/16-inch bakelite and are cylindrical. These dials are provided for the front and rear scale housing mechanisms. The periphery of the dials conforms to the periphery of their mounts. The dials have opposite clearance holes not directly in the centerline to fit over the inserted dowel pins (46) of their mounts. Each is secured to its respective height scale mount face (51) with four lockscrews (43). These lockscrews are inserted into countersunk clearance holes in each dial and screwed into tapped-holes in each mount.

The clearance hole in each dial center axis receives the lower pointer collar (76) of the pointer assemblies. The dials are graduated as before mentioned.

u. Factors governing the graduations. The factors governing the graduation of the height, range,

1. Lower pointers. The two lower pointers (78) are made of 1/16-inch clear lucite and are 2 3/32 inches in length. They are provided with clearance holes in their axis point to rotate over the lower pointer collars (76). The long and short sections on each side of their axis taper to 1/4-inch width, with rounded corners.

The long section lower face of each is provided with an engraved groove of shallow depth in the centerline which projects inward 1/2 inch and is filled with red lacquer. The short section of each is provided with a clearance hole near the end, countersunk from the lower face to accommodate a lockscrew (71). These lockscrews are inserted in countersunk clearance holes in each to attach to a lower pointer knob (79) to their upper face. The lower pointers are assembled to the height scale dials over the lower pointer collars (76), each on a felt friction washer (81).

2. Upper pointers. The two upper pointers (73) are made of 1/16-inch clear lucite and are 1.530 inches in length. The wider parts are 1 5/32 inch, with a clearance hole located in the center of a 5/16-inch radius. They are provided with three equally spaced countersunk clearance holes in each lower face for lockscrews (72). These lockscrews are inserted into tapped holes in the upper pointer knobs (74) and secured to each upper face of the pointers.

The upper pointers taper from their wider part to a 1/4-inch width, with rounded corners. These wider parts have an engraved groove of shallow depth in their centerline located in the lower faces, which projects inward 1/2 inch and is filled with red lacquer.

and length of target scale dials are: 1) focal length of the whole optical system (that is, the magnification or power), 2) angular displacement of the lower (split) objective lens, and 3) equivalent focal length of the upper eyepiece lens.

v. Pointer assemblies. The two pointer assemblies are provided for the front and rear scales. They consist of two pointers each located on the center of the height scale dials. The lower pointer is used for the height scale

The periphery of the upper pointer knob is knurled to offer a firm grip. It has countersunk clearance holes in the axis to receive spring washers (77) and the pointer shoulder screws (75).

3. Pointer shoulder screws. The two pointer shoulder screws (75) are made of brass and are 0.700 inch in length. The large diameter forms the heads, with screw driver slots of appropriate depth. The medium shoulders fit into the clearance

holes in the upper pointer knobs (74) with assembled spring washers (77) below the heads. The medium shoulders are provided with 0.030-inch depth tangs to fit into the broached tang clearance holes of the 1/32-inch brass friction washers (80). The brass friction washers (80) remain stationary between the upper pointers (73) and the lower pointers (78), thus separating the pointers, and providing sufficient friction to maintain the setting of the pointers. These shoulder screws extend into the tapped holes in the height scale dials' center axis to retain the complete pointer assemblies.

w. Housing cover plate. The housing cover plate (69) is made of 1/16-inch brass plate. Its outer surface conforms to cover the stadimeter housing center section. Each of the four corners has a clearance hole that coincides with the clearance holes for the stadimeter housing bolts (30). Two clearance holes diagonally opposite are provided for the inserted dowel pins (22)

referred to by the stamped numerals on the stadimeter housing.

3. Clean out all grease and wash out the transmission center section with a grease solvent.

4. Remove the four lockscrews (33) and remove the star wheel lock plunger housing (64). This allows the star wheel lock plunger (62), star wheel key (60), its holder (61), and the plunger spring (63) to be removed.

5. Remove the four lockscrews (57) and the ball bearing retainer (70).

6. Remove the transmission shaft pinion (65), carrying with it vertically the transmission shaft pinion thrust collar (66), its taper pin (58), ball bearing (20), female tang coupling (68), and its taper pin (58). It may be necessary to tap the female tang coupling lightly with a rawhide mallet around the periphery to loosen this assembly.

7. Remove the taper pin (58) and the female tang coupling (68) from

projecting upward from the front and rear side walls.

A clearance hole of appropriate size is provided at a proper location for the star wheel lock plunger (62) projecting above the face of the center section. A large clearance hole of 1 11/32 inches in diameter is provided to fit over the periphery of the ball bearing retainer (70).

The cover plate is secured to the center section face with six lockscrews (34). These lockscrews are inserted into countersunk clearance holes, properly located in all four sides and screwed into tapped holes in the four side walls of the center section. The cover plate covers the transmission center section of the stadimeter housing (67) after it is filled with mineral grease grade II medium.

4J9. Disassembly of the stadimeter housing assembly. The stadimeter housing assembly is disassembled in the following manner:

1. Remove the two alemite fittings (82) from the front ands rear scale housing section of the stadimeter housing (67).

2. Remove the six lockscrews (34), unscrewing them from the tapped holes in the four walls of the center section. Remove the housing cover plate (69). Check the stadimeter dials; they should be located at the observing position

the integral stub shaft section of the transmission shaft pinion (65).

8. Remove the ball bearing (20) from the integral stub shaft section of the transmission shaft pinion (65).

9. Remove the taper pin (58) from the transmission shaft pinion thrust collar (66), removing the thrust collar from the long integral shaft section of the transmission shaft pinion (65). Pay particular attention to reference marks on all gears, as these gears are lapped to make synchronization of both dial units possible.

10. Remove the taper pin (44) from the star wheel hub section (59) and remove the lockscrew (36) from the hub section of the transmission shaft bevel tear (5). The woodruff key (31) remains in the stub section of the handwheel shaft (23).

11. Remove the taper pin (44) from the hub section of the handwheel shaft bevel gear. (3), freeing the handwheel shaft (23) for removal.

12. Remove the handwheel shaft (23) by grasping the handwheel (12) and pulling it outward slowly. This allows the transmission shaft bevel gear (5), handwheel shaft bevel gear (3), and star wheel (59) to be removed.

13. Remove the lockscrew (35) from the hub section of the handwheel (12), removing the handwheel from the outer part of the handwheel

the tapped holes in the length of target scale mount (47).

23. Remove the four lockscrews (43) from the height scale dial (52), six

shaft (23). The handwheel key (1) can remain in the shaft.

14. Remove the two spring handle hinge screws (13) from the countersunk tapped holes in the scalloped periphery of the handwheel (12). The spring handle assembly slides out easily.

15. To disassemble the spring handle assembly, remove the plunger nut (27). Unscrew this nut from the spring handle plunger (26) by compressing the plunger spring (29). The plunger nut can then be removed easily by hand.

16. Remove the spring handle (25) from the spring handle stud (24).

17. Using a special wrench, remove the spring retainer nut (28) from the internal threaded section in the spring handle stud (24).

18. Remove the plunger spring (29) and the spring handle plunger (26) from the internal body section of the spring handle stud (24).

19. Remove the four lockscrews (37) from the handwheel bracket (6), unscrewing them from tapped holes in the center section right side wall. Remove the handwheel bracket.

20. Remove the pointer assembly from the front scale housing mechanism as follows: Remove the pointer shoulder screw (75), unscrewing it from the tapped hole axis in the height scale mount (51). This removes the pointer assembly of the following: pointer shoulder screw (75), spring washer (77), upper pointer knob (74), its lockscrews (72), upper pointer (73), brass friction washer (80), lower pointer knob (79), its lockscrews (71), lower pointer (78), lower pointer collar from the range scale dial (50), and six from the length of target scale dial (48). A total of 16 lockscrews (43) is removed.

24. Remove the height scale dial (52), range scale dial (50), and length of target scale dial (48).

25. Remove the four lockscrews (39) from the height scale mount (51). These lockscrews are unscrewed from the tapped holes in the scale housing base (9). Precaution must be taken to observe reference marks on all these parts upon disassembly in order to reassemble them correctly later.

26. Insert the pointer shoulder screw (75) in the tapped hole axis of the height scale mount (51) tapping the outer wall of the scale housing section with a light rawhide mallet and using an outward thrust on the above screw head and body to remove the height scale mount.

27. Remove the range scale mount (49), carrying with it the range scale actuating bevel gear (11) and the mounted ball bearing (32). The mount is removed by pulling it out of the scale housing (9).

28. Remove the four lockscrews (40) from the small counterbored face of the range scale mount (49). These lockscrews are unscrewed from tapped holes in the range scale actuating bevel gear (11). The ball bearing (32) should not be removed from the counterbore of the above bevel gear (11) unless corroded, in which case it should be pressed out and renewed.

29. Remove the eight lockscrews (42) from the outer face of the scale housing (9). These lockscrews are unscrewed from the tapped holes in

(76), and the felt friction washer (81).

21. The removal of the pointer assembly of the rear scale housing mechanism is followed in similar manner to that described for the front scale housing mechanism. Refer to Step 20.

22. Remove the front scale housing mechanism as follows: Remove the two length of target scale knobs (17), unscrewing them from the large counterbored face of the scale housing section.

30. To remove the scale housing (9) it is necessary to place four fingers of each hand below the length of target scale mount (47) and tap the outer wall of the scale housing section lightly with a small rawhide mallet. An alternate method is to insert an 8-36 jacking

screw in the tapped hole axis in the scale housing, and slowly jack the scale housing out; it may also be necessary to use a rawhide mallet to break the paint seal. The jacking screw rests against the lower inner wall of the scale housing section.

31. When the scale housing (9) is loosened from the large counterbore, tip it at an angle, and follow the first method for its removal.

32. Remove the four retaining screws (7) from the small periphery shoulder of the scale housing (9). These retaining screws are unscrewed from countersunk tapped holes in the scale housing and their protrusion in the undercut groove in the periphery of the length of target scale mount (47). Remove the length of target scale mount from the scale housing (9).

33. Remove the two lockscrews (38) from the index line plate (15). These lockscrews are unscrewed from the tapped holes in the scale housing outer face (9).

39. Remove the key (56) from the inner part of the short transmission shaft (53).

40. Remove the short transmission shaft (53) carrying it out of the mounted ball bearing (14) in the scale ball bearing housing (8). It is further carried out of the ball bearing (14) mounted in the rear scale housing section, carrying with it the range scale actuating bevel gear pinion (10).

41. Remove the taper pin (45) from the rear range scale actuating bevel gear pinion (10) and the outer end of the short transmission shaft (53) and remove the gear pinion (10) from the shaft.

42. Remove the two lockscrews (41) from each of the two transmission ball bearing housings (21). Remove the assembled ball bearings (20) with their housings.

43. Remove the two lockscrews (41) from each of the two scale ball bearing housings (8). Remove the assembled ball bearings (14) with their housings.

34. The removal of the rear scale housing mechanism is followed in similar manner to that described in Steps 22 to 34 inclusive for the front scale housing mechanism.

35. Remove the taper pin (44) from the transmission gear pinion (2) and the inner part of the long transmission shaft (4), and remove the transmission gear pinion (2).

36. Remove the long transmission shaft (4), carrying it out of the mounted ball bearing (14) located in the scale ball bearing housing (8), carrying with it the range scale actuating bevel gear pinion (10). It is further carried out of the ball bearing (14) mounted in the front scale housing section.

37. Remove the taper pin (45) from the front range scale actuating bevel gear pinion (10) and the outer part of the long transmission shaft (4), and remove the gear pinion (10) from the shaft.

38. Remove the lockscrew (55) by the insertion of a long screw driver blade protruding through the ball bearings (14) mentioned in Step 37. The lockscrew is unscrewed from the tapped axis hole in the inner part of the short transmission shaft (53). Remove the transmission gear pinion (54).

44. Remove the two ball bearings (14) from the front and rear scale housing section walls, and remove the one ball bearing (20) from the right side wall of the center section. Remove the ball bearing (20) from the raised semi-circular section in the center section base. This ball bearing is removed by inserting a special pair of calipers in the center clearance hole of the center race, allowing the calipers to get below the center race, and tapping on the stadimeter housing with a small rawhide mallet while an upward thrust is maintained with the calipers.

45. The length of target scale clamp screws (16) are not removed from the retaining collars (18) mounted in the right side of each scale housing (9), as this removal would necessitate drilling out the retaining collar rivets (19).

46. Clean all parts thoroughly with a grease solvent.

4J10. Reassembly of the stadimeter housing assembly. The stadimeter housing assembly is reassembled as follows:

1. Apply Lubriplate No. 110 lightly to all rotating parts as the reassembly procedure is followed.

2. Various parts have reference numerals with mating numerals stamped in or on the various parts to establish coincidence of these parts for correct reassembly.

3. Place the two ball bearings (14) in the front and rear scale housing

10. Place the transmission gear pinion (54) on the short transmission shaft (53) over the inserted key (56). Secure it with a lockscrew (55), screwing it tight by the use of a long screw driver blade inserted from the front scale housing section, and protruding

section walls of the stadimeter housing (67).

4. Place one ball bearing (20) in the right side wall of the center section, and one in the raised semi-circular section in the center section base. Tap this bearing all the way in until it touches the bottom.

5. Place the two transmission ball bearing housings (21) with the mounted ball bearings (20) at their respective places on the upper face of the raised G-wall section in the center section. The dowel pins of each housing base fit into aligning holes. Secure these two housings with two lockscrews (41) each. These lockscrews are inserted into two countersunk clearance holes in each housing and screwed into tapped holes in the raised G-wall section.

6. Place the two scale ball bearing housings (8) with the mounted ball bearings (14) in their respective places on the upper face of the raised G-wall section in the center section. These two housings are located perpendicular to the two assembled transmission ball bearing housings (21). The dowel pins of each housing base fit into aligning holes. Secure these two housings with two lockscrews (41) each. These lockscrews are inserted into two countersunk clearance holes in each housing and screwed into tapped holes in the raised G-wall section.

7. Place the rearrange scale actuating bevel gear pinion (10) on the outer end of the short transmission shaft (53) and secure it by the insertion of a taper pin (45). The insertion of the taper pin should be done with the gear pinion hub held on a soft metal V-block.

through the two mounted ball bearings (14).

11. Place the front range scale actuating bevel gear pinion (10) on the outer end of the long transmission shaft (4) and secure it by the insertion of a taper pin (45). The insertion of the taper pin should be done with the gear pinion hub held on a soft metal V-block.

12. Insert the long transmission shaft (4) from the front scale housing section side into the first mounted ball bearing (14) carrying it farther through the second mounted ball bearing (14) of the scale ball bearing housing (8). The shaft is a push fit into both ball bearings.

13. Place, the transmission gear pinion (2) on the long transmission shaft inner part (4) and secure it with a taper pin (44).

14. Place the handwheel bracket (6) on the alignment recess of the right side wall of the stadimeter housing center section. Secure the bracket with four lockscrews (37) which are inserted into countersunk clearance holes in the bracket and screwed into tapped holes in the center section right side wall.

15. Insert the handwheel key (1) in the outer part of the handwheel shaft (23), and assemble the handwheel (12) over the inserted key and this part of the handwheel shaft. Secure the handwheel (12) with a lockscrew (35). This lockscrew screws into the tapped hole in the handwheel hub section and extends into the spotted recess in the handwheel shaft.

16. Place the handwheel shaft (23) through the first mounted ball

8. Insert the short transmission shaft (53) from the rear scale housing section side into the first mounted ball bearing (14), carrying it farther through the second mounted ball bearing (14) in the scale ball bearing housing (8). The shaft is a push fit into both ball bearings.

9. Insert the key (56) in the keyway in the short transmission shaft inner part (53).

bearing (20) in the transmission center section. The shaft is a push fit in this ball bearing.

17. Place the star wheel (59) with its hub section toward the handwheel (12) on the handwheel shaft (23).

18. Push the handwheel shaft (23) through the second mounted ball bearing (20) of the transmission ball bearing housing (21). The shaft is a push fit in this ball bearing.

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19. Place the handwheel shaft bevel gear (3) on the handwheel shaft (23) with its hub section facing toward the handwheel (12).

20. Push the handwheel shaft (23) through the third mounted ball bearing (20) in the transmission ball bearing housing (21). The shaft is a push fit in this ball bearing.

21. Place the transmission shaft bevel gear (5) on the stub section of the handwheel shaft (23) over the inserted woodruff key (31) with its hub section facing toward the handwheel (12). Secure the bevel gear (5) by the insertion of the lockscrew (36), which is screwed into a tapped hole in the hub section and extends into the spotted recess in the handwheel shaft (23). The handwheel hub should be in contact with the hub section of the handwheel bracket (6).

22. Slide the star wheel (59) on the handwheel shaft and line up the taper pin holes. Secure the star wheel with the insertion of the taper pin (44).

23. Reassemble the front scale housing mechanism as follows:

26. Assemble the range scale mount to the range scale actuating bevel gear (11) recess seat, checking reference marks for proper coincidence of mating reference marks. Secure the mount with four lockscrews (40) which are inserted in clearance holes in the small counterbored shoulder in the mount and screwed into tapped holes in the bevel gear.

27. Rotate the front range scale actuating bevel gear pinion (10) until its reference tooth is down, so that upon the assembly of the range scale actuating bevel gear (11) the reference tooth opening of this bevel gear is upward for its engagement with the reference tooth of the gear pinion (10).

28. Place the range scale actuating bevel gear (11) and the assembled range scale mount (49) in the scale housing (9) tipping it slightly and properly meshing it with the front range scale actuating bevel gear pinion (10) as outlined in Step 27. Ascertain the central position of this assembly by checking the coincidence of the ball bearing race (32) and the small shoulder

Place the index line plate (15) on the scale housing (9) opposite the conical wall clearance hole, and secure it with two lockscrews (38). These lockscrews are inserted into countersunk clearance holes in the plate and screwed into, tapped holes in the scale housing large shoulder flange.

24. Place the length of target scale mount (47) in the counterbored seat in the scale housing (9). Secure the mount with four lockscrews (7). These lockscrews are inserted in countersunk tapped, holes in the scale housing shoulder periphery and screwed into the undercut groove in the mount periphery.

25. Place the scale housing (9) in the front scale housing section counterbored seat, tipping it sufficiently to allow the conical wall clearance hole, adequate clearance over the range scale actuating bevel gear pinion (10). The scale housing is a push fit into its counterbored seat. Secure the scale housing with eight lockscrews (42) which are inserted into countersunk clearance holes in the scale housing and screwed into tapped holes in the scale housing section counterbored seat.

counterbore of the scale housing (9).

29. The height scale mount (51) should be pushed slowly into the range scale actuating bevel gear ball bearing (32) and farther into the small shoulder counterbore in the scale housing (9). The small shoulder seat of the mount rests against the center ball bearing race and is secured with four lockscrews (39). These lockscrews are inserted into countersunk clearance holes in the mount and screwed into tapped holes in the scale housing lower wall. This retains the small shoulder seat of the mount snugly in contact with the center ball bearing race with sufficient tension to maintain it stationary.

30. Reassemble the rear scale housing mechanism by following Steps 23 to 29 inclusive.

31. Check the reference marks of the range and height scale mounts for the front and rear scale housing mechanisms and note their relation. Should both appear in unison, assemble the range and height scale dials (50 and 52) to their respective mounts of the front and rear scale housing mechanisms over the inserted dowel pins (46). Check the 2.2 numeral graduation on the range scale dial (50). It should appear approximately opposite the value 58

numeral graduation on the height scale dial (52). Values opposite the numbers 2.2 and 58 are found on Figure 2-12. Refer to both sets of dials, noting their proper relation.

inserted into clearance holes in the dials and screwed into tapped holes in the mounts.

38. Reassemble the front pointer assembly to the front scale housing mechanism as follows: Place the

Should both appear in unison, further assembly is to be continued.

32. With both sets of dials in unison, the handwheel shaft bevel gear (3) is now closely observed for reference marks. This bevel gear has two reference marks on opposite sides to engage with a reference tooth of the transmission gear pinions (2 and 54).

33. Properly engage the handwheel shaft bevel gear (3) reference marks with the reference tooth of each transmission gear pinion. Insert a temporary screw in the hub of the bevel gear which has a tapped hole for this purpose, and secure the temporary screw. Rotate the handwheel (12) and check both sets of scale housing dials through the complete series of range graduations. Should observations denote the unison of both sets of dials, observe the taper pin holes of the handwheel shaft bevel gear (3) and the handwheel shaft (23). They should be in coincidence. However, by releasing the temporary lockscrew and holding the bevel gear in mesh with the gear pinions, the handwheel shaft (23) is rotated for the insertion of the taper pin (44). The taper pin secures the bevel gear to the handwheel shaft.

34. Secure the front and rear range scale dials (50) with six lockscrews (43) each. These lockscrews are inserted into countersunk clearance holes in the dials and screwed into tapped holes in their mounts.

35. Secure the front and fear height scale dials (52) with four lockscrews (43) each. These lockscrews are inserted in countersunk clearance holes in the dials and screwed into tapped holes in their mounts.

spring washer (77) over the medium shoulder of the pointer shoulder screw (75).

39. Secure the upper pointer (73) to the upper pointer knob (74) with three lockscrews (72).

40. Place the pointer shoulder screw (75) with the spring washer (77) in the upper pointer knob (74).

41. Place the brass friction washer (80) on the pointer shoulder screw (75) aligning the flat part of the broached hole on the undercut shoulder.

42. Place the lower pointer collar (76) on the pointer shoulder screw (75).

43. Place the lower pointer knob (79) on the lower pointer (78) and secure it with a lockscrew (71). Place the lower pointer collar (76) on the pointer shoulder screw (75).

44. Place the felt friction washer (81) on the lower pointer collar (76) and the pointer shoulder screw (75).

45. Place the front pointer assembly at the axis of the height scale dial, and screw the pointer shoulder screw into the tapped axis hole in the height scale mount (51). Check the relation of the upper pointer to the lower pointer. If the brass friction washer is engaged properly on the pointer shoulder screw (75), a proper friction setting for the upper and lower pointers exists.

46. Reassembly of the rear pointer assembly to the rear scale housing mechanism is followed in similar manner to that described in Steps 38 to 45 inclusive for the front scale housing mechanism.

36. Place the length of target scale dials (48) on their respective mounts, and secure each with eight lockscrews (43). These lockscrews are inserted into countersunk clearance holes in the dials and screwed into] tapped holes in their mounts.

37. Place the sets of length of target scale knobs (17) in opposite sides of each length of target scale dials (48). These knobs are

47. Place the transmission shaft pinion thrust collar (66) on the long integral shaft section of the transmission shaft pinion (65) and secure it by the insertion of a taper pin (58).

48. Place the ball bearing (20) on the integral stub section of the transmission shaft pinion (65), allowing the ball hearing to contact the pinion.

49. Place the female tang coupling (68) over the male tang section of the integral stub section of the transmission shaft pinion (65), allowing the female tang coupling to contact the assembled ball bearing (20), and secure the coupling with the insertion of a taper pin (58).

50. With the dials of both front and rear scale housing mechanisms set to the observing position, place the transmission shaft pinion assembly vertically in the center section. It is carried through the ball bearing hole in the semi-circular lug section. The flat tang section in the female tang coupling (68) faces toward the handwheel (12), and the pinion is engaged into the transmission shaft bevel gear (5) as the long integral shaft section is pushed into the mounted ball bearing (20) in the raised semi-circular section of the center section base.

51. Assemble the ball bearing retainer (70) to the semi-circular lug section face of the center section over the female tang coupling (68) and secure with four lockscrews (57).

57. Fill the center section with soft mineral grease grade II medium.

58. Place the housing cover plate (69) on the center section, and secure it with six lockscrews (34). These lockscrews are inserted in countersunk clearance holes in the housing cover plate and screwed into tapped holes in the four center section walls.

59 Screw both alemite fittings into the lower part of the front and rear scale housing section walls, filling the housings with soft mineral grease grade II medium.

60. Reassemble the spring handle assembly as follows: Insert the spring handle plunger (26) in the spring handle stud (24).

61. Place the plunger spring (29) over the spring handle plunger (26) and into the large counterbored section in the spring handle stud (24).

62. Place the spring retainer nut (28) over the spring handle plunger (26). Using a special wrench, compress the plunger spring (29) so that the retainer nut engages in the internal

52. Check the mesh of all pinions and bevel gears for the detection of backlash or shallow depth of the teeth. A careful observation readily determines where shimming is required for a snug working depth of mating pinions and bevel gears.

53. Reassemble the automatic stop assembly into the center section as follows: Place the star wheel key (60) in the star wheel key holder (61), and secure it with the insertion of a taper pin (44).

54. Place the star wheel key (60) and its holder (61) with the star wheel lock plunger spring (63) below the handwheel shaft (23), engaging the key in the star wheel (59).

55. Place the star wheel lock plunger (62) in the star wheel lock plunges housing (64) and assemble them over the handwheel shaft (23). Carefully check the plunger housing as it is lowered to the center boss section. Secure the plunger housing with four lockscrews (33).

56. The automatic stop assembly should be locked at the observing position for its assembly to the base of the eyepiece box (11, Figure 4-29).

threaded section in the spring handle stud (24) until it is flush with the face.

63. Place the spring handle (25) over the spring handle stud (24).

64. To apply the spring handle plunger nut (27), press downward on the spring handle plunger (26), applying pressure with the spring handle (25). Screw on the spring handle plunger nut, securing it with a special wrench.

65. Place the spring handle assembly in the hinge opening in the side wall of the handwheel (12). Insert the two spring handle hinge screws (13). These hinge Screws are screwed into countersunk tapped holes in the handwheel scalloped periphery and extend into reamed holes in each side of the spring handle stud (24).

4J11. Description of the operation of the range and course angle finder. operation of the range and course angle finder is accomplished in the following manner:

The clockwise rotation of the handwheel (12, Figure 4-24) transmits motion to the handwheel shaft (23) to operate the handwheel shaft bevel gear (3). The clockwise rotation of this

handwheel shaft bevel gear (3) transmits counterclockwise rotation to the front transmission gear pinion (2) and clockwise rotation to the rear transmission gear pinion (54) in mesh with this bevel gear at right angles.

keys and integral shafts (15) to displace the mounting plate halves (5) and the attached lower (split) objective lens and mount halves (see Figure 4-22). The displacement of the lower (split) objective lens halves causes duplicate images to be produced, so that, for example, the waterline of one image may be

The counterclockwise rotation of the front transmission gear pinion (2) carries the long transmission shaft (4) in the same direction as the front range scale actuating bevel gear pinion (10) on the opposite end of this shaft.

The counterclockwise rotation of the front range scale actuating bevel gear pinion (10) in mesh with the front range scale actuating bevel gear (11) transmits motion to this bevel gear, causing it to rotate clockwise. It carries the attached range scale mount (49) and its range scale dial (50) clockwise.

The rear scale housing mechanism operates opposite to the front scale housing mechanism when the observer is located in the front of the periscope. However, relatively speaking, it operates similarly to the front scale housing mechanism, were the observer to be stationed on the rear side of the instrument.

The clockwise rotation of the handwheel shaft (23) operates the transmission shaft bevel gear (5) clockwise. This bevel gear in mesh with the transmission shaft pinion (65) and at right angles to it, operates the pinion clockwise, observing this pinion from the lower end. The clockwise rotation of the handwheel shaft (23) simultaneously operates the front and rear scale housing mechanisms and the transmission shaft pinion (65).

Clockwise rotation of the transmission shaft pinion (65) carries its attached female tang coupling (68) in the same direction. The female tang coupling (68) coupled with the stadimeter transmission shaft (22, Figure 4-27) carries it clockwise, as does also its brought into contact with the masthead or funnel top of the other image. The angle subtended is indicated in terms of yards on the range scale dial (50, Figure 4-24) and against the known height on the stationary height scale dial (52).

The grooves in the operating gear are cut so that the lateral movement of the lower (split) objective lens halves is proportional to the logarithm of the tangent of the angle through which the operating gear is rotated.

With the handwheel (12, Figure 4-24) rotating clockwise, the operating ear is rotated counterclockwise. The operating gear stop (19, Figure 4-23) moves with the operating gear (1) and leaves its contact with the observation position stop (20).

Actuation from the vertical range observing position is accomplished when the (split) lens halves function as a single lens, until the operating gear (1) travels through approximately 147 degrees of rotation and contacts the maximum displacement stop (20), thereby causing the optical axis of each half to be displaced from the periscope axis an amount equal to the movement of each half. The axis of each half remains parallel to the periscope axis, and the principal focal plane of each objective lens half remains in the same plane as before splitting.

Further clockwise rotation of the handwheel (12, Figure 4-24) causes the sliding track (3, Figure 4-23) to which the maximum displacement stop (20) is secured by the operating gear retaining ring (35), to rotate through 90 degrees inside the track sleeve (2). The maximum

interconnection with the operating gear pinion shaft (13, Figure 4-23) and its attached operating gear pinion (12).

The clockwise rotation of they operating gear pinion (12) in mesh with the operating gear (1), causes it to rotate counterclockwise. The cam grooves of the operating gear (1) in the counterclockwise rotation looking upward from the lower part of the instrument cause the cam shoes (4) attached to mounting plate guide

displacement stop (20) located on the operating gear retaining ring (35) absorbs the torque required to lift the range position detent pawl (7) against spring pressure of the detent pawl spring (6) by the movement of the detent pawl rest (8) attached to the sliding track (3).

The 90 degrees rotation of the sliding track (3, Figure 4-23) counterclockwise is accomplished by the

128 degrees circumferential slot of the track sleeve (2). This 90 degrees rotation ends when the detent pawl rest (8) comes into contact with the end of the 128 degrees slot in the track sleeve (2), and engages a locking device for the course angle position detent pawl (7).

Turning the handwheel (12, Figure 4-24) counterclockwise causes the operating gear (1) and its stop (19, Figure 4-23) to rotate clockwise and make the two lens halves approach each other. The known length of target having been set on the length of target scale dial (48, Figure 4-24) opposite the index mark on the scale housing (9), the course angle is indicated on the length of target scale dial against the previously found range on the range scale dial (50), when the bow of one image touches the stern of the other.

In clockwise rotation, the operating gear stop (19, Figure 4-23) loses contact with the maximum displacement stop (20) and is carried with the operating gear (1) until it contacts the observation

Collimation of the lower (split) objective lens and mount assembly (Figure 4-22), the objective operating mechanism assembly (Figure 4-23), and the stadimeter housing assembly (Figure 4-24) is described under Section 4V9.

4J12. Steps necessary to obtain range and course angle of a vessel. The range and course angle of a vessel may be found in the following manner:

1. The estimated length and height of the target must be known.

2. Set the length of target on the length of target scale dial (48, Figure 4-24) against the stationary index line mark. Clamp the outer scale by means of the locking clamp screw (16).

3. Set the estimated height of the target with a pointer.

4. Starting with the split objective lens as a whole lens in the observing position, first bring the target approximately into the center of the field of view. Rotate the handwheel

position stop (20) in which position the split lens functions again as a single lens. This return movement is approximately 147 degrees traversed previously in the counterclockwise rotation to obtain maximum displacement but giving the course angle single image position.

Further counterclockwise rotation of the handwheel (12, Figure, 4-24) causes the sliding track (3, Figure 4-23) to which the observation position stop (20) is secured to the operating gear retaining ring (35), to rotate through 90 degrees inside the track sleeve (2). The observation position stop (20) located on the operating gear retaining ring, (35) absorbs the torque required to lift the course angle position detent pawl (7) against the tension of the detent pawl spring (6) by the movement of the detent, pawl rest (8) attached to the sliding track (3).

The 90 degrees return clockwise rotation of the sliding track (3) is accomplished by the 128 degrees circumferential slot in the track sleeve (2) This 90 degrees rotation ends when the detent pawl rest (8) comes into contact with the end of the 128 degrees slot in the track sleeve (2), and engages a locking device for the range position detent pawl (7). Thus the observations are resumed as desired from the range position again.

(12) clockwise until the masthead of the object or target in one image coincides with the waterline in the other image.

5. Resume turning the handwheel (12) clockwise to the limit of its travel. At this point, the lower (split) objective lens is carried through a 90 degrees rotation.

6. Upon reaching the end of this 90 degrees rotation, the handwheel (12) is reversed or turned counterclockwise, stopping when the bow of the target of one image coincides with the stern of the other image.

7. Read the course angle on the inner scale of the length of target scale dial (48) against the range in yards on the range scale dial (50).

8. Continue counterclockwise rotation until the lens halves again function as a single lens at the observing position.

4J13. Operation of the stadimeter. The following problem illustrates the use of the stadimeter. Figure 4-25 shows the stadimeter setting for a target vessel whose height from waterline to masthead is known to be 60 feet, and whose length from bow to stern is known to be 375 feet. Find the range and course angle of the target.

First set the length of the target on the length of target scale dial against the index mark, and clamp the length of target scale dial and mount by the locking clamp screw. Then, starting with the stadimeter at

the observing position, bring the target approximately into the center of the field of view. Rotate the handwheel clockwise until the masthead of the target in one image coincides with its waterline in the other image. At this point, the scale dials are shown in Figure 4-25, and the range (2300 yards) is read on the range scale dial, opposite the height (60 feet) on the height scale dial.

Turn the handwheel clockwise to the limit of its travel; then reverse the direction, stopping when the bow of the target in one image coincides with the stern in the other image. The position of the scale dials at this stage is shown in Figure 4-26. The course angle (20 degrees) is read on the inner scale on the length of target scale dial, against the range (2300 yards) on the range scale dial. The angle thus found is measured from the line of sight of the periscope. Note that the course angle is measured without regard to the direction of movement of the target, and may be either the angle observed, or its supplement, in this case 160 degrees.

Figure 4-25. Operation of stadimeter for obtaining the range of an individual problem.

Figure 4-26. Operation of stadimeter for obtaining the course angle of previous problem.

By continuing the counterclockwise rotation of the handwheel to the limit of its travel, restore the periscope to the observing position, ready for the next observation.

The following hints may be of value:

1. Remember that the stadimeter measures only angles, and computes the range on the basis of the known height (and length in the case of course-angle measurements). If the height must be assumed, the range reading can be no more accurate than the estimate of the height. If both height and length are assumed, the course-angle reading thus obtained is subject to a large error.

2. The dimensions selected for these observations should be those which are known, or which can be estimated, with fair accuracy. In addition, the reference points, in so far as possible, should be definite, easy to see, and widely spaced. The masthead and waterline, for example, while affording the greatest vertical dimension, might both be invisible at long range.

3. The stadimeter is graduated up to 11,000 yards. Longer ranges may be obtained by remembering that the angle subtended by 80 feet, for

example, at 20,000 yards, is the same as that subtended by 40 feet at 10,000 yards. Thus an object 80 feet high may be set up at the 40-foot line and the range multiplied by two.

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4. The stadimeter scale dials are graduated for use with the periscope in high power. When necessary to range on an object more than 130 feet high, the stadimeter may be used with the periscope in low power, and the object set up on the height scale dial at one-fourth its actual height. The range reading is then correct.

5. Difficulty may at first be encountered in centering the eye in order to see the duplicate images with equal intensity. To a great extent, practice overcomes this difficulty. On bright days the use of one of the rayfilters permits the pupil of the eye to expand and intercept a greater portion of the divided exit pupil.

6. A stadimeter range may be taken with a periscope exposure of a few seconds. It is assumed that the approximate bearing of the target is known, and that the reference points have been selected. The known or estimated height between the reference points should be set in advance on the height scale dial. Use the pointer if one is provided, or a crayon mark. The periscope may be trained approximately on the target, the power shift placed in high power, and the focus set for the observer's eye. In addition, the estimated range may be set up on the stadimeter. All this may be done with the periscope partially housed. If the periscope is then exposed, no time is lost in focusing, and little in centering the object and bringing the reference points into coincidence. When this is done the instrument may again be partially housed and the range reading taken. Practice is essential to the efficient operation of the stadimeter.

Chapter 4 Continued

K. FIRST INNER TUBE SECTION ASSEMBLY

4K1. Description of the first inner tube section assembly. The first inner tube section assembly is part of the lower telescope system. It provides the necessary parts and distance between the objective operating mechanism assembly (Figure 4-23) and the eyepiece skeleton assembly (Figure 4-28). This distance is necessary for the focal length of the lower (split) objective lens with the eyepiece prism and the eyepiece lens. Figure 4-27 shows the first inner tube section assembly. All bubble numbers for Sections 4K1, 2, and 3 refer to Figure 4-27 unless otherwise specified.

Ill. No.	Drawing Number	Num-ber Re-quired	Nomenclature
1	P-1205-7	1	First inner tube section
2	P-1158-4	2	Spider (two halves)
3	P-1158-11	1	Spider bearing
4	P-1163-7	2	Stadimeter transmission shaft thrust collars
5	P-1179-24	8	First inner tube section lower end lockscrews
6	P-1179-	4	First inner

Ill. No.	Drawing Number	Num-ber Re-quired	Nomenclature
12	P-1207-7	1	Diaphragm
13	P-1361-1	4	Tape guides 14 P-1361-2 4 Tape guide straps
15	P-1362-1	1	Air line coupling (round) (long)
16	P-1362-2	1	Short bend round air line
17	P-1362-3	1	Short round air line coupling
18	P-1362-4	1	Air line (flat and round)
19	P-1362-10	1	Air line strap
20	P-1362-11	1	Air line strap (soldered)
21	P-1362-13	1	Air line strap
22	P-1409-7	1	Stadimeter transmission shaft
23	P-1410-7	4	Stadimeter transmission shaft bracket
24	P-1422-1	4	Air line strap lockscrews

	24		tube section upper end coupling lockscrews
7	P-1179-63	4	Spider flange lockscrews
8	P-1179-65	3	Diaphragm lockscrews
9	P-1179-179	1	Spider taper pin
10	P-1179-196	2	Stadimeter transmission shaft thrust collar taper pins
11	P-1205-6	1	First inner tube section upper end coupling

a. First inner tube section. The first inner tube section (1) is made of brass tubing and is approximately 57.125 inches in length. The inner and outer diameters are uniform throughout the entire length.

The inner circumference of this inner tube section upper part is provided with a threaded section, which screws on the threaded periphery of the lower part of the first inner tube section upper end coupling (11), while the turned alignment support section of this part of the coupling is a sliding fit in the inner circumference

of the inner tube. It is secured with four lockscrews (6) which are inserted in countersunk clearance holes in the inner tube section upper part and screwed into tapped holes in the lower alignment support section of the first inner tube section upper end coupling (11).

The internal surface of the inner tube section supports a diaphragm (12) which is located in the center part and secured with three lockscrews (8).

The lower part of this inner tube section is a push fit on the- upper alignment support section of the spider bearing (3) and is secured with eight lockscrews (5). These lockscrews are inserted into countersunk clearance holes in this inner tube section lower part and screwed

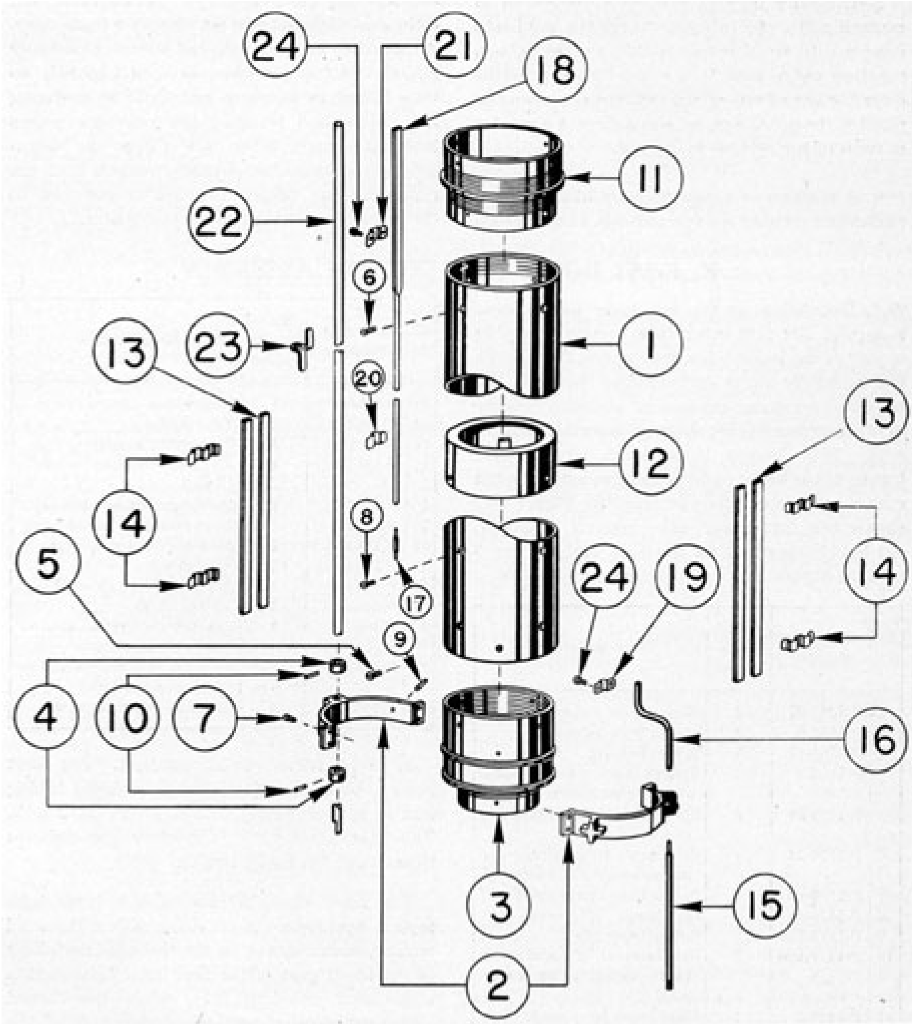

Figure 4-27. First inner tube section assembly.

into tapped holes in the spider bearing upper alignment support section (3).

b. First inner tube section upper end coupling. The first inner tube section upper end coupling (11) is made of cast phosphor bronze and is 3.187 inches in length. It is a step design, stepped downward from the upper part. It forms a joint between the track sleeve (2, Figure 4-23) of the objective operating mechanism assembly and the upper part of the first inner tube section (1).

In the upper part it is provided with a threaded periphery and an alignment support section, to receive the internal threaded section and smooth counterbore in the required. Three equally spaced brass strips are soldered on the inner wall of the diaphragm. It is a push fit in the first inner tube section and is secured with three lockscrews (8). These lockscrews are inserted into countersunk clearance holes in the first inner tube section and screwed into tapped holes in the soldered strips located in the diaphragm.

d. Air line sections. The air line section (29, Figure 4-21) extends downward from the second inner tube section (22) with a soldered air line coupling (28) on its lower end. It is secured to the upper part of the inner tube section with an air line strap (21) retained with two lockscrews (24).

track sleeve (2, Figure 4-23) and is secured with four lockscrews (23). These lockscrews are inserted into countersunk clearance holes in the track sleeve shoulder (2) and screwed into tapped holes in the first inner tube section upper end coupling alignment support section (11)

The center part is provided with a narrow shoulder 3/16 inch wide, and its diameter coincides with the diameter of the track sleeve shoulder (2, Figure 4-23).

The inner diameter is bored for light transmission and has anti-reflection threads. The upper part is counterbored a distance of 1 1/2 inches to lighten the coupling.

In the lower part it has a threaded periphery and straight turned section which serves as an alignment support section for the upper part of the first inner tube section (1). The threaded periphery screws into the internal, threaded section in the first inner tube section (1) and is secured with four lockscrews (6). These lockscrews are inserted in countersunk clearance holes in the upper part of the first inner tube section, and screwed into tapped holes in this coupling lower alignment support section.

c. Diaphragm. The diaphragm (12) is made of 1/32-inch spun brass of light weight and is 2 inches long. It is located in the central Part of the first inner tube section (1). The side wall of the diaphragm has an opening of ample size to permit the necessary light transmission. The diaphragm restricts the light rays from striking the inner wall of this inner tube section and confines it to the necessary clear aperture

The air line section (18) attaches to the air line coupling (28) of the air line section (29, Figure 4-21) in the upper part of the first inner tube section and extends downward through a soldered air line strap (20) soldered to the first inner tube section wall. The lower part of the air line section (18) has a soldered air line coupling (17) which couples with a bent air line (16). The bent air line (16) attaches to the soldered air line coupling (17) of the air line section (18). The bent air line (16) is secured to the lower part of the first inner tube section wall with a removable air line strap (19) secured with two lockscrews (24).

The bent air line (16) is bent in an S-shape and extends outward from the first inner tube section (1) to the air line hole in the spider (2), where it attaches to the long air line coupling (15)

e. Spider bearing. The spider bearing (3) is made of cast phosphor-bronze material and is 4.500 inches in lengths The upper part is smooth tuned a short distance to serve as an alignment support section, and push fit into the lower part of the first inner tube section (1) and is secured with eight lockscrews (5). These lockscrews are inserted in countersunk clearance holes in the first inner tube section lower part, and screwed into tapped holes in the spider bearing upper alignment support section.

Two narrow shoulders are provided, between which the spider halves (2) are attached and secured with four lockscrews (7) and an inserted taper pin (9).

The lower part of the spider bearing is stepped to a small shoulder. This small shoulder is provided with a threaded periphery and a straight turned section serving as an alignment support section. The alignment support section is a sliding fit in the counterbored and threaded counterbored section in the upper part of the eyepiece skeleton (42, Figure 4-28) and is secured with four lockscrews (37). These lockscrews are inserted into countersunk clearance holes in the eyepiece skeleton (42), and screwed into tapped holes in the spider bearing lower alignment support section.

The inner surface of the spider bearing is bored for light transmission and is provided with anti-reflection threads. The upper part is counterbored a distance of 3 1/16 inches, leaving a sufficient wall in the lower part of this counterbore.

f. Spider. The spider (2) is made in two halves of cast phosphor bronze and is 1 inch in width. It has three cast projections on the periphery set with their centerline 120 degrees apart in an extended Y-design. The periphery of these projections serves as a guide bearing in the lower counterbore of the outer tube (2, Figure 4-15). One projection is solid with a reamed hole serving as a bearing for the stadimeter transmission shaft (22, Figure 4-27). The other two projections are shaped like a plus sign with shoulders of nominal thickness extending outward from the wall periphery. An air line clearance hole is provided in the wall of one of thrust collars (4) are made of brass and are cylindrical. They are of nominal thickness and are provided with a reamed hole in their center axis. These thrust collars are a sliding fit on the stadimeter transmission shaft (22), extending through the bearing hole projection in the spider (2), and are located on each side of the spider bearing hole projection. They are secured with two taper pins (10). These thrust collars retain the stadimeter transmission shaft (22) from axial displacement.

h. Tape guides. The four tape guides (13). are made of flat brass tubing and are 12 1/2 inches in length. These four tape guides are divided in two sets for assembly to the lower part of the first inner tube section on opposite sides and are secured with tape guide straps (14). Each set of tape guides (13) is secured with two tape guide straps (14) separated proportionally and soldered to the tape guides and the wall periphery of the first inner tube section (1). Each set of tape guides serves to guide the prism tilt and change of power shifting wire tapes (38, Figure 4-28) in their vertical position.

i. Stadimeter transmission shaft bracket. The stadimeter transmission shaft bracket (23) is made of 1/16-inch brass and has a developed length of 0.228 inch. The projecting part of the bracket is provided with a clearance hole for the stadimeter transmission shaft (22). It is soldered to the wall periphery of the first inner tube section located in the center part. This bracket serves to remove any whip of the long stadimeter transmission shaft (22).

these projections at assembly for the long air line coupling (15).

The wall periphery of each half is provided with projecting flanges of 1/16-inch thickness and are stepped. The set of flanges of one half is provided with two clearance holes each, while the set of flanges of the opposite half is provided with two tapped holes each for four lockscrews (7). The spider halves are assembled, and bored a snug fit for their assembly on the undercut section of the spider bearing between the two narrow shoulders. A taper pain (9), inserted in the wall periphery of the spider and the spider bearing, properly maintains its correct alignment.

g. Stadimeter transmission shaft thrust collars. The two stadimeter transmission shaft

j. Stadimeter transmission shaft. The stadimeter transmission shaft (22) is made of corrosion-resisting steel and is 75.125 inches in length. The tipper part of this shaft fits into the large readied hole in the stadimeter transmission shaft coupling lower part (14, Figure 4-23) of the objective operating mechanism assembly and is secured during final collimation with a taper pin (33).

The lower part of this shaft has a milled off section forming a male tang section. This section is a sliding fit into the upper part of the female tang coupling (68, Figure 4-24) attached to the integral transmission shaft pinion stub section (65) located in the stadimeter housing assembly.

The shaft extends downward from the stadimeter transmission shaft coupling (14, Figure 4-23) of the objective operating mechanism assembly through the soldered bracket (23), the upper thrust collar (10), spider (2), lower thrust collar (10), and the clearance hole in the eyepiece skeleton flange (42, Figure 4-28). The shaft extends downward the entire length of the eyepiece skeleton (42) and into the reamed hole and stuffing box section in the eyepiece box (11, Figure 4-29).

4K2. Disassembly of the first inner tube section assembly. The first inner tube section assembly is disassembled in the following manner:

1. All air line sections, air line straps, thrust collars, and the stadimeter

4K3. Reassembly of the first inner tube section assembly. The first inner tube section assembly is reassembled in the following manner:

1. Check all reference marks for the reassembly of any part to prevent incorrect assembly.

2. Using an air hose, blow out the internal surfaces of the first inner tube section. If a circular brush is available, it should be used first. This procedure should be carried out also with the couplings.

3. Place the diaphragm (12) in the central part of the first inner tube section from the lower part. The diaphragm side wall faces up ward toward the first inner tube section upper end coupling (11). Tap the

transmission shaft (22) pertaining to this assembly were removed previously for the separation of the various telescope systems and their individual assemblies.

2. Remove the four lockscrews (6) from the upper part of the first inner tube section (1). These lockscrews are unscrewed from tapped holes in the lower alignment support section of the first inner tube section upper end coupling (11).

3. Unscrew the lower part of the first inner tube section upper end coupling (11) from the upper part of the first inner tube section (1).

4. Remove the eight lockscrews (9) from the lower part of the first inner tube section (1) These lockscrews are unscrewed from tapped holes in the upper alignment support section of the spider bearing (3).

5. Tap the spider bearing (3) from the lower part of the first inner tube section (1).

6. Remove the four lockscrews (7), unscrewing two from opposite side flanges of the spider halves (2). Remove the taper pin (9) from the spider half, and remove both spider halves from the spider bearing (3).

7. Remove the three lockscrews (8) from the central part of the first inner tube section (1). These lockscrews are unscrewed from tapped holes in each soldered strip in the inner wall of the diaphragm.

8. Tap the diaphragm (12) out through the lower part of the first inner tube section (1).

diaphragm in until the tapped holes in the inner tube section and the diaphragm coincide.

4. Insert and secure the three lockscrews (8) in the tapped holes in the diaphragm soldered inner wall strips.

5. Screw the first inner tube section upper end coupling (11) lower threaded periphery section into the upper part of the first inner tube section (1).

6. Insert and secure the four lockscrews (6) into countersunk clearance holes in the upper part of the first inner tube section (1) and tapped holes in the first inner tube section upper end coupling lower alignment support section (11).

7. Place the upper alignment support section of the spider bearing (3) in the lower part of the first inner tube section (1). Using a rawhide mallet and a block of wood, tap the spider bearing in until its narrow shoulder comes in contact with the lower end of the first inner tube section.

8. Insert and secure the eight lockscrews (5) into countersunk clearance holes in the first inner tube section and screw them into tapped holes in the upper alignment support section of the spider bearing (3).

9. Place both halves of the spider (2) on the spider bearing (3) between its two narrow shoulders.

10. Insert and secure each spider flange half (2) with two lockscrews (7) inserting them into clearance holes in one flange half and screwing

them into tapped holes in the other flange half of both sets of opposite flanges.

11. Insert the taper pin (9) in the spider half (2) and the spider bearing (3).

12. The air line sections, air line straps, thrust collars, and the stadimeter transmission shaft (22) are assembled later, upon the connection of individual assemblies of this lower telescope system.

L. EYEPIECE SKELETON ASSEMBLY

4L1. Description of the eyepiece skeleton assembly. The eyepiece skeleton assembly is apart of the lower telescope system. Figure 4-28 shows the eyepiece skeleton assembly. All bubble numbers in Sections 4L1, 2, and 3 refer to Figure 4-28 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1133-9	4	Shifting wire spindles
2	P-1133-10	4	Shifting wire clamps
3	P-1133-11	4	Shifting wire clamp nuts
4	P-1133-12	8	Shifting wire spindle adjusting nuts
5	P-1160-1	2	Ball bearings for rayfilter drive gear
		2	Ball bearings for eyepiece prism shift gear and eyepiece drive
		4	Ball bearings for training handle rack

Ill. No.	Drawing Number	Number Required	Nomenclature
18	P-1173-5	1	Eyepiece prism upper retaining plate
19	P-1173-6	1	Eyepiece lens mount
20	P-1173-7	1	Eyepiece prism mount
21	P-1173-7 A&B	2	Eyepiece prism mount stem gear racks
22	P-1173-7C	5	Eyepiece prism stem gear rack lockscrews
23	P-1173-7A1	4	Eyepiece prism stem gear rack dowel pin
24	P-1173-8	1	Eyepiece prism front retaining plate
25	P-1177-6	1	Counterweight
26	P-1177-7	2	Counterweight strap retaining plates
27	P-1177-9	2	Counterweight straps
28	P-1179-	16	Ball bearing

			gears (right and left)
6	P-1160-1A	4	Dowel pins for rayfilter and eyepiece drive housings
7	P-1160-2	2	Ball bearing housings for training handle rack gears (left and right)
		2	1 Ball bearing housing for rayfilter drive mechanism
8	P-1160-4	2	Retaining collar for training handle rack gears
9	P-1160-9	1	Ball bearing housing for eyepiece prism shift gear
10	P-1160-10	1	Eyepiece prism shift gear
11	P-1160-11	1	Eyepiece prism shift bevel gear
12	P-1161-3	1	Rayfilter drive gear
13	P-1161-5	2	Eyepiece prism actuating gears
14	P-1161-6	2	Eyepiece prism actuating gear shafts
15	P-1163-11	1	Eyepiece prism shift

	46		housing lockscrews
29	P-1179-57	28	Counterweight strap and shifting rack retaining plate lockscrews
30	P-1179-58	2	Eyepiece prism shift actuating gear shaft lockscrews
31	P-1179-59	8	Eyepiece skeleton flange and eyepiece box lockscrews
32	P-1179-60	1	Eyepiece prism shift bevel gear lockscrew
33	P-1179-62	8	Counterweight strap lockscrews
34	P-1179-67	8	Eyepiece prism retaining plate upper and front lockscrews
35	P-1179-190	2	Retaining collar taper pins
36	P-1179-192	2	Eyepiece box alignment dowel pins
37	P-1310-17	4	Spider bearing and eyepiece skeleton lockscrews
38	P-1314-3	4	Shifting wire tapes
39	P-1318-1	2	Training handle rack gears and integral shafts

			bevel gear key
16	P-1173-3	1	Eyepiece lens clamp ring
17	P-1173-4	1	Eyepiece prism upper clamp ring

40	P-1318-8	1	Rayfilter drive male coupling half section
41	P-1389-4	2	Eyepiece lens clamp ring and eyepiece prism clamp ring upper lockscrews
42	P-1402-1	1	Eyepiece skeleton

Ill. No.	Drawing Number	Number Required	Nomenclature
43	P-1403-1	1	Prism shifting rack (left)
44	P-1403-2	1	Prism shifting rack (right)
45	P-1403-3	1	Power shifting rack (right)
46	P-1403-4	1	Power shifting rack (left)
47	P-1409-1	2	Retaining plates for shifting racks
48	P-1417-2	1	Upper eccentric eyepiece prism centering ring
49	P-1417-3	1	Front eccentric eyepiece prism centering ring
50	P-1417-4	1	Eyepiece prism front clamp ring
51	P-1418-13	1	Eyepiece prism
52	P-1418-14	1	Eyepiece lens

a. Eyepiece skeleton frame. The eyepiece skeleton frame (42) is made of cast phosphor bronze with an over-all length of 18.062 inches. It is cast with various cored projections and recesses to accommodate the eyepiece drive, ray filter drive, change of power, and prism tilt mechanisms.

The upper part is provided with a large shoulder flange having a narrow shoulder as part of its lower face. The diameter of the large shoulder flange coincides with the diameter of the straight, turned alignment support section of the eyepiece box (11, Figure 4-29), while the narrow shoulder serves as an alignment support section, a sliding fit in the shallow counterbored section in the eyepiece box. The large shoulder flange is provided with eight

53	P-1422-177	1	Rayfilter drive coupling half section taper pin

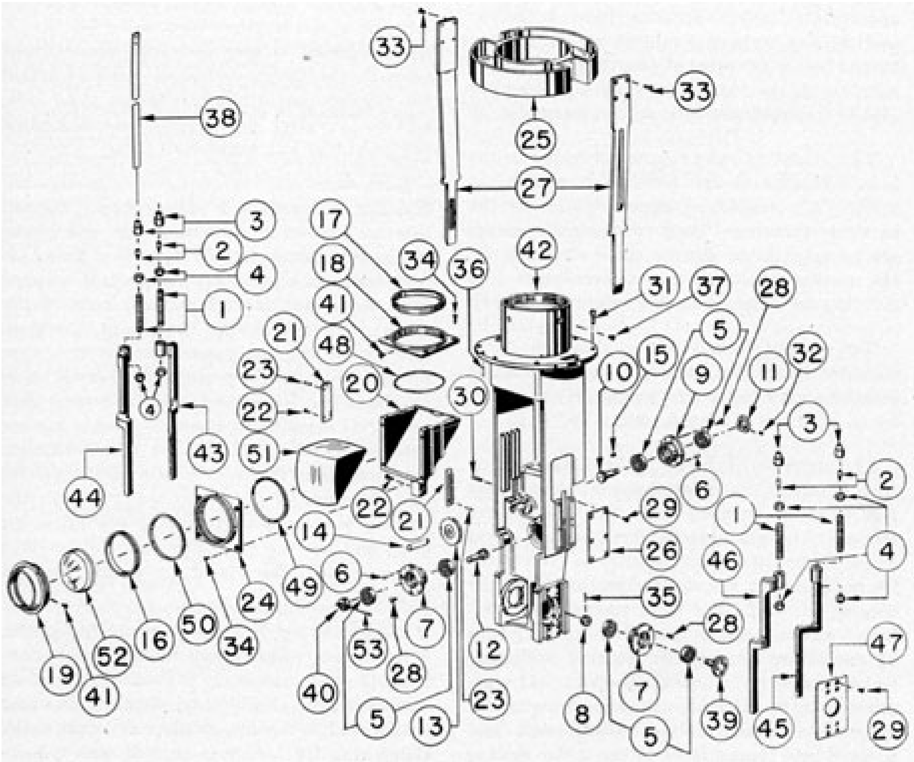

Figure 4-28. Eyepiece skeleton assembly.

equally spaced clearance holes for lockscrews (31) to secure the eyepiece box on the narrow shoulder against the large shoulder flange. These lockscrews are inserted into clearance holes in the large shoulder flange of the eyepiece skeleton and screwed into tapped holes in the upper face and alignment support section of the eyepiece box.

Two opposite reamed dowel pin holes are provided in the same hole circle as the eight clearance holes, and are located 22 degrees 30 minutes from the vertical centerline. These reamed holes receive dowel pins (36) of a drive fit, and provide the necessary radial alignment of the eyepiece box (11, Figure 4-29) for assembly.

A reamed hole is provided in the base of the eyepiece skeleton frame in the center of a shallow counterbored recess to receive the eyepiece skeleton centerscrew (12, Figure 4-29) which extends upward from the eyepiece box. The centering screw stabilizes the lower part of the eyepiece skeleton in the eyepiece box (11).

b. The eyepiece drive mechanism is composed of numerous mechanical internal parts to operate the eyepiece prism vertically to any diopter setting desired by an observer for his individual eye setting by means of suitable connecting attachments.

1. Eyepiece prism mount. The eyepiece prism mount (20) is made of cast duralumin. It provides the necessary body to retain the eyepiece

A clearance hole for the stadimeter transmission shaft (22, Figure 4-27) is provided in the large shoulder flange, and is located at an appropriate center distance from both the vertical and horizontal centerlines. An air line tapped hole is provided at assembly in the large shoulder flange for the long air line coupling (15) of the first inner tube section assembly.

Two elongated openings are provided in the large shoulder flange for the counterweight straps (27) located on opposite sides of the vertical centerline. These elongated openings are of appropriate size to allow clearance for the vertical travel of the counterweight (25) carrying the attached counterweight straps (27).

The straight turned section above the large shoulder flange has sufficient bearing surface length to carry the counterweight (25) vertically for all positions of focusing minus and plus.

The upper part is bored for light transmission to a depth of the large shoulder flange lower face and is provided with two counterbore, sections. The small counterbored section serves as an alignment support section to receive the lower alignment support section of the spider bearing (3) while the large threaded counterbored section receives the threaded periphery of the spider bearing (3), secured with four lockscrews (37). These lockscrews (37) are inserted in countersunk clearance holes in the eyepiece skeleton bearing section wall and screwed into tapped holes in the spider bearing lower alignment support section (3).

prism (51) and the eyepiece lens (52) in a fixed vertical moving position in the optical axis. The mount has two side walls, which protect the eyepiece prism from sideward thrust. Each sidewall is provided with four tapped holes in the upper and front faces to retain the eyepiece prism upper retaining plate (18), and the eyepiece prism front retaining plate (24) with four lockscrews each (34).

Each side wall is provided with two rail bearings, and each is a sliding fit into the rail bearings located in each inner flat wall of the eyepiece skeleton frame (42). The mount is provided with a stem which projects downward from the center part of the rear body of the mount. On each side of the mount, the stem Fear racks (21) are assembled to the stem projection with four alignment dowel pins (23) and five lockscrews (22). The stem gear racks (21) engage two eyepiece prism actuating gears (13) assembled on the eyepiece prism actuating gear shafts (14). The shafts extend into the front of the center wall, through the bearing hole in the eyepiece prism actuating gear, and the center section, and further into the rear wall. Each shaft is secured with a lockscrew (30).

2. Eyepiece prism upper retaining plate. The eyepiece prism upper retaining plate (18) is made of aluminum. It is a rectangular plate with a cylindrical projecting shoulder. The bore is threaded to receive an eyepiece prism upper clamp ring (17) which is secured with a lockscrew (41). The side facing toward the front

is beveled at right angles to form a 90 degrees miter joint with the beveled upper side of the eyepiece prism front retaining plate (24).

3. Eyepiece prism front retaining plate. The eyepiece prism front retaining plate (24) is made of aluminum. It is a rectangular plate with a cylindrical projecting shoulder. The bore is threaded to receive the threaded periphery of the eyepiece prism front clamp ring (50) and the eyepiece lens mount (19).

4. Eyepiece prism. The eyepiece prism (51) is a crown element, with a curvature ground on the entrance and exit faces called a dioptric prism or a double-convex right angle prism, with the 45 degrees reflecting face silvered, copper plated, and lacquered. It serves to deviate the optical axis from a vertical to a horizontal direction. Refer to Section 4U8 (e). The eyepiece prism is retained snugly in the eyepiece prism mount (20) in the fixed central position, with eccentric centering and clamp rings.

In the upper part of the mount, the eyepiece prism is secured by the application of an upper eccentric eyepiece prism centering ring (48) backed up with a threaded eyepiece prism upper clamp ring (17), of nominal thickness, secured with a lockscrew (41). The eccentric centering ring has a chamfer on its lower face, to offer the curved surface of the upper part of the eyepiece prism an equal bearing surface. This provides a means of distributing the pressure equally over at least 1/4 of the area of the serves internally to lock the eyepiece prism front clamp ring (50). The mount is bored with a counterbored beveled section, with a shallow shoulder remaining as the front wall. The counterbored beveled section conforms to the conical wall of the eyepiece lens, with the outer surface following the same pattern, to provide a uniform wall thickness. The lower part of the internal surface of the mount is provided with two additional counterbores, one for the periphery of the eyepiece lens. The other is threaded to receive an eyepiece lens clamp ring (16). The clamp ring engages into the internal threads in the mount to retain the eyepiece lens snugly in the mount, and is secured with a lockscrew (41).

6. Eyepiece lens. The eyepiece lens (52) is made of two optical elements, consisting of a double-convex crown element cemented to a double concave flint element, forming a positive doublet. It is mounted in the eyepiece lens mount (19) and is secured in the mount with a clamp ring (16). The clamp ring is provided with a lockscrew (41) to prevent it from unscrewing from the mount.

7. Counterweight. The counterweight (25) is made of cast composition brass, and is cylindrical. The periphery is 1/16 inch smaller in diameter than the large, shoulder flange of the eyepiece skeleton to allow the counterweight vertical clearance for its focusing travel. It is provided with cored sections on opposite sides of the vertical centerline for the insertion of lead. The amount of lead added should conform to the weight of the assembled eyepiece prism mount.

reflecting surface by tightening the clamp ring. The front eccentric eyepiece prism centering ring (49) serves at the front curved surface of the eyepiece prism in similar manner to the upper. It is backed up with a threaded eyepiece prism front clamp ring (50) of nominal wall thickness.

5. Eyepiece lens mount. The eyepiece lens mount (19) is made of aluminum. It is cylindrical and provides the outer wall to retain the eyepiece lens (52) in a concentric position in the eyepiece prism front retaining plate (24). The lower part is undercut and threaded to engage in the internal threads of the eyepiece prism front retaining plate (24). The threaded shoulder has sufficient length, that the when large shoulder of the mount is a metal to metal contact with the projecting cylindrical shoulder of the eyepiece prism front retaining plate, it

The counterweight serves to counterbalance the assembled eyepiece prism mount, and stabilizes the mount in any position of the allowed diopter setting the observer desires.

Two rectangular slots are provided on opposite sides of the horizontal centerline 180 degrees apart for two counterweight straps (27) and secured with four lockscrews (33) each. The inner walls of the cored sections provide a sufficient wall thickness in each half from the rectangular slots and the bore of the counterweight. An air line clearance hole is provided to the rear of the rectangular slot a nominal distance on the right side at assembly for the long air line coupling (15). A solid part of the cored section corner

on the left side to the rectangular slot rear wall has a clearance hole for the stadimeter transmission shaft (22, Figure 4-27). The counterweight is bored a sliding fit on the bearing section of the upper part of the eyepiece skeleton (42). The counterweight slides vertically on this eyepiece skeleton bearing section.

8. Counterweight straps. The counterweight straps (27) are made of cast phosphor bronze and have an over-all length of 12.840 inches. The upper part of each counterweight strap is attached to a rectangular slotted face on opposite sides of the counterweight (25). The

Both gears extend from slotted openings to engage the counterweight straps (27) mounted in vertical recess grooves on the opposite outer side walls of the eyepiece skeleton framework (42). Each gear is engaged with the mounted stem gear racks (21) of the eyepiece prism mount (20). The right eyepiece prism actuating gear (13) is also engaged with the eyepiece prism shift gear (10), and the rayfilter drive gear (12), located on opposite sides, in its upper and lower part.

10. Eyepiece prism actuating gear shafts. The two eyepiece prism actuating gear shafts (14) are made of corrosion-resisting steel material

lower part is provided with a raised gear rack of 12 teeth of 32 diametral pitch 1 3/4 inches long. Each gear rack meshes with an eyepiece prism actuating gear (13) projecting through slots in each side of the eyepiece skeleton frame (42). Each strap has a pronounced inward bend, from near the upper part to a short distance from the gear teeth of the gear rack. The bent section is supported with a narrow cast rib directly in the center. The counterweight straps form linkage arms between the counterweight (25) and the eyepiece prism actuating gears (13). When the eyepiece prism mount (20) is moved upward, the counterweight is moved downward and vice versa, by means of the actuating gears. The lower part of each counterweight strap is retained in the vertical recess groove in each side of the eyepiece skeleton frame with the counterweight strap retaining plates (26) secured with six lockscrews (29) each. These lockscrews are inserted in countersunk clearance holes in the retaining plates (26). and screwed into tapped holes in the vertical recess groove raised shoulders of the eyepiece skeleton frame (42).

9. Eyepiece prism actuating gears. The eyepiece prism actuating gears (13) are made of phosphor bronze and are 1 7/16 inches in diameter with a nominal width. Each gear is provided with 44 teeth of 32 diametral pitch which mesh with integral gear racks of the counterweight straps (27). Both gears have a reamed hole axis serving as bearing hole on eyepiece prism actuating gear shafts (14) and are provided with two narrow hub sections. The gears fit between two semicircular raised sections in and are 1 9/16 inches in length with a diameter of 5/16 inch. Each shaft serves to retain the two eyepiece prism actuating gears (13), and fits into reamed holes in the center and rear walls of the eyepiece skeleton, retaining the actuating gears between the two semicircular raised sections. Each shaft is secured with a lockscrew (30) which is inserted into a countersunk clearance hole and screwed into a tapped hole in opposite sides of the side wall and rear semicircular raised section of the eyepiece skeleton extending into a spotted recess in each shaft.

11. Eyepiece prism shift gear. The eyepiece prism shift gear (10) is made of phosphor bronze and is 1.281 inches in length. It has 16 teeth of 32 diametral pitch cut integral with the shaft in the shoulder part, while the main body part is mounted in two ball bearings (5) which in turn are mounted a press fit into a ball bearing housing (9). The stub section of the integral shaft is provided with a key way for the insertion of the key (15). This stub section receives the eyepiece prism shift bevel gear (11) with a keyseat and is secured with a lockscrew (32). This eyepiece prism shift gear, when mounted in the eyepiece skeleton center cored section, engages with the 44 teeth of the right eyepiece prism actuating gear (13) on its upper part.

12. Ball bearing housing. The ball bearing housing (9) is made of phosphor bronze and is 0.582 inch in length. It is cylindrical with a large shoulder flange, having a nominal wall thickness. Two undercut shoulders are provided, the larger is a sliding fit in the reamed hole and counterbored recess in the right side rear wall of the eyepiece skeleton, while the small shoulder

opposite sides of the eyepiece skeleton center framework inner walls.

section is undercut for clearance in the reamed hole, and provides sufficient wall area and length for the inner ball bearing (5).

The inside surface is bored for the integral shaft of the eyepiece prism shift gear (10) and has two counterbored sections. The upper and lower parts are counterbored for the insertion of two ball bearings (5), a press fit into each counterbore. The large shoulder flange is secured to the counterbored recess in the right side rear wall of the eyepiece skeleton with four lockscrews (28). These lockscrews are inserted into countersunk clearance holes in the large shoulder flange of the housing and screwed into tapped holes in the rear wall of the eyepiece skeleton. Two dowel pins (6) inserted in opposite sides of the large shoulder flange, permit a rapid alignment reference for reassembly of the housing in the reamed holes in the counterbored recess face in the eyepiece skeleton.

13. Ball bearings. The two ball bearings (5) are of antithrust type, and are mounted a press fit in the inner and outer counterbored sections of the ball bearing housing (9). The integral shaft of the eyepiece prism shift gear (10) is a push fit into these ball bearings. The ball bearings provide a smooth actuation of the eyepiece prism shift gear and its integral shaft (10).

1. Rayfilter drive gear. The rayfilter drive gear (12) is made of phosphor bronze and is 1.469 inches in length. It has 16 teeth of 32 diametral pitch cut integral with the shaft in the shoulder part, while the main body part is mounted in two ball bearings (5), which in turn are mounted a press fit into a ball bearing housing (7). This rayfilter drive gear when mounted in the eyepiece skeleton center cored section (42) engages with the 44 teeth of the right eyepiece prism actuating gear (13) in its lower part. The outer part of the integral shaft receives the rayfilter drive male coupling half section (40) which is secured with a taper pin (53).

2. Ball bearing housing. The ball bearing housing (7) is made of phosphor bronze and is 0.635 inch in length. This housing is similar in design to the ball bearing housing (9) except for the thickness of the large shoulder flange and the overall length, which allows a thicker shoulder in the internal part. It is provided with two counterbored sections in the inner and outer part for the ball bearings (5), a press fit in each counterbored section. Two undercut shoulders are provided; the larger is a sliding fit in the reamed hole in the front right center wall of the eyepiece skeleton (42), while the small shoulder section is undercut for clearance in the reamed hole and provides sufficient wall area for the inner ball bearing (5). The housing is bored for the integral rayfilter drive gear integral shaft (12).

14. Eyepiece prism shift bevel gear. The eyepiece prism shift level gear (11) is made of phosphor bronze, with a reamed hole in its center axis, and is provided with a keyseat. The large periphery is provided with 28 bevel teeth of 32 diametral pitch, and has a pitch cone angle of 60 degrees. It meshes with an identical gear called the eyepiece drive mechanism shift bevel gear (1, Figure 4-35) of the eyepiece drive packing gland assembly. The bevel gear is a push fit over the inserted key (15) and the stub section of the eyepiece prism shift gear and integral shaft (10) and is secured with a lockscrew (32). This lockscrew is screwed into the tapped hole in the hub section and extends into the spotted recess in the integral shaft stub section.

c. The rayfilter drive mechanism is composed of numerous mechanical parts forming an internal assembly to synchronize the movement of the rayfilter attachment with the eyepiece drive mechanism.

The large flange is provided with four equally spaced countersunk clearance holes to accommodate lockscrews (28) and is also provided on opposite sides with two dowel pins (6). The dowel pins permit a rapid alignment reference for reassembly of tree assembled housing (7) to the raised shoulder section of the front right center wall of the eyepiece skeleton (42) and to which the assembly is secured with four lockscrews (28).

3. Ball bearings. The two ball bearings (5) are of antithrust type, and are mounted a press fit in the inner and outer counterbored sections of the ball bearing housing (7). The integral shaft of the rayfilter drive gear (12) is a push fit into these ball bearings. The ball bearings provide a smooth actuation of the rayfilter drive gear (12) and its integral shaft.

4. Rayfilter drive male coupling half section. The rayfilter drive male coupling half section (40) is made of phosphor bronze of short length. It is cylindrical with a reamed hole in its center axis. Two projecting lugs of nominal thickness, width, and depth are provided on opposite sides. These lugs engage in opposite slots in the female coupling section (2, Figure 4-32) for interconnection with the rayfilter drive packing gland assembly. The male coupling half section is a push fit on the outer part of the integral shaft section of the rayfilter drive

46) are made of cast phosphor bronze, having an over-all length of 7.375 inches. Both racks are provided with offset arms and hubs to establish the center axis of each hub with proper clearance on each side of the mechanical centerline, and to provide clearance for the shifting wire spindle assemblies.

The left power shifting rack (46) is provided with gear teeth in the lower straight section in the right side face which mesh with the training handle rack gear and shaft teeth (39). The right power shifting rack (45) is provided with gear teeth in the lower

gear (12) and is secured with a taper pin (53).

d. The change of power mechanism is composed of numerous mechanical parts forming the internal assemblies for connection with an external attachment for change of power.

1. Right training handle rack gear and shaft. The right training handle rack gear and shaft (39) is made of phosphor bronze and is 1.156 inches in length. It has 32 teeth of 32 diametral-pitch cut integral with the shaft in the shoulder part, and meshes with teeth of the right and left power shifting racks (45 and 46) for change of power. It is mounted in two ball bearings (5) which in turn are mounted in a ball bearing housing (7).

The stub section of the integral shaft is provided with a retaining collar (8) secured to the stub section with a taper pin (35). The retaining collar serves as a thrust collar, to establish only sufficient clearance for its operation with the ball bearings.

The gear shoulder is provided with a recess in the outer part to form an inside male coupling section, with opposite lugs projecting toward its axis. This recess provides clearance for the female coupling section (3, Figure 4-36). The male coupling section provides the interconnection for the right training handle packing gland assembly. The ball bearing housing (7) and ball bearings (5) are identical to the housing (7) used for the rayfilter drive gear (12). It has no dowel pins inserted in the large shoulder flange. The assembled housing is secured in the reamed hole and to the counterbored face straight section in the left side face, to mesh with the training handle rack gear and shaft teeth (39) on the opposite side.

The arm of the right shifting rack (45) is offset to the right of the lower straight section, and slightly outward. The hub section is offset to the left and slightly outward, with a reamed hole in the center of the hub, to carry the shifting wire spindle assembly. The arm of the left shifting rack (46) is offset to the right and outward. The hub section is offset to the right and slightly outward, with a reamed hole in the center of the hub to carry the shifting wire spindle assembly. Both racks are carried in the vertical recess slotted sections in the right side of the eyepiece skeleton frame (42), to operate vertically for change of power. They are retained in the vertical recess slotted sections with a rectangular retaining plate (47), which is secured with eight lockscrews (29). The retaining plate is provided with a clearance hole in the central part for the female coupling section (3, Figure 4-36) of the right training handle packing gland assembly.

3. Shifting Wire spindles. The two shifting wire spindles (1) are made of phosphor-bronze rod and are 2 inches in length. The periphery is threaded to carry two shifting wire spindle adjusting nuts (4) on each spindle in the lower part on opposite sides of the hub section of the power shifting racks (45 and 46).

The upper part has a 16 degrees countersunk section in the center axis to receive a 14 degrees tapered shifting wire clamp (2). The center axis of the spindle has a clearance hole for the phosphor bronze wire of the shifting wire tape (38). Each

in the lower right side of the eyepiece skeleton (42).

2. Power shifting racks right and left. The power shifting racks right and left (45 and

shifting wire spindle is a sliding fit in the reamed hole

axis of each power shifting rack hub section, and has an adjusting nut on opposite sides. The adjusting nuts provide a variation in supplying tension or slack in the shifting wire tapes as desired.

4. Shifting wire clamps. The two shifting wire clamps (2) are made of corrosion-resisting steel material. A clearance hole is provided in their center axis, with a sawed slot, the depth of which corresponds to the length of the tapered part. The upper part is undercut and forms an alignment support section in the clamp nut (3). The slotted tapered section, when assembled in the upper countersunk section in the spindle, closes as the clamp nut (3) is tightened, and in this manner secures the phosphor-bronze wire of the shifting wire tape (38).

5. Shifting wire clamp nuts. The shifting wire clamp nuts (3) are made of hexagon phosphor bronze. The center axis has a clearance hole for the phosphor-bronze wire tape (38). A small counterbore in the upper part serves as an alignment support section of the shifting wire clamps (2), while the large counterbore is threaded to engage on threads of the spindle periphery.

6. Shifting wire tape. The four lengths of shifting wire tape (38) are made of monel metal and their length is determined at assembly. The upper part of each tape has two

1. Left training handle rack gear and shaft. The left training handle rack gear and shaft (39) is identical to the right training handle rack gear and shaft (39) with the exception that it is used in the left side of the eyepiece skeleton (42). This gear, cut integral with the shaft, engages with teeth of the left and right prism shifting racks (43 and 44) located on opposite sides. The integral shaft is mounted in two ball bearings (5) which in turn are mounted a press fit in the ball bearing housing (7). The ball bearings (5), ball bearing housing (7), and retaining collar (8) secured with a taper pin (35) are identical to their respective parts for the power shift side.

2. Prism shifting racks left and right. The prism shifting racks left and right (43 and 44) are made of cast phosphor bronze, having an overall length of 7.375 inches. Both racks are provided with offset arms and hubs to establish the center axis of each hub with proper clearance on each side of the mechanical centerline. They also provide clearance for the shifting wire spindles (1).

The left prism shifting rack (43) is provided with gear teeth in the lower straight section in the right side face to mesh with the training handle rack gear and shaft teeth (39). The right prism shifting (44) is provided with gear teeth in the lower straight section in the left side face to mesh

clearance holes for attachment to the head prism shifting racks (40 and 42, Figure 4-17) and is secured with two clamp blocks (16) and lockscrews (12). The lower part of each tape has a clearance hole located 1 1/4 inches from the end for the bronze wire. The section below the clearance hole has a 90 degrees groove bend 0.050 inch deep in the centerline. A suitable length of bronze wire 0.040 inch in diameter is inserted through the clearance hole with its upper end bent at 90 degrees. The monel metal tape is heated and bent to overlap the phosphor bronze wire, with its 90 degrees bent part a metal to metal contact with the monel metal overlapping end which is soldered together.

e. Prism tilt mechanism. The prism tilt mechanism is composed of numerous internal parts to operate the head prism for all degrees of elevation and depression. This is accomplished with internal connecting linkage and a suitable external attachment.

with the training handle rack gear and shaft teeth (39) on the opposite side.

The arm of the left shifting rack (43) is offset to the left of the lower straight section and slightly outward. The hub section is offset to the right and slightly upward, with a reamed hole in the center of the hub to carry the shifting wire spindle assembly. The arm of the right shifting rack (44) is offset to the left and outward. The hub section is offset to the left and slightly outward, with, a reamed hole in the center of the hub to carry the shifting wire spindle assembly. Both racks are carried in the vertical recess slotted sections in the left side of the eyepiece skeleton frame (42) to operate vertically for the elevation and depression of the head prism. They are retained in the vertical recess slots with a rectangular retaining plate (47), secured with eight lockscrews (29). The retaining plate is provided with a clearance hole

in the central part for the female coupling section (3, Figure 4-34) of the left training handle packing gland assembly.

3. Shifting wire spindles. The shifting wire spindles (1), shifting wire clamps (2), shifting wire clamp nuts (3), shifting wire spindle adjusting nuts (4), and the shifting wire tape (38) are identical to those used for the change of power mechanism.

4L2. Disassembly of the eyepiece skeleton. The eyepiece skeleton is

lens tissue. Place it to one side to prevent scratches and breakage.

8. Using lens tissue, slide the eyepiece prism (51) out of the eyepiece prism mount (20) from the upper part. Wrap the eyepiece prism with lens tissue and place it to one side to prevent scratches and breakage.

9. Remove the four lockscrews (34) from the eyepiece prism front retaining plate (24). These lockscrews are unscrewed from the tapped holes in the front side walls of the eyepiece

disassembled in the following manner:

1. Remove the eyepiece prism mount (20) by vertically pulling it clear of the rail bearings in the inner side walls of the eyepiece skeleton (42). In some cases it may be necessary to free the lower part of the counterweight straps (27) to accomplish this removal.

2. Remove the lockscrew (41) from the eyepiece prism upper retaining plate (18). The lockscrew is unscrewed from a tapped hole in the upper retaining plate and the eyepiece prism upper clamp ring (17).

3. Remove the four lockscrews (34) from the eyepiece prism upper retaining plate (18). The lockscrews are unscrewed from the tapped holes in the upper side walls of the eyepiece prism mount (20). Remove the eyepiece prism upper retaining plate (18) carrying with it the eyepiece prism upper clamp ring (17). Unscrew the clamp ring (17) from the upper retaining plate (18). Also remove the upper eccentric eyepiece prism centering ring (48).

4. Remove the eyepiece lens mount (19) carrying with it the eyepiece lens (52), eyepiece lens clamp ring (16), and its lockscrew (41) by unscrewing the eyepiece lens mount from the eyepiece prism front retaining plate (24).

5. Remove the lockscrew (41) from the eyepiece lens mount (19) and the eyepiece lens clamp ring (16). The lockscrew is unscrewed from the tapped hole in the clamp ring.

6. Remove the eyepiece lens clamp ring (16), unscrewing it from the eyepiece lens mount (19).

prism mount (20). Unscrew the eyepiece prism front clamp ring (50) from the front retaining plate (24) and remove the front eccentric eyepiece prism centering ring (49).

10. Remove the three lockscrews (22) from the left eyepiece prism mount stem gear rack (21) removing the rack. These lockscrews are unscrewed from the tapped holes in the eyepiece prism mount stem (20).

11. Remove the two lockscrews (22) from the left side of the eyepiece prism mount stem (20), removing the rack. These lockscrews are unscrewed from the tapped holes in the right eyepiece prism mount stem gear sack (21).

12. Remove the two shifting wire spindle assemblies from the right and left power shifting racks (45 and 46). The lower two shifting wire spindle adjusting nuts (4) were removed previously. Remove the two upper shifting spindle wire adjusting nuts (4). Unscrew them from the lower part of the shifting wire spindles (1).

13. Remove the two shifting wire clamp nuts (3), unscrewing them from the upper part of the shifting wire spindles (1). Remove the two shifting wire clamps (2).

14. Remove the eight lockscrews (29) from the power shifting rack's retaining plate (47). These lockscrews are unscrewed from tapped holes in the center raised section above the reamed hole and counterbored recess in the lower right side of the eyepiece skeleton (42). Remove the retaining plate (47), and the right and left power shifting racks (45 and 46).

15. Remove the four lockscrews (28) from the right training handle rack gear and shaft ball bearing housing

7. Remove the eyepiece lens (52) from the eyepiece lens mount (19) and wrap it in clean

(7). These lockscrews are unscrewed from tapped holes in the counterbored

recess face in the lower right side of the eyepiece skeleton (42). Remove the ball bearing housing (7), carrying with it the right training handle rack gear and shaft (39), two ball bearings (5), retaining collar (8), and its taper pin (35).

16. Follow the procedure outlined in Steps 12 and 13 for the removal of the shifting wire spindle assemblies of the prism shifting racks (43 and 44).

17. In case the assembly described in Step 15, is damaged or corroded, it requires removal. Remove the taper pin (35) from the right training handle rack gear and shaft (39) and the retaining collar (8).

18. Remove the right training handle rack gear retaining collar (8) from the stub section of the integral right training handle rack gear and shaft (39).

19. Remove the right training handle rack gear and shaft (39) from the center races of the two ball bearings (5). Push the integral shaft out from the small end of the ball bearing housing, carrying it out from the large shoulder flange end of the ball bearing housing (7).

20. Remove the two ball bearings (5) from the ball bearing housing (7), one from each side.

21. Remove the eight lockscrews (29) from the prism shifting rack retaining plate (47). These lockscrews are unscrewed from

described for the right side under Steps 16, 17, 18, and 19.

24. Remove the six lockscrews (29) from each counterweight strap retaining plate (26). These lockscrews are unscrewed from tapped holes in the two raised shoulders on each side of the eyepiece skeleton (42). Remove the two retaining plates (26).

25. Remove the four lockscrews (33) from the upper part of each counterweight strap (27). The lockscrews are unscrewed from tapped holes in the rectangular slotted faces in opposite sides of the counterweight (25). Remove each counterweight strap (27).

26. Remove the counterweight (25) by sliding it off the cylindrical bearing section of the upper part of the eyepiece skeleton (42).

27. Remove the four lockscrews (28) from the eyepiece prism shift gear ball bearing housing (9). These lockscrews are unscrewed from tapped holes in the counterbored face in the eyepiece skeleton rear wall. Remove the ball bearing housing (9) carrying with it the two ball bearings (5), eyepiece prism shift gear (10), eyepiece prism shift bevel gear key (15), and eyepiece prism shift bevel gear (11), its lockscrew (32), and two dowel pins (6).

28. In case the above assembly is damaged or corroded, it requires removal. Remove the lockscrew (32) from the eyepiece prism shift bevel gear (11). The lockscrew is unscrewed

tapped holes in the center raised section above the reamed hole and counterbored recess in the lower left side of the eyepiece skeleton (42). Remove the retaining plate (47) and the left and right prism shifting racks (43 and 44).

22. Remove the four lockscrews (28) from the left training handle rack gear and shaft ball bearing housing (7). These lockscrews are unscrewed from tapped holes in the counterbored recess face in the lower left side of the eyepiece skeleton (42). Remove the ball bearing housing (7), carrying with it the left training handle rack gear and shaft (39), two ball bearings (5), retaining collar (8), and its taper pin (35).

23. In case the above assembly is damaged or corroded, it requires removal. Follow the procedure of disassembly in the same manner as from the tapped hole in the hub of the eyepiece prism shift bevel gear (11) and its contact in the spotted recess in the integral shaft stub section of the eyepiece prism shift gear (10).

29. Remove the eyepiece prism shift bevel gear (11) from the integral shaft stub section of the eyepiece prism shift gear (10), and remove the inserted key (15) from the stub section.

30. Remove the integral shaft of the eyepiece prism shift gear (10) from the center of the two ball bearings (5), pushing it out from the large shoulder flange end of the ball bearing housing (9), and carrying it out from the small end of the ball bearing housing.

31. Remove the two ball bearings (5) from both ends of the ball bearing housing (9).

32. Remove the four lockscrews from the rayfilter drive gear ball bearing housing (7). These lockscrews are unscrewed from tapped holes in the raised shoulder of the eyepiece skeleton front center wall. Remove the ball bearing housing (7) carrying with it the two ball bearings (5), rayfilter drive gear (12), male coupling half section (40), its taper pin (53), and two dowel pins (6).

33. In case the assembly is damaged or corroded, it requires removal. Remove the taper pin (53) from the rayfilter drive male coupling half section (40) and the integral shaft of the rayfilter drive gear (12).

gears and shafts corresponding to reference marks on the framework should be noted for correct assembly.

4. Place both eyepiece prism actuating gear shafts (14) in the reamed hole in each front center and rear wall; the shafts extend into the front wall, then through the center bearing hole of each eyepiece prism actuating gear (13) into the rear wall. Insert lockscrews (30) into a countersunk clearance and tapped hole in the rear raised shoulder of each side wall and raised semi-circular section into a spotted recess in each shaft (14) for securing the shafts axially.

5. Place the counterweight (25) on the upper turned bearing section of

34. Remove the rayfilter drive male coupling half section (40) from the integral shaft section of the rayfilter drive gear (12).

35. Remove the integral shaft of the rayfilter drive gear (12) from the center of the two ball bearings (5), pushing the rayfilter drive gear out from the large shoulder flange end of the ball bearing housing (7), and carrying it out from the small end of the ball bearing housing.

36. Remove the two ball bearings (5) from both ends of the ball bearing housing (7).

37. Remove the two lockscrews (30) from the spotted recess in each eyepiece prism actuating gear shaft (14). These lockscrews are unscrewed from the tapped holes in the rear raised shoulder on each side of the eyepiece skeleton (42).

38. Remove the eyepiece prism actuating gear shafts (14) and the two eyepiece prism actuating gears (13). The shafts and gears slide out easily.

4L3. Reassembly of the eyepiece skeleton. The eyepiece skeleton is reassembled in the following manner:

1. Apply lubriplate No. 110 lightly to all rotating parts as the assembly procedure is followed.

2. Particular attention show d be directed to the reference marks and numerals on various parts for their proper coincidence for reassembly.

3. Place both eyepiece prism actuating gears (13) in the center cored section in the eyepiece skeleton. Reference marks on both the eyepiece skeleton. Slide the counterweight down to the large shoulder flange, with the cored opening face upward.

6. Place each counterweight strap (29) through the cored opening of the large shoulder flange of the eyepiece skeleton (42). The counter weight straps fit on the slotted face of opposite rectangular slots in the counterweight. Secure each counterweight strap to the rectangular slotted faces on each side of the counterweight with four lockscrews (33) each. These lockscrews are inserted into countersunk clearance holes in each counterweight strap and screwed into tapped holes in the opposite slotted faces in the counterweight (25).

7. Engage the lower part of each counterweight strap rack gear (27) in mesh with each eyepiece prism actuating gear (13). Place the retaining plates (26) over each counterweight strap (27) on the two raised shoulders of each outer side wall, securing each retaining plate with six lockscrews (29). These lockscrews are inserted into countersunk clearance holes in each retaining plate (26) and screwed into tapped holes, the two raised shoulders on each outer side of the eyepiece skeleton (42).

8. Place the two eyepiece prism shift gear ball bearings (5) in the eyepiece prism ball bearing housing (9) from both ends, pressing them snugly against the internal shoulder seats.

9. Place the eyepiece prism shift gear integral shaft (10) in the center of the two ball bearings (5), pushing it in from the small end of the ball

bearing housing (9). The shoulder of the eyepiece prism shift gear is a metal to metal fit with the center race of the ball bearing.

10. Place the eyepiece prism shift gear key (15) in the keyway in the integral shaft stub section eyepiece prism shift gear (10).

11. Place the hub section of the eyepiece prism shift bevel gear (11) over the inserted key (15) located in the stub section integral shaft eyepiece prism shift gear (10). Secure the bevel gear to the stub section with a lockscrew (32). The lockscrew is inserted into the tapped hole in the bevel gear hub section and screwed into the spotted recess of the stub section integral shaft.

12. The mounted eyepiece prism shift gear (10) and the eyepiece prism shift bevel gear (11) are assembled to the eyepiece skeleton by placing the ball bearing housing (9) in the reamed hole and counterbored recess in the right side rear wall of the eyepiece skeleton (42). The eyepiece prism shift gear (10) engages with the right eyepiece prism actuating gear (13) in its upper part, with coinciding reference marks. The ball bearing housing, after proper engagement of its dowel pins (6) in reamed holes, is secured with four lockscrews (28). These lockscrews are inserted into countersunk clearance holes in the housing and screwed into tapped holes in the counterbored recess face.

13. Place the two rayfilter drive gear ball bearings (5) in the rayfilter drive right side of the front center section of the eyepiece skeleton. The rayfilter drive gear (12) engages with the right eyepiece prism actuating gear (13) in its lower part, with coinciding reference marks. The ball bearing housing, after proper engagement of its dowel pins (6) in reamed holes, is secured with four lockscrews (28). These lockscrews are inserted in countersunk clearance holes in the housing and screwed into tapped holes in the raised section on the right side of the eyepiece skeleton front center wall.

17. Place the two training handle rack gear ball bearings (5) in the ball bearing housing (7) from both ends, pressing them snugly against the internal shoulder seats.

18. Place the training handle rack gear and integral shaft (39) in the center of the two ball bearings (5), carrying it in from the large shoulder flange end of the ball bearing housing (7). The shoulder of the training handle rack gear (39) is a metal to metal contact fit with the center race of the ball bearing.

19. Place the thrust collar (8) over the inner stub section of the training handle rack gear and integral shaft (39) and secure it with a taper pin (35).

20. The mounted training handle rack gear and integral shaft (39) is assembled to the right side of the eyepiece skeleton by placing the ball bearing housing (7) in the reamed hole and counterbored recess of the lower right side of the eyepiece skeleton (42). The ball bearing housing (7) is secured with four

gear ball bearing housing (7) from both ends, pressing them snugly against the internal shoulder, seats.

14. Place the rayfilter drive gear integral shaft (12) in the center of the two ball bearings (5), pressing it in from the small end of the ball bearing housing (7). The shoulder of the rayfilter drive gear (12) is a metal-to-metal fit with the center race of the ball bearing.

15. Place the rayfilter drive gear male coupling half section (40) on the integral shaft rayfilter drive gear stub section (12) and secure it with a taper pin.(53).

16. The mounted rayfilter drive gear (12) is assembled to the front center wall of the eyepiece skeleton by placing the ball bearing housing (7) in the reamed hole and raised section on the

lockscrews (28). These lockscrews are inserted into countersunk clearance holes in the housing and screwed into tapped holes in the counterbored recess face.

21. Reassemble the left training handle rack gear and integral shaft (39) in similar manner to that described in Steps 17, 18, 19, and 20 for the right training handle rack gear and integral shaft (39).

22. Place the power shifting racks right and left (45 and 46) in the vertical recess slotted sections in the right side of the eyepiece skeleton (42). The racks are placed with their lower ends even with the base of the eyepiece skeleton frame (42). The reference mark on the training

handle rack gear (39) must coincide with reference marks of the power shifting racks.

23. Place the retaining plate (47) over the power shifting racks right and left (45 and 46) on the raised shoulders. Secure the retaining plate with eight lockscrews (29). These lockscrews are inserted into countersunk clearance holes in the retaining plate and screwed into tapped holes in the raised center shoulder sections above and below the counterbored recess in the right side of the eyepiece skeleton.

24. Place the prism shifting racks left and right (43 and 44) in the vertical recess slotted sections in the left side of the eyepiece skeleton (42). The racks are placed with their lower

left side of the eyepiece prism mount stem (20), and secure it with three lockscrews (22). These lockscrews are inserted in countersunk clearance holes, in the left rack and screwed into tapped holes in the stem section.

29. Place the eyepiece prism front retaining plate (24) on the front face of the eyepiece prism mount (20). Secure the front retaining plate (24) with four lockscrews (34). These lockscrews are inserted in countersunk clearance holes in the front retaining plate and screwed into tapped holes in the eyepiece prism mount (20).

30. Clean the eyepiece prism (51), using clean lens tissue; also clean off any surface dust. Then place the eyepiece prism in the eyepiece prism

ends even with the base of the eyepiece skeleton frame. The reference mark on the training handle rack gear (39) must coincide with reference marks of the prism shifting racks.

25. The retaining plate (47) is placed over the prism shifting racks left and right (43 and 44) and secured to the lower left side of the eyepiece skeleton (42) in similar manner to the procedure described for the opposite side retaining plate (47).

26. Place the four shifting wire clamps (2) in each of the four shifting wire spindles (1) and place the four shifting wire clamp nuts (3) on the upper part of each spindle over each shifting wire clamp (2) Place four shifting wire spindle adjusting nuts (4) on the lower part of each spindle, and place each assembled spindle in the hub section reamed hole in each head prism shifting racks (43 and 44) and power shifting racks (45 and 46) carrying them in from the upper part. Place the second set of four shifting wire spindle adjusting nuts (4) on the lower part of each spindle, below each hub section.

27. Place the right eyepiece prism mount stem gear rack (21) with its dowel pins (23) on the right side of the eyepiece prism mount stem (20). Secure the rack with two lockscrews (22), inserting them from the opposite side of the eyepiece prism mount stem. The lockscrews are inserted in countersunk clearance holes in the stem section and screwed into tapped holes in the rack.

28. Place the left eyepiece prism mount stem gear rack (21) with its dowel pins (23) on the mount (20) from the upper part, with the shortest radius facing the eyepiece lens side.

31. Place the eyepiece prism upper retaining plate (18) on the upper face of the eyepiece prism mount (20). Secure the upper retaining plate with four lockscrews (34). These lockscrews are inserted in countersunk clearance holes in the upper retaining plate and screwed into tapped holes in the eyepiece prism mount (20).

32. Place the upper eccentric eyepiece prism centering ring (48) and the eyepiece prism upper clamp ring (17) in the upper retaining plate (18). The beveled side of the centering ring should bear to the curvature of the eyepiece prism (51). The upper clamp ring (17) is screwed down on the upper eccentric centering ring (48) until the lockscrew holes coincide. Insert the lockscrew (41) into the countersunk clearance hole in the upper retaining plate and screw it into the tapped hole in the upper clamp ring (17).

33. Place the, front eccentric eyepiece prism centering ring (49) to bear on the eyepiece prism (51) in similar manner to the upper eccentric centering ring, and place the eyepiece prism front clamp ring (50) in the front retaining plate (24). The front clamp ring (50) is screwed down on the front eccentric centering ring (49).

34. With the counterweight (25) at the extreme lower position, the assembled eyepiece prism mount (20) is placed in the rail bearings of the eyepiece skeleton, and moved downward. Move the counterweight upward to engage the eyepiece prism actuating gears (13) with

the eyepiece prism stem gear racks (21). The upward movement of the counterweight now causes the engagement of both the eyepiece prism actuating gears (13) with the eyepiece prism stem gear racks (21).

35. Clean the eyepiece lens (52) in similar manner to that noted under Step 28.

36. Place the eyepiece lens (52) in the eyepiece lens mount (19) with the shortest radius facing toward the eyepiece prism (51).

37. Place the eyepiece lens clamp ring (16) in the internal threaded part of the eyepiece lens mount (19). Screw the clamp ring into the mount until the lockscrew holes coincide, and secure the clamp ring with a lockscrew (41). This lockscrew is inserted in the countersunk clearance hole in the eyepiece lens mount (19) and screwed into the tapped hole in the clamp ring (16).

38. Place the assembled eyepiece lens mount (19) in the internal threads of the eyepiece prism front retaining plate (24). Screw the mount in until the shoulder of the mount is a metal to metal contact with the shoulder of the front retaining plate.

39. To determine the accuracy of the eyepiece skeleton assembly, a few simple observations can be made. If instructions have been correctly followed, the essential travel of the counterweight (25) and the eyepiece prism mount (20) should be 25 mm; the essential travel of the prism shifting racks should be 35 mm; and the essential travel of the power shifting racks should be 30 mm.

M. EYEPIECE BOX AND MISCELLANEOUS ASSEMBLIES

4M1. Description of the eyepiece box and miscellaneous assemblies. The eyepiece box and its miscellaneous assemblies are described as follows. Figure 4-29 shows the eyepiece box and miscellaneous assemblies. All bubble numbers for Section 4M1 refer to Figure 4-29 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1163-3	1	Outer tube and eyepiece

Ill. No.	Drawing Number	Number Required	Nomenclature
15	P-1410-2	2	Air valve bodies
16	P-1410-3	2	Air valve screws
17	P-1410-4	2	Air valve screw 3/16 inch steel balls
18	P-1410-5	2	Air valve body lead washers
19	P-1412-8	4	Anchor screw pins

			box angular alignment key
2	P-1163-8	1	Main coupling
3	P-1179-51	2	Name plate lockscrews
4	P-1179-65	2	Outer tube and eyepiece box angular alignment key lockscrews
5	P-1310-35	20	Side plate and pressure gage assembly lockscrews
6	P-1310-38	1	Star wheel lock plunger screw head
7	P-1314-12	2	Main coupling lockscrews
8	P-1314-13	1	Outer tube and eyepiece box soft rubber gasket
9	P-1353-5	1	Side plate
10	P-1353-6	2	Side plate and pressure gage soft rubber gaskets
11	P-1401-1	1	Eyepiece box
12	P-1409-4	1	Eyepiece skeleton centering screw
13	P-1409-5	1	Eyepiece skeleton centering screw lead washer
14	P-1410-1	2	Air inlet and outlet plugs
20	P-1430-7	1	Name plate
21	P-1454	1	Pressure gage assembly
22	Assembly	1	Spring type stadimeter transmission shaft packing gland
23	Assembly	1	Hycar type stadimeter transmission shaft packing gland modification
24	Assembly	1	Rayfilter drive packing gland assembly
25	Assembly	1	Eyepiece drive packing gland assembly
26	Assembly	2	Left and right training handle packing gland assemblies
27	Assembly	1	Eyepiece window assembly

a. Eyepiece box. The eyepiece box (11) is made of cast phosphor-bronze material and is 16.500 inches in length. It forms the outer shell covering the eyepiece frame (42, Figure 4-28). Various projections and recesses accommodate numerous inward projecting assemblies, also interconnecting with the external assemblies.

The upper face has eight tapped holes, two reamed dowel pin holes, and one air line clearance hole, to match with holes of the eyepiece skeleton large shoulder flange (42, Figure 4-28).

The inner circumference of the external upper alignment support section is bored to allow it to slide on the narrow alignment support shoulder of the eyepiece skeleton large shoulder flange, while the upper face contacts this large shoulder flange and is secured to it with eight lockscrews (31, Figure 4-28). The two dowel pin reamed holes of this upper face, when assembled over the protruding dowel pins (36, Figure 4-28) re-establish the correct angular alignment of the eyepiece box to the eyepiece skeleton (42, Figure 4-28).

The upper part of the eyepiece box is provided with an undercut section serving as an alignment

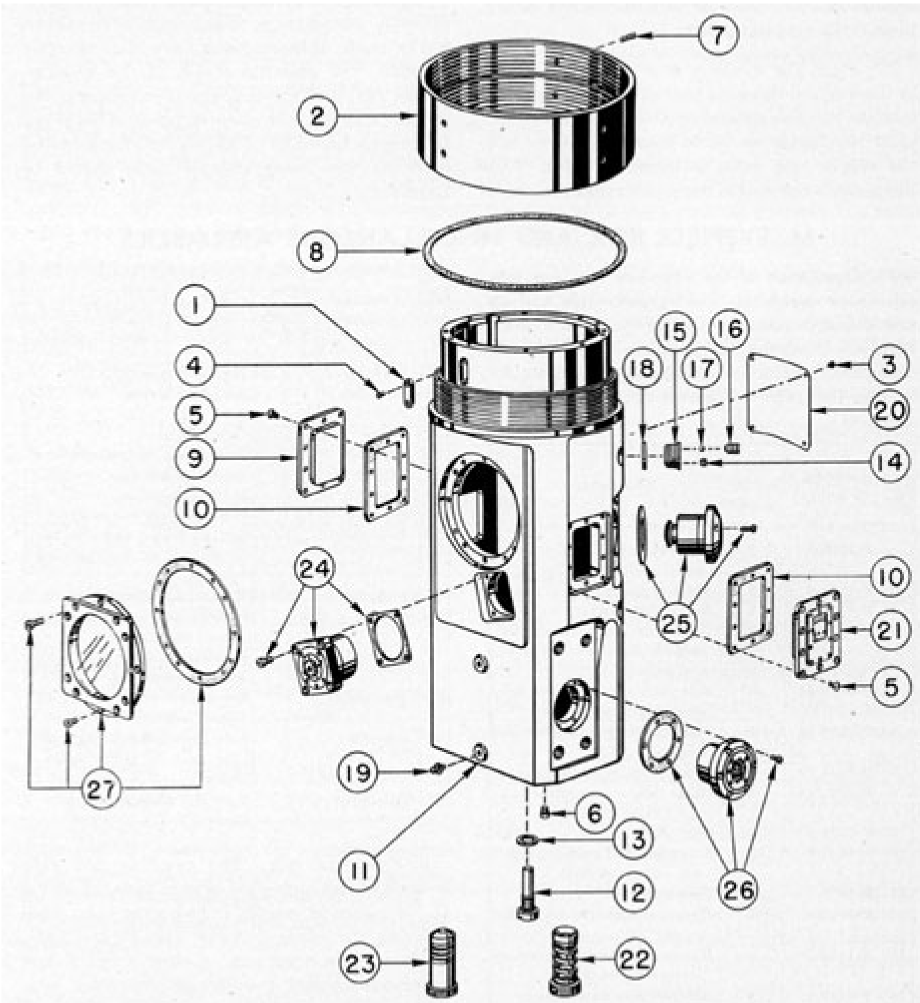

Figure 4-29. Eyepiece box and miscellaneous assemblies.

support section, a sliding fit in the lower counterbore in the outer tube (2, Figure 4-15). A keyway is provided in the front centerline in this section for the the horizontal and vertical centerlines to accommodate a short screw (6). The head of this short screw projects below the eyepiece box base sufficiently to

insertion of an angular alignment key (1) secured with two lockscrews (4). The key maintains the angular alignment of the emerging light rays within prescribed tolerance limits.

The threaded periphery section has 12 left-hand threads per inch to receive the lower internal threaded part of the main coupling (2). The joint shoulder face of the threaded periphery is provided with a triangular annular groove, to receive the soft rubber gasket (8) which is compressed by the tightening of the main coupling (2). This brings the triangular annular ridge detail of the lower joint shoulder of the outer tube (2, Figure 4-15) in contact with the soft rubber gasket (8) and upon further tightening of the main coupling, compresses the gasket into the above mentioned triangular annular groove of the eyepiece box forming an hermetically sealed joint.

The base of the eyepiece box is rectangular in shape with the corners rounded to conform to the remaining cored periphery of the eyepiece box. Four tapped holes are provided in the four corners to receive the four stadimeter housing bolts (30) which secure the stadimeter housing (67, Figure 4-24) to the base of the eyepiece box (11). Two dowel pin holes of shallow depth are provided diagonally on opposite sides to receive the protruding dowel pins (22, Figure 4-24) of the stadimeter housing (67, Figure/4-24).

The center axis of the rectangular base is provided with contact the star wheel lock plunger (62, Figure 4-24) in order to compress the star wheel key (60, Figure 4-24) and holder (61, Figure 4-24) when the stadimeter housing is assembled to the base of the eyepiece box. This releases the automatic stop of the stadimeter housing assembly for operation of the stadimeter.

A semi-circular projecting solid section is provided in the inner cored wall of the eyepiece box and forms part of the inner base wall. This section allows sufficient wall space after the machining of a stadimeter transmission shaft stuffing box. This stuffing box consists of a reamed hole for the stadimeter transmission shaft (22, Figure 4-27) and a larger reamed hole and threaded counterbored section.

The large reamed hole is chamfered in its inner shoulder at 30 degrees for flax packing, while the remainder of its length accommodates the various parts of the packing gland. The threaded counterbored section receives the spring retainer (3, Figure 4-30) of the spring type stadimeter transmission shaft packing gland assembly, or the packing retainer (2, Figure 4-31) of the modified hycar stadimeter transmission shaft packing gland. The 30 degrees chamfered seat receives the flax packing of the first type mentioned, or receives the gland filler piece (3, Figure 4-31) of the modified type.

This stadimeter transmission shaft packing gland assembly of either type provides the hermetically sealed joint for the protrusion of the stadimeter transmission shaft

an opening which consists of a reamed hole and partially tapped section. It also has two counterbored sections near the outer face for the eyepiece skeleton centering screw (12) and a lead washer (13).

A countersunk tapped drain hole is provided at an appropriate place in the base. This hole is countersunk sufficiently to receive a lead washer and to allow the drain screw to be slightly recessed upward from the lower surface of the eyepiece box base. This drain hole is provided to drain out water which may accumulate during flooding of the instrument.

A shallow tapped hole of 1/4-28 is provided in the base at an appropriate distance from both (22, Figure 4-27) for its interconnection with the stadimeter housing assembly (Figure 4-24).

All the various openings and recesses are described under each individual assembly as follows:

b. Main coupling. The main coupling (2) is made of cast phosphor-bronze material and is 2.531 inches in length. The outer diameter is within 0.010 inch of the outer tube diameter (Figure 4-15). In the center of the upper and lower internal threaded section, a threaded relief is provided to separate the left and righthand threads when machining and serving as an

area for the expansion of the rubber sealing gasket (8). The upper internal threaded section has 12 right-hand threads per inch, to engage on the right-hand threaded periphery of the lower part of the outer tube (2, Figure 4-15). The lower internal threaded section has 12 lefthand threads per inch, to engage the lefthand threaded periphery of the upper part of the eyepiece box (11).

The main coupling connects the lower part of the outer tube (2, Figure 4-15) to the eyepiece box (11). A soft rubber gasket (8) fits between the triangular annular ridge detail of the outer tube, and the corresponding triangular rests in a 90 degrees ground recess seat and seals off the nitrogen clearance hole. The second tapped hole opposite the large tapped hole is shallow, and is provided for the insertion of a nitrogen charging connection. The seat of this tapped hole is provided with a clearance hole, connecting the air valve hole at a 45 degrees angle. This tapped hole carries an air inlet plug (14) when the periscope is charged. Two opposite shallow holes are provided in the face of the air valve bodies for the insertion of a special wrench.

The air valve body section in the eyepiece box (11) is a solid cylindrically cored projection section in its inner cored wall. It

annular groove of the shoulder joint of the eyepiece box (11).

The compression of the soft rubber gasket (8) by means of the coupling's being tightened, causes the gasket to follow the triangular annular ridge and its corresponding groove to provide a hermetically sealed joint. Two lockscrews (7), located usually in opposite sides of the main coupling, screw into tapped holes in the coupling and extend in spotted recesses of the outer tube, to prevent the coupling from unscrewing and thus maintain the hermetical seal of the joint.

The main coupling has four sets of twin holes of shallow depth equally spaced. These holes accommodate a special spanner, wrench provided with twin prongs for the breaking or making up of the joint.

c. Air valve bodies. The two valve bodies (15) are made of phosphor-bronze material and blued. Both air valve bodies are of duplicate design, one is used as the AIR INLET and the other for the AIR OUTLET. Engraved markings for each valve are stamped in the eyepiece box above the individual valve body.

The inlet valve body has an external threaded section, with a short straight shoulder to carry a lead washer (18) next to its large shoulder. It engages into a tapped hole above the focusing knob assembly (Figure 4-39) in the eyepiece box (11). The lead washer rests on the counterbored recess seat to form an hermetical seal of this joint.

has sufficient wall area to accommodate the air valve body (15). An air line section of 4 3/4 inches in length connects this cylindrical wall seat section with a drilled hole, and is soldered to the clearance hole in the narrow flange section as well as to the inner wall of the eyepiece box.

The outlet valve body is located below the focusing knob assembly (Figure 4-39) with direct clearance from the threaded section to the internal part of the eyepiece box.

The inlet valve is connected by the soldered air line, to the various air lines and couplings to the air line adapter (11) which is attached to the fourth reduced tube section (9, Figure 4-19) to carry the charging nitrogen to the skeleton head, and for its circulation downward through the reduced tube sections and inner tube sections. It passes through the various channel provisions of each lens mount for as thorough circulation as is possible.

d. Pressure gage assembly. The pressure gage assembly (21) is a commercial product, manufactured by the Certified Gage and Instrument Co., of Long Island City, N.Y. This gage is graduated from 0 to 10 pounds, and can withstand a maximum pressure of 300 pounds. The gage is tested within 30 inches of vacuum with a corresponding mercury gage for leaks, and at 300 psi under water for 30 minutes, and then calibrated. This gage is assembled on the right side of the periscope in a rectangular recess and opening. A soft rubber gasket (10) is placed in the recess seat under the rectangular flange of

Two tapped holes are provided in the valve body, one is large for the insertion of an air valve screw (16) with an assembled ball bearing (17). The ball bearing when tightened the pressure gage assembly, and is secured with 10 lockscrews (5). The pressure

gage provides a constant indication of the internal gas pressure of the periscope.

The rectangular opening on this right side in the eyepiece box serves to allow the repairman access to the shifting wire spindle assemblies of the change of power mechanism, thus the repairman can make adjustments for removing or increasing the tension of the shifting wire tapes for the change of power mechanism without the removal of the eyepiece box. In the case of this instrument, it is necessary to remove the shifting wire spindle assemblies for disassembly of the skeleton head assembly from the outer taper section (1, Figure 4-15).

e. Side plate. The side plate (9) is made of phosphor bronze and is of rectangular shape, having a nominal wall thickness. It is provided with two shoulders of rectangular design, of which the larger forms the flange and fits over a rectangularly shaped soft rubber gasket (10) placed in the rectangular recess and opening in the eyepiece box (11). The rectangular opening in the left side serves the same purpose for the prism tilt mechanism on this side as that used for the pressure gage assembly on the right side for the change of power of this assembly, with two more rubber gaskets located in the front and rear face of the eyepiece window (9).

g. Rayfilter drive packing gland assembly. The rayfilter drive packing gland assembly (24) is assembled to the front bored hole and square recess seat in the front of the eyepiece box (11). This packing gland provides an internal coupling connection at the inner part with the eyepiece skeleton, and an external connection with the rayfilter assembly. The rayfilter drive stuffing box body rubber gasket (9) is placed between the stuffing box body flange and the square recess seat. The stuffing box body flange is secured to the gasket and recess seat with four lockscrews (13, Figure 4-32). This rubber gasket maintains the hermetical seal of this assembly along with the flax packing under spring pressure.

h. Eyepiece drive packing gland assembly. The eyepiece drive packing gland assembly (25) is assembled to the center right rear wall of the eyepiece box (11) in a bored hole and counterbored recess seat, between both air valve body assemblies. This packing gland assembly provides an internal connection with the eyepiece prism shift bevel gear (11, Figure 4-28) of the eyepiece

mechanism. The rectangular flange of the side plate (9) has 10 countersunk clearance holes for the insertion of lockscrews (5) which extend into the shallow tapped holes in the rectangular recess face in the eyepiece box. The side plate and pressure gage rubber gaskets (10) are made of crude rubber 0.030 inch in thickness of rectangular shape, having a width of 0.374 inch. The gasket is fitted in the rectangular recess seat below their respective rectangular flanges of the pressure gage assembly and the side plate to maintain the hermetical seal of these two joints, when drawn evenly by 10 lockscrews (5) of the side plate and pressure gage assembly.

f. Eyepiece window assembly. The eyepiece window assembly (27) is assembled to the front large bored hole and, counterbored recess seat in the eyepiece box (11). The eyepiece window frame rubber gasket (8) is placed between the frame flange and the counterbored recess seat. The frame flange is secured to the gasket and recess seat with four short and eight long lockscrews (2 and 3, Figure 4-38). This rubber gasket maintains the hermetical seal

skeleton assembly at the inner part, and an external coupling connection with the focusing knob assembly (Figure 4-39). The eyepiece drive stuffing box body rubber gasket (11) is placed between the stuffing box body flange and the counterbored recess seat. The stuffing box body flange is secured to the gasket and recess seat with six lockscrews (3, Figure 4-35). The rubber gasket maintains the hermetical seal of this assembly with the flax packing under spring pressure.

i. Left training handle packing gland assembly. The left training handle packing gland assembly (26) is assembled to the lower part of the left side of the eyepiece box (11) in a bored hole and counterbored recess seat. This packing gland assembly provides an internal coupling connection at the inner part with the eyepiece skeleton assembly (Figure 4-28), and an external connection with the left training handle assembly (Figure 4-43). The training handle stuffing box body gasket (10) is placed between the stuffing box body flange and the

counterbored recess seat. The stuffing box body flange is secured to the gasket and recess seat with six lockscrews (1, Figure 4-36). The rubber gasket maintains the hermetical seal of this assembly along with the flax packing under spring pressure.

reassembly of the eyepiece box to the eyepiece skeleton.

m. Eyepiece skeleton centering screw. The eyepiece skeleton centering screw (12) is made of phosphor bronze and is 1.750 inches in length. It is provided with a smooth stem section, which is a

j. Right training handle packing gland assembly. The right training handle packing gland assembly (26) is assembled to the right side of the eyepiece box, in a bored hole and counterbored recess seat. Refer to the left training handle packing gland assembly, as it is identical, and is secured in similar manner.

k. Angular alignment key. The angular alignment key (1) is made of monel metal. It has a nominal length, thickness, and width, with the upper and lower corners rounded off. It is secured in the machined recess keyway in the front centerline of the upper alignment support section of the eyepiece box (11) with two lockscrews (4). This key is a sliding fit in the inside keyway of the lower part of the outer tube (2, Figure 4-15). It provides the angular maintenance of the emerging light rays within the prescribed tolerance of five minutes of arc with the entering light rays.

l. Angular alignment determination of the eyepiece box and eyepiece skeleton. The correct location of the two inserted dowel pins (36, Figure 4-28) of the eyepiece skeleton (42, Figure, 4-28) large shoulder flange and their proper engagement in reamed dowel pin holes of the eyepiece box are determined as follows: This alignment is first determined by placing a false plate in the rail bearing slots in the inner side walls of the eyepiece skeleton, while the eyepiece box is being held to the large shoulder flange of the eyepiece skeleton. A sliding fit into a reamed hole in the base of the eyepiece skeleton. It stabilizes the lower part of the eyepiece skeleton (42, Figure 4-28) in the eyepiece box (11). The threaded periphery section of the centering screw engages into a tapped section in the eyepiece box, in the upper part of the inner wall of the base. The short shoulder carries the lead washer (13) against the large shoulder of the centering screw, and fits in the small counterbored recess, while the large shoulder carries the lead washer against the large counterbored recess seat in the base, of the eyepiece box. The lead washer maintains the hermetical seal of this opening. The head of the centering screw is slotted for the insertion of a screwdriver.

n. Name plate. The name plate (20) is made of nominal thickness and is of rectangular shape. It is secured to a cast recess of similar contour to the eyepiece box (11). The name plate is located in the cast recess in the rear wall of the eyepiece box above the horizontal optical centerline. It is secured with four lockscrews (3) which are inserted into clearance holes in the name plate and screwed into shallow tapped holes in the wall of the cast recess. Refer to Chapter 1, Section 1A6 for data inscribed on the name plate.

o. Anchor screw pins. The four anchor screw pins (19) are made of corrosion resisting steel and are 0.641 inch in length. Two anchor screw pins are provided in the two raised bosses of the front flat cast section below the eyepiece window assembly of the eyepiece box (11), while the other two are provided in the rear flat cast

depth micrometer is used to measure the distance from the counterbored recess seat of the eyepiece window assembly opening. The depth micrometer provides an accurate measuring device to determine the necessary rotation of the eyepiece box for obtaining equal distance to the false plate on opposite sides of the centerline. The reamed dowel pin holes are spotted in the eyepiece box, from the previously drilled holes of the large shoulder flange in the eyepiece skeleton. Thus permanent angular alignment is maintained for future disassembly and section in similar manner. Shallow tapped holes are provided in each raised boss with an appropriate center distance between bosses to receive the threaded periphery section of the two anchor screw pins. The upper part of each pin has an undercut section to allow the spring tension of the finger grip levers (1 and 2, Figure 4-41) of the variable density polaroid assembly to snap into the locked

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position. The outer shoulder of the undercut section retains the finger grip levers, a metal to metal fit on the bosses. The large shoulder section has two opposite sawed slots 180 degrees apart, for the attachment of a special wrench for disassembly or reassembly.

Chapter 4 Continued

N. PACKING GLAND ASSEMBLIES

4N1. General description of the packing gland assemblies. The eyepiece box (11, Figure 4-29) is provided with one stadimeter transmission shaft packing gland assembly of either the spring or modified hycar type, plus four spring-loaded type packing gland assemblies. Each assembly allows passage of a rotating shaft and maintains the hermetical seal around each shaft, used in the eyepiece drive or the focusing mechanism, the rayfilter drive, the prism tilt, the change of power mechanism, and the stadimeter transmission shaft.

4N2. Description of the stadimeter transmission shaft packing gland assembly (spring type). Figure 4-30 shows this packing gland assembly. All bubble numbers in this section refer to Figure 4-30 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1310-39	1	Spring retainer lockscrew
2	P-1405-7	1	Packing gland
3	P-1405-8	1	Spring retainer
4	P-1405-9	1	Packing gland spring

Figure 4-27) thereby permitting its rotation and providing a hermetical seal of this joint.

b. Packing gland spring. The packing gland spring (4) is made of chrome silicon manganese steel alloy, having a free length of 1.500 inches. The upper part of the spring fits loosely over the undercut section of the packing gland (2) and rests against its large shoulder lower face. The lower part is a loose fit on the small shoulder and rests on the medium shoulder face of the spring retainer (3). The external diameter of the spring is a loose fit in the bored stuffing box chamber in the eyepiece box base (11, Figure 4-29).

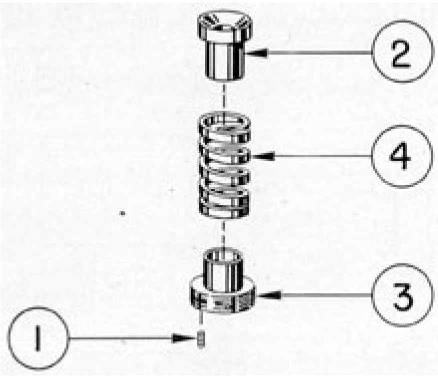

Figure 4-30. Stadimeter transmission shaft packing gland assembly (spring type).

c. Spring retainer. The spring retainer (3) is made of phosphor bronze and is 0.810-inch in length. It is undercut with a long section having a nominal wall thickness, and serves as a guide for the packing gland spring (4). The medium shoulder serves as the seat for the

a. Packing gland. The packing gland (2) is made of phosphor bronze and, is 0.937 inch in length. It is cylindrical with a reamed hole in its center axis. The external surface consists of an undercut section with a large shoulder a few thousandths-inch smaller than the bored diameter of the eyepiece box base stuffing box chamber. The undercut section is a loose fit in the packing gland spring (4). The reamed hole of the packing gland is a sliding fit on the stadimeter transmission shaft (22, Figure 4-27). The large shoulder is chamfered at 30 degrees from the reamed hole axis to contact sufficient flax packing, thus forcing the packing into the similarly chamfered shoulder seat in the bored diameter of the stuffing box chamber under tension of the packing gland spring (4). The compression of the packing between the two chamfered seats causes the packing to adhere around the stadimeter transmission shaft (22, spring. The large shoulder periphery is threaded to screw into the internal threaded stuffing box chamber in the eyepiece box base (11, Figure 4-29).

Two holes are drilled in the threaded periphery along a diameter, and the wall has a narrow slot cut halfway through the shoulder to these

drilled holes. In the center of the slotted section, a perpendicular tapped hole is provided near the periphery for the insertion of a lockscrew (1). When tightened, this lockscrew spreads the narrower slotted half of the wall away from the heavier part, and secures the spring retainer in the internal threaded section in the stuffing box chamber. The center axis is bored to provide sufficient clearance for the female tang coupling (68, Figure 4-24) of the stadimeter housing assembly, for its interconnection with the male tang section of the stadimeter transmission shaft (22, Figure 4-27). The face of the spring section of the stuffing box chamber. This allows the small undercut shoulder of the spring retainer a 1/16-inch metal to metal contact or solid compression with the packing gland and places a 3/8-inch compression on the packing gland spring (4) when the face of the spring retainer is flush with the eyepiece box base.

4N3. Description of the stadimeter transmission shaft packing gland assembly (modified hycar type). Figure 4-31 shows this packing gland assembly. All bubble numbers in this section refer to Figure 4-31 unless otherwise specified.

retainer is provided with four equally spaced shallow holes, to accommodate the projecting prongs of a special wrench.

Upon the loading of this packing gland with 9 inches of 1/4-inch flax packing, there is an initial compression of 1/8-inch required of the packing gland spring (4) before the spring retainer threads engage in the internal threaded

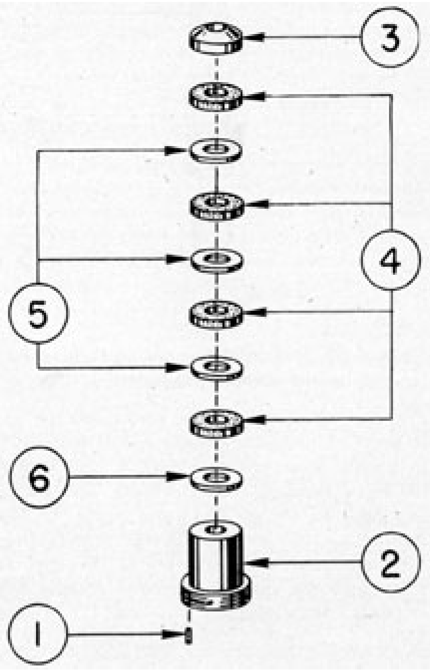

Figure 4-31. Stadimeter transmission shaft packing gland assembly (modified hycar type).

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1310-39	1	Packing retainer lockscrew
2	P-1468-2	1	Packing retainer
3	P-1468-3	1	Gland filler piece
4	P-1468-4	4	Hycar packing spacers
5	P-1468-5	3	Brass spacer washers (0.020 inch)
6	P-1468-6	1	Packing retainer brass washer (0.060 inch)

a. Gland filler piece. The gland filler piece (3) is made of rolled brass rod and is 0.338-inch in width. It is cylindrical with the periphery several thousandths-inch smaller than the bored diameter of the eyepiece box base stuffing box chamber. The axis is provided with a reamed hole a sliding fit on the stadimeter transmission shaft (22, Figure 4-27). The upper face is chamfered at 30 degrees. This gland filler piece serves to fill the 30 degrees chamfered seat of the stuffing box section, and has a flat shoulder upon which the uppermost hycar packing spacer rests under tension.

b. Hycar packing spacers. The four hycar packing spacers (4) are made of 1/8-inch special synthetic rubber sheet. Each spacer is cut cylindrical, with the external diameter 0.007-inch larger than the bored diameter of the eyepiece box base stuffing box chamber, while the center hole is 0.007-inch smaller than the

stadimeter transmission shaft (22, Figure 4-27).

c. Brass spacer washers. The three brass spacer washers (5) are made of 0.020-inch thick brass. The washers are cylindrical, having a 0.006-inch smaller diameter than the bored diameter of the eyepiece box base stuffing box,

chamber. The center axis hole of each washer is 0.058-inch larger than the diameter of the stadimeter transmission shaft (22, Figure 4-27). Each brass spacer washer is placed between each hycar packing spacer (4), and when compressed, spreads the hycar packing spacers, causing them to adhere to the stadimeter transmission shaft (22, Figure 4-27) and the inner circumference of the stuffing box chamber inner wall of the eyepiece box base. The spreading of the hycar packing spacers is sufficient to maintain the hermetical seal and still offer sufficient smoothness to the operation of the stadimeter transmission shaft (22, Figure 4-27).

d. Packing retainer brass washer. The packing retainer brass washer (6) is made of 0.060-inch rolled brass. It is cylindrical, having the same internal and external diameters as the three brass spacer washers (5). This washer is placed below the lower hycar packing spacer (4) and the upper face of the packing retainer (2). The flat face of this washer serves to protect the rubber gasket next to the face of the packing retainer from being disrupted when tightening the packing retainer for the compression of the hycar packing

Two holes are drilled in the threaded periphery shoulder along a diameter and the wall has a narrow slot cut halfway through the shoulder to these drilled holes. In the center of the slotted section a perpendicular tapped hole is provided near the periphery for insertion of a lockscrew (1). The lockscrew when tightened spreads the narrower slotted half of the wall away from the heavier part, and secures the packing retainer in the internal threaded section of the eyepiece box base stuffing box chamber. The face of the packing retainer is provided with four shallow equally spaced holes, to accommodate the projecting prongs of a special wrench.

4N4. Description of the rayfilter drive packing gland assembly. Figure 4-32 shows this packing gland assembly. All bubble numbers in Sections 4N4, 5, and 6 refer to Figure 4-32 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1310-39	1	Spring retainer lockscrew

spacers to maintain the hermetical seal.

e. Packing retainer. The packing retainer (2) is made of rolled phosphor bronze and is 1.190 inches in length. It is undercut a sliding fit into the bored diameter of the stuffing box chamber in the eyepiece box base, with a large shoulder having a threaded periphery. The threaded periphery engages into the internal threaded section in the stuffing box shoulder of the eyepiece box base. The packing retainer has a reamed hole in the axis of the upper part, and a counterbored section intercepting the reamed hole. The reamed hole is a sliding fit over the stadimeter transmission shaft (22, Figure 4-27) while the counterbored section has sufficient clearance for the female tang coupling (68, Figure 4-24) of the stadimeter housing assembly, for its interconnection with the male tang section of the stadimeter transmission shaft. The undercut shoulder is of sufficient length, with an adequate wall above the counterbored section, to compress the four hycar packing spacers for maintaining the hermetical seal.

2	P-1318-9	1	Female coupling section
3	P-1318-9A	1	wire
4	P-1405-1	1	Stuffing box body
5	P-1405-2	1	Spring retainer
6	P-1405-3	1	Spring cylinder
7	P-1405-4	1	Packing gland
8	P-1405-5	1	Packing gland spring
9	P-1405-6	1	Stuffing box body rubber gasket
10	P-1406-9	1	Rayfilter drive actuating shaft
11	P-1409-3	1	Rayfilter drive actuating gear
12	P-1422-7	1	Packing land lockscrew
13	P-1422-8	4	Stuffing box body lockscrews
14	P-1422-175	1	Spring retainer dowel pin

a. Stuffing box body. The stuffing box body (4) is made of phosphor bronze and is 1.485 inches in length. It consists of a body section undercut a distance of 0.785 inch, with a medium shoulder section a sliding fit in the bored hole in the eyepiece box front opening below and to the right of the eyepiece window assembly (27, Figure 4-29). It is provided with a large rectangular shoulder flange with

rounded corners a sliding fit in the rectangular recess section

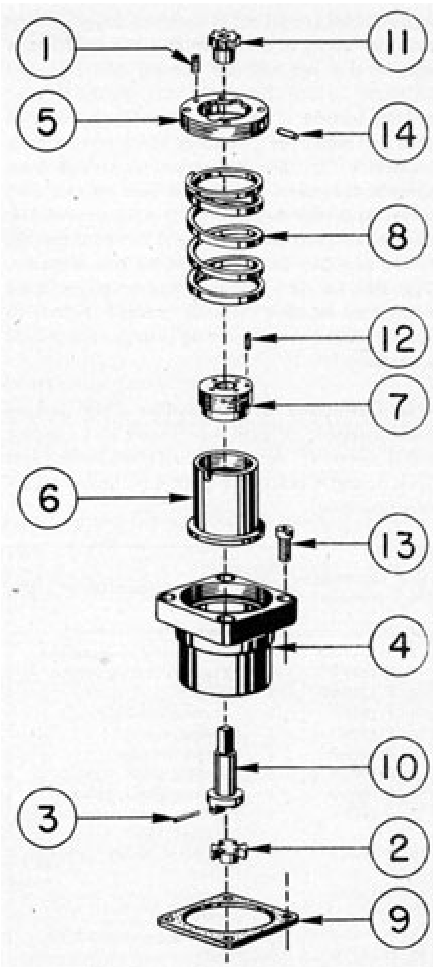

Figure 4-32. Rayfilter drive packing gland assembly.

part of the same opening. The rectangular flange has four countersunk clearance holes for the insertion of lockscrews (13), and is secured in the rectangular recess in the eyepiece box on a rectangularly shaped gasket (9). The lockscrews extend into nominal depth tapped holes in the remaining rectangular recess front wall of the eyepiece box.

The stuffing box body center axis is reamed to accommodate the rayfilter drive actuating shaft (10). The inside surface has three counterbored sections. One is counterbored a depth of 1.360 inches, leaving a center section, and providing a cylinder area for the spring cylinder (6) and sufficient clearance for compression of the packing gland spring (8).

The large counterbore, 0.282 inch deep, is threaded to receive the spring retainer threaded periphery against the shoulder seat of this counterbored section. The center section, located with its face a depth of 0.406 inch from the outer face of the rectangular flange, is counterbored a depth of 3/8 inch, having a chamfered seat of 30 degrees. This counterbored area serves as the stuffing box chamber to receive the flax packing and the undercut section and upper chamfered seat of the packing gland (7). The flax packing is compressed against the chamfered seat of the stuffing box chamber by the opposite chamfered seat of the packing gland, thus forcing the flax packing to adhere to the rayfilter drive actuating shaft (10).

The stuffing box body is counterbored in the lower part a depth of 0.484 inch to provide sufficient clearance for the rayfilter drive actuating shaft (10) shoulder male coupling section, the female coupling section (2), and its interconnection with the male coupling section (40, Figure 4-28) of the eyepiece skeleton assembly. This counterbore serves as an alignment support section for the

interconnecting coupling sections mentioned above.

b. Rayfilter drive actuating shaft. The rayfilter drive actuating shaft (10) is made of corrosion-resisting steel and is 1 15/32 inches long. The flange section of the shaft has two projecting lugs to form a male coupling section with the assembled female coupling section (2) which provides interconnection with the male coupling section (40, Figure 4-28) of the eyepiece skeleton assembly. The main body of the shaft is a sliding fit in the reamed hole in the stuffing box body (4) and the reamed hole in the packing gland (7). The flax packing surrounds the main body of the shaft in the stuffing box chamber. The square section of the upper part of the shaft carries a rayfilter drive actuating gear (11).

c. Female coupling section. The female coupling section (2) is made of corrosion

resisting steel and is of nominal thickness. It is shaped cylindrical with four equally spaced slots, and is assembled between the two opposite projecting lugs of the male coupling flange section of the rayfilter drive actuating shaft (10). It is secured with a bronze wire (3) which is inserted through a small drilled hole in the opposite lugs and the center section remaining between the depth of the opposite slots of this coupling. The bronze wire is spread on opposite sides of each male lug, allowing the female coupling section a small axial thrust. When it is assembled to the projecting male lugs of the rayfilter the spring retainer is bored to provide sufficient clearance for the packing gland (7). It is counterbored in the lower part and provided with sliding clearance for the upward movement of the spring cylinder (6) for the loading of the packing gland (7).

A dowel pin hole is provided in the threaded periphery for the insertion of a dowel pin (14) of a drive fit. The dowel pin projects inward from the counterbored wall a sufficient distance to engage in the axial slot of the spring cylinder upper part. Its protrusion in the axial slot serves only to restrict the movement of the

drive actuating shaft (10), it serves as a coupling for interconnection between the male coupling section (40, Figure 4-28) of the eyepiece skeleton assembly, using the two opposite slots at right angles to the assembled pinned slots.

d. Rayfilter drive actuating gear. The rayfilter drive actuating gear (11) is made of phosphor bronze with a square broached hole in its center axis, and is a push fit over the square section of the rayfilter drive actuating shaft (10). The large diameter is provided with 16 teeth of 32 diametral pitch which mesh with the rayfilter drive actuating gear rack (8, Figure 4-40) of the rayfilter assembly. The hub section of the gear is a sliding fit in the reamed hole axis of the packing gland (7). The rayfilter drive actuating gear (11), in mesh with the rayfilter drive actuating gear-rack (8, Figure 4-40) of the rayfilter assembly, provides the interconnection with the eyepiece drive mechanism located in the eyepiece skeleton assembly (Figure 4-28) to synchronize its vertical travel.

e. Packing gland spring. The packing gland spring (8) is made of chrome silicon manganese steel alloy and has a free length of 2 1/2 inches. The spring fits loosely over the undercut body and rests on the shoulder seat of the spring cylinder (6). The spring when compressed, has a length of 7/8-inch at its fully loaded position.

f. Spring retainer. The spring retainer (5) is made of phosphor bronze ands is 9/32 inch in width. It is cylindrical, having a threaded periphery to screw into the large threaded counterbored section and spring cylinder when loading the packing gland, and does not interfere with the threaded periphery of the packing gland (7).

Two opposite radius grooves are cut in the inner bored shoulder to a depth of the counterbored wall to provide the repairman a visual determination of the loaded position of the spring cylinder (6) as it contacts the shoulder seat of the spring retainer.

Two holes are drilled in the threaded periphery along a diameter, and the wall has a narrow slot cut halfway through the shoulder to these drilled holes. In the center of the slotted section, a tapped hole is provided near the periphery for insertion of a lockscrew (1). This lockscrew when tightened spreads the narrower slotted half of the wall away from the heavier part, and secures the spring retainer in the internal threaded counterbored section in the stuffing box body. The face of the spring retainer is provided with four equally spaced shallow holes to accommodate the projecting prongs of a special wrench. The spring retainer compresses the packing gland spring (8) for its initial compressed length of 31/64 inch.

g. Spring cylinder. The spring cylinder (6) is made of phosphor bronze and is 1.200 inches in length. It is bored a sliding fit over the external shoulder surface of the stuffing box chamber. The external surface is undercut down to a narrow shoulder of nominal wall thickness to carry the packing gland spring (8) loosely in the cylinder area between the internal and external walls of the stuffing box

shoulder seat in the stuffing box body (4). The internal surface of body. The upper part of the spring cylinder has

an internal threaded section to receive, the packing gland threaded periphery, with an elongated slot having a depth of 0.150 inch. This slot engages a stationary dowel pin (14) projecting inward from the inner wall of the spring retainer (5) to restrict the spring cylinder (6) from turning when the packing gland is screwed into the internal threaded section in the spring cylinder while loading the gland. As the packing gland (7) is screwed into the spring cylinder (6) against the flax packing surrounding the rayfilter drive actuating shaft (10) in the stuffing box body chamber, the initial compression of the packing gland spring (8) is compressed further by the upward movement of the spring cylinder (6), thus loading the packing gland (7). The loaded packing gland is always under spring pressure against the flax packing in the chamber, provided the spring cylinder is lifted clear of cylinder area base in the stuffing box body.

h. Packing gland. The packing gland (7) is made of phosphor bronze and is 1/2 inch in length. It is cylindrical with a large shoulder having a threaded periphery to engage into the internal threaded section of the upper part of the spring cylinder (6).

The packing gland is provided with an undercut section a sliding fit in the counterbored section of the stuffing box chamber. The center axis has a reamed hole, a sliding fit on the upper part of the rayfilter drive actuating shaft (10). The lower holes to accommodate the projecting prongs of a special wrench.

i. Stuffing box body rubber gasket. The stuffing box body rubber gasket (9) is made of synthetic rubber of rectangular shape, while the center hole is cylindrical. The rubber gasket fits between the rectangular flange of the stuffing box body, in the rectangular recess seat of the eyepiece box (11, Figure 4-29). Clearance holes are punched in the four corners to match with the clearance holes in the rectangular flange and the tapped holes in the rectangular recess face of the eyepiece box base.

4N5. Disassembly of the rayfilter drive packing gland assembly. The rayfilter drive packing gland assembly is disassembled in the following manner:

1. Remove the rayfilter drive actuating gear (11), pulling it off the square section of the rayfilter drive actuating shaft (10).

2. Remove the lockscrew (12) from the face of the packing gland (7).

3. Using a special wrench, insert the projecting prongs of the wrench in the four shallow holes in the packing gland face (7). Unscrew the packing gland from the spring cylinder (6), unloading the packing gland (7) and thus releasing the pressure on the flax packing. Remove the packing gland.

internal surface of the undercut section is provided with a 30 degrees chamfered seat to compress the flax packing properly for its adherence around the rayfilter drive actuating shaft.

Two holes are drilled in the threaded periphery along a diameter, and the wall has a narrow slot cut halfway through the shoulder to these drilled holes. In the center of the slotted section, a perpendicular upped hole is provided near the periphery for the insertion of a lockscrew (12). This lockscrew, when tightened A, spreads the narrower slotted half of the wall away from the heavier part and secures the packing gland in the internal threaded section of the spring cylinder (6). The face of the packing gland (7) is provided with four equally spaced shallow

4. Remove the rayfilter drive actuating shaft (10), carrying it out from the lower part of the stuffing box body (4) with the assembled female coupling section (2) and its securing bronze wire (3).

5. Remove the lockscrew (1) from the spring retainer face (5).

6. Using a special spring-unloading wrench (Figure 4-34), run the wing nut out a sufficient distance on the guide plug integral shaft threads. Screw the guide plug threaded periphery into the internal threaded section in the spring cylinder (6). Insert the projecting prongs of the wrench body into the four shallow holes in the

spring retainer face (5), and run the wing nut down snugly on the upper part of the wrench.

7. Unscrew the spring retainer (5), carrying with it the packing gland spring (8) and the spring cylinder (6). The spring remains at its initial compressed position (Figure 4-33).

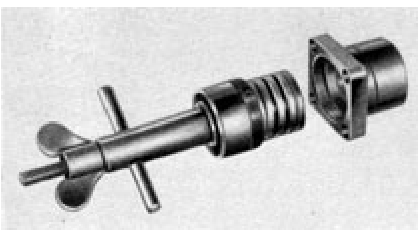

Figure 4-33. Special spring-unloading and loading wrench with spring fully loaded.

8. Unscrew the wing nut, carrying it outward on the guide plug shaft

4. Slowly screw the wing nut tight, observing the dowel pin from its recessed position in the spring retainer (5). The axial slot of the spring cylinder should be kept in alignment with the dowel pin (Figure 4-34) while screwing down the wing nut and compressing the packing gland spring (8). The wing nut is screwed down

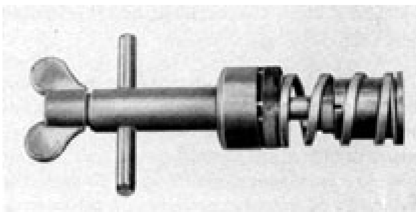

Figure 4-34. Unloading of the packing gland spring with the special wrench.

until the dowel pin is in contact with the bottom of the axial slot. In this

and thus releasing the spring tension (Figure 4-34).

9. Unscrew the spring cylinder (6) from the guide plug and integral shaft. Remove the spring cylinder (6), packing gland spring (8), and spring retainer (5).

10. Remove the old flax packing, and destroy it, leaning out the stuffing box chamber.

11. Clean all parts of this assembly in a clear cleaning solvent.

4N6. Reassembly of the rayfilter parking, gland assembly. The rayfilter packing gland assembly is reassembled in the following manner:

1. Using the special spring-loading wrench (Figure 4-34), run the wing nut out on the guide plug integral shaft threads.

2. Hole the wrench with the wing nut down, and place the spring retainer (5) over the guide plug. Engage the four shallow holes in its face on the projecting prongs of the wrench body.

3. Place the packing gland spring (8) over the guide plug, and screw the spring cylinder (6) on the threaded periphery of the guide plug.

position, the spring is fully loaded.

5. Screw the spring retainer (5) with the assembly in its fully loaded position (Figure 4-33), into the internal threaded counterbore of the stuffing box body (4). When the spring retainer is tight against the counterbored shoulder face of the stuffing box body, unscrew the wing nut and remove the projecting prongs. Unscrew the guide plug from the spring cylinder (6). As the wing nut is released, the spring releases the spring cylinder from the loaded position, carrying it down to the initial compression position.

6. The use of the loading wrench and its guide plug integral shaft and wing nut permits an ease in disassembly and reassembly of the packing gland spring (8) and removes the excessive wear of the spring retainer threaded periphery (5) and the internal threaded section in the stuffing box body (4). This would prevail were any other procedure of assembly or disassembly followed.

7. Insert and secure the lockscrew (1) in the tapped hole of the spring retainer face (5) locking the spring retainer in the stuffing box body (4) threads.

8. Place the rayfilter drive actuating shaft (10) with its assembled female coupling section (2) in the reamed hole axis in the stuffing box body (4). Carry the shaft in from the lower counterbored section of the stuffing box body.

9. Using 1/4-inch flax packing, cut a length of 3 1/4 inches, and insert it

drive packing gland assembly. All bubble numbers in Sections 4N7, 8, and 9 refer to Figure 4-35 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature

in the stuffing box chamber around the rayfilter drive actuating shaft (10).

10. Place the packing gland (7) over the shaft and in the stuffing box chamber, and press downward, using a special wrench. Place the projecting prongs of the wrench in the four shallow holes in the packing gland face. Engage the packing gland threaded periphery in the internal threads of the spring cylinder (6). Check the entrance of the packing gland in the stuffing box chamber to insure that there are no loose ends of the flax packing overlapping the shoulder of the stuffing box chamber.

11. After setting up the flax packing the first time, repeat Steps 9 and 10 the second time. Allow the packing to set 30 minutes before screwing the packing gland face flush with the face of the spring retainer (5). In this final setting up of the packing gland, the spring cylinder (6) should be observed by viewing its position through the opposite radius slots of the spring retainer (5). Note its position, as it should be in contact with the counterbored face of the spring retainer.

12. Insert and secure the lockscrew (12) in the tapped hole in the packing gland face (7), locking the packing gland in the threads of the spring cylinder (6).

13. Place the rayfilter drive actuating gear (11) on the square section of the rayfilter drive actuating shaft (10). Carry the hub section of the gear into the upper part of the reamed hole in the packing gland (7). Check the reference punched marks of the gear and shaft for proper coincidence.

1	P-1160-11	1	Eyepiece drive mechanism bevel gear
2	P-1163-11	1	Eyepiece drive mechanism bevel gear key
3	P-1179-45	6	Stuffing box body lockscrews
4	P-1179-60	1	Prism shift mechanism bevel gear lockscrew
5	P-1310-39	1	Spring retainer lockscrew
6	P-1406-2	1	Stuffing box body
7	P-1406-3	1	Spring retainer
8	P-1406-4	1	Spring cylinders
9	P-1406-5	1	Packing gland
10	P-1406-6	1	Packing gland spring
11	P-1406-7	1	Stuffing box body rubber gasket
12	P-1409-2	1	Eyepiece drive actuating shaft
13	P-1422-2	1	Packing gland lockscrew
14	P-1422-175	1	Spring retainer dowel pin

a. Stuffing box body. The stuffing box body (6) is made of phosphor bronze and is 1.500 inches in length. It is cylindrical and consists of a small undercut shoulder section, a medium shoulder section, and a large shoulder flange in the upper

14. This rayfilter packing gland assembly is pressure tested as described under Section 4N13.

4N7. Description of the eyepiece drive packing gland assembly. Figure 4-35 shows the eyepiece part. The small shoulder section is a loose fit in the bored opening and counterbored recess in the eyepiece box (11, Figure 4-29) between the two air valve body assemblies. The medium shoulder is a sliding fit in the bored hole, while the large shoulder flange is a sliding fit in the counterbored recess.

The outer face of the large shoulder flange is chamfered at 30 degrees. The chamfered face projects above the recess 6f the eyepiece box and conforms to the contour of its periphery, setting slightly below it. They large shoulder flange rests on a stuffing box body rubber gasket (11) and is secured to maintain the hermetical seal of the stuffing box body with six lockscrews (3). These lockscrews are inserted into countersunk clearance holes in the large shoulder flange and screwed into tapped holes in the counterbored recess seat.

The stuffing box body axis is provided with two reamed holes in the lower part to receive

the undercut stub section and main body section of the eyepiece drive actuating shaft (12), a sliding fit in both reamed holes.

The internal surfaces of the stuffing box body are treated in comparison to the rayfilter drive packing gland assembly stuffing box body (4, Figure 4-32) as follows: The cylinder area for the spring cylinder (8) and the packing gland spring (10) is the same depth but smaller in diameter. The center section wall is smaller in diameter and length. The stuffing box chamber is smaller in diameter displacement on the stub section of the shaft (12). The bevel gear engaging with the eyepiece prism shift bevel gear (11, Figure 4-28) of a 60 degrees pitch cone line angle, provides operation for the eyepiece drive mechanism of the eyepiece

and longer in depth, while it has a chamfered packing gland seat of 45 degrees. The large threaded counterbored section is smaller in diameter and has the same depth to receive the spring retainer (7).

b. Eyepiece drive actuating shaft. The eyepiece drive actuating shaft (12) is made of corrosion-resisting steel and is 1 29/32 inches long. The stub section is provided with a recess keyway for the insertion of a key (2). The stub section carries the eyepiece drive mechanism bevel gear (1) with a keyseat over this section and is secured with a lockscrew (4). The main body is carried a sliding fit in the large reamed hole axis, while a portion of the stub section is carried a sliding fit in the small reamed, hole axis in the stuffing box body (6). The main body section protruding through the stuffing box chamber is surrounded by flax packing.

The square section of the outer part of the shaft forms a connection with the square broached hole in the female coupling section (3) of the focusing knob assembly (Figure 4-39).

c. Eyepiece drive mechanism bevel gear. The eyepiece drive mechanism bevel gear (1) is made of phosphor bronze, with a reamed hole in its center axis, and is provided with a keyseat. The large diameter is provided with 28 bevel teeth of 32 diametral pitch, and has a pitch cone line angle of 60 degrees. It meshes with an identical bevel gear called the eyepiece prism shift bevel gear (11, Figure 4-28) of the eyepiece skeleton assembly. The bevel gear is a push fit over the inserted key (2) and the stub section of the eyepiece drive actuating shaft

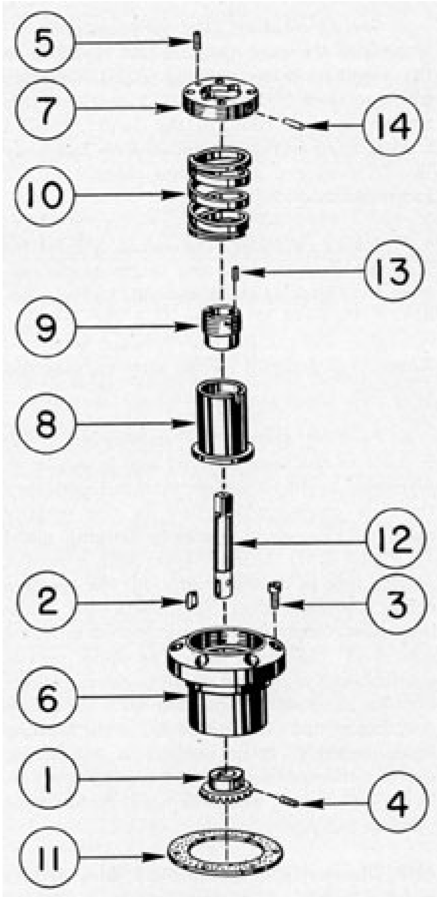

Figure 4-35. Eyepiece drive packing gland assembly.

skeleton assembly by the rotation of the focusing knob (1, Figure 4-39).

d. Packing gland spring. The packing gland spring (10) is made of the same material and thickness as the rayfilter drive packing gland assembly packing gland spring (8, Figure 4-32) except that it is shorter in length and

(12). The hub section has a tapped hole for the insertion of a lockscrew (4) to secure the bevel gear from axial

smaller in diameter. It provides the same function and is compressed to the same fully loaded length. It fits loosely on the undercut body and rests on the shoulder seat of the spring cylinder

e. Spring retainer. The spring retainer (7) is made of the same material and thickness as the rayfilter drive packing gland assembly spring retainer (5, Figure 4-32) except that it is smaller in proportion to the large threaded counterbored section of the stuffing box body (6). It is secured in the same manner with a lockscrew (5).

f. Spring cylinder. The spring cylinder (8) is of the same material and length as the rayfilter drive packing gland assembly spring cylinder (6, Figure 4-32) except that the diameter is smaller and the internal threaded section is longer. It is designed for the same purpose and functions.

g. Packing gland. The packing gland (9) is made of the same material and is smaller in diameter, having a longer threaded periphery than its corresponding part in the rayfilter drive packing gland assembly packing gland (7, Figure 4-32). It is provided with a smaller reamed hole in its center axis, for the eyepiece drive actuating shaft (12), with the lower internal surface of the undercut section provided with a 45 degrees chamfered seat. The upper part is counterbored a nominal

eyepiece drive actuating shaft (12) and the inserted key (2).

3. Remove the inserted key (2) from the stub section of the eyepiece drive actuating shaft (12).

4. Remove the lockscrew (13) from the packing gland face (9).

5. Remove the packing gland (9) in the manner described under Section 4N5, Step 3.

6. Remove the eyepiece drive actuating shaft (12), carrying it out from the large shoulder flange end of the stuffing box body (6).

7. Remove the lockscrew (5) from the spring retainer face (7).

8. Using a special spring-unloading wrench of smaller design such as that used under Section 4N5, Step 6, unscrew the spring retainer (7), carrying with it the packing gland spring (10) and the spring cylinder (8), in similar manner to that stated in Section 4N5, Step 7, and Figure 4-33.

9. Unscrew the spring cylinder (8) from the guide plug and integral shaft. Remove the spring cylinder packing gland spring (10) and the spring retainer (7, Figure 4-34).

10. Follow the procedure outlined in Section 4N5, Steps 10 and 11.

4N9. Reassembly of the eyepiece drive packing gland assembly. The eyepiece drive packing gland

depth to provide clearance for an external connection with the female coupling section (3, Figure 4-39) of the focusing knob assembly. It is secured in the spring cylinder threaded section with a lockscrew (13) in similar manner, and is designed for the same purpose and functions.

4N8. Disassembly of the eyepiece drive packing gland assembly. The eyepiece drive packing gland assembly is disassembled in the following manner:

1. Remove the lockscrew (4) from the hub section of the eyepiece drive mechanism bevel gear (1).

2. Remove the eyepiece drive mechanism bevel gear (1), pulling it off the stub section of the assembly is reassembled in the following manner:

1. Using the special spring-loading wrench of smaller design, follow the procedure described in Section 4N6, Steps 1, 2, 3, 4, and 5, for the reassembly of the spring retainer (7), packing gland spring (10), and the spring cylinder (8) in the stuffing box body (6).

2. Insert and secure the lockscrew (5) in the tapped hole of the spring retainer face (7), locking the spring retainer in the stuffing box body threads (6).

3. Place the stub section of the eyepiece drive actuating shaft (12) in the reamed hole in the stuffing box body (6), placing it in from the large shoulder flange end.

4. Using 1/8-inch flax packing, cut a length 5 inches, and insert it in the stuffing box chamber around the eyepiece drive actuating shaft (12).

5. Place the packing gland (9) on the shaft in the stuffing box chamber, and press downward using a special wrench. Place the projecting prongs of the wrench in the four shallow holes of the packing gland face. Engage the packing gland threaded periphery in the internal threads in the spring cylinder (8). Follow the precautions listed under Section 4N6, Step 10.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1179-45	12	Stuffing box body lockscrews
2	P-1310-39	2	Spring retainer lockscrews
3	P-1318-2	2	Female coupling sections
4	P-1318-2A	2	Wires
5	P-1406-1	2	Stuffing boxes bodies (L&R)
6	P-1406-3	2	Spring retainers
7	P-1406-	2	Spring

6. Follow Section 4N6, Step 11, for the second length of packing and the setting up of the packing gland (9).

7. Insert and secure the lockscrew (13) in the tapped hole in the packing gland face (9), locking the packing gland in the threads of the spring cylinder (8).

8. Insert the key (2) in the stub section of the eyepiece drive actuating shaft (12).

9. Place the eyepiece drive mechanism bevel gear (1) over the inserted key (2) and on the stub section of the eyepiece drive actuating shaft (12). The hub section of the gear faces the stuffing box body lower face (6).

10. Insert and secure the lockscrew (4) in the hub section of the bevel gear (1) and the spotted recess in the stub section of the shaft (12).

11. This eyepiece drive packing gland assembly is pressure tested as described under Section 4N13.

4N10. Description of the left and right training handle packing gland assemblies. The left end right training handle packing gland assemblies are identical. Figure 4-36 shows this assembly. All bubble numbers in Sections 4N10, 11, and 12 refer to Figure 4-36 unless otherwise specified.

	4		cylinders
8	P-1406-5	2	Packing glands
9	P-1406-6	2	Packing gland springs
10	P-1406-7	2	Stuffing box body rubber gaskets
11	P-1406-8	2	Actuating shafts (L&R)
12	P-1422-2	2	Packing gland lockscrews
13	P-1422-175	2	Spring retainer dowel pins

a. Stuffing box body. The stuffing box body (5) corresponds to the eyepiece drive packing gland assembly stuffing box body (6, Figure 4-35) except that it has a single axis reamed hole, and a chamfered lower end. This reamed hole carries the actuating shaft (11). The stuffing box body fits on either side of the eyepiece box (11, Figure 4-29) in a bored hole and countersunk recess seat on a stuffing box body rubber gasket (10). This rubber gasket maintains the hermetical seal of the stuffing box body when secured with six lockscrews (1). These lockscrews are inserted into countersunk clearance holes in the stuffing box large shoulder flange and screwed into tapped holes in the counterbored recess seat in the eyepiece box (11, Figure 4-29).

b. Actuating shaft. The actuating shaft (11) is almost identical to the rayfilter drive actuating shaft (10, Figure 4-32) except in diameter and length. The square section is larger in diameter and length. The main body is smaller in diameter and longer. The flange sections of the

shafts with two projecting lugs forming the male coupling section are identical. When assembled with the female coupling section (3), it provides interconnection with the male coupling section of the training handle rack gear and integral shaft (39, Figure 4-28) in either side of the eyepiece skeleton assembly. The square section of the shaft engages into the square broached hole in the inner bevel gear clutches (14 and 16, Figures 4-43 and

4-44 respectively) of the left and right training handle assemblies.

c. Female coupling section. The female coupling section (3) is almost identical to the female coupling section (2, Figure 4-32) of the

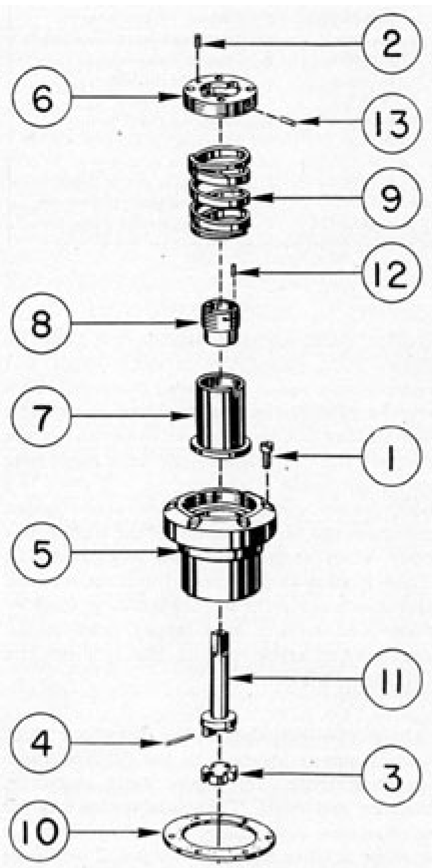

Figure 4-36. Left and right training handle packing gland assemblies.

gland spring (10, Figure 4-35) of the eyepiece drive packing gland assembly.

e. Spring retainer. The spring retainer (6) is identical to the spring retainer (7, Figure 4-35) of the eyepiece drive packing gland assembly, and is locked in the stuffing box body (5) in the same manner with a lockscrew (2).

f. Spring cylinder. The spring cylinder (7) is identical to the spring cylinder (8, Figure 4-35) of the eyepiece drive packing gland assembly.

g. Packing gland. The packing gland (8) is identical to the packing gland (9, Figure 4-35) of the eyepiece drive packing gland assembly. The counterbore receives the inner bevel gear clutches (14 or 16, Figures 4-43 and 4-44 respectively) of the left and fight training handle assemblies. It is secured in the spring cylinder (7) with a lockscrew (12) in the same manner.

4N11. Disassembly of the left or right training handle packing gland assembly. The left or right

rayfilter drive Backing gland assembly, with an exception in the outer diameter The coupling section is assembled with a bronze wire (4) in the same manner.

d. Packing gland spring. The packing gland spring (9) is identical to the packing

training handle packing gland assembly is disassembled in the following manner:

1. Remove the lockscrew (12) from the packing gland (8).

2. Remove the packing gland (8) in the manner described under Section 4N5, Step 3.

3. Remove the actuating shaft (11), carrying it out from the lower part of the stuffing box body (5).

4. Remove the lockscrew (2) from the spring retainer face (6).

5. Follow Section 4N8, Step 7, and Section 4N5, for the removal of the spring retainer (6), packing gland spring (9), and spring cylinder (7).

6. Unscrew the spring cylinder (7) carrying with it the packing gland spring (9) and the spring retainer (6). The spring remains in the initial loaded position (Figure 4-33).

7. Follow Section 4N5, Steps 10 and 11; see Figure 4-34.

4N12. Reassembly of the left or right training handle packing gland assembly. The left or right training handle packing gland assembly is reassembled in the following manner:

1. Follow the procedure stated in Section 4N9, Step 1, and Section 4N6, Steps 1, 2, 3, 4, and 5 for reassembly of the spring retainer (6), packing gland spring (9), and the spring cylinder (7) in the stuffing box, body (5) see Figures 4-33 and 4-34.

the spring is powerful and may cause injury or damage if suddenly freed.

Before being reassembled to the eyepiece box (11, Figure 4-29), packing gland assemblies of this type should be tested individually in a fixture (Figure 4-37) prepared for this purpose, using 100 psi air pressure. The glands are immersed in water. No leaks should be discernible in a half-hour test. The stadimeter transmission shaft packing gland assembly (Figure 4-30 or 4-31) can be tested upon completion of reassembly, at which

2. Insert and secure the lockscrew (2) in the tapped hole in the spring retainer face (6), locking the spring retainer in the stuffing box body (5).

3. Place the training handle actuating shaft (11) in the reamed hole axis of the stuffing box body (5), carrying it in from the lower end.

4. Follow the procedure outlined in Section 4N9, Steps 4, 5, and 6 for insertion of the flax packing and the reassembly of the packing gland (8) on the actuating shaft (11) and its engagement in the spring cylinder (7).

5. Insert and secure the lockscrew (12) in the tapped hole in the packing gland face (8), locking the packing gland in the threads of the spring cylinder (7).

6. The left and right training handle packing gland assemblies are pressure tested as described under Section 4N13.

4N13. Care of packing gland assemblies. a. General. During any general overhaul all packing gland assemblies on the instrument should be tightened, repacked if necessary, and pressure tested. All packing gland assemblies except the stadimeter transmission shaft packing gland assembly (Figures 4-30 and 4-31) can be removed with the operating shaft in place in the gland.

If repacking is necessary, it is advisable to disassemble the packing gland assembly to clean out worn particles of packing and to insure free spring action. This is done by removing the packing gland and the spring retainer. The spring retainer should be removed with care, as time an internal pressure test, using nitrogen at 100 psi, should be made. The test should be made with the periscope completely immersed in water and all glands, joints, and windows should be minutely examined for leaks.

b. Pressure test of the four springloaded type packing gland assemblies. The four spring-loaded type packing gland assemblies are pressure tested as follows:

1. Place each stuffing box body (4, 6, and 5, Figures 4-32, 4-35, and 4-36 respectively), and their respective stuffing box rubber gaskets (9, 11, and 10) in the bored hole and rectangular or counterbored recess seats in the pressure testing fixture (Figure 4-37).

2. Secure the four packing gland assemblies with lockscrews (13, 3, and 1, Figures 4-32,

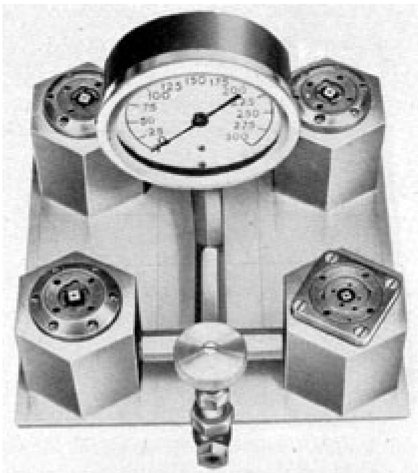

Figure 4-37. Packing gland pressure testing fixture.

4-35, and 4-36 respectively) to their respective rubber gasket and seat.

3. Use 100-psi air pressure, immersing the fixture in water. Each actuating shaft of each individual packing gland assembly must be rotated several times during the half-hour test. No leaks should be discernible during this test.

4. Upon completion of a satisfactory pressure test, remove each of the four packing gland assemblies from the pressure testing fixture, and blow off all water, drying them with air.

5. Place the packing gland assemblies to one side until ready for their reassembly to the eyepiece box (11, Figure 4-29).

O. EYEPIECE WINDOW ASSEMBLY

4O1. Description of the eyepiece window assembly. The eyepiece window assembly consists of the various parts to permit efficient and comfortable use by the observer of any combination of the rayfilter and eye blinder attachments. Figure 4-38 shows the eyepiece window assembly.

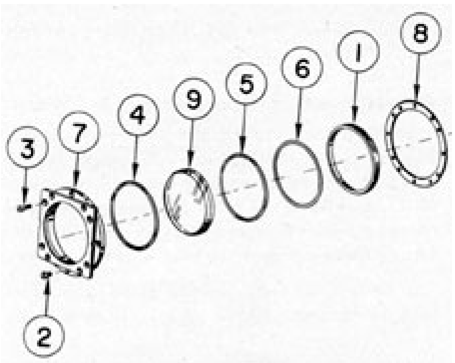

Figure 4-38. Eyepiece window assembly.

All bubble numbers in Sections 4O1, 2, and 3 refer to Figure 4-38 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1171-7	1	Clamp ring

an internal pressure test. It is cylindrical, and provides a means of sealing without obstruction to the emerging light rays, and offers a transparent medium through which light can be transmitted. The front surface is beveled at a 45 degrees angle, thus insuring the hermetical seal between the bezel seat of the frame (7) and the eyepiece window with a rubber gasket (4) at the above beveled surface,

b. Frame. The frame (7) is made of cast phosphor bronze and is 0.843 inch in width. It is of such construction as to withstand an internal pressure test of 300 psi. The outer part above the recess groove section has a rectangular projection section with narrow flat sides serving as flanges and it projects outward from the eyepiece box (11, Figure 4-29) when assembled. Each side flange has a. shallow recess groove section for clearance to carry two rayfilter plate straps (3, Figure 4-40) when assembled in the shallow recess groove sections which have sufficient sliding clearance.

2	P-1179-66A	4	Frame lockscrews (short)
3	P-1179-66B	8	Frame lockscrews (long)
4	P-1179-102	1	Bezel rubber gasket
5	P-1179-103	1	Clamp ring rubber gasket
6	P-1179-120	1	Metal protection washer
7	P-1408-1	1	Frame
8	P-1408-5	1	Frame rubber gasket
9	P-1418-15	1	Eyepiece window

a. Eyepiece window. The eyepiece window (9) consists of one crown element with parallel surfaces, and has sufficient thickness to withstand

The frame has a large cylindrical shoulder flange, with its outer face flush with the shallow recess groove sections. The large cylindrical shoulder flange has four equally spaced countersunk clearance holes, while the rectangular flange has eight countersunk clearance holes. The large cylindrical shoulder flange is a sliding fit in the counterbored recess seat in the eyepiece window assembly opening of the eyepiece box (11, Figure 4-29) and rests on this counterbored recess seat above a frame rubber gasket (8). It is secured with four short and eight long lockscrews (2 and 3) which extend into tapped holes in the counterbored recess seat.

The lower part of the frame below the large cylindrical shoulder flange is undercut, and serves as an alignment support section. It is a

sliding fit in the bored hole in the front of the eyepiece box and it also provides the necessary wall to carry the internal clamping arrangement for the eyepiece window (9).

The inner surface of the frame is bored to provide a clear aperture to the emerging light rays, for all positions of plus and minus diopter settings. Two counterbores are provided with a 45 degrees beveled seat section. The beveled seat section serves as a bezel shoulder, and has a bezel rubber gasket (4) adhering to it with the tightened eyepiece window (9). The small counterbore provides clearance for the eyepiece window periphery, while the large counterbore is

support section of the frame resting on its lower face. Press downward evenly on the lens tissue and eyepiece window to break the sticking contact of the eyepiece window (9) and the bezel rubber gasket (4). The loosened eyepiece window (9) allows the clamp ring rubber gasket (5) and the metal protection washer (6) to be removed with it.

3. The bezel rubber gasket (4) adheres to the bezel shoulder of the frame (7). This connection must be broken.

4O3. Reassembly of the eyepiece window assembly. The eyepiece

threaded to receive the eyepiece window clamp ring (1).

c. Metal protection washer. The metal protection washer (6) is a thin brass washer with nominal wall thickness. This washer is cylindrical, and offers a smooth face for the contact of the clamp ring (1) as it is screwed in to tighten the rubber gasket (5) which is located on the inner surface of the eyepiece window (9). The metal washer is placed between the clamp ring rubber gasket (5) and the clamp ring (1), and protects the clamp ring rubber gasket (5) from being disrupted when tightening the eyepiece window with the clamp ring to maintain the hermetical seal.

d. Clamp ring. The clamp rings (1) is made of brass tubing and is 0.285 inch in width. It is cylindrical and has a nominal wall thickness. The periphery is threaded to engage in the internal threaded section in the large counterbore of the frame (7). The internal wall is tapered, and is of nominal thickness to permit sufficient tension for sealing the eyepiece window (9). The narrow face has two opposite slots 180 degrees apart, to permit clamping, removal, and reassembly of the eyepiece window by means of a special wrench.

4O2. Disassembly of the eyepiece window assembly. The eyepiece window assembly is disassembled in the following manner:

1. Use a special wrench in the two opposite slots in the bottom face of the clamp ring (1). Unscrew the clamp ring from the frame (7).

2. Place a piece of lens tissue on the front face of the eyepiece window (9) with the alignment window assembly is reassembled in the following manner:

1. Turn the rectangular section of the frame (7) so that it is lying on its outer face.

2. Clean the eyepiece window in similar manner to that prescribed for the lenses of the various other assemblies.

3. Place the new bezel rubber gasket (4) on the bezel shoulder seat in the frame (7).

4. Place the new clamp ring rubber gasket (5) on the inner face of the eyepiece window (9).

5. Place the metal protection washer (6) on the clamp ring rubber gasket (5).

6. Screw the clamp ring (1) in the internal threaded section in the frame (7). Use a special wrench to tighten the eyepiece window (9) sufficiently to compress both the bezel rubber gasket (4) and the clamp ring rubber gasket (5). The eyepiece window should not be tightened to such an extent as to cause any strain in the glass. Any strain causes the eyepiece window to crack in time, necessitating renewal.

7. Place the eyepiece window assembly in a special pressure testing jig, with the frame rubber gasket (8) assemble in the counterbored recess seat in the jig. Secure the frame with four short and eight long lockscrews (2 and 3).

8. A pressure test of 100 psi under water for 30 minutes insures the hermetical seal of the eyepiece window (9).

9. After a successful pressure test, remove the four short and eight long lockscrews (2 and 3) and remove the assembly and the frame rubber gasket (8). Place aside the assembly with its lockscrews until ready for reassembly in the eyepiece box (11, Figure 4-29).

P. FOCUSING KNOB ASSEMBLY

4P1. Description of the focusing knob assembly. a. Location. The focusing knob assembly is attached to the external recess of the eyepiece box (11). It is located on the right-hand side of the periscope below the hoisting yoke in such position as to be within easy reach of the right

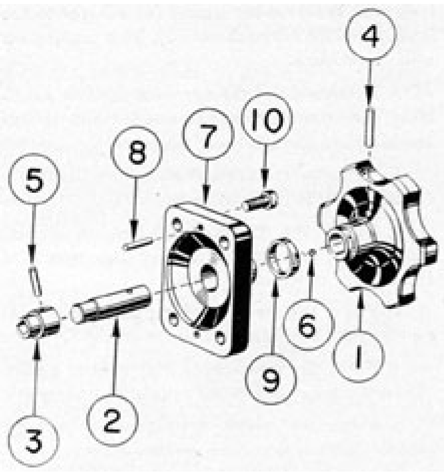

Figure 4-39. Focusing knob assembly.

hand of the observer. Figure 4-29 shows the focusing knob assembly. All bubble numbers in Sections 4P1, 2 and 3 refer to Figure 4-39 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1133-	1	Knob

mechanism by hand. The periphery is scalloped. It is filleted from the scalloped depth, and tapers down to a hub section. The hub section is undercut to carry a graduated diopter ring (9) secured with a lockscrew (6). The axis is provided with a reamed hole of appropriate depth to receive the long section of the shaft (2), and is secured to the shaft with a taper pin (4) after assembly.

c. Knob shaft. The knob shaft (2) is made of monel metal and is 1 7/8 inches in length. It forms a connection between the knob at one part and a female coupling section (3) at the other. The long section of the shaft carries the knob secured with a taper pin (4). The stub section of the shaft is undercut to carry the large hub section of the female coupling section (3) which is secured with a straight pin (5). When assembled, the shaft provides a rigid support for the knob between the female coupling section (3) and the reamed hole in the knob bracket (7) for manipulation of the focusing mechanism.

d. Female coupling section. The female coupling section (3) is made

	1		
2	P-1133-7	1	Knob shaft
3	P-1133-8	1	Female coupling section
4	P-1179-194	1	Knob and shaft taper pin
5	P-1179-195	1	Knob shaft and female coupling dowel pin
6	P-1310-39	1	Diopter ring lockscrew
7	P-1408-2	1	Knob bracket
8	P-1408-2A	2	Knob bracket dowel pins
9	P-1408-6	1	Diopter ring
10	P-1422-9	4	Knob bracket lockscrews

b. Knob. The knob (1) is made of phosphor bronze and is 1 13/32 inches long. It is of sufficient diameter to permit easy operation of the focusing

of bronze rod and is 3/4 inch in length. It consists of a large hub section and an undercut alignment support section. The hub section is provided with a reamed hole of sufficient depth to retain it to the knob shaft with a straight pin (5). The alignment support section has a square broached hole and is a sliding fit on the square section of the eyepiece drive actuating shaft (12, Figure 4-35) of the eyepiece drive packing gland assembly. The alignment support section is a sliding fit into the counterbored recess in the packing gland (9) of the same assembly. It fits simultaneously over the square section of the shaft and in the packing gland counter bored recess.

e. Knob bracket. The knob bracket (7) is made of cast phosphor bronze and is rectangular. It provides a rigid joint for interconnection between the eyepiece drive packing assembly and the female coupling section (3). The outer surface is filleted from the base of the knob bracket to the hub section. The base is counterbored with a 30 degrees chamfered section, extending from the small counterbore to the

large, to allow clearance over the protruding part of the assembled eyepiece drive packing gland assembly stuffing box body (6, Figure 4-35).

The axis is provided with a reamed hole and counterbored section, with the reamed hole serving as a bearing, and the counterbored section allowing clearance for the large hub of the female coupling section (3). The two dowel pins (8)

3. Remove the lockscrew (6) from the diopter ring (9) and the shoulder spot face of the knob (1). Remove the diopter ring (9) from the knob (1).

4. Remove the knob bracket (7) from the long section of the knob shaft (2).

5. The straight pin (5) is not removed from the female coupling

maintain the alignment of the knob bracket to the milled recess in the eyepiece box. The bracket is secured with four lockscrews (10). The lockscrews (10) are inserted into countersunk clearance holes in the rectangular bracket base wall and screwed in tapped holes in the eyepiece box (11, Figure 4-29).

f. Diopter ring. The diopter ring (9) is made of brass material and is cylindrical. It has a nominal width and wall thickness, and is a sliding fit on the turned shoulder of the knob section. The outer circumference is graduated from 0 to 3 minus and 0 to 1.5 plus diopters. The graduated lines are spaced equally for each diopter line, having a plus and minus engraved indication above and below the zero diopter line. The diopter ring is a visual indication of the diopter reading, as the eyepiece lens is focused, and is observed from its coincidence with the stationary zero reference line in the knob bracket (7). The diopter ring is set to zero diopter and is secured with a lockscrew (6) at the factory, after the periscope is charged with nitrogen at 7 1/2 psi, with the use of an auxiliary telescope:

4P2. Disassembly of the focusing knob assembly. The focusing knob assembly is disassembled in the following manner:

1. Remove the taper pin (4) from the knob (1) and the knob shaft (2).

2. Remove the knob (1) sliding it off the knob shaft (2).

section (3) and the knob shaft (2) as it is riveted at assembly.

4P3. Reassembly of the focusing knob assembly. The focusing knob assembly is reassembled in the following manner.

1. Slide the large hub section of the female coupling section (3) on the stub section of the knob shaft (2). Check the straight pin holes of both for proper alignment.

2. Insert and secure the straight pin (5) in the lined up holes, securing the female coupling section (3) to the stub section of the knob shaft (2) and riveting the straight pin at assembly. (Steps 1 and 2 are included for information, as these pieces normally are not disassembled.)

3. Place the knob bracket (7) over the long section of the knob shaft (2). The counterbored section slides over the large hub section of the assembled female coupling section (3).

4. Place the diopter ring (9) on the turned shoulder of the knob bracket hub section (7). Check the graduations; the minus graduations should be located in the lower part, using the stationary reference line of the knob bracket. Rotate the diopter ring, to ascertain that the tapped hole lines up with the spot face in the turned shoulder of the knob (1), and insert and secure the lockscrew (6).

5. Place the knob (1) on the outer part of the knob shaft (2). Insert and secure the taper pin (4) in the lined up holes of the knob and the knob shaft.

Q. RAYFILTER ASSEMBLY

4Q1. Description of the rayfilter assembly. a. Location. The rayfilter assembly is attached to the eyepiece window section of the periscope, and is of such design that it does not restrict the field of the periscope to the observer. It is mounted external to the hermetically sealed part of the periscope and comprises various parts to permit the operator free and unobstructed access to the eyepiece window (9). Figure 4-40 shows the rayfilter assembly. All bubble numbers in Sections 4Q1, 2, and 3 refer to Figure 4-40 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1389-4	2	Spring actuated plunger knob lockscrews
2	P-1411-2	1	Rayfilter plate
3	P-1411-3	2	Rayfilter plate straps
4	P-1412-1	1	Left side bar
5	P-1412-2	1	Right side bar
6	P-1412-5	2	Anchor screw pins
7	P-1412-6	1	Detent catch spring
8	P-1412-7	1	Rayfilter drive actuating gear rack
9	P-1413-1	1	Housing disk
10	P-1413-2	1	Housing knob
11	P-1413-3	2	Friction catch spring retainers
12	P-1413-	2	Friction catch

side. Each rayfilter plate strap is secured to the rayfilter plate (2) with seven lockscrews (19).

The lower section has a cast inside recess with nominal body thickness with wider side shoulders and a narrow lower shoulder. The side shoulders allow the rayfilter plate a vertical movement of 1 inch and serve as stops. The left side, when viewed from the rear of the inside recess of the lower section, is provided with a rectangular raised boss section or a rayfilter drive actuating gear rack (8) secured with four lockscrews (19) and maintained in alignment with two dowel pins (20). This gear rack meshes with a rayfilter drive actuating gear (11, Figure 4-32), projecting externally from the rayfilter drive packing gland assembly. The rayfilter drive actuating gear (11) is synchronized to carry the rayfilter plate (2) vertically with the eyepiece drive mechanism of the eyepiece skeleton assembly (Figure 4-28) for the focusing movement of 1 1/2 plus and 3 minus diopters.

The exteriors of the side shoulders of the lower section are stepped with two spotted recesses in the center of each step. The spotted recesses of 120 degrees engage the

	4		springs
13	P-1413-5	3	Rayfilter clamp rings
14	P-1413-6	1	Housing disk shoulder washer
15	P-1413-7	1	Housing disk shoulder washer lockscrew
16	P-1418-16	3	Red, green, and yellow rayfilters
17	P-1422-4	2	Detent catch spring lockscrews
18	P-1422-5	10	Housing side bar lockscrews
19	P-1422-6	18	Rayfilter plate strap and rayfilter gear rack lockscrews
20	P-1422-176	2	Rayfilter drive actuating gear rack dowel pins
21	P-1438-1	1	Rayfilter housing
22	P-1438-2	2	Plunger rod spring bushings
23	P-1438-3	2	Spring-actuated plunger rods
24	P-1438-4	2	Spring actuated plunger knobs
25	P-1438-5	2	Plunger rod springs
26	P-1448-2	2	Ball bearing friction catches

ball bearing friction catches (26) to retain the lower swinging part of the rayfilter housing (21). Two rectangular projecting bosses on the lower part serve as stops to engage in slots in the lower part of the inner, wall of the rayfilter housing (21) as the ball bearing friction catches (26) engage in the spotted recesses.

The main body wall is provided with a 3-inch opening which has anti-reflection threads in the inner circumference. This opening permits free access to the field of the periscope for the observer. The inside recess of the main body is provided with sliding vertical clearance over the flat flanges of the eyepiece window frame (7, Figure 4-38).

c. Rayfilter plate straps. The two rayfilter plate straps (3) are made of brass and are 4.624 inches in length, having a nominal thickness and width. Each strap fits in a recess in each side shoulder of the rayfilter plate (2), and is secured to each recess with seven lockscrews (19). These lockscrews are inserted into countersunk clearance holes in the rayfilter plate (2) and screwed into tapped holes in each strap. The outer side of each strap is flush with

b. Rayfilter plate. The rayfilter plate (2) is made of cast phosphor bronze and is rectangular. This plate serves as a foundation for the remaining parts of the assembly. The upper part is provided with a center male hinge projection section with a reamed hole in its axis to accommodate two spring actuated plunger rods (23) of the two female hinge projection sections of the rayfilter housing (21). The upper main inside section has a cast recess allowing a nominal main body thickness, with side shoulders and a narrow upper shoulder. The side shoulders are provided with recesses to carry the rayfilter plate straps (3) on each

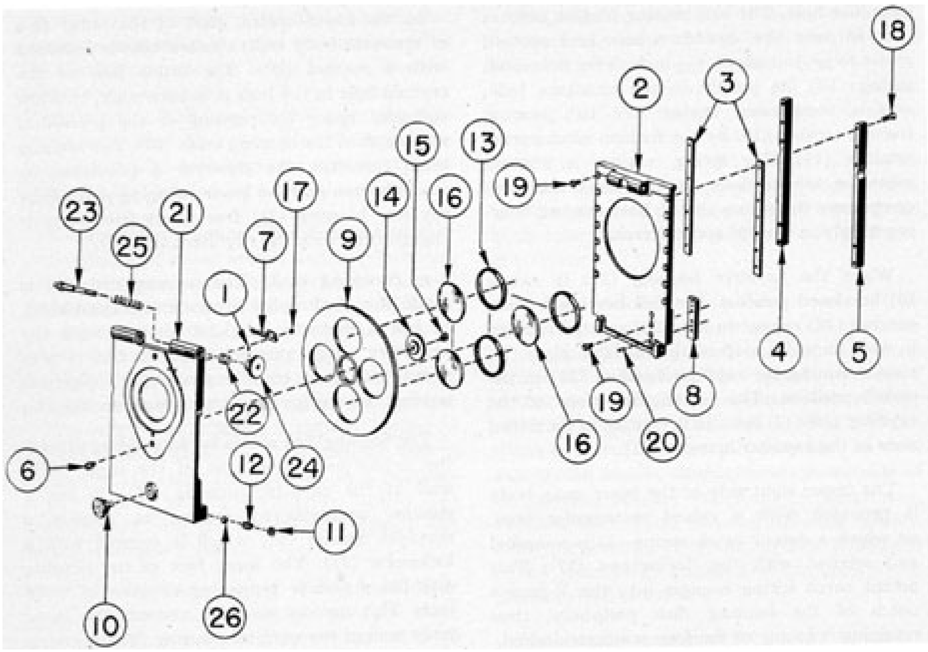

Figure 4-40. Rayfilter assembly.

the side shoulders of the rayfilter plate (2), while the inward protruding part fits under the side flanges and in the shallow recess groove section in the eyepiece window frame (7, Figure, 4-38).

d. Rayfilter housing. The rayfilter housing (21) is made of cast phosphor bronze, and is The inside section has cast recesses allowing a nominal main body thickness, with a shallow shoulder wall bordering its rectangular body. A cylindrical raised boss below the bored opening is provided to carry the housing disk bored axis hole (9). The side shoulders are counterbored, concentric

rectangular. This housing serves as an apron foundation which can be removed, readily during the installation and removal of the periscope. It carries the rayfilter parts.

The upper part is provided with two female hinge projection sections, a sliding fit over the center male hinge projection section of the rayfilter plate (2). Both hinge projection sections are reamed in their axis to carry the spring-actuated plunger rods (23) which are moved axially against spring tension for removal or reassembly to the center male hinge projection of the rayfilter plate. Both female hinge projection sections have a threaded section located at each outer end to carry two plunger rod spring bushings (22).

with the cylindrical raised boss to provide clearance for the protruding periphery of the housing disk (9).

The cylindrical raised boss has a tapped hole in its center axis and a shallow counterbored section. The counterbored section carries the housing disk shoulder washer (14), while the tapped hole receives a lockscrew (15) to secure the shoulder washer.

The lower part of the inner section has two rectangular shoulder projections on both sides, in the center of which two ball bearing friction catches are provided. These two shoulder projections are a sliding fit over the shoulder steps of the rayfilter plate (2). The center of each projection is provided with a 90 degrees spotted recess and a tapped section with a smaller

clearance hole. The ball bearing friction catches (26) fit into the clearance hole and spotted recess to project about 1/32 inch. A friction catch spring (12) fits loosely in the clearance hole, and is compressed against the ball bearing friction catches (26) by the friction catch spring retainer (11). The spring retainer is screwed into the tapped hole in the projection and compresses the spring (12) to hold the ball bearing snugly in the 90 degrees spotted recess.

When the rayfilter housing (21) is swung to the closed position, the ball bearing friction catches (26)

In the lower central part of the outer face of the main body wall, a raised boss is provided with a reamed hole. The inside face of the reamed hole in the boss is countersunk, to allow sufficient space for peening of the pressed-in stub shaft of the housing knob (10). The housing knob furnishes the observer a provision by which he can pull the lower swinging part of the rayfilter housing (21) free of its friction catch engagement with the rayfilter plate (2).

e. Housing disk. The housing disk (9) is made of cast

engage in the 120 degree spotted recesses in each shoulder stop of the rayfilter plate (2), thus retaining the rayfilter housing (21) in the closed position. The rectangular stops of the rayfilter plate (2) are also in contact in the milled slots in the rayfilter housing (21).

The upper right side of the inner main body is provided with a raised rectangular boss, on which a detent catch spring (7) is mounted and secured with two lockscrews (17). This detent catch spring engages into the V-groove notch of the housing disk periphery, thus retaining it in any of the four positions desired.

The side shoulders above the two lower rectangular projections are provided with a left and right side bar (4 and 5) on the inner face of the rayfilter housing (21). These side bars are secured with five lockscrews (18) which are inserted in countersunk clearance holes in the side bars and screwed into tapped holes in the rayfilter housing sides shoulders. These side bars prevent foreign matter from being carried into the inner assembly of the rayfilter housing (21).

The outer face of the main body is provided with a large, flat, raised boss which has a bored hole and shallow counterfaced section. The bored hole is provided for light transmission and has anti-reflection threads on its inner circumference. The base of the eye blinder assembly and the variable density polaroid filter assembly is centered in this shallow counterfaced recess, and rests on the large flat raised boss. Either of the two assemblies is retained by two anchor screw pins (6), located with an appropriate phosphor bronze and is cylindrical. It has a diameter of 5.200 inches, with the periphery rough parallel knurled, and is provided with four equally spaced 90 degrees V-groove notches to engage a detent catch spring (7).

The housing disk axis is bored a sliding fit over the cylindrical raised boss of the inner body wall of the rayfilter housing (21). It has a shallow counterbored section to receive a shoulder washer (14) which is secured with a lockscrew (15). The inner face of the housing disk has a narrow projecting shoulder of 0.016 inch. This narrow shoulder contacts the inner body wall of the rayfilter housing (21, allowing the remaining wall of the housing disk clearance over the rayfilter housing inner body wall. Four equally spaced bored holes and threaded counterbored sections are provided in the same centerlines with the four periphery V-groove notches, for the insertion of red, green, and yellow rayfilters (16). The rayfilters rest on the counterbored seat in the counterbore of the clamp rings (13). The fourth opening remains clear.

f. Rayfilters. The three rayfilters (16) consist simply of cylindrical, colored filter glass with parallel surfaces. Three shades are used red, green, and yellow. These are provided for various conditions of observation. Each rayfilter is mounted in the counterbore of the clamp ring (13) and rests against the narrow shoulder

center distance concentric with the bored hole and counterfaced shallow recess.

seat of each threaded counterbored section in the housing disk (9).

g. Clamp rings. The three clamp rings (13) are made of seamless brass tubing, having a bored hole and counterbored section provision. The periphery is threaded and engages in the threaded counterbored section of any of the four

openings of the housing disk. The counterbored recess is a sliding fit over the periphery of the rayfilter, securing it to the narrow shoulder seat of the housing disk (9). The inner wall of the clamp ring is chamfered at 20 degrees from the bore in its outer face. The outer face of each clamp ring is provided with opposite slots of shallow depth for the insertion of a special wrench.

h. Shoulder washer. The shoulder washer (14) is made of rolled bronze and is cylindrical. The large diameter is a sliding fit in the counterbored section in the housing disk axis while the small shoulder is a sliding fit in the counterbored section in the raised boss on the inner body wall of the rayfilter housing (21). The small shoulder rests in the counterbored section seat in the raised boss, offering a nominal clearance to the housing disk (9). It is secured with a lockscrew (15) which is inserted in a countersunk clearance hole in the shoulder washer (14) and screwed into the tapped hole axis in the cylindrical raised boss.

i. Detent catch spring. The detent catch spring (7) is made of

The finger grip levers of these assemblies, by means of tension springs, force them into the undercut sections of the anchor screw pins, thus retaining each assembly to the rayfilter housing (21). The upper and lower shoulders next to the undercut section are chamfered to allow for rapid removal of the finger grip levers of either assembly. The upper face has a radius to allow centering and ease of entry in the holes in the base plate of either assembly and the finger grip levers.

k. Spring-actuated plunger rods. The two spring-actuated plunger rods (23) are made of corrosion-resisting steel material. The stub section is a sliding fit in the reamed hole located in the center male hinge projection section of the rayfilter plate (2). The stub section of each spring-actuated plunger rod assembled in each side of the female hinge projection sections of the rayfilter housing (21) form the hinge pins, to allow the rayfilter housing to swing upward when

phosphor-bronze sheet and tempered. It has a developed length of 1.440 inches with a large rectangular section with two clearance holes as its securing part. This section is bent at 90 degrees and is secured to the raised rectangular boss section in the upper right side of the inner body wall of the rayfilter housing with two lockscrews (17). The projecting arm of this detent catch spring is provided with a 90 degrees detent bend conforming to the four 90 degrees V-groove notches in the housing disk periphery. The 90 degrees detent bend has a protruding depth of 0.093 inch, and when secured in the 90 degrees V-groove notch of the housing disk periphery, it holds the housing disk in the centerline under its spring tension.

j. Anchor screw pins. The two anchor screw pins (6) are made of corrosion-resisting steel and are 0.516 inch in length. The lower threaded part engages in the tapped holes in the flat raised boss section and main Wall of the rayfilter housing (21), up to its lower narrow shoulder and is soldered at assembly. The undercut section permits locking of the finger grip levers of the eye blinder assembly (Figure 4-42) and the variable density polaroid assembly (Figure 4-41).

the lower part of the rayfilter housing is pulled clear of its engagement in the friction catch spotted recesses.

The shoulder section of the plunger rod slides axially in the reamed hole in each female hinge projection section against the spring tension, when pulled outward by the assembled plunger knobs. The plunger knobs are pulled outward only when removing or replacing the rayfilter housing (21).

The stem section of the plunger rods slides through each reamed hole in the plunger rod spring bushings (22), with the outer part of the stem section threaded to carry a plunger knob (24). The main body is slightly larger than the stem section in order to serve as a stop and to restrict the outward thrust of the plunger rod. A compression spring (25) fits over the main body up to the shoulder section, and is retained in the reamed hole in each female hinge projection section with a threaded plunger rod spring bushing (22).

l. Plunger rod spring bushings. The two plunger rod spring bushings (22) are made of phosphor bronze, The periphery is threaded to engage into tapped holes in the outer part of the female hinge projection sections of the rayfilter housing (21). The plunger bushings

serve as a spring retainer and plunger release stop; the reamed axis hole serves as an alignment guide for the stem section of the plunger rod. Two opposite slots are provided in the outer face for the insertion of a screwdriver blade.

m. Spring-actuated plunger knobs. The two spring-actuated plunger knobs (24) are made of phosphor bronze and are chromium plated. The periphery of each knob is fine diamond knurled to provide a firm finger grip. The center axis has a tapped hole to engage on the threaded part of the plunger rod stem section. The contour of the external surface is similar to an ordinary knob, with a hub section provided with a tapped hole to receive a lockscrew (1), thus securing the knob to the plunger rod. The knob offers the observer a firm grip projection and serves as a stop when the rayfilter housing (21) is removed.

4Q2. Disassembly of the rayfilter assembly. The rayfilter assembly is disassembled in the following manner:

1. Lift the lower swinging part of the rayfilter housing (21) by grasping the housing knob (10) and pulling it clear of its engagement in the friction catch spotted recesses of the rayfilter plate (2).

2. Grasp the two spring-actuated plunger knobs (24) pulling them outward as far as possible, thus removing the rayfilter housing (21) from the rayfilter plate (2).

3. Remove the rayfilter plate (2) by removing the seven lockscrews (19) and the rayfilter plate straps (3) from each side. This simulates the

7. Using an adjustable wrench, unscrew the clamp rings (13) from the housing disk (9). Remove the clamp rings and the red, green, and yellow rayfilters (16), in the order named. Wrap the filters in lens tissue and place to one side to prevent scratches and breakage.

8. Remove the two lockscrews (1), unscrewing them from the hubs of the spring-actuated. plunger knobs (24).

9. Wrap a piece of emery cloth around the extended part of each spring-actuated plunger rod (23). Holding the emery cloth and rod firmly with a pair of parallel pliers, unscrew each spring-actuated plunger knob (24) from the threaded part of the spring-actuated plunger rods (23) one by one.

10. Remove each plunger rod spring bushing (22). Using a screwdriver of appropriate size, unscrew the plunger bushings from the outer parts of the two female hinge projection sections of the rayfilter housing (21).

11. Remove the spring-actuated plunger rods (23) and the plunger rod springs (2S) one by one from the reamed holes in the rayfilter housing two female hinge projection sections (21).

12. Remove the two friction catch spring retainers (11), unscrewing them from the outer two lower sides of the rayfilter housing (21), removing the two friction catch springs

removal of the rayfilter plate from the eyepiece window frame (7, Figure 4-38).

4. Remove the five lockscrews (18) from the left and right side bars (4 and 5), and remove the side bars from the rear shoulders of the rayfilter housing (21).

5. Remove the lockscrews (15) from the housing disk shoulder washer (14).

6. Remove the housing disk (9), lifting it away from the rayfilter housing (21), carrying the shoulder washer (14) with it. Remove the shoulder washer (14) from the housing disk (9).

(12), and the two ball bearing friction catches (26).

13. Remove the two lockscrews (17) from the detent catch spring (7) and remove the detent catch spring from the rayfilter housing (21).

14. Remove the four lockscrews (19) from the front lower right side of the rayfilter plate (2), unscrewing the lockscrews from the rayfilter drive actuating gear rack (8). Remove the rayfilter drive actuating gear rack with the two dowel pins (20).

4Q3. Reassembly of the rayfilter assembly. The rayfilter assembly is reassembled in the following manner:

1. Place the rayfilter drive actuating ear rack (8) with its two dowel pins (20) on the lower right inner face of the rayfilter plate (2). Secure the gear rack with four lockscrews (19).

These lockscrews are inserted in countersunk clearance holes in the rayfilter plate front wall (2) and screwed into tapped holes in the gear rack.

2. Focus the eyepiece lens to the center of the eyepiece window frame (7, Figure 4-38), making certain that the rayfilter drive actuating gear (11) is on the protruding square section of the rayfilter drive actuating shaft (10, Figure 4-32) of the rayfilter drive packing gland assembly. This central

the emery cloth and stub section with a pair of parallel pliers. Compress the spring and attach the spring-actuated plunger knobs (24), screwing them on the threaded sections of the plunger rods (23) until the shoulder section of the plunger rod is flush with the inner face of each female hinge projection section.

9. Insert the lockscrew (1) in the hub section of the spring-actuated plunger rod knobs

position is necessary for full focusing travel.

3. The rayfilter plate (2) is mounted only when the eyepiece lens is in the center of the eyepiece window frame to establish full synchronized movement. Place the rayfilter plate (2) over the flat sides of the eyepiece window frame (7, Figure 4-38); check the rayfilter drive actuating gear rack (8) to ascertain its engagement with the rayfilter drive actuating gear (11, Figure 4-32).

4. With the rayfilter plate (2) properly centered, and the gear rack in mesh with the rayfilter drive actuating gear, place both rayfilter plate straps (3) in each side shoulder recess of the rayfilter plate and the recess groove section of the eyepiece window frame (7, Figure 4-38). Secure the straps with seven lockscrews (19). These lockscrews are inserted in countersunk clearance holes in the rayfilter plate (2) and screwed in the tapped holes in the straps.

5. Place both ball bearing friction catches (26) in clearance holes in each rectangular side shoulder projection in the lower part of the rayfilter housing (21) with both friction catch springs (12), securing them with both friction catch spring retainers (11).

6. Place the two plunger rod spring bushings (22) in the outer threaded part of the female hinge projection sections of the rayfilter housing (21). Secure them with a screwdriver.

7. Place the plunger rod springs (25) on the spring-actuated plunger rods (3). Insert the spring and plunger rod in the reamed hole in each female hinge projection section, (24), securing the knobs on the spring-actuated plunger rods (23).

10. Place the detent catch spring (7) on the raised rectangular boss located on the inner right side of the rayfilter housing (21), and secure it with two lockscrews (17),

11. Clean the three rayfilters (16) before reassembling them in the housing disk (9), placing them in the housing disk in a counterclockwise order of red, green, and yellow when viewed from the rear. Place each rayfilter in the counterbored recess in the clamp ring (13), and screw the clamp ring with the rayfilter in the housing disk (9). Secure each rayfilter snugly, using a special wrench inserted in the opposite slots of the clamp ring. Do not place any strain on the rayfilters while clamping, as this causes breakage.

12. Place the housing disk (9) on the raised cylindrical boss, tip the housing disk, and engage the periphery V-groove notch in the detent catch spring (7). A slight pressure against the detent catch spring permits the housing disk to slide easily over the cylindrical raised boss.

13. Place the housing disk shoulder washer (14) in the counterbored recess in the cylindrical raised boss of the rayfilter housing (21) and the housing disk (9), and secure the shoulder washer with a lockscrew (15). This lockscrew is inserted in a countersunk

carrying them in from the center opening.

8. Place a piece of fine emery cloth around the stub section of the plunger rod and grasp

clearance hole in the shoulder washer (14) and screwed into a tapped hole in the raised cylindrical boss axis.

14. Place the left and right side bars (4 and 5) in the recess shoulders on each side of the rayfilter housing, and secure them with five lockscrews each (18). These lockscrews are inserted in the countersunk clearance holes in each side bar and screwed into tapped holes in the rayfilter housing recess shoulders.

15. Grasp both spring-actuated plunger knobs (24), pull them outward as far as possible, and assemble the rayfilter housing (21) female hinge projection sections to the center male hinge projection section of the rayfilter plate (2). Release the outward tension of the spring-actuated plunger knobs; the springs allow the plunger rods to snap into the reamed hole in the center male hinge projection section of the rayfilter plate. Push the lower part of the rayfilter housing down to the rectangular stops in the rayfilter plate (2); the ball bearing friction catches (26) will engage in the spotted recesses in the shoulder steps of the rayfilter plate in this closed position.

R. VARIABLE DENSITY POLAROID FILTER ASSEMBLY

4R1. Description of the variable density polaroid filter assembly. The variable density polaroid filter assembly is designed to provide an adjustable filter to eliminate glare from the surface of the sea. If desired, it may be used in conjunction with colored filters. Figure 4-41 shows this assembly; all bubble numbers in Sections 4N1, 2, and 3 refer to Figure 4-41 unless otherwise specified.

Ill. No.	Drawing Number	Num-ber	Nomenclature

receive a polaroid socket housing (11). The inner face has a cylindrical shoulder which is a sliding fit in the counterbored recess and rests on the recess seat in the large flat raised boss in the outer part of the rayfilter housing (21, Figure 4-40).

The upper and lower projecting parts of the base plate are slotted to carry the right and left finger grip levers (1 and 2) and two tension springs (3). Two clearance holes are provided in the upper and

		Re-quired	
1	P-1414-3	1	Right finger grip lever
2	P-1414-4	1	Left finger grip lever
3	P-1414-5	2	Finger grip lever springs
4	P-1415-2	2	Clamp rings
5	P-1415-3	1	Outer, polaroid cradle
6	P-1415-4	1	Outer polaroid cradle actuating screw
7	P-1415-5	1	Knurled actuating sleeve
8	P-1415-6	2	Special polaroid filters
9	P-1416-1	1	Base plate
10	P-1416-2	1	Face ring
11	P-1416-3	1	Polaroid socket housing
12	P-1416-4	1	Friction tension, spring
13	P-1416-5	2	Finger grip lever thrust stop screw pins
14	P-1416-6	2	Finger grip lever pivot screw pins
15	P-1416-7	1	Eyeguard mount
16	P-1416-8	2	Eyeguard mount friction

lower centerline in these slotted sections. Each hole is concentric with the bore, with an appropriate center distance to slide over the anchor screw pins (6, Figure 4-40) projecting from the rayfilter housing (21). On opposite sides of each center clearance hole, clearance holes are provided in each outer slotted wall, while the inner wall has tapped holes in line with each clearance hole.

The large clearance holes receive the finger grip lever pivot screw pins (14), which are inserted in clearance holes in the outer slotted walls and screwed into tapped holes in the rear slotted walls. They extend through the reamed pivot holes in the finger grip levers (1 and 2) assembled in the slotted section between the outer and inner walls. The small clearance holes receive the finger grip lever thrust stop screw pins (13) which are inserted in clearance holes in the outer slotted walls, extend through a thrust hole in each finger grip lever (1 and 2), and are screwed into tapped holes in the inner slotted walls.

The finger grip lever pivot screw pins (14) are the hinge pivot pins for the right and left finger grip levers (1 and 2), while the finger grip lever thrust stop screw pins (13) extending through the thrust holes in the finger grip levers (1 and 2) restrict the movement of these levers for their unlocking and locking engagement

			screws
17	P-1417-1	1	Rubber eyeguard

a. Base plate. The base plate (9) is made of cast phosphor bronze, and holds the parts making up the assembly. The base plate follows a cylindrical pattern, except for the projecting upper and lower parts, which have a nominal thickness.

The outer part of the base plate is counterbored to carry the small shoulder of the knurled actuating sleeve (7). The bore is threaded to

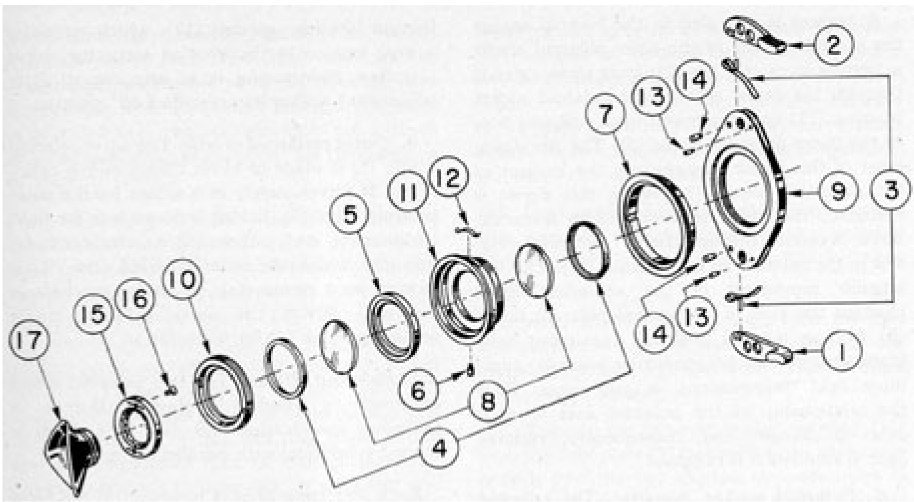

Figure 4-41. Variable density Polaroid filter assembly.

with the anchor screw pins (6, Figure 4-40) of the rayfilter housing (21).

b. Finger grip levers. The right and left finger grip levers (1 and 2) are made of cast phosphor-bronze of duplicate design, except for the cast finger projection section. It consists of a narrow arm, which is a sliding fit in the upper and lower slotted sections in the base plate (9) between the outer and inner walls. Both projecting finger sections are right and left, and project part of the spring is bent to rest on the bottom of the upper and lower base plate slotted sections.

When the finger grip levers (1 and 2) are gripped together, the spring is fully compressed. In this position the outer part of the thrust hole is resting on the finger grip lever thrust stop screw pin (13), and the center anchor screw pin clearance holes are in coincidence with the center clearance holes in the base plate (9). This position of the finger grip levers provides clearance for the removal of the base plate over the anchor screw pins (6, Figure 4-

outward, thus offering the observer a firm finger grip for removal or reattachment of the assembly. Three holes are provided in each lever. The center hole is a clearance hole for the anchor screw pins (6) and also serves as a catch in the undercut section of the anchor screw pins (6, Figure 4-40) when under tension by the finger grip lever springs (3).

The second hole toward the finger grip projection is a thrust hole, having sufficient clearance to contact the finger grip lever thrust stop screw pins (13) on opposite sides of its inner circumference. The reamed hole at the end of the arm serves as a pivot hole on the finger grip lever pivot screw pin (14). The inner side face of each arm has a narrow slot to carry the stub end of the finger grip lever springs (3). The stub end of each spring is a push fit in this narrow slot, while the remaining

40) of the rayfilter housing (21). Reassembly of this base plate necessitates only centering the clearance holes over the anchor screw pins (6) and pressing inward until the snapping of both levers is noticeable.

c. Knurled actuating sleeve. The knurled actuating sleeve (7) is made of brass tubing and is chromium plated. It is cylindrical and has three external shoulders. The small shoulder is a sliding fit in the outer counterbored recess, resting on the recess seat in the base plate (9). The medium shoulder serves as the outer wall, while the large shoulder periphery is fine diamond knurled. It is bored and counterbored a sliding fit on the shoulder body and shoulder flange of the Polaroid socket housing (11) which, when secured, is stationary in the base plate (9).

A keyseat is provided in the bore to engage the projecting part of the outer polaroid cradle actuating screw (6). The actuating screw extends through the radial seat in the polaroid socket housing (11) and is screwed into a tapped hole in the outer polaroid cradle (5). The remaining head of this screw engages into the keyseat in the actuating sleeve (7). When this sleeve is actuated, the outer polaroid cradle actuating screw is carried through the 90 degrees

friction tension spring (12) which provides a snug tension to the knurled actuating sleeve (7), thus maintaining it at any desired filter adjustment within its prescribed 90 degrees rotation.

e. Outer polaroid cradle. The outer polaroid cradle (5) is made of brass tubing and is cylindrical. It serves merely as a mount for the outer polaroid filter (8), having a bored hole for light transmission and a threaded counterbored section into which the outer polaroid filter (8) is secured by a clamp ring (4). A

circumferential slot in the polaroid socket housing (11). This 90 degrees angular movement of the actuating screw changes the axes of the special polaroid filters (8) from a parallel position (maximum light transmission) to a perpendicular position (minimum light transmission), or vice versa. Thus the relationship of the polaroid axes to each other is changed and, consequently, variable light transmission is obtained.

d. Polaroid socket housing. The polaroid socket housing (11) is made of phosphor bronze and is cylindrical. The external surface is provided with three shoulders. The small shoulder is threaded to engage into the threaded section in the base plate (9). The medium, shoulder and the narrow shoulder flange are a sliding fit in the bored and counterbored section in the knurled actuating sleeve (7).

The internal part is bored for light transmission and is provided, with two counterbored sections in the outer section. The small counterbored section carries the assembled outer polaroid cradle (5), a polaroid filter (8), and a clamp ring (4). The cradle is a sliding fit in this counterbored section and the wall of this counterbored section is provided with a circumferential slot for the protrusion of an outer polaroid cradle actuating screw (6) to be carried through a 90 degrees rotation.

tapped hole in the wall carries the outer polaroid cradle actuating screw (6) for 90 degrees rotation.

f. Polaroid filters. The two polaroid filters are made of polaroid J glass of Bureau of Ordnance specification O.S. No. 1155. Each is shaped cylindrical with parallel surfaces.

Each polarizing filter is furnished in the form of a sheet of polarizing material bonded between two water-white glass plates.

Each filter is scribed with two short, permanent lines to indicate, within 1 degree, the diameter which is vertical when the filter is so oriented as to reduce to a minimum the intensity of the light reflected from a horizontal specular surface at the polarizing angle. These lines extend in from the edge of the filter for a distance of approximately 3 mm, and are placed on the side of the filter which is free from birefringent inclusions.

Polarizing filters without a bevel should have the side carrying the axis marks facing the source of polarized light.

g. Clamp rings. The two clamp rings (4) are made of brass tubing, having a bored hole and counterbored section, with the periphery of both threaded. One clamp ring carries the outer polaroid filter (8) in its counterbored section and screws into the threaded counterbored section in the outer polaroid cradle (5), securing the outer polaroid filter (8) snugly against the shoulder seat in the outer polaroid cradle.

They second clamp ring carries the inner polaroid filter (8) in the same manner, and secures it to the inner

The large counterbored section is threaded to receive a face ring (10). The inner part of this polaroid socket housing has a threaded counterbored section to receive the inner polaroid filter (8) which is mounted in the counterbored section in the inner clamp ring (4). Two opposite drilled holes are provided in the rear face for the insertion of a special wrench to secure the housing in the base plate (9).

The medium shoulder periphery has a shallow 45 degrees radial recess slot for the insertion of a shoulder seat in the polaroid socket housing (11). The clamp ring

screws into the threaded counterbored section from the inner face. The inner walls of the clamp rings are chamfered at 20 degrees from the bore in its outer face. The outer face and periphery is provided with two opposite slots cut a depth of 0.030 inch at an angle of 30 degrees for the insertion of a special wrench.

h. Face ring. The face ring (10) is made of brass tubing and is cylindrical. It is bored for light transmission and provided with a counterbored section leaving a narrow shoulder seat to carry the eyeguard mount (15). The periphery is threaded to engage in the large threaded counterbored section in the polaroid socket housing (11) and rests in contact with this counterbored section seat. The undercut shoulder of the inner face of this face ring comes

j. Rubber eyeguard. The rubber eyeguard (17) is made of moulded black rubber, and is secured in the eyeguard mount (15) counterfaced cylindrical groove by the shearing outward of 12 equally spaced clips. The eyeguard prevents injury, locates the eye at the proper distance, and keeps out stray light.

4R2. Disassembly of the variable density polaroid filter assembly. The variable density polaroid filter assembly is disassembled in the following manner.

1. With a small screwdriver, turn the two friction screws (16) in the outer face of the eyeguard mount (15) clockwise. Then remove the eyeguard mount.

2. Remove the polaroid socket housing (11) from the base plate (9) by inserting an adjustable wrench into the two shallow opposite holes in the inner face of the polaroid socket housing (11). Turn the

within several thousandths inch to contact the outer polaroid cradle (5), allowing it sufficient free movement for its 90 degrees rotation. Two opposite slots are provided in the outer face for the insertion of a special wrench.

i. Eyeguard mount. The eyeguard mount (15) is made of brass rod and is cylindrical. It is bored for light transmission with a counterfaced cylindrical groove. The narrow remaining shoulder ring has 12 equally spaced slots which divide the inside narrow shoulder into 12 equally spaced clips, formed by shearing the narrow shoulder ring clips toward the rubber eyeguard (17).

The eyeguard mount has two shallow slots on opposite sides in the centerline that intercept the countersunk tapped holes, and two right angle slots intersecting the countersunk tapped holes and extending through the thickness of the mount. The two opposite countersunk tapped holes receive two eyeguard mount friction screws (16). These friction screws are inserted in countersunk tapped holes in the inner face of the eyeguard mount (15). The opposite side, or outer face, of each friction screw is slotted for a small screwdriver blade which can be tightened by turning the screwdriver counterclockwise. The slotted section of the eyeguard mount is thus spread by the upward tightening of the chamfered screw head in the countersunk angle, and the fixed position of the eyeguard wrench and housing clockwise, holding the base plate firmly in the left hand. When the housing is loosened, grip the knurled actuating sleeve (7) with the left hand and hold the base plate in the right hand; the remaining assembly can then be removed, by rotating it counterclockwise.

3. Remove the knurled actuating sleeve (7), lifting it evenly from the polaroid socket housing (11).

4. Remove the friction tension spring (12), lifting it out of the 45 degrees radial recess slot in the polaroid socket housing (11).

5 Turn the polaroid socket housing (11) so that its lower face is facing upward. Then insert an adjustable wrench in the slots in the clamp ring (4). Remove the clamp ring and the inner polaroid filter (8). Carefully check the opposite reference marks of the polaroid filter for reassembly.

6. Turn the polaroid socket housing (11) so that it is resting on its inner face. Then insert an adjustable wrench in the opposite slots in the face ring (10), holding the polaroid socket housing firmly. Unscrew the face ring by turning it counterclockwise.

7. Remove the outer polaroid cradle actuating screw (6), using a small screwdriver. Unscrew it from the tapped hole in the outer polaroid

for either the right or left eye of the observer is retained.

cradle (5). Carry the actuating screw out through the circumferential slot in the polaroid. socket housing (11). Turn the polaroid socket housing upside down to allow the outer polaroid cradle to drop out lightly, with the outer polaroid filter (8) and clamp ring (4).

8. Unscrew the clamp ring (4) from the outer polaroid cradle (5), inserting an adjustable wrench in the opposite slots in the clamp ring. Remove the clamp ring (4) and the outer polaroid (8). Carefully check the opposite reference marks of the polaroid filter for reassembly.

9. Using a small screwdriver, remove the finger grip lever thrust stop screw pins (13) and the finger grip lever pivot screw pins (14). Unscrew these screw pins from the tapped holes in the inner slotted walls of the base plate (9). Remove the right and left finger, grip levers (1 and 2) and their tension springs (3).

4R3. Reassembly of the variable density polaroid filter assembly. The variable density polaroid filter assembly is reassembled in the following manner:

1. Apply Lubriplate No. 110 lightly to all rotating parts as the assembly procedure is followed.

hand. Screw the clamp ring into the inner threaded counterbored section in the polaroid socket housing, using a special wrench to tighten the polaroid filter snugly against the counterbored seat.

6. Hold the outer polaroid cradle (5) with its inner face upward with the left hand, and the outer clamp ring (4) and the polaroid filter (8) with the right hand. Screw the clamp ring into the threaded counterbored section in the outer polaroid cradle (5), using a special wrench to tighten the polaroid filter snugly against the counterbored seat.

7. Place the assembled outer polaroid cradle in the counterbored seat in the polaroid socket housing (11), carrying it in from the outer part with the clamp ring side facing upward.

8. Insert the outer polaroid cradle actuating screw (6) through the 90 degrees radial slot in the polaroid socket housing (11) and screw it into the tapped hole in the outer polaroid cradle (5), securing the actuating screw.

9. Place the friction tension spring (12) in the 45 degrees radial recess slot in the polaroid socket housing (11).

10. Place the polaroid socket housing (11) in the knurled actuating sleeve (7). This is done by engaging the protruding actuating screw (6) in the keyseat in the knurled actuating sleeve, and pressing the friction tension spring

2. Insert the right and left finger grip levers (1 and 2) with their tension springs (3) in the upper and lower slotted-sections in the base plate (9) between the outer and inner walls: Compress the tension springs (3) sufficiently to line up the outer pivot hole in each finger grip lever with the pivot hole in the base plate for the insertion of the finger grip lever pivot screw pins (14) one by one, securing each screw pin in the tapped holes in the inner slotted base plate walls.

3. Grasp both finger grip levers and compress them together, until near the limit of their travel. Insert the finger grip lever thrust stop screw pins (13) and secure them in the tapped holes in the inner slotted base plate walls (9).

4. Clean the two polaroid filters (8) and place them in each clamp ring (4) with their axis marks facing the source of polarized light.

5. Hold the polaroid socket housing (11) with the left hand and the inner clamp ring (4) and the polaroid filter (8) with the right

(12) inward while pressing the polaroid socket housing downward until flush with the inner face of the sleeve. Lift the knurled actuating sleeve upward until its outer face is flush with the polaroid socket housing (11).

11. Screw the polaroid socket housing (11) with the assembled knurled actuating sleeve (7) into the threaded section in the base plate (9). Secure the socket housing using a special wrench inserted in the opposite shallow holes in its lower face, screwing it counterclockwise.

12. Using a special wrench inserted in the opposite slots of the inner clamp ring (4), loosen the clamp ring and check the opposite reference marks of the inner polaroid filter (8). The opposite reference marks should be lying parallel to the vertical centerline of the base plate (9).

13. With the knurled actuating sleeve (7) turned to its complete counterclockwise position, the actuating screw (6) is up against its stop in the polaroid socket housing (11). Using a special wrench inserted in the opposite slots in the outer clamp ring (4), loosen the

removes the water-reflected glare, and the quantity of light passing through is reduced almost to zero (or the minimum light transmission) when one polaroid filter is at right angles to the other.

15. Place the face ring (10) in the large threaded counterbored section in the polaroid socket

clamp ring and check the opposite reference marks of the outer polaroid filter (8). The opposite reference marks, should be lying parallel to the vertical centerline of the base plate (9) and the inner polaroid filter (8). This is the position of maximum light transmission.

14. The clockwise rotation of the knurled actuating sleeve (7) controls the relation of one polarizing filter axis to the other, and therefore the density of the field. The light that passes through is plane-polarized in a direction that housing (11), securing it with the use of an adjustable wrench inserted in opposite slots in the face ring.

16. Place the mounted eyeguard (17) and its mount (15) in the counterbored seat in the face ring (10). Secure the mount with the two friction screws (16), screwing them counterclockwise, and pressing down on the mount, setting the position of the eyeguard for either the right or left eye.

S. EYE BUFFER AND BLINDER ASSEMBLY

4S1. Description of the eye buffer and blinder assembly. a. General. The soft-rubber eye buffers are furnished with each periscope. The design of each eye buffer is such that it is convenient and comfortable to use with either eye. Ventilating holes or slots are provided in the eye buffer at a point as near as possible to the eyepiece window (9, Figure 4-38) for convenient use.

A suitable boss for attaching one of the eye buffers to the periscope when the eye buffer is not in use is provided on the eyepiece end of the periscope in such position as not to interfere with the observer. The eye buffers are supplied in the box containing spare parts and tools for the periscope.

A blinder for the unused eye of the observer is also furnished with each periscope. The of the observer's unused eye when the blinder is in use is a dull nonreflecting black. The blinder is fitted with a suitable eyebuffer for excluding light from the unused eye of the observer. Figure 4-42 shows the eye buffer and blinder assembly. All bubble numbers in Sections 4S1, 2, and 3 refer to Figure 4-42 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1134-9	2	Rubber eye guards
2	P-1414-2	1	Base plate
3	P-1414-3	1	Right finger grip lever
4	P-1414-4	1	Left finger grip lever
5	P-1414-5	2	Finger grip lever springs
6	P-1414-	1	Blinder plate

blinder may be used in covering either eye of the observer. Suitable provision is made for the efficient use of the blinder by the observer with any probable interpupillary distance. Suitable arrangements are also provided for securing the blinder to the periscope in such position as not to interfere with the observer or with any of the other eyepiece end fittings when the blinder is not in use. The blinder is arranged so that it may be used when either the rayfilter or the stadimeter and course-angle device is in use. The part of the blinder in the line of vision

	6		
7	P-1414-7	1	Blinder adjusting screw
8	P-1414-8	1	Blinder adjusting screw nut
9	P-1414-9	1	Blinder adjusting screw nut lockscrew
10	P-1416-5	1	Finger grip lever thrust stop screw pin
11	P-1416-6	1	Finger grip lever pivot screw

b. Rubber eyeguards. The two rubber eyeguards (1) are made of soft molded rubber. One eyeguard is mounted on the blinder plate (6) and the other is mounted on the base plate (2). They prevent injury, locate the eye at the proper

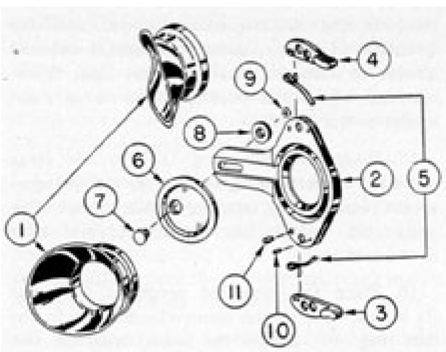

Figure 4-42. Eye buffer and blinder assembly.

distance, and keep out stray light. Ventilating holes or slots should be provided in the eyeguard at any point as near as possible to the base to prevent external fogging of the

angle of 18 degrees outward from a parallel position. A wide shallow keyway cut in the outer face of the stem section carries the small raised projection of the blinder plate (6) axially. An elongated axial slot allows the inserted blinder adjusting screw (7) with the blinder adjusting screw nut lockscrew (9) to be carried axially for adjustment to the observer's interpupillary setting.

d. Finger grip levers. The right and left finger grip levers (3 and 4) are identical to the finger grip levers (1 and 2, Figure 4-41) of the variable density polaroid filter assembly. Their purpose and function are

eyepiece window (9, Figure 4-38).

c. Base plate. The base plate (2) is made of cast phosphor bronze. The main section is similar to the base plate of the variable density polaroid filter assembly (Figure 4-41), except that it is provided with an extended boss for the attachment of the blinder plate (6).

The main section has a cylindrical groove which is undercut to allow the small flange section to fit into the inside recess in the eyeguard (1). The Cylindrical shoulder flange section allows the eyeguard to be rotated and prevents it from dropping off. The eyeguard is stretched over the shoulder flange section and grips in the undercut part of the cylindrical groove, while the inside recess of the eyeguard also grips over the cylindrical shoulder flange section. The center axis is bored to provide a clear aperture for the emerging light rays of the periscope.

The upper and lower parts of the main section are slotted in similar manner to the base plate (9) of the variable density polaroid filter assembly, for the right and left finer grip levers (3 and 4), their tension springs (5), finger grip lever pivot screw pins (11), and the finger grip lever thrust stop screw pins (10).

The blinder plate projection boss forms the stem section and is bent at an approximate identical. Refer to the variable density polaroid filter assembly for parts (3, 4, 5, 10, and 11).

e. Blinder plate. The blinder plate (6) is made of brass rod and is cylindrical. The outer surface is provided with a large shoulder flange and an undercut shoulder section. It carries an eyeguard (1) in similar manner to the main section of the base plate (2). The lower face has a small projection with two flat sides, which is a sliding fit in the wide shallow keyway in the stem projection boss in the base plate (2). A counterbored shallow recess chamfered at 30 degrees is provided in the outer face. This part of the blinder is in line with the observer's unused eye. When the blinder is in use, it is a dull nonreflecting black. The fitted eyeguard excludes light from the unused eye of the observer. A clearance hole offset from the center axis with a counterbored recess is provided for the blinder adjusting screw (7). The offset provides sufficient interpupillary distance.

f. Blinder adjusting screw. The blinder adjusting screw (7) is made of bronze rod. It has a large shoulder section, with the main body provided with two flat shoulders. It is a push fit in the offset clearance hole and counterbored recess in the blinder plate (6). The two flat shoulders are a sliding fit in the elongated hole An the stem projection boss of the base plate (2). The stub section is threaded to carry the blinder adjusting nut (8), with a tapped hole in the center axis in this section to carry the blinder adjusting screw nut lockscrew (9).

g. Blinder adjusting screw nut. The blinder adjusting screw nut (8) is made of bronze

rod and is chromium plated. The periphery is rough diamond knurled. The center axis has a tapped hole to engage on the threaded stub section in the blinder adjusting screw (7). The large part has a counterbored recess, allowing sufficient clearance for the head of the adjusting screw (7). The lockscrew is chromium plated, and extends the entire depth of the tapped hole in the adjusting screw. The lockscrew has sufficient length to allow the adjusting screw nut a quarter turn to release the adjustment. The blinder plate can be adjusted to any desired interpupillary distance, which is an axial movement of approximately 17/32 inch. The lockscrew head in contact with the inner face of the adjusting screw prevents the adjusting screw nut from further release.

4S2. Disassembly of the eye buffer and eye blinder assembly. The eye buffer and eye blinder assembly is disassembled in the following manner:

1. By pulling outward with two fingers, one from each hand placed inside near the base of the eyeguard, remove both eyeguards (1), one from the blinder plate (6) and the other from the base plate (2).

4S3. Reassembly of the eye buffer and eye blinder assembly. The eye buffer and eye blinder assembly is reassembled as follows:

1. Place the blinder adjusting screw (7) in the offset counterbored clearance hole in the blinder plate (6). Line up the flat shoulders of the adjusting screw with the flat shoulders of the blinder plate rear small projection, by turning the adjusting screw.

2. With the left thumb pressed against the blinder adjusting screw head (7), place the raised projection section part of the blinder plate (6) in the wide shallow keyway in the base plate projection boss and the protruding part of the adjusting screw in the elongated axial slot. Check to ascertain that the offset hole in the blinder plate is located outward.

3. Screw the blinder adjusting screw nut (8) on the threaded stub section of the blinder adjusting screw (7), turning it clockwise until tight. The counterbored recess side should face inward.

4. Insert the blinder adjusting screw nut lockscrew (9) in the threaded axis in the blinder adjusting screw (7). The head of the lockscrew comes in contact with the inner face of the blinder adjusting screw while the lockscrew head enters the blinder adjusting screwnut (8) counterbored section. Sufficient distance of this counterbored section remains to allow the nut to

2. Follow Section 4R2, Step 9 for the removal of the right and, left, finger grip levers (3 and 4), their tension springs (5), the finger grip lever thrust stop screw pins (10), and the finger grip lever pivot screw pins (11) from the base plate (2) in similar manner to that followed for the variable density Polaroid filter assembly (Figure 4-41).

3. Remove the blinder adjusting screw nut lockscrew (9), unscrewing it from the tapped hole in the center axis in the blinder adjusting screw (7).and the counterbored recess in the blinder adjusting screw nut (8).

4. Remove the Minder adjusting screw nut (8), unscrewing it from the threaded stub section in the blinder adjusting screw (7).

5. Remove the blinder plate (6) with the blinder adjusting screw (7). Remove the blinder adjusting screw (7) from the blinder plate (6).

be released 1/4 turn for the interpupillary adjustment of the blinder plate (6).

5. Insert the right and left finger grip levers (3 and 4) with their tension springs (5) in the base plate (2) in the same manner as that stated in Section 4R3, Step 2, and secure them in the same manner with finger grip lever pivot screw pins (11).

6. Follow Section 4R3, Steps 2 and 3 for the insertion of the finger grip lever thrust stop screw pins (10).

7. Reassemble the two eyeguards (1), one to the blinder plate (6) and the other to the base plate (2). Rotate the two low portions of the outer flared-out sections of the eyeguards so that they line up centrally.

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Chapter 4 Continued

T. TRAINING HANDLE ASSEMBLIES

4T1. General description. Two handles of rugged design for training the periscope in azimuth are secured to the eyepiece end of the periscope. These handles are capable of being folded out of the way quickly. They are located below the center of the eyepiece for convenient use in the extended position, and when folded, overlap the horizontal emerging light centerline a distance of 3 1/2 inches. The maximum extension of each handle is 15 inches from the axis of the eyepiece box (11, Figure 4-29) and the outer tube axis (Figure 4-15). The hinges for the handles are located 7 1/4 inches below the center of the eyepiece. When swung down, the handles project from the periscope horizontally. The handles are held in the downward position by gravity only. A friction device is provided for holding each handle in the up or folded position. Both handles are nontelescopic.

4T2. Description of the left training handle assembly. The left training handle assembly operates the prism tilt mechanism by the movement of the revolving grip, and is interconnected with an appropriate mechanism in the eyepiece skeleton assembly (Figure 4-28). It is further inter-connected by shifting wire tapes to the prism tilt mechanism in the skeleton head assembly (Figure 4-17) for elevation and depression of the head prism (55).

It is equipped with a spring detent to hold the line of sight at elevations of 14 degrees and 44 degrees above horizontal. The detent facilitates observation of the entire sky. This is done by placing the periscope in low power and observing in three zones with the line of sight set respectively at 1) 14 degrees elevation; 2) 44 degrees elevation; and 3) full, or 74.5 degrees, elevation. If the periscope is rotated a full revolution in azimuth in each position, the entire sky is seen with a minimum of overlap between the zones. The detent may be rendered inoperative by rotating the plunger release knob (35, Figure 4-43). Figure 4-43 shows the left training handle assembly. All bubble numbers in Sections 4J2, 3, and 4 refer to Figure 4-43 unless otherwise specified.

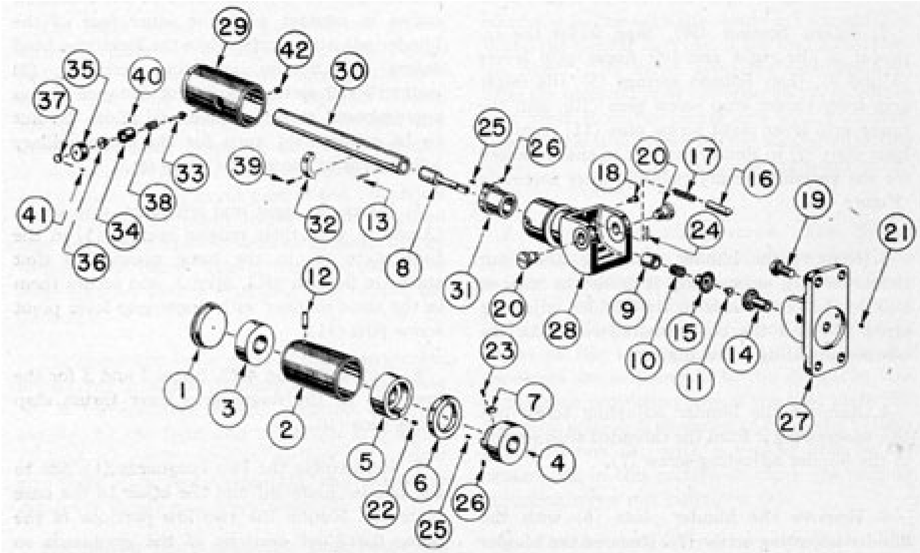


Figure 4-43. Left training handle assembly.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1069-1	1	Revolving grip end cap
2	P-1069-4	1	Revolving grip
3	P-1069-5	1	Revolving grip outer collar
4	P-1069-7	1	Fixed grip outer collar
5	P-1069-9	1	Revolving grip inner collar
6	P-1069-10	1	Index ring
7	P-1069-11	1	Segment stop
8	P-1069-12	1	Outer bevel gear clutch shaft
9	P-1069-14	1	Outer bevel gear clutch collar
10	P-1069-15	1	Outer bevel gear clutch

a. Revolving grip. The revolving grip (2) is made of brass tubing and is 3 9/16 inches in length. The periphery is rough diamond knurled to offer the observer a firm grip. Both ends of the knurled periphery are relieved with a small radius, and are provided with counterbored sections of varying depth.

The outer counterbored end carries an outer collar (3), a press fit in the counterbored section, and an end cap (1) which is also a press fit in the outer part of this same counterbored section. A reamed clearance hole in the revolving grip and the outer collar (3) is provided for the lockscrew (12). The inner counterbored end carries an inner collar (5), a press fit in this counterbored section.

b. Revolving grip outer collar. The revolving grip outer collar (3) is made of composition brass and is cylindrical. The periphery is a press fit in the outer counterbored section end in the revolving grip (2). It has a reamed hole in the center axis, a sliding fit on the revolving grip shaft (30). A reamed hole in this collar coinciding with the reamed hole in

			spring
11	P-1069-16	1	Outer bevel gear clutch retaining screw
12	P-1069-18	1	Revolving grip lockscrew
13	P-1069-21	1	Revolving grip shaft and outer bevel gear clutch shaft locking taper pin
14	P-1157-5	1	Inner bevel gear clutch
15	P-1157-6	1	Outer bevel gear clutch
16	P-1157-7	1	Handle detent plunger
17	P-1157-8	1	Handle detent plunger spring
18	P-1157-9	1	Handle detent plunger retaining screw
19	P-1161-7	4	Hinge bracket bolts
20	P-1171-6	2	Pivot screws
21	P-1179-39	2	Pivot screw lockscrews
22	P-1179-52	1	Index ring actuating screw
23	P-1179-53	2	Segment stop lockscrews
24	P-1179-191	1	Outer bevel gear clutch and collar taper pin
25	P-1310-39	4	Main body stop adjusting screws, also segment stop

the revolving grip wall accommodates a lockscrew (12) which screws into the tapped hole in the revolving grip shaft (30). This lockscrew secures the revolving grip and the other collar to the shaft for its operation

c. Revolving grip end cap. The revolving grip end cap (1) is made of brass rod and is cylindrical. The large narrow shoulder flange diameter coincides with the diameter of the outer end radius shoulder of the revolving grip (2) when the undercut shoulder is pressed into the outer end counterbored section in the revolving grip. The outer sharp corner of the large narrow shoulder flange is rounded off. This end cap covers the outer part of the revolving grip, thus preventing the entry of foreign matter. The small drilled hole in the center axis serves as an air release hole as the revolving grip is assembled on the revolving grip shaft (30).

d. Revolving grip inner collar. The revolving grip inner collar (5) is made of composition brass and is cylindrical. The periphery is a press fit in the inner end counterbored section of the revolving grip (2). It has a reamed hole and counterbored section. The reamed hole is a

			adjusting screw lockscrews
26	P-1389-7	4	Main body stop and segment stop adjusting screws
27	P-1408-3	1	Hinge bracket
28	P-1420-1	1	Handle hinge
29	P-1420-2	1	Fixed grip
30	P-1420-3	1	Revolving grip shaft
31	P-1420-4	1	Main body stop
32	P-1420-5	1	Main body stop segment
33	P-1420-6	1	Detent plunger
34	P-1420-7	1	Detent plunger housing
35	P-1420-8	1	Detent plunger release knob
36	P-1421-1	1	Detent plunger spring retaining bushing
37	P-1421-2	1	Detent plunger retaining cap
38	P-1421-3	1	Detent plunger spring
39	P-1421-4	2	Main body strip segment lockscrews
40	P-1421-5	1	Detent plunger

			release knob lockscrew
41	P-1421-6	1	Detent plunger retaining cap lockscrew
42	P-1421-7	1	Fixed grip lockscrew

sliding fit on the revolving grip shaft (30), while the counterbored section allows clearance for the segment stop (7) and the protruding semicircular section of the fixed grip outer collar (4). The side face of this inner collar (5) is provided with a tapped hole to carry an index ring actuating screw (22). The head of this screw projects from the side face into the elongated circumferential recess in the index ring (6). This screw head, turning with the revolving grip, carries the index ring for all degrees of elevation and depression.

e. Fixed grip. The fixed grip (29) is made of brass tubing and is 3 3/4 inches in length. The periphery is rough diamond knurled to offer the observer a firm grip. Both ends of the knurled periphery are relieved. The inner end has a small radius, while the outer end is provided with the same type of radius except that it has an undercut shoulder 7/32 inch in length. This undercut shoulder diameter conforms to the diameter of the index ring (6) and has the stationary index line engraved in its shoulder at assembly.

The counterbored section in the outer end carries the large shoulder section of the outer collar (4), a press fit in this counterbored inches. It carries the index ring (6) of a sliding fit, taking up 5/16 inch of its shoulder length.

The remaining undercut shoulder section extends into the counterbored section in the revolving grip inner collar (5) The outer part of the undercut shoulder has a cutaway semicircular section. The remaining semicircular section serves as a segment stop foundation. This section is provided with two tapped holes on opposite sides perpendicular to the split and in the center of the split wall thickness, for the insertion of two segment stop adjusting screws (26). The projecting part of each tapped hole in the remaining periphery is recessed to provide clearance for the insertion of a screwdriver blade. The adjusting screws, project into the milled-out part of the semicircular section to contact the segment stop (7) attached to the revolving grip shaft (30) for adjustment of the index ring (6).

The side face of the semicircular projection section is provided with opposite tapped holes in the centerline and at a perpendicular plane to the adjusting screws (26) for two segment stop adjusting screw lockscrews (25). After adjustments have been made with the adjusting screws (26), they are

section. The inner end is counterbored a depth of 1 1/2 inches, and is a sliding fit on the alignment support section of the handy hinge (28). It is secured on this alignment support section with a lockscrew (42), which extends from the tapped hole in the fixed grip and further into the tapped hole in the alignment support section of the handle hinge (28).

Directly opposite this tapped hole, a large tapped hole is located outward with an approximate variance of 9/16-inch counter distance. This tapped hole carries the detent plunger housing (34).

f. Fixed grip outer collar. The fixed grip outer collar. (4) is made of composition brass and is 1 3/8 inches in length. It is cylindrical, and has a reamed hole in its center axis, a sliding fit on the revolving grip shaft (30). The large shoulder section is a press fit in the fixed grip (29). The undercut shoulder section projects outward from the outer end of the fixed grip, and is provided with a diameter of 1 1/2 secured with these two lockscrews (25) to maintain the adjustments.

g. Revolving grip shaft. The revolving grip shaft (30) is made of brass tubing and is 8.375 inches in length. This shaft is a sliding fit in the reamed hole in the revolving rip outer collar, (3) and the inner collar (5). It has a tapped hole near its outer part to receive the threaded part of the lockscrew (12) which projects inward from the clearance hole in the revolving grip (2) and its outer collar (3) for the manipulation of the shaft upon the rotation of the revolving grip (2).

Two tapped holes are provided in the shaft for the segment stop lockscrews (23) at assembly to secure the segment stop (7) for its proper location in the counterbored section in the revolving grip inner collar (5).

The inner part of the shaft is a sliding fit in the reamed hole in the fixed grip outer collar (4) and extends the entire length of the fixed grip (29), a sliding fit in the large reamed hole in the handle hinge (28). The inner end of the

shaft is counterbored a depth of 1 1/4 inches, and serves as the alignment support section for the outer end of the outer bevel gear clutch shaft (8). This outer bevel gear clutch shaft is a press fit in the counterbored section, and is secured with a taper pin (13).

h. Index ring. The index ring (6) is made of composition brass and is cylindrical, with a width of 5/16 inch. The bored hole is a sliding fit on the undercut shoulder of the fixed grip the compensation for the 3/32-inch lost motion allowance.

j. Handle hinge. The handle hinge (28) is made of cast phosphor bronze and is approximately 5 inches in length. It forms the outer moving hinge part of the training handle assembly. The outer part has a turned alignment support section 1 1/2 inches long, with a narrow shoulder following this section. This alignment support section serves as a stabilizing support for the inner

outer collar (4). The periphery is engraved after assembly to indicate 10 degrees depression, 0 degrees, 14 degrees, 44 degrees, and 74.5 degrees elevation. The side face has a drilled hole with a radially sawed slot to permit adjustment so that the index ring fits snugly on the outer collar, providing sufficient friction so that it does not slide free when elevating or depressing the head prism by the rotation of the revolving grip (2). A circumferential recess slot 0.375 inch in length is opposite the drilled hole. The screw head of the index ring actuating screw (22) projecting from the side face of the revolving grip inner collar (5) engages in this recess slot. This recess slot has 3/32-inch movement to coordinate with the correction made with the adjusting screws (26) in the fixed grip outer collar semicircular section (4). The index ring fits between the inner face of the revolving grip (2) and the outer face of the fixed grip (29). The graduations are read when they coincide with the stationary engraved reference line on the fixed grip.

i. Segment stop. The segment stop. (7) is made of composition brass. It consists of a segment of approximately 60 degrees, with an inside radius of 3/8 inch and an external radius of 9/16 inch. The outside radius conforms to the contour of the undercut shoulder periphery of the fixed grip outer collar (4), while the inside radius conforms to the contour of the revolving grip shaft periphery (30). It is secured to the revolving grip shaft with two lockscrews (23). These lockscrews are inserted into countersunk clearance holes in the segment stop (7) and screwed into tapped holes in the revolving grip counterbored section of the fixed grip (29), which is a snug sliding fit on this alignment support section, and is secured with a lockscrew (42). This lockscrew screws into a tapped hole in the fixed grip (29) and extends into the tapped hole in the alignment support section wall.

The filleted cast section between the alignment support section shoulder and the hinge section wall forms a cylindrical extension between these sections. It is provided with a raised boss in the upper rear part to provide the necessary wall thickness for the retention of a handle detent plunger assembly.

The hinge section is similar in shape to an apron, with the contour of the outer circumference uniform with the inner wall circumference with a radius of approximately 140 degrees. The side walls of the hinge section have projecting bosses on the inner and outer faces, with a reamed hole through the center axis of each boss offset from the main horizontal centerline. The inner bosses are a sliding fit over the side walls of the stationary hinge section of the hinge bracket (27). The reamed holes in each side wall of the movable hinge section carry a pivot screw (20), thus serving as hinge pivots to carry the handle hinge (28) through 90 degrees rotation.

The inner circumference of the apron wall of the hinge section has sufficient clearance over the stationary hinge section wall periphery of the hinge bracket (27) to allow unrestricted movement for the folding and unfolding of the handle hinge (28). In the extended or unfolded position, the lower flat face of the apron section rests

shaft (30) located in the counterbored section of the revolving grip inner collar (5). The segment stop is rotated with the revolving grip shaft (30) and contacts the adjusting screws (26) for full depression and elevation, plus against the upper rectangular center face of the hinge bracket (27).

The inner surface of the handle hinge is provided with two counterbored sections in

the outer alignment support section, and with two reamed holes inward from the counterbored sections. The small and large counterbored sections carry the main body stop (31). It is a sliding fit in the small counterbored section while the large counterbored section has sufficient clearance for the detent plunger (33).

The large counterbored section wall is provided with a square broached hole for the square section of the detent plunger (33) and an opposite large clearance hole used for the broaching of this square hole. A shallow tapped hole in the same centerline and near the clearance hole receives the lockscrew (42).

The large reamed hole serves as an alignment support section for the inner end of the revolving grip shaft (30) of a sliding fit. The small reamed hole extends through the inner circumference of the cast apron wall. This small reamed hole carries the stem section of the outer bevel gear clutch shaft (8) secured to the revolving grip shaft (30). The small reamed hole is counterbored sufficiently in the inner circumference wall of the apron section to allow a partially flat surface for the assembly and the bearing contact of the outer bevel gear clutch collar (9). length. The bore is a sliding fit on the revolving grip shaft (30). The external part is provided with two shoulder sections. The small shoulder section is a sliding fit in the small counterbored section in the handle hinge outer part (28), while the larger shoulder section has 1/8-inch clearance in the large counterbored section of the same outer part.

The outer part of the large shoulder section has a semicircular section 3/8 inch wide removed in the same manner as the fixed grip outer collar (4). It is also provided with two adjusting screws (26) and two adjusting screw lockscrews (25) in the same manner for this remaining semicircular section. The adjusting screws project into the milled-out semicircular part so that the detent 90 degrees V-groove notches of 14 degrees and 44 degrees elevation are synchronized with the 3/32-inch lost motion of the revolving grip (2).

The 90 degrees V-groove notches are so located in the large shoulder that they provide an indication by means of the 90 degrees formed detent plunger (33) under tension of a spring for the observer to determine the location of the 14 degrees and 44 degrees positions when observing the zenith.

A reamed hole extends outward from the inner circumference wall of the apron section, into the raised boss provision of the cast filleted section, a distance of 1 1/2 inches. This reamed hole carries a handle detent plunger spring (17) and a handle detent plunger (16). The plunger is a sliding fit in this seamed hole, and is secured by a lockscrew (18). This lockscrew extends inward from the tapped hole in the rear hinge section side wall for its protrusion into A the axial recess keyway in the handle detent plunger (16). The handle detent plunger rides on the rear stationary hinge section side Wall periphery of the hinge bracket (27) under spring tension and engages in a 90 degrees V-groove notch to retain the movable handle hinge (28) in the folded or vertical position.

A small clearance hole is provided in the centerline of the lower part of the apron wall to allow sufficient clearance for the removal of the outer bevel gear clutch shaft and collar taper pin (24).

k. Main body stop. The main body stop (31) is made of bronze and is 1.750 inches in

1. Main body stop segment. The main body stop segment (32) is made of bronze. It consists of a segment 3/8 inch wide and approximately 165 degrees, with an inside radius of 3/8 inch and an external radius of 39/64 inch. The inside radius conforms to the contour of the revolving grip shaft periphery (30), while the outside radius is larger than the contour of the large shoulder of the main body stop periphery (31). The segment is secured to the revolving grip shaft with two lockscrews (39). These lockscrews are inserted in countersunk clearance holes in the main body stop segment (32) and screwed into tapped hole in the revolving grip shaft (30) located in coincidence with the main body stop semicircular protruding section (31). The main body stop is rotated with the revolving grip shaft and contacts the adjusting screws (26) for the rotation of the main body stop (31) for its use with the projecting detent plunger (33) located in the square broached hole in the handle hinge alignment support section (28).

m. Hinge bracket. The hinge bracket (27) is made of cast phosphor bronze, with a rectangular base. The hinge section projects

outward from the rectangular base, surrounded by a rectangular raised boss section. The rectangular base and the hinge section form the stationary half of the hinge. Four raised cylindrical bosses are provided with a clearance hole for the hinge bracket (27) and are screwed into tapped holes in the left

handle detent plunger (16) is then under full tension and the spring (17) is fully compressed.

The inner face of each raised boss of the handle hinge (28) side walls is a sliding fit over the hinge section side walls of the hinge bracket (27). The pivot screws (20) extending from the opposite reamed holes in

side of the eyepiece box (11, Figure 4-29) to retain the hinge bracket.

The inner face of the rectangular base is provided with a counterbored section and a reamed hole, offset from the horizontal centerline. The reamed hole serves as a bearing for the inner bevel gear clutch (14), while the counterbored section provides clearance over the left training handle packing gland assembly protruding stuffing box body flange (5, Figure 4-34) located in the eyepiece box. Two countersunk clearance holes and a tapped section are provided in the face of the counterbored section. These holes extend outward into both of the hinge section side walls and their perpendicular tapped holes for two pivot screw lockscrews (21). These lockscrews secure the pivot screws (20) when assembled in the hinge section side walls.

The central part of the hinge section is provided with a cylindrical raised boss, to carry the shoulder of the inner bevel gear clutch (14). Sufficient radius clearance is provided for assembly and removal of the inner and outer bevel gear clutches (14 and 15) and clearance inside the side walls for the 90 degrees rotation of the outer bevel gear clutch collar (9). The contour of the outer circumference of the side walls and the lower wall conforms to the inner circumference of the hinge section wall of the handle hinge (28). The rear side wall is carried above the upper flat wall approximately 1 1/16 inches and is provided with a 90 degrees V-groove notch in the same vertical centerline as the pivot screw tapped hole. The 90 degrees V-groove notch serves to retain the handle hinge (28) in the folded position by the handle hinge (28) extend into the tapped holes in the hinge section side walls of the hinge bracket (27) with the medium shoulder face of each pivot screw a metal to metal fit with the hinge section side walls.

n. Pivot screws. The pivot screws (20) are made of phosphor bronze and are 0.906 inch in length, with-the head section chromium plated. They form hinge pins on which the hinge section of the handle hinge (28) can be swung through 90 degrees rotation. Each screw has a slotted head section for a screwdriver blade. The head section projects outward from each side wall raised boss of the handle hinge (28). The main body section is a snug fit in reamed pivot holes in the hinge section side walls of the handle hinge, with this shoulder resting against the side wall faces of the hinge bracket hinge section (27). The stub section is threaded and engages in a tapped hole in each hinge section side wall of the hinge bracket (27). The pivot screws are secured with lockscrews (21) which are inserted into countersunk clearance holes in the counterbored section base of the hinge bracket (27) and screwed into tapped holes in each hinge section side wall to contact the threaded stub section of the pivot screws.

o. Outer bevel gear clutch shaft. The outer bevel gear clutch shaft (8) is made of monel metal and is 3 inches in length. The large diameter section is a pressed fit into the inner counterbored section end of the revolving grip shaft (30) and is secured with a taper pin (13). The stem section is a sliding fit into the small reamed hole in the handle hinge (28), and receives an outer

means of the handle detent plunger (16) under spring tension, and allows the handle hinge to swing downward of its own gravity by the force required to overcome the spring pressure of the handle detent plunger spring (17). The handle detent plunger rides on the periphery of the rear side wall, as the handle hinge is swung to the extended position. The bevel gear clutch collar (9) at the opposite end and the inner circumference end of the apron wall and hinge section. The outer bevel gear clutch collar (9) is secured to the stem section of the shaft with a taper pin (24) in the hinge section of the handle- hinge. The square section of the shaft carries the outer bevel gear clutch (15) against the spring tension

of the outer bevel gear clutch spring (10), by means of a retaining screw (11). The retaining screw extends into the tapped hole axis in the square section of the shaft.

p. Outer bevel gear clutch collar. The outer bevel gear clutch collar (9) is made of phosphor bronze and is 0.656 inch in length. It provides a container in which the outer bevel gear clutch spring (10) is carried. It has a reamed hole in its center axis with a counterbored section, and is secured to the stem section of the outer bevel gear clutch shaft (8) with a taper pin (24). The outer bevel gear clutch spring (10) is carried over part of the stem section and the square section of the outer bevel gear clutch shaft (8). The spring places a constant tension against the hub face of the outer bevel gear clutch (15).

q. Inner and outer bevel gear clutches. The inner and outer bevel gear clutches (14 and 15) are made of phosphor bronze and are chromium plated. Both the bevel gear sections have the same diameter and number of teeth. They are provided with 19 bevel teeth of 20 diametral pitch, and have a pitch cone line angle of 45 degrees. Each

r. Detent plunger. The detent plunger (33) is made of corrosion-resisting steel and is 1.180 inches in length. The detent section is square and is provided with a 90 degrees V-formed point for engagement into the 90 degrees V-groove notches in the main body stop large shoulder periphery (31). The square detent section is a sliding fit in the square broached hole in the alignment support section in the handle hinge (28). The large shoulder section rests against the flat spot face in the handle hinge alignment support section periphery, and moves axially in the detent plunger housing (34) against the tension of the detent plunger spring (38).

The small shoulder serves to center the detent plunger spring concentrically, while the stem shaft extends through the reamed hole in the detent plunger spring retaining bushing (36), detent plunger release knob (3S), and the detent plunger retaining cap (37).

s. Detent plunger housing. The detent plunger housing (34) is made of brass rod 5/8 inch in length and chromium plated. The center axis is provided with a reamed hole to

is provided with a square broached hole. The square broached hole and the hub sections of the outer bevel gear clutch (15) move axially in the outer bevel gear clutch collar (9) against the outer bevel gear clutch spring (10) on the square section of the outer bevel gear clutch shaft (8).

The hub section of the inner bevel gear clutch fits in the reamed hole axis of the hinge bracket (27), and it extends farther on the square section of the actuating shaft (11, Figure 4-36) of the training handle packing gland assembly. It extends simultaneously on the square section of the shaft and in the counterbored recess in the packing gland (8).

The inner and outer bevel gear clutches are in mesh in either the folded or extended positions by means of the outer bevel gear clutch spring (10). In the folded position, both bevel gears are in perpendicular relation to each other at 90 degrees, with both 45 degrees pitch cone line angles. In the extended position, both level gears act as a universal jaw clutch, with all teeth engaged for the operation of the prism tilt mechanism.

carry the large shoulder of the detent plunger (33) axially and has sufficient space for the detent plunger spring (38). The outer end has a threaded counterbored section of shallow depth to receive the threaded periphery shoulder of the detent plunger spring retaining bushing (36).

The inner end periphery is threaded a short distance, screws into the large tapped hole in the fixed rip (29), and rests against the flat spot face in the handle hinge alignment support section periphery (28). The outer face is provided with two opposite slots for a special wrench. A tapped hole in the wall periphery accommodates a detent plunger retaining bushing lockscrew (40), the head of which projects from the wall periphery the thickness of the detent plunger release knob undercut shoulder (35). This projecting lockscrew head offers the detent plunger release knob a contact support for the engagement or disengagement of the detent plunger (33) by turning the knob, thus allowing it to raise or lower the detent plunger.

t. Detent plunger spring retaining bushing. The detent plunger spring retaining bushing (36) is made of phosphor bronze and is 0.445 inch in length. It is provided with a large

threaded periphery shoulder with an undercut alignment support section shoulder which serves as a guide for the detent plunger spring (38) in the inner circumference of the detent plunger housing (34). The alignment support section extends into the detent plunger housing (34) to serve

a tapped hole in the retaining cap wall and extends into the spotted recess in the detent plunger stem section. The outer face of the retaining cap has a radius, thus breaking the sharp corners. The cap serves to carry the detent plunger (33) upward upon the rotation of

as an outer stop for the detent plunger (33). The threaded periphery of this bushing screws into the threaded counterbored section in the detent plunger housing (34) compressing the degrees detent plunger spring (38). Two opposite holes are provided in the shoulder for the insertion of a special wrench. The center axis has a reamed hole to accommodate the detent plunger stem section. This reamed hole guides and supports the detent plunger stem section.

u. Detent plunger spring. The detent plunger spring (38) is made of spring tempered phosphor-bronze wire having a free length of 0.870 inch and a coiled diameter of 0.280 inch. The spring is compressed in the detent plunger housing (34) by the detent plunger spring retaining bushing (36) and forces the detent plunger (33) into the 90 degrees V-groove notches in the main body stop large shoulder periphery in the engaged position, for 14 degrees and 44 degrees line of sight of the head prism (55, Figure 4-17).

v. Detent plunger release knob. The detent plunger release knob (35) is made of brass rod 1/2 inch in length and, chromium plated. The large shoulder periphery is knurled, having the sharp corner rounded off. The center axis has a reamed hole for the stem section of the detent plunger (33). It is provided with a counterbored section, a sliding fit on the detent plunger housing (34), leaving a nominal outer side wall. The undercut shoulder side face is provided with a shallow notch which rides in spring contact with the lockscrew head (40). When the shallow notch is in contact with the lockscrew head, the detent plunger is engaged for the detent plunger release knob (35) against the tension of the detent plunger spring (38).

x. Handle detent plunger spring. The handle detent plunger spring (17) is made of spring steel and has a free length of 1 3/4 inches. The spring is coiled to a diameter of 9/32 inch, and is a loose fit in the reamed hole of 1-inch depth in the handle detent plunger (16). The spring maintains a constant tension against the handle detent plunger (16) which is engaged in the 90 degrees V-groove notch in the rear side wall periphery of the hinge bracket hinge section (27) in the folded position. In the extended position, the spring is under full compression.

y. Handle detent plunger. The handle detent plunger (16) is made of corrosion resisting steel and is 1.593 inches in length. The outer end is provided with a reamed hole 1 inch deep, serving as a guide for the handle detent plunger spring (17). The inner end of the plunger is provided with a 90 degrees V-formed detent point for engagement in the 90 degrees V-groove notch in the hinge bracket hinge section side wall periphery (27) in the folded position.

The external diameter is a sliding fit in the reamed hole in the rear raised boss section, between the hinge section and the alignment support section, and a part of the filleted circular section of the handle hinge. The plunger, under heavy tension, projects outward from the apron wall of the handle hinge (28). A shallow keyway is provided at a perpendicular plane to the 90 degrees V-formed detent point. This keyway receives the undercut shoulder of the retaining screw (18)

operation. The rotation of the knob causes the disengagement of the detent plunger (33).

w. Detent plunger retaining cap. The detent plunger retaining cap (37) is made of corrosion-resisting steel material. A reamed hole of shallow depth is located in its center axis, a sliding fit on the upper part of the detent plunger stem section and is secured with a lockscrew (41). This lockscrew is screwed into which extends inward from the tapped hole in the rear side wall face of the handle hinge (28). The undercut part of the retaining screw (18) engaged in the keyway prevents loss and injury upon disassembly of the handle hinge (28) in case the handle detent plunger is improperly secured.

The handle detent plunger (16) and spring (17) serve as a friction catch to retain the handle hinge in the folded position, by the engagement

of the 90 degrees V-formed detent point in the 90 degrees V-groove notch located in the rear hinge section side wall of the hinge bracket (27) under heavy tension.

4T3. Disassembly of the left training handle assembly. The left training handle assembly is disassembled in the following manner:

1. Remove they detent plunger assembly from the fixed grip (29), unscrewing the detent plunger housing (34) from the large tapped hole in the fixed grip.

2. Remove the lockscrew (41), unscrewing it from the detent plunger retaining cap (37). Remove the retaining cap.

3. Remove the detent plunger release knob (35), the detent plunger (33), and the detent plunger spring (38) from the inner end of the detent plunger housing (34).

4. Remove the detent plunger spring retaining bushing (36), using a special wrench inserted in the

11. Remove the index ring (6), sliding it from the fixed grip outer collar (4).

12. Remove the two lockscrews (39) from the main body stop segment (32), unscrewing these lockscrews from tapped holes in the revolving grip shaft (30). Remove the main body stop segment (32).

13. Remove the main body stop (31) sliding it off the revolving grip shaft (30).

14. Remove the two pivot screw lockscrews (21), unscrewing them from contact with the two pivot screws (20) and the tapped holes in each hinge section side wall of the hinge bracket (27) in its inner counterbored recess in the base.

15. Swing the handle hinge to the extended position. Only in this position is there sufficient clearance for the removal of the outer bevel gear clutch (15) with the remaining assembly of the handle hinge (28) from the hinge bracket (27).

16. Remove the two pivot screws (20), unscrewing them from the

opposite holes to unscrew it from the detent plunger housing (34).

5. Remove the lockscrew (40), unscrewing it from the detent plunger housing (34).

6. Remove the lockscrew (12), unscrewing it from the tapped hole in the revolving grip shaft (30), and carrying it out of the revolving grip (2) and outer collar clearance holes (3).

7. Slide the revolving grip (2) off the revolving grip shaft (30), carrying with it the revolving grip end cap (1), outer collar (3), inner collar (5), and index ring actuating screw (22).

8. Remove the two lockscrews (23) from the segment stop (7), unscrewing them from tapped holes in the revolving rip shaft (30). Remove the segment stop (7).

9. Remove the lockscrew (42) from the fixed grip (29), unscrewing it from the tapped holes in the handle hinge alignment support section (28) and the fixed grip.

10. Remove the fixed grip (29 with the index ring (6) on the fixed grip outer collar (4), sliding it off the handle hinge alignment support section (28), and carrying it off the, revolving grip shaft (30).

tapped holes in the hinge section side walls of the hinge bracket (27). Remove the handle hinge assembly from the hinge bracket (27).

17. Remove the inner bevel gear clutch (14), sliding it out of the hinge bracket (27).

18. Remove the retaining screw (11), unscrewing it from the tapped hole in the outer bevel gear clutch shaft (8). Remove the outer bevel gear clutch (15) and the outer bevel gear clutch spring (10), sliding them off the square section of the outer bevel gear clutch shaft (8).

19. Rotate the revolving rip shaft (30) until the small end of the taper pin (24) is lined up with the drift clearance hole in the handle hinge wall (28).

20. Place a drift punch of suitable size in the handle hinge (28) clearance hole.

21. Drive the taper pin (24) from the outer bevel gear clutch collar (9) and the outer bevel gear clutch shaft (8).

22. Remove the outer bevel gear clutch collar (9) from the outer bevel gear clutch shaft (8).

23. Remove the revolving grip shaft (30) and the assembled outer bevel gear clutch shaft (8) from the handle hinge (28).

24. Do not disassemble the outer bevel gear clutch shaft (8) from the revolving grip shaft (30). Leave them secured with the taper pin (13).

8. Insert and secure the taper pin (24) from the open hinge section side of the handle hinge (28).

9. Place the outer bevel gear clutch spring (10) over the outer bevel gear clutch shaft (8) and in the counterbored section of the outer bevel gear clutch collar (9).

25. Remove the retaining screw (18), unscrewing it from its engagement in the keyway in the handle detent plunger (16), and the tapped hole in the hinge section rear side wall of the handle hinge (28).

26. Remove the handle detent plunger (16) and the handle detent plunger spring (17) from the reamed hole in the hinge section inner circumference wall of the handle hinge (28).

27. The two main body stops, the two segment stop adjusting screws (26), and the four lockscrews (25) are not altered during disassembly.

4T4. Reassembly of the left training, handle assembly. The left training handle assembly is reassembled in the following manner:

1. Lubricate lightly all rotating parts with Lubriplate No. 110 as the reassembly procedure is followed.

2. Place the handle detent plunger spring (17) in the handle detent plunger (16).

3. Place the handle detent plunger (16) and its spring (17) in the reamed hole in the rear inner circumference of the handle hinge (28). Rotate the handle detent plunger until the keyway is located to the rear, and its detent point is lying in a horizontal plane so that the, retaining screw (18) engages in the keyway.

4. Insert the retaining screw (18), screwing it into the tapped hole so that its undercut shoulder engages into the keyway in the handle detent plunger (16).

10. Place the outer bevel gear clutch (15) on the square section of the outer bevel gear clutch shaft (8) with the reference marks in line.

11. Compress the outer bevel gear clutch spring (10) by pressing inward on the outer bevel gear clutch (15) for the insertion of the retaining screw (11). Insert the retaining screw (11), screwing it into the square section axis tapped hole in the outer bevel gear clutch shaft (8).

12. Check the outer bevel gear clutch (15) for free spring movement.

13. Place the inner bevel gear clutch (14) in the reamed hole in the cored hinge section of the hinge bracket (27).

14. Holding the handle hinge assembly in the extended position, carry the outer bevel gear clutch (15) through the cored clearance section in the hinge bracket (27).

15. Check the reference marks of the inner bevel gear clutch (14) tooth with its mating reference mark in the outer bevel gear clutch (15). Engage the gear teeth of the inner and outer bevel gear clutches, carrying the hinge section of the handle hinge (28) over the hinge section of the hinge bracket (27).

16. Apply downward pressure to the handle hinge (28); the handle detent plunger (16) resting on the hinge section side wall periphery of the hinge bracket (27) compresses the spring fully for the insertion of the two opposite side pivot screws (20).

17. Insert the two pivot screws (20) in the opposite side walls of the handle hinge (28), check the

5. Place the assembled outer bevel gear clutch shaft (8) and revolving grip shaft (30) in their respective teamed holes in the handle hinge (28).

6. Place the outer bevel gear clutch collar (9) on the outer bevel gear clutch shaft (8).

7. Align the taper pin holes in the outer bevel gear clutch shaft (8) and collar (9).

reference marks, and screw them into tapped holes in the hinge section side walls of the hinge bracket (27).

18. Secure both pivot screws (20) with the lockscrews (21), insert them in body clearance

holes, and screw them in the tapped hole section in each of the hinge section side walls of the hinge bracket (27) from its inner counterbored recess in the base. The lockscrews contact the pivot screw threaded sections.

19. Place the main body stop (31) on the revolving grip shaft (30), sliding it into the small and large counterbored sections in the alignment support section of the handle hinge (28).

20. Place the main body stop segment (32) on the revolving grip shaft (30); secure it opposite the semicircular projecting section of the main body stop (31) to the revolving grip shaft (30) with two lockscrews (39). These lockscrews are inserted in countersunk clearance holes in the main body stop segment (32) and screwed into tapped holes in the shaft.

21. Place the fixed grip (29) on the revolving grip shaft (30), sliding it on the alignment support section of the handle hinge (28).

22. Align the tapped lockscrew holes and insert the lockscrew (42). This

22. Rotate the revolving grip (2) until the index ring (6) with the graduated line of 74.5 degrees is in full elevated position. This graduated line on the index ring should coincide with the stationary index line on the fixed grip (29). Correct the insufficient or over-travel of the index ring by means of two segment stop adjusting screws (26). The front adjusting screw corrects for elevation, while the rear adjusting screw corrects for depression. Follow the same procedure for 10 degrees, or full depression.

28. Insert the detent plunger release knob lockscrew (40) in the tapped hole in the detent plunger housing (34).

29. Insert the detent plunger spring retaining bushing (36), screwing it in the threaded counterbored section in the detent plunger housing (34), using a special wrench inserted in the opposite holes in its large shoulder face.

30. Place the detent plunger spring (38) in the detent plunger housing (34) from the inner end.

lockscrew screws the tapped hole in the fixed grip (29) and the handle hinge alignment support section wall (28).

23. Place the index ring (6) over the revolving grip shaft (30) and on the undercut shoulder section of the fixed grip outer collar (4). It should fit snugly on the shoulder of this collar.

24. Place the segment stop (7) on the revolving grill shaft (30). Secure it opposite the semicircular projecting section of the fixed grip outer collar (4) to the revolving grip shaft (30) with two lockscrews (23). These lockscrews are inserted in countersunk clearance holes in the segment stop (7) and screwed into tapped holes in the shaft.

25. Place the revolving grip (2) on the revolving grip shaft (30), carrying with it the outer and inner collars (3 and 5), the end cap (1), and the index ring actuating screw (22). Engage the actuating screw head in the elongated radial recess ins the outer face of the index ring (6).

26. Insert the lockscrew (12), carrying it in the clearance holes of the revolving grip (2) and the outer collar (3), and screwing it into the tapped hole in the revolving grip shaft (30).

31. Place the detent plunger (33) in the detent plunger spring (38), detent plunger housing (34), and in the reamed hole in the detent plunger spring retaining bushing (36).

32. Place the lockscrew (41) in the tapped hole in the detent plunger retaining cap (37).

33. Place the detent plunger release knob (35) and the detent plunger retaining cap (37) on the protruding stem of the detent plunger (33). Holding the detent plunger release knob (35) and the end of the detent plunger (33), compress the detent plunger spring (38), carrying the stem section of the detent plunger outward and securing it with the lockscrew (41). The lockscrew contact a spotted face in the detent plunger stem section.

34. Place the detent plunger assembly in the fixed grip (29). The reference punch mark on the square part of the detent plunger should face upward. Insert the square part of the detent plunger (33) in the square broached hole in the handle hinge (28). Screw the detent plunger housing (34) threaded periphery into the tapped hole in the fixed grip (29).

35. Rotate the detent plunger release knob (35) to the engagement position.

36. Rotate the revolving grip slowly to observe the detent action. The detent should engage at 14 degrees and 44 degrees elevation. Correct insufficient or excessive travel of the zone graduation of the index ring (6) by means of two adjusting

Ill. No.	Drawing Number	Number Required	Nomenclature
17	P-1157-6	1	Outer bevel gear clutch

screws in the main body stop (31). To make the necessary adjustments, follow Steps 1 to 12 of the disassembly procedure. The detent cannot be adjusted until the index ring has been corrected for elevation and depression.

4T5. Description of the right-training handle assembly. The right training handle assembly operates the change of power mechanism by the movement of the revolving grip (3, Figure 4-44) and its interconnection with an appropriate mechanism in the eyepiece skeleton assembly (Figure 4-28). It is further interconnected by shifting wire tapes to the change of power mechanism in the skeleton head assembly (Figure 4-17) for changing from high-power to low-power magnification and vice versa. The right training handle assembly is similar to the left training handle assembly, and the variance of similar parts is described only briefly. Figure 4-44 shows the right training handle assembly. All bubble numbers in Sections 4T5, 4T6, 4T7 refer to Figure 4-44 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1069-1	1	Revolving grip end cap
2	P-1069-2	1	Fixed grip
3	P-1069-3	1	Revolving grip
4	P-1069-5	1	Revolving grip outer collar
5	P-1069-6	1	Fixed grip outer collar

18	P-1157-7	1	Handle detent plunger
19	P-1157-8	1	Handle detent plunger spring
20	P-1157-9	1	Handle detent plunger retaining screw
21	P-1161-7	4	Hinge bracket bolts
22	P-1171-6	2	Pivot screws
23	P-1179-39	2	Pivot screw lockscrews
24	P-1179-53	2	Segment stop lockscrews
25	P-1179-191	1	Outer bevel gear clutch shaft and collar taper pin
26	P-1310-39	2	Segment stop adjusting screw lockscrews
27	P-1389-6	2	Power indicating screws
28	P-1389-7	2	Segment stop adjusting screws
29	P-1408-4	1	Hinge bracket

a. Revolving grip. The revolving grip (3) is made of the same material and diameter as the left revolving grip (2, Figure 4-43), except that it is longer, and is provided with an undercut shoulder at the inner end. This shoulder has two graduated index lines, the upper has the letters H.P. engraved below it, while the lower has the letters L.P. engraved above it. These two graduated lines,

6	P-1069-8	1	Revolving grip inner collar
7	P-1069-11	1	Segment stop
8	P-1069-12	1	Outer bevel gear clutch shaft
9	P-1069-13	1	Revolving grip shaft
10	P-1069-14	1	Outer bevel gear clutch shaft collar
11	P-1069-15	1	Outer bevel gear clutch spring
12	P-1069-16	1	Outer bevel gear clutch retaining screw
13	P-1069-18	2	Revolving and fixed grip lockscrews
14	P-1069-21	1	Revolving grip shaft and outer bevel gear clutch shaft taper pin
15	P-1157-2	1	Handle hinge
16	P-1157-5	1	Inner bevel gear clutch

when in coincidence with the stationary index lines on the fixed grip (2), visually indicate the power being used by the observer. A power indicating screw (27) is inserted in this undercut shoulder section to indicate low power when in coincidence with a similar power indicating screw (27) inserted in the fixed grip (2). When these screws are separated, the indication magnification is high power.

The counterbored section in the inner end is shallower in depth and receives the revolving grip inner collar (6), while the counterbored section in the outer end is the same as that which receives the revolving grip outer collar (4) and the revolving grip end cap (1).

b. Revolving grip outer collar. The revolving grip outer collar (4) is identical to the left revolving grip outer collar (3, Figure 4-43), and serves the same purpose and function in the outer end of the revolving grip (3). It is secured to the revolving grip shaft (9) with a lockscrew (13) in the same manner.

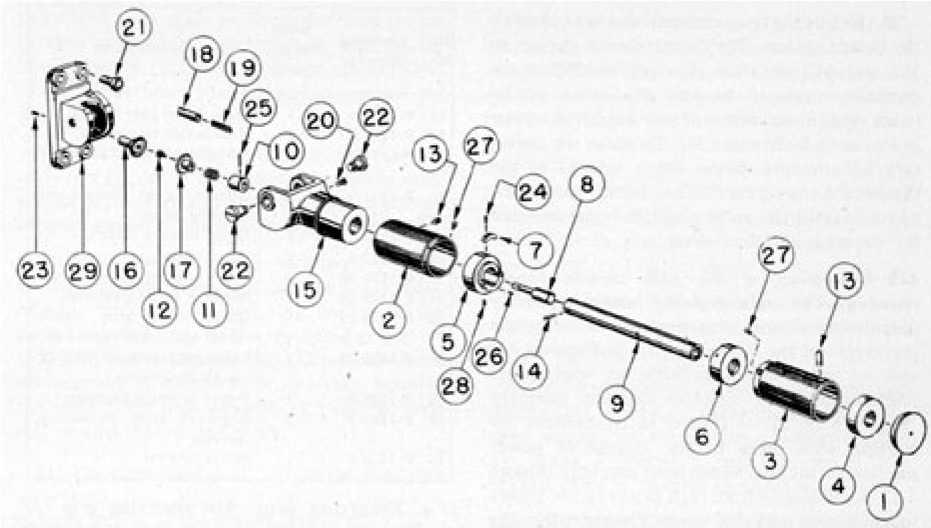


Figure 4-44. Right training handle assembly.

c. Revolving grip end cap. The revolving grip end cap (1) is identical to the left revolving grip end cap (1, Figure 4-43). It serves the same purpose and function in the outer end of the revolving grip (3).

d. Revolving grip inner collar. The revolving grip inner collar (6) is made of the same material and has the same external diameter, reamed hole diameter, and counterbored section diameter and depth as the left revolving grip inner collar (5, Figure 4-43). It differs in length and has no tapped hole for an index ring actuating screw (22, Figure 4-43). The counterbored section receives the projecting shoulder and semicircular section of the fixed grip outer collar (5) and the segment stop (7) on the opposite side of the semicircular projecting section which is secured to the revolving grip shaft (9) with two lockscrews (24).

e. Fixed grip. The fixed grip (2) is almost identical to the left fixed grip (29, Figure 4-43) except that it has no tapped hole for the insertion of a detent plunger assembly. The undercut shoulder fit, while the counterbored section in the inner end is a snug sliding fit on the alignment support section of the handle hinge (15). It is secured with a lockscrew (13) in the manner shown in Figure 4-43.

f. Fixed grip outer collar. The fixed grip outer collar (5) is similar to the left fixed grip outer collar (4, Figure 4-43) except for the length of the undercut shoulder. The semicircular section is provided with two segment stop adjusting screws (28) and two adjusting screw lockscrews (26) in the same manner. The adjusting screws (28) contact the segment stop (7) attached to the revolving grip shaft (9) for correcting insufficient or excessive travel of the segment stop (7) in relation to the high and low-power graduated index lines.

g. Revolving grip shaft. The revolving grip shaft (9) is identical to the left revolving grip shaft (30, Figure 4-43). This shaft is a sliding fit in the reamed hole in the revolving grip outer collar (4) and the inner collar (6). It has a tapped hole near its outer end to receive the threaded section of the lockscrew (13) which is inserted in a clearance hole in the revolving grip (3) and outer collar (4) for the

is provided with a graduated stationary index line and a power indicating screw (29) at assembly.

The counterbored section in the outer end carries the fixed grip outer collar (5) of a press manipulation of the shaft upon the rotation of the revolving grip (3).

Two tapped holes are provided in the shaft for the segment stop lockscrews (24) at assembly, to secure the segment stop (7) for its proper location in the counterbored section in the revolving grip inner collar (6).

The inner end of the shaft is a sliding fit in the reamed hole in the fixed grip outer collar (5), and extends the entire length of the fixed grip (2), a sliding fit into the large reamed hole in the handle hinge (15). The inner end of the shaft carries the large shoulder section of the outer bevel gear clutch shaft (8) of a press fit, and is secured with a taper pin (14).

h. Outer bevel gear clutch shaft. The outer bevel gear clutch shaft (8) is identical to the left outer bevel gear clutch shaft (8, Figure 4-43) serving the same purpose and function. It is secured to the revolving grip shaft (9) with a taper pin (14).

i. Segment stop. The segment stop (7) is similar to the left segment stop (7, Figure 4-43) and is approximately 114 degrees. It is secured to the revolving grip shaft (9) with two lockscrews (24). These lockscrews are inserted in countersunk clearance holes in the segment 4-43). They serve the same purpose and function for the handle hinge (15) and hinge bracket (29), and are secured with two lockscrews (23).

m. Outer bevel gear clutch collar. The outer bevel gear clutch collar (10) is identical to the left outer bevel gear clutch collar (9, Figure 4-43).

n. Inner and outer bevel gear clutches. The inner and outer, bevel gear clutches (16 and 17) are identical to the left inner and outer bevel gear clutches (14 and 15, Figure 4-43).

o. Handle detent plunger spring. The handle detent plunger spring (19) is identical to the left handle detent plunger spring (17, Figure 4-43), serving the same purpose and function in the handle hinge (15).

p. Handle detent plunger. The handle detent plunger (18) is identical to the left handle detent plunger (16, Figure 4-43), serving the same purpose and function in the handle hinge (15) and hinge bracket (29). It is secured with a retaining screw (20) in the same manner.

4T6. Disassembly of the right training handle. The right training

stop (7) and screwed into tapped holes in the revolving grip shaft (9) located in the counterbored section in the revolving grip inner collar (6). The segment stop is rotated with the revolving grip shaft (9) and contacts the adjusting screws (28) for high and low power,

j. Handle hinge. The handle hinge (15) is almost identical to the left handle hinge, (28, Figure 4-43) except that it is designed to be used by the opposite hand. The alignment support section carries the fixed grip (2) on its periphery and is secured with a lockscrew (13) in the same manner. However, the alignment support section of the handle hinge does not have the two countered sections for the main body stop (31) used in the left handle hinge (28, Figure 4-43) the square broached hole, and the opposite clearance hole.

k. Hinge bracket. The hinge bracket (29) is identical to the left hinge bracket (27, Figure 4-43) except that it is designed to be used by the opposite hand.

l. Pivot screws. The pivot screws (22) are identical to the left pivot screws (20, Figure

handle is disassembled in the following manner:

1. Remove the lockscrew (13), unscrewing it from the revolving grip shaft (9), and carrying it out from the revolving grip (3) and outer collar (4) clearance holes.

2. Remove the revolving grip (3), sliding it off the revolving grip shaft (9), and carrying with it the revolving grip end cap (1), revolving grip outer collar (4), and the revolving grip inner collar (6).

3. Remove the two lockscrews (24) from the segment stop (7), unscrewing them from the tapped holes in the revolving grip shaft (9). Remove the segment stop (7).

4. Remove the lockscrew (13) from the fixed grip (2), unscrewing it from the tapped holes in the handle hinge alignment support section (15) and the fixed grip.

5. Remove the fixed grip (2) with the fixed grip outer collar (5), sliding it off the handle hinge alignment support section 15) and carrying it off the revolving grip shaft (9).

6. Remove the two pivot screw lockscrews (23), unscrewing them from contact with the two pivot screws (22) and the tapped holes in each hinge section side wall of the hinge bracket (29) in the bottom counterbored recess.

7. Swing the handle hinge to the extended position. Only in this

the hinge section inner circumference wall of the handle hinge (15).

18. The two segment stop adjusting screws (28) and the two lockscrews (26) are not altered during disassembly.

position is there sufficient clearance for the removal of the outer bevel gear clutch (17) with the remaining assembly of the handle hinge (15) from the hinge bracket (29).

8. Remove the two pivot screws (22), unscrewing them from the tapped holes in the hinge section side walls of the hinge bracket (29). Remove the handle hinge assembly from the hinge bracket (29).

9. Remove the inner bevel gear clutch (16), sliding it out of the hinge bracket (29).

10. Remove the retaining screw (12), unscrewing it from the tapped hole in the outer bevel gear clutch shaft (8). Remove the outer bevel gear clutch (17) and the outer bevel gear clutch spring (11), sliding them off the square section of the outer bevel gear clutch shaft (8).

11. Rotate the revolving grip shaft (9) until the small end of the taper pin (25) is in line with the drift clearance hole in the handle hinge wall (15).

12. Place a drift punch of suitable size in the clearance hole.

13. Drive the taper pin (25) from the outer bevel gear clutch collar (10) and the outer bevel clutch shaft (8)

14. Remove the revolving grip shaft (9) and the assembled outer bevel gear clutch shaft (8) from the handle hinge (15).

15. Do not disassemble the outer bevel gear clutch shaft (8) from the revolving grip shaft (9). Leave

19. The power indicating screws (27) are not removed from the revolving and fixed grips (3 and 2).

4T7. Reassembly of the right training handle assembly. The right training handle assembly is reassembled in the following manner:

1. Lubricate lightly all rotating parts with. Lubriplate No. 110 as the reassembly procedure is followed.

2. Place the handle detent plunger spring (19) in the handle detent plunger (18).

3. Place the handle detent plunger (18) and its spring (19) in the reamed hole in the rear inner circumference of the handle hinge (15). Rotate the plunger until the keyway is located to the rear, and its detent point is lying in a horizontal plane so that the retaining screw (20) engages in the keyway.

4. Insert the retaining screw (20), screwing it into the tapped hole with its undercut shoulder engaging into the keyway in the handle detent plunger (18).

5. Place the assembled outer bevel gear clutch shaft (8) and the revolving grip shaft (9) in their respective reamed holes in the handle hinge (15).

6. Place the outer bevel gear clutch collar (10) on the outer bevel gear clutch shaft (8).

7. Align the taper pin holes in the outer bevel gear clutch shaft (8) and collar (10).

them secured with a taper pin (14).

16. Remove the retaining screw (20), unscrewing it from its engagement in the keyway in the handle detent plunger (18) and the tapped hole in the hinge section rear side wall of the handle hinge (15).

17. Remove the handle detent plunger (18) and its spring (19) from the reamed hole in

8. Insert and secure the taper pin (25), inserting it from the open hinge section side of the handle hinge (15).

9. Place the outer bevel gear clutch spring (11) on the outer bevel gear clutch shaft (8) and in the counterbored section in the outer bevel gear clutch collar (10).

10. Place the outer bevel gear clutch (17) on the square section of the outer bevel gear clutch shaft (8), with the reference marks in line.

11. Compress the outer bevel gear clutch spring (11) by pressing inward on the outer bevel gear clutch (17) for the insertion of the retaining screw (12). Insert the retaining screw (12), screwing it into the square section tapped hole in the outer bevel gear clutch shaft (8).

12. Check the outer bevel gear clutch (17) for free spring movement.

13. Place the inner level gear clutch (16) in the reamed hole in the cored hinge section of the hinge bracket (29).

14. Holding the handle hinge assembly in the extended position, carry the outer bevel gear clutch (17) through the cored clearance section in the hinge bracket (29).

15. Check the reference marks of the inner bevel gear clutch (16) tooth with its mating reference mark in the outer bevel gear clutch (17). Engage the gear

(2) and the handle hinge alignment support section wall (15).

21. Place the segment stop (7) on the revolving grip shaft (9). Secure it opposite the semicircular projecting section of the fixed grip outer collar (5) to the revolving grip shaft (9) with two lockscrews (24). These lockscrews are inserted in countersunk clearance holes in the segment stop (7) and screwed into tapped holes in the shaft.

22. Place the revolving grip (3) on the revolving grip shaft (9), carrying with it the outer and inner collars (4 and 6) and the end cap (1).

23. Insert the lockscrew (12), inserting it in the clearance holes in the revolving grip (3) and outer collar (4), and screwing it into the tapped hole in the revolving grip shaft (9).

24. Correct insufficient or excessive travel of the revolving grip power index lines by means of the two

teeth of the inner and outer bevel gear clutches, carrying the hinge section of the handle hinge (15) over the hinge section side walls of the hinge bracket (29).

16. Apply downward pressure to the handle hinge (15) with the handle detent plunger (18) resting on the hinge section side wall periphery of the hinge bracket (29) compressing the handle detent plunger spring fully for the insertion of pivot screws (22).

17. Insert the two pivot screws (22) in opposite side walls of the handle hinge (15), check the reference marks, and screw them into the tapped holes in the high section side walls of the hinge bracket (29).

18. Secure both pivot screws (22) with the lockscrews (23). Insert these lockscrews in body clearance holes, and screw them into the tapped hole section in each hinge section side wall of the hinge bracket (29) from the inner side of the base. The lockscrews contact the pivot screw threaded sections.

19. Place the fixed grip (2) on the revolving grip shaft (9), sliding it on the alignment support section of the handle hinge (15).

20. Align the tapped lockscrew holes and insert the lockscrew (13). This lockscrew is screwed into the tapped hole in the fixed grip

segment stop adjusting screws (28). The front adjusting screw corrects for low power, while the rear adjusting screw corrects for high power.

25. Make the correct adjustment of the low-power index line with the stationary index line on the fixed grip (2), by shifting to low power and then to high power. With an ear to the periscope, note the positive engagement click of the change of power mechanism in the skeleton head assembly. The adjustment should be made so that the adjusting screw has sufficient clearance to allow the revolving grip index line to come into coincidence with the stationary index line immediately after the change of power click is heard. This clearance should carry the segment stop (7) against the adjusting screw (28) after the positive engagement click has been heard. The high power adjustment is produced in, similar manner. Any adjustments necessary to the adjusting screws (28) for the low- and high-power index lines require the procedure outlined in Steps 2 and 3 for disassembly.

26. The change of power adjustment cannot be made until the shifting wire tapes are assembled to the skeleton head assembly (Figure 4-17) and attached to the shifting wire spindle

assemblies in the eyepiece

positive engagement at high and

skeleton assembly (Figure 4-28).

27. While making the change of power adjustment, it may be found that there is not a low power. Correct this by means of the spindle adjusting nuts of the eyepiece skeleton assembly to remove excessive slack from the shifting wire tapes (38, Figure 4-28).

U. OPTICAL SYSTEM

4U1. Principles of periscopic systems. The four most important considerations in any optical instrument are: a) field of view, b) magnifying power, c) light-gathering power, and d) resolving power. These optical qualities are all interrelated and an increase in one frequently causes a decrease in one or more of the others. Thus, it is necessary for the designer and the user to decide upon what is both desirable and possible.

In addition to these characteristics, another severe limitation is imposed on the submarine periscope: The ratio of the over-all length to the diameter of the tube must be large, from 40 to 100 to 1. And this must be accomplished without sacrificing field of view, magnifying power, brightness, or sharpness of image. The upper part of the periscope, in particular must be narrow and, in the case of the Type II periscope, this necessitates the addition of two one-power telescopes (five lenses). This undesirable addition of extra glass to the system is outweighed by the highly desirable reduction in diameter of the exposed part of the tube.

a. Telescope Systems. Inasmuch as the problem of the submarine periscope is solved by using two main telescopes with their axes that nothing has been gained. However, two changes have been effected: 1) the image has been given an apparent size different from the apparent size of the object, and 2) the image has been completely inverted, that is, inverted and reversed from left to right. Both the magnifying power and the inversion can be made to work for us. Also, if a physical object such as a reticle is placed in the focal plane common to both lenses, it is imaged at infinity and superimposed on the image of the object under consideration.

2. Galilean telescope. The condition described in paragraph 1 is true if both lenses are positive, or converging, lenses. However, if one of the lenses is negative, the magnification still occurs according to the ratio of the two focal lengths, but the image is not inverted. Such an instrument is known as a Galilean telescope. One of these Galilean telescopes is used in the Type II periscope with its negative (shorter focal length) lens facing the incident light to produce the low-power magnification. In high power, the two lenses of the Galilean telescope are swung out of the field. See Section 4U8-c, paragraph 17, for the method of tracing rays through a reversed Galilean telescope (Figures 4-48 and 4-49).

coincident and their objective lenses facing each other, a brief consideration of simple telescopes is necessary.

1. Inverting telescope. A telescope is established when two lenses lying on the same axis are separated so that the back focal plane of the objective lens exactly coincides with the front focal plane of the eye lens. Thus, an object at infinity, or at a distance several hundred times the focal length of the objective, is imaged in the back focal plane of that lens. This image serves as the object for the eye lens and, lying in the front focal plane of the eye lens, is imaged at infinity. Thus, the telescope forms at infinity an image of some object which is also at infinity, and it might seem

4U2. Magnifying power. a. General. The magnifying power of any optical instrument is defined as the ratio of the size of the image seen through the instrument divided by the size of the image seen by the unaided eye. Thus, a magnifying power of unity, which the layman would term no magnification, means that the ratio equals one. The human brain, however, plays tricks on an observer, and when the eye views an image through a restricted aperture such as an eyepiece, if the magnifying power is just equal to one, the image seen through the instrument seems smaller than the image seen by the eye alone, although both images are identical in size. However, it has been determined that a

magnifying power of 1.5 is required to make the image seen through the instrument seem equal in size of the image seen by the eye alone. This is the reason that low power on the Type II and on all modern periscopes is 1.5X.

b. Simple telescope. In the case of simple telescopes, which make up the periscope, there are three other ways to define the magnifying power. One of these methods is given here and the other two are found in Section 4U9-c-5. M.P. = f_1/f_2, where f_1 means the focal length of the first lens the light rays pass through, and f_2 means the focal length of the second lens the light rays pass through. Of

edges of the field in which the object lies. The apparent field of view is the angular field covered by the eyepiece of the instrument. In the Type II periscope, the apparent field equals 48 degrees. As indicated in paragraphs a and b the relation between these two fields and magnifying power of the instrument is as follows:

True field of view =
Apparent field of view/ Magnifying power

a. High power. With the periscope in high power, the true field of view equals 48 degrees/6 equals 8 degrees, or 4 degrees on either side of the centerline of sight. The centerline of sight may be elevated or depressed as noted in

course, in a simple telescope there are only two lenses, the objective and the eye lens. The formula applies both to Galilean and inverting telescopes.

c. Periscope. The magnifying power of a periscope is simply the combined product of the powers of all of the component telescopes of the system, remembering that the power of any reversed telescope (that is, one with its short focal length lens toward the incident light) is the reciprocal of its normal power. It should be noted that each of the main telescopes in the Type II periscope employs an eyepiece system consisting of an eye lens and a collective lens, and in this case the power of the telescope must be determined by using the equivalent focal length of the eyepiece system and the focal length of the objective lens. See Section 4U9-b, for the method of determining equivalent focal length of a system comprising two lens. In the Type II periscope, the light rays emerge from the head prism to meet the following telescopic systems in turn.

Type II Periscope	Low	High
Galilean telescope	1/4 X	Out
Upper auxiliary telescope	1 X	1 X
Lower auxiliary telescope	1 X	1 X
Upper main telescope	1/4.7 X	1/4.7 X
Lower main telescope	28 X	28 X
PERISCOPE	1.5 X	6 X

Section 4U6, and shown in Figure 4-45.

b. Low power. With the periscope in low power, the true field of view equals 48 degrees/1.5 equals 32 degrees, or 16 degrees on either side of the centerline of sight. See Figure 4-45 Section 4U6. These figures, of course, do not include the full 360 degrees through which the periscope can be trained or the 74.5 degrees from full elevation to full depression of the altiscope prism.

c. Narrow 1.414 outer taper section. The extreme narrowness of the tube sections (second to ninth inclusive) is the most significant feature of the Type II periscope. The small outer diameter (1.414 inches of the outer taper section, Figure 4-15), which enhances the safety of the ship by lowering its visibility, is achieved, without reducing the true field of view, by the addition of two one-power auxiliary telescopes in the reduced tube sections of the periscope. The five lenses thus included bend the rays toward the optical axis and away from the tube walls. The addition of five extra lenses is undesirable because of the loss of light and the deterioration of image quality. However, these considerations are greatly outweighed by the decreased wake produced by the small diameter at the waterline.

4U4. Image brightness. The brightness of the image seen in the eyepiece of any instrument depends upon three things: a) the brightness of the object, b) the transmission efficiency of the instrument, and c) the relative size of exit-pupil-of-the-instrument to

(combined product)		

A periscope in which it is possible to change from one power to another is called a bifocal or bipower instrument.

4U3. Field of view. The true field of view of any instrument is the angle between the extreme

entrance-pupil-of-observer's eye. Since we can seldom control

the brightness of the object, we will consider the last two factors.

a. Absorption-reflection losses. The amount of light that is absorbed in passing through an optical element depends upon the type of glass, and may vary from 0.06 of 1 percent to 0.10 of 1 percent. For our purposes, we assume that for each millimeter of glass path (measured along the axis of the periscope) 0.1 percent of the incident light is absorbed. Thus, in the Type II periscope at low power (total glass path = 268 mm) approximately 26.8 percent of the incident light is absorbed. At high power, the glass path is less because the Galilean system is out of the field (glass path = 258 mm) and the absorption is only about 25.8 percent. In applying this absorption loss to the reflection loss in order to determine the total loss, it is considerably simpler to employ the transmission which results from the absorption loss. Thus, at low power, the transmission effected is (100 percent - 26.8 percent =) 73.2 percent, and at high power, 74.2 percent.

This means that 0.959 must be multiplied by itself twenty times; 0.944 is to be multiplied by itself sixteen times; 0.94 is to be squared, and then the combined product of these results is to be found. In the above case, the result is found (by use of logarithms) to be 0.1522, or 15.22 percent. This value multiplied by that for transmission-after-absorption-losses (= 73.2 percent in low power) gives a result of 0.1114, or 11.14 percent of the incident light that finally succeeds in getting through the Type II periscope. Thus, we see that the transmission efficiency of the Type II is only about 11 percent, about 89 percent of the incident light is lost when the optical elements have not been coated.

The following table is a comparison of theoretically and actually measured values for glass that has not been coated, and also the values for glass that has been coated with a magnesium fluoride evaporated film. This film is only a few millionths-inch in thickness on each glass surface, hence, does not appreciably affect the refraction of the light rays.

The amount of light that is lost because of reflection depends upon the difference in index of refraction of the two optical media which are bounded by the surface causing the reflection loss. In most optical systems we find three types of boundaries, namely, a) air-to-crown glass, b) air-to-flint glass, and c) silvered glass surfaces. For our rough calculations of the theoretical values of reflection loss, we assume that in any periscope the loss of light at any silvered-glass surface is about 6 percent; and, on the basis of the Fresnel theory (see any optics textbook), we assume that for normal incidence at an air-crown glass surface, the loss is about 4.1 percent, and at an air-flint glass surface, about 5.6 percent. Again, in applying the above figures to those resulting from absorption in the glass, we employ the transmission (100 percent minus reflection loss in percent).

Since the Type II periscope has (low power) 20 air-crown surfaces, 16 air-flint surfaces, and 2 silvered glass surfaces, the transmission that would result if the only losses were due to reflection at the various surfaces is found as follows:

Transmission =
$(1,000 - 0.041)^{20}$ X
$(1.000 - 0.056)^{16}$ X
$(0.94)^{2}$

Transmission of Incident Light	Low Power	High Power
Uncoated optics (theoretical)	11.1%	14.2%
Uncoated optics (measured) *	14.7%	17.0%
COATED OPTICS (measured) *	33.9%	43.9%

* The actual measurements of transmission were observed by several trained technicians using a Lummber-Brodhun type photometer, and then averaged to provide the above figure.

b. Effect of papillary size. The amount of light that can enter an optical instrument depends upon the area of the entrance pupil which is proportional to the square of the diameter of the pupil. Neglecting the losses in the system, caused by reflection and absorption, the amount of light that can leave the instrument is proportional to the square of the diameter of the exit pupil.

It is apparent that four times as much light can pass through an exit pupil 6 mm in diameter as through an exit pupil 3 mm in diameter. However, the brightness of the image depends also upon the area of the entrance pupil of the observer's eye.

The smaller of these two factors is the limiting factor. If the exit pupil of the instrument is

smaller than the pupil of the observer's eye, the instrument has not been well designed and it is difficult to hold the eye in periscopically, that is, the optical axes of both always lie in the same plane, any change in orientation of image produced by the head

position to see the image and a bright field.

The pupil of the human eye varies in diameter with the brightness of the light entering the eye, carrying from about 2 mm, in bright light to about 8 mm in dim light. When the pupil is fully open, the spherical and chromatic aberrations inherent in the eye's optical system cause a falling off in image sharpness. When the pupil is fully stopped down, the reduced resolving power of the ocular systems causes a blurring of the image. Consequently, the ideal diameter of the eye pupil is somewhere between these two extremes. Actual measurements have shown that it is about 4 to 5 mm. It should be noted that the exit pupil of the Type II periscope is just 4 mm in both high and low powers.

c. Relation between central and oblique brightness. Upon entering the periscope, light rays from object points on or near the optical axis travel in lines approximately parallel to the axis in passing from one component telescope to the next. Of course, inside each component telescope these rays converge toward and then diverge from their respective image points. On the other hand, light rays from object points lying near the edges of the field upon entering the periscope, travel between telescopes in cylindrical bundles that are not parallel to the optical axis. And inside each component telescope these oblique bundles converge toward and then diverge from their respective image points.

prism is exactly compensated for by the eyepiece prism, furnishing a final image that is completely erect. Since, in high power, there is an even number of inverting telescopes in the periscope, the final image must be completely erect. In low power, one telescopic system is added but this is a Galilean type telescope which produces an erect image. Therefore, in all cases, an erect image is seen by the observer.

4U6. Head prism. The letters HA which are included in the design designation of the Type II periscope, indicate that the head prism may be elevated to a high angle, and the periscope is so designed that the head prism is able to move the line of sight through a total angle of 84.5 degrees, that is, from -10 degrees (below horizontal) to +74.5 degrees (above horizontal). The limits of the field of view in both powers are shown in the following table, and Figure 4-45 shows the low-power and high-power fields of view at maximum elevation of the prism tilt.

Type II Periscope	Low Power	High Power
Line of sight elevated to +74.5 degrees		
Upper limit of field	+90.5 deg.	+78.5 deg.
Lower limit of field	+58.5 deg.	+70.5 deg.
Line of sight depressed to -10 deg.		
Upper limit of field	+6 deg.	-6 deg.
Lower limit of	-26	-14

field	deg.	deg.

Since the objective lens of the lower main telescope is well removed from the objective lens of the upper main telescope, it is apparent that a sizable departure of any bundle from parallelism to the axis causes all or part of that bundle to strike the tube walls and be absorbed. Thus, the brightness of the image at the margins of the eyepiece field is always less than the brightness of the image at the center of the field. However, the human eye is not too critical in this matter and if the marginal or oblique brightness is at least half the central brightness, it is accepted by the observer as uniform brightness.

4U5. Orientation of image. Since the two reflecting prisms (head and eyepiece) are arranged

4U7. Target ranging devices. a. Telemeter. Each large division of a telemeter lens corresponds to an angle of 1 degree at high power, and 4 degrees at low power. Each subdivision corresponds to an angle of 15 minutes at high power, and 1 degree at low power.

If the angle subtended by the extremities of a target at the observer (angular size) and the linear size of the target are known, the range can be computed.

Since the telemeter is calibrated in degrees of true field, it provides a means of measuring the angular size of a target. The space between successive degree calibrations for high or low power on the telemeter is equal to f X tan 1 deg, where f is the focal length of the lens or optical system forming the image on the telemeter in

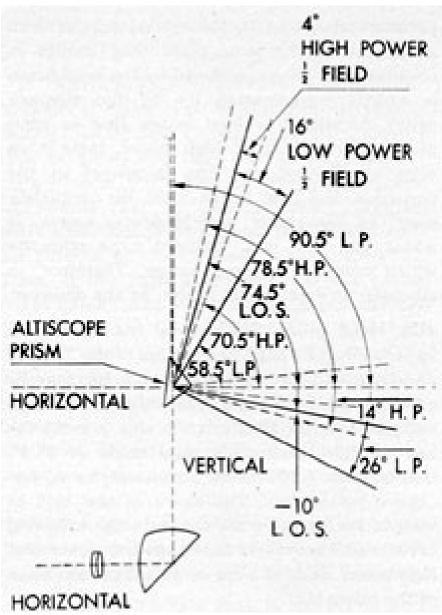


Figure 4-45. Head prism-elevation and depression limits.

the waterline of one image is coincident with the masthead of the other image of the same target. Splitting the image is accomplished by moving one half of the split objective lens against the other half until the waterline of one image and the masthead of the other coincide. By means of appropriate mechanisms, the movement of one objective half relative to the other half is translated to a pair of scale dials such that if the target height is read on one scale dial, the range is read approximately opposite the other scale dial. In a similar manner, scale dials are provided

high or low power as the case may be. Thus the telemeter can be used as a rangefinder. The waterline masthead height is independent of the bearing of the target. Since this height is known, it is used in finding the range; the length of the ship is used because its angular size varies with the ship's bearing. If the range is determined according to masthead height, a range determination based on the ship's length is different unless the course of the target is perpendicular to the line of sight of the observer. If two range determinations, one based on height and one on length, are made, the ratio of the two is a measure of the course angle. While a telemeter can be used to make range and course angle determinations as just described, it is not satisfactory for such determinations because of the great difficulty in taking a reading from the telemeter at both extremities of the target when the observer's ship is not stationary.

b. Stadimeter. The built-in split objective lens stadimeter overcomes the telemeter lens difficulty. The angular size of the target is measured by forming a double image so that from which the course angle can be read. While the correct procedure for taking range and course angle is treated comprehensively in Section 4J13, the principles involved in the measurement of the angular size of the target and the subsequent translation to the stadimeter scale dials are as follows.

For convenience the light image is considered as being at the center of the field.

1. When the objective halves are in position so that the split objective lens functions as a single whole lens, the inter-objective pupil, that is, the cylindrical bundle parallel to the optical axis of the periscope, is converged in a point lying on the optical axis of the lower objective (and periscope) in the back focal plane of the lower objective lens.

2. When the halves are moved as shown in Figure 4-46, the optical axis of each half is displaced from the periscope axis an amount equal to the movement of each half. However, the axis of each half remains parallel to the periscope axis. The back focal plane of each half of the objective lens remains in the same plane as before splitting.

3. Each half now picks up a lesser part of the inter-objective pupil than it did before splitting. However, the part picked up by any half is focused to a point lying on the axis-of that half and in the back focal plane.

4. Consequently each lens half forms an image, removed from the center of the field by a distance equal to the movement of that objective half.

5. If each half, on moving, causes the center of the image it forms to move a given amount,

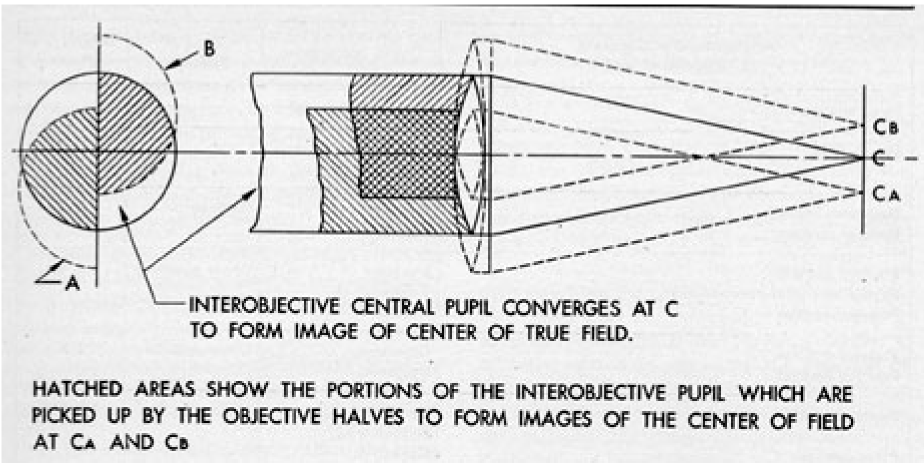


Figure 4-46. Lower (split) objective lens ray diagram.

it causes the entire image it forms to move the same amount.

6. If the split objective lens is normal, or unsplit, it forms a single image of the target. The halves, on being moved to different positions, each form a complete image of the target, displaced by an amount equal to the movement of that half from the original position of the target image formed by the unsplit objective lens.

7. Therefore, it is obvious that if a target image is split so that the waterline of one image coincides with the masthead d the other image, the sum of the movements of the objective halves in opposite directions is equal to the actual linear height of the target image, that is, waterline to masthead height.

8. If the linear height of the target is known and the equivalent focal length of the entire optical system forming the image is known, the angular halves is transmitted in the correct ratio to a set of scale dials similar to a circular slide rule. For a certain position of the lens halves, the values approximately opposite each other on the height and range scale dials are graduated in the ratio of target distance to angular height of the image. Therefore, with the scales in the same position, the value on the height scale dials corresponding to the height of the target lies opposite the target's range on the range scale dial.

10. Since the oblique pupils are smaller in cross section than the central pupil, as shown in Figure 4-46, beyond a certain angle the oblique pupils fall on only one of the objective halves. Consequently, when the lower objective lens is split, no double image appears for that portion of the field. This accounts for the fact that splitting does not occur all over the field.

The chief advantages of the stadimeter over the telemeter are:

height of the image can be computed. That is, for any particular movement of the objective halves necessary to Inform the waterline and masthead split-images there is a corresponding angular height of target.

9. By means of a cam and appropriate mechanism, the movement of the objective

a) the separation of the two images, at any stage of the separation, is independent of any movement of the observer's ship; b) range angle and course angle are available directly from scale dials for quick reading without computation.

4U8. Optical maintenance. a. Arrangement of optical elements (Figure 4-47, page 54).

Arrangement of Elements (in direction of rays)	Use in Instrument	Type of Telescope	Magnifying Power
Head window	Gas and water seal		
Head prism	Deviates axis to vertical		
Negative doublet Positive doublet	Eyepiece Objective	Galilean (a)	1/4 X
Positive doublet Reticle lens (plano-convex) Positive doublet	Eyepiece Telemeter (b) Objective	Upper auxiliary	1 X
Positive doublet Positive doublet	Objective Eyepiece	Lower auxiliary	1 X
Positive doublet Plano-convex	Eye lens Eyepiece (c) Collective	Upper main	1/4.7 X
Air space doublet	Objective		
Air-space doublet	Split lens Objective (d)		
Dioptric prism (e) Positive doublet	Collective Periscope Ramsden Eyepiece Eye lens	Lower main	28X
Eyepiece window	Gas seal		
Rayfilters Polaroid filters (f)	Improve visibility variable density		

1. The Galilean telescope is part of periscope's optical system only in low power. In high power in plane normal to the optical axis to produce a double image for use in the stadimeter.

both lenses are swung out of the field.

2. Placed in image plane of upper auxiliary telescope. It is placed in the first real image plane of the periscope, so that the graduations appear to vibrate in unison with the image and observation is easier.

3. It should be noted that the equivalent focal length of the Ramsden eyepiece system in the 1.414 periscope just equals the EFL of the upper eyepiece lens of the Type III periscope. This establishes the necessary data for machining the cam grooves that actuate the split objective lens, and permits the same stadimeter mechanism to be used in both designs.

4. The objective lens of the lower telescope is split so that the two halves may be shifted

5. A total reflection prism which has a curvature ground on entrance and exit faces may be called a dioptric prism (that is, a prism with refracting power), or a double-convex right-angle prism. It serves two functions, namely: it deviates the optical axis from a vertical to a horizontal direction, and it produces convergence in the ray bundles that are diverging from points in the image plane just ahead of the dioptric prism. In this latter function, it acts as a collective or field lens for the special eyepiece system of the Periscope-Ramsden eyepiece.

6. The fixed polaroid must be aligned with index marks on mount.

b. Ray tracing optical diagram (Figure 4-47, page 54).

c. Tracing rays. A ray-tracing optical diagram of any instrument is an abundant source of information regarding the location and action of the optical elements in the instrument, if we are aware of the following four simple rules:

1. Any ray passing through the optical center of a lens continues in the same direction, that is, there is no bending by the lens.

2. Any cylindrical bundle of rays entering a lens is converged to a point in the secondary focal plane of the lens, not necessarily on the optical axis.

auxiliary telescope, which lens converges each bundle to a point in its back focal plane.

e) If the periscope is in proper adjustment, the plane surface (containing the scale) of the telemeter lens also lies in this image plane. Thus, the target image is superimposed on the telemeter lens, and the rays continue on down the tube as though they originated at image points in the plane of the telemeter lens. By virtue of the fact that these ray bundles are diverging from the plane surface of the telemeter lens, that lens has practically no converging effect on the bundles. It does perform,

3. Any cone-shaped bundle of rays diverging from a point in the primary focal plane of a lens is converged to a cylindrical bundle.

4. The image of any object-point is the intersection, after passing through the lens, of all the usable rays from the object point.

These rules apply particularly to positive, or converging, lenses. By substituting converging for diverging and vice versa in the above four rules, they apply specifically to negative, or diverging, lenses.

5. Thus, referring to the ray tracing as shown in Figure 4-47, page 54, and to the table in Section 4U2-b we trace various ray bundles through the Type II submarine periscope by noting their behavior when passing through the various optical elements of the instrument:

a) Since the object is at infinity (or practically so), all the rays from any one point of the object arrive at the head window in a cylindrical bundle.

b) Since the head window is planes-parallel, it does not affect the direction of the ray bundles or the parallelism of rays in any one bundle.

c) Since the head prism has plane faces (entrance, reflecting, and exit), it produces no convergence or divergence in the cylindrical bundles. The head prism, however, does deviate the line of sight so that it travels along the optical axis down the periscope tube.

however, a collective action by deviating the direction of each entire bundle. It produces zero deviation in the one bundle which meets the lens at the optical axis; but it produces its maximum deviation in those bundles which meet it farthest from the optical axis. In other words, because of its unique position in the system (that is, in an image plane), this telemeter lens acts like a thin prism but not like a lens.

f) The objective lens of the upper auxiliary telescope is placed just one focal length from the telemeter, so that the ray bundles diverging from that image plane are converged by it to form cylindrical bundles that travel down the tube until they meet the next lens.

g) Lower auxiliary telescope. The objective lens of the lower auxiliary telescope receives the cylindrical ray bundles and converges them to converging bundles with vertices in the back focal plane of the objective, where the rays, in each bundle cross this plane at a point, and then diverge toward:

h) The eyepiece (lens) of the lower auxiliary telescope, which converges the bundles into cylinders, since the rays had previously intersected in the front focal plane of the eyepiece. Thus, as we expect, the lower auxiliary telescope receives cylindrical bundles of rays and after inversion, sends them on down the tube as cylindrical bundles of rays toward the next optical element.

i) Upper main telescope. The cylindrical bundles of rays meet

d) Upper auxiliary telescope. If the Type II is in high power (see Section 4U8-c-17 for ray tracing in low power) the Galilean telescope is swung out of the field, and the cylindrical bundles next meet the eyepiece of the upper

the eye lens of the eyepiece system of the upper main telescope and are converged toward image points in the back focal plane of this lens.

j) Before the converging bundles reach this plane, however, they are intercepted by another converging lens, the collective of the upper main eyepiece. The collective causes the bundles to converge still more, so that the rays in each bundle are caused to intersect sooner than they otherwise would, and the image plane is just below the collective lens. From these intersections (image points), the rays diverge until they meet the next lens in the system:

k) The objective lens of the upper main telescope receives the ray bundles which are diverging from the plane above (which is the front focal plane of the objective) and transforms them into cylindrical bundles that travel down the tube to the next telescopic system.

1) Lower main telescope. The objective lens of the lower main telescope (assume the two halves are not displaced but form a circle) receives cylindrical bundles and converges them to image points in its back focal plane, which is also the front focal plane of the lower eyepiece system, since this is a telescope.

o) Cylindrical bundles. The cylindrical bundles pass next through the eyepiece (gas-sealing) window, which is plano-parallel, and hence are neither deviated, converged, nor diverged.

p) Rayfilters and polaroids. The rayfilters and polaroids are also plano-parallel and do not affect the vergence or the deviation of the ray bundles, so that the observer's eye finally receives cylindrical bundles if his eye is normal. If the observer's eye requires, for example, a -1.5 diopter setting of the eyepiece unit, he still receives a sharp image on his retina with his eye relaxed. Such a setting would merely indicate that the observer's eye at rest saw most clearly those objects (or images) which were 2/3 of a meter distant from his eye.

q) Galilean telescope. When the Type II periscope is in low power, the reversed Galilean telescope is included in the system, following the head prism and preceding the eyepiece of the upper auxiliary telescope. Since the Galilean system is a telescope, it transmits cylindrical bundles if it receives cylindrical bundles. The action of a reversed Galilean telescope, however, may not be obvious, and its formation of images is

m) The rays diverging from this image plane are converged by the dioptric prism, which acts as a collective lens for the lower eyepiece. Since the image plane is closer to the collective than its own focal plane, the dioptric prism is unable to converge the various bundles enough to form cylindrical bundles, hence the ray bundles enter the next lens:

n) The eye lens of the lower eyepiece system, with a slight divergence, and the converging power of the eye lens (that is, the reciprocal of its focal length) is just enough to transform the ray bundles to cylindrical bundles.

discussed in the following drawings:

6. The rays shown in Figure 4-48 are parallel to each other (although not parallel to the optical axis) because they are traveling to the right from a single point (Q) of the infinitely distant object. This object point is not shown in the drawing.

The dashed line M to the left of the negative lens represents the secondary focal plane of the above lens, and this, of course, is the plane in which are imaged all infinitely distant

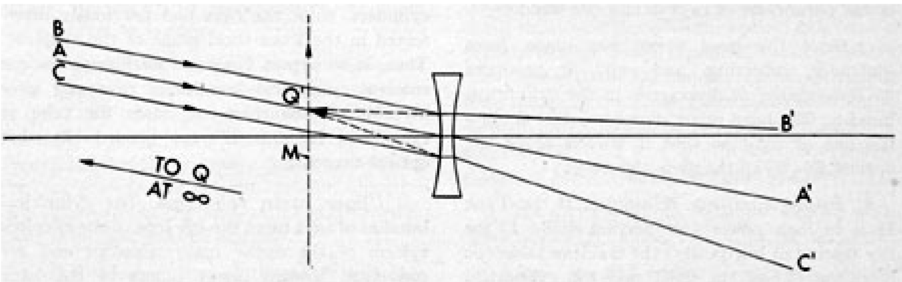


Figure 4-48. Galilean telescope system diagram.

objects. The-ray (A) passes through the optical center of the lens and, therefore, is not deviated by the lens. It is shown as ray (A') after passing through the lens. Furthermore, the point (Q') where the ray (A) passes through the image plane is the point image of the distant object point (Q). The other rays, (B) and (C), are each bent toward the thick part of the lens and, therefore, rays (B') and (C') seem to be traveling to the right from the image-point (Q'). This image, of course, is virtual, the ray bundle containing rays (A'), (B'), and (C') is diverging exactly the same amount as though these element cemented to the equi-concave element of the Galilean eyepiece lens to correct for spherical and chromatic aberration.

d. Method of removing parallax caused -by gas pressure. If the image seen through an optical instrument is not sufficiently sharp, the system is said to be out of focus. If the image is sharply defined, however, it does not follow that the exact separation of the various lens elements has been established perfectly, for the human eye accommodates easily to slight divergence or

rays had actually originated at the point (Q').

If a positive lens, as shown in Figure 4-49, is placed to the right of the above negative lens so that its primary focal plane coincides with the image plane shown, all points in this plane are imaged by the positive lens at infinity. This, then, is a simple telescope; the secondary focal plane of the objective (negative lens in this case, since it is first to receive the rays) coincides with the primary focal plane of the eyepiece (positive lens, since this is the one nearest the observer's eye). Since one of the lenses is negative, the image is neither inverted nor reversed, and the system is called a Galilean telescope. The reader should refer to the four rules listed in Section 4U8-c and study their application in Figure 4-49.

The Type II, Type III, and Type IV periscopes have a divergent meniscus optical glass convergence of the emerging ray bundles.

If the instrument carries one or more reticles, each reticle can be placed in its proper image plane with near perfection by means of parallax focusing. Since the Type II submarine periscope does have a reticle (the telemeter lens), the setting of this plane exactly in the first real image plane of the periscope is the problem we must solve with a great deal of care. When this is accomplished, the periscope is said to have no parallax.

Ordinarily this is a relatively simple matter inasmuch as parallax is detected readily by looking into the system and shifting the eye slightly (in a plane normal to the optical axis). If there is no parallax, there is no apparent movement of the image relative to the reticle, and if there is an apparent movement of image relative to the reticle, the image seems to shift

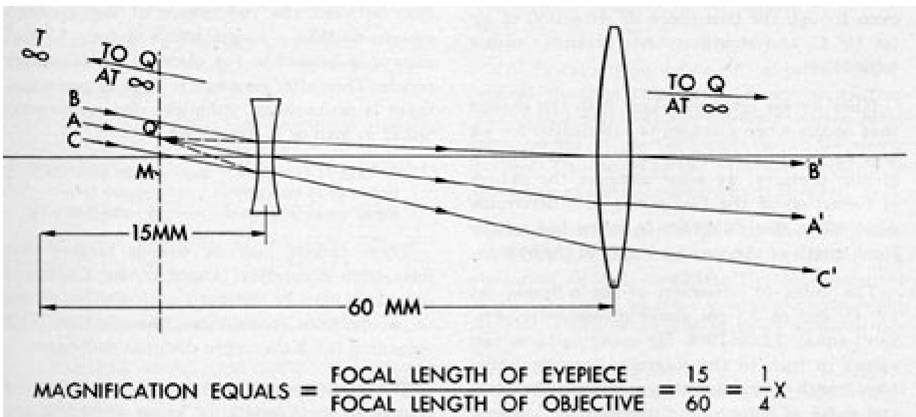


Figure 4-49. Galilean telescope system diagram.

in the same direction as the eye or in the opposite direction. When the shift of the image (relative to the reticle) is with the eye, we know that the image is by nitrogen under the above conditions, it has a focal length (EFL) which is 1.00038 times the focal length of the same lens in air under normal conditions.

farther from the eye than the reticle. When the shift of the image is against the eye, the image is closer than the reticle. (In the case of a submarine periscope, such as the Type II, which has a split lower-main telescope objective lens, the above method is not practicable; consequently, a good auxiliary telescope must be adjusted to the observer's eye and then used as follows: For the coarse adjustment, change the diopter setting of the periscope eyepiece and note whether the target image and telemeter reticle both come in and go out of focus simultaneously. For the fine adjustment, vary the diopter setting of the auxiliary telescope eyepiece and look for the above condition.)

Achieving the condition of no parallax in the Type II periscope is complicated by the fact that the proper separation of the various lenses is established while the optical system is surrounded by air (at normal atmospheric pressure), while the periscope is to be used with the optical system surrounded by dry nitrogen at 7.5 psi above atmospheric pressure. Now the index of refraction of the various kinds of glass comprising the optical system of the Type II may be used to calculate the focal length (or refracting power) of each of the lenses, and if we assume that the index of refraction of air is 1.00000000 no appreciable error is obtained, even though the true index of refraction of air (at 15 degrees C, and at atmospheric pressure) equals 1.00027734.

This means that if we remove parallax with the system in air and then gas the periscope to plus 7.5 psi, the telemeter reticle no longer lies in the image plane of the upper-auxiliary telescope eyepiece of the Type II periscope. It is necessary, in fact, before gassing the instrument, to increase the separation between the reticle and the preceding image-forming lens (in high power) by the factor 1.00038. This may be done by mechanical measurements; however, a much simpler method is to perform this shift optically, as follows:

If we use a target that is not infinity (when the system is in air) but is just 1,200 feet distant, the image formed by the upper-auxiliary telescope eyepiece falls slightly more than one focal length behind the eyepiece; in fact, it is just 1.00038 focal lengths behind the lens. Thus, when the parallax has been removed (high power) for a target 1,200 feet distant while the system is in air, after gassing the periscope, all targets that are infinitely distant are imaged exactly on the telemeter reticle; that is, there is no parallax.

After establishing the above separation between the telemeter reticle and the preceding image-forming lens, swing the Galilean system into the field (low power) and adjust the separation between the two lenses of the Galilean system so that a target which is only 35 feet distant is imaged in the plane of the telemeter reticle. Then after gassing the Type II periscope, there is no parallax (infinitely distant targets) either in high or in low power.

Since we are concerned herewith the change that occurs when nitrogen is substituted for air and particularly when the nitrogen is under a greater pressure, we must compare the indices of refraction of the two media and determine what effect this difference in index has on the focal length of the various lenses in the system.

The index of refraction of the nitrogen (at 15 degrees C, and at 7.5 psi above atmospheric pressure) equals 1.00041968. By applying these two values in turn to the formulas for calculating focal length (when curvatures, index of the glass, and index of surrounding medium are known), it may be calculated that when a lens is surrounded

Type II Periscope	Target Distance
Periscope in high power	1,200 feet
Periscope in low power	35 feet

These targets may be outside targets that have been accurately ranged or, for shipboard use, they may be obtained optically by means of a distance collimator. See Section 4V8 regarding the Kollmorgen distance collimator.

The above adjustments compensate for the change in focal length of lenses preceding the telemeter. For lenses that follow the telemeter,

set the periscope eyepiece at -3/4 diopters before gassing and return the eyepiece to zero diopter setting after gassing.

It is important to realize that the proper pressure for the nitrogen is from 5 to 7.5 psi. If the pressure is outside these limits there definitely is parallax in the instrument.

4U9. Glossary of optical terms.

a. Single thin lens.

1. Lens: any piece of glass or other optical medium that is bounded by two curved surfaces, usually spherical.

2. Center of curvature: the center of the sphere of which the lens face is a part.

8. Object plane: that plane in which the object point lies which is normal (perpendicular) to the optical axis.

9. Image plane: plane normal to the axis, in which the image point lies.

10. Object distance: distance along the axis from an object plane to the center plane of a lens.

11. Image distance: distance along the axis from the image plane to the center plane of a lens.

12. Secondary focal plane: plane in which the image is formed when an object is at infinity.

13. Primary focal plane: plane in which to place the object in order to produce an image at infinity.

3. Optical axis: the straight line connecting the centers of curvature of the two faces.

4. Thin lens: any lens thin enough that the primary and secondary nodal planes may be considered to coincide with each other and with the geometrical center plane of the lens itself.

5. Ray bundles:

a) Diverging bundles: all the rays that diverge from a single point of the object, or image, until they meet a refracting surface.

b) Cylindrical bundles: same as the diverging bundles except that the object point is so distant that only those rays that are parallel to each other succeed in getting into the lens.

c) Converging bundles: rays from a single object point that have been converged by a positive lens.

d) Paraxial bundles: ray bundles originating from an object point that lies on or near the optical axis of the lens.

e) Oblique bundles: originating from an object point that lies off the axis, near the margin of the field.

6. Object point: that point of the object which is under consideration.

7. Image point: that point of the image which corresponds to the object point under consideration; both object and image consist of an infinite number of points.

14. Focal point, primary or secondary: intersection of axis with appropriate focal plane.

15. Focal length: distance between focal plane and center plane of the lens.

16. Conjugate planes: planes so spaced that if the object lies in one, the image lies in the other. Thus, infinity and the secondary focal plane are conjugate. If the object distance is known in terms of the focal length of the lens instead of in inches or millimeters, it is quite easy to determine the image distance by the formula: if object distance equals n focal lengths, the image distance equals $n/(n - 1)$ focal lengths.

17. Prism: any piece of glass or other optical medium that is bounded by two or more plane surfaces. Since ordinary prism faces have no curvature, the prism has no refracting power. The prisms does, however, produce a deviation in the incident bundles of rays.

18. Prism diopter: unit of deviation produced by a thin prism. If a prism produces a deviation of one centimeter in one meter of travel, it is said to have a power of one prism diopter, which is equivalent to an angle of ten mils.

19. Dioptric image: Newtonian terminology denoting any image formed by refraction, that is, by lenses.

20. Catoptric image: Newtonian terminology denoting any image formed by reflection, that is, by a mirror or prism.

21. Dioptric prism, or catoptric lens: derived name for the eyepiece prism of the 1.414 periscope, indicating that this collective prism both deviates the incident bundles and contributes convergence to these bundles.

22. Nodal planes: See Section 4U9, paragraph b-5.

b. System of two thin lenses. A system of two thin lenses may be considered as a single thin lens if the following three quantities are first calculated:

1. Equivalent focal length: the focal length of an imaginary thin lens that is equivalent to the focal length of the combination of lenses.

2. Back focal distance: distance from back surface of second lens to the secondary focal plane of the system.

3. Front focal distance: distance from front surface of the first lens to the primary focal plane of the system.

4. Method of calculating these three quantities:

Equivalent focal length =
$(f_1 \times f_2) / (f_1 + f_2 - S)$

Back focal distance =
$((f_1 \times f_2) - (S \times f_2)) / (f_1+f_2-S)$

Front focal distance =
$((f_1 \times f_2) - (S \times f_1)) / (f_1+f_2-S)$

BFD: measure from the surface of the second lens to the right a distance equal to value calculated.

EFL: from the front focal point (F) measure to the right to locate the primary nodal plane (N), a distance equal to value found for EFL; from the back focal point (F') measure to the left to locate the secondary nodal plane (N'), a distance equal to the value found for EFL. Thus, the equivalent focal length of any combination of lenses is always the distance from either of the focal points of the system to the corresponding nodal plane.

5. Nodal planes: the primary nodal plane (N) of any system may be considered to be the plane of arrival for all rays entering the system, just as the secondary nodal plane (N') is said to be the plane of departure for all rays leaving the system. The object distance in the case of a system is always measured from the object plane to the N-plane; and the image distance is always measured from the N'-plane to the image plane.

6. Separation: when the distance between two lenses comprising a system has certain special values, optical systems with special characteristics are formed:

a) When the separation equals the sum of the two focal lengths, the system is a telescope.

b) When the two focal lengths are equal and the separation is equal to 2/3 of either, the system becomes a Ramsden eyepiece. This system is a form that has been modified to improve the color correction and is the type

f_1 and f_2 denote the focal lengths of the first and second positive lenses respectively; and S is the separation between them in the same units of linear measure.

The rules for locating on a simple optical diagram, the positions of the front focal point (f), the back focal point (f'), and the primary and secondary nodal planes (N and N' respectively) of the above system are indicated below for the case where each quantity is positive. If any quantity works out toy be negative in value, take measurements in a direction opposite to that indicated.

FFD: measure from the surface of the first lens to the left a distance equal to the value found.

used in most telescopes and in main telescopic systems of periscopes.

c) When the focal length of the first lens equals three times the focal length of the second lens, and the separation equals 1/2 the sum of the two focal lengths, the system becomes known as a Huyghens eyepiece, which is commonly used in microscopes. The Huyghens ocular does not take a graduated reticle nearly so well as does the Ramsden eyepiece.

d) When the separation between the first and second lenses of any eyepiece equals the average of the two focal lengths, the system is well corrected for chromatic aberration.

c. Optical instrument.

1. Inverting telescope: two positive lenses separated by a distance equal to the sum of their focal lengths. See Section 4U2, for magnifying power.

2. Galilean telescope: one positive lens and one negative lens separated by a distance equal to the algebraic sum (arithmetic: difference) of their lengths.

3. Periscope: two main telescope systems aligned so that one optical axis coincides with the other, and placed with the two objective lenses facing each other. This arrangement satisfies the mechanical limitation of great length compared to the magnifying power equal to 1/4 and the upper main telescope has a power equal to 1/4.7.

d. Ray tracing considerations. It may be helpful to consider the behavior of a bundle of light rays in traversing an optical instrument.

From each point of the object, light rays traveling in straight lines are radiating in all directions. We are interested, of course, only in those rays from a given object point that are directed in order to enter the first lens of our system. If this system is a telescope, the object is at infinity, or at a great distance, and the only bundles that enter the objective are those in which all rays are parallel to each other but not necessarily

diameter of the instrument. It consists of a tube containing the above and provided at each end with reflecting surfaces, either mirrors or reflecting prisms, inclined at 45 degrees to the axis of the tube, so that an observer looking into one mirror (generally looking through an eyepiece) can see the objects reflected by the other mirror.

4. Magnifying power of any optical instrument:

Magnifying power =
(Size of image seen through instrument) /
(Size of image seen by eye alone)

5. Magnifying power of simple telescope: defined three ways:

a) MP =
(Focal length of objective) /
(Focal length of eyepiece*)

b) MP =
(Diameter of entrance pupil of instrument) /
(Diameter of exit pupil of instrument)

c) MP =
Apparent field of view (object nearest eye) /
True field of view (eyepiece nearest eye)

6. Magnifying a power of periscope: the power of a periscope is the product of the magnifying powers of all the component telescope systems. Reversed telescopes have powers that are reciprocal to their normal power; in other words, the Galilean telescope has a

* EFL if eyepiece is a system.

parallel to the optical axis of the instrument.

Upon passing through the objective of the telescope, these various cylindrical bundles are converged to their respective image points in the back focal plane of the objective lens; from these points they cross over and diverge toward the eyepiece lens. The eyepiece lens causes the diverging bundles to converge (since each bundle is coming from a single point in the front focal plane of the eyepiece) just enough to form cylindrical bundles again. Thus, the telescope forms at infinity an image of some object that is also at infinity, this image being magnified or minified in size and inverted or left erect, depending upon the type of telescope.

If we trace the rays through the Type II periscope, we need only consider that each telescope system in the periscope acts in the manner outlined above, receiving cylindrical bundles of rays from each object point (and there are an infinite number of such points in every object, however small the object) and emitting cylindrical bundles toward the next telescope in the system. It is suggested that the student form a periscope by suitably placing two auxiliary telescopes, for example, a 3x and a 5x. Keeping them coaxial, vary the distance between the two objective lenses to note the effect on image sharpness and on image brightness. The only limitation is found to be the brightness difference between the center and the margin of the field of view as seen through the eyepiece of the second telescope.

In the Type II periscope, the field of view of the eyepiece is approximately 48 degrees, which is the apparent field of view of the periscope itself. If the center of the field is arbitrarily defined as that part lying within 11.5 degrees of the optical axis, the margin is then the rest of the field lying outside this inner circle of 23 degrees diameter. Those parts of the object lying on or near the line of sight are of course, imaged near the center of the field (by the central ray bundles); while those parts of the object lying off the axis are imaged (by the oblique ray bundles) in the margin of the field. Inasmuch as the central bundles travel down the periscope tube nearly parallel to the optical axis while going from one telescope to the next, they reach the observer's eye practically in their entirety. The oblique bundles, however, in passing down the periscope, make a considerable angle with the optical axis between the telescopes. Thus, if there is a large distance between the telescope systems, as there is between the two main telescopes, part of the oblique bundles are bent toward the tube walls where they are absorbed by the anti-reflection threading or by the diaphragm stops and thus fail to reach the entrance pupil of the observer's eye. The brightness of the margin of the field, consequently, is always less than the brightness of the center.

The design of the periscope is simplified by the fact that the human eye is not critical in the matter of comparing central and marginal brightness. In fact, if the margins are at least half as bright as the center of the field, the average observer agrees that the brightness is uniform throughout. If the marginal brightness is less than half the central brightness, the observer complains that the illumination is not uniform.

Chapter 4 Continued

V. REASSEMBLY OF THE UPPER AND LOWER TELESCOPE SYSTEMS

4V1. Reassembly of the upper telescope system. The upper telescope system is reassembled in the following manner:

1. Using an air hose, blow out the upper telescope system Part II consisting of the second, third, and fourth inner tube sections (Figure 4-21).

2. Screw the threaded periphery of the upper part of the fourth inner tube section upper end coupling (5) into the internal threaded section in the lower part of the fifth inner tube section (34, Figure 4-20) of the upper telescope system Part I.

3. Insert and secure the four lockscrews (35), inserting them in countersunk clearance holes in the lower part of the fifth inner tube section (34) and screw them into tapped holes in the upper alignment support section of the fourth inner tube section upper end coupling (5, Figure 4-21). This secures the upper telescope system Part I and Part II together.

4V2. Reassembly of the lower telescope system. The lower telescope system is reassembled in the following manner:

1. Connect the eyepiece skeleton assembly (Figure 4-28) to the

2. Screw the internal threaded section of the eyepiece skeleton upper part (42, Figure 4-28) on the threaded periphery of the spider bearing (3, Figure 4-27).

3. Insert and secure the four lockscrews (37, Figure 4-28), inserting them in countersunk clearance holes in the counterweight bearing section of the eyepiece skeleton (42) and screw them into tapped holes in the spider bearing lower alignment support section (3, Figure 4-27).

4. Connect the objective operating mechanism assembly (Figure 4-23) to the first inner tube section assembly (Figure 4-27).

5. Screw the internal threaded section in the lower part of the track sleeve (2, Figure 4-23) on the threaded periphery located in the upper part of the first inner tube section upper end coupling (11, Figure 4-27).

6. Insert and secure the four lockscrews (23, Figure 4-23), inserting them in countersunk clearance holes in the lower part of the track sleeve (2) and screwing them into tapped holes in the upper alignment support section of the first inner tube section upper end coupling (11, Figure 4-27). This secures the objective operating mechanism

lower part of the first inner tube section assembly (Figure 4-27).

assembly and the first inner tube section assembly together.

7. Place the stadimeter transmission shaft coupling (14, Figure 4-23) on the lower part of the operating gear pinion shaft (13) and secure it to the shaft with a taper pin (33).

8. Place the objective operating mechanism assembly and the eyepiece skeleton assembly attached to the first inner tube section assembly in two V-blocks on the optical I-beam bench.

9. Unscrew the eyepiece lens mount (19, Figure 4-28), carrying with it the eyepiece lens (52), eyepiece lens clamp ring (16), and its lock screw (41). The removal of the above outward projecting assembly is necessary for the assembly of the eyepiece box (11, Figure 4-29) to the eyepiece skeleton (42, Figure 4-28).

10. Check the base of the eyepiece box (11, Figure 4-29) to ascertain that the eyepiece skeleton centering screw (12) is not secured in place.

11. Assemble the outer tube and eyepiece box rubber gasket (8) on the upper alignment support section of the eyepiece box (11), resting it against the sealing shoulder located preceding the threaded periphery. Check the eyepiece box and eyepiece skeleton assembly to ascertain the elimination of all inward and external projecting parts and to make sure that nothing restricts

Guide the shaft as it is carried upward slowly through the clearance hole in the large shoulder flange of the eyepiece skeleton (42, Figure 4-28), and counterweight (25).

15. Place the lower thrust collar (4, Figure 4-27) on the stadimeter transmission shaft (22) and carry the shaft through the bearing hole in the spider (2).

16. Place the upper thrust collar (4) on the stadimeter transmission shaft, (22) and carry the shaft upward through the clearance hole in the soldered bracket (23) located on the central part of the first inner tube section periphery (1).

17. Line up the position of the taper pin holes in the stadimeter transmission shaft coupling (14, Figure 4-23) and the stadimeter transmission shaft (22, Figure 4-27). Insert two temporary lockscrews in tapped holes in the coupling until completion of procedure stated in Section 4V11.

18. Place the two thrust collars (4) next to the side faces of the cast bearing projection of the spider (2) and secure them with two taper pins (10).

19. Place the eyepiece drive packing gland assembly stuffing box body gasket (11, Figure 4-35) on the counterbored face of the eyepiece box (11, Figure 4-29) for this assembly.

the assembly of the eyepiece box (11).

12. Place the eyepiece box (11) over the eyepiece skeleton assembly (Figure 4-28), guiding it on slowly and carefully. It is carried on the narrow alignment shoulder of the large shoulder flange of the eyepiece skeleton (42). Engage the reamed dowel pin holes of the eyepiece box upper face over the downward protruding dowel pins (36) in the eyepiece skeleton large shoulder flange.

13. Insert and secure the eight lockscrews (31). These lockscrews are inserted with the counterweight (25) at its extreme upward position. The lockscrews are inserted in the clearance holes in the eyepiece skeleton (42) large shoulder flange and screwed into tapped holes in the upper face of the eyepiece box (11, Figure 4-29).

14. Place the stadimeter transmission shaft (22, Figure 4-27) in the stuffing box section of the eyepiece box face (11, Figure 4-29).

20. Place the counterweight (25, Figure 4-28) at the extreme upward limit of its travel (the plus position).

21. Place the female coupling section (3, Figure 4-39) of the focusing knob assembly on the square section of the eyepiece drive actuating shaft (12, Figure 4-35) of the eyepiece drive packing gland assembly. Check the reference punch mark on the eyepiece drive actuating shaft (12) and the corresponding reference mark on the female coupling section (3, Figure 4-39) for proper alignment.

22. Check the +1 1/2 diopter setting with the stationary zero reference line of the knob bracket hub (7). The +1 1/2 diopter setting should be turned to a slight overtravel of the stationary zero diopter reference line.

23. Place the eyepiece drive packing gland assembly together with the attached focusing

knob assembly in its opening in the eyepiece box (11, Figure 4-29). Align the rectangular base of the knob bracket (7, Figure 4-39) with the recess face in the eyepiece box on the stuffing box body rubber gasket (11, Figure 4-35).

24. The eyepiece drive mechanism bevel gear (1) attached to the eyepiece drive actuating shaft (12) should

eyepiece drive actuating shaft (12, Figure 4-35) in the same manner as described under Step 21.

29. Check the rectangular flange of the knob bracket (7, Figure 4-39) to ascertain that the two dowel pins (8) engage in the dowel pin holes in the eyepiece box recess face.

30. Insert and secure the four lockscrews (10). These lockscrews

engage into mesh correctly with the eyepiece prism shift bevel gear (11, Figure 4-28) of the eyepiece skeleton assembly.

25. Remove the focusing knob assembly (Figure 4-39) from the eyepiece drive packing gland assembly (Figure 4-35).

26. Rotate the stuffing box body of the eyepiece drive packing gland assembly so that reference numerals on the stuffing box body flange face coincide with the reference numerals on the eyepiece box recess face (11, Figure 4-29).

27. Insert and secure the six lockscrews (3, Figure 4-35) inserting them into countersunk clearance holes in the stuffing box body flange (6) and screwing them into tapped holes in the eyepiece box counterbored seat.

28. Replace the focusing knob assembly (Figure 4-39) on the square section of the

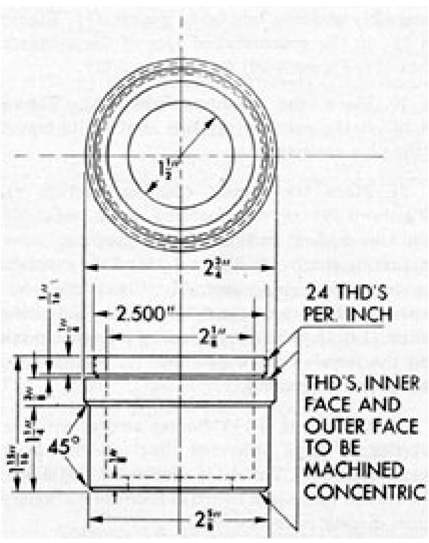


Figure 4-50. Special eyepiece alignment jig diagram.

are inserted in countersunk clearance holes in the knob bracket rectangular flange (7) and screwed into tapped holes in the eyepiece box.

31. Place the eyepiece skeleton centering screw lead washer (13, Figure 4-29) on the shoulder of the centering screw (12), inserting the centering screw in the base of the eyepiece box (11). The centering screw extends into the reamed hole in the eyepiece skeleton base (42, Figure 4-28) and screws into a tapped hole in the eyepiece box base. Secure the centering screw with a large screw driver blade, using a small wrench on the blade, to insure the hermetical seal of this opening.

32. Using a special wrench attached to the male tang section of the stadimeter transmission shaft (22, Figure 4-27) rotate the shaft, placing the objective operating mechanism at the observing position.

4V3. Alignment of the 90 degrees rotation of the objective operating mechanism. The 90 degrees rotation of the objective operating mechanism is aligned in the following manner:

1. Place the lower telescope system described in Section 4V2 in two V-blocks on the optical I-beam bench. Face the objective operating mechanism toward the end of the optical I-beam bench.

2. With the two special clamp brackets attached to the V-blocks, line up the eyepiece end of this assembly with the horizontal and perpendicular plane of the optical I-beam bench.

3. Place the threaded periphery of the special eyepiece alignment jig (Figure 4-50) in the internal threaded section in the eyepiece prism front retaining plate (24, Figure 4-28) of the eyepiece skeleton assembly. Screw the jig into this front retaining plate until the shoulder of the

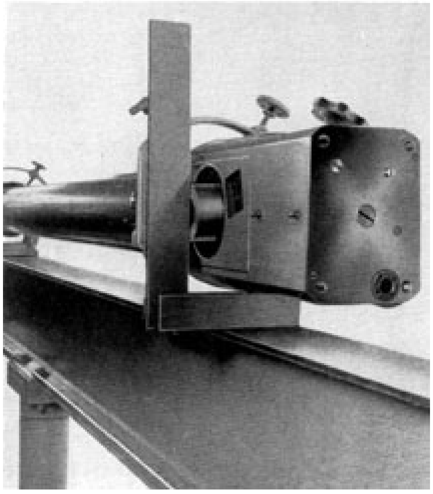


Figure 4-51. Lining up the eyepiece jig with machinist's square.

jig attains a tight metal to metal contact with the projecting cylindrical shoulder of this retaining plate.

4. Using a large machinist square, line up the special eyepiece jig to a true horizontal plane. The outer face of the alignment jig is aligned vertically with the vertical blade of the square in the following-manner:

5. Rotate the complete assembly in the V-blocks until the outer face of the alignment jig is parallel to the vertical blade of the square (Figure 4-51). The base of the square is placed on the I-beam surface with the 90

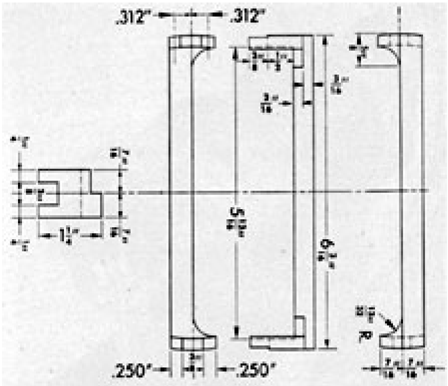


Figure 4-52. Ninety-degree alignment straight-edge.

transmission shaft (22, Figure 4-27) until the peripheries of the mounting plates (5, Figure 4-23) of the objective operating mechanism are in coincidence.

9. Insert the 90 degrees alignment straight-edge (Figure 4-52) with the four extension lugs of the straight-edge a push fit in the opposite elongated slots of the sliding track large shoulder flange (3, Figure 4-23). The straight-edge of this device locks the mounting plates (5) and the operating mechanism to provide only the 90 degrees rotation.

10. Using a dial indicator attached to a surface gage, determine the parallelism of the straight-edge with the horizontal surface of the optical I-beam bench.

degrees blade extending upward vertically.

6. Secure the V-block clamps by turning the adjusting knobs as shown on the above illustration. These clamp the lower telescope system tight in the V-blocks. Check the face of the alignment jig note and correct any change which may have taken place while clamping.

7. When the special eyepiece jig is in a true horizontal plane and well clamped] determine the parallelism of the observing position of the sliding track (3, Figure 4-23) in the following manner:

8. Rotate the special wrench attached to the male tang section of the stadimeter

11. Place the surface gage on the surface of the optical I-beam bench, with the dial indicator, set with sufficient tension on the straight-edge (Figure 4-53).

12. Keep a firm pressure on the base of the surface gage while checking throughout the length of the straight-edge.

13. Note the dial indicator for any variation while traveling the length of the straight-edge (Figure 4-54).

14. If variation is noticed, it indicates that wear has taken place at the detent pawl rest stop, which is the end of the circumferential slot of the track sleeve (2, Figure 4-23) for the observing position.

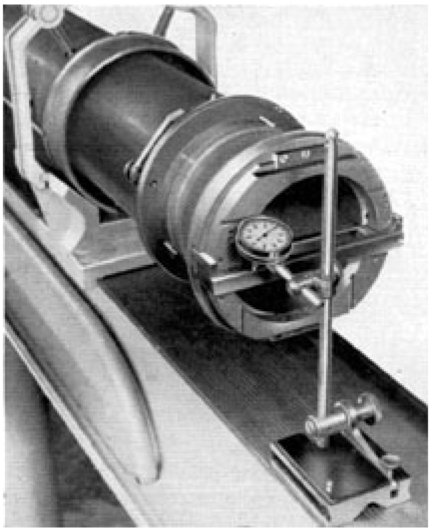


Figure 4-53. Dial indicator attached to surface gage, on 90 degrees straight-edge at the left side for range position.

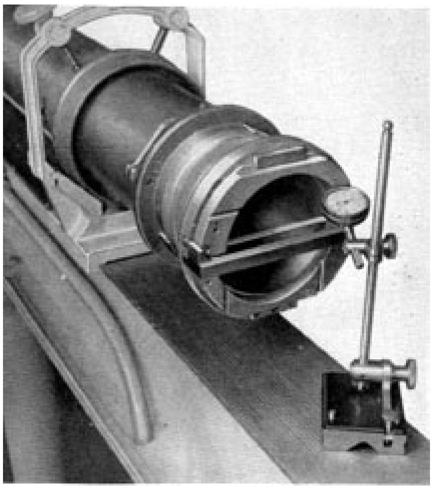


Figure 4-54. Dial indicator attached to surface gage on 90 degrees straight-edge at the right side for range position.

15. Remove the six lockscrews (26), unscrewing them from the tapped holes in the opposite raised mounts of the track sleeve (2). Remove the detent pawl

19. The opposite stop, or end, of the circumferential slot in the track sleeve (2) is the contact stop position of the opposite face of

spring (6), and swing the detent pawl (7) clear for the removal of the detent pawl rest (8)

16. Remove the two long and two short lockscrews (9 and 1-0), unscrewing then from the tapped holes in the sliding track (2). Remove the detent pawl rest (8).

17. The detent pawl rest (8) can be built up by welding or it can be renewed. If built up by welding, it can be worked down on a grinding wheel, using a trial and error checking method.

18. After building up the detent pawl rest (8), grind it down until it contacts the end of the track sleeve circumferential slot (2), leaving the straight-edge parallel with the surface of the optical I-beam. Use the dial indicator each time in the same manner as directed in step (13), and secure the detent pawl rest (8) each time with the long and short lockscrews (9 and 10).

the detent pawl rest (8) in the course-angle position.

20. The course-angle stop position of the circumferential slot in the track sleeve (2) has minor usage in the service. Therefore, no building up of the detent pawl rest (8) should be required.

21. Turn the special wrench attached to the male tang section of the stadimeter transmission shaft (22) clockwise until the course angle of the detent pawl rest (8) is against the end of the circumferential slot in the track sleeve (2).

22. Place the machinist square on the surface of the optical I-beam bench and slide the blade of the square in contact with the straight-edge (Figure 4-55). Check the parallelism of the straight-edge with the 90 degrees vertical blade of the square.

23. Build up and grind down this contact face of the detent pawl rest (8, Figure 4-23) for the course-angle position by following the procedure stated under Step 18; in this case, however, the square is used each time.

24. Secure the detent pawl rest (8) with the two long and two short lockscrews (9 and 10) after completion of the alignment of the 90 degrees movement for the observation and course-angle positions.

25. Swing the detent pawls (7) inward, and check their engagement in the 90 degrees V-groove notch in the detent

pawl rest (8) for the observing and course-angle positions. The detent pawls should retain the detent pawl rest against the opposite circumferential slot stops for either position. Should the detent pawls (7) require building up for proper engagement, they can be repaired in the same manner as the detent pawl rest (8).

26. Swing the detent pawls (7) inward and place the spring (6) so that it overlaps both detent pawls. Secure it to the opposite raised mounts of the track sleeve (2) with six lockscrews (26).

27. Remove the straight-edge from the sliding track (3), and rotate the special wrench attached to the male tang section of the stadimeter transmission shaft (22, Figure 4-27) counter-clockwise, placing the objective operating mechanism in the observing position.

28. Attach the lower (split) objective lens and mount assembly (Figure 4-22) to the objective operating mechanism assembly (Figure 4-23).

29. Place each assembled mount half on its respective mounting plate (S), and secure each temporarily with two stadimeter collimating screws (13, Figure 4-22) and washers (14). The collimating screws extend through clearance holes in the washers and elongated slots in each mount half (1 and 2) and screw into tapped holes in each mounting plate half (5, Figure 4-23).

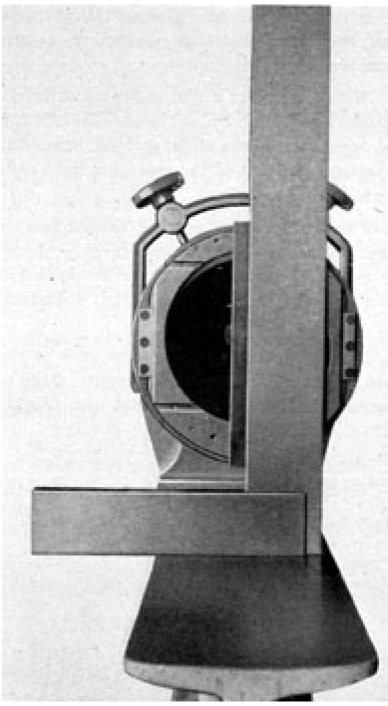


Figure 4-55. Machinist's square in contact with 90 degrees straight-edge at course-angle position.

This is necessary to lift the center axis of the upper telescope system in coincidence with the center axis of the lower telescope system coupling bearings which are larger in diameter.

2. Place the lower telescope system assembly described in Section 4V2 in two V-blocks, resting the large bearing flange periphery of the track sleeve (2, Figure 4-23) in one, and the large shoulder flange periphery of the eyepiece skeleton (42, Figure 4-28) and the upper alignment support section periphery of the eyepiece box (11, Figure 4-29) in the other.

3. Rotate the lower telescope system in the two V-blocks for vertical collimation, with the eyepiece end of the eyepiece box facing upward.

4. The special eyepiece alignment jig (Figure 4-50) inserted in Section 4V3, Step 3, remains

4V4. Primary collimation of the upper and lower telescope systems. The upper and lower telescope systems are primarily collimated in the following manner:

1. Assemble the necessary spacer thickness on each V-block face and finder the upper telescope system Parts I and II inner tube section bearings, except the second inner tube section lower end coupling (26, Figure 4-21).

in place for checking and placing the eyepiece end of the lower telescope system in a true vertical plane.

5. With the use of a dial indicator attached to a surface gage, determine the parallel position of the outer face of the alignment jig, hence the true vertical position of the emerging light rays in the following manner:

6. The surface gage is used on the surface of the optical I-beam bench (Figure 4-58), with the dial indicator set with sufficient tension on the outer face of the alignment jig.

7. Keep a firm pressure on the base of the surface gage, while checking opposite sides of the outer face of the alignment jig (Figure 4-59).

8. Rotate the lower telescope system on the two V-blocks until both outer faces opposite the bored hole in the jig indicate equal height or are parallel to the surface of the optical I-beam bench, as determined by the dial indicator pointer. This places the centerline of the emerging rays of light in the vertical direction, and the light rays enter the head prism in the same direction.

9. Secure the V-block clamps by turning the adjusting knobs of the clamp brackets, as shown on Figure 4-58. Check the face of the alignment jig again to detect any variation and make corrections in the same manner as before.

10. Slide the upper telescope system down on the optical I-beam until it is near the aligned lower telescope system assembly.

11. Line up the reference marks of the second inner tube section lower end coupling (26, Figure 4-21), checking it by the coupling sleeve

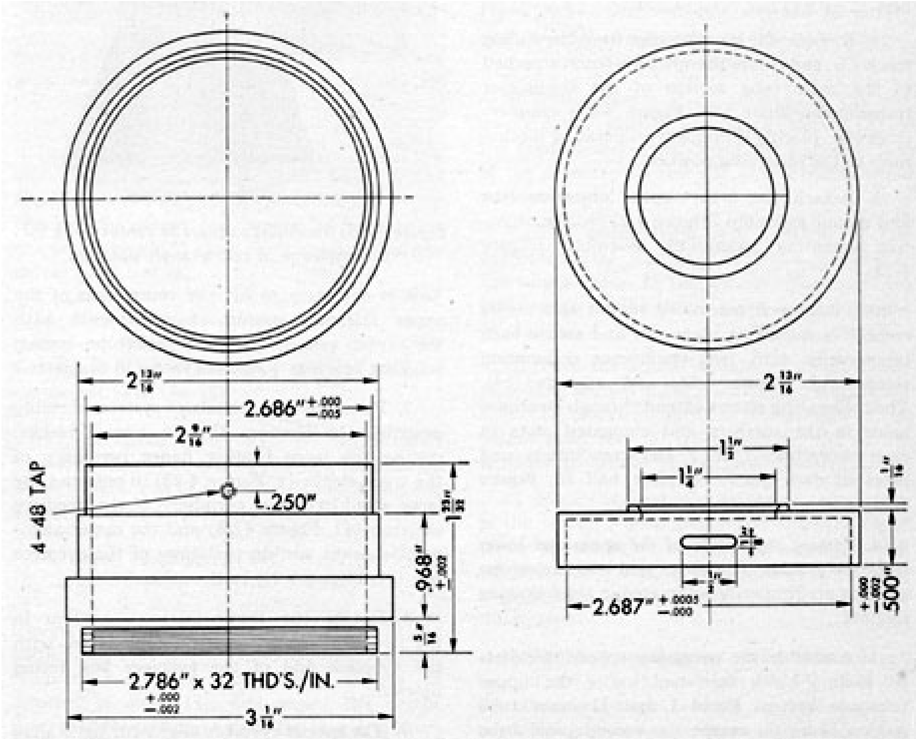


Figure 4-56. Temporary mechanical crosswise adapter detail diagram.

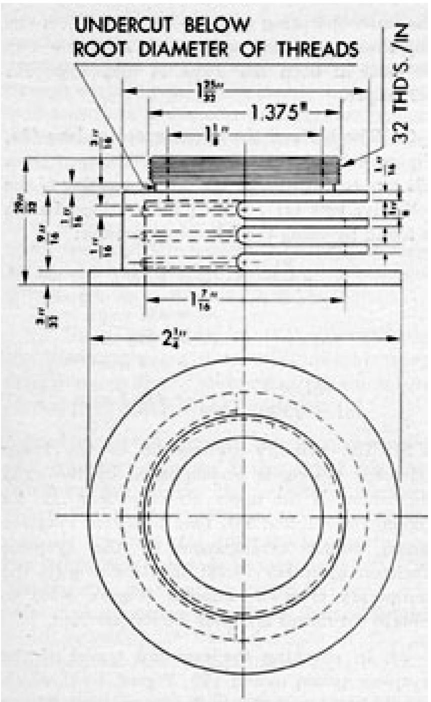


Figure 4-57. Auxiliary telescope adapter.

(34, Figure 4-23) in its proper coincidence relationship with the track sleeve (2) reference marks.

12. Holding the coupling sleeve (34) on the undercut alignment support sections of the track sleeve (2) and the second inner (24). Check the inner and outer surfaces of the eyepiece lens (52) for cleanliness before replacement.

14. Remove the four lockscrews (12, Figure 4-20) from the upper part of the reducing coupling (2), unscrewing them from the tapped holes in the lower alignment support section of the first reduced tube section (1).

15. Unscrew the first reduced tube section (1) from the internal upper part of the reducing coupling (2).

16. Screw the temporary mechanical crosswire adapter (Figure 4-56) into the threaded counterbored section in the lower part of the first reduced tube section (1, Figure 4-20).

17. Replace the first reduced tube section (1), screwing its lower threaded periphery into the internal threaded upper section in the reducing coupling (2). The lower part of the temporary

tube section lower end coupling (26, Figure 4-21), slide the upper telescope system Parts I and II downward snugly against the coupling sleeve. This permits the coupling sleeve to fit snugly between the bearing shoulders of the track sleeve (2, Figure 4-23) and the second inner tube section lower end coupling (26 Figure 4-21). Remove the coupling sleeve and place it in a convenient place until it is required again for distance measurement or for reassembly.

13. Remove the eyepiece alignment jig (Figure 4-50) and replace the assembled eyepiece lens mount (19, Figure 4-28) by screwing it into the eyepiece prism front retaining plate

Figure 4-58. Dial indicator determination of true vertical position on the left side face of the eyepiece alignment jig.

crosswise adapter is angularly adjusted to suit the observer by following the directions stated in Step 15, and releasing the lockscrew of the adapter. Rotate the lower part and replace the first reduced tube section (1).

18. The purpose of the temporary mechanical crosswise adapter (Figure 4-56) is to establish a target on which the upper objective lens is focused; it also provides a reference point from which the correct position of the collective lens (21, Figure 4-20) is found.

19. The collective lens (21) is located 52 mm from the focal plane toward the upper eyepiece lens (20). This distance establishes the proper lens separation of 394 mm between the same operating gear (1, Figure 4-23) of the objective operating mechanism assembly can be used in both the Type II and Type III periscopes.

21. The EFL of the upper eyepiece lens (20, Figure 4-20) in the Type II is changed from 451 mm to 432 mm by the proper spacing of the collective lens (21). The equivalent focal length is found by using the following formula:

$(F_1 \text{ X } F_2) / (F_1 + F_2 - S) = EFL$

$F_1 = 451$ mm
$F_2 = 1326$ mm
$S = 394$ mm

(451 X 1326) / (451 + 1326 - 394) = 432.3 mm

22. The primary collimation of the lower telescope system is

the upper eyepiece lens and the collective lens and results in the correct EFL of this eyepiece combination.

20. The EFL of the upper eyepiece lens must be 432 mm to have the correct image size so that

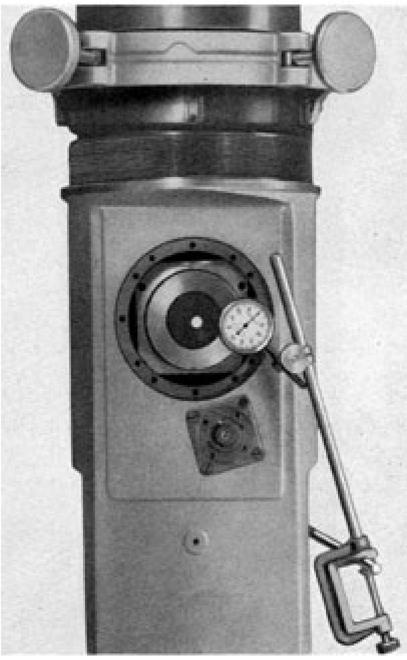


Figure 4-59. Dial indicator determination of true vertical position on the right side face of the eyepiece alignment jig.

accomplished by the axial movement of the upper objective lens and its mount (41, 42, and 38). This brings the eyepiece prism mount arrangement of the eyepiece skeleton assembly (4-28) into focus with the temporary crosswise adapter (Figure 4-56) to obtain the minus and plus diopter settings.

23. In checking the essential travel of the eyepiece prism mount (20, Figure 4-28) which should be 25 mm, diopter lenses are used. Minus and plus lenses must be inserted in the auxiliary telescope adapter to obtain the minus and plus diopter settings. This adapter is attached to the objective end of the auxiliary telescope.

24. Insert a -1 1/2 diopter lens in the auxiliary telescope adapter (Figure 4-57), moving the counterweight up to its stop for full travel; the stop is the spider bearing (3, Figure 4-27). This causes the eyepiece prism mount to move downward. Check the definition of the temporary crossline adapter to be sure that it fades slightly at the end of eyepiece prism travel. It is necessary to move the upper objective lens mount (38) and the lens (41 and 42, Figure 4-20) axially to make this definition check.

25. Insert the +3 diopter lens in the auxiliary telescope adapter (Figure 4-57), and bring the counterweight downward to the lower stop, the two lockscrews opposite each other in the eyepiece skeleton flange (42, Figure 4-28). These lockscrew heads are longer than the other six

lockscrews in the eyepiece skeleton flange.

The downward movement of the counterweight carries the eyepiece prism mount to the upward position. Check the definition of the temporary crosswire adapter to be sure that it fades slightly at the end of the eyepiece prism travel. It may be necessary to move the upper objective lens mount (38) and the lens (41 and 42, Figure 4-20), axially to make this definition check also.

26. Continue the procedure outlined in steps 24 and 25 until a slight overtravel is observed at -3 and +1 1/2 diopters.

27. Upon completion of the collimation of the lower telescope system, secure the upper objective lens mount (38) in the fifth inner tube section (34) with six lockscrews (36).

28. Now obtain the true zero diopter reading of the diopter ring of the focusing knob assembly (Figure 4-39). Using the auxiliary telescope minus the adapter (Figure 4-57), focus the eyepiece prism mount until sharp definition of the temporary crosswire adapter is noted. The diopter ring (9, Figure 4-39) should read -3/4 diopter at atmospheric pressure. This allowance is compensated for when nitrogen of 7 1/2 psi is introduced. Refer to Section 4V7.

29. Unscrew the first reduced tube section (1, Figure 4-20) from the reducing coupling (2). and screwed into tapped holes in the first reduced tube section lower alignment support section (1).

34. Move the upper eyepiece lens mount (6) axially until a clear well-defined image of the collimator reticule or target is apparent. Secure the upper eyepiece lens mount with two lockscrews (10). Do not move the upper eyepiece lens mount (6) in final collimation as this destroys the correct lens separation between the upper eyepiece lens (20) and the collective lens (21).

4V5. Reassembly of the auxiliary upper and lower telescope system assemblies to the upper telescope system assembly. The auxiliary upper and lower telescope systems are reassembled to the upper telescope system assembly in the following manner:

1. Screw the threaded periphery of the lower part of the second reduced tube section (19, Figure 4-19) into the internal threaded section in the first reduced tube section upper part (1, Figure 4-20). Support the attached auxiliary upper telescope system assemblies while making the connection of the auxiliary lower telescope system assembly to the upper telescope system assembly Part I.

2. Secure the first and second reduced tube sections (1 and 19, Figures 4-20 and 4-19 respectively) with four lockscrews

Remove the temporary crosswire adapter (Figure 4-56), unscrewing it from the lower part of the first reduced tube section.

30. Screw the diaphragm (13, Figure 4-20) into the lower internal threads, of the first reduced tube section (1) until its lockscrew hole coincides with the tapped hole in the alignment support section tapped hole in the first reduced tube section.

31. Insert and secure the lockscrew (7). The lockscrew is inserted into a countersunk clearance hole in the lower alignment support section of the first reduced tube section (1) and screwed into a tapped hole in the diaphragm, (13).

32. Screw the first reduced tube section lower threaded periphery (1) into the internal threaded part of the reducing coupling (2).

33. Insert and secure the four lockscrews (12). These lockscrews are inserted in countersunk clearance holes in the reducing coupling (2) (8). These lockscrews are inserted in countersunk clearance holes in the first reduced tube section upper part and screwed into tapped holes in the second reduced tube section lower alignment support section.

3. Place a support under the auxiliary upper telescope system (Figure 4-18). This is necessary because of the weight of the auxiliary upper and lower telescope system assemblies. The support is adjusted until the auxiliary upper telescope system appears in the center axis of the other telescope system assemblies. This is determined by measurement from the surface of the optical I-beam bench and by knowing the measurement previously taken with a special cylindrical disk. The disk diameter should coincide with the diameter of the second tube section lower end coupling (26, Figure 4-21).

4. Assemble the skeleton head assembly to a special adapter (Figure 4-60). The adapter is a

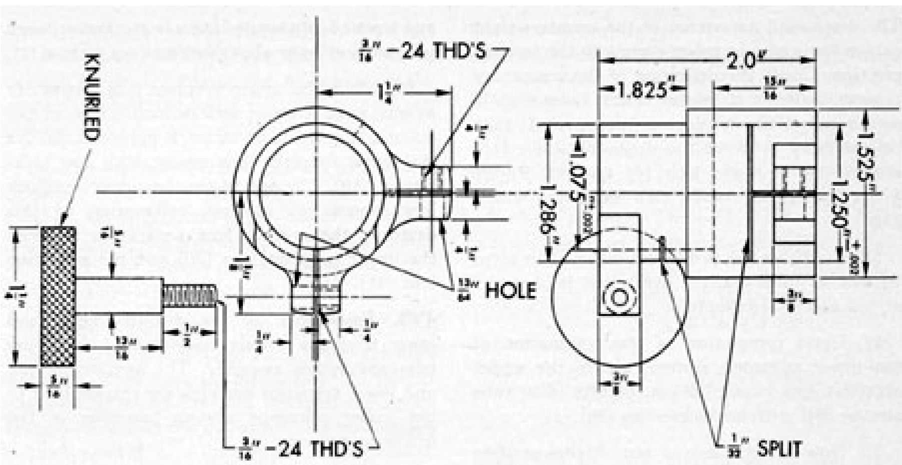


Figure 4-60. Skeleton head assembly adapter, detail drawing.

sliding fit on the lower part of the skeleton head frame (20, Figure 4-17) and is clamped to the ninth reduced tube section (1, Figure 4-18). The skeleton head assembly can then be used temporarily; it is rotated for alignment with the Kollmorgen universal collimator reticle (60, Figure 4-69).

4V6. Final collimation of the four telescope systems in high power. Final collimation of the four telescope systems in high power is accomplished in the following manner:

1. The auxiliary upper and lower telescope systems have been primarily collimated at assembly. This primary step enables the repairman to arrive at the focal distance adjustments in a much shorter time with the assurance that the individual telescope systems have been collimated.

2. Final collimation consists of coordinating the various telescope systems into a telescope combination; this requires minor fine adjustments.

3. Place an auxiliary telescope at the eyepiece end and set the periscope for -3/4, diopter at atmospheric pressure.

4. Check the series of telescope systems on the telemeter lens for clear definition. If necessary, move the auxiliary lower eyepiece lens mount (13, Figure 4-19) axially to improve the definition on the telemeter lens.

5. Check the eyepiece prism mount arrangement in focus on the telemeter lens, and observe that the prescribed limits of -3 and +1 1/2 diopter travel are maintained.

6. Secure the auxiliary lower eyepiece lens mount (13) with two lockscrews (17). These lockscrews are inserted into countersunk clearance holes in the third reduced tube section (12) and screwed into tapped holes in the mount.

7. Replacement of parts of the mechanical or optical system necessitates a change in the screw hole alignment. If no mechanical or optical parts have been required during overhaul, little difficulty should be experienced in arriving at the original screw alignment of the manufacturer.

8. Temporary squaring of the telemeter lens is required for the collimation of the lower (split) objective lens with the Kollmorgen universal collimator range reticle and the telemeter lens.

9. Displace the lower (split) objective lens to the maximum displacement of the range position. In this maximum displacement, the telemeter lens line should be apparent to the observer as a solid line. If this vertical line appears double or faded, it is necessary to rotate the telemeter lens mount. Continue until the telemeter lens line appears as a solid line.

4V7. Basic principles of focal length of lenses following the

collimating the Type II periscope for compensation of nitrogen. The basic principles of collimating the Type II periscope (1.414) are described in the following manner:

In the ordinary sense the term collimator implies that a target is placed in the focal plane of an objective lens so that an image is formed at infinity. This image, then, acts as an infinitely distant object for the periscopic system that is to be collimated.

The collimation of a periscope is complicated, however, by the fact that the highly important separations between the various lenses are established with the lenses surrounded by air at normal atmospheric pressure, whereas in actual use the lenses are surrounded by nitrogen at about 22.2 psi (absolute) pressure (atmospheric pressure plus 7.5 psi). The introduction of this denser gas causes a relative decrease in the index of refraction of the glass, effecting a decrease in the refracting power of each lens and an increase in the focal length of each lens in the periscope.

If we understand that periscope collimation means farming on the telemeter an image of an infinitely distant object without parallax, we may consider the effect of this denser gas on a) all the lenses following the telemeter lens and b) all the lenses preceding the telemeter lens. It has been computed that the increase in focal length of all lenses following the telemeter lens can be compensated after gassing by moving the eyepiece telemeter lens will have been compensated.

The lenses preceding the telemeter lens, however, cannot be precompensated so easily, and the problem may be approached in the following manner: In the Type II periscope (in high power) there is only one lens preceding the telemeter lens, that is, the auxiliary upper eyepiece lens with an equivalent focal length of plus 168.1 mm in air. Figure 4-61 shows the auxiliary upper eyepiece lens focused on an infinity target in air. The focal length of this same lens in nitrogen at 7.5 psi above atmospheric pressure is lengthened to plus 168.177 mm, or an increase of 0.077 mm. This is the same as saying that the focal length of the lens in dense nitrogen is 1.00046 times that in air. In order to adjust the lens in air so that there is no parallax caused by the dense gas, a target distance, which is less than infinity and causes the image to be formed 0.077 mm farther from the lens, exactly in the plane which becomes the back focal plane when the lens is surrounded by the nitrogen, should be chosen. This distance is found to be 1,200 feet.

The method of determining the conjugate object-distance is calculated as follows:

The equivalent focal length (EFL) of the image-forming lens or auxiliary upper eyepiece lens (Type II, high power) taken from the optical detail drawing equals 168.1 mm. The increase in EFL caused by gas pressure is found by multiplying the 168.1 mm by 1.00046 and then subtracting

lens 3/4 diopter in a plus direction. It is only necessary before collimating in air to set the eyepiece at minus 3/4 diopter. After the periscope is gassed and the eyepiece lens is moved to the zero diopter setting, all change in 168.1 mm from the result. A shorter method is to multiply the 168.1 by 0.00046 and find the increase directly.

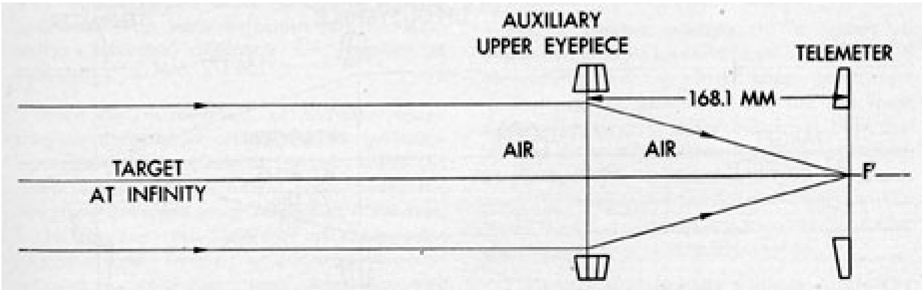


Figure 4-61. Auxiliary eyepiece lens focused on an infinity target in air.

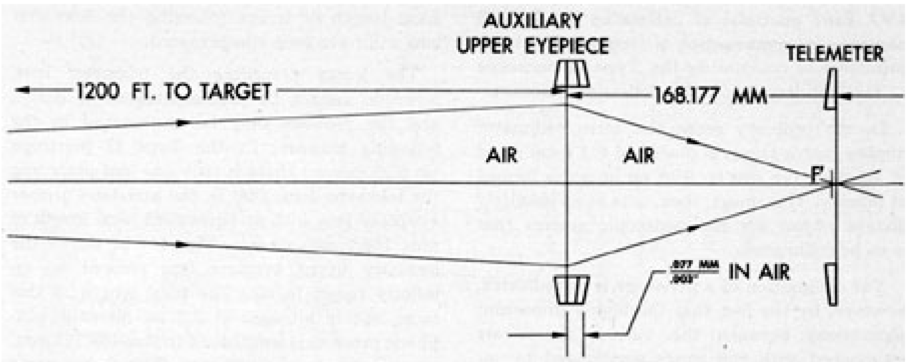


Figure 4-62. Ray diagram of periscope adjusted on 1200-foot target at atmospheric pressure.

This increase then, is divided into the square of the EFL, or

Desired object-distance = (168.1) X (168.1) = increase in EFL

or in the present example:

Object distance =
((168.1) X (168.1) / 0.077) =
28258 / 0.077 =
366,987 mm

Next, 366,987 mm is converted to feet by dividing by 304.8 mm (the number of mm in one foot). Thus, the desired object distance equals 1,204 feet, or as stated above, 1,200 feet.

pressure, all infinitely distant targets are imaged exactly in the plane of the telemeter lens.

What has actually been done, then, while the auxiliary upper eyepiece lens is still surrounded by air, is to shift the back focal point of that lens exactly 0.077 mm (= 0.003 in.) upward. Since the telemeter lens is 2.75 mm thick (= 0.110 in.), it is apparent that the back focal point of the auxiliary upper eyepiece in air will lie approximately 0.107 inch behind the curved surface and 0.003 inch ahead of the plane surface of the telemeter lens, that is, inside the

Summary: If the distance between the auxiliary upper eyepiece lens and the telemeter lens is adjusted so that a target 1,200 feet distant is imaged exactly in the plane of the telemeter lens when the lens is surrounded by air, when the lens is surrounded by nitrogen at the above

lens itself. Figure 4-62 shows the ray diagram of this action.

With the distance between the two lenses thus adjusted in air, the introduction of nitrogen at plus 7.5 psi lengthens the equivalent focal length of the auxiliary upper eyepiece lens exactly enough to cause its back focal point

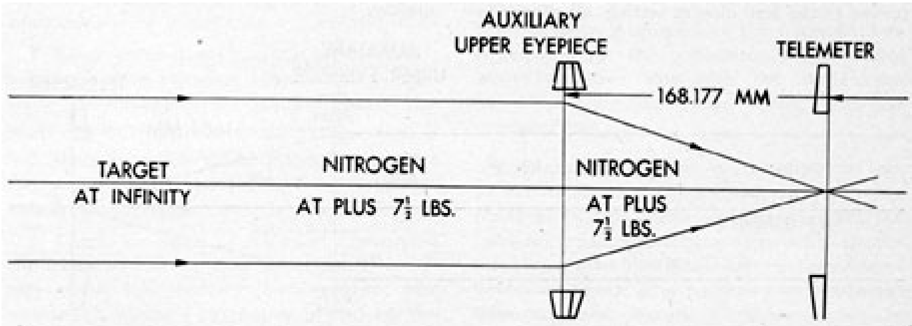


Figure 4-63. Ray diagram of periscope showing action of 7 1/2 psi of nitrogen introduction.

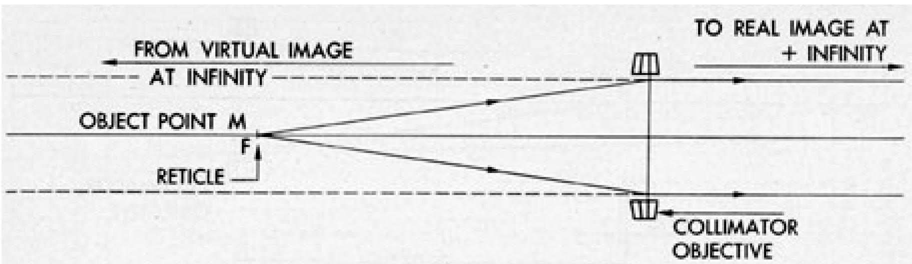


Figure 4-64. Collimator reticle lens and objective lens ray diagram.

to lie on the plane surface of the telemeter lens. Figure 4-63 shows the relative action created by introduction of nitrogen at 7 1/2 psi.

Obviously, this adjustment should not be made by moving the telemeter lens (for there already has been made a 3/4 diopter adjustment of the periscope eyepiece lens which is based on maintaining a fixed position of the telemeter lens, to compensate for the effect of the denser nitrogen on focal lengths of lenses following the telemeter); therefore, the only

If the target of a collimator lies exactly in the focal plane of the collimator objective lens, the image is formed at infinity. In fact, we can think of the lens as forming two images: a real one (where the rays actually intersect) at plus infinity, and a virtual image (where the rays seem to come from) at minus infinity, as shown in Figure 4-64.

If the target is placed less than one focal length away from the collimator objective, the ray bundles diverging from each point of the target have more divergence than the converging

possible adjustment is to move the auxiliary upper eyepiece. Since the manufacturers of the periscope are aware of these facts, they have designed the instrument so that only the ninth reduced tube section (which carries the auxiliary (upper eyepiece lens) is capable of adjustment.

It might be possible to move the auxiliary upper eyepiece, 0.003 inch away from the telemeter lens; however, since this distance is small, it is much more accurate to measure this distance optically (that is, by using a target or object-distance at 1,200 feet) than to measure it mechanically.

4V8. Basic principles of the Kollmorgen universal collimator. The basic principles of the Kollmorgen universal collimator are described as follows:

Since the introduction of nitrogen under pressure necessitates collimating the periscope on targets that are not at infinity, when the lenses are in air (see target table under the first function), and since targets at 4,800 feet, 3,110 feet, and even 1,200 feet are not possible aboard a repair tender, the distance collimator is used to reproduce these object-distances optically.

lens is able to neutralize, and the ray bundles emerging from the collimator lens are still diverging slightly. For example, if the equivalent focal length of the objective of the collimator equals 481.7 mm = 19.27 in. and if the target is moved 0.025 inch from the focal plane toward the objective, a virtual image is formed at a distance of 1,200 feet from the collimator lens and on the same side of the lens as the target (Figure 4-65). Thus, the rays from each point of the target, after emerging from the collimator lens, are still diverging at exactly the same rate as though they had originated at a real target 1,200 feet distant.

Taking another example, it is desired to adjust the distance between target and collimator objective so that the virtual image lies 35 feet in front of the collimator lens (on the same side as the target). If the collimator objective lens has the same focal length as in the preceding example, and if the target is moved 0.819 inch from the focal plane toward the objective, the image is virtual and is 35 feet from the collimator objective, as indicated in Figure 4-66.

Thus it is seen that by suitably controlling the distance between the target and the collimator

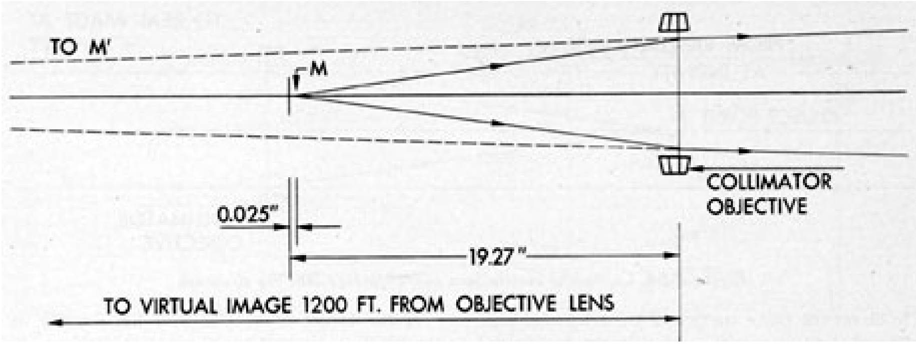


Figure 4-65. Collimator reticle lens set for 1200-foot target distance ray diagram.

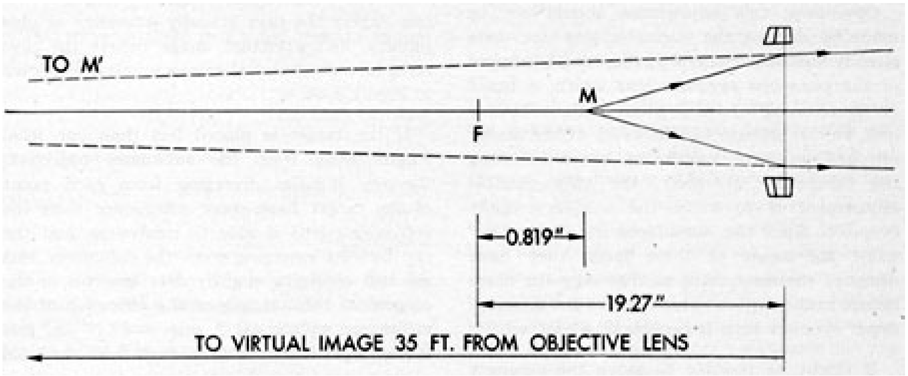


Figure 4-66. Collimator reticle lens set for 35-foot target distance ray diagram.

objective, it is possible within a limited space to obtain optical target at any distance desired from zero feet to infinity. The former could be obtained if the target were placed in contact with the collimator objective, and the latter if the target were placed in the focal plane of the collimator objective lens.

This, however, is only one of the three main functions of the Kollmorgen universal collimator. The three functions are as follows:

1. It is an optical means of producing distant targets in a limited space for shipboard use, as outlined above. The distances that are necessary for the different types of periscopes (to compensate for the introduction of nitrogen under pressure) are:

a. Type II (5 telescope systems) (1.414)	lp hp	35 ft 1,200 ft
b. Type III (3 telescope systems) (1.99)	lp hp	47 ft 3,110 ft
c. Type IV (3 telescope systems) (night use)	lp hp	62 ft 4,800 ft

If the collimator objective lens has an equivalent focal length of 481.7 mm (= 19.268 in.), in order to place the virtual target at the desired distances listed in the foregoing table, it is necessary to move the actual target from the focal plane of the collimator objective toward the objective lens by the amounts shown in the table on page 237.

It must be remembered that the figures in this table apply only

when the collimator objective lens has an equivalent focal length

Virtual Target Distance (in feet)	Range Table Actual Target Movement (in inches)	Actual Micrometer Turns
Infinity	0.0000	0
5,000	0.0060	6 graduations
4,800	0.0063	6 graduations
3,110	0.010	10 graduations
1,200	0.025	25 graduations
62	0.471	15 turns, 3 graduations
47	0.617	19 turns, 24 graduations
35	0.819	26 turns, 7 graduations

equal to the above value. Since the factory tolerance of lenses for this collimator is held to plus or minus 1 percent of the specified focal length, no sensible variation results.

2. The Universal collimator is an optical means for checking accurate displacement of the lower (split) objective lens halves with calibrated range dials of the stadimeter at a known height on a graduated reticle lens set at infinity.

It consists of a graduated reticle lens used with a collimator objective lens of effective focal

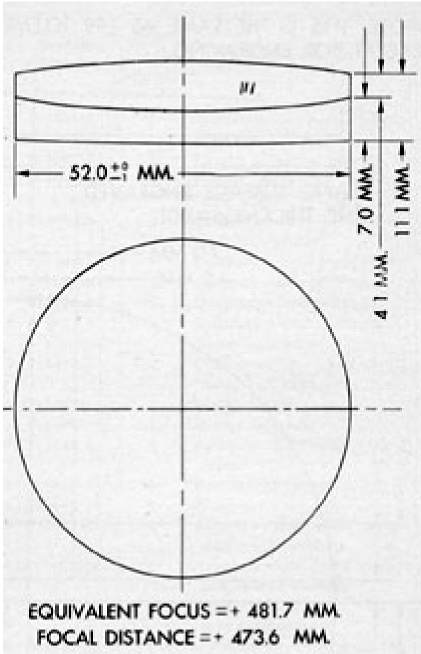


Figure 4-67. Collimator objective lens, detail drawing.

c. The third graduated line of 2.5 mm length is located 1.285 mm from the horizontal line of the crossline.

d. The fourth graduated line of 5.0 mm length is located 3.210 mm from the horizontal line of the crossline.

e. The fifth graduated line of 2.5 mm length is located 6.425 mm from the horizontal line of the crossline.

f. The sixth graduated line of 5.0 mm length is located 8.030 mm from the horizontal line of the crossline.

The angle formed by the distance between the first graduation and the horizontal line of crossline forms the base relative to

length of exactly 481.7 mm (Figure 4-67). The reticle lens (Figure 4-68) is provided with etched vertical and horizontal lines forming a crossline. The lower right quarter of the reticle has six etched graduated lines, each line being of alternate height to distinguish it clearly. The graduated lines are etched on the plano-surface of the reticle, while the curved surface is fine ground. The reticle, being in the focal plane of objective lens, produces parallel light, thereby forming an infinity target.

The reticle lines (Figure 4-68) are spaced consecutively in the following manner: All six graduated lines are located 2.0 mm from the vertical line of the crossline.

a. The first graduated line of 2.5 mm length is located 0.290 nun from the horizontal line of the crossline.

b. The second graduated line of 5.0 mm length is located 0.430 mm from the horizontal line of the crossline.

effective focal length of objective lens hypotenuse, and is found by dividing:

1) 0.290 mm by 481.7 mm which equals 0.0062 radians or 2 minutes 4 seconds of arc.

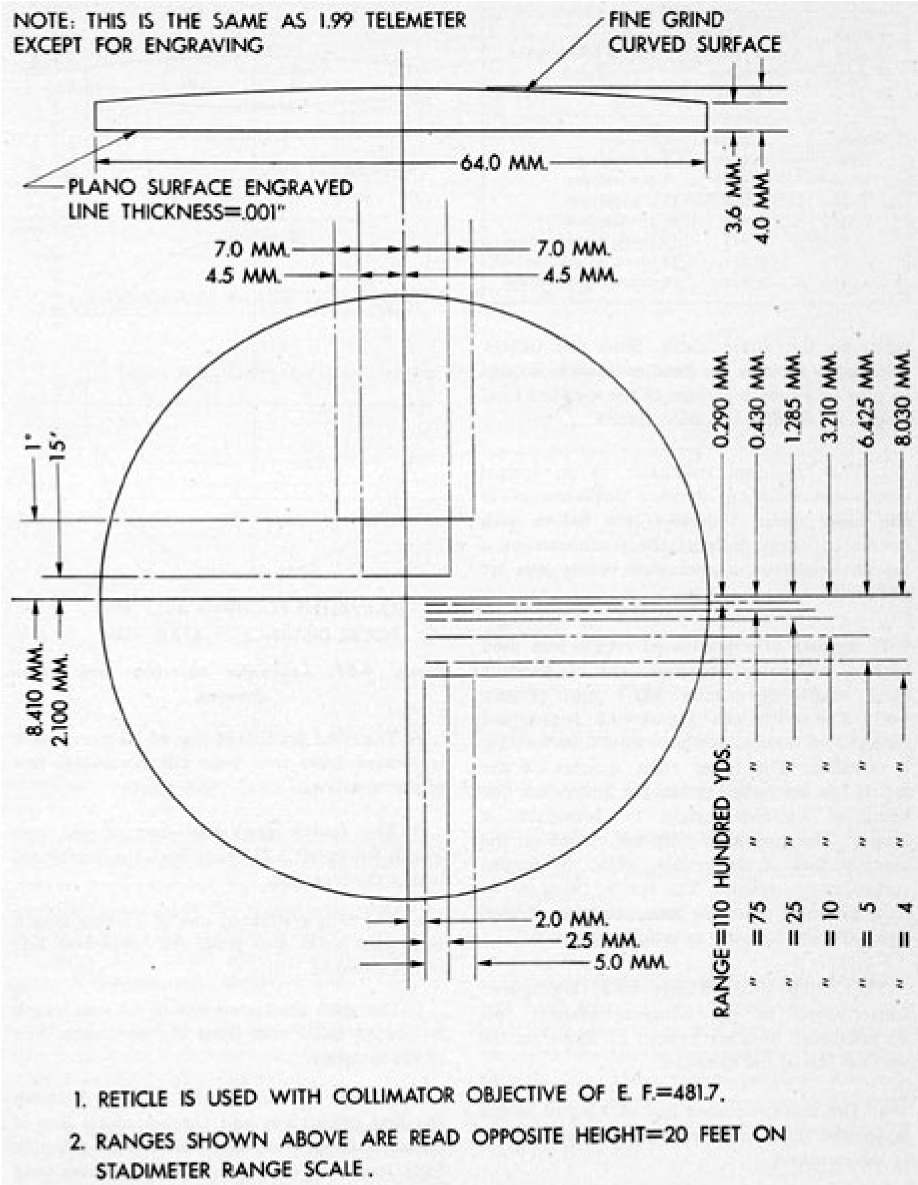


Figure 4-68. Collimator reticle lens, detail drawing.

The angles of the other five graduated lines are found in similar manner:

2) 0.430/481.7 = 0.00088 radians or 3' 4" of arc

3) 1.285/481.7 = 0.00266 radians or 9' 10" of arc

4) 3.210/481.7 - 0.00666 radians or 22' 55" of arc

5) 6.425/481.7 = 0.01333 radians or 45' 51" of arc

6) 8.030/481.7 = 0.01666 radians or 57' 18" of arc

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1641-1	1	Collimator base plate bracket
2	P-1641-2	1	Height adjusting bearing
3	P-1641-3	1	Height adjusting bearing lock ring
4	P-1641-	2	Collimator

The above angles correspond to a target angle of 20-foot height at the following ranges:

1) 11,000 yards	4) 1,000 yards
2) 7,500 yards	5) 500 yards
3) 2,500 yards	6) 400 yards

3. As its third function, the Universal collimator provides a means of checking the vertical displacement of the line of sight in changing from high to low power. Two graduations which intersect the vertical line are incorporated in the upper half of the reticle. These provide accurate graduations in degrees for checking this displacement. Both graduations are placed in the reticle as follows:

a. The large graduation intersects the vertical line, and is located 8.410 mm from the horizontal crossline. This distance represents 1 degree of arc in high power or 4 degree in low power. This line extends on each side of the vertical crossline a distance of 7.0 mm.

b. The small graduation intersects the vertical line, and is located 2.100 mm from the horizontal crossline. This distance represents 15' of arc in high power or 1 degree in low power. This line extends on each side of the vertical crossline a distance of 4.5 mm.

4V9. Description of the Sperry-Kollmorgen collimator. The Sperry-Kollmorgen collimator consists of the Sperry attachments which hold the Kollmorgen universal collimator. Figure 4-69 shows the Sperry-Kollmorgen collimator. All bubble numbers in Section 4V9 refer to Figure 4-69 unless otherwise specified.

	4		base plate shaft lock nut washers
5	P-1641-5	1	Collimator base plate shaft
6	P-1641-6	1	Azimuth disk plate
7	P-1642-1	1	Collimator base plate
8	P-1642-2	2	Collimator base plate shaft, outer lock nuts
9	P-1642-3	1	Collimator base plate shaft, inner lock nut
10	P-1642-4	1	Wedge lock
11	P-1642-5	1	Wedge lock bolt
12	P-1642-6	2	Azimuth disk plate clamp arms
13	P-1642-8	1	Reticle light shield
14	P-1642-10	1	Wing nut stud
15	P-1642-11	2	Azimuth disk plate outer clamp arm washers
16	P-1642-12	1	Azimuth disk plate clamp arm spacer washer
17	P-1642-14	1	Azimuth disk plate clamp arm wing nut
18	P-1642-15	1	Collimator tube bracket height adjusting cap screw

19	P-1642-16	4	Collimator base plate bracket and optical bench bracket cap screws
20	P-1642-17	4	Collimator base plate bracket and optical bench bracket cap screw nuts
21	P-1642-18	2	Reticle light shield lockscrews
22	P-1642-19	2	Filter mount lockscrews
23	P-1642-20	4	Collimator tube bracket cap screw
24	P-1642-20	4	Collimator base plate bracket and optical bench bracket cap screw washers
25	P-1642-21	4	Collimator tube bracket clamp screws
26	P-1642-22	1	Candelabra mazda bulb
27	P-1642-23	1	Keyless socket
28	P-1642-24	1	Brass tubing section
29	P-1642-25	1	Feed-thru cord switch
30	P-1642-26	1	Finger grip plug cap
31	P-1642-27	1	Rubber covered wire cord
32	P-1642-27A	1	Wire cord plug
33	P-1643-	1	Collimator

	1		tube bracket
34	P-1643-2	2	Collimator tube bracket clamps
35	P-1643-3	1	Collimator tube thrust collar
36	P-1644-1	1	Objective lens mount end bushing

Ill. No.	Drawing Number	Number Required	Nomenclature
37	P-1644-2	1	Objective lens mount
38	P-1644-3	1	Objective lens clamp ring
39	P-1644-4	1	Collimator tube
40	P-1644-5	1	Reticle lens mount retaining ring
41	P-1644-6	1	Reticle lens clamp ring
42	P-1644-7	1	Reticle lens mount
43	P-1644-8	1	Reticle lens mount axial alignment key
44	P-1644-9	1	Objective lens mount lockscrew
45	P-1644-10	1	Reticle lens mount alignment key lockscrew
46	P-1644-11	1	Objective lens clamp ring lockscrew
47	P-1644-	2	Collimator

of the arm tapers toward the large swivel hub section which is carried at an appropriate center distance for the height adjusting bearing (2). This hub section is bored to carry the height adjusting bearing, and has a projecting lug section on the periphery. The lug section is split in the inclined centerline. One lug has a tapped hole, while the other has a clearance hole for a cap screw (18). The cap screw when tightened secures the height adjusting bearing (2) at the desired inner tube or outer tube centerline required for the periscope being repaired.

The wall thickness of the projecting arm is uniform, except for a supporting web in the center extending upward to the hub section from the base flange, located on the outer side following the pattern of projecting arm inclination. The hub section extends outward 1 inch from the outer wall of the projecting arm.

The collimator base plate bracket holds the complete collimator attachment with provision for swinging the collimator base plate (7) through elevation of 95 degrees and depression of 25 degrees as noted by the graduations on the azimuth disk plate (6).

	12		tube and reticle lens mount end bushing also objective lens mount end bushing lockscrews
48	P-1644-13	1	Reticle lens clamp ring lockscrew
49	P-1645-1	1	Filter mount
50	P-1645-2	1	Filter clamp ring
51	P-1645-3	1	Reticle lens mount lock ring
52	P-1645-4	1	Reticle lens mount end bushing
53	P-1645-5	1	Reticle lens mount actuating sleeve
54	P-1645-6	1	Name plate
55	P-1645-7	2	Name plate lockscrews
56	P-1645-8	6	Reticle lens mount retaining ring lockscrews
57	P-1645-9	1	Micrometer vernier arm
58	P-1645-9A	4	Micrometer vernier, arm lockscrews
59	P-1646-1	1	Objective lens
60	P-1646-2	1	Reticle lens
61	P-1646-3	1	Filter, Corning sextant green

A tapped hole is provided in the wall of the projecting arm at an appropriate center distance below the center axis of the hub section for the azimuth disk plate wing nut stud (14). The stud carries the washer (15) next to the inner projecting arm wall, two azimuth disk plate clamp arms (12) separated with a spacer washer (16), and another washer (15) backed up by the wing nut (17).

b. Height adjusting bearing. The height adjusting bearing (2) is made of brass and is 3 3/16 inches in length. It is cylindrical and is blued. It has a large narrow shoulder flange with an undercut shoulder a sliding fit in the bore of the collimator base plate bracket (1) projecting arm hub section. Outward from this undercut shoulder section, a thread relief and a threaded periphery to carry a height adjusting bearing lock ring (3) are provided. A small undercut shoulder section is provided on the outer part of the threaded periphery.

The height adjusting bearing is provided with an offset 1 1/2-inch diameter hole running through

a. Collimator base plate bracket. The collimator base plate bracket (1) is made of cast bronze. It has a large rectangular base flange with two supporting webs below the base flange. The base flange is attached to a welded plate at the end of the optical I-beam bench with four cap screws (19), washers (24), and nuts (20). The four holes in the base flange are elongated, thus allowing for the adjustment of the bracket during the alignment of the Sperry-Kollmorgen collimator to the optical I-beam bench.

The rectangular base flange has a projecting arm, which has a 45 degrees inclination. The width

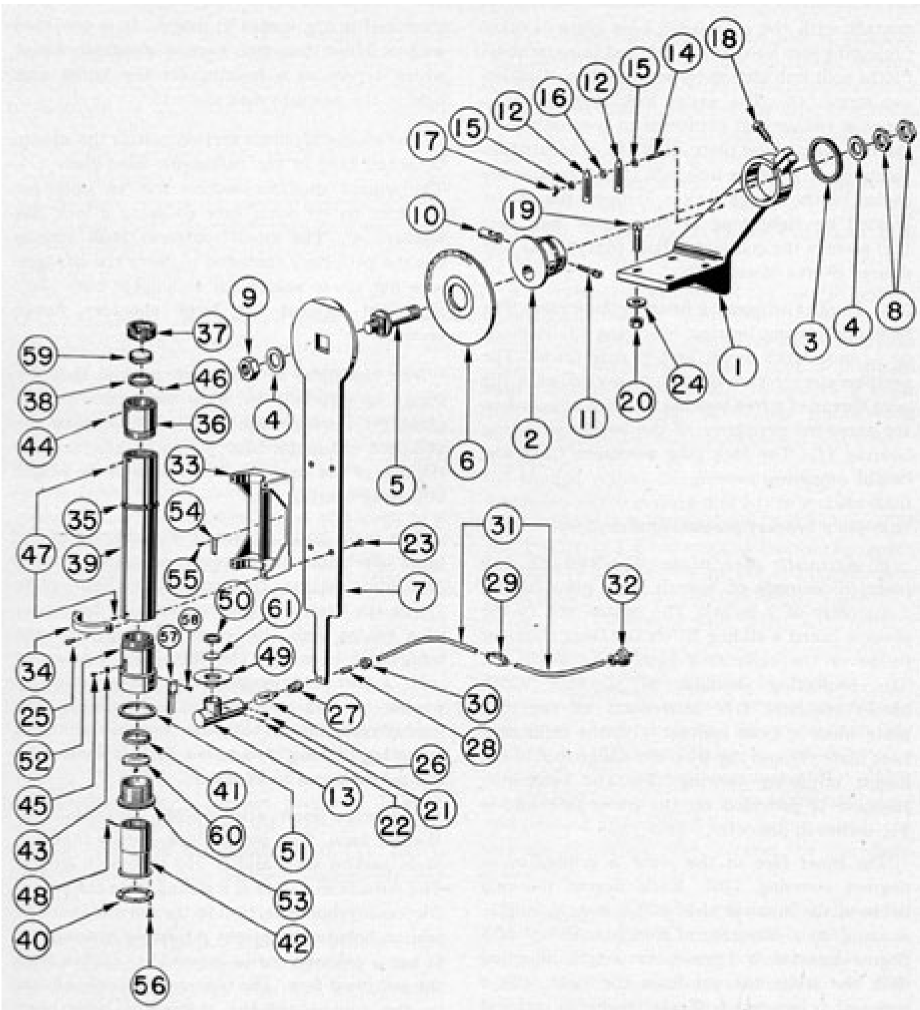


Figure 4-69. Sperry-Kollmorgen collimator.

its length. It is offset with its centerline 1 inch from the center from the center axis 0.156 inch. The entrance of the clearance hole

axis to carry the collimator base plate shaft (5). A perpendicular hole of 1 1/16-inch diameter is provided in the small undercut shoulder section having a counterbored section of 2 7/16 inches in depth to carry the wedge lock (10) and the wedge lock bolt (11). The centerline of this clearance hole and counterbored section is eccentric and is offset is spot faced to offer a flat surface to the shoulder of the wedge lock bolt (11).

The large hole carrying the collimator base plate shaft (5) permits a variance of eccentricity to the height adjusting bearing, and is secured temporarily with the lock ring (3) upon its

contact with the collimator base plate bracket projecting arm hub section (1), and is maintained by the split hub section by securing the adjusting cap screw (18). The wedge lock (10), having a concave radius that conforms to the contour of the collimator base plate shaft (5), is secured by tightening the wedge lock bolt (11). The concave radius of the wedge lock (10) upon the thrust created by tightening of the wedge lock bolt (11) secures the collimator base plate (7) at any desired degree of azimuth.

c. Height adjusting bearing lock ring. The height adjusting bearing lock ring (3) is made of 1/4-inch thick brass and is cylindrical. The periphery is medium diamond knurled, with the bore threaded a free turning fit when engaged on the threaded periphery of the height adjusting bearing (2). The lock ring serves to carry the height adjusting bearing (2) snugly against the inner surface of the hub section of the collimator base plate bracket projecting arm (1).

steel and is 6 1/4 inches in length. It is provided with a large diameter narrow shoulder flange which serves as a bearing for the bored axis hole in the azimuth disk plate (6).

The square shoulder section carries the square broached hole in the collimator base plate. (7). The square shoulder section has an undercut shoulder on its outer face to carry a lock nut washer (4). The small undercut stub section has the periphery threaded to carry the hexagon lock nut (9) to secure the collimator base plate (7) tight against the large shoulder flange section.

The thickness of the large narrow shoulder flange is sufficient to allow the azimuth disk plate (6) a snug sliding clearance between the attached collimator base plate (7) rear face and the face of the large shoulder flange of the height adjusting bearing (2).

The main body section is a sliding fit in the large offset hole in the height adjusting bearing (2), and retains the collimator base plate (7) at the desired degree of azimuth by means of a wedge lock

d. Azimuth disk plate. The azimuth disk plate (6) is made of 1/4-inch brass plate having a diameter of 9 inches. The center axis of the plate is bored a sliding fit on the large shoulder flange of the collimator base plate shaft (5). The projecting shoulder of 1/64-inch width allows sufficient free movement of the disk plate when in close contact with the collimator base plate (7) and the shoulder flange face of the height adjusting bearing (2). The projecting shoulder is provided on the inner face and is 3 7/8 inches in diameter.

The inner face of the plate is graduated in degrees covering 120 degrees. Each degree marking between the interval of 5 degrees is 3/16 inch in length, starting on a diameter of 8 inches. Every fifth degree interval is 1/4 inch in length. Starting with the sixth interval from the right, the 0 numeral is engraved. Each 10-degree interval is engraved additive to and including the 90 degrees for elevation. The same pattern is followed for the 10-degree intervals in depression.

The azimuth disk plate is secured with the two azimuth disk plate clamp arms (12). Each arm has a piece of green beige glued to its inner contact face, which secures the plate by the tightening of the wing nut (17).

e. Collimator base plate shaft. The collimator base plate shaft (5) is made of plain carbon (10) clamped snugly by the wedge lock bolt (11). The outer part is provided with a threaded periphery to carry a locknut washer (4) and two hexagon locknuts (8). The washer rests against the outer face of the height adjusting bearing (2) and the shaft is secured by the two hexagon locknuts (8).

f. Wedge lock and wedge lock bolt. 1. Wedge lock. The wedge lock (10) is made of plain carbon steel and is 2 1/8 inches in length. The outside diameter is a sliding fit in the eccentric counterbored section in the narrow shoulder section hole in the height adjusting bearing (2). It has a concave radius located 1 1/2 inches from the solid end face. The concave radius conforms to the contour of the collimator base plate shaft main body (5).

The center axis has a tapped hole to receive the threaded section of the wedge lock bolt (11). The tightening of the wedge lock bolt shoulder against the spot face in the height adjusting bearing narrow shoulder (2) causes the concave radius to secure the main body of the collimator base plate shaft (5), thus maintaining the collimator base plate (7) in the desired azimuth setting.

2. Wedge lock bolt. The wedge lock bolt (11) is made of plain carbon steel and is 2 3/4 inches in length. The long threaded stem section engages in the tapped hole axis in the wedge lock (10). The shoulder section serves as a support on the flat spot face in the small shoulder of the height adjusting bearing (2). The tightening of the bolt causes the wedge lock to grip the collimator base plate shaft (5), thus restricting it from rotation. The stub section is square for the attachment of a wrench.

g. Azimuth disk plate clamp arms. The two azimuth disk plate clamp arms (12) are made of 1/8-inch brass and are 3 inches in length. Both are provided with elongated slots to allow them to slide axially away from the azimuth disk plate (6). The inner face of each pointed clamp arm is provided with a piece of glued green beige for clamping of the azimuth disk plate (6) and the prevention of scratches to it while clamping. The clamp arms are carried on the projecting wing nut stud (14). The inner clamp arm rests against a washer (15) and is separated from the outer clamp arm with a spacer washer (16). The securement of both arms is accomplished by the tightening of a wing nut (17) on the outer washer (15).

h. Collimator base plate. The collimator base plate (7) is made of 3/8-inch steel plate and is 35 inches in length. The axial section is provided with a square broached hole, a sliding fit over the square section shoulder of the collimator base plate shaft (5), and is secured to it by the The collimator tube bracket (33) is mounted in the centerline of the arm and axial section, and is located with its perpendicular centerline 14 7/8 inches from the axis of the axial section, to carry the Kollmorgen universal collimator. The collimator tube bracket is secured to the arm with four cap screws (23). These cap screws are inserted into clearance holes in the arm and screw into tapped holes in the collimator tube bracket (33).

The outer 1-inch part of the handle section is undercut to carry the reticle light shield (13) secured on opposite side with two lockscrews (21). A 1/8-inch pipe tapped hole is provided near the end of the handle to receive a brass tubing section (28). It carries the keyless socket (27), and a candelabra mazda bulb (26).

i. Collimator tube bracket, thrust collar, and tube. 1. Collimator tube bracket. The collimator tube bracket (33) is made of cast bronze and is rectangular shaped. Its width conforms to the width of the collimator base plate (7) arm section, and the length is sufficient to carry the collimator tube (39).

The base of the bracket is provided with a 1 1/2-inch raised boss section on each end the entire width, with a cored section connecting the raised boss sections. These sections are secured to the arm section of the collimator base plate (7) with four cap screws (23) which are inserted into clearance holes in the base plate and screwed into tapped holes in the raised boss sections to secure the bracket to the base plate.

locknut washer (4) and locknut (9).

The axial section is 8 inches in diameter and forms a concave junction on opposite sides of the centerline with the arm 4 5/8 inches wide. The arm is uniform in width from the concave junctions in a distance of 21 1/4 inches. Beyond this point the arm forms a concave junction on opposite sides with a handle 1 1/2 inches in width and 6 3/4 inches in length.

The axial section is beveled at 30 degrees covering a 60 degree minor chord area with an engraved line intersecting its centerline. The engraved line serves as an index line to designate the position of the collimator in azimuth when in coincidence with the graduations of the azimuth disk plate (6).

The bracket is provided with end walls which are reinforced with 45 degrees angle webs from the main body, and has a center web connecting each end wall. A semicircular clamp (34) is fitted on each end wall upper lace and secured with two Allen head cap screws (25) each. The cap screws are inserted into clearance holes in the clamps (34) and screwed into tapped holes in the end walls. The end walls and the clamps are bored together, to carry the collimator tube (39)

A rectangular name plate (54) is secured to the main body with two lockscrews (55).

2. Collimator tube thrust collar. The collimator tube thrust collar (35) is made of brass and is cylindrical. It has an outside

diameter of 3 7/16 inches, with the axis bored. The bored diameter is tinned and soldered to the outer diameter of the collimator tube (39) to retain it axially as it lies in a vertical plane. The external surface of the thrust collar has a concave radius, with the sharp corners rounded off. The thrust collar rests against the outer wall of the collimator tube bracket (33) facing toward the axial section of the collimator base plate (7).

3. Collimator tube. The collimator tube (39) is made of brass and is 15 inches in length. The external surface is uniform its entire length with the bore having a

freely in the threaded counterbored section in the objective lens mount end bushing (36). It is bored for light transmission and has two counterbored sections. The small counterbored section carries the periphery of the objective lens (59) against a narrow shoulder seat. The large counterbored section is threaded and carries the clamping (38) threaded periphery for securing the objective lens (59) snugly, and is secured with a lockscrew (46). The lockscrew is screwed into a tapped hole in the mount and extends into the partially tapped hole in the clamp ring. The outer face of the mount is chamfered at 60 degrees from

nominal wall thickness. The bore is provided with blued anti-reflection threads.

The opposite ends of the tube are provided with threaded counterbored sections of equal depth. One end carries the threaded periphery section of the objective lens mount end bushing (36) secured with a lockscrew (47), while the opposite end carries the threaded periphery section of the reticle lens mount end bushing (52) secured with a lockscrew (47).

j. Objective lens mount end bushing, lens mount, lens, and clamp ring. 1. Objective lens mount end bushing. The objective lens mount end bushing (36) is made of brass and is 3 inches in length. The large external diameter conforms to the diameter of the collimator tube (39). The undercut section is threaded to engage in the threaded counterbored section in the collimator tube and is secured with a lockscrew (47).

The inner surface is bored for light transmission and threaded for anti-reflection. Its outer part is counterbored and threaded a sufficient depth to carry the threaded periphery objective lens mount (37). The threaded counterbored section is of sufficient depth to allow axial movement of the objective lens mount (37) for collimation of the collimator. The mount is secured with a lockscrew (44) after collimation. This lockscrew is screwed into a tapped hole in the objective lens mount end bushing wall (36) and extends its bore, leaving a shoulder seat wall of 1/16 inch.

3. Objective lens. The objective lens (59) is made of two optical elements, consisting of a double convex crown element cemented to a divergent meniscus flint element, forming a positive doublet. It is mounted in the objective lens mount (37) with the crown element resting against the seat of the mount. It is secured snugly with a clamp ring (38) and a lockscrew (46, Figure 4-67 shows this lens in detail).

4. Objective lens clamp ring. The objective lens clamp ring (38) is made of brass and is of nominal thickness and width. The periphery is threaded to screw into the threaded counterbored section in the objective lens mount (37) to secure the objective lens (59). The clamp ring is chamfered at 15 degrees from its bore, and is provided with opposite slots in the narrow side face for the insertion of a special wrench. The clamp ring As secured with a lockscrew (46) which extends inward from a tapped hole in the objective lens mount (37) into the partially tapped hole in the clamp ring.

k. Reticle lens mount end bushing, mount, lens, and clamp ring. 1. Reticle lens mount end bushing. The reticle lens mount end bushing (52) is made of brass and is 4 13/16 inches in length. The external surface is provided with a large shoulder section of 1 1/2 inches to accommodate sufficient wall thickness for the internal counterbored section. The medium shoulder section diameter conforms to the diameter of the collimator tube (39), while the

into the spotted face in the threaded periphery of the mount.

2. Objective lens mount. The objective lens mount (37) is made of brass and is 3/4 inch in length. The periphery is threaded and screws

small undercut shoulder is threaded to engage into the outer end of the collimator tube threaded counterbored section, and is

secured with a lockscrew (47). The lockscrew is screwed into a tapped hole in the collimator tube (39) and extends into a spotted recess in the threaded periphery of the end bushing.

The end bushing is bored for light transmission and is threaded for anti-reflection. It is provided with two counterbored sections; the smaller of the two has a depth of 3.875 inches and carries the reticle lens mount (42) of an axial sliding fit. The large counterbored section is threaded and has sufficient depth to accommodate the axial movement of the reticle lens mount actuating sleeve threaded periphery (53).

The medium shoulder is provided with an axial slot in a 1 1/16-inch distance. The axial slot serves as a guide for the axial alignment key (43) attached to the reticle lens mount (42). The periphery of the medium shoulder section is engraved at intervals for the various target distances of the present three types of periscopes used in the submarine service, starting from the infinity engraved graduation. These graduations are determined after assembly by

of this narrow shoulder flange, and inward by the attached retaining ring (40) secured on the outer side face of the reticle lens mount actuating sleeve.

The mount is bored for light transmission and is threaded for anti-reflection. The inner end has two counterbored sections. The smaller serves as a seat for the reticle lens (60), while the larger is threaded to carry the clamp ring (41) snugly against the reticle lens, and is secured with a lockscrew (48).

3. Reticle lens. The reticle lens (60) is a plano-convex crown element. The convex surface is fine round, and faces the seat of the reticle lens mount (42). It is secured snugly in the seat of the mount with the clamp ring (41) secured with a lockscrew (48). The plano surface of the lens is engraved, and is described under Section 4V8 and 2nd function. Figure 4-68 shows the detailed calibrations of this lens.

4. Reticle lens clamp ring. The reticle lens clamp ring (41) is made of brass and is of nominal thickness and width. The periphery is threaded to screw into the threaded counterbored section in the reticle lens mount (42) to

calculation and known target distances. The engraved index line on the axial alignment key (43) designates the position of the reticle lens (60).

A micrometer vernier arm (57) is secured on the large shoulder periphery with four lockscews (58) and furnishes the repairman an accurate determination as to the calculated distance the reticle lens mount is moved inward axially for each distance determination.

2. Reticle lens mount. The reticle lens. mount (42) is made of brass and is 4 9/16 inches in length. It is cylindrical, and is provided with a narrow shoulder flange in the outer part. The external diameter is a sliding fit in the small counterbored section in the reticle lens mount end bushing (52) and is carried axially by the reticle lens mount actuating sleeve (53) with its attached axial alignment key (43).

The external diameter is undercut a distance of 2.125 inches to its narrow shoulder flange, thus allowing a nominal bearing surface for the reticle lens mount actuating sleeve (53). The narrow shoulder flange fits into the counterbored section in the reticle lens mount actuating sleeve, and is carried outward axially by means secure the lens. It is bored for light transmission, and has a counterbored section threaded for anti-reflection. The counterbored section leaves a narrow flat shoulder to contact the plano-surface of the reticle lens (60). The narrow side face is provided with two opposite slots for the insertion of a special wrench. The clamp ring tightens the reticle lens snugly and is secured with a lockscrew (48). The lockscrew is screwed into a tapped hole in the reticle lens mount (42) and extends into a partially tapped hole in the clamp ring.

1. Reticle lens mount axial alignment key. The reticle lens mount axial alignment key (43) is made of corrosion-resisting steel and is 0.406 inch in length. It is a sliding fit in the axial slot in the reticle lens mount end bushing (52) and is secured to the reticle lens mount bearing shoulder periphery in the axial slot with a lockscrew (45). The lockscrew is inserted into a countersunk clearance hole located 1/8 inch from its end, and is screwed into a tapped hole in the mount. Both ends of the key have a convex radius to conform to the concave radius ends of the axial slot. An

engraved index line is provided 5/32 inch from the solid end to provide the repairman with a reference line designating the clearance holes in the retaining ring (40) and screwed into tapped holes in the reticle lens mount actuating sleeve (53).

position of the reticle lens on either the distance target or the infinity target. The key is carried axially with the reticle lens mount (42) in the axial slot of the reticle lens mount end bushing for an approximate distance of 0.875 inch. This distance is sufficient for the various distance targets of low- and high-power magnification required by the three types of periscopes used in the submarine service.

m. Reticle lens mount actuating sleeve. The reticle lens mount actuating sleeve (53) is made of brass and is 1 15/16 inches in length. It is provided with a large shoulder flange, having its periphery medium diamond knurled. The undercut section is threaded its entire length with 32 threads per inch to carry a lock ring (51) and engages into the threaded counterbored section in the reticle lens mount end bushing (52). It is bored to carry the reticle lens mount (42), a sliding fit with a counterbored section in its large shoulder flange. This counterbored section serves as a thrust stop to carry the reticle lens mount (42) axially in the reticle lens mount end bushing (52). The outer face of the large shoulder flange is provided with a retaining ring (40) secured with six lockscrews (56). This retaining ring serves as a thrust ring to carry the reticle lens mount (42) axially into the reticle lens mount end bushing (52). The six lockscrews (56) are inserted in countersunk

n. Reticle lens mount lock ring and retaining ring. 1. Reticle lens mount lock ring. The reticle lens mount lock ring (51) is made of brass and is of nominal thickness and width. Its periphery conforms to the periphery of the reticle lens mount actuating sleeve (53) large shoulder flange, and is knurled in the same manner. The bore is threaded and screws on the actuating sleeve threaded periphery. The lock ring, when screwed up against the shoulder of the reticle lens mount end bushing (52), secures the actuating sleeve from further movement, thus locking it in place.

2. Reticle lens mount retaining ring. The reticle lens mount retaining ring (40) is made of 1/16-inch brass. It is cylindrical, with the outer and inner diameter conforming to the large shoulder flange inner and outer diameters. The retaining ring is provided with six equally spaced countersunk holes for lockscrews (56). The lockscrews are inserted into the countersunk clearance holes in the retaining ring and screwed in tapped holes in the large shoulder flange of the reticle lens mount actuating sleeve (53). The retaining ring serves as a thrust ring to carry the reticle lens mount (42) axially into the reticle lens mount end bushing (52) with the movement of the actuating sleeve (53).

o. Micrometer vernier arm. The micrometer vernier arm (57) is made of brass and is 3 inches in length. It has a rectangular base section with a narrow vernier arm section. The inner circumference of the rectangular base section follows the contour of the reticle lens mount end bushing large

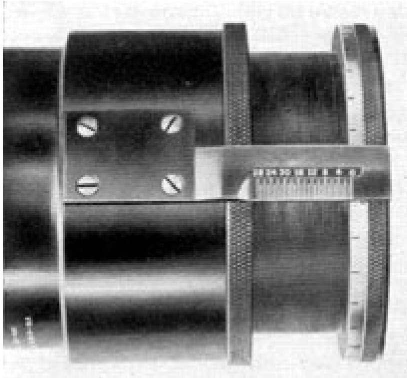


Figure 4-70. Collimator micrometer vernier arm.

periphery and has a nominal wall thickness. Figure 4-70 shows an enlargement of this vernier arm for fleet adaptation.

The inner circumference of the narrow vernier arm section is stepped upward with a chamfer allowing clearance over the periphery of the lock ring (51) and the shoulder flange of the reticle lens mount actuating sleeve (53). The vernier arm is beveled at approximately 20 degrees, and is engraved in 1/32-inch intervals, having a total

of 28 intervals in a distance of 7/8 inch. At intervals of 1/8 inch, a numeral starting with 0 is engraved along the graduations, representing each fourth 32nd. The numerals are additive by 4 for each additional numeral up to and including 28. The vernier arm is engraved in 1/32 inch to correspond with 32 threads per inch on the internal threaded section in the reticle lens mount end bushing (52) and the threaded periphery of the reticle lens mount actuating sleeve (53).

Each revolution of the reticle lens mount actuating sleeve (53) represents 1/32-inch axial movement of the reticle lens (60) and mount (42). The knurled periphery of the reticle lens actuating sleeve shoulder flange is undercut a distance of 9/64 inch from the inner shoulder face. This provides a smooth surface for the engraving of micrometer graduations and numerals. This undercut periphery has 31 equal secured snugly against the outer face of the reticle lens mount end bushing (52).

Secure the micrometer vernier arm to the periphery of the reticle lens mount end bushing (52) with four lockscrews (58). These lockscrews are inserted in countersunk clearance holes in the rectangular base and screwed into tapped holes in the reticle lens mount end bushing (52).

p. Reticle light shield. The reticle light shield (13) is made of brass tubing and is 5 inches in length. The lower part of the shield has two opposite 1/2-inch wide lugs for attachment to the outer handle section of the collimator base plate (7) and is secured with two lockscrews (21). The upper end of the shield has a soldered cap to confine the illuminated light rays to the perpendicular exit of the shield.

The shield setting on the side face of the collimator base plate (7) has a short piece of brass tubing

graduations which represent a fraction over one-thousandth inch between each graduation. Starting with 0 as the infinity numeral, every fifth graduation is additive by 5 for each additional numeral up to and including 30. The 31 graduations on the undercut periphery represent 0.03125 thousandths inch or 1/32 inch upon one complete revolution of the reticle lens mount actuating sleeve shoulder face from the 0 graduation until it again reads 0 next to the vernier arm. The vernier graduations designate the number of turns or 1/32 inch the reticle lens (60) and mount (42) are moved, axially from the 0, or infinity, setting of the Kollmorgen universal collimator. The lock ring (51) is secured each time snugly against the face of the reticle lens mount actuating sleeve (53). The securement of the lock ring starting at infinity removes the lost motion in the threads, and places an outward thrust on the reticle lens mount actuating sleeve at each locked setting.

The vernier arm rectangular base is secured to the reticle lens mount end bushing (52) periphery perpendicular to the axial slot on the light side. The four tapped holes are spotted from the clearance holes in the rectangular base after the Kollmorgen universal collimator is collimated at infinity by using a Quartermaster glass of 16-power or a transit of 24-power magnification set for sharp definition. The lock ring (51) is soldered to it, forming a spud joint. Two screws (22) are located on opposite sides of this junction section projecting inward to carry the filter mount (49). The shield covers the candelabra mazda bulb (26) screwed in the keyless socket (27).

q. Filter mount. The filter mount (49) is made of brass and is 25/32 inch in length. It consists of a large narrow shoulder and an undercut medium shoulder. The long undercut shoulder of 1/2-inch length is a sliding fit with the junction brass tubing section of the reticle light shield (13) and engages with the two opposite projecting screws (22).

The mount is bored for filtered light illumination, and is counterbored to carry the filter (61) of Corning sextant green. The outer part of the counterbored section is threaded to carry the filter clamp ring (50).

The narrow undercut shoulder carries a cylindrical disk 1/16 inch wide and 3 17/32 inches in diameter, which is soldered to the narrow shoulder. The large diameter of the cylindrical disk serves as a shield to prevent stray light other than the illuminated light from illuminating the reticle lens (60).

The long undercut shoulder section is provided with two bayonet slots to secure the mount in the shield junction upon their engagement with the inward projecting screws (22).

r. Feed-thru cord switch. The feed-thru cord switch (29) is connected between two pieces of rubber covered cord (31). One end of the rubber covered cord connects to a wire cord plug (32), while the other end passes. through a finger grip plug cap (30), and a brass tubing section (28) that is attached to the keyless socket (27).

The feed-thru cord switch is an a.c. or d.c. switch having an OFF and ON switch lever.

s. Collimation. 1. The Kollmorgen universal collimator is collimated at infinity with the reticle lens mount axial alignment key (43) near the outer end of the axial slot of the reticle lens mount end bushing (52). The transit is focused on an infinity distant target of 2,000 yards or better, free of any detection of parallax. The transit is transported with this setting for adjustment of the collimator at the transit infinity setting. Remove the lockscrew (44) and turn the objective lens mount axially until observations indicate that no parallax is apparent on the reticle lens crossline. Insert and secure the lockscrew (44) after collimation, placing a new spotted face in the objective lens mount threaded periphery (37).

2. A suitable method to be followed on a repair tender is to place a Quartermaster glass of 16-power magnification (with the eyepiece set at 0 diopter), followed with a 3-power magnification auxiliary telescope (with the eyepiece set for the observer's eye) to check the collimator infinity setting.

is performed in the following manner (all bubble numbers in this section refer to Figure 4-69 unless otherwise specified)

a. General. The Sperry-Kollmorgen collimator is swung through azimuth for checking the elevation and depression angles of the head prism. Since the altiscope mechanism elevates and depresses the line of sight of the periscope without change in azimuth of more than 10 minutes of arc, between an elevation of 10 degrees and depression of 10 degrees of the line of sight, it must be properly aligned to the perpendicular and horizontal plane of the optical I-beam bench. Check the reticle lens mount actuating sleeve (53) to ascertain that its 0 micrometer graduation is located at the 0 graduation as indicated by the micrometer vernier arm (57, Figure 4-71).

It is used with the periscope lying in a horizontal plane in V-blocks on the optical I-beam bench having a true parallel plane. The observer views the collimator reticle lens looking downward into the eyepiece end of the periscope. The Sperry-Kollmorgen collimator used travels in a vertical plane.

b. Alignment. The Sperry-Kollmorgen collimator is aligned to the optical I-beam bench in the following manner:

1. Place the boresight disk of 6.495-inch diameter in the V-block of the optical I-beam bench (Figure 4-72). Secure the boresight disk by turning the adjusting knobs of the V-block attached clamp bracket. These clamp the disk tight in the V-blocks.

The auxiliary telescope is focused from plus diopter to the observer's diopter reading, to ascertain that the reticle crossline and diopter readings are in sharp definition. At this reading there should be no parallax apparent on the reticle lens crossline. A series of observations to determine the correct setting of the objective lens (59) should be taken.

All ranges in feet below the infinity target are calculated in thousandths-inch as per actual target movement table. Refer to Section 4V8, first function.

The Quartermaster glass used should be in collimation.

4V10. Alignment of the Sperry-Kollmorgen collimator to the optical I-beam bench. This procedure

2. Insert the boresight telescope, screwing the threaded periphery into the internal threaded axis of the boresight disk. The telescope adjusting screws are to be set truly horizontal and vertical. Tighten the knurled lock ring of the boresight telescope against the disk (Figure 4-72).

3. Place the crossline disk of 6.495-inch diameter in the V-block located at the far end and on the optical I-beam bench.

4. Focus the telescope on the grooved-crossline disk until the crossline of the telescope is observed sharply. Center the crossline inter section on the hole of the grooved disk by means

Figure 4-71. Infinity setting of collimator.

of the telescope adjusting screws. Rotate the grooved crossline disk through 360 degrees. At the same time, observe whether the crossline intersection remains on the distant test point. If the crossline intersection does not shift, the telescope is in collimation.

6. The repairman at the boresight telescope directs the alignment of the collimator tube by observing the illuminated reticle lens crossline (60, Figure 4-74). These adjustments require the raising or lowering of the height adjusting bearing (2) by the loosening and securement of the height adjusting bearing cap screw (18). The loosening and tightening of the four collimator base plate bracket cap screws (19) and their lock nuts (20) are necessary to shift the collimator base plate bracket (1) to either side for the superimposing of the collimator reticle lens crossline to the boresight crossline (Figure 4-75).

5. Remove the grooved crossline disk from the V-block. Swing the collimator base plate (7) to a horizontal position, locking it by means of the wedge lock bolt (11, Figure 4-73).

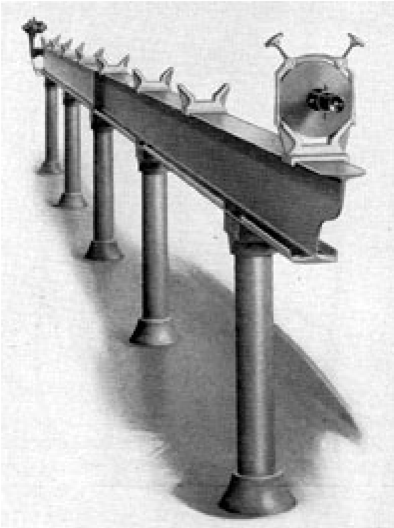


Figure 4-72. Boresight telescope attached in boresight disk and secured in V-block with clamp bracket; crossline disk in V-block at far end of the optical I-beam bench.

7. Release the wing nut (17), holding the azimuth disk plate arms (12). Rotate the azimuth disk plate (6) so that the 90 degrees numeral graduated line is in coincidence with the index line on the beveled 60 degrees minor chord of the axial section of the collimator base plate (7).

8. Secure the wing nut (17) and azimuth disk plate arms (12) after proper setting of the azimuth disk plate (6).

9. Place the checking telescope trunnion bracket on the far end of the optical I-beam

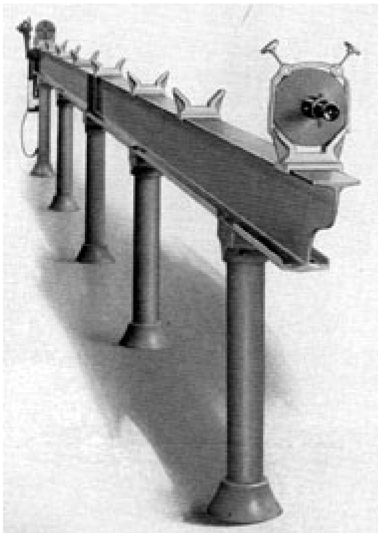


Figure 4-73. Collimator secured in a horizontal position.

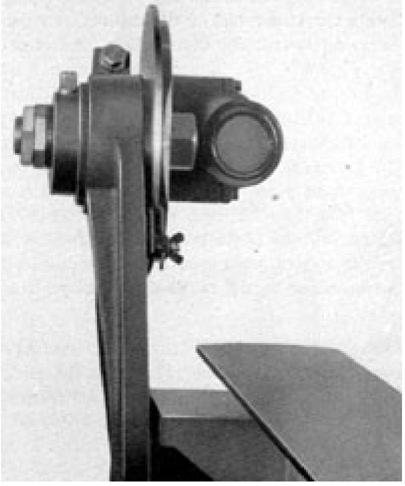


Figure 4-74. Close-up view of

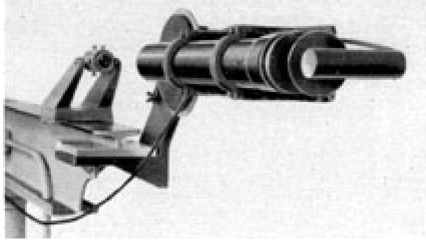


Figure 4-76. Alignment of Mark 1 checking telescope in trunnion bracket to collimator reticle.

collimator from the boresight telescope end of the optical I-beam bench.

Figure 4-75. Collimator in a horizontal position facing toward the boresight telescope for alignment with optical I-beam bench.

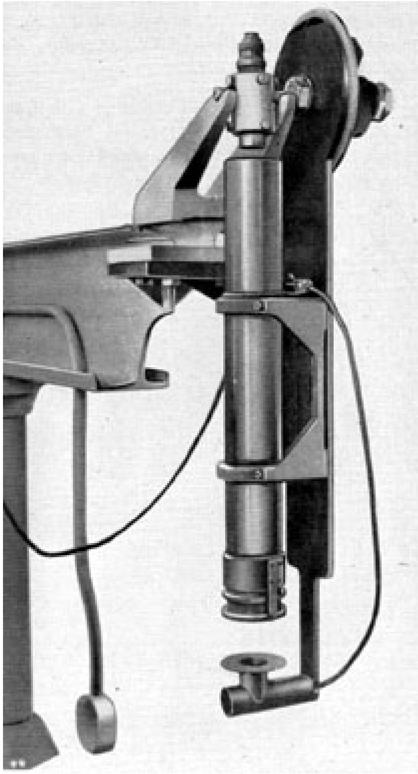


Figure 4-77. Alignment of the collimator using the Mark 1 checking telescope attached in the trunnion bracket.

bench, spotting the V-slots of the trunnion bracket in the center of the collimator base plate shaft (5).

10. Place the Mark 1 checking telescope in the trunnion bracket and screw the adjusting screws inward, allowing the adjusting screw segments to contact the checking telescope (Figure 4-76).

11. With the four outer and inner adjusting screws, align the checking telescope crossline to the collimator reticle crossline. When properly superimposed, the checking telescope is swung through azimuth vertically as the collimator base plate is carried through azimuth vertically.

12. The vertical line of the checking telescope crossline is

7.497 inches for the outer tube axis of the Type II and III periscopes, to parallel the axis of the Sperry-Kollmorgen collimator, and the setting of the azimuth disk plate (6) to 90 degrees.

18. It is necessary to have a boresight and grooved crossline disk having a diameter of 6.805 inches for the inner tube section offset optical axis of the Type IV periscope, to parallel the axis of the Sperry-Kollmorgen collimator, and the setting of the azimuth disk plate (6) to 90 degrees. However, when the inner tube sections are assembled in the outer tube, the optical axis is offset 0.125 inch higher than the Type II and III periscope optical axis, and requires a boresight and grooved crossline disk having a diameter of 7.618 inches for final checking.

used as a reference to check the vertical line of the collimator reticle crossline that is carried parallel through the azimuth for all degrees of elevation and depression (Figure 4-77). The collimator base plate bracket (1) should be shifted for any irregularity of parallelism, and properly adjusted for squaring of the vertical line of the collimator reticle crossline by the rotation of the collimator tube. This is followed by the adjustment of the Allen head cap screws in opposite sides of the welded plate of the optical I-beam bench.

13. Remove the Mark 1 checking telescope and the trunnion bracket from the optical I-beam bench.

14. These two checking procedures are followed continuously until the collimator reticle lies in a true horizontal plane and is carried through all degrees of azimuth for true vertical plane.

15. Remove the boresight telescope, boresight disk, and the V-block clamping bracket when the two procedures stated in Step 14 are properly corrected.

16. It is necessary to check the height of the inner tube section axis of the Type II and III periscopes using a boresight and grooved crossline disk having a diameter of 6.495 inches, to parallel the axis of the Sperry-Kollmorgen collimator, and the setting of the azimuth disk plate (6) to 90 degrees.

4V11. Collimation of the lower (split) objective lens to the stadimeter dials, using the telemeter lens and the Sperry-Kollmorgen collimator. This procedure is performed in the following manner:

1. Check the stadimeter dials to determine that the observing position of the dials is correct.

2. Check the objective operating mechanism assembly to determine that the lower (split) objective lens and mount assembly are located in the observing position.

3. Place the stadimeter housing assembly at the base of the eyepiece box (11, Figure 4-29). Check the entrance of the female tang coupling (68, Figure 4-24) to ascertain that it engages on the male tang section of the stadimeter transmission shaft (22, Figure 4-27). Insert the four housing bolts (30) in the clearance holes in the stadimeter housing (67, Figure 4-24), screwing the bolts into tapped holes in the eyepiece box base (11, Figure 4-27), securing them snugly.

4. Swing the Sperry-Kollmorgen collimator to the zero line of sight position. Release the wedge lock bolt (11, Figure 4-69) and wedge lock (10) sufficiently to swing the index line on the collimator base plate (7) into coincidence with the 0 numeral graduation on the azimuth disk plate (6).

5. Carry the inner tube sections axially on the optical I-beam bench with the V-blocks until the head prism is spotted centrally over the collimator axis.

17. It is necessary to have a boresight and grooved crossline disk having a diameter of

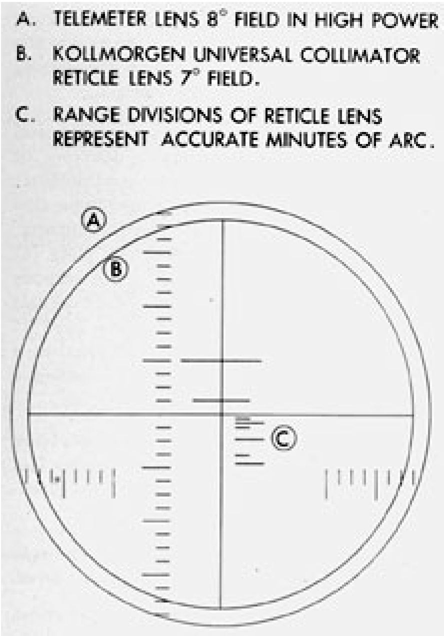


Figure 4-78. Collimator reticle lens as apparent to the repairman in the high-power field of the periscope.

6. Place the head prism at zero line of sight, checking the parallel position of its front 90 degrees face in the skeleton head by eyesight, by corresponding its parallelism to the skeleton head frame (Figure 4-78).

7. Unscrew the eyepiece lens mount (19, Figure 4-28), carrying with it the eyepiece lens (52), eyepiece lens clamp ring (16), and its lockscrew (41).

8. Follow the procedure stated in Section 4V4, Steps 1 to 3 inclusive.

9. Slide the lower telescope assembly axially, carrying it with the V-blocks until it is near the lower part of the second inner

11. Holding the coupling sleeve (34) on the undercut alignment support sections of the track sleeve (2) and the second inner tube section lower end coupling (26, Figure 4-21), slide the upper telescope system Part I-II downward snugly against the coupling sleeve. This permits the coupling sleeve to fit snugly between the bearing shoulders of the track sleeve (2, Figure 4-23) and the second inner tube section lower end coupling (26, Figure 4-21). Remove the coupling sleeve and place it in a convenient place until it is required for reassembly.

12. Replace the threaded periphery of the special eyepiece alignment jig (Figure 4-50) in the threaded bore of the eyepiece prism front retaining plate (24, Figure 4-28) of the eyepiece skeleton assembly. Screw the jig into this front retaining plate until the shoulder of the jig attains a tight metal to metal contact with the projecting cylindrical shoulder of this retaining plate.

13. Follow the procedure outlined in Section 4V4, Steps 3, 5, 6, 7, 8, and 9 for the alignment of the lower telescope system.

14. Remove the eyepiece alignment jig and replace the assembled eyepiece lens mount (19) by screwing it into the eyepiece prism front retaining plate (24). Check the inner and outer surfaces of the eyepiece lens

tube section lower end coupling (26, Figure 4-21).

10. Line up the reference marks of the second inner tube section lower end coupling (26), checking it by the coupling sleeve (34, Figure 4-23) in its proper coincidence relationship with the track sleeve (2) reference marks.

(52) for cleanliness before replacement.

15. Remove the observing position stop (20, Figure 4-23) from the retaining ring (35) by removing the lockscrews (30). Two factory scribed lines can be seen approximately 27/32 inch apart on the operating gear shoulder (1) and the retaining ring (35). This distance represents 10 degrees on the periphery of the operating gear. When the operating gear is rotated 10 degrees counterclockwise, viewing it from the lower end, the right scribe line on the operating gear coincides with the left scribe line on the retaining ring, and the mounting plates (5) are displaced an amount equal to 2' and 4" of arc.

16. With the operating gear in this position, the range scale dials (50, Figure 4-24) should read 11,000 yards approximately opposite the 20-foot height indication on the height scale dials (52). The collimator reticle should show the horizontal crossline in one image superimposed,

over the first small horizontal graduated line of the reticle in the other image.

17. If the horizontal crossline of one image shows that the horizontal crossline of the reticle is not superimposed over the first small line of the other image, the sliding half of the lower (split) objective lens and mount assembly (Figure 4-22) which has the elongated holes and recesses parallel to the split

22. If an error is noticed in the reading of the range scale dial, as much as a thickness of the dial line, turn the handwheel (12) to remove half the error. Release the two setscrews in the tapped holes in the stadimeter transmission shaft coupling (14, Figure 4-23) and turn the handwheel, setting the range scale dial indication of 400 yards approximately opposite the 20-foot height indication value on the height scale dial, and secure the two setscrews. Correct

of the lens, is moved so that the horizontal crossline of one image is superimposed over the first small horizontal line of the collimator reticle in the other, or the 110/20 graduation. It is necessary to use an offset screwdriver to loosen the stadimeter collimating screws (13) sufficiently to tap the mount lightly with a small rawhide mallet.

18. The stadimeter transmission shaft coupling (14, Figure 4-23) has been previously secured temporarily to the stadimeter transmission shaft (22, Figure 4-27) with two special setscrews inserted for collimation use, with the taper pin holes aligned. Using the offset screwdriver, secure the stadimeter collimating screws (13, Figure 4-22), securing the vertical sliding half of the lower (split) objective lens and mount assembly.

19. Turn the handwheel (12, Figure 4-24) clockwise until the horizontal crossline of the collimator reticle in one image superimposes over the second horizontal graduated line of the collimator reticle in the other image. The range scale dial (50,) should read 7,500 yards approximately opposite the 20-foot height indication value on the height scale dial,(52).

20. Continue turning the handwheel (12) clockwise until the horizontal crossline of the collimator reticle in one image superimposes over the third horizontal graduated line of the collimator reticle in the other image. The range scale dial should read 2,500 yards the remaining error by loosening the stadimeter collimating screws (13, Figure 4-22) with an offset screwdriver. Tap the vertical moving half of the lower (split) objective lens and mount assembly using a rawhide mallet, to make the horizontal crossline of the collimator reticle in one image superimpose over the collimator horizontal graduated line of the collimator reticle in the other image at 400/20, and secure the stadimeter collimating screws.

23. Return the displacement of the lower (split) objective lens images so that the horizontal crossline of the collimator reticle in one image superimposes over the first horizontal graduated line of the collimator reticle in the other image. The range scale dials should read 11,000 yards approximately opposite the 20-foot height indication value on the height scale dial. Check the complete series of ranges, 11,000/20, 7,500/20, 2,500/20, 1,000/20, 500/20, and 400/ 20, noting any error and correcting in the same manner as before.

24. When the range scale dials read correctly, the observation position is determined by turning the handwheel (12, Figure 4-24) counterclockwise slowly until the duplicate images almost close to one image.

25. Replace the observation position stop (20, Figure 4-23) to the retaining ring (35), securing it with two lockscrews (30). Rotate the operating gear (1) and its stop (19) from the observation position stop (20) to the maximum displacement stop (20) with sufficient impact to determine any

approximately opposite the 20-foot height indication value on the height scale dial.

21. Continue in like manner with the fourth horizontal line at 1,000 yards approximately opposite the 20-foot height indication value, the fifth horizontal line at 500 yards approximately opposite the 20-foot height indication value, and the sixth horizontal line at 400 yards approximately opposite the 20-foot height value indication.

misalignment which may take place. Check for a double image in the observing position. If one is apparent when the operating ear stop (19) is in contact with the observation position stop (20), it is necessary to manufacture a new observation position stop or build up the present observation position

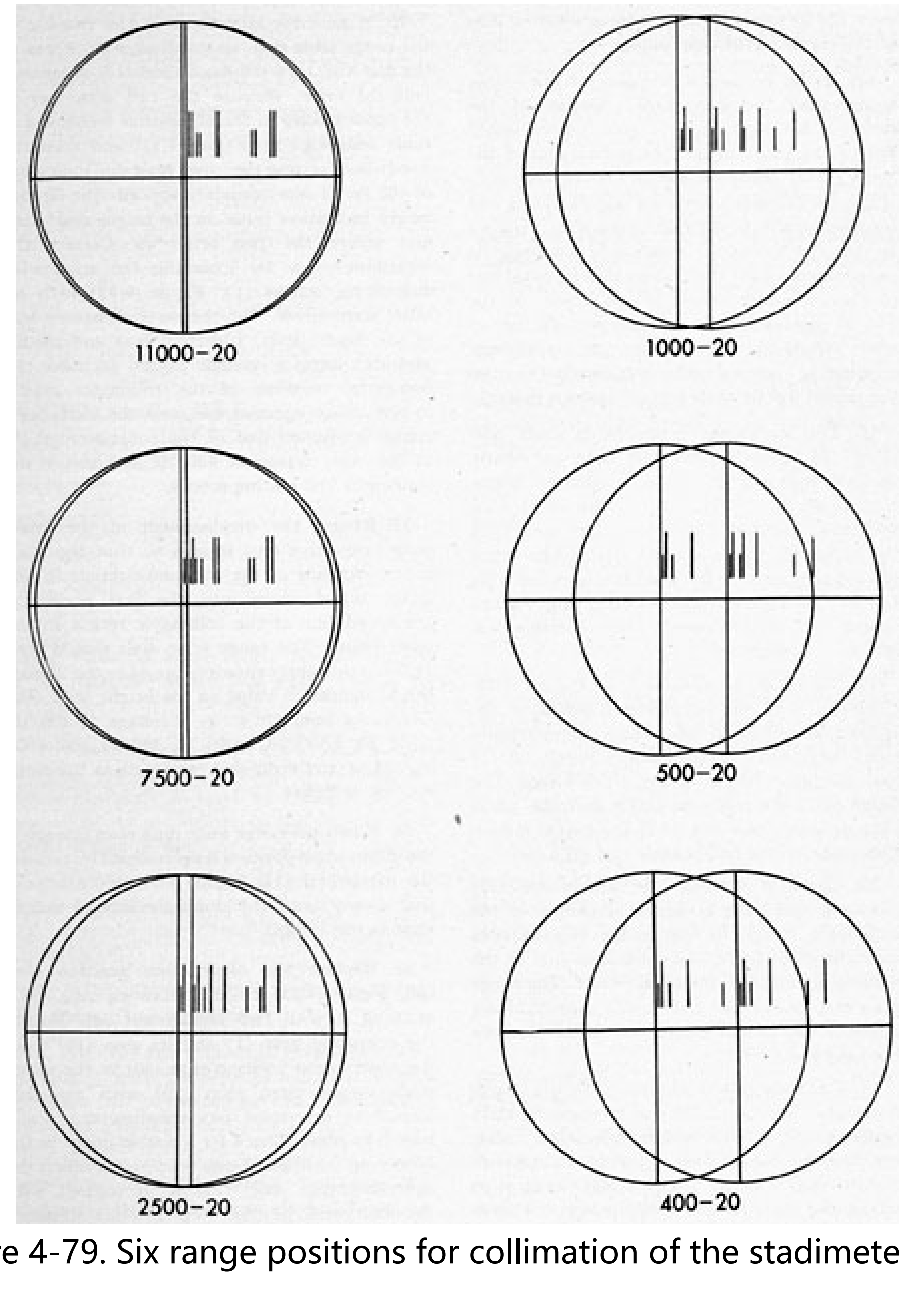


Figure 4-79. Six range positions for collimation of the stadimeter dials

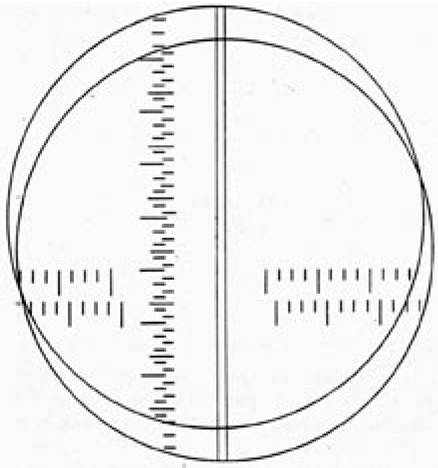
as indicated by the displacement of the lower (split) objective lens.

stop and grind it down. If the stop is built up, it must be ground down in a series of steps, taking off small amounts until no double image is apparent, or until duplicate images become one.

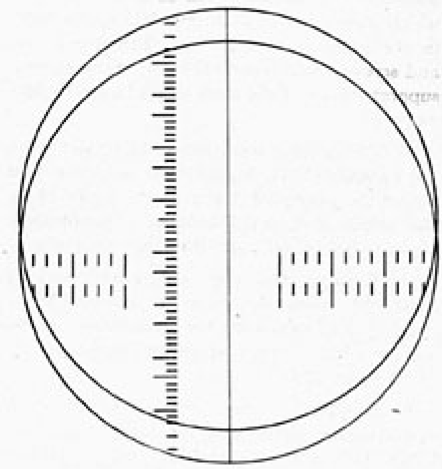
26. Upon completion of the stadimeter collimation, secure the stadimeter transmission shaft coupling (14) to the stadimeter transmission shaft (22, Figure 4-27) with a taper pin (33, Figure 4-23). It is seldom necessary to redrill and ream a taper pin hole in the coupling and the shaft for a new position of the taper pin (33). Remove the two temporary setscrews from the stadimeter transmission shaft coupling (14).

27. After securing the stadimeter collimating screws (13, Figure 4-22), the parallel moving half of the lower (split) objective lens and mount assembly is secured with two straight dowel pins (15). The dowel pins are also replaced in their original holes in the left mount half and its corresponding mounting plate (5, Figure 4-23).

28. With the optical focus of the instrument at infinity, the etched lines of the telemeter lens should be coincident, or of duplicate height. If it is noted that they are not in correct adjustment, the stadimeter collimating screws (13, Figure 4-22) are loosened sufficiently with an offset screwdriver to tap the perpendicular sliding half of the lower (split) objective lens and



INCORRECT COLLIMATION OF VERTICAL MOVING HALF OF SPLIT OBJECTIVE LENS



CORRECT COLLIMATION OF VERTICAL MOVING HALF OF SPLIT OBJECTIVE LENS

Figure 4-80. Collimation of the lower (split) objective lens perpendicular moving half.

mount assembly using a rawhide mallet until the coincident or duplicate height of the etched lines of the telemeter lens are correct. The clockwise rotation of the handwheel (12, Figure 4-24) displaces the lens halves sufficiently to distinguish this adjustment. When corrections have been made, tighten the stadimeter collimating screws (13, Figure 4-22) and insert the two straight dowel pins (15) in their original holes in the same manner as directed under Step 27 of this Section.

29. The range, scale dial (50, Figure 4-24) reading in the observing or single image position should be approximately 2 2/58-foot height indication on the height scale dial (52), as indicated by the numerals stamped on the stadimeter housing (67).

30. After collimation of the lower (split) objective lens and mount assembly (Figure

4-22) to the stadimeter dials and the telemeter lens, screw the coupling sleeve (34, Figure 4-23) on the threaded periphery of the second inner tube section lower end coupling (26, Figure 4-21). It is first necessary to slide the lower telescope system clear for the assembly of the coupling sleeve.

31. Secure the upper part of the coupling sleeve (34, Figure 4-23) with four lockscrews (22). These lockscrews are inserted in countersunk clearance holes in

In determining the range scale dial readings by this method, the cotangent of the angle is used. The angles measured are those angles formed by the graduated lines of the telemeter lens located 1 degree to the left of the vertical centerline in high power. In low power, the group of lines is located 4 degrees to the left of the vertical centerline.

Each large division on the telemeter lens corresponds to an angle of 1 degree at high power, and 4 degrees at low power. Each

the coupling sleeve (34) and screwed into tapped holes in the second inner tube section lower end coupling lower alignment support section (26, Figure 4-21).

32. Connect the assembled coupling sleeve (34, Figure 4-23) to the track sleeve (2) of the objective operating mechanism assembly as follows: Take precautions to see that the internal recess in the coupling sleeve is carried over the objective operating mechanism assembly axially in the correct alignment position and that this internal recess is carried over the operating gear pinion (12).

33. The coupling sleeve (34) is carried over the alignment support section of the track sleeve large shoulder flange (2) up against its bearing shoulder. It is secured with 15 lockscrews (27) which are inserted in countersunk clearance holes in the lower part of the coupling sleeve (34) and screwed into tapped holes in the alignment support section of the track sleeve large shoulder flange (2).

34. Check the stadimeter dials and turn the handwheel (12, Figure 4-24) until the dials are at the observing position; the figure 58 on the height scale dial should be approximately opposite the value 2.2 on the range scale dial.

35. Remove the four stadimeter housing bolts (30) from the base of the stadimeter housing (67), removing the stadimeter housing assembly from the base of the eyepiece box (11, Figure 4-29).

subdivision corresponds to an angle of 15' at high power and 1 degree at low power.

In high power, the cotangents at these angles are:

Cotangent of 15' = 229.18
Cotangent of 30' = 114.59
Cotangent of 45' = 76.39
Cotangent of 60' or 1 degree = 57.29
Cotangent of 1 degree and 15' = 45.85

When displacing the lower (split) objective lens, and overlapping or superimposing the telemeter lens lines over each other, the range is found as follows:

1. 15 minutes of arc represents a range scale dial reading of 1,500 yards over the 20-foot height scale dial reading.

229.18 X 20 ft = 4,583.60 ft, or 1,527 yd

2. 30' of arc represents a range scale dial reading of 760 yards over the 20-foot height scale dial reading.

114.59 X 20 ft = 2,291.80 ft, or 763.93 yd

3. 45' of arc represents a range scale dial reading of 500 yards over the 20-foot height scale dial reading.

76.39 X 20 ft = 1,527.80 ft, or 509.26 yd

4. 60', or 1 degree, of arc represents a range scale dial reading of 380 yards over the 20-foot height scale dial reading.

57.29 X 20 ft = 1,145,80 ft, or 381.93 yd

36. Overlap system of collimation. A ready means of checking the range scale dials of the stadimeter with the lower (split) objective lens is accomplished by use of the telemeter lens and is called the overlap system. This method is of great importance to a repairman as a rough check of the stadimeter when the periscope is installed in a submarine.

5. 1 degree 15' of arc represents a range scale dial reading of 300 yards over the 20-foot height scale dial reading.

45.80 X 20 ft = 916.58 ft, or 305.33 yd

Greater accuracy is obtained by using the Kollmorgen range collimator because a definite starting point of 2' 4" of arc is used. This permits ranges to be checked over the full throw of the range scale dial: from the longest range of 11,000 yards (the smallest displacement of the lower split objective lens) to the shortest range of 400 yards (the greatest displacement of the lower split objective lens).

In using the overlap system, no definite starting point is given and ranges are checked over only a small part of the range scale. This part consists of the lower ranges only, and any error is greatly multiplied at the upper end of the range scale where movement of the lens halves is small.

4V12. Orientation of the telemeter lens by the maximum displacement of the lower (split) objective lens. This procedure is performed in the following manner:

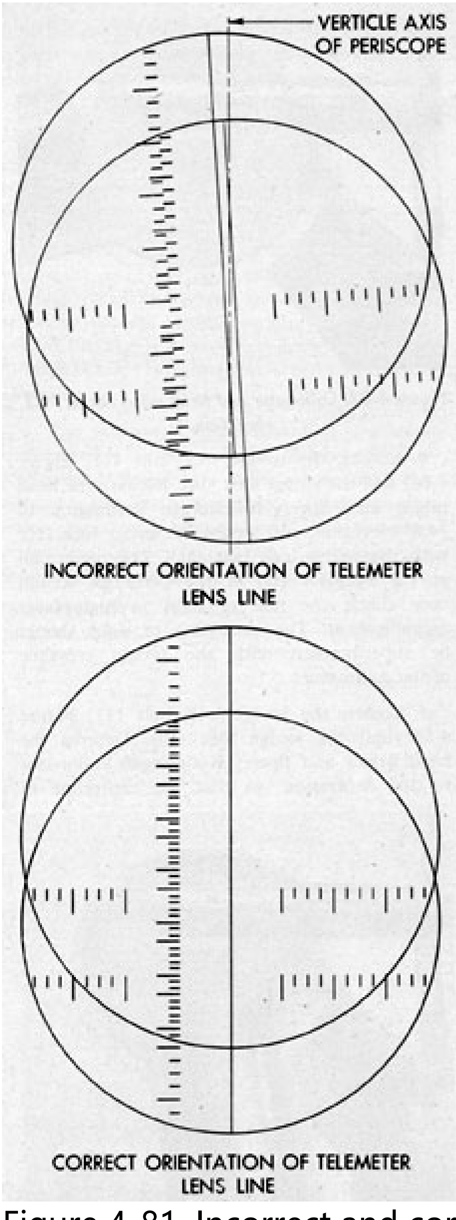


Figure 4-81. Incorrect and correct orientation of the telemeter lens line by means of the lower (split)

1. Place a special wrench on the male tang section of the stadimeter transmission shaft (22, Figure 4-27). Rotate the wrench clockwise until the lower (split) objective lens halves are displaced to maximum displacement in the range position.

2. The telemeter lens line should appear as one solid line. If it appears double or faded, it is necessary to rotate the telemeter lens mount (9, Figure 4.-18). This procedure is continued until the telemeter lens line appears as one solid line (Figure, 4-81).

3. Secure the telemeter lens mount (9, Figure 4-18) with the angular alignments lockscrew (7). This lockscrew is inserted in the circumferential recess and slot in the eighth reduced tube section (6) and screwed into the tapped hole in the mount.

4. Recheck the telemeter lens line 1, noting whether any change has taken place during tightening of the lockscrew (7).

4V13. Orientation check of the head prism using the Sperry-Kollmorgen collimator. This procedure is performed in the following manner:

1. Recheck the inner tube sections following the directions stated in Section 4V11, Steps 5, 6, 7, 8, 12, and Section 4V4, Steps 3, 5, 6, 7, 8, and 9 for alignment to the optical I-beam bench and the Sperry-Kollmorgen collimator.

objective lens maximum displacement.

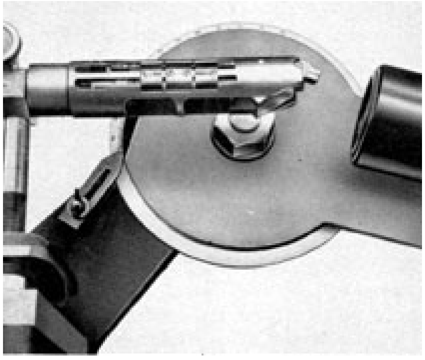


Figure 4-82. Collimator and head prism set at 74.5 degrees elevation.

2. Loosen the wedge lock bolt (11, Figure 4-69) and the wedge lock (10). Elevate the head prism and Sperry-Kollmorgen collimator to 74.5 degrees elevation, and secure the wedge lock (10) with the wedge lock bolt (11). The repairman at the eyepiece end of the periscope should now check the line of sight in high-power magnification. The centerline of sight should be superimposed with the reticle crossline of the collimator.

3. Loosen the wedge lock bolt (11, Figure 4-69) and the wedge lock (10). Depress the head prism and Sperry-Kollmorgen collimator to 10 degrees depression, so that the centerline of

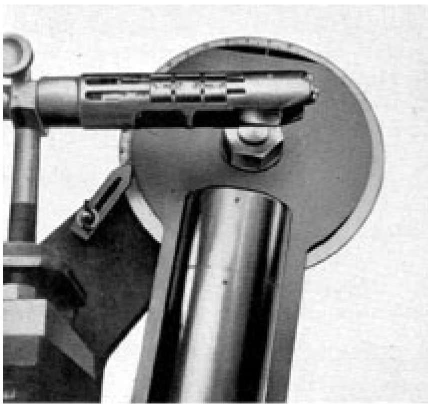


Figure 4-83. Collimator and head prism set at 100 depression.

sight is superimposed with the reticle crossline of the collimator. Secure the wedge lock (10) with the wedge lock bolt (11).

4. After all degrees of elevation and depression have checked correctly, the repairman is assured that the head prism travel is correct. Should the centerline of sight show an incorrect reading, it is necessary to disconnect the gear train bracket (30, Figure 4-17) of the skeleton head assembly and shift the eccentric accordingly.

5. At any time the periscope is moved on the optical I-beam in the V-blocks and spacers, it is checked at the eyepiece end by the insertion of the special eyepiece jig (Figure 4-50) and the face is checked with a dial indicator and surface gage (Figures 4-58 and 4-59).

4V14. Collimation of the high-power system Free of parallax on the Kollmorgen distance collimator function at atmospheric pressure. This procedure is performed in the following manner:

1. Loosen the wedge lock bolt (11, Figure 4-69) and the wedge lock (10) and place the Sperry-Kollmorgen collimator index line in coincidence with the 0 degree graduation of the azimuth disk plate (6). Secure the wedge lock (10) with the wedge lock bolt (11).

2. Release the lock ring (51) and turn the reticle lens mount actuating sleeve (53) clockwise 25 graduations as indicated by the micrometer graduation and the micrometer vernier arm (57), securing the lock ring (51) snugly against the reticle lens mount end

bushing (52). This places the reticle lens (60) and mount (42) at the 1,200-foot distance target position. Figure 4-84 shows the correct position of the reticle

Figure 4-84. Collimator reticle lens set at 1200-foot target distance.

lens mount actuating sleeve in relation to the micrometer vernier arm and the range table in Section 4V8 under the first function for the proper position of the reticle lens at this 1,200-foot distance.

3. Place the auxiliary telescope at the eyepiece of the periscope. Set the diopter reading of the auxiliary telescope at infinity for the observer. Move out the ninth reduced tube section (1, Figure 4-18) carrying the auxiliary upper eyepiece lens (5) until the image of the collimator reticle is detected on the telemeter lens. The ninth reduced tube section focuses the auxiliary upper eyepiece lens on the collimator reticle.

4. At the above setting, the auxiliary telescope is focused from plus diopter to the observer's diopter reading, to ascertain that the telemeter lens and the collimator reticle are in sharp definition. At this reading, no parallax should be apparent on the telemeter lens.

must be collimated primarily to the fixed high-power magnification series of the telescope systems.

4. The Galilean eyepiece lens mount housing (4) is provided with an adjustment allowance to correct the mechanical axis by means of the optical axis movement of the Galilean eyepiece lens (56).

5. Loosen the three lockscrews (5) sufficiently to adjust the Galilean eyepiece lens mount housing (4). The optical axis of the Galilean telescope system is collimated to the optical axis of the high-power system with a minimum of vertical and horizontal displacement tolerance allowance.

6. The horizontal displacement of the collimator reticle crossline image of low power is primarily collimated to superimpose with the telemeter lens line of high power. The collimator reticle crossline is superimposed with the telemeter lens line in high power. Therefore, the change of power is necessary for determining

5. Secure the ninth reduced tube section (1) with the clamp ring (8) and secure the clamp ring and the ninth reduced tube section with lockscrews (11 and 3).

4V15. Primary collimation of the Galilean telescope system to the high power system. This procedure is performed in the following manner:

1. Place the auxiliary telescope at the eyepiece of the periscope. Set them diopter reading of the telescope at infinity for the observer.

2. Focus the periscope to zero betting at atmospheric pressure or -3/4 diopter. Using the 1,200-foot distance target setting of the collimator, move the Galilean eyepiece lens mount (3, Figure 4-17) in the housing, (4) internal threads until the image of the target is apparent on the telemeter lens. At this setting, the auxiliary telescope is focused from plus diopter to the observer's diopter reading, to ascertain that the telemeter lens and the collimator reticle are in sharp definition. At this reading no parallax should be apparent on the telemeter lens. Secure the Galilean =eyepiece lens mount (3) temporarily with the lockscrew (14).

3. The Galilean telescope system lenses move through 90 degrees for change of power and therefore,

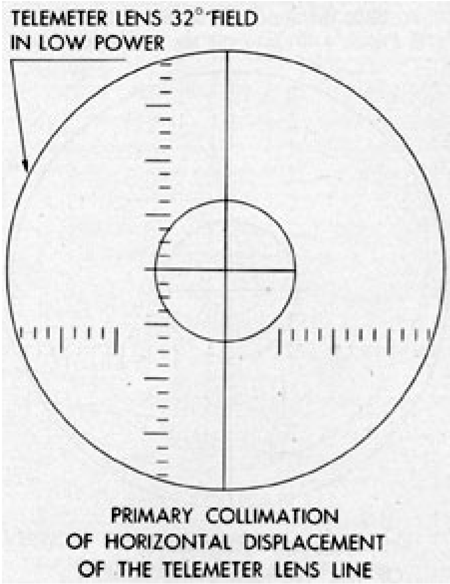


Figure 4-85. Primary collimation of the horizontal displacement of the collimator reticle crossline image of low power to superimpose with that of high power.

the proper relationship of the low-power system, with the

securement of the three lockscrews (5) each time (Figure 4-75).

7. The vertical displacement of the center line of sight of low power is primarily collimated to superimpose with the centerline of sight of high power. Use the collimator reticle crossline as a reference for the change of power to determine the proper relationship of the lower power system with the securement of the three lockscrews (5) each time (Figure 4-86).

8. Repeat the procedure stated in Steps 6 and 7, making any adjustments that may be necessary (Figure 4-87).

9. After primary collimation, remove the skeleton head assembly (Figure 4-17) with the skeleton head adapter (Figure 4-60) from the upper part of the ninth reduced tube section (1, Figure 4-18).

4V16. Reassembly of air lines, shifting wire tapes, and packing gland assemblies. This procedure is performed in the following manner:

1. Slide the upper end of the air line section (18, Figure 4-20) into the air line adapter (11,

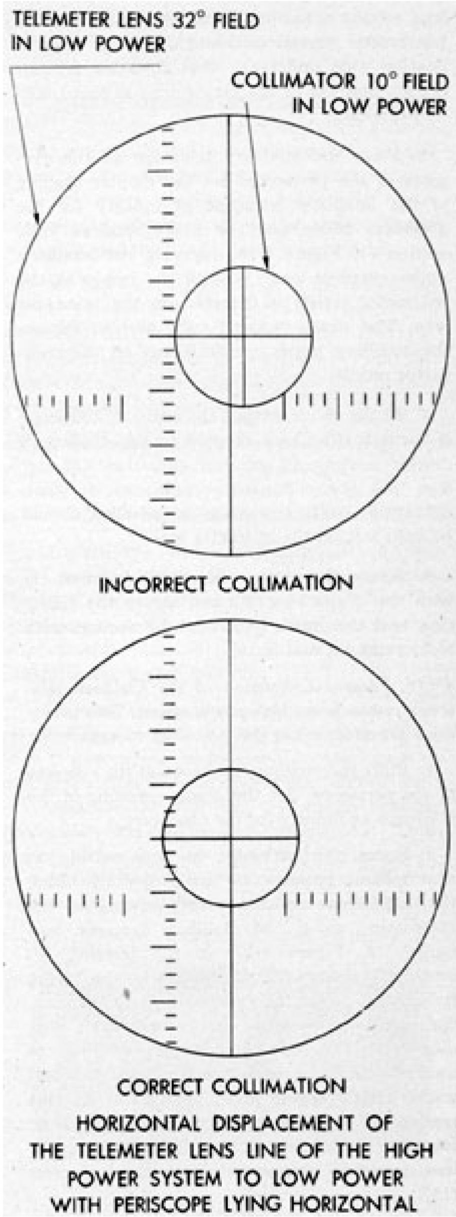


Figure 4-87. Incorrect and correct primary collimation of the horizontal displacement.

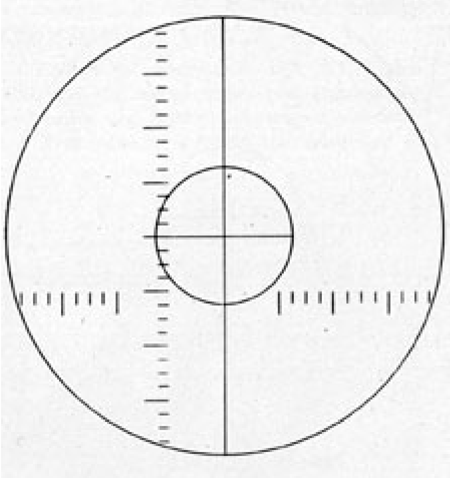


Figure 4-86. Primary collimation of the vertical displacement of the centerline of sight of low-power to superimpose with that of high power.

Figure 4-19) of the fourth reduced tube section (9). Secure the removable air line strap (21) over the air line section (18, Figure 4-20) to the periphery wall of the second reduced tube section (19, Figure 4-19) with two lockscrews

2. Place the bent air line section (17, Figure 4-20) with the flat soldered air line coupling (15) and short soldered air line section (16) in the upper end opening of the soldered air line section (30) of the sixth inner tube section (23). Attach the bent air line section (17) to the soldered air line coupling (14) of the air line section (18) by a slight outward thrust with one hand in the middle of the projecting air line section (18), while connecting the coupling in the upper end of the bent air line section (17). Attach the removable air line strap (19) over the bent air line section (17) and

secure it to the lower periphery wall of the first reduced tube section (1) with two lockscrews (22).

3. Slide one end of the air line section (31) into the lower end opening of the soldered air line (30) of the sixth inner tube section (23). Place the lower end of the air line section (31) in the upper end opening of the soldered air line section (10, Figure 4-21) of the fourth inner tube section (1).

4. Insert the long air line coupling section (15, Figure 4-27) in the clearance hole in the spider (2), and screw it further into the tapped hole in the eyepiece skeleton large shoulder flange (42, Figure 4-28) screwing it tight.

5. Place the short bent round air line section (16, Figure 4-27) on the upper end of the long airline coupling section (15), rotating it against the first inner tube section (1) and attaching the removable air line strap (19) over the bent air line section (16) to the lower periphery wall of the first inner tube section (1), securing it with two lockscrews (24).

6. Slide the air line section (18) with the soldered air line coupling (17) into the soldered air line strap (20) of the first inner tube section, and extend it further, the coupling entering the bent air line section (16).

7. Slide the upper end of the air line section (29, Figure 4-21) into the three soldered air line straps (31) of the second inner tube section (22),

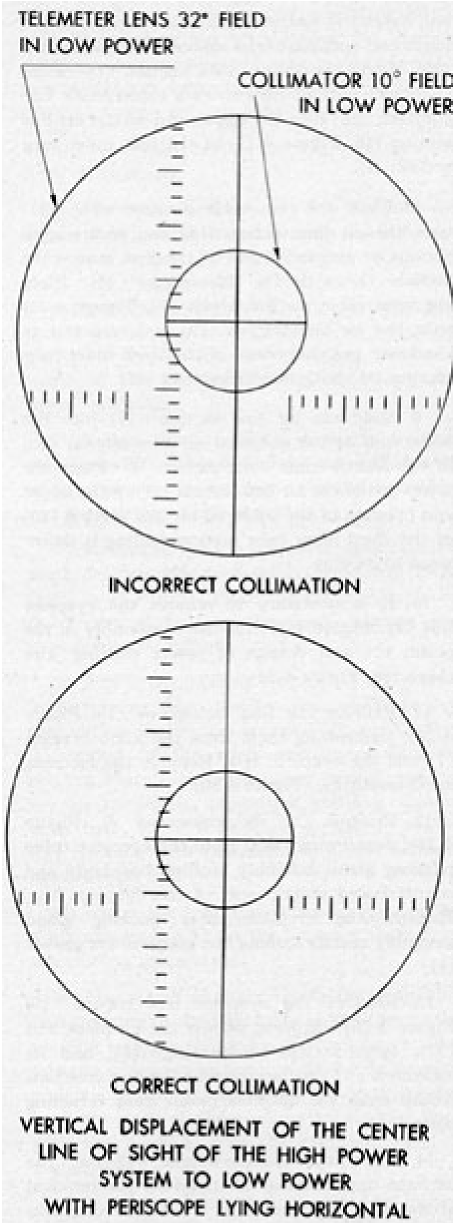


Figure 4-88. Incorrect and correct primary collimation of the vertical displacement.

and extend it farther until it is inserted in the lower end opening of the soldered air line section (20) of the third inner tube section (11). Push the lower part which carries a soldered air line coupling (28) into the upper end of the air line section (18, Figure 4-27) of the first inner tube section (1).

8. Place the removable air line strap (21) over the air line section (18) and secure it to the upper periphery wall of the first inner tube section (1) with two lockscrews (24). Place the removable air line strap (30, Figure 4-21) over the air line section (29) and secure it to the lower periphery wall of the third inner tube section (11) with two lockscrews (32).

9. Slide the air line section (21) into the lower end of the soldered air line section (10) of the fourth inner tube section (1). Place the lower end of the air line section (21) in the upper end opening of the soldered air line section (20) of the third inner tube section, sliding it downward to its stop.

10. It is necessary to remove the eyepiece box (11, Figure 4-29) for the reassembly of the prism tilt and change of power shifting wire tapes (38, Figure 4-28).

11. Remove the four lockscrews (10, Figure 4-39), unscrewing them from the knob bracket (7) and the eyepiece box. Remove the focusing knob assembly, (Figure 4-39).

holes of the large shoulder flange of the eyepiece skeleton (42).

15. Remove the eyepiece box (11, Figure 4-29) guiding it off slowly over the eyepiece skeleton assembly. The centering screw (12) and its lead washer (13) remain intact as does also the sealing gasket (8) located on the alignment support section of the eyepiece box (11).

16. Place the four shifting wire tapes (38, Figure 4-28) for the prism tilt and change of power mechanism through the various guides and straps on the inner and reduced tube sections.

17. Attach the two shifting wire tapes for the prism tilt mechanism to the head prism shifting racks (40 and 42, Figure 4-17). Remove the four lockscrews (12) and two clamp blocks (16). Attach each tape to the left and right head prism shifting racks, inserting them from the internal part of the skeleton head. Secure each tape to its respective head prism shifting rack with a clamp block (16) and two lockscrews (12).

18. Attach the two shifting wire tapes for the change of power mechanism to the cube shifting racks (17 and 18) in the same manner as directed in Step 16 for the prism tilt mechanism.

19. Pull the four shifting wire tapes downward, carrying the skeleton head assembly on the upper part of the ninth reduced tube section (1, Figure 4-18) until the lower face of the Galilean objective lens cube

12. Remove the six lockscrews (3, Figure 4-35), unscrewing them from the eyepiece drive packing gland assembly stuffing box body and counterbored section seat of the eyepiece box. Remove the eyepiece drive packing gland assembly and its stuffing box body rubber gasket (11).

13. Remove the eyepiece lens mount (19, Figure 4-28), carrying with it the eyepiece lens (52), eyepiece lens clamp ring (16), and its lockscrew (41) by unscrewing the eyepiece lens mount from the eyepiece prism front retaining plate (24).

14. Place the counterweight (25) at the extreme upper end of its travel for the removal of the eight lockscrews (31). Unscrew the lockscrews (31) from the tapped holes in the eyepiece box upper face and remove them from the clearance opening is in coincidence with the upper end of the ninth reduced tube section. Place the head prism shifting racks (40 and 42, Figure 4-17) and the cube shifting racks (17 and 18) at half throw. Hold the skeleton head assembly at the above location on the ninth reduced tube section until the lower ends of the tapes are secured.

20. Loosen the four shifting wire clamp nuts (3, Figure. 4-28) sufficiently to allow the phosphor-bronze wire extension of each tape to enter snugly in each shifting wire clamp (2). The wires extend equally beyond the lower end of each shifting wire spindle (1).

21. Place the prism shifting racks (43 and 44) and the power shifting racks (45 and 46) of the eyepiece skeleton assembly at half throw.

In this position pull all wires taut and secure each shifting wire clamp nut (3).

22. The upper and lower shifting wire spindle adjusting nuts (4) for this half throw position are secured against the hubs of the shifting racks, leaving an equal amount of the threaded periphery of the shifting wire spindle in the upper and lower part.

23. Whenever anew set of shifting wire tapes is installed, the phosphor-bronze wire extensions are longer than necessary, and they should be

27. Replace the eyepiece drive packing gland assembly stuffing box body gasket (11, Figure 4-35) on the counterbored seat in the eyepiece box (11, Figure 4-29) for this assembly.

28. Check the counterweight (25, Figure 4-28). It should be at the extreme upward limit of its travel.

29. Place the female coupling section (3, Figure 4-39) of the focusing knob assembly on the square section of the eyepiece drive actuating shaft (12, Figure 4-35) of the eyepiece drive packing gland assembly. Check the reference punch mark on the

cut off at an approximate distance of 1 inch from the lower part of the shifting wire spindles (1).

24. Replace the eyepiece box (11, Figure 4-29) over the eyepiece skeleton assembly, guiding it on slowly and carefully. It is carried on the narrow alignment shoulder of the large shoulder flange of the eyepiece skeleton (42, Figure 4-28). Engage the reamed dowel pin holes in the eyepiece box upper face over the downward protruding dowel pins (36) of the eyepiece skeleton flange, and guide the stadimeter transmission shaft male tang section (22, Figure, 4-27) into the reamed stuffing box chamber axis hole. The centering screw (12, Figure 4-29) engages in the reamed hole in the eyepiece skeleton easily. The outer tube and eyepiece box sealing rubber gasket (8) remain intact on the alignment support section of the eyepiece box (11).

25. Insert and secure the eight lockscrews (31, Figure 4L28). These lockscrews are inserted with the counterweight (25) at its extreme upward position. The lockscrews are inserted in clearance holes in the eyepiece skeleton (42) large shoulder flange and screwed into tapped holes in the upper face of the eyepiece box (11, Figure 4-29). The two lockscrews with longer heads should be located directly opposite each other.

26. Check the inner and outer surfaces of the eyepiece lens (52, Figure 4-28) and the front face of the eyepiece prism (51) for cleanliness. Replace the eyepiece eyepiece drive actuating shaft (12) and the corresponding reference mark on the female coupling section (3) for proper alignment.

30. Follow the procedure stated in Section 4V2, Steps 22 to 30 inclusive, for the replacement of the eyepiece drive packing gland assembly and the focusing knob assembly.

31. Reassembly of the stadimeter transmission shaft packing gland assembly (modified hycar type) is as follows: Place the gland filler piece (3, Figure 4-31) over the shaft, placing the chamfered side upward.

32. The hycar packing spacers (4) are soaked in Lubriplate No. 210 for one week. Before assembly all Lubriplate is willed off, and Glydag is applied to the shaft and hycar packing spacers. Place each of the hycar packing spacers (4) on the shaft, separating packing spacers from each other with a brass spacer washer (5), finishing with the insertion of the retainer brass washer (6).

33. Place the packing retainer (2) on the shaft and engage it in the internal threads of the stuffing box section.

34. Use a special wrench with the projecting pins inserted in the four holes in the face of the packing retainer (2). Screw the packing retainer upward, compressing the hycar packing spacers, and continue compressing the packing spacers until the face of the packing retainer is flush with the lower face of the eyepiece box (11, Figure 4-29).

lens mount (19) in the internal threads in the eyepiece prism front retaining plate (24). Screw the mount in until the shoulder of the mount is a metal-to-metal fit contact with the shoulder of the retaining plate.

35. Insert the lockscrew (1) in the tapped hole in the slotted section of the packing retainer (2), screwing it tight.

36. Place the special wrench on the male tang section of the stadimeter transmission shaft (22, Figure 4-27) and rotate the shaft in alternate directions for one half hour, to work in the packing. This should eliminate the freezing of the shaft, as the hycar packing spacers take a permanent set because of compression.

37. Assemble the rayfilter dry packing gland assembly stuffing box body rubber gasket (9, Figure 4-32) to the recess seat in the front of the eyepiece box.

38. Check the reference marks on the rayfilter drive packing gland assembly female coupling section (2) with the corresponding reference mark of the male coupling section (40, Figure 4-28) of the eyepiece skeleton assembly for proper alignment. Check the stamped numeral of the rayfilter drive stuffing box body (4, Figure 4-32) to coincide with a similarly stamped numeral on the eyepiece box. It may be necessary to rotate the female coupling section (2) for both corresponding reference marks. Place the rayfilter drive packing gland assembly in the bored hole and on the rubber gasket in the rectangular recess seat in the holes and on the assembled rubber gaskets (10, Figure 4-36).

42. Rotate each training handle stuffing box body (5) until the stamped figures coincide with their mating figures on the eyepiece box (11, Figure 4-29).

43. Secure both packing gland assemblies with six lockscrews (1, Figure 4-36) each. These lockscrews are inserted in countersunk clearance holes in each stuffing box body and screwed into tapped holes in the counterbored section seats in the eyepiece box.

44. Using two pieces of special cord of 3-foot length doubled, secure one end of each piece of cord to the shifting wire spindles (1, Figure 4-28) of the power shifting side, and secure the other two loose ends to the spindles (1) of the prism shifting side. Take special care that the end of one cord is secured to the left spindle of the power shifting side, while the other end is secured to the right spindle (1) of the prism shifting side. The second piece of cord is secured in like manner to permit one, man to hold one set of shifting wire spindles (1) with one hand, while the other set of spindles (1) is held with the other hand, using the looped cords.

eyepiece box. Remove the rayfilter drive actuating gear (11) if necessary, from the square section of the rayfilter drive actuating shaft (10) for the application of a pair of parallel pliers to juggle the female coupling section (2) for proper engagement.

39. Secure the rayfilter drive packing gland assembly stuffing box body with four lockscrews (13). These lockscrews are inserted in countersunk clearance holes in the stuffing box and screwed into tapped holes in the square recess seat in the eyepiece box (11, Figure 4-29).

40. Assemble the left and right training handle packing gland assembly rubber gaskets (10, Figure 4-36) to opposite sides of the eyepiece box.

41. Check the left and right training handle packing gland assemblies for their proper sides of the eyepiece box. Check the reference marks on each female coupling section of (3) one by one, and properly engage them in their respective male coupling sections in the training handle rack gears and shafts (39, Figure 4-28) simultaneously carrying the assemblies in the bored Figure 4-2 and Section 4C1, Step 4, show the attachment of the special chord used.

45. By means of a special adjusting nut removal adapter (refer to Section 4C1, Step 5, and Figure 4-3), remove the lower four shifting wire spindle adjusting nuts (4, Figure 4-28). Slide the adapter short stem section axis hole over the protruding phosphor-bronze wire of the shifting wire tape (38) up to the shifting wire adjusting nuts (4). Each lower adjusting nut, when removed from the shifting wire spindle (1), is turned on the short threaded stem section of the adapter. This permits each adjusting nut (4) to be lifted out through the side plate (9, Figure 4-29) opening of the eyepiece box (11).

46. Carry the skeleton head assembly (Figure 4-17) with the shifting wire tapes (38, Figure 4-28) clear of the ninth reduced tube section (1, Figure 4-18). This carries the shifting wire spindles free of the prism tilt and change of power mechanism in the eyepiece skeleton assembly (Figure 4-28).

47. Remove the shifting wire tapes (38) from the clamp blocks (16, Figure. 4-17), removing and replacing the clamp blocks (16) and clamp block lockscrews (12) to the prism and power shifting

6. Assemble the special hinged clamp over the upper part of the fifth inner tube section (34, Figure 4-14) and attach a shackle to the hinged clamp projection clearance hole.

racks (40, 42, 17, and 18) of the skeleton head assembly.

48. As each set of shifting wire tapes (38, Figure 4-28) is removed, it is immediately attached to the 1-inch metal dowel (Figure 4-5).

49. After the tapes are tightened to the 1-inch metal dowel, and pulled down into contact with the ninth reduced tube section (1, Figure 4-18) by means of the looped cords, the spindles (1, Figure 4-28) are pulled downward and outward. Secure the looped cords temporarily around the eyepiece box until the assembly of the inner tube sections into the outer tube.

4V17. Cleaning of the outer tube and taper section and reassembly of the inner tube sections in the outer tube. This procedure is performed in the following manner:

1. After flooding the outer tube (2, Figure 4-15) should be cleaned with the use of circular brushes and turkish toweling, to remove salt deposits, and should be blown out with filtered air.

2. Rotate the inner tube sections in the V-blocks, placing the eyepiece end facing downward.

3. Place the special lifting plate (Figure 4-9) at the base of the eyepiece box; insert the four special bolts in the clearance holes in this late and screw them into tapped holes in the eyepiece box base securing the lifting plate.

4. Assemble the special hinged clamp (Figure 4-12) over the

7. Place the hook of one chain hoist in the shackle, and take up any slack in the chain (Figure 4-14). Place the hook of the second chain hoist in the center pad clearance hole. in the spreader bar and take up the slack in the chain (Figure 4-11).

8. Lift the inner tube sections with both chain hoists evenly, and transport the inner tube sections to rest on V-blocks of the second I-beam bench or wooden blocks located on the deck. Remove the hooks of both chain hoists.

9. Using two canvas covered slings of 6-foot length wrap each around the outer tube once and engage the hook of each chain hoist in the end of the sling thimbles of each sling. Lift the outer tube with both chain hoists evenly and transport it to rest in the V-blocks of the optical I-beam bench. Apply grease to the faces of all V-blocks before resting the outer tube in them. Remove the chain hoist hooks and slings.

10. The outer tube is located in the V-blocks in such a position that adequate clearance is provided for the assembly of the inner tube sections.

11. Rotate the outer tube with two strap wrenches so that the keyway located in the lower end of the counterbore is centered downward.

12. Place the outer tube alignment guide (Figure 4-7) on the outer tube over the undercut section with the projecting arm downward. Secure it with a socket wrench, so that the reference line of the guide is lined up with the rear vertical azimuth line of the

coupling sleeve (34, Figure 4-23) covering the objective operating mechanism.

5. Connect a lifting spreader bar (Figure 4-13) to the hinged clamp projection opening; this projection slides between the center separations in the upper end of the spreader bar and a bolt is placed through the clearance holes of the above projection and spreader bar. The lifting plate projection slides into the center opening of the lower end of the spreader bar, and is held in similar manner.

outer tube. On the repair tender, the outer tube alignment guide is not removed from the outer tube upon removing the inner tube sections, and therefore, the proper entry of the radial alignment key of the eyepiece box in the outer tube keyway is reestablished.

13. Place the eyepiece box alignment guide over the two side flat sections of the eyepiece box, resting it on the flat front section of the eyepiece box. Assemble the radius clamp over the rear periphery of the eyepiece box, and insert

the two wing bolts in the tapped holes in the two projections of the alignment guide. The projecting arm extends outward from the left side of the eyepiece box.

14. Place the main coupling (2, Figure 4-29) on the lower end of the outer tube, screwing it on the threaded periphery a full turn.

15. Place the hook of one chain hoist in the shackle of the special hinged clamp attached to the fifth inner tube section (34, Figure 4-14) and the hook of the second chain hoist in the center pad clearance hole in the spreader bar (Figure 4-11).

16. Lift the inner tube sections evenly with both chain hoists and transport them to the lower end of the outer tube. Check the inner tube sections to ascertain that they are parallel and properly centered for entry in the outer tube.

until the projecting arms of the eyepiece box and outer tube alignment guides overlap each, other (Figure 4-8). The projecting arms should be held in contact for the proper entry of the radial alignment key (1, Figure 4-29) of the eyepiece box in the outer tube keyway (2, Figure 4-15).

23. Resume slowly the inward pushing movement of the remaining part of the inner tube sections in the outer tube until the threaded periphery of the eyepiece box is 1/8 inch from the main coupling (2, Figure 4-29). At this point, unscrew the main coupling and slide it over the alignment support section of the eyepiece box against the threaded periphery. Continue the inward pushing movement until the main coupling can be turned clockwise to engage the eyepiece box threaded periphery and the outer tube threaded periphery simultaneously.

17. Have one repairman hold the looped cords (Figure 4-2) carrying the 1-inch metal dowel in contact with the ninth reduced tube section during the entire assembly of the inner tube sections.

18. The reduced and inner tube sections are slowly pushed in the outer tube, guiding them parallel and properly centered.

19. When the fifth inner tube section contacts the main coupling (2, Figure 4-29) remove the chain hoisthook and hinged clamp.

20. Resume slowly the inward pushing movement of the remaining inner tube sections until the hinged clamp, secured/to the coupling sleeve (34, Figures 4-23 and 4-12), almost touches the edge, of the main coupling (2, Figure 4-29). Place an adjustable roller stand under the eyepiece box, adjusting it until the rollers touch the, eyepiece box (Figure 4-11). Release the load of the chain hoist to the roller stand.

21. Remove the spreader bar and hinged clamp, and attach a shackle to the lifting plate. Insert the chain hoist hook in the shackle (Figure 4-10) and remove the strain of the overhanging part of the inner tube sections from the roller stand.

22. Resume slowly the inward pushing movement of the remaining part of the inner tube

24. Use a spanner wrench and insert the tooth prongs in the twin wrench holes in the main coupling. Before turning the main coupling, scribe light vertical reference lines in the centerlines of the lockscrew holes on the coupling and make similar reference lines on the outer tube using the centerlines of the spotted recesses in the outer tube threaded periphery. Thus a reference line is established to enable the repairman to obtain a visual determination when the main coupling reference line and the outer tube reference line are in coincidence for proper insertion of the two lockscrews (7).

25. Screw the main coupling clockwise compressing the rubber gasket (8) between the lower face of the outer tube and the shoulder face preceding the threaded periphery of the eyepiece box. Place a pipe extension on the spanner wrench handle, to compress the sealing gasket further, following the procedure stated in Step 23.

26. When the lockscrew holes of the main coupling (2) and the spotted recesses in the outer tube periphery are aligned, insert the two lockscrews (7) securing the main coupling. The lockscrews when secured should not project beyond the periphery of the main coupling (2).

27. Remove the chain hoist hook, shackle, and lifting plate, unscrewing the four special bolts from the base of the eyepiece box. Remove the lifting plate.

28. Remove the four lockscrews (10, Figure 4-39) removing the focusing knob assembly.

29. Remove the eyepiece box and outer tube alignment guides.

4V18. Reassembly of the skeleton head assembly in the outer taper section. This procedure is performed in the following manner:

1. Carry the 1-inch metal dowel (Figure 4-6) with the shifting wire tapes (38, Figure 4-28) clear of the outer taper section a distance sufficient to allow the shifting wire tapes to be disconnected from the metal dowel and assembled to the prism tilt and change of power shifting racks of the skeleton head assembly. A shaft of nominal diameter and sufficient length for reaching the metal dowel is provided. The handle section of the shaft is knurled at one end to provide a firm grip, while the opposite end has a threaded periphery. The threaded periphery screws in the tapped axis hole in the metal dowel, thereby providing an extension to reach the metal dowel and serving to pull it out of the taper section with the shifting wire tapes (38).

2. Remove the two lockscrews (12, Figure 4-17), removing the clamp blocks (16) from the cube shifting racks (17 and 18). Disconnect each shifting wire tape in turn from the metal dowel and insert it through the lower bored section of the skeleton head and attach it to the lower clamping section of (1, Figure 4-15) for proper engagement in the keyway.

5. The tapped holes in the outer taper flange serve as peep holes while observing for the corresponding tapped holes in each side of the skeleton head assembly (Figure 4-17). When the tapped holes in the skeleton head come into alignment, the skeleton head is resting against its seat in the outer taper section counterbore.

6. Insert the two lockscrews (481 in the outer taper section flange tapped holes and the cube bracket (45) on the right side, while the other two lockscrews (48) on the left side enter into tapped holes in the outer taper section flange in similar manner but screw into tapped holes of the gear train bracket (30).

7. Disengage each end of the looped cords one by one, placing the shifting wire spindle assemblies in their respective hub sections of the prism and power shifting racks (43, 44, 45, and 46, Figure 4-28). Assemble each shifting wire spindle adjusting nut (4) on the short threaded stem of the spindle adjusting nut adapter one by one, and insert the wrench with the adjusting nut in the rectangular openings of opposite sides of the eyepiece box. Slide the axis clearance hole of the spindle adapter short threaded section on the protruding shifting wire tape phosphor bronze wire extensions and turn each of the four lower shifting wire spindle adjusting nuts (4) on the lower threaded periphery of their respective shifting wire spindles (1).

the right cube shifting rack (17). Lineup the holes in the shifting wire tape and the clamp block (16) securing them with two lockscrews (12). Follow the same procedure for the left cube shifting rack (18) and secure the shifting wire tape in similar manner.

3. The shifting wire tape (38, Figure 4-28) is attached to the head prism shifting racks (40 and 42) in similar manner to the procedure outlined in Step 2. Refer to Figure 4-4.

4. The repairman at the eyepiece end holding the looped cords now pulls the shifting wire tapes taut as the skeleton head is slowly carried in the counterbore simultaneously with the pulling of the tapes. Check the angular alignment key (19, Figure 4-17) as the skeleton head enters the counterbore of the outer taper section

8. Judgment of the tape tension is detected by the spring back of the adjusting nuts (4) when a light tension is applied. This requires extensive practice, as a staggered movement or jumping of the head prism is observed when the tapes are too tight. This condition can be observed with the prism tilt mechanism shifting wire tapes (38) with the periscope in the vertical position more readily, since adjustments made in the horizontal position do not have the same reaction when the periscope is in the vertical position.

9. The upper four shifting wire spindle adjusting nuts (4) are run down by hand flush with the upper hub section faces of the prism and power shifting racks (43, 44, 45 and 46 temporarily).

4V19. Reassembly of the hoisting yoke to the outer tube. The hoisting yoke is reassembled to the outer tube in the following manner:

1. Place the cover ring (2, Figure 7-26) on the undercut groove of the outer tube with the threaded periphery facing downward.

2. Place both halves of the split ring (3) in the undercut groove of the outer tube with the undercut shoulder section facing downward. Tap the split ring halves in place in the groove with a small rawhide maul.

bearing race (8), and locating collar (9) on upward over the eyepiece box (11, Figure 4-29) main coupling (2), and outer tube in contact with the upper ball bearing race (6, Figure 7-26).

8. Screw the cover ring (2) counterclockwise until a click is heard, then screw it clockwise into the internal threaded section in the hoisting yoke body (1), using the spanner wrench provided by the manufacturer. Screw it tight and then back it off sufficiently to align the lockscrew holes properly.

9. Insert and secure the two lockscrews (4) located directly

3. Place the upper ball bearing race (6) over the eyepiece box and tap the counterbored section on the undercut shoulder of the assembled split ring halves (3) with a rawhide maul against the flange of the split ring halves.

4. Place the locating collar (9) in the small counterbored section seat in the hoisting yoke body (1) with the concave radius seat facing upward.

5. Place the lower ball bearing race (8) in the hoisting yoke body (1), resting its convex radius seat in the concave radius seat in the locating collar (9).

6. Place the ball bearings and retainer (7) in the hoisting yoke body, resting them in the ball bearing recess groove in the lower ball bearing race (8).

7. Carry the hoisting yoke body (1) with the ball bearings and retainer (7), lower ball opposite in the cover ring (2). These lockscrews are inserted in countersunk clearance holes in the cover ring (2) and screwed into tapped holes in the hoisting yoke body (1).

10. Using an Alemite gun, fill the hoisting yoke with mineral grease Grade II. Soft water pump grease should be added occasionally, chiefly to protect the internal parts against entrance of water.

11. Whenever a submarine has undergone extensive depth charging or corrosion has attached the ball bearings of the hoisting yoke thrust bearing, the ball bearing races (6 and 8) should be inspected, and the ball bearing grooves reground, should there be any pitting or depressions detected: This necessitates the relocation of the tapped lockscrew holes in the hoisting yoke body face (1). When the ball bearings become rusted or pitted a new set of ball bearings should be installed.

W. FINAL COLLIMATION AND CHECKS

4W1. Checking and orientation of head prism travel. The checking of the periscope and the orientation of the head prism are accomplished in the following manner:

1. Check the height of the Sperry-Kollmorgen collimator by using the boresight and grooved crossline disks having, a diameter of 7.497 inches for the outer tube axis. Refer to the procedure described under Section 4V10 for the setting of the azimuth disk plate (6, Figure of the collimator base plate (7) into coincidence with the 0 degree numeral graduation of the azimuth disk plate (6), Secure the wedge lock (10) with the wedge lock bolt (11).

3. Remove all spacers from the V-block faces, and transport the periscope to rest in the V-blocks with the eyepiece lens facing upward, vertically. Locate the periscope in the V-blocks until the head prism is spotted centrally over the collimator axis. By eye sight, place the head prism face of

4-69) to 90 degrees. Secure the wedge lock (10) with the wedge lock bolt (11).

2. Loosen the wedge lock bolt (11) and wedge lock (10) sufficiently to swing the index line

the skeleton head assembly parallel to the edge of the skeleton head frame.

4. Unscrew the eyepiece lens mount (19, Figure 4-28), carrying with it the eyepiece lens

(52), eyepiece lens clamp ring (16), and its lockscrew (41).

5. Place the threaded periphery of the eyepiece alignment jig (Figure 4-50) in the threaded bore of the eyepiece prism front retaining plate (24, Figure 4-28) of the eyepiece skeleton assembly. Screw the jig into this front retaining plate until the shoulder of the jig attains a tight metal-to-metal contact with the projecting cylindrical shoulder of this retaining plate.

6. Follow the procedure of Section 4V4, Steps 5 to 8 inclusive, for the alignment of the eyepiece end. Rotate the periscope as necessary to follow this procedure.

7. Remove the eyepiece alignment jig (Figure 4-50) and replace the assembled eyepiece lens mount (19, Figure 4-28) by screwing it into the eyepiece prism front retaining plate (24). Check the inner and outer surfaces of the eyepiece lens (52) and the front face of the eyepiece prism (51) for cleanliness before replacement.

8. Replace the focusing knob assembly to the eyepiece box. Align the corresponding reference marks of the female

12. Reassemble the left and right training handle assemblies to their respective sides of the eyepiece box. Check reference marks of the connecting couplings for proper alignment. Secure both training handle assemblies with four hinge bracket bolts each (19 and 21, Figures 4-43 and 4-44 respectively).

13. Check the movement of the right training handle assembly as described in Section 4T7, Steps 24 to 27 inclusive. When no positive engagement is apparent, check as described in Section 4W2, Steps 4, 5, and 6.

14. Check the movement of the left training handle assembly. The correct tension of the prism tilt shifting wire tapes can be noted after the revolving grip as been rotated the necessary 3/32 inch. The head prism should elevate or depress at opposite positions of the 3/32-inch lost motion allowance of the index ring (6, Figure 4-43). If the observations indicate incorrect indexing, adjust the shifting wire spindle adjusting nuts (4, Figure 4-28) of the eyepiece skeleton assembly to enable the head prism to be oriented correctly.

15. Loosen the wedge lock bolt (11, Figure 4-69) and the wedge

coupling section (3, Figure 4-39) and the eyepiece drive actuating shaft (12, Figure 4-35) of the eyepiece drive packing gland assembly. Secure the knob bracket (7, Figure 4-39) after proper engagement of dowel pins (8) with four lockscrews (10).

9. Check the instrument; it should be in the observing position. Check the stadimeter dials; they should be locked at infinity, or single image position.

10. Reassemble the stadimeter housing assembly to the base of the eyepiece box. Check the entrance of the female tang coupling (68, Figure 4-24) to ascertain that it engages on the male tang section of the stadimeter transmission shaft (22, Figure 4-27). Insert the four housing bolts (30, Figure 4-24) in clearance holes in the stadimeter housing (67), screwing the bolts into tapped holes in the eyepiece box base (11, Figure 4-29) and securing them snugly.

11. Check the stadimeter dials to the range graduations of the Kollmorgen universal collimator reticle, to determine that they have been collimated correctly.

lock (10). Elevate the head

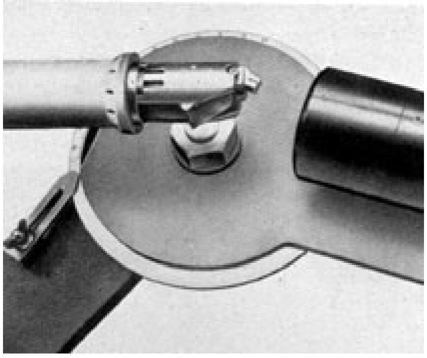


Figure 4-89. Head prism and collimator set at 74.5 degrees elevation.

prism and Sperry-Kollmorgen collimator to 74.5 degrees elevation, and secure the wedge lock (10) with the wedge lock bolt (11). The repairman at the eyepiece end of the periscope should now check the centerline of sight in high power magnification.

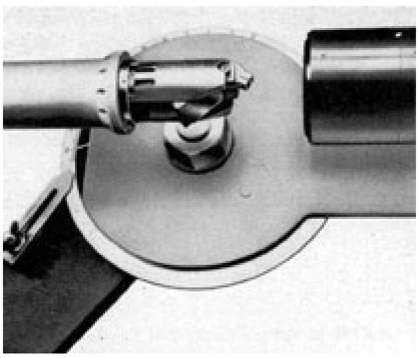


Figure 4-90. Head prism set at 74,5 degrees elevation in low

the wedge lock bolt (11). Rotate the revolving grip (3, Figure 4-44) of the right training handle assembly. This changes the instrument from low-power to high-power magnification. The observer at the eyepiece end of the periscope should check the centerline of sight in this position

power and collimator set at 90 degrees elevation.

16. Loosen the wedge lock bolt (11, Figure 4-69) and the wedge lock (10). Elevate the Sperry-Kollmorgen collimator to 90 degrees and secure the wedge lock (10) with the wedge lock bolt (11). Rotate the revolving grip (3, Figure 4-44) of the right training handle assembly. This changes the instrument from high power to low power magnification. The upper edge of the low-power field should overlap the horizontal crossline of the collimator reticle for 30' of arc, with the centerline of sight held at 74.5 degrees elevation.

17. Loosen the wedge lock bolt (11, Figure 4-69) and the wedge lock (10) sufficiently to swing the Sperry-Kollmorgen collimator to 10 degrees depression, and secure the wedge lock (10) with

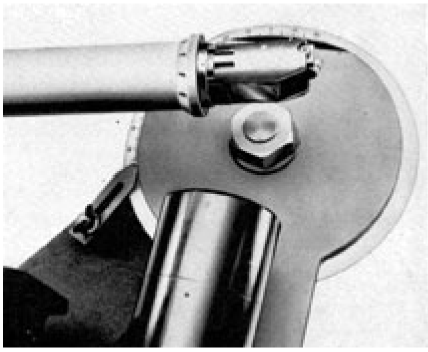


Figure 4-91. Head prism and collimator set at 10 degrees depression.

by depressing the head prism to full depression.

18. The telemeter lens line is now checked with the Sperry-Kollmorgen collimator reticle vertical crossline. Loosen the wedge lock bolt (11, Figure 4-69) and wedge lock (10) sufficiently to carry the collimator through 20 degrees with the head prism simultaneously from 10 degrees depression to 10 degrees elevation. The telemeter lens line should be carried within 10' of arc through an azimuth of 20 degrees. This is checked by observing the telemeter lens line in its relation to the collimator reticle vertical crossline while traveling in azimuth, and also observing the centerline of sight at 10 degrees elevation and 10 degrees depression.

19. Swing the index line of the collimator base plate (7) into coincidence with the 0 degree numeral graduation of the azimuth disk plate (6).

4W2. Final collimation of the Galilean telescope system to the high-power system. This operation is performed in the following manner:

1. Follow the procedure described under Section 4V15, Steps 1 to 8 inclusive.

2. The horizontal displacement of the collimator reticle crossline image of low power is collimated to superimpose with the telemeter lens line of the high power system to within a tolerance of 2' of arc.

3. The vertical displacement of the centerline of sight of low power is collimated to superimpose with

the telemeter lens centerline of sight of the high-power system to within a tolerance of 30' of arc.

4. After a periscope has been used extensively, the V-groves on the side face of the Galilean eyepiece lens and the objective lens cubes may become worn. The hardened pawls, working in the V-grooves, cause the edges of the V-groves to become worn or rounded. This excessive wear causes a decided displacement in vertical collimation which results in a vertical

displacement of a horizontal target as well as a pronounced general aberration.

5. Replacing the Galilean eyepiece lens and objective lens cubes, and making minor adjustments to the pawl holders can compensate for worn cubes.

6. The pawl holders (8, Figure 4-17) in the skeleton head assembly have lockscrew clearance holes which have a small amount of clearance and should be checked, if decided displacement or general aberration is observed. Refer to Section 4F3, Step 25, for the checking procedure.

4W3. Collimation of the low power system free of parallax on the Kollmorgen distance function at atmospheric pressure. This operation is performed in the following manner:

1. Release the lock ring (51, Figure 4-69) and turn the reticle

Figure 4-92. Collimator reticle, lens set at 35-foot target distance.

5. Secure the Galilean eyepiece lens mount (3) with the lockscrew (14).

4W4. Checking periscope in tower. Adjustments to eliminate creep and staggered movement. The periscope is transported and checked in the tower in the following manner:

1. Replace the eyepiece window frame rubber gasket (8, Figure 4-38) in the large counterbored section seat in the front part of the eyepiece box. Replace the eyepiece window assembly on the rubber gasket and secure it temporarily with four long lockscrews (3).

lens mount actuating sleeve (53) clockwise 26 complete turns and 7 graduations, as indicated by the micrometer 0 degree graduation of the actuating sleeve (53) and the micrometer vernier arm (57). Secure the lock ring (51) snugly against the reticle lens mount end bushing (52). This places the reticle lens (60) and mount (42) at the 35-foot distance target position.

2. Rotate the revolving grip (3, Figure 4-44) of the right training handle assembly. This changes the instrument from high- to low-power, magnification.

3. Place the auxiliary telescope at the eyepiece of the periscope. Set the diopter reading of the auxiliary telescope at infinity for the observer. Loosen the lockscrew (14, Figure 4-17) and move the Galilean eyepiece lens mount (3) in the housing (4) internal threads. Screw it outward until the image of the collimator reticle is apparent on the telemeter lens. The Galilean eyepiece lens mount (3) focuses the Galilean eyepiece lens (56) on the collimator reticle.

4. At the above setting, the auxiliary telescope is focused from plus diopter to the observer's diopter reading, to ascertain that the telemeter lens and the collimator reticle are in sharp definition. At this reading, no parallax should be apparent on the telemeter lens.

2. Rotate the revolving grip (2, Figure 4-43) of the left training handle assembly, placing the head prism at zero line of sight.

3. Replace the outer head seat rubber gasket (5, Figure 4-1) and the outer head (2) to the outer taper section flange (Figure 4-15). Secure it temporarily with six lockscrews (1, Figure 4-1). Place the brass protection housing on the outer head.

4. Secure a suitable hoisting clamp around the outer tube at least 12 inches below the joint between the outer tube and outer taper section (Figure 2-34). Line the clamp with emery cloth placed with its smooth side against the outer tube. Use special steel bolts and nuts for securing the clamp halves together.

5. Secure a safety clamp above the hoisting clamp as shown in Figure 2-34.

6. Lift the periscope with the two chain hoist hooks placed in the thimble ends of the canvas covered slings wrapped once around the outer tube.

7. Transport the periscope from the V-blocks to the tower

16. Disconnect the slot cables of the five tower platforms and swing

through the slot in the floor. Lower the periscope to a height of approximately 3 feet from the floor.

8. It is necessary to shift the load of the periscope with the two chain hoists and the pneumatic hoist for transfer to the tower hoist. Transfer the load of the periscope's upper end to the pneumatic hoist hook placed in the thimble ends of the canvas covered sling wrapped once around the outer tube. Transfer the forward chain hoist hook and sling to the lower end of the periscope, removing one chain hoist clear of the periscope.

9. Lower the tower hoist hook with the spreader bar and slings, carrying the slings inward for attachment to the hoisting clamp projections with two shackles.

10. Attach the thimble ends of the hoisting slings with two shackles to the hoisting clamp projections.

11 Elevate the tower hoist and slings to a point where the load of the periscope is carried by the tower crane which carries the periscope forward to the tower.

12. Place a safety clamp around the outer tube approximately 6 inches above the hoisting yoke. Transfer the pneumatic hoist hook and sling to the lower end of the periscope. The sling is located around the outer tube between the hoisting yoke and the safety clamp. Remove the second chain hoist and sling, carrying it clear of the periscope.

13. Elevate the tower hoist. At the same time, lower the the four steady bearing hinge caps clear for the periscope entry in the center or outboard slots.

17. Transport the periscope into the slots of the five tower platforms and swing the four steady bearing hinge caps in place, securing each with their wing nut.

18. Slowly lower the periscope onto the hoisting yoke cable adjusting nuts. This places the load of the periscope on the hoisting yoke and cables suspended from the lower platform. Remove the two shackles and hoisting slings from the hoisting clamp. Remove the brass protection housing from the outer head, and remove the six lockscrews, removing the outer head and its seat gasket from the outer taper section flange.

19. Focus the instrument to zero setting of -3/4 diopter.

20. Observe the travel of the head prism. During elevation or depression of the head prism procedure an irregularity called creep occurs, when the movement of the left revolving grip ceases to rotate, at which point the weight of the head prism carries the image downward with it and vice versa. With the eccentric shaft bearings quite loose, this condition results, and a tolerance not to exceed 1 division of arc, or 15', in high power is allowed.

21. Barely enough Lubriplate No. 110 to cover the bearings is considered ample lubrication of the eccentric shaft bearings. An excessive amount of lubricant during cold weather results in a condition in which the prism tilt mechanism is inoperative. In a

pneumatic hoist cable this carries the lower part of the periscope through the slot in the floor to within several feet of the ground floor. The upper part of the periscope is slowly carried upward to a vertical position.

14. During the operation of the tower hoist, proceed carefully while handling the head end of the periscope as this part carries the fragile skeleton head. Damage to the outer taper section would require a major overhaul.

15. When the periscope assumes a vertical position, remove the pneumatic hoist hook and sling, and the safety clamp near the hoisting yoke.

warm climate, too much lubricant may cause it to flow on the optics.

22. A staggered, or stepped movement occurs when the eccentric shaft bearings are set too tight. This irregularity is noted when the head prism is not carried smoothly as the left revolving grip is rotated. A similar condition results when the shifting wire tapes are too tight.

23. Rotate the revolving grip of the right training handle assembly for change of power mechanism to low power magnification. Check the Galilean telescope system on a 35-foot target, and make any adjustments necessary.

24. Check the change of power mechanism from high to low power and vice versa. No matter how slowly the shift is made, there should be a positive engagement of this system.

25. If the necessary positive shifting action is not noticeable, there is a decided displacement in the vertical collimation which results in a vertical displacement of a horizontal target as well as a pronounced general aberration. The procedure stated in Steps 23, 24, and 25 is to be followed more closely after the introduction of nitrogen and observing through the periscope on an infinity target.

26. Check the instrument for cleanliness. Remove the eyepiece window assembly and four lockscrews (3, Figure 4-38) from of the stadimeter housing assembly, left and right training handle assemblies, focusing knob assembly, and hoisting yoke assembly.

32. Check all four shifting wire spindle adjusting nuts (4, Figure 4-28) through the rectangular side plate openings of the eyepiece box, securing them snugly against the hub sections of the prism and power shifting racks (43, 44, 45, and 46) of the eyepiece skeleton assembly.

33. Reassemble the side plate and pressure gage rubber gaskets (10, Figure 4-29) to opposite sides of the eyepiece box in the rectangular recess seats. Assemble the side plate (9) in the rectangular opening to the rubber gasket, securing the side plate with 10

its temporary securement. With the eyepiece prism and eyepiece lens focused to the extreme lower or plus position, remove any dirt on the upper surface of the eyepiece prism with a bent camel's-hair brush.

27. Clean off fingerprints and surface dust from the eyepiece lens with clean lens tissue. Use a camel's-hair brush to remove any surface dust.

28. Clean the inner surface of the eyepiece window in similar manner and blow off any surface dust with an air bulb. Replace the rubber gasket (8) in the counterbored seat in the eyepiece box. Reassemble the eyepiece window assembly into the counterbored section resting it on the rubber gasket. Secure the assembly with four short and eight long lockscrews (2 and 3). These lockscrews are inserted in countersunk clearance holes in the eyepiece window frame (7) and screwed into tapped holes in the counterbored seat in the eyepiece box.

29. The periscope is transported to the assembly floor in a slightly different manner. Attach the hoisting slings of the spreader bar to the hoisting clamp with the two shackles, and take up the slack in the slings with the tower hoist.

30. Raise the periscope with the tower hoist and remove the load of the periscope from the hoisting yoke, removing the two cable suspensions.

31. Follow the procedure outlined in Section 4C1, Steps 9, 10, 11, and 14, for the removal lockscrews (5) to the left side of the eyepiece box.

34. Reassemble the pressure gage assembly to the right side of the eyepiece box, securing it in similar manner to that outlined in Step 33.

35. Follow the procedure outlined in Steps 2 and 3 of this section for the replacement of the outer head to the outer taper section, and the assembly of the brass protection housing.

36. Release the wing nuts of the four steady bearings and swing the hinge caps free for the removal of the periscope from the tower platform slots. Transport the periscope vertically to line up parallel with the slot in the assembly floor, and engage the five platform cables across each of the five slots.

37. Operate the tower hoist, carrying it to the rear wall of the tower, lowering the periscope in the open clamp cap and clearance wall of the hinge carriage to within 4 inches of the deck. Line the clamp cap and clamp section of the hinge carriage with emery cloth placed with its smooth side against the outer tube. Secure the clamp cap and clamp section of the hinge carriage to the outer tube with two special bolts and nuts over the emery cloth. Insert the toggle bolt in the lined up holes of the supporting arm and clearance wall periphery projection after the clamp cap is secured (Figures 2-39 and 2-41).

38. Carry the lower end of the periscope and hinge carriage toward the slot, lowering the tower hoist cables and the upper

end of the periscope. When the upper end of the periscope

is lowered to a point for transfer to the assembly floor, engage the pneumatic hoist hook in the hinge carriage shackle and elevate the lower end of the periscope and clamp carriage to the assembly floor.

39. Transfer the load of the hinge carriage and lower end of the periscope to the chain hoist hook and sling, and transfer the pneumatic hoist hook placed in the thimble ends of the canvas covered sling wrapped once around the upper section of the outer tube.

40. Lower the tower hoist hook and spreader bar slings, carrying the periscope in the assembly room, transferring the load of the periscope upper end to the pneumatic hoist hook and sling.

41. Transfer the periscope lower end to the second chain hoist hook and sling, carrying the first chain hoist hook and sling to the upper end to disconnect the pneumatic hoist hook and sling.

42. Lower the periscope and hinge carriage to the assembly floor evenly, and remove the hinge carriage from the lower end of the periscope.

43. Raise the periscope evenly with both chain hoists and transport it in the V-blocks of the optical I-beam bench.

4W5. Reassembly of the outer head to the outer taper section. rubber gasket located in the seat of the outer taper section.

5. Center the outer head over the skeleton head assembly so that the head prism is in the centerline of the head window.

6. Insert the 12 outer head seat lockscrews (1, Figure 4-1) in the countersunk clearance holes in the lower part of the outer taper section flange. The lockscrews are screwed into tapped holes in the flange seat of the outer head.

7. Take up all lockscrews evenly to insure the hermetical seal of this joint. Place putty in the remaining part of each countersunk hole section in the outer taper section flange (1, Figure 4-15). The putty covers up the screw heads and prevents personnel unfamiliar with the instrument from breaking the hermetical seal of this joint of the periscope.

4W6. Pressure testing and cycling of the periscope. The periscope is pressure tested and cycled in the following manner:

1. Follow the procedure described in Section 2C3, and omit Steps 1 to 12 inclusive.

2. Step 25 in Section 2C3 is followed by transporting the periscope to the built-in water tank in the deck with two chain hoist hooks and slings, resting the periscope in two roller brackets. The periscope is rotated during this test, and returned to the V-

The outer head is reassembled to the outer taper section in the following manner:

1. Check the head prism, the Galilean eyepiece, and objective lenses for cleanliness. Clean all lenses and head prism surfaces with clean lens tissue. Remove surface dust with a camel's hair brush, or vacuum brush used with ether.

2. Using a special wrench inserted in the square section of the left training handle packing gland assembly actuating shaft, place the head prism at zero line of sight.

3. Place the outer head seat rubber gasket (5, Figure 4-1) on the shoulder of the outer taper section (1, Figure 4-15) and in the seat of the flange section.

4. Carefully assemble the outer head (2, Figure 4-1) over the projecting part of the skeleton head assembly (Figure 4-17) to the blocks of the optical I-beam bench after blowing off all water and wiping it dry.

3. Follow the procedure described under Section 2C5.

4. Follow the 15 safety precautions of Section 2C6.

4W7. Optical tests of the periscope in the tower. Optical tests of the periscope in the tower are made in the following manner:

1. Place the brass protection housing over the outer head.

2. Follow the procedure described under Section 4W4, Steps 29 to 43 inclusive, to transport the periscope to the tower and the reassembly of the hoisting yoke assembly, focusing knob assembly, right and left training handle assemblies, and the stadimeter housing assembly in the inverse order.

3. Check the zero reading of the diopter index ring. Place the auxiliary telescope at the eyepiece end of the periscope. Focus the eyepiece lens until sharp definition of the telemeter lens is apparent on an infinity target, or infinity collimator.

4. Check the high- and low-power systems on an infinity target or infinity collimator. No parallax should be apparent on the telemeter lens in either power.

7. Check the stadimeter dials on a special target of known height and distance or the collimator reticle set at infinity.

8. Check the operation of the left and right training handles, noting particularly their limit of travel stops by corresponding stationary reference index lines.

9. Check the field. It must be free of internal and external fogging.

10. Return the periscope to the assembly floor by following the

5. Check the periscope in high- and low-power for cleanliness. Particles of dust, if present, will show clearly on the telemeter lens which lies in the focal plane of the instrument.

6. Turn the handwheel clockwise to the limit of its travel, the course angle position, and turn it counterclockwise to the single image location of this position. Continue the counterclockwise rotation until it is returned to the observing position (single image or whole lens position). There should be no apparent indication of a double image.

procedure outlined in Section 4W4, Steps 29 to 43 inclusive.

11. Remove the hoisting clamp and safety clamp from the outer tube.

12. Reassemble the rayfilter plate (2, Figure 4-40), plate straps (3), and lockscrews (19) to the eyepiece window frame (7, Figure 4-38) by following Section 4Q3. Steps 2 to 4 inclusive.

13. Reassemble all external projections to the eyepiece box of Section 4C1, Steps 9 to 14 inclusive, in the inverse order.

Figures 4-16 and 4-47
TYPE II
DESIGN DESIGNATION 91-KA-40T/1.414-HA
INNER TUBE AND TELESCOPE SYSTEMS
OPTICAL ARRANGEMENT
RAY DIAGRAM

Sub Periscope Home Page

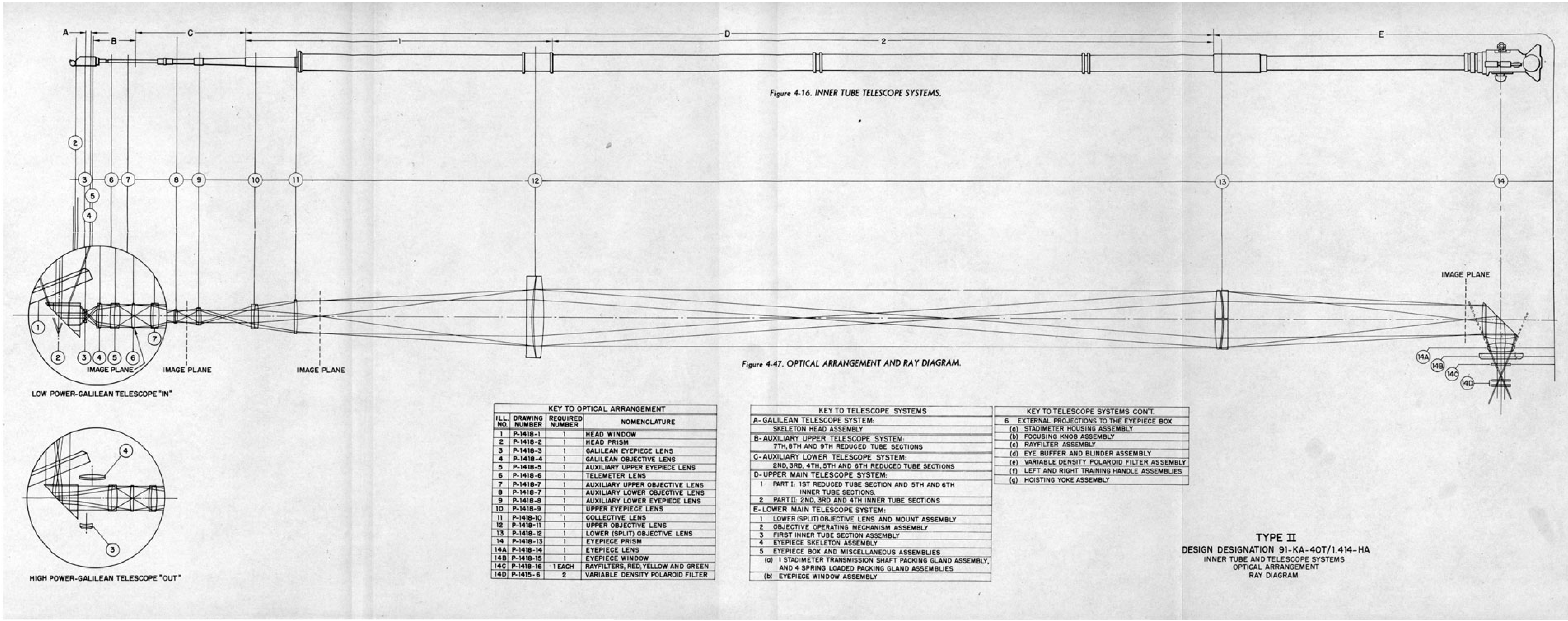


Figure 4-16. INNER TUBE TELESCOPE SYSTEMS.

Figure 4-47. OPTICAL ARRANGEMENT AND RAY DIAGRAM.

KEY TO OPTICAL ARRANGEMENT			
ILL. NO.	DRAWING NUMBER	REQUIRED NUMBER	NOMENCLATURE
1	P-1418-1	1	HEAD WINDOW
2	P-1418-2	1	HEAD PRISM
3	P-1418-3	1	GALILEAN EYEPIECE LENS
4	P-1418-4	1	GALILEAN OBJECTIVE LENS
5	P-1418-5	1	AUXILIARY UPPER EYEPIECE LENS
6	P-1418-6	1	TELEMETER LENS
7	P-1418-7	1	AUXILIARY UPPER OBJECTIVE LENS
8	P-1418-7	1	AUXILIARY LOWER OBJECTIVE LENS
9	P-1418-8	1	AUXILIARY LOWER EYEPIECE LENS
10	P-1418-9	1	UPPER EYEPIECE LENS
11	P-1418-10	1	COLLECTIVE LENS
12	P-1418-11	1	UPPER OBJECTIVE LENS
13	P-1418-12	1	LOWER (SPLIT) OBJECTIVE LENS
14	P-1418-13	1	EYEPIECE PRISM
14A	P-1418-14	1	EYEPIECE LENS
14B	P-1418-15	1	EYEPIECE WINDOW
14C	P-1418-16	1 EACH	RAYFILTERS, RED, YELLOW AND GREEN
14D	P-1415-6	2	VARIABLE DENSITY POLAROID FILTER

KEY TO TELESCOPE SYSTEMS
A- GALILEAN TELESCOPE SYSTEM:
SKELETON HEAD ASSEMBLY
B- AUXILIARY UPPER TELESCOPE SYSTEM:
7TH, 8TH AND 9TH REDUCED TUBE SECTIONS
C- AUXILIARY LOWER TELESCOPE SYSTEM:
2ND, 3RD, 4TH, 5TH AND 6TH REDUCED TUBE SECTIONS
D- UPPER MAIN TELESCOPE SYSTEM:
1 PART I: 1ST REDUCED TUBE SECTION AND 5TH AND 6TH INNER TUBE SECTIONS.
2 PART II: 2ND, 3RD AND 4TH INNER TUBE SECTIONS
E- LOWER MAIN TELESCOPE SYSTEM:
1 LOWER (SPLIT) OBJECTIVE LENS AND MOUNT ASSEMBLY
2 OBJECTIVE OPERATING MECHANISM ASSEMBLY
3 FIRST INNER TUBE SECTION ASSEMBLY
4 EYEPIECE SKELETON ASSEMBLY
5 EYEPIECE BOX AND MISCELLANEOUS ASSEMBLIES
(a) 1 STADIMETER TRANSMISSION SHAFT PACKING GLAND ASSEMBLY, AND 4 SPRING LOADED PACKING GLAND ASSEMBLIES
(b) EYEPIECE WINDOW ASSEMBLY

KEY TO TELESCOPE SYSTEMS CON'T.
6 EXTERNAL PROJECTIONS TO THE EYEPIECE BOX
(a) STADIMETER HOUSING ASSEMBLY
(b) FOCUSING KNOB ASSEMBLY
(c) RAYFILTER ASSEMBLY
(d) EYE BUFFER AND BLINDER ASSEMBLY
(e) VARIABLE DENSITY POLAROID FILTER ASSEMBLY
(f) LEFT AND RIGHT TRAINING HANDLE ASSEMBLIES
(g) HOISTING YOKE ASSEMBLY

TYPE II
DESIGN DESIGNATION 91-KA-40T/1.414-HA
INNER TUBE AND TELESCOPE SYSTEMS
OPTICAL ARRANGEMENT
RAY DIAGRAM

5
BORESIGHTING SUBMARINE TORPEDO TUBES

A. INTRODUCTION

5A1. Importance of boresighting. Torpedoes, compared to guns, are relatively inaccurate and there may be a tendency toward slipshod boresighting. At 4,000 yards, an error of 1 degrees in boresighting results in an error of 210 feet, about half the length of an average ship. Thus it can be seen that boresighting must be sufficiently accurate to prevent errors greater than 1/4 degrees, and even greater refinement is desirable.

In two-power periscopes, the line of sight usually is changed when low power is thrown in. Consequently, in both torpedo firing and boresighting the high power of the periscope should be used in which no movable lenses are in the line of sight.

B. BORESIGHTING PROCEDURE

5B1. Boresighting submarine torpedo tubes. When a periscope azimuth circle reads 0 degrees (or 180 degrees for the stern tubes), the line of sight through the periscope should be parallel to, or coincident with, the mean axis of the torpedo tubes. The object of boresighting is to determine whether this condition exists, and if it does not, to determine the relative alignment of the forward and after tube nests and the periscope with the azimuth circle.

Boresighting is done while the submarine is on the ways of a marine railway or in drydock, preferably on a cloudy day or at night with low wind velocity. Boresighting should not be done the unequal heating produces a slight curvature in the vessel's centerline. To create a condition of low wind velocity, it may be necessary to erect canvas shields, extending from the main deck to the ground on both sides of the bow and stern, to protect the outside plumb bob lines from the wind.

To establish the mean axis of each set of tube nests, two main targets must be erected for each nest of tubes. The usual arrangement consists of one set of targets inside and another set outside, fastened to the ship's structure. The outside targets must be as far away from the ends of the torpedo tubes as practicable (Figures 5-2 and 5-3). The two inside targets must be

with strong sun on one side of the vessel since

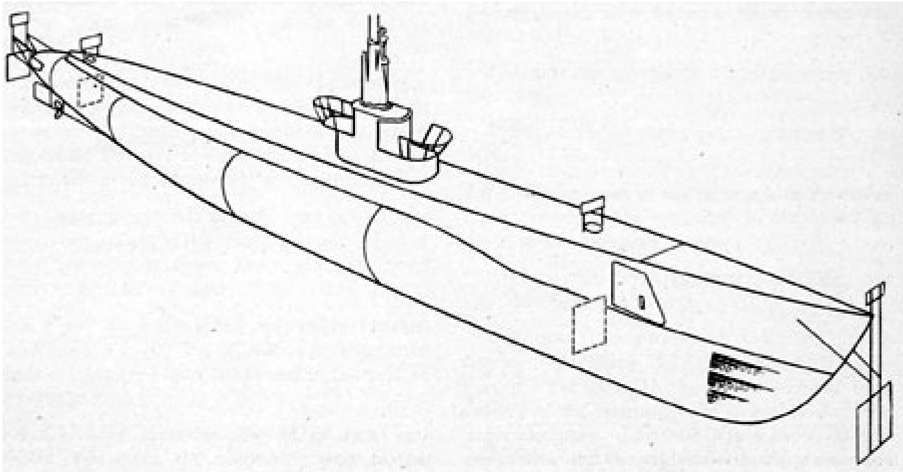


Figure 5-1. Construction of four main targets and four auxiliary targets in perspective.

located under the torpedo loading hatch openings (Figure 5-1), so that a plumb line can be dropped from topside to it. Small auxiliary targets on which to plumb up and sight, are located topside above the four main targets.

A set of boresight gages, which fits snugly into the tube bore at each end, is necessary. One boresight gage has a small peephole in its center axis (Figure 5-4) while the center axis of the other (Figure 5-5) is bored to receive a boresight gage bushing of a press fit. The bushing is threaded in the bore to receive the external threads of the boresight telescope (Figure 5-6).

5B2. Establishing the centerlines. The first operation is to establish the centerline of each tube on both inside and outside targets.

1. Starting with the outside target, set up the boresight gage with the small peephole

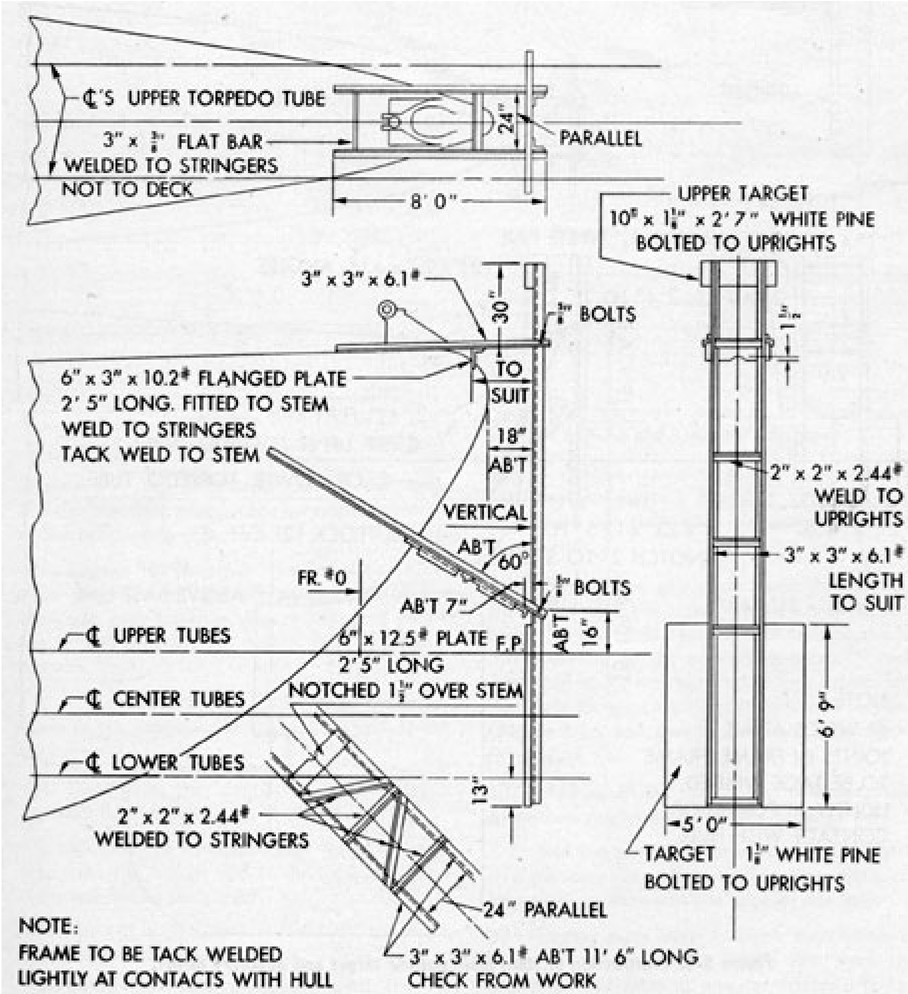


Figure 5-2. Construction of bow main outside target and auxiliary target.

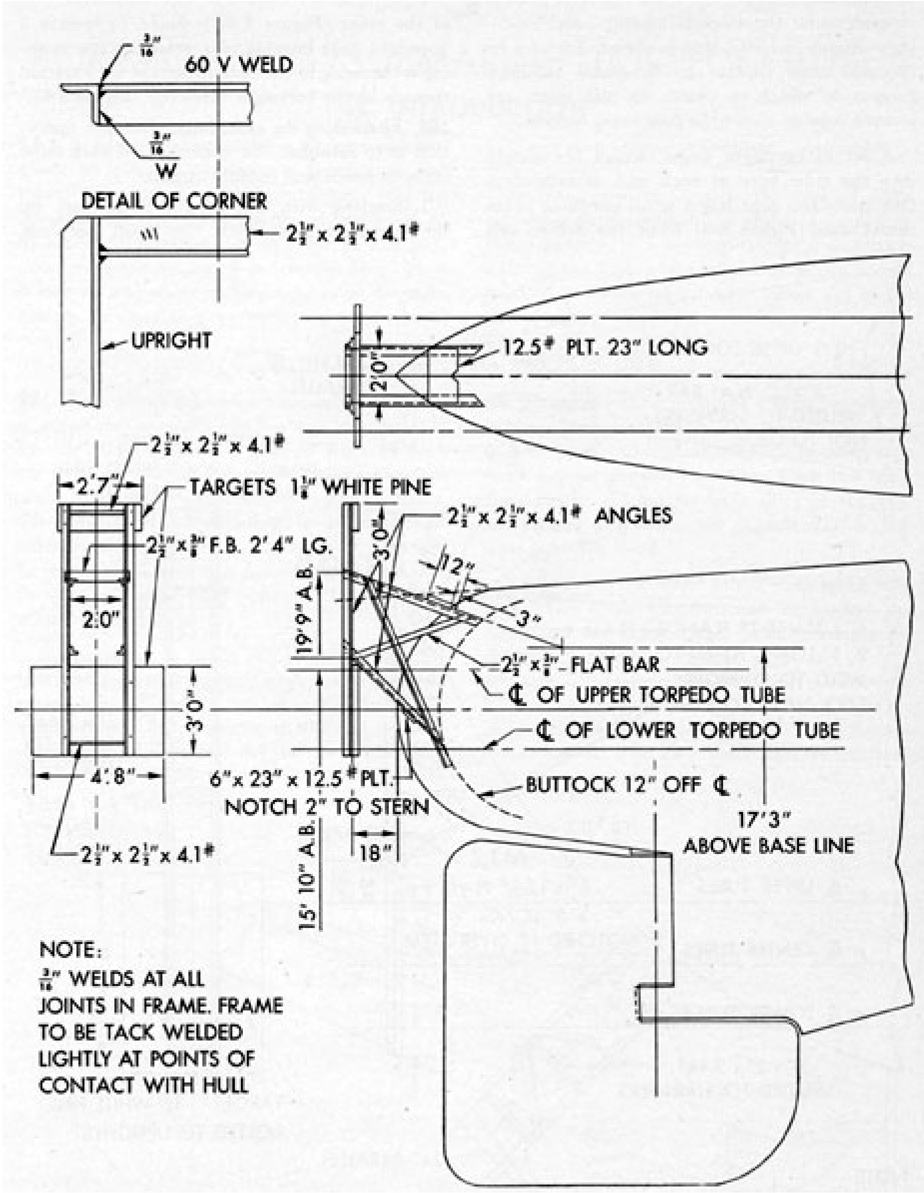


Figure 5-3. Construction of stern main outside target and auxiliary target.

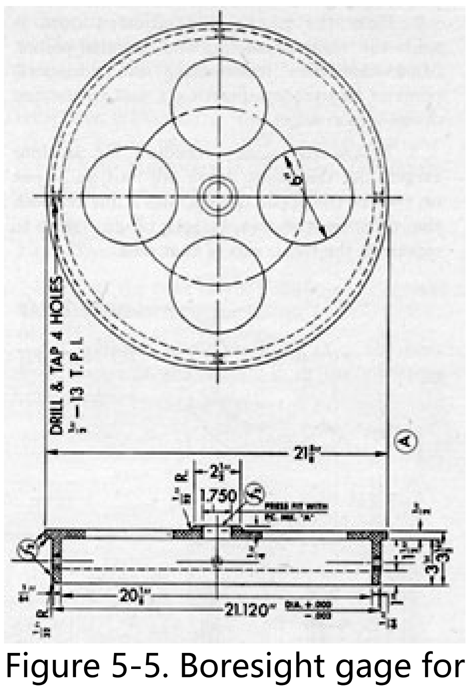


Figure 5-5. Boresight gage for

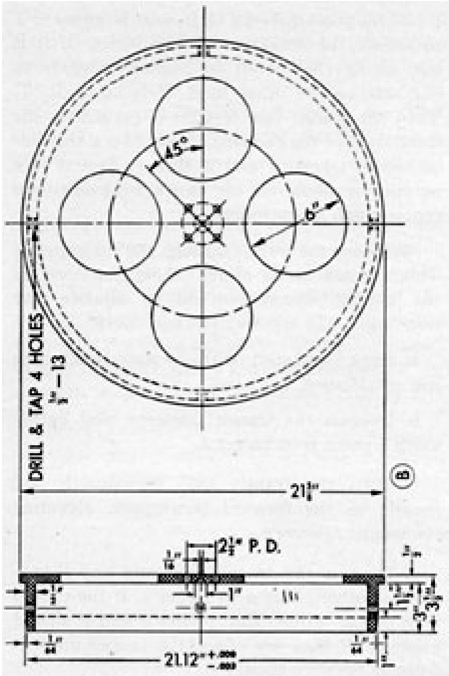


Figure 5-4. Boresight gage with peephole.

(Figure 5-4) at the muzzle end of the tube, and the boresight gage for the boresight telescope at the breech end (Figure 5-5).

2. Engage the external threads of the boresight telescope in the internal threads of the boresight gage bushing (Figure 5-6) and secure the boresight lock ring tightly with a spanner wrench.

3. Focus the telescope and adjust the crosswires to the peephole at the muzzle end of the tube.

4. Illuminate the peephole by holding a portable light or flashlight behind it.

5. Remove the boresight gage with the peephole from the muzzle end of the tube and focus the telescope on the target.

6. Have a helper mark the intersection of the crossline on the target.

7. Carry out this procedure with the remaining tubes of the nest.

boresight gage bushing and boresight telescope.

centers on the inside targets in like manner, with the boresighting telescope located in the muzzle of the tube and the peephole in the breech end.

8. Repeat the procedure used for the forward nest with the stern nest of tubes. At this point there are four targets, each bearing marks corresponding to the number of tubes in each nest; that is, for the current 310-foot submarine, there will be two targets with six marks forward (Figure 5-7), and two targets with four marks aft (Figure 5-8).

5B3. Marking off the targets. The next operation consists of marking off the individual targets.

1. Join the projected intersection points with straight lines as indicated. Measure distances on targets as shown in the appropriate figure.

5B4. Finding mean axes. 1. Upon completion of target marking, drop a plumb line from the plumb line adjustment adapter attached to the target to the lower target (Figure 5-9).

2. Have the plumb line adjusted until it splits the various bisecting and diagonal points. Mark this line, representing the horizontal point of impact, by inserting a nail in the top of the upper target.

3. Follow the same procedure for all four targets. At this point, there are four nails, one on each of the upper targets, and a line between the nails on the two targets of any nest to represent the mean axis of that nest.

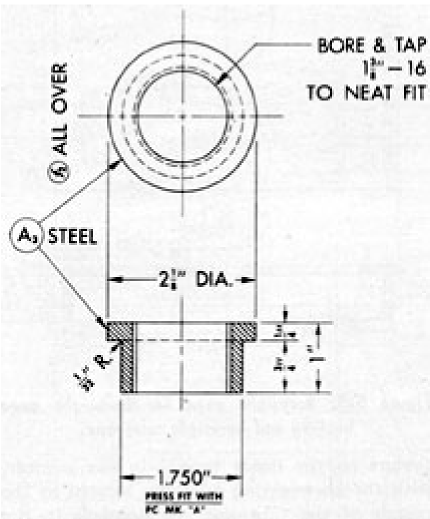


Figure 5-6. Boresight gage bushing for insertion in boresight gage Find attachment of boresight telescope.

5B5. Paralleling the mean axes. With the periscope removed from the submarine, provide a transit holding fixture on the periscope opening atop the periscope support. (See Figure 5-10 for construction of this fixture.) With the transit parallel to the mean axis of the forward nest of tubes, as represented-by a line through the nails referred

3. Measure distance U. It must be equal to T to satisfy the condition of parallelism. If it is not, swing the transit in azimuth slightly to one side or the other until U is equal to T. Then the transit line of sight is parallel to the mean axis of the forward tubes. Mark this line on top of targets 1 and 2, then project it to a permanent place on the ship's structure, and centerpunch a benchmark.

4. Swing the transit through 180 degrees in azimuth. This azimuth swing of 180 degrees should be done by the double reverse method to obviate any error which the transit itself may have.

a. Sight the transit on the forward benchmark just established.

b. Depress the transit telescope and lightly mark a point p on target 3.

c. Turn the transit 180 degrees in azimuth and resight on the forward benchmark, elevating the transit telescope.

d. Depress the transit telescope and lightly mark another point p on target 3. If the transit is in proper adjustment, points p and P should coincide. If they are apart, the proper mark is halfway between them.

e. Mark this point on target 3 and then project it aft to target 4. Continue the line to a permanent place on the hull and prick punch another benchmark. At this point there is, besides the nails already

to above, the paralleling is, done as follows:

1. Sight the transit on the nail established on target 2 (Figure 5-8) and project this point to target 1.

2. Measure the distance m. Then lay off distance T, which is equal to a/b X M. Mark this point and project it down to target 2.

mentioned above a mark on each upper target. A line through these marks represents a line parallel to the mean axis of the forward tubes. Two benchmarks on the hull represent the same line.

5. Measure the distance V and W. The tangent of the angular difference between the mean lines of the forward and stern tubes is ((W - V) / 12D), if W and V are measured in inches and D is measured in feet. This tangent represents the total angle of error, and if it is less than 0 degrees 5', it is considered negligible. If this error is greater, the officer in charge of boresighting should split the errors between the bow and stern nests and establish the permanent benchmarks accordingly. The required transverse distance in inches between the temporary and final forward benchmarks is equal to Re

(W - V), where e is the horizontal distance from the center of the periscope to the benchmark measured in feet, and R is the ratio of the final bow tube error to the total error. The permanent stern benchmark must be 180 degrees from the forward benchmark. If the error is less than 0 degrees 5', the benchmarks as established originally are considered permanent.

6. If periscope supports are not erected, the same operation may be performed by setting up a transit on the periscope support foundation. Set the transit in such position that the nails in temporary benchmarks at a convenient location and calculating the angle between the line of the forward and after tube nests. After the periscope supports are installed, it is necessary only to erect the transit atop the periscope supports on the periscope line and parallel the line between the temporary benchmarks. This operation may be performed as follows:

a. Set the transit on the fixture (Figure 5-10). This should be done on a rigid table.

b. Level the base of the fixture, using a level and shims; then level the transit plate.

targets 1 and 2 line up. This places the transit on the mean line of the forward tube nest. Project this line aft. Turn the transit 180 degrees in azimuth and proceed as before, placing the

c. Carry the whole assembly atop the periscope supports and install it in the periscope upper bearing.

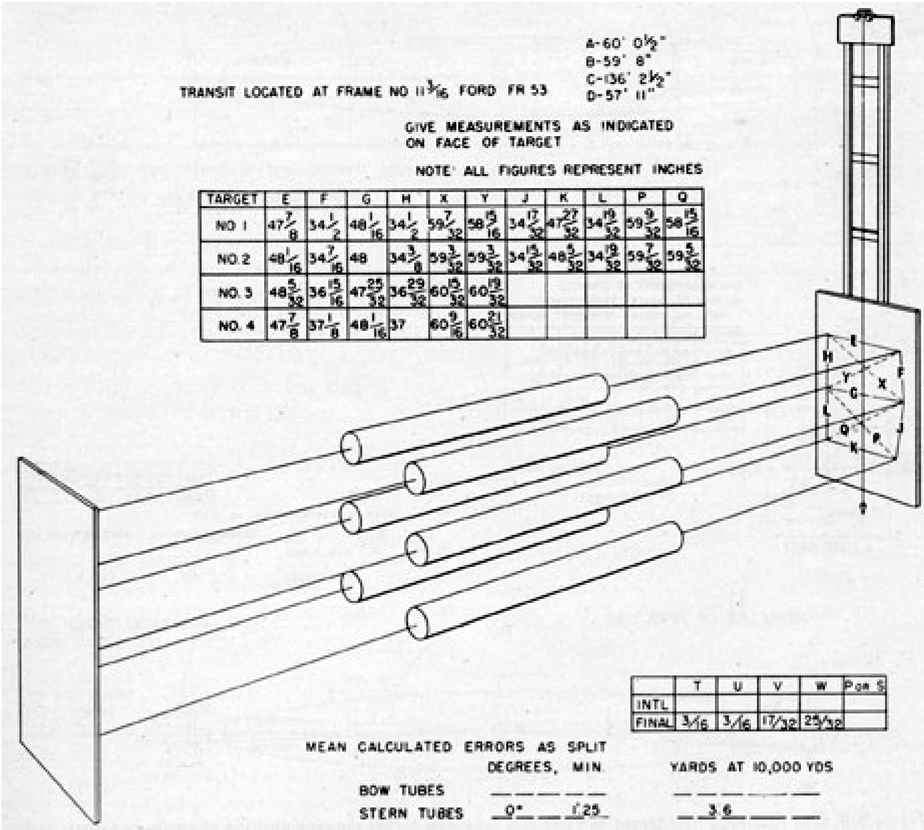


Figure 5-7. Two main targets of six tube nests in perspective.

d. Sight on the forward benchmark, project a line aft using the double reverse method described before, and mark a point next to the stern benchmark.

e. Measure distance S between this point and the benchmark.

f. Next to the forward benchmark, lay off a distance l/n XS, where l is equal to the distance from the forward benchmark to the periscope position, and n is the distance between the after benchmark forward point on the ship on the same side as the after mark from the after benchmark.

g. Project this point aft 180 degrees with the transit and mark another point next to the after benchmark. The distance from this point aft to the original after benchmark must be equal to the distance between the original forward benchmark and the mark laid off forward, and must be on the same side of the ship. The permanent benchmarks are then established on this parallel line; this line being parallel to the mean axis of the forward tubes.

and the periscope position. Mark this

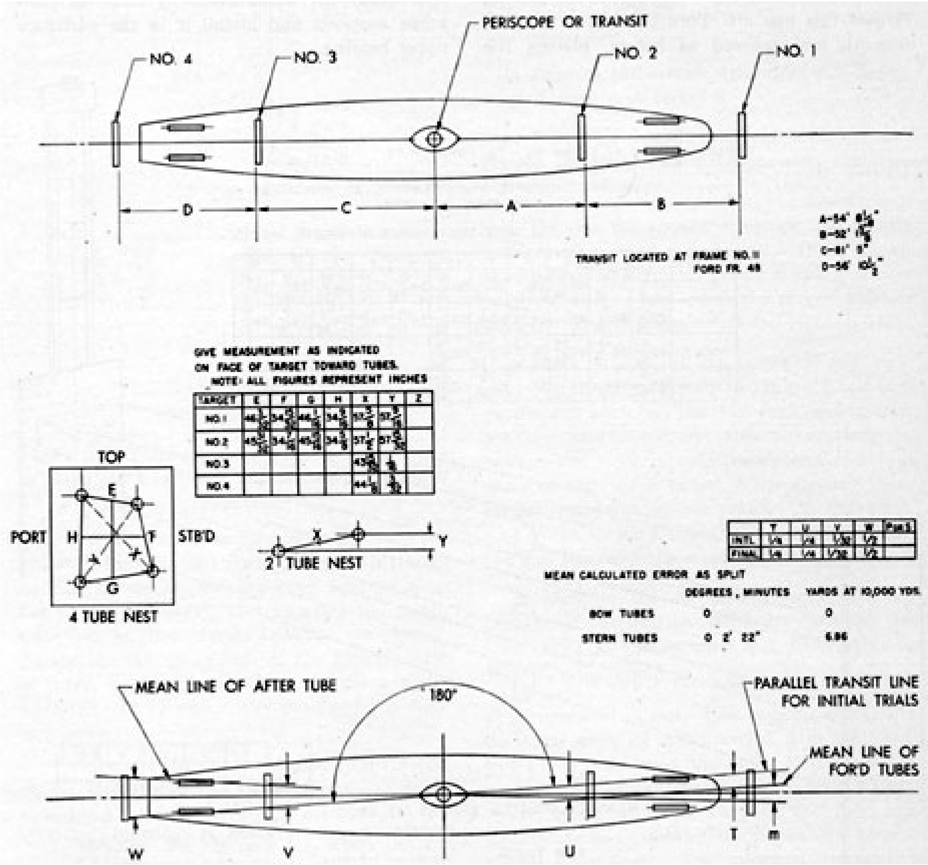


Figure 5-8. One four-tube nest target and one two-tube nest target showing position of auxiliary targets and paralleling mean axes.

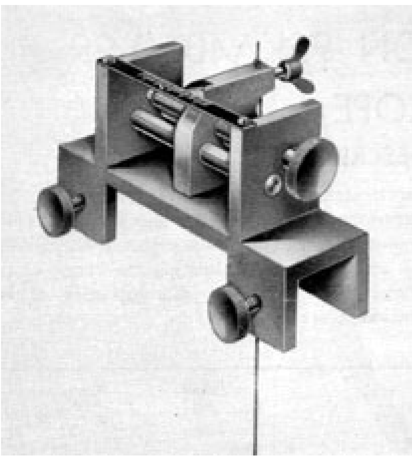


Figure 5-9. Plumb line adjustment adapter.

7. Periscopes, when installed, should be trained on the forward benchmark and the azimuth circle set on 0 degrees.

8. If the ship has a list, it is necessary to place the axis of the transit in the longitudinal

10. When any submarine has undergone extensive depth charging, or the periscope has been damaged, because of a collision or an ice flow, the repairman must check the periscope alignment to the bow and stern benchmarks to ascertain the alignment of the periscope supports.

centerline plane of the vessel and to project the mean target points upward parallel to the same line.

9. Final angles of error less than 5' of arc maybe considered as negligible.

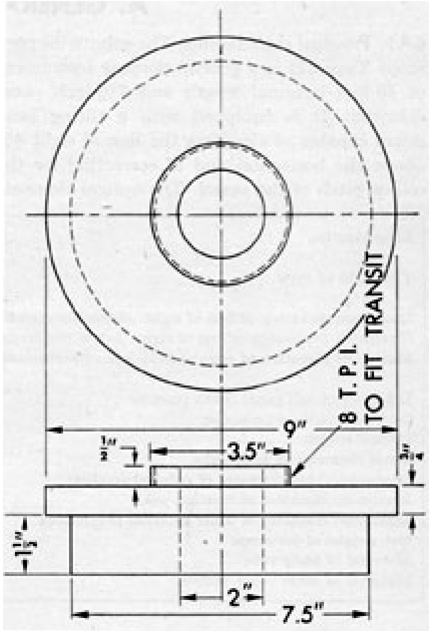


Figure 5-10. Transit fixture.

6
DESIGN DESIGNATION 92KA40T/1.99 PERISCOPE

A. GENERAL DESCRIPTION

6A1. Principal characteristics. The submarine periscope Type III is a general purpose instrument of 40-foot nominal length and 7 1/2-inch outer diameter. It is equipped with a tilting head prism capable of elevating the line of sight 45 degrees above the horizontal and of correcting for the roll or pitch of the vessel. The optical elements are treated to increase the light transmission. The instrument is designed for high-power and low-power observation, and is supplied with a built in stadimeter for estimating the range of the target. The principal characteristics of the periscope are as follows:

Magnification	Low power High power	1.5x 6.0x
True field of view	Low power High power	32 degrees 8 degrees
Maximum elevation of line of sight (above horizontal)		45 degrees
Maximum depression of line of sight (below horizontal)		10 degrees
Maximum elevation of edge of field (above horizontal)	Low power High power	61 degrees 49 degrees
Diameter of exit pupil (both powers)		4m/m
Over-all length of periscope		51'4"
Optical length		40'
Outer diameter of body tube		7-1/2"
Minimum outer diameter of reduced section		1.99"
Maximum diameter of hoisting yoke		14-3/4"
Maximum diameter of other external projections		15-1/4"

Net weight of periscope		2000 lb
Material of body tube	Corrosion-resisting steel	
Material of outer taper section	Corrosion-resisting steel	

B. REMOVING THE INNER TUBE

6B1. Disassembly of the inner tube from the outer tube. The inner tube is removed as follows:

1. Place the periscope in the V-blocks on the optical I-beam bench. Place it so that sufficient space remains to permit removal of the inner tube.

2. Rotate the revolving grip (3, Figure 6-11) of the left training handle assembly so that the zero line of sight graduation on the index ring (7) corresponds to the stationary index line graduation on the fixed grip (2). This places the head prism at zero line of sight and offers no obstruction for the removal of the inner tube. Check the right training handle for change of power; it should be set for low power.

3. Remove the air outlet plug (14, Figure 4-29) and open the air outlet valve (16) of the eyepiece box (11) to allow the internal gas pressure to be released slowly.

4. Turn the stadimeter handwheel (12, Figure 4-24) to the observing position as noted by the stamped numerals located on the stadimeter housing (8, Figure 6-8). The figure 15 on the height scale dial (13) should appear approximately opposite the value 220 on the range scale dial (14). This makes possible the correct rapid reassembly of the stadimeter housing assembly. Remove the four stadimeter housing bolts (30, Figure 4-24) and take the housing assembly off with care to avoid bending of the stadimeter transmission shaft (12, Figure 6-10). An automatic stop prevents rotation of the stadimeter handwheel (12) when not in place.

Figures 6-3 and 6-13. Inner Tube and Telescope Systems and Optical Arrangement Ray Diagrams

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5. Remove the training handles by taking out eight hinge bracket bolts (22 and 21, Figures 6-11 and 4-44 respectively) for the left and right training handle assemblies.

15. Connect the upper part of the lifting spreader bar (Figure 4-13) to the lifting projection of the hinged clamp. This projection slides between the center slot section of the upper end of the lifting spreader bar,

6. Remove the focusing knob assembly by taking out four lockscrews (10, Figure 4-39).

7. Remove the rayfilter by pulling outward on both spring actuated plunger knobs (24, Figure 4-40).

8. Remove the eyepiece attachments that are secured to the anchor screw pins (19, Figure 4-29) projecting from the eyepiece box itself.

9. Follow the procedure described under Step 14 of Section 4C1 for the removal of the hoisting yoke assembly.

10. After the nitrogen pressure is released, close the air outlet valve (16) and replace the air outlet plug (14).

11. Follow the procedure of Steps 15 to 19 inclusive of Section 4C1 for the attachment of special fixtures required in the removal of the inner tube.

12. Slowly pull the inner tube sections out of the outer tube until the lower (split) objective lens coupling sleeve (17, Figure 6-7) is clear of the outer tube. The inner tube should be guided parallel with the outer tube and properly centered in it.

13. Place the adjustable roller stand (Figure 4-11) under the eyepiece box (11,Fixture, 4-29), removing the hook of the chain hoist and the shackle.

14. Attach and secure the hinged clamp over the lower (split) objective lens coupling sleeve (17, Figure 6-7). Locate this hinged clamp at the upper part of the and a bolt is placed through the clearance holes in the above projection. The spreader bar is secured with a locknut. The lifting plate projection slides into the center slot section of the spreader bar lower part, and is held in similar manner to the upper part. Place the chain hoist hook in the center pad clearance hole of the lifting spreader bar (Figure 4-11).

16. Take a light strain with the chain hoist on the lifting spreader bar, and remove the adjustable roller stand. Resume the outward pulling movement slowly until the fifth inner tube section (1, Figure 6-5) is clear of the outer tube. The inner tube should be guided parallel with the outer tube and properly centered in it.

17. Attach and secure another hinged clamp over the upper part of the fifth inner tube section (1). Attach a shackle in the hole of the lifting projection of the hinged clamp, and with the chain hoist hook placed in the shackle, take a light strain with the chain hoist (Figure 4-14).

18. Slowly resume the outward pulling movement of the inner tube, checking to ascertain that it is guided parallel with the outer tube and is properly centered.

19. Transport the inner tube to the V-blocks on the second I-beam bench. Remove both chain hoist hooks, hinged clamps, and steel lifting plate.

coupling sleeve, as shown in Figure. 4-11.

20. Remove the outer tube from the V-blocks on the optical I-beam bench with two chain hoists, using canvas covered galvanized cable slings wrapped once around the outer tube in transporting it to the periscope rack.

C. OUTER HEAD, OUTER TAPER SECTION, OUTER TUBE AND INNER TUBE ASSEMBLIES

6C1. Description of the outer head, outer taper section, and outer tube. All bubble numbers in Sections 6C1, 2, and 4, refer to Figure 6-1 unless otherwise specified.

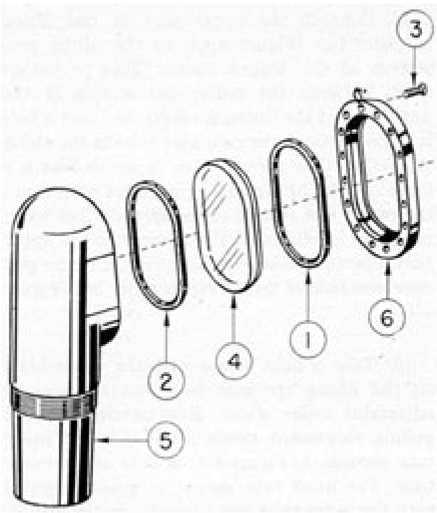

Figure 6-1. Outer head and head window assembly.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1257-8	1	Bezel frame rubber gasket
2	P-1257-9	1	Head window seat rubber gasket
3	P-1260-9	16	Bezel frame lockscrews
4	P-1396-1	1	head window
5	P-1397-	1	Outer head

The outer head is bored to accommodate a sliding fit for the assembly of the skeleton head frame (1, Figure 6-4) and has additional concave radius provisions in the upper wall to furnish sufficient clearance for the operation of the prism tilt mechanism of the skeleton head assembly (Figure 6-4).

The outer head flange is machined at an angle of 8 degrees, with a recess seat to carry a sealing rubber gasket (2) under a head window (4). Above the head window, an additional sealing rubber gasket (1) adheres directly to the beveled edge of the head window and the beveled seat in the head window bevel frame (6).

The normal diameter of the outer head is 1.990 inches and tapers outward on opposite sides to its outer flange face which has a larger diameter. The exterior surface of the outer head upper wall tapers

	1		
6	P-1397-2	1	Bezel frame

a. Outer head. The outer head (5) is made of solid forged corrosion resisting steel material. It serves as a covering for the skeleton head assembly and is assembled to the upper part of the outer taper section (1, Figure 6-2).

The lower part of the outer head has a tapered alignment support section with a straight threaded periphery of 32 threads per inch preceding it which fits into a similar internal tapered alignment support and threaded section in the upper part of the outer tapered section.

A mixture of litharge and glycerin is used over the threads to maintain an internal gas and external water seal, thus establishing a permanent joint between the outer head and outer taper section.

inward with the contour of its flange face surface at an angle of 9 1/2 degrees.

The outer head flange has 16 proportionately spaced tapped holes for retaining the head window bezel frame (6) by means of 16 lockscrews (3) which are inserted in countersunk clearance holes in the head window bezel frame.

b. Head window bezel frame. The head window bezel frame (6) is made of phosphor bronze. Its lower face has a machined irregular recess to fit over the head window (4) with a 45 degrees angle. The 45 degrees angle of the beveled recess accommodates the head window bezel frame rubber gasket (1) which compresses to the angle of the head window (4) to form an airtight joint.

The outer flange of the bezel frame has 16 proportionately spaced countersunk clearance holes to accommodate the lockscrews (3). These lockscrews extend into the tapped holes in the outer head flange (5). The upper side face of the bezel frame is beveled at a 22 degrees angle conforming to its contour, while the lower side face is beveled at a 16 degrees angle also conforming to its contour.

The inner irregular circumference of the bezel frame is beveled at an angle 45 degrees away from the line of contact with the glass to increase the effect of wind in clearing drops of water from

the glass and to reduce the lodgement of water

and deposits of salt by evaporation on the glass near the inner circumference.

c. Head window. The head window (4) is made of one crown optical glass element with parallel surfaces, and fits into the recess seat in the outer head on a seat gasket (2). It is molded with a 45 degrees angle edge to which a bezel frame rubber gasket (1) is applied. It provides a means of sealing without obstructing the entering light rays, and offers a transparent medium through which light is transmitted.

d. Outer taper section. The outer taper section (1, Figure 6-2) is made of solid forged corrosion-resisting steel. The external diameter at the lowest part is machined for connection to the outer tube (2) in similar manner to the Type II periscope outer taper section. Refer to Section 4D1.

The exterior surface of this taper section starting from the lower undercut part is a straight shoulder for 1/2 inch. From this straight shoulder, it is machined with a radius for a short distance to a diameter of 6 7/8 inches. It tapers upward to a diameter of 1.990 inches in 47 1/4 inches, which it retains for a distance of 15 inches. The inside diameter upward from the lower part does not vary from its calculated diameter at any point by +0.015 inch or -0.000 inch, and the bore of taper is concentric within 0.005 inch.

The inside diameter of the straight 15 inches is bored for light transmission, leaving a wall of approximately 21/64 inch. The upper part is provided with two counterbored sections. The small counterbored section is tapered to receive the tapered alignment section of the outer head (5), while the large counterbored section is threaded to receive the threaded periphery of the outer head as a permanent joint.

e. Outer tube. The outer tube (2, Figure 6-2) is identical to the Type II periscope. Refer to Section 4D2.

6C2. Disassembly of the head window assembly. The head window assembly is disassembled in the following manner:

1. Unscrew each of the 16 lockscrews (3) evenly, with several threads of each lockscrew remaining in the tapped holes in the outer head flange face (5).

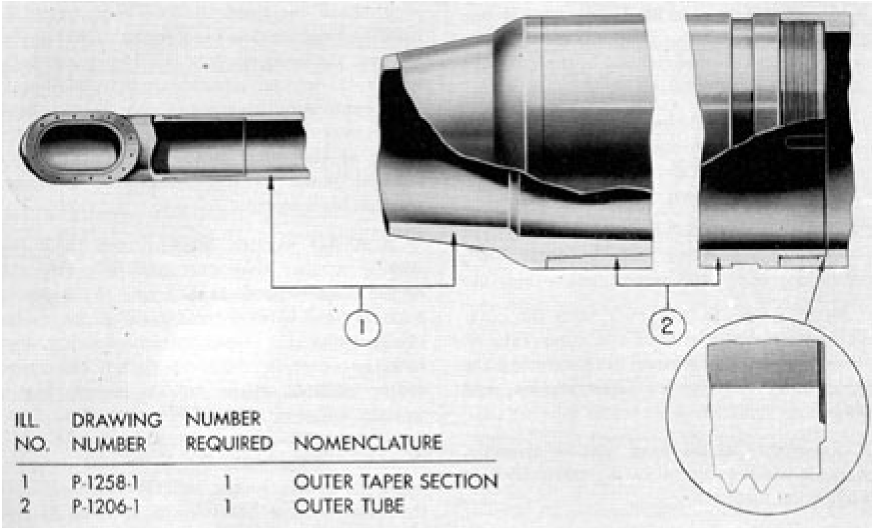

Figure 6-2. Outer taper section and outer tube.

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2. In order to break the seal of the head window (4), it is necessary to apply an internal nitrogen pressure of 15 to 30 pounds in the instrument. To apply an internal nitrogen pressure requires the blanking off of the lower part of the outer tube (2, Figure 6-2) with a suitable jig and fittings for a pressure gage and the nitrogen line.

3. After the head window (4) is broken free, release the internal gas pressure and remove the jig.

4. Remove the 16 lockscrews (3), unscrewing them from the tapped holes in the flange face of the outer head (5).

5. Remove the head window bezel frame (6), lifting it away from the flange face of the outer head (5).

6. Remove the head window (4) and the head window bezel frame rubber gasket (1). The head window may stick to the head window bezel frame rubber gasket (1) and the bezel frame (6). Remove the head window bezel frame rubber gasket (1) and destroy it.

bearing surface. The head window (4) must be marked in the position its seat is scraped, so that it cannot be turned end for end.

2. Insert the new head window seat rubber gasket (2) into the head window seat of the outer head (5).

3. The beveled seat of the head window bezel frame (6) should be scraped if necessary, to provide a true bearing surface in conjunction with the beveled edge of the head window (4).

4. Clean the inner surface of the head window (4) with clean lens tissue, and use a small air bulb to blow off any surface dust.

5. Place the head window (4) in the recess seat in the outer head (5) on the head window seat rubber gasket (2).

6. The head window bezel frame rubber gasket (1) should be approximately 0.031 inch larger than the head window outer irregular circumference, complying with factory drawing dimensions as to thickness. It is placed in the head window bezel frame (6) in one solid

7. Remove the head window seat rubber gasket (2) from the recess seat in the outer head (5) and destroy it.

6C3. Cleaning of the outer head, outer taper section and outer tube. The outer head, outer taper section, and outer tube are cleaned in the following manner:

1. These parts should be cleaned after flooding with they use of various sized circular wire brushes and turkish toweling to remove salt deposits, and then blown out with filtered air.

2. Under normal conditions turkish toweling should be used to clean out the outer head, outer taper section, and outer tube.

3. Place a canvas boot over both the outer head and the lower end of the outer tube to prevent any foreign matter from entering the cleaned outer head, outer taper section, and outer tube.

6C4. Reassembly of the head window assembly. The head window assembly is reassembled in the following manner:

1. Scrape the seat in the outer head (5) if necessary, to give the head window a true piece. A small hole is punched in the center of the rubber gasket to allow trapped air to escape.

7. Place the head window bezel frame (6) with the head window bezel frame rubber gasket (1) over the head window (4). Insert four lock screws (3) in four equally spaced positions in the countersunk clearance holes in the bezel frame, screwing them in tapped holes in the flange of the outer head. Each lockscrew is screwed down loosely, flush with the head window bezel frame.

8. A flat wooden block 1 inch thick and slightly smaller than the inner circumference of the head window bezel frame (6) is placed over the head window bezel frame rubber gasket (1). A C-clamp is placed over the wooden block and the outer head (5) to flatten the raised center portion of the rubber gasket. Use a wooden wedge on the opposite side of the outer head to tighten the C-clamp evenly. The flattening of the rubber gasket forces its outer edges to adhere to the inner beveled walls of the head window bezel frame (6), and utilizes the entire area of the beveled surface of the head window bezel frame to maintain the seal.

9. Lubricate the threads of the 16 lockscrews (3) Tightly with a medium grease before insertion in the bezel frame, and tighten them evenly. Each lockscrew is taken down equally in a series of all-around adjustments and a feeler gage is used as a check around the head window bezel frame (6), to

C. Lower main telescope system.
1. Lower (split) objective lens and mount assembly.
2. Objective operating mechanism assembly.
3. First inner tube section assembly.
4. Eyepiece skeleton assembly.
5. Eyepiece box and miscellaneous assemblies.

determine the equal tension. Remove the C-clamp and wooden block.

10. It is desirable to wet the head window bezel frame rubber gasket (1) thereby offering a lubricant for a brass knife edge when cutting the crude rubber gasket around the inner irregular circumference of the head window bezel frame (6). The brass blade will not scratch the head window surface.

11. Clean the outer surface of the head window (4) in the same manner as outlined in Step 4 of this section.

6C5. Inner tube assemblies. Figure 6-3 at the back of the book shows the inner tube of the periscope which is divided into three telescope systems. Each telescope system is made up of assemblies as follows:

A. Galilean telescope system: Skeleton head assembly.

B. Upper main telescope system.
1. Part I. First, second, third, fourth, and fifth reduced tube sections, and fifth and sixth inner tube sections
2. Part II. Second, third, and fourth inner tube sections.

a. One stadimeter transmission shaft packing gland assembly and four spring loaded packing gland assemblies.
b. Eyepiece window assembly.

6. External projections to the eyepiece box.

a. Stadimeter housing assembly.
b. Focusing knob assembly.
c. Rayfilter assembly.
d. Eye buffer and blinder assembly.
e. Variable density polaroid filter assembly.
f. Training handle assemblies.
g. Stadimeter illuminator assembly.
h. Hoisting yoke assembly.

D. SEPARATION OF THE THREE TELESCOPE SYSTEMS

6D1. Disassembly of the-shifting wire tapes and air line sections. This procedure is performed in the following manner:

1. Remove the 10 lockscrews each (5, Figure 4-29) from the left side plate (9) and the pressure gage assembly (21). Unscrew the 10 lockscrews each from the tapped holes in the rectangular recess seats in the left and right sides of the

2. Remove the shifting wire tape (38, Figure 4-28) from the clamp blocks (11, Figure 6-4), removing and replacing the lockscrews (49) and clamp blocks (11) to the prism and cube shifting racks (14, 15, 12, and 13) of the skeleton head assembly.

3. Remove each of the four lower shifting wire spindle adjusting nuts (4, Figure 4-28) one by one from each shifting wire spindle assembly,

eyepiece box (11). Its may be necessary to tap out two opposite holes located diagonally with an 8-32 tap in the side plate (9) and pressure gage assembly (21) for the insertion of special lockscrews to break the seal of the two rubber gaskets (10). Remove the side plate and pressure gage rubber gaskets and destroy them.

by following the method used under Step 5 of Section 4C1. Carry each of the prism and power shifting racks (43, 44, 45, and 46) to its lower position after removing each shifting wire spindle adjusting nut (4) for the removal of the shifting wire spindle assemblies and each

shifting wire tape one by one, carrying each out through the rectangular openings of its respective sides of the eyepiece box (11, Figure 4-29). Roll each shifting wire tape into a 15-inch diameter roll and secure each coil together with three pieces of friction tape.

4. Remove the two lockscrews (27, Figure 6-5) and the removable air line strap (26) from the first reduced tube section (23). Pull the air line section continuation (25) away from the periphery wall of the first reduced tube section (23) to remove the air line section (22) of the second reduced tube section (17) from the air line adapter (20) of the same reduced tube section.

5. Slide the air line section (22) of the second reduced tube section (17) upward, carrying its continuation (25) of the first reduced tube section (23), and its continuation (35) of the sixth inner tube section (28), with its soldered air line coupling (36) from its connection with the upper part of the air line section (37) of the sixth inner tube section. Slide it downward from the three soldered air line straps (39) of the sixth inner tube section, and one soldered air

(22, Figure 6-10), and the air line strap (18) from the upper part of the first inner tube section (1). Slide the air line section continuation (17) of the first inner tube section (1) and its soldered air line coupling (15) upward to disconnect the coupling from the air line section (16) of the first inner tube section (1). Carry the air line section continuation (17) with its soldered air line coupling (15) downward for removal. Slide its continuations (30 and 19, Figure 6-6) from six soldered air line straps (32) of the second inner tube section (23) and four soldered air line straps (22) of the third inner tube section (11).

8. Remove two lockscrews (22, Figure 6-10) and the removable air line strap (20) from the lower part of the first inner tube section (1). Slide the air line section (16) upward, carrying with it at its lower end the soldered air line coupling (15), disconnecting it from the short bent round air line (14). Slide the air line section (16) and its coupling (15) upward, bending it slightly outward and carrying it out of the soldered air line strap (19) of the first inner tube section (1).

9. Remove the short bent round air line (14), disconnecting it from the

line strap (21) of the second reduced tube section (17).

6. Remove the two lockscrews (40) and the removable air line strap (38) from the lower part of the sixth inner tube section (28). Slide the air line section (37) of the sixth inner tube section upward, carrying its continuation (47) of the fifth inner tube section (41), its continuation (9, Figure 6-6) of the fourth inner tube section (1), and its continuation (21) of the third inner tube section (11) upward. It is carried upward sufficiently to disconnect its soldered air line coupling (20) from the air line section (19) of the third inner tube section (11). Carry the air line section continuation (21) with its soldered airline coupling (20) downward for removal. Slide it out of two soldered air line straps (22) of the third inner tube section (11) and its air line section continuations (9, 47, Figure 6-5), of the air line section (37) from the seven soldered air line straps (10, Figure 6-6) of the fourth inner tube section (1).

7. Remove the two lockscrews (33) and the removable air line strap (31) from the second inner tube section (23). Remove the two lockscrews undercut section of the long round air line coupling section (13).

10. Unscrew the long round air line coupling section (13) from the tapped hole in the large shoulder flange of the eyepiece skeleton (42, Figure 4-28), sliding it out of the clearance hole in the bearing projection of the spider (2, Figure 6-10).

6D2. Separation of the Galilean telescope system. This procedure is performed in the following manner:

1. Remove the two lockscrews (55, Figure 6-4), unscrewing them from the tapped holes in opposite sides of the upper threaded periphery alignment support section of the fifth inner tube section (1, Figure 6-5), carrying them out of opposite countersunk clearance holes in the skeleton head (1, Figure 6-4).

2. Remove the skeleton head assembly, unscrewing it from the upper threaded periphery alignment support section of the fifth reduced tube section (1, Figure 6-5). Wrap the skeleton

head in clean lens tissue and place it to one side to prevent its becoming damaged.

6D3. Separation of the upper telescope system Part I from Part II and Part II from the lower telescope system. This procedure is performed in the following manner:

1. Remove the eight lockscrews (42, Figure 6-5), from the lower part of the fifth inner tube section (41).

2. Remove the taper pin (15) from the upper part of the stadimeter transmission shaft coupling (3).

3. Remove the two taper pins (10) from the two stadimeter transmission shaft thrust collars (4, Figure 6-10) located on the stadimeter transmission shaft (12) on each side of the spider (2) of the first inner tube section assembly.

Unscrew these lockscrews from tapped holes in the upper alignment support section of the fourth inner tube section upper end coupling (4, Figure 6-6).

2. Unscrew the lower part of the fifth inner tube section (41, Figure 6-5) from the threaded periphery of the fourth inner tube section upper end coupling (4, Figure 6-6). Support the reduced tube sections while unscrewing the lower part of the fifth inner tube section.

3. Remove the 15 lockscrews (11, Figure 6-7) from the lower part of the coupling sleeve (17). Unscrew these lockscrews from the tapped holes in the large flange section of the track sleeve (18).

4. Slide the lower telescope system approximately 1 foot clear of the coupling sleeve (17).

5. Remove the four lockscrews (8) from the upper part of coupling sleeve (17). Unscrew these lockscrews from tapped holes in the lower alignment support section of the second inner tube section lower end coupling (26, Figure 6-6).

6. Unscrew the coupling sleeve (17, Figure 6-7) from the lower part of the second inner tube section lower end coupling threaded periphery (26, Figure 6-6).

6D4. Separation of the lower telescope system. This procedure is performed in the following manner:

1. Remove the two stadimeter collimating screws (13, Figure 4-22) from each half of the lower (split) objective lens and mount assembly. These lockscrews are unscrewed from tapped holes in each mounting plate half (1, Figure 6-7) of the

4. Remove the taper pin (15, Figure 6-7) from the lower part of the stadimeter transmission shaft coupling (3).

5. Slide the stadimeter transmission shaft (12, Figure 6-10) out of the stadimeter transmission shaft coupling (3, Figure 6-7) and clear of the track sleeve (18). Remove this coupling from the operating gear pinion shaft (20).

6. Remove the four lockscrews (9) from the lower part of the track sleeve (18). Unscrew these lockscrews from the tapped holes in the upper alignment support section of the first inner tube section upper end coupling (23, Figure 6-10).

7. Unscrew the track sleeve (18, Figure 6-7) from the upper part of the first inner tube section upper end coupling threaded periphery (23, Figure 6-10), and remove the objective operating mechanism assembly.

8. Remove the stadimeter transmission shaft (12) from the first inner tube section assembly, also removing the two thrust collars (4) from each side of the spider bearing projection (2).

9. Check the reference marks on all four spring loaded packing gland assemblies with corresponding reference marks on the eyepiece box (11, Figure 4-29).

10. Follow the procedure described under Steps 10 to, 22 inclusive of Section 4E5, for the removal of the four spring loaded packing gland assemblies (Figures 4-32, 4-33, and 4-34 respectively), stadimeter transmission shaft spring type packing gland (Figure 4-30),

objective operating mechanism assembly. The straight dowel pins (15, Figure 4-22) will be carried out with the mounts (1 and 2) from the mounting plates (1, Figure 6-7).

modified hycar type, (Figure 4-31), rayfilter plate (2, Figure 4-40), eyepiece window frame assembly. (Figure 4-38), eyepiece box (11, Figure 4-29), and the eyepiece skeleton assembly (Figure 4-28). All of these assemblies are identical to the Type II periscope.

E. GALILEAN TELESCOPE SYSTEM

6E1. Description of the skeleton head assembly. Figure 6-4 shows the skeleton head assembly. All bubble numbers of Sections 6E1, 2, and 3, refer to Figure 6-4 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1254-1	1	Skeleton head
2	P-1255-1	1	Head prism mount
3	P-1255-2	1	Galilean objective lens retainer
4	P-1255-3	1	Head prism side plate (left)
5	P-1255-3A	4	Head prism shade and side plate wire link rivets
6	P-1255-4	1	Head prism side plate (right)
7	P-1255-5	1	Head prism shade arm (left)
8	P-1255-	1	I Head prism

Ill. No.	Drawing Number	Number Required	Nomenclature
37	P-1257-5	1	Galilean eyepiece lens mount housing
38	P-1257-6	3	Galilean eyepiece lens mount housing lockscrews
39	P-1257-11	2	Right prism mounting clamps
40	P-1257-12	2	Left prism mounting clamps
41	P-1260-1	2	Split bearing lockscrews
42	P-1260-1A	2	Split bearing lockscrew spacer washers
43	P-1260-2	2	Eccentric arm lockscrews
44	P-1260-2A	2	Eccentric arm lockscrew spacer washers
45	P-1260-	2	Head prism

	6		shade arm (right)
9	P-1255-7	1	Head prism shade
10	P-1255-8	2	Head prism shade wire links
11	P-1255-9	4	Clamp blocks
12	P-1255-10	1	Cube shifting rack (right)
13	P-1255-11	1	Cube shifting rack (left)
14	P-1255-12	1	Head prism shifting rack (right)
15	P-1255-13	1	Head prism shifting rack (left)
16	P-1256-1	1	Eccentric arm
17	P-1256-2	1	Eccentric disk
18	P-1256-3	1	Eccentric disk shaft
19	P-1256-4	1	Head prism shift actuating gear
20	P-1256-5	1	Fourth intermediate head prism shift gear
21	P-1256-6	1	Fourth intermediate head prism shift-gear shaft
22	P-1256-7	1	Third intermediate head prism shift gear
23	P-1256-8	1	Second intermediate head prism shift gear

	3		side plate bottom lockscrews
46	P-1260-4	1	Eccentric arm pivot pin lockscrew
47	P-1260-5	8	Head prism mounting clamp lockscrews
48	P-1260-6	6	Detent pawl holder and reinforcing spring lockscrews
49	P-1260-7	8	Clamp block lockscrews
50	P-1260-8	2	Head prism side plate lockscrews
51	P-1260-10	2	Head prism base bracket lockscrews
52	P-1260-12	1	Galilean eyepiece lens mount lockscrew
53	P-1260-13	8	Cube bracket lockscrews
54	P-1260-14	4	Gear train bracket lockscrews
55	P-1260-15	2	Skeleton head and fifth reduced tube section lockscrews
56	P-1260-175	1	Eccentric arm pivot pin
57	P-1260-176	4	Rivets for pawl holders and pawls
58	P-1260-177	1	Head prism shift actuating gear taper pin

24	P-1256-9	1	First intermediate head prism shift gear
25	P-1256-10	1	Head prism shift gear
26	P-1256-11	1	Power shift gear
27	P-1256-12	3	Cube brackets
28	P-1256-13	1	Head prism base bracket (right)
29	P-1256-14	1	Power shift gear bracket
30	P-1256-15	1	Gear train bracket
31	P-1256-16	2	Pawl holders
32	P-1256-17	2	Power shift pawls
33	P-1257-1	1	Reinforcing spring
34	P-1257-2	1	Galilean objective lens cube
35	P-1257-3	1	Galilean eyepiece lens cube
36	P-1257-4	1	Galilean eyepiece lens mount
59	P-1260-178	1	Eccentric disk and shaft taper pin
63	P-1260-179	1	Fourth intermediate prism shift gear shaft lockscrew
61	P-1260-180	2	Second and third intermediate prism shift gear rivets
62	P-1396-2	1	Head prism
63	P-1396-3	1	Galilean eyepiece lens
64	P-1396-4	1	Galilean objective lens
65		2	Right cube shifting rack pins

a. Skeleton head frame. The skeleton head frame (1) is made of cast phosphor-bronze material. It forms the necessary framework to

carry the prism tilt mechanism, Galilean telescope, and change of power mechanism. It is bored for light transmission, with antireflection threads in its central part, and is provided with three counterbored sections. The second largest counterbored section serves as an alignment support section for the upper alignment support section of the fifth reduced tube left side wall of the skeleton head to operate one optical element, the head prism (62).

b. Head prism, head prism mount, head prism side plates, and head prism shade. 1. Head prism. The head prism (62) is a right angle prism, made of dense flint optical glass material. It is used to reflect the light rays at right angles. The

section (1, Figure 6-5), while the largest counterbored threaded section engages on the threaded periphery of the upper part of the fifth reduced tube section (1, Figure 6-5). It is secured to the fifth reduced tube section with two lockscrews (55).

The skeleton head frame is a sliding fit in the inside bore of the straight 1.99-inch section of the outer taper section.

The prism tilt mechanism is composed of numerous mechanical parts in the upper and light rays enter from any position of elevation between 61 degrees elevation to 26 degrees depression in low power and from 49 degrees elevation to 14 degrees depression in high power, and are deflected downward into the instrument from any of the above angles.

2. Head prism mount. The head prism mount (2) carries the head prism (62) with a suitable clamping arrangement. The base pivot shoulder projections of the mount project outward on opposite sides and are a sliding fit in the milled out clearance section in the upper

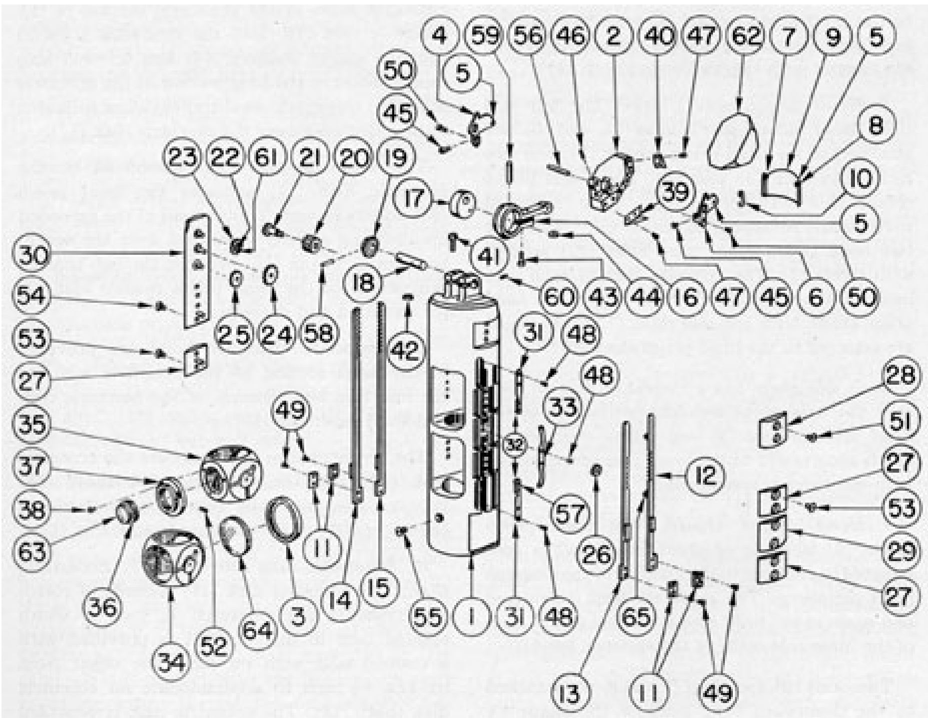

Figure 6-4. Skeleton head assembly.

part of the skeleton head frame (1). Each shoulder is provided with a reamed hole axis to receive the integral pin projections of the gear train bracket (30) and the right head prism base bracket (28). Each bracket pin projection extends into reamed holes in its respective side walls of the skeleton head frame (1) into the section to which the lower ends of the wire links (10) are secured with rivets (5). As the head prism (62) and its mount (2) are elevated or depressed, the head prism shade is carried vertically and is used principally in the elevated position to shade the lower 90 degrees face of the head prism, thus preventing a double image.

reamed hole axis in each base pivot shoulder.

The rear face of the mount is provided with two bearing projections for the insertion of the extended arm bearing section of the eccentric arm (16) attached to the mount with an eccentric arm pivot pin (56) and secured with a headless lockscrew (46). The skeleton head frame is provided with clearance in its milled out section to receive the eccentric arm (16) and the head prism mount (2) for all degrees of elevation and depression. The head prism (62) is retained from sideward movement with two head prism side plates left and right (4 and 6), and is held to the head prism mount (2) with two pairs of head prism mounting clamps (39 and 40) which are secured with two lockscrews each (47).

3. Head prism side plates. The left and right head prism side plates (4 and 6) are attached to the head prism mount (2) with two lockscrews each (45 and 50). These side plates retain the head prism (62) from sideward movement. Attached to each side plate are two head prism shade wire links (10) secured with rivets (5). The opposite ends of each wire link are secured to each rivet (5) of the head prism shade arms left and right (7 and 8) which are soldered to the head prism shade (9).

Each side plate has a clearance hole to slide over the base pivot shoulder projection of the head prism mount (2) and a bent-over section for its securement to the

c. Eccentric arm. The eccentric arm (16) is made of phosphor bronze and is 1 7/8 inches in length. The large section has a reamed hole with a stub arm section separated from the long arm section with a sawed slot, and fits over the eccentric disk (17). The stub section is provided with two spacer washers (44) fitted in the slotted section.

The stub arm is provided with two countersunk clearance holes, while the long section of the eccentric arm is provided with coinciding tapped holes for the two lockscrews (43). These lockscrews are inserted in countersunk clearance holes in the stub arm section of the eccentric arm (16) into the clearance holes in the two spacer washers (44) and screwed into tapped holes in the long section of the eccentric arm. The two spacer washers (44) allow sufficient sliding clearance over the eccentric disk (17).

The eccentric arm (16) assembled to the eccentric disk (17) actuates the head prism (62) and its mount (2) by means of the extended arm bearing section assembled over the eccentric arm pivot pin (56) between the two bearing projections of the head prism mount base (2) for elevation and depression.

Two opposite clearance holes are provided in the large section of the eccentric arm for the insertion and removal of the eccentric disk and shaft taper pin (59).

The eccentric warm operates over the eccentric disk (17) and the eccentric disk shaft (18) between the two split bearing projections in

lower face of the mount with one lockscrew each (45).

4. Head prism shade. The head prism shade (9) is made of sheet brass and is constructed to conform to the contour of the skeleton head periphery. The sides are bent downward and again at 90 degrees to fit into a vertical slot in each of the inner side walls of the skeleton head.

Two arms left and right (7 and 8) are attached to the downward bent sides of the shade by soldering. Each arm is bent and has a protruding the upper part of the skeleton head frame (1).

d. Eccentric disk and shaft. 1. Eccentric disk. The eccentric disk (17) is made of corrosion resisting steel material 1/4 inch in width and 5/8 inch in diameter. It is provided with a reamed hole with its centerline offset from its axis 1/8 inch to accommodate an eccentric disk shaft (18). The eccentric disk is provided with a reamed taper pin hole perpendicular

to the offset eccentric disk shaft reamed hole, to secure the eccentric disk to the shaft.

The offset reamed hole provides the necessary cam movement for the actuation of the head prism mount (2) and its head prism (62) to all the required degrees of elevation and depression.

2. Eccentric disk shaft. The eccentric disk shaft (18) is made of corrosion-resisting steel and is 27/32 inch in length. It is a sliding fit into the reamed holes in the two split bearing projections of the upper part of the skeleton head frame (1) and the offset reamed hole in the eccentric disk (17).

The shaft is secured in the split bearing projections by the tightening of the two lockscrews (41). The two spacer washers (42) fit into the slotted section in each split bearing projection to provide sufficient rotation of the

It has a reamed hole in its axis to receive the shaft (21). The gear is mounted with the fourth intermediate head prism shift gear shaft (21) in the left side of the skeleton head frame in a semicircular clearance provision.

2. Fourth intermediate head prism shift gear shaft. The fourth intermediate head prism shift gear shaft (21) is made of corrosion-resisting steel and is 0.578 inch in length. It is provided with three shoulder sections. The stem section fits into the reamed hole in the skeleton head frame (1) and is secured with a lockscrew (60) located in the front of the skeleton head frame. The medium shoulder is a sliding fit in the reamed hole axis in the fourth intermediate head prism shift gear (20), while the large narrow shoulder serves to retain the above gear axially. The large narrow shoulder has a concave relief to allow clearance for the actuation of the second

shaft by securing the lockscrews (41). The axial displacement of the shaft is maintained by the eccentric disk (17) and its allowed clearance between the two split bearing projections.

The protruding part of the shaft on the left side carries the head prism shift actuating gear (19) which is secured with a taper pin (58).

e. Head prism shift actuating-gear. The head prism shift actuating gear (19) is made of phosphor bronze material. It has 30 teeth of 60 diametral pitch around its outer circumference, to mesh with the teeth of the fourth intermediate prism shift gear (20).

The reamed hole in the axis of this gear is a push fit on the protruding part of the eccentric disk shaft (18) and is secured with a taper pin (58) through the hub section.

f. Fourth intermediate head prism shift gear and shaft. 1. Fourth intermediate head prism shift gear. The fourth intermediate head prism shift gear (20) is made of phosphor bronze and is 21/64 inch in length. It has 23 teeth of 60 diametral pitch around its outer circumference to mesh with teeth of the third intermediate head prism shift gear (22) on one side, while it meshes with the head prism shift actuating gear (19) on the opposite side. It has two undercut shoulders on opposite ends of 1/64-inch width.

intermediate head prism shift gear (23).

g. Third intermediate head prism shift gear. The third intermediate head prism shift gear (22) is made of corrosion-resisting steel and is 0.063 inch in width. It is provided with an undercut shoulder of 0.008-inch width for its metal to metal contact upon assembly to the second intermediate prism shift gear (23). It has 14 teeth of 60 diametral pitch around its outer circumference, to mesh with the teeth of the fourth intermediate head prism shift gear (20) as it is fitted into the small countersunk recess in the upper part of the skeleton head left side wall.

This intermediate gear has a reamed hole in its axis which is a sliding fit over the first upper pin projection of the gear train bracket (30). It is provided with two opposite No. 72 drilled holes for the insertion of rivets (61) and is secured to the second intermediate head prism shift gear (23) and riveted.

h. Second intermediate head prism shift gear. The second intermediate head prism shift gear (23) is made of corrosion-resisting steel and is 0.075 inch in width. It is provided with an undercut shoulder of 0.013-inch width. It has 18 teeth of 48 diametral pitch around its outer circumference to mesh with the teeth of the first intermediate head prism shift gear (24) as it is fitted in the countersunk recess in

the upper part of the skeleton head left side wall.

This intermediate gear has a reamed hole in its axis which is a sliding fit over the first upper pin projection of the gear train bracket (30), with the undercut shoulder fitting in the countersunk recess in the gear train bracket. It is provided with two opposite No. 72 drilled holes for the insertion of rivets (61) and is secured to the third intermediate head prism shift gear (22) and riveted.

i. First intermediate head prism shift gear. The first intermediate head prism shift gear (24) is made of phosphor bronze. It is identical in all other respects to the second intermediate head prism shift gear (23) except that it has no opposite drilled holes for rivets. This intermediate gear has a reamed hole in its axis which is a sliding fit over the second upper pin projection of the gear train bracket (30), with the undercut shoulder fitting in the countersunk recess in the gear train bracket.

It engages with the teeth of the second intermediate head prism shift gear (23) as it is fitted in the countersunk recess in the upper part of the skeleton head left side wall, and with the teeth of the head prism shift gear (25) on its lower opposite side.

j. Head prism shift, gear and shifting racks. 1. Head prism shift gear. The head prism shift gear (25) is made of corrosion-resisting steel and is 0.075 inch in width. It is provided with an undercut shoulder of 0.013-inch in vertical slots in the skeleton head left side wall. The left shifting rack (15) is made of nominal width and thickness and is provided with 20 gear teeth of 48 diametral pitch in the upper part of its right side in a distance of 1.250 inch, to mesh with teeth of the head prism shift gear (25) on the left side. This shifting rack (15) is offset to the right in the lower part for attachment of the shifting wire tape (38, Figure 4-28), secured with a clamp block (11) and two lockscrews (49). The lower section of the skeleton head is provided with a flat recess to allow clearance for operation of the prism shifting racks. Two tapped holes are provided in the centerline of the lower offset section of the shifting rack for two lockscrews (49).

The shifting wire tape (38, Figure 4-28), overlaps the narrow flat shoulder in the lower part of the skeleton head and is attached to the shifting rack (15) which is slightly higher. The clamp block (11) is made of the same material as the shifting rack and coincides with the length and width of the offset and main section. The periphery of the clamp block conforms to the contour of the skeleton head, as it operates vertically with the shifting rack slightly below the skeleton head periphery.

Above the offset section of the shifting rack, a protruding integral stop section 11/32 inch in length is located approximately 21/32 inch from the lower end. Its outer surface is provided with a radius slightly below the contour of the skeleton head periphery. The stop

width. It has 23 teeth of 48 diametral, pitch around its outer circumference to mesh with the teeth of the head prism shifting racks right and left (14 and 15), and the first intermediate head prism shift gear (24) as it is fitted in the countersunk recess in the upper part of the skeleton head left side wall.

It is provided with a reamed hole in its axis which is a sliding fit over the second lower pin projection of the gear train bracket (30) with the undercut shoulder fitting in the countersunk recess of the gear train bracket.

2. Head prism shifting racks. The right and left head prism shifting racks (14 and 15) are made of blued cold rolled steel, and operate section in contact with the lower side of the cube bracket (27) restricts the movement of the head prism (62) in the elevated position to its designed limits, thus preventing any damage to the head prism (62) and its operating mechanism.

The right head prism shifting rack (14) is similar to the left in design, except that it is constructed to the opposite hand. Its teeth mesh with the teeth of the head prism shift gear (25) on the right side. The integral stop section of this shifting rack when in contact with the lower side of the cube bracket (27) restricts the movement of the head prism (62) in the depressed position to its designed limit.

k. Gear train bracket. The gear train bracket (30) is made of blued cold rolled steel,

and serves various functions. It serves to carry the gear train of the first, second, and third intermediate head prism shift gears (24, 23, and 22), and the head prism shift gear (25), by means of three pin projections integral with the bracket. It provides a closed housing by means of countersunk recesses below each of the three upper pin projections for the first and second intermediate and the head prism shift gear (24, 23, and 25), and also serves as a retaining plate for the upper part of the head prism shifting racks right and left (14 and 15).

The lower integral pin projection serves as a pivot for the reamed negative Galilean eyepiece lens doublet and a positive Galilean objective lens doublet. It is used in reverse to effect a low-power magnification and increase the true field of view.

1. Galilean eyepiece lens. The Galilean eyepiece lens (63) is made of two optical elements. It consists of a divergent meniscus flint element, cemented to the equi-concave crown element, forming a negative doublet. The divergent meniscus element cemented to the equi-concave element of the Galilean eyepiece lens corrects for spherical and chromatic aberration. It is mounted in the Galilean eyepiece lens mount (36) and burnished in place. The

axis hole in the Galilean eyepiece lens cube (35). The second upper pin projection is of sufficient length to protrude into the reamed axis hole in the head prism mount (2) base pivot shoulder projection serving as a pivot for the left side of the mount. All four pin projections are a sliding fit into the reamed holes in the left side wall of the skeleton head. The bracket is secured in the flat recess face of the skeleton head left side wall with four lockscrews (54) located in the lower part. The periphery of the bracket when assembled to the skeleton head conforms to the skeleton head periphery.

l. Cube bracket. The cube bracket (27) is made of blued cold rolled steel. It serves to retain the lower part of the head prism shifting racks right and left (14 and 15). The pin projection integral with the cube bracket serves as a pivot for the reamed hole axis of the Galilean objective lens cube (34).

The pin projection is a sliding fit into the reamed hole in the skeleton head vertical centerline of the left side wall. The bracket is secured to the flat recess face of the skeleton head with two lockscrews (53) which are inserted in countersunk clearance holes in the bracket on opposite sides of the pin projection and screwed into tapped holes in the skeleton head. This bracket serves as a stop for each integral stop section of the head prism shifting racks (14 and 15) for the elevation and depression positions of the head prism (62).

threaded periphery of the mount can be screwed vertically in the threads of the Galilean eyepiece lens mount housing (37) by using a sharp pointed scribe inserted in any one of a series of eight drilled recesses. This vertical movement provides a means for focusing the Galilean eyepiece lens for elimination of parallax in low power.

2. Galilean eyepiece lens mount housing. The Galilean eyepiece lens mount housing (37) is provided with an internal threaded bore to carry the threaded periphery of the mounted Galilean eyepiece lens (63) and mount (36) vertically. Two undercut shoulders, one on each side of the flange section, provide sufficient body distance for the movement of the mounted Galilean eyepiece lens (63) and mount (36) to eliminate parallax. The housing flange has three equally spaced clearance holes. One hole is a pivot hole, while the other two are elongated for collimation. A tapped hole located in the undercut shoulder receives the lockscrew (52) used to secure the mounted Galilean eyepiece lens (63) and mount (36) after parallax removal.

3. Galilean eyepiece lens cube. The Galilean eyepiece lens cube (35) is constructed of a suitable blued cold rolled steel framework for holding the Galilean eyepiece lens mount housing (37). By means of integral pin projections of the cube bracket (27) and the gear train bracket (30) extending in the reamed hole axis in opposite sides of the cube, it can be rotated for change of power. The undercut shoulder 0.010 inch in width and 0.437 inch in diameter on each

m. Galilean eyepiece lens, lens mount housing, lens cube, objective lens, and objective lens cube. The Galilean telescope system is composed of two lenses; namely, a

side face provides sufficient bearing wall for preservation of alignment between the inner walls of the skeleton head. All corners are

rounded off with a radius of 3/4 inch. The two perpendicular 90 degrees V-grooves in the right side wall receive the upper pawl (32) which is attached to the pawl holder (31) with rivets (57). The pawl is held in either V-groove with a reinforcing spring (33) to retain the cube in either the IN or OUT position. The 90 degrees rotation of the cube is accomplished by the upper pin projection (65) of the right cube shifting rack (12) extending into the elongated slot in the right side face of the cube.

The clearance hole in the upper face of the cube allows the lower undercut shoulder of the Galilean eyepiece lens mount housing (37) sufficient free movement for collimation of the Galilean eyepiece lens (63). Three equally spaced tapped holes in the upper face, receive lockscrews (38) to secure the Galilean eyepiece lens mount housing (37) after collimation. The lower wall is bored and provided with antireflection threads. The front and rear walls are also bored and have antireflection threads, thus offering no obstruction for the entering light rays in either high or low power. The skeleton head is machined out, leaving only the side walls, center support, and lower section for the assembly, V-grooves in the right side wall receive the lower pawl (32) which is attached to the pawl holder (31) with rivets (57). The pawl is held in either V-groove with the reinforcing spring (33) to retain the cube in either the IN or OUT position. The 90 degrees rotation of the cube is accomplished by the lower pin projection (65) of the right cube shifting rack (12), extending into the elongated slot in the right side face of the cube. The lower part of the skeleton head is machined out in similar manner to that of the Galilean eyepiece lens cube (35), leaving only the side walls to accommodate sufficient clearance for the assembly, disassembly, and actuation of this cube.

The change of power mechanism is located on the right side wall of the skeleton head frame (1) and is composed of numerous parts to operate the Galilean telescope system.

n. Cube shifting racks. The cube shifting racks right and left (12 and 13) operate in vertical slots located in the right side wall of the skeleton head. These shifting racks are made of blued cold rolled steel and are constructed similarly to the head prism shifting racks right and left (14 and 15). The right cube shifting rack (12) is wider, and is provided with two

disassembly, and actuation of this cube.

4. Galilean, objective lens. The Galilean objective lens (64) is made of two optical elements. It consists of a double convex flint element cemented to a divergent meniscus dense crown element forming a positive objective lens doublet. It is mounted in the Galilean objective lens cube (34) and secured with a Galilean objective lens retainer (3). The retainer is spot soldered to the Galilean objective lens cube (34) to prevent it from unscrewing.

5. Galilean objective lens cube. The Galilean objective lens cube (34) is constructed similarly to the Galilean eyepiece lens cube (35). The lower part is counterbored a shallow depth to serve as a mount for the Galilean objective lens (64), while its outer shoulder is threaded to receive the internal threaded section of the Galilean objective lens retainer (3). The upper, front, and rear walls are bored and provided with antireflection threads, thus offering no obstruction for the entering light rays in either high or low power. The two perpendicular 90 degrees assembled and riveted pins (65). These pins extend through two elongated holes in the wide vertical slot to the right of the vertical centerline and into the elongated holes in the Galilean eyepiece lens and objective lens cubes (35 and 34).

These pin projections (65), by the movement of the right or left cube shifting racks (12 and 13), shift the Galilean telescope system to the IN or OUT position. That is, each cube carrying one lens doublet each of the Galilean telescope is shifted simultaneously to place the lenses in the line of sight for low power, or out of the line of sight to allow the light rays free passage through the cubes for high power.

The cubes (34 and 35) are retained in either position by means of two pawls (32) extending through elongated slots under spring tension in either 90 degrees V-groove in the right side wall of each cube. The right and left cube shifting racks (12 and 13) are provided with 10 teeth of 48 diametral pitch located 2 7/32 inches from the lower end in a distance of 11/16 inch, to engage the power shift gear (26) on opposite sides.

The left cube shifting rack (13) is narrower than any of the head prism shifting racks (14 and 15) and the right cube shifting rack (12).

This left cube shifting rack (13) operates in the vertical slot to the left of the vertical centerline.

2. Power shift pawls. The two power shift pawls (32) are made of tool steel with an over-all length of 3/8 inch. The detent section is constructed at a 90 degrees angle, to engage in either of the 90 degrees V-grooves in each Galilean objective lens and eyepiece lens cubes (34 and 35)

When it is pulled downward by the shifting wire tape (38, Figure 4-28), its teeth in mesh with the power shift gear (26) cause it to rotate. The power shift gear is also in mesh with the teeth of the right cube shifting rack (12) and causes it to be carried upward. By means of the protruding pins (65) extending through the elongated holes in the skeleton head and into the elongated holes in each cube, the power shift gear rotates the cubes to the OUT position and vice versa.

The integral stops of the cube shifting racks projecting outward in each vertical recess groove, contact the lower side face of the lower cube bracket (27) to restrict the movement of each cube beyond its 90 degrees V-groove engagement of both pawls (32).

The lower section of the skeleton head is provided with a flat shallow groove in the right side in similar manner to the left side. The lower part of each cube shifting rack is offset in similar manner to the head prism shifting racks (14 and 15) for the attachment of the shifting wire tape (38, Figure 4-28), clamp blocks (11) and lockscrews (49).

o. Power shift gear and pawls. 1. Power shift gear. The power shift gear (26) is made of corrosion-resisting steel, and is provided with two undercut shoulder sections 0.005 inch wide on opposite sides. It has 12 teeth of 48 diametral pitch around sits outer circumference. The gear sets in a countersunk recess in the vertical centerline and central through the elongated holes in the outer left vertical slot in the right side wall of the skeleton head.

Each pawl is attached to a pawl holder (31) made of sheet bronze and having two rivets (57). The left vertical slot of the skeleton head frame has three enlarged recess sections to accommodate the wider sections of the pawl holders (31) and the reinforcing spring (33). The pawl holders and the reinforcing spring are secured with two lockscrews each (48). The reinforcing spring (33) is made of clock spring material, bent to shape, with a wide center section for the insertion of two lockscrews (48). The upper and lower narrow sections of the reinforcing spring (33) overlapping the ends of the power shift pawls (32), provide a sufficient spring tension to retain the detent in the 90 degrees V-grooves for either the IN or OUT position of the cubes.

p. Cube brackets. The two cube brackets (27) are made of blued cold rolled steel material with pin projections integral with the bracket. The pin projection of the upper bracket is a sliding fit in the reamed hole in the vertical centerline of the skeleton head, and it extends into the reamed hole axis in the Galilean eyepiece, lens cube right side (35) to serve as a pivot. The bracket is secured in the flat milled recess over the upper part of the cube shifting racks right and left (12 and 13) with two lockscrews (53). These lockscrews are inserted in countersunk clearance holes in the bracket on opposite sides of the pin projection and screwed in tapped holes in the right side wall of the skeleton head.

part in the right side wall of the skeleton head (1). Its gear teeth are in mesh with the teeth of both cube shifting racks right and left (12 and 13) on opposite sides. A reamed hole in the renter axis of the gear is a sliding fit over the pin projection of the power shift gear bracket (29), with its outer shoulder fitting in the countersunk recess in this bracket. This gear serves to provide movement to the opposite cube shifting rack, carrying it upward as one cube shifting rack is carried downward and vice versa.

The lower cube bracket serves the same purpose as noted for the Galilean eyepiece lens cube (3S) except that it is used for the Galilean objective lens cube (34). The lower side of this cube bracket serves as a stop for the integral stop sections of the cube shifting racks right and left (12 and 13) as they contact it alternately for the IN and OUT positions of the cubes.

q. Power shift gear bracket. The power shift gear bracket (29) is similar in construction to the cube brackets (27) except for length. It is provided with a pin projection integral with the bracket, which has a countersunk recess around the pin projection which fits over the undercut shoulder of the power shift gear (26), The pin projection serves as a pivot for the power shift gear (26) and is a sliding fit in the reamed hole in the vertical centerline of the skeleton head right side wall. It is secured over the cube shifting racks right and left (12 and 13) in the flat milled recess of the center section of the skeleton head right side wall with two lockscrews (53).

r. Head prism base bracket. The prism base bracket right (28) is constructed similarly to the cube brackets (27). It is provided with a pin projection integral with the bracket, which serves as a pivot for the reamed axis hole in the

(34). Unscrew the retainer, and remove the objective lens (64). Wrap the lens doublet in clean lens tissue and store it in a box to prevent scratches and breakage.

4. Remove the four lockscrews (54) from the gear train bracket (30). These lockscrews are unscrewed from tapped holes in the left side wall of the skeleton head (1). Careful attention and skill are required to remove the gear train bracket. Since the gear train bracket (30) has four pin projections, it must be lifted evenly. Remove the gear train bracket observing these precautions.

5. Remove the head prism shift gear (25).

6. Remove the first intermediate head prism shift gear (24).

7. Remove the second and third intermediate head prism shift gears (23 and 22).

base pivot shoulder projection of the head prism mount (2). The pin projection is a sliding fit in the reamed hole in the vertical centerline of the upper part of the skeleton head right side wall, and is secured with two lockscrews (51).

6E2. Disassembly of the skeleton head assembly. The skeleton head assembly is disassembled as follows:

1. Move the cube shifting racks right and left (12 and 13), shifting the Galilean telescope system to the OUT position. This allows the Galilean objective lens (64), lens retainer (3), eyepiece lens (63), lens mount (36), and lens mount housing (37) to be removed in the following manner.

2. Remove the three lockscrews (38) from the flange of the Galilean eyepiece lens mount housing (37). These lockscrews are unscrewed from the tapped holes in the eyepiece lens cube (35). Remove the lens mount housing (37) with the mounted eyepiece lens (63) and its mount (36). Remove the lockscrew (52), unscrewing it from the housing (37) and unscrew the mounted eyepiece lens (63) and its mount (36) from the housing (37). Wrap the mounted Galilean eyepiece lens in clean lens tissue and store it in a box to prevent scratches and breakage.

3. Scrape off the spot solder from the Galilean objective lens retainer (3) and cube

8. Remove the lockscrew (60) from the lower part of the upper front wall right side, unscrewing it from its contact with the fourth intermediate head prism shift gear shaft (21).

9. Insert a 2-64 tap or special screw in the large shoulder axis tapped hole in the fourth intermediate head prism shift gear shaft (21) and pull the shaft with the fourth intermediate head prism shift gear (20) clear of the skeleton head, removing the gear from the shaft.

10. Remove the two lockscrews (53) from the cube bracket (27) on the left side of the skeleton head (1). These lockscrews are unscrewed from the tapped holes in the left side wall of the skeleton head (1). Remove the cube bracket (27), raising it carefully in order not to break its integral pin projection.

11. Remove the head prism shifting racks right and left (14 and 15), carrying with them the assembled clamp blocks (11) and lockscrews (49).

12. Remove the two lockscrews (53) from each of the two cube brackets (27) on the right side of the skeleton head. These lockscrews are unscrewed from the tapped holes in the skeleton head right side wall. Remove both cube brackets (27), raising each one carefully in order not to break the integral pin projections of each cube bracket.

13. Remove the two lockscrews (53) from the power shift gear bracket (29). These lockscrews are unscrewed from the tapped holes in the skeleton head right side wall. Remove the power shift gear bracket (29), raising it carefully in order not to break its integral pin projection.

14. Remove the cube shifting racks right and left (12 and 13), carrying with them the assembled clamp blocks (11) and lockscrews (49).

15. Remove the power shift gear (26).

16. Remove the Galilean objective lens and eyepiece lens cubes (34 and 35) sliding them out from the center and front of each opening in the skeleton head (1).

17. Remove the two lockscrews (48) from the reinforcing spring (33), unscrewing these lockscrews from tapped holes in the center enlarged recess in the outer left vertical slot in the skeleton head right side wall. Remove the reinforcing spring (33).

18. Remove the two lockscrews (48) from each upper and lower pawl holder (31) and remove the pawl holders and pawls (31 and 32). All lockscrews (48) for pawl holders and pawls are unscrewed from tapped holes in the enlarged recesses in the outer left vertical slot in the skeleton head right side wall.

19. Remove the two lockscrews (51) from the head prism base bracket (28). These lockscrews are unscrewed from tapped bearing projections of the head prism mount base (2) and the bearing section of the eccentric arm (16) supporting the mounted head prism (62) during this procedure. Remove the mounted head prism (62) with its mount (2), mounting clamps (39 and 40), and the side plates (4 and 6).

23. Remove the two lockscrews (45) from the bent over section of each head prism side plate (4 and 6). These lockscrews are unscrewed from tapped holes in the head prism mount base (2). Remove the lockscrew (50) from each head prism side plate (4 and 6), removing the two head prism side plates, and carrying the head prism shade (9) and its wire links (10) with them. The two lockscrews (50) are unscrewed from tapped holes in opposite sides of the head prism mount (2).

24. Remove the two lockscrews (47) from each of the upper two head prism mounting clamps (39 and 40). These lockscrews are unscrewed from tapped holes in the upper opposite side beveled faces of the head prism mount (2). Remove the two head prism mounting clamps (39 and 40).

25. Slide the head prism (62) upward and out of the remaining two lower head prism mounting clamps (39 and 40), removing the head prism (62). The lower two head prism mounting clamps (39 and 40) remain in place for reassembly. Wrap the head prism in clean lens tissue and store it in a box to prevent scratches and breakage.

26. Rotate the head prism shift actuating gear (19) carrying with it

holes in the upper part of the skeleton head right side wall. Remove the head prism base bracket (28), raising it carefully in order not to break its integral pin projection.

20. Press one side of the head prism shade (9) inward to snap it out of the vertical slot of the skeleton head inner side walls.

21. Push the mounted head prism (62) out from the front of the skeleton head, swinging it with the eccentric arm (16) completely around to the rear, resting the eccentric arm on the skeleton head upper wall.

22. Remove the lockscrew (46) from the left bearing projection of the head prism mount (2). This lockscrew is unscrewed from its contact with the eccentric arm pivot pin (56). Push the eccentric pivot pin outward from the the eccentric disk shaft (18) and eccentric disk (17) and look for the small end of the taper pin (59) through the clearance hole in the large section of the eccentric arm (16). When the small end of the taper pin (59) is lined up with the opposite clearance holes in the eccentric arm, use a small drift punch to remove the taper pin.

27. Remove the lockscrews (41) located in each split bearing projection of the skeleton head upper part. These lockscrews are unscrewed from tapped holes in the lower part of each skeleton head split bearing projection. Remove the two spacer washers (42) from the split sections of the bearing projections, and place them with proper reference marks in a special envelope to separate them for reassembly.

28. Grasp the head prism shift actuating gear (19) and carry the eccentric disk shaft (18) out of the skeleton head split bearing projections and the eccentric disk (17). Remove the head prism shift actuating gear (19) and eccentric disk shaft (18). Remove the eccentric arm (16) and eccentric disk (17), carrying them out of the center section of the skeleton head split bearing projections.

29. Remove the eccentric disk (17), sliding it out of the large section of the eccentric arm. Remove the two lockscrews (43), unscrewing them from the tapped holes in the long arm and in the taper pin hole section of the low point of the eccentric disk (17) temporarily, to restrict it from rotation for the insertion of the taper pin (59).

6. Place the eccentric arm (16) with the assembled eccentric disk (17) in the section between the two split bearing projections in the upper part of the skeleton head (1). Place the eccentric disk shaft (18) with the larger section of the taper pin hole facing toward the inserted special taper pin of the eccentric arm (16) and disk (17). Place the shaft in the left split bearing projection reamed hole in the skeleton head, carrying it through the eccentric disk (17) and

section of the eccentric arm (16). Remove the two spacer washers (44) from the split section of the stub arm section of the eccentric arm (16). Mark each spacer washer (44) with proper identification marks for replacement.

30. Place the hub section of the head prism shift actuating gear (19) on a brass V-block for the removal of the taper pin (58). It requires an additional helper to drift out the taper pin (58). Remove the head prism shift actuating gear (19) from the eccentric disk shaft (18) after the removal of the taper pin (58).

6E3. Reassembly of the skeleton head assembly. The skeleton head assembly is reassembled as follows:

1. Apply Lubriplate No. 110 lightly to all rotating parts as the reassembly procedure is followed.

2. Place the head prism shift actuating gear (19) on the eccentric disk shaft (18) and secure it with a taper pin (58). The hub section of the gear faces outward.

3. Place the two spacer washers (44) in the slotted section of the eccentric arm (16), replacing them in their proper position as noted by the reference marks made upon disassembly. Insert the two lockscrews (43), screwing them down snugly to a temporary setting.

4. Place the eccentric disk (17) in the large section of the eccentric arm (16). A reference scribed line on the left side of the eccentric further into the reamed hole in the opposite split bearing projection.

7. Remove the inserted special taper pin, and insert a drift punch through the clearance hole in the eccentric arm (16) and the taper pin holes in the eccentric disk (17) and shaft (18) for proper alignment of the taper pin holes. Remove the drift punch and insert the taper pin (59), securing it tightly with the use of a drift punch and small ball peen hammer.

8. Place the spacer washers (42) in the slotted section of each split bearing projection and insert the two lockscrews (41). These lockscrews are inserted into clearance holes in each upper split bearing cap into the spacer washer clearance holes and screwed into the lower split bearing projection tapped holes. Secure each lockscrew tightly, and check the rotation of the eccentric disk shaft (18). It may be necessary to finish off each spacer washer (42) to eliminate any excessive looseness of the shaft in the split bearings, for further tightening of the caps.

9. Check the movement of the eccentric disk (17) in the eccentric arm (16). It should have free movement without looseness. This is accomplished by removing the spacer washers (44) and finishing them off lightly on a fine abrasive stone, to permit further tightening of the eccentric arm stub arm section.

10. Assemble the left and right head prism side plates (4 and 6) to opposite sides of the head prism mount (2). Secure each side plate with two lockscrews (50). These

disk (17) and the eccentric arm (16) designates their proper assembly.

5. Place a special taper pin in the clearance hole of the eccentric arm large section (16)

lockscrews extend into tapped holes in the opposite sides of the head prism mount. Insert two lockscrews

(45), one to each of the bent over sections of the two side plates (4 and 6). These lockscrews extend into tapped holes in the opposite side of the head prism mount base (2). The head prism shade (9) and wire links (10) remain assembled with the head prism side plates (4 and 6).

11. Clean the head prism (62) using clean lens tissue; also clean off any surface dust. Place the head prism with its hypotenuse face on the scraped head prism mount (2), sliding the lower 90 degree face under the 60 degree prongs of the two assembled head prism mounting clamps (39 and 40). Apply the upper two head prism mounting clamps (39 and 40) to the upper beveled side faces of the head prism mount (2), securing each with two lockscrews (47). Take precautions to note that the 60 degree prongs of the clamps touch the 90 degree faces of the head prism (62).

12. Swing the extended arm bearing of the eccentric arm (16) to the rear of the skeleton head. Place the bearing projections of the head prism mount (2) over the extended arm bearing section, and insert the eccentric arm pivot pin (56) through the

tapped holes in the skeleton head right side wall.

14. Rotate the head prism shift actuating gear (19) counterclockwise, placing the head prism (62) at the extreme limit of depression. Place the fourth intermediate head prism shift gear (20) on its shaft (21). Observe the position of the spotted recess in the stub section of the shaft for proper alignment with the tapped hole in the front lower part of the split bearing projection. Carry the fourth intermediate head prism shift gear shaft (21) with the gear (20) in the semicircular clearance provision of the skeleton head left side wall; the stub section of the shaft is carried into the reamed hole below the split bearing projection. Slide the teeth of the fourth intermediate head prism shift gear (20) into engagement with the head prism shift actuating gear teeth (19). Push the stub section of the shaft in until the medium shoulder of the shaft is in contact with the countersunk semicircular clearance provision face. Insert the lockscrew (60) in the tapped hole below the split bearing projection, screwing the lockscrew into the spotted recess in the fourth intermediate head prism shift gear shaft stub section (21) for its securement.

reamed hole in the bearing projection and the reamed hole in the extended arm bearing section of the eccentric arm (16). Carry the eccentric arm pivot pin in the opposite bearing projection of the head prism-mount (2). Secure the pivot pin (56) with a lockscrew (46) which extends into the left rear bearing projection tapped hole of the head prism mount base (2) and contacts the spotted recess in the eccentric arm pivot pin (56).

13. Swing the mounted head prism (62) and mount (2), carrying with it the eccentric arm (16), into the front clearance section of the skeleton head. Carry it in until the pin projection reamed holes of the skeleton head left and right side walls and the head prism mount side base pivot projections are in coincidence. Insert the pin projection of the head prism base bracket (28) in the reamed hole in the skeleton head sight side wall and farther into the reamed hole in the head prism mount side base pivot projection. Check the stamped reference numerals on the bracket and skeleton head for correct reassembly. Secure the bracket with two lockscrews (51). These lockscrews extend into

15. Place one side of the head prism shade (9) in the vertical slot in the skeleton head inner right side wall, and snap the opposite side of the shade into the vertical slot in the skeleton head inner left side wall.

16. Place the Galilean objective lens and eyepiece lens cubes (34 and 35) in their respective openings in the skeleton head (1). Check the cubes to ascertain that they are located for the IN position.

17. Place the pawl holders (31) and the assembled pawls (32) in the outer vertical slot in the right side wall of the skeleton head. The pawls fit in the elongated slots, and the pawl holders in the enlarged recesses in the upper and lower part of this vertical slot. Secure each pawl holder (31) with two lockscrews (48). These lockscrews extend into tapped holes in the enlarged recess slot.

18. With the Galilean objective lens and eyepiece lens cubes (34 and 35) located in the IN position, apply the right cube shifting rack

(12), placing the assembled pin projections (65) through the elongated holes in the outer right vertical slot in the skeleton head right side wall.

19. Place the left cube shifting rack (13) in the center of the

24. Reassembly of the gear train is accomplished by following the procedure outlined in Steps 23 to 26 inclusive. Place the head prism shift gear (25) in the countersunk recess in the skeleton head left side wall. Check the reference lines on the face of the head prism shift

three vertical slots in the skeleton head right side wall.

20. Reassemble the two cube brackets (27) to the flat grooves in the right side wall of the skeleton head over the cube shifting racks right and left (12 and 13). Place the pin projection of each cube bracket in the reamed holes in the skeleton head and the reamed axis hole in each cube. Carefully push the pin projection of the cube bracket down into the reamed axis hole in each cube. Secure each cube bracket with two lockscrews (53). These lockscrews extend into tapped holes in the right side wall of the skeleton head.

21. Place both head prism shifting racks right and left (14 and 15) in the vertical slots in the skeleton head left side wall. The clamp blocks (11) and lockscrews (49) remain assembled to the head prism shifting racks.

22. Reassemble the cube bracket (27) to the flat groove in the left side wall of the skeleton head over the head prism shifting racks right and left (14 and 15). Place the pin projection of the cube bracket in the reamed hole in the skeleton head and reamed hole axis in the Galilean objective lens cube (34). Carefully push the pin projection of the cube bracket down into the reamed hole axis in the cube. Secure the bracket with two lockscrews (53) which extend into tapped holes in the groove seat.

23. To align the gear train for the head prism shift mechanism, check the scribed line of the eccentric disk (17) and the gear (25) with reference lines of the right and left head prism shifting racks (14 and 15) for proper engagement. An additional vertical reference line is provided for the proper engagement of the first intermediate head prism shift gear (24). The head prism shift gear (25) teeth engage on opposite sides with the head prism shifting racks (14 and 15).

25. Place the first intermediate head prism shift gear (24) so that its reference line coincides with the reference line of the head prism shift gear (25) for proper engagement in the countersunk recess in the skeleton head left side wall.

26. Place the second and third intermediate head prism shift gears together in the small and large countersunk recesses in the left side wall of the skeleton head. Check the reference line of the second intermediate head prism shift gear (23) for proper engagement by lining it up with the corresponding reference line of the first intermediate head prism shift gear (24). The third intermediate head prism shift gear (22) assembled to the second gear (23) engages with the teeth of the fourth gear (20) when the alignment stated in Step 23 is maintained.

27. Ascertain that all bearing holes of this gear train align with the reamed holes in the skeleton head left side wall. Carefully place the pin projections of the gear train bracket (30) in the center bearing holes in the gear train and press downward slowly. The second upper pin projection will enter first. It extends into the first

eccentric arm (16) large section for coincidence. This position places the head prism (62) in the full elevated position. In this position move the left head prism shifting rack (15) upward until its stop is in contact with the lower side face of the cube bracket (27). Move the right head prism shifting rack (14) downward and measure a distance of 0.625 inch from the lower side face of the cube bracket (27) to the upper shoulder of the integral stop of the head prism shifting rack. This distance is required to shift the head prism (62) to 45 degrees elevation and 10 degrees depression.

intermediate head prism shift gear (24), and farther into the skeleton head left side wall and reamed hole axis in the pivot shoulder projection of the head prism mount (2). The lower pin projection extends into the skeleton head left side wall and into the reamed hole axis in the Galilean eyepiece lens cube (35). Secure the gear train bracket with four lockscrews (54) which extend into tapped holes in the skeleton head left side wall.

28. With the use of a surface gage and dial indicator attachment, stand the skeleton head

on a surface plate. Measure the front and rear sides of the upper face of the Galilean eyepiece lens cube (35). Release the two lockscrews (48) and move the upper pawl holder (31) and pawl (32) axially to obtain a true horizontal measurement. Secure the two lockscrews (48) after the true horizontal measurement is ascertained.

Follow the same procedure for the Galilean objective lens cube (34) using the lower face of the cube for determining the true horizontal measurement. Release the two lockscrews (48) and move the lower pawl holder (31) and pawl (32) axially to obtain a true horizontal measurement. This measurement determination of the Galilean telescope mechanism in a true horizontal position is made so that upon the assembly of the lenses, the

hole axis in the power shift gear (26) and farther into the reamed hole in the skeleton head side wall. Secure the bracket with two lockscrews (53) which extend into tapped holes in the skeleton head right side wall.

31. Check the movement of the Galilean objective lens and eyepiece lens cubes (34 and 35) in the IN and OUT positions to ensure that a positive engagement of the pawls in the 90 degrees V-grooves in the cubes is obtained.

32. Shift the Galilean objective lens and eyepiece lens cubes (34 and 35) to the OUT position.

33. Clean the Galilean eyepiece lens (63), using clean lens tissue; also clean off the surface dust.

34. Reassemble the mounted Galilean eyepiece lens (63) and mount (36) in the lens mount

optical line of sight of this system will be parallel to the optical line of sight of the remaining telescope systems. This prevents a pronounced general aberration which results when the IN position pawl holders (31) and pawls (32) have a faulty alignment.

29. With the Galilean objective lens and eyepiece lens cubes (34 and 35) located in the IN position, place the left cube shifting rack (13) with its integral stop against the lower side face of the lower cube bracket (27). In this position, insert the power shift gear (26) to coincide its reference mark with the mating reference mark of the right cube shifting rack (12) in the countersunk recess in the skeleton head right side wall. The teeth of the gear in the countersunk recess mesh with the teeth in the right and left cube shifting racks (12 and 13) on opposite sides. The clamp blocks) (11) and lockscrews (49) remain assembled to the cube shifting racks.

30. Reassemble the power shift gear bracket (29) to the flat, groove in the right side wall of the skeleton head over the cube shifting racks right and left (12 and 13). Carefully: push the pin projection of the bracket into the reamed

housing (37). Attach the housing to the lens cube (35), placing the pivot hole downward, and securing it with three lockscrews (38). These lockscrews extend into tapped holes in the face of the cube. Collimation of this lens doublet will be accomplished in the collimation of the instrument.

35. Clean the Galilean objective lens (64), using clean lens tissue; also clean off any surface dust. Place this lens doublet in the objective lens cube (34), with the flint element resting in the counterbored seat in the cube and replace the retainer ring (3), clamping the lens doublet. Spot solder the retainer ring to the cube to prevent its backing off the threaded periphery of the cube.

36. Shift the head prism (62) to the zero line of sight by eyesight, and shift the Galilean telescope system to the IN position. Wrap the skeleton head assembly in clean lens tissue and store conveniently to preserve it from damage, until the assembly is required for collimation.

Chapter 6 Continued

F. UPPER TELESCOPE SYSTEM

6F1. Description of the upper telescope system assembly Part I. The upper telescope system is divided into two individual assemblies, namely:

Part I: First, second, third, fourth, and fifth reduced tube sections, fifth and sixth inner tube sections.

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Part II: Second, third, and fourth inner tube sections.

The upper telescope system is divided principally to permit familiarization as to nomenclature, description, disassembly, and reassembly. It is composed of 3 lenses, namely: a positive upper eyepiece lens doublet, a plano convex telemeter lens, and an air space upper objective lens doublet. This system is used in reverse to decrease the lower telescope system to a 6-power magnification. Figure 6-5 shows the upper telescope system assembly Part I. All bubble numbers in Section 6F1 refer to Figure 6-5 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1257-7	1	Fifth reduced tube section
2	P-1253-3	1	Fourth reduced tube section
3	P-1253-	1	Upper

Ill. No.	Drawing Number	Number Required	Nomenclature
26	P-1362-13	1	Air line strap
27	P-1422-1	2	Air line strap lockscrews
28	P-1204-3	1	Sixth inner tube section
29	P-1179-24	8	Sixth inner tube section lower end coupling lockscrews
30	P-1204-2	1	Sixth inner tube section upper end coupling
31	P-1204-4	1	Sixth inner tube section lower end coupling
32	P-1260-11	4	Sixth inner tube section and upper end coupling lockscrews
33	P-1310-	4	First reduced

	1		eyepiece lens mount
4	P-1253-2	1	Upper eyepiece lens clamp ring
5	P-1260-18	4	Upper eyepiece lens mount and fifth and fourth reduced tube section lockscrews
6	P-1260-19	1	Upper, eyepiece lens clamp ring lockscrew
7	P-1260-23	2	Fourth and third reduced tube section lockscrews
8	P-1396-5	1	Upper eyepiece lens
9	P-1254-4	1	Third reduced tube section
10	P-1253-5	1	Telemeter lens mount
11	P-1253-5A	1	Telemeter lens clamp ring
12	P-1260-20	1	Telemeter lens mount angular alignment lockscrew
13	P-1260-21	2	Third and second reduced tube section lockscrews
14	P-4260-24	2	Telemeter lens clamp ring lockscrews
15	P-1396-6	1	Telemeter lens

	34		tube section and sixth inner tube section upper end lockscrews
34	P-1361-3	2	Tape straps
35	P-1361-6	1	Air line section continuation
36	P-1362-6	1	Air line coupling
37	P-1362-7	1	Air line section
38	P-1362-13	1	Air line strap
39	P-1362-14	2	Air line straps (soldered)
40	P-1422-1	2	Air line strap lockscrews
41	P-1204-5	1	Fifth inner tube section
42	P-1179-23	8	Fifth inner tube section upper and lower end lockscrews
43	P-1179-23	4	Upper objective lens mount lockscrews
44	P-1179-35	1	Upper objective lens clamp ring lockscrew
45	P-1204-6	1	Upper objective lens mount
46	P-1204-7	1	Upper objective lens clamp ring
47	P-1362-7	1	Air line section continuation

16	P-1396-6A	1	Telemeter lens lockscrew
17	P-1253-6	1	Second reduced tube section
18	P-1260-22	4	Second and first reduced tube section lockscrews
19	P-1361-5	2	Tape straps
20	P-1361-7	1	Air line adapter (soldered)
21	P-1362-14	1	Air line strap (soldered)
22	P-1361-6	1	Air line section
23	P-1204-1	1	First reduced tube section
24	P-1361-4	2	Tape straps
25	P-1361-6	1	Air line section continuation

48	P-1396-7A	1	Upper objective lens flint element
49	P-1396-7B	1	Upper objective lens crown element
50	P-1417-5	1	Upper objective lens spacer ring

a. Fifth reduced tube section. The fifth reduced tube section (1) is made of brass rod, and is 5 1/4 niches in length. It serves to provide the necessary distance between the skeleton head assembly and the fourth reduced tube section (2).

The upper part is smooth turned, to serve as an alignment support section, and has a threaded periphery section. The alignment support and threaded periphery sections receive the internal threaded and counterbored alignment support sections in the lower part of the skeleton head

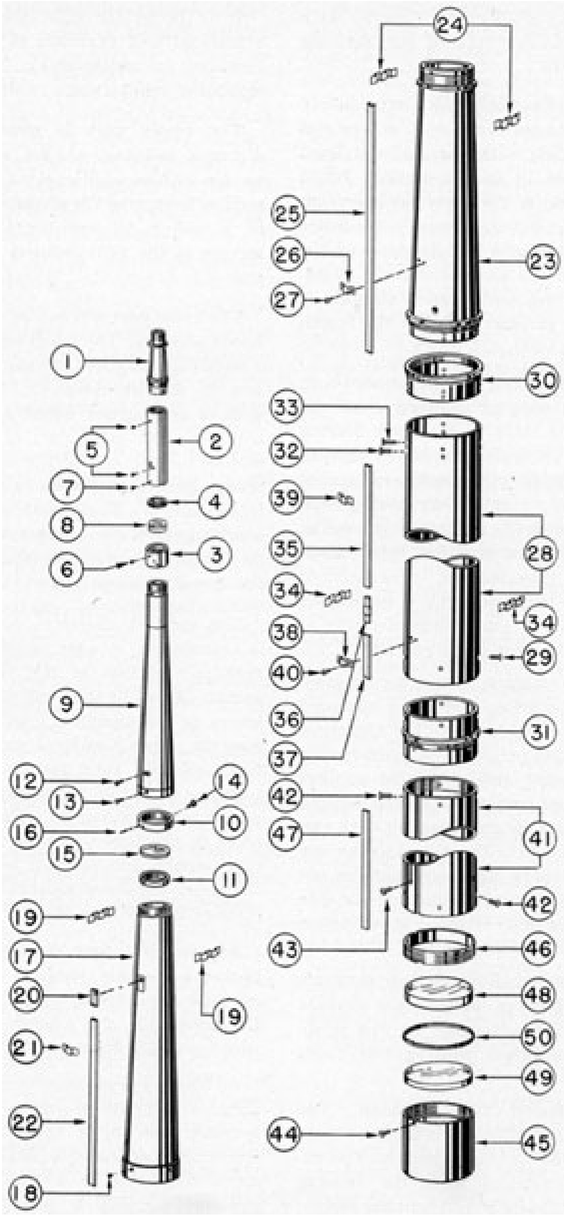

Figure 6-5. Upper telescope system assembly, Part I.

(1, Figure 6-4) and are secured together with two opposite lockscrews (55) of the skeleton head assembly.

A bearing flange of nominal width immediately follows the threaded periphery section, and has a diameter coinciding with the skeleton head periphery, a sliding fit in the straight bored 1.99 external section of the outer taper section (1, Figure 6-2). The bearing flange in the lower part is the same thickness and diameter and is also a sliding fit in the straight bored 1.99 external section of the outer taper section. It

It is bored for light transmission, leaving a nominal wall thickness of 0.080 inch, and is threaded for antireflection between the upper and lower counterbored sections.

The upper part is counterbored a short distance, serving as an alignment support section with an additional counterbored threaded section to receive the alignment support section of a sliding fit and the threaded periphery section of the fifth reduced tube section lower part (1).

coincides with the periphery wall of the fourth reduced tube section (2).

The external body of this section between both bearing flanges is tapered outward from the upper bearing flange down to the lower bearing flange. The inner circumference of the tapered section is counterbored with a uniform tapered wall thickness of 3/32 inch, commencing from the lower counterbored section and ending at the upper bored section for light transmission, and is threaded for antireflection. The upper part is bored straight a distance of 1 inch, with a straight counterbored section of 1.110 inch in length in the lower part.

The lower part is smooth turned, serves as an alignment support section, and has a threaded periphery section preceding it. The alignment support and threaded periphery sections receive the internal threaded and alignment support sections in the upper part of the fourth reduced tube section, and are secured together with two opposite lockscrews (5). These lockscrews are inserted in countersunk clearance holes in the fourth reduced tube section (2 and screwed into tapped holes in the fifth reduced tube section lower alignment support section.

At assembly, four shallow vertical slots are provided in both bearing flanges, two opposite the others to provide clearance for the prism tilt and change of power shifting wire tapes (38, Figure 4-28).

b. Fourth reduced tube section. The fourth reduced tube section (2) is made of brass tubing, and is 6.450 inches in length. The external The lower part is provided with three counterbored sections. The small counterbored section 2 inches long carries the mounted upper eyepiece lens (8) and its mount (3). Two opposite axial slots of appropriate length are provided in the wall near the lower part of this counterbored section for the insertion of two opposite special screws into tapped holes in the upper eyepiece lens mount (3). These two special inserted screws serve to carry the upper eyepiece lens (8) and its mount (3) vertically during collimation of the upper telescope system.

The medium diameter counterbored section is threaded to engage on the upper threaded periphery section of the third reduced tube section (9), while the large counterbored section serves as an alignment support of a sliding fit over the upper alignment support section of the third reduced tube section, and are secured together with two lockscrews (7). These lockscrews are inserted in countersunk clearance holes in the lower part of the fourth reduced tube section and screwed into tapped holes in the upper alignment support section of the third reduced tube section (9).

At assembly, four vertical shallow slots are provided in this reduced tube section, two opposite the others, to provide clearance for the prism tilt and change of power shifting wire tapes (38, Figure 4-28).

c. Upper eyepiece lens, mount, and clamp ring. 1. Upper eyepiece lens. The upper eyepiece lens (8) is made of two optical elements. It consists of a piano concave flint element cemented to a double convex crown

diameter coincides with the bearing flange diameter of the fifth reduced tube section (1) and is a sliding fit in the straight bored 1.99 external section of the outer taper section.

element, forming a positive doublet. It is mounted in the upper eyepiece lens mount (3) with the crown element resting in the seat of

the mount, and is secured with an upper eyepiece lens clamp ring (4) which is secured with its lockscrew (6).

2. Upper eyepiece lens mount. The upper eyepiece lens mount (3) is made of brass tubing, and is 1 1/4 inch in length. It is bored for light transmission and has two counterbored sections. The small counterbored section carries the upper eyepiece lens doublet (8), while the large counterbored section is threaded to carry the threaded periphery of the upper eyepiece lens clamp ring (4). The lower face is chamfered from the bore at an angle of 15 degrees outward. Two opposite clearance holes are located in the wall of this chamfered section for the insertion of a special pair of calipers in order that, the assembled mount can be carried out of the lower part of the fourth reduced tube section (2). The mount is an axial sliding fit in the small counterbored section in the lower part of the fourth reduced tube section.

The mount is moved axially during collimation by the two special screws inserted in the opposite axial slots in the fourth reduced tube section and screwed into opposite tapped holes in the mount. This axial movement is necessary to obtain correct adjustment for definition and the elimination of parallax in the upper and lower

d. Third reduced tube section. The third reduced tube section (9) is made of brass rod, and is 17.634 inches in length. The upper part is smooth turned a short distance and serves as an alignment support section with a threaded periphery section preceding it. The threaded periphery and alignment support section receive the counterbored alignment support section and internal threaded section in the lower part of the fourth reduced tube section (2), and are secured together with two lockscrews (7).

The external diameter is turned straight 2 inches below the alignment support section. From this point the wall is tapered outward down to the 5/8-inch straight section.

The lower part is provided with two counterbored sections. The small counterbored section carries the telemeter lens mount (10) of a sliding fit, and is provided with two opposite vertical air channel slots for the passage of nitrogen. These two channel slots extend vertically inch above the small counterbored shoulder.

A circumferential slot of appropriate length with an additional similar recess is provided in the wall and located in the center of this small counterbored section, to accommodate an angular alignment lockscrew (12). It is used to permit

telescope systems during collimation. The mount is secured in the fourth reduced tube section (2) with two lockscrews (5) after, collimation. These lockscrews are inserted in countersunk clearance holes in the fourth T educed tube section (2) and screwed into tapped holes in the mount.

Two opposite narrow air channel slots are provided in the periphery of the mount to allow sufficient clearance for the passage of nitrogen.

3. Upper eyepiece lens clamp ring. The upper eyepiece lens clamp ring (4) is made of brass tubing, and is of nominal thickness and width. The periphery is threaded for engagement in the counterbored threaded section in the upper part of the eyepiece lens mount (3) to secure the lens doublet. The clamp ring is bored for light transmission, and is threaded for antireflection. Two opposite slots are provided in the face of the clamp ring for the insertion of a special wrench. The clamp ring is secured with a lockscrew (6) which is inserted in a countersunk clearance hole in the mount (3) and screwed into the tapped hole in the clamp ring.

angular adjustment of the telemeter lens mount (10) during collimation, so that the telemeter lens line will lie in a true vertical plane. The angular alignment lockscrew is inserted in the circumferential slot and screwed in a tapped hole in the telemeter lens mount (10), while the head of the lockscrew rests on the circumferential recess face.

The large counterbored section is threaded and serves as an alignment support section to receive the upper threaded periphery alignment support section of the second reduced tube section (17) to which it is secured with two opposite lockscrews (13).

The inner surface of this reduced tube section is bored tapered, commencing from a diameter of 1.420 inch in the upper part to a diameter of 1.590 inch, in a length of 3 21/32 inches, and is threaded for antireflection starting from the upper end for a distance of 3.152 inches. The remainder of the inner surface is counterbored tapered from the small straight counterbored

section in the lower part to the diameter of 1.590 inch, and threaded for antireflection.

At assembly, four vertical shallow slots are provided in both shoulder flanges, to provide clearance for the prism tilt and change of power shifting wire tapes (38, Figure 4-28).

e. Telemeter lens, mount, and clamp ring. 1. Telemeter lens. The

3. Telemeter lens clamp ring. The telemeter lens clamp ring (11) is made of brass tubing, and is of nominal thickness and width. It is a push fit in the counterbored section in the telemeter lens mount (10). This clamp ring fits snugly against the convex surface of the telemeter lens, and is secured with two opposite lockscrews (14). These lockscrews are inserted in

telemeter lens (15) is made of one ordinary crown piano convex element. The piano surface is etched with vertical and horizontal calibrations in degrees of true field, and provides a means of measuring the angular size of a target. Refer to Section 4U7, Paragraph a, for further detail.

The telemeter lens is placed in the image plane of the upper telescope and first real image plane of the periscope, so that the graduations appear to vibrate in unison with the image, and observation is easier.

The telemeter lens periphery is provided with a vertically stoned groove. A lockscrew (16) in the telemeter lens mount (10) fits in this groove, thus permitting the lens to be reassembled in its original position, and preventing any angular shift of the telemeter lens in the mount. The piano surface of the lens is placed toward the seat of the mount, and is secured with a clamp ring (11) and lockscrew (14).

2. Telemeter lens mount. The telemeter lens mount (10) is made of brass tubing and is 1/2 inch in width. Its inside diameter is bored for light transmission. The mount is a sliding fit into the counterbored section in the lower part of the third reduced tube section (9), and is secured after collimation with an angular alignment lockscrew (12). The mount is counterbored to carry the telemeter lens (15) and telemeter lens clamp ring (11). The mount is provided with a small lockscrew (16) located as a permanent fitting and filed off so that the protruding section of the lockscrew will allow the free disassembly and reassembly of the telemeter lens in the mount. This countersunk clearance holes in the telemeter lens mount (10) and screwed into tapped holes in the clamp ring. The bore of the clamp ring is threaded for antireflection. The clamp ring is provided with opposite holes for the insertion of a special pair of calipers for the removal of the assembled telemeter lens mount (10).

f. Second reduced tube section. The second reduced tube section (17) is made of phosphor bronze and is 22 1/2 inches in length. It serves to enclose the light rays to their designed clear aperture area for its length and provides a partial assembly of the upper telescope system.

The upper part has a threaded periphery alignment support section to receive the internal threaded section of the lower part of the third reduced tube section (9) and is secured together with two lockscrews (13). These lockscrews are inserted in countersunk clearance holes in the third reduced tube section (9) and screwed in tapped holes in the upper threaded periphery alignment support section of the second reduced tube section.

The external circumference is tapered from the upper alignment support section downward to the straight turned shoulder section. The inner surface is bored tapered for light transmission and threaded for antireflection, commencing from the small straight counterbored section in the lower part.

The straight turned shoulder 1 1/4 inches long in the lower part provides sufficient wall area for the small counterbored and larger counterbored threaded sections.

protruding section of the lockscrew when engaged in the stoned vertical groove in the telemeter lens periphery, prevents it from shifting angularly in the mount and also provides the original reassembly of the lens in the mount.

The small counterbored section serves as an alignment support section, a sliding fit over the upper alignment support section of the first reduced tube section (23). The large counterbored threaded section engages on the upper threaded periphery of the first reduced tube section (23) and is secured to it with four lockscrews (18).

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At assembly an air line adapter (20) is soldered to the upper periphery wall of this reduced tube section over a small clearance hole for the introduction of nitrogen. An air line strap (21) is soldered to the periphery wall of this reduced tube section several inches below the air line adapter (20) to retain the air line section (22). This air line section is connected in the opening of the air line adapter (20) and extends downward over the lower joint of this reduced tube section.

Two opposite tape straps (19) are soldered to the upper periphery wall of this reduced tube section, located 2 3/4 inches from the upper end, and retain the prism tilt and change of power shifting wire tapes (38, Figure 4-28) at their required vertical centerline position.

g. Air line adapter. The air line adapter (20) consists of a piece of flat brass air line with the upper end closed, and is provided with a 1/8-inch diameter drilled hole located 7/64 inch from the upper end. The adapter is soldered to the periphery of the upper part of the second reduced tube section (17) with both 1/8-inch holes in coincidence. The

The bearing flange in the lower part is the same width as the upper shoulder flange, except that its diameter is within a few thousandths-inch smaller than the outer tube inner diameter in order to provide a sliding fit.

The external body of this section between the upper shoulder flange and lower bearing flange is tapered outward and downward. The inner circumference of this reduced tube section is bored tapered its entire length with a uniform wall thickness of 7/64 inch between the flanges for light transmission. It is threaded for antireflection.

The lower part is smooth turned and serves as an alignment support section in the bored diameter of the sixth inner tube section upper end coupling (30). The threaded periphery section preceding this alignment support section engages in the internal threaded section in the sixth inner tube section upper end coupling (30) and is secured with four lockscrews (33). These lockscrews are inserted in countersunk clearance holes in the upper part of the sixth inner tube section (28) with clearance holes in its upper end coupling (30) and

lower opening of the adapter receives the air line section (22).

h. First reduced tube section. The first reduced tube section (23) is made of cast phosphor bronze, and is 22.646 inches in length. It serves to enclose the light rays to their designed clear aperture area for this, length and provides partial assembly of the upper telescope system.

The upper part is smooth turned, to serve as an alignment support section, and has threaded periphery section. The alignment support and threaded periphery sections receive the internal threaded and counterbored alignment support sections of the lower part of the second reduced tube section (17) and are secured together with four lockscrews (18). These lockscrews are inserted in countersunk clearance holes in the second reduced tube section (17) and screwed into tapped holes in 4 the upper alignment support section of the first reduced tube section.

A shoulder flange of nominal width immediately follows the threaded periphery section, and has a diameter coinciding with the lower part of the second reduced tube section (17).

screwed in tapped holes in the lower alignment support section of the first reduced tube section (23).

The central part of this reduced tube section is provided with a removable air line strap (26) to retain the air line section continuation (25). It is secured with two lockscrews (27) which are inserted in clearance holes in the air line strap and screwed into tapped holes in the periphery wall of this reduced tube section. The air line continuation (25) is the extension of the air line section (22) of the second reduced tube section (17), and extends the entire length of this reduced tube section.

Four tape slots are provided in both flanges, two opposite the others to provide free movement of the prism tilt and change of power shifting wire tapes (38, Figure 4-28), Two tape straps (24) are soldered to opposite sides on the periphery, located 2 1/8 inches from the upper shoulder flange to provide vertical guidance to the shifting wire tapes.

One air port is provided in the lower part, and is located 1 inch from the lower bearing flange. A wire screen is placed in the countersunk

section of a clearance hole with a brass bushing soldered in the countersunk section against the wire screen. The bushing is filed down to conform to the contour of this reduced tube section periphery.

i. Sixth inner tube section. The sixth inner tube section (28) is made of brass tubing and is 31 1/4 inches in

tapped holes in the periphery wall of the lower part of this inner tube section.

Two opposite tape straps (34) are soldered to the lower part of this inner tube section periphery wall, to provide vertical guidance to the prism tilt and change of power shifting wire tapes (38, Figure 4-28).

length. Its inner and outer diameter are uniform the entire length. The upper part is a push fit and is soldered on the lower alignment support section of the sixth inner tube section upper end coupling (30) with four lockscrews (32). These lockscrews are inserted in soldered countersunk clearance holes in the upper part of the sixth inner tube section and screwed into soldered tapped holes in the lower alignment support section of the sixth inner tube section upper coupling (30), to form a permanent joint.

The lower part of this inner tube section is a push fit and is soldered on the upper alignment support section of the sixth inner tube section lower end coupling (31) with eight lockscrews (29). These lockscrews are inserted in soldered countersunk clearance holes in the lower part of the sixth inner tube section, and screwed into soldered tapped holes in the upper alignment support section of the sixth inner tube section lower end coupling (31) to form a permanent joint.

The aid line section, continuation (35) of this inner tube section extending downward from the airline section continuation (25) of the first reduced tube section (23) and the air line section (22) of the second reduced tube section (17), ends in the lower part of this inner tube section. An air line coupling (36) is soldered in the lower end of the air line section continuation (35). The upper part of this continuation (35) is retained by two soldered air line straps (39) to the periphery wall of this inner tube section.

The air line section (37) located in the lower part of this inner tube section, connects to the soldered air

j. Sixth inner tube section upper and lower end couplings. 1. Sixth inner tube section upper end coupling. The sixth inner tube section upper end coupling (30) is identical to the sixth inner tube section upper end coupling (26, Figure 4-20) Type II periscope. Refer to Section 4I1.

At assembly it is provided with a vertical air line slot to allow for clearance of the air line section continuation (25) extending downward from the first reduced tube section (23).

There are no air ports in this coupling as there are in the Type II periscope.

2. Sixth inner tube section lower end coupling. The sixth inner tube section lower end coupling (31) is identical to the sixth inner tube section lower end coupling (27, Figure 4-20) of the Type II periscope. Refer to Section 4I1.

At assembly it is provided with a vertical air line slot to provide clearance for the air line section (37) extending downward from the lower part of the sixth inner tube section (28).

k. Fifth inner tube section. The fifth inner tube section (41) is identical to the fifth inner tube section (34, Figure 4-20) of the Type II periscope. Refer to Section 411.

At assembly it is provided with a vertical air line slot to allow for clearance of the air line section continuation (47) of this section extending downward from the air line section (37) of the sixth inner tube section (28).

l. Upper objective lens, mount, spacer ring, and clamp ring. 1.

line coupling (36) and is retained in place with a removable air line strap (38) which is secured with two lockscrews (40). These lockscrews are inserted in clearance holes in the air line strap (38) and screwed into

Upper objective lens. The upper objective lens is made of two optical elements. It consists of a plano concave flint element (48) separated from the crown element with a spacer ring (50). The second is a double convex crown element (49) forming an air space doublet. The doublet is

mounted on the upper objective lens mount (45) and is secured with a threaded clamp ring (46) and its lockscrew (44).

2. Upper objective lens mount. The upper objective lens mount (45) is identical to the upper objective lens mount (38, Figure 4-20 of the Type II periscope. Refer to Section 4I1.

3. Upper objective lens spacer ring. The upper objective lens spacer ring (50) is identical to the upper objective lens spacer ring (40 Figure 4-20) of the Type II periscope. Refer to Section 4I1.

4. Upper objective lens clamp ring. The upper objective lens clamp ring (46) is identical to the upper objective lens clamp ring (39 Figure 4-20) of the Type II periscope. Refer to Section 4I1.

6F2. Description of the upper telescope system assembly Part II: second, third, and fourth inner tube sections. These three inner tube sections have new lenses, but form the necessary inner tube bodies to enclose the inter-objective parallel light ray that are deflected downward to the magnifying lower telescope system. Figure 6-6 shows the upper telescope system assembly Part II. All bubble numbers

Ill. No.	Drawing Number	Number Required	Nomenclature
13	P-1179-24	4	Third inner tube section lower end coupling and second inner tube section upper end coupling lockscrews
14	P-1179-53	6	Diaphragm lockscrews
15	P-1205-2	1	Third inner tube section lower end coupling
16	P-1205-3	1	Third inner tube section upper end coupling
17	P-1207-6	2	Diaphragms
18	P-1361-3	2	Tape straps
19	P-1362-5	1	Air line section
20	P-1362-6	1	Air line coupling
21	P-1362-7	1	Air line section continuation

in Section 6F2 refer to Figure 6-6 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1205-1	1	Fourth inner tube section
2	P-1179-24	1	Fourth inner tube section upper and lower end lockscrews (soldered)
3	P-1179-24	4	Fourth inner tube section lower end coupling lockscrews and third inner tube section upper end coupling lockscrews
4	P-1204-8	1	Fourth inner tube section upper end coupling
5	P-1205-2	1	Fourth inner tube section lower end coupling
6	P-1207-5	1	Diaphragm
7	P-1310-13	3	Diaphragm lockscrews
8	P-1361-3	2	Tape straps
9	P-1362-7	1	Air line section continuation
10	P-1362-14	7	Air line straps (soldered)
11	P-1205-1	1	Third inner tube section
22	P-1362-14	6	Air line straps (soldered)
23	P-1205-1	1	Second inner tube section
24	P-1179-24	8	Second inner tube section upper and lower end coupling lockscrews (soldered)
25	P-1205-3	1	Second inner tube section upper end coupling
26	P-1205-4	1	Second inner tube section lower end coupling
27	P-1207-5	3	Diaphragms
28	P-1310-13	9	Diaphragm lockscrews
29	P-1361-3	2	Tape straps
30	P-1362-5	1	Air line section continuation
31	P-1362-13	1	Air line strap
32	P-1362-14	6	Air line straps (soldered)
33	P-1422-1	2	Air line strap lockscrews

a. Fourth inner tube section. The fourth inner tube section (1) is identical to the fourth inner tube section (1, Figure 4-21) of the Type II periscope. Refer to Section 4I2.

Two tape straps (8) are soldered to opposite sides of the periphery in the lower part to provide the vertical guidance to the prism tilt

12	P-1179-24	16	Third inner tube section upper and lower end coupling lockscrews (soldered)

and change of power shifting wire tapes (38, Figure 4-28).

The internal diameter of this inner tube section carries a diaphragm (6) which is located in the central part and is secured with three lockscrews (7).

The upper part of this inner tube section is a push fit and is soldered on the lower alignment support section of the fourth inner tube section upper end coupling (4) with eight lockscrews (2). These lockscrews are inserted in soldered countersunk clearance holes in the upper part of the fourth inner tube section and screwed into

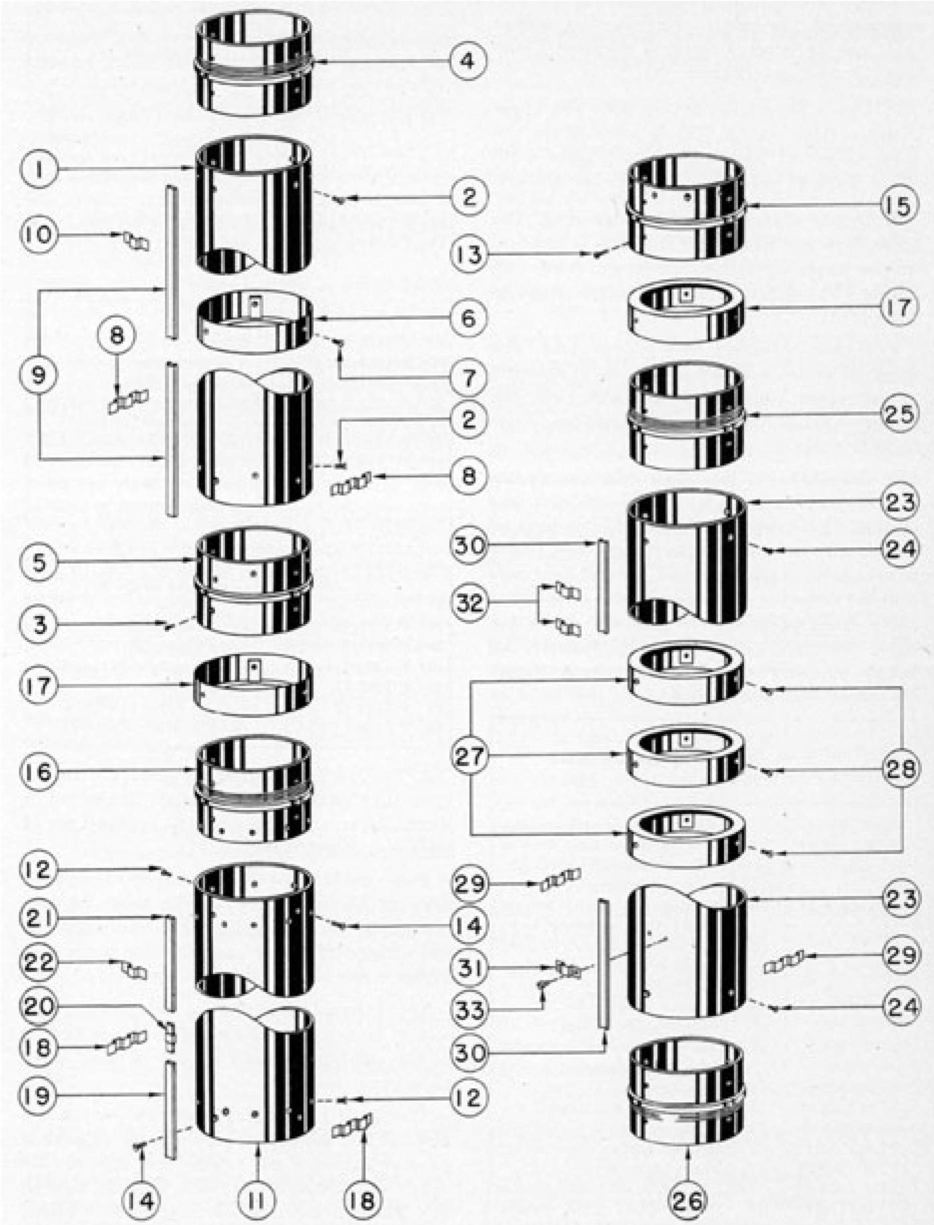

Figure 6-6. Upper telescope system assembly, Part II.

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soldered tapped holes in the lower alignment support section of the fourth inner tube section upper end coupling (4) to form a permanent joint.

The lower part of this inner tube section is a push fit and is soldered on the upper alignment support section of the fourth inner tube section lower end coupling (5) with eight lockscrews (3). These lockscrews are inserted in soldered countersunk clearance holes in the lower part of the fourth inner tube section and screwed into soldered tapped holes in the upper alignment support section of the

c. Third inner tube section. The third inner tube section (11) is identical to the third inner tube section (11, Figure 4-21) of the Type II periscope. Refer to Section 4I2.

Two tape straps (18) are soldered to opposite sides on the periphery wall in the lower part to provide vertical guidance to the prism tilt and change of power shifting wire tapes (38, Figure 4-28).

The upper part of the third inner tube section (11) is a push fit and is soldered on the lower alignment support section of the third inner

fourth inner tube section lower end coupling (5).

The air line section continuation (9) extends the entire length of this inner tube section, and is part of the air line section continuation (47, Figure 6-5) of the fifth inner tube section (41) and the air line section (37) of the sixth inner tube section (28). It is retained to this inner tube section with seven air line straps (10), which are soldered to the periphery wall.

b. Fourth inner tube section upper end coupling, diaphragm, and lower end coupling. 1. Fourth inner tube section upper end coupling. The fourth inner tube section upper end coupling (4) is identical to the fourth inner tube section upper end coupling (5, Figure 4-21) of the Type II periscope. Refer to Section 4I2.

At assembly it is provided with a vertical air line slot to allow for clearance of the air line section continuation (47, Figure. 6-5) extending downward from the fifth inner tube section (41).

2. Diaphragm. The diaphragm (6) is identical to the diaphragm (7, Figure 4-21) of the Type II periscope. Refer to Section 4I2.

3. Fourth inner tube section lower end coupling. The fourth inner tube section lower end coupling (5) is identical to the fourth inner tube section lower end coupling (6, Figure 4-21) of the Type II periscope. Refer to Section 4I2.

At assembly it is provided with a vertical air line slot to allow for clearance of the air line section continuation (9) extending downward from the fourth inner tube section (1).

tube section upper end coupling (16) with eight lockscrews (12). These lockscrews are inserted in soldered countersunk clearance holes in the upper part of the third inner tube section and screwed into soldered tapped holes in the lower alignment support section of the third inner tube section upper end coupling (16) to form a permanent joint.

The lower part of this inner tube section is a push fit and is soldered on the upper alignment support section of the third inner tube section lower end coupling (15) with eight lockscrews (12). These lockscrews are inserted in soldered countersunk clearance holes in the lower part of the third inner tube section and screwed into soldered tapped holes in the upper alignment support section of the third inner tube section lower end coupling (15).

The air line section continuation (21) extending downward on this inner tube section, ends in its upper part and is retained to the periphery wall of the third inner tube section with two soldered air line straps (22). An air line coupling (20) is soldered in the lower end of the air line section continuation (21).

The air line section (19) located in the upper part of this inner tube section, connects to the soldered air line coupling (20) and is retained in place with four air line straps (22) soldered on the periphery wall of this inner tube section.

d. Third inner tube section upper end coupling, diaphragms, and lower end coupling. 1. Third inner tube section upper end coupling. The third inner tube section upper

end coupling (16) is identical to the third inner tube section upper end coupling (17, Figure

4-21) of the Type II periscope. Refer to Section 4I2.

At assembly it is provided with a vertical air line slot to allow for clearance of the air line section continuation (9) extending downward from the fourth inner tube section (1).

2. Diaphragms. The two diaphragms (17) are identical to the two diaphragms (18, Figure 4-21) of the Type II periscope. Refer to Section 4I2.

One is secured in the bore in the lower part of the third inner tube section upper end coupling (16) with its side wall facing downward. It is secured with three lockscrews (14), which are inserted in countersunk clearance holes in the upper part of the third inner tube section (11) in clearance holes in its upper end coupling (16) and screwed into tapped holes in the diaphragm (17).

The second diaphragm (17) is secured with three lockscrews (14) which are inserted in countersunk clearance holes in the lower part of the third inner tube section (11) in clearance holes in its lower end coupling (15) and screwed into tapped holes in the diaphragm (17).

3. Third inner tube section lower end coupling. The third inner tube section lower end coupling (15) is identical to the third inner tube section lower end coupling (16, Figure 4-21) of the Type II periscope. Refer to Section 4I2.

At assembly it is provided with a vertical air line slot to allow for support section of the second inner tube section upper end coupling (25) to form a permanent joint.

The lower part of this inner tube section is a push fit and is soldered on the upper alignment support section of the second inner tube section lower end coupling (26) with four lockscrews (24). These lockscrews are inserted in soldered countersunk clearance holes in the lower part of the second inner tube section (23) and screwed into soldered tapped holes in the upper Alignment support section of the second inner tube section lower end coupling (26) to form a permanent joint.

Two tape straps (29) are soldered on opposite sides of the periphery in the lower part to provide vertical guidance for the prism tilt and change of power shifting wire tapes (38, Figure 4-28).

The air line section continuation (30) extends the entire length of this inner tube section from the air line section (19) of the third inner tube section (11). This air line section continuation (30) is retained to the periphery wall of this inner tube section with six soldered air line straps (32) and a removable air line strap (31) secured with two lockscrews (33). These lockscrews are inserted in clearance holes in the air line strap (31) and screwed into tapped holes in the periphery wall of this inner tube section.

clearance of the air line section (19) of the third inner tube section (11).

e. Second inner tube section. The second inner tube section (23) is made of brass tubing and is 96.400 inches in length. The inner and outer diameters are uniform throughout the entire length.

The upper part of this inner tube section is a push fit and is soldered on the lower alignment support section of the second inner tube section upper end coupling (25) with four lockscrews (24). These lockscrews are inserted in soldered countersunk clearance holes in the upper part of the second inner tube section and screwed into soldered tapped holes in the lower alignment

The internal diameter of this inner tube section carries three diaphragms (27). The upper diaphragm is located 42 13/16 inches from its upper end. The second diaphragm is located 18 inches from the upper diaphragm, while the lower diaphragm is located 9 1/2 inches from the center diaphragm. Each diaphragm is located with its side wall facing upward and is secured with three lockscrews (28), which are inserted in countersunk clearance holes in this inner tube section and screwed into tapped holes in each diaphragm.

f. Second inner tube section, upper end coupling, diaphragms, and lower end coupling. 1. Second inner tube section upper end coupling. The second inner tube section upper end coupling (25) is identical to the second inner tube section upper end coupling (25, Figure 4-21) of the Type II periscope. Refer to Section 4I2.

At assembly it is provided with a vertical air line slot to allow for clearance of the air line section (19) extending downward from the third inner tube section (11).

2. Diaphragms. The three diaphragms (27) are identical to the diaphragm (7, Figure 4-21) of the Type II periscope. Refer to Section 4I2.

3. Second inner tube section lower end coupling. The second inner tube section lower end coupling (26) is identical to the second inner tube section lower end coupling (26, Figure 4-21) of the Type II periscope. Refer to Section 4I2.

8. Using a special pair of calipers inserted in opposite holes in the lower part of the upper eyepiece lens mount (3), slide the upper eye piece lens mount out from the lower part of the fourth reduced tube section (2), removing the assembled mount with the upper eyepiece lens (8) its clamp ring (4) and its lockscrew (6).

9. Remove the lockscrew (6) from the upper eyepiece lens mount (3) and its clamp ring (4). This lockscrew is unscrewed from the tapped hole in the clamp ring (4).

6F3. Disassembly of Part I. The first, second, third, fourth, and fifth reduced tube sections and the fifth and sixth inner tube sections are disassembled in the following manner. (All bubble numbers in Sections 6F3 and 4 refer to Figure 6-5 unless otherwise specified.)

1. Separation of the lower part of the fifth reduced tube section (1) from the upper part of the fourth reduced tube section (2) proceeds as follows:

2. Remove the two lockscrews (5) from the upper part of the fourth reduced tube section (2). These lockscrews are unscrewed from tapped holes in the fifth reduced tube section (1).

3. Unscrew the fifth reduced tube section (1) from the upper part of the fourth reduced tube section (2).

4. Separation of the lower part of the fourth reduced tube section (2) from the upper part of the third reduced tube section }(9 degrees) proceeds as follows:

5. Remove the two lockscrews (7) from the lower part of the fourth reduced tube section (2). These lockscrews are unscrewed from tapped holes in the third reduced tube section

6. Unscrew the fourth reduced tube section (2) from the upper part of the third reduced tube section (9).

7. Remove the two lockscrews (5) from the upper eyepiece lens mount (3). These lockscrews are unscrewed from the tapped holes in the mount, and are carried out of countersunk clearance holes in the lower part of the fourth reduced tube section (2).

10. Using a special wrench, unscrew the upper eyepiece lens clamp ring (4) and remove it from the upper eyepiece lens mount (3).

11. Place the upper eyepiece lens mount (3) on a piece of lens tissue, resting it on its upper face. Using a piece of lens tissue on the lower face, press downward on the lens tissue and the upper eyepiece lens (8) for its removal. Wrap the lens doublet in clean lens tissue and store it in a box to prevent scratches and breakage.

12. Separation of the third reduced tube section (9) from the upper part of the second reduced tube section (17) proceeds as follows:

13. Remove the two lockscrews (13) from the lower part of the third reduced tube section (9). These lockscrews are unscrewed from tapped holes in the second reduced tube section (17).

14. Unscrew the third reduced tube section (9) from the upper part of the second reduced tube section (17).

15. Remove the angular alignment lockscrew (12) from the circumferential slot in the lower part of the third reduced tube section. This lockscrew is unscrewed from the tapped hole in the telemeter lens mount (10) and is carried out of the circumferential slot.

16. Remove the assembled telemeter lens mount (10) from the lower part of the third reduced tube section. This is done by means of a special pair of calipers inserted in opposite holes in the telemeter lens clamp ring (11). Slide the telemeter lens mount out of the lower part of the third reduced tube section,

removing the mount, telemeter lens (15), its clamp ring (11), and its lockscrews (14).

17. Remove the two lockscrews (14) from opposite sides of the telemeter lens mount (10). These lockscrews are unscrewed from tapped holes in the telemeter lens clamp ring (11).

18. Turn the telemeter lens mount (10), resting it on its lower face on a piece of lens tissue. If necessary, using a piece of lens tissue, press downward on the plano surface of the telemeter lens (15), removing the lens and the clamp ring (11). Wrap the lens in clean lens tissue and store it in a box to prevent scratches and breakage.

19. Separation of the second reduced tube section (17) from the upper part of the first reduced tube section (23) proceeds as follows:

20. Remove the four lockscrews (18) from the lower part of the second reduced tube section (17). These lockscrews are unscrewed from tapped holes in the first reduced tube section (23).

21. Unscrew the second reduced tube section (17) from the upper part of the first reduced tube section (23).

22. Separation of the first reduced tube section (23) from the sixth inner tube section upper end coupling (30) proceeds as fellows:

23. Remove the four lockscrews (33) from the upper part of the sixth inner tube section (28). These lockscrews are unscrewed from tapped holes in the first reduced tube section (23).

ring (50), clamp ring (46) and lockscrew (44) With the fifth inner tube section (41).

28. Remove the four lockscrews (43), unscrewing them from tapped holes in the upper objective lens mount (45), and carrying their out of countersunk clearance holes in the fifth inner tube section (41).

29. Remove the assembled upper objective lens mount (45) from the fifth inner tube section (41). The mount can be slid out from either end. Remove the assembled mount (45) with the upper objective lens (48 and 49), upper objective lens spacer ring (50), upper objective lens clamp ring (46), and its lockscrew (44).

30. Remove the lockscrew (44) from the upper objective lens mount (45). This lockscrew is unscrewed from the tapped hole in the upper objective lens clamp ring (46).

31. Using a special wrench, unscrew the upper objective lens clamp ring (46) from the upper part of the upper objective lens mount (45).

32. Place the lower part of the upper objective lens mount (45) over a special padded wooden block. The mount will slide down over the block, with the upper objective lens elements (48 and 49) and the upper objective lens spacer ring (50) remaining on the padded part of the wooden block.

24. Unscrew the first reduced tube section (23) from the 6th inner tube section upper end coupling (30).

25. Separation of the fifth inner tube section (41) from the sixth inner tube section lower end coupling (31) proceeds as follows:

26. Remove the four lockscrews (42) from the fifth inner tube section (41). These lockscrews are unscrewed from tapped holes in the lower alignment support section of the sixth inner tube section lower end coupling (31).

27. Unscrew the fifth inner tube section (41) from the sixth inner tube section lower end coupling (31). Carry the mounted upper objective lens (48 and 49), its mount (45), spacer

33. Wrap the flint and crown elements of the upper objective lens air-space doublet (48 and 49) with lens tissue and store them in a box or place them to one side to prevent scratches and breakage.

6F4. Reassembly of Part I. The first, second, third, fourth, and fifth reduced tube sections and the fifth and sixth inner tube sections are reassembled in the following manner:

1. Using an air hose, blow out the internal surfaces of the reduced and inner tube sections. If various sized circular brushes are available, they should be used first. This procedure should be carried out with the clamp rings and lens mounts.

2. Clean the upper eyepiece lens (8) with clean lens tissue. Surface dust can be removed

with a rubber air bulb and a clean camel's hair brush or a vacuum brush used with ether.

3. Place the upper eyepiece lens (8) in the upper eyepiece lens mount (3). The crown element of this doublet is placed toward the seat of the mount.

4. Place the upper eyepiece lens clamp ring (4) in the internal threaded section in the upper part of the upper eyepiece lens mount (3). Screw this clamp ring tight against the plano face of the upper eyepiece lens doublet. The lockscrew holes should coincide when the lens doublet is tightened sufficiently.

5. Insert and secure the lockscrew (6), inserting it in the countersunk clearance hole in the mount (3) and

11. Insert and secure the two opposite lockscrews (7), screwing them into countersunk clearance holes in the fourth reduced tube section (2) and tapped holes in the third reduced tube section (9). This secures the third and fourth reduced tube sections together.

12. Clean the telemeter lens (15), in similar manner to that outlined in Step 2 of this section for the upper eyepiece lens (8).

13. Place the telemeter lens in the telemeter lens mount (10). The etched graduations on the piano side of the lens are placed toward the seat in the mount, with the stoned vertical slot meshing with the inward projecting lockscrew (16) in the mount.

screwing it into the tapped hole in the upper eyepiece lens clamp ring (4).

6. Reassemble the assembled upper eyepiece lens mount (3) sliding it in the lower part of the fourth reduced tube section (2). The clamp ring side of the assembled mount should be located upward.

7. Secure the upper eyepiece lens mount (3) temporarily with two lockscrews (5). These lockscrews are inserted into countersunk clearance holes in the fourth reduced tube section (2) and screwed into tapped holes in the mount.

8. The connection of the lower part of the fifth reduced tube section (1) in the upper part of the fourth reduced tube section proceeds as follows: Screw the lower part of the fifth reduced tube section (1) into the upper part of the fourth reduced tube section (2) until the lockscrew holes coincide.

9. Insert and secure the two opposite lockscrews (5), inserting them in countersunk clearance holes in the fourth reduced tube section (2), screwing them into tapped holes in the fifth reduced tube section (1), thus securing the fourth and fifth reduced tube sections together.

10. The connection of the lower pat of the fourth reduced tube section (2) on the upper part of the third reduced tube section (9) proceeds as follows: Screw the lower part of the fourth reduced tube section (2) on the upper part of the third reduced tube section (9) until the lockscrew holes coincide.

14. Slide the telemeter lens clamp ring (11) in the telemeter lens mount (10) to the convex face of the telemeter lens (15) so that opposite lockscrew holes of the mount and clamp ring coincide.

15. Insert and secure the two lockscrews (14). These lockscrews are inserted in countersunk clearance holes in the telemeter lens mount (10) and screwed into tapped holes in the telemeter lens clamp ring (11).

16. Slide the telemeter lens (15) with its mount (10) into the lower part of the third reduced tube section (9), with the clamp ring side of the assembled mount facing downward.

17. Insert and secure the angular alignment lockscrew (12) in the circumferential slot in the lower part of the third reduced tube section (9). This lockscrew is screwed into the tapped hole in the telemeter lens mount (10).

18. The connection of the lower part of the third reduced tube section (9) on the upper part of the second reduced tube section (17) proceeds as follows: Screw the lower part of the third reduced tube section (9) on the upper part of the second reduced tube section (17), until the lockscrew holes coincide.

19. Insert and secure the two lockscrews (13). These lockscrews are inserted in countersunk clearance holes in the third reduced tube section (9) and screwed into tapped holes in the second reduced tube section (17). This secures the second and third reduced tube sections together.

20. The connection of the upper part of the first reduced tube section (23) in the lower part of the second reduced tube section (17) proceeds as follows: Screw the upper part of the first reduced tube section (23) into the lower part of the second reduced tube section (17) until the lockscrew holes coincide.

21. Insert and secure the four lockscrews (18). These lockscrews are inserted in countersunk clearance holes in the second reduced tube section (17) and screwed into tapped holes in the first reduced tube section (23). This secures the first and second reduced tube sections together.

22. The connection of the lower part of the first reduced tube section (23) in the sixth inner tube section upper end coupling (30) proceeds as follows: Screw the lower part of the first reduced tube section (23) in the sixth inner tube section upper end coupling (30), supporting the assembled reduced tube sections during this connection procedure, until the lockscrew holes coincide.

23. Insert and secure the four lockscrews (33). These lockscrews are inserted in countersunk clearance holes in the sixth inner tube section (28) into clearance: holes in the sixth inner tube section upper end coupling (30) and screwed in tapped holes in the first reduced tube section (23). This secures the first reduced tube section and sixth inner tube section upper end coupling together.

24. Clean the upper objective lens flint element (48) and the crown element (49) in similar manner to the procedure described in Step 2, of this section for the upper eyepiece lens (8).

that the crown element (49) with the shortest radius is resting in the seat of the mount.

27. Place the upper objective lens clamp ring (46) in the threaded section in the upper part of the upper objective lens mount (45). Using a special wrench, screw this clamp ring tightly against the plano side of the flint element (48) until the lockscrew holes coincide.

28. Insert and secure the lockscrew (44). This lockscrew is inserted in a countersunk clearance hole in the upper objective lens mount (45) and screwed into the tapped hole in the upper objective lens clamp ring (46).

29. Slide the assembled upper objective lens mount (45) into the fifth inner tube section (41). The clamp ring side of the assembled mount should face upward.

30. Secure the upper objective lens mount (45) temporarily with four lockscrews (43). These lockscrews are inserted in countersunk clearance holes in the fifth inner tube section (41) and screwed into tapped holes in the upper objective lens mount (45).

31. The connection of the upper part of the fifth inner tube section (41) on the sixth inner tube section lower end coupling (31) proceeds as follows: Screw the upper part of the fifth inner tube section (41) on the lower alignment support section of the sixth inner tube section lower end coupling (31) until the lockscrew holes coincide.

32. Insert and secure the four lockscrews (42). These lockscrews are inserted in countersunk clearance holes in the fifth inner

25. Place the plano side of the flint element (48) on the padded part of a special wooden block. Place the upper objective lens spacer ring (50) on the concave surface of the flint element (48). Place the longest radius of the double convex crown element (49) on the spacer ring. Line up the periphery of both, elements and the spacer ring.

26. Place the upper objective lens mount (45) with the clamp ring side facing downward, over the assembled upper objective lens doublet and the padded wooden block. Turn the complete assembly with the padded block over, so

tube section (41), and screwed into tapped holes in the sixth inner tube section lower end coupling (31), securing the fifth inner tube section and the sixth inner tube section lower end coupling together.

33. Place a canvas boot over the upper end of the fifth reduced tube section (1) and the lower end of the fifth inner tube section (41) to prevent foreign matter entering and adhering to the cleaned lenses.

6F5. Disassembly of Part II. The second, third, and fourth inner tube sections are disassembled in the following manner (all bubble numbers in Sections 6F5 and 6 refer to Figure 6-6 unless otherwise specified):

1. Separation of the fourth inner tube section lower end coupling (5) from the third inner tube section upper end coupling (16) proceeds as follows:

2. Remove the four lockscrews (3) from the fourth inner tube section lower end coupling (5). These lockscrews are unscrewed from tapped holes in the upper alignment support section of the third inner tube section upper end coupling (16).

3. Unscrew the fourth inner tube section lower end coupling (5) from the third inner tube section upper end coupling (16). This removes the fourth inner tube section (1) and its lower end coupling (5) from its connection with the third inner tube section (11) and its upper end coupling (16). The diaphragm (6) should of be removed from the central part of the fourth inner tube section (1) unless the periscope is known to be flooded with sea water. To remove it would require

8. The three diaphragms (27) should not be removed from the second inner tube section (23) unless the periscope is known to be flooded with sea water. To remove them would require the removal of either the upper or lower end couplings which are soldered to form a permanent joint.

6F6. Reassembly of Part (I. The second, third, and fourth inner tube sections are reassembled in the following manner:

1. Using an air hose, blow out the internal surfaces of the second inner tube section. If a circular brush is available, it should be used first. This procedure is also carried out with each succeeding inner tube section and couplings.

2. Place the two diaphragms (17) in the third inner tube section upper and lower end couplings (16 and

the removal of either the upper or lower end couplings which are soldered to form a permanent joint.

4. Separation of the third inner tube section lower end coupling (15) from the second inner tube section upper end coupling (25) proceeds as follows:

5. Remove the four lockscrews (13) from the third inner tube section lower end coupling (15). These lockscrews are unscrewed from the tapped holes in the upper alignment support section of the second inner tube section upper end coupling (25).

6. Unscrew the third inner tube section lower end coupling (15) from the second inner tube section upper end coupling (25). This removes the third inner tube section (11) and its lower end coupling (15) from its connection with the second inner tube section (23) and its upper end coupling (25).

7. If it is necessary to remove the two diaphragms (17) from the third inner tube section upper and lower end couplings (16 and 15), remove the three lockscrews (14) each from the upper} and lower parts of the third inner tube section (11). These lockscrews are unscrewed from tapped holes in each diaphragm (17). The diaphragms can be pulled out easily, as they are a push fit into these two couplings.

15). The side wall of each diaphragm should face inward toward the inner part of this inner tube section.

3. Insert and secure the three lockscrews each (14) into each diaphragm (17). These lockscrews are inserted into countersunk clearance holes in the upper and lower part of the third inner tube section (11), further into clearance holes in their respective couplings, and screwed into tapped holes in the diaphragms.

4. The connection of the third inner tube section lower end coupling (15) on the second inner tube section upper end coupling (25) proceeds as follows: Screw the third inner tube section lower end coupling (15) on the second inner tube section upper end coupling (25).

5. Insert and secure the four lockscrews (13). These lockscrews are inserted in countersunk clearance holes in the third inner tube section lower end coupling (15) and screwed in tapped holes in the upper alignment support section of the second inner tube section upper end coupling (25). This secures the third inner tube section lower end coupling and second inner tube section upper end coupling together.

6. The connection of the fourth inner tube section lower end coupling (5) on the third inner tube section upper end coupling (16) proceeds as follows: Screw the fourth inner tube section lower end coupling (5) on the third inner tube section upper end coupling (16).

7. Insert and secure the four lockscrews,(3). These lockscrews are inserted in countersunk clearance holes in the fourth inner tube section lower end coupling (5) and screwed into tapped holes in the upper alignment support section, of the third inner tube section upper end coupling (16). This secures the fourth inner tube section lower end coupling and the third inner tube section upper end coupling together.

8. Place a canvas boot over each end of this assembly to prevent dust and foreign matter from entering the cleaned inner tube sections.

G. RANGE FINDER

6G1. Description of the lower (split) objective lens and mount assembly. The lower (split) objective lens and mount assembly is identical to the lower (split) objective lens and mount assembly used in the Type II periscope. Refer to Section 4J2. The lower (split) objective lens halve, crown (8A) and flint (8B, Figure 6-13) are the only detail numbers which change, all other parts are identical to those shown in Figure 4-22. This assembly serves the same purpose and functions as the assembly used in the Type II periscope.

6G2. Description of the objective operating mechanism assembly. This mechanism consists of the necessary parts which transmit the displacement of the lower (split) objective lens and mount assembly, and is described as follows. Figure 6-7 shows this assembly. All bubble numbers in Sections 6G2, 3, and 4 refer to Figure 6-7 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1158-3	2	Mounting plates
2	P-1159-1	1	Operating gear pinion
3	P-1159-3	1	Stadimeter transmission

Ill. No.	Drawing Number	Number Required	Nomenclature
13	P-1179-33	6	Mounting plate guide lockscrews
14	P-1179-177	2	Mounting plate guide key and shaft taper pins
15	P-1179-179	2	Stadimeter transmission shaft coupling taper pins
16	P-1362-5	1	Air line section continuation
17	P-1441-1	1	Coupling sleeve
18	P-1442-1	1	Track sleeve
19	P-1442-2	1	Sliding track
20	P-1442-3	1	Operating gear pinion shaft
21	P-1443-1	1	Operating gear retaining ring
22	P-1443-3	1	Operating gear
23	P-1449-	1	Operating

			coupling shaft coupling
4	P-1159-4	2	Mounting plate guide key a and integral shafts
5	P-1159-6	2	Mounting plate guide keys
6	P-1159-10	2	Mounting plate guides
7	P-1172-15	1	Operating gear pinion key
8	P-1179-23	4	Coupling sleeve lockscrews (upper end)
9	P-1179-23	4	Track sleeve and first inner tube section upper end coupling lockscrews
10	P-1179-27	2	Operating gear pinion lockscrews
11	P-1179-30	15	Coupling sleeve lockscrews(lower end)
12	P-1179-32	2	Mounting plate guide key lockscrews

	1		gear stop
24	P-1449-2	1	Observation position stop
25	P-1449-2	1	Maximum displacement stop
26	P-1449-3	2	Cam shoes
27	P-1453-1	6	Operating gear retaining ring lockscrews
28	P-1453-2	6	Operating gear retaining ring and track sleeve lockscrews
29	P-1453-3	8	Maximum displacement stop, observation position stop, and operating gear stop lockscrews

a. Sliding track. The sliding track (19) is made of cast/ phosphor bronze and is 7 7/8 inches in length. It is machined cylindrical, with a large shoulder flange of nominal thickness at the upper part. Its internal diameter is machined for light transmission and is threaded for anti-reflection.

A brass plate spacer 1/16 inch thick and 1/4 inch wide is inserted and soldered in the slots cut directly in the centerline in each side of the bore in the large shoulder flange. The spacer when assembled is flush with the face of the large shoulder flange. It prevents stray light from entering the gap between the two split lens

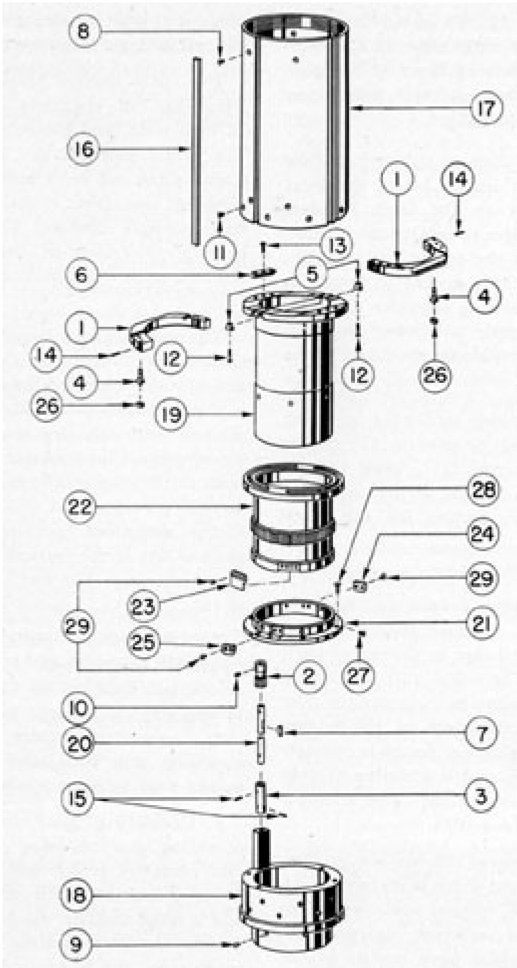

Figure 6-7. Objective operating mechanism assembly.

doublet halves, of the lower (split) objective lens (8A and 8B).

Two longitudinal T-slots are milled parallel to the centerline, at an appropriate center distance from the vertical centerline on each side; there are two more 180 degrees apart on the opposite side in the large shoulder flange. These longitudinal T-slots project inward on each side, to correspond to an appropriate center distance from the vertical centerline, to receive two mounting plate guide keys with integral shafts (4) and mounting plate guide keys (5). The large shoulder flange face has two shallow grooves 1 5/16 inches wide located at an appropriate distance from the horizontal centerline and running parallel with it. The remaining parts of the face serve as a bearing for the lower surfaces of two mounting plates (1) retained with two mounting plate guides (6). The mounting plate guides are mounted parallel to the vertical centerline, on opposite sides, and are secured with

three lockscrews each (13). The mounting plates (1) are moved against each other in the horizontal plane on the bearing faces of the operating gear retaining ring (21) which is secured with six lockscrews (27).

large shoulder flange with their undercut sides under the mounting plate guides (6).

The sliding track has a cylindrical tube section 7 1/2 inches in length below the large shoulder flange. Next to the large shoulder flange is a small shoulder to receive the shallow centerbored section in the operating gear (22). An undercut section 3 3/16 inches in length is provided to allow a bearing shoulder thickness of 7/64 inch in the upper and lower part, for the upper and lower remaining shoulders of the operating gear bore.

The lower bearing section carries the operating gear retaining ring (21) secured to the sliding track with six lockscrews (27), while the remainder of this lower bearing section serves as an alignment support section for the track sleeve (18).

b. Operating gear. The operating gear (22) is made of cast phosphor bronze and is 4 11/16 inches in length. It is machined cylindrical with a large shoulder flange in the upper part. It is counterbored in the center part of the bore to provide only sufficient bearing surface over the bearing section shoulders of the sliding track (19). The large shoulder flange is counterbored a shallow depth and is a sliding fit over the small shoulder next to the large, shoulder flange of the sliding track (19).

The large shoulder flange has two cam grooves of appropriate depth and width in its face, which extend 1 degree beyond the vertical centerline. This 1 degree extension provides sufficient clearance for the The outer surface below the large shoulder flange has two shoulders, one near the center, 5/8 inch wide, and the other at the lower end. The center shoulder has 160 teeth of 32 diametral pitch cut in its periphery, which engage with an assembled operating gear pinion (2) that projects upward from the rectangular bearing projection of the track sleeve (18) assembled on the operating gear pinion shaft (20).

The operating gear stop (23) is assembled in a shallow circumferential slot 0.047 inch deep and 1 1/8 inch long, located in the lower shoulder of this operating gear. The stop is secured in the shallow slot with four lockscrews (29). These lockscrews are inserted in countersunk clearance holes in the stop and screwed into tapped holes in the operating gear shoulder. The centerline of the assembled operating gear stop in the shallow slot is the vertical reference line of the operating gear, the stop covering a distance of 26 degrees.

The observation position stop (24) and the maximum displacement stop (25) have a predetermined location on the operating gear retaining ring (21) of approximately 166 degrees between their contacting surfaces, thus providing the operating gear stop (23) a travel of approximately 140 degrees with the operating gear.

c. Operating gear retaining ring. The operating gear retaining ring (21) is made of cast phosphor bronze and is 3/4 inch in width. It is cylindrical with an undercut shoulder and a large shoulder flange. It is bored a push fit over the lower bearing section of the sliding track (19), and

cam shoes (26) which have centers in the vertical centerline of the operating gear (22) at zero displacement of the lower (split) objective lens (8A and 8B). Using the vertical centerline as a reference, these two cam grooves are machined 153 degrees circumferentially on opposite sides starting 180 degrees apart.

The operating gear fits over the two bearings of the sliding track (19) with its large shoulder flange face a metal-to-metal bearing contact with the lower face of the sliding track large shoulder flange. It is retained from axial displacement on the sliding track (19) by an is secured with six lockscrews (27). These lockscrews are inserted in countersunk clearance holes in the undercut shoulder and screwed into tapped holes in the sliding track tube section periphery wall.

The large shoulder flange has a rectangular slot to provide clearance for the rectangular cast bearing projection of the track sleeve (18) extending upward from the lower face of this . flange a distance of 21 11/32 inches.

The undercut shoulder and large shoulder flange are provided with two rectangular 90 degrees

circumferential recesses. The first recess is located within 70 degrees of the rectangular slot centerline in the large shoulder flange, and has a depth of 0.047 inch in the undercut shoulder and 0.060 inch in the large shoulder flange, for the maximum displacement stop (25). The second rectangular 90 degrees circumferential recess is located approximately 166 degrees on the opposite side for the observation position stop (24) of similar design, thus the operating gear stop (23) covering 26 degrees distance in length allows the operating gear (22) a travel of approximately 140 degrees. The observation position and maximum displacement stops (24 and 25) are secured to these rectangular circumferential recesses in the undercut shoulder with two lockscrews each (29). These lockscrews are inserted in countersunk clearance holes in each stop and screwed into tapped holes

The external surfaces of the track sleeve consist of a bearing flange 3/8-inch wide and an alignment support section preceding it. This alignment support section receives the lower part of the coupling sleeve (17) of a push fit, and is secured with 15 lockscrews (11). These lockscrews are inserted in countersunk clearance holes in the coupling sleeve (17) and screwed into tapped holes in the alignment support section of the track sleeve. The rectangular bearing projection is undercut below the alignment support section.

The lower part of the track sleeve is cored a depth of 2 inches, leaving an inner body wall and an outer body wall with four inter-connecting webs. One web is larger below the rectangular bearing projection which has a reamed hole for the operating gear pinion shaft (20). The outer body wall of smaller diameter extends downward a short distance

in each rectangular circumferential recess in the undercut shoulder.

The large shoulder flange has six equally spaced countersunk clearance holes to receive lockscrews (28) which extend into tapped holes in the upper face of the track sleeve (18). The retaining ring serves to retain the operating gear (22) axially and also serves as a stationary support for the track sleeve (18).

d. Track sleeve. The track sleeve (18) is made of cast phosphor bronze and is 5 31/32 inches in length. The upper part has a cast rectangular bearing projection that extends upward from its upper face through the rectangular slot in the operating gear retaining ring (21) a sufficient distance for the support of the operating gear pinion (2). It is provided with a reamed hole in its center axis which serves as a bearing for the operating gear pinion shaft (20).

It is bored a push fit on the lower bearing alignment support section of the sliding track (19). The rectangular bearing projection is counterbored for clearance over the undercut shoulder and in the rectangular slot of the operating gear retaining ring (21). The lower part is counterbored to serve as an alignment support section with a threaded section in the lower part to receive the upper alignment support and threaded periphery section of the first inner tube section upper end coupling (23) which is secured with four lockscrews (9).

from the bearing flange face and tapers inward. It serves to provide sufficient body wall for attachment to the first inner tube section upper end coupling (23, Figure 6-10).

Four tape slots are provided in the bearing flange of this track sleeve, two opposite the others, for the prism tilt and change of power shifting wire tapes (38, Figure 4-28). A vertical air line slot is provided at assembly in the bearing for the air line section continuation (16) extending downward from the air line section continuation (30, Figure 6-6) of the second inner tube section (23, figure 6-6).

e. Mounting plates, guide keys, and integral shafts, and guides. 1. Mounting plates. The mounting plate halves left and right (1) are identical to the mounting plate halves left and right (5, Figure 4-23) used in the Type II periscope. Refer to Section 4J5.

2. Mounting date guide keys and integral shafts. The two mounting plate guide keys and integral shafts (4) are identical to the mounting plate guide keys and integral shafts (15, Figure 4-23) used in the Type II periscope. Refer to Section 4J5.

3. Mounting plate guide keys. The two mounting plate guide keys (5) are identical to the mounting plate guide keys (17, Figure 4-23) used in the Type II periscope. Refer to Section 4J5.

4. Mounting plate guides. The two mounting plate guides (6) are identical to the two mounting plate guides (18, Figure 4-23) used in the Type II periscope. Refer to Section 4J5.

f. Cam shoes. The two cam shoes (26) are identical to the cam shoes (4, Figure 4-23) used in the Type II periscope. Refer to Section 4J5. The factory detail numbers differ between the two periscopes, but their construction is identical.

g. Maximum displacement stop. The maximum displacement stop (25) is made of cold rolled steel and is a rectangular circumferential design. It conforms to the contour of the rectangular circumferential recess in the undercut shoulder of the operating gear retaining ring (21) and is provided with two countersunk clearance holes for lockscrews (29) to secure it in the recess.

It serves to restrict the operating gear stop (23) from displacing the lower (split) objective lens (8A and 8B, Figure 6-13) beyond its required maximum displacement. It also relieves the torque of the cam shoes (26) so that they do not contact the ends of the cam grooves in the operating gear (22) at this position.

h. Observation position stop. The observation stop (24) is identical to the maximum displacement stop (25), and is located in the rectangular circumferential recess in the opposite side of the operating gear retaining ring (21) in the undercut shoulder section. It serves to relieve the torque from the cam shoes (26) so that they do not contact the ends of the cam grooves in the operating gear (22) in the This stop is secured in the above manner with its centerline in the vertical reference line of the operating gear (22) cam groove. The stop overlaps the undercut shoulder of the operating gear retaining ring (21) to contact the observation and maximum displacement stops (24 and 25) for these positions of the lower (split) objective lens (8A and 8B, Figure 6-13). The overlapping part of the stop which contacts the observation position stop (24) is finished off during the collimation of the lower (split) objective lens, to provide the single image or whole lens position.

j. Operating gear pinion. The operating gear pinion (2) is identical to the operating gear pinion (12, Figure 4-23) used in the Type II periscope. Refer to Section 4J5.

k. Operating gear pinion shaft. The operating gear pinion shaft (20) is almost identical to the operating gear pinion shaft (13, Figure 4-23) used in the Type II periscope, except that it is 2 inches shorter. Refer to Section 4J5.

1. Stadimeter transmission shaft coupling. The stadimeter transmission shaft coupling (3) is identical to the stadimeter transmission shaft coupling (14, Figure 4-23) used in the Type II periscope. Refer to Section 4J5.

m. Coupling sleeve. The coupling sleeve (17) is identical to the coupling sleeve (34, Figure 4-23) used in the Type II periscope, except that it is 4 inches shorter. Refer to Section 4J5. At assembly it is provided with a vertical slot for the air line section continuation (16) Which extends its entire length from the air line section continuation (30,

observing position. It also serves as a stop to restrict the lower (split) objective lens (8A and 8B, Figure 6-13) for the single image or whole lens position.

i. Operating gear stop. The operating gear stop (23) is made of cold rolled steel and is shaped rectangular. It covers are length of 26 degrees of a circumferential step design, with the seat of the stop conforming to the shallow circumferential slot in the lower shoulder of the operating gear (22) and is secured with four lockscrews (29). These lockscrews are inserted in countersunk clearance holes in the stop and screwed into tapped holes in the shallow circumferential slot in the operating gear lower shoulder (22).

Figure 6-6) of the second inner tube section (23).

A counterbored section 0.020 inch deep, commencing 1 7/8 inch from the upper end for the same distance, provides clearance for the assembled parallel moving lower (split) objective lens mount half, in case it is collimated beyond the approximate clearance allowed.

6G3. Disassembly. The objective operating mechanism assembly is disassembled in the following manner:

1. Remove the six lockscrews (28) from the operating gear retaining ring (21). These

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lockscrews are unscrewed from tapped holes in the track sleeve upper face (18) and carried out of countersunk clearance holes in the shoulder flange of the operating gear retaining ring (21).

2. Turn the complete assembly, allowing it to rest on the mounting plates (1). A helper should hold downward on the operating gear (22) large shoulder flange as the track sleeve (18) is slowly carried off the sliding track (19). The operating gear pinion (2) rests on the lower face of the operating gear large shoulder flange lower face as the track sleeve (18) is removed. The operating gear pinion (2) and its shaft (20) are carried off with it.

3. Remove the operating gear pinion (2) with its shaft (20), carrying the shaft out of the rectangular

10. Remove the two cam shoes (26) from the stub shaft of the two mounting plate guide keys and integral shafts (4), or lift them from the cam grooves in the operating gear (22).

11. Remove the three lockscrews (13) from each of the two mounting plate guides (6). These lockscrews are unscrewed from tapped holes in the large shoulder flange face on opposite sides of the sliding track (19). Remove the two mounting plate guides (6).

12. Remove the two lockscrews (12) from the two mounting plate guide keys (5). These lockscrews are unscrewed from the two mounting plate halves (1). Remove the two mounting plate guide keys from the T-slots in opposite sides of the sliding track (19).

bearing projection of the track sleeve through the upper end.

4. Remove the two lockscrews (10) from opposite sides of the operating gear pinion (2). Pull the operating gear pinion off the operating gear pinion shaft (20). The woodruff key (7) remains in the shaft.

5. Remove the six lockscrews (27) from the operating gear retaining ring (21), unscrewing them from tapped holes in the sliding track (19).

6. Slowly carry the operating gear retaining ring (21) off the lower end of the sliding track.

7. Remove the four lockscrews (29), unscrewing two each from the observation position and maximum displacement stops (24 and 25) from tapped holes in the operating guar retaining ring milled recesses (21). Apply reference marks to both stops and the undercut shoulder section of the operating gear retaining ring (21) for proper reassembly. Remove the observation position and maximum displacement stops (24 and 25).

8. Remove the operating gear (22) from the tube section of the sliding track (19).

9. Remove the four lockscrews (29) from the operating gear stop (23). These lockscrews are unscrewed from the tapped holes in the lower shoulder circumferential slot of the operating gear (22).

13. Carefully slide out each mounting plate half (1) with the mounting plate guide keys and integral shafts (4), moving them outward in opposite directions.

14. Remove the two taper pins (14) from the large eccentric section of the two mounting plate halves (1). Drive out the two mounting plate guide keys and integral shafts (4) from both mounting plate halves.

6G4. Reassembly. The objective operating mechanism is reassembled in the following manner:

1. Apply Lubriplate No. 110 lightly to all rotating parts as the reassembly procedure is followed.

2. Assemble the mounting plate guide keys and integral shafts (4) in the reamed holes in the large eccentric part of the two mounting plate halves (1) checking their corresponding reference marks for proper reassembly. The long section of each integral shaft section is inserted from the lower face and secured with a taper pin (14).

3. Stand the sliding track (19) in a vertical position resting it on its lower end. Place one and then the other of the two mounting plate halves (1) on the large shoulder flange face of the sliding track (19). Carefully slide the mounting plate guide keys of the assembled integral shafts into the elongated T-slots in the sliding track in opposite directions, noting the reference marks for correct reassembly.

4. Assemble one and then the other of the mounting plate guide keys (5)

10. Place the operating gear stop (23) in the shallow circumferential

in the elongated T-slots in opposite sides of the sliding track large shoulder flange (19). Secure each with a lockscrew (12), screwing it into the tapped hole in the narrow eccentric part of each mounting plate half (1).

5. Place one and then the other of the two mounting plate guides (6) over the side shoulder of each mounting plate half, noting their reference marks on the sliding track large shoulder flange face (19). Secure each with three lockscrews (13), screwing them into tapped holes in the large shoulder flange on opposite sides. The mounting plate guides are placed 180 degrees apart.

6. Place the two earn shoes (26) on the two mounting plate guide keys and integral stub shafts (4), placing the thinner wall of the cam shoe outward on each side.

7. Place the operating gear (22) on the tube section of the sliding track (19). The upper face of the operating gear large shoulder flange (22) contacts the lower face of the sliding track large shoulder flange (19), and the cam shoes (26) are fitted into the cam grooves in the operating gear (22). The proper position of the operating gear (22) for its contact with the sliding track large shoulder flange (19) is obtained from corresponding reference marks on the sliding track.

8. Place the operating gear retaining ring (21) on the tube section of the sliding track (19). Check to ascertain that the scribed lines on the operating gear (22) lower shoulder and the operating gear retaining ring are in coincidence. These scribed lines represent the position slot in the operating gear (22) lower shoulder, and secure it with four lockscrews (29).

11. Place the operating gear pinion (2) on the operating gear pinion shaft (20), sliding it over the inserted woodruff key (7) located in the upper part of this shaft. Secure the pinion with two lockscrews (10), screwing them into tapped holes in opposite sides of the pinion and into spotted recesses in the shaft.

12. Place the operating gear pinion shaft (20) in the reamed hole axis in the track sleeve rectangular bearing projection.

13. Turn the complete assembly, allowing it to rest on the mounting plates (1). Place the track sleeve (18) with the assembled operating gear pinion (2) and its shaft (20) on the sliding track (19). Allow the pinion to rest on the operating gear large shoulder flange face (22) as the rectangular bearing projection is located in the rectangular circumferential slot in the operating gear retaining ring (21). When located properly, slowly push the track sleeve on the alignment support section of the sliding track (19) until it contacts the shoulder flange of the operating gear retaining ring (21). Insert and secure the six lockscrews (28), inserting them in countersunk clearance holes in the retaining ring and screwing them into tapped holes in the upper face of the track sleeve.

14. Wrap up both ends of the objective operating mechanism assembly until required for its connection to the first inner tube section upper end coupling (23) to preserve the cleanliness of this assembly.

of the cam shoes (26) in the ends of the cam grooves for the observing position. Insert the six lockscrews (27) in countersunk clearance holes in the operating gear retaining ring (21) and screw them into tapped holes in the sliding track tube section (19) for its securement.

9. Place the observation position and maximum displacement stops (24 and 25) in their respective rectangular circumferential slots in the operating gear retaining ring (21) and secure each with two lockscrews (29).

6G5. Description of the stadimeter housing assembly. The stadimeter housing assembly is described in the following manner:

a. General. This assembly is similar to the stadimeter housing assembly used in the Type II periscope except that it contains the alterations required for computing the estimated range of the target and the deletion of the course angle mechanism. The scale housing mechanisms and the stadimeter housing are altered. Therefore, the variance alone will be described.

This assembly contains gearing which is connected to the internal mechanism of the

eyepiece box (11, Figure 4-29) and the eyepiece skeleton assembly with a female tang coupling (68, Figure 4-24). This coupling projects upward from the stadimeter housing assembly and engages a milled tang section of the stadimeter transmission shaft (12, Figure 6-10) in the eyepiece box.

The stadimeter housing assembly is coupled to the operating gear pinion shaft (20, Figure 6-7) of the objective operating mechanism assembly by means of the stadimeter transmission shaft (12, Figure 6-10) and the stadimeter transmission shaft coupling (3). The stadimeter transmission shaft (12, Figure 6-10) extends through a bearing hole in the spider (2) where its thrust is maintained by two thrust collars (4) secured with taper pins (10). These thrust collars (4) maintain the axial thrust of the shaft on either side of the spider (2). The

Ill. No.	Drawing Number	Number Required	Nomenclature
10	P-1445-2	2	Range scale mount housings
11	P-1445-3	2	Range scale actuating bevel gears
12	P-1445-4	2	Range scale mount housing shafts
13	P-1445-5	2	Height scale dials
14	P-1445-7	2	Range scale dials
15	P-1446-1	2	Pointers
16	P-1446-2	2	Pointer knob spring washers
17	P-1446-	2	Pointer knobs

eyepiece skeleton (42, Figure 4-28) has a clearance hole in its large shoulder flange to accommodate the stadimeter transmission shaft (12, Figure 6-10).

The lower (split) objective lens and mount assembly is secured to the objective operating mechanism assembly by means of four stadimeter collimating screws (13, Figure 4-22). The stadimeter housing assembly is secured to the eyepiece box (11, Figure 4-29) by means of four housing bolts (30, Figure 4-24). The stadimeter housing assembly modifications are shown in Figure 6-8. Alt bubble numbers in Sections 6G5, 6, and 7 refer to Figure 6-8 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1171-18	4	Indicator mount knobs
2	P-1172-3	4	Range scale mount housing ball bearings
3	P-1179-39	2	Range scale actuating bevel gear ball bearing shaft lockscrews
4	P-1179-74	32	Height and range scale lockscrews
5	P-1179-198	2	Range scale actuating gear pinion taper pins
6	P-1179-200	8	Height and range scale dowel pins
	3		
18	P-1446-4	2	Pointer shoulder screws
19	P-1446-5	2	Indicator shims
20	P-1446-6	2	Indicators
21	P-1446-7	2	Indicator mounts
22	P-1446-8	6	Indicator mount axial retaining lockscrews
23	P-1446-9	2	Range scale actuating bevel gear pinions
24	P-1453-4	8	Ball bearing housing and range scale bevel actuating gear lockscrews
25	P-1453-5	8	Range scale mount lockscrews
26	P-1453-6	4	Indicator lockscrews

b. Stadimeter housing. The stadimeter housing (8) is almost identical to the stadimeter housing (67, Figure 4-24) used in the Type II periscope, except for the construction of the front and rear scale housing sections. The center section which carries the transmission mechanism is identical, therefore, the scale housing sections and the scale housing mechanisms alone are described.

The front scale housing only will be described as the rear scale housing is of identical design. The internal

7	P-1422-10	6	Pointer lockscrews
8	P-1444-1	1	Stadimeter housing
9	P-1445-1	2	Range scale mounts

part of this section is cored following the outer conical wall of the section a short distance, at which point it is cored inward to allow a stationary undercut shoulder section to serve as the height scale mount. It is bored to allow free actuation of the range scale mount (9). A counterbored section is provided in the outer part to allow sufficient area for the indicator mount (21) and its free actuation.

The lower inner wall of this section is provided with a reamed hole in its axis having a depth of 1/2 inch with a smaller tapped hole below it of 11/32-inch depth to receive the

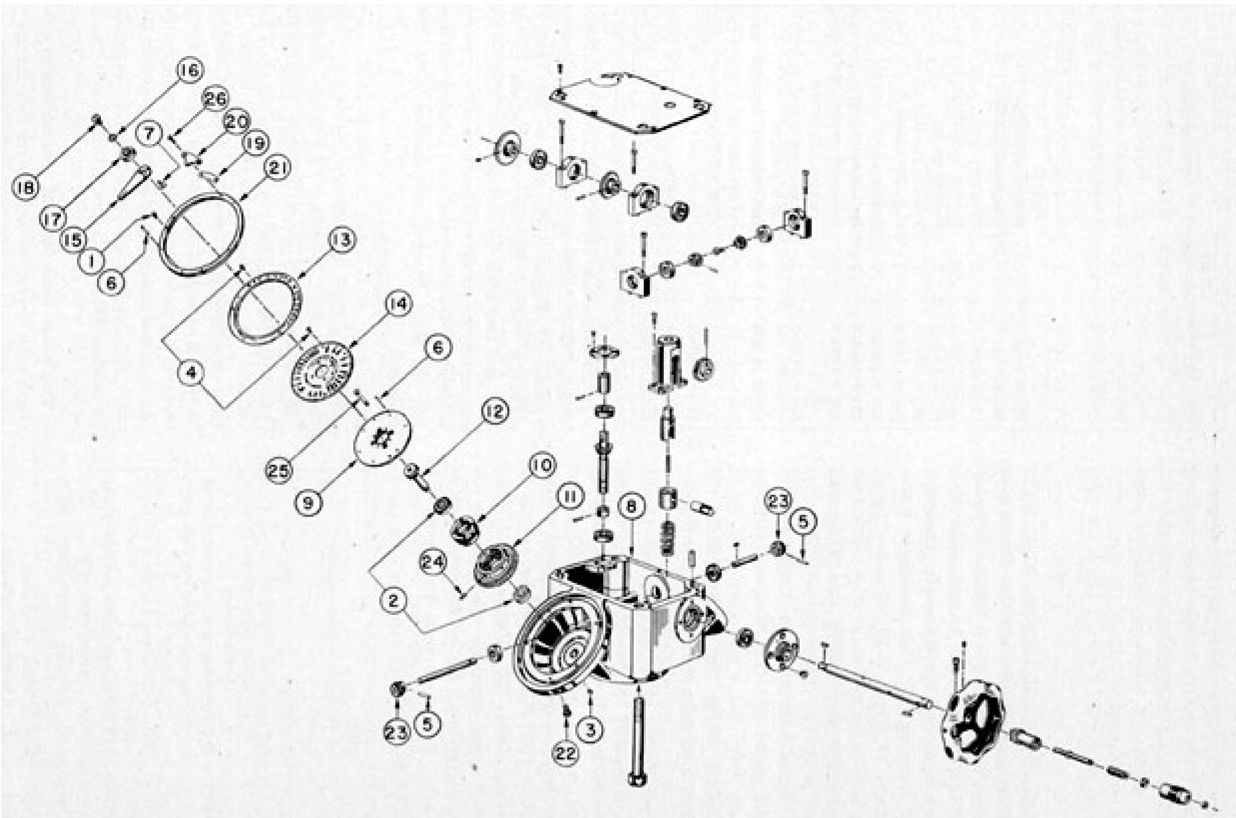

Figure 6-8. Stadimeter housing assembly.

range scale mount housing ball bearing shaft (12).

The lower inner wall is machined smooth, serving as a contact face for the lower range scale mount housing ball it above the surface of the height scale dial (13) and is secured with two lockscrews (26). These lockscrews are inserted in countersunk clearance holes in the indicator (20) and screwed into tapped holes in the mount. Two

bearing (2). The shallow counterbored section in the inner wall face serves as a grease cell for this ball bearing.

A tapped hole is provided in the lower conical wall of this section to receive the alemite fitting (82, Figure 4-24) for the introduction of grease. In the upper part of the conical wall and height scale mount section, it has a concave clearance provision for the range scale actuating bevel gear pinion (23).

c. Range scale actuating bevel gear pinion. The range scale actuating bevel gear pinion (23) replaces that used in the Type II periscope (10, Figure 4-24). It is made of phosphor bronze with a reamed hole in its center axis. The large diameter is provided with 26 bevel teeth of 32 diametral pitch, with a pitch cone line angle of 21 degrees 36 minutes, to mesh with 78 bevel teeth of a range scale actuating bevel gear (11) having a pitch cone line angle of 68 degrees 24 minutes. It is provided with a hub section which faces toward the assembled ball bearing (14, Figure 4-24) located in the wall of the scale housing section. Both, gear pinions are a push fit on the long and short transmission shafts (4 and 53, Figure 4-24) secured with a taper pin (5). Both pinions operate their respective range scale actuating bevel gears (11) for the front and roar scale housing mechanisms.

d. Indicator mount. The indicator mount (21) is made of indicator mount knobs (1) are located at right angles to the indicator centerline (20) on opposite sides and are secured in tapped holes in the mount. They provide the observer small projecting knobs for the rotation of the indicator mount (21), thus setting the reference line indicator (20) at the indicated height of the enemy ship on the height scale dial (13).

e. Range scale actuating bevel gear. The range scale actuating bevel gear (11) is made of phosphor bronze. The large diameter has 78 teeth of 32 diametral pitch, with a pitch cone line angle of 68 degrees 24 minutes, to mesh with 26 bevel teeth of a range scale actuating bevel gear pinion (23) having a pitch cone line angle of 21 degrees 36 minutes.

The lower face has an undercut shoulder with its corner rounded off. It is bored to accommodate the range scale mount housing (10) and the range scale mount housing shaft (12). It is provided with two counterbored sections in the upper part. The small counterbored section is threaded to engage on the threaded periphery section of the range scale mount housing (10), while the large counterbored section receives the large shoulder of the above housing. The range scale mount housing (10) is secured in this bevel gear with four lockscrews (24). These lockscrews are inserted in four tapped holes in the hub section of the bevel gear and extend into the spotted recesses in the range scale mount housing (10). The axial height adjustment of this bevel gear in mesh with the range scale actuating bevel gear pinion (23) is maintained by the range scale mount housing (10) in this bevel gear, as it is not

bronze and is shape cylindrical. It has a width of 0.210 inch and is a sliding fit in the large counterbored section area, resting on the seat of this counterbored section.

An undercut groove is provided in its periphery for the protrusion of three retaining screws (22). These screws are inserted in three equally spaced countersunk taped holes in the outer wall of the scale housing section. Their protrusion in the indicator mount groove retains it in its seat, and permits free rotation of the mount. The face of this indicator mount is flush with the outer face of the scale housing section and the assembled height scale dial (13).

The mount face carries an indicator (20) separated with an indicator shim (19) to raise secured against the counterbored seat.

f. Range scale mount housing ball bearings. The two range scale mount housing ball bearings (2) are of a torque tube type. Both ball bearings are a push fit in the upper and lower counterbored section in the range scale mount housing (10), with the outer races resting against the seats in the counterbored sections. The range scale mount housing shaft (12)

is a push fit through both ball bearing center races. These ball bearings offer smooth actuation of the range scale actuating bevel gear (11).

g. Range scale mount housing. The range scale mount housing (10) is made of brass and is 31/32 inch in length. It is provided with three shoulder sections. The small undercut shoulder section is a sliding fit in the bore of the range scale actuating bevel gear (11). The medium shoulder section periphery is threaded to engage in the internal threaded section of the above bevel gear the range scale mount (9) and are screwed into tapped holes in the upper face of this housing.

h. Range scale mount. The range scale mount (9) is made of brass and is shaped cylindrical. It is provided with a large shoulder flange and an undercut shoulder section. It has a clearance hole in its center axis to fit loosely over the hexagon section of the range-scale mount housing shaft (12). The undercut shoulder section has a shallow counterbored section which is a sliding fit and rests on the upper part of the range scale mount housing (10) which is secured with four lockscrews (25). These

to maintain its height adjustment, while the large shoulder section is a sliding fit in the counterbored section and is secured with 4 lockscrews (24). These lockscrews, extending from tapped holes in the bevel gear hub, extend into spotted recesses in the large shoulder section.

The housing is bored to accommodate the range scale mount housing shaft (12) and is provided with two counterbored sections. The lower counterbored section of 1/4-inch depth, receives the lower ball bearing (2) of a push fit, with its outer race resting in the seat of this counterbored section. The upper counterbored section of 17/64-inch depth, receives the upper ball bearing (2) of a push fit, with its outer race resting in the seat of this counterbored section.

The range scale mount housing shaft (12) extending through both center ball bearing races and into the reamed hole and threaded axis in the scale housing section, maintains the axial thrust of the two mounted ball bearings. The lower ball bearing center race rests against the inner face of the scale housing section, while the upper ball bearing center race is in contact with the hexagon shoulder face of the above shaft. The lower face of the shaft above the undercut threaded periphery section contacts the seat of the scale housing section reamed hole axis and is secured with a lockscrews are inserted in four equally spaced countersunk clearance holes in the mount and are screwed into tapped holes in the range scale mount housing (10).

The large shoulder flange is provided with a shallow undercut shoulder to allow clearance for the rotation of the large shoulder flange over the range scale actuating bevel gear pinion (23), while the outer diameter rotates freely in the large bored opening in the height scale mount section of the stadimeter housing (8). The outer face of the mount is provided with two dowel pins (6), a drive fit in opposite drilled holes, which are not both located in the centerline, for reassembly alignment of the range scale dial (14). This outer face carries the range scale dial (14) secured with 10 lockscrews (4). These lockscrews are inserted in countersunk clearance holes in the range scale dial and screwed into tapped holes in the range scale mount.

The range scale mount is actuated clockwise with the range scale actuating bevel gear (11), range scale mount housing (10), and the range scale dial (14) as the handwheel (12, Figure 4-24) is turned clockwise.

i. Range scale mount housing shaft. The range scale mount housing shaft (12) is made of corrosion resisting steel and is 2 7/64 inches in length. The lower stub section has a threaded periphery which screws into the tapped axis hole in the scale housing section. The body section is a push fit through both range scale mount housing ball bearing center races (2), and is a sliding fit, bottoming in the reamed

lockscrew (3). This lockscrew extends into the spotted recess in the shaft from a tapped hole in the scale housing section lower outer wall.

The upper part of this housing receives the range scale mount (9) which is secured with four lockscrews (25). These lockscrews are inserted in countersunk clearance holes in axis hole in the scale housing section.

The upper part of the shaft is provided with a hexagon shoulder section for the attachment of a socket wrench. The upper part of the hexagon section is undercut slightly below the distance across the flats to allow the range scale dial axis opening (14) sufficient clearance for actuation and to restrict foreign matter from entering the mechanism.

The axis of the outer part is provided with a tapped hole to receive the pointer shoulder screw (18).

The body section and threaded periphery section of the shaft assembled in the reamed hole axis and tapped hole axis in the scale housing section, is secured with a lockscrew (3). This lockscrew is inserted in the tapped hole from a screwdriver clearance provision in the lower outer wall of the scale housing section, and extends into the spotted recess in the body section of the shaft for its securement. The shaft serves as a stationary support for the scale housing mechanism, and angular height of the image. By means of a cam and appropriate mechanism, the movement of the objective halves is transmitted to these scale dials for quick reading without computation.

1. Indicator. The indicator (20) is made of 1/16-inch clear Lucite sheet, and is 1 11/64 inch in length. It conforms to the contour and width of the indicator mount (21). The index line section of 1/4-inch width forms a concave junction on opposite sides with the main section of the indicator, with the outer index line section having a convex radius. The lower face of this section is provided with an engraved groove of shallow depth in the centerline, which projects inward toward the main section 5/16 inch, and is filled with red lacquer. The main section is provided with two countersunk clearance holes for the insertion of lockscrews (26), securing the indicator to its mount and separated with an indicator shim of 0.016-inch. The lockscrews extend into tapped holes in the mount.

m. Pointer. The pointer (15) is made of 1/16-inch clear Lucite sheet and is 1.590 inches in length. The wider

maintains the axial thrust of the two range scale mount housing ball bearings (2).

j. Height scale dial. The height scale dial (13) is made of 1/16-inch bakelite, having an inside diameter of 3 3/16 inches and an outside diameter of 3.996 inches. It is attached to the undercut stationary shoulder provision of the scale housing section over two opposite inserted dowel pins (6) which reestablish its proper reassembly. It is secured with six lockscrews (4) which are inserted in countersunk clearance holes in the dial and screwed into tapped holes in the undercut stationary shoulder provision. The dial is graduated 15 to 130 feet and inscribed Height in Feet.

k. Range scale dial. The range scale dial (14) is made of 1/16-inch bakelite. It has an axis hole of 0.630 inches and an outside diameter of 3.180 inches. It is attached to the range scale mount (9) over two dowel pins (6) and is secured with 10 lockscrews (4). These lockscrews are inserted in countersunk clearance holes in the dial and screwed into tapped holes in the range scale mount (9). The dial is graduated from 220 to 11,000 yards and inscribed Range in Yards.

The height and range scale dials are graduated in a correct ratio of the target distance to the

part is 15/32 inch, with a clearance hole located in the center of a 5/16-inch radius. It is provided with three equally spaced countersunk clearance holes in the lower face for lockscrews (7). These lockscrews extend into tapped holes in the pointer knob (17) and secure it to the upper face of this pointer.

The pointer tapers from the wider part to 1/4 inch in width, with the corners rounded. This part has an engraved groove of shallow depth in the centerline located in the lower face, which projects inward 1/2 inch, and is filled with red lacquer.

The periphery of the pointer knob (17) is knurled to offer a firm grip. It has a countersunk clearance hole in its axis to receive a spring washer (16) and the pointer shoulder screw (18). This pointer serves to indicate the reference points of range setting, previously set up by the known silhouette chart of enemy ships for the particular type of ship encountered.

n. Pointer shoulder screw. The pointer shoulder screw (18) is made of bronze and is 19/32 inch in length. The large diameter forms

the head, with a screwdriver slot of appropriate depth. The medium shoulder fits into the axis clearance hole in the pointer knob (17) with an assembled pointer knob spring washer (16) below its head. This shoulder screw extends into the tapped axis hole in the range scale mount housing shaft (12) to retain the pointer assembly. The spring washer (16) provides sufficient tension to the pointer (15) and pointer knob (17) to retain it at any desired reference position.

6G6. Disassembly. The stadimeter housing assembly is disassembled in the following manner:

1. Follow steps 1 to 19 inclusive of Section 4J9, as the parts removed are identical to those in the disassembly procedure of the Type II periscope stadimeter housing assembly.

2. Remove the pointer shoulder screw (18), unscrewing it from the tapped hole axis in the range scale mount housing shaft (12). Remove the pointer knob (17) and the pointer (15).

3. Remove the three lockscrews (22), unscrewing them from their protrusion in the indicator mount (21) from countersunk tapped holes in the scale housing section outer wall. Remove the indicator mount (21), lifting it out by grasping both of the indicator mount knobs (1).

4. Remove the two lockscrews (26) from the indicator (20), unscrewing them from tapped

8. Remove the lockscrew (3) located in the tapped hole in the scale housing section lower outer wall. Unscrew this lockscrew from its contact in the spotted recess in the range scale mount housing shaft (12). Place a socket wrench over the hexagon section of the shaft and unscrew it from the axis tapped hole in the scale housing section.

9. Remove the range scale mount housing shaft (12), carrying it out with the assembly consisting of the range scale actuating bevel gear (11), range scale mount housing (10), and its two mounted ball bearings (2).

10. Remove the range scale mount housing shaft (12), pulling it out of the center races of the two mounted ball bearings (2).

11. Remove the four lockscrews (24), unscrewing them from tapped holes in the hub section of the range scale actuating bevel gear (11) and their contact in spotted recesses in the range scale mount housing (10).

12. The repairman should apply reference marks on the range scale mount housing (10) noting its position in the range scale actuating bevel gear (11) for proper reassembly. Using a special fibre wrench attached over the protruding outer circumference of the range scale mount housing (10), unscrew it from the hub section of the range scale actuating bevel gear (11), removing the housing.

13. Remove the two range scale mount housing ball bearings (2), pushing them out from opposite counterbored sections in the range-scale mount housing (10).

holes in the indicator mount (21). Remove the indicator (20), and indicator shim (19). Remove the two indicator, mount knobs (1), unscrewing them from tapped holes in the indicator mount (21).

5. Remove the six lockscew (4) from the height scale dial (13) and 10 from the range scale dial (14).

6. Remove the height scale dial (13) and range scale dial (14).

7. Removed the four lockscrews (25) from the range scale mount (9). These lockscrews are unscrewed from tapped holes in the range scale mount housing (10). Precaution must be taken to observe reference marks on all these parts upon disassembly in order to reassemble them correctly later. Remove the range scale mount (9).

14. The removal of the rear scale housing mechanism is followed in similar manner to Steps 2 to 12 inclusive for the front scale housing mechanism.

15. Remove the taper pin (44, Figure 4-24) from the transmission gear pinion (2, Figure 4-24) and the inner part of the long transmission shaft (4, Figure 4-24), and remove the transmission gear pinion (2, Figure 4-24).

16. Remove the long transmission shaft (4, Figure 4-24) carrying it out of the mounted ball bearing (14, Figure 4-24) of the scale transmission ball bearing housing (8). The range scale actuating bevel gear pinion (23) is carried out

with it. It is further carried out of the ball bearing (14, Figure 4-24) mounted in the front scale housing section wall.

17. Remove the taper pin (5) from the front range scale actuating bevel gear pinion (23) and the outer part of the long transmission shaft (4, Figure 4-24) and remove the gear pinion (23) from the shaft.

18. Remove the lockscrew (55, Figure 4-24) by the insertion of a long screw driver blade extending through the ball bearing center races (14, Figure 4-24). The lockscrew is

3. Follow the reassembly procedure stated in Steps 3 to 6 inclusive for the stadimeter housing assembly used in the Type II periscope under Section 4J10.

4. Place the rear range scale actuating bevel gear pinion (23) on the outer end of the short transmission shaft (53, Figure 4-24) and secure it by the insertion of a taper pin (5). The insertion of the taper pin should be done with the gear pinion hub held on a soft metal V-block.

5. Follow the reassembly procedure stated in Steps 8 to 10 inclusive of Section 4J10.

unscrewed from the tapped hole axis in the inner end of the short transmission shaft (53, Figure 4-24). Remove the transmission gear pinion (54, Figure 4-24).

19. Remove the key (56, Figure 4-24) from the inner end of the short transmission shaft (53, Figure 4-24).

20. Remove the short transmission shaft (53, Figure 4-24) carrying it out of the mounted ball bearing (14, Figure 4-24) in the scale ball bearing housing (8). It is further carried out of the ball bearing (14, Figure 4-24) mounted in the rear scale housing section, carrying with it the rear range scale actuating bevel gear pinion (23).

21. Remove the taper pin (5) from the range scale actuating bevel gear pinion (23) and the outer end of they short transmission shaft (53 Figure 4-24) and remove the gear pinion (23) from the shaft.

22. Follow the procedures J stated in Steps 43 to 47 inclusive of Section 4J9 of the Type II periscope for the remainder of the disassembly of the stadimeter housing assembly, omitting Step 46.

6G7. Reassembly. The stadimeter housing assembly is reassembled as follows:

1. Apply Lubriplate No. 110 lightly to all rotating parts as the reassembly procedure is followed.

6. Place the front range scale actuating bevel gear pinion (23) on the outer end of the long transmission shaft (4, Figure 4-24) and secure it by the insertion of a taper pin (5). The insertion of the taper pin should be done with the gear pinion hub held on a soft metal V-block.

7. Follow the reassembly procedure stated in Steps 12 to 22 inclusive of Section 4J10.

8. Reassembly of the front scale housing mechanism proceeds as follows: Place both range scale mount housing ball bearings (2) in their respective counterbored sections in the range scale mount housing (10).

9. Place the range scale mount housing (10) in the range scale actuating bevel gear (11), screwing it in until its reference marks and the spotted recesses are in coincidence. Insert and secure the four lockscrews (24), screwing them into tapped holes in the bevel gear hub and extending them into the spotted recesses in the range scale mount housing (10).

10. Rotate the front range scale actuating bevel gear pinion (23) until its reference tooth is down, so that upon the assembly of the range scale actuating bevel gear (11) the reference tooth opening of this bevel gear is upward for its engagement with the reference tooth of the pinion gear (23).

11. Place the range scale actuating bevel gear (11) and the assembled range scale mount housing (10) with its two ball bearings (2) in the front scale housing section, and properly mesh it with the range scale actuating bevel gear pinion (23) as

2. Various parts have reference numerals with mating numerals stamped in or on the various parts to establish coincidence of these parts for correct reassembly.

outlined in step 10. Holding the range scale actuating bevel gear (11) in

mesh with its gear pinion (23), insert and secure the range scale mount housing shaft (12). Push the shaft through the two ball bearing center races (2) and into the axis reamed hole in the front scale housing section. Screw the shaft into the axis tapped hole in the scale housing section and check the reference scribed line on the outer face of the shaft. It should be lined up vertically for the engagement of the lockscrew (3) in the spotted recess in the shaft. The ball bearings (2), if installed incorrectly in the range scale mount housing (10), will prevent the reference lines of the shaft and also its spotted recess from coming into coincidence and from maintaining the correct axial adjustment.

12. Place the range scale mount (9) over the hexagon section of the range scale mount housing shaft (12) and on the range scale mount housing (10). Insert and secure the four lockscrews (25). Insert these lockscrews in countersunk clearance holes in the range scale mount (9) and screw them into tapped holes in the range scale mount housing (10). The reference line on the range

holes in the range scale mount sections of the scale housing sections.

17. Secure the front and rear range scale dials (14) with 10 lockscrews (4) each. These lockscrews are inserted in countersunk clearance holes in the dials and screwed into tapped holes in the range scale mounts (9).

18. Place the indicator shims, (19) and indicators (20) on their respective indicator mounts (21) and secure them with two lockscrews each (26). These lockscrews are inserted in countersunk clearance holes in each indicator (20) and screwed into tapped holes in each indicator mount (21).

19. Place the two indicator mount knobs (1) in opposite sides of each indicator mount (21). These knobs are screwed into tapped holes in the indicator mounts.

20. Place each indicator mount (21) in each counterbored section seat in the front and rear scale housing sections, and insert and secure them with three lockscrews (22) each. These lockscrews are screwed into tapped countersunk holes in the outer body wall of each scale housing section the extend further into each indicator mount undercut groove.

scale mount should be lined up vertically.

13. Reassembly of the rear range scale mechanism proceeds as follows (follow Steps 8 to 12 inclusive for the front scale housing mechanism):

14. Check the reference marks of the height and range scale mounts for the front and rear scale housing mechanisms and note their relation. Should both appear in unison, assemble the height and range scale dials (13 and 14) to their respective mounts in the front and rear scale housing mechanisms over the inserted dowel pins (6). Check the 220 numeral graduation on the range scale dial (14) for its coincidence with the 15 numeral graduation on the height scale dial (13). Refer to both sets of dials, noting their proper relation. Should both appear in unison, further, assembly is to be followed.

15. Follow the reassembly procedure stated in Steps 32 and 33 of Section 4J10.

16. Secure the front and rear height scale dials (13) with six lockscrews (4) each. These lockscrews are inserted in countersunk clearance holes in the dials and screwed into the tapped

21. Reassembly of the front pointer assembly to the front scale housing mechanism proceeds as follows: Place the spring washer (16) over the medium shoulder of the pointer shoulder screw (18).

22. Secure the pointer (15) to the pointer knob (17) with three lockscrews (7).

23. Place the pointer shoulder screw (18) with the spring washer (16) in the counterbored section in the pointer knob (17).

24. Holding the pointer knob (17) with the assembled pointer (15) and the pointer shoulder screw (18) and its spring washer (16), screw the pointer shoulder screw (18) into the reamed axis hole in the range scale mount housing shaft (12) until its medium shoulder is tight against the outer face of the shaft.

25. Reassembly of the rear pointer assembly to the rear scale housing mechanism is followed in similar manner to that for the front scale housing mechanism.

26. Follow the reassembly procedure stated in Steps 47 to 65 inclusive of Section 4J10 as they are identical.

6G8. Principles of the stadimeter. The stadimeter relies for its operation upon the formation of two identical images, capable of being vertically displaced with relation to each other, the amount of such displacement being controlled by the observer. For example, the waterline of a vessel in one image can be brought into apparent contact with the masthead as seen in the other image. The extent of displacement necessary to effect this is translated on the stadimeter dial to the range of the vessel as read against the known distance between the masthead and the waterline. The duplicate images are produced by two movable lens halves which travel in a plane normal to their axis and parallel to their dividing line. When so placed as to constitute a complete circle, they form only one image and in this condition are said to be in the observing position. The displacement of the lens halves is actuated by the handwheel (12, Figure 4-24) through transmission gears, to which the stadimeter dials are connected.

6G9. Operation of the stadimeter. See Figure 6-9 which illustrates the following problem: Given a target vessel whose height from waterline to masthead is known to be 60 degrees feet, find the range. Starting with the periscope in high power and the stadimeter in the observing position, i.e., with the handwheel (12, Figure 4-24). turned counterclockwise to the limit of its travel, the

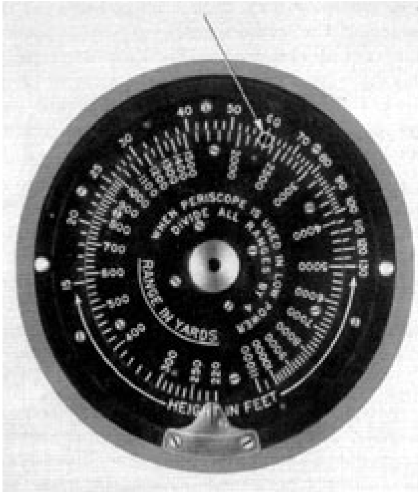

Figure 6-9. Operation of the stadimeter for obtaining the range of an individual problem.

will be no more accurate than the estimate of the heights.

b. The dimension selected for this observation should be one which is known, or which can be estimated with fair accuracy. The reference points should, as far as possible, be definite, easy to see, and widely spaced. The masthead and waterline, for instance, while affording the greatest vertical dimension, might both be invisible at long range.

c. The stadimeter is graduated up to 11,000 yards Longer ranges may be obtained by remembering, that the angle subtended by 80 feet, for instance, at 20,000 yards, is the same as that subtended by 40 feet at 10,000 yards. Thus an object 80 feet high may be set up at the 40-foot line, and the range obtained multiplied by 2.

d. The range scale dial is graduated for use with the periscope in high power. The stadimeter may also be used with the periscope in low power, by dividing the range, as read against the correct height of the object, by 4. In the case of high objects, the periscope should be placed in low power, and the object

target is brought approximately into the center of the field of view. The observer rotates the handwheel clockwise, causing the duplicate images of the target to separate, until the masthead in one image coincides with the waterline in the other. At this point the scale dials are as shown in the illustration, and the range (2,300 yards) is read on the range scale dial opposite the known height (60 feet) on the height scale dial. The stadimeter is then restored to the observing position by rotating the handwheel counterclockwise to the limit of its travel.

The following hints may be of value:

a. Remember that the stadimeter measures only angles, and computes the range on the basis of the estimated height. Hence the range reading

set up on the height scale dial at 1/4 its actual height. In this case the range reading will be correct.

e. Difficulty may at first be encountered in centering the eye in order to see duplicate images of equal intensity. Practice will overcome this difficulty to a great extent. On bright days the use of one of the rayfilters will permit the eye pupil to expand and intercept a greater portion of the divided exit pupil.

A stadimeter range may be taken with a periscope exposure of a few seconds. It is assumed that the approximate provided. The periscope may be trained approximately on the target, the power shift placed in high power, and the focus set for the observer's eye. In addition, the estimated range may be set up on the stadimeter. All this may be done with the periscope partially housed. If the periscope is then exposed, no time will be lost in focusing, and little in centering the object and bringing the reference points into coincidence. When this is done, the instrument may again be partially housed and the range reading taken.

bearing of the target is known, and that the reference points have been selected. The known or estimated height between the reference points should be set in advance on the height scale dial, using the pointer

Practice is essential to the efficient operation of the stadimeter.

H. FIRST INNER TUBE SECTION ASSEMBLY

6H1. Description of the first inner tube section assembly. The first inner tube section assembly is part of the lower telescope system. It provides the necessary parts and distance between the objective operating mechanism assembly and the eyepiece skeleton assembly. This distance is necessary for the focal length of the lower (split) objective lens (8A and B, Figure 6-13) with the eyepiece prism (9) and eyepiece lens (9a). Figure 6-10 shows the first inner tube section assembly. All bubble numbers in Sections 6H1, 2, and 3 refer to Figure 6-10 unless otherwise specified.

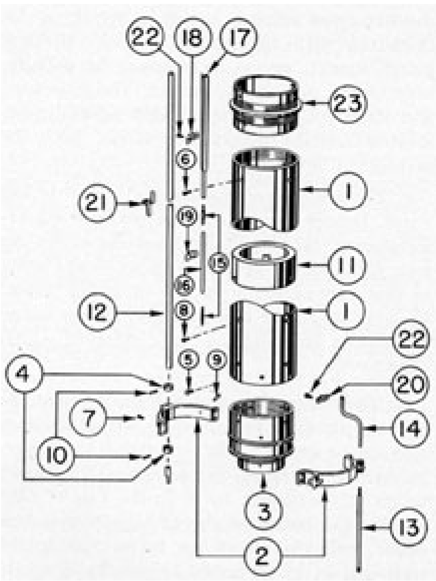

Figure 6-10. First inner tube section assembly.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1441-2	1	First inner tube section
2	P-1158-4	2	Spider halves
3	P-1158-11	1	Spider bearing
4	P-1163-7	2	Stadimeter transmission shaft thrust collars
5	P-1179-24	8	First inner tube section lower end lockscrews
6	P-1179-24	4	First inner tube section upper end coupling lockscrews
7	P-1179-63	4	Spider flange lockscrews
8	P-1179-65	3	Diaphragm lockscrews
9	P-1179-179	1	Spider taper pins
10	P-1179-196	2	Stadimeter transmission

			shaft thrust collar taper pins
11	P-1207-7	1	Diaphragm
12	P-1315-1	1	Stadimeter transmission shaft
13	P-1362-1	1	Long round air line coupling section
14	P-1362-2	1	Short bent round air line
15	P-1362-3	2	Short round air line couplings
16	P-1362-4	1	Air line round
17	P-1362-5	1	Air line continuation
18	P-1362-10	1	Air line strap
19	P-1362-11	1	Air line strap soldered
20	P-1362-13	1	Air line strap
21	P-1410-7	1	Stadimeter transmission shaft bracket
22	P-1422-1	4	Air line strap lockscrews
23	P-1443-2	1	First inner tube section upper end coupling

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a. First inner tube section. The first inner tube section (1) is made of brass tubing and is approximately 61.750 inches in length. The inner and outer

The bent air line (14) attaches to the air line coupling (15) which is soldered to the air line section (16). The bent air line is secured to the lower part of the first inner tube section with a removable air line

diameters are uniform for the entire length.

The upper part is bored a distance of 13/16 inch and threaded to engage on the lower threaded periphery section of the first inner tube section upper end coupling (23), and is secured with four lockscrews (6). These lockscrews ate inserted in countersunk clearance holes in the upper part of this inner tube section and screwed into tapped holes in the lower alignment support section of the first inner tube section upper end coupling (23).

The inner surface of this inner tube section supports a diaphragm (11) which is located in the center part and is secured with three lockscrews (8).

The lower part is a push fit on the upper alignment support section of the spider bearing (3), and is secured with eight lockscrews (5). These lockscrews are inserted in countersunk clearance holes in the lower part of this inner tube section and screwed into tapped holes in the upper alignment support section of the spider bearing (3).

The air line section continuation (16) of the objective operating mechanism assembly extends downward from the, coupling sleeve (17, Figure 6-7) and forms the airline section continuation (17) of this inner tube section ending in the upper part. It is retained in the periphery wall strap (20) secured with two lockscrews (22). It is bent in an S-shape and extends outward from the first inner tube section (1) to the air line clearance hole in the spider (2), where it attaches to the long air line coupling section (13). This long airline coupling section has a threaded periphery in the lower end to engage in the tapped hole in the large shoulder flange of the eyepiece skeleton assembly. The upper end of this air line section extends through the spider bearing projection shoulder clearance hole (2), and has an undercut section to receive the lower end of the bent air line (14).

b. First inner tube section upper end coupling. The first inner tube section upper end coupling (23) is made of cast phosphor bronze and is 3 1/4 inches in length. It forms a joint between the track sleeve (18, Figure 6-7) of the objective operating mechanism assembly and the upper part of the first inner tube section (1).

In the upper part it is smooth turned and serves as an alignment support section in the counterbored alignment support section in the lower part of the track sleeve (18, Figure 6-7). The threaded periphery section following the alignment support section engages in the internal threaded section in the track sleeve (18, Figure 6-7) and is secured with four lockscrews (9, Figure 6-7). These lockscrews are inserted in countersunk clearance holes in the track sleeve (18, Figure. 6-7) and screwed into tapped holes in the upper alignment support section of this coupling.

The center part is provided with a narrow shoulder 1/4 inch wide, and

of this inner tube section in the upper part with a removable air line snap (18) secured with two lockscrews (22). These lockscrews are inserted in clearance holes in the air line strap (18) and screwed into tapped holes in the periphery wall of this inner tube section. The air line section continuation (17) has an air line coupling (15), soldered in its lower end.

The air line section (16) located in the upper part of this inner tube section, connects to the soldered air line coupling (15) and is retained in place with an air line strap (19) soldered to the periphery wall of this inner tube section in the central part. The lower end of this air line section (16) has an air line coupling (15) soldered in its lower end, which receives the bent air line (14).

its diameter coincides with the diameter of the lower part of the track sleeve (18, Figure 6-7).

The inner diameter is bored for light transmission and threaded for anti-reflection.

The lower part is similar to the upper part, having a threaded periphery and alignment support sections. The alignment support section is carried in the first inner tube section, while

the threaded periphery section engages in the internal threaded section in this inner tube section, and is secured with four lockscrews (6).

At assembly the narrow shoulder is provided with a vertical slot to provide clearance for the air line section continuation (17).

c. Diaphragm. The diaphragm (11) is identical to the diaphragm (12, Figure 4-27) used in the first inner tube section (1) of the Type II periscope. Refer to Section 4K1.

These lockscrews are unscrewed from tapped holes in the lower alignment support section of the first inner tube section upper end coupling (23).

3. Unscrew the lower part of the first inner tube section upper end coupling (23) from the upper part of the first inner tube section (1). Remove the first inner tube section upper end coupling from the first inner tube section.

4. Remove the eight lockscrews (5) from the lower part of the first inner tube section (1). These lockscrews are unscrewed from tapped holes in

d. Spider bearing and spider. 1. Spider bearing. The spider bearing (3) is identical to the spider bearing (3, Figure 4-27) used in the Type II periscope. Refer to Section 4K1.

2. Spider. The spider (2) is identical to the spider (2, Figure 4-27) used in the Type II periscope. Refer to Section 4K1.

e. Stadimeter transmission shaft thrust collars. The two stadimeter transmission shaft thrust collars (4) are identical to the two stadimeter transmission shaft thrust collars (4, Figure 4-27) used in the Type 11 periscope. Refer to Section 4K1.

f. Stadimeter transmission shaft bracket. The stadimeter transmission shaft bracket (21) is identical to the stadimeter transmission shaft bracket (23, Figure 4-27) used in the Type II periscope. Refer to Section 4K1.

g. Stadimeter transmission shaft. The stadimeter transmission shaft (12) is identical to the stadimeter transmission shaft (22, Figure 4-27) used if the Type II periscope. Refer to Section 4K1. This shaft however, is slightly longer to make up for the variance in length of the first inner tube section (1).

6H2. Disassembly of the first inner tube section assembly. The first inner tube section assembly is disassembled in the following manner:

1. All airline sections and continuations, air line straps, thrust collars, and the the upper alignment support section of the spider bearing (3).

5. Remove the spider bearing (3) from the lower part of the first inner tube section (1). Tap the spider bearing from the lower end of the first inner tube section.

6. Remove the four lockscrews (7) unscrewing two from opposite side flanges of the spider halves (2). Remove the taper pin (9) from the spider half, and remove both spider halves from the spider bearing (3).

7. Remove the three lockscrews (8) from the central part of the first inner tube section (1). These lockscrews are unscrewed from tapped holes in each soldered strip in the inner diaphragm wall (11).

8. Tap the diaphragm (11) out through the lower part of the first inner tube section (1).

6H3. Reassembly of the first inner tube section assembly. The first inner tube section assembly is reassembled in the following manners:

1. Check all reference marks in the reassembly of and part to prevent incorrect reassembly.

2. Using an air hose, blow out the internal surfaces of the first inner tube section. If a circular brush is available, it should be used first. This procedure should be carried out also with the couplings and the diaphragm.

3. Place the diaphragm (11) in the central part of the first inner tube section from the lower end. The diaphragm side wall faces upward toward the first inner tube section

stadimeter transmission shaft (12), pertaining to this assembly were removed previously for the separation of the various telescope systems and their individual assemblies.

2. Remove the four lockscrews (6) from the upper part of the first inner tube section (1).

upper end coupling (23). Tap the diaphragm in until the

clearance holes in the inner tube section and the tapped holes in the diaphragm coincide.

4. Insert and secure three lockscrews (8). The lockscrews are inserted in countersunk clearance holes in the first inner tube section (1) and screwed into tapped holes in the diaphragm soldered inner wall strips.

5. Screw the lower threaded periphery section of the first inner tube section upper end coupling (23) into the upper part of the first inner tube section (1).

6. Insert and secure the four lockscrews (6). These lockscrews are inserted in countersunk clearance holes in and screwed into tapped holes in the upper part of the first inner tube section of the first inner tube section upper end coupling (23).

7. Place the upper alignment support section of the spider bearing (3) in the lower part of the first inner tube section (1). Using a rawhide maul and a in until its narrow shoulder comes in contact with the lower end of the first inner tube section.

8. Insert and secure the eight lockscrews (5). These are inserted in countersunk clearance holes in the first inner tube section and screwed into tapped holes in the upper alignment support section of the spider bearing (3).

9. Place both halves of the spider (2) over the spider bearing (3) between its two narrow shoulders.

10. Insert and secure each flange half of the spider with two lockscrews (7). Insert the lockscrews in clearance holes in one flange half and screw them into tapped holes in the other flange half of both sets of opposite flanges.

11. Insert the taper pin (9) in one spider half (2) and the spider bearing (3).

12. The air line sections and the air line continuation, air line straps, thrust collars, and the stadimeter transmission shaft (12) are assembled later, upon the connection of individual assemblies of this lower telescope system.

block of wood, tap the spider bearing

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Chapter 6 Continued

I. EYEPIECE SKELETON ASSEMBLY

6I1. Description of eyepiece skeleton assembly. The eyepiece skeleton assembly (Figure 4-28) is almost identical to the eye piece skeleton assembly used in the Type II periscope. All parts except the eyepiece prism and the eyepiece lens are identical. Refer to Section L, Chapter 4, following the procedure of Sections 4L1, 2, and 3 for description, disassembly, and reassembly.

J. EYEPIECE BOX AND MISCELLANEOUS ASSEMBLIES

6J1. Description of eyepiece box and miscellaneous assemblies. This eyepiece box and miscellaneous assemblies (Figure 4-29) are identical to the eyepiece box and miscellaneous assemblies used in the Type II periscope. Refer to Section 4M1 for its description.

K. PACKING GLAND ASSEMBLIES

6K1. Description of packing gland assemblies. The packing gland assemblies (Figures 4-30, 31, 32, 33, and 34) ale identical to the packing gland assemblies used in the Type II periscope. Refer to Sections 4N1 to 4N13 inclusive, for description, disassembly, and reassembly.

L. EYEPIECE WINDOW ASSEMBLY

6L1. Description of the eyepiece window assembly. The eyepiece window assembly (Figure 4-38) is almost identical to the eyepiece window assembly used in the Type II periscope. All parts except the eyepiece window are identical. Refer to Section O of Chapter 4, following the procedure stated in Sections 4O1, 2, and 3 for description, disassembly, and reassembly.

M. FOCUSING KNOB ASSEMBLY.

6M1. Description of the focusing knob assembly. The focusing knob assembly (Figure 4-39) is identical to the focusing knob assembly used in the Type II periscope. Refer to Sections 4P1, 2, and 3 for description, disassembly, and reassembly.

N. RAYFILTER ASSEMBLY

6N1. Description of rayfilter assembly. The rayfilter assembly (Figure 4-40) is identical to the rayfilter assembly used in the Type II periscope. Refer to Sections 4Q1, 2, and 3 for description, disassembly, and reassembly.

O. VARIABLE DENSITY POLAROID FILTER ASSEMBLY

6O1. Description of variable density polaroid filter assembly. The variable density polaroid filter assembly (Figure 4-41) is identical to the variable density polaroid filter assembly used in the Type II periscope. Refer to Section R under Chapter 4 following the procedure stated in Sections 4R1, 2, and 3 for description, disassembly, and reassembly.

P. EYE BUFFER AND BLINDER ASSEMBLY

6P1. Description of the eye buffer and blinder assembly. The eye buffer and blinder assembly (Figure 4-42) is identical to the eye buffer and blinder assembly used in the Type II periscope. Refer to Section S under Chapter 4, following the procedure stated in Sections 4S1, 2, and 3 for description, disassembly, and reassembly.

Q. TRAINING HANDLE ASSEMBLIES

6Q1. Description of the left training handle assembly. This left training handle assembly operates the prism tilt mechanism by the movement of the revolving grip (3, Figure 6-11) and is interconnected, with an appropriate mechanism in the eyepiece skeleton assembly. It is further interconnected by shifting wire tapes (38, Figure 4-28) to the prism tilt mechanism and the skeleton head assembly for elevation and depression of the head prism.

This assembly is similar to the left training handle assembly (Figure 4-43) used in the Type II periscope, except for various deletions, such as the spring detent assembly and its accompanying parts. There is also a variation in the construction of

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1069-1	1	Revolving grip end cap
2	P-1069-2	1	Fixed grip
3	P-1069-4	1	Revolving grip
4	P-1069-5	1	Revolving grip outer collar
5	P-1069-7	1	Fixed grip outer collar
6	P-1069-9	1	Revolving grip inner collar
7	P-1069-	1	Index ring

various parts. Several parts of this assembly are used in the right training handle assembly of the Type II periscope the handle hinge (16, Figure 6-11) is the only part of this assembly having a variance in construction. Figure 6-11 shows the left training handle assembly. All bubble numbers in Sections 6Q1, 2, and 3 refer to Figure 6-11 unless otherwise specified.

	10		
8	P-1069-11	1	Segment stop
9	P-1069-12	1	Outer bevel gear clutch shaft
10	P-1069-13	1	Revolving grip shaft
11	P-1069-14	1	Outer bevel gear clutch shaft collar
12	P-1069-15	1	Outer bevel gear clutch spring
13	P-1069-16	1	Outer bevel gear clutch spring retaining screw
14	P-1069-18	2	Revolving and fixed grip lockscrews
15	P-1069-21	1	Revolving grip shaft and outer bevel gear clutch shaft locking taper pin
16	P-1157-1	1	Handle hinge
17	P-1157-5	1	Inner bevel gear clutch

Ill. No.	Drawing Number	Number Required	Nomenclature
18	P-1157-6	1	Outer bevel gear clutch
19	P-1157-7	1	Handle detent plunger
20	P-1157-8	1	Handle detent plunger

3. Remove the two lockscrews (26) from the segment stop (8), unscrewing them from tapped holes in the revolving grip shaft (10). Remove the segment stop (8).

4. Remove the lockscrew (14) from the fixed grip (2), unscrewing it from tapped holes in the handle hinge (16) alignment support section and the fixed grip.

			spring
21	P-1157-9	1	Handle detent plunger retaining screw
22	P-1161-7	4	Hinge bracket bolts
23	P-1171-6	2	Pivot screws
24	P-1179-39	2	Pivot screw lockscrews
25	P-1179-52	1	Index ring actuating screw
26	P-1179-53	2	Segment stop lockscrews
27	P-1179-191	1	Outer bevel gear clutch shaft collar taper pin
28	P-1310-39	2	Segment stop adjusting screw lockscrews
29	P-1389-7	2	Segment stop adjusting screws
30	P-1408-3	1	Hinge bracket

a. Handle hinge. The handle hinge (16) is identical to the left handle hinge (28, Figure 4-43) used in the left training handle assembly of the Type II periscope. The alignment support section of the handle hinge, however, does not include the two counterbored sections for the main body stop (31, Figure 4-43) used in the left handle hinge (28, Figure 4-43) and the square broached hole and opposite clearance hole.

b. Index ring. The index ring (7) is almost identical to the index ring (6, Figure 4-43) used in the left training handle assembly of the Type II

5. Remove the assembled fixed grip (2) with the index ring (7) on its outer collar (5) sliding it off the handle hinge (16) alignment support section and carrying it off the revolving grip shaft (10).

6. Remove the index ring (7), sliding it off the fixed grip outer collar (5).

7. Remove the two pivot screw lockscrews (24), unscrewing them from their contact with the two pivot screws (23) and the tapped holes in each hinge section side wall of the hinge bracket (30) in its lower counterbored section seat.

8. Swing the handle hinge (16) to the extended position. Only in this position is there sufficient clearance for the removal of the outer bevel gear clutch (18) with the remaining assembly of the handle hinge (16) from the hinge bracket (30).

9. Remove the two pivot screws (23), unscrewing them from the tapped holes in the hinge section side walls of the hinge bracket (30). Remove the hinge bracket.

10. Remove the inner bevel gear clutch (17), sliding it out of the hinge bracket (30).

11. Remove the retaining screw (13), unscrewing it from the tapped hole in the outer bevel gear clutch shaft (9). Remove the outer bevel gear clutch (18), and the outer bevel gear clutch spring (12), sliding them off the square section of the outer bevel gear clutch shaft (9).

12. Rotate the revolving grip shaft (10) until the small end of the taper pin (27) is lined up with the drift clearance hole in the handle hinge wall (16).

periscope, except for the fact that the periphery is engraved after assembly to indicate 10 degrees depression, 0 degrees line of sight, and 45 degrees elevation.

6Q2. Disassembly. The left training handle assembly is disassembled in the following manner:

1. Remove the lockscrew (14), unscrewing it from the tapped hole in the revolving grip shaft (10), and carrying it out of the clearance holes in the revolving grip (3) and the outer collar (4).

2. Remove the assembled revolving grip (3) sliding it off the revolving grip shaft (10), carrying with it the revolving grip end cap (1), revolving grip outer collar (4), revolving grip inner collar (6), and the index ring actuating screw (25).

13. Place a drift punch of suitable size in the handle hinge clearance hole (16).

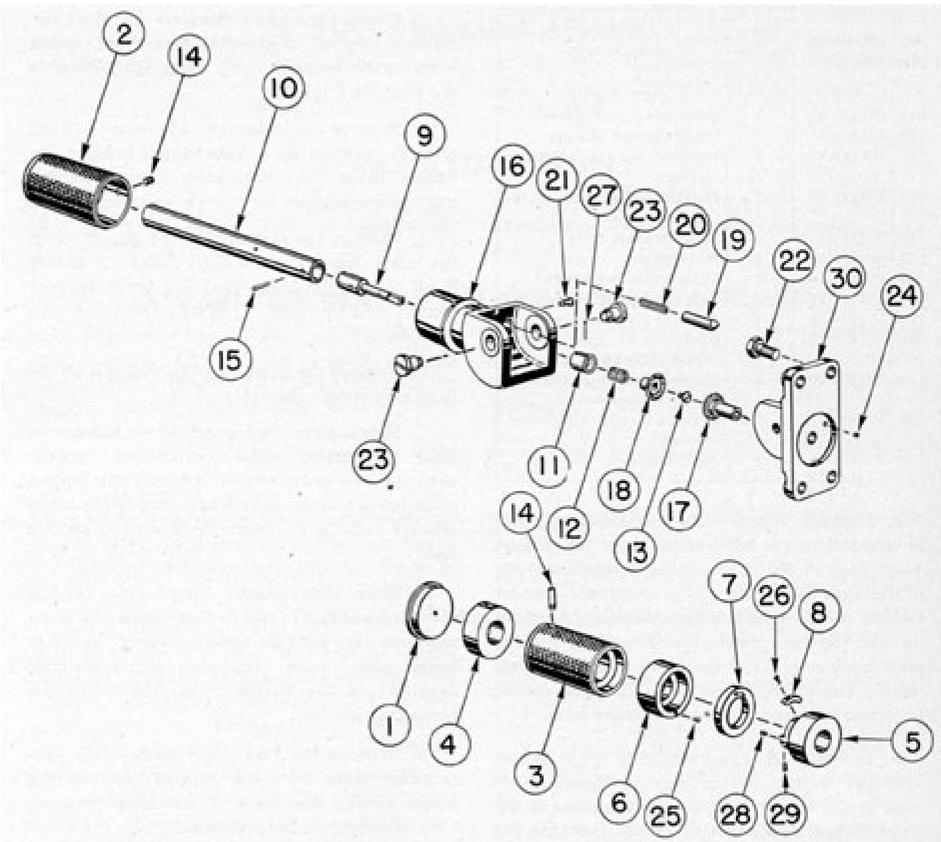

Figure 6-11. Left training handle assembly.

14. Drive the taper pin (2I) from

18. Remove the retaining screw

the outer bevel gear clutch collar (11) and the outer bevel gear clutch shaft (9).

15. Remove the outer bevel gear clutch collar (11) from the outer bevel gear clutch shaft (9).

16. Remove the revolving grip shaft (10) with the assembled outer, bevel gear clutch shaft (9) from the handle hinge (16).

17. Do not disassemble the outer bevel gear clutch shaft (9) from the revolving grip shaft (10). Leave them secured with the taper pin (15).

(21), unscrewing it from its engagement in the keyway in the handle detent plunger (19) and the tapped hole in the hinge section rear side wall of the handle hinge (16).

19. Remove the handle detent plunger (19) and the handle detent plunger spring (20) from the reamed hole in the hinge section inner circumference wall of the handle hinge (16).

20. The two segment stop adjusting screws (29) and the two lockscrews (28) are not altered during disassembly.

6Q3. Reassembly. The left training handle assembly is reassembled in the following manner:

1. Lubricate lightly all rotating parts with Lubriplate No. 110 as the reassembly procedure is followed.

2. Place the handle detent plunger spring (20) in the reamed clearance holes in the handle detent plunger (19).

3. Place the handle detent plunger (19) and the spring (20) in the reamed hole in the rear inner circumference wall of the handle hinge (16). Rotate the handle detent plunger until its keyway is located to the rear, and its detent point is lying in a horizontal plane, so that the retaining screw (21) engages in the keyway.

4. Insert the retaining screw (21), screwing it into the tapped hole with its undercut shoulder

13. Place the inner bevel gear clutch (17) in the reamed hole in the cored hinge section of the hinge bracket (30).

14. Holding the handle hinge assembly in the extended position, carry the outer bevel gear clutch (18) through the cored clearance hole in the hinge bracket (30).

15. Check the reference marks of the inner bevel gear clutch tooth (17) with its mating reference mark between two teeth of the outer bevel gear clutch (18). Engage the gear teeth of the inner and outer bevel gear clutches, carrying the hinge section of the handle hinge (16) over the hinge section of the hinge bracket (30).

16. Apply downward pressure to the handle hinge (16) and the handle detent plunger (19) resting

engaging in the keyway in the handle detent plunger (19).

5. Place the assembled outer bevel gear clutch shaft (9) with revolving grip shaft (10) in their respective reamed holes in the handle hinge (16).

6. Place the outer bevel gear clutch collar (11) on the outer bevel gear clutch shaft (9).

7. Align the taper pin holes in the outer bevel gear clutch shaft (9) and the collar (11).

8. Insert and secure the taper pin (27) in these lined up holes from the open hinge section of the handle hinge (16).

9. Place the Outer bevel gear clutch spring (12) on the outer bevel gear clutch shaft (9) and into the counterbored section in the outer bevel gear clutch collar (11).

10. Place the outer bevel gear clutch (18) on the square section of the outer bevel gear clutch shaft (9) with reference marks properly reestablished.

11. Compress the outer bevel gear clutch spring (12) by pressing inward on the outer bevel gear clutch (18) for the insertion of the retaining screw (13). Insert the retaining screw (13), screwing it into the square section tapped axis hole in the outer bevel gear clutch shaft (9).

12. Check the outer bevel gear clutch (18) for free spring movement.

on the hinge section side wall periphery of the hinge bracket (30). This compresses the handle detent plunger spring fully, for the insertion of the two opposite side pivot screws (23).

17. Insert the two pivot screws (23) into opposite side walls of the handle hinge (16), check their reference marks for proper insertion, and screw them into tapped holes in the hinge section side walls of the hinge bracket (30).

18. Secure both pivot screws (23) with lockscrews (24). Insert these lockscrews in body clearance holes and screw them into the tapped hole section in each of the hinge section side walls of the hinge bracket (30) located in the lower counterbored section seat in its base. The lockscrews contact the pivot screw threaded sections to prevent them from unscrewing.

19. Place the fixed grip (2) on the revolving grip shaft (10), sliding it on over the alignment support section of the handle hinge (16).

20. Align the tapped lockscrew holes and insert the lockscrew (14). This lockscrew is screwed into the tapped hole in the fixed grip (2) and in the alignment support section wall of the handle hinge (16).

21. Place the index ring (7) over the revolving grip shaft (10) and on the undercut shoulder of the fixed grip outer collar (5). It should fit snugly over the shoulder of this collar.

22. Place the segment stop (8) on the revolving grip shaft (10), secure it opposite the semi-circular projecting section of the fixed grip outer collar (5) to the revolving grip shaft (10) with two lockscrews (26). These lockscrews are inserted in countersunk clearance holes in the segment stop (8) and screwed into tapped holes in the above shaft.

23. Place the assembled revolving grip (3) on the revolving grip shaft (10), carrying with it the outer and inner collars (4 and 6), end cap (1), and index ring actuating screw (25). Engage the actuating screw head in the elongated circumferential recess in the outer side face of the index ring (7).

24. Insert the lockscrew (14), carrying it into the clearance holes of the revolving grip (3) and its outer collar (4), screwing it into the tapped hole in the revolving grip shaft (10).

25. Rotate the revolving grip (3) until the index ring (7) with its graduated line of 45 degrees is located in the full elevated position. This graduated line on the index ring should coincide with the stationary index line on the fixed grip (2). Correct the insufficient or over-travel of the index ring by means of two segment stop adjusting screws (29). The front adjusting screw corrects for elevation, while the rear adjusting screw corrects for depression. Follow the same procedure for 10 degrees or full depression. To make the necessary adjustments requires the removal of the revolving grip (3).

6Q4. Description of the right training handle assembly. The right training handle assembly (Figure 4-44) is identical to the right training handle assembly used in Type II periscope. Refer to Sections 4T5, 6, and 7 for description, disassembly, and reassembly.

R. STADIMETER ILLUMINATOR ASSEMBLY

6R1. Description. The stadimeter illuminator assembly may be attached to the anchor screw pins (19, Figure 4-29) in the front or rear sides of the eyepiece box (11). It is adjusted in such position as to illuminate either the front or rear stadimeter housing dials (Figure 4-24) in an emergency, or when the observer desires the extinguishing of the submarine control tower lighting. The light intensity is adjustable for varying degrees of darkness adaptation in the observer's eye. Figure 6-12 shows the stadimeter illuminator assembly. All bubble numbers

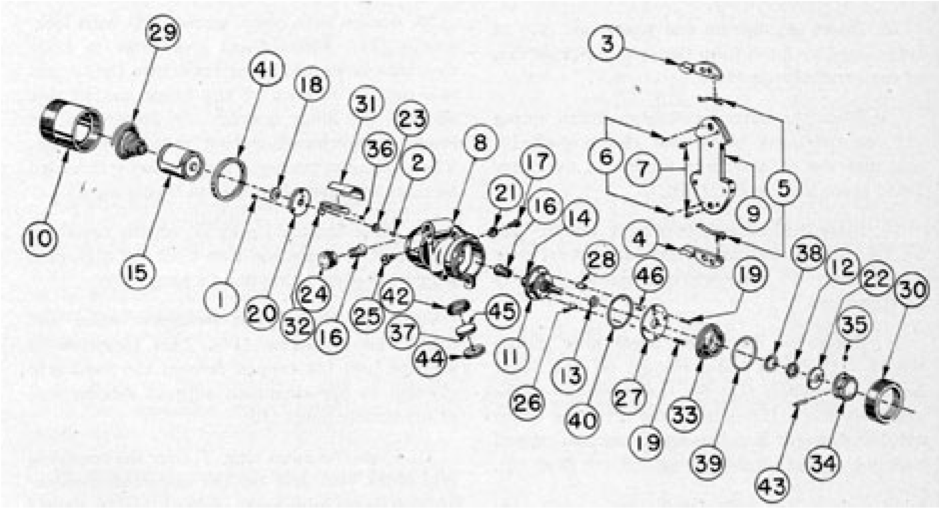

Figure 6-12. Stadimeter illuminator assembly.

in Section 6R1 refer to Figure 6-12 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1179-26	3	Insulating plate lockscrews
2	P-1179-31	1	Contact strip lockscrew
3	P-1414-3	1	Right finger grip lever
4	P-1414-4	1	Left finger grip lever
5	P-1414-5	2	Finger grip lever springs
6	P-1416-5	2	Finger grip lever thrust stop screw pins
7	P-1416-6	2	Finger grip lever pivot screw pins
8	P-1431-1	1	Illuminator housing
9	P-1431-2	1	Housing base plate
10	P-1431-	1	Battery cell

Ill. No.	Drawing Number	Number Required	Nomenclature
42	P-1436-9	1	Condenser lens mount
43	P-1436-10	1	Rheostat operating knob taper pin
44	P-1436-11	1	Condenser lens clamp ring
45	P-1436-12	1	Red lucite filter
46	P-1-1	1	Rheostat mount plate stop pin

a. Housing base plate. The housing base plate, (9) is made of cast phosphor bronze and is 4.190 inches in length. The upper and lower projecting parts are similar to the base plate (9) used in the variable density polaroid filter assembly of the Type II and III periscopes, for the attachment of two finger grip levers right and left (3 and 4), and the two tension springs (5). Refer to (9), Figure 4-41,

	3		housing
11	P-1433-1	1	Rheostat assembly
12	P-1433-1A	1	Rheostat hub locknut
13	P-1433-1B	1	Rheostat shaft retaining lock washer
14	P-1433-2	1	Bulb socket assembly
15	P-1433-9	1	Battery single cell
16	P-1433-12	2	Battery bulbs
17	P-1434-1	2	Illuminator housing spacer screws
18	P-1434-2	1	Battery center contact
19	P-1434-3	4	Bulb and rheostat mount plates lockscrews
20	P-1434-5	1	Insulating plate
21	P-1434-6	2	Illuminator housing spacing screw locknuts
22	P-1434-7	1	Stuffing gland
23	P-1434-8	1	Contact spring usher
24	P-1434-9	1	Spare bulb housing
25	P-1435-1	3	Illuminator housing screws
26	P-1435-2	3	Bulb and rheostat mount plate spacers
27	P-1435-	1	Rheostat

Section 4R1, for these upper and lower projecting sections.

The upper and lower projecting sections are separated on opposite sides with rectangular slotted sections, leaving a narrow center section. This narrow center section fits between the rear cylindrical walls of the illuminator housing (8) with an axial adjustment clearance of approximately 1/8 inch. This allows the housing to be adjusted, axially, so that the position of the lamp filament will illuminate the stadimeter housing dials uniformly.

The lower projecting section is provided with two tapped holes to receive two cap screws (25). The narrow section in the center of the connecting section below the upper projecting section is provided with a tapped hole for the third cap screw, (25). These three cap screws (25) inserted in three elongated holes in the three illuminator housing lug sections, secure the housing axially and angularly. Two tapped holes located in opposite recesses in the rear of the illuminator housing cylindrical periphery (8) receive spacer screws (17) fitted with locknuts to adjust the lamp filament angularly as desired for uniform illumination of the stadimeter housing dials.

b. Finger grip levers. The finger grip levers right and left (3 and 4) with their two thrust stop screw pins (6) and the two pivot screw pins (7) are identical to the finger grip levers right and left (1 and 2, Figure 4-41) and

	3		mount plate
28	P-1435-4	1	Bulb and rheostat mount plate key spacer
29	P-1435-6	1	Battery cell spring
30	P-1435-7	1	Bulb and rheostat mount knurled retaining ring
31	P-1435-8	1	Contact strip insulator
32	P-1435-9	1	Contact strip
33	P-1436-1	1	Rheostat assembly cover
34	P-1436-2	1	Rheostat operating knob
35	P-1436-2A	1	Rheostat operating knob lockscrew
36	P-1436-3	1	Contact strap aligning Screw.
37	P-1436-4	1	Condenser lens,
38	P-1436-5	1	Rheostat hub lock washer
39	P-1436-6	1	Rheostat assembly cover lead washer
40	P-1436-7	1	Rheostat mount plate lead washer
41	P-1436-8	1	Battery housing lead washer

their thrust stop screw pins (13) and pivot screw pins (14) used in the variable density polaroid filter assembly of the Type II periscope. Refer to Section 4R1.

c. Illuminator housing. The illuminator housing (8) is made of cast phosphor bronze and is 3 1/4 inches in length. The external surfaces of this housing follow an irregular cast design from the main cylindrical body on opposite ends. Its left cylindrical body has a cast projection extending upward sufficiently to serve as a container. This cast projection is drilled a depth of 7/8 inch and is provided with a coarse thread to receive a left-hand housing (24) containing a spare battery bulb (16).

The housing from the cast projection slopes downward to form a hood arrangement between its two cylindrical body sections in the central part. The two cylindrical body sections are separated by a space of 7/8 inch. This hood arrangement leaves a narrow wall with a raised boss in the left side to accommodate an elongated hole for a cap screw (25). The hood arrangement follows a convex contour in a distance of approximately 120 degrees, at which point it slopes inward at an angle of about 24 degrees.

The inward sloping section is spotted with a router in the inner wall section of the hood arrangement, with a counterbored and internal threaded section to receive the condenser lens mount (42). This section is counterbored to receive the large shoulder of the condenser lens mount (42), with the remaining sides of the cylindrical body sections having a cored inserted in countersunk clearance holes in the insulating plate (20) and screwed into tapped holes in the small counterbored seat. The large counterbored section accommodates sufficient clearance for a single cell battery (15).

The right cylindrical body section is undercut and threaded to receive the bulb and rheostat mount knurled retaining ring (30), which retains the rheostat assembly cover (33) and rheostat mount plate (27). The inner surface of this right side is counterbored with a 45 degrees chamfer in its seat to provide clearance for the bulb socket assembly (14). The inner circumference of the counterbored section is provided with a milled recess for the bulb and rheostat mount key spacer (28), which serves to designate its correct assembly.

The center section between the left and right side counterbored sections in both body sections is cored with a semi-circular section bounded on both ends with narrow raised boss sections located directly opposite. This semi-circular section carries a contact strip insulator (31) to prevent the battery from grounding to the illuminator housing.

The rear part of the housing between the two cylindrical body sections is machined flat as are also the two projecting lug sections. This allows it an axial adjustment on the housing base plate (9) by means of the three elongated holes in the two projecting lug sections and the upper narrow wall and raised boss section above the hood arrangement.

concave seat. The cored convex seat allows clearance for adequate divergence of the illuminated light beam projecting downward and inward.

Two projecting lugs extend downward on opposite sides of the bored and internal threaded condenser lens mount opening and each cylindrical body section to form the rear flat-wall section extension. Each projecting lug has an elongated hole for insertion of cap screws (25).

The left cylindrical body section is undercut and threaded to receive a lead washer (41) and battery cell housing (10). The inner surface of this left side is provided with two counterbored sections. The small section of shallow depth carries an insulating plate (20) which is secured with three lockscrews (1). These lockscrews are

d. Spare bulb housing. The spare bulb housing (24) is made of phosphor bronze and is 1/2 inch in length. The large outer diameter is rough diamond knurled to offer a firm grip to the observer. The outer face has the letters Spare Lamp inscribed on it, and is filled with white monofil, in order to be clearly visible to the observer. The undercut section is threaded with 12 threads per inch and engages into the coarse tapped hole in the upper projecting section of the left cylindrical body section of the illuminator housing (8). The inside axis of the bulb housing has a tapped hole for an American national miniature thread to receive the threaded periphery of the spare bulb.

e. Battery cell housing. The battery cell housing (10) is made of brass rod and is 2 1/32

inches in length. The outer diameter is uniform its entire length with a knurled band 1/16-inch wide near its outer end. The outer sharp corner is rounded off.

The inner part is bored to carry the battery cell (15) of a loose fit. It is provided with a counterbored section 1 3/16 inch long to reduce its weight, and is provided, with an undercut trap 1/16 inch in width to retain the battery cell spring (29) within 1/8 inch of the outer side wall.

The inner end is counterbored a depth of 1/8 inch and is threaded to engage on the threaded periphery of the illuminator housing (8) left side against a lead washer (41).

clearance holes in each of the three bulb and rheostat mount plate spacers (26) and one bulb and rheostat mount plate key spacer (28) to screw in the insulating plate of this bulb socket assembly. The rheostat assembly (11) axis section fits through the axis clearance hole in the rheostat mount plate (27). This plate is provided with a stop pin (46) which is a drive fit in a reamed hole located 15 degrees from the vertical centerline and an appropriate distance from its center axis. This stop pin (46) extends through a clearance hole in the rheostat coil plate of the rheostat assembly, and restricts the rheostat resistance contact finger from further rotation for a known OFF

f. Insulating plate. The insulating plate (20) is made of 1/8-inch Bakelite and is shaped cylindrical. It is a sliding fit in the small shallow counterbored section in the left side of the illuminator housing (8) and is secured with three lockscrews (1). These lockscrews are inserted in countersunk clearance holes in the outer face of this insulating-plate and screwed into tapped holes in the counterbored seat.

It carries the battery center contact (18) mounted in its axis. The inner face of this plate carries the contact strip (32) secured with an aligning screw (36), contact strip washer (23), and lockscrew (2). The lockscrew (2) inserted in a hole in the contact strip (32) extends into the axis tapped hole in the battery center contact.

The contact, strip (32), which is 1 5/16 inches long and extends the entire length of the center axis section in the illuminator housing (8), is properly insulated from grounding with the illuminator housing by means of the contact strip insulator (31). The contact strip is chromium plated and serves as a reflector.

g. Bulb socket assembly. The bulb socket assembly (14) is directly connected electrically with the rheostat assembly (11). It is a commercial product consisting of a bulb socket and finger contact attached to a 1/8-inch Bakelite insulating plate. The insulating plate is supported by the rheostat mount plate (27) and is separated from it by three bulb and rheostat mount plate spacers (26) and a bulb and rheostat mount plate key spacer (28). It is secured with four lockscrews (19). These lockscrews position inscribed on the rheostat assembly cover (33) with a reference line on the rheostat operating knob (34).

h. Rheostat assembly cover. The rheostat assembly cover (33) is made of brass and is 27/32 inch in width. It is provided with three external shoulder sections. The large diameter shoulder is counterbored a shallow depth to carry a lead washer (39) in its outer face to provide a negative ground for the battery, and contacts the inner counterbored seat of the knurled retaining ring (30). The medium diameter shoulder section is a sliding fit in the bored opening of the retaining ring, while the small diameter shoulder section is chamfered to a diameter which is coincident with the large diameter of the rheostat operating knob (34). The chamfered shoulder periphery is inscribed with the letters OFF and filled with white monofil to designate to the observer the OFF position of the illuminator as indicated by the rheostat operating knob reference line.

The center axis is provided with a clearance hole which is a sliding fit over the rheostat hub threaded periphery, and has a counterbored and threaded section in the outer part. This counterbored section allows sufficient clearance for the attachment of the rheostat hub lock washer (38) and rheostat hub locknut (12). This cover is secured to the rheostat mount plate (27) in direct relation to its inscribed OFF designation with the rheostat operating knob (34) reference line. The internal threaded section receives a stuffing gland (22) which locks the rheostat hub lock nut (12).

are inserted in countersunk clearance holes in the rheostat mount plate (27), and extend through

i. Stuffing gland. The stuffing gland (22) is made of phosphor bronze and is shaped

cylindrical. Its outer periphery is threaded to engage in the internal threaded section in the rheostat assembly cover (33). Its center axis is provided with a reamed clearance hole, a sliding fit over the projecting section of the rheostat assembly shaft. The inner face is countersunk to provide clearance over the rheostat shaft retaining lock washer (13). The outer face is provided with two opposite drilled holes for the insertion of a special wrench. This stuffing gland serves to prevent moisture from entering the rheostat assembly, and also serves to lock the rheostat hub locknut (12).

j. Rheostat operating knob. The rheostat operating knob (34) is made of black bakelite with a clearance hole in its inner axis, and is a sliding fit on the rheostat assembly shaft secured with a taper pin (43) and lockscrew (35). The knob has two shoulder sections, the large shoulder coincides with the chamfered shoulder section of the rheostat assembly cover (33) and is filleted with the octagon shoulder section.

k. Bulb and rheostat mount knurled retaining rings. The bulb and rheostat mount knurled retaining ring (30) is made of brass and is 0.570 inch in width. It is shaped cylindrical, with the periphery rough diamond knurled to offer the observer a firm grip. The outer 1/16 inch of the periphery is undercut, with the sharp corner rounded off.

a threaded periphery to engage in the internal threaded section in the illuminator housing, and rests, against the counterbored seat.

The mount is bored for the illuminated light transmission and is counterbored, leaving a narrow shoulder seat. The smooth part of this counterbored section carries the red lucite-filter (45) and the condenser lens (37), while the internal threaded section carries the threaded clamp ring (44). The outer face of the mount is provided with opposite slots for the insertion of a special wrench.

2. Condenser lens. The condenser lens (37) is made of one optical element consisting of a plano convex crown element. It is mounted in the condenser lens mount (42) with the plano side resting against the red Lucite filter (45), and is secured with a clamp ring (44).

m. Red Lucite filter. The red lucite filter (45) is shaped cylindrical with parallel faces and is placed in the condenser lens mount (42) below the condenser lens (37). This red filter presents a red beam of light to the stadimeter housing dials. The light intensity is adjustable by counterclockwise rotation of the rheostat operating knob from maximum intensity to minimum intensity as desired by the observer.

n. Clamp ring. The clamp ring (44) is made of brass and has a nominal

It is bored a sliding fit over the medium shoulder section of the rheostat assembly cover (33), and is provided with two counterbored sections. The small counterbored shoulder section is provided with clearance over the large diameter of the rheostat assembly cover (33) while the large counterbored and threaded section fits over the rheostat mount plate (27) and engages on the threaded periphery section on the right side of the illuminator housing (8) to secure the rheostat assembly with a good negative battery ground against the lead washer (39).

l. Condenser lens mount and lens. 1. Condenser lens mount. The condenser lens mount (42) is made of brass and is 1 3/64 inch wide. It has an undercut shoulder section which serves as an alignment support section for its entry in the internal threaded section in the illuminator housing (8). Its large diameter has thickness and width. The periphery is threaded and engages in the internal threaded section in the condenser lens mount (42) to secure the red lucite filter (45) and condenser lens in the seat of the mount. The inner face is chamfered at 30 degrees and rests against the convex surface of the condenser lens (37). The outer face is provided with two opposite slots for the insertion of a special wrench.

o. Electrical circuit. The negative side of the battery cell (15) is grounded to the battery cell housing (10) by a battery cell spring (29) and the illuminator housing (8) with a lead washer (41). The positive battery terminal feeds through the center contact (18), contact strip (32), and contact finger of the bulb socket assembly (14) to one side of the bulb (16). The other side of the bulb feeds through the rheostat assembly (11) and grounds to the illuminator housing (8) completing the circuit.

S. OPTICAL SYSTEM

6S1. Principles of periscopic systems. The principles discussed in Section 4U1 apply equally well to the Type III periscope except as noted below:

1. Magnifying power. While the over-all power of the Type II and III is the same, the Type III has a different arrangement of telescopes for obtaining the high and low powers (6X and 1.5X). Omit, therefore, the list of component telescopes in section 4U2-b, and substitute the following list:

which in the Type III is 222 mm in low power and 213 mm in high power. Assuming that about 0.1,percent of the incident light is absorbed by each millimeter of glass path, we arrive at the absorption loss shown in the table.

By multiplying the transmission (= 100 percent minus the percent of loss) values together, we find that the overall theoretical transmission of the periscope is 19.2 percent in low power and 24.4 percent in high power. These values may also be

Type III Periscope	Low Power	High Power
Galilean telescope	1/4 X	Out
Upper main telescope	1/4.7 X	1/4.7 X
Lower main telescope	28 X	28 X
PERISCOPE (Combined product)	1.5 X	6 X

2. Field of view. The apparent field of view and the true field of view are the same in the two types discussed so far; however, the head prism in the Type III can be elevated only far enough to raise the line of sight 45 degrees above horizontal, thus, the limits of the field are different in the present instrument. Refer to section 6S1-4 for complete data. Also, since the Type III periscope does not have the two one-power auxiliary telescopes, omit Section 4U1-c.

3. Image brightness. Omit Section 4U4 and substitute the following details. Since there are five fewer lenses in the Type III, we may expect this periscope to transmit more light than the Type II. Less light is lost by absorption and reflection.

a. Absorption-reflection losses. The reflection loss at the successive air-glass surfaces may be calculated approximately on the basis of the Fresnel theory, by assuming that about 4.1 percent of the incident light is lost at each air-crown glass surface and about 5.6 percent at each air-flint glass surface. The number of such surfaces are shown in the following table. A further reflection loss occurs at each of the two silvered glass surfaces (head prism and eyepiece prism), and this amounts to about 6 percent at each, called the transmission efficiencies, since the incident light was taken as 100 percent.

Type III Periscope	Low Power	High Power
Total axial thickness, glass	222mm	213mm
No. of air-crown surfaces	14	14
No. of air-flint surfaces	12	8
No. of silvered surfaces	2	2
TRANSMISSION that would result if loss were due to:		
Absorption by glass	77.80% *	78.70%
Reflection, air-glass	27.87% **	35.09%
Reflection, silvered-glass	88.36% ***	88.36%
Uncoated theoretical TRANSMISSION	19.2% ****	24.4%
Uncoated Measured TRANSMISSION	19.5%	25.2%
Measured TRANSMISSION (Coated optics)	43.6%	50.9%

* 100 % - (222 mm X 0.001) = 0.778 = 77.80% (absorption loss).
** $(1.000 - 0.041)^{14}$ X $(1.000 - 0.056)^{12}$ = 0.2787 = 27.87%.
*** $(1.00 - 0.06)^2$ = 0.8836 = 88.36%.
**** (0.7780) X (0.2787) X (0.8836) = 0.192 = 19.2%.

The actual measurements of transmission for coated and uncoated optical elements were compiled from the measurements of

or 11.64 percent for the two (=1.0000 - 0.8836).

In addition, there is the light lost due to absorption by the glass, the total axial thickness of

several trained technicians using a Lummer-Brodhun type photometer. The measured values above are the averages of their results.

b. Effect of pupillary size. Since the exit pupil of the Type III periscope is also 4 mm (either low or high power), refer to Section 4U1, b.

c. Central and oblique brightness. Essentially the same considerations are involved here as in the Type II. Refer to Section 4U4, c. A comparison of the ray tracing diagram for

each type, however, will disclose that the objective lens of the upper main telescope is filled with ray-bundles in the Type III periscope (Figure 6-13, page 288), while in the case of the Type II only the central area (112 mm diameter) of the free aperture (144 mm) is used. The reasons for this situation are discussed in the following.

It must be realized that the classification of submarine periscopes into Types I (now obsolete), II, III, and IV occurred some time after the periscopes were actually designed and built. For instance, the periscope (88KA40/1.99) now known as the Type III was actually in use before the Type II periscope (91KA40T/ 1.414HA) was designed. Hence, since the optical arrangement of the Type III is simpler than that of the Type II, and since much of the optical design of the Type II is actually a carry-over from the Type III, it might be easier for some students to study the Type III before

During the design of the Type II, then, it was necessary to change the direction of these oblique bundles so that the lower-main objective's free aperture would be fully illuminated. This was accomplished by modifying the curvature of the collective of the eyepiece system of the upper main telescope. In the Type II, this particular lens has a focal length that is shorter than that of its counterpart in the Type III, hence the Type II collective produces more deviation in the ray bundles it receives from its eye lens and sends down the tube to the upper-main objective lens. These oblique bundles, which have been bent more by the collective, strike the upper-main objective closer to the optical axis than they otherwise would and, hence, are deviated less than they otherwise would be. The result of this change in the focal length of the collective (change from Type III to Type II) is that the oblique bundles are sent down the tube with just enough inclination to the optical axis so that they completely fill the free aperture of

investigating the principles of the Type II.

As mentioned in Section 4U3,c, the over-all length of a submarine periscope is a most important part of the design. Thus, when the Type III was modified to arrive at the design of the Type II (which carries the two one-power auxiliary telescopes in order to achieve the ultra-narrow upper reduced tube section), it was necessary to reduce the distance between the two main telescopic systems so that there would lie room for the reduced-tube optics. A comparison of the optical assembly drawings for the two instruments shows that this inter-objective distance was 7300.5 mm in the Type III and is only 6091.8 min in the Type II, a decrease of over 1200 mm or about 4 feet.

Shifting the upper main telescope system down the tube, however, would produce an undesirable reduction of the exit pupil of the periscope as follows: Shortening the inter-objective distance causes the oblique ray-bundles traveling down the tube from the upper main objective to meet the lower main objective before they are far enough from the optical axis to fill the free aperture of the latter lens. If the entire aperture of the lower-main objective is not filled with light, its image (the exit pupil of the periscope) will not be filled with light, causing a smaller exit pupil and a dimmer image.

the lower-main objective lens. Of course, it would be possible in the Type II periscope to reduce the diameter of the upper-main objective so that its free aperture is just 112 mm (the same as that of the lower-main objective), however, it is more practicable from the standpoint of mechanical mounting to retain the 144-mm aperture for this lens.

The behavior of the central bundle, it will be noted, is essentially identical in both types, since the collective has little effect on it.

4. Head prism. Omit Section 4U6. The head prism of the Type III periscope may be elevated only to 45 degrees above horizontal and depressed to 10 degrees below horizontal; therefore, the limits of the field are somewhat different from the Type II. It should be noted that the field of view of both types covers 32 degrees in low and 8 degrees in high power. The limits of the field of view in both powers are shown in the following table.

Type III Periscope	Low Power	High Power
Line of sight elevated to 45 deg Upper edge of the field Lower edge of the field	61 deg 29 deg	49 deg 41 deg
Line of sight depressed to -10 deg Upper edge of the field Lower edge of the field	6 deg -26deg	-6 deg -14deg

a. Target ranging devices. Refer to Section 4U7.

6S2. Optical Maintenance. For method of tracing rays read Section 4U8, c, concerning the four rules of ray tracing until these rules are thoroughly

Arrangement of Optical Elements			
Arrange-ment of Elements (in direction of rays)	Use in Instrument	Type of Telescope	Magni-fying Power
Head window Head prism	Gas&water seal Deviates op-tical axis		
Negative doublet Positive doublet	Eyepiece Objective	GALI-LEAN *	1/4X
Positive doublet Telemeter lens Air-space doublet	Eye-lens Collective ocular** Objective	UPPER MAIN	1/4.7X
Air-space doublet	Split-lens objective ***		
Dioptric prism Positive doublet	Collective **** Eye-lens ocular	LOWER MAIN	28X
Eyepiece window Rayfilters Polaroids *****	Gas seal Visibility aids Variable density		

* In the system for low power only.
** Telemeter lens reticle is etched on the plane side of this piano-convex lens and is thus located in the first real image plane of

understood. Then referring to Section 6S2, and to the ray tracing diagram in Figure 6-13, page 288, consider the action of the various optical elements on these bundles (which are cylindrical upon entering the periscope, since they have come from infinitely distant object-points).

UPPER MAIN TELESCOPE

1. Since the head window is piano-parallel, it does not affect the direction of the ray-bundles or the parallelism of rays in any one bundle.

2. Since the head prism has plane faces (entrance, reflecting, and exit), it produces no convergence or divergence in the cylindrical bundles. The head prism does, however, deviate the line of sight so that it travels along the optical axis down the tube.

3. If the Type III periscope is in high power, the Galilean system is swung out of the field, and the cylindrical bundles next meet the upper eyepiece eye lens, which converges each

the periscope so that the reticle will vibrate in unison with the image-forming lenses preceding it.
*** The plane of the split lens also contains the -optical axis of the system. The two halves moue in a plane normal to the axis to produce a double image for use in the stadimeter.
**** Refer to section 4U8 (a, Note "e") and also section 4U9-a-21.
***** The fixed polaroid filter must be lined up with its index marks vertical when the variable density polaroid filter assembly is in place on the periscope.

bundle to a point in its back focal plane.

4. If the parallax has been removed from the periscope, the plane surface (containing the reticle) of the telemeter lens will lie in the back focal plane of the eye lens. Thus, the target image is superimposed on the telemeter lens and the rays continue down the tube as though they originated at each image-point in the plane of the telemeter lens.

By virtue of the fact that these ray bundles seem to originate in the plane surface of the telemeter lens, that lens has practically no converging effect on the diverging bundles; however, it does perform a collective action by deviating the course of each bundle. It produces zero deviation in the one bundle which meets it at the axis, and produces its maximum deviation in those bundles which meet it farthest from the optical axis. In other words, because of its unique position in the system (that is, with one of its surfaces lying in an image plane), this collective

lens acts like a thin prism but not like a lens.

5. The objective lens of the upper main telescope is so placed (one focal length from the telemeter lens) in the periscope that the

above ray bundles diverging from the plane of the telemeter lens are converged by the objective to form cylindrical bundles that travel on down the tube until they meet the next lens.

LOWER MAIN TELESCOPE

6. The above cylindrical bundles are converged by the lower-main-telescope objective lens (assume that it acts as a single lens, that is, the two halves have not been shifted) to the back focal plane of the objective, which is the next real image plane in the system. Thus, the rays in any one bundle are converged to a point (not necessarily on the optical axis) in this image plane where they cross each other at this image-point, and they proceed as a diverging bundle to enter the dioptric prism.

7. The dioptric prism, acts as the collective lens of the lower eyepiece. This collective is very thick, and since the image plane from which it receives the diverging ray bundles is some distance in front of its first surface, the dioptric prism deviates the bundles and also

GALILEAN TELESCOPE

11. When the periscope is in low power, the reversed Galilean telescope is included in the system, following the head prism and preceding the eyepiece lens of the upper main telescope. Since this component is a telescope, we know that cylindrical bundles will emerge from it if cylindrical bundles enter it.

For the action of a reversed Galilean telescope, refer to Section 4U8-c-17.

6S3. Method of removing parallax caused by gas pressure. Read Section 4V7 concerning the basic principles of the Kollmorgen universal collimator, and also Section 4U8, 18, omitting only the data regarding pre-gassing setting of the eyepiece lens and eyepiece prism on the Type II and the data regarding target distances used for the Type II.

Since the introduction of nitrogen at the specified pressure (7.5 lbs. above atmospheric) will invariably introduce parallax in the periscope system, so adjust the spacing of the various lens elements before gassing that they will produce no

produces convergence in them. The image plane, however, is less than one focal length in front of the collective and, therefore, the dioptric prism is unable to converge the bundles enough to make them cylindrical. Thus, they leave the collective and enter the eye lens of the lower eyepiece still diverging a slight amount.

8. These slightly diverging bundles are converge by the eyepiece lens of the eyepiece system so that they emerge from that lens as cylindrical bundles. In other Fords, the equivalent focal length of the eyepiece system (collective and eye lens) is such that the front focal plane of the system coincides with the back focal plane of the objective.

9. The eyepiece window is plano-parallel, hence it does not deviate the raybundles or cause them to converge or diverge.

10. The rayfilters and polaroids are also plano-parallel and do not deviate the ray bundles or cause them to converge or diverge. They do, however, absorb all rays of colors different than their own and thus provide the observer with some control over the visual contrast between various parts of the image.

parallax (between the image and the telemeter lens) after gassing.

This is accomplished by considering one, all the lenses that

the telemeter lens and two, all the lenses that precede the telemeter lens.

1. Lenses that follow the telemeter lens. To compensate for the effect of the nitrogen in both high and low power, before gassing, the eyepiece must be set at -0.4 diopters (or shifted toward objective 2.1 mm) while the telemeter lens is brought into sharp focus (using an auxiliary telescope correctly focused for the observer's eye). Then when the gas is introduced and the eyepiece returned to its zero diopter position, there will be no parallax in that part of the periscope system following the telemeter lens.

2. Lenses that precede the telemeter lens. With the periscope in high power, there is only one lens that precedes the telemeter lens, namely, the upper eyepiece eye lens. Since the nitrogen under pressure will reduce the relative index of refraction of this glass or speed of light transmission (actually it increases the

index of refraction of the surrounding medium), it will cause the focal length of this eye lens to be lengthened slightly.

Now with the system in air, we can choose a target that is not at infinity but at some finite distance so that the upper

periscope sealed, all infinitely distant objects will be imaged exactly in the plane of the telemeter lens.

When the periscope is in low power, there are three lenses which precede the telemeter lens, namely, the upper eyepiece lens of

eyepiece lens will form its image in a plane which is slightly more than one focal length behind the upper eyepiece lens. In the case of the particular lens in question, this particular distance equals 3,110 feet. Thus, if we remove the parallax for lenses preceding the telemeter lens while the system is in air, by using the above object-distance of 3,110 feet, when the gas has been introduced and the the upper main telescope and the two lenses of the Galilean telescope. If a target distance of 47 feet is used and if the position of the eye lens is not disturbed, there will be no parallax in low power for infinitely distant objects after gassing.

Type III Periscope	Target Distance
Periscope in high power	3,100 feet
Periscope in low power	47 feet

T. REASSEMBLY OF THE UPPER AND LOWER TELESCOPE SYSTEMS AND SKELETON HEAD

6T1. Reassembly of the upper telescope system. The upper telescope system is reassembled in the following manner:

1. Screw the threaded periphery of the upper part of the fourth inner tube section upper end coupling (4, Figure 6-6) into the internal threaded section in the lower part of the fifth inner tube section (41, Figure 6-5) of the upper telescope system Part I.

2. Insert and secure the four lockscrews (42) in countersunk clearance holes in the lower part of the fifth inner tube section, (41), screwing them into tapped holes in the upper alignment support section of the fourth inner tube section upper end coupling (4, Figure 6-6). This secures the upper telescope system Part I and Part II together.

6T2. Reassembly of the lower telescope system. The lower telescope system is reassembled in the following manner:

tapped holes in the lower alignment support section of the spider bearing (3, Figure 6-10).

4. Connection of the objective operating mechanism assembly to the first inner tube section assembly proceeds as follows:

5. Screw the internal threaded section located in the lower part of the track sleeve (18, Figure 6-7) on the threaded periphery of the upper part of the first inner tube section upper end coupling (23, Figure 6-10).

6. Insert and secure the four lockscrews (9, Figure 6-7) in countersunk clearance holes in the lower part of the track sleeve (18), screwing them into tapped holes in the upper part of the first inner tube section upper end coupling (23, Figure 6-10).

7. Place the stadimeter transmission shaft coupling (3 Figure 6-7) on the lower part of the operating gear pinion shaft

1. Connection of the eyepiece skeleton assembly to the lower part of the first inner tube section assembly, proceeds as follows:

2. Screw the internal threaded section in the upper part of the eyepiece skeleton (42, Figure 4-28) on the threaded periphery of the spider bearing (3, Figure 6-10).

3. Insert and secure the four lockscrews (37, Figure 4-28) in countersunk clearance holes in the counterweight bearing section of the eyepiece skeleton (42), screwing them into

(20) and secure it to the shaft with a taper pin (15).

8. Place the objective operating mechanism assembly and the eyepiece skeleton assembly attached to the first inner tube section assembly in two V-blocks on the optical I-beam bench.

9. The four coiled shifting wire tapes (38, Figure 4-28) for the prism tilt and change of power mechanisms are unwound sufficiently for their attachment to their respective sides of the eyepiece skeleton assembly.

10. Loosen the two shifting wire clamp nuts (3) of the prism tilt mechanism side sufficiently

to allow the phosphor-bronze wire extensions of the tapes to enter snugly in each shifting wire clamp (2). The wires extend downward from the rectangular slot in the large shoulder flange of the eyepiece skeleton (42). Each wire will extend equally beyond the lower end of each shifting wire spindle (1).

11. Secure the two shifting wire clamp nuts (3) temporarily and secure each coiled up shifting wire tape to the first inner tube section (1, Figure 6-10) with friction tape.

12. Follow the procedure described under Steps 10 and 11 for the change of power mechanism side.

13. Unscrew the assembled eyepiece lens mount (19, Figure 4-22), carrying with it the

position. The lockscrews are inserted in clearance holes in the eyepiece skeleton (42) large shoulder flange and screwed into tapped holes in the upper face of the eyepiece box (11, Figure 4-29).

18. Place the stadimeter transmission shaft (12, Figure 6-10) in the stuffing box section in the eyepiece box base. Guide the shaft as it is carried upward slowly through the clearance hole in the large shoulder flange of the eyepiece skeleton (42, Figure 4-28) and the counterweight (25).

19. Place the lower thrust collar (4, Figure 6-10) on the stadimeter transmission shaft (12) and carry the shaft through the bearing hole in the spider (2).

20. Place the upper thrust collar (4) on the stadimeter transmission shaft (12), and carry the shaft

eyepiece lens (9a, Figure 6-13), eyepiece lens clamp ring (16, Figure 4-28) and its lockscrew (41). The removal of the above outward projecting assembly is necessary for the assembly of the eyepiece box (11, Figure 4-29) to the eyepiece skeleton (42, Figure 4-28).

14. Check the base of the eyepiece box (11, Figure 4-29) to ascertain that the eyepiece skeleton centering screw (12) is not secured in place.

15. Reassemble the outer tube and eyepiece box rubber gasket (8) on the upper alignment support section of the eyepiece box (11), resting it against the sealing shoulder located preceding the threaded periphery. Check the eyepiece box and eyepiece skeleton assembly to ascertain the removal of all inward and external parts to make sure that nothing restricts the assembly of the eyepiece box (11).

16. Place the eyepiece box (11) over the eyepiece skeleton assembly, guiding it on slowly and carefully. It is carried on the narrow alignment shoulder of the large shoulder flange of the eyepiece skeleton (42, Figure 4-28). Engage the reamed dowel pin holes of the eyepiece box upper face over the downward protruding dowel pins (36) in the eyepiece, skeleton large shoulder flange. This reestablishes the factory alignment.

17. Insert and secure the eight lockscrews (31). These lockscrews can be inserted only with the upward through the clearance hole in the soldered bracket (21) located on the central part of the first inner tube section periphery (1).

21. Disengage the operating gear pinion (2, Figure 6-7) from its engagement with the gear teeth of the operating gear (22) in the observing position. Check the male tang section of the stadimeter transmission shaft (12) to ascertain that it faces outward and toward the left face of the eyepiece box (11, Figure 4-29). This places the male tang section of the shaft in correct position for proper engagement with the female tang coupling (68, Figure 4-24) of the stadimeter housing assembly for its reassembly.

22. Check the dowel pin holes of the stadimeter transmission shaft (12, Figure 6-10) in the above position for proper entry in the stadimeter transmission shaft coupling (3, Figure 6-7) and for proper coincidence of dowel pin holes. Insert and secure two temporary lockscrews in tapped holes in the coupling until completion of collimation.

23. Reengage the operating gear pinion (2) into mesh with the gear teeth of the operating gear (22) checking the position of the male tang section of the stadimeter transmission shaft (12, Figure 6-10) following the procedure described in Step 21 of this section.

counterweight (25) at its extreme upward

24. Place the two thrust collars (4) next to the side faces of the cast bearing projection of the spider (2) and secure them with two taper pins (10).

25. Place the counterweight (25, Figure 4-28) at the extreme upward limit of its travel (the plus position).

26. Place the female coupling section (3, Figure 4-39) of the focusing knob assembly on the square section of the eyepiece drive actuating shaft (12, Figure 4-35) of the eyepiece drive packing gland assembly. Check the reference punch mark on the eyepiece drive actuating shaft (12) and the corresponding reference mark on the female coupling section (3, Figure 4-39) of the focusing knob assembly for proper alignment.

27. Check the 1 1/2 diopter setting with the stationary zero reference line of the knob bracket hub (7). The 1 1/2 diopter setting should be turned to a slight over-travel of the stationary reference line.

28. Place the eyepiece drive packing gland assembly with its rubber gasket (11, Figure 4-35) and the attached focusing knob assembly in its opening in the eyepiece box (11, Figure 4-29). Align the rectangular base of the knob bracket (7, Figure 4-39) with the rectangular recess face on the eyepiece box.

shaft (12) in the same manner as described in Step 26.

34. Check the rectangular flange of the knob bracket (7, Figure 4-39) to ascertain that the two dowel pins (8) engage in the dowel pin holes in the eyepiece box recess face.

35. Insert and secure the four lockscrews (10) in countersunk clearance holes in the knob bracket (7), screwing them into tapped holes in the eyepiece box (11, Figure 4-29).

36. Place the eyepiece skeleton centering screw lead washer (13) on the centering screw shoulder (12), inserting the centering screw in the base of the eyepiece box (11). The centering screw extends into the reamed hole in the eyepiece skeleton base (42, Figure 4-28), and is screwed into the tapped hole section in the eyepiece box base. Secure the centering screw with a large screwdriver blade, using a small wrench attached to the blade to insure the hermetical seal of this opening.

37. Reassembly of the stadimeter transmission shaft packing gland assembly (modified hycar type) proceeds as follows: Place the gland filler piece (3, Figure 4-31) over the shaft, placing the chamfered side upward.

38. The hycar packing spacers (4) are soaked in Lubriplate No. 210 for a week. Before assembly all

29. The eyepiece drive mechanism bevel gear (1, Figure, 4-35) attached to the eyepiece drive actuating shaft (12) should mesh with the eyepiece prism shift bevel gear (11, Figure 4-28) of the eyepiece skeleton assembly correctly.

30. Remove the focusing knob assembly from the eyepiece drive packing gland assembly.

31. Rotate the stuffing box body (6, Figure 4-35) of the eyepiece drive packing gland assembly so that the-reference numerals on the stuffing box body flange coincide with the reference numerals on the eyepiece box recess face.

32. Insert and secure the six lockscrews (3), inserting them in countersunk clearance holes in the stuffing box body flange (6) and screwing them into tapped holes in the eyepiece box counterbored section seat.

33. Replace the focusing knob assembly on the square section of the eyepiece drive actuating Lubriplate is wiped off, and Glydag is applied to the shaft and hycar packing spacers. Place each of the hycar packing spacers (4) over the stadimeter transmission shaft (12, Figure 6-10), separating each packing spacer with a brass spacer washer (5, Figure 4-31) and finishing with the insertion of the retainer brass washer (6).

39. Place the packing retainer (2) over the above shaft and engage it in the internal threads in the stuffing box section of the eyepiece box.

40. Use a special wrench with the projecting pins inserted in the four holes in the face of the packing retainer (2). Screw the packing retainer upward, compressing the hycar packing spacers, and continue compressing the packing spacers until the packing retainer face is flush with the lower face of the eyepiece box (11, Figure 4-29).

41. Insert the lockscrew (1, Figure 4-31) in the tapped hole in the face of the slotted section of the packing retainer (2), screwing it tight to secure the packing retainer (2).

42. Place a special wrench on the male tang section of the stadimeter transmission shaft (12, Figure 6-10) and rotate the shaft in alternate directions for one half hour to work in the packing. This should eliminate of the eyepiece box. Check the reference marks of each female coupling section (3, Figure 4-36) one by one and properly engage them in their respective male coupling sections of the training handle rack gears and shafts (39, Figure 4-28), simultaneously carrying the assemblies in the bored holes and on the assembled rubber gaskets (10, Figure 4-36) in the counterbored section seats.

the freezing of the shaft, as the hycar packing spacers take a permanent set because of compression.

43. Assemble the rayfilter drive packing gland assembly stuffing box body rubber gasket (9, Figure 4-32) to the square recess seat in the front of the eyepiece box.

44. Check the reference marks on the rayfilter drive packing gland assembly female coupling section (2) with the corresponding reference mark of the male coupling section (40, Figure 4-28) of the eyepiece skeleton assembly for proper alignment. Check the stamped numeral of the rayfilter drive stuffing box body (4, Figure 4-32) to coincide with a similar stamped numeral on the eyepiece box. It may be necessary to rotate the female coupling section (2) for both corresponding reference marks. Place the rayfilter drive packing gland assembly in the bored hole and on the rubber gasket located in the square recess seat in the eyepiece box. Remove the rayfilter drive actuating gear (11) if necessary, from the square section of the rayfilter drive actuating shaft (10) for the application of a pair of parallel pliers, juggle the female coupling section (2) with the pliers for proper engagement.

45. Secure the rayfilter drive packing gland assembly stuffing box body (4) with four lockscrews (13). These lockscrews are inserted in countersunk clearance holes in the stuffing box body and screwed into

48. Rotate each training handle stuffing box body (5) until the stamped figures coincide with their mating figures on the eyepiece box (11, Figure 4-29).

49. Secure both packing gland assemblies with six lockscrews each (1, Figure 4-36). These lockscrews are inserted in countersunk clearance holes in each stuffing box body (5) and screwed into tapped holes in the counterbored section seats in the eyepiece box (11, Figure 4-29).

50. Assemble the lower (split) objective lens and mount assembly (Figure 4-22) to the objective operating mechanism assembly.

51. Place each assembled mount half on its respective mounting plate (1, Figure 6-7) and secure each temporarily with two stadimeter collimating screws (13, Figure 4-22) and washers (14). The collimating screws are inserted in the washers and elongated slots in each mount half (1 and 2) and screwed in tapped holes in each mounting plate half (1, Figure 6-7).

6T3. Reassembly of the skeleton head assembly to the upper telescope system Part I assembly. The skeleton head assembly is reassembled in the following manner:

1. Screw the skeleton head assembly on the upper threaded periphery of the fifth reduced tube section (1, Figure 6-5) until the lockscrew holes coincide.

2. Insert and secure the two lockscrews (55, Figure 6-4) in opposite countersunk clearance holes in the skeleton head (1),

tapped holes in the square recess seat in the eyepiece box.

46. Assemble the left and right training handle packing gland assembly rubber gaskets (10, Figure 4-36) in the counterbored section seats in opposite sides of the eyepiece box.

47. Check the left and right training handle packing gland assemblies for their proper sides screwing them into tapped holes in the upper alignment support section of the fifth reduced tube section (1, Figure 6-5). This secures the skeleton head assembly to the upper part of the upper telescope system Part I assembly.

U. FINAL COLLIMATION

6U1. Collimation of the upper and lower telescope systems in high power. The upper and lower telescope systems are collimated in the following manner:

1. Check the height of the Sperry-Kollmorgen collimator by using the boresight and grooved crossline disks having a diameter of 6.495 inches for the inner tube axis. Refer to the procedure described under Section 4V10 for the setting of the azimuth disk plate (6, Figure 4-69) to 90 degrees.

2. Loosen the wedge lock bolt (11) and wedge lock (10) sufficiently to swing the index line of the collimator base plate (7) into coincidence with the 0 degree numeral graduation of the azimuth disk plate (6). Secure the wedge lock (10) with the wedge lock bolt (11). Check the collimator reticle; it should be located at the infinity setting (Figure 4-71).

(17, Figure 6-7) in its proper coincidence relationship with the reference marks of the track sleeve (18).

9. Holding the coupling sleeve (17) on the undercut alignment support sections of the track sleeve (18) and the second inner tube section lower end coupling (26, Figure 6-6), slide the lower telescope system with the V-blocks snugly against the coupling sleeve. This permits the coupling sleeve to fit snugly between the bearing shoulders of the track sleeve (18, Figure 6-7) and the second inner tube section lower end coupling (26, Figure 6-6). Remove the coupling sleeve and place it in a convenient place until it is required again for distance measurement or for reassembly.

10. Place the threaded periphery of the special eyepiece alignment jig (Figure 4-50) in the threaded bore of the eyepiece prism front retaining plate (24, Figure 4-28) of the eyepiece skeleton assembly. Screw the jig into this front

3. Place the assembled upper telescope system and skeleton head assembly in V-blocks on the optical I-beam bench, resting the bearing sections of the various couplings in the V-blocks.

4. Slide the assembly axially with the V-blocks toward the Sperry-Kollmorgen collimator until the head prism is spotted centrally over the collimator axis. Place the head prism at zero line of sight, placing the front face parallel to the skeleton head frame by eye.

5. Place the lower telescope system assembly of Section 6T1 in two V-blocks, resting the bearing flange periphery of the track sleeve (18, Figure 6-7) in one, and the large shoulder flange periphery of the eyepiece skeleton (42, Figure 4-28,) and upper alignment support section periphery of the eyepiece box in the other.

6. Rotate the lower telescope in the two V-blocks for vertical collimation, with the eyepiece end of the eyepiece box facing upward.

7. Slide the lower telescope system with the two V-blocks axially until near the upper telescope system assembly.

8. Line up the reference marks of the second inner tube section lower end coupling (26, Figure 6-6) checking it by the coupling sleeve

retaining plate until the shoulder of the jig is a metal to metal contact with the projecting cylindrical shoulder of this retaining plate.

11. Rotate the lower telescope system in the two V-blocks for vertical Collimation, with the eyepiece end of the eyepiece box facing upward.

12. Follow the procedure described under Section 4V4, Steps 5 to 9 inclusive for the vertical position of the eyepiece end of the eyepiece box.

13. Remove the eyepiece alignment jig and replace the assembled eyepiece lens mount (19, Figure 4-28) by screwing it into the eyepiece prism front retaining plate (24). Check the inner and outer surface of the eyepiece lens (9a, Figure 6-13) for cleanliness before replacement.

14. The position of the upper objective lens mount (45, Figure 6-5) in the fifth inner tube section (41) and the upper eyepiece lens mount (3) in the fourth reduced tube section (2) should be that of their original settings unless a lens is replaced because of damage. A renewal of any one or both lenses requires a resetting of the lockscrew holes in both mounts in their reduced tube and inner tube sections.

15. Release the temporary

lens mount (45, Figure 6-5) to the

securement of the upper eyepiece lens mount (3) and the upper objective lens mount (45), by the removal of the two lockscrews (5) and our lockscrews (43) from their respective mounts.

16. The collimation of the lower telescope system is accomplished by the axial movement of the upper objective lens mount. This brings the eyepiece prism mount arrangement into focus with the telemeter lens (15) within the prescribed limits of -3 and +1 1/2 diopters.

17. In checking the essential travel of the eyepiece prism mount (20, Figure 4-28) which should be 25 mm, diopter lenses are used. Minus and plus lenses must be inserted in the auxiliary telescope adapter (Figure 4-57) attached in the interval threads in the objective end of the auxiliary telescope to obtain the minus and plus diopter settings.

18. Insert a -1 1/2 diopter lens in the auxiliary telescope adapter, moving the counterweight up to its stop for full travel; the stop is the spider bearing. This causes the eyepiece prism mount to move downward. Check the definition of the telemeter lens to ascertain that it will fade slightly at the end of the prism travel. It is necessary to move the upper objective lens axially for make this definition check.

19. Insert the +3 diopter lens in the auxiliary telescope adapter, and bring the counterweight downward to the lower stop with the two lockscrews opposite fifth inner tube section (41) with four lockscrews (43).

22. Now obtain the true zero diopter reading of the diopter ring of the focusing knob assembly. Using the auxiliary telescope minus the adapter, focus the eyepiece prism mount until sharp definition of the telemeter lens is detected. The diopter ring should read -0.4 diopter at atmospheric pressure. This allowance is compensated for when nitrogen of 7 1/2 psi is introduced; refer to Section 6S3-1.

23. With the auxiliary telescope at the eyepiece end set for -0.4 diopter at atmospheric pressure, proceed to check the upper and lower telescope systems on the collimator reticle at the infinity setting. Move the upper eyepiece lens mount axially until a clear, well-defined image is apparent. The upper eyepiece lens mount is not secured until the completion of the orientation of the telemeter lens, and collimation for parallax elimination on the distance target of the collimator reticle set to 3,110 feet. 24. Temporary squaring of the telemeter lens is required for the collimation of the lower (split) objective lens with the Kollmorgen universal collimator range function and the telemeter lens.

25. Using a special wrench attached to the male tang section of the stadimeter transmission shaft (12, Figure 6-10), rotate the shaft, displacing the lower (split) objective lens to the maximum displacement. In this maximum displacement, the telemeter lens line should appear to the observer as a solid line. If it appears double

each other in the eyepiece skeleton flange. These lockscrew heads are longer than the other six lockscrews in the eyepiece skeleton large shoulder flange. The downward movement of the counterweight carries the eyepiece prism mount to the upward position. Check the definition of the telemeter lens to be sure that it will fade slightly at the end of the prism travel. It may be necessary to move the upper objective lens axially to make this definition check.

20. Continue the procedure stated in Steps 18 and 19 until a setting is obtained at which a slight over-travel is observed at -3 and +1 1/2 diopters.

21. Upon completion of the collimation of the lower telescope system, secure the upper objective or faded, it is necessary to release the angular alignment lockscrew (12, Figure 6-5) slightly and tap the telemeter lens mount angularly. Continue until the telemeter lens line appears as a solid line, and secure the angular alignment lockscrew (12). Using the above special wrench, return the lens halves, placing them and the objective operating mechanism at the observing position and removing the special wrench. Refer to Figure 4-81 for the incorrect and correct orientation of the telemeter lens line.

6U2. Collimation of the lower (split) objective lens to the stadimeter dials, using the telemeter lens and Sperry-Kollmorgen collimator. This procedure is performed in the following manner:

1. Check the stadimeter dials to determine that the observing position of the dials is correct.

2. Check the objective operating mechanism assembly to determine that the lower (split) objective lens mounts are located in the observing position.

3. Place the stadimeter housing assembly at the base of the eyepiece box (11, Figure 4-29). Check the entrance of the female tang coupling (68, Figure 4-24) to determine that it engages on the male tang section of the stadimeter transmission shaft (12 Figure 6-10). Insert the four housing bolts (30, Figure 4-24) in in the other, or the 11,000/20 graduation. It is necessary to use an offset screwdriver to loosen the stadimeter collimating screws (13, Figure 4-22) sufficiently to tap the mount lightly with a small rawhide mallet. Figure 4-79 shows the six positions for collimating the stadimeter dials as indicated by the displacement of the lower (split) objective lens.

7. The stadimeter transmission shaft coupling (3, Figure 6-7) has previously been secured temporarily to the stadimeter transmission shaft (12, Figure 6-10) with two special setscrews inserted for collimation use and with the taper pin holes aligned.

clearance holes in the stadimeter housing (8, Figure 6-8), screwing the bolts into tapped holes in the eyepiece box base (11, Figure 4-29), and securing them snugly.

4. Remove the operating gear stop (23, Figure 6-7) from the operating gear (22) by removing four lockscrews (29). The two factory scribed lines can be seen approximately. 27/32 inch apart on the operating gear shoulder and the retaining ring (21). This distance represents 10 degrees on the periphery of the operating gear (22). When the operating gear is rotated 10 degrees counterclockwise, viewing it from the lower end, the right scribe line of the operating gear (22) coincides with the left scribe line on the retaining ring (21). At this position the mounting plates (1) are displaced on amount equal to 2 minutes and 4 seconds of arc, and corresponding scribed lines are in coincidence to the right of the above scribed lines.

5. With the operating gear in this position, the range scale dials (14, Figure 6-8) should read 11,000 yards opposite the value 20-foot height indication on the height scale dials (13). The collimator reticle should show the horizontal crossline in one image superimposed over the first small horizontal graduated line of the reticle in the other image.

6. If the horizontal crossline of one imago shows that the horizontal crossline of the reticle is not superimposed over the first small line of the other image, the parallel sliding half of Using the offset screwdriver, secure the stadimeter collimating screws (13, Figure 4-22), securing the vertical sliding half of the lower (split) objective lens and mount assembly.

8. Turn the handwheel (12, Figure 4-24) clockwise until the horizontal crossline of the collimator reticle in one image superimposes over the second horizontal graduated line of the collimator reticle in the other image. The range scale dials (14, Figure 6-8) should read 7,500 yards opposite the value 20-foot height indication on the height scale dials (13).

9. Continue turning the handwheel (12, Figure 4-24) clockwise until the horizontal crossline of the collimator reticle in one image superimposes over the third horizontal graduated line of the collimator reticle in the other image. The range scale dials should read 2,500 yards opposite the value 20-foot height indication on the height scale dials.

10. Continue in like manner with the fourth horizontal line at 1,000 yards opposite the value 20-foot height indication, the fifth horizontal line at 500 yards opposite the value 20-foot height indication, and the sixth horizontal line at 400 yards opposite the value 20-foot height indication.

11. If an error, as much as the thickness of a dial line, is noticed in the reading of the range scale dials, the handwheel (12) is turned to remove half the error. Release the two setscrews in the tapped holes in the stadimeter transmission shaft coupling (3, Figure 6-7) and turn the

the lower (split) objective lens and mount assembly is moved so that the horizontal crossline of one image is superimposed over the first small horizontal line of the collimator reticle

handwheel (12, Figure 4-24) setting the range scale dial indication of 400 yards opposite the

value 20-foot height indication on the height scale dials. Then secure the two setscrews. Correct the remaining error by loosening the stadimeter collimating screws (13, Figure 4-22) with an offset screwdriver. Tap the vertical moving half of the lower (split) objective lens and mount assembly with a rawhide mallet to make the horizontal crossline of the collimator reticle in one image superimpose over the sixth horizontal graduated line of the collimator reticle in the other image at 400/20, and secure the stadimeter collimating screws (13).

12. Return the displacement of the lower (split) objective lens images so that the horizontal crossline of the collimator reticle in one image superimposes over the first horizontal graduated line of the collimator reticle in the other image. The range scale dials should read 11,000 yards opposite the value 20-foot height indication on the height scale dials. Check the complete series of ranges, 11,000/20, 7,500/20, 1,000/20, 500/20, and 400/20, noting any error and correcting in the same manner as before.

13. When the range scale dials read correctly, the operating gear stop (23, Figure 6-7) is

pin (15, Figure 6-7). It is seldom necessary to redrill and ream a taper pin hole in the coupling and the shaft for a new position of the taper pin (15). Remove the two temporary setscrews from the stadimeter transmission shaft coupling (3).

16. After securing the stadimeter collimating screws (13, Figure 4-22), the parallel moving half of the lower (split) objective lens and mount assembly is secured with two straight dowel pins (15); the dowel pins are also replaced in their original holes in the left mount half and its corresponding mounting plate (1, Figure 6-7).

17. With the optical focus of the instrument at infinity, the etched lines on the telemeter lens should be coincident, or of duplicate height. If it is noted that they are not in correct adjustment, the stadimeter collimating screws (13) are loosened sufficiently with an offset screwdriver to tap the perpendicular sliding half of the lower (split) objective lens and mount assembly using a rawhide mallet until the coincident or duplicate height of the etched lines of the telemeter lens is correct. The clockwise rotation of the handwheel (12) displaces the lens halves sufficiently to distinguish this adjustment. When corrections have been made,

reassembled to the operating gear (22) and is secured with four lockscrews (29). The observation position is determined by slowly turning the handwheel (12, Figure 4-24) counterclockwise until the duplicate images almost close to one image.

14. Rotate the operating gear (22, Figure 6-7) and its stop (23) from the observation position stop (24) to the maximum displacement stop (25) with sufficient impact to determine any misalignment which may take place. Check for a double image in the observing position; if one is observed when the operating gear stop (23) is in contact with the observation position stop (24), it will be necessary to manufacture a new operating gear stop (23) or build up the present one and grind it down. If the stop is built up, it must be ground down in a series of steps, taking off small amounts until no double image is observed, or until duplicate images become one.

15. Upon completion of the stadimeter collimation, secure the stadimeter transmission shaft coupling (3) to the stadimeter transmission shaft (12, Figure 6-10) with a taper

tighten the stadimeter collimating screws (13) and insert the two straight dowel pins (15) in their original holes in the same manner as stated in Step 16 of this section. Figure 4-80 shows the collimation of the lower (split) objective line perpendicular moving half.

18. The range scale dial readings in the observing position should be 220 yards opposite the value 15-foot height indication on the height scale dials, as indicated by numerals stamped on the stadimeter housing (8, Figure 6-8).

19. After collimation of the lower (split) objective lens and mount assembly to the stadimeter dials and telemeter lens, screw the coupling sleeve (17, Figure 6-7) on the threaded periphery of the second inner tube section lower end coupling (26, Figure 6-6). It is first necessary to slide the lower telescope system and the V-blocks clear for the assembly of the coupling sleeve.

20. Secure the upper part of the coupling (17, Figure 6-7) with four lockscrews (8).

These lockscrews are inserted from countersunk clearance holes in the coupling sleeve (17) and screwed into tapped holes in the second inner tube section lower end coupling alignment support section (26, Figure 6-6).

is necessary to release the angular alignment lockscrew (12, Figure 6-5) sufficiently to rotate the telemeter lens mount (10) angularly. This procedure is continued until the telemeter lens line appears as one solid line.

21. Connection of the assembled coupling sleeve (17, Figure 6-7) to the track sleeve (18) of the objective operating mechanism assembly proceeds as follows (take precautions to see that the operating gear pinion (2) is carried axially with the lower telescope system in the correct alignment position in the coupling sleeve (17) internal recess):

22. The track sleeve (18) alignment support section is carried into the coupling sleeve (17) until its bearing shoulder is a metal to metal contact with the lower face of the coupling sleeve. It is secured with 15 lockscrews (11) inserted in countersunk clearance holes in the coupling sleeve (17) and screwed into tapped holes in the track sleeve (18) alignment support section.

23. Check the stadimeter dials and turn the handwheel (12, Figure 4-24) until the dials are in the observing position; the figure 15 on the height scale dial should appear approximately opposite the value 220 on the range scale dial.

6U3. Orientation of the telemeter lens by the maximum displacement of the lower (split) objective lens. This procedure is performed in the following manner:

1. Slide the inner tube axial with the V-blocks toward the Sperry-Kollmorgen collimator until the head prism is spotted centrally over the collimator axis. Place the head prism at zero link of sight, lacing the front face

Figure 4-81 shows the incorrect and correct orientation of the telemeter lens by means of the lower (split) objective lens maximum displacement.

5. Secure the telemeter lens mount (10, Figure 6-5) with the circumferential recess and slot in the third reduced tube section (9) and screw into the tapped hole in the mount.

6. Recheck the telemeter lens line, noting whether any change has taken place during the tightening of the lockscrew (12).

7. Turn the handwheel (12, Figure 4-24) counterclockwise, and return the lower (split) objective lens halves back to the observing position.

Figure 6-14. Collimator reticle lens set at 3110-foot target distance.

6U4. Collimation of the high power system free of parallax on the Kollmorgen distance collimator function at atmospheric pressure. This procedure is performed in the following manner:

1. Release the lock ring (51, Figure 4-69) and turn the reticle lens mount actuating sleeve (53) clockwise 10 graduations as indicated by the micrometer graduation and the micrometer vernier arm (57), securing the lock ring (51) snugly against the reticle lens mount end bushing (52). This places the reticle lens (60) and

parallel to the skeleton head frame by eye.

2. Recheck the inner tube, following the procedure stated in Section 6U1, Steps 12 and 13 for the vertical position of the eyepiece end of the eyepiece box.

3. Turn the stadimeter handwheel. (12, Figure 4-24), clockwise until the lower (split) objective lens halves are displaced to maximum displacement.

4. The telemeter lens line should appear as one solid line. If it appears double or faded, it mount (42) at the 3,110-foot distance target position. Figure 6-14 shows the correct position of the reticle lens mount actuating sleeve in relation to the micrometer vernier arm and the range table in Section 4V8 in the first function

for the proper position of the reticle lens of the 3,110-foot distance.

2. Place the auxiliary telescope at the eyepiece of the periscope. Set the diopter reading of the auxiliary telescope at infinity for the observer (this should be based on at least five observations of an infinity target which give consistent readings). Move out the upper eyepiece lens mount (3, Figure 6-5), carrying the upper eyepiece lens (8) until the image of the collimator reticle is apparent on the telemeter lens. The axial movement of the upper eyepiece lens mount focuses the upper eyepiece lens on the collimator reticle.

3. At the above setting, the auxiliary telescope is focused from plus diopter to the observer's diopter reading, as a

3. The Galilean telescope system lenses move through 90 degrees for change of power and therefore must be collimated to the fixed high power magnification series of telescope systems.

4. The Galilean eyepiece lens mount housing (37) is provided with an adjustment allowance to correct the mechanical axis of the Galilean telescope system by means of the optical axis movement of the Galilean eyepiece lens (63).

5. Loosen the three lockscrews (38) sufficiently to adjust the Galilean eyepiece lens mount housing (37). The optical axis of the Galilean telescope system is collimated to the optical axis of the high power system with a minimum of vertical and horizontal displacement tolerance allowance.

check to prove that the telemeter lens and the collimator reticle are in sharp definition. At this reading, no parallax should be apparent on the telemeter lens.

4. Secure the upper eyepiece lens mount (3) with two lockscrews (5). These lockscrews are inserted in countersunk clearance holes in the fourth reduced tube section (2) and screwed into tapped holes in the upper eyepiece lens mount (3).

6U5. Collimation of the Galilean telescope system to the high power system, and free of parallax on the Kollmorgen distance collimator function at atmospheric pressure. This procedure is performed in the following manner:

1. Place the auxiliary telescope at the eyepiece of the periscope. Set the diopter reading of the telescope at infinity for the observer, and place the periscope in low power.

2. Focus the periscope to zero setting at atmospheric pressure or -0.4 diopter. Using the 3,100-foot distance target of the collimator, move the, Galilean eyepiece lens mount (36, Figure 6-4) in its housing internal threads (37) until the image of the target is apparent on the telemeter lens. At this setting, the auxiliary telescope is focused from plus diopter to the observer's diopter reading to ascertain that the telemeter lens and the collimator reticle are in sharp definition. At this reading, no parallax should be apparent

6. The horizontal displacement of the collimator reticle crossline image of low power is collimated to superimpose with the telemeter lens line of high power system to within a tolerance of 2 minutes of arc. The collimator reticle crossline is superimposed with the telemeter lens line in high power; therefore, it is necessary to change to power in determining the proper relationship of the low power system with the securement of the three lockscrews (38) each time.

7. The vertical displacement of the centerline of sight of low power is collimated to superimpose with the centerline of sight of the high power system to within a tolerance of 30 minutes of arc. Use the collimator reticle crossline as a reference in changing power to determine the proper relationship of the low power system and the securement of the three lockscrews (38) each time.

8. Repeat the procedure stated in Steps 6 and 7, making any adjustments that may be necessary.

9. Release the lock ring (51, Figure 4-69) and turn the reticle lens mount actuating sleeve (53) clockwise 19 complete turns and 24 graduations, as indicated by the micrometer 0 graduation of the actuating sleeve (53) and the micrometer vernier arm (57) from the infinity setting. Secure the lock ring (51) snugly against the reticle lens mount end bushing (52). This places the reticle lens (60) and its mount (42) at the 47-foot distance target position. Figure

on the telemeter lens. Secure the Galilean eyepiece lens mount (36) temporarily with the lockscrew (52).

6-15 shows the correct position of the reticle lens mount actuating sleeve in relation to the micrometer vernier arm and the range table in Section 4V8 in the first function for the proper position of the reticle lens of this 47-foot distance.

10. Loosen the lockscrew (52, Figure 6-4) and move the Galilean eyepiece lens mount (36) in its housing internal threads (37). Screw it outward until the image of the collimator reticle is apparent on the telemeter lens. The Galilean eyepiece lens mount (36) focuses the Galilean eyepiece lens (63) on the collimator reticle.

11. At the above setting, the auxiliary telescope is focused from plus diopter to the observer's diopter reading, as a check to make certain that the telemeter lens and collimator reticle are in sharp definition. At this reading, no parallax should be apparent on the telemeter lens.

12. Secure the Galilean eyepiece lens mount (36) with its lockscrew (52).

Figure 6-15. Collimator reticle lens set at 47-foot target distance.

V. FINAL ASSEMBLIES AND CHECKING

6V1. Reassembly of shifting wire tapes and air lines to the inner tube sections and skeleton head assembly. This procedure is performed in the following manner:

1. Remove the friction tape from the coiled up prism tilt mechanism shifting wire tapes straps of the inner tube sections and reduced tube sections.

4. Remove the four lockscrews (49, Figure 6-4) and two clamp blocks (11). Attach each tape to its respective cube shifting racks (12 and 13) individually, securing them with one clamp block (11) and two lockscrews (49) each. Loosen the

(38, Figure 4-28) and place them through the various guides and straps of the inner tube sections and reduced tube sections.

2. Remove the four 1ockscrews (49, Figure 6-4) and two clamp blocks (11). Attach each tape to its respective head prism shifting racks (14 and 15), individually securing them with one clamp block (11) and two lockscrews (49) each. Loosen the two shifting wire clamp nuts (3, Figure 4-28) sufficiently to allow the phosphor-bronze wire extensions of the tapes to be carried upward as necessary for the attachment of the tapes to the head prism shifting racks (14 and 15, Figure 6-4). The shifting wire tapes should be secured by the clamp nuts (3, Figure 4-28) so that an equal amount of adjustment of both shifting wire spindles (1) at half throw of both prism shifting racks (43 and 44) is provided for the shifting wire spindle adjusting nuts (4).

3. Remove the friction tape from the coiled up change of power shifting wire tapes (38) and place them through the various guides and two shifting wire clamp nuts (3, Figure 4-28) sufficiently to allow the phosphor-bronze wire extensions of the tapes to be carried upward as necessary for the attachment of the tapes to the cube shifting racks (12 and 13, Figure 6-4). The shifting wire tapes should be secured by the clamp nuts (3, Figure 4-28) so that an {equal amount of adjustment of both shifting wire spindles (1) at half throw of the power shifting rack (45 and 46) is provided for the shifting wire spindle adjusting nuts (4).

5. Slide the upper end of the air line section (22, Figure 6-5) and its continuations (25 and 35) through the two soldered air line straps (39) of the sixth inner tube section (28), carrying it upward through the soldered air line strap (21) and connecting it in the air line adapter (20) of the second reduced tube section (17). The air line section continuation (25) of the first reduced tube section (23) is secured to its periphery wall by the removable air line strap (26) and its two lockscrews (27). The air line

section continuation (35) of the air line section (22) carries the soldered air line coupling (36) at its lower end in the lower part of the sixth inner tube section (28).

6. Slide the upper end of the air line section (37) through the two soldered air line straps (22, Figure 6-6) in the upper part of the third inner tube section (11), of the first inner tube section (1), and securing it with two lockscrews (22).

10. Slide the air line section (16) downward through the soldered air line strap (19) and connect its soldered air line coupling (15) at its lower end in the short bent round air line section (14) of the first inner tube section.

carrying it upward through the seven soldered air line straps (10) of the fourth inner tube section (1) and connecting it to the air line coupling (36, Figure 6-5) at, the lower part of the sixth inner tube section (28). The air line section continuations (21 and 9, Figure 6-6), and (47, Figure 6-5), of the air line section (37) of the sixth inner tube section (28), adhere to their respective inner tube sections, third, fourth, fifth, and sixth inner tube sections. The air line section (37) is secured to the lower part of the sixth inner tube section (28) periphery wall with a removable air line strap (38) which is secured with two lockscrews (40). The air line section continuation (21, Figure 6-6) of the third inner tube section (11) carries the soldered air line coupling (20) at its lower end in the upper part of the third inner tube section (11).

7. Slide the upper end of the air line section (19) through the six soldered air line straps (32) of the second inner tube section (23), carrying it upward through the four soldered air line straps of the third inner tube section (11) and connecting it in the air line coupling (20) in the upper part of the third inner tube section (11). The air line-section continuations, (30 and 16, Figure 6-7) of the air line section (19, Figure 6-6) of the third inner tube section (11) adhere to their respective inner tube sections and the coupling sleeve (17, Figure 6-7).

8. Insert the long air line coupling section (13, Figure 6-10) in the clearance hole in the

11. Pull the air line section continuations (16, Figure 6-7) of the coupling sleeve (17) and the continuation (17, Figure 6-10) of the first inner tube section (1) outward sufficiently for the connection of the air line coupling (15) in the upper end of the air line section (16) of the first inner tube section (1).

12. Place the removable air line strap (31, Figure 6-6) over the air line section continuation (30) and secure it to the lower periphery wall of the second inner tube section (1) with its two lockscrews (33).

13. Place the removable air line strap (18, Figure 6-10) over the air line section continuation (17) and secure it to the upper periphery wall of the first inner tube section (1) with its two lockscrews (22).

6V2. Orientation check of the head prism using the Sperry-Kollmorgen collimator. This procedure is performed in the following manner:

1. Recheck the head prism to ascertain that it is spotted centrally over the collimator axis.

2. Recheck the inner tube following the procedure stated in Section 6U1, Steps 12 and 13 for the vertical position of the eyepiece end of the eyepiece box.

3. Recheck the stadimeter dials to ascertain that the lower (split) objective lens is in the observing position.

4. Reassemble the left and right training handle assemblies to their respective sides of the eyepiece box. Check reference punch marks

spider (2), and extend it farther into the tapped hole in the eyepiece skeleton large shoulder flange, screwing it tight.

9. Place the short, bent, round air line section (14) on the upper end of the long air line coupling section (13), rotating it against the first inner tube section (1), attaching the removable air line strap (20) over the bent air line section (14) to the lower periphery wall of the connecting couplings for proper alignment. Secure both training handle assemblies with four hinge bracket bolts each (22 and 21, Figures 6-11 and 4-44 respectively).

5. Check the movement of the right training handle assembly as described under Section 4T7, Steps 24 to 27 inclusive. When no positive

engagement is apparent, check as described under Section 4W2.

6. Check the movement of the left training handle assembly. The correct tension of the prism tilt shifting wire tapes can be noted after the revolving grip has been rotated the necessary 3/32 inch. The head prism should elevate or depress at opposite positions of the 3/32-inch lost motion positions of the index ring (7, Figure 6-11). If observations indicate incorrect indexing, adjust the shifting wire adjusting nuts (4, Figure 4-28) of the eyepiece skeleton assembly to enable the head prism to be oriented correctly.

7. Judgment of the tape tension is detected by the spring-back of the shifting wire adjusting nuts (4) when a light tension is applied. This requires extensive practice. A staggered movement or jumping of the head prism is observed more readily with the periscope in the observing position, since adjustments made in the horizontal position will not Should the centerline of sight show an incorrect reading, it will be necessary to disconnect the gear train bracket (30, Figure 6-4) of the skeleton head assembly and shift the eccentric accordingly.

12. The telemeter lens line is now checked with the Sperry-Kollmorgen collimator reticle vertical crossline. Loosen the wedge lock bolt (11, Figure 4-69) and wedge lock (10) sufficiently to carry the collimator through 20 degrees with the head prism simultaneously from 10 degrees depression to 10 degrees elevation. The telemeter lens line should be carried within 10 minutes of arc through azimuth of 20 degrees. This is checked by observing the telemeter lens line and its relation to the collimator reticle vertical crossline while traveling in azimuth, and also observing the centerline of sight at 10 degrees depression and 10 degrees elevation.

13. Swing the index line of the collimator base plate (7) into coincidence with the 0 degree

have the same reaction when the periscope is in the vertical position.

8. Release the lock ring (51, Figure 4-69) and return the reticle lens mount actuating sleeve (53) to the position described under Section 6U4, Step 1, using the 3,110-foot distance target position. Secure the lock ring (51) snugly against the reticle lens mount end bushing (52).

9. Loosen the wedge lock bolt (11) and wedge lock (10). Elevate the head prism and Sperry-Kollmorgen collimator to 45 degrees elevation, and secure the wedge lock (10) with the wedge lock bolt (11). The observer at the eyepiece end of the periscope should now check the centerline of sight in high power magnification. The centerline of sight should be superimposed with the reticle crossline of the collimator.

10. Loosen the wedge lock bolt (11) and the wedge lock (10). Dress the head prism and Sperry-Kollmorgen collimator to 10 degrees depression, so that the centerline of sight is superimposed with the reticle crossline of the collimator. Secure the wedge lock (10) with the wedge lock bolt (11).

11. After all degrees of elevation and depression have checked correctly, the repairman is assured that the head prism travel is correct.

numeral graduation of the azimuth disk plate (6).

6V3. Reassembly of the inner tube sections in the outer tube. This procedure is performed in the following manner:

1. Check the head prism, the Galilean eyepiece, and objective lenses for cleanliness. Clean all lenses and head prism surfaces with clean lens tissue. Remove any surface dust with a camel's hair brush or vacuum brush used with ether.

2. Rotate the revolving grip (3, Figure 6-11) of the left training handle assembly so that the zero line of sight graduation on the index ring corresponds to the stationary index line graduation on the fixed grip (2). This places the head prism at zero line of sight and offers no obstruction for the entry of the inner tube. Check the right training handle for change of power; it should be set for low power.

3. Follow the procedure described under Section 6B1, Steps 4 to 6 inclusive, for the removal of the stadimeter housing assembly, training handle assemblies, and focusing knob assembly.

4. Rotate the inner tube sections in the V-blocks, placing the eyepiece end facing downward.

5. Attach the special lifting plate

the hinged clamp secured to the

(Figure 4-9) at the base of the eyepiece box; insert the four special bolts in the clearance holes of this plate and screw them into the tapped holes in the eyepiece box base securing the lifting plate.

6. Assemble the special hinged clamp over the coupling sleeve (17, Figure 6-7) covering the objective operating mechanism (Figure 4-11).

7. Connect the upper part of the lifting spreader bar (Figure 4-13) to the lifting projection of the hinged clamp. This projection slides between the center slot section of the upper end of the lifting spreader bar and a bolt is placed through the clearance holes in the above projection and the spreader bar secured with a locknut. The lifting plate projection slides into the center slot section of the lower part, and is held in similar manner to the upper part.

8. Assemble the special hinged clamp over the lower part of the fifth inner tube section (41, Figure 6-5) and attach a shackle to the hinged clamp projection clearance hole.

9. Follow the procedure described under Section 4V17, Steps 7 to 14 inclusive,

10. Place the hook of the chain hoist in the shackle of the special hinged clamp attached to the fifth inner tube section (1) and the hook of the second chain hoist in the center pad clearance hole of the spreader bar (Figure 4-14).

coupling sleeve (17, Figure 6-7) almost touches the edge of the main coupling (2, Figure 4-29). Place an adjustable roller stand under the eyepiece box, adjusting it until the rollers touch the eyepiece box. Release the load of the chain hoist to the roller stand as shown in Figure 4-11.

15. Follow the procedure described under Section 4V17, Steps 21 to 27 inclusive.

16. Remove the eyepiece box and outer tube alignment guides.

17. Reassemble the side plate and pressure gage rubber gaskets (10, Figure 4-29) to opposite sides of the eyepiece box (11) in the rectangular recess seats. Assemble the side plate (9) in the rectangular opening to the rubber gasket, securing the side plate with 10 lockscrews (5) to the left side of the eyepiece box.

18. Reassemble the pressure gage assembly to the right side of the eyepiece box, securing it in similar manner to that stated under Step 17 above.

19. Clean off all fingerprints and surface dust from the eyepiece lens with clean lens tissue. Use a camel's hair brush to remove any surface dust.

20. Clean the inner surface of the eyepiece window (9, Figure 4-38) in similar manner. Blow off any surface dust with an air bulb. Reassemble the eyepiece window frame rubber gasket (8) to the counterbored section seat in the eyepiece box. Reassemble the eyepiece window assembly in the counterbored section and rest it on the rubber gasket (8). Secure

11. Lift the inner tube sections evenly with both chain hoists and transport them to the lower end of the outer tube. Check the inner tube sections to ascertain that they are parallel and properly centered for entry in the outer tube.

12. Recheck the skeleton head lenses and head prism for cleanliness. The skeleton head, reduced, and inner tube sections are slowly pushed in the outer tube, guiding them parallel and properly centered.

13. When the fifth inner tube section contacts the attached main coupling (2, Figure 4-29) remove the chain hoist hook and hinged clamp.

14. Slowly resume the inward pushing movement of the remaining inner tube sections until the assembly with four short and eight long lockscrews (2 and 3). These lockscrews are inserted in countersunk clearance holes in the eyepiece window frame (7) and screwed into tapped holes in the counterbored section seat in the eyepiece box.

6V4. Pressure testing and cycling of the periscope. This procedure is performed in the following manner:

1. Follow the procedure described under Section 2C3, and omit Steps 1 to 12 inclusive.

2. The 25th step of 2C3 is followed by transporting the periscope to the built-in water

tank in the deck with two chain hoist hooks and slings, resting the periscope in two roller brackets. The periscope is rotated during this test, and returned to the optical I-beam bench after blowing off all water and wiping it dry.

3. Follow the procedure described under Section 2C5.

4. Follow the 15 safety precautions stated in Section 2C6.

6V5. Reassembly of all external projections and final checks of the instrument. This procedure making certain that the rayfilter drive actuating gear (11, Figure 4-32) is on the protruding square section of the rayfilter drive actuating shaft (10) of the rayfilter drive packing gland assembly. This central position is necessary for full focusing travel.

7. The rayfilter plate (2, Figure 4-40) is mounted only when the eyepiece lens is in the center of the eyepiece window frame to establish full synchronized movement. Place the rayfilter plate (2) over the flat sides of the eyepiece window frame (7, Figure 4-38); check the rayfilter drive actuating gear rack (8, Figure 4-40) to ascertain its engagement with

is performed in the following manner:

1. Follow the procedure described under Section 4V19, Steps 1 to 11 inclusive, for the reassembly of the hoisting yoke assembly.

2. Reassemble the focusing knob assembly to the eyepiece box. Align the corresponding reference marks of the female coupling section (3, Figure 4-39) and the eyepiece drive actuating shaft (12, Figure 4-33) of the eyepiece drive packing gland assembly. Secure the knob bracket (7, Figure 4-39) after proper engagement of dowel pins (8) with four lockscrews (10).

3. Check the instrument; it should be in the observing position. Check the stadimeter dials; they should be locked at infinity, or single image position.

4. Reassemble the stadimeter housing assembly to the base of the eyepiece box. Check the entrance of the female tang coupling (68, Figure 4-24) to ascertain that it engages on the male tang section of the stadimeter transmission shaft (12, Figure 6-10). Insert the four housing bolts (30, Figure 4-24) in clearance holes in the stadimeter housing (8, Figure 6-8), screwing the bolts into tapped holes in the eyepiece box base (11, Figure 4-29) and securing them snugly.

5. Reassemble the left and right training handle assemblies to their respective sides of the eyepiece box. Check reference marks of the connecting couplings for proper alignment. Secure both training handle the rayfilter drive actuating gear (11, Figure 4-32).

8. With the rayfilter plate (2, Figure 4-40) properly centered, and the gear rack in mesh with the rayfilter drive actuating gear, place both rayfilter plate straps (3) in each side shoulder recess of the rayfilter plate and recess groove section of the eyepiece window frame (7, Figure 4-38). Secure the straps with seven lockscrews (19, Figure 4-40). These lockscrews are inserted in countersunk clearance holes in the rayfilter plate (2) and screwed into tapped holes in the straps.

9. Check the zero reading of the diopter index ring (9, Figure 4-39). Place the auxiliary telescope at the eyepiece end of the periscope. Focus the eyepiece lens until sharp definition of the telemeter lens is apparent on an infinity target or collimator.

10. Check the field. It must be free of internal and external fogging.

11. Check the instrument in high and low power for cleanliness. If particles of dirt are present, they will clearly show on the telemeter lens which lies on the focal plane of the instrument.

12. Check the high- and low-power system on an infinity target or collimator. No parallax should be apparent on the telemeter lens in either power.

13. Turn the handwheel (12, Figure 4-24) clockwise to the limit of its travel, and turn it counterclockwise back to the observing position (single image or whole lens position). There should be no signs of double image.

assemblies with four hinge bracket bolts each (22 and 21, Figures 6-11,and 4-44 respectively).

6. Focus the eyepiece lens to the center of the eyepiece window frame (7, Figure 4-38)

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14. Check the stadimeter dials on special targets of known height and distance or the collimator reticle set at infinity.

15. Check the operation of the left and right training handles, noting particularly their limit of travel stops by corresponding stationary reference index lines.

16. Grasp both spring actuated plunger knobs (24, Figure 4-40), pull them outward as far as possible, and assemble the rayfilter housing (21) female hinge projection sections to the center male hinge projection section of the rayfilter plate (2). The spring actuated plunger rods (23) will snap into place under spring tension. Push the lower part of the rayfilter housing down to the rectangular stops of the rayfilter plate (2); the ball bearing friction catches (26) will engage in the spotted recesses of the shoulder stops of the rayfilter plate in the closed position.

17. Place the eye buffer and blinder assembly on the anchor screw pins (6) of the rayfilter housing (21), snapping it in place.

18. Place the variable density polaroid filter assembly on the anchor screw pins (19, Figure 4-29) in the front wall of the eyepiece box (11) snapping it in place.

19. Place the stadimeter illuminator assembly on the anchor screw pins (19) in the rear wall of the eyepiece box (11), snapping it in place.

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Figures 6-3 and 6-13
TYPE III
DESIGN DESIGNATION 92-KA-40T/1.99
INNER TUBE AND TELESCOPE SYSTEMS
OPTICAL ARRANGEMENT
RAY DIAGRAM

Sub Periscope Home Page

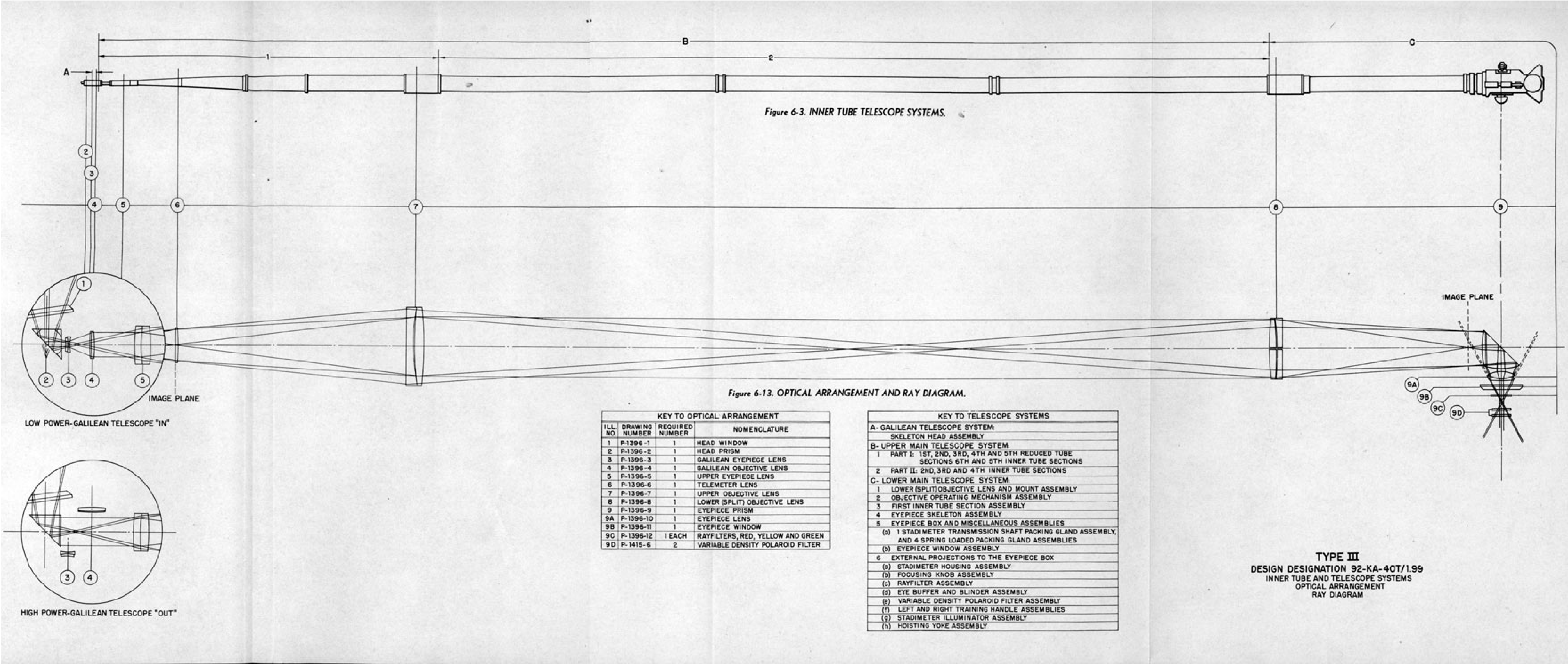

Figure 6-3. INNER TUBE TELESCOPE SYSTEMS.

Figure 6-13. OPTICAL ARRANGEMENT AND RAY DIAGRAM.

KEY TO OPTICAL ARRANGEMENT

ILL. NO.	DRAWING NUMBER	REQUIRED NUMBER	NOMENCLATURE
1	P-1396-1	1	HEAD WINDOW
2	P-1396-2	1	HEAD PRISM
3	P-1396-3	1	GALILEAN EYEPIECE LENS
4	P-1396-4	1	GALILEAN OBJECTIVE LENS
5	P-1396-5	1	UPPER EYEPIECE LENS
6	P-1396-6	1	TELEMETER LENS
7	P-1396-7	1	UPPER OBJECTIVE LENS
8	P-1396-8	1	LOWER (SPLIT) OBJECTIVE LENS
9	P-1396-9	1	EYEPIECE PRISM
9A	P-1396-10	1	EYEPIECE LENS
9B	P-1396-11	1	EYEPIECE WINDOW
9C	P-1396-12	1 EACH	RAYFILTERS, RED, YELLOW AND GREEN
9D	P-1415-6	2	VARIABLE DENSITY POLAROID FILTER

KEY TO TELESCOPE SYSTEMS

A- GALILEAN TELESCOPE SYSTEM:
- SKELETON HEAD ASSEMBLY

B- UPPER MAIN TELESCOPE SYSTEM:
- 1 PART I: 1ST, 2ND, 3RD, 4TH AND 5TH REDUCED TUBE SECTIONS 6TH AND 5TH INNER TUBE SECTIONS
- 2 PART II: 2ND, 3RD AND 4TH INNER TUBE SECTIONS

C- LOWER MAIN TELESCOPE SYSTEM:
- 1 LOWER (SPLIT) OBJECTIVE LENS AND MOUNT ASSEMBLY
- 2 OBJECTIVE OPERATING MECHANISM ASSEMBLY
- 3 FIRST INNER TUBE SECTION ASSEMBLY
- 4 EYEPIECE SKELETON ASSEMBLY
- 5 EYEPIECE BOX AND MISCELLANEOUS ASSEMBLIES
  - (a) 1 STADIMETER TRANSMISSION SHAFT PACKING GLAND ASSEMBLY, AND 4 SPRING LOADED PACKING GLAND ASSEMBLIES
  - (b) EYEPIECE WINDOW ASSEMBLY
- 6 EXTERNAL PROJECTIONS TO THE EYEPIECE BOX
  - (a) STADIMETER HOUSING ASSEMBLY
  - (b) FOCUSING KNOB ASSEMBLY
  - (c) RAYFILTER ASSEMBLY
  - (d) EYE BUFFER AND BLINDER ASSEMBLY
  - (e) VARIABLE DENSITY POLAROID FILTER ASSEMBLY
  - (f) LEFT AND RIGHT TRAINING HANDLE ASSEMBLIES
  - (g) STADIMETER ILLUMINATOR ASSEMBLY
  - (h) HOISTING YOKE ASSEMBLY

Figures 7-3 and 7-27. Inner Tube and Telescope Systems and Optical Arrangement Ray Diagrams

7
DESIGN DESIGNATION 93KN36 PERISCOPE

A. GENERAL DESCRIPTION

7A1. Principal characteristics. The submarine periscope Type IV is a night-service instrument of 36-foot nominal length and 7 1/2-inch outer diameter. It is equipped with a tilting head prism capable of elevating the line of sight 45 degrees above the horizontal, and of correcting for the roll of pitch of the vessel. The optical elements are treated to increase the light transmission. The instrument is designed for high- and low-power observation, and is supplied with a suitable antenna for the attachment of a ST electronic device to the base of the instrument. The principal characteristics of the periscope are as follows:

Magnification	Low power High power	1.5X 6.0X
True field of view	Low power High power	32 deg 8 deg

Maximum elevation of the line of sight (above horizontal)		45 deg
Maximum depression of the line of sight (below horizontal)		10 deg
Maximum elevation of the edge of the field (above horizontal)		
	Low power	61 deg
	High power	49 deg
Diameter of exit pupil (both powers)		7 mm
Over-all length of periscope		37' 2 1/4"
Optical length		36'
Outer diameter of body tube		7.50"
Minimum outer diameter of taper section		3.75"
Maximum diameter of hoisting yoke		14.75"
Maximum diameter of external projections		15.25"
Net weight of periscope		2,000 lb
Material of body tube		Corrosion resisting steel

Material of outer taper section	Corrosion resisting steel

B. REMOVING THE INNER TUBE

7B1. Disassembly of the inner tube from the outer tube. The inner tube is disassembled in the following manner:

1. Place the periscope in V-blocks of the optical I-beam bench. Place it so that sufficient space remains to permit removal of the inner tube.

2. Rotate the revolving grip (26, Figure 7-21) of the left training handle assembly so that the zero line of sight graduation on the index ring (31) corresponds to the stationary index line graduation on the fixed grip (24). This places the head prism at zero line of sight and offers no obstruction for the removal of the inner tube. Check the right training handle far change of power; it should be set for low power.

3. Remove the air outlet plug (3, Figure 7-12) and open the air outlet valve (5) of the eyepiece box (11) to allow, the internal gas pressure to be released slowly.

4. Remove the five bolts (16) from the base of the eyepiece box bottom flange plate (13). These bolts are unscrewed from tapped holes in the base of the eyepiece box (11). Remove the eyepiece box bottom flange plate (13) and the rayfilter stowage case assembly (31).

5. Remove the training handles by taking out eight hinge bracket bolts (5, Figure 7-21 and 7-22 respectively), for the left and right training handle assemblies.

6. Remove the focusing knob by taking out four lockscrews (10, Figure 4-39).

7. Remove the rayfilter housing (13, Figure 7-19) by pulling outward on both spring actuated plunger knobs (7).

8. Remove the eyepiece attachments that are secured to the anchor screw pins (8, Figure 7-12) projecting from the eyepiece box itself.

9. Follow the procedure described in Step 14 of Section 4C1 for the removal of the hoisting yoke assembly.

10. After the nitrogen pressure is released, close the air outlet valve (5) and replace the air outlet plug (3).

11. Rotate the periscope in the V-blocks on the optical I-beam bench so that its eyepiece end is down.

17. Attach and secure the hinged clamp (similar to Figure 4-17 with variance in size) over the upper eccentric bearing of

12. Place the special outer tube alignment guide on the outer tube over the undercut section (Figure 4-7). Using a socket wrench, secure it so that the slotted section is lined up temporarily to the rear vertical azimuth line of the outer tube. Place the eyepiece box alignment guide over the two flat side portions of the eyepiece box (11, Figure 7-12), resting it on the front flat portion. Assemble the radius clamp (Figure 4-7) from the rear side of the eyepiece box to the two bolt projections of the alignment guide, and secure the radius clamp with two wing bolts.

Check the outer tube and eyepiece box alignment guide handles to ascertain their contact (Figure 4-8). Should any separation be detected, loosen the outer tube alignment guide bolt with a socket bench and rotate its handle in contact with the eyepiece box alignment guide handle. The purpose of the outer tube and eyepiece box alignment guides is to establish correct entry and removal guidance for the radial alignment key (17, Figure 7-12) in the eyepiece box (11) with the keyway in the lower part of the outer tube (2, Figure 7-2).

13. Remove the two lockscrews (21, Figure 7-12) in the main coupling (12) at the eyepiece box (11). The main coupling (12) is unscrewed by using a spanner wrench with an extension handle. Unscrew the main coupling counterclockwise, as it has right-hand threads for the outer tube and left-hand threads for the eyepiece box.

14. Follow the procedure outlined in Steps 18 and 19 of Section 4C1, for the detachment of special fixtures the third inner tube section (1, Figure 7-10), and the eccentric bearing of the fourth inner tube section lower end coupling (40, Figure 7-7).

18. Connect the upper part of the lifting spreader bar (similar to Figure 4-13, but shorter in length) to the lifting projection of the hinged clamp. This projection slides between the center slot section of the upper end of the lifting spreader bar, and a bolt is placed through the clearance holes in the above projection and the spreader bar and secured with a locknut. The lifting plate projection slides into the center slot section of the spreader bar at the lower part, and is held in similar manner to the upper part. Place the chain hoist hook in the center pad clearance hole of the lifting spreader bar. The lifting spreader bar for this periscope is 15 inches shorter.

19. Take a light strain with the chain hoist on the lifting spreader bar, and remove the adjustable roller stand (Figure 4-11). Resume the removal of the inner tube slowly until the seventh inner tube section (79, Figure 7-6) is clear of the outer tube. The inner tube should be guided parallel to the outer tube and properly centered in it.

20. Attach and secure another hinged clamp over the seventh inner tube section (79) upper eccentric bearing and the eighth inner tube section lower end coupling (63) eccentric bearing, similar to Figure 4-14. Attach a shackle in the hole of

required in the removal of the inner tube.

15. Slowly pull the inner tube sections out of the outer tube until the third inner tube section (1, Figure 7-10) is clear of the outer tube.

The inner tube should be guided parallel with the outer tube and properly centered in it.

16. Place the adjustable roller stand (Figure 4-11) under the eyepiece box (11, Figure 7-12), removing the hook of the chain hoist and the shackle.

the lifting projection of the hinged clamp, and with the chain hook placed in the shackle, take a light strain with the chain hoist.

21. Resume the removal of the inner tube slowly, checking to ascertain that it is guided parallel to the outer tube and properly centered in it.

22. Transport the inner tube to the V-blocks on the second I-beam bench. Remove both chain hoist hooks, hinged clamps, and steel lifting plate.

23. Remove the outer tube from the V-blocks on the optical I-beam bench with two chain hoists, using canvas covered galvanized wire taped slings wrapped once around the outer tube, transporting it to the periscope rack.

C. OUTER HEAD, OUTER TAPER SECTION, OUTER TUBE, AND INNER TUBE ASSEMBLIES

7C1. Description of the outer head, outer taper section, and outer tube. Figure 7-1 shows the outer head, head window and range window assemblies. All bubble numbers in Sections 7C1, 2, and 4, refer to Figure 7-1 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1475-1	1	Head window
2	P-1475-	1	Range

	2		window
3	P-1480-1	1	Outer head
4	P-1481-1	1	Range window bezel frame
5	P-1481-2	1	Head window bezel frame
6	P-1481-3	1	Range window seat rubber gasket
7	P-1481-4	1	Head window seat rubber gasket
8	P-1481-5	1	Range window bezel frame rubber gasket
9	P-1481-6	1	Head window bezel frame rubber gasket
10	P-1506-16	14	Head window bezel frame lockscrews
11	P-1506-17	28	Range window bezel frame lockscrews

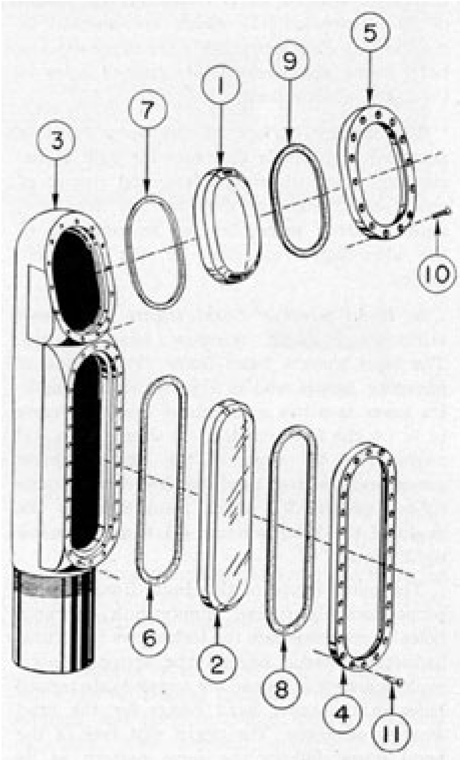

Figure 7-1. Outer head, head window, and range window assemblies.

a. Outer head. The outer head (3) is made of solid forged corrosion-resisting steel. It serves as a covering for the skeleton head assembly (Figure 7-5) and is assembled to the upper part of the outer taper section (1, Figure 7-2). The lower part of the outer head has a tapered alignment support section with a straight threaded periphery of 32 threads per inch preceding it, which fits into a similar internal tapered alignment support section and threaded section in the upper part of the outer taper section.

A mixture of litharge and glycerin is used over the threads to maintain

The outer head flange has 14 proportionately spaced tapped holes for retaining the head window bezel frame (5) by means of 14 lockscrews (10) which are inserted in countersunk clearance holes in the head window bezel frame and screwed into tapped holes in the outer head flange.

Below the head window flange provision, a machined range window flange and recess seat is provided to carry a sealing rubber gasket (6) under a range window (2). Above the range window an additional sealing rubber gasket (8) adheres directly to the beveled edge of the range window and the beveled seat in the range window bezel frame (4).

an internal gas and external water seal, thus establishing a permanent joint between the outer, head and upper part of the outer taper section.

The outer head flange is machined at an angle of 17 degrees 30', with a recess seat to carry a sealing rubber gasket (7) under a head window (1). Above the head window an additional sealing rubber gasket (9) adheres directly to the beveled edge of the head window and beveled seat in the head window bezel frame (5).

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The range window flange provision has 28 proportionately spaced tapped holes for retaining the range window bezel frame (4) by means of 28 lockscrews (11) which are inserted in countersunk clearance holes in the range window bezel frame and screwed into tapped holes in the range window flange.

The interior surface of the outer head is provided with ample clearance for light transmission, prism tilt mechanism, and change of power mechanism of the skeleton head and antenna array assemblies for transmission of the ultra-high frequencies of the electronic device.

b. Head window bezel frame and head window. 1. Head window bezel frame. The head window bezel frame (5) is made of phosphor bronze and is 5 7/32 inches in length. Its lower face has a machined irregular recess to fit on the head window (1) which has a 45 degrees angle. The 45 degrees angle of the beveled recess accommodates the head window provides a means of sealing without obstructing the entering light rays, and offers a transparent medium through which light is transmitted.

c. Range window bezel frame and range window. 1. Range window bezel frame. The range window bezel frame (4) is made of phosphor bronze and is 9.675 inches in length. Its lower face has a machined irregular recess to fit on the range window (2) which has a 45 degrees angle. The 45 degrees angle of the beveled recess accommodates the range window bezel frame rubber gasket (8), which compresses to the angle of the range window (2) to form an air tight joint.

The outer flange of this bezel frame has 28 proportionately spaced countersunk clearance holes to accommodate lockscrews (11). These lockscrews extend beyond the above countersunk clearance

bezel frame rubber gasket (9), which compresses to the angle of the head window (1) to form an air tight joint.

The outer flange of this bezel frame has 14 proportionately spaced countersunk clearance holes to accommodate the lockscrews (3). These lockscrews extend beyond the above countersunk clearance holes and are screwed into tapped holes in the outer head flange for the head window assembly. The upper side face of the bezel frame follows the same pattern as its sides, while the lower side is beveled inward at an angle of 17 degrees 30', thus providing ample clearance for the range window, bezel frame (4) directly below it.

The inner irregular circumference of the bezel frame is beveled at an angle of 45 degrees away from the line of contact with the glass to increase the effect of wind in clearing drops of water from the glass and to reduce the lodgement of water and deposits of salt by evaporation oil the glass near the inner circumference.

2. Head window. The head window (1) is made of one crown optical glass element with parallel surfaces, and rests in the recess seat in the outer head on a seat gasket (7). It is molded with a 45 degrees angle edge to which a bezel frame rubber gasket (9) is applied. It holes, and are screwed into tapped holes in the outer head flange for the range window assembly. The upper and lower side faces follow the same pattern as its sides, with all corners rounded.

The inner irregular circumference of the bezel frame is beveled at an angle of 45 degrees away from the line of contact with the glass, for the same purpose as that described for the head window bezel frame (5).

2. Range window. The range window (2) is made of No. 774 Corning glass with parallel surfaces. It is 0.630 inch thick with an accuracy of 0.002 inch, and fits into the recess seat in the range window assembly flange of the outer head on a seat gasket (6). It is molded with a 45 degrees angle edge to which a bezel frame rubber gasket (8) is applied. In some periscopes this window has been left in an unpolished condition to reduce reflection from sunlight.

The distance between the inner face of the range window and the antenna array must have a clearance of 0.612 inch plus or minus 0.031 inch. Any substitution for No. 774 Corning glass in the window will radically change performance, as likewise will any chipping of the silvered or copper plated surfaces.

d. Outer taper section. The outer taper section (1, Figure 7-2) is made of solid forged corrosion resisting steel

material, and has an over-all length of 5 feet 9.500 inches. It forms

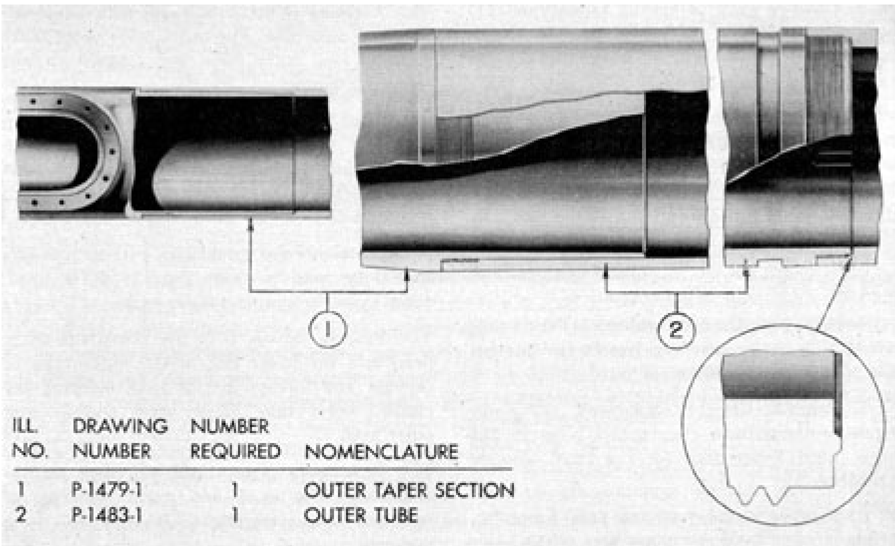

Figure 7-2. Outer taper section and outer tube.

the outer body to protect the five reduced tube sections. The assembly of its upper part of the outer head is described in Section 7c1-a on page 373.

The lower part of the outer taper section is provided with a tapered alignment support section with a straight threaded periphery of 12 threads per inch preceding it which fits into a similar internal tapered alignment support section and threaded section in the upper part of the outer tube (2). A mixture of litharge and glycerine is used over the threads to maintain an internal gas and external water seal, thus establishing a permanent joint between the outer taper section and the outer tube.

The inside diameter of the outer taper section does not vary from its calculated diameter at any point by plus 0.015 inch or minus 0.000 inch; and the bore of the taper is concentric within 0.005-inch finished machined.

has an internal alignment support and threaded section, to receive the lower part of the outer taper section as a permanent joint.

The interior of the outer tube is bored, with the eccentric bearing flanges of the inner tube sections and their couplings having a sliding clearance. The external diameter, azimuth scale lines, and numerals are similar to the Type II periscope outer tube, except for the fact that the numerals start from 35 feet. The milled inside keyway, undercut groove, and ridge detail are also similar to the Type II periscope outer tube. The external threaded periphery has 16 right-hand threads per inch, whereas the Types II and III periscopes have 12 threads per inch.

7C2. Disassembly of the head and range window assemblies. The head window and range window assemblies are disassembled in the following manner:

e. Outer tube. The outer tube (2, Figure 7-2) is made of solid forged corrosion-resisting steel and has an over-all length of 29 feet 3.375 inches. It forms the outer body for the inner tube sections as shown in Figure 7-3. The upper part

1. Unscrew each of the 14 lockscrews (10) evenly, with several threads of each lockscrew remaining in the outer head flange face for the head window assembly (3).

2. Unscrew each of the 28 lockscrews (11) evenly, with several threads of each lockscrew remaining in the outer head flange face for the range window assembly (3).

3. In order to break the seal of the head window (1) and range window (2) it is necessary to apply an internal nitrogen pressure of 15 to 30 pounds in the instrument. To apply an internal nitrogen pressure requires the blanking off of the lower part of the outer tube (2, Figure 7-2) with a suitable jig and fittings for a pressure gage and a charging line.

4. After both the head window (1) and range window (2) are broken free, release the internal gas pressure, and remove the jig.

5. Remove the 14 lockscrews (10), unscrewing them from the tapped holes in the outer head flange face for the head window assembly (3).

6. Remove the head window bezel frame (5), lifting it away from the flange face of the outer head.

7. Remove the head window (1) and the head window bezel frame rubber gasket (9). The head window may stick to the head window bezel frame rubber gasket (9) and the bezel frame (5). Remove the head window bezel frame rubber gasket (9) and destroy it.

7C3. Cleaning of the outer head, outer taper section, and outer tube. The outer head, outer taper section, and outer tube are cleaned in the following manner:

1. They should be cleaned after flooding with the use of various sized circular wire brushes and turkish toweling to remove salt deposits. They should then be blown out with filtered air.

2. Under normal conditions, turkish toweling should be used to clean out the outer head, outer taper section, and outer tube.

3. Place a canvas boot over both the outer head and the lower end of the outer tube to prevent any foreign matter from entering the cleaned outer tube, outer taper section, and outer head.

7C4. Reassembly of the head and range window assemblies. The head and range window assemblies are reassembled in the following manner.

1. Scrape the seat of the outer head for the head window if necessary, to give a true bearing surface. The head window (1) must be marked in the position its seat is scraped so that it cannot be turned end for end.

8. Remove the bead Window seat rubber gasket (7) from the recess seat in the outer head (3) and destroy it.

9. Remove the 28 lockscrews (11), unscrewing them from the tapped holes in the outer head flange face for the range window assembly (3).

10. Remove the range window bezel frame (4), lifting it away from the flange face of the outer head (3).

11. Remove the range window (2) and the range window bezel frame rubber gasket (8). The range window may stick to the range window bezel frame rubber gasket (8) and the bezel frame (4). Remove the range window bezel frame rubber gasket (8) and destroy it.

12. Remove the range window seat rubber gasket (6) from the recess seat in the outer head (3) and destroy it.

2. Place the new head window seat rubber gasket (7) of crude rubber and specified factory drawing dimensions for its insertion in the head window seat in the outer head (3).

3. The beveled seat in the head window bezel frame (5) should be scraped if necessary, to provide a true bearing surface in conjunction with, the beveled edge of the head window (1).

4. Clean the liner surface of the head window (1) with clean lens tissue and use a small air bulb to blow off any surface dust.

5. Place the head window (1) in the head window seat in the outer head (3) on the head window seat rubber gasket (7).

6. The head window bezel frame rubber gasket (9) should be approximately 1/8 inch larger than the head window outer irregular circumference, except to comply to factory drawing dimensions as to thickness. It is placed in the head window bezel frame (5) in one solid piece. Punch a small hole in the center of

the rubber gasket to allow the tapped air to escape.

7. Place the head window bezel frame (5) with the head window bezel frame rubber gasket (9) on the head window (1). Insert the four lockscrews (10) in countersunk clearance holes in the bezel frame and screw them in the tapped holes in the flange face of the outer head. Each lockscrew is screwed down

12. Insert the new range window seat rubber gasket (6) of crude or synthetic rubber of specified factory drawing dimensions in the range window seat in the outer head (3).

13. The beveled seat in the range window bezel frame (4) should be scraped if necessary, to provide a true bearing surface in conjunction with the beveled edge on the range window (2).

flush with the head window bezel frame.

8. A flat wooden block 1 inch thick and slightly smaller than the inner circumference of the head window bezel frame (5) is placed on the head window bezel frame rubber gasket (9). Place a C-clamp over the wooden block and the outer head to flatten the raised center portion of the rubber gasket. Use a wooden wedge on the opposite side of the outer head to tighten the C-clamp evenly. The flattening of the rubber gasket forces its outer edges to adhere to the inner beveled walls in the head window bezel frame (5), and utilizes the entire area of the beveled surface in the bezel frame to maintain the seal.

9. Lubricate the 14 lockscrews (10) lightly with a medium grease before insertion and tighten them evenly. Each lockscrew is taken down equally in a series of all around adjustments, and a feeler gage is used as a check around the head window bezel frame (5). The bezel frame is tightened down to a snug setting of all lockscrews about 0.040. inch. It is desirable to maintain a .0.007-inch to 0.010-inch clearance between the bottom face of the head window bezel frame (5) and the flange face of the outer head (3). Remove the C-clamp and wooden block.

10. It is desirable to wet the head window bezel frame rubber gasket (9) thereby offering a lubricant for a brass knife edge when cutting the crude rubber gasket around the inner irregular circumference of the head window bezel frame (5). The brass knife edge will not scratch the head window surface.

14. Clean the inner surface of the range window (2) in the same manner as described for the head window (1) under Step 4 of this section. The range window should be silvered and copper plated on three surfaces; namely, the beveled edge, the outer irregular circumference, and the bottom face in contact with the seat gasket. The silvered and copper plating of the range window wherever it contacts the metal seat of the outer head eliminates the possibility of a fluctuation in the standing wave ratio of the antenna system, should water become lodged between the window and its seat in the outer head. However, its most important function is to insure that there is no RF leakage through the crack between the range window bezel frame (4) and the range window seat in the outer head (3).

15. Place the range window (2) in the range window seat in the outer head (5) on the range window seat rubber gasket (6).

16. The range window bezel frame rubber gasket (8) should be of specified factory drawing dimensions as to thickness. It should be approximately 1 3/16 inch larger than the range window outer irregular circumference. It is placed in the range window bezel frame (4) in one solid piece. Punch two 3/16-inch holes in the rubber gasket to allow trapped air to escape.

17. Place the range window bezel frame (4) with the range window bezel frame rubber gasket (8) on the range window (2). Insert six lockscrews (11) in countersunk clearance holes in the bezel frame and screw them in the tapped holes in the flange of the outer head. Each

11. Scrape the range window seat in the outer head (3), if necessary, to give a true bearing surface. The range window (2) must be marked in the position its seat is scraped so that it cannot be turned end for end.

lockscrew is screwed down flush with the range window bezel frame.

18. A flat wooden block 1 inch thick and slightly smaller than the inner irregular circumference of the range window bezel frame (4) is placed on the range window bezel rubber

gasket (8). A C-clamp is placed over the wooden block and the outer head to flatten the raised center portion of the rubber gasket. The flattening of the rubber gasket confines its, outer edges to adhere to the inner beveled walls in the range window bezel frame, and utilizes the entire area of the beveled surface in the range window bezel frame (4) to maintain the seal.

19. Lubricate the threads of the 28 lockscrews (11) lightly with a medium grease before insertion and tighten them evenly. Each lockscrew is taken down in a series of all around adjustments, and a feeler gage is used as a check around the range window bezel frame (4) to determine whether it is tightened down evenly. The range window bezel frame is tightened down to a snug setting of all lockscrews about 0.030 to 0.035 inch with crude rubber. With a synthetic rubber gasket, the bezel frame is tightened from an even all around snug setting of all lockscrews to about 0.025 to 0.027-inch. After a hydraulic and temperature test, this type of rubber gasket will require a further tightening of all lockscrews (11) about 3/4 to a full turn. However, this condition does not exist with crude rubber.

seriously impair the efficiency of attached electronic apparatus.

7C5. Inner tube assemblies. Figure 7-3 shows the inner tube of the periscope divided into telescope systems. Each telescope system is made up of assemblies as follows:

A. Galilean telescope system.
1. Skeleton head assembly.
2. Antenna array and taper section assembly,

B. Upper main telescope system.
1. Part I. First, second, third, fourth, and fifth reduced tube sections and seventh and eighth inner tube sections.
2. Part II. Fourth, fifth, and sixth inner tube sections.

C. Lower main telescope system.
1. Part I. First, second, and third inner tube sections.
2. Part II. Eyepiece skeleton assembly.

a. Part II.	Eyepiece box and miscellaneous assemblies.
b. " "	Four packing gland assemblies.
c. " "	Eyepiece window assembly.
d. " "	Bottom plug assembly.
e. " "	Focusing knob

20. It is not desirable to wet the range window rubber gasket while using synthetic rubber material; however, it is desirable to wet the crude rubber gasket. This offers a lubricant for a brass knife edge when cutting the rubber gasket around the inner irregular circumference of the range window bezel frame (4). The brass blade will not scratch the range window surface.

21. If the outer surface of the range window has been polished and the window has not been painted, a thin coat of black aircraft enamel, type AL-E-7, should be applied by spraying. This is to reduce specular reflection of the sun from the window. IMPORTANT: Use only the paint designated. Any other paint will

assembly.

f. " " Rayfilter housing and plate assembly.

g. " " Rayfilter, eyebuffer, blinder, and stowage case assemblies.

h. " " Variable density polaroid filter assembly.

i. " " Training handle assemblies.

j. " " Hoisting yoke assembly (electric and hydraulic).

D. SEPARATION OF THE THREE TELESCOPE SYSTEMS

7D1. Removal of external projections, miscellaneous assemblies, and the eyepiece box. This procedure is performed in the following manner:

1. Remove the 12 bottom plug window housing lockscrews (7, Figure 7-17) from the bottom face in the bottom plug housing (1). These lockscrews are unscrewed from tapped holes in the counterbored seat in the eyepiece box base (11, Figure 7-12).

2. Attach a special square plate jig (Figure 7-4) to the face of the bottom plug clamp ring (2, Figure 7-17) with coinciding clearance

holes to match four 8-32 tapped holes. Insert the four special 8-32 screws into the tapped holes in the bottom plug clamp ring, securing the special square plate jig.

3. Tap the handle part of the special square plate jig, thereby loosening and pulling out the bottom plug

Place a pair of parallel pliers on the square section of the rayfilter drive actuating shaft (8) using a slight sideward thrust to remove the rayfilter drive packing gland assembly. Remove the rayfilter drive stuffing box body rubber gasket (3).

assembly from the counterbored recess seat in the eyepiece box base. Remove the bottom plug housing rubber gasket (3, Figure 7-17), and destroy it.

4. Remove the 10 pressure gage assembly lockscrews (18, Figure 7-12), removing the pressure gage assembly (10).

5. Remove the four short and eight long eyepiece window frame lockscrews (2, and 3, Figure 4-38) removing the eyepiece window assembly.

6. Remove the eyepiece lens mount (78, Figure 7-11) with the eyepiece lens (33) eyepiece lens clamp ring (15), and its lockscrew (70) from the eyepiece prism front retaining plate (22).

7. Remove the six lockscrews (10, Figure 7-15) from the left training handle stuffing box body (7). Place the special packing gland wrench on the square section of the training handle actuating shaft (8), using a slight sideward thrust to remove the left training handle packing gland assembly. Remove the training handle stuffing box rubber gasket (3). 8. Remove the six 1ockscrews (10, Figure 7-16) from the right training handle stuffing box body (7). Remove the right training handle packing gland assembly in the same manner as noted in Step 7 for the left training handle packing gland assembly.

9. Remove the six lockscrews (10, Figure 7-14) from the eyepiece drive stuffing box body (8). Remove the eyepiece drive packing gland assembly in the same manner as noted in Step 7 for the left training handle packing, gland assembly.

11. Remove the seven lockscrews (40, Figure 7-11) from the large flange of the eyepiece skeleton (42). These lockscrews are unscrewed from tapped holes in the upper face of the eyepiece box.

12. Remove the eyepiece box (11, Figure 7-12) from the eyepiece skeleton (42, Figure 7-11), sliding it off the eyepiece skeleton.

7D2. Removal of the waveguide and air line sections. This procedure is performed in the following manner:

1. Remove the two antenna array end plate bracket lockscrews (49, Figure 7-5) from the antenna array end plate bracket (64). These lockscrews are unscrewed from tapped holes in the front face of the skeleton head (10).

2. Remove the two antenna array taper section bracket lockscrews (54) from the antenna array taper section bracket (66). These lock

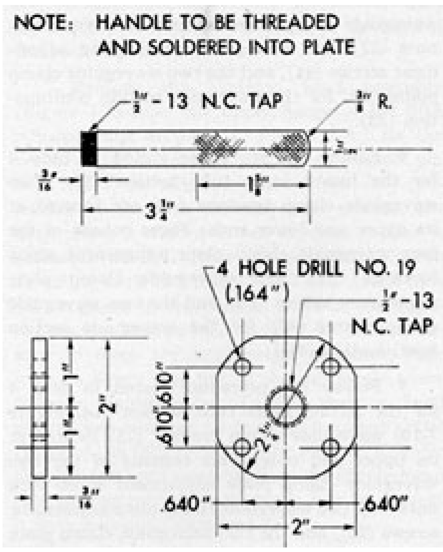

Figure 7-4. Bottom plug assembly removal jig.

Remove the eyepiece drive stuffing box body rubber gasket (3).

10. Remove the four rayfilter drive stuffing box body lockscrews (11, Figure 7-13) from the rayfilter drive stuffing box body (6). Remove the rayfilter drive actuating gear (9) from the square section of the rayfilter drive actuating shaft (8).

screws are unscrewed from tapped holes in the front face of the skeleton head. Remove the antenna array taper section bracket.

3. Release the two waveguide clamp plate adjustment screw lock nuts (75, Figure 7-6) and two waveguide clamp plate adjustment screws (74) to release the tension of the wave guide clamp plates (71) from the waveguide section continuation (65). These adjustment screws extend into tapped holes in the waveguide clamp bracket (73) attached to the eighth inner tube section lower end (60).

4. Release the four waveguide clamp plate adjustment screw lock nuts (14, Figure 7-7) and the four waveguide clamp plate adjustment screws (13). This releases the tension of the two waveguide clamp plates (10) from the waveguide section continuation (5). These adjustment screws extend into two tapped holes in each waveguide clamp bracket (12) attached to the sixth inner tube section (1) upper and lower ends.

5. Follow the procedure stated in Step 4, for the fifth inner tube section (19). Two waveguide clamp brackets, (30) are located at its upper and lower ends. These consist

8. Remove the antenna array, taper section, and waveguide to an isolated place where damage is not likely to occur.

9. Remove the waveguide clamp plate (71, Figure 7-6) and its pins (72) from the waveguide clamp bracket (73) of the eighth inner tube section (60) located at its lower end.

10. Remove the two waveguide clamp plates (10, Figure 7-7) and their pins (11) from the two waveguide clamp brackets (12) of the sixth inner tube section (1) located at its upper and lower ends.

11. Remove the two waveguide clamp plates (28) and their pins (29) from the two waveguide clamp brackets (30) of the fifth inner tube section (19) located at its upper and lower ends.

12. Remove the two waveguide clamp plates (47) and their pins (48) from the waveguide clamp brackets (49) of the fourth inner tube section (37) located at its upper and lower ends.

13. Remove the waveguide clamp plate (23, Figure 7-10) and its pins (24) from the waveguide clamp bracket (25) of the second inner

of the four waveguide clamp plate adjustment screw locknuts (32), four waveguide clamp plate adjustment screws (31), and the, two waveguide clamp plates (28) for the waveguide section continuation (23).

6. Follow the procedure stated in Step 4 for the fourth inner tube section (37). Two waveguide clamp brackets (49) are located at its up and lower ends. These consist of the four waveguide clamp plate adjustment screw locknuts, (51), four waveguide clamp plate adjustment screws (50), and the two waveguide clamp plates (47) for the waveguide section continuation (41)

7. Follows the procedure stated in Step 4 for the second inner tube section (14, Figure 7-10) waveguide clamp bracket (25), located at its upper end only. This consists of the two waveguide clamp plate adjustment screw lock nuts (27), two waveguide clamp plate adjustment screws (26), and the two waveguide clamp plate (23) for the waveguide section continuation (19).

tube section (14), located at its upper end only.

14. Slide the lower air line section continuations (13, 29, and 39) with the soldered air line coupling (40), through a clearance hole in and below the bottom face of the eyepiece skeleton large shoulder flange. It is carried downward sufficiently to break the air line coupling (35, Figure 7-7) joint with the center air line section continuation (34). After breaking the air line coupling joint, the lower air line section I(34) is slid upward and carried out at the disconnection point which is located in the lower part of the fifth inner tube section (19). It is carried out of the eyepiece skeleton large shoulder flange, through a clearance provision in the counterweight half (37, Figure 7-11). It is further carried through one soldered air line strap (28, Figure 7-10) located on the second inner tube section (14), four soldered air line straps (52, Figure 7-7) located on the fourth inner tube section (37), and one soldered air line strap (33) located on the fifth inner tube section (19).

15. Remove the center air line section (16) and its continuation (34) with a soldered air

line coupling (17) at its upper end and another air line coupling (35) at its lower end. Slide the center air line section and its continuation downward out of three soldered air line straps (15) of the sixth inner tube section (1) and three soldered air line straps (33) of the fifth inner tube section (19). The center air line section disconnection point is

Pull upward and out on both phosphor-bronze wire extensions from the shifting wire spindle assemblies. Pull both lengths of the power shifting wire tape from various soldered tape straps on the inner tube sections. Roll up each power shifting tape separately in a 15-inch circle, and secure together

located at the lower part of the fifth inner tube section.

16. Remove the upper air line section (19, Figure 7-6) and its continuations (27, 41, 50, 59, 77, 90, and 16, Figure 7-7) from the skeleton head (20, Figure 7-5), sliding it downward for its disconnection from the skeleton head. It is carried out of clearance holes in flanges of the reduced tube sections and the reducing coupling. It is further carried out of two soldered air line straps (76, Figure 7-6) on the eighth inner tube section (60) and one soldered air line strap (15, Figure 7-7), on the sixth inner tube section (1). The upper air line section disconnection point is located at the upper part of the sixth inner tube section.

7D3. Separation of the Galilean telescope system and fifth reduced tube section. This procedure is performed in the following manner:

1. Separate the Galilean telescope system which is located in the skeleton head assembly (Figure 7-5) from the upper flange of the fifth reduced tube section (I, Figure 7-6) in the following manner:

2. Remove the three lockscrews (42, Figure 7-5) from the left cube shifting rack (36), removing the upper end of left power shifting wire tape (35, Figure 7-11). Replace the clamp block (26, Figure 7-5) on the left tape spacer (27) and insert the lockscrews (42), screwing them into the tapped holes in the left cube shifting rack.

3. Remove the three lockscrews (43) from the right cube shifting rack (34), removing the upper end of the right power shifting wire tape (35, at three equal places with friction tape.

5. Elevate the head prism (1, Figure 7-5) to full elevation, which places the quadruple screw follower (3, Figure 7-6) in a suitable position, so that the head prism actuating rack (65, Figure 7-5) with its inserted dowel pins (56) has sufficient clearance for its removal from the quadruple screw follower (3, Figure 7-6). Check the position of the quadruple screw follower (3) on the quadruple screw shaft (16) so that it will be replaced in this identical position for reassembly. Remove the three lockscrews (41, Figure 7-5) from the head prism actuating rack (65). These lockscrews ate unscrewed from tapped holes in the quadruple screw follower (3, Figure 7-6).

6. Support the skeleton head assembly (Figure 7-5), while removing the six lockscrews (10, Figure 7-6) from the upper flange of the fifth reduced tube section (1). These lockscrews are unscrewed from tapped holes in the base of the skeleton head.

7. Remove the skeleton head assembly (Figure 7-5) from the upper flange of the fifth reduced tube section (1, Figure 7-6). As the skeleton head reamed alignment dowel pin hole clears the alignment dowel pin (15) projection of the fifth reduced tube section, the head prism is shifted to full depression. This is accomplished in fact, by having the head prism actuating rack (65, Figure 7-5) and dowel pins (56) engaged in the reamed holes in the quadruple screw follower (3, Figure 7-6). It is necessary to force the head prism actuating rack with its dowel pins free of the quadruple

Figure 7-11). Replace the clamp block (26, Figure 7-5) on the right tape spacer (28) and insert the lockscrew (43) screwing them into the tapped holes in the right cube shifting rack.

4. Release the shifting wire clamp nuts (3, Figure 7-11) of both shifting wire spindle assemblies of the eyepiece skeleton assembly.

screw follower reamed holes (3). The skeleton head assembly is now free for removal from the upper flange of the fifth reduced tube section. Remove the skeleton head assembly from the fifth reduced tube section and place it to one side to prevent it from becoming damaged.

8. It is necessary to remove the skeleton head from the fifth reduced tube section, and the fifth

reduced tube section from the fourth, to provide sufficient clearance for disassembly of the head prism drive shaft sections and their universal couplings.

9. Remove the head prism drive shaft universal coupling taper pin (26) from the lower part of the head prism drive universal coupling (23) and the head prism drive shaft section (21) of the fourth reduced tube section (20).

10. Separate the fifth reduced tube section lower flange (1) from the fourth reduced tube section upper flange (20) by removing the six lockscrews (10) from the lower flange of the fifth reduced tube section (1). Unscrew these lockscrews from tapped holes in the upper flange of the fourth reduced tube section. The lower part of the head prism drive shaft universal coupling (23) slides off the undercut part of the head prism drive shaft section (21) as the fifth reduced tube section is removed. Remove the assembled fifth reduced tube section from the fourth reduced tube section.

7D4. Removal of the head prism drive shaft sections and their

at the disconnection point located in the lower part of the first reduced tube section (51).

3. Remove the head prism drive shaft universal taper pin (36, Figure 7-10) from the upper part of the head prism drive universal coupling (34) and the stub section of the head prism drive shaft section continuation (15) and slide this shaft continuation upward sufficiently to clear the coupling.

4. Remove the head prism drive shaft section (33) and its continuation (48, Figure 7-11), sliding it upward to free it from the upper part of the head prism drive shaft universal coupling (59), carrying with it the inserted woodruff key (46). Check the position of the coupling for proper reassembly. Remove the shaft from the disconnection point located at the upper end of the first inner tube section (31, Figure 7-10) sliding it out of the elongated holes in the large and small flanges of the eyepiece skeleton and the clearance holes in the first inner tube section lower flange, carrying with it the assembled head prism drive shaft universal coupling (34).

universal couplings. This procedure is performed in the following manner:

1. Remove the head prism drive shaft universal coupling taper pin (56, Figure 7-6), from the lower part of the head prism drive shaft universal coupling (54) of the first inner tube section (51) and the head prism drive shaft section (61) of the eighth inner tube section (60).

2. Remove the assembled head prism drive shaft, consisting of the head prism drive shaft section (21) and its shaft continuation (30) with an attached spherical bushing (49), head prism drive shaft universal coupling (45), head prism drive shaft section (43) with an attached spherical bushing (58), its shaft continuation (52), and the attached head prism drive shaft universal coupling (54), by carrying the above assembly upward. The upward movement of this assembly clears the stub section of the head prism drive shaft section (61) from the lower part of the head prism drive shaft universal coupling (54) at the lower end of the first reduced tube section (51). The assembly is then carried downward out of the clearance holes in the fourth, third, second, and first reduced tube section flanges

5. Remove the head prism drive shaft section continuations (15 and 4, Figure 7-10) and its continuations (38, 20, and 2, Figure 7-7) of the head prism drive shaft section (61, Figure 7-6), from its disconnection point located at the upper part of the first inner tube section (31, Figure 7-10). The shaft section is carried downward from various clearance holes in the coupling flanges, and the head prism drive shaft guides which are attached to or part of the second, third, fourth, fifth, sixth, seventh, and eighth inner tube sections. The head prism drive shaft rubber noise eliminators are removed from the head prism drive shaft section and its continuations W the eighth, sixth, fifth, fourth, and second infer tube sections. This shaft and its continuations can also be carried upward from the first reduced tube section (51) by the inverse method.

7D5. Separation of the upper telescope system Part I from Part II. This consists of the first, second, third, fourth, fifth reduced tube sections and the seventh and eighth inner tube sections.

1. Remove the 24 lockscrews (87, Figure 7-6), from the lower part of the seventh inner

tube section (79) and the sixth inner tube section upper end coupling (4, Figure 7-7). These lockscrews are unscrewed from tapped holes in the upper alignment support section of the sixth inner tube section upper end coupling.

of the fourth inner tube section lower end coupling.

2. Remove the fourth inner tube section (37) carrying with it the fourth inner tube section lower end coupling (40) from the upper part of the third inner tube section (1, Figure 7-10).

2. Remove the seventh inner tube section (79, Figure 7-6), carrying it off the upper alignment support section of the sixth inner tube section upper end coupling (4, Figure 7-7).

7D6. Separation of the upper telescope system Part If from the lower telescope system Part I. This consists of the fourth, fifth, and sixth inner tube sections.

1. Remove the 24 lockscrews (10, Figure 7-10) from the upper part of the third inner tube section (1) and the fourth inner tube section lower end coupling (40, Figure 7-7). These lockscrews are unscrewed from tapped holes in the lower alignment support section

7D7. Separation of the lower telescope system Part I from the lower telescope system Part II, eyepiece skeleton assembly. This consists of the first, second, and third inner tube sections.

1. Remove the seven lockscrews (40, Figure 7-11) from the small flange of the eyepiece skeleton (42). These lockscrews are unscrewed from tapped holes in the lower flange of the first inner tube section (31, Figure 7-10). Remove the eyepiece skeleton assembly (Figure 7-11) from the lower flange and alignment support section of the first inner tube section (31, Figure 7-10).

E. GALILEAN TELESCOPE SYSTEM

7E9. Description of the skeleton head and antenna array assemblies as shown on Figure 7-5. All bubble numbers in Sections 7E1, 2, and 3, refer to Figure 7-5 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1475-3	1	Head Prism
2	P-1475-4	1	Galilean eyepiece lens
3	P-1475-5	1	Galilean objective lens
4	P-1476-1	1	Galilean eyepiece lens cube
5	P-1476-2	1	Galilean objective lens cube

Ill. No.	Drawing Number	Number Required	Nomenclature
17	P-1478-8	2	Link connecting shaft bushings
18	P-1478-9	2	Link connecting shafts
19	P-1478-10	1	Galilean eyepiece lens cube bracket (prism shift side)
20	P-1491-2	1	Head prism shade
21	P-1491-2A	2	Head prism shade rivets
22	P-1491-3	2	Head prism shade wire links

6	P-1476-3	1	Galilean eyepiece lens mount, housing
7	P-1476-4	1	Galilean eyepiece lens mount
8	P-1476-5	1	Galilean objective lens retainer
9	P-1476-6	3	Galilean eyepiece lens mount housing lockscrews
10	P-1441-1	1	Skeleton head
11	P-1478-1	1	Head prism mount
12	P-1478-2	1	Field prism mount lever
13	P-1478-4	2	Galilean eyepiece objective lens cube brackets (power shift side)
14	P-1478-5	1	Galilean objective lens cube bracket (prism shift side)
15	P-1478-6	1	Power shift gear bracket
16	P-1478-7	1	Head prism actuating link
23	P-1491-4	1	Head prism side plate (left)
24	P-1491-4A	2	Head prism side plate rivets
25	P-1491-5	1	Head prism side plate (right)
26	P-1491-6	2	Clamp blocks
27	P-1491-7	1	Left tape spacer
28	P-1491-8	1	Might tape spacer
29	P-1491-10	2	Head prism mount pivot shaft bushings
30	P-1492-1	2	Power shift pawls
31	P-1492-2	2	Pawl holders
32	P-1492-2A	4	Pawl holders and pawl rivets
33	P-1492-3	1	Reinforcing spring
34	P-1492-4	1	Cube shifting rack (right)
35	P-1492-5	1	Power shift gear
36	P-1492-6	1	Cube shifting rack (left)
37	P-1493-1	1	Head prism mount pivot shaft
38	P-1493-2	2	Head prism mounting clamps (left)

Ill. No.	Drawing Number	Num-ber	Nomenclature

The following brief description covers the skeleton head assembly:

		Re-quired	
39	P-1493-3	2	Head prism mounting clamps (right)
40	P-1506-1	6	Bracket lockscrews (power shift side)
41	P-1506-4	3	Quadruple screw follower and head prism actuating rack lockscrews
42	P-1506-9	3	Clamp block and left tape spacer lockscrews
43	P-1506-10	3	Clamp block and right tape spacer lockscrews
44	P-1506-19	8	Head prism mounting clamp lockscrews
45	P-1506-20	2	Head prism mount pivot shaft lockscrews
46	P-1506-21	6	Head prism side plate lockscrews
47	P-1506-22	7	Pawl holder and reinforcing spring lockscrews
48	P-1506-31	2	Link connecting shaft lockscrews
49	P-1506-33	2	Antenna array end plate

a. Skeleton head frame. The skeleton head frame (10) forms the necessary framework to carry the prism tilt mechanism, Galilean telescope, and the change of power mechanism.

The prism tilt mechanism is composed of numerous mechanical parts in the upper and left side wall of the skeleton head to operate one optical element, the head prism (1).

b. Head prism. The head prism (1) is a right angle prism, made of dense flint optical glass material. It is used to reflect the light rays at right angles. The light rays enter from the horizontal and are deflected downward into the instrument. Light enters from 61 degrees elevation to 26 degrees depression in low power, and 49 degrees elevation to 14 degrees depression in high power.

c. Head prism mount. The head prism mount (11) carries the head prism (1) with a suitable clamping arrangement. Two head prism side plates left and right (23 and 25) restrict the head prism from sideward movement, and are held to the head prism mount with three lockscrews each (46). Each head, prism side plate has a head prism shade wire link (22) attached to it with a rivet (24). The opposite end of each wire link is attached to the head prism shade (20) in similar manner. Two pairs of head prism mounting clamps left and right (38 and 39) hold the head prism to its mount. Each pair of mounting clamps is held to the head prism mount with four lockscrews (44). The head prism mount is held in the skeleton head by means of a head prism mount pivot shaft (37) which is secured with two taper pins (57). The pivot shaft is secured in a

			bracket lockscrews
50	P-1506-34	1	Galilean eyepiece lens mount lockscrew
51	P-1506-41	4	Galilean eyepiece lens and objective lens cube bracket lockscrews (prism shift side)
52	P-1506-48	2	Head prism actuating rack guide lockscrews (short)
53	P-1506-58	2	Head prism actuating rack guide lockscrews (long)
54	P-1506-60	2	Antenna array taper section bracket lockscrews
55	P-1506-10	1	Head prism mount lever taper pin
56	P-1506-116	2	Head prism actuating rack and quadruple screw, follower dowel pins
57	P-1506-117	2	Head prism mount and pivot shaft taper pins
58	P-1513-6	1	Head prism actuating rack guide
59	P-1513-	1	Head prism

bearing bracket projection looted under and a part of the head prism mount base. The pivot shaft rotates in two head prism mount pivot shaft bushings (29) inserted in opposite sides of the skeleton head (10).

d. Head prism shade. The head prism shade (20) by means of two wire links (22) moves vertically with the head prism and its mount by its insertion in opposite vertical grooves in the inner side walls of the skeleton head. It is carried with the head prism (1) and its mount for all degrees of elevation and

	7		actuating rack guide spacer
60	P-1516-1	1	2 Perforated antenna tubes
61	P-1516-2	2	Antenna tube taper pieces
62	P-1516-3	1	Antenna tube taper piece assembly
63	P-1516-4	1	Antenna array assembly
64	P-1516-5	1	Antenna array end plate bracket
65	P-1522-3	1	Head prism actuating rack
66	P-1522-5	1	Antenna array taper section bracket
67	P-1522-7	1	Head prism mount lever key

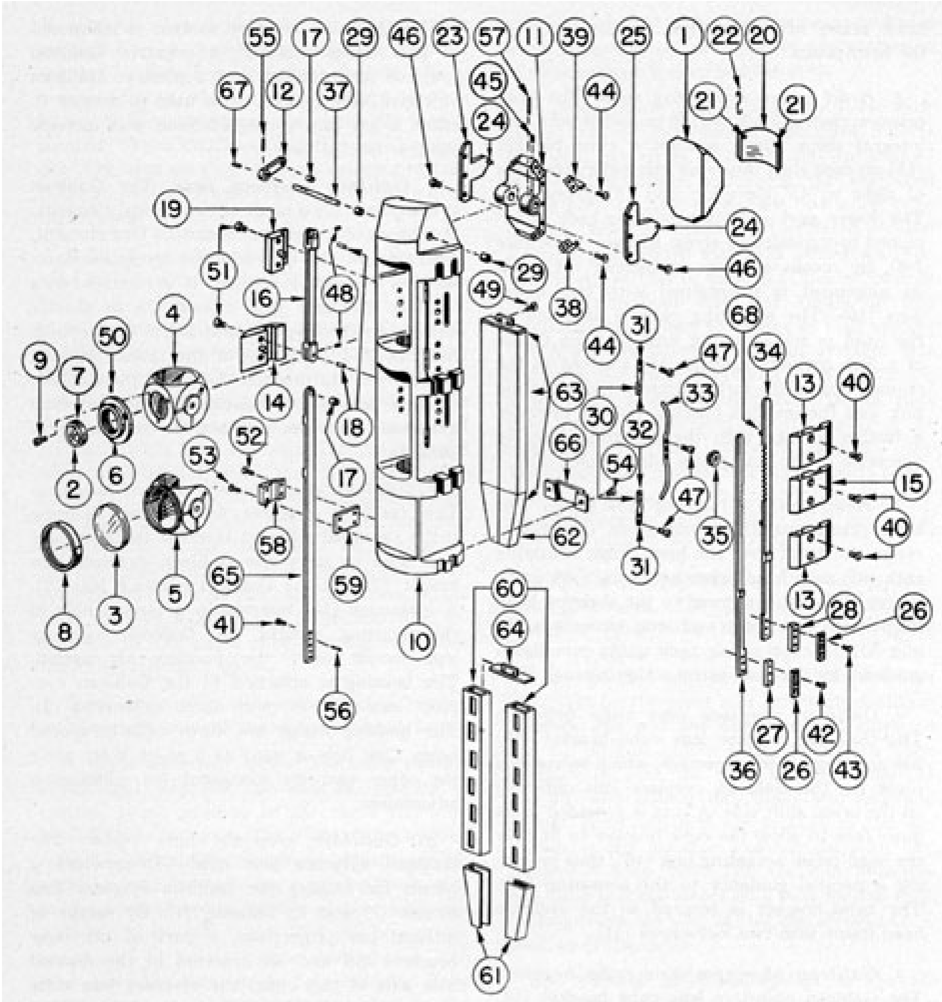

Figure 7-5. Skeleton head and antenna array assemblies.

depression and shades the lower 90 degrees face of the head prism when in, the elevated position, thus preventing a double image.

e. Head, prism mount lever. The head prism mount lever (12) is attached to the head prism mount pivot shaft (37) with a key (67) and a taper pin (55) to operate the pivot shaft for the elevation and the depression of the head prism (1).

f. Head prism actuating link. The head prism actuating link (16) fork section attaches to the head prism mount lever (12) by means of a link connecting shaft (18) and is secured with a lockscrew (48) at its upper part. The fork section of the lower part is attached to a head prism actuating rack (65) in similar manner. The above actuating link forms a linkage between the head prism mount lever and the

head prism actuating rack for actuation of the head prism.

g. Head prism actuating rack. The head prism actuating rack (65) is provided with two integral stops which contact a cube bracket (14) on each side, thus restricting the centerline of sight to 45 degrees

The Galilean telescope system is composed of two lenses; namely, a negative Galilean eyepiece lens doublet and a positive Galilean objective lens doublet. It is used in reverse to effect a low power magnification and increase the true field of view.

elevation and 10 degrees depression. The lower part of this actuating rack is attached to a quadruple screw follower (3, Figure 7-6), by means of three lockscrews (41), and its alignment is maintained with two dowel pins (56). The actuating rack is attached to the head prism actuating link (16), by means of a link connecting shaft (18) inserted in the reamed hole in the fork section of the actuating link and the inserted bushing (17). It provides a further linkage with the actuating link for operation of the head prism mount lever (12).

h. Head prism actuating rack guide. The head prism actuating rack guide (58) has a recess slot to fit over the head prism actuating rack (65) on a head prism actuating rack guide spacer (59) and is secured to the skeleton head frame with two short and long lockscrews (52 and 53). The actuating rack guide provides a guidance for the head prism actuating rack (65).

i. Galilean eyepiece lens cube bracket. The Galilean (eyepiece lens cube bracket (19) has an integral pin projection, which serves as a pivot for the Galilean eyepiece lens cube (4) on the prism shift side. A stop is provided in its inner face to allow the cube bracket to fit over the head prism actuating link (16), thus providing a parallel guidance to the actuating link. The cube bracket is secured the skeleton head fame with two lockscrews (51).

j. Galilean objective lens cube bracket. The Galilean objective lens cube bracket (14) has an integral pin projection and serves as a pivot for the Galilean objective lens cube (5) on the prism shift side. A recess slot is provided in its inner face to fit

k. Galilean eyepiece lens. The Galilean eyepiece lens (2) is made of two optical elements. It consists of a divergent meniscus flint element, cemented to the equi-concave crown element, forming a negative doublet. It is mounted in a Galilean eyepiece lens mount (7) in similar manner to the Type II and III periscope with the threaded periphery of the mount moving vertically in the internal threads in the Galilean eyepiece lens mount housing (6). This vertical movement provides a means for elimination of parallax.

1. Galilean eyepiece lens mount housing. The Galilean eyepiece lens mount housing (6) is provided with an internal threaded section bore to carry the Galilean eyepiece lens mount (7) and the Galilean eyepiece lens (2). A lockscrew (50) inserted in a tapped hole in this housing secures the Galilean eyepiece lens mount after the parallax elimination. The housing is attached to the Galilean eyepiece lens cube (4) with three lockscrews (9). The housing flange has three equally spaced holes. One hole is used as a pivot hole, while the other two are elongated for collimation adjustment.

m. Galilean eyepiece lens cube. The Galilean eyepiece lens cube (4) provides a means for holding the Galilean eyepiece lens mount (7) and its housing (6). By means of integral pin projections, a part of the cube brackets (19 and 13) inserted in the reamed hole axis of this cube, the eyepiece lens cube can be rotated 90 degrees for either the IN or OUT position. The pawl holder (30) engaged in the V-grooves in the right side face of the cube, by the tension of a reinforcing

over the head prism actuating rack (65). The cube bracket is secured to the skeleton head frame with two lockscrews (51) and provides a parallel guidance to the head prism actuating rack. It also serves as a stop in its upper and lower parts for the integral stops of the head prism actuating rack for elevation and depression of the head prism (1).

spring (33), retains it in either the IN or OUT position. An elongated slot in the right side face of the cube receives an upper pin projection (68) assembled in the right cube shifting rack (34) for its actuation.

n. Galilean objective lens. The Galilean objective lens (3) is made of two optical elements.

It consists of a double convex flint element cemented to a double concave flint element forming a positive objective doublet. It is mounted in a shallow counterbored section in the Galilean objective lens cube (5) and is secured with a Galilean objective lens retainer (8). The lens retainer is spot soldered to the Galilean objective lens cube to prevent it from unscrewing.

o. Galilean objective lens cube. The Galilean objective lens cube (5) provides a means for holding the Galilean objective lens (3) in a shallow counterbored section. The outer shoulder has a threaded periphery to carry the Galilean objective lens retainer (8). By means of integral pin projections, a part of the cube brackets (14 and 13) inserted in the reamed hole axis in the cube, the objective lens cube can be rotated 90 degrees for either the IN or OUT position. The pawl holder (30) engaged in the V-grooves in the right side face of the cube retains it in either the IN or OUT position by the tension of the reinforcing spring (33). An elongated slot in the right side face of the cube receives a lower pin projection (68) assembled in the right cube shifting rack (34) for its actuation.

shifting rack (36) is carried downward and vice versa. It pivots on the integral pin projection of the power shift gear bracket (15).

r. Power shift pawls. The two power shift pawls (30) are attached to the pawl holders (31) with two rivets each (32) and are secured in a vertical recess groove in the side wall of the skeleton head to the left of the left cube shifting rack (36). Each pawl holder is secured in the recess groove with two lockscrews (47). The detent section of each pawl holder extends into its individual axial slot located in this vertical recess groove to engage in their respective V-grooves in each Galilean eyepiece lens and objective lens cube (4 and 5). A reinforcing spring (33) is placed over each power shift pawl (30), and is secured into the center of the recess groove with three lockscrews (47). The reinforcing spring overlapping each power shift pawl section of the pawl holder places a constant tension on the power shift pawls, for their retention in the V-grooves.

s. Galilean eyepiece and objective lens cube brackets. The Galilean eyepiece and objective lens cube brackets (power shift side) (13) are of duplicate design. Each bracket

The change of power mechanism is located on the right side of the skeleton head frame.

p. Cube shifting racks. The tube shifting racks right and left 36) operate in vertical recess grooves in the right side wall of the skeleton head. The right cube shifting rack (34) has two assembled pin projections (68) which extend through the two elongated slots in the vertical recess groove in the right side wall of the skeleton head. The pin projections are riveted to the right cube shifting rack, and after extending through the two elongated slots, extend farther into the elongated slots in the right side faces of the Galilean eyepiece lens and the objective lens cubes (4 and 5). An integral stop is provided on each rack to contact the Galilean objective lens cube bracket (13) at the IN and OUT positions.

q. Power shifts gear. The power shift gear (35) fits between the gear teeth cut in the right and left cube shifting racks (34 and 35). The power shift gear carries the right cube shifting rack (34) to the upward position as the left cube has an integral pin projection, which serves as a pivot for the pivot hole axis in the Galilean eyepiece lens and the objective lens cubes (4 and 5) on the power shift side. Both cube brackets fit over the cube shifting racks (34 and 36) and power shift pawls and retaining spring. These brackets are secured to the flat section of the skeleton head frame with two lockscrews each (40). The Galilean objective lens cube bracket serves as a stop for the cube shifting racks (34 and 36) for the IN and OUT position of the cubes.

The Galilean telescope system in the IN position has the Galilean eyepiece and objective lenses located at the upper part of their respective cubes. When in the OUT position, both lenses are located in the rear of the skeleton head frame.

The skeleton head assembly is attached to the upper flange of the fifth reduced tube section (1, Figure 7-6) by means of a shallow counterbored alignment support section fitting on the alignment support section shoulder of the fifth reduced tube section upper flange.

The skeleton head lower face is provided with six tapped holes, one reamed dowel pin hole, and an air line clearance hole. The reamed dowel pin hole receives the dowel pin (15) secured in the upper flange face of the fifth reduced tube section to reestablish the factory alignment upon disassembly. The six tapped holes receive the lockscrews (10) inserted in clearance holes in the fifth reduced tube section upper flange for the securement of the

3. Antenna array taper section bracket. The antenna array taper section bracket (64) is bent to conform to the taper section assembly (62) for the securement of the lower end of the antenna array (63) to the skeleton head. This bracket has opposite overlapping sections, each provided with a clearance hole for the insertion of lockscrews (54). These lockscrews extend into tapped holes in the front face of the skeleton head.

skeleton head assembly. The air line clearance hole coincides with a clearance hole in the upper flange of the fifth reduced tube section for the insertion of the upper end of the upper air line section (19) for the introduction of nitrogen.

t. Taper section. The taper section (62) consists of two sections of waveguide tubing (61) which are silver soldered together.

u. Antenna array assembly. The antenna array assembly (63) consists of three parts: 1) end plate bracket (64), 2) perforated antenna tubes (60), and 3) taper section assembly (62). All three parts are silver soldered together to form the antenna array assembly. The taper section (62) is silver soldered to the waveguide section (7, Figure 7-6). This assembly is secured to the skeleton head in a recess seat of similar construction milled in the front face of the skeleton head. It is secured as before mentioned in its upper and lower parts.

1. Antenna array end plate bracket. The antenna array end plate bracket (64) consists of a rectangular plate with a small rectangular projecting section. The plate section is silver soldered to the upper end of the assembled perforated antenna tubes (60). The rectangular projector extending upward is provided with two clearance holes for the insertion of the lockscrews (49). These lockscrews, when inserted, extend into tapped holes in the antenna array milled recess in the skeleton head for the securement of the upper end of the antenna array (63).

2. Perforated antenna tubes. A The two perforated sections of waveguide tubing (60) consist of

7E2. Disassembly. The skeleton head assembly is disassembled in the following manner:

1. Move the cube shifting racks (34 and 36), shifting the Galilean telescope system in the OUT position. This allows the Galilean eyepiece lens (2), its mount (7), and the Galilean eyepiece lens mount housing (6) to be removed. Remove the three lockscrews (9) from the flange section of the Galilean eyepiece lens mount housing (6). These lockscrews are unscrewed from the tapped holes in the face of the Galilean eyepiece lens cube (4). Scrape off the spot solder from the Galilean objective lens retainer (8) and the Galilean objective lens cube (5). Remove the Galilean objective lens (3). Release the lockscrews (50) and remove the Galilean eyepiece dens (2) and its mount (7), unscrewing it from the Galilean eyepiece lens mount housing (6). Wrap the Galilean eyepiece lens, its mount, and the Galilean objective lens separately in clean lens tissue and place to one side to prevent scratches and breakage.

2. Remove the two short and long head prism actuating rack guide lockscrews (52 and 53). Remove the head prism actuating rack guide (58) and the head prism actuating rack guide spacer (59).

3. Remove the two Galilean objective lens cube bracket lockscrews (prism shift side) (51) from the } Galilean objective lens cube bracket (prism shift side) (14). Remove the Galilean objective lens cube bracket (prism shift side) (14).

4. Remove the two Galilean eyepiece lens cube bracket lockscrews (prism shift side) (51).

two sections of waveguide tubing with six staggered rectangular perforations located in each outer face. Both sections are silver soldered together.

Remove the Galilean eyepiece lens cube bracket (prism shift side) (19).

5. Shift the head prism (1) to full elevation, in order to insert a drift punch from the rear

side of the skeleton head (10). Drive out both the head prism mount and the head prism mount pivot shaft taper pins (57).

6. Shift the head prism to full depression and release the two head prism mount pivot shaft lockscrews (45).

7. Remove the complete assembly of the prism tilt mechanism which consists of the following from the skeleton head: head prism mount lever (12), head prism actuating link (16), link connecting shaft bushing (17), two link connecting shafts (18), head prism mount pivot shaft (37), two link connecting shaft lockscrews (48), head prism mount lever taper pin (55), head prism actuating rack (65), and the head prism mount lever key (67). The head prism mount pivot shaft (37) is carried out of the integral bearing brackets of the head prism mount and the opposite head prism mount pivot shaft bushings (29).

8. Remove the head prism mount assembly of the following: head prism (1), head prism mount (11), head prism shade (20), two head prism shade wire links (22), left and right head prism side plates (23 and 25), left and right head prism mounting clamps (38 and 39), head prism mounting clamp lockscrews (44), and the six head prism side plate lockscrews (46). The head prism shade will slide out of its

11. Remove the taper pin (55) from the head prism mount lever (12) and the head prism mount pivot shaft (37).

12. Remove the head prism mount pivot shaft (37) by driving it from the head prism mount lever (12). The head prism mount lever key (67) remains in the head prism mount pivot shaft (37).

13. The head prism mount (11) and the head prism (1) are disassembled by following Steps 13 to 15 inclusive. Remove the two lockscrews (44) from the left and right head prism mounting clamps (38 and 39) at the upper end of the head prism mount (11). These lockscrews are unscrewed from tapped holes in the head prism mount. Remove the head prism (1), sliding it upward to free it of the assembled lower left and right head prism mounting clamps (38 and 39). Wrap clean lens tissue around the head prism and place it in a convenient place to prevent scratches and breakage.

14. Remove the three lockscrews (46) from the left and right head prism side plates (23 and 25), carrying with them the two head prism shade wire links (22) and the head prism shade (20). These lockscrews are unscrewed from tapped holes in each side of the head prism mount (11).

opposite axial recess grooves in the inner side walls of the skeleton head, carrying it out from the upper end.

9. The prism tilt mechanism is disassembled by following Steps 9 to 12 inclusive. Release two link connecting shaft lockscrews (48) and unscrew them from the tapped holes in both ends of the head prism actuating link (16). This allows both link connecting shafts (18) to be removed.

10. Place a drift punch in each tapped hole in the end of each link connecting shaft (18) for its removal as the shafts are a snug fit to prevent lost motion. The head prism actuating rack (65) is now free of its connection in the fork section of the head prism actuating link (16). The fork section of the head prism actuating link (16) is now freed of its connection with the head prism mount lever (12).

15. The lower left and right head prism mounting clamps (38 and 39) and their lockscrews (44) remain in place. This allows the head prism to be assembled into its original factory position.

16. Remove the four lockscrews (40) from the Galilean eyepiece and the objective lens cube brackets (power shift side) (13). These lockscrews are unscrewed from tapped holes in the right side wall of the skeleton head. Remove both cube brackets, raising each one equally as each bracket has an integral pin projection which extends into the skeleton head and each pivot hole axis in the Galilean eyepiece lens and the objective lens cubes (4 and 5).

17. Remove the two lockscrews (40) from the power shift gear bracket (15). These lockscrews are unscrewed from tapped holes in the right side wall of the power shift gear bracket and its integral pin projection.

18. Remove the right and left cube shifting racks (34 and 36), carrying with them the left and right tape spacers (27 and 28) and the left and right tape spacer and clamp block lockscrews (42 and 43).

19. Remove the power shift gear (35).

20. Remove the Galilean eyepiece lens and the objective lens cubes (4 and 5) from the center of each opening in the skeleton head (10).

21. Remove the three lockscrews (47) from the reinforcing spring (33) and remove the reinforcing spring.

the right cube shifting rack (34), placing its assembled pin projections (68) through the axial slots in the recess groove and in the elongated slot in the right side wall in each cube.

5. Place the left cube shifting rack (36) in the center of the three vertical recess grooves in the right side wall of the skeleton head. The left cube shifting rack (36) also operates the power shift gear (35) meshing with the gear teeth of the cube shifting rack.

6. Reassemble the Galilean eyepiece lens and the objective lens cube brackets (13) oil the flat outer

22. Remove the two lockscrews (47) from each pawl holder (31), removing the power shift pawls and the pawl holders (30 and 31). All lockscrews for Steps 21 and 22 are unscrewed from tapped holes in the enlarged recesses in this vertical recess groove in right side wall of the skeleton head. Precautions should be taken to replace the power shift pawls and the pawl holders to their original positions.

7E3. Reassembly. The skeleton head assembly is reassembled in the following manner:

1. Place the IN and OUT position power shift pawls (30) and pawl holders (31) in the vertical recess groove in the right side wall of the skeleton head. The power shift pawls (30) fit through the axial slots in the vertical recess groove and in the V-grooves in the cubes for the IN and OUT position. Secure each pawl holder (3-1) with two lockscrews (47) which extend into tapped holes in the recess seat in the vertical recess groove located in the right side wall of the skeleton head (10).

2. Place the reinforcing spring (33) over the power shift pawls (30), securing it with three lockscrews (47). These lockscrews extend into tapped holes in the recess seat in the vertical recess groove.

3. Place the Galilean eyepiece lens and the objective lens cubes (4 and 5) in the two center openings in the skeleton-head (10), with the V-groove of the cubes fitting into the power shift pawls (30) with the Galilean telescope system in the IN position,

4. Reassemble the cube shifting racks by following the procedure of surface located on the right side wall of the skeleton head over the left and right cube shifting racks (34 and 36). Check reference marks for their proper assembly. Place the pin projection of each cube bracket in the reamed hole in the skeleton head and the pivot hole axis in each cube. Carefully push the pin projection of the cube bracket down into the reamed pivot hole axis in each cube. Secure each Galilean eyepiece and objective lens cube brackets with two lockscrews (40). These lockscrews extend into tapped holes in the skeleton head right side wall.

7. Reassemble the Galilean eyepiece lens cube bracket (prism shift side) (19) on the flat outer face on the left side wall of the skeleton head. The integral pin projection is pushed into a reamed hole in the skeleton head and the pivot hole axis in the Galilean eyepiece lens cube (4). Secure the bracket with two lockscrews (51) which are inserted in countersunk clearance holes in the bracket and screwed into the tapped holes in the left side wall of the skeleton head.

8. Reassemble the Galilean objective lens cube bracket prism shift side (14) on the fiat outer face on the left side wall of the skeleton head. The integral pin projection is pushed into a reamed hole in the skeleton head and the pivot hole axis in the Galilean objective lens cube (5). Secure the bracket with two lockscrews (51) which are inserted in countersunk clearance holes in the bracket and screwed into tapped holes in the left side wall of the skeleton head.

9. Stand the skeleton head on a surface plate. With the use of a

indicator attachment, measure the front and rear sides of the upper face of the Galilean eyepiece lens cube (4). Release the two lockscrews (47) and move the upper pawl holder (31) and pawl (30) axially to obtain a true horizontal measurement. Secure the two lockscrews (47) when this is accomplished.

Follow the same procedure for the Galilean objective lens cube (5), measuring the front and rear sides of the upper face of the cube. Release the two lockscrews (47) and move the lower pawl holder (31) and pawl (30) axially to obtain a true horizontal measurement. Secure the two lockscrews (47) when this is accomplished.

This adjustment of the Galilean telescope mechanism is made so that upon the assembly of the lenses the optical line of sight of this system will be parallel to the optical line of sight of the remaining telescope systems. This prevents a pronounced general aberration which results when the pawl shoulders (31) and pawls (30) have a faulty alignment.

10. With the Galilean telescope system in the IN position, the left cube shifting rack (36) is placed with its integral stop against the lower side face of the Galilean objective lens cube bracket (13). In this position the power shift gear (35) is inserted in the circular recess engaging with the teeth in the right and left cube shifting racks (34 and 36). The reference mark on the gear pawls (30) for the IN position. When the right cube shifting rack (34) integral stop touches the Galilean objective-lens cube bracket (power shift side) (13), the V-grooves in the Galilean eyepiece lens and objective lens cubes (4 and 5) engage the power shift pawls (30) for the OUT position.

13. Reassemble the head prism and mount assembly by following the procedure outlined in steps 10 to 12 inclusive: Reassemble the left and right head prism side plates (23 and 25) to their respective sides of the head prism mount (11). Secure each head prism side plate with three lockscrews (46). These lockscrews extend into tapped holes in opposite sides of the head prism mount (11).

14. Place the head prism (1) in the head prism mount (11) between both head prism side plates (23 and 25), and allow the lower face of the head prism to engage under the lower left and right head prism mounting clamps (38 and 39).

15. Attach the upper left and right head prism mounting clamps (38 and 39) with two lockscrews (44) each. These lockscrews extend into the tapped holes in the head prism mount (11).

16. Reassemble the head prism shift mechanism by following the procedure outlined in Steps 16 to 18 inclusive: Reassemble the head prism mount shaft (37) with the inserted head prism mount lever key (67) in the head mount lever (12). Insert the taper pin (55) into the

should coincide with the reference mark on the right cube shifting rack.

11. Reassemble the power shift gear bracket (15), placing its integral pin projection in the bearing hole in the power shift gear (35), and extending it further into the reamed hole in the milled flat in the right side wall of the skeleton head. Secure the bracket with the two lockscrews (40). These lockscrews extend into tapped holes in the outer flat face on the right side wall of the skeleton head.

12. Check the movement of the Galilean telescope system in the IN and OUT position to ascertain whether the pawls engage properly. When the left cube shifting rack (36) integral stop touches the Galilean objective lens cube bracket (power shift side) (13), the V-grooves in the Galilean eyepiece dens and objective lens cubes (4 and 5), engage the power shift head prism mount lever (12) and the head prism mount pivot shaft (37) for their securement.

17. Place the head prism mount lever (12) in the upper fork section of the head prism actuating link (16) with the thickest part of the actuating link fork section facing outward. The long section of the head prism pivot shaft (37) should face inward. Line up the holes of both the head prism mount lever (12) and the fork section of the head prism actuating link (16) for the insertion of the link connecting shaft (18). The spot face end of the link connecting shaft remains outward. Insert the link connecting shaft in the lined up holes until its lower face is flush with the lower face of the head prism actuating link (16). Insert a headless

lockscrew (48) in a tapped hole in the side face of the head prism actuating link (16). This lockscrew extends into a spot face in the link connecting shaft (18).

18. Place the head prism actuating rack (65) in the lower fork section of the head prism actuating link (16). This actuating rack is placed with its integral stop projection facing outward. Line up the holes of the head prism actuating rack (65) and the fork section of the head prism actuating link (16). Insert the link connecting shaft (18) into the lined up holes, until its lower face is flush with the lower face of the head prism actuating link (16). The spot

22. Reassemble the Galilean eyepiece lens cube bracket (prism shift side) (19) over the head prism actuating link (16) to the flat outer face on the left side wall of the skeleton head. The integral pin projection is pushed into a reamed hole in the skeleton head and the pivot hole axis in the Galilean eyepiece lens cube (4). Secure the bracket with two lockscrews (51) which are inserted in countersunk clearance holes in the bracket and screwed into the tapped holes in the left side wall of the skeleton head.

23. Reassemble the Galilean objective lens cube bracket (prism shift side) (14) over the head prism

face end of the link connecting shaft (18) should remain outward. Insert a headless lockscrew (48) in a tapped hole in the side of the head prism actuating link (16). This lockscrew extends into a spot face in the link connecting shaft (18).

19. Remove the cube brackets (14 and 19) as described in paragraphs 3 and 4, Section 7E2.

20. Slide the head prism and mount assembly in the upper part of the skeleton head, sliding the head prism shade (20) downward in the opposite inner wall vertical grooves of the skeleton head (10). Lineup the holes of the head prism mount integral brackets (11) with the opposite inserted head prism mount shaft bushings (29).

21. Reassemble the prism tilt mechanism to the led side wall of the skeleton head. Place the head prism mount pivot shaft (37) in the head prism mount pivot shaft bushing (29) located in the left side wall of the skeleton head. Extend the shaft further into the head prism mount integral bracket (11) reamed holes and further into the head prism mount pivot shaft bushing (29) located in the right side wall of the skeleton head. Align the taper pin and lockscrew spot faces of the head prism mount pivot shaft (37) with the taper pin and lockscrew holes in the head prism Mount integral brackets (11). Insert the two lockscrews (5) into the tapped holes in the head prism mount integral brackets and spot faces in the head prism mount pivot shaft (37). Insert both taper pins (57) in the head prism mount integral brackets (11) and the head prism mount pivot shaft, with the head prism (1) in the depressed position.

actuating rack (65) to the flat outer face on the left side wall of the skeleton head. The integral pin projection is pushed into a reamed hole in the skeleton head and the pivot hole axis in the Galilean objective lens cube (5). Secure the bracket with two lockscrews (51) which are inserted in countersunk clearance holes in the bracket and screwed into tapped holes in the left side wall of the skeleton head.

24. Place the head prism actuating rack guide spacer (59) under the head prism actuating rack (65). Reassemble the head prism actuating rack guide (58) over the head prism actuating rack (65). Secure it in place with two short and two long lockscrews (52 and 53). These lockscrews are inserted into countersunk clearance holes in the rack guide and clearance holes in the rack guide spacer and screwed into tapped holes in the left side wall of the skeleton head.

25. Shift the Galilean telescope system to high power or the OUT position.

26. Reassemble the Galilean eyepiece lens mount housing (6) to the face of the Galilean eyepiece lens cube (4). Secure the housing with three lockscrew (4), which are inserted into clearance holes in the housing and screwed into tapped holes in the face of the Galilean eyepiece lens cube (4).

27. Clean all surface dust off both sides of the Galilean eyepiece lens (2). Reassemble the Galilean eyepiece lens with its mount (7), screwing it into the Galilean eyepiece lens mount housing (6). The Galilean eyepiece lens mount is placed in the housing with the

concave-convex lens cemented to a double concave negative lens facing the head prism in the IN position.

28. Clean the Galilean objective lens (3) using clean lens tissue. Also clean off the surface dust. Place this lens in the Galilean objective lens cube (5) with the longest radius facing downward in the IN position. Screw the Galilean objective lens retainer (8) on the threaded periphery of the Galilean objective lens cube (5). The Galilean objective lens (8) is clamped sufficiently to maintain a snug fit without any strain exerted on the lens. Apply spot solder to the Galilean objective lens retainer (8) and the Galilean objective lens cube (5) to prevent its unscrewing from the threaded periphery of the Galilean objective lens cube.

29. Check the Galilean telescope system and its mechanism for surface dust, using a small air bulb to blow off any surface dust and dirt. Check the head prism in similar manner.

30. Wrap the complete skeleton head assembly in clean lens tissue, until ready for its attachment to the upper flange of fifth reduced tube section (1. Figure 7-6).

F. UPPER TELESCOPE SYSTEM

7F1. Description of the upper telescope system Part I: first, second, third, fourth, and fifth reduced tube sections and 7th and 8th inner tube sections. The upper telescope system is divided into two individual assemblies, namely:

Part I: First, second, third, fourth, and fifth reduced tube sections and seventh and eighth inner tube sections.

Part II: Fourth, fifth, and sixth inner tube sections.

The upper telescope system is divided principally to permit familiarization as to nomenclature, description, disassembly, and reassembly. It is composed of three lenses, namely: a positive upper eyepiece lens doublet, a plano-convex telemeter lens, and a positive upper objective lens air-

Ill. No.	Drawing Number	Number Required	Nomenclature
7	P-1497-1	1	Waveguide section (silver soldered)
8	P-1505-5	2	Quadruple screw shaft ball bearings
9	P-1506-3	1	Upper eyepiece lens mount axial alignment screw
10	P-1506-5	12	Fifth reduced tube section lockscrews, upper and lower flanges
11	P-1506-7	2	Upper eyepiece lens

space doublet. This system is used in reverse to decrease the lower telescope system to a 6-power magnification. Figure 7-6 shows the upper telescope system assembly Part I. All bubble numbers of Sections 7F1, 3, and 4, refer to Figure 7-6 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1521-1	1	Fifth reduced tube Section
2	P-1475-6	1	Upper eyepiece lens
3	P-1478-3	1	Quadruple screw follower
4	P-1493-7	2	Quadruple screw shaft adjusting nuts
5	P-1493-8	1	Quadruple screw shaft adjusting nut washer
6	P-1495-4	1	Upper eyepiece lens clamp ring

			mount lockscrews
12	P-1506-12	1	Upper eyepiece lens clamp ring lockscrew
13	P-1506-30	1	Quadruple screw follower slot spreading screw
14	P-1506-33	2	Quadruple screw follower slot closing screws
15	P-1506-102	2	Fifth reduced tube section alignment dowel pins, upper and lower flanges
16	P-1522-1	1	Quadruple screw shaft
17	P-1522-2	1	Quadruple screw shaft thrust bushing
18	P-1522-4	1	Upper eyepiece lens mount
19	P-1523-8	1	Upper airline section
20	P-1521-2	1	Fourth reduced tube section
21	P-1482-3	1	Head prism drive shaft section
22	P-1497-1	1	Waveguide section continuation
23	P-1505-7	1	Head prism drive shaft universal coupling
24	P-1506-	6	Third and

	8		fourth reduced tube section lockscrews
25	P-1506-103	1	Third and fourth reduced tube section alignment dowel pin
26	P-1506-104	2	Head prism drive shaft universal coupling taper pins

Ill. No.	Drawing Number	Number Required	Nomenclature
27	P-1523-8	1	Upper air line section continuation
28	P-1501-2	1	Third reduced tube section
29	P-1475-7	1	Telemeter lens
30	P-1482-3	1	Head prism drive shaft section continuation
31	P-1495-1	1	Telemeter lens mount
32	P-1495-2	1	Telemeter lens clamp ring
33	P-1497-1	1	Waveguide section continuation
34	P-1506-12	1	Telemeter lens clamp ring lockscrew
35	P-1506-14	1	Angular alignment

Ill. No.	Drawing Number	Number Required	Nomenclature
55	P-1506-28	6	First reduced tube section and inner tube section reducing coupling flange lockscrews
56	P-1506-104	2	Head prism drive shaft universal coupling taper pins
57	P-1506-114	1	First reduced tube section and reducing coupling alignment dowel pin
58	P-1522-6	1	Head prism drive shaft spherical bushing
59	P-1523-8	1	Upper air line section

			lockscrew
36	P-1506-14A	1	Angular alignment lockscrew washer
37	P-1506-15	6	Second and third reduced tube section flange lockscrews
38	P-1506-20	2	Telemeter lens mount lockscrews
39	P-1506-21	1	Telemeter lens lockscrew
40	P-1506-105	1	Second and third reduced tube section alignment dowel pin
41	P-1523-8	1	Upper air line section continuation
42	P-1487-1	1	Second reduced tube section
43	P-1482-4	1	Head prism drive shaft section
44	P-1497-1	1	Waveguide section continuation
45	P-1505-1	1	Head prism drive shaft universal coupling
46	P-1506-15	6	First and second reduced tube section flange lock screws
47	P-4506-104	2	Head prism drive shaft universal coupling taper pins
			continuation
60	P-1485-2	1	Eighth inner tube section
61	P-1482-5	1	Head prism drive shaft section
62	P-1482-7	2	Head prism drive shaft rubber noise eliminators
63	P-1485-1	1	Eighth inner tube section lower end coupling
64	P-1487-3	1	Reducing coupling
65	P-1497-1	1	Waveguide section continuation
66	P-1506-23	24	Eighth inner tube section and reducing coupling lockscrews
67	P-1506-24	24	Eighth inner tube section lower part lockscrews
68	P-1506-58	2	Waveguide clamp bracket lockscrews
69	P-1513-8	1	Head prism drive shaft guide (soldered)
70	P-1514-1	2	Anti-reflection screen liners
71	P-1523-1	1	Waveguide clamp plate
72	P-1523-1A	2	Waveguide clamp plate pins
73	P-1523-2	1	Waveguide clamp bracket

48	P-1506-105	1	First and second reduced tube section alignment dowel pin
49	P-1522-6	1	Head prism drive shaft spherical bushing
50	P-1523-8	1	Upper air line section continuation
51	P-1489-1	1	First reduced tube section
52	P-1482-4	1	Head prism drive shaft section continuation
53	P-1497-1	1	Waveguide section continuation
54	P-1505-1	1	Head prism drive shaft universal coupling

74	P-1523-3	2	Waveguide clamp plate adjustment screws
75	P-1523-4	2	Waveguide clamp plate adjustment screw locknuts
76	P-1523-5	2	Air line straps (soldered)
77	P-1523-8	1	Upper air line section continuation
78	P-1523-10	2	Tape straps (soldered)
79	P-1484-3	1	Seventh inner tube section
80	P-1475-8A	1	Upper objective lens flint element
81	P-1475-8B	1	Upper objective lens crown element
82	P-1484-1	1	Upper objective lens mount
83	P-1484-2	1	Upper objective lens clamp ring
84	P-1484-4	1	Upper objective lens spacer ring
85	P-1497-1	1	Waveguide section continuation

Ill. No.	Drawing Number	Number Required	Nomenclature
86	P-1506-23	4	Upper objective lens

hole in the skeleton head frame (10, Figure 7-5), and the upper flange of the fourth reduced tube section (20). Each upper and lower flange is provided with six clearance holes for the insertion of lockscrews (10) with

			mount lockscrews
87	P-1506-25	48	Seventh inner tube section upper and lower port lockscrews
88	P-1506-26	1	Upper objective lens mount axial alignment lockscrew
89	P-1506-27	4	Upper objective lens clamp ring lockscrews
90	P-1523-8	1	Upper air line section continuation

a. Fifth reduced tube section. The fifth reduced tube section (1) is made of brass material with an over-all length of 6.870 inches: An undercut shoulder concentric with the bore projects outward from the upper and lower flanges, and forms an alignment support section to fit in a shallow counterbored alignment support section in the skeleton head, and at the lower part with the concentric bored alignment support section in the upper part of the fourth reduced tube section (20). Three bearing flanges are provided, with the outer circumference eccentric 0.125 inch from the optical centerline. The offset is necessary to provide sufficient space for the waveguide section (7) and for the optical system.

Each offset bearing flange is slotted rectangular in the thickest part, to provide a clearance space for the waveguide section. The lower and center flanges are provided with one additional hole provided in each of the three flanges for the upper air line section (19). The lower flange of the fifth reduced tube section is secured to the upper flange of the fourth reduced tube section (20) with six lockscrews (10).

1. Quadruple screw shaft thrust bushing. The quadruple screw shaft thrust bushing (17) is placed on the quadruple screw shaft (16) between both quadruple screw shaft ball bearings (8). The thrust bushing serves as a distance piece between both the above ball bearing center races.

2. Quadruple screw shaft. The quadruple screw shaft (16) is machined with a quadruple right-hand thread, 20 threads per inch with a 10 degrees 30' helix angle. It engages in the internal quadruple thread in the quadruple screw follower (3). A short threaded section below the quadruple threaded section carries two adjusting nuts (4) with a straight turned stem section. The stem section extends through two quadruple screw shaft ball bearings (8) and a quadruple screw shaft thrust bushing (17) into the upper part of a head prism drive shaft universal coupling (23). The quadruple screw shaft operates the quadruple screw follower (3), moving it vertically for operation with appropriate linkage on the skeleton head for the elevation and depression of the head prism (1, Figure 7-5).

3. Quadruple screw shaft adjusting nuts. The two quadruple screw shaft adjusting nuts (4) screw vertically on the short threaded section of the quadruple screw shaft (16). The lower adjusting nut establishes the

two reamed holes and counterbored recesses to accommodate, two quadruple screw aft ball bearings (8) of a push fit. The reamed holes and the counterbored recesses are located to the left of the rectangular slot. Two power shifting wire tape slots are located in each of the three flanges to the right of the rectangular waveguide slot. An axial slot and recess are provided near the center of this reduced tube section for an axial alignment screw (9) to provide sufficient movement for the upper eyepiece lens mount (18) to focus the upper eyepiece lens (2) for the removal of parallax in high power.

The upper and lower flanges are each supplied with a dowel pin (15), which reestablishes the factory alignment upon reassembly in a reamed

thrust elimination in the above shaft, when tightened against an adjusting nut washer (5) which contacts the upper ball bearing race (8). The upper adjusting nut serves as a locknut, preventing the lower adjusting nut from destroying the thrust setting.

4. Head prism drive shaft universal coupling. The head prism drive shaft universal coupling (23) provides a joint between the quadruple screw shaft (16) and the head prism drive shaft (21) of the fourth reduced tube

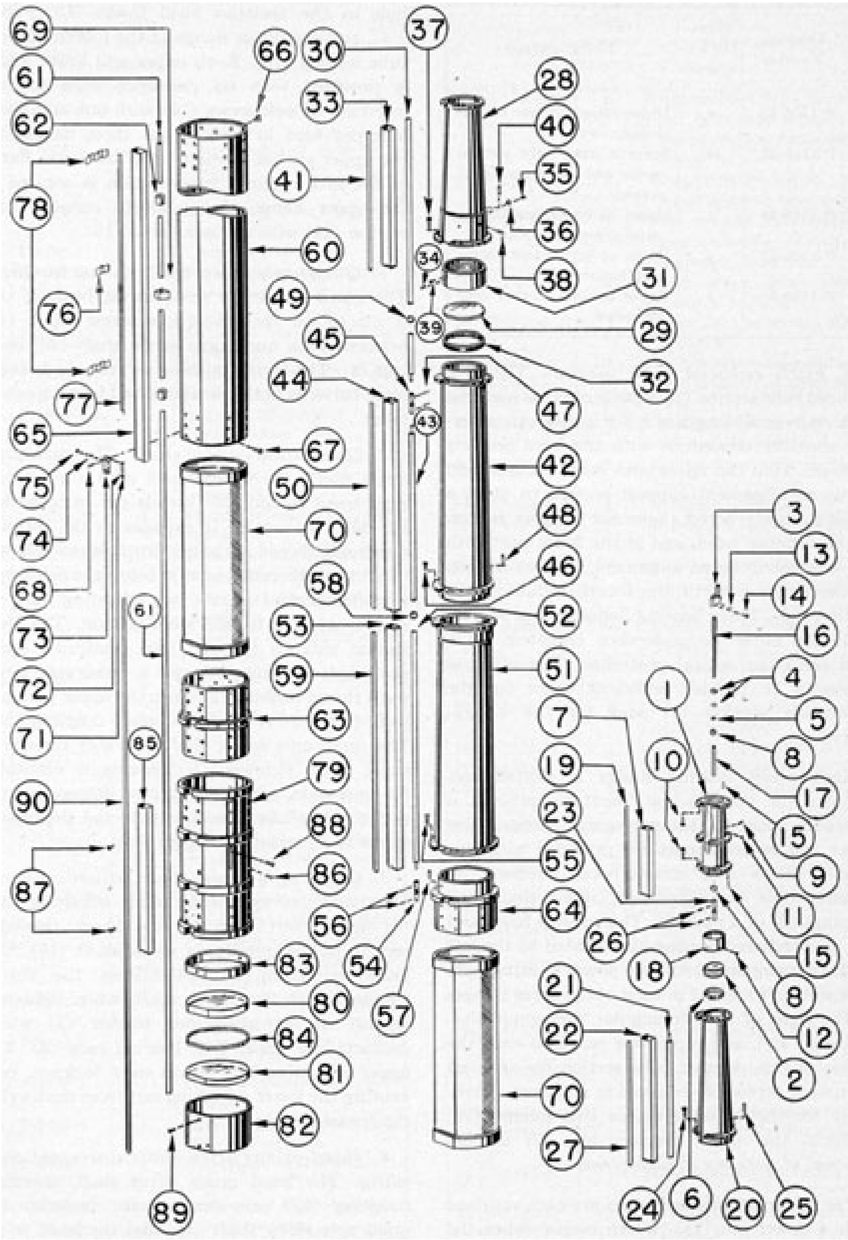

Figure 7-6. Upper telescope system assembly, Part I.

section (20). The coupling permits turning of the shafts at any angle within defined limits.

5. Thrust assembly. The thrust assembly is described as follows: The quadruple screw shaft (16) with two quadruple screw shaft adjusting nuts (4) and a quadruple screw shaft adjusting nut washer (5) are the main thrust adjusting factors. The stem section of the quadruple screw shaft extends through the center race of the upper quadruple screw shaft ball

The hub of the quadruple screw follower is provided with an offset arm. The offset arm forms the connection of the follower to the head prism actuating rack (65, Figure 7-5) of the skeleton head assembly. It is secured to the actuating rack with three lockscrews (41, Figure 7-5) and its alignment is maintained with two dowel pins (56, Figure 7-5). The quadruple screw shaft (16) and follower (3) provide a smooth positive drive for the elevation and depression of the head prism (1, Figure 7-5). This arrangement

bearing (8), mounted in a counterbored recess in the center flange of the fifth reduced tube section (1). The stem section extends farther through the quadruple screw shaft thrust bushing (17) and through the center race of the lower quadruple screw shaft ball bearing (8), mounted in a counterbored recess in the lower flange of the fifth reduced tube section. The upper part of the head prism drive shaft universal coupling (23) is secured to the quadruple screw shaft with a taper pin (26), and serves as a fixed thrust collar for the shaft in its lower part.

6. Thrust principle. The thrust principle is described in the following manner: When the lower adjusting nut (4) is tightened against the adjusting nut washer (5), the quadruple screw shaft (16) is drawn upward until the upper part of the universal coupling comes into contact with the center race of the lower ball bearing (8). The thrust bushing (17) between the two center races of the upper and lower ball bearings (8) provides the necessary separation between its center races to allow the ball bearings to revolve freely without any thrust in the shaft. Both ball bearings are installed back to back so that the thrust adjustment is taken up against each upper and lower outer race thrust shoulder.

7. Quadruple screw follower. The quadruple screw follower (3) is provided with a large hub and has an internal quadruple thread to engage on the quadruple eliminates staggered movement and creep, heretofore encountered with the use of the skeleton head gear train, the head prism shifting racks, and the shifting wire tapes for the prism tilt mechanism.

8. Upper eyepiece lens. The upper eyepiece lens (2) is made of two optical elements, consisting of a divergent meniscus flint element cemented to a double convex crown element, forming a positive upper eyepiece lens doublet. It is mounted in the upper eyepiece lens mount (18) and secured in the mount with a clamp ring (6). The clamp ring is provided with a lockscrew (12) to prevent its unscrewing from the mount.

9. Upper eyepiece lens mount. The upper eyepiece lens mount (18) carries the upper eyepiece lens (2) against its shoulder seat with a short threaded section to receive a threaded upper eyepiece lens clamp ring (6). The mount slides in the fifth reduced tube section (1), and it carries the upper eyepiece lens (2) axially for the removal of parallax. After final collimation, the mount is secured with two lockscrews (11) to maintain it in the adjusted position. An air channel provision is provided in the mount. Check Section A-A of the factory detail drawing. The air channel is a vertical drilled hole through the wall of the moat to provide a passage for nitrogen.

b. Fourth reduced tube section. The fourth reduced tube section (20) is made of brass material with an over-all length of 11.810-inches. An undercut shoulder projects outward from its lower flange to form an alignment support section of a sliding fit in

screw shaft (16). The hull is slotted and supplied with one slot spreading screw (13) and two slot closing screws (14). The slot spreading screw controls the separation of the slotted section, and the slot closing screws eliminate the lost motion of the quadruple screw follower when engaged on the quadruple screw threads of the shaft.

the straight bored section in the upper part of the third reduced tube section (28). Two bearing flanges are provided, one in the upper and one in the lower part with their outer circumference

eccentric 0.125 inch from the optical centerline. The rectangular waveguide slot, power shifting wire tape slots, and the air line clearance holes for the upper air line section continuation (27) are provided in both bearing flanges, similar to the fifth reduced tube section.

The upper flange is provided with a clearance hole located to the left of the rectangular waveguide slot for the upper part of the head prism drive shaft universal coupling (23). The lower flange has a radius cut through the flange periphery for sufficient clearance around the head prism drive shaft section (21). The upper flange is provided with six tapped holes and a reamed dowel pin hole. The upper flange of the fourth reduced tube section is secured to the lower flange of the fifth reduced tube section (1) with six lockscrews (10). The lower flange is provided with six clearance holes and an inserted dowel pin (25). The dowel pin engages in a reamed hole in the upper flange of the third reduced tube section (28) to reestablish the factory alignment upon reassembly.

sections. The rectangular waveguide slot, power shifting wire tape slots, and the air line clearance holes for the upper air line section continuation (41) are provided in both flanges similar to the fifth reduced tube section (1).

The upper flange has a radius cut through the flange periphery, for sufficient clearance around the head prism drive shaft section continuation (30) to the left of the rectangular waveguide slot. The lower flange is provided with a clearance hole for the same purpose, and its location is similar. The upper flange is provided with six tapped holes and a reamed dowel pin hole. The upper flange of the third reduced tube section is secured to the lower flange of the fourth reduced tube section (20) with six lockscrews (24). The lower flange is provided with six clearance holes, and an inserted dowel pin (40). The dowel pin engages in a reamed hole in the upper flange of the second reduced tube section (42) to reestablish the factory alignment upon reassembly-.

The periphery of this seduced tube section tapers outward from the

The periphery of this reduced tube section tapers outward from near the upper flange, down to its lower flange. The bore is tapered in similar manner to the periphery, maintaining a uniform wall thickness. The tapered bore is provided with anti-reflection threads. The wall of this reduced tube section is tapered to provide only the necessary wall body over the marginal or oblique done of light rays diverging downward from the upper eyepiece lens (2) to the telemeter lens (29).

The head prism drive shaft section (21) is attached to the lower part of the head prism drive shaft universal coupling (23) at the upper part of this reduced tube section with a taper pin (26). No lenses are carried in the fourth reduced tube section (20). This section serves to form a partial section with the third and fifth reduced tube sections to provide the necessary focal distance between the upper eyepiece lens and the telemeter lens.

c. Third reduced tube section. The third reduced tube section (28) is made of brass material with an overall length of 13 inches. Two bearing flanges are provided, one in the upper and one in the lower part, with an eccentric offset similar to the fourth and fifth reduced tube upper flange, down to a shoulder. The shoulder is raised slightly and tapers outward to the lower flange. The lower part has two counterbored sections, the small counterbored section carries the telemeter lens mount (31). A circumferential slot is provided in the wall of this counterbored section to supply a means for orientation of the telemeter lens by angular movement, with an angular alignment lock screw (35). The large counterbored section serves as an alignment support section to carry the upper alignment support section of the second reduced tube section upper flange (42)

The bore is straight at the upper end to receive the alignment support section of the fourth reduced tube section lower flange. The bore is tapered in similar manner to the periphery, maintaining a uniform wall thickness. The tapered bore is provided with anti-reflection threads. The wall of this reduced tube section is tapered to provide only the necessary wall body over the marginal or oblique cone of light rays diverging downward from the upper eyepiece lens (2) to the telemeter lens (29). The head prism drive shaft section continuation (30) extends the length of this reduced tube

section, with a spherical bushing (49) soldered to this drive shaft. The spherical bushing is located in the center of two assembled

d. Second reduced tube section. The second reduced tube section (42) is made of phosphor-bronze material with an over-all length of

flange faces of the third and second reduced tube section flanges (28 and 42).

1. Telemeter lens. The telemeter lens (29) is made of one optical element, and is a plano-convex crown element. The piano surface is graduated with a vertical line. Each large division on the telemeter lens corresponds to an angle of 1 degree at high power, and 4 degrees at low power. Each subdivision corresponds to an angle of 15' at high power, and 1 degree at low power. The convex radius is designed to permit convergence to the marginal or oblique cone of light rays so that they will enter the clear aperture of the upper objective lens (80 and 81). It is mounted in the telemeter lens mount (31) and secured in the mount with a clamp ring (32).

The clamp ring is secured with a lockscrew (34) to prevent it from unscrewing and destroying the adjustment of the telemeter lens (29) position in its mount. The telemeter lens is grooved on its periphery and slides into the mount (31) with the groove engaging a lockscrew (39). This prevents angular movement of the telemeter lens in the mount.

2. Telemeter lens mount. The telemeter lens mount (31) carries the telemeter lens (29) with the plano surface of the lens resting in a shoulder seat with a short threaded section. The threaded section receives a threaded telemeter lens clamp ring (32).

The mount can be rotated by the use of the angular alignment 21.940 inches. An undercut shoulder concentric with the bore projects outward from the upper flange and forms an alignment support section to fit in a large counterbored alignment support section in the lower part of the third reduced tube section (28). The lower flange has a similar alignment support section and is carried in the counterbored section in the upper part of the first reduced tube section (51). The outer circumference of both bearing flanges is eccentric 0.125-inch from the optical centerline.

The rectangular waveguide slot, power shifting wire tape slots, and the air line clearance holes for the upper air line section continuation (50) are provided in both bearing flanges similar to the fifth reduced tube section (1). The upper and lower flanges are each provided with clearance holes to the left of the rectangular waveguide slot. Each of these clearance holes carries half of the head prism drive shaft spherical bushing (58). The upper flange is provided with six tapped holes and a reamed dowel pin hole. The upper flange of the second reduced tube section is secured to the lower flange of the third reduced tube section with six lockscrews (46). The lower flange is provided with six clearance holes, and an inserted dowel pin (48). The dowel pin engages in a reamed hole in the upper flange of the 1st reduced tube section (51) to reestablish the factory alignment upon reassembly.

The periphery of this reduced tube section tapers outward from the upper flange to its lower flange. The bore is tapered in similar manner to the periphery,

lockscrew (35). The mount is secured with two lockscrews (38) after it is oriented during the procedure of final collimation. An air channel provision is provided in the mount. Check Section A-A of the factory detail drawing. The air channel is a vertical drilled hole through the shoulder seat in the mount, and a vertical groove cut below the depth of the internal thread, and the upper chamfer in the mount, to provide a passage for nitrogen.

The clamp ring is threaded on its periphery to engage in the internal threads in the mount, and is secured with a lockscrew (34) after clamping the telemeter lens sufficiently to prevent the clamp ring from unscrewing from the mount.

maintaining a uniform wall thickness, with an internal shoulder of nominal thickness at the upper end. The shoulder serves as a diaphragm to restrict the field of the telemeter lens to 8 degrees. The wall of this reduced tube section is tapered to conform to the marginal or oblique cone of light rays diverging downward to the telemeter lens (29).

e. First reduced tube section. The first reduced tube section (51) is made of cast phosphor-bronze material, with an over-all length of 21.244 inches. Two bearing flanges are provided, one at the upper and one at the lower

part, with the outer circumference eccentric 0.125 inch from the optical centerline. The rectangular waveguide slot, power shifting wire tape slots, and air line clearance holes for the upper air line section continuation (59) are provided in both bearing flanges similar to the fifth reduced tube section (1).

The upper and lower flanges are provided with clearance holes to accommodate the head prism drive shaft section (61) and head prism drive shaft section continuation (52) and are located to the left of the rectangular waveguide slot. The upper flange carries a portion of the soldered spherical bushing (58) assembled

anti-reflection threads. The wall of this reduced tube section is tapered to conform to the divergence of the marginal or oblique cone of light rays extending downward from the telemeter lens (29).

f. Eighth inner tube section. The eighth inner tube section (60) is made of seamless drawn brass tubing material with a flat 50 degrees minor chord, having an over-all length of 41 inches. The upper part of this inner tube section is secured to the lower alignment support section of the reducing coupling (64) with 24 lockscrews (66) while the lower part is secured to the upper alignment support section of the eighth inner tube section lower

on the head prism drive shaft section continuation (52). The head prism drive shaft section and its continuation are coupled together with ahead prism drive shaft universal coupling (54). The upper part of the head prism drive shaft universal coupling is secured to the lower stub end of the head prism drive shaft section continuation (52) with a taper pin (56).

The lower part of the universal coupling is secured to the upper end of head prism drive shaft section (61) with a taper pin (56). The coupling provides a joint to permit turning of the shafts at any angle within defined limits. The reduced tube section upper flange is provided with six tapped holes and a reamed dowel pin hole. The upper range of the first reduced tube section (51) is secured to the lower flange of the second reduced tube section with six lockscrews (46). The lower flange is provided with six clearance holes and, an inserted dowel pin (57). The dowel pin engaging a reamed hole in the bearing flange of the reducing coupling (64) to reestablish the factory alignment upon reassembly.

The periphery of this reduced tube section tapers outward from a straight turned shoulder down to the lower flange. In the lower part the bore is straight turned a sufficient distance to allow for the upper alignment support section of the reducing coupling, (64). The upper part is provided with a counterbored section to receive the lower alignment support section of the second reduced tube section end coupling (63) with 24 lockscrews (67).

Two anti-reflection screen liners (70) with a flat 50 degrees minor chord of similar length are installed in this eighth inner tube section. Because of the flat 50 degrees minor chord of the inner tube section tubing, it is impossible to machine a concentric anti-reflection thread. This necessitates the installation of anti-reflection screen liners.

1. Reducing coupling. The reducing coupling (64) is made of phosphor-bronze material with an overall length of 5 inches. An undercut shoulder concentric with the mechanical axis of the outer tube bore projects upward from the bearing flange, and is of sufficient length to form an alignment support section for the straight alignment support section in the lower part of the first reduced tube section. The outer circumference of the bearing flange is eccentric 0.125 inch from the optical centerline. The offset is necessary to provide sufficient space for a rectangular slot for the waveguide section continuation (65) and also to establish sufficient space for the optical system.

Two power shifting wire tape slots are located in the flange to the right of the rectangular waveguide slot. A clearance hole located to the left of the rectangular waveguide slot is provided for the head prism drive shaft section (61). An air line clearance hole is provided for the upper air line section continuation (77) located on the right side of the rectangular waveguide slot. The flange is provided with six tapped holes for

(42). The bore is tapered in similar manner to the periphery, maintaining a uniform wall thickness, except where otherwise specified. The tapered bore is provided with lockscrews (55) and a reamed hole to receive an alignment dowel pin (57) of the first reduced

tube section (51) to reestablish the factory alignment upon reassembly.

The lower part of this coupling is provided with a 3-inch long alignment support section of uniform thickness. It is machined with an offset of 0.125 inch from the mechanical axis of the outer tube, and is provided with a flat 50 degrees minor chord. It is designed to carry the upper part of the eighth inner tube section (60) which is a brass tube section with a flat 50 degrees minor chord. This lower alignment support section is provided with 24 equally spaced tapped holes for lockscrews (66) and it secures the upper part of the eighth inner tube section on the lower part of the reducing coupling.

2. Anti-reflection screen liners. The two anti-reflection screen liners (70) are made up of two diaphragm rings with a flat 50 degrees minor chord. The screen mesh envelope is made of 30 X 30 phosphor-bronze mesh. Each mesh envelope has a diaphragm ring soldered to the upper and lower part, with an over-all length of 17.250 inches.

3. Head prism drive shaft section. The head prism drive shaft section (61) extends the entire length of the eighth inner tube adjustment screws (74) of sufficient length to carry locknuts (75).

The bracket is provided with two holes of sufficient depth to accommodate two pin projections (72) of the waveguide clamp plate (71). The clamp plate with the pin projections provides a means of clamping the waveguide against the left side of the rectangular waveguide slot. The adjustment screws (74) contact the clamp plate, with the adjustment locknuts maintaining the waveguide snugly in the rectangular slot.

5. Upper air line section continuation. The upper air line section continuation (77) extends the entire length of the eighth inner tube section (60). Two air line straps (76) are soldered on the periphery of the eighth inner tube section, and located in the upper and lower parts, in the vertical centerline of air line clearance holes in the bearing flanges.

6. Tape straps. The two tape straps (78) are soldered to the periphery of the eighth inner tube section (60) and are located at the upper and lower parts, in the vertical centerline of the tape slots in both coupling bearing flanges. These straps preserve vertical guidance

section. It is supported with a head prism drive shaft guide (69) soldered on the flat 50 degrees minor chord wall of the eighth inner tube section (60) and located in the central part. The head prism drive shaft guide (69) is a flat piece of brass, provided with a clearance hole. It supports the head prism drive shaft section (61) in the center of the eighth inner tube section. Two head prism drive shaft rubber noise eliminators (62) are assembled over the drive shaft, one on the upper and one on the lower part of the head prism drive-shaft section (61) of the eighth inner tube section. These noise eliminators prevent noise caused by the vibration of the head prism drive shaft in the shaft guides.

4. Waveguide clamp bracket. The waveguide clamp bracket (73) is a small bracket arrangement on the lower part of the eighth inner tube section, flush with the lower face. It is secured to the right side on the flat 50 degrees minor chord section with two lockscrews (68). The bracket is provided with two tapped holes for the insertion of two waveguide clamp plate

to the change of power shifting wire tapes (35, Figure 7-11).

7. Eighth inner tube section lower end coupling. The eighth inner tube section lower end coupling (63) is made of phosphor-bronze material with an over-all length of 6.500 inches. This coupling is provided with a center bearing flange with two 3-inch long alignment support sections of uniform wall thickness, located on each side of the center bearing flange. Each alignment support section is provided with an offset of 0.125 inch from the outer circumference of the center bearing flange. The offset is necessary to provide sufficient space for the waveguide section continuation (65) and also to establish sufficient space for the optical system. This coupling forms a joint between the lower part of the eighth inner tube section (60) and the upper part of the seventh inner tube section (79). Each coupling alignment support section is similar to the wall of each inner tube section, except that it is a push fit in the inner tube section with a flat 50 degrees minor chord.

The bearing flange is provided with a clearance hole to accommodate the head prism drive shaft section (61) located to the left of the rectangular waveguide slot. A radius is cut through the flange on the right side of the rectangular waveguide slot to allow

which is a double convex crown element. These form an air space doublet. Both the flint and crown elements have a flat 50 degrees minor chord section ground off. This is a result of the same principle involved with the mechanical parts, to allow clearance for the waveguide. It is mounted in the upper objective

clearance for the upper air line section continuation (90).

Two power shifting wire tape slots are located in the bearing flange to the right of the rectangular waveguide slot. The upper alignment support section is provided with 24 equally spaced tapped holes for lockscrews (67). These lockscrews secure the lower part of the eighth inner tube section on the upper alignment support section. The lower alignment support section is provided with similar tapped holes for lockscrews (87). These lockscrews secure the upper part of the seventh inner tube section on the lower alignment support section.

g. Seventh inner tube section. The seventh inner tube section (79) is made of phosphor-bronze material with an overall length of 13 inches. Four bearing flanges are provided, with the outer circumference eccentric 0.125-inch from the optical centerline. The rectangular waveguide slot, power shifting wire tape, slots, clearance holes for the head prism drive shaft section (61), and the air line radius clearance provision are made in each of the four bearing flanges similar to the eighth inner tube section lower end coupling (63). The three undercut sections are of similar design as the alignment support sections of the eighth inner tube section lower end coupling except that the irregular periphery of each is later.

The undercut center section of this inner tube section is provided with an axial slot, to lens mount (82) and secured in the mount with a clamp ring (83). The clamp ring is secured in the mount with four lockscrews (89).

2. Upper objective lens mount. The upper objective lens mount (82) carries the upper objective lens (80 and 81) separated with a spacer ring (84). The mount is designed with a flat 50 degree minor chord, and is a sliding fit in the seventh inner tube section. The mount moves the upper objective lens axially to effect sufficient ravel of the eyepiece lens to within limits of plus 1 1/2 diopters and minus 3 diopters. After final collimation, the mount is secured with four lockscrews (86) to retain it in the adjusted position. An air channel provision is provided in the mount. Check Section A-A of the factory detail drawing. The air channel is a wide shallow vertical slot extending in the wall of the mount to a shallow depth in its shoulder seat, to provide a passage for nitrogen. The shoulder seat of the mount is fitted to the optical crown element, because of the ground off flat 50 degrees minor chord section.

3. Upper objective lens spacer ring. The upper objective lens spacer ring (84) is placed between the flint and crown elements of the upper objective lens (80 and 81). It provides an air spacer between both elements. Lenses of large diameter cannot be cemented because of the difference in the thermal expansion coefficients of crown and flint glasses. The spacer ring is fitted to both contact faces of the optical elements as result of a ground off flat 50 degrees minor chord section.

allow an exterior means of moving the upper objective lens mount with the use of the axial alignment lockscrew (88). The upper and lower part of this inner tube section is a push fit on the lower alignment support section of the eighth inner tube section lower end coupling, and the upper alignment support section of the sixth inner tube section upper end coupling, and each end is secured with 24 lockscrews (87).

1. Upper objective lens. The upper objective lens (80 and 81) is made of two optical elements. The first is a divergent meniscus-flint element separated with a spacer ring (84) from the second

4. Upper objective lens clamp ring. The upper objective lens clamp ring (83) lamps the upper objective lens to the shoulder seat in the mount with sufficient tension, after the insertion of four lockscrews (89). The clamp ring is a sliding fit in the mount, and is designed with a flat 50 degrees minor chord. The clamp ring in contact with the flint element is fitted as a result of the flat 50 degrees minor chord section ground off this element.

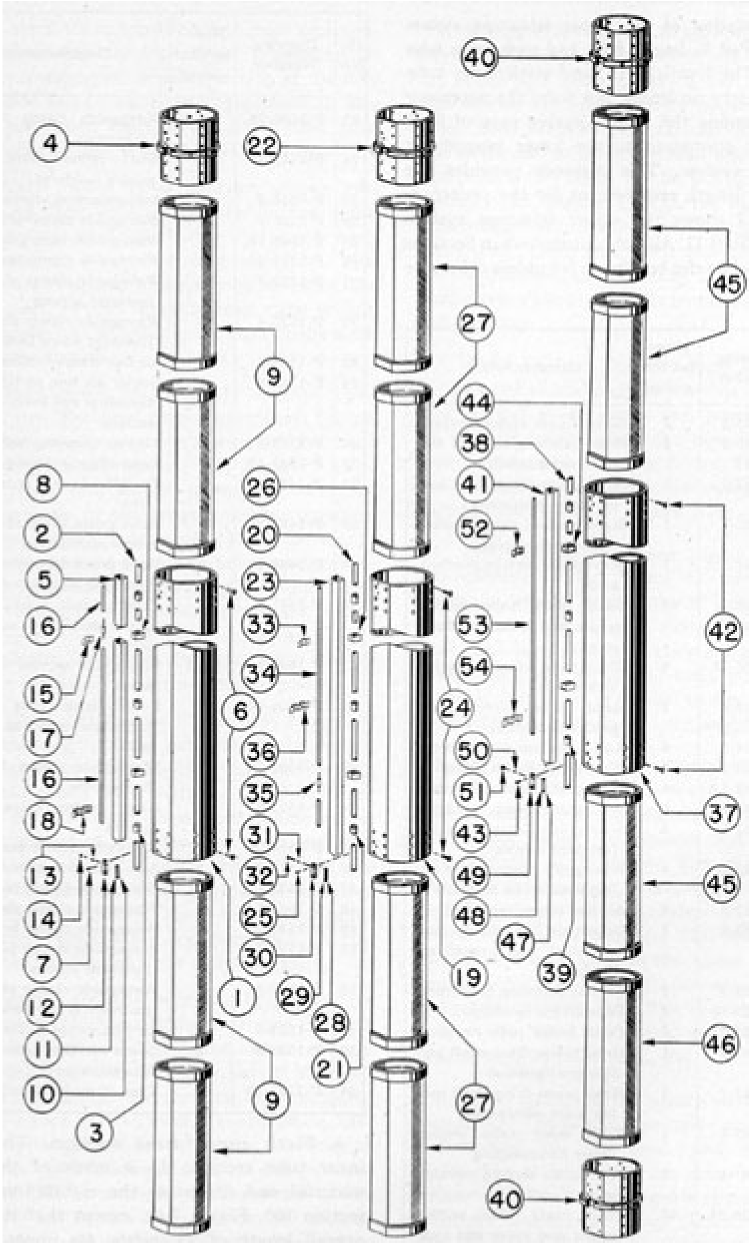

Figure 7-7. Upper telescope system assembly, Part II.

7F2. Description of the upper telescope system assembly Part II: fourth, fifth, and sixth inner tube sections. The fourth, fifth, and sixth inner tube sections carry no lenses, but form the necessary wall to confine the interobjective rays of light extending downward to the lower magnifying telescope system. This distance provides the necessary length requirement for the periscope. Figure 7-7 shows the upper telescope system assembly Part II. All bubble numbers in Sections 7F2, 5, and 6 refer to Figure 7-7 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
25	P-1506-58	4	Waveguide clamp bracket lockscrews
26	P-1513-8	2	Head prism drive shaft guides (soldered)
27	P-1514-2	4	Anti-reflection screen liners

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1485-3	1	Sixth inner tube section
2	P-1482-5	1	Head prism drive shaft section continuation
3	P-1482-7	3	Head prism drive shaft rubber noise eliminators
4	P-1485-1	1	Sixth inner tube section upper end coupling
5	P-1497-1	1	Waveguide section continuation
6	P-1506-24	48	Sixth inner tube section upper and lower end lockscrews
7	P-1506-58	4	Waveguide clamp bracket lockscrews
8	P-1513-8	2	Head prism drive shaft guides (soldered)
9	P-1514-2	4	Anti-reflection screen liners
10	P-1523-1	2	Waveguide clamp plates
11	P-1523-1A	4	Waveguide clamp plate pins
12	P-1526-2	2	1 Waveguide clamp brackets
13	P-1523-	4	Waveguide
28	P-1523-1	2	Waveguide clamp plates
29	P-1523-1A	4	Waveguide clamp plate pins
30	P-1523-2	2	Waveguide clamp brackets
31	P-1523-3	4	Waveguide clamp plate adjustment screws
32	P-1523-4	4	Waveguide clamp plate adjustment screw locknuts
33	P-1523-5	3	Air line straps (soldered)
34	P-1523-8	1	Center air line section continuation and lower air line section
35	P-1523-9	1	Air line coupling (soldered)
36	P-1523-10	1	Tape strap (soldered)
37	P-1485-3	1	Fourth inner tube section
38	P-1482-5	1	Head prism drive shaft section continuation
39	P-1482-7	3	Head prism drive shaft rubber noise eliminators
40	P-1485-1	2	Fourth inner tube section upper and lower end couplings
41	P-1497-1	1	Waveguide section

	3		clamp plate adjustment screws
14	P-1523-4	4	Waveguide clamp plate adjustment screw locknuts
15	P-1523-5	4	Air line straps (soldered)
16	P-1523-8	1	Upper air line section continuation and center air section
17	P-1523-9	1	Air line coupling (soldered)
18	P-1523-10	2	Tape straps (soldered)
19	P-1485-3	1	Fifth inner tube section
20	P-1482-5	1	Head prism drive shaft section continuation
21	P-1482-7	3	Head prism drive shaft rubber noise eliminators
22	P-1485-1	1	Fifth inner tube section upper end coupling
23	P-1487-1	1	Waveguide section continuation
24	P-1506-24	48	Fifth inner tube section upper and lower end lockscrews

			continuation
42	P-1506-24	48	Fourth inner tube section lockscrews upper and lower ends
43	P-1506-58	4	Waveguide clamp bracket lockscrews
44	P-1513-8	2	Head prism drive shaft guides
45	P-1514-2	3	Anti-reflection screen liners
46	P-1514-3	1	Anti-reflection screen liner
47	P-1523-1	2	Waveguide clamp plates
48	P-1523-1A	4	Waveguide clamp plate pins
49	P-1523-2	2	Waveguide clamp brackets
50	P-1523-3	4	Waveguide clamp plate adjustment screws
51	P-1523-4	4	Waveguide clamp plate adjustment screw locknuts
52	P-15232-5	4	Air line straps (soldered)
53	P-1523-8	1	Lower air line section continuation
54	P-1523-10	1	Tape strap (soldered)

a. Sixth inner tube section. The sixth inner tube section (1) is made of the same material and design as the

eighth inner tube section (60, Figure 7-6), except that it has an overall length of 75 inches. Its upper part is secured on the lower alignment support section

of the sixth inner tube section upper end coupling (4), while its lower part is secured on the upper alignment support section of the fifth inner tube section upper end coupling (22). The upper and lower ends of the sixth inner tube section are secured with 48 lockscrews (6).

1. Sixth inner tube section upper end coupling. The sixth inner tube section upper end coupling (4) is identical to the eighth inner tube section lower end coupling (63). This upper end coupling forms a joint between the lower part of the seventh inner tube section (79, Figure 7-6) and the upper part of the sixth inner tube section (1).

2. Head prism drive shaft section continuation. The head prism drive shaft section continuation (2) is an extension of the head prism drive shaft section (61, Figure 7-6) of the seventh and eighth inner tube sections. It is made up of two lengths welded together, with an overall length of 318.47 inches. It extends downward from the lower part of the first reduced tube section (51, Figure 7-6) to the upper part of the first inner tube section (31, Figure 7-10). At each succeeding inner tube section it carries an illustration bubble number denoting its continuation reference.

The shaft continuation (2) extends downward the entire length of the

4. Waveguide clamp brackets. The two waveguide clamp brackets (12) are secured to the upper and lower parts of the sixth inner tube section (1) flush with its upper and lower faces. Both brackets are retained on the right side of the 50 degrees minor chord wall with two lockscrews each (7). Refer to the waveguide clamp brackets (73, Figure 7-6) of the eighth inner tube section (60), as the two waveguide clamp plates (10), their pins (11), waveguide clamp plate adjustment screws (13), and the adjustment screw locknuts (14) are identical in purpose and function.

5. Tape straps. The two tape straps (18) are soldered to the periphery of the sixth inner tube section at its upper and lower parts, in the vertical centerline of the tape slots in the upper end coupling bearing flange. These straps provide vertical guidance to the change of power shifting wire tapes (35, Figure 7-11).

6. Anti-reflection screen liners. The four anti-reflection screen liners (9) are each 17 inches in length. Refer to the anti-reflection screen liners (70, Figure 7-6), of the eighth inner tube section (60) as they are identical in construction and serve the same purpose and function. All four of these screen liners are installed in the sixth inner tube section (1).

sixth inner tube section (1). It is supported to this inner tube section with two head prism drive shaft guides (8) soldered on the flat 50 degrees minor chord wall. These guides merely consist of flat pieces of brass provided with a clearance hole, with the outer circumference conforming to the, contour of the inner tube section periphery. Three head prism drive shaft noise eliminators are assembled on this shaft continuation at three equal places.

3. Center air line section. The center air line section (16) has a soldered air line coupling (17) at its upper end. This center section extends downward from near the upper part of the sixth inner tube section through three soldered air line straps (15) to form a continuation (34) at the upper part of the fifth inner tube section (19). The upper undercut section of the air line coupling (17) connects in the lower end of the upper air line section continuation (16) secured to the upper part of the sixth inner tube section periphery with a soldered air line strap (15).

b. Fifth inner tube section. The fifth inner tube section (19) is made of the same material and design as the eighth inner tube section (60, Figure 7-6) except that it has an overall length of 75 inches. The upper end of this inner tube section is secured on the lower alignment support section of the fifth inner tube section upper end coupling (22) while at its lower end it is secured to the upper alignment support section of the fourth inner tube section upper end coupling (40). The upper and lower parts of the fifth inner tube section are each secured with 24 lockscrews (24).

1. Head prism drive shaft section continuation. The head prism drive shaft section continuation (20), two head prism drive shaft guides (26), three head prism drive shaft noise eliminators (21), two waveguide clamp brackets (30), two waveguide clamp plates (28), their pins (29), four waveguide clamp plate adjustment screws (31), and four waveguide clamp

plate adjustment screw locknuts (32) are similar to the sixth inner tube section (1).

2. Center air line section continuation. The center air line section continuation (34) is retained to the periphery of the fifth inner tube section (19) with three soldered air line straps (33) equally distributed. The air line section continuation (34) is an extension of the center air line section (16) and is soldered on the air line coupling

1. Head prism drive shaft section continuation. The head prism drive shaft section continuation (38) is an extension of the head prism drive shaft section (61, Figure 7-6) of the eighth inner tube section and extends the entire length of the fourth inner tube section. The drive shaft is supported to the fourth inner tube section, with two head prism shaft guides (44) soldered to the flat 50 degrees minor chord wall. Each guide consists of a flat piece of brass provided with a

(35) at its lower end in the lower part of the fifth inner tube section. The lower air line section (34) attaches on the lower undercut section of the air line coupling (35) and is secured to the lower periphery wall of the fifth inner tube section (19) with one soldered air line strap (33).

3. Tape strap. The tape strap (36) is soldered to the periphery of the fifth inner tube section in the center and in the vertical centerline of the tape slots in the coupling bearing flange to preserve vertical guidance of the change of power shifting wire tapes (35, Figure 7-11).

4. Anti-reflection screen liners. The four anti-reflection screen liners (27) are installed in the fifth inner tube section (19). Refer to anti-reflection screen liners of the sixth and eighth inner tube sections (1 and 60, Figure 7-6) as they are identical in construction and serve the same purpose and function.

5. Fifth inner tube section upper end coupling. The left inner tube section upper end coupling (22) is identical to the eighth inner tube section lower end coupling (63, Figure 7-6). This upper end coupling forms a joint between the lower part of the sixth inner tube section (1) and the upper part of the fifth inner tube section (19).

o. Fourth inner tube section. The fourth inner tube section (37) is made of the same material and design as the eighth inner tube section (60, Figure 7-6) except that it has an over-all length of 73.750 inches. The upper part of this inner tube section is secured on the upper alignment support section of the fourth inner tube section upper end clearance hole. Three head prism drive shaft noise eliminators (39) are equally spaced over the drive shaft.

2. Waveguide clamp brackets. The two waveguide clamp brackets (49) are secured to the upper and lower parts of the fourth inner tube section (37) flush with the upper and lower faces. Both clamp brackets are retained on the right side of the flat 50 degrees minor chord wall with two lockscrews each (43). Refer to the waveguide clamp brackets (73, Figure 7-6) of the eighth inner tube section (60) for details as well as for the two waveguide clamp plates (47), their pins (48), four waveguide clamp plate adjustment screws (50), and the four waveguide clamp plate adjustment screw locknuts (51) which are identical.

3. Lower air line section continuation. The lower air line section continuation (53) is an extension of the lower air line section (34) of the fifth inner tube section (19). It extends the entire length of the fourth inner tube section (37), and is secured to its periphery with four soldered air line straps (52) equally distributed.

4. Tape strap. The tape strap (54) is soldered on the periphery of the fourth inner tube section (37) located in the central part. It is located in the vertical centerline of the tape slots in the coupling bearing flanges. This strap provides vertical guidance to the change of power shifting wire tapes (35, Figure 7-11).

5. Anti-reflection screen liners. Four antireflection screen liners (45 and 46) are installed. in the fourth inner tube section (37). Three of these

coupling (40) while its lower part is secured on upper alignment support section of the fourth inner tube section lower end coupling (40). The upper and lower parts of the fourth inner tube section are each secured with 24 lockscrews (42).

screen liners (45) are identical in length to the screen liners (27) located in the fifth inner tube section (19). The fourth screen liner (46) is 15.750 inches in length. Refer to the anti-reflection screen liners (70, Figure 7-6) of

the eighth inner tube section (60), as they are identical.

6. Fourth inner tube section upper end coupling. The fourth inner tube section upper end coupling (40) is identical to the eighth inner tube section lower end coupling (63, Figure 7-6). This upper end coupling forms a joint between the lower part of the fifth inner tube section (19) and the upper part of the fourth inner tube section (37).

7. Fourth inner tube section lower end coupling. The fourth inner tube section lower end coupling (40) is identical to the eighth inner tube section lower end coupling (63, Figure 7-6). This lower end coupling forms a joint between the lower part of the fourth inner tube section (37) and the upper part of the third inner tube section (1, Figure 7-10).

7F3. Disassembly of Part I. The upper telescope system assembly Part I is disassembled in the following manner:

1. Remove the head prism drive shaft universal coupling taper pin (26) from the upper part of the head prism drive shaft universal coupling (23) and the quadruple screw shaft (16).

2. Remove the quadruple screw follower (3), unscrewing it from the lens mount axial alignment screw (9). The two lockscrews and the alignment screw are unscrewed from tapped holes in the upper eyepiece lens mount (18).

6. Remove the upper eyepiece lens mount (18), sliding it out from the lower end of the fifth reduced tube section (1). Remove the upper eyepiece lens mount with the upper eyepiece lens (2), the upper eyepiece lens clamp ring (6), and its lockscrew (12).

7. Remove the lockscrew (12) from the upper eyepiece lens clamp ring (6). This lockscrew is unscrewed from the tapped hole in the upper eyepiece lens clamp ring and carried out of the countersunk clearance hole in the upper eyepiece lens mount (18).

8. Remove the upper eyepiece lens clamp ring (6), unscrewing it with a special wrench from the upper eyepiece lens mount (18).

9. Place the upper eyepiece lens mount (18) on a piece of clean lens tissue, resting it on its upper face. Use a piece of clean lens tissue on the lower face of the upper eyepiece lens (2) and press downward on the lens tissue and the upper eyepiece lens to remove it from the mount. After removal, wrap the upper eyepiece lens in a piece of clean lens

quadruple screw shaft (16).

3. Remove the quadruple screw shaft (16), carrying it out of the outer and lower flange quadruple screw shaft ball bearings (8) and the quadruple screw shaft thrust bushing (17). Remove bath quadruple screw shaft adjusting nuts (4) an the quadruple screw shaft adjusting nut washer (5) from the quadruple screw shaft (16). The quadruple screw shaft thrust bushing (17) remains in place, between the center and lower flanges of the fifth reduced tube section.

4. The two quadruple screw shaft ball bearings (8), and the quadruple screw shaft thrust bushing (17) should not be removed unless corroded or damaged. Should replacement be required, it will be necessary to tap out both ball bearings (8) and the thrust bushing (17).

5. Remove the two upper eyepiece lens mount lockscrews (11) and one upper eyepiece

tissue, and store it in a dry container to prevent scratches and breakage.

10. Separate the lower part of the fourth reduced tube section (20) from the upper part of the third reduced tube section (28). Remove the six lockscrews (24) from the lower flange of the fourth reduced tube section and the upper flange of the third reduced tube section. These lockscrews are unscrewed from tapped holes in the upper flange of the third reduced tube section (28). Remove the fourth reduced tube section from the third reduced tube section, carrying it off axially.

11. Separate the lower part of the third reduced tube section (28) from the upper part of the second reduced tube section (42). Remove the six lockscrews (37) from the lower flange of the third reduced tube section. These lockscrews are unscrewed from tapped holes in the upper flange of the second reduced tube section. Remove the third reduced tube section from

the second reduced tube section, carrying it off axially.

12. Remove the two telemeter lens mount lockscrews (38) and one angular alignment lockscrew (35). These two lockscrews and the angular alignment lockscrew are unscrewed from tapped holes in the telemeter lens mount (31).

13. Place the third reduced tube section (28) so that it is resting on its lower face to allow the telemeter lens mount (31) with the telemeter lens (29), telemeter lens clamp ring

19. Separate the lower part of the reducing coupling (64) from the upper part of the eighth inner tube section (60). Remove the 24 lockscrews (66) from the eighth inner tube section and the reducing coupling. These lockscrews are unscrewed from tapped holes in the lower alignment support section of the reducing coupling. Remove the reducing coupling from its connection in the upper part of the eighth inner tube section, carrying it off axially.

(32), and its lockscrew (39) to slide out

14. Remove the telemeter lens clamp ring lockscrew (34). This lockscrew is unscrewed from the tapped hole in the telemeter lens mount (31) and the partially tapped hole in the telemeter lens-clamp ring (32).

15. Remove the telemeter lens clamp ring (32), unscrewing it from the telemeter lens mount (31) by the use of a special wrench.

16. Place the telemeter lens mount (31) on a clean piece of lens tissue, resting the lower face of the mount on the lens tissue. Place a piece of clean tissue on the upper face of the telemeter lens (29) and push the telemeter lens down on the lens tissue easily. After removal, wrap the telemeter lens in a piece of clean lens tissue and store it in a dry container to prevent scratches and breakage

17. Separate the lower part of the second reduced tube section (42) from the upper part of the first reduced be section (51). Remove the six lockscrews (46) from the lower flange of the second reduced tube section. These lockscrews are unscrewed from tapped holes in the upper flange of the first reduced tube section. Remove the second reduced tube section from the first reduced tube section, carrying it off axially.

18. Separate the lower part of the first reduced tube section (51) from the upper part of the reducing coupling (64). Remove the six lockscrews (55) from the lower flange of the first reduced tube section. These lockscrews are unscrewed from tapped holes in the

20. Separate the lower part of the eighth inner tube section (60) from the upper alignment support section of the eighth inner tube section lower end coupling (63). Remove the two lockscrews (68) from the waveguide clamp bracket (73). These lockscrews are unscrewed from tapped holes in the lower part of the eighth inner tube section flat 50 degrees minor chord wall, and the upper alignment support section of the eighth inner tube section lower end coupling. Remove the clamp bracket (73), carrying with it the two waveguide clamp plate adjustment screws (74) and the two waveguide clamp plate adjustment screw locknuts (75). Remove the 24 lockscrews (67) from the lower end of the eighth inner tube section. These lockscrews are unscrewed from tapped holes in the upper alignment support section of the eighth inner tube section lower end coupling. Remove the eighth inner tube section from the eighth inner tube section lower end coupling, carrying it off axially.

21. Remove the two anti-reflection screen liners (70) from the inside of the eighth inner tube section (60). Use a special ramming plunger jig (Figure 7-8) to force out the antireflection screen liners.

22. Separate the lower alignment support section of the eighth inner tube section lower end coupling (63) from its connection in the upper part of the seventh inner tube section (79). Remove the 24 lockscrews (87) from the upper part of the seventh inner tube section. These lockscrews are unscrewed from tapped holes in the lower alignment support section of the eighth inner tube section lower end coupling. Remove the eighth inner

reducing coupling bearing flange. Remove the first reduced tube section from the reducing coupling, carrying it off axially.

tube section lower end coupling from the upper part of the seventh inner tube section, carrying it out axially.

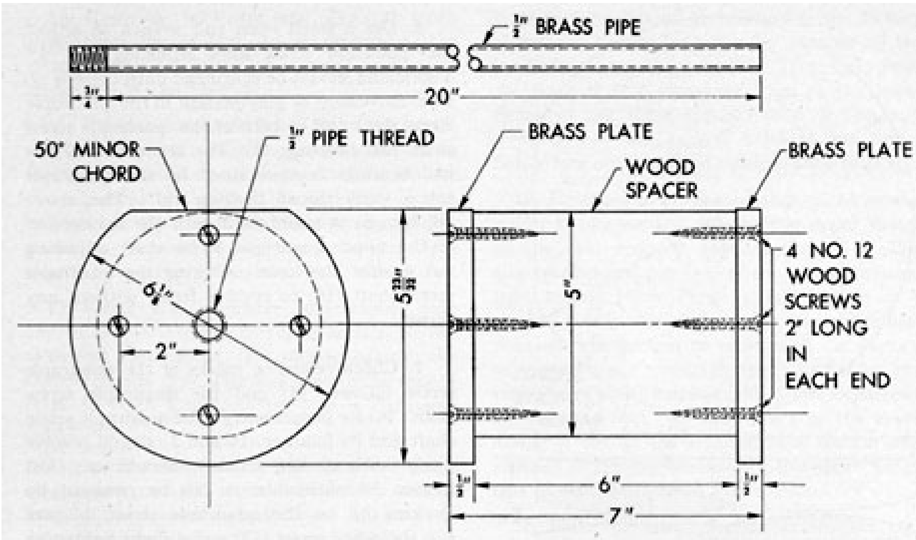

Figure 7-8. Special ramming plunger jig.

23. Remove the four upper objectives lens mount lockscrews (86). These lockscrews are unscrewed from tapped holes in the upper objective lens mount (82) and carried out of countersunk clearance holes in the seventh inner tube section (79).

24. Remove the upper objective lens mount axial alignment lockscrew (88). This alignment lockscrew is unscrewed from a tapped hole in the upper objective lens mount (82) and carried out of the axial slot in the seventh inner tube section (79).

25. Place a special upper objective lens mount removal jig in the two holes provided in the lower part of the upper objective lens mount (82) to slide the upper objective lens mount out of either end of the seventh inner tube section (79).

28. Place the upper objective lens mount (82) with the upper objective lens (80 and 81) on a special padded wooden block (Figure 7-9). The mount will slide down over the block, with the upper objective lens and the upper objective lens spacer (84) remaining on the padded portion of the block.

29. Wrap the flint and crown elements of the upper objective lens (80 and 81) in clean lens tissue, and store them in a dry container to prevent scratches and breakage.

7F4. Reassembly of Part I. The upper telescope system assembly Part I is reassembled in the following manner:

1. Circular brushes must be used with a cleaning solvent followed with an air line hose. Brush and blow out the fifth reduced tube section internal surfaces. This must

26. Remove the four upper objective lens clamp ring lockscrews (89). These lockscrews are unscrewed from tapped holes in the upper objective lens clamp ring (89) and carried out of countersunk clearance holes in the upper objective lens mount (82).

27. Remove the upper objective lens clamp ring (83), sliding it out of upper objective lens mount (82).

be repeated with each of the succeeding reduced tube sections, inner tube sections, couplings, lens mounts, and clamp rings.

2. Reassemble both quadruple screw shaft adjusting nuts (4) and the quadruple screw shaft adjusting nut washer (5) on the short threaded section of the quadruple screw shaft (16). The adjusting nuts must be run up against the shoulder of the quadruple screw threads.

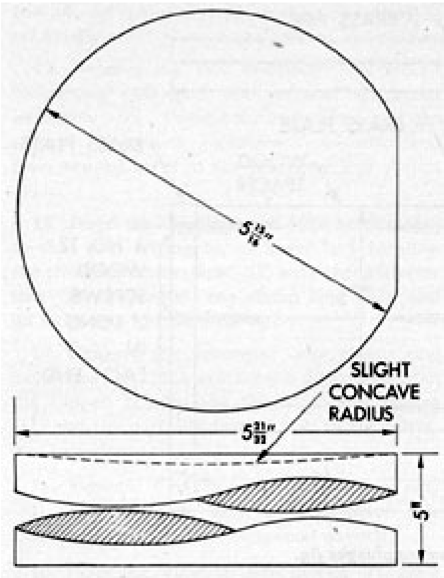

Figure 7-9. Objective lens special padded wooden block.

3. Lubricate lightly the quadruple screw threads (16) and the two ball bearings (8). Ball bearings should be placed back to back in the counterbored recesses in their respective flanges of the fifth reduced tube section (1) separated with quadruple screw shaft thrust bushing (17).

4. Insert the lower part of the quadruple screw shaft (16) through the center flange of the fifth reduced tube section (1), and further through the center flange and the reassembled

6. Use a small open end wrench to adjust the quadruple screw shaft adjusting nut (4). Tightening should be continued until there is no axial movement or play present in the quadruple screw shaft and in both of the quadruple screw shaft ball bearings (8). The separation of the ball bearings is maintained by the quadruple screw shaft thrust bushing (17). The above adjustment is maintained with the securement of the upper quadruple screw shaft adjusting nut against the lower, allowing the quadruple screw shaft (16) to revolve freely without any thrust.

7. Check reference marks of the quadruple screw follower (3) and the quadruple screw shaft (16) for proper entry. The quadruple screw shaft and its follower (16 and 3) should revolve freely without lost motion. Should any lost motion be noticeable, it can be removed by slacking off on the quadruple screw follower slot spreading screw (13) and a slight tightening of the quadruple screw follower slot closing screws (14) to maintain

upper quadruple screw shaft ball bearing (8). The lower part of the quadruple screw shaft is carried further through the quadruple screw shaft thrust bushing (17), into the lower quadruple screw shaft ball bearing (8), and is further carried through the lower flange of the fifth reduced tube section (1).

5. Reassemble the upper part of the head prism drive shaft universal coupling (23) on the stub section of the quadruple screw shaft (16). Insert the taper pin (26) into the lined up holes of the universal coupling and the quadruple screw shaft stem section.

sufficiently smooth actuation. This provides a snug movement which is necessary to eliminate backlash, but operates smoothly throughout the entire travel of the follower.

8. The fifth reduced tube section (1) is not assembled to the fourth reduced tube section (20) until after the reassembly of the head prism drive shafts and the universal couplings to the reduced tube and inner tube sections. The upper eyepiece lens (2), upper eyepiece lens mount (18), and the upper eyepiece lens clamp ring (6), are cleaned and assembled under Section 7T1, Steps 9 to 18 inclusive.

9. Reassemble the lower flange of the fourth reduced tube section (20) to the upper flange of the third reduced tube section (28). The alignment dowel pin (25) of the fourth reduced tube section lower flange should engage in a reamed hole in the flange face of the third reduced tube section to reestablish the factory alignment. Secure both flanges together by the insertion of six lockscrews (24). These lockscrews are inserted into clearance holes in the lower flange of the fourth inner tube section and screwed into tapped holes in the upper flange face of the third reduced tube section.

10. Clean the telemeter lens (29) with clean lens tissue; surface dust can be removed with a clean camel's hair brush. A vacuum brush used with ether is also effective.

reduced tube section to reestablish the factory alignment. Secure both flanges together by the insertion of six lockscrews (37). These lockscrews are inserted into clearance holes in the lower flange of the third reduced tube section and screwed into the tapped holes

11. Place the telemeter lens (29) in the telemeter lens mount (31) with the etched graduations facing the shoulder seat in the mount. Rotate the telemeter lens so that the periphery groove will engage the telemeter lens lockscrews (39) projecting inward from the telemeter lens mount inner circumference.

12. Screw the telemeter lens clamp ring (32) into the internal threaded section in the telemeter lens mount (31) tightly against the telemeter lens (29). The lockscrew holes should coincide when the telemeter lens is tightened sufficiently.

13. Insert and secure the telemeter lens clamp ring lockscrew (34), screwing it into a tapped hole in the telemeter lens mount (31) and a partially tapped hole in the clamp ring (32).

14. Place the assembled telemeter lens mount (31) in the counterbored section in the lower part of the third reduced tube section, sliding it in with the etched graduated surface facing upward.

15. Insert the angular alignment lockscrew (35) through the circumferential slot in the third educed tube section. (28) and screw it into a tapped hole in the telemeter lens mount (31).

16. The two telemeter lens mount lockscrews (38) should not be inserted into the tapped holes in the, third reduced tube section (28) and the partially tapped holes in the telemeter lens mount until completion of final collimation. Place these in the upper flange face of the second reduced tube section.

19. Reassemble the lower flange of the second reduced tube section (42) to the upper flange of the first reduced tube section (51). The alignment dowel pin (48) of the second reduced tube section lower flange should engage in a reamed hole in the upper flange face of the first reduced tube section to reestablish the factory alignment. Secure both flanges together by the insertion of six lockscrews (46). These lockscrews are inserted into clearance holes in the lower flange of the second reduced tube section and screwed in the tapped holes in the upper flange face of the first reduced tube section.

20. Place one anti-reflection screen liner (70) in the upper end of the 8th inner tube section (60). Wash the anti-reflection screen liners, using a circular brush with a suitable cleaning solvent and blow it out with well filtered air. Use a special ramming plunger jig (Figure 7-8) to force the screen liner into this inner tube section, allowing three inches for reassembly of the reducing coupling (64).

21. Insert another anti-reflection screen liner (70) forcing the screen liner into the lower end of the eighth inner tube section, allowing 3 inches for reassembly of the eighth inner tube section lower end coupling (63).

22. Reassemble the reducing coupling (64) into the upper end of the eighth inner tube section (60). Secure them together by inserting 24 lockscrews (66). These lockscrews are inserted into

lockscrews in a small box until ready for securing.

17. Check the telemeter lens (29) for cleanliness before reassembly of the third reduced tube section (28) to the second reduced tube section (42).

18. Reassemble the lower flange of the third reduced tube section (28) to the upper flange of the second reduced tube section (42). The alignment dowel pin (40) of the third reduced tube section lower flange should engage in a reamed hole in the upper flange face of the second

countersunk clearance holes in the upper part of the eighth inner tube section and are screwed into tapped holes in the lower alignment support section of the reducing coupling.

23. Reassemble the eighth inner tube section lower end coupling (63) into the lower end of the eighth inner tube section. Check reference marks for proper alignment of both the eighth inner tube section and lower end coupling. Secure them together by inserting 24 lockscrews

(67). These lockscrews are inserted into countersunk clearance holes in the lower part of the eighth inner tube section and screwed into tapped holes in the upper alignment support section of the eight inner tube section lower end coupling (63).

24. Reassemble the waveguide clamp bracket (73) to the lower part of the eighth inner tube section of the flat 50 degrees minor chord and secure it with two lockscrews (68). These lockscrews are inserted in countersunk clearance holes in the bracket and screwed into tapped holes in the lower part of the eighth inner tube section and its lower end coupling. The waveguide clamp plate adjustment screws (74) and the waveguide clamp plate adjustment screw locknuts (75) are assembled with the waveguide clamp bracket (73).

31. Reassemble the assembled upper objective lens mount (82) sliding it in the seventh inner tube section, with the upper objective lens clamp ring (83) facing upward.

32. Insert the upper objective lens mount axial alignment lockscrew (88) through the axial slot in the seventh inner tube section, and screw it into a tapped hole in the upper objective lens mount (82).

33. The four upper objective lens mount lockscrews (86) are not inserted into the upper objective lens mount (82) until after the final collimation. Place these lockscrews in a small box until ready for securing.

34. Reassemble the lower flange of the first reduced tube section (51) to the reducing coupling (64). The alignment dowel pin (57) of the first reduced tube section lower flange should engage in the reamed hole in the flange face of

25. Clean the upper objective lens (80 and 81) in similar manner to that noted under Step 10.

26. Place the flint element (80) of the upper objective lens on the padded wooden block (Figure 7-9) with the longest radius of this lens lying on the padded surface with its concave face upward.

27. Place the upper objective lens spacer ring (84) with the filed flat 50 degrees minor chord radius portion facing upward.

28. Place the crown element (81) of the upper objective lens on the upper objective lens spacer ring (84) with the shortest radius resting in the spacer ring. Align the flat 50 degrees minor chord surfaces of both lenses with the flat 50 degrees minor chord surface of the upper objective lens spacer ring.

29. Place the upper objective lens mount (82) over the assembled upper objective lens and the padded wooden block. Turn the complete assembly with the padded block over so that the crown half of the upper objective lens is resting on the shoulder seat in the-upper objective lens mount (82).

30. Reassemble the upper objective clamp ring (83) sliding it in the upper objective lens mount (82) with the flat 50 degrees minor chord section having the slight radius resting against the flint element face (80). Secure the upper objective lens clamp ring with four lockscrews (89).

the reducing coupling to reestablish the factory alignment. Secure them together by the insertion of the six lockscrews (55). These lockscrews are inserted in clearance holes in the lower flange of the first reduced tube section and screwed into tapped holes in the bearing flange of the reducing coupling.

35. Reassemble the upper end of the seventh inner tube section (79) on the lower alignment support section of the lower part of the eighth inner tube section lower end coupling (63). Secure them together by inserting 24 lockscrews (87). These lockscrews are inserted into countersunk clearance holes in the upper part of the seventh inner tube section and screwed into tapped holes in the lower alignment support section of the eighth inner tube section lower end coupling. Place a canvas boot over the lower end of the seventh inner tube section, and the upper end of the fourth reduced section to prevent dirt and dust settling on the lenses and the inner surfaces of cleaned reduced and inner tube sections.

7F5. Disassembly of Part II. The upper telescope system Part II is disassembled in the following manner:

1. Separate the sixth inner tube section upper end coupling (4) from the upper part of the sixth inner tube section (1). Remove the two lockscrews (7) from the waveguide clamp

bracket (12). These lockscrews are unscrewed from tapped holes in the flat 50 degrees minor chord wall of the upper part of the sixth inner tube section and the lower alignment support section of the sixth inner tube section upper end coupling. Remove the waveguide clamp bracket (12) carrying with it the two waveguide clamp plate adjustment screws (13) and screw locknuts (14). Remove the 24 lockscrew (6) from the upper part of the sixth inner tube section. These lockscrews are unscrewed from tapped holes in the lower alignment support section of the sixth inner tube section upper end coupling and carried out of countersunk clearance holes in the upper part of the sixth inner tube section.

2. Separate the sixth inner tube section (1) from the upper part of the fifth inner tube section upper end coupling (22). Remove the two lockscrews (7) from the waveguide clamp bracket (12). These lockscrews are unscrewed from tapped holes in the flat 50 degrees minor chord wall of the lower part of the sixth inner tube section and the upper alignment support section of the fifth inner tube section upper end coupling. Remove the waveguide clamp bracket (12) from the lower part of this inner tube section in similar manner to the procedure followed under Step 1. Remove the 24 lockscrews (6) from the lower part of the sixth inner tube section. These lockscrews are unscrewed from tapped holes in the peer alignment support section of the fifth inner tube plate adjustment screws (31) and screw locknuts (32). Remove the 24 lockscrews from the upper part of the fifth inner tube section. These lockscrews are unscrewed from tapped holes in the lower alignment support section of the fifth inner tube section upper end coupling and carried out of countersunk clearance holes in the upper part of the fifth inner tube section.

5. Separate the fifth inner tube section (19) from the upper part of the fourth inner tube section upper end coupling (40). Remove the two lockscrews (25) from the waveguide clamp bracket (30). These lockscrews are unscrewed from tapped holes in the flat 50 degrees minor chord wall of the lower part of the fifth inner tube section and the upper alignment support section of the fourth inner tube section upper end coupling (40). Remove the waveguide clamp bracket (30) from the lower part of this inner tube section in similar manner to the procedure followed under Step 4. Remove the 241ockscrews (24) from the lower part of the fifth inner tube section. These lockscrews are unscrewed from tapped holes in the upper alignment support section of the fourth inner tube section upper end coupling and carried out of countersunk clearance holes in the lower part of the fifth inner tube section.

6. Remove the four anti-reflection screen liners (27) from the fifth inner tube section, in similar manner to the procedure followed under Step 3.

section upper end coupling and carried out of countersunk clearance holes in the lower part of the sixth inner tube section.

3. Remove the four anti-reflection screen liners (9) from the sixth inner tube section. Use a special ramming plunger jig (Figure 7-8) to force out the anti-reflection screen liners.

4. Separate the fifth inner tube section upper end coupling (22) from the upper part of the fifth inner tube section (19). Remove the two lockscrews (25) from the waveguide clamp bracket (30). These lockscrews are unscrewed from tapped holes in the flat 50 degrees minor chord wall of the upper part of the fifth inner tube section and the lower alignment support section of the fifth inner tube section upper end coupling. Remove the waveguide clamp bracket (30), carrying with it the two waveguide clamp

7. Separate the fourth inner tube section upper end coupling (40) from the upper part of the fourth inner tube section (37). Remove the two lockscrews (43) from the waveguide clamp bracket (49). These lockscrews are unscrewed from tapped holes in the flat 50 degrees minor chord wall of the upper part of the fourth inner tube section (37) and the lower alignment support section of the fourth inner tube section upper end coupling. Remove the waveguide clamp bracket (49), carrying with it the two waveguide clamp plate adjustment screws (50) and the two screw locknuts (51). Remove the 24 lockscrews (42) from the upper part of the fourth inner tube section. These lockscrews are unscrewed from tapped holes in the lower alignment support section of the fourth inner tube section upper end coupling and carried out of countersunk

clearance holes in the upper part of the fourth inner tube section.

8. Separate the fourth inner tube section lower end coupling (40) from the lower part of the fourth inner tube section (37). Remove the two lockscrews (43) from the waveguide clamp bracket (49). These lockscrews are unscrewed from tapped holes in the flat 50 degrees minor chord wall of the lower part of the fourth inner tube section and the upper alignment support section of the fourth inner tube section lower end coupling. Remove the waveguide clamp bracket (49)

upper alignment support section of the fifth inner tube section upper end coupling (22) in the lower part of the sixth inner tube section.

4. Reassemble the lower part of the sixth inner tube section upper end coupling (4) in the upper part of the sixth inner tube section (1). Secure the coupling to the inner tube section with 24 lockscrews (6). These lockscrews are inserted into countersunk clearance holes in the upper part of the sixth inner tube section and screwed into tapped holes in the lower alignment support section of the

from the lower part of this inner tube section in similar manner to the procedure followed under Step 7. Remove the 24 lockscrews (42) from the lower part of the fourth inner tube section. These lockscrews are unscrewed from tapped holes in the upper alignment support section of the fourth inner tube section lower end coupling and carried out of countersunk clearance holes in lower part of the fourth inner tube section.

9. Remove three long and one short antireflection liners (45 and 46) from the fourth inner tube section (37) in the same manner as that noted under Step 3.

7F6. Reassembly of Part II. The upper telescope system assembly Part II is reassembled in the following mariner:

1. Circular brushes must be used with a cleaning solvent followed with a filtered air line hose. Brush and blow out all the inner tube sections, couplings and the anti-reflection screen liners of Section 7F5.

2. Install the two anti-reflection screen liners (9) in the upper part of the sixth inner tube section (1). Use a special ram pang plunger jig (Figure 7-8) to force the screen liners into this inner tube section allowing 3 inches for the assembly of the lower alignment support section of the sixth inner tube section upper end coupling (4).

3. Install the two anti-reflection screen liners (9) in the lower part of the sixth inner tube section (1). Follow the procedure of inserting the screen liners in the sixth inner tube section upper end coupling. Reassemble the waveguide clamp bracket (12) to the upper part of the sixth inner tube section flat 50 degrees minor chord wall with two lockscrews (7). The two waveguide clamp plate adjustment screws (13) and screw locknuts (14) are reassembled with the bracket. These lockscrews are inserted into countersunk clearance holes in the bracket and screwed into tapped holes in the upper part of the sixth inner tube section flat 50 degrees minor chord wall and the lower alignment support section of the sixth inner tube section upper end coupling.

5. Install the four anti-reflection screen liners (27) in the upper and lower parts of the fifth inner tube section (19) in similar manner to the procedure followed under Steps 2 and 3.

6. Reassemble the lower part of the fifth inner tube section upper end coupling (22) in the upper part of the fifth inner tube section (19). Secure the coupling to the inner tube section with 24 lockscrews (24). These lockscrews are inserted into countersunk clearance holes in the upper part of the fifth inner tube section and screwed into tapped holes in the lower alignment support section of the fifth inner tube section lower end coupling. Reassemble the waveguide clamp bracket (30) to the upper part of the fifth inner tube section with two lockscrews (25). These lockscrews are inserted into countersunk clearance holes in the bracket and screwed into tapped holes in the upper part of the fifth inner tube section flat 50 degrees minor chord wall and the

lower part of this inner tube section stated under Step 2. Three inches is allowed for assembly of the

lower alignment support section of the fifth inner tube section upper end coupling. The two waveguide clamp plate adjustment screws (31) and screw locknuts (32) are reassembled with the bracket.

7. Reassemble the lower part of the sixth inner tube section (1) on the upper part of the fifth inner tube section upper end coupling (22). Secure the above inner tube section to the coupling in similar manner to the procedure followed under Step 4. Reassemble the waveguide bracket (12) to the lower part in the similar manner to the procedure followed under Step 4.

8. Install the four anti-reflection screen liners (45 and 46) in the upper end lower parts of the fourth inner tube section (37) in similar manner to the procedure followed under Steps 2 and 3.

9. Reassemble the lower part of the fourth inner tube section upper end coupling (40) in the upper part of the fourth inner tube section (37). Secure the above coupling to the inner tube section with 24 lockscrews (42). These lockscrews are inserted in countersunk clearance holes in the upper part of the fourth inner tube section and screwed into the tapped holes in the lower alignment support section of the fourth inner tube section upper end coupling. Reassemble the waveguide clamp bracket (49) to the upper part of the fourth inner tube section (37) with two lockscrews (43). These the lower alignment support section of the fourth inner tube section upper end coupling. The two waveguide clamp plate adjustment screws (50) and screw locknuts (51) are reassembled with the bracket.

10. Reassemble the upper part of the fourth inner tube section lower end coupling (40) in the lower part of the fourth inner tube section (37). Secure the coupling in the inner tube section with 24 lockscrews (42). These lockscrews are inserted into countersunk clearance holes in the lower part of the fourth inner tube section and screwed into tapped holes in the upper alignment support section of the fourth inner tube section upper end coupling. Reassemble the waveguide clamp bracket (49) in similar manner to the procedure followed under Step 9.

11. Reassemble the lower part of the fifth inner tube section (19) on the upper part of the fourth inner tube section upper end coupling (40). Secure the inner tube section to the coupling with 24 lockscrews (24). These lockscrews are inserted in countersunk clearance holes in the lower part of the fifth inner tube section and screwed into tapped holes in the upper alignment support section of the fourth inner tube section upper

lockscrews are inserted into countersunk clearance holes in the bracket and screwed into tapped holes in the upper part of the fourth inner tube section flat 50 degrees minor chard wall and end coupling. Reassemble the waveguide clamp bracket (30) to the lower part of the fifth inner tube section in similar manner to the procedure followed under Step 6.

Chapter 7 Continued

G. LOWER TELESCOPE SYSTEM

7G1. Description of the lower telescope system into various assemblies. The lower telescope system is divided into two parts, namely:

1. Part I: First, second, and third inner tube section assembly.

2. Part II: Eyepiece skeleton assembly.

a. " " Eyepiece box and miscellaneous assemblies.
b. " " Four packing gland assemblies.
c. " " Eyepiece window assembly.
d. " " Bottom plug assembly.
e. " " Focusing knob assembly.
f. " " Rayfilter housing, and plate assembly.
g. " " Rayfilter eye buffer, blinder, and stowage case assemblies.
h. " " Variable density polaroid filter assembly.
i. " " Training handle assemblies (left and right).
j. " " Hoisting yoke assembly (electric and hydraulic).

The lower telescope system comprises numerous assemblies end is divided principally to permit familiarization as to nomenclature, description, disassembly, and reassembly. It is composed of two lenses and a dioptric prism, namely: A lower objective lens air-space doublet, and eyepiece prism (dioptric prism), and an eyepiece lens doublet.

7G2. Description of Part I. The first, second, and third inner tube section assembly is shown in Figure 7-10. All bubble numbers in Sections 7G2, 3, and 4, refer to Figure 7-10 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature	Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1484-3	1	Third inner tube section	31	P-1490-1	1	First inner tube section
2	P-1475-9A	1	Lower objective lens	32	P-1497-1	1	Waveguide section

			crown element
3	P-1475-9B	1	Lower objective lens flint element
4	P-1482-5	1	Head prism drive shaft section continuation
5	P-1484-1	1	Lower objective lens mount
6	P-1484-2	1	Lower objective lens clamp ring
7	P-1484-4	1	Lower objective lens spacer ring
8	P-1497-1	1	Wave guide section continuation
9	P-1506-23	4	Lower objective lens mount lockscrews
10	P-1506-25	48	Third inner tube section lockscrews, upper and lower parts
11	P-1506-26	1	Lower objective lens mount axial alignment lockscrew
12	P-1506-27	4	Lower objective lens clamp ring lockscrews
13	P-1523-8	1	Lower air line section continuation
14	P-1485-4	1	Second inner tube section
15	P-1482-5	1	Head prism drive shaft

			continuation
33	P-1500-4	1	Head prism drive shaft section
34	P-1505-2	1	Head prism drive shaft universal coupling
35	P-1506-28	6	First inner tube section lockscrews, upper part
36	P-1506-100	2	Head prism drive universal coupling taper pins
37	P-1506-112	1	First inner tube section & eyepiece skeleton dowel pin
38	P-1506-114	1	First inner tube section and reducing coupling alignment dowel pin
39	P-1523-8	1	Lower air line section continuation
40	P-1523-9	1	Air line coupling (soldered)

			section continuation
16	P-1482-7	1	Head prism drive shaft rubber noise eliminator
17	P-1485-1	1	Second inner tube section upper end coupling
18	P-1487-2	1	Reducing coupling
19	P-1491-1	1	Wave guide section continuation
20	P-1506-23	24	Second inner tube section lower part lockscrews
21	P-1506-24	24	Second inner tube section upper part lockscrews
22	P-1506-58	2	Waveguide clamp, bracket lockscrews
22A	P-1513-8	1	Head prism drive shaft guide (soldered)
23	P-1523-1	1	Waveguide clamp plate
24	P-1523-1A	2	Waveguide clamp plate pins
25	P-1523-2	1	Waveguide clam bracket
26	P-1523-3	2	Waveguide clamp plate adjustment screws
27	P-1523-4	2	Waveguide clamp plate adjustment

			screw locknuts
28	P-1523-5	1	Air line strap (soldered)
29	P-1523-8	1	Lower air line section continuation
30	P-1523-10	1	Tape strap (soldered)

a. Third inner tube section. The third inner tube section (1) is identical to the seventh inner tube section (79, Figure 7-6) and should be referred to under Section 7F1, Part I. The upper and lower part of this inner tube section is a push fit on the lower alignment support section of the fourth inner tube section lower end coupling (40, Figure 7-7) and the upper alignment support section of the second inner tube section upper end coupling (17). The upper and lower parts are each secured to their couplings with 24 lockscrews (21 and 20). This inner tube section carries the lower objective lens elements (2 and 3) in a mount (5) with a spacer ring (7), a clamp ring (6), and its lockscrews (12). The mount is secured with four lockscrews (9).

1. Lower objective lens. The lower objective lens (2 and 3) is made of two optical elements. It consists of a double convex crown element separated with a spacer ring (7) from a divergent meniscus flint element, forming an air space doublet. Both the crown and flint elements have a flat 50 degrees minor chord section ground off, similar to the upper objective lens. It is mounted in the lower objective lens mount (5) and is secured in the mount with a clamp ring (6). The clamp ring is secured in the mount with four lockscrews (12).

2. Lower objective lens mount. The lower objective lens mount (5) carries the lower objective lens (2 and 3) separated with a spacer ring (7). The mount is identical to the upper objective lens mount (82, Figure 7-6). Refer to the upper objective lens mount (82) of Section 7F1 Part I. The mount slides in the third inner tube section and is secured at the correct focal distance at the factory. It is secured with four lockscrews (9) after adjustment.

3. Lower objective lens spacer ring. The lower objective lens spacer ring (7) is placed between the crown and flint elements. Refer, to the upper objective lens spacer ring (84, Figure 7-6) of Section 7F1, Part I, as it is identical in design and purpose.

4. Lower objective lens clamp ring. The lower objective lens spacer ring (6) clamps the lower objective lens (2 and 3) to the shoulder of the mount with sufficient tension to hold it there after the insertion of four lockscrews (12). Refer to the upper objective lens clamp ring (84, Figure 7-6) of Section 7F1 Part I, as it is identical in design.

5. Head prism drive shaft section continuation. The head prism drive shaft section continuation (4) is an extension of the head prism drive shaft section (61, Figure 7-6) of the eighth inner tube section (60). This shaft continuation extends downward through clearance holes in the four bearing flanges of the third inner tube section (1) to the left of the rectangular waveguide slots.

6. Waveguide section continuation. The waveguide section continuation (8) is an extension of the waveguide section (7, Figure 7-6) of the fifth reduced tube section (1). This

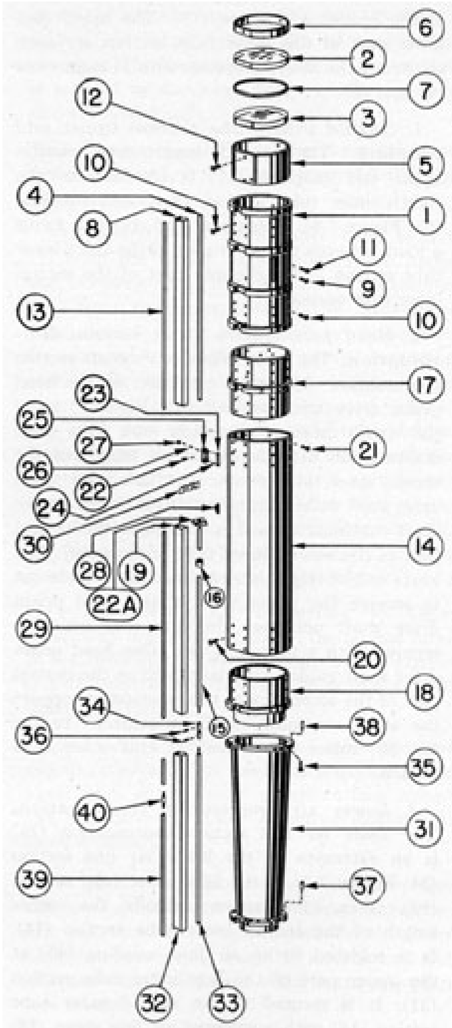

Figure 7-10. Lower telescope system assembly, Part I.

material and design as the eighth inner tube section (60, Figure 7-8) except that it has an overall length of 21.500 inches. Its upper part is secured to the lower alignment support section of the second inner tube section upper end coupling (17) while at its lower part it is secured to the upper alignment support section

extension extends the entire length of the third inner tube section and fits in the four rectangular slots in its bearing flanges.

7. Lower air line section continuation. The lower air line section continuation (13) is an extension of the lower air line section (34, Figure 7-7) of the lower part of the fifth inner tube section (19). This continuation extends the entire length of the 3rd inner tube section (1).

b. Second inner tube section. The second inner tube section (14) is made of the same

of the reducing coupling (18). The upper and lower part of this inner tube section are each secured to the above couplings with 24 lockscrews (21 and 20).

1. Second inner tube section upper end coupling. The second inner tube section upper end coupling (17) is identical to the eighth inner tube section lower end coupling (63, Figure 7-6). This upper end coupling forms a joint between the lower part of the third inner tube section and the upper part of the second inner tube section.

2. Head prism drive shaft section continuation. The head prism drive shaft section continuation (15) is an extension of the head prism drive shaft section (61, Figure 7-6) of the eighth inner tube section (60). This shaft continuation extends the entire length of the second inner tube section (14). One head prism drive shaft noise eliminator (16) is placed on the shaft continuation and is located in the central part of the

plate (23), its pins (24), two waveguide clamp plate adjustment screws (26) and screw locknuts (27) are identical in purpose and function.

5. Tape strap. The tape strap (30) is soldered to the periphery of the second inner tube section (14) and is located in the central part. It is placed in the vertical centerline of the tape slots of the bearing flanges. This provides vertical guidance to the change of power shifting wire tapes (35, Figure 7-11).

6. Reducing coupling. The reducing coupling (18) is identical to the eighth inner tube section reducing coupling (64, Figure 7-6), with some exceptions. The reducing coupling is reversed, which necessitates various changes in the bearing flange, such as the various clearance holes and tape slots.

a) Two shifting wire tape slots are located in the flange to the right of the rectangular waveguide slot.

second inner tube section (14). The lower end of this shaft continuation is undercut to receive the upper part of the head prism drive shaft universal coupling (34) which is secured with a taper pin (36). One head prism drive shaft guide (22A) is located in the central part of the second inner tube section to support the shaft continuation. It is soldered to the flat 50 degrees minor chord wall of this inner tube section.

3. Lower air line section continuation. The lower air line section continuation (29) is an extension of the lower air line section (34, Figure 7-7) of the fifth inner tube section (19). This continuation extends the entire length of the second inner tube section (14). It is soldered to an air line coupling (40) at the upper part of the first inner tube section (31). It is secured to the second inner tube section (14) with a soldered airline strap (28) located in the central part.

4. Waveguide clamp bracket. They waveguide clamp bracket (25) is secured to the upper part of the second inner tube section (14) flush with its upper face. The clamp bracket is retained on the flat 50 degrees minor chord wall with two lockscrews (22). Refer to the waveguide clamp brackets (73, Figure 7-6) of the eighth inner tube section (60) as the waveguide clamp

b) The clearance hole located to the left of the rectangular slot is provided for the lower part of the head prism drive shaft section continuation (15).

c) An air line clearance hole is provided for the lower air line section continuation (29), located on the left side of the rectangular wave guide slot.

d) The relative position of six tapped holes and one dowel pin hole in the bearing flange are changed.

Refer to the eighth inner tube section reducing coupling (64, Figure 7-6) of Section 7F1, Part I, for detail concerning the alignment support sections. The upper alignment support section is secured in the lower part of the second inner tube section with 24 lockscrews (20).

c. First inner tube section. The first inner tube section (31) is made of cast phosphor bronze material with an overall length of 18.970 inches. It is provided with an upper bearing flange and a lower flange, with the thickest part of the offset provided with a rectangular waveguide slot in similar manner to the first reduced tube section (51, Figure 7-6). The upper flange is provided with six clearance holes and an inserted dowel pin (38), and is secured to the

bearing flange of the second inner tube section reducing coupling with six lockscrews (35). The dowel pin (38) is installed to reestablish the factory alignment upon reassembly. Refer to the reducing coupling for the location of the head prism drive

means of an air line coupling (40). Both the 11-foot and 2-foot sections are soldered to the coupling. The lower part of the air line section is secured in the large flange of the eyepiece skeleton (42, Figure 7-11).

shaft section (33), the clearance holes in both flanges, the lower air line clearance holes, and the shifting wire tape slots in the upper flange.

The lower flange is provided with seven tapped holes for lockscrews (35) and a dowel pin hole for the insertion of a dowel pin (37). Two cored rectangular slots are provided 180 degrees apart at right angles to the rectangular waveguide slot. The slot on the right side provides clearance for the power shifting wire tapes, while the slot on the left side serves no particular purpose other than to provide the flange with a symmetrical design.

The periphery of this reduced tube section tapers inward from the upper bearing flange down to its lower flange. The upper part is bored straight a sufficient distance to allow for the undercut alignment support section of the reducing coupling (18). The lower part is provided with an undercut alignment support section, which is a sliding fit in the counterbored section in the upper part of the eyepiece skeleton (42, Figure 7-11). The bore is tapered from the straight bored section in the wiper part, in similar manner to the periphery, maintaining a uniform wall thickness to the lower flange. The inside shoulder of the lower flange bore is chamfered. The tapered bore is provided with anti-reflection threads. The wall of this inner tube section is tapered to conform to the convergence of the marginal or oblique cone of light rays extending downward from the lower objective lens (2 and 3).

The upper part of the head prism drive shaft universal coupling (34) couples with the stub section of the lower part of the head prism drive

7G3. Disassembly of Part I. The lower telescope system assembly Part I is disassembled in the following manner:

1. Separate the third inner tube section (1) from the second inner tube section upper end coupling (17). Remove the 24 lockscrews (10) from the lower part of the third inner tube section. These lockscrews are unscrewed from tapped holes in the upper part of the second inner tube section upper end coupling, and carried out of countersunk clearance holes in the lower part of the third inner tube section. Remove the third inner tube section with the assembled lower objective lens (2 and 3), the lower objective lens mount (5), the lower objective lens clamp ring (6), its lockscrews (12), the lower objective lens spacer ring (7), and the lower objective lens mount lockscrews (9).

2. Remove the four lockscrews (9). These lockscrews are unscrewed from the tapped holes in the lower objective lens mount (5) and carried out of countersunk clearance holes in the third inner tube section.

3. Place a special lower objective lens mount removal jig in the holes provided in the lower part of the lower objective lens mount (5), to allow the lower objective lens mount to be removed.

4. Remove the four lower objective lens clamp ring lockscrews (12). These lockscrews are unscrewed from tapped holes in the lower objective lens clamp ring (6) and carried out of countersunk clearance holes in the objective lens mount (5).

5. Remove the lower objective lens clamp ring (6), sliding it out of the lower objective lens mount (5).

shaft section continuation (15), and is secured together with a taper pin (36) at the upper part of the first inner tube section (31) . The lower part of the universal coupling couples with the head prism drive shaft section (33) and is secured together with a taper pin (36).

The lower part of the lower air line section (39) is coupled to a 2-foot air line section by

6. Place the lower objective lens mount (5) with the upper face downward, resting the flint element of the lower objective lens (2) on a special padded wooden block (Figure 7-9). The mount will slide down over the padded block with the lower objective lens and

spacer ring (7) remaining on the padded portion of the block.

7. Wrap the crown and the flint elements (2 and 3) of the lower objective lens in clean lens tissue and store them in a dry container to prevent scratches and breakage.

8. Remove the two lockscrews (22) from the waveguide clamp bracket (25). These lockscrews are unscrewed from tapped holes in the upper part of the second inner tube section (14) flat 50 degrees minor chord wall and the lower alignment support section of the second inner tube section upper end coupling (17).

9. Separate the second inner tube section upper end coupling (17) from the second inner tube section (14). Remove the 24 lockscrews (21) from the upper part of the second inner tube section. There lockscrews are unscrewed from tapped holes in the lower alignment support section of the second inner tube section upper end coupling, and carried out of countersunk clearance holes in the upper part of the second inner tube section. Remove the coupling from the upper part of the second inner tube section.

1. Circular brushes must be used with a cleaning solvent followed with a filtered air line hose, Brush and blow out all internal surfaces of the inner tube sections, couplings, lens mounts, and clamp rings of Section 7G3.

2. Reassemble the reducing coupling (18) in the upper flange of the first inner tube section (31). The alignment dowel pin (38) of the first inner tube section upper flange should engage in a reamed hole in the lower flange of the second inner tube reducing coupling to reestablish the factory alignment. Secure them together by the insertion of six lockscrews (35). These lockscrews are inserted in clearance holes in the upper flange of the first inner tube section and screwed into tapped holes in the lower flange face of the reducing coupling.

3. Reassemble the lower part of the second inner tube section (14) on the upper alignment support section of the reducing coupling (18). Secure the coupling to the inner tube section with 24 lockscrews (20). These lockscrews are inserted in countersunk clearance holes in the

10. Separate the second inner tube section (14) from the upper part of the reducing coupling (18). Remove the 24 lockscrews (20) from the lower part of the second inner tube section. These lockscrews are unscrewed from tapped holes in the upper alignment support section of the reducing coupling and carried out of countersunk clearance holes in the lower part of the second inner tube section. Remove the reducing coupling and the attached first inner tube section from the lower part of the second inner tube section.

11. Separate the lower part of the reducing coupling (18) from the upper part of the first inner tube section (31). Remove the six lockscrews (35) from the, upper flange of the first inner tube section. These lockscrews are unscrewed from tapped holes in the reducing coupling flange and carried out of clearance holes in the upper flange of the first inner tube section. Remove the reducing coupling from the upper flange of the first inner tube section.

7G4. Reassembly of Part I. The lower telescope system, Part I is reassembled in the following manner:

lower part of the second inner tube section and screwed into tapped holes in the upper alignment support section of the reducing coupling.

4. Reassemble the lower part of the second inner tube section upper end coupling (17) in the upper part of the second inner tube section (14). Secure the coupling of the inner tube section with 24 lockscrews (21). These lockscrews are inserted in countersunk clearance holes in the upper part of the second inner tube section and screwed into tapped holes in the lower alignment support section of the second inner tube section upper end coupling.

5. Reassemble the waveguide clamp bracket (25) to the upper part of the second inner tube section on the flat 50 degrees minor chord wall and secure it with two lockscrews (22). These lockscrews are inserted in countersunk clearance holes in the bracket and screwed into tapped holes in the upper part of the second inner tube section and lower alignment support section of the second inner tube section upper end coupling.

6. Clean the lower objective lens (2 and 3) in similar manner to that noted under Step, 9 of Section 7F4.

7. Place the crown element of the lower objective lens (2) on the padded wooden block

(Figure 7-9) with the longest radius of this element lying on its padded surface.

8. Place the lower objective lens spacer ring (7) with the filed flat

13. Insert one lockscrew (9), screwing it temporarily into the tapped hole in the lower objective lens mount (5), until after the reassembly of the third inner tube section (1) to the

radius facing downward.

9. Place the flint element of the lower objective lens (3) on the lower objective lens spacer ring with the concave surface resting on the lower objective lens spacer ring. Line up the irregular circumference of the lenses with the spacer ring.

10. Place the lower objective lens mount (5) over the assembled lower objective lens (2 and 3) and the padded wooden block. Turn the complete assembly with the padded block over so that the flint element (3) of the lower objective lens is resting on the shoulder seat in the lower objective lens mount (5).

11. Place the lower objective lens clamp ring (6) in the lower objective lens mount (S) with the flat 50 degrees minor section having a slight radius resting against the crown element face. Secure the upper objective lens clamp ring with four lockscrews (12).

12. Place the assembled lower objective lens mount (5) in the third inner tube section (1) with the lower objective lens clamp ring (6) facing upward.

second inner tube section upper end coupling (17).

14. The four lower objective lens mount lockscrews (9) are not inserted in the lower objective lens mount until after final collimation. Place these lockscrews in a small box until ready for securing.

15. Reassemble the lower part of the third inner tube section (1) on the upper part of the second inner tube section upper end coupling (17). Secure the coupling to the inner tube section with 24 lockscrews (10). These lockscrews are inserted into countersunk clearance holes in the lower part of the third inner tube section and screwed into tapped holes in the upper alignment support section of the second inner tube section upper end coupling.

16. Place a canvas boot over the upper end of the third inner tube section (1) and over the lower flange of the first inner tube section (31) to prevent dirt and dust settling on the lenses and inner surface of the cleaned lenses and inner tube sections.

H. EYEPIECE SKELETON ASSEMBLY

7H1. Description of the eyepiece skeleton assembly. Figure 7-11 shows the eyepiece skeleton assembly. All bubble numbers in Sections 7H1, 2, and 3, refer to Figure 7-11 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature

Ill. No.	Drawing Number	Number Required	Nomenclature
6	P-1166-2	1	Ball bearing housing for right training handle rack gear
		1	Ball bearing housing for

1	P-1183-9	2	Shifting wire spindles
2	P-1133-10	2	Shifting wire clamps
3	P-1133-11	2	Shifting wire clamp nuts
4	P-1133-12	4	Shifting wire spindle adjusting nuts
5	P-1160-1	2	Ball bearings for rayfilter drive gear
		2	Ball bearings for eyepiece prism shift gear
		2	Ball bearings for training handle rack gear (right)

			rayfilter drive gear
7	P-1160-2A	2	Dowel pins for rayfilter drive gear ball bearing housing
8	P-1160-4	1	Retaining collar, right training handle rack gear
9	P-1160-9	1	Ball bearing housing for eyepiece prism shift gear
10	P-1160-9A	2	Dowel pins for eyepiece prism shift gear ball bearing housing
11	P-1161-3	1	Rayfilter drive gear

Ill. No.	Drawing Number	Number Required	Nomenclature
12	P-1161-5	2	Eyepiece prism actuating gears
13	P-1161-6	2	Eyepiece prism actuating gear shafts
14	P-1163-11	1	Eyepiece prism shift bevel gear key
15	P-1173-3	1	Eyepiece lens clamp ring

Ill. No.	Drawing Number	Number Required	Nomenclature
43	P-1497-1	1	Waveguide section continuation
44	P-1499-1	1	Spiral drive housing
45	P-1500-1	1	Spiral bull gear shaft
46	P-1500-2	3	Spiral pinion gear key, spiral bull gear key, and head prism drive universal coupling key

16	P-1173-4	1	Eyepiece prism upper clamp ring
17	P-1173-5	1	Eyepiece prism upper retaining plate
18	P-1173-7	1	Eyepiece prism mount
19	P-1173-7A&B	8	B 2 Eyepiece prism mount stem gear racks
20	P-1173-7C	5	Eyepiece prism mount stem gear rack lockscrews
21	P-1173-7A1	4	Eyepiece prism mount stem gear rack dowel pins
22	P-1173-8	1	Eyepiece prism front retaining plate
23	P-1177-7	2	Counterweight strap retaining plates
24	P-1318-1	1	Training handle rack gear and shaft
25	P-1318-8	1	Rayfilter drive male coupling half section
26	P-1403-3	1	Power shifting rack right
27	P-1403-4	1	Power shifting rack left
28	P-1409-1	1	Retaining plate for power shift racks
29	P-1417-2	1	Nipper eccentric eyepiece prism centering ring

47	P-1500-3	1	Spiral pinion gear shaft
48	P-1500-4	1	Head prism drive shaft section continuation
49	P-1500-5	1	Spiral pinion gear
50	P-1500-6	1	Spiral bull gear
51	P-1500-7	1	Large spiral drive housing ball bearing clamp ring
52	P-1500-8	2	Small spiral drive housing ball bearing clamp rings
53	P-1500-9	1	Spiral bull gear retaining nut
54	P-1500-10	2	Spiral pinion gear thrust nuts
55	P-1500-11	1	Spiral bull gear guard
56	P-1502-9	1	Eyepiece prism shift gear
57	P-1505-3	2	Spiral bull gear and spiral pinion gear shaft small ball bearings
58	P-1505-4	4	Spiral bull gear and spiral pinion gear shaft large ball bearings
59	P-1505-8	1	Head prism drive shaft universal coupling
60	P-1506-29	3	Spiral pinion gear shaft

30	P-1417-3	1	Front eccentric eyepiece prism centering ring
31	P-1417-4	1	Eyepiece prism front clamp ring
32	P-1475-10	1	Eyepiece prism
33	P-1475-11	1	Eyepiece lens
34	P-1482-2	1	Spiral pinion gear shaft bracket
35	P-1482-6	2	Shifting wire tapes
36	P-1494-1	2	Counterweight straps
37	P-1494-2	1	Counterweight half
38	P-1494-3	6	Counterweight lockscrews
39	P-1494-4	1	Counterweight half
40	P-1495-5	14	Eyepiece skeleton and eyepiece box lockscrews and eyepiece skeleton and first inner tube section lockscrews
41	P-1495-9	1	Eyepiece prism shift bevel gear
42	P-1496-1	1	Eyepiece skeleton

			bracket lockscrews
61	P-1506-3	1	Spiral drive housing outer ball bearing clamp ring lockscrew
62	P-1506-35	3	Spiral drive housing short lockscrews
63	P-1506-36	2	Spiral drive housing long lockscrews
64	P-1506-37	12	Ball bearing housing lockscrews
65	P-1506-38	2	Eyepiece prism actuating gear shaft lockscrews
66	P-1506-39	20	Counterweight strap and shifting rack retaining plate lockscrews
67	P-1506-43	1	Spiral bull gear retaining nut lockscrew
68	P-1506-45	1	Eyepiece prism shift bevel gear lockscrew
69	P-1506-48	16	Counterweight strap, also upper and front eyepiece prism retaining plate lockscrews

Ill. No.	Drawing Number	Num-ber	Nomenclature

slots in the large flange provide clearance for the assembly of the counterweight straps for their attachment to the counterweight,

		Re-quired	
70	P-1506-49	2	Eyepiece lens clamp ring, and eyepiece prism upper clamp ring lockscrews
71	P-1506-59	2	Spiral bull gear guard lockscrews
72	P-1506-100	1	Head prism drive shaft universal coupling taper pin
73	P-1506-106	2	Spiral pinion gear and shaft, and spiral bull gear and shaft taper pins
74	P-1506-110	1	Rayfilter drive male coupling half section taper pin
75	P-1506-111	1	Right training handle rack gear retaining collar taper pin
76	P-1506-112	2	Eyepiece box and eyepiece skeleton alignment dowel pins
77	P-1506-118	2	Spiral drive housing dowel pins
78	P-1511-2	1	Eyepiece lens mount

a. Eyepiece skeleton frame. The eyepiece skeleton frame (42) is made of cast phosphor-bronze material with an over-all length of 22.747 inches. It is cast with various cored also to allow sufficient clearance for the counterweight to be moved vertically, and for the power shifting tape on the right side. Both flanges are provided with an elongated slot, to allow clearance for the head prism drive shaft section continuation (48) located to the left of the rectangular waveguide slot. The flange is provided with seven clearance holes and a dowel reamed hole located to match with holes in the lower flange of the first inner tube section (31, Figure 7-10). The small flange of the eyepiece skeleton is secured to the lower flange of the first inner tube section with seven lockscrews (40).

The large shoulder flange is provided with seven clearance holes and two inserted alignment dowel pins (76). An air line clearance hole is located on the right side of the rectangular waveguide slot to carry the lower part of the lower air line section continuation (39, Figure 7-10). It matches with the air line hole in the eyepiece box (11, Figure 7-12). This lower flange provides the necessary support to carry the upper part of the eyepiece box and is secured to the above flange with seven lockscrews (40).

The upper part of the eyepiece skeleton is provided with two counterbored sections. The small counterbored section provides the necessary clearance for light transmission and is provided with anti-reflection threads. The large counterbored section provides sufficient clearance for the lower alignment support section of the lower part of the first inner tube section (31, Figure 7-10). Both counterbored sections are concentric with the optical axis, as is also the periphery bearing surface between the two flanges for the

projections and recesses to accommodate the eyepiece drive mechanism, rayfilter drive mechanism, power shifting mechanism and the prism tilt mechanism.

The upper part of the eyepiece skeleton is provided with small and large shoulder flanges with sufficient bearing surface between flanges to carry the assembled halves of the counter weight (37 and 39) in the optical centerline. The outer circumferences of both flanges are eccentric with the optical axis 0.125 inch. defer to the offset provision in the preceding bearing flanges of the inner tube section couplings, as it offers the same provision for the rectangular waveguide section continuation (43).

The small flange is provided with rectangular slots 180 degrees apart and perpendicular to the rectangular waveguide slot. The slots of the small flange provide the necessary clearance for the counterweight straps (36) while the right rectangular slot also furnishes clearance for the power shifting wire tape (35). The elongated counterweight's vertical travel. A reamed hole is provided in the base of the eyepiece skeleton frame in the center of a shallow counterbored section, to receive the eyepiece skeleton centering screw (24, Figure 7-12) which extends upward from the eyepiece box base. The centering screw stabilizes the lower part of the eyepiece skeleton in the eyepiece box.

The eyepiece drive mechanism is composed of numerous mechanical internal parts to actuate the eyepiece prism vertically to any diopter

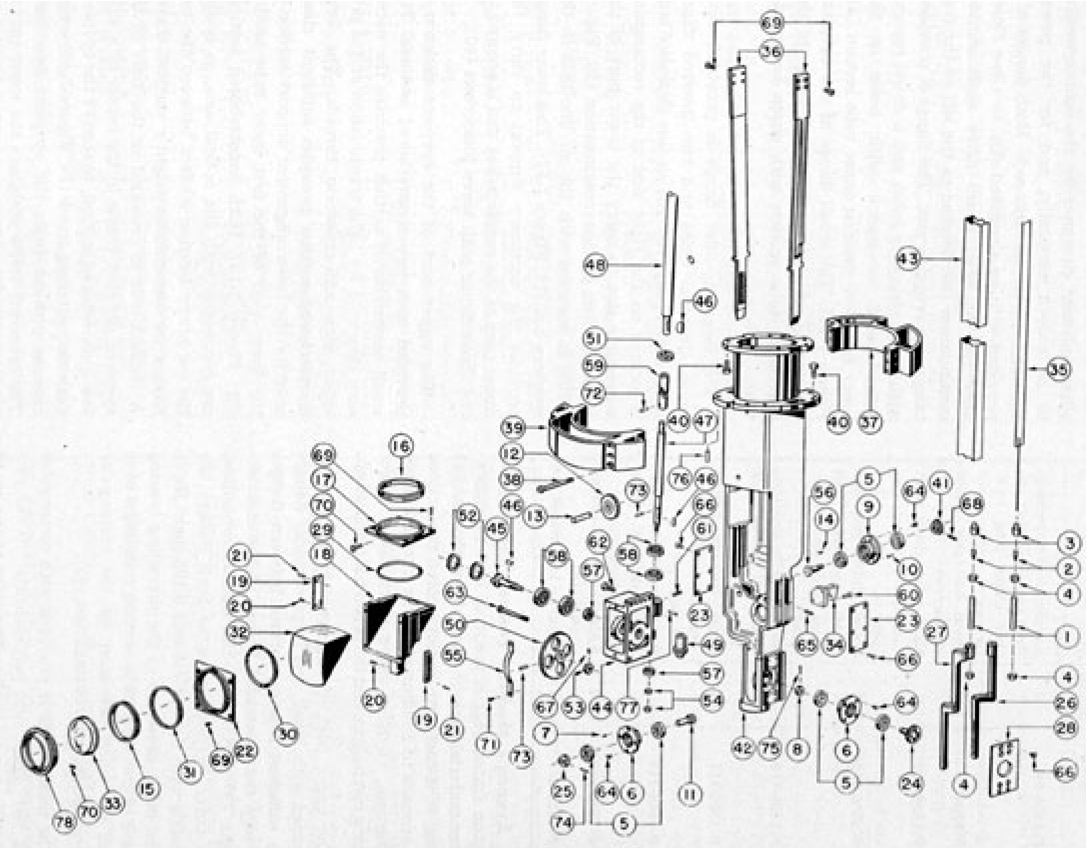

Figure 7-11. Eyepiece skeleton assembly.

setting desired by the observer, with suitable connecting external attachment.

b. Eyepiece prism mount, upper retaining plate, front retaining plate, and prism. 1. Eyepiece prism mount. The eyepiece prism mount (18) provides the necessary body to retain the eyepiece prism (32) and the eyepiece lens (33) in a fixed vertical moving position in the optical axis. The mount has two side walls which prevent the eyepiece prism from sideward motion. Each side wall is provided with four tapped holes in the upper and front faces to retain the eyepiece prism upper retaining plate (17) and the eyepiece prism front retaining plate (22) with four lockscrews each (69).

Each side wall is provided with two raised rail bearings which are a sliding fit into the rail bearings in each inner wall of the eyepiece skeleton frame. The mount is provided with a stem which projects the entrance and exit faces and is called a dioptric prism or a double-convex right angle prism, with the 45 degrees reflecting face silvered, copper plated, and lacquered. It serves to deviate the optical axis from a vertical to a horizontal direction. Refer to section 7P optical system. The eyepiece prism is retained snugly in the eyepiece prism mount (18) in the fixed central position, with eccentric centering rings and clamp rings. In the upper part of the mount, the eyepiece prism is secured by the application of an upper eccentric eyepiece prism centering ring (29) backed up with a threaded eyepiece prism upper clamp ring (16) of nominal thickness which is secured with a lockscrew (70). The eccentric centering ring has a chamfer on its lower face, to offer the curved surface of the upper

downward from the center part of its rear body. On each side of the mount, the stem gear racks (19) are assembled to the stem projection. Both stem gear racks are maintained in alignment on the stem projection with two alignment dowel pins each (21) The left gear rack is secured with three lockscrews (20), while the right gear rack is secured with two lockscrews (20). The stem gear racks (19) engage with two eyepiece prism actuating gears (12) assembled on the eyepiece prism actuating gear shafts (13). The shafts extend into the front of the center wall through the bearing hole in the gear in the center section and into the rear wall. Each shaft is secured with a lockscrew (65)

2. Eyepiece prism upper retaining plate. The eyepiece prism upper retaining plate (17) is a rectangular plate with a cylindrical projecting. shoulder. The bore is threaded to receive an eyepiece prism upper clamp ring (16) secured with a lockscrew (70). The side facing toward the front is beveled at 45 degrees to form a miter joint with the beveled upper side of the plate.

3. Eyepiece prism front retaining plate. The eyepiece prism front retaining plate (22) is a rectangular plate with a cylindrical projecting shoulder. The bore is threaded to receive an eyepiece prism front clamp ring (31) and the eyepiece lens mount (78).

4. Eyepiece prism. The eyepiece prism (32) is a crown element, with a curvature ground on part of the eyepiece prism an equal bearing surface. This provides a means of distributing the pressure equally over at least 1/4 the area of the reflecting surface, by tightening the clamp ring. The front eccentric eyepiece prism centering ring (30) serves at the front curved surface of the eyepiece prism as in the upper. It is backed up with a threaded eyepiece prism front clamp ring (31) of nominal wall thickness.

c. Eyepiece lens mount and lens. 1. Eyepiece lens mount. The eyepiece lens mount (78) provides an outer wall to retain the eyepiece lens (33) in a concentric position in the eyepiece prism front retaining plate (22). The mount is cylindrical with the lower part undercut and threaded to engage in the internal threads in the eyepiece prism front retaining plate. The threaded shoulder has sufficient length that when the large shoulder of the mount is in a metal to metal contact with the projecting shoulder of the front retaining plate, it also serves to lock the front eyepiece prism clamp ring (31). The mount is bored with a counterbored beveled section with a shallow shoulder remaining as the front wall. The counter bored beveled section conforms to the angle of the eyepiece lens with the outer surface following the same pattern to provide a uniform wall thickness. The lower part of the inside surface of the mount is provided with two

additional counterbored sections, one for the periphery of the eyepiece lens (33) and the other threaded for an eyepiece lens clamp ring (15). The clamp ring engages in the internal threaded section in the mount to hold the eyepiece lens and is secured with a lockscrew (70).

2. Eyepiece lens. The eyepiece lens (33) is made of two optical elements. It consists of a double-convex crown element cemented to a double concave flint element, forming a positive doublet. It is mounted in the eyepiece lens mount (78) and is secured with a clamp ring (15). The clamp ring is secured with a lockscrew (70) to prevent its unscrewing from the mount.

d. Counterweight. The counterweight is made up of two halves (37 and 39) of cast brass composition material. It is provided with cored sections, for the insertion of lead. The amount of lead added should conform to the weight of the assembled eyepiece prism mount. The counterweight serves to counterbalance the assembled eyepiece prism mount, and to stabilize the mount in any position of the allowed diopter setting the observer desires. Both halves are assembled together with six lockscrews (38). Body clearance holes are provided in the counterweight half (39) for the lockscrews (38) and their extension into the tapped holes in the counterweight half (37). The counterweight half section (37) is provided with tapped holes to receive the lockscrews (38), a rectangular waveguide slot, a radius

eyepiece skeleton frame. Each strap has a pronounced inward bend, from near its upper part to a short distance from the gear teeth in its gear rack. The bent section is supported with a narrow cast rib directly in the center. The counterweight straps form linkage arms between the counterweight and the eyepiece prism actuating gears (12). When the eyepiece prism mount (18) is moved upward, the counterweight is moved downward and vice versa, by means of the actuating gears. The lower part of each counterweight strap is retained in the vertical groove in each side of the eyepiece skeleton frame with counterweight strap retaining plates (23), each secured with six lockscrews (66).

f. Eyepiece prism actuating gears, shift gear, and shift bevel gear. 1. Eyepiece prism actuating gears. The eyepiece prism actuating gears (12) are perpendicular to the optical centerline of the eyepiece skeleton center framework. Both gears are retained with two eyepiece prism actuating

clearance provision cut through, and an additional part of the rectangular slot for the head prism drive shaft section continuation (48). An air line clearance hole is provided to the right of the rectangular waveguide slot for the lower air line section continuation (39, Figure 7-10). Each counterweight half is stepped 180 degrees apart, and when assembled it forms a rectangular slot 180 degrees apart. Each rectangular slot carries a counterweight strap (36) secured with four lockscrews (69). The bore of the counterweight is eccentric 0.125 inch with the outer circumference. The offset is necessary for a similar provision as indicated in each preceding bearing flange of the inner tube section couplings. The counterweight slides vertically on the bearing section of the eyepiece skeleton, between the small and large shoulder flanges.

e. Counterweight straps. The two counterweight straps (36) are made of casts phosphor-bronze material with an over-all length of 16.400 inches. The upper part of each counterweight strap is attached to a rectangular slot in each side of the counterweight halves. The lower part of each is provided with a raised gear rack that meshes with each eyepiece prism actuating gear (12) projecting through slots in each side of the gear shafts (13) and secured with lockscrews (65). The actuating gears revolve on the shafts, and are meshed with gear racks of the counterweight straps (36) and the gear teeth of the eyepiece prism mount stem gear racks (19). The right actuating gear is meshed with the teeth of the eyepiece prism shift gear (56) in its upper part, while in its lower part, it is meshed with the teeth of the rayfilter drive gear (11).

2. Eyepiece prism shift gear. The eyepiece prism shift gear (56) has gear teeth cut integral with the shaft in its large shoulder part, while the stub end of the shaft is supplied with a recess keyway. The prism shift gear is mounted in two ball bearings (5) which are mounted in a ball bearing housing (9). An eyepiece prism shift bevel gear (41) fits on the stub end of the shaft over the inserted key (14), and is secured with a lockscrew (68). The complete assembly is assembled into a clearance hole and counterbored recess seat in the right side of the eyepiece skeleton frame rear wall and is secured with four lockscrews (64). Two dowel pins (10) provide a rapid alignment reference for reassembly. The eyepiece prism shift gear extends into the center section of the eyepiece skeleton frame and meshes with the right eyepiece prism actuating gear (13) in its upper part.

3. Eyepiece prism shift bevel gear. The eyepiece prism shift bevel gear (41) attached to

the stub end of the eyepiece prism shift gear shaft (56), extends outward from the ball bearing housing (9) and the rear wall of the eyepiece skeleton frame. This bevel gear has a 60 degrees pitch cone line angle, meshing with another bevel gear having a similar pitch cone line angle. The eyepiece prism shift mechanism bevel gear (1, Figure 7-14), attached to the eyepiece drive actuating shaft (4), extends inward from the eyepiece drive packing gland assembly in the eyepiece box to mesh with the eyepiece prism shift bevel gear, with the angular axes of 120 degrees.

g. The rayfilter drive mechanism. It is composed of numerous mechanical parts forming an internal assembly to synchronize the movement of the rayfilter attachment with the eyepiece drive mechanism-.

1. Rayfilter drive gear. The rayfilter drive gear (11) has gear teeth cut integral with the shaft in its large shoulder part. It is mounted in two ball bearings (5) which are mounted in a ball bearing housing (6). The rayfilter drive male coupling half section (25) fits on the stub end of the rayfilter drive gear shaft and is secured with a taper pin (74). The complete assembly is assembled into a clearance hole in the right side of the eyepiece skeleton frame front center wall, and the flange is secured with four lockscrews (64). Two dowel pins (7) provide a rapid alignment reference for reassembly. The rayfilter drive gear extends into the center section of the eyepiece skeleton bearing housing (6). The stub end of the shaft is provided with a retaining collar (8) secured to the shaft with a taper pin (75). The retaining collar serves as a thrust collar to establish only sufficient clearance for its operation with the two ball bearings.

The complete assembly is assembled into a clearance hole and counterbored section seat in the right side of the eyepiece skeleton frame and is secured with four lockscrews (64). The training handle rack gear is provided with a milled recess in the form of an inside male coupling section. The male coupling section is recessed to provide clearance for the female coupling section (1, Figure 7-16) attached to the actuating shaft (4, Figure 7-16). The training handle rack gear meshes with the right and left power shifting racks (26 and 27) to provide actuation to the power shifting racks for change of power.

2. Power shifting racks right and left. The power shifting racks (26 and 27) are made of cast phosphor bronze material, each rack having an overall length of 7.375 inches. Both racks are provided with offset arms and hubs to establish the center axis of

frame, and meshes with the right eyepiece prism actuating gear (12) in its lower part. It is located 180 degrees opposite the eyepiece prism shift gear (12). The male coupling half section (25) serves as a thrust collar and couples with the rayfilter drive female coupling section (1, Figure 7-13) attached to the rayfilter drive actuating shaft (8, Figure 7-13) extending inward from the rayfilter drive packing gland assembly in the eyepiece box.

h. The change of power mechanism. The change of power mechanism is composed of numerous mechanical parts forming the internal assemblies for connection with an external attachment for change of power.

1. Right training handle rack gear and shaft. The right training handle rack gear and shaft (24) has gear teeth cut integral with the shaft in the large shoulder part. It is mounted in two ball bearings (5) which are mounted in a ball

each hub with proper clearance on each side of the optical centerline, and to provide sufficient clearance for both shifting wire spindle assemblies. The left power shifting rack (27) is provided with gear teeth in the lower straight section in the right side face to mesh with the training handle rack gear (24). The right power shifting rack (26) has gear teeth in the lower straight section in the left side that mesh as in the left power shifting rack.

The arm of the right power shifting rack is offset to the right of the lower straight section and slightly outward. The hub section is offset to the left and slightly outward, with a reamed hole in the center of the hub to carry the shifting wire spindle assembly. The arm of the left power shifting rack is offset to the right and outward. The hub section is offset to the right and slightly outward, with a reamed hole in the center of the hub to carry the shifting wire spindle assembly. Both power shifting racks are carried in the vertical grooves in the right side of the eyepiece skeleton frame. Both racks are, retained in the vertical recess slots with a retaining plate (28) and secured with eight lockscrews (66). The retaining plate is provided with a clearance hole in its central part to accommodate the female

coupling section (1, Figure 7-16) of the right training handle packing gland assembly.

3. Shifting wire spindles. The two shifting wire spindles (1) are made of phosphor-bronze rod material with an overall length of 2 inches. The outer circumference is threaded to carry two shifting wire spindle adjusting nuts (4) on the lower part. The upper part has a 16 degrees countersunk section in its center axis, to receive a 14 degrees tapered shifting wire clamp (2) and the shifting wire clamp nut (3) on its threaded periphery. The center axis of the spindle has a clearance hole for the phosphor-bronze wire extension of the shifting wire tape (35). Each shifting wire spindle fits in the reamed hole in either power shifting rack hub section and has an adjusting nut on its upper and lower part in contact with the upper and lower faces of the shifting rack hub section.

4. Shifting wire clamps. The two shifting wire clamps (2) are made of corrosion-resisting steel material. A clearance hole is provided through the center axis of each, with a sawed slot the depth of which corresponds to the length of the tapered part. The upper part is undercut and forms an alignment support section in the clamp nut. The tapered slotted section when assembled in the upper countersunk section in the spindle, closes as the clamp nut is tightened and in this manner clamps the phosphor bronze wire extension of the power shifting wire tape (35).

5. Shifting wire clamp nuts. The two shifting wire clamp nuts (3) are made of phosphor-bronze material. The center axis of each has a clearance hole for the phosphor bronze wire mechanism and is secured to the offset section located on the right side of the eyepiece skeleton, with three short and two long lockscrews (62 and 63). The alignment dowel pins (77) provide a rapid alignment reference for reassembly. The housing is shaped like a box with two integral projections located on the rear wall. The upper projection carries two ball bearings (58) and the lower carries one ball bearing (57).

2. Spiral pinion gear shaft. The spiral pinion gear shaft (47) is made of corrosion-resisting steel material with an over-all length of 7 inches. The upper stub section carries the lower part of a head prism drive shaft universal coupling (59) secured together with a taper pin (72). The upper part of the universal coupling with a keyseat, is a sliding fit on the lower stub section of the head prism drive shaft section continuation (48) over an inserted woodruff key (46). The upper part of the spiral pinion gear shaft is supported with a bracket (34) at an angle of 9 degrees. The bracket is secured to the rear wall of the eyepiece skeleton with three lockscrews (60).

The lower undercut part of the spiral pinion gear shaft extends through a large spiral drive housing ball bearing clamp ring (51), and two large ball bearings (58) mounted in the large projection of the spiral drive housing (44) at a 9 degrees angle. The spiral pinion gear shaft is provided

extension of the shifting tape (35). In the upper part a small counterbore is provided as an alignment support section with the 1arge counterbored section threaded to engage on the threaded periphery of the shifting wire spindles (1).

i. The prism tilt mechanism. It is composed of numerous mechanical internal parts, to operate the head prism for all degrees of elevation and depression. This is accomplished with internal connecting linkage and a suitable connecting external attachment.

1. Spiral drive housing. The spiral drive housing (44) is made of cast phosphor-bronze material. This housing carries the spiral drive with an inserted woodruff key (46) which extends into the spiral pinion gear keyway and axis hole (49). The long hub of the pinion gear is secured snugly against the center ball bearing race with a taper pin (73). The stub section of this shaft has a small straight shoulder and a small threaded section. The small straight shoulder extends into a small ball bearing (57) mounted in the small projection of the spiral drive housing (44) at a 9 degrees angle. Two thrust nuts (54) engage on the threaded periphery of the shaft, an provide a means of eliminating the axial play of the small ball bearing (57).

3. Spiral pinion gear. The spiral pinion gear (49) is made of corrosion-resisting steel material with an overall length of 1.218 inches. Its center axis is reamed to slide on the spiral pinion gear shaft (47) with an inside keyway its entire length. The external part is provided with a small and large hub, separated with a shoulder. The shoulder is provided with right-hand spiral

teeth, having an angle of 45 degrees to mesh with the right-hand spiral teeth of a spiral bull gear (50) at right angles. The small hub is undercut to provide only a sufficient bearing contact with the center ball bearing race of the small ball bearing (57). The spiral pinion gear is driven by the spiral bull gear (50) with the spiral teeth coming in contact gradually axis has a reamed hole, and a keyseat which is a sliding fit on the inserted woodruff key (46) and spiral bull gear shaft (45). The external part is provided with a short and long hub, separated by a large shoulder. The large shoulder is provided with right-hand spiral teeth, having an angle

instead of touching across the entire face instantaneously which is a usual procedure with spur gearing. This increases the average number of teeth in contact and makes the gears stronger and more quiet. The spiral pinion gear is secured snugly against the center ball bearing race of the lower large ball bearing (57) with a taper pin (73).

4. Large spiral drive housing ball bearing clamp ring. The large spiral drive housing ball bearing clamp ring (51) is a cylindrical ring of nominal wall thickness, threaded on its outer circumference, to engage in the internal threaded section in the upper part of the large projection of the spiral drive housing (44). Two shallow slots are provided in the upper face 180 degrees apart for the insertion of a special wrench. This clamp ring retains both large ball bearing races (58) against a counterbored shoulder seat in the large ball bearing projection of the spiral drive housing and is secured with a lockscrew (61).

5. Spiral bull gear shaft. The spiral bull gear shaft (45) is made of corrosion-resisting sting steel material, with an overall length of 2.150 inches. A large shoulder is provided with two projecting lugs to form a male coupling section to connect with a female coupling section (1, Figure 7-15) of the left training handle packing gland assembly extending inward from the eyepiece box. The main body section of this shaft fits in two large ball bearings mounted in the outer wall of the spiral drive housing (44). An inserted woodruff key (46), in the shaft fits into the spiral bull gear (50) with a keyseat. A small straight shoulder is threaded to carry a retaining nut (53). The stub end of of 45 degrees, to mesh with the right-hand spiral teeth of a spiral pinion gear (49). The spiral pinion gear and the spiral bull gear have a 3 to 1 ratio. The shoulder body of the spiral bull gear is provided with four equally spaced clearance holes. The bull gear is placed in the cored center section of the spiral drive housing. It is secured to its shaft with a taper pin (73) through the long hub, after adjustment has been made with a retaining nut (53). The retaining nut is secured with a lockscrew (67),

7. Small spiral drive housing ball bearing clamp rings. The two small spiral drive housing ball bearing clamp rings (52) are cylindrical with nominal wall thickness, with their outer circumference threaded to engage in the internal threaded section in the outer side wall of the spiral drive housing (44). Each ring is provided with two shallow slots in the outer face 180 degrees apart for the insertion of a special wrench. The inner clamp ring secures the large ball bearing races against the counterbored shoulder seat in the spiral drive housing, while the outer clamp ring serves as a lock ring to maintain the adjustment of the inner ring.

8. Spiral bull gear guard. The spiral bull gear guard (55) is placed over the front face of the spiral bull gear (50) and centered. It is secured to the upper and lower walls of the spiral drive housing (44) with two lockscrew (71). The guard

the shaft fits into a small ball bearing (57) mounted in the inner wall of the spiral drive, housing. The stub end of the shaft extends through a clearance hole beyond the ball bearing counterbored seat into a reamed hole in the offset side wall of the eyepiece skeleton.

6. Spiral bull gear. The spiral bull gear (50) is made of phosphor-bronze material. Its center prevents the gear teeth of the spiral bull gear from damage when removing the eyepiece box from the eyepiece skeleton or vice versa.

7H2. Disassembly of the eyepiece skeleton assembly Part II. This procedure is performed in the following manner:

1. Remove the eyepiece prism mount (18) by pulling it out vertically clear of the rail bearings in the inner side walls of the eyepiece skeleton (42).

2. Remove the lockscrew (70) from the eyepiece prism upper retaining plate (17). This lockscrew is unscrewed from a tapped hole in the

eyepiece prism upper retaining plate and the eyepiece prism upper clamp ring (16).

3. Remove the four lockscrews (69) from the eyepiece prism upper retaining plate (17). These lockscrews are unscrewed from tapped holes in the upper side walls of the eyepiece prism mount (18). Remove the eyepiece prism upper retaining plate with the eyepiece prism upper clamp ring (16). Remove the upper eccentric eyepiece prism centering ring (29) and unscrew the eyepiece prism upper clamp ring (16) from the above retaining plate.

4. Remove the assembled eyepiece lens mount (78) with the eyepiece lens (33), eyepiece lens clamp ring (15), and its lockscrew (70) by unscrewing the eyepiece lens mount

11. Remove the two lockscrews (20) from the right prism mount stem gear rack (19) and remove the rack. These lockscrews are unscrewed from tapped holes in the rack and carried out of countersunk clearance holes in the eyepiece prism mount stem (18).

12. Remove the eight lockscrews (66) from the power shifting rack retaining plate (28). These lockscrews are unscrewed from the center raised portion on the power shift side of the eyepiece skeleton. Remove the retaining plate.

13. As the power shifting rack retaining plate (28) is

from the eyepiece prism front retaining plate (22).

5. Remove the lockscrew (70) from the eyepiece lens mount (78) and the eyepiece lens clamp ring (15). This lockscrew is unscrewed from the tapped hole in the eyepiece lens clamp ring and carried out of the countersunk clearance hole in the eyepiece lens mount.

6. Remove the eyepiece lens clamp ring (15) unscrewing it from the eyepiece lens mount (78).

7. Remove the eyepiece lens (33) from the eyepiece lens mount (78) and wrap the eyepiece lens in clean lens tissue. Place it in a dry container to prevent scratches and breakage.

8. Use clean lens tissue to remove the eyepiece prism {32) slicing it out of the eyepiece prism mount (18) from the upper end. Wrap the eyepiece prism in clean lens tissue and store it in a dry container to prevent scratches and breakage.

9. Remove the four lockscrews (69) from the eyepiece prism front retaining plate (22). These lockscrews are unscrewed from tapped holes in the front side walls of the eyepiece prism mount (18). Unscrew the eyepiece prism clamp ring (16) from the eyepiece prism front retaining plate (22). Remove the front eccentric eyepiece prism centering ring (30).

10. Remove the three lockscrews (20) from the left prism stem gear rack (19) removing the rack. These lockscrews are unscrewed from tapped holes in the stem of the eyepiece prism mount (18).

removed, the power shifting racks (26 and 27) are removed from the right side of the eyepiece skeleton frame (42).

14. Remove the two shifting wire spindle adjusting nuts (4). Unscrew them from the lower part of the shifting wire spindles (1) of the power shifting racks (26 and 27). The shifting wire spindle assemblies consist of two shifting wire spindles (1), two shifting wire clamps (2), two shifting wire clamp nuts (3), and four shifting wire spindle adjusting nuts (4).

15. Remove the head prism drive shaft universal coupling taper pin (72) from the head prism drive shaft universal coupling (59) and the spiral pinion gear shaft (47). Remove the head prism drive shaft universal coupling (59) from the upper part of the spiral pinion gear shaft (47).

16. Remove the three lockscrews (60) from the spiral pinion gear shaft bracket (34). These lockscrews are unscrewed from tapped holes in the rear wall of the eyepiece skeleton frame. Remove the spiral pinion gear shaft bracket (34) sliding it off the upper part of the spiral gear shaft (47).

17. Remove the three short and two long lockscrews (62 and 63) from the spiral drive housing (44). These lockscrews are unscrewed from tapped holes in the left side of the eyepiece skeleton

frame. Remove the assembled spiral drive housing from the left side of the eyepiece skeleton frame (42).

18. The spiral drive housing (44) is disassembled by following the procedure of Steps 19 to 29 inclusive. Remove two spiral bull gear guard lockscrews (71). These lockscrews are

unscrewed from the tapped holes in the front wall of the spiral drive housing (44). Remove the spiral bull gear guard (55).

19. Remove the spiral bull gear retaining nut lockscrew (67). It is unscrewed from a tapped hole in the spiral bull gear retaining nut (53).

20. Remove the spiral drive housing large ball bearing clamp ring lockscrew (61). The lockscrew is unscrewed from a tapped hole in the large bearing projection in the rear part of the spiral drive housing (44).

21. Remove the taper pin (73) by driving it out of the spiral pinion gear (49) and the spiral pinion gear shaft (47).

22. Remove the taper pin (73) from the spiral bull gear (50) and its shaft (45).

23. With the use of a special wrench, remove the two spiral drive housing small ball bearing clamp rings (52). These clamp rings are unscrewed from the left side face of the spiral drive housing (44).

24. With the use of a special wrench, remove the spiral drive housing large bull gear retaining nut (53) from the spiral drive housing (44).

28. Remove the spiral pinion gear shaft (47), pulling it out carefully from the spiral pinion gear (49) and the small spiral pinion gear shaft ball bearing (57). Remove the spiral pinion gear. The large spiral pinion gear shaft bail bearings (58) and the spiral pinion gear key (46) remain on the shaft.

29. The spiral bull gear and the spiral pinion gear shaft small ball bearings (57) remain in the spiral drive housing.

30. Remove the six lockscrews (66) from each counterweight strap retaining plate (23). These lockscrews are unscrewed from the raised shoulder on each side of the eyepiece skeleton. Remove each of the retaining plates.

31. Remove the four lockscrews (69) from the upper part of each counterweight strap (26). These lockscrews are unscrewed from tapped holes

ball bearing clamp ring (51). This ball bearing clamp ring is unscrewed from the large ball bearing projection in the rear part of the spiral drive housing (44). Carry the large ball bearing clamp ring off over the spiral pinion gear shaft (47).

25. Remove the two spiral pinion gear thrust nuts (54). Unscrew these thrust nuts from the lower end of the spiral pinion gear shaft (47).

26. Release the spiral buff gear retaining nut (53) and tap the spiral bull gear shaft (45) toward the left side wall in a series of steps allowing the retaining nut to touch the inner side wall of the spiral drive housing (44) each This procedure is followed until the retaining nut is removed from the threaded periphery of the spiral bull gear shaft. This method prevents the spiral bull gear teeth from becoming damaged. 27. Tap the spiral bull gear shaft (45) out of the spiral drive housing a center punch in the center of the small end of the shaft. Remove the spiral bull gear shaft with the two assembled large ball bearings (58) and a spiral gear key (46) remaining in the spiral bull gear shaft. Remove the spiral bull gear (50) and the spiral

in the rectangular slots in each counterweight half (37 and 39). Remove each counterweight strap.

32. Remove the six lockscrews (38) from the counterweight half (39). These lockscrews are unscrewed from the tapped holes in the counterweight half. (37). Remove both counterweight halves (37 and 39) from between the large and small flanges of the upper part of the eyepiece skeleton (42).

33. Remove the four lockscrews (64) from the eyepiece prism shift gear ball bearing housing (9). These lockscrews are unscrewed from the tapped holes in the counterbored section seat in the rear wall of the eyepiece skeleton. Remove the assembly consisting of the following: eyepiece prism shift gear ball bearing housing (9), two eyepiece prism shift gear ball bearings (5), eyepiece prism shift gear and integral shaft (56), eyepiece prism shift bevel gear key (14), its lockscrew (68), eyepiece prism shift bevel gear (41), and two dowel pins (10).

34. In case the assembly is damaged or corroded, it will require disassembly. This is accomplished by following the disassembly procedure of Steps 34 to 37 inclusive. Remove the lockscrew (68) from the eyepiece prism shift bevel gear (41). This lockscrew is unscrewed from a

tapped hole in the eyepiece prism shift bevel gear and removed from its contact in the spotted recess in the eyepiece prism shift gear integral. shaft (56).

35. Remove the eyepiece prism shift bevel gear (41) from the eyepiece prism shift gear integral shaft (56) and remove the inserted eyepiece prism shift bevel gear key (14) from the integral shaft.

36. Remove the eyepiece prism shift gear integral shaft (56) from the center races of the two ball bearings (5), carrying it out of the small end of the eyepiece prism shift gear ball bearing housing (9).

37. Remove the two eyepiece prism shift gear ball bearings (5) from both ends of the eyepiece prism shift gear ball bearing housing (9).

38. Remove the four lockscrews (64) from the rayfilter drive gear ball bearing housing (6). These lockscrews are unscrewed from tapped holes in the counterbored raised boss face of the eyepiece skeleton center wall. Remove the assembly consisting of the rayfilter drive ball bearing housing (6), two rayfilter drive gear ball bearings (5), rayfilter drive gear and integral shaft (11), rayfilter drive male coupling half section (25), its taper pin (74), and two dowel pins (7).

39. In case the assembly is damaged or corroded, it will require disassembly. This is accomplished by following the disassembly procedure of Steps 39 to 42 inclusive. Remove the taper, pin (74) from the rayfilter drive male coupling half section (25) and the rayfilter drive gear and integral shaft (11).

from tapped holes in the counterbored seat in the right side of the eyepiece skeleton. Remove this assembly consisting of the right training handle rack gear ball bearing housing (6), two right training handle rack gear ball bearings (5), right training handle gear and shaft (24), right training handle rack gear retaining collar (8), and its taper pin (75).

44. In case the assembly is damaged or corroded, it will require removal. This is accomplished by following the disassembly procedure of Steps 44 to 47 inclusive. Remove the taper pin (75) from the right training handle rack gear retaining collar (8) and the right training handle rack gear integral shaft (34).

45. Remove the right training handle rack gear retaining collar (8) from the right training handle rack gear integral shaft (24).

46. Remove the right training handle rack gear and shaft (24) from the center races of the two ball bearings (5), carrying it out from the large shoulder flange end of the right training handle rack gear ball bearing housing (6).

47. Remove the two training handle rack gear ball bearings (5) from both ends of the right training handle rack gear ball bearing housing (6).

48. Remove the two lockscrews (65) from their

40. Remove the rayfilter drive male coupling half section (25) from the integral shaft of the rayfilter drive gear (11).

41. Remove the rayfilter drive gear integral shaft (11) from the center races of two ball bearings (5), carrying it out of the small end of the rayfilter drive gear ball bearing housing (6).

42. Remove the two rayfilter drive gear ball bearings (5) from both ends of the rayfilter drive gear ball bearing housing (6).

43. Remove the four lockscrews (64) from the right training handle rack gear ball bearing housing (6). These lockscrews are unscrewed contact in the spot faces in two eyepiece prism actuating gear shafts (13). These lockscrews are unscrewed from tapped holes in a raised shoulder on each side of the eyepiece skeleton.

49. Remove the eyepiece prism actuating gear shafts (13) and the eyepiece prism actuating gears (12). The shaft and gears slide out easily.

7H3. Reassembly of the eyepiece skeleton assembly, Part II. his procedure is performed in the following manner.

1. Place both eyepiece prism actuating gears (12) in the center section of the eyepiece skeleton (42). Reference marks on both gears and shaft must be noted for correct reassembly to corresponding reference marks on the eyepiece skeleton frame.

2. Place both eyepiece prism actuating gear shafts (13) in the reamed holes in the center and the rear frame wall of the eyepiece skeleton.

These shafts extend into the front wall, then through the center bearing hole in each eyepiece prism actuating gear (12) into the rear wall. Secure the shafts with two lockscrews (65). These lockscrews are inserted in clearance holes and screwed into the tapped sections in each raised shoulder on opposite sides of the eyepiece skeleton to extend into a spotted recess in each eyepiece prism actuating gear shaft (13).

two ball bearings (5) from the small end of the eyepiece prism shift gear ball bearing housing (9). The shaft extends through both ball bearing center races, with the shoulder of the eyepiece prism shift gear a metal-to-metal contact with the center race of the inner ball bearing.

3. Reassemble both counterweight halves (37 and 39) on the bearing surface between the small and large flanges of the eyepiece skeleton (42). The cored part of each counterweight half faces upward. Secure both halves of the counterweight together by inserting six lockscrews (38). These lockscrews are inserted in clearance holes in the counterweight half (39) and screwed into tapped holes in its opposite counterweight half (37).

4. Place each counterweight strap (36) through each elongated slot in the large shoulder flange of the eyepiece skeleton located 180 degrees apart. Secure each counterweight strap to the rectangular slotted face on opposite sides of the counterweight with four lockscrews each (69). These lockscrews are inserted in countersunk clearance holes in each counterweight strap and screwed into tapped holes in the opposite rectangular slotted faces of the assembled counterweight.

5. Engage the lower end of each counterweight strap gear race (36) in mesh with each eyepiece prism actuating gear (1,2) in the grooved section between two rectangular raised bosses.

6. Reassemble the counterweight strap retaining plates (23) over each counterweight strap (36) on the rectangular raised bosses on opposite side walls of the eyepiece skeleton frame. Secure each retaining plate with six lockscrews (66). The lockscrews are inserted into countersunk clearance holes in the retaining plate and screwed into the tapped holes in the rectangular raised bosses of the left and right side-walls of the eyepiece skeleton.

9. Place the eyepiece prism shift bevel gear key (14) in the keyway in the eyepiece prism shift gear integral shaft (56).

10. Reassemble the hub end of the eyepiece prism shift bevel gear (41) on the inserted key (14) and the stub end of the eyepiece prism shift gear integral shaft (56) up against its shoulder. Secure the bevel gear to the shaft by the insertion of a lockscrew (68). This lockscrew is screwed into a tapped hole in the hub of the above bevel gear and extends into a spotted recess in the stub end of the shaft (56).

11. Reassemble the eyepiece prism shift gear mechanism assembly into the clearance hole and the counterbored section seat in the rear wall of the eyepiece skeleton frame. The dowel pins (10) of the housing engage in the reamed holes in the counterbored section seat in the eyepiece skeleton frame. Secure the eyepiece prism shift gear ball bearing housing (9) with four lockscrews (64). These lockscrews are inserted in countersunk clearance holes in the housing and screwed into tapped holes in the counterbored section seat in the eyepiece skeleton frame. Check the reference mark of the eyepiece prism shift gear (56) to engage with a corresponding reference mark on the right eyepiece prism actuating gear (12).

12. Reassemble the rayfilter drive gear ball bearings (5)

7. Reassemble the eyepiece prism shift gear ball bearings (5) into the eyepiece prism shift gear ball bearing housing (9) from both ends.

8. Reassemble the eyepiece prism shift gear integral shaft (56) into the center races of the into both ends of the rayfilter drive gear ball bearing housing (6).

13. Reassemble the rayfilter drive gear integral shaft into the center aces of the rayfilter drive gear ball bearings (5) from the small end of the rayfilter drive gear ball bearing housing (6). The shaft extends through the ball bearing races with the shoulder of the rayfilter drive. gear (11), a metal-to-metal contact with the inner ball bearing race.

14. Reassemble the rayfilter drive male coupling half section (25) on the stub end of the rayfilter drive gear integral shaft (11) and secure the coupling to the shaft with a taper pin (74).

15. Reassemble the rayfilter drive gear mechanism assembly into a reamed hole and the raised boss of the front center wall of the eyepiece skeleton frame. The dowel pins (7) of the housing engage in reamed holes in the eyepiece skeleton frame raised boss. Secure the rayfilter drive gear ball bearing housing (6) with four lockscrews (64). These lockscrews are inserted in countersunk clearance holes in the housing and screwed into tapped holes in the raised boss of the eyepiece skeleton frame front center wall. Check the reference marks of the rayfilter drive gear (11) to engage with a corresponding reference mark in the right eyepiece prism actuating gear (12).

and the inserted spiral pinion gear key (46) into the keyseat in the spiral pinion gear (49). Push the shaft with the key into the spiral pinion gear keyseat and carry the stub and of the shaft further into a spiral pinion gear shaft ball bearing (57).

22. Reassemble both spiral pinion gear thrust nuts (54). Screw them on the lower threaded periphery of the spiral pinion gear shaft (47). Tighten both thrust nuts. This prevents any axial motion of the spiral pinion gear (49) between the small spiral pinion gear shaft ball bearings (57) and the large spiral

16. Reassemble the right training handle rack gear ball bearings (5) in both ends of the right training handle rack gear ball bearing housing (6).

17. Reassemble the right training handle rack gear integral shaft (24) into the center races of the right training handle rack gear ball bearings (5) from the large end of the ball bearing housing. The shaft extends through the center ball bearing races with the shoulder of the right training handle rack gear a metal-to-metal contact with the inner ball bearing race.

18. Reassemble the right training handle rack gear retaining collar (8) to the stub end of the right training handle rack gear integral shaft (24), and secure the retaining collar to the shaft with a taper pin (75).

19. Reassemble the right training handle rack gear mechanism assembly into the bored hole and counterbored section seat in the right side of the eyepiece skeleton frame. Secure the right training handle rack gear ball bearing housing (6) with four lockscrews (64). These lockscrews are inserted in countersunk clearance holes in the housing and screwed into tapped holes in the counterbored section seat in the right side of the eyepiece skeleton frame.

20. The spiral drive housing is reassembled by following Steps 20 to 29 inclusive. Place the spiral pinion gear (49) between the large and small bearing projection of the spiral drive housing (44) with the large hub of the spiral pinion gear fitting into the large bearing projection.

21. Reassemble the spiral pinion gear shaft (45) with two assembled large ball bearings (58) pinion gear shaft ball bearings (58).

23. Insert a taper pin (73) into the large hub of the spiral pinion gear (49) and its shaft (47) for its securement.

24. Reassemble the spiral drive housing large ball bearing clamp ring (51), carrying it on over the spiral pinion gear shaft (47). Screw the above ball bearing clamp ring into the internal threaded section of the large bearing projection, using a special wrench. Tighten the clamp ring until no axial motion is noticed in the spiral pinion gear shaft (47).

25. Place the spiral bull gear (50) in the spiral drive housing (44) with the longer hub facing the small spiral bull gear shaft ball bearing (57). Check the reference mark of the spiral pinion gear (49) to make sure that the reference tooth of this pinion gear will engage between the two reference teeth of the spiral bull gear (50).

26. Place the spiral bull gear shaft (45) with the assembled large spiral bull gear shaft ball bearings (48) and the inserted spiral bull gear key (46) through the outer wall of the spiral. drive housing (44) in the spiral bull gear and its keyseat (50). Place the spiral bull gear retaining nut (54) between the hub of the spiral bull gear and the inner wall of the spiral drive housing. With the retaining nut held with a pair of tweezers, the spiral bull

gear shaft assembly is pushed in to allow the inserted key (46) to engage in the keyseat in the spiral bull gear (40). The retaining nut is screwed on the spiral bull gear shaft in a series of tightening steps. As the retaining nut reaches the hub of the spiral bull gear each time, the assembly is pushed in. The

pushing operation allows the retaining nut to touch the inner wall of the spiral drive housing each time. This procedure must be followed in order to prevent damage to the teeth of the spiral bull gear. Place a screw driver in one of the spiral bull gear openings, allowing the screw driver to touch the bottom cored surface of the spiral drive housing. This provides an anchorage for the bull gear, and allows the retaining nut to be tightened without damaging the teeth of the bull gear.

27. Insert a taper pin (73) into the hub of the spiral bull gear (50) and its shaft (4S). Align the retaining nut tapped hole with the spotted recess in the spiral bull gear shaft. The retaining nut will require a slight further tightening. When the alignment is ascertained, insert the spiral bull gear retaining nut lockscrew (67). The lockscrew is screwed into a tapped hole in the above retaining nut and extends into the spotted recess in the spiral bull gear shaft (45).

28. Place the inner of two small spiral drive housing ball bearing clamp rings (52) in the internal threads in the outer left side wall of the spiral drive housing (44). Tighten the inner

of the spiral pinion gear shaft (47) and secure the bracket to the rear wall of the eyepiece skeleton frame with three lockscrews (60). These lockscrews are inserted in clearance holes in the bracket and screwed into tapped holes in the rear wall of the eyepiece skeleton frame.

32. Reassemble the lower part of the head prism drive shaft universal coupling (59) to the upper part of the spiral pinion gear shaft (47). Secure the coupling to the shaft with a taper pin (72).

33. Place the power shifting racks (26 and 27) in the vertical slots in the right side wall of the eyepiece skeleton frame. The gear racks are placed with their lower ends even with the base of the eyepiece skeleton frame. The right training handle rack gear and shaft (24) reference mark should coincide with the reference marks on each power shifting rack. Place the shifting rack gear retaining plate (28) over the power shifting racks on the raised

clamp ring until there is no axial motion noticeable in the spiral bull gear shaft (45). Reassemble the second small clamp ring in the same manner, as this clamp ring serves to lock the inner clamp ring. A special wrench is required for tightening the clamp rings.

29. Place the spiral bull gear ward (55) over the spiral bull gear (50) and secure it to the front of the spiral drive housing (44) with two lockscrews (71). These lockscrews are inserted in countersunk clearance holes in the guard and screwed into tapped holes in the front walls of the spiral drive housing (44).

30. Reassemble the spiral drive housing assembly the offset face of the left side of the eyepiece skeleton frame. Secure the assembly with three short and a two long lockscrews (62 and 63). These lockscrews are inserted in clearance holes in the spiral drive housing (44) and screwed into tapped-holes in the left side of the eyepiece skeleton frame.

31. Reassemble the spiral pinion gear shaft bracket (34), sliding it on over the upper part

center bosses. Secure the shifting rack retaining plate with eight lockscrews (66). These lockscrews are inserted in countersunk clearance holes in the retaining plate and screwed into tapped holes in the raised bosses on the right side of the eyepiece skeleton frame.

34. Reassemble both shifting wire spindle assemblies in the hubs of the power shifting racks (26 and 27). The shifting wire spindle assemblies consist of the following: two shifting wire spindles (1), two shifting wire clamps (2), two shifting wire clamp nuts (3), and four shifting wire spindle adjusting nuts (4). Assemble the two shifting wire spindle adjusting nuts (4) up to the lower hub faces of the power shifting racks by screwing them on the lower part of the shifting wire spindles (1).

35. Reassemble the right eyepiece prism stem gear rack (19) with dowel pins (21) on the right side of the eyepiece prism mount stem (18). Secure it with two lockscrews (20) from the opposite side of the eyepiece prism mount stem (18). These lockscrews are inserted in countersunk clearance holes in the stem and screwed into tapped holes in the right eyepiece prism stem gear rack (19).

36. Reassemble the left eyepiece prism mount stem gear rack (19) with dowel pins (21) on the

left side of the eyepiece prism mount stem (18) and secure it with three lockscrews (20). These lockscrews are inserted in countersunk clearance holes in the stern gear rack and screwed into tapped holes in the eyepiece prism mount stem (18).

37. Reassemble the eyepiece prism front retaining plate (22) on the front face of the eyepiece prism mount (18). Secure it with four lockscrews (69). These lockscrews are inserted in countersunk clearance holes in the retaining plate and screwed into tapped holes in the front face of the eyepiece prism mount side walls.

38. Clean the eyepiece prism (32) in similar manner to the procedure followed for cleaning the lenses in the various reduced and inner tube sections. Place the eyepiece prism in the eyepiece prism mount (18) from the upper end, with the shortest radius toward the eyepiece lens side.

39. Reassemble the eyepiece prism upper retaining plate (17) on the upper face of the eyepiece prism mount (18). Secure it with four lockscrews (69). These lockscrews extend into tapped holes in the upper face of the eyepiece prism mount side walls.

40. Place the upper eccentric eyepiece prism centering ring (29) and the upper eyepiece prism clamp ring (16) in the eyepiece prism upper retaining plate (17). The beveled side of the centering ring should bear to the curvature of the prism. The retaining ring is screwed down on the upper eccentric eyepiece prism centering ring until the lockscrew holes coincide. Insert the lockscrew (70) in a countersunk clearance hole the front eccentric eyepiece prism centering ring (30).

42. With the counterweight at the extreme lower position, the assembled eyepiece prism mount (18) is placed in the rail bearings of the eyepiece skeleton and moved downward. Move the counterweight upward to engage the prism actuating gears (12) with the eyepiece prism stem gear rack (19). The upward movement of the counterweight will not cause the engagement of both the eyepiece prism actuating gears (12) with the eyepiece prism stem gear racks (19).

43. Clean the eyepiece lens (33) in similar manner to the procedure followed for cleaning lenses in the various reduced and inner tube sections.

44. Reassemble the eyepiece lens (33) into the eyepiece lens mount (78) with the concave radius facing the shoulder seat in the mount.

45. Place the eyepiece lens clamp ring (15) in the internal threaded section in the eyepiece lens mount (78). Screw the clamp ring into the mount until the lockscrew holes coincide. Secure the clamp ring with a lockscrew (70). This lockscrew is inserted in a countersunk clearance hole in the mount and screwed into a tapped hole in the eyepiece lens clamp ring.

in the eyepiece prism upper retaining plate and screw it into a tapped hole in the upper eyepiece prism clamp ring.

41. Place the front eccentric eyepiece prism centering, ring (30) to bear on the prism in similar manner to the upper centering ring, and assemble the eyepiece prism front clamp ring (31) into the eyepiece prism front retaining plate (22). The clamp ring is screwed down on

46. Reassemble the assembled eyepiece lens mount (78) into the internal threads in the eyepiece front retaining plate (22). Screw the eyepiece lens mount into the retaining plate until the shoulder of the lens mount is a metal-to-metal contact with the shoulder of the retaining plate.

47. **PRECAUTION:** a) The essential travel of the assembled counterweight halves (37 and 39) and the eyepiece prism mount (18) is 24 mm.

b) The essential travel of the power shifting racks should be approximately 29 mm.

c) The essential travel of the head prism drive shaft should be 2 1/3 turns or 11.5 mm movement of the head prism actuating rack (65, Figure 7-5) of the skeleton head assembly.

I. EYEPIECE BOX AND MISCELLANEOUS ASSEMBLIES

7I1. Description. The eyepiece box and miscellaneous assemblies (Figure 7-12) are described as follows (all bubble numbers in Section 7I refer to Figure 7-12 unless otherwise specified):

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1353-6	1	Eyepiece box pressure gage, assembly soft rubber gasket
2	P-1409-5	1	Eyepiece skeleton

over-all length of 20.312 inches. It forms an outer shell covering the eyepiece skeleton frame (42, Figure 7-11). Various cored projections and recesses accommodate numerous inward projecting assemblies and inter-connecting external assemblies.

			centering screw lead washer
3	P-1410-1	2	Air inlet and outlet plugs
4	P-1410-2	2	Air valve bodies (inlet and outlet)
5	P-1410-3	2	Air valve screws (inlet and outlet)
6	P-1410-4	2	6-inch steel balls for air valve screws (inlet and outlet)
7	P-1410-5	2	Lead washers for air valve bodies (inlet and outlet)
8	P-1412-8	2	Anchor screw pins
9	P-1430-7	1	Name plate
10	P-1454	1	Pressure gage assembly
11	P-1473-1	1	Eyepiece box
12	P-1486-2	1	Main coupling
13	P-1488-1	1	Eyepiece box bottom flange plate
14	P-1488-2	1	Eyepiece box bottom flange plate rubber gasket (inserted)
15	P-1495-6	2	Alignment dowel pin bushings
16	P-1495-7	5	Eyepiece box bottom flange plate bolts
17	P-1495-8	1	Outer tube and eyepiece

The upper face has seven tapped holes, two reamed dowel pin holes, and an air line clearance hole to match with holes in the large shoulder flange of the eyepiece skeleton.

The inside diameter of the upper flange section is bored to allow it to slide on the small alignment shoulder provision of the large shoulder flange of the eyepiece skeleton. The inside bore of the upper flange section is provided with three cored recesses, allowing clearance for the waveguide in the rear part and on both sides of the center axis for the counterweight straps (36, Figure 7-11).

The alignment dowel pin reamed holes provide a rapid alignment reference for the reassembly of the eyepiece box to the large shoulder flange of the eyepiece skeleton. The dowel pins maintain the angular alignment of the eyepiece skeleton and the eyepiece box, which is established in similar manner to the Type II periscope.

The upper part of the eyepiece box is a sliding fit in the lower part of the outer tube (2, Figure 7-2). A short keyway with concave corners is provided in the front center axis of the shoulder preceding a threaded shoulder. An outer tube and eyepiece box angular alignment key (17) is a pressed fit in the milled keyway. This alignment key

			box angular alignment key
18	P-1506-40	10	Pressure gage assembly lock screws
19	P-1506-52	4	Name plate lockscrews
20	P-1506-113	2	Eyepiece box bottom flange plate dowel, pins
21	P-1511-3	2	Main coupling 1ockscrews
22	P-1511-4	1	Outer tube and eyepiece box soft rubber gasket
23	P-1523-8	1	Air line section (soldered)
24	P-1523-11	1	Eyepiece skeleton centering screw
25	Assembly	1	Rayfilter drive packing gland assembly
26	Assembly	1	Eyepiece drive packing gland assembly
27	Assembly	1	Left training handle packing gland assembly
28	Assembly	1	Right training handle packing gland assembly
29	Assembly	1	Eyepiece window assembly
30	Assembly	1	Bottom plug assembly
31	Assembly	1	Rayfilter

maintains the angular alignment of the eyepiece box, in a vertical inside keyway in the lower part of the outer tube.

The upper face of the threaded shoulder is provided with a triangular annular groove similar to the Type II periscope to allow the rubber gasket (22) to be compressed in this groove, by the triangular annular ridge detail on the outer tube when joining them together by the main coupling (12).

All the various openings will be described under each individual assembly in the following manner:

b. Main coupling. The main coupling (12) is made of cast phosphor bronze and is 2.531 inches

			stowage case assembly

a. Eyepiece box. The eyepiece box (11) is made of cast-phosphor bronze material with an

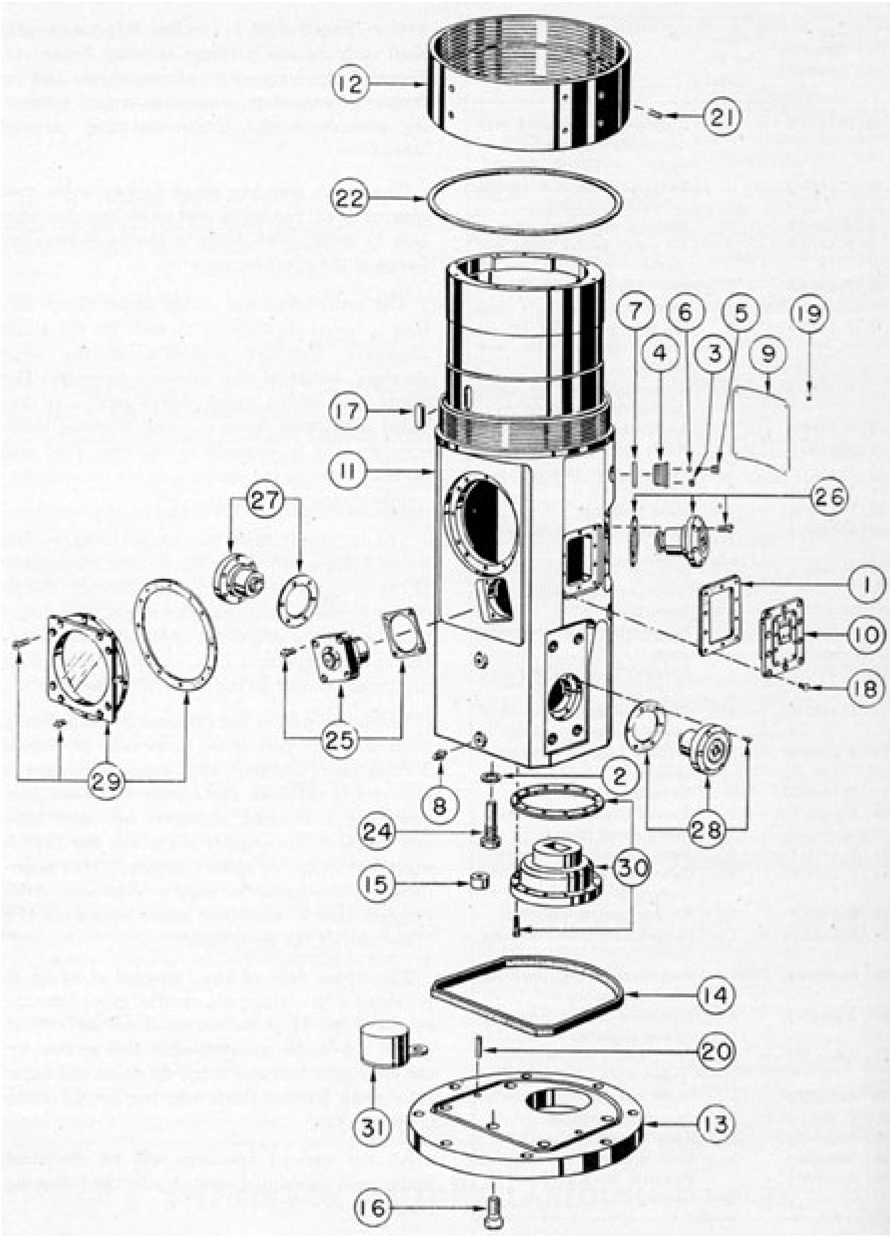

Figure 7-12. Eyepiece box and miscellaneous assemblies.

long. The outer diameter is within 0.010-inch of the outer tube diameter (2, Figure 7-2). In the center of the upper and lower internal threaded section, a thread relief is provided to separate the

d. Pressure gage assembly. The pressure gage assembly (10), its sealing rubber gasket (1), and lockscrews (18) are identical to the pressure gage assembly (21, Figure 4-29), sealing gasket and lockscrews

left- and right-hand threads when machining, and serves as an area for the compression of the rubber gasket (22). The upper internal threaded section has 16 right-hand threads per inch to engage on the right-hand threaded periphery of the lower part of the outer tube. The lower internal threaded section of the coupling has 16 left-hand threads per inch to engage on the left-hand threaded periphery of the upper part of the eyepiece box (11).

The main coupling connects the lower part of the outer tube to the eyepiece box. A soft rubber gasket (22) fits between the triangular annular ridge detail of the outer tube and the corresponding triangular annular groove in the shoulder joint of the eyepiece box (11).

The compression of the soft rubber gasket (22), by means of the coupling being tightened, joins the two faces together, thus causing the gasket to follow the triangular annular ridge and its corresponding groove to provide a hermetically sealed joint. Two lockscrews (21) usually located on opposite sides of the main coupling, screw into tapped holes in the main coupling and extend into spotted recesses in the outer tube to prevent the coupling from unscrewing, and thus maintain the hermetical seal of this joint.

The main coupling has four sets of twin holes equally spaced of shallow depth. These holes accommodate a special spanner wrench provided with, twin prongs for the breaking or making up of the joint.

c. Air valve bodies. The two air valve bodies (4) are identical to the air (10 and 5, Figure 4-29) used in the Types II and III periscopes. Refer to Section 4M1.

e. Eyepiece window assembly. The eyepiece window assembly (29) is identical to the eyepiece window assembly (27, Figure 4-29) of the Types II and III periscopes. Refer to Section 4M1.

f. Rayfilter drive packing gland assembly. The rayfilter drive packing gland assembly (25) is assembled to the front bored hole and square recess seat in the front of the eyepiece box (11). It serves the same purpose and function as the rayfilter drive packing gland assembly (24, Figure 4-29) used in the Types II and III periscope except that it is not a spring type. Refer to Section 4M1. Use the rubber gasket and lockscrews (3 and 11, Figure 7-13). The rubber gasket maintains the hermetical seal of this assembly along with its hycar packing.

g. Eyepiece drive packing gland assembly. The eyepiece drive packing gland assembly (26) is secured in the eyepiece box (11) with a sealing rubber gasket and lockscrews (3 and 10, Figure 7-14) in similar manner to the eyepiece drive packing gland assembly used in the Types II and III periscopes. Refer to (25, Figure 4-29) Section 4M1. It is not a spring type. This packing gland provides an internal connection with eyepiece prism shift bevel gear (41, Figure 7-11) of the eyepiece skeleton assembly at the inner part, and an external connection with the focusing knob assembly (Figure 4-39). The rubber gasket maintains the hermetical seal of this assembly along with its hycar packing.

valve bodies (15, Figure 4-29) used in the Types II and III periscopes. The two air INLET and OUTLET plugs (3), the two air valve screws (5) and the two 3/16-inch steel balls (6) are also identical, to the bubble numbers 14, 16, and 17, Figure 4-29. Refer to Section 4M1. A soldered air line section (23) 8 1/2 inches long (not shown in Figure 7-12) connects the cylindrical wall seat section in the eyepiece box in the same manner as the 4 3/4-inch length soldered air line section of the Types II and III periscopes.

h. Left training handle packing gland assembly. The left training handle packing gland assembly (27) with the rubber gasket and lockscrews (3 and 10, Figure 7-15) is assembled to the eyepiece box (11) in similar manner to the left training handle packing gland assembly used in the Types II and III periscopes. Refer to Figure 4-29, Section 4M1, as it serves the same purpose and function except that it is not a spring type. The rubber gasket maintains the hermetical seal of this assembly along with its hycar packing.

i. Right training handle packing gland assembly. The right training handle packing gland assembly (28) is assembled to the right side of the eyepiece box in a bored hole and counterbored section seat. Refer to the left training handle packing gland assembly above as it is secured in similar manner and serves the same purpose and function.

j. Bottom plug assembly. The bottom plug assembly (30) is assembled in the bored hole and counterbored section seat on a rubber gasket (3, Figure 7-17) in the base of the eyepiece box located in the rear part of the center axis. The bottom plug assembly provides an external connection with the electronic device attached to the eyepiece box bottom flange plate (13), and an internal connection with the waveguide section continuation (43, Figure 7-11). The bottom plug housing rubber gasket (3, Figure 7-17) is placed between the bottom plug housing shoulder flange and the counterbored section seat in the

m. Eyepiece skeleton centering screw. The eyepiece skeleton centering screw (24) has an over-all length of 1.657 inch. It serves the same purpose and function as the eyepiece skeleton centering screw (12, Figure 4-29), used in the Types II and III periscopes. Refer to Section 4M1. The lead washer (2) maintains the hermetical seal of this opening in the eyepiece box.

n. Eyepiece box bottom flange plate. The eyepiece box bottom flange plate (13) is made of cylindrical cast phosphor-bronze material inch thick and has a diameter of 9 inches. It is provided with eight equally spaced clearance holes in a diameter circle of 8.203 inches for eight 3/8 inch X 20 threads per inch hexagon bolts and nuts. The above clearance holes match the corresponding clearance holes in the electronic device flange, with a rubber gasket placed between both flanges. The bottom flange plate is provided with five clearance holes. Each hole has a counterbored recess in the bottom face to provide clearance for the

eyepiece box (11). The bottom plug housing is secured to the gasket and the counterbored section seat with 12 lockscrews (7, Figure 7-17). The rubber gasket (3, Figure 7-17) maintains the hermetical seal of this assembly along with the bottom plug window (5, Figure 7-17) and the two bottom plug window rubber gaskets (4, Figure 7-17).

k. Angular alignment key. The angular alignment key (17) is made of monel metal, having a nominal length, thickness, and width, with the upper and lower corners rounded. It is a force fit in the machined recess keyway in the front centerline of the eyepiece box (11). This key is a sliding fit in the inside keyway In the lower part of the outer tubs. It provides the angular maintenance of the emerging light rays within the prescribed tolerance of five minutes of arc with the entering light rays.

1. Angular alignment determination of the eyepiece box to the eyepiece skeleton. The correct location of the two inserted dowel pins (76, Figure 7-11) of the eyepiece skeleton (42, Figure 7-11) large shoulder flange and their proper engagement in reamed dowel pin holes of the eyepiece box (11) is determined through the procedure followed under the same subject in Section 4M1.

heads of five bolts (16). These bolts extend into tapped holes in the base of the eyepiece box. Two inserted dowel pins (20) fit into the inserted dowel pin bushings (15) in the base of the eyepiece box to reestablish factory alignment upon reassembly.

The upper face of the bottom flange plate is provided with a narrow slot of shallow depth for the insertion of a rubber gasket (14). The narrow slot conforms to the irregular outer circumference of the eyepiece box base. The rubber gasket (14) prevents water from entering the bottom plug assembly.

A clearance hole of 2 1/2 inches in diameter is located in the rear central half of the plate, and provides sufficient clearance for the attachment of an electronic device projection that connects to the bottom plug assembly.

o. Rayfilter stowage case assembly. The rayfilter stowage case assembly (31) rests on the eyepiece box bottom flange plate (13) and is secured to it with one of the bolts and nuts of the eight used in attachment of the electronic device.

p. Name plate. The name plate (9) is of the same dimensions and material as the name plates (20, Figure 4-29) used in the Types II

and III periscopes. It serves the same purpose and is located and secured in similar manner with four lockscrews (19). Refer to Section 4M1.

(19, Figure 4-29) used in the Types II and III periscopes. They serve the same purpose and function. Refer to Section 4M1. However, in the Type IV design, two are provided on the front of the eyepiece box only.

q. Anchor screw pins. The two anchor screw pins (8) are identical to the anchor screw pins

J. PACKING GLAND ASSEMBLIES, PART II

7J1. General description of the four packing gland assemblies. The eyepiece box is provided with four packing gland assemblies in the form of stuffing boxes. Each assembly allows passage and maintains the hermetical seal around each moving shaft, such as the eyepiece drive, or the focusing mechanism, the rayfilter drive, the prism tilt, and the change of power mechanisms.

All four are similar in design, with the exception of the rayfilter drive stuffing box body.

These four packing gland assemblies are of an improved design using hycar synthetic rubber packing and should provide a much longer service life than the flax packing type. However, these glands are carefully run in at the factory and should not be disassembled or the shaft removed unless pressure tests or service experience indicate the need of replacement. The following sections outline the procedure to follow should repacking be found necessary.

7J2. Description of the rayfilter drive packing gland assembly. Figure 7-13 shows this picking gland assembly. All bubble numbers in Sections 7J2, 3, and 4 refer to Figure 7-13 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature

a. Stuffing box body. The rayfilter drive stuffing box body (6) is made of phosphor-bronze material with an over-all length of 1 inch. The external part is made of a step design, with a square

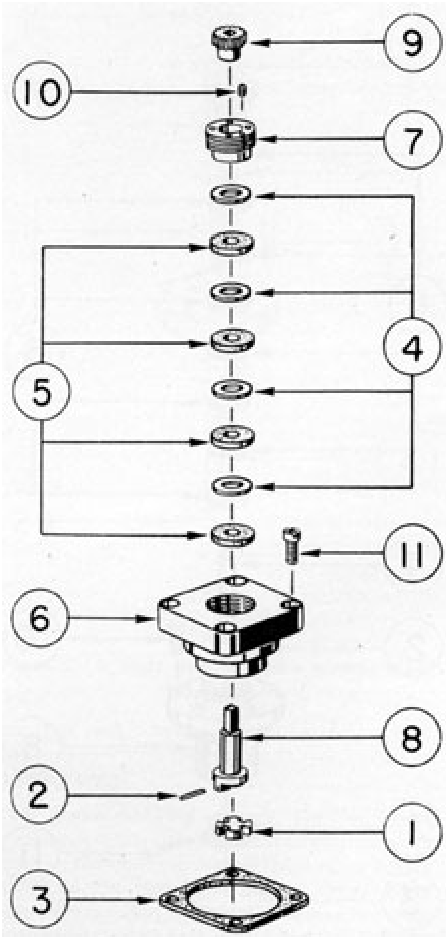

Figure 7-13. Rayfilter drive packing gland assembly.

1	P-1318-9	1	Female coupling section
2	P-1318-9A	1	Phosphor-bronze wire
3	P-1405-6	1	Stuffing box body rubber gasket
4	P-1503-2	4	Brass spacer washers (0.020 inch)
5	P-1503-3	4	Hycar packing spacers
6	P-1503-4	1	Stuffing box body
7	P-1503-5	1	Packing retainer
8	P-1503-6	1	Rayfilter drive actuating shaft
9	P-1503-7	1	Rayfilter drive actuating gear
10	P-1506-43	1	Packing retainer lockscrew
11	P-1506-53	4	Stuffing box body lockscrews

flange section. Each of the four corners of the square flange section is rounded with a clearance hole in each corner having a counterbored recess for lockscrews (11). The cylindrical shoulder section directly below the square flange section offers a sufficient seat for a rubber gasket (3). The square flange section of the stuffing box body with the cylindrical shoulder section is a sliding fit into the bored hole and the countersunk square recess in the front of the eyepiece box (11, on the countersunk square recess seat in the eyepiece box and is secured with four lockscrews (11) inserted in the tapped holes in the square recess seat.

The small cylindrical shoulder provides sufficient wall area for strength with the corner beveled. The inside is provided with a reamed hole and two counterbored sections. The reamed hole is a sliding fit for the assembly of the rayfilter drive actuating shaft (8).

Figure 7-12). The square flange section rests on the rubber gasket, which in turn rests

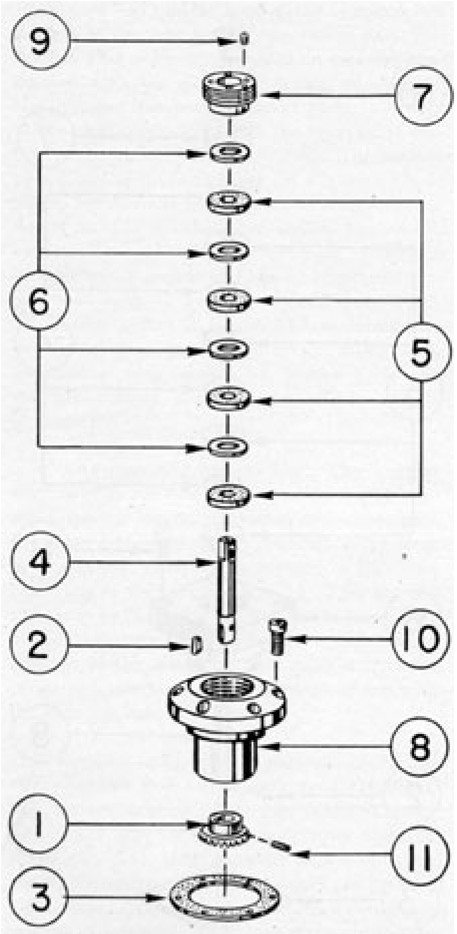

Figure 7-14. Eyepiece drive packing gland assembly.

The small counterbored section provides a sufficient chamber

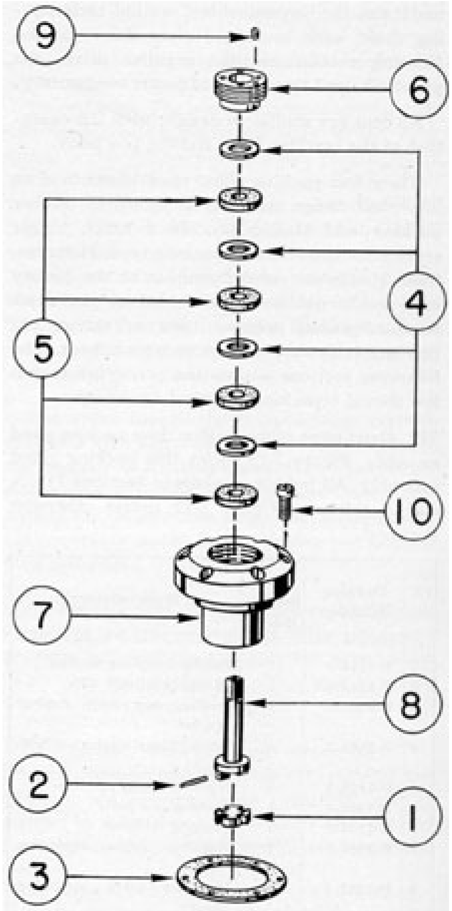

Figure 7-15. Left training handle packing gland assembly.

area for four Hycar packing spacers (5) separated with four brass, spacer washers (4). The large counterbored section is threaded for the assembly of an external threaded packing retainer (7).

b. Rayfilter drive actuating shaft. The rayfilter drive actuating shaft (8) is made of corrosion-resisting steel material. The flange section of the shaft has two projecting lugs to form a male coupling section with the assembled female coupling section (1) which provides an interconnection with the male coupling section (25, Figure 7-11) of the eyepiece skeleton assembly. The

main body of the shaft is a sliding fit in the reamed hole in the rayfilter stuffing box body (6) and part of the reamed hole in the packing retainer (7). The four Hycar packing spacers (5) and the four brass spacer washers (4) fit over the main body of the shaft. The square section of the shaft carries a rayfilter drive actuating gear (9).

c. Female coupling section. The female coupling section (1) is made of corrosion-resisting steel material of nominal thickness. It is shaped cylindrically with four equally spaced slots and is assembled between the projecting lugs of the male coupling flange section of the rayfilter drive actuating shaft (8). It is secured with a phosphor-bronze pin (2) which is inserted through a small drilled hole in the lugs and the center section remaining between the depth of the opposite slots. The pin is spread at opposite sides of each male lug, allowing the female coupling section a small axial motion. When it is assembled to the projecting male lugs of the rayfilter drive actuating shaft, it serves as a coupling for its interconnection between the male coupling section (25, Figure 7-11) of the eyepiece skeleton assembly, using the two slots perpendicular to the assembled pinned slots.

d. Rayfilter drive actuating gear. The rayfilter drive actuating gear (9) is made of phosphor-bronze material. Its center axis has a broached hole for its assembly over the square section of the rayfilter drive actuating shaft (8). The gear section has 15 teeth of the similar diametral pitch to the rayfilter drive actuating gear rack (1, Figure 7-19) of the rayfilter housing and plate assembly. The hub section of the

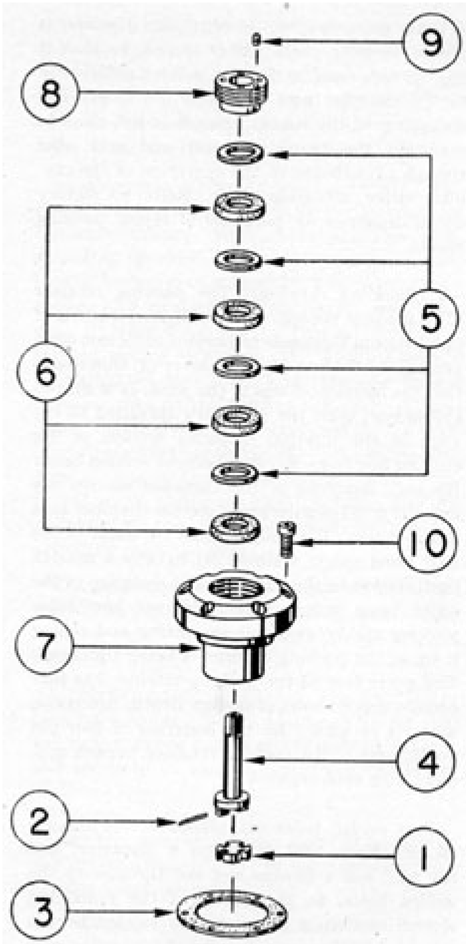

Figure 7-16. Right training handle packing gland assembly.

the gear rack provides an interconnection with the eyepiece drive mechanism to synchronize its vertical travel.

e. Hycar packing spacers. The four Hycar packing spacers (5) are synthetic rubber spacers used in the chamber area of the stuffing box to maintain the hermetical seal of the rayfilter drive mechanism. Each spacer is punched from 0.125 inch thick sheet rubber with a clearance hole for the rayfilter drive actuating shaft (8).

gear is a sliding fit in the reamed hole in the packing retainer (7). The rayfilter drive gear in mesh with

A brass spacer washer (4) of smaller diameter is placed between each rubber spacer, so that it will spread, causing them to adhere sufficiently to the chamber area wall and the shaft. The spreading of the rubber spacers is sufficient to maintain the hermetical seal and still offer enough smoothness to the operation of the rayfilter drive actuating shaft. Refer to factory detail drawings for purchase of Hycar packing sheets.

f. Packing retainer. The packing retainer (7) is made of phosphor-bronze material and is of proportional thickness to provide sufficient compression of the four Hycar spacers (5) that maintain the hermetical seal of the joint. It is shaped cylindrical, with the periphery threaded to engage in the internal threaded section in the stuffing box body (6). An undercut section below the root diameter of the threaded section fits into the small counterbored section chamber area in the stuffing box body against the outer of the four brass spacer washers (4) to offer a smooth compression to the packing. The omission of the outer brass spacer would damage the outer packing spacer, resulting in cutting and rolling it up as the packing retainer is being tightened. The outer face of the packing retainer has four equally spaced holes of shallow depth, concentric with its periphery for the insertion of four pin projections of the packing retainer wrench supplied with each repaid kit.

2. Remove the lockscrew (10), unscrewing it from the tapped hole in the face of the packing retainer (7).

3. Place the pin projections of a packing retainer wrench in the four holes in the packing retainer (7), unscrewing it from the stuffing box body (6).

4. Remove the rayfilter drive actuating shaft (8), carrying it out of the small end of the stuffing box body (6). The female coupling section (1) remains assembled to the male coupling section of the shaft.

5. Remove the four Hycar packing spacers (5) and the four brass spacer washers (4) from the chamber area in the stuffing box body (6). The Hycar packing spacers should not adhere to the chamber walls or freeze to the rayfilter drive actuating shaft (8).

6. The Hycar packing spacers, after being stamped to conform to detail drawings, are soaked in Lubriplate No. 210 for one week. Before assembly all Lubriplate is wiped off and Glydag is applied to shafts and Hycar packing spacers. After complete assembly each shaft should be rotated 1,000 revolutions in each direction. The running in of each packing gland assembly should eliminate the freezing of the shaft, since the Hycar packing spacers take a permanent set because of compression.

Two drilled hole are placed in the threaded periphery 180 degrees apart on a diameter, and the wall has a narrow slot through to the drilled holes. In the center of the remaining slotted section, a perpendicular tapped hole is provided in the outer face for the insertion of a lockscrew (10). The lockscrew when tightened causes the narrow slotted half of the wall to spread away from the heavier part, and secures the packing retainer in the internal threaded section in the stuffing box body (6).

7J3. Disassembly of the rayfilter picking gland assembly. The rayfilter packing glazed assembly is disassembled in the following manner:

1. Remove the rayfilter drive actuating gear (9) from the square section of the rayfilter drive actuating shaft (8).

7J4. Reassembly of the rayfilter drive packing gland assembly. The rayfilter drive packing gland assembly is reassembled in the following manner:

1. Reassemble the rayfilter drive actuating shaft (8) with the assembled female coupling section (1) and fits pin (2) into the reamed hole through the small end of the stuffing box body (6).

2. Follow the Lubriplate soaking process and Glydag application stated in Step 6 of Section 7J3. Rest the stuffing box body and its shaft on the coupling section (1) for further reassembly. Assemble each of the four Hycar packing spacers (5) over the body of the shaft, separating each packing washer with a brass spacer washer (4). Center the hole of each brass pacer washer on each packing spacer so that when it is compressed the packing will adhere to the shaft with full concentricity.

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3. Reassemble the packing retainer (7) over the shaft, and engage it into the internal threaded section in the stuffing box body (6).

4. Use a packing retainer wrench with pin projections inserted in the four holes in the face of the packing retainer (7). Screw the packing retainer down to the outer brass spacer washer (4) and further compress the four Hycar packing spacers (5). Continue the screwing in of the packing retainer until the upper face is flush with the face of the stuffing box body (6).

5. Insert the lockscrew (10) in the tapped hole in the slotted section of drive actuating shaft (4). The cylindrical flange section rests on a rubber gasket (3), which in turn rests in the counterbored seat in the eyepiece box (11, Figure 7-12) and is secured with six lockscrews (10) inserted in the tapped holes in the above counterbored seat.

b. Eyepiece drive actuating shaft. The eyepiece drive actuating shaft (4) is made of corrosion-resisting steel material. The stem section is provided with a short recess keyway for the insertion of a key (2). The stem section carries the eyepiece drive mechanism bevel gear (1) with a keyseat on this section and, is

the packing retainer face (7), screwing it tight to secure the packing retainer.

6. Rotate the rayfilter drive actuating shaft (8) 1,000 revolutions in each direction.

7. Assemble the rayfilter drive actuating gear (9), placing its hub section on the square section of the rayfilter drive actuating shaft (8).

7J5. Description of the eyepiece drive packing gland assembly. Figure 7-14 shows this packing gland assembly. All bubble numbers in Section 7J5, 6, and 7 refer to Figure 7-14 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1160-11	1	Eyepiece drive mechanism bevel gear
2	P-1163-11	1	Eyepiece drive, mechanism bevel gear key
3	P-1406-7	1	Stuffing box body rubber gasket
4	P-1409-2	1	Eyepiece drive actuating shaft
5	P-1502-3	4	Hycar packing spacers
6	P-1502-2	4	Brass spacer washers (0.020 inch)
7	P-1502-5	1	Packing retainer
8	P-1502-7	1	Stuffing box body

secured with a lockscrew (11). The main body is carried in the small counterbored section chamber area of the stuffing box body (8) and forms the body section over which the four Hycar packing spacers (5) are assembled, separated with four brass spacer washers (6) to which the Hycar packing spacers adhere for maintaining the hermetical seal around the actuating shaft.

The square section of the shaft forms a connection with the square broached hole in the focusing knob female coupling section (3, Figure 4-39).

c. Hycar packing spacers. The four Hycar packing spacers (5) are identical to the left and right training handle Hycar packing spacers, and are used in similar manner to the Hycar packing spacers (5, Figure 7-13) separated with the four brass spacer washers (6) which are used in similar manner to the four brass spacer washers (4, Figure 7-13) of the rayfilter drive packing grand assembly.

d. Eyepiece drive mechanism bevel gear. The eyepiece drive mechanism bevel gear (1) is made of phosphor-bronze material. It consists of a bevel gear section with a pitch cone line angle of 60 degrees to engage with the teeth of the eyepiece prism shift bevel gear (41, Figure 7-11) of the eyepiece skeleton assembly. Its center axis has a reamed hole with a keyseat to fit on the stem section of the eyepiece drive actuating shaft (4) and the inserted key (2). The hub section has a tapped hole for the insertion of a lockscrew (11) to secure the bevel gear from axial displacement on the shaft. The bevel gear, engaging with the eyepiece prism shift bevel gear (41,

9	P-4506-43	1	Packing retainer lockscrew
10	P-1506-44	6	Stuffing box body lockscrews
11	P-1506-45	1	Eyepiece drive mechanism bevel gear lockscrew

a. The stuffing box body. The stuffing box body (8) is similar to the stuffing box bodies of both training handles except that it has a small counterbored section with an additional reamed hole for the stem section of the eyepiece

Figure 7-11) of a 60 degrees pitch cone line

angle, provides operation for the eyepiece drive mechanism of the eyepiece skeleton assembly by turning the focusing knob (1, Figure 4-39).

e. Packing retainer. The packing retainer (7) is similar to the rayfilter drive packing retainer (7, Figure 7-13) except in diameter, the undercut shoulder section, and the reamed hole. It has a counterbored section that allows entry of the square broached hole section of the focusing knob female coupling section (3, Figure 4-39) which is a sliding fit on the square section of the eyepiece drive actuating shaft (4). The packing retainer lockscrew (9) is used in similar manner (7) to the lockscrew (10, Figure 7-13) in the packing retainer (7) of the rayfilter packing gland assembly.

7J6. Disassembly of the eyepiece drive packing gland assembly. The eyepiece drive packing gland

shaft (4). Secure the bevel gear to the shaft by the insertion of a lockscrew (9) in the tapped hole in the hub section.

3. Refer to the procedure in Step 2, Section 7J4, for reassembly of the Hycar packing spacers (5) and the brass spacer washers (6) over the eyepiece drive actuating shaft (4).

4. Reassemble the packing retainer (7) in the stuffing box body (8) in similar manner to the procedure described in Steps 3, 4, and 5, Section 7J4. Secure the packing retainer with the lockscrew (9) in similar manner.

5. Rotate the eyepiece drive actuating shaft (4) 1,000 revolutions in each direction.

7J8. Description of the left training handle packing gland assembly. Figure 7-15 shows this packing gland assembly. All bubble numbers in Sections 7J8, 9, and 10

assembly is disassembled in the following manner:

1. Remove the lockscrew (11), unscrewing it from the hub section of the eyepiece drive mechanism bevel gear (1). Remove the bevel gear, sliding it from the stem section of the eyepiece drive actuating shaft (4). Remove the inserted key (2).

2. Remove the lockscrew (9) and the packing retainer (7) in similar manner to the procedure followed in Steps 2 and 3, Section 7J3.

3. Remove the eyepiece drive actuating shaft (4) from the stuffing box body large flanged section end (8).

4. Remove the four Hycar packing spacers (6) and the four brass spacer washers (5) in a similar manner to the procedure followed in Step 5, Section 7J3.

7J7. Reassembly of the eyepiece drive packing gland assembly. The eyepiece drive packing gland assembly is reassembled in the following mariner:

1. Reassemble the eyepiece drive actuating shaft (4) into the stuffing box body (8) from the large flange section end.

2. Reassemble the key (2) in the keyway in the stem end of the eyepiece drive actuating shaft (4). Reassemble the eyepiece drive mechanism bevel gear (1) oil the stem section and the inserted key (2) of the eyepiece drive actuating

refer to Figure 7-15 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1318-2	1	Female coupling section
2	P-1318-2A	1	Phosphor-bronze wire
3	P-1406-7	1	Stuffing box body rubber gasket
4	P-1502-2	4	Brass spacer washers (0.020inch)
5	P-1502-3	4	Hycar packing spacers
6	P-1502-5	1	Packing retainer
7	P-1502-6	1	Stuffing box body
8	P-1502-8	1	Actuating shaft
9	P-1506-43	1	Packing retainer lockscrew
10	P-1506-44	6	Stuffing box body lockscrews

a. Stuffing box body. The stuffing box body (7) is made of phosphor-bronze material. The external part is made of a step design. It has a large cylindrical flange section with the medium stepped section. The large flange section and the medium section are a sliding fit into a bored and counterbored section seat in the left side of the eyepiece box. The face of the large flange section is beveled at 30 degrees to avoid projecting corners over the contour

of the eyepiece box (11, Figure 7-12). The small section is short because of the added spiral drive housing (44, Figure 7-11) of the eyepiece skeleton assembly. The corner of the small section is chamfered to break the sharp edge.

The small and large counterbored sections and the threaded section serve the same purpose as those in the rayfilter drive stuffing box body (6, Figure 7-13). The large cylindrical flange section is provided with six equally spaced clearance holes having counterbored recesses for lockscrews (10). The large flange section rests on a rubber gasket (3) which in turn rests in the counterbored section seat in the eyepiece box which is secured with six lockscrews (10). These lockscrews are screwed into tapped holes in the eyepiece box counterbored section seat.

b. Actuating shaft. The actuating shaft (8) is made in similar manner to the rayfilter drive actuating shaft (8, Figure 7-13) with variations in size. The square section is larger and shorter in length. The main body is smaller in diameter and longer. The flange section of the shaft with the two projecting lugs forming the male coupling section are identical. When assembled with the female coupling section (1) by means of a phosphor-bronze wire (2), it provides an interconnection with the male coupling section of the spiral bull gear shaft (45, Figure 7-11) in the left side of the eyepiece skeleton assembly. The four Hycar packing spacers (5) fit over the main body of the shaft. The square section of the shaft engages in the (3, Figure 7-21) to be assembled in it and over the square section of the actuating shaft (8) and the packing retainer (6) simultaneously. The packing retainer lockscrew (9) is used in similar manner to the rayfilter drive packing retainer lockscrew (10, Figure 7-13).

7J9. Disassembly of the left training handle packing gland assembly. The left training handle packing gland assembly is disassembled in the following manner:

1. Remove the lockscrew (9) and the packing retainer in similar manner to the procedure followed in Steps 2 and 3, Section 7J3.

2. Remove the actuating shaft (8) from the stuffing box body (7) in similar manner to the procedure followed in Step 4, Section 7J3. The female coupling section (1) remains assembled to the male coupling section of the shaft.

3. Remove the four Hycar packing spacers (5) and the four brass spacer washers (4) from the stuffing box body (7) in similar manner to the procedure followed in Step 5, Section 7J3.

7J10. Reassembly of the left training handle packing gland assembly. The left training handle

square broached hole in the left training handle inner bevel gear clutch (3, Figure 7-21).

c. Female coupling sections. The female coupling section (1) is similar to the rayfilter drive female coupling section (1, Figure 7-13) with the exception of its outer diameter. This female coupling section is assembled to the actuating shaft (8) in similar manner to the rayfilter drive female coupling section (1, Figure 7-13).

d. Hycar packing spacers. The four Hycar packing spacers (5) are similar to the rayfilter drive Hycar packing spacers (5, Figure 7-13) except for their inside clearance holes and periphery.

e. Packing retainer. The packing retainer (6) is similar to the rayfilter drive packing retainer (7, Figure 7-13) except for its diameter, undercut shoulder section, and reamed hole. It has a counterbored section which allows for the protrusion of the square broached hole section of the inner bevel gear clutch hub section

assembly is reassembled in the following manner:

1. Reassemble the actuating shaft (8) with the assembled female coupling section (1) in the stuffing box body (7) in similar manner to the procedure followed in Step 1, Section 7J4.

2. Refer to the procedure followed in Step 2, Section 7J4 for the reassembly of the four Hycar packing spacers (5), and the four brass spacer washers (4) over the actuating shaft (8).

3. Reassemble the packing retainer (6) in the stuffing box body (7) in similar manner to the procedure followed in Steps 3, 4, and 5, Section 7J4. Secure the packing retainer (6) with the lockscrew (9) similarly.

4. Rotate the actuating shaft (8) 1,000 revolutions in each direction.

7J11. Description of the right training handle packing gland assembly. Figure 7-16 shows this packing gland assembly. All bubble numbers in Section 7J11, 12, and 13 refer to Figure 7-16 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1318-2	1	Female coupling section
2	P-1318-2A	1	Phosphor-bronze wire
3	P-1406-7	1	Stuffing box body rubber gasket

Figure 7-15) of the left training angle packing gland assembly. It is secured in the stuffing box body (7) with a lockscrew (9) in similar manner to the lockscrew used in the packing retainer (7, Figure 7-13) of the rayfilter drive packing gland assembly.

7J12. Disassembly of the right training handle packing gland assembly. The right training packing gland assembly is

4	P-1406-8	1	Actuating shaft
5	P-1502-2	4	Brass spacer washers (0.020 inch)
6	P-1502-3	4	Hycar packing spacers
7	P-1502-4	1	Stuffing box body
8	P-1502-5	1	Packing retainer
9	P-1506-43	1	Packing retainer lockscrew
10	P-1506-44	6	Stuffing box body lockscrews

a. Stuffing box body. The stuffing box body (7) is made of phosphor-bronze material. The external part is of a step design. It is similar to the left training handle stuffing box body (7, Figure 7-15), except that the small shoulder section is longer. The large flange section rests on a rubber gasket (3) which in turn rests in the counterbored section seat in the eyepiece box (11, Figure 7-12). It is secured with six lockscrew (10) which are inserted into countersunk clearance holes in the large shoulder flange of the stuffing box body and screwed into tapped holes in the right side counterbored section seat in the eyepiece box.

b. Actuating shaft. The actuating shaft (4) is similar to the actuating shaft (8, Figure 7-15), with variation in the length of the main body. Refer to the actuating shaft (8, Figure 7-15), of Section 7J8, as all other details are identical. The square section of the shaft engages in the square broached hole in the inner bevel gear clutch (3, Figure 7-22).

disassembled in the following manner:

1. Remove the lockscrew (9) and the packing retainer (8) in similar manner to the procedure followed in Steps 2 and 3, Section 7J3.

2. Remove the actuating shaft (4) from the stuffing box body (7) in similar manner to the procedure followed in Step 4, Section 7J3. The female coupling section (1) remains assembled to the male coupling section of the shaft.

3. Remove the four Hycar packing spacers (6) and the four brass spacer washers (5) from the stuffing box body (7) in similar manner to the procedure followed in Step 5, Section 7J3.

7J13. Reassembly of the right training handle packing gland assembly. The right training handle packing gland assembly is reassembled in the following manner:

1. Reassemble the actuating shaft (4) with the assembled coupling section (1) in the stuffing box body (7) in similar manner to the procedure followed in Step 1, Section 7J4.

2. Refer to the procedure followed in Step 2, Section 7J4 for reassembly of the four Hycar packing spacers (6) and the four brass spacer washers (5) over the actuating shaft (4).

3. Reassemble the packing retainer (8) in the stuffing box body (7) in similar manner to the procedure followed in Steps 3, 4, and 5, Section 7J4. Secure the packing retainer (8) with the lockscrew (9) similarly.

c. Female coupling section. The female coupling section (1) is identical to the female coupling section (1, Figure 7-15) of the left training handle packing gland assembly.

d. Hycar packing spacers. The four Hycar packing spacers (6) are identical to the Hycar packing spacers (5, Figure 7-15) of the left training handle packing gland assembly. The four brass spacer washers (5) are also identical to the brass spacer washers (4, Figure 7-15).

e. Packing retainer. The packing retainer (8) is identical to the packing retainer (6,

4. Rotate the actuating shaft (4) 1,000 revolutions in each direction.

7J14. Pressure test of the four packing gland assemblies:

1. Place each stuffing box body rubber gasket of the four packing gland assemblies (3, Figure

7-13, 14, 15 and 16 respectively) in the recess seat provisions in the pressure testing fixture (Figure 4-37).

2. Assemble each of the four packing gland assemblies on its respective rubber gasket seat and insert the four lockscrews (11, Figure 7-13) and the 18 lockscrews (10, Figures 7-14, 15 and 16 respectively) for the securement of each stuffing box body.

3. Secure each packing gland assembly to the counterbored recess seat, and counterbored section seats in the fixture by screwing the lockscrews into the tapped holes in each provision.

4. Use 100 psi air pressure, with the pressure testing fixture and packing gland assemblies immersed in water. No leaks should be discernible in a half-hour test.

5. Remove the lockscrews inserted in Step 2 and remove each of the four packing gland assemblies from the pressure testing fixture and blow off all water with an air hose.

K. EYEPIECE WINDOW ASSEMBLY, PART II

7K1. Description. The eyepiece window assembly is similar to the Type II and III periscopes except for minor details. Part numbers change for the Type IV periscope in some respects; however, the purpose and

function are the same. Refer to Sections 4O1, 2, and 3 for description, disassembly, and reassembly, as shown in Figure 4-38.

Ill. No.	Drawing Number Type I	Drawing Number Type IV	Number Required	Nomenclature
1	P-1171-7	P-1171-7	1	Clamp ring
2	P-1179-66A	P-1506-46A	4	Frame lockscrews (short)
3	P-1179-66B	P-1506-46B	8	Frame lockscrews (long)
4	P-1179-102	P-1506-175	1	Bevel rubber gasket
5	P-1179-103	P-1506-176	1	Clamp ring rubber gasket
6	P-1179-120	P-1506-150	1	Metal protection washer
7	P-1408-1	P-1511-1	1	Frame
8	P-1408-5	P-1408-5	1	Frame rubber gasket
9	P-1396-11 (Type III) P-1418-15 (Type II)	P-1475-12	1	Eyepiece window

L. BOTTOM PLUG ASSEMBLY

(For the electronic engineer only)

7L1. Description. The bottom plug assembly is described in the following manner: The hermetical seal of the periscope necessitates a plug connection, like the bottom, plug assembly, for interconnection with the antenna array and the electronic device adapter. Figure 7-17 shows the bottom plug assembly. All bubble numbers in Sections 7L1, 2, and 3, refer to Figure 7-17 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1498-2	1	Bottom plug housing
2	P-1498-3	1	Bottom plug window clamp ring
3	P-1498-4	1	Bottom plug housing rubber gasket
4	P-1498-5	2	Bottom plug window rubber gaskets
5	P-1498-6	1	Bottom plug window
6	P-1498-7	12	Bottom plug window

a. Bottom plug housing. The bottom plug housing (1) is made of phosphor-bronze material with an over-all length of 1.803 inch. The external body is stepped to provide the necessary wall thickness to conform to the inside counterbored sections. The inner shoulder section

			clamp ring lockscrews
7	P-1498-8	12	Bottom plug housing lockscrews
8	P-1516-7	3	Choke insulation rings

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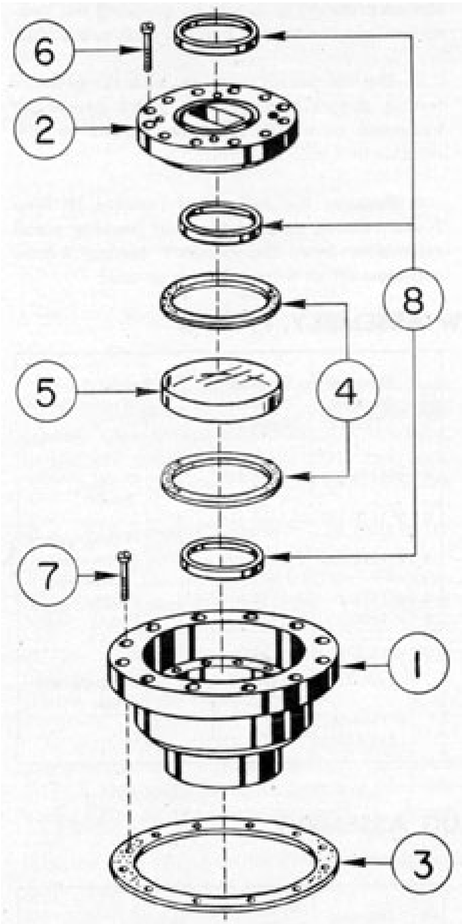

Figure 7-17. Bottom plug assembly.

is made of three parts to provide the rectangular dimensional clearance for the necessary electronic area. The inner shoulder of the bottom plug housing is slotted and has two major chord sections silver soldered as shown in the cross sectional view (Figure 7-18) and the factory detail drawing. It is machined to the required diameter. The third part is a cylindrical disk with a rectangular broached opening to allow clearance for the rectangular

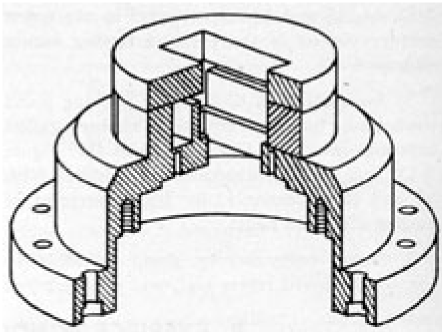
Figure 7-18. Bottom plug housing, cross-sectional view.

soldered major chord sections and the remaining chord sections of the bottom plug housing. The second larger shoulder is a sliding fit in the bored hole in the base of the eyepiece box (11, Figure 7-12) while the large flange section is a sliding fit into the counterbored section seat. The bottom plug housing is secured to the counterbored section seat on a rubber gasket (3) to maintain the hermetical seal with the bottom plug window (5) and two bottom plug window rubber gaskets (4). Twelve equally spaced clearance holes with counterbored recesses are provided in the large flange section to secure the bottom plug housing on the inserted rubber gasket (3) in the counterbored section seat in the eyepiece box with 12 lockscrews (7). These lockscrews are screwed into tapped holes in the counterbored section seat in the eyepiece box base.

waveguide section continuation (43, Figure 7-11). This cylindrical disk is silver soldered to the two faces of the

The internal part of the bottom plug housing has a rectangular broached opening for the electronic passage. A circular groove carries a choke insulation ring (8). A counterbored section of shallow depth provides additional dimensional area. A thin raised shoulder section carries the inner bottom plug window rubber gasket (4). The small counterbored section carries the bottom plug window (5), with sufficient sliding clearance, and serves as a centering guide for the small alignment support section of the bottom plug window clamp ring (2). The large counterbored section carries the clamp ring with sufficient sliding clearance. The face of the large counterbored section seat has 12 equally spaced tapped holes to retain

the clamp ring with the outer rubber gasket (4) against the outer parallel face of the bottom plug window (5) and is secured with 12 lockscrews (6).

b. Bottom plug window clamp ring. The bottom plug window clamp ring (2) is made of phosphor-bronze material, with an over-all thickness of 0.500 inch. It is shaped cylindrically with a rectangular opening in its center axis with sufficient clearance for the electronic device adapter. A small undercut shoulder section serves as an alignment support section in the small counterbored section in the bottom plug housing (1). A shallow counterbored section in the inner part provides additional dimensional area. The remaining thin raised shoulder area covers and compresses the outer bottom plug

3. Tap the handle part of the special square plate jig, thereby loosening and pulling out the bottom plug window clamp ring (2). The bottom plug window rubber gasket (4) may stick to the counterbored section seat in the bottom plug window clamp ring.

4. Remove the bottom plug window rubber gasket (4) and clean off the thin raised shoulder seat in the bottom plug window clamp ring. Destroy the old outer bottom plug window rubber gasket (4).

5. Remove the bottom plug window (5) from the bottom plug housing (1). It may be necessary to use a rectangular piece of wood to break the contact of the bottom plug window from the inner bottom plug window rubber gasket (4). Remove the bottom plug window rubber

window rubber gasket (4). Two circular grooves in the inner and outer face carry two choke insulation rings (8) flush with each face. The flange section is provided with 12 clearance holes, each having a counterbored recess for its lockscrews and their heads.

c. Choke insulation rings. The three choke insulation rings (8) confine the ultra high frequency impulses of the electronic device to the desired dimensional area. The impulses travel on the inner surface of the rectangular slotted sections, thus the choke rings minimize attenuation.

d. Bottom plug window. The bottom plug window (5) is made of No. 774 Corning glass material, shaped cylindrically with both faces parallel and fine-ground. The window has a thickness of 0.300 inch.

7L2. Disassembly. The bottom plug assembly is disassembled in the following manner:

1. Remove the 12 lockscrews (6) from the bottom plug window clamp ring (2). These lockscrews are unscrewed from tapped holes in the counterbored section seat in the bottom plug housing (1).

2. Attach a special square plate jig (Figure 7-4) to the face of the bottom plug window clamp ring (2) with the coinciding clearance holes to match four 8-32 tapped holes. Insert the four 8-32 screws in the tapped holes in the bottom plug window clamp ring and secure the jig.

gasket from the thin raised shoulder seat in the bottom plug housing, and clean off both parallel faces of the bottom plug window. Destroy the old inner bottom plug window rubber gasket (4).

7L3. Reassembly. The bottom plug assembly is reassembled in the following manner:

1. Place the new inner bottom plug window crude rubber gasket (4) on the thin raised shoulder seat in the bottom plug housing (1).

2. Place the bottom plug window (5) on the inner rubber gasket (4).

3. Place the new outer bottom plug window crude rubber gasket (4) on the outer face of the bottom plug window (5) centering the gasket to conform to the circumference of the bottom plug window.

4. Reassemble the bottom plug window clamp ring (2) with its thin raised shoulder seat on the centered outer bottom plug window rubber gasket (4). Check the waveguide slots of both the bottom plug housing (1) and the bottom plug window clamp ring (2) for proper matching.

5. Insert the 12 bottom plug window clamp ring lockscrews (6) in the counterbored recesses and clearance holes in the bottom plug window clamp ring (2), and screw them in tapped holes in the counterbored section seat in the bottom plug housing (1). Tighten these lockscrews to a

snug all around setting. Both

6. In the renewal of rubber gaskets,

bottom plug window rubber gaskets are tightened to approximately 25 to 30 percent of the original thickness of the rubber gaskets.	refer to factory detail drawings, and comply with original dimensions. Refer to Section 7V for testing procedure of the bottom plug assembly.

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Chapter 7 Continued

M. FOCUSING KNOB ASSEMBLY, PART II

7M1. Description of the focusing knob assembly, Part II. The focusing knob assembly of the Type IV periscope is similar to the Types II and III periscopes except for minor part numbers; however, their purpose and function are the same. Refer to Sections 4P1, 2, and 3 for description, disassembly, and reassembly, as shown in Figure 4-39.

Ill. No.	Drawing Number Type I	Drawing Number Type IV	Number Required	Nomenclature
1	P-1133-1	Same	1	Knob
2	P-1133-7	Same	1	Knob shaft
3	P-1133-8	Same	1	Female coupling section
4	P-1179-194	P-1506-109	1	Knob and shaft taper pin
5	P-1179-195	P-1506-108	1	Knob shaft and female coupling section dowel pin
6	P-1310-39	P-1506-50	1	Diopter ring lockscrew
7	P-1408-2	Same	1	Knob bracket
8	P-1408-2A	Same	2	Knob bracket dowel pins
9	P-1408-6	Same	1	Diopter ring
10	P-1422-9	P-1506-51	4	Knob racket lockscrews

N. RAYFILTER HOUSING AND PLATE ASSEMBLY, PART II

7N1. Description. The rayfilter housing and plate assembly provides the necessary foundation when attached to the eyepiece window frame (7, Figure 4-38) of the eyepiece window assembly for the attachment of the rayfilter,

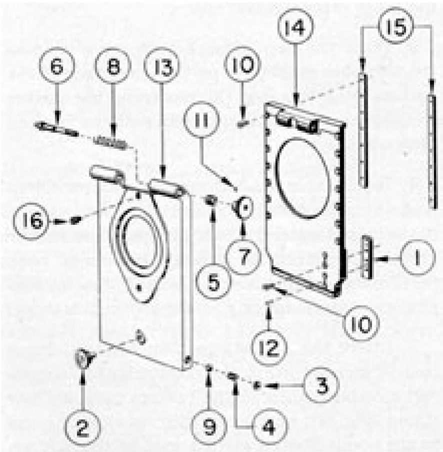

Figure 7-19. Rayfilter housing and plate assembly.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1412-7	1	Rayfilter drive actuating gear rack
2	P-1413-2	1	Housing knob
3	P-1413-3	2	Friction catch spring retainers
4	P-1413-4	2	Friction catch springs
5	P-1438-2	2	Plunger rod spring bushings
6	P-1438-3	2	Spring actuated plunger rods
7	P-1438-4	2	Spring actuated plunger knobs
8	P-1438-5	2	Plunger rod springs
9	P-1448-2	2	Ball bearing friction catches
10	P-1506-42	18	Rayfilter plate strap and rayfilter drive actuating gear rack lockscrews
11	P-1506-57	2	Spring actuated plunger knob lockscrews
12	P-1506-116	2	Rayfilter drive actuating gear rack dowel pins

13	P-1512-1	1	Rayfilter housing
14	P-1512-2	1	Rayfilter plate
15	P-1512-3	2	Rayfilter plate straps
16	P-1513-5	2	Anchor screw pins

eyebuffer and blinder assembly (Figure 7-20), and the variable density polaroid filter assembly (Figure 4-41). Figure 7-19 shows the rayfilter housing and plate assembly. All bubble numbers in Sections 7N1, 2, and 3 refer to Figure 7-19 unless otherwise specified.

a. Rayfilter plate. The rayfilter plate (14) is made of cast phosphor-bronze and is rectangular shaped. This plate serves as a foundation for the rayfilter housing (13). The upper part is provided with a center male hinge projection with a reamed hole to accommodate two spring actuated plunger rods (6) of the two female hinge projection sections of the rayfilter housing (13). The upper main inside section has a cast recess, while the remaining wall has a nominal thickness, with side shoulders and a narrow upper shoulder. The side shoulders are provided with recesses that carry the rayfilter plate straps (15) on each side. A rayfilter plate strap (15) is secured to the rayfilter plate (14) on each side with seven lockscrews each (10).

friction catches of the rayfilter housing (13) are engaged in the spotted recesses.

The main body wall is provided with a 3-inch opening for light transmission with anti-reflection threads in the inner circumference. This opening permits free access to the field of the periscope. The inside recess of the main body wall is provided with sliding vertical clearance over the flat flanges of the eyepiece window frame (7, Figure 4-38). The upper and lower shoulders of the main section serve as stops to restrict the vertical movement of the rayfilter plate (14) which has 1 inch of vertical guided travel over the eyepiece window frame upper and lower rectangular section shoulders (7, Figure 4-38).

b. Rayfilter plate straps. The rayfilter plate straps (15) are 1/8 inch longer than the rayfilter plate straps (3, Figure 4-40) of the Types II and III periscope rayfilter assembly. They are secured to the rayfilter plate (14) with seven lockscrews (10) in the same manner. Refer to Section 4Q1.

c. Rayfilter housing. The rayfilter housing (13) is made of cast phosphor bronze and is shaped rectangular. This housing serves as an apron foundation which can be removed readily during the

The lower section of the rayfilter plate (14) has a cast inside recess, while the remaining wall has a nominal thickness with side shoulders and a narrow lower shoulder. The left side of the inside recess of the lower section when viewed from the rear is provided with a rectangular boss section for the rayfilter drive actuating gear rack (1), secured with four lockscrews (10), and maintained in alignment with two dowel pins (12) This gear rack meshes with a rayfilter drive actuating gear (9, Figure 7-13) projecting externally from the rayfilter drive packing gland assembly. The rayfilter drive actuating ear (9) is synchronized to carry the rayfilter p fete (14) vertically with the eyepiece drive mechanism for the focusing movement of 1 1/2 plus and 2 minus diopters.

The exteriors of the side shoulders of the lower section are beveled at a 45 degrees angle, with a straight section having two spotted recesses of 120 degrees The spotted recesses allow the ball bearing friction catches (9) to retain the lower swinging part of the rayfilter housing (13). The lower part of the straight section corners are beveled at a 45 degrees angle to allow clearance for the milled concave corners of the inside recess of the rayfilter housing (13). A raised rectangular boss section on the exterior surface of the wall in the lower part serves as a stop when the ball bearing installation and removal of the periscope. The upper part is provided with two female hinge projection sections, a sliding fit over the center male hinge projection section of the rayfilter plate (14). Both female hinge projection sections have an axis reamed hole to carry the spring actuated plunger rods (6) which are moved axially against spring tension for removal or reassembly to the center male hinge projection section of the rayfilter plate (14). Both female hinge projection sections have a threaded section located in their outer sides to carry two plunger rod spring bushings (5).

The internal part when viewed from the rear has machined recesses allowing a remaining main body wall of nominal thickness with side shoulders. The side shoulders are a sliding fit over the sides of the rayfilter plate (14). The lower part of the internal lower section of each side shoulder has a projecting section with a raised boss section, leaving a narrow lower side wall. The two projecting sections of the side shoulders provide sufficient wall area for the ball bearing friction catch assemblies. The

center of each projection is provided with a 90 degrees spotted recess and a tapped section with a smaller clearance hole. The ball bearing friction catches (9) fit into the clearance hole and spotted recess to protrude about 1/32 inch. A friction catch spring (4) fits loosely in the clearance hole, and is compressed against the ball bearing friction catches (9) by friction catch spring retainers (3). The spring retainer is screwed into the tapped hole in the side wall section of the two projecting sections and compresses the spring (4) to hold the ball bearing snugly, against the 90 degrees recesses.

When the rayfilter housing (13) is swung to the closed position, the ball bearing friction catches (9) engage in the 120 degrees spotted recesses in each shoulder step of the rayfilter plate (14). The raised boss section connecting the two side shoulder projecting sections contacts the raised rectangular boss section of the rayfilter plate (14) upon engagement of the two ball bearing friction catches (9).

The outer face of the main body wall is provided with a large flat raised boss which has a bored hole and shallow counterbored section. The bored hole is provided for light transmission and anti-reflection threads on its inner circumference. The variable density polaroid filter assembly

e. Spring actuated plunger rods and plunger rod springs. The two spring actuated plunger rods (6) and the two plunger rod springs (8) are identical to the spring actuated plunger rods (23, Figure 4-40) and plunger rod springs (25) used in the Types II and III periscopes. Refer to Section 4Q1.

f. Plunger rod spring bushings. The two plunger rod spring bushings (5) are identical to the plunger rod spring bushings (22, Figure 4-40) used in the Types II and III periscopes. Refer to Section 4Q1.

g. Spring actuated plunger knobs. The two spring actuated plunger knobs (7) with their lockscrews (11) are identical to the spring actuated plunger knobs (24, Figure 4-40) used in the Types II and III periscopes. Refer to Section 4Q1.

7N2. Disassembly. The rayfilter housing and plate assembly is disassembled in the following manner:

1. Lift the lower swinging part of the rayfilter housing (13) by grasping the housing knob (2) and pulling it clear of its engagement in the friction catch spotted recesses in the rayfilter plate (14).

2. Grasp the two spring actuated plunger knobs (7), pulling them outward as far as possible, thus removing the rayfilter housing (13) from the rayfilter plate (14).

3. Remove the rayfilter plate (14) by removing the seven lockscrews (10) and the two rayfilter plate straps (15) from each side. Remove the rayfilter plate (14) and straps (15)

(Figure 4-41), is centered in this shallow counterbored section and rests on the large flat raised boss. Either of the two assemblies is retained by two inserted anchor screw pins (16) located with an appropriate center distance concentric with the bored hole and counterbored shallow section.

In the lower central part of the outer face of the main body wall there is a raised boss with a reamed hole. The inside face of the reamed hole of the boss, when viewed from the rear, is countersunk to allow sufficient space for peening of the pressed in stub shaft section of the housing, knob (2). The housing knob furnishes the observer a provision by which he can pull the lower swinging part of the rayfilter housing (13) free of its friction catch engagement with the rayfilter plate (14).

d. Anchor screw pins. The two anchor screw pins (16) are similar to the anchor screw pins (6, Figure 4-40) of the Types II and III rayfilter assembly. Refer to Section 4Q1.

from the eyepiece window frame (7, Figure 4-38).

4. Remove the two lockscrews (11), unscrewing them from the hubs of the spring actuated plunger knobs (7).

5. Wrap a piece of emery cloth around the extended part of each spring actuated plunger rod (6). Holding the emery cloth and plunger rod firmly with a pair of parallel pliers, unscrew each spring actuated plunger knob (7) from the threaded periphery of the spring actuated plunger rods (6) one by one.

6. Remove the spring actuated plunger rods (6) and the plunger rod springs (8) one by one

from the reamed holes in the rayfilter housing (13) two female hinge projection sections.

7. Remove the two friction catch spring retainers (3) unscrewing them from the outer two lower sides of the rayfilter housing (13), removing the two friction catch springs

section of the eyepiece window frame (7, Figure 4-38). Secure the straps with seven lockscrews (10). These lockscrews are inserted in countersunk clearance holes in the rayfilter plate (14) and screwed into tapped holes in the straps.

5. Place both ball bearing friction catches (9) in clearance holes in the rayfilter housing side shoulders (13)

(4) and the two ball bearing friction catches (9).

8. Remove the four lockscrews (10) from the front lower right side of the rayfilter plate (14), unscrewing these lockscrews from the tapped holes in the rayfilter drive actuating gear rack (1). Remove the rayfilter drive actuating gear rack with its two dowel pins (12).

7N3. Reassembly. The rayfilter housing and plate assembly is reassembled in the following manner:

1. Place the rayfilter drive actuating gear rack (1) with its two dowel pins (12) on the lower left inner raised boss face of the rayfilter plate (14), when viewed from the rear. Secure the gear rack with our lockscrews (10). These lockscrews are inserted in countersunk clearance holes in the rayfilter plate front lower right side and screwed into tapped holes in the gear rack.

2. Focus the eyepiece prism to the center of the eyepiece window frame (7, Figure 4-38) making certain that the rayfilter drive actuating gear (9, Figure 7-13) is on the projecting square section of the rayfilter drive actuating shaft (8, Figure 7-13) of the rayfilter drive packing gland assembly. This central position is necessary for full focusing travel.

3. The rayfilter plate (14) is mounted only when the eyepiece lens (33, Figure 7-11) is in the center of the eyepiece window frame (7, Figure 4-38) to establish full synchronized of the lower section with both friction catch springs (4), securing them with both friction catch spring retainers (3).

6. Place the two plunger rod spring bushings (5) in the outer threaded parts of the opposite female hinge projection sections of the rayfilter housing (13). Secure them with a screwdriver.

7. Place the plunger rod springs (8) on the spring actuated plunger rods (6). Insert the spring and plunger rod in the reamed axis hole in each female hinge projection section, carrying them in from the center milled out section.

8. Place a piece of fine emery cloth around the stub section of the spring actuated plunger rod; grasp the emery cloth and stub section with a pair of parallel pliers. Compress the spring and attach the spring actuated plunger knobs (7), one by one, screwing them on the threaded part of the plunger rods (6). Secure the knobs when the shoulder section of each plunger rod is flush with the inner face of each female hinge projection section.

9. Insert the two lockscrews (11) in the hub section of each spring actuated plunger rod knob (7), securing the knobs on the two spring actuated plunger rods (6).

10. Grasp both spring actuated plunger knobs (7) and pull them outward as far as possible, and assemble the rayfilter housing female hinge projection sections (13) to the center male hinge projection section of the rayfilter plate (14). Release the outward tension of the spring actuated plunger knobs, as the springs will

movement. Place the rayfilter plate (14) over the flat sides of the eyepiece window frame (7, Figure 4-38). Check the rayfilter drive actuating gear rack (1) to ascertain its engagement with the rayfilter drive actuating gear (9, Figure 7-13).

4. With the rayfilter plate (14) properly centered and the gear rack in mesh with the rayfilter drive actuating gear, place both rayfilter plate straps (15) in each side shoulder recess of the rayfilter plate in the recess groove allow the plunger rods to snap into the reamed axis hole in opposite sides of the center male hinge projection section of the rayfilter plate. Push the lower part of the rayfilter housing down on the rectangular raised boss stop of the rayfilter plate (14); the ball bearing friction catches (9) will engage the spotted recesses of the shoulder stops in the rayfilter plate in this closed position.

O. RAYFILTER, EYE BUFFER, AND BLINDER, AND STOWAGE CASE ASSEMBLIES, PART II

7O1. Description. These assemblies are described in the following manner: The rayfilter, eye buffer, and blinder assembly is provided for attachment to the eyepiece end of the periscope. It is so designed as not to restrict the field of the periscope to the observer. The rayfilter plates are of the following colors: red, green, yellow, and polarizer. Each mounted rayfilter plate can be mounted in the base plate individually. The polaroid filter plates are carried in a separate assembly. Refer to Section 4R of the variable density polaroid filter assembly (Figure 4-41).

The rayfilter and eye buffer and blinder assembly are external to the hermetically sealed part of the periscope, as is also the

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1134-9	2	Rubber eyeguards
2	P-1414-3	1	Right finger grip lever
3	P-1414-4	1	Left finger grip lever
4	P-1414-5	2	Finger grip lever springs
5	P-1414-6	1	Blinder plate
6	P-1414-7	1	Blinder adjusting screw
7	P-1414-8	1	Blinder adjusting screw nut
8	P-1414-9	1	Blinder adjusting

rayfilter stowage case assembly. The stowage case assembly is secured to the eyepiece box bottom flange plate (13, Figure 7-12) and carries the mounted rayfilters.

Refer to Section 4S1 for the description of the eye buffer and blinder assembly. Figure 7-20 shows the rayfilter, eye buffer, blinder, and stowage case assemblies. All bubble numbers in Sections 7O1, 2, and 3, refer to Figure 7-20 unless otherwise specified.

			screw nut lockscrew
9	P-1416-5	2	Finger grip lever thrust stop screw pins
10	P-1416-6	2	Finger grip lever pivot screw pins
11	P-1475-13	3	Rayfilters, red, green, and yellow
12	P-1506-34	3	Rayfilter clamp ring lockscrews
13	P-1506-62	3	Stowage case body and base plate lockscrews
14	P-1511-5	1	Stowage case body
15	P-1511-6	1	Stowage case cap
16	P-1511-6A	1	Stowage case cap rivet
17	P-1511-7	1	Stowage case lower felt washer
18	P-1511-9	2	Felt separation washers
19	P-1511-10	1	Stowage case base plate
20	P-1513-2	1	Base plate
21	P-1513-3	3	Rayfilter mounts
22	P-1513-4	3	Rayfilter clamp rings

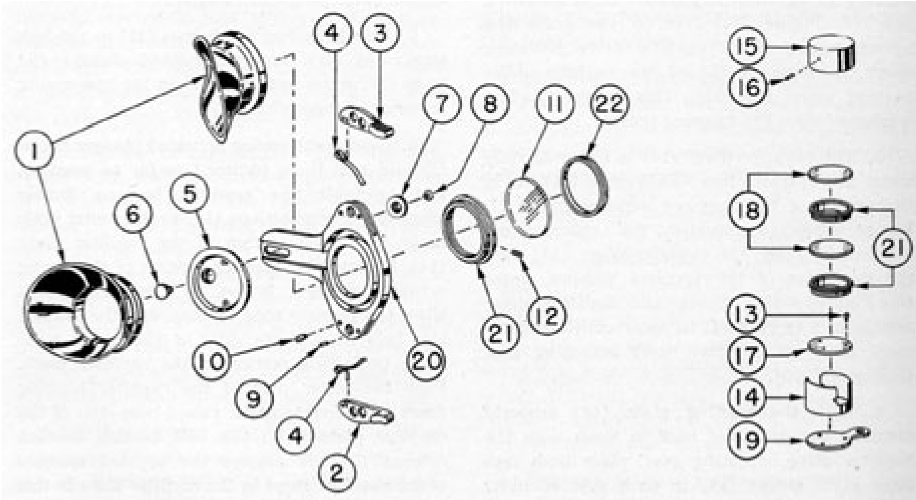

Figure 7-20. Rayfilter, eye buffer, blinder, and stowage case assemblies.

a. Rubber eyeguards. The two rubber eyeguards (1) are identical to the two rubber eyeguards (1, Figure 4-42) described under Section 4S1.

b. Base plate. The base plate (20) is almost identical to the base plate (2, Figure 4-42) described under Section 4S1. It differs in the center axis bored hole, and has no cylindrical raised boss on the lower face. The lower part of the base plate is counterbored and threaded with a coarse thread to carry the threaded periphery of the rayfilter mounts (21) against its counterbored seat. This counterbored threaded section carries any of the three assembled rayfilter mounts desired by the observer.

c. Finger grip levers. The right and left finger grip levers (2 and 3) are identical to the right and left finger grip levers (1 and 2, Figure 4-41) described under Section 4R1 They serve the same purpose and function along with the following parts: two finger grip lever springs (4), two finger grip lever pivot screw pins (10), counterbored section against its counterbored seat. The outer part of the counterbored section is threaded to receive the threaded periphery of the clamp ring (22) which secures the rayfilter snugly and is secured with a lockscrew (12).

The external surface of the mount consists of an undercut shoulder with a threaded periphery to engage into the internal threaded section in the base plate (20) with a 3/4 turn. The shoulder section contacts the base plate when in position and has ample clearance in the bored hole of the rayfilter housing (13, Figure 7-19).

The outer beveled surface of the shoulder section has a straight knurl to provide a rough surface, and offers a firm grip for the removal or replacement of any shade of the three mounted rayfilters (11).

i. Rayfilter clamp rings. The three rayfilter clamp rings (22) are cylindrical, and of nominal width. The clamp ring is bored for light transmission and has a nominal

and two finger grip lever thrust stop screw ins (9).

d. Blinder plate. The blinder plate (5) is identical to the blinder plate (6, Figure 4-42), described under Section 4S1.

e. Blinder adjusting screw. The blinder adjusting screw (6) is identical to the blinder adjusting screw (7, Figure 4-42) described under Section 4S1.

f. Blinder adjusting screw. The blinder adjusting screw nut (7) together with the blinder adjusting screw nut lockscrew (8) is identical, to the blinder adjusting screw nut (8, Figure 4-42), and lockscrew (7) described under Section 4S1.

g. Rayfilters. The three rayfilters (11) consist simply of cylindrical colored filter glass with parallel surfaces. Three shades are used; red, green, and yellow, which are provided for various conditions of observation. Each rayfilter is mounted in an individual rayfilter mount (21) and secured with a clamp ring (22) which is secured with a lockscrew (12).

h. Rayfilter mounts. The rayfilter mounts (21) are provided for each of the three shades of rayfilters. The rayfilter (11) is carried in the

remaining wall thickness. The periphery is threaded to engage into the internal threaded section in each rayfilter -mount, and is secured with a lockscrew (12) after clamping the rayfilter (11) sufficiently to prevent it from unscrewing from the mount. Each mounted rayfilter (11) is carried in the rayfilter stowage case assembly (31, Figure 7-12) attached to the eyepiece box bottom flange plate (13, Figure 7-12). The outer face of each clamp ring is provided with opposite slots for the insertion of a special wrench.

j. Stowage case base plate. The stowage case base plate (19) is made of 1/8-inch brass and is 3 1/32 inches in length. The main section is 1 15/16 inch in diameter and forms a concave junction on opposite sides with an arm 7/8 inch in diameter. The arm has a clearance hole in its center axis for attachment to the eyepiece box bottom flange plate (13, Figure 7-12) upon which it rests.

The main section carries the stowage case body (14) secured with three lockscrew (13) which are inserted in clearance holes in the stowage case body (14) and screwed into tapped holes in the stowage case base plate (19).

k. Stowage case body. The stowage case body (14) is made of sheet brass of nominal thickness and is shaped cylindrical. The

periphery coincides with the periphery of the stowage case base plate main section (19) and

any one of the three shades of mounted rayfilters be assembled in the base plate).

is secured to it with three lockscrew (13). Two opposite slots of large area having a depth of 13/16 inch are provided for rapid removal of any of the extra mounted rayfilters (11). The corners of the opposite slots are rounded. Each remaining wall directly opposite has a circumferential slot to receive the projecting rivet (16) attached in the stowage case cap (15) for its securement.

The inner face of the stowage case body wall has a felt washer (17) glued to it. The felt washer has three clearance holes for the lockscrew heads (13) which are inserted into three clearance holes in the lower wall of the stowage case body and screwed into tapped holes in the stowage case base plate (19) for the securement of the stowage case body.

1. Stowage case cap. The stowage case cap (15) is made of sheet brass of nominal thickness. The cap is a sliding fit over the stowage case body wall (14). A rivet (16) is secured at an appropriate location in the outer wall of the cap so that its inward projecting part engages in the circumferential slot in the stowage case body wall. The cap when assembled covers the large opposite slotted sections of the stowage case body and the mounted rayfilters (11) to prevent breakage and foreign matter from entering. The assembly, provides an adequate stowage case to prevent the mounted rayfilters from becoming lost.

2. By pulling outward with two fingers (one on each hand) placed inside near the base of the eyeguard, remove both eyeguards (1), one from the blinder plate (5) and the other from the base plate (20).

3. Using a small screwdriver, remove the two finger grip lever thrust stop screw pins (9) and the two finger grip lever pivot screw pins (10). Unscrew these four screw pins from the lower slotted walls of the base plate (20). Remove the right and left finger grip levers (2 and 3) and their two tension springs (4).

4. Remove the blinder screw nut lockscrew (8), unscrewing it from the tapped hole in the center axis in the blinder adjusting screw (6) and the counterbored recess in the blinder adjusting screw nut (7).

5. Remove the blinder adjusting screw nut (7), unscrewing it from the threaded stub section of the blinder adjusting screw (6).

6. Remove the blinder plate (5) with blinder adjusting screw (6). Remove the blinder adjusting screw (6).from the blinder plate (5).

7O3. Reassembly of the rayfilter, eye buffer, and blander assembly. The rayfilter, eye buffer, and blinder assembly is reassembled in the following manner:

1. Place the blinder adjusting screw (6) in the offset counterbored clearance hole in the blinder plate (5). Line up the flat shoulders of the adjusting screw with the flat shoulders of the blinder plate small projection by turning the adjusting screw.

m. Felt separation washers. The two felt separation washers (18) are made of 1/32-inch felt, having a diameter of 1 3/4 inch. One felt washer is centered and glued in the inner face of the upper wall of the stowage case cap (15), while the other is used to separate the mounted rayfilters in the stowage case body (14). On the outer face of the cap are the engraved letters rayfilters filled with, white monofil to be clearly visible to the observer.

7O2. Disassembly of the rayfilter, eye buffer, and blinder assembly: The rayfilter, eye buffer, and blinder assembly is disassembled in the following manner:

1. Unscrew the mounted rayfilter (11) from the inner face of the base plate (20) (should

2. Press the left thumb against the blinder adjusting screw thread (6), and place the raised projection pant of the blinder plate (5) in the wide shallow keyway in the base plate projection boss (20) and the protruding part of the adjusting screw into its elongated axial hole. Check to ascertain that the offset hole in the blinder plate is located outward.

3. Screw the blinder adjusting screw nut (7) on the threaded stub section of the blinder adjusting screw (6), turning it clockwise until tight. The counterbored section side should face inward.

4. Insert the blinder adjusting screw nut lockscrew (8) in the threaded axis in the blinder adjusting screw (6). The head of the lockscrew will contact the lower face of the blinder adjusting screw while the lockscrew head enters the blinder adjusting screw nut counterbored section (7). Sufficient distance of this counterbored section remains to allow the nut to be released 1/4 turn for the interpupillary adjustment of the blinder plate (5).

5. Insert the right and left finger grip levers (2 and 3) with their two tension springs (4) in the

Secure each screw pin in the tapped holes in the lower slotted base plate walls.

6. Grasp both finger grip levers (2 and 3) and compress them together, until near the limit of their travel. Insert the two finger grip lever thrust stop screw pins (9), and screw them into the tapped holes of the lower slotted base plate walls (20) one by one.

7. Reassemble the two eyeguards (1), one to the blinder plate (5), and the other to the base plate (20). Rotate the two lower portions of the outer flared out sections of the eyeguards so that they line up centrally.

upper and lower slotted sections in the base plate (20). Compress the tension springs (4) sufficiently to line up the outer pivot hole in each finger grip lever with the pivot hole in the base plate for the insertion of the two finger grip lever pivot screw pins (10) one by one.

Clean all three shades of the mounted rayfilters (11) and place them in the rayfilter stowage case assembly (31, Figure 7-12) attached to the eyepiece box bottom flange plate (13).

P. VARIABLE DENSITY POLAROID FILTER ASSEMBLY, PART II

7P1. Description. The variable density polaroid filter assembly (Figure 4-41) is identical to the variable density Polaroid filter assembly used in the Types II and III periscopes. Refer to Section R of Chapter 4. Follow Sections 4R1, 2, and 3 for description, disassembly, and reassembly.

Q. TRAINING HANDLE ASSEMBLIES, PART II

7Q1. General description of the left and right training handles. The left and right training handles are described in the following manner: Two handles of rugged design for training the periscope in azimuth and for operation of the prism tilt mechanism and the change of power

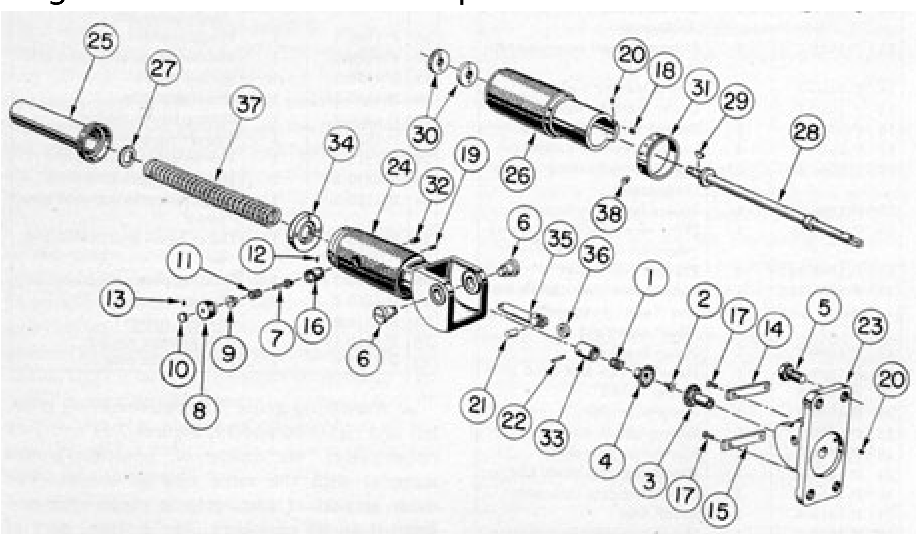

Figure 7-21. Left training handle assembly.

are secured to the eyepiece box. Each training handle interconnects with a separate training handle packing gland assembly in each side of the eyepiece box by means of a clutch. The hinges for the handles are located below the level of the

Ill. No.	Drawing Number	Number Required	Nomenclature
33	P-1510-6	1	Outer bevel gear clutch

center of the eyepiece. When pulled downward the handles project from the periscope horizontally. The handles are held in the extended position by a set of plunger rollers under heavy spring tension resting on the hinge cam periphery beyond the high point of the cams. As each handle is raised, the heavy tension on the rollers will return the handle to the folded position after the rollers pass the high point of the cams.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1069-15	1	Outer bevel gear clutch spring
2	P-1069-16	1	Outer bevel gear clutch retaining screw
3	P-1157-5	1	Inner bevel gear clutch
4	P-1157-6	1	Outer bevel gear clutch
5	P-1161-7	4	Hinge bracket bolts
6	P-1171-6	2	Pivot screws
7	P-1420-6	1	Detent plunger
8	P-1420-8	1	Detent plunger release knob
9	P-1421-1	1	Detent plunger spring retaining bushing
10	P-1421-2	1	Detent plunger retaining cap

			collar
34	P-1510-7	1	Bearing plate
35	P-1510-8	2	Plungers
36	P-1510-9	2	Plunger rollers
37	P-1510-10	1	Coil plunger spring
38	P-1523-7	1	Index ring actuating screw

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1069-15	1	Outer bevel gear clutch spring
2	P-1069-16	1	Outer bevel gear clutch retaining screw
3	P-1157-5	1	Inner bevel gear clutch
4	P-1157-6	1	Outer bevel gear clutch
5	P-1161-7	4	Hinge bracket bolts
6	P-1171-6	2	Pivot screws
7	P-1486-3	1	Upper leather cushion
8	P-1486-4	1	Lower leather cushion
9	P-1506-21	4	Leather cushion lockscrews
10	P-1506-30	2	Segment adjusting screw lockscrews
11	P-1506-54	2	Power indicating

11	P-1421-3	1	Detent plunger spring
12	P-1421-5	1	Detent plunger release knob lockscrew
13	P-1421-6	1	Detent plunger retaining cap lockscrew
14	P-1486-3	1	Upper leather cushion
15	P-1486-4	1	Lower leather cushion
16	P-1505-9	1	Detent plunger housing
17	P-1506-21	4	Leather cushion lockscrews
18	P-1506-30	2	Segment adjusting screw lockscrews
19	P-1506-55	1	Spring barrel lockscrew
20	P-1506-56	4	Pivot screw lockscrews, and segment adjusting screws
21	P-1506-107	2	Plunger roller
22	P-1506-115	1	Outer bevel gear clutch collar and revolving grip shaft taper pin
23	P-1509-1	1	Hinge bracket
24	P-1509-2	1	Handle hinge and fixed grip
25	P-1509-	1	Spring barrel

			screws
12	P-1506-55	1	Spring barrel lockscrew
13	P-1506-56	4	Pivot screw lockscrews, and segment adjusting screws
14	P-1506-107	2	Plunger roller pins
15	P-1506-115	1	Outer bevel gear clutch collar and revolving grip shaft taper pin
16	P-1509-1	1	Hinge bracket
17	P-1509-2	1	Handle hinge and fixed grip
18	P-1509-3	1	Spring barrel
19	P-1509-5	1	Revolving grip
20	P-1509-6	1	Spring barrel washer
21	P-1510-1	1	Revolving grip shaft
22	P-1510-2	1	Revolving grip shaft key
23	P-1510-3	2	Revolving grip lock nuts
24	P-1510-5	1	Revolving grip segment stop screw
25	P-1510-6	1	Outer bevel gear clutch collar
26	P-1510-7	1	Bearing plate
27	P-1510-8	2	Plungers
28	P-1510-9	2	Plunger rollers

	3		
26	P-1509-4	1	Revolving grip
27	P-1509-6	1	Spring barrel washer
28	P-1510-1	1	Revolving grip shaft
29	P-1510-2	1	Revolving grip shaft key
30	P-1510-3	2	Revolving grip lock nuts
31	P-1510-4	1	Index ring
32	P-1510-5	1	Revolving grip segment stop screw

29	P-1510-10	1	Coil plunger spring
30	P-1523-6	1	Power index ring

a. Revolving grips. The two revolving grips, left and right (26 and 19, Figures 7-21 and 7-22 respectively) are made of phosphor-bronze material with the same over-all length. The outer section of each grip is rough diamond knurled on its periphery. The internal part of this outer section is counterbored with a wall

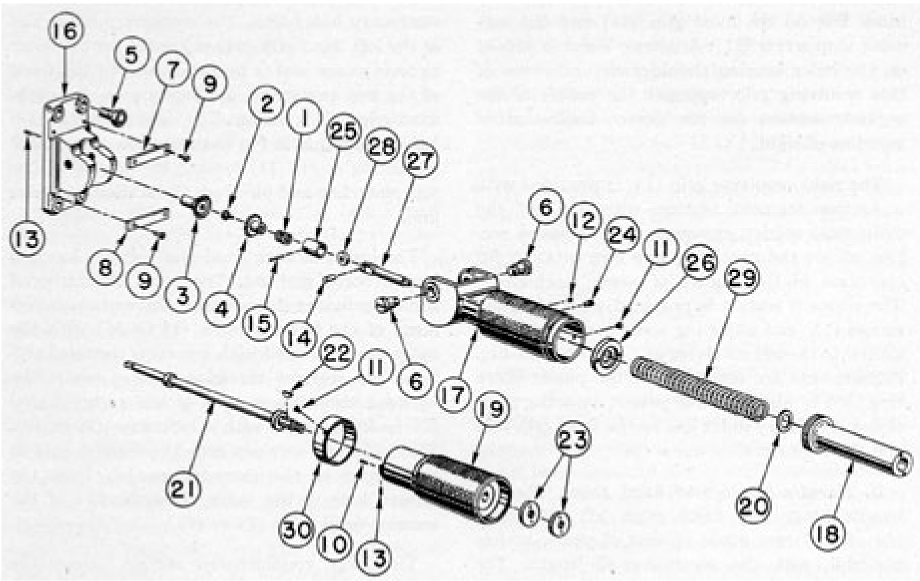

Figure 7-22. Right training handle assembly.

hub section located a short distance from the outer end. The axis of each wall hub section has a reamed hole with a keyseat to carry the stub section of each revolving grip shaft (28 and 21, Figures 7-21 and 7-22 respectively) with an inserted key each (29 and. 22). The shoulder section of each revolving grip shaft is secured to the inner face off the wall hub section with two lock nuts each (30 and 23) on the The inside of each grip is bored and has two counterbored sections with a 30 degrees chamfered section near the center part. The bore provides clearance over the spring barrel (25 or 18). The inner end of each grip is provided with a segment section which stops the revolving grip (26 or 19) when in contact with a segment stop screw (32 or 24) of the fixed grips and training handle hinges (24 or 17).

outer face of the wall hub section. The lock nut engage on the threaded section of the revolving grip shaft to secure the revolving grip.

Both grips have a short undercut shoulder next to the inner art of the knurled section. The graduated index ring (31, Figure 7-21) is a sliding fit on the shoulder section of the left revolving grip (26) and is carried by the inserted actuating screw (28) placed through the elongated slot and in the tapped hole in the shoulder section. The power index ring (30, Figure 7-22) is a sliding fit on the shoulder section of the right revolving grip (19) and is secured with a power indicating screw (11).

Both grips are provided with bearing shoulder sections which are a sliding fit in the inner fixed grips of the training handle hinges (24 or 17).

The segment section of the left revolving grip (26) consists of a narrow section with 275 degrees of the cylindrical shoulder wall section removed. The removed section allows the revolving grip free rotation for operation of the prism tilt mechanism. The segment section is provided with two tapped holes to carry the headless adjusting screws (20) and two perpendicular tapped holes in the face of the segment for the adjusting screw lockscrews (18). These lockscrews are headless screws, which secure the adjusting screws and maintain the adjustment. The adjusting screws project into the cutaway section sufficiently to permit the revolving grip to be adjusted. Adjustments are made to set the graduated index ring (31) to 10 degrees depression and 45 degrees elevation, with the coinciding stationary

index line on the fixed grip (24) and the segment stop screw (32). A detent V-slot is placed on the inner bearing shoulder circumference of this revolving grip, opposite the center of the segment section for the detent indication of zero line of sight.

The right revolving grip (19) is provided with a narrow segment section with 117 degrees of the cylindrical section removed. The removed section allows the revolving grip free rotation for operation of the change of power mechanism. The segment section is provided with

stationary index line. The stationary index line of the left fixed grip (24) is located on the outer circumference and is perpendicular to the front of the top centerline. Its location on the right fixed grip (17) is similar. The right fixed grip (17) has a tapped hole for the insertion of a power indicating screw (11) located to the rear of the top centerline and 90 degrees from the stationary index line.

The inside of both fixed grip sections has two counterbored sections. The small counterbored section provides clearance for the

adjusting screws (13) and adjusting screw lockscrews (10) similar to the left revolving grip (19, Figure 7-21). Adjustments are made to set the power index ring (30) to high and low power, with the coinciding stationary index line on the fixed grip (17) and the segment stop screw (24).

b. Handle hinge and fixed grips. The two handle hinge and fixed grips deft and right (24 and 17) are made of cast phosphor-bronze material, with the same over-all length. The outer parts of both are rough diamond knurled, and when in the extended position provide the revolving grip sufficient length for leverage to turn the periscope through azimuth. The inner part of each fixed grip has a cast filleted section between the grip and the hinge sections. The hinge section is shaped similarly to an apron, with the contour of the main wall uniform with the inner circumference wall of 150 degrees. The side walls of each hinge angle section have projecting bosses on the inner and outer faces, with a reamed hole through the center axis of each boss, offset from the main centerline of the fixed grip section. The inner bosses of each are a sliding fit over the side walls of the cam projection section of the hinge brackets (23 or 16). The reamed holes of each side wall of the hinge section carry, a pivot screw (6), thus serving as hinge pivots to carry the fixed grip and its hinge through 90 degrees of rotation.

Both fixed grip sections, have two narrow undercut shoulder sections on their outer part. The vertical movement of the bearing plate (34 or 26) with the outer part provided with a narrow threaded section. The internal threaded section carries the external threaded section of the spring barrel (25 or 18), secured with a lockscrew (19 or 12). The lockscrew extends into the tapped hole in the center of the threaded section from the tapped hole in the outer circumference of the knurled fixed grips (24 or 17).

The large counterbored section carries the inner moving part of the revolving grip shoulder bearing sections (26 or 19). In the bottom of each knurled fixed grip a clearance hole with a tapped section is provided near the inner depth of the large counterbored section for the revolving grip segment stop screws (32 or 24). The left fixed grip (24) is provided with a tapped hole near the center of the knurled section for a spring detent assembly to hold the line of sight at zero degree, and is located in the front centerline. Refer to the spring detent assembly of the Type II periscope,

The inside of the inner hinge section, from the small counterbored section, is provided with three equally spaced reamed holes. One is in the center axis to carry the stem section of the revolving grip shaft (28 or 21), while the other two reamed hole of the same size are located on opposite sides of the center reamed hole and are parallel. The two outer reamed holes are located in a perpendicular plane to the inner face of the projecting bosses of the side walls of the hinge section. Each outer reamed hole is counterbored a sufficient

small shoulder of the left fixed grip (24) carries half of the graduated index ring (31), a drag fit on this half, while on the right fixed grip (17) it carries half of the power index ring (30), a sliding fit on this half. The next larger shoulders of both fixed grips are each provided with a depth from the hinge section to carry the shoulder section of each plunger (35 or 27). The center reamed hole is counterbored sufficiently in the inside 150 degrees radius of the apron wall section to allow a flat surface for

the assembly and the bearing contact of the outer bevel gear clutch collars (33 or 25). A clearance hole is provided in the apron wall of the bottom of each hinge section, to allow the gear clutch collar taper pins (22 or 15) to be removed for disassembly of the outer bevel gear clutch collars (33 or 25).

c. Index ring. The index ring (31, Figure 7-21) is made of brass tubing material of nominal wall thickness. The bore is a sliding fit over the shoulder section of the revolving grip (26) and is a drag fit over the shoulder section of the fixed grip shoulder section (24). The periphery is engraved after assembly to indicate specifically 10 degree depression, 0 degree line of sight, 45 degree elevation, and individual 1 degree graduations between the designed limits. A plus and minus indication is engraved above and below the 0 degree graduation. It is provided with a circumferential slot, located for the insertion of an actuating screw (38) in the tapped hole in the center of the shoulder section of the revolving grip. The circumferential slot has 3/32-inch angular movement to coordinate with the correction section and a reamed hole, offset from the horizontal centerline. The reamed hole serves as a bearing for the inner bevel gear clutches (3) while the counterbored section provides clearance over the training handle stuffing box bodies (7, Figures 7-15 and 7-16 respectively) assembled in the eyepiece box. Two holes with body clearance and a tapped section are provided in the inner face of the counterbored section for two pivot screw lockscrews (20 and 13, Figures 7-21 and 7-22 respectively) to secure the pivot screws (6) when assembled in the side walls of each cam section.

The center cored section of each cam section is provided with a cylindrical raised boss, to carry the shoulder of the inner bevel gear clutches (3). Sufficient radius clearance is provided for assembly and removal of the inner and outer bevel gear clutches (3 and 4) and clearance inside the side walls for the 90 degrees rotation of the outer bevel gear clutch collar (33 or 25, Figures 7-21 and 7-22 respectively). The concave recesses are located for the folded position only, with the heavy tension on the set of plunger rollers retaining the handle beyond the high point of the cam. In the folded position,

made with the adjusting screws (13) in the segment section of the revolving grip.

d. Power index ring. The power index ring (30, Figure 7-22) is made of brass tubing material of nominal wall thickness. The bore is a sliding fit over the shoulder, section of both the revolving grip (19) and lie fixed grip (17). The periphery has index marks: and the engraved letters of hp and lp above each index mark, located at assembly. The power index ring is secured to the shoulder section of the revolving grip (19) with a power indicating screw (11).

e. Hinge brackets. The two hinge brackets (23 and 16, (Figures 7-21 and 7-22 respectively) are made of cast phosphor-bronze material of duplicate design, with the base flange section shaped rectangular. A cam section projects upward from each base flange section. Both of these sections form the fixed half of the training handle hinge. Four raised bosses are provided in each corner of each base flange section, and each boss has a clearance hole in which the hinge bracket bolts (5) are inserted. The bolts extend into the tapped holes in each side of the eyepiece box to retain each hinge bracket. The lower face of each base flange section is provided with a counterbored the spring pressure is at a minimum, and with the handle hinge swung downward in the extended position, the tension is increased, with the maximum tension reached at the highest point of the cams. Each set of rollers rides on the cams constantly because of heavy spring tension. When they pass the high point of the cam, the handle hinge and fixed grip of each will be returned to the folded position by the heavy recoil of the spring. The upper and lower part of the outer face of the base flange section is provided with leather cushions (14 and 15, Figure 7-21) or (7 and 8, Figure 7-22) secured with two lockscrews (17 or 9, Figures 7-21 and 7-22 respectively). The outer face of each cam section side wall is a snug fit between the apron side wall bosses of the hinge section of each handle hinge and fixed grip. Two tapped holes located in each side wall and in the main horizontal centerline are offset slightly, and carry hinge bracket pivot screws (6).

f. Training handle and hinge recoil principle. This recoil is provided as a safety device to return each training handle to the folded position when lowering the periscope in the well of the submarine. It also prevents damage to each

handle when elevating the periscope. With training handles of the friction holding device type used in Types II and III

j. Coil plunger springs. The two coil plunger springs (37 or 29, Figures 7-21 or 7-22 respectively) are made of chrome-silicon

periscopes, instances have occurred where the handles did not remain in the folded position and caught on the sides of the periscope well when the periscope was raised.

g. Leather cushions. The two leather cushions (14 and 15, Figure 7-21) or (7 and 8, Figure 7-22) are attached on the upper and lower part of the outer base flange section of the hinge brackets (23 or 16, Figures 7-21 or 7-22 respectively) next to the cam section. Two lockscrews (17 or 9) secure each leather cushion to its hinge bracket. They provide a cushion to absorb the heavy shock of the spring recoil of the hinge when in the folded and extended positions.

h. Pivot screws. The two pivot screws (6, Figures 7-21 and 7-22) are made of phosphor-bronze rod material. They form hinge pins on which the hinge section of the fixed grip can be swung through 90 degrees of rotation. Each screw has a head section, with the main body section a snug sliding fit in each of the hinge section pivot holes in each handle hinge and fixed grips (24 or 17, Figures 7-21 or 7-22, respectively). The stub section is threaded and engages into a tapped hole in each side wall of each set of cam sections. The lockscrews (20 or 13, Figures 7-21 or 7-22 respectively) prevent the threaded section of each pivot screw from unscrewing.

i. Spring barrels. The two spring, barrels (25 or 13, Figures 7-21 or 7-22 respectively) are made of brass rod material. They consist of an enclosed cylinder with a manganese alloy steel material, and fit over the revolving grip shafts (28 or 21). Both load ends of the spring are ground, with one load end having tension against a spacer washer (27 or 20), and the other load end against the counterbored section seat in the bearing plates (34 or 26). The spacer washer offers a smooth surface to the load shoulder of the spring barrel when loading the spring. The spring when compressed places a 90-pound pressure on the high point of the cam. The pressure is decreased gradually as the handle hinge comes to the folded position. Each bearing plate in turn is distributing the same pressure on the assembled plungers and rollers (35 and 36, Figure 7-21) or (27 and 28, Figure 7-22).

k. Bearing plates. The two bearing plates (34 or 26, Figures 7-21 or 7-22 respectively) are made of phosphor-bronze rod material. They consist of a cylindrical plate with a clearance hole in the center axis that moves axially over the revolving shaft (28 or 21). Under spring tension each plate distributes equal pressure to their plungers (35 or 27). Two square broached holes are provided in the outer body for the square stub section of the plungers. The square section of the plungers and the square broached holes in the bearing plate maintain proper alignment for the plungers and rollers (35 and 36, Figure 7-21) or (27 and 28, Figure 7-22), preventing angular movement. The counterbored recess in each bearing plate centers the plunger springs (37 or 29) at the lower load end.

uniform wall thickness, and a reamed clearance hole in the load end shoulder center axis for the revolving grip shafts (28 or 21). The opposite end has a threaded flange section with uniform wall thickness. The coil plunger spring (37 or 29) is stabilized by the side walls of each spring barrel. The threaded flange section of each engages into the small counterbored threaded section in the handle hinge and fixed grips (24 or 17, Figures 7-21 or 7-22 respectively), after compressing 2 inches of coil plunger spring. It is secured with a lock Screw (19 or 12). Two opposite holes are provided in the outer load shoulder part of each spring barrel for the insertion of a special wrench to tighten the spring barrel against the heavy tension of the coil plunger spring.

l. Plungers. The two plungers (35 or 27, Figures 7-21 or 7-22 respectively), are made of corrosion-resisting steel material. Both the main body sections are a close axial sliding fit in both reamed holes in the handle hinge and fixed grips (24 or 17). The hub section is slotted to carry a plunger roller (36 or 28) with a reamed hole perpendicular to the slotted section to carry each plunger roller pin (21 or 14). The pin provides a bearing for the plunger rollers and is riveted over at assembly. The large section of each plunger is milled on one side sufficiently to allow it to clear the inside boss of the hinge section side wall of each handle hinge and fixed grip. The square section of the plunger is cut parallel with the pivot pin hole and the slotted section.

Each plunger roller is cylindrical with a reamed hole through its center axis for a plunger roller pin (21 or 14), and is a snug fit in the slotted part of the hub section. The plunger rollers roll on the hinge cams of the hinge bracket, and pass the high point of the cam against the tension of the plunger springs (37 or 29).

m. Revolving grip shafts. The two revolving grip shafts (28 or 21, Figures 7-21 or 7-22 respectively) are made of corrosion-resisting steel material. The shaft forms the connection between each revolving grip (26 or 19) through the spring barrels (25 or 18), plunger springs (37 or spring (1) on the square section of each revolving grip shaft (28 or 21).

The hub section of the inner bevel gear clutch fits in the reamed hole in each hinge bracket (23 or 16), and further extends on the square section of the right and left training handle actuating shafts (8 or 4, Figures 7-15 or 7-16, respectively) of the training handle packing gland assemblies. It extends simultaneously over the square section of the shaft and in the counterbored recess in each packing retainer (6 or 8).

Each set of inner and outer portion bevel gear clutches is in mesh in

29), bearing plates (34 or 26), handle hinge, and fixed grips (24 or 17) to connect with the outer bevel gear clutch collars (33 or 25) and each outer bevel gear clutch (4) at the opposite end. The outer bevel gear clutch collars (33 or 25) are secured to the stem section of each shaft with a taper pin (22 or 15) in the hinge section of the fixed grips. The square section of each shaft carries each outer bevel gear clutch (4) against the spring tension of each gear clutch spring (1) by means of each retaining screw (2). The retaining screw extends into a tapped hole in the square section of each shaft.

n. Outer bevel gear clutch collars. The outer bevel gear clutch collars (33 or 25, Figures 7-21 or 7-22 respectively) are made of phosphor-bronze material of short length. They provide a container in which each gear clutch spring (1) is carried. The collar has a reamed hole in its center axis with a counterbored section, and is secured to the stem section of each revolving grip shaft with a taper pin (22 or 15). Each gear clutch spring (1) is carried over part of the stem section and the square section of the revolving grip shafts (28 or 21). The spring places a constant pressure against the hub face of each outer bevel gear clutch (4).

o. Inner and outer bevel gear clutches. The two sets of inner and outer bevel gear clutches (3 and 4, Figures 7-21 and 7-22 respectively) are made of phosphor-bronze material. Both the bevel gear sections have the same diameter and number of either the folded or extended position by means of each gear clutch spring (1). In the folded position both sets of bevel gears are in relation to each other at 90 degrees, with both 45 degrees pitch cone line angles. In the extended position both sets of bevel gears act as universal jaw clutches with all teeth engaged for the operation of the prism tilt or the change of power mechanisms.

p. Detent plunger housing. The detent plunger housing (16, Figure 7-21) is made of brass-rod material, with an over-all length of 0.812-inch. It differs from the Type II periscope detent plunger housing (34, Figure 4-43) in several ways. It is 3/16 inch longer in order to provide a sufficient shoulder section. The shoulder section is provided with a square broached hole to accommodate the square section of the detent plunger (7, Figure 7-21). In the Type II periscope, this square hole provision was made in the training handle hinge (28, Figure 4-43).

7O2. Disassembly. The left or right training handle assembly is disassembled in the following manner:

1. Remove the two pivot screw lockscrews (20 or 13, Figures 7-21 or 7-22 respectively) from the counterbored section seat in the hinge bracket (23 or 16). These lockscrews are unscrewed from tapped holes in the base of the hinge bracket.

2. Place either training handle in the folded position before removing the two training handle pivot screws (6). This prevents damage to the outer bevel gear

teeth. Each is provided with a square broached hole. The square broached hole and the hub sections of the outer bevel gear clutch (4) move axially in the gear clutch collar (33 or 25) against each gear clutch clutch (4) and reduces the spring pressure. The spring pressure in the folded position is at a minimum.

3. Remove the two training handle pivot screws (6) from the handle hinge (24 or 17). The pivot screws are unscrewed from the tapped holes in the cam walls of the hinge bracket. Remove the handle hinge from its hinge bracket by tilting it upward to allow the outer bevel gear clutch teeth (4) to be removed from the inner clutch clearance recesses of the two cam side walls of the hinge bracket (23 or 16).

4. Remove the inner bevel gear clutch . (3) from the hinge bracket (23 or 16). It will slide out easily from the outer side.

5. Remove the detent plunger retaining bushing lockscrew (13, Figure 7-21) from the detent plunger retaining bushing (10). This lock screw is unscrewed from a tapped hole in the detent plunger retaining bushing and spotted recess in the detent plunger (7).

6. Remove the detent plunger retaining bushing (10) from the detent plunger (7).

7. Remove the plunger release knob (8) from the detent plunger housing (16) and detent plunger (7).

8. Remove the detent plunger retaining spring bushing (9) using a special wrench, unscrewing it from the internal threaded section in the detent plunger housing (16).

9. Remove the detent plunger spring (11) and the detent plunger (7) from the detent plunger housing (16).

10. Remove the two revolving grip lock nuts (30 or 23) from the outer part of the revolving grip (26 or 19). Unscrew the first lock nut using a special wrench (Figure 7-23), then unscrew the second lock nut from the threaded periphery of the revolving grip shaft (28 or 21).

11. Remove the revolving grip (26 or 19) from the handle hinge and fixed grip (24 or 17) and the revolving grip shaft (28 or 21). Remove the graduated index ring (31) or power index ring (30) with the revolving grip (26 or 19). The two segment adjusting screws (20 or 13) and the segment adjusting screw lockscrews (18 or 13) should not be removed unless they are damaged.

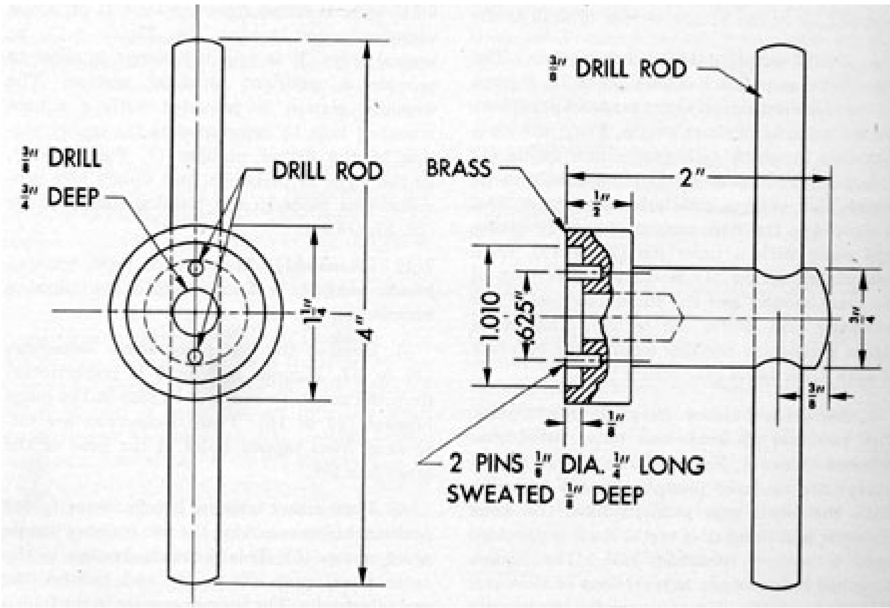

Figure 7-23. Special revolving grip shaft locknut wrench.

12. Remove the index ring actuating screw (38, Figure 7-21), unscrewing it from the tapped hole in the revolving grip (26) and carrying it out of the radial slot in the graduated index ring (31). Remove the graduated index ring. Remove the power indicating screw (11, Figure 7-22), unscrewing it from the tapped hole in the revolving grip (19) and power index ring. Remove the power index ring.

13. Remove either of the gear clutch retaining screws (2) from either of the outer portion bevel gear clutches (4) and the revolving grip shafts (28 or 21). The retaining screw is unscrewed from a tapped hole in either revolving grip shaft.

14. Remove either of the outer bevel gear clutches (4) and the gear clutch springs (1). Check either of the outer bevel gear clutches for reference marks with the square section of the revolving grip shafts (28 or 21). Should observations indicate

from the tapped hole in the fixed grip of the handle hinge.

22. Remove the spring barrel (25 or 18) from the fixed grip of the handle hinge (24 or 17). Unscrew the spring barrel from the fixed grip of the handle hinge, using a special guide bushing and wrench in the load end. Figure 7-24 shows the guide bushing while Figure 7-25 shows the spring barrel wrench. Remove the spring barrel (25 or 18) coil plunger spring (37 or 29), and spring barrel washer (27 or 20).

23. Remove the two assembled plungers (35 or 27) consisting of the plungers, plunger rollers (36 or 28) and plunger roller pins (21 or 14) from the lower reamed holes in the handle hinge and fixed grip (24 or 17). Check reference marks of both plungers to insure proper reassembly alignment. Should observations indicate that there are no factory reference marks, the repairman should make reference marks at appropriate places at

that there are no reference marks, the repairman should mark the parts as they are disassembled for proper reassembly alignment.

15. Remove the taper pins (22 or 15) after rotating the revolving grip shaft (28 or 21) until the small end of the taper pin (22 or 15) is lined up with a drift clearance hole in its respective wall of the handle hinge and fixed grip (24 or 17).

16. Place a drift punch of suitable size in either small clearance hole in the fixed grip and handle hinge (24 or 17).

17. Drive either taper pin (22 or 15) from its gear clutch collar (33 or 25) and the revolving grip shaft (28 or 21).

18. Remove the bevel gear clutch collar (33 or 25) from the evolving grip shaft (28 or 21).

19. Remove the revolving grip shaft (28 or 21) with its inserted key (29 or 22) from the handle hinge and fixed grip (24, or 17).

20. Remove the spring barrel lockscrew (19 or 12) from the fixed grip of the handle hinge (24 or 17) and from its contact with the spring barrel (25 or 18). This lock screw is unscrewed from the tapped hole is the handle hinge and fixed grip.

21. Remove the revolving grip segment stop screw (32 or 24) from the fixed grip of the handle hinge (24 or 17). The stop screw is unscrewed disassembly to provide for proper reassembly alignment.

24. It is not necessary to disassemble the plunger roller pins (21 or 14) and rollers (36 or 28).

25. Remove the bearing plate (34 or 26) from the fixed grip of the handle hinge (24 or 17).

26. It is not necessary to remove the detent plunger housing (16, Figure 7-21), and the detent plunger release knob lockscrew (12) from the inner grip of the handle hinge (24).

27. It is not necessary to remove the leather cushions (14 and 15) or (7 and 8) and lockscrews (17 or 9) from the hinge bracket (23 or 16).

7Q3. Reassembly. The left or right training handle assembly is reassembled in the following manner:

1. Check the factory reference marks on each plunger (35 or 27). The plunger should be replaced in the proper reamed hole in the handle hinge (24 or 17).

2. Reassemble the bearing plate (34 or 26) into the fixed grip of the handle hinge (24 or 17). Place the shallow counterbored section seat facing the plunger spring (37 or 29). Align the bearing plate so that its square broached holes fit on the square section of the plungers (35 or 27). The plungers should move freely with the bearing plate, as any tendency of tightening

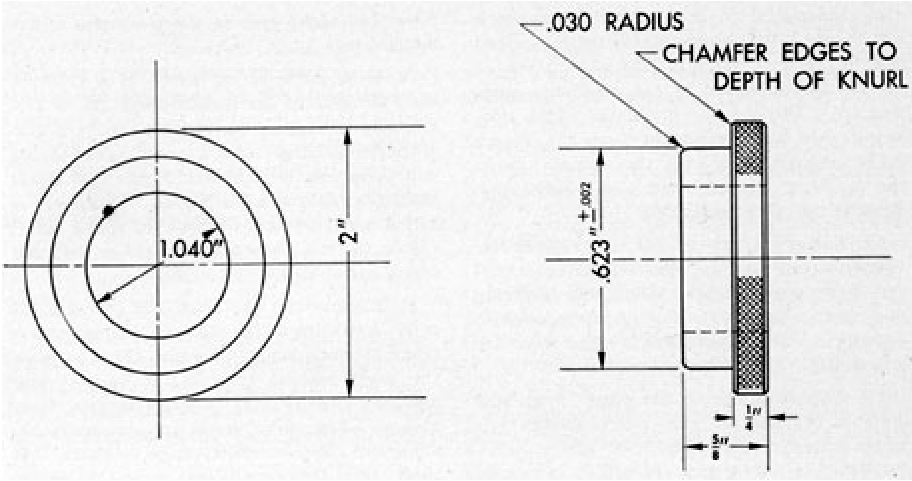

Figure 7-24. Spring barrel wrench guide bushing.

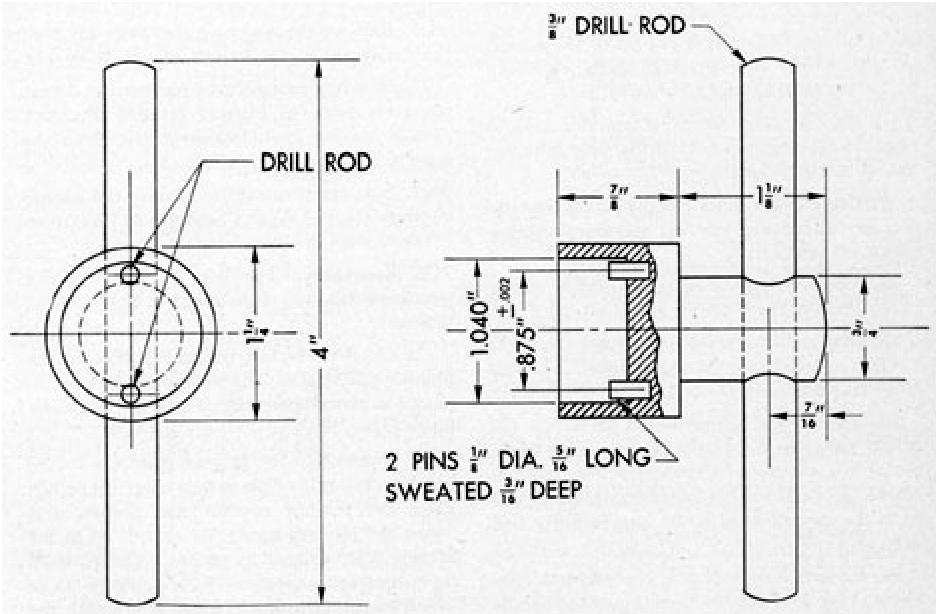

Figure 7-25. Spring barrel wrench.

would not insure positive spring action to the handle hinge, and would restrict the handle from returning to its folded position.

3. Reassemble the spring barrel washer (27 or 20) into the bottom of the spring barrel (25 or 18) and place the coil plunger spring (37 or 29) on its spring barrel washer.

4. Reassemble the spring barrel (25 or 18) in the fixed grip of the handle hinge (24 or 17). The plunger spring should be compressed sufficiently for the spring barrel to engage into the internal threaded part of the fixed grip of the handle hinge.

clutch spring. Insert the outer bevel gear clutch retaining screw (2) into a tapped hole in the inner end of the revolving grip shaft (28 or 21).

10. Reassemble the graduated index ring (31, Figure 7-21) on the inner shoulder of the revolving grip (26). Align the elongated circumferential slot over the tapped hole in the revolving grip.

11. Insert the index ring actuating screw (38) through the elongated circumferential slot in the graduated index ring

Screw the spring barrel in until it rests on the shoulder of the fixed grip of the handle hinge, using a special guide bushing and wrench (Figures 7-24 and 7-25). The plunger spring is compressed approximately 1 1/8 inch.

5. Insert the spring barrel lockscrew (19 or 12), screwing it into a tapped hole in the fixed grip of the handle hinge (24 or 17) and further into the threads in the spring barrel (25 or 18).

6. Insert the revolving grip segment stop screw (32 or 24) into the fixed grip of the handle hinge (24 or 17). The segment stop screw extends into a tapped hole in the fixed grip of the handle hinge and projects further to allow the adjusting screws of the revolving grip segment to contact it for full elevation and depression as a stop screw and for high and low power magnification.

7. Reassemble the revolving grip shaft (28 or 21), with its inserted hey (29 or 22) into the spring barrel, (25 or 18), spring barrel washer (27 or 20), coil plunger spring (37 or 29), bearing plate (34 or 26), and handle hinge aid fixed grip (24 or 17).

8. Check the large taper pin hole in the revolving grip shaft (28 or 21) and the outer bevel gear clutch collar (33 or 25) for proper assembly of the collar on the shaft. Tap the collar on the revolving grip shaft (28 or 21) and insert a taper pin (22 or 15). The taper pin should not be drive into the collar and shaft excessively, as it will spread them.

9. Reassemble the outer bevel gear clutch spring (1) over the square section end of the revolving grip shaft (28 or 21) acid assemble the (31) and screw it into a tapped hole in the revolving grip (26).

12. Reassemble the power index ring (30, Figure 7-22) on the inner end shoulder of the revolving grip (19). Align the tapped holes in the power index ring and the revolving grip and insert the power indicating screw (11) for the securement of the power index ring.

13. The segment adjusting screws (20 or 13) and the segment adjusting screw lockscrews (18 or 10) were not removed during disassembly. Therefore, it may be necessary to release the segment adjusting screw lockscrews (18 or 10) and make fine adjustments with the segment adjusting screws (20 or 13) to permit full elevation and depression of the head prism, the necessary slack allowance, and a positive engagement of the change of power mechanism.

14. Reassemble the revolving grip (26 or 19) with the assembled graduated index ring (31) or the power index ring (30) and the index ring actuating screw (38) or the power indicating screw (11) over the spring barrel (25 or 18) and the revolving grip shaft (28 or 21). Align the inserted key (29 or 22) in the revolving shaft with the keyseat in the revolving grip. Carry the revolving grip into the fixed grip of the handle hinge (24 or 17).

outer bevel gear clutch. (4) compressing the gear

15. Reassemble both revolving grip lock nuts (30 or 23) on the threaded part of the revolving grip shaft (28 or 21). Secure each lock nut in turn with the special wrench (Figure 7-23).

16. Rotate the revolving grip (26, Figure 7-21) to carry the graduated index ring (31) so that the full elevation and depression position index lines coincide with a stationary index line on the fixed grip of the handle hinge (25). Insufficient or over-travel of the index ring can be corrected by the segment adjusting screws (20). The front adjusting screw provides correction for elevation

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while the rear adjusting screw provides correction for depression.

17. Rotate the revolving grip (19, Figure 7-22) to carry the power index ring (30) so that the high- and low-power index lines coincide with the stationary index line on the fixed grip of the handle hinge (17). Insufficient or excessive travel of the power index ring is described in Steps 7, 8, and 9 of Section 7V4.

18. Reassemble the detent plunger (7, Figure 7-21) into the square hole in the detent plunger housing (16). Check the detent plunger for proper reference marks so that the plunger 90 degrees angle point is placed in proper mesh to engage into a 90 degrees groove on the inner shoulder of the revolving grip (26).

19. Reassemble the detent plunger spring (11) and the detent plunger spring bushing (9) over the detent

walls of the hinge bracket. Carry the handle in the folded position, and check the inner and outer bevel gear clutch teeth (3 and 4) to make sure that their reference teeth engage properly.

24. The hinge bracket (23 or 16) should be held in a vise to enable the repairman to apply sufficient pressure on the two plungers (35 or 27) and the coil plunger spring (37 or 29). Reassemble both pivot screws (6) into the walls of the hinge section. The pivot screws extend into the tapped holes in the walls of the hinge bracket hinge section (23 or 16).

25. Reassemble the two lockscrews (20 or 13) into the counterbored section seat in the base of the hinge bracket

plunger shaft (7) and place them in the detent plunger housing (16). Using a special wrench, screw the detent plunger spring bushing into the internal threaded section in the detent plunger housing down to the shoulder. Check the detent plunger to insure that it moves freely.

20. Reassemble the plunger release knob (8) over the detent plunger shaft (7) and the detent plunger housing (16).

21. Reassemble the detent plunger retaining bushing (10) on the detent plunger shaft (7) and secure the above plunger retaining bushing with a lockscrew (13).

22. Reassemble the inner bevel gear clutch (3) into the reamed hole in the hinge bracket (23 or 16).

23. Reassemble the handle hinge (24 or 17) over the side walls of the hinge section of the hinge bracket (23 or 16). Carry the handle hinge in a sufficiently tilted position to allow the outer bevel gear clutch (4) to slide into the center clearance recesses in the inner hinge section (23 or 16). The lockscrews extend into the body clearance holes and tapped holes in the counterbored section seat in the base of the hinge bracket (23 or 16).

26. Rotate the knurled plunger release knob (8, Figure 7-21) to the observing position.

27. Turn the revolving grip (26) slowly to observe the detent action. The detent should engage at 0 degree elevation.

28. Insufficient or over travel of the zero graduation can be corrected by the two adjusting screws located in the segment section of the revolving grip (26).

29. To make the necessary adjustments to either training handle assembly requires the disassembly of both revolving grip locknuts (30 or 23) and the removal of the revolving grip (26 or 19).

30. The correction of the detent of the left training handle assembly cannot be made until its graduated index ring (31, Figure 7-21) has been corrected for elevation and depression.

31. Both training handle assemblies are adjusted during the procedure outlined in Section 7V4.

R. HOISTING YOKE ASSEMBLY (ELECTRIC AND HYDRAULIC)

7R1. Description. A hydraulic hoist has been designed to ensure the operational security of a submarine. It permits silent operation plus split hydraulic hoisting system is easily accomplished. It necessitates the removal of various parts consisting of the

second timing for the vertical travel of the periscope to and from the observing position.

The alteration of the hoisting yoke used with the electric hoisting system for use in the

phosphor-bronze locating collar (9, Figure 7-26), lower ball bearing race (8), split ring (3), cover ring (2), and wire rope sleeves (11). Suitable replacements consisting of a new lower ball bearing race (18), split ring (17), cover ring (16), and various additions such as two

bracket connectors (19), limit stop (22), and two locknuts (21) constitute the hydraulic hoisting yoke.

The electric and hydraulic hoisting yoke assemblies are described in the sections discussing their use. Figure 7-26 shows the electric and hydraulic hoisting yoke assemblies. All bubble numbers in Section 7R1 refer to Figure 7-26 unless otherwise specified.

Ill. No.	Drawing Number	Number Required	Nomenclature
1	P-1326-1	1	Hoisting yoke body (electric and hydraulic)
2	P-1326-2	1	Cover ring (electric)
3	P-1326-3	2	Split ring halves (electric)
4	P-1326-4	3	Cover ring lockscrews (electric and hydraulic)
5	P-1326-5	4	Spherical movement and guide stop

a. Hoisting yoke body. The hoisting yoke body (1) is made of corrosion-resisting steel material and is utilized for both the electric and hydraulic hoists. It is cylindrical in shape with two cable projections located 180 degrees apart. The outer body tapers inward from its large diameter with rounded corners, thus offering a smooth surface for safety to personnel when lowering the periscope in the well of the submarine. Two cable projections are bored tapered with the lower face of each having a spherical counterbored seat. The spherical seat accommodates the spherical face of each wire rope adjusting nut (10) or the hydraulic bracket connector adjusting nuts (10) of the hydraulic hoisting yoke. Each cable projection has a 15 degrees angle slot for assembly of the 7/16-inch wire rope. Both cable projections are utilized for the hydraulic plunger rods by the attachment of two bracket connectors (19) thus transferring the electric cable center distance to the greater center distance of the bracket connectors for connection with the plunger

			lockscrews (electric)
6	P-1327-1	2	a. Upper ball bearing race (electric and hydraulic)
7	P-1327-1	2	b. Ball bearings by retainer (electric and hydraulic)
8	P-1327-1	1	c. Lower ball bearing race (electric)
9	P-1327-1	1	d. Phosphor-bronze locating collar (electric)
10	P-1327-2	2	Adjusting nuts for wire rope and hydraulic bracket connectors (electric and by hydraulic
11	P-1327-3	2	7/16 inch wire rope sleeves (electric).
12	P-1327-4	2	Adjusting nut lockscrews (electric)
13	P-1327-5	2	Spherical movement guide stops (electric).
14	P-1327-6	2	Spherical movement stops (electric)
15	P-1448-7	1	Zerk grease fitting (electric and hydraulic)
16	P-1519-1	1	Cover ring (hydraulic)

rods (24) of the hydraulic system.

The internal part is bored with sufficient clearance for assembly around the body tube of the periscope. The lower face is beveled outward at 30 degrees to allow the spherical movement required with the self-aligning thrust bearing of the electric hoisting yoke. Four equally spaced recesses are provided in the bottom face for assembly of the spherical movement and guide stops (14 and 13) with each stop secured with two lockscrews (5).

The small counterbored section carries the phosphor-bronze locating collar (9) for the electric hoisting yoke, and the lower ball bearing race (18) for the hydraulic hoisting yoke. The large counterbored Section area directly above the small counterbored section, serves as clearance to allow the lower spherical face of the lower ball bearing race sufficient spherical alignment. The lower face of the large counterbored section is beveled at a 45 degrees angle, to permit sufficient clearance for the electric hoisting yoke thrust bearing. This large counterbored section area has no special purpose for the hydraulic hoisting yoke other than serving to utilize the same hoisting yoke body. The small counterbored section and the large counterbored section area carry the upper ball bearing race (6), ball bearings and retainer (7), lower ball bearing,

17	P-1519-2	2	Split ring halves (hydraulic)
18	P-1519-3	1	Lower ball bearing race (hydraulic)
19	P-1520-1	2	Bracket connectors (hydraulic)
20	P-1520-2	2	Plunger rod locknuts (hydraulic)
21	P-1520-3	2	Bracket 11 connector locknuts (hydraulic)
22	P-1520-4	1	Limit stop (hydraulic)
23	P-1520-5	4	Limit stop lockscrews (hydraulic)
24	P-0-0	2	Plunger rods (hydraulic)

spherical race (8) and phosphor-bronze locating collar (9) called the self-aligning thrust bearing. For the hydraulic hoisting yoke it carries the upper ball bearing race (6), ball bearings and retainer (7), and lower ball bearing race (18) of the thrust bearing.

The small counterbored and threaded section above the large counterbored section area provides a sufficient threaded section to carry the cover ring (2) of the electric hoisting yoke. The outer tapered wall of the hoisting yoke body is provided with four tapped holes for the assembly of a limit stop (22) for the hydraulic hoisting yoke. The centerline of the stop is located 72 degrees from the cable projection, and is secured with four lockscrews (23).

The upper face is provided with two tapped holes spotted at assembly to carry the cover ring lock-screws (4).

The outer wall is provided with a drilled clearance hole and a larger tapped hole section for the insertion of a Zerk grease fitting (15).

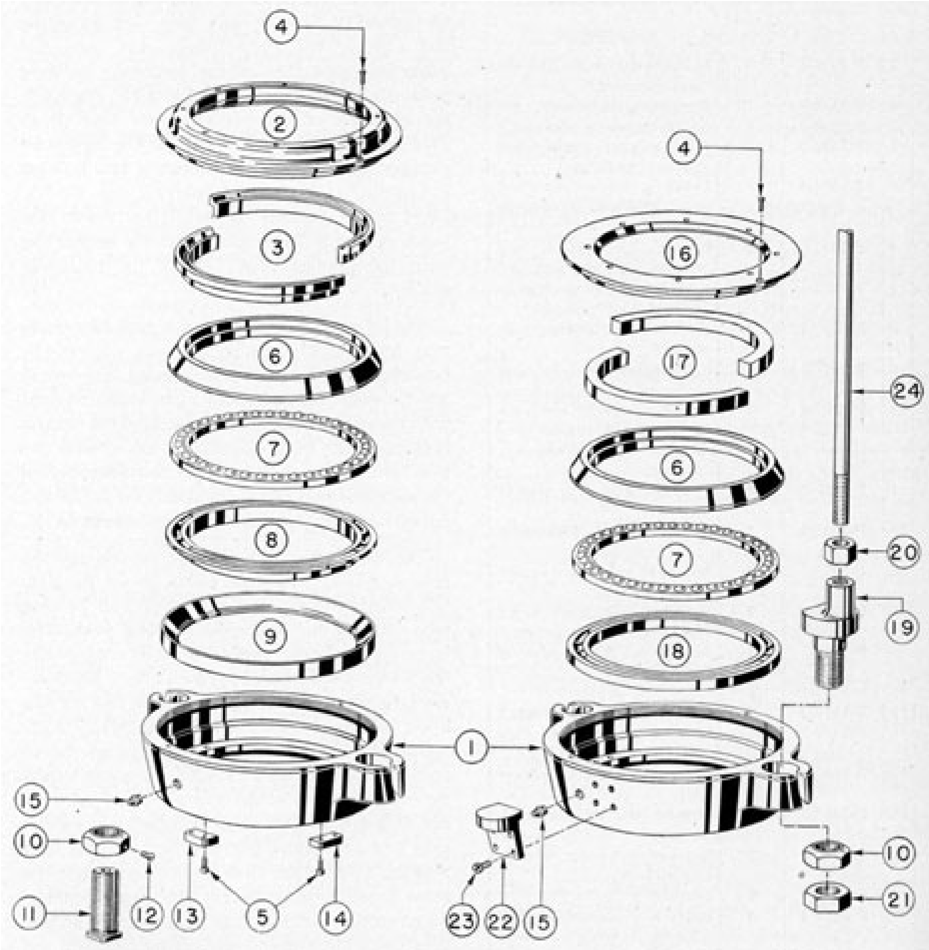

Figure 7-26. Hoisting yoke (electric and hydraulic).

b. Self-aligning thrust bearing. The self-aligning thrust bearing for the electric hoisting yoke consists of four parts divided in the following manner: upper ball bearing race (6), 38 half inch ball bearings and retainer (7), lower ball bearing race (8), and phosphor-bronze locating collar (9). It is subdivided for description in the following manner:

1. Upper ball bearing race. The upper ball bearing race (6) is one part of four component parts which constitute the self-aligning thrust bearing. It is made of SAE 52100 steel material, hardened and ground. (Refer to the factory detail drawing.) This race is cylindrical in shape, with a bored hole and counterbored section. It is bored with nominal wall thickness over the outer tube. The lower face and the periphery have narrow shoulder sections to provide sufficient wall strength. The upper face has a cylindrical concave groove of the same design as the upper race. All sharp corners are stoned off to prevent cracking and chipping. The spherical convex face rests in the spherical seat of the phosphor-bronze locating collar.

4. Phosphor-bronze locating collar. The phosphor-bronze locating collar (9) is a part of the self-aligning thrust bearing. It is cylindrical in shape and is bored with sufficient clearance to allow approximately 3/8 inch self-alignment on each side. The periphery is a sliding fit in the

The bored hole has nominal clearance over the outer tube (2, Figures 4-15, 6-2, and 7-2). The periphery is beveled at a 35 degrees angle to allow sufficient clearance inside the yoke for self-alignment, with a narrow shoulder section of the periphery remaining to maintain sufficient wall strength. The counterbored section carries both halves of the assembled split ring (3) which fits in the undercut groove in the lower part of the outer tube body. The lower face of the race has a cylindrical concave groove 1/16 inch deep and a pitch diameter of 8.470 inches. All sharp corners are stoned off to prevent cracking and chipping the cylindrical concave groove in its lower face rests on the 38 half-inch ball bearings in the retainer (7).

2. 38 half-inch ball bearings and retainer. The 38 half-inch ball bearings and retainer (7) are a part of the self-aligning thrust bearing made of stainless steel material and are located in a bronze retainer with 38 equally spaced ground spherical seats. The ball bearings roll between the cylindrical concave grooves in both the upper and lower ball bearing races (6 and 8) in the electric hoisting yoke, to carry the weight of the periscope. The bronze retainer is cylindrical with a bored hole. It has a nominal clearance over the outer tube, and a nominal wall thickness, with all sharp corners beveled.

3. Lower ball bearing race. The lower ball bearing race (8) is a part of the self-aligning thrust bearing and is made of the same material as the upper race. It is small counterbored section in the hoisting yoke body (1). The collar has a spherical concave seat to carry the thrust bearing parts (6, 7, and 8).

The self-aligning thrust bearing assembled in the hoisting yoke body serves to carry the weight of the periscope plus the downward force created by the water pressure acting on the periscope. It also allows the periscope to turn easily through azimuth. The self-alignment principle serves to provide a means for equalizing any difference of the wire rope cable lengths which would otherwise result in the binding of the thrust bearing. The self-alignment bearing and clearance provided allow for a shortening or lengthening of each cable of 0.218 inch or a cable differential of 0.437 inch.

c. Thrust bearing. The thrust bearing of the hydraulic hoisting yoke is similar to the self-alignment thrust bearing, as it utilizes the upper ball bearing race (6) and 38 half inch ball bearings and retainer (7). The lower ball bearing race (8) and phosphor-bronze locating collar (9) are omitted. A new lower ball bearing race (18) is made of the same material as the upper race (6). The race is cylindrical, with a bored hole having sufficient wall thickness to carry the weight of the periscope. All corners are chamfered to strengthen the race, thus preventing it from cracking as a result of the shock created by the hydraulic hoist system. The upper face is provided with a cylindrical concave groove similar to the lower face of the upper ball

shaped cylindrically with a spherical convex face.

bearing race (6). This race fits into the small counterbored

section in the hoisting yoke body (1) with side clearance.

d. Split ring. The split ring (3) for the electric hoisting yoke is made of phosphor-bronze material. It is shaped cylindrically, with the flange section undercut a tap fit in the counterbored section in the upper ball bearing race. The bore conforms to the undercut diameter of the outer tube undercut groove, with the width of the inner shoulder a tap fit in the above groove.

The flange section is counterbored with a spherical concave seat with an additional filleted cylindrical recess. The spherical concave seat allows the split ring sufficient clearance inside of the counterbored spherical overlapping guide section of the cover ring (2). The split ring carries the weight of the periscope in the counterbored section in the upper ball bearing race (6).

e. Split ring. The split ring (17) for the hydraulic hoisting yoke is made of phosphor-bronze material of nominal wall thickness. It is made cylindrical with the bore conforming to the undercut diameter of the outer tube undercut groove, and the width of the split ring a tap fit in the above groove. The ring is slotted through its center axis, for assembly to the outer tube. Both halves of the split ring serve the same purpose as the split

Both beveled sections allow the thrust bearing sufficient clearance for self-adjustment.

The spherical overlapping guide section is provided with a spherical convex shoulder that rests snugly on the spherical flange section of the split ring (3). The upper face is provided with eight equally spaced holes of shallow depth on an 8 1/2-inch diameter circle for the insertion of projecting pins of a spanner wrench used in the assembly or removal of the cover ring. The cover ring secures the hoisting yoke together, thus retaining the thrust bearing against the split ring halves with sufficient clearance for free rotation.

g. Cover ring. The cover ring (16) for the hydraulic hoisting yoke is made of phosphor-bronze material and is shaped cylindrical. The periphery is provided with a flange section with an undercut threaded section. The threaded section engages into the internal threaded section in the hoisting yoke body (1). The ring is bored with sufficient clearance over the outer tube, with a counterbored section to allow sufficient wall thickness. A small cylindrical shoulder is provided for the adjustment of the thrust bearing, so that it has sufficient free rotation. The upper face is beveled at a 45 degrees angle toward its bore, allowing a narrow shoulder section. The upper face of the ring has eight equally spaced holes of

ring (3) of the electric hoisting yoke, that of carrying the weight of the periscope. The counterbored section of the upper ball bearing race (6) is a tap fir over both assembled halves of the split ring.

f. Cover ring. The cove ring (2) for the electric hoisting yoke is made of phosphor-bronze material add is shaped cylindrically. The periphery is provided with a narrow flange section in which two clearance holes are countersunk for the lockscrews (4). These lockscrews secure the cover ring after adjustments have been made for the proper clearance. The undercut threaded, section of the cover ring engages in the internal threaded section in the hoisting yoke body (1) the upper part has a raised overlapping guide section bored with sufficient clearance around the outer tube for self-alignment. The inside is counterbored at an angle of 16 degrees to the depth of the filleted section, with an additional counterbored section beveled at 37 degrees.

shallow depth for the projecting pins of a spanner wrench, to assemble or remove the cover ring.

h. 7/16-inch wire rope sleeve. The two 7/16-inch wire rope sleeves (11) are made of corrosion-resisting steel material. The body section of each has the periphery threaded to carry adjusting nuts (10). Two opposite vertical slots are provided 180 degrees apart in the threaded section, the entire length and are cut to a depth below the root of the threads. The recess slot on each side receives the inserted adjusting nut lockscrew (12) which extends inward from the adjusting nut. Each half turn for adjustment of the adjusting nut can be secured by the lockscrew to maintain its adjustment.

The square section located in the lower part provides a means for attaching a wrench, thus restricting the sleeve from turning while taking up the adjusting nut, and preventing any twist in the wire rope. A narrow undercut radius

groove next to the square section allows the adjusting nut to be carried to the square section for full travel on its threaded periphery of the sleeve.

The center axis of each has a reamed guide hole of short length for the wire rope, with the lower part tapered. The wire rope is inserted through the reamed hole and extends a sufficient length for spreading. The strands

project inward to the center axis of the hoisting yoke, and are provided with sufficient clearance over the outer tube of the periscope to guide the self-aligning bearing and restrict its movement in two directions.

k. Spherical movement stops. The two spherical movement stops (14) are similar to the spherical movement guide stops (13) in length and thickness. The

are back spliced, and separated after splicing, to provide an enlargement in the tapered section. The wire rope is now carried back with the built-up section in the tapered part of the sleeve. The sleeve is heated and filled with molten lead, which adheres to the separated wire rope strands and fills up the tapered section. It also adheres to the bored tapered walls of the sleeve. The lead prevents the wire rope strands from unraveling and provides a positive means of supporting the weight of the periscope. The sleeves are assembled in the cable projections of the hoisting yoke body (1) with the weight of the periscope carried on the convex face of the adjusting nuts in contact with the lower concave seat in each opposite cable projection.

i. Adjusting nuts. The two adjusting nuts (10) are made of corrosion-resisting steel material of hexagon design. The upper face of each nut is provided with a convex face and fits into the lower seat in each cable projection of the hoisting yoke body (1). The center axis is provided with a bored and tapped hole, and engages on the threaded periphery of the 7/16-inch wire rope sleeves (11). The adjusting nut provides the adjustment to the wire rope with a tapped hole in one of the hexagon flats for the insertion of an adjusting nut lockscrew (12). This lockscrew maintains each half turn of adjustment, thus preventing slack in the wire rope. The adjusting nuts are used for the hydraulic brackets by not using the lockscrews (12) but clearance holes and counterbored recesses are similar, and are attached to the recesses 180 degrees apart and perpendicular to the recesses for the spherical movement guide stops (13). The movement stops are narrower in width, and are provided with a concave seat conforming to the contour of the outer tube. The spherical movement stops when assembled project inward toward the axis of the outer tube of the periscope to restrict the self-alignment of the thrust bearing to 3/8-inch movement.

l. Bracket connectors. The two bracket connectors (19) for the hydraulic hoisting yoke are made of corrosion-resisting steel material. Each bracket connector has an offset section for connection to the plunger rods of the hydraulic hoist. By utilizing the electric hoisting yoke body (1) and using both cable projections, it was necessary to design an offset bracket to accommodate the greater center distance of both hydraulic hoist plunger rods (24).

The large flange section of the bracket connector is concentric with the part attached to the cable projections of the hoisting yoke body (1). The large flange section is sufficiently thick with the connector section offset from the center axis a distance of 5/8-inch. The offset connector section is cylindrical, with a tapped hole in its axis of sufficient depth to carry the threaded part of the plunger rods (24) of the hydraulic hoist. The large flange section rests on the face of the cable projection, with a concave section of the shoulder removed to allow sufficient clearance for the

using two additional locknuts (21).

j. Spherical movement guide stops. The two spherical guide stops (13) are made of corrosion-resisting steel material of nominal thickness, width, and length. Two clearance holes with counterbored recesses are provided for lockscrews (5). Two corners of the stop are rounded for assembly in recesses 180 degrees apart in the lower face of the hoisting yoke body (1). The guide stops removal of the cover ring (16). The removed section is located opposite the offset connector section, and has a concave seat to conform to the contour of the cover ring.

The taper section below the large flange section fits in the tapered hole in each cable projection of the hoisting yoke body (1) with a threaded section that carries an adjusting nut (10) and a locknut (21). The plunger rods (24)

of the hydraulic hoist are secured in the offset section of each bracket connector with a locknut (20).

m. Limit stop. The limit stop (22) for the hydraulic hoisting yoke (1) is made of phosphor-bronze material. The stop is made from a section of a large cylindrical ring having a flange section. The ring is bored and counterbored with a 14 degrees 2' wall to conform to the periphery of the hoisting yoke. The counterbored section has a stepped shoulder that rests on the upper face of the hoisting yoke body. Four clearance holes are provided in the wall to secure the stop to the periphery of the hoisting yoke body, by means of four tapped holes spotted at assembly for lockscrews (23). Refer to the hoisting yoke body plan for the correct location of the limit stop. The cylindrical ring will produce 21 full limit stop pieces which are cut at approximately an angle of 16 degrees 28' width. The flange system has three positions, namely: TO RAISE, NEUTRAL, and TO LOWER.

1. The NEUTRAL position of the control valve allows the supply and return ports to remain closed.

2. The TO RAISE position of the control valve allows the supply port to open to the high-pressure side of the ship's hydraulic system. The high-pressure system supplies sufficient oil volume below the plunger pistons for elevation. This volume of oil below the pistons is under an approximate pressure of 600 psi.

3. The TO LOWER position of the control valve closes the supply port, and the return port is open to the low-pressure side of the hydraulic system. The weight of the periscope action on the volume of oil below the plunger pistons allows the periscope to be lowered into the well against the oil in the cylinders at a slightly faster rate of speed than for elevation.

section is finished with a 7-inch radius located from a 12.250-inch diameter circle.

The limit stop of the hoisting yoke body serves to restrict the elevation of the periscope at the observing position. When the periscope is elevated to the observing position by means of the TO RAISE position of the ship's hydraulic system control valve, the limit stop contacts the operating linkage of the control valve. The linkage shifts the control valve to the NEUTRAL position, closing the supply and return ports. The trapped oil in the lower part of the plunger pistons in the cylinders will hold the periscope in the elevated position.

7R2. Operation of hydraulic control valve of the hydraulic hoist system. The control valve of this

There is no limit stop in the well to restrict the lowering of the periscope. The bumper is the only stop and when contacting the bumper, the periscope has an approximate bounce of 3/8-inch. Elevation of the periscope is accomplished in approximately eleven seconds, while it is lowered in approximately seven seconds.

The pressure on the return side of the hydraulic system, plus whatever friction exists in the return piping, is the resistance pressure on which the plunger pistons allow the periscope to be lowered of its own weight.

S. OPTICAL SYSTEM

7S1. Principles of periscope systems. The principles discussed in Section 4U1 apply equally well to the Type IV periscope except as noted below:

a. Magnifying power. While both, powers are the same as those of the Type II or Type III, the arrangement of telescopes in the Type IV for obtaining the 6X and 1.5X magnifications is different; therefore, omit the list of component telescopes in Section 4U1, 2 and substitute the following list:

	Low Power	High Power
Galilean telescope	1/4 X	out
Upper main telescope	1/3.56 X	1/3.56 X
Lower main telescope	21.2 X	21.2 X
(Combined product)	1.5 X	6 X

b. Field of view. Same as Type III.

c. Image brightness.

1. Absorption-reflection losses. In respect . to transmission efficiency, the Type IV is practically the same as the Type III. See Section 6S1, 3a.

Type IV Periscope	Low Power	High Power
Total of axial thicknesses	248 mm	233 mm
No. of air-crown surfaces	15	14
No. of air-flint surfaces	11	8
No. of silvered-glass surfaces	2	2

Sources of loss and the transmission resulting therefrom are:

Absorption, by glass	73.20%	76.70%
Reflection, by glass-air	28.31%	35.09%
Reflection, silver-glass	88.36%	88.36%
Theoretical TRANSMISSION (not coated)	18.8%	23.8%

No figures are available for actual measurements of the Type IV with optics uncoated and coated; however, approximately double the above percentages of incident light would be transmitted if the optical elements have the magnesium fluoride coating.

2. Effect of pupillary size. In respect to the effect of pupillary size, see Section 4U4, b. The Type IV periscope is designed for night use and, consequently, See Section 4U4-c. The portion of oblique raybundles that are lost because of the cut-off segments of the two main telescope objectives is small compared to the total amount of light that is transmitted.

d. Head prism. The head prism is identical to that in the Type III, except that it is larger, thus allowing a 42-mm entrance pupil.

7S2. Principles of target ranging devices. For principles of the telemeter, refer to Section 4U7-a. Omit Section 4U7, b, because the Type IV periscope is not equipped with a lower (split) objective lens or stadimeter.

The ranging in the Type IV is accomplished by means of an ST electronic device, which is attached to the base of the periscope.

7S3. Optical maintenance. a. Arrangement of optical elements. See Figure 7-27, page 378.

b. Method of tracing rays. This section is similar to the Type III. See Figure 7-27, page 378.

c. Method of removing parallax caused by gas pressure. This section is identical to the Type III except for the distances the various lenses must be shifted:

1. For all the lenses following the telemeter lens, the periscope eyepiece lens, before gassing, must be shifted toward the lower objective lens an amount equal to 1.25 mm. This is accomplished by setting the eyepiece lens to -0.25 diopters. Then, after the instrument is gassed and the eyepiece shifted back to its zero

differs from the preceding two types in that it has an exit pupil of 7-mm diameter, whereas the exit pupil of the two day periscopes is 4 mm in diameter. If the same amount of light were to enter, for example, the Type II and the Type IV, the latter would permit about 3 times as much light (49/16) to emerge because of the larger area of it exit pupil. It must bet remembered, however, that at night there is usually a great deal less light at the target.

Also, the exit pupil of the Type IV is not quite a full circle inasmuch as the two main objectives have a minor chord segment ground off each to permit space in the instrument for the waveguide. The area then of the actual exit pupil is only 99.5 percent of what it would be if the two objectives were full circles. Actually, the, deformity of the exit pupil is not apparent at the eye point.

3. Central and oblique brightness. This is essentially the same as that in the Type II.

setting, it will be found that there is no parallax in that part of the system following the telemeter lens.

2. To compensate 1for lenses preceding the telemeter lens, the following target distances are used:

Type IV Periscope	Target Distance
Periscope in high power	4,800 feet
Periscope in low power	62 feet

The setting of the image-forming optics must first be performed for the system in high power. This setting of the upper-main-telescope eyepiece lens must not be disturbed when the low power compensation is undertaken.

T. REASSEMBLY OF THE UPPER AND LOWER TELESCOPE SYSTEMS AND GALILEAN TELESCOPE SYSTEM

7T1. Reassembly of the upper and lower telescope systems and skeleton head assembly. This procedure is performed in the following manner: 1. Reassembly of the upper telescope system Part I together with Part II. Reassemble the upper part of the sixth inner tube section upper end coupling (4,

4. Reassembly of the head prism drive shaft section and its continuations. Reassemble the head prism drive shaft section (61, Figure 7-6) and its continuations (4 and 15, Figure 7-10) to the connection point located at the upper part of the first inner tube section (31). The shaft section continuations are carried upward

Figure 7-7), in the lower part of the seventh inner tube section (79, Figure 7-6). Check reference marks of both the sixth inner tube section upper end coupling and the seventh inner tube section for proper reassembly alignment. Secure them together by the insertion of 24 lockscrews (87). These lockscrews are inserted in countersunk clearance holes in the lower part of the seventh inner tube section and screwed into tapped holes in the upper alignment section of the sixth inner tube section upper end coupling.

2. Reassembly of the lower telescope system Part I together with the upper telescope system Part II. Reassemble the upper part of the third inner tube section (1, Figure 7-10) on the lower part of the fourth inner tube section lower end coupling (40, Figure 7-7). Check reference marks in similar manner to Step 1. Secure them together by the insertion of 24 lockscrews (10, Figure 7-10). These lockscrews are inserted in countersunk clearance holes in the upper part of the third inner tube section an screwed into the tapped holes in the lower alignment support section of the fourth inner tube section lower end coupling.

3. Reassembly of the lower, telescope system Part II eyepiece skeleton assembly together with the lower telescope system Part I. Reassemble the eyepiece skeleton (42, Figure 77-11) to the lower flange of the first inner tube section Figure 7-10). The alignment dowel pin (37, Figure 7-10) in the lower flange of the first inner tube section engages through various clearance holes in the coupling flanges and the head prism drive shaft guides which are attached to or part of the second, third, fourth, fifth, sixth, seventh, and eighth inner tube sections. The head prism drive shaft noise eliminators are reassembled to the head prism drive shaft section and its continuation at the second, fourth, fifth, sixth, and eighth inner tube sections. The head prism drive shaft section and its continuations can be reassembled at the lower part of the first reduced tube section as the connection point and then carried downward; however, in this manner it is carried through in the inverse order to that used with the upward method.

5. Reassembly of the head prism drive shaft and its continuations. Reassemble the head prism drive shaft (33, Figure 7-10) and its continuation (48, Figure 7-11) with the assembled head prism drive shaft universal coupling (34, Figure 7-10) to the connection point located at the upper part of the first inner tube section. The lower stub end of the shaft continuation (48, Figure, 7-11) with the inserted woodruff key (46) is carried downward through the elongated holes in the lower flange of the first inner tube section (31, Figure 7-10) and the small and large flanges of the eyepiece skeleton (42, Figure 7-11). Check the alignment of the inside keyway of the universal coupling, turning the shaft continuation for proper engagement of the inserted woodruff key.

6. Reassembly of the lower end of the long head prism drive shaft section to head prism drive shaft

in a reamed hole in the upper small shoulder flange of the eyepiece skeleton to reestablish the factory alignment. Secure both flanges together by the insertion of seven lockscrews (40, Figure 7-11). These lockscrews are inserted in clearance holes in the upper flange of the eyepiece skeleton and screwed into the tapped holes in the lower flange of the first inner tube section.

universal coupling. The stub end of the head prism drive shaft section continuation (15, Figure 7-10) should be slid clear of the upper flange of the first inner tube section to allow the upper part of the head prism drive shaft universal coupling (34) to swing next to the wall of the first inner tube

section. Check the taper pin holes of both the stub end of the shaft continuation and the universal coupling before assembly. Insert the taper pin (36) in the lined up holes of the assembled universal coupling and the shaft continuation (15).

7. Reassembly of the assembled head prism drive shaft sections. Reassemble the assembled head prism drive shaft section (21, Figure 7-6) and its shaft continuation (30) with the attached spherical bushing (49) and head prism drive shaft universal coupling (45). The lower half of this assembly is attached to the head prism drive shaft section (43), the attached spherical bushing (58), its shaft continuation (52) with the attached head prism drive shaft universal coupling (54). Carry the above assembled arts to the connection point located at the lower part of the first reduced tube section (51) and place them through the flange clearance holes in the 1st, 2nd, 3rd, and 4th reduced tube sections (51, 42, 28, and 20).

ring should coincide when the upper eyepiece lens is tightened sufficiently.

b. Insert and secure the upper eyepiece lens clamp ring (6) with its lockscrew (12). Insert the lockscrew in a countersunk clearance hole in the mount and screw it into the tapped hole in the clamp ring.

c. Place the assembled upper eyepiece lens mount (18) in the lower part of the fifth reduced tube section (1), and ascertain that the clamp ring faces downward.

d. Insert the upper eyepiece lens mount axial alignment screw (9) in the axial slot in the fifth reduced tube section (1), and screw it in the tapped hole in the upper eyepiece lens mount (18).

(12. Reassembly of the fifth reduced tube section to the fourth reduced tube section. Reassemble the lower flange of the fifth reduced tube section to the upper flange of the fourth reduced tube section. The head prism drive shaft universal coupling (23) is carried through a clearance hole in the upper flange of the fourth reduced

8. Reassembly of the upper end of the long head prism drive shaft section to the head prism drive shaft universal coupling. Check the taper pin holes in the lower part of the head prism drive shaft universal coupling (54, Figure 7-6), and the stub section of the head prism drive shaft section (61). After alignment, reassemble the stub section of the shaft in the lower part of the coupling and insert the taper pin (56).

9. Follow the procure of Step 1 in Section 7F4 to clean the fifth reduced tube section (1) and the upper eyepiece lens mount (18) and its clamp ring (6).

10. Follow the procedure of Step 10 in Section 7F4 to clean the upper eyepiece lens (2).

11. Reassembly of the fifth reduced tube section. Place the upper eyepiece lens (2) in the upper eyepiece lens mount (18) with its flint element resting in the shoulder seat of the mount.

a. Screw the upper eyepiece lens clamp ring (6) into the internal threaded section in the upper eyepiece lens mount (18) against the crown element of the upper eyepiece lens (2). The lockscrew holes of the mount and clamp tube section as is the alignment dowel pin (15) to engage in a reamed hole in the same flange. The dowel pin reestablishes the factory alignment. The alignment projection of the lower flange of the fifth reduced tube section extends into the upper part of the fourth reduced tube section. The lower part of the head prism drive shaft universal coupling (23) is reassembled to the stub section of the upper part of the head prism drive shaft section (21) as the fifth reduced tube section is reassembled, checking the alignment of the taper pin holes of the coupling and the shaft.

a. Secure the fifth reduced tube section (1) to the fourth reduced tube section (20) by the insertion of six lockscrew (10). These lockscrews are inserted in clearance holes in the lower flange of the fifth reduced tube section and screwed into tapped holes in the upper flange face of the fourth reduced tube section.

b. Secure together the lower part of the head prism drive shaft universal coupling (23) and the stub section of the head prism drive shaft section (21) by the insertion of a taper pin (26).

13. Reassembly of the skeleton head assembly to the upper flange of the fifth

reduced tube section. Reassembly of the skeleton head assembly (Figure 7-5) to the upper flange of the fifth reduced tube section (1, Figure 7-6) proceeds in the following are in contact, the quadruple screw shaft (16) is turned to depress the head prism (1) sufficiently to relieve any strain in its mechanism in the full elevated position.

manner: Depress the head prism (1, Figure 7-5) to full depression and turn the quadruple screw shaft (16, Figure 7-6) carrying the quadruple screw follower (3) to the position used for disassembly of the skeleton head, which is the full elevated position.

a. Reassemble the head prism actuating rack (65, Figure 7-6) and engage its dowel pins (56) in the reamed dowel pin holes in the quadruple screw follower (3, Figure 7-6). Reassemble the skeleton head assembly to the upper flange of the fifth reduced tube section (1). As the skeleton head reamed alignment dowel pin hole engages on the dowel pin (15) projection of the fifth reduced tube section, it reestablishes factory alignment. The head prism is slowly shifted to full elevation. When the flange faces of both the skeleton head and the fifth reduced tube section

b. Support the skeleton head assembly while insetting the six lockscrews (10). These lockscrews are inserted in clearance holes in the upper flange of the fifth reduced tube section and screwed into the tapped holes in the base of the skeleton head.

c. Insert the three lockscrews (41, Figure 7-5) in the clearance holes in the head prism actuating rack (65). These lockscrews are screwed into tapped holes in the quadruple screw follower (3, Figure 7-6), securing the head prism actuating rack to the quadruple screw follower.

d. The assembled inner tube sections of the periscope are now ready for the procedure of collimation.

U. FINAL COLLIMATION

7U1. Collimation of upper and lower telescope system in high power. 1. Check the height of the Sperry-Kollmorgen collimator by using the boresight and grooved crossline disks having a diameter of 6.875 inches in similar manner to that shown in Figure 4-72, for the assembled inner tube section offset optical axis. It is 0.125 inch higher than its mechanical axis. Refer to the procedure described under Section 4V10 for the setting of the azimuth disk plate (6, Figure 4-69) to 90 degrees.

4. Rotate the inner tube in the V-blocks to a position for vertical collimation, with the eyepiece end of the periscope facing upward.

5. Remove the eyepiece lens mount (78, Figure 7-11) with the assembled eyepiece lens (33), eyepiece lens clamp ring (15), and its lockscrew (70) by unscrewing the eyepiece dens mount from the eyepiece prism front retaining plate (22).

6. Place the threaded periphery of the eyepiece alignment jig (Figure 4-50) in the internal threaded

2. Loosen the wedge lock bolt (11) and wedge lock (10) sufficiently to swing the index line of the collimator base plate (7) into coincidence with, the 0 degree numeral graduation on the azimuth disk plate (6). Secure the wedge lock (10) with the wedge lock bolt (11). Check the collimator reticle. It should be located at the infinity setting (Figure 4-71),

3. Place the inner tube sections assembled in the V-blocks of the collimated optical I-beam bench, or adjustable optical benches of a tender, in a horizontal position. The head prism should be placed at 0 degree line of sight and centered in the field of the collimator.

section in the eyepiece prism front retaining plate (22, Figure 7-11) of the eyepiece skeleton assembly. Screw the jig into the retaining plate until the shoulder of the jig is a metal-to-metal contact with the shoulder of the retaining plate.

7. The parallel position of the outer face of the alignment jig is determined with the use of a dial indicator attached to a surface gage.

8. The surface gage is used on the face of the I-beam bench, with the dial indicator set with sufficient tension on the outer face of the alignment jig.

9. Keep a firm pressure on the base of the surface gage while checking each side of the outer face of the alignment jig, (Figures 4-58 and 4-59).

10. Rotate the inner tube on the V-blocks until both outer faces opposite the bored hole in the jig indicate equal height, as determined by the dial indicator pointer. This places the centerline of the emerging rays of light in the vertical direction and the light rays enter the head prism in the same direction.

11. Secure the V-block clamps by turning the adjusting knobs of the clamp brackets (Figures 4-58 and 4-59). Check the face of the alignment jig again to detect any variation and make corrections in the same manner as before.

17. The mechanical travel is measured by the assembled counterweight halves (37 and 39, Figure 7-11) from its upper and lower positions. The zero diopter reading at atmospheric pressure is determined by a measurement of 0.571-inch distance between the lower stop of the assembled counterweight and the lower face of counterweight for minus diopters. The remaining distance from the upper face of the counterweight to its upper stop screw heads should measure 0.349 inch for plus diopters. The zero diopter reading at atmospheric pressure is now compensated at 1.25 mm minus for the introduction of gas.

18. Set the assembled upper objective lens mount (82, Figure 7-6), 1/4-inch from the lower end of

12. When the eyepiece alignment jig is in a true parallel plane and well clamped, collimation of the instrument commences.

13. Remove the eyepiece alignment jig and replace the assembled eyepiece lens mount which was removed in Step 5, by screwing it into the eyepiece prism front retaining plate (22, Figure 7-11). Check the inner surface of the eyepiece lens and eyepiece prism front surface for cleanliness before reassembly of the eyepiece lens mount (78) in the eyepiece prism front retaining plate.

14. The position of the lower objective lens mount (5, Figure 7-10) a the third inner tube section (1) and the upper objective lens mount (82, Figure 7-6) in the seventh inner tube section (79) should remain in their original factory settings Mess a lens is replaced because of damage. A renewal of any one or both lenses requires a resetting of the lockscrew holes of both mounts in their respective inner tube sections.

15. The telemeter lens of the upper telescope system is used as a target for collimation of the lower telescope system.

16. To determine the correct position of the lower objective lens, the mechanical eyepiece prism travel of 0.920 inch or 23.85 mm is adjusted to allow a variance of travel for plus or minus to arrive at 0 diopter reading at atmospheric pressure. its travel temporarily. The assembled lower objective lens mount (5, Figure 7-10) is now moved axially until sharp definition is detected on the telemeter lens. Secure the lower objective lens mount with four lockscrews (9) after obtaining sharp definition on the telemeter lens.

19. The collimation of the lower telescope system is accomplished by the axial movement of the upper objective lens mount. This brings the eyepiece prism mount arrangement into focus with the telemeter lens within the prescribed limits of -3 and +1 1/2 diopters.

20. In checking the essential travel of the assembled eyepiece prism mount (18, Figure 7-11) which should be 25 mm, diopter lenses are used. Minus and plus lenses must be inserted in the auxiliary telescope adapter (Figure 4-57) to obtain the minus and plus diopter settings.

21. Insert a -1 1/2 diopter lens in the auxiliary telescope adapter, owing the counterweight up to its stop for full travel; the stop is the opposite screw heads of two lockscrews (40, Figure 7-11) in the small flange of the eyepiece skeleton. This causes the eyepiece prism mount to move downward. Check the definition of the telemeter lens to ascertain that it will fade slightly at the end of the prism travel. It is necessary to move the upper objective lens axially to make this definition check.

22. Insert the +3 diopter lens in the auxiliary telescope adapter,

and bring the counterweight to its lower stop. The two lockscrews (40)

opposite each other 180 degrees in the large flange of the eyepiece skeleton have washers below their heads, and are the same size as the screws used to secure the eyepiece box to the eyepiece skeleton. The downward movement of the counterweight carries the assembled eyepiece prism mount to its upward position. Check the definition of the telemeter lens to be sure that it will fade slightly at the end of the prism travel. It may be necessary to move the upper objective lens axially to make this definition check also.

23. Continue the procedure of Steps 21 and 22 until a slight overtravel is observed at both -3 and +1 1/2 diopters.

24. Upon completion of the collimation of the lower telescope system, secure the upper objective lens mount (82, Figure 7-6) to the seventh inner tube section (79) with four lockscrews (86).

25. Move the assembled upper eyepiece lens mount axially until a clear, well-defined image is apparent. The upper eyepiece lens mount is not secured until the completion of the orientation of the telemeter lens and collimation for parallax elimination on the distance target of the collimator reticle set to 4800 feet.

observing the orientation procedure. The repairman should direct his helper for the amount of angular movement required until the telemeter lens line is parallel with the vertical crossline of the collimator reticle. Secure the telemeter lens mount (31) temporarily with the angular alignment screw (35).

7. Check the parallelism of the telemeter lens line with the vertical crossline of the collimator reticle after temporary securement and make any corrections that are necessary.

8. Elevate and depress the head prism and Sperry-Kollmorgen collimator through azimuth for an elevation of 45 degrees and depression of 10 degrees. Check the parallelism of the telemeter lens line with the vertical crossline of the collimator reticle in the above degrees of azimuth. It should remain properly oriented.

9. Recheck the telemeter lens line after securing, to detect any change which may have taken place during the securement of the two telemeter lens mount lockscrews (38).

7U3. Collimation of the high power system free of parallax on the Kollmorgen distance collimator function at atmospheric pressure. This operation is carried out in the following manner:

7U2. Orientation of the telemeter lens. The telemeter lens is oriented in the following manner:

1. Loosen the wedge lock bolt (11, Figure 4-69) and the wedge lock (10) sufficiently to allow the Sperry-Kollmorgen collimator; base plate (7) to swing through, azimuth for an elevation of 45 degrees and depression of 10 degrees.

2. Check the position of the in tier tube sections in the V-blocks to ascertain that the head prism is spotted centrally oven the collimator axis.

3. Check the Galilean telescope system to ascertain that the instrument is in high power.

4. The telemeter lens line is oriented or squared to the vertical crossline of the collimator reticle.

5. Loosen the angular alignment screw (35, Figure 7-6) to allow free angular movement of the telemeter lens mount (31).

6. Rotate the telemeter lens mount, tapping the angular alignment screw (35) lightly while

1. Check the Sperry-Kollmorgen collimator index line on its base plate (7, Figure 4-69) to ascertain that it is in coincidence with the 0 degrees graduation of the azimuth disk plate (6). Secure the wedge lock (10) with the wedge lock bolt (11).

2. Release the lock ring (51) and turn the reticle lens mount actuating sleeve (53) clockwise six graduations as indicated by the micrometer graduation and the micrometer vernier arm (57), securing the lock ring (51) snugly against the reticle lens mount end bushing (52). This places the reticle lens (60) and its mount (42) at the 4800-foot distance target position. Figure 7-28 shows the correct position of the reticle lens mount actuating sleeve in relation to the micrometer vernier arm and the range table in Section 4V8, under the first function for the proper position of the reticle lens at this 4800-foot distance.

3. Place the auxiliary telescope at the eyepiece lens of the periscope. Set the diopter reading of

the auxiliary telescope at infinity for the observer. Focus the periscope to zero setting at atmospheric pressure or minus 1/4 diopter.

4. The upper eyepiece lens mount (18, Figure 7-6) is moved axially upward approximately 0.3 mm until the image of the

Figure 7-28. Collimator reticle lens set at 4800-foot target distance.

collimator reticle is apparent on the telemeter lens. The upper eyepiece lens mount focuses the upper eyepiece lens (2) on the collimator reticle.

5. At this setting, the auxiliary telescope is focused from plus diopter to the observer's diopter reading, to-make sure that the telemeter lens and the collimator reticle are in sharp definition. At this reading no parallax should be apparent on the telemeter lens.

6. Secure the upper eyepiece lens mount (18) with the axial alignment screw (9) and two lockscrews (11).

7. Check the procedure of Step 5, after securing the upper eyepiece lens mount, to detect any apparent change which may have taken place.

7U4. Collimation of the Galilean telescope system to the high power system, and free of parallax on the Kollmorgen distance collimator function at atmospheric pressure. This operation is performed in the following manner:

1. Follow the procedure described under Steps 1 and 3 of Section 7U3.

2. Using the 4800-foot distance target setting of the collimator, move the Galilean eyepiece lens mount (7, Figure 7-5) in the internal threads in the housing (6) until the image of the target is apparent on the telemeter lens. At this setting the auxiliary telescope is focused from plus diopter to the observer's diopter leading to check that the

4. The Galilean eyepiece lens mount housing (6) is provided with two elongated holes to permit adjustment and to correct its mechanical axis by means of an optical axis movement of the Galilean eyepiece lens (2).

5. Loosen the three lockscrews (9) sufficiently to adjust the. Galilean eyepiece lens mount housing (6). The optical axis of the Galilean telescope system is collimated to the optical axis of the high power system with a minimum of vertical and horizontal displacement tolerance allowance.

6. The horizontal displacement of the collimator reticle crossline image of low power is collimated to superimpose with the telemeter lens line of high power to within a tolerance of 2 minutes of arc. The collimator reticle crossline is superimposed with the telemeter lens line in high power; therefore, the change of power is necessary for determining the proper relationship of the low power system with the securement of the three lockscrews (9) each time.

7. The vertical displacement of the centerline of sight of low power is collimated to superimpose with the centerline of sight of high power within a tolerance of 30 minutes of arc. Use the horizontal crossline of the collimator reticle as a reference for the change of power to determine the proper relationship of the low power system with the securement of the three lockscrews (9) each time.

8. After the periscope has been used extensively, the V-grooves in the right side faces of the Galilean eyepiece lens and the objective

telemeter lens and the collimator, reticle are in sharp definition. At this reading no parallax should be apparent on the telemeter lens. Secure the Galilean eyepiece lens mount (7) temporarily with the lockscrew (50).

3. The Galilean telescope system lenses operate through 90 degrees for change of power and, therefore, must be collimated to the fixed high power magnification series of telescope systems.

lens cubes may become worn. The hardened

Figure 7-29. Collimator reticle lens set at 62-foot target distance.

pawls, working in the V-grooves, cause the edges of the V-grooves to become rounded. This excessive wear will cause a decided displacement of a horizontal target as well as a pronounced general aberration.

9. Follow the procedure described under Section 4F3, Step 25, for checking the Galilean eyepiece lens and objective lens cubes (4 and 5).

10. Release the lock ring (51, Figure 4-69), and turn the reticle lens mount actuating sleeve (53) clockwise from infinity 14 complete turns and 25 graduations, as indicated by the micrometer

0 degrees graduation of the actuating sleeve (53) and the micrometer vernier arm (57). Secure the lock ring (51) snugly against the reticle lens mount end bushing (52). This places the reticle lens (60) and its mount (42) at the 62-foot distance target position. Figure 7-29 shows the correct position of the reticle lens mount actuating sleeve in relation to the micrometer vernier arm and the range table in Section 4V8 under the first function for the proper relation of the reticle lens at this 62-foot distance.

11. Loosen the lockscrew (50, Figure 7-5) and focus the Galilean eyepiece lens mount (7) in the internal threads in the Galilean eyepiece lens mount housing (6), screwing out the mount with the Galilean eyepiece lens (2) until the image of the collimator reticle is apparent on the telemeter lens.

12. At this setting, the auxiliary telescope is focused from plus diopter to the observer's diopter

reading, as a check that the telemeter lens and the collimator reticle are in sharp definition. At this reading, no parallax should be apparent on the telemeter lens.

13. Secure the Galilean eyepiece lens mount (7) with its lockscrew (50).

V. FINAL ASSEMBLIES AND CHECKING

7V1. Soldering precautions of antenna array and waveguide. In the silver-soldered butt joint between the waveguide attached to the antenna array and the long length extending to the bottom plug assembly, the following precautionary measures are recommended:

1. Singe the important surface to be kept clean and free from gobs of solder is the inside surface of the tubing, this surface, should be coated with powdered whiting or powdered chalk before starting the soldering operation.

2. The contact surfaces should be smooth and clean before soldering.

3. A major consideration is the avoiding of any deformity or warping in the tubing, and for this reason it is advisable to localize the heat to as small a length of the tubing as possible, but at the same time heating the joint uniformly. It is also desirable to make the soldering operation as brief as possible, so that a larger torch than would ordinarily be used for material of this size should be selected in order to obtain an intense localized heat.

4. Experience has indicated that the warping problem presented by the silver-soldering of the thin-walled waveguide is one which can be coped with only through practice. In view of the high tolerance (+-.005 inch) which must be maintained on the original shape and the inside dimensions of the tubing, it is recommended that short pieces of waveguide be used for experimental joints until confidence is obtained in the ability to maintain the shape and dimensions of the tubing, and in the ability to produce a neat joint on the inside of the waveguide, free from gobs of solder or other discontinuity.

7V2. Cleaning and assembly of waveguide and reassembly of power shifting tapes. a. Cleaning of antenna array and waveguide. 1. Place the antenna array and waveguide on two supports, allowing both ends to be raised, while

the center will sag to the deck about 4 feet. The perforated section of the antenna array is placed upward.

2. Attach the funnel spout (Figure 7-30) in the lower end of the waveguide.

3. Fill the waveguide with approximately 1 gallon of carbon tetrachloride.

4. Lower the antenna array end over a deep pan and at the same time raise the lower end of the waveguide as high as possible.

5. Rotate the antenna array and waveguide 180 degrees while in the raised position, allowing the carbon tetrachloride to be drained into the deep pan.

6. Attach the air hose adapter (Figure 7-31) sliding it over the antenna array and securing it in place with an additional clip at its lower end.

7. Attach the air hose to the cylindrical air line projections of the air hose adapter alternately and blow out the carbon tetra chloride until the antenna array and waveguide are dry.

8. Precaution: The fumes of carbon tetrachloride are dangerous to personnel and the flushing with this chemical must be done in the open air.

9. Filter the carbon tetrachloride and carry out the above procedure twice.

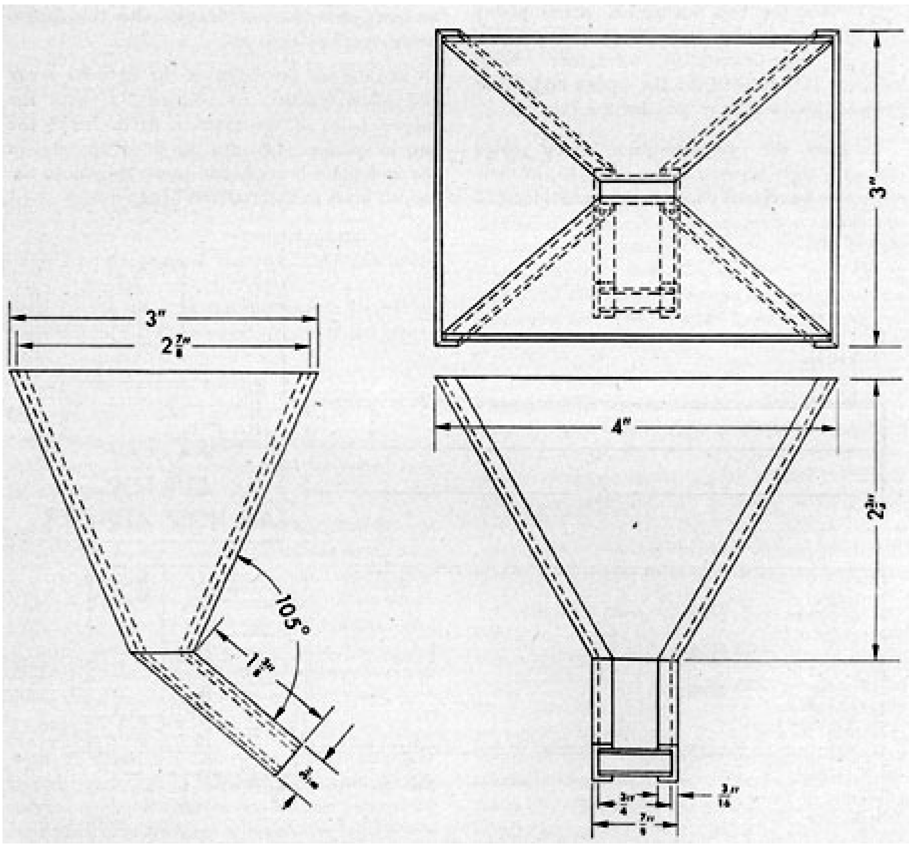

Figure 7-30. Waveguide funnel.

10. After flushing the antenna array and waveguide with carbon on the upper and lower parts of the fifth inner tube section (19).

tetrachloride twice, it should be flushed with alcohol and blown out with air in similar manner. (Use clear alcohol.)

11. When the antenna array and waveguide are dry, the perforated sections of the antenna array and the lower end of the waveguide are sealed off with masking tape, thus preventing the entrance of foreign matter.

b. Reassembly of waveguide. 1. Place the waveguide clamp plate (71, Figure 7-6) with its inserted dowel pins (72) in the waveguide clamp bracket (73) located on the lower part of the eighth inner tube section (60).

2. Place the two waveguide clamp plates (10, Figure 7-7) with their inserted dowel pins (11) in their respective waveguide clamp brackets (12) located on the upper and lower parts of the sixth inner tube section (1).

3. Place the two waveguide clamp plates (28) with their inserted dowel pins (29) in their respective waveguide clamp brackets (30) located

4. Place the two waveguide clamp plates (47) with their inserted dowel pins (48) in their respective waveguide clamp brackets (49) located on the upper and lower parts of the fourth inner tube section (37).

5. Place the waveguide clamp plate (23, Figure, 7-10) with its inserted dowel pins (24) on its waveguide clamp bracket (25) located on the upper part of the second inner tube section (14).

6. Reassemble the antenna array and waveguide to their respective rectangular slotted sections in the reduced tube and the inner tube sections and coupling flanges, also the flanges in the eyepiece skeleton.

7. Line up the holes of the antenna array end plate bracket (64, Figure 7-5) with the tapped holes in the skeleton head. Insert the two lockscrews (49) into the lined up holes in the end plate bracket and screw them into the tapped holes in the skeleton head.

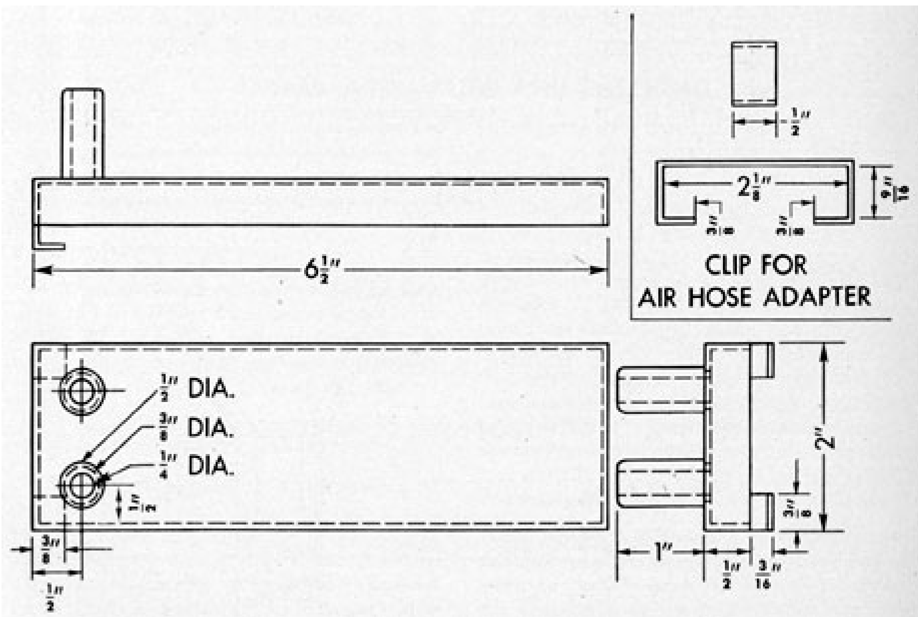

Figure 7-31. Air hose adapter for antenna array.

8. Reassemble the antenna array taper section bracket (66) over the taper section at the lower part of the skeleton head. Insert and secure the two lockscrews (54) after lining up the clearance holes in the bracket with the tapped holes in the skeleton head.

9. Press the waveguide down into the rectangular slotted sections of each reduced tube and inner tube sections and coupling flanges. Maintain a tension on each waveguide clamp plate against the waveguide by tightening each set of waveguide clamp plate adjustment screws and maintaining the tension by securing the waveguide clamp plate adjusting screw locknuts. The waveguide clamp plates force the waveguide against the left side of the rectangular slotted section. The tension maintained should be sufficient to secure the waveguide without placing any undue strain on its material, thus preventing any change in its internal dimensions.

10. Refer to Steps 1 to 5, inclusive, of this section for the securement of the eight waveguide clamp plates.

11. Insert a 3/8-inch straight dowel in the reamed hole section of the centering screw opening in the base of the eyepiece skeleton (42, Figure 7-11) with a sufficient portion projecting wire extension of each shifting wire tape is carried into the axis hole in the shifting wire clamp nuts (3) and through the shifting wire spindle assemblies of the eyepiece skeleton.

2. Remove the three lockscrews (42, Figure 7-5) from the left cube shifting rack (36), removing the clamp block (26). Attach the left power shifting wire tape (35, Figure 7-11) to the left cube shifting rack. (36, Figure 7-5) and replace the clamp block (26) tape spacer (27) and lockscrews (42).

3. Remove the three lockscrews (43) from the right cube shifting rack (34) removing the clamp block (26). Attach the right power shifting wire tape (35, Figure 7-11) to the right cube shifting rack (34, Figure 7-5) tape spacer (28) and replace the clamp block (26) and lockscrews (43).

4. Pull the phosphor-bronze wire extensions of each power shifting wire tape tight and secure each wire with the shifting wire clamp nuts (3, Figure 7-11).

7V3. Eyepiece box assembly with miscellaneous external assemblies and air line sections.

1. Remove the assembled eyepiece lens mount (78, Figure 7-11), eyepiece lens (33), eyepiece lens clamp ring (15), and its lockscrews (70) by unscrewing the eyepiece lens mount from the eyepiece prism front retaining plate (22).

2. Reassembly of the eyepiece box (11, Figure 7-12) of the lower telescope system, Part II over the

outward for a measurement check of the waveguide position.

12. The inner side of the waveguide should measure 2 5/32 inch to the 3/8-inch straight dowel so that the waveguide is properly centered for its entry in the rectangular broached hole in the bottom plug assembly.

13. The lower ends of the waveguide should be located 32 mm upward from the lower face of the eyepiece box-base. This measurement allows a 0.060-inch gap at the end of the waveguide with the shoulder of the bottom plug housing, thus having the end of the waveguide at the optimum point, and still having a differential allowance of +0.020 inch.

c. Reassembly 9 power shifting wire tape. 1. Reassemble both lengths of the power shifting wire tape (35, Figure 7-11) through the various soldered tape straps of the inner tube sections. Carry the tape through the tape straps from the first inner tube section end. The phosphor-bronze

eyepiece skeleton assembly proceeds as follows: Reassemble the outer tube and eyepiece box rubber gasket (22) on the upper cylindrical body of the eyepiece box, against the sealing shoulder. Check the eyepiece box to ascertain the elimination of all inward projecting assemblies so that nothing restricts its assembly.

Reassemble the eyepiece box to the large shoulder flange of the eyepiece skeleton, carrying it over the eyepiece skeleton slowly and carefully. It is carried on the small shoulder section of the large shoulder flange, where two downward projecting dowel pins in the large shoulder flange of the eyepiece skeleton engage into the reamed alignment holes in the face of the eyepiece box. Secure both together by insertion of seven lockscrews (40, Figure 7-11). These lockscrews are inserted into clearance holes in

the eyepiece skeleton and screwed into tapped holes in the upper face of the eyepiece box. Place the original washers below the heads of the two lockscrews directly opposite, as the washers under these lockscrew heads provide the necessary projection to serve as a counterweight stop for the minus position.

3. Reassemble the assembled eyepiece lens mount (78) into

on the rubber gasket of Step 8. Align the rectangular base of the focusing knob bracket (7, Figure 4-39) with its recess face on the eyepiece box.

10. The eyepiece drive mechanism bevel gear (1, Figure 7-14) attached to the eyepiece drive actuating shaft (4) should drop into mesh correctly with the eyepiece prism shift bevel gear

the internal threads in the eyepiece prism front retaining plate (22). Screw the eyepiece lens mount in the eyepiece prism front retaining plate until the shoulder of the lens mount is a metal-to-metal contact with the shoulder of the retaining plate.

4. Reassemble the eyepiece skeleton centering screw lead washer (2, Figure 7-12) on the shoulder of the centering screw (24), inserting the centering screw in the base of the eyepiece box. The centering screw extends into the reamed hole in the base of the eyepiece skeleton and engages in the threaded section in the eyepiece box base.

5. Place the assembled counterweight of the eyepiece skeleton assembly at the extreme upper end of its travel (the plus position).

6. Check the +1 1/2 diopter setting with the stationary reference line of the focusing knob bracket (7, Figure 4-39). The +1 1/2 diopter setting should be turned until a slight overtravel of the stationary reference line on the focusing knob bracket exists:

7. Check the reference marks of the eyepiece drive actuating shaft (4, Figure 7-14) of the eyepiece drive packing gland assembly and the reference mark of the female coupling section (3, Figure 4-39) of the focusing knob assembly for proper alignment and assemble together.

8. Place the eyepiece drive stuffing, box body rubber gasket (3 Figure 7-14) in the (41, Figure 7-11) of the eyepiece skeleton assembly.

11. Remove the focusing knob assembly (Figure 4-39) from the eyepiece drive packing gland assembly.

12. Rotate the eyepiece drive stuffing box body (8, Figure 7-14) so that its reference numerals coincide with similar reference numerals on the recess face of the eyepiece box.

13. Secure the eyepiece drive packing gland assembly by the insertion of six lockscrews (10). These lockscrews are inserted in counterbored recess clearance holes in the stuffing box body flange (8) and screwed into tapped holes in the counterbored section seat in the eyepiece box.

14. Reassemble the focusing knob assembly (Figure 4-39) checking its reference marks as indicated in Step 7 of this section and place the female coupling section (3) over the square section of the eyepiece drive actuating shaft (4, Figure 7-14).

15. The dowel pins (8, Figure 4-39) of the focusing knob bracket (7) are pushed into place and the bracket is secured to the eyepiece box with our lockscrews (10). These lockscrews are inserted in counterbored recess clearance holes in the bracket and screwed into the tapped holes in the face of the eyepiece box flat rectangular recess.

16. Rotate the focusing knob (1) and check the overtravel by the +1 1/2 and -3 diopter graduations inscribed on the diopter ring (9) with the stationary reference line

counterbored section, seat in the eyepiece box (11, Figure 7-12) for the eyepiece drive packing gland assembly and line up the holes of the gasket with the tapped holes in the counterbored section seat.

9. Place the eyepiece drive packing gland assembly with the assembled focusing knob assembly in the opening of the eyepiece box

on the focusing knob bracket (7) to ascertain the correct focusing travel.

17. Reassemble the rayfilter drive stuffing box body rubber gasket (3, Figure 7-13) on the rectangular recess seat in the front of the eyepiece box.

18. Check the reference marks on the rayfilter drive female coupling section (1) with its corresponding reference mark on the male coupling half section (25, Figure 7-11) of the eyepiece skeleton assembly for proper alignment. Check the stamped numeral on the rayfilter drive stuffing box body (6, Figure 7-13) to see that it coincides with the stamped numeral on the eyepiece box. It may be necessary to rotate the female coupling section (1) for both corresponding reference marks. Place the rayfilter drive packing gland assembly in the bored hole and on the rubber gasket (3) in the rectangular recess seat in the eyepiece box. Remove the rayfilter drive actuating gear (9) if necessary, from the square section of the rayfilter drive actuating shaft (8) for the application of a wrench to juggle the female coupling section (1) for its proper engagement.

19. Secure the rayfilter drive packing gland assembly with four lockscrews (11). These lockscrews are inserted in

24. Check the reference marks of the left training handle female coupling section (1, Figure 7-15), with its corresponding reference mark on the male coupling section of the spiral bull gear shaft (45, Figure 7-11) for proper reassembly.

25. Reassemble the left training handle stuffing box body (7, Figure 7-15) with its assembled rubber gasket (3), in the bored hole and counterbored section seat in the left side of the eyepiece box.

26. Rotate the left training handle stuffing box body (7) until its stamped numerals coincide with corresponding stamped numerals on the eyepiece box. Line up the clearance holes of the stuffing box body with the tapped holes in the counterbored section seat in the eyepiece box and insert the six lockscrews (10).

27. Check the face of the eyepiece lens (33, Figure 7-11) for cleanliness before reassembly of the eyepiece window assembly (Figure 4-38).

counterbored recess clearance holes in the stuffing box body (6) and screwed into tapped holes in the rectangular recess seat in the eyepiece box.

20. Reassemble the left and right training handle stuffing box body rubber gaskets (3, Figures 7-15 and 7-16 respectively) over the right and left training handle stuffing box bodies (7) up to their large flange section shoulders.

21. Check the reference marks of the right training handle female coupling section (1, Figure 7-16) with its corresponding reference mark on the male coupling section in the training handle rack gear and shaft (24, Figure 7-11), for proper reassembly.

22. Reassemble the right training handle stuffing box body (7, Figure 7-16) with its assembled rubber gasket (3), in the bored hole and counterbored section seat in the right side of the eyepiece box.

23. Rotate the right training handle stuffing box body (7) until its Stamped numerals coincide with corresponding stamped numerals on the eye piece box. Line up the clearance holes in the stuffing box body with the tapped holes in the counterbored section seat and insert the six lockscrews (10).

28. Check the cleanliness of the inner face of the eyepiece window assembly. Assemble the eyepiece window frame rubber gasket (8) to its counterbored section seat in the front of the eyepiece box. Line up the holes of the gasket with the tapped holes in the counterbored section seat.

29. Reassemble the eyepiece window assembly on the rubber gasket of Step 28, and check the reference numerals on the eyepiece window frame (7) and the eyepiece box for proper assembly.

30. Secure the eyepiece window frame (7) with four short and eight long lockscrews (2 and 3). These lockscrews are inserted in counterbored clearance holes in the frame and screwed into tapped holes in the counterbored section seat in the front of the eyepiece box.

31. Remove the masking tape from the lower end of the waveguide section continuation, and check the distance measurement of 32 mm from the lower end of the waveguide to the bottom face of the eyepiece box base for the optimum point of the waveguide and the bottom plug assembly.

32. Reassemble the bottom plug housing rubber gasket (3, Figure 7-17) over the medium

Range section of the bottom plug housing (1) up to its large flange section shoulder. Line up the holes of the rubber gasket with clearance holes in the

through four soldered air line straps (52) of the fourth inner tube section (37), the clearance holes in its lower end coupling (40), the clearance holes in the bearing

bottom plug housing large flange section shoulder.

33. Check the position of the rectangular slot in the bottom plug housing for proper alignment over the lower end of the waveguide. Reassemble the bottom plug assembly with its rubber gasket over the end of the waveguide and into the bored hole on the counterbored section seat in the base of the eyepiece box.

34. Secure the bottom plug assembly by the insertion of 12 lockscrews (7). These lockscrews are inserted in counterbored recess clearance holes in the bottom plug housing (1) and screwed into tapped holes in the counterbored section seat in the base of the eyepiece box. The lower face of the bottom plug housing extends into the counterbored section a short distance below the base of the eyepiece box, thus allowing the eyepiece box bottom flange plate (13, Figure 7-12) to contact the base of the eyepiece box.

35. Reassemble the left and right training handle assemblies (Figure 7-21 and 7-22) to the left and right sides of the eyepiece box. Check reference marks of each inner bevel gear clutch (3) with the corresponding reference marks on each square section of the right and left training handle packing gland actuating shafts (23 and 16, Figures 7-21 and 7-22 respectively).

36. Secure each hinge bracket of the left and right training handle assemblies with four bolts (5) each. The hinge bracket bolts are

flanges in the third inner tube section (1, Figure 7-10), and one soldered air line strap (30) of the second inner tube section (14). This air line section slides further through clearance holes in the reducing coupling (18), first inner tube section flanges (31), and the eyepiece skeleton flanges (42, Figure 7-11).

2. Reassemble the center air line section (16, Figure 7-7), with its soldered coupling (17) at its upper end and its air line continuation (34) with its soldered air line coupling (35) at its lower end, to the connection point located at the lower part of the fifth inner tube section (19). This air line section and its continuation slides upward through three soldered air line straps (33) of the fifth inner tube section (19), the clearance hole in the fourth inner tube section upper end coupling (40), and three soldered air line straps (15) of the sixth inner tube section (1). Connect the upper part of the lower air line section (34) to the soldered coupling (35) at the lower end of the center air line section continuations (34).

3. Reassemble the upper air line section (19, Figure 7-6) and its continuations (27, 41, 50, 59, 77, 90) and (16, Figure 7-7), to the connection point located at the upper part of the sixth inner tube section (1). Slide the upper air line section upward through one soldered air line strap (15) of the sixth inner tube section, the clearance holes in the bearing flanges of the seventh inner tube section (79, Figure 7-6), two soldered air line straps (76) of the eighth inner tube section (60), and the clearance holes in the flanges

inserted in clearance holes in the hinge brackets (23 and 16, Figures 7-21 and 7-22 respectively) and screwed into tapped holes in the left and right sides of the eyepiece box.

7V4. Reassembly of air line sections to the reduced tube and inner tube sections. This procedure is performed in the following manner:

1. Reassemble the lower air line section (34, Figure 7-7) and its continuations (53, 13, 29, and 39, Figure 7-10) with the soldered air line couplings (40) to the connection point located at the lower part of the fifth inner tube section (19, Figure 7-7). Slide this air line section downward of the first, second, third, fourth, and fifth reduced tube sections and into the skeleton head (10, Figure 7-5). Connect the lower end of the upper air line section continuation (16, Figure 7-7) to the soldered air line coupling (17) at the upper end of the center air line section (16). It will be necessary to pull the upper air line section outward from the first reduced tube section (51, Figure 7-6) to connect the coupling in the lower end of the air line section continuation.

7V5. Orientation check of head prism travel. This procedure is performed in the following manner

1. The head prism is allowed 46 degrees elevation and 11 degree depression, thus leaving a 1 degrees tolerance at the limits of travel for correction by the adjustment screws.

2. Rotate the revolving grip (26, Figure 7-21) to carry the index ring (31) with its graduated line of 45 degrees to the elevated position. Swing the Sperry-Kollmorgen collimator index line to the 45 degrees graduation as indicated by the azimuth disk plate and check the graduated line of the index ring for coincidence with the stationary line on the fixed grip (24). An overtravel of the index ring, checked with the line of sight of a slight overtravel, should be compensated by screwing out the segment adjusting screw (20) without change in azimuth of more than 10 minutes of arc between an elevation of 10 degrees and a depression of 10 degrees of the line of sight.

7. Check the movement of the revolving grip (19, Figure 7-22) of the right training handle assembly. Correct the insufficient or excessive travel of the power index ring index lines by means of the two segment adjusting screws (13). The front adjusting screw corrects for low power, while the rear adjusting screw corrects for high power.

8. Make the correct adjustment of the low power index line on the power index ring (30) with the stationary index line on the fixed grip (17) by shifting to low and then to high power. With an ear to the periscope, note the positive

and maintaining the adjustment with the segment adjusting screw lockscrew (18).

3. Rotate the revolving grip (26) to carry the index ring (31) with its graduated line of 10 degrees to the full depression position. Swing the Sperry-Kollmorgen collimator index line to the 10 degrees graduation as indicated by the azimuth disk plate, and check the graduated line of the index ring for coincidence with the stationary line on the fixed grip (24). An overtravel of the index ring, checked with the line of sight of a slight overtravel, should be compensated by screwing out, the opposite segment adjusting screw (20) and maintaining the adjustment with the segment adjusting screw lockscrew (18).

4. Swing the Sperry-Kollmorgen collimator to zero line of sight and rotate the revolving grip (26) elevating the head prism, to check the center line of sight with the horizontal line of the collimator reticle.

5. The zero degree groove in the revolving grip inner shoulder (26) is made at the factory in the following manner. The detent plunger release knob is now rotated to the IN position, and a rawhide hammer is used to tap the detent plunger retaining bushing (10). The tapping on the bushing causes the detent plunger to make an impression on the inner bearing shoulder of the revolving grip. The V-slot is now cut on the inner bearing shoulder by following the disassembly procedure of Steps 11 and 12 of Section 7Q2.

engagement click of the change-of-power mechanism in the skeleton head. The adjustment should be made so that the adjusting screw has sufficient clearance to allow the index line on the power index ring (30) carried by the revolving grip (19) to come into coincidence with the stationary index line on the fixed grip (17). The coincidence of these index lines should occur immediately after the change-of-power click is heard. This clearance should carry the adjusting screw (13) against the revolving grip segment stop screw (24) located in the fixed grip (17) after the positive engagement click is heard. The high-power adjustment is produced in similar manner. Any necessary adjustments to the adjusting screws (13) for the low- and high-power index lines require the disassembly of the two revolving grip locknuts (23) and the removal of the revolving grip (19).

9. While making the change-of-power adjustment, it may be found that there is not a positive engagement at high and low power. Correct this by means of the shifting wire spindle adjusting nuts (4, Figure 7-11).

7V6. Reassembly of inner tube in the outer tube. 1. Check the head prism and the Galilean eyepiece and objective lenses for cleanliness. Clean all lenses and the head prism surfaces with clean lens tissue. Remove surface dust with a clean camel's-hair brush or vacuum brush used with ether.

2. Check the left training handle, setting it to zero line of sight.

6. The prism tilt mechanism should elevate and depress the line of sight of the periscope

3. Place the outer tube in the V-blocks on the optical I-beam bench, properly located for the assembly of the inner tube sections.

4. Place the special outer tube alignment guide (Figure 4-7) on the outer tube over the undercut section. Secure it temporarily by the use of a socket wrench so that the reference line of the guide is lined up with the front vertical azimuth line on the outer tube. Place the eyepiece box alignment guide (Figure 4-7) over the two side flat sections of the eyepiece box, resting it on its flat front section. Assemble the eyepiece box radius clamp from the rear side of the eyepiece box and insert two wing bolts into the tapped holes in the two projections of the eyepiece box alignment guide. The purpose of this outer tube and eyepiece box alignment guide is to insure correct entry and guidance for the assembly of the inserted key (17, Figure 7-12) of the eyepiece box with the inside keyway in the lower end of the outer tube (2, Figure 7-2).

5. Place the main coupling (12) on the lower end of the outer tube threads and give it a full turn.

6. Assemble the special hinged clamp (Figure 4-12) over the outer circumference of the second eccentric bearing flange

10. Assemble the special hinged clamp over the outer circumference of the third eccentric bearing flange of the seventh inner tube section (79, Figure 7-6).

11. Attach a shackle to the hinged clamp projection on the seventh inner tube section. Place the hook of the chain hoist in the shackle and take up any slack in the chain (as shown in Figure 4-14).

12. Lift the assembled inner tube sections with both chain hoists and transport them to the lower end of the outer tube. Center the skeleton head in the outer tube, and check the lower end of the inner tube sections to make sure that they are parallel with the outer tube. Check the skeleton head lenses and head prism for cleanliness.

13. The skeleton head, reduced and inner tube sections are slowly carried in the outer tube, guiding them parallel and properly centered in the outer tube.

14. When the first and second eccentric bearing flanges of the seventh inner tube section (79, Figure 7-6) have entered the attached main coupling, the movement of the inner tube sections is halted temporarily.

15. Remove the hook of the chain hoist and special hinged clamp from the seventh inner tube section.

of the third inner tube section (1, Figure 7-10).

7. Attach a special steel lifting plate (Figure 4-9) to the base of the eyepiece box insert the four special bolt's into the clearance holes in the lifting plate and screw them into the tapped holes in the base of the eyepiece box.

8. Connect a lifting spreader bar (similar to Figure 4-13, but shorter in length) to the hinged clamp lifting projection. Thus projection slides between the center slot section of the upper part of the spreader bar and a bolt is placed through the clearance holes in the projection and the spreader bar. The lifting plate projection slides into the center slot section of e spreader bar at the lower part and is held in similar manner to the upper part. Place the hook of the chain hoist in the center pad of the spreader bar (Figure 4-11).

9. Take a light strain with the chain hoist in the center pad of the spreader bar.

16. Slowly resume the movement of the inner tube sections in the outer tube, until the first eccentric bearing flange of the third inner tube section (1, Figure 7-10) has entered the attached main coupling. The movement of the inner tube sections is again halted. Place the roller stand under the eyepiece box (Figure 4-11) adjusting it until the rollers touch the eyepiece box, and release the load of the chain hoist to the roller stand.

17. Remove the spreader bar and hinged clamp and attach a shackle to the lifting plate projection. Insert the hook of the chain hoist into the shackle (Figure 4-10), and remove the strain of the overhanging inner tube sections and the eyepiece box from the roller stand.

18. Slowly resume the movement of the inner tube sections in the outer tube, until the projecting arm of the outer tube guide and the

projecting arm of the eyepiece box alignment guide are near contact (Figure 4-8). Check to see that both their projecting arms will come into contact, and that they remain so for the remainder of the assembly of the inner tube sections in the outer tube, resuming the movement slowly.

19. When the upper part of the eyepiece box comes into coincidence with the attached

25. Remove the eyepiece box and outer tube alignment guides from the eyepiece box and outer tube.

26. Locate the periscope in the V-blocks on the optical I-beam bench to check the telemeter lens line in high power. It will first be necessary to follow the procedure of Section 4V10 for alignment of the Sperry-Kollmorgen collimator to the optical I-beam bench for the axis of the outer tube, which is 0.125 inch higher than the axes of

main coupling, unscrew the coupling from the outer tube and slide it on the upper part of the eyepiece box against its threaded periphery and continue the movement slowly. Check the position of the outer tube and the eyepiece box to ascertain that the inserted key (17, Figure 7-12) and the outer tube inside keyway will come into proper engagement.

20. When the main coupling comes in contact with the outer tube, continue the movement slowly until the coupling can be turned clockwise.

21. Use a spanner wrench, insert its tooth prongs in the twin holes in the main coupling (22) and turn it clockwise. Before turning the main coupling, scribe a reference line from each lockscrew hole to the outer edge of the coupling and make a similar reference line on the outer tube for the spotted recesses. Thus a reference line is established to enable the repairman to obtain a visual determination as to when the main coupling reference line and the outer tube reference line are in coincidence for proper insertion of lockscrews (21). Thus coincidence of both tapped lockscrew holes in the main coupling with the spotted recesses in the outer tube is easily determined. The lockscrews, when inserted, should not project beyond the periphery of the main coupling.

22. Remove the hook of the chain hoist from the shackle, and remove the special bolts and the lifting plate.

the Types II and III periscopes. Center the head prism in the axis of the collimator. The collimator is set at infinity (Figure 4-71) and the collimator base plate index line (7, Figure 4-69) is in coincidence with the 0 degree graduation on the azimuth disk plate (6). Shift the Galilean telescope system to the IN position and check the vertical and horizontal displacement of the line of sight.

27. Should the horizontal and vertical displacement of the line of sight indicate that it is out of collimation, it will be necessary to make the adjustments as indicated in Steps 6 and 7 in Section 7U4. It is necessary to remove the inner tube sections to make this adjustment.

28. Reassemble the eyepiece box pressure gage assembly rubber gasket (1, Figure 7-12), in the rectangular recess seat in the right side of the eyepiece box. Reassemble the pressure gage assembly (10) on the rubber gasket (1) and secure it with 10 lockscrews (18). These lockscrews are inserted into countersunk clearance holes in the pressure gage assembly and screwed into tapped holes in the rectangular recess seat in the eyepiece box.

7V7. Pressure testing and cycling. The periscope is pressure tested and cycled in the following manner:

1. Follow the procedure of Section 4W6 and the cross references.

2. Use an air hose to blow off all water around the bottom plug assembly.

23. Remove the left and right training handle hinge bracket bolts (5, Figures 7-21 and 7-22) removing the left and right training handle assemblies from the eyepiece box.

24. Remove the four lockscrews (10, Figure 4-39) from the focusing knob assembly, removing the focusing knob assembly from the eyepiece box.

3. Attach a special bottom plug cycling cup (Figure 7-32) over the bottom plug assembly and secure it with a strongback, using two of the eyepiece box bottom flange plate bolts (16, Figure 7-12) to secure the strongback for the securement of the bottom plug cycling cup.

The bolts are inserted in clearance holes in the strongback and screwed into tapped holes in the base of the eyepiece box.

4. Attach the vacuum gage rubber hose to one of the bottom plug cycling cup fittings, and the Hyvac pump rubber hose to the other fitting.

5. Apply apiezon wax around the periphery of the bottom plug cycling cup connection and around the joints of the vacuum gage and Hyvac pump hose.

6. Lower the pressure from the area of the bottom plug cycling cup with the Hyvac pump, thus boiling out all moisture in this area.

7. A vacuum of 1 or 2 mm absolute pressure should be obtained and held for several hours.

8. Remove hose connections. Remove the two bolts (16, Figure 7-12), removing the strongback and the bottom plug cycling cup. After removal of the bolts, immediately apply masking tape to the bottom plug assembly to prevent any moisture from entering around the assembly.

7V8. Optical tests of the periscope in the tower. This procedure is performed in the following manner:

1. Secure a suitable hoisting clamp around the outer tube at least 12 inches below the joint between the outer tube and outer taper section. Line up the clamp with emery cloth placed with

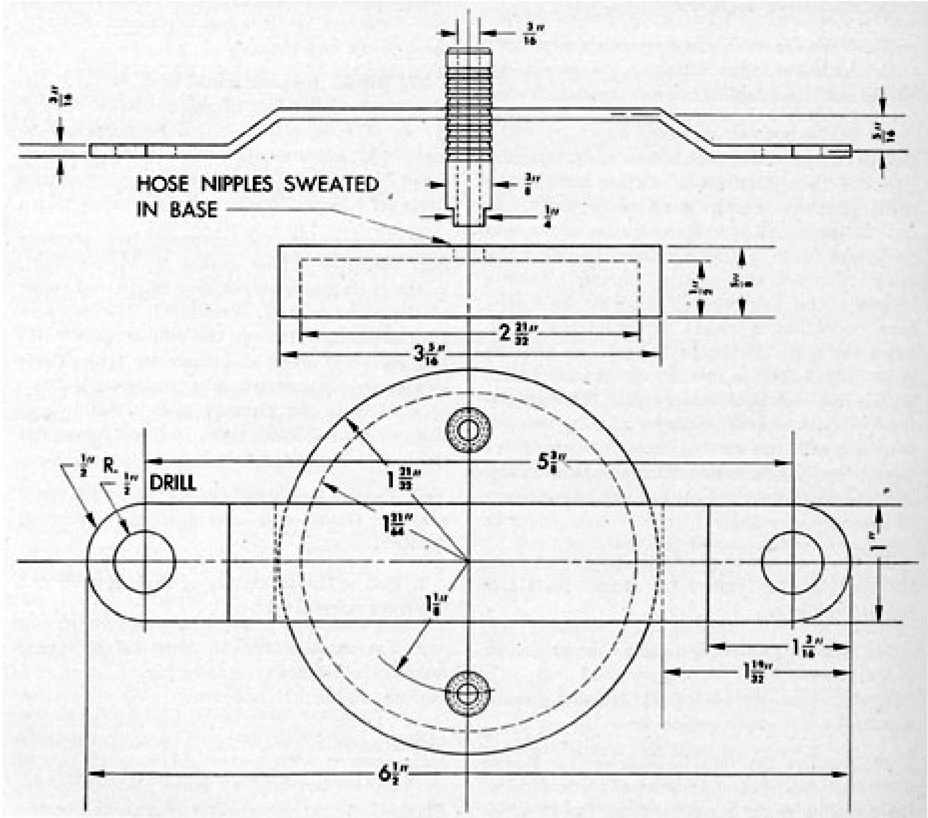

Figure 7-32. Bottom plug cycling cup.

its smooth side against the outer tube. Use special steel bolts and nuts for securing the clamp halves together (Figure 2-34).

2. Secure a safety clamp above the hoisting clamp (Figure 2-34).

3. Lift the periscope with two chain hoist hooks placed in the thimble ends of the canvas covered slings wrapped once around the outer tube.

4. Transport the periscope from the V-blocks, lowering it to within 10 inches of the assembly floor for attachment of the hinge carriage (Figure 2-39).

5. Remove the toggle bolt and open the clamp cap of the hinge carriage and line the clamp cap and clamp section of the hinge carriage with emery cloth placed with its smooth side against the outer tube. Secure the clamp cap

10. Reassemble the left and right training handle assemblies to their respective sides of the eyepiece box. Check the reference marks of the connecting couplings for proper alignment. Secure both training handle assemblies with four hinge bracket bolts each (5, Figures 7-21 and 7-22).

11. Check the zero reading of the diopter index ring (9, Figure 4-39). Place the auxiliary telescope at the eyepiece end of the periscope. Focus the eyepiece prism mount until sharp definition of the telemeter lens is apparent on an infinity target or infinity collimator.

12. Check the high- and low-power system on an infinity target or infinity collimator. No parallax should be apparent on the telemeter lens in either power.

13. Check the periscope in high and low power for cleanliness. If

and clamp section of the hinge carriage to the outer tube with two special bolts and nuts over the emery cloth. Insert the toggle bolt in the lined up holes of the supporting arm and clearance wall periphery projection of the hinge carriage after the clamp is secured.

6. Follow the procedure described under Steps 36, 38, 39, 40, and 41 of Section 4W4, in the inverse order, for transporting the periscope to the tower.

7. Reassemble the housing yoke assembly by following the procedure described under Section 4V19.

8. Slowly lower the periscope onto the hoisting yoke cable suspension adjusting nuts. This places the load of the periscope on the hoisting yoke and cables suspended from the lower platform in the tower. Remove the two shackles and hoisting slings from the hoisting clamp.

9. Reassemble the focusing knob assembly to the eyepiece box. Align the corresponding reference marks of the female coupling section (3, Figure 4-39) and the eyepiece drive actuating shaft (4, Figure 7-14) of the eyepiece drive packing gland assembly. Secure the knob bracket (7, Figure 4-39) after proper engagement of dowel pins (8) with the four lockscrews (10).

particles of dirt are present, they will show clearly on the telemeter lens which lies in the focal plane of the instrument, in which case it is necessary to remove the inner tube sections, and further disassemble for cleaning purposes.

14. Check the vertical and horizontal displacement of the line of sight of the Galilean telescope system in the IN and OUT positions. Use a church steeple, flagstaff, chimney or infinity collimator for checking the prescribed displacement tolerances.

15. Check the field; it must be free of fog.

16. Check the operation of the left and right training handle assemblies, noting particularly their limit of travel stops by corresponding stationary index lines.

17. After inspection, the periscope is returned to the assembly floor by first following the procedure describes under Section 7B, Steps 5, 6, and 9 for the disassembly of the left and right training handle assemblies, focusing knob assembly, and hoisting yoke assembly. Follow the procedure described under this section, Steps 1 to 6 inclusive, in the inverse order, for the return of the periscope in the V-blocks on the optical I-beam bench and the reassembly of the external projections.

18. Reassemble all external projections of Section 7B, Steps 3 to 7 inclusive, to the eyepiece box in the inverse order.

19. The periscope is now ready for the electronic engineer for the prescribed electronic tests.

20. After the prescribed electronic tests of Section 7V8, the eyepiece box bottom flange plate (13, Figure 7-12) is reassembled to the base of the eyepiece box (11) and is secured with five bolts (16). The inserted rubber gasket side of the flange plate is placed next to the base of the eyepiece box.

21. Cover the opening in the eyepiece box bottom flange plate with masking tape to prevent moisture from entering the open area of the flange plate and around the bottom plug assembly.

7V9. Electronic testing procedure. (For electronic engineer only.) a. Modifications to equipment. 1. The following modifications of the TS-12/AP and TS-13/AP test sets are necessary to adapt them for testing the ST antenna assemblies:

a) Supply matched load CG-88/U without connector and so constructed that it will have a voltage standing wave ratio of 1.03 or lower at wavelengths of 3.36 cm and 3.44 cm. Engrave a line around the matched load, 0.537 inch 0.005 inch from the open end.

b) Supply standing wave machine CG-87/U with the round cover flange replaced with a choke flange AN type UG-52/U.

six screws holding the micrometer head support in place. The wavemeter should be thoroughly cleaned and burrs removed from the edges of the enlarged hole. Reassemble the wavemeter with micrometer engraving 90 degrees counterclockwise from plane of mounting flange, so that readings may be taken from above when the meter is in position in the TS-13/AP. The TS-13/AP must be taken out of the case in order to read the wavemeter unless further modification can be suggested.

e) Drill a 5/8-inch hole in the panel of the TS-13/AP to accommodate the micrometer head of the wavemeter.

b. Instructions for testing ST antenna assembly and plug on submarine tenders and at advanced bases. 1. Introduction. Standing wave ratio measurements are made on the ST antenna assembly and the bottom plug alone by the TS-12/AP and TS-13/AP test sets. The TS-13/AP is a source of a square wave modulated radio-frequency signal variable in frequency. The TS-12/AP test set detects the signal with a CG-87/U standing wave machine and a linear amplifier which is provided with a meter which indicates voltage standing wave ratio directly.

2. Operation of TS-13/AP signal generator.

a) Connect the line cord to a source of 115 volts, 60-800 cycle power, and operate the POWER switch to ON.

c) Revise the carrying case for TS-12/AP (Unit 2) to fit the modified standing wave machine.

d) The Model 53 wavemeter supplied with the TS-13/AP cannot be calibrated for the ST frequency band because several revolutions of the wavemeter dial are required to cover the entire band. Replace the Model 53 wavemeter assembly with a General Electronics Industries wavemeter Model 1510 modified in the following manner:

1) Drill and tap holes in, the wavemeter flange for mounting it on the TS-13/AP coupling flange.

2) Enlarge the wavemeter coupling hole to 19/64 inch. After enlarging the hole, the wavemeter should be disassembled by removing the

b) Allow 3 minutes for the equipment to warm up.

c) The following switches should be in the indicated positions:

Switch	Position
SYNC/SELF SYNC	SYNC
CALIBRATE/USE	USE
PULSE/SQUARE WAVE	PULSE
INPUT SEL.	+ TRIG

d) Adjust REFLECTOR control for minimum meter deflection.

e) Vary ZERO SET control until meter reads zero.

f) Operate CALIBRATE/USE switch to CALIBRATE.

g) Vary REFLECTOR control throughout its range. Select the point which gives maximum

deflection. Vary ADJUST OUTPUT control to keep meter reading on scale.

h) Throw the following switches to the indicated positions:

Switch	Position
SYNC/SELF SYNC	SYNC
CALIBRATE/USE	USE
PULSE/SQUARE WAVE	SQUARE WAVE

i) Measure frequency by very slowly turning FREQUENCY micrometer head while carefully watching the meter. The signal generator frequency is indicated

standing wave ratio at frequencies corresponding to wavemeter readings of 355, 356, 357, 358, 359, 443, 444, 445, 446, 447.

To test the bottom plug alone, attach the square flange connector of the standing wave machine to the face of the bottom plug housing clamp ring as before. Insert the open end of the matched load CG-88/U into the other end of the bottom plug until the engraved line on the matched load is flush with the surface of the plug. If the matched load fits too tightly into the plug to allow easy insertion, the outside surfaces of the matched load may be filed down slightly where necessary,

by a sharp dip in the meter reading.

j) Tune the signal generator to the proper frequency by varying the TUNING control. Clockwise rotation of the TUNING control decreases the frequency (increases the wavelength). Adjust REFLECTOR control for maximum meter reading after each adjustment of the tuning control and before measuring the frequency.

k) Rotate the ATTENUATOR control to the maximum clockwise position.

l) The equipment is now ready for use.

c. Operation of TS-12/AP standing wave indicator-amplifier. 1. Connect the line cord to a source of 115 volts, 60-800 cycle power and operate POWER switch to ON.

2. Connect the probe cable to either input jack and throw the INPUT selector switch to the corresponding position, NO. 1 or NO. 2,

3. The METER switch, should be at AMP. and the BOL/XTAL switch in the XTAL position.

4. Adjust MASTER and appropriate INPUT gain controls for a meter reading near lull scale.

d. Procedure for standing wave ratio measurements. 1. Set up test equipment as shown in Figure 7-33.

2. To test the periscope assembly attach the square flange provided that the filings are entirely removed with an air hose (inside and outside) before the matched load is reused. Measure the standing wave ratio at frequencies corresponding to wavemeter readings of 355 and 447.

3. Place test equipment in operation as indicated in b and c.

4. Tune the traveling probe for maximum deflection on the meter by turning the knurled nut on the probe assembly. Do not make any other adjustment on the probe. Tune the probe every time the operating frequency is changed.

5. Run the probe along the slotted line until the meter shows maximum deflection. Adjust the INPUT gain control until the meter reads exactly 1.0 on the upper scale. Then move the probe to the point of minimum deflection and read the voltage standing wave ratio on the upper scale of the meter.

e. Performance specifications. The voltage standing wave ratio of the assembled periscope must be 1.33 or less over the entire frequency band of the antenna.

If the specified performance is not obtained on the assembled periscope, the bottom plug assembly should be removed and tested alone for its standing wave ratio. If the voltage standing wave ratio is lower than 1.26 at both frequencies the plug is satisfactory and the long length of waveguide should be recleaned, and if necessary, replaced. If the voltage standing wave ratio of the plug is equal to or higher than 1.26 at either frequency, another bottom

connector of the standing wave machine: CG-87/U to the periscope eyepiece box by means of the four tapped holes provided in the bottom plug housing clamp ring (2, Figure 7-17), being sure to dine up the waveguide opening with the corresponding dimensions of the opening in the bottom plug. Measure the plug assembly should be tested and, if satisfactory,

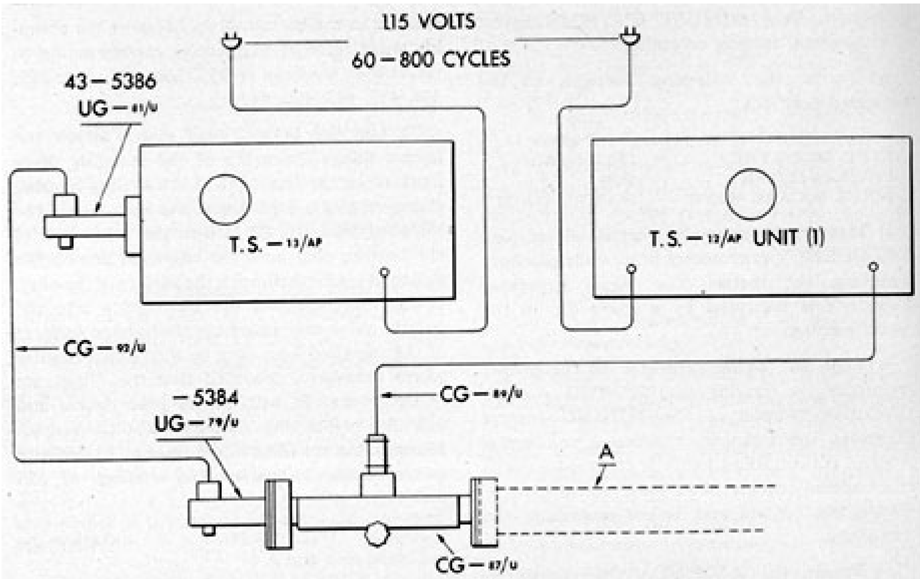

Figure 7-33. Electronic diagram.

used in place of the first bottom plug assembly in a second assembly test.

A is the component to be measured.

1. Periscope test. Attach the standing wave machine CG-87/U, to the periscope eyepiece box by means of the four tapped holes in the bottom plug housing clamp ring. (2, Figure 7-17). Be sure to line up the long dimension of the waveguide and the corresponding dimension of the opening in the bottom plug.

2. Bottom plug test. Attach the standing wave machine to the bottom plug assembly as before. Insert the open end of the matched load CG-88/U into the other end of the bottom plug until the engraved line on the matched load is flush with the surface of the plug.

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Figures 7-3 and 7-27.
TYPE IV
DESIGN DESIGNATION 93-KN-36
INNER TUBE AND TELESCOPE SYSTEMS
OPTICAL ARRANGEMENT
RAY DIAGRAM

Sub Periscope Home Page

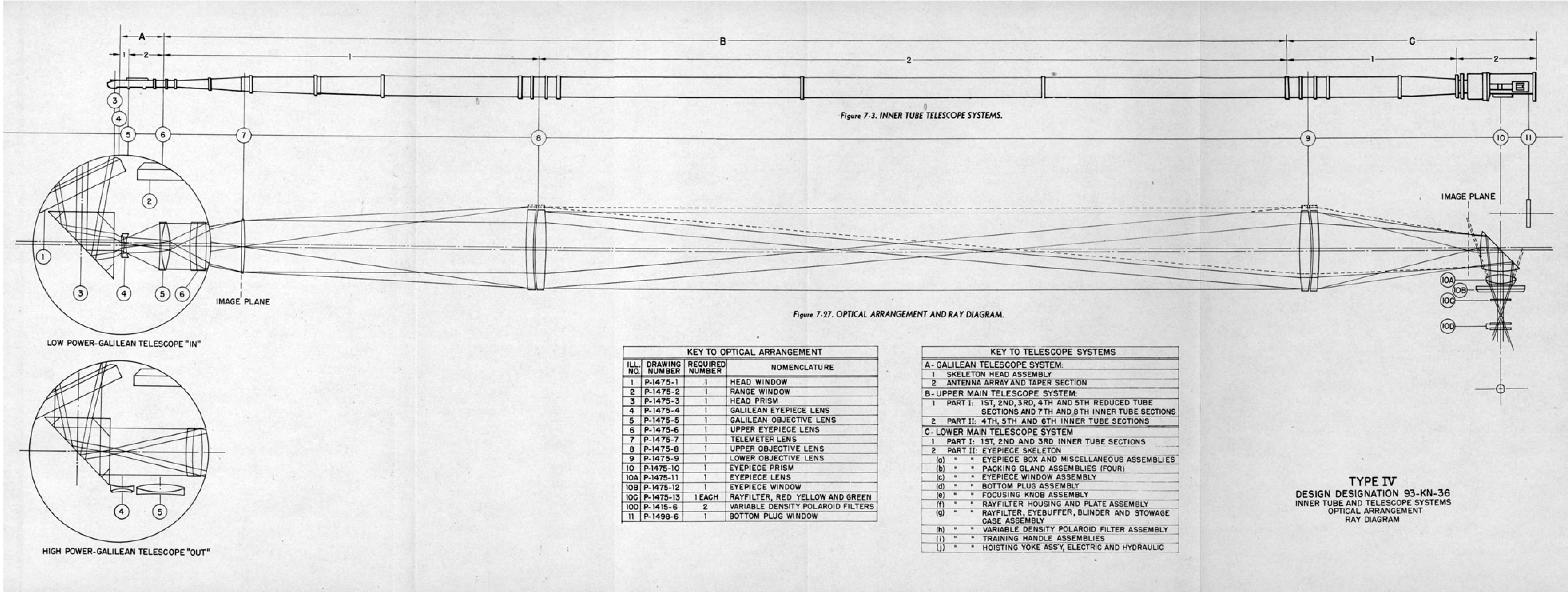

Figure 7-3. INNER TUBE TELESCOPE SYSTEMS.

Figure 7-27. OPTICAL ARRANGEMENT AND RAY DIAGRAM.

KEY TO OPTICAL ARRANGEMENT			
ILL. NO.	DRAWING NUMBER	REQUIRED NUMBER	NOMENCLATURE
1	P-1475-1	1	HEAD WINDOW
2	P-1475-2	1	RANGE WINDOW
3	P-1475-3	1	HEAD PRISM
4	P-1475-4	1	GALILEAN EYEPIECE LENS
5	P-1475-5	1	GALILEAN OBJECTIVE LENS
6	P-1475-6	1	UPPER EYEPIECE LENS
7	P-1475-7	1	TELEMETER LENS
8	P-1475-8	1	UPPER OBJECTIVE LENS
9	P-1475-9	1	LOWER OBJECTIVE LENS
10	P-1475-10	1	EYEPIECE PRISM
10A	P-1475-11	1	EYEPIECE LENS
10B	P-1475-12	1	EYEPIECE WINDOW
10C	P-1475-13	1 EACH	RAYFILTER, RED YELLOW AND GREEN
10D	P-1415-6	2	VARIABLE DENSITY POLAROID FILTERS
11	P-1498-6	1	BOTTOM PLUG WINDOW

KEY TO TELESCOPE SYSTEMS	
A- GALILEAN TELESCOPE SYSTEM:	
1	SKELETON HEAD ASSEMBLY
2	ANTENNA ARRAY AND TAPER SECTION
B- UPPER MAIN TELESCOPE SYSTEM:	
1	PART I: 1ST, 2ND, 3RD, 4TH AND 5TH REDUCED TUBE SECTIONS AND 7TH AND 8TH INNER TUBE SECTIONS
2	PART II: 4TH, 5TH AND 6TH INNER TUBE SECTIONS
C- LOWER MAIN TELESCOPE SYSTEM	
1	PART I: 1ST, 2ND AND 3RD INNER TUBE SECTIONS
2	PART II: EYEPIECE SKELETON
(a)	" " EYEPIECE BOX AND MISCELLANEOUS ASSEMBLIES
(b)	" " PACKING GLAND ASSEMBLIES (FOUR)
(c)	" " EYEPIECE WINDOW ASSEMBLY
(d)	" " BOTTOM PLUG ASSEMBLY
(e)	" " FOCUSING KNOB ASSEMBLY
(f)	" " RAYFILTER HOUSING AND PLATE ASSEMBLY
(g)	" " RAYFILTER, EYEBUFFER, BLINDER AND STOWAGE CASE ASSEMBLY
(h)	" " VARIABLE DENSITY POLAROID FILTER ASSEMBLY
(i)	" " TRAINING HANDLE ASSEMBLIES
(j)	" " HOISTING YOKE ASS'Y, ELECTRIC AND HYDRAULIC

Transparencies

The following pages come from transparencies that are located at the end of the Submarine Periscope manual, but that are not in its index.


The periscope is the eye of the submarine. It is provided with a suitable altiscope mechanism for observing the surface of the sea and the sky above while the submarine remains submerged. In addition, it is equipped with a built-in stadimeter for estimating the range and course angle of the target. ★ The operational effectiveness and the security of the submarine depend, in great part, upon the condition of the periscope. For this reason, the structural details and functional relationship of its more complicated mechanisms must be thoroughly understood and pictured by the optical repairman charged with its maintenance. ★ With these facts in mind, the following special presentation has been prepared.

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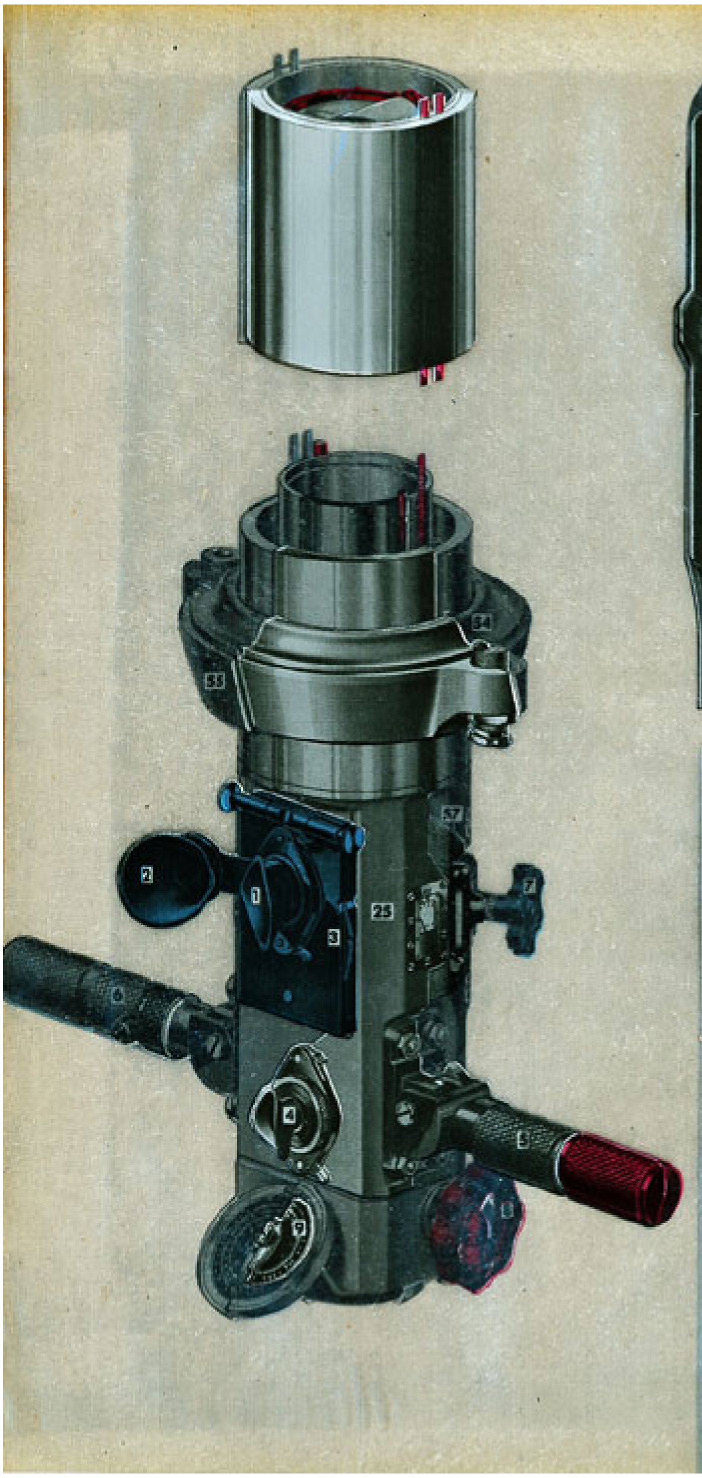


OUTER HEAD
AND TAPER SECTION

SPLIT OBJECTIVE
LENS AREA

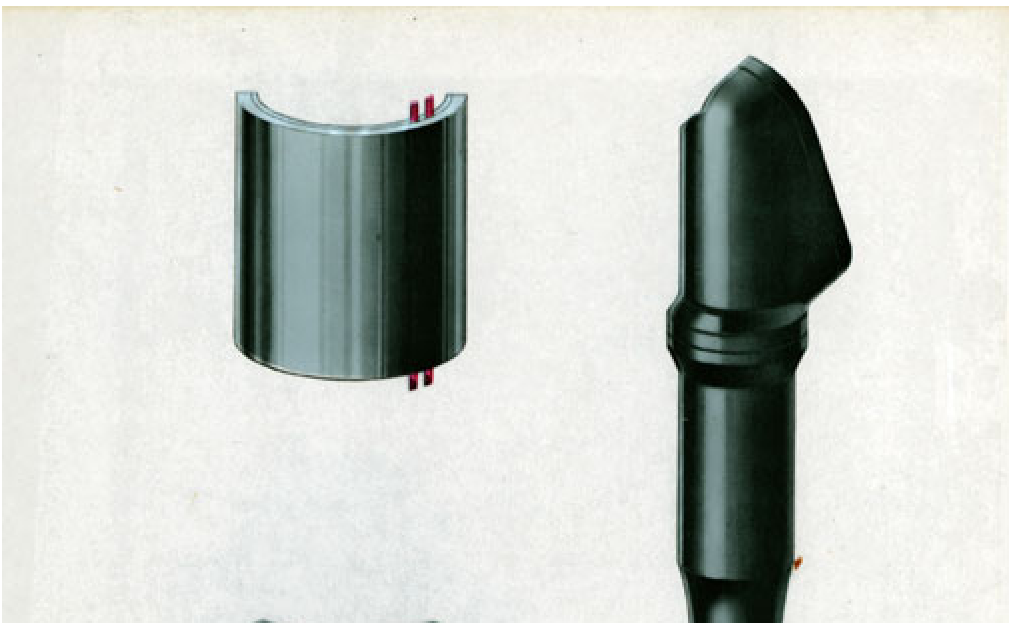
HOISTING YOKE

EYEPIECE END

1. EYE BUFFER.
2. EYE BLINDER.
3. RAYFILTER ATTACHMENT.
4. VARIABLE DENSITY POLEROID ATTACHMENT.
5. RIGHT TRAINING HANDLE (Change of power).
6. LEFT TRAINING HANDLE (Elevation—Depression Control).
7. FOCUSING KNOB.

STADIMETER
HOUSING

8. STADIMETER HANDWHEEL.
9. DIALS.



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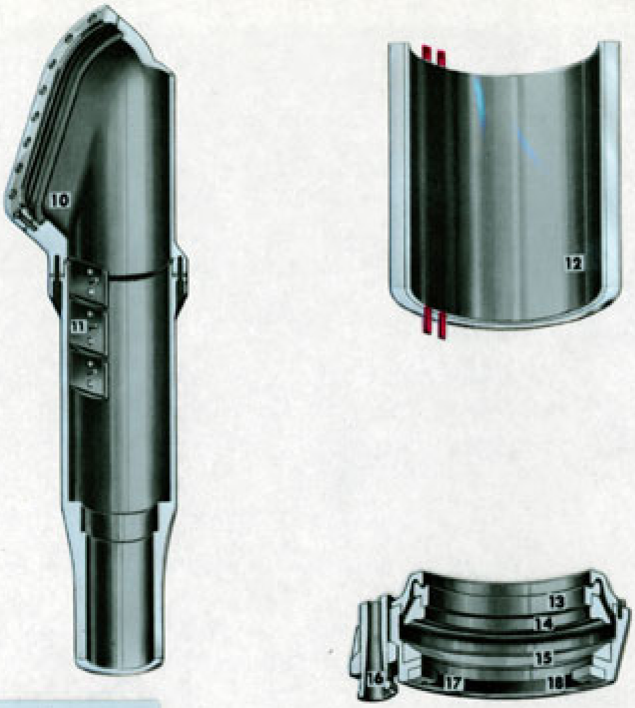

10. CROSS SECTION THROUGH OUTER HEAD.

WINDOW BEZEL FRAME SHOWING SEAL.

11. POWER SHIFT GEAR BRACKET. CUBE BRACKETS ABOVE AND BELOW.

12. SECTIONS OF SPLIT OBJECTIVE LENS COUPLING SLEEVE AND OF OUTER TUBE. (Clearance between them .005").

13. SPLIT RING.

14. UPPER BEARING RACE.

15. BRONZE LOCATING RACE.

16. WIRE ROPE SLEEVE.

17. SPHERICAL MOVEMENT STOP.

18. SPHERICAL MOVEMENT GUIDE.

19. RAYFILTER DRIVE GEAR RACK.

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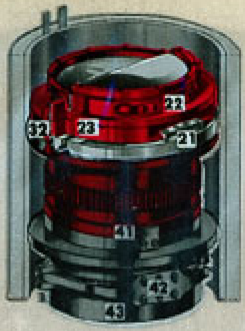
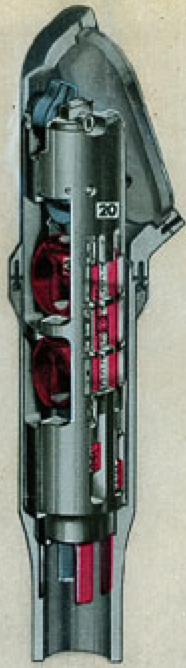
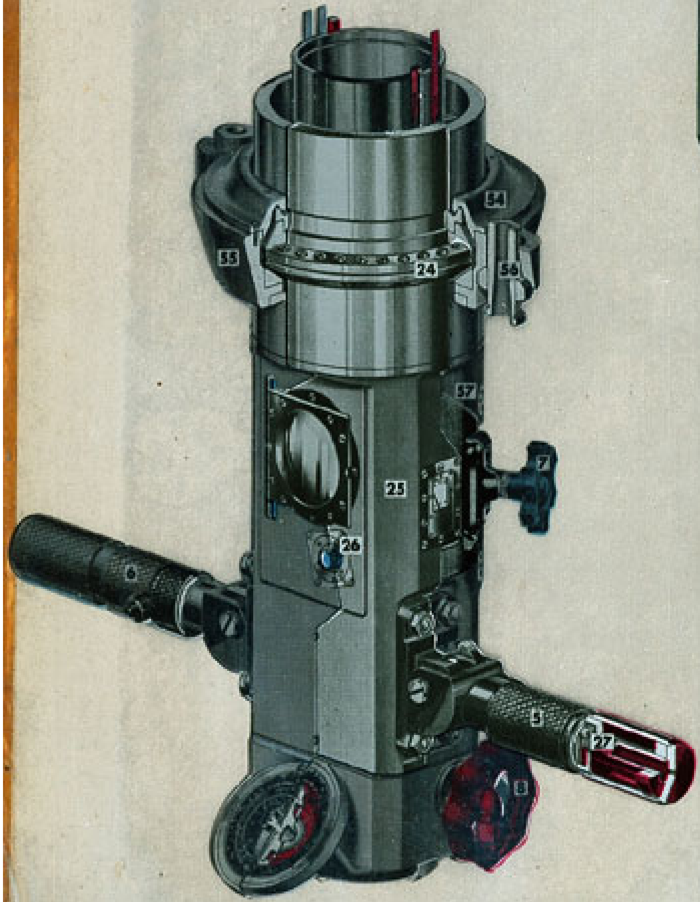
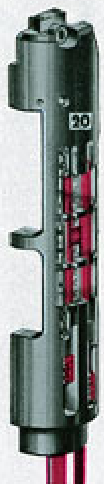
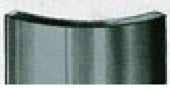


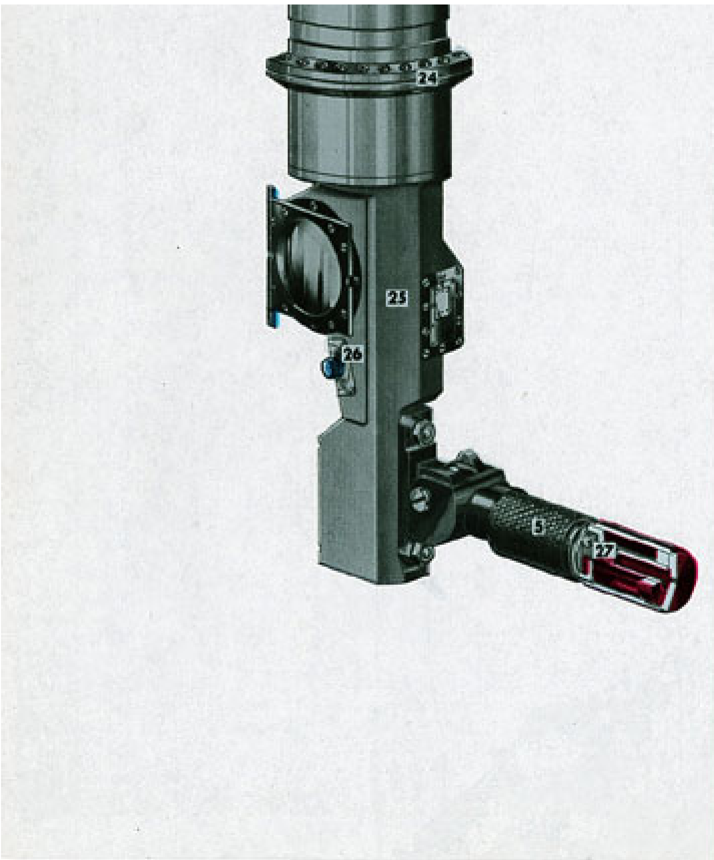




20. SKELETON HEAD FRAME SHOWING POWER SHIFT SIDE MECHANISM.
21. OBJECTIVE SLIDING TRACK. LOWER OBJECTIVE MOUNT GUIDE ABOVE NUMERAL.
22. OBJECTIVE LENS MOUNT. TENSION PLUG SPRINGS ON EACH SIDE OF THIS NUMERAL AND OBJECTIVE MOUNTING PLATE BELOW.
23. STADIMETER COLLIMATING SCREWS.
5. RIGHT TRAINING HANDLE. (Stationary Grip, Moveable Grip to right.)
24. HOISTING YOKE BEARING BALL RETAINER AND LOWER BEARING RACE.
25. EYEPIECE BOX. TO THE LEFT OF NUMERAL IS EYEPIECE WINDOW AND TO RIGHT THE PRESSURE AND VACUUM GAGE ASSEMBLY.
26. RAYFILTER DRIVE GEAR AND STUFFING BOX.
27. SEGMENT STOP. SEGMENT STOP AND ADJUSTING SCREW AND LOCK SCREW BELOW NUMERAL.







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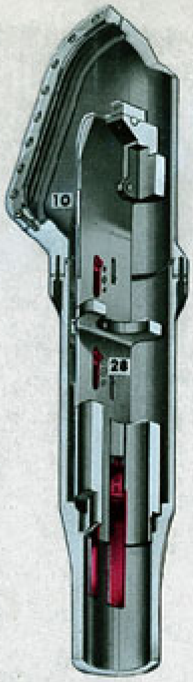
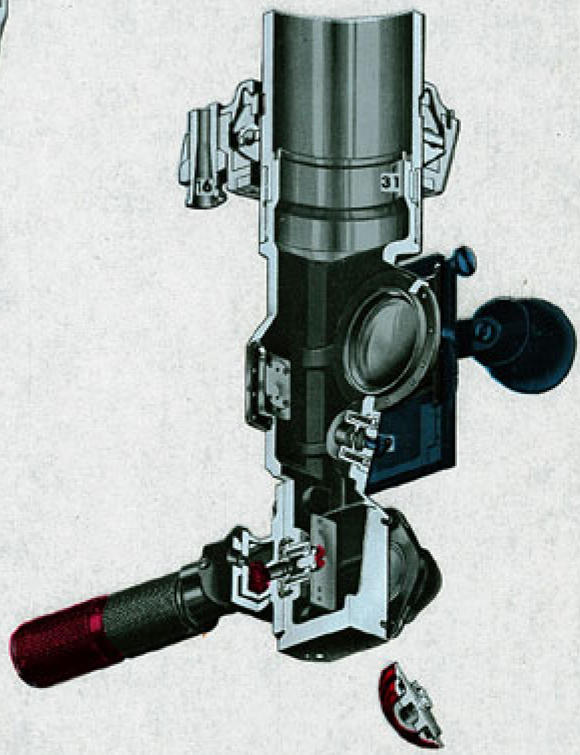


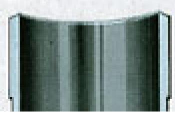


28. PIN PROJECTIONS OF RIGHT CUBE SHIFTING RACK, AND BELOW NUMERAL, POWER SHIFTING PAWL.

29. HALF-SECTION OF SPLIT OBJECTIVE LENS.

30. SPLIT OBJECTIVE CAM SHOES.

31. CROSS-SECTION SHOWING ATTACHMENTS OF EYE-PIECE BOX TO OUTER TUBE. KEY IMMEDIATELY TO THE RIGHT OF THIS NUMERAL. THIS PAGE SHOWS THE BACK OF THE PRESSURE GAGE AND SECTIONS THROUGH THE RAYFILTER DRIVE PACKING GLAND AND THE RIGHT TRAINING HANDLE PACKING GLAND.



28. PIN PROJECTIONS OF RIGHT CUBE SHIFTING RACK, AND BELOW NUMERAL, POWER SHIFTING PAWL.

29. HALF-SECTION OF SPLIT OBJECTIVE LENS.

30. SPLIT OBJECTIVE CAM SHOES.

31. CROSS-SECTION SHOWING ATTACHMENTS OF EYE-PIECE BOX TO OUTER TUBE. KEY IMMEDIATELY TO THE RIGHT OF THIS NUMERAL. THIS PAGE SHOWS THE BACK OF THE PRESSURE GAGE AND SECTIONS THROUGH THE RAYFILTER DRIVE PACKING GLAND AND THE RIGHT TRAINING HANDLE PACKING GLAND.

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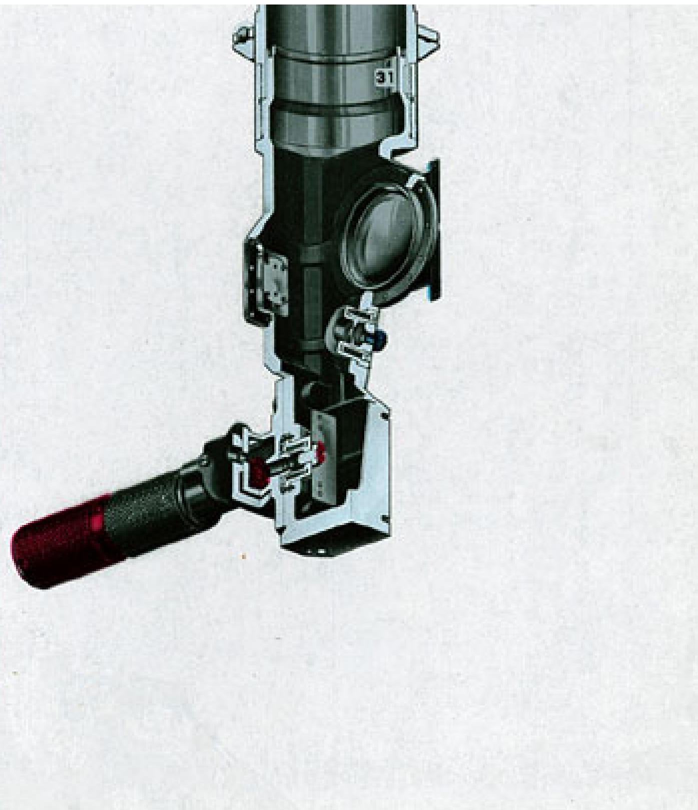

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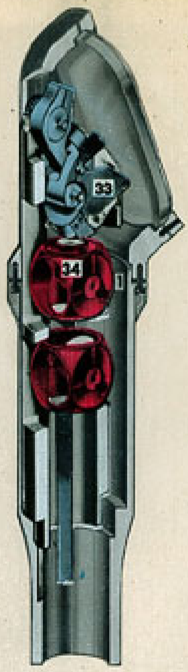
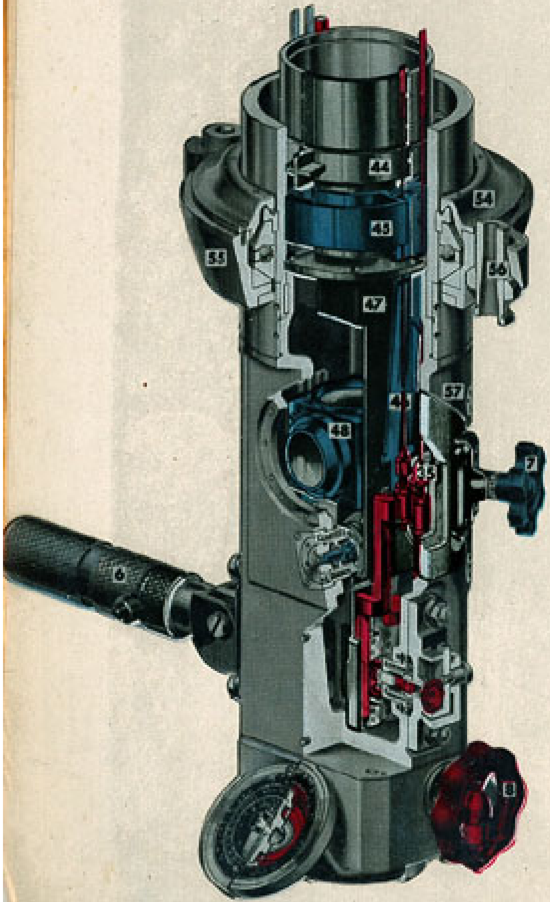


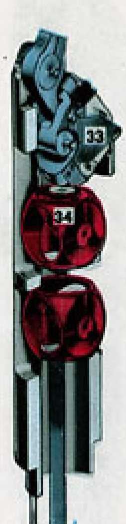


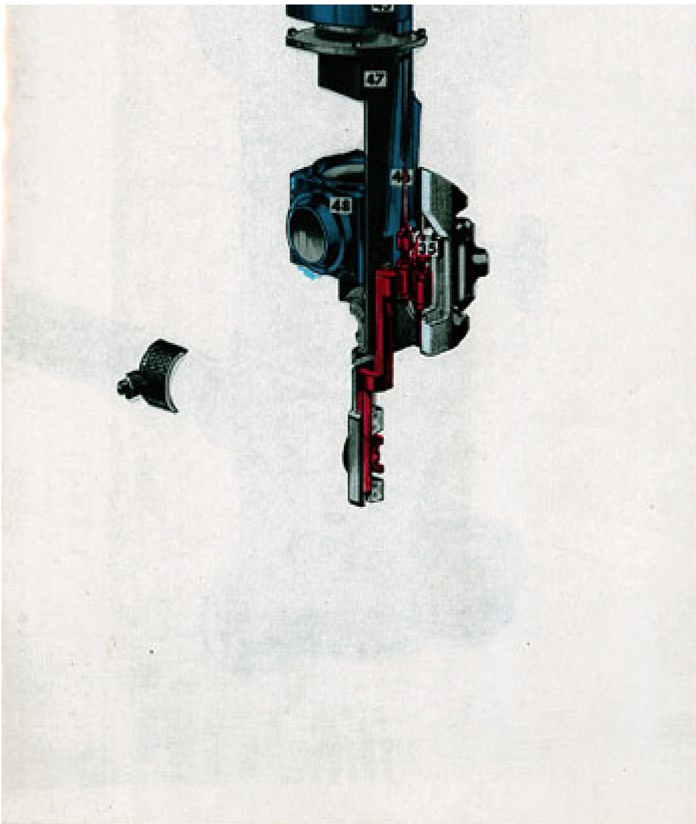
32. OBJECTIVE OPERATING KEY GUIDE AND SHAFT.

33. HEAD PRISM, MOUNT AND OPERATING MECHANISM.

34. GALILEAN TELESCOPE IN LOW POWER.

35. SHIFTING TAPE SPINDLE ASSEMBLIES ATTACHED TO POWER SHIFTING RACKS.





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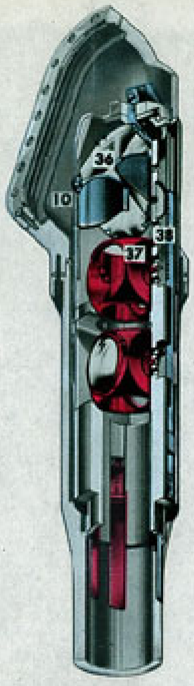
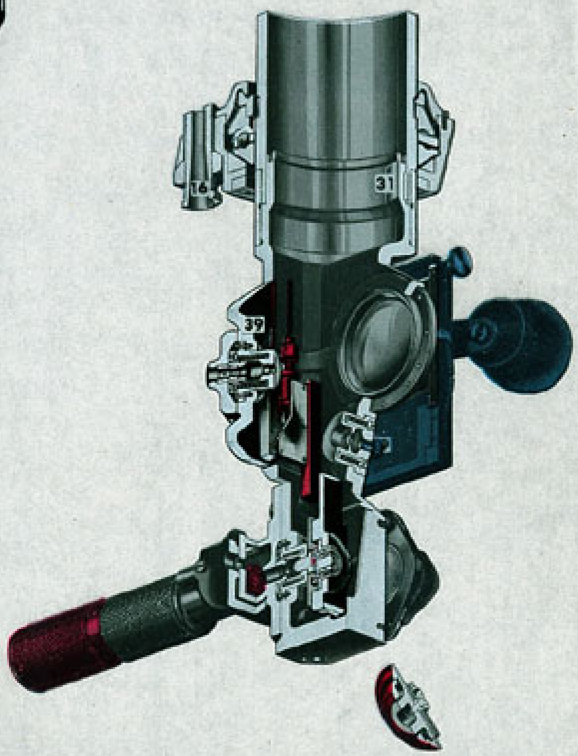


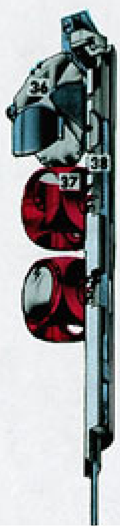


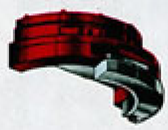
36. HEAD PRISM AND HEAD PRISM SHADE (Below prism).

37. GALILEAN TELESCOPE IN "OUT" POSITION.

38. RIGHT PRISM SHIFTING RACK.

39. EYEPIECE DRIVE PACKING GLAND.





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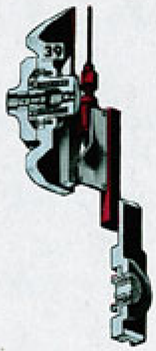

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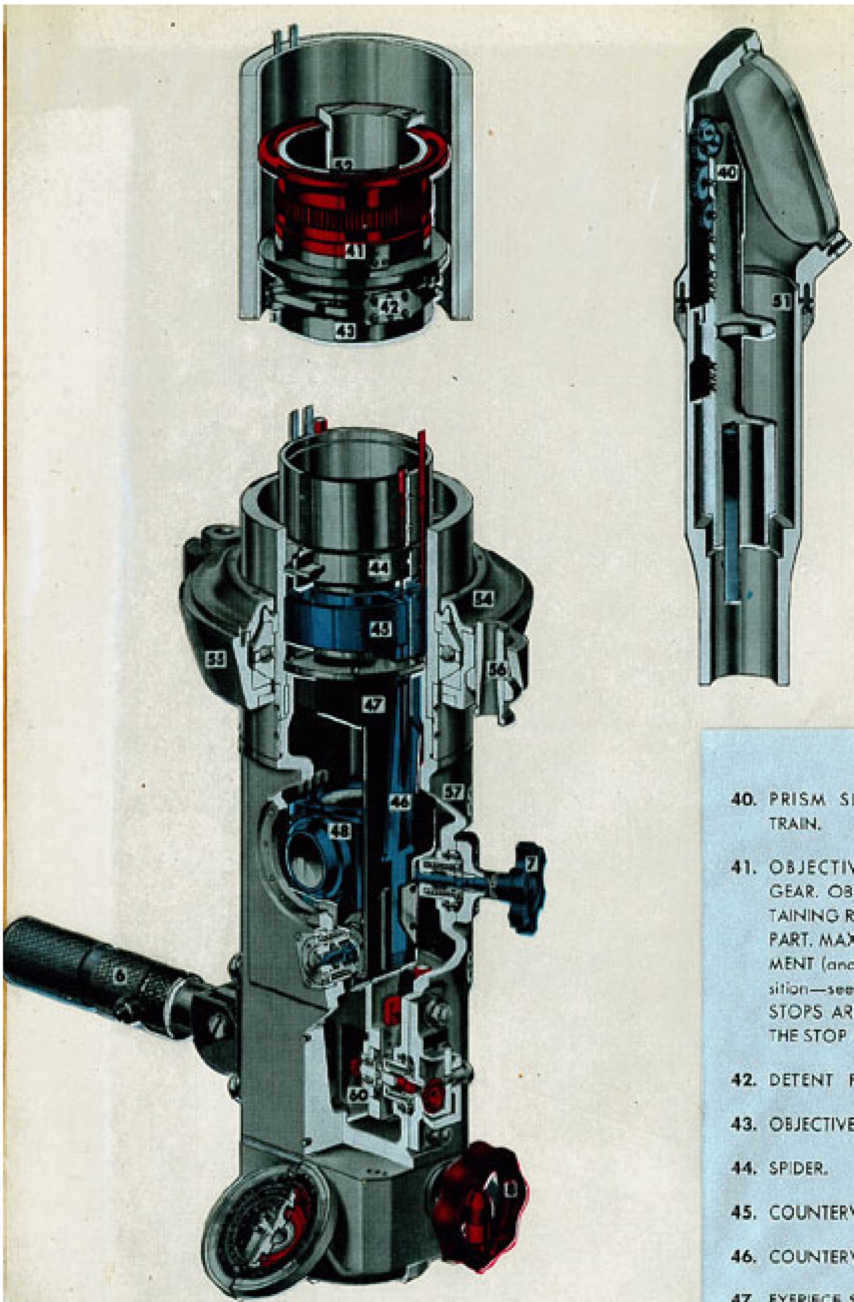


40. PRISM SHIFTING GEAR TRAIN.

41. OBJECTIVE OPERATING GEAR. OBJECTIVE STOP RETAINING RING BELOW THIS PART. MAXIMUM DISPLACEMENT (and Observation Position—see page 10, No. 61) STOPS ARE ATTACHED TO THE STOP RETAINING RING.

42. DETENT PAWL SPRING.

43. OBJECTIVE TRACK SLEEVE.

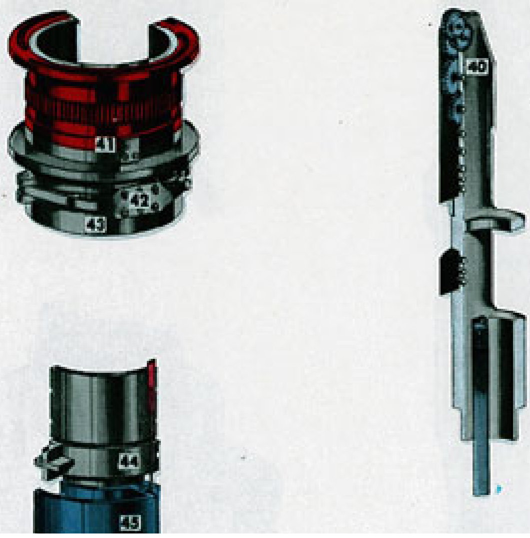
44. SPIDER.

45. COUNTERWEIGHT.

46. COUNTERWEIGHT STRAP.

47. EYEPIECE SKELETON.

48. EYEPIECE PRISM ASSEMBLY.



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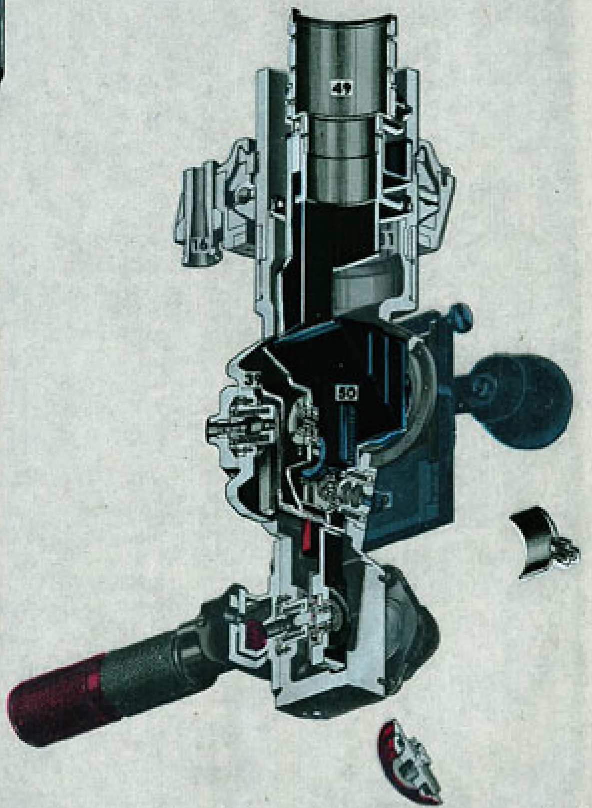

49. SPIDER BEARING.

50. EYEPIECE PRISM MOUNT AND RACK. EYEPIECE PRISM ACTUATING GEAR (one of two) SHOWN MESHING WITH PRISM RACK.

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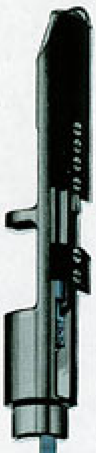

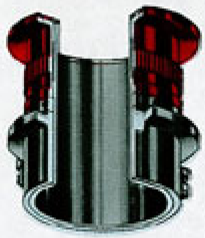

49. SPIDER BEARING.

50. EYEPIECE PRISM MOUNT AND RACK. EYEPIECE PRISM ACTUATING GEAR (one of two) SHOWN MESHING WITH PRISM RACK.

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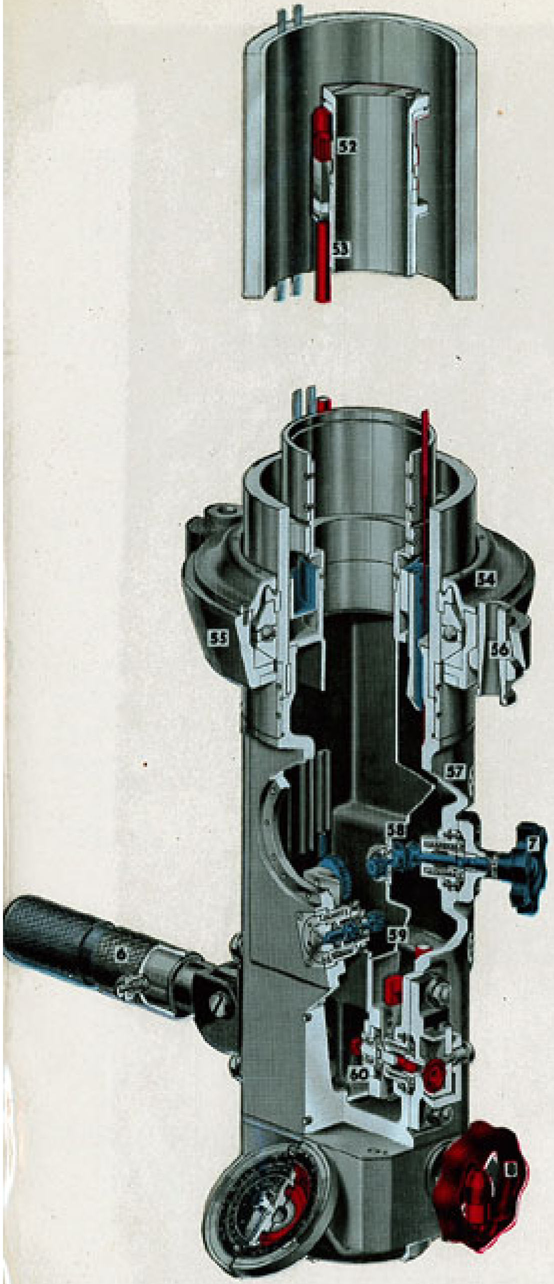
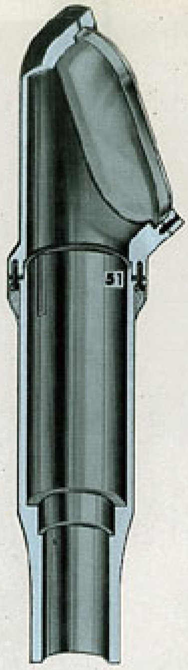




51. SHOWING ATTACHMENT OF OUTER HEAD TO OUTER TAPER SECTION.

52. OBJECTIVE OPERATING GEAR PINION.

53. OBJECTIVE OPERATING GEAR PINION SHAFT.

6. SPRING DETENT ASSEMBLY.

54. COVER RING.

55. HOISTING YOKE BODY.

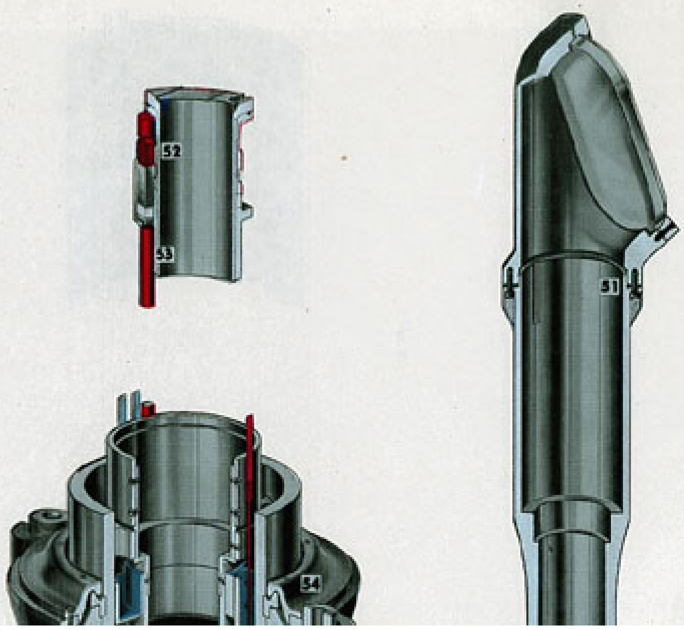
56. WIRE ROPE SLEEVE AND ADJUSTING NUT.

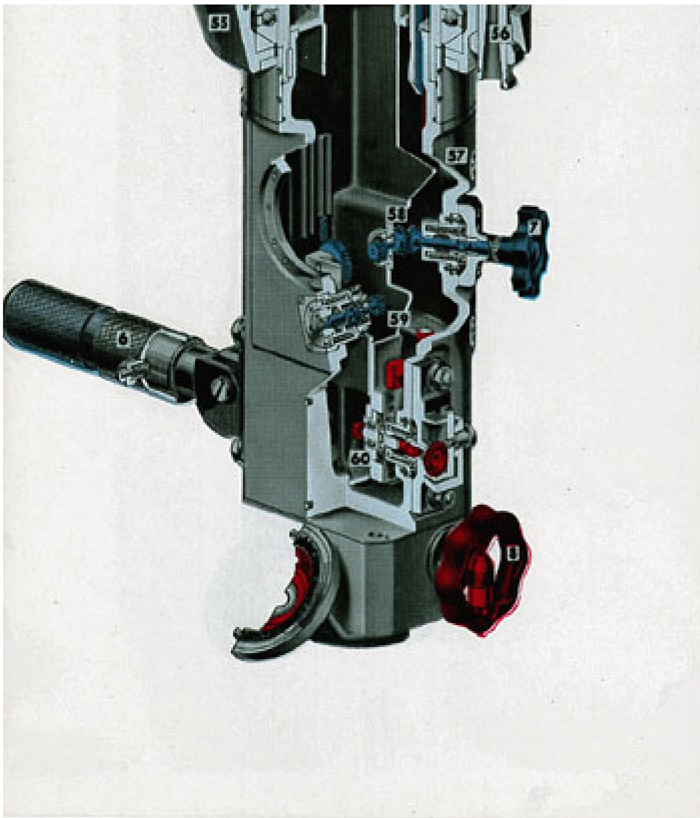
57. AIR INLET VALVE BODY. AIR OUTLET VALVE BODY BELOW FOCUSING KNOB.

58. BALL BEARING HOUSING ASSEMBLY FOR EYEPIECE PRISM SHIFT GEAR AND EYEPIECE DRIVE.

59. BALL BEARING HOUSING ASSEMBLY FOR RAYFILTER DRIVE GEAR. NOTE—Coupling (shown connected) in this shaft.

60. BALL BEARING HOUSING ASSEMBLY FOR RIGHT TRAINING HANDLE RACK GEAR (Similar construction for Left Training Handle).





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57. AIR INLET VALVE BODY. AIR OUTLET VALVE BODY BELOW FOCUSING KNOB.
58. BALL BEARING HOUSING ASSEMBLY FOR EYEPIECE PRISM SHIFT GEAR AND EYEPIECE DRIVE.
59. BALL BEARING HOUSING ASSEMBLY FOR RAYFILTER DRIVE GEAR. NOTE—Coupling (shown connected) in this shaft.
60. BALL BEARING HOUSING ASSEMBLY FOR RIGHT TRAINING HANDLE RACK GEAR (Similar construction for Left Training Handle).

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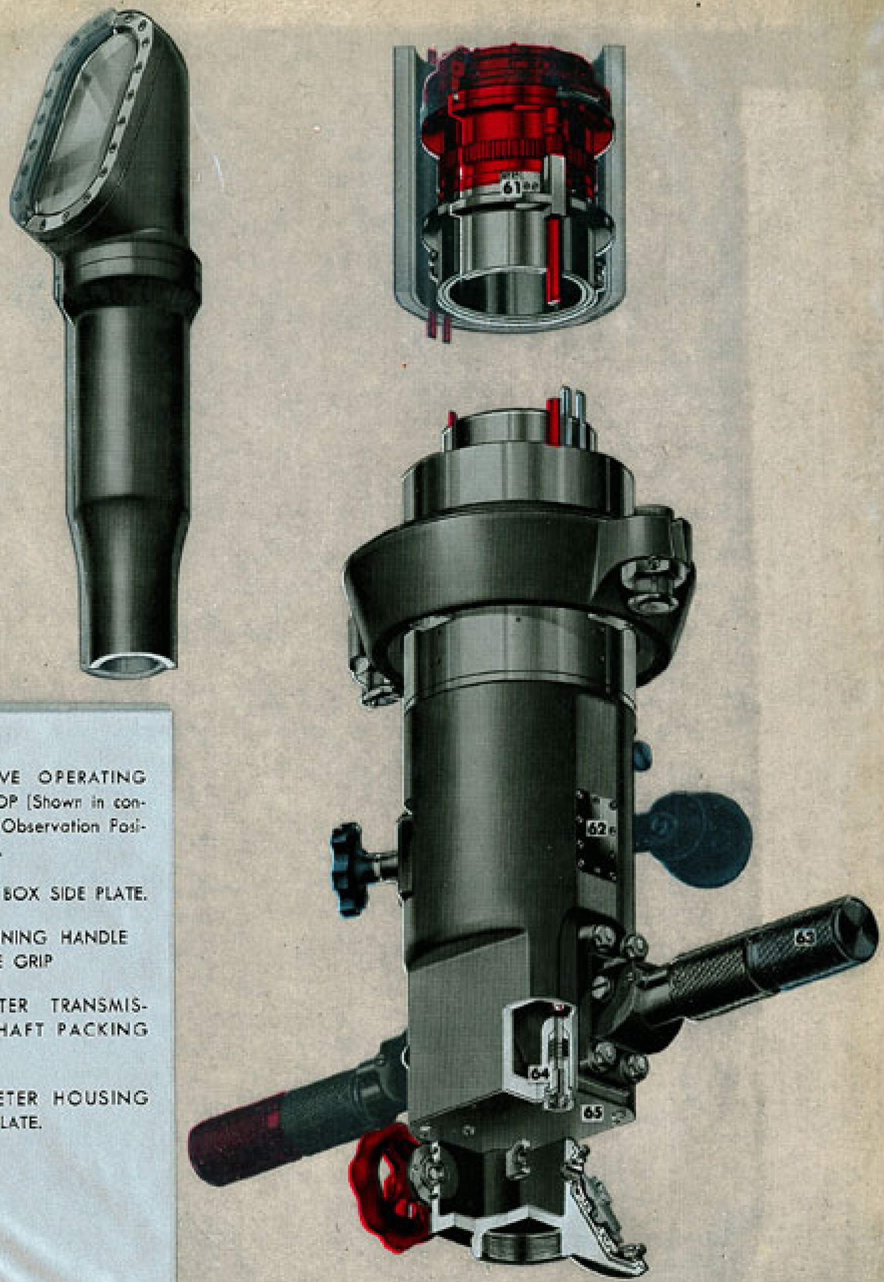


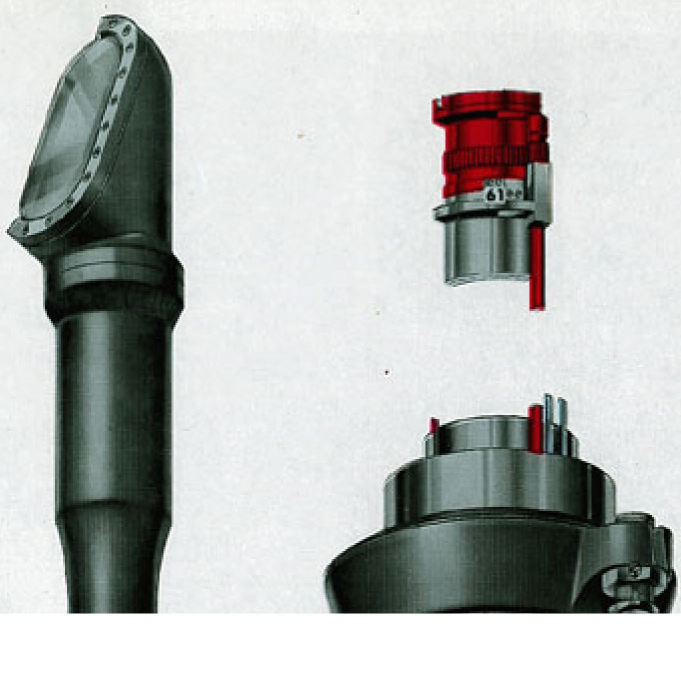
61. OBJECTIVE OPERATING GEAR STOP (Shown in contact with Observation Position Stop).

62. EYEPIECE BOX SIDE PLATE.

63. LEFT TRAINING HANDLE MOVABLE GRIP

64. STADIMETER TRANSMISSION SHAFT PACKING GLAND.

65. STADIMETER HOUSING COVER PLATE.



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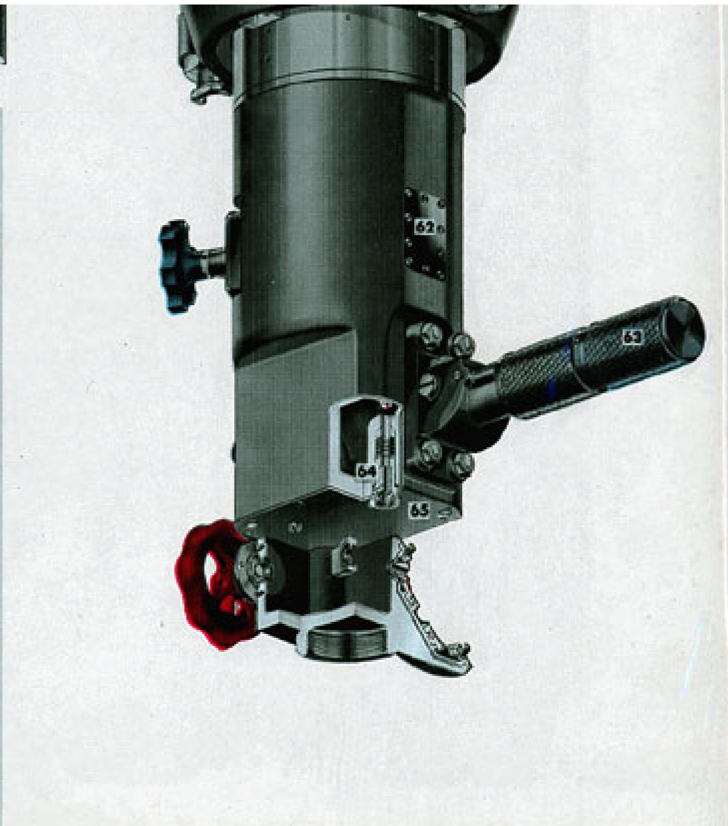

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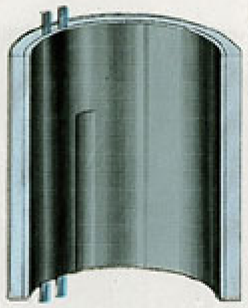

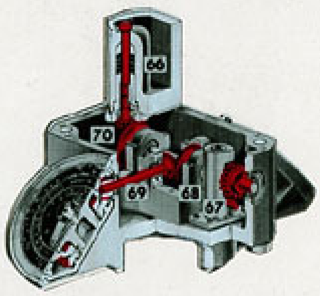

66. STADIMETER TRANSMISSION SHAFT. NOTE — Coupling below this numeral.

67. STARWHEEL LOCK PLUNGER SHOWN IN POSITION IT ASSUMES WHEN STADIMETER HOUSING IS ASSEMBLED TO THE EYEPIECE BOX. PLUNGER KEY TO RIGHT OF THIS NUMERAL IS THEREFORE DISENGAGED FROM THE STARWHEEL.

68. STADIMETER HANDWHEEL SHAFT BEVEL GEAR — MESHED WITH STADIMETER TRANSMISSION GEAR PINION. (There is a similar pinion on the other side).

69. RANGE SCALE ACTUATING GEAR AND PINION (Meshed).

70. STADIMETER TRANSMISSION SHAFT PINION AND BEVEL GEAR.

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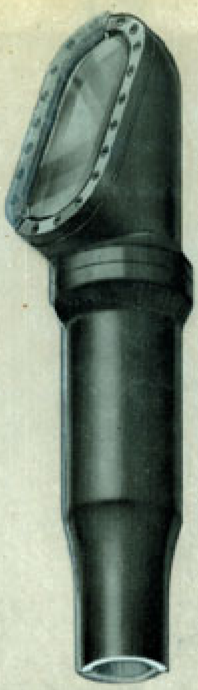

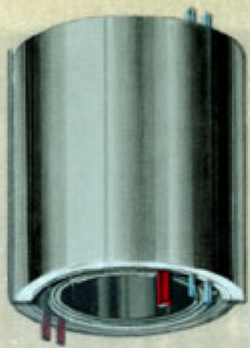

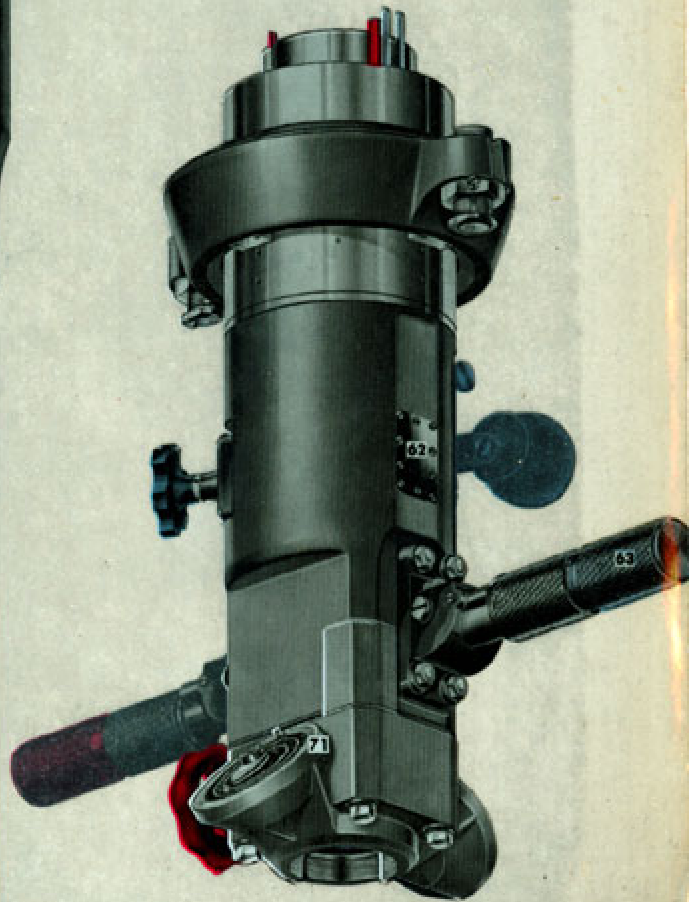

71. REAR DIALS (Duplicate of Front Dials).

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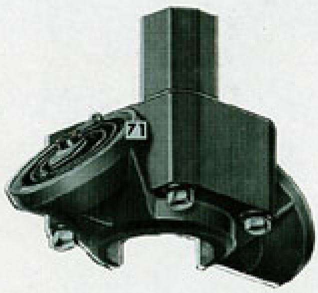

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