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OPTICAL EQUIPMENT

BORE-SIGHT TELESCOPES MARKS VIII, IX, AND XIII INCLUDING THEIR MODIFICATIONS

GENERAL DESCRIPTION

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JANUARY, 1923.

OPTICAL EQUIPMENT.

BORE-SIGHT TELESCOPES, MARKS VIII, IX, AND XXIII, INCLUDING THEIR MODIFICATIONS.

Chapter I.

CARE AND PRESERVATION.

CARE.

1. Bore-sight telescopes should be treated with the greatest care in order to keep them serviceable and ready for immediate use. They should not be taken apart unless necessary, and then only by men from the optical repair shop or other mechanics skilled in the care and adjustment of delicate optical instruments. It is advisable to completely reassemble one before disassembling another.

2. When practicable, the bore sight should be placed in its box, which is furnished, and stowed in a dry place. When carried, bore-sight telescopes should be kept in their boxes and any unnecessary shaking or jolting avoided.

3. The exterior of bore-sight telescopes should be kept clean by wiping with a dry cloth. If very dirty, turpentine is used; none should be permitted to touch the lenses.

4. Special care should be taken to prevent injury to the bearing surfaces of bore-sight telescopes. These bearings should be kept clean and smooth, but emery paper or other abrasive must not be used for this purpose. When bore sights are unshipped, the threaded part should be coated with vaseline. This must be wiped off before shipping the bore sight.

5. The objective lenses and eyelenses must be protected from the direct rays of the sun, as the direct sunlight will in time cause crystallization of the balsam used in cemented lenses.

6. Moisture must not be allowed to remain on prism or lenses for any length of time, as it

causes pitting, and this condition can only be remedied by regrinding the surface so affected.

7. Small particles of dirt, visible in the field, should be tolerated in preference to cleaning the optical surfaces. If, however, the efficiency of the telescope is seriously affected by presence of dirt in the field of view, the interior optical parts should be cleaned. This should be done by the optical force of the fleet repair ship or by men who have had special instructions in this work.

8. It may be mentioned that small particles of dirt on the object glass or on lenses, not in or near a focal plane of the telescope, are not visible in the field, and only cause a general darkening of the field, if dirt is excessive.

9. Rubber eyeguards should not unnecessarily be exposed to extremes of temperature, to the sun's rays, or bright light. If perspiration or oil accumulates on the eyeguard, it should be removed immediately by wiping with a clean cloth soaked in gasoline. Spare eyeguards should be stored in boxes filled with French chalk (*talcum powder*) to exclude air, or should be kept under water. A temperature of about 60° Fahrenheit is the most desirable for storage purposes. Eyeguards can be made pliable by steeping them in warm water.

Rust should be removed by washing eyeguards in soapy water and rinsing in fresh water.

The washing of the soft rubber eyeguards at regular intervals will prevent deterioration of the rubber.

PRESERVATION.

10. Each repair ship has a well-equipped repair shop in charge of a warrant officer and manned by machinist mates who have received a thorough, practical training in the repair and adjustment of all optical instruments and who are competent to make all repairs and adjustments.

11. The optical components of bore-sight telescopes should be cleaned only by a person having a thorough knowledge of telescope optics and mechanism, including the processes of cleaning, adjustments of parallax, focusing, and collimation.

12. He must thoroughly understand the construction of prism and lens mounts in order to prevent straining of optics when assembling. Strains in prisms or lenses are causes of parallax and broken optics under certain conditions.

13. The lubricants for bore sights should not liquefy (run) in summer or harden (set) in winter temperature. It should not gum or dry up and must be noncorrosive. Vaseline should not be used as found on board ship. A half-and-half mixture of white vaseline and Japan wax melted and stored in closed jars has been found to answer all requirements.

DISASSEMBLING.

14. Before disassembling a bore sight, a line should be scribed across the joints adjoining parts to facilitate reassembling. Screw threads should be guarded against crossing as they are thereby rendered useless. When screwing caps or lens mounts turn to the left until the threads "snap," then turn to the right in the usual way.

15. Screw drivers must fit the screw slots to prevent damage to screw heads. Remember telescope screws are easily lost or broken and difficult to replace.

CLEANING.

16. The proper way to clean a lens or optical surface is to blow hard on it to remove all the dust and grit possible. Brush off the remaining particles with a clean, dry, soft camel's hair brush, and gently with proper cleaning material, a dry linen cloth, lens paper, or selvyt cloth. If lens is greasy, it may be cleaned by moistening the corner of the cleaning cloth with alcohol or ether. Lenses must not be touched with the fingers and must not be rubbed unnecessarily. Ordinarily only the entering and emergent faces of the optical system should require cleaning. Do not pour alcohol on the lenses. It dissolves the balsam used in cementing lenses.

17. Cloths that are used for cleaning lenses should be washed and kept in dust-proof jars (such as tobacco humidors). This is to prevent accumulation of grit on the cloths.

18. The inside surfaces of telescope tubes are cleaned by gently tapping outside of tubes with a rawhide mallet and brushing the inside of tubes with a telescope brush. A blast of compressed air is then directed through the tubes. After cleaning, all tube openings are covered to prevent the entrance of small specks of dirt.

REASSEMBLING.

19. Telescopes are properly assembled by the maker or repair man in a dust-proof room free from moisture. The atmosphere should be dry, or as dry as possible, when telescopes are closed up after cleaning. If telescopes are closed up on a damp day, the inclosed moisture, or suspended vapor, is condensed, and appears on the lenses in the form of dew when the telescope is exposed to a drop in temperature.

20. Steel screws should not be used on the exterior of telescopes; they corrode and are hard to remove. Use Monel metal screws. Exposed screw heads should be covered with plugging wax to prevent deterioration.

CHAPTER II.

GENERAL DESCRIPTIONS.

TELESCOPE MARK VIII.

1. The Mark VIII bore-sight telescope, manufactured by the Bausch & Lomb Optical Co. and shown on Plate 3, has the following optical characteristics:

Magnification.....	10 diameters.
Field.....	8° 30'.
Exit pupil.....	10 inches.
Eye distance.....	0.08 to 0.40 inch.
Linear field at 5,000 yards.....	306 yards.
Linear field at 10,000 yards.....	612 yards.
Linear field at 15,000 yards.....	917 yards.

2. The bore-sight telescopes, Mark VIII, are used for the alignment of the bore of the gun with the various gun sights and gun-sight telescopes. They may also be used for the checking the parallelism of travel in the vertical plane of gun sights and guns.

3. The telescope is approximately 1½ inches in diameter and 10 inches long. The front and rear end of the body tube is threaded to carry the objective lens cell and erecting eyepiece which permits focusing for the individual eyes. The center of the body tube is enlarged to form a spherical bearing. This bearing is provided with the annular groove. The groove in turn is pierced by four radial equidistant slots, through which pass the adjusting screws of the crossline diaphragm.

4. Universal motion of the telescope body tube is provided for by means of a spherical bearing ring. The rear portion of the body tube support clamp ring (*adapter*) is 1½ inches in diameter and screwed 16 threads per inch, and it carries the locking ring. The front of the adapter carries the spherical bearing lock ring which is used for adjusting the spherical bearing. The adapter bearing also carries the outside adjusting tube, which in

turn carries the four telescope tube adjusting screws. These screws are used for bringing the crossline intersection to the central hole in the muzzle disk and also for holding the telescope in this position. Near each end of the body tube are turned two cylindrical bearing surfaces approximately one-quarter of an inch wide. These bearing surfaces fit in a special V block fixture shown in Plate I, which is used to center the crossline intersection of the telescope.

5. The principal feature of this telescope is that the distance between the object glass and crossline lens is permanently fixed. It follows that no adjustment for parallax of the crossline can be made when observing near objects. The crosslines are permanently fixed to be in sharp focus and free from parallax when observing objects at a distance not less than 2,000 yards. Near objects such as the muzzle disk central hole can not be sharply focused on and it may be necessary to place a pinhole disk in front of the eyelens to accurately center the bore-sight telescope in the gun.

TELESCOPES, MARK VIII, MODS. 1, 2, 3, AND 4.

6. The description of the Mark VIII bore-sight telescope applies to the Mark VIII, Mods. 1, 2, 3, and 4, except as follows:

Mark VIII, Mod. 1, has crosslines, thus



Mark VIII, Mod. 2, has crosslines, thus



Mark VIII, Mods. 3 and 4, have crosslines, thus



7. Telescopes Mark VIII, Mods. 1 and 2, have been converted to the Mark VIII, Mod. 3. Mark VIII, Mod. 4, is the same as the Mod. 3, except that the tubes have been made stronger and crossline diaphragm is fitted with a cover glass to protect the crosslines.

TELESCOPE MARK VIII, MOD. 5.

8. The Mark VIII, Mod. 5, bore-sight telescope shown on Plate IV differs from the others in that it has an extra heavy tube. The crossline diaphragm is mounted in a separate cell and means are provided to collimate the crosslines without removing the spherical bearing adapter. The weight of the Mark VIII, Mods. 4 and 5, is 3 pounds.

Directions for use.

9. Enter the telescope in the breech bar nearly the entire length until the telescope tube adjusting screws are vertical and horizontal. Set up the breech bar locking ring against the breech bar. Elevate gun so that a clear sky can be seen through telescope. Rotate focusing ring until crosslines are in sharp focus. Grasp telescope body tube and rotate it until the crosslines are horizontal and vertical. Ship muzzle disk. Center crossline intersection on central hole in muzzle disk by means of telescope-adjusting screws. Rotate the muzzle disk 180° and recheck intersection of crosslines. From this point the bore sighting is done in the usual way. The telescope body tube may be easily deformed if too much pressure is exerted upon it by the adjusting screws.

TELESCOPE MARK VIII, MOD. 6.

10. The Mark VIII, Mod. 6, bore-sight telescope, manufactured by the Bausch & Lomb Optical Co. and the Spencer Lens Co., is shown on Plate V. This telescope is practically the same as the Mark VIII, Mod. 5, with the following exceptions:

11. The principal features and advantages of the Mod. 6 over preceding telescopes is that it has an objective draw tube which permits focusing the telescope free from parallax on far and near objects (infinity 6 feet). The eyepiece is adjustable for individual focusing by a rotary movement of the knurled focusing ring. A knurled adjusting ring (rotating ring) for the body tube is provided. This ring is used when checking the central position of the crossline intersection.

The four telescope-adjusting screw shoes protect the telescope body tube from damage by the adjusting screws and permits rotation of the telescope in the spherical bearing for the purpose of testing true central position of the crossline intersection, while the telescope is shipped in the breech adapter, using the central hole in the muzzle disk as a testing point.

The crossline adjusting screws are accessible through openings provided in the adjusting screw housing. These openings are covered by the adjusting screw guard. The weight of the telescope is 3.5 pounds.

Directions for use.

12. Enter telescope in breech bar nearly the entire length of the threads and until the telescope-adjusting screws are horizontal and vertical. Set up telescope lock ring against breech bar. Elevate gun so that a clear sky is visible through telescope. Rotate eyepiece focusing ring until crosslines are in sharp focus. Grasp adjusting ring (rotating ring) and rotate telescope tube until crosslines are horizontal and vertical. Ship muzzle disk. Adjust objective focusing ring until crosslines are without parallax on central hole of muzzle disk. Refocus the eyepiece on the crossline if necessary.

13. Center crossline intersection on central hole in muzzle disk by means of telescope-

adjusting screws. Grasp rotating ring and rotate telescope through 360°. At the same time observe if the crossline intersection remains on the central hole in muzzle disk for each 90° position. If it does not shift, the crossline intersection is truly central. All telescopes are shipped correctly adjusted and should remain so unless they are tampered with. If the crosslines shift, they must be adjusted as described below (par. 14).

Remove muzzle disk; rotate objective focusing ring until crosslines are free from parallax on the sight-adjusting battens or the distant target used for bore sighting. From this point the bore sighting is done in the usual way.

14. If the crossline intersection shifts off the central hole in muzzle disk as described in paragraph 13, proceed as follows:

Unscrew telescope-adjusting screw guard, with crosslines horizontal and vertical; center the crossline intersection on the central hole in muzzle disk by means of telescope-adjusting screws. Rotate telescope tube 180°. Move the vertical crossline half the distance of the error to the central side in the muzzle disk by means of two screw drivers, loosening and tightening the horizontal crossline adjusting screws; and the other half of the distance by means of the horizontal telescope adjusting screws. Perform the same operation for error in the horizontal crossline by adjusting the vertical crossline and telescope adjusting screws. If the crossline intersection has not been perfectly centered, repeat the operation until the intersection does not shift.

TELESCOPE MARK VIII, MOD. 7.

15. This telescope, shown on Plate VI, was manufactured by the Winchester Arms Co. and its outer barrel (adapter) was manufactured by the Recording & Computing Co., Dayton, Ohio. The assembly is made at the

Naval Gun Factory, Washington, D. C. This bore sight was constructed in an emergency caused by the shortage of such telescopes during the late war. It consists of an A-5 Winchester rifle telescope mounted in a special outer barrel or adapter. It has the following optical characteristics:

Magnification	5 diameters.
Field	3°.
Exit pupil	0.10 inch.
Eye distance	2 inches.

16. The body tube or inner barrel is made of seamless drawn steel tubing and approximately 0.75 inch by 15 inches over all.

The objective and eyepiece lenses are held in steel mounts which are threaded internally to screw over the body tube, thus providing means for focusing these lenses. The eyelens mount lock ring prevents movement of the eyepiece mount after eyepiece has been focused for individual eyes. The objective mount is graduated. The objective glass may be focused for far or near objects (infinity to 8 feet). For objects beyond 200 yards the focus is universal.

17. The crossline diaphragm and erector lens mount is a sliding fit in the main body tube. Lock screws are provided to secure them in a place to prevent longitudinal movement. A small reach rod is provided to separate the stop from erector lens mount. This reach rod has an extension which is found convenient when mounting and adjusting the erector lens.

Directions for use.

18. Directions for use of Mark VIII, Mod. 7, telescopes are the same as for Mark VIII, Mod. 6, as described in paragraphs 12, 13, and 14.

Adjustment.

19. Screw objective lens mount on body tube, stopping when leading edge comes to

200-yard line and zero graduation corresponds with index mark on telescope.

20. From 200 yards up to and including 2,000 yards and infinity the focus of the objective lens is universal and therefore requires no change in adjustment.

21. When sighting on near objects, screw objective cell out on body tube until sharp definition is had. The shortest distance to which the telescope may then be focused is 8 feet.

22. Use an auxiliary telescope and obtain a clear definition of the crosslines by screwing eyepiece in or out, then locking by means of its locking collar. Now observe a distant object not less than 2,000 yards and make test for parallax. Parallax is removed by a longitudinal adjustment of the erector lens cell in the body tube.

23. When supplied to ships, these telescopes are collimated. This adjustment is made by four collimating screws which are in the spherical bearing and bear against the forward band around the telescope. These screws are covered by a sliding ring secured by a small screw.

24. To test for collimation, place bore sight in breech adapter. Ship muzzle disk in gun. Adjust crosslines on central hole in disk by means of the telescope-adjusting screws. Slowly rotate telescope in holder, noting that intersection of crosslines adhere to the central hole. If they do not, adjust collimating screws until this is accomplished.

TELESCOPE MARK IX.

25. The bore-sight telescope Mark IX, manufactured by the Bausch & Lomb Optical Co., is shown on Plate VII and has the following optical and physical characteristics:

Magnification	10 diameters.
Field	3° 30'.
Exit pupil.....	10 inches.

Eye distance.....	0.08 to 0.40 inch.
Linear field at 5,000 yards.....	306 yards.
Linear field at 10,000 yards.....	612 yards.
Linear field at 15,000 yards.....	917 yards.

26. Bore-sight telescopes Mark IX and modifications are used to bore-sight guns of the "drop-plug" type.

27. The line of sight is bent through an angle of 90°. The initial and final direction of the line of sight is downward and outward.

28. The construction of telescopes Mark IX and Mods. differs from telescopes Mark VIII by (a) a 90° prism situated between the front and rear erecting lens and (b) an extension of the body tube, called the inside adjusting tube. This construction permits adjustment of the telescope in the necessarily restricted space of the breech plug housing of 6-pounders and other guns of the "drop-plug" type. The weight of this telescope is 4 pounds.

TELESCOPES MARK IX AND MODS. 1 AND 2.

29. The Mark IX, Mods. 1 and 2, are the same as the Mark IX, with the following exceptions:

The Mark IX has a crossline, thus



The Mark IX, Mod. 1, has a crossline, thus



The Mark IX, Mod. 2, has a crossline, thus



NOTE.—Telescopes Mark IX and Mark IX, Mod. 1, have been converted to the Mark IX, Mod. 2.

Directions for use.

30. Enter the telescope in the special breech adapter nearly the entire length and until the telescope-adjusting screws are vertical and

horizontal. Set up the telescope lock nut against breech adapter; then insert breech adapter in gun so that eyepiece tube points up. Elevate gun so that a clear sky can be seen through the telescope. Adjust eyepiece until crosslines are in sharp focus. Clamp eyepiece by means of rotating clamp ring. Grasp eyepiece tube and rotate telescope tube until the crosslines are horizontal and vertical. Ship muzzle disk. Center crossline intersection on central hole in muzzle disk by means of telescope tube adjusting screws. Rotate muzzle disk 180° and recheck the intersection of crosslines. From this point the bore sighting is done in the usual way.

TELESCOPE MARK XXIII.

31. The bore-sight telescope Mark XXIII, manufactured by the Bausch & Lomb Optical Co., shown on Plate VIII, has the general features of bore-sight telescope Mark VIII, Mod. 6, except that its weight has been increased to 7 pounds and the diameter of the telescope tube adapter has been increased from $1\frac{1}{4}$ inches to $1\frac{3}{4}$ inches. Optical and mechanical refinements have been introduced which are noticed below. This telescope has the following optical characteristics:

Magnification	5 diameter.
Field	8° .
Exit pupil	0.11 inch.
Eye distance	0.65 inch.

32. When a telescope is used to observe objects at different distances the objective lens forms the image of a near object farther to the rear than the image of a distant object. The usual method of eliminating parallax of the crosslines in such telescopes is either to remove the objective lens or the crosslines. Either method has a tendency to cause a change in the line of sight and this probability of error will, of course, increase as the

instrument wears, especially if handled roughly or by inexperienced men. The optical construction of this telescope is designed to eliminate as far as possible this chance of error.

33. A parallax or focusing lens is introduced between the objective lens and the crossline lens. By moving the parallax lens along the tube, the image formed by the objective lens can be brought to the plane of the crossline regardless of the distance of the observed object.

34. The range of adjustment of the telescope is sufficiently wide to eliminate parallax when sighting on any object from 10 feet to infinity. This will include a muzzle disk from 3 inches up, sight-adjusting battens at any distance, or targets at any range. The advantage of this adjustment in bore-sighting for target practice or in installing or checking sights is apparent.

35. An error in the line of sight caused by the displacement of the parallax lens in a plane at right angles to the line of sight should be only one-fifth as great as the error caused by a similar displacement of either the objective lens or the crossline diaphragm.

36. Any displacement of the focusing lens is prevented by the long wearing surfaces at each end of the parallax lens draw tube, which is a sliding fit inside the body tube.

37. The parallax lens is moved by the focusing tube rack and pinion which are actuated by the detachable focusing key that can be inserted through either of the two holes in the adjusting screw housing. The two arrows (A) on the rear of the housing mark the position of these two holes. The arrow (B) on the rotating ring marks the position of the head of the pinion shaft. The observer can thus insert the key without moving from his position at the eyepiece of the telescope.

38. In some bore-sight telescopes it is necessary to disassemble completely the telescope and to remove the crossline adjusting screws before the crossline diaphragm could be cleaned, and in reassembling the crossline intersection was almost certain to be placed out of the correct central position.

39. In the Mark XXIII telescopes, owing to the coned crossline diaphragm mount and the construction of the telescope in the rear of the housing, the crosslines can be readily removed, cleaned, and replaced without the slightest change in the line of sight and with very little disassembling of the parts of the telescopes. The crossline mount pin in the female cone mount prevents the rotation of the crossline diaphragm mount, which is forced home in its coned seat by the locking cap. The securing screw, which is the only one that has to be touched, is large and has strong threads; it can not be lost as it is prevented from coming entirely out by a keep screw. An index mark (c) on the rotating ring and the securing screw bracket marks the position when the securing screw can be inserted.

40. In the old telescopes the telescope tube was easily deformed by the pressure of the adjusting screws, and it was impossible to test the telescope for the true central position of the crossline intersection and to adjust the intersection without the use of special facilities and without disassembling the telescope.

Adjustment.

41. In this telescope the floating ring, which is ground to fit over the telescope tube, protects the telescope tube from damage by the adjusting screws and permits rotation of the telescope on the spherical bearing for the purpose of testing the true central position of the crossline intersection, while the telescope is shipped in the breech piece, using the central hole in the muzzle disk as a testing point. It

is essential that this test be made before bore sighting.

42. The four crossline adjusting screws provide a means of adjusting the crossline intersection from the outside of the telescope if such adjustment is necessary. At the same time unauthorized tampering with the crossline adjustment is prevented by the adjusting screw cover, which is held in place by a screw.

43. The crossline adjusting mount retaining rings and the four crossline adjusting screws hold the female cone mount firm in place, preventing any chance of the accidental displacement of the crosslines.

44. The eyepiece is adjustable for individual focusing by a rotary movement and can be clamped in any desired position by the eyepiece clamp ring. The eyepiece is fitted with a rubber eye guard which rotates freely on the eyepiece.

45. This telescope has been designed with the idea of reducing to a minimum the necessity for disassembling the mechanical parts, and it should be noted that it will never be necessary to disassemble the female cone mount, the crossline adjusting screws, the crossline mount, the crossline adjusting ring, the adjusting screw housing, the focusing tube rack and pinion, the parallax lens draw tube, the floating ring, or the eyepiece tube from the eyepiece focusing ring.

To replace Mark VIII telescopes.

46. The diameter of the opening in the breech piece which the telescope adapter threads enter is $1\frac{3}{8}$ inches. This is larger than the opening for the Mark VIII bore-sight telescope, which is $1\frac{1}{8}$ inches. Where the Mark XXIII telescopes replace the Mark VIII aboard ship it will be necessary to bore out this opening to the larger diameter; this should be done accurately in order to keep the center of the opening in the center line of the bore.

Directions for use.

47. Enter telescope in breech piece nearly the entire length of the threads and until the telescope-adjusting screws are truly horizontal and vertical. Set up telescope lock ring against the breech piece. Elevate gun so that a clear sky can be seen through telescope. Rotate eyepiece focusing ring until the crosslines are in sharp focus. Grasp adjusting ring (rotating ring) and rotate telescope until crosslines are horizontal and vertical. Ship muzzle disk. Insert focusing key and turn (focus) until crosslines are free from parallax on central hole of muzzle disk.

48. Center crossline intersection on central hole in muzzle disk by means of telescope-adjusting screws. Grasp rotating ring and rotate telescope through 360° . At the same time observe if the crossline intersection remains on the central hole in muzzle disk for each 90° rotation. If it does not shift, the crossline intersection is truly central. All telescopes are shipped correctly adjusted and should remain so unless they are tampered with. Set up on telescope clamp screw, turn muzzle disk 180° , and check the crossline intersection on central hole in muzzle disk.

Remove muzzle disk; turn focusing key until crosslines are free from parallax on the sight-adjusting battens or the distant target used for bore sighting. From this point the bore sighting is done in the usual way.

49. If the crossline intersection shifts off the central hole in muzzle disk when rotating telescope, as described in paragraph 48, proceed as follows:

Unscrew adjusting screw cover with crossline horizontal and vertical; center the crossline intersection on the central hole in muzzle disk by means of telescope-adjusting screws. Rotate telescope tube 180° . Move the vertical crossline half the distance of the error to the central hole in the muzzle disk by means of two pin-face wrenches provided (focusing keys), loosening and tightening the horizontal crossline adjusting screws; and the other half of the distance by means of the horizontal telescope-adjusting screws. Perform the same operation for error in the horizontal crossline by adjusting the vertical crossline and telescope adjusting screws. If the crossline intersection has not been perfectly centered, repeat the above operation until the intersection does not shift.

Chapter III.

DISASSEMBLING AND CLEANING.

TELESCOPE MARK VIII AND MODS. 1, 2, 3, 4, AND 5.

Eyelenses.

1. Unscrew eyelens cap from eyepiece drawtube. Pull eyelens tube clear of drawtube. Unscrew eyelens and collective lens cell. Clean lenses.

Erector lenses.

2. Remove lock screw and unscrew eyepiece drawtube adapter. Pull erector tube clear of drawtube. Unscrew front and rear erector lens. Clean lenses.

Object glass.

3. Remove lock screw and unscrew objective cell from telescope body tube. Clean lenses.

Crossline lens.

4. Unscrew outside adjusting tube. Remove lock screw and unscrew spherical bearing lock ring. Remove crossline adjusting screws and diaphragm. Clean crossline lenses.

5. Assemble in reverse order, and collimate by means of V block fixture shown on Plate I, and directions given in Chapter IV, page 15.

TELESCOPE MARK VIII, MOD. 6.

6. Unscrew eyepiece cap. Remove eyeshield adapter. Remove focusing ring, screw, and plug screw and rotate focusing ring until plug-screw hole comes over erector draw lock screw. Remove lock screw and unscrew erector draw.

Eyelens.

7. Remove lock screw. Pull eyepiece tube clear. Remove lock screws, eyelens, and collective lens cells. Clean lenses.

Erector lens.

8. Remove lock screw. Pull erector tube clear. Remove lock screws and front and rear erecting lens cells. Clean lenses.

Object glass.

9. Unscrew eyepiece focusing, objective retaining rings. Remove objective focusing ring. Remove objective focusing shoe and key. Pull objective drawtube clear. Remove lock screw and unscrew objective cell. Clean lenses.

Crossline lens.

10. Remove lock screws and unscrew adjusting ring (rotating ring) and adjusting-screw housing. The crossline lens may now be cleaned in place. Removal of lens for cleaning is accomplished by removing three lock screws and four adjusting screws of crossline diaphragm.

11. Assemble in reverse order. Collimate as described in paragraphs 13 and 14, Chapter II, page 5.

TELESCOPE MARK VIII, MOD. 7.

Adapter or outer barrel.

12. Remove the two-lock screws in barrel. Unscrew telescope-adjusting screws until special pin face plug wrench can be inserted.

Unscrew spherical bearing. Remove telescope tube and spherical bearing.

13. In reassembling, be careful that spherical bearing ring is screwed only tight enough to allow free rotation of the telescope without any fore or aft movement. Then insert and set up on the two lock screws.

Object glass.

14. Unscrew objective adapter ring; mount lock ring and retaining ring. Push lens clear of mount and clean.

Eyelens.

15. Loosen mount lock ring; unscrew mount and retaining ring. Gently push lens clear of mount. Clean lens.

Erector lens.

16. Screw down on cross wire diaphragm lock screw until it is flush with the inside of the body tube; withdraw diaphragm to the rear, being careful not to injure the crosslines, which are fine wires. Screw down on the erector lens cell lock screw until it is flush with the inside of body tube. By means of a special tool withdraw stop and erector lens cell, which are joined by a small rod. This rod extends to the rear, having a cannellure at its extremity which receives the special tool. Disconnect erector lens cell from rod; remove lens-retaining ring and gently push lens from cell. Both surfaces are now free for cleaning.

17. Assemble in reverse order.

TELESCOPES MARK IX AND MODS. 1 AND 2.

Objective lens.

18. Remove locking screw. Unscrew cell from body tube. Clean lens.

Crossline lens.

19. Remove lock screw. Unscrew eyepiece tube, outside and inside adjusting tubes, body center, tube-support clamp ring. Remove tube support, unscrew main body tube. Remove adjusting screw of crossline lens. Clean lens.

Erector lenses (front lens).

20. Remove lock screw. Unscrew cell. Clean lens (rear lens). Remove lock screw. Unscrew cell. Clean lens.

Prism.

21. The surfaces are cleaned without removing prism from housing unless back surface of prism requires cleaning.

Eyelenses.

22. Remove lock screw. Unscrew eyepiece mount. Unscrew eyelens cell and collective lens cell. Clean lenses.

23. Assemble in reverse order.

24. The directions for collimating bore-sight telescope Mark VIII and Mods. up to Mod. 5 apply to the Mark IX telescope and its modifications, except that the outside adjusting tube is left off, allowing the main body tube to make a full revolution in the bearings of the V block fixture used for collimating bore-sight telescopes. (See Pl. I.)

TELESCOPES MARK XXIII.

Eyelens.

25. Remove lock screw. Unscrew rotating ring, or (adjusting ring), thus removing rear end of telescope. Remove lock screw and pull eyepiece tube clear of eyepiece draw. Unscrew cells and clean eyelens and collective lens.

Erector lenses.

26. Remove lock screw of adapter. To find this screw, turn focusing ring to right until it stops. Screw is then exposed. Unscrew erector cells. Clean lenses.

Crossline lens.

27. Unscrew lens cell cap by means of special pin face wrench provided in telescope box. Reverse wrench and screw into cell. Pull clear of body tube. Unscrew cell and clean lens.

Object glass.

28. Remove lock screw. Unscrew lens cell. Clean lens.

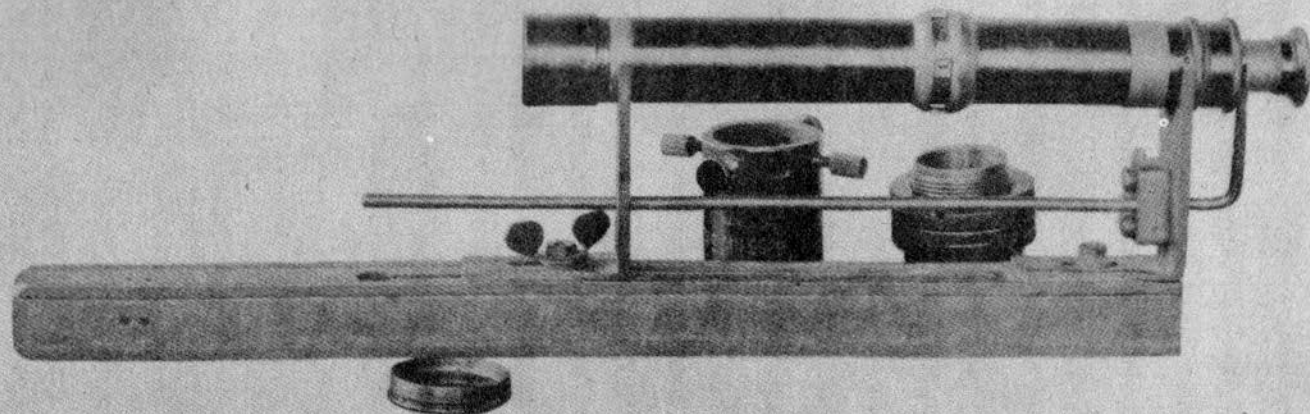
Focusing lens (Parallax lens).

29. Remove screw cover plug. Move focusing draw tube forward until lock screw appears under hole of cover plug. Remove focusing lens cell by means of special pin face wrench. Clean lens.

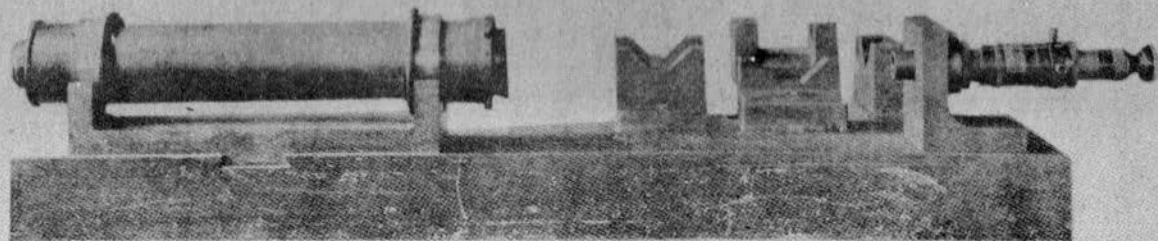
30. Assemble in reverse order.

Collimation.

31. Ordinarily, cleaning does not disturb the collimation adjustment, but the adjustment should be checked as described in paragraphs 47, 48, 49, Chapter II, page 9.



"V" Block Fixture



Collimator Mark I.

Chapter IV.

NOTES ON COLLIMATING.

1. A bore-sight telescope is collimated when the line of sight is parallel to the instrumental axis, and by analogy when the crossline intersection is truly central. It is also demanded that the vertical and horizontal cross wires pass through the meridian and equator of the field of view. To test for this condition, place the telescope in a firm but adjustable holder, V block fixture, shown on Plate I. (This need not be done in case of telescope Mark VIII, Mods. 6 and 7, and Mark XXIII. Use the breech adapter.) Focus the telescope, and, free from parallax on a distant point object, 2,000 yards or more, center the crossline intersection on the distant point by means of telescope-adjusting screws. Grasp rotating ring or body tube and revolve 360° . At the same time observe if the crossline intersection remains on the distant test point; if it does not shift, the telescope is in collimation. For adjustment of the crossline intersection see paragraph 63.

2. The collimation adjustment is intended to bring the crossline truly central. To do this it is assumed that the bearings at each end of the body tube are true cylinders and concentric to the spherical bearing ring. This condition should be determined by means of a test indicator and any defect remedied before collimating. The spherical bearing must be adjusted to turn free but without end play.

3. Eccentricity of the objective: If the crossline intersection and the field of view appear to move around in a small circle, the objective is not perfectly centered, but this

need cause no apprehension. If the crossline intersection adheres to the test point on inversion, the extreme requirements of the case have been met. Further rectification can only be accomplished by recentering the objective in its mount. Accurate construction of bore-sight telescopes eliminates eccentricity of the objective.

4. Eccentricity of the eyepiece: If the eyepiece is not perfectly centered, the collimated cross wires may not appear in the exact center of the field of view, but this state of affairs need cause no apprehension. If the cross wires in the field of view appear to move around in a small circle, eccentricity of the mounting is evident, but if the cross adheres to the point on inversion the utmost requirements in the case have been fulfilled and the further rectification can only be accomplished by aligning the axis of the eyepiece with that of the objective. Accurate construction of gun-sight telescopes eliminates eccentricity of the eyepiece.

5. Eccentricity of the eyepiece or object glass will not affect the accuracy of results.

6. The necessity for collimating bore-sight telescopes will be evident when we consider that this telescope must project a line of sight coincident with the axis of the gun bore.

"V" BLOCK FIXTURE.

7. This fixture (Pl. I) consists of a rectangular bar to which are secured two adjustable V blocks. The bar may be clamped

to a stand so that the fixture is held firmly in any position.

It is used for collimating bore-sight telescopes Mark VIII, Mods. 1 to 5. The test or adjustment could be conducted in two V notches cut into a cigar box or by any other such expedient. The only requirement is that the fixture be firmly mounted and that a distant target, 2,000 yards or more, be available.

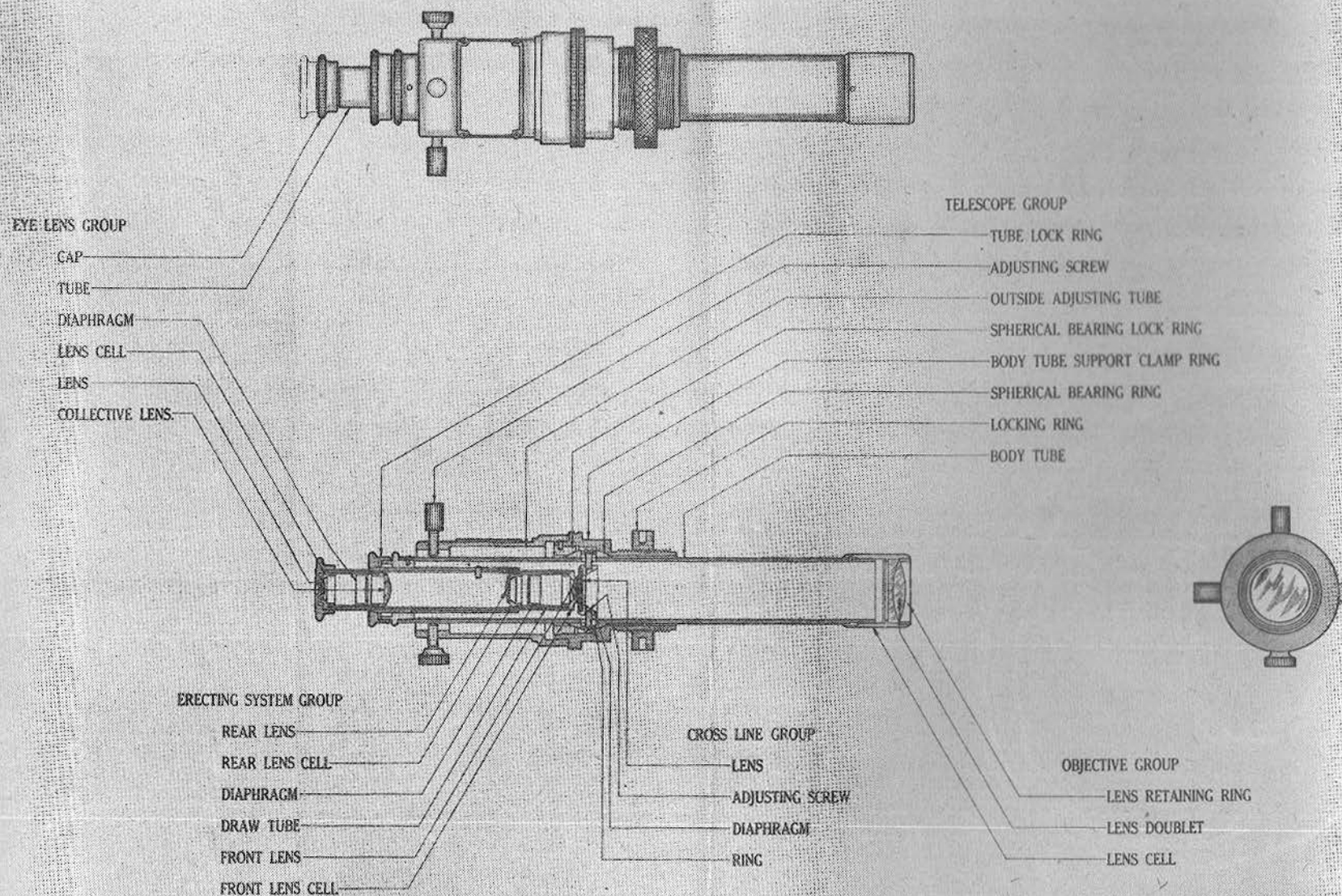
COLLIMATOR MARK I.

8. If this collimator is available (Pl. 2), it is generally found in the optical repair shop; no distant target or V block fixture is needed. A special adapter can be made up which is pierced by four radial holes, through which the crossline adjusting screws can be reached, and thus the telescope may be tested or adjusted.

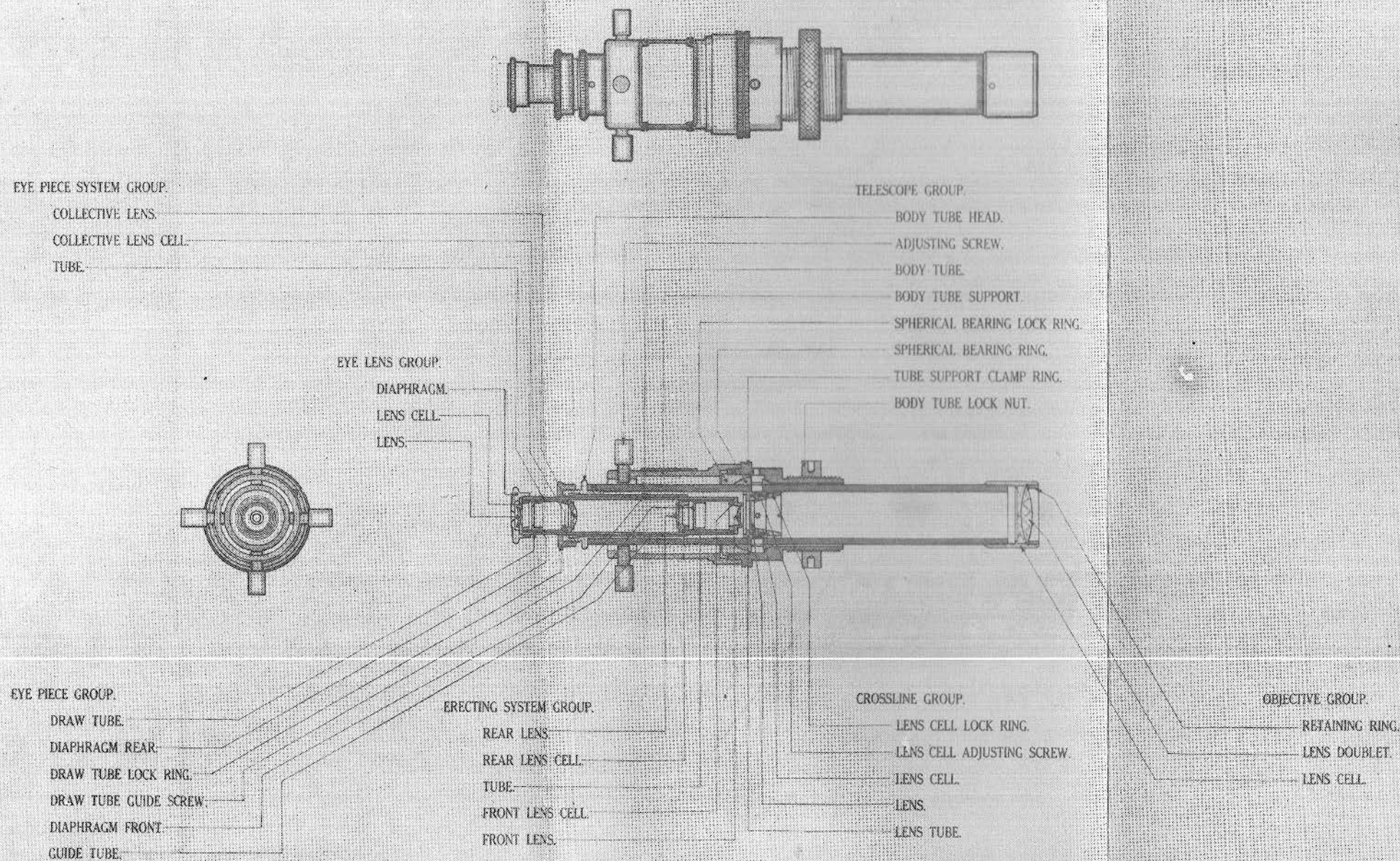
CHAS. B. McVAY, JR.,
Chief of Bureau.

NAVY DEPARTMENT,
Bureau of Ordnance,
January, 1923.





Telescope Mk VIII Mod. 3



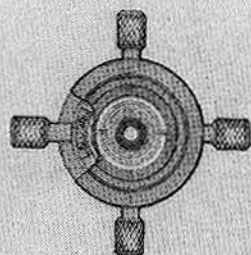
Telescope Mark VIII Mod. 5

EYE PIECE SYSTEM GROUP.

COLLECTIVE LENS.
COLLECTIVE LENS CELL.
LENS RETAINING RING.

EYE LENS GROUP.

RETAINING RING
LENS
CELL



EYE PIECE GROUP.

SHIELD.
CAP.
SHIELD SUPPORT.
SHIELD ADAPTER.
ADAPTER TUBE.
DIAPHRAGM.
ADAPTER.
FOCUSING RING.
SPIRAL SLEEVE.
SPIRAL KEY.
SPIRAL GUIDE SCREW.
SPIRAL SLEEVE RETAINING RING.

ERECTING SYSTEM GROUP.

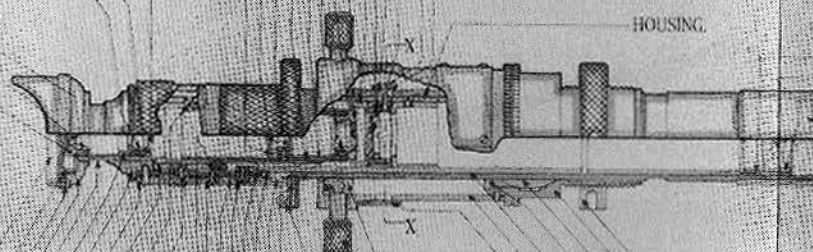
REAR LENS CELL.
REAR LENS.
REAR LENS RETAINING RING.
DRAW TUBE.
TUBE.
FRONT LENS RETAINING RING.
FRONT LENS.
FRONT LENS CELL.

CROSSLINE GROUP.

CELL RETAINER.
LENS RETAINING RING.
LENS.
LENS CELL.
ADJUSTING SCREW.
ADJUSTING SCREW WASHER.
HOUSING.

OBJECTIVE GROUP.

LENS CELL.
LENS DOUBLET.
LENS RETAINING RING.
CAP.



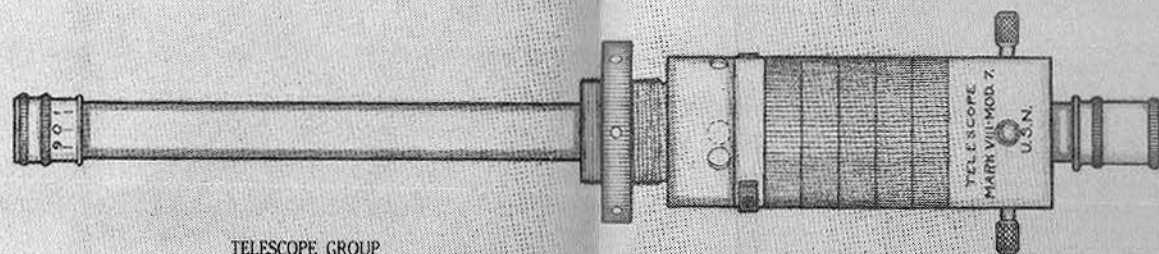
SECTION X-X

OBJECTIVE SYSTEM GROUP.

DRAW TUBE.
SPIRAL.
GUIDE SLOT.
KEY.
SPIRAL KEY.
FOCUSING RING.
FOCUSING RING RETAINER.

TELESCOPE GROUP.

LOCK RING.
TUBE SUPPORT.
SPHERICAL BEARING.
TUBE SUPPORT CLAMP RING.
BODY TUBE.
ADJUSTING SCREW HOUSING.
ADJUSTING SCREW GUARD.
ADJUSTING SCREW SHOE.
TUBE ADJUSTING SCREW.
ADJUSTING RING.



TELESCOPE GROUP

- ADJUSTING SCREW
- REAR BEARING
- OUTER BARREL
- BEARING RING
- SPHERICAL BEARING
- FRONT BEARING
- COLLIMATING SCREW
- COLLIMATING SCREW COVER
- CLAMP RING
- INNER BARREL

EYE LENS GROUP

- MOUNT LOCK RING
- MOUNT
- RETAINING RING
- EYE LENS

SECTION X-X

OBJECTIVE GROUP

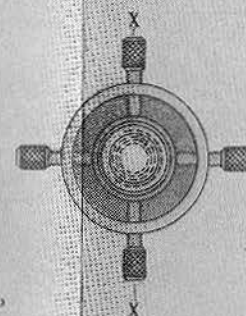
- MOUNT
- DIOPTER RING
- LENS
- RETAINING RING
- MOUNT LOCK RING

CROSS LINE GROUP

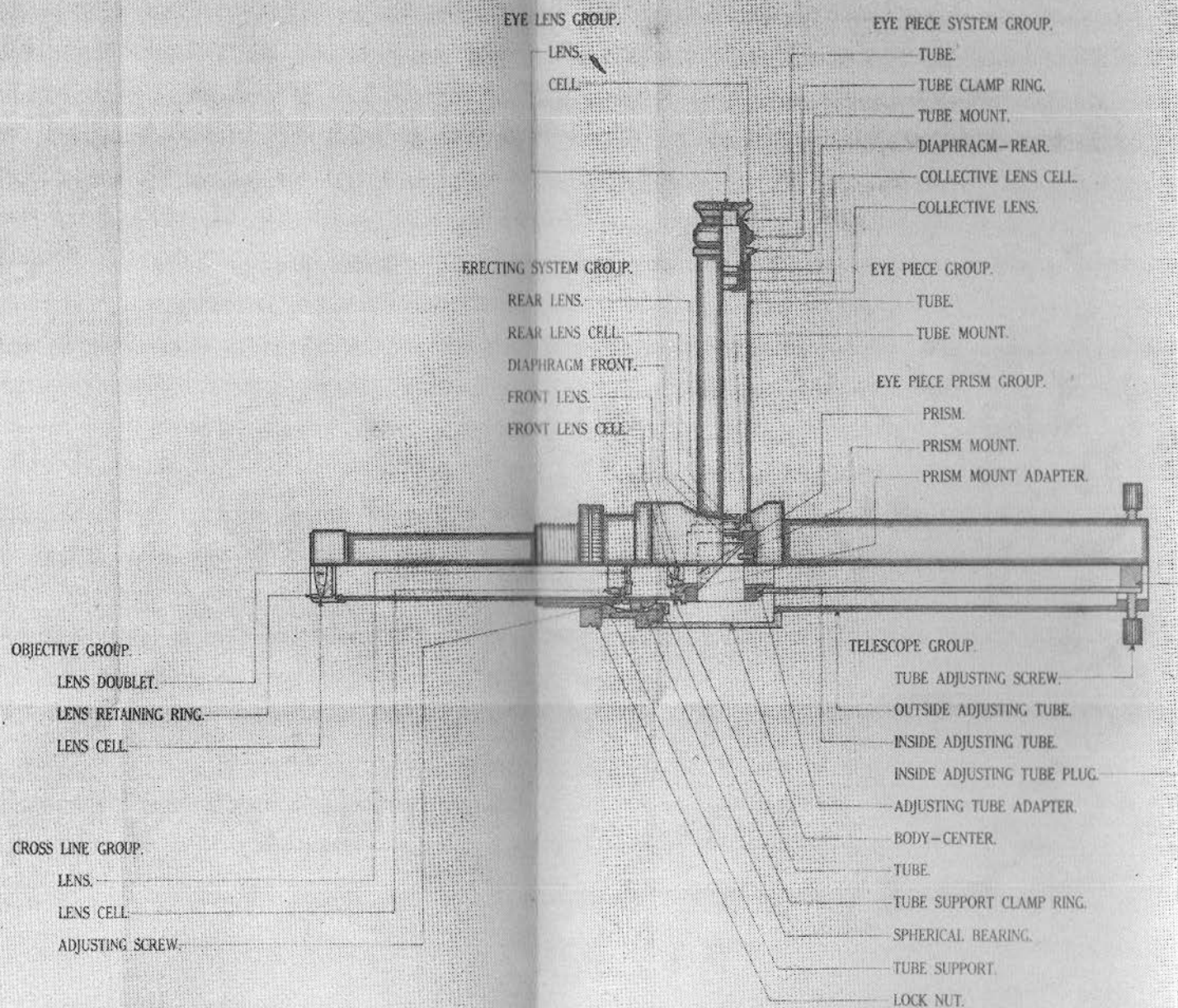
- ADJUSTING RING
- MOUNT
- RING

ERECTING SYSTEM GROUP

- DIAPHRAGM ROD EXTENSION
- DIAPHRAGM
- DIAPHRAGM ROD
- ADJUSTING RING
- MOUNT
- LENS



Telescope Mark VIII Mod. 7



Telescope Mark IX Mod. 2

