TM 9-585

WAR DEPARTMENT

TECHNICAL MANUAL

RANGE FINDER M9

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No. 9-585

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CONTENTS

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Section I

INTRODUCTION

1. PURPOSE AND SCOPE.*

a. This manual is published for the information and guidance of the using arms and services.

b. Disassembly, assembly, and such repairs of the materiel as may be handled by the using arm personnel are described in this manual. They will be undertaken only by the battery mechanic.

c. In all cases where the nature of the repair is beyond the scope or the facilities of the unit, the responsible ordnance service should be informed in order that trained personnel, with suitable tools and equipment, may be provided, or proper instructions issued for the performance of the work.

d. Instructions for storage and shipment are not included in this manual.

2. CHARACTERISTICS.

a. The range finder is an optical instrument used for measuring the distance of a target or other object.

b. The range finder is used without a tripod by resting it upon any secure object approximately the height of the observer.

c. The observer, looking into the range finder eyepiece, sees two images of the target in his field of view. The combined images appear as an upper inverted image and a lower erect image, separated by a halving line. To measure range, the observer turns the range measuring knob (fig. 7) to bring both images into coincidence at the halving line. When the two images have been brought into coincidence, the range is shown directly in yards on a calibrated range scale.

d. The range finder has a focusing lever and scale for focusing the image in the right eyepiece, an astigmatizer lever for elongating a point target, a filter selector lever, an auxiliary finder for locating the target, and necessary adjustment controls.

*To provide operating instructions with the materiel, this Technical Manual has been published in advance of complete technical review. Any errors or omissions will be corrected by changes or, if extensive, by an early revision.

INTRODUCTION

3. INSTRUMENT DATA.

Base length	1 meter
Magnification	14
Type of field	Coincidence, upper image inverted
Angular field of view, horizontal	3°0′
Angular field of view, vertical	2°10′
Diameter of objective	26 mm (1.04 in.)
Exit pupil	1.8 mm (0.07 in.)
Scale graduations	500 to 20,000 yds
Weight of range finder	16½ lb (7.5 kg) in fibre case

APPROXIMATE UNCERTAINTY OF OBSERVATION UNDER FAVORABLE CIRCUMSTANCES

Range	Error
500 yards	1 yard
1,000 "	3.8 yards
2,000 "	15 "
3,000 "	34 "
4,000 "	61 "
5,000 "	95 "

and so on, the error varying in proportion to the square of the distance.

Section II

DESCRIPTION

4. WHAT THE OBSERVER SEES.

a. Eyepiece. The eyepiece (figs. 2 and 4) is at the center of the range finder tube, to the rear. The soft rubber eyeshield serves as a cushion for the observer's forehead, and protects the eyes from extraneous light, cold, rain, or dust.

b. The Windows. The range finder has two windows at its ends (fig. 3). Each window has a cover attached to the body. The distance between window centers is one meter.

c. Split-field Images.

(1) The observer looking into the right eyepiece sees two images of the field of view, divided by a "halving" line (fig. 5). The lower image appears as a normal, erect image. The upper image appears inverted.

(2) Usually, when first observing a target, these images will appear displaced from each other by a small distance.

5. HOW SPLIT-FIELD IMAGES ARE FORMED.

a. It will be noticed that as the range finder is aimed on objects at different distances, the position of the images will move either together or apart. The reason for this is illustrated in figure 6. Each window receives a ray of light from the image. These two rays of light at the image form an angle with each other. The upper image is formed by the

DESCRIPTION

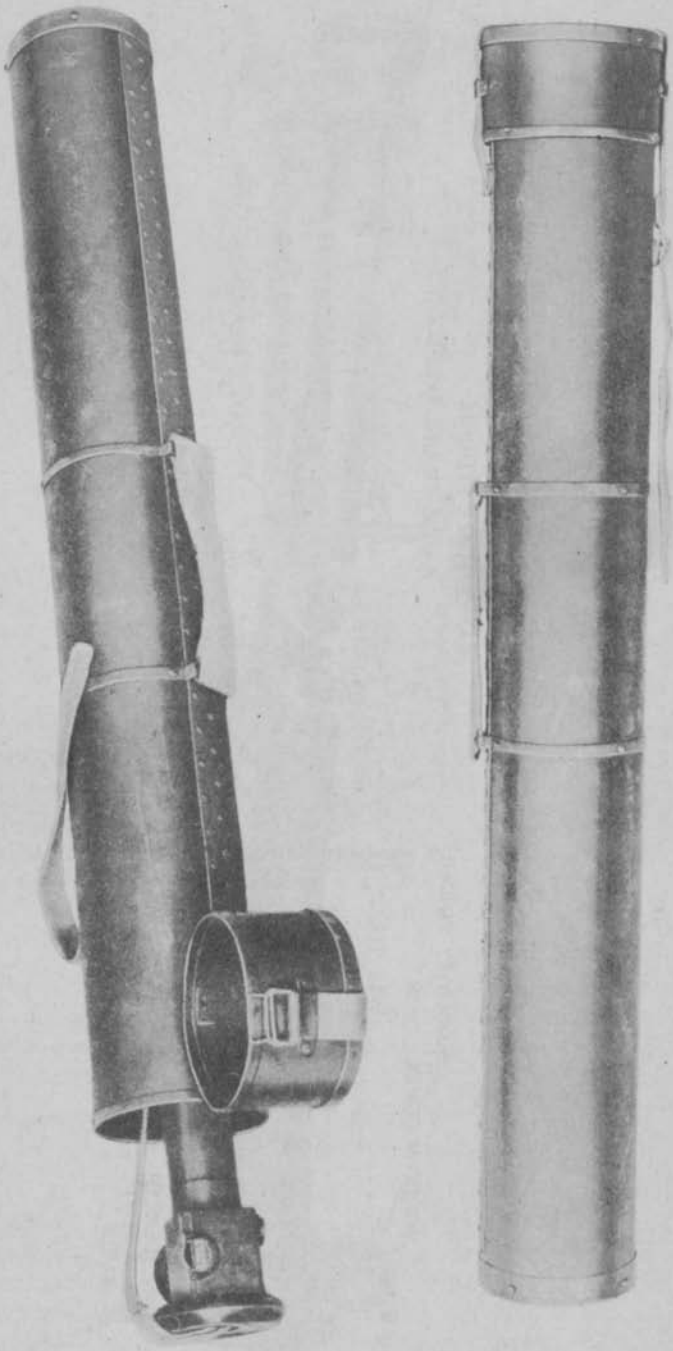

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Figure 1—Range Finder M9 in Case

RANGE FINDER M9

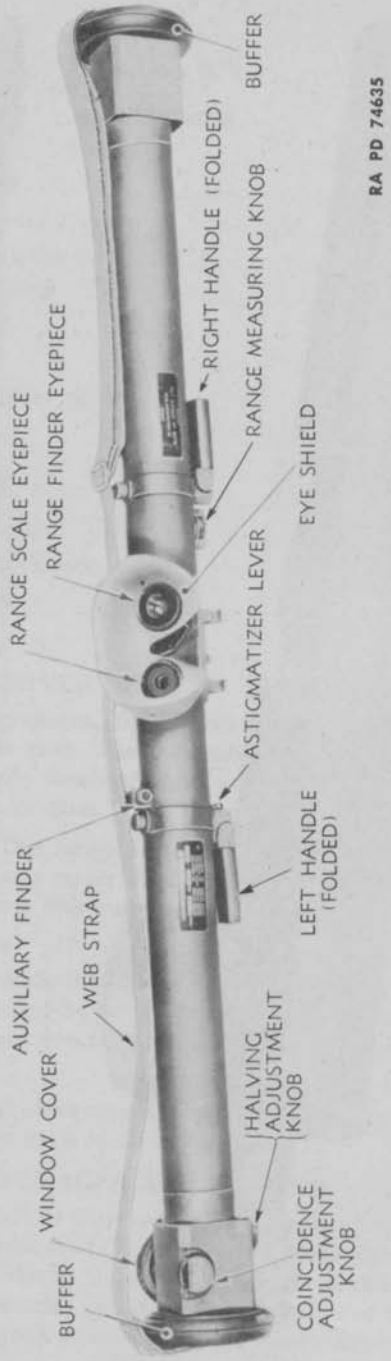

Figure 2—Range Finder M9—Rear View

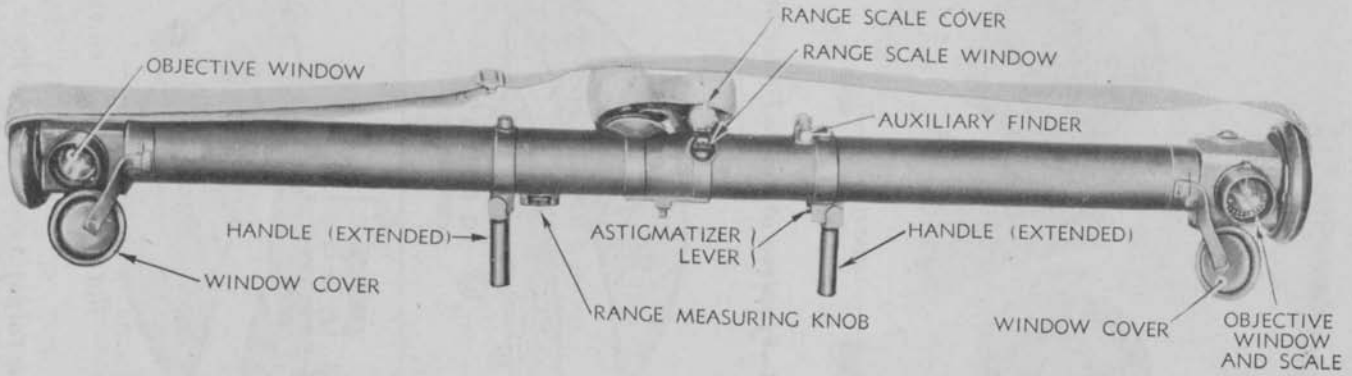

Figure 3—Range Finder M9—Front View

RANGE FINDER M9

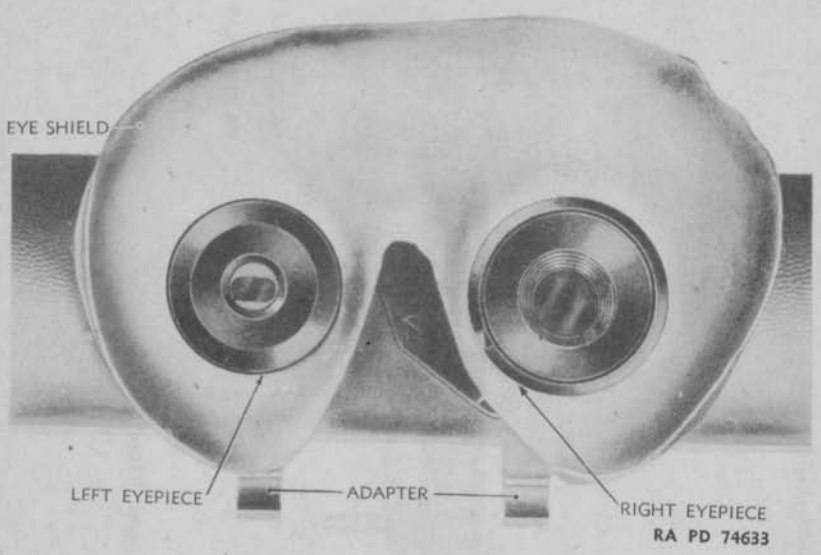

Figure 4—Eyepiece of Range Finder M9

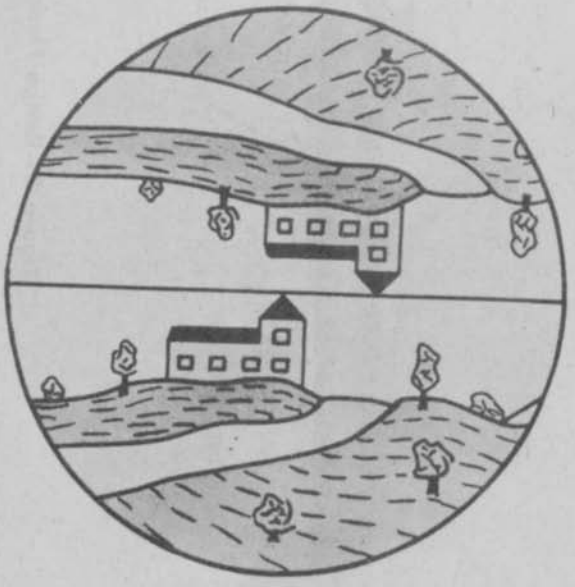

Figure 5—How Target Appears in the Right Eyepiece

DESCRIPTION

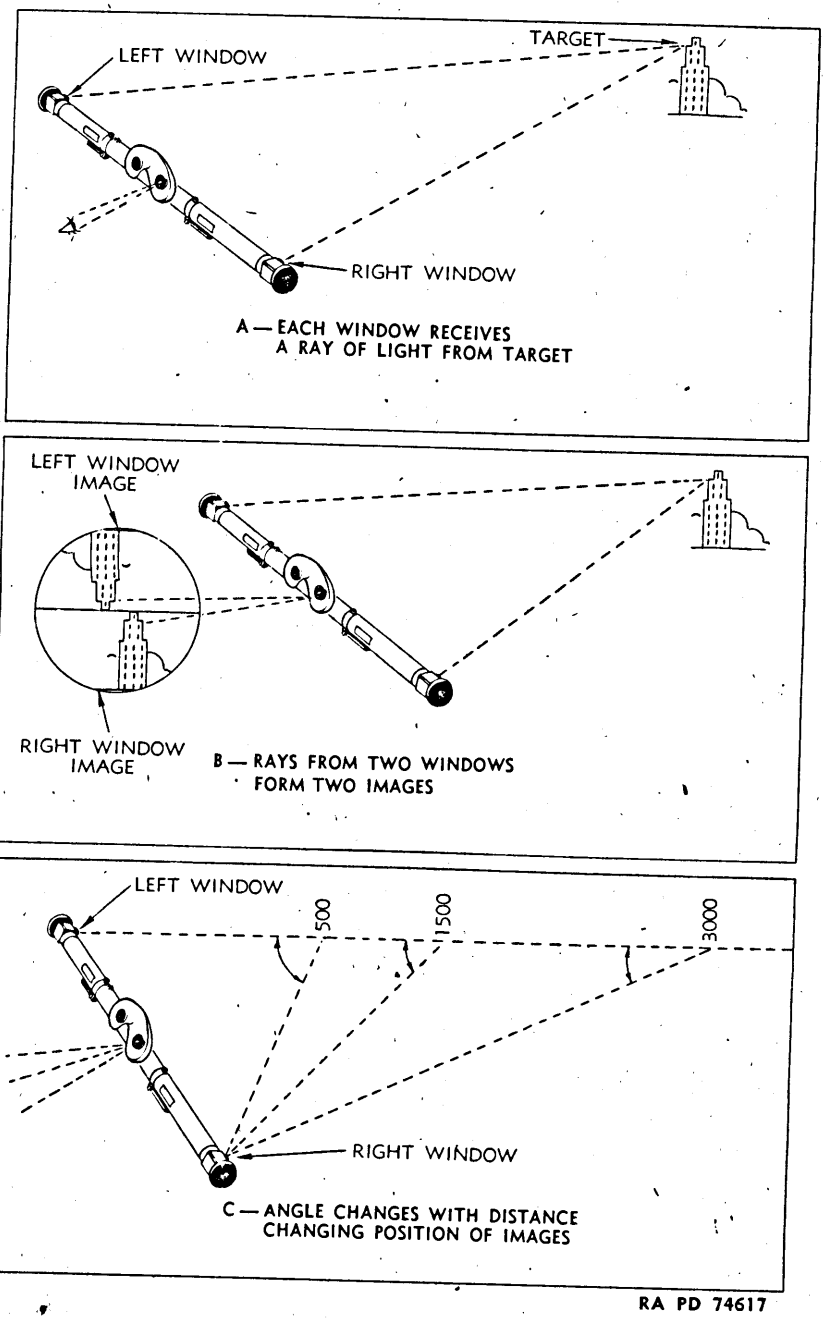

Figure 6—How the Split Field Images Are Formed

ray of light which passes through the left window, the lower image by the ray from the right window. As the range finder is aimed on targets of different distances, the angle between the two rays of light changes, and the position of the images changes.

6. WHAT RANGE MEASURING KNOB DOES.

a. Range Measuring Knob Moves Lower Image. The range measuring knob (figs. 2 and 7) controls a movable optical wedge which is located between the right window and the right eyepiece. By moving the range measuring knob, the wedge is moved causing the ray of light to be moved, and thus moving the lower image. This enables the operator to bring the images together into "coincidence."

b. Range Measuring Knob Moves Range Scale. The observer looking into left eyepiece sees a range scale (A, fig. 11). While continuing to look into the eyepiece, he turns the range measuring knob. It will be seen that not only will the lower image of the right eyepiece move, but the scale of the left eyepiece (range scale eyepiece) also will move. The range knob, thus, not only moves the lower image, but also correspondingly moves the range scale. The two images can be brought into coincidence by moving the range measuring knob. If the instrument is in correct adjustment (as described in section IV), the range scale will then read correct distance to the target.

7. ACCURACY OF RANGE READING.

a. The range measuring accuracy of the range finder depends on matching the two images accurately. A point is selected, like a chimney stack or church spire which can be easily matched. The range finder is first aimed on the target so as to center the upper image, and then the lower image is brought into coincidence.

b. The percentage of error (uncertainty of observation) becomes greater when ranging on distant objects. It is always necessary to be careful to obtain as exact coincidence as possible. Unless coincidence is exact, the observer is not measuring correct angles, and therefore not obtaining correct range.

8. RANGE SCALE.

a. The appropriate scale divisions are engraved on both sides of an ivory strip, and the indications are read against a black index mark. When viewed through the range scale window (fig. 10), the scale appears in its true horizontal position. When viewed through the left eyepiece, the scale is caused by a simple arrangement of prisms to appear to lie vertically (A, fig. 11), thus avoiding any interference of the scale image in the right eyepiece. At the extreme high range end of the scale there is engraved the "Infinity" line, marked by a star. The small divisions on either side of the "Infinity" graduation are pro-

DESCRIPTION

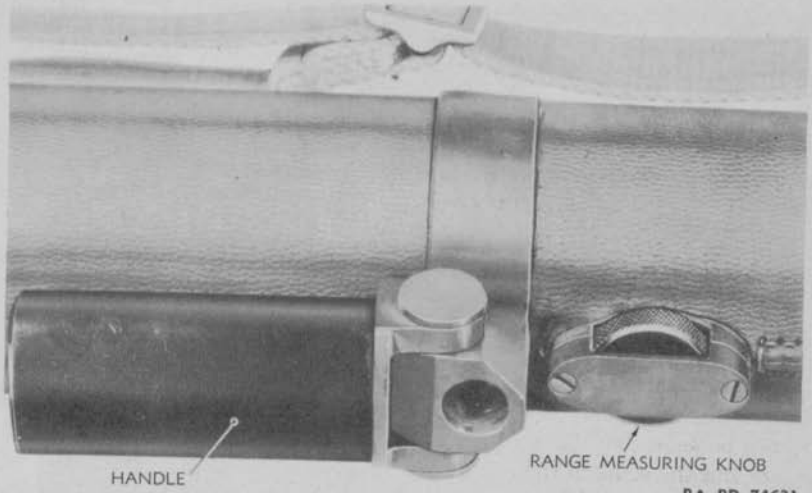

Figure 7—Range Measuring Knob

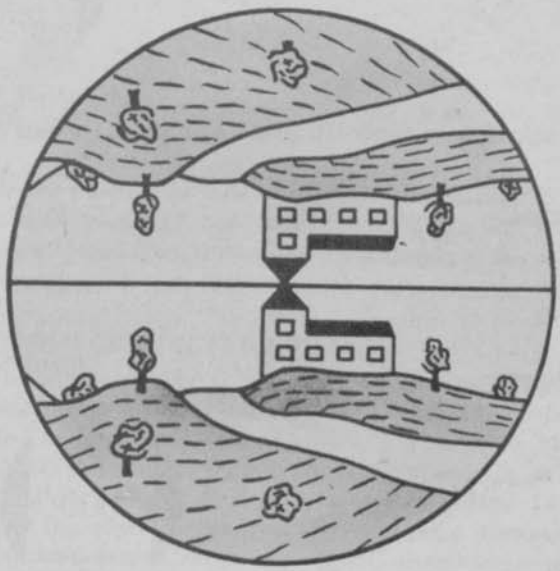

Figure 8—Images Brought into Coincidence

RANGE FINDER M9

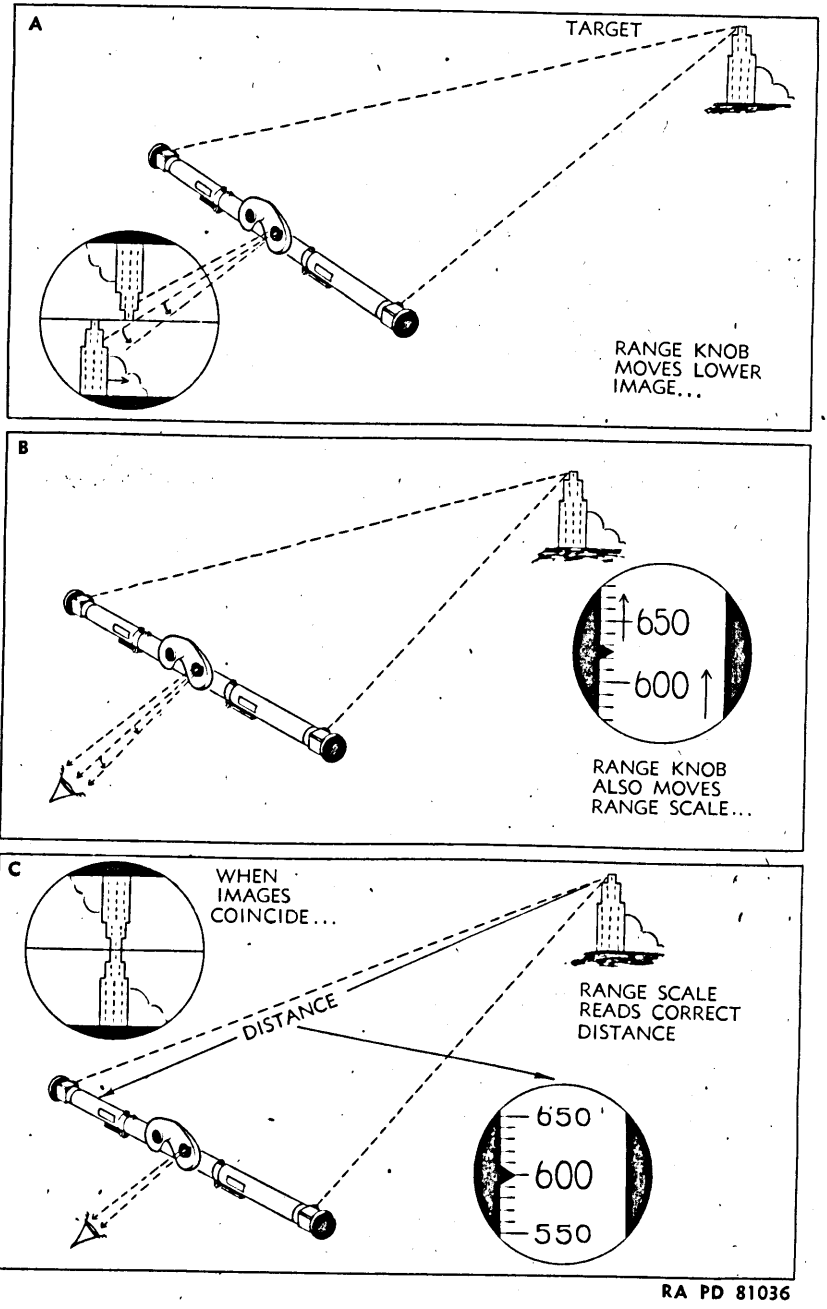

Figure 9—What the Range Measuring Knob Does

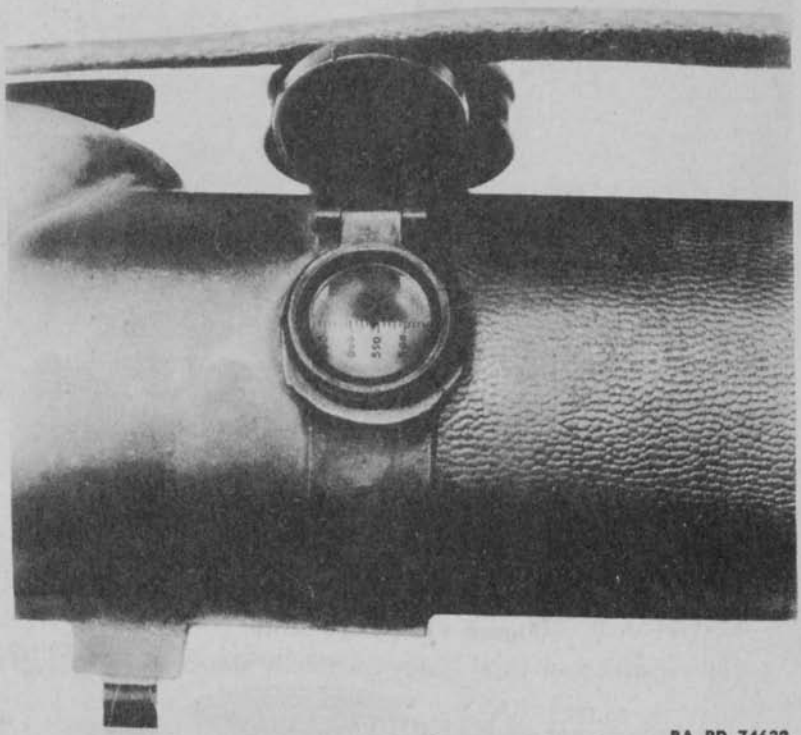

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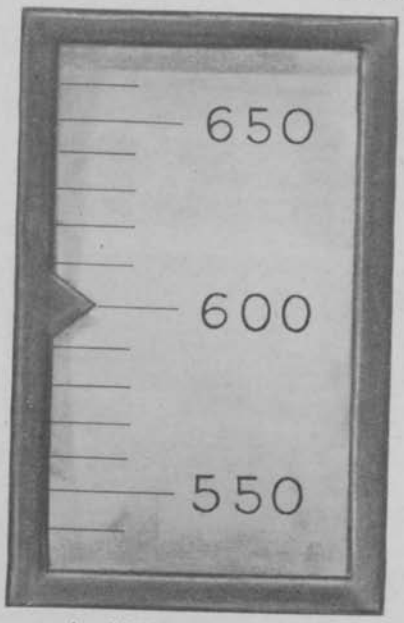
Figure 10—Range Scale Window and Range Scale

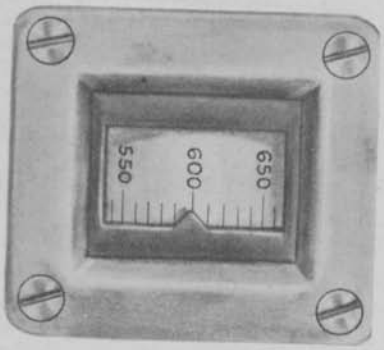
vided for the purpose of facilitating the adjustment (to correct errors in range scale reading) described in paragraph 20. The range scale graduations extend from minimum of 500 yards to maximum of 20,000 yards.

9. OPTICAL CHARACTERISTICS.

a. When the observer is in proper position, with forehead against the eyeshield, the whole boundary of the field of view (oval in form) is visible. The horizontal field of view is 3°0′, and the vertical field of view is 2°10′. All objects embraced within these angles are visible at one time. Objects in the field of view are magnified 14 times, which means that the objects appear as if viewed at a distance of one-fourteenth of their actual range. Exit pupil diameter is approximately 0.077 inch. The exit pupil is the bright disk seen in the eyepiece through which the light leaves the instrument to enter the observer's eye.



A — RANGE SCALE AS SEEN THROUGH LEFT EYEPIECE



B — RANGE SCALE AS SEEN THROUGH RANGE SCALE WINDOW

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Figure 11—Range Scale

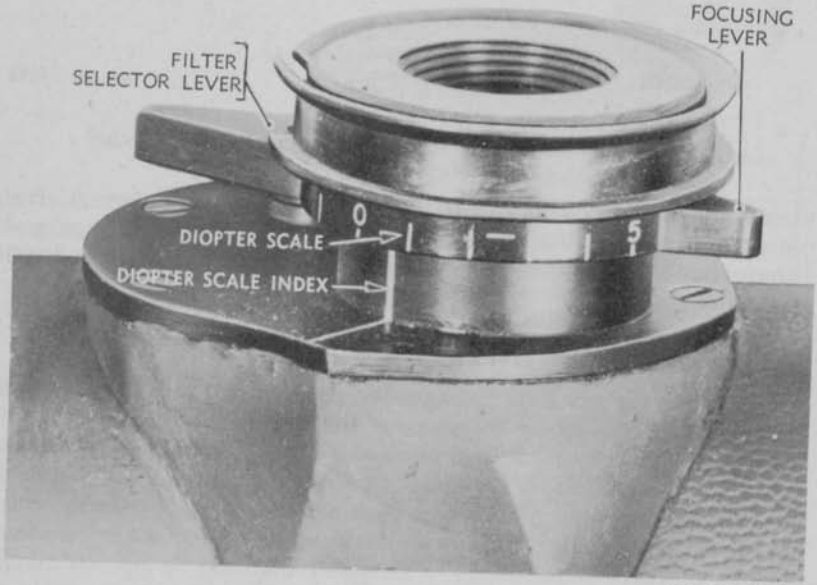

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Figure 12—Eyeshield Removed—Showing Diopter Scale and Focusing Lever

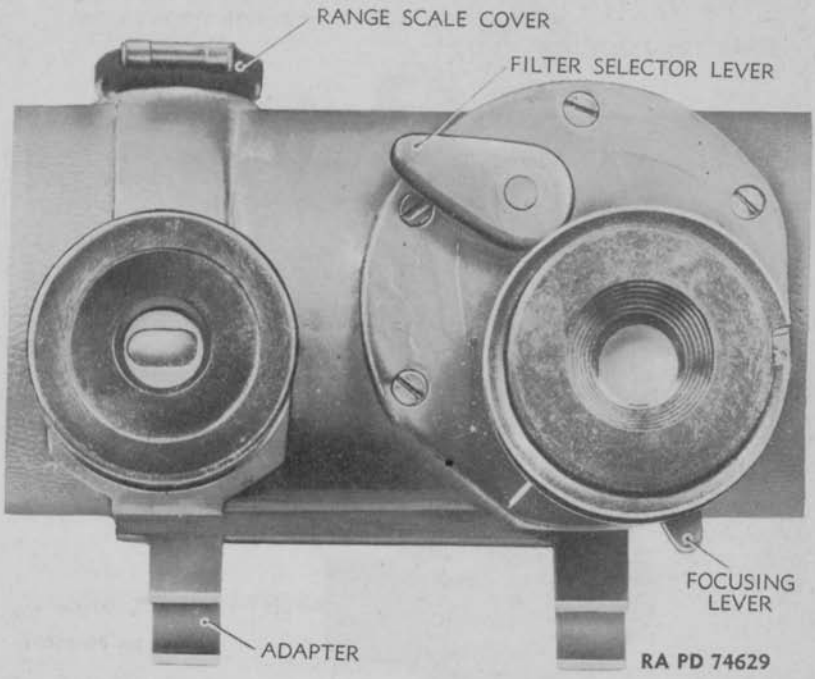


Figure 13—Eyeshield Removed—Showing Filter Selector Lever

10. FOCUSING LEVER AND DIOPTER SCALE.

a. The right eyepiece can be focused to suit the individual observer by means of the focusing lever and diopter scale (fig. 12). The diopter scale is graduated from 0 to 5 "diopters". Diopters are units of optical measurement. An observer who knows his own eye correction can prefocus the right eyepiece by setting the diopter scale to his known eye correction. The scale is read against the diopter scale index, which consists of a fixed white line adjacent to the movable diopter scale.

11. FILTER SELECTOR LEVER.

a. The filter selector lever (fig. 12) operates a set of light filters marked: "clear", "yellow-green", "smoke", "light blue". Moving the lever shifts the desired color filter into the field of view. This operation is performed to suit the existing conditions of visibility as explained in paragraph 23.

12. AUXILIARY FINDER.

a. The auxiliary finder (fig. 14), located a short distance to the left of the eyepiece (fig. 2), enables the operator to observe the field of view, pick up the target, and direct the range finder upon the target

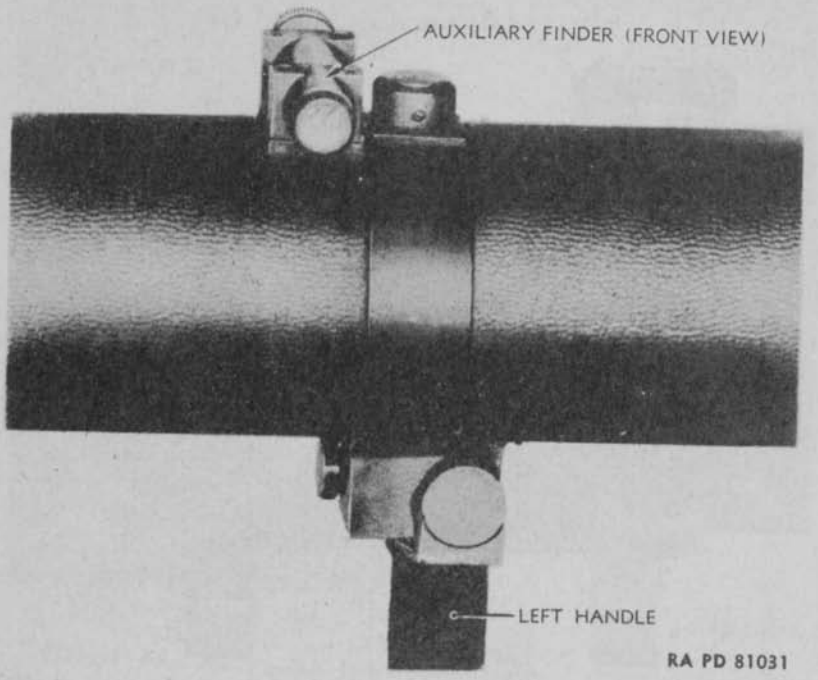


Figure 14—Auxiliary Finder

with the aid of crosslines. The crosslines are etched so that their intersection represents the center of the field of view of the instruments. This aids the operator to bear directly upon the desired aiming point.

13. ASTIGMATIZER LEVER.

a. The astigmatizer lever (figs. 2 and 3), when engaged, interposes into the field of view, a lens which has the effect of drawing out points of light into narrow streaks, perpendicular to the halving line.

b. When the astigmatizer is engaged (fig. 22), the streak in the upper and lower fields can be matched exactly and quickly, even though the light is not exactly on the halving line.

c. The use of the astigmatizer is described in paragraph 24.

14. HALVING ADJUSTMENT KNOB.

a. The halving adjustment knob is located on the under side of the left end of the range finder (fig. 15). Its purpose is to adjust the instrument so that a desired point of the target will fall exactly on the halving line for both the lower and upper images. When out of adjustment in this respect, a point directed to fall, for example, on the

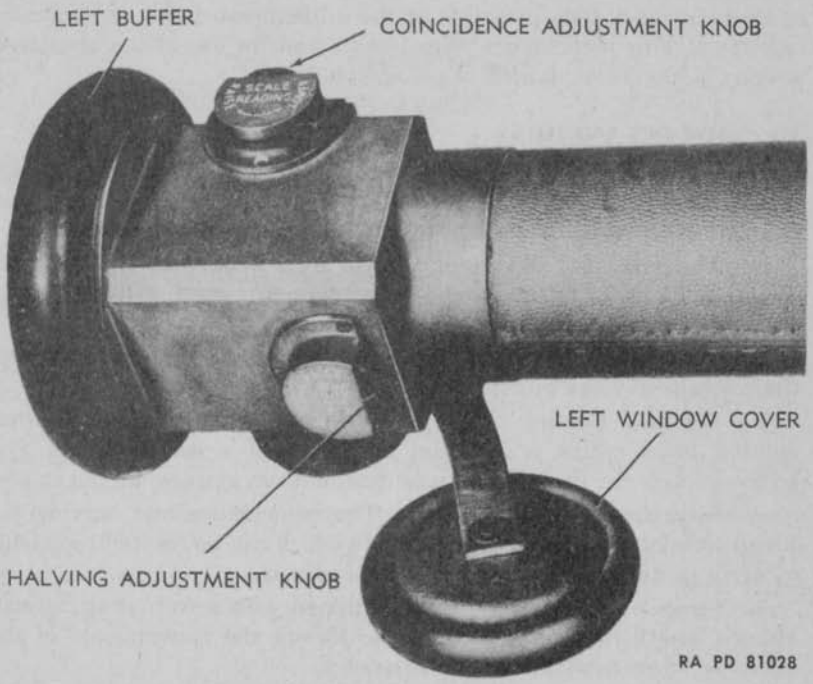


Figure 15—Left End of Range Finder M9—Rear View

halving line for the lower image, will be either too high or too low in the upper image. The halving adjustment knob is marked "upper image" and an arrow indicates the direction in which to "raise" or to "lower" the upper image. This adjustment is described in paragraph 19.

15. COINCIDENCE ADJUSTMENT KNOB.

a. The coincidence adjustment knob (fig. 15) is located on the rear of the left end of the range finder (fig. 2), and is marked "SCALE READING". Its purpose is to correct any errors in range reading without disturbing the range scale itself (par. 20). The coincidence adjustment knob is connected by means of a shaft and gear to move and adjust an optical wedge and scale located in the left objective window.

16. OBJECTIVE WINDOW SCALE.

a. The objective window scale is visible when the left objective window cover (fig. 3) is removed. The scale is graduated from "0" to "25" to both right and left. The graduations are arbitrary and are not related to range reading. Moving the coincidence adjustment knob causes the wedge to move and deflect the left beam of light. The extent

of the deflection is shown by the movement of the scale which is read against its index. The principle of the adjustment, tests, and instruction for making coincidence adjustments and for use of the objective window scale are explained in paragraph 20.

17. MISCELLANEOUS.

a. The Handles. On the under side of the range finder are hinged two handles so that they can be opened for use (fig. 3), or used flat against the tube when the range finder is not in use (fig. 2).

b. The Adapter. The adapter (fig. 4) is a device which permits the range finder to be mounted on a tripod and mount, if these should be furnished.

c. Buffers. At the ends of the instrument are buffers to protect the instrument from minor shocks.

d. Window Covers. Each window is provided with a leather window cover which is attached by means of a leather strap. The covers protect the instrument from dust and sun glare when not in use.

e. Adjustment Knob Covers. The coincidence and halving adjustment knobs are protected by covers which can be rotated by means of small protecting pins to expose the controls.

f. Strap. The range finder is equipped with a web strap, adjustable in length by means of a buckle to suit the convenience of the operator when carrying the instrument.

Section III
EMPLACEMENT

18. SET TO COMFORTABLE HEIGHT.

a. Set up the instrument properly so as to permit a comfortable attitude in operating the instrument.

b. No tripod is furnished with the instrument. Set on a firm object at convenient height for use and manipulation. However, the adapter fits a standard Type S Tripod.

c. Support the range finder at such a height that the face can rest comfortably in the rubber eyepiece, and the observer can look with comfort into the eyepiece.

Section IV

ADJUSTMENTS PRIOR TO OPERATION

19. HALVING ADJUSTMENT.

a. Incorrect Halving Adjustment. If an aiming point falls on the halving line for the lower image, but falls either below or above the halving line for the upper image, the halving adjustment is incorrect. It is advisable on all occasions to test halving adjustment before commencing to make range observations.

b. Testing Halving Adjustment. To test the halving adjustment of the instrument, proceed as follows:

(1) Select any well defined object and bring the images into alinement in the field of view. Note that it is not necessary to know the actual range of the object.

(2) Elevate or depress the range finder in altitude so that the images are a noticeable distance from the halving line.

(3) Gently and steadily rotate the instrument, and thus cause the images to approach the halving line.

(4) If halving is correct, the images will meet on the separating line. If they do not, the halving is incorrect and must be corrected.

c. Correcting a Halving Error. To correct a halving error, proceed as follows:

(1) Rotate the small cover to expose the halving adjustment knob.

(2) If the upper image must be lowered, rotate the halving adjustment knob in the direction of the arrow pointing to "lower". If the upper image is to be raised, rotate in the direction of the arrow pointing to "raise".

(3) Check the adjustment by repeating the halving test.

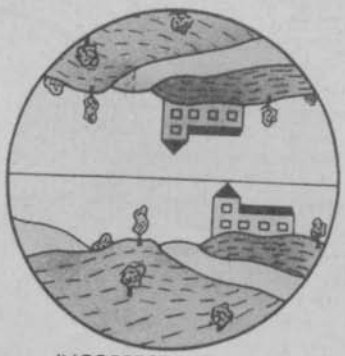
(4) Cover the halving knob by rotating the cover.

d. Need for Making Halving Adjustment. A small amount of halving error will not necessarily affect accurate range measuring to any serious extent, except in the case of objects that are inclined to the halving line. In such cases, halving errors should always be corrected. The necessity for this can be realized by observing A and B, figure 18,

20. COINCIDENCE ADJUSTMENT.

a. The range scale may not read the range correctly in yards, even though the two images are exactly in coincidence. The instrument may

ADJUSTMENTS PRIOR TO OPERATION



INCORRECT HALVING

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Figure 16—Effect of Incorrect Halving Adjustment on Images in the Field of View

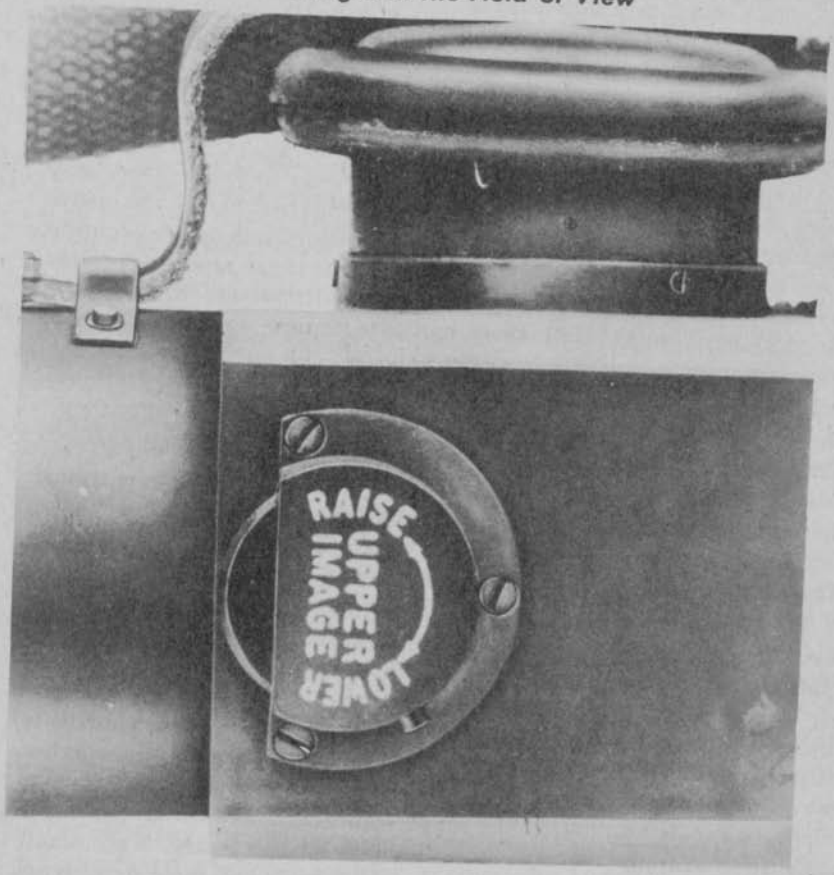

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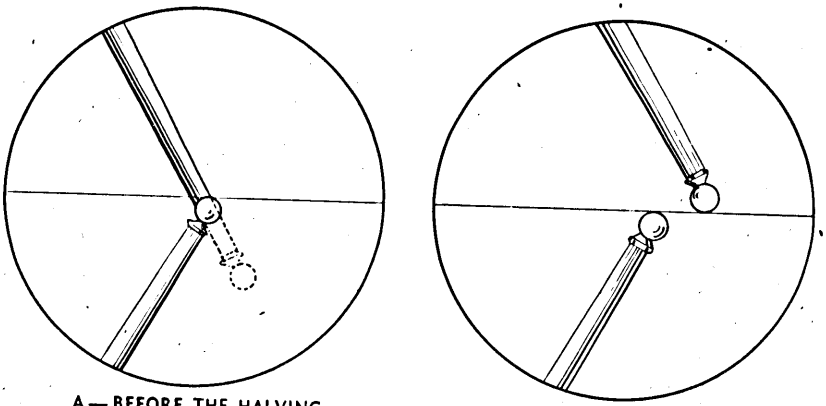
Figure 17—Halving Adjustment Knob

RANGE FINDER M9



A—BEFORE THE HALVING ADJUSTMENT IS MADE. APPEARS TO BE IN COINCIDENCE

B—AFTER THE HALVING ADJUSTMENT IS MADE. IMAGES ARE SEEN TO BE NOT IN COINCIDENCE

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Figure 18—Halving Errors of Sloping Targets Should Always Be Corrected

be out of adjustment mechanically, or differences in temperature may throw the instrument out of adjustment. For this reason, test the instrument frequently when in operation, and adjust often to assure accurate range finding. The adjustment for correction of range reading is called the "coincidence" adjustment. There are two methods of correcting range scale readings. Both these methods require use of coincidence adjustment knob.

b. The coincidence adjustment knob is marked "SCALE READING" (fig. 19), with an arrow pointing to "RAISE" or "LOWER". This control makes it possible to correct range scale readings.

c. Testing with Object of Known Range. Direct the range finder upon an object, at a distance of 550 yards or more, whose range is known. Set the range scale at this range. Then observe the images. They should coincide if the instrument is in adjustment.

d. "Infinity" Method. Direct the range finder upon a very distant object (such as a star). Set the range scale at its position of "infinity". (At great distances the beams of light entering the two windows are parallel, regardless of the actual distance.) Observe the images in the range finder. They should coincide if the instrument is in adjustment. If they almost coincide, and you are not certain whether an adjustment is required, make the images coincide exactly, and note the range scale reading. If the range scale reading is within two-fifths of a division from "infinity", adjustment is not necessary. Each small graduation on either side of the star (*), "infinity" mark represents one-fifth of a division.

Figure 19—Coincidence Adjustment Knob

e. Testing With the Adjusting Lath. If an adjusting lath is provided, the following test can be made: Place the adjusting lath in a horizontal position at least 125 yards away from the instrument. Use the sight of the lath to insure that it is perpendicular to the line of sight. Set the range scale at its "infinity" position (marked with a star). If the images appear alined as in right illustration of figure 20, the instrument needs no adjusting. If out of alinement as shown in left illustration of figure 20, the instrument requires adjustment.

f. Making the Adjustment.

(1) Set the range measuring knob at the known range or at "infinity", according to whether a known range or infinity will be used

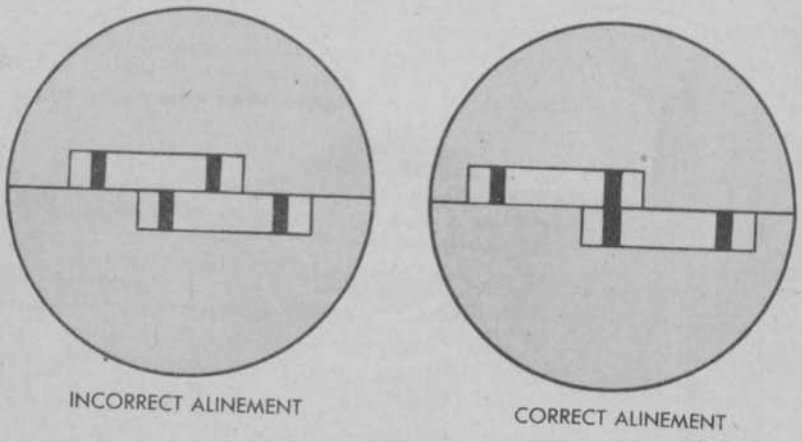


Figure 20—Range Adjustment by Use of Adjusting Lath

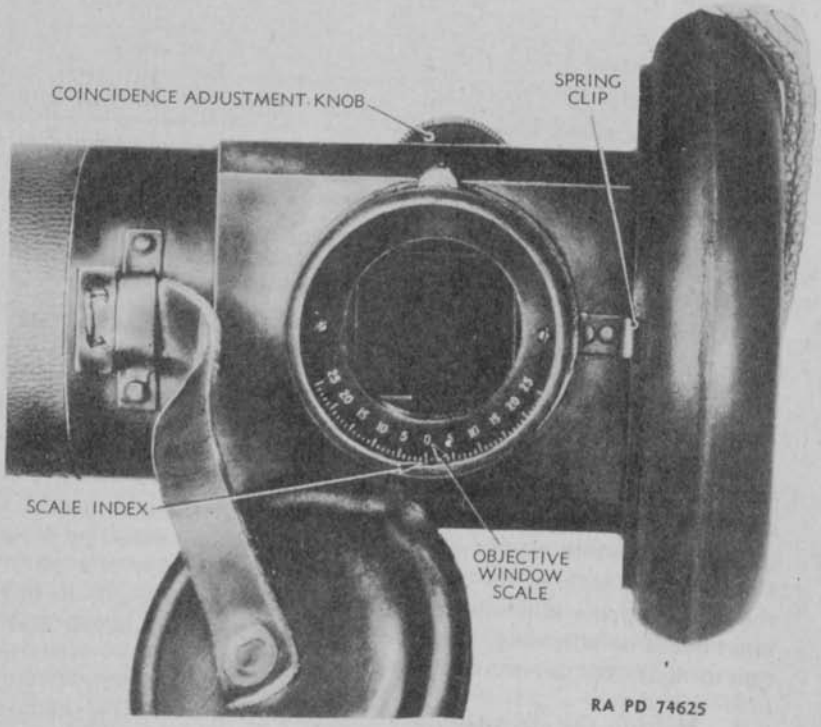


Figure 21—Left Objective Window and Scale

in making the coincidence adjustment. Leave this range setting throughout this adjustment.

(2) Uncover the coincidence adjustment knob, thus exposing the knob. Move the knob in whatever direction is necessary, until the two images are in coincidence.

(3) When the adjustment is completed, close the cover over the coincidence adjustment knob.

g. Use of Objective Window Scale for Precise Coincidence Adjusting.

(1) When it is desired to make the coincidence adjustment as precisely as possible, the left objective window scale (fig. 21) may be used to obtain an average of 10 readings.

(2) The rotation of the coincidence adjustment knob causes the left objective window scale (fig. 21) to move relative to its index. This scale is visible when the cover of the left objective window is removed. It is graduated in arbitrary units to right and left from "0" up to "25." Record this reading.

(3) Now throw the images out of coincidence by moving the coincidence adjustment knob, and once again bring them into coincidence, and again record the scale reading.

(4) Average the readings. If some of the readings are to the right of "0", and some to the left, record the two in separate columns, add each column, and subtract the smaller sum from the larger. Divide the answer by 10. This represents the mean reading (averaged algebraically).

(5) Rotate the coincidence adjustment knob until the scale index is opposite the mean reading figure. Be sure to set it to the right or to the left, according to which column added up to the larger figure.

(6) This completes the adjustment operation.

h. Precautions Before Making "Coincidence" Adjustment. Note especially these precautions:

(1) Undertake the "coincidence" adjustment only when conditions are favorable for accurate and deliberate observation.

(2) It is very important that the "halving" adjustment be correct, before the "coincidence" adjustment is undertaken. A small error in one may lead to a considerable error in the other.

(3) It is important, when bringing two images into coincidence, to fix upon a definite recognizable point, so that the same point can be brought into coincidence in the two images, otherwise an error will result. For example, when ranging upon the moon, the curvature of the moon makes it necessary to be certain that the same point is brought into coincidence. This can be done by sighting on the lowest point of its outside boundary.

Section V
OPERATION

21. BRING THE TARGET INTO FIELD OF VIEW.

a. Before the range can be measured, the target must be brought into view of the instrument in proper position and in proper focus (par. 22).

b. Remove the leather cover to uncover the windows.

c. Direct the range finder upon the object. Move it in direction and in elevation by means of the controls on the tripod and mount, until the target is centered in the field of view of the instrument.

d. Bring the target into the field of view of the instrument by using the auxiliary finder (fig. 14). Its cross hairs will help to position the target image in the center of the field of view.

e. When ready, press the face gently into the eyepiece, and look into the right eyepiece.

f. By suitably directing the range finder, bring the upper image of the target to the center of the halving line. This centers the target in the field of view, and is the best position from which to range on the target.

22. FOCUS EYEPIECE.

a. Make the target image as sharp and clear as possible, by focusing the right eyepiece upon the target. To focus, move the focusing lever (fig. 12) until the target is sharp and clear. (If you know your own eye correction, prefocus the right eyepiece by setting the diopter scale to the known eye correction.)

23. SELECT FILTER.

a. If sunlight, glare, or fog causes poor visibility, interpose a light filter by moving the filter selector lever (fig. 13). For glaring sunlight use the "smoke" filter, which acts like a sun glass to shut out glare. For

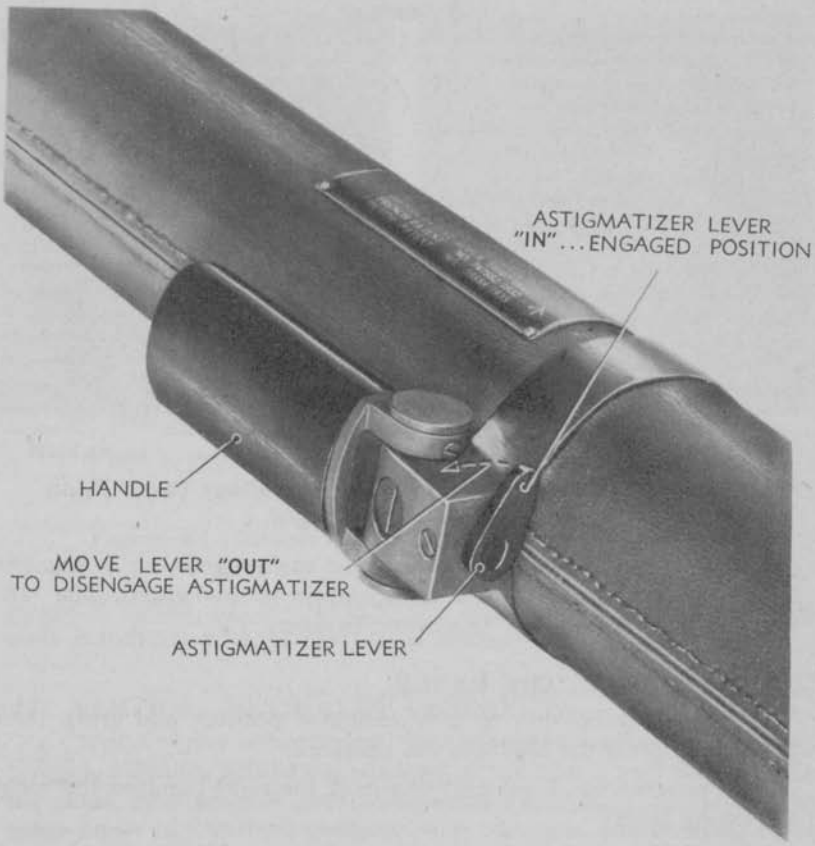


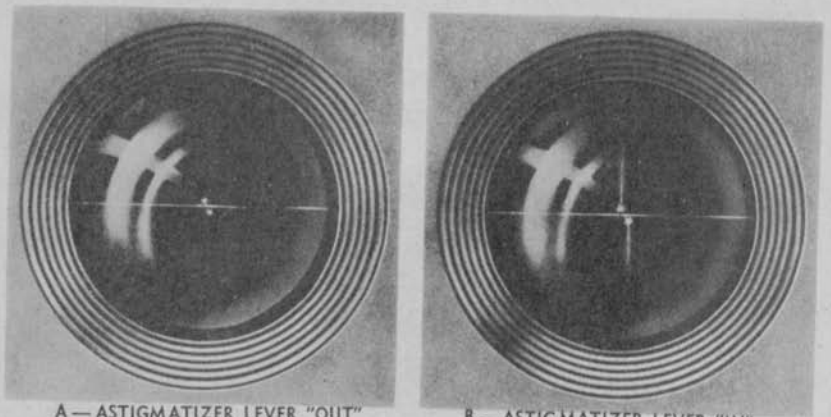
Figure 22—Astigmatizer Lever

fog or fine suspended dust, use the "yellow-green" filter. To improve visibility of camouflaged objects, use the "light blue" filter. Under normal conditions of visibility the "clear" filter is used.

24. USE OF THE ASTIGMATIZER.

a. The astigmatizer lever (fig. 22), when engaged, interposes into the field of view a lens, which has the effect of drawing out points of light into narrow streaks perpendicular to the halving line.

b. This operation is useful when ranging on a distant point of light at night. Without the astigmatizer, a point target is difficult to keep centered on the halving line, since the halving line must touch the point (A, fig. 23). When the astigmatizer is engaged (B, fig. 23), the streak in the upper and lower fields can be matched exactly and quickly, even though the light is not exactly on the halving line.



A — ASTIGMATIZER LEVER "OUT"

B — ASTIGMATIZER LEVER "IN"

RA PD 74622

Figure 23—Effect of Engaging Astigmatizer Lever Upon Small Point of Light

c. When the astigmatizer lever is up, the astigmatizer is engaged. When the lever is down, the astigmatizer is disengaged. The "IN" and "OUT" positions are illustrated in figure 22.

25. DETERMINE THE RANGE.

a. Move the handles to their extended position and grasp them firmly, and press the face into the eyepiece.

b. Place the forefinger and thumb of the right hand on the range measuring knob.

c. Observe the position of the upper image relative to the lower.

d. Turn the range measuring knob with thumb and forefinger until the images coincide.

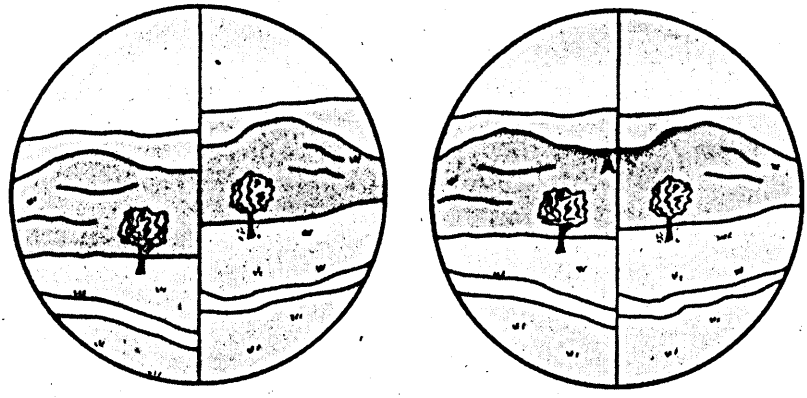
e. When the coincidence is exact, read the range scale through the left eyepiece, or in the case of a second observer, through the range scale window. The range scale indicates the correct range only when the two images are in very close coincidence.

26. INTERPRETING THE MOVEMENT OF IMAGES.

a. When moving the range measuring knob, the lower image will move to the left or right relative to the upper image.

b. If the target is approaching the observer, the image in the upper field appears to travel to the left relative to the lower image. This means that the range is decreasing. If the target is receding, the upper image will travel to the right. This means that the range is increasing.

c. If the upper image appears displaced to the left of the lower



1 NOT IN COINCIDENCE

2 IN COINCIDENCE AT "A"

RA PD 61318

Figure 24—Measuring Range of Horizontal Objects

image, it means that the range of the target is LESS than the range scale is indicating at that particular moment.

27. VERTICAL METHOD OF OBSERVING.

a. If the object is horizontal (like a trench, road, river, crest, or bridge), difficulty will be experienced in selecting a well defined aiming point. It is possible then to determine the range by setting the range finder in a vertical position (with the main axis vertical). This can be done by setting the range finder on end. The halving line will then be vertical, and the images can then be made to coincide more readily as shown in figure 24.

28. "ABOVE AND BELOW" METHOD OF READING SCALE.

a. When conditions are favorable and time permits, the range of stationary or slowly moving objects can be obtained most accurately by following what is known as the "above and below" method. This method of determining the range is slower, but more accurate than determining the range by a single reading.

(1) Move the range measuring knob until the upper image is not in exact alinement, but is just perceptible to the left of the lower image. Note the scale indication.

(2) Move the range measuring knob until the upper image appears out of alinement by an equal amount to the right of the lower image. Note the scale indication.

(3) Take as the range of the object, the average of the two scale readings (add and divide by two).

RANGE FINDER M9

b. The great accuracy obtainable by the use of the "above and below" method may be explained as follows:

(1) Suppose that the range of the object is exactly 1,000 yards, and that a change of 6 yards up and down in the setting of the range finder cannot be detected readily because the two images are almost in coincidence. When working with special care, the operator may then get indications of range varying from 994 yards to 1,006 yards.

(2) On the other hand, a change of setting corresponding to 8 yards may be distinctly visible. If, then, the observer sets the scale to read 992, he will see the images perceptibly out of alinement in one direction, and if he sets the scale to read 1,010, they will appear out by about the same amount in the other direction. The average of these readings, namely, 1,001 yards, gives the distance of the object to within one yard of the true range.

(3) If the scale had been set to read 992 and then 1,016, the images at the latter range would have appeared to be twice as far out of coincidence and the difference would have been distinctly visible. If conditions permit, it is much easier and more accurate to use this "above and below" method than to try and secure an exact coincidence in one reading.

Section VI

ORGANIZATIONAL MAINTENANCE

29. ALLOCATION OF MAINTENANCE DUTIES BY ECHELONS.

a. Scope. The scope of maintenance and repair, by the crew and other units of the using arms, is limited to those duties described below under First and Second Echelons of maintenance.

b. Definitions. Echelons and words as used in this list of maintenance allocation are defined as follows:

FIRST AND SECOND ECHELON:	Line organization regiments, battalions, companies (first and second echelons).
THIRD ECHELON:	Ordnance light maintenance companies, ordance medium maintenance companies, ordnance divisional maintenance battalions, and post ordnance shops.
FOURTH ECHELON:	Ordnance heavy maintenance companies and service command shops.
FIFTH ECHELON:	Ordnance base regiments, ordnance bases, arsenals, and manufacturer's plants.
SERVICE: (Including preventive maintenance) (par. 23a(1) and (2), AR 850-15 (6 Oct 42))	Consists of servicing, cleaning, lubricating, tightening bolts and nuts, and making external adjustments of subassemblies or assemblies and control.
REPLACE: (par. 23a(4), AR 850-15 (6 Oct 42))	Consists of removing the part, subassembly or assembly and replacing it with a new or reconditioned or rebuilt part, subassembly or assembly, whichever the case may be.
REPAIR: (par. 23a(3) and (5), in part, AR 850-15 (6 Oct 42))	Consists of making repairs to, or replacement of the part, subassembly or assembly that can be accomplished without completely disassembling the subassembly or assemblies, and does not require heavy welding, or riveting, machining, fitting and/or balancing.
REBUILD: (par. 23a(5) in part, and (6), AR 850-15 (6 Oct 42))	Consists of completely reconditioning and replacing in serviceable condition any unserviceable part, subassembly, or assembly including welding, riveting, machining, fitting, alining, balancing, assembling, and testing.

RANGE FINDER M9

c. Maintenance Operations.

(1) FIRST, SECOND, THIRD, AND FOURTH ECHELONS.

(a) Inspect (preliminary).

(b) Clean external surfaces of lens and body of instrument.

(c) Replace eye guard.

(d) Adjust for coincidence and halving by either the known range method or the "infinity" method.

(2) FIFTH ECHELON. All maintenance, other than that prescribed for lower echelons, will be performed in a base shop.

Section VII

CARE AND PRESERVATION

30. CLEANING AND PRESERVING MATERIALS.

OIL, lubricating, for aircraft instruments and machine guns.
BRUSH, artist, camel's-hair, rd.
PAPER, lens, tissue (For cleaning lens, optical instruments, etc.).
SOAP, liquid, lens cleaning.

31. CARE IN HANDLING.

a. Avoid unnecessary shocks to the instrument. The range finder contains delicate mechanisms, and accurately adjusted optical parts. Rough handling can cause serious damage to the instrument.

b. Avoid sighting the instrument directly at the sun if this can be avoided, and do not allow the instrument to be so exposed for a long time. Keep covers on windows when not ranging. The heat of the focused rays may melt the cement which holds the optical elements together.

c. Moisture may collect and cause fogging of the optical parts. Place the instrument in a warm place for a few minutes until the fogginess passes away. Do not apply heat from a concentrated source as it may cause damage to the instrument, and disturb its accuracy.

d. When not in use, the instrument should be kept in its case.

e. The interior of the range finder case should be kept dry, and the range finder should not be placed in its case unless quite dry.

32. LUBRICATION.

a. The using arms will not lubricate any part of the range finder.

b. The instrument should be kept clear of lubricant, as none must be allowed to enter the interior, nor come in contact with optical elements.

c. Lubricate exposed moving parts of the tripod, if furnished, sparingly with OIL, lubricating, for aircraft instruments and machine guns.

33. CLEANING.

a. Clean the range finder at least once daily, and exercise extra care. The lenses must not be removed for cleaning purposes.

b. To obtain satisfactory vision, keep all the exposed surfaces of the lenses and other parts affecting vision clean and dry. Clean these parts as often as required to secure satisfactory vision.

c. Remove dust from optical elements by using only a clean camel's-hair brush. After brushing, tap the brush against a hard object to loosen the adhering dust particles. Repeat until the optical elements are free of dust. Do not use cleaning cloths for wiping optical elements.

d. Do not use polishes of any kind for cleaning the range finder.

34. REMOVING GREASE AND DRYING LENSES.

a. Do not wipe lenses with finger tips.

b. Oil or grease must not be allowed to remain in contact with optical elements.

c. To remove grease or oil, use SOAP, liquid, lens cleaning. Apply with a tuft of PAPER, lens, tissue. Dry with clean PAPER, lens, tissue. Repeat until clean. If no SOAP, liquid, lens cleaning, is available, breathe heavily on the lens and wipe off with clean PAPER, lens, tissue. Repeat until clean.

Section VIII

ORGANIZATIONAL SPARE PARTS AND ACCESSORIES

35. CARRYING CASE.

a. A carrying case is provided with the Range Finder M9 (fig. 1). The case is tube shaped and is provided with a cap. An adjustable strap facilitates carrying the case. The strap fits through buckles in the cap to hold the cap to the case.

Section IX
OPERATION UNDER UNUSUAL CONDITIONS

36. DESERT OPERATIONS.

a. Dust and Sand.

(1) Dust and sand are the principal foes of the desert operations, and will penetrate through the slightest openings, interfering greatly with the precision mechanisms of the range finder.

(2) Keep the range finder in its case when not in use. Keep covers on windows when not ranging.

(3) Do not permit accumulation of dust in any of the operating controls. Keep them free of dust by brushing dust away, before excessive amounts can accumulate.

b. High Temperatures. Metal parts exposed to the desert sun will badly blister the hands if touched. Keep the range finder under cover to shade it from the sun whenever practical.

37. JUNGLE AND SWAMP OPERATIONS.

a. Fungus. If the instrument is kept in reserve and not in active use, in hot, humid climates, exercise care to clean all external lens surfaces at least every 30 days to prevent the formation of fungus growth.

38. OPERATION IN SEVERE COLD.

a. External Fogging.

(1) Do not breathe on dials and telescope lenses as this may cause excessive condensation and fogging. Even close proximity will cause condensation.

(2) Remove fogging on external surfaces of lenses and windows by wiping with tuft of PAPER, lens, tissue, moistened with alcohol. Repeat as often as necessary.

(3) Alcohol will also retard frosting of lenses, but use alcohol sparingly only as here instructed. Do not apply so much alcohol that it will run between the edge of the lens and cell, as it may dissolve cement which holds lenses in place.

b. **Internal Fogging.**

(1) Internal fogging may often be removed by placing the instrument in a warm place for few minutes until clear. Do not apply heat from concentrated source as this may damage the instrument.

(2) If internal fogging is persistent, correction by qualified ordnance personnel is required.

39. PREPARATION FOR DEEP WATER FORDING AND SURF OPERATIONS.

a. **General.**

(1) The following instructions are designated to protect materiel for complete immersion during deep water fording operations or surf landings, and still permit immediate use of the materiel after landing. They will serve as a general guide for supplementing supervision of actual waterproofing by trained personnel.

(2) Necessity for extreme care in all steps cannot be overemphasized. Every seam, joint, or opening of the carrying case must be completely sealed. When waterproofing is completed, the material should be carefully inspected to make sure all openings and parts have been properly treated.

b. **Materials.**

TAPE, adhesive, non-hygroscopic (Utilitape) 6 in. wide, 4 in. wide.

c. **Waterproofing Procedure.**

(1) Apply tape to joint between cover and case, and over all seams, being sure that the seal is complete and secure.

(2) If case has been exposed to salt water, wash thoroughly in fresh water.

d. **Quantities of Material Required:**

Waterproof tape ..... 2 yards

Section X
REFERENCES

40. STANDARD NOMENCLATURE LISTS.

a. Cleaning, preserving and lubrication materials; recoil fluids, special oils, and miscellaneous related items ..... SNL K-1

b. Harbor defense, railway and antiaircraft artillery sighting equipment and fire control instruments ..... SNL F-2

c. Small arms, automatic gun, trench mortar and field artillery sighting equipment and fire control instruments ..... SNL F-1

Current Standard Nomenclature Lists are as tabulated here. An up-to-date list of SNL's is maintained as the "Ordnance Publications for Supply Index" now published in ..... OFSB 1-1

41. EXPLANATORY PUBLICATIONS.

a. Chemical decontamination materials and equipment ..... TM 3-220

b. Cleaning, preserving, lubricating, and welding materials and similar items issued by the ordnance department ..... TM 9-850

c. Defense against chemical attack ..... TM 21-40

d. Range finders, 1-meter base and 80-cm base, all types ..... TM 9-1585

INDEX

RANGE FINDER M9

[A.G. 300.7 (29 Sep 43)
O.O. 461/49129 (19 Oct 43)]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION: R 9(4); Bn 9(2); C 9(5); IC 7(3)

(For explanation of symbols, see FM 21-6.)

PUBLICATIONS DIVISION - RARITAN ARSENAL

TB 9-585-1

WAR DEPARTMENT TECHNICAL BULLETIN

RANGE FINDER M7

Ref: TM 9-585, Range Finder M9, 19 October 1943

War Department, Washington 25, D. C., 6 July 1944

1. CHARACTERISTICS.

a. The 1-meter Base Range Finder M7 (fig. 1) is an optical instrument used to measure distances or ranges to distant targets. The target is seen in a central field of view as two separate images: one erect and the other inverted. The images are separated by a horizontal line or halving line. When the images are brought into coincidence, the range of the target can be read on a range scale.

b. The range finder is provided with elevating and traversing mechanisms and associated scales and micrometers, and adjusting mechanism to assure accurate ranging.

2. DATA.

a. The 1-meter Base Range Finder M7 is a 14-power instrument with a field of view of 3°—0. The range scale is graduated from 500 yards to 20,000 yards.

APPROXIMATE UNCERTAINTY OF OBSERVATION UNDER FAVORABLE CIRCUMSTANCES

Range (yards)	*Error (yards)
500	2
1,000	7.5
2,000	29
3,000	66
4,000	110
5,000	180

3. DESCRIPTION.

a. General.

(1) Beams of light from the target enter the range finder through two end windows whose centers are 1 meter apart. After entering the windows the beams of light are bent and pass through two separate

*The average error in yards for greater ranges can be determined from the formula $.00000577R^2$, where R is the range in yards.

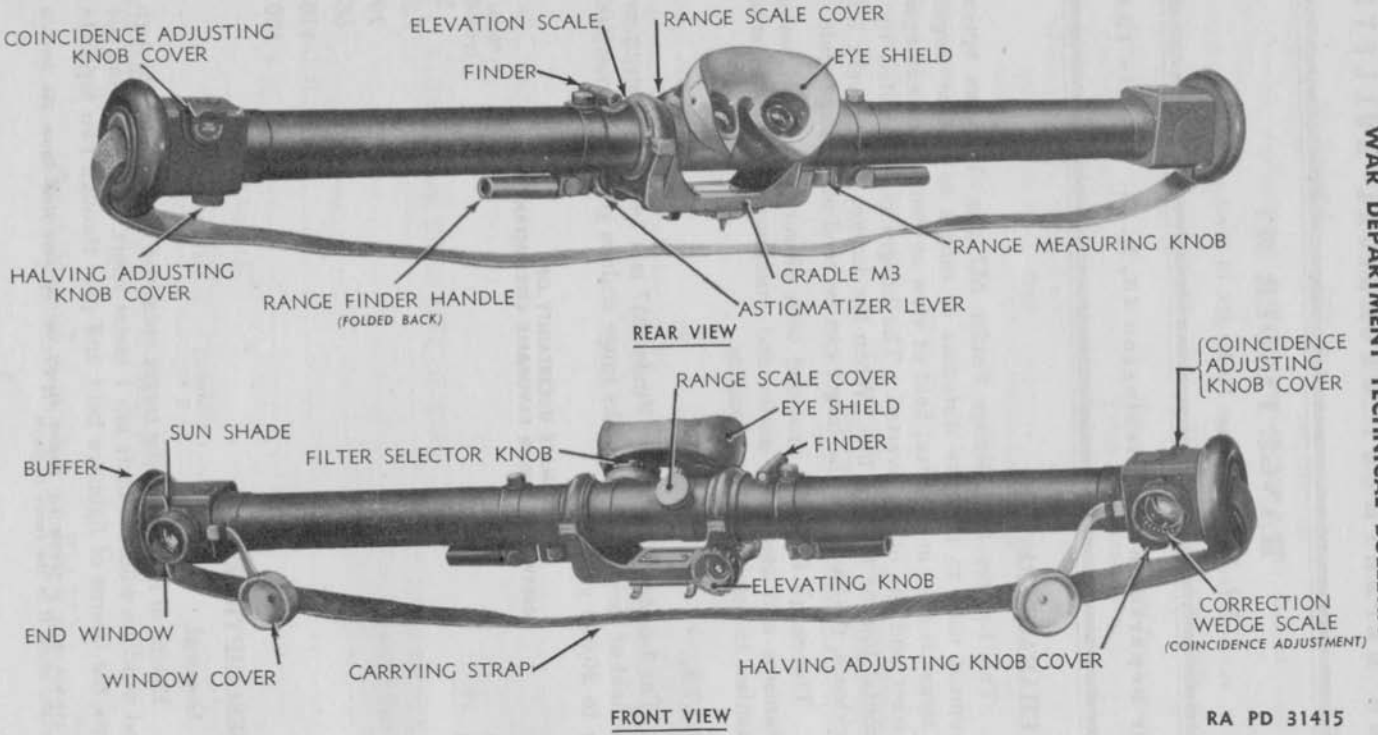


Figure 1 — 1-meter Base Range Finder M7, Rear and Front Views

WAR DEPARTMENT TECHNICAL BULLETIN

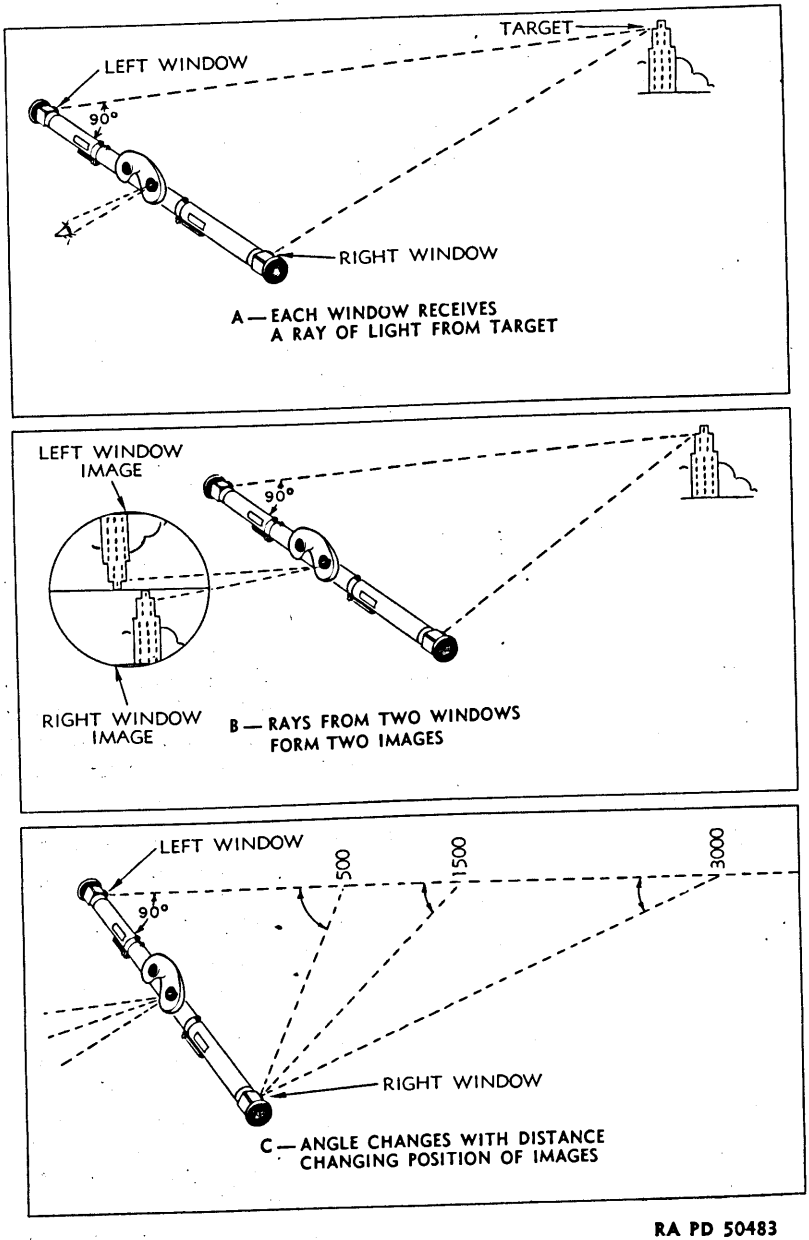


Figure 2 — How the Split Field Images Are Formed

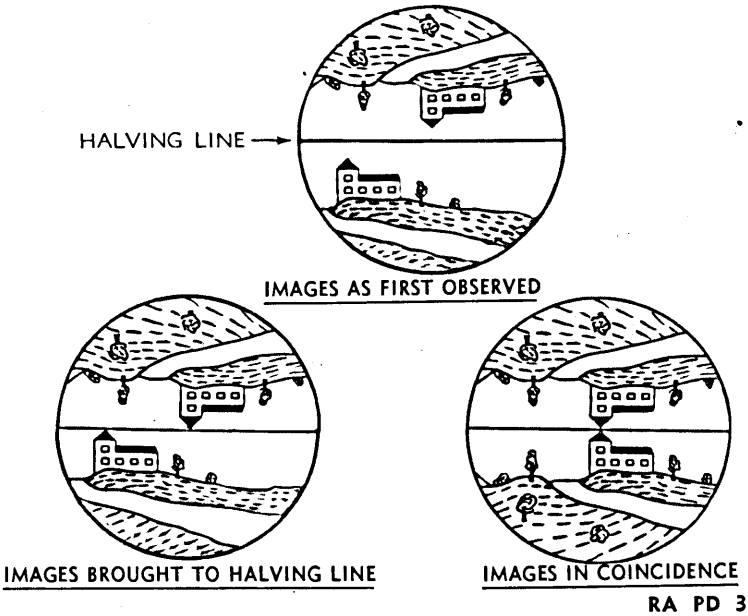


Figure 3 — Field of View of 1-meter Base Range Finder M7

objective systems to coincide in the image plane of a centrally located eyepiece; there they form an erect image and an inverted image, separated by a horizontal dividing line (halving line) as shown in figure 2. The images may appear in any one of several positions as shown in figure 3.

(2) The distance between the end windows forms the base of a triangle whose apex is at the target. Light rays enter the left window at a constant 90-degree angle to the base; thus the angle of the triangle at the left end of the base is a right angle. The angle of the triangle at the right end of the base line determines the range to the target. This angle is measured optically by the range finder, and the reading in yards is read on a range scale.

(3) To assure an accurate range reading, two adjustments to the range finder are necessary: the halving adjustment and the coincidence adjustment. The purpose of the halving adjustment is to make the images in the field of view appear equidistant from the halving line so they can be brought into the position where the images touch the halving line as shown in figure 3. The purpose of the coincidence adjustment is to make the images appear in exact coincidence when the range scale reads the actual or true range to the target.

b. Equipment.

(1) The equipment furnished with the Range Finder M7 is dependent upon which branch of the armed forces is to use the instrument. The table below shows the allocation of the equipment. The Range Finder M7 is standard for all Field Artillery requirements.

EQUIPMENT FURNISHED WITH 1-METER BASE RANGE FINDER M7

Field Artillery	Infantry	Armored Command	Cavalry	Tank Destroyer Command
Cradle, M3	—	Cradle, M3	—	—
Mount, range finder, M62 (For Tripod M18)	—	—	—	—
Cover, M436	—	Mount, range finder, M58	—	—
Tripod, M18	—	—	—	—
Lath, adjusting, M2	—	—	—	—
Case, carrying, M49	Case, carrying, M51	Case, carrying, M49	Case, carrying, M51	Case, carrying, M51
Case, carrying, M50	—	—	—	—

(2) The end windows of the range finders are provided with sun shades to reduce glare. A leather cover fits on the sun shade to prevent dust and moisture from accumulating on the glass surface when the instrument is not in use. Buffers on the ends of the range finder guard against minor shocks to the instrument

c. Operating Parts for Directing the Range Finder.

(1) ON THE RANGE FINDER. The auxiliary sight on these range finders consists of an auxiliary finder (fig. 1) to the left of the eyepiece. The finder enables the operator to observe the field of view, pick up the target, and direct the range finder upon the target with the aid of cross lines which represent the center of the field of view of the instrument. Since this auxiliary sight is of the "collimator," or "infinity" type, all sighting is done by simultaneously looking over it and into it, retaining the cross lines in the field of vision. Two range finder handles are used for directing the instrument in azimuth.

(2) ON THE CRADLE M3. The Cradle M3 (fig. 1) contains an elevation mechanism for elevating and depressing the instrument. The mechanism is operated by an elevating knob and registers the amount of movement on a scale and a micrometer. The scale is graduated in 100-mil intervals from 0 to plus 800 and minus 400, and numbered every 100 mils. The micrometer is graduated in 1-mil intervals from 0 to 100, and numbered every 10 mils. The micrometer reading supplements the scale reading. The Cradle M3 fits the Mount M62 or Mount M58 (figs. 4 and 5).

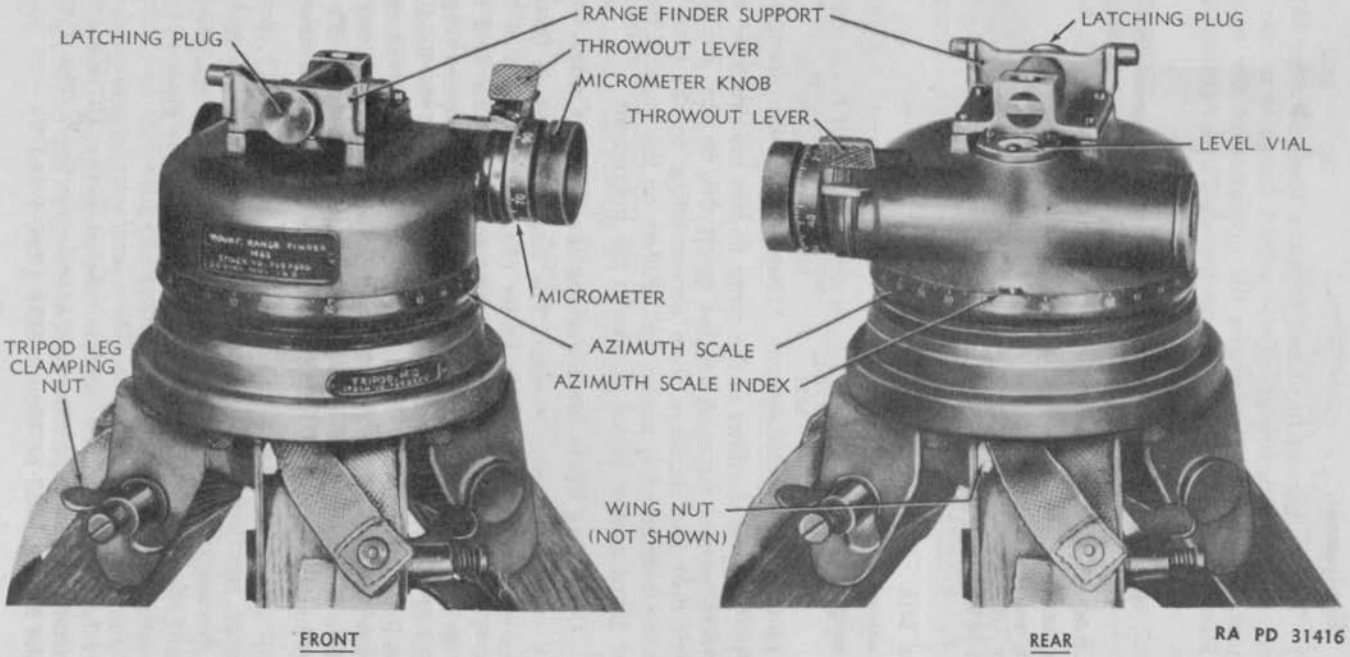


Figure 4 — Range Finder Mount M62, Assembled to Tripod M18

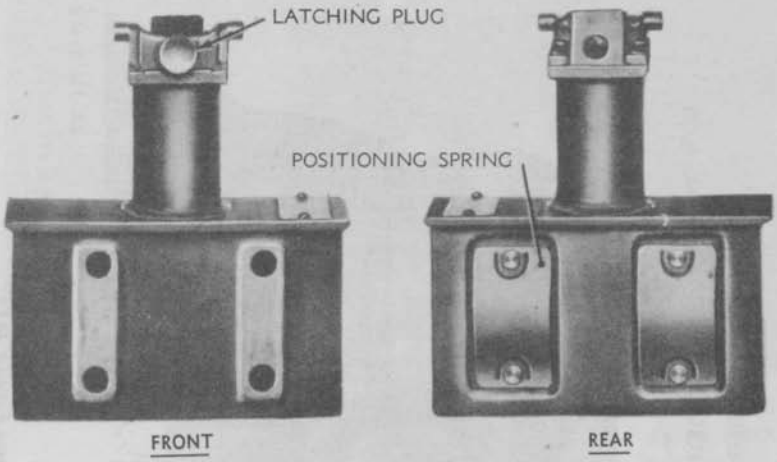


Figure 5 — Range Finder Mount M58, Rear and Front Views

(3) On the Range Finder Mount M62. The Range Finder Mount M62 (fig. 4) seats in the head of the Tripod M18, of which it is a part. The seat consists of a ball and socket joint which allows the mount to be leveled after the tripod has been set up. A level bubble in a circular level vial on the top of the mount indicates when the mount is level, and a wing nut on the spindle of the mount acting against a spring-loaded clamp holds the mount in position. A slight loosening of the wing nut allows the mount to be traversed. Traversing mechanism, a scale, and a micrometer for measuring azimuth angles are contained in the mount. The scale is graduated in 100-mil intervals from 0 to 64 and numbered every 200 mils. The micrometer is graduated in 1-mil intervals from 0 to 100 and numbered every 10 mils The micrometer readings supplement the scale readings. The mechanism is operated by the micrometer knob. A throwout lever is provided for disengaging the azimuth worm from its gear, thereby allowing free rotation of the range finder without the use of the micrometer knob. When using the throwout lever, be sure to keep it completely disengaged to avoid damaging the gear teeth. The throwout lever is used when swinging the instrument through large angles, and the micrometer knob is used for the fine setting. When ranging, use the throwout lever to direct the range finder on the target, and then use the micrometer knob to bring the images near the center of the field of view.

(4) On the Range Finder Mount M58. The Range Finder Mount M58 (fig. 5) which is furnished with the Range Finder M7 when issued to the armored command, supports the range finder on a

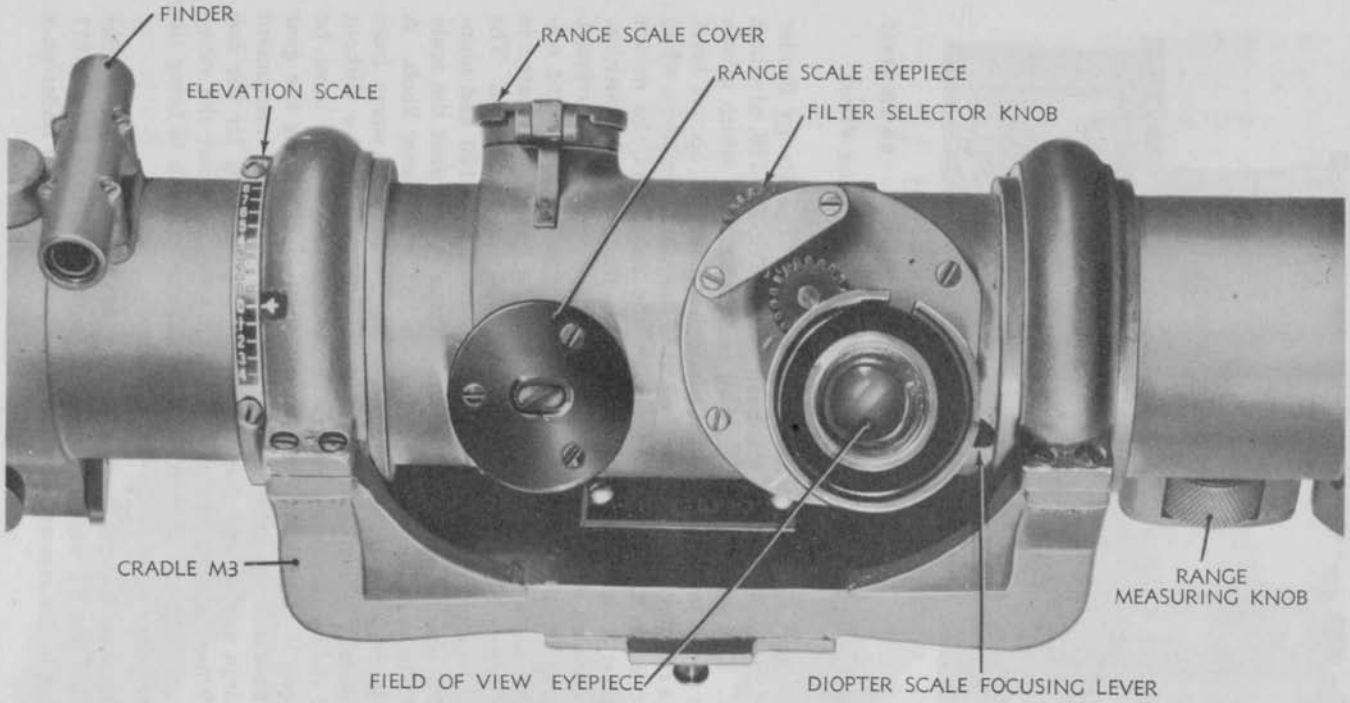


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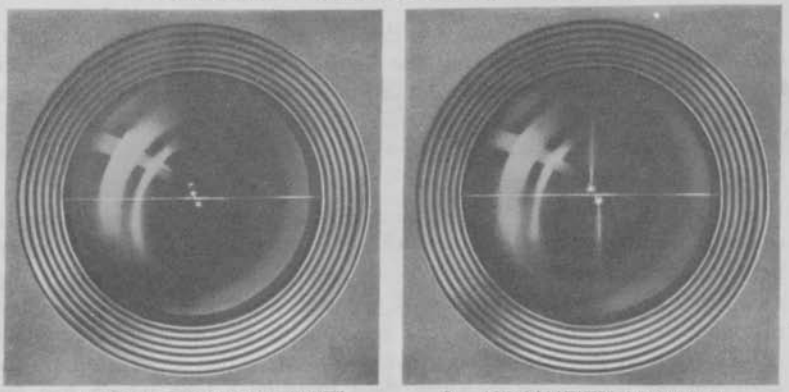
Figure 6 — Eyepiece Enlargement, 1-meter Base Range Finder M7

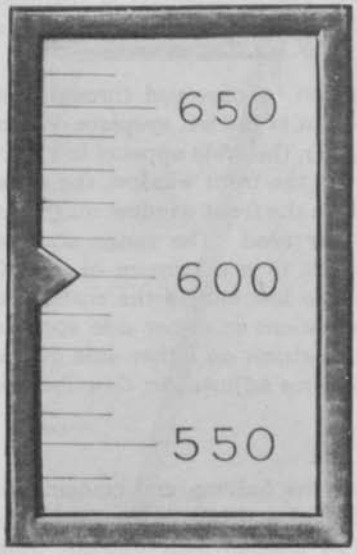


A — ASTIGMATIZER LEVER "OUT"

B — ASTIGMATIZER LEVER "IN"

RA PD 74622

Figure 7 — Effect on Field of View When Using the Astigmatizer



A — RANGE SCALE AS SEEN THROUGH LEFT EYEPIECE

B — RANGE SCALE AS SEEN THROUGH RANGE SCALE WINDOW

RA PD 31848

Figure 8 — Range Scale, 1-meter Base Range Finder M7

hinge seat in the front and in a socket in the rear. A spring-loaded latching plug secures the range finder in place on the mount. The mount does not contain any traversing or elevating mechanisms, but is designed to be inserted in the housing of the tank commander's periscope.

d. **Eyepiece.** This range finder is equipped with two eyepieces: a right eyepiece for observing the field of view, and a left eyepiece for observing the range scale. A diopter scale and light filters are contained in the right eyepiece. The light filters are neutral, amber, and red, and are operated by turning a knurled edge or knob which protrudes from the housing (fig. 6).

e. **Field of View.** The images in the field of view are brought together at the halving line with the elevating knob, and are brought into coincidence with the range measuring knob (fig. 1). An astigmatizer is provided for ranging at night on an object such as a point of light, which ordinarily would be difficult to bring into accurate coincidence as it has no prominent vertical parts. Operation of the astigmatizer interposes into the field of view a lens which has the effect of drawing out points of lights into narrow streaks perpendicular to the halving line (fig. 7). As these streaks appear in both the upper and the lower portion of the field of view, they can be readily and accurately brought into coincidence. The astigmatizer is operated by a lever in the upper portion of the left-hand range finder handle (fig. 1).

f. **Range Scale.** The range scale can be observed through the left eyepiece and through a window in front of the left eyepiece. When observed through the left eyepiece (fig. 8), the scale appears in a vertical position, and when observed through the front window, the scale appears in a horizontal position. A lens in the front window magnifies the scale graduations so they are easily read. The range scale is graduated from a minimum of 500 yards to a maximum of 20,000 yards. The word "YARD" appears at the low end of the scale, and the infinity mark "★" with several graduations on either side appears at the high end of the scale. The graduations on either side of the star represent tolerances for the coincidence adjustment described in paragraph 8 b.

g. **Adjusting Mechanisms.**

(1) The adjusting mechanisms for the halving and coincidence adjustments are contained in the left-hand end box as shown in figure 11. The mechanisms are operated by knobs which protrude from the box. The knobs are protected against accidental turning, and the entrance of dust or moisture into the mechanism, by covers which can be rotated. When the covers are fully opened, approximately one-half of the knob is exposed.

(2) The halving adjusting knob is on the under side of the end box, and is marked "UPPER IMAGE." An arrow indicates the direction in which to "raise" or to "lower" the upper image (fig. 12).

(3) The coincidence adjusting knob is on the rear of the end box, and is marked "SCALE READING." An arrow indicates the

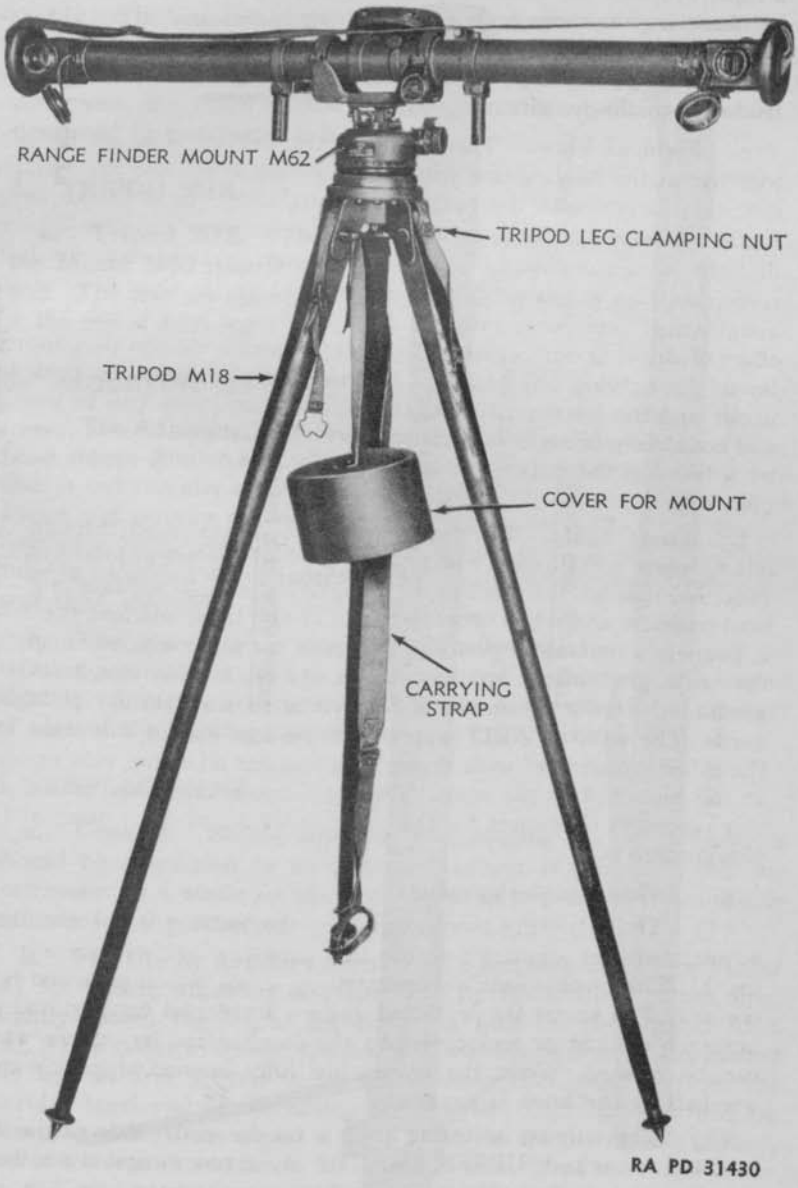


Figure 9 — Tripod M18 With Range Finder Mount M62 and Range Finder, Front View

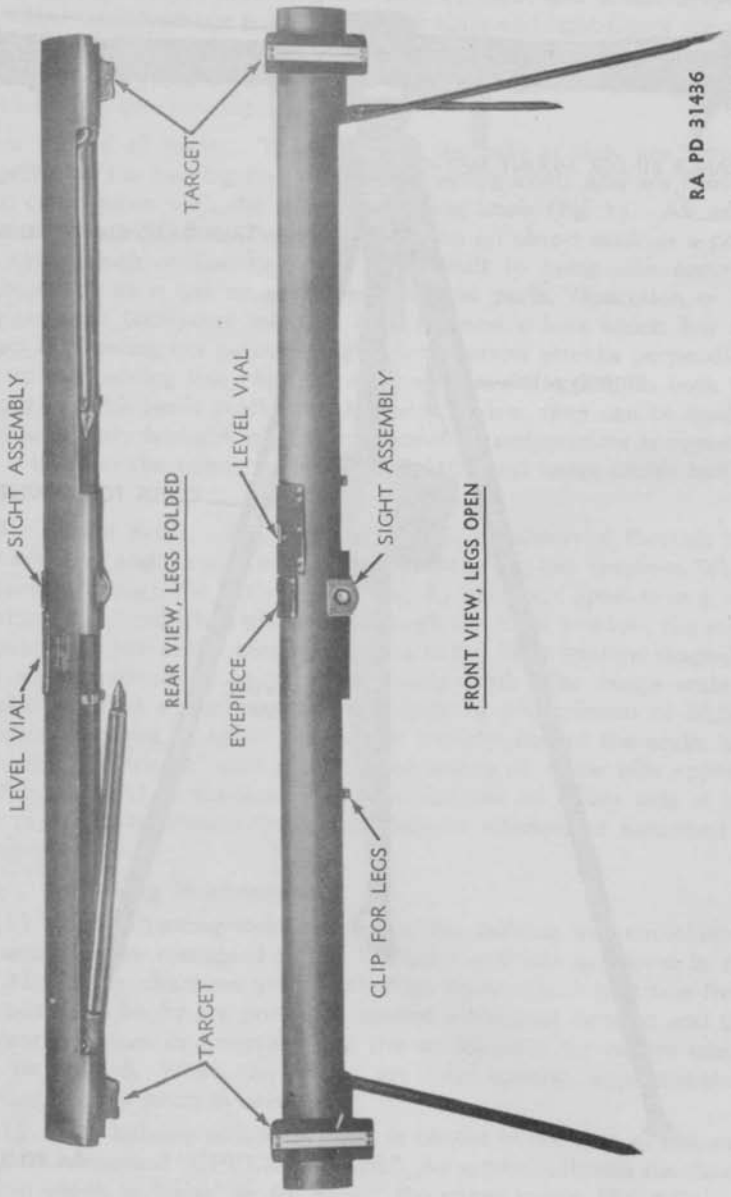


Figure 10 — Adjusting Lath M2, Front and Rear Views

direction in which to turn the knob in order to "raise" or "lower" the range scale reading ((fig. 12).

(4) The amount of the coincidence adjustment is registered on a correction wedge scale, which is visible on the end window (fig. 12). This scale is graduated in arbitrary units from 0 to 25 in both directions, and reads against a pointer on the sun shade. Its use is described in paragraph 8 b.

4. TRIPOD M18.

a. Tripod M18. The Tripod M18 shown in figure 9 supports the Mount M62 described in paragraph 3 c (3). It is a stiff leg tripod. The legs are secured in position with a tripod leg clamping nut at the top of each leg.

5. ADJUSTING LATH M2.

a. The Adjusting Lath M2 (fig. 10) is furnished with the 1-meter Base Range Finder M7, when issued to Field Artillery. Since each lath is individually adjusted, only the lath furnished with the range finder and serially numbered the same is to be used. The lath consists of a body tube which carries a target at each end. The body tube is mounted on collapsible legs, and is fitted with a level vial and sight assembly.

b. The level vial is used for cross-leveling the lath, and the sighting assembly is used to square the end targets with the line of sighting. A vertical center line across the lower portion of the field of view of the sighting assembly is used for this purpose.

6. EMPLACEMENT.

a. General. Before adjusting or operating the range finder, it should be assembled to its mount, if mount is provided, and the instrument as a whole set up properly, so as to permit a comfortable attitude for the observer.

b. For Use by Artillery Forces. To emplace the Range Finder M7 for testing, adjusting and operating by the artillery forces, first, slightly loosen the tripod leg clamping nuts on the Tripod M18 (fig. 9), in order to spread the legs to a stable position. Then, embed the legs in firm ground in such a manner that the bubble in the circular level vial on the mount is centered. Tighten the tripod leg clamping nuts. If the tripod is being set up on steeply sloping ground, two of the legs should be on the downhill side. Seat the range finder on the mount, making sure that the latching plug engages the lug on the cradle. Remove the covers on the end windows, and raise the cover on the range scale window.

c. **For Use by Armored Command.** To emplace the range finder for testing, adjusting and operating by the Armored Command, first, insert the Range Finder Mount M58 in the housing of the tank commander's periscope. Then, seat the range finder on the mount, making sure that the latching plug engages the lug on the cradle. The range finder is now ready for testing and operating.

d. **For Use by Infantry, Cavalry or Tank Destroyer Command.** The testing and operating of these range finders by the Infantry, Cavalry, or Tank Destroyer Command is performed with the range finder either on the ground or held by the observer, as tripods and mounts are not furnished with the range finder when issued to these branches of the armed forces.

7. ADJUSTMENTS PRIOR TO OPERATION.

a. **Halving Adjustment.** Select as a target a sharply defined object at least 500 yards away, and direct the range finder on the target. Elevate or depress the range finder to bring the images in the field of view into a position where they both touch the halving line. If the images cannot be moved into this position, expose the halving adjustment knob (fig. 12) and turn the knob until the images appear equidistant from the halving line, and can be brought into the touching position with the elevating knob. Directions as to which way to turn the knob to raise or lower the image are inscribed on the cover of the knob. After the adjustment has been made, close the cover to protect the knob against accidental turning, and from accumulation of dust and moisture in the mechanism.

b. **Coincidence Adjustment.**

(1) GENERAL. There are two methods for performing the coincidence test: the known range method and the infinity method. Their use is dependent upon the facilities available for performing the test. Both of these methods require the use of the coincidence adjusting knob. The coincidence test is performed only after the halving adjustment has been made, as a small error in halving may lead to a considerable error in range. Undertake the adjustment only when conditions are favorable for accurate and deliberate observation. It is important, when bringing two images into coincidence, to fix upon a definite recognizable point, so that the same point in both images can be brought into coincidence; otherwise, an error in range will result.

(2) KNOWN RANGE METHOD.

(a) The known range method employs the use of a target of known range with the range scale accurately set to register the range. Direct the range finder on a sharply defined object at a distance of 500 yards or more, whose range is known. Set the range

scale accurately to indicate the range. Then observe the position of the images in the field of view. They should coincide if the instrument is in adjustment.

(b) If the images do not coincide, expose the coincidence adjusting knob, and turn the knob until coincidence is obtained. Directions as to which way to turn the knob to raise or lower the range scale indication are inscribed on the cover of the knob. Read the amount of the adjustment or correction on the correction wedge scale (fig. 12), and record it.

(c) Now throw the images out of coincidence by turning the coincidence adjusting knob, and once again bring them into coincidence. Do not change the original range setting on the range scale. Read and record the amount of the adjustment on the correction wedge scale. Repeat the procedure ten times. Average the ten readings and, with the coincidence adjusting knob, set the average on the correction wedge scale. Make a final check and, if satisfactory, close the cover to protect the knob against accidental turning and accumulation of dust and moisture in the mechanism.

(3) INFINITY METHOD. The infinity method is performed in the same manner as the known range method, with the exception that a celestial body or an adjusting lath is used as the target and the range scale is set to register infinity. If an adjusting lath is used, place the Adjusting Lath M2 in a horizontal position at least 125 yards away from the range finder. It is important that the adjusting lath be positioned so that the end targets are square with the line of sighting. Use the sight on the lath to insure this position. Set the range scale to register infinity. If the range finder is in correct adjustment, the images of the lath in the field of view should appear in coincidence as in right illustration of figure 11. The infinity mark on the Range Finder M7, has three graduations either side of the star, which indicate tolerances for this adjustment. If the range reads within two graduations either side of the star when the images are in exact coincidence, adjustment is not necessary.

c. Micrometer Adjustments. Micrometers should read zero when their scales read normal. If they do not, loosen the clamping screw in the end of the micrometer knob, and shift the knob until it reads zero. Be careful not to let the scale move when shifting the micrometer.

8. OPERATION.

a. To Focus the Eyepiece. The eyepiece is focused by rotating the diopter scale to produce a clear and sharp image. If the operator knows the value of the correction for his own eye, the setting may be made directly on the diopter scale.

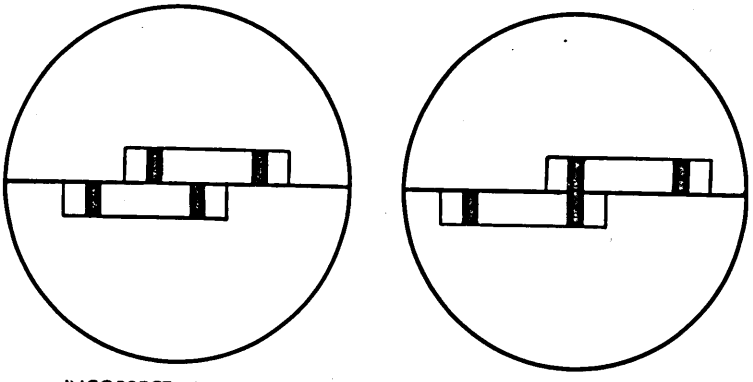


Figure 11 — Range Adjustment by Use of the Adjusting Lath

b. To Bring the Target Into the Field of View.

(1) The target must first be brought into the field of view with the longitudinal axis of the range finder in either a horizontal or a vertical position, before coincidence of the images can be obtained. The horizontal position is used when ranging on objects having prominent vertical parts which appear in the field of view. The vertical position is used when ranging on horizontal objects, such as roads, rivers, trenches, crests of ridges, etc., which have no prominent vertical parts.

(2) To bring the target into the field of view with the range finder in a horizontal position, disengage the azimuth worm with the throwout lever in the mount (fig. 4), and swing the instrument horizontally to bear in the direction of the target; use the auxiliary sight for approximate aiming. Elevate or depress the instrument with the elevating knob, and if necessary turn the instrument to the right or left with the micrometer knob so that the target will appear near the center of the field of view. If ranging on a moving target, it is advisable to start with the target at the edge of the field of view so that it may be brought into coincidence as it crosses the field.

(3) To bring the target into the field of view with the range finder in a vertical position, first remove it from the mount and stand it on end. The target is then brought into the field of view by directing the instrument with the hands.

c. To Determine the Range.

(1) In order to determine the range, the images n the field of view must be brought into exact coincidence. Select a clearly defined recognizable point of the target, perpendicular, if possible, to the

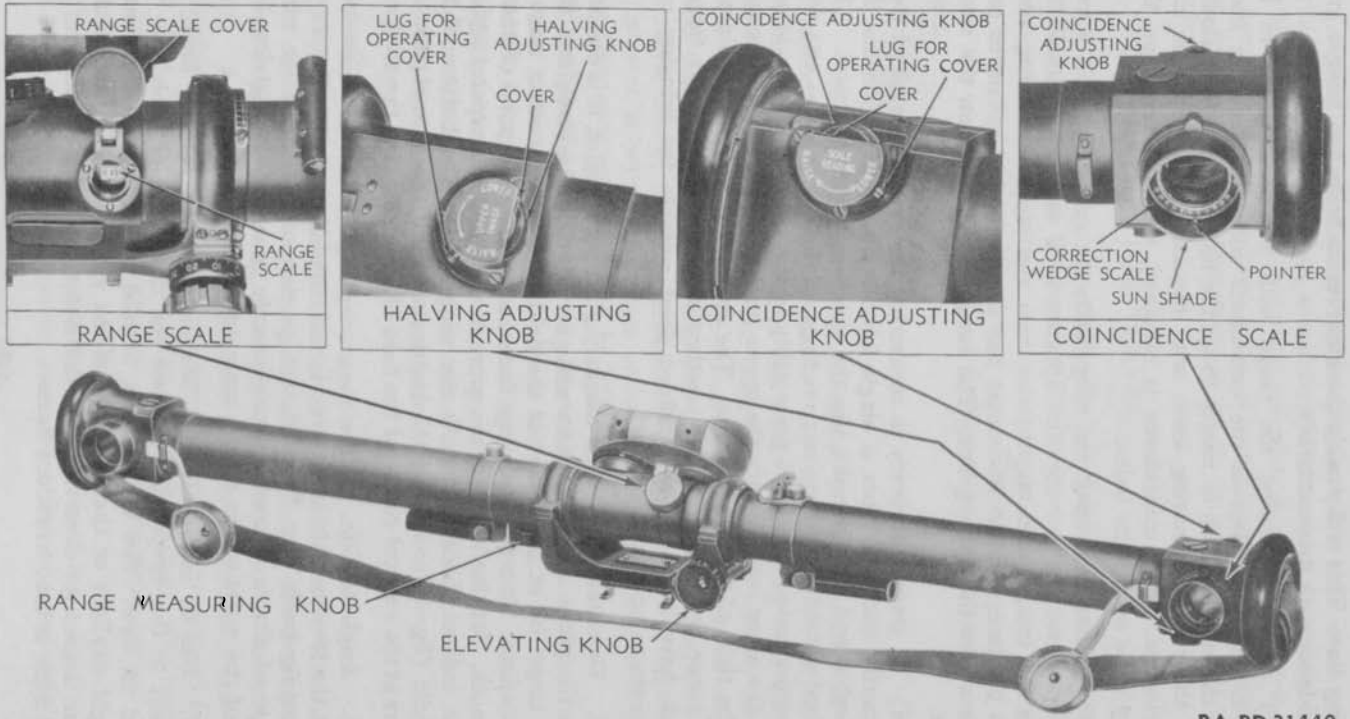


Figure 12 — 1-meter Base Range Finder M7, Adjusting and Operating Controls

halving line. This will enable the observer to bring the images into coincidence with more accuracy.

(2) When measuring the range with the range finder in its mount, elevate or depress the instrument with the elevating knob until the images touch or nearly touch the halving line. Now slowly turn the range measuring knob until the images are brought into coincidence. After coincidence is obtained, read the range on the range scale against its index.

(3) When measuring the range with the range finder in a vertical position, the halving line appears in a vertical position. To bring the images into coincidence, turn the range measuring knob until the image of the horizontal line of the target appears to continue across the halving line. The range is then read on the range scale.

(4) If greater accuracy in measuring the range is required than ordinarily obtained from a single observation, and conditions are favorable and time permits, use the above-and-below method. This method consists of taking two readings on the range scale: one with the upper image being just perceptibly to the left of the lower image, and the other reading with the upper image being the same distance to the right of the lower image. The average of the two readings is the range that is used. This method applies especially to targets which have no sharp, well-defined point suitable for bringing into accurate coincidence.

d. Orientation. When measuring azimuth angles, it is essential that the plane of the azimuth scale be substantially level, and that the target be at the center of the field of view for correct angular indications. To orient the range finder, select a datum point of known azimuth. Set this value on the azimuth scale and micrometer against their indices. Loosen slightly the wing nut on the bottom of the spindle (fig. 4) and swing the instrument until the datum point appears at the vertical center of the field of view. Tighten the wing nut.

e. Angle of Site. When measuring angles of site, it is essential that the level bubble is centered in the circular level vial. Rotate the elevating knob (fig. 1) until that portion of the target for which angle of site is desired appears exactly touching the halving line. Read the angle of site on the scale and micrometer.

f. Use of Light Filters. Moving the filter selector knob, adjacent to the eyepiece, interposes the desired color filter into the field of view. The amber filter is used to moderate exceptionally bright daylight or the reflection of the sun over water; the neutral filter is used for observing into the direct rays of a searchlight; the red filter is used to reduce haze.

g. Use of Astigmatizer. The astigmatizer is used when ranging at night on an object, such as a point of light, which ordinarily would be difficult to bring into accurate coincidence in the field of view as it has no prominent vertical parts. The astigmatizer is brought into use by moving the astigmatizer lever, in the top of the left range finder handle (fig. 1).

9. PREPARATION FOR TRAVEL.

a. To prepare the range finder for travel, fold up the range finder handles and see that the cover to the range scale window cover is down, and that the leather covers are on the sun shades. Remove the range finder from the mount and place it in its carrying case. Place the tripod with mount and the adjusting lath in their carrying cases.

10. MAINTENANCE.

a. General. Disassembly, assembly, and such repairs as may be handled by using arm personnel may be undertaken only under the supervision of an officer or the battery mechanic. The maintenance of the range finder by the using personnel is ordinarily limited to the halving and coincidence adjustments and micrometer adjustments described in paragraph 8, and to the lubricating and cleaning described below. In all cases where the nature of the repair or adjustment is beyond the scope or facilities of the unit, the responsible Ordnance service should be informed.

b. Cleaning and Preserving Materials. The authorized cleaning and preserving materials include the following:

BRUSH, artist, camel's hair, rd. (for optical parts)
CLOTH, wiping, cotton (for metal parts)
OIL, lubricating, for aircraft instruments and machine guns
PAPER, lens, tissue (for optical parts)
SOAP, liquid, lens cleaning

c. Care in Handling.

(1) Avoid unnecessary shocks to the instrument. The range finder contains delicate mechanisms, and accurately adjusted optical parts. Rough handling can cause serious damage to the instrument.

(2) Avoid sighting the instrument directly at the sun if this can be avoided, and do not allow the instrument to be so exposed for a long time. Keep covers on windows when not ranging. The heat of the focused rays may melt the cement which holds the optical elements together.

(3) Moisture may collect and cause fogging of the optical parts. Place the instrument in a warm place for a few minutes until the

fogginess passes away. Do not apply heat from a concentrated source as it may cause damage to the instrument, and disturb its accuracy.

(4) When not in use, the instrument should be kept in its case.

(5) The interior of the range finder case should be kept dry, and the range finder should not be placed in its case unless quite dry.

d. Lubrication.

(1) Lubricate exposed moving parts of the tripod sparingly with lubricating oil, and keep the contact surfaces of the mount coated with a light film of lubricating oil to prevent rust.

(2) Do not lubricate any part of the range finder itself. The instrument should be kept clean of lubricant. None must be allowed to enter the interior, nor come in contact with the optical elements.

e. Cleaning Optical Parts.

(1) To obtain satisfactory vision, keep all the exposed surfaces of lenses and other parts affecting vision clean and dry.

(2) Remove grease or oil with lens-cleaning liquid soap applied with a tuft of clean lens tissue. Rub the surface of the lens gently until clean. If lens-cleaning liquid soap is not available, breathe heavily on the lens and wipe off with clean lens tissue. Repeat until clean.

(3) Remove dust from optical elements with the camel's-hair brush provided. After brushing, tap the brush against a hard object to loosen the adhering dust particles. Repeat until the surface is clean.

(4) Do not remove lenses for cleaning, and do not touch the surface with the bare fingers.

f. Cleaning Metal Parts.

(1) Clean the range finder and head of the tripod or mount at least once daily, exercising care to remove all excess lubricant which may have seeped out from the operating parts. Use a piece of clean cotton cloth.

(2) Do not use polishes of any kind for cleaning the range finder.

11. OPERATING UNDER UNUSUAL CONDITIONS.

a. General.

(1) Keep instruments as dry as possible. If the instrument becomes wet, dry it before placing it in its carrying case.

(2) Wipe off all oil that seeps from bearings to prevent the accumulation of snow and grit.

(3) Do not grasp metal parts such as handwheels with the bare hands. Use gloves if possible and as an added precaution, knobs

should be wrapped with a strip of friction tape to prevent direct contact with the metal. At low temperatures frozen fingers or loss of skin may result if this precaution is not followed.

b. Optical Elements.

(1) To obtain satisfactory vision, exposed surfaces of lenses and other optical parts must be kept clean and dry. Corrosion and etching of the surface of the glass can be prevented or greatly retarded by keeping the glass clean and dry.

(2) Optical surfaces should be cleaned in cold-weather operation by using a lens tissue, moistened with a few drops of ethyl alcohol. Alcohol should never be applied directly to the surfaces, as it may injure the sealing compound. If alcohol is not available, a dry lens tissue will do the job. See SNL K-1.

(3) Never breathe on the lens in cold weather. This will only serve to aggravate conditions already present, and in extreme cases may even break the lens.

(4) Optical instruments should not be brought from cold temperatures immediately into warm inclosures. Sudden changes in temperature will cause optics to break, especially those under internal stress or an artificial strain set up by tight retaining ring or tight adjusting screw. Optical instruments should be brought from cold up to normal temperature gradually.

(5) Heat from strongly concentrated sources should not be applied directly lest it cause unequal expansion of parts, thereby resulting in breakage of optical parts or inaccuracies in observation.

(6) In case of a frozen focusing part or filter selector parts, Ordnance personnel will take proper steps to insure working in cold weather. However, the user should set the diopter scale to his own setting before attempting operations in cold weather.

(7) The use of Antidim, used on lenses of gas masks, and especially on eye lenses of telescopes, will prevent fogging of eye lens, when in close proximity with the eye. To apply, use very sparingly and wipe surplus off surface of lens with lens tissue.

c. Use of Rubber Eye Shield. Be especially cautious of flexing the rubber eye shield, as cold makes it extremely brittle.

d. Care of Carrying Cases.

(1) Proper care must be taken of carrying cases to prevent deterioration. It is necessary that they be protected from moisture, dirt, grit and foreign material. They should be periodically cleaned with oval sash brush or compressed air to insure that foreign matter will not collect in the cases to be transferred to optical elements or delicate mechanisms.

(2) Leather is dried by cold-weather conditions. A light coat of neat's-foot oil (SNL K-1 and TM 9-850) should be applied monthly to the grain or finished side of all carrying straps or cases. NOTE: This should be applied to all leather goods monthly, if in use; every six months if in storage.

e. Fungus. In hot, humid climates, exercise care to clean all external lens surfaces daily to prevent the formation of fungus growth.

[A.G. 300.5 (6 Jul 44)
O.O. 300.7/2136]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:
J. A. ULIO,
Major General,
The Adjutant General.

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(For explanation of symbols, see FM 21-6.)