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OS 9-61
Vol. 3

THE ORDNANCE SCHOOL

ORDNANCE SCHOOL TEXT

FOREIGN MATERIEL

VOLUME 3

PREPARED BY
THE ORDNANCE SCHOOL
ABERDEEN PROVING GROUND, MARYLAND

JULY 1943

NOTE

This publication is a temporary expedient pending the incorporation of the information contained herein in an approved War Department manual.

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Other manuals in this series:

Volume 1

Small-arms (rifles, light and heavy machine guns, submachine guns, and antitank rifles).

Volume 2

Small-arms (aircraft machine guns and cannon), artillery, and automotive materiel.

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Prepared under the direction of
the Commandant, The Ordnance School

Reproduction Plant
The Ordnance School
Aberdeen Proving Ground, Maryland

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FOREIGN MATERIEL

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FOREIGN MATERIEL

CHAPTER 1

GENERAL

1. PURPOSE. - This text is published for use in courses at The Ordnance School.

2. SCOPE. - The equipment covered forms a representative grouping of foreign small arms, artillery weapons and mortars, fire-control equipment, and automotive materiel. The information presented includes a detailed description of each item, together with data on operation, procedures for disassembly and assembly, and, in those cases where basic functions or construction differ, a comparison with the systems employed in similar American materiel.

a. Volume 1 is devoted in its entirety to small arms; volume 2 concludes the study of small arms with data on aircraft machine guns and cannon and continues with data on foreign artillery pieces and automotive materiel. The present volume covers fire-control instruments and sighting equipment.

b. Information on additional items of foreign materiel will be published in subsequent volumes.

3. REFERENCES. - The information incorporated in this text has been obtained from the small-arms, artillery, fire-control, and automotive sections of The Ordnance School. All the materiel discussed has been available to these sections for disassembly and study.

CHAPTER 2

FIRE-CONTROL INSTRUMENTS

SECTION I

GERMAN AIMING CIRCLE, Rkr 31

4. GENERAL. - a. Prior to its capture by Allied forces in North Africa, this instrument was in use as a part of the fire-control system of a German 105-mm howitzer.

b. The abbreviation Rkr denotes richtkreis, the German equivalent of aiming circle; 31 is the model number.

5. USES. - a. The aiming circle, Rkr 31, is employed in the following ways by German military personnel:

(1) To measure angles of azimuth.

(2) To measure angles of site and elevation.
(3) To lay field pieces.
(4) For plane table work.

b. The first three uses closely parallel those of the American aiming circle, M1. The fourth, however, is unique. This adaptation to plane table work eliminates the miscellaneous instruments which otherwise would be employed in making plane table calculations. These features are described more fully in paragraph 13.

6. COMPONENTS AND ACCESSORIES. - a. The assemblies and accessories making up a complete outfit are:

Aiming circle, Rkr 31, and periscope (fig. 2).
  Secondary mount (fig. 1C).
  Night-lighting device (fig. 38).
    Battery container.
    Plug-in lamp.
    Four 3.5-volt bulbs.
  Cleaning cloth.
  Dust brush.
  Impregnated cloth.
Tripod (fig. 12C).
  Carrying case (fig. 12D).

b. Not all of the accessories were present with the instrument examined; the complete list was taken from an inclosure found in the case. The impregnated cloth was not found. Evidently such cloths are intended for decontaminating the instrument of vesicant agents. It is known that items of this nature have often been issued by the German command.

c. The night-lighting device is a "universal" type in that it is adapted for use with various German optical instruments. The device is treated in detail in section V. Similarly, the tripod used with the Rkr 31 is common to certain other pieces of equipment and is described in section II as an accessory of the German battery commander's telescope.

7. OPTICAL CHARACTERISTICS. - a. Components. - Listed progressively, in the order in which they pass light from the target, the optical components of the Rkr 31 are:

Periscope assembly (figs. 2A and 8).
  Window (fig. 8F).
  90° reflecting prism (large) (fig. 8H).
  90° reflecting prism (small) (fig. 8B).

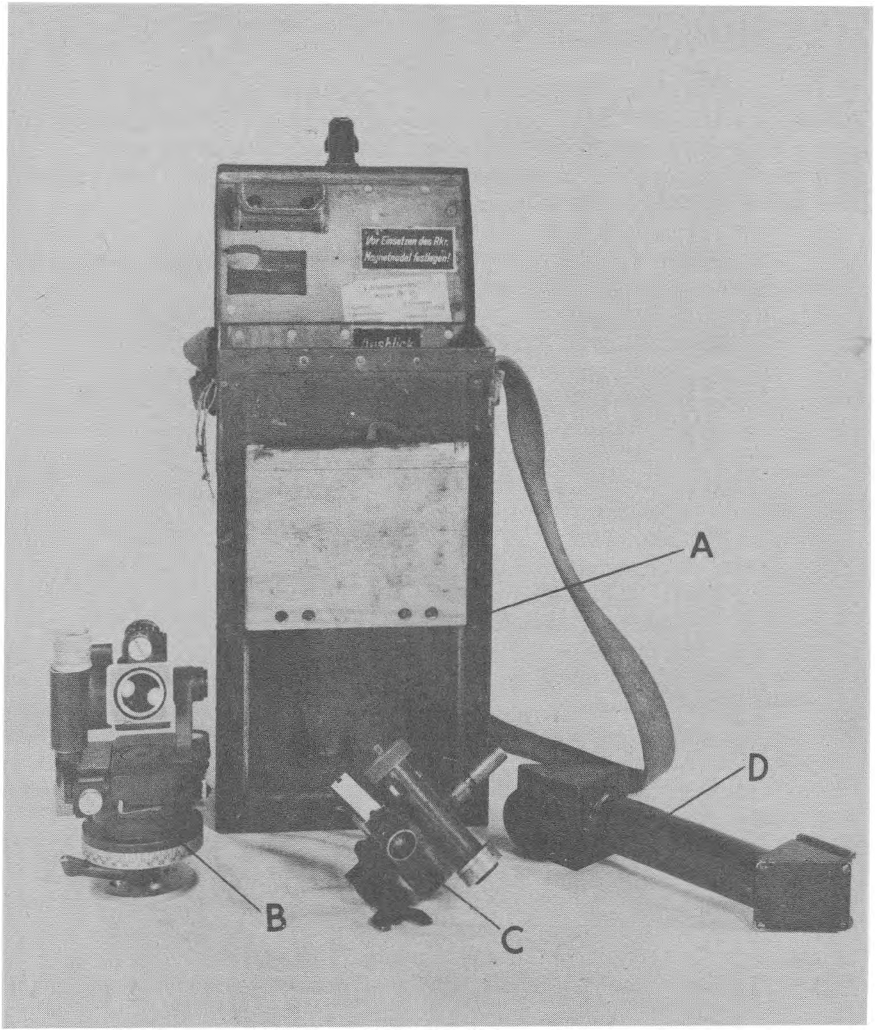


FIGURE 1. - GERMAN AIMING CIRCLE, Rkr 31 - COMPLETE

A. Rkr 31 carrying case
B. Aiming circle proper
C. Secondary mount
D. Periscope

Telescope assembly.
Objective (fig. 7A).
Erecting prism (figs. 7B, 9, and 10).
Reticle (figs. 7C and 11).
Field lens (fig. 7D).
Eye lens (fig. 7E).

b. Design. - The fundamental optical design of the German instrument is similar to that of the American aiming circle, M1, with the exception of the erecting prism. In the American instrument a system of porro prisms is used, whereas in the Rkr 31 the erecting prism is a single optical element, in the shape of a wedge, with the base ground and polished as a roof angle (amici). (See figs. 7B, 9, and 10.)

8. SCALES. - Two scales are present on the German instrument -- one for angle of site (fig. 2B) and another for azimuth (fig. 4D). Both are graduated in mils.

9. ANGLE-OF-SITE MECHANISM. - With the American aiming circle, M1, angles of site may be measured only by means of a vertical mil scale on the reticle. This is so graduated that angles up to 85 mils may be measured either in elevation or depression. In the German instrument, angles of 300 mils of depression and 1,100 mils of elevation are provided for; 300 mils is the conventional normal or level line. The scale on the Rkr 31 which permits the taking of these readings is operated directly off the elevation worm (fig. 2B). The scale on the angle-of-site mechanism has an additional feature — an adjustable indicating arrow, which makes possible small corrections and adjustments of the angle-of-site mechanism.

10. LEVEL VIAL. - On the Rkr 31 the level vial (fig. 5C) is set on an eccentric so that adjustment or replacement may be accomplished with only a screwdriver.

11. AZIMUTH MECHANISM. - The relative position of the azimuth mechanism (fig. 5B) and the underlying principles of operation of the Rkr 31 are the same as those of the American instrument. Special attention should be given the machine work on the German azimuth mechanism. It will be noted that the precision machining of the worm and the eccentric sleeve which fits over the worm insures a minimum of backlash. The simple locking device on the azimuth throw-out lever (fig. 3C) is also worthy of mention. By its use the observer may lock the azimuth mechanism in a disengaged position.

12. COMPASS. - The compass of the German aiming circle is located on the right side of the instrument (figs. 3B and 4B) and may be removed by turning out two screws. The needle of the compass, which

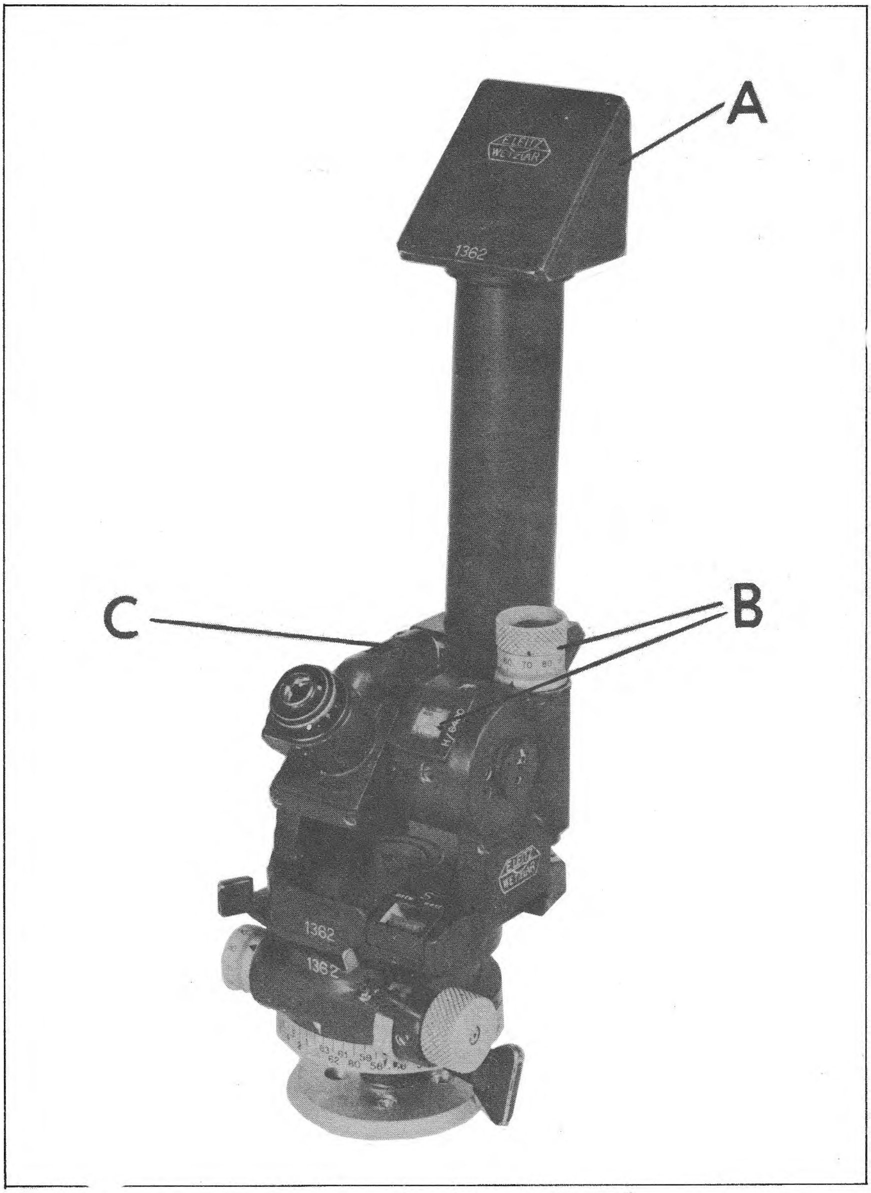


FIGURE 2. - GERMAN AIMING CIRCLE, Rkr 31 - HALF-RIGHT VIEW

A. Periscope
B. Elevating and angle-of-site mechanism
C. Level vial assembly

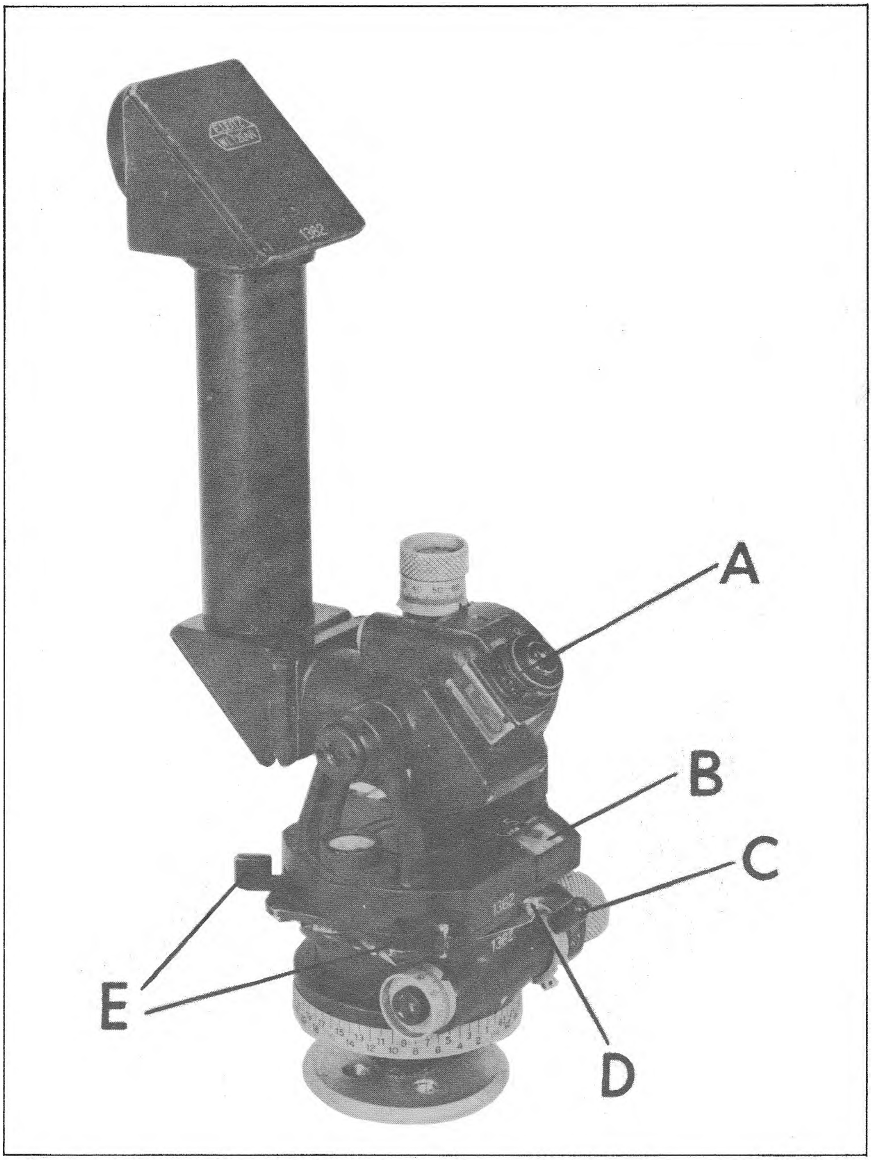


FIGURE 3. - GERMAN AIMING CIRCLE, Rkr 31 - HALF-LEFT VIEW

A. Diopter scale of eye and field lens assembly
B. Compass
C. Azimuth throw-out lever
D. 10-cm scale and straightedge
E. Scissor clamping lever

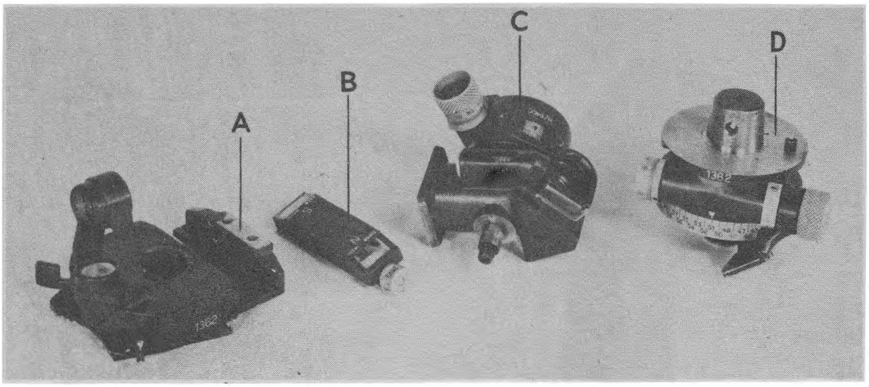


FIGURE 4. - GERMAN AIMING CIRCLE, Rkr 31 - DISASSEMBLED

A. Body frame
B. Compass
C. Elevating and angle-of-site mechanism and telescope
D. Azimuth mount

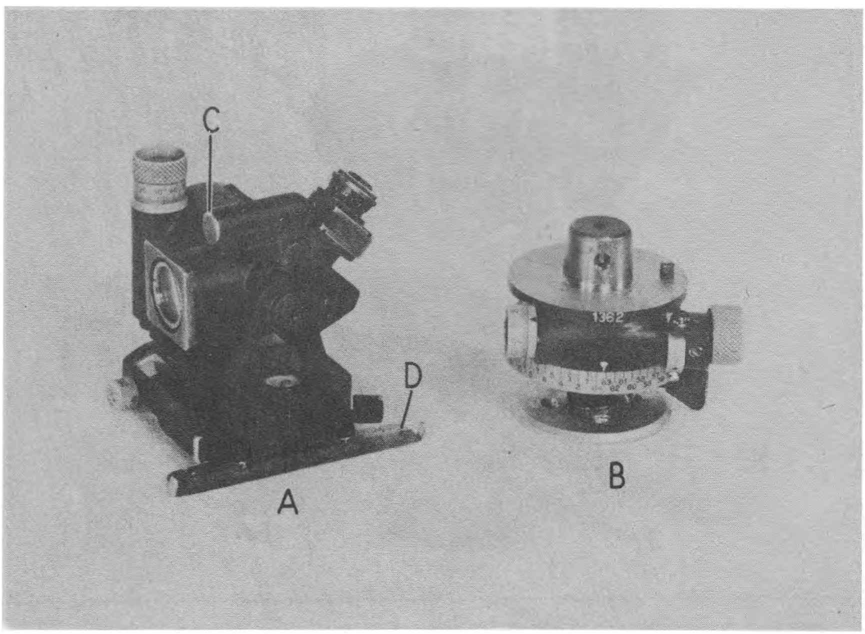


FIGURE 5. -GERMAN AIMING CIRCLE, Rkr 31, AND AZIMUTH MOUNT

A. Aiming circle body
B. Azimuth mount
C. Eccentric adjustment for level vial
D. 10-cm scale and straightedge

can swing through only 28° of arc, may be secured by means of a locking screw at the north end of the compass assembly. Although the compass of the American aiming circle has a greater swinging arc, it is of the same functional design as the German instrument. The Rkr 31 has a small declinator window, which minimizes chances of breakage in the field.

13. BODY (Telescope, elevating mechanism, and compass) (see fig. 4). - On the left side of the Rkr 31 are two scissor clamping levers (fig. 3E). When these clamps are squeezed together the instrument may be broken down into two assemblies -- the azimuth mount and the body (fig. 5). Directly beneath the clamping levers is a small scale, divided into two segments of 5 cm each (fig. 3D). When the instrument is used as an aiming circle, mounted on a tripod, this dual scale is pushed back under the body of the piece. When the body of the Rkr 31 is to be used for plane table work the two 5-cm segments of the scale are so positioned that they may be used as a 10-cm straightedge (fig. 5D). The body of the instrument is so constructed that it may be removed from the tripod for plane table use without changing the azimuth scale.

14. PERISCOPE. - When the Rkr 31 is in use as an aiming circle, the observer has the added protection of a periscope attachment (figs. 1D, 2A, and 8), which is supplied as a standard accessory. Optically the periscope is of orthodox design and is so arranged that it slides into position directly in front of the objective. This provision of an easily attached or removed accessory periscope is of extreme value to the user. It facilitates camouflage, affords maximum protection for the observer, and permits the use of the instrument in sectors of the combat zone which might otherwise be denied to it.

15. DISASSEMBLY. - With the aid of a single special tool, disassembly of the Rkr 31 is a matter easily within the province of an experienced instrument repairman. Other than the one tool noted, which is used to remove the eccentric objective housing assembly, all of the necessary equipment is present in the American instrument repairman's tool kit.

16. ADJUSTMENT. - a. The eye and field lens assembly and the reticle are set at the factory. However, in the event these have to be cleaned, the lenses are so set that they may be returned to their original position with a minimum of labor. The diopter setting can be changed only if machine work is performed on the assembly.

b. The objective housing, as already noted, is of eccentric design, so that the horizontal reticle line may be superimposed on the established level line of the target.

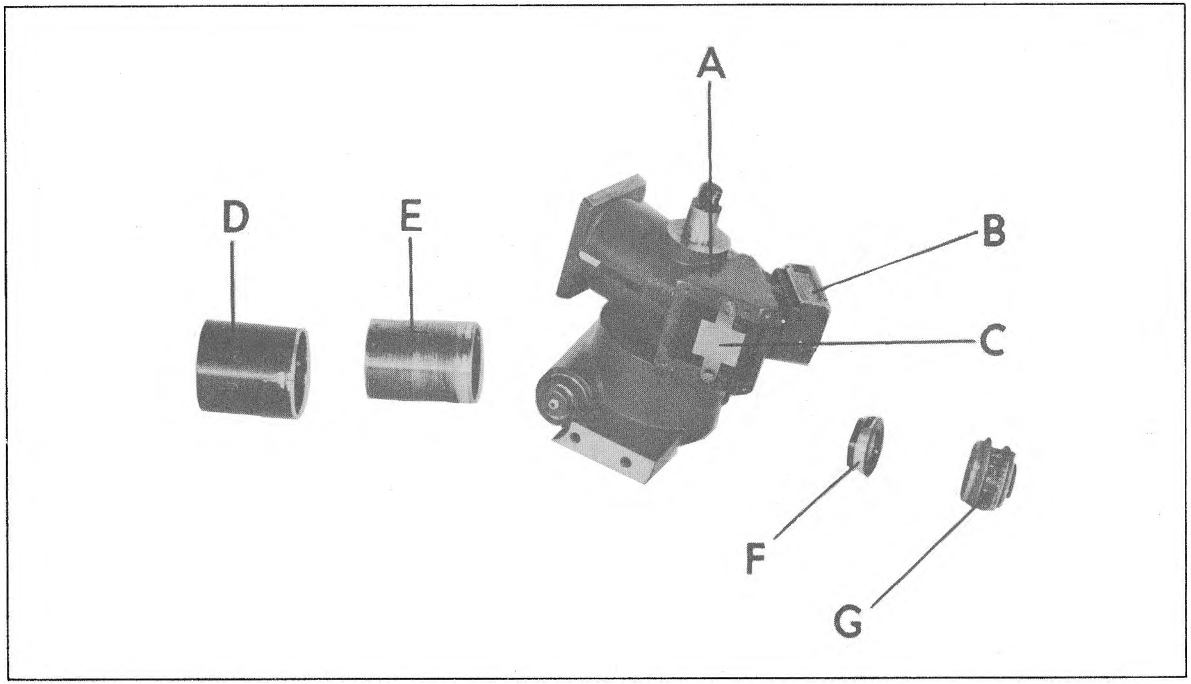


FIGURE 6. - ELEVATING AND ANGLE-OF-SITE MECHANISM AND TELESCOPE - DISASSEMBLED

A. Elevating and angle-of-site mechanism and telescope
B. Window for night-lighting device
C. Erecting prism housing
D. Objective sunshade
E. Eccentric objective retaining cell
F. Reticle and reticle cell
G. Eye and field lens assembly

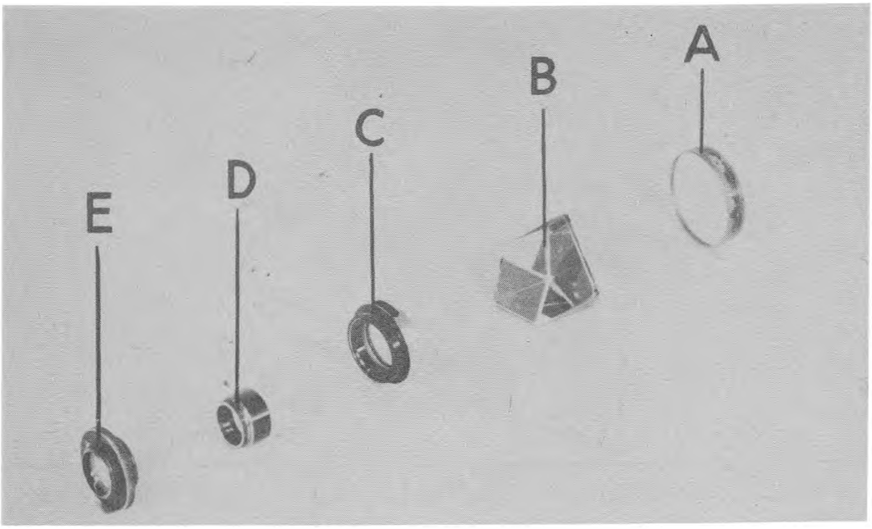


FIGURE 7. - TELESCOPE ASSEMBLY

A. Objective
B. Erecting prism
C. Reticle and reticle cell
D. Field lens and cell
E. Eye lens and cell

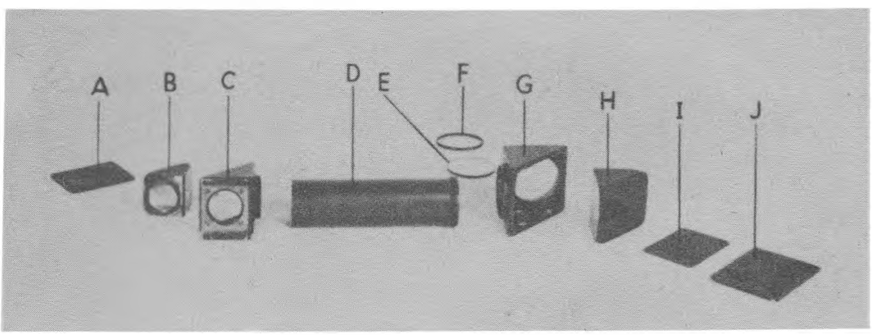


FIGURE 8. - PERISCOPE ASSEMBLY

A. Cover plate, 90° reflecting prism (small)
B. 90° reflecting prism (small)
C. 90° reflecting prism (small) housing
D. Body
E. Retaining ring
F. Window
G. 90° reflecting prism (large) housing
H. 90° reflecting prism (large)
I . Spring plate
J . 90° reflecting prism (large) cover plate

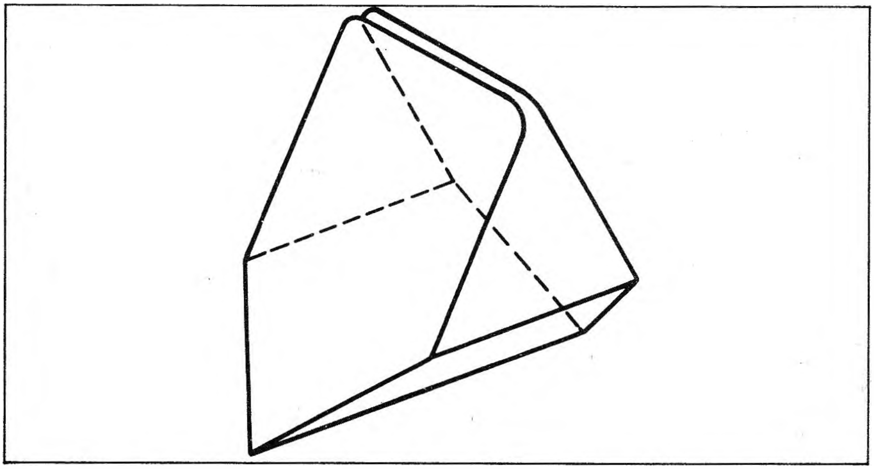


FIGURE 9. - GERMAN AIMING CIRCLE, Rkr 31 - ERECTING PRISM

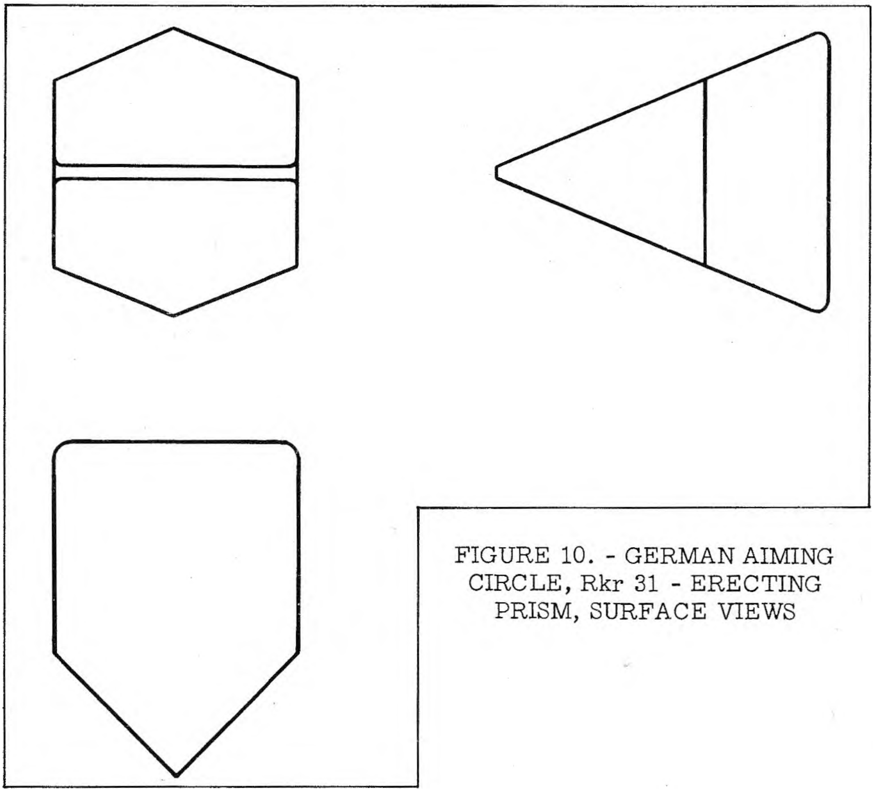


FIGURE 10. - GERMAN AIMING CIRCLE, Rkr 31 - ERECTING PRISM, SURFACE VIEWS

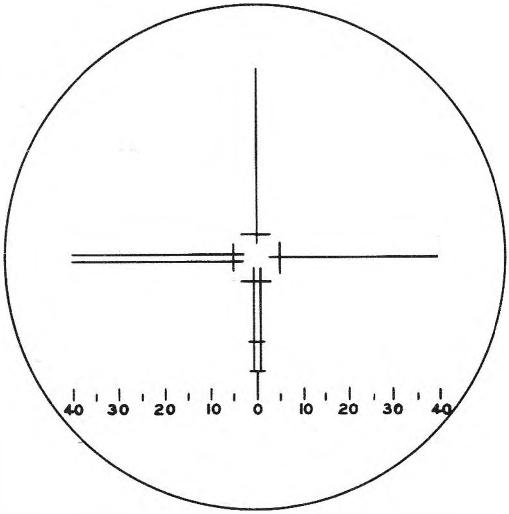


FIGURE 11. - GERMAN AIMING CIRCLE, Rkr 31 - RETICLE

17. COMMENT. - a. Although no interchangeability of parts is possible between this instrument and the American equivalent, the Rkr 31 may readily be used by United States troops in the combat zone, since the principles of operation of this and the American M1 are the same.

b. The magnification of the German instrument, approximately 4.5, is not more than 1 power greater than that of the American aiming circle, M1.

SECTION II

GERMAN STEREOSCOPIC TELESCOPE, B.C. TYPE

18. GENERAL. - a. The information contained in this section has been compiled from examination of an instrument captured in the African theater of war.

b. This "scissors type" observation telescope (scherenfernrohr) ıe equivalent of the American battery commander's telescope.

19. USES. - a. The stereoscopic observation telescope is employed for the following purposes in the German Army:

(1) Observation and reconnaisance.
(2) To measure angles of azimuth.
(3) To measure angles of site and elevation.
(4) To measure height of shell bursts.
(5) To establish safety zone for advancing friendly troops.
(6) To lay field pieces.

b. These uses were obtained from a German manual, Der artillerist, (1) Der Kanonier, 1940, and checked by visual inspection. It is obvious that the German instrument is employed in generally the same manner as the American battery commander's telescopes M1915, M1915A1, and M1917.

20. COMPONENTS AND ACCESSORIES. - The elements making up a complete outfit are:

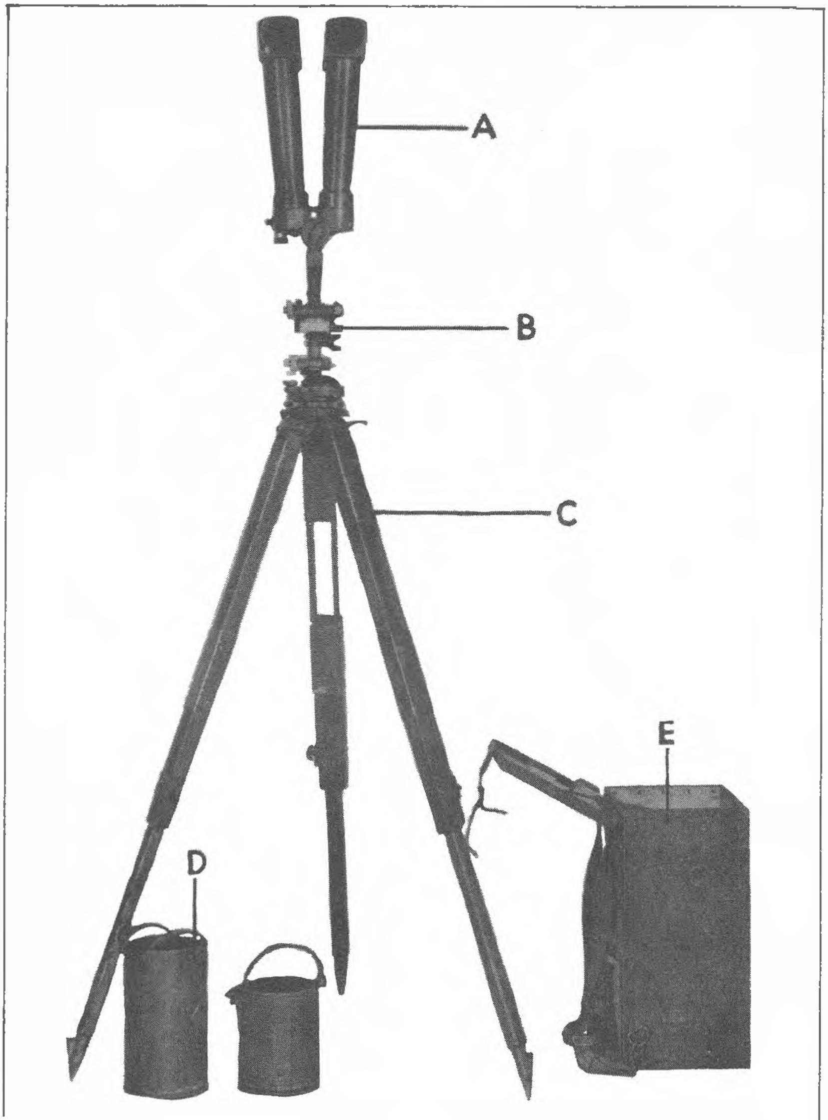


FIGURE 12. - GERMAN STEREOSCOPIC TELESCOPE, B.C. TYPE - FRONT VIEW

A. Telescope, B.C.
B. Azimuth mount
C. Tripod
D. Carrying case for tripod
E. Carrying case for telescope and azimuth mount

FIGURE 13. - TRIPOD AND MOUNTS FOR TELESCOPE, B.C.

A. Orienting mounts B. Eccentric cross-leveling mount

Telescope, B.C. type (fig. 12A).
- Instrument carrying case (fig. 12E).
- Azimuth mount (fig. 12B).
- Night-lighting device (fig. 38).
  - Container for battery.
  - Hand lamp.
  - Plug-in lamp.
  - Double distributor.
  - Four 3.5-volt bulbs
- Eye guard.
- Two rain-protector tubes.
- Two light filters.
- Two dark filters.
- Cleaning cloth.
- Dust brush.
- Impregnated cloth (see par. 6b).

Tripod (fig. 12C).
- Carrying case (fig. 12D).

21. TELESCOPE ASSEMBLY. - The German B.C. type telescope is made up of three main assemblies:

a. Telescope proper (fig. 12A).
b. Angle-of-site mechanism (fig. 14B).
c. Elevating mechanism.

22. DESIGN. - The basic optical and mechanical design of the German B.C. telescope, with the exception of the erecting system, is similar to that of the American battery commander's instruments M1915 and M1915A1. Both the German and American instruments are of binocular type, consisting of two telescopes joined by a hinge assembly. This permits use either vertically (fig. 12), for periscopic observation, or horizontally, for maximum stereoscopic effect (fig. 14). The magnification is approximately 10.

23. OPTICAL SYSTEM. - The optical components of the German instrument, in the order in which light enters from the target, are:

a. 90° reflecting prism.

b. Objective lens.

c. Erecting system, consisting of a protruding roof-angle (amici) prism and a small right-angle prism (figs. 18A and 20). These elements of the erecting system are separated by two small shims, approximately .003 inch thick. The prisms are mounted permanently in an aluminum housing, and no attempt should be made to remove them. However, the

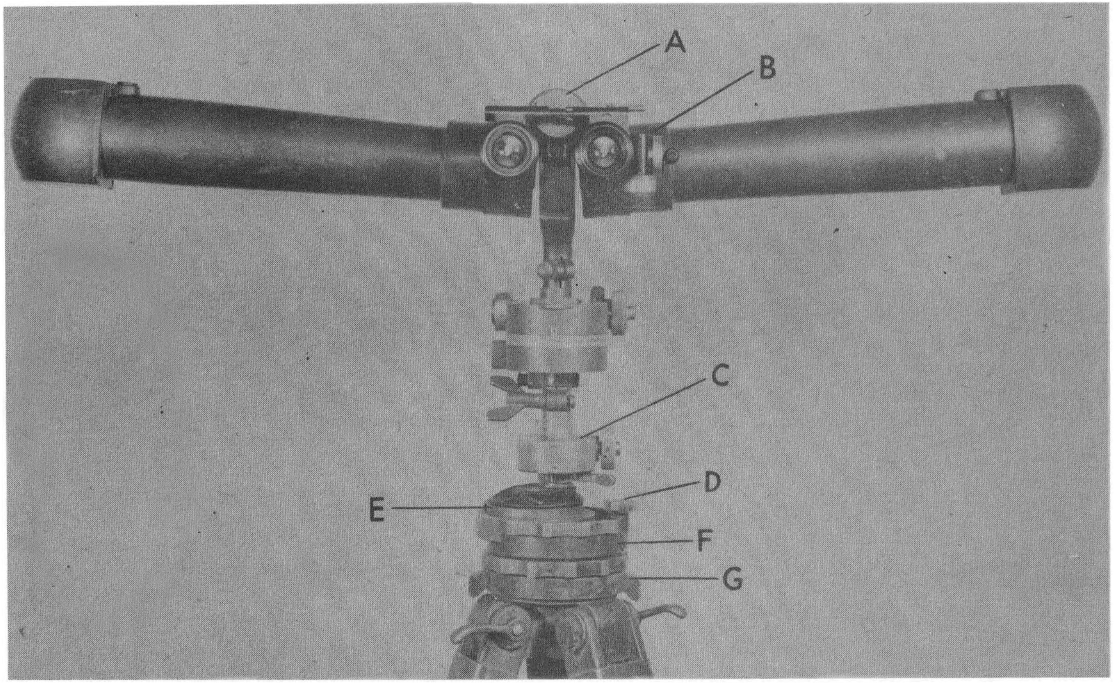


FIGURE 14. - TELESCOPE, B.C. - HORIZONTAL POSITION

A. Interocular scale
B. Angle-of-site mechanism
C. Orienting mount
D. Locking knob
E. Upper motion ring
F. Lower motion ring
G. Locking ring for lower motion

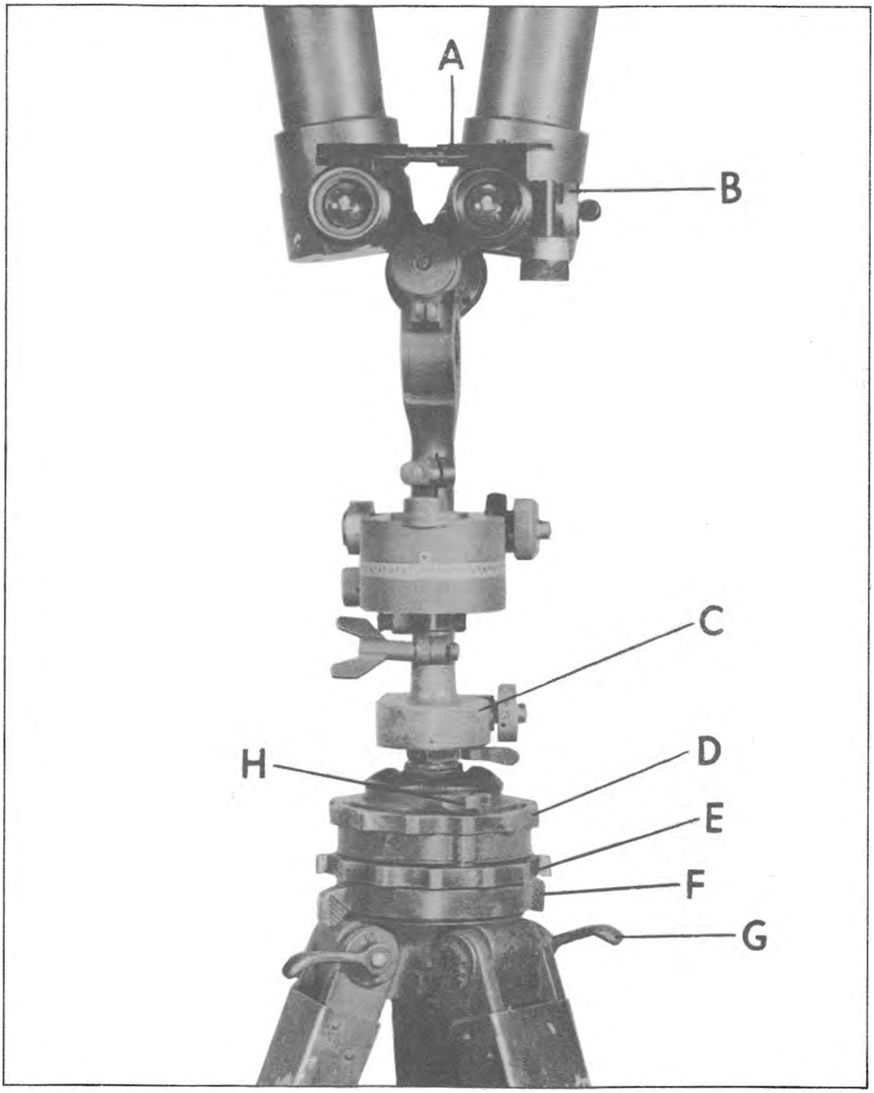


FIGURE 15. - TELESCOPE, B.C., ON MOUNT AND TRIPOD - VERTICAL POSITION

A. Interocular scale
B. Angle-of-site mechanism
C. Orienting mechanism
D. Upper motion ring
E. Lower motion ring
F. Locking ring for lower motion
G. Locking clamp arm
H. Locking knob

entire housing, with the prisms in place, may be removed during disassembly.

d. Reticle (fig. 19).

e. Eye and field lens.

24. EYEPIECE ASSEMBLY. - a. The two eyepiece assemblies are attached to the right and left eyepieces by an adapter, and the fixed end of the adapter is held to the body of the telescope by four screws (fig. 16). The other end of the adapter is a sleeve arrangement which will rotate within the eyepiece assembly. With this arrangement the two eyepiece assemblies, to which are attached the angle-of-site mechanism and interocular scale, will remain in the same position regardless of the angle of the telescope bodies.

b. The optical elements of the eyepiece assemblies of the German instrument are similar to those employed in the American B.C. telescope, in that the conventional two-element eye and field lens system is used.

c. The eyepieces may be focused independently for each eye, and a diopter scale is provided for rapid adjustment. This is graduated from +5 to -5; 0 is the normal setting.

25. INTERPUPILLARY SCALE. - Varying interpupillary distances are compensated for by means of a graduated rod fixed to the top of the left eyepiece assembly and sliding in a sleeve fixed to the top of the right eyepiece assembly. This interpupillary or interocular rod is graduated from 50 to 75 mm; normal setting is 64 mm (see figs. 14A, 15A, and 16A).

26. RETICLE. - a. Since the reticle, which is located in the optical system of the right telescope, is an integral part of the eyepiece assembly, it is in an erect position regardless of the angle of the telescope bodies.

b. The pattern etched on the reticle is a block design (fig. 19), with the sides of the blocks in the form of dashes. The intersection of each block is evaluated in multiples of ten, depending upon its relative position from the center of the reticle, which serves as the zero point. This zero point is the optical axis of the telescope.

27. ANGLE-OF-SITE MECHANISM. - a. The angle-of-site mechanism is mounted on the right side of the right eyepiece assembly (figs. 16B and 18D). The angle-of-site scale is graduated from 0 to 1,300 mils, with a normal or level line of 300 mils. This main scale on the housing of the angle-of-site mechanism is supplemented by a micrometer scale, graduated from 0 to 100 mils, on which multiples of ten are indicated by

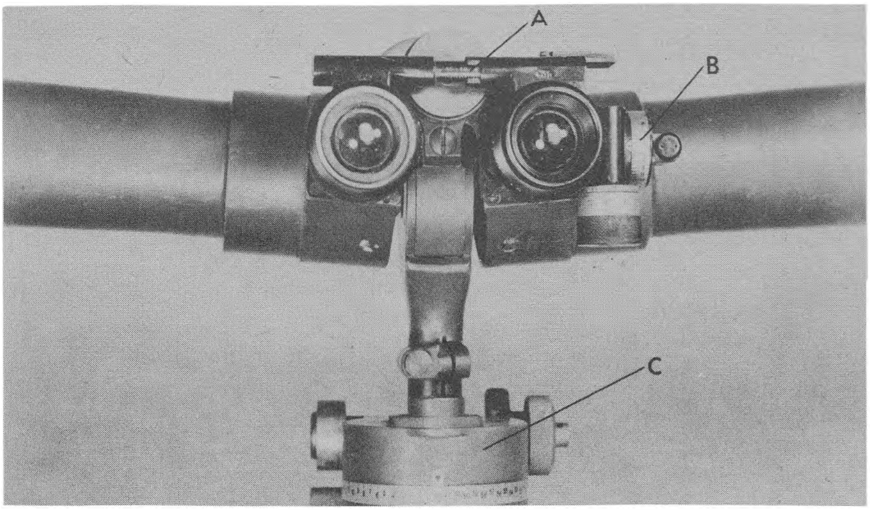


FIGURE 16. - TELESCOPE, B.C., ON AZIMUTH MOUNT - CLOSE-UP VIEW

A. Interocular scale
B. Angle-of-site mechanism
C. Azimuth mount

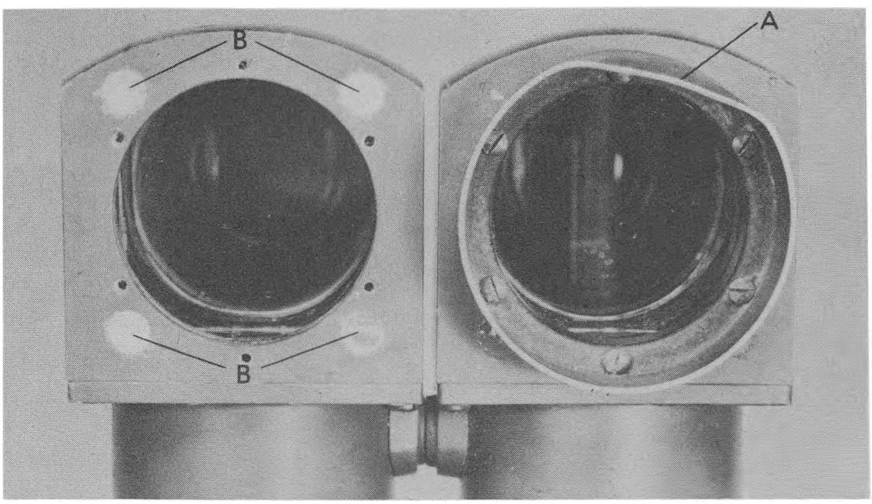


FIGURE 17. - TELESCOPE, B.C. - OBJECTIVE WINDOWS

A. Protective ring and adapter
B. Adjusting screws for 90° reflecting prism

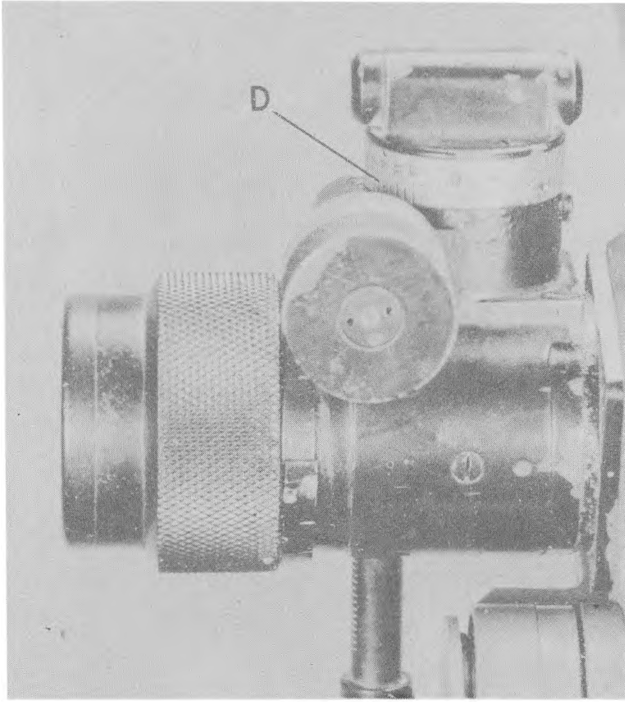
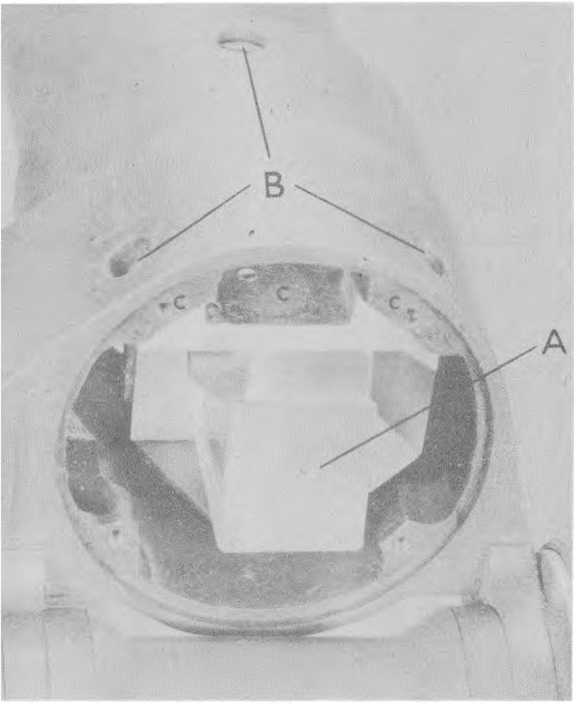


FIGURE 18. - TELESCOPE, B.C

A. Prism erecting system
B. Adjusting screws for erecting system



. - PRISM ERECTING SYSTEM

C. Shelf for prism erecting system

D. Angle-of-site mechanism

Arabic numerals. The combination of main scale and micrometer makes it possible for an observer to set off any whole number between 0 and 1,300

b. This German instrument may be used to measure angle of site up to 1,000 mils in elevation, or approximately 56°.

28. ELEVATING MECHANISM. - The elevating mechanism consists essentially of a worm wheel and worm. Actuating the worm causes the worm-wheel housing and telescope to move in an arc about the axis supplied by the worm wheel. The elevating mechanism has no scales.

29. ADJUSTMENT. - a. All collimating and adjusting of the German instrument may be done externally, without breaking the main seal.

b. The 90° prisms are adjusted by means of four easily reached external screws (fig. 17B). Similarly the erecting system is controlled by three readily available outside screws (fig. 18B). Either of the eyepiece assemblies may be removed as a unit by turning out four screws (fig. 16).

30. TRIPOD. - a. Assembled to the tripod are two permanent mounts (figs. 14 and 15). The lower of these is an eccentric cross-leveling device (fig. 13B), on the spindle of which is an orienting mount (fig. 14C).

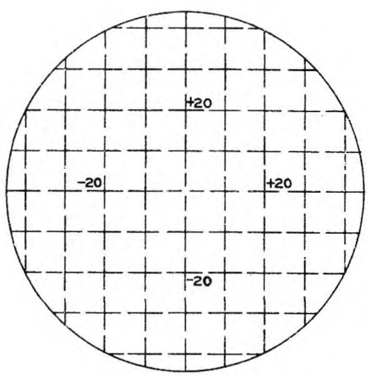


FIGURE 19. - GERMAN B.C. TELESCOPE - RETICLE

b. The eccentric cross-leveling mount has two motions, the lower of which (fig. 14F) is rotary, or circular. The size of the imaginary circle it will describe is governed by an upper motion (fig. 14E) which is in a straight line and controls the diameter of the rotary motion (figs. 14 and 15).

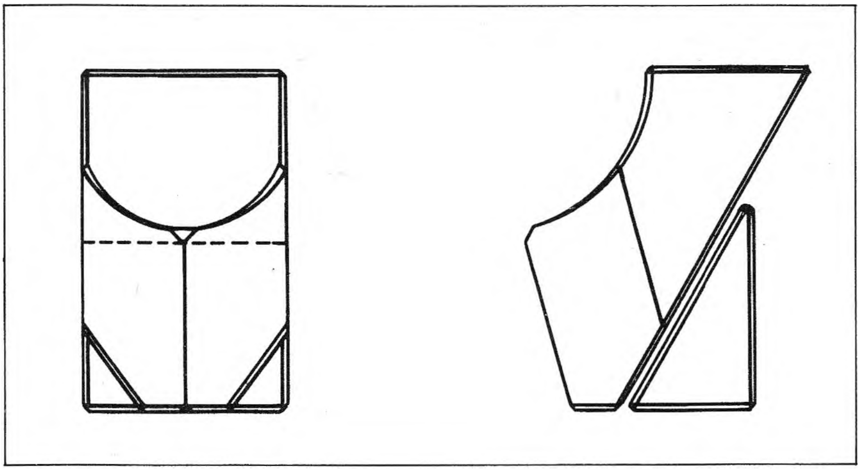


FIGURE 20. - GERMAN B.C. TELESCOPE - ERECTING PRISM

c. The tripod proper is of wood, finished with metal fittings, and extremely sturdy. The carrying case (fig. 12D) is made up of two cylindrical covers, one for the mount and the other to hold the tripod legs together. The covers themselves are joined by leather straps.

d. This tripod is the standard field artillery type of the German Army and is used with both the German telescope, B.C. type, and the aiming circle, Rkr 31.

SECTION III

GERMAN RANGE FINDER, EM 34, 70-CM BASE, COINCIDENCE INSERT-IMAGE TYPE

31. GENERAL. - a. The instruments described and illustrated,

serial numbers 9608 and 276808, were captured in the African theater of operations. Though manufactured by at least two other concerns, the Busch Company, of Rathenow, Germany, and the Hensoldt Company, the design is a readily recognizable Carl Zeiss pattern. Proper nomenclature is "Entfernungsmesser No. 34," generally abbreviated to EM 34.

b. The EM 34 is a coincidence range finder with insert-image type field of view. In the German Army these instruments are used by machine-gun squads, mortar crews, and airborne troops for obtaining the range of ground targets. They are also used with 7.92-mm German light machine guns of the 34 and 42 series when employed against aircraft. The EM 34 appears adaptable to use by any unit with an effective firing range not greater than 10,000 meters (10,936 yards).

32. DATA. -

Base length of instrument ------------------	centimeters	70
	inches	27.56
Magnification ------------------------------	diameters	11
Range ---------------------------------------	meters	200-10,000
	yards	219-10,936
Width of field of view at 1,000 meters -----------	meters	62
1,093 yards --------------	yards	67.75
Approximate weight of instrument (excluding accessories) --------------------------------	pounds	10

33. USE OF CAPTURED EM 34's. - a. An American soldier trained in the use of the range finders standard with our forces may readily use a captured EM 34 in an emergency. There are a few minor points to keep in mind.

(1) The range scale of the EM 34 is read directly from the field of view (fig. 23). To illuminate this scale when natural light is insufficient, a small light should be placed at the range-scale illuminating window.

(2) The eyepiece has a removable eye-guard arrangement (fig. 28) which permits use of the EM 34 while the observer is wearing a gas mask.

(3) For antiaircraft fire the range-taker sets the range scale for the effective firing range. Then, if the target is at a greater height, the upper, inverted image will be to the right of the lower, upright one (fig. 23A). When the two images are in coincidence (fig. 23B), the target is within effective firing range. Up to the point of coincidence the upper image moves from right to left; after it passes out of coincidence it moves back from left to right. When the upper image is back to the right of the lower, the target is again out of effective range.

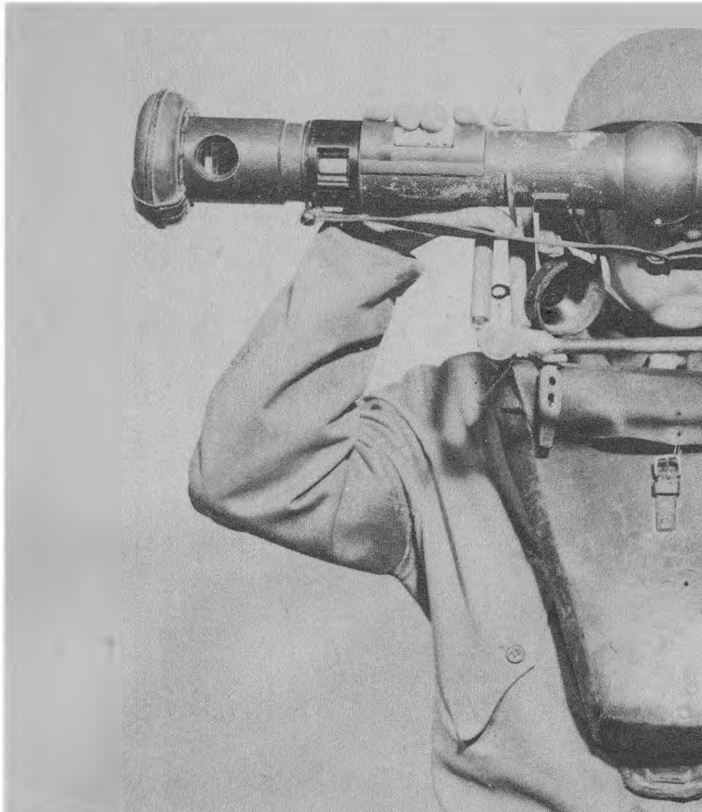


FIGURE 21. - EM 34 WITH CARL ZEISS SH

HOULDER HARNESS - FRONT VIEW

FIGURE 22. - POSITION OF EM 34 WITH CARL ZEISS SHOULDER HARNESS WHEN SIGHTING AIRCRAFT TARGET

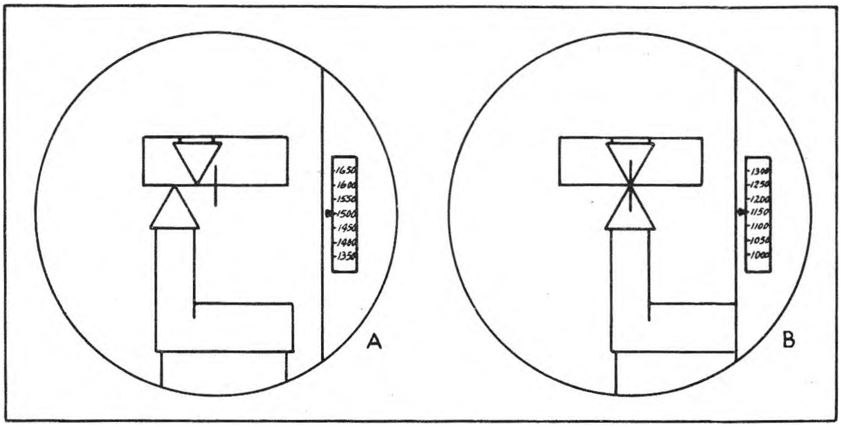


FIGURE 23. - FIELD OF VIEW OF EM 34

b. It must be remembered that all readings are in meters and that the maximum range at which reasonably accurate readings may be expected is 10,000 meters (10,936 yards).

34. USING-ARM ADJUSTMENTS. - a. First-echelon adjustment of the correction wedge is accomplished by means of a correction-wedge roller, which is covered by a revolving protection ring. Covered also by the same revolving ring is a halving correction roller.

b. The following instructions are inscribed on the revolving protection rings (figs. 24A and 25):

(1) "Berichtigung der Entfernung" - correction for distance. This is equivalent to coincidence correction of the American instrument by using troops.

(2) "Nur in Stellung 'Zu' sperren u. Offnen" - lock and open only in "closed" position.

(3) "Sperren" - lock.

(4) "Zu" - closed.

(5) "Berichtigung der Höhe" - correction for height. This is equivalent to halving correction on the American instrument.

c. The correction wedge is the means by which the using arm secures coincidence when the instrument is not reading range accurately.

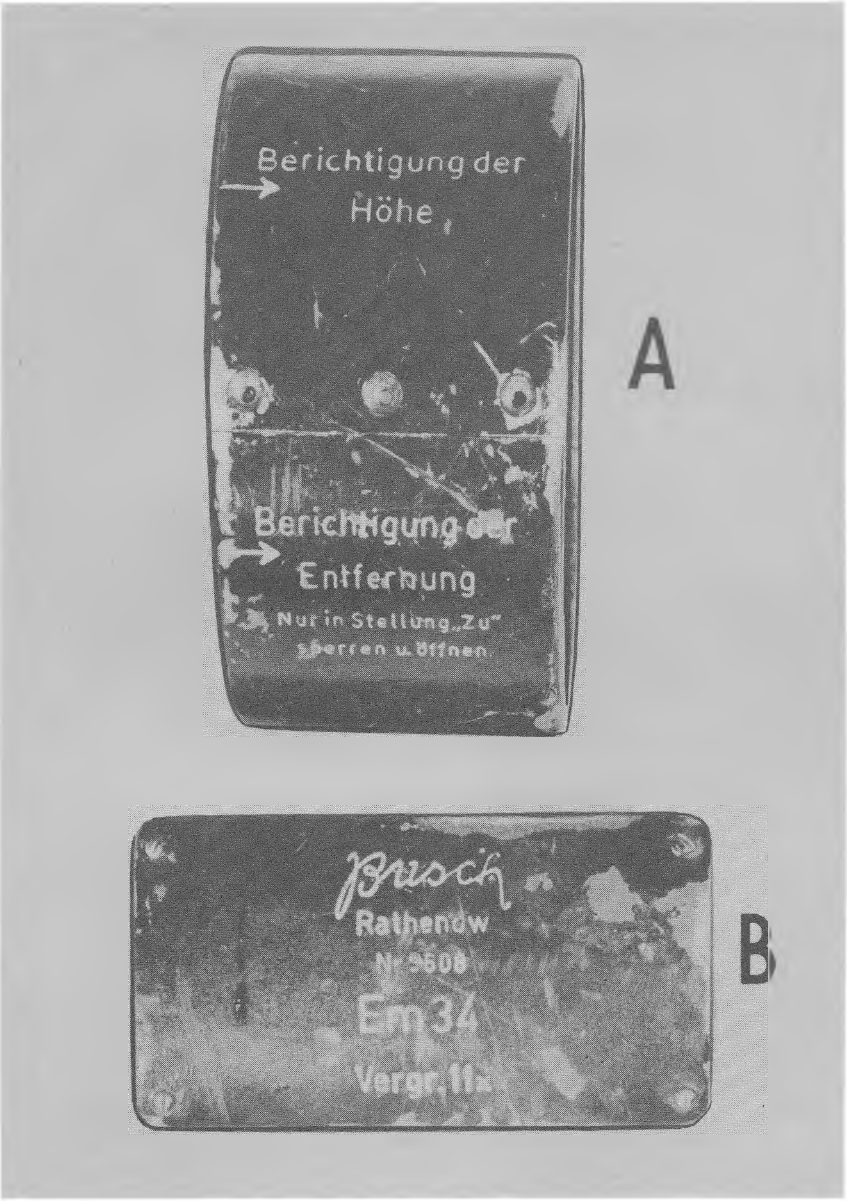


FIGURE 24. - NAME PLATE AND REVOLVING PROTECTION RING

d. After a correction has been set into the range finder through the correction-wedge roller, the protection ring is locked. This is accomplished by turning the lockscrew (fig. 25) in the direction of the word "Zu." In its closed position the revolving protection ring can be turned only enough to uncover the halving correction roller. In this way the range taker may make the necessary halving correction with no possibility of moving the correction-wedge roller and thus throwing the instrument out of adjustment.

35. SHOULDER HARNESS. - At least two types of shoulder harness are in use with the EM 34.

a. The harness manufactured by Carl Zeiss appears to be the more common of the two (figs. 21 and 22). This Zeiss harness may be disassembled and the parts carried in a leather carrying case.

b. A less elaborate type consists of a leather pad with a neck strap fastened to it (fig. 26). The tripod is left on the instrument, with the legs placed in small pockets provided for that purpose on the leather pad. The tripod is employed when using the range finder in the prone position (fig. 27B) and is fitted to the shoulder harness when the range taker is sitting, kneeling, or standing, particularly in use against air targets.

36. MAINTENANCE. - a. Repairs. - Like most German instruments, the EM 34 cannot readily be repaired or serviced in the field. It is definitely a base-shop job.

b. Adjustments. - Minor field adjustments for accurate range-taking may be accomplished as outlined in paragraph 34.

37. OPTICAL SYSTEM (figs. 29 and 30). - The optical system of the EM 34 is similar to that employed

FIGURE 25. - REVOLVING PROTECTION RING - OPPOSITE SIDE

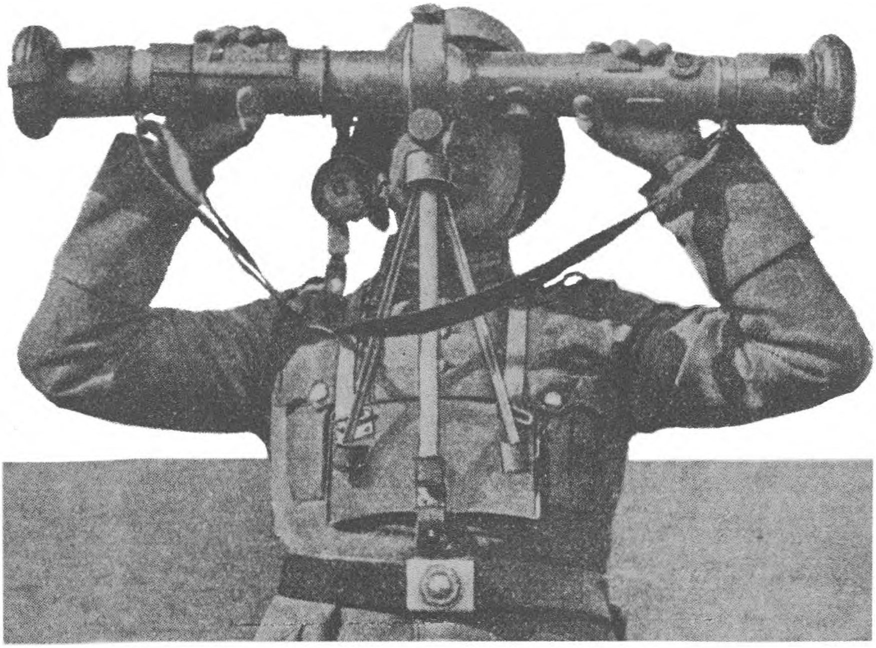


FIGURE 26. - EM 34 WITH TRIPOD SHOULDER HARNESS

in American range finders with the exception of the following:

a. Measuring-wedge assembly and range-scale disk.
b. Ocular prism.

38. MEASURING-WEDGE ASSEMBLY AND RANGE-SCALE DISK. - a. Measuring-wedge assembly. - The measuring-wedge assembly (or, as it may be called, the compensating-wedge assembly) consists of two wedge-shaped prisms held in aluminum mounts, which in turn are mounted within brass spur gears. These gears are caused to mesh with each other and also with two larger spur gears. One of the smaller gears is connected directly to the input coupling, so that the rotary movement of the range roller will transmit the motion through the gear train, causing the compensating wedges to rotate. These wedges rotate with equal angular velocities, but in opposite directions — one clockwise, the other counterclockwise (fig. 31).

b. Range-scale disk. - This element is annular in shape, made of glass, with minute Arabic numerals photo-etched upon its face. There are approximately 185 graduated figures between the minimum range of 200 meters and the maximum of 10,000.

(1) The scale progresses as follows (fig. 23):

From	To	Increments
200	350	2
350	500	5
500	700	10
700	1,000	20
1,000	2,000	50
2,000	3,000	100
3,000	4,000	200
4,000	7,000	500
7,000	10,000	1,000

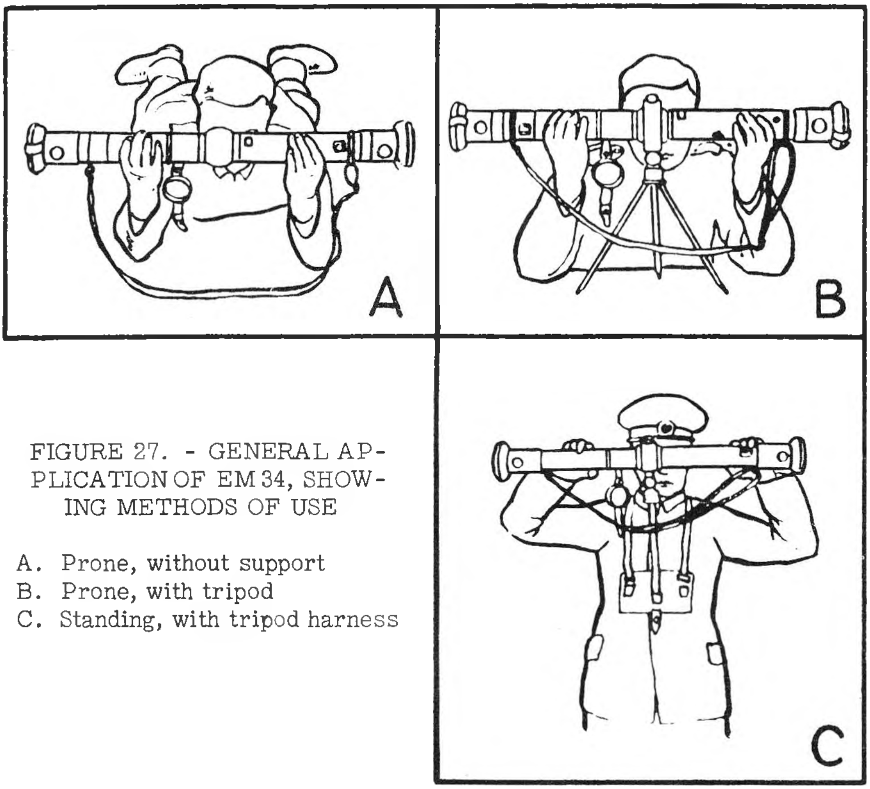


FIGURE 27. - GENERAL APPLICATION OF EM 34, SHOWING METHODS OF USE

A. Prone, without support
B. Prone, with tripod
C. Standing, with tripod harness

(2) Note that accuracy decreases as ranges approach the maximum. The figures are etched close to the edge of the range-scale disk and are spaced over approximately one-third of its circumference.

(3) The range-scale disk is held in an aluminum mount, which is

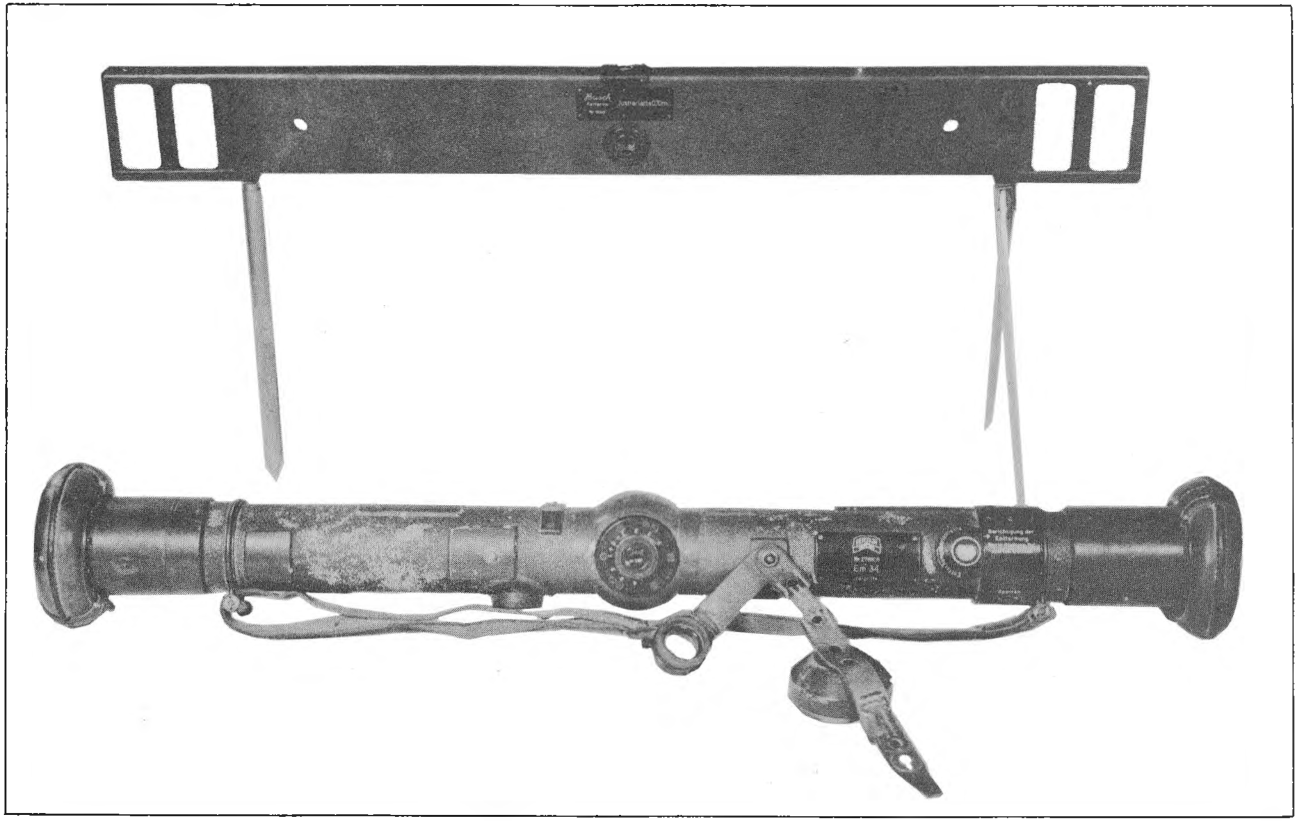


FIGURE 28. - EM 34 AND ADJUSTING LATH

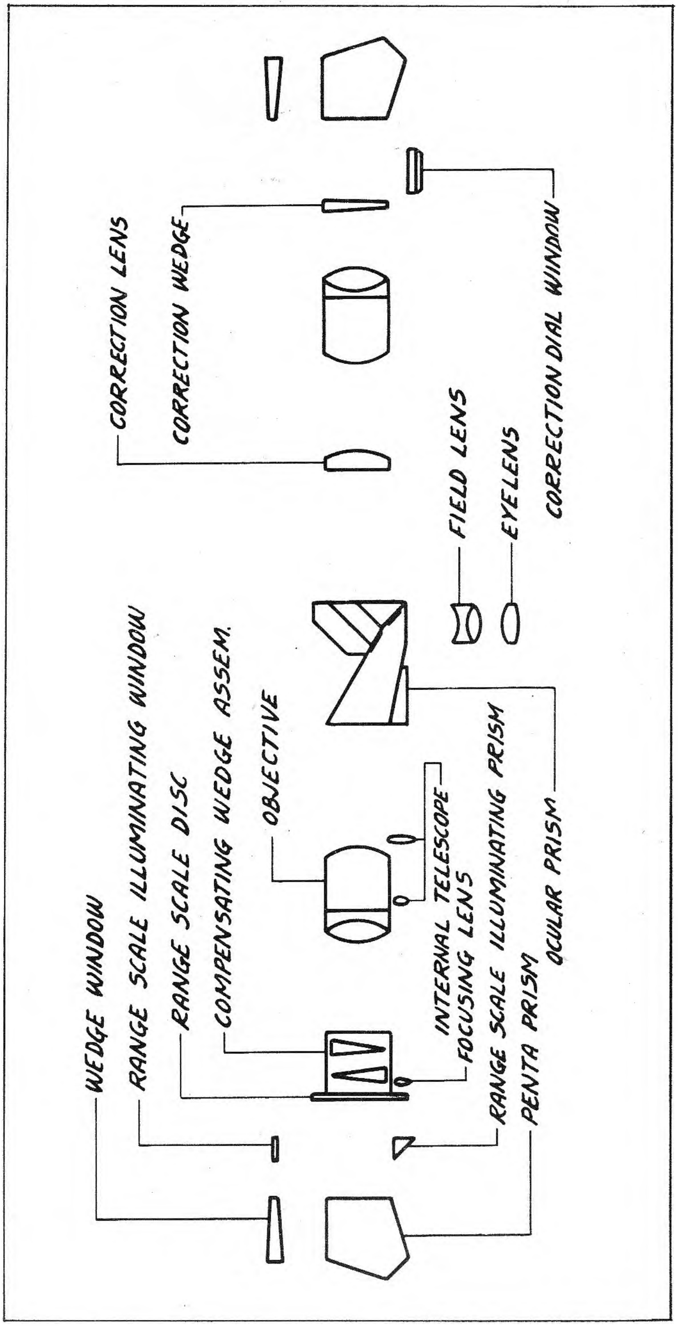


FIGURE 29. - OPTICAL SYSTEM OF THE GERMAN EM 34

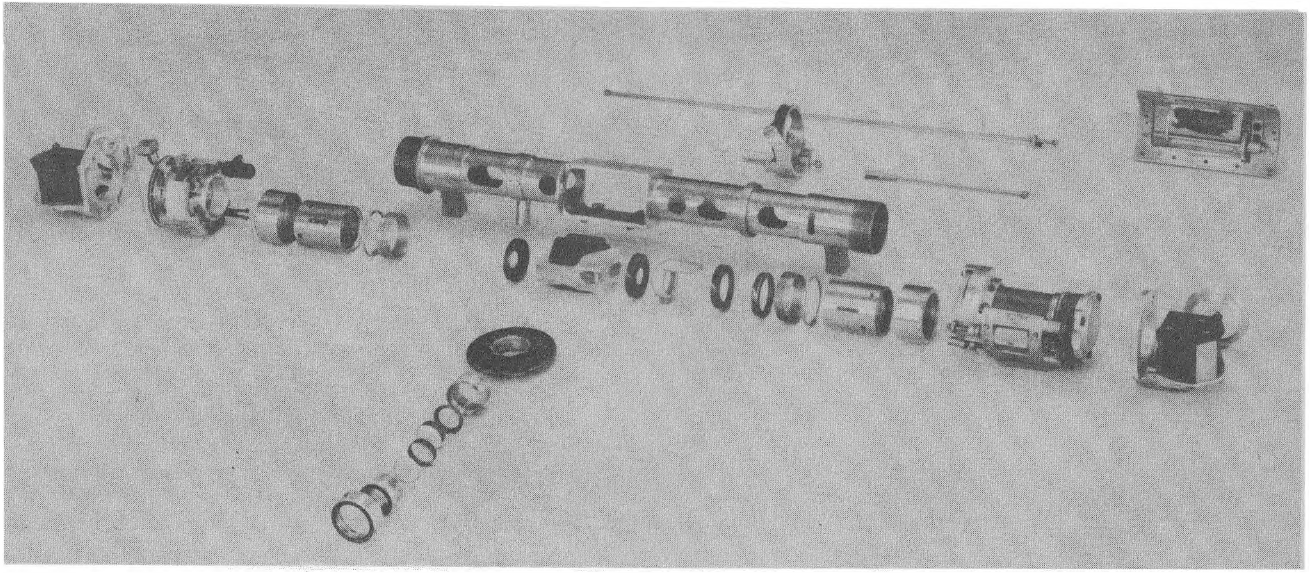


FIGURE 30. - EXPLODED VIEW OF OPTICAL BAR

connected directly to another aluminum mount holding one of the two measuring wedges. The range-scale disk, therefore, revolves whenever motion is transmitted from the range roller to the input coupling of this assembly.

(4) The range scale is illuminated by light rays admitted through a window designed for this purpose (fig. 29). After passing through the range-scale window the light is deflected 90° by means of a small internal right-angle prism. The light then passes through the range-scale disk, illuminating about 1/4 inch of the circumference of the photo-etched scale. The image of this illuminated portion of the scale is then brought to a focus by means of a small lens. The focused image then passes through an internal telescope to the compensating prism of the ocular-prism assembly. After passing through the compensating prism it strikes the mirrored surface on the right side of the field of view and is reflected to the eye of the observer.

(5) The photo-etched scale is so minute and the graduations so close together that it would be difficult to read them with the naked eye. An internal telescope is therefore provided and arranged in such a way that the scale may be seen through the eyepiece at the same time as the target whose range is being measured (fig. 29).

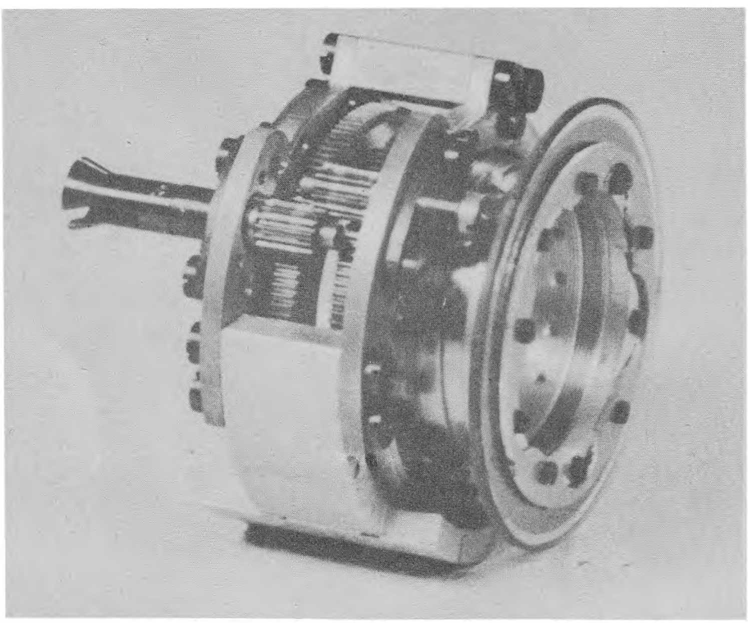


FIGURE 31. - MEASURING-WEDGE ASSEMBLY AND RANGE-SCALE DISK

39. OCULAR PRISM. - The compound ocular prism (fig. 32) consists of four prisms (1, 2, 3 and 4) cemented together, with two mirrored surfaces (A and B) cemented into the ocular assembly. The purpose of the reflecting surface at the right of the field of view is to transmit the range readings from the range-scale disk to the eye. The other mirrored surface reflects to the eye the image coming in from the left side of the range finder.

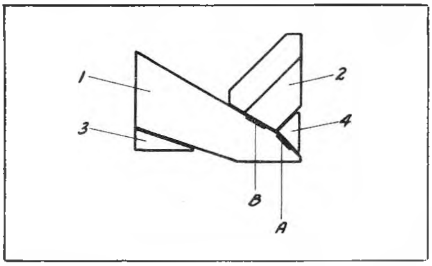


FIGURE 32. - OCULAR PRISM OF EM 34 - TOP VIEW

a. The prism through which the image must pass from the left side of the range finder does not erect the image. Therefore, when it is reflected to the observer's eye from the mirrored surface, the image appears in an inverted position.

b. An optical system differing from that present in the left side of the range finder is employed to secure an upright image from the right side. The element utilized is a modified form of roof-angle (amici) prism which is essentially a tetrahedron. The principal ray of the image passes normally through the first surface and is then deflected by a 90° roof surface and emerges perpendicular to the last surface. The path of the ray is thus deflected 90°. Because of these reflections there results a complete inversion of the image, which appears upright to the observer.

c. The prism through which the image of the figures from the range-scale disk must pass is merely a compensating element which causes the Arabic numerals to strike the mirrored surface on the right of the field of view.

d. The fourth and last prism of the ocular assembly has no functional value but is used to protect one of the mirrored surfaces.

40. INSERT-IMAGE SYSTEM. - a. In this system the image from the left end of the instrument is confined within a small rectangular insert in the middle of the field of view (fig. 23).

b. The lower edge of the rectangle forms the halving line.

c. The inserted image is inverted.

d. The advantage of this system is that it allows the observer to see a large field of view and facilitates picking up the object whose range is required, making it possible to keep under observation a certain amount of ground beyond the object.

41. EYE AND FIELD LENS. - The eye lens is a simple double-convex type, whereas the field lens is compound achromatic. The flint compound of the field lens is double-concave. This means that a concave surface must face the ocular prism. The purpose of the arrangement is threefold: to maintain a large field of view and at the same time permit reasonable magnification and prevent loss of illumination of the field of view. This type of eye and field lens appears to be a modified form of the "Erfle" eyepiece.

42. LATH. - a. General. - The adjusting lath for the German 70-cm-base range finder (fig. 28) has two vertical reference marks, one at each end of the lath. These correspond exactly with the interobjective distance (70 cm) of the range finder. The lath is made of the same material as the outer tube of the range finder in order to minimize the effects of expansion or contraction due to varying temperature.

b. Operation. - When the lath is set up at the required distance and sighted on the range finder, it provides a so-called "artificial infinity." That is, when coincidence is obtained the range reading will indicate infinity.

(1) When the lath is set up it is essential that it be parallel to the range-finder tube, with its surface perpendicular to the plane of triangulation. To accomplish this, an optical sight of the elbow collimator type is employed (fig. 35).

(2) This optical sight is built into the center of the lath and serves the same purpose as the peep sight used with American laths.

c. Optical system (fig. 36). - The 90° prism of the German 70-cm lath sight enables the observer to look down through the eyepiece and the plano-parallel plates, where he can see an inverted image of the range finder in the upper part of the field of view.

(1) There is a line etched on the top face of the 90° prism; it may therefore be considered as a reticle for the convex lens segment, which is analagous to the eyepiece of a 1-power astronomical telescope. The observer must line up the etched reticle line with the center of the range finder in order to insure correct position of the adjusting lath.

(2) Since the reticle line is in the focal plane of the convex lens segment, its image is projected out to infinity and there is no parallax between it and the image of the range finder. This is the chief disadvantage of nonoptical peep sights. In other words, the light coming from the reticle line leaves the convex lens segment in the form of parallel rays, and the principle of the collimator sight is obtained.

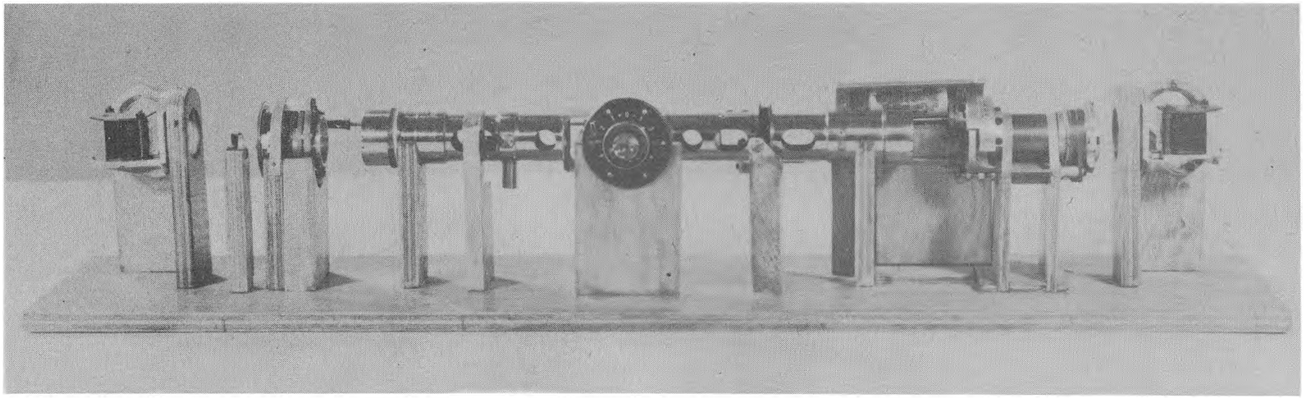


FIGURE 33. - CUTAWAY VIEW OF EM 34 - FRONT

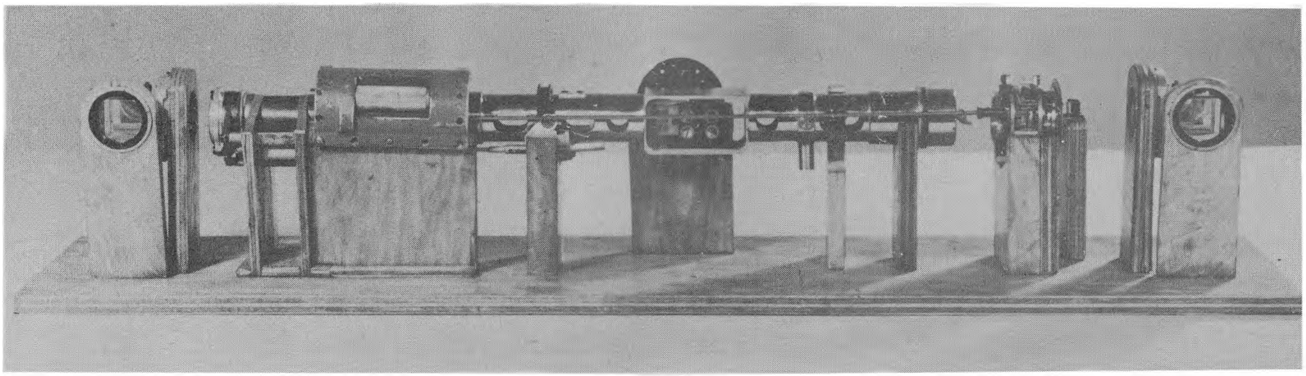


FIGURE 34. - CUTAWAY VIEW OF EM 34 - REAR

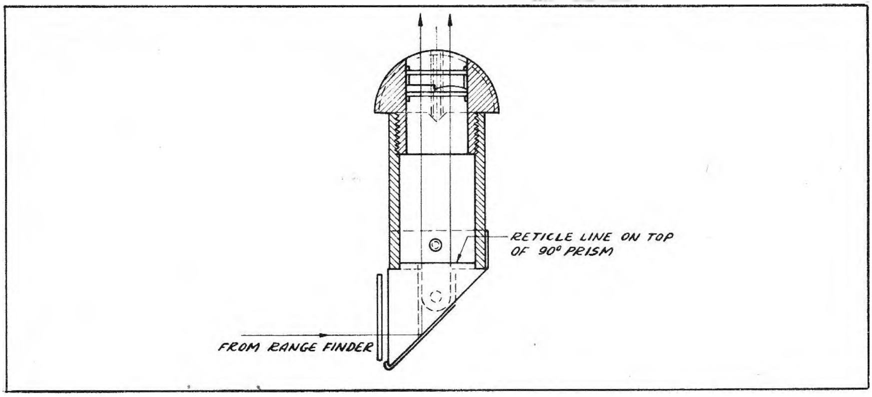


FIGURE 35. - OPTICAL SIGHT OF GERMAN
70-CM LATH

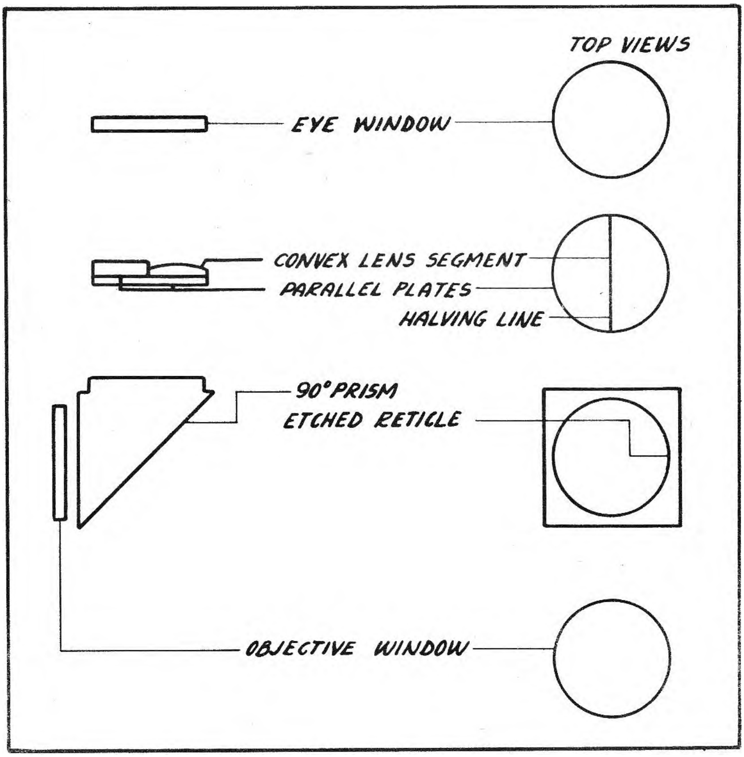


FIGURE 36. - OPTICAL SYSTEM OF GERMAN 70-CM LATH SIGHT

(3) In using the optical sight of this German lath the observer sees a divided field. The light entering the upper half of his pupil comes from the field of view and includes the range finder. The light entering the lower half of the pupil comes from the reticle line, which is on the upper face of the 90° prism and is in the focal plane of the convex lens segment.

d. Construction. - In addition to its use of an optical sight, the German 70-cm lath differs from its American counterpart in having a self-contained stand (fig. 28). At one end of the lath is a single folding leg; at the other is a bipod support. The folding leg has a knurled sliding cover, designed to hold both the leg and bipod in place when the lath is to be returned to its carrying case.

SECTION IV

GERMAN RANGE FINDER, 70-CM BASE, SUPERPOSED-IMAGE TYPE

43. GENERAL. - a. With the exception of the ocular prism, the German 70-cm range finder of superposed-image type is identical in optical system, mechanical design, and use to the German range finder, EM 34.

b. The example described was made up of parts from two captured instruments.

44. OCULAR-PRISM ASSEMBLY. - a. The ocular prism (fig. 37) consists of five optical components:

(1) Two amici prisms
(2) One rhomboid prism
(3) Two small auxiliary prisms

b. These components are cemented together with Canada balsam or a material of similar nature.

c. The function of each amici prism is to erect the image produced by the objective lens and to deflect the course of the light rays 90°. The rhomboid prism displaces the rays of light which pass through the left amici prism. This is made possible by a semisilvered surface on the left side of the rhomboid prism. The ocular prism thus produces a field of view which contains two erect images of the target.

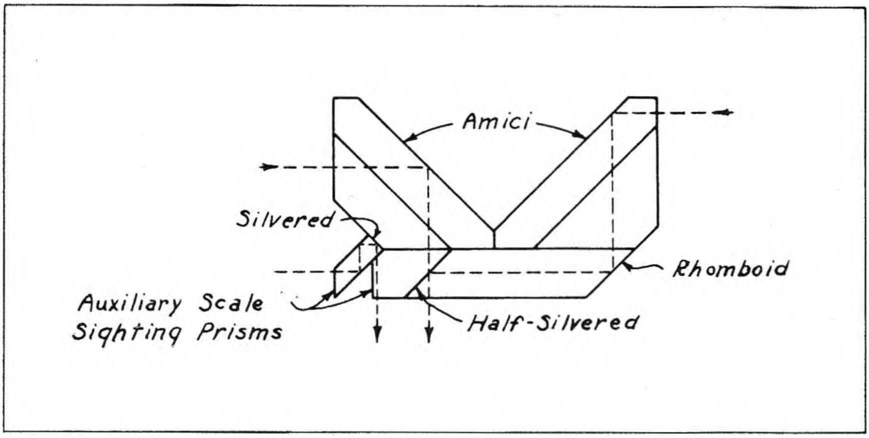


FIGURE 37. - GERMAN RANGE FINDER, 70-CM BASE, SUPERPOSED-IMAGE TYPE - OCULAR PRISM

(1) When the images are superimposed the range may be read from the scale visible at the left side of the field of view.

(2) The function of the two auxiliary prisms is to reflect the readings from the range-scale disk to the eye.

(3) It will be noted that one of the images is of a milky color. This is due to the semisilvered surface of the ocular prism.

45. USE, FUNCTION, AND MAINTENANCE. - In all other respects, this superposed-image type range finder is identical to the German EM 34, and details of use, function, and maintenance may be found in the section devoted to that instrument.

SECTION V

GERMAN NIGHT-LIGHTING DEVICE

46. GENERAL. - a. This German night-lighting device, captured in the North African theater, was originally a part of the fire-control equipment of a German 105-mm howitzer.

b. The device may be used with practically all fire-control instruments currently used in the German field artillery. It cannot, however, be used on any American instrument, nor can any of its parts be utilized in other than a makeshift manner.

47. MAIN ASSEMBLIES. - The instrument may be divided into three primary assemblies:

a. Battery container (fig. 38A).

b. Double distributor (fig. 38B-1) and plug-in lead (fig. 38B-2).

c. Plug-in lead (fig. 38C-3) and adapter head with lamp (fig. 38C-4).

48. LIGHT BULBS. - Two light bulbs were received with this night-lighting device, both manufactured by Osram. One is marked "Osram, 3,5/0,2," interpreted to mean 3.5 volts and 0.2 amperes. The

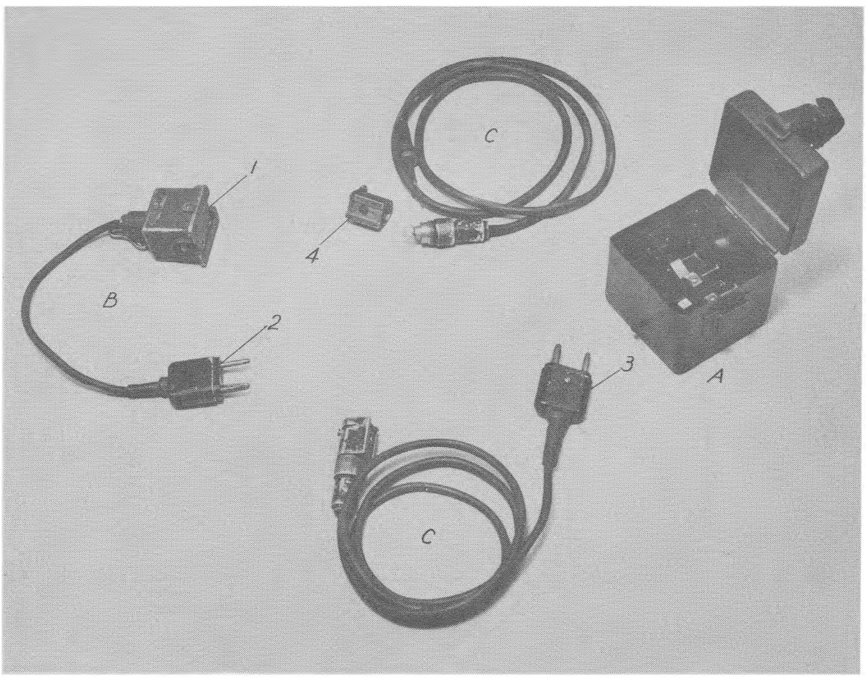


FIGURE 38. - MAIN ASSEMBLIES OF GERMAN NIGHT-LIGHTING DEVICE

A. Battery container
B. Distributor (1) and plug-in lead (2)
C. Plug-in lead (3) and adapter head with lamp (4)

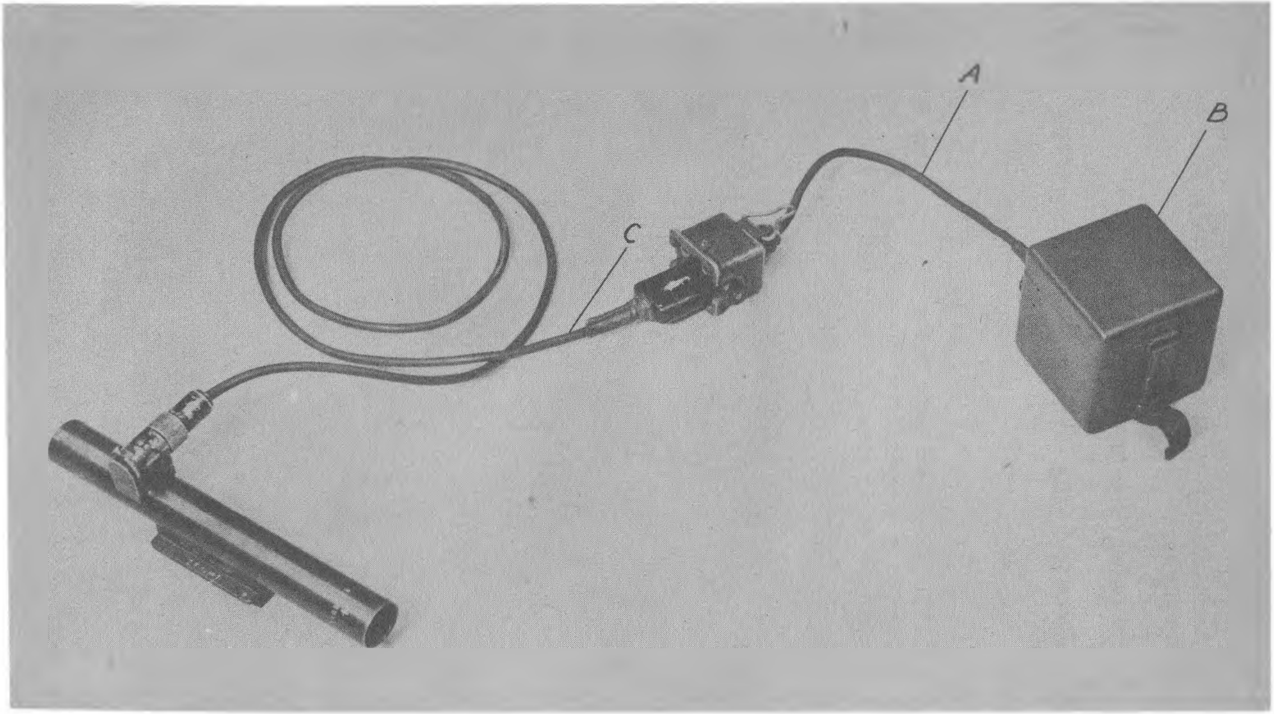


FIGURE 39. - APPLICATION OF GERMAN NIGHT-LIGHTING DEVICE TO GERMAN STRAIGHT-TUBE TELESCOPE, ANTITANK TYPE

A. Double distributor and plug-in lead
B. Battery container
C. Plug-in lead and adapter head with lamp

other bulb is marked "Osram 2.5 V - .2 A, England." Osram is a large electrical-supply manufacturer with factories both in England and Germany.

49. CONSTRUCTION AND USE. - a. Construction. - Little brass has been employed in the manufacture of this device, a common practice in the production of German instruments. Most of the metal used is of aluminum base. The instrument is of sturdy construction and appears designed to withstand hard field use.

b. Light control. - Intensity of lighting is controlled by a shield with a V-slot. When the shield is slid past the aperture of the adapter head the amount of light allowed to pass is relative to the position of the V-slot. This arrangement is used in place of an electrical rheostat.

c. Use. - In setting up the lighting device, the double distributor and plug-in lead assembly (fig. 39A) is plugged into the back of the battery container (fig. 39B) and the light proper attached to the lighting window of the instrument in use. In figure 39 the night-lighting device is shown set up with a German straight-tube antitank telescope.

SECTION VI

JAPANESE RANGE FINDER, 75-CM BASE, COINCIDENCE TYPE

50. GENERAL. - a. The Japanese range finder described below, serial number 93, was captured in the Solomon Islands, South Pacific theater of operations.

b. The instrument was manufactured by the "Nikko Japanese Optical Company" in March 1936.

c. This range finder normally is used by Japanese light field artillery units for the measurement of ranges between 100 and 10,000 yards. It is a coincidence type instrument, with split field of view.

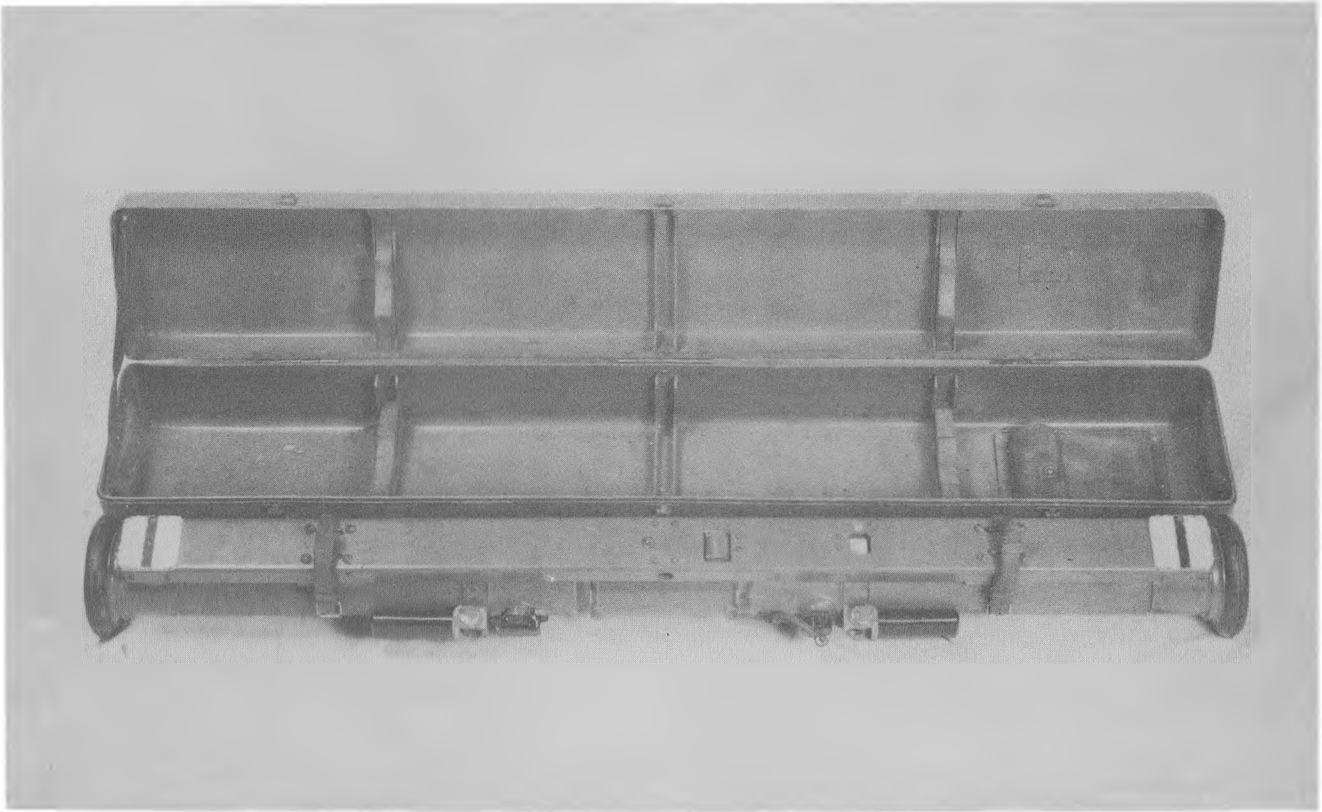


FIGURE 40. - JAPANESE RANGE FINDER, 75-CM BASE, WITH LATH AND CARRYING CASE

51. DATA. -

Base length of instrument ----------------	inches	29.53
	centimeters	72
Magnification ------------------------	diameters	11
Range ----------------------------------	yards	100 to 10,000
Field of view --------------------------	vertical	2°
	horizontal	3°
Weight of range finder -------------------	pounds	9
Weight of carrying case -----------------	pounds	6

52. COMPONENTS. - The following items constitute a complete outfit:

Range finder, 75-cm base (figs. 43 and 44).
    Carrying case (fig. 40).
    Brush.
    Amber ray filter.
Lath, nonadjustable (fig. 47).
Tripod and mount (fig. 41).

53. USING-ARM ADJUSTMENTS. - Four adjustments may be made by the using arms. No disassembly is necessary.

a. Focus the eyepiece for correct diopter setting.

b. Obtain proper halving of field of view by means of the halving-adjuster knob.

c. Use measuring-wedge knob to obtain coincidence.

d. Adjust range-scale index. This index is used in place of the correction-wedge key present on American range finders.

54. USE AND OPERATION. - This Japanese instrument may readily be used by an American soldier familiar with domestic military range finders. The following notes on operation may be used as a guide:

a. The right eyepiece is used to observe the target.

b. The left eyepiece is used to read range from the range scale after coincidence has been obtained.

c. Coincidence of the field of view is obtained by rotating the measuring-wedge knob.

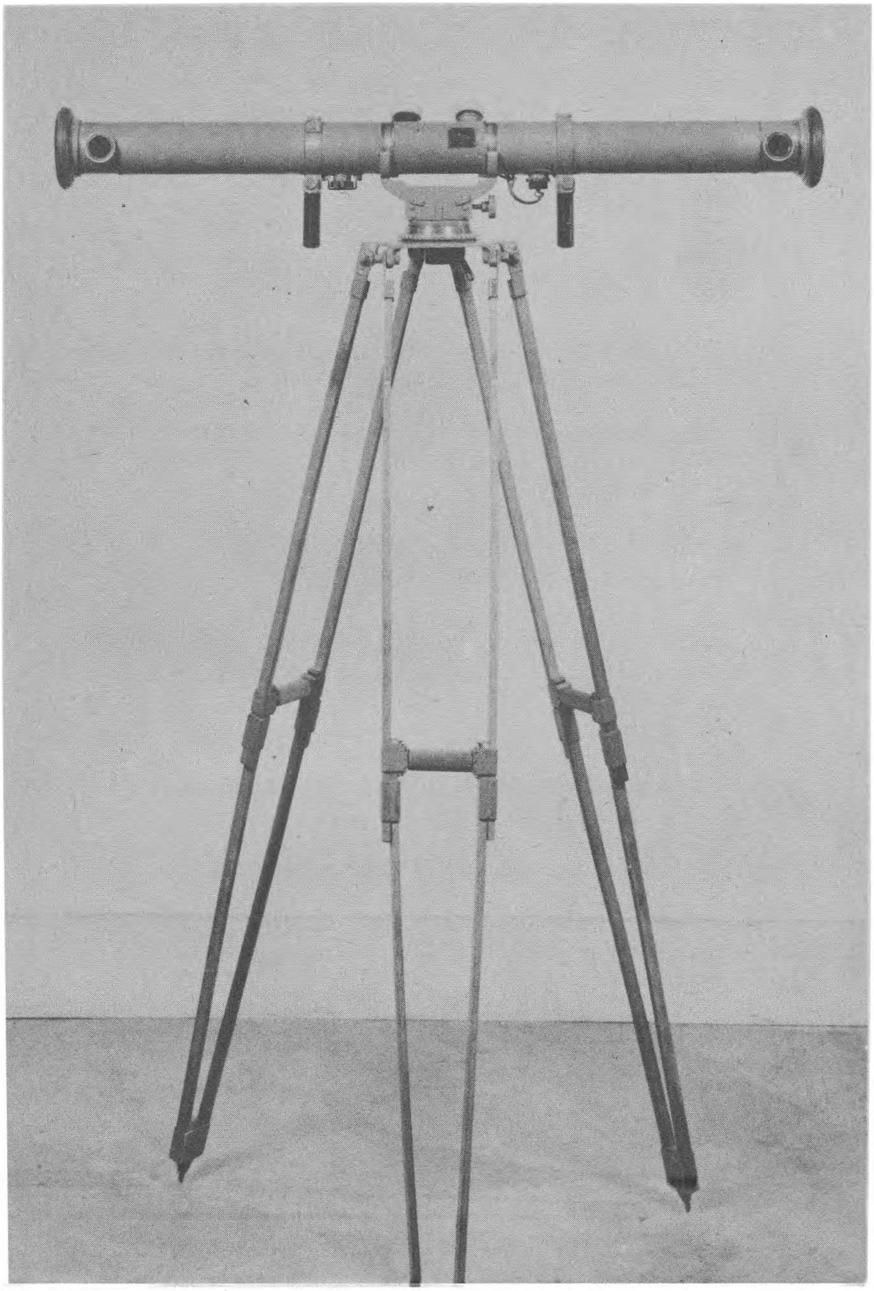


FIGURE 41. - JAPANESE RANGE FINDER, 75-CM BASE, ON TRIPOD

d. Halving of the field of view is obtained by rotating the halving-adjuster knob.

e. In adjusting the instrument by either the known range or artificial infinity method the range-scale index adjusting knob must be used. This type of range finder does not have a correction wedge. Therefore, if the instrument is out of proper adjustment (not more than the maximum which may be corrected by using the correction-wedge key on our range finders) and is checked on a known range, coincidence is first obtained, and then the range-scale correction knob is moved until the range scale agrees with the correct range-scale reading.

f. The range scale reads as follows:

From	to	in increments of	numbered every
100	200	1/2	1 yd.
200	300	1	5 yd.
300	400	2	10 yd.
400	700	5	20 yd.
700	1,000	10	50 yd.
1,000	1,400	20	100 yd.
1,400	2,000	50	200 yd.
2,000	5,000	100	500 yd.
5,000	6,000	500	1,000 yd.
6,000	10,000	1,000	4,000 yd.

(1) Beyond the 10,000 yard marking is an "infinity" graduation, denoted by a star and with numbered divisions to the right and left marked + and - respectively. These graduations are used for testing and adjusting purposes. When coincidence has been obtained on an infinitely distant object the infinity mark should be opposite the range-scale index.

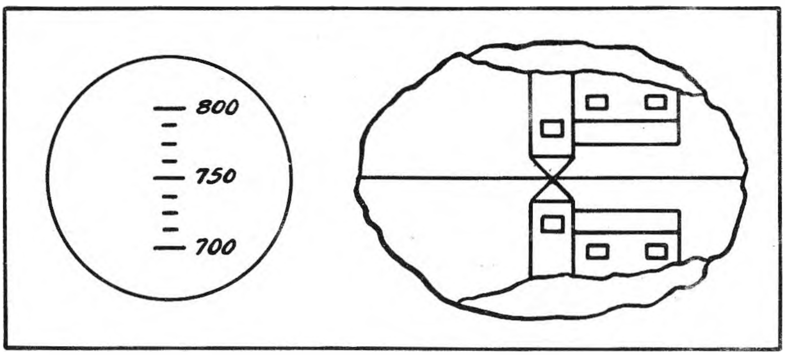


FIGURE 42. - JAPANESE RANGE FINDER, 75-CM BASE - OBSERVER'S VIEW

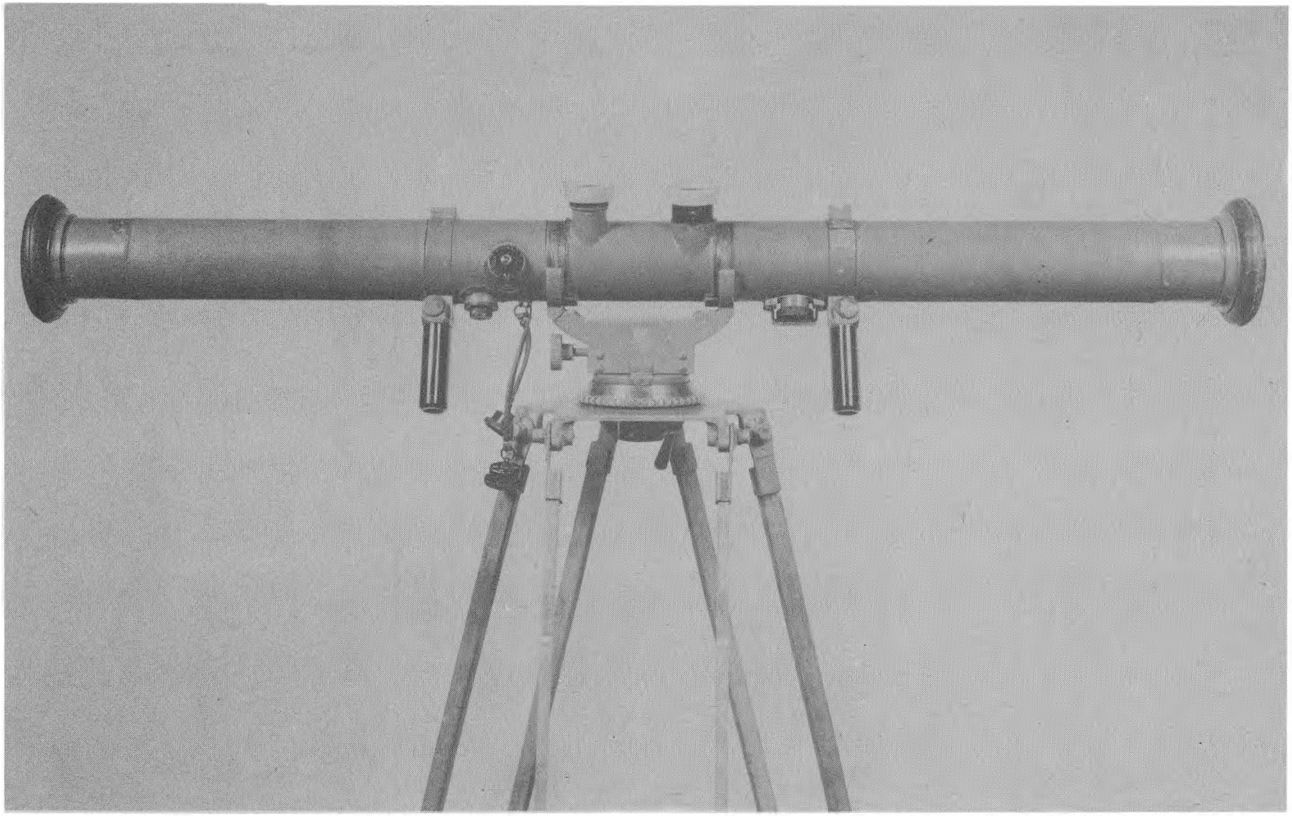


FIGURE 43. - JAPANESE RANGE FINDER, 75-CM BASE, ON TRIPOD - REAR

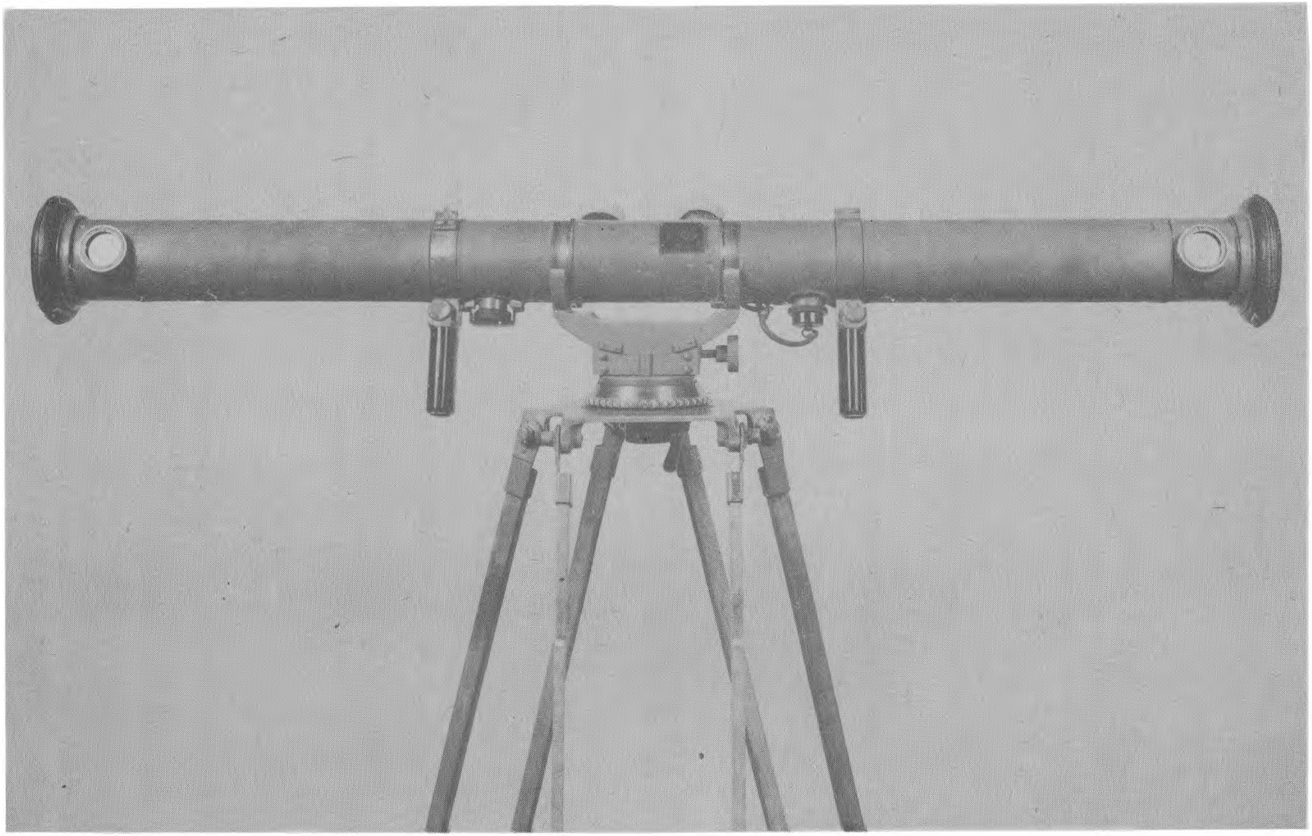


FIGURE 44. - JAPANESE RANGE FINDER, 75-CM BASE, ON TRIPOD - FRONT

55. OPTICAL SYSTEM (fig. 46). - a. Ocular prism. - Although there are only three cemented optical components in the ocular prism of the Japanese range finder, it performs exactly the same job as the ocular in the American range finder, 1-meter base, M1916. Fundamentally, the design of the two ocular prisms is the same.

(1) The image entering the prism from the left side undergoes the two reflections necessary for correction. The image entering the ocular prism from the right objective is first inverted and reverted. The first two reflections, which are analagous to those occurring in a rhomboid prism, do not affect the image. The third reflection, however, occurring on a horizontal plane of action, serves to re-revert the image. The fourth and fifth reflections leave the image unchanged but present it to the eyepiece above the image formed by the left objective. Thus the eye sees a divided field (fig. 42). The upper half, from the right objective, is inverted; the lower half, from the left objective, is erect and correct.

b. Eyepiece assembly. - The eyepiece assembly is of the symmetrical type, with a diopter movement from +3 to -4. Filters are attached directly to the eyepiece assembly when needed.

c. Halving plate. - The halving plate is a thick piece of optical glass with plano-parallel surfaces. Situated in the optical bar (fig. 45) between the left objective and the ocular prism, it is mounted in a mechanical fixture which is capable of being rotated about a horizontal axis perpendicular to the optical axis of the instrument. Light rays passing through the left objective can then be displaced in a vertical direction without altering their angular direction.

(1) The maximum displacement of the light rays passing through the halving plate is governed by the maximum angle of rotation (approximately 30°), the index of refraction, and the thickness of the halving plate.

d. Measuring wedge and range scale. - These elements are assembled as a single unit in the Japanese range finder. When the range knob is turned by the observer, a rack-and-gear system actuates the measuring-wedge and range-scale assembly in a translatory manner, parallel to the axis of the optical bar.

(1) The range scale is illuminated by light entering the optical bar through a range-scale illuminating window. This light is reflected to the range scale by a mirror.

(2) The range scale (fig. 42) is read by the observer through the left eyepiece, which is a simple magnifying assembly. Situated between the eyepiece assembly and range scale is an optical assembly consisting of two 90° prisms. These range-scale prisms correct the light rays

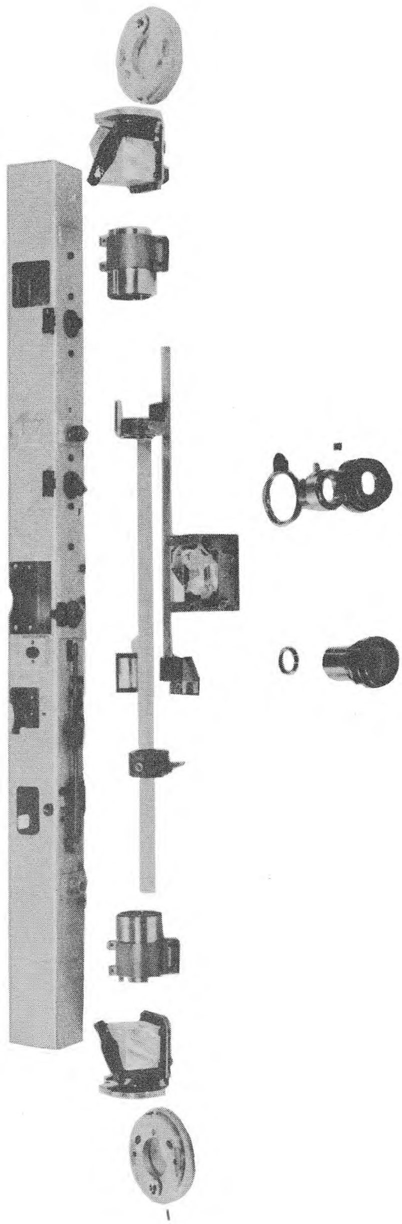


FIGURE 45. - JAPANESE RANGE FINDER, 75-CM BASE - EXPLODED VIEW

passing from the range scale so that the inner surface of the range scale appears to move vertically instead of horizontally when viewed through the eyepiece. The figures then appear correct.

e. Objectives. - The objectives, which are burnished in their cells, are matched pairs, since there is no lens to correct for possible unequal magnification.

f. Penta prisms and wedge windows. - Both the penta prisms and wedge windows are similar to those used in American range finders, although the Japanese wedge windows have a smaller angular deviation.

56. MAINTENANCE. - a. Repairs. - Repairing or servicing of this type of range finder is an arsenal job and cannot be performed in the field.

b. Adjustments. - Other than those covered in paragraph 53, no adjustments may be made in the field.

57. LATH. - a. General. - The Japanese 75-cm lath (fig. 47) serves a twofold purpose. First, like all other laths for range finders, it is used when adjusting the instrument by the artificial infinity method. Secondly, it serves a practical purpose in providing protection for the range finder when both are strapped together for transit or storage (fig. 40). The lath has two rubber-lined recesses and two wooden supports assembled to it. When the range finder is to be transported the lath is strapped to it in such a way that these rubber-lined recesses cover the wedge windows. The wooden supports provide added rigidity and protection, preventing bowing or buckling of the instrument.

b. Optical sight. - The optical sight of the Japanese 75-cm lath (fig. 48) is of a periscopic collimator design and is assembled so as to give a line of sight 90° to the axis of the lath. This enables the user to position the lath exactly parallel to the tube of the range finder.

(1) The components of the optical sight, as light enters from the image, are:

(a) Plane mirror (fig. 49A).
(b) Reticle (fig. 49B).
(c) Converging lens (fig. 49C).
(d) Penta prism (fig. 49D).

(2) Light entering the instrument first strikes the plane mirror, which is set at a 45° angle. This illuminates the reticle, which is in the focal plane of the converging lens. The parallel rays from this lens then strike the penta prism and are reflected out to the eye. Thus, when the

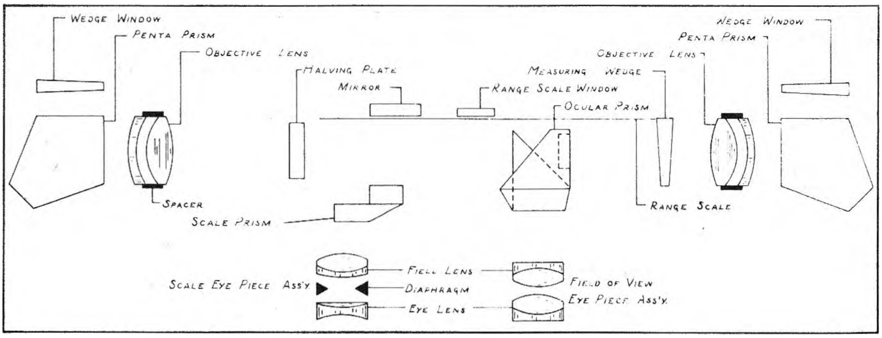


FIGURE 46. - JAPANESE RANGE FINDER, 75-CM BASE - OPTICAL SYSTEM

collimating sight is used, the reticle appears to be in a direct line with the observer.

c. Use. - In use, the lath stake is first driven into the ground vertically and the lath placed on the stake. The lath is now in the plane of triangulation. The observer then sights on the range finder, using the collimator sight, and makes the necessary adjustment of the lath by rotating it in the plane of triangulation. The lath is rotated to the point where the vertical reticle line is centered on the range finder and also centered in its own circular field of view. In this position the lath is within the allowable tolerance of being parallel to the range finder. When the proper adjustment has been secured the lath is locked to the stake by means of an integral locking device.

d. Comments. - The range-finder tube and lath seem to be made of different metallic materials, and it is possible that the two will have different coefficients of expansion. There are no provisions for adjusting or correcting vertical reference marks at the ends of the lath. The optical sight is too elaborate for a collimator, and its potential value is not completely realized because of the poor manner in which it is employed.

58. TRIPOD (fig. 41). - The tripod, possibly designed for jungle warfare, is lightly constructed and cannot be transported conveniently because of its unorthodox design. It does not have locking devices for the legs, and this deficiency further restricts its usefulness.

(1) The tripod mount (figs. 43 and 44) has a simple locking device which permits the observer either to lock the range finder in azimuth or allow it to rotate freely in azimuth for orienting the instrument. The mount also has a device for leveling the range finder in the event the tripod itself is not properly leveled. Since a level vial was not built into this Japanese tripod mount, the observer must judge by eye when the range finder is level.

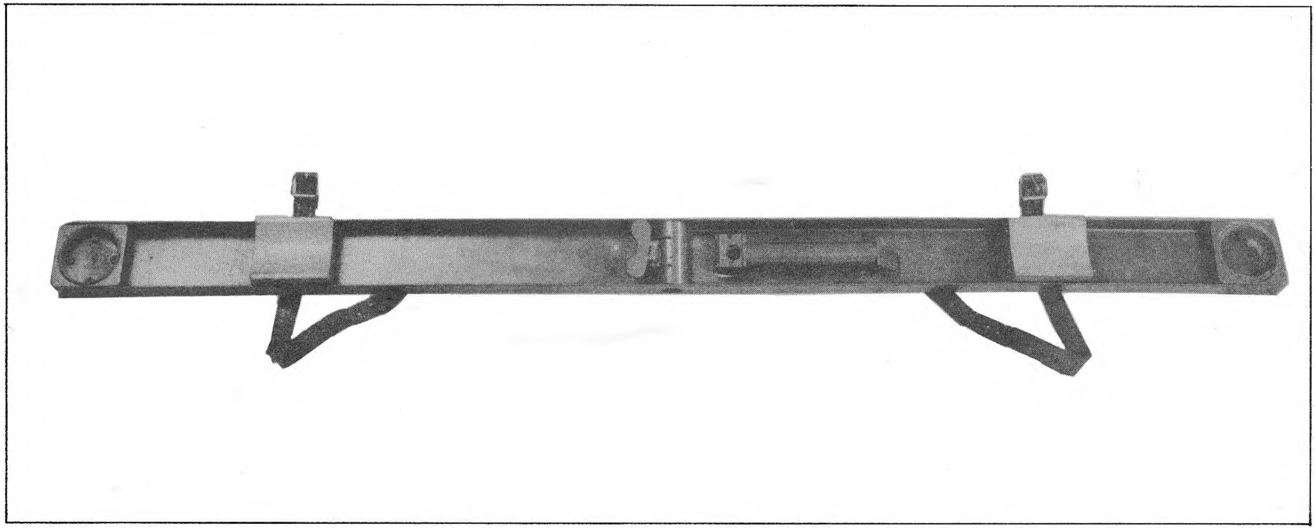


FIGURE 47. - JAPANESE LATH, 75-CM BASE - REAR

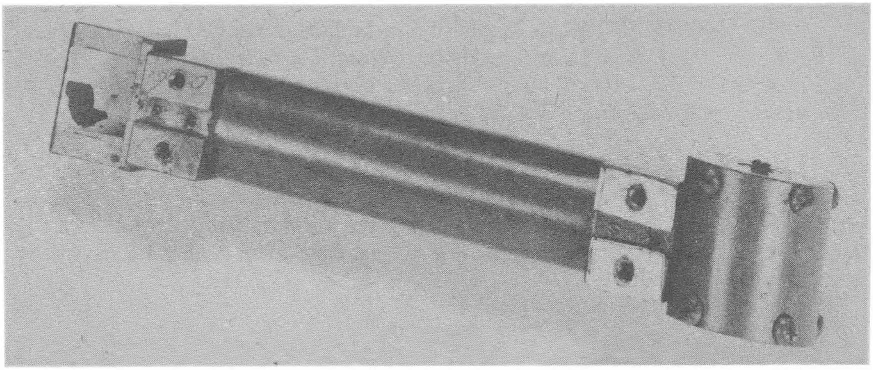


FIGURE 48. - JAPANESE LATH, 75-CM BASE - OPTICAL SIGHT

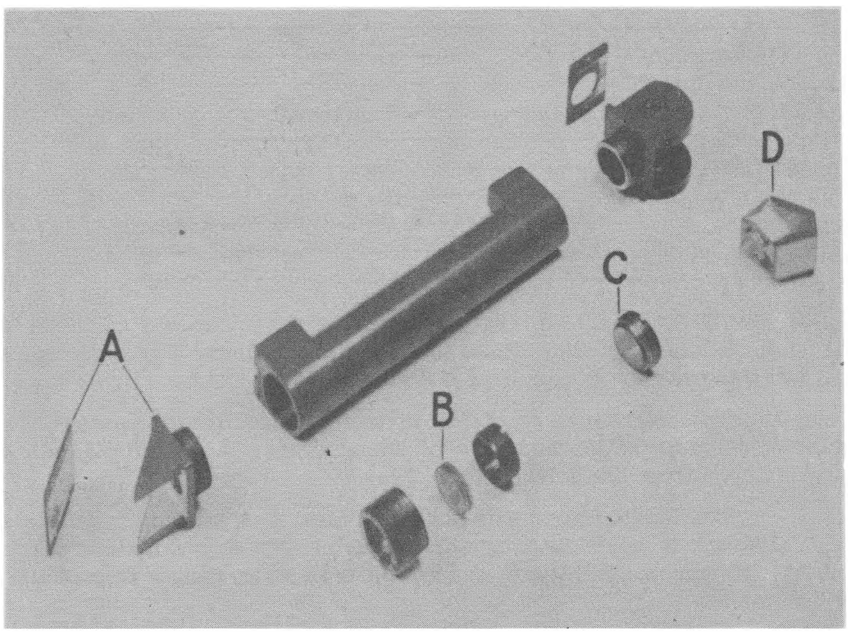


FIGURE 49. - JAPANESE LATH, 75-CM BASE - OPTICAL SIGHT, EXPLODED VIEW

A. Plane mirror
B. Reticle
C. Converging lens
D. Penta prism

59. COMMENTS. - a. This 75-cm Japanese range finder is similar to the 80-cm-base instrument, model of 1918, manufactured by the Keuffel & Esser Co., the design of which appears to parallel one of those of Messrs. Archibald Barr and William Stroud.

b. The Japanese have attempted to provide for dessication of the instrument by installing a bushing in the center of the buffer assemblies. Because of the construction of the eyepiece assemblies, however, the range finder cannot be sealed properly, making effective dessication of the instrument impossible.

SECTION VII

JAPANESE HEIGHT FINDER, 2-METER BASE, STEREOSCOPIC TYPE

Paragraph

60. GENERAL. - a. This Japanese height finder was captured in the Solomon Islands, South Pacific theater of operations. The instrument reached this country lacking both tripod and accessories.

b. The manufacturer of the instrument is unknown, as are the exact model designation and year of manufacture. All name plates had been stripped from the height finder.

c. The height finder was obviously used with an antiaircraft battery, although it would be adapted to use by artillery units as a range finder. Of stereoscopic type, it may be used over ranges from 400 to 20,000 yards.

61. DATA. -

Base length of instrument	meters	2
	inches	78.74
Magnification	diameters	24
Range	yards	400 to 20,000
Correction wedge	degrees	+50 to -50
Elevation	degrees	0 to + 88
Weight, less tripod	pounds	164

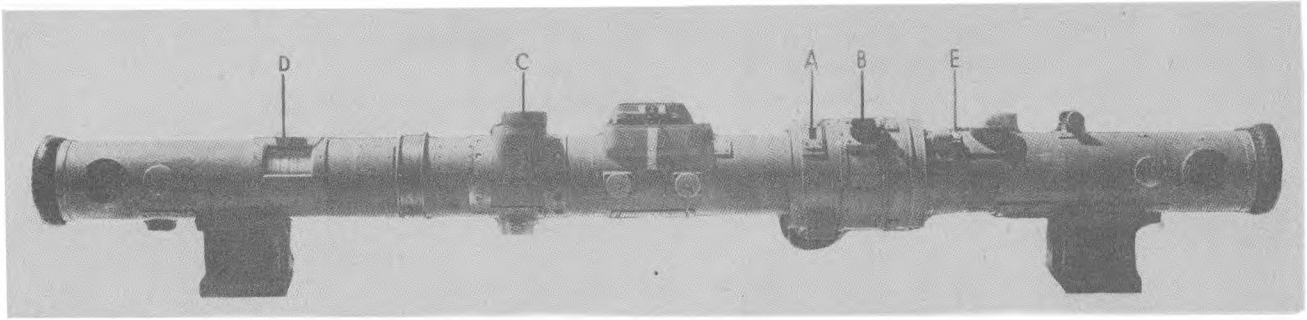


FIGURE 50. - JAPANESE HEIGHT FINDER, 2-METER BASE - FRONT

A. Elevation scale
B. Elevation knob
C. Range knob
D. Range drum
E. Locking device

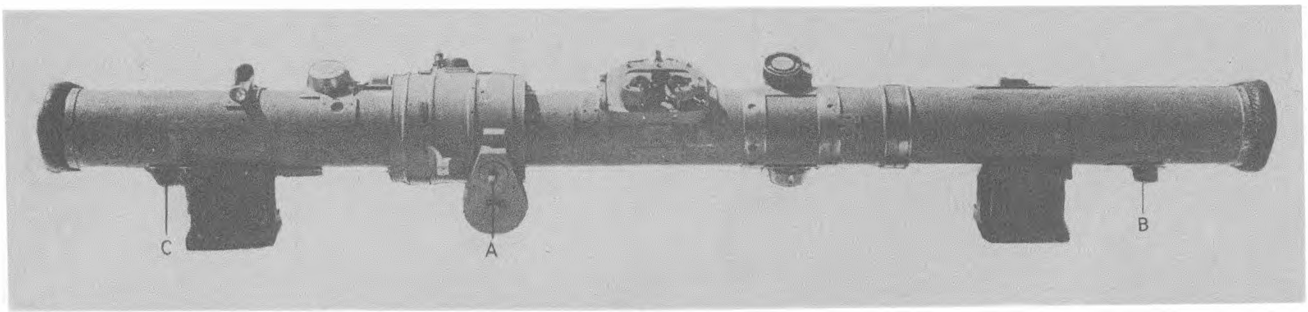


FIGURE 51. - JAPANESE HEIGHT FINDER, 2-METER BASE - REAR

A. Elevation mechanism B. & C. Correction-lens knobs

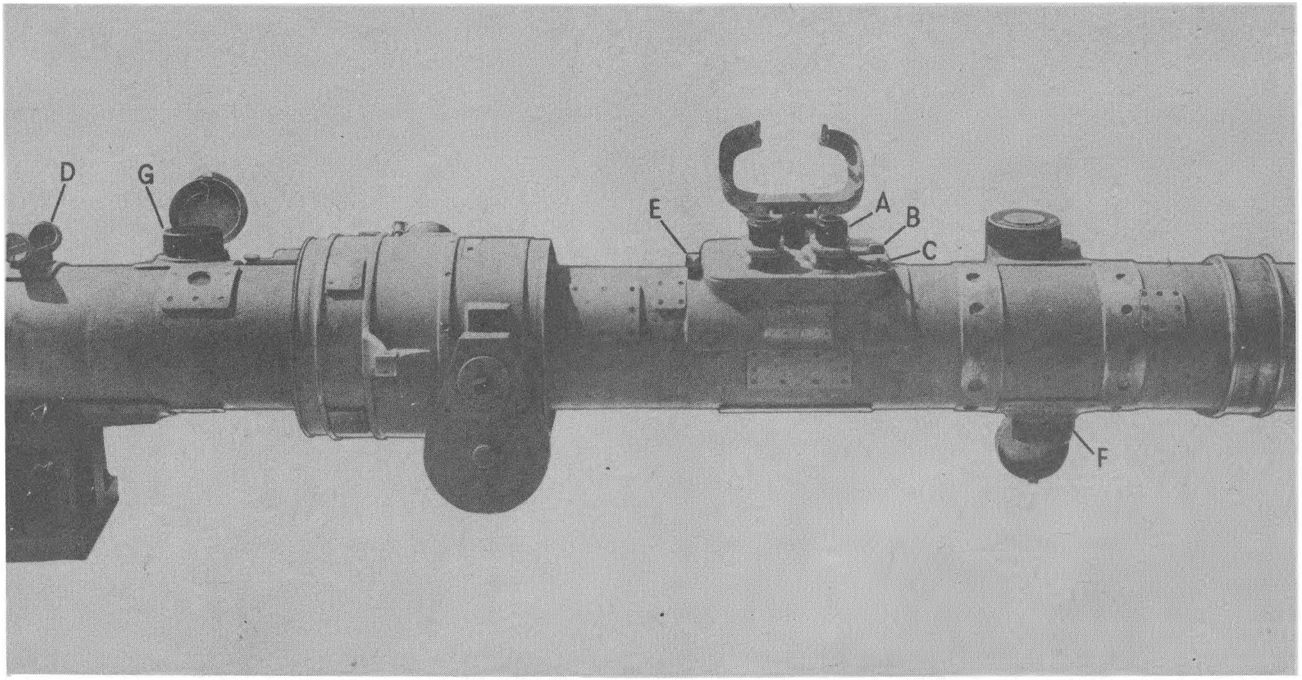


FIGURE 52. - JAPANESE HEIGHT FINDER, 2-METER BASE - MAIN CONTROLS

A. Eyepieces
B. Interpupillary-distance lever
C. Ray-filter lever
D. Open sight
E. Open sight
F. Height-of-image knob
G. Correction wedge

62. USE AND OPERATION. - a. Method of operation. - An American soldier trained as a stereoscopic observer can use this instrument effectively. In doing so, the following facts should be used as a guide:

(1) The two eyepieces are of the focusing type, with a diopter movement from + 2 to - 4 (fig. 52A).

(2) The interpupillary distance of the observer may be accommodated by means of an adjusting lever located on the right eyepiece (fig. 52B).

(3) The eyepiece assembly also contains two ray filters — amber and smoke. These may be introduced by means of a lever located below the interpupillary lever (fig. 52C).

(4) For rapid orientation of the instrument on the target two open sights are provided — one on the extreme left side of the instrument (fig. 52D) and another to the left of the eyepiece assembly (fig. 52E).

(5) To read ranges, the elevation scale (fig. 50A) is set at zero and the elevation knob (fig. 50B) is turned to the extreme unlocked position. Observation through the eyepiece and rotation of the range knob (fig. 50C) produce stereoscopic contact. The range may then be read directly from the range drum (fig. 50D).

(6) To read altitude or height, the elevation knob is set in a locked position. The instrument is elevated by means of the elevation mechanism (fig. 51A) until the target is in view, at which time stereoscopic contact is obtained by means of the range knob. The height reading is taken directly from the range drum.

(7) The necessary correction for height of image may be obtained by turning the height-of-image knob (fig. 52F). As in the American instrument, this affects only the left field of view.

(8) A locking device (fig. 50E) is provided for locking the instrument for travel. This is accomplished by setting the elevation mechanism at zero and then setting the elevation knob in a locked position and pushing the plunger down. Then, by turning the locking lever toward the observer, the elevation housing and wedge ring gear are locked to the outer tube.

b. Correction wedge. - (1) The correction wedge (fig. 52G) is used to compensate or correct for three conditions:

(a) Temperature changes (thermal conductivity of the instrument).
(b) Slight errors in adjustment of the instrument.

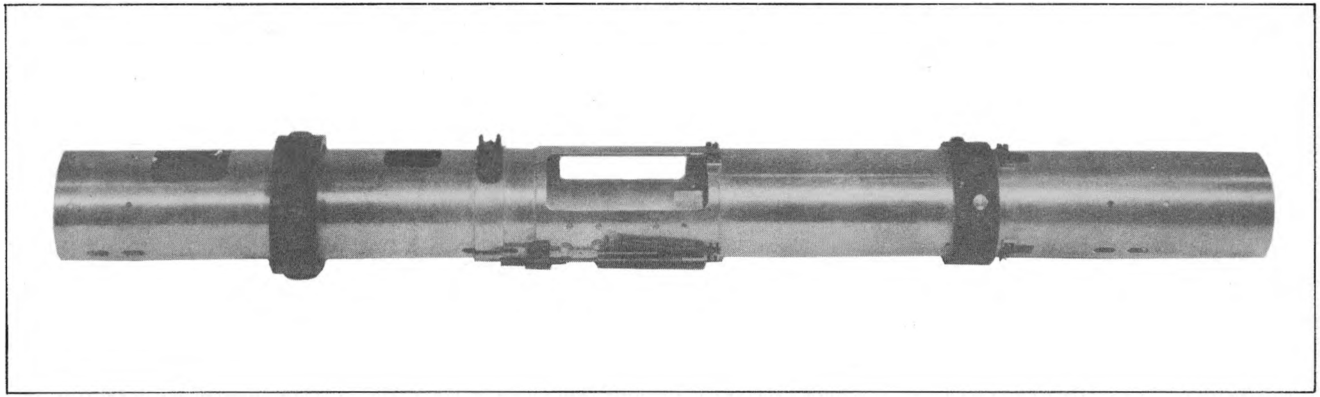


FIGURE 53. - JAPANESE HEIGHT FINDER, 2-METER BASE - OPTICAL TUBE, STRIPPED

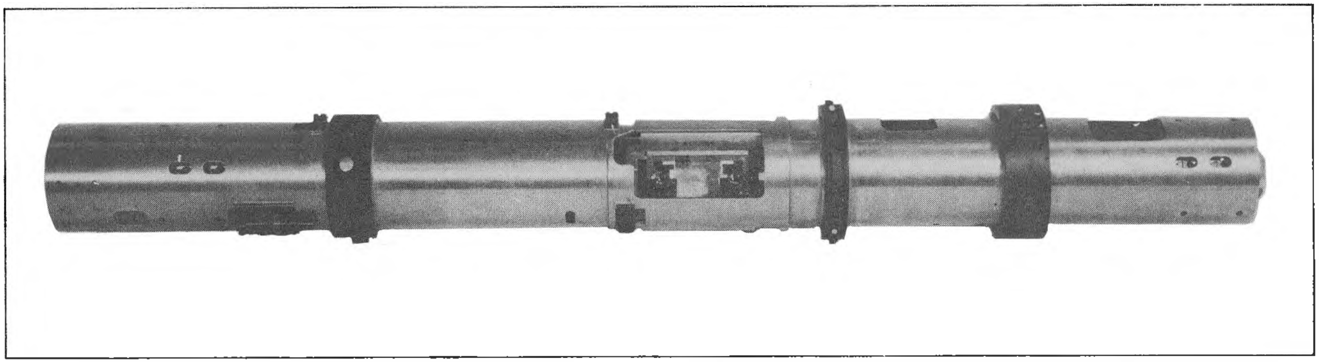


FIGURE 54. - JAPANESE HEIGHT FINDER, 2-METER BASE - OPTICAL TUBE, ASSEMBLED

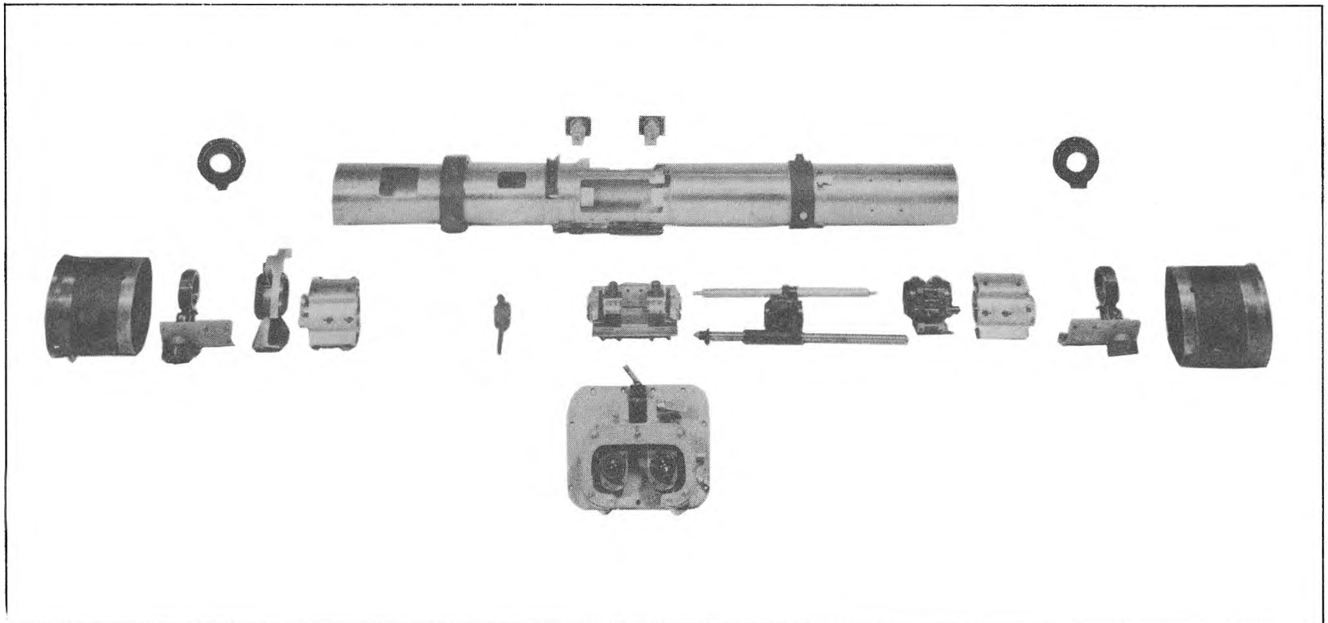


FIGURE 55. - JAPANESE HEIGHT FINDER, 2-METER BASE - OPTICAL SYSTEM, EXPLODED VIEW

(c) Difference in individual observer's stereo-acuity.

(2) To correct for these conditions, sight the instrument on a target of known distance and set this known distance on the range drum. Then obtain stereo-contact by using the correction wedge. Actually the observer may be correcting for all three conditions simultaneously.

(3) To adjust the instrument by the artificial infinity method, set the lath approximately 68 yards from the height finder. Set the range drum at a reading of infinity and introduce the infinity correction lenses into the optical system. This is done by turning the correction-lens knobs (fig. 51B and C) to the "on" position (figs. 71 and 72). Finally, ob-

FIGURE 56. - JAPANESE HEIGHT FINDER, 2-METER BASE - EYEPIECE ASSEMBLY, FRONT

tain stereo-contact by using the correction wedge. The infinity correction lenses introduce a correction in the optical system of the range finder whereby an object at 68 yards appears to be at infinity. Therefore, the lath, being approximately 68 yards distant, seems to be at infinity.

63. USING-ARM ADJUSTMENTS. - The using arm may make only nine adjustments, for which no disassembly is necessary.

a. The range knob (fig. 52H) may be turned to obtain stereo-contact — in other words, range and altitude readings.

b. The eyepieces may be focused to adjust for individual diopter setting.

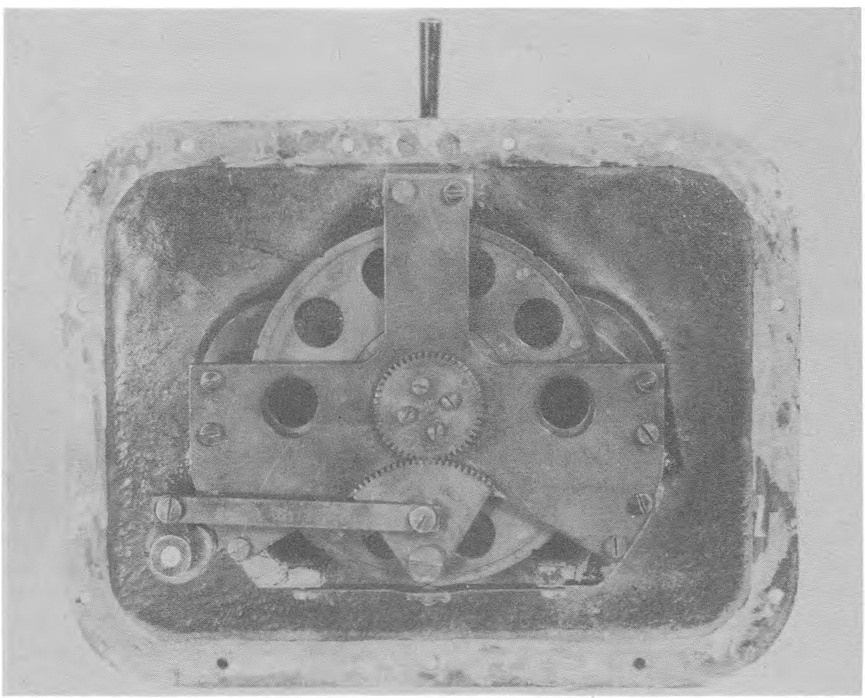


FIGURE 57. - JAPANESE HEIGHT FINDER, 2-METER BASE - EYEPIECE ASSEMBLY, REAR

c. The interpupillary lever (fig. 52B) may be moved to adjust for proper interpupillary distance.

d. Proper ray filters may be introduced by movement of the ray-filter lever (fig. 52C).

e. Height of image in left telescope may be adjusted by height-of-image knob (fig. 52F).

f. Proper elevation and tracking of target may be controlled by the elevation shaft (fig. 51A). The crank normally used with this instrument is missing.

g. The altitude knob (fig. 50B) may be turned to set the instrument for slant-range or elevation readings.

h. The correction-wedge knob (fig. 52G) may be used to adjust for proper individual stereoscopic effect.

i. Infinity adjustments may be made by turning the infinity-correction-lens knobs (fig. 51B and C).

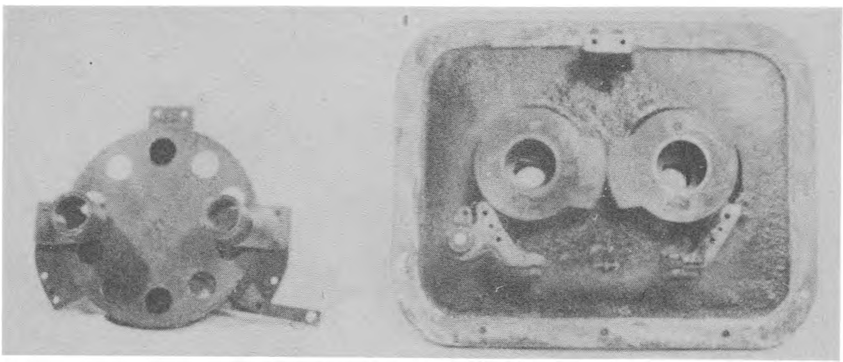


FIGURE 58. - JAPANESE HEIGHT FINDER, 2-METER BASE - EYEPIECE OBJECTIVES AND RHOMBOID PRISMS

64. MAINTENANCE. - The Japanese height finder, like other Japanese fire-control instruments, cannot be repaired in the field but must be returned to an arsenal for maintenance. The instrument is sealed in such a manner that disassembly or replacement of parts is almost impossible other than in a base shop or similar installation. The only adjustments practicable in the field are those outlined in paragraph 63.

65. OPTICAL SYSTEM (Fig. 62). - a. Eyepiece assembly, orthoscopic type. - (1) Eye lens (plano-convex).

(2) Field lens (triplet, cemented).

(3) Rhomboid prisms.

(4) Ray filters (amber, smoked).

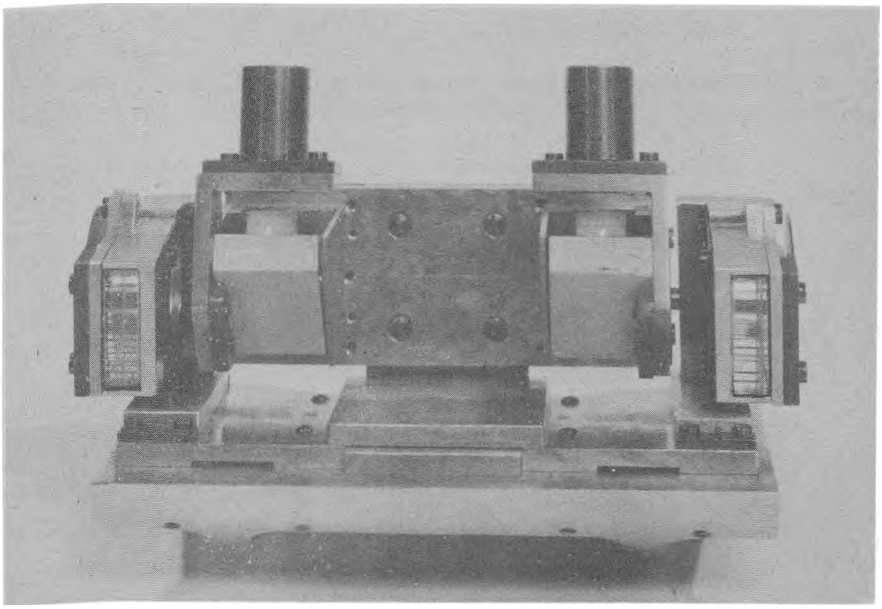


FIGURE 59. - JAPANESE HEIGHT FINDER, 2-METER BASE - CENTRAL PRISM AND RETICLE ASSEMBLY

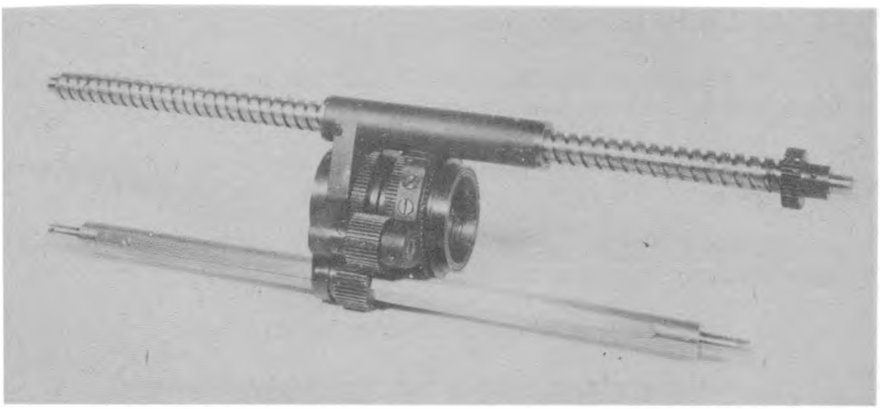


FIGURE 60. - JAPANESE HEIGHT FINDER, 2-METER BASE - TRANSLATORY AND ROTARY WEDGE ASSEMBLY

(5) Erecting system (compound).

(6) Eyepiece objectives (compound, meniscus convex, meniscus concave).

(7) Collecting lens (compound converging lens cemented to central prism).

(8) Central prisms.

(9) Reticle lens (plano-convex cemented to illuminating plate).

(10) Illuminating plate (plano-parallel).

(11) Reticle (plano-parallel).

(12) Reticle windows (plano-parallel).

b. Left side of optical system. - (1) Height-of-image plate (plano-parallel).

(2) Correction wedge.

(3) Objective lens (compound achromatic lens with air space between elements, double convex and concave meniscus).

(4) Infinity correction lens.

(5) Penta prism (similar to but larger than the penta prisms used in the American 1-meter-base range finder).

(6) Wedge windows (similar to those used in our 1-meter-base range finder).

c. Right side of optical system. - (1) Rotating and translating wedges (stronger than outer rotating wedges).

(2) Objective lens (same as objective in left side).

(3) Rotating wedges (weaker than the translating wedges).

(4) Infinity correction lens.

(5) Penta prism (same as penta prism used in left side).

(6) Wedge window (same as wedge window on left side).

66. WEDGES. - a. Description. - There are two sets of wedges in the Japanese height finder. Set number one, located between the central prism assembly and the right objective lens, translates and rotates, thus causing movement in the field of view and permitting stereoscopic contact. At the lowest range or height reading (400 yards) these translatory wedges are at their closest point to the objective lens. When the

FIGURE 61. - JAPANESE HEIGHT FINDER, 2-METER BASE - ROTARY WEDGES AND GEAR ASSEMBLY (ALTITUDE-COMPUTING WEDGES)

highest range or height reading (infinity) is taken, the wedges are at their farthest point from the objective lens. Set number two is in a fixed position between the right objective lens and the penta prism. This set of wedges only rotates.

(1) The two sets of wedges are connected by connection rods and couplings, and the connection rods are geared to the height ring gear, which is in turn geared to the height knob. Thus, when the height knob is turned, the motion of the height ring gear is introduced to the connection-

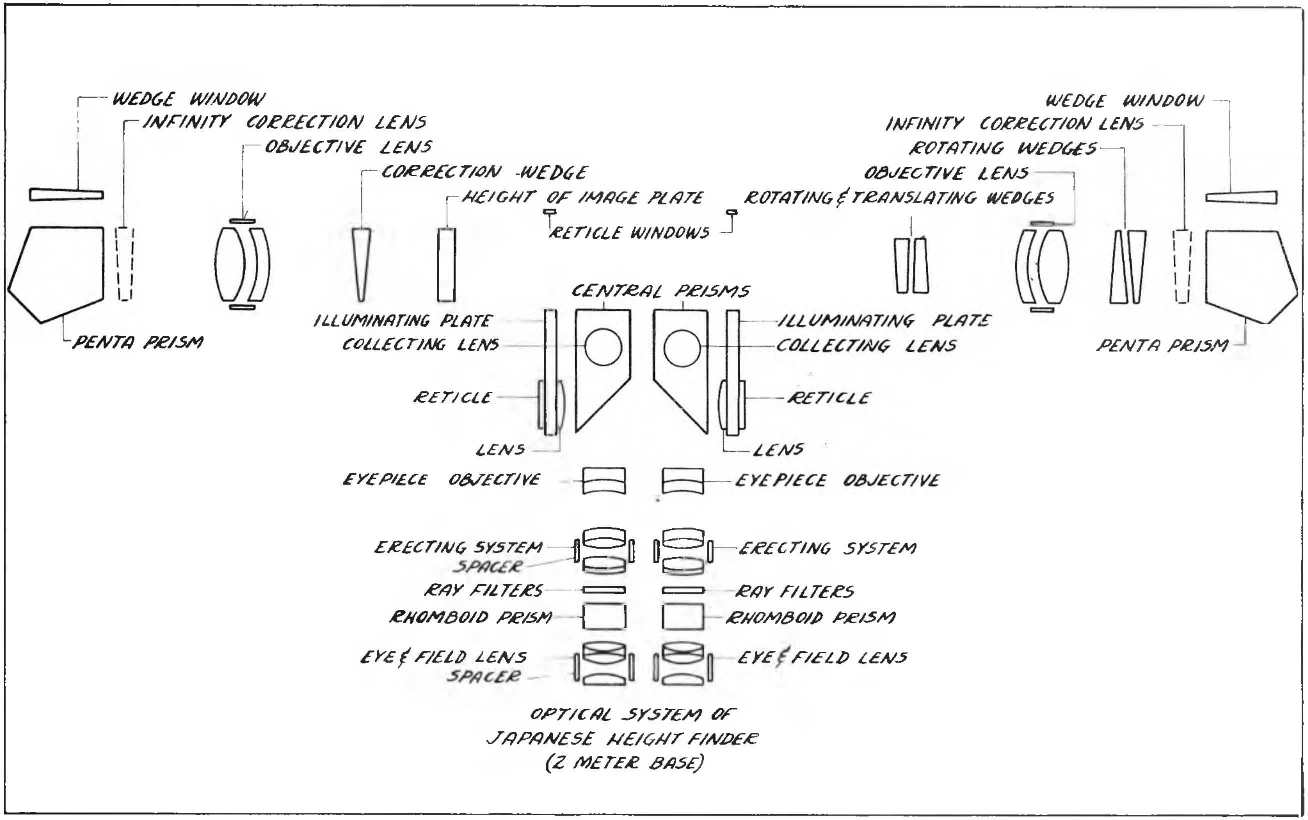


FIGURE 62. - JAPANESE HEIGHT FINDER, 2-METER BASE - OPTICAL SYSTEM

rod gear assembly. This in turn rotates the two sets of wedges.

(2) When the height knob is set in a locked position it locks the height ring gear to the elevation mechanism. Therefore, when the height knob is in a locked position and the elevation knob is turned, a rotary motion is introduced in the two sets of wedges to compute height. Rotation of the wedges is proportional to the amount of elevation.

b. Function when reading height. - When the height knob is set in a locked position and the elevation set at zero, the two pairs of wedges are in a neutral position. At this point, if the range knob is turned, introducing motion in the translatory wedges, there will be no horizontal

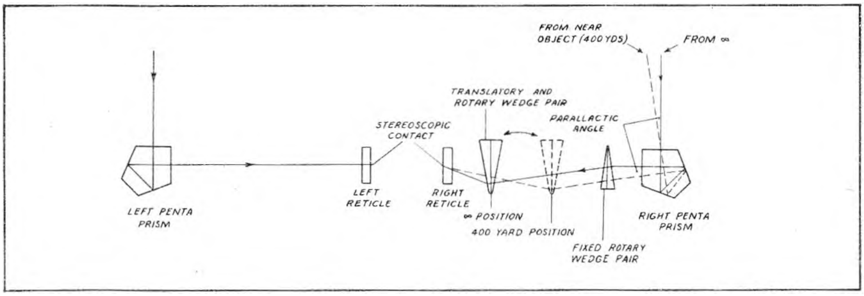


FIGURE 63. - JAPANESE HEIGHT FINDER, 2-METER BASE - OPTICAL FUNCTION OF WEDGES

movement in the field of view. However, when the height knob is in a locked position and the elevation knob is turned, the rotary motion of the two sets of wedges, being proportionate to the elevation, will cause a horizontal movement in the field of view. This horizontal movement in-

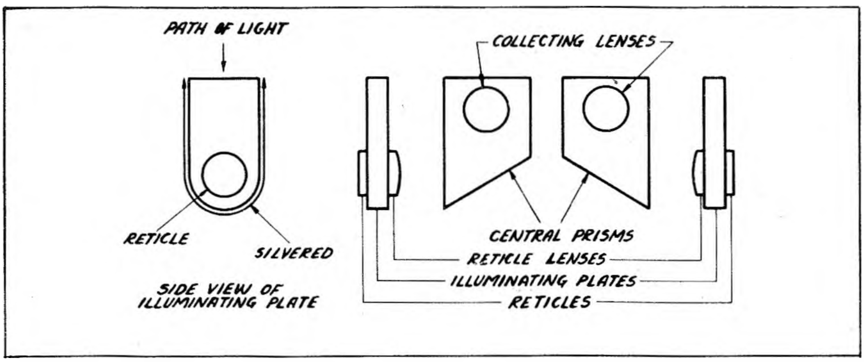


FIGURE 64. - JAPANESE HEIGHT FINDER, 2-METER BASE - CENTRAL PRISMS AND RETICLE ASSEMBLY

creases in direct ratio to the elevation, the maximum movement being attained at maximum elevation (88°).

c. Function when reading ranges. - The height knob is set in the extreme unlocked position, thus turning the two sets of wedges 90° from their neutral position and causing the translatory wedge to act as a measuring wedge. This is similar to the action of the wedge used in a range finder, which measures the range by triangulation. The range knob of the height finder is turned, translating the translatory wedge assembly until stereo-contact is obtained.

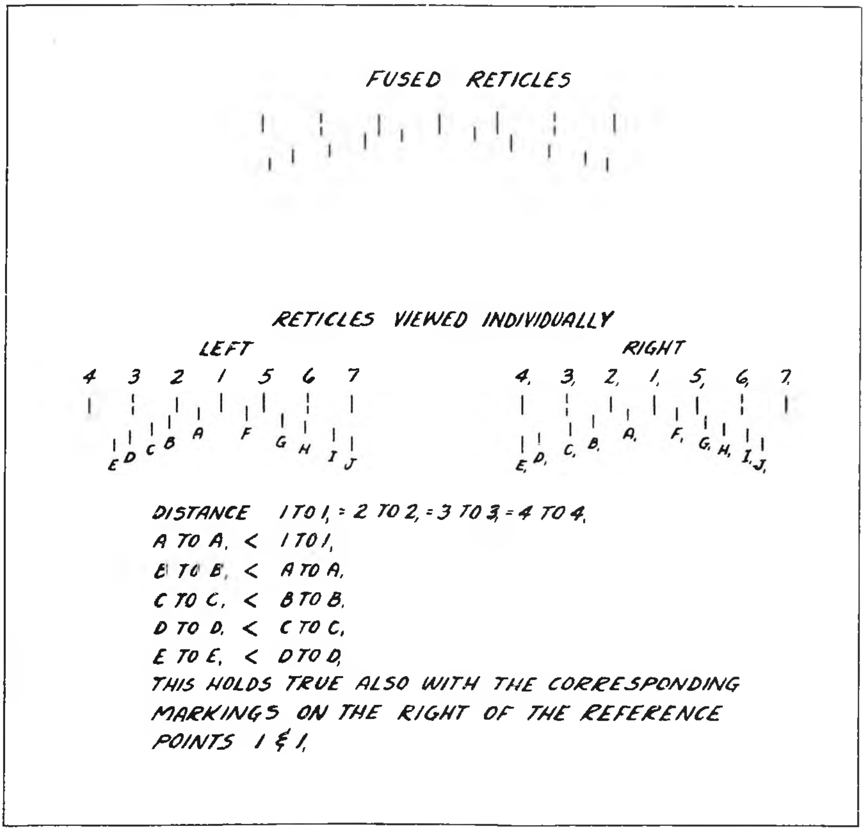


FIGURE 65. - JAPANESE HEIGHT FINDER, 2-METER BASE - RETICLES

d. Optical function. - In the M2 height finder, stereoscopic contact is obtained by rotation of diasporameter or measuring wedges, whereas the Japanese instrument employs translation of a diasporameter pair along

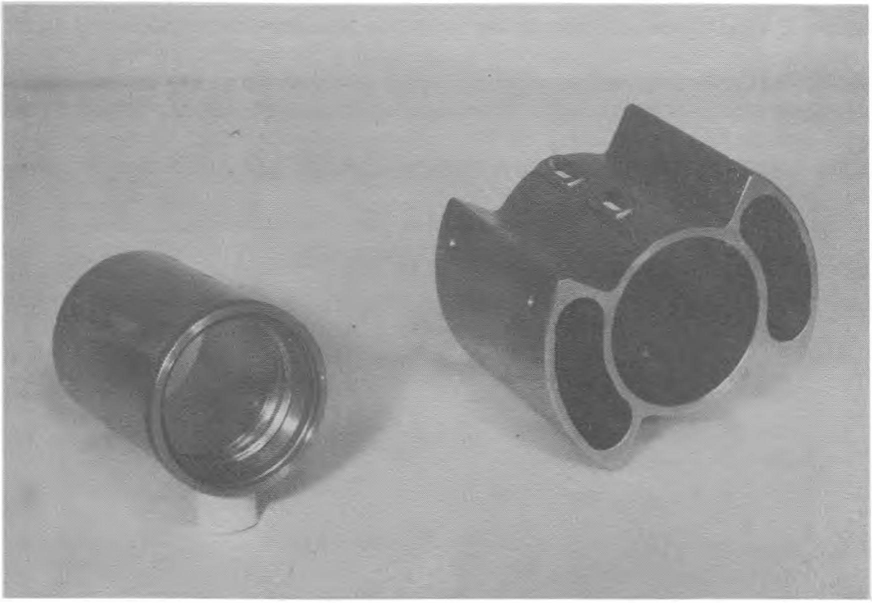


FIGURE 66. - JAPANESE HEIGHT FINDER, 2-METER BASE - OBJECTIVE LENS AND CELL, AND HOUSING ASSEMBLY

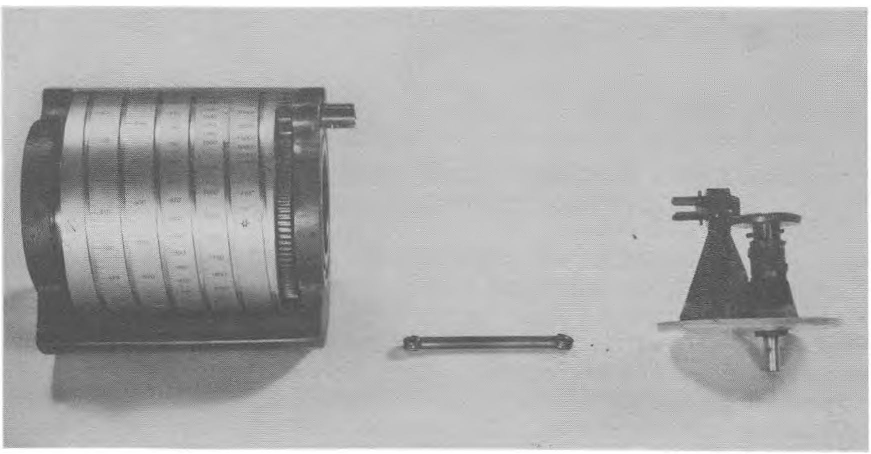


FIGURE 67. - JAPANESE HEIGHT FINDER, 2-METER BASE - MEASURING DRUM, CONNECTION, AND STOP MECHANISM

the optical tube to create stereoscopic contact. In the Japanese height finder the height or altitude of the target is measured by rotation of each element of both pairs of diasporameter wedges (compensating-wedge assemblies) through an angle which is equal to the angle of the target above the horizontal. Stereoscopic contact in height measurement, however, is still obtained by translation of the translatory-wedge pair along the tube after both pairs of wedges have rotated through the angle of elevation.

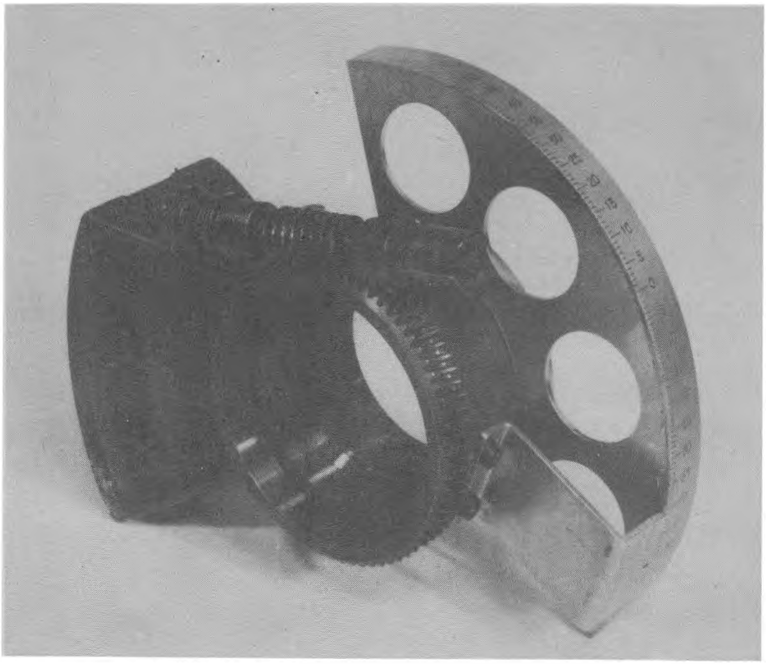


FIGURE 68. - JAPANESE HEIGHT FINDER, 2-METER BASE - CORRECTION-WEDGE ASSEMBLY

67. PRINCIPLES OF OPERATION. - a. Using the schematic diagram (fig. 63), the principles employed in the Japanese height finder can be readily followed. When the two images of an aircraft fall on corresponding parts of the two reticles, stereoscopic contact is obtained. Of course, there are two central prisms between the reticles for the purpose of presenting images to the two eyepieces. Each penta prism deflects any entering ray 90°. If the object, such as a star, may be considered infinitely distant, the two chief rays entering the penta prism of the height finder will be parallel to each other. Then, even if there were no wedge assemblies in the instrument, stereoscopic contact would result. However, as may be seen in the solid-line portion of the diagram, there are two wedge pairs so oriented that they cause the rays from the

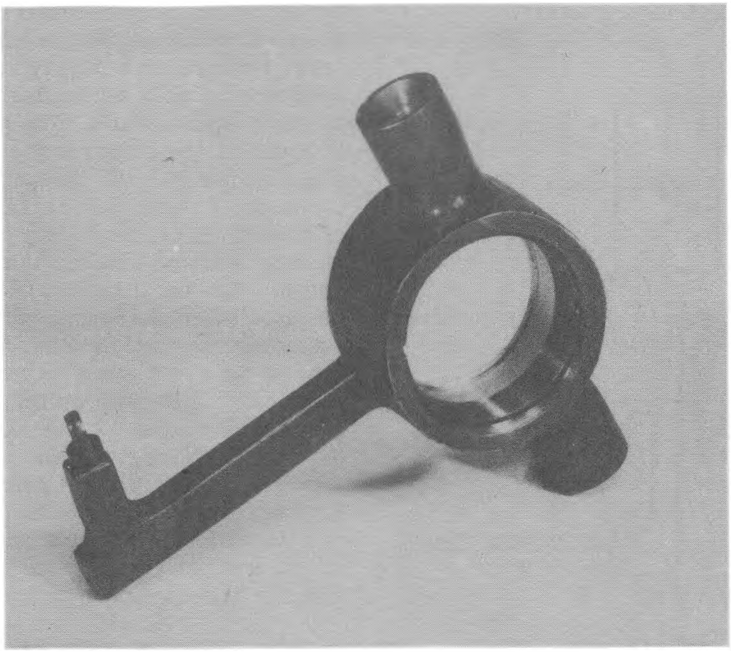


FIGURE 69. - JAPANESE HEIGHT FINDER, 2-METER BASE - HEIGHT-OF-IMAGE PLATE

right penta prism to intersect the right reticle at the proper point. The fixed rotary-wedge pair is thinner and deflects light less than the translatory-wedge pair. For reading ranges, the translatory assembly functions exactly as the measuring wedge in a range finder. Thus, if the target is close at hand, say 400 yards, the chief ray, represented by a dotted line, enters at a parallactic angle to the chief ray from ∞. Since it is deflected 90° by the penta prism and still more by the fixed-wedge assembly, it must be brought back to the position of stereoscopic contact on the reticle by moving the translatory-wedge assembly. Therefore it is obvious that, for a new target, the translatory wedge must be moved closer to the fixed wedge in order to give the dotted ray more space in which to be brought back to the proper position on the reticle.

(1) For reading ranges it can be seen that no rotary or diasporameter action of the prisms is needed. However, for reading height directly, each wedge pair rotates so that its components revolve through an angle which is equal to the angle of elevation of the target. When the instrument is set in the height position, each component of each pair is given an initial rotation of 90°. In this diasporameter action the resultant deviation is always in the plane of triangulation. The devia-

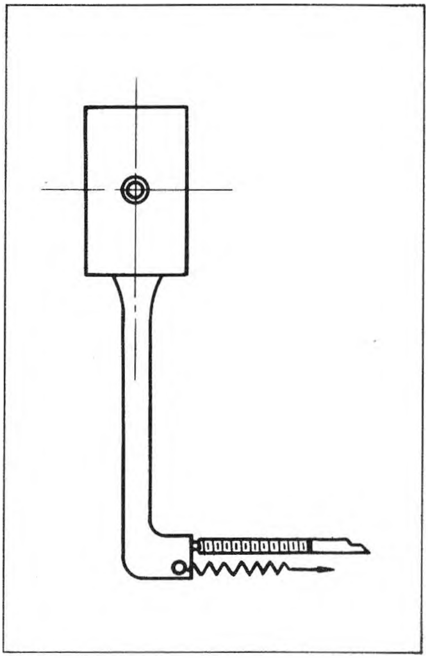


FIGURE 70. - JAPANESE HEIGHT FINDER, 2-METER BASE - HEIGHT-OF-IMAGE PLATE

tion in a plane perpendicular to the plane of triangulation is always zero, because the component wedges of a pair neutralize each other in such a plane. The height is equal to the slant range multiplied by the sine of the angle of elevation. Therefore, for all angles of elevation less than 90° the height reading will be smaller than the range. As the height finder is elevated when reading height, the diasporameter action is such as to weaken the deviating power of each pair (i.e., to multiply the original deviation of the pair by the sine of the angle of elevation). Hence, the translatory pair will have to be moved toward the fixed pair in order to produce stereoscopic contact at a value lower than the range reading.

68. CONSTRUCTION. - The Japanese height finder consists of three major assemblies:

a. The outer tube. - Made of seamless steel tubing, the outer tube is pierced with seven openings for adjustments, all of which are sealed with cover plates. There also are openings for the eyepiece assembly, wedge windows, infinity correction lens assemblies, range knob, height-of-image knob, correction-wedge assembly, range-drum window, and reticle-light windows. Welded to the outer tube are two races for the heavy assembly of the elevation housing. A machined surface is also provided for the ring-gear assembly which is used to rotate the wedges. Machined surfaces are provided at each end of the tube for the penta-prism holders.

(1) The following parts are screwed directly to the outer tube:

Penta-prism assemblies.
Infinity correction lens assemblies.
Reticle-light windows.
Range drum.
Eyepiece assembly.
Correction-wedge assembly.
Rotating-wedge gear assembly.
Objective-wedge windows.

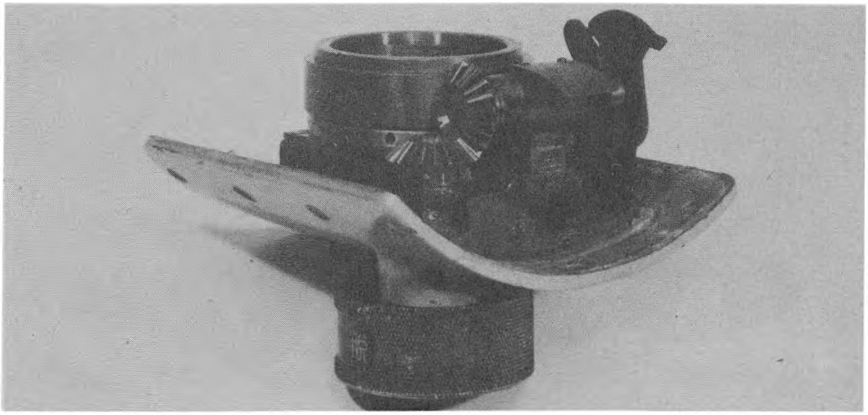


FIGURE 71. - JAPANESE HEIGHT FINDER, 2-METER BASE - INFINITY CORRECTION LENS ASSEMBLY ("OFF" POSITION)

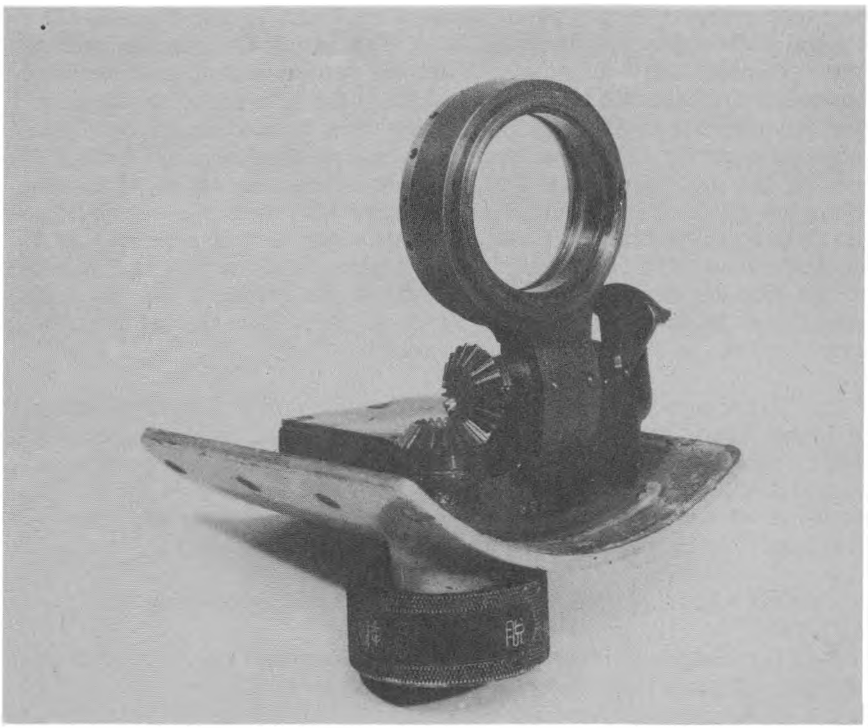


FIGURE 72. - JAPANESE HEIGHT FINDER, 2-METER BASE - INFINITY CORRECTION LENS ASSEMBLY ("ON" POSITION)

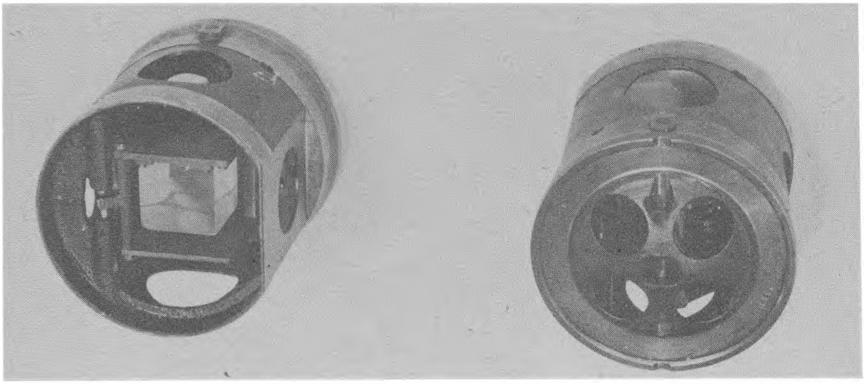


FIGURE 73. - JAPANESE HEIGHT FINDER, 2-METER BASE - PENTA-PRISM ASSEMBLIES, FRONT AND REAR

b. Optical bar. - The machining of the seamless steel optical bar is the best example of machine work found in any Japanese fire-control instrument examined to date. The inside and outside surfaces are well machined, and locating holes for subassemblies are accurately positioned. Connected to the outer side of the tube and approximately 1 foot from each end are two rings. The ring located on the left side is screwed securely to the optical tube and has three legs 1/2 inch in diameter and 3/4 inch long protruding at equidistant points about the tube. When the optical bar is placed in the outer tube these three legs fit accurately to a machined surface, thus centering the bar correctly within the outer tube. The ring located on the right side of the tube is connected to the tube by two pivots acting on the same principle as the gimbal joint found in our 1-meter-base range finder. Thus the optical tube is suspended in the outer tube by two points.

(1) Connected also to the outside of the optical tube is the height-of-image assembly, which consists of the screw, tension spring, and height-of-image support. Screwed to the outside of the tube are the six supports which hold the translatory-wedge assembly in position. The sequence of subassemblies in the optical tube, starting from the left side, is:

(a) Left objective lens and cell (eight holding screws).

(b) Height-of-image plate (held in place by two pivot-point screws, allowing the plate to be moved with a rocking motion.

(c) Central prism assembly (eight holding screws, four locating pins).

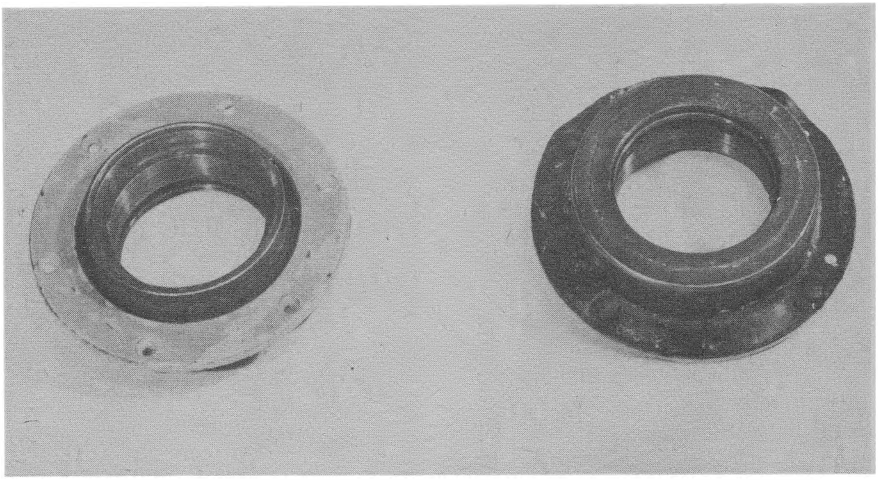


FIGURE 74. - JAPANESE HEIGHT FINDER, 2-METER BASE - WEDGE WINDOWS, FRONT AND REAR

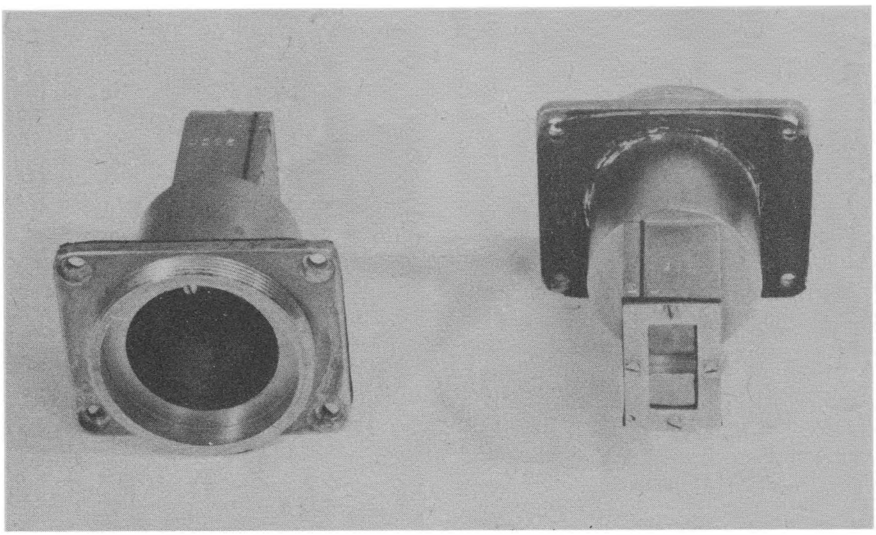


FIGURE 75. - JAPANESE HEIGHT FINDER, 2-METER BASE - RETICLE LIGHT WINDOWS, FRONT AND REAR

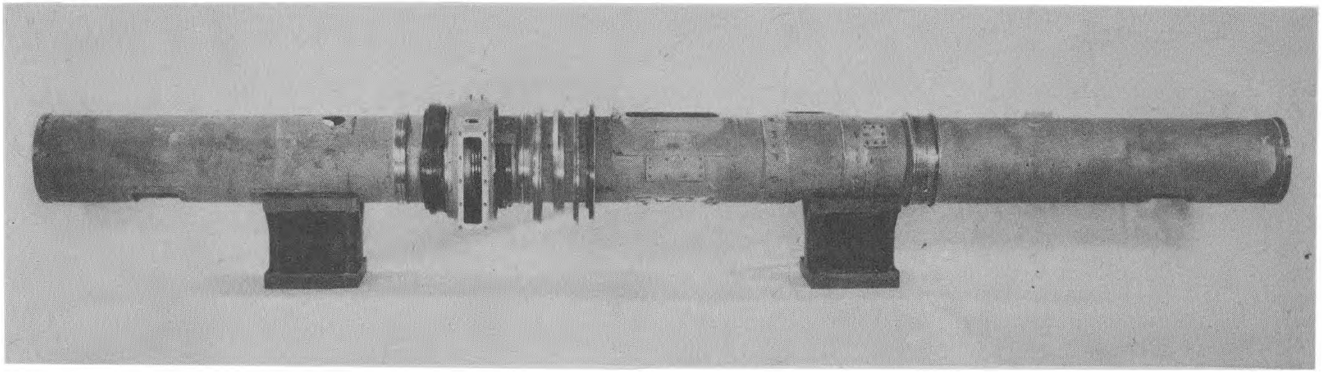


FIGURE 76. - JAPANESE HEIGHT FINDER, 2-METER BASE - OUTER TUBE, REAR

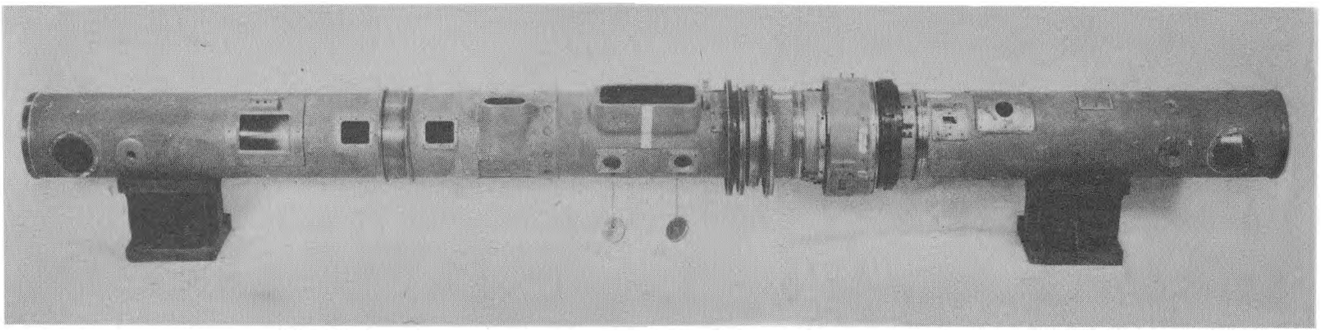


FIGURE 77. - JAPANESE HEIGHT FINDER, 2-METER BASE - OUTER TUBE, FRONT

(d) Translatory and rotary wedge assembly (six supporting points).

(e) Right objective lens and cell (eight holding screws).

(f) Rotary wedges and gear assembly (six holding screws, four locating pins).

c. Elevating mechanism. - The mechanism controlling elevation consists of three major subassemblies:

(1) Elevation-worm segment, elevation worm, and anti-backlash spring assembly; elevation housing stops and elevation-gear assembly; and elevation scale.

(2) Altitude ring gear assembly with locking device.

(3) Elevation-housing assembly, consisting of elevation housing, two bearing races, level vial, and holder; elevation-scale index; and elevation-scale window.

69. SEALING AND LUBRICATION. - a. Primarily, sealing of the Japanese height finder has been accomplished with rubber gaskets. The eye lens and wedge windows are sealed with a compound similar to our black navy. Some of the screws are staked with solder.

b. The lubricant used is similar to our grease, special, low temperature. The only assembly that must be lubricated is the elevation mechanism, worm segment, worm, and ring gear.

70. ADJUSTMENTS. - The adjustments described below can be done only by a base shop or arsenal and must not be attempted in the field.

a. Obtain clear definition of the reticles, with proper diopter reading (+2 -4) by adjusting eye and field lens.

b. Aline reticle or eliminate tilt of reticle. This may be accomplished by moving the eye and field lens housing from left to right or up and down.

c. Move objective lens in or out to obtain clear definition of field of view.

d. Move objective lens in or out to eliminate parallax.

e. Eliminate tilt of image by adjusting penta prisms. There are six adjusting screws on each penta-prism holder.

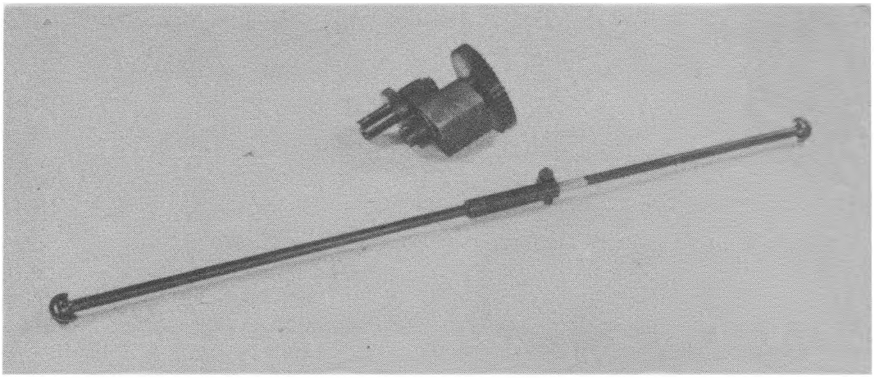


FIGURE 78. - JAPANESE HEIGHT FINDER, 2-METER BASE - ROTATING-WEDGE GEAR ASSEMBLY AND ADJUSTABLE CONNECTION ROD

FIGURE 79. - JAPANESE HEIGHT FINDER, 2-METER BASE - ELEVATION WORM AND ANTI-BACKLASH SPRING ASSEMBLY

f. Adjust for proper height of image by adjusting left penta prism. First make sure that the height-of-image knob is in the center of its movement.

g. Adjust the translatory wedges by disengaging gears and rotating wedges independently. When adjusted, the wedges are vertical to the instrument, with the outside wedge base up and the inside wedge base down.

h. Adjust the rotary wedges by disengaging gears and rotating wedges independently. When properly adjusted, outside wedge is off at approximately 30° to the left of the vertical.

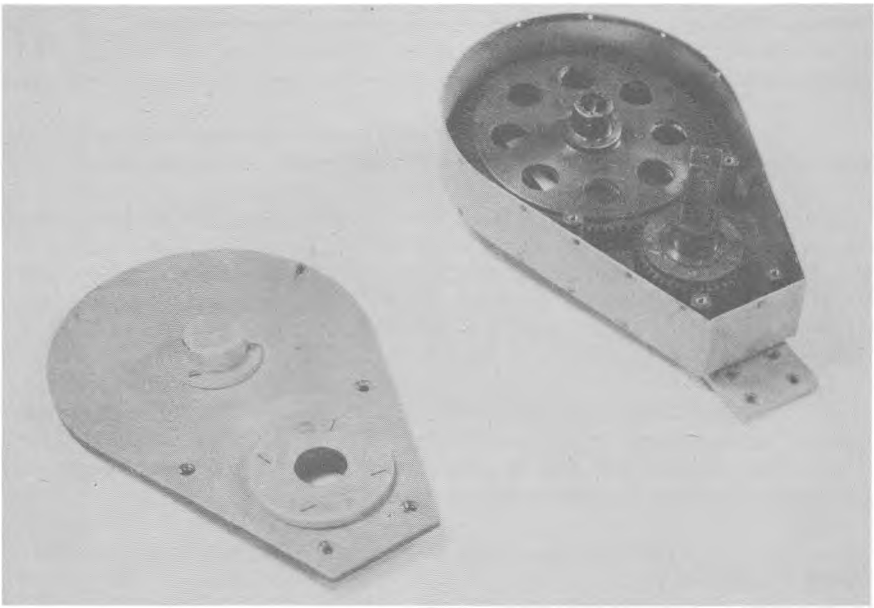


FIGURE 80. - JAPANESE HEIGHT FINDER, 2-METER BASE - ELEVATION GEARS AND HOUSING

i. Adjust range drum by means of split connection rod.

j. Adjust correction wedge by setting correction scale at zero and rotating wedge windows.

k. Adjust level vial. If a slight error is present, correction may be made by resetting the elevation scale. Larger errors may be corrected only by resetting the level vial in plaster of paris.

CHAPTER 3

SIGHTING EQUIPMENT

SECTION I

GERMAN ANTITANK TELESCOPE, Z.F.

71. HISTORY. - This instrument was removed from a 28/20 Gerlich antitank gun captured in the African theater of operations.

72. NAME-PLATE DATA. - The following inscriptions are present on the telescope (fig. 81): "C.Z. 56 M. Nr. 2821, Z.F. 1 x 11°." "C.Z." is interpreted to mean Carl Zeiss, "56 M." the model number, and "2821" the serial or patent number. "Z.F." is the abbreviation for zielfernrohr (telescope sight) and "1 x 11°" indicates the power and field of view.

73. GENERAL DESCRIPTION. - a. Type. - This telescope is a 1-power erect-image telescopic aiming instrument with a field of view of 11°. The reticle (fig. 83) is graduated to give the necessary right or left lateral lead for estimated target speeds.

b. Component parts. - The telescope, Z.F., consists of the following component parts:

(1) Tube-body and mount-adapter assembly (fig. 82A).
(2) Eyepiece assembly (fig. 82B).
(3) Erector and reticle assembly (fig. 82C).
(4) Objective assembly (fig. 82D).

c. Tube-body and mount-adapter assembly. - This assembly consists of a tube with a mount adapter and receptacle for a night-lighting device welded to it. Machined into the tube is an integral internal diaphragm. The mount adapter is the male portion of a dovetail fit, the female portion being a permanent mount on the gun.

d. Eyepiece assembly. - The eyepiece assembly is made up of the eyepiece cell (fig. 82B-1) and the eye and field lenses (fig. 82B-2 and B-4),

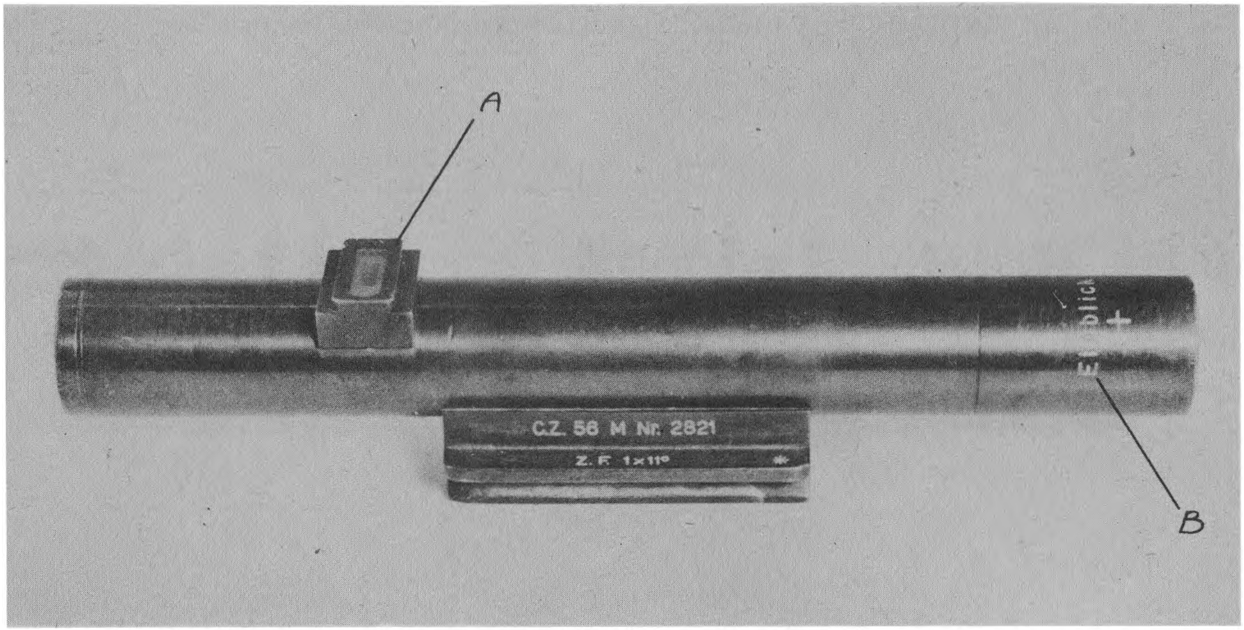


FIGURE 81. - GERMAN ANTITANK TELESCOPE - COMPLETE

A. Lighting window B. Eyepiece

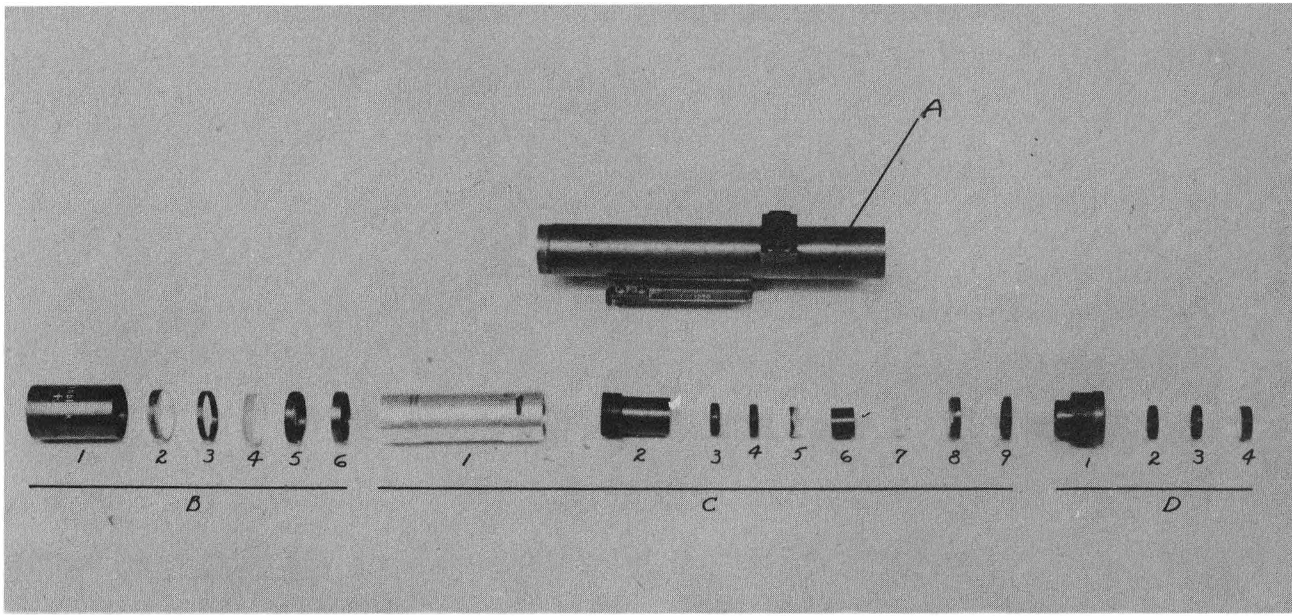


FIGURE 82. - GERMAN ANTITANK TELESCOPE - COMPONENTS

which fit into the eyepiece cell. The two lenses are separated by a spacer (fig. 82B-3) and are held in the eyepiece cell by a retaining ring (fig. 82B-5) and locking ring (fig. 82B-6). The eyepiece assembly (fig. 81B), marked with the German word "einblick," screws onto the tube-body and mount-adapter assembly.

e. Erector and reticle assembly. - This assembly is made up of:

(1) Erector assembly cell. - The erector assembly consists of two erecting lenses (figs. 82C-5 and C-7) separated by a spacer (fig. 82C-6) and held in the erector cell by a retaining ring (fig. 82C-4) and locking ring (fig. 82C-3). The erector assembly screws into the reticle cell.

(2) Reticle cell. - The reticle cell (fig. 82C-8) is graduated with three horizontal lines and one vertical line. The numerals 4, 6, 8, and 12 are etched on the reticle (fig. 83). It is a fair conjecture to say that the unit of measurement is 100 meters. The reticle is held in the reticle cell by a retaining ring (fig. 82C-9) and is so placed that its etched graduations can be illuminated through the night-lighting device windows

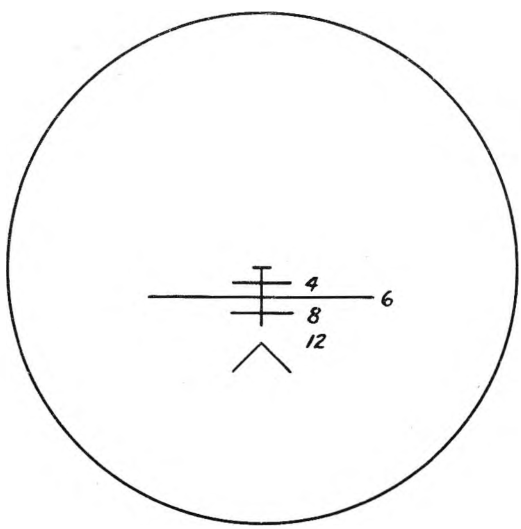


FIGURE 83. - GERMAN ANTITANK TELESCOPE - RETICLE

(fig. 81A). The erector and reticle assembly slides into the tube-body and mount-adapter assembly and is held in place by two setscrews.

f. Objective assembly. - The objective assembly consists of an objective cell (fig. 82D-1) containing the objective lens (fig. 82D-4), retaining ring (fig. 82D-3), and locking ring (fig. 82D-2).

74. CANNIBALIZATION OF THE TELESCOPE. - The optical system of the German antitank telescope, Z.F., is similar in many respects to that employed in the American telescope, M6.

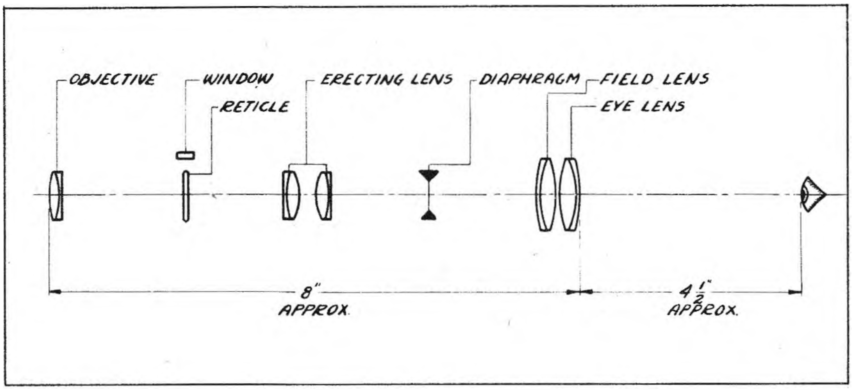


FIGURE 84. - GERMAN ANTITANK TELESCOPE - OPTICAL SYSTEM

a. Both instruments are used on antitank guns. (The telescope, M6, is used on the American 37-mm antitank gun.)

b. The arrangements for use of a night-lighting device differ in the fact that on the American model the illumination is from the under side of the instrument, whereas on the German telescope illumination is from the top (fig. 39).

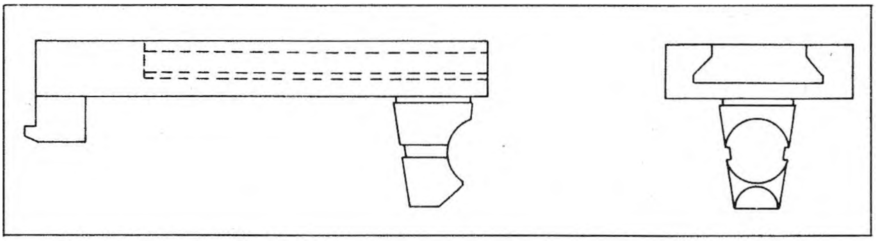


FIGURE 85. - PROPOSED ADAPTER FOR USE OF GERMAN ANTITANK TELESCOPE ON TELESCOPE MOUNT, M19

c. The standard and special tools used to disassemble the American telescope, M6, are sufficient to disassemble the German telescope.

d. The reticle used in the American telescope, M6, will fit into the reticle cell of the German instrument. This is an important fact. In the event German telescopes are captured in quantity, the reticle used in the telescope, M6, may be used to replace the German reticle.

SECTION II

GERMAN 81-MM MORTAR SIGHT

75. GENERAL. - The German 81-mm mortar sight is used in laying the German 81-mm mortar in azimuth and elevation. The sight embodies means for obtaining right or left lateral deflection, elevation, or depression and a collimating sight for sighting on an aiming point.

76. CONSTRUCTION. - a. The sight is made up of the following main assemblies:

Collimator.
Elevating mechanism.
Lateral deflection mechanism.
Longitudinal level.
Cross level.
Mounting plate.
Body.
Head with mirror assembly.

b. These main assemblies are supported by a bracket with a base in which is the male portion of a dovetail fit; the female element is a part of the mortar yoke. The sight is held in the dovetail by a spring latch arrangement which is also a part of the yoke.

c. When the longitudinal level and cross level are centered, indicating a cross-level condition, elevation angles will be from a true vertical plane and angles of deflection from a true horizontal. The longitudinal level also provides a datum line for elevation settings.

d. When the instrument is level and the collimator set to zero on its scale, the collimator establishes a vertical line in the field of view, the line of sight with zero deviation being parallel to the plane of fire. The collimator, being pivoted, may be elevated or depressed as required

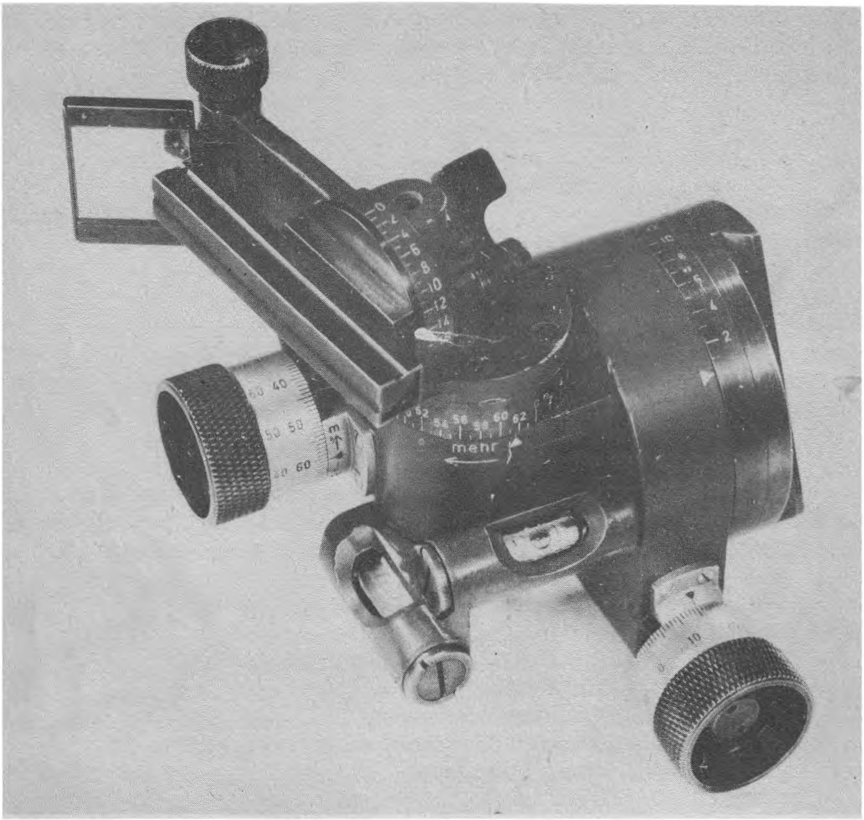


FIGURE 86. - GERMAN 81-MM MORTAR SIGHT - COMPLETE

to bring the aiming point into the field of view. The collimator is moved independently of the elevating mechanism and thus does not affect the elevation-scale settings.

77. COMPONENTS (fig. 87). - a. Deflection-worm and worm-wheel assembly. -

Locking screw, deflection-micrometer knob.
Deflection-micrometer knob.
Deflection-micrometer scale.
Adapter, deflection knob and micrometer.
Throw-out lever.
Eccentric bushing locking collar.
Throw-out lever adapter.
Torsion-spring adapter.

Torsion spring.
Eccentric bushing.
Deflection worm.
Deflection worm wheel locking screw.
Level-vial housing assembly.
Main housing assembly.
Deflection worm wheel.
Head, collimator mount, and mirror.
Collimator.

b. Elevation assembly. -

Elevation-worm plug.
Elevation-worm eccentric bushing.
Elevation worm.
Elevation-micrometer knob and scale adapter.
Elevation-micrometer scale.
Elevation-micrometer knob.
Elevation-knob locking screw.
Elevation worm wheel.
Elevation worm wheel locking screw.
Mounting plate.

78. ELEVATION SCALE. - The elevation scale is graduated from 0 to 1,600 mils. This is one quadrant or, in terms of degrees, 0° to 90°. The scale is graduated in increments of 2 x 100/6400 and supplemented by a micrometer graduated from 0 to 100 in increments of 10. Each of these divisions is divided into ten parts, resulting in a graduation for each integer from 0 to 100.

79. LATERAL DEFLECTION SCALE. - The lateral deflection scale is graduated from 0 to 64, which is an employment of the standard mil system of measurement. The scale is supplemented with a micrometer reading from 0 to 100 and graduated with two sets of Arabic numerals, one clockwise and the other counterclockwise. The normal deflection indicated on the scale is zero. Directions for left or right deflection are indicated by arrows and the words "mehr" (more) and "weniger" (less), respectively.

80. COLLIMATOR SIGHT. - The collimator sight consists of a reticle having a horizontal and vertical located at the focal length of a single eye lens which is part of the collimator assembly. The collimator scale is graduated from 0 to 16, representing 0 to 1,600 mils.

81. COMPARISON WITH AMERICAN MORTAR SIGHT. - a. The elevation scale of the German instrument is graduated in mils.

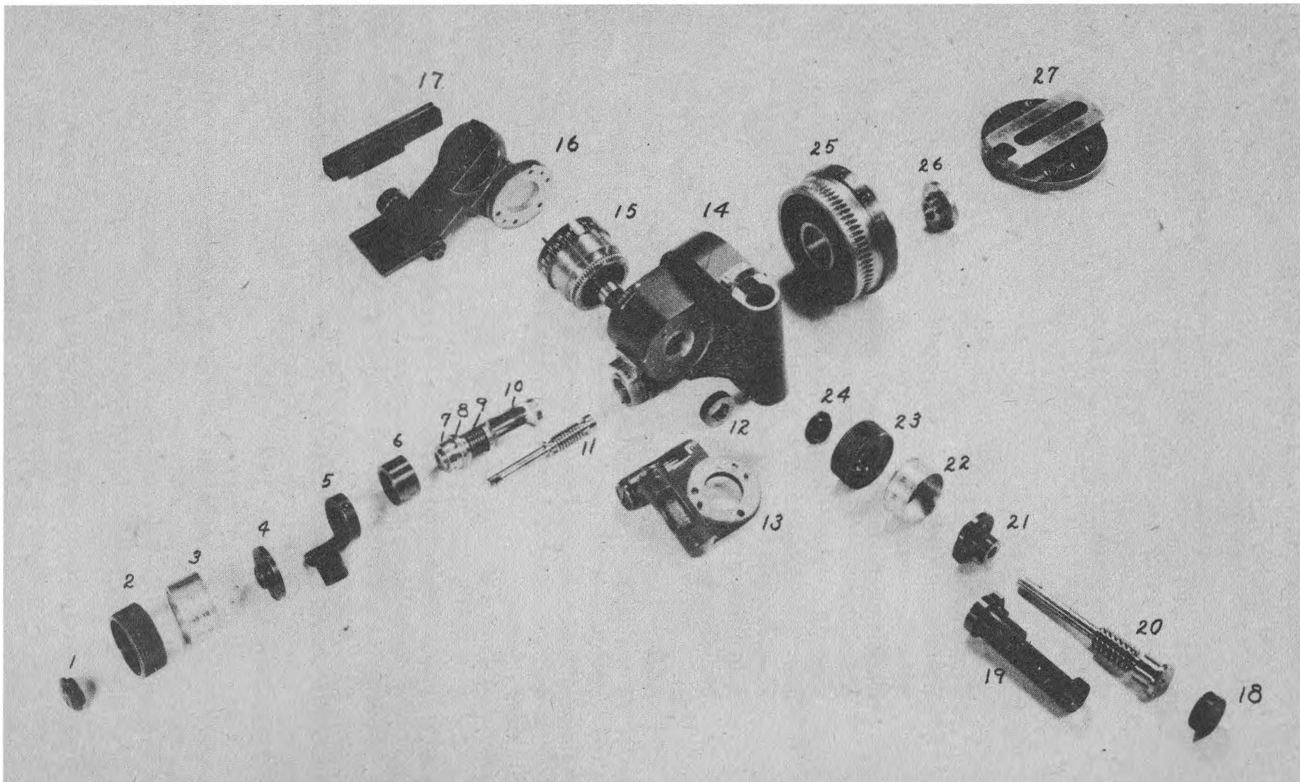


FIGURE 87. - GERMAN 81-MM MORTAR SIGHT - EXPLODED VIEW

b. The German sight has grooves on the top and sides of the collimator for use as open sights.

c. The collimator is provided with a scale, graduated from 0 to 1,600 mils, and a locking device, and may possibly be used for direct fire.

d. The German sight has a mirror mounted on a hinged bracket in front of the collimator. This mirror may be used when sighting on aiming stakes placed to the side of or behind the mortar. It is also possible that the mirror can be used to illuminate the reticle of the collimator.

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