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TM 9-659

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

REFERENCE COPY

DIRECTORS

Rescinded

M5A1, M5A2

AND

M5A3

Rescinded By DA Cir 310-62, May 1963

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DEPARTMENT OF THE ARMY
DECEMBER 1947

RESTRICTED

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DEPARTMENT OF THE ARMY
TECHNICAL MANUAL TM 9-659

This manual supersedes TM 9–659, 16 July 1943; TB 9–659–1, 16 April 1945; and TB 9–659–2, 9 August 1945. It also supersedes so much of TB ORD 193, 30 September 1944, as pertains to the matériel covered in this manual.

DIRECTORS

M5A1, M5A2

AND

M5A3

DEPARTMENT OF THE ARMY
DECEMBER 1947

U. S. Government Printing Office
Washington : 1947

DEPARTMENT OF THE ARMY

Washington 25, D. C., 22 December 1947

TM 9–659, Directors M5A1, M5A2, M5A3, is published for the information and guidance of all concerned.

The information in this manual is correct as of 22 August 1947.

[AG 300.7 (10 Jun 44)]

BY ORDER OF THE SECRETARY OF THE ARMY:

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PART ONE
INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual is published for the information and guidance of the using arm and service. It contains technical information required for the operation and maintenance of the matériel as well as descriptions of the major units and their functions in relation to the other components of the matériel.

b. When the nature of the repair, modification, or adjustment of this matériel is beyond the scope or facilities of the unit, the responsible ordnance service should be informed so that trained personnel with suitable tools and equipment may be provided, or proper instructions issued.

2. Records

Suggestions for improvement in design, maintenance, safety, and efficiency of operation prompted by chronic failure or malfunction of the matériel should be reported on WD AGO Form 468 (Unsatisfactory Equipment Report), with all pertinent information necessary to initiate corrective action. The report should be forwarded to the Office, Chief of Ordnance, Field Service Division, Maintenance Branch, through command channels in accordance with instruction No. 7 on the form. Such suggestions are encouraged in order that other organizations may benefit.

Section II. DESCRIPTION AND DATA

3. Description

a. GENERAL (FIGS. 1 THROUGH 5). (1) Directors M5A1, M5A2, and M5A3 are electromechanical systems for computing the necessary firing data and directing the fire of antiaircraft guns on the basis of optical observation of a moving target. They are used for directing fire on aerial targets and mechanical ground targets. The principal purpose of these directors is the calcula-

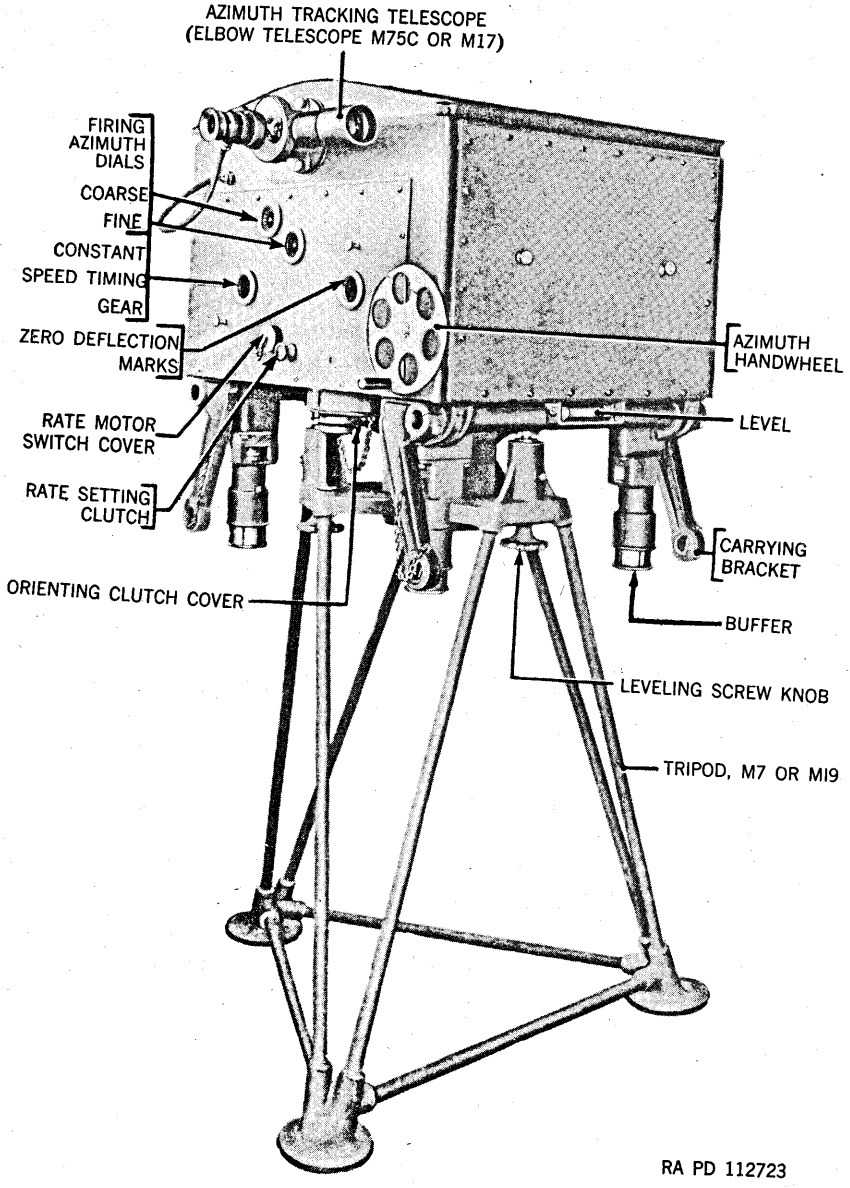


Figure 1. Director M5A1—front and right side.

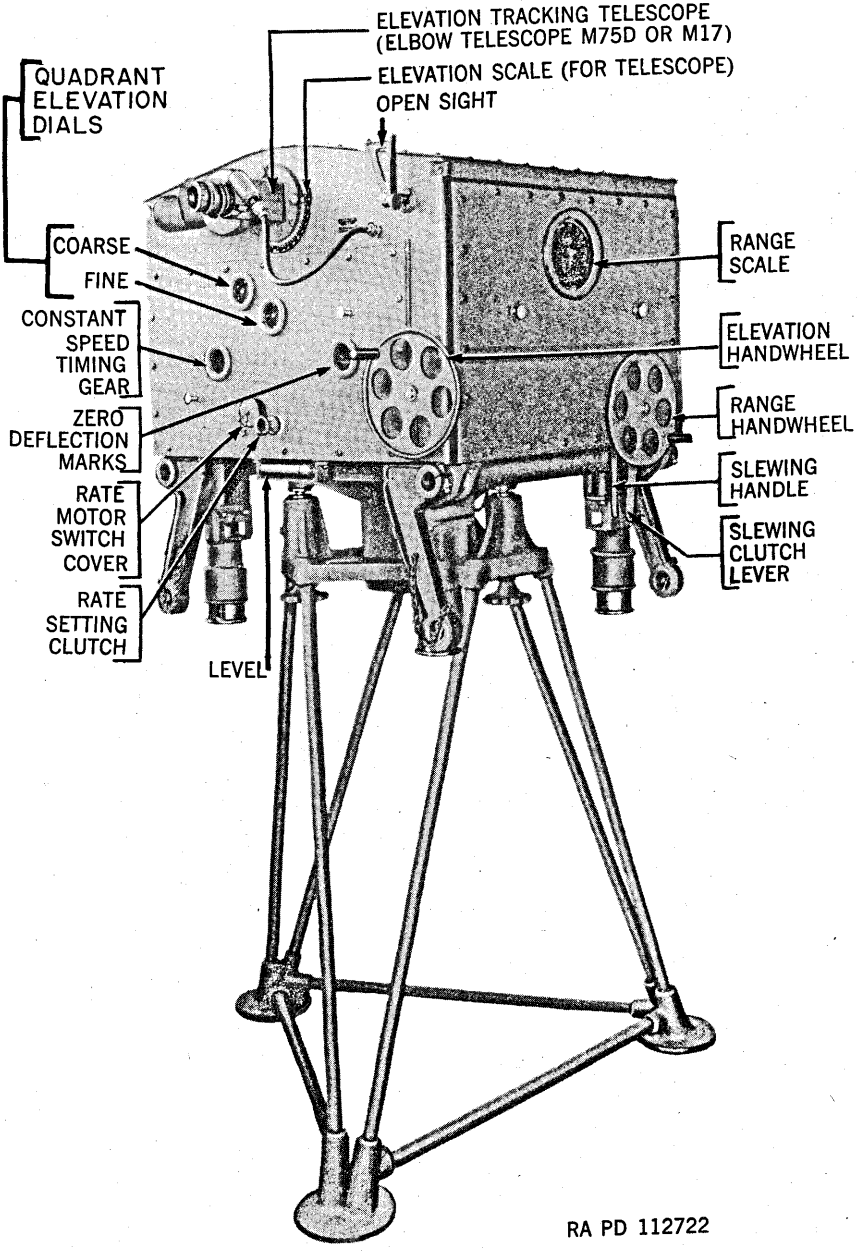


Figure 2. Director M5A1—rear and left side.

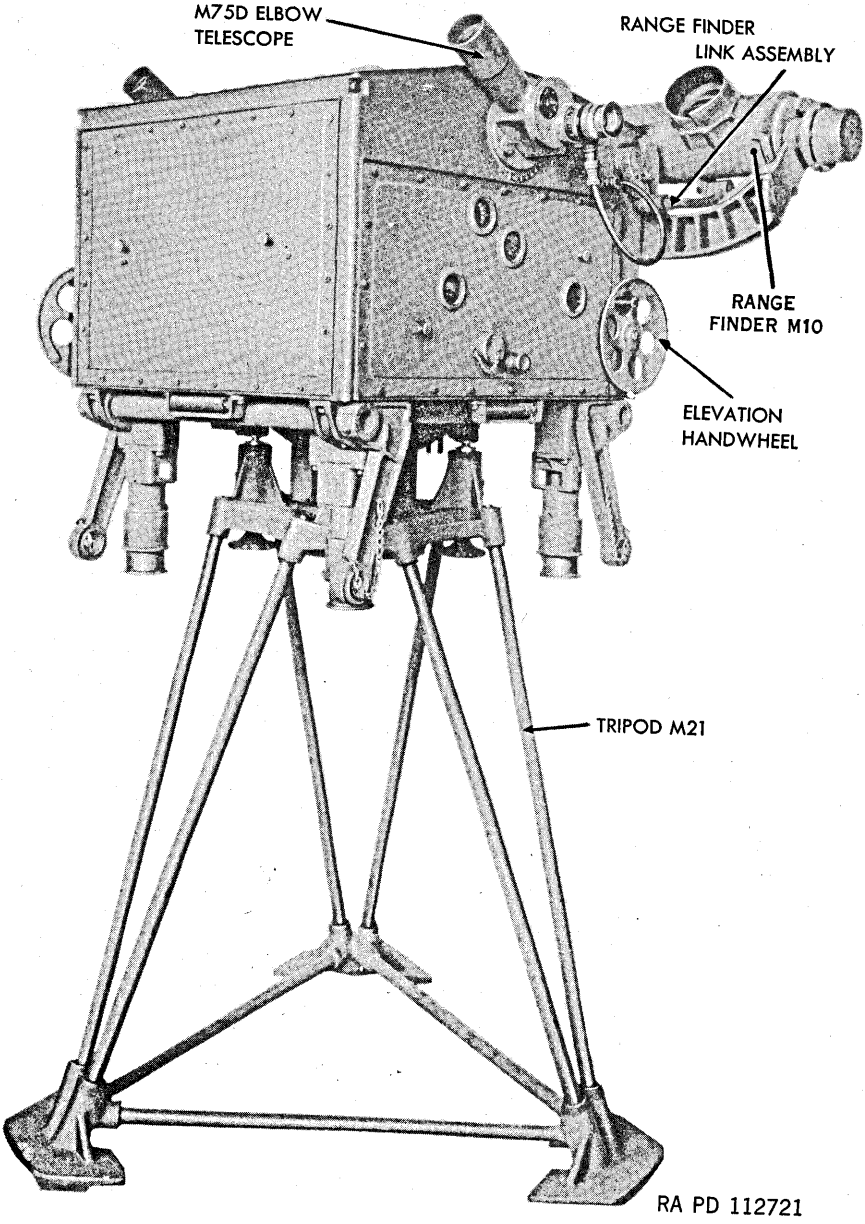


Figure 3. Director M5A2—front and left side views.

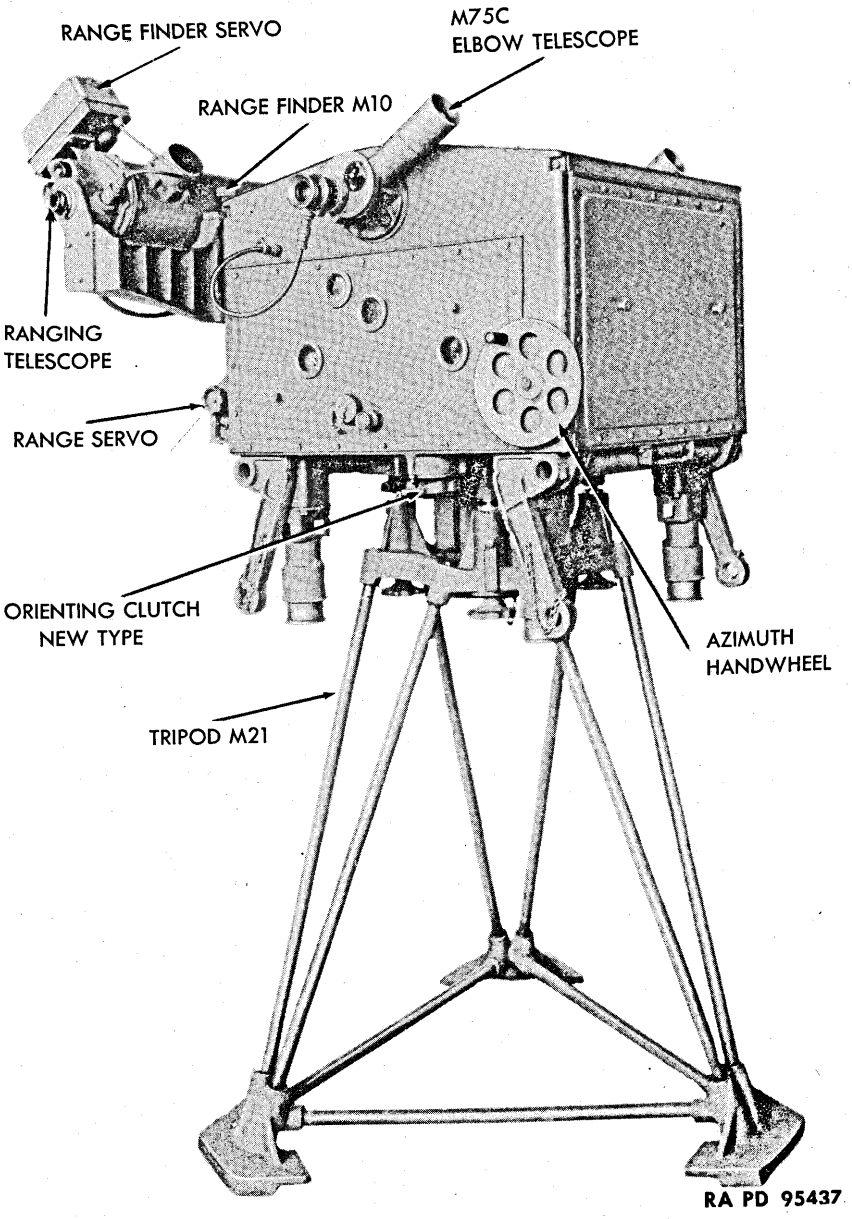


Figure 4. Directors M5A2 and M5A3—front and right side views.

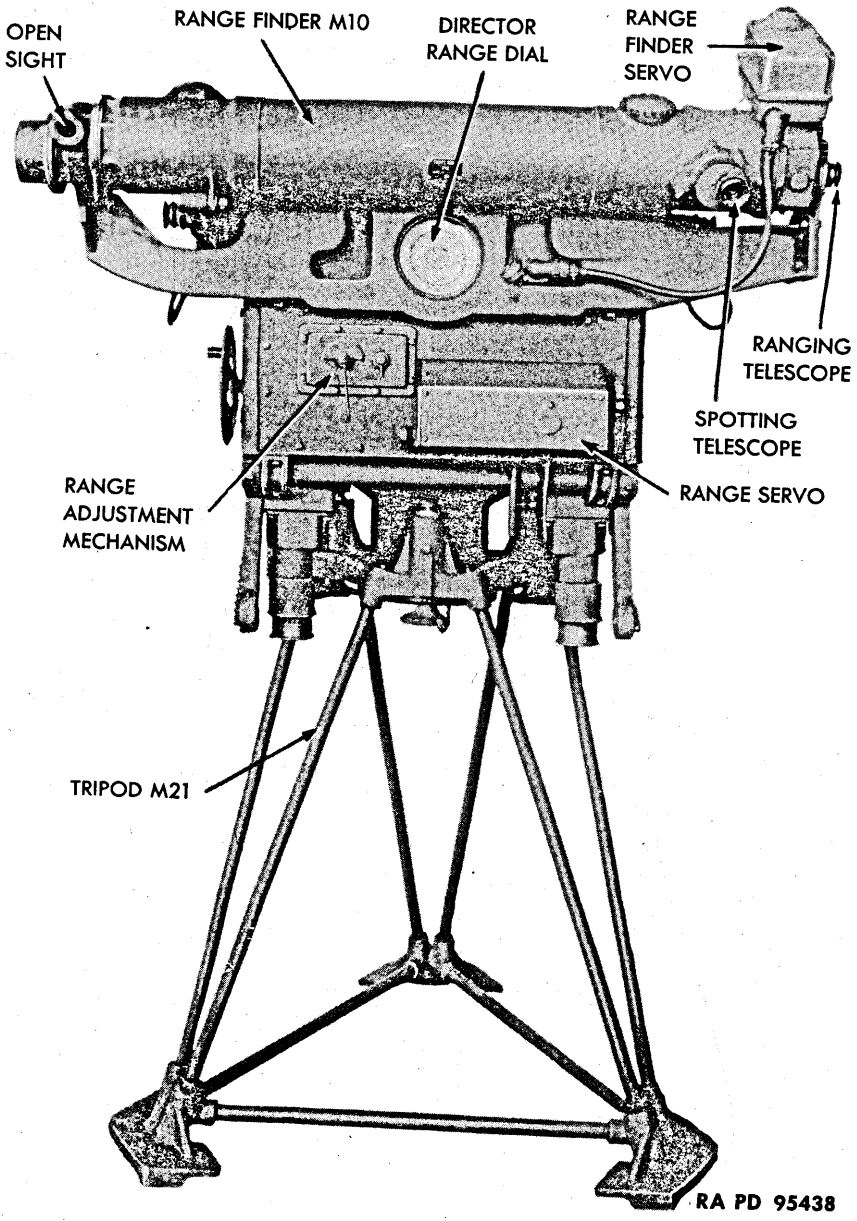


Figure 5. Directors M5A2 and M5A3—rear view.

tion of firing data on low-flying, high speed airplanes which fly within the maximum effective range of automatic short range antiaircraft weapons where it is imperative that the antiaircraft unit function at maximum speed.

(2) The director receives its power from the generating unit M5.

b. IDENTIFICATION INFORMATION. (1) Each of the directors is most easily identified by its name plate, located on the left side of the director a little below and in front of the open sight or range finder level arm.

(2) Each of the telescopes is identified by its name plate, located on the prism housing of the telescope.

(3) The range finder is identified by its name plate, located on the outside tube.

c. DIFFERENCE IN MODELS. (1) Directors M5A1, M5A2, and M5A3 are intended for use with the remote control system M15 and are therefore designed for fully self-synchronous operation of the remote control system.

(2) Director M5A1 is mounted on tripod M7 or M19; directors M5A2 and M5A3 are each mounted on a tripod M21. Tripods M7 and M19 are similar. The difference is that tripod M7 is shipped assembled and cannot be disassembled in the field whereas tripod M19 is shipped disassembled and may be readily assembled in the field. Tripod M21 differs from tripod M19 in stability and its method for locking the director on the tripod. Increased stability is provided by a larger foot plate. The tripod plungers are grooved to permit the locking of the director into the tripod.

(3) The directors M5A2 and M5A3 differ from director M5A1, principally in the method of establishing and introducing slant range into the director computing mechanisms. In the earlier type directors, slant range is introduced by estimating range and rotating the range handwheel. In this model the range setter observes the target, and estimates and sets the range. The trackers follow the target by means of the telescopes. The range setter corrects the estimated range by noting the path of tracers fired toward the target. In directors M5A2 and M5A3, the range spotter brings the target into the field of view of the range finder. The range finder determines the exact range, which is automatically fed into the director computing mechanisms (fig. 6) by means of the servo systems. When the range finder is inoperative for any reason, these models can be operated in the same manner as director M5A1, by installing an emergency range handwheel and estimating the range. The director M5A1 makes all computations by mechanical means such as differentials, cams, gears,

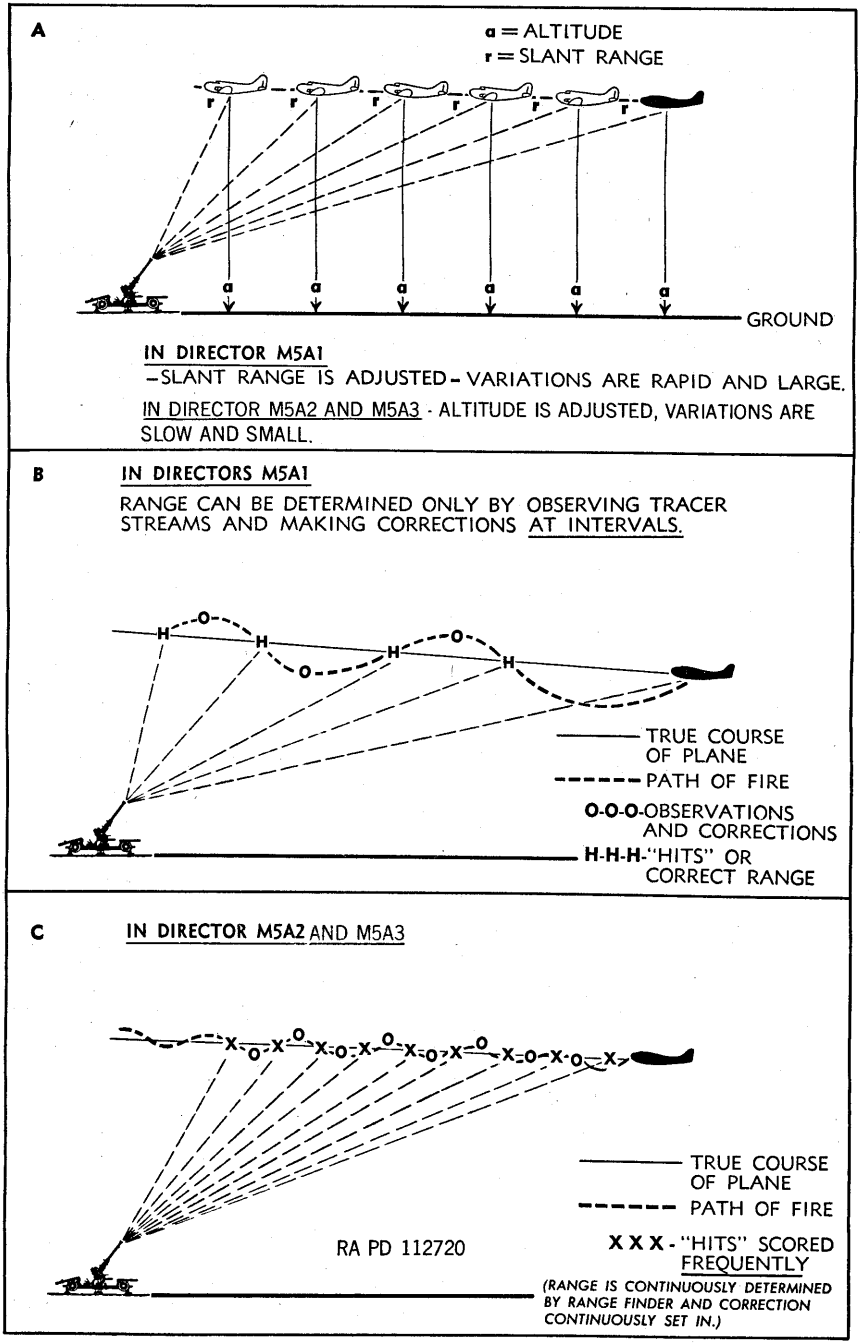


Figure 6. Advantages of directors M5A2 and M5A3.

and variable speed drives; the directors M5A2 and M5A3, in addition, employ electrical means of computation by use of potentiometers.

(4) The director M5A3 differs from the director M5A2 in that it has a maximum azimuth tracking rate of 30° per second instead of 20° per second. In the director M5A3, the time constant in both azimuth and elevation has changed from 0.14 to 0.50 second without any change in range scales. Later models of director M5A3 have time constants of 0.14 second.

Note: A limited number of directors M5A3 were produced with a time constant of 0.5 second. These are identified by a plate which is affixed below the director name plate and which bears the following inscription:

This director equipped
with tracking time
constants of 0.5
second.

(5) Special explanation of any differences between any of the directors is made next to or within the paragraphs pertaining to parts in which differences exist.

d. PRINCIPLES OF OPERATION. The directors M5A1, M5A2, and M5A3 contain mechanisms for calculating and transmitting two elements of data, quadrant elevation and firing azimuth. The elements of data introduced into the instruments are angular travel in elevation and in azimuth, and slant range. Fuze data are not required because the ammunition is assembled with a point detonating supersensitive fuze.

4. Tabulated Data

a. LIMITS OF OPERATION.

	M5A1	*M5A2*	*M5A3*
Azimuth (mils)	No limit.	No limit.	No limit.
Present elevation (electrical stops) (degrees)	Minus 5 to plus 85.	Minus 5 to plus 85.	Minus 2 to plus 85.
Present elevation (mechanical stops) (degrees)	Minus 10 to plus 92.	Minus 10 to plus 92.	Minus 10 to plus 92.
Maximum angular rate of tracking in azimuth (degrees per second)	20	20	30
Maximum angular rate of tracking in elevation (degrees per second)	20	20	20
Range (yards) (40-mm range scale)	375 to 2,800	375 to 2,800	375 to 2,800

Altitude scale (yards)		0 to 2,500	0 to 2,500
Slant range scale (range finder)		400 to 2,500	400 to 2,500
Time constant, aided tracking	0.140	0.140	0.500 or 0.140

b. WEIGHTS.

	M5A1	*M5A2*	*M5A3*
Director with packing chest	690 lb	766 lb	766 lb
Shipping crate for director	410 lb	528 lb	528 lb
Tripod M7 with crate	229 lb		
Tripod M19 with crate	226 lb		
Tripod M21 with crate		226 lb	226 lb
Range finder with crate		247 lb	247 lb

c. DIMENSIONS (INCHES).

Director (all models) with packing chest	47¼	by 35⅞	by 38½
Shipping crate for director	60½	by 58⅛	by 44¼
Tripod M7 with crate	42¾	by 35⅞	by 47⅜
Tripod M19 with crate	42¾	by 36¾	by 12¼
Range finder with crate	51⅝	by 27	by 19¾

PART TWO
OPERATING INSTRUCTIONS

Section III. GENERAL

5. Scope

Part two contains information for the guidance of the personnel responsible for the operation of this matériel. It contains information on operation of the matériel, with description and location of the controls and instruments.

Section IV. SERVICE UPON RECEIPT OF EQUIPMENT

6. General

a. Upon receipt of new or used matériel, it is the responsibility of the officer in charge to ascertain whether or not the matériel is complete and in sound operating condition. A record should be made of any missing parts or malfunctions and replacement or correction made as quickly as possible.

b. Attention should be given to small or minor parts, as these are likely to become lost and may seriously affect the proper functioning of the matériel.

c. Prepare the matériel for service in accordance with instructions given in the following paragraphs. Lubricate the matériel as instructed in paragraphs 77 through 79.

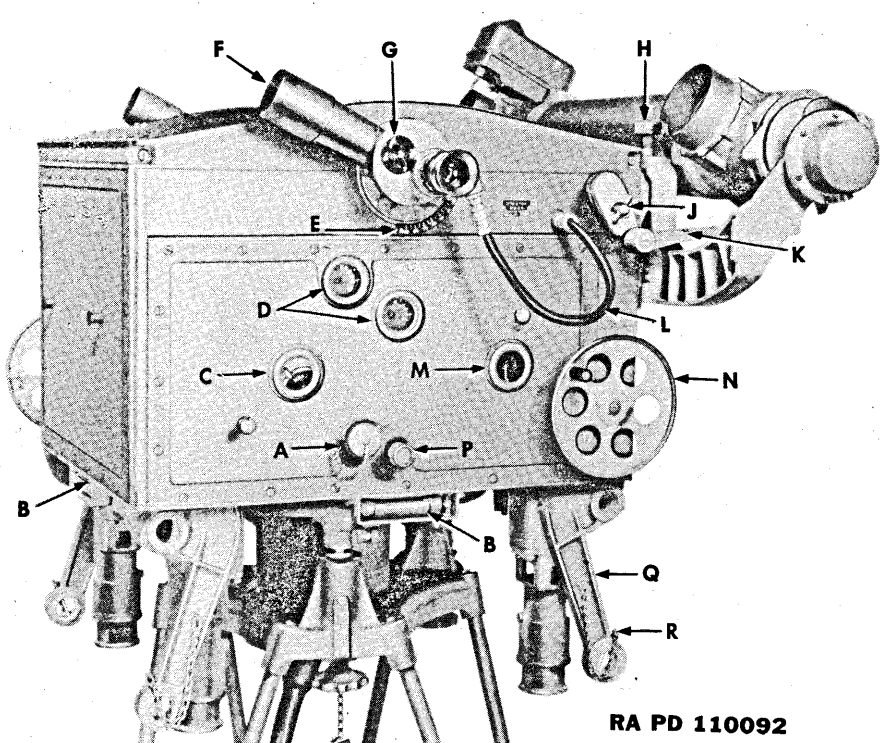
7. New Equipment

a. Assemble tripod M19 as follows:

(1) Remove top of case and check contents. The box contains the following:

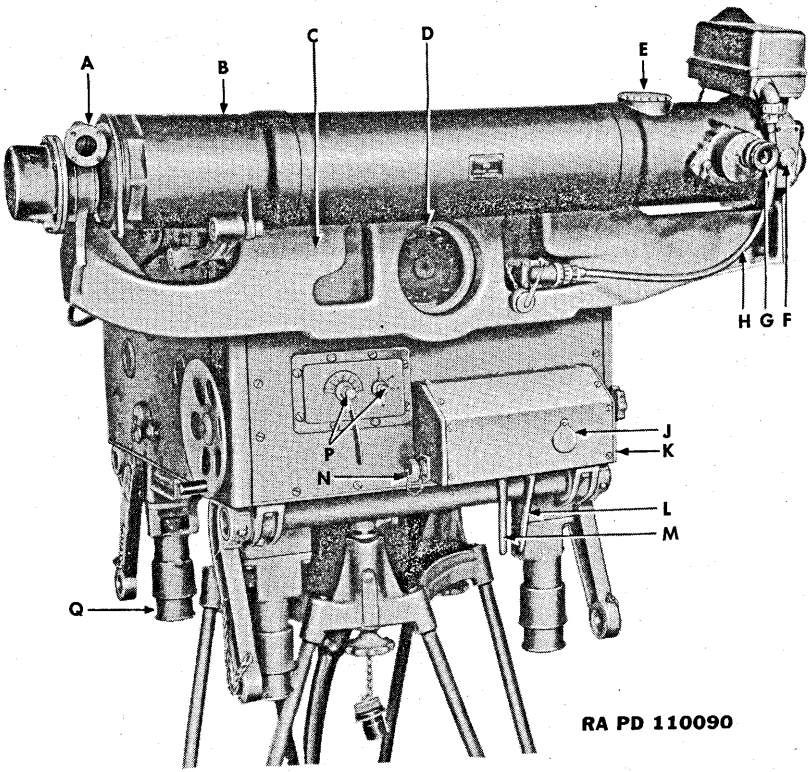
Tripod head.
Tripod base.
Six legs.
Six screws for feet.
Wrench for screws.
Spanner wrench for inserting legs in head.

(2) Open the wire loop fasteners on one corner of the box and spread the sides. Remove sides from base of case. Take bundle of legs and bag of screws from wooden frame and lay on box top; then remove frame.



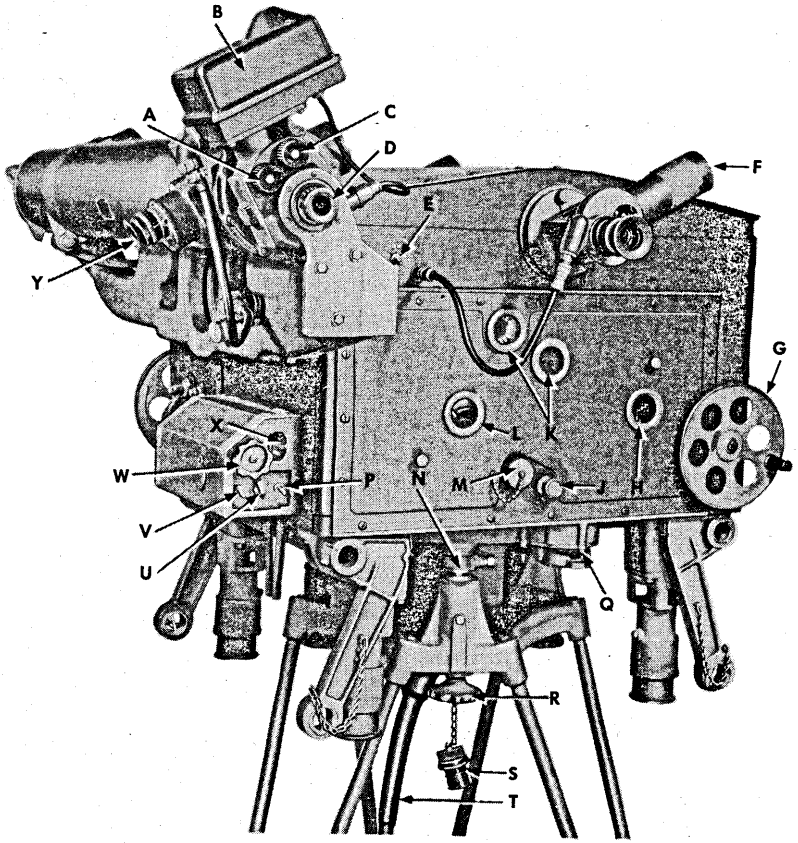
A—RATE MOTOR SWITCH
B—LEVEL
C—CONSTANT SPEED INDEX
D—QUADRANT ELEVATION DIALS
E—ELEVATION SCALE
F—ELEVATION TELESCOPE
G—FILTER KNOB
H—MOUNTING BRACKET THUMBSCREW
J—LINKAGE CONNECTION SCREW
K—RANGE FINDER COUPLING LINK
L—TELESCOPE LIGHT CABLE
M—ZERO DEFLECTION INDEX
N—ELEVATION TRACKING HANDWHEEL
P—RATE SETTING CLUTCH
Q—CARRYING BRACKET
R—LOCKING PIN

Figure 7. Directors M5A2 and M5A3—elevation side.



A—POLAROID OPEN SIGHT
B—RANGE FINDER M10
C—RANGE FINDER MOUNTING BRACKET
D—SLANT RANGE SCALE
E—DESICCATING UNIT
F—SPARE RANGE FINDER LAMP
G—SPOTTING TELESCOPE
H—RANGE FINDER SERVO CABLE
J—RECEPTACLE FOR RANGE HANDWHEEL
K—RANGE SERVO HOUSING
L—SLEWING CLUTCH
M—SLEWING HANDLE
N—HEATER SWITCH
P—RANGE ADJUSTMENT LEVERS
Q—BUFFER

Figure 8. Directors M5A2 and M5A3—rear view.



A—RANGE CORRECTION KNOB
B—RANGE FINDER SERVO
C—HEIGHT CORRECTION KNOB
D—RANGING TELESCOPE
E—LIGHT SWITCH
F—AZIMUTH TELESCOPE
G—AZIMUTH TRACKING HANDWHEEL
H—ZERO DEFLECTION INDEX
J—RATE SETTING CLUTCH
K—FIRING AZIMUTH DIALS
L—CONSTANT SPEED INDEX
M—RATE MOTOR SWITCH
N—SAFETY LATCH
P—RANGE SERVO SWITCH
Q—ORIENTING CLUTCH
R—LEVELING SCREW
S—D-PLUG RECEPTACLE PLUG
T—POWER AND DATA CABLE
U—RHEOSTAT
V—RANGE FINDER SERVO SWITCH
W—ALTITUDE KNOB
X—ALTITUDE SCALE
Y—SPOTTING TELESCOPE

RA PD 110089

Figure 9. Directors M5A2 and M5A3—azimuth side.

(3) Remove large base and place on box lid. Turn head over and place on box with leg holes up. Clean all holes in head and base. Unwrap legs; clean the ends and lay them on base to keep them clean.

(4) Insert the six legs in the holes toward the head. Use spanner wrench to screw legs into head. Legs must be screwed in until they seat solidly against the bottom of the hole.

(5) Turn base upside down. Insert two legs in one foot about ¼ inch; next insert two legs in second foot, then two in third foot. Be sure legs are in each foot about ¼ inch. Tap the point of each foot gently and in succession so that the legs are driven in evenly about ¼ inch at each tap, until the feet are secure on the legs.

(6) Place the six screws, two to each foot, in the countersunk holes. Tighten firmly with special wrench.

(7) Lift completely assembled tripod from case and set it on its base. When assembly is completed, paint bare metal spots to prevent rust.

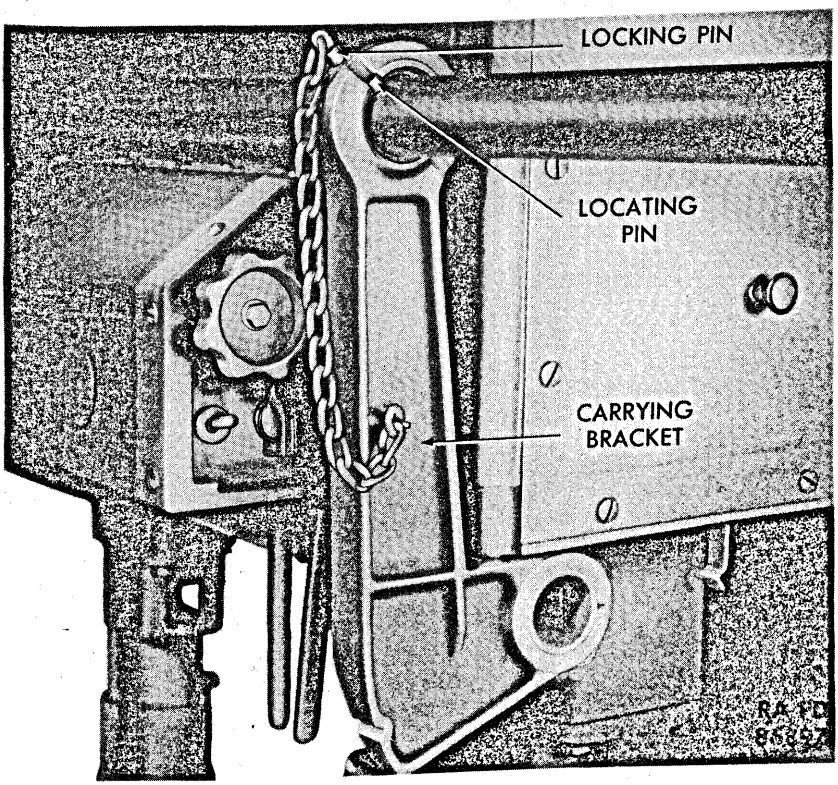


Figure 10. Carrying bracket—porter bar installed.

b. Assemble tripod M21 as follows:

(1) The procedure for assembling the tripod M21 is similar to that for the M19 except that the legs are not screwed into the head but are inserted in the holes and then are held by screws similar to those in the base.

(2) The bag, therefore, contains 12 screws, 6 short, 6 long. The long ones are for the base, the short ones for the head.

c. Set up the equipment.

d. Remove corrosion preventative materials with clean wiping cloths.

e. Inspect over-all condition for bent, broken, or missing parts. See that paint is not chipped. Look particularly for broken windows or levels.

f. Clean eyepieces and exposed optical surfaces (par. 82*c.*).

g. Lubricate the equipment as instructed in paragraphs 77 through 79.

h. Install amplified tubes or accessories required for operation, which may have been removed for shipment.

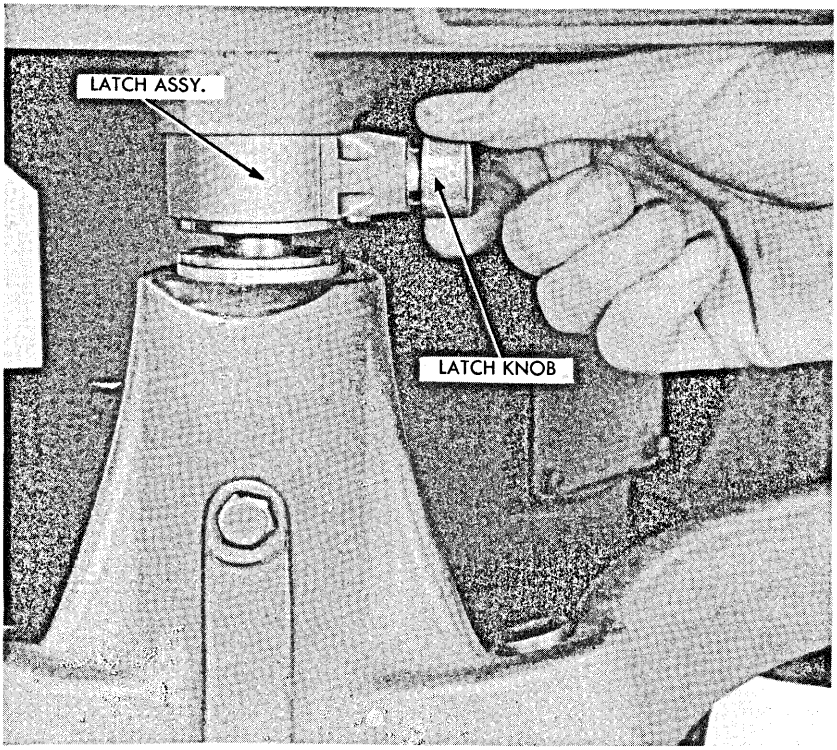


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Figure 11. Latch assembly being released—tripod M21.

i. On directors M5A2 and M5A3, check range finder with lath (par. 62).

j. Run test problems in azimuth and elevation as instructed in paragraphs 85 through 96. Conduct superelevation run-down time. Note smoothness of operation of all moving parts.

k. Check spare parts and accessories with ORD 8 SNL F209.

l. Inspect auxiliary equipment.

m. Inspect tools and accessories (pars. 75 and 76).

8. Used Items

a. Check entries in Antiaircraft Director and Seacoast Gun Data Computer Book, Form 00-108, to ascertain if all modifications have been applied. If such is the case, ordnance maintenance should be so notified and arrangements made to have necessary maintenance accomplished.

b. The steps outlined in paragraph 7 should be followed as carefully for used items as for new items of equipment.

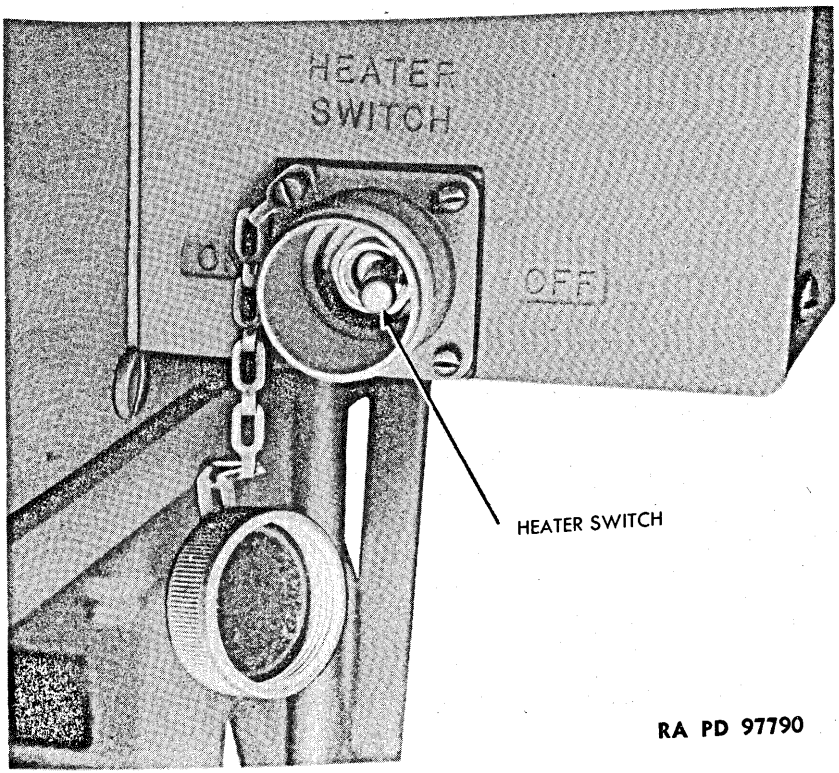


Figure 12. Heater switch (director M5A2 and M5A3).

Section V. CONTROLS AND INSTRUMENTS — DIRECTORS M5A2 AND M5A3

9. General

This section describes, locates, illustrates, and tells the operator how to use the various controls and instruments provided for the proper operation of the directors M5A2 and M5A3. The controls and instruments for director M5A1 which differ from those described in this section are described in paragraphs 27 through 33.

10. Carrying Brackets and Porter Bars

a. Four carrying brackets and two porter bars are provided for the purpose of manually transporting and installing the director from the packing chest to the director tripod.

b. One carrying bracket is hinged to each corner of the director (figs. 7 and 10). The bracket receives the porter bar. The porter bar is locked in place by a locking pin. The locking pin prevents the director from sliding on the porter bar.

c. The porter bars are metal. Each bar passes through two brackets. Each bar extends beyond the brackets a sufficient distance to provide handle space for three men.

11. Safety Latch Knobs

Three safety latch knobs are on the director. The knobs operate three latches which lock the director on the tripod (figs. 9 and 11). These knobs are finger grips. When pulled, they unlock the safety latch permitting the director to be removed from the tripod.

12. Levels

Two levels (fig. 7) secured to the base of the director indicate if the director is level. One is located in the front of the director, the other is on the elevation side (fig. 7). They are used in conjunction with the tripod leveling screw knobs when leveling the director. Each level vial is protected by an outer cover. To observe the level vial the outer cover must be rotated. Adjusting nuts are on each level to permit adjustment of the levels on the director.

13. Cable Receptacles and Light Sockets

a. The cable receptacle which receives the 15-conductor cable **D**-plug assembly (fig. 9) is located in the center of the base of the director. It carries power to the director and also director data to the on-carriage control at the gun.

b. A socket located near the ranging telescope (fig. 9) receives the cable plug that furnishes illuminating power to the range finder.

c. Each director telescope contains a light socket. Power for these sockets is supplied through cables the receptacles of which are located on the director frame behind and on the same side as the telescopes (figs. 7 and 9).

14. Switches

a. RATE MOTOR SWITCHES. The two switches control the operation of the rate motors which drive the director. One switch is for the azimuth rate motor and one for the elevation rate motor. The azimuth switch is located behind a removable screw-on cap beside the azimuth rate setting clutch (figs. 9 and 18). The cap is attached to the director by a chain to prevent it from being lost. The switch is of the toggle type. When in its lower position, electric power passes through to the rate motor. The elevation rate motor switch is the same as the azimuth switch and it is located in a similar position on the elevation side of the director (fig. 7).

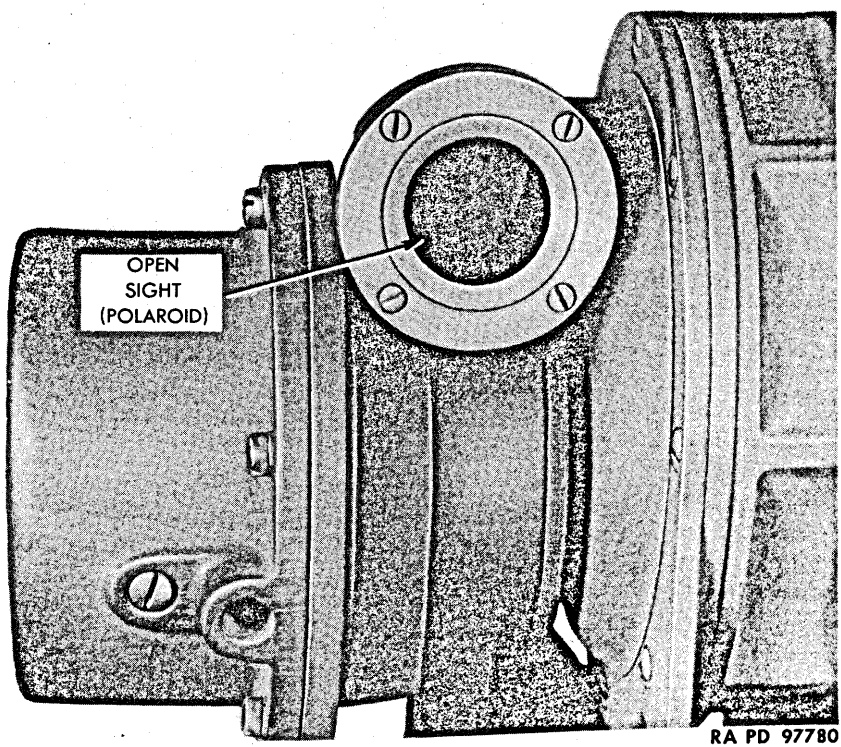


Figure 13. Open sight on left end of range finder M10.

b. LIGHT SWITCH. The light switch is located to the left of the azimuth telescope on the upper director frame (fig. 9). The purpose of the switch is to turn on power for both telescope lights and range dial lights. The range finder lights are automatically furnished with electric power when the director is energized. Range finder range scale illumination is controlled by a rheostat (fig. 22).

c. HEATER SWITCH. The heater switch is located behind a removable screw-on cap on the left end of the range servo housing (figs. 8 and 12) and is of the toggle type. This switch controls the power to four heating elements within the director. The switch also cuts out a portion of the main field winding of the range servo motor in such a manner as to increase its torque. This switch is used only when temperature is below 32° F.

15. Sights

a. RANGE FINDER OPEN SIGHT (INFINITY SIGHT OR RING SIGHT) (fig. 13). The purpose of the open sight is to pick up the target quickly and to bring it (target) into the field of view of the director telescopes. It is a polaroid sight having a broad field of view with a series of concentric circles. The sight is a component of and is located on the left end of the range finder (fig. 8).

b. DIRECTOR OPEN SIGHT. When the range finder is removed from the director, a three-ring open sight is used to pick up the target (fig. 2). This sight is carried as an accessory. It fits on the hub of the director after the range finder lever has been removed. It requires the same adjustment as the open sight on the director M5A1 (par. 67).

16. Slewing Clutch

The purpose of the slewing clutch is to disconnect the tracking mechanism and power drive from the azimuth gear. The director can be slewed freely without disturbing the orientation of the director. Slewing is necessary to move the director quickly when a new target is to be picked up. The clutch proper is located under a plate on the underside of the director (fig. 55③). The control lever for the clutch is located on the lower part of the director under the servo housing (figs. 8 and 14). The clutch lever is connected to the clutch proper. The slewing handle is a rigid handle attached to the director alongside the clutch lever. When the slewing clutch lever is held against the slewing handle, the gears are disengaged. The director can then be slewed by the slewing handle.

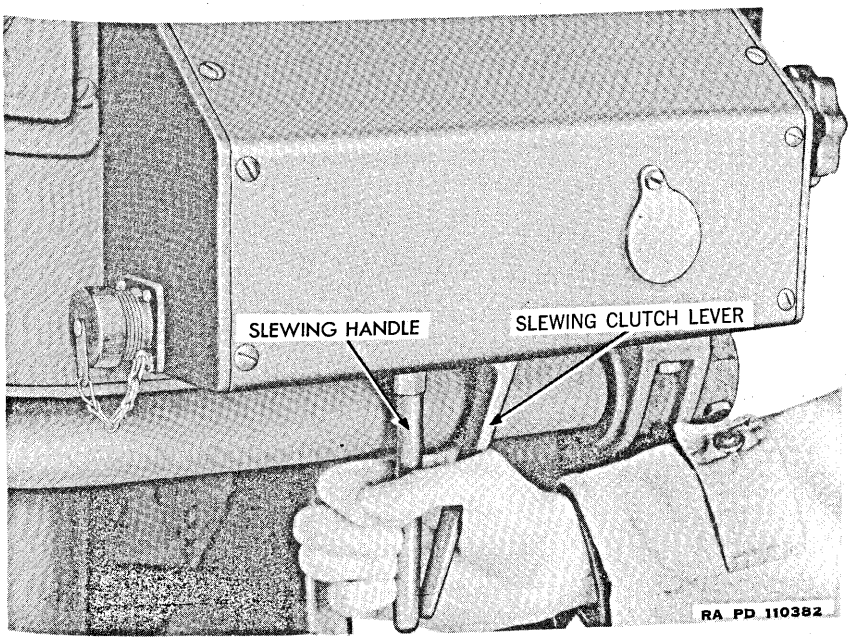


Figure 14. Slewing director M5A2 or M5A3.

17. Tracking Handwheels (Azimuth and Elevation)

a. GENERAL. Tracking handwheels are provided to control the tracking mechanisms of the director. The azimuth handwheel controls movement of azimuth tracking. It is located on the lower right corner of the azimuth side of the director (fig. 9). The elevation handwheel controls tracking in elevation. It is located on the lower right corner of the director on the elevation side (fig. 7). There are two types of tracking, hand power (direct tracking) and motor power (aided tracking).

b. DIRECT TRACKING. When the rate clutches are pulled out and the rate motors turned off, the director can be kept moving in azimuth or elevation only by continuous rotation of the handwheels. When the handwheel motion stops, the director stops. With this type of tracking all the power necessary to move the director comes from the operator.

c. AIDED TRACKING (MOTOR POWER). When the rate clutches are pushed IN and the rate motor switches ON, the director is moved in azimuth or elevation by electric motor power. The speed at which the director moves is in direct relation to the position in which the handwheels are placed. The azimuth handwheel, positioned slightly to the right, will cause the director to rotate continuously to the right at slow speed. The director will continue to move until the handwheel is returned to its original

(neutral) position. The speed of rotation of the director will increase as the handwheel is moved farther away from its neutral position. Movement of the handwheel beyond left of neutral will cause a corresponding movement of the director to the left. In other words, when under aided tracking, the handwheels are used only as a pilot movement to control the speed of the tracking mechanisms. The elevation handwheel controls elevation in a similar manner except that the travel is not through 360° but is limited to —5° to +85° by the electrical stops.

18. Firing Azimuth and Quadrant Elevation Dials

a. The firing azimuth dials (fig. 15) are located beneath the azimuth telescope on the right side of the director (fig. 9). The quadrant elevation dials occupy the same relative positions on the left side of the director (fig. 9). The quadrant elevation dials occupy the same relative positions on the left side of the director (fig. 7).

b. Each set of dials consists of a fine and a course dial (figs. 15 and 16) and each dial has an index line for a reference point.

c. The firing azimuth course dial is divided into 18 equal spaces, each representing 20°. The lines on the dial are numbered 0, 20, 40, 60, etc., up to 340, representing degrees in azimuth.

d. The quadrant elevation course dial has graduation marks on only a portion of its face. These lines are numbered —10, 0, 20, 40, 60, 80, and 100, representing the degrees of elevation.

e. Each of the fine dials is divided in 20 equal spaces, each space representing 1°. The lines representing 0°, 5° 10° and 15° are numbered. One revolution of the fine dial represents 20°, the number of degrees between spacings on the course dial.

f. These dials are provided to furnish a visual check on the data as calculated by the director and transmitted to the gun. The readings on these dials are referred to when running test problems. The quadrant elevation dials indicate the quadrant elevation in degrees, and the firing azimuth dials indicate the firing azimuth in degrees.

19. Elevation Scale

The elevation scale is mounted on the director body beneath the elevation telescope (figs. 7 and 17). The scale is divided into 20 equal spaces representing an elevation of —10° to +90°. Every other graduation line is numbered in units of 10° apart (—10, 0, 10, 20, 30, etc.). The unnumbered graduation lines represent —5, 5, 15, 25, etc. The scale is read at the movable index mounted on the elevation telescope. The reading represents the degrees of elevation of the telescope, which is present elevation.

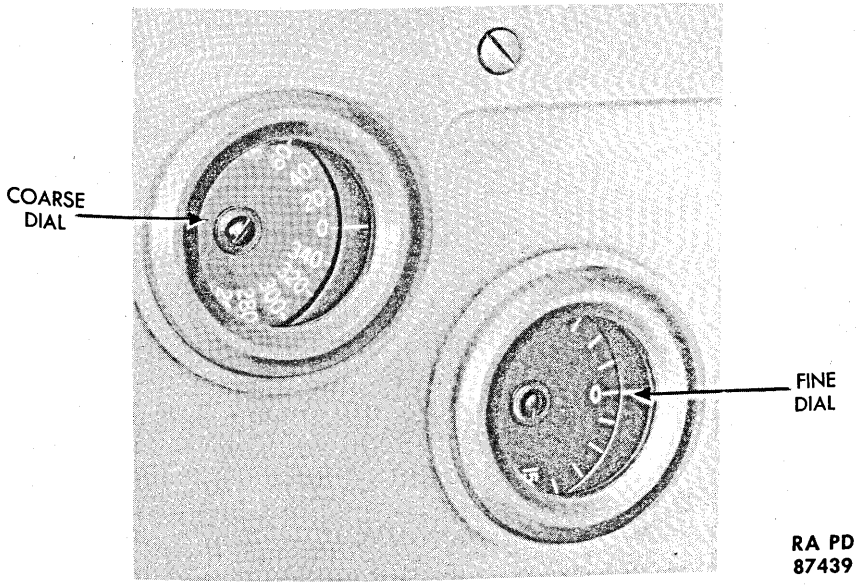


Figure 15. Azimuth dials.

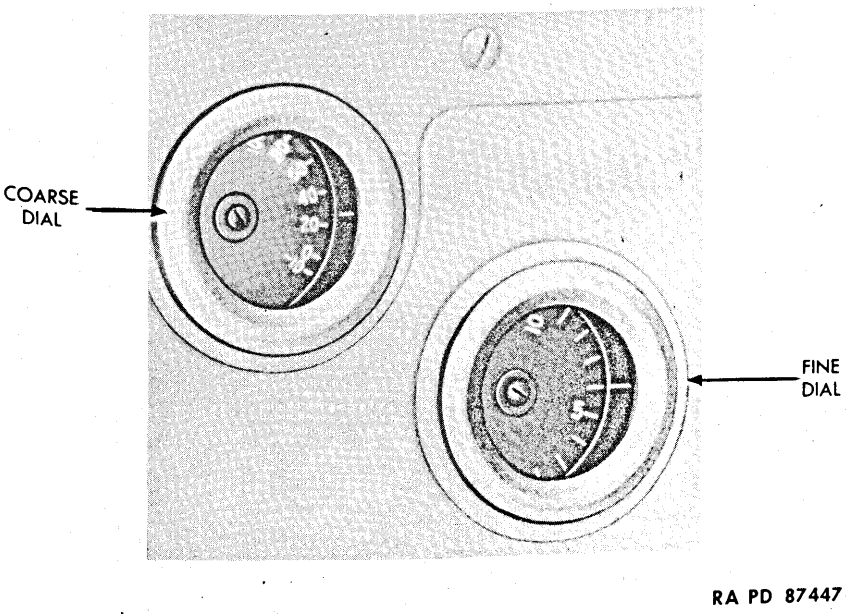


Figure 16. Quadrant elevation dials.

20. Rate Setting Clutches

a. There are two rate setting clutches on the director, one for azimuth, on the right side (figs. 9 and 18), and one for elevation, on the left side of the director (figs. 7 and 18.)

b. The clutch as shown in the illustration is a pull and push knob with the word CLUTCH marked on its face. This knob is the control for the clutch proper within the director. Its movement engages or disengages the clutch. The purpose of the clutch is to put the tracking handwheel into aided tracking (motor power) or direct tracking (hand power). When the clutch is pushed in, the tracking handwheel and its mechanism are in aided tracking; when pulled out, they are in direct tracking.

21. Zero Deflection Indexes

a. There are two sets of zero deflection indexes (fig. 19), one for azimuth and one for elevation. These indexes are located behind a window to the left of the tracking handwheels (figs. 7 and 9). They are luminous indexes and indicate if a deflection is set in the calculating mechanism of the director.

b. When power is on the director, and tracking handwheels turned to match both sets of zero indexes, the gun will point in the same direction as the director telescopes, present azimuth and present elevation.

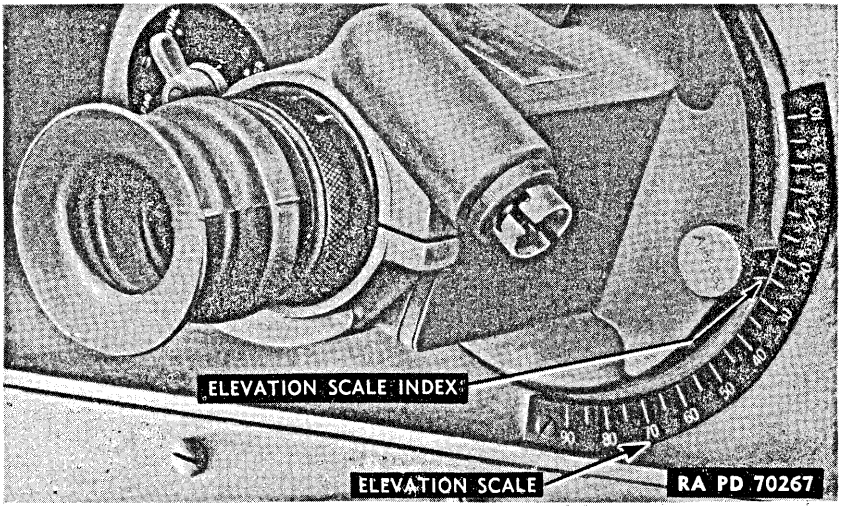


Figure 17. Elevation scale and index.

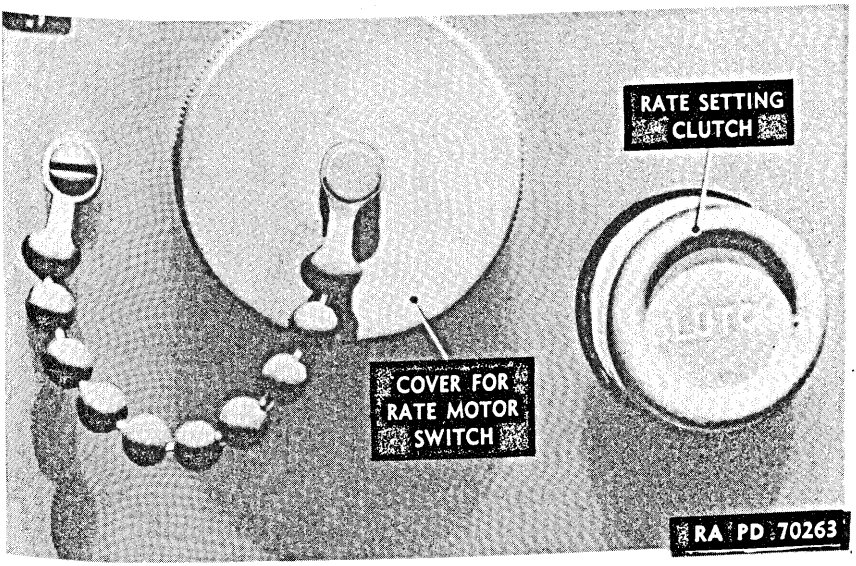


Figure 18. Rate setting clutch.

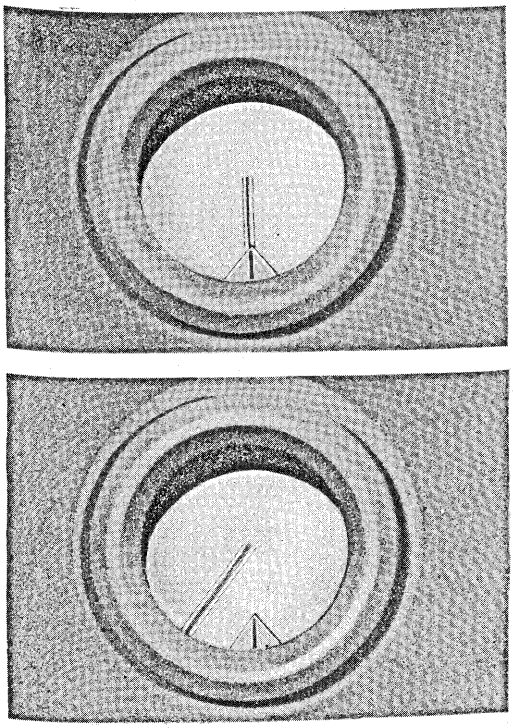


Figure 19. Zero deflection indexes—Director M5A2.

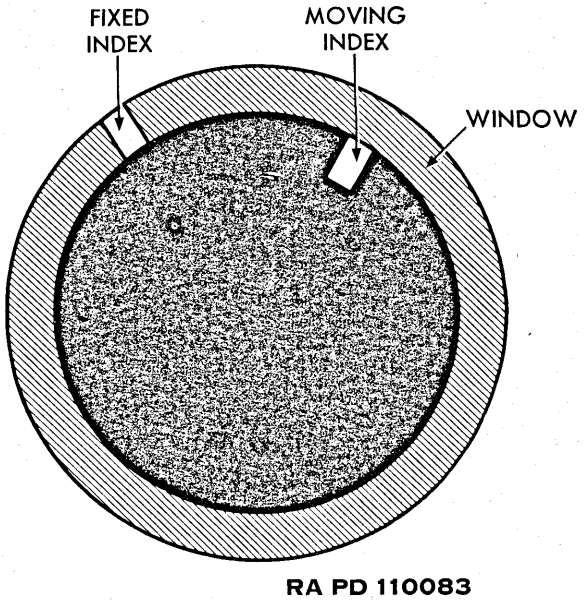


Figure 20. Constant speed indexes.

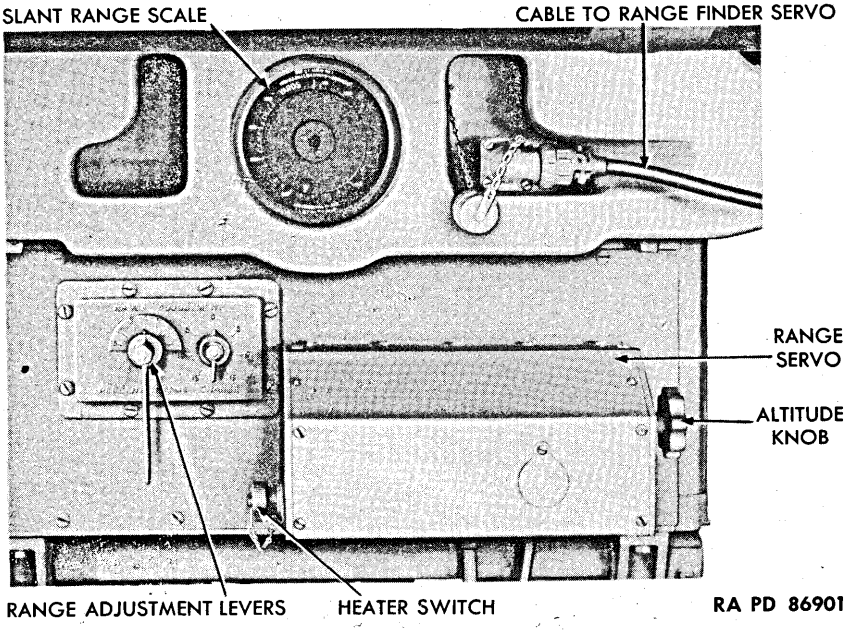


Figure 21. Slant range mechanism—directors M5A2 and M5A3.

c. These indexes are observed, and set to zero by the tracking handwheels before turning the power off. This action prevents the director from unexpectedly rotating or elevating when the power is again turned on.

22. Constant Speed Indexes

There are two sets of constant speed luminous indexes (fig. 20), one set for the elevation mechanism and one for the azimuth mechanism. The indexes for the azimuth mechanism are behind a window on the left end of the azimuth side of the director (fig. 9). The indexes for the elevation mechanism are in a similar position on the elevation side (fig. 7). The correct operation of

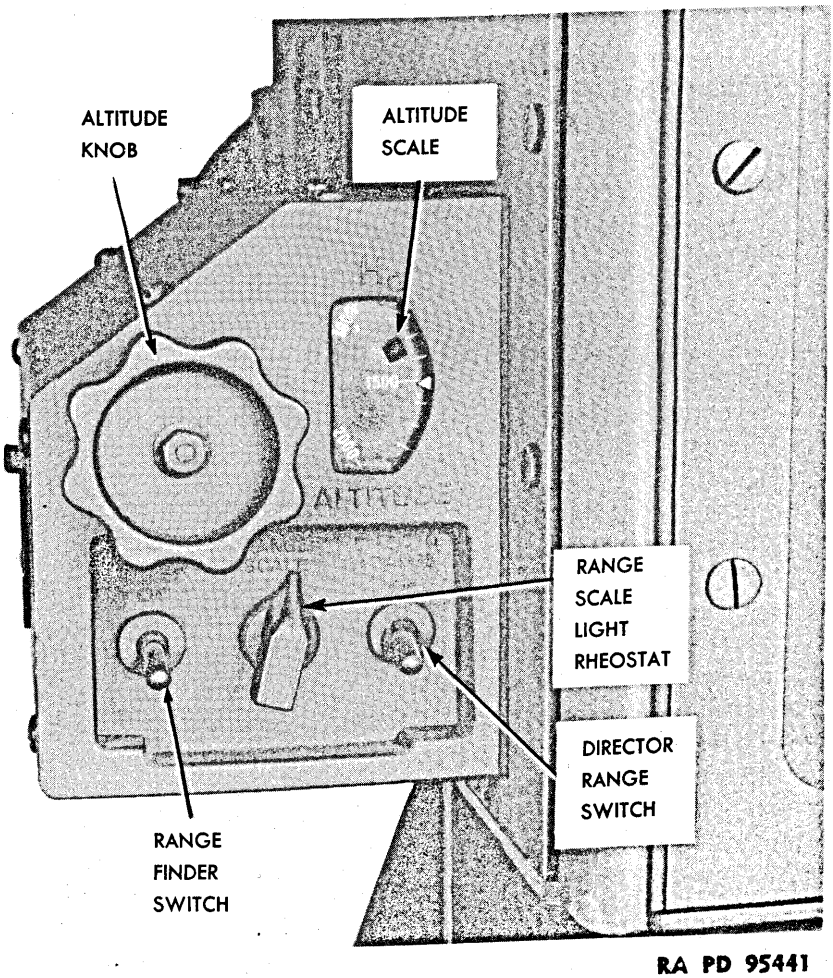


Figure 22. Director M5A2—range servo housing.

the director requires a constant speed drive. The indexes are the indicators of this speed. The rotating index, in each set, is placed on a comparatively slow-moving gear, making it possible to count the revolutions per minute.

23. Range Handwheel

The range handwheel is provided as an accessory to be used in an emergency. The handwheel is used when the range finder becomes inoperative and the range servo is turned off. At this time it is installed and used to set estimated slant range into the director's calculating mechanism. When installed, it is located on range servo housing (fig. 54) on rear of director (J, fig. 8).

24. Range Servo Controls

a. The controls on the range servo housing mounted on the rear panel of the director (figs. 21 and 22) consist of two switches, a rheostat, an altitude scale, and an altitude knob. These controls are used only in connection with the range finder. The two switches, front and rear, control the range servo and the range finder servo, respectively. The rheostat controls the intensity of illumination of the range finder slant range scale light (fig. 21). The altitude knob operates the altitude scale and controls the range finder servo when bringing the range finder into coincidence to obtain slant range. It is used when the target is being observed through the range telescope eyepiece.

b. The other range servo controls are set in a panel on the rear of the director to the left of the servo housing. These are the range adjusting handle and the trial fire knob (fig. 23). Both the handle and the knob adjust the same mechanism in the director. The long handle is spring-loaded and will hold the adjustment only while it is manually held. When the operator removes his hand, it will return to its zero position. The knob (trial fire knob) is not spring-loaded. It will hold any adjustment it is moved to until it is manually returned to zero by the operator. These controls are used to make range corrections. Scales adjacent to both handle and knob have numbered graduations of 5, 10, and 15 each side of zero. They represent percent of change in range. When the handle or knob index is to the right of zero there is an increase in range. Movement to the left is a decrease. If the knob is set for an increase of 5 percent and the long handle is held at 5 percent decrease, they will cancel each other and the director range scale (dial) (fig. 24③) will read the same as the ranging telescope range scale. Further action of these controls is shown in figure 24.

25. Orienting Clutch

a. The orienting clutch (fig. 25) is used when orienting the director. The clutch is located on the under side of the director below the azimuth rate clutch (fig. 9).

b. When the clutch is turned downward to the orienting position (fig. 25), it locks the firing azimuth transmitters and dials, and frees the director. This permits turning the director in azimuth without disturbing the setting of the firing azimuth transmitter or the firing azimuth dials.

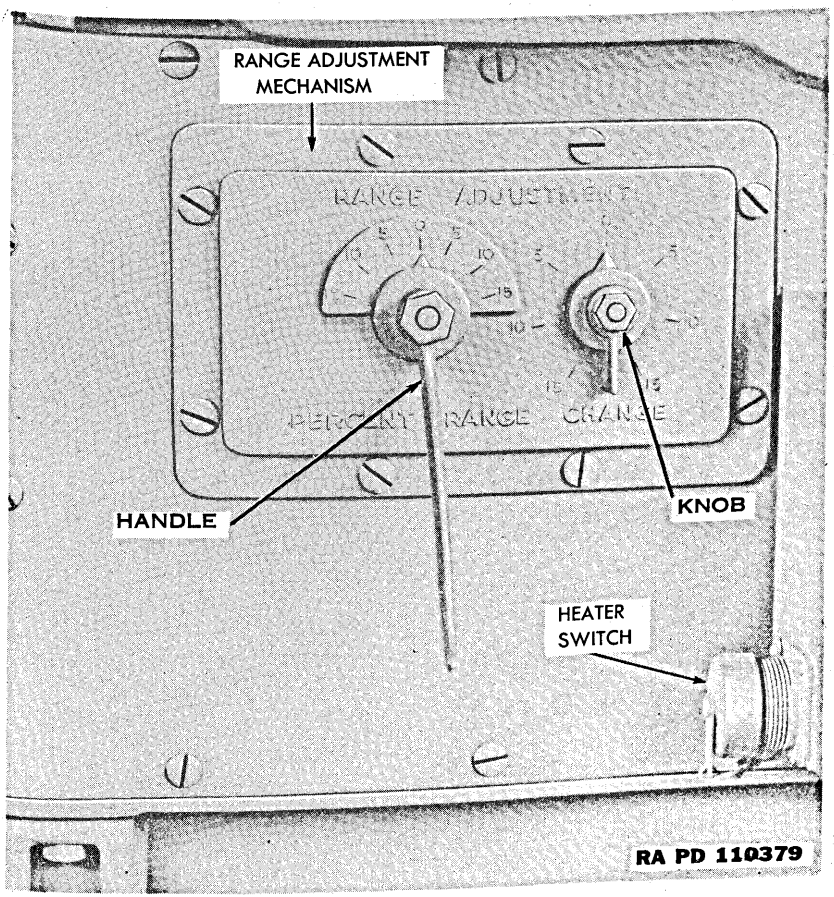
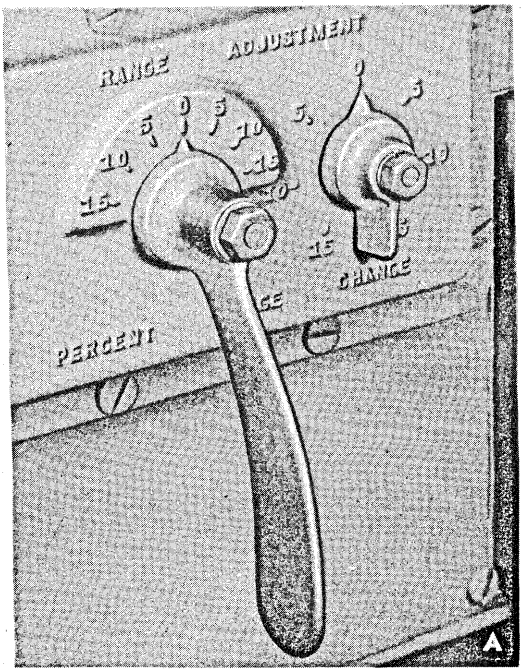
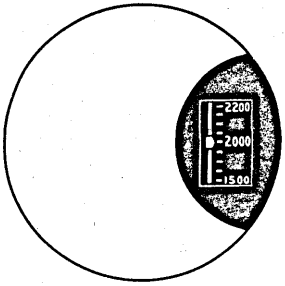
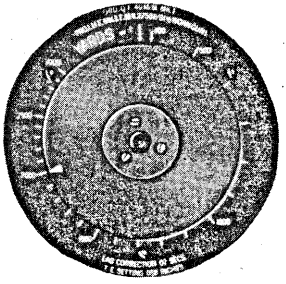


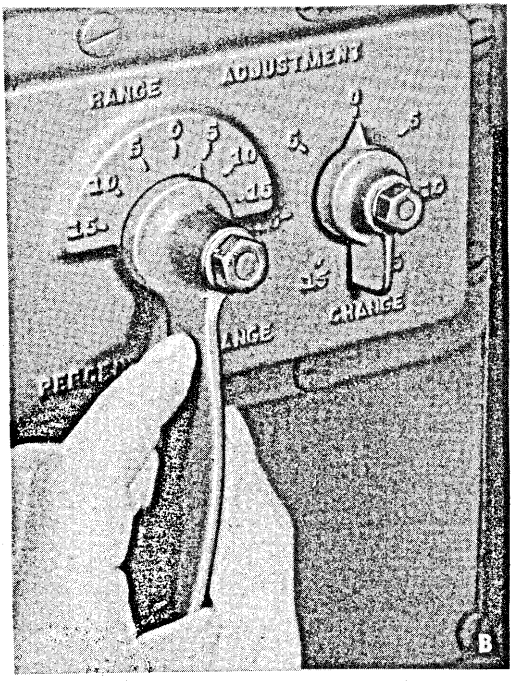
Figure 23. Directors M5A2 and M5A3—range adjustment mechanism.

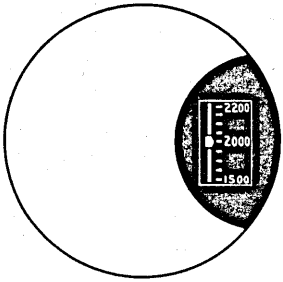


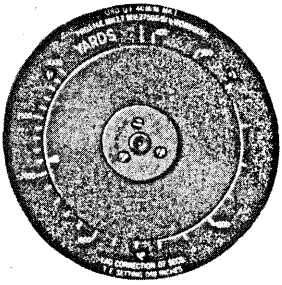




RANGE SCALE AND RANGE DIAL AGREE IN THIS POSITION





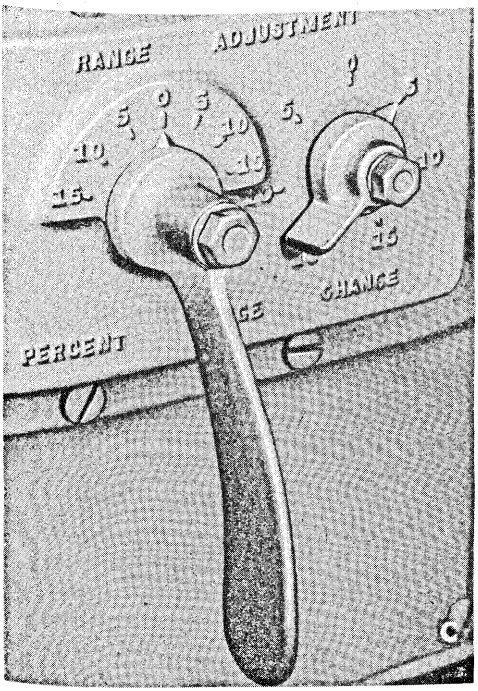


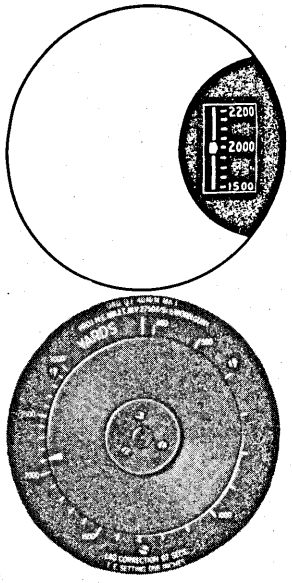
RANGE DIAL READS 5% MORE THAN RANGE SCALE

RA PD 29067

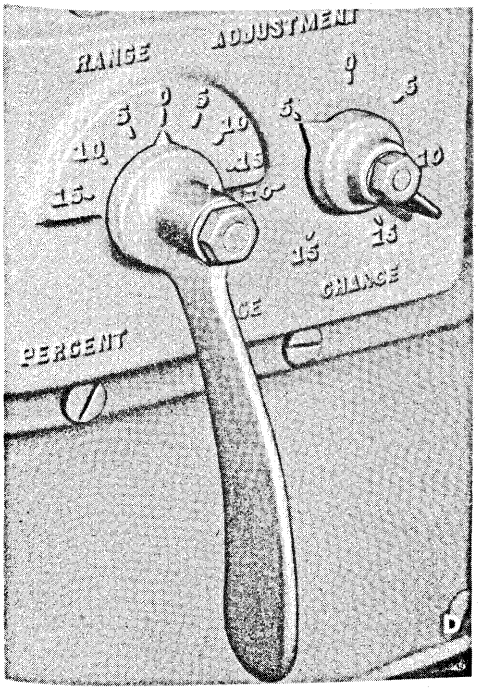
① *Part I.*

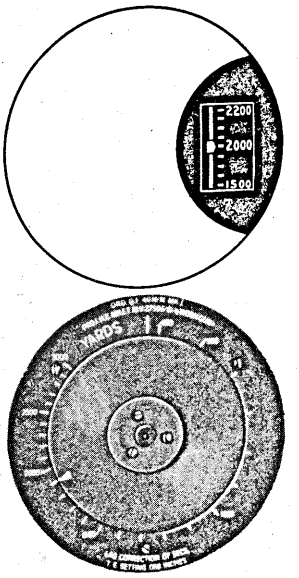
Figure 24. Directors M5A2 and M5A3—range adjustments.





RANGE DIAL READS 5%
MORE THAN RANGE SCALE



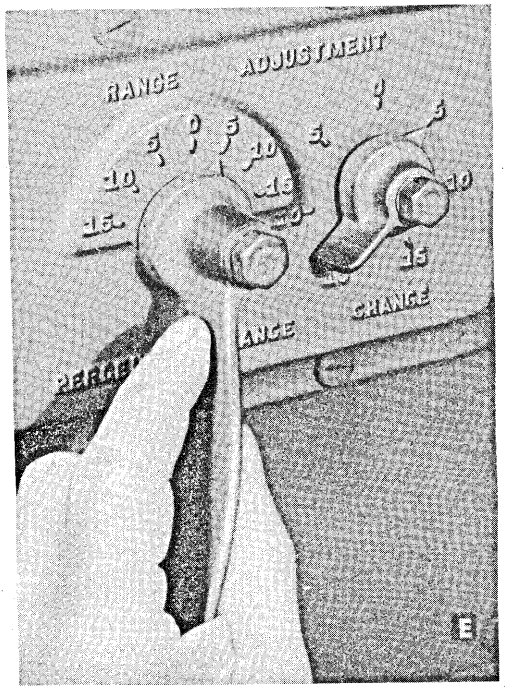


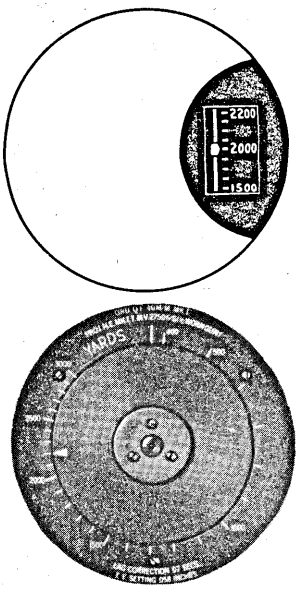
RANGE DIAL READS 5%
LESS THAN RANGE SCALE

RA PD 29065

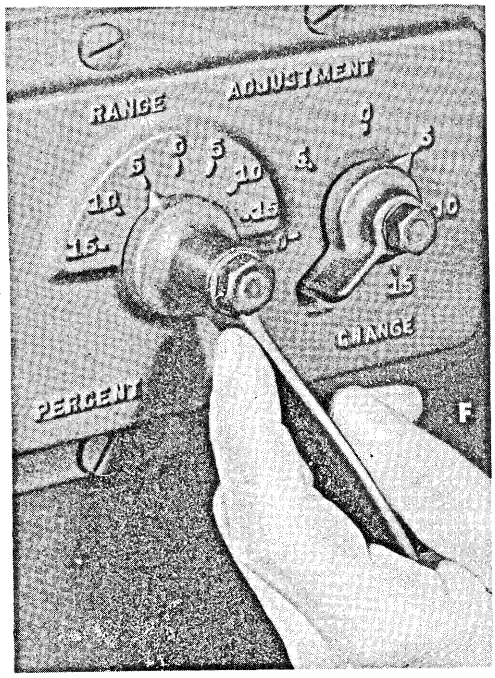
② *Part II.*

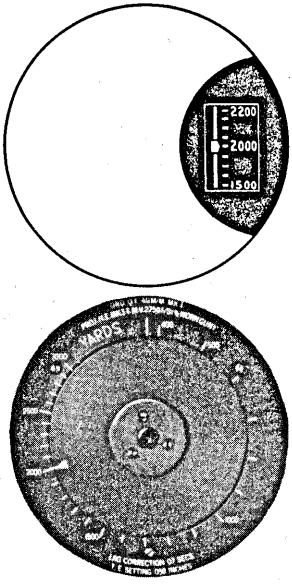
Figure 24—Continued.





RANGE DIAL READS 10% MORE THAN RANGE SCALE





RANGE DIAL READS SAME AS RANGE SCALE

RA PD 29066

③ *Part III.*

Figure 24—Continued.

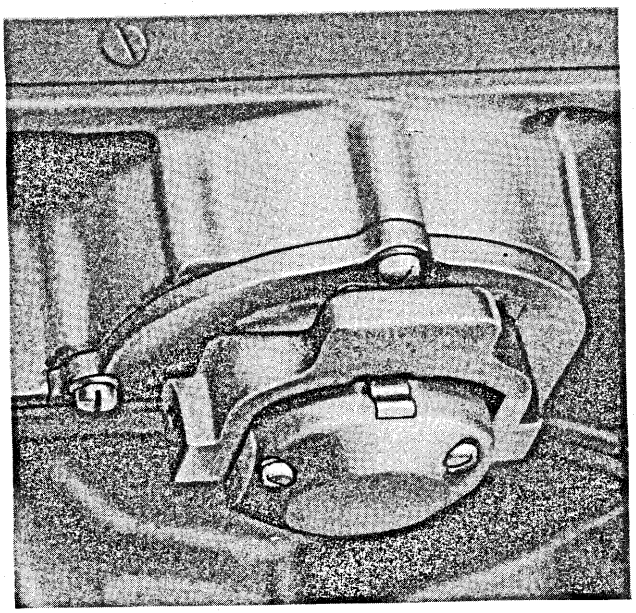
26. Mechanical and Electrical Stops

a. Two types of stops are provided to limit the range of movement of the director telescopes in elevation. There are no stops in azimuth, since the director can move a continuous 360° in azimuth.

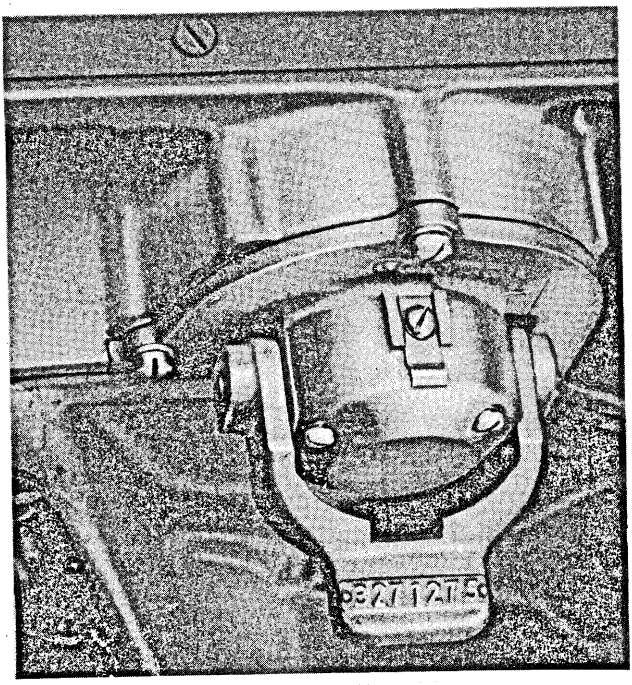
b. Electrical stops cut out the rate motor automatically when the telescopes reach an 85° elevation or a depression of minus 5° (M5A1, M5A2) or minus 2° (M5A3).

c. Two mechanical stops are located on the inside upper frame on the left side of the director. These stops are reached at a 92° elevation and a minus 10° depression. Although the mechanical stops are rugged in construction, care must be exercised when reaching the ends of the paths of travel in elevation not to slam the mechanism against the stops. This type of treatment will injure the mechanism internally and may throw the director entirely out of adjustment in elevation. The stops can be tested to determine whether they operate at the specified position, as explained in paragraph 87.

d. A mechanical stop is provided to limit the movement of the range finder in directors M5A2 and M5A3. The limits to which the range finder may be depressed or elevated are minus 13° and plus 93°.



WHEN DIRECTOR IS OPERATING CLUTCH HANDLE SHOULD BE <u>UP</u> AS SHOWN



WHEN ORIENTING CLUTCH HANDLE SHOULD BE PULLED FULLY <u>DOWN</u> AS SHOWN

RA PD 87442

Figure 25. Directors M5A2 and M5A3—new type orienting clutch.

Section VI. CONTROLS AND INSTRUMENTS — DIRECTOR M5A1

27. General

a. This section describes, locates, illustrates, and tells the operator how to use those controls and instruments which are different from those described in paragraphs 9 through 26. Controls which are not described in this section are identical with those described in paragraphs 9 through 26.

b. The following controls on director M5A2 and M5A3 have no counterparts on director M5A1: safety latch, heater switch, and range servo housing.

28. Open Sight

a. The open sight (fig. 2) is located on the hub of the director lever directly behind the elevation telescope. The range setter alines the target with the two sighting elements of the open sight to bring the target within the field of view of the two telescopes.

b. The open sight moves in azimuth with the director and in elevation with the telescopes. Sight and telescopes should remain parallel with each other at all times.

29. Constant Speed Indexes

The constant speed indexes (figs. 1 and 2) serve as a visible check on the speed and direction of the constant speed motors.

30. Range Handwheel

The range handwheel is located on the rear panel of the director (fig. 2). This handwheel is used to set an estimated slant range. Movement of the handwheel also positions the range index against the range scale (fig. 26).

31. Orienting Clutch

a. Most of the M5A1 directors are equipped with the old type orienting clutch (figs. 27 and 28). This clutch is located on the under side of the director on the azimuth side. The remaining M5A1 directors are equipped with the new type clutch (par. 25 and fig. 25).

b. The old type clutch has two adjustment nuts (fig. 27). These nuts have knurled surfaces and are made only handtight. The adjusting nuts are protected by a cover during operations.

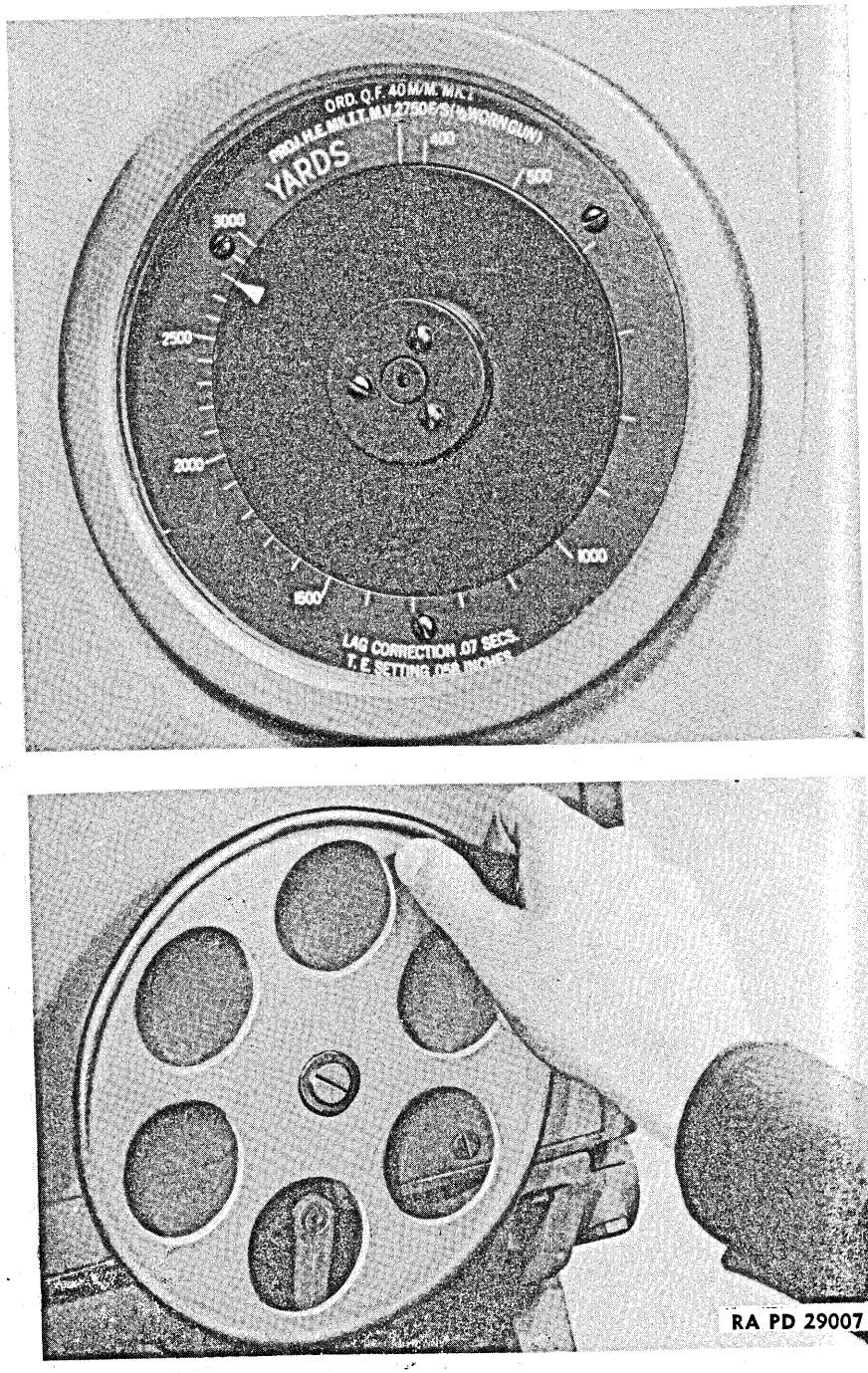


Figure 26. Setting in slant range—director M5A1.

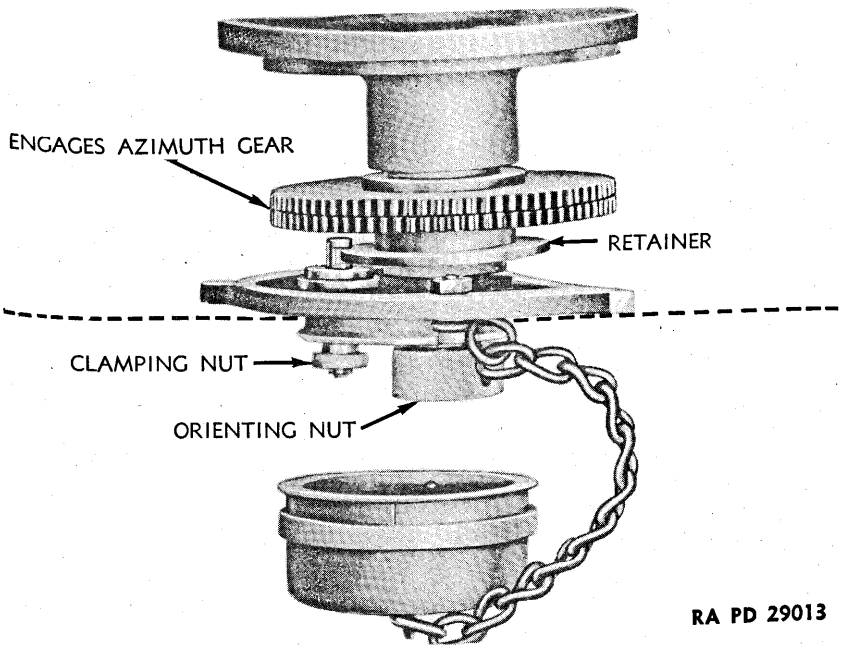


Figure 27. Orienting clutch, old type.

c. The small clamping nut clamps the azimuth transmitter and firing azimuth dials in a fixed position when screwed up tightly (fig. 28). The large orienting nut releases the transmitter and firing azimuth dials from the tracking mechanism when it is screwed down (loose). With the two adjusting nuts as above, the director can be freely turned for orienting purposes without disturbing the setting of the azimuth dial. After orientation, the large (orienting) nut must be screwed up tightly before the small clamping nut is loosened by screwing it down.

Caution: Do not use tools on the adjusting nuts. Never loosen both adjusting nuts simultaneously. Both adjusting nuts should be tightened only for that length of time it takes to shift fingers from the one to the other.

32. Zero Deflection Indexes

Above and to the left of the azimuth and elevation handwheels are windows for the deflection indexes (figs. 1 and 29). These indexes indicate if a deflection is set in the calculating mechanism of the director.

33. Slant Range Handwheel and Range Scale

a. The slant range handwheel and the slant range scale are located on the rear panel of the director (fig. 2).

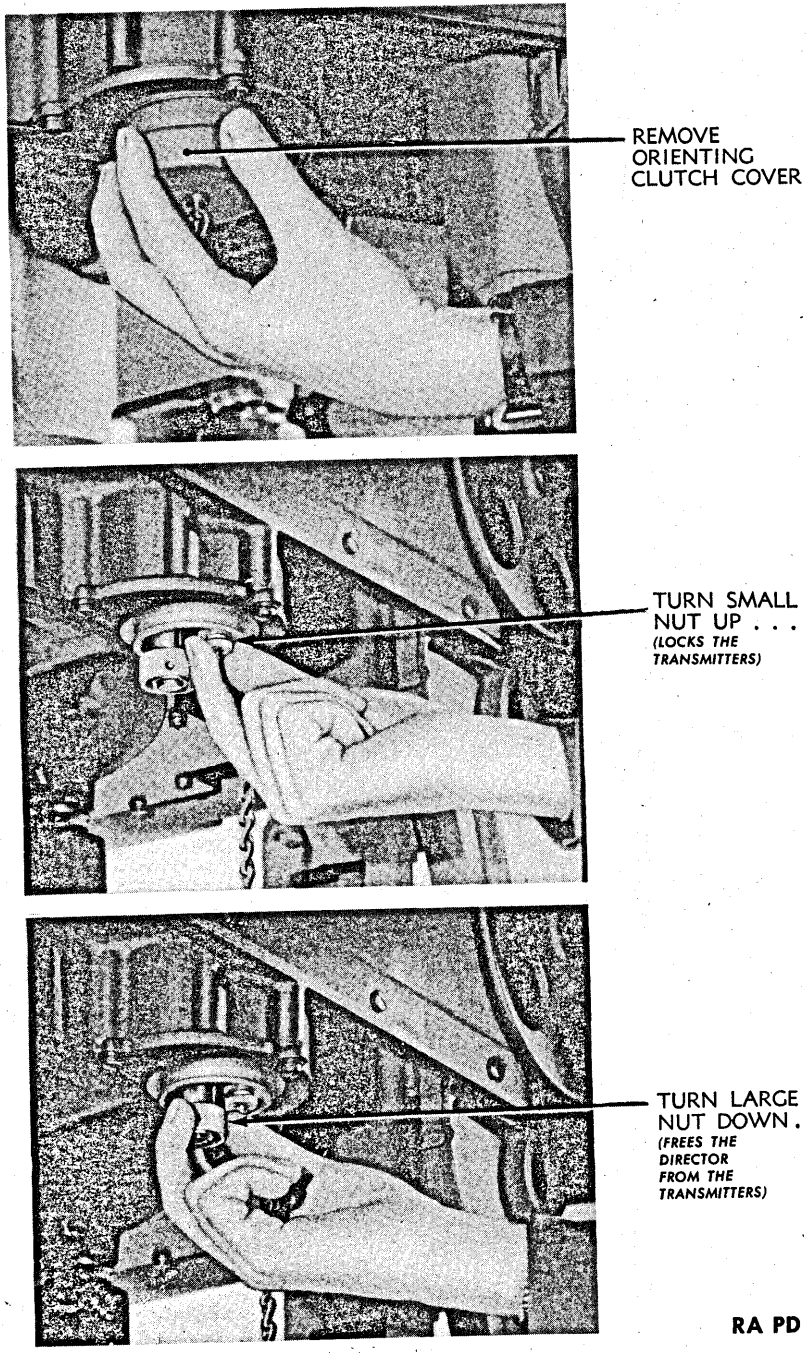


Figure 28. Director M5A1—orienting clutch, old type.

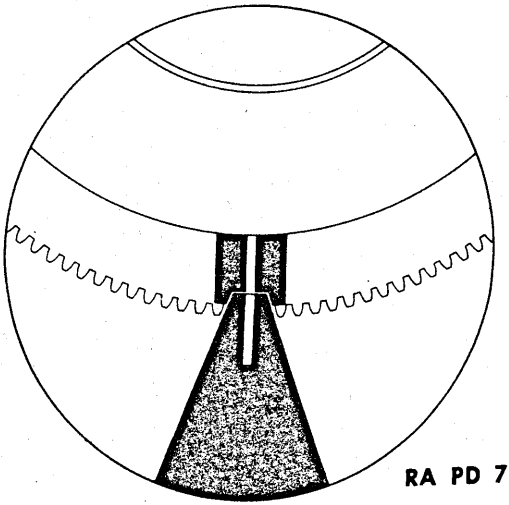


Figure 29. Zero deflection indexes—director M5A1.

b. The range handwheel is used to put estimated slant range in the director calculating mechanism. The index of the range scale indicates the amount of slant range put into the director by the range handwheel.

c. The range scale is not graduated into equal divisions. It is graduated in a clockwise direction with the initial graduation (approximately 375 yards) at the top. The second graduation represents 400 yards, and the scale is graduated each 100 yards and numbered each 500 yards thereafter. The range index has a limit of motion from slightly less than 375 to about 2,800 yards.

Section VII. CONTROLS AND INSTRUMENTS — RANGE FINDER M10

34. General

a. This section describes, locates, illustrates, and tells the operator how to use the controls on the range finder; other controls which control the range finder that are mounted on the director proper and are covered in paragraphs 9 through 26.

b. Range finder M10 is used on directors M5A2 and M5A3 (figs. 8 and 9). It determines slant range to the target and inserts this range into the calculating mechanism of the director.

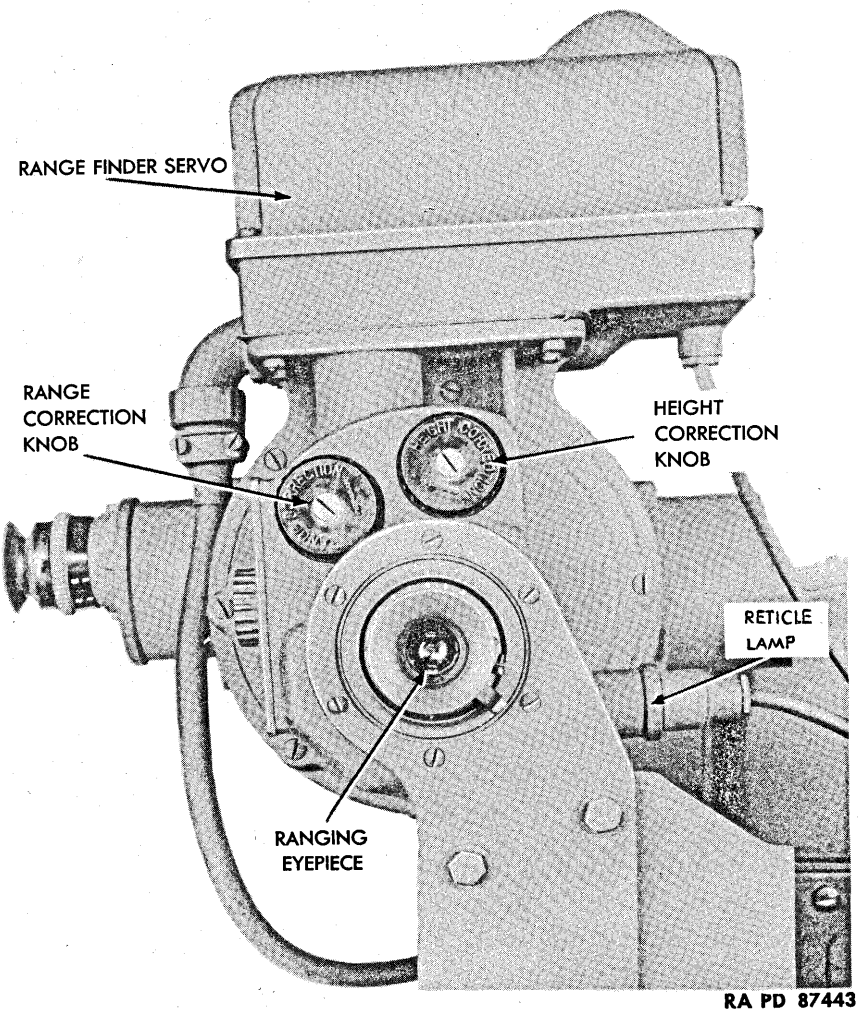


Figure 30. Right end of range finder M10.

35. Ranging Eyepiece

The ranging eyepiece (fig. 30) is located on the right end of the range finder telescope (fig. 9). It is used to observe the target while bringing its images into coincidence to obtain slant range. The ranging eyepiece is part of an 8-power optical system with a 7½° field of view. The eyepiece is equipped with a diopter scale.

36. Diopter Scale (Ranging Eyepiece)

The diopter scale located on the ranging eyepiece (fig. 31) is used to adjust the eyepiece to the operator's vision. The scale is graduated for plus and minus diopters. The scale can be set to the operator's requirements (if known) before operations begin.

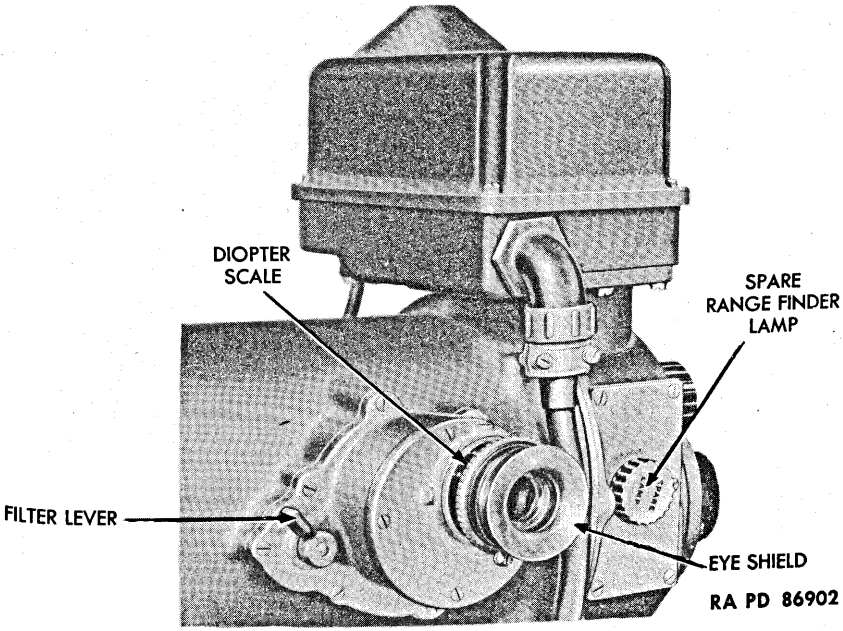


Figure 31. Range finder spotting telescope.

37. Slant Range Scale and Internal Adjuster Line

a. The slant range scale is within the range finder. Viewed through the range finder eyepiece, the slant range scale (fig. 24③) can be observed on the right side of the ranging telescope field of view. When the range finder is correctly adjusted and the images are in coincidence, the scale reading is the slant range to the target.

b. In conjunction with the range scale is a vertical line called the "internal adjuster line." A gate on the index can also be seen. When the range finder is in perfect adjustment, the internal adjuster line will be centered within the gate between the two short index lines projected from the reticle (fig. 49).

38. Range Correction Knob

The range correction knob is located above the ranging eyepiece (fig. 30). It is used in conjunction with the internal adjuster line in the ranging telescope to make range correction adjustments. These adjustments are made at time of original set-up of equipment or on changes in weather, as explained in paragraph 62.

39. Height Correction Knob

The height correction knob is located above the ranging eyepiece (fig. 30). It is used in conjunction with internal adjuster line in the ranging telescopes to make height correction adjustments. These adjustments are made at time of original set-up of equipment or on changes in weather, as explained in paragraph 62.

40. Spotting Eyepiece

a. The spotting eyepiece is located at the rear of the range finder (fig. 30). It is used to observe the target during gun fire to judge if range correction is necessary.

b. The spotting eyepiece is part of a 6-power optical system with an 8½° field of view. The eyepiece is provided with a diopter scale which should be set to the operator's vision before operations begin. The target images observed are identical with and are in coincidence at the same time as those seen in the ranging eyepiece.

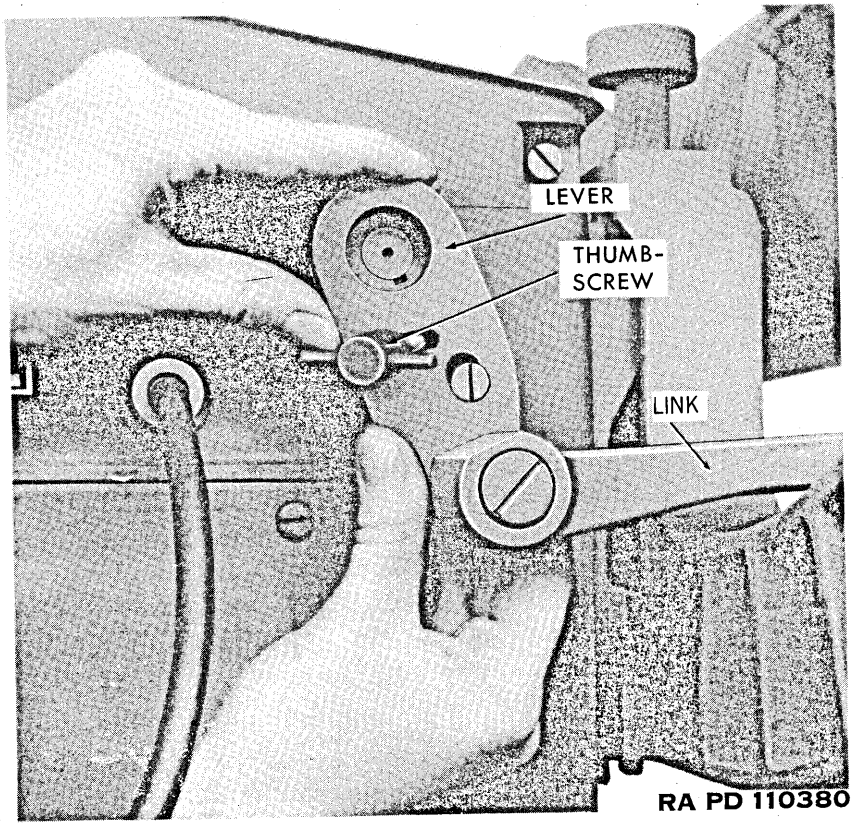


Figure 32. Coupling link assembly.

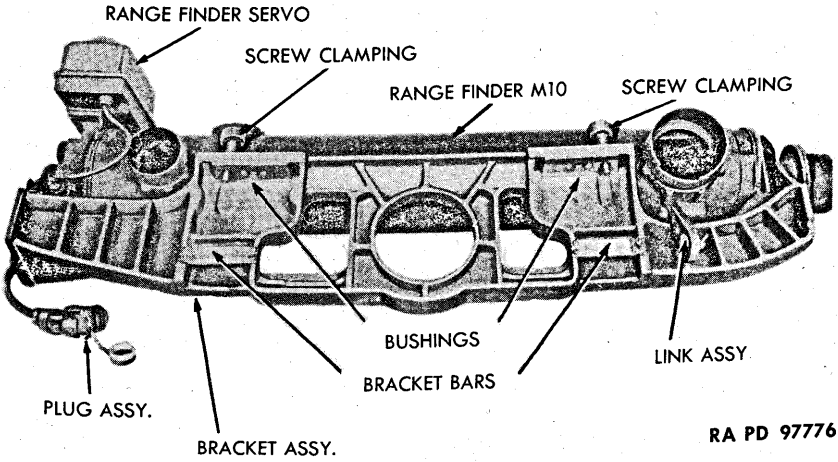


Figure 33. Bracket and range finder assembly.

41. Coupling Link Assembly

The coupling link assembly is the control between the director and the range finder. It mechanically connects the left end of the range finder to the hub of the director lever (figs. 32 and 53) so that the range finder will operate at the same angle of elevation as the director. It is secured to the hub of the director by a thumbscrew. The thumbscrew passes through an elongated hole, which allows for minor adjustments to aline range finder telescopes with the director telescope.

42. Mounting Bracket

The range finder mounting bracket (fig. 33) is the medium through which the range finder is attached to the director. The bracket is a component part of the range finder. Two thumbscrews are furnished for attaching the bracket to the director.

43. Desiccating Unit

The desiccating unit (fig. 8®) is a silica-gel container mounted in the top of the range finder. It is provided to protect the interior of the range finder against moisture caused by condensation or humid weather conditions. The crystals in the container absorb the moisture in the range finder and are normally blue in color. When they turn pink, they are fully charged with moisture. Containers that have turned pink must be replaced by containers containing blue crystals.

Section VIII. CONTROLS AND INSTRUMENTS — ELBOW TELESCOPES M75C AND M75D

44. General

a. Two elbow telescopes are provided with each director (fig. 34). The elbow telescope M75C is located on the right side of the director (fig. 9) and is used when tracking the target in azimuth. The elbow telescope M75D is located on the left side of the director (fig. 7) and is used when tracking the target in elevation. Some directors M5A1 were equipped with two elbow telescopes M17, one for tracking in azimuth and one for tracking in elevation. This elbow telescope differs from elbow telescopes M75C, and M75D only in the marking on the reticle, as shown in figure 34.

b. Each of the telescopes is 8-power with a 6° field of view. The attaching surface contains a vertical keyway which locates the optical axis in the true vertical plane. The flat portion locates the optical line of sight in the true horizontal plane.

c. The two telescopes move in elevation as a unit. They are fixed in azimuth on the director and move in azimuth with the director.

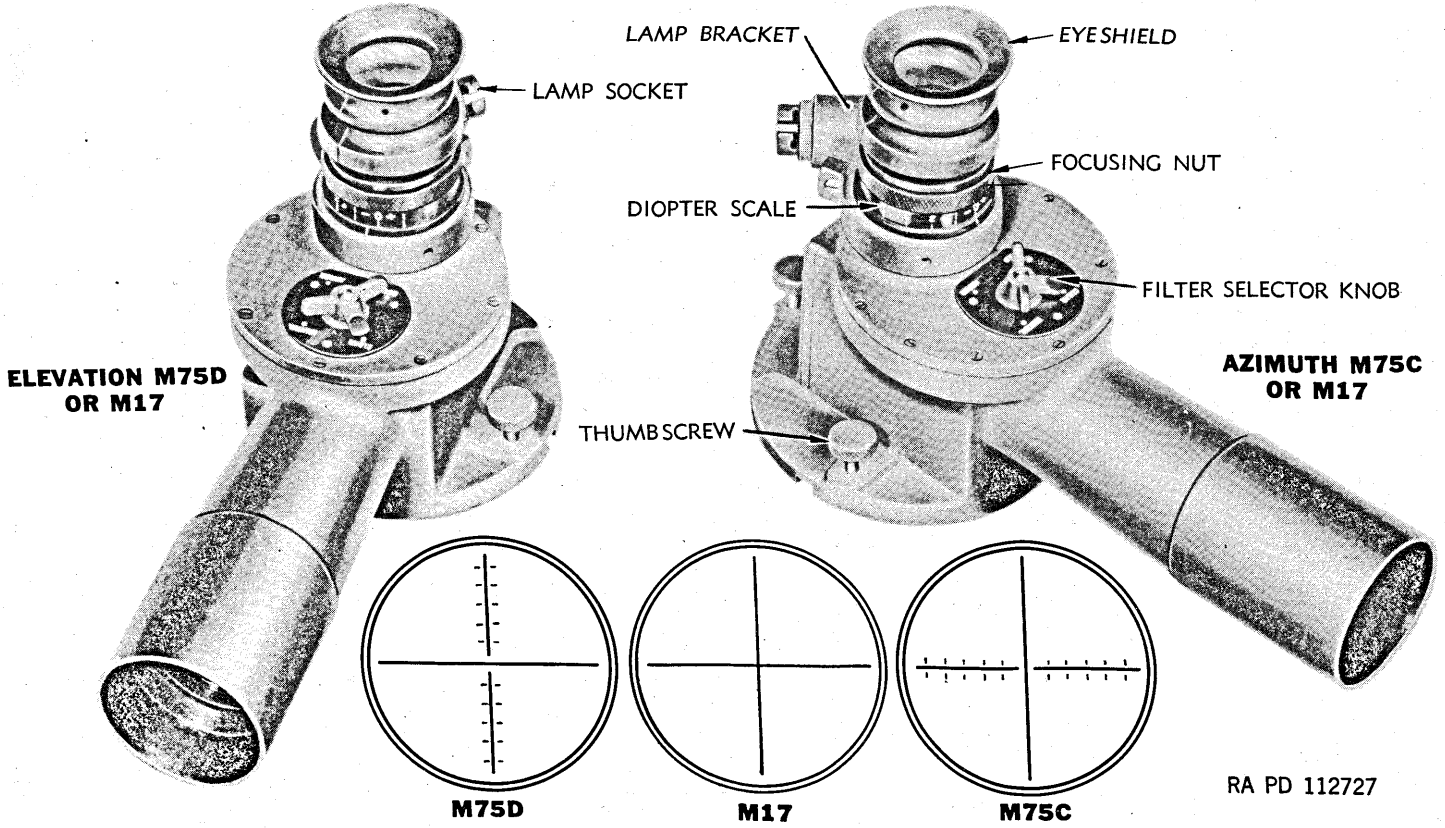
d. The only difference between the two telescopes is in the pattern of their reticles (fig. 34).

45. Diopter Focusing Nut

A diopter focusing nut is located on the eyepiece of each telescope (fig. 34). It is used to set the eyepiece to the user's vision. Its index can be rotated around the diopter scale. The scale is graduated in plus and minus optical units known as diopters. This permits the operator to preset the focusing nut to the diopter scale graduation suited to his eyes (if known) without focusing on an object in the field of view.

46. Reticles

The reticle is the instrument within the telescope which indicates the position of the target in relation to the optical axis of the telescope. Reticle patterns of elbow telescopes M75C and M75D (fig. 34) consist of an unbroken line through the center of the field of view (used for tracking) and a cross line broken at the center. The broken cross line has short lines on each side spaced at intervals of 5 mils from center. They are used for tracking off on ground targets. The elevation telescope reticle tracking line is horizontal, the azimuth telescope reticle tracking line is vertical.


LAMP BRACKET
EYESHIELD
LAMP SOCKET
FOCUSING NUT
DIOPTER SCALE
FILTER SELECTOR KNOB
ELEVATION M75D
OR M17
AZIMUTH M75C
OR M17
THUMB SCREW
M75D
M17
M75C
RA PD 112727

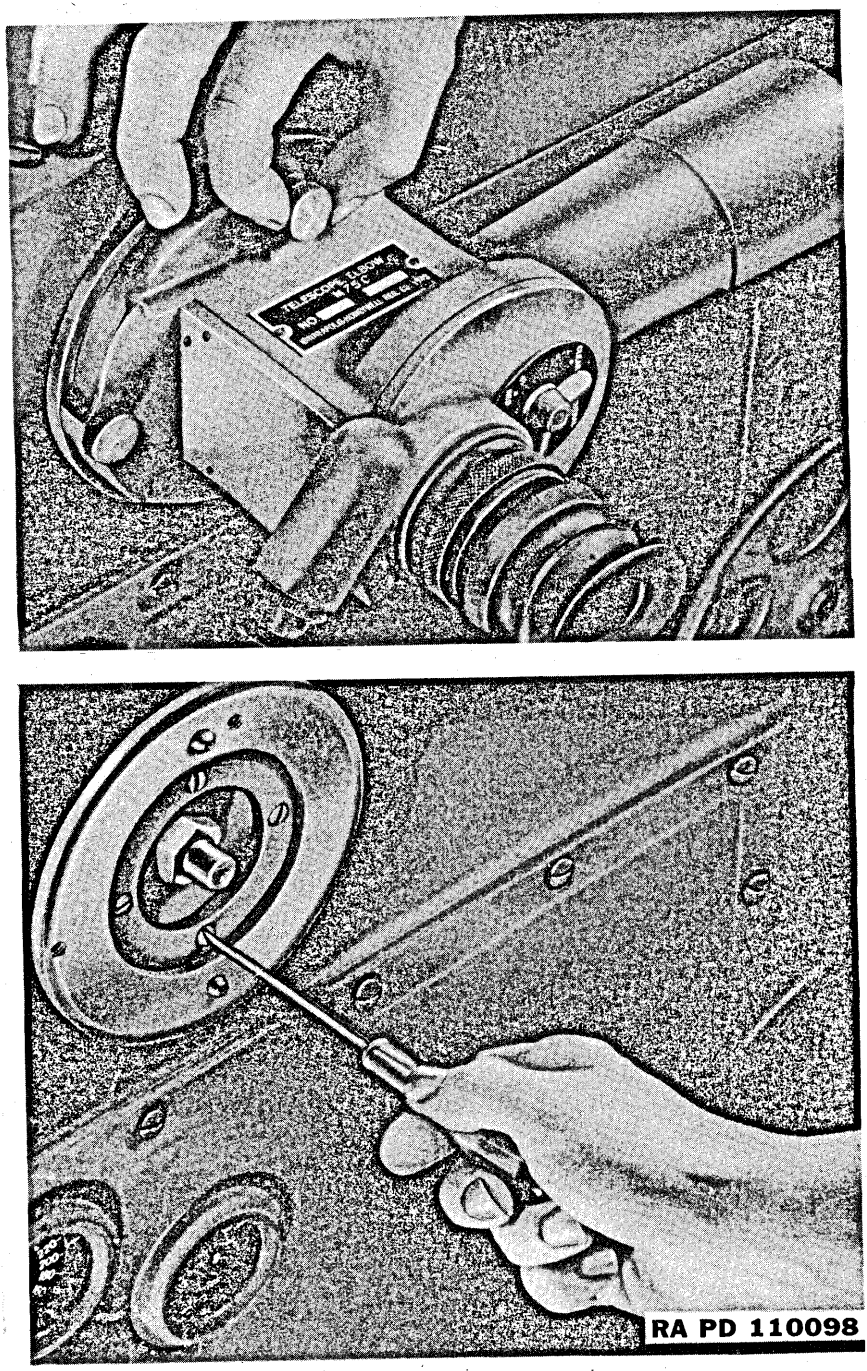


Figure 35. Thumbscrews and mounting surfaces.

47. Ray Filter Selection Knob

Each telescope is equipped with a ray filter selection knob. This knob (fig. 34) controls the position of the four light filters. By rotating the knob, any one of the four filters (CLEAR, NEUTRAL, RED, AMBER) may be placed across the optical axis of the telescope. The filters improve visibility under unfavorable light conditions.

48. Toggle Switch

A toggle switch, located to the rear of the azimuth telescope, is used to turn on or off lights which illuminate the reticle of the telescopes (fig. 9Ⓔ).

49. Adjusting Screws and Elevation Index

a. The telescopes are mounted on the director by two adjusting thumbscrews (figs 34 and 35). The thumbscrews have knurled heads and are held loosely in the unmounted telescope by a locking ring.

b. The mounting surface on the director (fig. 35) to which the telescope is attached is provided with four adjusting screws.

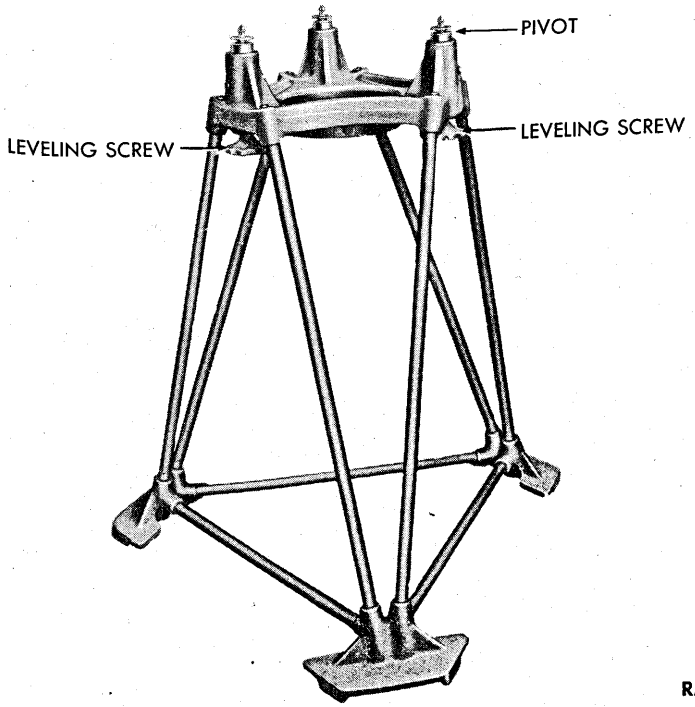


Figure 36. Tripod M21.

These screws are used to aline the telescope with the director (par. 107) when orienting.

c. The mounting surface of the elevation telescope (M75D) contains an index. This index is used together with the elevation scale on the director to determine the degrees of elevation at which the telescopes are raised or lowered.

Section IX. CONTROLS — TRIPODS M7, M19, AND M21

50. Tripod Leveling Knobs

a. Each tripod is provided with three leveling knobs. These knobs are located under the upper portion of the tripod. The knobs are of the hand-grip type and are used to turn the leveling screws (fig. 36) when leveling the director.

b. Turning the leveling screws raises or lowers the leveling plungers upon which the director sets (figs. 1 and 36).

c. The knobs are turned to the right or left as needed to center the bubbles in the two levels on the base of the director.

Section X. AUXILIARY EQUIPMENT

51. General

This section contains only the information required by using personnel to properly identify, connect, and protect the cable systems, generating unit, and remote control systems while they are being used with the directors covered in this manual. For detailed instructions pertaining to related equipment, see appendix II.

52. Cable System M8

a. The cable system M8 comprises the necessary off-carriage equipment to interconnect the director, gun, and generating unit. This system consists of two cable assemblies and a switch box. A 30-foot, 15-conductor cable with **D**-type plugs connects the gun to the director. Either end of the cable may be plugged into the director and the other end plugged into the gun junction box. The plug fits into a receptacle at the bottom of the director (fig. 9) and should be pushed in as far as it will go, then turned a quarter turn. A 225-foot, 3-conductor cable connects the generating unit

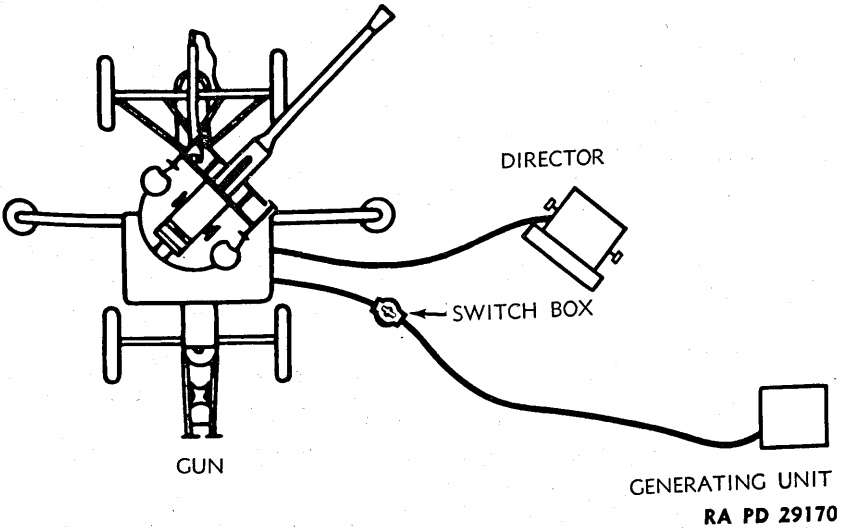


Figure 37. Cable connections—schematic diagram.

with the switch box, and a 15-foot, 3-conductor cable connects the switch box to the gun junction box (fig. 37).

b. Always be sure that the power is off at the generator and the director before inserting or removing the cable. Serious injury to the director or a shock to the operator may otherwise result. The **D**-plugs must be kept perfectly dry, as moisture will cause short circuits and cause considerable damage.

53. Generating Unit M5

The director derives its power from the generating unit M5 (fig. 38). The power is transmitted to the gun junction box by a 3-conductor cable and then to the director by a 15-conductor cable. The switch on the generating unit and the switch box must be in the ON position to energize the director and gun. With the generating unit and switch box switches in the ON position, the director motors are energized when the director switches are turned to the ON position.

54. Remote Control Systems M10 and M15

The remote control systems M10 and M15, used with directors M5A1, M5A2, and M5A3, make self-synchronous operations possible. The remote control system M5 is obsolete and should not be used.

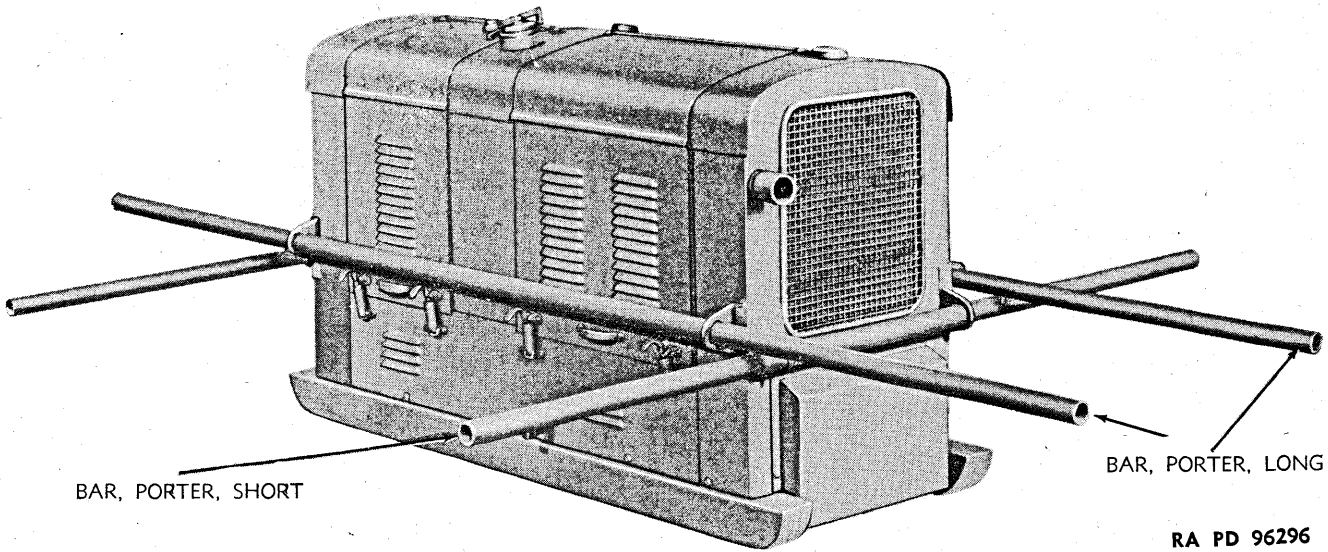


Figure 38. Generating unit M5.

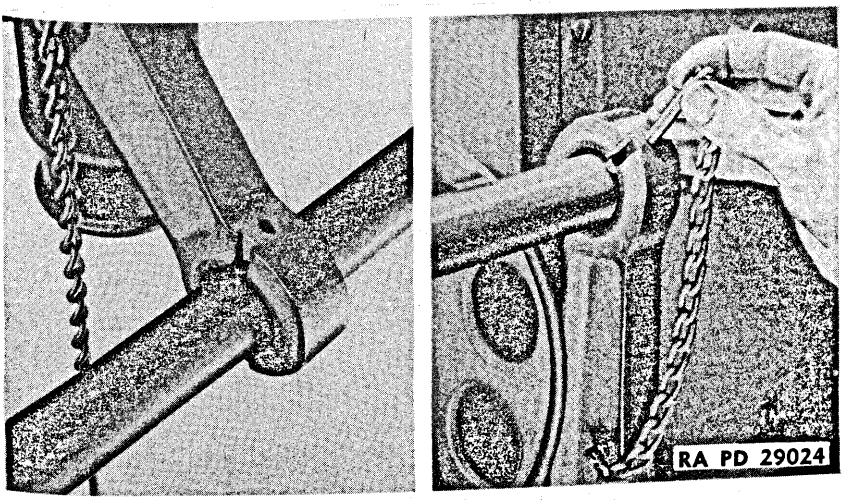


Figure 39. Inserting porter bars in director.

Section XI. OPERATION UNDER USUAL CONDITIONS

55. General

In order that the correct information be sent to the gun, the director must be set up, leveled, and oriented in the proper manner. Extreme care must be exercised in these operations, for no matter how accurate the tracking may be, the data sent to the gun will not be correct unless the preliminary operations have been performed carefully. Operation of all M5 series directors is the same except where specifically stated otherwise.

56. Setting Up Tripod

Before removing the director from its packing chest, select the spot at which it will be set up. Choose a firm, approximately level location. Emplace the tripod. The tripod M7 comes assembled in its case. The tripod M19 or M21 must be assembled as described in paragraph 7.

57. Mounting Director on Tripod

Caution: Never lift the director by any means other than by the porter bars expressly provided for this purpose. Be sure to insert the locking pins so that the director cannot slide sideways and cause injury to the bearers (fig. 39). Lower the director

gradually and gently. Do not drop the director as it is not constructed to withstand bumps or jars.

a. Insert the porter bars into the holes in the carrying brackets. On director M5A1, it will be necessary to turn the range handwheel to the 6 o'clock position to prevent breaking when the porter bars are used to lift the director.

b. Lift the porter bars sufficiently to bring the carrying brackets up against the sides of the director. Insert the locking pins (fig. 39). The locking pins are secured to the carrying brackets by chains. If the pins are inserted before raising the brackets, they must be inserted from the under side; otherwise the pins will strike the director body when it is lifted.

c. Using the porter bars, carry the director to the site.

d. Lift the director over the tripod and lower it carefully into position so that the three bushings, or safety latches, in the base of the director slip down and over the three plungers on the tripod. These latches may be alined with the plungers by disengaging the slewing clutch and rotating the director support housing until the latches are alined. The safety latches (directors M5A2 and M5A3) will snap locked when the weight of the director is placed on the tripod.

58. Leveling

a. Exact leveling is necessary to assure accurate direction of gun fire by the director. Leveling must be done carefully. Continue leveling until both bubbles stay within one graduation of center in any position of the director. Avoid the mistake of assuming the director is "level enough." Any error in leveling will cause a corresponding error in the data transmitted to the gun.

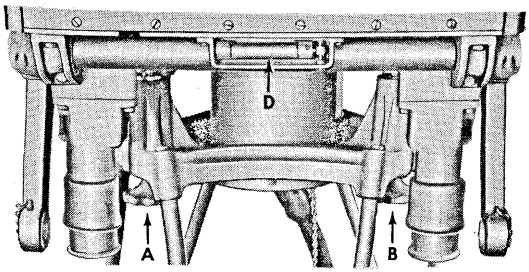
b. Leveling is accomplished by means of three leveling knobs in the top of the tripod (fig. 40). To level, proceed as follows:

(1) Rotate the covers of the levels to expose the level vials.

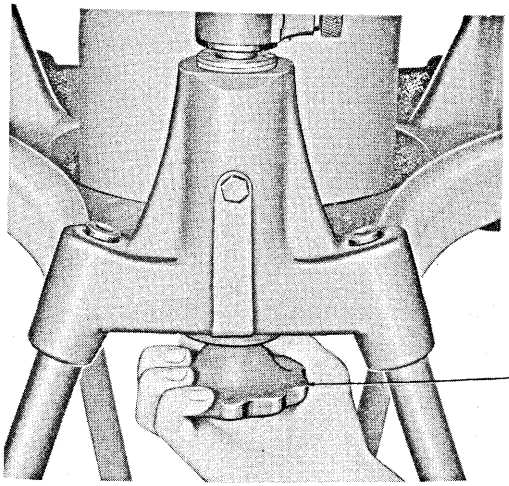
(2) Squeeze the slewing clutch to the handle (fig. 14) and slew the director until any side with a level vial is parallel to two leveling knobs, that is, until one level vial is centered between two knobs (fig. 40).

(3) If the bubble is not in the exact center, turn the knobs to bring the bubble to center.

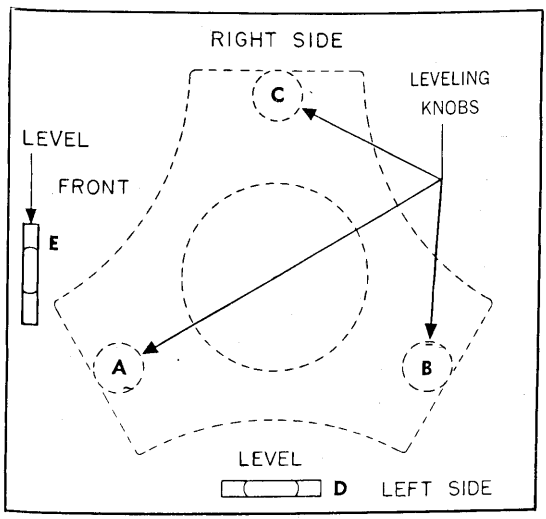
(4) Turn the third leveling knob to center the bubble of the second level vial located on the adjacent side of the director.



LEVEL (D) SHOULD
BE PARALLEL
TO TWO KNOBS
(A) AND (B)



ADJUST KNOBS
(A) AND (B) UNTIL
BUBBLE IS CENTERED
THEN ADJUST KNOB (C)
UNTIL BUBBLE
OF SECOND
VIAL (E) IS
LEVEL



RA PD 110226

Figure 40. Leveling director.

(5) Slew the director and note at each quarter revolution whether the bubbles move from the center of the vials. If the bubbles move more than one division, repeat the leveling procedure as directed above. Continue leveling until both bubbles stay within one graduation of center in any position of the director. If it is impossible to obtain exact level in this manner, it will be necessary to adjust the levels as described in paragraph 109.

59. Mounting Telescopes

a. Mount the telescope M17 or M75C on the azimuth side of the director, and telescope M17 or M75D on the elevation side.

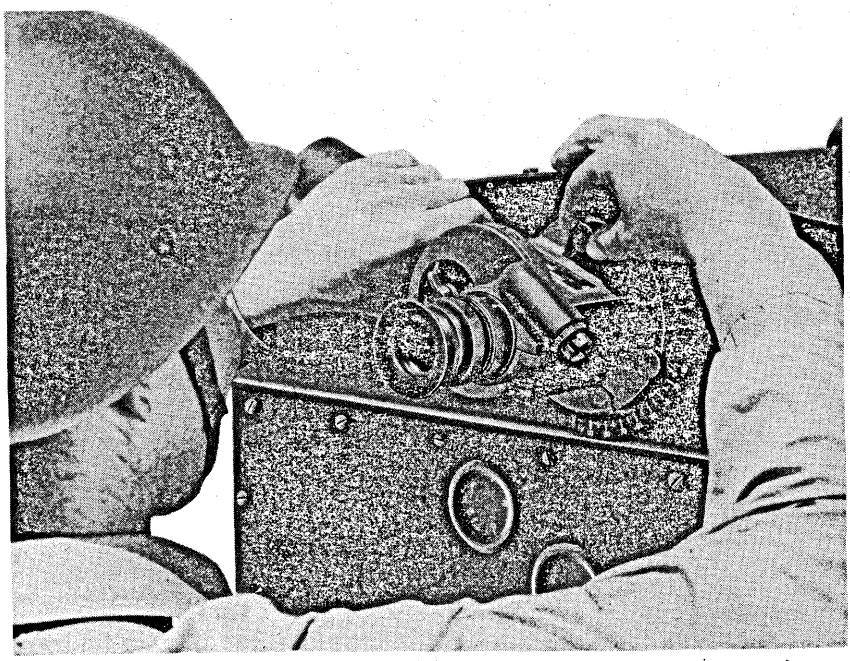


Figure 41. Mounting telescope on director.

b. Position the telescopes so that the slots in the base of the telescopes engage the locating studs on the adapter. Turn down the thumbscrews until the telescopes are firmly mounted in position (figs. 35 and 41).

c. Install reticle lamp in lamp socket and insert lamp socket with lamp into light bracket. Install plug of cable in socket and install other end in receptacle (fig. 9).

d. Point the telescopes at a target at least 1,500 yards distant. The horizontal cross hairs of both telescopes should fall on the

same reference point of this target. If they do not, adjust the telescopes as described in paragraph 107.

e. Check to see that a suitable color filter is in the field of view of the telescopes. This should be appropriate to the conditions of visibility. Use the CLEAR filter when visibility is good or for night operations. In intense glare of the sun, the NEUTRAL filter, acting like a sun glass, cuts down the glare. In fog, mist, or fine suspended dust, the RED filter should be used. If it is difficult to see the tracer stream in daylight operation, the RED filter will help increase its visibility by screening out all but the red light rays.

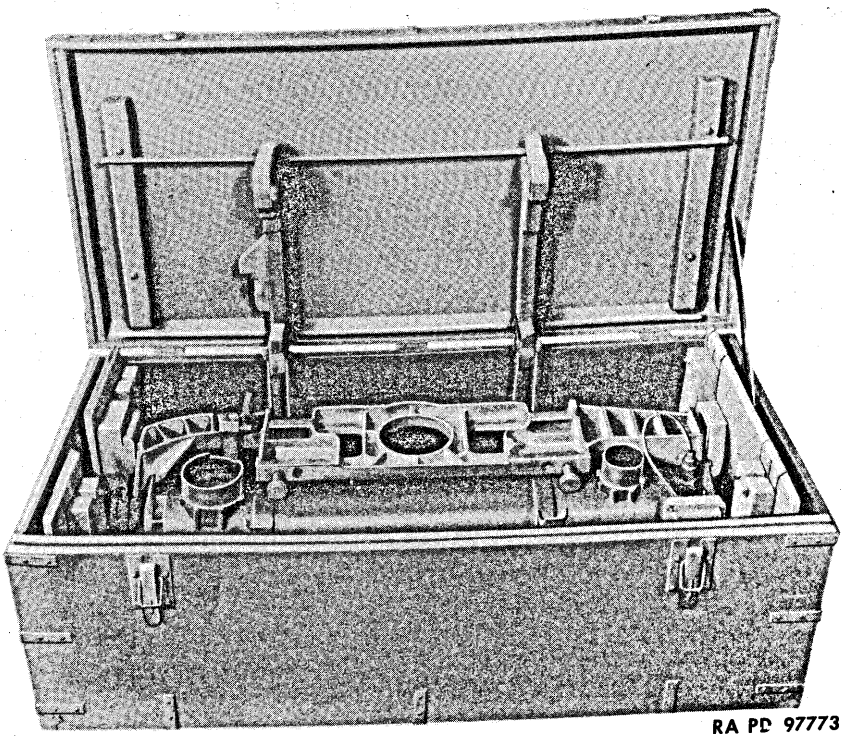


Figure 42. Range finder M10 in its packing chest.