TM E9-325A

WAR DEPARTMENT TECHNICAL MANUAL

GERMAN 105-MM HOWITZER MATERIEL

WAR DEPARTMENT • *15 JUNE 1944*

WAR DEPARTMENT TECHNICAL MANUAL

TM E9-325A

GERMAN 105-MM HOWITZER MATERIEL

WAR DEPARTMENT *15 JUNE 1944*

RESTRICTED *DISSEMINATION OF RESTRICTED MATTER*—
The information contained in restricted documents and the essential characteristics of restricted materiel may be given to any person known to be in the service of the United States and to persons of undoubted loyalty and discretion who are cooperating in Government work, but will not be communicated to the public or to the press except by authorized military public relations agencies. (See also paragraph 23b, AR 380-5, 15 March 1944.)

WAR DEPARTMENT
Washington 25, D. C., 15 June 1944

TM E9-325A, German 105-mm Howitzer Materiel, is published for the information and guidance of all concerned.

[A.G. 300.7 (23 Dec 42)
O.O. 461/30245]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

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

DISTRIBUTION: As prescribed in Par 9a, FM 21-6; X.

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

CONTENTS

This page has been left blank intentionally.

RESTRICTED

CHAPTER 1

INTRODUCTION

1. SCOPE.

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

b. There is included the technical information required for identification use, and care of the German 105-mm howitzer, as much as can be ascertained from printed matter and the materiel on hand.

c. In all cases where the nature of the repair, modification, or adjustment is beyond the scope or facilities of the unit, or beyond the scope of this manual, the responsible Ordnance service should be informed so that proper instructions may be issued.

2. CHARACTERISTICS.

a. The German 105-mm howitzer comprises a tube, breech mechanism, and safety lock. The breech mechanism consists of a horizontal sliding breechblock which slides in the breech ring recess. The movement of the breechblock is controlled by the breechblock operating lever. Firing of the howitzer is performed through the action of the firing mechanism housed within the firing mechanism recess of the breechblock.

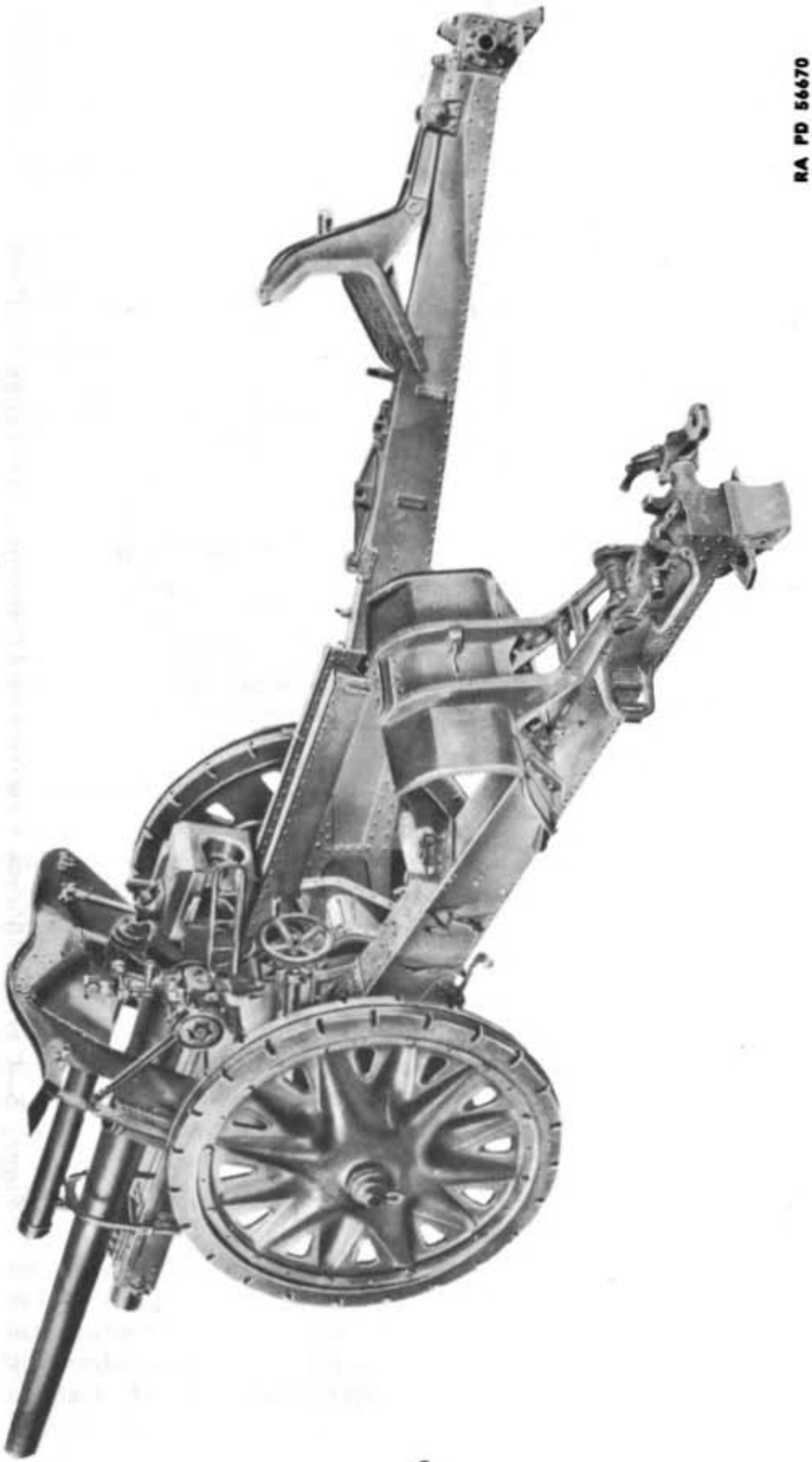
b. Witness lines are cut into the muzzle face of the tube, for use when using the bore sighting equipment.

c. The carriage is of the split-trail type and is equipped with solid rubber-tired wheels. Brakes are provided and are operated by straps connected to the brake lever. Extensions to these straps are provided so that the brakes can be both released or applied from the limber or prime mover. The piece is safely towed at 25 miles per hour on concrete roads or secondary gravel roads.

d. In addition to its use as divisional artillery, the German 105-mm howitzer is used as an antitank weapon. For fire against tanks, it uses an armor-piercing shell with base percussion fuze, or field howitzer shell with the same fuze. The armor-piercing shell is used only up to 1,635 yards. For antitank fire, the howitzer can be fired without opening the split trail.

e. In the German military organization, one battery in each divisional artillery medium battalion is equipped with the 105-mm howitzer. It is normal to place this battery with the advance guard, thereby making maximum use of its range. When horse-drawn, the materiel is transported in two loads, and when motorized, it is transported in one load.

GERMAN 105-MM HOWITZER MATERIEL



RA PD 56670

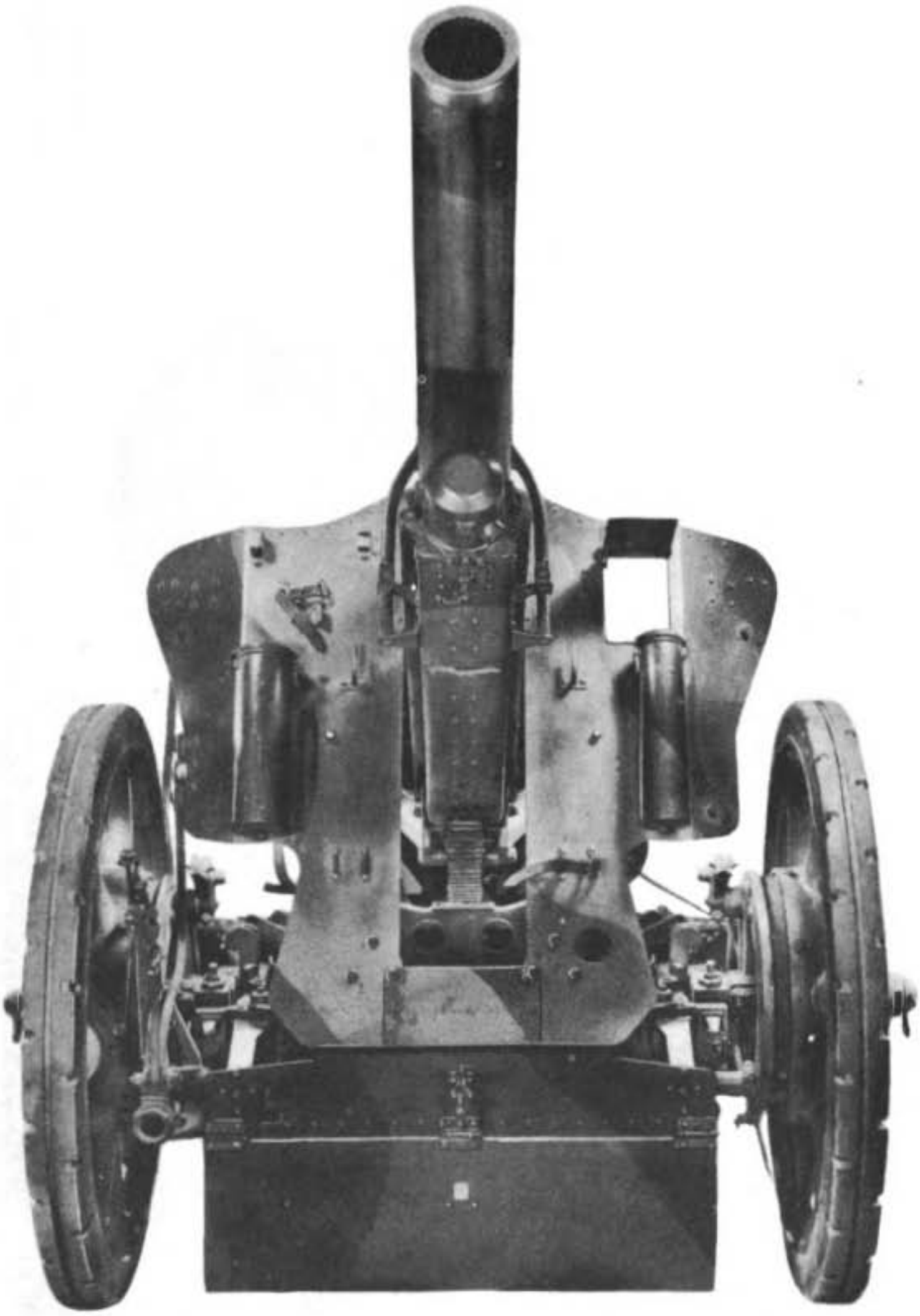
Figure 1—German 105-mm Howitzer and Carriage—Firing Position

INTRODUCTION

RA PD 56671

Figure 2—German 105-mm Howitzer and Carriage—Traveling Position

GERMAN 105-MM HOWITZER MATERIEL



RA PD 56672

Figure 3—German 105-mm Howitzer and Carriage—Front View

INTRODUCTION

3. DATA.

a. General Data.

Weight of howitzer and carriage	4,255 lb
Weight of tube with breech mechanism	1,160 lb
Maximum range	11,674 yd
Maximum muzzle velocity	1,542 ft per sec
Weight of shell (std)	32.65 lb
Weight of explosive	3.0 lb

b. German 105-mm Howitzer, 1936.

Total length of howitzer	115.78 in.
Depth of breech recess	9.06 in.
Depth of chamber	11.2 in.
Length of bore	92 in.
*Diameter across grooves	4.235 in.
*Diameter across lands	4.140 in.
Depth of groove	0.047 in.
**Maximum diameter of powder chamber	4.545 in.
Width of grooves:	
At top	0.240 in.
At bottom	0.223 in.
Width of lands at bottom	0.174 in.
Number of lands	32
Number of grooves	32
Twist at origin of rifling	6 deg
***Twist at muzzle	12 deg

c. Weights and Dimensions of Carriage.

Weights:	
Complete equipment	4,312 lb
Wheel	341 lb
Spade	84 lb
Elevating arc	12 lb
Trail leg, left, with fittings	313 lb
Trail leg, right, with fittings	332 lb
Cradle	275 lb
Saddle	234 lb
Shieldless stays	163 lb
Axle body and brake gear	584 lb
Equilibrator	43 lb
Trail eye 1 in. from ground	407 lb
Trail eye 30 in. from ground	338 lb

*The diameters listed are the assumed zero points used in star-gaging.
**The diameter listed is the section of the powder chamber which seats the cartridge case.
***The rifling is of a uniformly increasing twist.

GERMAN 105-MM HOWITZER MATERIEL

Capacities (liquid):	
Recuperator cylinder (approx)	10 pt
Recoil cylinder (approx)	12½ pt
Cooling tank (approx)	14 pt
Air pressures:	
Recuperator cylinder	710 lb per sq in.
Equilibrator	510 lb per sq in.
Elevation and traverse:	
Maximum elevation (approx)	42 deg
Maximum depression	Minus 6 deg 30 min
Traverse	28 deg right; 28 deg left
Dimensions:	
Over-all width of carriage	77¾ in.
Recoil:	
Metal to metal	46.9 in.
Normal	43.3 in.
Ground clearance	14.5 in.
Trunnion height	46.5 in.
Distance between hinge pins of trail arms	25.3 in.
Diameter of wheel	50⅛ in.
Width of tire	4 in.
Track of carriage	61½ in.
Trail length, over-all	135½ in.
Brake band diameter	19 in.
Trail length to center of hinge pin	127 in.
Cradle length	107½ in.
Cradle width between trunnions	14¾ in.
Cradle length, front end to beating face	68 in.
Cradle, over-all length of slides	90 in.
Cradle, width of slide	1.675 in.
Cradle, thickness of slide	0.4 in.
Cradle, depth	5.505 in.
Cradle, thickness of plate	0.130 in.
Saddle, thickness of plate	0.125 in.
Shield, thickness of plate	0.132 in.
Trail, distance between spade tips	155¼ in.
Articulation, trail arms open for firing	7.5 in.
Articulation, trail arms closed for traveling	5.5 to 5.7 in.
Efforts:	
Elevating gear	6 to 10 lb
Traversing gear	3 to 5 lb
Essential translations:	
Feuer	Fire
Sicher	Safe
Achtung	Caution
Feuerpause	Stop firing

CHAPTER 2

GERMAN 105-MM HOWITZER AND CARRIAGE

Section I

DESCRIPTION AND FUNCTIONING OF HOWITZER

4. GERMAN 105-MM HOWITZER, 1936.

a. The German 105-mm howitzer, 1936, includes the tube and breech ring assembly.

b. The barrel is of solid construction. At the breech end a collar is formed, the outer edge being chamfered to meet a corresponding chamfer in the breech ring. In the rear of the collar, part of the barrel is ground to receive the jacket. The barrel is then tapered to the recess for the spring clip. A cartridge stop base is formed in front of the collar, as there is no cartridge recess.

c. The under side of the breech ring is recessed to receive a detachable gun lug. A bracket is secured on the upper face of the breech ring. A clinometer plane, or leveling surface, is cut on the left of the breech ring. Positioning of the clinometer is done by means of fillister-head screws.

d. The front part of the breech ring is machined to form a buttress thread, in front of which there is a stop. This stop, with a corresponding stop on the jacket, forms a stuffing box to receive a packing ring. Behind the threaded portion, a cone engages the chamfer at the breech end of the barrel. The cartridge clearance in the breech ring is cut to three radii at different centers, so as to form a "lead-in" to the chamber when ramming the projectile.

5. BREECH MECHANISM.

a. General. The breech mechanism (figs. 4 and 5) includes the breechblock, breechblock operating lever, and safety lock (figs. 8 and 9). The breech mechanism is of the horizontal sliding breechblock type. The breechblock is held closed by the lever latch trigger on the operating lever engaging in a recessed insert on the top of the breech ring (fig. 6).

b. Breechblock.

(1) The breechblock is rectangular in form. A semicircular opening is provided which is in axial alinement with the tube when the breech is open, and provides a guide for the ammunition. Another opening is provided which is in axial alinement with the tube when the breechblock is in the closed position, and which houses the firing mechanism.

GERMAN 105-MM HOWITZER MATERIEL

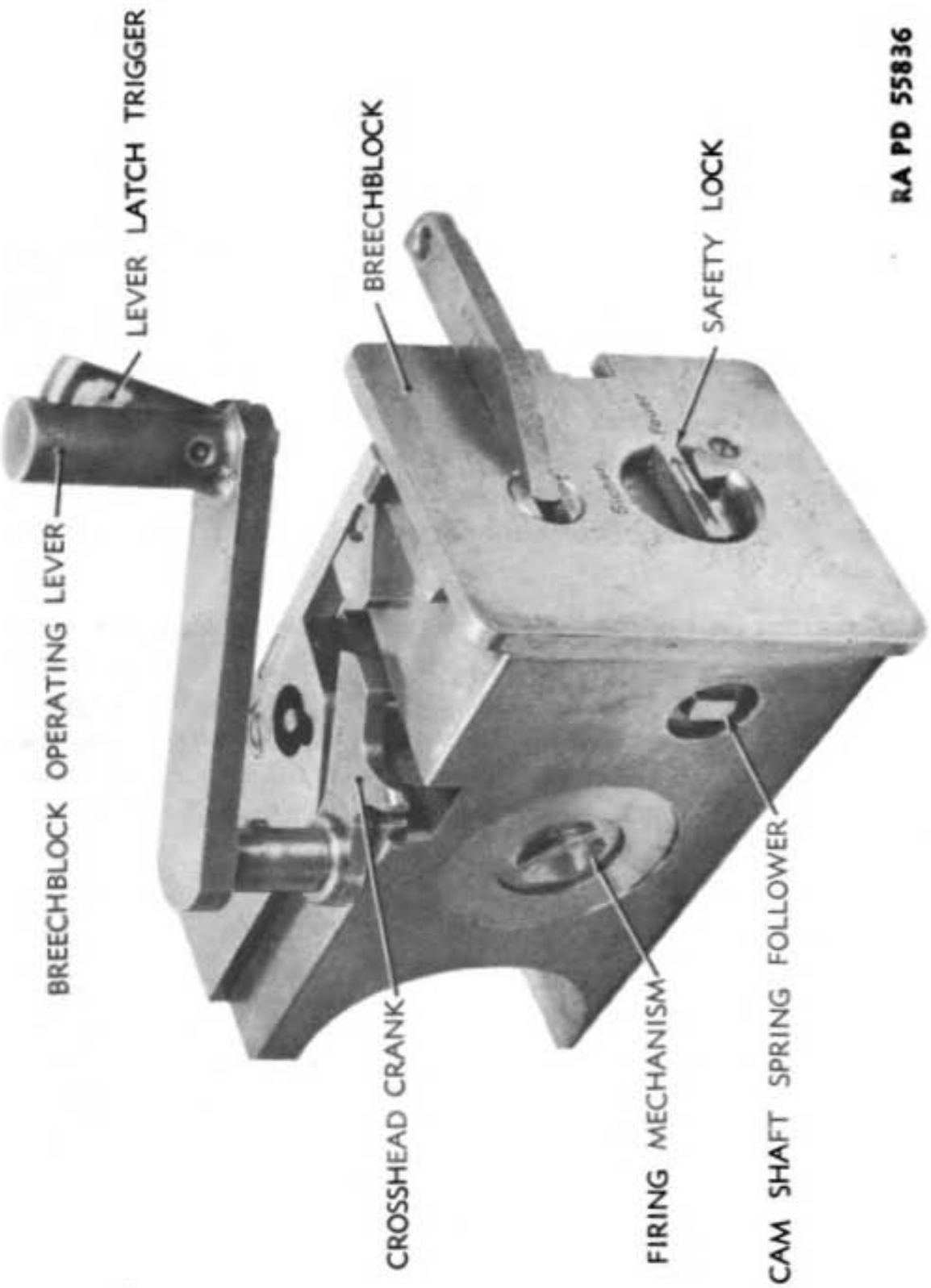


Figure 4—Breech Mechanism—Rear View

DESCRIPTION AND FUNCTIONING OF HOWITZER

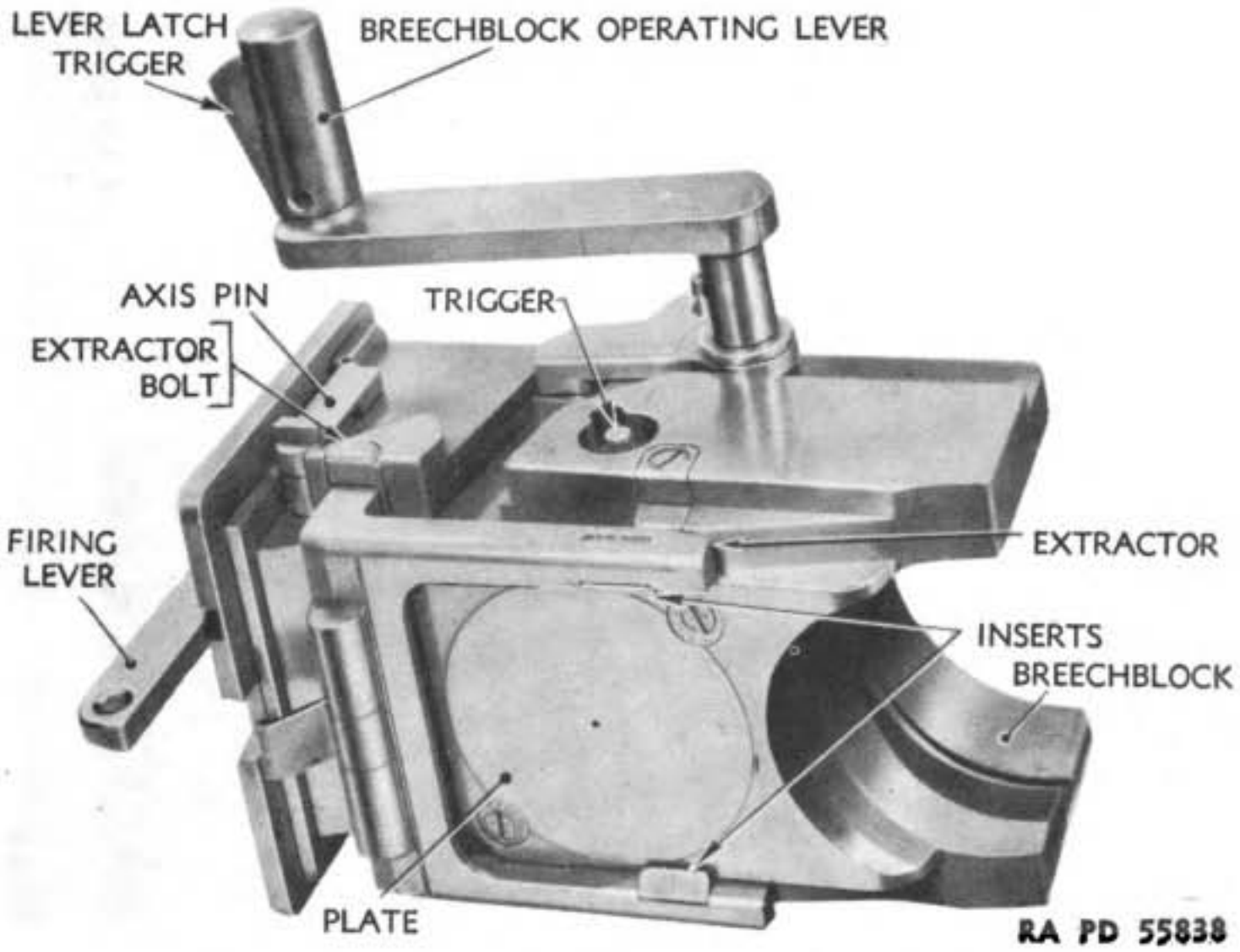


Figure 5—Breech Mechanism—Front View

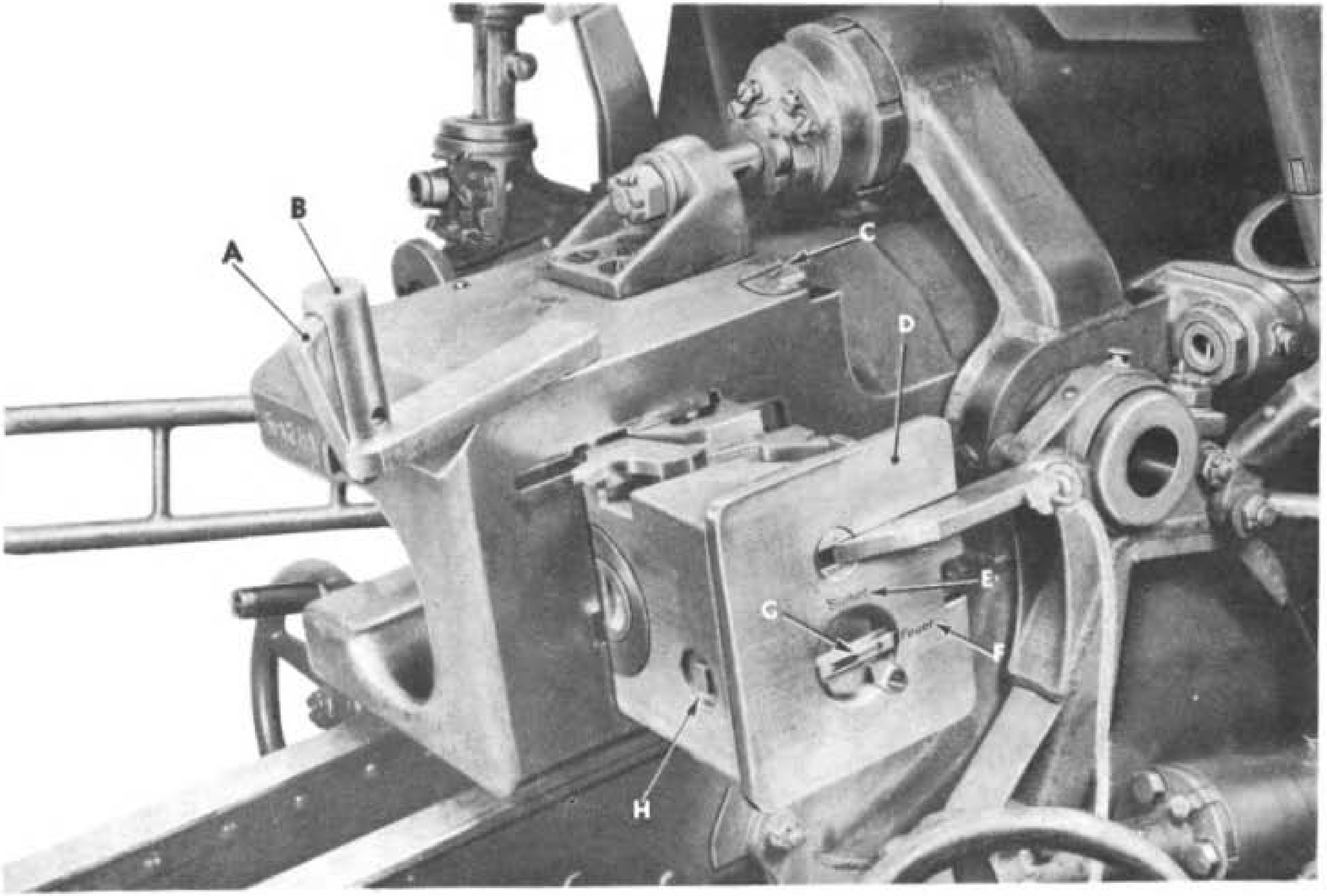
(2) The breechblock is a sliding wedge. When in the closed position, the front face of the breechblock is flush with the front face of the breech recess in the breech ring. The left front edge of the breechblock is chamfered to force the cartridge case to seat, if it has not properly seated when the breechblock is closed.

(3) The breechblock is recessed on the front face to receive a plate. Beneath this plate, a shim is provided to adjust the cartridge head space. The plate is secured by two sunken washers fastened in place with screws (fig. 5).

(4) Inserts are provided at the ejection surfaces of the extractor ways. An insert is also provided at the end of the cam groove on the top of the breechblock.

c. Extractor. The extractor lies in the recess of the breech ring. Two arms extend from the body of the extractor, and inserts are at the ends of these arms. When the breechblock is fully open, these inserts on the extractor ways of the breechblock engage with the projections on the extractor, forcing the extractor to rotate, and thus extracting the cartridge case (fig. 5).

d. Breechblock Operating Lever. The breechblock operating lever suggests a crank in shape, one end representing the handle and the other its axis pin. A projection on the axis pin engages in a key-



A — LEVER LATCH TRIGGER

B — OPERATING LEVER

C — RECESSED INSERT

D — BREECHBLOCK

E — "SAFE" POSITION

F — "FIRE" POSITION

G — SAFETY LOCK

H — CAM SHAFT SPRING FOLLOWER

RA PD 55839

Figure 6—Breech Open

DESCRIPTION AND FUNCTIONING OF HOWITZER

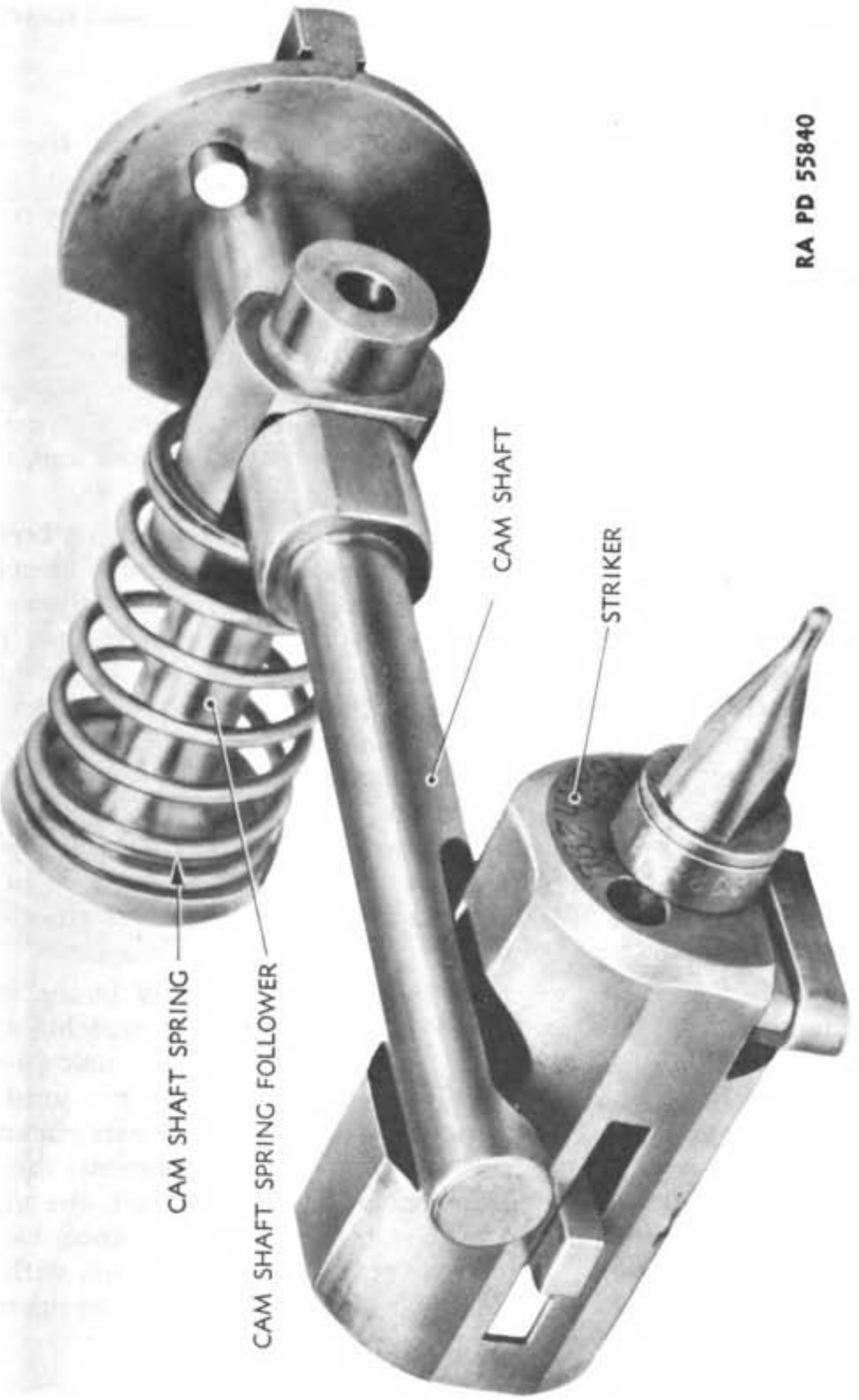


Figure 7—Safety Lock—"FIRE" Position

way in the axis pin bearing of the breech ring to hold the lever in place. The breechblock is held in the closed position by the lever latch trigger on the operating lever handle which engages a recessed insert on the top of the breech ring.

e. Safety Lock.

(1) The safety lock (fig. 6) consists of three parts: the cam shaft, cam shaft spring follower, and cam shaft spring. The cam shaft passes transversely from the right face of the breechblock to the recess for the striker. At this point the cam shaft is reduced to a semicircular section which passes over a notched portion of the striker. This arrangement permits locking or freeing rearward movement of the striker by one-fourth turn of the cam shaft. When the safety lock is in the FIRING ("Feuer") position (fig. 7), the striker can be moved to the rear. When the safety lock is in the SAFE ("Sicher") position (fig. 8), the movement of the striker to the rear is blocked and, thus, the firing mechanism is locked.

(2) The follower holds the cam shaft transversely in the breechblock in either the SAFE or FIRE positions. When the breech is closed and the safety lock set on "SAFE," the cam shaft allows the follower to move to the rear. The head of the follower then projects from the rear of the breechblock into a groove in the rear face of the breech recess. Thus, the breechblock cannot be opened when the safety lock is set on SAFE. If the safety lock is set on SAFE with the breechblock open, the breechblock can be closed. As the breechblock closes, a chamfer on the rear of the breech recess forces the follower into the breechblock against the spring. When the breechblock is fully closed, the follower snaps back into the groove in the rear face of the breech recess and locks the breechblock in the closed position.

(3) The design of the safety lock as incorporated in the firing mechanism allows the lock to operate only when the breechblock is fully open or closed. The projection on the crosshead crank (fig. 4) interferes with the movement of the arm on the axis pin until the breechblock is almost fully closed. Then, the top of the axis pin enters a groove in the upper face of the breech recess, and prevents the axis pin from rotating. When the breechblock is fully closed, the top of the axis pin enters a recess and is free to rotate. Thus, since the axis pin cannot rotate until the breechblock is closed or open, with the firing lever keyed to the axis pin, the firing mechanism can be operated only when the breech mechanism is closed or open.

6. FIRING MECHANISM.

a. The firing mechanism (fig. 9) is assembled in the axial hole in the breechblock. It is retained in its seat by a spring and retaining

DESCRIPTION AND FUNCTIONING OF HOWITZER

RA PD 55841

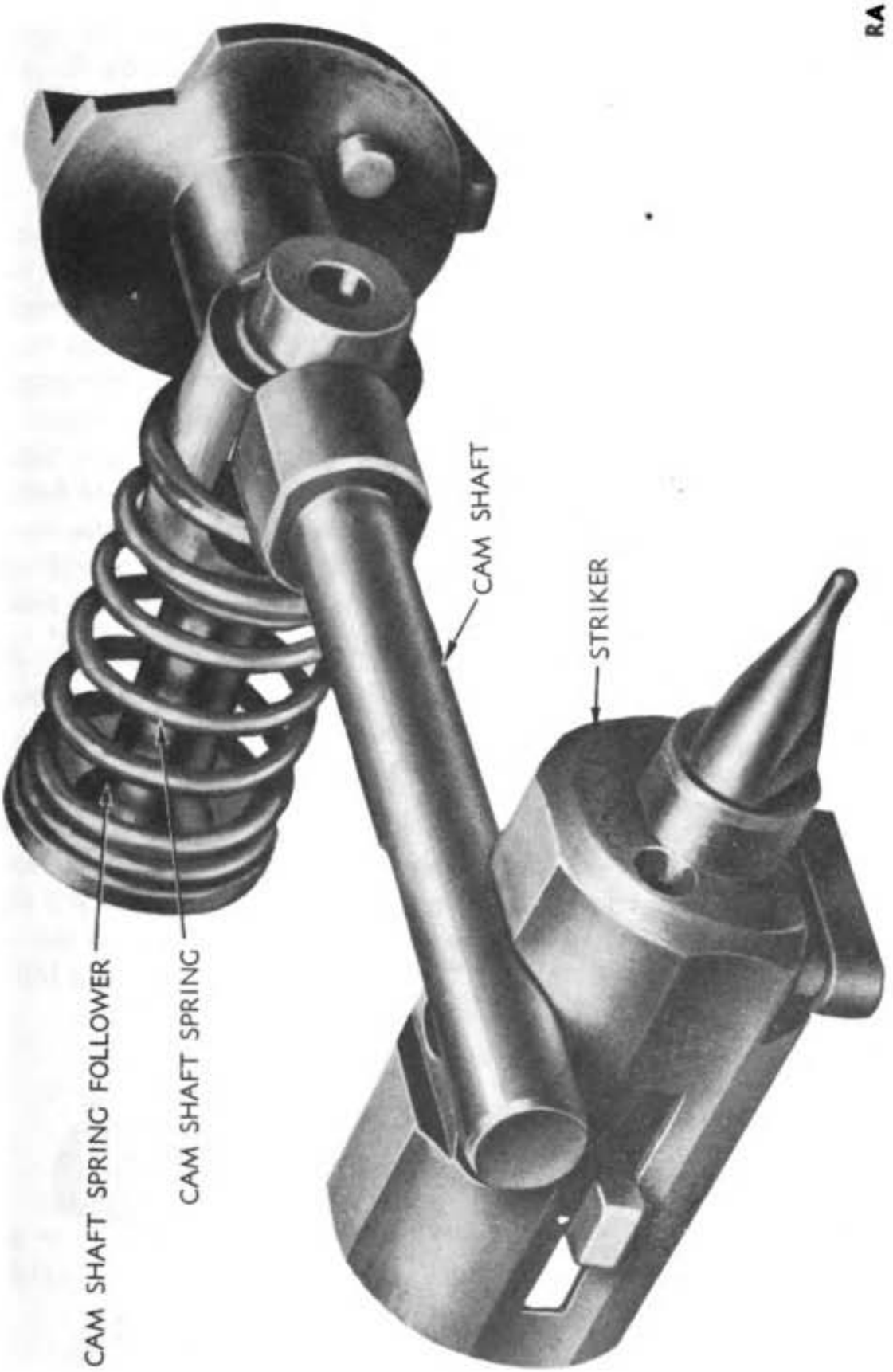


Figure 8—Safety Lock—"SAFE" Position

GERMAN 105-MM HOWITZER MATERIEL

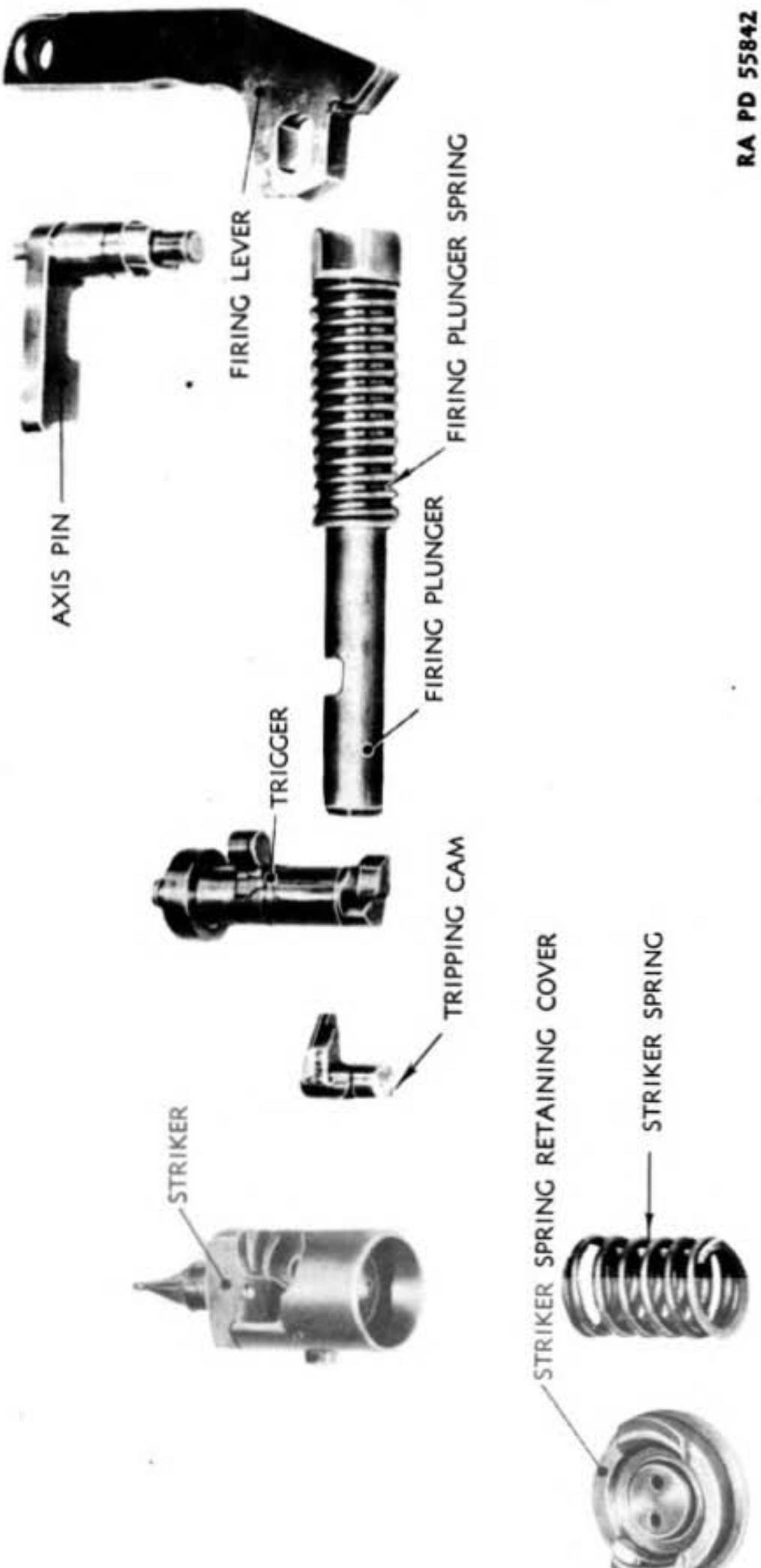


Figure 9—Firing Mechanism—Exploded View

cover. Projections on the retaining cover engage mating surfaces in the breechblock.

b. The firing mechanism consists of a firing lever, axis pin, firing plunger, firing plunger spring, trigger, tripping cam, striker, striker spring, and striker spring retaining cover. The striker is a firing case, inside of which is a bearing plate. The pivot pins of the bearing plate are riveted over. At the front end of the firing case, the firing pin is staked in place.

c. The firing lever pivots about its axis pin located in a horizontal groove in the right face of the breechblock. The rear end of the firing lever moves the firing plunger from right to left in the breechblock against the spring. A recess on the plunger engages a projection on the trigger and rotates it to the right (clockwise). The cam on the trigger engages with the tripping cam which pivots in the striker. The tripping cam is held in position in the striker by the force of the striker spring against the inner bearing plate of the striker. The bearing plate is pivoted to allow movement of the tripping cam. The plate has a projection which engages a groove in the breechblock to assure correct assembly of the striker. In the rear of the striker bearing plate is the striker spring and its retaining cover.

d. A pull on the lanyard rotates the trigger, and the trigger cam forces the striker, by means of the tripping cam, three-eighths inch to the rear, until the trigger cam clears the tripping cam. The striker spring then drives the striker forward nine-sixteenths inch to fire.

e. Releasing the firing lever allows the firing plunger spring to rotate the trigger to the left (counterclockwise). The trigger cam engages the striker, forcing it to the rear. The trigger forces the tripping cam back out of position, thus allowing all parts to resume their normal positions under the action of the striker spring.

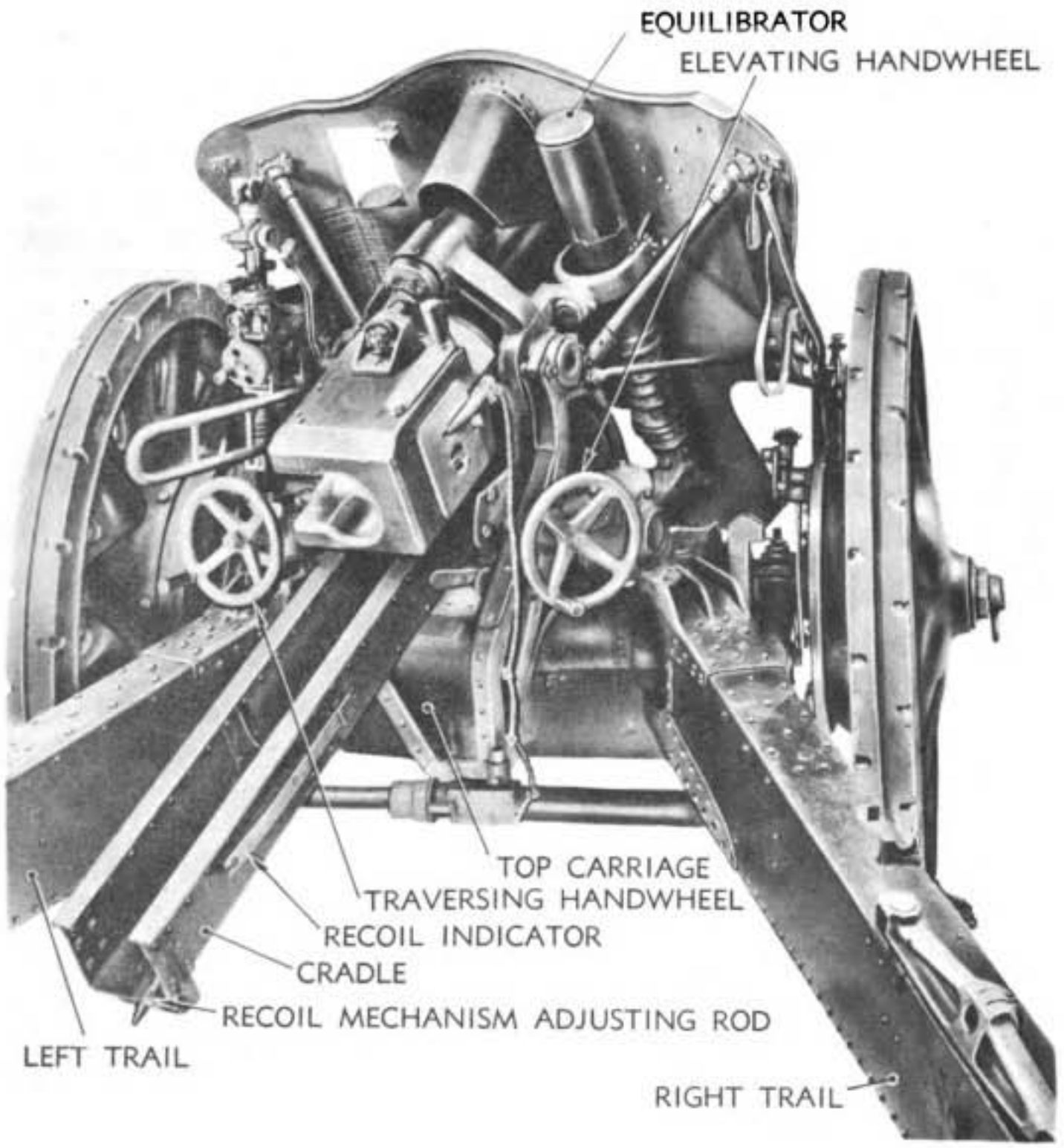
GERMAN 105-MM HOWITZER MATERIEL

Section II

DESCRIPTION AND FUNCTIONING OF CARRIAGE

7. GENERAL.

a. The German 105-mm howitzer carriage is of the split-trail type. The carriage consists mainly of the cradle, recoil mechanism, recuperator mechanism, top carriage, bottom carriage, elevating mechanism, equilibrator, traversing mechanism, and trails. The top carriage pivots about a pintle bearing. The firing stresses are ab-



RA PD 55843

Figure 10—German 105-mm Howitzer and Carriage—Rear View

sorbed by the elevating mechanism, the worm and wormwheel being permitted to move, during recoil and counterrecoil, against Belleville springs. The spades, imbedded in the ground, prevent movement of the carriage. The equilibrator acts to neutralize unbalanced weight and reduce the manual effort needed to elevate the howitzer. Brakes are provided which are operated by straps connected to a single brake lever.

8. CRADLE.

a. The cradle is of box section. It is continued to the rear of the piece for about the full length of recoil (fig. 10).

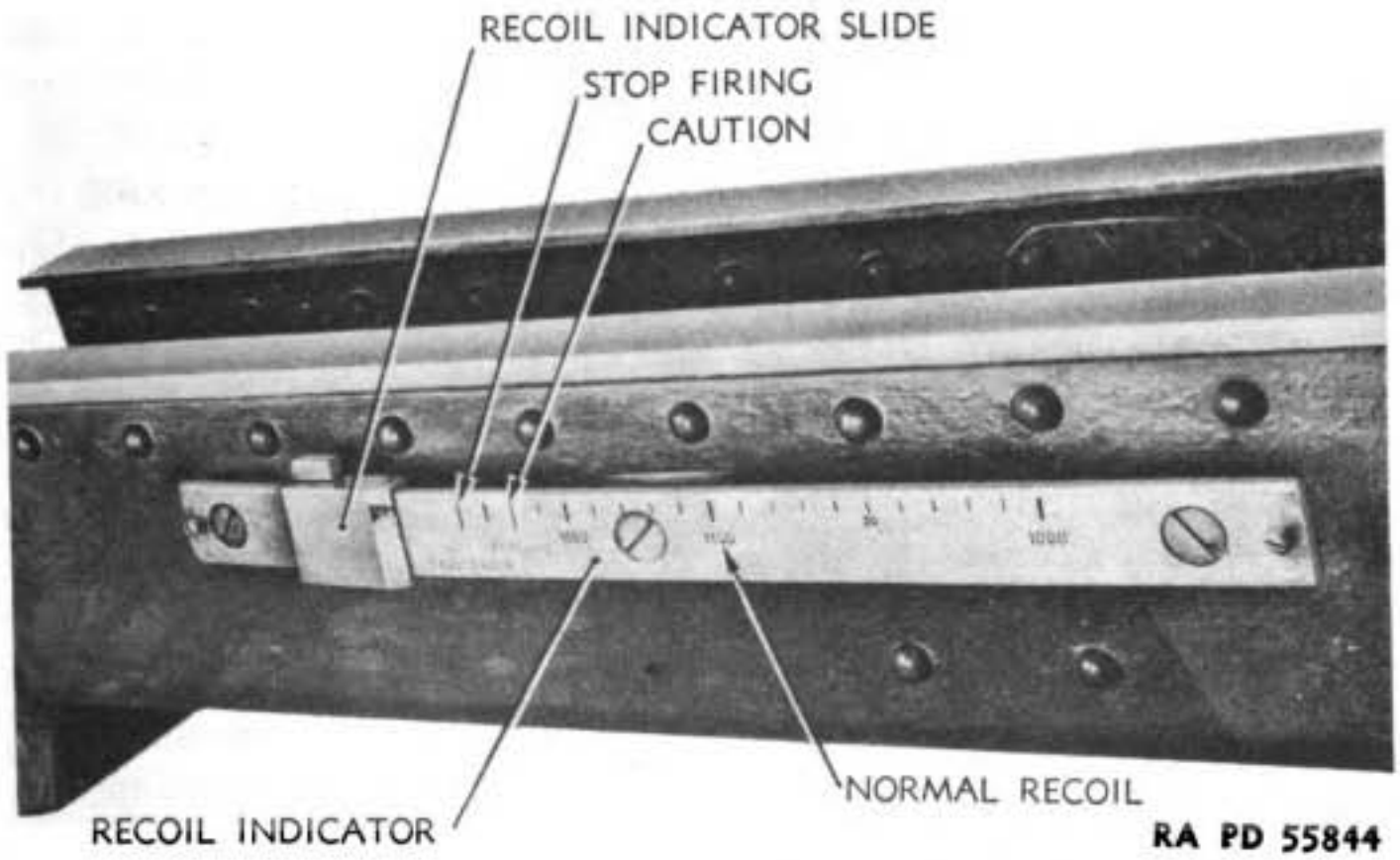


Figure 11—Recoil Indicator

b. On the right side of the cradle is the recoil indicator (fig. 11), graduated in millimeters. The graduations in black are for normal recoil; the graduations in red are for abnormal recoil. During recoil a lug on the howitzer slide pushes the indicator slide to the point of maximum length of recoil. The reading shown by the indicator slide may not be true in all cases as the slide fits loosely on the indicator and is moved easily. There is no provision made to stop further movement of the slide after the howitzer reaches maximum recoil.

9. EQUILIBRATOR MECHANISM.

a. A single hydropneumatic equilibrator (fig. 12) is provided on the right hand side of the carriage. It is a sealed chamber filled with compressed air, the pressure of which was varied by means of

GERMAN 105-MM HOWITZER MATERIEL

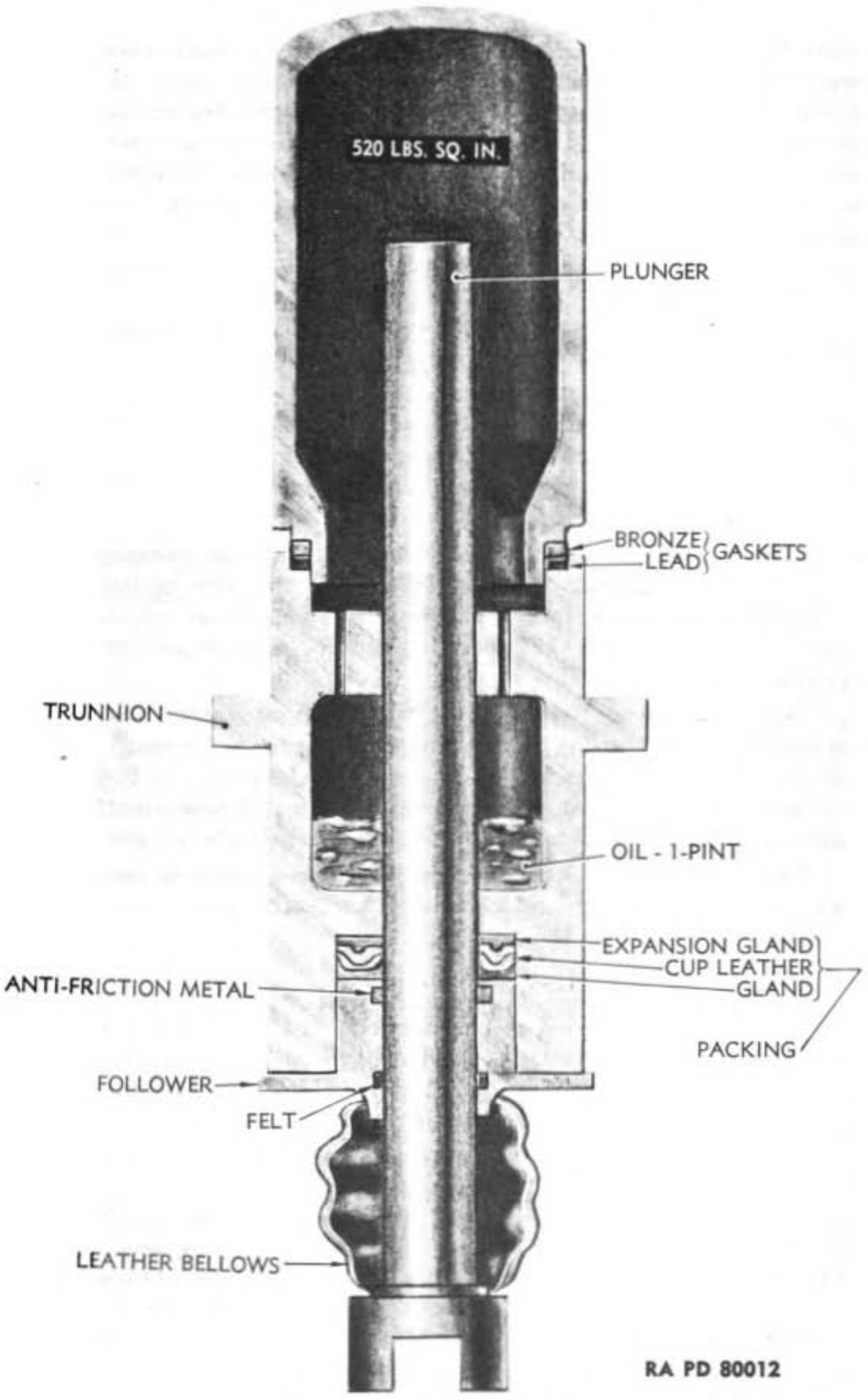


Figure 12—Equilibrator

the plunger which changed the air volume. This equilibrator provides an approximate constant elevating handwheel effort, throughout the entire elevating arc, both in elevating and depressing. The equilibrator is mounted on universal joints, at the trunnions by a heavy rotating yoke, and at the bottom of the plunger by a universal joint which is pinned to the support. The trunnions rest freely in their mounting yoke, being held there by the internal air pressure which tends to separate the plunger and the housing and air chamber. The joint between the housing and air chamber is sealed by means of lead and bronze gaskets. The air filling valve is the same as provided on the recuperator mechanism.

b. The plunger, which may be easily removed from the equilibrator, is a hollow steel rod with a fine ground finish. It is centered at the top by a bronze insert forming a shoulder in the housing, and at the bottom by the packing and packing gland follower. The lower end of the plunger is protected by a leather bellows.

c. The packing consists of a single cup leather packing supported by bronze glands. The packing gland follower contains an anti-friction metal insert and a felt wiper. Assisting the cup leather packing is approximately 12 ounces of liquid. This liquid helps to effect the air seal.

d. Upon elevating the howitzer, the plunger pivots about its lower support. The housing and air chamber are forced upward under the action of the compressed air and assists in elevating the howitzer. The plunger withdraws as the howitzer elevates. Consequently the air pressure decreases, thus decreasing the assistance to elevation.

e. Upon depressing the howitzer, the above cycle is reversed: the air pressure increases and counterbalances the increasing movement due to the shift in the howitzer.

10. RECOIL MECHANISM.

a. General. The recoil mechanism is of the independent hydropneumatic type, with a direct contact recuperator. It consists of five main parts, as follows: cooling cylinder, recoil cylinder, recoil piston and rod, control rod, and front cap.

b. Cooling Cylinder.

(1) The cooling cylinder is of steel, having a lug at its front end, to locate itself in its correct position with the front cap. There are two internal flanges, one at each end, which act as centralizers, and also supporting rings for the joint packing (greased square). On the outside of the cylinder near the front end are two projections, one for the filler cap and one for the drain plug (fig. 13).

(2) The filler cap is fastened over the projection for filling, and is held in position by a bayonet fastening. Inside the cap is a spring

GERMAN 105-MM HOWITZER MATERIEL

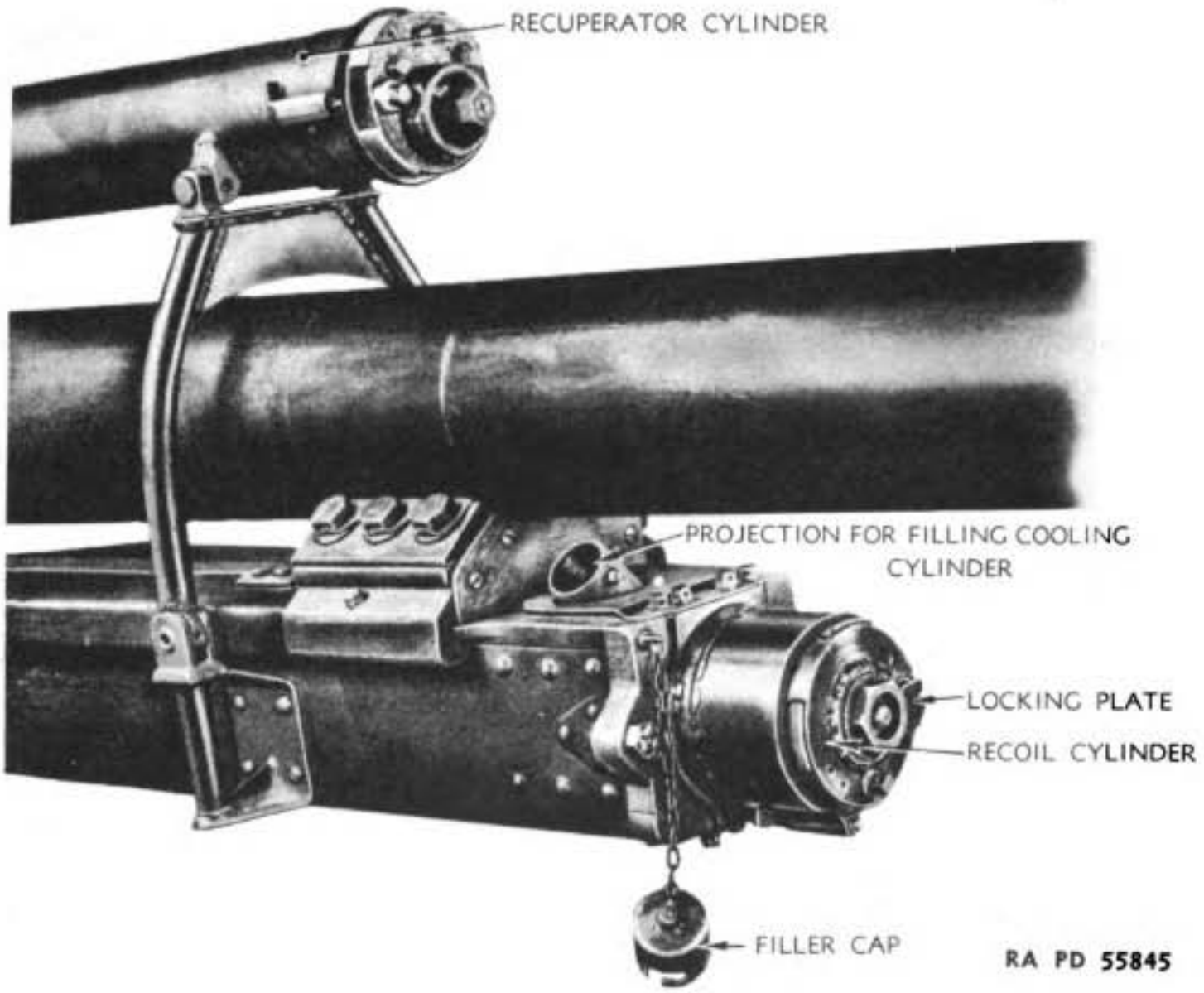


Figure 13—Recoil and Recuperator Cylinders

and plate to prevent spilling while traveling, and to allow any excess pressure due to heat to escape during firing. This cylinder may well be called a heat transfer cylinder since it will cool or heat the recoil liquid.

(3) A bronze ring supporting packing is fitted in the rear end of the cylinder.

c. Recoil Cylinder.

(1) The recoil cylinder is of steel, enlarged at both ends and lead coated externally. The front and rear ends are serrated for the use of spanner and locking plates. A flange is formed externally near the front end to form an inner supporting ring for packing in conjunction with cooling cylinder. The cylinder is threaded externally to suit the rear nut securing cooling cylinder. The cylinder is threaded internally at each end, the front end for the reception of the front cap or expansion chamber, and the rear end to take the stuffing box (fig. 13).

(2) The stuffing box is of steel, being threaded externally at both ends, with hexagon formed about the center. The box is bored internally to accommodate a supporting ring at its front end, 12 turns

DESCRIPTION AND FUNCTIONING OF CARRIAGE

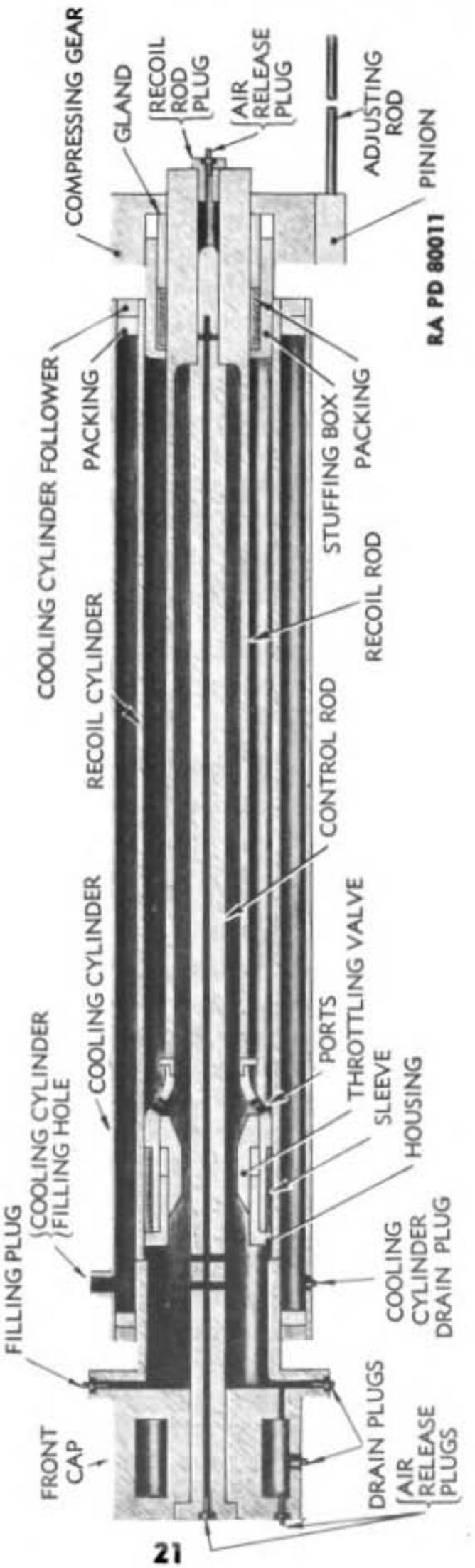


Figure 14—Recoil Cylinder Assembly

of packing, and a rear supporting ring. The rear supporting ring is held in position by a steel cap, threaded internally, while externally on the outer periphery is cut a spur wheel. Two locking plates are secured by screws to two flats of the hexagon.

d. Recoil Piston and Rod.

(1) The piston is made of steel, being hollow and threaded internally at both ends (fig. 14). The hollow portion takes a throttle or sliding bushing, while the threaded portions receive the piston rod, and sleeve securing sliding bushing. Externally, the piston is cut to receive a sleeve, and its rear face is cut at an angle of 15 degrees through which eight ports are cut to connect to the interior. The sleeve is held in position by the sleeve securing sliding bushing.

(2) The throttle or sliding bushing of the recoil mechanism is fitted inside the piston head, and has longitudinal movement. It is bored longitudinally throughout to allow passage of the control rod. In this boring are also cut four longitudinal grooves.

(3) The piston rod is made of steel, being hollow throughout. The front end is threaded externally for the attachment of the piston, while the rear end is threaded for the attachment of howitzer securing nut. The rear end is closed by a screwed plug through which an air release plug is fitted.

e. Control Rod and Plunger.

(1) The control rod is made of steel, having a plunger fitted on the rear end. The rod is tapered and bored throughout. Externally, near the front end, it is threaded and flanged, while on the extreme end is formed a hexagon. The front end is closed by an air release plug, and the rear end by the control plunger. Holes are bored through the rod to assist in filling the control chamber or piston rod and also to control run-out.

(2) The control plunger is threaded at its front end and connects on the rear end of the control rod, being finally secured by a rivet. It is tapered externally to the rear, having a longitudinal groove cut approximately five-eighths of its length. This groove varies in depth. The plunger is hollow, and has eight holes bored through it to assist in controlling run-out.

f. Front Cap. The front cap is made of steel, being threaded on the rear end for its reception into the hydraulic buffer cylinder. It has a flanged surface through which two slots are cut for correct location to the cradle. It is threaded internally to receive the control rod. Between the flange and the front end an expansion chamber is formed, which is connected by a small port to the buffer cylinder. Two filling plugs are arranged at the top of the flanged portion and a drain plug at the bottom. A cover fits over the front end of the front cap, and is held in position by interrupted thrust collar with spring and plunger.

g. On firing, the howitzer moves to the rear, pulling the recoil rod and piston with it. Liquid flows through the ports in the piston head assembly; the throttling valve slides forward under action of the liquid pressure, and liquid is throttled between the throttling valve and the control rod. The control rod is tapered, and an increased throttling action occurs as the howitzer continues to move out of battery. This action plus the compression of the air in the recuperator mechanism absorbs the majority of the recoil forces. A portion of the liquid in the recoil cylinder flows rearward to the void created in the recoil rod.

h. On counterrecoil, the air pressure in the recuperator mechanism forces the howitzer back into battery. The liquid pressure in front of the throttling valve forces it rearward and partially closes the ports in the piston. Liquid flows from the front of the piston between the throttling valve and the control rod, and to the rear of the recoil cylinder through the partially closed piston ports. The liquid trapped in the recoil rod enters the control rod via the holes in the buffer, thence to the front end of the control rod into the front of the recoil cylinder, and follows the liquid path previously described to the rear of the piston. The liquid trapped in the buffer chamber is throttled as the buffer enters. In addition, a throttling groove is provided on the buffer.

11. RECUPERATOR MECHANISM.

a. General. The recuperator (fig. 15) is hydropneumatic with liquid (par. 34) and air in direct contact, and consists principally of the following parts: high pressure cylinder, recuperator ram cylinder, and recuperator ram and rod.

b. High Pressure Cylinder.

(1) The high pressure cylinder is a steel cylinder having a steel plug welded on the front end. This plug is drilled and threaded in the front for the reception of the recuperator ram cylinder. On the front face are two plugs and an air valve. One of the plugs is connected to the air valve and is used for attaching the adapter for testing and charging with air. The other plug, made of steel, is for liquid charging. An interrupted flange is formed externally at the front end for the attachment of a cover which is finally secured by a spring plunger (fig. 13).

(2) The rear end of the cylinder is flanged and fits into the bracket supporting the recuperator on the carriage, and is threaded at the rear end for the securing nut. It is bored through longitudinally, so that the front end will take the rear end of the recuperator ram cylinder. This front end has two ports (holes) cut in its front face, which connect to the longitudinal boring just in rear of the seating for the recuperator ram cylinder. The rear end is screwed to take the

GERMAN 105-MM HOWITZER MATERIEL

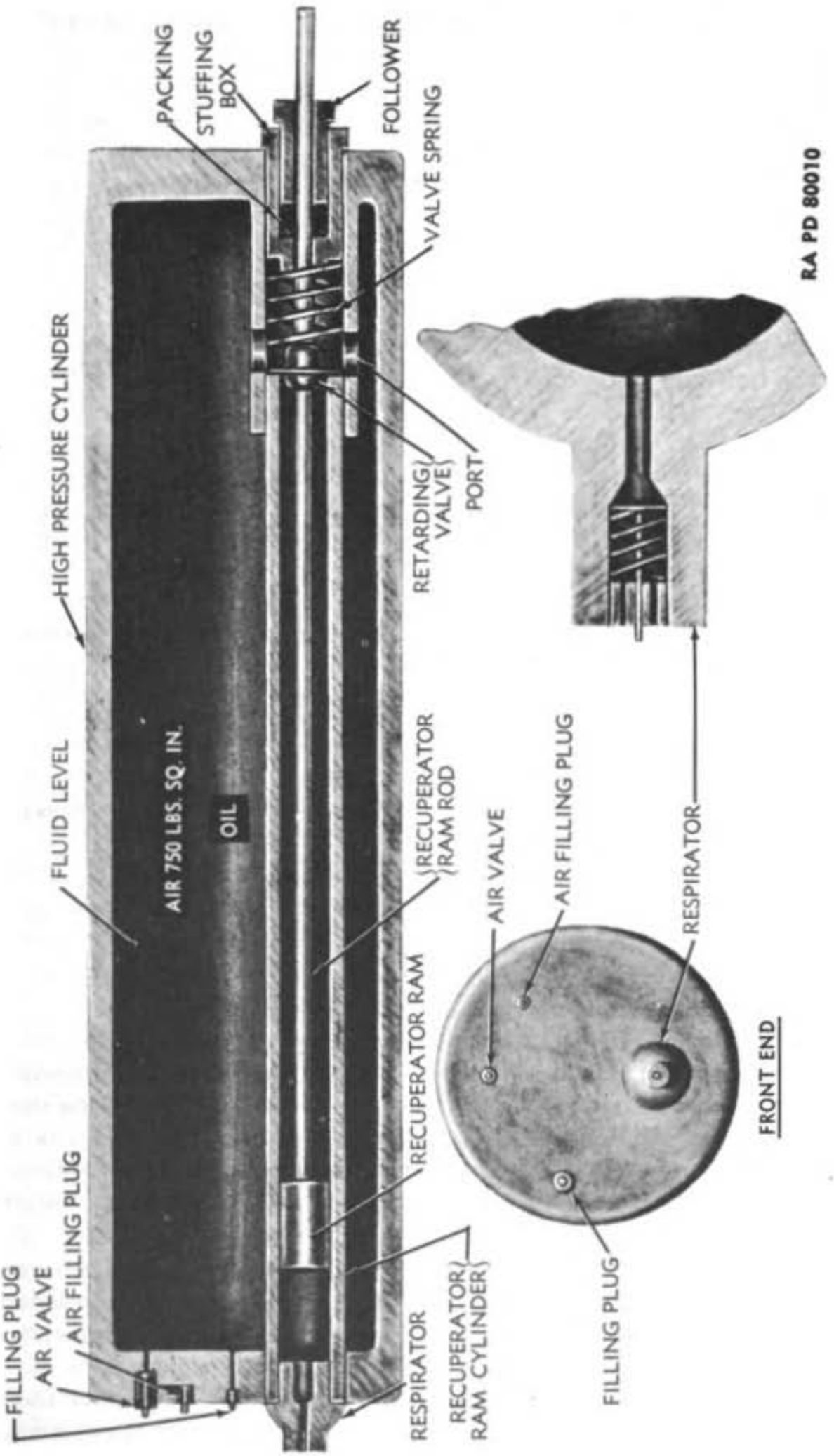


Figure 15—Recuperator Mechanism

stuffing box and gland. On the rear face four holes are bored to take four screws securing two locking plates.

c. Recuperator Ram Cylinder. The recuperator ram cylinder is a steel tube closed at its front end by a screw-threaded dust cap. It is screwed externally at its front end for screwing into the front end of the high pressure cylinder, while at the rear, externally, a seating is formed for fitting into the rear portion of the high pressure cylinder. A chamfered face is formed on the rear face of the cylinder to form a seating for the retarding valve. The retarding valve is held on to its seating by a coil spring whose rear end fits over a spigot formed on the stuffing box.

d. Recuperator Ram and Rod. The recuperator ram is a steel rod, threaded at its rear end for attachment to the howitzer through the medium of two washers (one concave and one convex) and a nut. The two special washers are for any slight misalinement and jump of howitzer. Near the front end is fitted a piston head, behind which two U leathers are carried, with supporting rings and securing nut.

e. Recuperator Action.

(1) On firing the howitzer, it recoils to the rear, taking with it the recuperator ram which in turn sweeps the liquid out of the recuperator ram cylinder into the high pressure cylinder, by the way of the retarding valve (pushing it off its seating), and through the two ports in the high pressure cylinder, thus increasing the air pressure through decreasing the air space.

(2) In counterrecoil, the accumulated air pressure forces the howitzer forward, and at the same time the retarding valve is returned to its seating by the spring, thus allowing only a certain rate of flow of liquid through the four small port holes in the valve.

12. TOP CARRIAGE.

a. The top carriage is principally of welded design. It is divided into two parts: the top carriage proper and the lower pintle bearing. Shims are provided to compensate for the variation in distance between the shoulders of the upper and lower pintle bearings. The top carriage is of welded construction, except the reinforcements for the lower portion of the top carriage which are riveted in place. The bottom of the top carriage contains holes to prevent any water collecting in the pockets formed by the reinforcing braces. Two holes are provided at the front of the top carriage to allow access for cleaning this portion of the top carriage (figs. 16, 17, 18, and 19).

b. The top carriage rotates on a pintle bearing attached to the trail support. The upper bearing consists of two parts: the end bearing and the rotating bearing.

GERMAN 105-MM HOWITZER MATERIEL

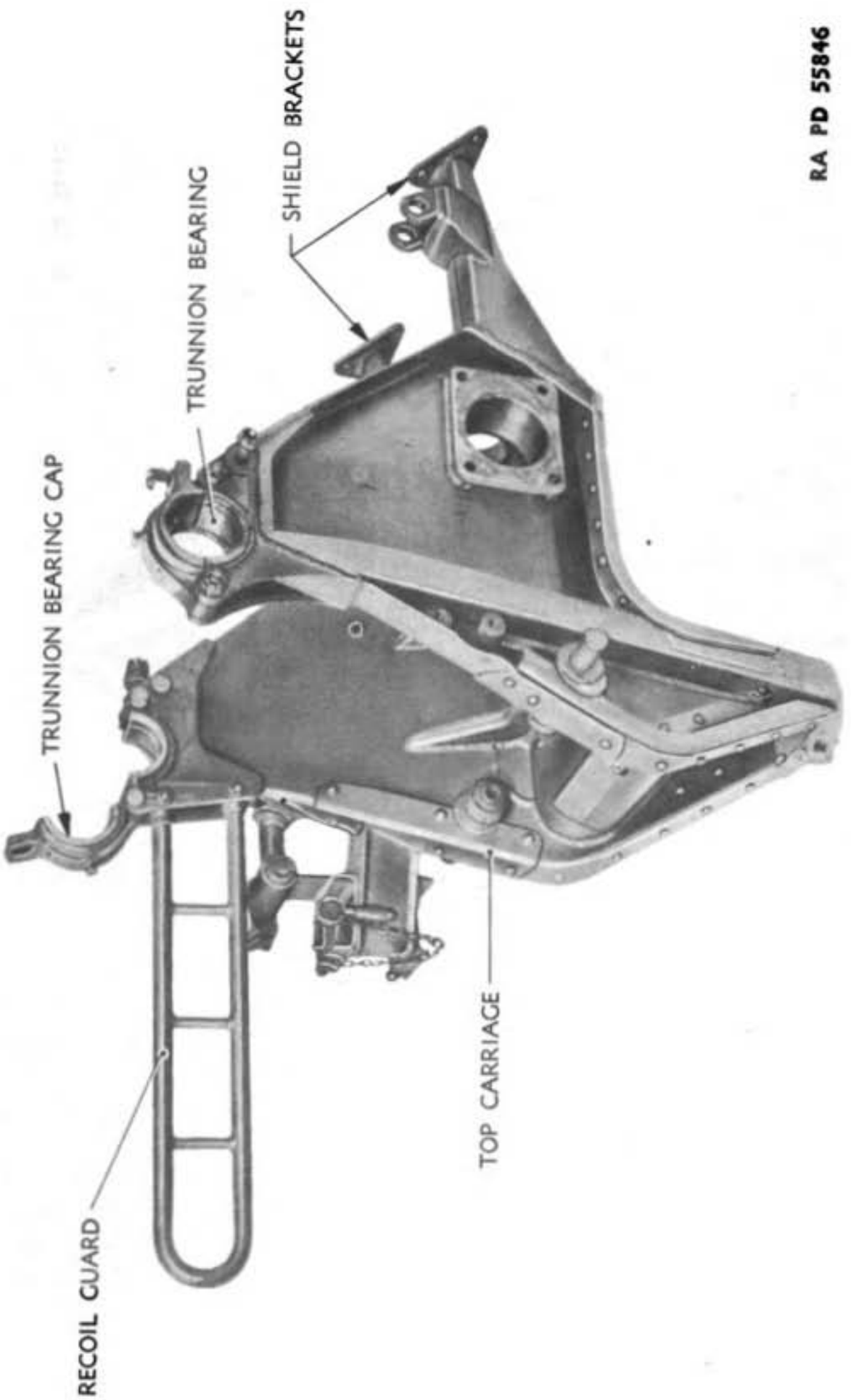


Figure 16—Top Carriage—Right Side

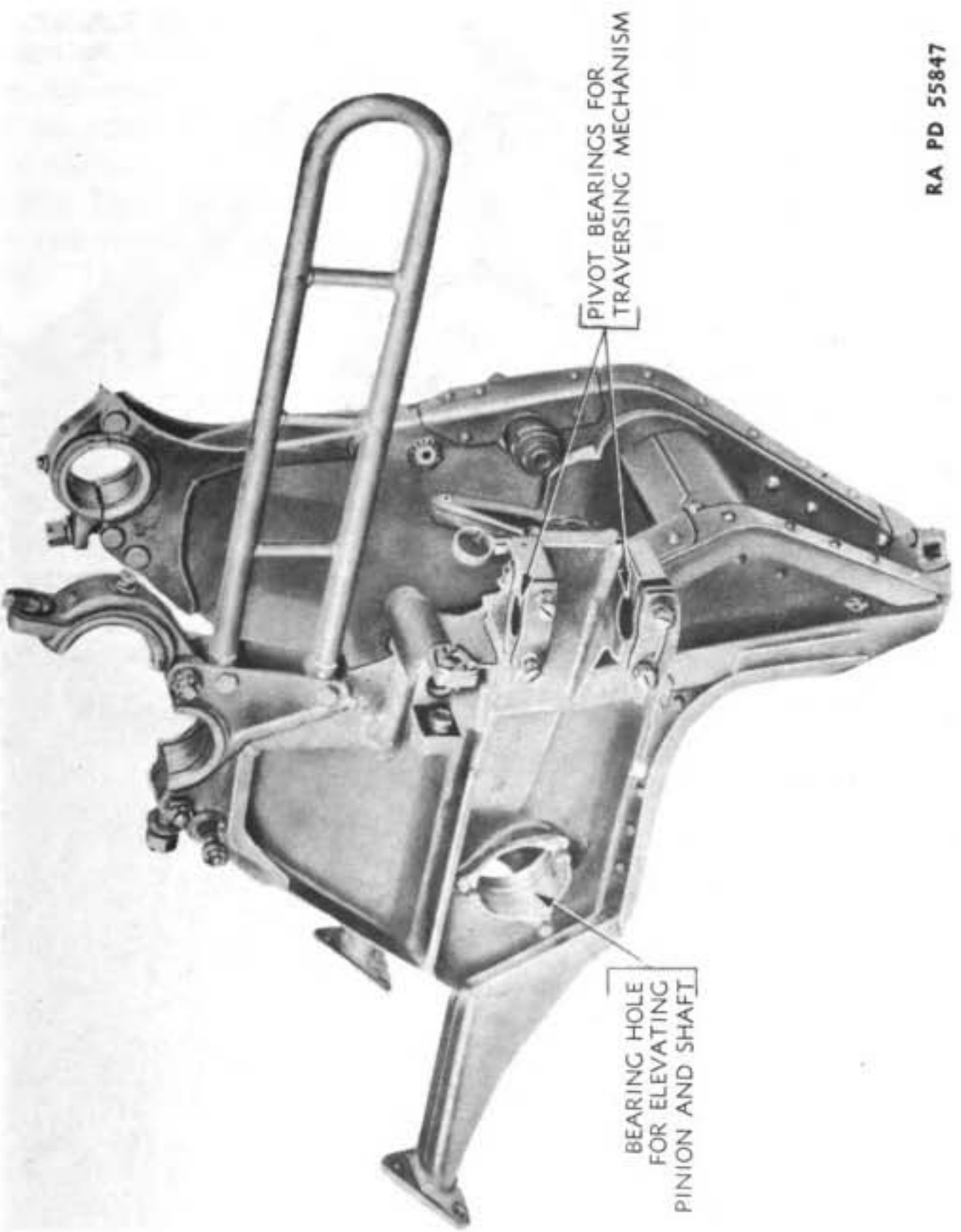


Figure 17—Top Carriage—Left Side

GERMAN 105-MM HOWITZER MATERIEL

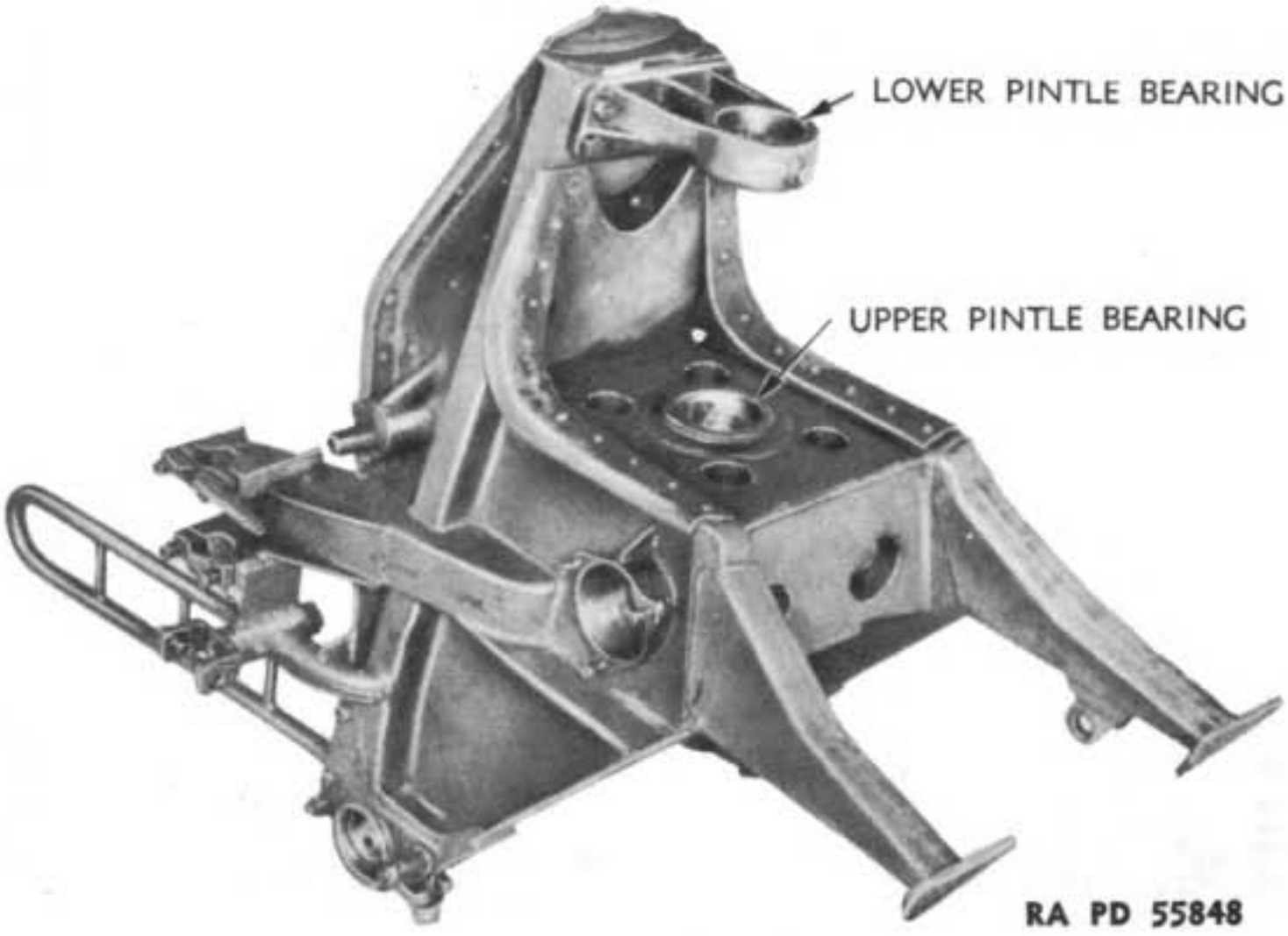


Figure 18—Top Carriage—View Showing Upper and Lower Pintle Bearings

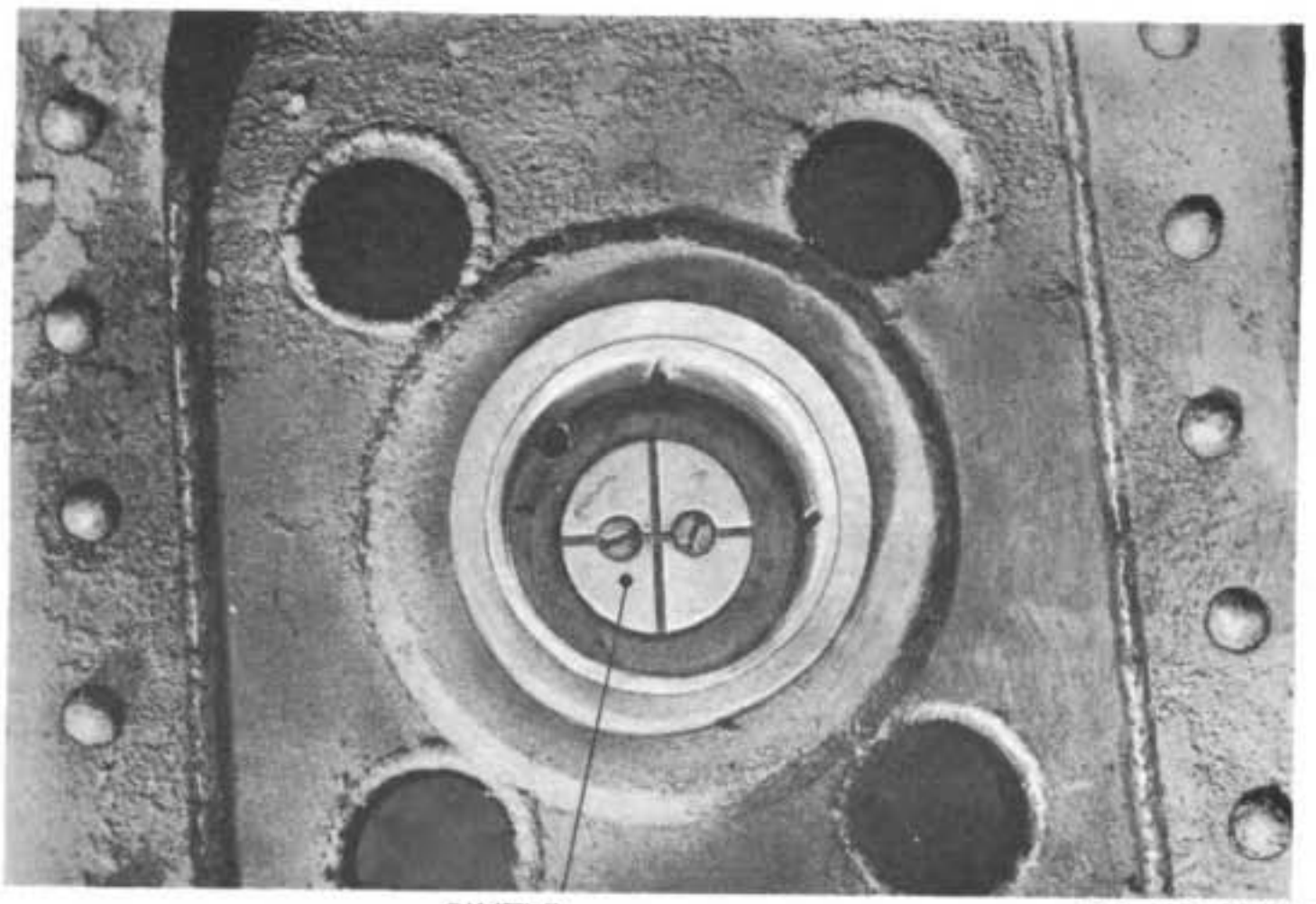


Figure 19—Upper Pintle Bearing—Pintle in Place

DESCRIPTION AND FUNCTIONING OF CARRIAGE

13. BOTTOM CARRIAGE.

a. The bottom carriage consists of the trail support, main axle, pintle, auxiliary axle, leaf springs, and the mechanism which changes the means by which the forces are transferred to the wheels.

b. The trail support pivots around the horizontal bearing attached to the center of the main axle. When the trails are spread, the movement of the trail support is limited to 6 degrees by replaceable lugs on the trail support striking projections on the main axle. The ends of the main axle are turned back to form stubs. The auxiliary axles are correspondingly formed, and they pivot around the ends of these stubs. The movement of the auxiliary axles are limited by projections on the auxiliary axle arm striking lugs on the stubs of the main axle (fig. 21).

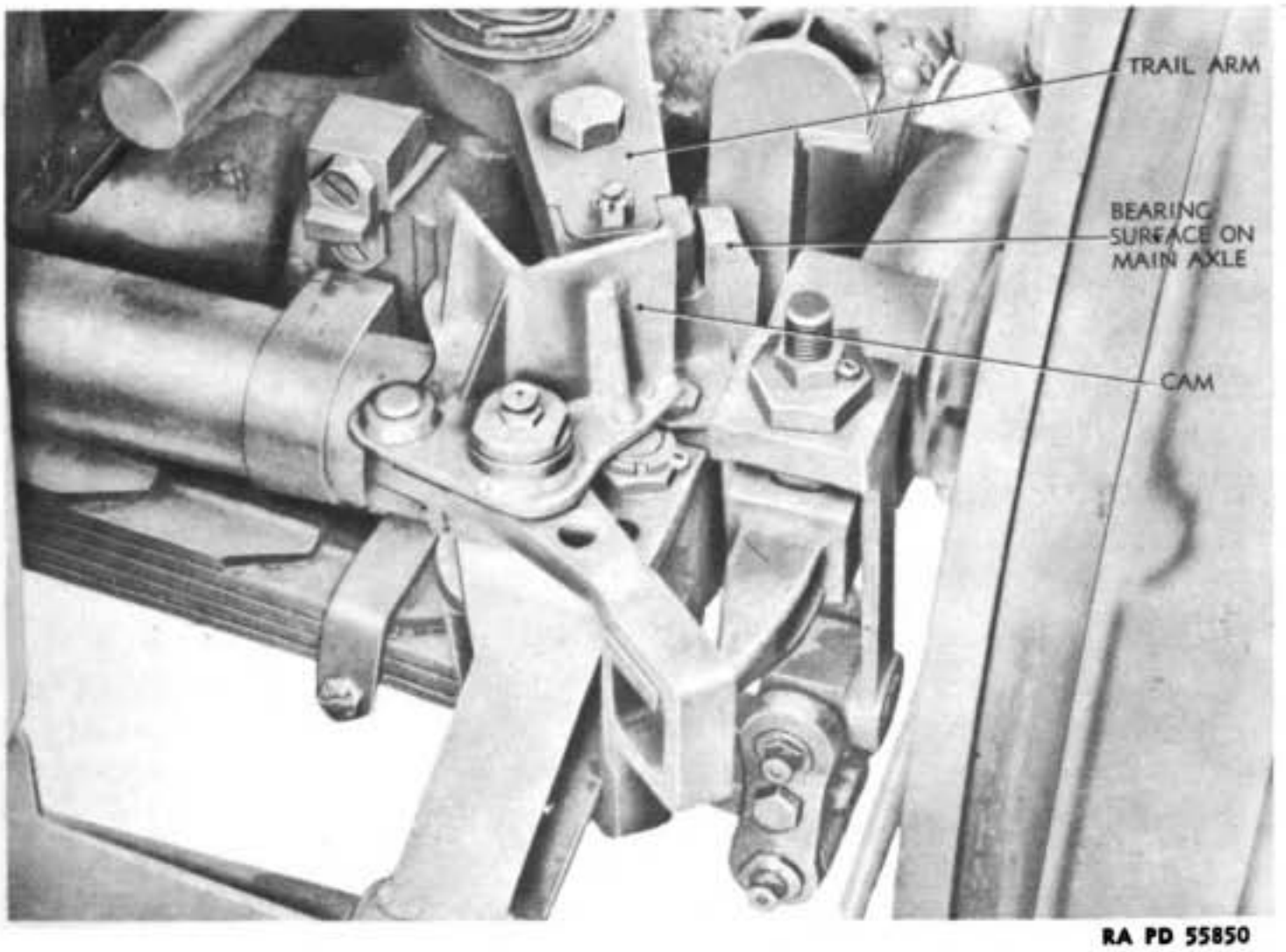


Figure 20—Position of Locking Mechanism—Trails Closed

c. When the trails are closed, the trail arm rotates a cam and contacts the bearing surface on the main axle. In this position the weight of the howitzer is transferred to the wheels by means of the leaf springs (fig. 20).

d. When the trails are opened, the trail arm rotates the cam in the opposite direction, causing the auxiliary axles to be locked to the main axles. Thus, the leaf springs are disengaged, and the weight of

GERMAN 105-MM HOWITZER MATERIEL

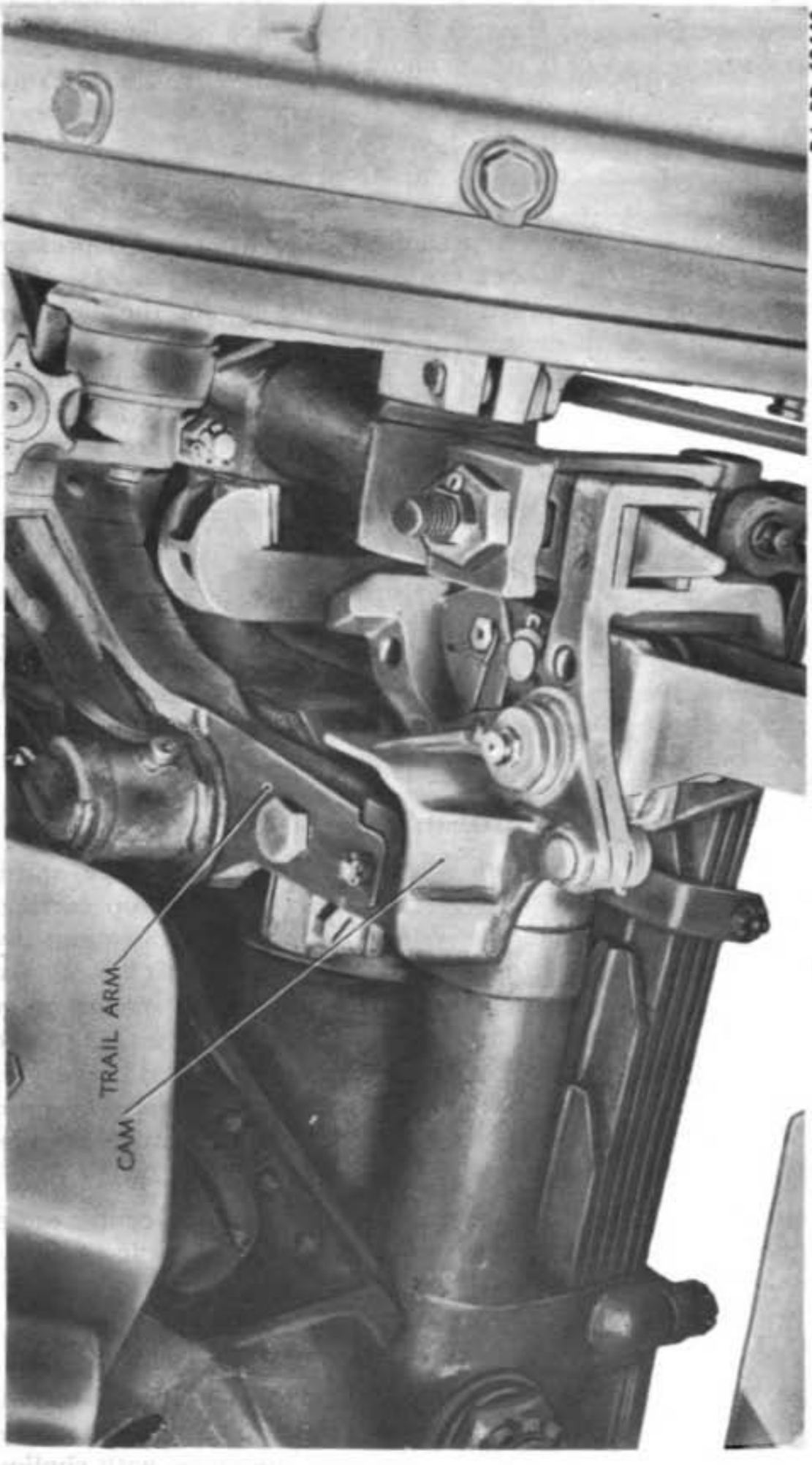


Figure 21—Position of Locking Mechanism—Trails Open

the howitzer is transferred directly to the wheels. Simultaneously, the trail arm is disengaged from its bearing surface on the main axle and the trail support is free to rotate about the main axle (fig. 21).

14. ELEVATING MECHANISM.

a. The elevating mechanism consists of a series of gears and single elevating arc bolted under the center of the cradle (fig. 23). The range of the mechanism is limited both in elevation and depression by the cradle striking the top carriage at points "B" (fig. 22). The elevating mechanism is completely inclosed except for the elevating arc and its pinion. The mechanism is designed to absorb the forces of recoil and counterrecoil by permitting a movement of the worm and wormwheel against Belleville springs. Provision is made for alining the worm and wormwheel, and for alining the bevel gears on the handwheel and intermediate shafts (figs. 23 and 24). The maximum elevation is 42 degrees, and the maximum depression is 6 degrees 30 minutes.

b. The elevation of the howitzer in traveling position is limited by a bracket on the cradle which strikes the spring loaded pins ("A," fig. 22). When the trails are open, the pins spring out into position shown and allow the cradle to reach maximum elevation. When the trails are closed, the flasks of the trails force the pins inward, and limits the elevation of the howitzer to 12 degrees 22 minutes.

15. TRAVERSING MECHANISM.

a. The traversing mechanism is of the screw-and-nut type, and is almost completely inclosed. Traverse is limited by the top carriage striking either trail flask. The traversing mechanism pivots about two points: the left trail pin and the rear of the top carriage (figs. 25 and 26.) The mechanism is held in the left trail pin by means of an interrupted collar, and to the top carriage by means of two split bearing caps (fig. 26). Traverse of the top carriage is obtained by varying the distance between these two points by means of the traversing screw. The limits of traverse are 28 degrees to the right and 28 degrees to the left.

b. Two indexing pointers are supplied for checking center alinement for the traveling position: one for the trails open, and one for the trails closed (figs. 37 and 38).

16. TRAILS.

a. The trail support carries a vertical pivot at each end for the trail arms. Underneath, it has a third and central pivot for the saddle. The trail arms are formed from deep channel pressings, with shallow channels riveted on to stiffen the open under side.

GERMAN 105-MM HOWITZER MATERIEL

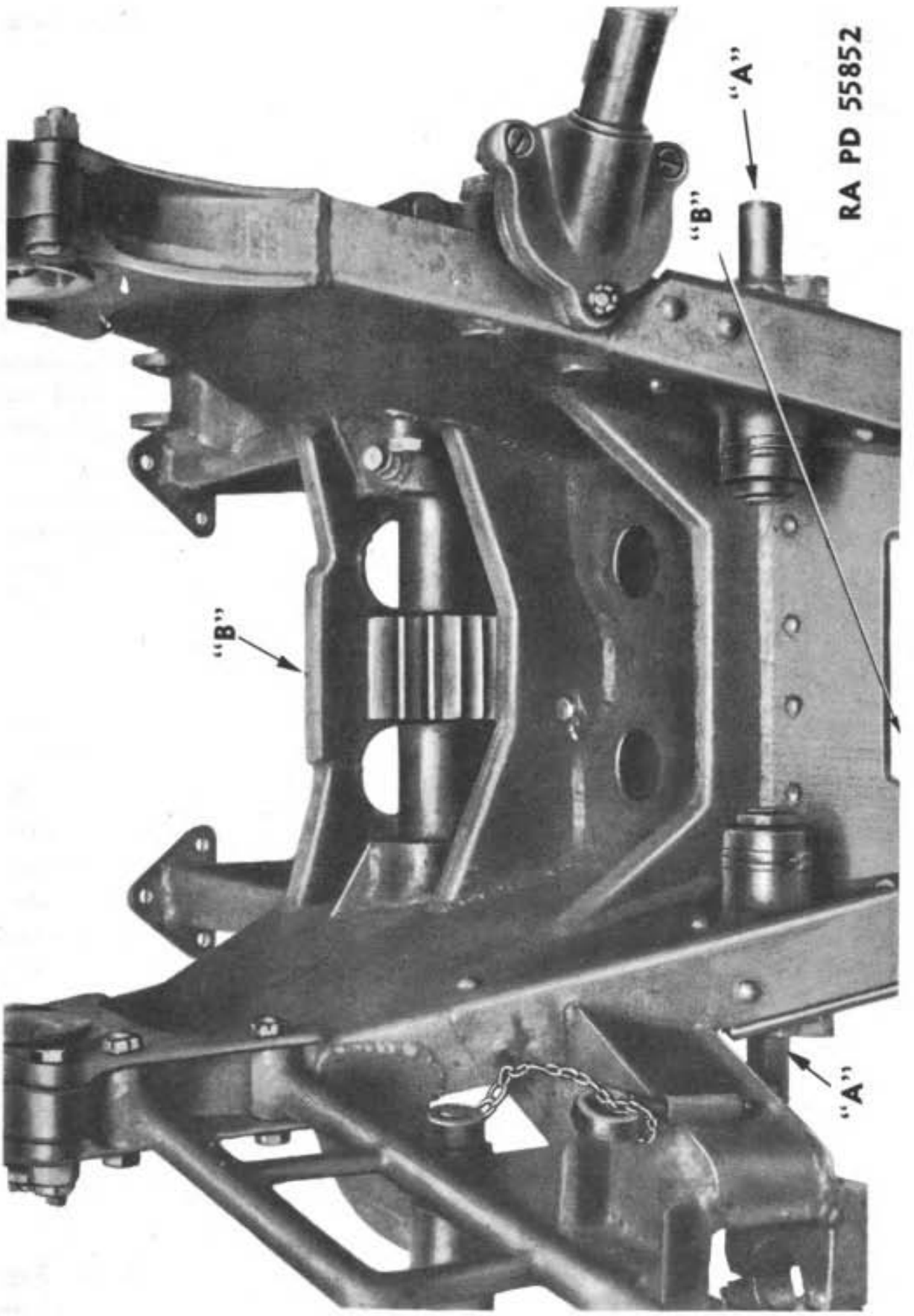


Figure 22—Top Carriage—Rear View

DESCRIPTION AND FUNCTIONING OF CARRIAGE

b. The jaw of the trail hinge is on the trail; a steel sleeve fits in the bushing in the body and acts as a distance piece between the jaws. The hinge bolt passes through this and tightens the jaws on to it, not on to the body. The extensions for locking the articulation are on the upper halves of the jaws. These operate a mechanism which disengages the leaf springs for firing when the trails are opened.

17. SPADES.

a. The trails are provided with two sets of spades: soft ground spades and hard ground spades. The soft ground spades are permanently attached to the trails and can be folded back over the trails. The hard ground spades are plates on the trail ends.

b. The soft ground spades (fig. 32) are of a welded construction except for the tips, which are riveted in place. Trail hand spikes and handles are provided for moving the spades into position, and for swinging the trail into position. The spades pivot about an eccentric bearing. The eccentric locks the spades in firing position by positioning a bar on the spades under two lugs on the trail. The eccentric is locked in position by a spring loaded pin in the operating handle engaging a locking hole on the trail. The spades are locked in position while folded back on the trails.

18. WHEELS AND BRAKES.

a. The wheels are of the fluted-disk type with solid rubber tires. The tires are an integral part of a rim which is bolted to the wheels.

b. The brakes are operated from one lever located on the right side of the carriage in front of the shield. A transverse bar transmits the motion of the lever to the left wheel. Straps are fitted so that the brakes may be applied or released from behind the shield. Extensions to these straps are provided so that the brakes may be operated from the limber or prime mover (figs. 27 and 28).

c. Each wheel brake is equipped with a means of adjustment to compensate for the wear of the brake lining. The adjusting mechanism is assembled in the brake mechanism. Brake adjustment is made by turning a small knob (fig. 28) located near the top of each brake drum.

19. DRAWBAR.

a. The drawbar is a welded component of the left trail. The lunette in the drawbar is too small to fit the pintle on an American prime mover. When it is desired to tow the piece with an American prime mover, improvise a method to connect the piece to the prime mover using whatever materials are available.

GERMAN 105-MM HOWITZER MATERIEL

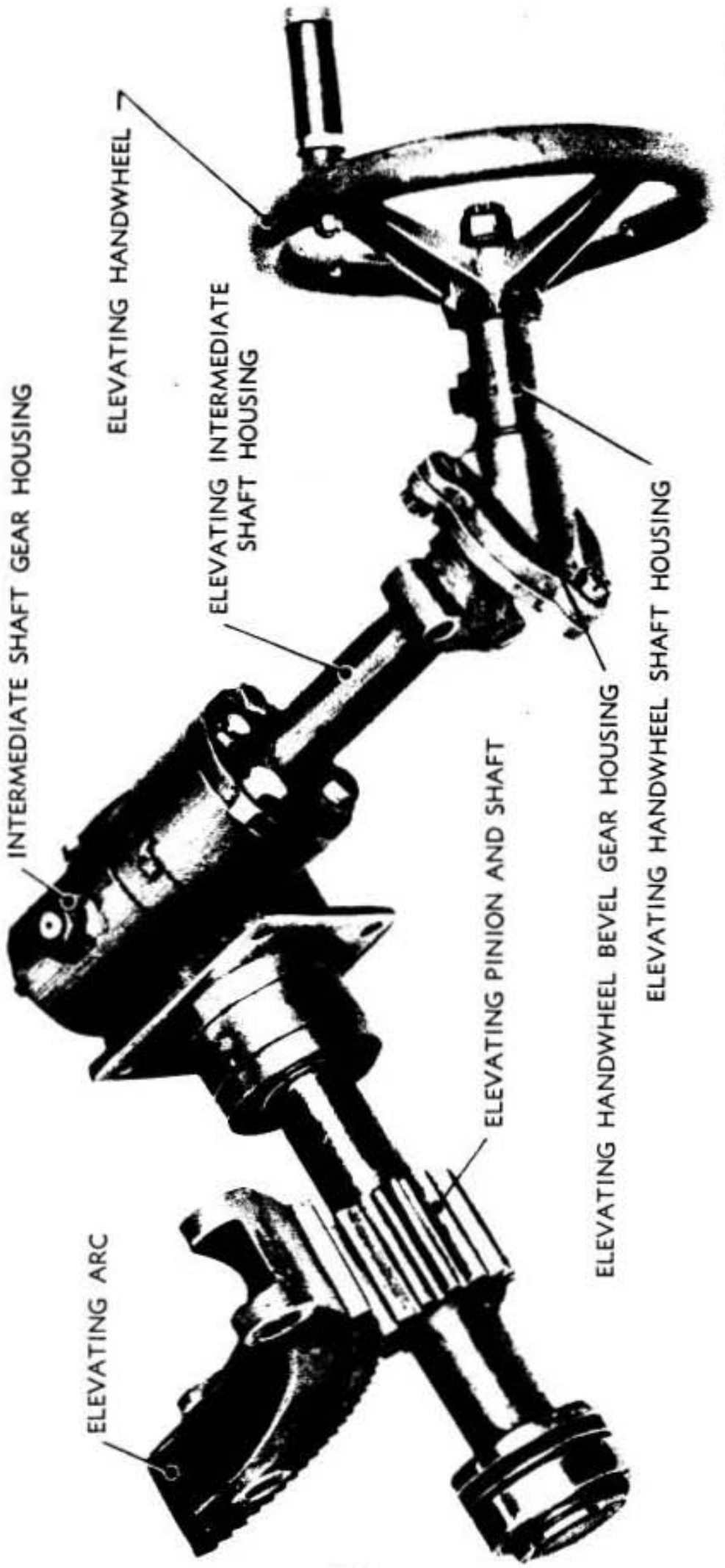


Figure 23—Elevating Mechanism

DESCRIPTION AND FUNCTIONING OF CARRIAGE

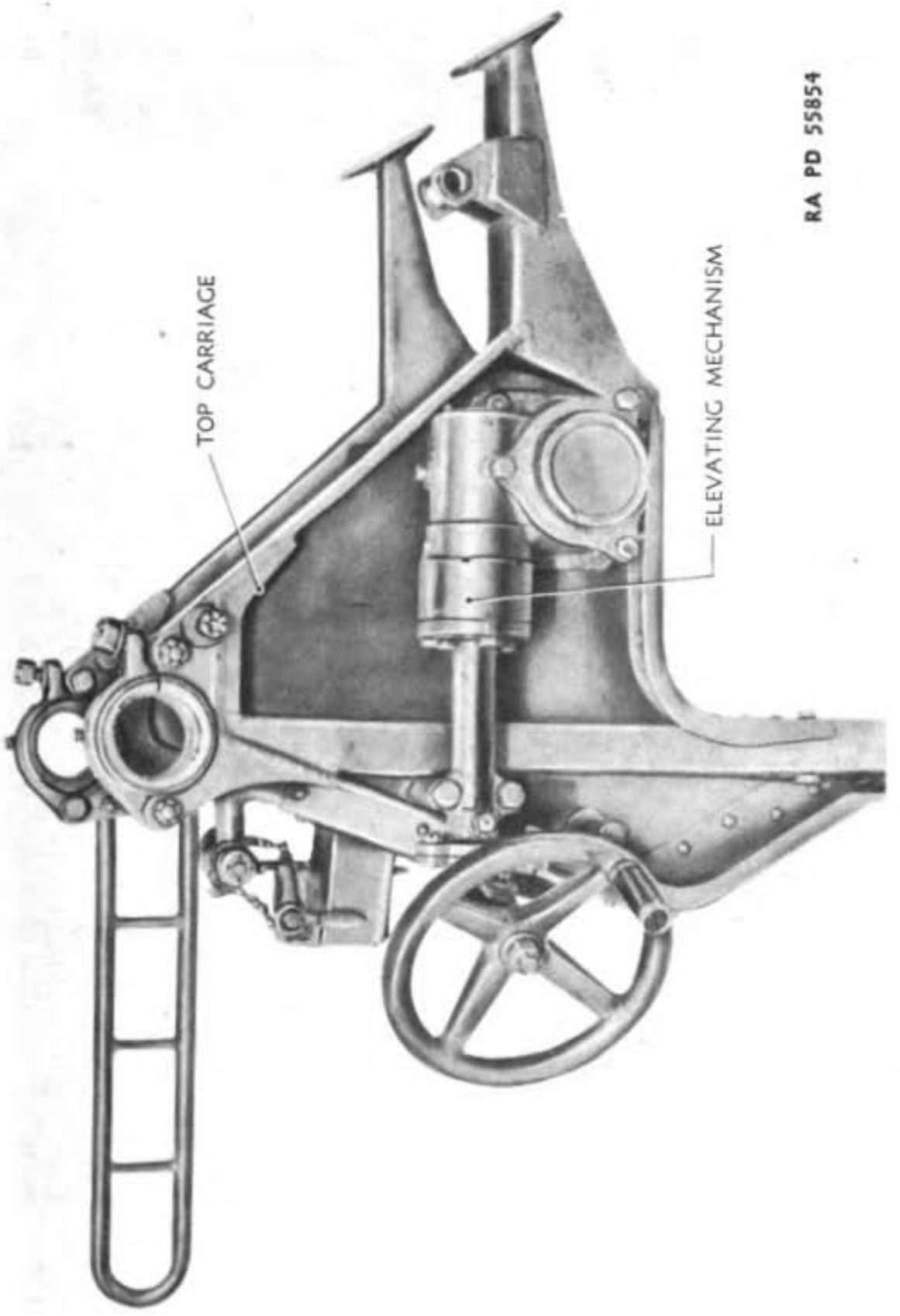
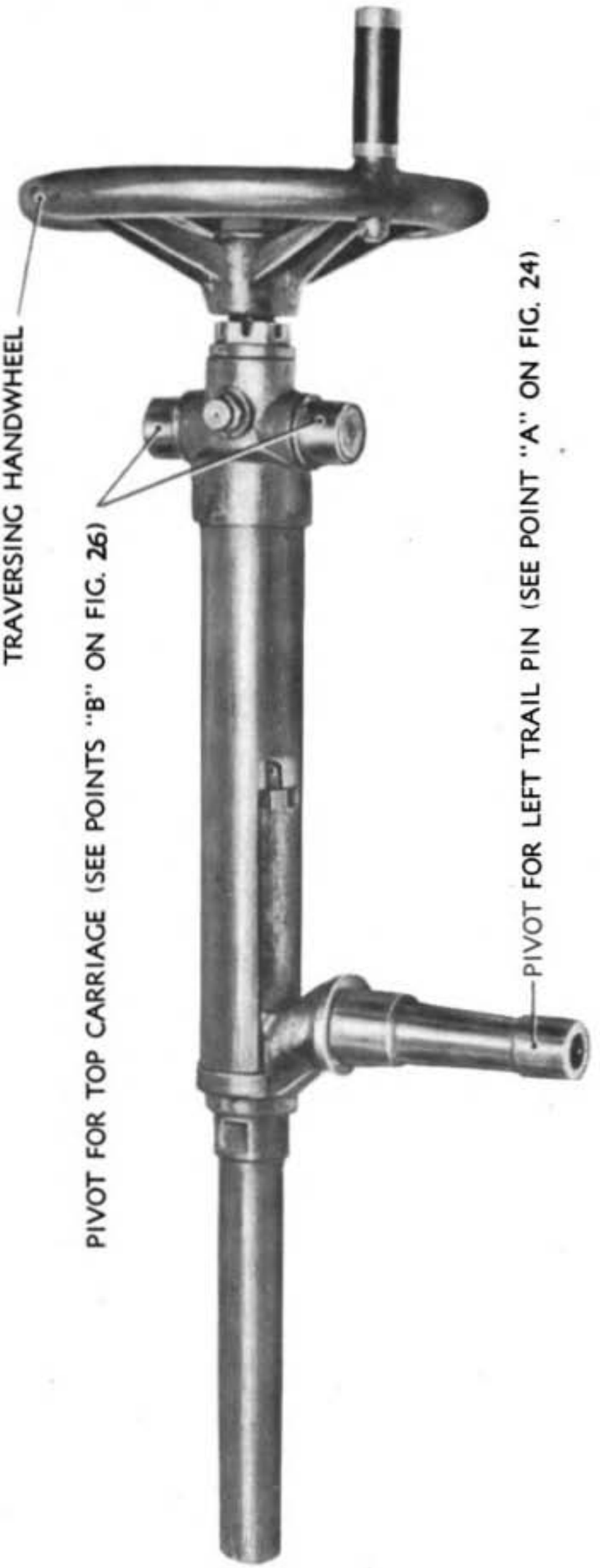


Figure 24—Elevating Mechanism Assembled to Top Carriage

GERMAN 105-MM HOWITZER MATERIEL



RA PD 55855

Figure 25—Traversing Mechanism

DESCRIPTION AND FUNCTIONING OF CARRIAGE

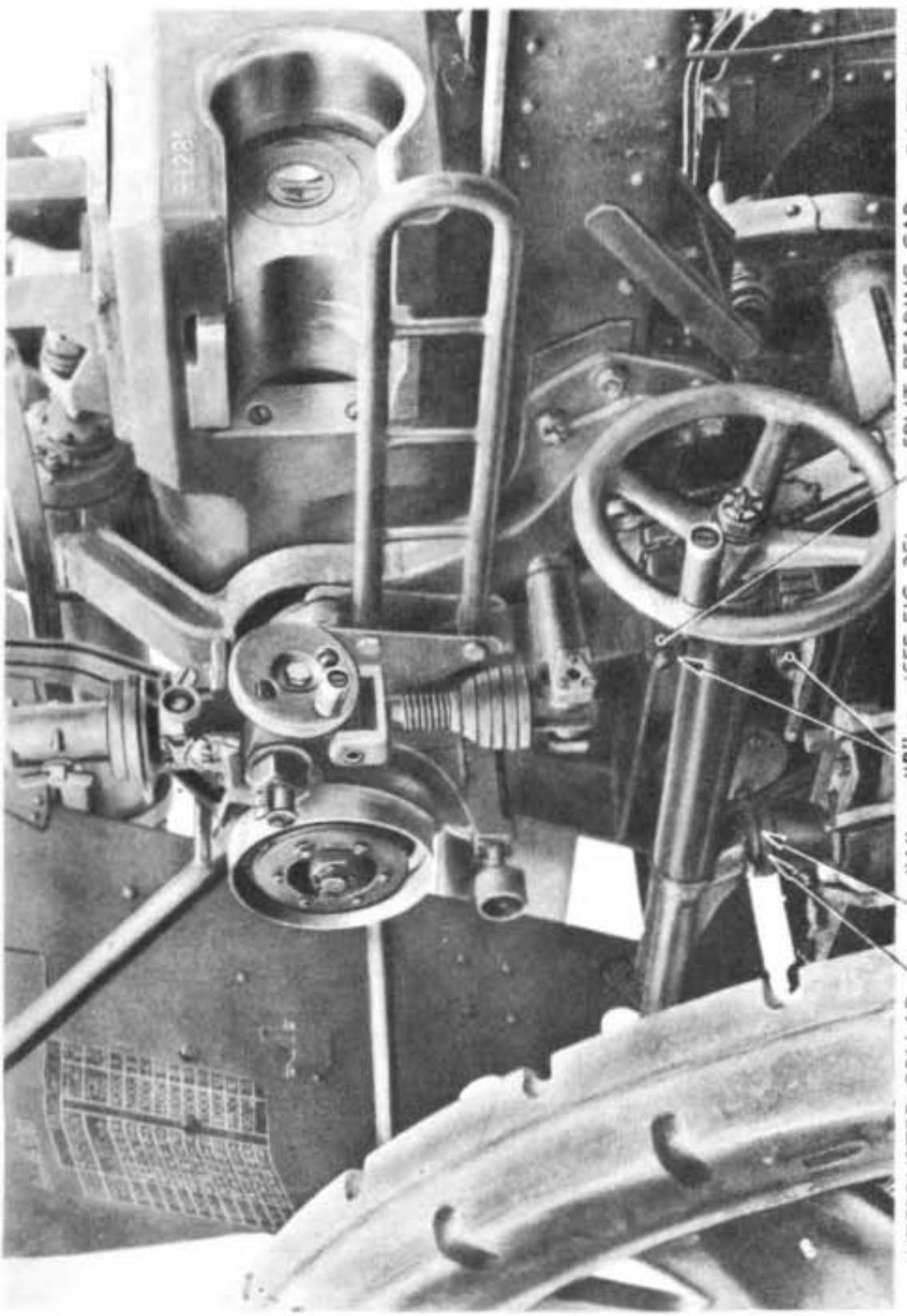
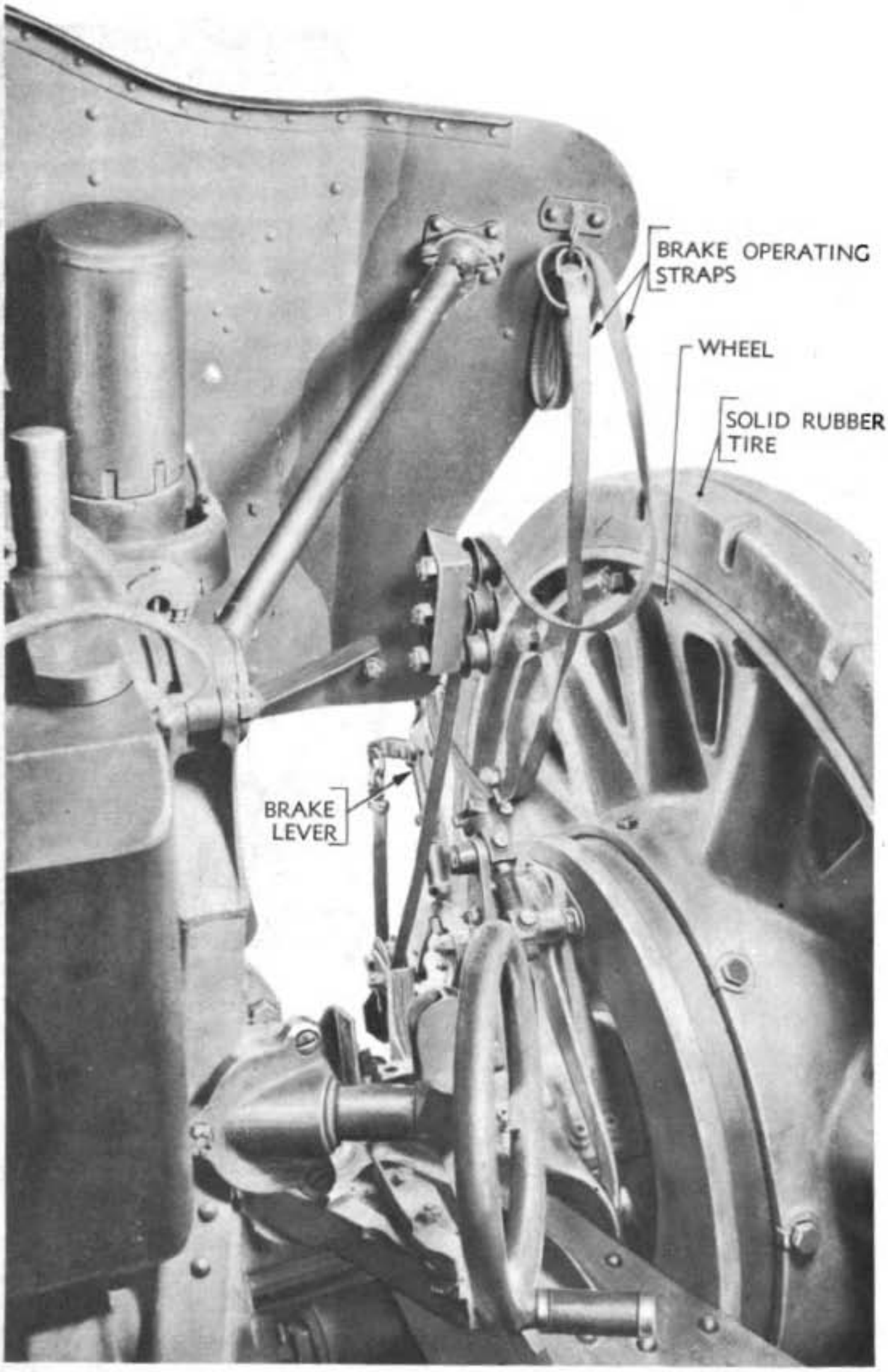


Figure 26—Traversing Mechanism Assembled to Howitzer Carriage

GERMAN 105-MM HOWITZER MATERIEL



RA PD 55858

Figure 27—Brake Straps—Rear View

DESCRIPTION AND FUNCTIONING OF CARRIAGE

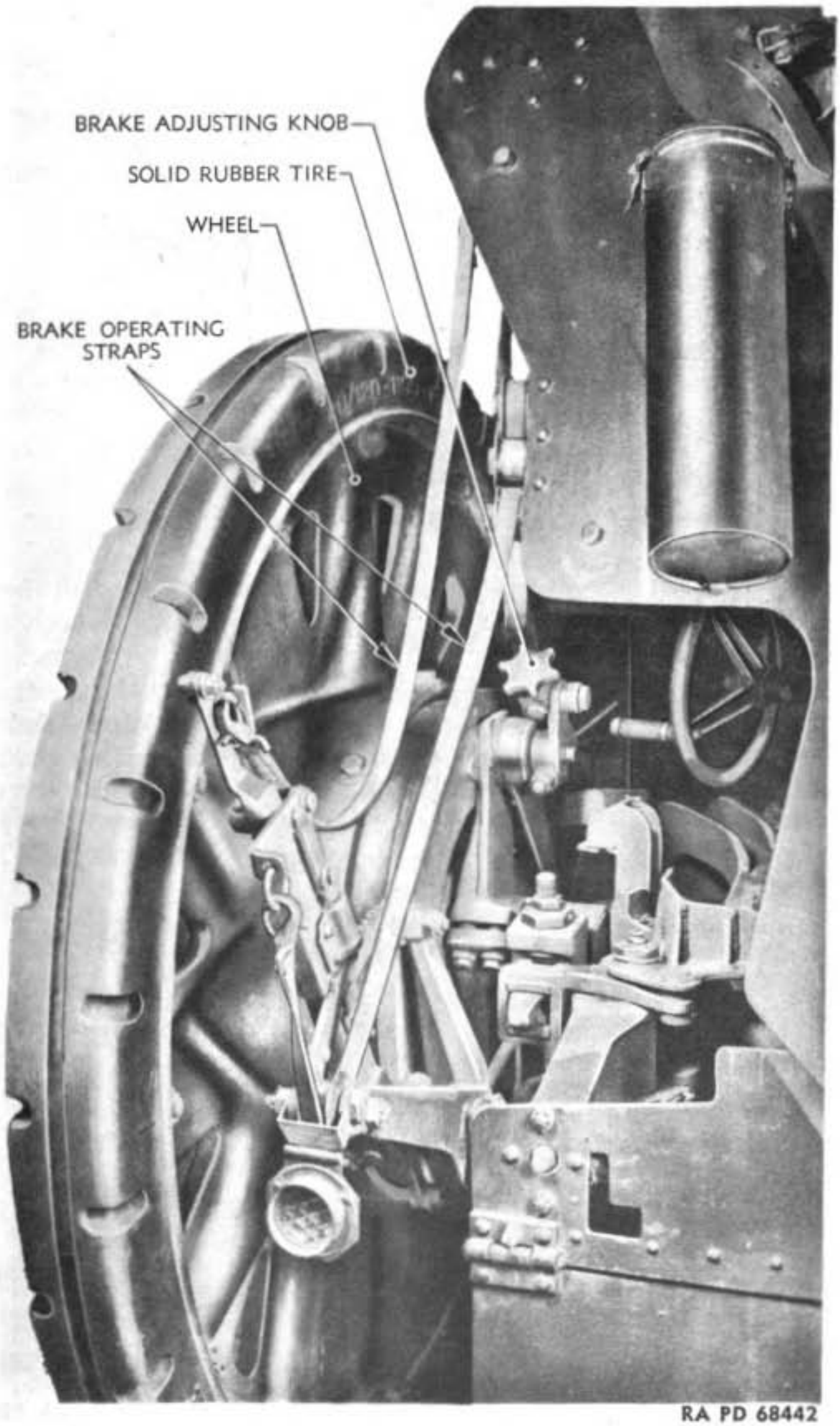


Figure 28—Brake Straps—Front View

GERMAN 105-MM HOWITZER MATERIEL

Section III

OPERATION

20. TO PLACE THE WEAPON IN FIRING POSITION.

a. Certain steps are necessary to place the weapon in firing position. They are, in order:

b. Disconnect the weapon from the prime mover.

c. Remove all covers and place them out of the way.

d. Disconnect the cradle traveling lock by raising the spring actuated knob (fig. 29) on the cradle traveling lock lever, and rotating the lever to the left. Swing the cross bar over to the right trail until the bar engages in its latch (fig. 30).

e. Release the trail traveling lock by rotating the trail locking lever (fig. 31) to the right, as viewed from the back of the trails, and then spread the trails fully until they are automatically locked in the open position.

f. Apply the brakes by pulling the strap connected to the brake lever, thereby pulling the brake lever toward the breech end of howitzer (figs. 27 and 28).

g. The hard ground spades need no adjustment. If the soft ground spades are required, pull out the spring actuated knobs, and rotate the spade locking levers toward the front of the carriage to release the spade locking mechanism (fig. 32). Lift the trails from the ground and swing the spades over the trail ends (fig. 33). Rotate the locking levers to the rear of the carriage and engage the plunger in its hole to lock the spades in position.

h. Set the safety lock in the FIRE ("Feuer") position (fig. 34).

21. TO TRAVERSE.

a. The traversing handwheel is located on the left side of the carriage. Rotate the handwheel clockwise for right traverse, and counterclockwise for left traverse (fig. 10).

22. TO ELEVATE.

a. The elevating handwheel is located on the right side of the carriage. Rotate the handwheel counterclockwise for elevation, and clockwise for depression (fig. 10).

23. TO OPERATE THE BREECH MECHANISM.

a. To Open (fig. 34). Grasp the breechblock operating lever and release the operating lever latch by squeezing the lever latch trigger. Swing the operating lever to the right and rear until the breechblock is fully open.

OPERATION

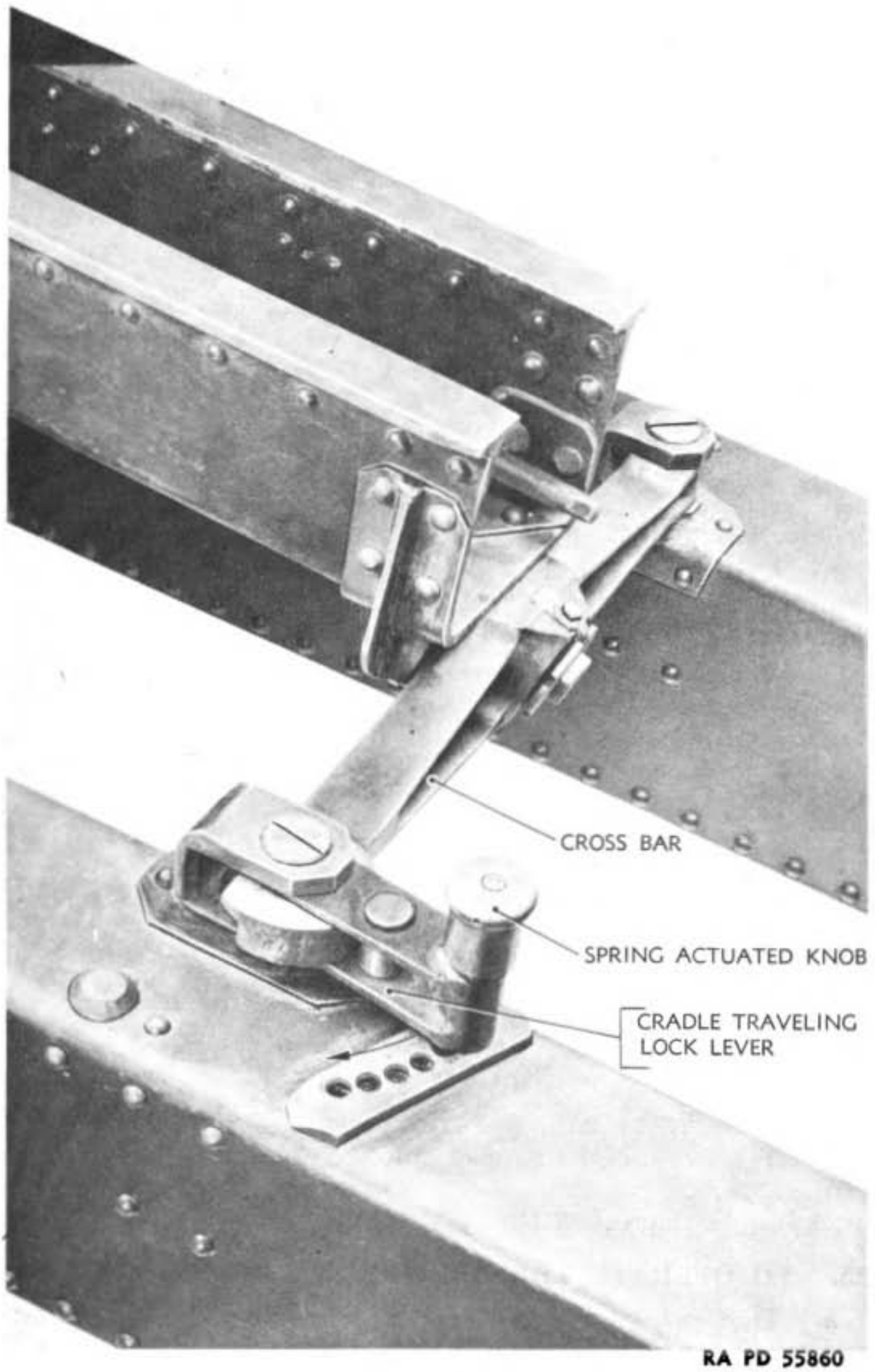


Figure 29—Cradle Traveling Lock

GERMAN 105-MM HOWITZER MATERIEL

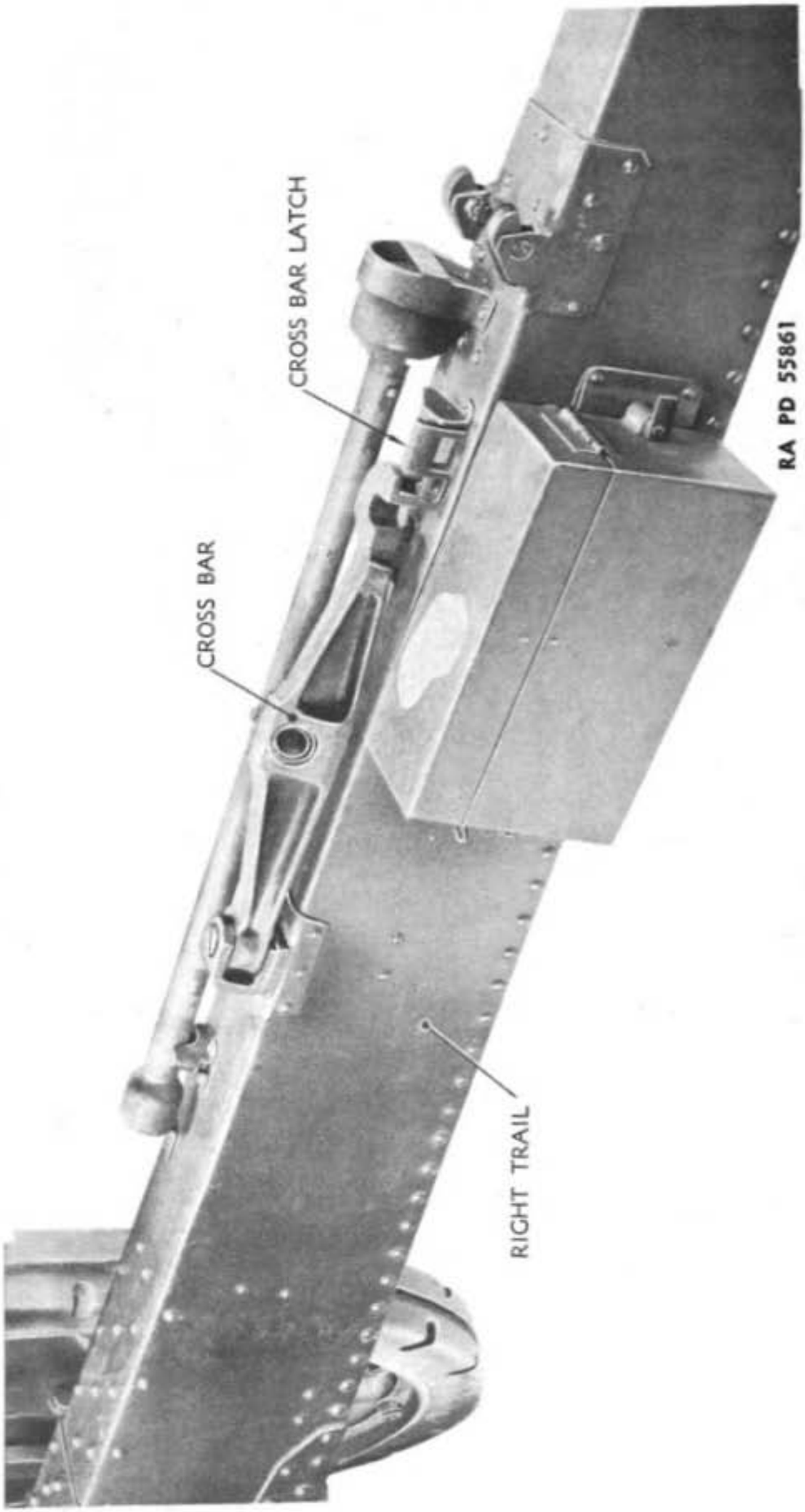


Figure 30—Cross Bar in Latched Position

OPERATION

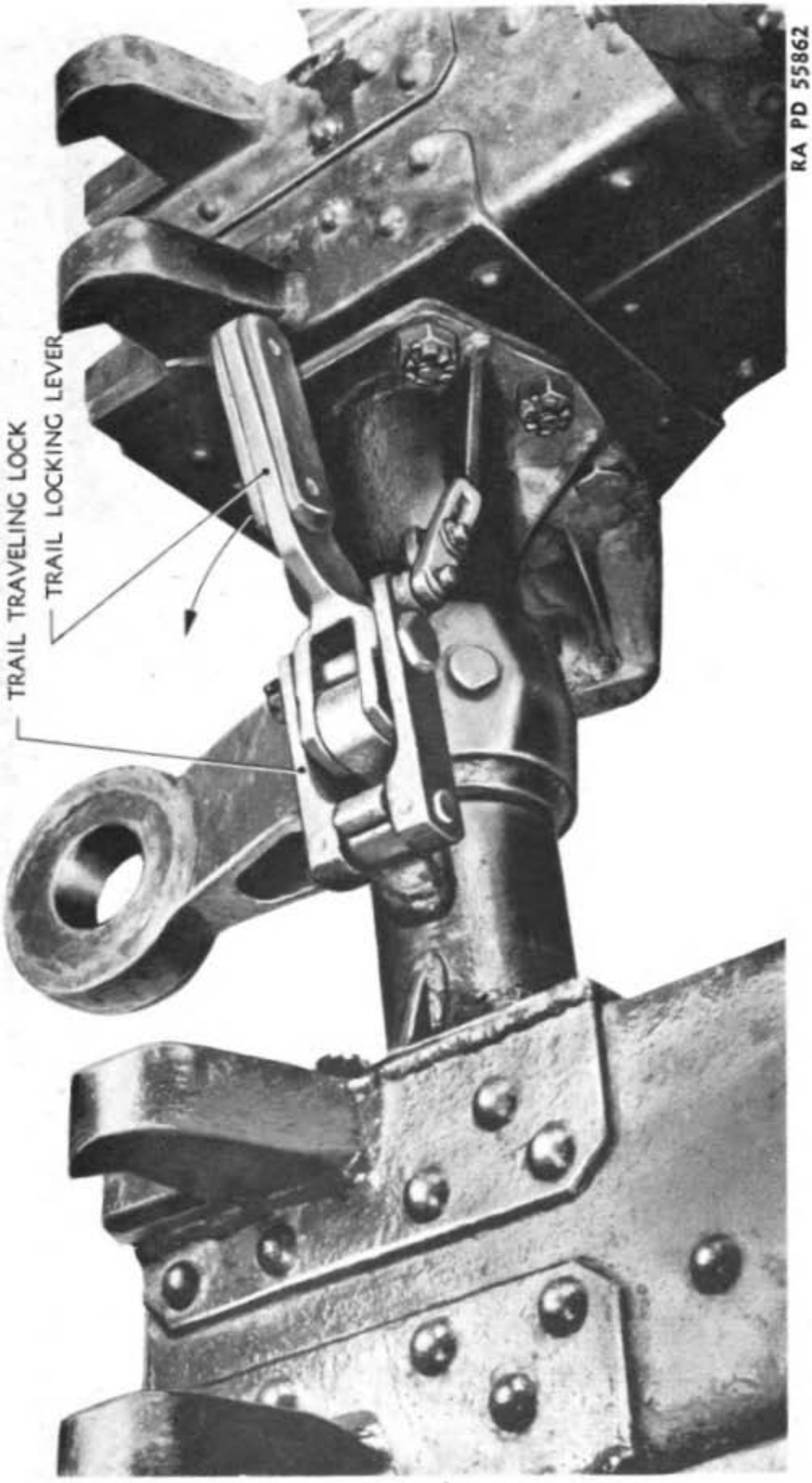


Figure 31—Trail Traveling Lock—Locked Position

GERMAN 105-MM HOWITZER MATERIEL

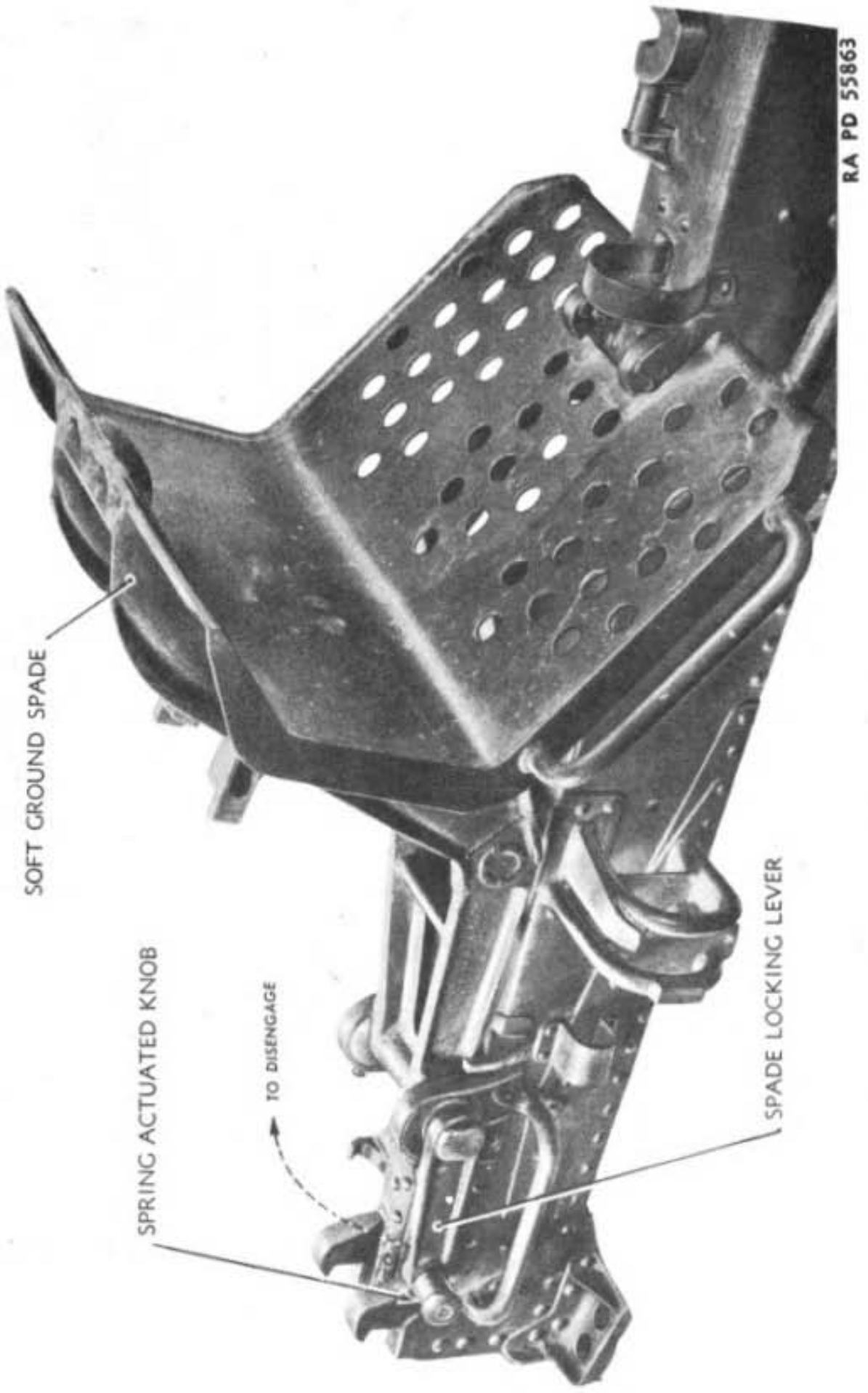


Figure 32—Spade Locking Mechanism Engaged—Traveling Position

OPERATION

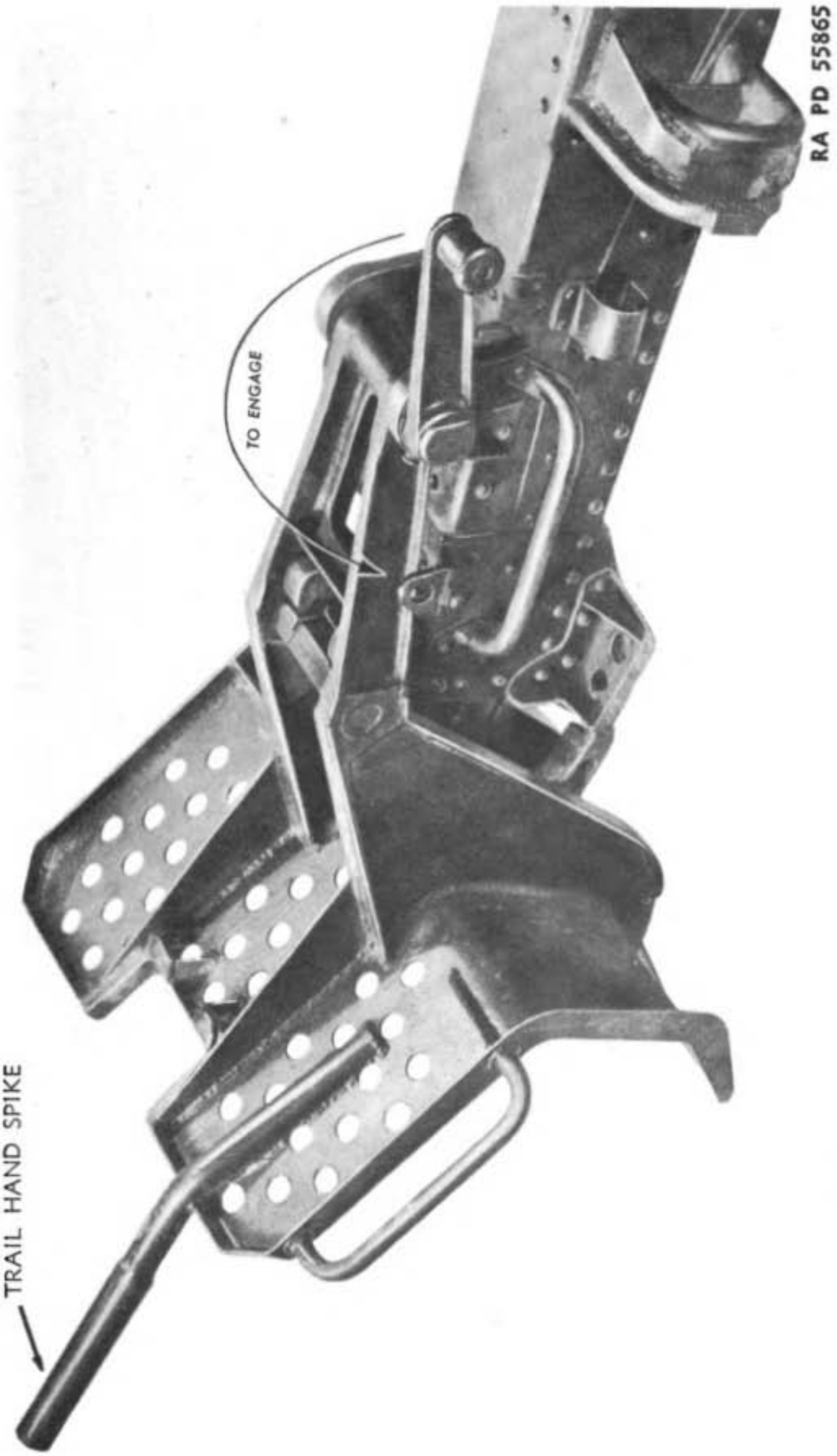


Figure 33—Spade Locking Mechanism Disengaged—Firing Position

GERMAN 105-MM HOWITZER MATERIEL

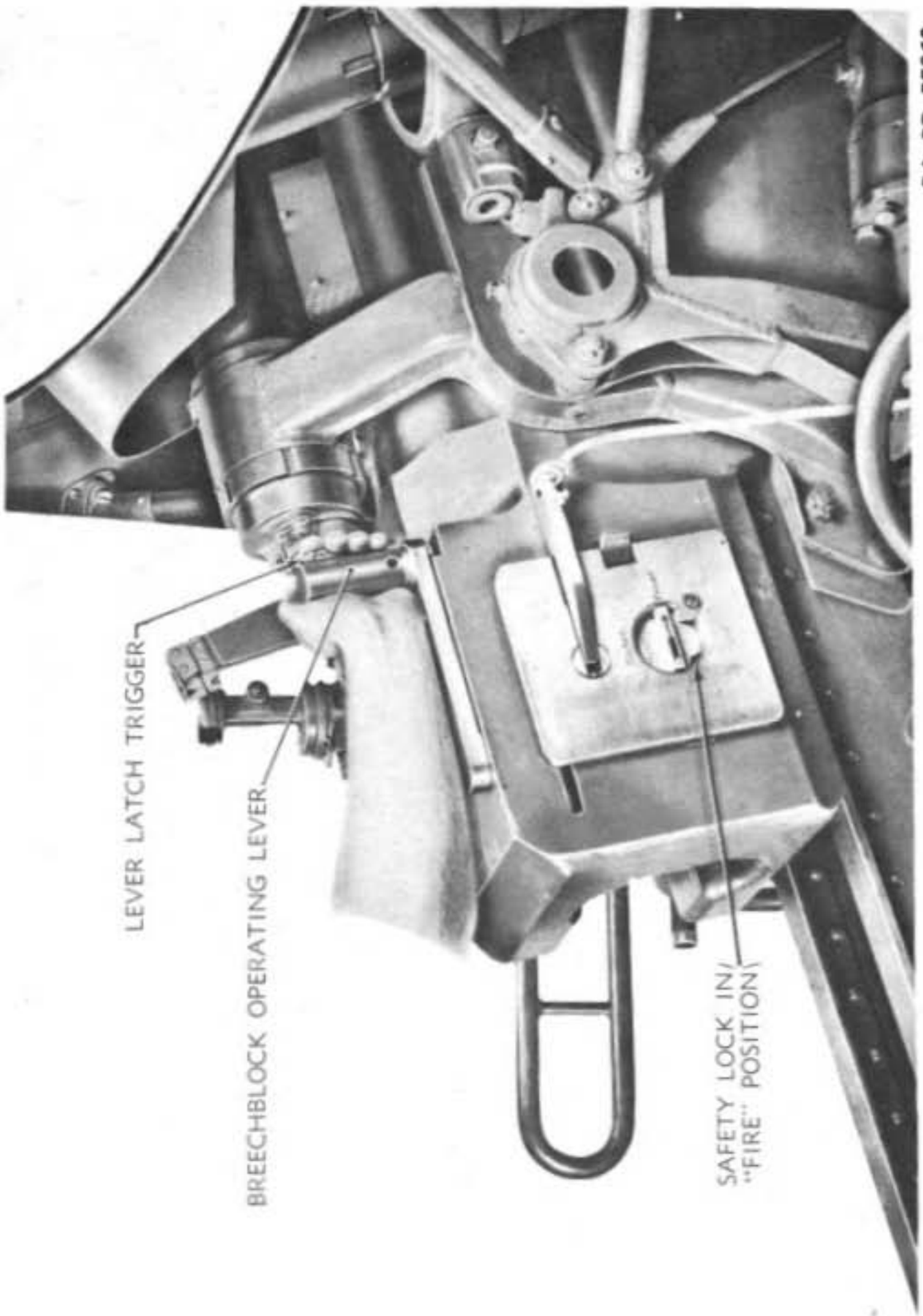


Figure 34—Opening Breech

OPERATION

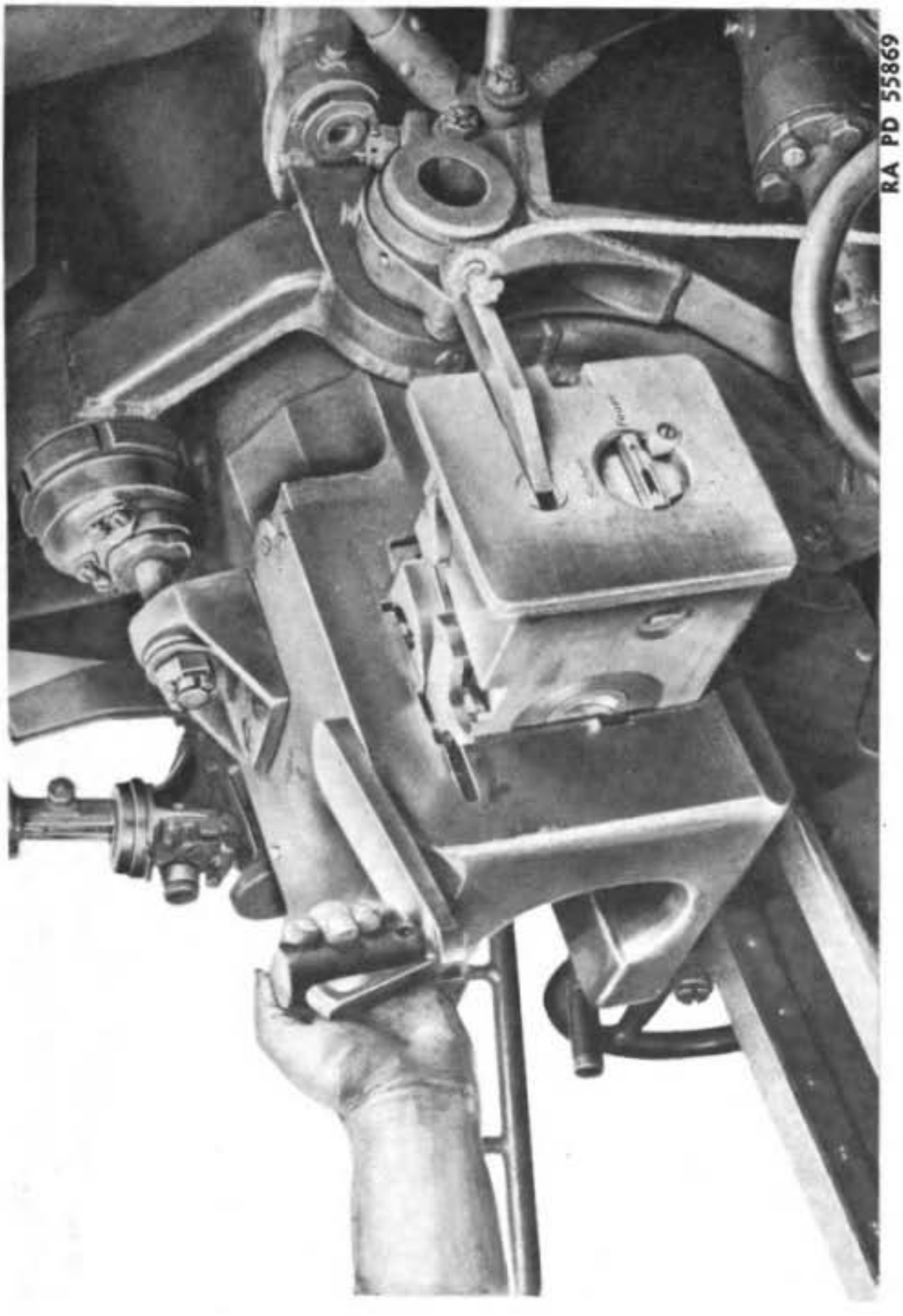


Figure 35—Closing Breech

b. To Close (fig. 35). With the breech open, grasp the breech-block operating lever and swing the operating lever to the front and left, until the operating lever engages its latch.

24. POINTS TO BE OBSERVED BEFORE FIRING.

a. Recuperator Cylinder. Before firing, the recuperator cylinder should be filled to the proper capacity with liquid, and charged to the correct air pressure (pars. 35 and 38). Examine the cylinder for leakage of liquid.

b. Recoil Cylinder. The recoil cylinder should be filled to the proper capacity with liquid (pars. 36 and 38). Examine the cylinder for leakage of liquid.

c. Equilibrator. The equilibrator should be filled to the proper capacity with liquid and charged to the correct air pressure (pars. 37 and 38). Examine cylinder for leakage of liquid.

d. Lubrication. All points should be lubricated as prescribed in paragraph 29.

e. Tube. The bore should be swabbed out with solvent, using a bore sponge, and wiped dry with the sponge covered with burlap. The gunner should examine the bore to determine if perfectly clean. If not, the bore should be swabbed again with solvent, then a wire brush should be applied until dirt or rust has been removed. Repeat swabbing and wiping operations until bore is clean and ready for firing.

25. POINTS TO BE OBSERVED DURING FIRING.

a. *CAUTION: If the howitzer fails to fire when the lanyard is pulled, the following safety precautions must be observed:*

(1) Stand clear of the path of recoil.

(2) Keep the howitzer at firing elevation. Do not depress the piece.

(3) Keep the howitzer in traverse either on the target or on a safe place in the field of fire.

(4) The breech will not be opened until 30 seconds after the second unsuccessful attempt to fire the piece.

b. Recoil Mechanism. The action of the recoil mechanism should be noted, and the following operations checked:

(1) Howitzer recoils its prescribed distance of 43.3 inches (1,100 mm). Should the recoil approach $46\frac{1}{16}$ inches (1,170 mm), it may indicate that the recoil mechanism is out of order. This point is marked with a warning "Achtung" on the recoil indicator. A recoil length of $46\frac{7}{8}$ inches (1,190 mm) is also marked with a warning on the recoil indicator to stop firing "Feuerpause" (fig. 11).

(2) Howitzer returns into battery without shock.

OPERATION

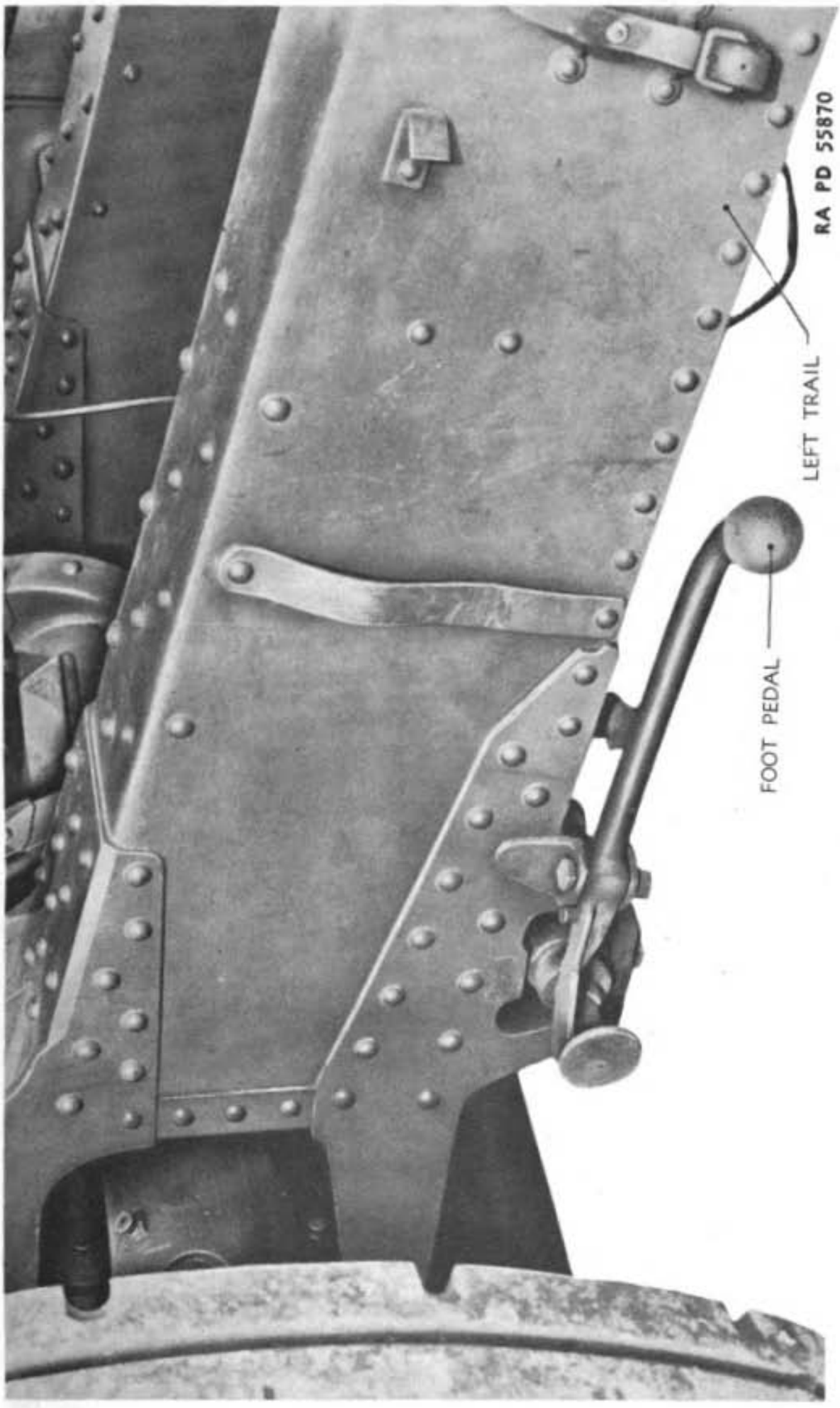


Figure 36—Trail Locking Mechanism

(3) Leakage of liquid from the filling holes at the front of the recoil cylinder.

26. TO LOAD.

a. The ammunition for this weapon is semifixed, and of a weight that can be handled entirely by hand. The complete round is rammed home into the breech recess of the howitzer and the breech is then closed.

27. TO FIRE.

a. Firing of the howitzer is accomplished by pulling the lanyard to the rear.

28. TO PLACE WEAPON IN TRAVELING POSITION.

a. The steps necessary to place the weapon in traveling position are as follows:

b. If the soft ground spades are used, pull out the spring actuated knobs and rotate the spade locking levers forward to release the spade locking mechanism. Lift the spades out of the ground by means of the hand spikes and swing the spades back onto the trails. Rotate the locking levers to the rear, and engage the plunger in its hole to lock the spades in position.

c. Release the brakes by pulling on the strap connected to the brake lever release, thereby allowing the brake lever to trip toward the muzzle end of the howitzer.

d. Release the trail locking mechanism by stepping on the foot pedal provided on the left trail (fig. 36). Should this fail to release the mechanism, the trails and trail locking mechanism will have to be shaken to get the mechanism to function.

e. Swing the trails into the closed position, and lock the trails together by rotating the trail locking lever to the left to engage trail traveling lock catch. Difficulty may be experienced when attempting to close the trails when the bottom carriage is spattered with mud and dust. This condition will not allow the cams to be disengaged from the arm (fig. 20). (See paragraph 31 for correction of this condition.) These parts, therefore, will have to be pried loose. A similar condition may exist should moisture be present and the parts freeze together.

f. Check the howitzer for center alinement in traverse as follows:

(1) With the trails closed, operate the traversing handwheel so that the indexing pointer on the top carriage is located over the indexing pointer on the outside of the left trail (fig. 37).

(2) If the trails are open, the left edge of the indexing pointer on the top carriage should be alined with the right edge of the indexing pointer on the inner side of the left trail (fig. 38).

OPERATION

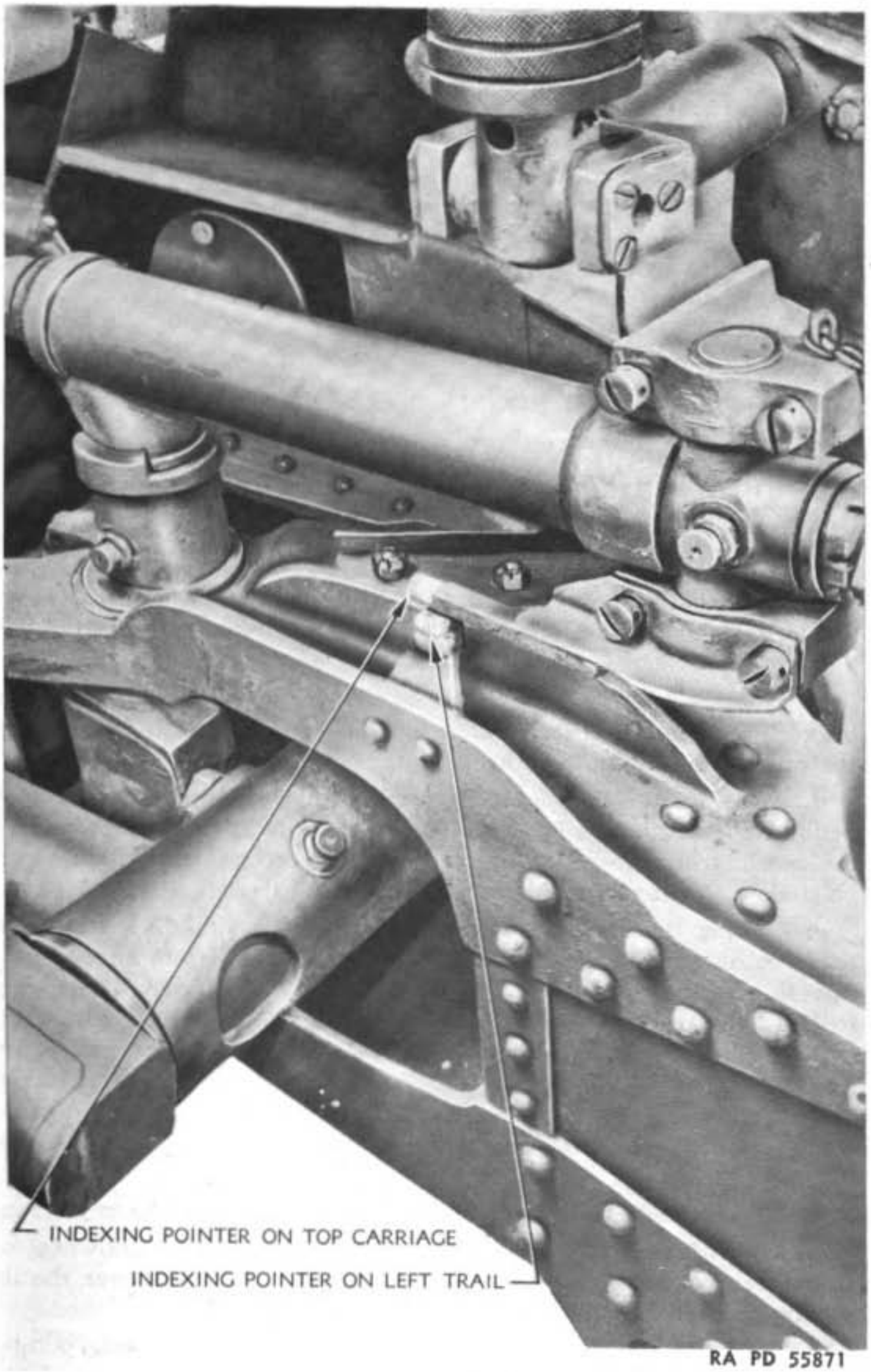
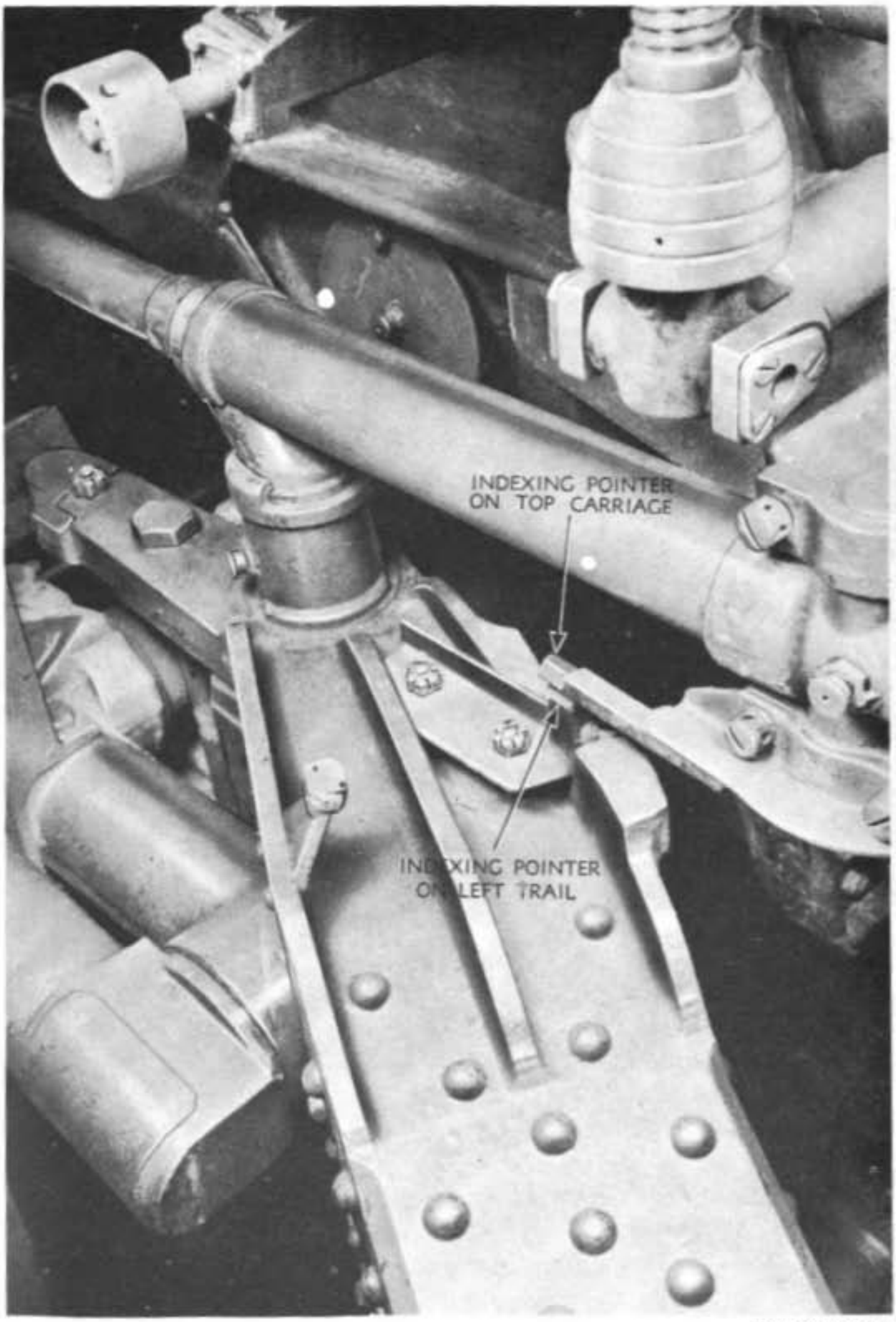


Figure 37—Indexing Pointers—Trails Closed

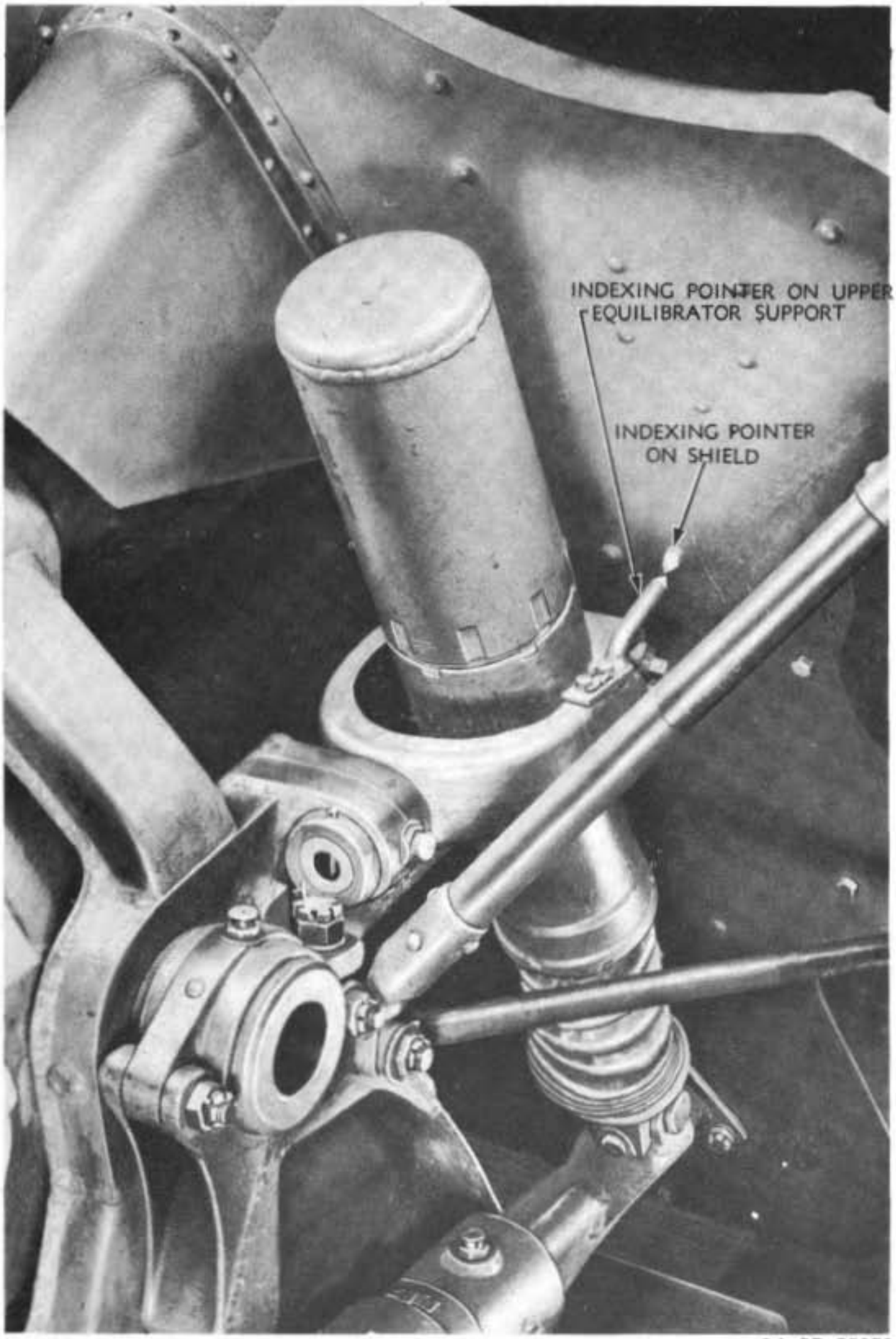
GERMAN 105-MM HOWITZER MATERIEL



RA PD 55872

Figure 38—Indexing Pointers—Trails Open

OPERATION



RA PD 55873

Figure 39—Elevation Indexing Pointers

GERMAN 105-MM HOWITZER MATERIEL

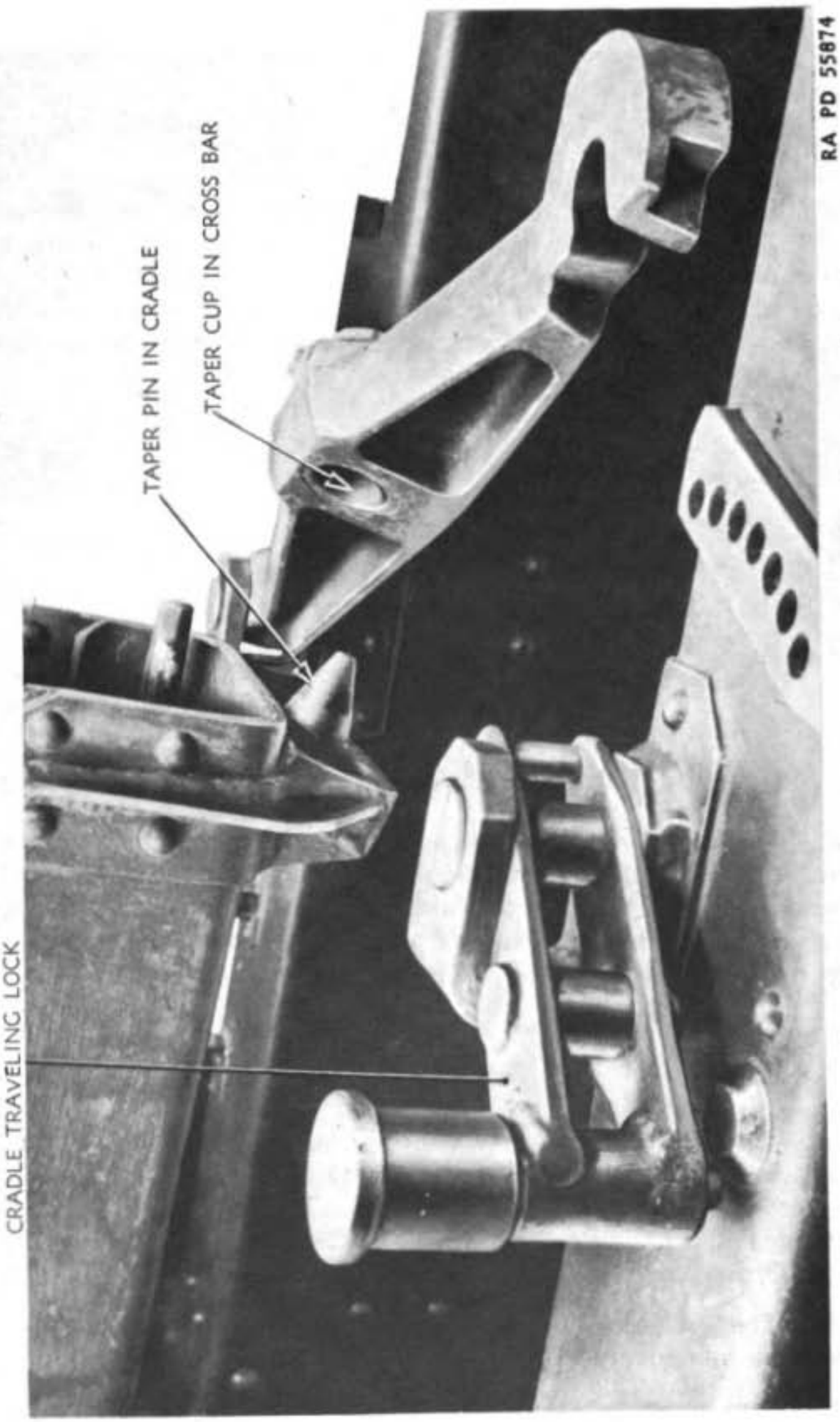


Figure 40—Engaging Cradle Traveling Lock

g. Bring the howitzer to proper elevation by matching the indicator on the upper equilibrator support with the indicator on the shield (fig. 39).

h. Subparagraphs **f** and **g**, above, should bring the taper pin (fig. 40) at the rear of the cradle in line with the taper cup in the cross bar of the cradle traveling lock. Release the cross bar latch (fig. 30), and swing the cross bar toward the left trail. Make sure the taper pin of the cradle fits into the cup in the cross bar (fig. 40). Engage the cradle traveling lock by raising the spring actuated knob on the cradle traveling lock lever, and rotating the lever counterclockwise, allowing the plunger to engage its hole. Seven holes are provided for the plunger, the one nearest the right trail is the one normally used, although any one of the others will secure the cradle rigidly enough for traveling.

i. Replace all covers.

Section IV

LUBRICATION

29. LUBRICATION INSTRUCTIONS.

a. Excessive wear can be prevented by keeping the materiel clean and well lubricated. The life of the howitzer and carriage depends very largely on proper lubrication. Particular attention should be given to sliding and bearing surfaces of the slide bearing and breech mechanism.

b. Lubricants, oils, and greases shown in the lubrication guide must be used as prescribed.

c. Oilholes and similar lubricating fittings should be marked with a circle about three-quarters inch in diameter painted with gloss red synthetic enamel, in order that they may be readily located. ***NOTE:*** ***Do not paint the fittings themselves.*** For replacement, American Ordnance lubricating fittings are interchangeable with German fittings. Ordnance lubricating devices fit German lubricating fittings.

d. The oil gun should be worked slowly, and the parts oiled should be maneuvered to insure proper distribution of the lubricant.

e. Care must be taken when cleaning oil and grease compartments to insure the complete removal of all residue or sediment. Dirt or other foreign matter should not be allowed to drop into any of the lubricating compartments.

f. Operating personnel are cautioned when cleaning the howitzer to refrain from playing water from either a normal pressure or a high pressure hose directly against the trunnion bearings, since this will result in water entering into the bearings causing malfunctions of the operating parts.

g. Lubrication frequencies are based on continuous use of the materiel with frequent firing.

Section V

CARE AND PRESERVATION

30. GENERAL.

a. It is of vital importance that all parts of the materiel be kept in proper operating condition in order that the weapon may be ready for immediate service. The proper use of tools, accessories, and lubricating, cleaning, and preserving materials provided with the howitzer and carriage will enable personnel to keep the materiel in proper working condition.

b. Proper lubrication, with lubricants and intervals prescribed in paragraph 29, is essential to the care and preservation of the weapon. Examination should be made periodically to insure that lubricants are reaching the parts for which they are intended.

c. The howitzer, carriage, and sighting equipment covers should be used when traveling, or when the howitzer is not in service.

d. In disassembly, assembly, and inspection, extreme care must be exercised to prevent dust, dirt, and other foreign matter from entering the mechanisms of the howitzer and carriage.

e. All spare parts, tools, and accessories should be kept in an orderly manner in the chests and containers provided, so that they can be quickly located when required. Items which are susceptible to rust or corrosion must be cleaned thoroughly after use and coated with a film of oil.

f. If the howitzer has been under fire, it must be determined that the weapon has not been damaged to a dangerous degree before further use of the howitzer. Damage of a serious nature must be reported to Ordnance maintenance personnel.

31. HOWITZER.

a. Tube.

(1) Immediately after firing, clean the bore to insure complete removal of powder residue and primer salts. Under no circumstances

will the howitzer remain without cleaning after it has been fired. Swab the bore with a cleaning solution of one-half pound of soda ash to each gallon of water. Rinse with clean warm water. After drying thoroughly with burlap, a film of engine oil (SAE 30 above + 32 degrees F, SAE 10 from + 32 degrees to 0 degrees F), or light preservative lubricating oil below 0 degrees, will be applied with clean dry burlap. If soda ash is not available, a soap sponging solution will be prepared by dissolving 1 pound of castile soap in 4 gallons of water. If castile soap is not available, issue soap may be used as a substitute. The soap should be shaved from the bar to facilitate dissolving. It should then be added to the water and the water heated until the soap is dissolved. The water should be stirred as quietly as possible to prevent foaming. To avoid the necessity of handling large receptacles, as much soap as is required for all the water to be used can be dissolved in one pail of water. This concentrated soap solution can then be added to water in other receptacles to make up the prescribed proportions. Special precautions must be taken to rinse the bore thoroughly before drying, if issue soap is used in the solution, because of the possibility of soap leaving a gummy residue, and of corrosion from the presence of free caustic in the soap. In an emergency, water alone, preferably hot, may be used for cleaning. The cleaning process will be repeated daily for 3 days or more, until there is no longer any evidence of sweating. A uniform gray appearance is indicative of a clean bore.

(2) Daily, clean out the bore by thoroughly wiping with clean burlap or wiping cloths, and oiling the bore with the grade of engine oil prescribed for the bore in paragraph 29.

(3) Before firing, wipe the bore with clean dry burlap or wiping cloths, to insure that it is clean and dry.

(4) During firing, whenever the rate of fire permits, examine the bore for powder fouling.

(5) The cleaning of a cold howitzer tube after firing cannot be accomplished, normally, at temperatures below + 32 degrees F, because the water in the cleaning solution will freeze in the tube. If cleaning can be done with the tube hot, and hot water is available, it may be possible to use the normal soda ash or other cleaning solutions. Otherwise, it will be necessary to add denatured alcohol, or as emergency alternative, grade A glycerine, or antifreeze compound. To ten parts by volume of cleaning solution, add the number of parts of one of the antifreeze solutions listed below. If it is not possible to mix a cleaning solution with an antifreeze solution as indicated below, the bore may be cleaned with dry-cleaning solvent. This should be done only in an emergency since it is not very effective as a cleaning solution.

GERMAN 105-MM HOWITZER MATERIEL

Temperature, Degrees F.	Alcohol	or	Glycerine	or	Antifreeze Compound
20	2		2½		2
10	4		5		3⅓
0	6½		6½		5
–15	9		10		7¼
–30	16		13		10
–40	27		16		12

32. BREECH AND FIRING MECHANISM.

a. Breech Mechanism.

(1) The breech mechanism should be kept clean and the parts well lubricated with engine oil. Since no provision is made for lubricating the breech mechanism, it is necessary to disassemble, clean, and lubricate the mechanism when it is in use, and always after firing periods. When not in use, it should be disassembled daily and lubricated to prevent rusting. Dry-cleaning solvent is issued for cleaning purposes and may be applied with a cloth or brush.

(2) A steel hammer must never be used directly on any part of the mechanism. A hardwood block buffer should be interposed, or a copper or plastic hammer or bronze drift used.

(3) Constant care must be taken to detect any cutting or abrasions on the breechblock and breech recess. If the mechanism does not operate smoothly, it should be disassembled and inspected. Scoring or bruising should be reported to Ordnance maintenance personnel.

(4) Whenever possible, the breech should be kept covered to protect it from dust and grit.

b. Firing Mechanism. The parts require the same attention as the breech mechanism. Frequent disassembly, therefore, for the purpose of cleaning and oiling is required.

33. CARRIAGE.

a. Attention should be given to cleaning, lubricating, and loose or broken parts. Lubrication, with the method and frequency of application, is carried in detail in paragraph 29.

b. The carriage should be given a general inspection daily or weekly.

34. FLUIDS USED IN HOWITZER CARRIAGE.

a. It is recommended that solutions of:

(1) 70 percent antifreeze compound (ethylene type) plus 30 percent water be used in the recoil cylinder.

CARE AND PRESERVATION

(2) 75 percent antifreeze compound (ethylene type) plus 25 percent water be used in the recuperator cylinder.

(3) 87 percent U.S.P. glycerine plus 13 percent water be used in the equilibrator cylinder.

(4) 100 percent water be used in the cooling cylinder of the recoil mechanism.

35. FILLING AND CHARGING THE RECUPERATOR CYLINDER.

CAUTION: Air or nitrogen may be used in charging the recuperator system or the equilibrator. Under no circumstances will oxygen be used.

a. Nitrogen, hydrogen, oxygen, helium, and carbon dioxide are supplied in similar high pressure cylinders. These cylinders are $9\frac{1}{16}$ inches in diameter and $56\frac{3}{16}$ inches high, including the cap. *NOTE: Nitrogen may also be issued in cylinders 8 inches in diameter and $76\frac{5}{8}$ inches high, including the cap.* Acetylene gas is supplied in cylinders $12\frac{1}{4}$ inches in diameter and 41 inches high. Although the cylinders are marked and tagged at the supply point, the tag may be lost and the markings obliterated in transit. Errors in tagging, marking, or filling of a supply cylinder may result in serious damage to equipment and injury to personnel.

b. Valves of nitrogen cylinders have special round metric threads on the outlet. Apply flexible gas filling tube to the valve to see if the threads match. Screw the fitting on by hand. Do not force. If the threads do not fit by hand application, the supply cylinder does not contain nitrogen.

c. Even though the threads on the valve do fit the threads on the flexible gas filling tube, the contents of the supply cylinder still may not be nitrogen because of an error in filling. To make certain that the contents are nitrogen proceed as follows:

(1) Open the supply cylinder valve momentarily to blow out any dirt or moisture. *CAUTION: If the valve turns white or becomes very cold, the gas is carbon dioxide and should not be used.*

(2) Place the mouth of a small balloon over the valve opening and slowly fill it to a diameter of about 1 foot.

(3) Shut off the valve. Twist or pinch the neck of the balloon to prevent the escape of gas. Remove the balloon from the valve, and away from ammunition, oil, fuels, or other inflammable material. Then, with the aid of an assistant, continue.

(4) Tie the neck of the balloon with a piece of light string. Cautiously release the balloon. If it rises, it contains either hydrogen or

helium. *NOTE: If the balloon walls are heavy, or if it is not inflated to good size, it may not rise even though one of these gases is inside.*

(5) Have the assistant hold a lighted cigarette, with a pair of pliers, about 1 inch from the balloon mouth. Unite the balloon neck and hold it so the gas will blow against the cigarette. Do not hold the cigarette in the hand. Note the reaction when the gas comes in contact with the burning end of the cigarette.

(a) If the escaping gas makes the cigarette glow intensely and then burst into flame, the gas is oxygen and should not be used in recoil mechanisms and equilibrators.

(b) If the escaping gas catches on fire, it is hydrogen.

(c) If the force of the escaping gas tends to make the cigarette glow slightly at first, and continued exposure extinguishes the cigarette, it is nitrogen.

(d) Helium will extinguish a cigarette in the same manner as nitrogen. However, buoyancy of the gas filled balloon (subpar. **c** (4)) above, will identify the gas as helium.

(e) If the escaping gas produces a yellow smoky flame, it is acetylene.

d. Acetylene gas in cylinders is under pressure not exceeding 150 pounds. If it is compressed more than 150 pounds, it is likely to explode spontaneously. It cannot be forced into recoil mechanisms and equilibrators because of this low pressure. Therefore, if it is attached to a recoil mechanism or equilibrator, the gas may back up into the acetylene cylinder and cause it to explode with serious results.

e. Oxygen is especially dangerous to use in recoil mechanisms and equilibrators. If a balloon is not available for determining the type of gas in the supply cylinder, the following test will determine whether the cylinder contains oxygen.

(1) Place an open, clean container, such as a bucket or large open-top can, in a convenient location near the supply cylinder. Fill it with water.

(2) Place a smaller can or bottle (1-pt to 1-qt capacity) in the water. Allow it to fill and sink. Grasp the bottom of the small container and hold it with the mouth down.

(3) Insert the end of the flexible filling tube into the water, in such a position that it is just below, or inside, the mouth of the small container.

(4) Have the assistant open the valve of the supply cylinder so that the gas emerging from the end of the tube will bubble up inside the small container and displace the water.

CARE AND PRESERVATION

(5) When all the water has been forced out, shut off the valve and place one hand over the open mouth of the small container to hold in the gas to be tested.

(6) Remove the small container filled with gas to a safe place.

(7) Hold the mouth of the container down. Remove the hand from the mouth, and immediately, but slowly, insert a long glowing splinter of wood, held with pliers, into the gas.

(a) If the splinter bursts into flame or glows intensely, the gas is oxygen.

(b) If the gas ignites and burns, or explodes with a pop, as the splinter enters the container, the gas is either hydrogen or acetylene.

NOTE: The purpose of inserting the glowing splinter immediately upon removing the hand is to make the test before the gas has had a chance to escape from the container. The purpose of inserting it slowly is to determine the reaction of the gas as the splinter enters the mouth of the container where the gas is mixed with air (plunging the splinter into the gas might extinguish the splinter even though the gas is combustible, because the gases must be mixed with air before they will burn).

f. If the supply cylinder does not contain nitrogen, tag the valve "NOT NITROGEN" and make a special report to the nearest Ordnance maintenance unit.

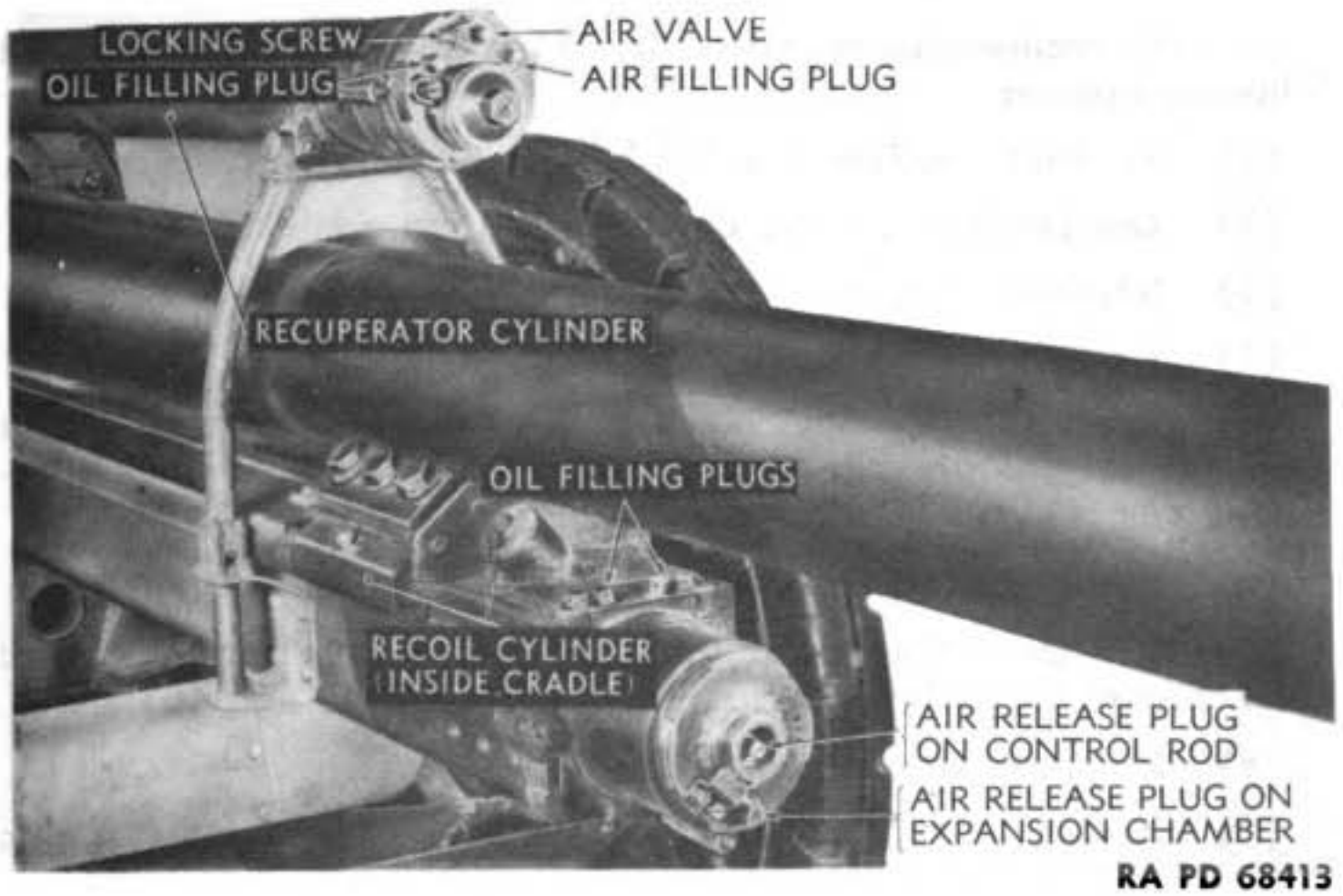
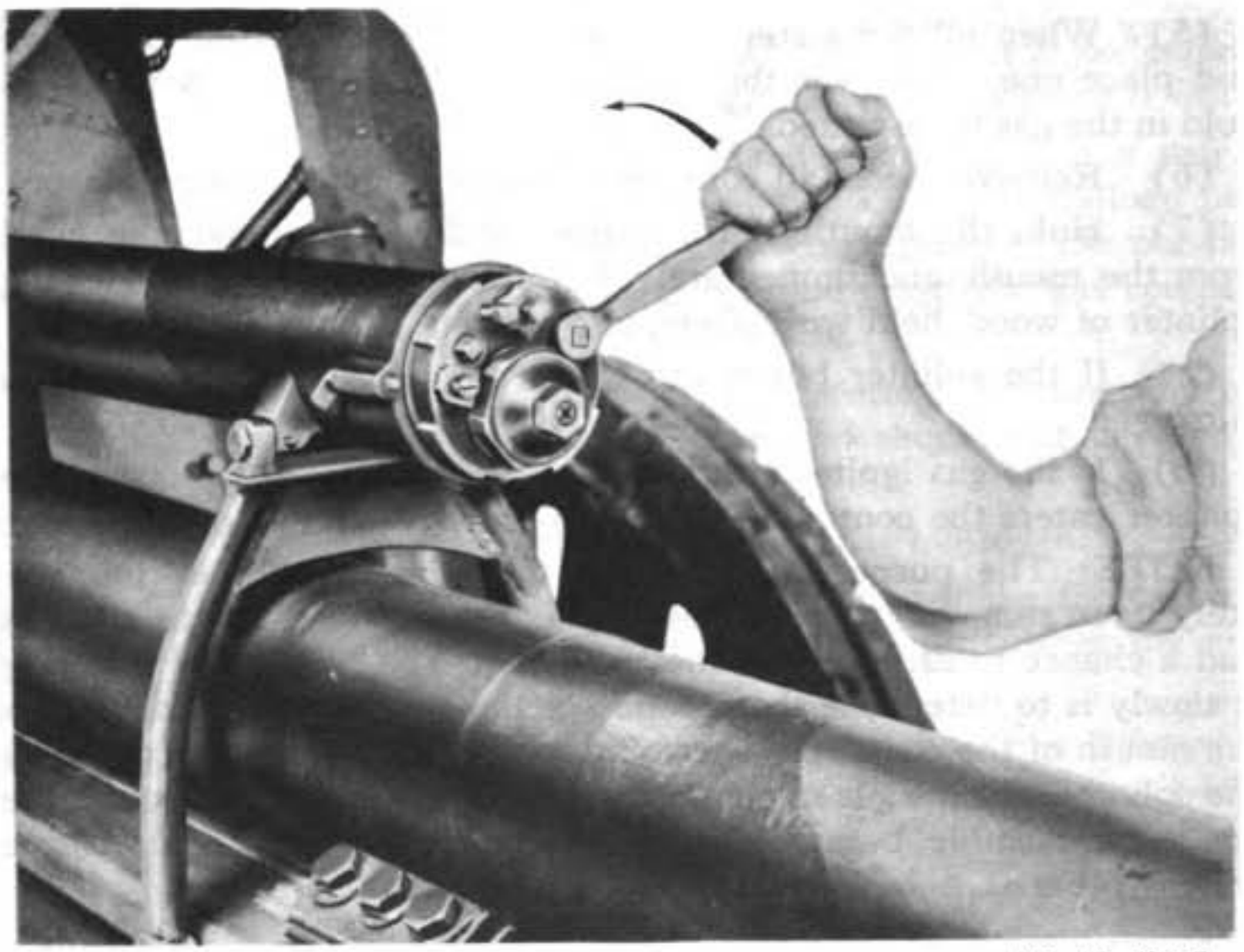


Figure 41—Recoil and Recuperator Cylinders—Front View

GERMAN 105-MM HOWITZER MATERIEL



RA PD 68415

Figure 42—Removing Air Filling Plug

g. The recuperator cylinder (fig. 41) is filled and charged in the following manner:

(1) See that howitzer is in full battery position and secured.

(2) Lay howitzer at zero degrees elevation and cross level.

(3) Remove front cover cap.

(4) Remove air filling plug (fig. 42).

(5) Open air valve and bleed all air pressure. Manipulate the air valve several times to make sure all air pressure has been removed (fig. 43).

(6) Remove filling plug (fig. 44).

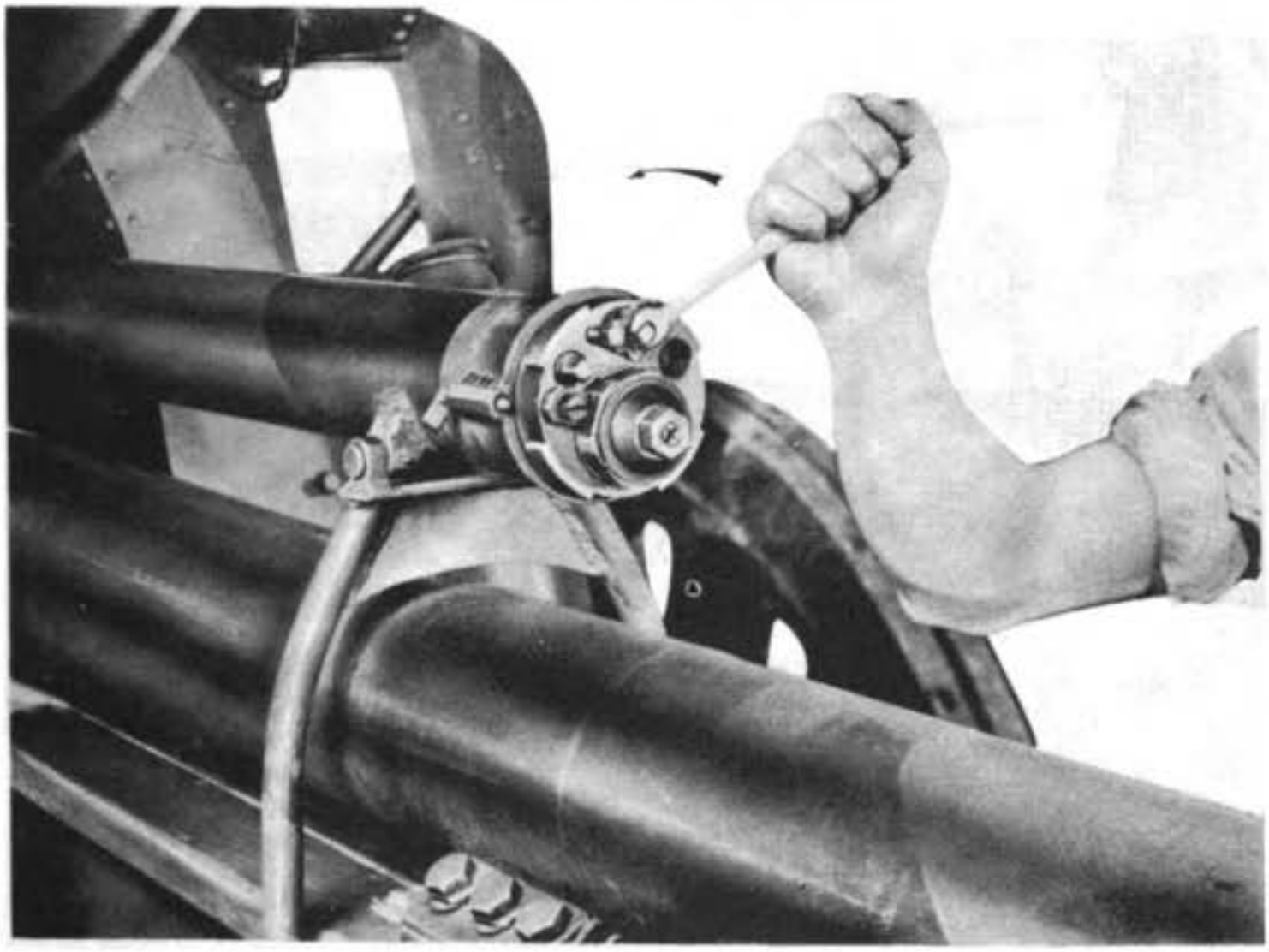
(7) Syringe or pour in liquid through filling hole until the liquid level reaches the bottom of the filling hole (figs. 45 and 46).

(8) Replace filling plug.

(9) Elevate and depress several times, leaving howitzer at zero degrees on completion.

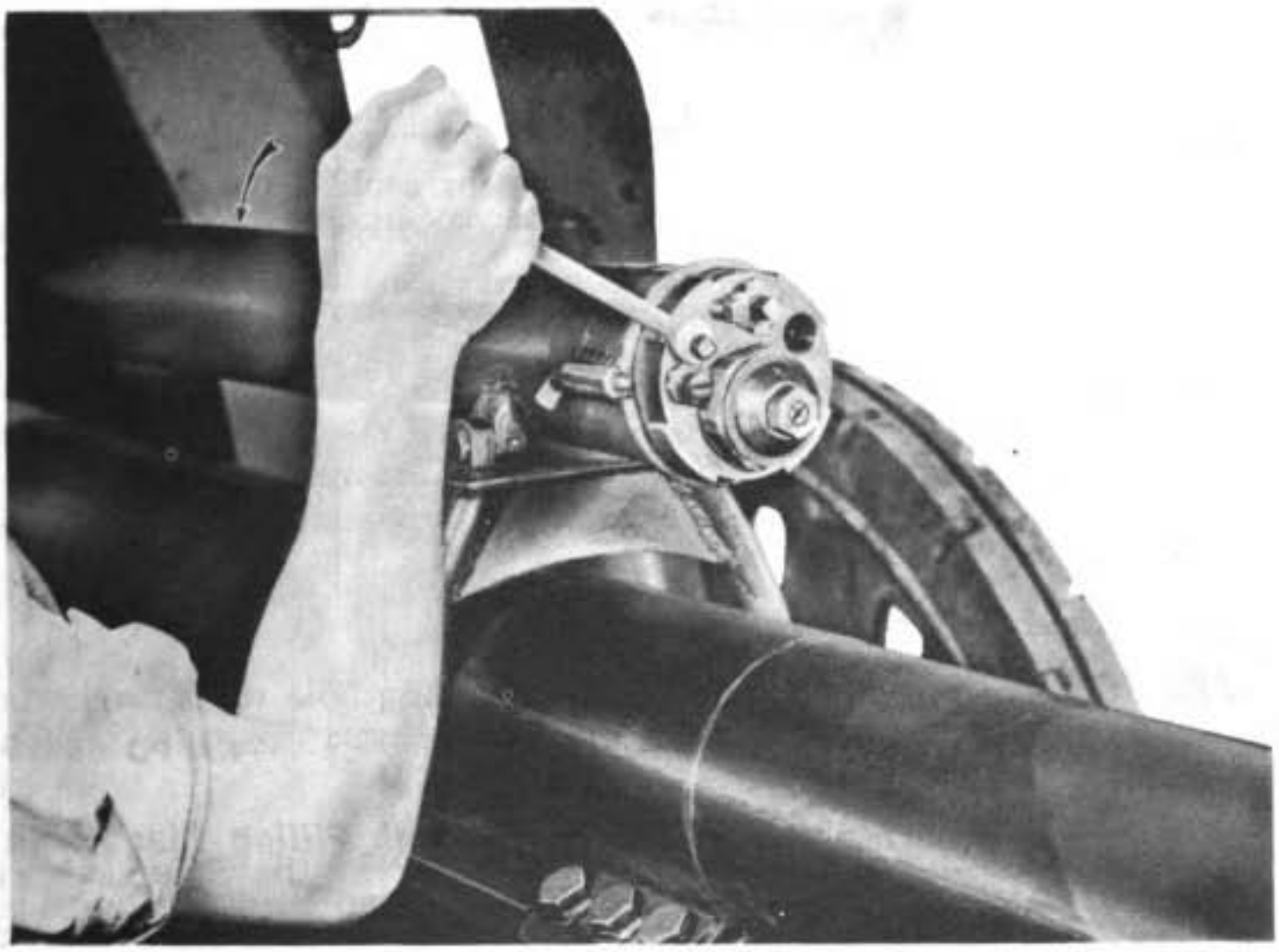
(10) Remove filling plug. Liquid should just appear; if not, pour in more liquid until it overflows.

CARE AND PRESERVATION



RA PD 68416

Figure 43—Opening Air Valve



RA PD 68417

Figure 44—Removing Liquid Filling Plug

GERMAN 105-MM HOWITZER MATERIEL

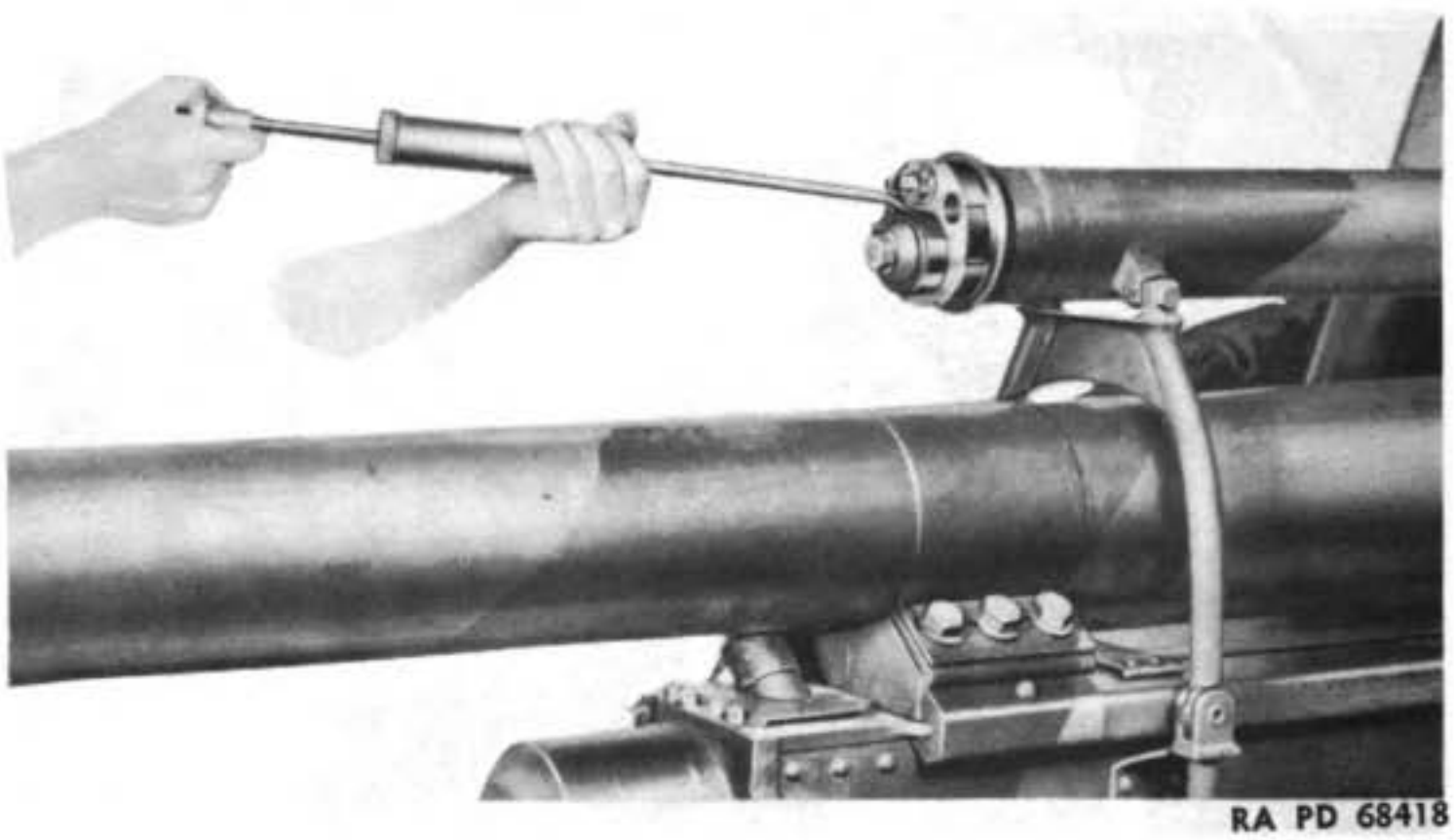


Figure 45—Filling With Recoil Liquid, Using Syringe

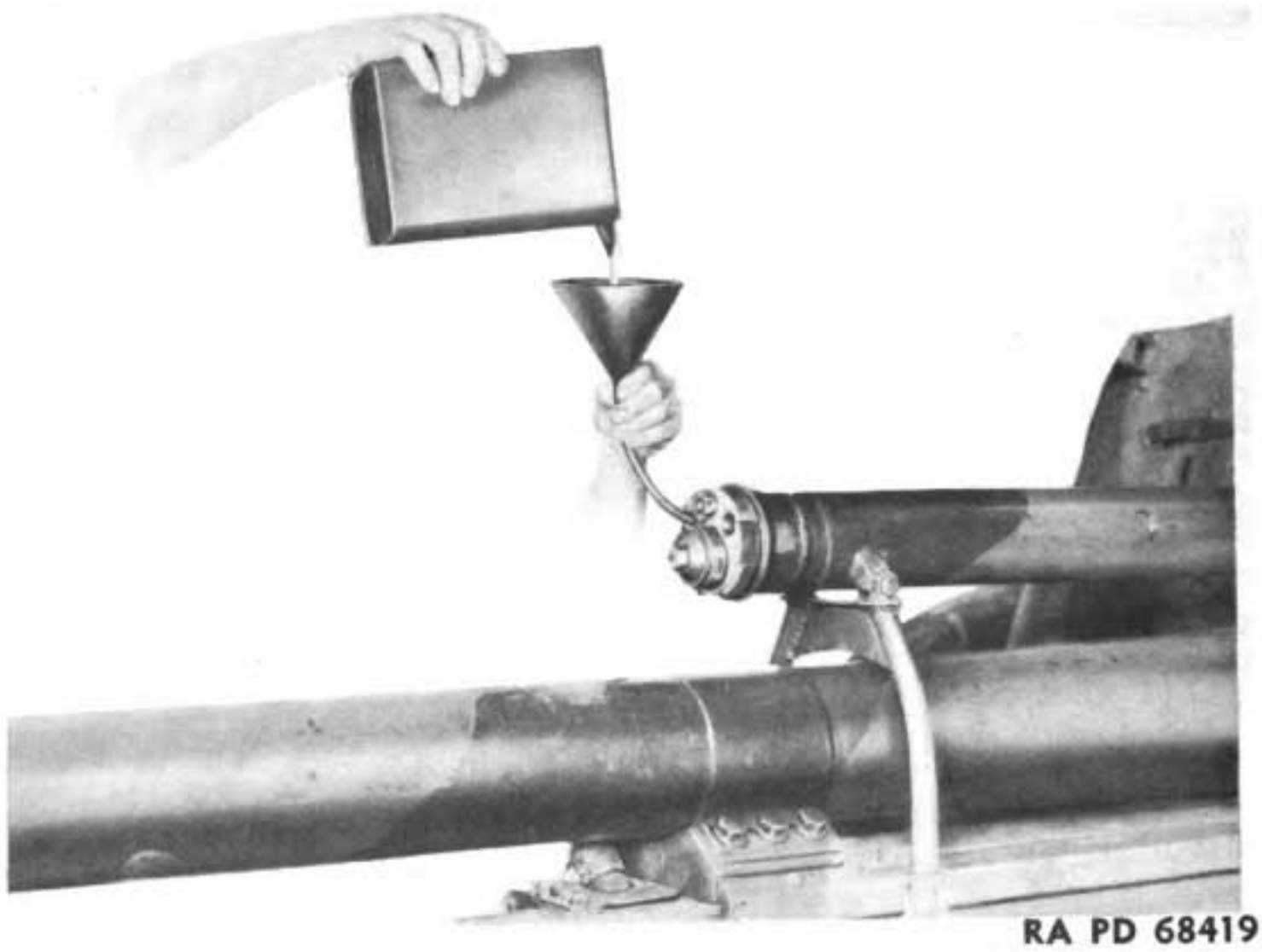


Figure 46—Pouring Recoil Liquid Through Filling Plug Hole

(11) Attach air filling adapter, connecting pipe, and air reservoir to recuperator at air filling plug hole (fig. 47).

(12) Attach pressure gage number 22 to adapter (fig. 48).

CARE AND PRESERVATION

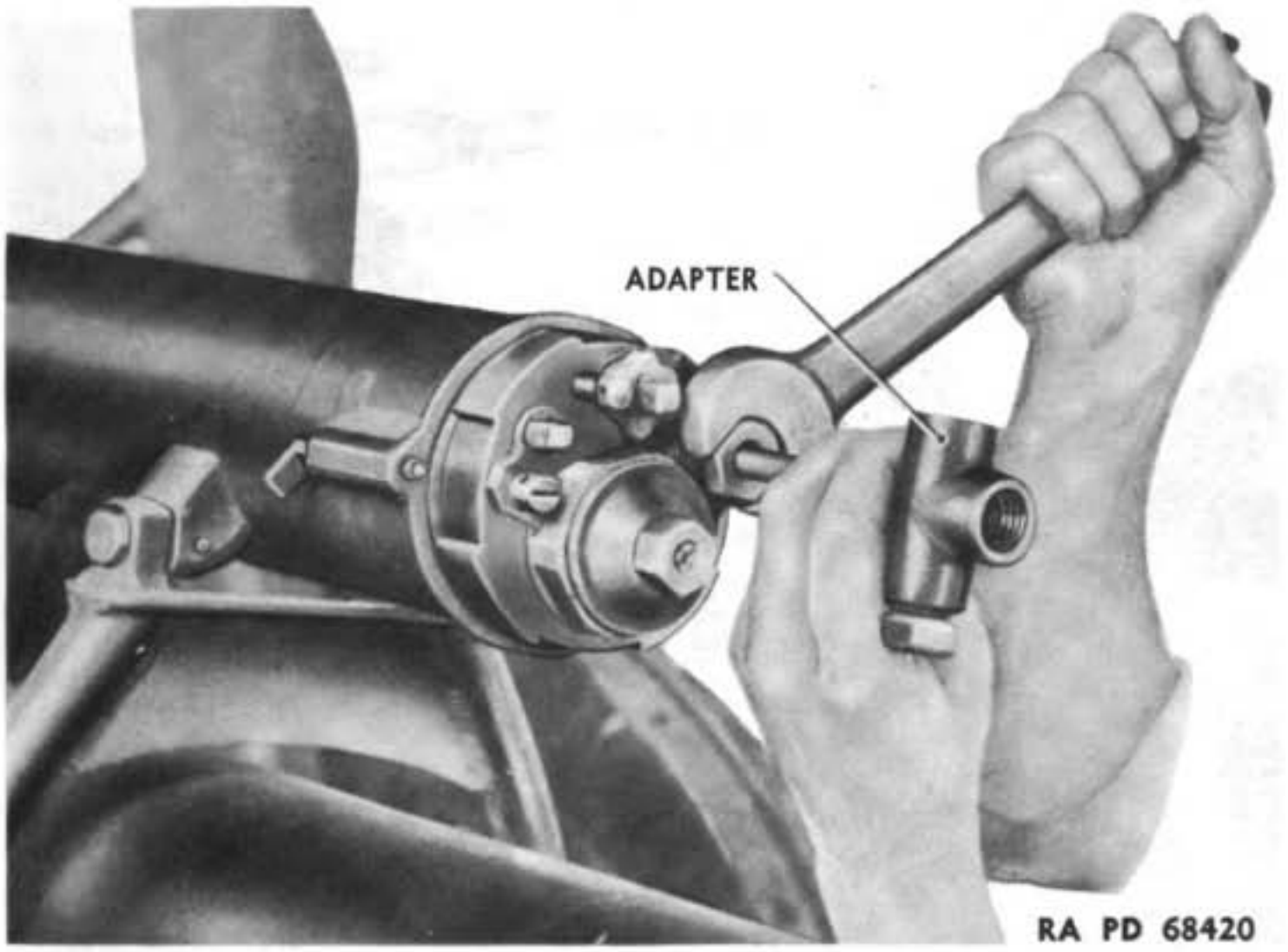


Figure 47—Attaching Adapter

(13) Close air valve on recuperator cylinder.

(14) Open air reservoir slowly until 750 pounds per square inch registers on gage. Close reservoir. Air pressure should remain constant; if not, check connections for leakage.

(15) Open air valve on recuperator cylinder.

(16) Open up air reservoir and charge recuperator to 730 pounds per square inch plus or minus 20 pounds.

(17) Close air reservoir.

(18) Close air valve on recuperator cylinder.

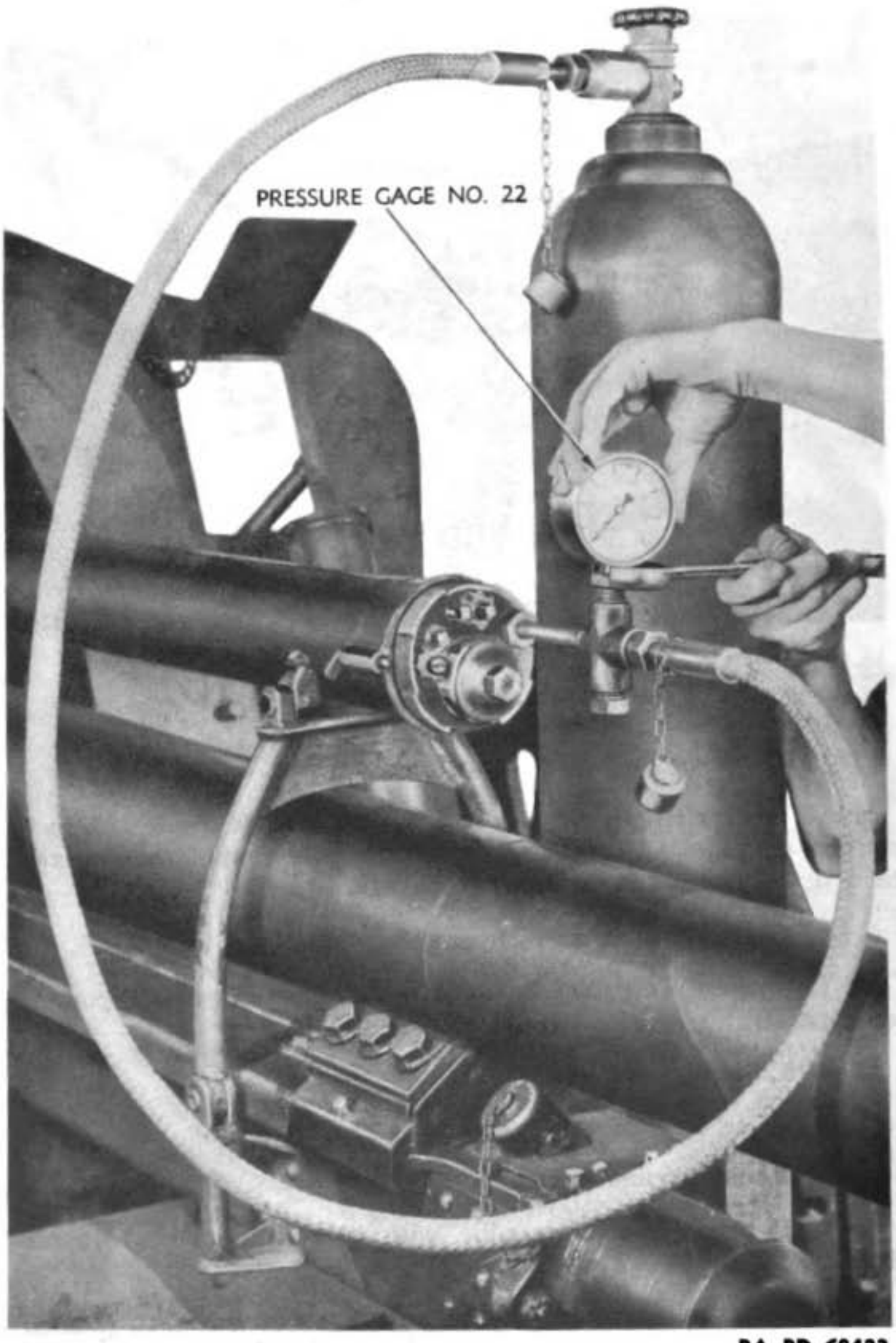
(19) Remove connecting pipe.

(20) Replace connecting pipe with bleeder plug on adapter (fig. 49).

(21) Open air valve. Pressure should read at least 710 pounds per square inch; if under, add more; if over 750 pounds per square inch, unscrew bleeder plug slightly to release excessive air pressure.

(22) Remove air filling adapter and replace air filling plug.

GERMAN 105-MM HOWITZER MATERIEL



RA PD 68423

Figure 48—Attaching Pressure Gage to Adapter

CARE AND PRESERVATION

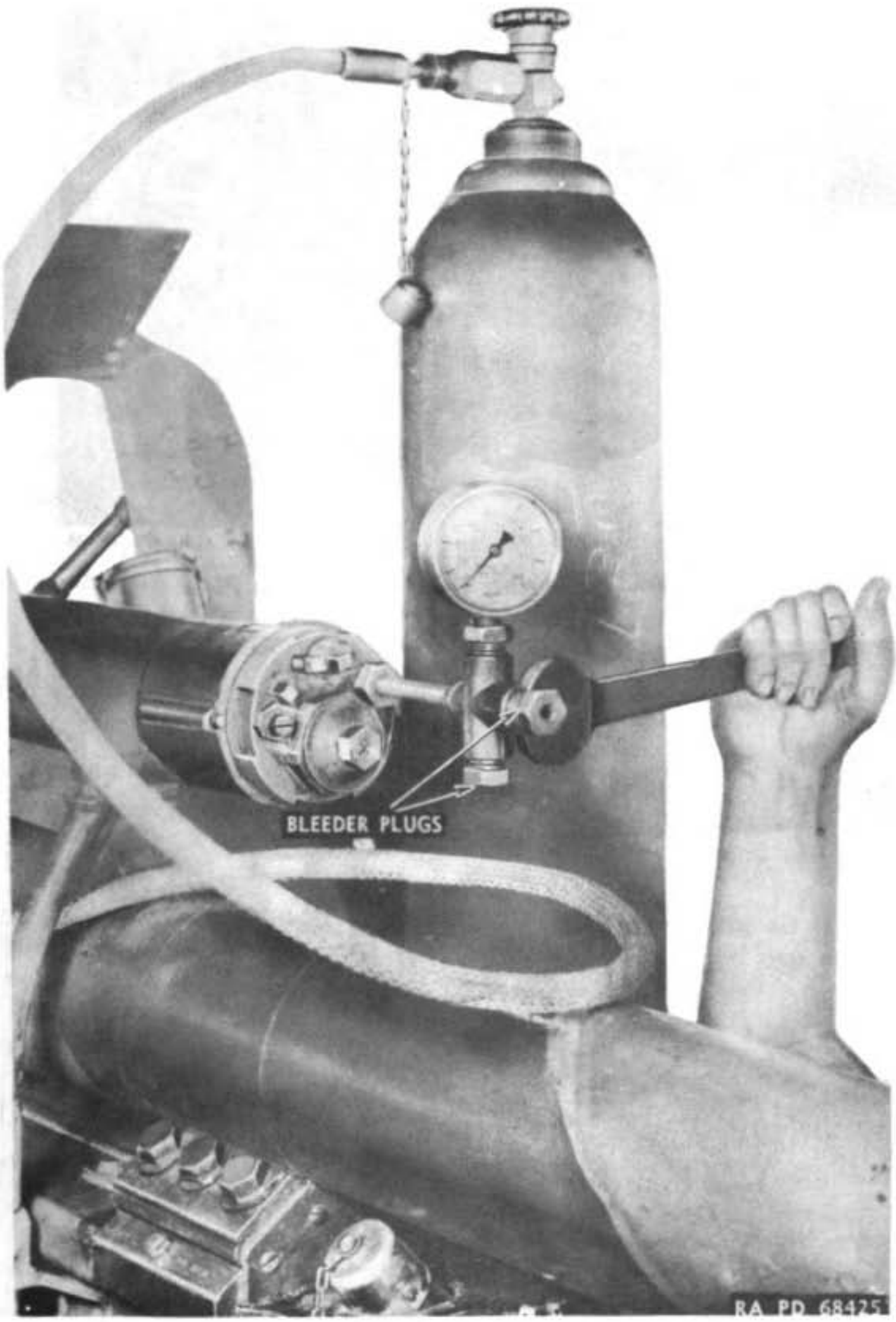
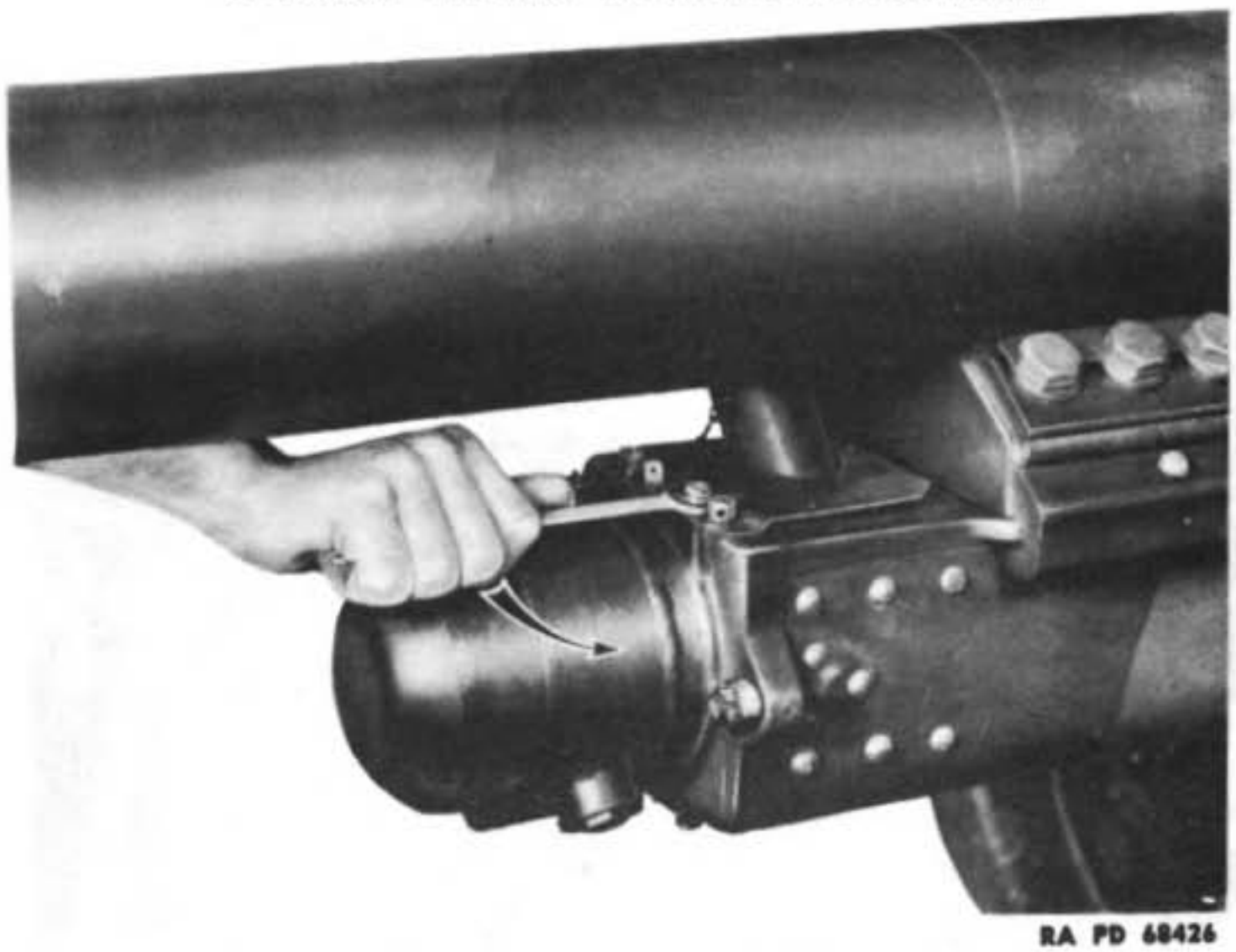


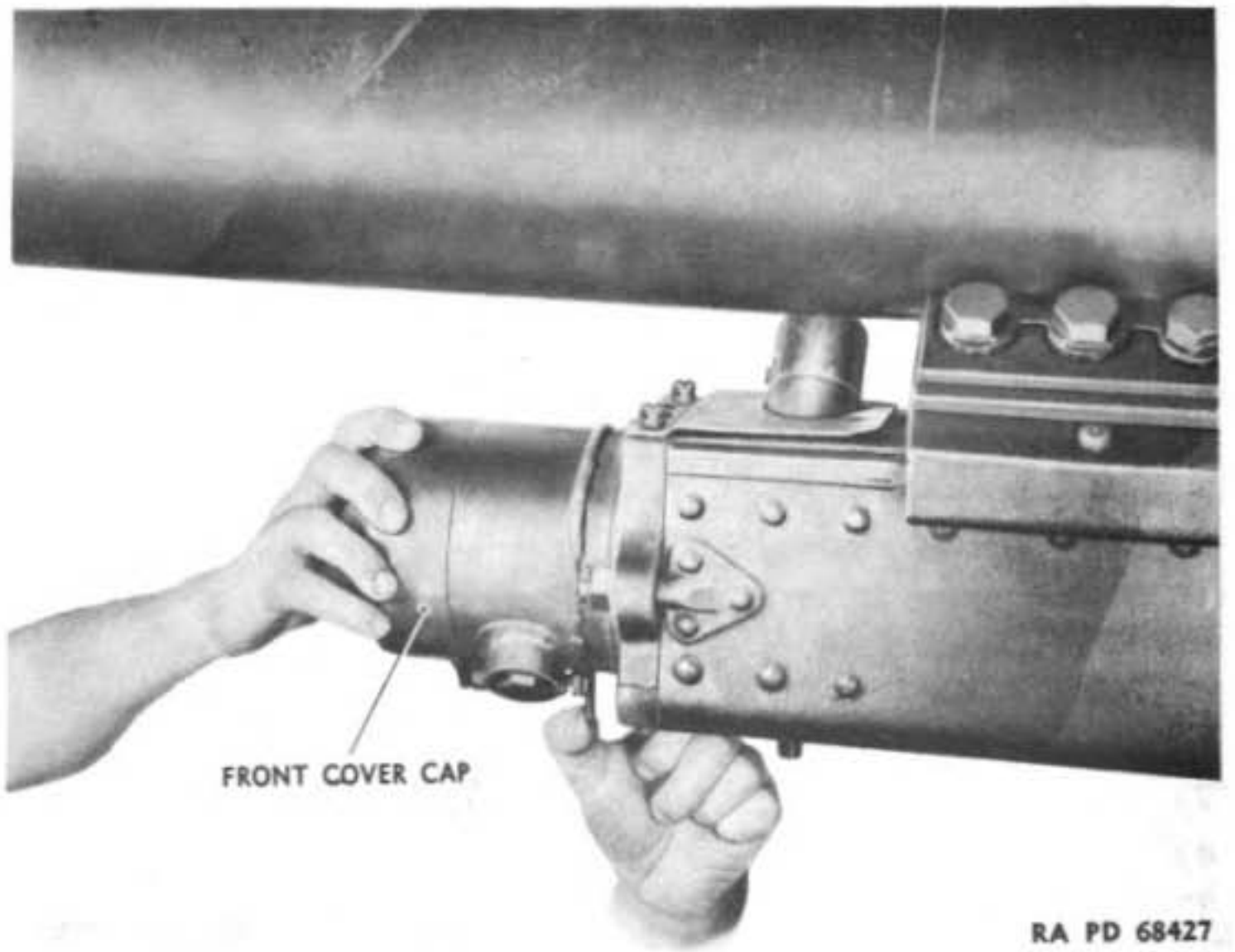
Figure 49—Attaching Bleeder Plug to Adapter

GERMAN 105-MM HOWITZER MATERIEL



RA PD 68426

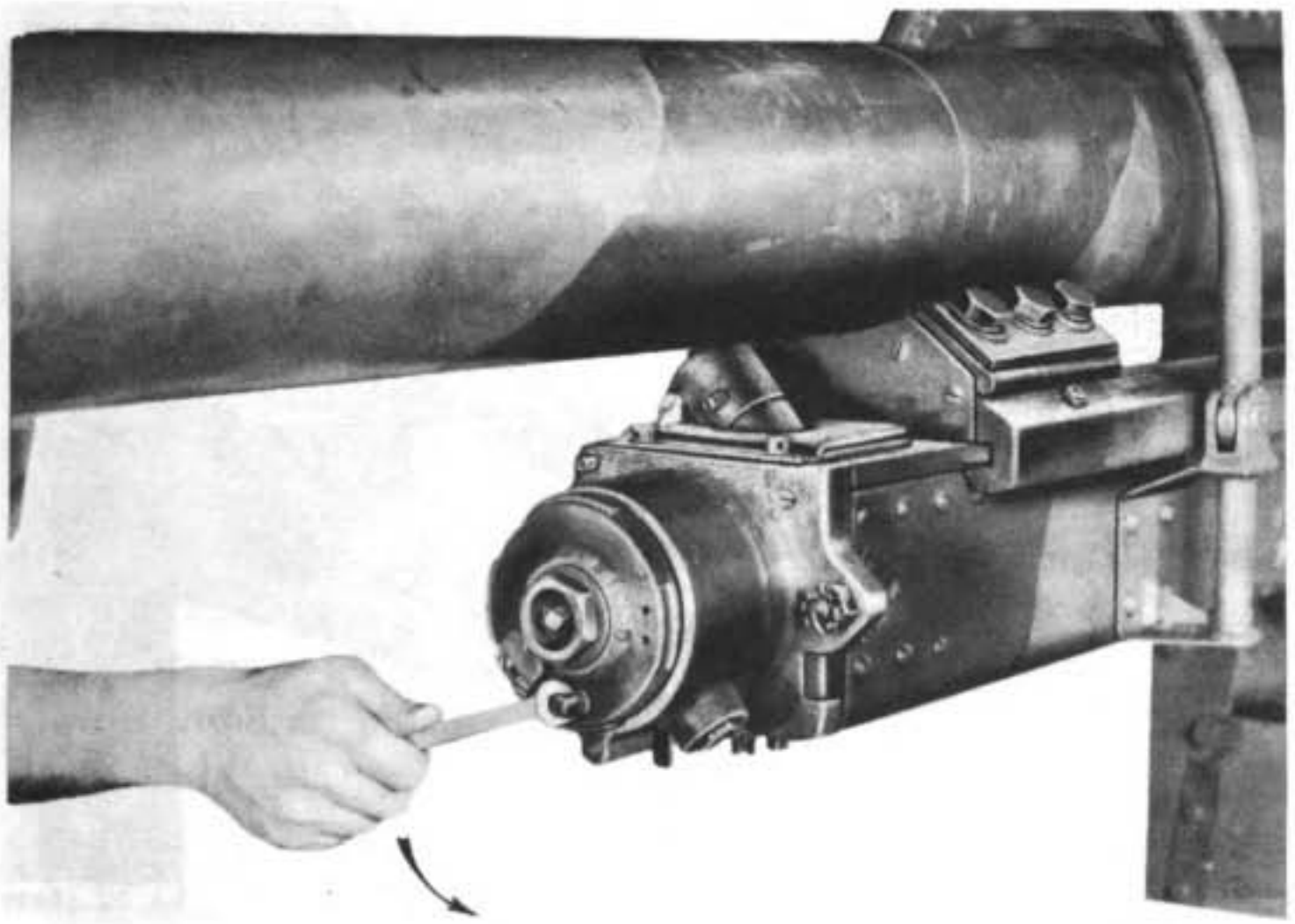
Figure 50—Removing Top Filling Hole Plug



RA PD 68427

Figure 51—Removing Front Cover Cap

CARE AND PRESERVATION



RA PD 68428

Figure 52—Removing Air Release Plug on Expansion Chamber

36. FILLING THE RECOIL CYLINDER.

a. The following procedure is used in filling and charging the recoil cylinder (fig. 41):

(1) See that howitzer is in full battery position.

(2) Remove the two filling plugs from the front end of cradle (fig. 50).

(3) Remove front cover cap (fig. 51) and remove the air release plugs (2), one on the expansion chamber (fig. 52) and one at the end of the control rod (fig. 53).

(4) Remove air release plug from rear end of recoil piston rod (fig. 54).

(5) Lay the howitzer at zero degrees.

(6) Pour in liquid slowly at one of the top filling holes, until it overflows at air release plugs, closing each in turn as liquid appears.

(7) Continue to pour in liquid until it appears at filling hole.

(8) Replace filling plugs.

(9) Elevate and depress several times and bring the howitzer to 5 degrees on completion.

(10) Remove the two filling plugs from the front end of cradle.

GERMAN 105-MM HOWITZER MATERIEL

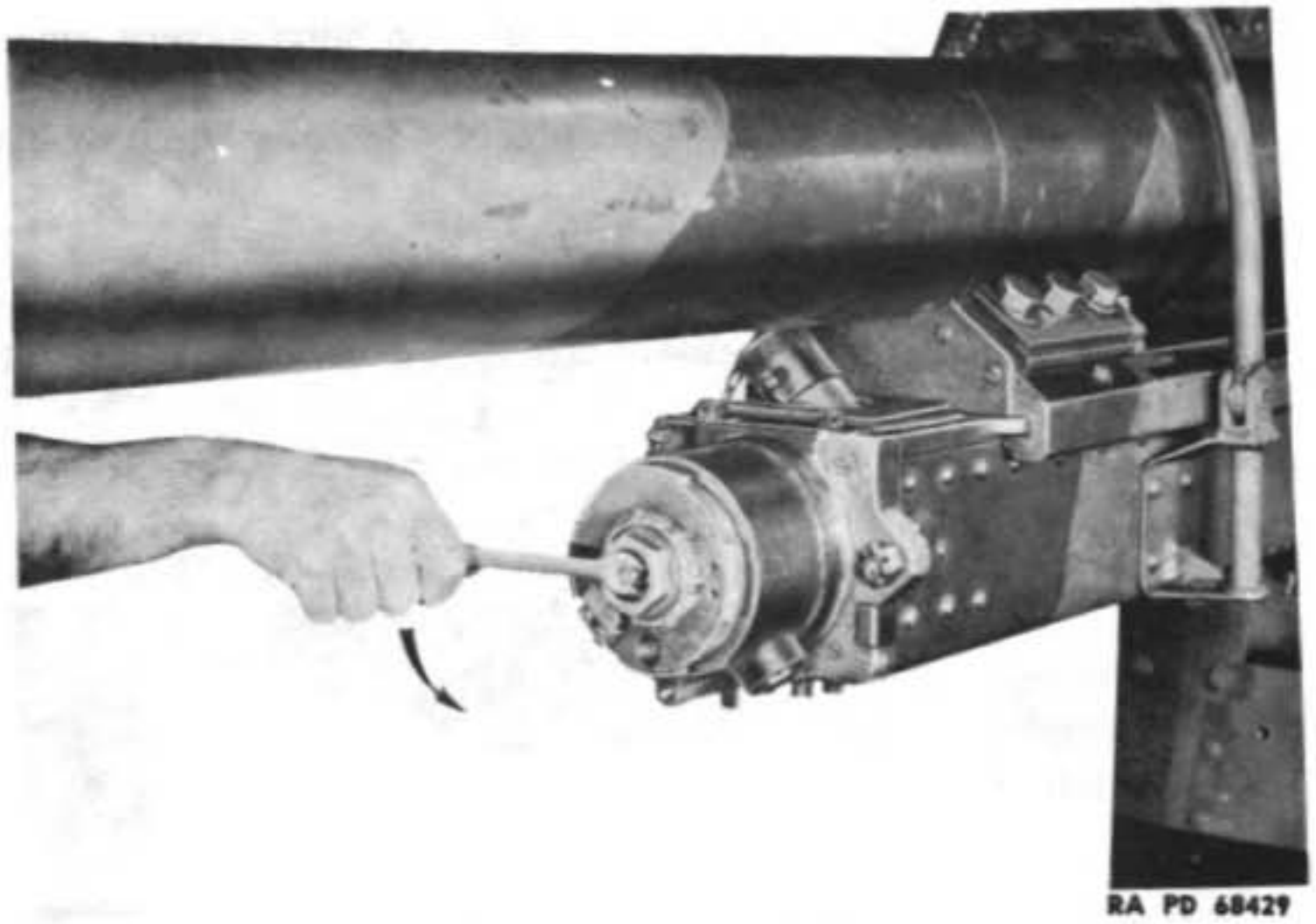


Figure 53—Removing Air Release Plug on Control Rod

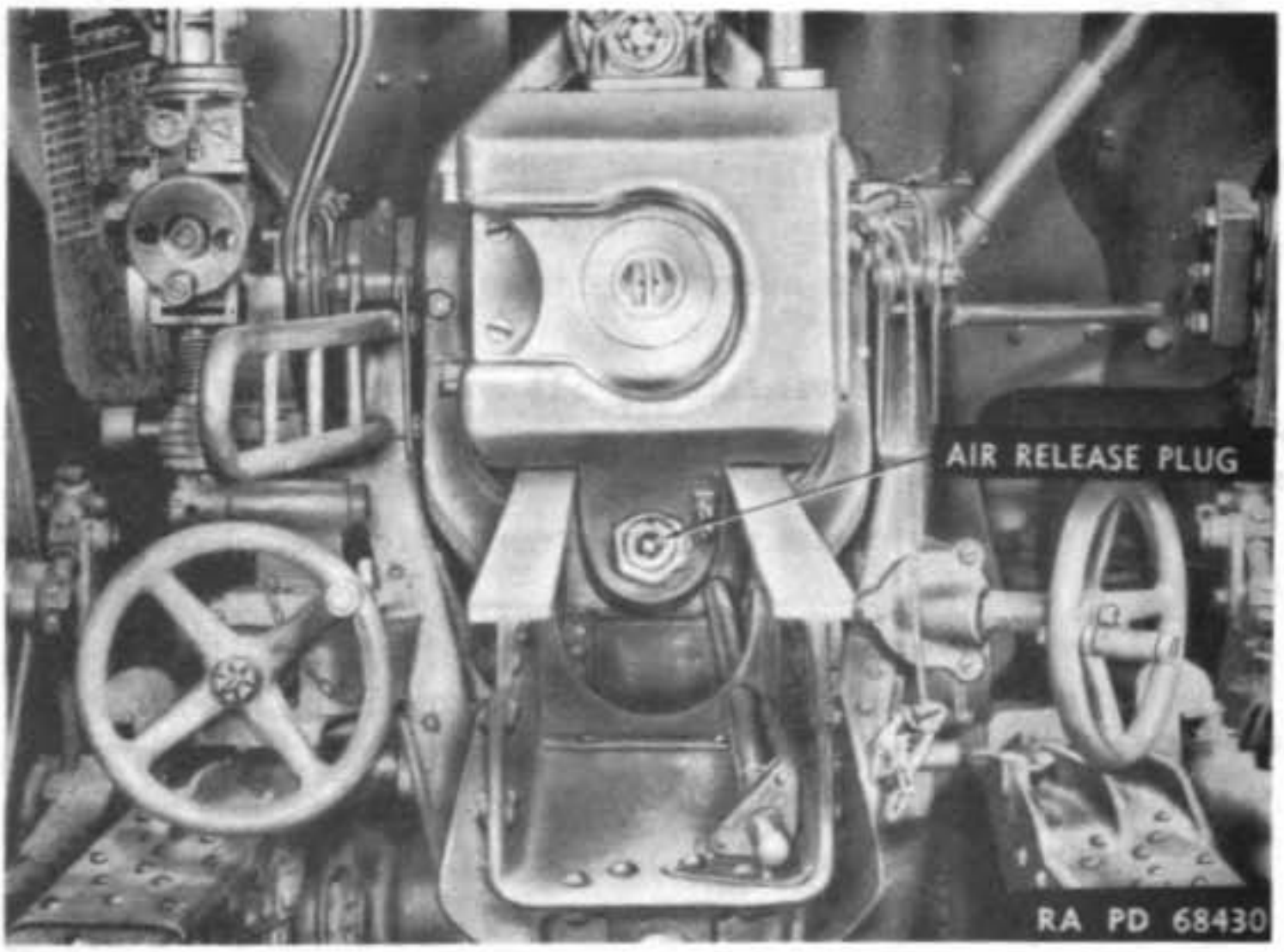


Figure 54—Location of Air Release Plug at Rear End of Recoil Piston Rod

CARE AND PRESERVATION

(11) Pour in more liquid (it should be only a very small amount) until it appears at filling plugs.

(12) Replace filling plugs. Approximate amount of liquid should be 12½ pints.

37. FILLING AND CHARGING THE EQUILIBRATOR.

a. The following procedure is used in filling and charging the equilibrator:

(1) Lay howitzer at 4 degrees elevation.
(2) Remove air filling plug (fig. 55).
(3) Open air valve and allow all air to escape (fig. 56).
(4) Remove equilibrator.
(5) Remove leather bellows.
(6) Withdraw plunger (fig. 57).
(7) Drain all liquid from cylinder.

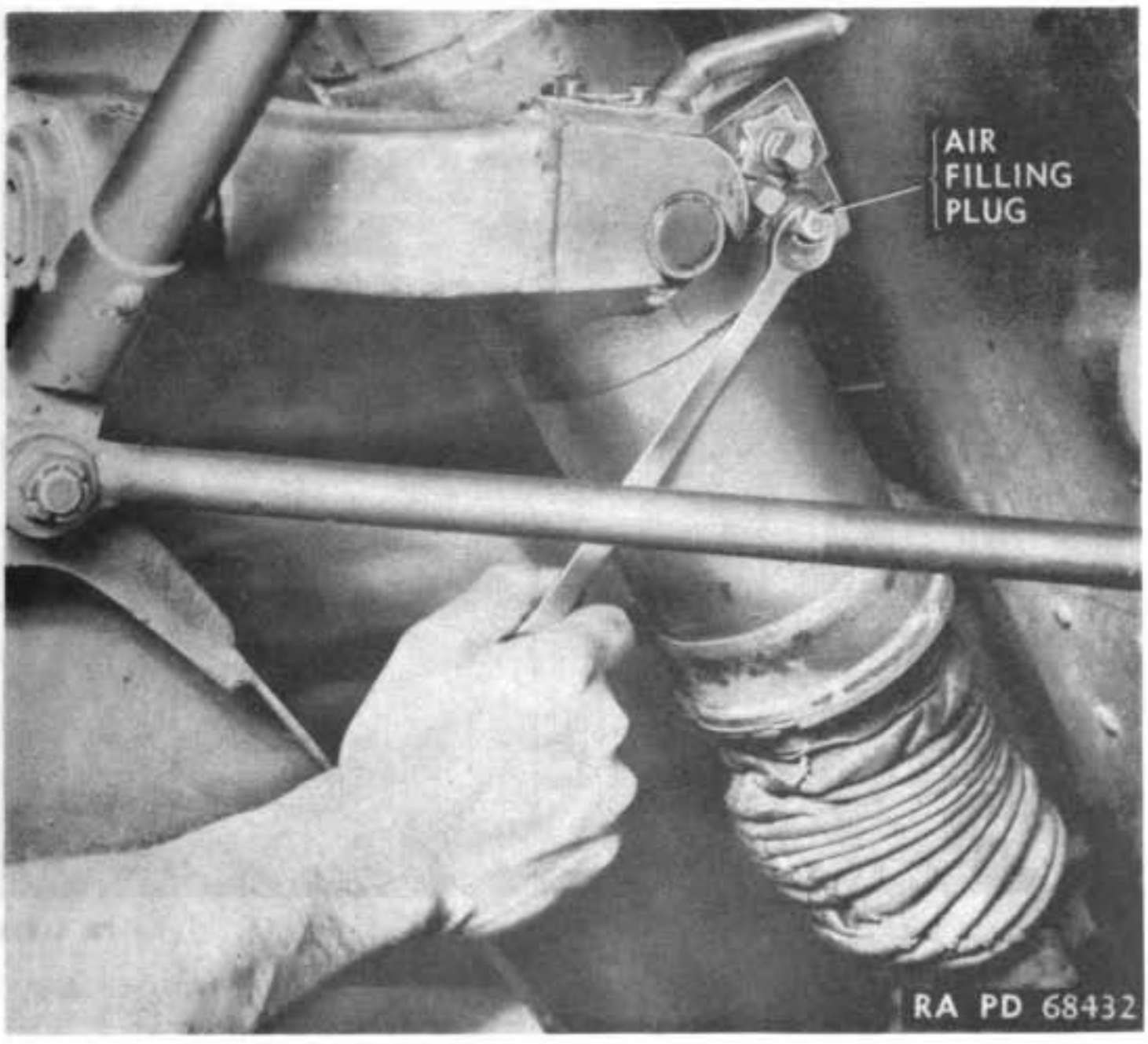
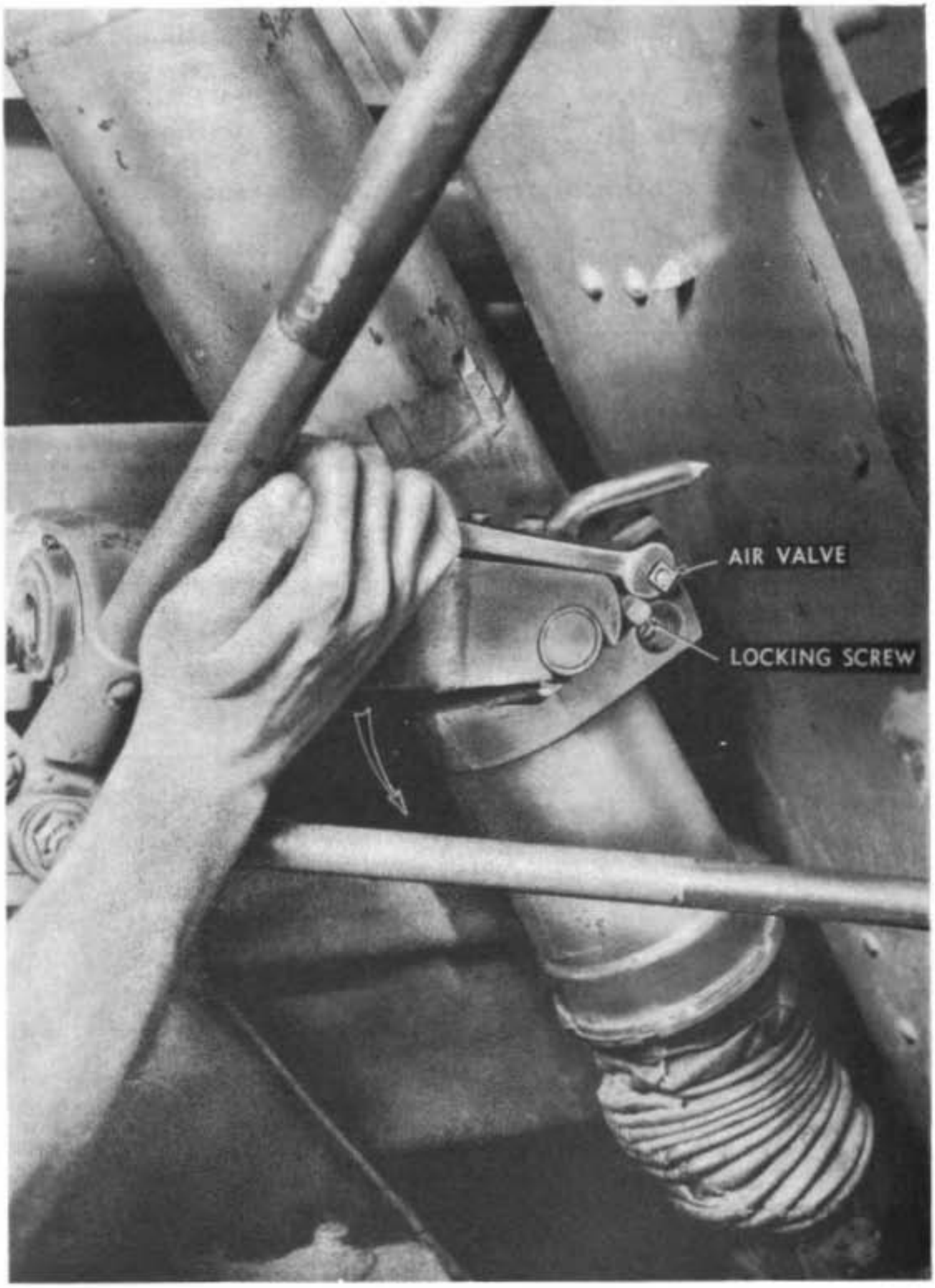


Figure 55—Removing Air Filling Plug on Equilibrator

GERMAN 105-MM HOWITZER MATERIEL



RA PD 68433

Figure 56—Opening Air Valve on Equilibrator

CARE AND PRESERVATION

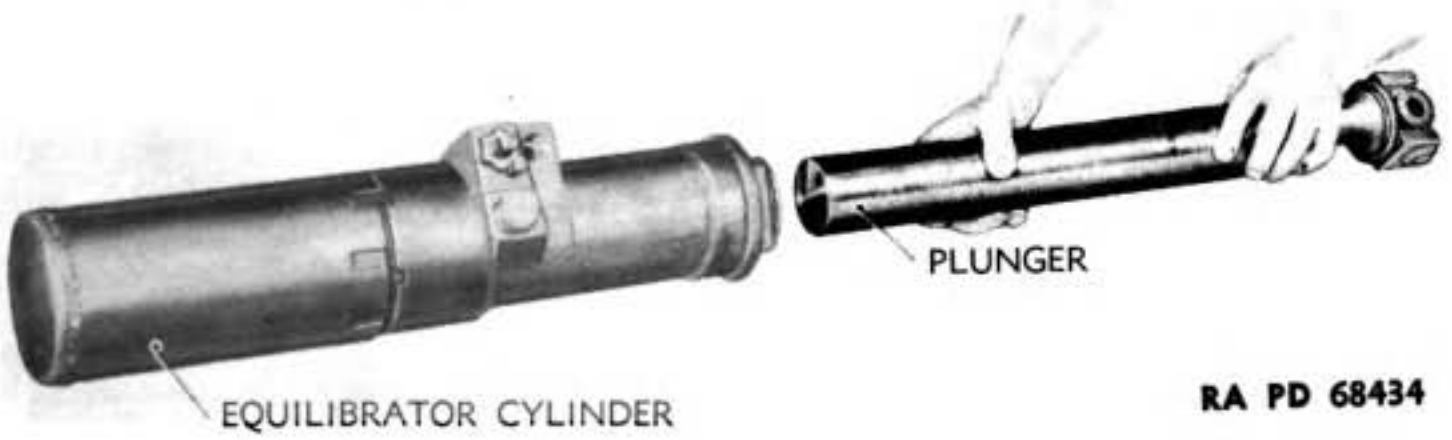


Figure 57—Withdrawing Plunger

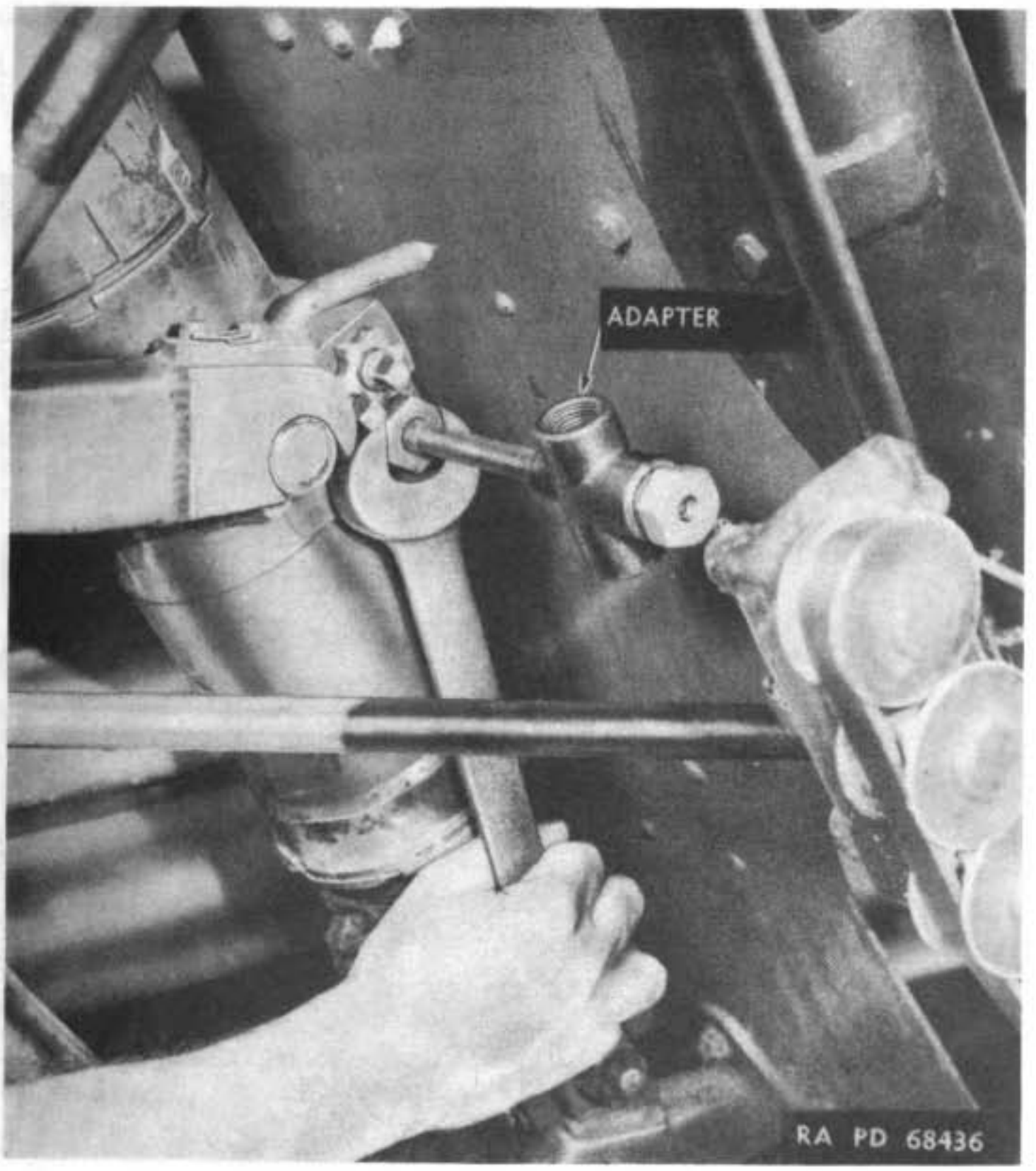
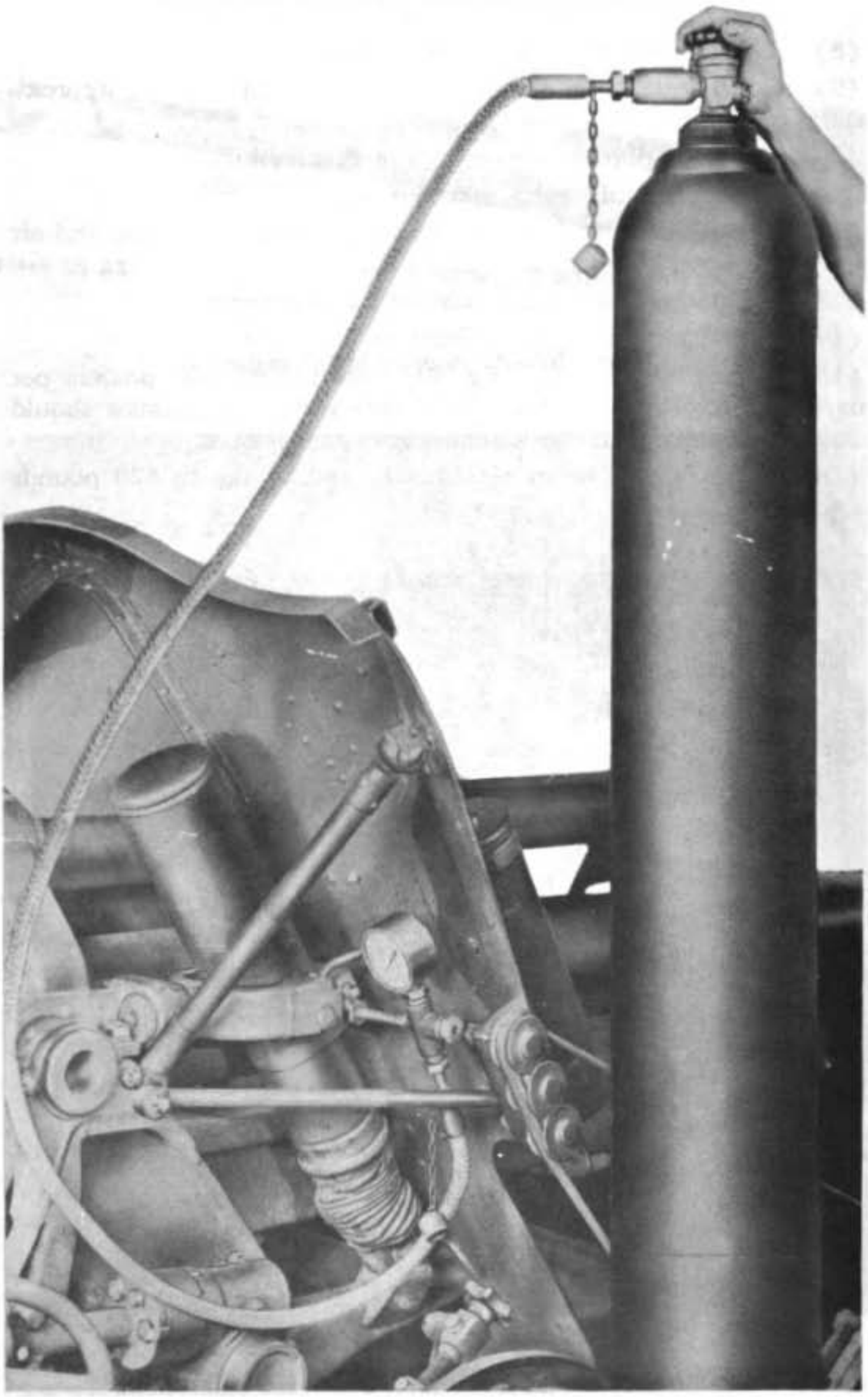


Figure 58—Attaching Adapter to Equilibrator Air Filling Plug Hole

GERMAN 105-MM HOWITZER MATERIEL



RA PD 68437

Figure 59—Opening Valve on Air Reservoir

CARE AND PRESERVATION

(8) Check condition of cup leather packing.

(9) Pour liquid into the cylinder to the amount of, approximately, one pint.

(10) Replace plunger and secure leather bellows.

(11) Replace equilibrator on mounting.

(12) Attach air filling adapter (fig. 58), connecting pipe, and air reservoir to equilibrator at air filling hole.

(13) Attach pressure gage number 22 to adapter.

(14) Close air valve on equilibrator.

(15) Open air reservoir (fig. 59) slowly until 600 pounds per square inch registers on gage. Close reservoir. Air pressure should remain constant; if not, check connections for leakage.

(16) Open air valve on equilibrator and charge to 520 pounds per square inch.

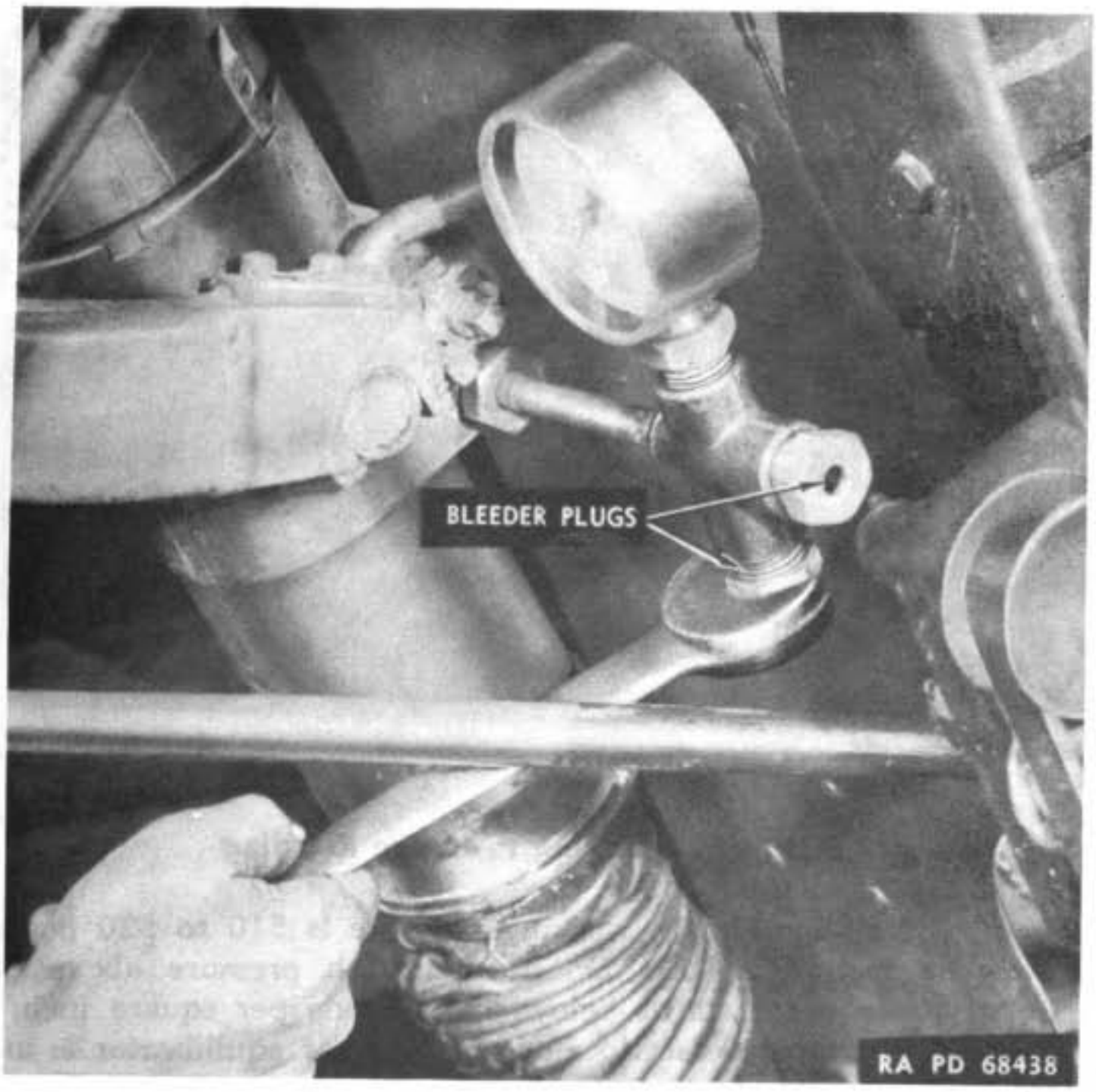
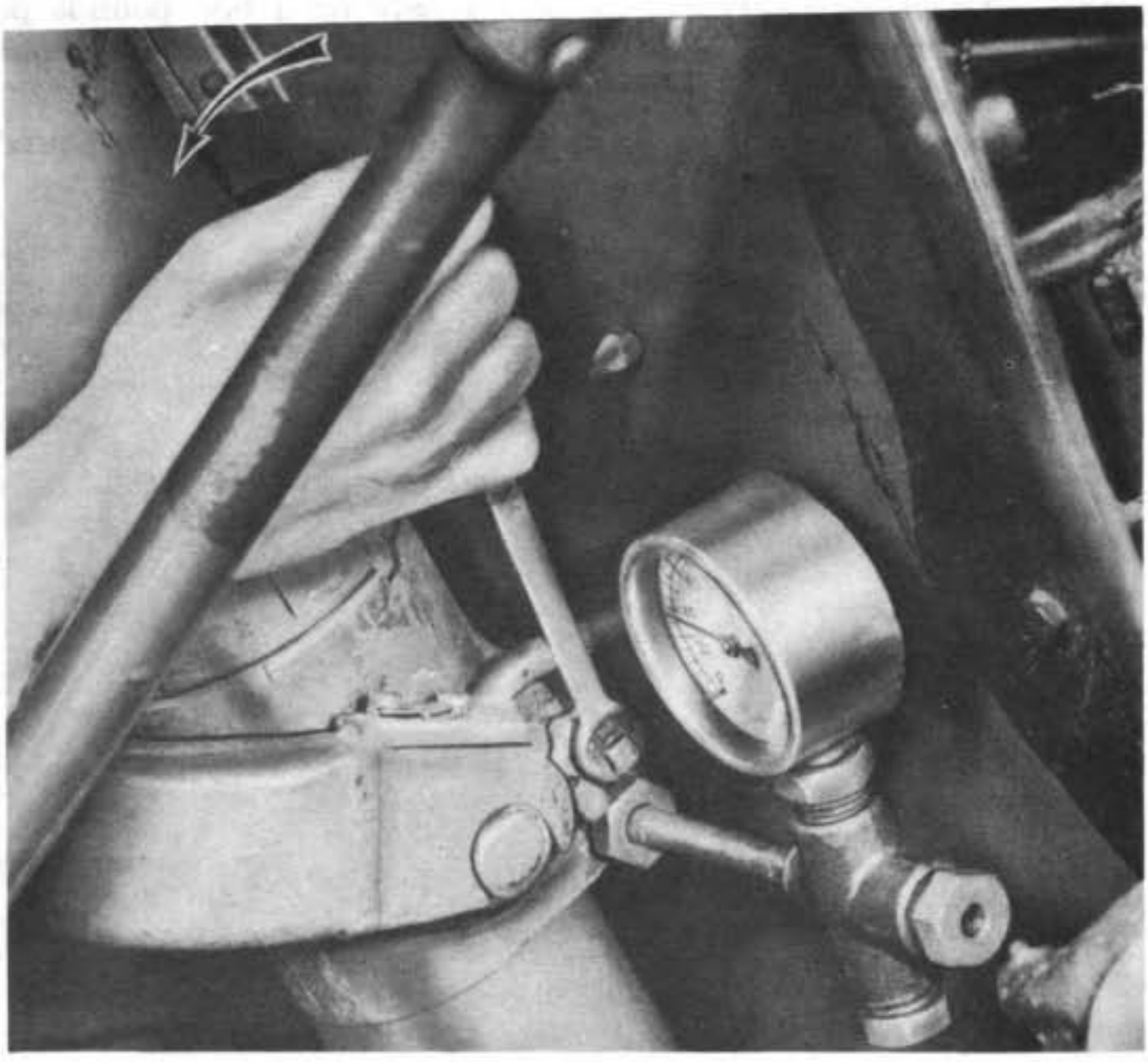


Figure 60—Attaching Bleeder Plug on Adapter

GERMAN 105-MM HOWITZER MATERIEL

(17) Close valve on air reservoir.
(18) Close air valve on equilibrator.
(19) Remove connecting pipe from adapter and replace with bleeder plug (fig. 60).
(20) Elevate and depress howitzer for trail of handwheel effort.
(21) If handwheel effort is great in elevation, increase pressure to approximately 550 pounds per square inch. If handwheel effort is found to be hard in depression, allow air to escape to approximately 480 pounds per square inch by loosening the bleeder plug. Test the effort at each 5-pound rise or drop in pressure.



RA PD 68439

Figure 61—Taking Pressure Reading

(22) The approximate working pressure is 510 to 520 pounds per square inch (fig. 61). Do not establish pressure above 550 pounds per square inch, or below 480 pounds per square inch, in adjustment, as some defect in elevating gear or equilibrator is indicated by these extreme limits.
(23) Remove adapter and pressure gage.
(24) Replace air filling plug.

Section VI

INSPECTION AND ADJUSTMENT

38. INSPECTION AND ADJUSTMENT.

Parts To Be Inspected in Order of Inspection	Points To Observe
The howitzer as a unit.	Note general appearance and smoothness of operation of breech mechanism. Measure protrusion of firing pin, which should be three thirty-seconds inch. Disassemble breech mechanism and firing mechanism. Inspect parts for wear, burs, or other mutilations. See that they are clear and well lubricated. Note condition of bore for erosion at origin of rifling. Examine bearing surface of exterior of tube for scoring or other mutilation.
Breech ring.	Inspect breech ring and breech recess for burs, roughness, or scoring.
Breechblock.	Inspect the bearing surfaces of the breechblock for scores or bruises.
Firing mechanism.	Inspect the condition of all parts; check for weak or broken springs.
Adjustment.	The howitzer is so designed that it requires no adjustment. If any of the parts show excessive wear, they should be replaced.
The carriage as a unit.	General appearance.
Recoil cylinder.	Check for the proper amount of oil in the system (approximately 12½ pints). To check: Lay the howitzer at zero degrees elevation. Remove the filling plugs from front end of cradle (fig. 50). Liquid should appear; if not, proceed as follows: Remove front cover (fig. 51). Loosen air release plugs (figs. 52 and 53). Liquid should appear. In this case proceed as in steps (11) and (12) in paragraph 36 **a**. In event no liquid appears, proceed as from step (6) in paragraph 36 **a**.

GERMAN 105-MM HOWITZER MATERIEL

Parts To Be Inspected in Order of Inspection	Points To Observe
Recuperator cylinder.	Check for proper amount of liquid in the system as follows: Lay howitzer at zero degrees and cross level. Lay howitzer at 10 minutes depression. Remove front cover cap. Unscrew filling plug slightly (fig. 44). This should cause liquid to appear; if it does not, screw up plug and repeat with howitzer laid at 30 minutes depression. If there is still no liquid, recuperator requires a complete recharging. Proceed as in paragraph 35. Screw up filling plug. Lay howitzer at 1 degree 30 minutes elevation. Unscrew filling plug slightly. Gas only should appear; if liquid appears, reduce air pressure to zero, establish liquid level (par. 35), and recharge recuperator. Check for proper amount of air pressure in the system as follows: Lay howitzer at zero degrees and cross level. Remove front cover cap. Remove air filling plug (fig. 42). Attach adapter and pressure gage to recuperator at air filling plug hole (fig. 49). See that bleeder plugs are on the adapter and are tightened up (fig. 49). Open gas valve. Pressure should read at least 710 pounds per square inch. (Normal air pressure is 730 pounds per square inch plus or minus 20 pounds.) If it does not, proceed as from step (11) in paragraph 35 g. Close air valve.

INSPECTION AND ADJUSTMENT

Parts To Be Inspected in Order of Inspection	Points To Observe
Equilibrator.	Check elevation handwheel efforts. They should not be excessive. Inspect to see that the proper amount of fluid and air pressure is in the cylinder. Proceed as follows: Try elevating gear of carriage for handwheel efforts, in elevation and depression. If handwheel efforts are found to be excessive, check the air pressure as follows: Remove air filling plug (fig. 55). Attach adapter and pressure gage No. 22 to hole for filling plug (fig. 60). See that joints are tight and bleeder plugs are on the adapter (fig. 60). Open air valves. Air pressure should read between 510 and 520 pounds per square inch (fig. 61); if not, note the pressure and, if below 520 pounds per square inch, equilibrator should be examined at joint and packings and a complete recharge given. If above 520 pounds per square inch repeat as from step (18) in paragraph 37 **a.**
Elevating mechanism.	Inspect to see that operation is smooth and that the mechanism is properly lubricated. Turn the handwheels back and forth and note the amount of backlash. If it exceeds one quarter turn of the handwheel, notify the Ordnance maintenance personnel.
Traversing mechanism.	Inspect to see that operation is smooth and that the parts are properly lubricated. Turn the handwheel back and forth and note the amount of backlash. If it exceeds one quarter turn of the handwheel, notify Ordnance maintenance personnel.

GERMAN 105-MM HOWITZER MATERIEL

Parts To Be Inspected in Order of Inspection	Points To Observe
Hand Brakes.	Apply the hand brakes to see if they need adjustment. Adjustment is made by rotating each brake adjusting knob in a clockwise direction for tightening.
Wheels.	Check for the proper lubrication.

Section VII

MALFUNCTIONS AND CORRECTIONS

39. MALFUNCTION OF HOWITZER.

a. Fails To Fire: No Percussion on Primer.

Cause	Correction
Broken striker spring. Broken or deformed firing pin or striker.	Disassemble firing mechanism and replace broken or deformed parts if available. The firing pin is staked in place. Remove peened-over metal, unscrew firing pin from case, and replace with new firing pin if available. The metal must be peened back to prevent the firing pin from backing out.

b. Fails To Fire Until After Several Percussions on Primer.

Firing mechanism parts not working freely.	Disassemble firing mechanism and examine carefully for burs and rough surfaces, and smooth with crocus cloth. Wash parts with dry-cleaning solvent to remove gummy oil; thoroughly dry and lubricate with lubricating oil before assembly. Use SAE 10 engine oil below +32 degrees F, and SAE 30 above +32 degrees F.
Weak striker spring.	Replace spring.
Defective firing pin.	Replace pin.

c. Fails To Fire When Proper Pressure on Primer Is Obtained.

Defective primer.	Replace round.

d. Fails To Extract Empty Case.

Broken extractor.	Carefully remove the case by operating preferably from the breech end, or else from the muzzle end. Examine the edge of the chamber for deformation or burs which might cause difficult extraction. Replace spare extractors are on hand.

MALFUNCTIONS AND CORRECTIONS

40. MALFUNCTION OF CARRIAGE.

a. Howitzer Returns to Battery With Too Great a Shock.

Cause	Correction
Improper amount of liquid and air pressures in recuperator cylinder.	Refill to normal (pars. 35 and 38).
Retarding valve fails to seat properly.	Jar trails to shake retarding valve free. Fire two rounds. If condition persists, notify Ordnance maintenance personnel.

b. Howitzer Fails To Return to Battery.

Excessive friction at recoil stuffing box.	Notify Ordnance maintenance personnel.
Damaged slides, piston rod, or piston.	Notify Ordnance maintenance personnel.
Leakage of air pressure in recuperator.	Notify Ordnance maintenance personnel.

c. Abnormal Length of Recoil.

Improper amount of liquid in recuperator cylinder.	Refill to normal (pars. 35 and 38).
Presence of air in recoil cylinder.	Release the air from the cylinder by removing the filling plugs.
Improper amount of liquid in recoil cylinder.	Refill to normal (pars. 36 and 38).

d. Excessive Efforts Required To Operate the Elevating Mechanism.

Improper amount of liquid and air pressures in the equilibrator.	Refill to normal (pars. 37 and 38).
Insufficient lubricant in elevating mechanism.	Lubricate (par. 29).

e. Difficulty in Closing the Trails.

Bottom carriage spattered with mud and dust.	Remove mud and dust to allow the cam to be disengaged from the arm (fig. 20).

GERMAN 105-MM HOWITZER MATERIEL

Section VIII

DISASSEMBLY AND ASSEMBLY

41. GENERAL.

a. Incidents of wear, breakage, cleaning, and inspection, make necessary the occasional disassembly of various parts of the howitzer and carriage. This work comes under two headings: that which may be performed by the battery personnel with the equipment furnished, and that which must be performed by trained Ordnance personnel.

b. The battery personnel may, in general, do such dismounting as is required for ..ery use. Such work should be done in the manner prescribed herein. Any difficulty which cannot be overcome by the prescribed method must be brought to the attention of Ordnance personnel.

c. The battery personnel will not attempt to disassemble any part of the recoil mechanism not authorized in this manual, nor do any filing on the sights or howitzer parts; and then only by order of the battery commander on any carriage part.

d. The use of wrenches that do not fit snugly on the parts should be avoided. They will not only fail to tighten the part properly, but will damage the corners of the nuts and bolt heads. There is also danger of spreading the wrenches and rendering them useless.

e. Before attempting the assembly of the larger mechanisms, the assembling of the subassemblies should be completed. In all assembling, the bearings, sliding surfaces, threads, etc., should be cleaned and lubricated.

42. DISASSEMBLY OF BREECH MECHANISM.

a. The necessary steps to disassemble the breech mechanism are, in order (fig. 62):

(1) Set the safety lock to FIRE ("Feuer") position (fig. 6).

(2) Open the breech until the extractor is clear of the breech ring.

(3) Rotate the firing lever as far as possible and remove the extractor bolt.

(4) Allow the firing lever to return to normal.

(5) Close the breech sufficiently to allow finger pressure on the extractor tong to move the extractor into a recess in the breechblock.

(6) Open breech and remove the extractor.

DISASSEMBLY AND ASSEMBLY

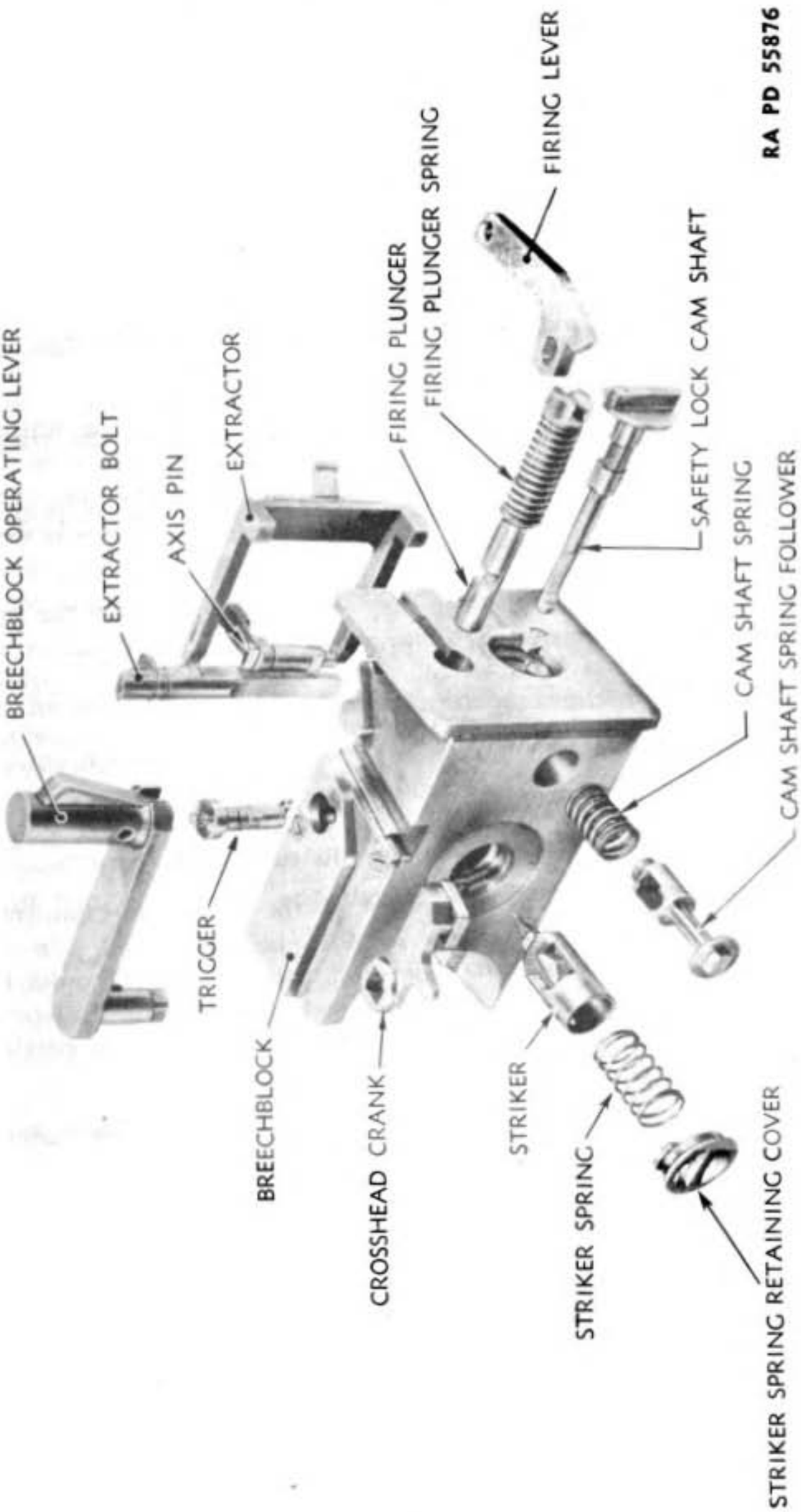


Figure 62—Breech Mechanism—Exploded View

(7) With breechblock out of the breech recess as far as the assembly lines marked on the breechblock, aline the projection on the axis pin with keyway, and remove the operating lever.

(8) Withdraw the crosshead crank.

(9) The breechblock and its remaining component parts may now be removed.

(10) Withdraw the axis pin and remove firing lever.

(11) Set in the safety lock to SAFE ("Sicher") position.

(12) Press in on the cam shaft spring follower and withdraw the cam shaft.

(13) The spring and follower may now be removed.

(14) Press in on the firing plunger and withdraw the trigger. Then remove the firing plunger.

(15) Press in on the firing spring retainer and rotate it in either direction and remove the retainer and spring.

(16) Remove the striker and tripping cam.

43. ASSEMBLY OF BREECH MECHANISM.

a. Assembly of the breech mechanism is the reverse of disassembly.

44. REMOVAL OF WHEELS.

a. Removal of the wheels is accomplished as follows:

(1) Block up the carriage so that the wheels do not touch the ground.

(2) Remove the hub caps.

NOTE: Under each hub cap is a locking wire that is sprung into place. This wire may fall out when the hub cap is partially or wholly removed.

(3) Remove the cotter pins from the wheel spindles.

(4) Remove the wheel spindle nuts.

(5) Remove the wheels.

45. REPLACEMENT OF WHEELS.

a. The wheels are replaced in the reverse order of removing them. The short bend in the locking wire is inserted in one of the three grooves on the wheel hub. The rest of the locking wire is sprung on the lip on the wheel hub provided for the purpose. When the hub cap is screwed into place, the end of the locking wire with the short bend will seat itself into a small indentation on the hub cap, thus preventing the hub cap from backing out.

CHAPTER 3

SIGHTING AND FIRE CONTROL EQUIPMENT

Section I

SIGHTING EQUIPMENT

46. INTRODUCTION.

a. The sighting and fire control equipment for the 105-mm German howitzer includes instruments for laying the gun in direct and indirect fire, and instruments for observation.

b. The sighting equipment includes the Panoramic Telescope Rbl. F. 32 (Rundblickfernohr 32) or the Panoramic Telescope Rbl. F. 16, of earlier design, secured to the telescope mount; aiming plates and aiming posts used to correct for shifting of the piece in firing; bore sights for alining the telescope with the piece; and lighting equipment for night use. The use of a gunner's quadrant for orienting the piece is indicated.

c. The fire control equipment includes the following instruments:

(1) The aiming circle is used for measuring angle of site, azimuth angles, for declinating, for spotting, and as an alidade for topographic survey for the battery.

(2) The Artillery Computer 34 calculates mechanically the meteorological corrections for firing.

(3) The Range Finder Em 34 is used for measuring ranges, and may be used against either land or aerial targets.

(4) The surveying rod is used for initial orientation of the battery.

(5) The plotting rules and protractor are used on a plotting table for measuring map ranges and angles.

(6) The fuze setter is a hand fuze setter used for cutting the time fuze.

(7) The battery commander's telescope is the principal observing instrument of the battery.

47. MOUNT, TELESCOPE WITH PANORAMIC TELESCOPE 32 (Rbl. F. 32), PANORAMIC TELESCOPE 16 (Rbl. F. 16) ON EXTENSION SOCKET AND RANGE DRUM.

a. Description.

(1) The telescope mount (figs. 63 and 64) is mounted on the left side of the carriage, and is used to lay the howitzer in azimuth and elevation.

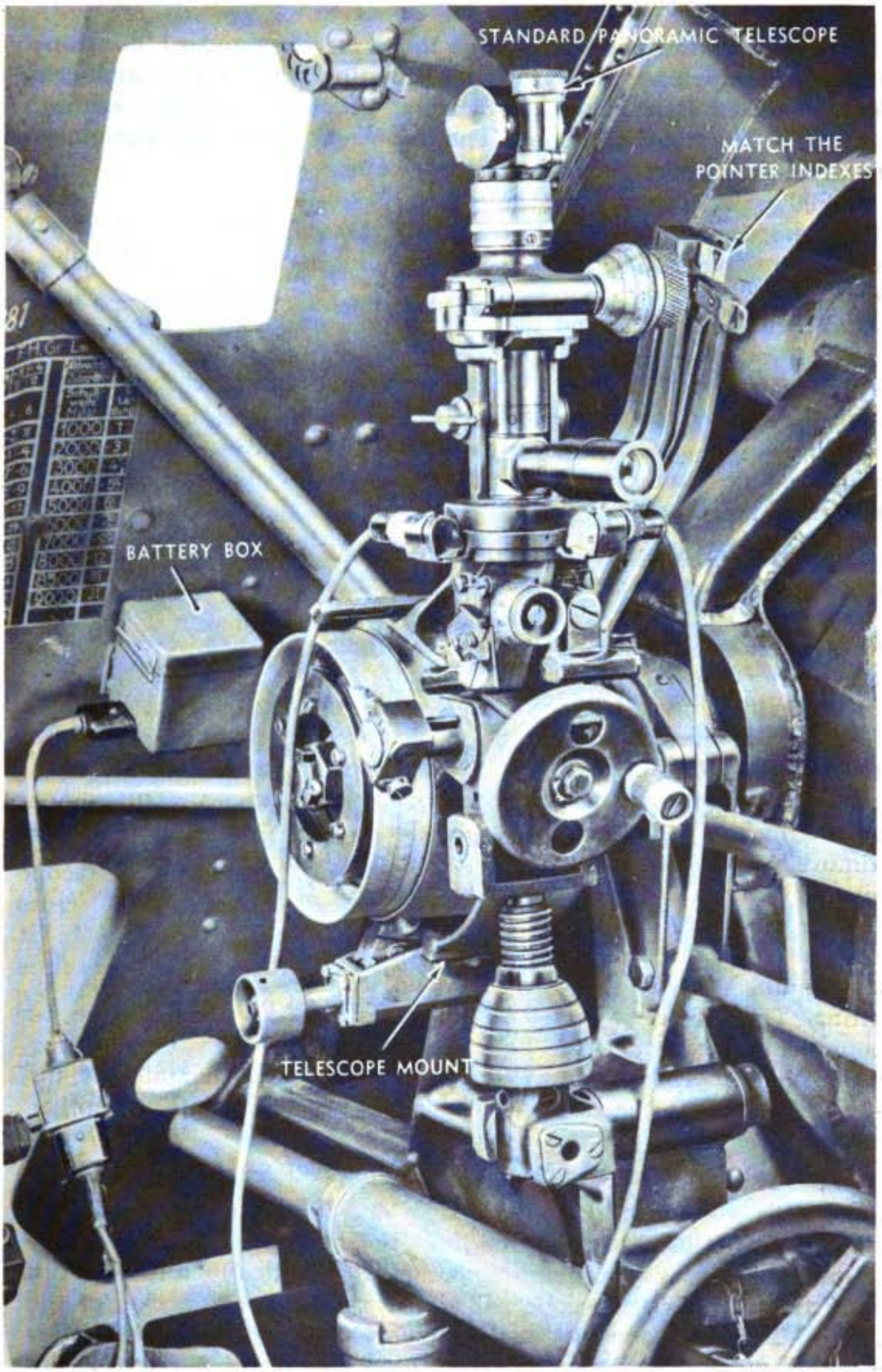
GERMAN 105-MM HOWITZER MATERIEL

(2) The telescope mount (fig. 65) is of the azimuth compensating type which permits azimuth correction when the howitzer is elevated with the trunnions out of level. Provision is made for cross leveling and setting in angle of site, with the level vial and knob provided for each motion. The angle of site scale is graduated from 0 to 500 mils. The normal setting is 300 mils. The angle of site micrometer is graduated from 0 to 100 mils in 1-mil intervals. The range drum and range drum knob are set in quadrant elevation. The range drum bears two scales: one in mils (0 to 800), and one in meters (150 to 9,150), and the corresponding mil readings are from 0 to 742 for use with the standard zone 5 charge. The pointer may be placed over either scale. The mount includes match the pointer indexes by which the elevation obtained from the telescope and telescope mount is applied to the barrel. A canvas cover, with leather reinforcement around the telescope, is provided for the telescope and telescope mount.

(3) The standard telescope (Rbl. F. 32) (figs. 63, 66, and 67) is a 4-power, fixed-focus type, and is positioned and locked in the telescope socket on the mount. The cam of the socket telescope lever engages a notch in the body of the telescope. The line of sight may be raised or lowered by rotation of the elevation knob. Coarse and fine graduations in mils are provided for reference in elevation of the head. The azimuth scales on the vertical barrel of the telescope are graduated in 100-mil intervals, the upper scale, 0 to 64; the lower scale, 0 to 32. A knurled portion permits adjustment. The center index is locked in place by a lug at the front of the telescope. The azimuth micrometer includes 2 scales graduated in mils from 0 to 100 mils. The index between the scales is fixed. It is believed that one scale is used for setting in corrections, and the other for setting in fine azimuth values. A throwout lever is provided for rapid setting in azimuth. A locking lever locks the azimuth micrometer in any setting. The reticle pattern is shown in figure 67. With the telescope mounted in the socket, the field of view is limited by the opening in the shield to 180 mils left and 214 mils right, approximately. This telescope also fits the extension which is furnished with the other telescope.

(4) The auxiliary panoramic telescope (Rbl. F. 16) (figs. 64, 66, and 67) is a 4-power, fixed-focus type and is provided with a sight extension. It is used to bring the line of sight above the shield. This permits the selection of aiming points at practically any azimuth from the gun. This telescope will not fit the telescope socket of the mount. The telescope has a cross level and longitudinal level, for checking the alinement when the telescope and bracket are secure to the mount. Since the levels ar not readily visible in this position, a mirror is provided on the telescope. The elevation scale and

SIGHTING EQUIPMENT



RA PD 55348

Figure 63—Telescope Mount With Standard Panoramic Telescope

micrometer of the head resembles those of the standard telescope. The azimuth scale is graduated in 100-mil intervals and numbered from 0 to 64. The azimuth micrometer bears only the fine azimuth scale of the standard telescope. The throwout and locking mechanism is the same as that of the standard telescope.

b. Operation.

(1) DIRECT LAYING.

(a) Set the elevation scale and micrometer on the telescope head to zero. Set the angle of sight knob to zero.

(b) Set off the lateral deflection on the azimuth micrometer of the panoramic telescope.

(c) Rotate the cross level worm knob until the bubble of the cross level is central.

(d) Set off the desired range on the range drum.

(e) Turn the longitudinal knob and the howitzer traversing handwheel to bring the telescope cross lines to bear on the target.

(f) Turn the howitzer elevating handwheel to match the pointer.

(g) During the operation of direct laying, coincidence of telescope cross lines and target must be maintained, and the telescope mount must be kept cross leveled.

(2) INDIRECT LAYING.

(a) Set off the azimuth of the target with respect to the aiming point of the azimuth scale and micrometer of the panoramic telescope.

(b) Traverse the howitzer until the vertical line in the telescope reticle falls on the aiming point, keeping the telescope mount cross leveled. To cross level the mount, turn the cross leveling knob. It may be necessary to rotate the elevating knob on the panoramic telescope in order to keep the aiming point within the field of view; this procedure being permissible in indirect laying.

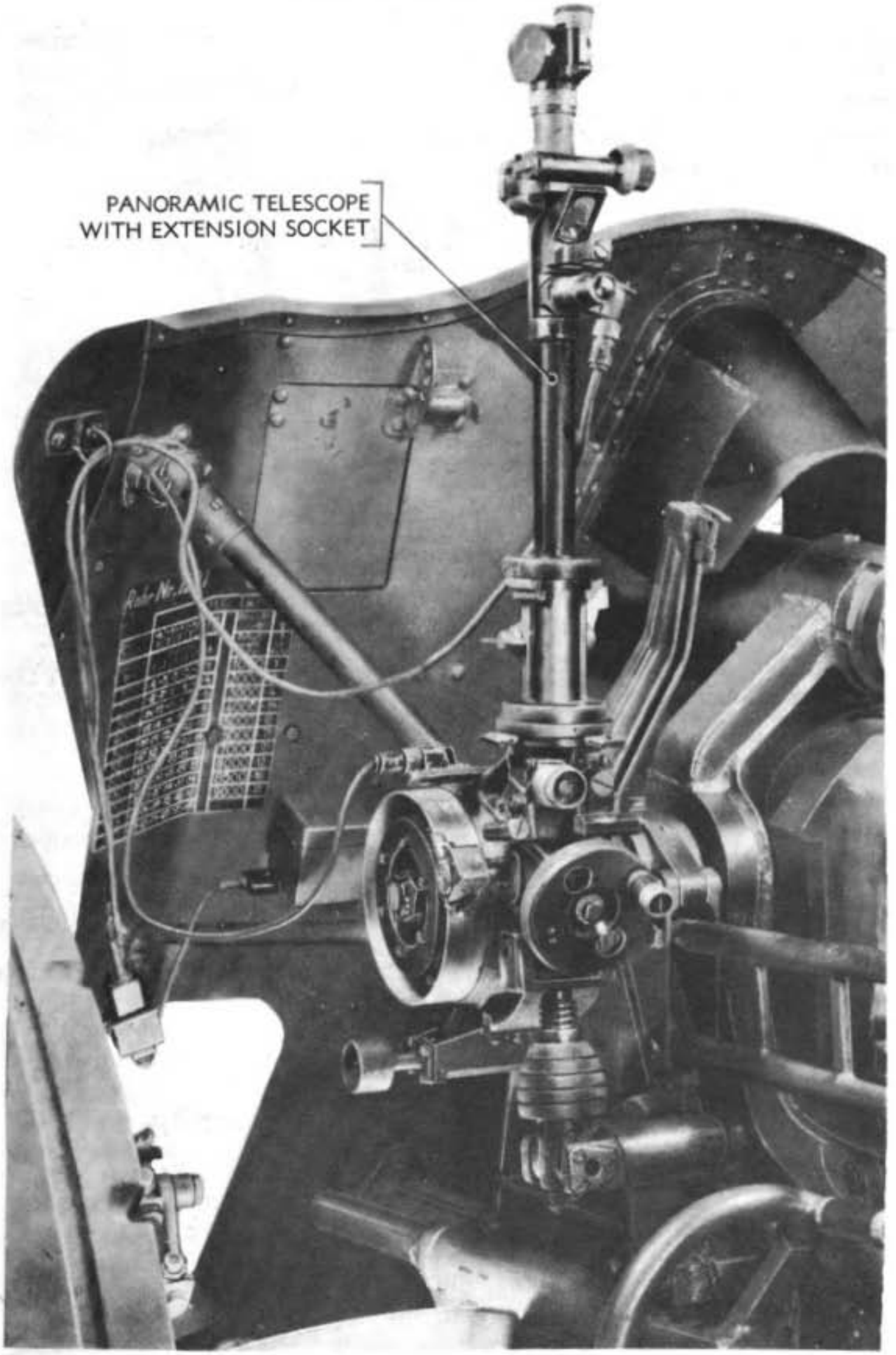
(c) Set the angle of sight on the angle of sight scale and micrometer, then center the angle of sight level bubble by turning the longitudinal knob.

(d) Set off the desired range by rotating the range drum handwheel, and reading the proper scale against the pointer. Quadrant elevation may be set off instead of range by using the elevation scale.

(e) Turn the elevation handwheel of the howitzer to match the pointers. The howitzer is now properly pointed at the target.

(f) The telescope mount must be kept cross leveled, the angle of site bubble centered, and the vertical line of the panoramic telescope coincident with the aiming point, at all times during the operation of indirect laying.

SIGHTING EQUIPMENT



RA PD 55349

Figure 64—Telescope Mount With Panoramic Telescope and Extension

GERMAN 105-MM HOWITZER MATERIEL

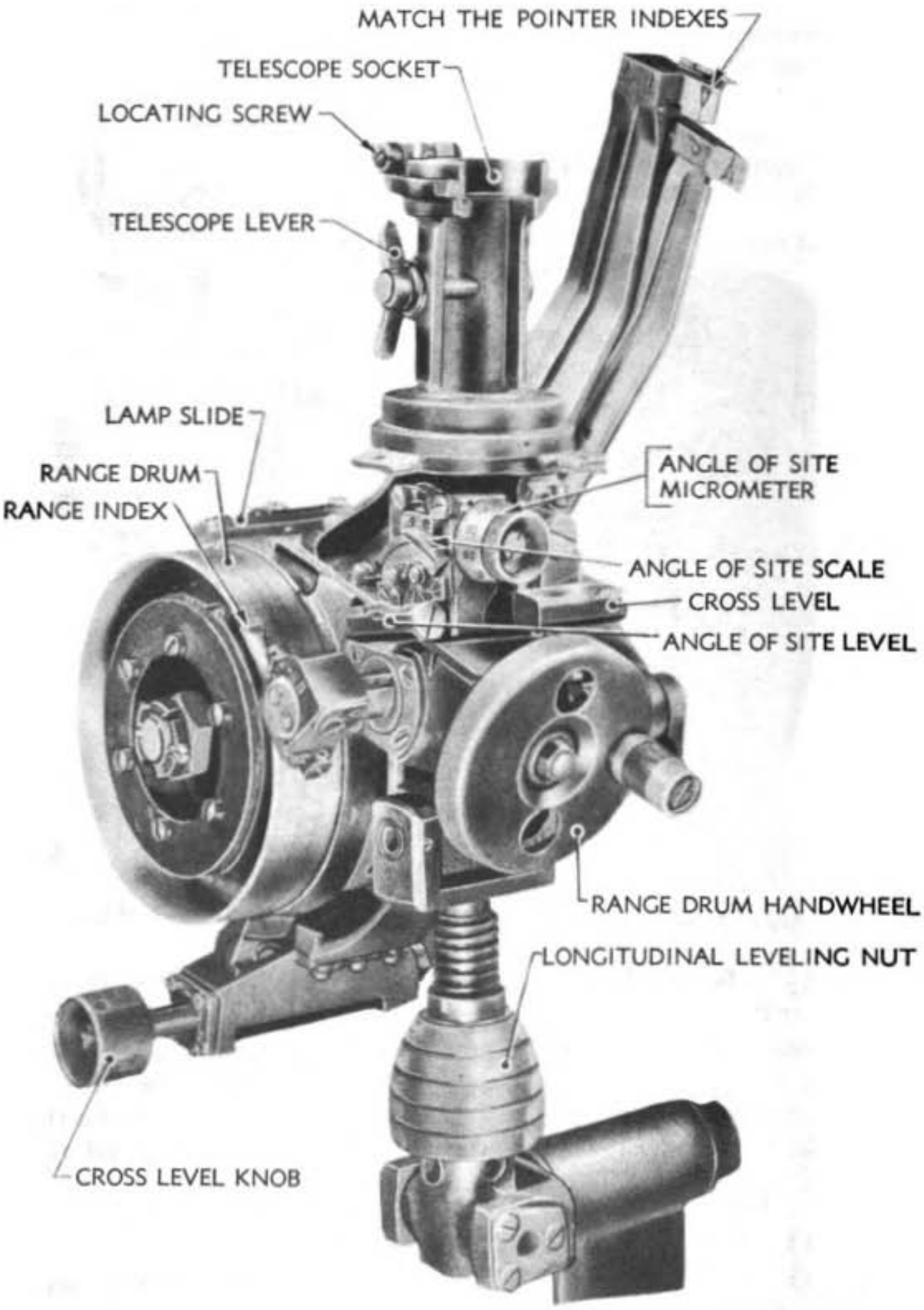
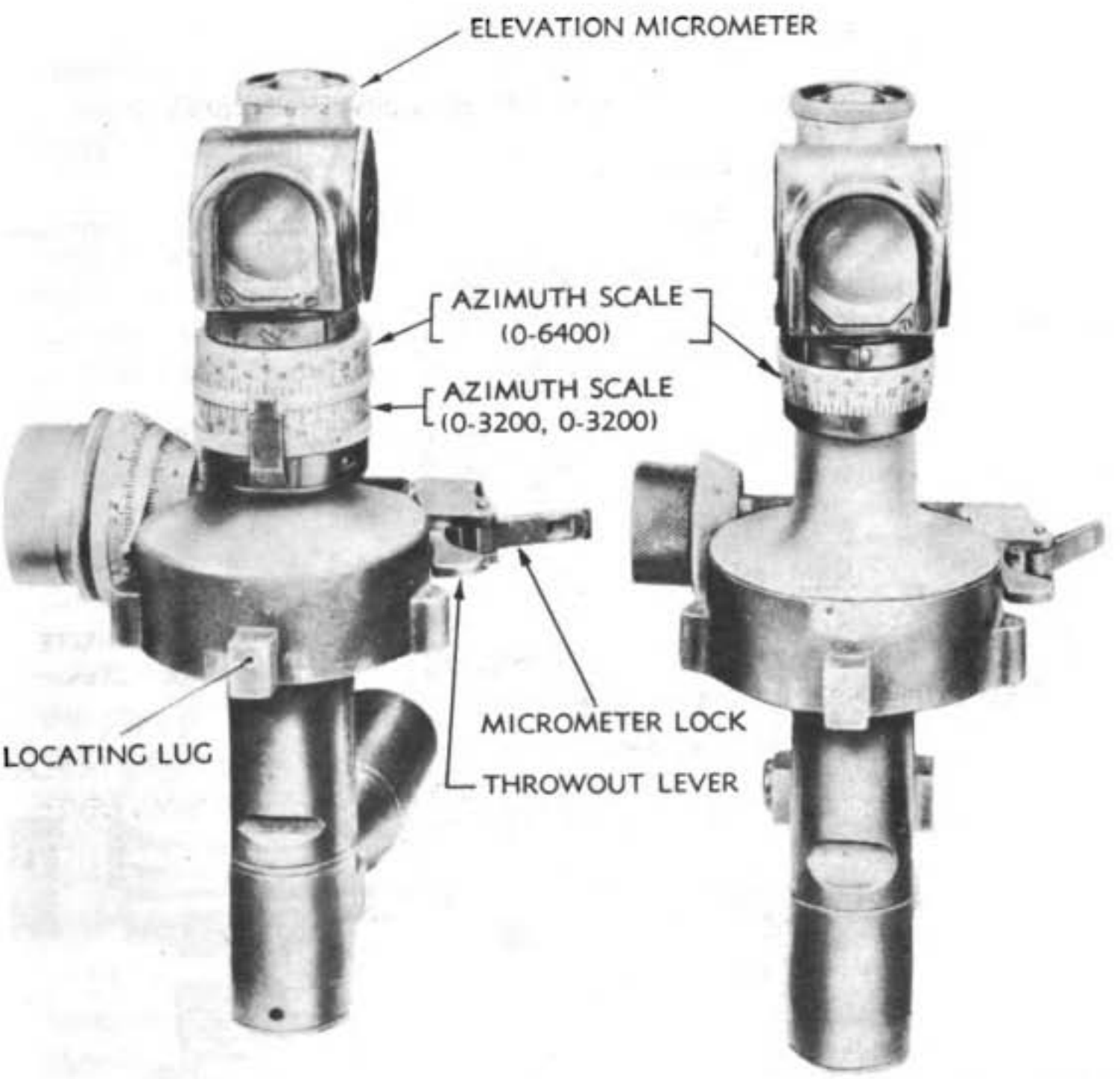


Figure 65—Telescope Mount

SIGHTING EQUIPMENT



RA PD 55351

Figure 66—Panoramic Telescopes—Front View

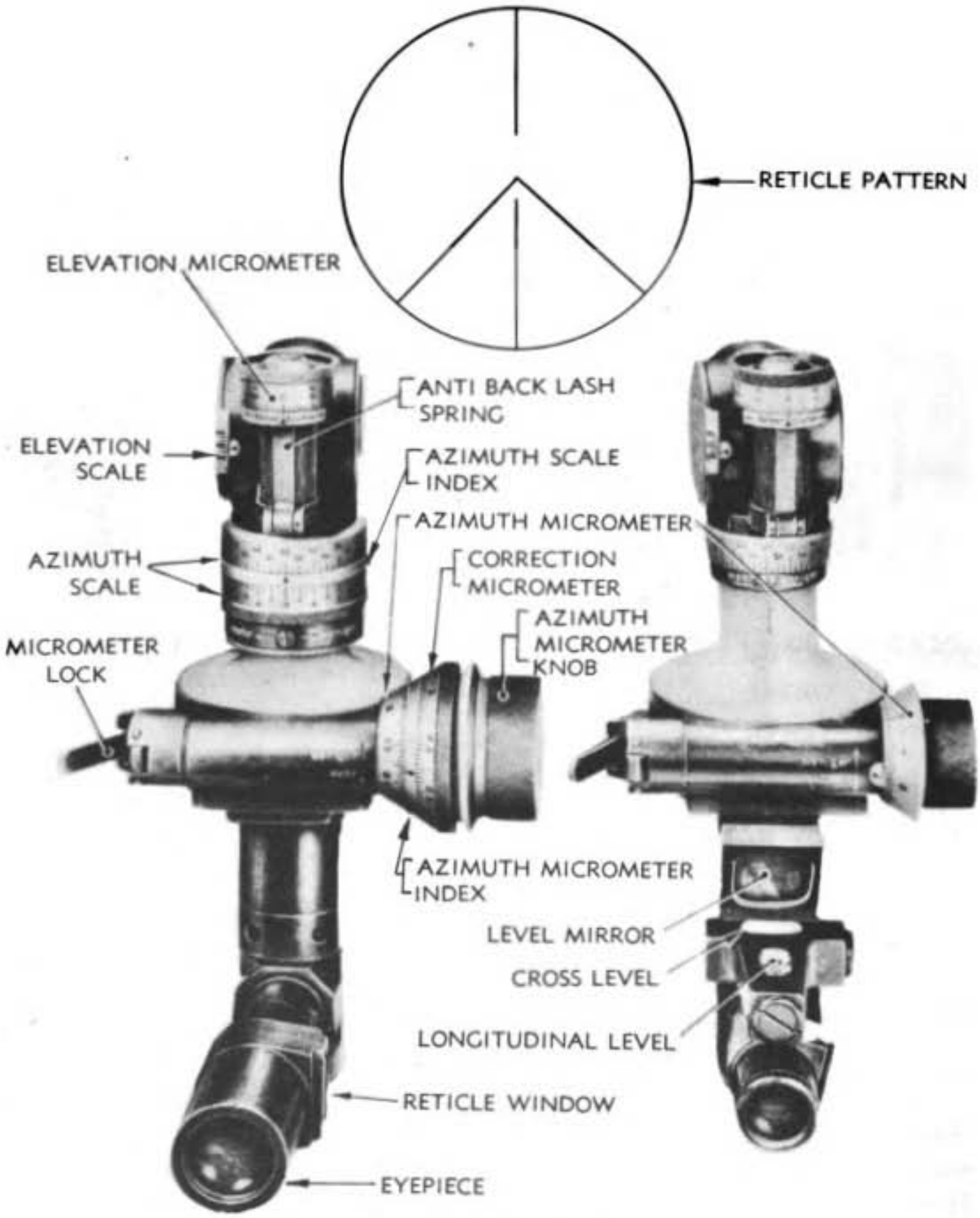
(3) USE OF PANORAMIC TELESCOPE WITH EXTENSION (fig. 64). The instructions given above apply to this panoramic telescope and extension as well, with the added condition that the level and cross level attached to the telescope be checked, to make sure that the telescope is properly seated and the extension is true, when the levels of the mount are centered and the angle of sight knob is set at normal.

c. Tests and Adjustments.

(1) VERIFICATION OF TELESCOPE MOUNT.

(a) Level the howitzer laterally (axis of trunnions) and longitudinally (axis of bore). Set the angle of sight scale and micrometer to normal. Center the bubbles in the angle of site level and in the cross level. Place a gunner's quadrant, the accuracy of which has been established, on the machined surface at the top of the telescope socket, and in a line parallel first to the axis of trunnions, and then

GERMAN 105-MM HOWITZER MATERIEL



TRANSLATION

MEHR - MORE

WENIGER - LESS

HOHER - HIGHER

TIEFER - LOWER

RA PD 55352

Figure 67—Panoramic Telescopes—Rear View

in a line parallel to the axis of bore. If the bubble of the gunner's quadrant is centered in both positions, the mount is in adjustment. If the bubble is not centered, it will be necessary to adjust the mount level in question.

(b) Adjustment of the locating screws of the telescope socket may be made, using a panoramic telescope in good adjustment. Bore sight the howitzer on a distant point and, with the telescope set in its normal position, turn the screws in or out to bring the telescope to bear exactly on the bore sighted point.

(2) VERIFICATION OF PANORAMIC TELESCOPE. Place the panoramic telescope in the telescope socket of an adjusted mount and level. Cross level and bore sight the howitzer on a distant point. With each scale and micrometer set at the normal position, sight through the telescope on the point. If the telescope is not alined in azimuth with the point, the scale and micrometer require adjustment. Turn the micrometer to accurately aline the telescope with the distant point. Loosen the locking screw off center in the end of the micrometer knob, shift the micrometer to index exactly, then reclamp the knob. If the azimuth scale is also out of alinement, loosen the scale clamp, adjust the scale, and reclamp. Check the new settings by turning the telescope away from the point, and then bring it to bear again on the point.

(3) VERIFICATION AND ADJUSTMENT OF MATCH THE POINTER INDEXES OF TELESCOPE MOUNT. The match the pointer indexes should line up with each other when the telescope mount and howitzer are level. One of the indexes has slotted mounting holes for adjustment. Adjustment may be performed by temporarily loosening the two screws on the index, and shifting the index to correct alinement.

d. Care and Preservation.

(1) Refer to paragraph 60 for general instructions pertaining to the care and preservation of instruments.

(2) Stops are provided to limit the longitudinal and cross leveling motions, and no attempt should be made to force the mechanisms beyond these limits. Avoid rough handling which might disturb adjustment of the telescope and mount.

(3) Oil cups circled in red are provided for lubrication of the principal bearings, and oil only is to be applied.

(4) Disassembling of the panoramic telescopes or telescope mount, other than the disassembling incident to normal operating procedure, is not permitted.

GERMAN 105-MM HOWITZER MATERIEL

48. AIMING PLATES.

a. Description. One or two aluminum plates (fig. 68), graduated in two centimeter divisions to a length of one meter, are provided with each howitzer. Each plate has two detachable steel pickets for embedding the plate in the ground. When it is not in use, the plate is folded in half. Two plates are placed in a canvas carrying case.

b. Use. The aiming plate is used with the split-trail howitzer to compensate for the shifting of the piece and telescope in firing. The scale is placed at a distance of 20 meters (65.62 feet) from the telescope to give readings of 1 mil. The center graduation of the plate is lined up with the aiming post and the telescope. If the piece and the telescope move, the displacement is read through the telescope in mils on the scale of the plate. The telescope is reset accordingly.

49. AIMING POST.

a. Two round wooden aiming posts (fig. 69), painted in alternate red and white bands, are provided with each howitzer. Each post consists of two sections which are assembled with a left-hand thread. The thread also fits the brushes used for cleaning the bore. The lower section of each post has a steel foot support for embedding the post in the ground. One of the posts is carried on the carriage, one section on the outside of each trail leg. It is not known whether a definite place is set aside for the other post.

50. GUNNER'S QUADRANT.

a. Information on the gunner's quadrant is not available. The use of a quadrant in bore sighting the howitzer is indicated by the presence of three screws on the breech. The screws are used for positioning the quadrant each time in the same position.

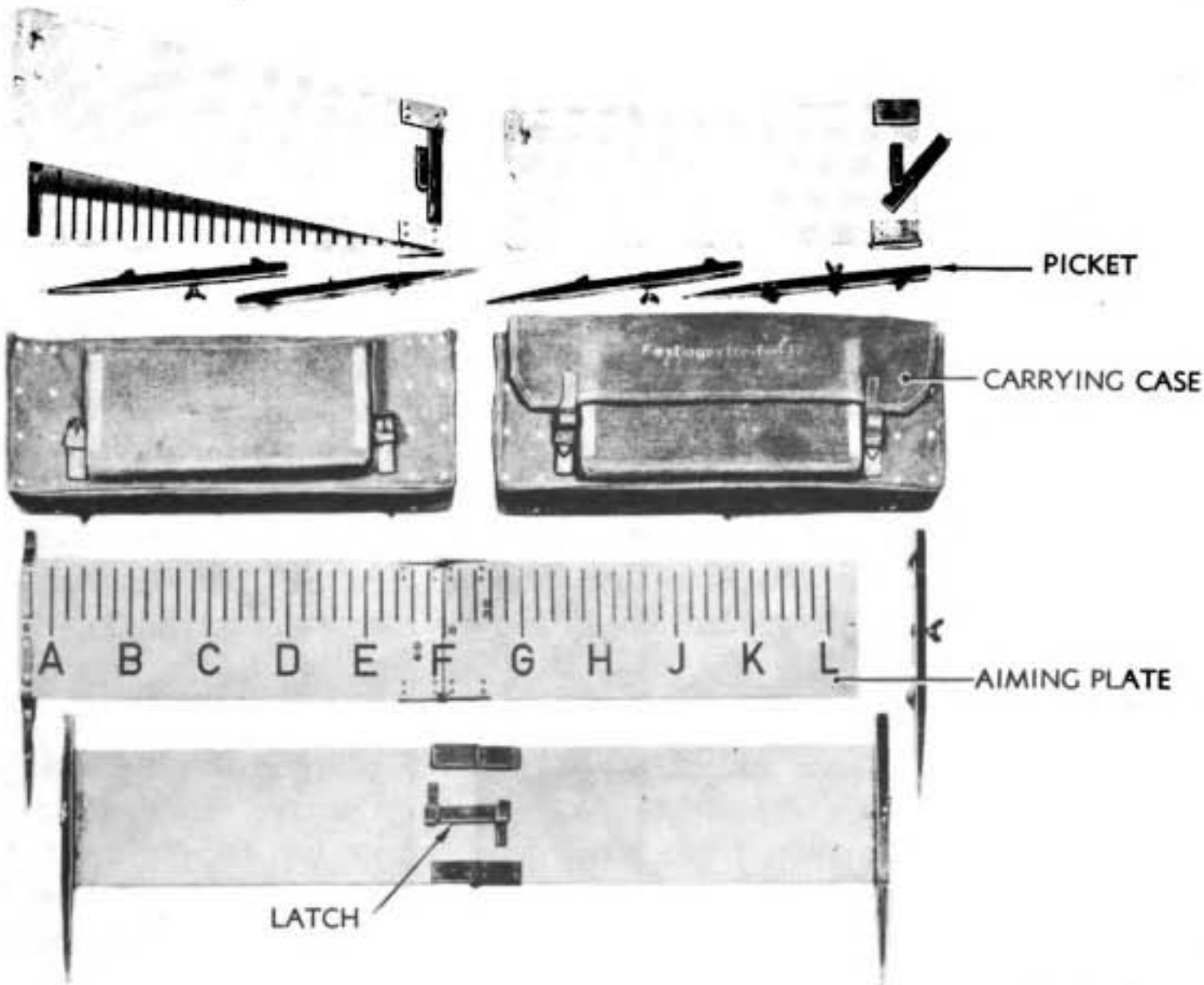
51. BORE SIGHT.

a. The bore sight is used to indicate the direction of the axis of the bore for orientation purposes. Each bore sight consists of a breech element and a muzzle element.

b. Description.

(1) The American breech bore sight is a disk which fits accurately in the breech chamber of the howitzer. There is no information available as to the construction of the breech bore sight used on this howitzer although it probably resembles the American type. Where the breech bore sight is lacking, an empty cartridge case with primer removed is sometimes used, or the firing pin may be removed and the firing pin hole will then serve as the breech bore sight.

SIGHTING EQUIPMENT



RA PD 55353

Figure 68—Aiming Plates

(2) Score marks on the face of the muzzle indicate that the muzzle bore sight consists of two pieces of string, stretched tightly across the muzzle, positioned by the horizontal and vertical score marks, and held in place by a strap.

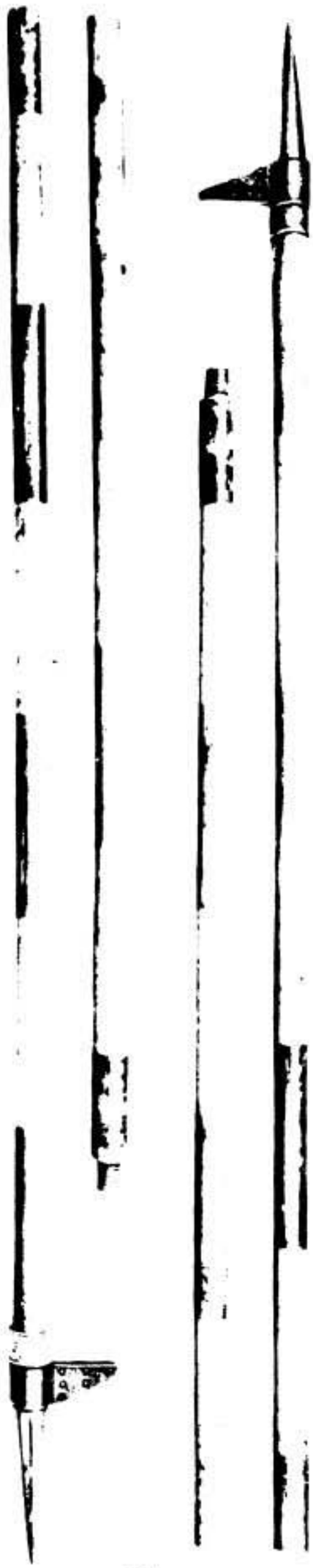
c. Operation. With the two elements in place, look through the aperture in the bore sight; the direction of the axis is indicated by the cord intersection.

d. Care and Preservation. The cord and belt of the muzzle bore sight should be wound into a compact bundle when not in use. Handle the breech bore sight carefully to prevent nicking and burring.

52. LIGHTING.

a. The on-carriage sighting equipment and the fire control instruments have individual lighting units made up of battery and battery box and cable assemblies. These lighting units appear to be interchangeable on German instruments, but may not be used on any American instrument. Two battery boxes are supplied.

GERMAN 105-MM HOWITZER MATERIEL



RA PD 55354

Figure 69—Aiming Posts

SIGHTING EQUIPMENT

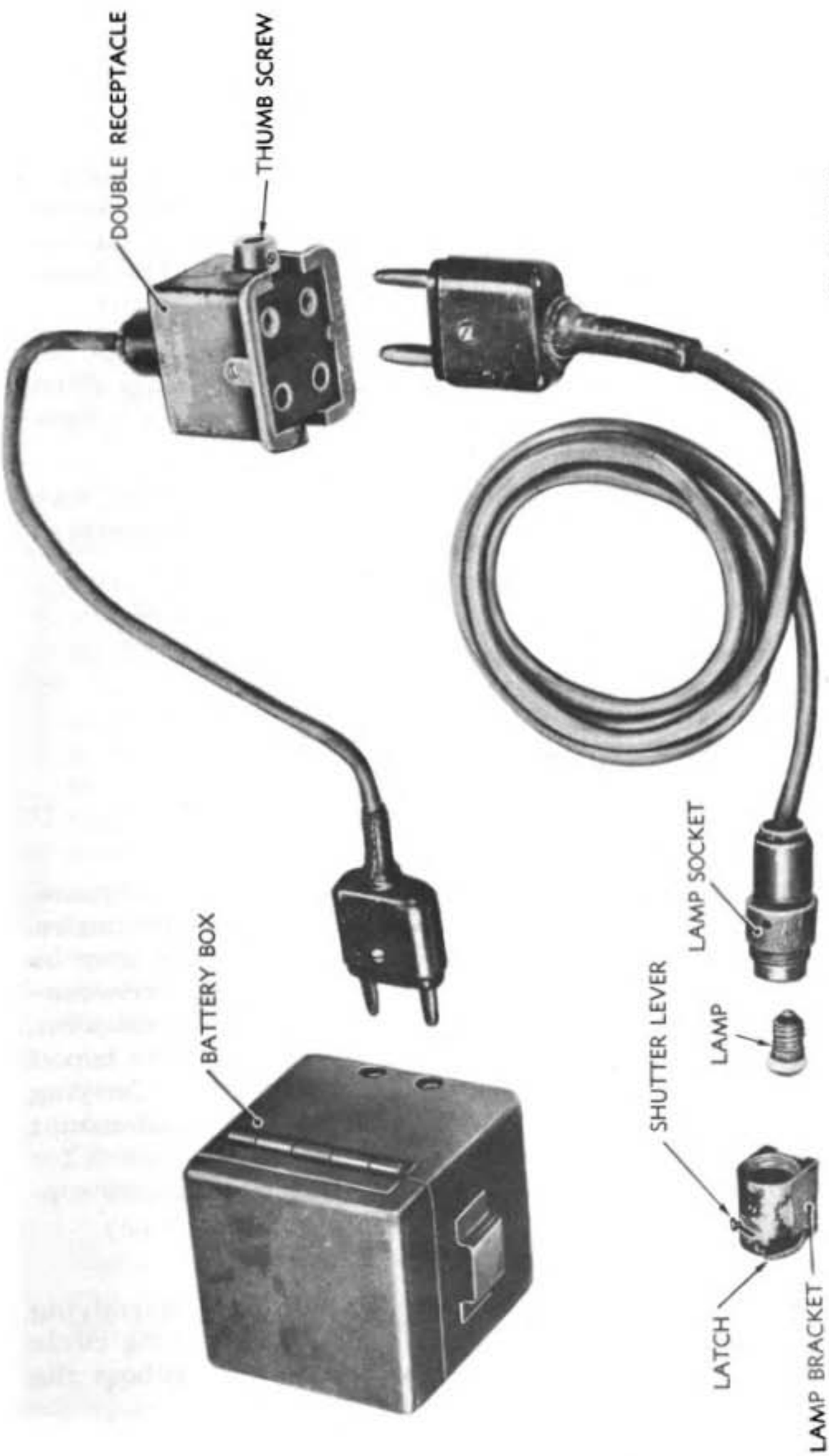


Figure 70—Lighting Equipment

b. The shape of the battery is unknown but it probably is of flashlight type, fitting the battery boxes (fig. 70). The battery box contains a receptacle for the cable. Two types of cable assemblies are furnished: one, including a plug, cable, and lamp bracket; the other, a plug, cable, and double receptacle for extension purposes. The lamp bracket assemblies include a lamp socket screwed into the bracket which has dovetail slots for engaging the slides in the instruments. A shutter regulates the amount of light given off. A latch at the end of the bracket engages a notch in the slide for locking. The lamps are 3.5-volt, 0.2-ampere, miniature screw base type.

c. Slides are provided on the telescope for illumination of the reticle. Slides on the mount permit illumination of the range drum index, and the two levels. On the shield of the carriage is a hook for holding the extension receptacle, and for loose cable.

d. The battery commander's telescope and the aiming circle have slides adjacent to the reticles, for attachment of the lamp brackets as required.

e. A lighting device is also furnished for the aiming post.

Section II

FIRE CONTROL EQUIPMENT

53. AIMING CIRCLE.

a. **General.** The aiming circle (figs. 71 to 74) is used for measuring angle of site, for declinating and determining azimuth angles, and for spotting. The instrument, removed from the tripod, may be used on a plane table for topographic survey. The aiming circle consists of a periscope, a telescope having 4- or 5-power magnification, an angle of site mount, an azimuth mount, and a tripod. The tripod is the same as that of the battery commander's telescope. Carrying cases for the instrument and the tripod are provided. A trench mount is furnished which can be embedded in the ground or in wood, for use in place of the tripod. A lamp bracket and portable battery supplies light for the telescope reticle. Graduations are in mils.

b. **Description of Components.**

(1) The periscope raises the line of sight, but has no magnifying power. It is attached, but not locked in place, to the aiming circle by a dovetailed slide. The aiming circle may be used without the periscope.

(2) The telescope has an adjustable focusing eyepiece. Horizontal and vertical cross lines and a deflection scale are on the reticle of the

telescope. On top of the telescope body is a level used with the angle of site mechanism. On the left of the telescope is a circular level. A sun shade is provided for use when the periscope is not attached.

(3) The angle of site mount supports the telescope, and includes a graduated elevation scale and micrometer, a magnetic needle, a circular level, and clamping devices.

(a) The elevation scale is graduated from 0 to 1,400 mils, and the micrometer from 0 to 100 mils. The normal setting is 300 mils.

(b) The magnetic needle has a visible range of 10 degrees on either side of the magnetic north line. A knob below the window marked "N" locks the needle when it is not in use. A window at the "S" end permits observation from the rear of the instrument.

(c) The circular level is used with the compound head of the tripod for leveling the instrument.

(d) Clamping levers lock the angle of site mount on the azimuth mount.

(e) The folded 10-centimeter ruler (fig. 74) is for use when the telescope and angle of site mount, disengaged from the traversing mechanism, are in use on a plane table in topographic survey.

(4) The azimuth mount has a tapered stud which supports the angle of site mount; an azimuth scale, graduated from 0 to 6,400 mils in 100-mil intervals; and a micrometer graduated from 0 to 100 mils in 1-mil intervals. A throwout lever permits rapid traversing of the instrument. The azimuth mount is clamped to the spindle of the tripod.

(5) The tripod is used for both the aiming circle and battery commander's telescope. The tripod includes a spindle, a worm and a worm wheel mechanism, a ball and socket joint, and individually clamped legs. The spindle supports the instrument and is attached to the worm and worm wheel which is used for orientation. The ball and socket joint includes the ball at the end of the spindle, and two clamping nuts, one of which permits cross leveling and the other, circular oscillation. The tripod legs have clamping levers at the head for locking each leg to the head. At the foot of each leg is a steel point and footrest which facilitates embedding in the ground.

(6) The carrying case (fig. 73) is provided for the instrument. The table of contents pasted in the cover also lists 1 plug in lamp and 4 lamps, a dry cell battery box, a dust brush, a cleaning cloth, and an impregnated cloth to be used for decontamination purposes.

c. Operation.

(1) To set up the instrument, clamp the tripod legs at the desired length and embed them firmly in the ground. Level the instrument, using the circular level and the ball and socket joint. Tighten

GERMAN 105-MM HOWITZER MATERIEL

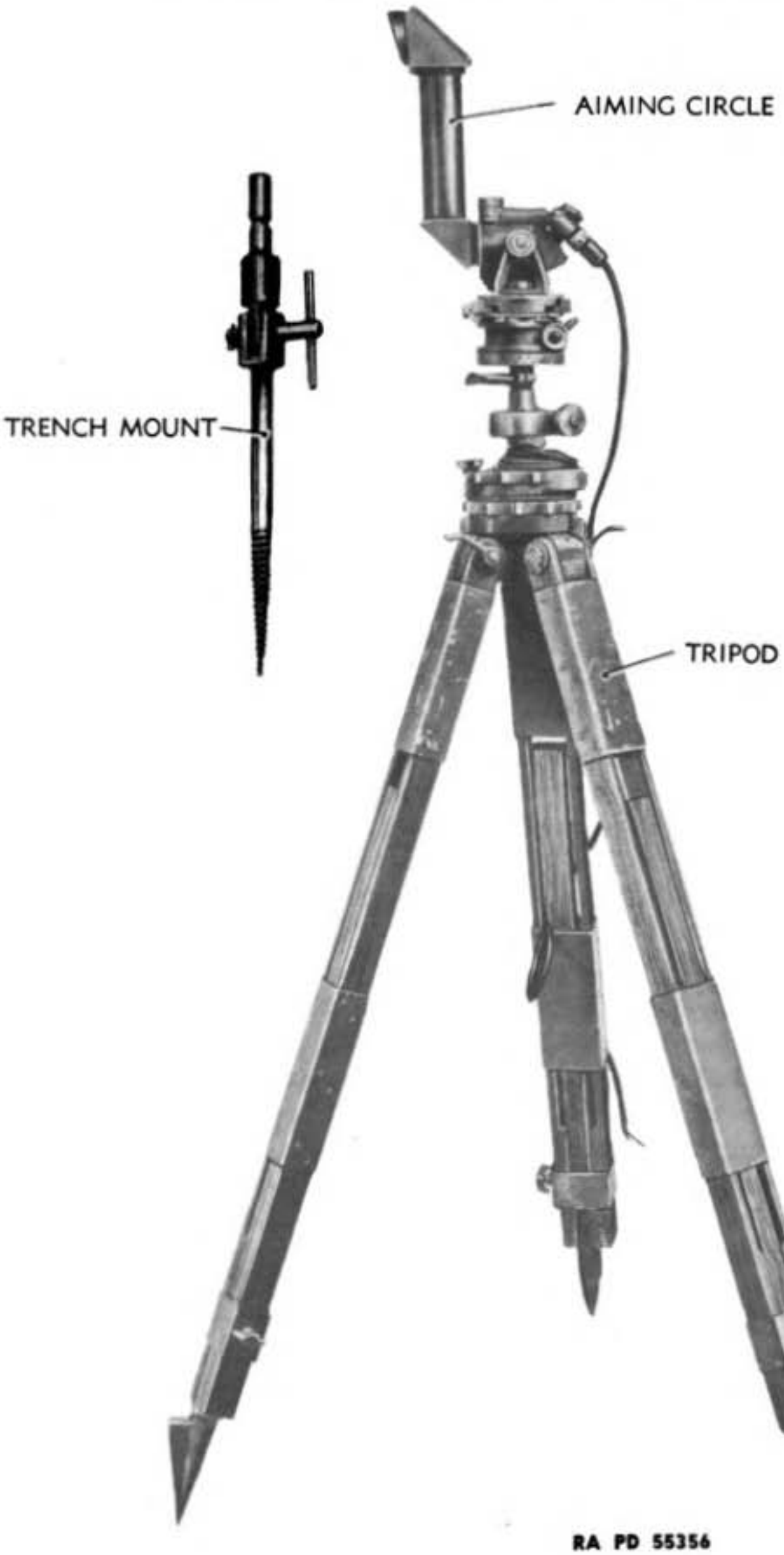


Figure 71—Aiming Circle

FIRE CONTROL EQUIPMENT

TRANSLATION

LOS - LOOSE

FEST - LOCKED

OSTW. - EASTWARD

WESTI. - WESTWARD

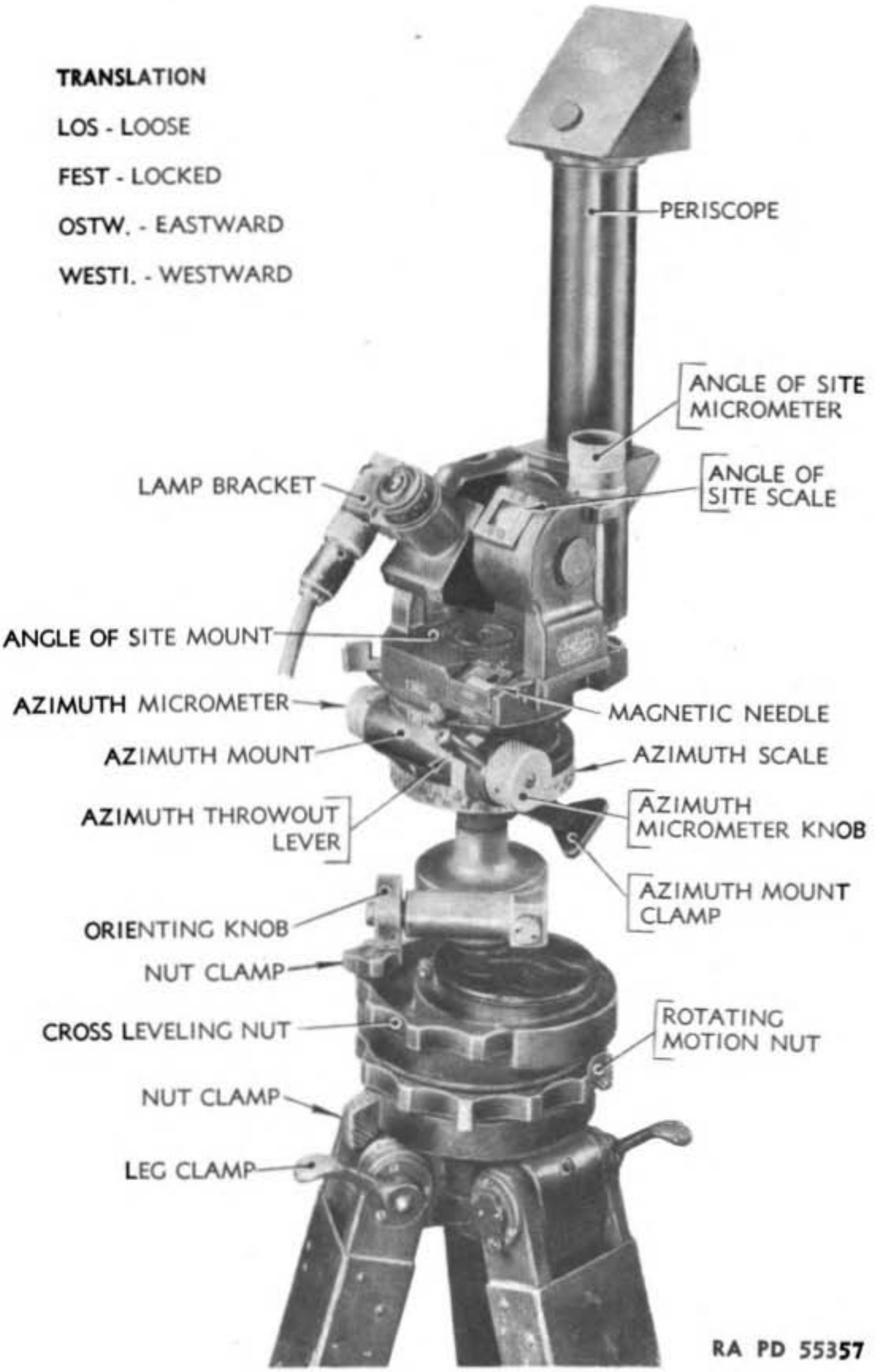


Figure 72—Aiming Circle—Close-up

GERMAN 105-MM HOWITZER MATERIEL

TRANSLATION

VOR EINSETZEN DES RKR. MAGNETNA DEL FESTLAGEN!
BEFORE PACKING THE AIMING CIRCLE CLAMP THE MAGNETIC NEEDLE

AUSBLICK - CAUTION

INHALTSVERZEICHNIS
LIST OF CONTENTS

KASTEN RKR 31
CHEST - AIMING CIRCLE 31

1 - RICHTKREIS -
1 AIMING CIRCLE

1 - DECKUNGSPIEGEL -
1 PERISCOPE

1 - ANSTECKLAMPE -
1 PLUG IN LAMP

1 - BEHALTER FUR STROMQUELLE -
1 BATTERY BOX

1 - KLARINOLTUCH IN TACHE - 1 IMPREGNATED CLOTH

4 GLUHLAMPEN - 4 LAMPS
3.5 V, 0.2 A.

1 PUTZTUCH -
1 CLEANING CLOTH

1 STAUBPINSEL -
1 DUST BRUSH

Figure 73—Aiming Circle Components

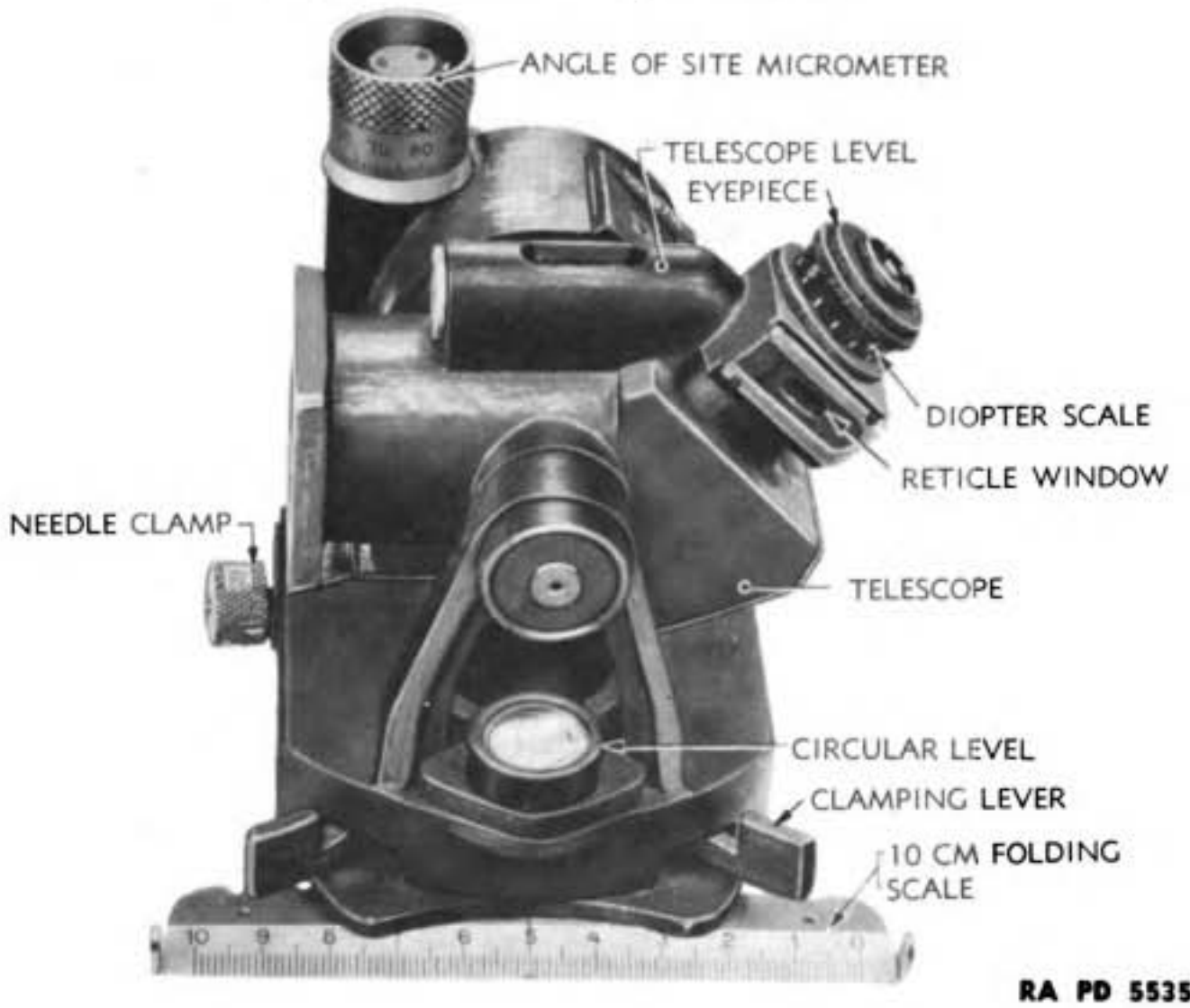


Figure 74—Aiming Circle—Angle of Site Mount

the clamping nuts. Focus the telescope as required, using the sleeve on the eyepiece to set in the correction necessary for the observer's eye.

(2) To orient the instrument, a datum point of known azimuth or a magnetic bearing may be used.

(a) To orient on a datum point of known azimuth, set the main azimuth scale (100-mil intervals) and micrometer (1-mil intervals) to the azimuth of the datum point, and turn the orienting knob until the datum point appears on the vertical cross line of the reticle. The instrument may also be relocated on the tripod spindle, using the orienting clamping screw for large angular changes. The telescope may be elevated or depressed as required to center the point in the field of view.

(b) To orient on magnetic north, set the main azimuth scale and micrometer to indicate zero. Press the plunger releasing the magnetic needle and turn one of the orienting knobs until the north-seeking end of the magnetic needle appears approximately opposite the "N" index at the front of the instrument, then refine the setting so that the south-seeking end of the needle is centered in the reticle. The instrument may also be relocated on the tripod spindle using the orienting clamping screw for large angular changes. The aiming circle will then indicate magnetic azimuths.

(c) To orient on grid north, proceed as for magnetic north, but set the azimuth to the magnetic declination of the locality (subtracting west declinations from 6,400 mils) instead of to zero. The instrument will then indicate grid azimuths.

(d) When orientation by magnetic bearings has been completed, turn the knob to clamp the magnetic needle.

(3) To read azimuth, bring the object on the vertical cross line of the reticle using the azimuth knob; the throwout lever may be depressed for making large azimuth changes rapidly. Azimuths from 0 to 6,400 mils are read directly on the azimuth scale; the scale is graduated at 100 mil-intervals, and the micrometer is graduated at 1-mil intervals.

(4) To read angle of site, first make sure that with the telescope level bubble and the circle level bubble centered the angle of site scale and micrometer read normal. Then center the object in azimuth. Raise or depress the angle of site micrometer to center the object on the reticle cross lines and read the angle of site on the scale and micrometer.

(5) To prepare the instrument for traveling, place it in the carrying case provided.

d. Tests and Adjustments.

(1) The azimuth micrometers should read "0" when the azimuth scale indicates zero. The screw in the end of the azimuth micrometer may be temporarily loosened for this adjustment.

(2) The telescope level should indicate the line of sight as determined by the center of the reticle to be horizontal. This may be verified by sighting on a distant point at the same level as the telescope, the error, if any, being read on the reticle. No corrective adjustment by the using arms is permitted.

(3) To check the accuracy of the declinator, it is necessary to set up the instrument in a position not subject to local magnetic attraction, and sight on one or (preferably) more points of known azimuth. The average error should be noted and the necessary correction recorded. No adjustment by the using arms is permitted.

54. ARTILLERY COMPUTER 34 (ARTILLERIE RECHENSCHIEBER 34).

a. General.

(1) The Artillerie Rechenschieber 34, sometimes called artillery computer; artillery slide rule; and artillery weather calculator are

FIRE CONTROL EQUIPMENT

intended for use with the 105-mm Light Field Howitzer 18 with the following ammunition:

Abbreviation on Instrument	German Terminology	American Translation
F.H. Gr. 38 Stg	Feldhaubitze granate 38 stahlguss	Field howitzer shell 38—cast steel
und	und	and
F.H. Gr.	Feldhaubitze granate	Field howitzer shell
mit	mit	with
A.Z. 23V (0,25)	Aufshlagzünder 23 Verzögerung (0,25)	Percussion fuze, 23, delay action (0.25 sec.)
Dopp Z.S./60 Fl.	Dopplezünder S/60 Fleihkraft	Combination fuze S.60, centrifugal

(2) The instrument mechanically calculates firing data from the metro message data.

(3) In using the computer with American data the following points should be remembered.

(a) The German Wetter-Meldung differs from the American metro message in giving data in terms of time of flight rather than in zones of height.

(b) The German values for wind bearing and gun target bearing are given in wind numbers, i.e., the azimuth scale is graduated in 32 parts for a complete circle corresponding to the 32 points of the compass. Divide American mil values by 200 when setting them into the instrument.

(c) The German wind velocity is given in meters per second. Multiply the American values in miles per hour by 0.447 to set meters per second into the instrument.

(d) The German air density is given in kilograms per cubic meter. The American air density is expressed in percent of standard, or 100 percent based at a sea level air density of 525.9 grains per cubic foot at 59°F. This corresponds for standard air density to 1.203 kilograms per cubic meter. Conversion to air densities other than standard may be done by multiplying 1.203 by the percent of standard and dividing by 100. If air density values expressed in kilograms per cubic meter cannot be readily obtained, set the instrument to 1.20 kilograms per cubic meter (the closest practical setting to the theoretical value).

(e) The German angle of site values include a correction for non-rigidity of trajectory.

(f) The fuze setting values (Zünderstellung in Grad vom Kreuz) obtained are the German arbitrary values graduated on the fuze setter time scale.

GERMAN 105-MM HOWITZER MATERIEL

Figure 75—Artillery Computer 34 (German)—Case

(g) Muzzle velocity corrections are normally carried on the shield of each piece with which this instrument may be used.

b. Description.

(1) The instrument is carried and operated in its light aluminum carrying case. Its dimensions are approximately 19 inches x 8 inches x 3 inches, and its weight is approximately 15 pounds complete.

(2) It includes a range scale with pointer; correction disks on which are set off, in turn, wind velocity and direction, and gun target direction; and mechanisms correcting for air density, weight of projectile, muzzle velocity, and powder temperature. The disks are linked so that the corrections are accumulated and give a lateral correction for cross wind and a corrected range. In the cover of the case are curves and scales for determination of charge, angle of site, time of flight in seconds, and fuze setting.

(3) The data set into the computer includes:

(a) Metro message.
Wind velocity (meters per second).
Direction of wind.
Density of air (kilograms per cubic meter) for prevailing temperature and barometric pressure.

(b) Temperature of powder (Celsiusgrad (same as degrees Centigrade)).

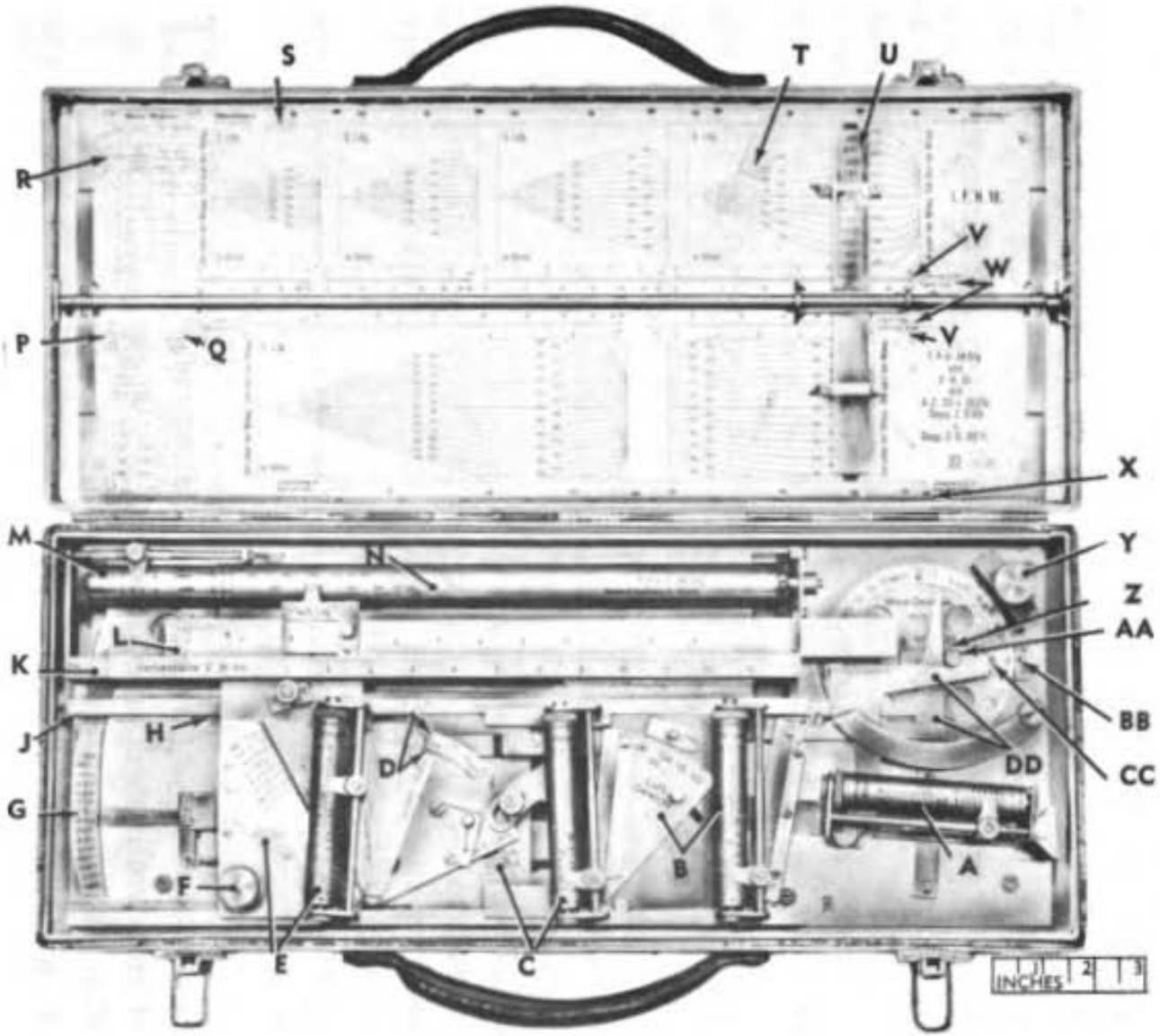
(c) Weight of projectile (zones).

(d) Correction for change of muzzle velocity.

(e) Measured range (map ranges in kilometers).

(f) Gun target direction.

(g) Difference in height between gun and target (meters).



A—WIND COMPONENT RANGE DRUM
B—AIR DENSITY CORRECTION MECHANISM AND RANGE DRUM
C—PROJECTILE WEIGHT CORRECTION MECHANISM AND RANGE DRUM
D—MUZZLE VELOCITY CORRECTION SCALE AND INDEX
E—POWDER TEMPERATURE CORRECTION MECHANISM AND RANGE DRUM
F—RANGE CORRECTION KNOB
G—LATERAL CORRECTION SCALE *(FOR CROSS WIND)*
H—RANGE CORRECTION INDEX
J—RANGE CORRECTION SCALE
K—CORRECTED RANGE SCALE
L—MAP RANGE SCALE
M—RANGE DRUM *(LATERAL CORRECTION)*
N—TANGENT ELEVATION SCALES
P—AIR DENSITY CORRECTION TABLE
Q—FLASH REDUCER TABLE
R—METRO MESSAGE TABLE
S—FUZE SETTING SCALE
T—ANGLE OF SITE CURVES *(FOR EACH CHARGE)*
U—GUN-TARGET HEIGHT SCALE
V—RANGE SCALES
W—TIME OF FLIGHT SCALES
X—FUZE SETTING SCALE
Y—WIND COMPONENT KNOB
Z—WIND VELOCITY SCALE
AA—CLAMP
BB—GUN-TARGET BEARING INDEX
CC—WIND BEARING INDEX
DD—SHOES

RA PD 81302

Figure 76—Artillery Computer 34 (German)—Arrangement

GERMAN 105-MM HOWITZER MATERIEL

(4) The instrument contains the following tables and mechanisms:

(a) Metro message table: containing columns for day, month, hour, and height of plane of metro message.

(b) Air density correction table: correction between firing point and metro station.

(c) Time of flight, and fuze setting and angle of sight charts.

(d) Powder temperature correction mechanism.

(e) Muzzle velocity correction mechanism.

(f) Projectile weight correction mechanism.

(g) Air density correction mechanism.

(h) Wind component mechanism.

(5) The following data is obtained from the instrument:

(a) Lateral correction for cross wind in mils.

(b) Corrected range in kilometers.

(c) Amount of range corrected in kilometers.

(d) Corrected tangent elevation.

(e) Corrected angle of site in mils.

(f) Fuze setting in degrees from the cross or safe setting.

(g) Time of flight in seconds.

c. Operation—Settings.

(1) METRO MESSAGE.

(a) On the metro message table, use a soft lead pencil or crayon to fill in the columns marked:

Tag—day.

Monat—month.

Uhr—hour.

Höhe (Dm)—height in decimeters.

Ball. Luftgew. i. Dezim. kg/cbm—ballistic air density in kilograms/cu. meter.

Ball.—wind.

Richtg. Windz.—wind figures (direction of wind).

Geschw. m/s—velocity meters/sec.

(b) In noting the data in the column headed "Richtg. Windz." the values noted (wind numbers) represent intervals of 200 mils, to match the wind component disk which has 32 graduations in 360 degrees. Hence, the number "2" would mean 400 mils.

(2) AIR DENSITY CORRECTION.

FIRE CONTROL EQUIPMENT

Wetter-Meldung — METEOROLOGICAL REPORT

Tag	Monat	Uhr	Höhe (Dm)

DAY — MONTH — HOUR (TIME) — HEIGHT

Flugzeit s	Ball. Luftgew. L Dezim. kg/cbm	Ball.-Richtg. Windz.	Wind-Geschw. m/s
10			
15			
20			
25			
30			
40			
50			
60			
70			
80			

TIME OF FLIGHT (SECONDS) — VELOCITY OF WIND — DIRECTION OF WIND (IN WIND FIGURES) — BALLISTIC AIR DENSITY KILOGRAMS PER CUBIC METER

CORRECTION OF AIR DENSITY FOR DIFFERENCE IN ALTITUDE: FIRING POSITION-HEIGHT OF METRO STATION

Verbesserung des Luftgewichts für Höhenunterschied: Feuerstellung - Höhenlage der Wettermeldung		Kartusch-Vorlage	
		Ldg.	Stufen-Ändg.
Feuerstellung: höher + / tiefer −	Luftgewicht: kleiner − / grösser +	1	+ 8
		2	+ 6
m	kg/cbm	3	+ 4
± 50	∓ 0,01	4	+ 3
± 100	∓ 0,01	5	+ 2
± 150	∓ 0,02	6	± 0
± 200	∓ 0,03		
± 250	∓ 0,04		

FLASH REDUCER TABLE — MUZZLE VELOCITY CORRECTION — CHARGE OR ZONE — FIRING POSITION HIGHER +; LOWER − — AIR DENSITY LESS −; MORE + KILOGRAMS/CU. METER

L.F.H.18

RA PD 31745

Figure 77—Artillery Computer 34 (German)—Metro Message Table

GERMAN 105-MM HOWITZER MATERIEL

(a) At the bottom of the metro message platen is a two-columned table headed:

"Verbesserung des Luftgewichts für Höhenunterschied:
Feurstellung—Höhenlage der Wettermeldung"

Translated, this becomes:

Correction of air density for difference in altitude:
Firing position—height of metro station

(b) The columns are headed:

"Feurstellung	"Lufgewicht
höher +, tiefer —, m"	kleiner —, grossert +, kg/cbm"

Translated, these become:

Firing Position	Air Density
higher +, lower —, meters	less —, more +, kilograms/cubic meter

(c) This correction is added to the air density value obtained from the metro station.

(3) CORRECTION FOR FLASH REDUCER. Next to the air density correction table is a table headed:

"Kartush—Vorlage Ldg. Stufen—Andg"	Flash reducer Charge or zone	Muzzle velocity correction

If flash reducer is used, the necessary correction should be noted.

(4) RANGE DRUMS, SCALE AND INDEXES.

(a) Set each of the 5-range drums to the charge selected, and set the index for each drum on the measured range.

(b) Set the measured (map) range in on the scale marked "Gemessene E. in km."

(5) WIND COMPONENT SETTING.

(a) On the scale marked "Wind—Geschw. m/s," set the index to the ballistic wind velocity noted in the "Geschw. m/s" column.

(b) Set the red arrow to the bearing in wind number of the ballistic wind noted in the "Richtg. Windz." Column and clamp the knurled handle.

(c) Turn the wind component knob to set the target bearing in wind number against the index marked "Sch.—R" (Schiess—Richtung).

(6) CORRECTION FOR POWDER TEMPERATURE. Loosen the knurled clamping nut and set the knife edge of the mechanism labeled "P. Temp. Cels." (Pulver Temperatur Celsiusgrad or powder temperature, Centigrade) to that point on the chart corresponding to the type of powder and to the temperature. The chart has black lines for diglycol propellant, and red lines for neuglycol propellant. The

FIRE CONTROL EQUIPMENT

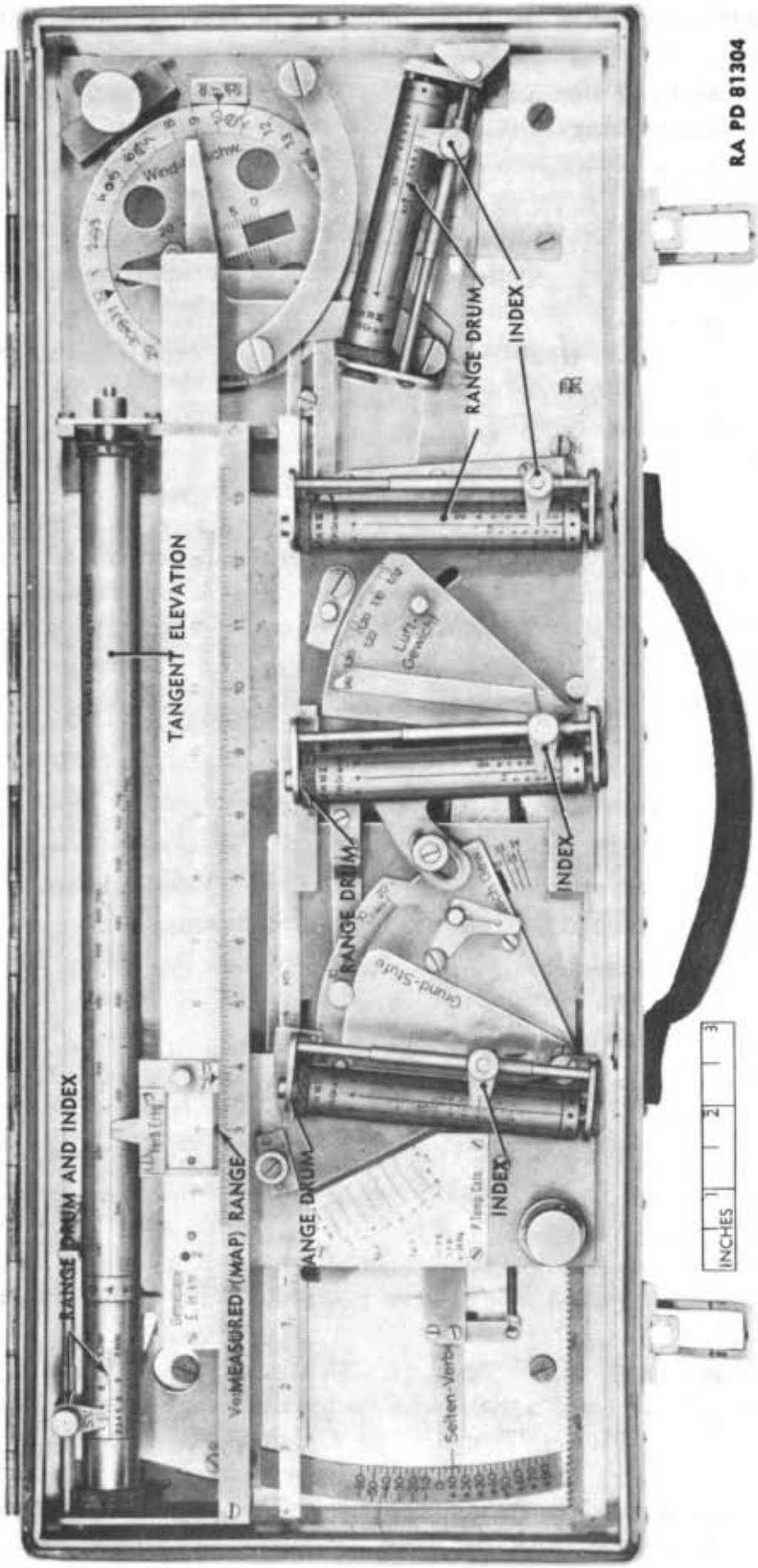


Figure 78—Artillery Computer 34 (German)—Range Drums and Measured Range Scale

GERMAN 105-MM HOWITZER MATERIEL

radial lines represent degrees Centigrade, and the red radial line (10°C) is the standard setting. Reclamp the nut.

(7) CORRECTION FOR PROJECTILE WEIGHT. Loosen the knurled clamping nut and set the index marked "Gesch.—Gew." (projectile weight) to the zone corresponding to that zone marked on the projectile. Zone III is the standard weight. Reclamp the nut.

(8) BASIC STEP CORRECTION (MUZZLE VELOCITY CORRECTION.)

(a) The "Grund—Stufe" or howitzer correction mechanism is provided for correction for variation from the standard muzzle velocity.

(b) German guns are calibrated by measuring the remaining velocity at 50 meters (55 yards) from the muzzle. Range tables give, for each charge, the increment to be added to obtain the corresponding muzzle velocity.

(c) The "Grundstufen Tafel" (howitzer correction table) marked on the shield of the weapon gives the correction to be added for each charge and range. Set the stop to give this correction. If minus corrections are necessary, these may be set in as a last step, as noted in subparagraph d (2), below, when making the final setting.

(9) AIR DENSITY CORRECTION. On the "Luft-Gewicht" (air density) mechanism, set the ratchet index to the air density value

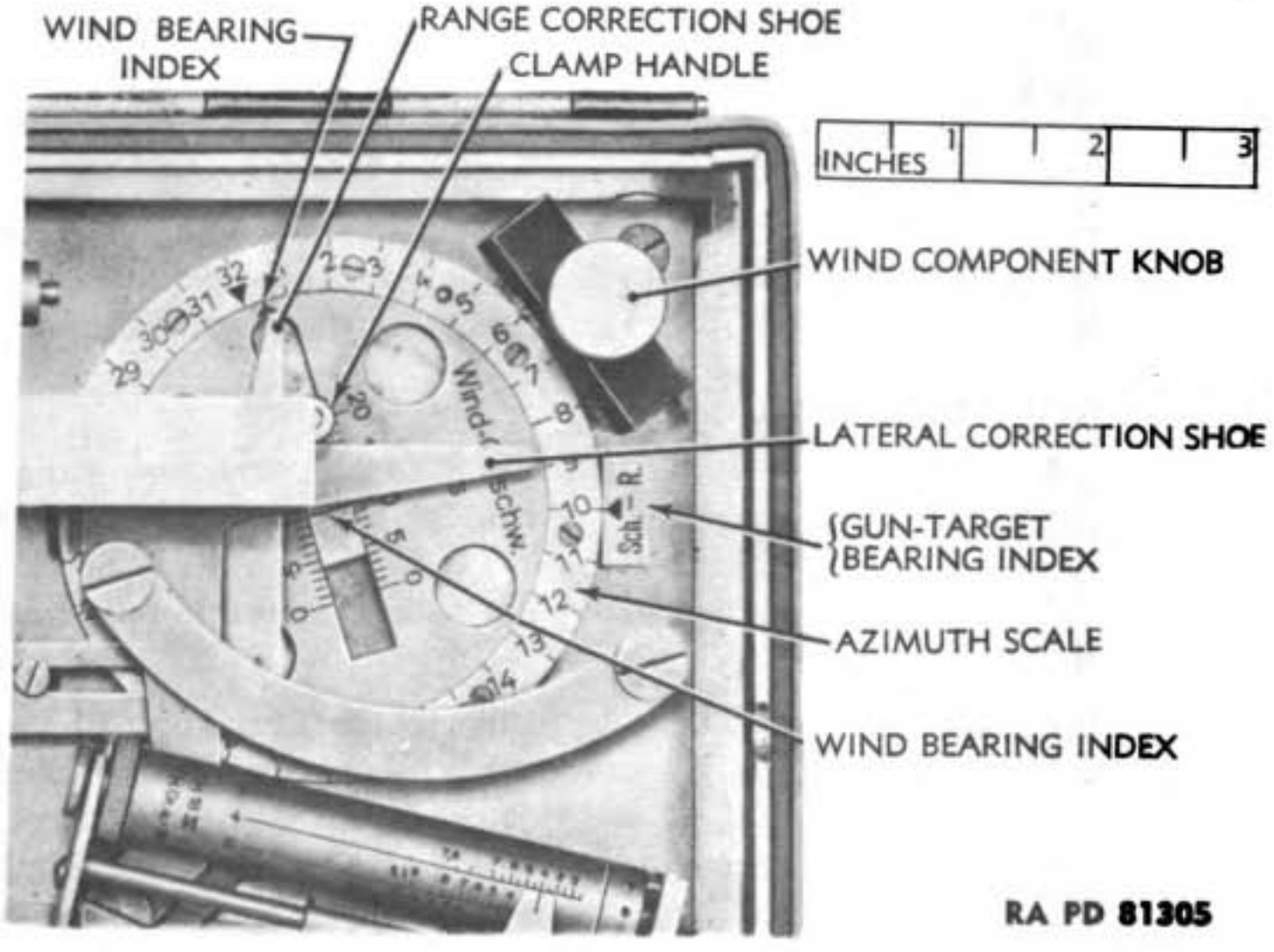
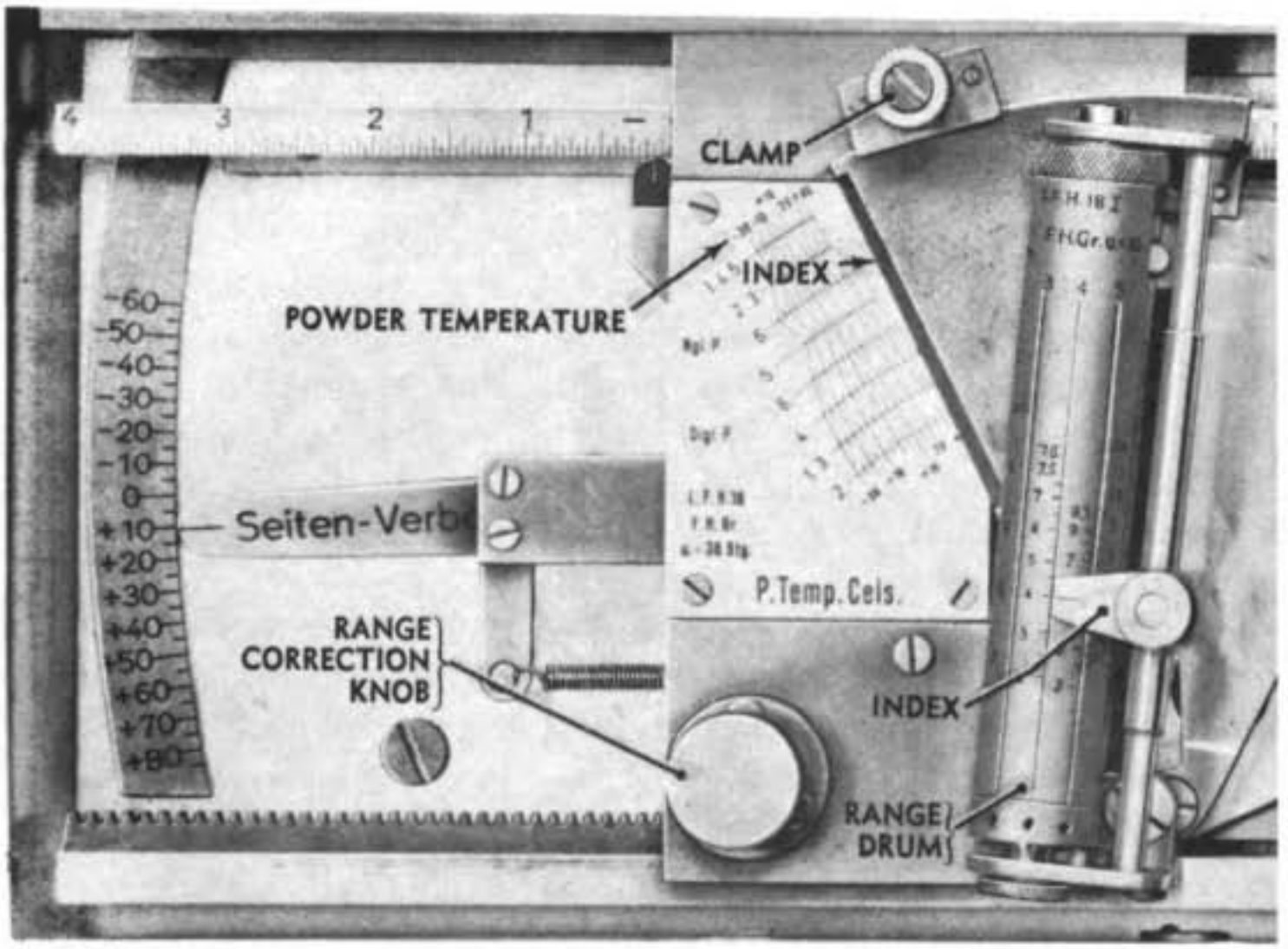


Figure 79—Artillery Computer 34 (German)—Wind Component Mechanism

FIRE CONTROL EQUIPMENT



RA PD 81306

Figure 80—Artillery Computer 34 (German)—Powder Temperature Correction

obtained from the metro table by addition of the air density value at the metro station and the air density correction required for difference in height between firing position and metro station.

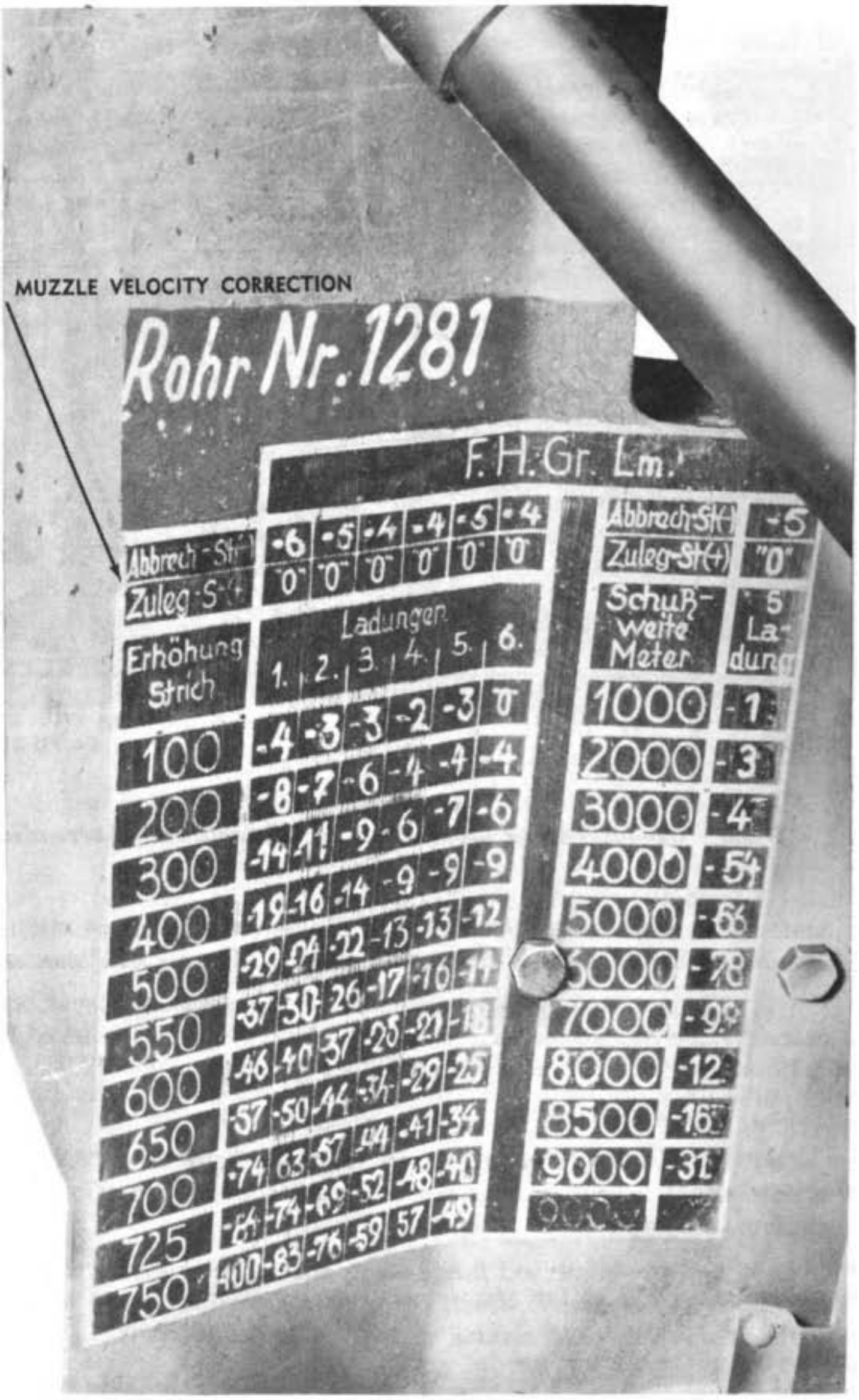
d. Operation—Readings.

(1) LATERAL CORRECTION. Push the lateral correction range drum until its shoe bears against the clamp of the wind component indicator. Read off on the scale associated with the pointer "Seiten-Verbesserung" (lateral correction) the necessary correction in mils for cross wind.

(2) CORRECTED RANGE. Turn the range correction knob at the left of the instrument until all the correction mechanisms have been moved to the right as far as their settings permit. (If a plus correction on the "Grund-Stufe" mechanism is necessary, turn the knob all the way, then back until the "Grund-Stufe" index reads the required value). Read the corrected range on the scale marked "Verbesserte E. in km" (corrected range in kilometers).

(3) CORRECTION OF RANGE. The amount of range corrected is indicated on the unnamed scale just below the corrected range

GERMAN 105-MM HOWITZER MATERIEL



RA PD 81307

Figure 81—105-mm Howitzer (German)—View of Correction Table on Shield

FIRE CONTROL EQUIPMENT

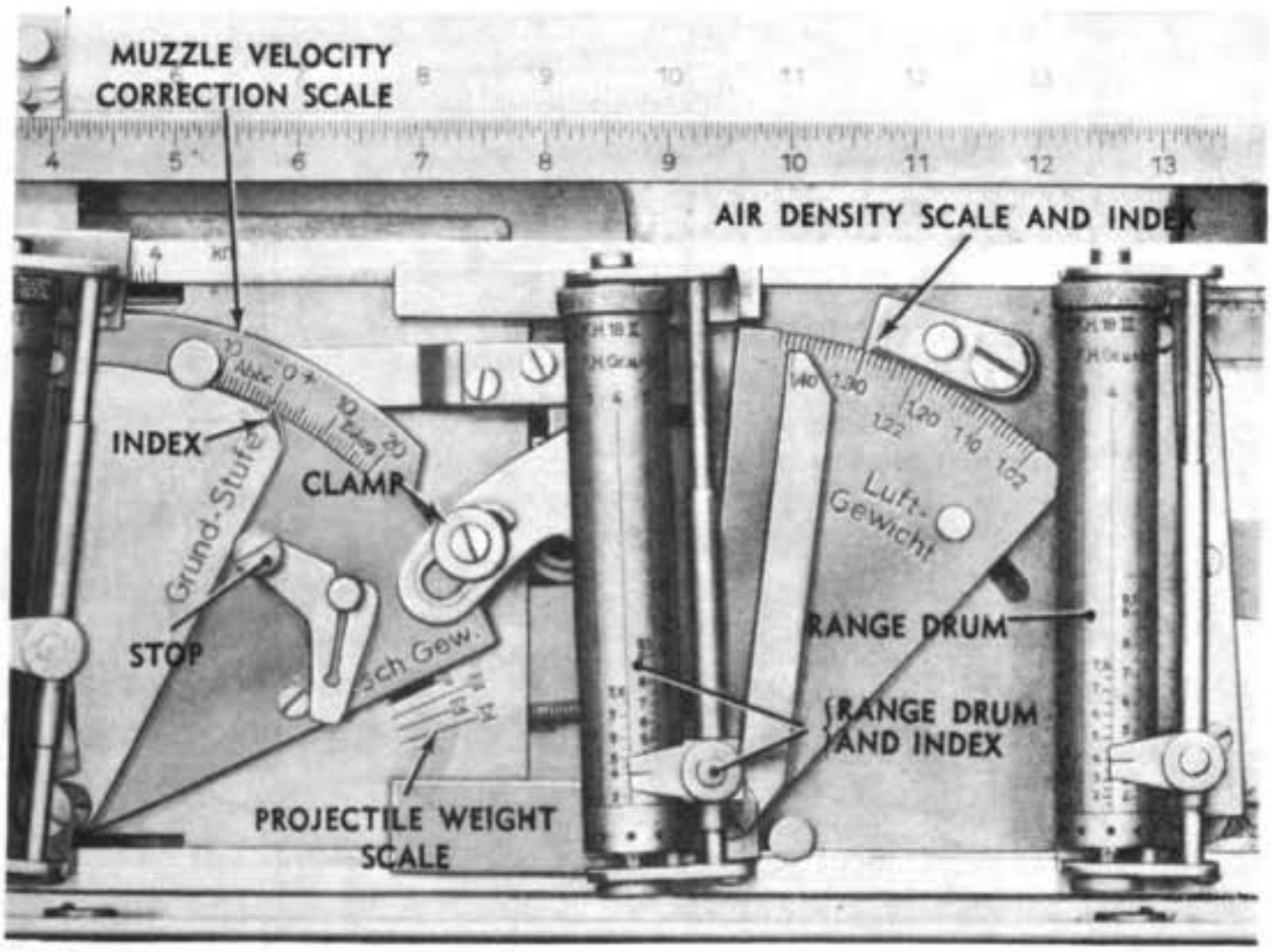


Figure 82—Artillery Computer 34 (German)—Correction Mechanisms

scale which is graduated from plus 4 kilometers to minus 4 kilometers. The index for this scale is mounted on the "P. Temp. Cels." mechanism.

(4) TANGENT ELEVATION. Read off the tangent elevation indicated by the index marked "Verb. Erhg." on the drum marked "Verb. Erhöhung in Strich" (tangent elevation in mils).

(5) ANGLE OF SITE.

(a) The angle of site set on German guns is a "total" angle of site which includes map angle of site plus a correction for non-rigidity of trajectory. It is set in mils.

(b) Set the corrected range in on the range scale for the particular chart, in the cover, which corresponds to the charge used. The scale is marked "Entfernung in km." (range in km).

(c) Set difference in height between gun and target, as obtained from map, on the scale "Höhenunterschied Gesh.—Ziel m" (difference in height between gun and target in meters). Read the "total" angle of sight in mils from the curve picked out by the sliding pointer.

GERMAN 105-MM HOWITZER MATERIEL

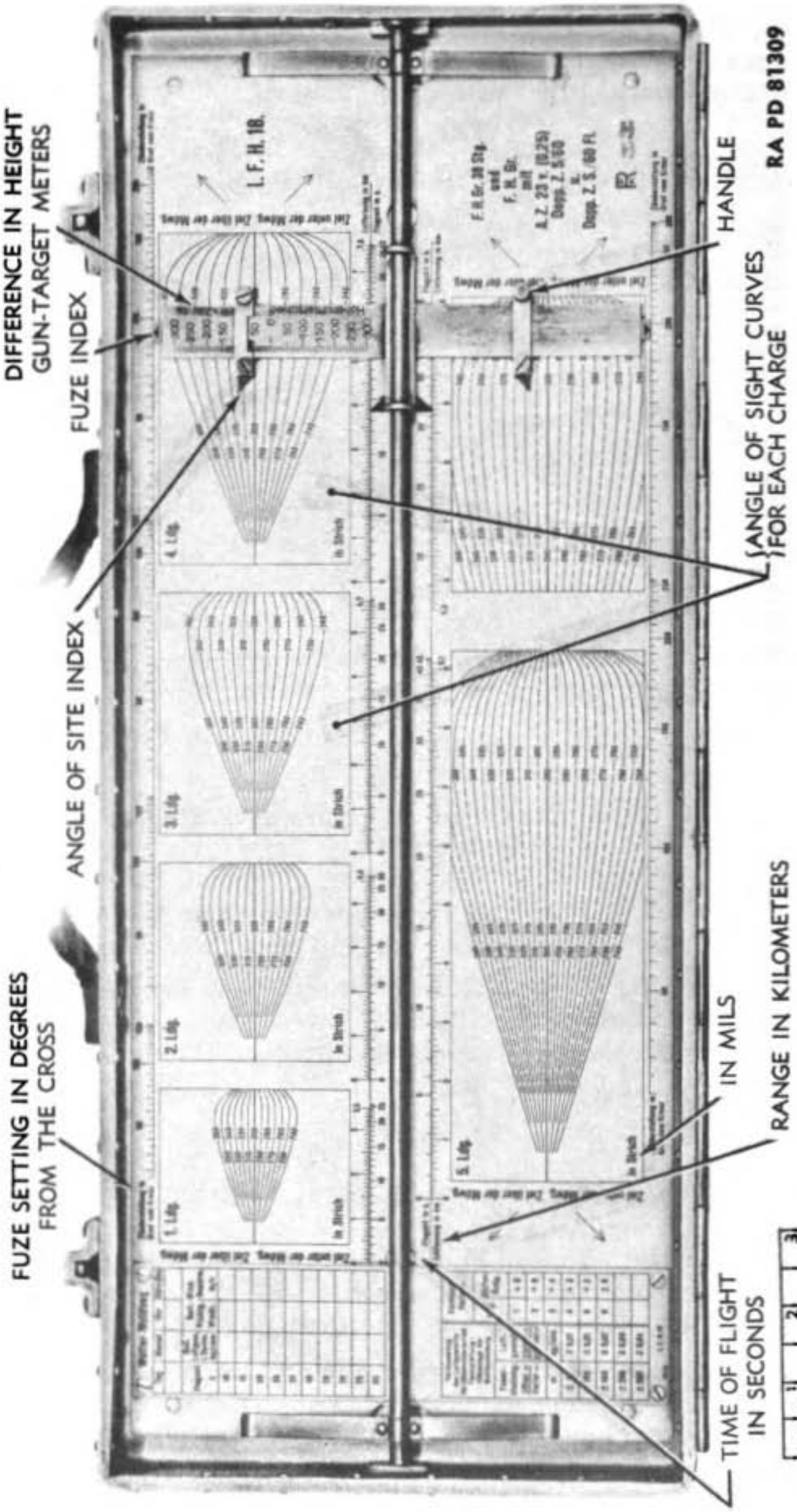


Figure 83—Artillery Computer 34 (German)—Angle of Site Charts

FIRE CONTROL EQUIPMENT

(6) FUZE SETTING. This value may be read off directly on the scale in the cover marked "Zünderstellung in Grad vom Kreuz" (fuze setting in degrees from the index cross).

e. Example.

(1) PROBLEM.

Map range—4,000 meters.
Direction of fire—2,000 mils.
Difference in altitude between gun and target—52 meters.
Metro datum plane and gun—same elevation.
Direction of wind—100 mils.
Velocity of wind—10 meters per second.
Air density—1.30 kg/cbm.
Shell weight—zone II.
Powder temperature—(Diglycol + 40°C).
Flash reducer correction—none.
Charge—4 (may be obtained from table painted on gun shield).

(2) SOLUTION.

(a) Set the five range drums to charge 4, and set the index of each range drum to 4 km (A, fig. 84). Set 4 km in on the scale marked "Gemessene E. in km." (B, fig. 84).

(b) Set the red arrow of inner circle to 0.5 (direction of wind (100 mils), expressed in increments of 200 mils, equals 0.5) (C, fig. 84). Set wind velocity of 10 meters per second in on the scale marked "Wind-Geschw. m/s. Clamp (D, fig. 84). Set the index marked "Sch. -R" to 10 (direction of fire (2,000 mils), expressed in increments of 200 mils, equals 10) (E, fig. 84).

(c) Set the knife edge of the "P. Temp. Cels." mechanism to the intersection of the red charge 4 (Diglycol) line and the + 40°C line (F, fig. 84). Then clamp.

(d) Set the index marked "Gesch -Gew." to zone II and clamp (G, fig. 84).

(e) Set the stop for the "Grund-Stufe" mechanism to "0" (H, fig. 84). ***NOTE: If a flash reducer is used, a correction to the muzzle velocity will be necessary.*** The stop for the "Grund-Stufe" mechanism is then set to the "Stufen-Andg" corresponding to the "Ldg." (charge) shown in the chart in figure 75. An additional correction may be necessary if the bore of the howitzer is worn. Values for this correction for various ranges are tabulated in the chart in figure 81.

(f) Set the ratchet of the "Luft-Gewicht" mechanism to "1.30 kg/cbm" (I, fig. 84).

(g) Turn knob (J, fig. 84) at left of instrument to push mechanisms as far to right as permitted by settings. Push the lateral

GERMAN 105-MM HOWITZER MATERIEL

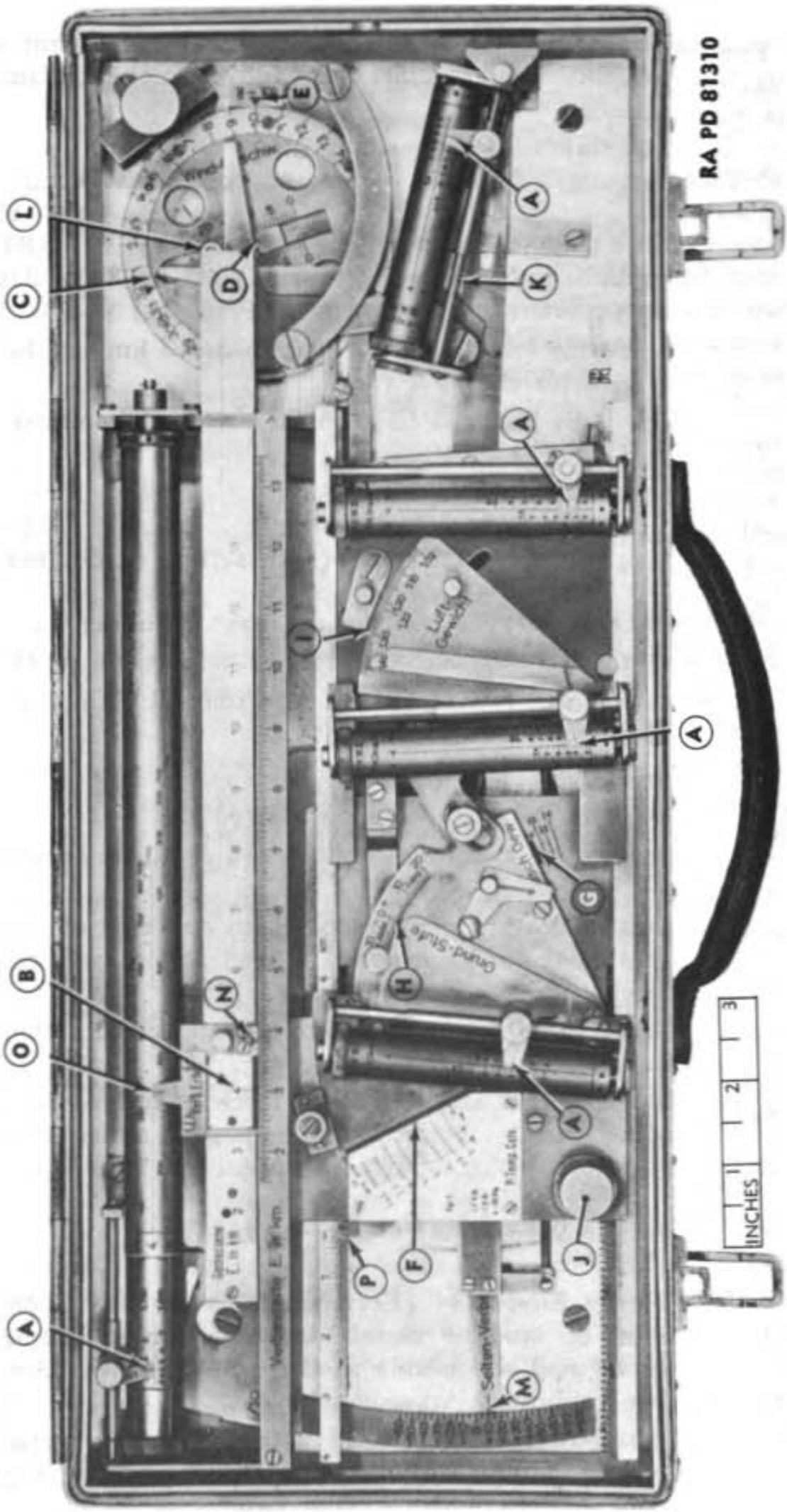


Figure 84—Artillery Computer 34 (German)—Problem Settings

deflection drum (K, fig. 84) (adjacent to wind component mechanism) until its shoe bears against the wind component clamp (L, fig. 84).

(h) Read off the following results:

"Seiten-Verbesserung" (lateral correction for cross wind) (M, fig. 84) ..... + 10 mils
"Verbesserte E. in Km" (corrected range) (N, fig. 84) ..... 3.840 km
Verb. Erhöhung in Strich" (tangent elevation) (O, fig. 84) .... 226 mils
Unmarked scale (amount range corrected) (P, fig. 84) .... + 0.156 km

(i) Set the sliding index in the cover to 3.840 km on the scale "Entfernung in km" for charge 4 (A, fig. 85).

(j) Set the sliding index to 52m on the scale "Höhenunterschied Gesh-Ziel m." (B, fig. 85).

(*k*) Read the following values:

"Flugzeit in s." (time of flight) (C, fig. 85) ..... 13.8 sec
Zünderstellung in Grad vom Kreuz" (fuze setting in degrees from index cross) (D, fig. 85) 91
Unnamed numbered curves (angle of site, including correction for nonrigidity of trajectory) (E, fig. 85) ..... 315 mils

f. Preparation for Travel. Make sure that all clamping knobs are secure. Close the case.

g. Care and Preservation.

(1) Normally no lubrication is necessary.

(2) The instrument should be kept closed at all times when not in use.

(3) The instrument should be kept clean and free of dust and dirt or sand. It should not be operated, if sand or dirt is found, until after being thoroughly cleaned.

(4) Care should be taken to avoid marring or scratching the scales and drums.

(5) Knobs and slides should not be forced. If binding occurs, clean the binding parts. If parts are damaged, notify Ordnance personnel.

55. FINDER, RANGE, 34 (Em 34).

a. General.

(1) The Range Finder 34 (Entfernungsmesser 34) is used for measuring ranges of land or aerial targets. Range readings are obtained in *meters* and are visible in the field of view. American range finders are calibrated in *yards*.

(2) The range finder is furnished with a shoulder harness (at least two types of which are known), tripod, and an adjusting lath (Justierlatte 0.70m) with carrying case.

GERMAN 105-MM HOWITZER MATERIEL

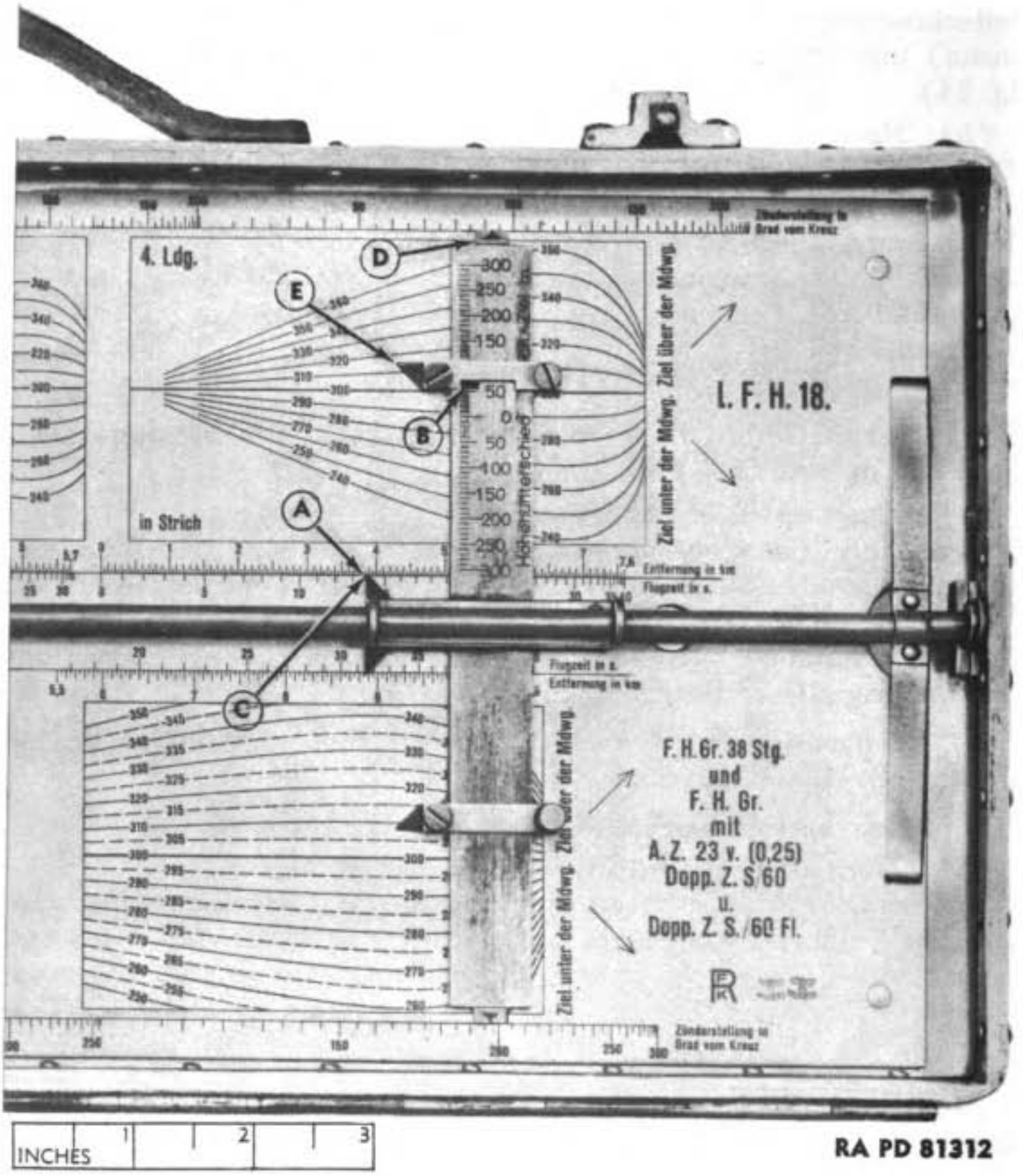


Figure 85—Artillery Computer 34 (German)—Problem Settings

b. Description.

(1) The instrument is a coincidence-type range finder having the following characteristics:

Base length	70 centimeters
Magnification	11-power
Range	200 to 10,000 meters (219 to 10,936 yards)
Width of field of view at 1,000 meters	62 meters (67.75 yards)
Weight of range finder	10 pounds

(2) The range finder has an insert-type field of view, and a range scale also visible in the field of view (fig. 87).

FIRE CONTROL EQUIPMENT

RA PD 55360

Figure 86—Range Finder 34 With Harness

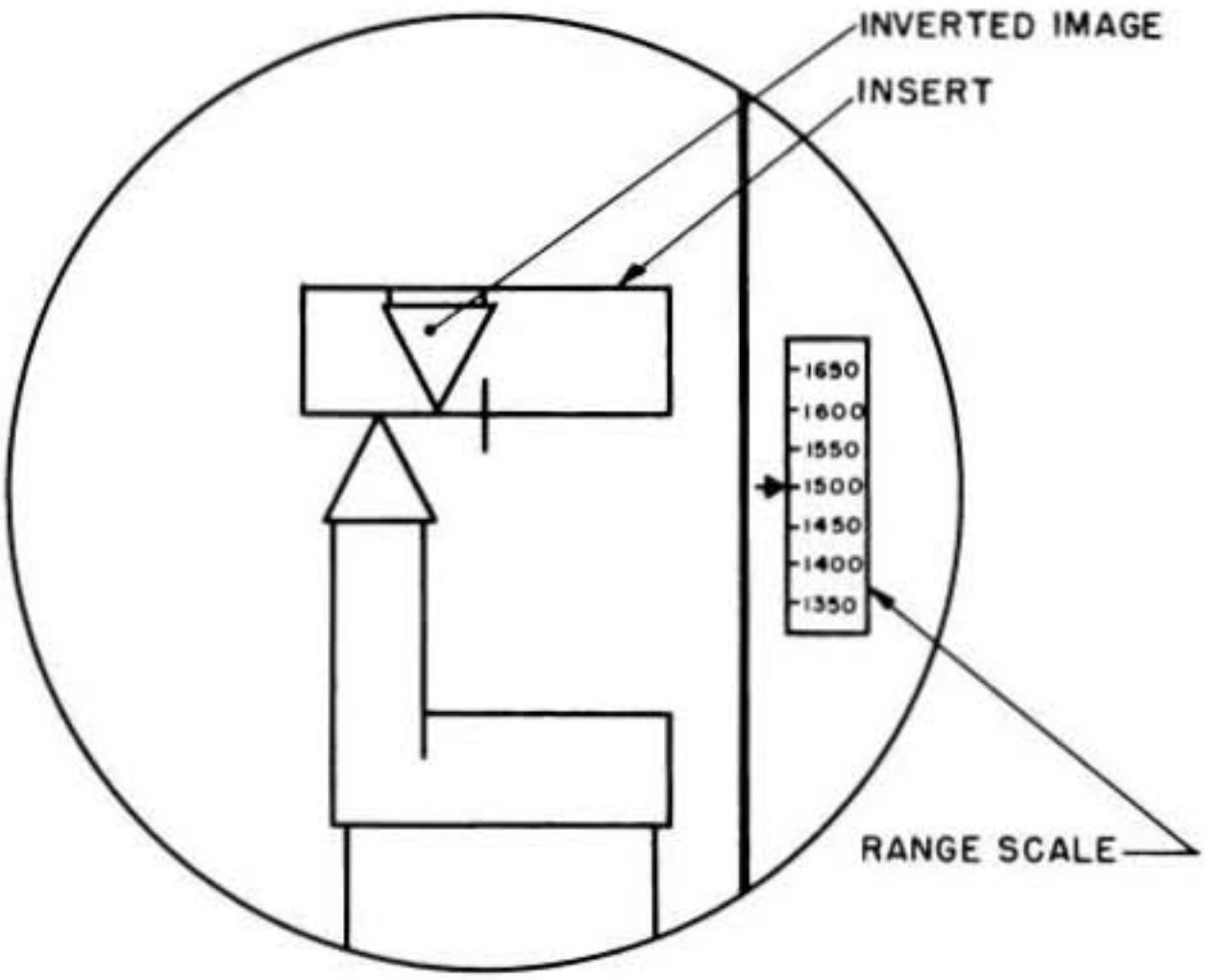
(3) The eyepiece has a diopter scale for adjustment for the observer's eye. The open sight, close to the eyepiece, facilitates the rapid picking up of the target. The end box sleeves (fig. 88) may be rotated to cover the end windows for travel or storage. The range knob, when rotated, simultaneously brings the images into coincidence and rotates the range scale.

(4) The coincidence correction or range correction knob or roller (Berichtigung der Entfernung) is covered by a revolving protecting ring. The halving correction knob or roller (Berichtigung der Höhe) is covered by the same ring. The lock screw marked "Sperren" (locked) permits access only to the halving correction knob. The amount of range correction set in is visible in the window labeled "Entfernungsuerrichtigung" (range correction).

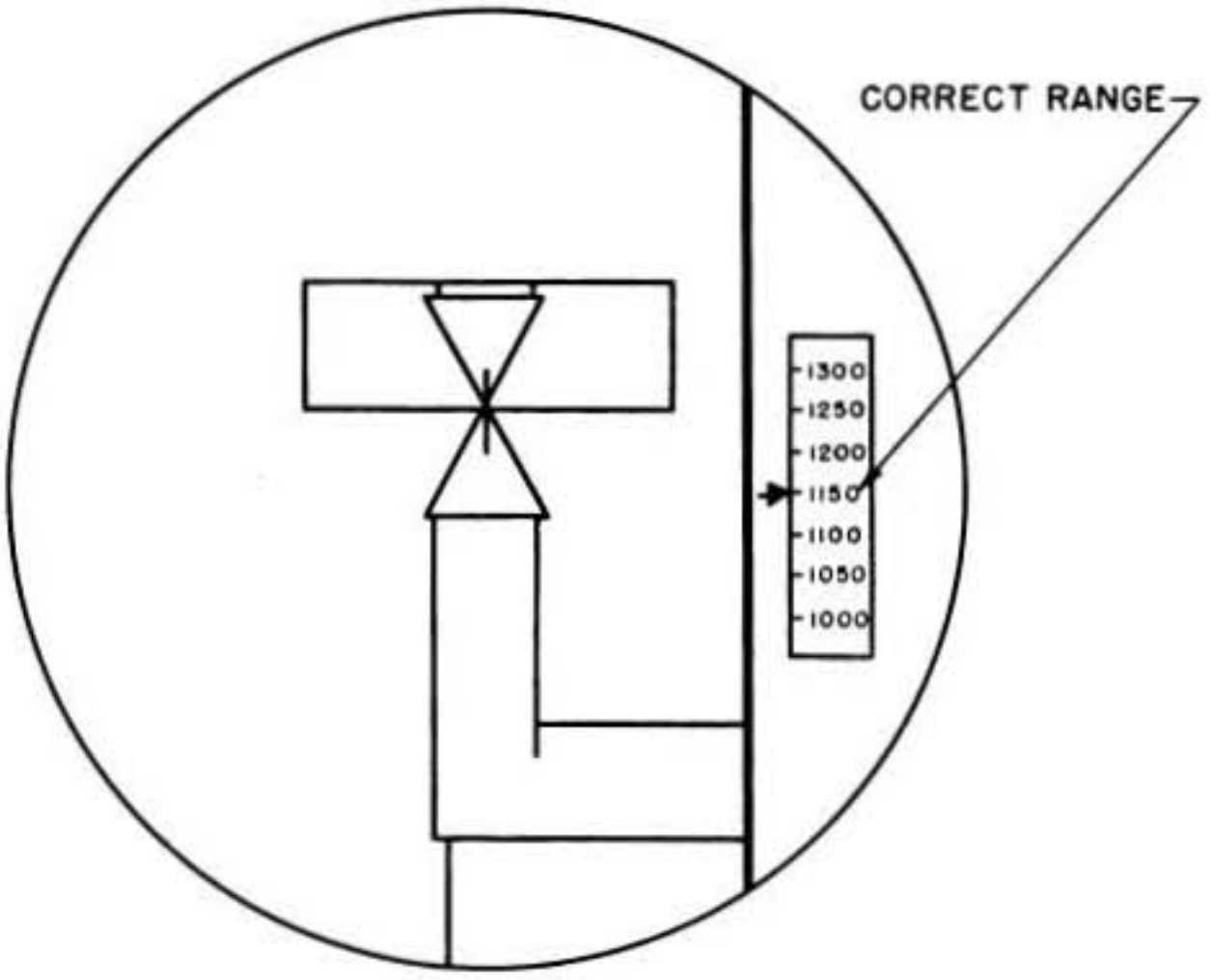
(5) The eyepiece cap and the buffers protect the instrument in use and in travel. The carrying strap facilitates carrying.

(6) The shoulder harness shown in figures 86 and 89 is normally worn with the pouch on the back, out of the way, although the harness may be readily assembled for use with the pouch on the chest. The harness is disassembled and placed in the pouch for

GERMAN 105-MM HOWITZER MATERIEL

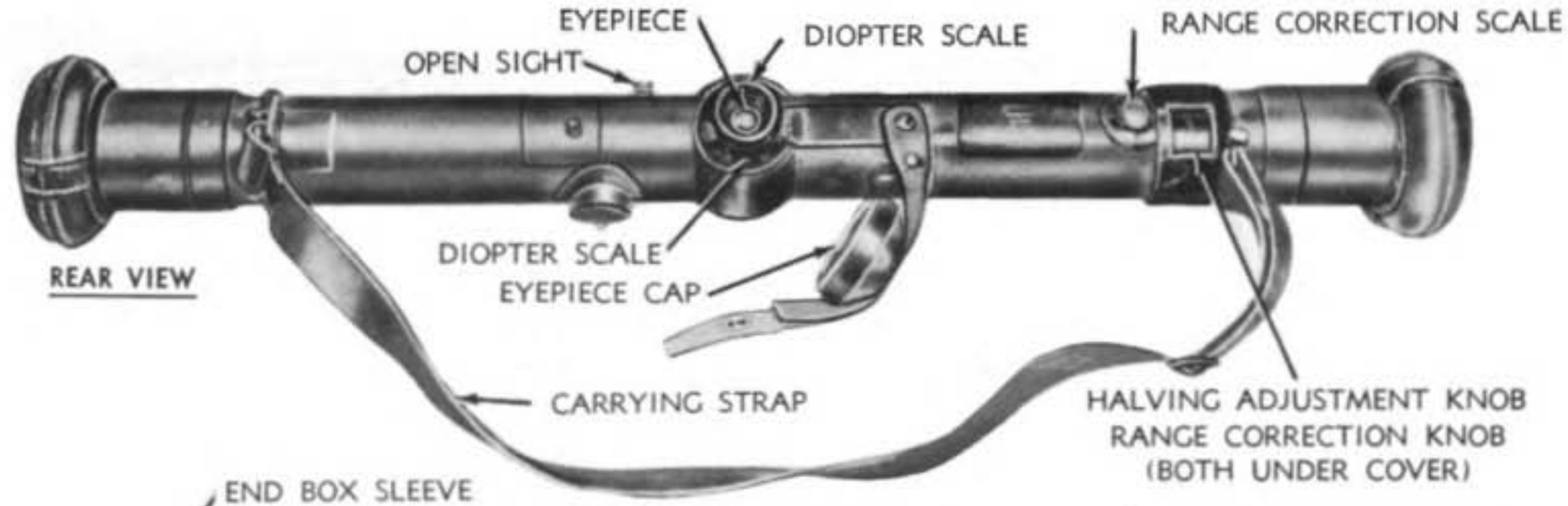


A — RANGE FINDER NOT FOCUSED ON TARGET



B — RANGE FINDER FOCUSED ON TARGET RA PD 81311

Figure 87—Range Finder 34—Field of View



TRANSLATION

EM 34 (ENTERNUNGMESSER) - RANGE FINDER 34
ENTFERNUNGSBERICHTIGUNG - RANGE CORRECTION
VERGR - IIX - MAGNIFICATION IIX
SPERREN - SHUT
NUR IN STELLUNG "ZU" SPERREN U. OFFEN - LOCK ONLY| WHEN IN THE "'ZU" POSITION
BERICHTIGUNG DER HOHE - ADJUST FOR HEIGHT
BERICHTIGUNG DER ENTFERNUNG - ADJUST FOR RANGE
GEBR. WICHMANN M.B.H. - WICHMANN BROS. LTD.
ENTERNUNGN TEILUNG IM EINBLICK ABLESEN - RANGE SCALE - READ OFF IN EYEPIECE

RA PD 31746

Figure 88—Range Finder 34—Assembled Views

GERMAN 105-MM HOWITZER MATERIEL

Figure 89—Range Finder 34—Harness

FIRE CONTROL EQUIPMENT

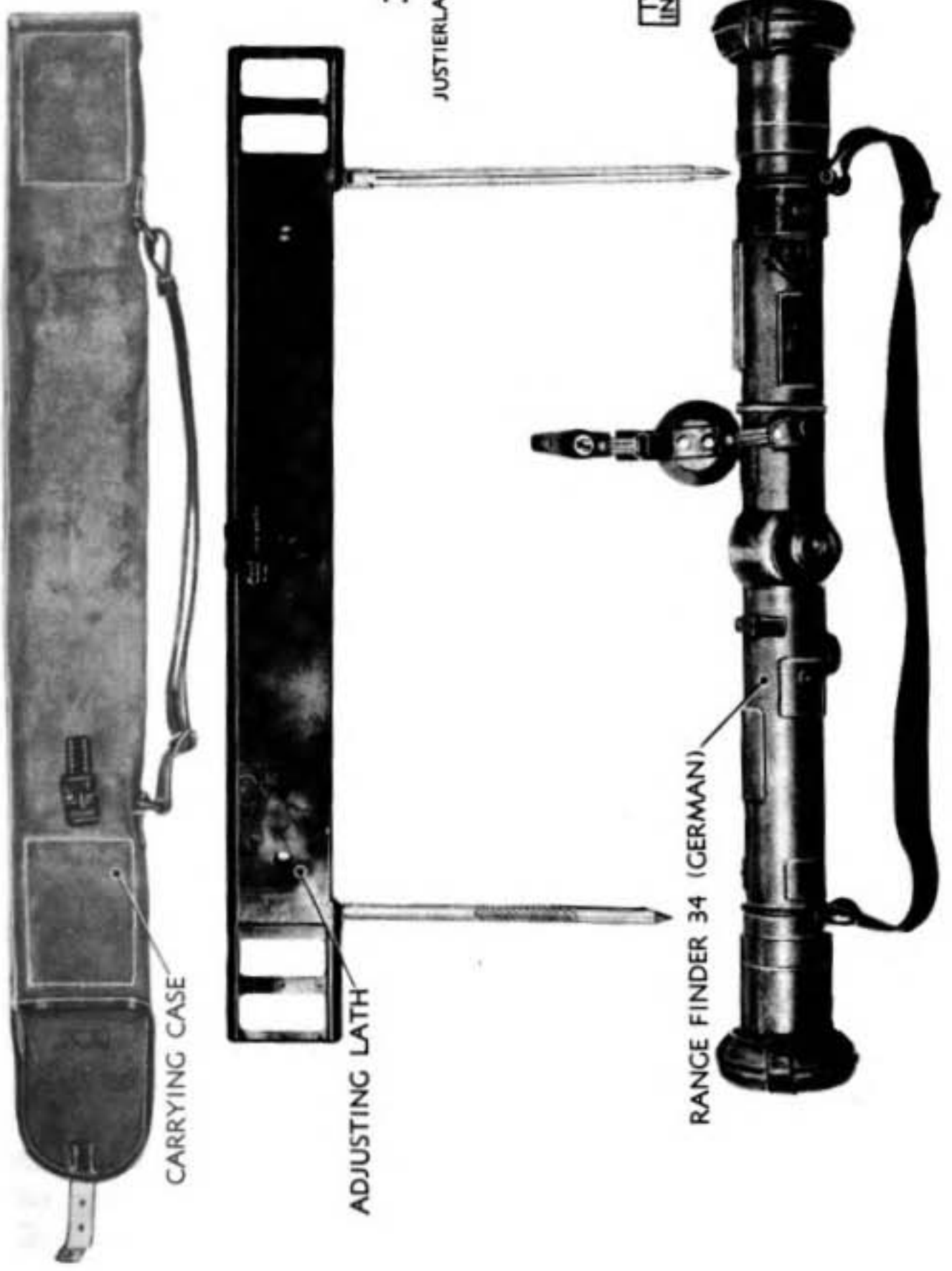


Figure 90—Range Finder 34 With Adjusting Lath

travel. Another type of harness sometimes furnished, makes use of a tripod held on a chest pad for sighting by an observer who may be erect, sitting, or kneeling.

(7) A tripod is furnished for ranging by a prone observer, and has a socket and clamp for engaging the ball-shaped bearing at the center of the range finder.

(8) The lath (Justierlatte 0.70 cm) has a small elbow telescope built into the center for alining the lath with the range finder, and folding adjustable legs for setting up. A case is provided for carrying (fig. 90).

c. Operation.

(1) To set up the instrument, adjust the harness on the observer (fig. 86). The carrying pouch should hang on the back, and the spring-mounted holders for the range finder should extend in front of the observer. Carefully place the range finder in the holders, and in line with the eye of the observer.

(2) Focus the eyepiece by rotating the diopter scale to produce a sharp image. If the operator knows the value for his own eye, the setting may be made directly on the scale.

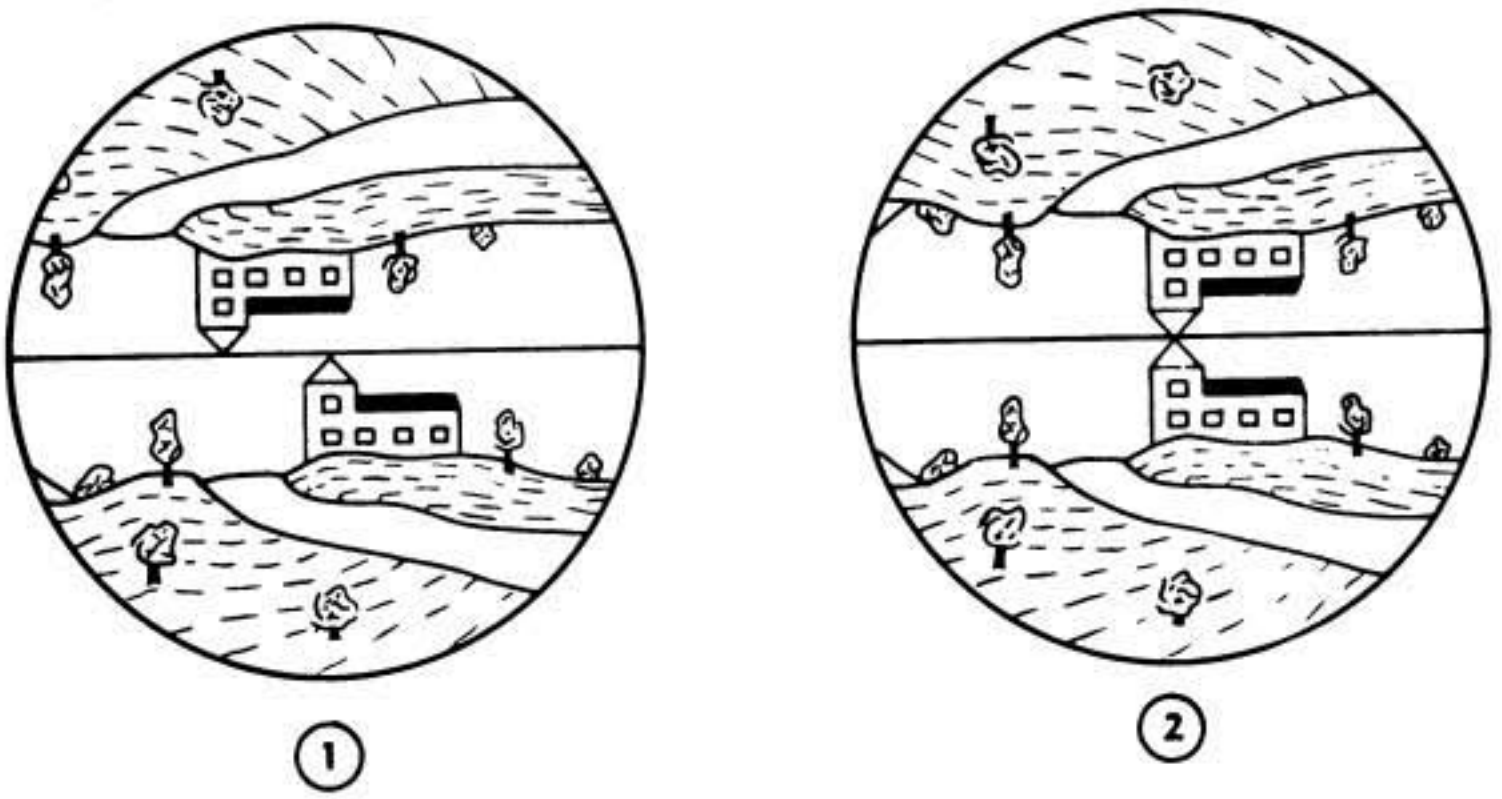
(3) To measure the range of the target, aline the instrument on the target, using the open sight. Select a clearly defined part, perpendicular, if possible, to the halving line. Center the target in the field ot view. Turn the range knob until the images of the target appear in coincidence. Read the range value centered in the field of view.

(4) To prepare the instrument for traveling, remove the instrument from the harness, close the end box covers, and cover the eyepiece. Disassemble the harness and put it in the carrying pouch.

d. Tests and Adjustments.

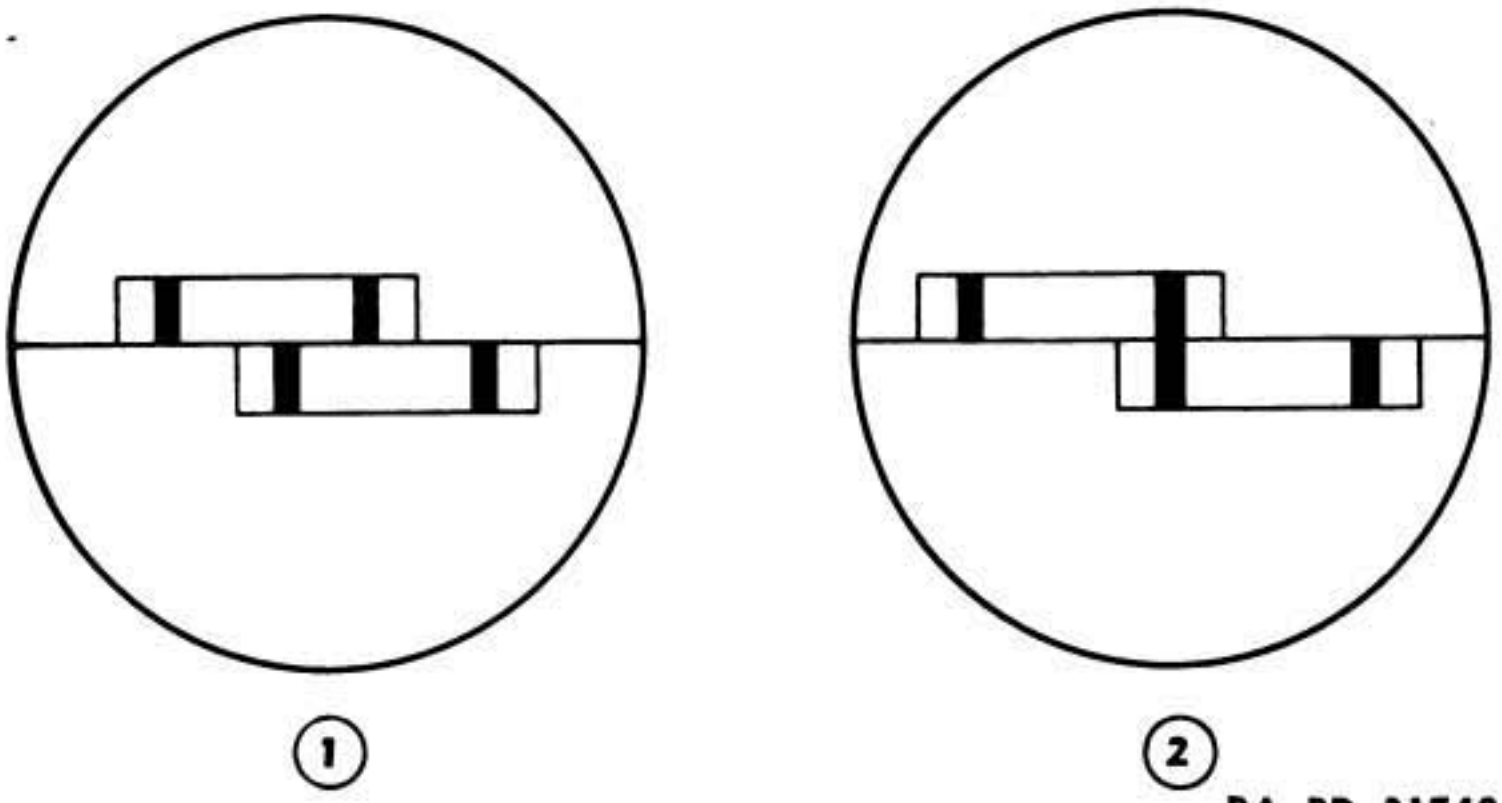
(1) HALVING ADJUSTMENT. Incorrect adjustment of the halving line is indicated by the failure of the corresponding points on the inverted and erect images to fall on the halving line. To correct the halving, slide back the cover to index the arrow adjacent to "Berichtigung der Höhe," and turn the exposed roller or knob until the corresponding point of each image touches the halving lines, as in figure 91. A sharply defined point at least 200 meters (220 yards) away must be used for this adjustment. Return the cover to its original position when the adjustment is completed, to guard against accidental turning of the roller or knobs. The inverted image will, of course, not be as complete as the inverted images shown in figure 91, since the insert permits visibility of only a small portion of the inverted image.

FIRE CONTROL EQUIPMENT



RA PD 31747

Figure 91—Fields of View



RA PD 31748

Figure 92—Views When Using Adjusting Lath

(2) RANGE ADJUSTMENT—DISTANT TARGET METHOD. Select a sharply defined object at least 200 meters (220 yards) away, the range of which is accurately known, and bring the object into coincidence (②, fig. 91). If the range scale agrees with the known range, the instrument is in adjustment. If adjustment is required, turn the lock screw in the direction marked "Sperren" and aline the arrow adjacent to "Berichtigung der Entfernung," on the protecting cover, thus exposing the range correction knob or roller. Turn the knob to obtain coincidence then cover and lock.

(3) RANGE ADJUSTMENT—INFINITY METHOD. To test the instrument by the infinity method, set up the adjusting lath (Justierlatte 0,70 cm) belonging to the instrument in a horizontal position at least 110 meters (125 yards) from the instrument. An American adjusting lath bears the same serial number as the range finder with which it is to be used. Make sure that the lath is perpendicular to the line of sight from the range finder by sighting on the range finder with the elbow telescope built into the lath. Set the range scale to the infinity position. If the images appear alined (②, fig. 92), the instrument is adjusted. If the images appear as in ①, figure 92, the following adjustment is required. Turn the lock screw in the direction marked "Sperren" and aline the arrow adjacent to "Berichtigung der Entfernung" on the protecting cover, thus exposing the range correction knob. Turn the knob until the images appear as in ②, figure 92, then cover and lock.

e. Care and Preservation.

(1) Refer to paragraph 60 on general instructions pertaining to the care and preservation of instruments.

(2) Keep the end box sleeves closed and eyepiece covered when the instrument is not in use.

(3) When the instrument is to be carried for long distance, or is to be stored, disassemble the harness, clean it, and stow it in the pouch.

(4) Keep the adjusting lath in its carrying case when not in use.

56. SURVEYING ROD.

a. A 3-meter surveying rod (fig. 93), graduated in 1-centimeter divisions, is provided for orientation of the battery. The rod is hinged to reduce its length to about three-quarters of a meter for storage and travel. The folded rod is carried in a canvas case fitted with a sling strap.

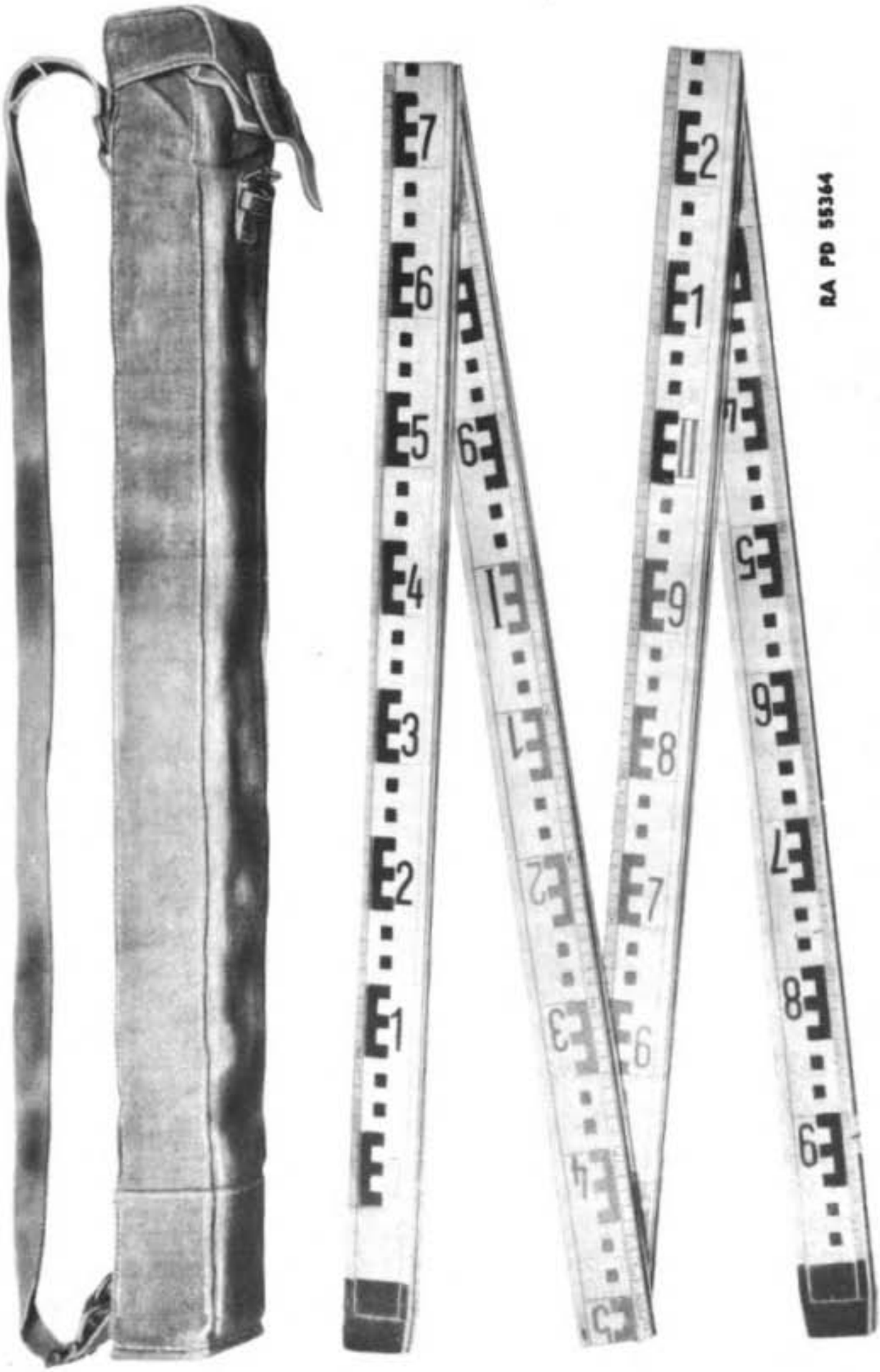
57. PLOTTING RULES.

a. Three rules are furnished as plotting board accessories.

b. One steel rule (fig. 94) bears a linear scale, graduated from 0 to 14 kilometers in 5-meter intervals, and a quadrant, graduated from minus 800 mils to plus 800 mils in 50-mil intervals. At the zero end is a center for pivoting. This rule may be used for plotting azimuth and range values on a topographic map with a scale of 1:25,000.

c. The steel protractor is graduated from minus 500 mils to plus 500 mils in 2-mil intervals. The radius of curvature is 480 millimeters. Two points permit pinning the protractor to a board.

FIRE CONTROL EQUIPMENT



RA PD 55364

Figure 93—Surveying Rod and Carrying Case

GERMAN 105-MM HOWITZER MATERIEL

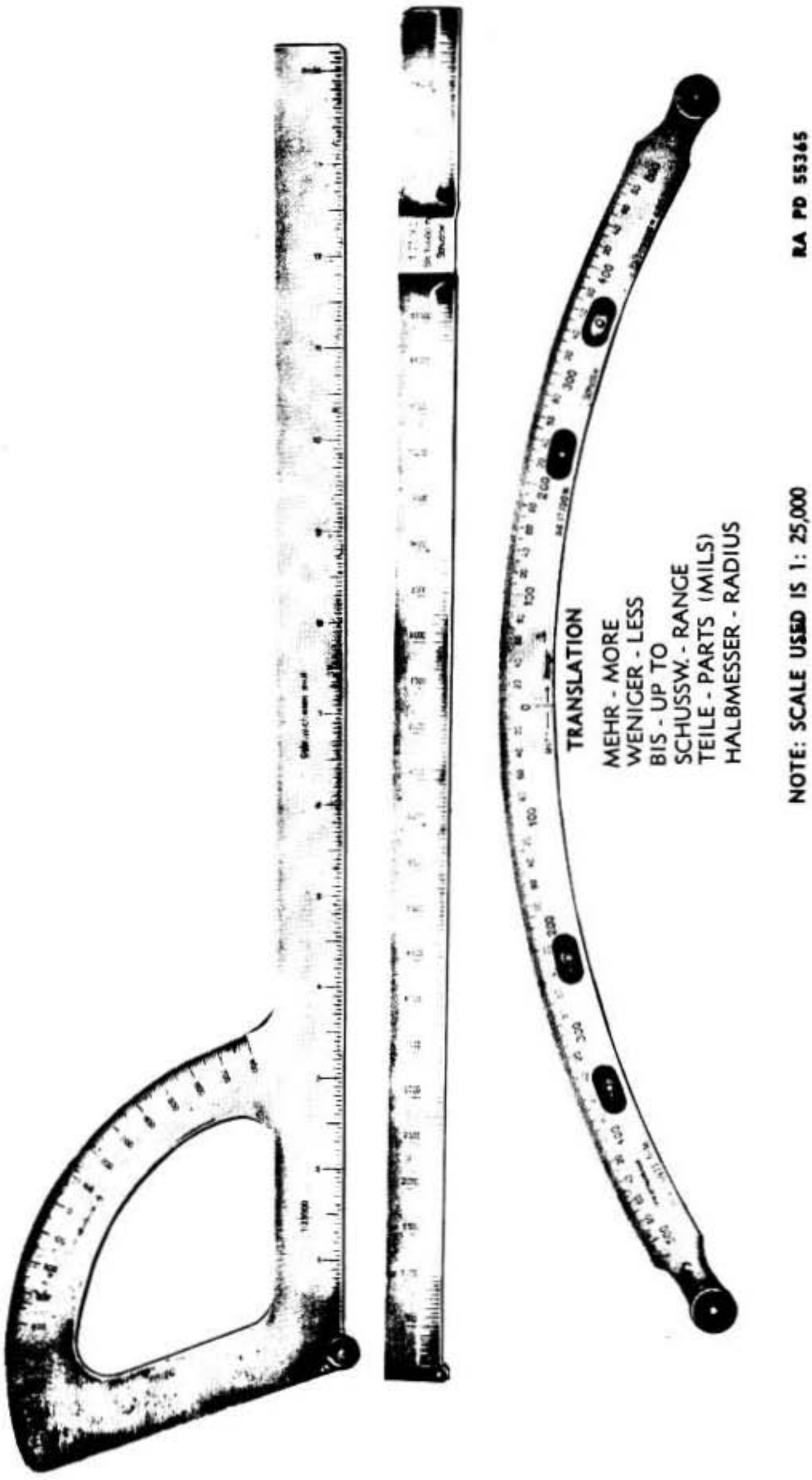
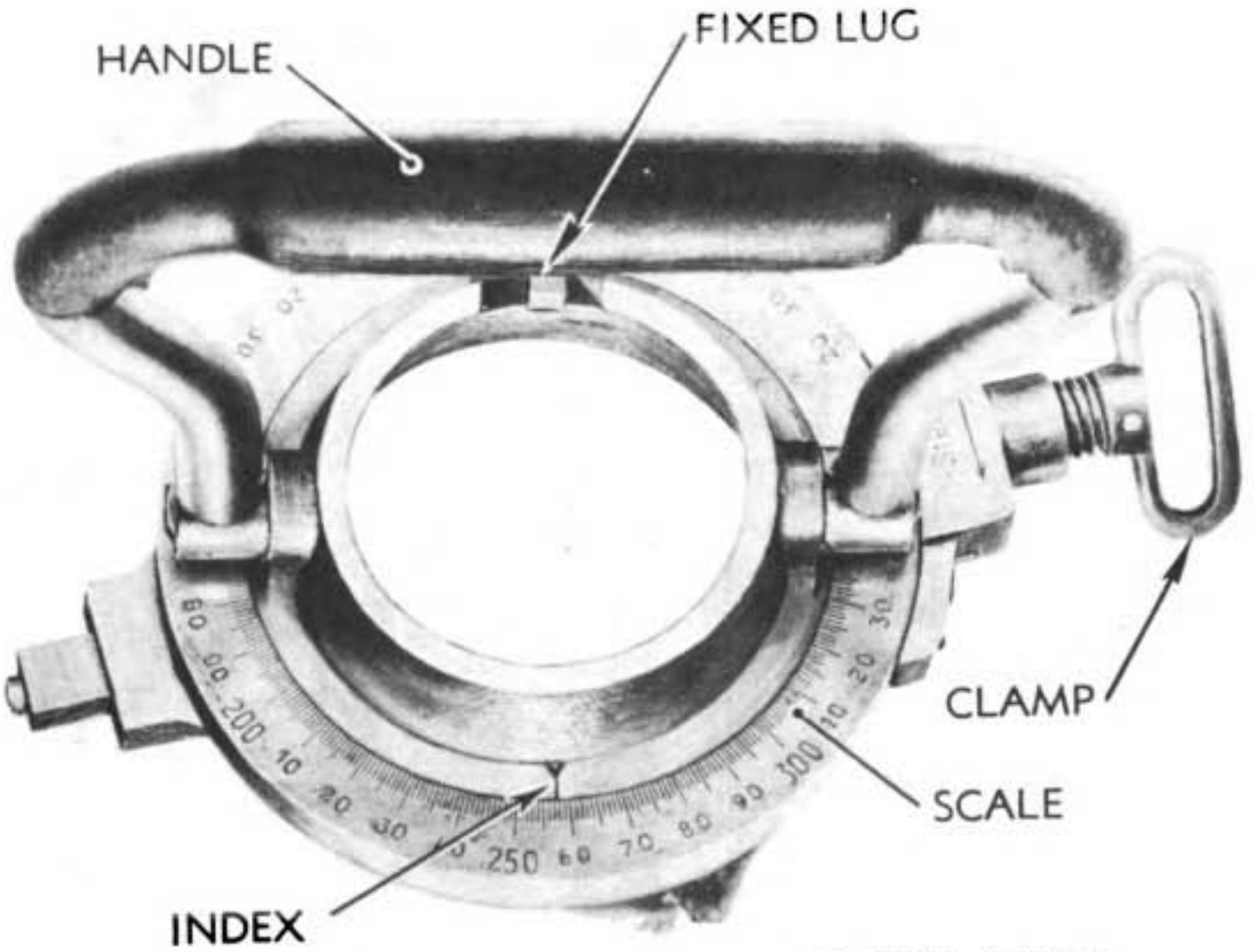


Figure 94—Plotting Rules

FIRE CONTROL EQUIPMENT



TRANSLATION

STELLUNG - POSITION

RA PD 55366

Figure 95—Fuze Setter—Top

d. The other steel rule bears a linear scale, graduated from 0 to 14,600 meters in 50-meter intervals, and a center at the zero end. At about 11,800 meters is a raised section. When this rule is set up with the protractor on a deflection chart, the raised section clears the protractor. The rule and protractor are used for plotting deflections on a chart with a scale of 1:25,000.

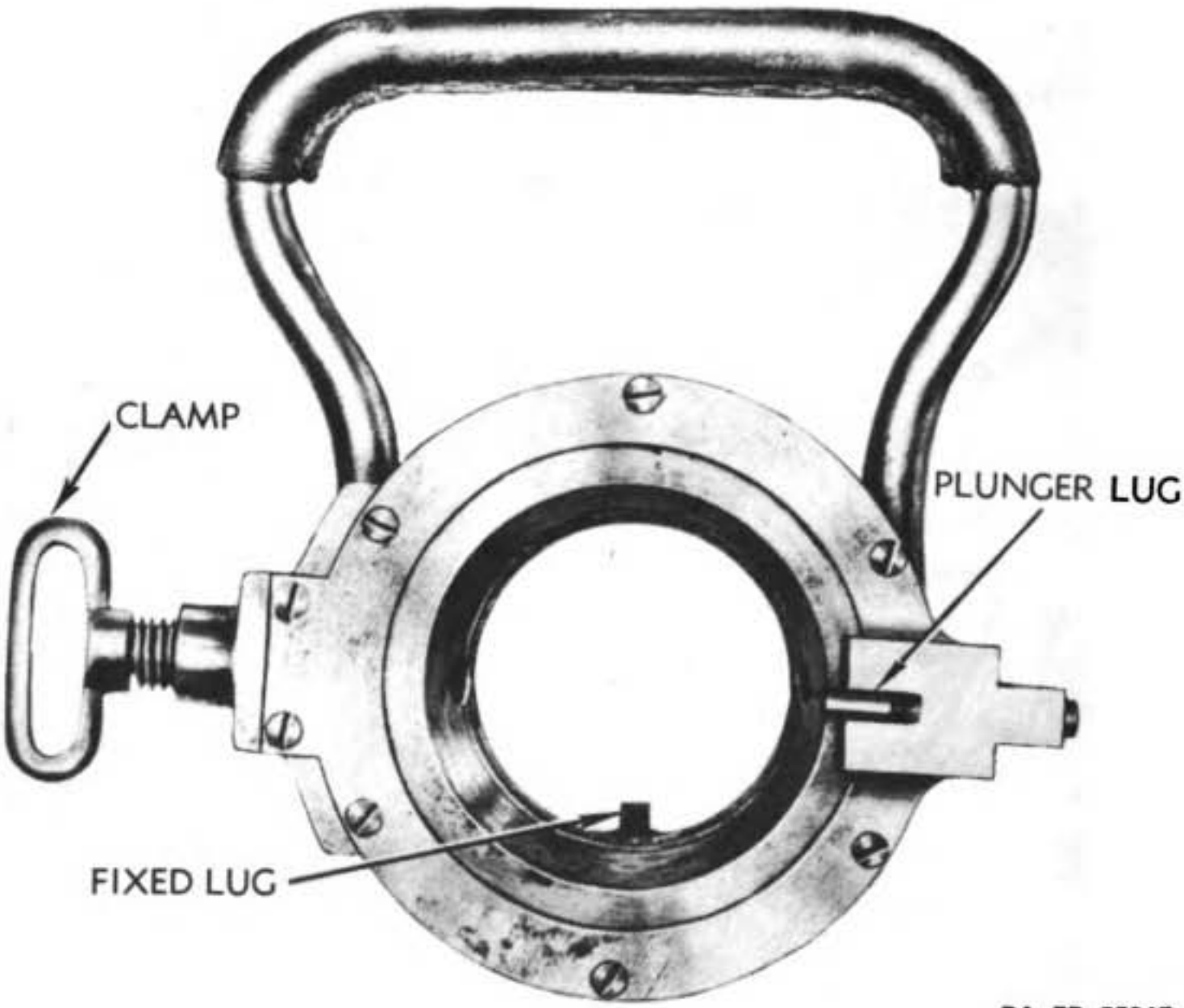
58. FUZE SETTER.

a. Description.

(1) The fuze setter (figs. 95 and 96) is used by the gunner for setting the time fuze. The leather covered handle can be folded back for storage.

(2) The principal parts of the fuze setter are an upper rotating section which contains a fixed lug, and a lower section which contains a movable spring-loaded plunger lug. The lower section is graduated from 15 to 350 degrees.

GERMAN 105-MM HOWITZER MATERIEL



RA PD 55367

Figure 96—Fuze Setter—Bottom

b. Operation. Make the desired setting and clamp the two sections together, the fuze setter being carefully positioned on the fuze so that the fixed lug engages with the fuze. This forces the spring-loaded lug back into its recess. The fuze setter is then rotated *in the direction indicated by the arrow* until the plunger lug snaps into place. Lift off the fuze setter without further rotation.

59. BATTERY COMMANDER'S TELESCOPE.

a. Description.

(1) The battery commander's telescope (figs. 97 and 98) is a 0-power, binocular instrument used for observation and for measuring azimuths and angles of site. The instrument consists of a telescope and an azimuth mount, tripod, carrying case, and accessories. The tripod includes an orienting mount. A trench mount is furnished, which can be embedded in the ground or in wood, for use in place of the tripod.

(2) The telescope may be positioned vertically (fig. 97), or it may be swung horizontally (fig. 99) to increase the stereoscopic

effect. The recticle, which remains erect in any position of the telescope arms, is illuminated by the removable lamp on the slide near the reticle.

b. Operation.

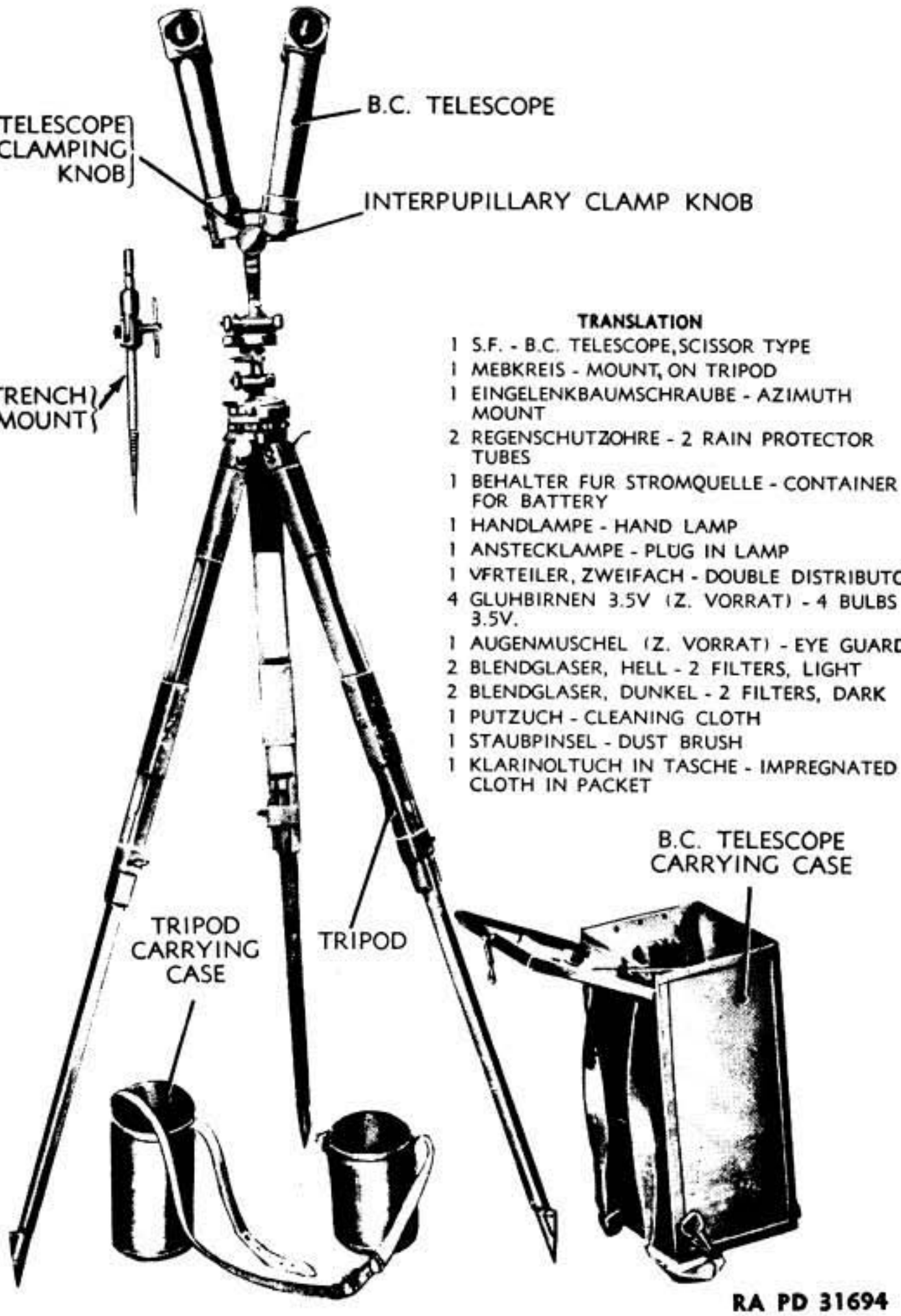
(1) To set the instrument, clamp the tripod legs at the desired length, embed them firmly in the ground, and tighten the leg clamps (fig. 100). Using the spring plunger, clamp the telescope on the vertical spindle extending from the orienting mount. (The tripod has a mount which permits cross leveling and orienting.) Level the mount by centering the bubble in the circular level (fig. 101). When the bubble is centered, clamp the ball-and-socket joint on the lower mount.

(2) To prepare the telescope, release the telescope clamping knob (fig. 97), and turn the telescope elbows to the vertical or horizontal position, as required. Set the proper interpupillary distance on the interpupillary scale (fig. 98), graduated from 55 to 75 millimeters, and clamp the interpupillary wing knob. If the interpupillary distance for the observer is not known, it may be found by observing the sky, and moving the eyepiece apart or together, until the field of view changes from two circles, or two overlapping circles, to one sharply defined circle. The interpupillary wing knob is then clamped. Focus each eyepiece independently by covering one of them and looking through the telescope with both eyes open at an object several hundred yards away; turn the diopter scale until the object observed appears sharply defined. The diopter scale on each eyepiece permits immediate adjustment for each eye if the observer knows his own eye corrections. If required, place the light or dark filters over the eyepiece, and the metal sun shades over the objective lenses. Tubular sections, about 8 inches long, can be attached to the sun shades for protection against rain.

(3) To orient the instrument, select a datum point of known azimuth, and set this value of the azimuth scale (100-mil steps) and micrometer (1-mil steps). The throwout lever may be used for making large changes in azimuth rapidly. Turn the telescope with the orienting knob until the datum point appears at the center of the reticle of the right-hand telescope. The orienting clamping knob may be temporarily released for making large angular changes rapidly. Thereafter, use only the azimuth knob, or, for large changes, the azimuth throwout lever, and the correct azimuth of the point observed will be indicated. For azimuths in the 3,200- to 6,400-mil region, additional numbers (0 to 3,200 mils) are provided, corresponding to the azimuth scale on the panoramic telescope.

(4) Direct the telescope on the object, and rotate the elevating knob until the object appears at the center of the reticle. Center the angle of site level bubble by adjusting the angle of site knob. The

GERMAN 105-MM HOWITZER MATERIEL



TRANSLATION

1 S.F. - B.C. TELESCOPE, SCISSOR TYPE
1 MEBKREIS - MOUNT, ON TRIPOD
1 EINGELENKBAUMSCHRAUBE - AZIMUTH MOUNT
2 REGENSCHUTZOHRE - 2 RAIN PROTECTOR TUBES
1 BEHALTER FUR STROMQUELLE - CONTAINER FOR BATTERY
1 HANDLAMPE - HAND LAMP
1 ANSTECKLAMPE - PLUG IN LAMP
1 VFRTEILER, ZWEIFACH - DOUBLE DISTRIBUTOR
4 GLUHBIRNEN 3.5V (Z. VORRAT) - 4 BULBS 3.5V.
1 AUGENMUSCHEL (Z. VORRAT) - EYE GUARD
2 BLENDGLASER, HELL - 2 FILTERS, LIGHT
2 BLENDGLASER, DUNKEL - 2 FILTERS, DARK
1 PUTZUCH - CLEANING CLOTH
1 STAUBPINSEL - DUST BRUSH
1 KLARINOLTUCH IN TASCHE - IMPREGNATED CLOTH IN PACKET

Figure 97—Battery Commander's Telescope With Case

FIRE CONTROL EQUIPMENT

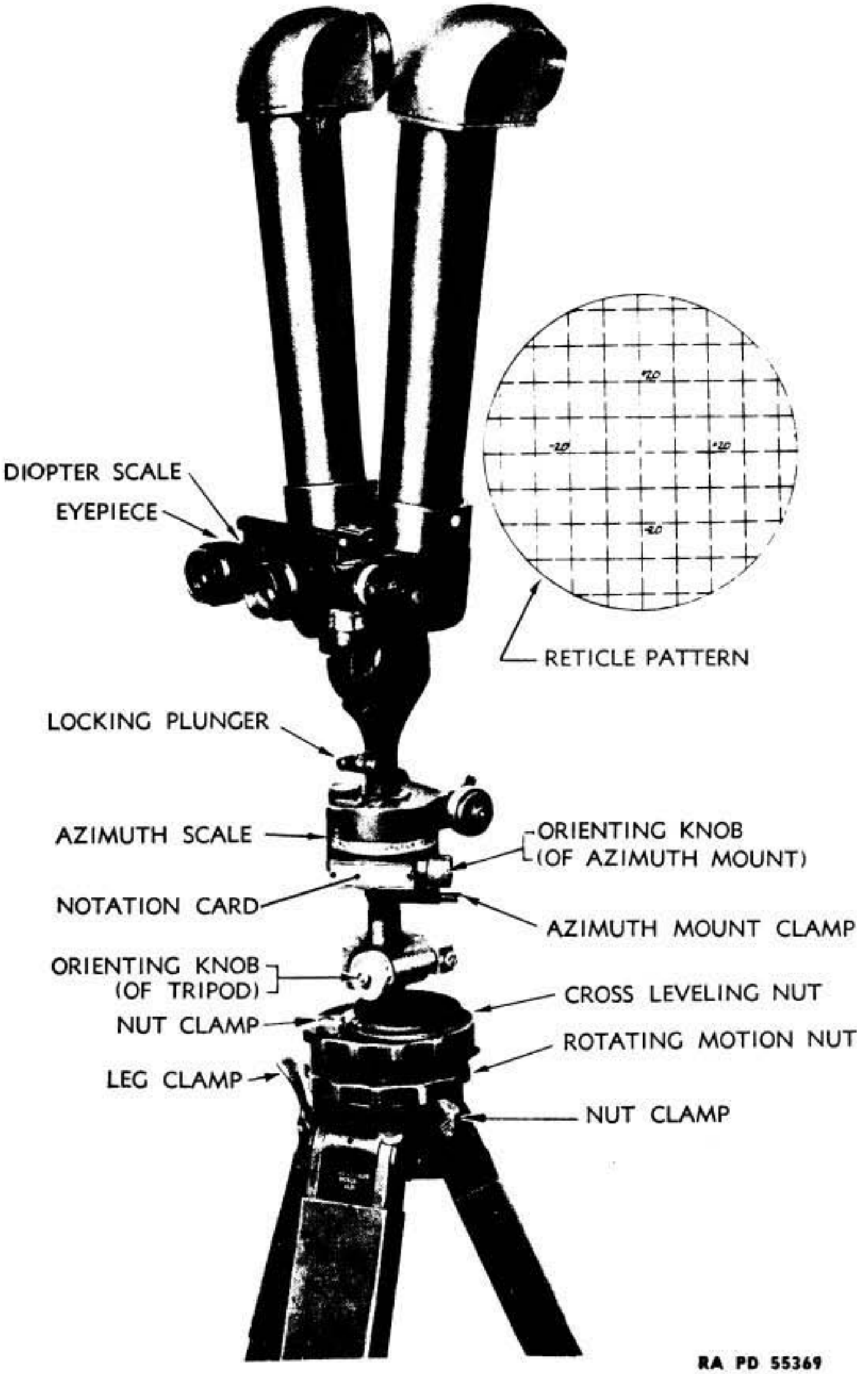


Figure 98—Battery Commander's Telescope—Close-up

GERMAN 105-MM HOWITZER MATERIEL

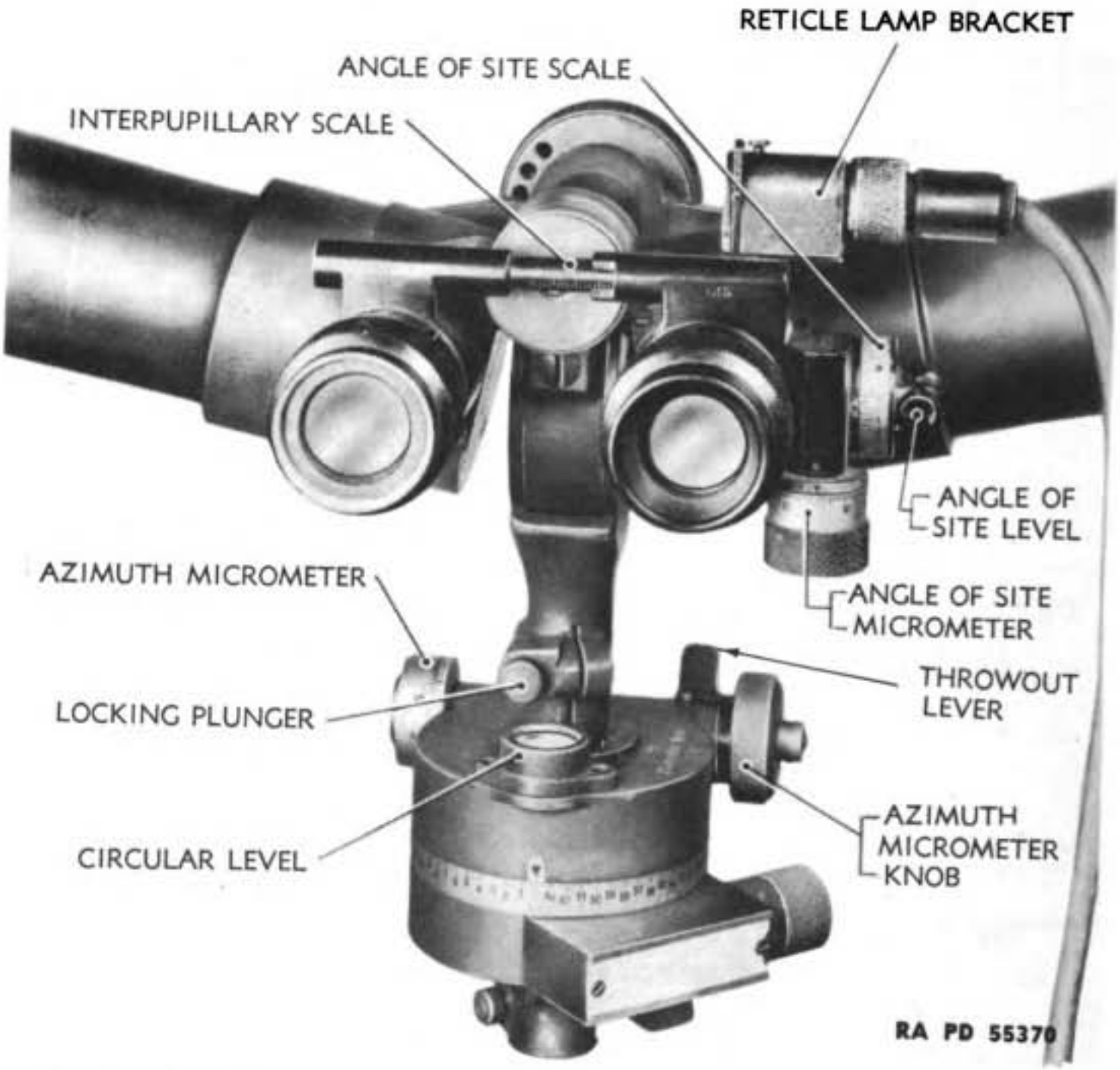


Figure 99—Battery Commander's Telescope—Interpupillary Scale and Angle of Site Mechanism

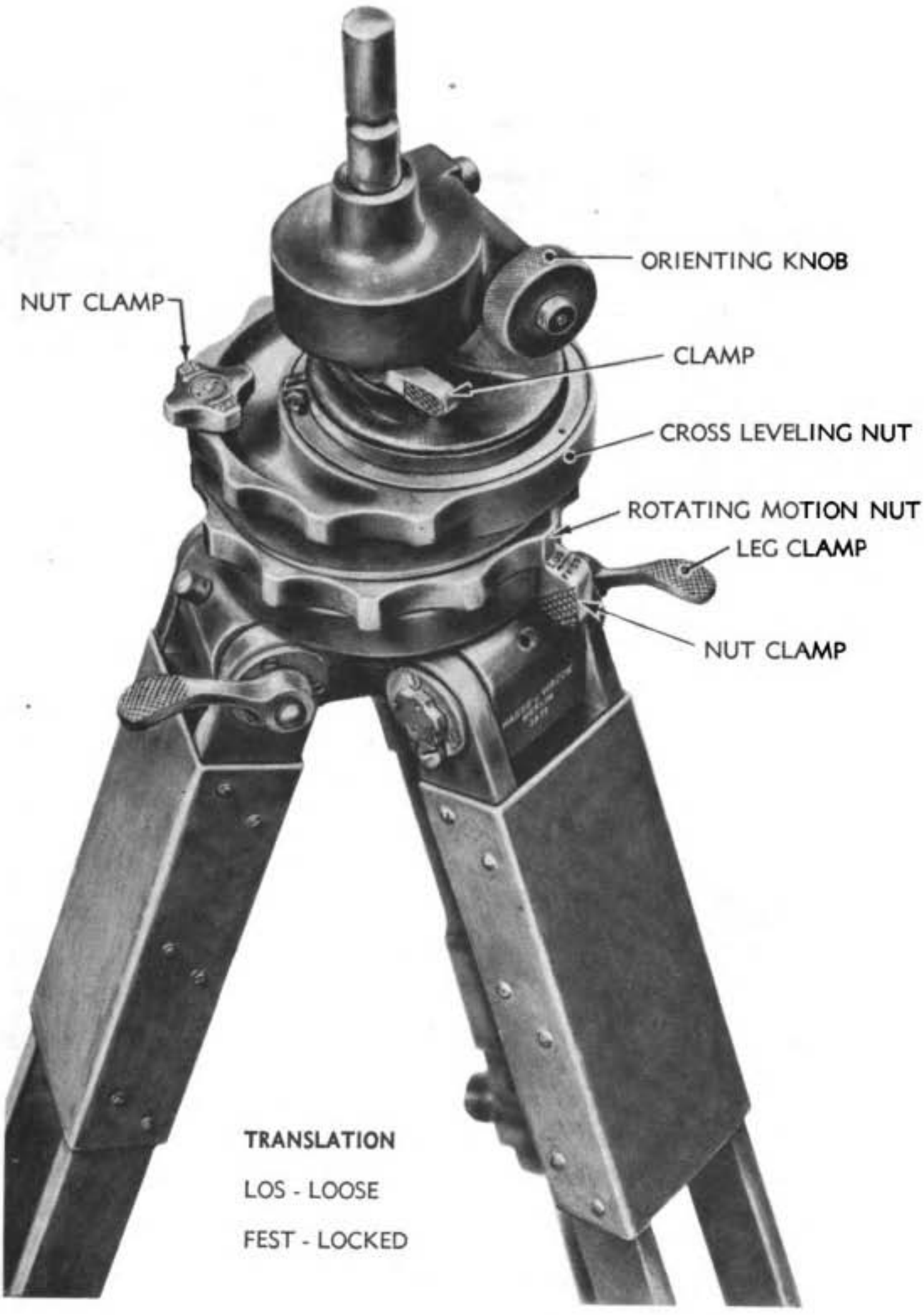
angle of site is then read on the angle of site scale, which is graduated in mils. An indication of "300" corresponds to a horizontal line of sight. *CAUTION: Always release the telescope knob before rotating the telescopes in a vertical plane. Failure to do this may result in damage to the instrument and cause double vision.*

(5) The reticle (fig. 98), located in the right eyepiece, is a grid, the horizontal and vertical axis of which are graduated in 10-mil intervals.

(6) The throwout mechanism is provided for rapidly traversing the telescope. A circular level is provided for leveling the head. The traversing head is graduated from 0 to 64 in 100-mil divisions, with a micrometer adjustment from 0 to 100 in 1-mil divisions.

(7) To prepare the instrument for traveling, remove the sun shades and filters, if used. With the telescope shanks in a vertical position, disengage the telescope from the mount. Loosen the tele-

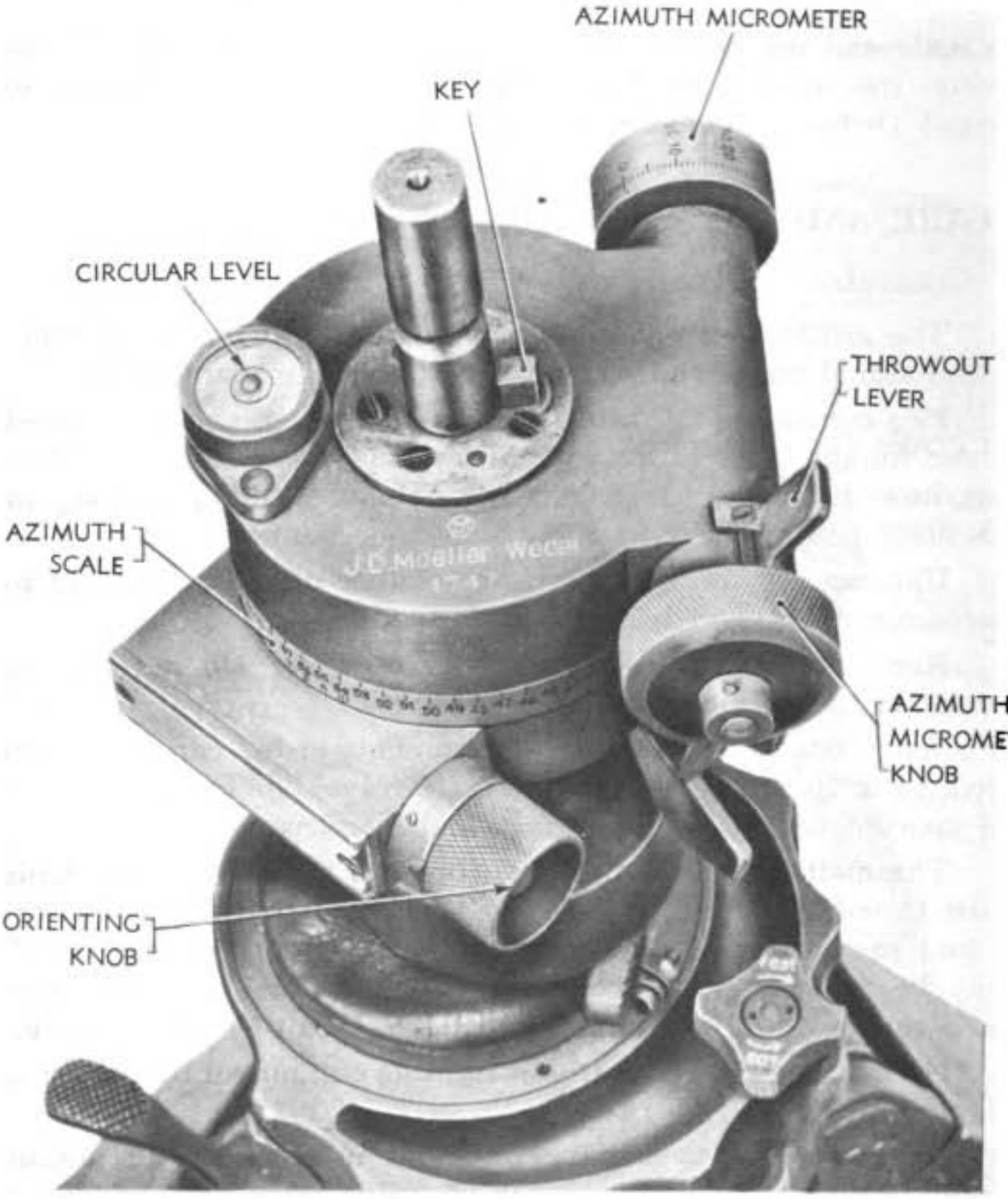
FIRE CONTROL EQUIPMENT



RA PD 55372

Figure 100—Battery Commander's Telescope and Aiming Circle—Tripod Head

GERMAN 105-MM HOWITZER MATERIEL



RA PD 55371

Figure 101—Battery Commander's Telescope—Azimuth Mount

scope clamping knob, and place the telescope shafts in a vertical position. Place the instrument in the wooden carrying case.

c. Tests and Adjustments.

(1) The azimuth micrometer and azimuth scale should read "0" simultaneously. The screw in the end of the micrometer may be temporarily loosened to permit adjustment.

(2) The angle of site mechanism may be checked by observing a datum point of known angle site. Small errors may be corrected by temporarily loosening the screw in the end of the knob, and slipping the micrometer and knob to the correct position. Should the angle

of site scale and micrometer then fail to indicate "300" and "0" respectively, the instrument should be turned in for adjustment by authorized Ordnance personnel.

60. CARE AND PRESERVATION.

a. General.

(1) The instructions given here supplement instructions pertaining to individual instruments included in preceding paragraphs.

(2) Fire control and sighting instruments are, in general, rugged and suited for the purpose for which they have been designed. They will not, however, stand rough handling or abuse, and inaccuracy or malfunctioning may result from such mistreatment.

(3) Unnecessary turning of screws or other parts not incident to the use of the instrument is expressly forbidden.

(4) Keep the instruments as dry as possible. Do not put an instrument in its carrying case when wet.

(5) When not in use, keep the instruments in the carrying cases provided, or in the condition indicated for traveling. Box sleeves on optical instruments should be closed, and eyepieces covered.

(6) The maintenance duties described are those for which tools and parts have been provided the using arm personnel. Other replacements and repairs are the responsibility of maintenance personnel, but may be performed by the using arm personnel, when circumstances permit, within the discretion of the pertinent Ordnance officer.

(7) No painting of fire control or sighting equipment by the using arms is permitted.

(8) Many worm drives have throwout mechanisms to permit rapid motion through large angles. When using these mechanisms, it is essential that the throwout lever be fully depressed to prevent injury to the worm and gear teeth.

(9) When using a tripod with adjustable legs, be certain that the legs are clamped tightly to prevent possibility of collapse.

(10) When setting up tripods on sloping terrain, place two legs on the downhill side to provide maximum stability.

(11) Dry-cell batteries should not be kept in the battery boxes when the instrument is not in use. Dry-cell batteries when weak deteriorate rapidly, and will cause corrosion and other damage to containers.

b. Optical Parts.

(1) To obtain satisfactory vision, it is necessary that the exposed surfaces of the lenses and other parts be kept clean and dry. Cor-

rosion and etching of the surface of the glass can be prevented, or greatly retarded, by keeping the glass clean and dry.

(2) Under no condition will polishing liquids, pastes, or abrasives be used for polishing lenses and windows.

(3) For wiping optical parts, use only lens paper specially intended for cleaning optical glass. Use of the cleaning cloths in the field is not permitted. To remove dust, brush the glass lightly with a clean camel's-hair brush, and rap the brush against a hard body in order to knock out the small particles of dust that cling to the hairs. Repeat this operation until all dust is removed. With some instruments, an additional brush with coarse bristles is provided for cleaning mechanical parts. It is essential that each brush be used only for the purposes intended.

(4) Exercise particular care to keep optical parts free from oil and grease. Do not wipe the lenses or windows with the fingers. To remove oil or grease from optical surfaces, apply ethyl alcohol with a clean camel's-hair brush, and rub gently with clean lens paper. If alcohol is not available, breathe heavily on the glass and wipe off with clean lens paper; repeat this operation several times until clean.

(5) Moisture due to condensation may collect on the optical parts of the instrument when the temperature of the parts is lower than that of the surrounding air. This moisture, if not excessive, can be removed by placing the instrument in a warm place. Heat from strongly concentrated sources should not be applied directly, as it may cause unequal expansion of parts, thereby resulting in breakage of optical parts or inaccuracies in observation.

c. Lubricants.

(1) Where lubrication with oil is indicated, use lubricating oil for aircraft instruments and machine guns.

(2) Where lubrication with grease is indicated, use special lubricating grease.

(3) Exposed moving points should be oiled occasionally. Interior parts are not to be lubricated by the using arms. Wipe off any excess lubricant that seeps from the mechanism to prevent accumulation of dust and grit.

(4) The tripod pivots should be carefully oiled at frequent intervals.

(5) Do not oil optical parts.

CHAPTER 4
AMMUNITION

61. GENERAL.

a. Ammunition for the German 105-mm field howitzer (1.F.H. 18) is similar to U. S. 105-mm howitzer ammunition in that the propelling charge is adjustable in the field for zone firing. The German ammunition differs, however, in that the projectile is shipped and loaded into the weapon separate from the cartridge case which contains the propelling charge and primer. As shipped, the projectiles are fuzed. A complete round of ammunition is shown in figure 102.

62. FIRING TABLES.

a. The firing tables for use with the German 105-mm howitzer will be found in chapter 6. See also paragraph 70.

63. CLASSIFICATION.

a. The German 105-mm howitzer ammunition is classified according to type of projectile (Granate, Gr.) as high-explosive, armor-piercing, or smoke. The armor-piercing projectile contains a small explosive charge and a base-detonating fuze, with a tracer element, for use against armored vehicles and tanks. The high-explosive shell contains a larger charge of high explosive and a point-detonating fuze for blast effect against targets. The smoke shell contains a chemical filler for producing a screening smoke.

64. AUTHORIZED ROUNDS.

a. The following rounds of 10.5 cm. howitzer ammunition may be found for use in the German Light Field Howitzer 18 (1.F.H. 18, leichte Feldhaubitze 18):

TABLE I
GERMAN 105-MM ROUNDS

NOTES	PROJECTILE			CARTRIDGE CASE MODEL NO.[1]
	Nomenclature[2]	Action of Fuze	Wt. as Fired (pounds)	
3	F.H. Gr. AZ 23 (H.E. Shell with Fuze, A.Z. 23v(0.25))	Superquick and delay	32.58	6342
3	F.H. Gr. 38 AZ 23 (H.E. Shell, 38, with Fuze, A.Z. 23v (0.25))	Superquick and delay	32.58	6342
3	F.H. Gr. Dopp. Z.S./60s (H.E. Shell with Fuze, Dopp. Z.S./60s)	Time and percussion	32.58	6342
3	F.H. Gr. 38 Dopp. Z.S./60 Fl. (H.E. Shell, 38, with Fuze, Dopp. Z.S./60 Fl.)	Time and percussion	32.58	6342
4	F.H. Pzgr. (A.P. Shell with Bd. Z.)	Base percussion and tracer	30.8	6342
	F.H. Gr. Nb. (Smoke Shell with Fuze, K1 A.Z. 23 Nb)	Superquick and delay	30.87	6342

1 Two types of charges may be found: One consisting of sections 1 to 5 and, the other a supercharge, charge 6. Primer, C/12nA, is assembled in the cartridge case.
2 For an explanation of German abbreviations, see paragraph 75.
3 This shell with A.Z. 23v (0.25) Fuze, or with Dopp. Z.S./60 Fuze set at zero, and with charge 5, may be used against tanks if A.P. shell are not available.
4 Used with charge 5, which is ready for firing, or the special charge 6.

GERMAN 105-MM HOWITZER MATERIEL

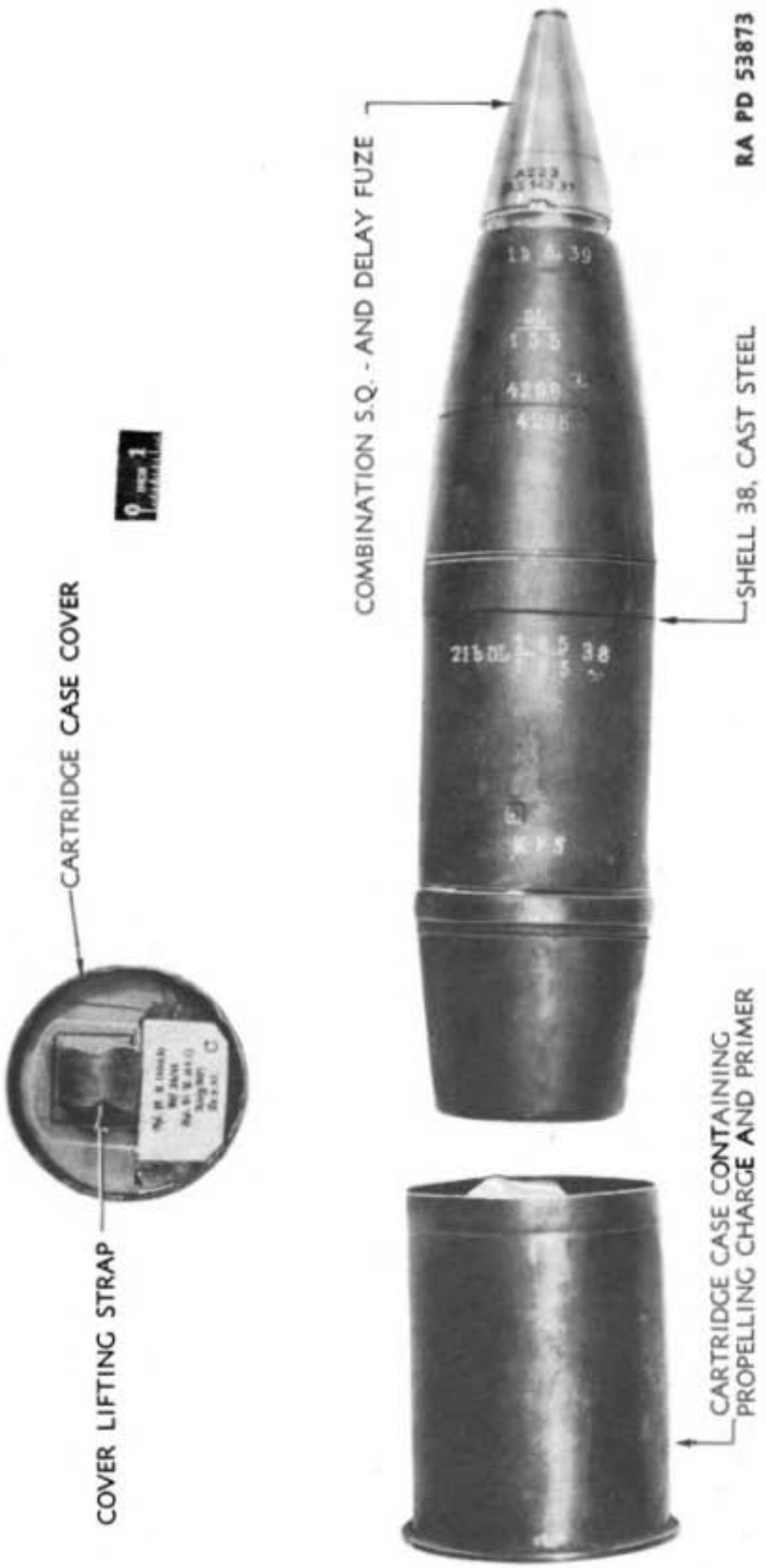


Figure 102—Complete Round, High-explosive, for German 105-mm Light Field Howitzer

AMMUNITION

65. PREPARATION FOR FIRING.

a. Fuzed projectiles, once removed from their packing containers and the fuzes properly adjusted, are ready for firing. In preparing the armor-piercing projectile for firing, the protective covering of the tracer must be removed.

b. Should it be necessary to fuze or unfuze projectiles, authorized personnel only will do this work. A spanner wrench labeled "A.Z. 23 and Zt. Z.S./30" should be used, if available. Also, the fuze setter for "A.Z. 23" and Zt. Z.S./30 may be used to screw and unscrew fuzes.

c. Fuzes are adjusted for the desired action as described in paragraph 68.

d. When firing charge 5, which is considered the "standard" charge, the propelling charge as shipped in its cartridge case is ready for firing. For firing lower zones of fire, the cartridge case cover is removed, and the appropriate number of increments removed, as described in paragraph 67. For firing the special charge 6, the entire standard charge (five sections) is removed. Charge 6 (base section and one increment section) is then inserted in the cartridge case. The cartridge case cover is always replaced to hold the charge sections in place. A flash reducer (Kartuschvorlage) of spun lead wire (Bleidraht) may also be included in the charge if not already present, its normal position being immediately above the base section.

66. PROJECTILES.

a. General. The authorized projectiles for use in the German 105-mm Light Field Howitzer, 18, are listed in paragraph 64. The high-explosive shell is illustrated in figures 102 and 103.

b. Identification. The following identification markings may be found on projectiles. These markings may vary, dependent upon the particular lots found in the field.

(1) OLIVE-DRAB COLOR. High-explosive shell are painted olive drab.

(2) SHELL NUMBER. This appears on both upper and lower sections of the high-explosive shell body. To the left of this number is an alining mark on both sections.

(3) WEIGHT-ZONE MARKING (GEWICHTSKLASSE). A black roman numeral indicates weight-zone marking. The numeral "III" indicates "standard" weight. No weight corrections in the firing tables are necessary in firing shells which are in weight zone III.

(4) Date of assembly and manufacturer's initials or symbol.

GERMAN 105-MM HOWITZER MATERIEL

RA PD 53874

Figure 103—Comparison of: "1" U.S. 105-mm M1 H. E. Shell and "2" German 105-mm H. E. Shell

AMMUNITION

(5) A number indicating type of H.E. filler, for example: 1—indicates TNT; 2—indicates picric acid. Other number designations will be found in paragraph 75.

(6) Abbreviations denoting type of shell, for example:

Tp (Tropen)—For the tropics.

Üb (Übung)—Practice.

Nb (Nebel)—Smoke.

c. High-explosive Shell.

(1) GENERAL. There are two types of high-explosive shell, the field howitzer shell (Feldhaubitze Granate, F.H. Gr.) and the Field Howitzer 38 Cast Steel Shell (figs. 102 and 103).

(2) The German shell is similar in appearance and contour to the U. S. 105-mm Howitzer Shell, M1 (fig. 103). Differences to be noted are:

(a) The German shell is painted a dark olive drab with marking in white. The U. S. shell has been painted yellow, but is now painted lusterless olive drab with marking in yellow.

(b) The 7-degree taper of the base of the German shell starts immediately to the rear of the $\frac{5}{8}$-inch wide copper rotating band, whereas in the U. S. shell the base begins to taper about 1 inch to the rear of the rotating band.

(c) The German shell consists of two sections with an adapter screwed into the nose of the upper section. The two sections are screwed together and staked. The U. S. shell is made of one piece of forged steel.

(d) The German shell has no base cover.

(e) The German shell is shipped, and loaded into the weapon, separate from the propelling charge and primer in their cartridge case. The U. S. shell is a component of a semifixed round, the shell being normally seated with a free fit in the cartridge case.

(3) DESCRIPTION. The German point-fuzed shell weighs 32.6 pounds and contains 3 pounds of high explosive. The length of the fuzed shell is $18\frac{9}{16}$ inches. It is fuzed with a combination superquick and delay fuze (A.Z. 23) or with a combination time and percussion fuze (Dopp. Z.S./60). Besides the high-explosive charge, the shell contains a spotting charge of 3.7 ounces of red phosphorus. The booster of the shell is assembled in an aluminum container which fits snugly into the booster case. The leather washer which is part of the booster assembly projects above the container, and acts as a shock absorber against the bottom of the fuze. The adapter which holds the booster casing in place is a steel disk, three-eighths inch thick. Four flats are provided to stake the fuze in place. The average

diameter of the bourrelet is 4.111 inches, and of the rotating band, 4.256 inches. On some shell the base immediately below the rotating band is grooved, on others it is not.

(4) BALLISTIC DATA.

TABLE II

BALLISTIC DATA FOR GERMAN 105-MM HIGH-EXPLOSIVE SHELL

Propelling Charge (zones)	Muzzle Velocity (feet per second)	Maximum Range (yards)	Gas Pressure (pounds per square inch)
1	656	3910	——
2	761	5058	——
3	866	6288	——
4	1040	8311	——
5 (Standard)	1283	10,007	31,605
6 (Special)	1542	11,674	33,810

(5) PACKING. The fuzed projectile is packed in an individual carrying case (fig. 104). A steel plate protects the tip of the fuze. The projectile is removed from the base end of the carrying case. The rear end of the projectile is held in place by a leather or steel fastener. The handles of the carrying case may be of canvas or steel.

(6) PREPARATION FOR FIRING. The projectile as shipped is fuzed, and is ready for firing once removed from its packing container. Its fuze need only be adjusted for the desired action as described in paragraph 68.

d. Armor-piercing Shell.

(1) GENERAL. The armor-piercing shell (Panzergranate, Pzgr.) contains a base-detonating fuze (Bodenzünder, Bd. Z.), an explosive charge, and a tracer element in the fuze assembly. It weighs 30.8 pounds (14 kilograms). It is fired only with charge 5, which is ready for use as shipped, or the special charge 6. If armor-piercing projectiles are not available, the high-explosive shell with impact fuze (A.Z. 23) can be used against armored targets. Also, the high-explosive shell with the time fuze set at "zero" may be used for the same purpose.

(2) BALLISTIC DATA. The muzzle velocity of this shell with charge 5 is 1,295 feet per second. The armor-piercing shell is normally used for ranges up to 1,500 meters or 1,640 yards.

(3) PREPARATION FOR FIRING.

(a) Remove shell from its packing container.

(b) Remove the protective covering of the tracer element.

e. Smoke Shell. No information is available at present on the smoke shell (Nebelgranate, Nbgr.), except that it is fuzed with a special combination superquick and delay fuze, K1. A. Z. 23 Nb.

RA PD 53878

Figure 104—German 105-mm Projectile in Packing Container

GERMAN 105-MM HOWITZER MATERIEL

67. PROPELLING CHARGES.

a. General. The German 105-mm howitzer propelling charges are contained in a brass or steel cartridge case (fig. 106), the former case being in one piece, and the latter being either a one-piece or two-piece assembly. The charge is divided into five sections to provide for zone firing (fig. 105). To fire the special charge 6, the entire five-section charge is removed and replaced by the special increment 6 and its special base section. The sections are held in place over the primer by a cartridge case cover which must be removed, by means of its cloth handle, to remove any sections of the charge. This cover is replaced after adjustment of the charge is made. A label attached to the top of the cartridge case cover identifies the propelling charge as to contents and use.

b. Identification.

(1) The cartridge case model number (Hülsenbezeichnung) stamped on the base of the cartridge case, serves to identify the charge for the 105-mm field howitzer. The brass case number is 6342. The steel case, which is coated or washed with a brass plating, is marked 6342/St, "St" (stahl) indicating steel, or 6342/65 for the two-piece type steel case. Other typical markings on the base of the cartridge case are shown in figure 107.

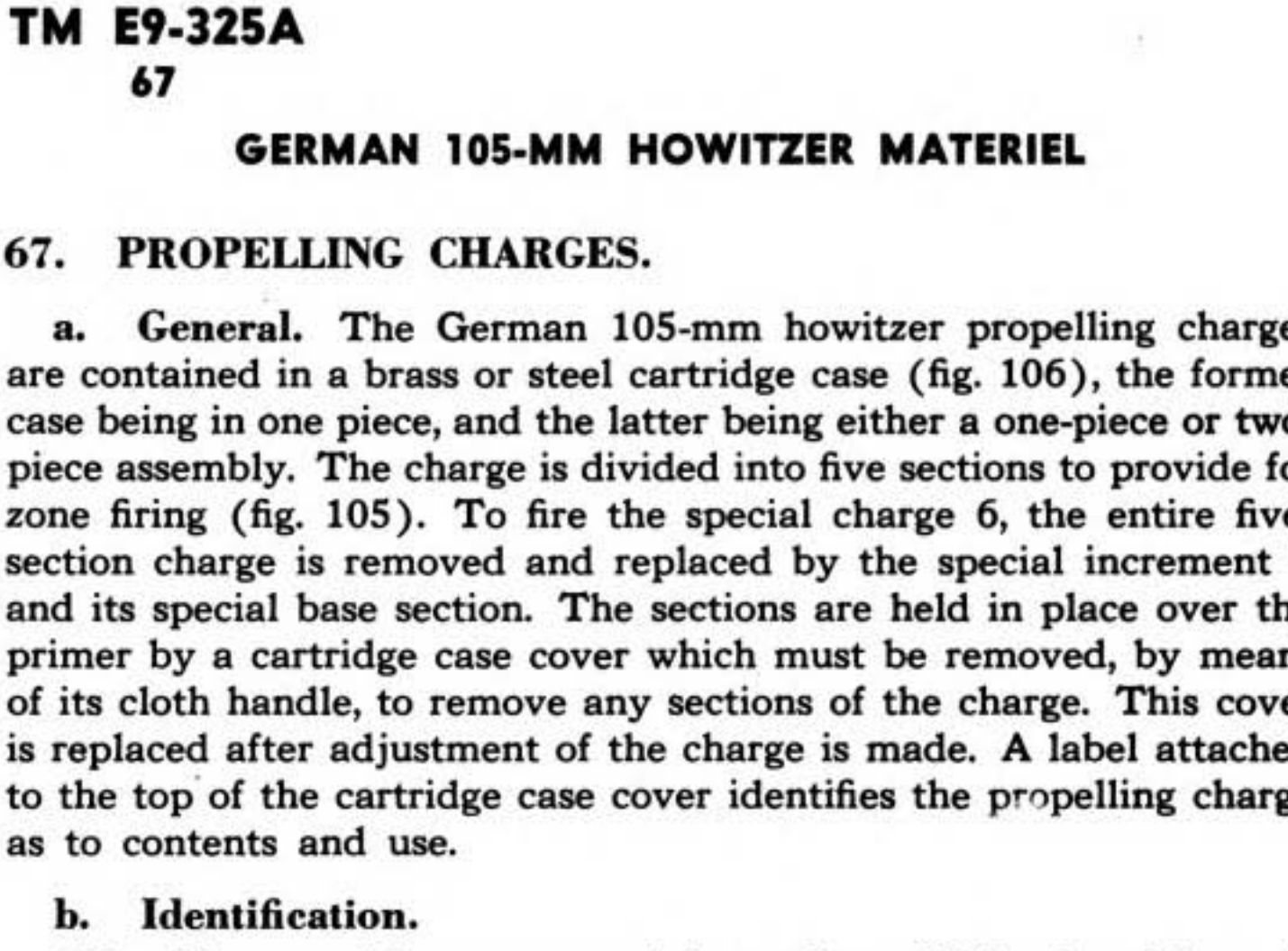


Figure 105—Components of Cartridge Case and Propelling Charge for German 105-mm Howitzer

AMMUNITION

RA PD 53876

Figure 106—Sectional Type of Cartridge Case for German 105-mm Howitzer

GERMAN 105-MM HOWITZER MATERIEL

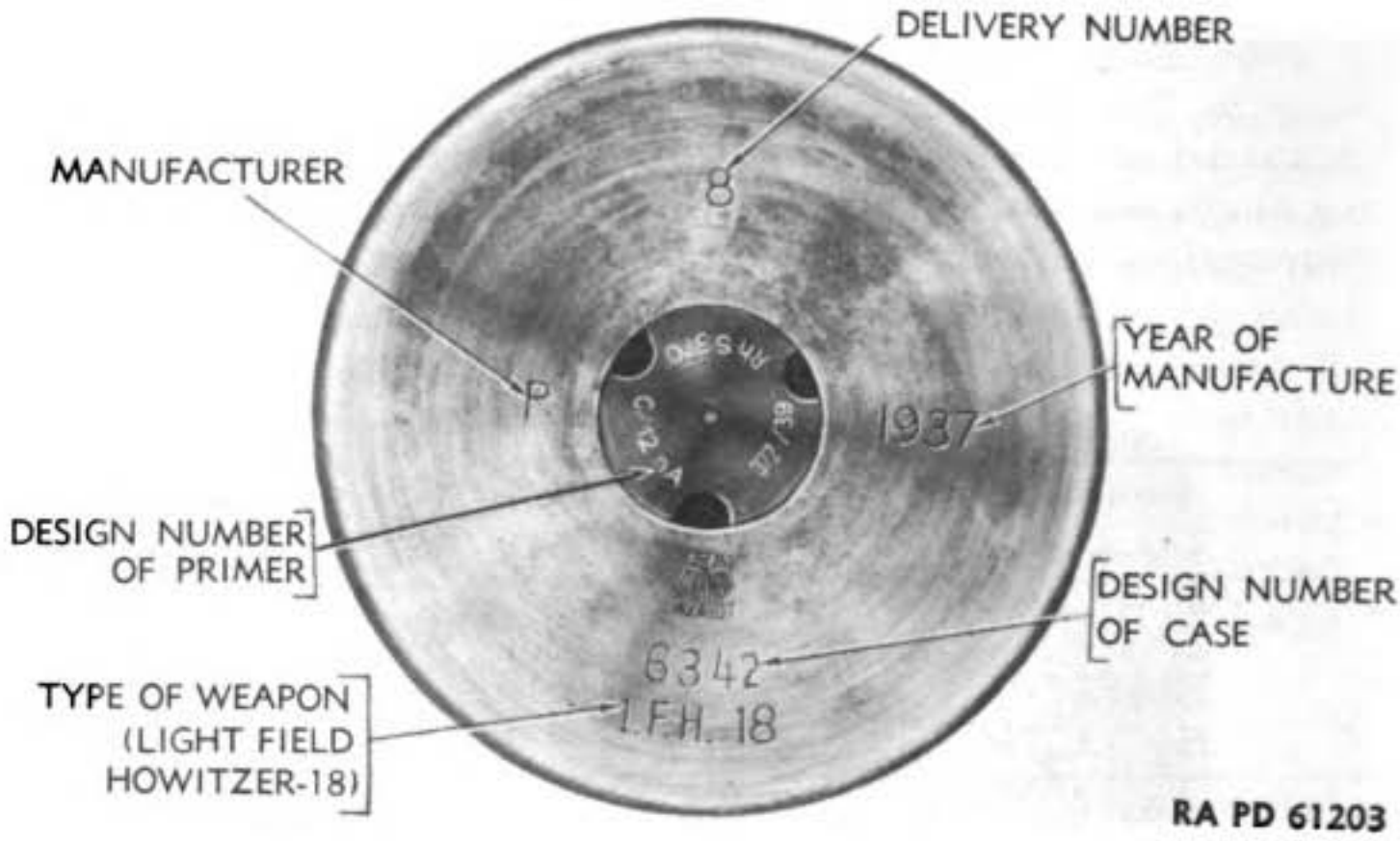


Figure 107—Typical Markings on Base of German 105-mm Cartridge Case

(2) The label on the closing cover of the brass case is marked as follows:

TABLE III
BRASS CARTRIDGE CASE LABEL

German Marking	English Equivalent
1.F.H. 18	Light field howitzer, 18
Ngl. Bl. P. 12.5 (40 x 40 x 0.2)	Nitroglycerin powder, number (grain size) base charge
Dbg. 37/8	Manufacturer, date, delivery number
Digl. Bl. P. 10.5 (3 x 3 x 0.8)	Diglycol powder, number (grain size) increment charge
Ha. 12.37H	Manufacturer, date, work mark

(3) The label on the closing cover of the steel case is marked as follows:

TABLE IV
STEEL CARTRIDGE CASE LABEL

German Marking	English Equivalent
Ngl. Bl. P. (50. 0. 2)	Nitroglycerin powder (grain size) base charge
Rdf 36/44	Manufacturer, date, delivery number
Ngl. Bl. P. (4. 4. 1)	Nitroglycerin powder (grain size) increment charge
Klietz 36/7	Manufacturer, date, delivery number
Ce 3.37D	Manufacturer, date, work mark

AMMUNITION

(4) Each section of the propelling charge is numbered 1, 2, 3, 4, or 5. The special charge 6 consists of a special base section and a special increment section (fig. 105). Typical marking on each section is indicated in table V. Specific markings for all sections are summarized below in table VI.

TABLE V

TYPICAL MARKINGS ON CHARGE SECTIONS

German Marking	English Equivalent
2	Charge number 2
65g. Digl. Bl. P. 10.5 (3, 3, 0.8)	65 grams, diglycol powder, number (grain size)
Dbg. 37/3	Manufacturer, date, delivery number
Ha. 12.37H	Manufacturer, date, work mark

TABLE VI

SPECIFIC MARKING DATA ON CHARGE SECTIONS

A. In Brass Cartridge Case (No. 6342) (Standard)

Kind of Powder (marked on each section)	Weight in Grams* (marked on each section)						
	Charge Section Number (marked on each bag)					Special Zone 6	
	1	2	3	4	5	Base Section	Special Section
Nz. Man. N.P. (1.5, 1.5)	20	—	—	—	—	—	—
Digl. Bl. P.—10.5—(3, 3, 0.8)	245	63	70	120	190	222	—
Digl. Bl. P.—10.5—(4, 4, 1.2)	—	—	—	—	—	—	800

B. In Steel Cartridge Case (No. 6342/St) (Substitute Standard)

Kind of Powder (marked on each section)	Weight in Grams* (marked on each section)						
	Charge Section Number (marked on each bag)					Special Zone 6	
	1	2	3	4	5	Base Section	Special Section
Nigl. Bl. P.—12.5—(40, 40, 0.2)	180	—	—	—	—	—	—
Nigl. Bl. P.—12.5—(4, 4, 1)	—	55	60	115	185	200	—
Nigl. Bl. P.—12.5—(10, 10, 1.5)	—	—	—	—	—	—	705

*—Kilogram (Kg.) weights may appear in marking on cartridge bags in place of grams (g); thus: .180 Kg. may be stenciled on the bag in lieu of 180 g.

c. Description. Sections are arranged in numerical sequence in the cartridge case. To fire charge 5, which is the "standard" charge, no adjustment of the charge is necessary. To fire charge 4, the section numbered 5 is removed; the remaining sections, sections 1, 2, 3, and 4, are left in numerical sequence so that numeral "4" appears uppermost. The same procedure applies to adjusting the charge for

firing charges 1, 2, or 3. To fire the special charge 6, the entire five-section charge is removed and replaced in the cartridge case by the special charge 6, which consists of a special base section and a special increment section. The cartridge case cover, which is removed when adjusting the charge, is replaced after adjustment is made. Since the propellent powders used are not flashless, a flash reducer (Kartuschvorlage) of spun lead wire (Bleidraht) is normally attached to the top of the base section. This flash reducer varies the performance of the gun. The propellent powders are of the diglycol nitrate type (Digl. or Dgl.) or the nitroglycerin type (Nigl. or Ngl.). For muzzle velocities and pressures developed with charges 1 through 6, inclusive, see table II, paragraph 66.

d. Packing. Cartridge cases are packed in a wooden box (fig. 108). Steel projections on the base of the box hold the closing cover of the cartridge case in place. The dimensions of the box are, approximately, 19¼ by 8 x 11 inches.

e. Preparation.

(1) The cartridge case, as shipped, is ready for firing the charge 5 which is the "standard" charge.

(2) For lower zones of fire, the charge is prepared for firing as follows:

(a) Remove the cartridge case cover by means of the canvas lifting handle. If the cover cannot be removed easily, it should be pressed into the case at the circumference opposite the lifting handle. This will slightly loosen the cover.

(b) Remove the sections until the uppermost section indicates the desired charge number.

(c) Replace the cartridge case cover, pressing it firmly against the charge.

(3) For firing special charge 6, remove the cover as described above, replace the entire charge with the special section 6 with its special base section (par. 67, table VI), and replace the cartridge case cover.

(4) To assemble the flash reducer, the cartridge cover is removed as described above, the appropriate flash reducer—the 25-gram spun lead wire for all zones and Nigl. P. charges, the 10-gram spun lead wire for all zones and Digl. P. charges—is placed in the charge to be used, and the cartridge case cover replaced.

NOTE: The flash reducer varies the performance of the weapon.

68. FUZES.

a. General. The fuzes used with the German 105-mm howitzer H.E. shell consist of a combination superquick and delay fuze similar to the U. S. fuze, P. D., M48, and a combination time and point-

detonating fuze. It appears that these German fuzes are not boresafe fuzes.

CAUTION: Fuzes will not be disassembled. Any attempt to disassemble fuzes in the field is dangerous and is prohibited except under specific directions from the Chief of Ordnance.

b. German Fuze, A.Z. 23.

(1) DESCRIPTION. This fuze (figs. 102, 103) contains two actions, superquick (ohne versögering, o.v.) and delay (mit versögering, m.v.). Although both actions are initiated on impact, the functioning of the shell depends upon the setting of the selector of the fuze. Unlike the U. S. Fuze, P. D., M48, it should be noted that there is only one firing pin (fig. 109). Should this firing pin fail in the German fuze, the projectile will become a dud. However, it appears that the firing pin assembly is more sensitive to impact than the U. S. Fuze, P. D., M48. Also, unlike the M48 Fuze, the German fuze is not a boresafe fuze. As shipped, the fuze is set for superquick action, that is, the slot in the setting sleeve of the selector is parallel to the axis of the fuze and is thus alined with the registration line marked "0." To set the fuze for delay action, the slotted setting sleeve is turned 90 degrees so that the slot is alined with the line marked "M" on one side of the setting sleeve, and with "V 0.25" on the other side. The delay action is provided by a delay pellet of 0.25-second delay. The setting may be changed at will with a screwdriver or with "setting key A.Z. 23" (Stellschüssel Für A.Z. 23) at any time before firing. This can be done even in the dark by noting the position of the slot—parallel to the fuze action for superquick ("0") action, or at right angles thereto for delay action ("M" and "V" 0.25).

(2) PREPARATION FOR FIRING. As shipped, the fuze is ready for firing with superquick action. To set the fuze for delay action, the setting sleeve is turned with the setting key or screwdriver, as described above, through 90 degrees, so that the slot on the setting sleeve is alined with the letters "M" and "V 0.25." Fuzes which have not been fired should be reset to superquick. The slot will then be in line with "0."

c. German Fuzes, Dopp. Z.S./60s and Dopp. Z.S./60Fl.

(1) DESCRIPTION. These are combination time and impact fuzes similar in action to the U. S. Fuze, P. D., M54. The Dopp. Z.S./60s is used with the field howitzer shell and the Dopp. Z.S./60Fl. is used with the Field Howitzer Shell 38 Cast Steel. As shipped, these fuzes are ready for firing as impact fuzes. For use as time fuzes, they must be set at the setting values indicated in firing tables by means of the fuze setter provided. These values apply to the remaining distance of flight, in meters, starting from the muzzle. The zero setting of the

GERMAN 105-MM HOWITZER MATERIEL

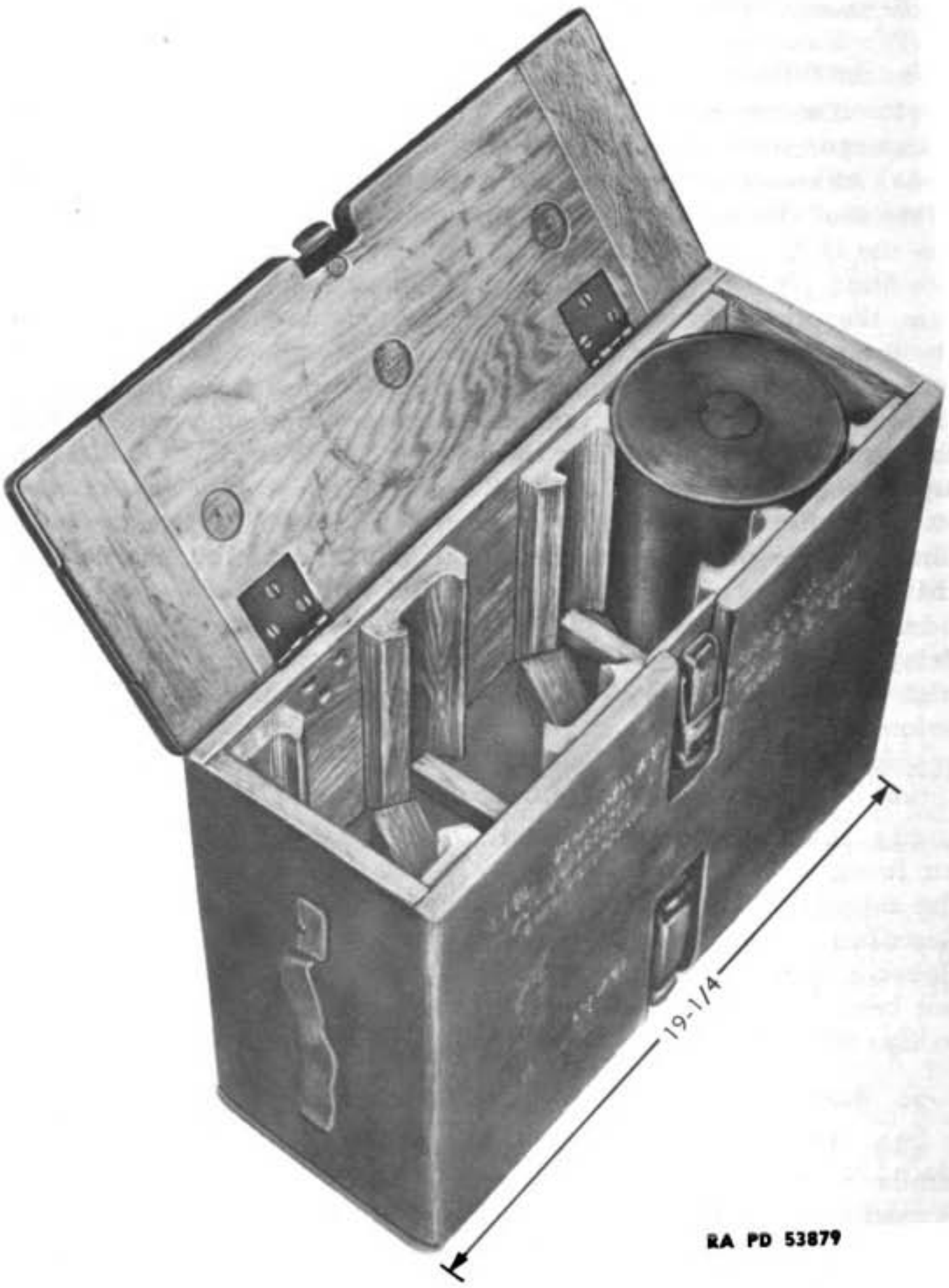


Figure 108—Packing Box for German 105-mm Cartridge Cases

fuze is "recess over recess"; on the fuze setter, indicator (arrow) at zero. The fuze setter is set at the fuze setting found in the firing table, and the fuze is set as described in paragraph 58. A time-safety feature in these fuzes prevents time action below 1 second time of flight, but they can operate upon impact before that time.

(2) PREPARATION FOR FIRING. The Dopp. Z.S./60 fuzes are ready for firing as impact fuzes. For time action they are prepared for firing as described in step (1), above. Fuzes which have been set on projectiles prepared for firing but not fired, must be reset at zero. This resetting is accomplished in the same manner as described above but with the fuze setter index at zero.

69. PRIMERS.

a. A primer (figs. 105 and 107) is screwed into the cartridge case at time of manufacture. This primer, marked "C/12nA", is of the same type and contour as the British 40-mm primer and is interchangeable with it. All metal parts of the primer are brass. The percussion element is screwed into the body of the primer. A wrench supplied with equipment for the weapon is for the assembly of primers to, or the disassembly of primers from, the cartridge case. The presence of this wrench indicates the possibility of frequent misfires.

70. INTERCHANGEABILITY OF AMMUNITION ITEMS.

a. Use of U. S. Ammunition Components.

(1) The following information is based on preliminary firing tests and should be used only in cases of emergency where the tactical situation demands such practices. *All safety measures must be observed when interchanging and mixing ammunition components.*

(2) The American 105-mm Shell, H. E., M1, has been fired from the German 105-mm howitzer, using the American 105-mm Howitzer M2, M2A1, and M4 charges for zones 1 through 5, inclusive. Firing table 105-H-3 is approximately correct for such firing.

(3) A charge prepared by removing section 4 from charge 7 of the American 105-mm howitzer charge produces approximately the same result as the German special charge 6.

(4) The charges described in steps (2) and (3), above, must be placed in the German 105-mm Cartridge Case, 6342. The American cartridge case *cannot* be used in the German howitzer.

(5) The German howitzer should not normally be fired with charges above charge 5 of the American charge because the German weapon was not designed to withstand the recoil produced by charges 6 and 7.

b. Primers. The British No. 18 primer is interchangeable with

GERMAN 105-MM HOWITZER MATERIEL

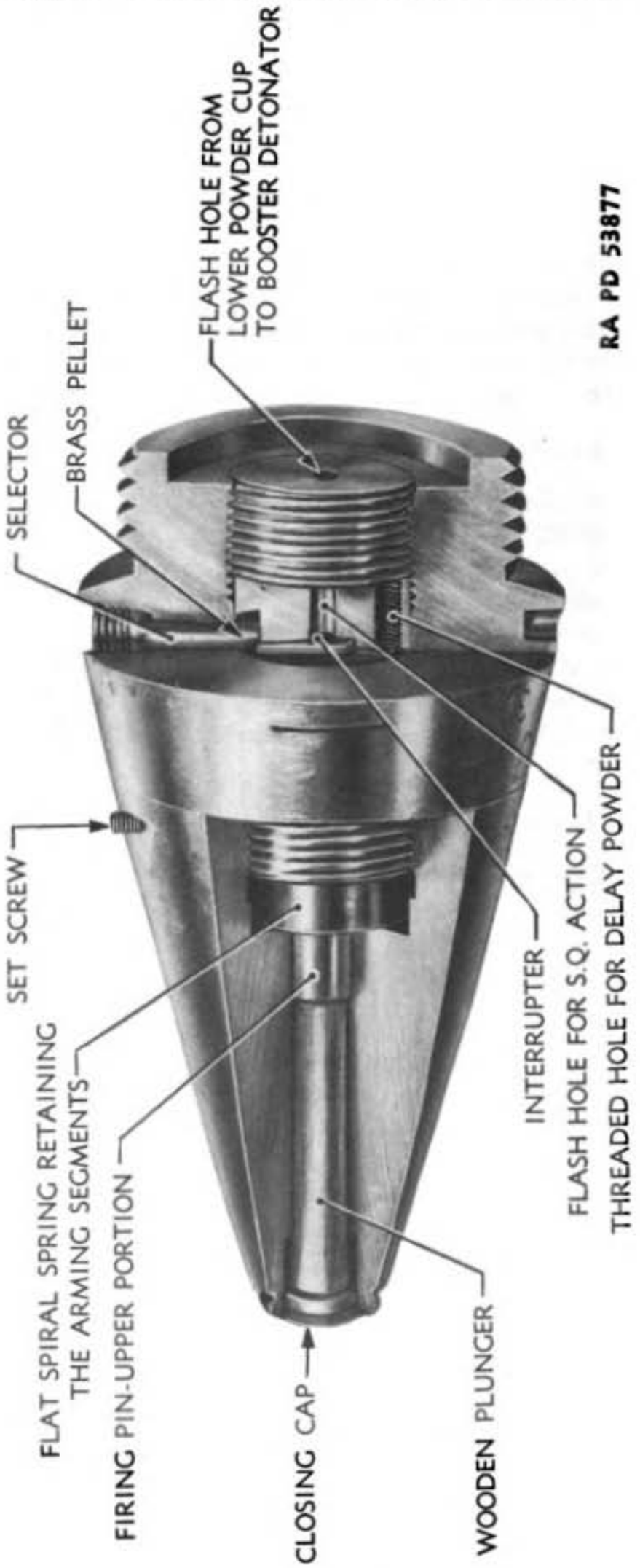


Figure 109—German A. Z. 23 Fuze—Sectional View

the German primer C/12nA. In addition, other calibers of German ammunition have the German C/12nA primer as a component of the cartridge case.

71. TROPICAL AMMUNITION.

a. Ammunition for use in the tropics is marked in red lettering, as follows: "P. T. + 25° C." This marking is indicated on sections of variable propelling charges, on the bottom of cartridge cases, and on the label of the cartridge case closing cover. Shell for use in tropics may be marked "Tp."

b. Containers for tropical ammunition have the following labels printed in red on white:

Für Tropen
Normale Pulvertemperature
+ 25° C.

c. Tropical ammunition has reduced weight of propellent and gives normal range table performance at +25° C (77° F). Where tropical ammunition has not been issued or manufactured, special range tables are provided for use in the tropics with standard ammunition. The temperature taken as normal for standard ammunition is 10° C (50° F).

72. PRECAUTIONS IN HANDLING CAPTURED AMMUNITION.

a. *All* captured ammunition should be examined by qualified personnel as soon as practicable. Loose ammunition may be dangerous, and is rarely worth the trouble of collection.

b. Ammunition may be dangerous because of:

(1) Deliberate "booby traps" laid by the enemy.

(2) Having been subjected to fire or shelling.

(3) Removal of safety devices from fuzes, etc. (either deliberate or accidental).

(4) Exposure rendering explosive elements unreliable.

c. Ammunition known or suspected of being dangerous will not be moved or touched, but destroyed in accordance with TM 9-1900.

d. Destroyed ammunition should be salvaged for brass parts. In addition, all enemy airtight containers should be returned to the base. This also applies to timber and wooden boxes suitable for use as dunnage, or for remaking ammunition boxes.

e. Ammunition should be recovered by complete rounds, for example; unfuzed shells are useless without the appropriate fuzes.

f. Personnel handling captured ammunition should keep in mind the fact that although the two types of ammunition appear to have

identical measurements, they are not necessarily interchangeable. Experiments to ascertain interchangeability are forbidden except by special authority.

g. No unauthorized modifications or experimentation will be carried out on any ammunition.

73. CARE, HANDLING, AND PRESERVATION.

a. In addition to the precautions and care in handling ammunition given in TM 9-325, the following apply particularly to German ammunition used in the German 105-mm howitzer:

(1) In firing the armor-piercing shell, remove the protective covering of the tracer before loading into the gun.

(2) The fuze, A.Z. 23v (0.25) is particularly sensitive, hence, it is important that the path of flight before the muzzle be free of all obstacles including small branches and leaves. Otherwise, premature burst may occur.

(3) Components of ammunition prepared for firing but not fired will be returned to their original condition and packing.

(4) Projectiles with impact fuzes (A.Z. fuzes) whose top or forward closing disk has been so damaged that the firing pin is pressed down or has fallen out, will not be fired. They are, however, safe to transport.

(5) Projectiles with time and percussion fuzes (Dopp. Z. fuzes) may not be fired when the rotatable closing cap of the fuze is bent, dented, damaged, or cannot be turned by the fuze setter. However, they are safe to transport.

(6) Projectiles and fuzes which have fallen and have not been damaged may be fired.

(7) After each round is fired, at night or in the daytime, it is necessary to examine the bore of the weapon to determine whether any pieces of bag or other foreign matter remains in the bore. All particles or obstructions should be removed to prevent jamming of the weapon upon firing the next round.

74. FIELD REPORT OF ACCIDENTS.

a. Any malfunctions of ammunition must be promptly reported to the Ordnance officer under whose supervision the materiel is maintained or issued (AR 750-10).

75. GERMAN ABBREVIATIONS AND GLOSSARY OF AMMUNITION ITEMS.

a. General. The following abbreviations, symbols, and terms may be found on labels or in communications and literature pertaining to the ammunition items described herein. Certain general terms are also included.

AMMUNITION

b. Abbreviations.

TABLE VII
GERMAN AMMUNITION ABBREVIATIONS

A.Z.	Aufschlagzünder	Percussion fuze
A.Z. m. V.	Aufschlagzünder mit versögerung	Percussion fuze with delay action
Bd. Z.	Bodenzünder	Base percussion fuze
Bl.	Blindgänger	Dud
Bl. P.	Blättchenpulver	Flaked gunpowder
Bz.	Brennzünder	Time fuze (powder train type)
Digl. or Dgl.	Diglycol	Diglycol
Dopp. Z. or D. Z.	Doppelzünder	Combination fuze
Ex. Mun.	Exerziermunition	Dummy ammunition; blank ammunition
f	Für	For
F.H.	Feldhaubitze	Field howitzer
Flb.	Flügbahn	Trajectory
Fp	Füllpulver	High explosive
Gesch	Geschoss	Projectile; shell
G Gr.	Gasgranate	Gas shell
Gr.	Granate	Shell
Grf.	Granatfülling	Bursting charge of shell
Gr. m. P.	Granate mit Panzerkopf	Armor-piercing shell
Gr. Z. or G.Z.	Granatzünder	Shell fuze
H	Hexagen	Cyclonite, R.D.X.
Hülzenkart	Hülzenkartusche	Cartridge case (separate loading)
H.Z.	Haubitzzünder	Howitzer shell fuze
Kl.	Klein	Small
Kp.	Krupp	Krupp
Kz.	Kopfzünder	Point-detonating fuze
l.F.H.	Leichte Feldhaubitze	Light field howitzer
Ldg. or L.	Ladung	Charge; propelling charge; load
lg. F. H. Gr.	Länge Feldhaubitzgranate	Long field howitzer shell
Lggr.	Langgranate	Long shell
m.	Mit	With
Mun.	Munition	Ammunition
m.v.	Mit versögerung	With delay (fuzes)
Nb.	Nebel	Smoke
Nbgr.	Nebelgranate	Smoke shell
Ngl. or Nigl.	Nitroglyzerin	Nitroglycerin
Np.	Nitropenta	P.E.T.N.; penthrite
Nr.	Nummer	Number

GERMAN 105-MM HOWITZER MATERIEL

TABLE VII
GERMAN AMMUNITION ABBREVIATIONS (Contd.)

o.	Ohne	Without
o.v.	Ohne versögerung	Without delay (super-quick)
P.K.	Pulverkasten	Ammunition box
P. S. Gr.	Panzerstahlgranate	Steel armor-piercing shell
P. T.	Pulvertemperature	Ammunition temperature
Pzgr. or Pz. Gr.	Panzergranate	Armor-piercing shell
Pz. Spr. Gr.	Panzersprenggranate	High-explosive armor-piercing shell
Sch. Tf.	Schlusstafel	Firing table
Sch. Z. Schr.	Schlagzündschraube	Threaded base percussion fuze
Sonderkart	Sonderkartusche	Special charge
Sprgr. or Spr. Gr.	Sprenggranate	High-explosive shell
St.	Stahl	Steel
Tp.	Tropen	Tropics
Ub.	Ubung	Practice
Ubgr. or Ub. Gr.	Ubungsgranate	Practice shell
v.	Versögerung	Delay (fuzes)
Z.	Zunder	Fuze
Zdschr.	Zundschraube	Threaded percussion primer
Zt. Z. or ZZ.	Zeitzunder	Time fuze

c. Glossary.

TABLE VIII
GERMAN AMMUNITION TERMS

Bleidraht	Lead wire	Haubitzzünder (H. Z.)	Howitzer shell fuze
Brisanz	High explosive	Hauptladung	Propellant (lit: main charge)
Brisanzgeschoss	High-explosive shell	Holzkasten	Wooden box
Brizanzmunition	High-explosive ammunition	Hülse	Cartridge case
Gewichtsklasse	Weight class (shell)	Hülsenbezeichnung	Cartridge case designation (number)
Haube	Ballistic cap		
Haubitze	Howitzer		

AMMUNITION

TABLE VIII

GERMAN AMMUNITION ABBREVIATIONS (Contd.)

Kartusche	Cartridge case	Rauchloses Pulver	Smokeless powder
Kartuschhülse	Cartridge case	Rauch-schwaches Pulver	Smokeless powder
Kartuschkorb	Ammunition basket	Rohrsicherer Zunder	Bore-safe fuze
Kartuschmunition	Semifixed ammunition	Stellschlussel	Setting key (fuzes); hand fuze setter; adjusting wrench
Kartuschvorlage	Cartridge case wad; flash reducer	Vorlage	Flash hider
Kennbuchstabe	Identification mark	Zünderstellung	Fuze setting
Lieferungsnummer	Delivery number	Zünderschlussel	Hand fuze setter
Nebelgeschoss	Smokeshell	Zünderstellmaschine	Fuze setter
Pulver	Powder	Zünderstellschlussel	Hand fuze setter
Pulverladung	Powder charge		

d. German Explosives Abbreviations.

TABLE IX

GERMAN EXPLOSIVES ABBREVIATIONS

Abbreviation	German Nomenclature	English Equivalent
Fp 02	Füllpulver 02	TNT
Fp 5	Füllpulver 5	TNT with 5% montan wax
Fp 10	Füllpulver 10	TNT with 10% montan wax
Fp 40/60	Füllpulver 40/60	40-60 amatol, poured
Grf 88	Granatfulling 88	Picric acid
H	Hexagen	Cyclonite; R.D.X.
H 5	Hexagen 5	Cyclonite with 5% montan wax
Np	Nitropenta	P.E.T.N.; penthrite
Np 10	Nitropenta 10	P.E.T.N. with 10% montan wax
Np 40	Nitropenta 40	P.E.T.N. with 40% montan wax
Np 65	Nitropenta 65	P.E.T.N. with 65% montan wax

GERMAN 105-MM HOWITZER MATERIEL

e. Index Numbers on German Shell Indicating Type of H. E. Filler.

TABLE X

NUMBERS ON GERMAN SHELL INDICATING TYPE OF H. E. FILLER

Number on Shell	Type of Filler
1	Fp 02 (TNT) in paper or cardboard container
2	Grf 88 (picric acid) in paper or cardboard container
10	Fp 02 + Fp 5 + Fp 10 (TNT fillers) in paper or cardboard container
13	Fp 40/60 (40-60 amatol, poured)
14	Fp 02 (TNT), poured
32	Np 10 (P.E.T.N. filler) in paraffin-waxed paper wrapping
36/38	Np 40 + Np 60 (P.E.T.N. fillers) in paraffin-waxed paper wrapping
91	H 5 (Cyclonite; R.D.X.) in paraffin-waxed paper wrapping

CHAPTER 5

ACCESSORIES

76. ACCESSORIES.

a. Accessories include the tools and equipment required for such disassembling and assembling as the using arms is authorized to perform, and for cleaning and preserving the (German) 105-mm howitzer and carriage. Accessories should not be used for purposes other than those prescribed, and when not in use should be properly stored.

(1) AIR TESTING AND REFILLING APPARATUS (F, fig. 111). This apparatus is used when testing and/or refilling the equilibrator with compressed air. It consists of an adapter, a flexible hose connection, two pressure gages, and two plugs contained in a metal chest which has a wood insert cut to receive these items. Spare washers and gaskets are also contained in this chest. A high pressure compressed air cylinder is the source of supply of the compressed air. The adapter is T-shaped with three female threaded openings at one end, and a male threaded connector at the other end. The flexible hose connection is 7 feet long with connectors at both ends which are protected by caps. Both pressure gages are identical and are interchangeable. They are graduated from 0 to 160 kilograms per square centimeter (2,275 pounds per square inch), in 5-kilogram units (71 pounds). The plugs fit the openings of the adapter. The compressed air cylinder has a capacity of 5.2 liters (0.24 cubic feet), and has a cap which protects the hand valve. When testing the air pressure of the system, assemble the adapter with two plugs and one gage, and screw into the equilibrator. The reading on the gage gives the pressure of the system. When refilling the system, assemble the adapter with one plug, one gage and screw into the equilibrator. Connect one end of the flexible hose connection to the adapter, and the other to the compressed air cylinder. Turn the hand valve so that air flows into the system, and disconnect after the proper gage reading is reached.

(2) BORE BRUSH (A, C, D, fig. 110). The bore brush is used for cleaning the bore of the howitzer. The aiming posts supplied with the howitzer are used as a handle for the bore brush. The bristles of the brush are made from a vegetable fiber. A cover is furnished for the bore brushes.

(3) BREECH AND CRADLE COVER (C, fig. 112). The breech and cradle cover is made of artificial leather. It is held in place by straps passing under the cradle and held snugly around the breech ring.

(4) ENGINEER'S WRENCH (C, fig. 111). This is a standard open-end wrench with 27-mm and 32-mm openings. The 27-mm end is used on the wheel rim bolts and the howitzer locking bracket bolts. The 32-mm end is used on the compressed air cylinder.

GERMAN 105-MM HOWITZER MATERIEL

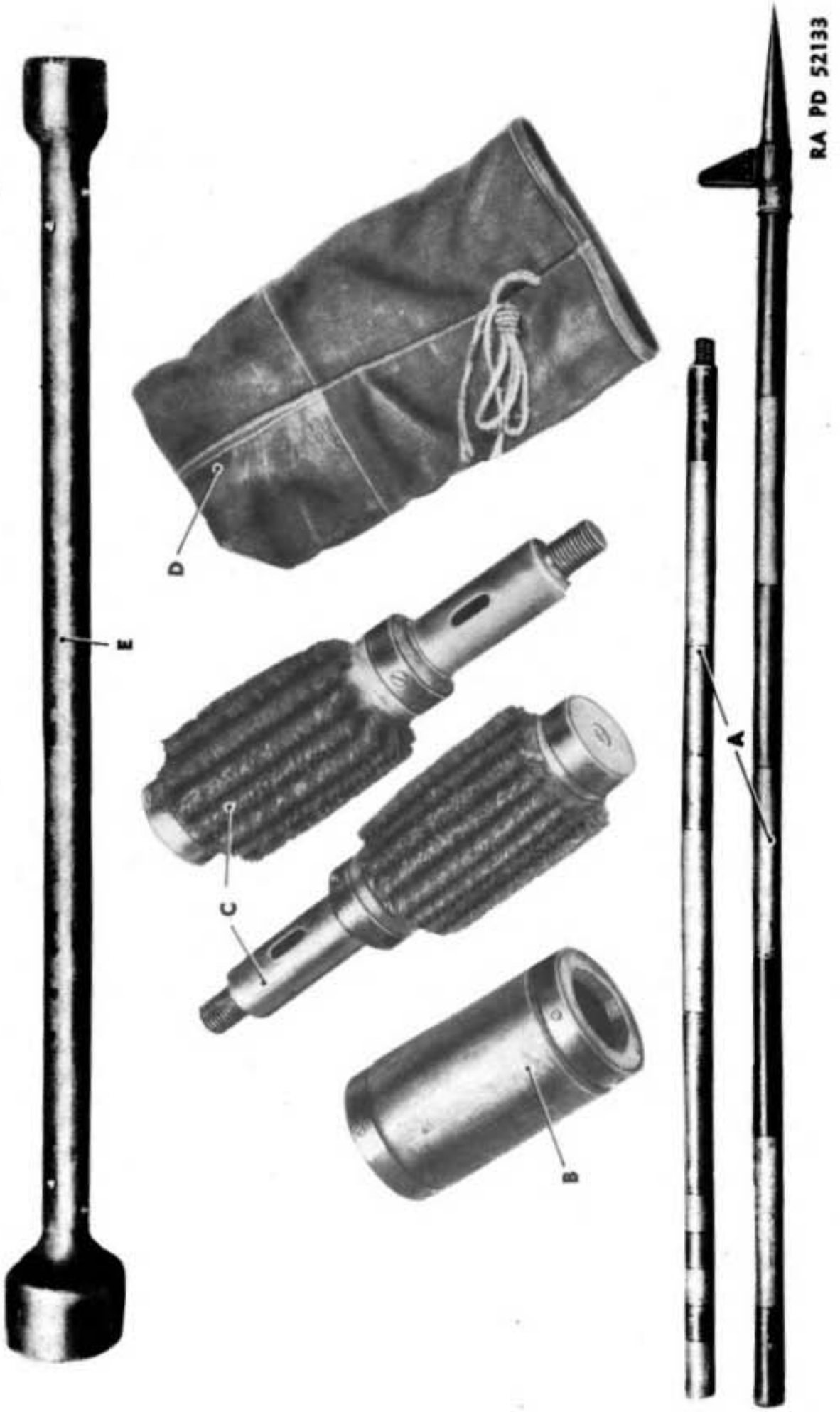


Figure 110—Muzzle Cleaning Equipment With Case

ACCESSORIES

Figure 111—Accessories

GERMAN 105-MM HOWITZER MATERIEL

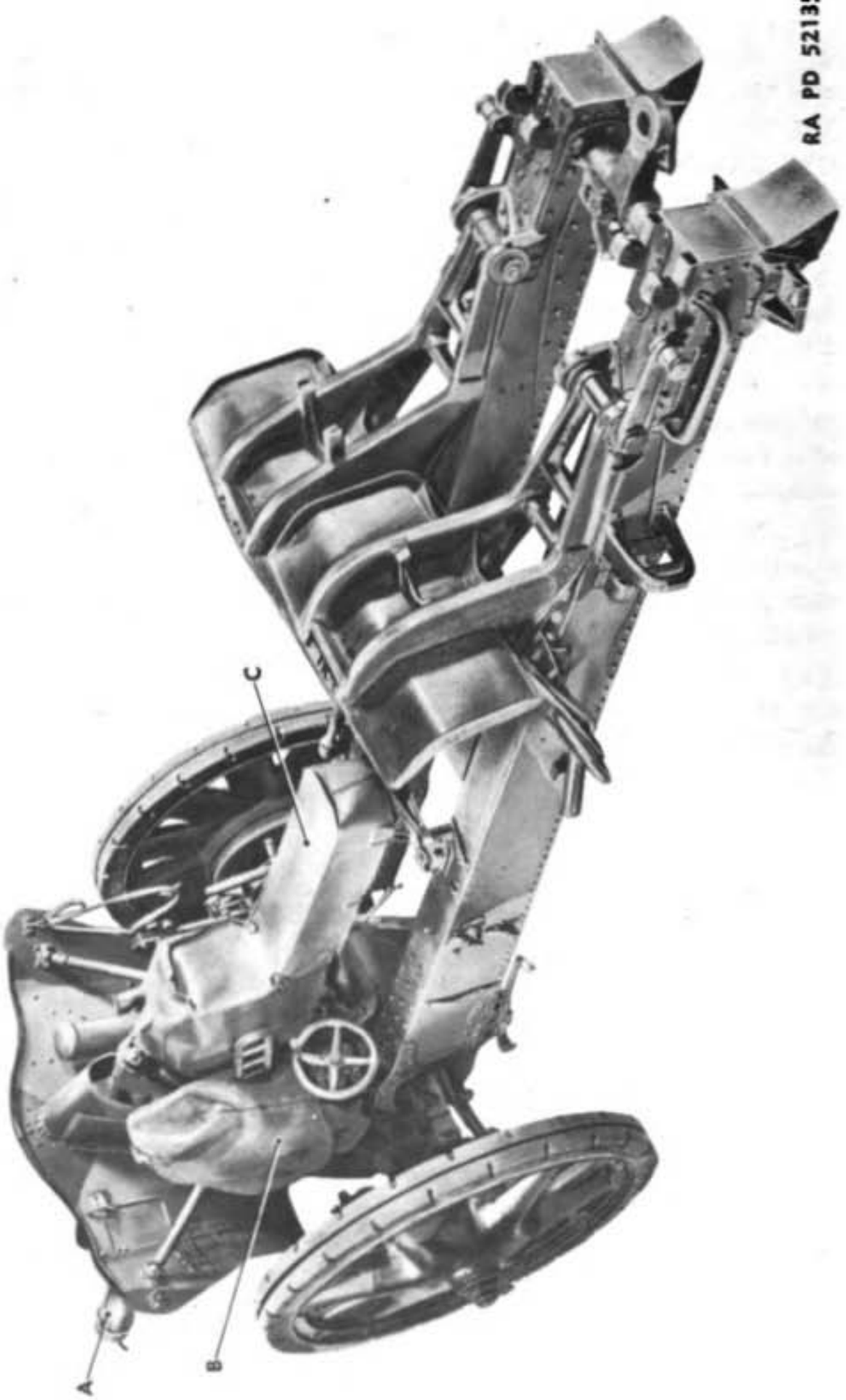


Figure 112—Covers Mounted on German 105-mm Howitzer Materiel

ACCESSORIES

(5) FUZE WRENCH (D, fig. 111). This wrench is a circular single pin spanner wrench used for the A.Z. 23 Fuze.

(6) GREASE AND OIL CONTAINERS (A, B, fig. 111). These containers are metal boxes used for storing the grease and oil necessary for the lubrication of the howitzer and carriage.

(7) LUBRICATING GUN AND HOSE (E, fig. 111). This is a screw-handle-type grease gun with a flexible metal covered hose. The hose has a button-head fitting used for greasing the howitzer and carriage.

(8) MUZZLE COVER (A, fig. 112). The muzzle cover is made of leather and has a red reflector. It fits snugly over the muzzle and is held in place by a strap which attaches to the recuperator support.

(9) RAMMER (E, fig. 110). The rammer is used for ramming in the powder charge and projectile. It is 38 inches long and has two wooden heads. Both heads are circular in shape, the larger one having an indentation at the end, while the smaller one is flat.

(10) SHELL REMOVER (B, fig. 110). The shell remover consists of a piece of hardwood recessed to fit the shell contour. Two metal ferrules prevent the wood from splitting. No handle was provided for this shell remover.

(11) SIGHT COVER (B, fig. 112). The sight cover is made principally of canvas. A leather section is provided at the top where it contacts the panoramic telescope. It is held in place by straps.

GERMAN 105-MM HOWITZER MATERIEL

CHAPTER 6

FIRING TABLES

77. FIRING TABLES.

a. The following are the firing tables for the 105-mm (German) light field howitzer. They are divided into two parts: the first contains data for the Field Howitzer Shell (F.H. Gr.), Field Howitzer Shell, Cast Steel (F.H. Gr. 38 Stg.), and Field Howitzer Projectile (10 cm. Pzgr.); and the second contains data for Field Howitzer Shell, Smoke (F.H. Gr. Nb.).

LIGHT FIELD HOWITZER, 105-MM (GERMAN)

FIRING

FIELD HOWITZER SHELL (F.H. Gr.)

FIELD HOWITZER SHELL, CAST STEEL (F.H. Gr. 38 Stg.)

AND

FIELD HOWITZER PROJECTILE (10 cm Pzgr.) (See Charge 5)

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl★.
Muzzle Velocity, 656 f/s — Charge 1

1	2	3	4	5	6	7	8	9	10	11	12	13
						Probable error					Deflection effect	
Range R	Elevation El	Fork F	Change in elevation for 100-yd change in range C	Change in range for 1 mil change in elevation mil	Time of flight Time	Range e_{pr}	Deflection e_{pd}	Height of burst	Slope of fall Slope	Line number of metro message L	Drift Dft	Lateral wind of 1 MPH (+) W-D
yd	mil	mil	mil	yd	sec	yd	yd	mil	1/—	No	mil	mil
0	—5.0	5	11.2	9	0.0	0	0			1	0	0.0
100	+6.2	5	11.2	9	0.5	12	0		93	1	0	0.0
200	17.6	6	11.4	9	0.9	13	0		46	1	0	0.0
300	29.2	6	11.6	9	1.4	14	0	1	30	1	1	0.0
400	40.8	7	11.8	9	1.8	15	0	1	22	1	1	0.0
500	52.6	7	11.8	8	2.3	16	0	1	17.5	1	1	0.0
600	64.6	8	12.0	8	2.8	17	0	2	14.5	1	2	0.0
700	76.6	8	12.0	8	3.3	18	0	2	12.4	1	2	0.0
800	88.8	9	12.2	8	3.7	19	0	2	10.7	1	2	0.0
900	101.2	10	12.4	8	4.2	20	0	2	9.4	1	3	0.0
1000	113.6	10	12.4	8	4.7	21	0	2	8.4	1	3	0.0
1100	126.2	11	12.6	8	5.2	22	0	3	7.6	1	3	0.1
1200	139.0	12	12.8	8	5.7	23	0	3	6.8	1	4	0.1
1300	151.8	12	13.0	8	6.2	24	0	3	6.2	1	4	0.1
1400	164.8	13	13.2	8	6.7	25	0	3	5.7	1	4	0.1
1500	178.0	14	13.2	8	7.2	26	1	3	5.3	1	5	0.1
1600	191.4	14	13.4	7	7.7	27	1	4	4.9	1	5	0.1
1700	205.0	15	13.6	7	8.2	28	1	4	4.6	1	5	0.1
1800	218.8	17	13.8	7	8.7	30	1	4	4.3	1	6	0.1
1900	232.8	18	14.2	7	9.3	31	1	4	4.0	1	6	0.1
2000	247.0	19	14.4	7	9.8	32	1	4	3.7	1	7	0.1
2100	261.6	20	14.8	7	10.4	33	1	5	3.5	1	7	0.1
2200	276.6	21	15.2	7	10.9	35	1	5	3.3	1	8	0.1
2300	291.8	22	15.6	6	11.5	36	1	5	3.1	1	8	0.1
2400	307.6	24	16.0	6	12.1	38	2	6	2.9	1	9	0.1
2500	323.8	26	16.4	6	12.7	39	2	6	2.8	2	9	0.1
2600	340.6	28	17.0	6	13.3	41	2	6	2.6	2	10	0.2
2700	358.0	30	17.8	6	14.0	42	2	7	2.5	2	10	0.2
2800	376.2	33	18.6	5	14.6	44	2	7	2.4	2	11	0.2
2900	395.2	35	19.4	5	15.3	45	2	7	2.2	2	11	0.2
3000	415.2	38	20.4	5	16.0	47	3	8	2.1	2	12	0.2

CHARGE 1

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl★.
Muzzle Velocity, 656 f/s — Charge 1

14	15	16	17	18	19	20	21	22	23	1
Complementary angle of site for each		Range effect of increase of—								
+1 mil of site	−1 mil of site	One proj in wt of is std Wt	One foot per sec in MV VE	Air temp 1 deg S'd is 59° F Temp	Rear wind of 1 MPH W-R	One pct in air density Den	Fuze setting for graze burst FS	Displacement of burst for change of 5 points in fuze setter corrector in— Ht	 R	Range R
mil	mil	yd	yd	yd	yd	yd	sec	mil	yd	yd
.00	.00		0.0		0.0	0				0
.00	.00		+0.3		0.0	0				100
.00	.00		+0.6		0.0	0				200
.00	.00		+0.9		0.0	0	20			300
.00	.00		+1.2		0.0	0	22			400
.00	.00		+1.5		0.0	0	25			500
.00	.00		+1.8		0.0	0	28			600
+.01	−.01		+2.1		0.0	0	31			700
+.01	−.01		+2.4		+0.1	0	33			800
+.01	−.01		+2.7		+0.1	0	36			900
+.02	−.02		+3.0		+0.1	0	39			1000
+.02	−.02	Data not available	+3.3	Data not available	+0.1	0	42	Data not available	Data not available	1100
+.03	−.03		+3.6		+0.1	0	44			1200
+.03	−.03		+3.8		+0.1	0	47			1300
+.04	−.04		+4.1		+0.2	−1	50			1400
+.04	−.04		+4.4		+0.2	−1	53			1500
+.05	−.05		+4.7		+0.2	−1	56			1600
+.05	−.05		+5.0		+0.2	−1	59			1700
+.06	−.06		+5.3		+0.3	−1	62			1800
+.07	−.07		+5.6		+0.3	−1	65			1900
+.08	−.08		+5.8		+0.4	−1	68			2000
+.10	−.09		+6.1		+0.4	−1	71			2100
+.11	−.10		+6.3		+0.5	−1	74			2200
+.13	−.12		+6.6		+0.5	−1	77			2300
+.14	−.13		+6.8		+0.6	−2	81			2400
+.15	−.15		+7.1		+0.6	−2	84			2500
+.17	−.16		+7.3		+0.7	−2	87			2600
+.19	−.18		+7.6		+0.7	−2	91			2700
+.21	−.20		+7.8		+0.8	−2	95			2800
+.23	−.22		+8.1		+0.9	−2	99			2900
+.26	−.25		+8.4		+0.9	−3	103			3000

CHARGE 1

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl*.
Muzzle Velocity, 656 f/s — Charge 1

1	2	3	4	5	6	7	8	9	10	11	12	13
						Probable error					Deflection effect	
Range	Elevation	Fork	Change in elevation for 100-yd change in range	Change in range for 1 mil change in elevation	Time of flight	Range	Deflection	Height of burst	Slope of fall	Line number of metro message	Drift	Lateral wind of 1 MPH (+)
R	El	F	C	mil	Time	e_{pr}	e_{pd}		Slope	L	Dft	W-D
yd	mil	mil	mil	yd	sec	yd	yd	mil	1/–	No	mil	mil
3000	415.2	38	20.4	5	16.0	47	3	8	2.1	2	12	0.2
3100	436.2	42	21.6	5	16.7	49	3	8	1.99	2	13	0.2
3200	458.6	47	23.2	4	17.5	51	3	9	1.87	2	14	0.2
3300	482.8	52	25.0	4	18.3	52	3	9	1.75	2	16	0.2
3400	509.0	59	27.2	4	19.2	54	4	10	1.64	2	17	0.2
3500	537.6	68	30.2	3	20.1	56	4	11	1.52	3	18	0.2
3600	569.8	80	34.6	3	21.1	58	4	12	1.41	3	19	0.2
3700	607.4	101	41.2	2	22.3	61	5	13	1.30	3	21	0.2
3800	654.6	136	53.0	2	23.9	64	5	15	1.20	3	24	0.3
3900	732.0				26.1	68	5	17	1.10	3	28	0.3

CHARGE 1

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl*.
Muzzle Velocity, 656 f/s — Charge 1

14	15	16	17	18	19	20	21	22	23	1
Complementary angle of site for each		Range effect of increase of—								
+1 mil of site	−1 mil of site	One proj is std in wt of	One foot per sec in MV	Air temp 1 deg Std is 59° F	Rear wind of 1 MPH	One pct in air density	Fuze setting for graze burst	Displacement of burst for change of 5 points in fuze setter corrector in—		Range
		Wt	VE	Temp	W-R	Den	FS	Ht	R	R
mil	mil	yd	yd	yd	yd	yd	sec	mil	yd	yd
+.26	−.25		+8.4		+0.9	−3	103			3000
+.32	−.29	Data not available	+8.6	Data not available	+1.0	−3	107	Data not available	Data not available	3100
+.41	−.35		+8.9		+1.1	−3	112			3200
+.52	−.42		+9.1		+1.2	−3	116			3300
+.66	−.50		+9.4		+1.3	−3	121			3400
+.83	−.60		+9.6		+1.4	−4	126			3500
			+9.9		+1.6	−4	132			3600
			+10.1		+1.8	−4	139			3700
			+10.3		+2.0	−4	148			3800
			+10.5		+2.2	−5	161			3900

CHARGE 1

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl★.
Muzzle Velocity, 761 f/s — Charge 2

1	2	3	4	5	6	7	8	9	10	11	12	13
						Probable error					Deflection effect	
Range	Elevation	Fork	Change in elevation for 100-yd change in range	Change in range for 1 mil change in elevation	Time of flight	Range	Deflection	Height of burst	Slope of fall	Line number of metro message	Drift	Lateral wind of 1 MPH (+)
R	El	F	C	mil	Time	e_{pr}	e_{pd}		Slope	L	Dft	W-D
yd	mil	mil	mil	yd	sec	yd	yd	mil	1/–	No	mil	mil
0	—4.0	3	8.4	12	0.0	8	0			1	0	0.0
100	+4.4	3	8.4	12	0.4	9	0		123	1	0	0.0
200	13.0	3	8.6	12	0.8	9	0		61	1	0	0.0
300	21.6	3	8.6	12	1.2	10	0	0	40	1	0	0.0
400	30.2	4	8.6	12	1.6	10	0	0	30	1	1	0.0
500	39.0	4	8.8	11	2.0	11	0	0	24	1	1	0.0
600	47.8	4	8.8	11	2.4	12	0	1	19.5	1	1	0.0
700	56.6	5	8.8	11	2.8	13	0	1	16.6	1	1	0.0
800	65.4	5	9.0	11	3.2	14	0	1	14.4	1	2	0.0
900	74.4	5	9.0	11	3.6	14	0	1	12.7	1	2	0.0
1000	83.6	5	9.2	11	4.0	15	0	1	11.3	1	2	0.0
1100	92.8	6	9.2	11	4.4	16	0	1	10.2	1	2	0.0
1200	102.0	6	9.2	11	4.8	17	0	1	9.3	1	2	0.0
1300	111.2	6	9.4	11	5.3	17	0	2	8.5	1	3	0.0
1400	120.6	7	9.4	11	5.7	18	0	2	7.8	1	3	0.0
1500	130.2	7	9.6	10	6.1	19	0	2	7.2	1	3	0.1
1600	139.8	8	9.6	10	6.5	20	0	2	6.7	1	3	0.1
1700	149.6	8	9.8	10	7.0	21	0	2	6.3	1	4	0.1
1800	159.4	8	10.0	10	7.4	21	0	2	5.9	1	4	0.1
1900	169.4	9	10.0	10	7.9	22	0	2	5.5	1	4	0.1
2000	179.4	9	10.2	10	8.3	23	0	2	5.2	1	5	0.1
2100	189.6	10	10.4	10	8.8	24	1	3	4.9	1	5	0.1
2200	200.0	10	10.4	10	9.2	25	1	3	4.6	1	5	0.1
2300	210.6	11	10.6	9	9.7	26	1	3	4.4	1	6	0.1
2400	221.2	12	10.8	9	10.1	27	1	3	4.2	1	6	0.1
2500	232.0	12	11.0	9	10.6	28	1	3	4.0	1	6	0.1
2600	243.2	13	11.2	9	11.1	29	1	3	3.8	1	7	0.1
2700	254.6	14	11.4	9	11.6	30	1	3	3.6	1	7	0.1
2800	266.0	14	11.6	9	12.1	31	1	3	3.4	1	7	0.1
2900	277.6	15	11.8	8	12.6	32	1	3	3.2	2	8	0.1
3000	289.4	16	12.0	8	13.1	33	1	4	3.1	2	8	0.1

CHARGE 2

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl*.
Muzzle Velocity, 761 f/s — Charge 2

14	15	16	17	18	19	20	21	22	23	1
Complementary angle of site for each		Range effect of increase of—								
+1 mil of site	−1 mil of site	One proj wt is std in wt of	One foot per sec in MV	Air temp 1 deg Std is 59° F	Rear wind of 1 MPH	One pct in air density	Fuze setting for graze burst	Displacement of burst for change of 5 points in fuze setter corrector in—		Range
		Wt	VE	Temp	W-R	Den	FS	Ht	R	R
mil	mil	yd	yd	yd	yd	yd	sec	mil	yd	yd
.00	.00		0.0		0.0	0				0
.00	.00		+0.2		0.0	0				100
.00	.00		+0.5		0.0	0				200
+.01	−.01		+0.7		0.0	0	19			300
+.01	−.01		+1.0		+0.1	0	21			400
+.01	−.01		+1.2		+0.1	0	24			500
+0.1	−0.1		+1.4		+0.1	0	26			600
+0.1	−0.1		+1.7		+0.1	0	28			700
+.02	−.02		+2.0		+0.1	0	30			800
+.02	−.02		+2.2		+0.2	0	33			900
+.02	−.02		+2.4		+0.2	0	35			1000
+.02	−.02	Data not available	+2.7	Data not available	+0.2	−1	37	Data not available	Data not available	1100
+.02	−.02		+3.0		+0.2	−1	40			1200
+.03	−.03		+3.2		+0.3	−1	42			1300
+.03	−.03		+3.4		+0.3	−1	45			1400
+.03	−.03		+3.7		+0.3	−1	47			1500
+.03	−.03		+3.9		+0.4	−1	50			1600
+.03	−.03		+4.2		+0.4	−1	52			1700
+.04	−.04		+4.4		+0.5	−1	55			1800
+.04	−.04		+4.7		+0.5	−1	57			1900
+.04	−.04		+4.9		+0.5	−1	60			2000
+.05	−.04		+5.1		+0.6	−1	63			2100
+.05	−.05		+5.4		+.06	−1	65			2200
+.06	−.05		+5.6		+0.6	−2	68			2300
+.06	−.06		+5.9		+0.7	−2	70			2400
+.07	−.06		+6.1		+0.7	−2	73			2500
+.08	−.07		+6.3		+0.7	−2	76			2600
+.08	−.07		+6.6		+0.8	−2	78			2700
+.09	−.08		+6.8		+0.8	−2	81			2800
+.09	−.08		+7.0		+0.8	−2	84			2900
+.10	−.09		+7.3		+0.9	−2	87			3000

CHARGE 2

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl★.
Muzzle Velocity, 761 f/s — Charge 2

1	2	3	4	5	6	7	8	9	10	11	12	13
						Probable error					Deflection effect	
Range	Elevation	Fork	Change in elevation for 100-yd change in range	Change in range for 1 mil change in elevation	Time of flight	Range	Deflection	Height of burst	Slope of fall	Line number of metro message	Drift	Lateral wind of 1 MPH (+)
R	El	F	C	mil	Time	e_{pr}	e_{pd}		Slope	L	Dft	W-D
yd	mil	mil	mil	yd	sec	yd	yd	mil	1/–	No	mil	mil
3000	289.4	16	12.0	8	13.1	33	1	4	3.1	2	8	0.1
3100	301.6	17	12.4	8	13.6	34	1	4	3.0	2	8	0.1
3200	314.0	18	12.6	8	14.1	35	1	4	2.8	2	9	0.1
3300	326.8	18	13.0	8	14.7	35	1	4	2.7	2	9	0.2
3400	340.0	19	13.2	8	15.3	36	1	4	2.6	2	10	0.2
3500	353.4	20	13.6	7	15.8	37	1	4	2.5	2	10	0.2
3600	367.2	22	14.2	7	16.4	38	2	4	2.4	2	11	0.2
3700	381.6	23	14.6	7	17.0	39	2	5	2.3	2	11	0.2
3800	396.6	24	15.2	7	17.6	40	2	5	2.2	2	12	0.2
8900	412.2	26	15.8	6	18.2	41	2	5	2.1	2	13	0.2
4000	428.4	28	16.6	6	18.8	42	2	5	1.99	2	13	0.2
4100	445.4	30	17.4	6	19.5	43	2	6	1.89	3	14	0.2
4200	463.2	32	18.4	5	20.2	44	2	6	1.80	3	15	0.2
4300	482.2	35	19.6	5	21.0	46	2	6	1.71	3	15	0.2
4400	502.6	39	21.0	5	21.8	47	2	7	1.62	3	16	0.2
4500	524.4	44	22.8	4	22.6	48	2	7	1.54	3	18	0.2
4600	548.2	50	25.2	4	23.5	49	2	8	1.46	3	19	0.2
4700	574.8	58	28.4	3	24.5	51	3	8	1.39	3	20	0.3
4800	605.4	69	33.2	3	25.6	52	3	9	1.32	3	21	0.3
4900	642.2	89	41.2	2	26.8	54	3	10	1.26	3	23	0.3
5000	693.4				28.3	55	3	11	1.20	4	26	0.3

CHARGE 2

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl★.
Muzzle Velocity, 761 f/s — Charge 2

14	15	16	17	18	19	20	21	22	23	1
Complementary angle of site for each		Range effect of increase of—								
+1 mil of site	−1 mil of site	One proj is std in wt of	One foot per sec in MV	Air temp 1 deg Std is 59° F	Rear wind of 1 MPH	One pct in air density	Fuze setting for graze burst	Displacement of burst for change of 5 points in fuze setter corrector in—		Range
		Wt	VE	Temp	W-R	Den	FS	Ht	R	R
mil	mil	yd	yd	yd	yd	yd	sec	mil	yd	yd
+.10	−.09		+7.3		+0.9	−2	87			3000
+.11	−.10		+7.5		+0.9	−3	90			3100
+.12	−.11		+7.7		+1.0	−3	93			3200
+.13	−.12		+8.0		+1.1	−3	96			3300
+.14	−.13		+8.2		+1.1	−3	99			3400
+.16	−.15		+8.4		+1.2	−3	102			3500
+.18	−.17	Data not available	+8.6	Data not available	+1.3	−4	105	Data not available	Data not available	3600
+.20	−.19		+8.8		+1.3	−4	109			3700
+.22	−.21		+9.0		+1.4	−4	112			3800
+.24	−.23		+9.2		+1.5	−4	115			3900
+.27	−.26		+9.4		+1.6	−5	119			4000
+.31	−.30		+9.6		+1.7	−5	123			4100
+.36	−.34		+9.8		+1.8	−5	127			4200
+.43	−.39		+10.0		+2.0	−5	131			4300
+.52	−.45		+10.2		+2.1	−6	136			4400
+.62	−.52		+10.4		+2.2	−6	141			4500
			+10.6		+2.4	−6	147			4600
			+10.8		+2.5	−7	153			4700
			+11.0		+2.7	−7	159			4800
			+11.2		+2.8	−7	166			4900
			+11.3		+3.0	−8	174			5000

CHARGE 2

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl★.
Muzzle Velocity, 866 f/s — Charge 3

1	2	3	4	5	6	7	8	9	10	11	12	13
						Probable error					Deflection effect	
Range	Elevation	Fork	Change in elevation for 100-yd change in range	Change in range for 1 mil change in elevation	Time of flight	Range	Deflection	Height of burst	Slope of fall	Line number of metro message	Drift	Lateral wind of 1 MPH (+)
R	El	F	C	mil	Time	e_{pr}	e_{pd}		Slope	L	Dft	W-D
yd	mil	mil	mil	yd	sec	yd	yd	mil	1/–	No	mil	mil
0	—3.0	2	6.4	15	0.0	9	0			1	0	0.0
100	+3.4	2	6.4	15	0.3	9	0		152	1	0	0.0
200	10.0	2	6.6	15	0.7	9	0		76	1	0	0.0
300	16.6	2	6.6	15	1.0	10	0	0	50	1	0	0.0
400	23.2	3	6.6	15	1.4	10	0	0	38	1	0	0.0
500	30.0	3	6.8	15	1.7	10	0	0	30	1	1	0.0
600	36.8	3	6.8	15	2.1	11	0	0	25	1	1	0.0
700	43.6	3	6.8	15	2.4	11	0	0	21	1	1	0.0
800	50.4	3	7.0	14	2.8	11	0	0	18.6	1	1	0.0
900	57.4	3	7.0	14	3.1	12	0	0	16.4	1	1	0.0
1000	64.4	3	7.0	14	3.5	12	0	0	14.7	1	1	0.0
1100	71.6	3	7.0	14	3.9	12	0	0	13.3	1	2	0.0
1200	78.8	4	7.2	14	4.3	13	0	0	12.1	1	2	0.0
1300	86.0	4	7.2	14	4.6	13	0	0	11.1	1	2	0.0
1400	93.2	4	7.2	14	5.0	14	0	0	10.2	1	2	0.1
1500	100.4	4	7.4	14	5.4	14	0	0	9.5	1	2	0.1
1600	107.8	4	7.4	14	5.8	15	0	0	8.8	1	3	0.1
1700	115.2	4	7.4	13	6.2	15	0	1	8.2	1	3	0.1
1800	122.6	5	7.6	13	6.5	16	0	1	7.7	1	3	0.1
1900	130.2	5	7.6	13	6.9	16	0	1	7.3	1	3	0.1
2000	137.8	5	7.6	13	7.3	17	0	1	6.9	1	3	0.1
2100	145.6	5	7.8	13	7.7	18	0	1	6.5	1	4	0.1
2200	153.4	6	7.8	13	8.1	18	0	1	6.1	1	4	0.1
2300	161.2	6	7.8	13	8.4	19	0	1	5.8	1	4	0.1
2400	169.0	6	8.0	13	8.8	20	0	1	5.5	1	4	0.1
2500	177.0	6	8.0	12	9.2	20	0	1	5.2	1	5	0.1
2600	185.2	7	8.2	12	9.6	21	1	1	5.0	1	5	0.1
2700	193.4	7	8.2	12	10.0	21	1	1	4.8	1	5	0.1
2800	201.6	7	8.2	12	10.5	22	1	1	4.6	1	5	0.1
2900	210.0	7	8.4	12	10.9	22	1	1	4.4	1	6	0.1
3000	218.4	8	8.4	12	11.3	23	1	2	4.2	1	6	0.1

CHARGE 3

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl*.
Muzzle Velocity, 866 f/s — Charge 3

14	15	16	17	18	19	20	21	22	23	1
Complementary angle of site for each		Range effect of increase of—								
+1 mil of site	−1 mil of site	One proj in wt of is std Wt	One foot per sec in MV VE	Air temp 1 deg Std is 59° F Temp	Rear wind of 1 MPH W-R	One pct in air density Den	Fuze setting for graze burst FS	Displacement of burst for change of 5 points in fuze setter corrector in— Ht	 R	Range R
mil	mil	yd	yd	yd	yd	yd	sec	mil	yd	yd
.00	.00		0.0		0.0	0				0
.00	.00		+0.2		0.0	0				100
.00	.00		+0.4		0.0	0				200
.00	.00		+0.7		0.0	0	19			300
.00	.00		+0.9		0.0	0	21			400
.00	.00		+1.1		+0.1	0	23			500
.00	.00		+1.4		+0.1	0	25			600
.00	.00		+1.6		+0.1	0	27			700
+.01	.00		+1.8		+0.1	0	29			800
+.01	−.01		+2.0		+0.1	0	31			900
+.01	−.01		+2.2		+0.2	0	33			1000
+.01	−.01	Data not available	+2.4	Data not available	+0.2	0	35	Data not available	Data not available	1100
+.01	−.01		+2.6		+0.2	−1	37			1200
+.01	−.01		+2.8		+0.2	−1	39			1300
+.02	−.01		+3.0		+0.3	−1	41			1400
+.02	−.02		+3.2		+0.3	−1	43			1500
+.02	−.02		+3.4		+0.3	−1	45			1600
+.02	−.02		+3.6		+0.4	−1	47			1700
+.02	−.02		+3.8		+0.4	−1	50			1800
+.03	−.02		+4.0		+0.5	−1	52			1900
+.03	−.03		+4.2		+0.5	−1	54			2000
+.03	−.03		+4.4		+0.6	−1	56			2100
+.03	−.03		+4.6		+0.6	−1	58			2200
+.04	−.03		+4.7		+0.7	−2	60			2300
+.04	−.04		+4.9		+0.8	−2	63			2400
+.04	−.04		+5.1		+0.8	−2	65			2500
+.05	−.04		+5.3		+0.9	−2	67			2600
+.05	−.04		+5.5		+1.0	−2	70			2700
+.05	−.05		+5.7		+1.0	−2	72			2800
+.06	−.05		+5.9		+1.1	−2	75			2900
+.06	−.05		+6.1		+1.2	−2	77			3000

CHARGE 3

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl★.
Muzzle Velocity, 866 f/s — Charge 3

1	2	3	4	5	6	7	8	9	10	11	12	13
						Probable error					Deflection effect	
Range	Elevation	Fork	Change in elevation for 100-yd change in range	Change in range for 1 mil change in elevation	Time of flight	Range	Deflection	Height of burst	Slope of fall	Line number of metro message	Drift	Lateral wind of 1 MPH (+)
R	El	F	C	mil	Time	e_{pr}	e_{pd}		Slope	L	Dft	W-D
yd	mil	mil	mil	yd	sec	yd	yd	mil	1/–	No	mil	mil
3000	218.4	8	8.4	12	11.3	23	1	2	4.2	1	6	0.1
3100	226.8	8	8.6	12	11.7	24	1	2	4.0	1	6	0.1
3200	235.4	8	8.8	11	12.2	24	1	2	3.9	2	6	0.1
3300	244.2	9	8.8	11	12.6	25	1	2	3.7	2	7	0.1
3400	253.2	9	9.0	11	13.1	25	1	2	3.5	2	7	0.1
3500	262.4	10	9.0	11	13.5	26	1	2	3.4	2	7	0.1
3600	271.6	10	9.2	11	14.0	27	1	2	3.3	2	8	0.2
3700	280.8	10	9.4	11	14.4	27	1	2	3.1	2	8	0.2
3800	290.2	11	9.6	10	14.9	28	1	2	3.0	2	8	0.2
3900	300.0	11	9.8	10	15.3	28	1	2	2.9	2	9	0.2
4000	310.0	12	10.0	10	15.8	29	1	2	2.8	2	9	0.2
4100	320.2	12	10.2	10	16.3	30	1	3	2.7	2	9	0.2
4200	330.6	13	10.6	10	16.8	31	2	3	2.6	2	10	0.2
4300	341.2	13	10.8	9	17.3	31	2	3	2.6	2	10	0.2
4400	352.0	14	11.0	9	17.8	32	2	3	2.5	2	10	0.2
4500	363.2	15	11.4	9	18.3	33	2	3	2.4	2	11	0.2
4600	374.8	16	11.8	9	18.8	34	2	3	2.3	2	11	0.2
4700	386.8	17	12.2	8	19.4	34	2	3	2.2	3	12	0.2
4800	399.2	18	12.6	8	20.0	35	2	3	2.1	3	12	0.2
4900	412.0	19	13.0	8	20.5	35	2	4	2.0	3	13	0.2
5000	425.2	20	13.6	7	21.1	36	2	4	1.96	3	13	0.2
5100	439.0	21	14.2	7	21.8	37	3	4	1.89	3	14	0.2
5200	453.4	22	14.8	7	22.4	38	3	4	1.82	3	14	0.2
5300	468.4	23	15.4	6	23.1	38	3	4	1.74	3	15	0.2
5400	484.2	25	16.2	6	23.7	39	3	4	1.67	3	16	0.3
5500	501.0	28	17.2	6	24.4	40	3	5	1.60	3	16	0.3
5600	518.8	30	18.4	5	25.1	41	3	5	1.53	3	17	0.3
5700	538.0	33	19.8	5	25.9	42	3	5	1.46	3	18	0.3
5800	558.6	37	21.6	5	26.8	43	4	5	1.38	3	19	0.3
5900	581.4	42	24.0	4	27.7	44	4	6	1.31	4	20	0.3
6000	607.2	50	27.8	4	28.7	45	4	6	1.24	4	21	0.3

CHARGE 3

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl*.
Muzzle Velocity, 866 f/s — Charge 3

14	15	16	17	18	19	20	21	22	23	1
Complementary angle of site for each		Range effect of increase of—								
+1 mil of site	−1 mil of site	One proj in wt of is std Wt	One foot per sec in MV VE	Air temp 1 deg Std is 59° F Temp	Rear wind of 1 MPH W-R	One pct in air density Den	Fuze setting for graze burst FS	Displacement of burst for change of 5 points in fuze setter corrector in— Ht	 R	Range R
mil	mil	yd	yd	yd	yd	yd	sec	mil	yd	yd
+.06	−.05		+6.1		+1.2	−2	77			3000
+.07	−.06		+6.3		+1.2	−3	80			3100
+.08	−.06		+6.4		+1.3	−3	82			3200
+.08	−.07		+6.6		+1.4	−3	85			3300
+.09	−.07		+6.8		+1.5	−3	87			3400
+.10	−.08		+7.0		+1.5	−3	90			3500
+.11	−.09		+7.2		+1.6	−3	93			3600
+.12	−.10		+7.4		+1.7	−4	96			3700
+.12	−.10		+7.6		+1.8	−4	98			3800
+.13	−.11		+7.8		+1.8	−4	101			3900
+.14	−.12		+7.9		+1.9	−4	104			4000
+.15	−.13	Data not available	+8.1	Data not available	+1.9	−4	107	Data not available	Data not available	4100
+.16	−.14		+8.3		+2.0	−5	110			4200
+.17	−.14		+8.5		+2.1	−5	112			4300
+.18	−.15		+8.7		+2.1	−5	115			4400
+.20	−.16		+8.8		+2.2	−5	118			4500
+.21	−.17		+9.0		+2.3	−6	121			4600
+.23	−.18		+9.2		+2.3	−6	124			4700
+.25	−.19		+9.3		+2.4	−6	127			4800
+.27	−.21		+9.5		+2.5	−6	130			4900
+.29	−.23		+9.6		+2.6	−7	133			5000
+.31	−.26		+9.8		+2.7	−7	136			5100
+.34	−.29		+10.0		+2.8	−7	140			5200
+.37	−.32		+10.1		+2.9	−8	143			5300
+.40	−.35		+10.3		+3.0	−8	147			5400
+.45	−.39		+10.4		+3.1	−8	151			5500
+.54	−.45		+10.6		+3.3	−9	155			5600
+.68	−.54		+10.8		+3.4	−9	160			5700
+.87	−.65		+11.0		+3.6	−9	165			5800
+1.10	−.79		+11.2		+3.7	−10	170			5900
+1.39	−.98		+11.3		+3.9	−10	176			6000

CHARGE 3

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl*.
Muzzle Velocity, 866 f/s — Charge 3

1	2	3	4	5	6	7	8	9	10	11	12	13
						Probable error					Deflection effect	
Range	Elevation	Fork	Change in elevation for 100-yd change in range	Change in range for 1 mil change in elevation	Time of flight	Range	Deflection	Height of burst	Slope of fall	Line number of metro message	Drift	Lateral wind of 1 MPH (+)
R	El	F	C	mil	Time	e_{pr}	e_{pd}		Slope	L	Dft	W-D
yd	mil	mil	mil	yd	sec	yd	yd	mil	1/–	No	mil	mil
6000	607.2	50	27.8	4	28.7	45	4	6	1.24	4	21	0.3
6100	637.8	64	34.2	3	29.9	46	4	7	1.17	4	23	0.3
6200	678.0				31.7	48	4	8	1.11	4	25	0.3

CHARGE 3

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl*.
Muzzle Velocity, 866 f/s — Charge 3

14	15	16	17	18	19	20	21	22	23	1
Complementary angle of site for each		Range effect of increase of—								
+1 mil of site	−1 mil of site	One proj is std in wt of	One foot per sec in MV	Air temp 1 deg Std is 59° F	Rear wind of 1 MPH	One pct in air density	Fuze setting for graze burst	Displacement of burst for change of 5 points in fuze setter corrector in—		Range
Wt		VE	Temp	W-R	Den	FS	Ht	R	R	
mil	mil	yd	yd	yd	yd	yd	sec	mil	yd	yd
+1.39	−.98	Data not available	+11.3	Data not available	+3.9	−10	176	Data not available	Data not available	6000
			+11.5 +11.6		+4.1 +4.3	−12 −12	183 192			6100 6200

CHARGE 3

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl★.
Muzzle Velocity, 1040 f/s — Charge 4

1	2	3	4	5	6	7	8	9	10	11	12	13
						Probable error					Deflection effect	
Range	Elevation	Fork	Change in elevation for 100-yd change in range	Change in range for 1 mil change in elevation	Time of flight	Range	Deflection	Height of burst	Slope of fall	Line number of metro message	Drift	Lateral wind of 1 MPH (+)
R	El	F	C	mil	Time	e_{pr}	e_{pd}		Slope	L	Dft	W-D
yd	mil	mil	mil	yd	sec	yd	yd	mil	1/–	No	mil	mil
0	—3.0	2	4.6	22	0.0	9	0			1	0	0.0
100	+1.4	2	4.6	22	0.3	9	0		217	1	0	0.0
200	6.0	2	4.6	22	0.6	9	0		108	1	0	0.0
300	10.6	2	4.6	22	0.8	9	0	0	71	1	0	0.0
400	15.2	2	4.8	21	1.1	9	0	0	53	1	0	0.0
500	20.0	2	4.8	21	1.4	9	0	0	42	1	0	0.0
600	24.8	2	4.8	21	1.7	9	0	0	35	1	1	0.0
700	29.6	2	4.8	21	2.0	9	0	0	30	1	1	0.0
800	34.4	2	4.8	21	2.3	9	0	0	26	1	1	0.0
900	39.2	2	5.0	20	2.6	9	0	0	23	1	1	0.0
1000	44.2	2	5.0	20	2.9	9	0	0	21	1	1	0.0
1100	49.2	2	5.0	20	3.2	9	0	0	18.7	1	1	0.0
1200	54.2	2	5.0	20	3.5	9	0	0	17.0	1	1	0.0
1300	59.2	2	5.0	20	3.9	10	0	0	15.6	1	1	0.0
1400	64.2	2	5.2	20	4.2	10	0	0	14.4	1	1	0.0
1500	69.4	2	5.2	19	4.5	10	0	0	13.3	1	2	0.0
1600	74.6	2	5.2	19	4.8	10	0	0	12.4	1	2	0.0
1700	79.8	2	5.2	19	5.1	10	0	0	11.6	1	2	0.1
1800	85.0	2	5.2	19	5.5	10	0	0	10.9	1	2	0.1
1900	90.4	2	5.4	19	5.8	10	0	0	10.3	1	2	0.1
2000	95.8	2	5.4	19	6.1	10	0	0	9.7	1	2	0.1
2100	101.2	2	5.4	18	6.4	10	0	0	9.2	1	2	0.1
2200	106.6	2	5.4	18	6.7	10	0	0	8.7	1	3	0.1
2300	112.0	2	5.6	18	7.1	10	0	0	8.2	1	3	0.1
2400	117.6	2	5.6	18	7.4	10	0	0	7.8	1	3	0.1
2500	123.2	2	5.6	18	7.7	11	0	0	7.4	1	3	0.1
2600	128.8	2	5.6	18	8.0	11	0	0	7.1	1	3	0.1
2700	134.4	3	5.8	18	8.4	11	0	0	6.8	1	3	0.1
2800	140.2	3	5.8	17	8.7	11	1	0	6.5	1	3	0.1
2900	146.0	3	5.8	17	9.1	11	1	0	6.2	1	4	0.1
3000	151.8	3	5.8	17	9.4	11	1	0	6.0	1	4	0.1

CHARGE 4

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl*.
Muzzle Velocity, 1040 f/s — Charge 4

14	15	16	17	18	19	20	21	22	23	1
Complementary angle of site for each		Range effect of increase of—								
+1 mil of site	−1 mil of site	One proj is std in wt of Wt	One foot per sec in MV VE	Air temp 1 deg Std is 59° F Temp	Rear wind of 1 MPH W-R	One pct in air density Den	Fuze setting for graze burst FS	Displacement of burst for change of 5 points in fuze setter corrector in— Ht	R	Range R
mil	mil	yd	yd	yd	yd	yd	sec	mil	yd	yd
.00	.00		0.0		0.0	0				0
.00	.00		+0.2		0.0	0				100
.00	.00		+0.4		+0.1	0				200
.00	.00		+0.5		+0.1	0	18			300
.00	.00		+0.7		+0.1	0	19			400
.00	.00		+0.9		+0.2	0	21			500
.00	.00		+1.0		+0.2	0	23			600
.00	.00		+1.2		+0.2	0	25			700
.00	.00		+1.4		+0.3	0	26			800
.00	.00		+1.5		+0.3	0	28			900
.00	.00		+1.7		+0.4	0	30			1000
.00	.00	Data not available	+1.9	Data not available	+.04	0	32	Data not available	Data not available	1100
.00	.00		+2.0		+0.5	0	34			1200
.00	.00		+2.1		+0.5	0	35			1300
.00	.00		+2.3		+0.6	0	37			1400
.00	.00		+2.4		+0.7	−1	39			1500
.00	.00		+2.5		+0.7	−1	41			1600
.00	.00		+2.7		+0.8	−1	43			1700
+.01	−.01		+2.8		+0.9	−1	44			1800
+.01	−.01		+2.9		+1.0	−1	46			1900
+.01	−.01		+3.0		+1.1	−1	48			2000
+.01	−.01		+3.2		+1.2	−1	50			2100
+.01	−.01		+3.3		+1.3	−1	52			2200
+.01	−.01		+3.4		+1.4	−1	54			2300
+.01	−.01		+3.5		+1.5	−1	56			2400
+.01	−.01		+3.6		+1.6	−2	58			2500
+.01	−.01		+3.7		+1.7	−2	60			2600
+.01	−.01		+3.9		+1.8	−2	62			2700
+.01	−.01		+4.0		+2.0	−2	63			2800
+.02	−.02		+4.1		+2.1	−2	65			2900
+.02	−.02		+4.2		+2.2	−2	67			3000

CHARGE 4

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl*.
Muzzle Velocity, 1040 f/s — Charge 4

1	2	3	4	5	6	7	8	9	10	11	12	13
Range	Elevation	Fork	Change in elevation for 100-yd change in range	Change in range for 1 mil change in elevation	Time of flight	Probable error			Slope of fall	Line number of metro message	Deflection effect	
						Range	Deflection	Height of burst			Drift	Lateral wind of 1 MPH (+)
R	El	F	C	mil	Time	e_{pr}	e_{pd}		Slope	L	Dft	W-D
yd	mil	mil	mil	yd	sec	yd	yd	mil	1/–	No	mil	mil
3000	151.8	3	5.8	17	9.4	11	1	0	6.0	1	4	0.1
3100	157.6	3	6.0	17	9.8	11	1	0	5.7	1	4	0.1
3200	163.6	3	6.0	17	10.1	11	1	0	5.5	1	4	0.1
3300	169.6	3	6.0	17	10.5	11	1	0	5.3	1	4	0.1
3400	175.6	3	6.0	16	10.8	11	1	0	5.1	1	4	0.1
3500	181.8	3	6.2	16	11.2	12	1	0	4.9	1	5	0.1
3600	188.0	3	6.2	16	11.6	12	1	1	4.8	1	5	0.1
3700	194.2	3	6.2	16	11.9	12	1	1	4.6	1	5	0.1
3800	200.4	3	6.4	16	12.3	12	1	1	4.4	2	5	0.1
3900	206.8	3	6.4	16	12.6	12	1	1	4.3	2	5	0.1
4000	213.2	3	6.4	15	13.0	12	1	1	4.1	2	6	0.1
4100	219.6	3	6.6	15	13.4	12	1	1	4.0	2	6	0.1
4200	226.2	3	6.6	15	13.7	13	1	1	3.8	2	6	0.1
4300	232.8	3	6.6	15	14.1	13	1	1	3.7	2	6	0.1
4400	239.6	4	6.8	15	14.5	13	1	1	3.6	2	7	0.2
4500	246.4	4	6.8	15	14.9	13	1	1	3.5	2	7	0.2
4600	253.4	4	7.0	14	15.3	13	1	1	3.4	2	7	0.2
4700	260.4	4	7.0	14	15.7	13	1	1	3.3	2	7	0.2
4800	267.6	4	7.2	14	16.1	14	2	1	3.2	2	7	0.2
4900	274.8	4	7.2	14	16.5	14	2	1	3.1	2	8	0.2
5000	282.0	4	7.4	14	16.9	14	2	1	3.0	2	8	0.2
5100	289.4	4	7.4	13	17.3	14	2	1	2.9	2	8	0.2
5200	297.0	4	7.6	13	17.7	14	2	1	2.8	2	8	0.2
5300	304.8	5	7.8	13	18.1	15	2	1	2.8	2	9	0.2
5400	312.6	5	7.8	13	18.6	15	2	1	2.7	2	9	0.2
5500	320.6	5	8.0	12	19.0	15	2	1	2.6	2	9	0.2
5600	328.6	5	8.2	12	19.4	15	2	1	2.5	3	9	0.2
5700	336.8	5	8.4	12	19.9	15	2	1	2.4	3	10	0.2
5800	345.2	5	8.4	12	20.4	16	2	1	2.3	3	10	0.2
5900	354.0	6	8.6	12	20.8	16	2	1	2.3	3	10	0.2
6000	362.8	6	8.8	11	21.3	16	2	2	2.2	3	11	0.2

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl*.
Muzzle Velocity, 1040 f/s — Charge 4

14	15	16	17	18	19	20	21	22	23	1
Complementary angle of site for each		Range effect of increase of—								
+1 mil of site	−1 mil of site	One proj in wt of is std	One foot per sec in MV	Air temp 1 deg Std is 59° F	Rear wind of 1 MPH	One pct in air density	Fuze setting for graze burst	Displacement of burst for change of 5 points in fuze setter corrector in—		Range
		Wt	VE	Temp	W-R	Den	FS	Ht	R	R
mil	mil	yd	yd	yd	yd	yd	sec	mil	yd	yd
+.02	−.02		+4.2		+2.2	−2	67			3000
+.02	−.02		+4.3		+2.3	−2	69			3100
+.02	−.02		+4.4		+2.5	−3	71			3200
+.02	−.02		+4.5		+2.6	−3	73			3300
+.02	−.02		+4.6		+2.7	−3	75			3400
+.03	−.03		+4.7		+2.9	−3	77			3500
+.03	−.03		+4.8		+3.0	−3	79			3600
+.03	−.03		+5.0		+3.1	−4	81			3700
+.03	−.03		+5.1		+3.3	−4	83			3800
+.04	−.04		+5.2		+3.4	−4	85			3900
+.04	−.04		+5.3		+3.5	−4	87			4000
+.04	−.04	Data not available	+5.4	Data not available	+3.7	−5	89	Data not available	Data not available	3100
+.05	−.05		+5.5		+3.8	−5	91			4200
+.05	−.05		+5.6		+3.9	−5	94			4300
+.06	−.06		+5.7		+4.1	−5	96			4400
+.06	−.06		+5.8		+4.2	−6	98			4500
+.07	−.06		+5.9		+4.3	−6	100			4600
+.07	−.07		+6.0		+4.5	−6	103			4700
+.08	−.07		+6.1		+4.6	−7	105			4800
+.08	−.08		+6.2		+4.7	−7	108			4900
+.09	−.08		+6.3		+4.8	−7	110			5000
+.10	−.09		+6.4		+5.0	−8	112			5100
+.10	−.09		+6.5		+5.1	−8	115			5200
+.11	−.10		+6.6		+5.2	−8	117			5300
+.11	−.10		+6.7		+5.4	−9	120			5400
+.12	−.11		+6.8		+5.5	−9	122			5500
+.13	−.12		+6.9		+5.6	−9	124			5600
+.14	−.13		+7.0		+5.7	−10	127			5700
+.15	−.14		+7.1		+5.9	−10	129			5800
+.16	−.15		+7.2		+6.0	−10	131			5900
+.17	−.16		+7.3		+6.1	−11	134			6000

CHARGE 4

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl*.
Muzzle Velocity, 1040 f/s — Charge 4

1	2	3	4	5	6	7	8	9	10	11	12	13
						Probable error					Deflection effect	
Range	Elevation	Fork	Change in elevation for 100-yd change in range	Change in range for 1 mil change in elevation	Time of flight	Range	Deflection	Height of burst	Slope of fall	Line number of metro message	Drift	Lateral wind of 1 MPH (+)
R	El	F	C	mil	Time	e_{pr}	e_{pd}		Slope	L	Dft	W-D
yd	mil	mil	mil	yd	sec	yd	yd	mil	1/–	No	mil	mil
6000	362.8	6	8.8	11	21.3	16	2	2	2.2	3	11	0.2
6100	371.6	6	9.0	11	21.8	16	3	2	2.2	3	11	0.2
6200	380.6	6	9.2	11	22.3	16	3	2	2.1	3	11	0.2
6300	390.0	6	9.4	11	22.8	17	3	2	2.1	3	12	0.2
6400	399.6	7	9.6	10	23.3	17	3	2	2.0	3	12	0.2
6500	409.6	7	10.0	10	23.8	17	3	2	1.94	3	13	0.3
6600	419.6	7	10.2	10	24.3	17	3	2	1.88	3	13	0.3
6700	429.8	7	10.4	10	24.9	18	3	2	1.83	3	13	0.3
6800	440.4	8	10.8	9	25.4	18	3	2	1.78	3	14	0.3
6900	451.4	8	11.2	9	26.0	18	4	2	1.72	3	14	0.3
7000	462.8	9	11.6	9	26.6	19	4	2	1.67	3	15	0.3
7100	474.6	9	12.0	8	27.2	19	4	2	1.62	3	15	0.3
7200	486.8	10	12.6	8	27.8	20	4	2	1.57	4	16	0.3
7300	499.6	11	13.2	8	28.5	20	4	2	1.52	4	16	0.3
7400	513.0	12	13.8	7	29.2	21	5	3	1.47	4	17	0.3
7500	527.2	13	14.6	7	29.9	21	5	3	1.42	4	18	0.3
7600	542.4	14	15.6	6	30.7	22	5	3	1.37	4	18	0.3
7700	558.8	15	17.0	6	31.4	22	5	3	1.31	4	19	0.3
7800	576.4	17	18.6	5	32.2	23	6	3	1.26	4	20	0.4
7900	595.8	19	20.6	5	33.1	23	6	3	1.20	4	21	0.4
8000	617.6	22	23.4	4	34.1	24	6	3	1.14	5	22	0.4
8100	643.2	27	28.0	4	35.3	25	7	4	1.09	5	23	0.4
8200	675.4	38	36.4	3	36.9	26	7	4	1.04	5	25	0.4
8300	724.4				39.2	27	7	5	0.99	6	28	0.4

CHARGE 4

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl*.
Muzzle Velocity, 1040 f/s — Charge 4

14	15	16	17	18	19	20	21	22	23	1
Complementary angle of site for each		Range effect of increase of—								
+1 mil of site	−1 mil of site	One proj in wt of is std Wt	One foot per sec in MV VE	Air temp 1 deg Std is 59° F Temp	Rear wind of 1 MPH W-R	One pct in air density Den	Fuze setting for graze burst FS	Displacement of burst for change of 5 points in fuze setter corrector in— Ht	 R	Range R
mil	mil	yd	yd	yd	yd	yd	sec	mil	yd	yd
+.17	−.16		+7.3		+6.1	−11	134			6000
+.18	−.17		+7.4		+6.2	−11	137			6100
+.20	−.18		+7.5		+6.4	−11	139			6200
+.21	−.19		+7.6		+6.5	−11	142			6300
+.23	−.20		+7.7		+6.6	−12	145			6400
+.24	−.21		+7.8		+6.8	−12	148			6500
+.26	−.23	Data not available	+7.9	Data not available	+6.9	−12	151	Data not available	Data not available	6600
+.28	−.25		+8.0		+7.1	−13	154			6700
+.30	−.26		+8.1		+7.2	−13	157			6800
+.33	−.28		+8.2		+7.4	−13	161			6900
+.36	−.30		+8.3		+7.5	−14	164			7000
+.40	−.33		+8.4		+7.7	−14	167			7100
+.45	−.36		+8.5		+7.8	−14	171			7200
+.51	−.39		+8.6		+7.9	−15	175			7300
+.59	−.42		+8.7		+8.0	−15	179			7400
+.68	−.47		+8.9		+8.2	−15	183			7500
	−.55		+9.0		+8.3	−16	187			7600
	−.66		+9.1		+8.4	−16	192			7700
	−.80		+9.2		+8.5	−16	197			7800
	−.97		+9.3		+8.6	−17	202			7900
	−1.19		+9.4		+8.8	−17	208			8000
			+9.5		+9.0	−17	215			8100
			+9.6		+9.3	−18	224			8200
			+9.7		+9.5	−18	236			8300

CHARGE 4

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl★.
Muzzle Velocity, 1283 f/s — Charge 5

1	2	3	4	5	6	7	8	9	10	11	12	13
						Probable error					Deflection effect	
Range	Elevation	Fork	Change in elevation for 100-yd change in range	Change in range for 1 mil change in elevation	Time of flight	Range	Deflection	Height of burst	Slope of fall	Line number of metro message	Drift	Lateral wind of 1 MPH (+)
R	El	F	C	mil	Time	e_{pr}	e_{pd}		Slope	L	Dft	W·D
yd	mil	mil	mil	yd	sec	yd	yd	mil	1/–	No	mil	mil
0	—4.0	1	3.0	34	0.0	9	0			1	0	0.0
100	—1.0	1	3.0	34	0.2	9	0		357	1	0	0.0
200	+2.0	1	3.0	33	0.5	9	0		172	1	0	0.0
300	5.0	1	3.0	33	0.7	9	0		112	1	0	0.0
400	8.0	1	3.2	32	1.0	9	0	0	82	1	0	0.0
500	11.2	1	3.2	32	1.2	9	0	0	64	1	0	0.0
600	14.4	1	3.2	31	1.5	9	0	0	52	1	0	0.1
700	17.6	1	3.2	30	1.7	9	0	0	44	1	0	0.1
800	21.0	1	3.4	30	2.0	8	0	0	38	1	1	0.1
900	24.4	1	3.4	29	2.2	8	0	0	33	1	1	0.1
1000	27.8	1	3.4	29	2.5	8	0	0	29	1	1	0.1
1100	31.2	1	3.6	28	2.8	8	0	0	26	1	1	0.1
1200	34.8	1	3.6	28	3.0	8	0	0	23	1	1	0.1
1300	38.4	1	3.6	27	3.3	8	0	0	21	1	1	0.1
1400	42.2	1	3.8	27	3.5	8	0	0	19.5	1	1	0.1
1500	46.0	1	3.8	26	3.8	8	0	0	17.9	1	1	0.1
1600	49.8	1	3.8	26	4.1	8	0	0	16.5	1	1	0.1
1700	53.6	1	4.0	26	4.4	8	0	0	15.3	1	1	0.1
1800	57.4	1	4.0	25	4.6	8	0	0	14.3	1	1	0.1
1900	61.4	1	4.0	25	4.9	8	0	0	13.4	1	1	0.1
2000	65.6	1	4.0	24	5.2	8	0	0	12.6	1	2	0.1
2100	69.6	1	4.2	24	5.5	8	0	0	11.8	1	2	0.1
2200	73.8	1	4.2	24	5.8	8	0	0	11.1	1	2	0.1
2300	78.0	1	4.2	23	6.1	8	0	0	10.5	1	2	0.2
2400	82.4	1	4.4	23	6.4	8	0	0	10.0	1	2	0.2
2500	86.8	1	4.4	23	6.7	8	0	0	9.5	1	2	0.2
2600	91.2	1	4.4	22	7.0	7	0	0	9.0	1	2	0.2
2700	95.6	1	4.6	22	7.3	7	0	0	8.6	1	2	0.2
2800	100.2	1	4.6	22	7.6	7	0	0	8.2	1	2	0.2
2900	104.8	1	4.6	22	7.9	7	1	0	7.8	1	3	0.2
3000	109.4	1	4.6	21	8.2	7	1	0	7.5	1	3	0.2

NOTE: Charge 5 is also applicable to projectile, 10 cm. Pzgr., with fuze, Bd. Z. f. 10 cm. Pzgr., to range of 1600 yds.

CHARGE 5

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl*.
Muzzle Velocity, 1283 f/s — Charge 5

14	15	16	17	18	19	20	21	22	23	1
Complementary angle of site for each		Range effect of increase of—					Fuze setting for graze burst	Displacement of burst for change of 5 points in fuze setter corrector in—		Range
+1 mil of site	−1 mil of site	One proj in wt of is std	One foot per sec in MV	Air temp 1 deg Std is 59° F	Rear wind of 1 MPH	One pct in air density				
		Wt	VE	Temp	W-R	Den	FS	Ht	R	R
mil	mil	yd	yd	yd	yd	yd	sec	mil	yd	yd
.00	.00		0.0		0.0	0				0
.00	.00		+0.1		0.0	0				100
.00	.00		+0.2		+0.1	0				200
.00	.00		+0.4		+0.1	0				300
.00	.00		+0.5		+0.2	0	18			400
.00	.00		+0.6		+0.2	0	20			500
.00	.00		+0.7		+0.3	−1	21			600
.00	.00		+0.8		+0.4	−1	23			700
.00	.00		+0.9		+0.4	−1	24			800
.00	.00		+1.0		+0.5	−1	26			900
.00	.00		+1.1		+0.5	−1	27			1000
.00	.00	Data not available	+1.2	Data not available	+0.6	−1	29	Data not available	Data not available	1100
.00	.00		+1.3		+0.7	−1	30			1200
.00	.00		+1.4		+0.8	−2	32			1300
.00	.00		+1.5		+0.9	−2	33			1400
.00	.00		+1.6		+1.0	−2	35			1500
.00	.00		+1.7		+1.1	−2	37			1600
.00	.00		+1.8		+1.2	−2	39			1700
.00	.00		+1.8		+1.3	−2	41			1800
.00	.00		+1.9		+1.5	−3	42			1900
.00	.00		+2.0		+1.6	−3	44			2000
.00	.00		+2.1		+1.7	−3	46			2100
.00	.00		+2.1		+1.8	−3	47			2200
.00	.00		+2.2		+2.0	−3	49			2300
.00	.00		+2.3		+2.1	−3	50			2400
.00	.00		+2.4		+2.2	−4	52			2500
.00	.00		+2.4		+2.4	−4	54			2600
.00	.00		+2.5		+2.5	−4	56			2700
.00	.00		+2.6		+2.6	−4	57			2800
.00	.00		+2.6		+2.8	−4	59			2900
.00	.00		+2.7		+2.9	−5	61			3000

NOTE: Charge 5 is also applicable to projectile, 10 cm. Pzgr., with fuze, Bd. Z. f. 10 cm. Pzgr., to range of 1600 yds.

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl*.
Muzzle Velocity, 1283 f/s — Charge 5

1	2	3	4	5	6	7	8	9	10	11	12	13
Range	Elevation	Fork	Change in elevation for 100-yd change in range	Change in range for 1 mil change in elevation	Time of flight	Probable error			Slope of fall	Line number of metro message	Deflection effect	
						Range	Deflection	Height of burst			Drift	Lateral wind of 1 MPH (+)
R	El	F	C	mil	Time	e_{pr}	e_{pd}		Slope	L	Dft	W·D
yd	mil	mil	mil	yd	sec	yd	yd	mil	1/–	No	mil	mil
3000	109.4	1	4.6	21	8.2	7	1	0	7.5	1	3	0.2
3100	114.0	1	4.8	21	8.5	7	1	0	7.2	1	3	0.2
3200	118.8	1	4.8	21	8.8	7	1	0	6.9	1	3	0.2
3300	123.6	1	4.8	21	9.2	7	1	0	6.6	1	3	0.2
3400	128.4	1	4.8	21	9.5	7	1	0	6.4	1	3	0.2
3500	133.4	1	5.0	20	9.8	7	1	0	6.1	1	3	0.2
3600	138.4	1	5.0	20	10.1	7	1	0	5.9	1	3	0.2
3700	143.4	1	5.0	20	10.4	7	1	0	5.7	1	4	0.2
3800	148.4	1	5.0	20	10.8	7	1	0	5.5	1	4	0.2
3900	153.4	1	5.2	20	11.1	7	1	0	5.3	1	4	0.2
4000	158.6	1	5.2	19	11.4	7	1	0	5.1	1	4	0.2
4100	163.8	1	5.2	19	11.7	7	1	0	4.9	1	4	0.2
4200	169.0	1	5.2	19	12.1	8	1	0	4.8	1	4	0.2
4300	174.2	2	5.4	19	12.4	8	1	0	4.6	2	4	0.3
4400	179.6	2	5.4	19	12.8	8	1	0	4.5	2	5	0.3
4500	185.0	2	5.4	18	13.1	8	1	0	4.3	2	5	0.3
4600	190.4	2	5.4	18	13.5	8	1	0	4.2	2	5	0.3
4700	196.0	2	5.6	18	13.9	8	1	0	4.1	2	5	0.3
4800	201.6	2	5.6	18	14.2	8	1	0	4.0	2	5	0.3
4900	207.2	2	5.6	18	14.6	8	1	0	3.9	2	5	0.3
5000	212.8	2	5.6	18	14.9	8	1	0	3.8	2	6	0.3
5100	218.4	2	5.8	17	15.3	8	2	0	3.7	2	6	0.3
5200	224.2	2	5.8	17	15.6	8	2	0	3.6	2	6	0.3
5300	230.0	2	5.8	17	16.0	8	2	0	3.5	2	6	0.3
5400	235.8	2	5.8	17	16.3	8	2	0	3.4	2	6	0.3
5500	241.8	2	6.0	17	16.7	8	2	0	3.3	2	7	0.3
5600	247.8	2	6.0	17	17.1	9	2	0	3.2	2	7	0.3
5700	253.8	2	6.0	16	17.4	9	2	0	3.1	2	7	0.3
5800	260.0	2	6.2	16	17.8	9	2	0	3.1	2	7	0.3
5900	266.2	2	6.2	16	18.2	9	2	0	3.0	2	7	0.3
6000	272.4	2	6.4	16	18.6	9	2	0	2.9	2	8	0.3

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl★.
Muzzle Velocity, 1283 f/s — Charge 5

14	15	16	17	18	19	20	21	22	23	1
Complementary angle of site for each		Range effect of increase of—					Fuze setting for graze burst	Displacement of burst for change of 5 points in fuze setter corrector in—		Range
+1 mil of site	−1 mil of site	One proj in wt of is std	One foot per sec in MV	Air temp 1 deg Std is 59° F	Rear wind of 1 MPH	One pct in air density				
		Wt	VE	Temp	W-R	Den	FS	Ht	R	R
mil	mil	yd	yd	yd	yd	yd	sec	mil	yd	yd
.00	.00		+2.7		+2.9	−5	61			3000
.00	.00		+2.8		+3.1	−5	63			3100
.00	.00		+2.8		+3.2	−5	65			3200
+.01	−.01		+2.9		+3.3	−5	66			3300
+.01	−.01		+3.0		+3.5	−6	68			3400
+.01	−.01		+3.0		+3.6	−6	70			3500
+.01	−.01		+3.1		+3.8	−6	72			3600
+.01	−.01		+3.2		+3.9	−6	73			3700
+.01	−.01		+3.2		+4.1	−7	75			3800
+.01	−.01		+3.3		+4.2	−7	77			3900
+.01	−.01		+3.4		+4.3	−7	79			4000
+.01	−.01	Data not available	+3.5	Data not available	+4.5	−7	81	Data not available	Data not available	4100
+.02	−.02		+3.5		+4.6	−8	83			4200
+.02	−.02		+3.6		+4.7	−8	85			4300
+.02	−.02		+3.7		+4.9	−8	87			4400
+.02	−.02		+3.8		+5.0	−9	89			4500
+.02	−.02		+3.8		+5.2	−9	91			4600
+.02	−.02		+3.9		+5.3	−9	93			4700
+.03	−.03		+4.0		+5.4	−9	95			4800
+.03	−.03		+4.1		+5.6	−10	97			4900
+.03	−.03		+4.2		+5.7	−10	99			5000
+.03	−.03		+4.2		+5.9	−10	101			5100
+.04	−.03		+4.3		+6.0	−11	103			5200
+.04	−.03		+4.3		+6.2	−11	105			5300
+.04	−.04		+4.4		+6.3	−11	107			5400
+.05	−.04		+4.5		+6.5	−12	109			5500
+.05	−.04		+4.5		+6.7	−12	111			5600
+.06	−.04		+4.6		+6.8	−12	113			5700
+.06	−.05		+4.6		+7.0	−13	116			5800
+.07	−.05		+4.7		+7.2	−13	118			5900
+.07	−.05		+4.7		+7.4	−13	120			6000

CHARGE 5

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl*.
Muzzle Velocity, 1283 f/s — Charge 5

1	2	3	4	5	6	7	8	9	10	11	12	13
						Probable error					Deflection effect	
Range	Elevation	Fork	Change in elevation for 100-yd change in range	Change in range for 1 mil change in elevation	Time of flight	Range	Deflection	Height of burst	Slope of fall	Line number of metro message	Drift	Lateral wind of 1 MPH (+)
R	El	F	C	mil	Time	e_{pr}	e_{pd}		Slope	L	Dft	W-D
yd	mil	mil	mil	yd	sec	yd	yd	mil	1/-	No	mil	mil
6000	272.4	2	6.4	16	18.6	9	2	0	2.9	2	8	0.3
6100	278.8	2	6.4	16	19.0	9	2	0	2.8	2	.8	0.3
6200	285.2	2	6.4	15	19.4	9	2	0	2.8	3	8	0.3
6300	291.8	2	6.6	15	19.8	9	2	0	2.7	3	8	0.3
6400	298.4	2	6.6	15	20.2	9	2	0	2.7	3	8	0.3
6500	305.0	3	6.8	15	20.6	9	2	1	2.5	3	9	0.4
6600	311.8	3	6.8	15	21.0	10	2	1	2.5	3	9	0.4
6700	318.6	3	7.0	14	21.4	10	3	1	2.5	3	9	0.4
6800	325.6	3	7.0	14	21.8	10	3	1	2.4	3	9	0.4
6900	332.8	3	7.2	14	22.3	10	3	1	2.4	3	10	0.4
7000	340.0	3	7.2	14	22.7	10	3	1	2.3	3	10	0.4
7100	347.2	3	7.4	14	23.1	10	3	1	2.2	3	10	0.4
7200	354.6	3	7.6	13	23.6	10	3	1	2.2	3	10	0.4
7300	362.2	3	7.6	13	24.0	10	3	1	2.1	3	11	0.4
7400	370.0	3	7.8	13	24.4	11	3	1	2.1	3	11	0.4
7500	378.0	4	8.0	13	24.9	11	3	1	2.0	3	11	0.4
7600	386.0	4	8.2	12	25.4	11	3	1	1.95	3	12	0.4
7700	394.2	4	8.2	12	25.8	11	3	1	1.91	3	12	0.4
7800	402.4	4	8.4	12	26.3	11	3	1	1.86	3	12	0.4
7900	411.0	4	8.6	12	26.8	11	4	1	1.81	3	13	0.4
8000	420.0	4	9.0	11	27.3	12	4	1	1.77	4	13	0.4
8100	429.0	4	9.2	11	27.8	12	4	1	1.73	4	13	0.4
8200	438.2	5	9.4	11	28.4	12	4	1	1.69	4	14	0.4
8300	447.6	5	9.6	10	28.9	12	4	1	1.64	4	14	0.4
8400	457.4	5	10.0	10	29.4	13	4	1	1.60	4	15	0.4
8500	467.6	5	10.4	10	30.0	13	4	1	1.56	4	15	0.5
8600	478.0	6	10.6	9	30.6	13	4	1	1.52	4	15	0.5
8700	488.8	6	11.0	9	31.2	14	5	1	1.48	4	16	0.5
8800	500.0	6	11.4	9	31.8	14	5	1	1.43	4	16	0.5
8900	511.6	7	11.8	8	32.4	15	5	1	1.39	4	17	0.5
9000	523.8	7	12.4	8	33.0	15	5	1	1.35	4	17	0.5

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl*.
Muzzle Velocity, 1283 f/s — Charge 5

14	15	16	17	18	19	20	21	22	23	1
Complementary angle of site for each		Range effect of increase of—					Fuze setting for graze burst	Displacement of burst for change of 5 points in fuze setter corrector in—		Range
+1 mil of site	−1 mil of site	One proj in wt of is std Wt	One foot per sec in MV VE	Air temp 1 deg Std is 59° F Temp	Rear wind of 1 MPH W-R	One pct in air density Den	FS	Ht	R	R
mil	mil	yd	yd	yd	yd	yd	sec	mil	yd	yd
+.07	−.05		+4.7		+7.4	−13	120			6000
+.07	−.06		+4.8		+7.5	−14	122			6100
+.08	−.06		+4.8		+7.7	−14	124			6200
+.08	−.06		+4.9		+7.9	−14	126			6300
+.09	−.07		+4.9		+8.1	−15	129			6400
+.09	−.07		+5.0		+8.2	−15	131			6500
+.10	−.07		+5.0		+8.4	−15	133			6600
+.10	−.08		+5.0		+8.6	−16	136			6700
+.11	−.08		+5.1		+8.8	−16	138			6800
+.11	−.09		+5.1		+9.0	−16	141			6900
+.12	−.09		+5.2		+9.1	−17	143			7000
+.13	−.10	Data not available	+5.2	Data not available	+9.3	−17	146	Data not available	Data not available	7100
+.13	−.11		+5.3		+9.5	−17	148			7200
+.14	−.11		+5.3		+9.7	−18	151			7300
+.15	−.12		+5.3		+9.9	−18	153			7400
+.16	−.13		+5.4		+10.1	−19	156			7500
+.17	−.14		+5.4		+10.3	−19	159			7600
+.18	−.15		+5.5		+10.5	−19	161			7700
+.20	−.17		+5.5		+10.7	−20	164			7800
+.21	−.18		+5.6		+10.9	−20	167			7900
+.23	−.19		+5.6		+11.1	−21	170			8000
+.25	−.20		+5.7		+11.2	−21	173			8100
+.27	−.22		+5.7		+11.4	−22	176			8200
+.29	−.24		+5.8		+11.6	−22	179			8300
+.31	−.25		+5.8		+11.8	−22	182			8400
+.34	−.27		+5.9		+12.1	−23	185			8500
+.37	−.29		+5.9		+12.3	−23	188			8600
+.40	−.31		+6.0		+12.5	−24	192			8700
+.44	−.34		+6.0		+12.7	−25	195			8800
+.48	−.37		+6.1		+12.9	−25	198			8900
+.53	−.40		+6.1		+13.1	−26	202			9000

CHARGE 5

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl*.
Muzzle Velocity, 1283 f/s — Charge 5

1	2	3	4	5	6	7	8	9	10	11	12	13
						Probable error					Deflection effect	
Range	Elevation	Fork	Change in elevation for 100-yd change in range	Change in range for 1 mil change in elevation	Time of flight	Range	Deflection	Height of burst	Slope of fall	Line number of metro message	Drift	Lateral wind of 1 MPH (+)
R	El	F	C	mil	Time	e_{pr}	e_{pd}		Slope	L	Dft	W-D
yd	mil	mil	mil	yd	sec	yd	yd	mil	1/–	No	mil	mil
9000	523.8	7	12.4	8	33.0	15	5	1	1.35	4	17	0.5
9100	536.4	8	13.0	8	33.7	16	5	1	1.31	5	18	0.5
9200	549.6	9	13.8	7	34.4	16	5	1	1.27	5	18	0.5
9300	563.8	10	14.6	7	35.1	17	6	2	1.23	5	19	0.5
9400	578.8	11	15.6	6	35.9	17	6	2	1.19	5	20	0.5
9500	595.0	12	17.0	6	36.7	18	6	2	1.15	5	20	0.5
9600	612.8	14	18.8	5	37.6	19	6	2	1.11	5	21	0.5
9700	632.8	17	21.4	5	38.5	20	7	2	1.08	6	22	0.5
9800	656.4	22	26.0	4	39.5	21	7	2	1.05	6	23	0.6
9900	686.6	31	35.4	3	40.9	22	7	2	1.02	6	25	0.6
10000	731.2				43.6	23	7	2	0.99	6	28	0.6

CHARGE 5

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl★.
Muzzle Velocity, 1283 f/s — Charge 5

14	15	16	17	18	19	20	21	22	23	1
Complementary angle of site for each		Range effect of increase of—					Fuze setting for graze burst	Displacement of burst for change of 5 points in fuze setter corrector in—		Range
+1 mil of site	−1 mil of site	One proj in wt of is std	One foot per sec in MV	Air temp 1 deg Std is 59° F	Rear wind of 1 MPH	One pct in air density				
		Wt	VE	Temp	W-R	Den	FS	Ht	R	R
mil	mil	yd	yd	yd	yd	yd	sec	mil	yd	yd
+.53	−.40		+6.1		+13.1	−26	202			9000
+.59	−.44	Data not available	+6.2	Data not available	+13.3	−26	206	Data not available	Data not available	9100
+.67	−.50		+6.2		+13.5	−27	210			9200
+.76	−.57		+6.3		+13.6	−27	215			9300
+.88	−.66		+6.3		+13.8	−28	219			9400
+1.03	−.77		+6.4		+14.0	−29	224			9500
			+6.4		+14.2	−29	230			9600
			+6.5		+14.4	−30	237			9700
			+6.5		+14.6	−31	245			9800
			+6.6		+14.8	−32	254			9900
			+6.7		+15.0	−33	264			10000

CHARGE 5

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl★.
Muzzle Velocity, 1542 f/s — Charge 6

1	2	3	4	5	6	7	8	9	10	11	12	13
Range	Elevation	Fork	Change in elevation for 100-yd change in range	Change in range for 1 mil change in elevation	Time of flight	Probable error			Slope of fall	Line number of metro message	Deflection effect	
						Range	Deflection	Height of burst			Drift	Lateral wind of 1 MPH (+)
R	El	F	C	mil	Time	e_{pr}	e_{pd}		Slope	L	Dft	W-D
yd	mil	mil	mil	yd	sec	yd	yd	mil	1/–	No	mil	mil
6000	203.6	2	5.0	20	16.4	8	1	0	3.5	2	6	0.4
6100	208.6	2	5.2	19	16.7	8	1	0	3.4	2	6	0.4
6200	213.8	2	5.2	19	17.1	8	1	0	3.3	2	6	0.4
6300	219.0	2	5.2	19	17.4	8	1	0	3.3	2	6	0.4
6400	224.4	2	5.4	19	17.8	9	1	0	3.2	2	6	0.4
6500	229.8	2	5.4	18	18.2	9	1	1	3.1	2	6	0.4
6600	235.2	2	5.4	18	18.6	9	1	1	3.0	2	7	0.4
6700	240.8	2	5.6	18	18.9	9	2	1	2.9	2	7	0.4
6800	246.4	2	5.6	18	19.3	9	2	1	2.9	3	7	0.4
6900	252.0	2	5.6	18	19.6	10	2	1	2.8	3	7	0.4
7000	257.8	2	5.8	17	20.0	10	2	1	2.7	3	7	0.4
7100	263.6	2	5.8	17	20.3	10	2	1	2.6	3	7	0.4
7200	269.4	2	5.8	17	20.7	10	2	1	2.6	3	7	0.4
7300	275.4	2	6.0	17	21.1	10	2	1	2.5	3	8	0.4
7400	281.4	3	6.0	17	21.4	11	2	1	2.5	3	8	0.4
7500	287.4	3	6.2	16	21.8	11	2	1	2.4	3	8	0.4
7600	293.6	3	6.2	16	22.2	11	2	1	2.4	3	8	0.4
7700	299.8	3	6.2	16	22.6	11	2	1	2.3	3	8	0.4
7800	306.0	3	6.4	16	23.0	11	2	1	2.3	3	8	0.4
7900	312.4	3	6.4	16	23.4	12	2	1	2.2	3	9	0.5
8000	318.8	3	6.4	15	23.8	12	2	1	2.2	3	9	0.5
8100	325.4	3	6.6	15	24.2	12	2	1	2.2	3	9	0.5
8200	332.0	3	6.6	15	24.6	12	2	1	2.1	3	9	0.5
8300	338.6	3	6.6	15	25.0	13	2	1	2.1	3	10	0.5
8400	345.4	4	6.8	15	25.5	13	2	1	2.0	3	10	0.5
8500	352.2	4	6.8	14	25.9	13	2	1	1.96	3	10	0.5
8600	359.2	4	7.0	14	26.3	14	2	1	1.92	3	11	0.5
8700	366.2	4	7.2	14	26.8	14	3	1	1.88	3	11	0.5
8800	373.4	4	7.2	14	27.2	14	3	1	1.85	3	11	0.5
8900	380.6	4	7.4	14	27.6	15	3	1	1.81	4	11	0.5
9000	388.0	5	7.4	13	28.1	15	3	1	1.77	4	12	0.5

NOTE: Charge 6 is not to be fired below 200 mils elevation.

CHARGE 6

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl★.
Muzzle Velocity, 1542 f/s — Charge 6

14	15	16	17	18	19	20	21	22	23	1
Complementary angle of site for each		Range effect of increase of—								
+1 mil of site	−1 mil of site	One proj is std in wt of	One foot per sec in MV	Air temp 1 deg Std is 59° F	Rear wind of 1 MPH	One pct in air density	Fuze setting for graze burst	Displacement of burst for change of 5 points in fuze setter corrector in—		Range
		Wt	VE	Temp	W-R	Den	FS	Ht	R	R
mil	mil	yd	yd	yd	yd	yd	sec	mil	yd	yd
+.04	−.03		+4.8		+4.8	−17	108			6000
+.04	−.03		+4.9		+5.0	−17	111			6100
+.04	−.03		+4.9		+5.2	−18	113			6200
+.05	−.04		+4.9		+5.4	−18	115			6300
+.05	−.04		+4.9		+5.6	−19	117			6400
+.05	−.04		+4.9		+5.8	−19	119			6500
+.06	−.05		+4.9		+6.0	−20	121			6600
+.06	−.05		+5.0		+6.3	−20	123			6700
+.06	−.05		+5.0		+6.5	−20	126			6800
+.07	−.06		+5.0		+6.7	−21	128			6900
+.07	−.06		+5.0		+6.9	−21	130			7000
+.07	−.06	Data not available	+5.0	Data not available	+7.1	−22	132	Data not available	Data not available	7100
+.08	−.07		+5.0		+7.4	−22	134			7200
+.08	−.07		+5.0		+7.6	−23	137			7300
+.09	−.08		+5.1		+7.8	−23	139			7400
+.09	−.08		+5.1		+8.0	−23	141			7500
+.10	−.08		+5.1		+8.3	−24	143			7600
+.10	−.09		+5.1		+8.5	−24	145			7700
+.11	−.09		+5.1		+8.7	−25	148			7800
+.11	−.10		+5.1		+9.0	−25	150			7900
+.12	−.10		+5.1		+9.2	−26	152			8000
+.13	−.10		+5.2		+9.4	−26	154			8100
+.13	−.11		+5.2		+9.6	−27	157			8200
+.14	−.11		+5.2		+9.9	−27	159			8300
+.14	−.12		+5.2		+10.1	−28	161			8400
+.15	−.12		+5.2		+10.3	−28	164			8500
+.16	−.13		+5.2		+10.5	−29	167			8600
+.16	−.13		+5.3		+10.7	−29	169			8700
+.17	−.14		+5.3		+11.0	−30	172			8800
+.17	−.14		+5.3		+11.2	−30	174			8900
+.18	−.15		+5.3		+11.4	−31	177			9000

CHARGE 6

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl*.
Muzzle Velocity, 1542 f/s — Charge 6

1	2	3	4	5	6	7	8	9	10	11	12	13
						Probable error					Deflection effect	
Range	Elevation	Fork	Change in elevation for 100-yd change in range	Change in range for 1 mil change in elevation	Time of flight	Range	Deflection	Height of burst	Slope of fall	Line number of metro message	Drift	Lateral wind of 1 MPH (+)
R	El	F	C	mil	Time	e_{pr}	e_{pd}		Slope	L	Dft	W-D
yd	mil	mil	mil	yd	sec	yd	yd	mil	1/–	No	mil	mil
9000	388.0	5	7.4	13	28.1	15	3	1	1.77	4	12	0.5
9100	395.6	5	7.6	13	28.6	15	3	1	1.73	4	12	0.5
9200	403.2	5	7.8	13	29.0	16	3	1	1.70	4	12	0.5
9300	411.0	5	7.8	13	29.5	16	3	1	1.66	4	13	0.5
9400	418.8	5	8.0	13	30.0	16	3	1	1.63	4	13	0.5
9500	426.8	6	8.2	12	30.5	17	3	1	1.59	4	13	0.5
9600	435.2	6	8.4	12	31.0	17	3	1	1.56	4	14	0.5
9700	443.6	6	8.6	12	31.5	17	3	1	1.52	4	14	0.6
9800	452.2	6	8.8	12	32.0	18	3	1	1.49	4	14	0.6
9900	461.0	7	9.0	11	32.6	18	3	1	1.45	4	15	0.6
10000	470.0	7	9.2	11	33.1	19	3	1	1.42	4	15	0.6
10100	479.4	7	9.4	11	33.7	19	3	1	1.39	5	15	0.6
10200	489.0	8	9.8	10	34.2	19	3	1	1.35	5	16	0.6
10300	499.0	8	10.2	10	34.8	20	3	1	1.32	5	16	0.6
10400	509.4	8	10.6	10	35.4	20	4	2	1.28	5	17	0.6
10500	520.0	9	11.0	9	36.0	21	4	2	1.25	5	17	0.6
10600	431.0	10	11.4	9	36.7	22	4	2	1.22	5	18	0.6
10700	542.8	11	12.0	8	37.4	22	4	2	1.19	5	18	0.6
10800	555.2	12	12.6	8	38.0	23	4	2	1.15	5	19	0.6
10900	568.2	13	13.4	7	38.7	23	4	2	1.12	6	19	0.6
11000	582.0	14	14.4	7	39.5	24	4	2	1.09	6	20	0.6
11100	597.0	16	15.6	6	40.4	25	4	2	1.06	6	21	0.6
11200	613.4	18	17.2	6	41.3	26	4	2	1.03	6	22	0.7
11300	631.8	21	19.4	5	42.2	26	4	2	1.00	6	22	0.7
11400	652.8	25	22.8	4	43.2	27	4	3	0.98	6	23	0.7
11500	678.2	32	28.4	3	44.4	28	4	3	0.96	6	25	0.7
11600	712.6				46.2	30	4	3	0.94	6	26	0.7

CHARGE 6

Shells, F.H. Gr. and F.H. Gr. 38 Stg.
Fuzes, A.Z.23v(0.25), Dopp. Z. S/60s., and Dopp. Z. S/60 Fl*.
Muzzle Velocity, 1542 f/s — Charge 6

14	15	16	17	18	19	20	21	22	23	1
Complementary angle of site for each		Range effect of increase of—								
+1 mil of site	−1 mil of site	One proj in wt of is std	One foot per sec in MV	Air temp 1 deg Std is 59° F	Rear wind of 1 MPH	One pct in air density	Fuze setting for graze burst	Displacement of burst for change of 5 points in fuze setter corrector in—		Range
		Wt	VE	Temp	W-R	Den	FS	Ht	R	R
mil	mil	yd	yd	yd	yd	yd	sec	mil	yd	yd
+.18	−.15		+5.3		+11.4	−31	177			9000
+.19	−.16		+5.3		+11.7	−31	180			9100
+.20	−.17		+5.4		+11.9	−32	182			9200
+.20	−.17		+5.4		+12.1	−32	185			9300
+.21	−.18		+5.4		+12.3	−33	188			9400
+.25	−.19		+5.4		+12.5	−34	191			9500
+.23	−.20		+5.5		+12.7	−34	194			9600
+.25	−.21		+5.5		+12.9	−35	197			9700
+.26	−.22		+5.5		+13.1	−35	200			9800
+.28	−.24		+5.5		+13.3	−36	203			9900
+.30	−.25		+5.6		+13.5	−36	206			10000
+.33	−.27	Data not available	+5.6	Data not available	+13.7	−37	209	Data not available	Data not available	10100
+.36	−.29		+5.6		+13.9	−38	212			10200
+.39	−.31		+5.6		+14.1	−38	216			10300
+.43	−.34		+5.7		+14.3	−39	219			10400
+.47	−.38		+5.7		+14.6	−39	223			10500
	−.43		+5.7		+14.8	−40	227			10600
	−.48		+5.7		+15.0	−41	231			10700
	−.53		+5.8		+15.3	−42	235			10800
	−.59		+5.8		+15.6	−42	239			10900
	−.67		+5.8		+15.8	−43	243			11000
			+5.8		+16.1	−44	248			11100
			+5.9		+16.4	−45	253			11200
			+5.9		+16.6	−46	259			11300
			+5.9		+16.9	−47	265			11400
			+6.0		+17.1	−48	273			11500
			+6.0		+17.4	−50	283			11600

CHARGE 6

This page has been left blank intentionally.

LIGHT FIELD HOWITZER, 105-MM (GERMAN)

FIRING

FIELD HOWITZER SHELL, SMOKE (F.H. Gr. Nb.)

RANGE — ELEVATION RELATION

NOTE: All other trajectory data and effects are the same as those listed for the High Explosive Shell (F.H. Gr.).

Shell, F.H. Gr. Nb.
Fuze, kl. A.Z. 23 Nb.
Muzzle Velocity, 656 f/s — Charge 1

Range yards	Elevation mils
0	−5.0
100	+5.2
200	15.8
300	26.4
400	37.2
500	48.0
600	59.0
700	70.0
800	80.2
900	92.6
1000	104.2
1100	116.0
1200	128.0
1300	140.2
1400	152.6
1500	165.2
1600	177.8
1700	190.6
1800	203.8
1900	217.2
2000	230.8
2100	244.6
2200	258.8
2300	273.2
2400	288.0
2500	303.2

Range yards	Elevation mils
2500	303.2
2600	319.0
2700	335.2
2800	352.0
2900	369.4
3000	387.6
3100	407.0
3200	427.6
3300	449.4
3400	472.4
3500	497.0
3600	524.0
3700	553.8
3800	587.6
3900	628.2
4000	691.8

Shell, F.H. Gr. Nb.
Fuze, kl. A.Z. 23 Nb.
Muzzle Velocity, 761 f/s — Charge 2

Range yards	Elevation mils
0	−4.0
100	+4.0
200	12.0
300	20.2
400	28.4
500	36.6
600	44.8
700	53.0
800	61.4
900	69.8
1000	78.2
1100	86.8
1200	95.4
1300	104.2
1400	113.0
1500	122.0
1600	131.2
1700	140.4
1800	149.8
1900	159.4
2000	169.2
2100	179.0
2200	189.0
2300	199.2
2400	209.4
2500	219.8

Range yards	Elevation mils
2500	219.8
2600	230.2
2700	240.8
2800	251.6
2900	262.6
3000	273.8
3100	285.4
3200	297.4
3300	309.6
3400	322.2
3500	335.2
3600	348.6
3700	362.4
3800	376.8
3900	391.8
4000	407.2
4100	423.2
4200	439.8
4300	457.2
4400	475.8
4500	495.6
4600	516.8
4700	540.0
4800	566.0
4900	595.8
5000	632.2

Shell, F.H. Gr. Nb.
Fuze, kl. A.Z. 23 Nb.
Muzzle Velocity, 866 f/s — Charge 3

Range yards	Elevation mils
0	−3.0
100	+3.0
200	9.2
300	15.4
400	21.6
500	28.0
600	34.4
700	40.8
800	47.4
900	54.2
1000	60.8
1100	67.6
1200	74.4
1300	81.4
1400	88.4
1500	95.4
1600	102.4
1700	109.4
1800	116.6
1900	123.8
2000	131.2
2100	138.6
2200	146.2
2300	153.8
2400	161.4
2500	169.0

Range yards	Elevation mils
2500	169.0
2600	176.8
2700	184.6
2800	192.6
2900	200.6
3000	208.6
3100	216.8
3200	225.0
3300	233.4
3400	242.0
3500	250.6
3600	260.4
3700	268.4
3800	277.6
3900	287.0
4000	296.4
4100	306.0
4200	315.8
4300	325.8
4400	336.2
4500	347.0
4600	358.2
4700	369.8
4800	381.8
4900	394.2
5000	407.0

Range yards	Elevation mils
5000	407.0
5100	420.4
5200	434.2
5300	448.4
5400	463.0
5500	478.4
5600	494.8
5700	512.6
5800	531.8
5900	552.6
6000	575.0
6100	599.4
6200	627.4
6300	664.0

Shell, F.H. Gr. Nb.
Fuze, kl. A.Z. 23 Nb.
Muzzle Velocity, 1040 f/s — Charge 4

Range yards	Elevation mils
0	−3.0
100	+1.4
200	5.8
300	10.2
400	14.6
500	19.2
600	23.8
700	28.4
800	33.0
900	37.6
1000	42.2
1100	47.0
1200	51.8
1300	56.6
1400	61.6
1500	66.6
1600	71.6
1700	76.6
1800	81.6
1900	86.8
2000	92.0
2100	97.2
2200	102.4
2300	107.8
2400	113.2
2500	118.6
2600	124.2
2700	129.8
2800	135.4
2900	141.0
3000	146.6

Range yards	Elevation mils
3000	146.6
3100	152.4
3200	158.2
3300	164.0
3400	170.0
3500	176.0
3600	182.0
3700	188.2
3800	194.4
3900	200.6
4000	206.8
4100	213.2
4200	219.6
4300	226.2
4400	232.8
4500	239.6
4600	246.4
4700	253.2
4800	260.2
4900	267.4
5000	274.6
5100	282.0
5200	289.4
5300	297.0
5400	304.8
5500	312.6
5600	320.6
5700	328.8
5800	337.2
5900	345.8
6000	354.4

Range yards	Elevation mils
6000	354.4
6100	363.2
6200	372.4
6300	381.8
6400	391.4
6500	401.2
6600	411.4
6700	421.8
6800	432.4
6900	443.2
7000	454.4
7100	466.2
7200	478.4
7300	491.0
7400	504.0
7500	517.8
7600	532.6
7700	548.6
7800	565.8
7900	584.4
8000	604.6
8100	627.2
8200	654.8
8300	697.6

Shell, F.H. Gr. Nb.
Fuze, kl. A.Z. 23 Nb.
Muzzle Velocity, 1283 f/s — Charge 5

Range yards	Elevation mils
0	−4.0
100	−1.2
200	+1.6
300	4.6
400	7.6
500	10.6
600	13.6
700	16.6
800	19.8
900	23.0
1000	26.4
1100	29.8
1200	33.2
1300	36.8
1400	40.4
1500	44.0
1600	47.6
1700	51.4
1800	55.2
1900	59.2
2000	63.2
2100	67.2
2200	71.2
2300	75.4
2400	79.6
2500	83.8
2600	88.2
2700	92.6
2800	97.0
2900	101.6
3000	106.2
3100	110.8
3200	115.4
3300	120.0
3400	124.8
3500	129.6

Range yards	Elevation mils
3500	129.6
3600	134.6
3700	139.6
3800	144.6
3900	149.6
4000	154.8
4100	160.0
4200	165.2
4300	170.4
4400	175.8
4500	181.2
4600	186.6
4700	192.0
4800	197.6
4900	203.2
5000	208.8
5100	214.4
5200	220.2
5300	226.0
5400	232.0
5500	238.0
5600	244.0
5700	250.0
5800	256.2
5900	262.4
6000	268.6
6100	275.0
6200	281.4
6300	287.8
6400	294.4
6500	301.0
6600	307.8
6700	314.8
6800	321.8
6900	328.8
7000	336.0

Range yards	Elevation mils
7000	336.0
7100	343.4
7200	350.8
7300	358.4
7400	366.2
7500	374.2
7600	382.2
7700	390.2
7800	398.4
7900	407.0
8000	415.8
8100	424.8
8200	434.0
8300	443.6
8400	453.4
8500	463.6
8600	474.0
8700	484.8
8800	496.0
8900	507.6
9000	519.8
9100	532.6
9200	546.0
9300	560.2
9400	575.4
9500	591.6
9600	609.2
9700	628.6
9800	650.6
9900	680.6

CHARGE 5

Shell, F.H. Gr. Nb.
Fuze, kl. A.Z. 23 Nb.
Muzzle Velocity, 1542 f/s — Charge 6

Range yards	Elevation mils
6000	201.6
6100	206.8
6200	212.0
6300	217.4
6400	222.8
6500	228.2
6600	233.8
6700	239.4
6800	245.0
6900	250.6
7000	256.4
7100	262.2
7200	268.0
7300	274.0
7400	280.0
7500	286.2
7600	292.4
7700	298.6
7800	305.0
7900	311.4
8000	317.8
8100	324.4
8200	331.0
8300	337.8
8400	344.6
8500	351.4
8600	358.4
8700	365.6
8800	372.8
8900	380.2
9000	387.6

Range yards	Elevation mils
9000	387.6
9100	395.2
9200	403.0
9300	410.8
9400	418.8
9500	427.0
9600	435.2
9700	443.6
9800	452.4
9900	461.4
10000	470.6
10100	480.0
10200	489.8
10300	500.0
10400	510.6
10500	621.6
10600	533.0
10700	545.0
10800	557.8
10900	571.2
11000	585.6
11100	601.2
11200	618.2
11300	637.2
11400	659.2
11500	685.6

NOTE: Charge 6 is not to be fired below 200 mils elevation.

78. LINEAR CONVERSION TABLES.

TABLE 1.

Meters	Yards	Meters	Yards	Meters	Yards	Meters	Yards
100	109.36	3100	3390.2	6100	6671.0	9100	9951.9
200	218.72	3200	3499.6	6200	6780.4	9200	10061.
300	328.08	3300	3608.9	6300	6889.7	9300	10171.
400	437.44	3400	3718.3	6400	6999.1	9400	10280.
500	546.81	3500	3827.6	6500	7108.5	9500	10389.
600	656.18	3600	3937.0	6600	7217.8	9600	10499.
700	765.53	3700	4046.4	6700	7327.2	9700	10608.
800	874.89	3800	4155.7	6800	7436.6	9800	10717.
900	984.25	3900	4265.1	6900	7545.9	9900	10827.
1000	1093.61	4000	4374.4	7000	7655.3	10000	10936.
1100	1203.0	4100	4483.8	7100	7764.6	10100	11046.
1200	1312.3	4200	4593.2	7200	7874.0	10200	11155.
1300	1421.7	4300	4702.5	7300	7983.4	10300	11265.
1400	1531.1	4400	4811.9	7400	8092.7	10400	11374.
1500	1640.4	4500	4921.2	7500	8202.1	10500	11483.
1600	1749.8	4600	5030.6	7600	8311.4	10600	11592.
1700	1859.1	4700	5140.0	7700	8420.8	10700	11702.
1800	1968.5	4800	5249.3	7800	8530.2	10800	11811.
1900	2077.9	4900	5358.7	7900	8639.5	10900	11920.
2000	2187.2	5000	5468.1	8000	8748.9	11000	12030.
2100	2296.6	5100	5577.4	8100	8858.2		
2200	2405.9	5200	5686.8	8200	8967.6		
2300	2515.3	5300	5796.1	8300	9077.0		
2400	2624.7	5400	5905.5	8400	9186.3		
2500	2734.0	5500	6014.9	8500	9295.7		
2600	2843.4	5600	6124.2	8600	9405.1		
2700	2952.7	5700	6233.6	8700	9514.4		
2800	3062.1	5800	6342.9	8800	9623.8		
2900	3171.5	5900	6452.3	8900	9733.1		
3000	3280.8	6000	6561.8	9000	9842.5		

TABLE 2.

Yards	Meters	Yards	Meters	Yards	Meters	Yards	Meters
100	91.44	3100	2834.6	6100	5577.9	9100	8321.1
200	182.88	3200	2926.1	6200	5669.3	9200	8412.5
300	274.32	3300	3017.5	6300	5760.7	9300	8503.9
400	365.76	3400	3108.9	6400	5852.2	9400	8595.4
500	457.20	3500	3200.4	6500	5943.6	9500	8686.8
600	548.64	3600	3291.8	6600	6035.1	9600	8778.3
700	640.06	3700	3383.3	6700	6126.5	9700	8869.7
800	731.52	3800	3474.7	6800	6217.9	9800	8961.1
900	822.96	3900	3566.2	6900	6309.4	9900	9052.6
1000	914.40	4000	3657.6	7000	6400.6	10000	9144.0
1100	1005.8	4100	3749.0	7100	6492.3	10100	9235.5
1200	1097.3	4200	3840.5	7200	6583.7	10200	9326.9
1300	1188.7	4300	3931.9	7300	6675.1	10300	9418.3
1400	1280.2	4400	4023.4	7400	6766.6	10400	9509.8
1500	1371.6	4500	4114.8	7500	6858.0	10500	9601.2
1600	1463.0	4600	4206.2	7600	6949.5	10600	9692.7
1700	1554.5	4700	4297.7	7700	7040.9	10700	9784.1
1800	1645.9	4800	4389.1	7800	7132.3	10800	9875.5
1900	1737.4	4900	4480.6	7900	7223.8	10900	9967.0
2000	1828.8	5000	4572.0	8000	7315.2	11000	10058.
2100	1920.2	5100	4663.4	8100	7406.7	11100	10149.
2200	2011.7	5200	4754.9	8200	7498.1	11200	10241.
2300	2103.1	5300	4846.3	8300	7589.5	11300	10332.
2400	2194.6	5400	4937.8	8400	7681.0	11400	10424.
2500	2286.0	5500	5029.2	8500	7772.4	11500	10515.
2600	2377.4	5600	5120.7	8600	7863.9	11600	10607.
2700	2468.9	5700	5212.1	8700	7955.3	11700	10698.
2800	2560.3	5800	5303.5	8800	8046.7	11800	10790.
2900	2651.8	5900	5395.0	8900	8138.2	11900	10881.
3000	2743.2	6000	5486.4	9000	8229.6	12000	10972.

79. ANGULAR CONVERSION TABLES.

ANGULAR CONVERSION TABLE—DEGREES TO MILS

Degrees	0	1	2	3	4	5	6	7	8	9
00	0	18	36	53	71	89	107	124	142	160
10	178	196	213	231	249	267	284	302	320	338
20	356	373	391	409	427	444	462	480	498	516
30	533	551	569	587	604	622	640	658	676	693
40	711	729	747	764	782	800	818	836	853	871
50	889	907	924	942	960	978	996	1013	1031	1049
60	1067	1084	1102	1120	1138	1156	1173	1191	1209	1227
70	1244	1262	1280	1298	1316	1333	1351	1369	1387	1404
80	1422	1440	1458	1476	1493	1511	1529	1547	1564	1582
90	1600	(Conversion factor: 1 deg = 17.77778 mils)								

CHAPTER 7

REFERENCES

80. PUBLICATIONS INDEXES.

The following publications indexes should be consulted frequently for latest changes or revisions of references given in this chapter and for new publications relating to materiel covered in this manual:

a. Introduction to Ordnance Catalog (explaining SNL system)	ASF Cat. ORD 1 IOC
b. Ordnance Publications for Supply Index (index to SNL's)	ASF Cat. ORD 2 OPSI
c. Index to Ordnance Publications (listing FSM's, TM's, TC's, and TB's of interest to Ordnance personnel, OPSR, FSMWO's, BSD, S of SR's, OSSC's, and OFSB's, and including alphabetical listing of Ordnance major items with publications pertaining thereto)	OFSB 1-1
d. List of Publications for Training (listing MR's, MTP's, T/BA's, T/A's, FM's, TM's, TR's, TB's, SB's, MWO's, WDLO's, and Firing Tables)	FM 21-6
e. List of Training Films, Film Strips, and Film Bulletins (listing TF's, FS's, and FB's by serial number and subject)	FM 21-7
f. Military Training Aids (listing graphic training aids, models, devices, and displays)	FM 21-8

81. STANDARD NOMENCLATURE LISTS.

a. Cleaning, preserving, and lubricating materials; recoil fluids, special oils, and miscellaneous related items	ASF Cat. ORD 5 SNL K-1

82. EXPLANATORY PUBLICATIONS.

a. Ammunition.

Ammunition, general	TM 9-1900
Range regulations for firing ammunition for training and target practice	AR 750-10

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

GERMAN 105-MM HOWITZER MATERIEL

c. Decontamination.

Decontamination	TM 3-220
Defense against chemical attack	FM 21-40

d. Fire Control.

Auxiliary fire control instruments (field glasses, eyeglasses, telescopes, and watches)	TM 9-575
Field artillery fire control instruments	TM 6-220

e. Maintenance and Repair.

Artillery lubrication, general	OFSB 6-4
Cold weather lubrication and service of artillery materiel	OFSB 6-5

f. Miscellaneous.

German 88-mm antiaircraft gun materiel	TM E9-369A
Handbook on German military forces	TM 30-450
Military dictionary (English-German, German-English)	TM 30-255

INDEX

A

B

GERMAN 105-MM HOWITZER MATERIEL

INDEX

GERMAN 105-MM HOWITZER MATERIEL

R—(Contd)

S

T

W

Z