TM 9-1600

WAR DEPARTMENT

TECHNICAL MANUAL

ORDNANCE MAINTENANCE

DIRECT-FIRE TELESCOPES FOR 3-INCH AND 90-MM ANTI-AIRCRAFT GUNS

August 21, 1942

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No. 9–1600

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SECTION I

GENERAL

1. Scope.—This manual is published for the information and guidance of ordnance maintenance personnel. It contains detailed instructions for inspection, disassembly, assembly, maintenance, and repair of the telescope mounts M26, M27, M28, and M29, and elbow telescopes M24, M25, and M26, supplementary to those in the Field Manuals and Technical Manuals prepared for the using arm. Additional descriptive matter and illustrations are included to aid in providing a complete working knowledge of the matériel.

NOTE.—Information as to assembling telescope mounts to the gun; preparation of matériel for use under unusual conditions; and packing, storage, and shipment, is not available now but will be included in a revision of the manual.

2. Characteristics.—*a.* The telescope mounts and elbow telescopes discussed herein are used as direct fire sighting equipment on 3-inch and 90-mm antiaircraft gun carriages. These carriages operate from a separate fire-control system for antiaircraft fire, and from direct-fire telescopes when used against ground and naval targets. These telescopes are used by the azimuth and elevation hand-

wheel setters of the gun crew independently of the usual antiaircraft fire-control system.

b. The sighting equipment for each gun consists of a telescope mount and elbow telescope for aiming the gun in azimuth, and a telescope mount and elbow telescope for aiming the gun in elevation. The elevation telescope reticle is graduated in yards range, and the azimuth telescope reticle is graduated in mils lead. In aiming the gun, the target image is held on the appropriate range and lead graduations.

c. Application of these telescope mounts and elbow telescopes is as follows:

(1) *3-inch antiaircraft gun mount M2A2.*

Telescope mount M26, Elbow telescope M24 — azimuth

Telescope mount M27, Elbow telescope M25 — elevation

(2) *90-mm antiaircraft gun mount M1 and M1A1.*

Telescope mount M28, Elbow telescope M24 — azimuth

Telescope mount M29, Elbow telescope M26 — elevation

3. Differences in models.—*a.* The several telescope mounts are shown in figures 1 to 4. The mounting brackets of these telescope mounts are differently shaped to fit the particular mounting surfaces on the gun. The M26 and M28 mounts (azimuth) are bolted onto the top carriage on the left side of the gun; whereas the M27 and M29 mounts (elevation) are bolted onto the right side of the gun cradle. The supporting bracket (fig. 15) is not used when the M28 mount is applied to 90-mm gun mounts M1, equipped with data transmission systems M6 or T17. The M26 and M28 mounts also have an elevating mechanism that rotates the telescope holder in the elevation plane. This keeps the azimuth scale of the elbow telescope on the target when the target is above or below the level of the gun. Apart from these differences, the telescope mounts are similar in design and construction.

b. The elbow telescopes M24, M25, and M26 (fig. 5) are identical except for the reticle pattern. Reticle patterns for these telescopes are shown in figure 6. Elbow telescope M24 (azimuth) uses the reticle with the horizontal mil scale. Elbow telescopes M25 and M26 (elevation) use reticles which are marked to indicate ranges in

yards for specific ammunition, as indicated by the legend engraved on the reticle.

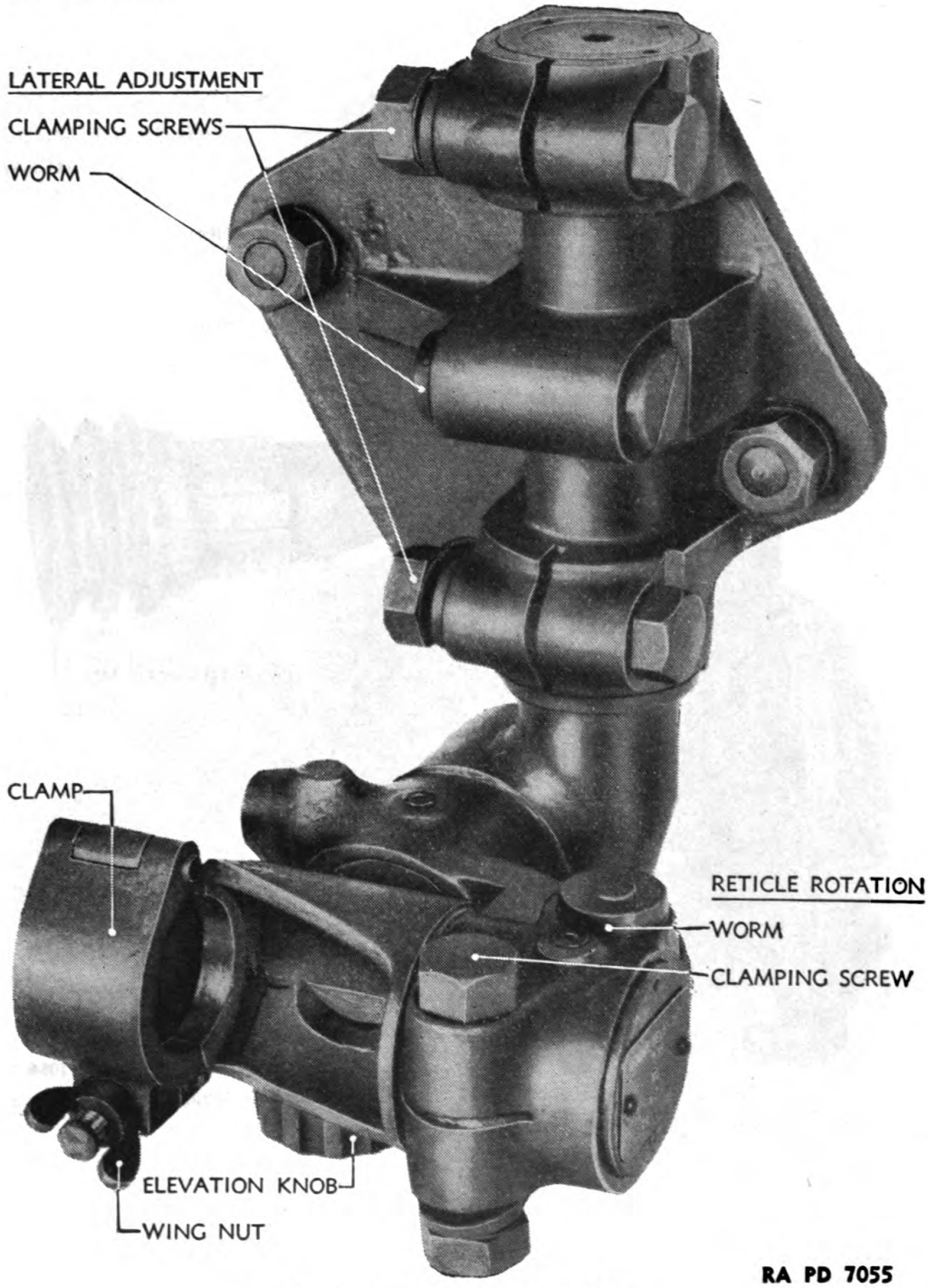


FIGURE 1.—Telescope mount M26.

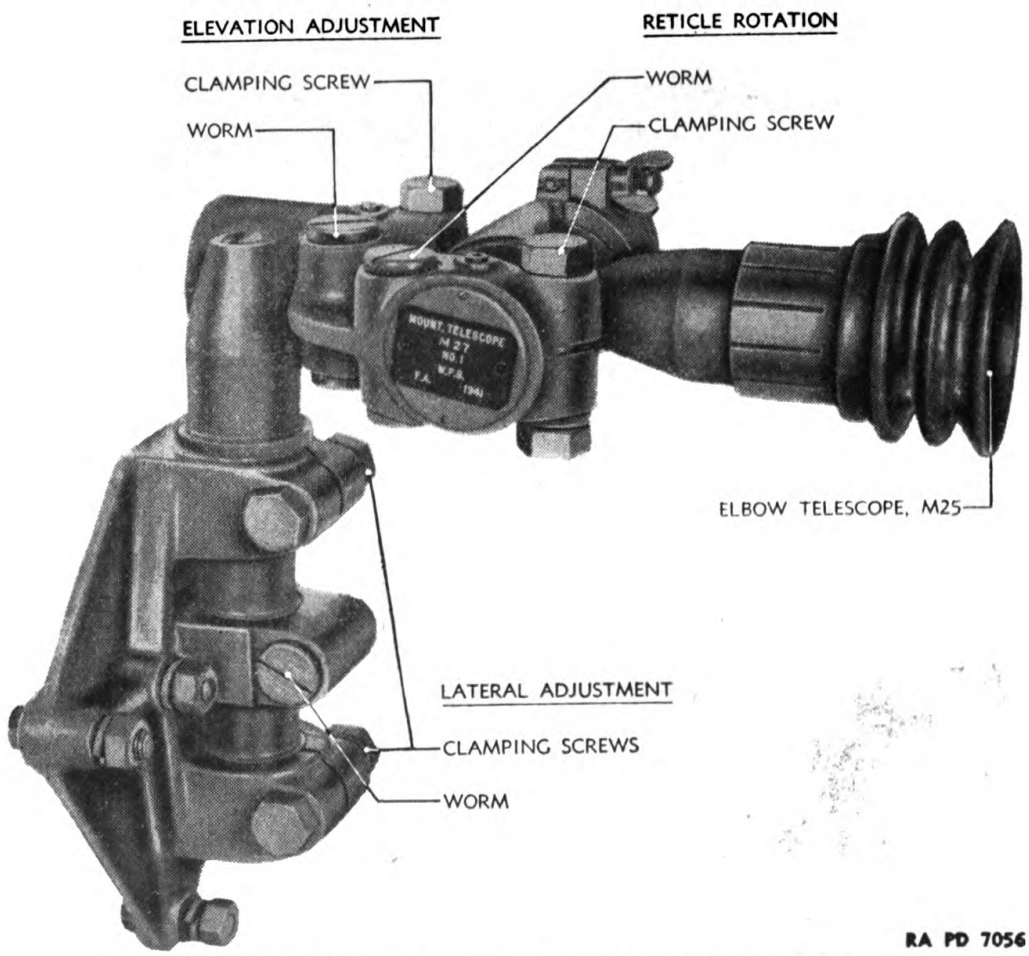


FIGURE 2.—Telescope mount M27 with elbow telescope M25.

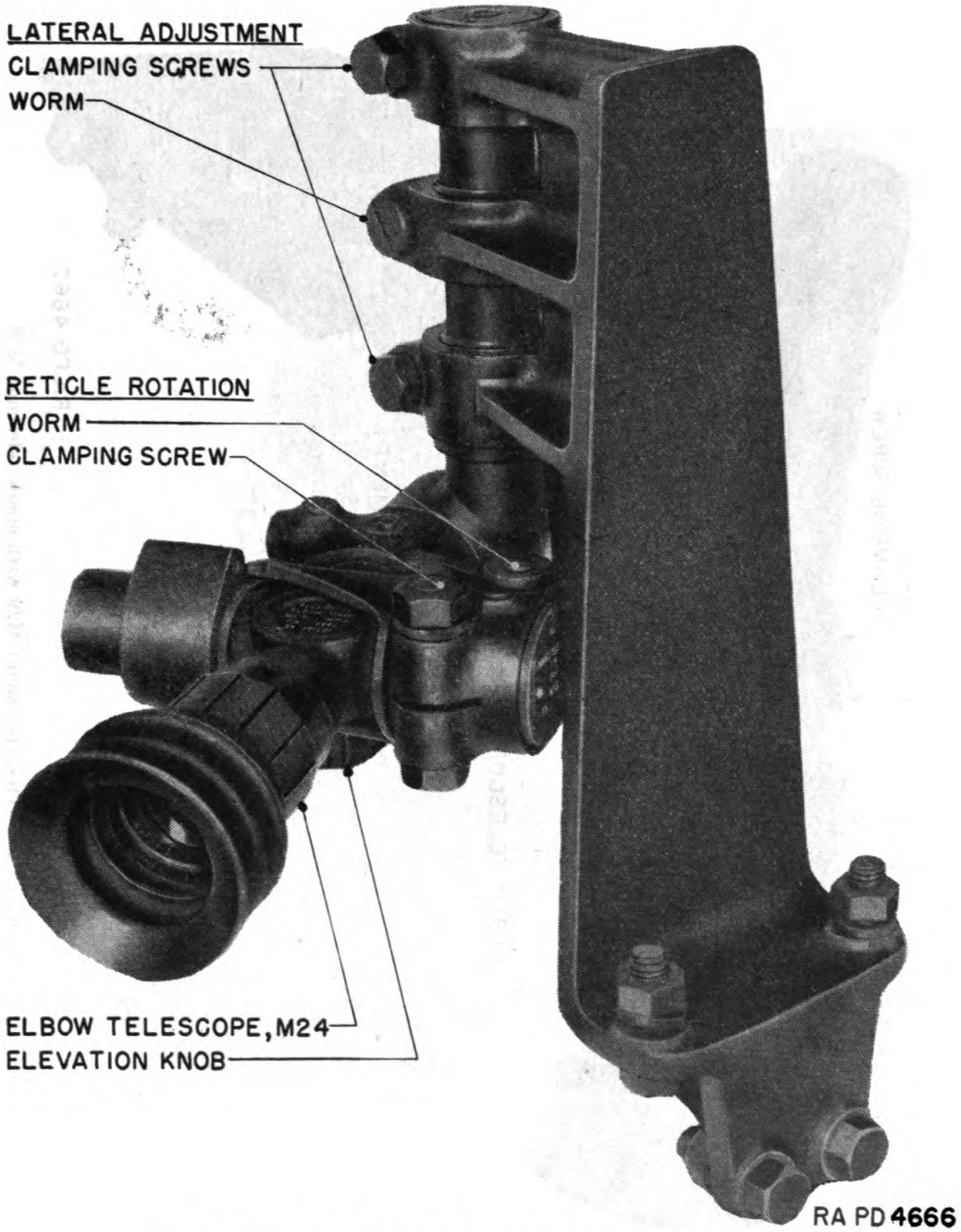


FIGURE 3.—Telescope mount M28 with elbow telescope M24.

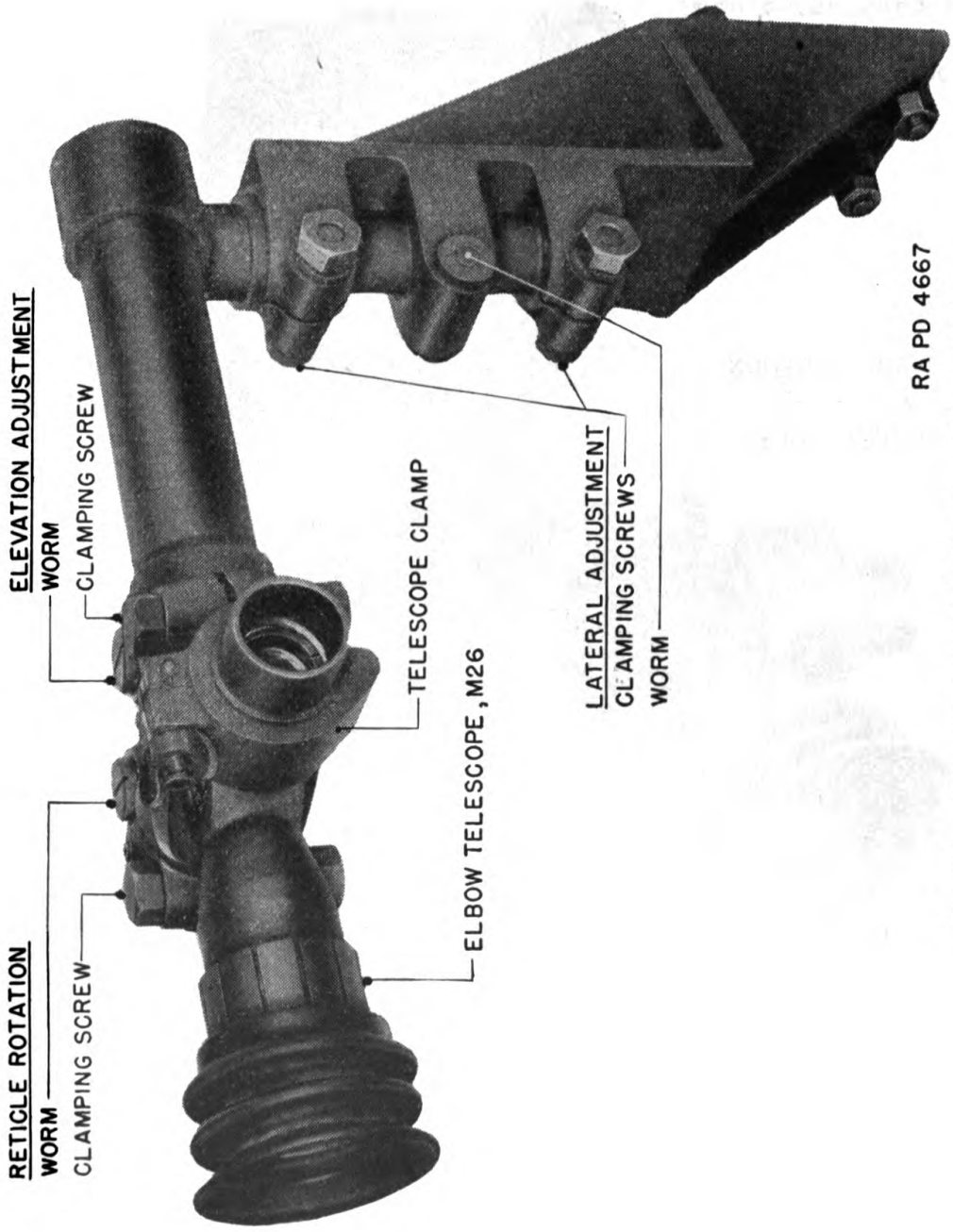


FIGURE 4.—Telescope mount M29 with elbow telescope M26.

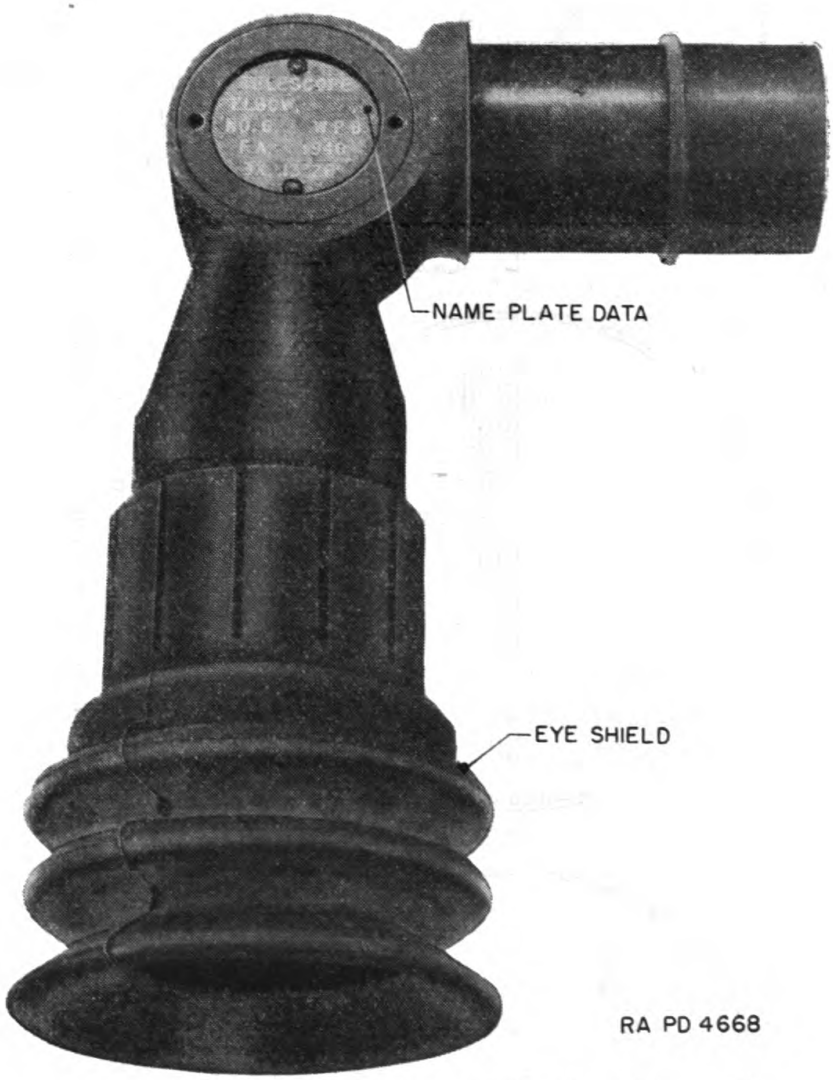
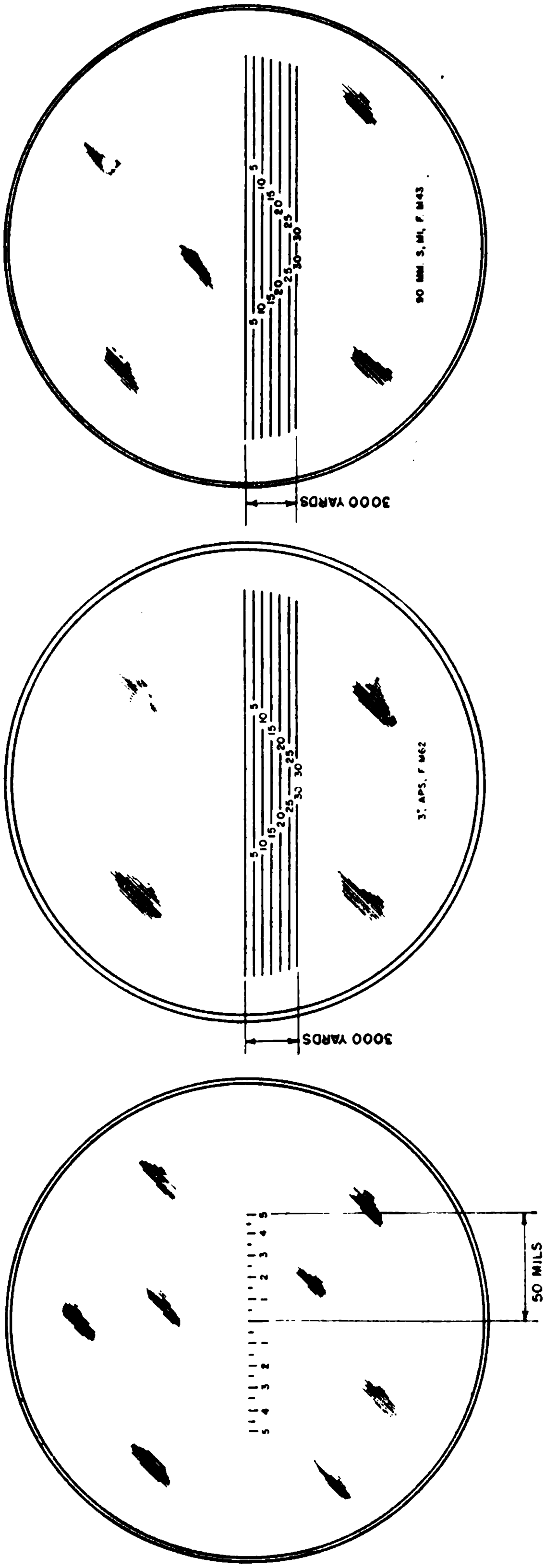


FIGURE 5.—Elbow telescopes M24, M25, M26.



RA PD 7057

① M24. ② M25. ③ M26.

FIGURE 6.—Reticle patterns for elbow telescopes.

SECTION II

DESCRIPTION

4. Telescope mount M26.—*a.* The telescope mount M26 consists principally of the mounting bracket, spindle assembly, elevation worm housing, and telescope holder.

b. The mounting bracket (fig. 9, sec. E–E) bolts onto the left side of the top gun carriage and is the supporting element of the mount. It has two split clamping collars (fig. 9, sec. F–F) and a third solid collar (fig. 9, sec. G–G) which houses the lateral adjusting worm. The clamping collars lock the lateral adjustment setting against accidental rotation or backlash of the adjusting worm.

c. The spindle assembly (fig. 9, sec. E–E) consists of a spindle and gear pinned together to form an offset L as shown in figure 8, section A–A, and figure 9, section E–E. The spindle fits into the three collars on the mounting bracket. It is held by a shoulder on the spindle below the lower split clamping collar, and by a round nut (fig. 9, sec. E–E) on the upper end above the upper split clamping collar. Operation of the elevation worm rotates the elevation worm housing about its supporting gear (fig. 8, sec. A–A).

d. The elevation worm housing (fig. 8, sec. A–A) contains the elevation worm (fig. 8, sec. C–C) and supports the telescope holder assembly (fig. 8, sec. A–A, and fig. 10). The telescope holder is rotated by the reticle rotation worm (fig. 8, sec. B–B) and may be clamped in position by the clamping screw.

e. One end of the telescope holder (fig. 10) fits into a bearing surface in the elevation worm housing (fig. 8, sec. A–A) and is held in position by a plug. A clamp on the other end of the holder fits around the telescope body. When the telescope is placed in the telescope holder, a flat locating surface on the telescope body engages a similar surface on the holder so that when the clamp is tightened the telescope is held firmly.

f. The schematic arrangement of the telescope mount is shown in figure 11. There are three axes of rotation: one through the spindle vertical axis, one through the horizontal axis perpendicular to the gun bore, and one through the telescope objective axis. The first two motions permit movement of the telescope in azimuth and elevation

so that the line of sight can be directed parallel to the bore of the gun. The third motion permits rotation of the field of view with respect to the reticle pattern, thus bringing the horizontal reticle lines parallel to the horizon or other horizontal line in the field of view which is parallel to the horizontal reticle line.

5. Telescope mount M27.—*a.* The telescope mount M27 consists principally of the mounting bracket, spindle assembly, elevation worm housing, and telescope holder.

b. The mounting bracket (fig. 14, sec. D–D) fits onto the gear segment on the right gun trunnion. Mounted in this way, the telescope mount rotates in elevation as well as in azimuth with the gun. The bracket has two split clamping collars (fig. 14, sec. E–E) and a third solid collar (fig. 14, sec. F–F) which houses the lateral adjusting worm.

c. The spindle assembly (fig. 14, sec. D–D) consists of a spindle and gear pinned together to form an offset L as shown in figure 14, section D–D, and figure 13, section A–A. The spindle fits into the three collars on the mounting bracket. It is held by a shoulder on the spindle above the upper clamping collar, and by a round nut (fig. 14, sec. D–D) on its lower end below the lower collar. Operation of the elevation worm rotates the elevation worm housing about its supporting gear (fig. 13, sec. A–A).

d. The elevation worm housing (fig. 13, sec. A–A) contains the elevation worm and clamping screw, and supports the telescope holder assembly (fig. 13, sec. A–A, and fig. 10). A worm and clamping screw (fig. 13, sec. C–C) similar to the elevation worm and clamping screw are provided for rotating the telescope holder and clamping it in position.

e. One end of the telescope holder (fig. 10) fits into a bearing surface in the elevation worm housing (fig. 13, sec. A–A) and is held in position by a threaded plug. A clamp on the other end of the holder fits around the telescope body. When the telescope is placed in the bracket, a flat locating surface on the telescope engages a similar surface on the bracket so that when the clamp is tightened the telescope is held firmly.

f. The telescope mount M27 closely resembles the telescope mount M26. The schematic diagram shown in figure 11 applies to the telescope mount M27, with the following differences: The bracket is fastened to the right gun trunnion with the spindle in an inverted position. The elevation worm is not provided with a knob, but is arranged for screw driver adjustment.

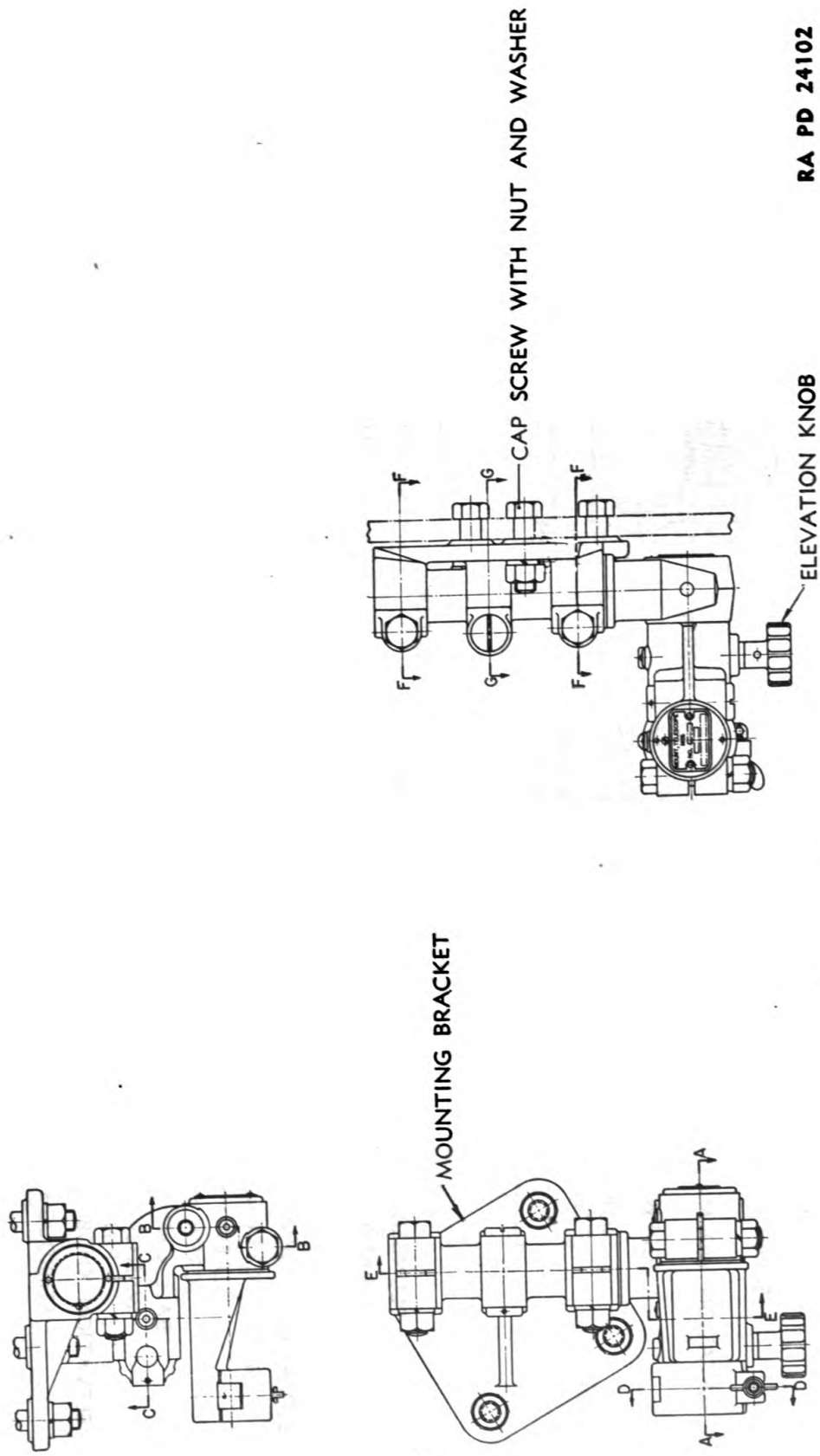


FIGURE 7.—Telescope mount M26, assembled view.

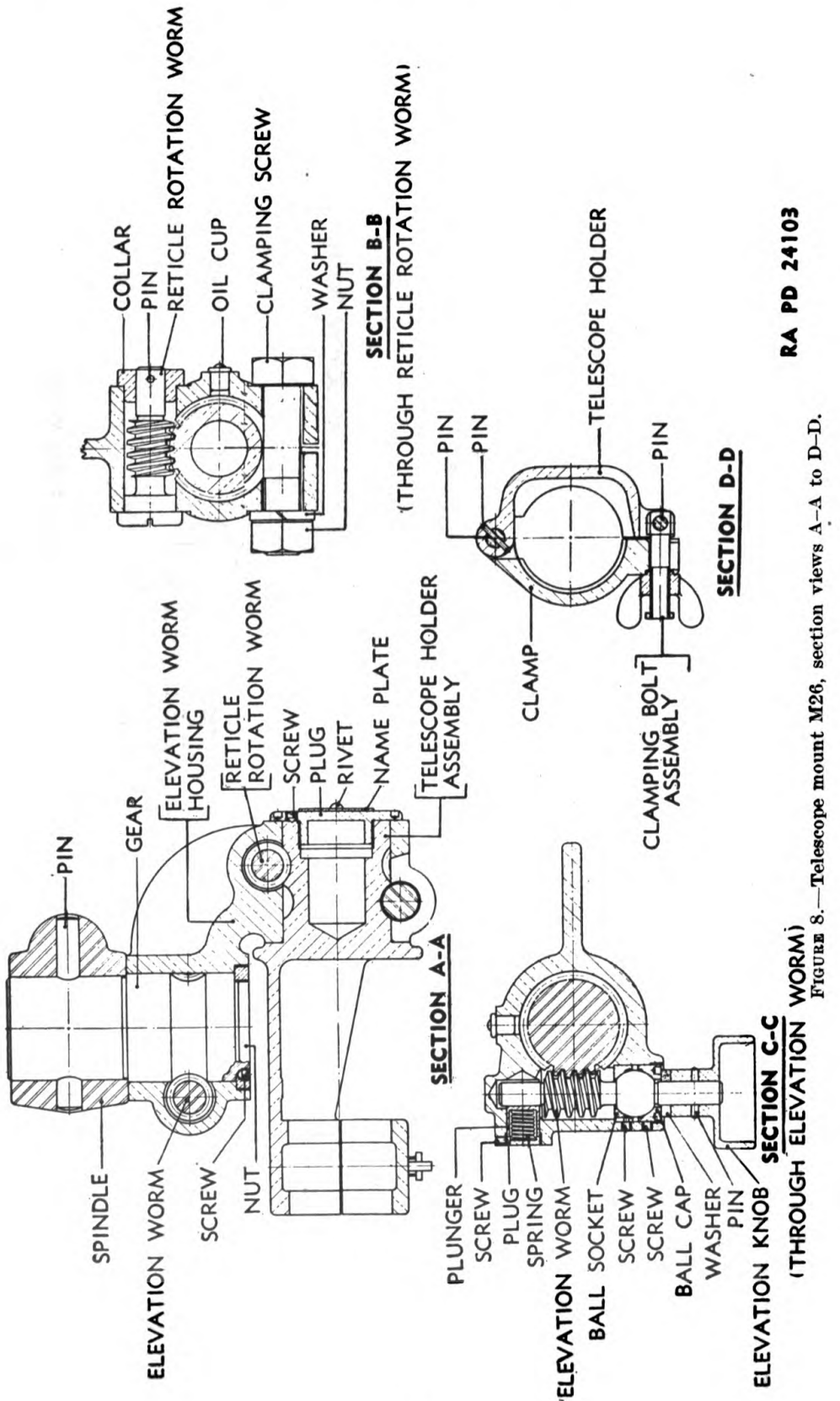


FIGURE 8.—Telescope mount M26, section views A–A to D–D.

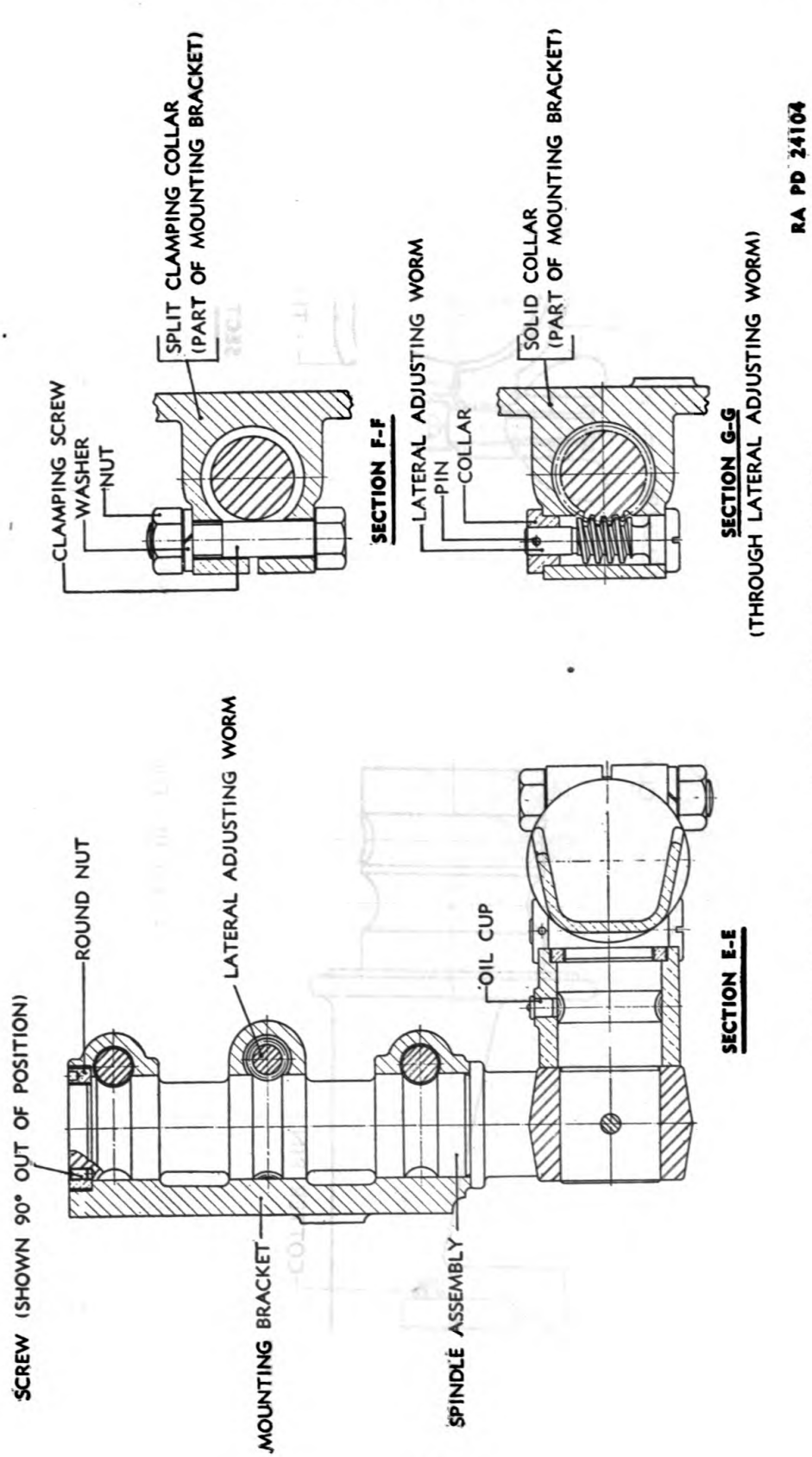


FIGURE 9.—Telescope mount M26, section views E–E to G–G.

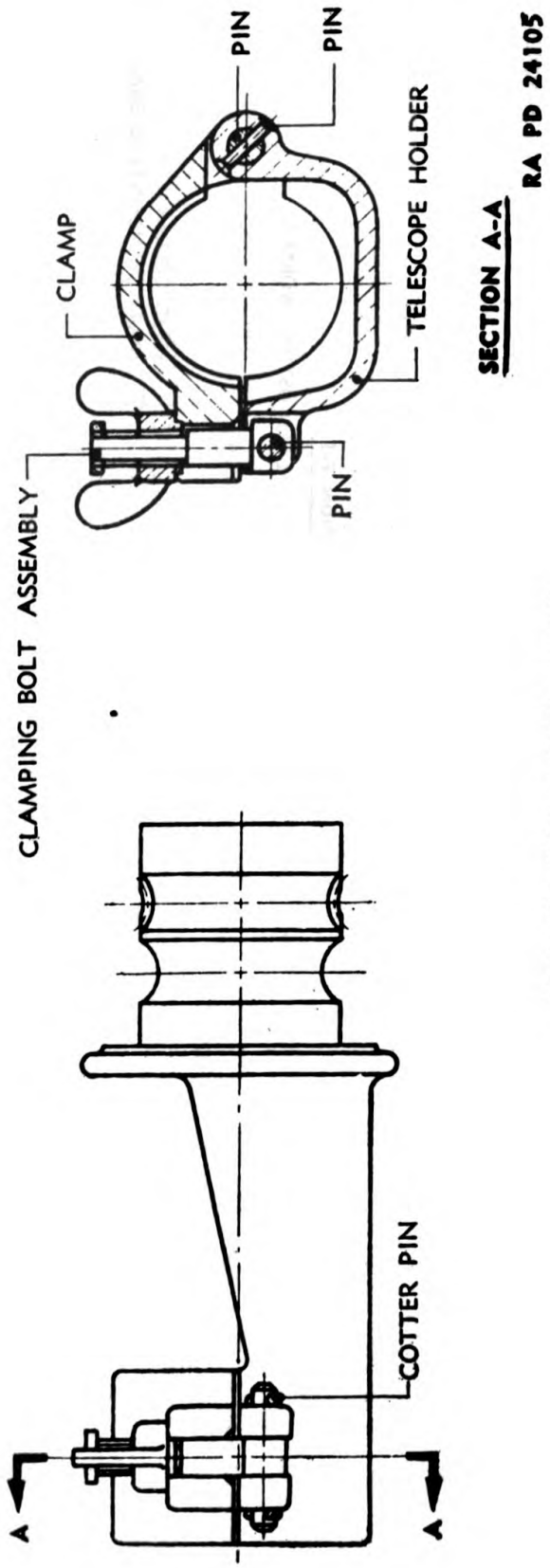


FIGURE 10.—Telescope holder assembly.

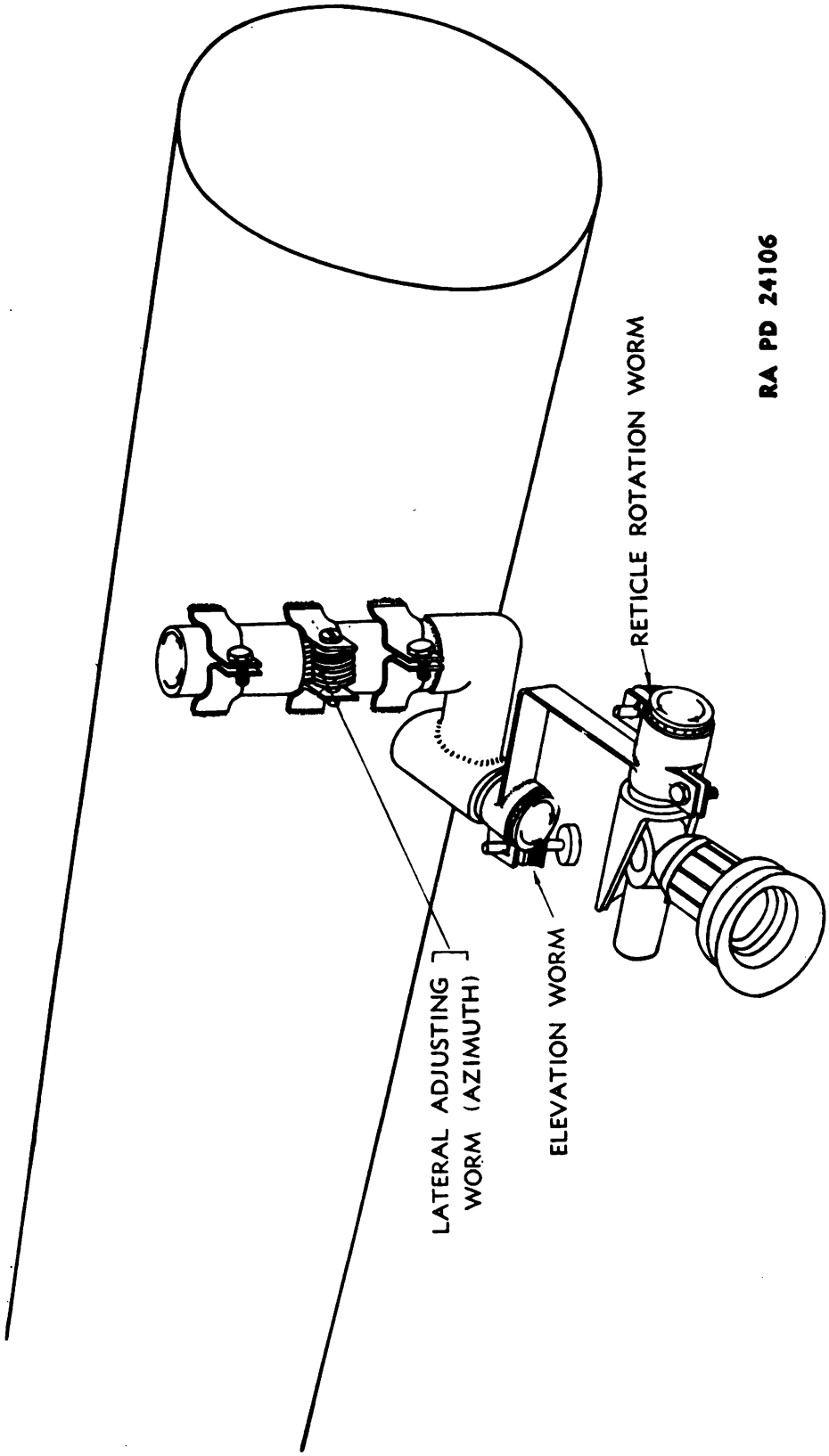


FIGURE 11.—Telescope mount M26, schematic diagram.

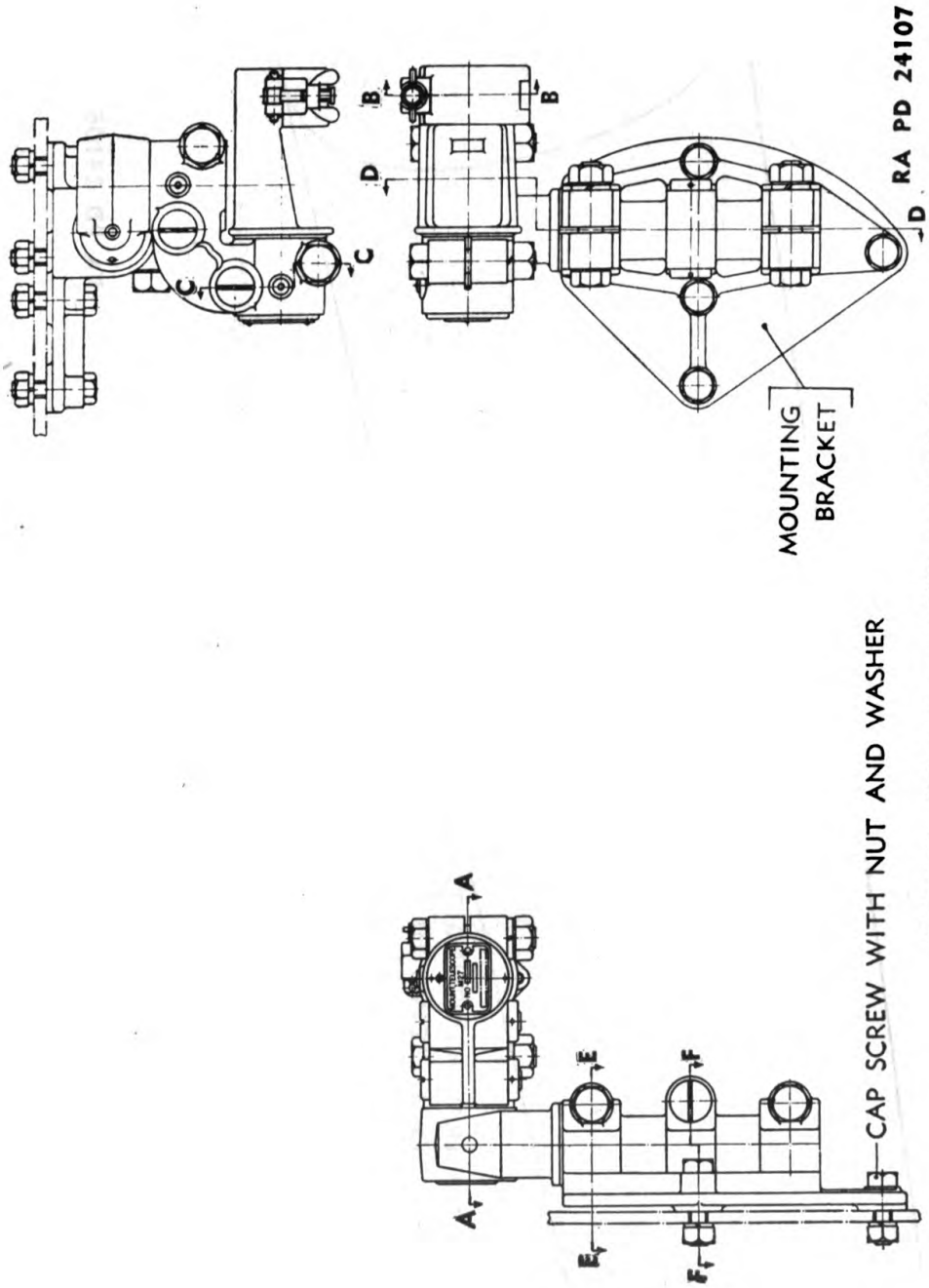


FIGURE 12.—Telescope mount M27, assembled views.

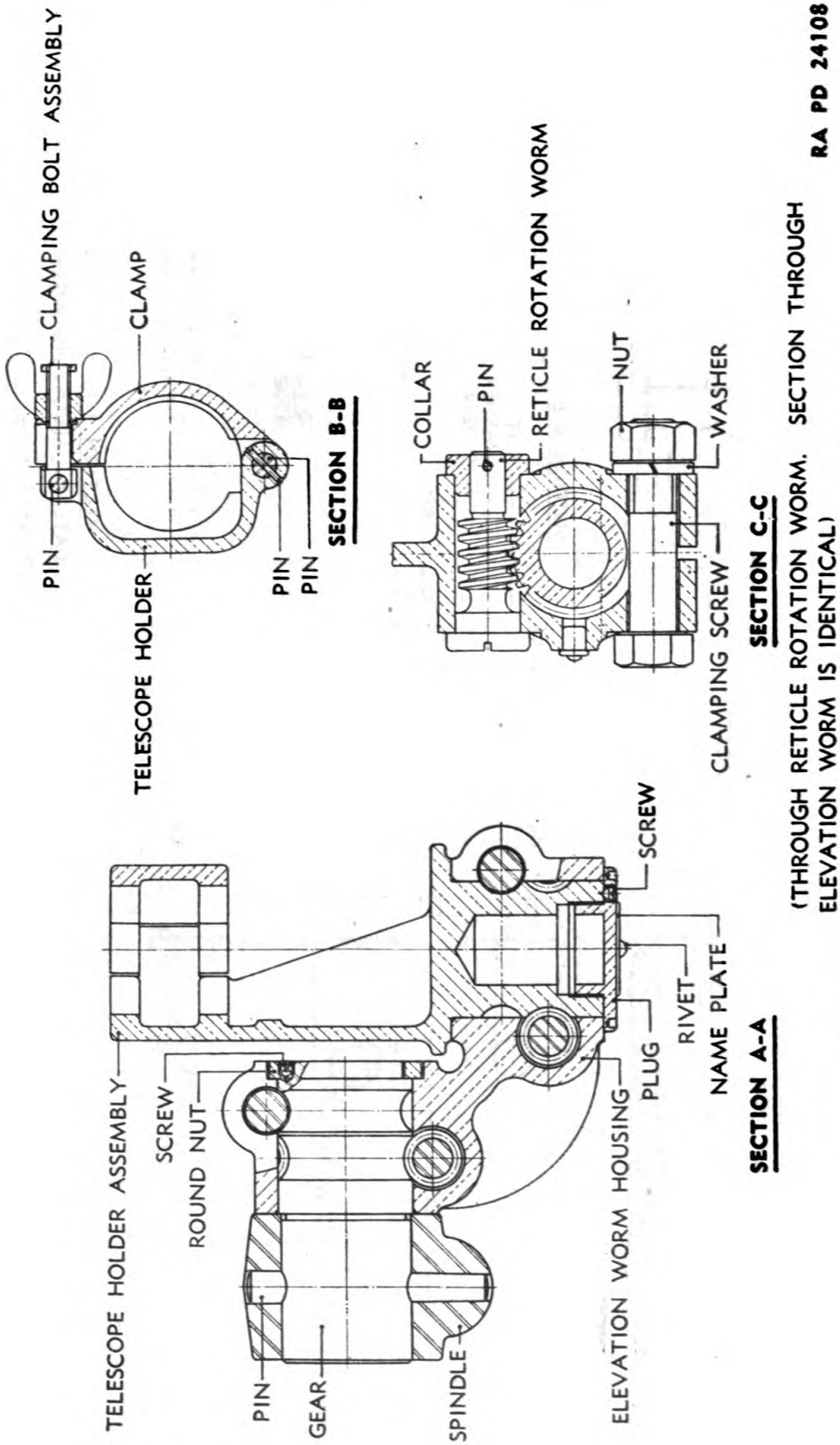


FIGURE 13.—Telescope mount M27, section views A–A to C–C.

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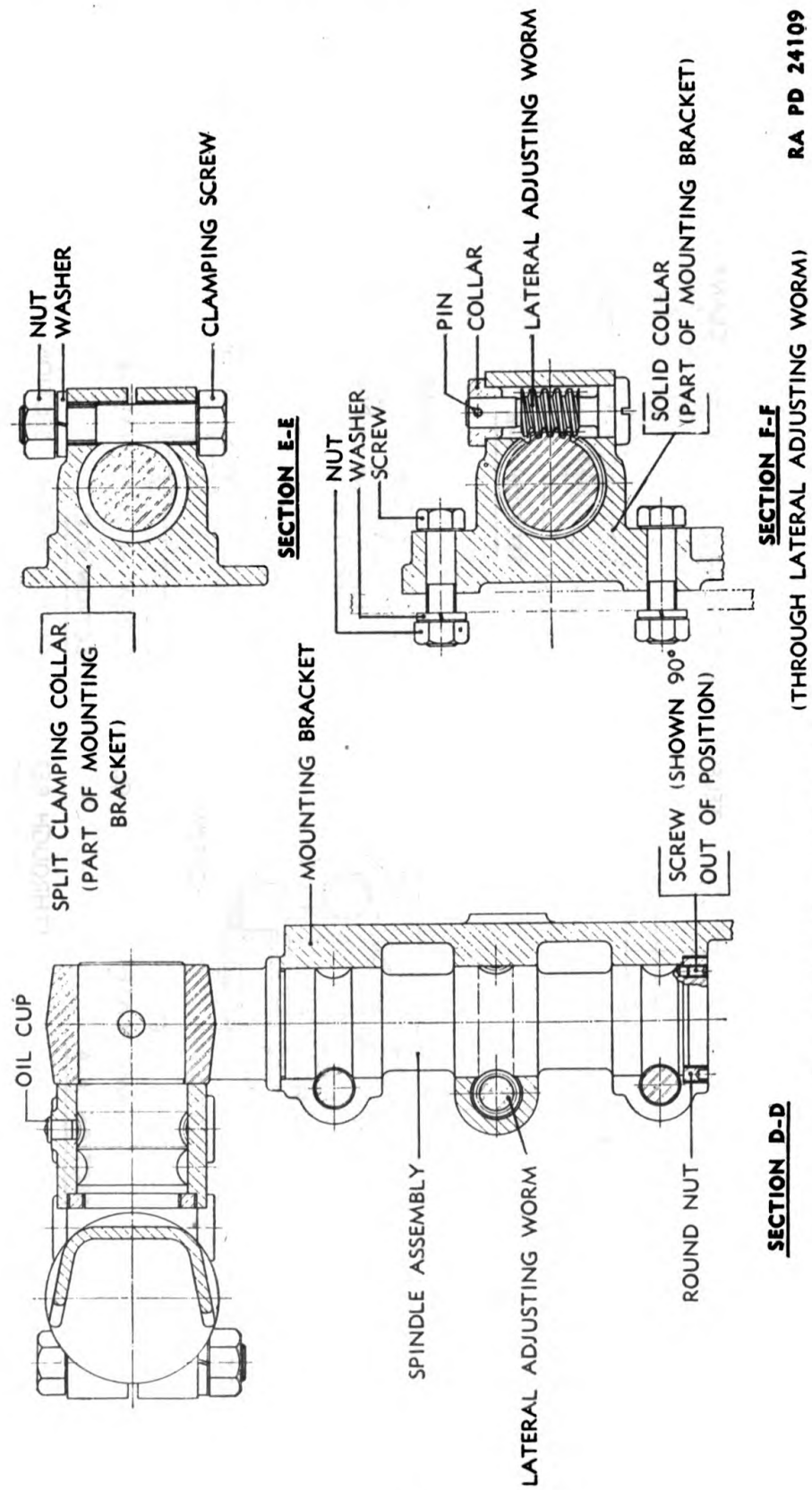


FIGURE 14.—Telescope mount M27, section views D–D to F–F.

6. Telescope mount M28.—*a.* The telescope mount M28 consists principally of the mounting bracket, spindle assembly, elevation worm housing, and telescope holder.

b. The mounting bracket (fig. 17, sec. E–E) bolts onto the left side of the top gun carriage above the azimuth handwheels, and rotates only in azimuth with the gun. The bracket has two split clamping collars (fig. 17, sec. F–F) and a third solid collar (fig. 17, sec. G–G) which contains the lateral adjusting worm. The supporting bracket (fig. 15) is not required with 90-mm gun mounts M1, when equipped with data transmission systems M6 or T17.

c. The spindle assembly (fig. 17, sec. E–E) consists of a spindle and gear pinned together to form an offset L as shown in figure 16, section A–A, and figure 17, section E–E. The spindle fits into the three collars on the mounting bracket. It is held by a shoulder on the spindle below the lower clamping collar, and by a round nut on its upper end above the top collar. Operation of the elevation worm rotates the elevation worm housing about its supporting gear (fig. 16, sec. A–A).

d. The elevation worm housing (fig. 16, sec. A–A) contains the elevation worm (fig. 16, sec. C–C) and supports the telescope holder assembly (fig. 16, sec. A–A, and fig. 10). The telescope holder is rotated by the worm (fig. 16, sec. B–B) and may be clamped in position by the clamping screw.

e. One end of the telescope holder (fig. 10) fits into a bearing surface in the elevation worm housing (fig. 16, sec. A–A) and is held in position by a plug. A clamp on the other end of the holder fits around the telescope body. When the telescope is placed in the bracket, a flat locating surface on the telescope body engages a similar surface on the bracket so that when the clamp is tightened the telescope is held firmly.

f. The schematic arrangement of the telescope mount is similar to that shown in figure 11.

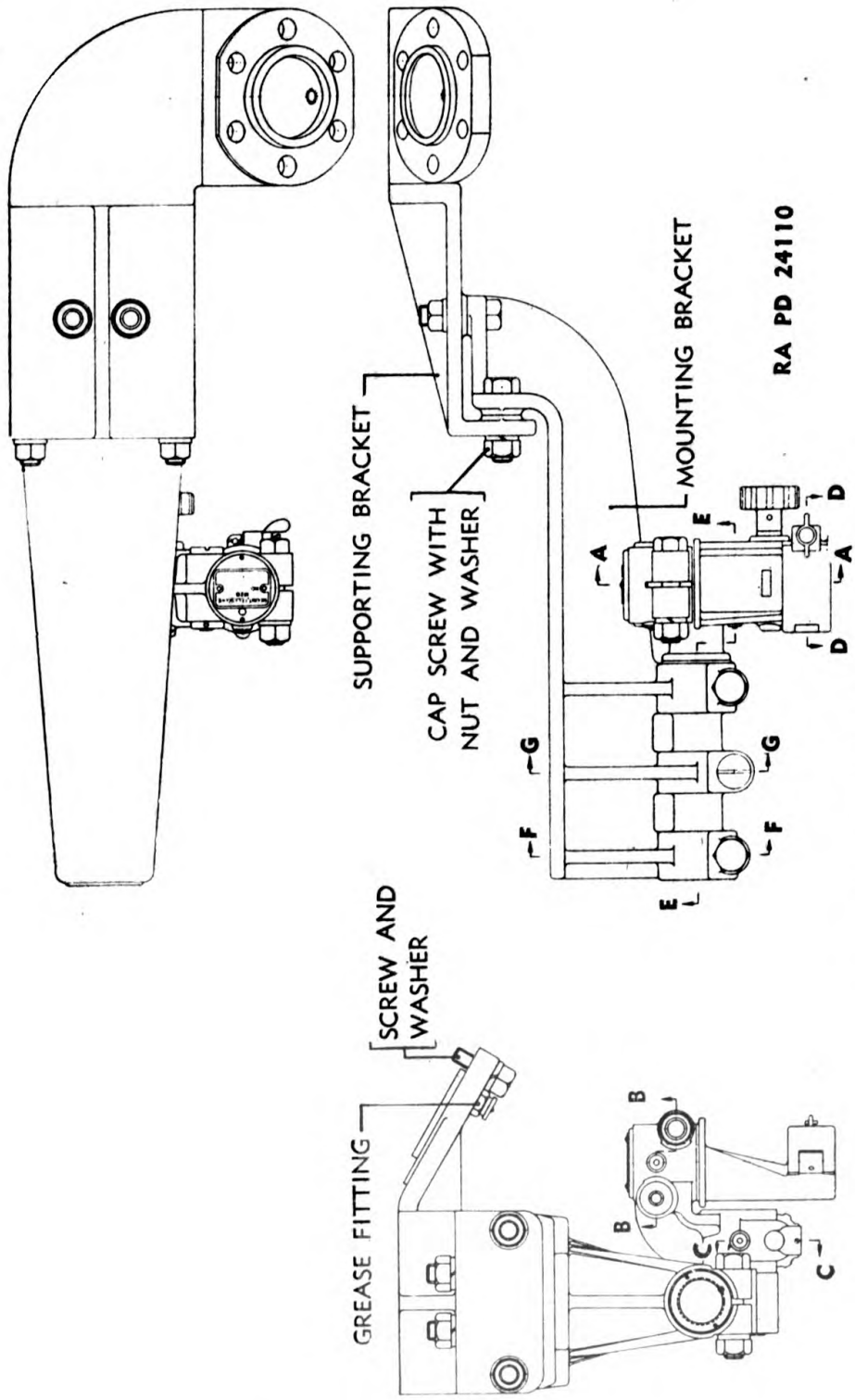


FIGURE 15.—Telescope mount M28, assembled views.

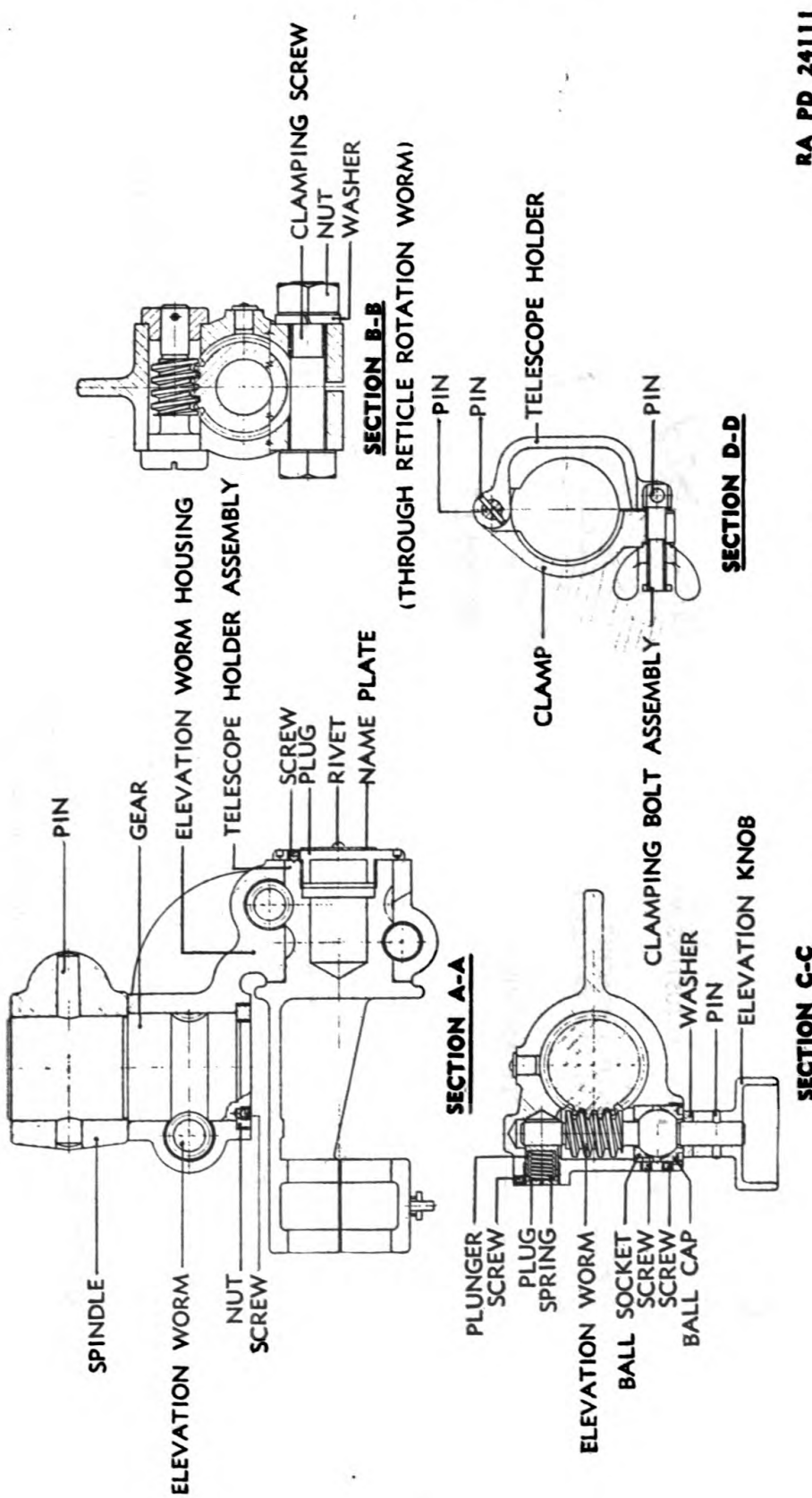


FIGURE 16.—Telescope mount M28, section views A–A to D–D.

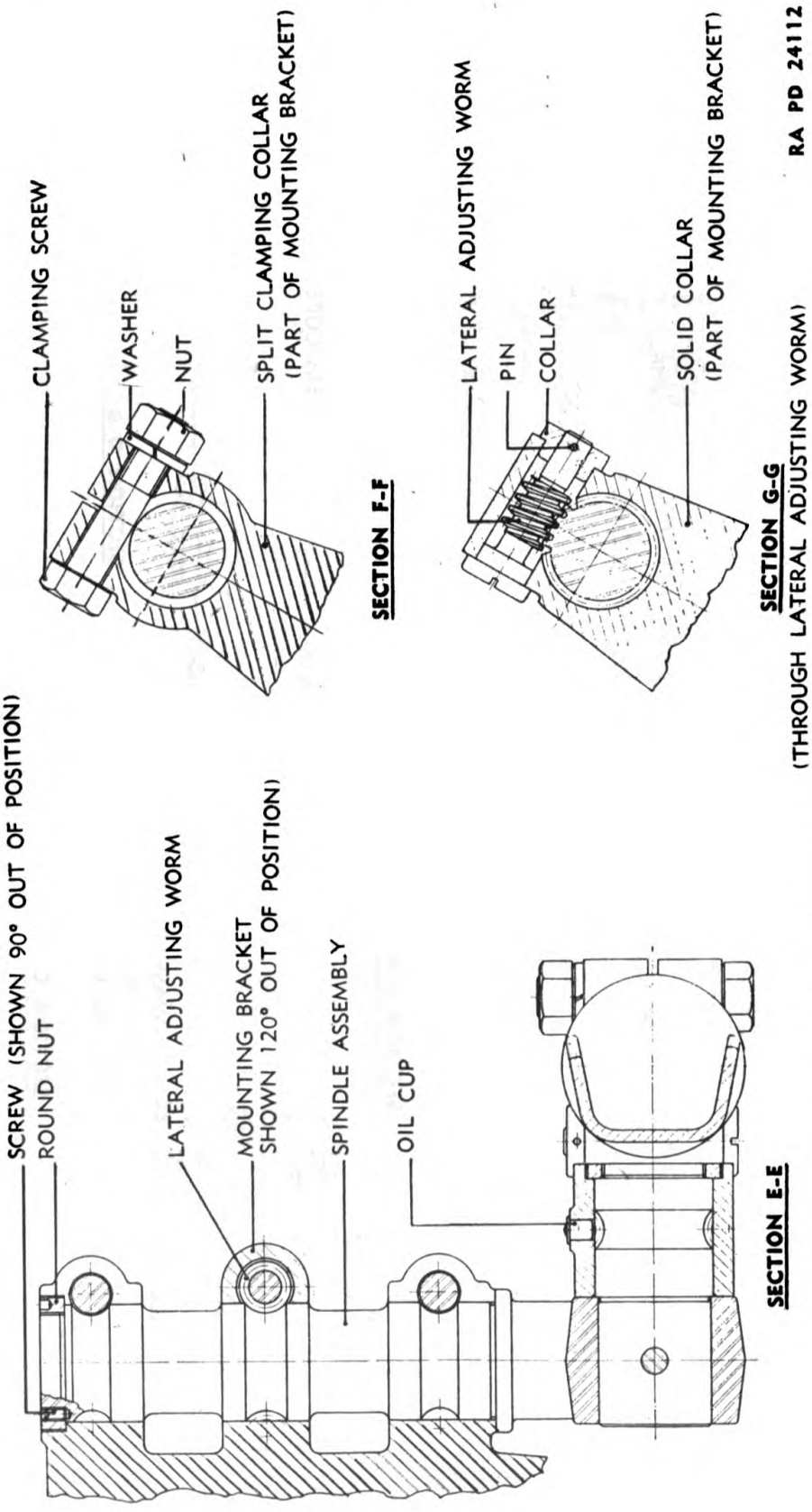


FIGURE 17.—Telescope mount M28, section views E–E to G–G.

7. Telescope mount M29.—*a.* The telescope mount M29 consists principally of the mounting bracket, spindle assembly, elevation worm housing and telescope holder.

b. The mounting bracket (fig. 20, sec. D–D) bolts onto the right side of the gun cradle in front of the right trunnion. Mounted in this way, the telescope mount rotates in elevation and azimuth with the gun. The bracket has two split clamping collars (fig. 20, sec. E–E) and a third solid collar (fig. 20, sec. F–F) which houses the lateral adjusting worm.

c. The spindle assembly (fig. 20, sec. D–D) consists of a spindle and gear pinned together as shown in figure 20, section D–D, and figure 19, section A–A. The spindle fits into the three collars on the mounting bracket. It is held by a shoulder on the spindle above the upper clamping collar, and by a round nut onto its lower end below the lower collar. Operation of the elevation worm rotates the elevation worm housing about its supporting gear (fig. 19, sec. A–A). The gear is elongated to place the telescope in a convenient position for observation.

d. The elevation worm housing (fig. 19, sec. A–A) contains the elevation worm and clamping screw and supports the telescope holder assembly (fig. 19, sec. A–A, and fig. 10). A worm and clamping screw (fig. 19, sec. C–C) similar to the elevation worm and clamping screw rotate the telescope holder and clamp it in position.

e. One end of the telescope holder (fig. 10) fits into a bearing surface in the elevation worm housing and is held in position by a plug (fig. 19, sec. A–A). A clamp on the other end of the holder fits around the telescope body. When the telescope is placed in the bracket, a flat locating surface on the telescope engages a similar surface on the bracket so that when the clamp is tightened the telescope is held firmly.

f. Except for the shape of the mounting bracket and the relative length of the gear which supports the elevation worm housing, the telescope mount M29 closely resembles the telescope mount M27. The schematic diagram shown in figure 11 applies to the telescope mount M29, with the following differences: The bracket is fastened to the right side of the gun with the spindle in an inverted position. The elevation worm is not provided with a knob, but is arranged for screwdriver adjustment.

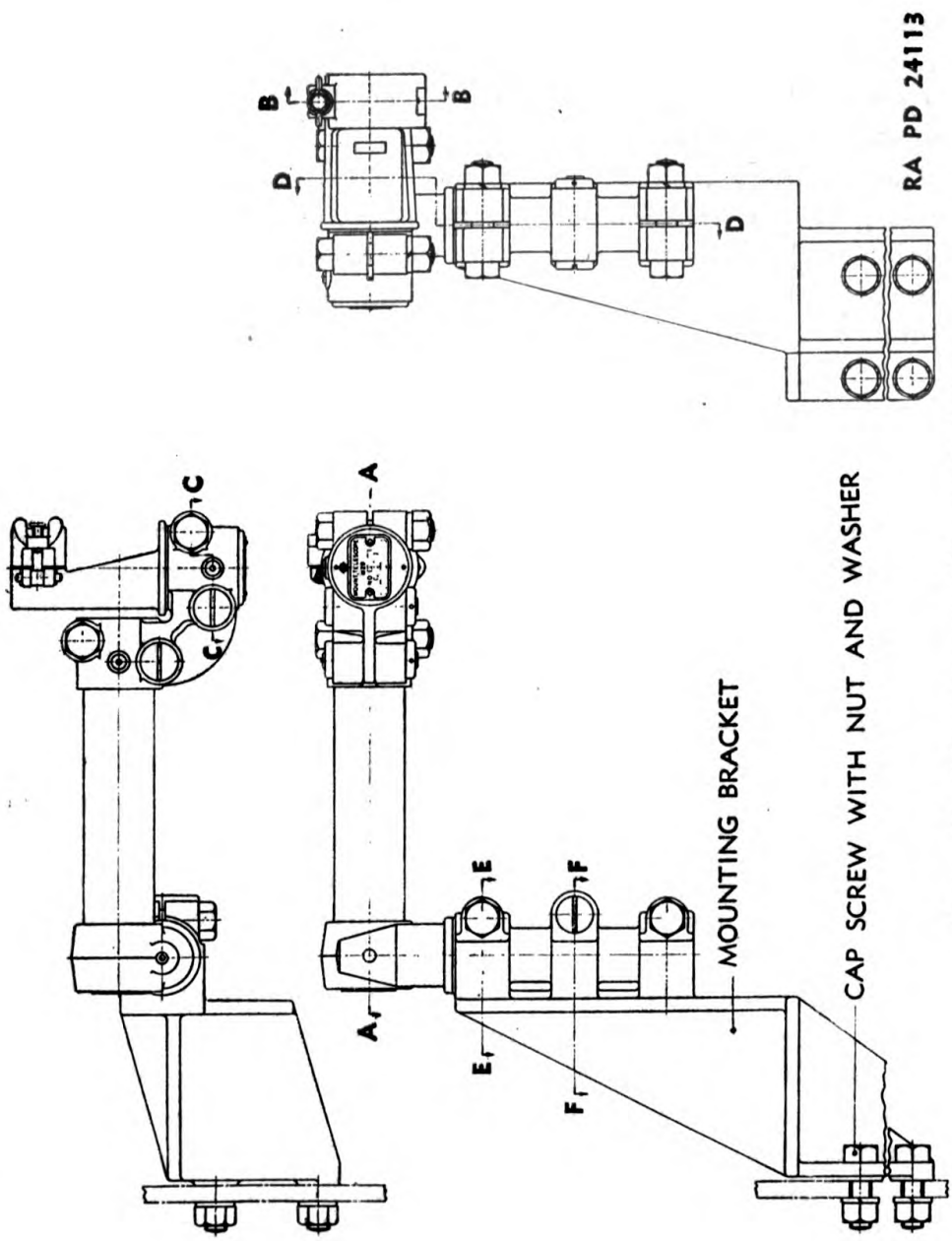


FIGURE 18.—Telescope mount M29, assembled views.

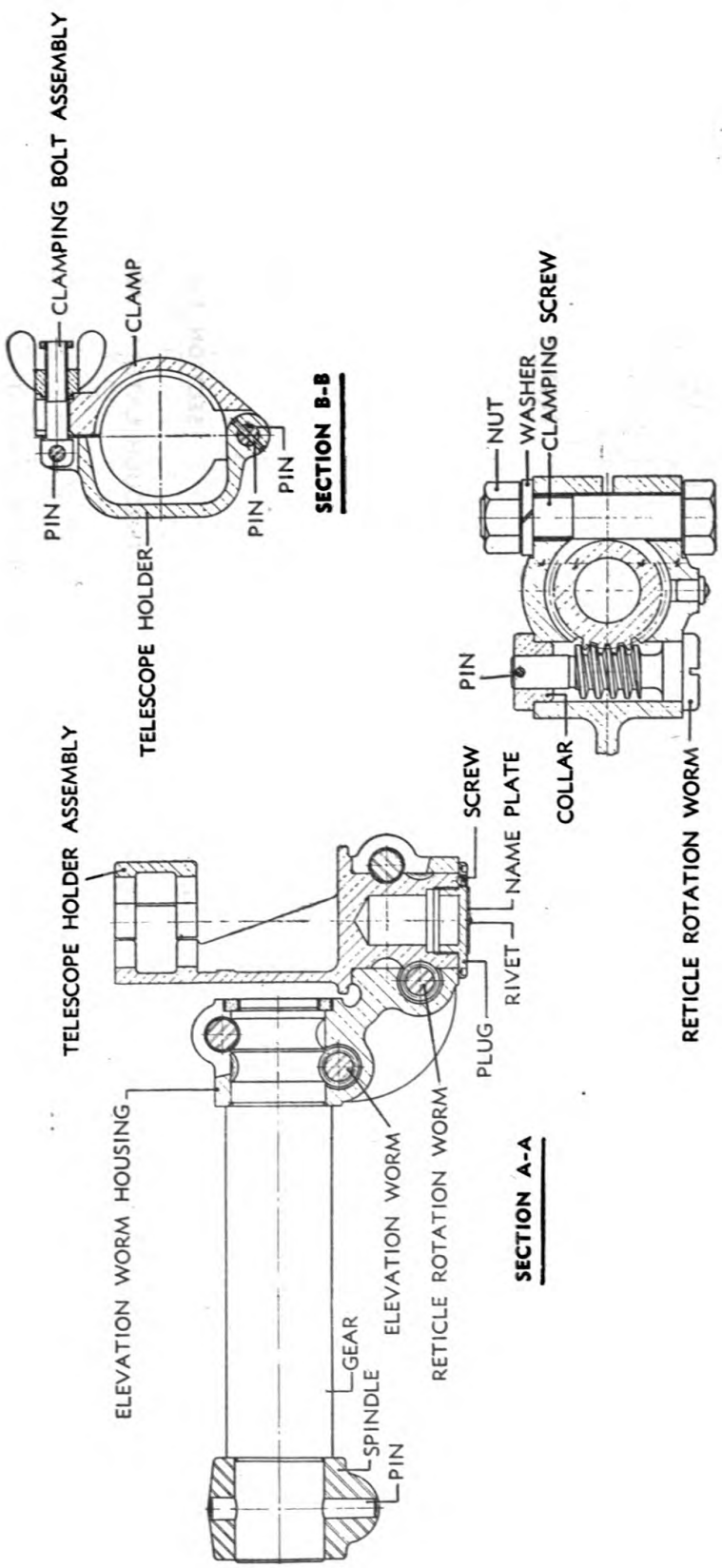


FIGURE 19.—Telescope mount M29, section views A–A to C–C.

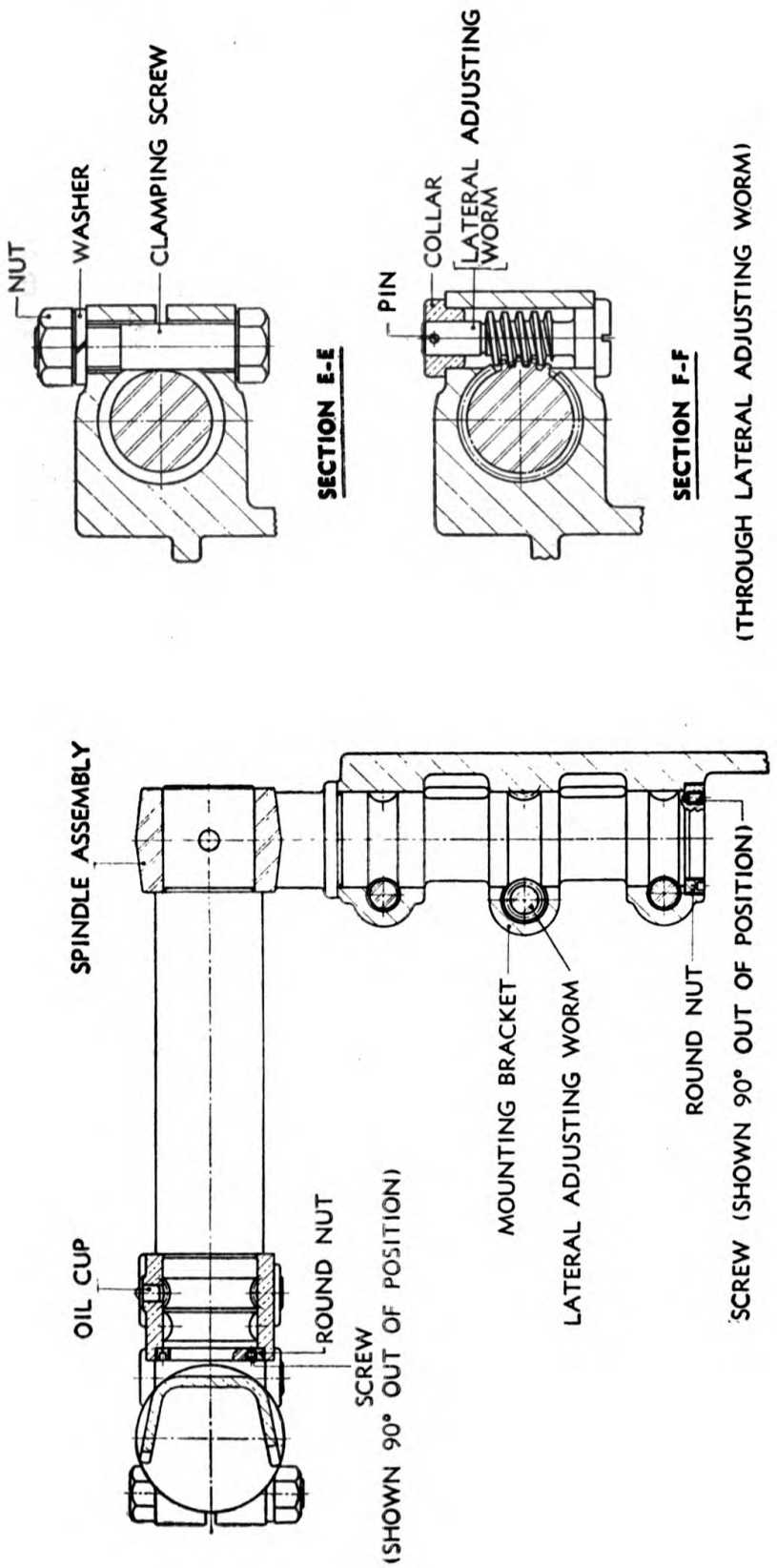


FIGURE 20.—Telescope mount M29, section views D–D to F–F.

8. Elbow telescopes M24, M25, M26.—*a.* These elbow telescopes are mechanically identical, differing only in the reticle patterns (fig. 6). Assembled and sectioned views of the elbow telescope are shown in figure 21.

b. The telescope legs are approximately 3 and 3½ inches long, respectively. The shorter leg has a cylindrical bearing surface and a flat locating surface to match the corresponding surfaces of the telescope holder. The longer leg, which houses the eyepiece portion of the telescope, carries a soft rubber eyeshield (fig. 21). The adapter to which the eyeshield is clipped can be disengaged from the groove in the telescope body and slid along the tube until the end of the shield is flush with the end of the tube.

c. The lenses and reticle are contained in cylindrical metal cells, and are retained in their respective cells by threaded rings and lock screws. The cells, in turn, are firmly secured in the telescope body in a manner which minimizes the possibility of parts working loose in service.

d. The Amici prism is secured in the elbow of the telescope body by a holder and wedge. The prism is protected by covers which screw into the sides of the telescope body as shown in figure 21, section A–A.

e. Optical characteristics of the telescope are as follows:

Power	3X.
Field of view	13°20′.
Diameter of exit pupil—inch	0.30.
Effective focal length of objective—inches	4.123.
Effective focal length of eyepiece—do	1.374.
Apparent field of view	40°.
Eye distance (eye lens to pupil)—inches	1.25.

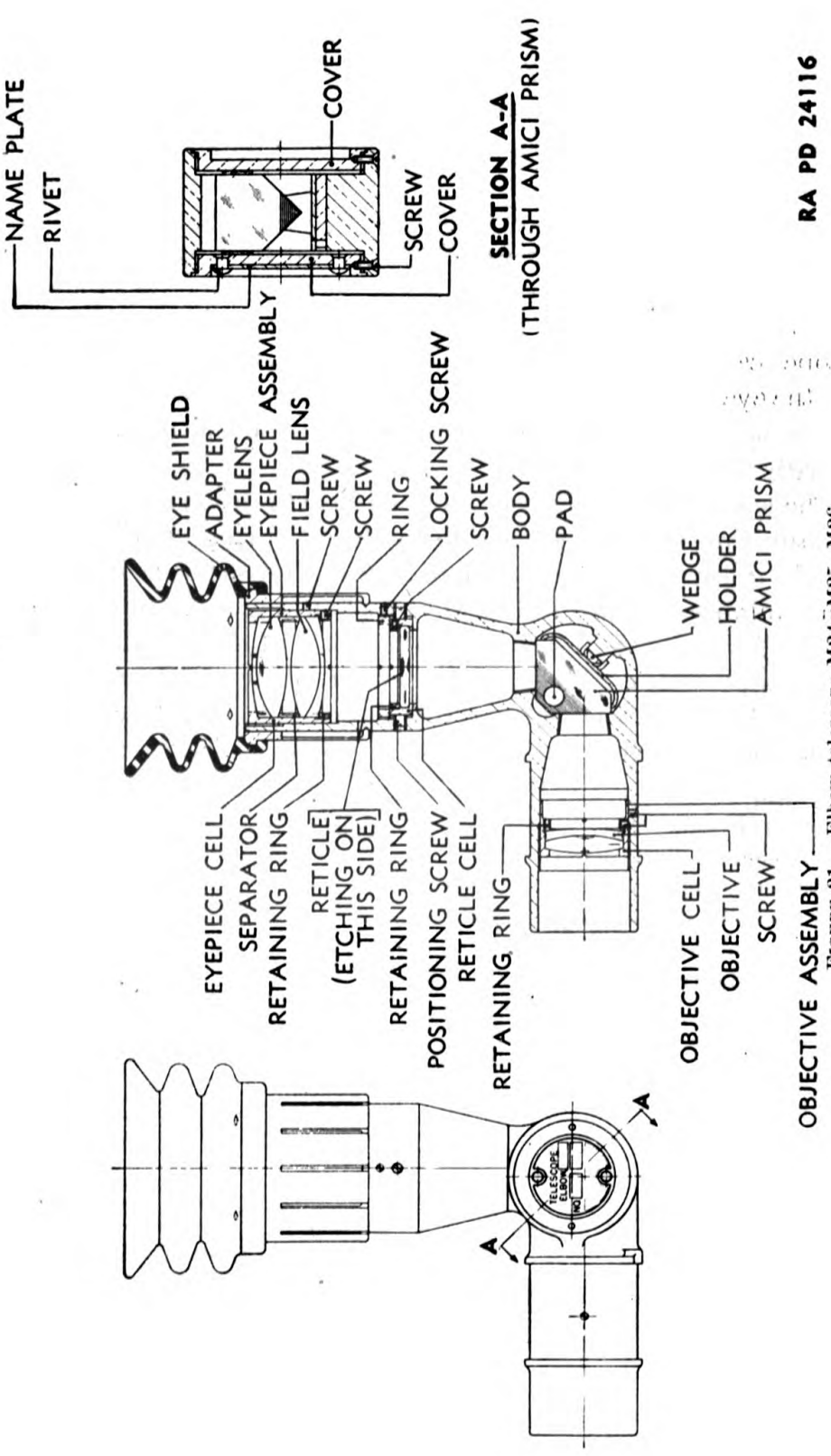


FIGURE 21.—Elbow telescope M24, M25, M26.

SECTION III

CARE AND PRESERVATION

9. Cleaning and preserving materials.—*a. Lubricants.*

Oil, lubricating, for aircraft instruments and machine guns (for all lubrication where oil is required).
Grease, lubricating, special (for all lubrication where grease is required).

b. Cleaning materials.

Alcohol, ethyl (for cleaning optical parts).
Solvent, dry-cleaning (for cleaning metal components).
Paper, lens, tissue (for cleaning polished glass surfaces).
Brush, camel's-hair (for removing dust and lint from optics).

10. Telescope mounts.—*a.* Oil cups are provided for the lubrication of the elevation worm and worm gear, and the telescope rotating worm and worm gear on all four mounts. Fill the cups with oil as required.

b. The lateral adjusting worms are lubricated at assembly and should require no attention by using personnel.

c. Apply a few drops of oil occasionally to the clamp pivot on the telescope holder.

d. Wipe off all excess oil to prevent accumulation of dust and grit.

e. Wipe off all dust and grit from the contact surfaces and locating surface on the telescope holder before assembling the telescope to the mount.

f. Do not attempt to rotate the worms without first loosening the clamping screws.

g. Keep the clamping screws tight at all times except when adjusting.

11. Elbow telescopes.—*a.* Care must be exercised in handling the telescopes to prevent damage to, or disturbance of, the optical system.

b. Wipe all dust and grit from the bearing surfaces and locating surfaces on the telescopes before assembling to the mounts.

c. Do not touch or attempt to wipe the lenses with the fingers or a cleaning cloth. Remove dust or grit with a camel's-hair brush. Brush the glass lightly and then rap the brush against a hard object in order to knock out the small particles of dust that cling to the hairs.

d. To remove oil or grease from the lenses, apply alcohol with a camel's-hair brush and wipe dry with clean lens paper. If alcohol is not available, breath heavily on the lens to moisten it and wipe dry as directed above. Repeat the operation until all traces of oil have been removed.

e. Under no conditions whatever will polishing liquids, pastes etc., be used for polishing lenses or other parts.

Section IV

INSPECTION

12. Purpose of inspection.—Inspection is made for the purpose of determining the condition of the instrument, whether repairs or adjustments are required, and the action necessary to place the instrument in serviceable condition.

a. The basic inspection performed on an instrument is a preliminary inspection to determine its condition and to locate basic faults. As a result of this inspection, proper disposition of the instrument can be made and necessary action taken or recommended. Inspection forms (O. O. F. 7228 and O. O. F. 7229, fig. 22) are provided for recording the results of the inspection. Instructions concerning the entries to be made are printed on the back of the form.

b. The detailed inspection and correction instructions in section V are performed by the instrument repairman. From these instructions he locates and then performs the specific repair required to place the instrument in serviceable condition. The procedure may vary with each instrument, depending on the faults indicated by the preliminary inspection. Inspection forms and methods used in connection with the detailed inspection are described in TM 9–2602.

13. Tools for inspection and repair.—An instrument repair kit containing common tools and supplies for instrument inspection and repair is furnished to ordnance maintenance companies. (This kit, repair, instrument, replaces kits previously issued as kit, repair, optical, for Field Artillery and kit, repair, optical, for harbor defense.) Most of the items in the kit, such as screw drivers, etc., require no de-

scription as their uses are self-evident. The collimating telescope which is furnished with the kit is a small cylindrical prefocused telescope. It is used for inspecting the optics of a telescope and for setting up test fixtures. The collimating telescope does not require adjustment in use and is not to be disassembled in the field.

14. Tolerances.—Tolerances, or allowable errors, are specified where necessary to indicate the degree of accuracy required in performing certain adjustments. In general, an instrument is considered unserviceable if the error in any part exceeds the specified tolerance. However, it must be realized that the specified tolerance is intended to serve mainly as a guide for the inspector, and must be supplemented by the inspector's good judgment. The repairman should not infer from these tolerances that he should not attempt to reduce the errors to closer limits if time and conditions permit.

15. Inspection requirements.—*a.* Telescope mounts should be checked for—

Name plate data.
Completeness.
Appearance.
Condition of paint.
Condition of machined locating surfaces on mounting bracket and telescope holder.
Smoothness of worm motions (lateral adjustment worm, elevation worm, reticle rotation worm).
Action of clamps.

NOTE.—O. O. F. 7228 is the same as O. O. F. 7229 except that it is not ruled. Instructions are printed on back.

b. Elbow telescopes should be checked for—

Name plate data.
Completeness.
Appearance.
Sealing.
Condition of paint.
Condition of machined locating surfaces.
Operation of eyeshield adapter.
Definition.
Reticle alinement.
Collimation.
Focus of eyepiece.
Focus of objective (parallax).

16. Facilities needed for inspection.—The inspection can be made with only a few common hand tools, but it will be facilitated if the following are available:

a. Sturdy work bench, affording clear vision to the front.

b. Collimating telescope.

c. V-block for elbow telescope.

d. Common hand tools (screw driver, wrenches, etc.).

17. Basic inspection of telescope mounts.—*a.* Record the serial number from the name plate. The name plate is located on the plug which secures the telescope holder.

b. Examine the telescope mount for completeness, appearance, condition of paint, and for broken or bent parts. The mounting screws, with their nuts and washers, are part of the telescope mount and should be assembled to it.

c. Machined locating surfaces on mounting bracket and telescope holder should be smooth and clean. The elbow telescope should fit easily into the telescope holder when the telescope clamp is opened, and should be held securely when the clamp is tightened.

d. Release the screws which tighten the clamping collars. Operate each worm (lateral adjustment worm, elevation worm, reticle rotation worm) through its complete range of motion and note any unusual conditions such as binding of the worm, backlash, or chatter. Worm parts in good condition should produce a smooth, even motion with no perceptible backlash. A slight amount of backlash is permissible in worm motions which are secured by means of clamping collars, but any perceptible backlash in the elevation worms of telescope mounts M26 and M28 (azimuth) is not permissible.

e. Tighten the screws on the clamping collars. The clamping action should be positive, and sufficiently strong to withstand possible accidental motion.

18. Basic inspection of elbow telescopes.—*a.* Record the serial number from the name plate. The name plate is located on the elbow cover of the telescope.

b. Examine the elbow telescope for completeness, appearance, condition of paint, and for broken or bent parts. See that setscrew openings in the telescope body are properly sealed.

c. The cylindrical bearing surface and flat locating surface on the shorter leg of the telescope should be smooth and clean.

d. Check eyeshield adapter to see that it clips securely into the locating groove, and that it can be engaged or disengaged with only normal hand pressure. Check condition of eyeshield.

e. Look through the telescope and examine the optical elements for signs of breakage, dirt, grease, moisture, and deterioration of

O. O. F. 7229

INSPECTION OF ORDNANCE MATERIAL

Sheet No._____

Organization _____ Date of inspection _____

Station _____ Inspected by _____

Organization commander _____

Item and Serial No.	Defects noted	Action to be taken

RA PD 9693

FIGURE 22.—O. O. F. 7229 (Inspection of Ordnance Material).

adhesive balsam in the compound lenses. Defects can best be examined with the aid of the collimating telescope. The image should

appear sharp and clear, and the reticle should be in sharp focus. When observing a distant object, there should be no relative movement (parallax) between the object and the reticle as the eye is moved slightly from side to side or up and down. The image and reticle pattern should both be upright when the telescope is in normal operating position.

19. Action to be taken.—Instruments found defective must be repaired or adjusted to render them serviceable. Defects noted and action to be taken must be entered on the inspection form for each instrument. The action to be taken will be governed by the facilities available. If the facilities of the section do not permit satisfactory accomplishment of the repair or adjustment, pass the unserviceable instruments on to a higher maintenance echelon, and issue replacement items to the using arm.

SECTION V

MAINTENANCE AND REPAIR

20. General.—*a.* The following operations may be performed only by qualified ordnance personnel. The using arm is prohibited from attempting them. Correction for defects in the telescope mounts is accomplished primarily by replacement of worn and broken parts. The necessary disassembly and assembly is described in section VI.

b. Correction for defects in the elbow telescopes is primarily a matter of adjustment to correct for optical defects, and replacement of damaged or broken optical components. Replacement of mechanical components other than the eyeshield and eyeshield adapter should seldom be required. The necessary repairs can generally be performed by the instrument section in the field. Repairs involving replacement of the telescope body, baking of paints or cementing of lenses should be performed only at an arsenal or base shop.

21. Detailed inspection and correction of telescope mounts.—Because of the simple construction of these telescope mounts, the preliminary inspection is sufficient to locate any faults and to indicate the specific repairs required.

22. Detailed inspection and correction of elbow telescopes.—The repairman will use only the parts of the following instructions that seem to be necessitated by the results of his preliminary inspection.

a. Preliminary.—To make the adjustments described below, the Amici prism must be secured in position and the other optical elements must be assembled in the relation shown in figures 21 and 23. Note that the reticle etching is on the side toward the eyepiece. The eyepiece and objective should be focused to at least a rough approximation, so that both the reticle pattern and the field of view are visible through the eyepiece. Optical elements must be clean. There is no provision for adjusting the Amici prism. The prism is correctly located in assembly by means of accurately machined metal surfaces, and if the prism is properly seated on these surfaces no further adjustment will be required. There is, however, a possibility of improper seating if dirt lodges on these surfaces during disassembly or reassembly, in which case the subsequent adjustments will be difficult or impossible to perform. This is particularly important in the case of the reticle adjustment. The prism should be properly seated and prism covers should be in place before any optical adjustments can be made.

b. To test reticle alinement and collimation.—(1) Place the telescope in normal operating position, with the face of the locating lug accurately vertical and the eyepiece facing either right or left as in the telescope mount. The reticle pattern should appear upright and the principal horizontal line of the reticle pattern (fig. 6) should be parallel to a true level line. The tolerance, or allowable deviation, is plus or minus 0.5 mil at any point on the reticle line. The deviation can be estimated by comparison with the lettering on the reticle, which is approximately 2 mils high.

(2) Collimation is the adjustment by which the line of sight through the reticle center is made to coincide with the mechanical center axis of the telescope.

(3) A V-block (fig. 25) to fit the cylindrical bearing surface is required for performing the collimation test, but if a V-block is not available the telescope may be secured in the telescope holder of the mount and rotated by means of the reticle rotating worm. In either case, the effect is to permit rotation of the telescope about its mechanical center axis. The V-block is preferable as it eliminates the possibility of error due to misalinement of the telescope holder.

(4) The reticle center point for elbow telescope M24 is the top point of the central vertical line. The reticle center point for elbow telescopes M25 and M26 is the center of the top (zero range) horizontal line. (See fig. 6.)

(5) To test for collimation, direct the reticle center point on a clearly defined distant reference point, and then rotate the telescope

about its mechanical center axis. If the collimation is correct, the reticle center point will not move off the reference point. If collimation is incorrect, the reticle center point will follow a circular path through the reference point. The maximum deviation from the reference point is the collimation error.

(6) The tolerance for collimation error is 0.5 mil. It should be understood that a telescope may be continued in service even if the collimation error is rather large, as the construction of the telescope mount permits adjustment to compensate for this error. However, accurate collimation simplifies procedure when changing telescopes.

c. To correct reticle alinement and collimation.—(1) The reticle is in correct adjustment when the reticle center agrees with the mechanical center of the telescope (collimation), and when, with the telescope in normal operating position, the reticle pattern appears erect (reticle alinement).

(2) The reticle cell, containing the reticle, is supported between a cast shoulder in the telescope body and the reticle cell retaining ring (figs. 23 and 24). This method of support permits rotation of the reticle cell for reticle alinement. The reticle cell is also supported laterally and vertically by four positioning screws which permit shifting the reticle cell for collimation adjustment.

(3) Correct collimation is desirable but, as previously noted, adjustment can be made in the telescope mount to correct for collimation error. Correct reticle alinement, on the other hand, cannot be obtained by any adjustment other than that of the reticle within the telescope. The reticle rotation worm of the telescope mount merely brings the reticle pattern into parallel with the field of view, so that any tilt of the reticle results in a corresponding tilt of the image in the field of view.

(4) To adjust for reticle alinement remove the eyepiece (par. 25*a*), loosen the reticle cell retaining ring locking screw, and back off the reticle cell retaining ring a small amount to allow rotation of the reticle cell. Loosen two of the reticle cell positioning screws (one lateral and one vertical), leaving the other two screws in place if necessary to retain the collimation adjustment. Turn the reticle cell in the required direction, then tighten the reticle cell positioning screws and retaining ring, assemble the eyepiece, and check alinement. To check alinement, place the elbow telescope in a leveled V-block (fig. 25) with the flat locating surface vertical. (The image of an object in the field of view will then appear without tilt unless the Amici prism has been incorrectly assembled.) Compare the horizontal reticle line with a

true horizontal line in the field of view. Repeat the procedure until satisfactory adjustment is obtained.

(5) To adjust for collimation, shift the reticle laterally or vertically by means of the reticle cell positioning screws. Check the reticle centering by turning the telescope in the V-block and noting any deviation of the reticle center point. Repeat the procedure until satisfactory adjustment is obtained.

d. To test focus of eyepiece.—The eyepiece is correctly focused if the reticle pattern is sharp and clear when viewed through the collimating telescope.

e. To correct focus of eyepiece.—(1) The eyepiece focus depends only on the reticle position. Eyepiece focus is correct when the reticle etching is sharp and clear.

(2) To focus the eyepiece, loosen the eyepiece cell locking screw and screw the eyepiece cell in or out to obtain sharpest definition of the reticle pattern. Check results with the collimating telescope. When the best focus has been obtained, tighten the locking screw to retain the adjustment.

f. To test focus of objective.—The objective is correctly focused if there is no parallax between the image and the lines near the center of the reticle when viewing an object at a distance of about 125 yards.

g. To correct focus of objective.—(1) Parallax is due to the fact that the etched side of the reticle is not lying in the focal plane of the objective. This defect can be corrected by focusing the objective to make the focal plane coincide with the reticle etching.

(2) To focus the objective, direct the telescope on an object about 125 yards distant. Remove the objective cell locking screw and screw the objective cell in or out to obtain sharpest definition of the object. Assuming that the eyepiece has been correctly focused, the objective position which provides sharpest definition will also be the position for minimum parallax. Check results with the collimating telescope. When the best focus has been obtained, tighten the locking screw to retain the adjustment.

(3) Always check for parallax any time an optical element has been moved or replaced.

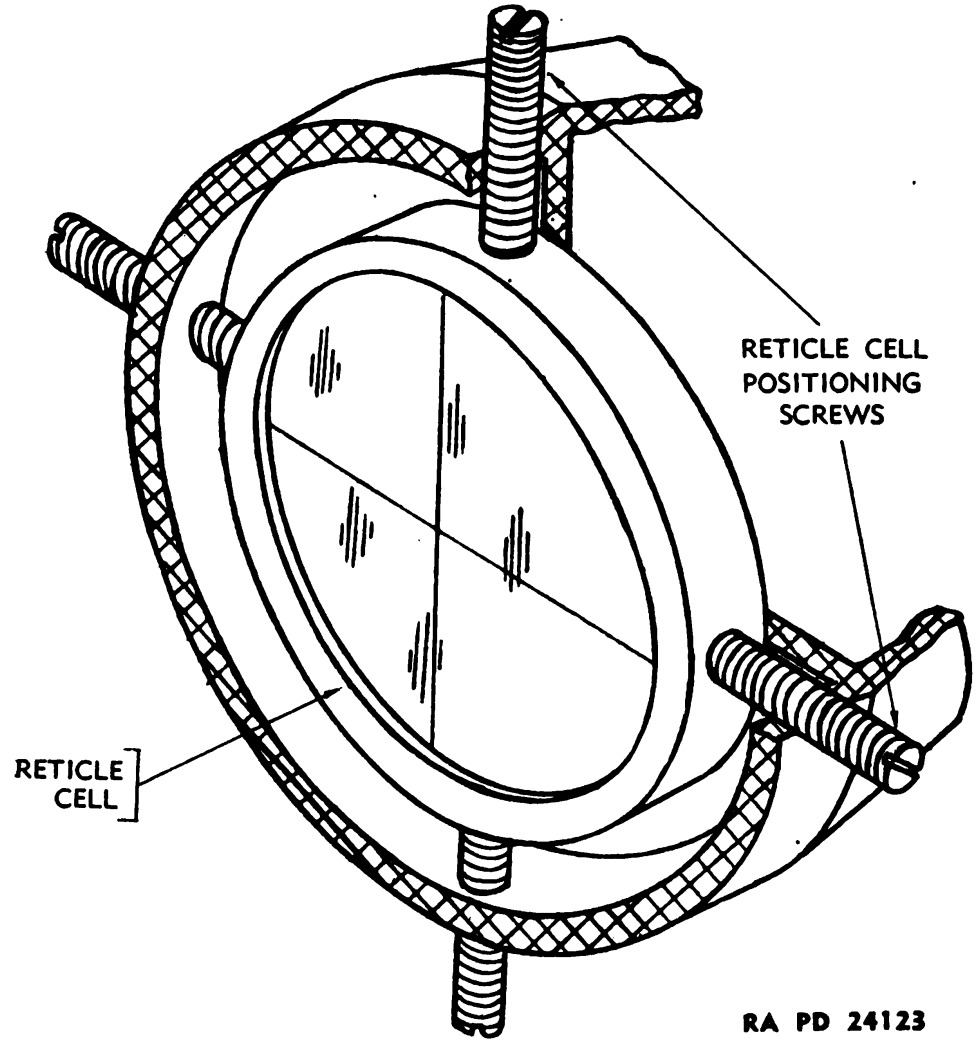


FIGURE 23. Reticle adjustment.

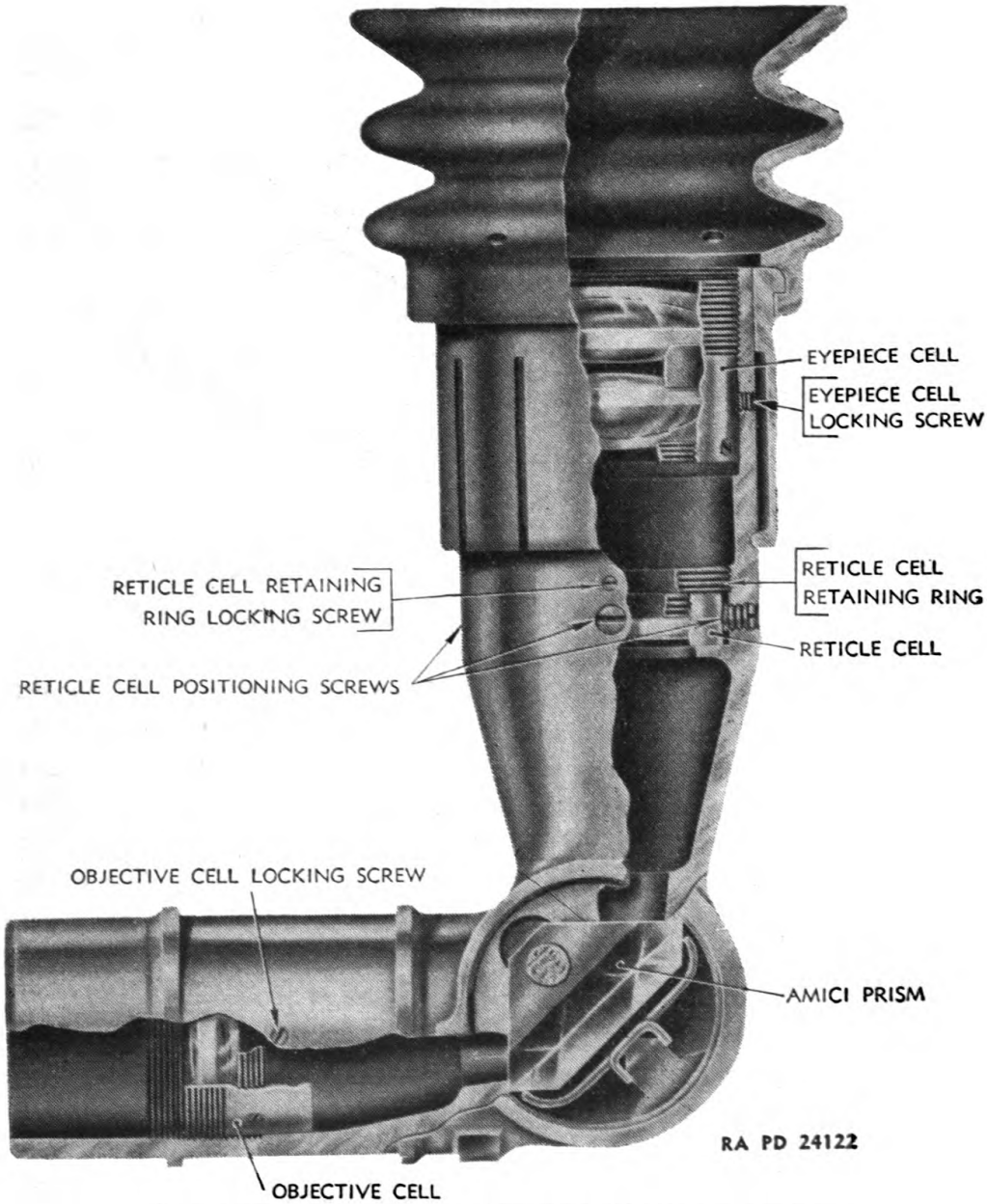


FIGURE 24.—Elbow telescope M24, M25, M26, cut away view.

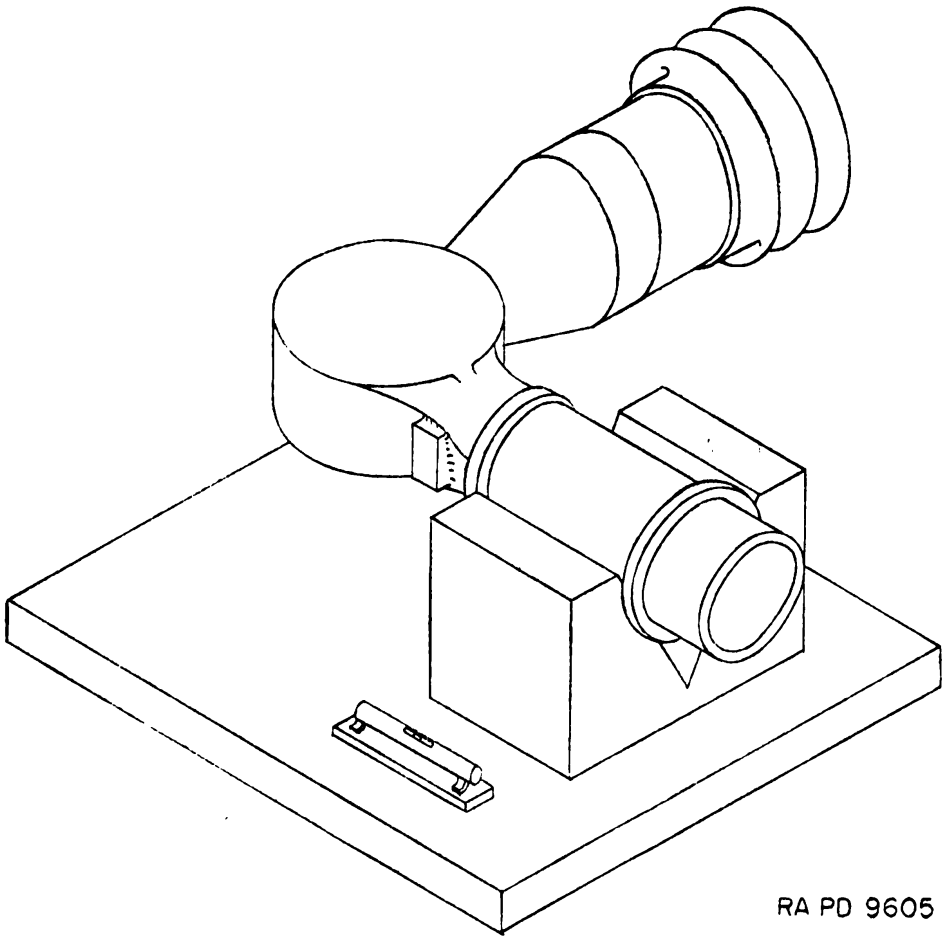


FIGURE 25.—Elbow telescope in V-block.

SECTION VI

DISASSEMBLY AND ASSEMBLY

23. General.—*a.* To preserve the parts of the instrument, it is necessary to exercise care and close attention during disassembly, cleaning, and adjustment. The extent of disassembly for any given repair job is determined by the repairman when he makes his detailed inspection.

b. All optical elements and metal components should be carefully marked or tagged as they are disassembled to insure correct positioning in the instrument on reassembly. If parts are not so marked or tagged, considerable difficulty may be encountered in the final adjustment. Reference marks should be scribed when deemed advisable. An indelible pencil or diamond may be used for marking on *unpolished* surfaces of optical elements. Metal components may be scribed, marked, or tagged.

c. Defective parts should be replaced from stock. Replacement of defective optical elements must be carefully checked inasmuch as replacement of even one optical element may change the optical characteristics of the telescope and render readjustment necessary. Replacement of metal components is easily accomplished since the components are all standardized and available as replacements. Keep in mind, however, that the replacement of certain mechanical components which affect optical dimensions, such as the reticle cell, may cause parallax and affect the final adjustment of the telescope.

24. Disassembly of telescope mounts.—The disassembly procedure outlined below is based on the telescope mount M26 (fig. 26). The procedure for any of the other telescope mounts described is generally the same. Division of the disassembly procedure into four steps is for convenience in performing complete disassembly; partial disassembly may be performed without regard to these steps. Refer to figures showing assembly and sectioned views of the particular telescope mount (figs. 7 to 20).

a. First step (fig. 26 ①).—Remove telescope holder assembly. To do this—

(1) Remove locking screw in retaining plug and unscrew retaining plug.

(2) Drive out the taper pin in the worm collar and slide the collar off the worm shaft. Thread the worm out of its housing.

(3) Remove clamping screw with nut and washer.

(4) Remove telescope holder assembly.

b. Second step (fig. 26 ②).—Remove the elevation worm parts. For telescope mounts M27 and M29 these parts consist of a screw-driver operated worm and a clamping screw similar to the reticle rotation worm parts. For telescope mounts M26 and M28, proceed as follows:

(1) Drive out the taper pin in the worm knob and slide the knob off the worm shaft. Remove the felt washer.

(2) Remove the clamping screw which secures the worm plunger plug. Unscrew the plug and remove plunger and spring underneath.

(3) Remove the clamping screw which secures the ball cap and the dog-point screw which secures the ball socket. Unscrew the ball cap. Thread the worm out of the housing and remove it together with the ball socket.

c. Third step (fig. 26 ③).—(1) Remove the screw which secures the round nut to the elevation gear, and remove the round nut. Slide the elevation worm housing off the gear.

(2) Remove the screw which secures the round nut to the spindle and remove the round nut.

(3) Remove the worm and two clamping screws which secure the spindle to the mounting bracket.

d. Fourth step (fig. 26 ④).—Slide the spindle assembly out of the mounting bracket. An arbor press will be required for performing any further disassembly of the spindle and gear, as these parts are pressed together under force fit in addition to being pinned. If replacement is required, a complete spindle assembly will generally be used.

25. Disassembly of elbow telescopes (figs. 24 and 27).—*a. Disassembly of eyepiece parts.*—(1) Remove the eyeshield adapter by sliding it off the telescope body.

(2) Remove the eyepiece cell locking screw.

(3) Unscrew the eyepiece cell until the threads are clear of the telescope body and then carefully remove the cell.

(4) To remove the reticle, remove the reticle cell retaining ring locking screw and unscrew the reticle cell retaining ring. Loosen the reticle cell positioning screws and then carefully remove the reticle cell.

b. Disassembly of Amici prism.—Remove the prism cover screws and unscrew the prism covers. One side of the prism holder will be

found to contain a slot through which a pointed tool can be inserted into a hole in the wedge underneath. Pull the wedge out through this end of the prism holder, and then lift out the prism holder and Amici prism.

c. Disassembly of objective.—(1) Remove the objective cell locking screw.

(2) Unscrew the objective cell and then carefully remove the cell from the telescope body.

d. Removal of lens from cell.—To remove a lens from its cell, remove the small locking screw in the side of the cell and unscrew the retaining ring. Figure 27 shows the optical elements mounted in their cells.

26. Assembly.—*a.* To assemble, reverse the disassembly procedure. Necessary adjustments are performed as indicated in previous parts of this manual.

b. All parts which have been removed from the instrument should be carefully cleaned before assembly.

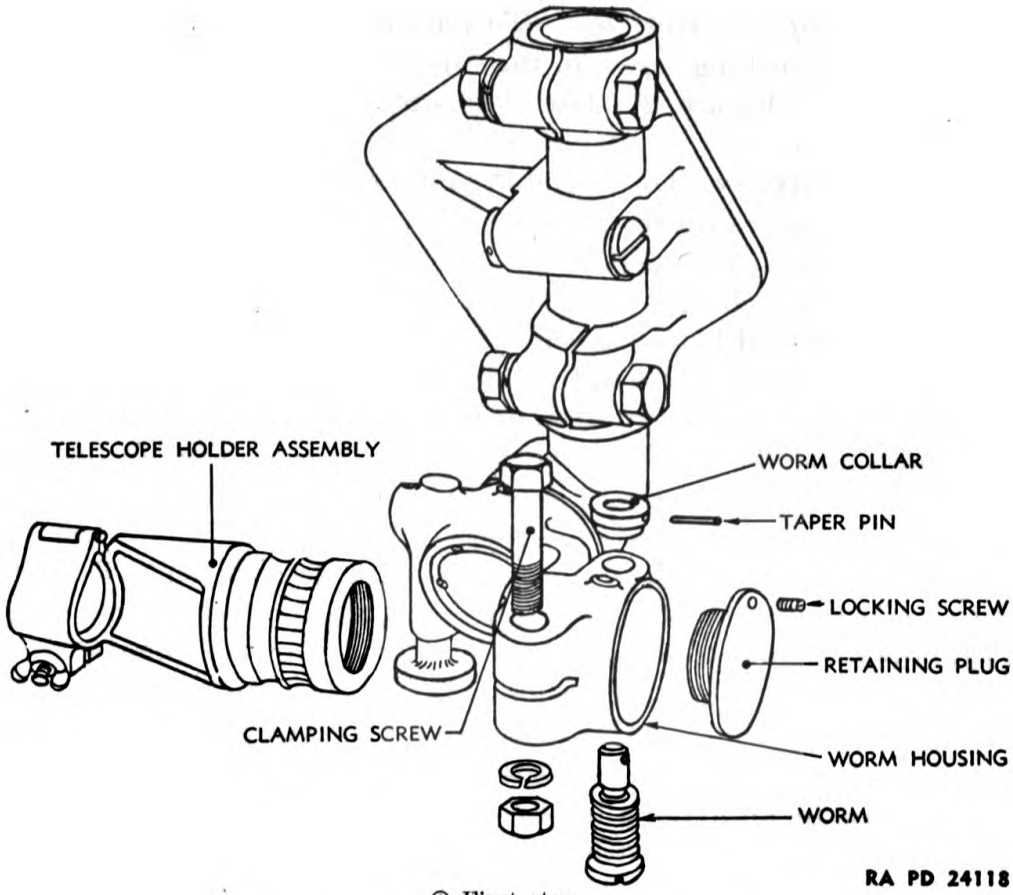
(1) Optical elements should be cleaned with ethyl alcohol. Care must be exercised to prevent alcohol from coming in contact with the edges of compound lenses as the lens cement is soluble in alcohol. If pencil marks have been placed on the unpolished surfaces of lenses or prisms, avoid removing them to prevent difficulty when assembling. Polish the optical element with lens paper. Remove dust and dirt with an air bulb and a small, clean camel's-hair brush.

(2) Metal components should be cleaned in dry-cleaning solvent and quickly dried in air. ***Caution:*** *Do not clean metal components in dry-cleaning solvent when the optical elements have not been removed.* After cleaning, lubricate worms, worm gears, and similar moving parts by applying a light coating of grease.

c. When replacing the eyepiece and objective cells of the elbow telescopes, apply a *very light* film of grease to the threaded part of the cell. The grease film facilitates assembly and is effective in sealing the telescope. There should be just enough grease to make the joint air- and moisture-tight, but not enough to overrun onto the lenses.

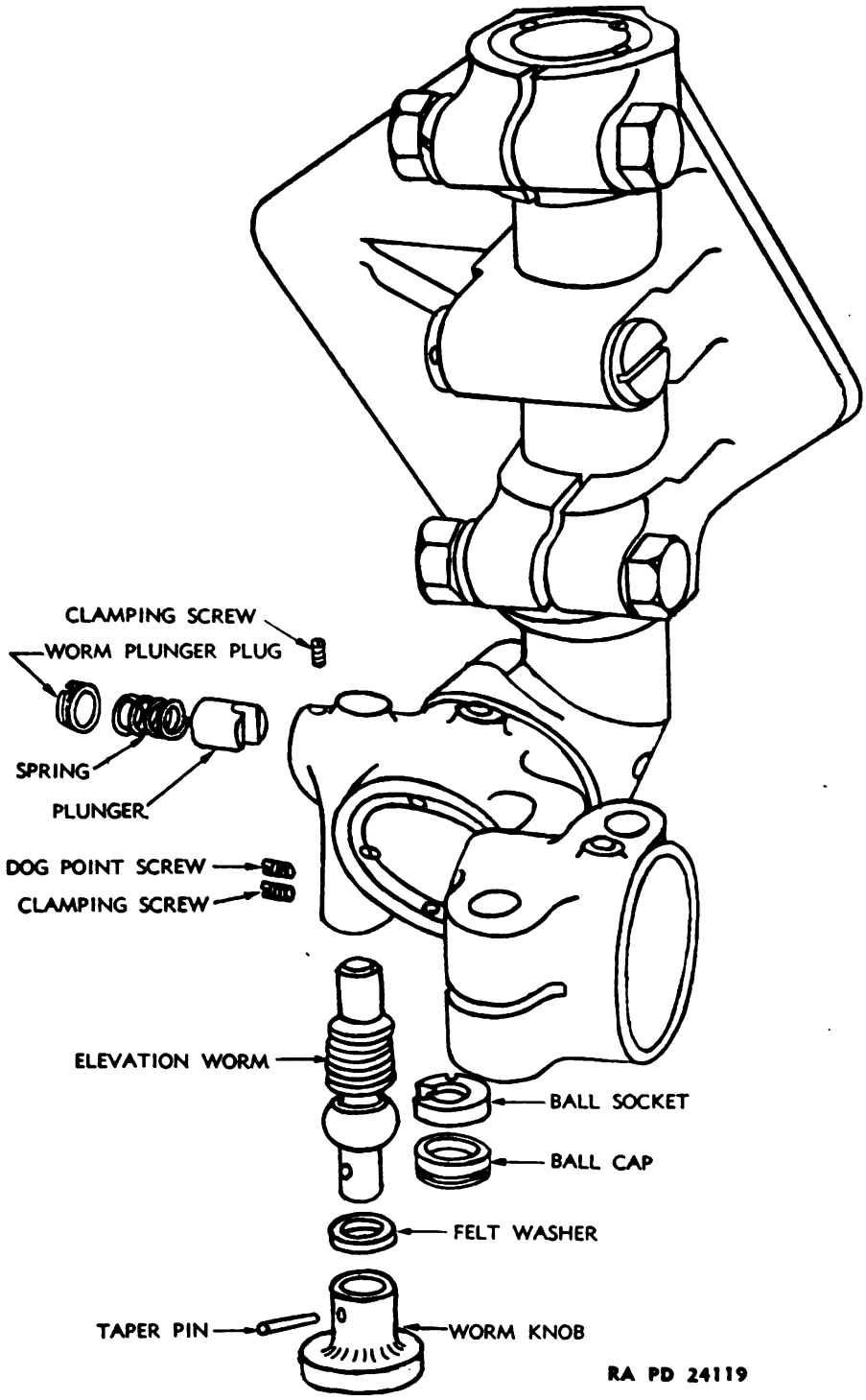
d. Plug the recesses above the various adjusting screws, etc., with plugging cement of the same color as the instrument. Smooth the cement to hide the openings as completely as possible.

e. After assembly and adjustment, the various parts and mechanisms should be again inspected according to the procedure given in section IV.



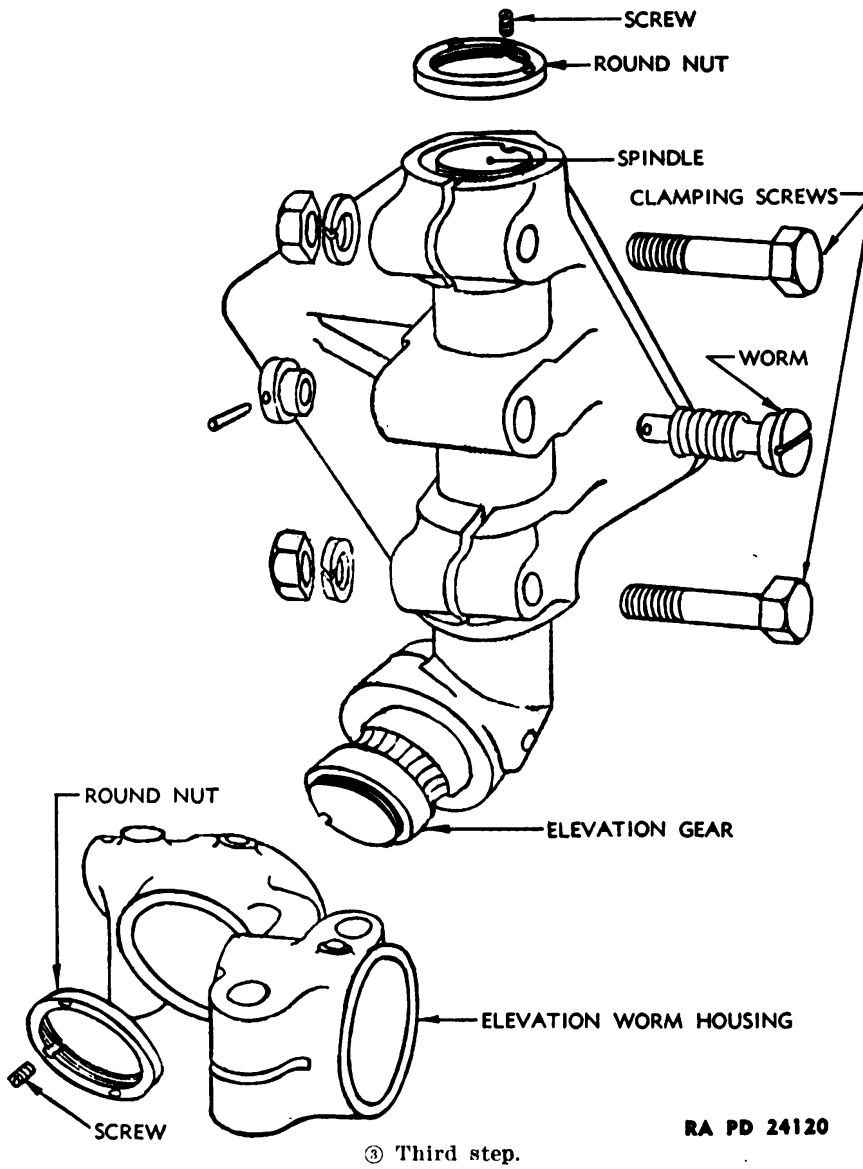
① First step.

FIGURE 26.—Disassembly of telescope mount M26.



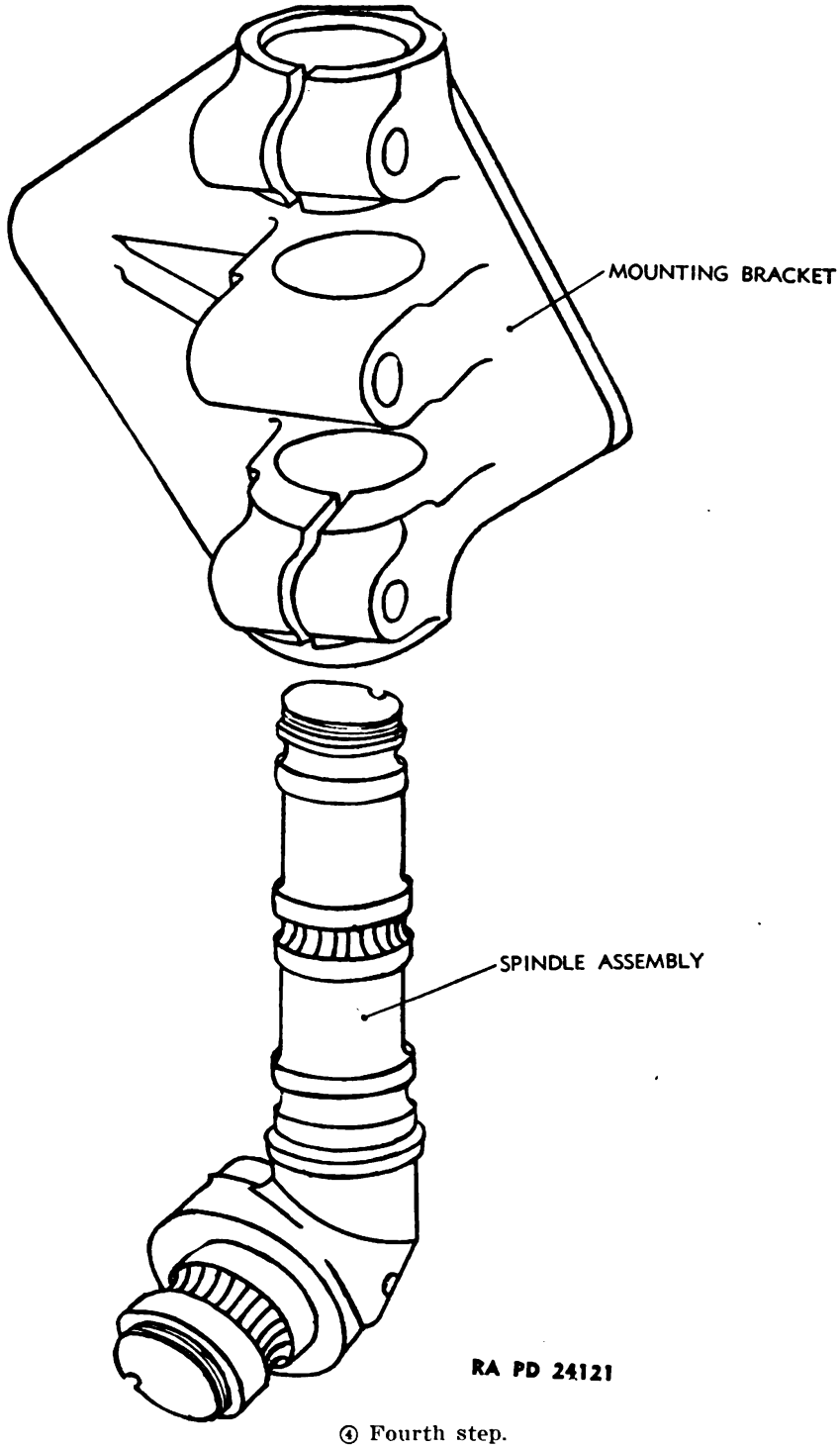
③ Second step.

FIGURE 26.—Disassembly of telescope mount M26—Continued.



③ Third step.

FIGURE 26.—Disassembly of telescope mount M26—Continued.



④ Fourth step.

FIGURE 26.—Disassembly of telescope mount M26—Continued.

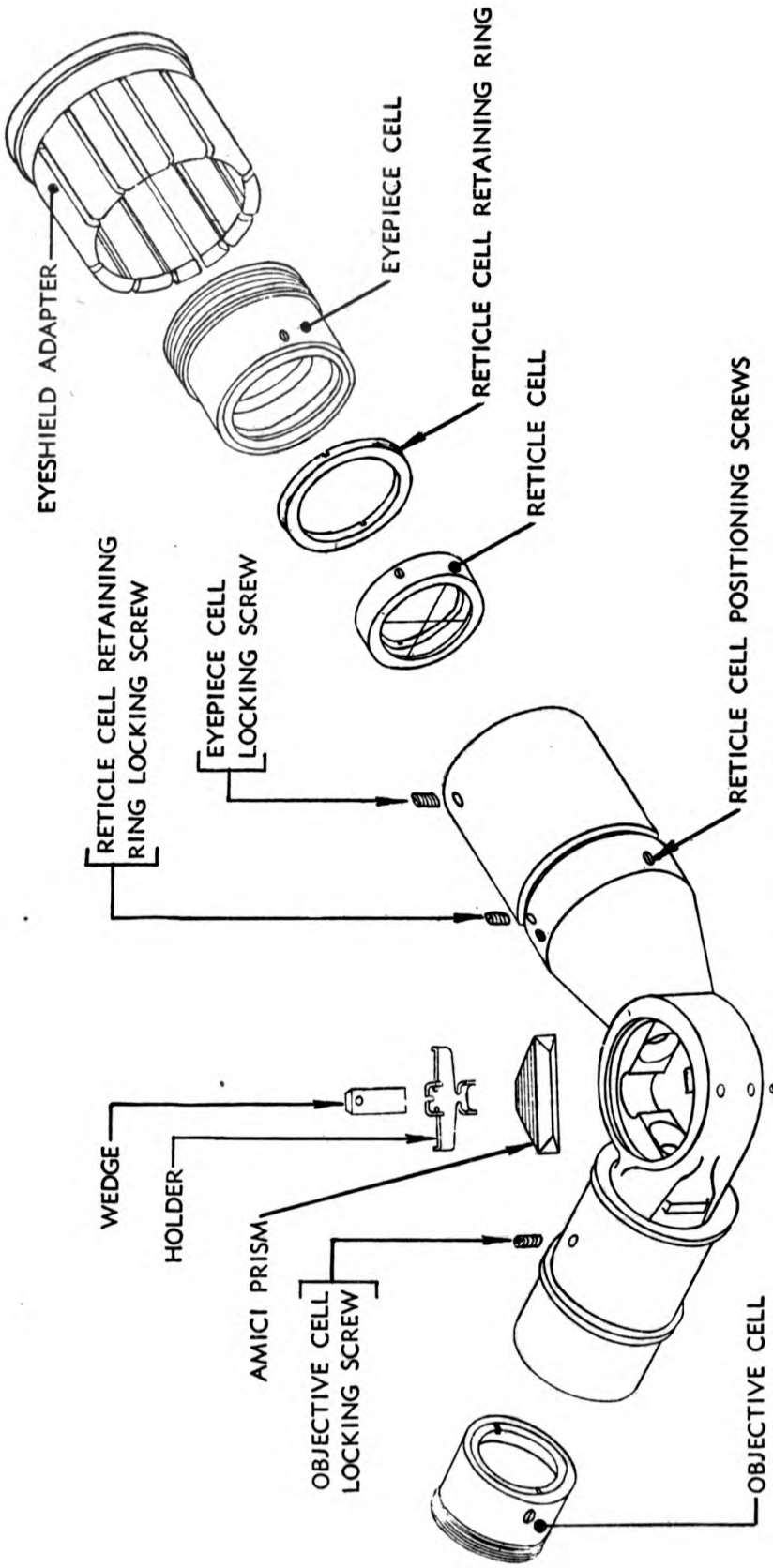


FIGURE 27.—Elbow telescope M24, M25, M26, exploded view.

SECTION VII

PAINTING

27. Touch-up painting.—Small scratches or worn spots, as well as unavoidable blemishes caused by assembly or adjusting operations, should be touched up with an air drying enamel of a practical color match of the original finish.

28. Over-all painting.—*a.* Occasionally, there are received for repair at the arsenals instruments which function improperly because paint has entered bearings and bearing surfaces and has splashed on scales and lenses. The effect of paint on bearing surfaces and in bearings is obvious. The removal of paint from scales and lenses has resulted in the scratching of scales and damage to the lenses.

b. The painting of fire-control instruments by the using service is therefore prohibited.

c. The painting of instruments by ordnance personnel must be supervised by a person who is familiar with the functioning of the instruments and who is in a position to caution against the application of paint to scales, lenses, bearing surfaces, sight seats, etc. The paint to be used depends on the instrument to be serviced.

d. Exterior parts will be universally painted olive-drab.

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APPENDIX

LIST OF REFERENCES

1. Standard Nomenclature Lists.

a. Direct fire sights for 3-inch antiaircraft and 90-mm antiaircraft gun matériel ..... SNL F–224

b. Instrument repair kit ..... SNL F–206

c. Matériel, cleaning and preserving, and tools and equipment used therewith ..... SNL K–1

d. Current Standard Nomenclature Lists are as tabulated here. An up-to-date list of SNL's is maintained as the Ordnance Publications for Supply Index (OPSI).

2. Technical Manuals.

a. Cleaning, preserving, and lubricating materials ..... TM 9–850

b. 3-inch antiaircraft gun matériel (mobile) ..... TM 9–360

c. 90-mm antiaircraft gun matériel M1 and M1A1 ..... TM 9–370

d. Instruction guide, the instrument repairman ..... TM 9–2602

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(For explanation of symbols see FM 21–6.)

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