Chapter 12

BROWNING 37-MM AIRCRAFT AUTOMATIC CANNON

SECTION 1. HISTORY AND BACKGROUND

The first Browning 37-mm aircraft cannon was designed in the 1920's by John M. Browning. Shortly after successful demonstrations of the prototype had been held, interest in all military weapons in the United States became apathetic; and interest in the 37-mm cannon did not revive until 1935, when the Air Force needed an automatic gun of large caliber for aircraft. The history of this gun, known as the M4, and of the full-automatic, high-velocity 37-mm automatic cannon M9, is discussed in volume 1 of The Machine Gun (pp. 531–536).

The M9 was basically the same as the M1A2 in general overall appearance, and the functioning of its parts was very similar. The M9 was used primarily to attack mechanized ground forces, a purpose for which characteristics of ammunition for the M4 were inadequate.

The M9 had a muzzle velocity of 3,000 feet per second with approximately the same cyclic rate (140 rounds per minute) as the 37-mm gun M4, which had a muzzle velocity of 2,000 feet per second. It could be fed from either the right or left side by disintegrating belt links.

The standard 37-mm M4 gun was fed by an endless belt magazine from the left side only, but to satisfy the requirements of the Army Air Force it was

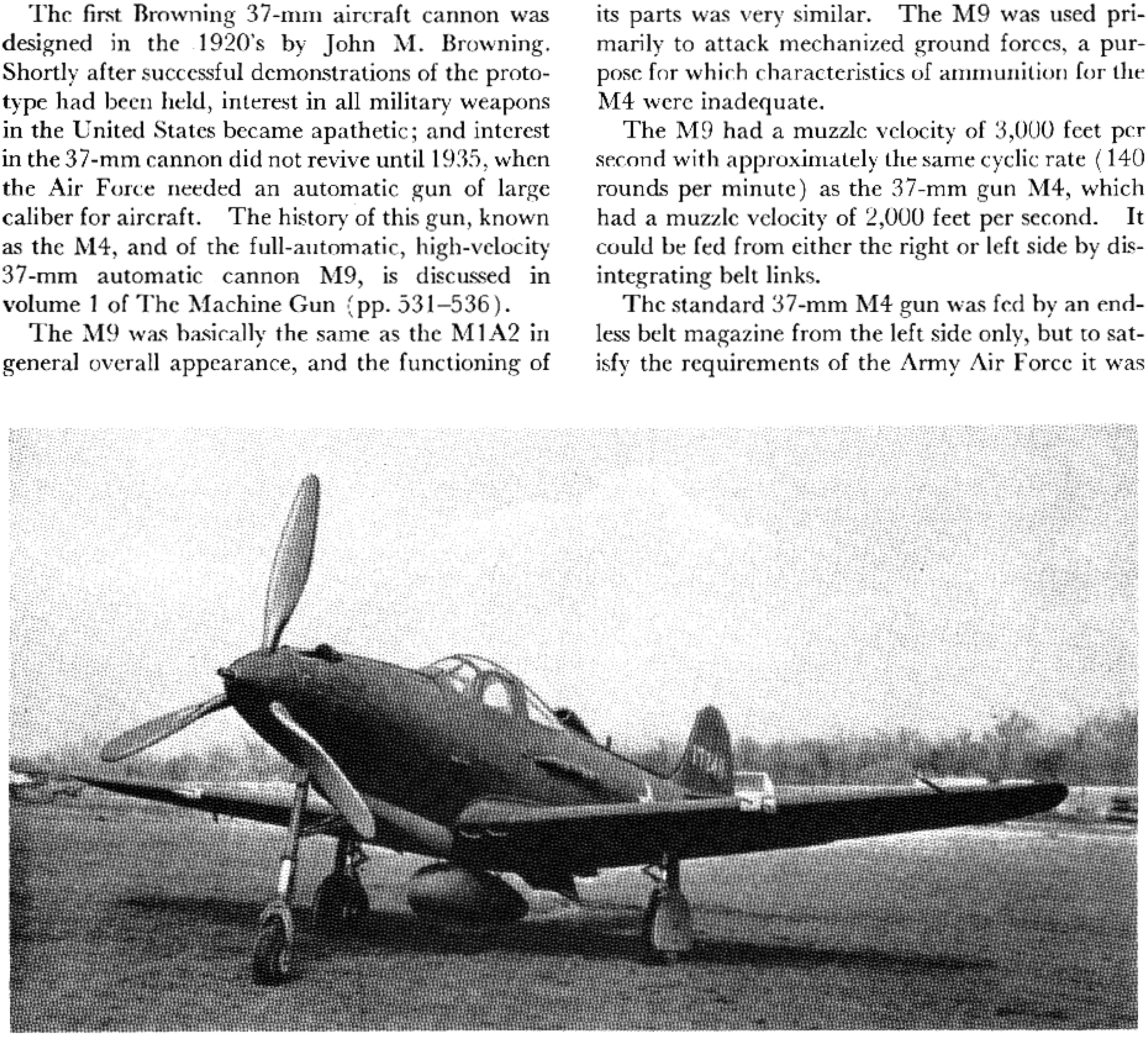

Figure 12–1. 37-mm Browning Gun M4 mounted in a P39F aircraft to fire through the propeller hub.

necessary to provide for its feeding also from the right. Five additional endless belt magazines were developed because of variations in the installation requirements of different airplanes. This constituted an additional disadvantage to the already existing disadvantages of size, weight, and magazine capacity, making it evident, early in 1942, that as long as an endless belt type was used with 37-mm automatic gun M4, it would be necessary to have a different magazine for each new type of airplane in which the gun was to be mounted. Accordingly, since a requirement still existed for a gun with the characteristics of the M4, the Ordnance Corps initiated a development program to modify this weapon so that it would be fed by a disintegrating link belt from either the right or the left side.

The result of this development was standardized as 37-mm automatic gun M10. This gun fired at a rate of 25 to 30 shots faster than the M4 (165 as against 140 rounds per minute), and, because of the disintegrating link belt used, it was possible to carry in the P–63 airplane 28 additional rounds for each gun, a total of 56 additional rounds of 37-mm ammunition.

To increase aerial firepower further, a new development was initiated to step up the cyclic rate of 37-mm guns to at least 400 rounds per minute, while maintaining a muzzle velocity of 3,000 feet per second and firing a family of matched projectiles of improved ballistic characteristics. Four facilities made preliminary studies, from which the belt design was to be selected for further development.

These 37-mm guns were full automatic weapons of the long recoil type, especially designed for aircraft and for use of belted ammunition. They could be mounted to fire through the hub of the propeller shaft, or they could be mounted at some point outside the plane of propeller rotation, but they could not be used as synchronized weapons. They were fired by means of a remotely controlled electric solenoid mounted at the rear of each gun.

SECTION 2. COMPARATIVE DATA

Component	Component differences		
	M4	M9	M10
Loading handle	Cam and base assembly on feedbox.	On feedbox cover	Assembly replaced by loading slide with cable connection for manual loading.
Recuperator	None	Positioned rearward of the socket extends upward at 21° angle.	None.
Side plates	Without longitudinal rib.	Heavy longitudinal rib	Four tapped holes to attach manual charger.
Backplate	Cylindrical portion inside gun between side plates.	Cylindrical portion outside gun.	Top of adjustment screw recessed. Longer plunger.
Trunnion block	Notches on outer flange.	No notches on the flange. Held by two screws to trunnion block.	Pressed in from front end of trunnion block body.
Tube splines and flats	Neither	Splines on muzzle end of tube.	Splines on muzzle end of tube.
Feedbox and feed mechanism.		For disintegrating link belt. Boxes and mechanisms changeable for right or left feeding.	For disintegrating link belt. Boxes and mechanisms changeable for right or left feeding.

Comparative Data: 37-mm Automatic Guns, M4, M9, and M10

Characteristic	M4	M9	M10
Gun length, overall...inches	89.5	104	89.57.
Gun weight, without mount and accessories...pounds	213	405	231.
Rate of fire (average)...rounds/minute	140 to 150	140	150 to 165.
Muzzle velocity (HE shell)...feet/second	2,000	2,600	2,000.
Muzzle velocity (AP shell)...do	1,825	2,800 to 3,050	1,825.
Weight of projectile (HE)...pounds	1.34	1.34	1.34.
Weight of projectile (AP)...do	1.66	1.92 or 1.66	1.66.
System of operation	Long recoil	Long recoil	Long recoil.
Type of recoil operation	Automatic	Automatic	Automatic.
Length of recoil...inches	9⅝	10¾	9¾.
Recuperator oil capacity...ounces	42	72	42.
System of locking	Vertical rising wedge	Vertical sliding wedge	Vertical rising wedge.
System of feeding	Recoil actuated	Recoil actuated	Recoil actuated.
Method of headspace	Not adjustable	Factory set	Not adjustable.
Location of feed opening	Top of receiver either right or left hand.	Top of receiver either right or left hand.	Top of receiver either right or left hand.
Location of ejection opening	Bottom of receiver	Bottom of receiver	Bottom of receiver.
Method of charging	Hydraulic, air or manual	Hydraulic, air or manual	Hydraulic.
Method of cooling	Air	Air	Air.
Barrel length...inches	65	78	65.
Barrel weight...pounds	55	120	57.5.
Rate control	None	None	None.
Barrel removal	Can be removed readily	Can be removed readily but not designed for field replacement.	Can be removed easily.
Bore:			
Number of grooves	12	12	12.
Groove depth...inches	0.020	0.020	0.020.
Groove width...do	0.2314	0.2314	0.2314.
Pitch	1.48 turns in 65 inches	1.56 turns in 78 inches	1.48 turns in 65 inches.
Direction of twist	Right hand	Right hand	Right hand.
Form of twist	Constant	Constant	Constant.
Width of lands...inches	0.150	0.150	0.150.
Number of turns rifling in tube, approximately.	1.48	1.56	1.48.

SECTION 3. 37-MM AUTOMATIC GUN M4

Functioning of 37-mm Automatic Guns M4 and M10

The 37-mm automatic guns M4 and M10, designed for use in aircraft, were equipped to use belted ammunition. The M4 gun was fed from the left side, employing the M6 magazine. The M10 gun was fed by a disintegrating metallic empty belt. Empty links were ejected through an opening in the opposite side of the feedbox. Empty cartridge cases were ejected through a longitudinal opening in the bottom of the feedbox, between the trunnion block side plates.

This type of gun depends upon a long movement of the recoiling portions for its operation. The series of operations and motions of the various parts of the gun occur in a definite and interrelated sequence. Each part receives its motion from some other part, and each functions in a definite and specific moment of the entire cycle. There are as many as 165 cycles a minute.

The trunnion block assembly houses the gun. In addition to providing for mounting the gun, it supports the operating mechanism, which consists of the tube and tube extension, recuperator group,

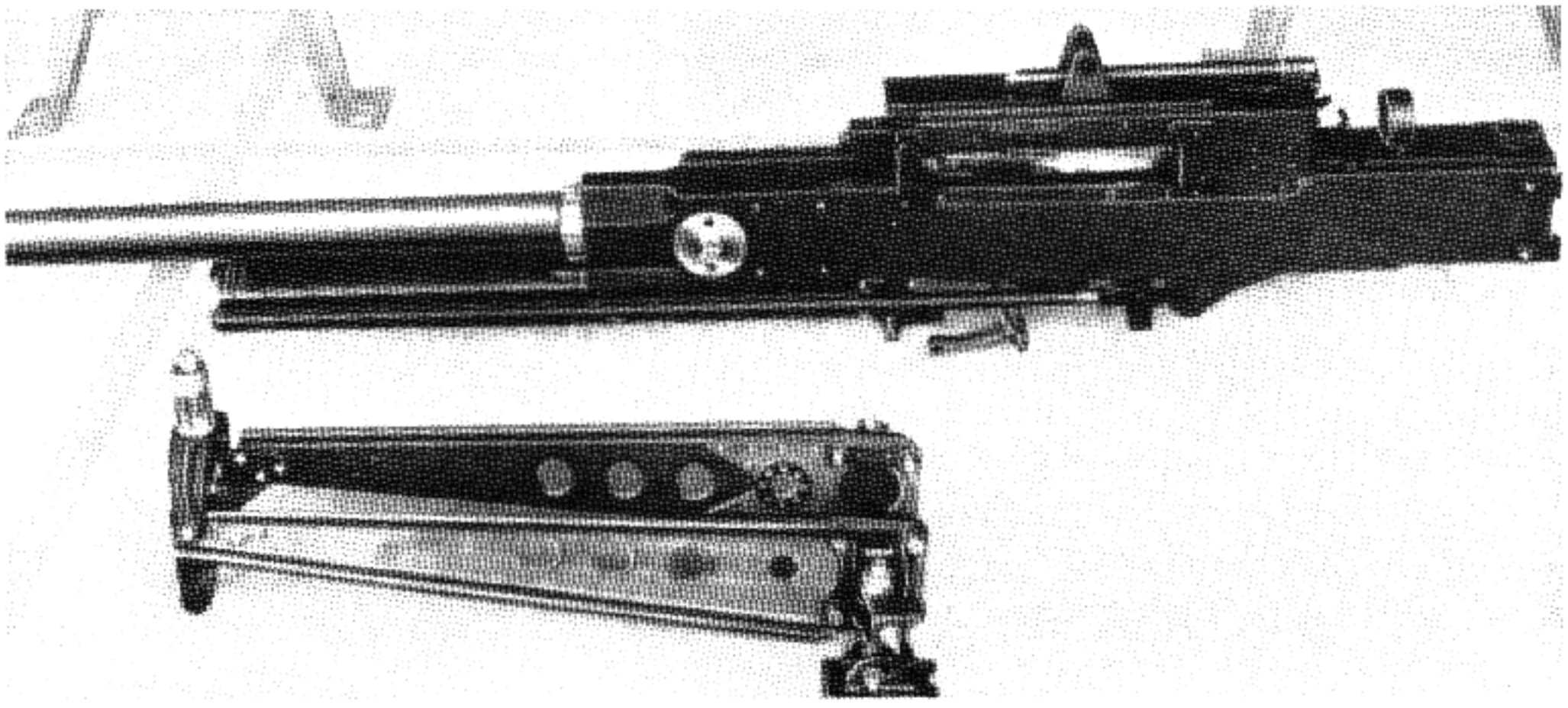

Figure 12–2. 37-mm Browning Gun M4. Left side view.

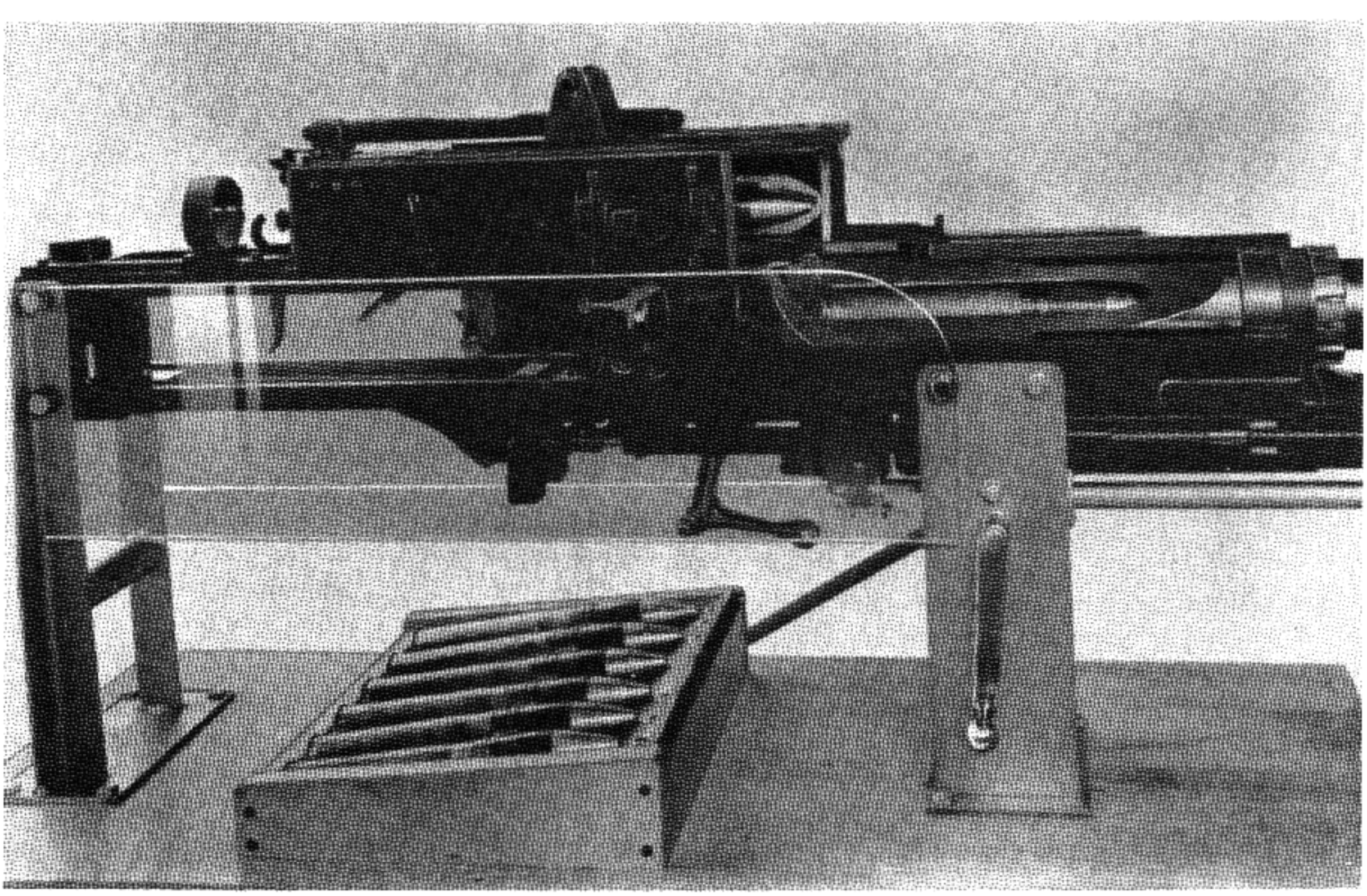

Figure 12–3. Cutaway demonstration model of 37-mm Browning Gun M4.

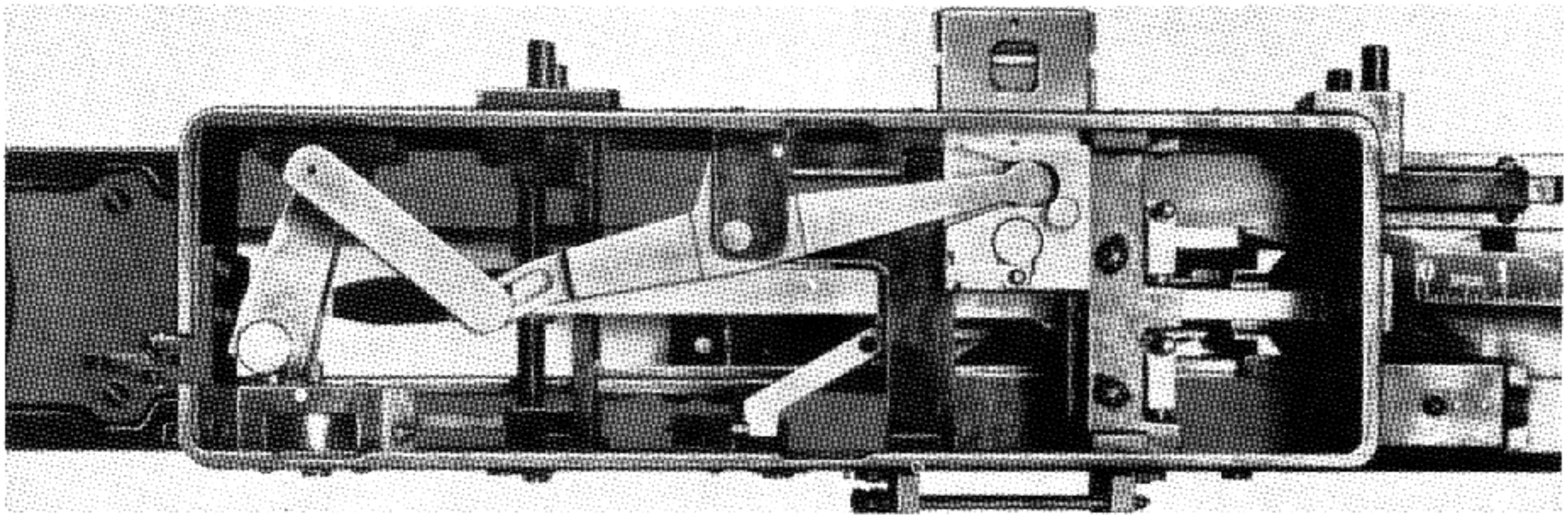

Figure 12–4. 37-mm Browning Gun M4 with cover removed. Top view.

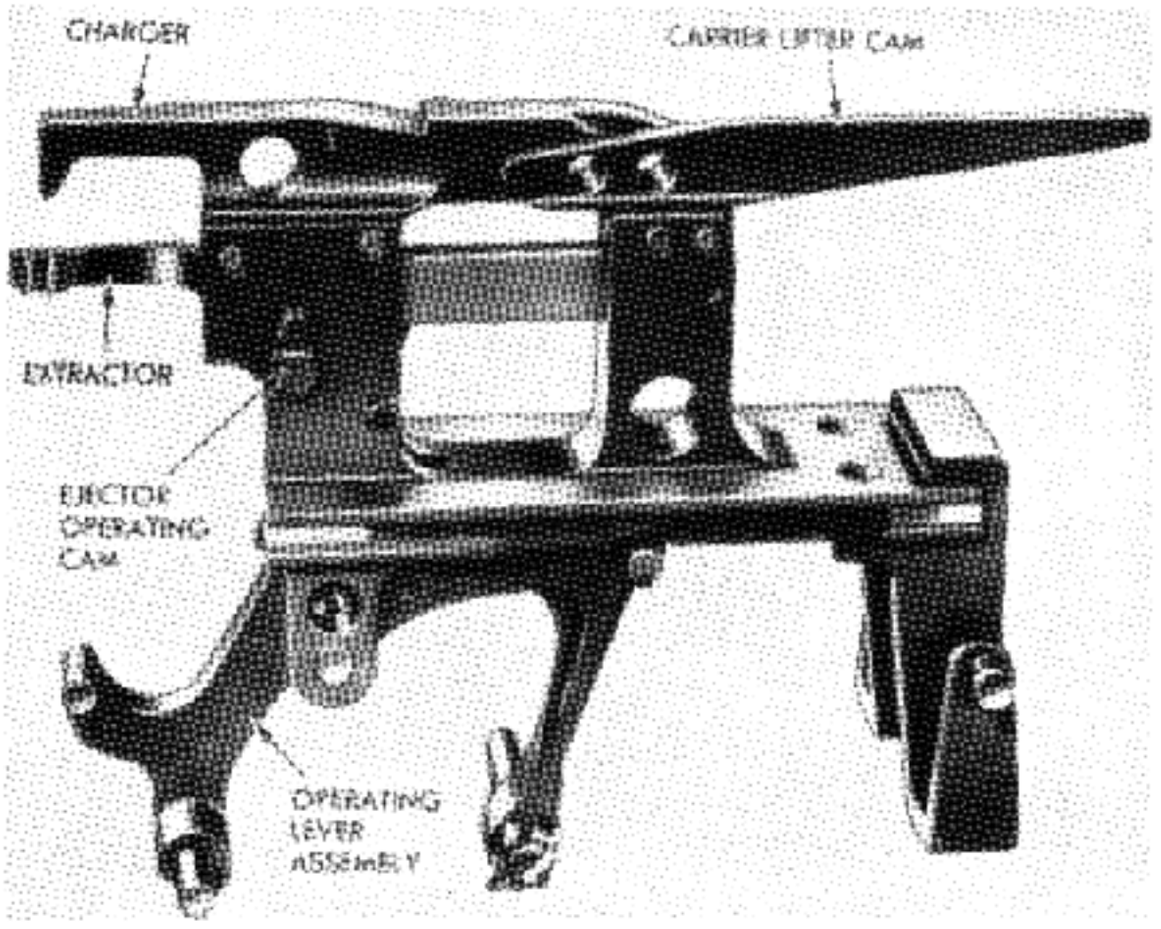

Figure 12–5. The lock frame assembly of the 37-mm Browning gun. The operating lever is retracted.

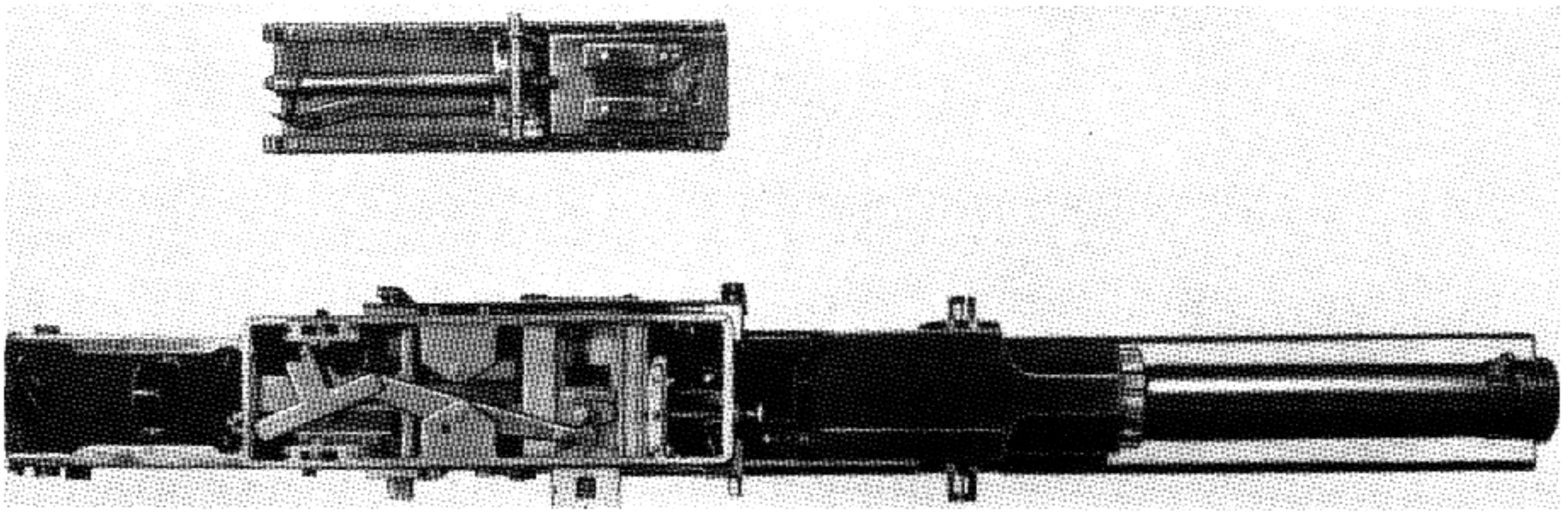

Figure 12–6. 37-mm Browning Gun M4E2 with right-hand feed box assembly. Top view.

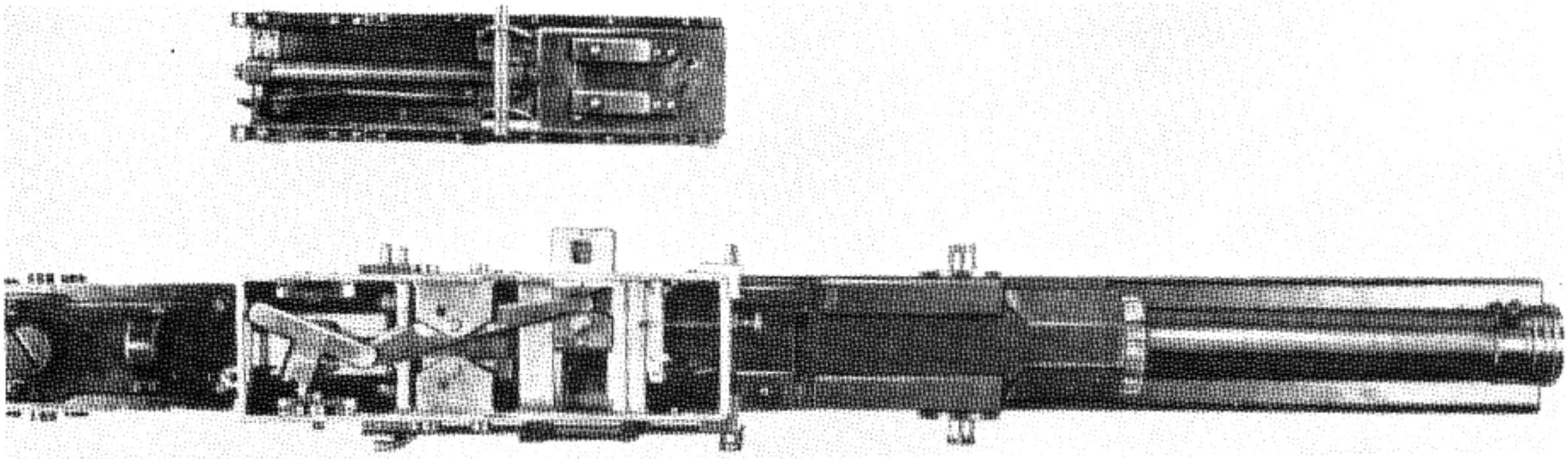

Figure 12–7. 37-mm Browning Gun M4E2 with left-hand feed box assembly. Top view.

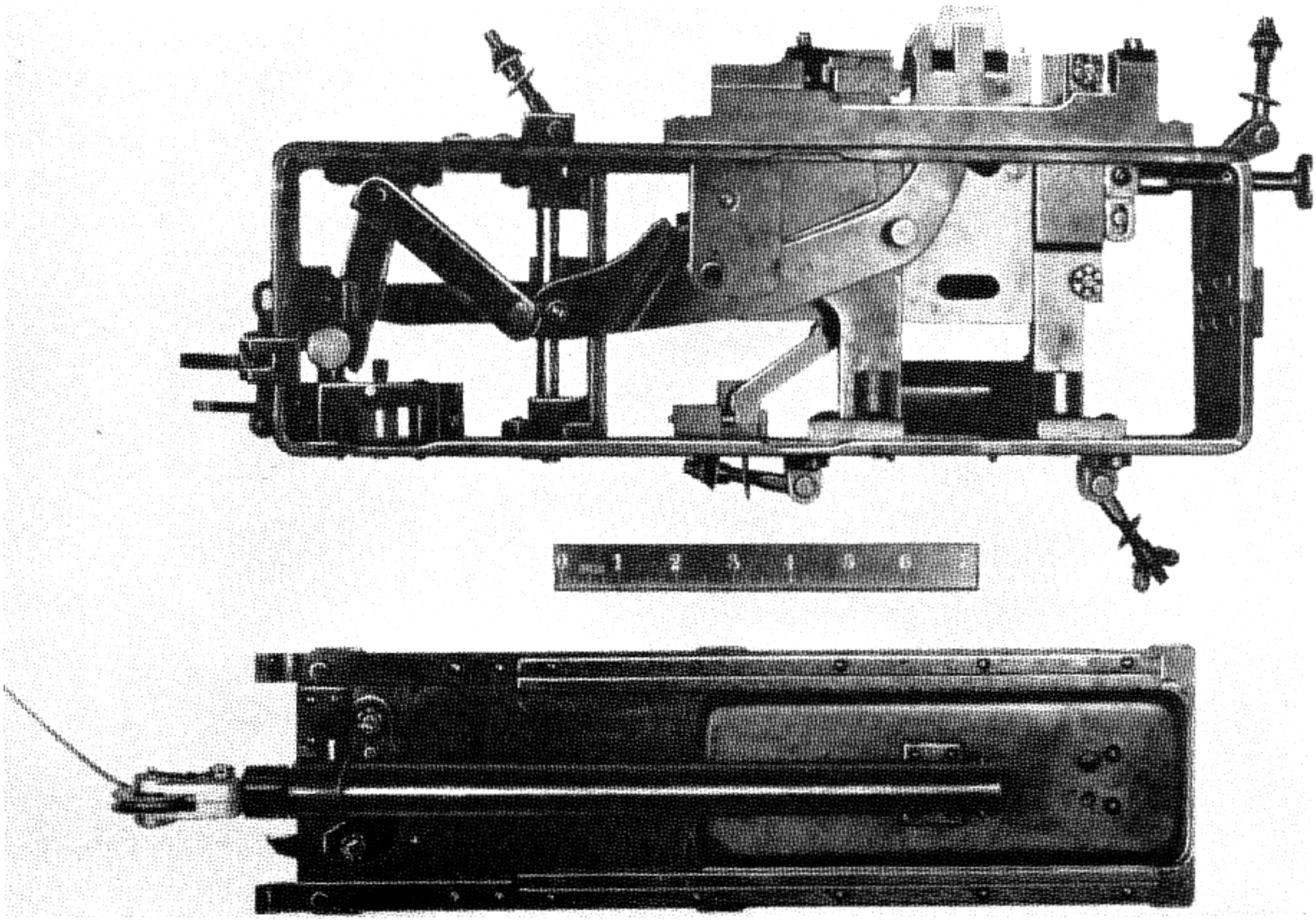

Figure 12–8. 37-mm Browning Gun M4E3 with left-hand feed box assembly.

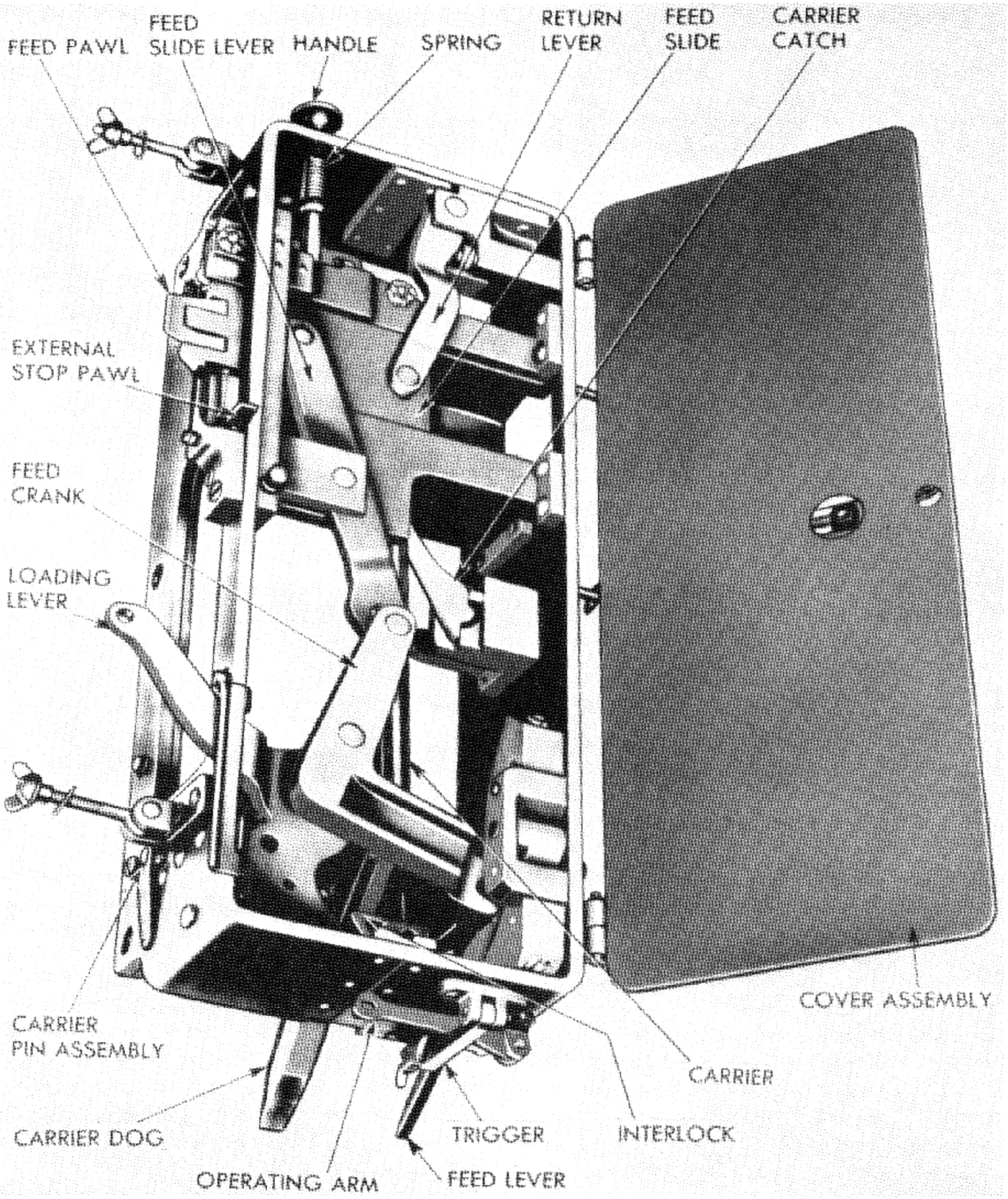

Figure 12–9. Feed box for 37-mm Automatic Gun M4E4.

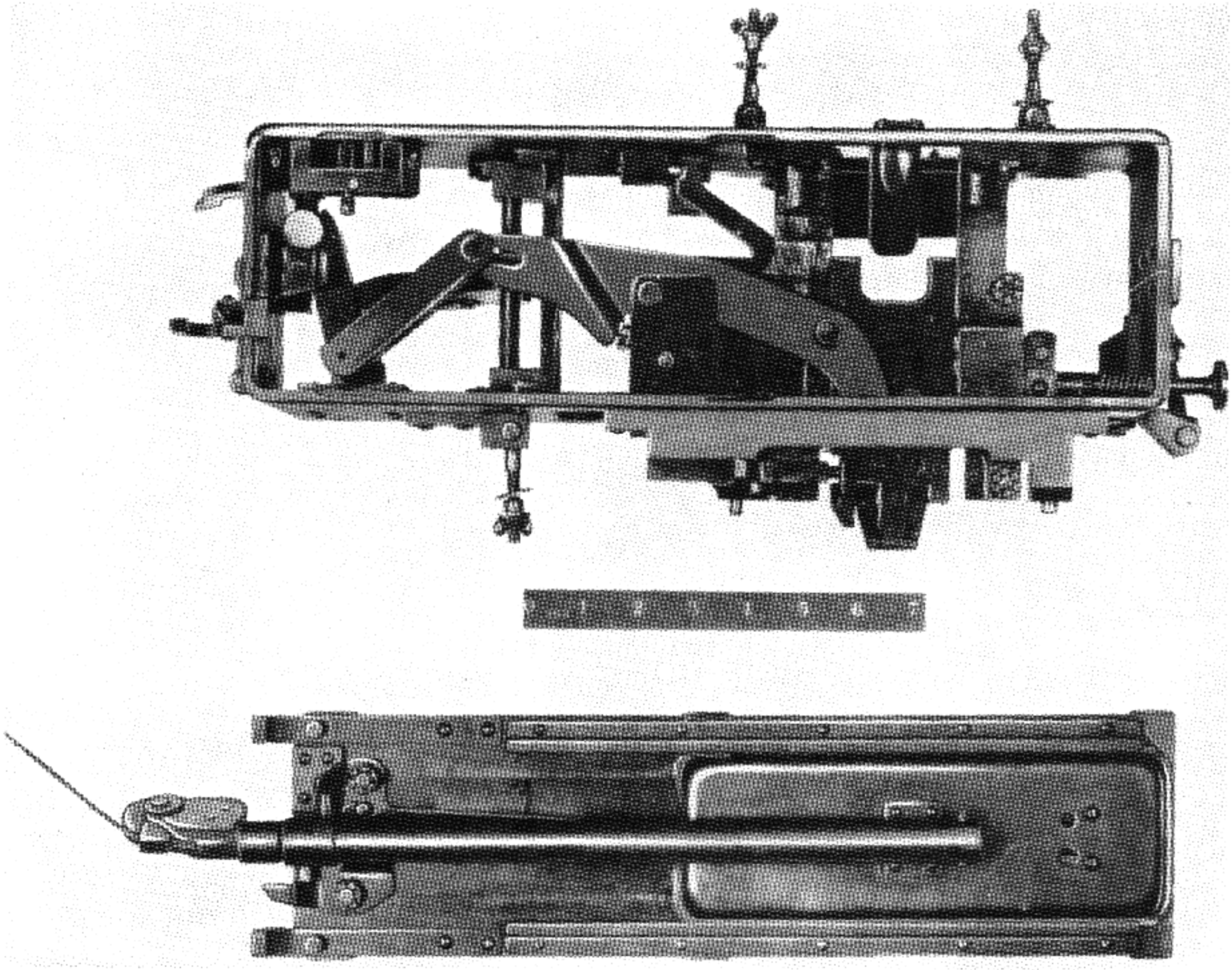

Figure 12–10. Right-hand feed box assembly for 37-mm Automatic Gun M4E4.

lock frame assembly, breechblock assembly backplate assembly, driving spring assemblies, and the feedbox group.

The principal function of the tube is to direct the discharged projectile and house the propellant charge. The rifling rotates the projectile, maintains direction, and prevents tumbling. The tube extension guides the rear end of the tube and provides a means of connecting the tube to the recuperator. The recuperator hydraulically controls the recoil and counterrecoil of the tube and tube extension, and serves to return these parts to battery position.

The major function of the lock frame assembly is to force the cartridge into the chamber, to actuate the breechblock, to fire the round by means of the hammer striking the firing pin, to perform initial extraction, and to aid ejection. The breechblock assists in the final chambering of the round, closing the breech and actuating the trigger trip. It also provides a mounting for the firing pin.

The backplate absorbs the inertia of the lock frame during recoil and reduces its tendency to rebound against the carrier pin. Driving spring assemblies hold the lock frame against the carrier dog until the carrier is released by the incoming round and then drive the lock frame forward.

During the feeding operation of the M10 gun, in which the lock frame travels forward, the carrier lifter cam on the lock frame engages a surface on

the carrier and raises it above the carrier catch, which holds the carrier in the upper position. The feed lever operating stud on the side of the tube extension makes contact with the lower end of the feed lever, pivoting it rearward. The stud passes under the end of the lever which then snaps back into position, in front of the stud, by the force of the feed lever rear spring and plunger. During counterrecoil, the operating stud pushes the lower end of the feed lever forward.

The feed lever swivel actuates the feed crank, which in turn moves the feed slide lever, forcing the feed slide toward the inside of the feedbox. The spring-loaded feed pawl on the under side of the slide engages the inner ears of the link holding the first round. Therefore, as the slide moves inward, the belt is moved with it, bringing this round farther into the feedbox.

Near the end of this motion of the feed slide, the stop pawl on the front feed slide guide drops off the tongue of the slide and engages the outer ear of the link, positioning the round.

The external stop pawl engages the outer ear on the opposite side of the belt, one round back. This stop pawl differs in action from the first pawl, as it does not disengage from the link ear when the feed slide returns and thus prevents overfeeding when there is a heavy load tending to push the rounds inward. The holding pawl, on the front feed slide guide, slides behind the outer link ear of the following round, preventing the belt from moving backward as the feed slide returns to engage the next link to feed in another round.

The stop pawls are operated by beveled surfaces on the feed slide, while the holding pawl is operated by the outer ears of the belt links. When the tube extension is near the battery position, the feed lever operating stud passes under the lower end of the feed lever. The feed slide lever, plunger, and spring then force the feed slide toward the inlet side of the feedbox to pick up the next round. This movement carries the feed crank and feed lever back to the initial feeding position. As the cartridge is fed into the feedbox, it is stripped from the belt.

The feeding operation of the M4 gun is similar to that of the M10 gun except that the M4 gun is provided with 2 feed pawls instead of the 1 feed pawl in the M10 gun. These feed pawls engage openings in the endless belt link plates. A stop and holding pawl engages notches which are cut in the side of the belt link plates.

Because the M4 gun does not incorporate an external stop pawl in its design, the chance of double feeding is reduced by incorporating a loading index into the endless belt magazine. This loading index, which is actuated by the upper left end surface of the feed slide, is spring loaded and engages the openings in the belt link plates.

SECTION 4. 37-MM AUTOMATIC GUN M9

General Description

The 37-mm automatic gun M9 is a fully automatic, high-velocity weapon of the long recoil type. It is designed for use in aircraft and may be mounted to fire through the propeller shaft or at some point outside the plane of propeller rotation. It is not used as a synchronized weapon. The gun is fired by means of a remotely controlled electric solenoid mounted at the rear of the gun.

The cannon is built with either a left-hand or a right-hand feedbox. With the exception of the feedbox and feeding mechanism, the right-hand feed and left-hand feed guns are identical. By changing the feedbox and feeding mechanism, the cannon can be made to feed from left to right or from right to left. The cartridges are fed into the side of the feedbox and the empty cartridge links ejected through an opening in the opposite side of the feedbox. The empty cases are ejected through a longitudinal opening between the bottom of the trunnion block side plates.

The gun depends upon the movement of the recoiling portions for its operation. Recoil and counterrecoil are controlled by means of a hydro spring recoil mechanism.

Components

General. The following mechanisms are described in the paragraphs which follow: manual charger assembly; backplate assembly; accelerator cam assembly; lock frame assembly; driving spring assemblies; tube; top plate assembly; carrier bearing brace; tube lock depressor; breechblock assembly; tube extension; trigger and trigger bar; backplate

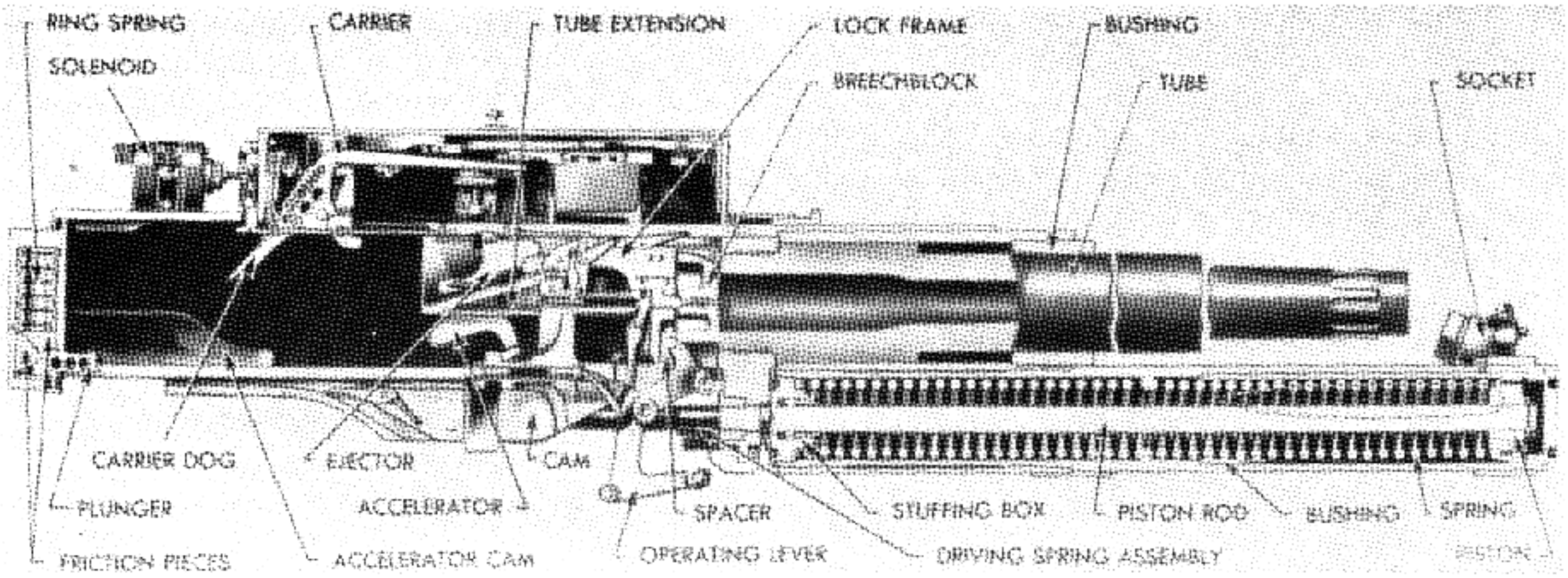

Figure 12–11. 37-mm Gun M9. Sectional view.

latch assembly; feedbox and feeding mechanism; driving spring tube guards; recuperator group; trunnion block group.

Manual Charger Assembly. A manual charger assembly known as the 37-mm charger M3 is attached to either side of the gun by four 7/16-inch cap screws.

This assembly consists principally of a longitudinally slotted tube fitted with two mounting brackets and enclosing a coil spring and plunger. The plunger is fitted with a projecting shoe which contacts a pin attached to the operating lever. A flexible charging cable engages a plunger plug which contacts the plunger and moves it rearward within the tube when the cable is pulled, thus charging the gun manually. The plunger is returned to its forward position by the coil spring when the charging cable is released.

In certain installations it may be necessary to mount the charger on the left side. This may be done by installing the right-hand mounting brackets with a left-hand charger shoe. The manual charger shoe contact pin must be installed from the left side of the operating lever to complete this installation.

REMOVAL.

1. Remove the figure-eight locking wires from the bracket attaching screws.

2. Using a hexagonal wrench, remove the four cap screws attaching charger front and rear brackets to trunnion block side plate.

INSTALLATION. Reverse the above removal procedure.

DISASSEMBLY.

1. Remove screws and lockwashers securing front and rear brackets to tube, and remove brackets.

2. Pull out on cable slightly compressing the spring and remove safety wire, nuts, and shoe from plunger assembly and spring from tube.

3. Cut safety wire and remove pin, spacer, guard, and pulley from bracket on forward end of tube.

4. Loosen clamping screw, remove setscrew (staked), and remove bracket from tube.

ASSEMBLY.

1. Place bracket on forward end of tube. Replace and stake setscrew. Tighten clamping screw.

2. Replace guard, spacer, pulley, and pin in bracket and safety wire pin and clamping nut.

3. Place spring in tube. Thread cable through tube and pulley, and pull plunger into tube slightly compressing spring. Aline holes in plunger with slot in tube and replace shoe and screws.

4. Replace brackets and bracket screws.

Backplate Assembly. The backplate body assembly contains the buffer mechanism of the gun consisting of a plunger, plunger stop screw, two bronze V-shaped friction pieces, a ring spring (consisting of 13 rings), an adjusting screw, and a lock screw.

During recoil, the lock frame contacts the buffer plunger forcing it rearward. The bronze friction pieces are so designed that they move upward against spring pressure and press outward against the walls of the housing as well, when acted upon by the tapered rear end of the buffer plunger. With this type of buffer, most of the energy of the

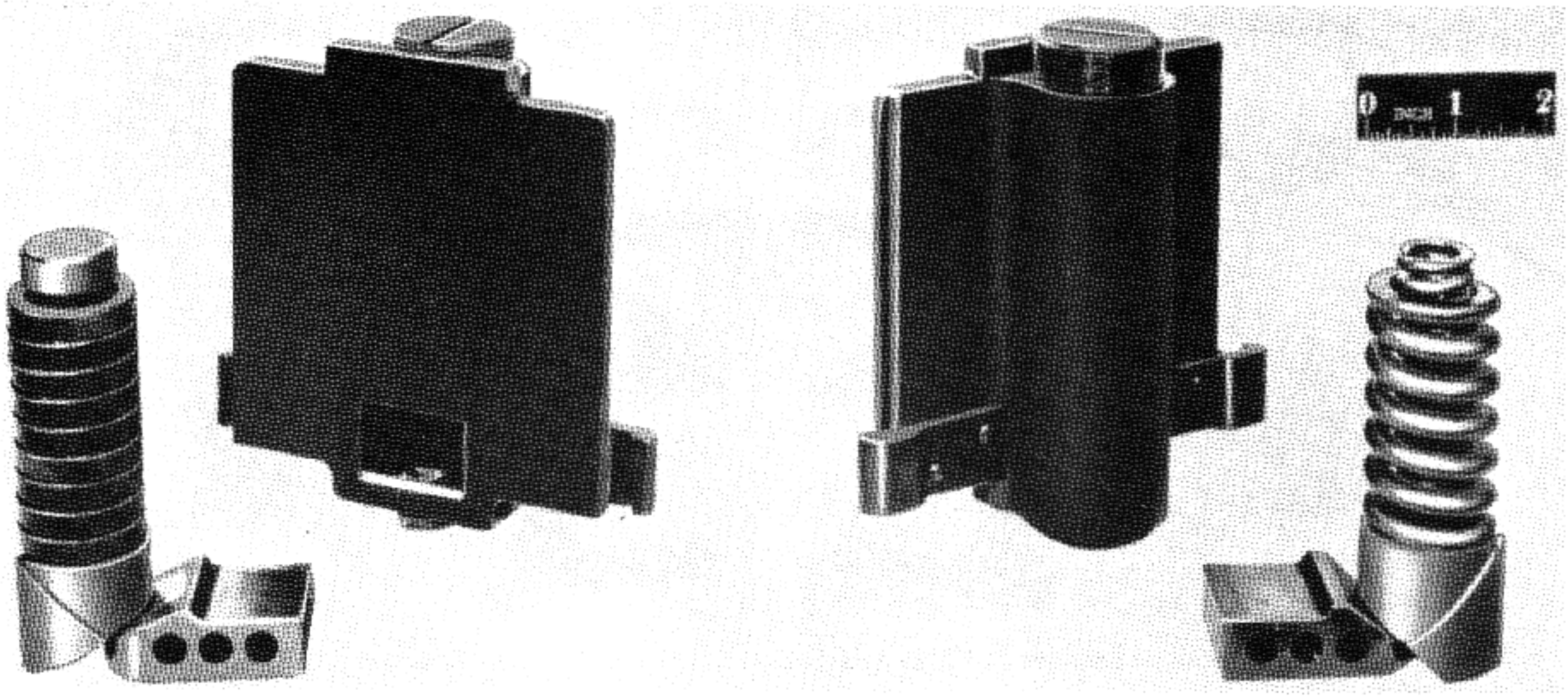

Figure 12-12. Comparison of buffers for different 37-mm Browning guns (left, T20; and right, M1A2).

lock frame is absorbed within the unit so as to reduce the tendency of the lock frame to rebound.

The backplate assembly, by absorbing the energy of the lock frame, reduces the shock against the carrier pin as the lock frame is latched to the rear.

REMOVAL. Push forward on backplate latch slide and slide backplate assembly downward.

INSTALLATION. Push forward on backplate latch slide and slide the backplate up into the slideways. Release backplate latch slide which must go under bottom edge of backplate housing.

DISASSEMBLY AND ASSEMBLY. The backplate assembly will not be disassembled. The unit will be replaced if not working properly.

Accelerator Cam Assembly. The accelerator cam is a flat plate with a stud projecting from one side and has an inclined surface at the forward end. The cam is held in position by the stud passing through a keyhole slot in the rear end of the left side plate.

As the tube extension moves rearward in recoil, the accelerator roll is brought in contact with the inclined surface of the accelerator cam, forcing the accelerator roll upward while the other end of the accelerator contacts the lock frame and accelerates it rearward.

REMOVAL.

1. Remove backplate assembly.

2. Slide accelerator cam rearward and remove the cam by pushing the cam stud out of the keyhole slot in the left side plate.

INSTALLATION. Installation is in the reverse order of removal.

Lock Frame Assembly. The lock-frame assembly is a separate recoiling unit that fits between the side plates of the tube extension. It consists principally of the slide assembly, hammer, sear, extractor, operating lever, and cocking lever, together with several springs.

The slide assembly is made up of the lock-frame body, driving spring rear bracket, charger, carrier lifter cam, and rivets. The carrier lifter cam raises the carrier to its uppermost position while the purpose of the charger is to help chamber the round as the lock frame moves into battery position. The driving spring rear bracket provides a means of attaching the driving spring rod hooks to the lock frame. Grooves at each side of the lock-frame body engage the side plate lower flanges. A square lug projects upward from the left rear surface of the lock-frame body in such a way that it will be contacted by the accelerator. The slide assembly supports all other parts of the lock-frame assembly.

The operating lever is pivoted at the lower side of the lock-frame body. The front end of the lever engages the breechblock, and both ends are fitted with guide pins which operate against cams on the

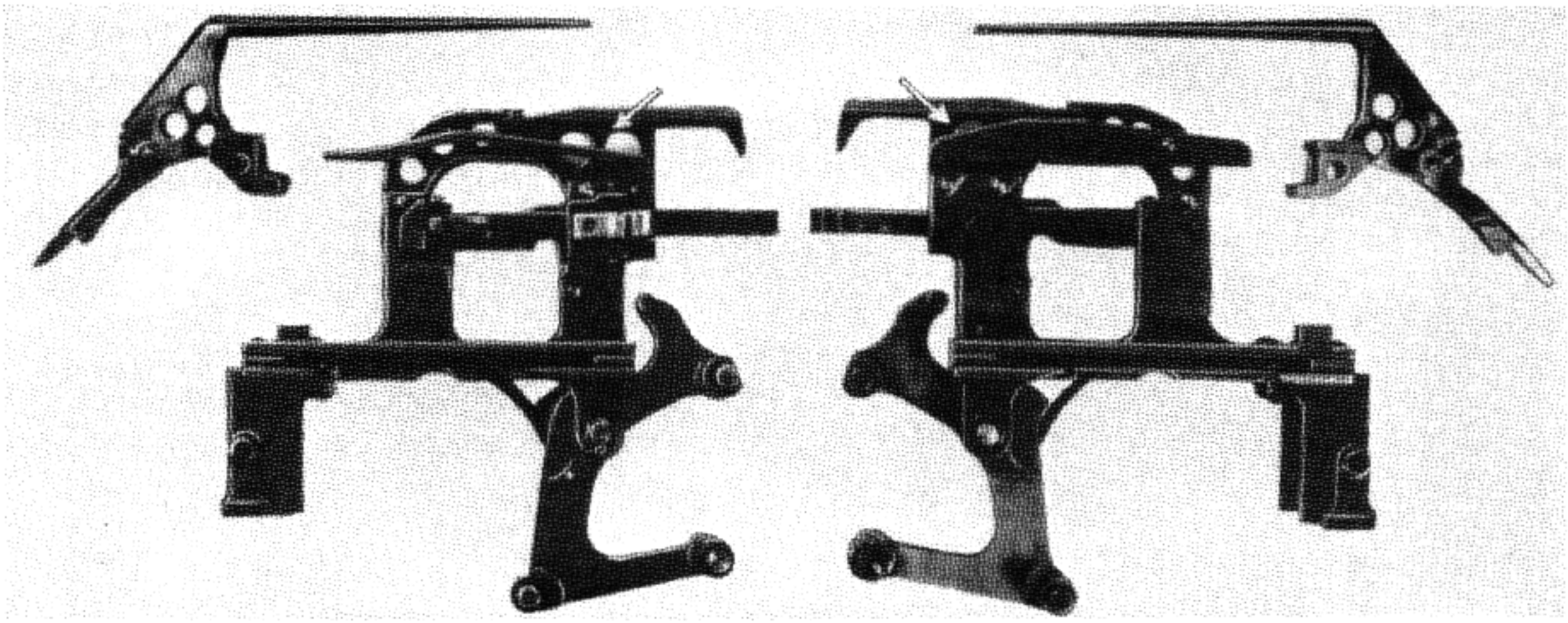

Figure 12–13. Comparison of different lock frame assemblies for 37-mm Browning guns (left, T20; and right, T20E2).

bottom of the side plates. These cams, by means of the guide pins and operating lever, actuate the breechblock assembly. The operating lever also carries a pin which is contacted by the shoe of the manual charger to provide for initial retracting of the lock frame, thus cocking the gun, or to allow manual extraction of a round from the chamber. A lobe on top of the operating lever actuates the cocking lever.

The hammer moves backward and forward in an opening of the lock-frame assembly. It has a latching hook on the right side which engages the sear. When the gun is cocked and the sear pivoted away from the hammer, a spring drives the hammer forward to fire the round.

The upper end of the cocking lever engages a notch in the hammer; therefore, when the lower end is pivoted forward by the operating lever, the cocking lever cams the hammer rearward past the latching hook of the sear.

A spring-loaded extractor is mounted on a removable pivot pin at the right front side of the lock frame assembly. The front end of the extractor is notched and beveled to facilitate engagement with the rim of the cartridge. At approximately the time the lock frame is contacted by the accelerator, the extractor starts to withdraw the cartridge case from the chamber.

The operating lever strut pivots on a pin in the operating lever. During recoil, the motion of the operating lever causes the strut to compress the operating lever spring. Near the end of counter-recoil, this compressed spring assists the operating lever to lift the breechblock into battery position.

The major function of the lock-frame assembly is to force the cartridge into the chamber, actuate the breechblock, fire the round by means of the hammer striking the firing pin, and extract the cartridge case from the chamber.

REMOVAL.

1. Make sure that lock frame is in the battery position.
2. Remove the backplate assembly.
3. Disconnect the driving spring assembly from the lock frame.

INSTALLATION.

1. Release the carrier catch to lower the carrier.
2. Pull operating lever into rear position.
3. Install in reverse order of removal from gun.

NOTE. Always make sure a dummy round is being fed into the gun before allowing the lock frame to go forward under full force of the driving springs.

DISASSEMBLY.

1. Always release sear and place operating lever in forward (battery) position before disassembling lock frame.
2. Remove operating lever spring lock assembly, spring, and follower by engaging a screwdriver in slotted end of lock, forcing it in and turning counterclockwise as far as it will go. Lock assembly, spring, and follower can then be removed as a unit.

3. Remove cotter pin, operating lever pivot pin, and operating lever.

4. Remove operating lever strut by drifting out strut pin.

5. Remove cotter pin, compress sear spring, and remove pin and sear. Remove sear spring.

6. Remove cotter pin from hammer spring guide pin. Now compress hammer spring firmly with thumb while removing the hammer spring guide pin. Remove hammer spring guide and spring.

7. Remove cotter pin, cocking lever pin, and cocking lever.

8. Remove hammer.

9. Remove cotter pin, then compress extractor spring while removing extractor pin. Remove extractor and spring.

ASSEMBLY.

1. Place extractor spring in hole in right side of lock frame. Place extractor in position and compress spring while installing extractor pin, with head up. Install 1/16- by 5/8-inch cotter pin.

2. Place hammer in lock frame.

3. Place cocking lever in lock frame, with concave side forward and rounded end engaged in groove in hammer. Install cocking lever pin from the right side and lock with 1/16- by 5/16-inch cotter pin.

4. Place hammer spring and guide in hammer. Compress spring firmly while inserting hammer spring guide pin through holes in lock frame body and spring guide, from the right side. Lock guide pin with a 1/16- by 5/16-inch cotter pin.

5. Place sear spring in hole in lock frame, install sear and sear pin. Lock sear pin with a 1/16- by 5/16-inch cotter pin.

6. Install operating lever strut in operating lever, with concave side toward rear. Install strut pin and stake in place.

7. Place operating lever in lock frame, with lobe on the rear side of cocking lever. Install pivot pin from the right side and lock it in place with a 3/32- by 5/8-inch cotter pin.

8. Swing end of strut into slot in lock frame. Place operating lever spring follower, spring, and lock assembly in lock frame, with the follower engaging end of strut.

9. Push lock in with screwdriver, engage lockpin in groove in lock frame, and lock it in position with one-fourth turn clockwise.

Driving Spring Assemblies. Two driving spring assemblies are used, one installed lengthwise on each side of the gun. They fit into guards along the outside of the recuperator cylinder and trunnion block body. Bronze bushings in the trunnion block body provide supports for the driving spring assemblies.

Each assembly consists of a long, narrow tube into which is fitted a rod, piston, spacer, and two springs. A connection, secured to the outside of the tube near its rear end, is attached to the bracket located on the lower front part of the tube extension. The end of the piston rod extends from the rear of the driving spring assembly and is provided with a hook that connects to a projecting lug of the lock frame rear driving spring bracket. Thus, when the lock frame is latched to the rear and the tube and tube extension return to battery on counterrecoil, the springs are energized.

The driving spring assemblies hold the lock frame against the carrier dog until the carrier is released by the carrier catch which is pivoted by the incoming round. The springs then drive the lock-frame assembly forward to chamber the round and operate the breechblock.

REMOVAL.

1. Remove the manual charger.

2. Remove the lock frame.

3. Disconnect the driving spring assemblies from the tube extension by pulling the driving spring tube connection pin knobs to the rear and twisting the driving spring tubes so that they are disengaged from the tube extension.

INSTALLATION. The assemblies are installed in the reverse order of removal.

DISASSEMBLY.

1. Unscrew driving spring tube connection pin knob by first removing lockpin, thus releasing connection pin and spring.

2. Remove cotter pin and pin from driving spring-rod connection, thus releasing the safety, rod hook, plunger, and spring.

ASSEMBLY. Both assemblies are identical except as outlined in note following.

NOTE. Driving spring assemblies are not interchangeable because of the driving spring rod hook safety, left and right.

1. Place hook spring and plunger in rod connection. Place hook in the connection, with dowel pin on same side as head of cotter pin in connection.

Install rod connection pin and safety on the same side. Secure connection pin with a 3/32- by 3/4-inch cotter pin with head up.

2. Place spring on driving spring tube connection pin. Install pin and spring in tube connection, compress spring, and screw knob on the pin until lockpin hole is through the knob. Install tube connection pin lockpin, bending ends around connection pin. Unscrew knob tight against lockpin.

CARE.

1. No adjustments are provided for the driving springs. Dents in the housing assemblies or bent rods may cause the gun to malfunction. Also, a malfunction may result from accidental sealing of the vents in the driving spring tube end caps with heavy grease or foreign matter.

2. A critical point in the operation occurs when the forward movement of the lock frame ceases and the breechblock is forced into firing position. At this point the driving springs cease to function and give over to the small operating lever spring in the lock frame itself. Dirt in the cam grooves, burs on the breechblock, dirt or grit on the lock frame or side plate flanges, weak driving springs, or a weak operating lever spring may result in a failure of the breechblock to close. It is important that the connections of the driving spring assemblies to the tube extension and lock frame be properly locked and secure at all times.

Tube. The gun tube is of one-piece construction threaded into and locked to the front of the tube extension. Splines are machined at the muzzle end for application of a wrench for removing and replacing the tube. The breech end has a deep notch to accommodate the extractor and a shallow groove to provide clearance for the charger.

The function of the tube is to direct the discharged projectile, the lands and grooves cause the projectile to rotate to maintain direction and to prevent tumbling.

REMOVAL.

1. Retract the lock frame. This is very important; otherwise damage to the extractor will result.

2. Remove the trunnion block bushing retaining screws.

3. Place tube wrench on the splines at the muzzle end, push tube lock depressor to the rear as far as it will go, and unscrew the tube counterclockwise approximately five turns. After about one-quarter turn the tube lock depressor can be released and the tube unscrewed by hand. If considerable force is required, it is probably due to binding of the threads which may be avoided by lifting slightly on the muzzle end and turning only when the tube rotates freely.

4. Slide the tube and trunnion block bushing from the trunnion block and remove bushing from the tube.

INSTALLATION.

1. Retract the lock frame.

2. Place trunnion block bushing over the tube and against the rear shoulder, with flanged end of bushing toward muzzle.

3. Coat threads of tube with light graphited grease to prevent damage to the threads.

4. Carefully insert the tube and bushing into trunnion block, aline holes, and install the two trunnion block bushing retaining screws.

5. Push the tube rearward until it contacts the tube extension. Maintaining pressure rearward, slowly turn tube counterclockwise until a slight bump is felt, indicating that the end of the thread on the tube has indexed with the thread in the tube extension. Turn tube clockwise approximately five revolutions by hand until the tube is seated. Do not

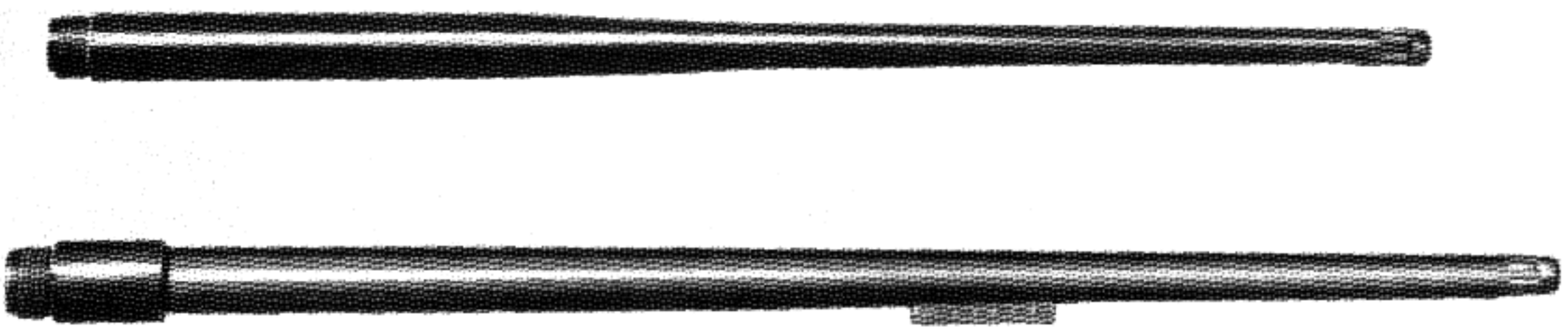

Figure 12–14. Comparison of tubes for 37-mm Gun M9E1 (above) and 37-mm Gun M9 (below).

depress the tube lock because it must snap into the groove in the tube just as the shoulder contacts the tube extension. Check this lock engagement by looking through the sighting hole.

CAUTION. Tube should thread into tube extension freely. If it does not, do not force it with the wrench. Remove the tube and examine threads on tube and in extension for burs or rough spots, which should be removed with a fine stone.

NOTE. If the recuperator piston rod nut has been removed or loosened during repairs to gun, it should not be reinstalled until after the gun tube has been installed. When indexing the tube threads with this nut off, it will be necessary to hold the tube extension forward either by hand or with a suitable wooden wedge inserted between the lower flange of the side plate and the tube extension.

Top Plate Assembly. The serial number of the gun is stamped into the top plate which is a flat steel plate attached by four screws to the upper ends of the trunnion block assembly side plates. This top plate serves to aline the rear ends of the side plates and keeps them from spreading. It also mounts a hinged, quick-operating clamp to position and secure the solenoid.

REMOVAL.

1. Remove cotter pin and solenoid plunger pin from trigger operating arm.

2. Remove top plate with solenoid attached by removing four screws threaded into side plates.

INSTALLATION. Reverse the removal procedure to install top plate.

DISASSEMBLY.

1. Remove solenoid connecting pin at trigger operating arm.

2. Remove solenoid by loosening clamp eyebolt wing nut.

3. Remove nuts, lockwashers, and bolts which secure solenoid clamp to the top plate.

ASSEMBLY. Reverse the disassembly procedure.

Carrier Bearing Brace. The carrier bearing brace is a flat steel plate mounted on top of the side-plate flange. It is positioned by a dowel, is secured by two screws, and functions to reinforce the carrier bearing in the feedbox. There are two noninterchangeable braces, 1 for the left-hand feed gun and 1 for the right. In a left-hand feed gun the brace is attached to the right side plate, while in a right-hand feed gun it is on the left side plate. The top flange of each side plate is drilled and tapped to permit installation of the brace on either side.

REMOVAL.

1. Remove feedbox.

2. Remove the two attaching screws and lift the carrier brace from the dowel in the top of the trunnion block side plate flange.

INSTALLATION. Installation is in the reverse order of removal. There are two noninterchangeable carrier bearing braces. One brace is mounted on the left side plate flange of a right-hand feed gun, and the other is mounted on the right side plate of a left-hand feed gun.

CAUTION. When replacing feedbox, always make sure rear end of carrier bearing brace, when installed, contacts extension of carrier bearing. If brace is too short, a new part, which is supplied, approximately one-sixteenth inch longer, should be fitted in place.

Tube Lock Depressor. The tube lock depressor and spring are housed within the tube lock compressor body. This is attached by 2 short screws and 1 long screw to the top of the left side plate just forward of the feedbox. When pushed rearward, a lower projection of the depressor engages the tube lock and moves it rearward. This action disengages the lock from the recess in the tube, thus unlocking the tube so it may be unscrewed from the tube extension.

REMOVAL. Remove the 1 long and 2 short fillister-head screws which secure the tube lock depressor body to the side-plate flange, and remove the body, depressor, and spring.

INSTALLATION. Installation is in the reverse order of removal.

Breechblock Assembly. The breechblock assembly, actuated by the operating lever, slides up and down on lands in the tube extension. These lands and the mating grooves in the breechblock are inclined forward 1° 30′ from vertical, to provide a wedging effect as the breechblock travels to battery position. This wedging action, in conjunction with a beveled radius on the front upper face of the breechblock, acts to completely chamber the cartridge before it is fired.

The breechblock carries the firing pin, spring, and stop pin. The firing pin protrudes through a hardened steel bushing which is pressed into a hole in the

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front face of the breechblock and ground flush. Holes machined in the rear side of the breechblock decrease weight.

A safety feature incorporated in the design of the trigger mechanism prevents firing the round until the breechblock assembly is in battery position.

The breechblock assists in the final chambering of the round, closes the breech, and actuates the trigger trip. It also provides a mounting for the firing pin.

REMOVAL.

1. Disengage the driving-spring assemblies from the lock frame.

2. Pull the lock frame to the rear.

3. Pull outward on the breechblock stop retaining pin knob. Swing breechblock stop forward and remove breechblock assembly.

INSTALLATION.

1. Reverse the procedure for removal of the breechblock.

2. When replacing the breechblock and the breechblock stop, be sure that the breechblock is resting on the breechblock stop before returning the lock frame to battery position.

DISASSEMBLY.

1. Hold a finger over the back part of the firing pin.

2. Drift out the firing-pin stop pin which is lightly staked in place.

3. Remove the firing pin and firing-pin spring.

ASSEMBLY. Assemble in the reverse order of disassembly. Be sure that the flat on the firing pin will line up with the firing pin stop pin.

Tube Extension. The tube extension consists of the front portion which contains the tube receptacle, tube lock, driving spring front brackets, breechblock plunger, and breechblock stop. Two vertical side plates extend rearward and assist in the movement for the incoming cartridge. They also provide a mounting for the accelerator, trigger levers, ejector, feed-lever operating studs, and trigger trip.

The tube receptacle is a threaded opening at the front end of the tube extension into which the breech end of the tube is threaded. A vertical opening directly in back of the tube receptacle acts as a guide for the breechblock, as the latter moves up and down during the operation of the gun.

The spring-loaded tube lock engages a notch provided in the rear outer circumference of the tube. The lock can be released, when the tube extension is in battery position, by pushing the tube lock depressor to the rear as far as it will go.

A breechblock plunger positions the breechblock and holds it in the open (out of battery) position, when the gun or plane is in an inverted position.

The driving spring front bracket is located at the lower front end of the tube extension. This bracket has two projections to which the driving spring tubes are attached.

The breechblock stop, hinged on a removable pin at the lower front end of the tube extension, is locked in place by the spring-loaded breechblock stop retaining pin. The stop limits the downward movement of the breechblock and positions it where the operating lever of the lock frame may enter the T-slot.

Two bronze shoes are inserted in the lower front surface of the tube extension, and similar shoes are inserted in the top surface at the rear end. These shoes, together with a round auxiliary bronze shoe on the left side, provide a bearing between the tube extension and the side plates.

Two feed lever operating studs are provided (one on each side) so that the tube extension assembly can be used with either a left- or right-hand feed. As the tube extension recoils, this stud passes to the rear of the feed lever. On counterrecoil the stud pivots the feed lever forward, thus actuating the entire feeding mechanism and feeding a new round into the gun.

An accelerator assembly and plunger are located near the rear left side of the tube extension. This assembly has a roll which rides up the cam surface of the accelerator during recoil. The rotating accelerator contacts a square lug of the lock frame assembly and accelerates its rearward motion, insuring its traveling rearward sufficiently to be caught by the carrier dog.

The ejector pivots on a stud and is located on the inside of the left side plate of the tube extension. As the cartridge case is extracted from the cartridge chamber, a cam located in the left side plate of the trunnion block assembly operates the ejector so that it pushes the case out through the bottom of the gun.

The trigger lever assembly, trigger lever spring, and plunger are located on the right side of the tube extension. The trigger trip is also located on the right side in a recess provided in the right side plate top flange and transmits the motion of the trigger

to the sear through the trigger levers. The trigger trip is pivoted on a pin, so that when its front end is raised by the breechblock its rear end is held down to serve as a stop for the trigger lever connecter. The trigger lever spring and plunger serve to return and hold the trigger, trigger bar, and trigger lever assembly forward when the trigger is released.

The tube extension guides the rear end of the tube and provides a means of connecting the tube to the recuperator mechanism. The recoil and counterrecoil of the tube extension actuate the feed mechanism, and relative movement between the tube extension and lock frame extract and eject the empty cartridge case.

REMOVAL.

1. Remove the breechblock assembly.
2. Remove the lock frame assembly.
3. Disconnect driving spring assemblies from the tube extension bracket.
4. Remove the gun tube.
5. Remove the accelerator cam assembly.
6. Remove feed-lever pin assembly by pushing lower end of lock counterclockwise until the short end of lock is clear of lock screw and pulling pin from feedbox side.
7. Lift feed lever assembly up and out of feedbox.
8. Pry carrier-pin lock out slightly and push it counterclockwise until short end is clear of lock screw, then remove the pin and lock assembly.
9. Lower carrier assembly down between the side plates.
10. Remove recuperator piston-rod nut by means of recuperator and piston-rod nut wrench.
11. Pull tube extension out through rear end of gun, lifting it during removal to clear hooked end of trigger bar.

INSTALLATION.

1. Slide tube extension into position between the side plates and push it forward, lifting it to clear the hooked front end of the trigger bar.
2. Turn recuperator piston rod to aline the notch in collar of the rod with the piston rod screw in the tube extension. This alinement must be exact, to avoid damage to these parts when piston rod nut is installed.
3. The recuperator piston-rod nut should not be tightened before the gun tube is screwed into the tube extension. If, when the tube extension is in place, the tube does not seat properly in its socket, the recuperator piston-rod nut should be removed and a further attempt made to seat the tube in place. If the gun tube is still not properly seated or if the gun tube cannot be seated, remove the tube extension and assemble the gun tube to the tube extension outside of the gun. The tube and tube extension will then have to be put into the trunnion block through the backplate opening. The recuperator piston-rod nut can then be assembled to the recuperator piston rod by means of the proper wrench. When assembling the recuperator piston-rod nut, its final setting should be such that a flat surface is parallel to the breechblock stop. When the breechblock stop is rotated to its closed position, the stop acts as a lock for the recuperator piston-rod nut.

DISASSEMBLY.

1. Remove cotter pin and remove breechblock stop pin and breechblock stop.
2. Remove recuperator piston-rod screw.
3. Remove breechblock stop lockpin, unscrew knob from breechblock stop retaining pin, and remove retaining pin and spring.
4. Remove tube lock plate assembly by depressing tube lock plate plunger through the small hole in front face of tube extension. Then remove tube lock spring and lock.
5. Remove trigger trip pin and trigger trip.
6. Remove trigger-lever pin, compress trigger-lever plunger and spring, and hold fully compressed by means of wire looped over front end of plunger, or by holding rear end of plunger with pliers. If pliers are used, care must be exercised not to burr the plunger. Remove trigger-lever assembly, spring, and plunger.
7. Remove cotter pin and castellated nut from ejector stud and remove ejector and spring.
8. Remove accelerator retainer screw (staked) and retainer. Depress accelerator spring plunger and remove accelerator assembly. Remove plunger and spring.
9. Remove breechblock plunger screw, spring, and plunger. The screw is staked in place.
10. Riveted parts of the tube extension will not be removed by using arms. Replacement of these parts will be made only by authorized personnel.

ASSEMBLY.

1. Install breechblock plunger, spring, and screw in left side of tube extension until screw is slightly below surface. Screw must not be screwed in until

it bottoms spring and binds the breechblock. Stake screw in place.

2. Install accelerator spring and plunger, and hold compressed while installing the accelerator assembly. The small end of plunger must engage in the groove in accelerator body. Install accelerator retainer and stake retainer screw in place.

3. Install ejector spring and ejector, with the flanged edge of ejector under the bronze shoe. Install castellated nut and 1/16- by 5/8-inch cotter pin.

4. Place trigger lever spring and plunger in the trigger lever stud on tube extension. Hold the spring fully compressed by drawing back on a wire looped over the front end of the plunger while installing the trigger lever assembly. Install trigger lever pin.

NOTE. As an alternative, the spring may be held fully compressed by pliers on the rear end of the plunger. However, when using this method, care must be exercised to avoid burring the plunger.

5. Install trigger trip and pin with offset end of trigger trip to the rear.

6. Install tube lock and spring. Install tube lock plate assembly with tongue on the rear end downward to engage groove in tube extension body.

7. Install breechblock stop retaining pin spring and pin; screw knob on pin until lock wire hole is through knob. Install breechblock stop lockpin and bend ends flat against retaining pin. Unscrew knob tight against lockpin.

8. Install recuperator piston rod screw.

9. Install breechblock stop and pin. Lock the pin with 1/16- by 5/16-inch cotter pin.

Trigger and Trigger Bar.

REMOVAL.

1. Remove cotter pin, trigger pin, and trigger.

2. The trigger bar is removed from the gun after the lock frame and tube extension have been removed. Slide the trigger bar in its groove in the upper right-hand portion of the trunnion block to the rear to disengage it from the two trigger bar guides.

INSTALLATION.

1. Place trigger bar all the way to the rear in the groove on the under side of the top flange of the right side plate. The notch which is closer to one end of the bar must lie toward the front of the gun. Slide the bar forward to engage the tongues on the bar under the two trigger bar guides on the side-plate flange. Be sure that the small bent end at the rear of the trigger bar points upward and through the hole behind the feedbox.

2. Place the trigger in position with notch in trigger engaging the hooked rear end of the trigger bar. This is important; otherwise the gun will not fire or will fire without a pull on the trigger.

3. Install the trigger pin and cotter pin.

Backplate Latch Assembly. A latch slide is attached by screws to the lower rear end of the right side plate flange. This houses the backplate latch slide which extends under the backplate housing to hold the assembly in place.

REMOVAL. Remove the six fillister-head screws which secure the backplate latch body to the side-plate flange, and remove the body, latch slide, and spring.

INSTALLATION. Installation is the reverse of removal.

Feedbox and Feeding Mechanism. The feedbox, a rectangular, boxlike structure about half the length of the trunnion block assembly, is approximately centered and is attached to the top of the side plates by six screws. The feedbox has an opening in one side through which the cartridges enter and a smaller opening in the opposite side for the ejection of the belt links. The top of the box has a hinged cover that may be opened by releasing a latch. The feeding mechanism housed within the feedbox governs the movement of the ammunition belt and removes the rounds from it.

The function of the feed mechanism is to draw belted ammunition from a box or magazine and feed it into the gun automatically as the gun is fired. The feedbox provides a mounting for the feed mechanism, trigger levers, feed chute, and link chute.

The principal difference between the left-hand feed and the right-hand feed 37-mm M9 guns is the construction of the feedbox. The gun can be changed from a left- to a right-hand feed, or vice versa, by replacing the feedbox group and the carrier bearing brace. In the left-hand feed, the cartridges enter the feedbox from the left side and the belt links are ejected thrugh an opening in the right side. The cartridges enter the feedbox on the right-hand feed from the right side and eject the links from the left. Therefore, many of the corresponding parts of the feeding mechanisms are not inter-

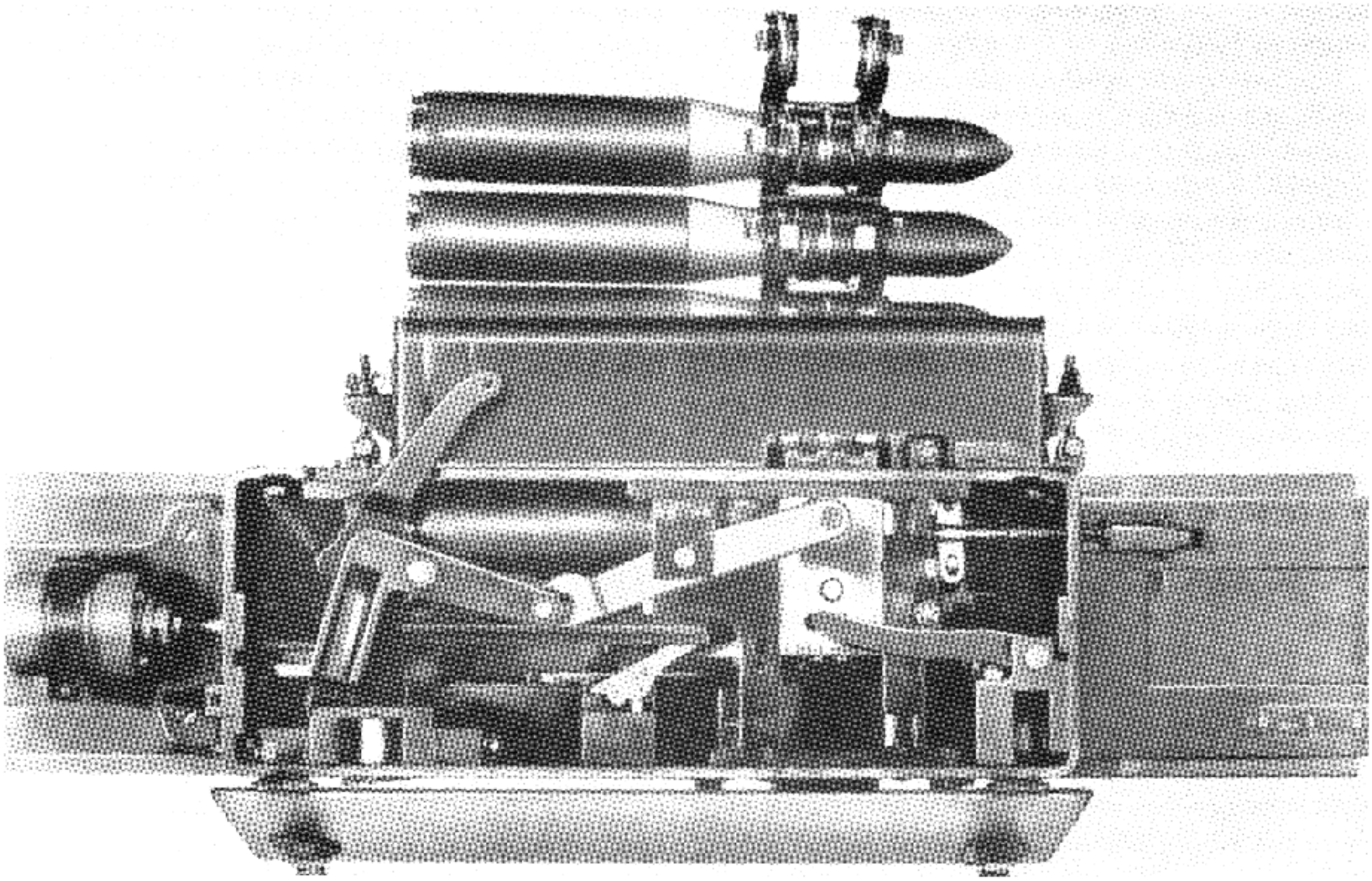

Figure 12–15. Representative 37-mm Browning gun with cover removed. Top view.

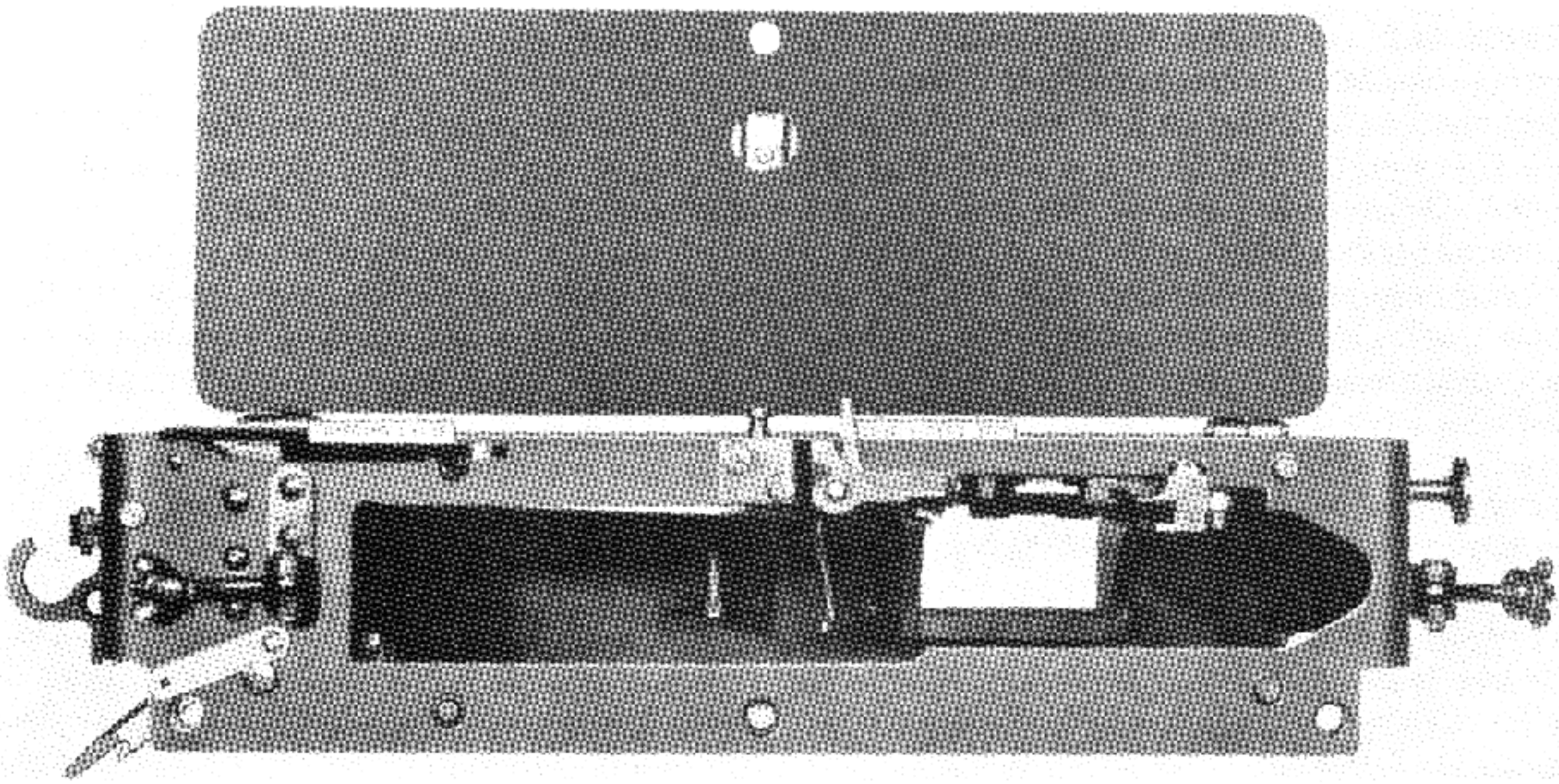

Figure 12–16. Representative feed box assembly for a 37-mm Browning gun. The feed chute is not shown.

changeable, but differ only in that they are mirror images of each other.

Enclosed in the feedbox are the following principal parts: feed lever; feed crank; feed-slide lever; feed slide and feed pawl; feed-slide return lever; cartridge feeder stop and holding pawls; stripper cam; carrier assembly and carrier catch; loading lever and spring; interlock; trigger and trigger operating arm; feedbox cover. Attached to the feedbox is the external stop pawl assembly and part of the trigger mechanism. A feed chute and a link ejection chute are attached by wing nuts and eyebolts on opposite sides of the feedbox.

FEED LEVER. This is a long-pointed lever pivoted in the right rear corner of the feedbox on a left-hand feed gun and in the left rear corner on a right-hand feed gun to actuate the feeding mechanism. A swivel stud mounted on the feed lever engages the feed crank and transmits motion of the feed lever to the feed crank. The feed lever is pivoted forward during counterrecoil of the gun by a stud mounted on the rear of the tube extension and is returned by force of the feed slide return lever plunger spring. The feed lever is checked at either end of its travel by the feed lever plungers and springs. The rear plunger and spring also return the feed lever to its initial operating position by overcoming the force of the slide return spring.

FEED CRANK. This is a large right-angled lever having a stud which transmits the motion of the feed lever to the feed-slide lever.

FEED-SLIDE LEVER. This lever actuated by the feed crank moves the feed slide to bring the ammunition into the feedbox.

FEED SLIDE AND FEED PAWL. These two parts move together in guides just below the upper surface of the feedbox. The feed pawl pivots downward from the slide and a projection engages the ammunition belt. As the feed slide and feed pawl are moved by the feed slide lever, the feed pawl feeds the belt into the mechanism. A finger release tab on the pawl extends beyond the end of the feed slide to provide for manual release.

FEED SLIDE RETURN LEVER. This is a lever which is pivoted on a pin located in the upper front corner of the feedbox. When moved by the feed slide, the return lever compresses its spring and plunger. At the end of the stroke, the spring and plunger cause the lever to move and feed pawl and feed slide back to the initial position for feeding the next round.

CARTRIDGE FEEDER STOP AND HOLDING PAWLS. The cartridge feeder stop and holding pawls are pivoted to the feed slide front guide by means of shouldered studs and castellated nuts. The pawls are held in the proper position for engagement with the ammunition belt by a connector attached to both pawls. A spring-loaded connector shaft is attached at the middle of the connector and is provided with a button-type handle extending through a hole in the front end of the feedbox frame. Pulling forward on the handle retracts both pawls. The spring on the connector shaft pushes both pawls into their operating position.

STRIPPER CAM. A stripper cam with two camming surfaces is riveted to the side of the feedbox. As the belt moves in, this cam forces the cartridge from the belt links and down into position for chambering.

CARRIER ASSEMBLY AND CARRIER CATCH. The carrier is a long flat lever which pivots vertically on a pin extending through the sides of the feedbox. The carrier dog is a short flat-edged piece which pivots on a pin through the lower rear end of the carrier and is positioned by a spring and plunger located in the carrier body. During recoil the lock frame cams the carrier dog up, compressing the spring and plunger. The compressed spring forces the dog downward so that it will engage a notch in the top of the lock frame and thus hold the lock frame in the rearward position. In this position the compressed carrier spring causes the carrier to exert a downward force on the carrier catch. The carrier catch is so positioned that it holds the carrier in a horizontal plane just above the incoming cartridges. As the cartridge is stripped from the belt link, it pushes the carrier catch against a spring and plunger, thus freeing the carrier to push the cartridge down into the gun mechanism. During this downward movement of the carrier, the carrier dog is released from the notch in the lock frame, thus releasing the lock frame, which drives the cartridge forward into the chamber. The carrier is raised above the carrier catch by the carrier lifter cam during the forward movement of the lock frame.

LOADING LEVER AND SPRING. A loading lever and return spring are located near the rear of the feedbox, the lever pivoting about the bearing of the feed crank and operating through a slot in the side of the feedbox. This lever engages a pin in the feed crank to actuate the feeding mechanism during manual loading.

INTERLOCK. An interlock mechanism, consisting of an interlock body, plate, and spring, positioned at the rear of the feedbox, prevents operation of the loading lever unless the lock frame is in the retracted position.

TRIGGER AND TRIGGER OPERATING ARM. The trigger mechanism, consisting of a horizontal trigger operating arm and a vertical trigger, is pivoted on pins through brackets riveted to the outside rear end of the feedbox. The trigger is actuated by a solenoid mounted on the top plate. The lower notched end of the trigger engages the trigger bar.

FEEDBOX COVER. The feedbox cover is a flat steel plate hinged on removable pins. A slide latch and knob assembly operates in a housing riveted to the cover and, when latched, engages a stud on the feedbox which locks the cover in the closed position.

REMOVAL.

1. Loosen the wing nuts and remove the feed and link chutes.

2. Remove cotter pin from trigger pin, then remove trigger pin and trigger.

3. Remove the six attaching cap screws and lift feedbox from gun.

NOTE. Since the cap screws attaching the feedbox to the gun are staked in place, the feedbox will normally be disassembled in place and not removed from the gun.

INSTALLATION.

1. Place feedbox on gun and, using a soft hammer, tap the corners of the box lightly until correct position is obtained.

2. Install the six feedbox screws.

3. Install trigger, trigger pin, and cotter pin.

4. Install feed and link chutes.

DISASSEMBLY.

1. Raise feedbox cover assembly by pushing sideways on the knurled cover latch knob to release lock from pin.

NOTE. Cover assembly may be removed from the feedbox by removing the two cover hinge pins retained by cotter pins, on the side. These are located on the right side for the left-hand feed and on the left side for right-hand feedboxes. Feed chute and link ejection chute eyebolts and wing nuts may be removed by removing cotter pins and pins; however, removal of these parts is not necessary for disassembly of the feedbox.

3. Remove two fillister-head screws attaching external stop pawl assembly. Disassemble external stop pawl assembly by sliding pawl from bracket and removing the stop pawl bracket spring and plunger. Drift out stop pawl plunger stop pin; remove external stop pawl plunger and spring.

4. Remove feed slide return lever pin and feed slide return lever while depressing the spring and plunger.

5. Push the feed slide to the inner side of feedbox and remove feed-slide lever pin and feed-slide lever.

6. Remove feed lever pin assembly by rotating the long end of lock until short end is clear of lock screw. Lift feed assembly out of feedbox.

7. Rotate feed crank assembly to clear the feed lever bracket and lift it out of feedbox.

8. Depress feed lever spring plungers and springs, remove cotter pins, and carefully remove the springs and plungers.

9. Pull feed slide assembly out of feedbox. Disassemble feed slide assembly by removing cotter pin and drift out feed pawl pin. Remove feed pawl and spring.

10. Pry carrier pin lock out slightly and rotate until short end is clear of lock screw; then remove the pin and lock assembly. Lower the carrier assembly down between the side plates.

11. Hold carrier catch spring and plunger depressed while removing the carrier catch. Remove plunger and spring.

12. Remove cotter pin and castellated nut from the cartridge feeder holding pawl (outer) and remove pawl and cartridge feeder pawl connecter.

13. Remove cotter pin and castellated nut from the cartridge feeder stop pawl (inner) and remove the pawl.

14. Remove cotter pin; unscrew cartridge feeder pawl handle from the cartridge feeder pawl con-

necter shaft assembly. Remove handle, spring, and shaft from the feedbox.

15. Remove trigger operating arm and trigger by removing cotter pins and pins.

16. Remove loading lever by unhooking loading lever return spring and lifting out lever. Remove spring and anchor pin from feedbox.

17. Remove cotter pin from the feed slide return lever plunger pin. Compress plunger and spring, remove the pin, then the plunger and spring.

18. Unscrew interlock body. Remove spring and interlock plate.

ASSEMBLY.

1. Install interlock spring and body through feedbox rear tie (interlock bracket). Position interlock plate on top of tie, and screw body tight to plate with wrench applied to flats on lower end of interlock body. Stake body to plate.

NOTE. The interlock spring must be positioned in the lower end of the opening through the feedbox tie.

2. Place feed slide return lever spring and plunger in bracket at front corner of feedbox. While compressing spring and plunger, install plunger pin. Lock pin with a 1/16- by 5/16-inch cotter pin.

3. Install trigger operating arm and pin. Lock pin with 1/16- by 5/16-inch cotter pin.

4. Place rear end of cartridge feeder pawl connector shaft assembly in hole in feed slide guide. Place spring between front end of shaft and feedbox. Screw feeder pawl handle into connector shaft through hole in feedbox and through the spring. Aline the cotter-pin holes and install a 1/16- by 5/8-inch cotter pin.

5. Install stop pawl (inner pawl) in the feed slide guide. Install castellated nut and 1/16- by 5/8-inch cotter pin. Be sure that pawl swings freely.

6. Hold cartridge feeder pawl connecter in position to engage pins on stop pawl and connector shaft while installing holding pawl (outer pawl) on outer end of feed slide guide. Install castellated nut and 1/16- by 5/8-inch cotter pin. Be sure that pawl swings freely.

7. Place carrier catch plunger and spring in carrier catch bracket in feedbox frame. Depress plunger with end of screwdriver so that carrier catch can be installed. Check for free movement of carrier catch.

8. Place carrier assembly in feedbox, from below, with carrier dog toward rear. Install carrier pin assembly through feedbox and carrier. Press pin in and turn lock until short end is engaged under the head of the carrier pin lock screw. Check for free movement of carrier.

9. Assemble feed slide by inserting feed pawl spring into spring seat and install pawl with spring entering spring seat. Line up hole in pawl and slide and install feed pawl pin and cotter pin 1/16- by 1/2-inch.

10. Install feed pawl assembly (pawl down and to outside) by releasing stop pawl and inserting slide in grooves in feed slide guide.

11. Install feed lever springs and spring plungers in feed lever bracket (rear corner of feedbox) and lock the plungers in place with 3/32- by 1/2-inch cotter pin.

12. Install loading lever by inserting long end through slot in side of feedbox and place inner end over shoulder on feed crank bearing; install return spring anchor pin and spring.

13. Place feed crank assembly in position, with yoke and to rear of feed lever bracket.

14. Place feed lever crank assembly in bracket, from above, with swivel stud engaged in the yoke end of the feed crank. Insert feed lever pin assembly through feedbox and upper end of feed lever. Press pin in and turn lock until short end is engaged under the head of lock screw on feedbox.

15. Push feed slide to the inner side of feedbox. Install feed slide lever and pin, with the forked rear end engaging stud on feed crank, and stud on front end engaged in large slot in top surface of the feed slide.

16. While depressing plunger and spring, install feed slide return lever and pin, with stud on rear end of lever in slot at inner end of feed slide.

17. If feedbox cover assembly was removed from feedbox, on disassembly, install this assembly with cover hinge pins.

18. Assemble external stop pawl assembly by placing the stop pawl plunger and spring in pawl, compressing spring sufficiently to permit installation of plunger stop pin which should be staked in place.

Place stop pawl bracket spring and plunger into bracket, compress spring, and install external stop pawl into position on the bracket. Attach external stop pawl assembly to feedbox with two fillisterhead screws.

19. Install feed chute and link ejection chute over dowels provided, and tighten in place securely with the attaching eyebolt wing nuts.

CARE. The many parts of the feedbox assembly and feeding mechanism must be kept clean and free from dirt, grit, and moisture. All studs, pivoting parts, holes, and plungers must be kept clean, properly lubricated with special preservative lubricating oil, and free from dents and burs. Cotter pins should always be bent close to their pins or nuts so that no projecting parts will interfere with the operation of the mechanism.

Driving Spring Tube Guards. The driving spring tube front guards are placed lengthwise of the recuperator cylinder, one on each side. These are attached to the front and rear yokes by cap screws. The guards support and align the front end of the driving spring tubes.

REMOVAL.

1. Remove driving springs.

2. Remove driving spring guard front yoke by removing four screws.

INSTALLATION.

1. Place driving spring tube guards on the recuperator cylinder with projecting portion of guards engaged in the recesses in the cylinder. Secure rear ends of the guards to the rear yoke, with two screws in each guard. Do not tighten screws.

2. Install driving spring tube guard front yoke with four screws extending through the yoke and the guards into the expansion tube socket.

3. Now tighten all screws securely.

4. Replace driving spring assemblies.

Recuperator Group. The recuperator group consists principally of an oil-filled recuperator cylinder, bushing, two end caps and packings, piston, piston rod, stuffing box packings, expansion tube, two recuperator recoil springs, and a bronze separator.

The recuperator cylinder is threaded into the lower front opening of the trunnion block and houses the piston rod, piston, recuperator recoil springs, recoil oil, and recuperator bushing. A bronze socket containing openings for the expansion tube, relief screws, and filler screws is attached to the front end of the cylinder.

The front end cap is of steel and contains a packing at its outer edge to seal the front end of the recuperator cylinder. This cap has two holes on its front surface to receive the special wrench used in its removal and installation.

The rear end cap made of bronze accommodates a packing at its outer edge and is threaded to screw into and seal the rear end of the cylinder. Two holes on its rear face are provided to fit the end cap wrench. To effect an oil seal where the piston rod passes through the rear end cap, a stuffing box is provided containing chevron-type packings, a gland, spring, and spring holder.

There are four chevron-type packings used, each consisting of a concave knife-edged composition washer with a rubber filler inserted in the bottom of the recess between the two knife edges. These packings fit into a corresponding recess in the rear end cap, and are pressed into contact around the piston rod by the force of the spring which is held in place by a spring holder screwed into the rear end cap.

The piston is screwed on the front end of the piston rod to which it is locked by a cotter pin. Four equally spaced steel seats are riveted to the rear side of the piston to form a locating seat for the recuperator recoil front spring.

The piston operates in a long steel bushing which is provided with three elongated slots, tapered at both ends, so as to hydraulically assist in the control of recoil and counterrecoil. The bushing is retained in the front end of the recuperator cylinder by a shoulder in the cylinder and the front end cap. It is prevented from rotating by a spring lock which engages a notch in the cylinder.

The piston rod extends through the rear end cap and is threaded to accommodate a piston rod nut by which the rod is attached to the tube extension. A shoulder near the rear end of the rod is provided with a groove which indexes with a piston rod screw in the tube extension to prevent the rod from turn-

ing. As the tube and tube extension recoil, the piston moves rearward, compressing the recuperator recoil spring and forcing the recoil oil through the slots of the recuperator recoil spring and forcing the recoil oil through the slots of the recuperator bushing. The tube and tube extension are carried forward to battery by the force of the recoil springs acting upon the recuperator piston.

A recuperator expansion tube is screwed into a socket at the front end of the cylinder and extends upward and to the rear at an angle of 21° from the centerline of the gun. The recuperator socket is provided with a threaded opening for the expansion tube on each side of the gun; the hole not being used is fitted with a closing plug. The socket also provides holes for the oil filler screw and relief screw on both sides. The filler screw on the expansion tube side is fitted with an oil indicator (dip stick). The removal of the relief screw from the expansion tube side vents the tube and the opening serves as a drain to prevent overfilling. The recuperator cylinder is provided with connecting passages to allow complete filling and venting. The hollow expansion tube provides space for the increase in the volume of oil resulting from temperature changes. There is space for the collection of air which may get into the recuperator system and impair its functioning.

The two identical recuperator recoil springs are positioned on the piston rod between the piston and the rear end cap. They are separated by a bronze separator. When assembled with the piston, rod, and end cap, the springs are under approximately 365 pounds compression. During recoil of the gun, these springs are further compressed. The expansion of the springs returns the piston, piston rod, and recoil to their initial positions, thereby returning the tube and tube extension to battery.

NOTE. The recuperator spring will not be removed from the recuperator piston rod by the using arms.

The recuperator mechanism hydraulically controls the recoil and counterrecoil of the tube and tube extension, and serves to return these parts to battery position.

CARE. The recuperator piston rod nut should be screwed on the recuperating piston rod so that the nut seats solidly on the shoulder of the tube extension and the flat on the nut is in line with the top surface of the breechblock stop. This latter provision is necessary to prevent the nut from shaking loose on the piston rod.

The recuperator spring must move the weights of the tube, the tube extension, and the piston and piston rod and, in addition, force the oil past the piston. It has very little power in excess of that required for these functions. The use of recoil oil of improper viscosity or the development of undue friction, due to dirt, old grease, or improper lubricants, may cause the gun to fail to return completely into battery. If this failure does not exceed one-eighth inch, the gun will fire safely. When the lock frame is more than one-eighth inch out of battery, the breech lock cannot close and the gun will not fire.

Great care should be exercised in maintaining the correct amount of oil in the mechanism. With too little oil it is possible to have excess recoil to the extent that the recuperator piston drives against a solid column of the compressed springs, which will severely damage the gun.

There is no manual adjustment provided for the stuffing box packing in the rear end of the cylinder. The development of excess leakage should be reported to ordnance personnel.

Trunnion Block Group. The trunnion block assembly on which the feedbox is mounted is composed principally of the trunnion block body and two side plates.

TRUNNION BLOCK ASSEMBLY. The block body is open at the front to accommodate the tube and trunnion block bushing, and a second lower opening serves to mount the recuperator cylinder. The two side plates are flanged inward at the top and bottom, have an integral longitudinal rib at the center on the outside, and are grooved vertically at the rear ends to secure the back-plate assembly. They are open at the bottom sufficiently to permit ejection of the empty cartridge case. The side plates are attached to the trunnion block body by 28 tapered pins. The longitudinal ribs carry the load of recoil and counterrecoil of the gun in its mount. The lower flanges of the side plates serve as a track for the tube extension and lock frame as they move back and forth during recoil and counterrecoil. The left plate top flange incorporates a cam to operate the ejector, while the

right plate top flange has a channel machined in its bottom surface for installation of the trigger bar. Both side plate top flanges are slotted to accommodate the feed lever so that a right-hand or a left-hand feedbox may be used with the same trunnion block assembly. A keyhole slot is cut near the rear end of the left side plate to accept the accelerator cam stud which holds the accelerator cam assembly in place. A sighting slot is provided at the top of the trunnion block body to check the engagement of the tube lock with the recess in the tube.

TRUNNION BRACKET ASSEMBLIES. A trunnion bracket assembly, incorporating a close fitting key, is attached to each side plate by four 7/16-inch cap screws. The bracket fits closely over the longitudinal rib and its key is forced into the tapered slot of the rib by an adjusting screw. This key securely positions the bracket which has an accurately machined boss to fit the airplane mounting brackets.

The trunnion block group may be considered the housing of the gun. In addition to providing for mounting the gun, it supports the operating mechanism, consisting of the tube and tube extension, recuperator group, lock-frame assembly, backplate assembly, driving-spring assemblies, and the feedbox and feeding mechanism.

OPERATING CAM ASSEMBLIES. Two front and two rear operating cam assemblies are attached by screws to the bottom side of the trunnion block assembly side-plate flanges. These cams are contacted by the guide pins of the operating lever during recoil and counterrecoil of the lock frame. The guide pins follow the camming surfaces and thus actuate the operating lever which in turn cocks the hammer and raises and lowers the breechblock. Both front and rear cams have bronze inserts secured by pins at points of high bearing load to increase the lift of the parts. Each rear cam also incorporates a spring-loaded switch near the rear end of its cam groove to insure proper tracking of the short guide pins during the movement of the lock frame in its return to battery.

TRUNNION BLOCK BUSHING. This is a single piece bronze bushing securing in the front end of the trunnion block body by two retaining screws to form a supporting bearing for the tube. Grooves are cast in the internal bearing surface and these are packed with a graphite compound for lubrication.

REMOVAL OF TRUNNION BRACKET ASSEMBLIES.

1. Remove lock wires, the attaching socket-head cap screws, and the bracket assemblies.
2. Remove trunnion key.
3. Remove the set screw and long screw from the tapped hole in the trunnion.

INSTALLATION.

1. Place trunnion bracket key in slot provided between the front and rear sections of the side-plate longitudinal rib. The key must be positioned with the recessed side having the large beveled inner edge rearward, in order to mate properly with the tapered slot in the longitudinal rib.
2. Install trunnion bracket over the key and longitudinal rib and attach securely to the trunnion block with the four socket-head cap screws wired with figure-eight locking wires.
3. Install the long trunnion bracket screw in the tapped hole provided through the trunnion, and tighten it securely to seat the trunnion key firmly in its slot.
4. Install the cup point set screw.

Functioning of the Gun

General. The series of operations and motions of the various parts of the gun occur in a definite and interrelated manner. Each part receives its motion from another part, and each functions in a definite and specific moment of the entire cycle. To describe the actions and functions of the various recoiling and nonrecoiling parts of the gun during one complete cycle, the entire operation has been broken into the following motions and each discussed in detail, giving the events as they normally occur: cocking and loading; trigger action; recoil action; breechblock action; recuperator action; lock-frame action; extraction and ejection; driving-spring action; feeding.

Cocking and Loading. When the manual charger is operated by pulling the cable, the shoe of the manual charger contacts the pin on the operating lever of the lock frame and causes the lever to rotate. This cams the hammer rearward beyond the latching hook of the sear, thus permitting the firing-pin spring to retract the firing pin. The

breechblock is lowered until it rests against its stop at the bottom of the tube extension. The rotation of the operating lever also forces the strut back against the follower, thus compressing the strut spring located in the body of the lock frame. The lock frame moving rearward compresses the driving springs. The lock frame continues rearward until it passes under the carrier dog and contacts the plunger of the backplate. With the release of the charger cable, the lock frame moves forward until the carrier dog engages the notch in the top of the lock frame.

The initial round is fed into the gun by pulling the loading lever rearward. This actuates the feeding mechanism, bringing the incoming round into contact with the stripper cam, which pulls it downward out of the links of the ammunition belt. At this instant, the rear end of the cartridge is positioned on the two prongs of the carrier which hold it in the path of the charger on the lock frame. Just before the cartridge is stripped from the links, it contacts the carrier catch moving it sufficiently to release the carrier. This allows the carrier to snap downward under force of the carrier spring. As the front end of the carrier pushes the cartridge downward, the carrier dog releases the lock frame.

As the lock frame goes toward battery under force of the driving springs, the charger (assisted by the extractor) forces the round into the cartridge chamber. The lug on the front end of the operating lever enters the T-slot in the lower end of the breechblock at the same time that the short guide pin on the operating lever comes in contact with the rear surface of the front operating cams. This rotates the operating lever which raises the breechblock toward battery position. The compressed operating lever spring acting on the rear end of the strut assists in completing this movement. The gun is now ready to fire when the trigger is pulled. The final chambering of the round is completed by the wedging action of the beveled radius on the front upper face of the breechblock as it slides up behind the cartridge. During final chambering, the extractor is cammed away from the rim of the cartridge by a cam surface on the front end of the extractor contacting a corresponding surface in the breech end of the tube.

Trigger Action.

MANUAL FIRE. As the breechblock moves into battery position, it raises the front end of the trigger trip. The rear end of the trigger trip is held downward to serve as a stop for the front end of the trigger lever connecter. The trigger engages the rear end of the trigger bar while the forward end of the bar hooks over the upper end of the trigger lever. The trigger, trigger bar, trigger lever, and connecter are all held in a forward position by the trigger lever spring and plunger.

When the trigger is pulled to fire the initial round, the trigger bar pulls the upper end of the trigger lever rearward, causing it to rotate on the trigger lever pin. Since the front end of the trigger lever connecter is held down by the trigger trip, the connecter is moved rearward. The rear end of the connecter contacts the outer arm of the sear, causing it to rotate out of engagement with the latching hook of the hammer. The hammer is then driven forward by force of its spring, striking the firing pin to fire the round.

AUTOMATIC FIRE. If the trigger is held in the firing position, the gun will continue to fire automatically. As the breechblock is lowered, it releases the trigger trip and the front end of the trigger lever connecter.

The connecter is then rotated out of contact with the sear by force of the trigger lever spring and plunger. When the breechblock returns to battery position, it pivots the trigger trip which in turn rotates the connecter so that the rear end of the connecter again contacts the sear to release the hammer and fire the next round.

Recoil Action. When the cartridge in the chamber is fired, the reaction of the expanding gas is in all directions. As the projectile is driven forward through the tube, an equal force is applied in the opposite direction against the front face of the breechblock, which is mounted in the tube extension. Thus, the recoiling parts, the tube and tube extension, breechblock, lock frame, driving-spring assemblies, piston and piston rod are all driven to the rear together. This takes place because the tube is screwed into the tube extension, the breechblock is engaged in the lands in the forward end of the tube extension, the lock frame rests against the rear face

of a spacer (bridge) on the tube extension, the driving-spring assemblies are connected to both the tube extension and lock frame, and the piston rod is connected to the tube extension. All the recoiling parts remain together during part of the distance of recoil. The total recoil travel of the tube, tube extension, breechblock, piston and rod is approximately 10¾ inches.

Breechblock Action. The breechblock is lowered (breech opened) during recoil. The operating lever long guide pin, following the front cams, causes the operating lever to rotate, bringing the breechblock downward. Rotation of the operating lever during recoil causes a lobe on top of the lever to move the lower end of the cocking lever forward. As the lever pivots in the lock frame, the upper end operating in a recess in the hammer, cams the hammer to the rear, releasing the firing pin, and allowing the firing-pin spring to retract the pin. This movement compresses the hammer spring and forces the latching hook on the hammer past the hooked end of the sear, thus cocking the hammer. The short guide pin enters the ramps of the rear cams and is carried above the two switches into the horizontal grooves of the rear cams. This completes the downward movement of the breechblock which is now resting against the breechblock stop. As the breechblock moves downward, it releases the trigger trip and the front end of the trigger connecter as previously explained under "Trigger Action."

Recuperator Action. The recuperator piston rod is pulled rearward by the tube extension during recoil. The piston, on the front end of the rod, is drawn rearward in the recuperator bushing. This bushing, secured in the front end of the recuperator cylinder, has three elongated slots tapered at each end, although the rear ends of the slots are longer and more gradually tapered than those of the front.

The fluid on the rear side of the piston is forced through these slots to the front side as the piston moves rearward. Therefore, the long tapered rear ends of the slots restrict the bypassing of oil as the tube and tube extension near the rear end of their travel. The tapered slots provide an increasingly greater restriction to the flow of oil on the last part of the recoil stroke, and the rearward movement of the tube and tube extension is decreased accordingly.

During this action the recuperator springs are compressed. When the land of the piston reaches the end of the slots, the passage of oil has been entirely blocked, thus providing an almost solid stop against the confined fluid. The tube and tube extension are returned to battery position by the force of the recuperator recoil springs.

The movement of these parts near the forward end of their travel during counterrecoil is controlled by the taper of the slots in the front end of the recuperator bushing in the same manner as the recoil action is controlled. Three shallow grooves (approximately 0.030 inch deep) extend from the slots to the front end of the bushing to bypass oil after the piston passes the front end of the slots, to assure these parts going completely into battery with a minimum of shock. Drilled passages from the front ends of two of the elongated slots are connected with the expansion tube which is screwed into a socket on the outside of the recuperator cylinder.

The air-filled chamber of this expansion tube provides for expansion and contraction of the recoil oil in the cyinder due to temperature changes. Two slots in the front end of the bushing allow the escape of air to the expansion tube chamber when the recuperator is being filled with oil, or when air might otherwise be trapped in the cylinder during firing.

Lock Frame Action. The lock-frame assembly is not affected by the retarding action of the recuperator, since it was unlocked from the tube extension by the downward movement of the breechblock. Therefore, as the tube and tube extension near the end of their rearward travel, the lock frame separates from these parts and continues rearward because of its inertia and the action of the accelerator.

An accelerator is mounted on the tube extension to assure the lock frame continuing rearward, after separating a sufficient distance to permit the carrier dog to engage the notch in the top of the lock frame and thus latch the lock frame in its retracted position. The accelerator is actuated by a removable cam mounted at the rear end of the left side plate. At approximately the point of separation, the roll on the rear arm of the accelerator rides upward on the

inclined surface of the cam. The lower arm of the accelerator pushes rearward against a lug on the lock-frame body, thus giving the lock-frame assembly an accelerated movement rearward to the backplate buffer plunger.

The rear of the lock-frame body strikes the buffer plunger, compressing the ring spring and pressing the two friction pieces upward and outward against the inside of the backplate housing. Thus, the remaining recoil force of the lock frame is transferred to the back assembly.

The lock frame rebounds from the buffer plunger due to the action of the buffer ring springs. After traveling a short distance forward, the carrier dog engages the notch in the top of the charger (on the lock frame) holding the lock frame stationary, while the tube and tube extension continue forward toward battery.

Extraction and Ejection. Initial extraction occurs during the separation of the lock frame from the tube extension. The rim of the cartridge case is engaged by the extractor hook and, as the lock-frame assembly separates from the tube extension, the case is partially withdrawn from the cartridge chamber.

When the lock frame is held in its rearward position and tube extension has gone forward on counterrecoil to a point where the empty case is entirely extracted from the chamber, the ejector is pivoted downward by a cam on the upper flange of the left side plate. The flanged rear end of the ejector deflects the empty case downward between the side plates and out of the gun.

Driving Spring Action. The driving-spring assemblies are used to drive the lock-frame assembly to battery position. As the tube extension travels forward on counterrecoil, the driving spring housings are also carried forward. The rods are connected to the lock frame, which is held back by the carrier dog; therefore, the four driving springs are compressed. These compressed springs act on the driving spring rods to force the lock-frame assembly forward into battery position when it is released by the carrier dog.

Feeding. During the forward travel of the lock frame, the carrier lifter cam on the lock frame engages a surface on the carrier and raises it above the carrier catch which holds the carrier in the upper position.

During recoil, the feed lever operating stud on the side of the tube extension contacts the lower end of the feed lever, pivoting it rearward. The stud passes under the end of the lever which then snaps back into position in front of the stud, by force of the feed lever rear spring and plunger. During counterrecoil, the operating stud pushes the lower end of the feed lever forward.

The feed lever swivel stud actuates the feed crank which in turn moves the feed slide lever, forcing the feed slide toward the inside of the feedbox against the force of the feed slide return lever and spring. The spring-loaded feed pawl on the underside of the slide engages the inner ears of the link holding the first round. Therefore, as the slide moves inward, the belt is moved with it, bringing this round farther into the feedbox.

Near the end of this motion of the feed slide, the stop pawl on the front feed slide guide drops off the tongue of the slide and engages the outer ear of the link, positioning the round.

The external stop pawl engages the outer ear on the opposite side of the belt, one round back. This stop pawl differs in action from the first as it does not disengage from the link ear when the feed slide returns, thus preventing overfeeding when there is a heavy load tending to push the rounds inward. The holding pawl on the front feed slide guide slides behind the outer link ear of the following round, preventing the belt from moving backward as the feed slide returns to engage the next link to feed in another round.

The stop pawls are operated by beveled surfaces on the feed slide, while the holding pawl is operated by the outer ears of the belt links. When the tube extension is near battery position, the feed lever operating stud passes under the lower end of the feed lever. The feed slide return lever, plunger, and spring then force the feed slide toward the inlet side of the feedbox to pick up the next round. This movement carries the feed slide lever, feed crank, and feed lever back to initial feeding position.

As the cartridge is fed into the feedbox, it is stripped from the belt.

SECTION 5. 37-MM AUTOMATIC GUN M10

Functioning of 37-mm Automatic Gun M10

Functioning of this weapon is described along with the functioning of 37-mm automatic gun M4, in section 3 of this chapter.

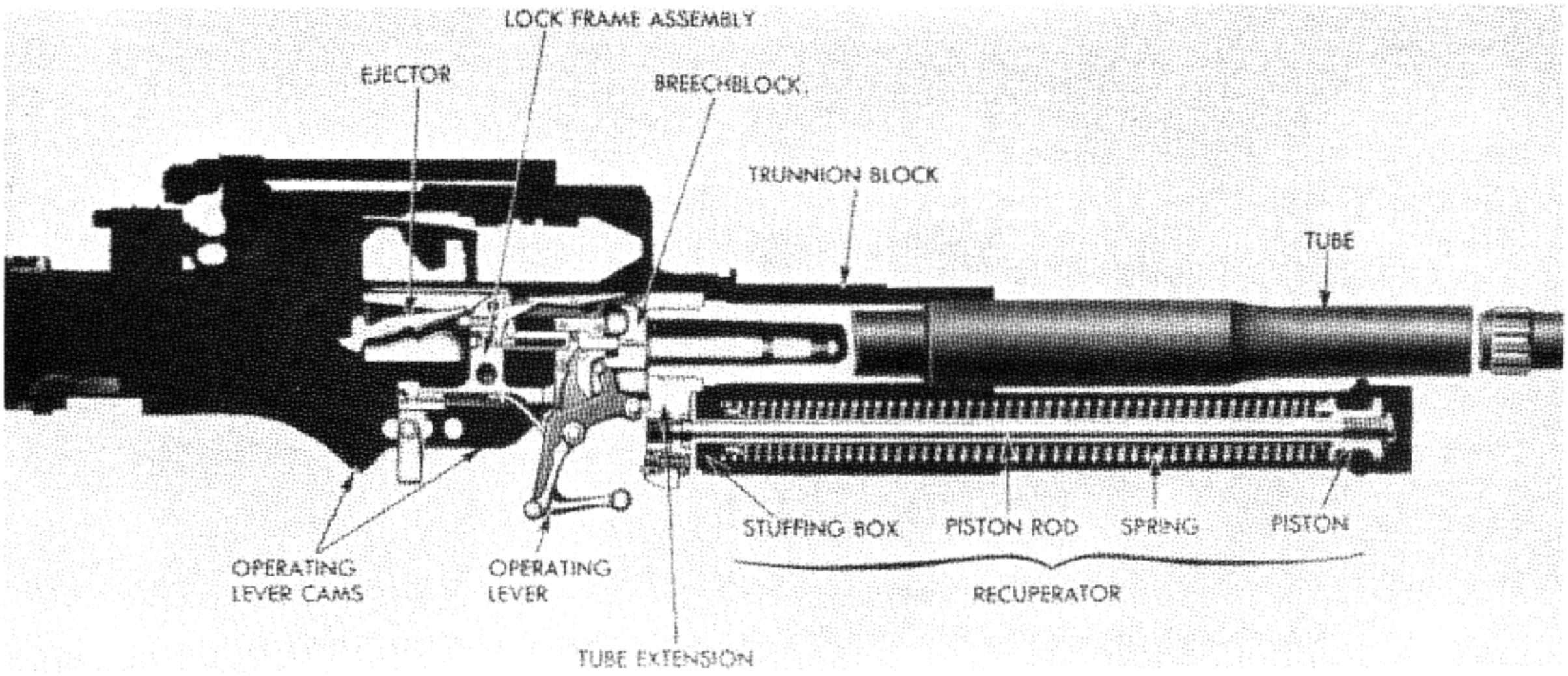

Figure 12–17. 37-mm Gun M10. Sectional view. Light area indicates recoiling parts.

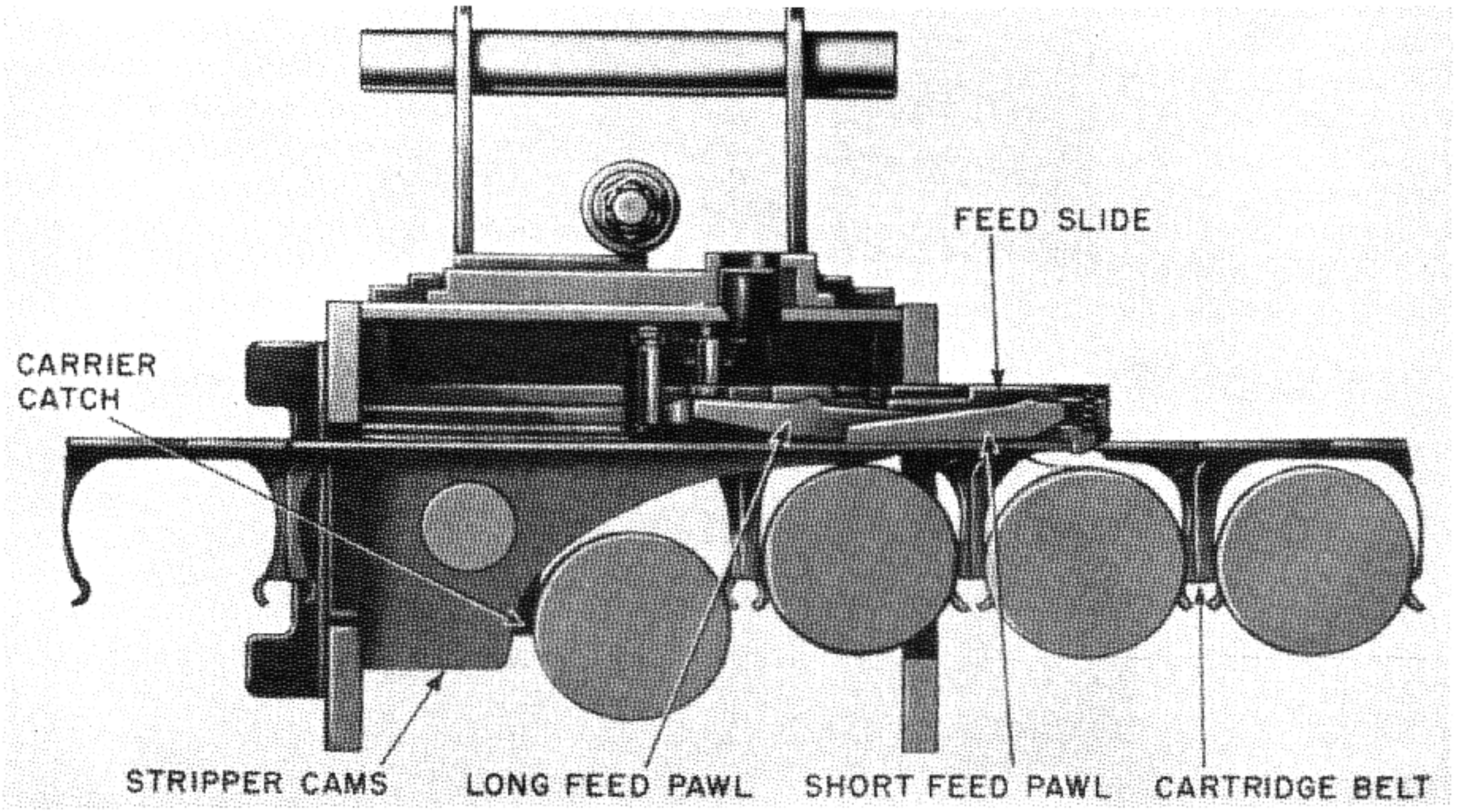

Figure 12–18. 37-mm Gun M10. Action of stripper cam.

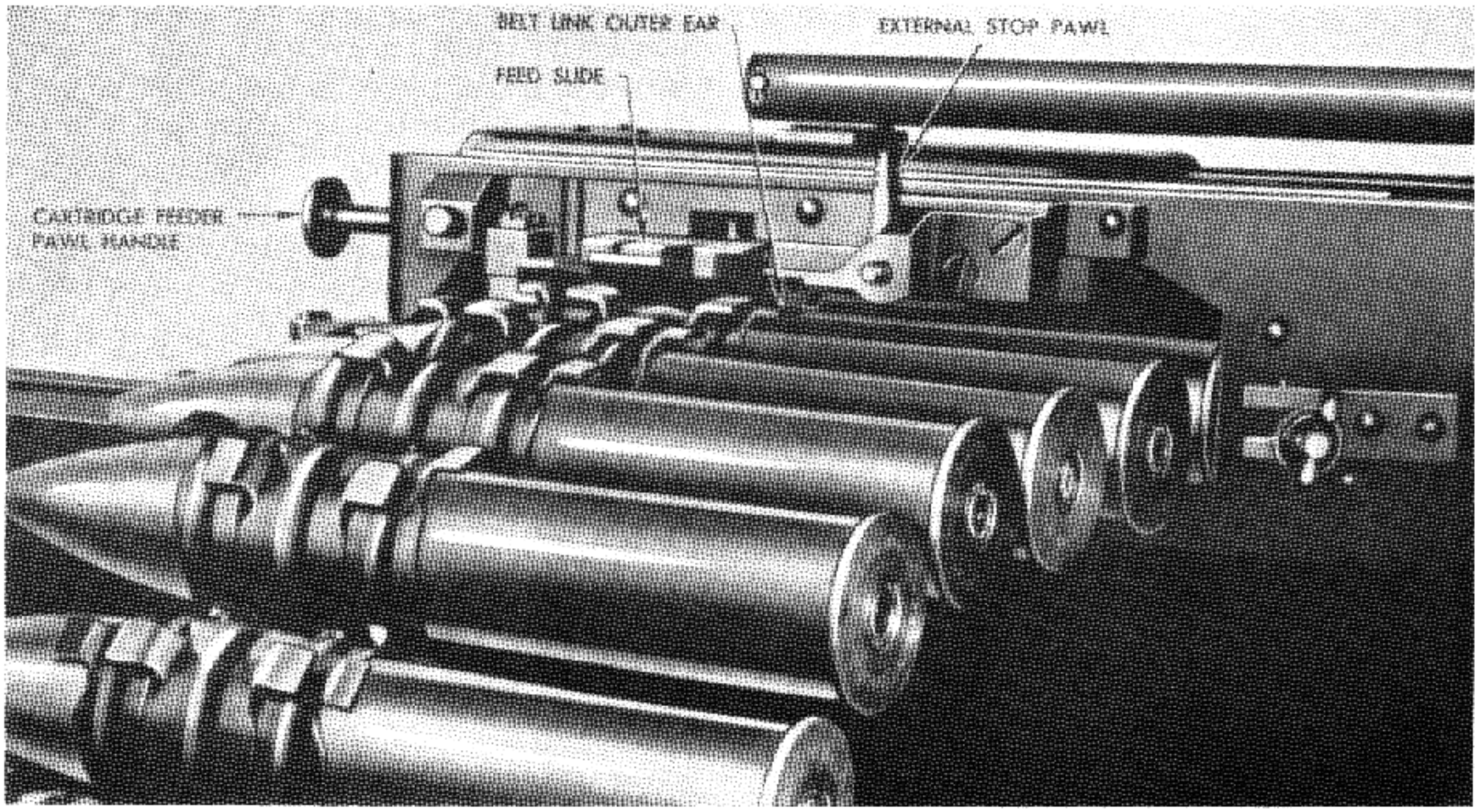

Figure 12–19. 37-mm Gun M10. External stop pawl contacting outer ear of belt link.

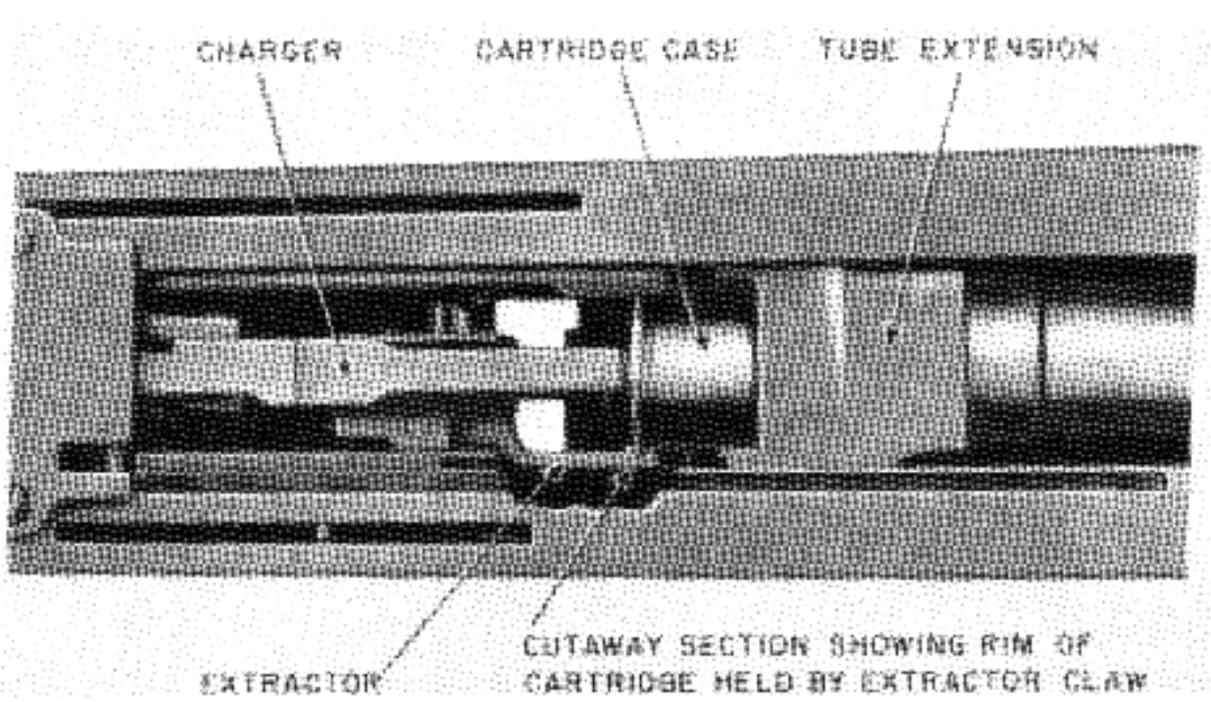

Figure 12–20. 37-mm Gun M10. Initial extraction, during separation of lock frame and tube extension.

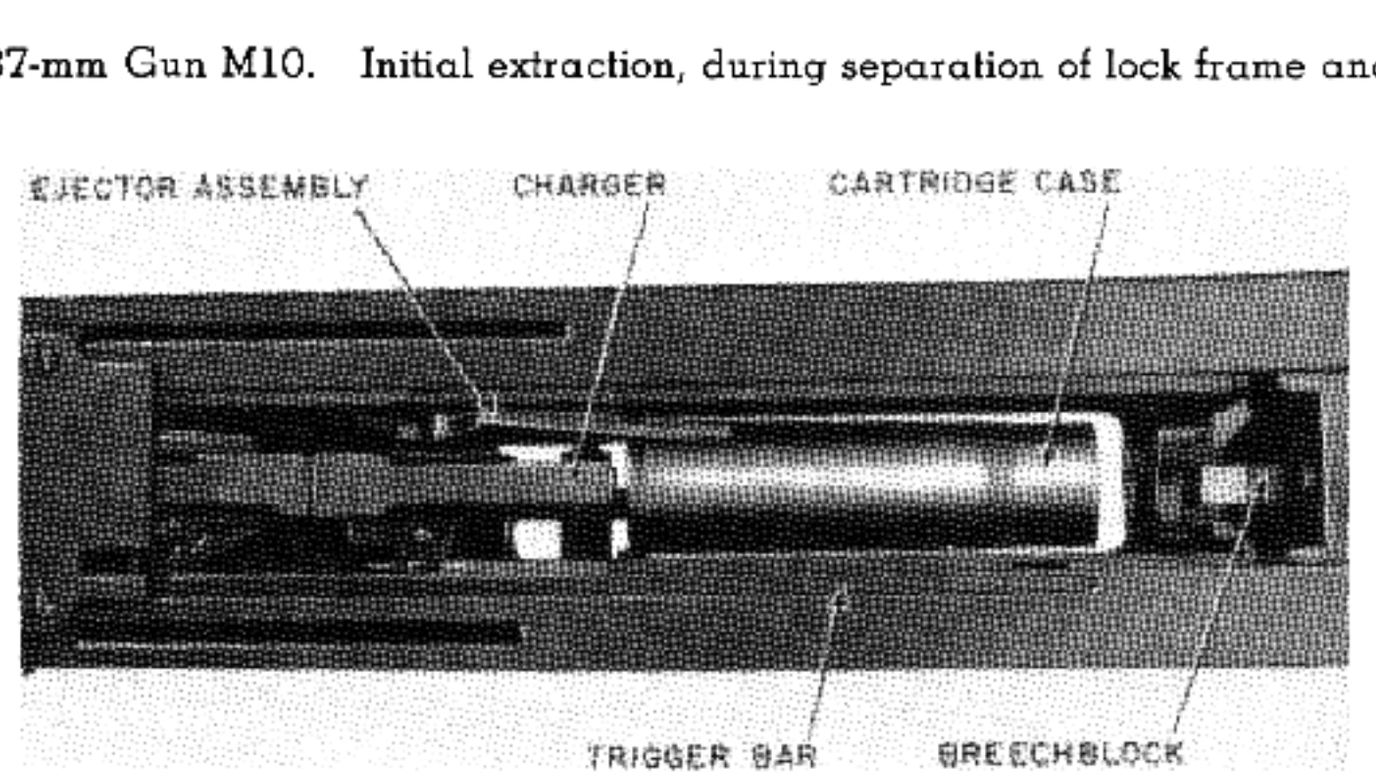

Figure 12–21. 37-mm Gun M10. Ejection.

Chapter 13

UNITED STATES AIRCRAFT CANNON DEVELOPMENT BASED ON THE BIRKIGT TYPE 404 (HISPANO-SUIZA)

SECTION 1. HISTORY AND BACKGROUND

In 1936, the United States Navy turned its attention to the procurement of an automatic weapon heavier than the caliber .50 machine gun. The Navy's overseas attachés were instructed to check all tests being conducted in Europe with a view to finding a suitable weapon that was readily available.

As a part of this program, the development of the Birkigt type 404 20-mm automatic gun was followed closely in France by both the Navy and the Army. In 1937 negotiations were begun to procure a sample gun for tests. In 1940 the United States acquired the rights to manufacture the gun, and production was begun under the designation "type M1." The details of this phase of the weapon's history are given in volume 1 of The Machine Gun (pages 562–577), along with an account of American modifications through the year 1943, when Gun, automatic, 20-mm, T31 had evolved. The action of this gun is the parent of two of the Navy's recent 20-mm weapons: Gun, automatic, 20-mm, T34; and 20-mm gun mechanism Mk 12, which is also known officially by the Army designation Gun, Automatic, 20-mm T118. These two weapons are described in detail in this chapter.

Technical data regarding some of the predecessors of the T31 are included in this chapter to supplement the history of the development of these models which is presented in volume 1 (pp. 577–590). Other 20-mm models antedating the T31 which are discussed in volume 1 are, in addition to the Type M1: M2, AN–M2, T25, T26, T27, T28, and T29.

Other related 20-mm models may be identified by means of the short descriptions in chapter 1. These are: T16, T18, T19, T20, T21, and T23.

The chart showing the important stages in the American development of the Hispano-Suiza gun summarizes the evolution and development of this automatic firing mechanism. In addition to the chart, illustrations give a pictorial history of the many modifications made in attempts to produce the optimum weapon.

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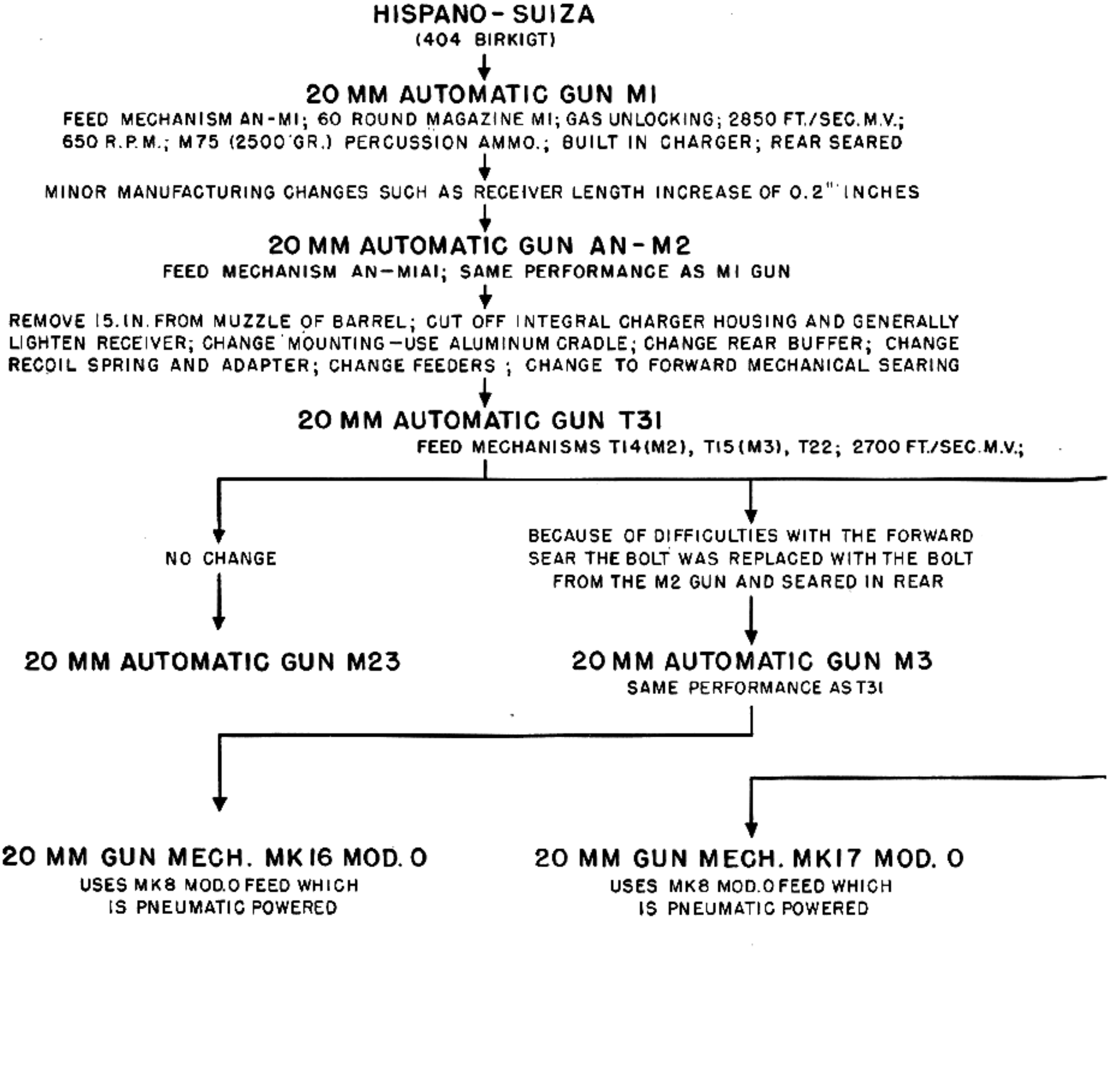


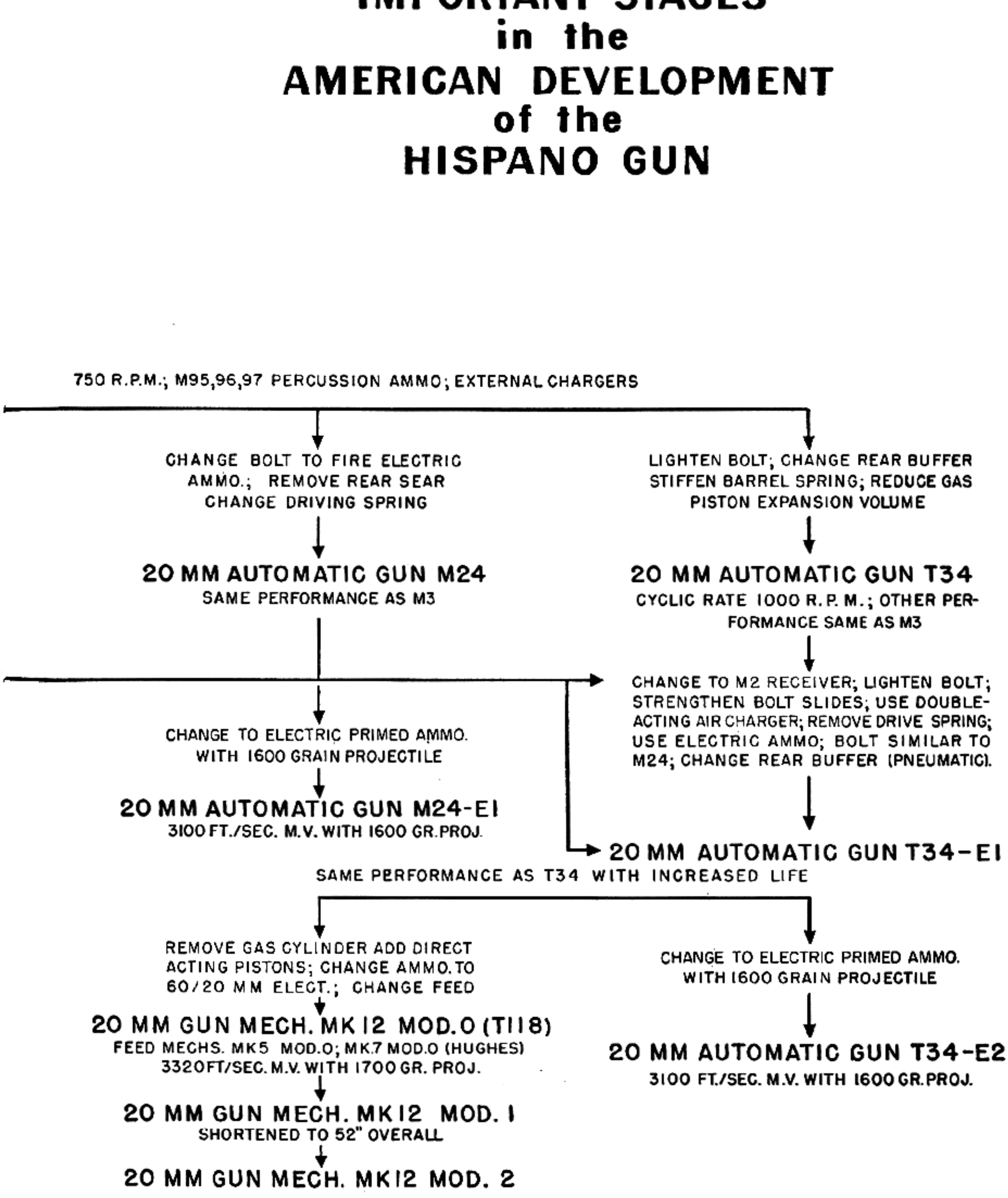
NOTE:

WEAPONS LISTED AS AUTOMATIC GUNS ARE ORD. CORPS (ARMY) DEVELOPMENTS.

THOSE SHOWN AS GUN. MECH. ARE BU. ORD. (NAVY) VERSIONS.

Figure 13–1. Schematic summary of important stages

IMPORTANT STAGES in the AMERICAN DEVELOPMENT of the HISPANO GUN



in the American development of the Hispano-Suiza Gun.

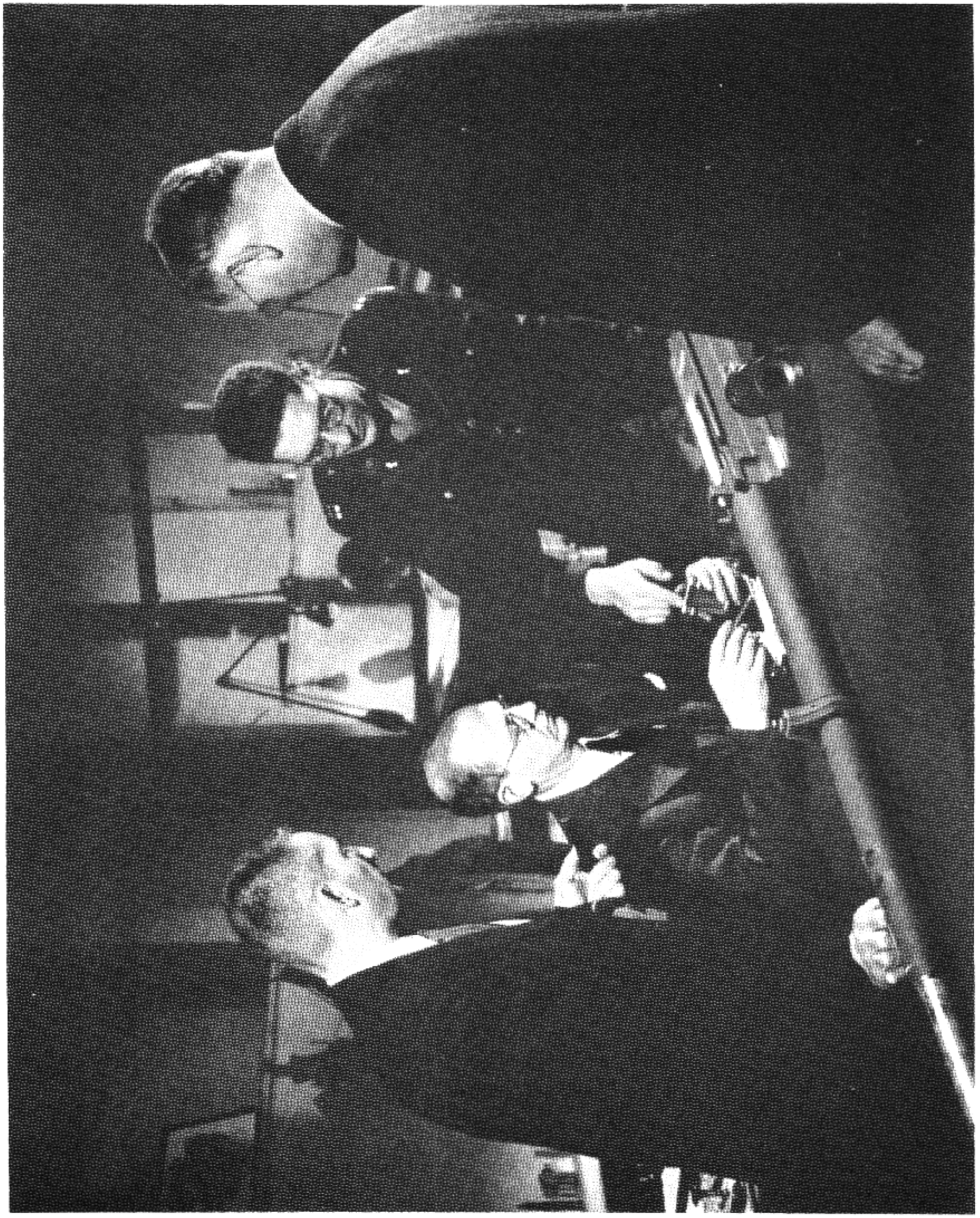


Figure 13-2. Production engineering the American version of the Birkigt Type 404 Gun.

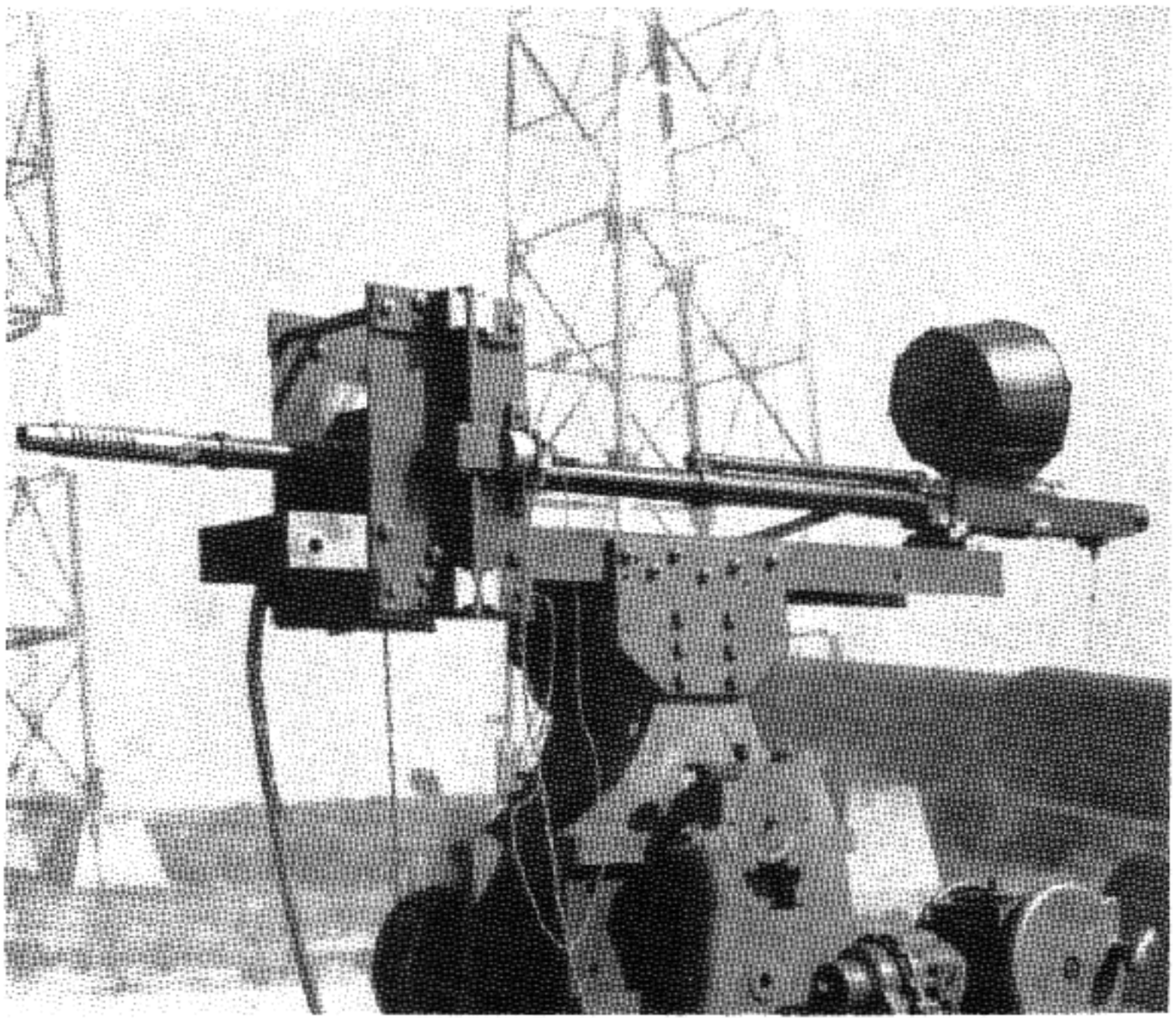


Figure 13-3. Birkigt Type 404 Gun at the Naval Proving Ground, Dahlgren, Va., during test firing in 1940.

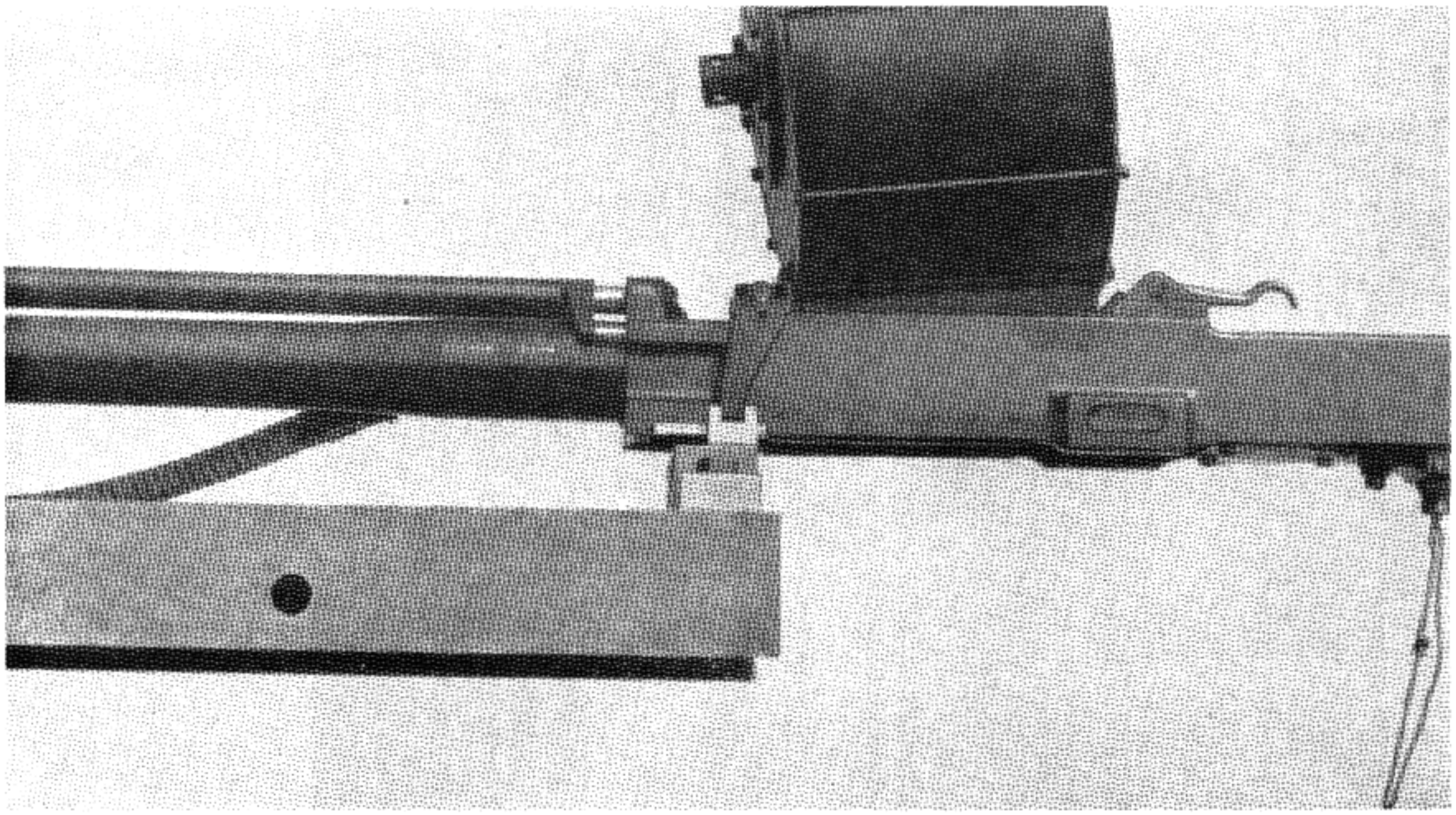


Figure 13-4. Birkigt Type 404 Gun. Closeup view taken at the Naval Proving Ground, Dahlgren, Va.

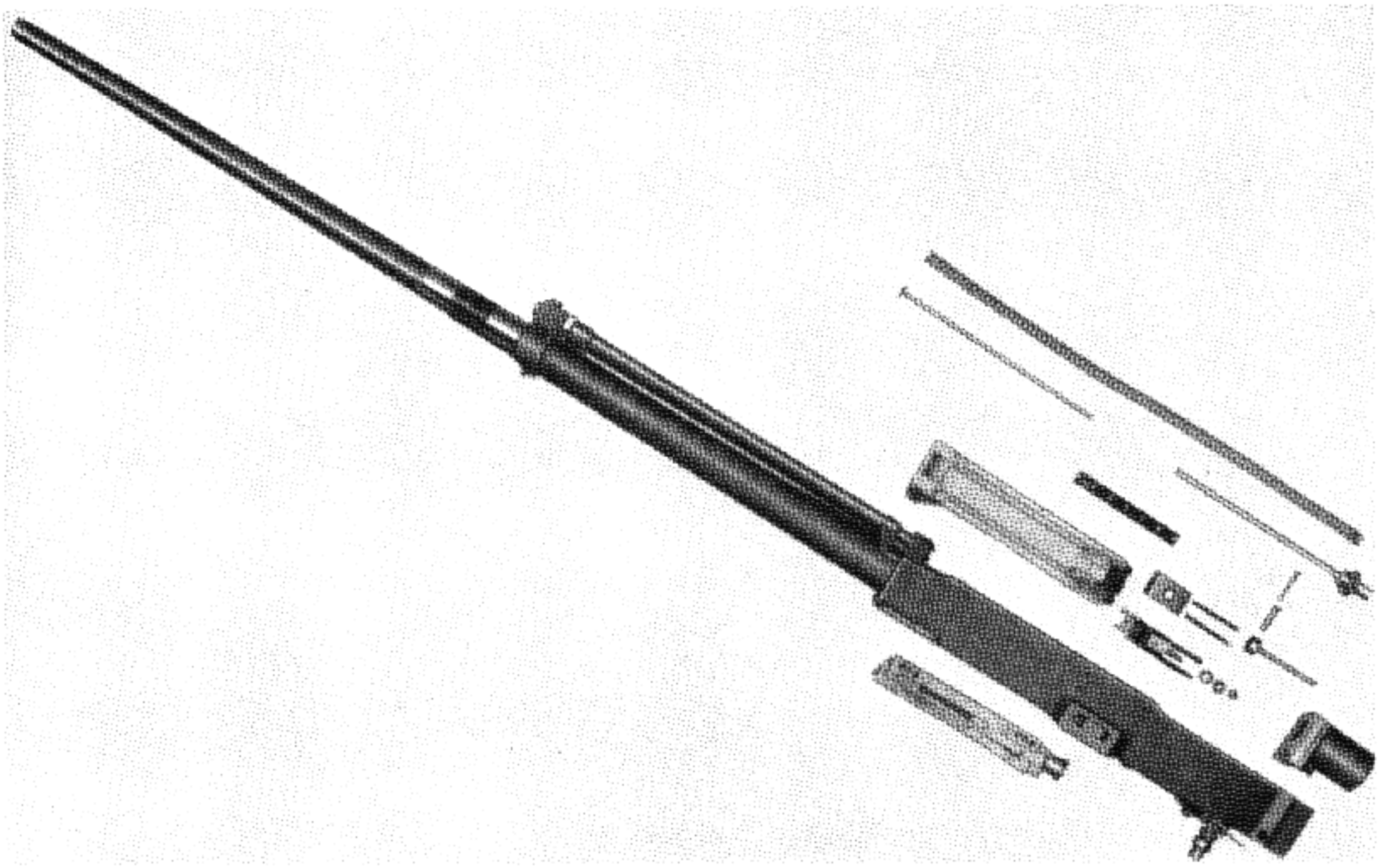


Figure 13–5. 15-mm Bendix Machine Gun. Disassembled view.

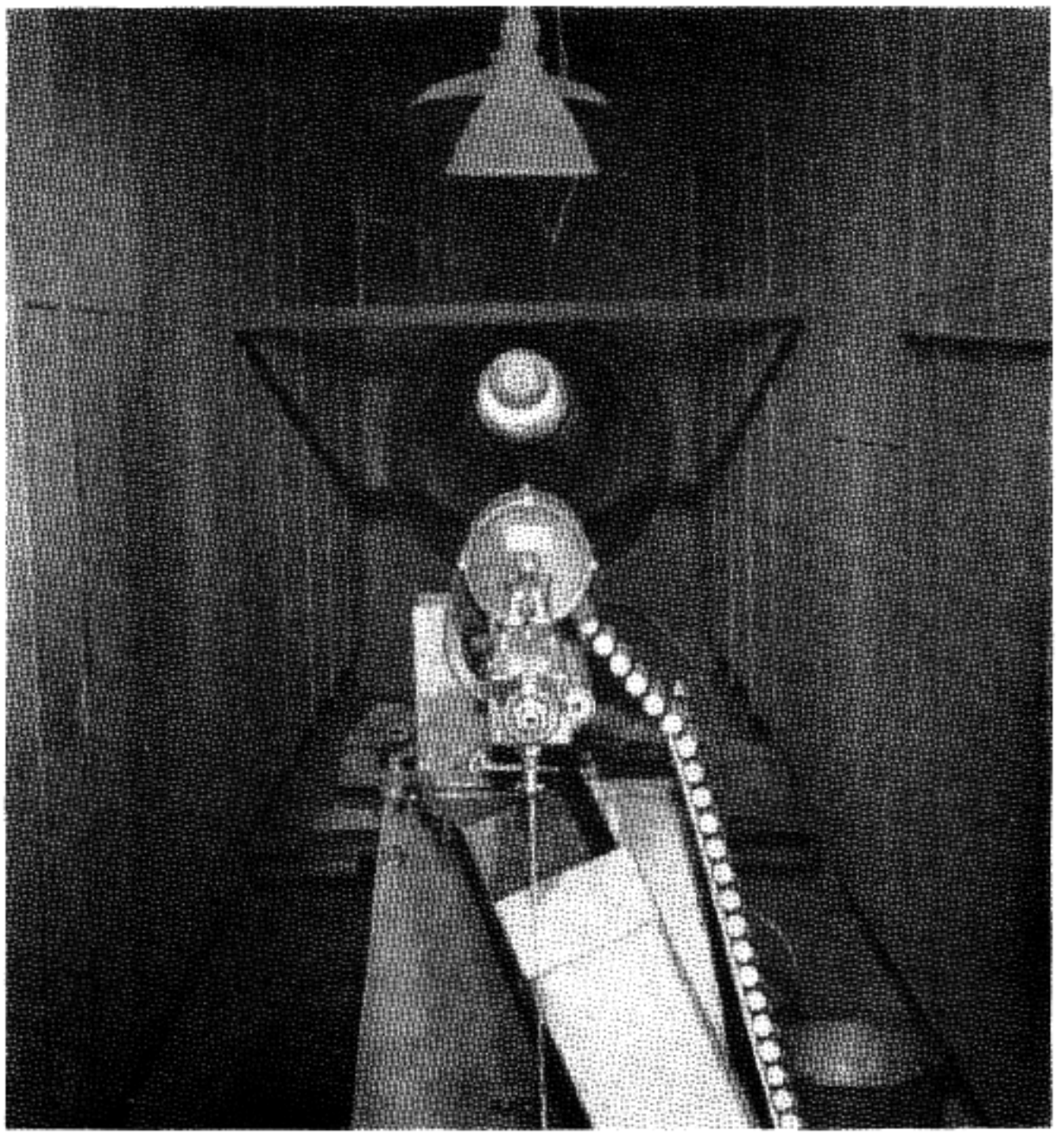


Figure 13–6. Proof-firing Gun, Automatic, 20-mm M1 at the Eclipse Plant.

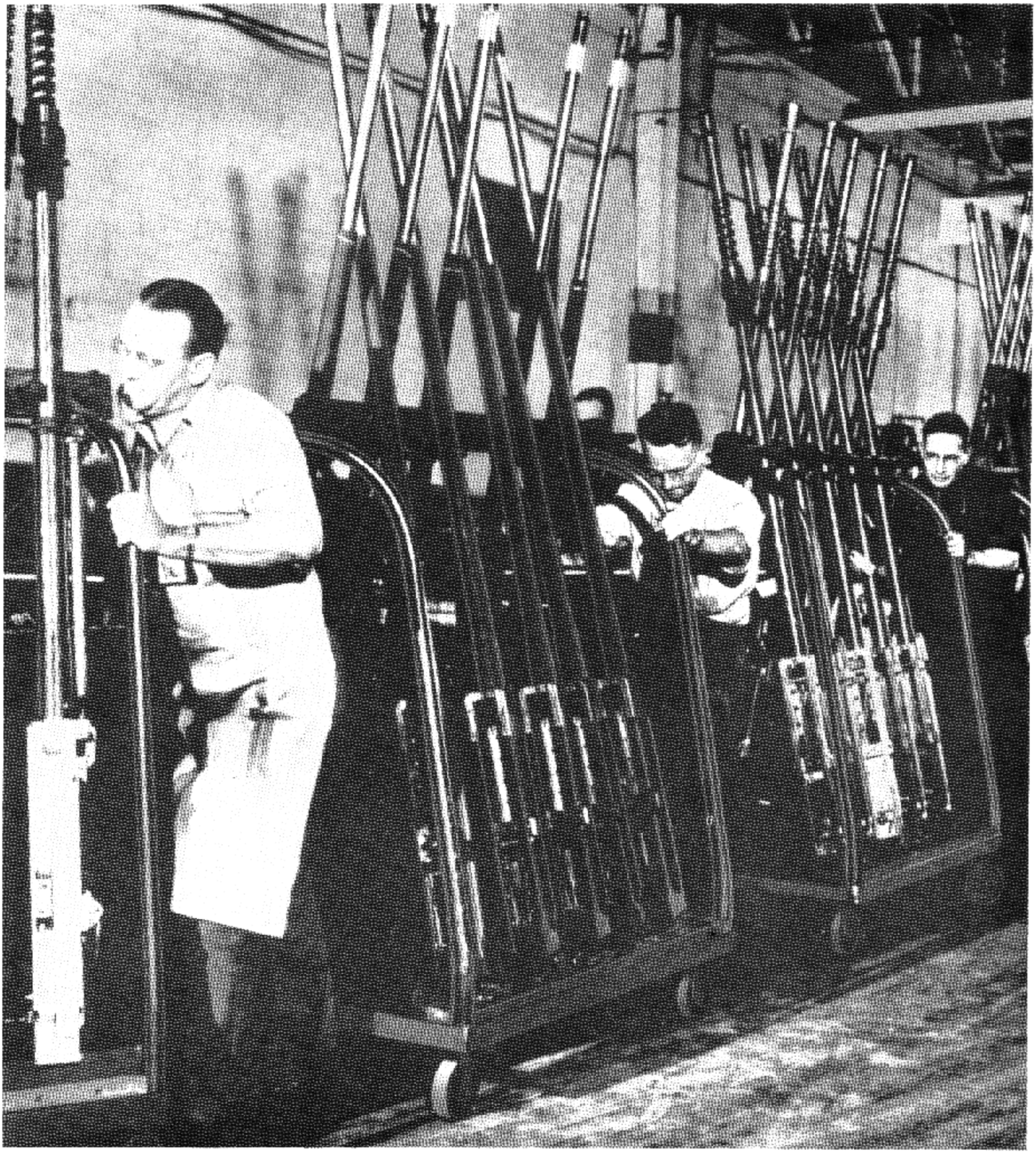


Figure 13-7. Gun, Automatic, 20-mm M2 coming off the production line.

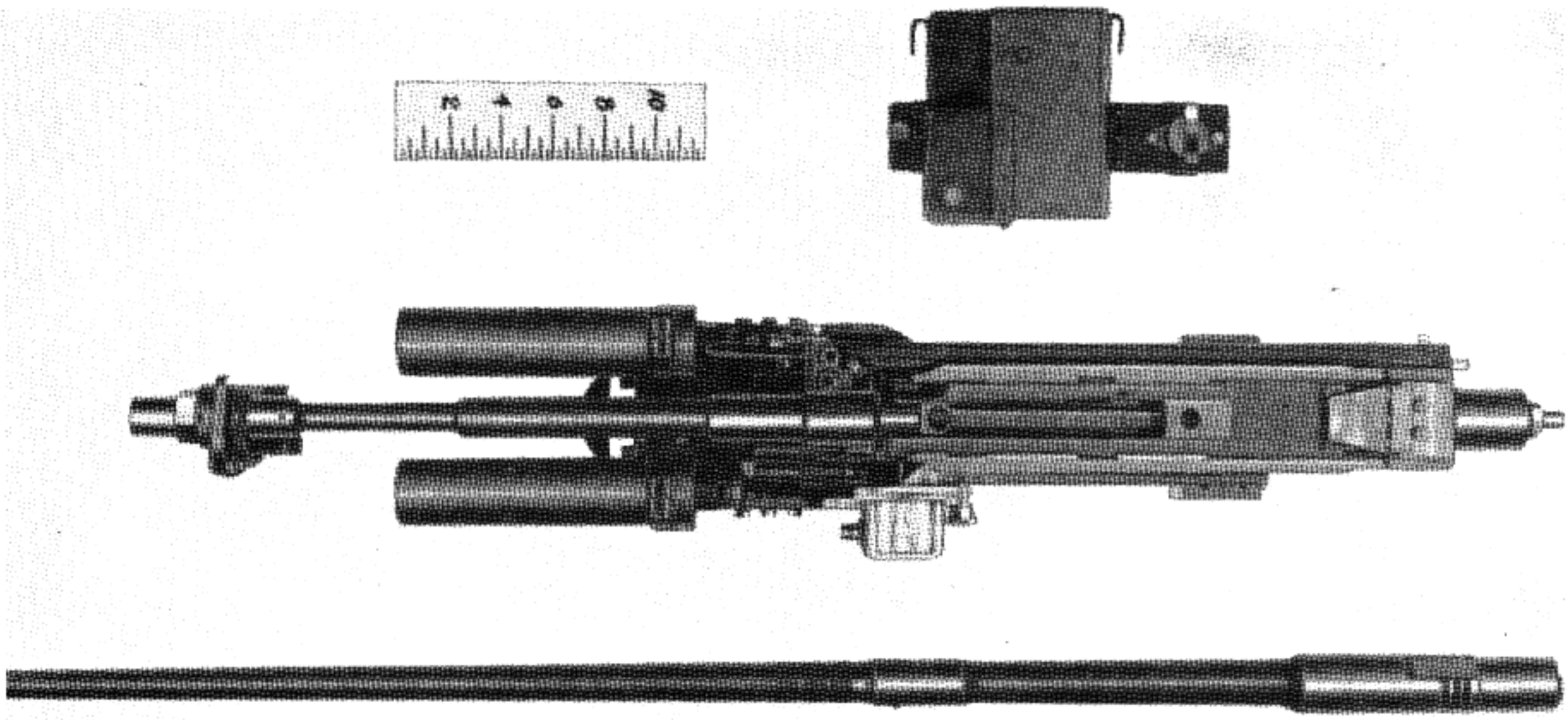


Figure 13–8. Gun, Machine, Aircraft, Caliber .60, T18E1, with barrel and feeder detached.

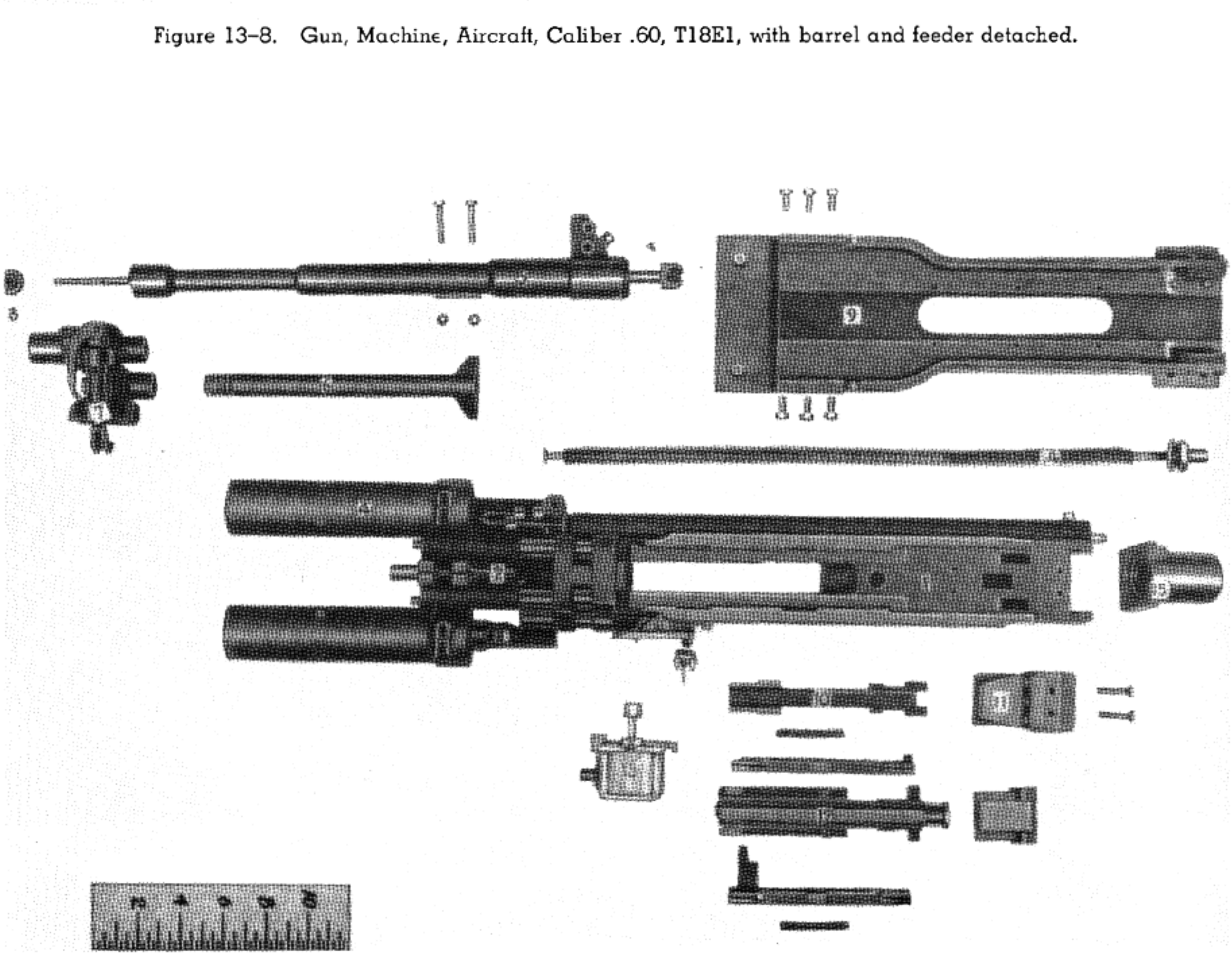


Figure 13–9. Gun, Machine, Aircraft, Caliber .60, T18E1, partially disassembled.

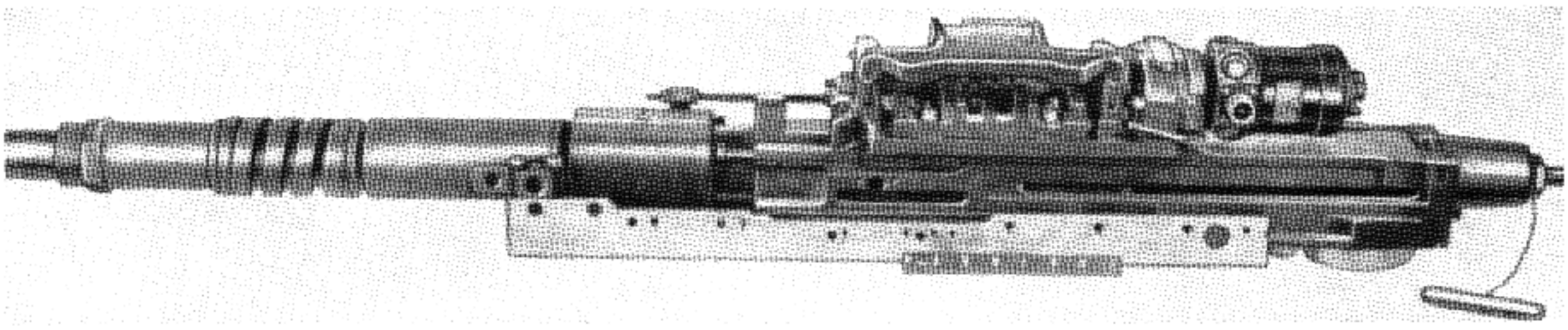


Figure 13–10. Receiver of 20-mm Gun T32. Left side view.

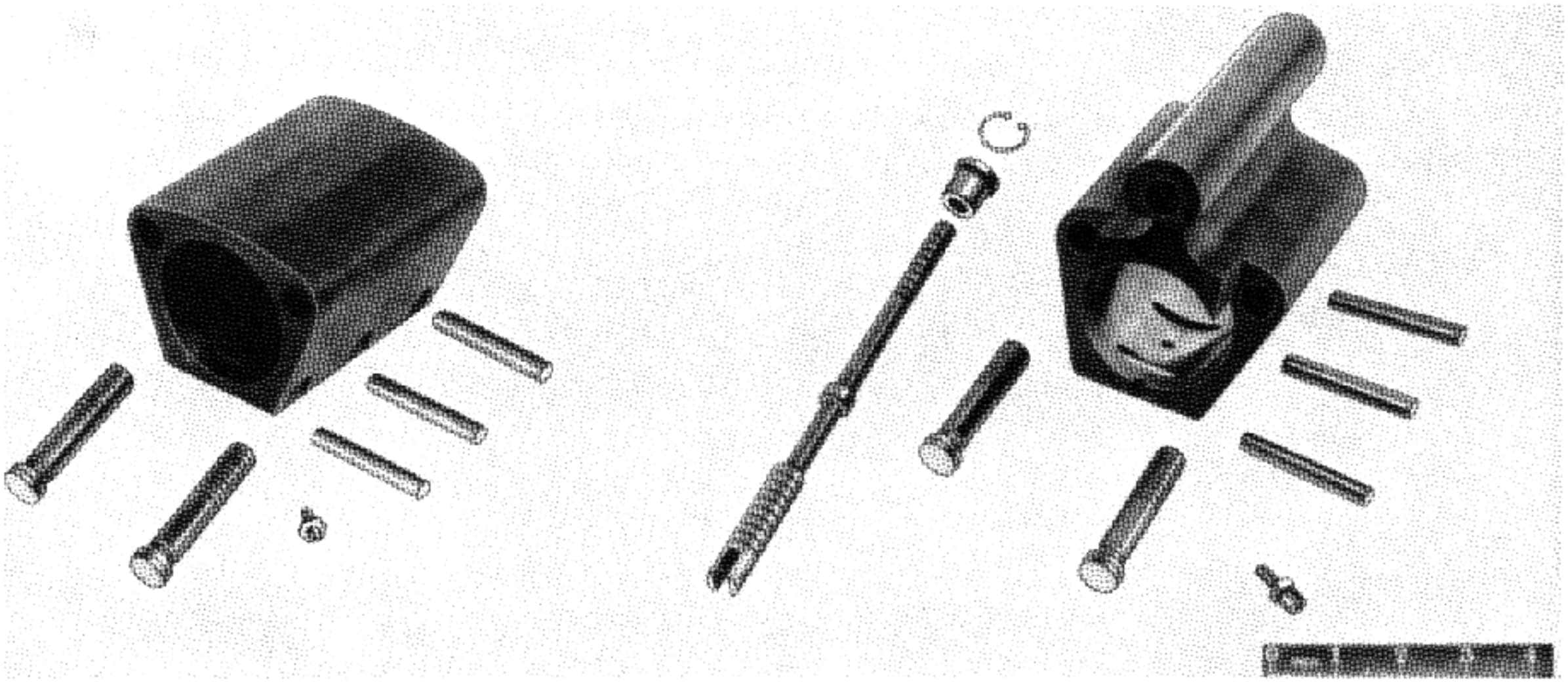


Figure 13–11. Gas systems for 20-mm Gun T32. Exploded view. Left, unlocking system. Right, gas unlocking system and modification whereby gas is employed for operation of feeder.

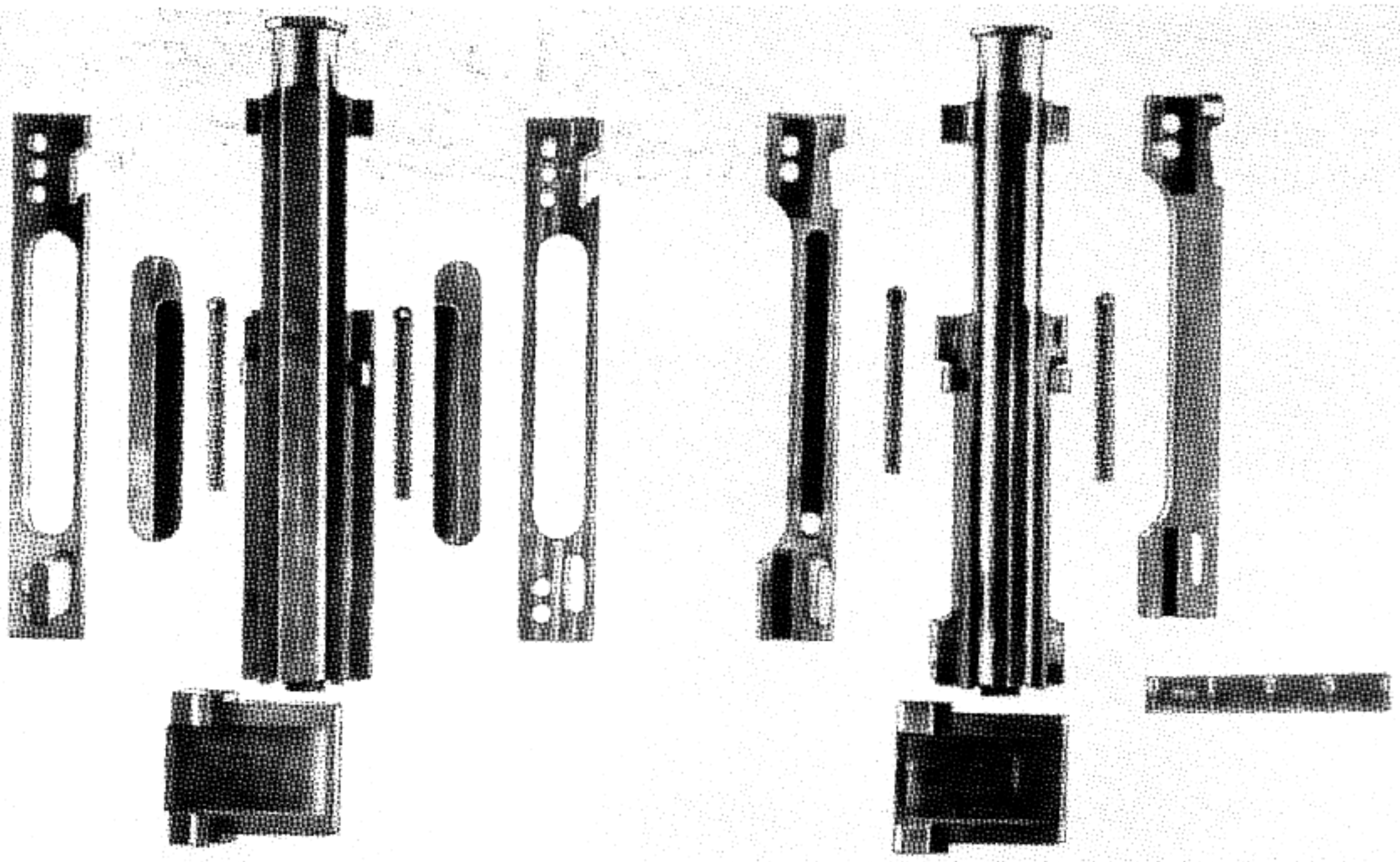


Figure 13–12. Bolt components of 20-mm Gun M3 (left) compared with those of 20-mm Gun T32 (right).

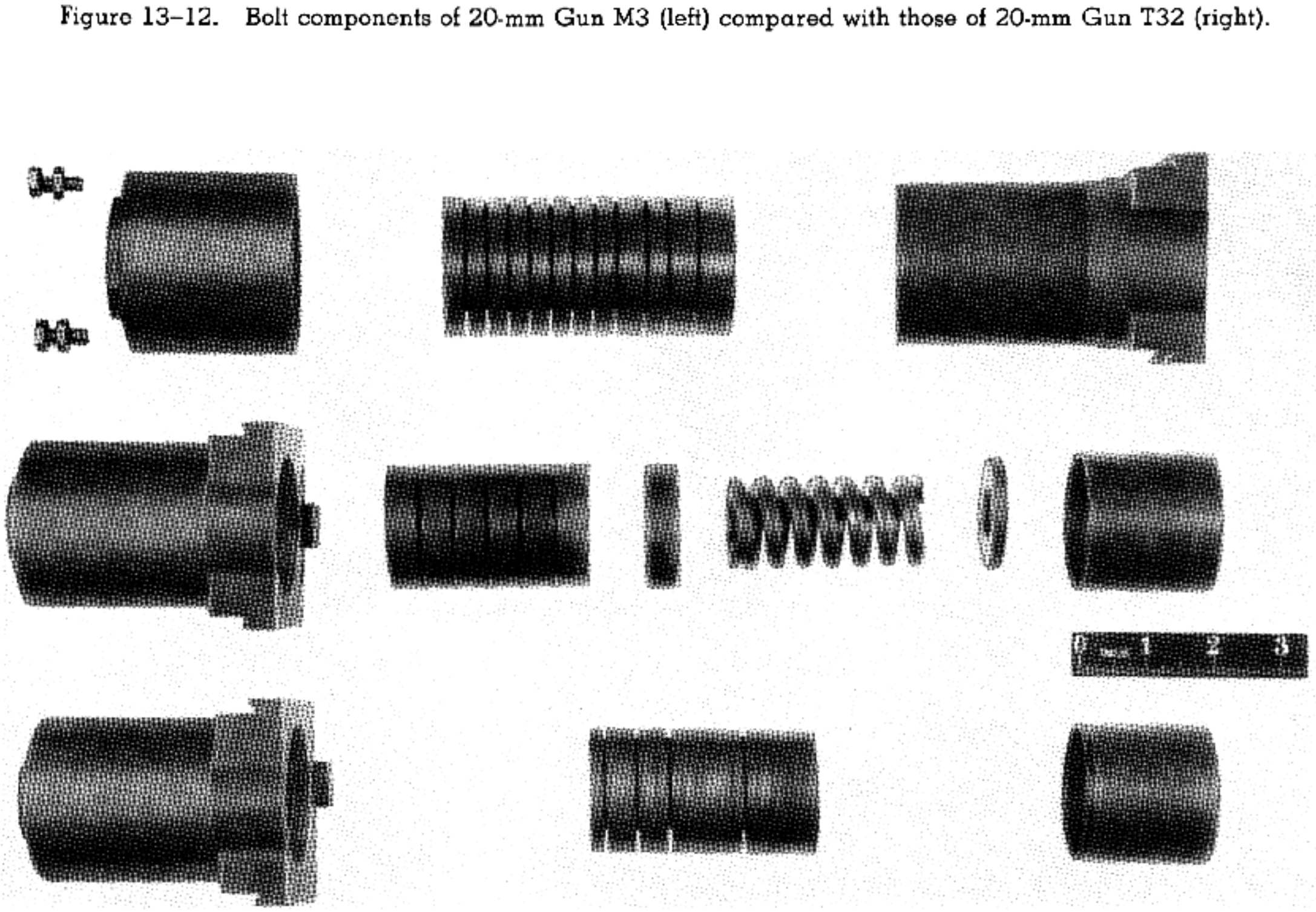


Figure 13–13. Development of buffers. Top to bottom: experimental Belleville washer type; standard type for M3 Gun; Belleville washer type for T34 Gun.

SECTION 2. DEVELOPMENT OF GUN, AUTOMATIC, 20-MM, T31 (M3) SINCE 1943

General

The 20-mm T31 is an outgrowth of modifications and attempts at standardization of the Birkigt type 404 20-mm cannon in both the United States and England. In physical appearance it shows many refinements of earlier modifications and it forms the basis for development work on models designated gun, automatic, 20-mm, T34 and 20-mm gun mechanism Mk 12 (which is also known as the T118).

The 20-mm automatic gun T31 is a combination blowback, gas unlocked, aircraft cannon. A developmental progress report early in 1944 showed that it weighed 99½ pounds without the feed mechanism and was furnished with a cradle mounting designed for installation in the wing, fuselage, or turret of an airplane. The cyclic rate was 750 to 850 rounds per minute, and the gun was so designed that it could be synchronized to fire between the propeller blades of the airplane. The ammunition used was a complete family of matched projectiles which included AP, API, I, and HE rounds.

Among other military characteristics, the T31 gun was to be capable of synchronization by means of separate, interchangeable actions, one to fire percussion-primed ammunition and one to use electrically primed ammunition. However, in April 1944 the Navy, then the major customer for 20-mm guns, requested that its guns be delivered with a rear seared mechanical percussion bolt, in order to expedite delivery of guns required for production aircraft. This led to the typing of the T31 gun as follows:

T31 (M3), rear seared percussion fired gun.
T31 (M23), forward seared percussion fired gun.
T31 (M24), forward seared electrically fired gun.

In 1944, the Air Force advised the Ordnance Corps that it was actively engaged in a number of experimental armament installations in various bombardment and fighter aircraft intended for use

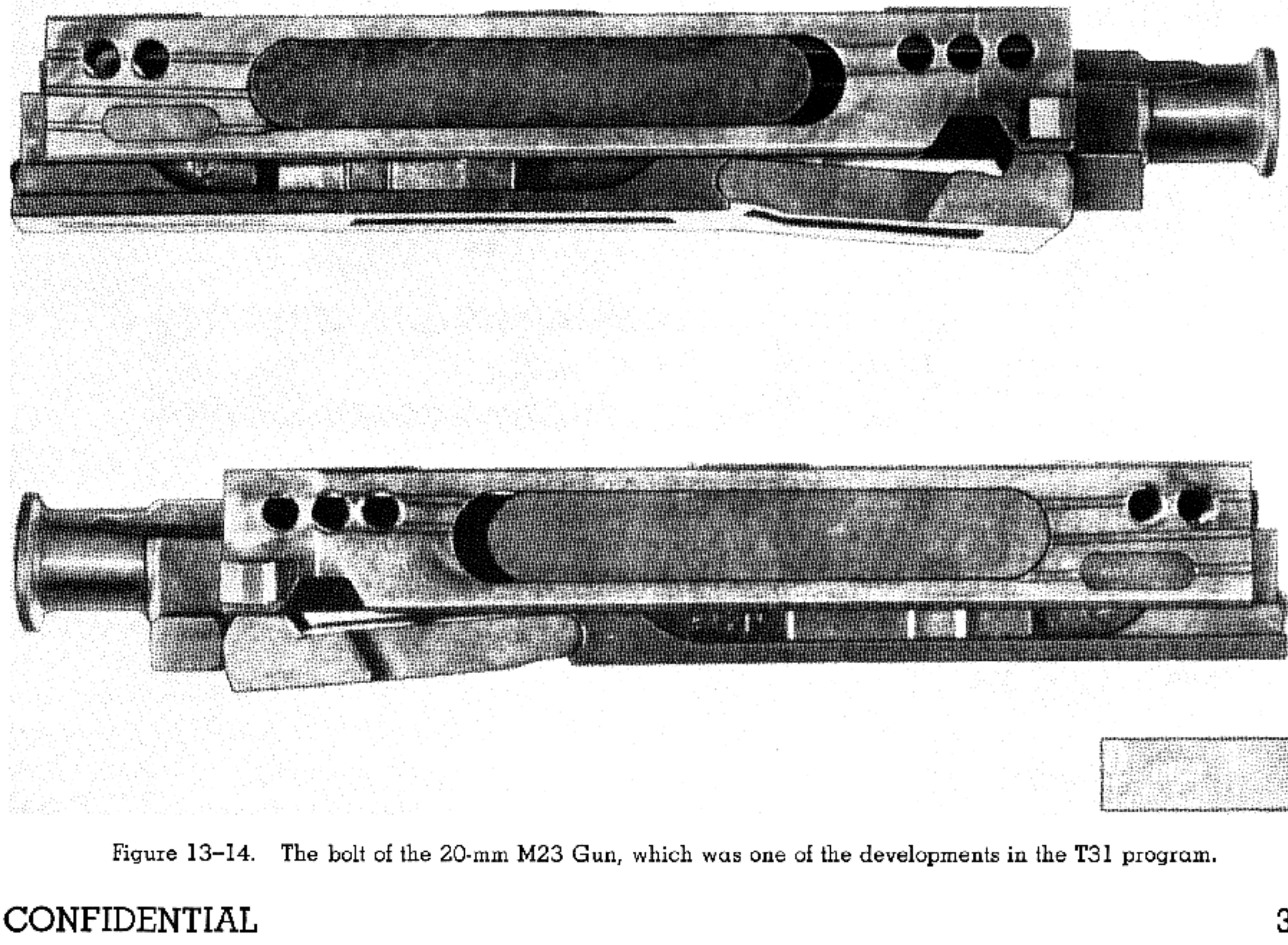


Figure 13–14. The bolt of the 20-mm M23 Gun, which was one of the developments in the T31 program.

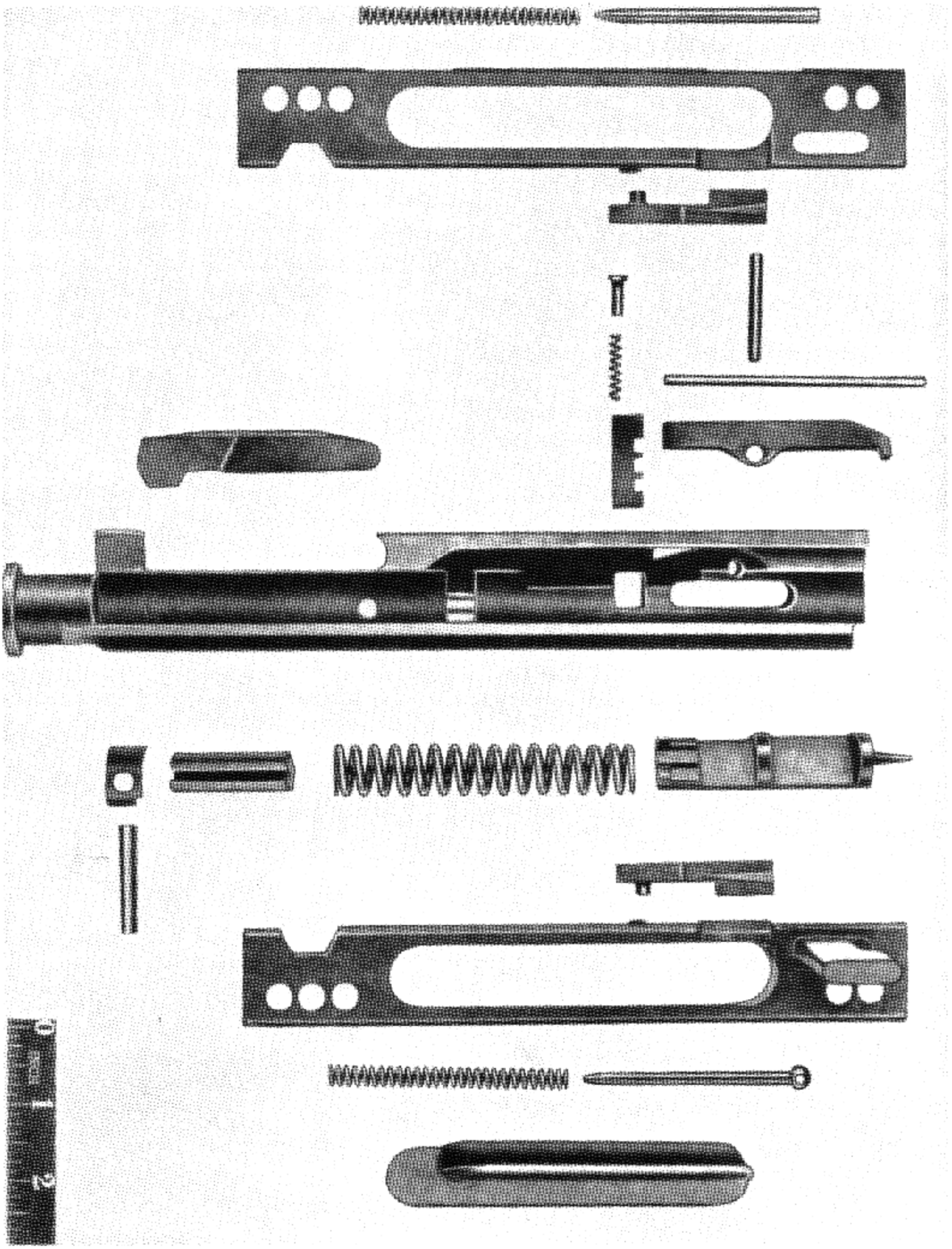


Figure 13–15. Components of the bolt of 20-mm Gun M23.

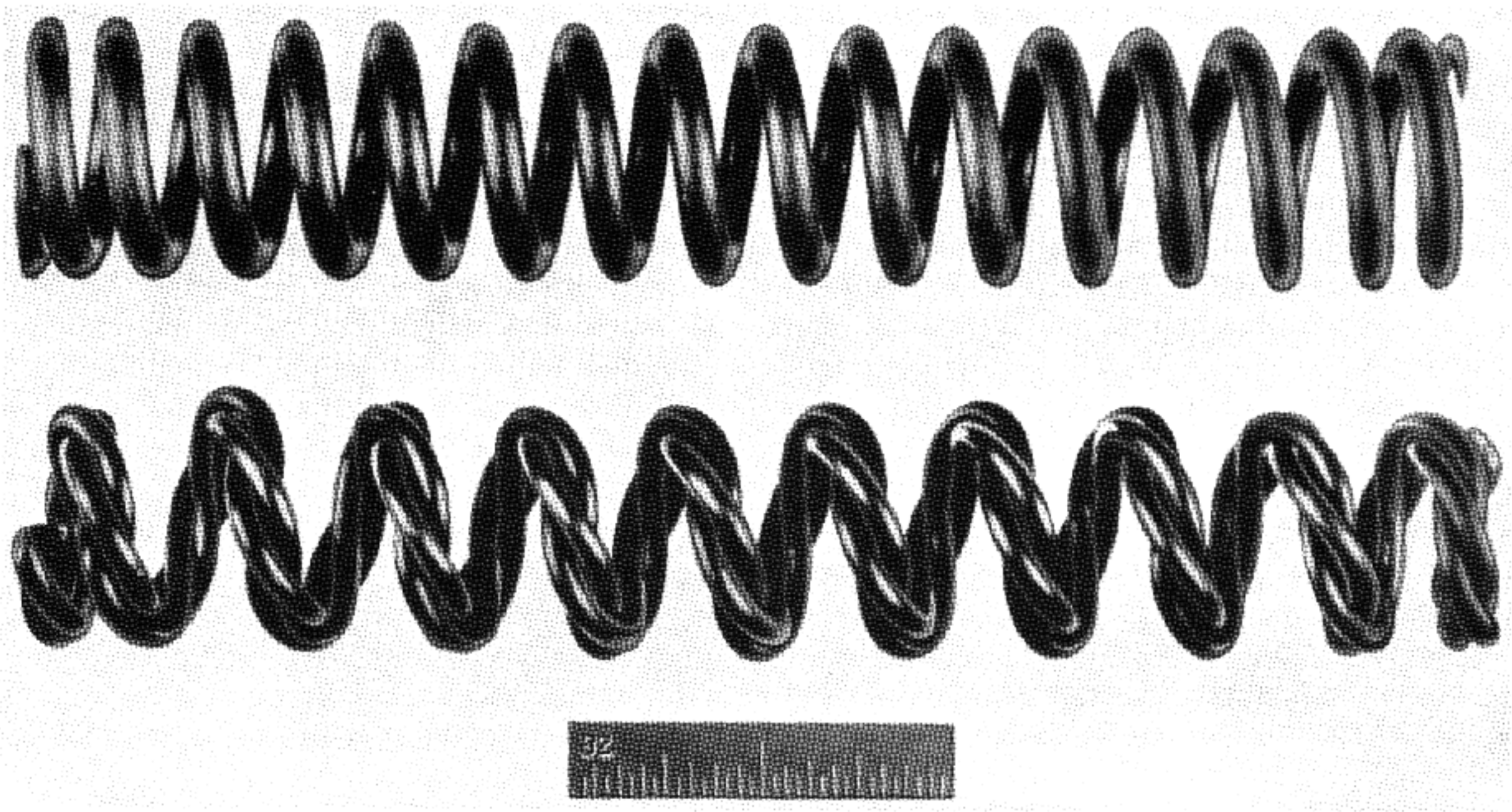


Figure 13–16. Comparison of the original firing pin spring and a braided spring developed later for the 20-mm T31 Gun.

with the 20-mm automatic gun T31. To expedite the development of mounts, turrets, and other related aircraft equipment, they requested 500 T31 guns by July 1944, each supplied with a percussion firing device, an electric firing device, a manual charger, a heater, a solenoid (for percussion firing device), and a receptacle (for electrical firing device). Also 50 of each of these items were to be supplied as spares. OCM 23039, dated 2 March 1944, classified the T31 gun as a limited procurement item in order to meet the above requirements.

At the request of the Bureau of Ordnance, the T31 gun was equipped with a bolt mechanism from the standard 20-mm AN–M2. The left slide of this bolt was modified by the addition of a lug so that the bolt mechanism could be charged from either side. The gun fitted up in this manner made another model of the T31 gun, in addition to the two already established. After tests were completed on the use of this standard bolt in the T31 gun, it was seared in a rear position. The Navy established its requirements for 22,826 such weapons and the Air Force established a requirement for 500, making a total of 23,326 guns in addition to the 500 guns previously ordered by the Air Force, which were to be equipped with a forward seared mechanical bolt and electric bolt. In order to expedite this heavy procurement, the T31 gun classification was changed from restricted to unclassified on 30 March 1944.

Tests of the rear seared T31 gun by both the Army and Navy were successful, and on 12 July standardization of this weapon as gun, automatic, 20-mm M3 was approved.

In view of the fact that there are two additional types of T31 guns still under development, the nomenclature "gun, automatic, 20-mm T31E1" was assigned to the forward seared mechanical percussion bolt design and the nomenclature "gun, automatic, 20-mm T31E2", assigned to the electric bolt development. The nomenclature "gun, automatic, 20-mm M23" was reserved for standardization of the T31E1 gun, and "gun, automatic, 20-mm M24" was reserved for a corresponding standardization of the T31E2. The using services concurred with the Ordnance Corps in typing the guns in this manner.

Many projects were under way in conjunction with the T31 development, including electric heaters, chargers, several types of electric triggers,

gun adaptors, and cradles. A basic requirement was established that such accessories be designed in such a manner that they could be mounted interchangeably on either the right or left side of the weapon.

The trend at the end of 1944 was toward higher muzzle velocity. Efforts were being made then to increase it from 2,800 feet per second to 3,500 feet per second with the objective of improved armor penetration.

The general trend of research and development in the 20-mm Hispano automatic aircraft cannon in the United States for the period from the standardization of the M1 to January 1945, was toward higher firepower and increased reliability of functioning.

The early spring-operated feeds forcibly held the next round on top of the bolt when the gun was fired so that, after firing, the rearward motion of the bolt was retarded. Positioning of the next round was delayed, holding down the rate of fire. Positive (mechanical) feeds were developed which lessened the force of the round on the top of the bolt. This materially reduced friction, making the gun more reliable under all climatic conditions and contributed to increase the cyclic rate from 600 to 850 rounds per minute.

Reduction in weight of the gun and accessories permitted additional rounds of ammunition to be carried, which were made available for action by disintegrating link belts of far greater capacity than the original 60-round magazine.

The cross-sectional area of feeding devices and accessories, normal to the axis of the gun, was reduced, permitting greater ease of installation in restricted locations in aircraft.

In June 1945, the T31 type gun was standardized as the M3 gun. At the same time, 20-mm

General Data: 20-mm Automatic Guns M1 and M2

Gun length: 93.7 inches.
Gun weight:
M2: without feeder 112 pounds.
M1: without feeder 105 pounds.
NOTE: The 7-pound difference in weight is in the heavier construction of the receiver. See volume 1, page 576.
Rate of fire: 600–700 rounds/minute.
Muzzle velocity:
HEI or ball ammunition: 2,850 feet/second.
AP ammunition: 2,950 feet/second.
System of operation: Gas unlock; blowback assist.
System of locking: Swinging lock.
System of feeding: Drum, or spring actuated; continuous feed employing metal disintegrating links.
Method of headspace: Cannot be adjusted.
Location of feed opening: Top of receiver.
Location of ejection opening: Bottom of receiver.
Method of charging: Manual, pneumatic.
Method of cooling: Air.
Weight of 20-mm adaptor AN–M1: 11.3 pounds.
Weight of electric trigger AN–M1: 3 pounds.
Weight of hydraulic charger M1: 2.6 pounds.
Weight of 20-mm feed mechanism AN–M1A1: 18.5 pounds.
Weight of 20-mm adaptor M6: 14 pounds.
Weight of 20-mm adaptor M7 (with thread protector): 7.5 pounds.
Weight of 20-mm adaptor M7 (with muzzle brake): 10.7 pounds.

Barrel length: 67.5 inches.
Barrel weight: 47.5 pounds.
Rate control: None.
Barrel removal: Not quick disconnect.
Chamber pressure: 42,000 p. s. i.
Bore:
Number of grooves: 9.
Groove depth: 0.015 inch.
Groove width: 0.205 inch.
Pitch: 7° (equals 1 turn in 25.187 calibers and 1 turn in 20.137 inches).
Direction of twist: Right hand.
Form of twist: Constant.
Width of lands: 0.068 inch.
Rifling length: 63.08 inches.
Cartridge: 20-mm Hispano-Suiza (M75 series).
Bore of tube:
Across rifling lands: 7.787 inches.
Across rifling grooves: 0.817 inch.
Chamber pressure (maximum): 48,000 pounds/square inch.
Travel of projectile in tube: 63.68 inches.
Weight of muzzle brake M1: 4.6 pounds.
Weight of sear mechanism M1: 1.3 pounds.
Weight of manual charger M2: 1.5 pounds.
Weight of 60-round 20-mm (empty): 22 pounds.

automatic gun AN–M2 was classified as limited standard.

The M3 gun is a light-weight version of the M2 weapon using the same breechblock mechanism, but having a tube 15 inches shorter and a recoil cradle for mounting purposes. A complete line of accessories, such as heaters, chargers, muzzle covers, and flash hiders, was standardized for the weapon.

After the standardization, the Navy carried on extensive tests resulting, first, in revealing certain weaknesses, and, second, in correction of some of them. Also, the use of ceresin-waxed ammunition was begun to eliminate extraction difficulties.

Air Force orders for the T31 gun included the interchangeable components for all three types; but in mid-1947, the requirement for the T31 (M3) and T31 (M24) components was dropped in favor of the T31 (M23) type. The latter type was abandoned, in turn, in late 1947 when extensive Air Force tests revealed that certain experimental turrets for a military aircraft then in production could not meet dispersion requirements unless a definite phase relationship of the guns to each other could be obtained, a requirement that was impractical for the T31 (M23). This fact resulted in a change in Air Force requirements to specify only the T31 (M24) gun. Extensive development of both the gun and the electric primed ammunition has continued since that time. For supply reasons, the T31 (M24) was made substitute standard in November 1947.

For comparative purposes, general data for the 20-mm M1 and the 20-mm AN–M2 are given along with a summary of the development of these two models. In February 1944 production of all M1 and AN–M2 cannon ceased. In October 1944 the M1 was declared obsolete.

Standardization of the 20-mm M1 and AN–M2 (Summary)

In February 1942, a subdivision of the Joint Aircraft Committee recommended that 20-mm automatic gun type M2 as shown in Ordnance Corps list of drawings 51–107–1 be accepted as standard for use by the United States Army and Navy and by the British, and that this gun be designated 20-mm automatic aircraft gun AN–M2.

The principal components of the basic gun were the tube and the receiver, which housed most working parts. Working parts consisted of the gas cylinder and sleeve group, the magazine slide group, the breechblock assembly, the breechblock locking key, the scar block group, the rear buffer assembly, and the driving-spring guide group.

The differences between the AN–M2 and M1 were in manufacture only; they did not affect troop use or care, but were useful as a means of identifying the different models. The guns were identical

General Data: 20-mm Automatic Gun T31, or M3

Gun length: 77.7 inches.
Gun weight, without feeder: 99.5 pounds.
Rate of fire: 700–750 rounds/minute.
Muzzle velocity: 2,750 feet/second.
System of operation: Gas unlocking, blowback assist.
System of locking: Swinging lock.
System of feeding: Automatic spring-wound feeder employing metal disintegrating links.
Method of headspace: No provision made for adjustment.
Location of feed opening: Top, either right or left hand.
Location ejection opening: Bottom of receiver.
Method of charging: Hydraulic, air, manual.
Method of cooling: Air.

Barrel length: 52.5 inches.
Barrel weight: 26 3/16 pounds.
Rate control: None.
Barrel removal: Cannot be easily removed in field.
Chamber pressure, maximum: 42,000 p. s. i.
Bore:
- Number of grooves: 9.
- Groove depth: 0.015 inch.
- Groove width: 0.205 inch.
- Pitch: 7° (equals 1 turn in 25.587 calibers and 1 turn in 20.137 inches).
- Direction of twist: Right hand.
- Form of twist: Constant.
- Width of lands: 0.068 inch.
- Distance across rifling lands: 0.787 inch.
- Distance across rifling grooves: 0.817 inch.

Rifling length: 48.06 inches.
Travel of projectile in the tube: 48.66 inches.
Cartridge: Hispano-Suiza (M90 series).

in tube construction and working parts, the only difference being in the dimensions of the receiver. The AN–M2 receiver was 0.2 inch longer and 5 pounds heavier. Each receiver slide of the AN–M2 gun had a projection which fitted into a slot in the side of the receiver, and the receiver slide bolts were locked by cotter pins. In the M1 guns, the receiver slides had no flanges and were riveted, not bolted, to the receiver. The shoulders on the bottom faces of the receiver sides serve as further means of identifying the M1 gun.

In some M1 guns, each receiver slide has a flange which overlapped the side of the receiver, and the receiver slide bolts were locked by locking wires.

Description of the 20-mm M3 Gun

The description of the 20-mm M3 gun is organized around the following components: cradle group; tube and receiver group; breechblock group; gas cylinder sleeve group; recoil group.

Cradle Group. The cradle assembly is the actual mount for the gun. It is so designed that it will allow the gun to move backward in recoil and forward in counterrecoil. The nonrecoiling recoil housing assembly of the gun, which fits around the recoiling gun tube, is secured to the mounting bracket of the cradle by means of two trunnion blocks and four trunnion block and mounting bracket screws safetied by a plate, the corner of which is bent up. The receiver, which is recoiling, engages one horizontally rotating roller and two vertically rotating rollers at the rear of the cradle. The rollers carry the weight and control the vertical movement of the gun.

The cradle also mounts the anchor support bracket to which the magazine slide is fixed by means of a magazine slide anchor. In this manner the magazine slide is made nonrecoiling, whereas the receiver, on which it is mounted, recoils during firing. This condition is utilized in the operation of the 20-mm feed mechanism AN–M2, which is recoil operated.

The sides of the cradle have drilled and tapped holes for mounting the various chargers.

Tube and Receiver Group. In the following description, these components are treated as parts of the tube and receiver group: gun tube; receiver; rear buffer, and driving spring guide.

Gun Tube. The tube serves to accommodate the front mounting arrangements, recoil housing, and the gas cylinder sleeve group. The threaded muzzle end is for attaching a flash hider. The threads to the rear of the threaded muzzle end serve for attaching certain types of British mounts but are not used for mounting the gun in United States airplanes. When these threads are not in use, they are protected by a thread protector sleeve and cap.

Receiver. The receiver houses most of the working parts. The front of the receiver is threaded internally to receive the tube. The guideway on each side of the opening on top of the receiver accommodates the magazine slide by means of which the feed mechanism is secured to the gun. The rear of the receiver has vertical dovetail grooves for attaching the rear buffer.

The rear underside of the receiver accommodates the sear mechanism. The front underside of the body is open to permit ejection of empty cartridge cases. Above the ejector opening are two receiver slides which are bolted to the sides of the receiver and serve to support the breechblock in its forward movement. The slides have cammed surfaces at the rear which engage corresponding cams on the breechblock lock, to cam it into the locked position with the assistance of the camming action of the breechblock slides. To the rear of the ejector opening, a transverse slot is cut in each side of the receiver body to accommodate the breechblock locking key. The breechblock locking key engages the breechblock lock when the lock is cammed down into the locked position.

The cradle mounting plate on the middle underside of the receiver serves to support the gun and control its vertical movement by means of cradle rollers fitted in the gun cradle.

The electric heater is installed on the breechblock locking key and receiver slides.

Rear Buffer and Driving Spring Guide. The function of the rear buffer is to cushion the shock of the rearward movement of the breechblock and start the breechblock on its forward movement. These actions are accomplished by a series of ring springs guided by a sleeve and a coil spring placed inside the sleeve.

As the breechblock moves to the rear, it compresses the driving spring and much of the inertia of the breechblock is absorbed. As the breechblock hits the rear buffer, it transmits the shock of recoil to the springs. The springs absorb the remaining

shock and bring the breechblock to a stop. At this time, the rear buffer springs and the driving spring expand, forcing the breechblock forward.

MAGAZINE SLIDE. The magazine slide has a guide on each side. These guides provide for sliding engagement with corresponding guideways on the receiver. The feed mechanism is secured to the magazine at the front by two hook-shaped projections on the slide, and at the rear by the magazine slide latch.

The ejector fits into the lower two grooves in the magazine slide beneath the latch. It has two prongs projecting from a steel plate. The upper inner surfaces of the prongs are shaped to center the incoming round into the path of the breechblock as it moves forward. The top shoulder of the breechblock moves between the two prongs of the ejector. The prongs deflect the empty cartridge case downward as the breechblock moves to the rear.

The slide is connected by the magazine slide anchors and anchor support bracket to the cradle; it is, therefore, fixed while the gun recoils during firing.

Breechblock Group. The function of the breechblock group is to carry the round from the mouth of the feed mechanism into the chamber, fire the round, extract and eject the empty case, and support the case until it is deflected out of the receiver by the ejector. For detailed description of functioning, see Cyclic Functioning, which follows.

Gas Cylinder Sleeve Group. The function of the gas cylinder sleeve group is to unlock the breechblock so that it can be forced back by straight blowback action. For details of functioning, see Cyclic Functioning, which follows.

Recoil Group. The function of the recoil group is to absorb the shock of recoil of the gun and return it to battery. For details of functioning of the group, see the following topic.

Installation and Maintenance of the 20-mm M3 Gun

Removal and Installation of Thread Protector Sleeve Cap.

1. Unstake the thread protector cap.

2. Unscrew the thread protector cap and slide the thread protector sleeve off the gun tube.

3. To install, slide the sleeve on the tube, screw the cap in place, and stake the cap.

Removal and Installation of Flash Hider M4.

1. To remove flash hider, if assembled, proceed as follows: unscrew flash hider; unscrew the flash hider nut.

2. To install flash hider M4, proceed as follows: screw the flash hider nut on the tube; screw the flash hider on the tube.

Tube and Receiver Group: Maintenance by Using Arms. Gun tubes become copper fouled to less extent when cared for in the proper manner. Wear in the bore does not depend entirely upon the number of rounds fired; it also depends on the care given the bore in cleaning and cooling between periods of firing. Since the accuracy life of a gun tube is decreased by a fast rate of firing and the attendant heat, the gun should be allowed to cool and should be washed as often as practical. It is important that the gunner inspect the bore, whenever possible, to make certain that it does not contain extraneous particles that might cause damage to the gun.

1. Note general appearance of gun bore for wear and deformation of lands and grooves and for pitting and pastilles. Examine for evidence of powder fouling and rust. A clean bore is not necessarily a shiny bore and may frequently have a dull gray appearance. A shiny, polished bore might indicate that abrasives have been used in cleaning operations. If the lands and grooves are excessively pitted or deformed, the gun should be turned over to ordnance maintenance personnel for replacement of the gun tube.

2. Before firing, wipe the bore clean if expandable muzzle covers have not been installed or if the bore has previously been heavily oiled.

3. To clean the bore after firing, run several wet patches of bore-cleaning cloth impregnated with rifle-bore cleaner through the bore from the breech end. Remove the patch from the cleaning rod and attach the cleaning brush. Run the brush through the bore several times. Make certain that the brush goes all the way through before reversing the direction.

Tube and Receiver Group: Maintenance by Ordnance Maintenance Personnel.

1. Perform maintenance operations given above whenever necessary.

2. To clean the gas port, remove the gas cylinder vent plug and bracket plug and clean with No. 16 American Wire Gage (DWG–0.0508-inch diam-

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eter). Make certain that no bits of the wire are left in gas port.

3. To replace a gun tube, proceed as follows: remove cradle; remove gas cylinder sleeve group; extract the cotter pin and remove tube locking pin with tube lock removing tool; place receiver in receiver vise and clamp securely; install the tube clamp over the tube as close to the receiver as possible; unscrew the tube and clean the threads in the front of the receiver; before installing a new tube, examine the threads and coat them with a light film of graphited grease (light) to aid in assembly; install the tube and aline hole in the receiver with hole for the tube locking pin; ream a hole in tube to $^{25}/_{64}$ inch; install the tube locking pin and secure with a cotter pin.

Receiver: Maintenance By Using Arms.

1. Clean the receiver, particularly the portion near the tube, with rifle-bore cleaner to remove all primer salts. Wipe with a cloth dampened with oil.

2. Inspect the receiver for cracks, dents, or other damage; if any are found, notify ordnance maintenance personnel.

3. Check for burs, particularly on the receiver slides, breechblock locking key, and dovetail grooves for the rear buffer. Remove burs with crocus cloth or a fine oilstone. Do not remove more metal than is necessary.

4. If breechblock locking key is loose, notify ordnance maintenance personnel.

Receiver: Maintenance by Ordnance Maintenance Personnel.

1. Perform maintenance operations given above, whenever necessary.

2. Check condition of breechblock locking key. If loose or excessively worn, replace as follows: remove locking wire, the two cap screws, and the lockwashers from the breechblock locking key; remove the locking key plate and tap the breechblock key from the receiver with a brass drift and a hammer; when fitting a new key in place, make sure it is a snug fit in the receiver. Replace the receiver if key slot is elongated sufficiently to prevent a tight fit with a new key which meets specified dimensions; lay the plate on the key as an indication for positioning the key correctly; when proper alinement is obtained, secure the key and plate with cap screws and lockwashers; secure the cap screws with locking wire.

3. Check receiver slides for alinement and inspect the cam surfaces for damage. If slides are misalined or cam surfaces damaged, replace the slides as follows: extract the cotter pins and remove the castle nuts, lockwashers, and bolts to release the slides; clean the sliding surfaces of the receiver and slides thoroughly; install new slides in place, positioning them carefully; when slides are positioned correctly, install bolts and nuts; install cotter pins and bend the ends out of the way; install breechblock and see that it operates freely.

4. Check condition of all threaded holes in receiver and chase out if necessary.

Rear Buffer and Driving Spring Guide Removal.

1. With a blunt chisel, straighten the rim of the driving spring guide retainer so that it does not engage the driving spring guide head. Similarly, disengage driving spring guide cap lock plate from cap (if used), unscrew cap, and remove plate.

2. Insert the driving spring assembling tool through the driving spring guide head. Push the tool forward until it engages the driving spring guide plunger.

3. Unscrew the driving spring guide sleeve assembly, using the special rear buffer wrench. Remove the guide with the driving spring and plunger.

4. Retract the rear buffer lock plunger and remove the rear buffer group by sliding it out of the dovetail grooves in the receiver.

5. Keep the driving spring guide retainer with the rear buffer.

NOTE. Disassembly of rear buffer prohibited.

Rear Buffer and Driving Spring Guide Installation.

1. Slide the rear buffer up in the dovetail grooves of the receiver.

2. Retract the rear buffer lock plunger and slide the buffer upward until the plunger snaps into position in the slot in the receiver.

3. Position the driving spring retainer (old type) on the rear buffer so that pin on the retainer fits into hole on the rear buffer. New type retainer does not have a pin but has a flange which fits under the rear buffer.

4. Insert the split end of the driving spring assembling tool into the driving spring guide plunger.

5. Place the driving spring over the tool and plunger. Insert the driving spring guide into the driving spring so that it fits over the tool.

6. Insert the assembled unit into the receiver through the opening of the rear buffer, making certain that it slides into the bore of the breechblock.

7. Place the rear buffer wrench on the guide, press the guide in until it contacts the rear buffer, and then turn the tool to screw the guide into the buffer.

8. Bend the rim of the retainer on a flat of the guide.

9. Assemble cap lock plate (if used) on guide, screw cap onto guide, and bend rim of plate on a flat of the cap.

Rear Buffer and Driving Spring Guide: Maintenance by Using Arms.

1. Examine the rear buffer for rough or bruised surfaces on dovetail connections. Remove all rough spots with crocus cloth or fine oilstone to make a good push fit to the receiver. If fit is too tight, it will tend to spread the receiver; if too loose, it will cause the buffer to hammer the receiver.

2. Wipe the dovetail surfaces clean with a dry cloth but do not dip the rear buffer in any cleaning fluid. The rear buffer is lubricated with graphite at assembly and fluid will wash the graphite out and thus impair the functioning of the buffer.

3. Check the functioning of the rear buffer lock. If the lock malfunctions or if the buffer is otherwise damaged, replace the rear buffer. Remove all burs from the lock plunger but take off no more metal than is absolutely necessary; removal of excess metal will cause the plunger to fit loosely and allow the rear buffer to move vertically in the receiver.

4. Examine the retainer assembly for condition; note whether pin on face of retainer is broken, bent, or missing. If any of these conditions exist, replace the retainer.

5. Note condition of threads on the driving spring guide; if mutilated or excessively worn, replace the guide.

6. Check the guide tube for looseness in head and for deformation. If loose or bent, replace the guide.

7. Examine driving spring for any sharp kinks or offset of coils which might cause binding or excess friction and replace if these conditions exist or if free length is less than 23.5 inches.

8. Check driving spring guide plunger for straightness and note general condition and look for cracks or indications of fracture just in rear of head. Test to see that plunger moves freely in and out of guide. If plunger is bent or shows cracks, replace it.

Rear Buffer and Driving Spring Guide: Maintenance by Ordnance Maintenance Personnel.

1. Perform maintenance operations given above, whenever necessary.

2. Check for broken rear buffer spring by firing a burst of 10 or 15 rounds. If rear buffer gets heated up, the spring is broken and the rear buffer assembly should be replaced.

3. Check functioning of rear buffer lock spring. If weak or broken, drive out lock plunger pin, remove lock collar, plunger and spring, replace spring, and assemble.

Rear Buffer and Driving Spring Guide: Disassembly.

1. Unscrew the two magazine slide anchor front nuts.

2. Remove the rear buffer.

3. Remove the cotter pin from the ejector stud.

4. Unscrew the ejector stud nut.

5. Withdraw the ejector, taking care not to lose the two ejector springs.

6. Remove the ejector stud nut, washer (steel) and ejector stud washer (fiber).

7. Remove the lock wire and unscrew the magazine slide backplate screws, keeping the screws even.

8. Remove the backplate and the two latch springs.

9. Remove the cotter pin from the magazine slide to the rear and off the receiver.

10. Slide the magazine slide to the rear and off the receiver.

11. Remove the cotter pin from the anchor securing screw.

12. Remove the anchor screw lockwasher.

13. Unscrew the anchor securing screw and withdraw the magazine slide anchor from the magazine slide.

Rear Buffer and Driving Spring Guide: Assembly.

1. Fit the magazine slide anchor to the magazine slide. The threaded end of the anchor should point away from the front end of the slide. The anchor

should be on the same side with the anchor support bracket.

2. Screw in the anchor securing screw, replace the anchor screw lockwasher, and secure with the cotter pin.

3. Slide the magazine slide (anchor) leading on the gun.

4. Place the magazine latch on the upper grooves in the rear of the magazine slide. The sharp end of the latch should point toward the muzzle of the gun so that the angle surface on the latch can be seen when looking down.

5. Position the magazine slide lever on the magazine latch. The ball on the lever should fit into the hole of the latch, the lever handle should point to the rear, and the holes in the magazine slide should aline with the hole in the lever. Push in the lever pin and secure with the cotter pin.

6. Insert the two latch springs into their seats in the rear of the latch.

7. Place the magazine slide backplate flush against the latch springs and screw in the two magazine slide backplate screws. The screws should be screwed in evenly. Lock-wire the screws.

8. Insert the two ejector springs into their seats in the rear of the ejector. Position the ejector in the two grooves of the magazine slide below the latch and slide it to the rear until the ejector stud protrudes through the hole in the backplate.

9. Place the fiber ejector stud washer on the ejector stud, follow with the steel ejector stud nut washer, and then screw on the ejector stud nut. Secure the nut to the stud with a cotter pin.

10. Replace the anchor front nuts.

Rear Buffer and Driving Spring Guide: Maintenance by Using Arms.

1. Check movement of magazine slide on receiver. Remove any burs from guideways on slide. If magazine moves with excessive slide play, replace the slide.

2. Check functioning of magazine latch springs. If springs are weak, check free length and replace if necessary.

3. Check free length of ejector springs and replace if necessary.

4. Check movement of magazine latch in grooves of slide; it must slide freely. Remove any burs from the angle surface of the magazine latch and from the ejector.

5. If the ejector horns or the ejector stud show signs of fracture, replace the ejector.

6. Inspect the ejector for wear on the slides and on the two prongs. Use a smooth stone to remove burs from the prongs. The ejector must slide freely in the grooves of the magazine slide, but should have a minimum amount of side play. Replace ejector if stud is loose or threads damaged.

7. Replace the fiber washer on the ejector stud, if it is deformed.

Rear Buffer and Driving Spring Guide: Maintenance by Ordnance Maintenance Personnel.

1. Perform maintenance operations given above, whenever necessary.

2. Chase out thread holes in magazine slide whenever necessary.

3. If ejector stud is damaged or loose, drive out the ejector stud pin, unscrew the ejector, and examine condition of threads in ejector. Chase out if necessary, replace ejector, and pin securely.

Removal of Breechblock.

1. Remove the rear buffer.

2. Back up the two magazine slide anchor rear nuts all the way and move the magazine slide forward as far as it will go.

3. Place the breechblock unlocking tool on right side of breechblock in receiver and manipulate the tool so that the projection on the arm of the tool engages the front face of the right breechblock slide, and the other arm of the tool is along the top of the breechblock with its end against the receiver.

4. Press the lever of the tool forward until the breechblock is unlocked.

5. Move the breechblock to the rear of the receiver. As soon as it starts to come out, grasp the breechblock lock and hold it in the unlocked position. Failure to do this may cause the breechblock to get jammed in the rear portion of the receiver as it is being pulled out. Pull the breechblock out of the receiver. Do not drop the breechblock lock.

NOTE. If the special tool is not available, force the gas cylinder push rods rearward to unlock the breechblock or actuate with charger.

Installation of Breechblock.

1. Assemble the breechblock lock to the breechblock by forcing the breechblock slides rearward and, at the same time, exerting pressure against the lock until it is in the unlocked position.

2. Hold the breechblock firmly in this position and push it into the receiver as far as it will go so that the lock will not spring out of position.

3. Push breechblock home.

4. Replace rear buffer and adjust magazine slide.

Removal of Sear Mechanism.

1. Remove the cradle from the gun.

2. Straighten the 2 mounting screw lock plates, unscrew the 4 screws, and remove the cradle mounting plate from the receiver.

3. Insert the sear buffer retaining tool into the hole in the sear block. Push the tool through the sear block so that it fully engages the circumferential grooves on the sear buffer spring plungers.

4. Carefully lift the sear block and sear out of the receiver with the retaining tool in place. Remove the steel and fiber sear buffer blocks from the receiver.

Installation of Sear Mechanism.

1. Replace the sear with sear block in receiver. Do not remove sear buffer spring retaining tool.

2. Replace sear buffer steel block in receiver adjacent to the sear block.

3. Replace the sear buffer fiber block in receiver next to steel block with flat side adjacent to steel block.

4. Hold down the sear block and remove the sear spring retaining tool.

Disassembly of Breechblock.

1. Remove the breechblock lock. Remove the left and right inertia blocks.

2. Withdraw the left breechblock slide, being careful not to let the breechblock slide spring and guide fly out. Then withdraw the breechblock slide plate assembly, taking care not to let the spring and guide fly out. Do not remove the breechblock slide key except for replacement.

3. Press the extractor against the extractor spring and drift out the extractor pin. Withdraw the extractor and extractor spring. Lift the front end of the breechblock and allow the firing pin to slide out through the rear. Do not drop the firing pin.

Assembly of Breechblock.

1. Insert the firing pin in bore of breechblock, slide it forward, and position it so that slot in firing pin alines with the recess for the breechblock slide key.

2. Install the extractor spring and extractor and secure with extractor pin.

3. Install the right-hand breechblock slide assembly, making certain that the slide key engages the slot in the firing pin. Install the left-hand breechblock slide.

4. Mount one breechblock slide spring on the guide. Position the rear end of the spring (and guide) into the hole of the breechblock pin, and force the plunger and spring against pin and sideways into slide until the ball on guide is seated in circular seat in the slide. Similarly, install the second spring and guide.

5. Install the inertia blocks.

Disassembly of Sear Mechanism.

1. Withdraw the sear pin to detach the sear from the sear block.

2. Place the sear block in the sear block assembling tool, so that the radial bearing surface of the sear block contacts the jaw of the tool, while the plungers which protrude from the sear block engage the hook-shaped projection at the front of the tool. The seat buffer spring retaining tool should enter the hole in the sear block assembling tool.

3. Turn the handle of the sear block assembling tool sufficiently to take the tension off the sear buffer spring retaining tool. Remove the retaining tool. Gradually turn the handle of the tool to release the tension of the springs. Remove the plungers and springs. If the special sear block assembling tool is not available, an ordinary vise will serve. If the retaining tool is not available, use a slightly tapered steel rod which nearly fills the hole.

Assembly of Sear Mechanism.

1. Insert the sear buffer springs in their recesses in the sear block.

2. Replace the plungers with their hollow ends against the springs.

3. Place the unit on the sear block assembling tool with the flanged side of the sear block up, and with the radial bearing surface against the jaw of the tool. Compress the springs until the sear buffer spring retaining tool can be inserted to engage the grooves of the plungers.

4. Loosen handle and remove the sear block with retaining tool from the assembling tool.

5. Attach the sear to the block so that the forked end of the sear is on the same side as the flanged side of the sear block.

Breechblock: Maintenance by Using Arms.

1. Check freedom of movement in receiver.

2. Disassemble and clean breechblock.

3. Examine front face of bolt for erosion and wear, and note condition of firing-pin hole. If firing-pin hole is enlarged sufficiently to cause blown primers, replace the bolt.

4. Check for cracks on longitudinal shoulders of bolt. If shoulders are cracked, replace the bolt.

5. Remove all burs and rough spots from surface of bolt.

6. Examine breechblock slides for burs or rough surfaces on cam; remove burs or rough surfaces. Check for swedging near front end of slot for inertia block. Check for cracks around cam surface.

7. Check movement of firing pin in bolt. Remove any burs. Examine firing pin for pitting, deformation, or cracks. If firing pin is broken or bent, it should be replaced.

8. Examine inertia blocks for general condition. Check movement of blocks in breechblock slides. Remove any burs or rough spots.

9. Examine breechblock lock carefully for condition of cams on both sides and for wear or roughness on hinging locking surfaces. Check under side for wear.

10. Test tension of breechblock slide springs; replace if broken or shorter than allowable free length.

Sear Mechanism: Maintenance by Using Arms.

1. Examine sear mechanism for general condition.

2. Check for wear or roughness on sear surface.

3. Check plunger for burs or rough surfaces around the disassembling recesses.

4. Remove all rough spots and burs.

5. Check tension of sear buffer springs; replace if broken or shorter than allowable free length.

Breechblock Group: Maintenance by Ordnance Maintenance Personnel.

1. Perform maintenance operations on breechblock and sear mechanism whenever necessary (see two preceding topics).

2. Measure diameter of firing-pin hole, which should be 0.156 inch + 0.004. A No. 22 (0.157) standard drill can be used to clean the firing-pin hole to proper size.

3. Measure firing pin protrusion; it should be 0.100 to 0.110 inch. If protrusion is less, discard firing pin.

4. Note condition of breechblock slide key; see whether taper pin is in place or loose. If taper pin in key is loose, replace with a new pin.

5. Note condition of breechblock pins. If loose or damaged, drive out breechblock pin taper pins and replace breechblock pins and taper pins.

6. Measure radius of scar. If radius is less than 0.04 inch, replace the scar.

Gas Cylinder Sleeve Group: Disassembly.

1. Remove cotter pin and lockwasher from gas cylinder guide and unscrew gas cylinder sleeve spring.

2. Remove gas cylinder sleeve spring.

3. Remove locking wire from gas cylinder bracket plug and then remove the gas cylinder lockwasher. Unscrew gas cylinder bracket plug.

4. Remove gas cylinder lock plate and unscrew gas cylinder with the sleeve.

5. Push the gas cylinder sleeve to the rear and remove gas cylinder with the sleeve.

6. Withdraw the gas cylinder sleeve push rods.

Gas Cylinder Sleeve Group: Assembly.

1. Insert the gas cylinder sleeve push rods into their recesses in the receiver.

2. Assemble gas cylinder to the gas cylinder piston on the sleeve, position the unit on the gun tube, and slide it forward so that the gas cylinder fits in the opening in the gas cylinder bracket.

3. Screw in the gas cylinder vent plug and replace the gas cylinder lock plate.

4. Screw in the gas cylinder bracket plug, replace the gas cylinder lockwasher, and secure with locking wire.

5. Replace the gas cylinder sleeve spring.

6. Screw in the gas cylinder guide, replace lockwasher, and secure with the cotter pin.

Gas Cylinder Sleeve Group: Maintenance by Using Arms.

1. Examine all parts for condition. If sleeve is bent, replace it.

2. Check tension of gas cylinder sleeve spring; if kinked or shorter than allowable free length, replace it.

3. Check movement of gas cylinder sleeve guide in sleeve. Guide should have a medium close fit in sleeve. If clearance is excessive, replace with new parts.

4. Check gas cylinder vent plug for looseness; if loose, replace it. Whenever replacing the vent plug,

use the new type of vent plug (larger vent hole) which can be identified by the part number stamped on its face.

5. Remove all carbon and any other foreign matter from cylinder, piston, bracket, and plugs.

6. Remove burs from piston if not burred excessively. If it is excessively burred, replace gas cylinder sleeve with piston.

7. Check movement of push rods in their recesses in the receiver. Remove all burs from push rods.

Gas Cylinder Sleeve Group: Maintenance by Ordnance Maintenance Personnel.

1. Perform maintenance operations given above whenever necessary.

2. Guns that were converted to the T31 (M3) included both long and short chamber tubes. To provide proper chamber length, approximately two threads of length were removed from the long chamber tube before installation in the weapon, which resulted in a misalinement between the tube gas port and the bracket gas port. This misalinement was originally compensated for by applying a 45° chamfer to the bracket gas port.

Cyclic Functioning of the 20-mm M3 Gun

The cyclic functioning of the weapon as a whole, from the firing of one round to the next, is described in the following paragraphs. For purposes of explanation, the cyclic functioning is divided into the following actions: recoil action; breechblock unlocking action; extraction and ejection; rear buffer and driving spring action; cocking action; feeding and chambering; breechblock locking action; and firing action.

Recoil Action. When the round is fired, the pressure of propellent gases in the tube forces the gun to recoil to the rear for about 1 inch. As the gun recoils, the recoil spring front seat located on the gun tube moves to the rear and compresses the recoil spring. Since the compression of the ring spring in the recoil housing assembly is greater than the final force of the recoil spring, it can thus be seen that during this phase of the recoil, the recoil spring alone will offer resistance to the rearward movement of the gun. The action will continue until the gun has recoiled for about seven-eighths inch. At this point, the rear end of the recoil spring front seat contacts the front end of the recoil spring rear seat, thus stopping the compression of the recoil spring. While the recoil spring rear seat begins to compress the ring spring of the recoil housing assembly which absorbs the remaining shock of recoil, the recoil spring begins to recover. The recovery of the recoil spring returns the gun to battery.

The ring spring of the recoil housing assembly will act as a counterrecoil buffer if the gun should travel past its battery position. The ring springs will be compressed in the same manner as during recoil movement of the gun, but the action of the parts will be reversed.

Breechblock Unlocking Action. The breech is unlocked by the action of the gas cylinder sleeve group. At the moment of firing, the breechblock is held in its forward position by the action of the breechblock lock. The lock engages the breechblock and bears against a surface of the breechblock key. The breechblock slide engages the lock, thus preventing the lock from being forced upward prematurely.

As the round is fired, the projectile is driven forward in the tube, passing the gas port. A portion of the expanding gases enters the gas port and passes through the gas cylinder vent plug into the gas cylinder. As the gas expands against the gas cylinder piston, it forces the piston and the gas cylinder sleeve (integral with it) to the rear, compressing the gas cylinder spring.

As the sleeve is forced to the rear, the yoke on the sleeve contacts the two push rods which, in turn, move the breechblock slides rearward to unlock the breechblock. The slides are connected to the slide key which engages a slot in the bottom of the firing pin. As the slides are forced rearward by the push rods, the key retracts the firing pin. The moment the breechblock is unlocked, it is forced to the rear by blowback action with a resultant drop of gas pressure in the tube. As the gas pressure drops, the gas cylinder sleeve spring expands, returning the sleeve and piston to the original position.

Extraction and Ejection. When the breechblock assembly is forced to the rear, the empty cartridge case, which has been forcing the bolt back by blowback action, is contacted on the upper edge by the two prongs of the ejector, forcing the cartridge case to pivot about and force downward the forward end of the extractor. The cartridge case leaves the lip of the extractor and moves through an opening in the bottom of the receiver, completing the ejection

of the empty cartridge case. When the cartridge case frees itself from the extractor, the extractor is returned to its normal position by the action of the extractor spring.

Rear Buffer and Driving Spring Action. As the breechblock is driven rearward, it compresses the driving spring. When the breechblock nears the end of its rearward movement, it strikes the rear buffer washer which transmits the shock of recoil to the buffer springs which absorb the remaining force of recoil and bring the breechblock to a stop. As the breechblock comes to a stop, the inertia blocks continue to move rearward in their slots in the breechblock slide until they reach the end of the slots. By this time the breechblock has started forward again, and the inertia blocks remain in a rearward position with respect to the breechblock slides during the forward motion of the breechblock. The rear buffer springs and the driving spring expand, forcing the breechblock forward.

Cocking Action. As the breechblock is forced to the rear by blowback, it passes over and depresses the sear; then, when the breechblock starts forward and the scar is released, the scar will engage the breechblock lock and hold the breechblock in the rear position. The shock produced when the sear and breechblock engage is absorbed by the sear buffer springs and the sear buffer plates. If the sear is held down by actuating the trigger, the breechblock will move forward into the locked position under the force of the driving spring.

Feeding and Chambering. When the recoiling breechblock is sufficiently far to the rear to clear the feed mechanism, a new round is forced downward into the mouth of the feed mechanism. As the breechblock is forced forward by the driving spring, it engages the new cartridge which has been positioned in the mouth of the feed mechanism. As the cartridge is forced forward, it drops into the recess in the bolt where it is gripped by the lip of the extractor as it enters the chamber.

Breechblock Locking Action. As the breechblock reaches the end of its forward motion, it seats against the end of the tube, closing the chamber. The momentum of the slides and the action of the slide springs cause the slides to continue to move forward, releasing the breechblock lock. At the same time, projecting cams of the lock are engaged by cam surfaces on the receiver slides which, together with the action of the cams on the bevel of the lock, cam the lock downward. The lock seats against the breechblock key and is locked in its downward position by the lower surface of the breechblock slides, which move over the rear end of the lock.

Firing Action. As the slides approach the end of their forward motion, the firing pin is carried forward by the slide key and the driving spring to fire the round. When the slides have reached the end of their forward motion the inertia blocks continue to move forward for a short distance, striking against the forward end of the slot, thereby counteracting any tendency to rebound that the slides or pin might have.

Development of the M24 Series of Guns

As outlined earlier in this section, the T31 (M24) designation was chosen to represent the T31 gun made to synchronize by means of separate interchangeable actions and to fire electrically primed ammunition. For supply reasons the T31 (M24) gun was made substitute standard in November 1947. The designation M24 was then officially given.

20-mm M24A1 Gun. Intensive development of the M24 gun began in late 1947, following urgent requests from the Air Force that certain requirements be met. Tests at Aberdeen Proving Ground revealed a number of deficiencies and resulted in development tests and adoption of various new components culminating in the release for production of M24A1 guns. This model contained all prior improvements as well as additional changes which necessitated the revised nomenclature. Comparison of the M24 gun as it was constructed in 1947 with the M24A1 gun reveals the following improvements in the later model: Pawl-type bolt to aid in extraction and ejection of misfired rounds; a receiver made from a new forging instead of by modification; an improved gas system which reduced leakage, had fewer parts, had greater durability, and required less maintenance; redimensioning of the firing-pin parts to eliminate time delays in synchronization and the possibility of momentary "shorts"; various components having greater durability, including a two-piece driving spring and corresponding guide, breechblock lock and locking key, firing-pin contact, gas-cylinder return spring, breechblock slide

springs, firing cable, and various locking devices. In addition, the M24A1 gun incorporates provisions for a chamber plunger required by the Air Force in connection with new charger developments for a synchronizing switch which was still under development.

20-mm M24A2 Gun. One change to the M24 gun consisted of the addition of a plunger to the top rim of the chamber and the removal of some metal from the top of the bolt body as developed by the Air Force and incorporated in all M24 guns used in the B36 aircraft. Guns so modified were designated M24E2.

The purpose of this modification was to eliminate failures to charge out a misfired round in the B36 aircraft. However, although improvements resulted, tests showed the operation of the gun in charging to be marginal in the B36 and unsatisfactory in other circumstances, and all M24E2 guns would eventually be replaced by the M24A1. The charging failures experienced in the B36 aircraft caused double feeding, which not only put the gun out of action but also occasionally resulted in explosions caused by ignition of the misfired electric primer by the nose of a practice projectile. In addition to development of the pawl bolt used in the M24A1 gun the following measures were taken:

1. To prevent double feeding, a study of means necessary to prevent double feed rounds caused by failures to charge or extract led to development and tests of a so called "antidouble feed device". The first attempt was unsuccessful.

2. A study was also initiated to determine whether there was actual danger of explosion when an HEI round was involved instead of a practice round. Incomplete results indicated that the danger was very slight.

20-mm M24E1 Gun. This nomenclature was assigned to the M24 gun when modified to fire 1,600-grain projectiles. Some preliminary testing was accomplished indicating that only minor changes would be required, including changes to the gas vent plug and filler pieces added to the feed mechanism because of the reduced projectile length. Further testing was suspended due to the urgency of work on the M24 gun.

Tests Conducted in 1948–1949. Along with the intensive development of the M24 gun begun late in 1947, various firing tests were initiated. In May 1948, a stock of old electric ammunition (N3 primed), which had been located at the Picatinny Arsenal, was fired. Two new guns were started using the Navy-manufactured firing-pin parts and one example each of two designs of slide key (heat treatment changes designed to increase the impact properties of the steel). Results of 1,500 rounds per gun are as follows:

Due to gun: One cable failure at less than 500 rounds; firing-pin guides peened and had to be deburred after each 250 rounds of firing.

Due to defective link: One link tab broke, causing failure to feed.

Due to ammunition: Four primer failures, four small leaks in first 500 rounds per gun.

New cables were ordered from Watervliet Arsenal incorporating changes suggested by General Electric. The Magnavox Co. was approached on the fabrication of several experimental cables incorporating their suggestions.

New firing-pin contracts incorporating suggestions of Aberdeen Proving Ground and of the Ordnance Corps were secured from Watervleit Arsenal.

Slight modifications of the firing-pin guide and slide key, designed to replace line contact between the tube by area contact, were developed.

Twisted wire slide springs were ordered from Eaton Manufacturing Co.

Perhaps the most critical phase of this development was that involving the electric primer, which was under ORDTM. Following is a brief summary of events in this field from October 1947 to October 1948.

1. T44N10 primer was tested and appeared satisfactory at ambient temperatures. The primer was standardized as M52.

2. Test of the M24 gun at −65° F. revealed that the ammunition had excessively high-pressure peaks at low temperatures, the difficulty being traced to the quantity of primer mix. A reduction from 4 to 2.5 grains of mix was found to eliminate this difficulty, and this primer (the T44N10E) was in turn standardized as the M52A1.

3. Turret tests with guns synchronized revealed the inadequacy of the M52A2 primer under these conditions, the difficulty being attributed to the fact that the primer button was unsupported. This difficulty resulted in greatly accelerated development of

new types, including the T44N11, the M52A1 with a supporting cup added, and the T44N13.

4. Limited tests of the T44N11 were not completely satisfactory.

5. Limited tests of the M52A1 with supporting cup were more promising and resulted in its standardization as the M52A2 and instructions to Picatinny Arsenal to convert to it as soon as possible.

Kinematic studies and analyses of the gun revealed that there were several possibilities for momentary "shorts" and that slide bounce would interfere with synchronization at rates of fire near the gun's free rate. Changes in the firing pin parts to eliminate these difficulties were devised, tested, and incorporated in future production.

A considerable volume of endurance firing during the year resulted, first, in a fairly complete knowledge of the weaknesses of the gun, and, second, in considerable progress toward correcting them. In addition to the changes in firing-pin parts, several changes in locking devices were approved for production, and certain other parts appeared satisfactory but were still under tests.

Only limited endurance firing was possible in the latter part of 1948 because of shortage of ammunition, and firing was then stopped completely until ammunition was received. This condition was expected to be corrected in the immediate future since a total of a hundred thousand rounds of ammunition was reportedly in route to Aberdeen Proving Ground at the time.

The M52A2 primer continued to show improvement. However, no air firing had been conducted at this time and that was, of course, the necessary final test of the primer. Meanwhile, arrangements had been made to test fire 5,000 rounds of T44N13 primed ammunition for endurance. Preliminary tests of the latter primer indicated satisfactory results.

Evidence at hand at this time showed that the only completely satisfactory method of firing any of the primer types was by condenser discharge. In this connection, the General Electric's electronic synchronizer, developed at the B36 turret, had been found inadequate for low resistance primers. Since the specification for the M52A2 primer permitted a resistance as low as 500 ohms and the majority of the primers were below 10,000 ohms, the circuit therefore required modification.

Production waxing of ammunition had resulted in several failures to extract due to too little wax. It was found that a spraying process was being used and that a thickness of coat of 0.0003 inch maximum was specified, but no minimum. As a temporary measure, the arsenal was instructed to maintain a coat thickness as close to the maximum as possible. Meanwhile, arrangements were being made for a test of ammunition waxed to thicknesses of 0.0003, 0.0005, 0.0007, the object being to determine the maximum thickness that could be specified without excessive residue so that a range of thickness could be specified. The high-altitude tests were to begin at the Naval Proving Ground at Dahlgren and when completed, all reports to be studied.

In 1949, an M3 gun with a fluted chamber was air fired 5,000 rounds using dry ammunition. The test was conducted at Dahlgren. There were no extraction stoppages. However, failures to feed occurred, probably due to drying out the oil on the parts of the gun firing dry ammunition. The air firing of the M3 gun showed excellent results.

In March 1949, in ground firing at Aberdeen, Md., 14,500 rounds were expended and parts life according to the existing parts replacement schedule was further substantiated. Nylon insulation of the firing pin and firing-pin guide failed consistently before a satisfactory number of rounds had been fired. Cold test firing revealed no arcing in 1,800 rounds, and two misfires experienced were attributed to short-circuited primers. The Ballistic Research Laboratory firing circuit was used for 300 rounds, and the remainder of 1,500 rounds were fired with the dynamotor unit.

Investigations at Picatinny Arsenal on waxed ammunition resulted in a satisfactory method of gaging the thickness of ceresin wax and a dipping process had been set up by utilizing production methods. Ammunition was being wax coated with a slightly less than 0.0003 inch coating which is a maximum figure under the present specification. Further tests were made to ascertain whether the existing specification (0.0003 inch) should be changed.

In the spring of 1949, agreement was reached between the Air Force and the Ordnance Corps to the effect that the Air Force firing circuits would henceforth employ the condenser discharge method of firing upon which the design of both the primer

and gun had been based. This agreement grew out of reports of a high instance of misfires.

The Ordnance Corps also agreed to assist the Air Force by providing two General Electric control boxes modified to incorporate the condenser discharge circuit developed by the Ballistic Research Laboratory and previously submitted to the Air Force. This work was done by Armour Research Foundation, which was provided with two General Electric control boxes and the necessary circuit information. The first of the boxes were expected to be completed within the first month and were sent to the Consolidated-Vultee Aircraft Corp. for tests, accompanied by Armour and BRL personnel.

From study and analysis of the tests conducted there, the following changes designed to improve life of the parts was adopted.

1. Firing-pin contact: A new design, good for 2,500 rounds or more, was substituted for the former standard part which required replacement after each disassembly.

2. A change in the bolt body was made to make possible easier disassembly of the firing-pin contact. A special tool had been adopted for use in connection with the modified bolt body.

3. Extraction failures were believed to be eliminated by production ammunition which had an adequate wax coating. However, tests were under way to determine the maximum film thickness that would permit firing of 1,000 rounds without removal of wax deposits from the gun.

In 1939, after the Air Force had experienced several instances in which a round was double fed on top of a misfire which failed to be extracted out of the gun, resulting in ignition of the primer and damage to the gun, a test was run to determine the effect of this malfunction if HEI and I rounds were involved. Although I rounds were found to be unaffected, HEI rounds exploded causing considerable damage. Accordingly, Armour Research Foundation was requested to undertake a study to determine what change to the gun would be necessary to eliminate or diminish this possibility.

It was pointed out that with improvement in primers and firing circuits, an adoption of one or the other of the designs which were in process to make charging of live rounds more positive, the odds against this type of malfunction could become quite large.

Attempts to fire rounds assembled with the T59E1 primers were unsuccessful, due to the small primer button coupled with accumulated tolerances and clearances in the gun.

SECTION 3. DEVELOPMENT OF THE 20-MM T34 SERIES OF GUNS

In April 1945, an urgent request was received from the Bureau of Ordnance, Navy Department, for a high cyclic rate 20-mm automatic gun to be used for antiaircraft fire against Japanese suicide planes. The nomenclature T34 had been assigned in November 1944 as one approach to a high-cyclic-rate operation and many of the principles of this weapon had been tested using standard 20-mm ammunition. Ordnance Committee action was taken to delete the high-velocity requirements in order to fulfill the Navy requirements, and the T34 gun was converted to standard ammunition. The Navy request of April 1945 called for 200 such guns.

The T34 weapon was based on experiments carried on at the Naval Air Test Center at Patuxent River, Md. Modifications of existing components were made to speed up the action of the gun. A Belleville spring buffer was substituted for the conventional spring buffer. The bolt was skeletonized, and the weight was accordingly reduced. The piston was plugged to within 0.202 inch in order to create a high-compression stroke. The functioning of the gun, the detail description of components, and the general data for the T34 are the same as for the T31.

By V–J Day, 12 T34 guns with a claimed parts life of 1,500 rounds with 2 exceptions had been delivered.

Tests revealed numerous deficiencies, chiefly short-lived parts such as driving spring, firing pins, gas piston rings, receiver slides, and slide keys.

The original models of the T34 were built by Oldsmobile. The principal importance of the model is the fact that it was the connecting link between the M3 and the Mk 12 guns. Before this high-speed weapon could be perfected, World War II ended, and all activity concerning the development of the T34 was dropped. There was a lull

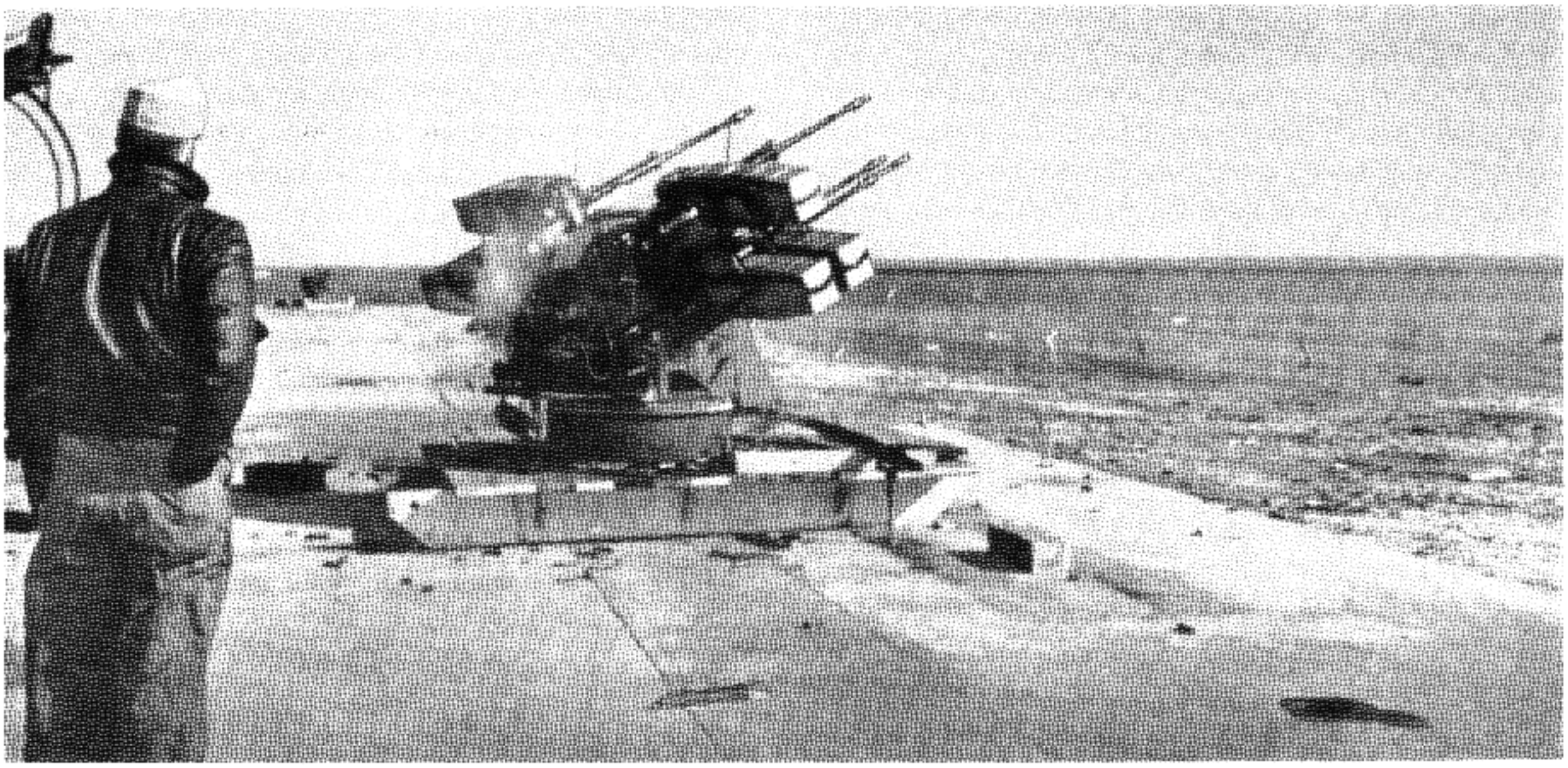

Figure 13–17. Prototype of Gun, Automatic, 20-mm T34 on an anti-Kamikaze mount nicknamed the "blizzard buggy".

Figure 13–18. 20-mm Gun T34. Gun No. 25119 mounted on a test stand having spring of 7,600-pound-per-inch rigidity.

of 3 years, from 1945 to 1948, before any further development work was undertaken.

Development of the T34E1 Gun. This weapon was an electrically fired version of the T34, development of which was commenced in 1948. The purpose of the project was to meet a Navy requirement for high-cyclic-rate, electrically fired guns. Early changes eliminated two of the most serious T34 deficiencies. The receiver weakness was eliminated by utilizing a modified M2 receiver of which a large stock was available, and the driving spring was removed by utilizing a double-acting pneumatic charger fitting into the new receiver. Later changes which appeared to correct nearly all known deficiencies included a new pneumatic buffer, double slide key with internal slide spring, and a new type firing pin assembly having a buffer which floats against the rear slide key.

Development of the T34E2 Gun. This nomenclature applied to the T34E1 gun when modified to fire 1,600-grain projectiles using a standard Hispano-Suiza cartridge case. The development was held in abeyance pending solution of difficulties on the T34E1 gun.

SECTION 4. DEVELOPMENT PROGRAM FOR 20-MM MARK 12 GUN

General Description

This high-cyclic-rate, high-velocity, aircraft automatic cannon is intended for both air-to-ground and air-to-air combat. The two versions of the gun vary in barrel length. The longer version is designated Mk 12 Mod 0 and is discussed in detail in this section. The shorter gun, with an overall length of 52 inches, was designed primarily for turret use and is designated Mk 12 Mod 1. It is presented here only in the form of an illustration, as the basic operating principles are identical with the Mk 12 Mod 0.

The cannon is similar to the 20-mm automatic gun T34E1 as to the principle of operation, but it fires a lighter projectile with a larger powder charge at a higher rate of fire and an increased muzzle velocity. The 20-mm gun mechanism Mk 12 Mod 0 with the 20-mm gun barrel Mk 11 Mod 0 may be substituted, as a unit, for the 20-mm automatic gun M24, provided that the physical characteristics of the installation can withstand the increased trunnion loading and increased rate of fire, and that the necessary compressed air is available

The basic design of the weapon features a combination of blowback and gas operation to open the breechblock. The breechblock is unlocked by gas operation and opened by blowback. The breechblock is returned to its closed position by a pneumatic buffer at the rear of the receiver. The

General Data: 20-mm Gun Mechanism Mk 12

Gun length: 75.187 inches.
Gun weight, with feeder (Mk 7): 88 pounds.
Rate of fire: 1,000–1,100 rounds/minute.
Muzzle velocity: 3,200–3,400 feet/second.
System of operation: Gas operated.
System of locking: Swinging lock.
System of feeding: Pneumatic feeder, metallic belt.
Method of headspace: None.
Location of feed opening: Right- or left-hand side of receiver.
Location of ejection opening: Bottom of receiver.
Method of charging: Air.
Method of cooling: Air.
Gun width, without feeder: 5.690 inches.
Gun height, without feeder: 5.276 inches.

Barrel length: 48.042 inches.
Barrel weight: 31.5 pounds.
Rate control: None.
Barrel removal: Quick disconnect.
Bore:
- Number of grooves: 9.
- Groove depth: 0.015 inch.
- Groove width: 0.205 inch.
- Pitch: 7° (equals 1 turn in 25.587 calibers and 1 turn in 20.137 inches).
- Direction of twist: Right hand.
- Form of twist: Constant.

Cartridge: 20-mm T130 series, high velocity.
Trunnion reaction (based on 95,000 pounds/inch rigidity test mount):
- Recoil: 3,300 pounds.
- Counterrecoil: 5,000 pounds.

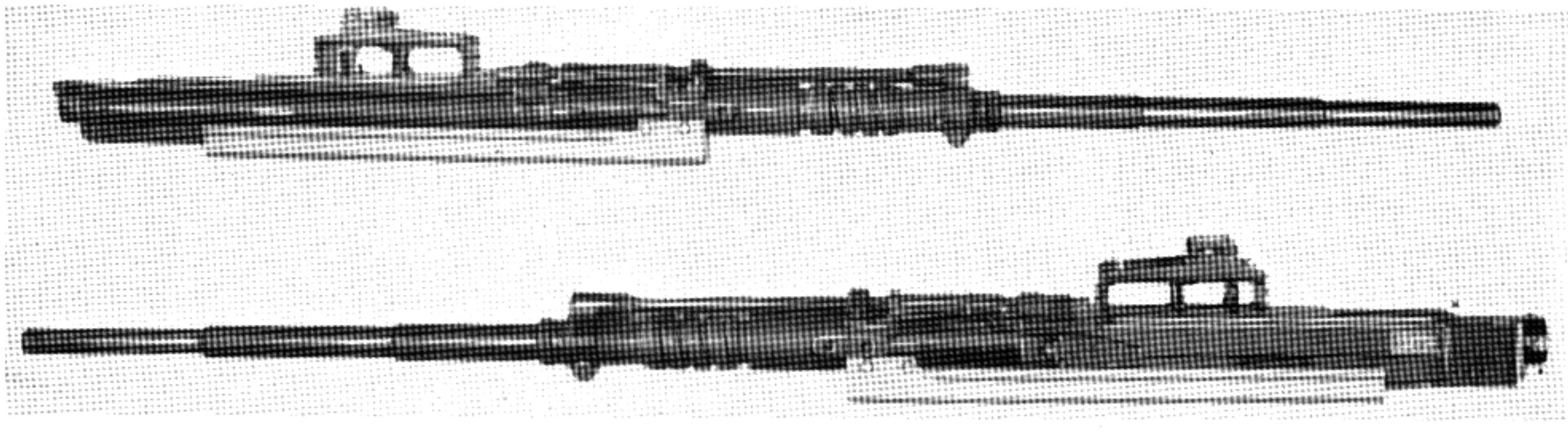

Figure 13–19. 20-mm Machine Gun Mechanism Mk 12 Mod 0.

gun is automatically electrically fired and will continue to fire as long as the firing circuit is closed and ammunition is available.

This weapon uses external power for feed to prevent lowering rates of fire due to (1) diversion of recoil energy, and, (2) increased loads at low temperatures. Pneumatic buffers, using a reasonably small air bottle and air compressor, appear satisfactory when a piston-type feeder motor is used. A new type electric motor drives the electric feeder when this type is used. This motor, under development in 1950, employs a magnetic clutch and should overcome the deficiency of former ones employing the solid clutch which had a time lag in starting under load. There was also under development in 1950 new type recoil feeders to provide sufficient recoil energy to operate the feeders satisfactorily.

The gun mechanism is supported in the cradle, and the cradle has fixed mountings in a support designed for mounting in either turret or fixed mounting. The cradle guides the gun mechanism in recoil and counterrecoil. Nonrecoiling parts of the gun mount are the cradle and the recoil housings of the recoil mechanism.

Detail Description

Components. The weapon consists of the following components: gun barrel, gun mechanism, recoil mechanism, receiver, breechblock, cradle, charger, gas mechanism, and buffer assembly.

Gun Barrel. 20-mm gun barrel, Mk 11 Mod 0 is a tubular alloy steel forging. Threads on the breech end of the gun attach it to the receiver. A locking pin hole on the under side of the breech end is engaged by a locking pin in the receiver assembly, preventing rotation of the gun barrel after assembly with the receiver.

The breech end of the gun bore is internally machined to the shape of the cartridge to form the chamber. The chamber has 16 longitudinal grooves machined in the sides to insure proper extraction of the cartridge case. The rear walls of the chamber are smooth to insure proper gas sealing.

Rifling grooves are cut in the bore from just forward of the chamber to the muzzle, interrupted only by the gas port drilled through the top of the barrel.

The exterior of the barrel is tapered in steps from the breech end to the muzzle. An external thread is machined near the center of the gun for attaching the gas bracket and retaining the recoil mechanism.

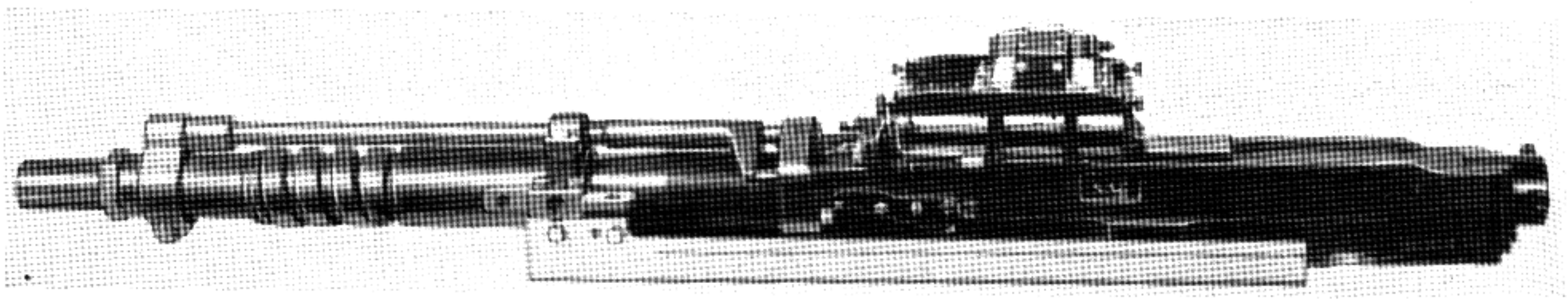

Figure 13–20. 20-mm Machine Gun Mechanism Mk 12 Mod 1, left side view.

To the rear of this thread, the gas port is drilled through the top of the barrel.

Gun Mechanism. The gun mechanism includes the recoil mechanism, the receiver, the breechblock, the cradle, the charger, the gas mechanism, and the buffer assembly.

Assembled Arrangement. The cradle is a mounting unit for the recoiling receiver. The receiver is the main structural member of the gun mechanism. It houses and acts as a guide for the reciprocating breechblock and charger. The charger is on the right side of the receiver and actuates the breechblock for first-round loading and round-clearing actions. The gas mechanism is attached to the gun; it actuates the breechblock slides to unlock the bolt after firing. The buffer is mounted at the rear of the receiver to absorb the force created by the movement of the breechblock rearward and to return the breechblock to battery position.

Recoil Mechanism. The recoil mechanism is a spring mechanism that checks the movement of the recoiling parts and returns them to battery. The arrangement consists of: two spring assemblies; an external, flat, helical, recoil spring assembly; and a housed ring spring assembly.

RECOIL SPRING ASSEMBLY. The recoil spring assembly consists of a front seat, recoil spring, a rear seat, and a spacer.

The front seat is a flanged cylindrical sleeve that fits over the gun barrel. The flanged, rear end seats the forward end of the recoil spring; the front of the seat is held by the gas bracket attached to the gun barrel.

The recoil spring is a heavy, helical spring positioned around the gun barrel between the front and rear seats. During recoil, the front seat moves back with the gun to compress the spring against the rear seat. The spring has 4.6 coils, 2.6 active. Its free length is $4\frac{47}{64}$ inches, and its inside diameter is 2.188 inches. A force of 350 pounds is required to compress it to 4.375 inches in length. To compress it to 3.50 inches, 1,200 pounds are required.

The rear seat is concentric with the gun barrel and is free to move along the barrel. The rear of the recoil spring fits against the forward end of the rear seat. The after end of the rear seat contacts the spacer inserted between the forward follower of the recoil ring spring assembly.

RECOIL HOUSING ASSEMBLY. The recoil housing assembly houses an arrangement of the ring spring, forward and rear followers, and a sleeve. The housing is a cylindrical steel tube concentric with the gun barrel. It is secured to the nonrecoiling aircraft mounting by horizontal cylindrical trunnions at the rear.

The ring spring is an arrangement of internal and external rings. During recoil, these rings are forced together, tending to flatten the V-shaped cross sections of the rings to absorb the final recoil movement.

Ring-spring followers are enclosed in the housing forward, aft, and to the rear of the ring spring to hold the rings in position. The forward follower transmits the recoil load from the recoil assembly spacer to the ring spring. In recoil, the rear follower functions as a spring seat as it is held by the sleeve. In counterrecoil, the rear follower transmits the counterrecoil forces from the gun barrel shoulder to the ring spring. The sleeve is an externally threaded steel cylinder that screws into the rear of the housing. It positions, preloads, and retains the ring spring in the housing.

RECEIVER. The receiver houses or supports all working parts of the gun mechanism and provides attaching surfaces for the feed mechanism.

RECEIVER BODY. The body is a hollow, rectangular-shaped member, partially open on the bottom and top and fully open at the rear. It is approximately $23\frac{3}{4}$ inches long, $4\frac{1}{2}$ inches wide, and $4\frac{1}{2}$ inches high. The front of the receiver is internally threaded for attachment to the gun barrel and has a machined hole on the under side for the gun barrel locking pin. At the top front is a threaded hole for attaching the gas mechanism sleeve guide. The underside is open from the front to approximately the center to permit ejection of empty cartridge cases. The breechblock locking key is mounted in oval-shaped transverse slots in a swelled-out section of the body sides just rear of the ejection slot. The left side is machined to attach the synchronizing switch. A longitudinal cylindrical protrusion on the right side is bored to house the gun charger assembly. At the rear are machined two dovetailed slots for attaching the buffer.

RECEIVER PLATE. The plate is a machined rectangular-shaped part that attaches in the bottom

rear of the receiver. It provides sliding surfaces in the rear of the receiver for the breechblock.

RECEIVER SLIDES. The receiver slides are thin plates bolted to the right- and left-front inner sides of the receiver body. With the receiver plate and the breechblock key, they guide and support the breechblock. At the rear of each slide is a protruding cam which assists in forcing the breechblock lock down during the locking action.

BREECHBLOCK LOCKING KEY. The locking key is a solid metal block that fits into the elongated slots on either side of the receiver body. Two tapped holes provide attachment for a retaining plate to hold the key in place. The key provides the bearing surface for the breechblock lock during firing and acts as an abutment for the lock in the locked position.

GAS CYLINDER SLEEVE GUIDE. The sleeve guide is a cylindrical rod fastened to the lug on top and in the front end of the receiver by means of the threaded hole. It guides the gas-cylinder sleeve.

Breechblock. The breechblock is the reciprocating assembly that brings the loaded cartridge into the gun, closes the breech, fires the round, and removes the empty cartridge case. The following components comprise the breechblock: bolt, breechblock slides, firing-pin assembly, extractor, breechblock lock.

BOLT. The bolt is the main component of the breechblock. It closes the breech when firing and houses the firing-pin assembly. In the bolt, two horizontal slots are machined, one at the front and the other about halfway to the rear. These slots provide an opening for assembly of the forward and rear slide keys and are elongated to allow motion backward and forward during unlocking and locking action of the breechblock. A longitudinal hole through the bolt houses the firing-pin assembly, slide spring, and plug. The hole tapers in the front to permit protrusion of the firing-pin tip. Two long shoulders, one on either side at the bottom of the bolt, form bearing surfaces for the breechblock assembly in the receiver. A machined surface in the bottom of the bolt provides a pivot for the breechblock lock. On the left side, to the rear of the front slide key slot, is a machined groove for the firing pin contact.

BREECHBLOCK SLIDES. Two breechblock slides, one on each side of the bolt, support and guide the bolt in the receiver. They function to interlock firing and breechblock locking actions. Each is a similar steel piece about 8½ inches long with a rectangular cross section. The forward and rear slide keys extend between the two slides through the breech bolt. The right slide has a lug at the rear that contacts the charger latch to actuate the breechblock. The left slide has an insulated contact wire that contacts two wires of the synchronizing switch to complete the firing circuit when the slide is completely forward.

FIRING-PIN ASSEMBLY. The firing-pin assembly completes the electrical circuit for discharging the ammunition. The assembly consists of a firing pin, guide bushing, guide sleeve, contact, guide insulator, insulating washer, spring plug, and spring, all housed in the bolt. The firing-pin contact connects the firing pin to the synchronizing switch.

The firing pin is arranged within the bolt so that it is electrically insulated from the bolt whenever the pin is retracted or the bolt is in battery with the cartridge in the chamber.

The firing pin is retracted by the forward slide key. The key extends between the right and left breechblock slides through the guide sleeve and bushing. When the slides are moved rearward by the gas mechanism, the guide sleeve and bushing are moved rearward carrying the firing pin to a retracted position. On return to battery, the breechblock slides move forward to release the firing pin allowing it to be extended by the firing-pin spring.

EXTRACTOR. The extractor removes the cartridge from the chamber when the breechblock begins its rearward movement. It is held in place on the forward underside of the bolt by a pin through the bolt and to the volute springs. The springs pivot the extractor to engage the cartridge and to protect the extractor lips when hit by the cartridge.

BREECHBLOCK LOCK. The lock is rectangular in shape and flat, with a thin cross sectional area. It has a rounded forward edge which fits into a similarly shaped slot in the rear under side of the bolt. Two lugs at the rear and on either side of the lock engage the receiver cams, forcing the lock down when the bolt assembly comes forward into battery. The lock is then held in place by the rear of the breechblock slides, bearing on the top surface of the lock lugs.

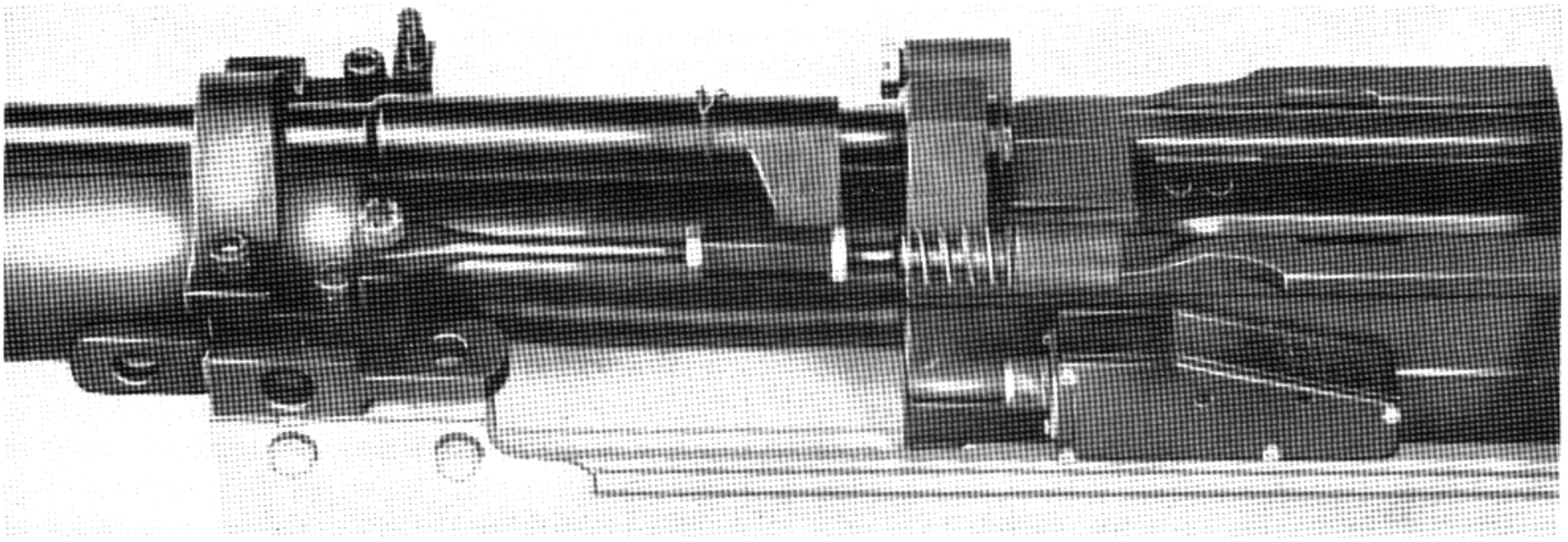

Figure 13–21. 20-mm Machine Gun Mechanism Mk 12 Mod 0. Closeup view of cradle mounting assembly.

Cradle. The cradle is a mount for the gun. It is designed to allow recoil and counterrecoil of the gun and gun mechanism and to transmit the resulting forces to the gun support structure. In addition, it provides anchoring surfaces for the feed mechanism. It consists of a cradle body, bracket, trunnion box, anchor support brackets, and anchor assemblies.

The cradle body is an aluminum channel, shaped to guide and support the receiver. It is machined at the forward end to provide for attaching the steel cradle bracket. Tapped holes in the bottom provide for mountings to support members and for attaching the case chute to carry away empty cartridge cases.

The cradle bracket is a semicircular forging secured to the receiver ring-spring housing in the front of the cradle body to support the gun. The top surfaces are machined for attaching the trunnion blocks, the anchor support bracket bolts, and the gas cylinder sleeve bracket. Trunnion blocks mounted on the recoil spring housing are bolted to each side of the cradle bracket to secure the gun mechanism. Each is a square block with a flat part on either end, one vertical and the other horizontal.

On the top and bottom of each block is a tongue that mates with the grooves in the cradle support and anchor support brackets. At the assembly point on either side of the tongue is a drilled hole to permit passage of the anchor-support-bracket bolt. The anchor support brackets are L shaped with a rectangular cross section. A stud screwed into the shorter leg provides attachment for the anchor assembly. The anchor assemblies are turnbuckle, quick-disconnect devices for attaching the feed mechanism.

Charger. The charger is a pneumatic mechanism that provides remote-control power operation of the breechblock for first-round loading or for round clearing. The charger piston is actuated by 1,000-p. s. i. air pressure from the aircraft supply. The charger consists of a charger tube, piston, ram head, and a dumping valve. The entire assembly is housed in a tubular housing on the right side of the receiver.

Charger Tube. The charger tube is a steel cylinder that fits into the forward end of the charger housing. Six drilled holes near the rear of the two provide air inlets to the piston within the tube. Air, to the rear of the piston head, enters through a hose connection on the charger housing, passes through the housing, then through the six holes into the charger tube. Air is prevented from escaping out of the housing by an O-ring seal at each end of the tube. The dumping valve assembly is screwed into the forward end of the tube.

Piston and Ram Head. The piston is a hollow tube with a piston head at the front end and the ram head at the rear. The piston is moved by pneumatic pressure, moving the ram head which engages a lug on the right-hand breechblock slide to charge the gun. A lug on the bottom of the ram head rides in a groove in the charger housing to prevent rotation of the piston and ram head.

Dumping Valve. The dumping valve, in the forward end of the charger tube, is arranged to re-

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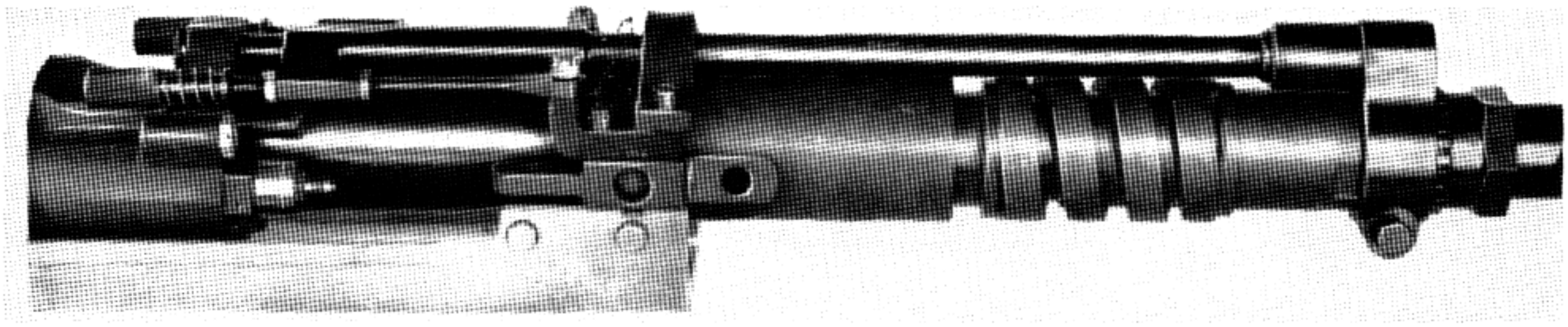

Figure 13–22. 20-mm Machine Gun Mechanism Mk 12 Mod 0. Closeup view of gas-cylinder and recoil assembly.

lease quickly the air used to move the piston rearward before the return strike. It consists of a nylon charger seat and valve assembly. During the piston's rearward movement, compressed air seats the valve to hold it closed. On the return stroke, the compressed-air supply is cut off and the valve is opened by the air in the charger tube to exhaust quickly the air forward of the piston head.

Gas Mechanism. The gas mechanism furnishes the force necessary to unlock the breechblock at the proper time and to start it rearward. The gas bracket assembly consisting of a bracket and a vent plug is secured against the shoulder on the gun by the gas bracket nut. The proper angular position of the gas bracket is maintained by a key fitting in the slot on the bottom of the gun barrel and the slot in the bottom of the bracket. The key also acts as a locking device for the bracket nut by engaging one of the slots in the rear of the nut. The key is held in place by the gas bracket clamping screw. The cylinder portion of the gas bracket guides the piston end of the gas cylinder sleeve assembly. The piston and piston ring insure a gas seal between the sliding sleeve and the chamber of the gas bracket, thereby maintaining full effect of the gas pressure transmitted through the vent plug. The rear of the sleeve assembly is directed by the guide attached at the top of the forward end of the receiver. The guide also acts as a stop for the gas cylinder sleeve spring. When the sleeve is forced to the rear by the gas pressure, it contacts a push rod in either side of the receiver. The push rods are alined with the breechblock slides and they unlock the breechblock when forced to the rear by the gas cylinder sleeve.

Gas Bracket. The bracket is a forged housing with a hollow cylinder extending toward the rear on the top side. A hole from the top of the inner diameter extends through to the cylinder. The inside end of the cylinder is tapped to attach the vent plug. A hole extends transversely through two lugs machined on the split bottom side of the bracket to permit passage of the clamping bolt and position the key. The vent plug is cylindrical and is drilled to permit passage of the necessary gas pressure for breechblock unlocking.

Gas Cylinder Sleeve. The gas cylinder sleeve is a piston and piston rod extending between the gas bracket and a guide mounted on the receiver. The piston end of the sleeve in the gas bracket is actuated by the firing gases to move the sleeve rearward. Forked arms at the rear of the sleeve contact push rods to move the breechblock slides. This action unlocks the breechblock and starts it moving rearward. The rear end of the sleeve fits over a cylindrical guide on the receiver that guides the movement of the sleeve and seats the sleeve return spring.

Gas Cylinder Guide. The guide is a short, hollow cylinder attached to the receiver to guide the sleeve. The sleeve spring bears against the face of the guide.

Gas Cylinder Sleeve Spring. The gas cylinder sleeve spring is a three-wire, twisted-strand spring fitting inside the sleeve and bearing against the sleeve guide for returning the sleeve forward.

Push Rods. Two push rods, one in either side of the receiver, extend forward, from the front face of the breechblock lock slides, to the legs on the gas cylinder sleeve.

Buffer Assembly. The buffer is a pneumatic device which, by means of internal air pressure, retards the rearward motion and supplies forward acceleration to the reciprocating breechblock. The buffer housing has an accurately machined internal cylindrical surface closely fitting a reciprocating buffer piston. Assembled on the rear of the piston

are an O-ring and two leather backup rings held in place by a collar threaded on the piston. The O-ring provides the seal to prevent escape of the air pressure fed to the rear of the piston. An externally threaded sleeve retains the piston in the buffer housing. The air inlet at the rear of the piston provides a constant pressure through the check valve, which seals the area behind the piston when it is forced rearward by the breechblock. The trapped air is thus compressed until rearward motion of the breechblock is stopped, at which time it expands, thereby thrusting the breechblock forward.

HOUSING. The housing is internally machined and threaded to receive the plunger and sleeve. A drilled and tapped boss protrudes from the internal rear face of the cylinder to house the check valve assembly. Drilled holes in the housing connect to the air supply through an air inlet fitting into a bleeder valve. The bottom extension of the housing is machined to house a spring-loaded plunger that positions and locks the buffer to the rear of the receiver.

PISTON. The piston has a raised shoulder against which the O- and backup rings bear. The rear is externally threaded for attaching the collar and thus holding the backup ring in place.

VALVE. The check valve consists of two parts: A ball supported by a spring, and a valve plug. The plug is screwed into the rear of the housing with the spring and ball assembled behind it. The intake fitting and the check valve may be interchanged for right- and left-hand assembly.

Firing Circuit. In a single free-firing gun installation, current flows from the supply source to the synchronizing switch. When the left breechblock slide is approximately 0.25 inch from its locked position, contact is made and the bolt contact completes the circuit.

When two guns are wired in synchronized firing, current is supplied to the synchronizing switches of both guns. Current flow through the circuit allows both guns to fire together.

If either gun jams, or if breakage prevents use, the FREE-SYNC firing switch should be turned to FREE. This permits current flow directly to the usable gun. In this condition, firing takes place immediately when the firing pin contacts the cartridge primer.

Synchronizing Switch. The synchronizing switch is composed of three contacts which operate with the breechblock to complete the firing circuit. The case is composed of two halves bolted together. The receptacle assembly consists of two connectors and the connecting wires.

Feed Mechanism. The feed mechanism Mk 7 Mod 0 is a pneumatic, piston-type feeder. Its prime purpose is to pull the ammunition belt through the feeder, strip the belt links, and place the cartridge in a position to be pushed into the gun chamber by the reciprocating breechblock.

Mounting. The feed mechanism is mounted on top of the receiver. Two slots on the forward top side of the receiver permit passage of the feeder feet downward. The feed mechanism is then pushed forward with the feeder feet engaged in the slots in the sides of the receiver. The feeder is then secured to anchor rods, and is a nonrecoiling mechanism.

Preparation for Operation

Safety Checks. The following checks are mandatory for safe and effective tactical operation of the weapon.

1. Make certain the master armament switch is OFF.
2. Check the air supply to the buffer by pressing the buffer piston inward.
3. Check the air supply to the charger by actuating the charger valve.
4. With the breech open, check the gun bore for obstructions.
5. Check the anchor assemblies to see that the connections to the feed mechanism are secure. The extreme back end of the feed mechanism should be in line with V notches on the gun.
6. Check the trunnions to be sure they are secure in anchors.

Loading. Load the gun mechanism as follows:

1. Shut off air supply to the feed mechanism.
2. Bleed off air to the feeder if the shutoff valve is not self-bleeding.
3. Attach the ammunition chute to the feeder by opening the cover on the chute side and placing the chute ends on the supports on the front and rear end plates. Close the cover, securing the ammunition chute.

4. Move ammunition through the chute to the feeder. When loading right-hand feeders, start the belt with an empty link.

5. Lead the first link on the guides located on the under side of the cover.

6. Push the first round over the retaining pawls engaging the link and round on the stripper.

7. Check by pulling on the belt.

8. Turn on the air supply.

9. Charge the gun mechanism.

Charging. After feeding the first round into the feed mechanism, actuate the charging valve by turning the gun charging switch to SAFE. This will retract the breechblock. Wait at least 2 seconds, and turn the charging switch to READY to move the breechblock forward. In moving forward, the breechblock picks up the first round and drives it into the gun chamber.

First Round Loading Action. To initiate automatic firing, it is necessary to place the first round in the gun chamber as follows: With the ammunition belt fed into the feed mechanism, actuate the charger valve to force the breechblock to the rear and then forward. As the breechblock moves forward, it will push the round from the feeder tray into the open chamber.

Cyclic Actions

The firing of a round of ammunition occurs in the following sequence, and the cycle is divided into six actions. These actions are indicated by parentheses, as indicated in the following list. Each round requires a total of 60 milliseconds.

1. Recoil gun (0.013 second).
2. Breechblock unlocking (slide unlocking: 0.002 second).
3. Breech opening (bolt movement to the rear: 0.028 second).
4. Case extraction.
5. Case ejection.
6. Breechblock buffing.
7. Counterrecoil (0.032 second).
8. Breechblock closing.
9. Breechblock locking (bolt movement forward: 0.026 second; slide locking 0.003 second).
10. Firing.

Recoil Gun. When the gun is fired, the propellant gases in the barrel force the gun to recoil to the rear. During recoil, the front recoil-spring seat and gun move to the rear, compressing the recoil spring. This action continues until the rear end of the front recoil-spring seat contacts the front end of the rear recoil-spring seat after travelling about five-eighths inch. This contact prevents further compression of the recoil spring. The rear end of the rear recoil-spring seat is in contact with the spacer which contacts the front follower ring of the recoil housing assembly. As the ring-spring assembly is compressed, it absorbs the remaining recoil energy. After maximum recoil has been reached, both the recoil spring and the ring-spring recover to return the gun to battery. When the battery position is reached, a shoulder on the gun barrel contacts the rear follower of the ring spring, thereby compressing the ring springs and absorbing counterrecoil energy.

Breechblock Unlocking. When the breech is closed, the breechblock is held forward by the breechblock lock which bears against the locking key in the receiver. The breechblock slides prevent the lock from disengaging until after firing or charging. As the projectile is driven forward in the barrel, it passes the gas port, allowing the propellant gases to enter the port and move the gas cylinder sleeve assembly to the rear.

As the gas cylinder sleeve moves to the rear, it forces the push rods back, moving the breechblock slides rearward. During this action, the forward slide key retracts the firing-pin guide to retract the firing pin. Simultaneously, the rear slide key retracts the firing-pin spring plug to compress the breechblock slide spring. As the slides approach the end of the unlocking stroke, the rear end of the lock is uncovered and it is allowed to rise clear of the locking key to unlock the breechblock.

At the end of its stroke, the gas cylinder sleeve strikes the receiver and is returned to its original position by the gas cylinder sleeve spring.

Breech Opening. After unlocking, the breechblock is started to the rear by the blowback action of the gases in the gun barrel. The extractor lip engaging the cartridge aids in withdrawing the empty case from the chamber.

Case Ejection. As the breechblock moves to the rear, the empty cartridge case is blown back with it by the blowback action and also by the lips on the extractor and bolt face. Near the end of the breechblock rearward movement, the cartridge case is contacted by two ejector prongs on the feed mechanism.

This action forces the cartridge case to pivot about the extractor down out of the weapon through the ejection slots in the receiver. The extractor, which is forced down during ejection, is returned to its usual position by spring action.

Breechblock Buffing. At the end of the breech-opening movement, the breechblock contacts the piston of the pneumatic buffer at the rear of the receiver. As the piston is moved in by the impact of the breechblock, the air pressure within the buffer compresses and finally stops the rearward movement of the breechblock. The compressed air then expands, pushing the piston out to return the breechblock forward. A continuous supply of compressed air is maintained through the air-hose connection.

Breechblock Closing. Expansion of the air trapped within the buffer forces the rubber piston forward, starting the breechblock forward to close the breech. This accelerating force is sufficient to move the breechblock and a round of ammunition completely forward to load the gun and close the breech for the firing of the next round. During the closing stroke, the breechblock picks up the next round in the feed mechanism. As the breechblock continues forward, it carries the round with it and forces the round into the gun chamber. As the round is chambered, the cartridge case lip is engaged by the extractor in readiness to fire.

Breechblock Locking. When the breechblock reaches the end of its forward motion, it seats against the rear face of the gun barrel, closing the chamber. Simultaneously, the breechblock lock is forced to rotate downward by the action of the cam surfaces on the forward end of the receiver slides and the pressure of the breechblock slides, which continue to move forward by inertia and the force of the breechblock slide spring within the breechblock. The lock seats against the locking key in the receiver and is held in this position by the lower rear ends of the breechblock slides.

Firing. When the breechblock is approximately one-eighth inch out of battery, the bolt contact engages the ignition squib of the synchronizing switch. As the breechblock slides move forward, the firing-pin guide is carried by the forward slide key, allowing the firing-pin spring to bring the firing pin into contact with the electric primer 0.25 inch before the slides reach their full forward position. Simultaneously, the synchronizing switch contact in the left breechblock slide bridges the gap between the synchronizing squibs. When the three synchronizing switch contacts are made and the firing pin is in contact with the primer, the round is electrically fired. In a synchronized pair of guns, these conditions must be met in both guns before firing occurs. The two guns then fire simultaneously.

Detailed Maintenance of Gun Barrel

Bore wear depends upon cleaning, preservation, cooling between periods of firing, and number of rounds fired. Whenever possible, the bore should be examined for foreign material, including copper fouling and propellant residue, deformation of lands or grooves, indentations resembling pits in castings and pitting of the lands or grooves. It is not necessary that the bore be shiny to be clean. A clean bore may have a dull, gray appearance.

Before-Firing Maintenance. Wipe the bore clean if no covers are installed or if the bore was previously excessively oiled.

After-Firing Maintenance. Thorough cleaning is extremely important and should be carried out as soon as possible after firing. When a gun is fired, the gas pressure forces a deposit of primer salts into the pores of the bore and chamber. These salts are extremely corrosive and, if not properly removed, will result in pitting and other forms of corrosion. The salts are water soluble but will not dissolve in petroleum distillate. Removal can be effectively accomplished by use of Rifle Bore Cleaner JAN-C-372.

NOTE. The rifle bore cleaner contains water, so all traces must be removed with a dry cloth. Incomplete drying may result in malfunctioning at low temperatures. If the specified rifle bore cleaner is not available, an emergency substitute of ½ to 1 pound of soda or sodium carbonate, Federal Specification O-S-571, to 1 gallon of boiling water, may be used. Thereafter, the bore must be rinsed in fresh water and thoroughly dried. After cleaning the bore, apply a thin coating of preservative Lubricating Oil JAN-L-644. If the gun is to be temporarily inactive, apply a coating of Lubricating Oil OS 1363. If the chamber becomes excessively fouled, polishing Tool R40–D–510 (see OP 1910) may be used.

Erosion Indicator. The bore-erosion gage is placed in the barrel chamber to determine the amount of erosion caused by the burning ammuni-

tion gases. When the gage can protrude forward into the chamber beyond the maximum allowable depth reading, the barrel should be replaced.

Barrel Removal and Replacement. For removing the barrel, the following procedure should be followed:

1. Remove the gas mechanism.
2. Remove the recoil mechanism.
3. Using the gun-locking, pin-removal tool, remove the barrel-locking pin.
4. Unscrew the barrel from the receiver.

NOTE. If there is seizing between the barrel and receiver, use the barrel wrench applying torque while tapping the barrel near the receiver with a rawhide hammer.

Detailed Maintenance of Receiver

The receiver houses and guides most of the working parts of the gun mechanism and is the major strength member resisting rearward and spreading forces. Careful inspection and maintenance are therefore essential for long service life and operation.

Cleaning and Lubrication. Clean all foreign particles from the breechblock ways in the sides of the receiver and keep coated with a thin film of oil JAN-L-644.

After firing, always clean the portion of the receiver near the barrel with Rifle Bore Cleaner JAN-L-372, wipe and dry and coat with JAN-L-644.

Inspection. Inspect the receiver for cracks or spreading of receiver plates in vicinity of dovetail grooves for attaching the rear buffer. Check for burs, particularly along the slides or buffer dovetail grooves, and remove with crocus cloth or a very fine oilstone. If the receiver has welded inserts at the gas mechanism sleeve guide bracket, check for breakage.

Detailed Maintenance of Breechblock Assembly

Generally check the freedom of movement of the breechblock in the receiver. After disassembly and cleaning, perform the following checks:

1. Examine all components for damage and remove burs with crocus cloth or fine oilstone.
2. Check for enlargement of the firing-pin hole. If sufficiently large to cause blown primers, replace the bolt.
3. Check for cracks around forward seat of breechblock lock or either slide key. Replace if necessary.
4. Check for cracks around breechblock lock cam surfaces and cracks or roughness on breechblock locking surfaces.
5. Check for firing-pin guide breakage or set.
6. Check for extractor and extractor-pin breakage.
7. Check for damaged, broken, or permanently set springs. Replace if necessary.
8. Check electrical components for broken insulation on bolt contact, firing-pin guide, and firing pin.

Cleaning and Lubrication. Clean the front face of the bolt and slides with a cloth dampened in Rifle Bore Cleaner JAN-C-372, wipe dry, and coat with light film of Oil JAN-L-644 to prevent corrosion of the parts exposed to the primer salts during firing. When disassembled, all parts, except electrical insulation, may be wiped clean and oiled in a similar manner.

Removal. To remove the breechblock, first remove the rear buffer. Then, using the bolt-unlocking tool:

1. Place the tool on the right side of the bolt so that the projection of the arm of the tool engages the front face of the right slide and the other arm of the tool fits along the top of the bolt with its forward end bearing on the receiver.
2. Press the handle of the tool forward until the breechblock is unlocked.
3. Move the breechblock rearward out of the receiver, being careful to place one hand below the unit to prevent the lock from falling.

CAUTION. Make certain air pressure to the charger is off. Actuation of the charger could project the assembly out of the gun with excessive force, resulting in possible injury to personnel or to the mechanism or both.

Installation. To install the breechblock, use the breechblock assembly tool and hold the lock in its unlocked position with the slides rearward. Holding the assembly in this manner, push it into the move toll and push the breechblock forward into its locked position.

Disassembly and Assembly. When the breechblock is removed from the receiver, the lock falls free. Further disassembly is as follows:

1. Remove pin from the slide spring plug pin and bolts.

2. Unscrew the slide-spring plug from the bolt. The slide spring will fall out.

3. With the rear of the bolt held against a soft surface, such as wood or cardboard, use a screwdriver to pry the left-hand slide away from the bolt. The rear slide key, which is pinned to the left side, will come with it, and the firing pin spring plug will be ejected from the bolt.

4. Remove the firing-pin spring.

5. Pry the right-hand slide away from the bolt and remove it with the forward slide key which is pinned to it.

6. Press out the extractor pin by pressing on the small end. The extractor will be forced out by the extractor spring.

7. Remove the bolt contact using the contact extractor bolt.

8. Remove the firing pin and firing-pin guide.

9. If necessary, due to breakage, remove the slide keys from the slides by driving out the spring pins with a punch and light hammer.

To assemble, reverse the foregoing procedure.

Detailed Maintenance of Charger

Careful maintenance of the charger is very important. A faulty charging system may cause loss of use of the gun in combat.

Cleaning and Lubrication. Since most of the working parts are totally enclosed, cleaning and lubricating are essential only when the charger is disassembled.

1. Give a very close inspection to the internal parts for presence of any foreign material in the air port or on the tube internal surfaces.

2. Inspect the condition of all O-rings and backup rings for wear or breakage.

3. Inspect all metal parts for damage or breakage.

4. Remove all burrs with a fine oil stone.

5. Lubricate O-rings with Grease MIL–G–15793 at reassembly. Coat all other components of the charger with a light film of Oil JAN–L–644.

Inspection. Operate the charger valve to see that the charger cycles the breechblock freely without sticking or hesitating action.

Removal. To remove the charger assembly, take the following steps:

1. Cut off the air pressure to the charger and remove the air hoses. Hose connection should be removed carefully to allow for escape of air pressure.

2. In the receiver, remove the locking wires, screws, and latch cam.

3. Unscrew the retaining nut.

4. Withdraw the assembly from the rear carefully to prevent damage to the external tube O-rings.

Installation. Installation is the reverse of the procedure just given. Be careful not to damage the O-ring when starting the assembly into the receiver housing and while passing surface interruptions.

Disassembly. The disassembly procedure is as follows:

1. Remove the two pins in the ramhead. The latch and spring will be ejected.

2. Slide the ramhead off the piston.

3. Unscrew the charge tube cap from the charger tube, and remove the piston by pushing it from the rear.

4. Unscrew the valve body from the tube cap, being careful not to drop the valve and shuttle. Do not remove the shuttle seat unless it is to be replaced.

Assembly. The assembly procedure is the reverse of disassembly. Successful assembly is largely dependent on the careful insertion of O-rings and proper positioning of the shuttle valve.

Detailed Maintenance of Gas Mechanism

Maintenance of the gas mechanism is exceedingly important to insure the proper rate of fire:

1. Check the sleeve assembly. If bent, replace.

2. Check the gas cylinder sleeve spring. If set or broken, replace.

3. Check free movement of gas cylinder sleeve assembly on the guide. If binding, replace the guide or sleeve.

4. Check the gas cylinder vent plug for erosion or fouling. If eroded, replace the gas bracket. If fouled, clean and reinstall.

5. Remove light burs from the piston end of the sleeve. Replace if excessively worn.

6. Check the piston ring. Replace if broken, set, or excessively worn. To replace, remove pin from gas cylinder sleeve and unscrew gas cylinder sleeve.

7. Remove burs from push rods. Replace if excessively peened on the ends.

Cleaning. Inspect and clean carbon from the vent plug and piston ring after firing frequently.

Removal.

1. Remove the cotter pin and lockwasher.
2. Unscrew the sleeve guide from the receiver lug.
3. Remove the trunnion securing screws through the gas cylinder bracket.
4. Remove the gas cylinder sleeve bracket.
5. Remove the cotter pin from the gas bracket screw.
6. Unscrew the castellated nut and slide out the gas bracket screw.
7. Unscrew the barrel nut. Note: This allows the recoil-spring to expand and force the gas bracket forward. If the bracket remains stationary as the barrel nut is loosened, tap the bracket until it is free to follow the nut.

Installation.

1. Place the gas cylinder bracket on the barrel butting against the recoil-spring seat.
2. Screw the sleeve guide into position but do not install lockwasher and cotter pin.
3. Slip the yoke of the gas cylinder sleeve onto the guide, leaving out the gas cylinder sleeve spring. Fit the piston end of the sleeve into the cylinder of the gas-cylinder bracket.
4. Screw the barrel nut onto the barrel in front of the gas cylinder bracket, and tighten.
5. Install the screw, nut, and key, but do not tighten down.
6. Lightly tap the gas cylinder bracket to rotate it as far as the key will permit, and, at the same time, slide the gas cylinder sleeve in and out. Leave the bracket in the position at which the sleeve moves easiest.
7. Tighten the nut to secure the gas cylinder bracket, and insert the cotter pin.
8. Check free movement of the sleeve.
9. Remove the gas cylinder sleeve guide and install the sleeve spring. Reinstall the guide. Install lockwasher and cotter pin on the guide.
10. Install the gas cylinder sleeve bracket.

Detailed Maintenance of Buffer Assembly

To check the buffer action, bleed the air pressure by loosening the bleeder plug on the left rear end of the buffer housing.

1. Check free movement of the piston. If it binds or sticks excessively, replace the buffer.
2. Check the buffer lock plunger.
3. When the buffer is disassembled, check to see that the O-ring is not worn or broken.

Cleaning and Lubrication. When disassembled, precaution should be taken to prevent any dirt or foreign substance from entering the housing. The parts, before assembly, should be thoroughly wiped with a lint-free cloth and the piston O-ring and backup rings should be lubricated with Grease MIL G–15793 at reassembly. All other components of the buffer must be coated with a light film of Oil JAN–L–644.

Disassembly.

1. Remove the locking wire.
2. Bleed all air pressure through the bleeder valve.
3. Disconnect the air hose and remove the air inlet fitting. Do not remove the valve seat and ball check valve unless necessary.
4. Unscrew the bleeder valve.
5. Force the piston to the rear, and drive out the sleeve pin.
6. Unscrew the buffer sleeve and remove the piston assembly.
7. Further disassembly is apparent.

Assembly. Assembly is the reverse of the procedure just given, except that the buffer piston and sleeve should be installed before the air inlet fitting and bleeder valve.

SECTION 5. GUN, AUTOMATIC, 20-MM, T118

After World War II, both the Navy and the Army were interested in a high-velocity 20-mm weapon based on the Hispano-Suiza principle. The design developed by the Navy, the 20-mm Mk 12, is described in the preceding section. Early in the development program the Navy and Army disagreed on the cartridge design. The Army was interested in using its caliber .60/20 ammunition, which incorporates a 1,600-grain projectile in a caliber .60 cartridge case. The designation Gun, Automatic,

20-mm, T118 was established in the latter part of 1948 to identify a T34E1 gun rechambered and modified to use this ammunition.

The Navy, however, favored a round which consists of a 1,700-grain projectile and a cartridge case similar to the caliber .60 case but approximately 0.266 inch longer in the body. The Navy adopted this round under the designation T130 for use in its 20-mm Mk 12 gun.

Because of the difference in the ammunition, two development programs have been carried on concurrently. Approximately 20,000 rounds have been fired in tests of the T118 gun. However, the larger part of the development work has been carried on in the Mk 12 program, since the Navy has the primary interest in the 20-mm series of guns. Accordingly only the details of the development of the Mk 12 are given in this chapter.

Chapter 14

ORDNANCE CORPS LIGHT MACHINE GUN, 7.92–MM

SECTION 1. HISTORY AND BACKGROUND

In World War II, paratroop soldiers of the German army were equipped with a very lightweight 7.92-mm machine gun capable of delivering at a high rate of fire or single shot with extreme accuracy. The gun was known as the FG–42 and was designed and produced by the Krieghoff Waffenfabrik in Suhl, Germany. (See volume 1, pp. 489–491.)

After the war, a project was initiated by the United States Ordnance Corps to refine and improve the design of the Krieghoff 7.92-mm FG–42 and, if possible, to convert it from clip to belt feed, employing the feed system of another popular German light machine gun, the MG–42. (See volume 1, pp. 484–488.) This work was carried on under the designation "Gun Machine, Light, 7.92-mm T44" by the Bridge Tool and Die Works.

By December 1946, the mechanical solution for the conversion had been completed.

SECTION 2. GUN, MACHINE, LIGHT, 7.92-MM T44

Description of Components

Receiver Group. The receiver body in which the essential parts of the gun operate is a sheet metal fabrication. The barrel is permanently mounted into the forward end, and the receiver swaged circumferentially into a recess around the rear end of the barrel and secured by a locking ring, likewise swaged. The hinge member about which the feed mechanism rotates is welded to that portion of the receiver body directly rearward from the swaged area, thereby making the receiver body, barrel, and hinge member an integral unit.

Holding the receiver body in a normal firing position, there is an opening on the left-hand side running longitudinally from the welded hinge member for the length of the housing. This opening is bridged at a point located approximately 4 inches rearward from the hinge member by the ejector assembly. The resultant opening between the hinge member and the ejector assembly permit the receiver plate to position the cartridge for insertion into the barrel. Directly opposite this opening there is a similar smaller opening through which cartridge cases are ejected.

Further description of the receiver body is given in connection with the following descriptions of components.

Muzzle Brake Group. The muzzle end of the barrel accommodates the muzzle-brake assembly, bipod, and front sight.

The front sight is held in radial alinement by a milled surface along the top side of the barrel and locked in place by the muzzle brake mounting ferrule, which at the same time serves as a mounting for the bipod.

The muzzle brake is threaded onto the muzzle brake mounting ferrule and locked in place by a spring latch attached to the front sight which registers in a milled slot in the end of the muzzle brake. The function of the muzzle brake is to absorb a part of the recoil.

Gas Cylinder Group. The gas cylinder is tube-like in appearance and is mounted beneath the barrel. It is attached on the forward end by a collar. The rear end of the gas cylinder is turned for a slip fit into the rear end of the barrel. The gas cylinder is held in place by the gas cylinder locking nut, which is threaded onto the barrel.

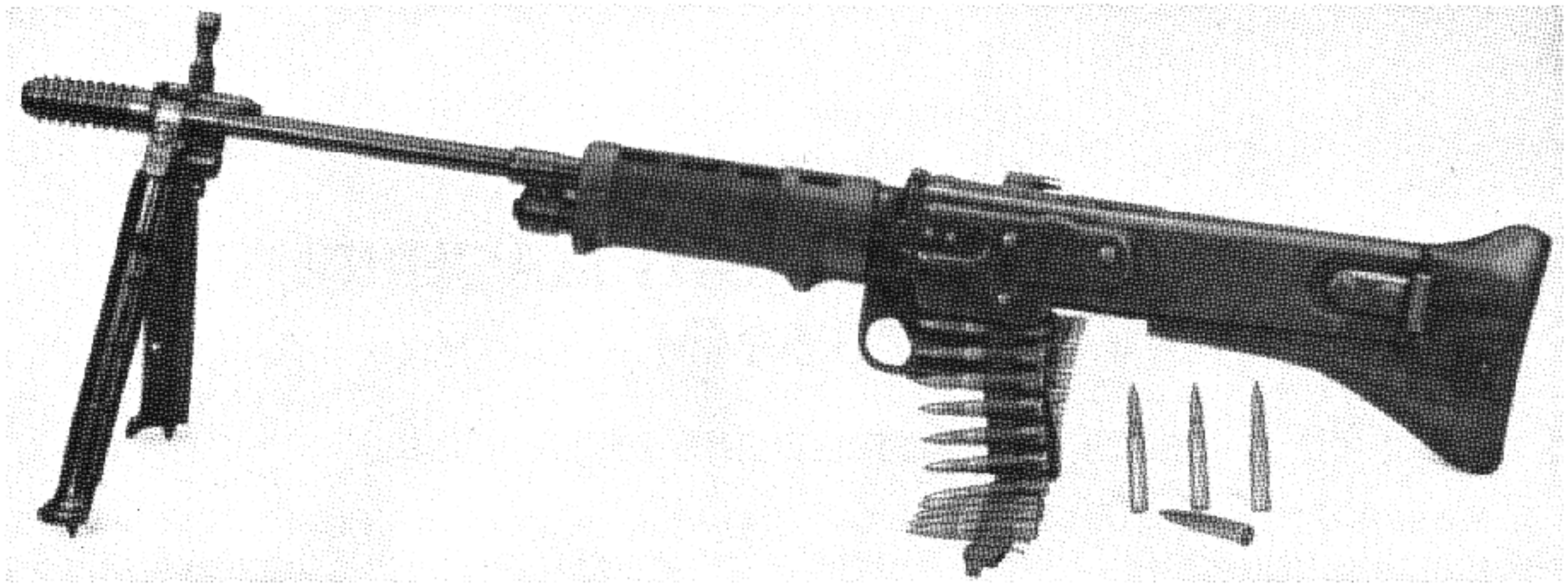

Figure 14–1. United States 7.92-mm Light Machine Gun T44.

When the gas cylinder is in place, a port in the collar end of the cylinder lines up with a similar port in the barrel. This port is for conducting the flow of gas from the barrel into the gas cylinder during the firing cycle. The amount of gas to flow is determined by the radial positioning of the gas cylinder orifice selector, which is inserted through the collar portion of the gas cylinder.

The gas cylinder orifice selector is screwlike in appearance. The head is cross slotted, and the body portion has three notches in radial alinement with the cross slots in the head. The notches increase in size from zero (or no notch) to about one-sixteenth inch deep by three-thirtyseconds inch wide. The four quadrants formed by the cross slotting of the head are center punched in depth to correspond with the size of the notch in radial alinement. It is therefore possible to determine, by the position of the center punches, the size of the orifice between the barrel and gas cylinder, and to increase or decrease the size accordingly.

The gas cylinder orifice selector is retained in position by the gas cylinder orifice selector retainer, which is a U-shaped spring yokelike on one end and on the other end is shaped to fit into the cross-slotted head of the gas cylinder orifice selector.

The gas cylinder orifice selector retainer serves a dual and reciprocal service with the gas cylinder pressure regulator, fitting itself by spring action into radial slots milled into the perimeter of the gas cylinder pressure regulator. The gas cylinder pressure regulator is threaded into the gas cylinder on the forward end, thereby regulating the headspace in the gas cylinder as the milled slots in the perimeter

General Data: 7.92-mm Krieghoff FG–42

Gun length: 39 inches.	Barrel length: 19.3 inches.
Gun weight: 14 pounds.	Rate control: Trigger can be set to deliver single shot or full automatic fire.
Rate of fire: 500–600 rounds/minute.	Barrel removal: Cannot be removed in the field.
Muzzle velocity: 2,850 feet/second.	Bore:
System of operation: Gas piston actuated.	Number of grooves: 4.
System of locking: Rotating bolt head.	Groove depth: 0.007 inch.
System of feeding: Clip holding 20 rounds.	Groove width: 0.027 inch.
Method of headspace: Factory established; cannot be adjusted in the field.	Pitch: 1 turn in 10 inches.
Location of feed opening: Left side of receiver.	Direction of twist: Right hand.
Location ejection opening: Right side of receiver.	Form of twist: Constant.
Method of charging: Manual.	
Method of cooling: Air.	

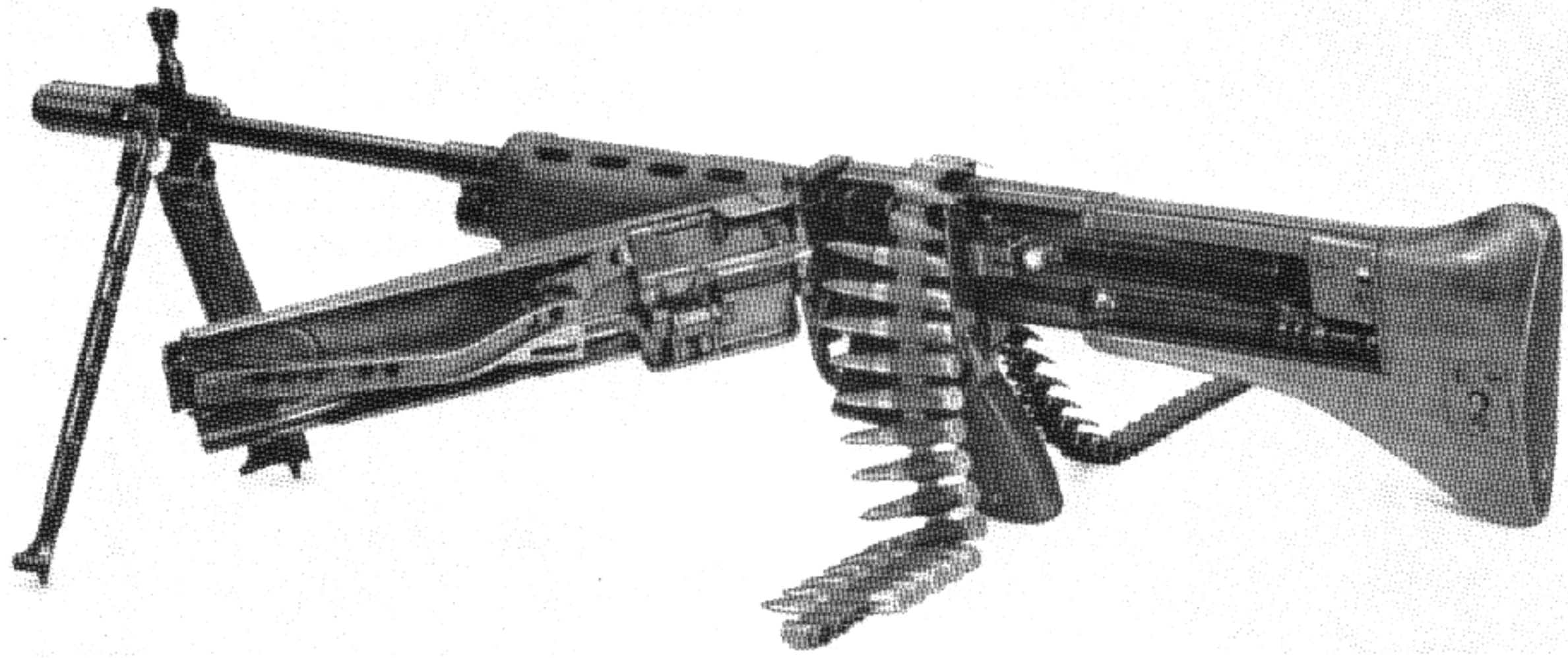

Figure 14–2. United States 7.92-mm Light Machine Gun T44, with feed open.

become engaged with the spring action of the gas cylinder orifice selector retainer. By this method the depth of penetration can be controlled without the full seating of its machined surfaces, thereby giving adjustment for regulation, at the same time serving its reciprocal role, that of retaining the gas cylinder orifice selector retainer.

The gas cylinder has four radial ports located a sufficient distance from the forward end to permit the piston rod in its rearward action to unlock the bolt before uncovering these ports, which then permit an air intake into the gas cylinder as the blowback action of the bolt comes into effect.

Piston Rod Group. The piston rod is tubelike in appearance, closed on the forward, or piston, end. The rear portion has a tongue rising up from the top side which is yoke-shaped at its end to accommodate the firing pin, thereby controlling its forward and rearward movements within the bolt. The rear portion underneath side is machined in such a manner that the sear will either lock and hold back, or permit to ride over, depending upon the setting of the sear, thereby giving choice to either single or automatic firing cycles. At a point just forward from the midpoint of the piston rod is machined a double **D**-shaped hole to accommodate the piston rod operating handle, thus supplying the means for cocking the gun.

The piston rod operating handle is held in its slot by the driving spring plug, which registers in a re-

General Data: 7.92-mm Light Automatic Machine Gun T44

Gun length: 39 inches (approximate).
Gun weight: 14 pounds (approximate).
Rate of fire: Single shot to 500 rounds/minute.
Muzzle velocity: 2,850 feet/second.
System of operation: Gas-operated blowback combination.
System of feeding: German 20-shot clip converted by U. S. engineers to employ metallic links for continuous feed.
Method of headspace: Factory established.
Location of feed opening: Left side of receiver.
Location ejection opening: Top of receiver.
Method of charging: Manual.
Method of cooling: Air.

Barrel length: 19½ inches.
Rate control: Trigger setting can be made to deliver full automatic fire or single shot.
Barrel removal: Swaged permanently to receiver.
Bore:
- Number of grooves: 4.
- Groove depth: 0.015 inch.
- Groove width: 0.035 inch.
- Pitch: 1 turn in 15 inches.
- Direction of twist: Right hand.
- Form of twist: Constant.

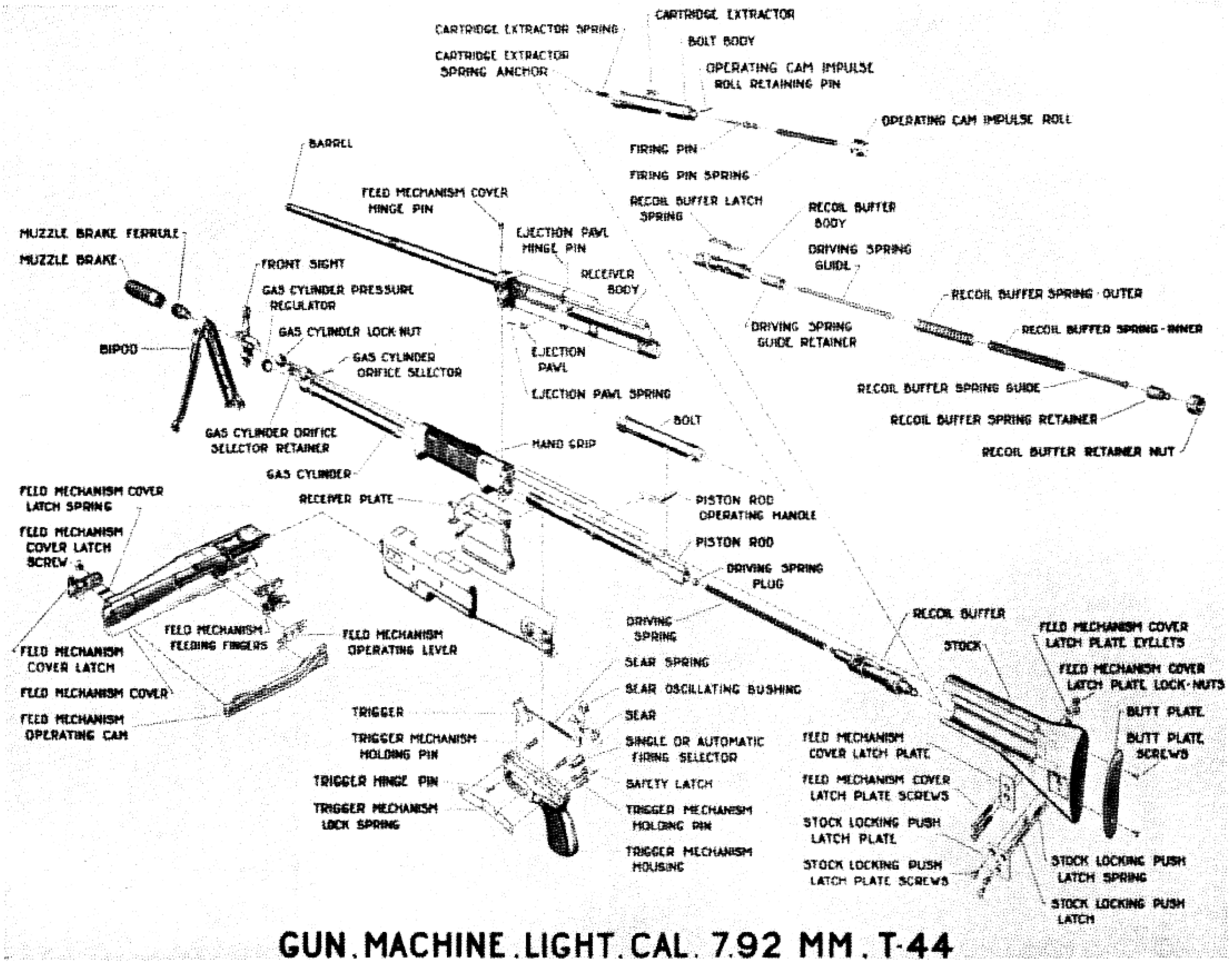

Figure 14–3. Gun, Machine, Light, 7.92-mm T44. Exploded view.

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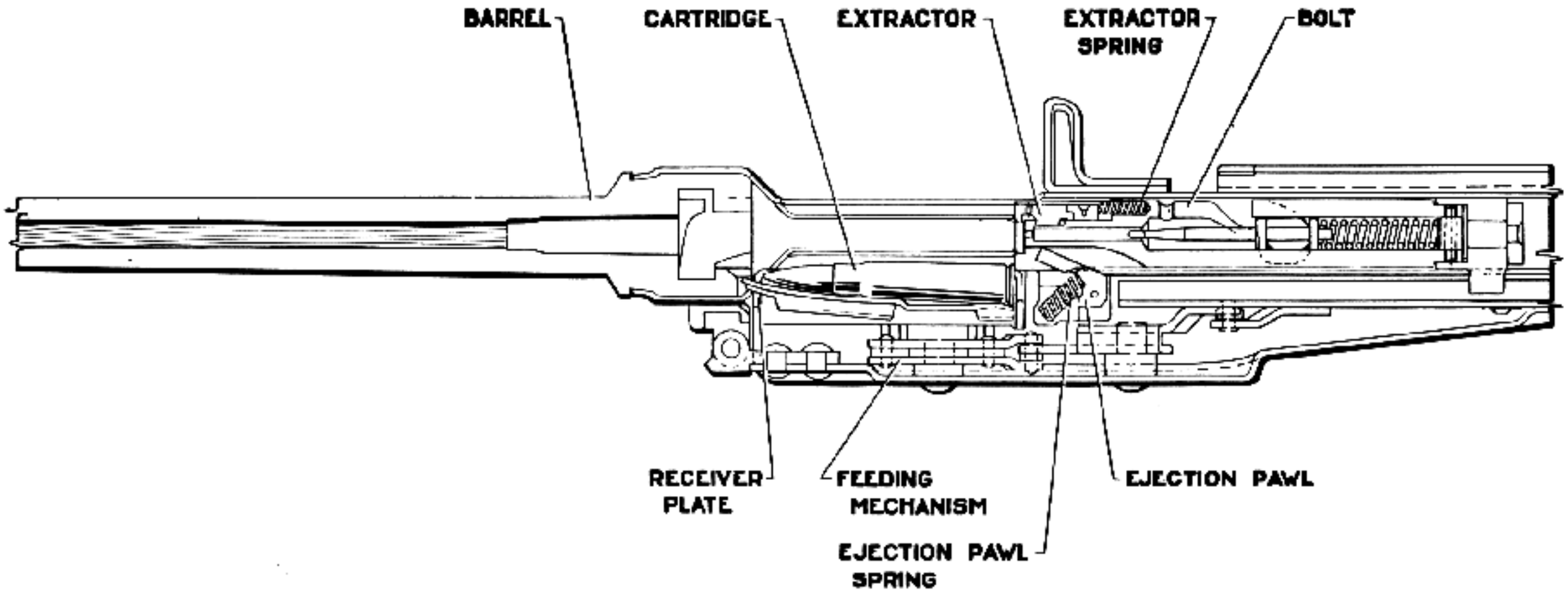

Figure 14–4. Gun, Machine, Light, 7.92-mm T44. Stripping a round.

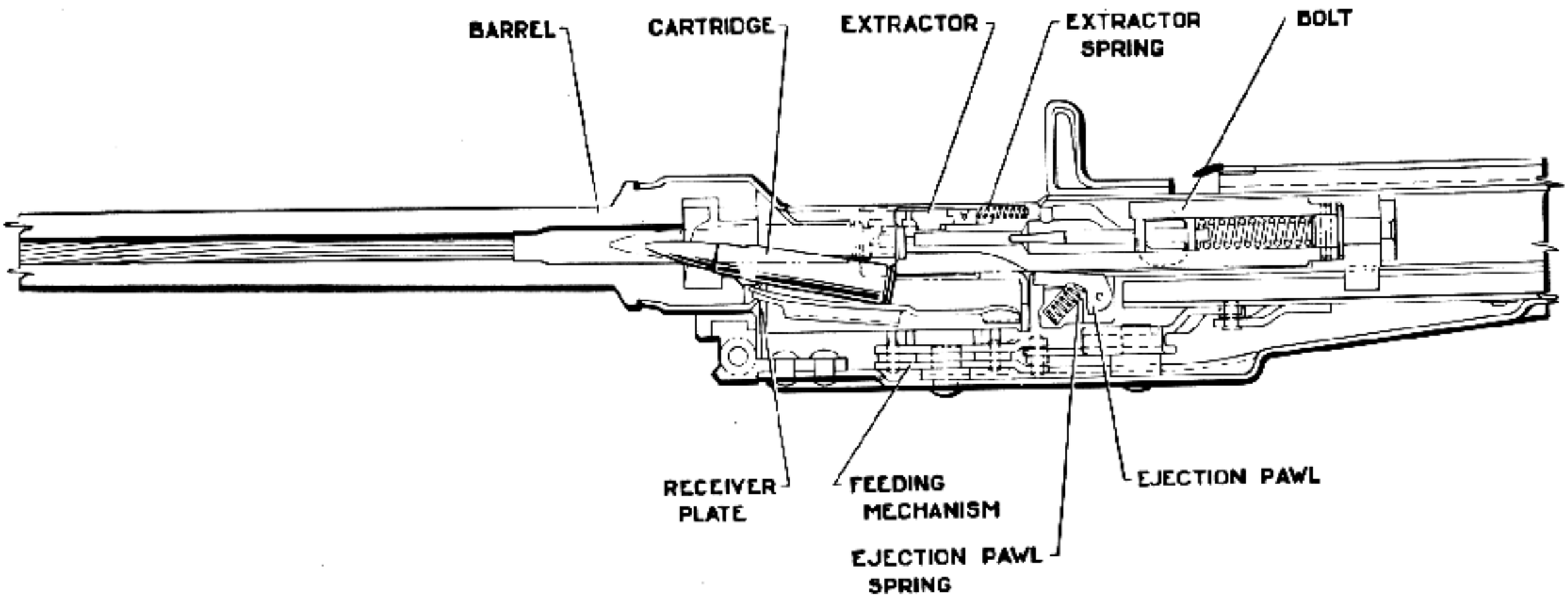

Figure 14–5. Gun, Machine, Light, 7.92-mm T44. Ramming action.

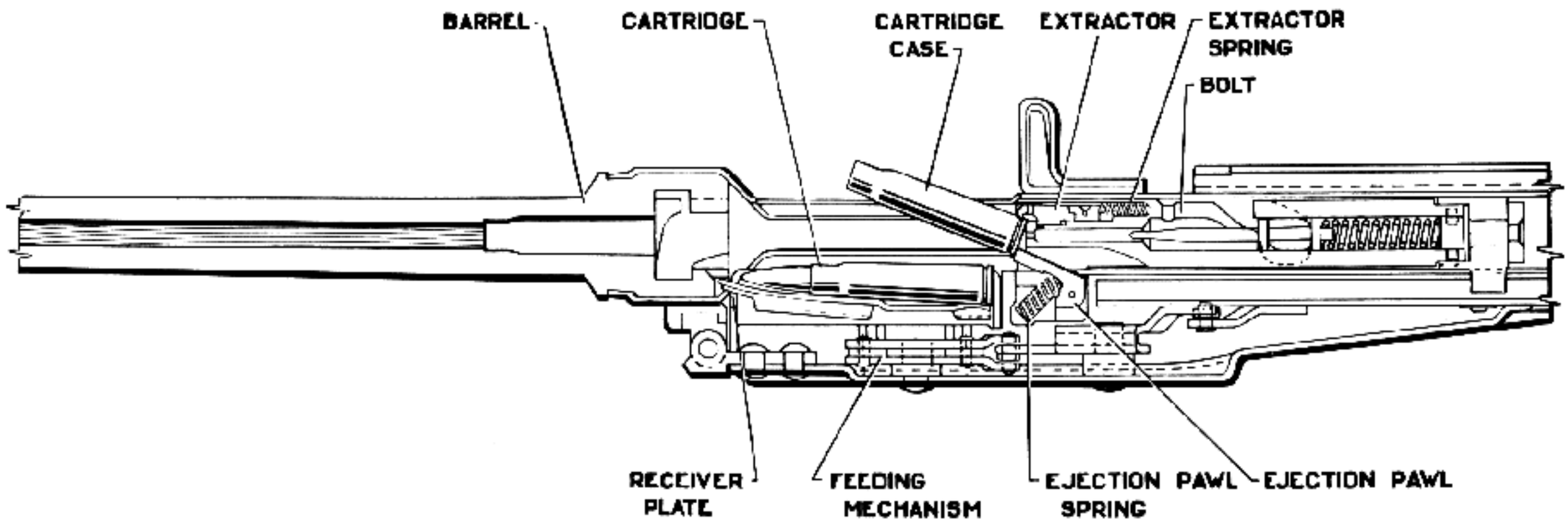

Figure 14–6. Gun, Machine, Light, 7.92-mm T44. Ejection phase.

cess of the piston rod operating handle and is held in place by pressure from the driving spring.

Driving Spring Group. The driving spring is located around the driving spring guide and inserted into the rear end of the piston rod. The forward end of the spring is obstructed within the piston rod by the piston rod operating handle, and contained within the receiver body by the recoil buffer. Its function is to store energy, developed during the rearward travel of the bolt, to be used to drive the bolt forward to start the firing cycle.

Recoil Buffer Group. The recoil buffer group is mounted into the lower portion of the rear end of the receiver body, its position being directly rearward of the piston rod. The recoil buffer is inserted into the receiver body and rotated through 90°. The recoil buffer latch spring then positions itself into a slot in the receiver body, thereby resisting any turning movement of the recoil buffer unless the recoil buffer latch spring is in turn depressed.

The recoil buffer body houses the driving spring guide retainer which is shouldered against the forward end of the recoil buffer body, thereby restricting its movement. The driving spring guide is shouldered on its rearward end and in turn is inserted into the driving spring guide retainer, and retained in its forward movement by means of this shoulder.

The shock from this piston rod during recoil is absorbed by the recoil buffer through its inner and outer recoil buffer springs, which are guided and retained within the recoil buffer body by means of the recoil buffer spring guide, recoil buffer spring retainer, and recoil buffer retainer nut. The recoil buffer retainer nut is secured by threading it onto an external diameter of the recoil buffer body and prevented from loosening itself by a detent on the rear end of the recoil buffer latch spring.

The Bolt Group. The bolt is inserted from the rear into the upper portion of the receiver body, and is positioned radially by cams, protruding radially from the forward end of the bolt, which ride in rectangular sections of the receiver body, thereby permitting the bolt a guided lateral movement. Motion is imparted to and received from the bolt through the yokelike section rising up from the rearward end of the piston rod.

This yokelike section is inserted into a cam developed opening through the side of the bolt at its midportion, and by acting against this cam surface rotates the bolt at a time when the forward or rearward progress of the bolt is resisted. By this rotary action, the protruding cams on the forward end of the bolt lock and unlock in the barrel.

The firing pin, which is inserted into the bolt, has two turned shoulders which straddle the yokelike section of the piston rod, thereby causing the firing pin to act in accordance with the piston rod. The firing-pin spring is confined by the rear end of the firing pin and the inside section of the operating cam impulse roller, which in turn is secured to the rear portion of the bolt by the operating cam impulse roll retaining pin.

The function of the firing-pin spring is to impart energy into the firing pin, moving it forward and firing the primer.

The extractor parts are fitted into a milled slot located on the side and forward portion of the bolt. The cartridge extractor, by spring pressure, engages the rim on the cartridge case, and, as the bolt is moving rearward, withdraws the cartridge case from the barrel.

A slot is milled opposite the extractor slot and parallel with it to provide an opening for the ejection pawl to operate through and eject the cartridge case through an opening in the receiver body.

Feeding Mechanism Group. The feeding mechanism group parts are housed in and mounted on the feed mechanism cover. This is a sheet metal fabrication channel-shaped in appearance, mounted by a welded hinge member on the forward end and secured by a latch on the rearward end. There are various studs secured to the inside of the feed mechanism cover about which the various members operate.

The entire feeding motion is a reciprocating action developed through the operating cam impulse roller moving laterally in the feed mechanism operating cam. This motion is transferred through the feed mechanism operating lever to the feed mechanism feeding fingers, thereby causing them to move with a reciprocating motion. This motion causes the cartridge belt to advance across the receiver plate, one cartridge space with each cycle of the bolt.

The cartridge belt is guided as it advances from bottom to top with each cycle of the bolt, across the receiver plate, thereby positioning the cartridge in a fitted opening in the receiver plate. The car-

tridge is held against this opening by the shell guide which is spring-loaded with sufficient pressure to permit the bolt in its forward progress to push the cartridge out of its belt retainer into the barrel.

The shell guide is hinged onto the feed mechanism cover and serves a dual purpose. It applies pressure to the cartridge and gives direction as the cartridge is launched by the bolt.

Trigger Mechanism Group. The trigger mechanism housing is a sheet metal fabrication, with left- and right-hand sections, bead-welded together. The hand grip is made of two plastic sections riveted onto the metal housing. The unit is mounted to the receiver body by two trigger mechanism holding pins; these, in turn, are secured by the trigger mechanism lock spring.

The unit houses the sear, firing selector, and safety latch. The sear, protruding through the receiver body, acts against the underneath side of the piston rod, and controls the single and automatic firing cycles.

Stock Group. The stock is of wood construction, machined so as to fit around the rearward portion of the receiver body. The stock has a machined opening along one side to permit the feed mechanism cover to position itself laterally and parallel with the receiver body. Mounted on the stock at the end of this opening is the feed mechanism cover latch plate, which positions and secures the feed mechanism cover.

The stock is held in place by means of a spring-loaded push latch, which positions itself into a recess in the recoil buffer spring retainer and is readily removable by depressing the stock locking push latch.

The stock is protected on the rearward end by a steel butt plate, retained in position by two wood screws.

Functioning of the 7.92-mm T44 as a Whole

The following is an account of a complete firing cycle from the explosion of one propelling charge to the next.

At the moment of firing, the projectile starts down the barrel, propelled by the expanding gases. The firing pin is in its forward position, having struck the primer of the cartridge. The bolt is held in its forward position, due to the bolt having rotated and the protruding cams having locked in the barrel.

As the projectile moves forward, it passes the gas port. A portion of the expanding gases enters the gas port, passes through the orifice formed by the gas cylinder orifice selector, enters the gas cylinder, and exerts pressure on the piston rod. This piston rod moves rearward, carrying with it the firing pin which is contained by the yokelike section on the rear portion of the piston rod. As the yokelike section moves back in the bolt, it starts to act against the cam opening of the bolt, causing the bolt to rotate counterclockwise, thereby unlocking the protruding cams in the barrel. When the rotating is complete, the bolt is unlocked and is forced rearward by direct blowback.

As the bolt is forced to the rear, the empty cartridge case is contacted on the rim by the ejector pawl operating through a slot in the bolt, causing the cartridge case to pivot about the extractor. The cartridge case leaves the hook of the extractor and moves through an opening in the side of the receiver body, completing the ejection of the fired case.

The first part of the rearward travel of the bolt causes the feed mechanism cam to operate. This motion advances the cartridge belt so that a cartridge is now in position in the receiver plate opening.

In recoiling, the bolt compresses the driving spring. As the bolt nears the end of its blowback, it compresses the recoil buffer springs, which absorb the remaining force of recoil and bring the bolt to a stop.

The recoil buffer spring and driving spring expand, forcing the bolt forward. The side of the front surface of the bolt engages the new cartridge, which has been positioned on the lips of the receiver plate. As the cartridge is forced forward, it leaves the feeding belt, is directed by the shell guide into the path of the ramming bolt, and is gripped by the hook of the extractor as it is rammed into the chamber.

As the bolt reaches the end of its forward motion, it seats against the face of the barrel. However, the piston rod has not reached the end of its forward progress, and as it continues forward, the cam action of the yokelike section against the bolt causes the bolt to rotate, thereby locking the bolt. As the bolt completes its rotating, the piston rod is in position

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to move forward with the firing pin. The necessary energy is provided by the firing-pin spring. The firing pin strikes the primer of the cartridge, firing it and starting the cycle all over again.

To stop firing the gun, release the trigger mechanism. The sear is forced upward by the sear spring. This engages the underneath side of the piston rod and blocks the forward motion.

Disassembly and Assembly

General. To facilitate complete disassembly and assembly, the procedure as outlined in the following paragraphs should be followed. The disassemblies and assemblies have been divided into four main classes.

1. Disassembly into major parts and subassemblies.
2. Disassembly of subassemblies.
3. Assembly of subassemblies.
4. Assembly of gun from subassemblies and major parts.

The construction of this gun is such that all parts may be disassembled and assembled without the use of special tools.

Disassembly Into Major Parts and Subassemblies.

Feed Mechanism Cover Group.

1. Unlock feed mechanism cover by pushing the feed mechanism cover latch forward.
2. Rotate feed mechanism cover 90° about feed mechanism cover hinge pin and away from receiver body.
3. Remove feed mechanism cover hinge pin. (It will be noted that both the feed mechanism cover and the retainer plate are retained by the feed mechanism cover hinge pin.)

Stock Removal. Push stock locking latch completely in and draw stock to the rear.

Recoil Buffer Group.

1. Depress recoil buffer latch spring.
2. Rotate recoil buffer 90° and draw rearward.

Driving Spring.

1. Remove recoil buffer group.
2. Elevate forward end of gun and driving spring will fall free.

Piston Rod.

1. Draw the piston rod operating handle to the rear for the complete throw of the bolt.
2. Remove the piston rod operating handle by pulling it away from the receiver body.
3. Elevate forward end of gun and remove piston rod. (It will be noted that the piston rod is interlocked with the bolt. One cannot be removed without the other.)

Bolt Group. Removal of the bolt group is precisely the same as the removal of the piston rod.

Muzzle Brake.

1. Place gun in such a position as to look down forward end of barrel.
2. Lift muzzle brake locking latch, integral with front sight.
3. Rotate muzzle brake counterclockwise until threads release.

Muzzle Brake Ferrule.

1. Rotate muzzle brake ferrule in a counterclockwise direction until free.

Bipod Removal.

1. Remove muzzle brake ferrule.
2. Remove bipod from muzzle brake ferrule.

Front Sight.

1. Remove bipod.
2. Slide front sight off barrel.

Gas Cylinder Locking Nut.

1. Revolve gas cylinder locking nut in a counterclockwise direction, until free.
2. Slide gas cylinder locking nut over barrel.

Gas Cylinder Group.

1. Remove gas cylinder locking nut.
2. The gas cylinder group is free.
3. Slide gas cylinder group over barrel.

Hand Grip.

1. Remove gas cylinder locking nut.
2. Remove gas cylinder group.
3. Slide hand grip over barrel.

Trigger Mechanism Group.

1. Remove trigger mechanism locking spring by depressing and pushing spring away from the barrel, toward the trigger until slots are free from pins.
2. Remove front trigger mechanism holding pin.
3. Remove safety latch by pulling it away from trigger group.
4. Remove rear trigger mechanism holding pin.
5. Pull trigger group away from retainer body.

Disassembly of Subassemblies.

Bolt Group.

1. Place bolt with rear pointing toward operator.
2. Grasp piston rod and apply pressure to rear of bolt until bolt is full forward.
3. Hold pressure and lift bolt free of piston rod.

4. Rotate operating cam impulse roller assembly clockwise through 45°.

5. Apply pressure to rear of operating cam impulse roller assembly and hold, to counteract spring pressure within bolt.

6. Remove operating cam impulse roller retaining pin.

7. Remove operating cam impulse roller assembly.

8. Withdraw firing pin spring.

9. Elevate forward end of bolt and firing pin will fall free.

Feed Mechanism Cover Group.

1. Place feed mechanism cover group so that the interior is in full view and the feed mechanism operating cam is pointing to the left.

2. Apply pressure on the shell guide to counteract spring beneath and move same to the left and release pressure.

3. Rotate shell guide about pivot pin through 90° to clear linkage.

4. Push the feed mechanism operating cam lock spring in as far as possible and lift feed mechanism operating cam, feed mechanism operating lever, and the feed mechanism operating fingers from studs. (It will be noted that the above named parts are interlocked and are removed as a unit.)

Recoil Buffer Group.

1. Remove recoil buffer latch spring by revolving recoil buffer retaining nut in a counterclockwise direction until it is not overlapped by the recoil buffer retaining nut.

2. Insert fingers under recoil buffer latch spring, lift spring up, and move forward approximately one-half inch.

3. Remove the recoil buffer retainer nut by turning the recoil buffer retainer nut counterclockwise. Note that constant pressure must be applied when removing recoil buffer retainer nut, to counteract spring pressure within recoil buffer assembly.

4. Withdraw recoil buffer spring retainer from recoil buffer spring nut.

5. Lift out recoil buffer spring guide.

6. Remove inner and outer recoil buffer springs from recoil buffer body.

7. Remove driving spring guide.

8. Slip driving spring retainer guide from recoil buffer body.

Trigger Mechanism Group.

1. Pull out firing selector.

2. Lift out sear and sear oscillating bushing from the trigger mechanism housing.

3. Rotate sear oscillating bushing 90° and remove from sear.

4. Remove trigger hinge pin.

5. Invert trigger mechanism housing and both the sear spring and trigger will fall free.

6. Slip sear spring from rod on trigger.

Gas Cylinder Group.

1. Remove the gas cylinder pressure regulator by rotating in a counterclockwise direction until threads become free of the gas cylinder.

2. Remove the gas cylinder orifice selector retainer from the gas cylinder orifice selector.

3. Pull out the gas cylinder orifice selector.

Assembly of Subassemblies. Prior to assembly, all parts must be free of dirt, rust, and other extraneous matter. Metal parts in contact must be covered with a light film of lubricating oil.

Bolt Group.

1. Insert firing pin and firing-pin spring into hole through the center of the bolt body.

2. Place piston rod yoke between shoulders of firing pin with both the piston rod and the bolt in operating arrangement.

3. Insert firing-pin spring.

4. Place operating cam impulse roller directly behind firing-pin spring, and compress.

5. When operating cam impulse roller is in position for assembly, rotate operating cam impulse roller until holes of the bolt body and the operating cam impulse roller come into line.

6. Insert operating cam impulse roller retaining pin.

Trigger Mechanism Group.

1. Place sear spring on pin attached to trigger.

2. Holding the trigger mechanism housing with the pistol grip to the right and pointing toward the operator, insert the trigger into the trigger mechanism housing, until the holes in both the trigger and the trigger mechanism housing appear in line.

3. Insert trigger hinge pin.

4. Place the sear oscillating bushing in the recess and hole provided for it in the sear, and rotate the sear oscillating bushing 90°.

5. Insert the sear with the finger to the rear of the trigger mechanism housing, and insert in such

a manner as to engage the trigger spring pin in the hole in the sear.

6. Line up hole in sear oscillating bushing with corresponding holes through the trigger mechanism housing, and insert the firing selector.

Recoil Buffer Group.

1. Insert driving spring guide through the small hole in the driving spring guide retainer until it is shouldered against the inside of the driving spring guide retainer.

2. Place the small end of the driving spring guide retainer through the large bore of the recoil buffer body until it is seated against the shoulder.

3. Push the outer recoil buffer spring into the hole in the recoil buffer body until it contacts the driving spring guide retainer.

4. Insert inner recoil buffer spring inside the outer recoil buffer spring until it seats against the driving spring guide.

5. Slide the recoil buffer spring guide through the inner recoil buffer spring.

6. Insert the recoil buffer spring retainer with the smaller cylindrical sections entering first through the locating hole in the recoil buffer retainer nut until it shoulders within the recoil buffer retainer nut.

7. Place the recoil buffer retainer nut over the inner and outer recoil buffer springs, compressing the springs and revolving the recoil buffer retainer nut clockwise with the recoil buffer body facing away from the operator.

Feed Mechanism Cover Group.

1. Locate the feed mechanism feeding fingers, the feed mechanism operating cam and the feed mechanism operating lever in such a manner that the holes provided in each member will correspond to the pivoting studs in the feed mechanism cover. It will be noted that the above-mentioned parts are interlocked and must be assembled as a unit.

2. Slip the feed mechanism feeding finger and the feed mechanism operating lever over their respective studs.

3. Depress the feed mechanism operating cam lock spring, and press the feed mechanism operating cam into position.

Gas Cylinder Group.

1. Push the gas cylinder orifice selector into the hole provided for it at the front of the gas cylinder. Locate one of the slots on the head parallel with the slot in the gas cylinder, and push the gas cylinder orifice selector in until it is seated on the counterbored surface.

2. Slip the gas cylinder orifice selector retainer into position over the gas cylinder in such a manner as to confine the movement of the gas cylinder orifice selector.

3. Insert the gas cylinder pressure regulator into the front threaded section of the gas cylinder, and rotate the gas pressure regulator until it is locked into position by the gas cylinder orifice selector retainer engaging the slots located on the circumference of the gas cylinder pressure regulator.

Assembly of Gun From Subassemblies and Major Parts. Prior to assembly, all parts must be free of dirt, rust, and other extraneous matter. Metal parts in contact must be covered with a light film of lubricating oil.

Gas Cylinder and Forward Section of Gun.

1. Slide the handgrip over the forward end of the barrel until it seats itself against the receiver body.

2. Slide the gas cylinder assembly over the forward end of the barrel and back over the piston rod into position.

3. Place gas cylinder locknut over barrel and tighten into position by revolving the gas cylinder locknut in a clockwise direction when looking into the muzzle of the gun.

4. Slide the front sight over the barrel so that the muzzle brake locking latch is forward and sighting ring is pointing up.

5. Place the holding ring of the bipod over the barrel of the gun and locating unit so that the arms are pointing down and will fold back to the rear.

6. Slip the muzzle brake ferrule over the barrel and screw into position by rotating the muzzle brake ferrule in a clockwise direction with the threads on the outside diameter away from the rear of the gun.

7. Place the muzzle brake over the muzzle brake ferrule and rotate the muzzle brake in a clockwise direction when looking into the barrel, until it is locked into position by the muzzle brake locking latch engaging the slot located in the muzzle brake.

Piston Rod Assembly.

1. Insert both the bolt and the piston into the receiver body, moving the piston rod forward until the rectangular slot in the piston rod can be sighted

at the rear end of the clearance slot for the piston rod operating handle in the receiver body.

2. Insert the piston rod operating handle through the receiver body into the rectangular slot in the piston rod.

3. Move the piston rod operating handle forward until bolt locks into positon.

Bolt Group. Assembly of the bolt group is precisely the same as the assembly of the piston rod.

Driving Spring Assembly.

1. Insert driving spring plug into driving spring.

2. Insert driving spring with driving spring plug end first into the hole through the center of the piston rod.

Recoil Buffer Group.

1. Push the driving spring guide through the driving spring. It will be noted that the driving spring guide is assembled to the recoil buffer body.

2. Holding gun horizontally with the muzzle pointing to the left and the trigger mechanism assembly pointing down, apply pressure to the rear of the recoil buffer assembly to compress the driving spring, making sure to hold the recoil buffer assembly with the recoil buffer latch spring slot facing the operator.

3. Shoulder recoil buffer assembly against the rear of the receiver body and rotate through 90°.

4. Place recoil buffer latch spring into slot in receiver body and resting against and located in the hole in the receiver body.

5. Rotate the recoil buffer retaining nut clockwise until it overlaps and locks on the recoil latch spring.

Trigger Group.

1. Holding the receiver body firmly, push the trigger mechanism housing into position over the locating studs connected to the receiver body.

2. Holding the trigger mechanism with the pistol grip to the left and pointing toward the operator, insert front and rear trigger mechanism holding pins into their respective holes.

3. Insert the safety latch into its position in the trigger mechanism housing.

4. Holding the trigger mechanism with the pistol grip to the right and pointing toward the operator, slip the trigger mechanism lock spring so that the grooves in it slip around the recesses cut into the trigger mechanism housing locating pins, the single or automatic firing selector and safety latch, thus locking the assembly in position.

Stock Assembly. Grasp the receiver body firmly. Depress the stock locking push latch and slide stock over the rear of the receiver into position, then release stock locking push latch.

Feed Mechanism Cover Group.

1. Place the receiver plate so that the hinging fingers fit into the clearance slots of the feed mechanism cover mounting bracket, with the hand guard down and the receiver plate resting against the receiver body.

2. Place the feed mechanism cover with the hinge inserted into the locating slot in the feed mechanism cover mounting bracket so that its longitudinal axis is 90° to the longitudinal axis of the receiver body, with the feed mechanism feeding fingers pointing upward.

3. Line up the holes in the feed mechanism cover mounting bracket, the receiver plate, and the feed mechanism cover. Insert the feed mechanism cover hinge pin, so that the flats on the feed mechanism cover hinge pin locate on the sides of the elongated slot in the receiver plate.

4. Apply pressure to and depress the shell guide through its total movement. Hold pressure and move the shell guide to its maximum forward position.

5. Rotate the feed mechanism cover about the feed mechanism cover hinge pin toward the stock; as the feed mechanism cover swings back, insert the operating cam impulse roller into the feed mechanism operating cam and lock the feed mechanism cover against the stock.

PART IX

AUTOMATIC WEAPON DEVELOPMENT DURING AND AFTER WORLD WAR II BY OTHER WORLD POWERS (EXCEPT USSR AND HER SATELLITES)

Chapter 15

ROLLS-ROYCE AIRCRAFT CANNON

SECTION 1. 40-MM TYPE BD NAVAL GUN

General Description of the Basic Features of the Gun

The Rolls-Royce 40-mm type BD naval gun was originally a quick-firing single-shot weapon, modified to fire full automatic for aircraft use. Ease and safety of handling and simplicity of operation are its main features, while ease of maintenance and manufacture are also characteristic of the weapon.

The gun consists of a barrel and a breech ring and body in which a rectangular breechblock can reciprocate. This assembly is attached to the recoil and recuperator mechanism, which serves the several purposes of absorbing the recoil, returning the barrel to the firing position, and closing the breech. The main ram of the recoil mechanism is anchored in a cradle in which the barrel and recoil assembly is free to slide on three supports within the limits of recoil. The front support, besides allowing for thermal expansion of the barrel, acts as a vibration damper.

Attached to the right-hand side of the cradle is a loading tray. A round placed in the tray may be swung up into the lips of the feed opening, whereupon the breechblock is automatically released, sweeping the round into the chamber. The loading tray is interconnected with a manually operated trigger, controlled from a twist grip conveniently mounted on the cradle. A safety device insures that this tray is in the unloaded position before the trigger is released. A safety position is also incorporated in the trigger mechanism.

The breechblock is designed to remain open on cease fire but may be opened manually when necessary with the aid of a tool supplied. A recoil guard is fitted to the rear of the cradle, and a suitable shoulder rest is provided.

General Data: 40-mm Type BD Naval Gun

Gun length: 126 inches.
Gun weight: 336 pounds.
Rate of fire: 200–250 rounds/minute.
Muzzle velocity: 2,450 feet/second.
System of operation: Long recoil.
Maximum distance of recoil: 17 inches.
System of locking: Double swinging locks.
System of feeding: Drum; or recoil actuated system employing metallic links.
Method of headspace: Not adjustable.
Location of feed opening: Top, right hand or left hand.
Location ejection opening: Bottom of receiver.
Method of charging: Air, manual.
Method of cooling: Air.

Barrel length: 80 inches.
Barrel weight: 72 pounds.
Rate control: Single shot or full automatic.
Barrel removal: Can be removed easily.
Bore:
  Number of grooves: 12.
  Groove depth: 0.020 inch.
  Groove width: 0.214 inch.
  Pitch: 1 turn in 34 inches.
  Direction of twist: Right hand.
  Form of twist: Constant.

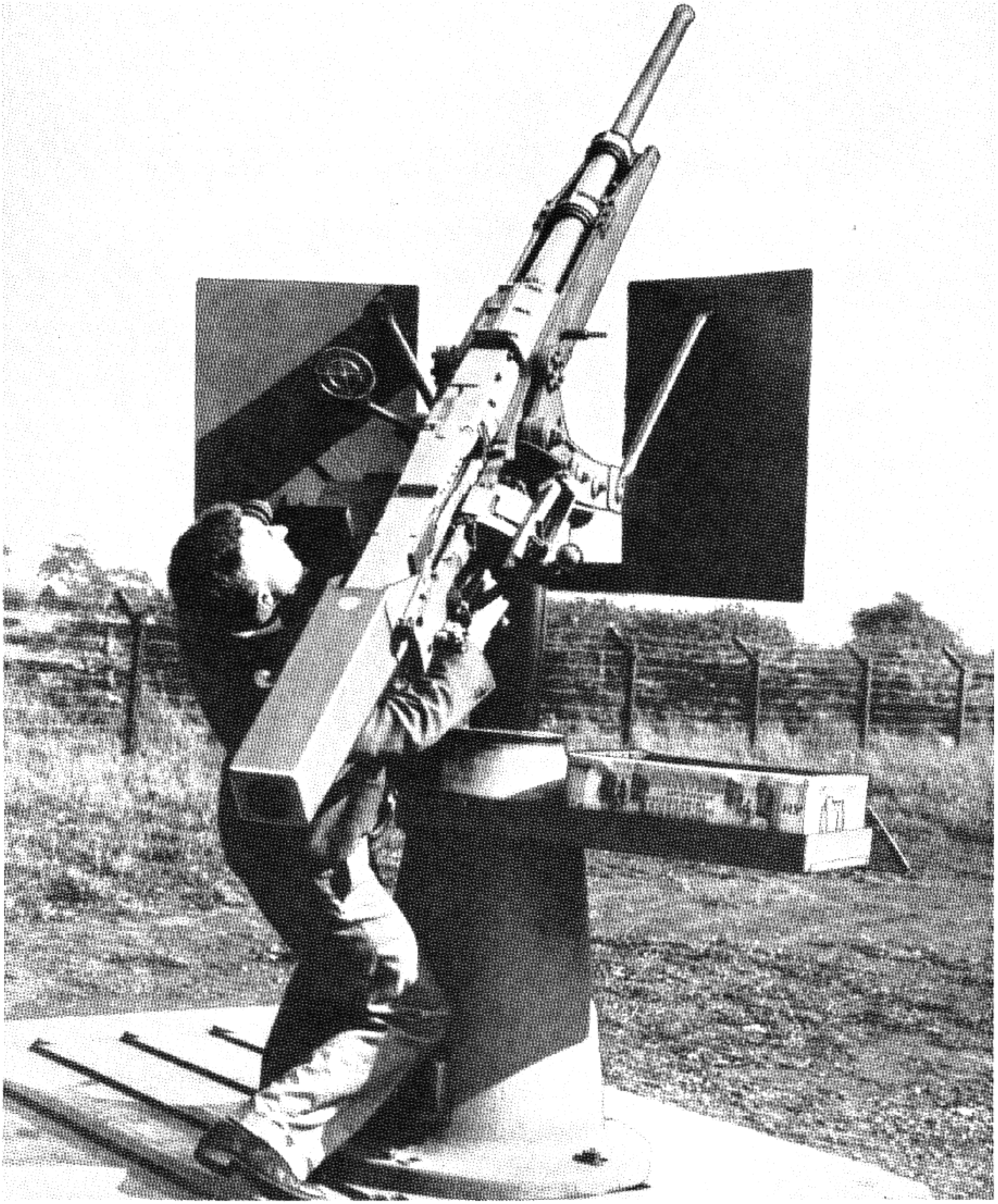

Figure 15–1. Rolls Royce 40-mm Type BD Naval Gun on cone mount. Right rear view.

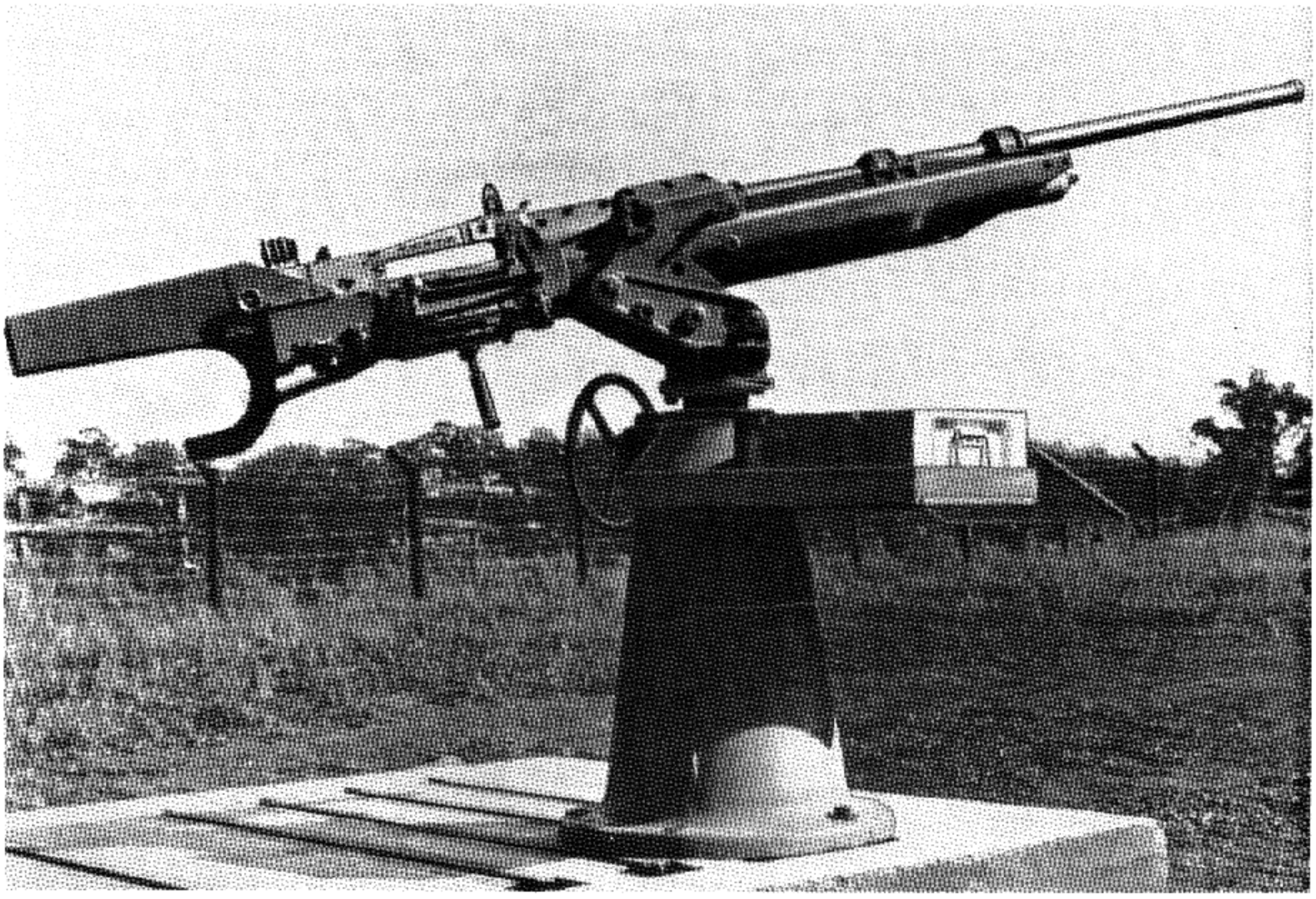

Figure 15–2. Rolls Royce 40-mm Type BD Naval Gun. Right side view.

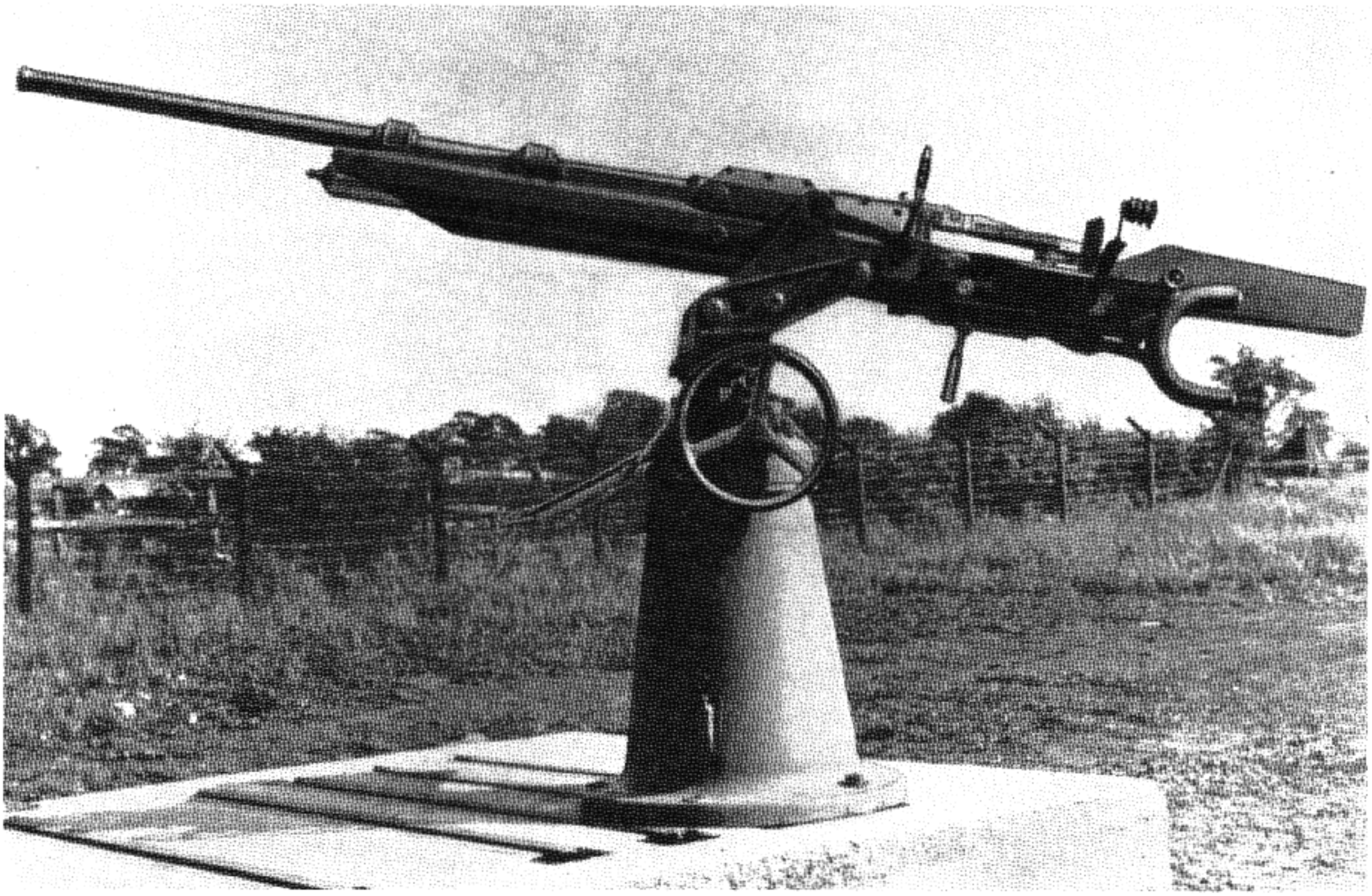

Figure 15–3. Rolls Royce 40-mm Type BD Naval Gun. Left side view.

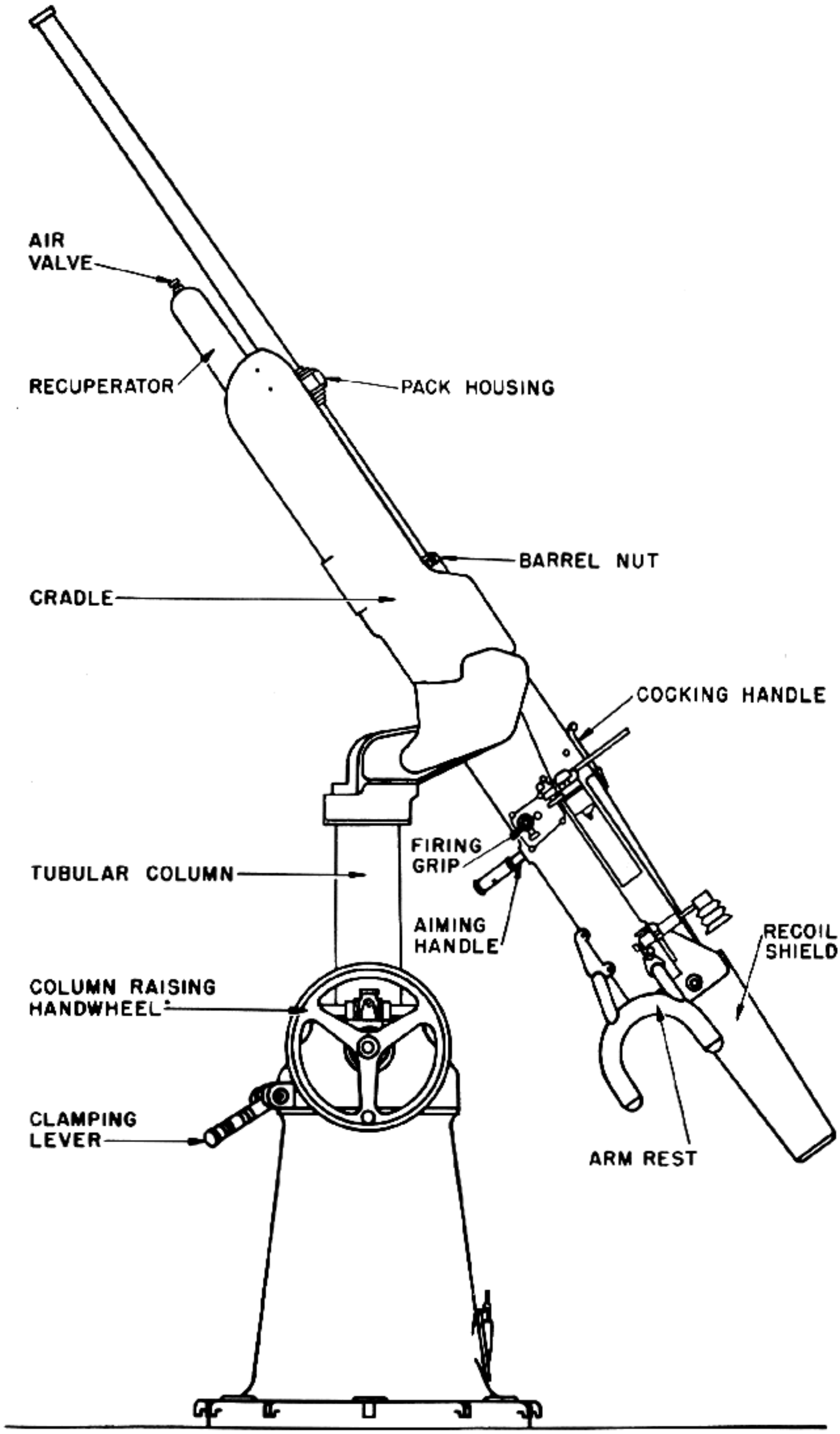

Figure 15–4. Rolls Royce 40-mm Type BD Naval Gun. Nomenclature.

SECTION 2. 40-MM TYPE BH

Similarity to the 40-mm Type BD Naval Gun

The general description of the 40-mm type BD naval gun given in section 2 applies to the BH.

The components of both guns are essentially the same, and, accordingly the pictures of the BD naval gun shown in this section apply equally to the BH.

Detail Description

Barrel and Breech Ring Assembly. The barrel is machined from a nickel chrome molybdenum steel forging with two parallel portions to accommodate the barrel housings and a threaded portion of "buttress" form at the breech end to accommodate the breech ring. A screwed portion is also provided for locking the barrel to the recoil mechanism by means of a large nut.

The breech ring has an internal thread of similar form and is split in halves, being held together on the barrel and clamped thereto by means of eight bolts. The clamping effect is produced due to tolerances on diameters and the local recessing in the barrel, to clear some of the bolts, affords to some extent an additional means of locking the breech ring in position. Two slides, integral with the breech ring, support the breech end of the gun in the cradle. Two cylindrical locking shoulders are contained in the rear end of the breech ring and are retained by means of spring clips attached externally.

The barrel is mounted on three supports which are free to slide in corresponding grooves in the cradle. The two rear supports are rigidly connected to the barrel, one being integral with the breech ring and the other locked to the barrel by means of a retaining nut screwed to the barrel. The retaining nut is held in position by means of a small lock plate attached to the housing.

The forward support is attached to the barrel by means of a self-alining pack housing consisting mainly of a series of concentric split rings of V cross section interposed by similar split rings of inverted V cross section. The rings are contained in a housing and are also in contact with one of the parallel portions on the barrel. A strong coiled spring, retained in the housing by means of a nut, imparts an axial load to the split rings, the radial component tending to close the rings onto the barrel and housing. Thus the barrel is firmly supported in position. Should the barrel be deflected, the spring load insures a firm support, at the same time tending to return the barrel to its concentric position.

Body Assembly. The body is made up of rectangular sections and is attached to the breech ring by means of four studs. The interior of the body is machined to accommodate the breechblock, in which it is free to reciprocate. The rear end of the body is closed by means of an easily detachable cover.

In the body there is a steel adjusting plate for adjusting the protrusion of the firing pin. Steel lips for the cover opening are attached to the body by means of eight studs. A stop is included for limiting the travel of the firing stirrup. Also in the body are the cartridge ejector trip, ejector trip springs, and the cocking mechanism consisting mainly of a cocking lever, cocking slide, cocking slide spring, etc.

Breechblock Assembly. The bleechblock assembly consists of a breechblock body, striker housing, striker housing arm, striker, firing spring, sear, firing stirrup, firing stirrup spring, struts, and cams.

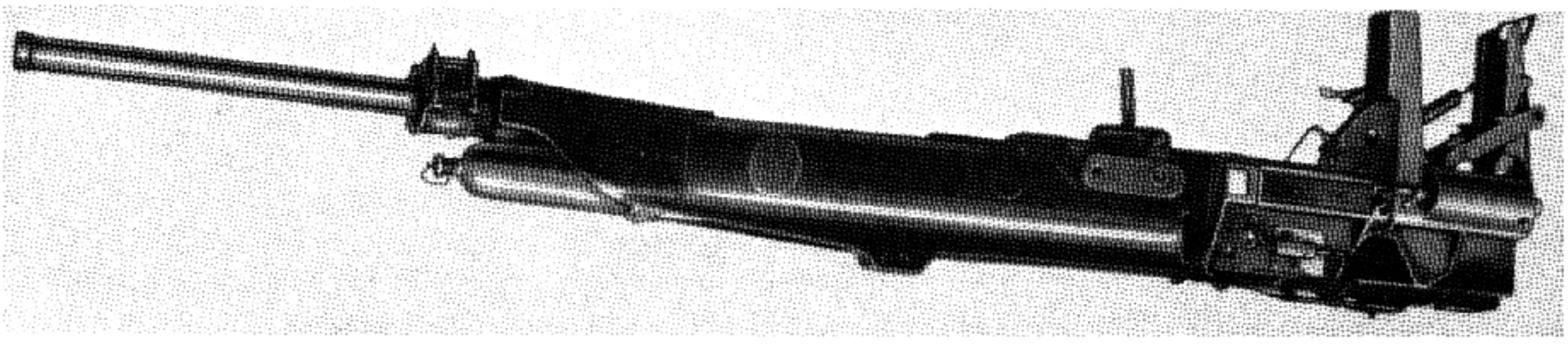

Figure 15–5. Rolls Royce 40-mm Type BH Aircraft Cannon. Left side view.

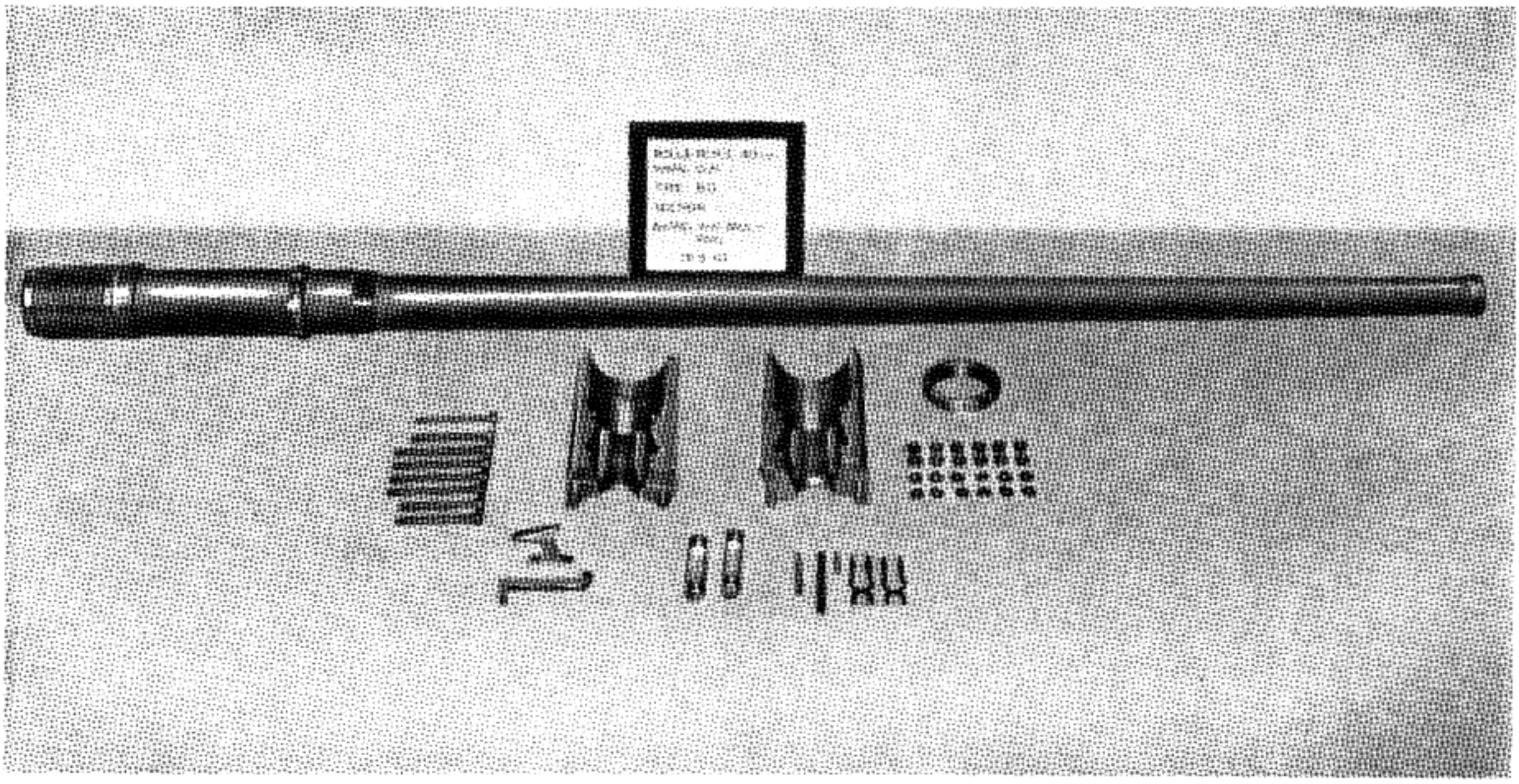

Figure 15–6. Rolls Royce 40-mm Type BD Naval Gun. Barrel and components of breech ring.

The breechblock body is of rectangular section and has an axial cylindrical hole to accommodate the striker housing. The striker housing is retained in the breechblock body by two floating cams which permit a limited relative axial movement between breechblock body and striker housing. The sear is pivoted in the breechblock body and engages the striker contained in the striker housing.

The striker housing arm is attached to the rear of the striker housing by means of a T-slot connection and is held in position by a thimble sliding in the striker housing, pressed into a registering hole in the arm by the firing spring.

The breechblock body accommodates two locking struts which are operated by the floating cams and engage the locking shoulders in the breech ring when the breech is closed.

The firing stirrup and firing stirrup spring are accommodated in the leg of the striker arm, the firing stirrup being carried on the tail of the sear.

Recoil Mechanism Assembly. The recoil mechanism assembly consists mainly of a recoil cylinder which is connected by means of studs to a recuperator cylinder but separated by a diaphragm that carries the adjustable control orifice and dashpot body.

The recoil cylinder has a main cylinder, in which the main ram operates, and a bypass, which is fitted with a restricting orifice at one extremity and a short controlling rod at the other. A floating piston operates in the recuperator cylinder which is fitted with an air valve for filling purposes and a control orifice adjusting gear.

One end of the main ram is anchored to a bridge piece attached to the cradle, and a floating piston is fitted to the other end. The rear end of the recoil cylinder is closed by a large screwed plug. Concentric with the main ram is the breechblock pull rod, which is connected to a glanded piston and has a tubular extension carrying a dashpot plunger.

The recoil mechanism is underslung from the barrel, being attached to the barrel supporting brackets.

Cradle and Fittings. The cradle consists of two castings bolted together, the joint face being through the centerline of the gun. Two grooves are machined along the full length of the cradle to accommodate the slides of the barrel supporting brackets. The main ram of the recoil mechanism is anchored to a bridge piece in the well of the cradle.

A feed mechanism is attached to the right-hand side of the cradle to the rear of the gun.

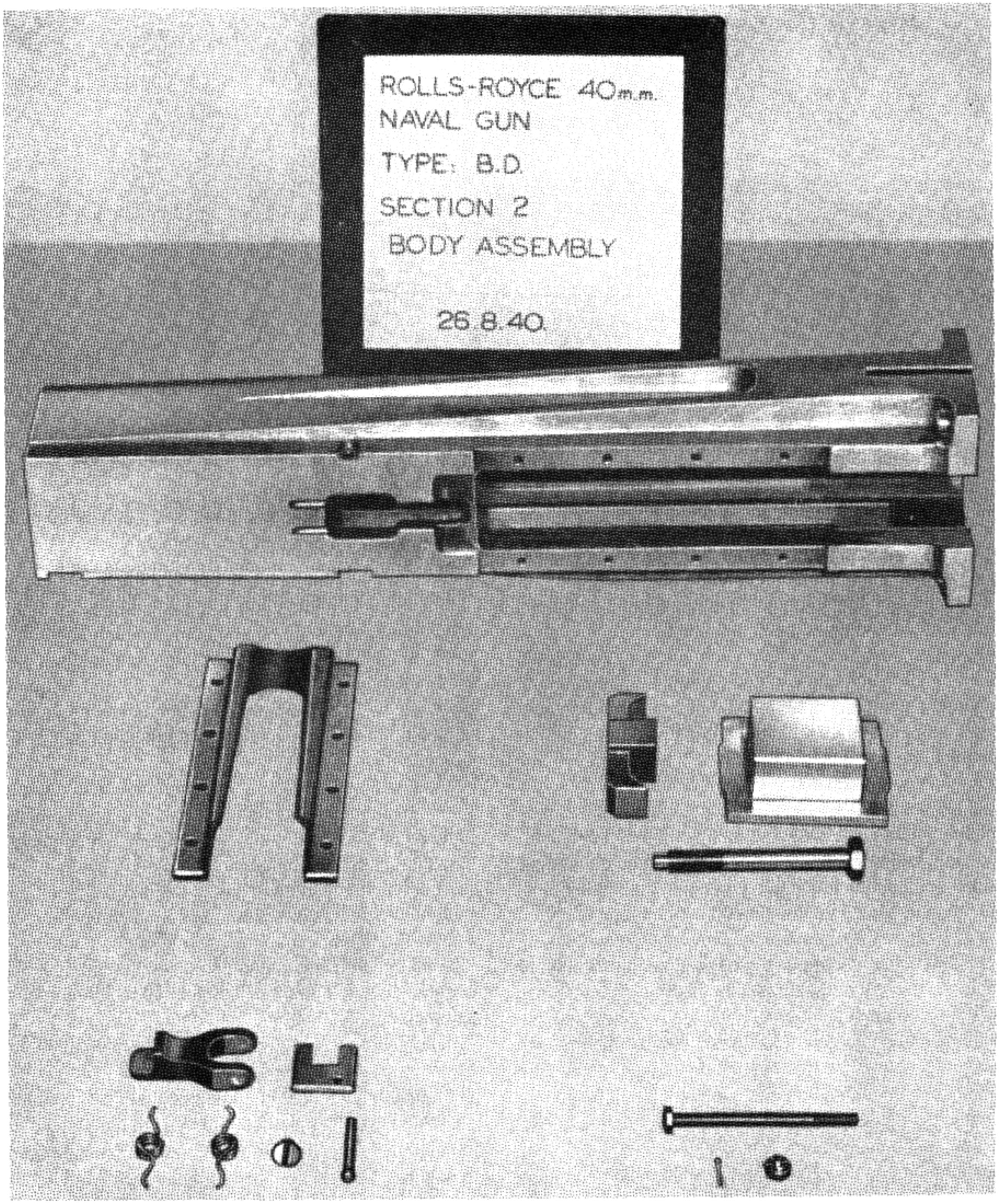

Figure 15–7. Rolls Royce 40-mm Type BD Naval Gun. Components of body assembly.

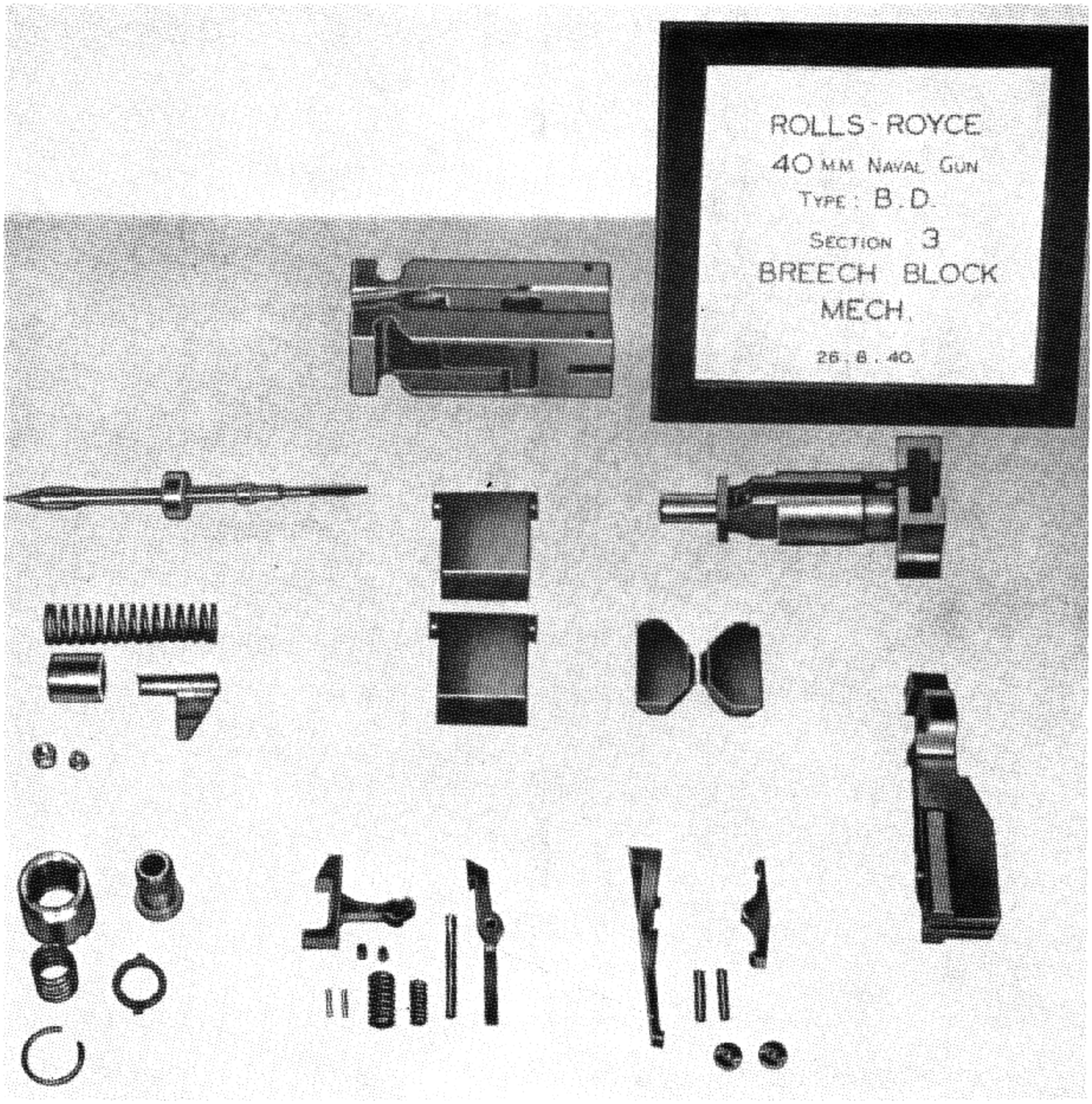

Figure 15–8. Rolls Royce 40-mm Type BD Naval Gun. Components of breechblock.

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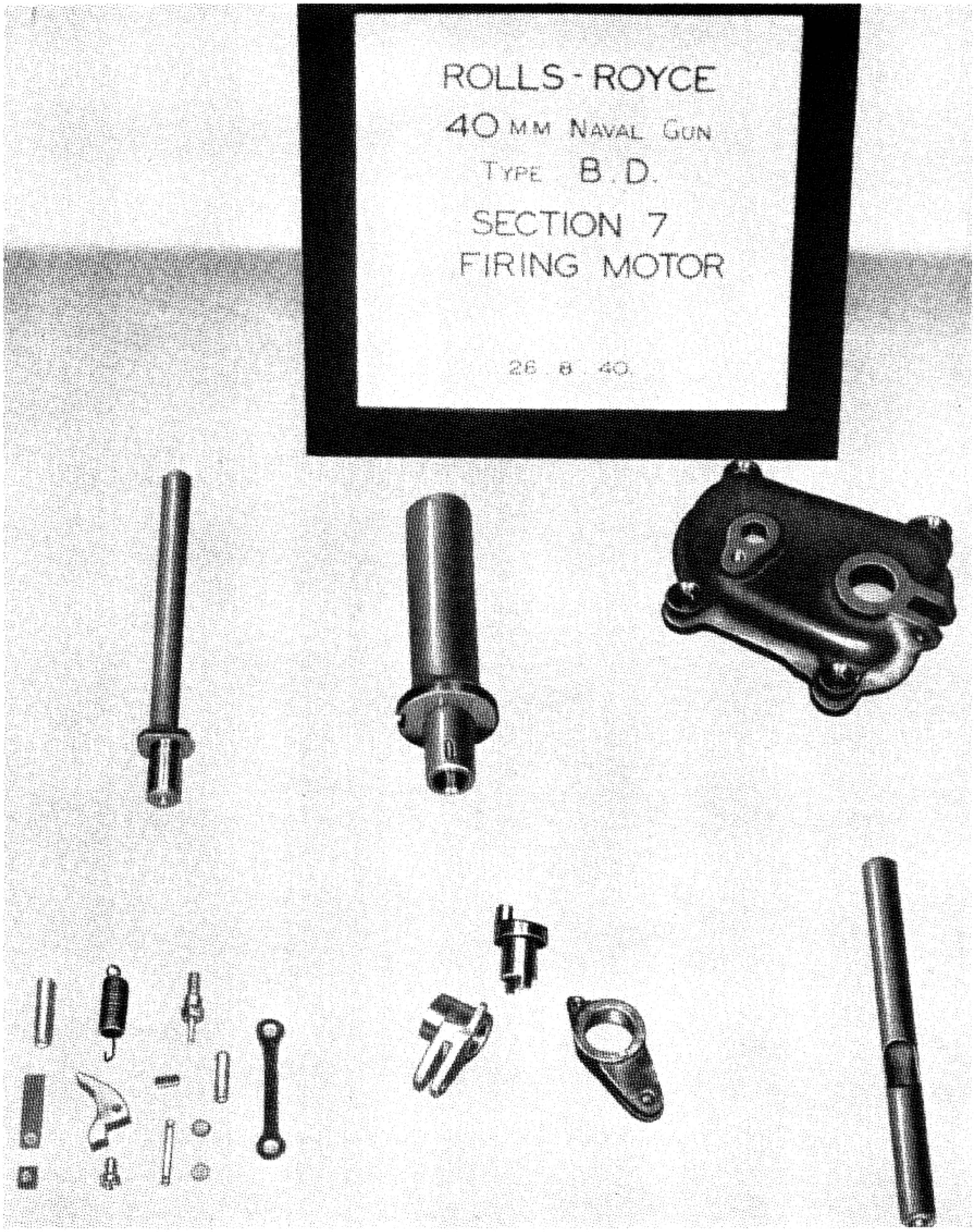


Figure 15–9. Rolls Royce 40-mm Type BD Naval Gun. Components of firing motor.

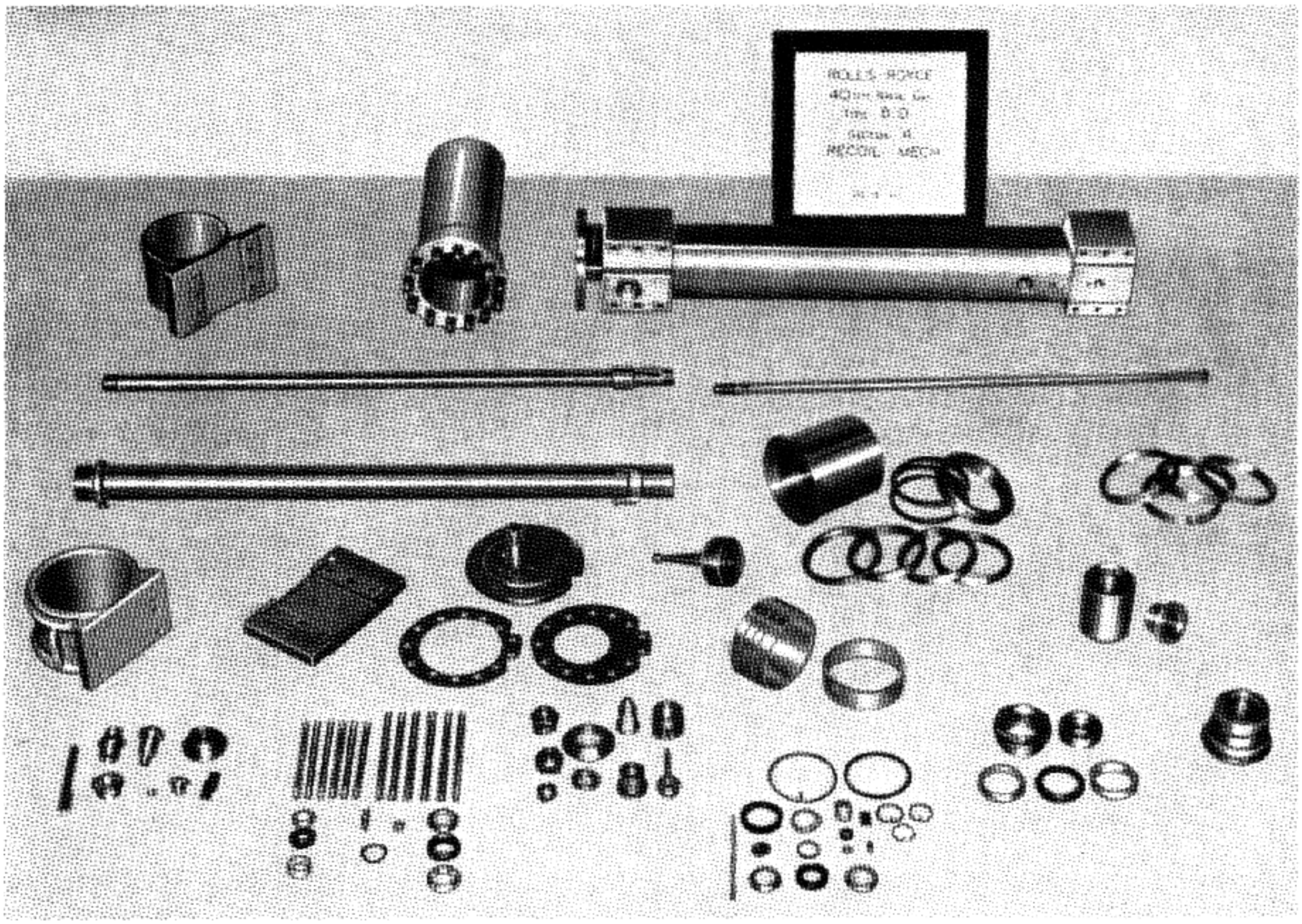


Figure 15–10. Rolls Royce 40-mm Type BD Naval Gun. Components of recoil mechanism.

An ejection chute is mounted on the cradle opposite the ejection opening in the body on the left-hand side of the gun.

A breechblock release mechanism is accommodated in the rear of the cradle. It comprises a spring-loaded release shaft mounted transversely in the well of the cradle and retained by means of a screwed plug and setscrew.

A rubber coated arm rest of tubular construction is attached to the rear of the cradle on the left-hand side of the gun.

A rubber buffer is suitably arranged on the underside of the cradle to cushion the gun when lowered to the rest position.

An aiming handle is also provided to assist the gunner in controlling the gun when firing.

Hand Feed and Breechblock Release Mechanism. The hand feed is essentially a loading tray, which is machined from a simple U-shaped casting. The tray is carried on a shaft lying parallel with the axis of the barrel and supported by two brackets attached to the underside of the cradle on the right-hand side of the gun. Pivoted to the loading tray is a spring-loaded auxiliary tray. The movement of the tray is limited by a small stop plate attached to the main casting. Attached to the side of the cradle to guide the round into the feed opening are a quadrant on the guide plate and an end locating plate and bracket.

Interconnected with the hand feed mechanism is a breechblock release mechanism. This consists mainly of a cam, keyed to a short vertical spindle mounted in a bracket attached to the right-hand side of the cradle and operated by a lever connected to a universal joint on the rear end of the loading tray shaft.

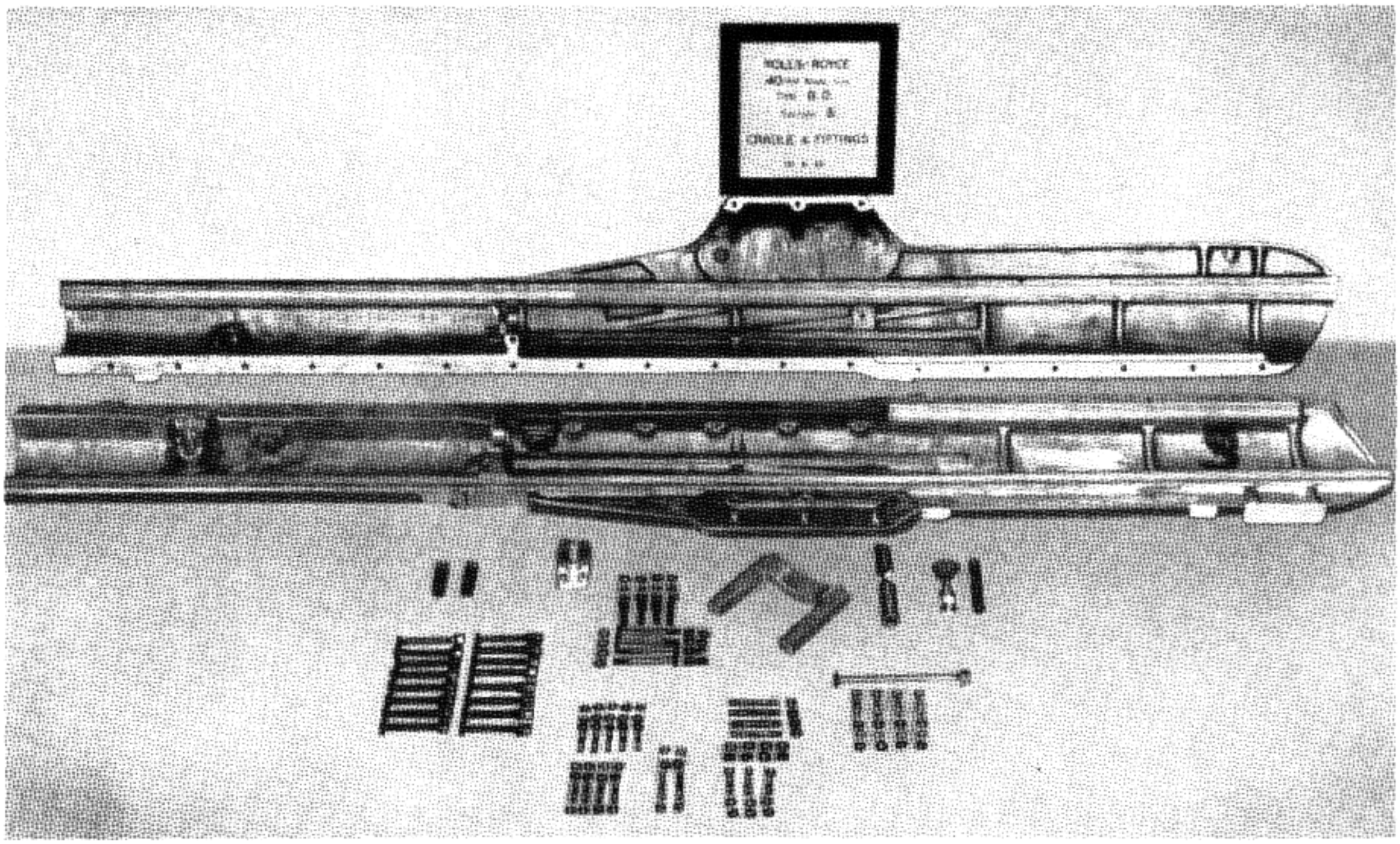


Figure 15–11. Rolls Royce 40-mm Type BD Naval Gun. Components of cradle assembly.

General Principles of Operation

The general principles of operation of the gun are as follows:

1. The barrel, breech ring, body, breechblock, and recuperator mechanism constitute the recoiling parts.

2. The cradle, recoil shield, main recoil ram, hand loading tray, shoulder piece, and sights do not recoil.

3. The breechblock is closed by pneumatic pressure.

4. The breechblock is positively locked before firing.

5. The striker is inoperative until the breechblock is locked.

6. Energy of recoil is absorbed by a hydropneumatic recoil mechanism.

7. The barrel is returned to its firing position by pneumatic pressure.

8. The gun cannot be fired with the loading tray in the up position.

9. The firing grip must be released after firing each round.

Principal Steps in the Cycle of Operation

Breechblock Closed and Locked; Round Fired. The breechblock is in the closed locked position, the trigger has been released and a round has been fired.

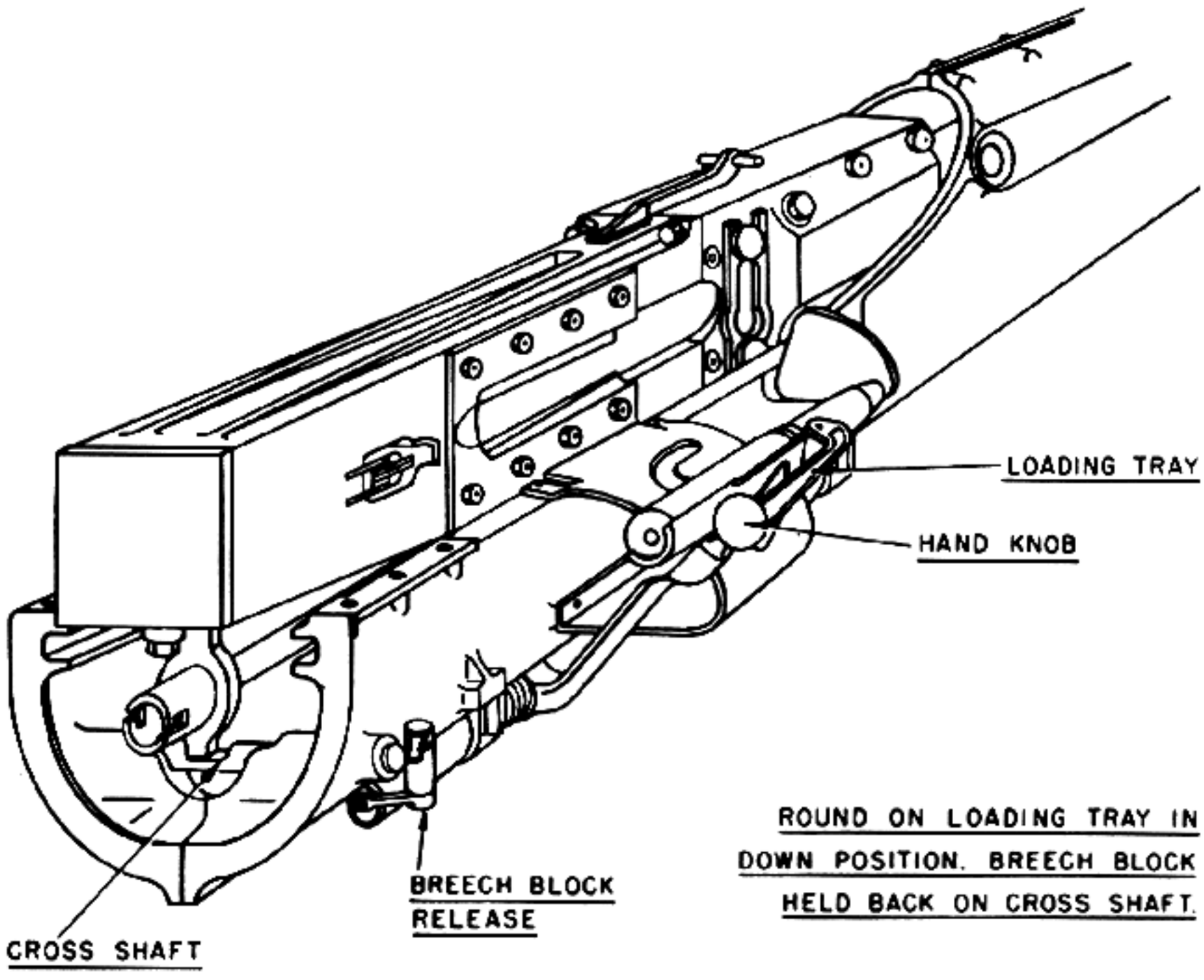
Breechblock Closed and Locked; Gun Recoiling. The breechblock remains in its locked position during recoil.

Breechblock Closed and Locked; Gun Recoiled. The breechblock, still in its closed locked position, has recoiled beyond the spring-loaded cross-shaft pushed aside by the striker housing arm.

Barrel Running Out; Breechblock Unlocked and Held Back. The barrel commences to run out and the striker housing arm is caught by the spring loaded cross-shaft, the initial relative movement causing the breechblock to unlock. Further movement causes the empty case to be extracted from the chamber.

Barrel Run-Out; Empty Case Ejected. During barrel runout, the empty case is presented to the ejection opening. After the case leaves the chamber, it is supported by the extractor and the breechblock face. In this position, the spring-loaded ejec-

Figure 15–12. Rolls Royce 40-mm Type BD Naval Gun. Components of feed mechanism.



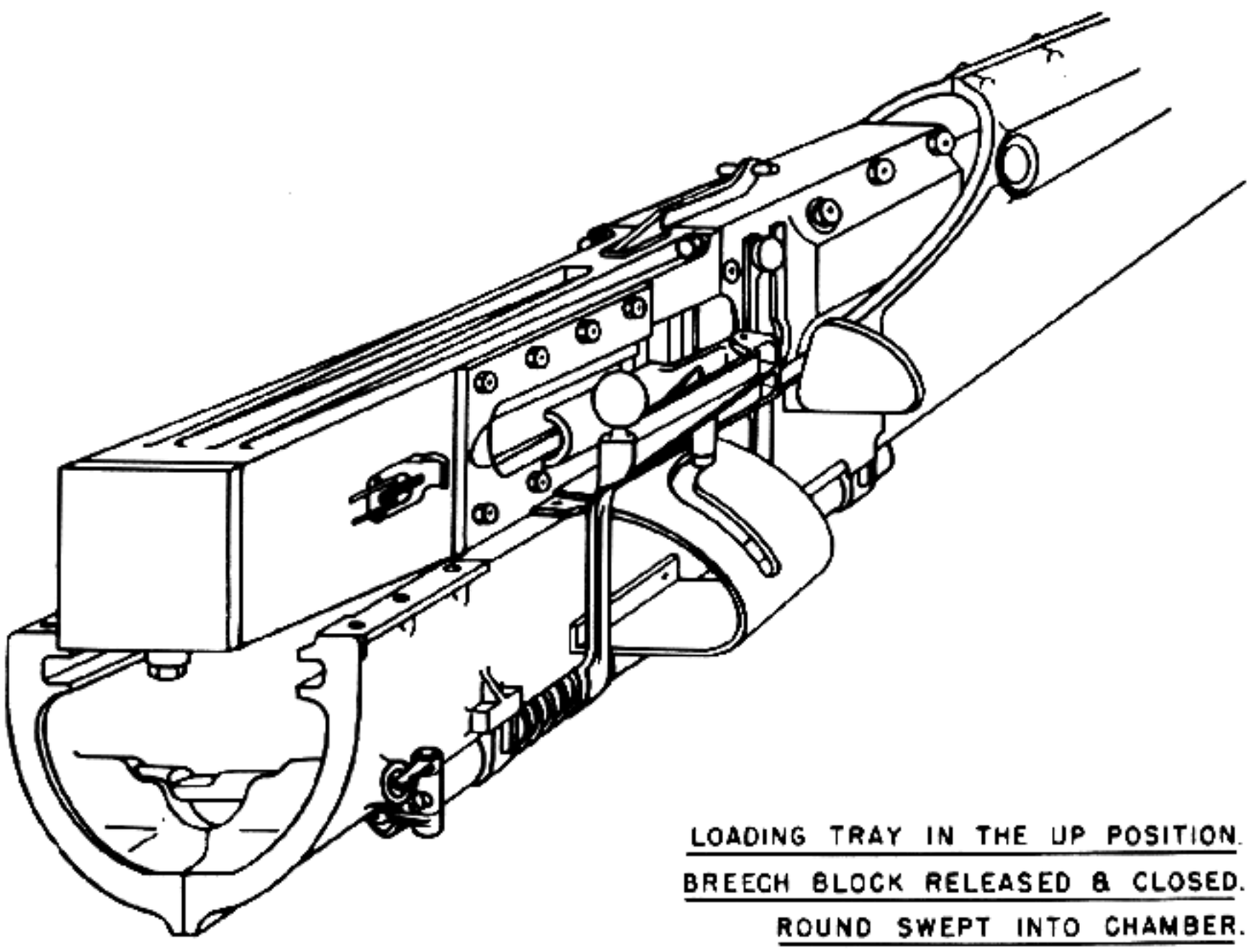


Figure 15–13. Rolls Royce 40-mm Type BD Naval Gun. Method of loading.

tor trip in the body catches the ejector in the breechblock, causing it to project beyond the breech face. The empty case is thus pushed away from the breechblock and, pivoting about the extractor, is thrown out through the ejector opening.

Breechblock Released; Feeding Next Round. The next round, placed in the loading tray, is fed into the loading position whereupon the breechblock is automatically released and the round swept from the lips into the chamber.

Breechblock Closed and Locked Ready for Firing. The breechblock automatically closes and locks on the feeding round, and the gun is once again loaded and armed ready for firing.

Operation of the Gun

Opening the Breech. After the gun has been prepared for action, the breech, if not already open, should be opened manually with the aid of the tool supplied. The tool should be attached to the striker housing arm by means of a bayonet connection. The breechblock should then be pulled back against the pressure in the recoil mechanism until it is held in its fully open position by the cross-shaft of the breechblock release mechanism.

Loading. A round may then be placed on the loading tray and swung up into the lips of the feed opening. When in this position, the loading tray is pushed forward a certain distance, automatically releasing the breechblock which sweeps the round into the chamber and locks when in the fully closed position.

Firing the Gun. If the trigger safety catch is on SAFE, it should be ready to fire. Having loaded as described, the gun is then ready to fire. This is done by rotating the twist group on the left-hand side of the cradle about one-fourth turn.

Recocking. Should the gun misfire, the striker may be cocked by hand by raising the cocking lever on the breech ring until the striker bent engages on the sear.

To ascertain whether the striker has gone forward, look for the cocking claw locknuts at the rear of the breechblock. These should be projecting approximately 1 inch from the rear of the breechblock when the striker is cocked and should almost disappear from view when the striker is released.

Ejecting a Live Round. Should there be a case of repeated misfires, the live round must be removed.

To do this, the breech should be opened in the normal manner as described in this section. Simultaneously, the ejector trip on the right-hand side of the body should be depressed so that the ejector is

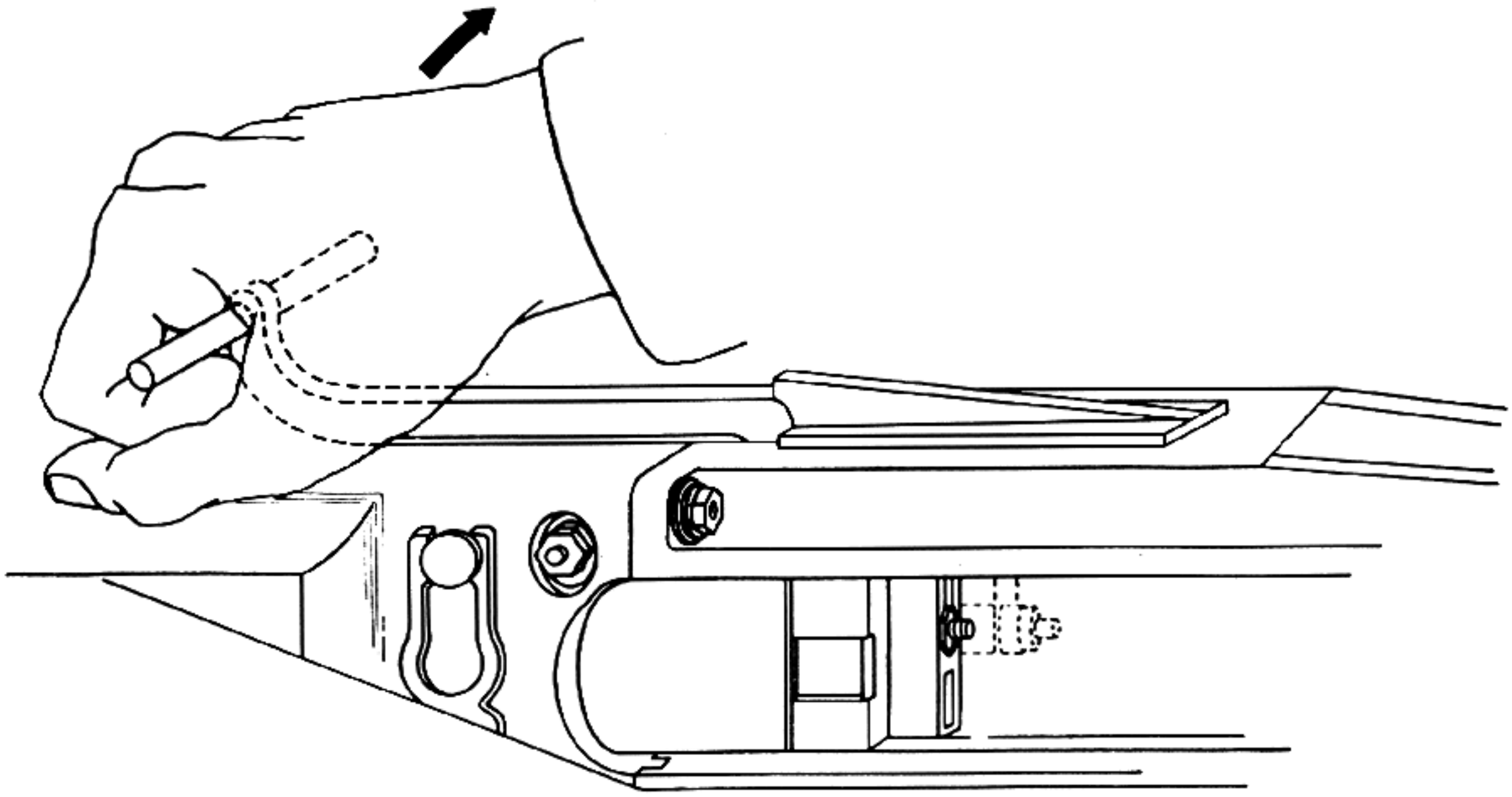


Figure 15–14. Rolls Royce 40-mm Type BD Naval Gun. Charging handle.

rendered inoperative. Having caught the breechblock up on the cross-shaft, the live round may be removed by hand, leaving the gun ready for loading another round.

Functioning of the Weapon

Breechblock Mechanism. When the breechblock is in the locked position, the locking struts are engaged on the locking shoulders in the breech ring and are held there by the floating cams contained in the striker housing.

On firing, the axial load on the breechblock is transmitted to the locking struts, which distribute the load partly to the breech ring through the locking shoulders and partly to the cams.

During recoil, the breechblock remains locked. At the end of recoil, it is caught up by the cross-shaft in the rear of the cradle.

At the beginning of runout, the breechblock body extends from the striker housing, which is held back by the cross-shaft, and the locking struts are drawn out of engagement with the locking shoulders due to the natural angle of their contacting surfaces and continue rearward until the breechblock strikes the buffer, where it is held momentarily.

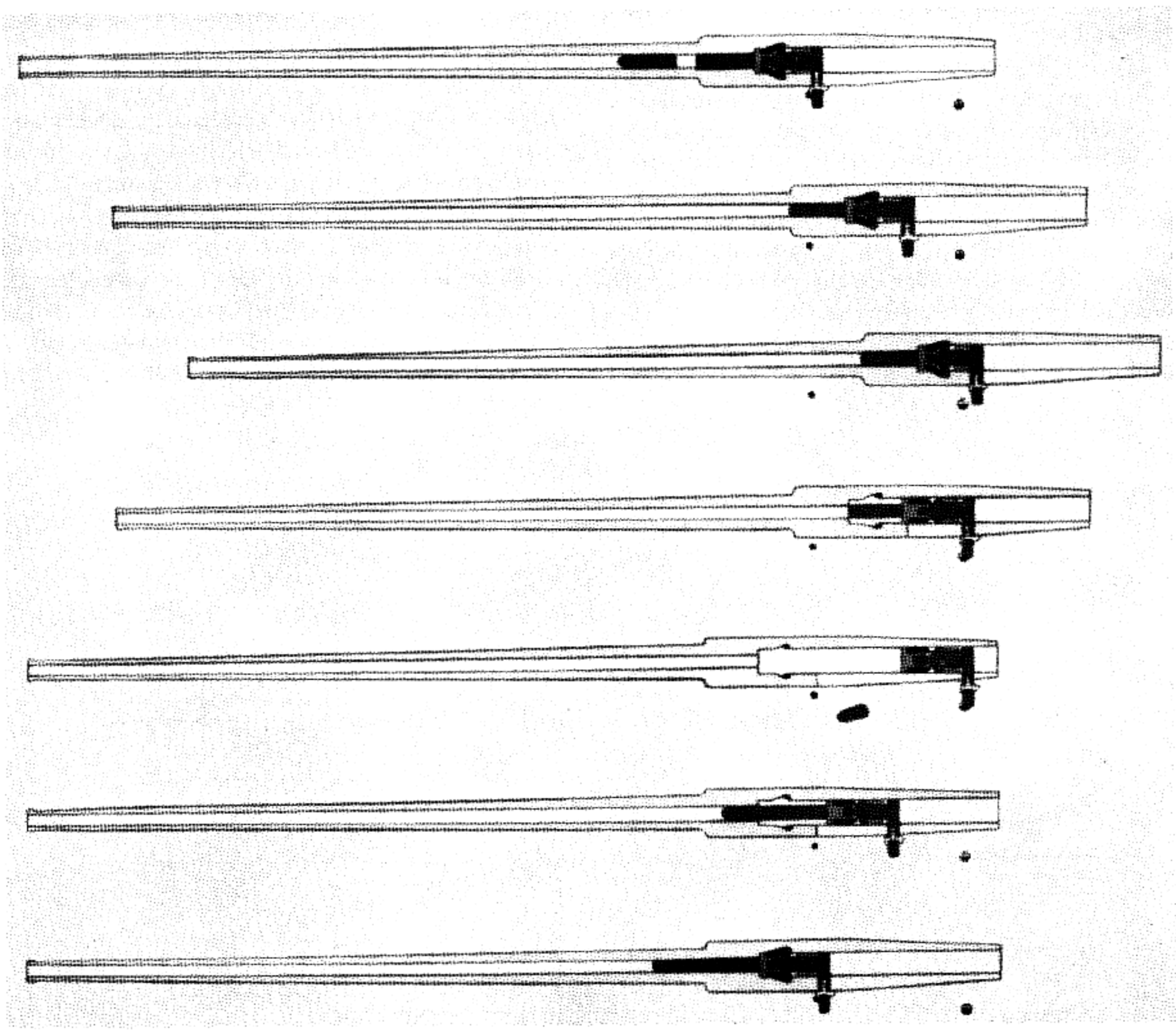


Figure 15–15. Rolls Royce 40-mm Type BD Naval Gun. Cycle of operation of breech.

When the breechblock is released, it travels forward in the extended position under the influence of the breechblock return rod, which is attached to the striker housing arm. When the breechblock body reaches the breech face, the former is arrested; but the striker housing continues to move forward, taking up the initial lost motion. During this operation, the floating cams, which are contained in the striker housing, come into contact with the locking struts, pushing them into engagement with the locking shoulders once more. Simultaneously, the striker, also contained in the striker housing, is caught by the sear which is pivoted in the breechblock body, and the lost motion is thus utilized to compress the firing spring and so again fire the gun.

Breechblock Mechanism—Firing Mechanism. The firing pin or striker, its axis coincident with the centerline of the gun, is accommodated in the striker housing, which is rigidly connected to the striker housing arm. The striker housing is contained in the breechblock body, which is free to slide in the body.

The sear, operating in the vertical plane through the centerline of the gun, pivots about a pin, contained in the breechblock body, whose axis is at right angles to the vertical plane.

The firing stirrup contained in the arm and lying in the vertical plane, though resiliently restrained by the stirrup spring which is also contained in the striker housing arm, is free to move vertically with reciprocating motion in guides and is free to rock in the same vertical plane, within the range available, on the tailpiece of the firing sear.

The breechblock locking principle introduces a connection between breechblock body and the striker housing to effect locking and unlocking of the breechblock. This lost motion connection between breechblock body and striker housing is utilized in the above mechanism to arm the gun, as follows.

Assume the gun has been fired, and is in a state where the breechblock is returning in readiness for firing the next round. By virtue of design, the breechblock is extended during return until the breechblock body reaches its furthermost position, when the striker housing is free to close up once more, taking up the lost motion. The extent of this lost motion corresponds more or less to the movement of the striker housing. As the breechblock commences to close up, the firing sear catches on a bent on the striker and restrains it from further movement.

Meanwhile, the lost motion is taken up; and since there is no relative movement between the breechblock body and the striker, the firing spring is compressed, thus arming the gun. It should be remembered that the striker does not project beyond the breechblock face during this operation.

The gun is fired by raising the leg of the firing stirrup. The firing stirrup is restricted to vertical movement during firings; thus, vertical movement is imparted to the tailpiece of the firing sear, which pivots about a pin and releases the striker.

When the gun has passed through this cycle of operation, the weapon is restored once more to its initial state provided the trigger is released after firing.

If, however, the trigger mechanism is not released, the operating member comes into contact with the leg of the firing stirrup as the breechblock closes. The firing stirrup pushed sideways, which it is free to do by virtue of the design, makes no attempt to move the sear and any effort to fire the gun is nullified until the trigger is released, whereupon initial conditions are reestablished.

Operation of the Recoil Mechanism. Energy of recoil is absorbed by a hydropneumatic recoil mechanism, which also incorporates a breechblock return mechanism in the system.

The recoil piston, floating on the extremity of the ram which is rigidly connected to the cradle, operates in the main recoil cylinder attached to the barrel. An adjustable orifice, externally controlled, restricts the left-hand extremity of the main recoil cylinder. A bypass connects the two extremities of the main recoil cylinder, the left-hand end of the bypass being restricted by a control orifice and the right-hand end by an orifice and a short rod. The left-hand end of the main cylinder is connected to the recuperator cylinder. A floating piston operates in the recuperator cylinder and acts as a separator between air on the left-hand side and oil in the remainder of the system.

The interior of the main ram accommodates a breechblock return piston which has an extension rod connected to the striker housing arm and a tubular extension carrying a dashpot plunger. Oil is free to pass from the main recoil cylinder to the recuperator cylinder and also to one side of the

breechblock return piston via the tubular extension. Thus one side of the breechblock return piston is subjected to the pressure prevailing in the main system and the other side is open to the atmosphere by the air vent.

On recoiling, the recuperator and recoil cylinders, being attached to the barrel, move toward the right relative to the main ram. Oil in the main recoil cylinder passes through the adjustable orifice into the recuperator cylinder, displacing the floating piston and compressing the air contained in the recuperator cylinder.

Meanwhile, some oil escapes through the control orifice and through the orifice in the recoil piston to the back of the main ram. The quantity of oil passing to the back of the main ram is governed by the differential areas of the ram and recoil piston.

Thus the energy of recoil is absorbed in the system, some being stored by the air for recuperation and the remainder lost either in internal or external work.

When all the energy has been absorbed, the barrel commences to run out by virtue of the air pressure in the recuperator acting on the main ram. Oil from behind the recoil piston is returned to the main cylinder via the bypass. Immediately before the barrel has returned to its original position, the recoil piston blanks off the right-hand bypass orifice and the remaining oil from behind the recoil piston escapes via the reed. The rod is designed to effect suitable buffering of the mechanism at the end of barrel runout.

The orifice in the recoil piston is open during recoil but closed during runout.

During recoil, the barrel and breechblock are locked together and hence the breechblock piston moves toward the right, relative to the breechblock return cylinder, in the main ram. Oil in this cylinder escapes along the tubular extension into the main cylinder.

During barrel runout, the breechblock is held back in the recoil position, no relative motion taking place between the breechblock piston and the main ram.

When the breechblock is released, the pressure difference on the breechblock return piston drives it forward into its original closed position. When the breechblock is almost closed, the dashpot plunger chokes the opening in the dashpot and buffers the breechblock at the end of its travel, whereupon initial conditions are reestablished.

Disassembly

To Remove the Breechblock. Swing the recoil-shield forward over the gun after slackening the two clamping nuts. Free the clamp on the end cover by loosening the bolt.

Close the breech automatically by placing the loading tray in the loading position. Disconnect the striker housing arm from the breechblock return rod. This may be done by standing behind the gun, inserting the serrated spanner in the bayonet socket on the striker housing arm, applying an axial pressure to release the serrated locking disk, and unscrewing in a counterclockwise direction.

The tool supplied for opening the breech by hand may then be used to withdraw the breechblock from the body, the end cover being removed automatically.

On no account should the striker housing arm be disconnected from the breechblock return rod with the breech open.

To Strip the Breechblock. Remove the locking struts and cams and withdraw the striker housing and arm assembly from the breechblock. Unscrew the cocking claw locknuts from the rear extension of the striker. This may be done by holding the striker housing arm in a vise and depressing the striker into the striker housing by means of a screwdriver handle when the locknuts will be rendered accessible.

Remove the cocking claw. With the aid of a screwdriver, depress the locking thimble in the rear of the striker housing until it is clear of the registering hole in the striker housing arm, then slide the two parts apart. The striker, firing spring, thimble, stirrup, and stirrup spring may then be removed.

This completes the dismantling of the breechblock assembly except for the sear, ejector, and extractor, which may be removed from the breechblock body by withdrawing their respective pins.

To Remove the Barrel, Breech Ring, and Body Assembly. Remove the breechblock as previously described. Remove the lockplate from the rear

barrel housing and unscrew the barrel retaining nut. The barrel, breech ring, and body assembly may then be withdrawn from the rear of the cradle.

Adequate support should be given to the barrel and cradle during this operation.

To Remove the Recoil Mechanism Assembly. Release the air in the recuperator cylinder by carefully inserting one end of the tommy bar of the adjustable orifice key in the union at the front of the recuperator cylinder and depressing the air valve. Push the recoil mechanism back a little to test whether any air has leaked into the recoil system. If there is air in the system, care must be taken when removing the front stop from the cradle because the recoil mechanism will tend to move forward a short distance. The bridge piece, mounted in the cradle, should then be disconnected by removing the four bolts. Then the recoil mechanism assembly may be removed bodily from the forward end of the cradle.

When disassembly has been accomplished to this point, routine cleaning and oiling operations can be carried out.

Assembly

To Replace the Recoil Mechanism Assembly. Support the cradle in a convenient position for inserting the recoil mechanism assembly from the front. Enter the recoil mechanism assembly, main ram first, into the front of the cradle, taking care to guide the supports into their corresponding grooves and holding the recoil mechanism parallel to the cradle until it is fully supported. Replace the front stop in the cradle. Push the recoil mechanism back until the bridge attached to the main ram is in contact with the bridge in the well of the cradle, and bolt. Recharge the recuperator cylinder with air.

To Replace the Barrel, Breech Ring, and Body Assembly. Support the cradle in a suitable position and start the barrel, muzzle first, into the rear of the cradle. Having passed the muzzle through the rear barrel housing, thread the barrel locating nut onto the barrel with the serrated side facing the rear of the gun. Continue to pass the barrel into the cradle until the supports on the breech ring are about to enter. Carefully guide them into the grooves in the cradle, and push the barrel home. Screw up the barrel locating nut firmly with the C spanner provided, and replace the lockplate on the barrel housing.

To Reassemble the Breechblock. Insert the ejector, thick end first, into the corresponding slot in the side of the breechblock body. Hold the ejector in position with the thick end projecting about one-fourth of an inch beyond the breech face, and replace the pin.

Place the two extractor springs in the hole in the breechblock body directly opposite the ejector, and place the extractor in position with the springs located in the seating provided and the claw of the extractor projecting beyond the breech face. With the aid of a hammer shaft, apply pressure to the extractor immediately above the pivotal point and insert the extractor pin.

Replace the sear in the breechblock body with the claw facing inward and nearest the breech face, and insert the sear pin.

Place the striker, followed by the firing spring and thimble, in the striker housing. Replace the firing stirrup and stirrup spring in the striker housing arm.

With the striker housing arm held in a vise, slide the striker housing into position. This should be done by engaging the forked end of the striker housing arm with the T-slot in the striker housing.

Meanwhile, the firing-pin spring should be depressed by applying a screwdriver to the thimble and pushing it into the striker housing to clear the arm, which can then be pushed home and the thimble allowed to register in its appropriate recess. The longitudinal slot in the striker housing should be facing the striker housing arm during the process of assembling.

Rotate the firing pin until the bent appears opposite the longitudinal slot in the striker housing. Then place the cocking claw on the rear of the striker.

Hold the striker housing arm in a vise and push the firing pin back into the striker housing with the aid of a screwdriver handle; the rear of the striker will then be accessible for placing the cocking claw in position and replacing the lock nuts.

Then replace the assembly in the breechblock body, guiding the sear in the longitudinal slot in the striker housing and threading the tail of the sear between the pins on the firing stirrups.

With the breechblock assembly closed, the two cams may be replaced and held in position by the locking struts.

To Replace the Breechblock in the Body. Extend the breechblock, taking care not to drop the loose parts, and insert it in the body. Replace the body end cover and clamp it in position.

The breechblock should then be pushed down the body to the breech face and the striker housing arm connected to the breechblock return rod. This may be done by inserting the serrated spanner in the bayonet socket on the striker housing arm, as before, and rotating in a clockwise direction, meanwhile applying an axial pressure to the tool to disengage the serrated locking disc.

The recoil shield should then be swung back into position and locked by means of the two clamping nuts.

Adjustments

Recharging the Recuperator with Air. After the recoil mechanism assembly has been assembled in the cradle, the recuperator valve cap should be removed and the recuperator cylinder connected, by means of the piping supplied, to an air bottle. The recuperator cylinder should then be recharged with air to 400 pounds per square inch gage pressure. The piping may then be removed and the recuperator valve cap replaced.

Controlling Length of Recoil.

By Means of the Adjustable Orifice. The length of recoil may be increased or decreased within specified limits by opening or closing the adjustable orifice mounted on the recuperator cylinder.

This may be controlled externally with the aid of the key supplied. Turn clockwise to reduce recoil length and counterclockwise to increase recoil length.

If the recuperator cylinder air pressure has previously been lowered or the cylinder recharged, it is advisable to close the orifice down before firing. Should recoil be short, this can be adjusted by opening the orifice.

By Varying the Recuperator Air Pressure. For large discrepancies in length of recoil, the air pressure in the recuperator should be lowered or increased in the recuperator accordingly.

Care should be taken not to lower the recuperator pressure below that which will cause the gun to recoil beyond 17½ inches.

To Check the Recuperator Pressure. Remove the recuperator valve cap, and attach the pressure-gage unit to the union.

Screw down the air-release key, and read the gage pressure. Screw the air-release key back to its original position, disconnect the pressure-gage unit, and replace the recuperator valve cap.

Possible Stoppages and Method of Clearing.

Failure to Fire. Striker failed to move forward, due to:

1. Sear not released from bent. (Check for sufficient trigger movement.)
2. Breechblock not fully closed. (Check for gummy lubricant or excess of lubricant; loss of pressure in recuperator; dirt or foreign particles in breechblock mechanism.)
3. Broken firing spring.
4. Broken striker nose wedging striker back.

Striker moved forward too gently, due to:

1. Broken striker spring.
2. Weakened striker spring.
3. Gummy or congealed lubricant or excess of lubricant.
4. Striker prematurely released on closing movement of breech. (Check for: wearing or rounding of bent and sear; adequate stirrup spring strength; full return of firing shaft to rest position.)

Insufficient Striker Protrusion, Due to:

1. Obstruction by foreign matter.
2. Accumulation of very stiff lubricant in forward end of striker passage.

Failure to Eject. Breechblock not caught up on cross-shaft, due to:

1. Insufficient recoil from weak round.
2. Insufficient recoil due to excessive resistance in recoil mechanism. (Check air pressure in recuperator cylinder, viscosity of fluid in recoil mechanism, freedom of sliding surfaces.)
3. Broken ejector stop.
4. Empty case falling off breechblock face on extraction, consequently not being held in ejecting position. (Check for extractor being free to close in until it bears with its full spring pressure on the edge of the rim, thus clamping the round against the opposite side of the breechblock face recess.)

5. Seizure of ejector, preventing its forward movement. Unlikely to occur, but would cause breakage of ejector trip.

FAILURE TO EXTRACT. Extractor riding over rim, due to:

1. Weak extractor spring.
2. Worn or rounded extractor claw.
3. Obstruction preventing extractor fully closing on rim.
4. Excessively tight round. Faulty ammunition.

FAILURE TO FEED IN NEW ROUND. Breechblock failed to move forward, due to:

1. Breechblock not released. (Check interconnection between loading tray and breechblock release.)
2. Breechblock not moved forward. (Check: pressure in recuperator system; connection between breechblock rod and striker housing arm.)

New round jamming on way to chamber, due to:

1. Premature release of breechblock before round is well into lips. (Check interconnection between loading tray and breechblock release.)
2. Tilting and binding of round by projecting ejector.

FIRING WHEN BREECHBLOCK CLOSES. Striker going forward on shock of breechblock closing, due to:

1. Inadequate hold of sear in bent. (Check: angle and condition of sear and bent; strength of stirrup spring; full return of trigger to nonfiring position.)

Striker permanently forward, due to:

1. Complete failure of sear to hold in bent. (Check: angle and condition of sear and bent; stirrup spring strength.)

This condition may cause failure to fire.

Chapter 16

VICKERS AUTOMATIC 40-MM AIRCRAFT CANNON ("S" GUN)

SECTION 1. HISTORY AND BACKGROUND

When World War II was imminent, Great Britain was faced with the necessity of arming her aircraft with large bore automatic guns capable of destroying armored vehicles, tanks, and locomotives. As in the past, the first attempt was to adapt proved mechanisms until a development program could produce a weapon specially adapted for the existing need.

The British "S" gun, a 40-mm aircraft cannon, was designed by Vickers Armstrong, Ltd., to specifications furnished by the Royal Air Force in 1939. It was intended for air-to-ground work against armored fighting vehicles and other ground targets.

Although 20-mm Hispano-Suiza gun installations were intended primarily for air-to-air use, they were of course also used for air-to-ground attack against transport vehicles and shipping and other similar objectives. For air-to-ground attack of armored vehicles, however, the striking power was insufficient, and 40-mm gun installations were needed for this purpose in the interval before rocket installations came into use. The 40-mm "S" gun served this interim purpose.

Since this gun has a low rate of fire and long recoil, variations in gun kinematics caused little trouble; accordingly, the development stages were not extensive. Only two changes proved to be necessary when the weapon was tested in aircraft: A change from an abnormally larger drum feed to the conventional type automatic feeder; and modification of the recoil system.

The hydraulic recoil system of this gun was first designed with a four-port liner to suit normal ball ammunition which weighed 1 pound 14 ounces. The operational use of the gun against armored vehicles, however, led to the use of 2½-pound and 3-pound A. P. projectiles. With these heavier projectiles, the recoil energy is higher and solid buffing occurred. This necessitated the introduction of a three-port liner to dissipate the additional energy and bring gun kinematics back to normal.

Another factor which had to be borne in mind was the temperatures in North Africa, where the weapon was intended to see service. Since these temperatures affect internal ballistics, special tropical propellants were used. The gun did extremely useful work against the lighter type of tank and against armored fighting vehicles in the North African campaign.

SECTION 2. INSTALLATIONS OF THE "S" GUN

Fixed Gun Installations

The muzzle energy of the 40-mm "S" gun is about eight times that of the 20-mm Hispano-Suiza gun; but since the rate of fire is only about 100 rounds per minute and the recoil stroke is about 17 inches, the time available for the dissipation of the recoil energy is about seven times that of the Hispano-Suiza gun. Thus, the recoil forces and mounting loads are of a lower order than with the 20-mm gun, but the duration is much longer. The problem of mounting this gun in an aircraft was therefore a question of bulk rather than mounting strength.

Wing Installations

The first installation of the 40-mm "S" gun reached the test stage by the end of 1941. This consisted of two guns in the Hurricane IID. One gun was mounted beneath each wing with the muzzles about 3 feet forward from the leading edge. The guns were supported from the front and rear spars and were fed from 16-round magazines. A belt feed was developed at a later stage.

A similar installation was also made in the Mustang at a later date, but it was not used to the same extent as that in the Hurricane.

Although the angle subtended at the eye by the gun muzzle was small, pilots complained of excessive dazzle while making dusk and dawn attacks. The addition of a flash eliminator to a gun of this caliber slung underneath the wing of an aircraft was clearly impractical, and the only solution was to suitably dope the propellants to reduce the flash. Similar methods to those used for the 20-mm Hispano-Suiza gun were used and gave satisfactory results for dusk and dawn firing.

Fuselage Installations

Early in 1941, before the Hurricane installation had reached the test stage, the possibility was contemplated of using 40-mm guns in the fuselage of the Beaufighter. An installation was prepared by the British aircraft armament group in collaboration with Bristol Aeroplane Co. for mounting two 40-mm guns in the position normally occupied by the 20-mm guns. This installation was designed to mount one Vickers "S" gun and one Rolls-Royce type BH gun for the purpose of comparing the performance of the two weapons under flying conditions. The idea of using the Beaufighter in service with 40-mm guns was abandoned, but much useful information was obtained from it as a flying test bed for tests on 40-mm guns.

Another installation of the Vickers "S" gun was in the nose of the Fortress.

Free Gun Installations

The only free gun installation of the 40-mm "S" gun was in a turret designed by Vickers Armstrong Ltd., in a Wellington in the mid-upper position.

This was a "hydromechanical," fully rotating turret mounting one 40-mm "S" gun and equipped with rangefinder and redictor. The turret never went into production or service, but it is fully described in a report by the testing activity.

These guns were mounted beneath the wings at an angle that prevented the muzzles from being seen by the pilot gunner. Even so, pilots complained of excessive flash while making dusk and dawn attacks.

SECTION 3. GENERAL DESCRIPTION OF THE "S" GUN

The 40-mm "S" gun is an automatic, recoil-operated weapon using the more or less orthodox big-gun principle of spring and hydraulic system to absorb the recoil energy. The weapon has a low rate of fire and long recoil stroke. As a result, efficient buffer systems are possible.

Energy is absorbed gradually during the recoil and return stroke of the barrel, barrel extension, and breech. The recuperator for the barrel, barrel extension, and breech consists of helical springs, and, in addition, the recoil stroke is buffered by a hydraulic buffer.

In the original buffer, the cylinder liner was provided with four tapering ports through which the oil was forced from the rear of the piston to the front. The tapered ports in the liner allow a quick flow of liquid during the first part of recoil; but, because of the shape of the ports, the liquid is throttled as the barrel and barrel extension move farther to the rear, thus retarding recoil. When, however, 2½-pound AP ammunition was used instead of the original 1½-pound practice round, it was found that solid buffering occurred at the end of the recoil stroke. The number of liner ports was therefore changed from 4 to 3, and no further trouble occurred.

The gun consists of a fixed chassis, to which is attached the hydraulic cylinder; the barrel, around which is fitted the barrel return spring; the barrel extension, to which the barrel is permanently attached and to which the piston of the hydraulic system is connected; the striker frame; and the breechblock.

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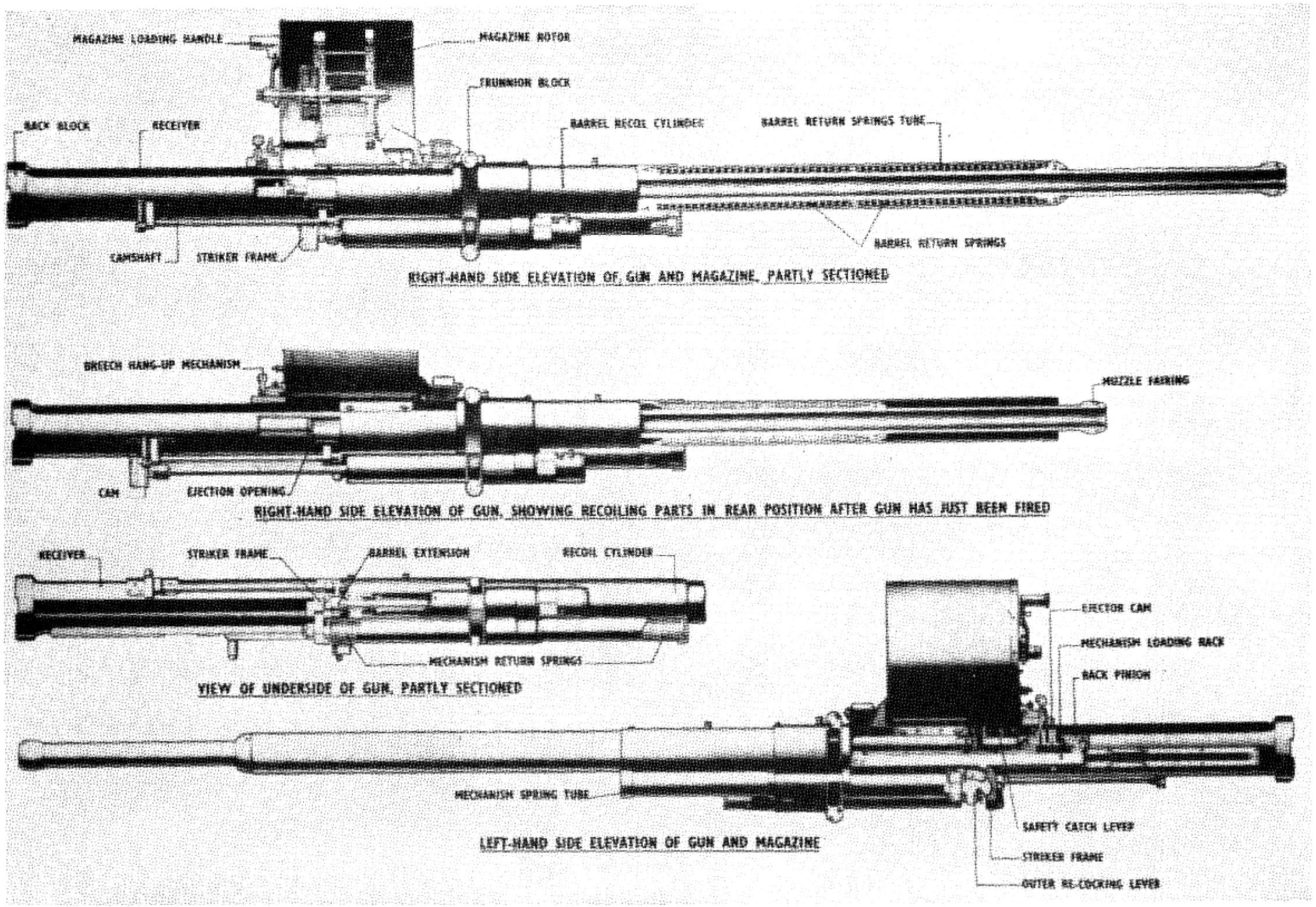

Figure 16–1. 40-mm Vickers "S" Gun. Assembly and nomenclature.

CONFIDENTIAL

General Data: 40-mm Vickers "S" Gun

Gun length, overall: 9 feet 9 inches.
Gun weight, complete: 385 pounds.
Rate of fire: 100 rounds/minute.
Muzzle velocity: 2,400 feet/second.
System of operation: Long recoil (approximately 17 inches).
System of locking: Camming of sliding breechblock. (Bolt scared automatically to rear after full recoil stroke.)
System of feeding: Spring-actuated 16-round drum or automatic belt feed employing metallic links.
Method of headspace: Factory established.
Location of feed opening: Top of receiver.
Location of ejection opening: Bottom of receiver.
Method of charging: Air.
Method of cooling: Air.
Barrel length: 5 feet 7 inches.
Barrel weight: 88 pounds.
Rate control: None.
Barrel removal: Not quick disconnect.

Bore:
  Number of grooves: 24.
  Groove depth: 0.020 inch.
Gun-mounting unit: 3-port liner.
Installation in Hurricane IID:
  Ammunition: 3-pound AP:
    Peak load, recoil [1]: 5,000 pounds.
    Peak load, return [1]: 3,500 pounds.
Installation in Mustang low attack wing:
  Ammunition: 2.5-pound AP:
    Peak load, recoil [1]: 4,000 pounds.
    Peak load, return [1]: 2,000 pounds.
  Ammunition: 3-pound AP:
    Peak load, recoil [1]: 5,000 pounds.
    Peak load, return [1]: 2,500 pounds.
Weight of projectile: 2 pounds.

[1] Measured on a ground stand. In the Hurricane and Mustang aircraft, the peak recoil and return loads were 6,500 and 4,500 pounds, respectively.

SECTION 4. CYCLE OF OPERATION

When the gun is fired, the barrel, barrel extension, hydraulic piston, striker frame, and breechblock recoil backwards in the fixed chassis against the barrel return spring and the resistance of the oil in the hydraulic cylinder in which is fitted a variable port liner. The breechblock remains locked to the barrel extension, and the maximum recoil is governed by contact of the barrel extension with a buffer spring in the fixed back block.

On completion of the recoil stroke, the barrel return spring and mechanism return springs force the recoiling parts forward again; after about 2 inches of forward travel, a cam unlocks the breech from the barrel extension. The breechblock is then arrested by the striker frame while the barrel and barrel extension travel forward.

The empty case, still retained on the face of the breechblock, is extracted from the chamber as the barrel moves forward, then the case is ejected sideways by an ejector.

The cycle of operation may be divided into 9 distinct steps, as follows:

1. Recoiling parts in forward position, breechblock locked, striker spindle forward, gun just fired.

2. Recoiling parts in rear position, breechblock remains locked to barrel extension, holding it in the retracted position.

3. Recoiling parts are driven forward by the barrel return springs and mechanism return springs, striker frame abuts cam on camshaft to unlock breechblock from barrel extension.

4. Breechblock, unlocked, is held back by striker frame, and cam barrel and barrel extension are moved forward by the barrel return springs. Cartridge case withdrawn from chamber and held by extractor and retaining clip, breechblock to start.

5. Lug on ejector engages ejector cam, causing ejector to rotate and push cartridge case through ejection opening.

6. Barrel extension almost home, cartridge nose deflector runs off end of barrel extension, pushing nose of next round down onto cartridge nose platform.

7. Ramp on barrel extension lug engages camshaft actuating lever, releasing striker frame and breechblock which are moved forward by the mechanism return springs. Front of extractor pushes round forward.

8. Breechblock raises cartridge nose deflector and pushes round toward chamber.

9. Cartridge rammed into chamber, breechblock abuts breech face to barrel. Striker spindle is held back by automatic sear as mechanism return

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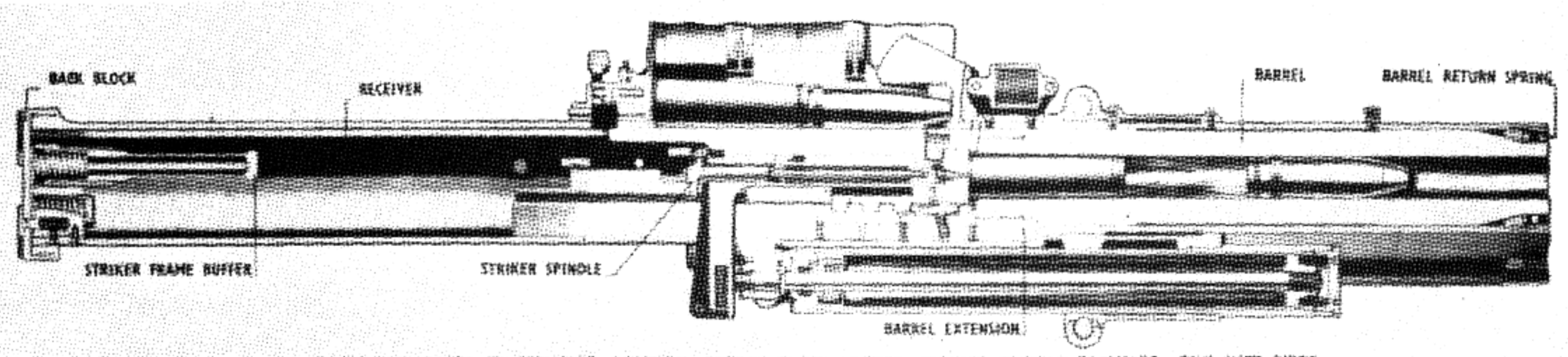
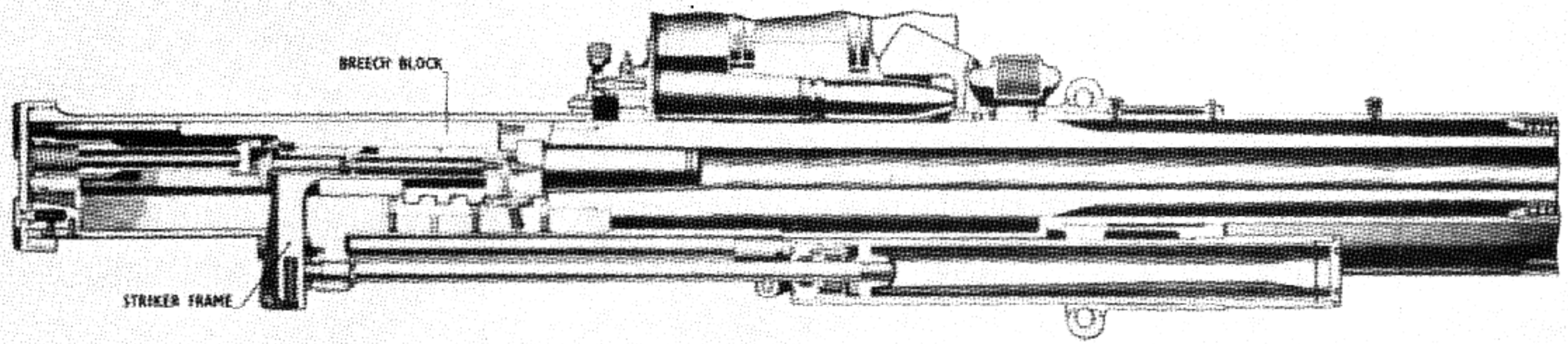
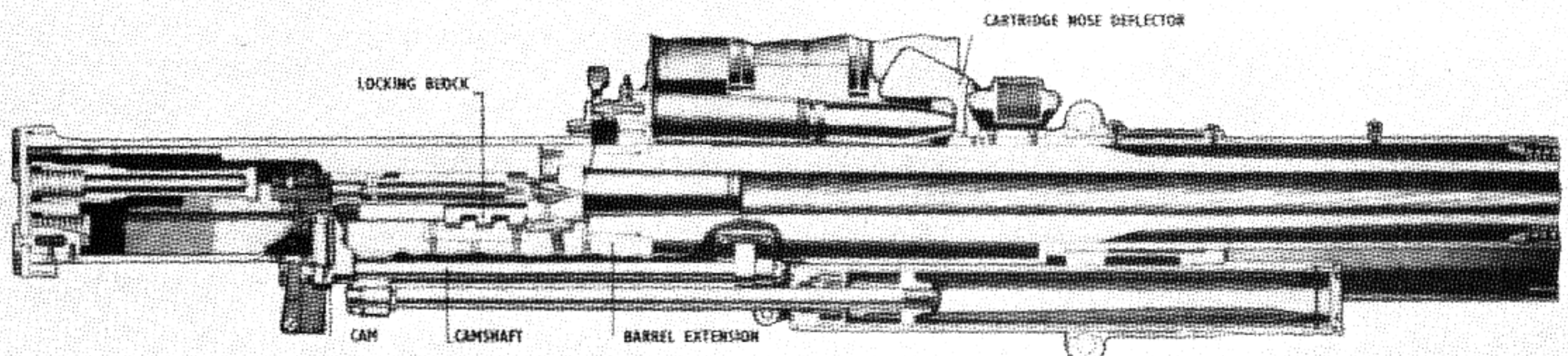


1. RECOILING PARTS IN FORWARD POSITION, BREECH BLOCK LOCKED, STRIKER SPINDLE FORWARD, GUN JUST FIRED

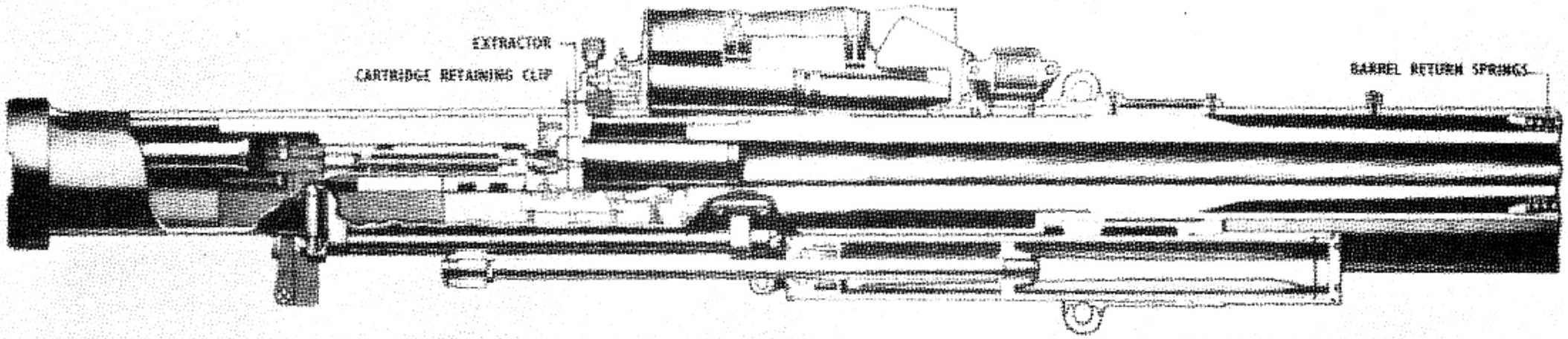


2. RECOILING PARTS IN REAR POSITION, BREECH BLOCK REMAINS LOCKED TO BARREL EXTENSION

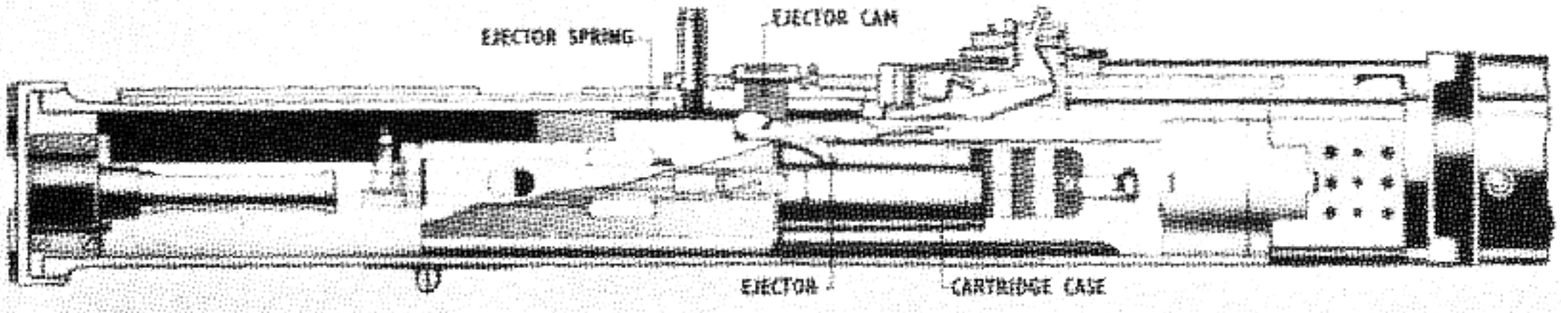


3. RECOILING PARTS ARE URGED FORWARD BY THE BARREL RETURN SPRINGS AND MECHANISM RETURN SPRINGS, STRIKER FRAME ABUTS CAM ON CAMSHAFT TO UNLOCK BREECH BLOCK FROM BARREL EXTENSION

Figure 16–2. 40-mm Vickers "S" Gun. Barrel recoil phase.

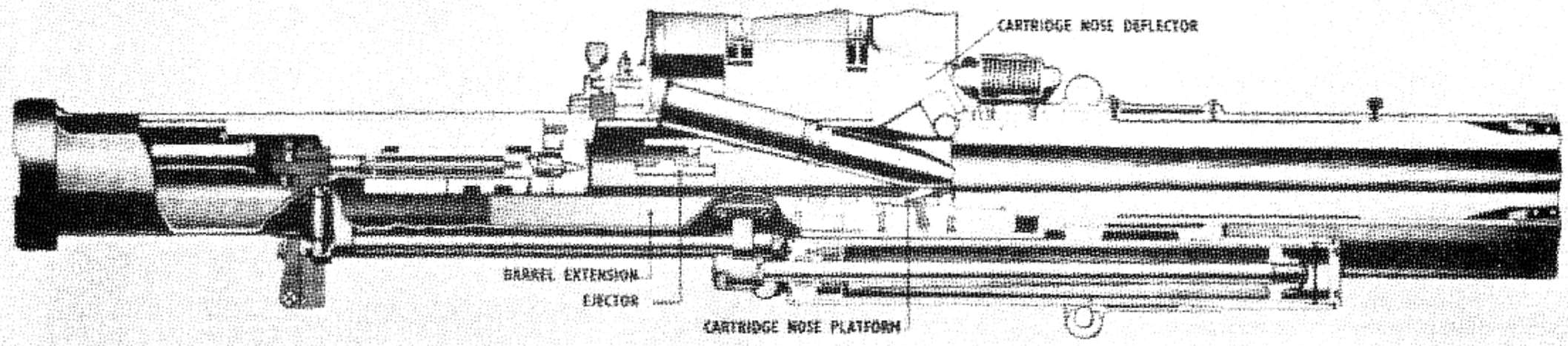


4. BREECH BLOCK, UNLOCKED, IS HELD BACK BY STRIKER FRAME AND CAM. BARREL AND BARREL EXTENSION ARE MOVED FORWARD BY THE BARREL RETURN SPRINGS. CARTRIDGE CASE WITHDRAWN FROM CHAMBER AND HELD BY EXTRACTOR AND RETAINING CLIP



5. (PLAN VIEW) LUG ON EJECTOR ENGAGES EJECTOR CAM, CAUSING EJECTOR TO ROTATE AND PUSH CARTRIDGE CASE THROUGH EJECTION OPENING.

END VIEW OF EJECTOR AND CAM



6. BARREL EXTENSION ALMOST HOME. CARTRIDGE NOSE DEFLECTOR RUNS OFF END OF BARREL EXTENSION. PUSHING NOSE OF NEXT ROUND DOWN ON TO CARTRIDGE NOSE PLATFORM

Figure 16–3. 40-mm Vickers "S" Gun. Barrel counterrecoil phase.

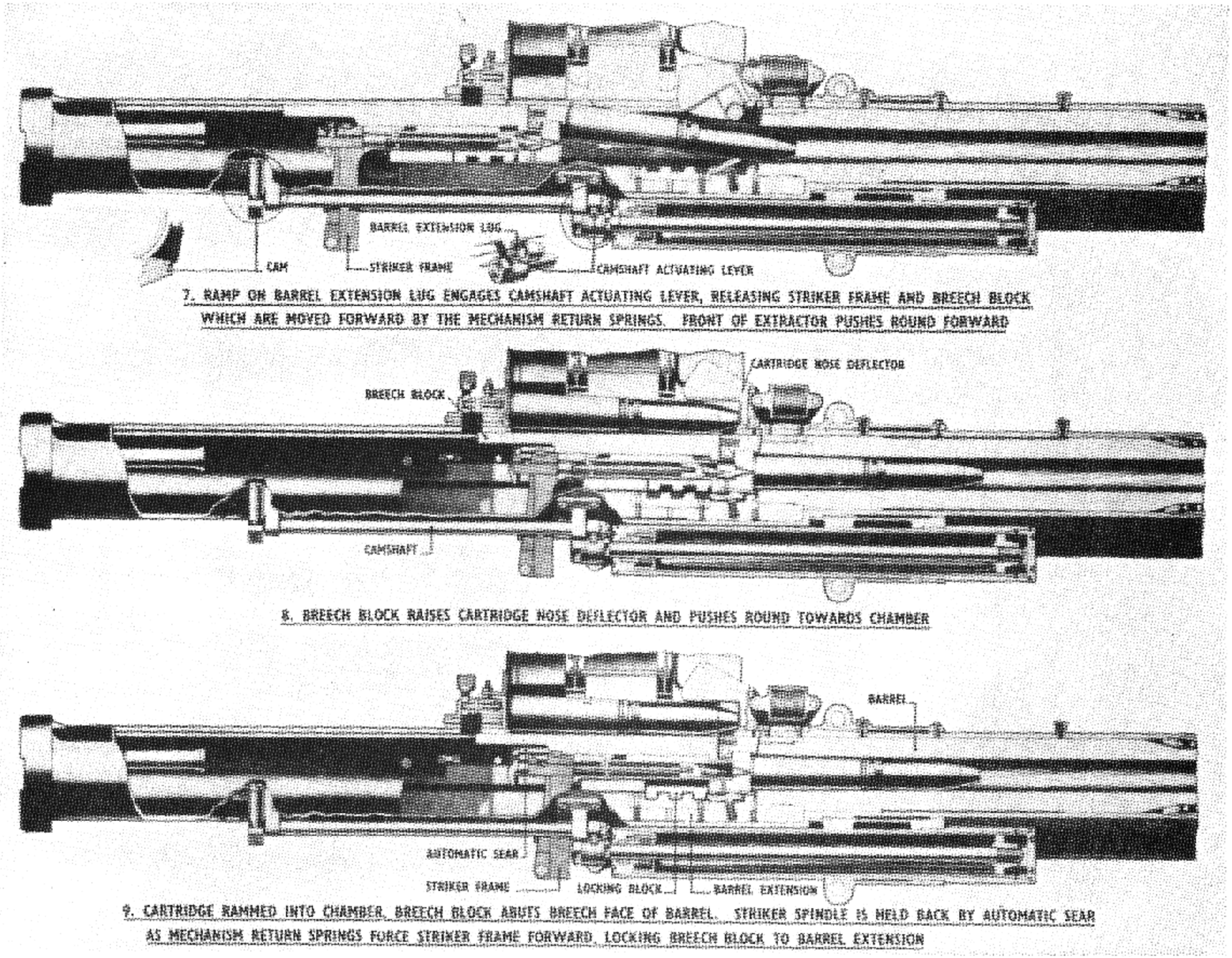


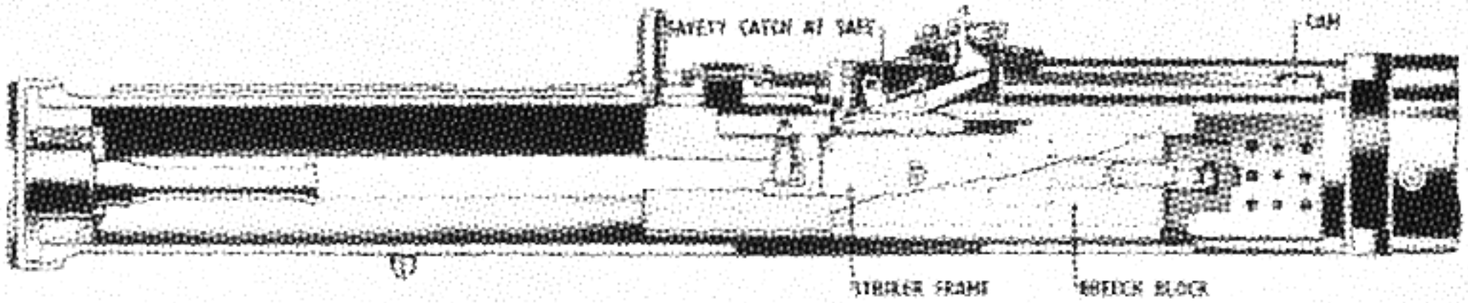
Figure 16–4. 40-mm Vickers "S" Gun. Ramming and locking action.

springs force striker frame forward, locking breechblock to barrel extension.

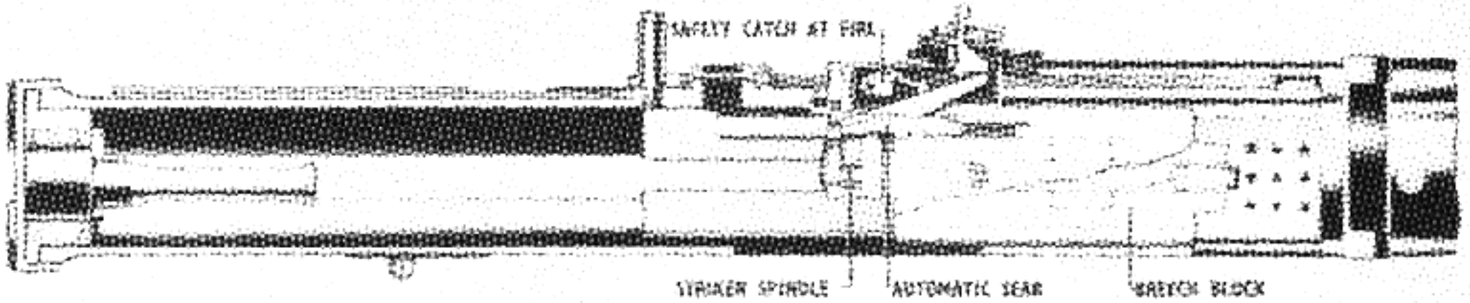
Action of the Sear Mechanism

When the breechblock and striker frame move forward, the automatic sear mechanism holds the striker spindle in the retracted position. At this time, the breechblock abuts the breech face of barrel. This movement allows the striker frame to continue forward. The breechblock, which up until now has been locked to the barrel extension, starts in counter-recoil when the cam of the striker disengages the automatic sear from the striker spindle. When all operating parts have reached their furthermost movement forward and are securely locked in the battery position, the striker spindle automatically moves forward to fire the chambered round. If the trigger remains depressed, the cycle will continue.

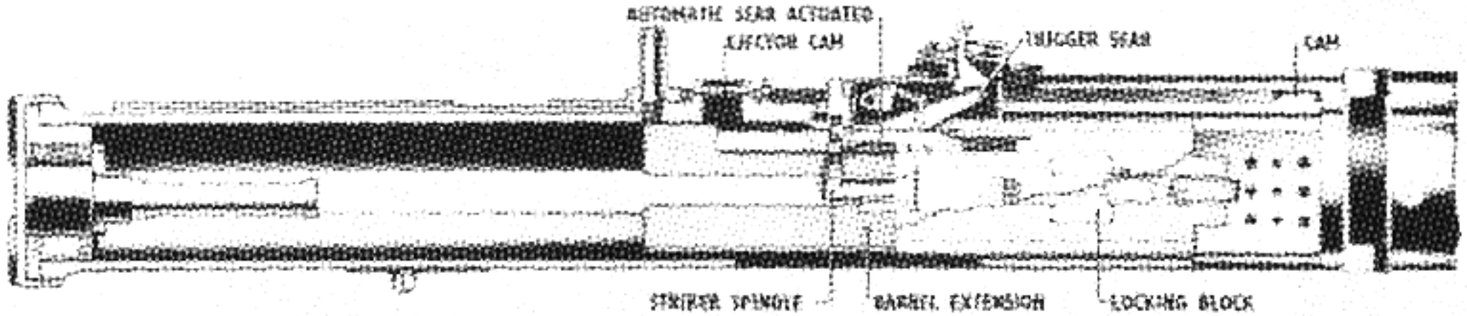
(PLAN VIEWS) ACTION OF TRIGGER MECHANISM



(A) BREECH BLOCK AND STRIKER FRAME MOVING FORWARD

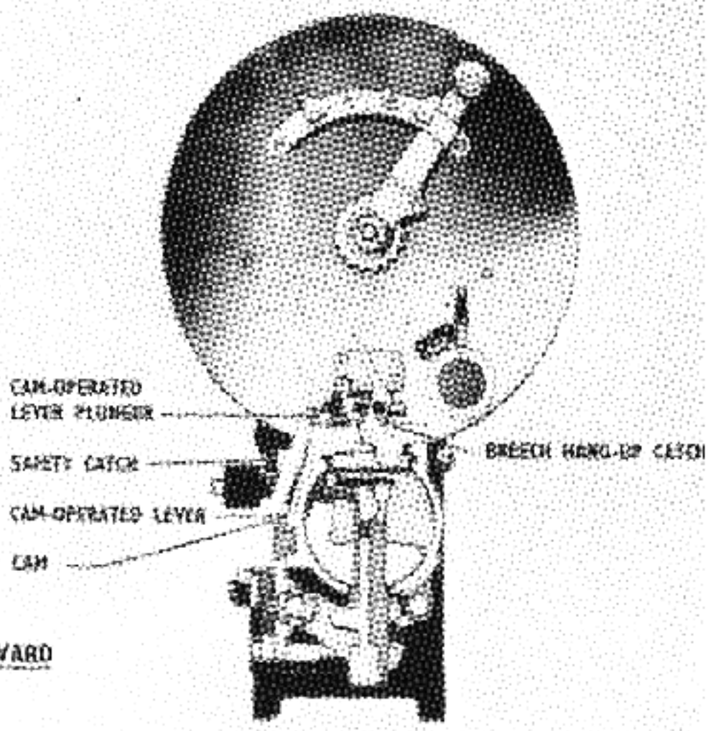


(B) AUTOMATIC SEAR HOLDS BACK STRIKER SPINDLE, BREECH BLOCK ABUTS BREECH FACE OF BARREL, STRIKER FRAME CONTINUES FORWARD



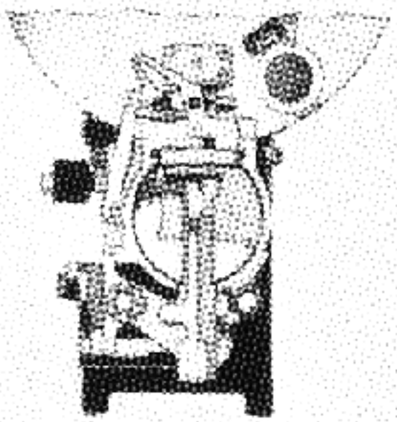
(C) BREECH BLOCK IS NOW LOCKED TO BARREL EXTENSION, CAM ON STRIKER FRAME DISENGAGES AUTOMATIC SEAR FROM STRIKER SPINDLE WHICH IS NOW HELD BACK BY TRIGGER SEAR

(D) TRIGGER SEAR ACTUATED BY FIRING MECHANISM, ALLOWING STRIKER SPINDLE TO MOVE FORWARD AND FIRE CARTRIDGE



SECTIONAL VIEW OF BREECH HANG-UP MECHANISM OPERATED POSITION

RACK PINION HAS BEEN HAND-OPERATED TO MOVE STRIKER FRAME AND BREECH BLOCK TO REAR. CAM OPERATED BREECH HANG-UP MECHANISM TO RETAIN BREECH BLOCK IN REAR POSITION



SECTIONAL VIEW OF BREECH HANG-UP MECHANISM NORMAL UNOPERATED POSITION

Figure 16–5. 40-mm Vickers "S" Gun. Searing.

Chapter 17

57-MM BRITISH AUTOMATIC AIRCRAFT CANNON

SECTION 1. DESCRIPTION OF THE WEAPON

General Description

The weapon known in British Army circles as the 6-pounder class M gun was developed originally from the standard 6-pounder antitank gun, which is normally loaded and fired manually by a gun team. In order to increase the rate of loading and hence the rate of fire, the British Army initiated the development of an automatic feed and firing system by Messrs. Molins Machine Co., Ltd. The final and official designation of the weapon is O. Q. F. 6-pounder class M Mark I with automatic loader Mark III. It is also known unofficially by the British as the TSE–TSE 57-mm gun. This high-velocity weapon was subsequently used in the Mosquito installation.

Before this cannon went into British Army service use, the British Air Staff set up a requirement for a weapon of at least this caliber for use in aircraft against submarines, and it was decided to continue development of an existing and proved firing system with that end in view.

The principle of the gun follows the orthodox light artillery practice whereby the gun barrel recoils in a fixed chassis, which is rigidly attached to the gun carriage.

The recoil system consists of a hydraulic cylinder and a recoil spring for returning the piece after recoil, and the breechblock slides vertically downward on opening for ejection of the empty case.

The feed system consists of an electrically driven transporter mechanism which conveys vertical con-

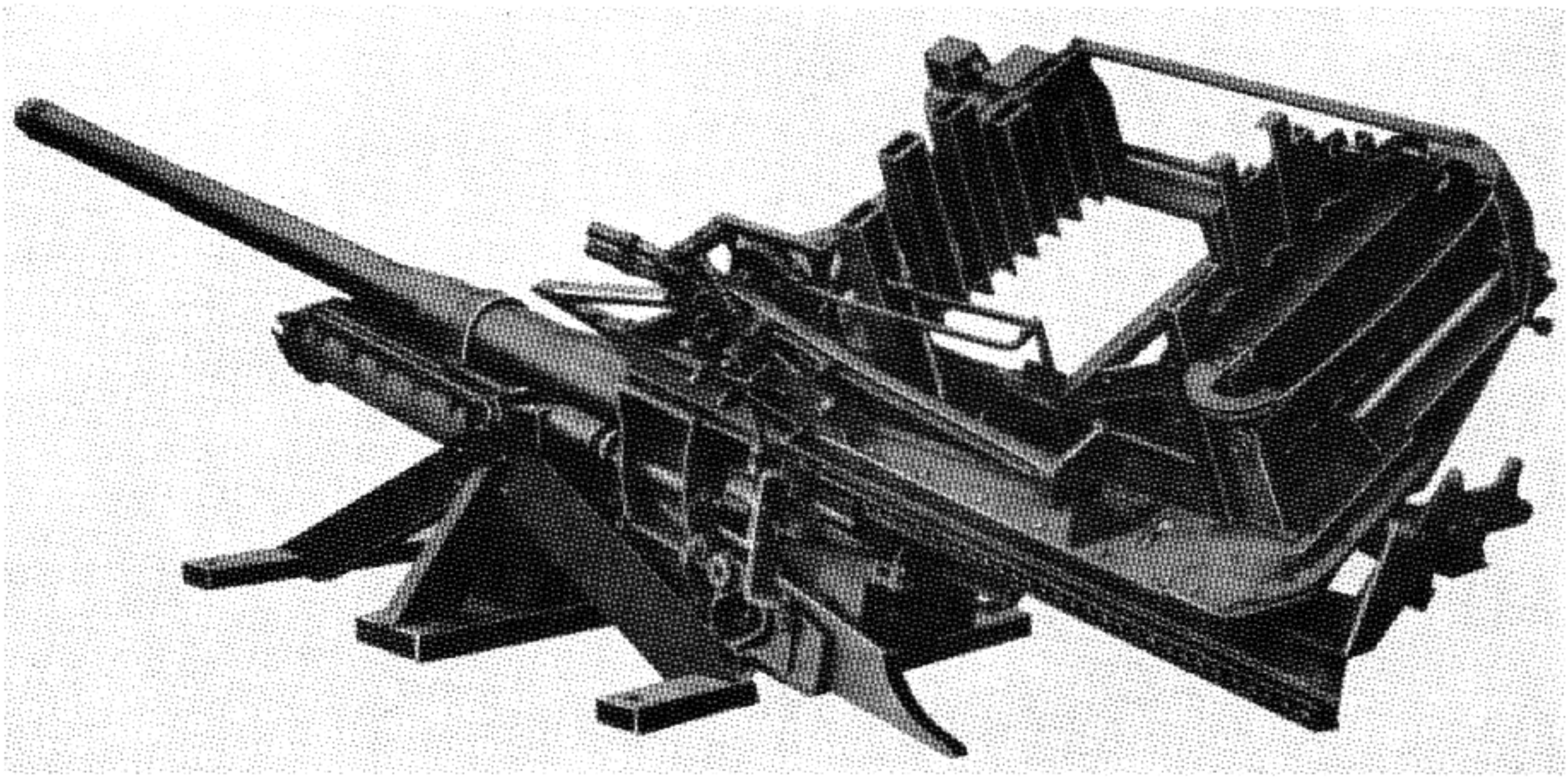


Figure 17–1. British 57-mm Automatic Aircraft Cannon. Left rear view.

secutive banks of cartridges to a position above the breech opening.

The cartridges in the first bank are pressed down by a spring-loaded arm; and when this row has been fired, the arm is lifted by cams while the next bank is transported to a position above the breech opening.

The semiautomatic arrangements of the basic gun provide for the opening of the breech and the ejection of the empty cartridge case toward the end of runout; and the closing of the breech after the round has been loaded. The opening of the breech compresses an actuating spring, against the reaction of which the breechblock is held by the extractors. When a round is loaded, the rim of the cartridge case engages the extractors and disengages them from the breechblock and the actuating spring closes the breech.

The firing mechanism consists of a percussion striker which is automatically cocked as the breech opens. Firing is effected by a lever mounted on the side of the gun which is operated by a solenoid. The solenoid circuit is completed through a main switch and the pilot's firing button.

The gun is secured to the slipper by two bolts. The slipper slides along the top of a cradle, recoiling with the gun to a normal length of 30 inches. The recoil distance is controlled by a hydraulic buffer and a single bank recuperator spring, the latter returning the gun to the firing position. The buffer and recuperator are situated in the cradle beneath the gun.

The automatic loader is mounted above the rear of the gun and, after the breech has been opened by the semiautomatic gear, loads a round which releases the extractors and allows the actuating spring to close the breech. The first round, however, must be loaded into the gun by hand, but after this has been fired, the energy of recoil and runout along with power from an electric motor provide the necessary motive power for operating the loader. When the firing button is pressed, the first round is fired and the gun is reloaded. For a single shot, pressure on the button must be released

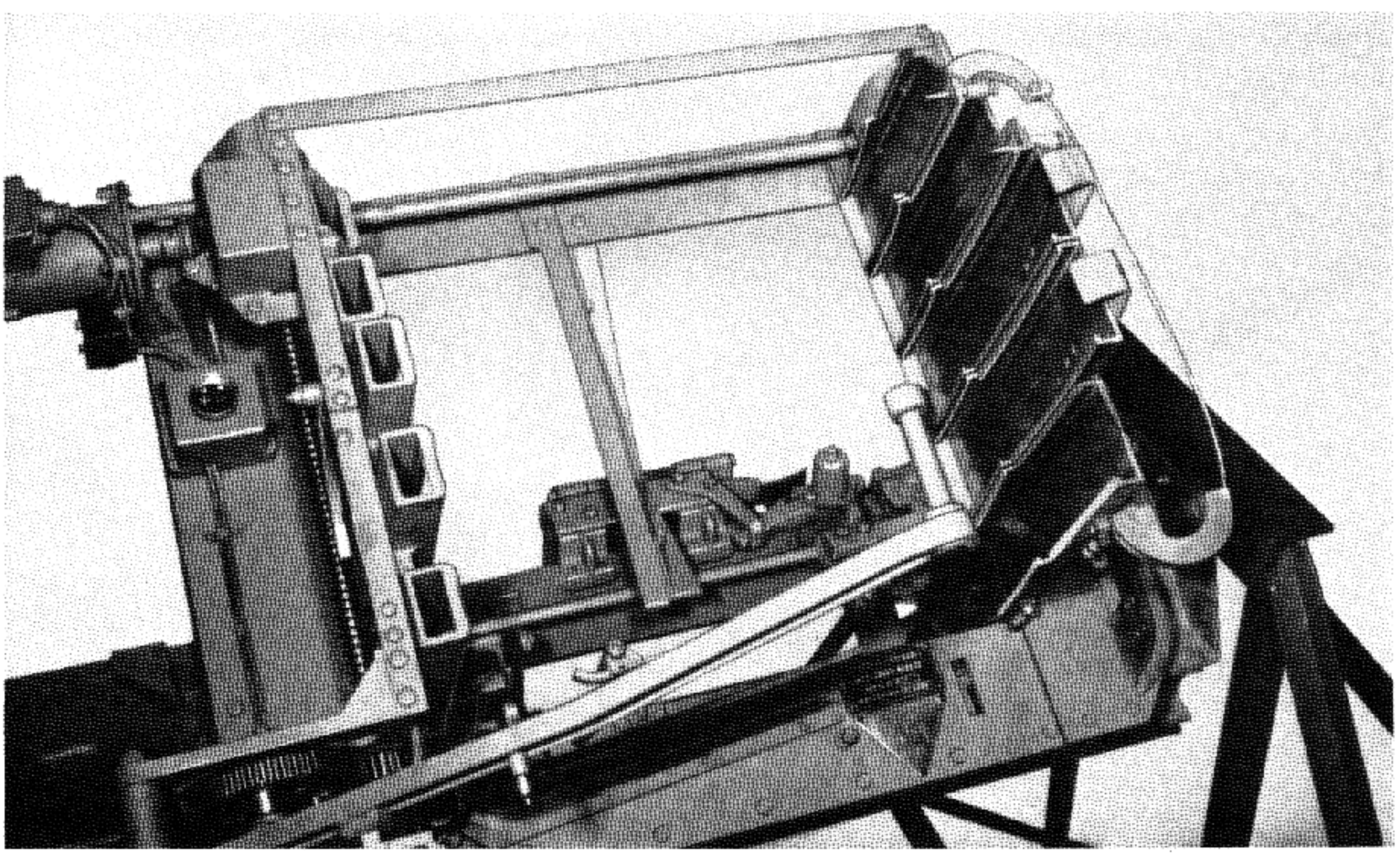


Figure 17–2. British 57-mm Automatic Aircraft Cannon. Closeup view of automatic loader, empty.

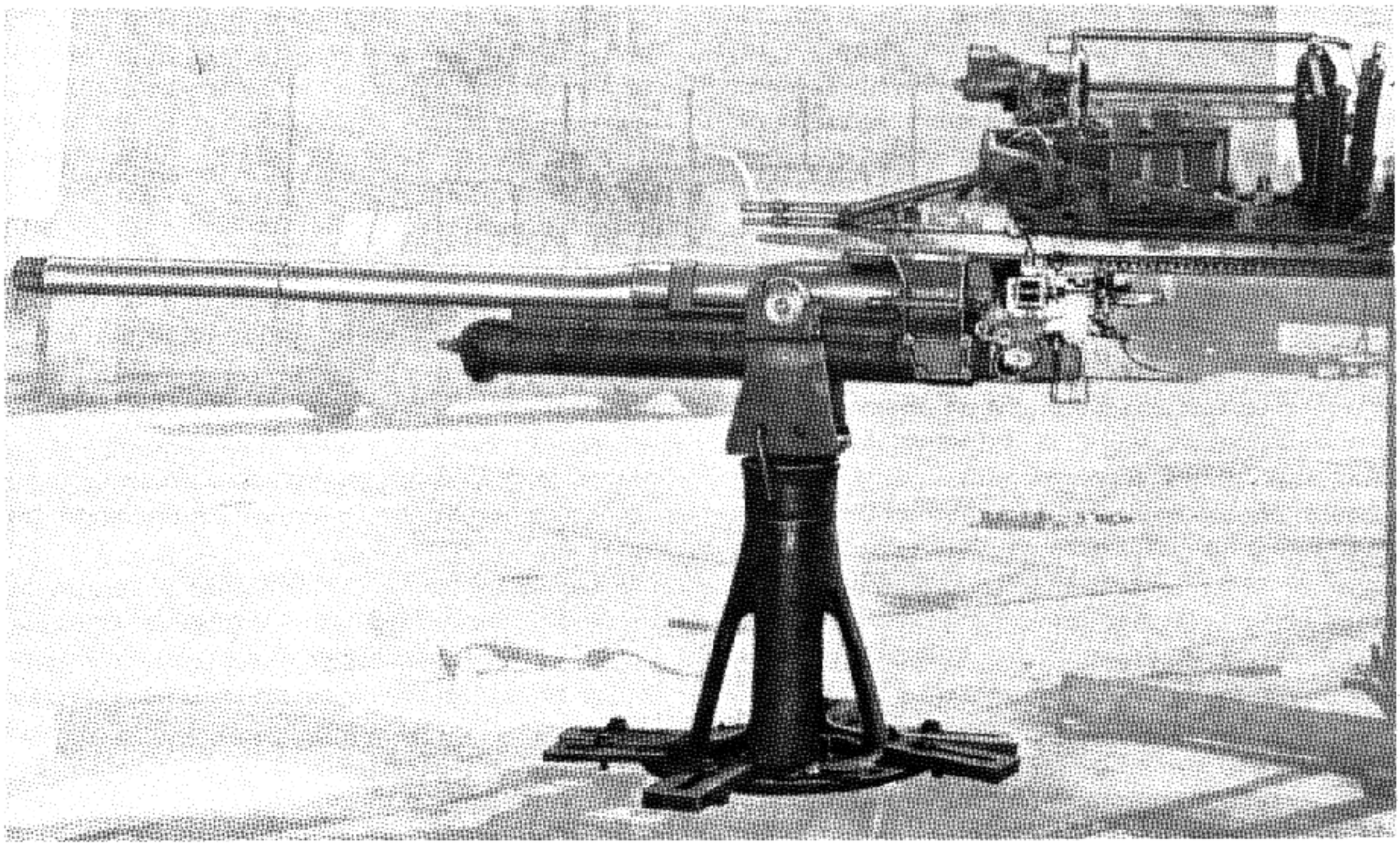


Figure 17–3. British 57-mm Automatic Aircraft Cannon on a test mount at U. S. Naval Air Test Center.

promptly. Automatic bursts can be fired by maintaining the pressure on the firing button. The gun will cease firing with a round in the chamber as soon as the firing button is released, or with the breech open when the ammunition is expended.

The principal parts of the gun are: gun body; gun slipper; cradle; recoil and recuperator systems; semiautomatic gear; breech mechanism; automatic loader.

Gun Body. The gun body consists principally of a barrel, breech ring, and muzzle recoil brake.

Barrel. The barrel is either an auto-frettaged or a high-tension steel forging, prepared internally for most of its length with polygroove, plain section rifling, at the rear of the rifling being a coned chamber for the cartridge case. On the outside of the barrel at the rear, guides are formed to locate it in the gun slipper and a screw thread is cut for the breech ring. Two pockets are cut in the rear face of the barrel for the extractors. At the muzzle is a screw thread for the muzzle recoil brake which may or may not be fitted when the gun is mounted in an aircraft.

Breech Ring. The breech ring is a rectangular shaped block which screws on to the rear end of the barrel and is secured by a screw. A vertical mortice is cut in the breech ring for the breechblock to slide in. On each side of the mortice are inclined guideways to accommodate corresponding guides on the breechblock. A transverse hole is bored through the bottom of the breech ring for the breechblock actuating shaft, bronze bearings being fitted to provide bearings for the shaft. Clearances are cut in the front inside face of the mortice for the crank and extractors, and a stop face is provided to limit the downward movement of the crank on opening the breech.

A slot is cut in the left-hand side of the breech ring and two threaded holes are provided for securing the left-hand register plate of the automatic loader. In the right-hand side, there are a dovetailed slot and two threaded holes for securing the actuating spring case, and a slot and four threaded holes for the rammer lifting cam. Two threaded holes are provided in the top of the breech ring for

securing the rammer lifting cam and five for securing the cam track of the automatic loader.

A firing lever support plate is secured to the rear face of the breech ring by four screwed studs. Above the support plate is a stop stud for the firing lever and below it a firing lever axis stud.

Two holes are bored in the front of the breech ring, one on each side, the holes being threaded for the bolts which secure the gun to its slipper. The bolts are prevented from turning by spring washers.

Gun Slipper. The gun slipper, or chassis, consists of a number of steel plates welded together to form an elongated block and furnished with a base plate. Six bronze liners provided with lubricating grooves are secured, three on each side of the block, by screws and rivets. Formed on the upper part of the slipper are two circular bands which accommodate the gun, the rear band being provided with two guideways to accommodate the guides on the gun and prevent this from turning. On each side of the rear band a hole is bored for the bolts which secure the gun to the slipper. A lug having a cylindrical hole is formed on the under side of the rear band for the reception of the buffer cylinder which is prevented from turning by a feather and feather-way. The gun slipper slides in guideways on the top of the cradle. The ingress of dirt to the cradle guideways is prevented by steel cover plates with leather packing strips, the cover plates being secured to the slipper by screws and rivets.

Cradle. The cradle is a built-up structure consisting of a tubular-shaped steel case to which the various component parts are welded. Along the top of the case are two slipper guides, one on each side, the guides being prepared with guideways to receive the gun slipper. Inside the case are left and right slides which accommodate the guide keys of the runout springs compressor, and support the buffer and recuperator during the recoil and runout.

Six lubricators are provided for lubricating the slipper guides and four for the left and right slides. Near the middle of the case and toward the rear a trunnion band with brackets and trunnion arms is welded, the trunnions providing mounting points for the gun in the aircraft.

At the rear of the case, a transom bracket is welded, the left-hand side of which is prepared to receive the semiautomatic cam bracket. The rear of the case is partially closed by a steel ring which is welded to the transom bracket and forms a rear bearing for the buffer and recuperator. A bearing face ring of bronze, with an asbestos pad interposed, is secured to the rear of the steel ring by six screws. The pad absorbs the shock at the end of runout, forming a stop face for the lug on the underside of the gun slipper.

To the front of the case is riveted a band which has three sets of hinge lugs, the lugs being provided with a belt arrangement which secures the cradle front cap. The front cap has a central hole for the buffer piston rod which is secured by a nut and split pin and prevented from turning by corresponding flats. A hinged inspection cover on the side of the front cap gives access to the piston rod stuffing box gland.

Recoil and Recuperator Systems. These systems absorb the energy of recoil. The recuperator system returns the gun to the firing position and retains it there. The system is housed and supported within the cradle and is attached to the gun through the medium of the gun slipper.

The recoil system comprises a hydraulic buffer which consists of a steel cylinder, stuffing box, rear plug with runout adjusting valve, and piston.

The recuperator system consists of three runout springs, a buffer cylinder bushing, and a runout springs compressor.

BUFFER CYLINDER. The buffer cylinder is attached at the rear to the lug on the underside of the gun slipper, an integral collar on the front and a nut at the rear holding the cylinder in place, while a key engaging a keyway in the slipper prevents the cylinder from turning. The collar also enables the runout springs to be compressed when the system is not assembled in the cradle. Externally at the front and for the greater part of its length the buffer cylinder has a square-cut screw thread for the attachment of the runout springs compressor. Five longitudinal grooves are cut inside the cylinder for the passage of oil. These grooves are equally spaced but vary in depth so as to regulate the flow of oil past the piston head. The rear end of the cylinder is screw threaded internally for the rear plug, and the front end for the stuffing box. In addition, the front end has four spanner slots.

STUFFING BOX. The stuffing box screws into the front end of the buffer cylinder, a liquid-tight joint being made by a soft copper washer. A flange at

the front of the stuffing box has six spanner slots cut in it, one of these slots being engaged by a key attached to the runout springs compressor to prevent the stuffing box from turning after it has been assembled. Internally at the rear the stuffing box accommodates an L-shaped piece which is retained by a screwed bronze collar. In front of the L-shaped leather gasket and supported by a bronze packing collar on each side, is a compressed packing ring of asbestos. Holes are drilled in the packing collars to facilitate withdrawal. Screwed into the front of the stuffing box is a bronze gland which compresses and retains the packings. Six spanner slots are cut in the gland for the application of a spanner.

The rear plug screws into the rear of the buffer cylinder, a liquid-tight joint being made by a soft copper washer. The rear plug accommodates a filling hole plug, an air plug, and a runout adjusting valve. Screwed into the front of the rear plug and secured by a setscrew, is a steel cylinder into the front of which is screwed a bronze throttle bushing. The cylinder and bushing form a control chamber. The bushing also forms a bearing for the piston rod and is secured by a setscrew. An external flange at the front of the throttle bushing supports the bushing in the buffer cylinder, the bushing having six equally spaced slots to allow for the passage of oil.

Rear Plug. The filling hole plug screws diagonally into the rear plug and closes a longitudinal hole which leads to the rear plug cylinder. A liquid-tight joint is made by a fiber washer.

The air plug screws into a hole in the right rear face of the rear plug, a liquid-tight joint being made by a fiber washer. When the air plug is partly unscrewed, a hole in the front face communicates with a radial hole in the rear plug and allows air to escape.

Runout Adjusting Valve. This valve consists of a spindle with valve head and gland and fits into a prepared hole in the top center of the rear plug. The spindle passes through round greased packing, which fits between two bronze neck valve rings held in position by a bronze valve gland screwed into the rear plug. Near the center of the spindle are screw threads which engage corresponding threads in the rear plug and permit adjustment, and near the front of the spindle is an integral collar on which are three flats to allow the oil to escape past the valve. A central hole is bored in the spindle from the front to accommodate a spigot on the valve head. A hole is bored in the spindle behind the collar for a locking wire which secures the valve head to the spindle. The valve head is coned at the front and is formed with a spigot at the rear. Around the spigot is cut a cannelure for the locking wire which secures the valve head to the spindle, but allows the spindle to rotate independently of the valve head.

A valve locking plate, which is secured by a split pin, fits over the rear end of the runout adjusting valve gland and air plug, preventing them from turning when assembled.

Piston. The piston consists of a steel rod and head. The piston rod is reduced in diameter at the front and is screw-threaded for a nut which secures it to the cradle front cap, the nut being secured by a split pin. On the reduced portion, behind the thread, is a flat which engages a corresponding flat in the hole in the cradle front cap and prevents the piston rod from turning. Toward the rear of the rod is a flange against which the piston head is secured by a nut. The rear end of the piston rod is reduced in diameter to form a control plunger, the end being tapered to facilitate entry through the throttle bushing of the rear plug cylinder. A tapering flat cut on the control plunger regulates the flow of oil and controls the runout of the gun.

To facilitate filling the buffer when the gun is mounted in the aircraft, an air plug has been fitted in the front end of the piston rod. The piston rod is bored and threaded to receive the plug, and a longitudinal and radial hole are provided to communicate with the buffer cylinder.

Run-Out Springs. These springs are generally rectangular in section having a free length of 25.5 inches and consist of 2 left-hand-wound and 1 right-hand-wound springs. They are assembled over the buffer cylinder with the right-hand-wound spring in the midposition. Steel parting plates are situated between each spring to prevent them from interlocking and at each end to form bearing plates, the four plates being interchangeable.

Buffer-Cylinder Bushing. This L-shaped bronze bearing is situated on the buffer cylinder between the rear spring bearing plate and the steel ring in the rear transom bracket of the cradle.

The runout springs compressor is cylindrical in shape and is prepared with internal square-cut threads to engage those on the buffer cylinder. Screwed and sweated, or sometimes welded, to the front end is an enlarged head having four slots to accommodate a spanner. Integral with the head and diametrically opposite to each other are 2 projections to which 2 guide keys are riveted. A stuffing box key is secured to the right projection by a screw. The guide keys engage the guideways in the cradle and, in addition to preventing the compressor from turning, form a support for the front end of the buffer cylinder.

Breech Mechanism. The breech is closed by a vertical sliding block which is accommodated in the mortice in the breech ring. The breech is opened automatically as the gun runs out and is held in the open position by the extractors against the reaction of a spring. The loading of a round releases the extractors and allows the spring to close the breech. Carried in the breechblock is a percussion striker which is automatically cocked by the opening of the breech. The striker is released by a firing lever which is operated by a solenoid.

The following are the principal parts of the breech mechanism: breechblock; breechblock operating mechanism; extractors; striker mechanism; firing mechanism.

BREECHBLOCK. The breechblock is rectangular in shape and has two inclined guides, one on each side, which mate with the inclined grooves in the breech ring and cause the breechblock to move forward slightly on closing to seat the cartridge case in the chamber. When the gun fires, the shock is taken on the guides. Stops are formed at the bottom of the guides to limit the upward movement of the breechblock.

Screwed into the front face of the breechblock, and secured by a fixing screw, is a firing-hole bushing. The front face of the firing-hole bushing when it is home is flush with the face of the breechblock. The top of the front face of the breechblock is beveled to push the cartridge into the chamber as the breech closes. On each side of the bevel are inclined recesses forming stops to engage hooks on the extractors and hold the breechblock in the open position. The bottom of the front face is relieved to clear the extractor lugs, an inclined surface and shoulder being formed at the top of the relieved portion to actuate the extractors on opening the breech. Above the shoulders, the sides of the front face are cut away to allow the extractors to operate.

A slot is cut in the front of the breechblock at the bottom to form a crank recess. Above the crank recess and extending through the block is cut a recess for the cocking link, a guideway being cut at the top of the recess for a guide on the cocking link. The front of the cocking link recess is concentric with the axis of the crank when the breechblock is closed, permitting an idle movement of the crank after it has raised the breechblock to the closed position and before it commences to open the breech.

The breechblock is bored and recessed behind the firing hole bushing to accommodate the striker mechanism, interrupted thrust collars being formed at the rear to engage similar collars on the striker case and hold the striker in position. On the right of the striker recess is a radial groove, the bottom of the groove being inclined to accommodate the striker case retaining plunger during assembly. At the top of the recess is a hole which receives the end of the retaining plunger to retain the striker in position. Above the striker recess and extending to the left is a second radial groove which provides a clearance for the end of the safety catch plunger during assembly. A small recess is cut in the left of the rear face of the breechblock to clear a flange on the firing lever, permitting the firing lever to rotate and engage the striker sear only when the breech is closed.

The top of the breechblock is shaped to conform to the bottom of the chamber and provides a shell guide. In the front is cut a dovetailed recess in which is fitted a retaining piece to prevent the round from rebounding beyond the front face bevel after it has been loaded. The retaining piece is held in position by a spring-loaded plunger accommodated in a hole in the top of the breechblock. On each side of the top of the block, slots are cut to accommodate left-hand and right-hand packing plates which are secured by screws and project to the rear to form shell guides. The screws are secured by center punching. To the outside of the left-hand packing plate is welded a stop piece which disengages the locking lever from the firing lever when the breech is closed.

BREECHBLOCK OPERATING MECHANISM. The breechblock operating mechanism consists of an

actuating shaft, crank, striker cocking link, rack pinion, actuating shaft sleeve, spring case, rack, and breechblock actuating spring.

The actuating shaft is mounted in bearings formed in the underside of the breech ring, being retained in position by a slotted nut and split pin at its right-hand end. The left-hand end of the actuating shaft is cranked and carries a roller which engages the semiautomatic cam and breech cam on runout. Cut along the shaft for the greater part of its length are three feather ways which engage feathers on the crank, actuating shaft sleeve, and the rack pinion. The key ways are unequally spaced to insure correct assembly.

The crank is mounted on the actuating shaft to which it is feathered and operates in the recess in the breechblock. The upper end of the crank arm is forked to accommodate the striker cocking link. On the outside of the fork, lugs are formed to engage the upper and lower surfaces of the cocking link recess and raise or lower the breechblock, depending upon the direction of rotation of the actuating shaft. The tops of the lugs are flat and bear against the concentric portion of the recess to retain the breechblock in the closed position. The downward movement of the breechblock is limited by a boss on the crank contacting the breech ring.

The striker cocking link is rectangular in shape and has a guide on the top to engage the groove in the breechblock. At the rear of the guide is a projection which engages the striker cocking sleeve. At the front of the cocking link is a projection in which an elongated hole is cut for attachment to the crank fork by an actuating pin which is passed through the fork from the right. The elongated hole permits the striker to be withdrawn before the crank commences to open the breech and allows the crank link to continue to move after the breechblock has been closed.

The rack pinion is mounted on the right-hand end of the actuating shaft to which it is feathered. It is retained in position by the actuating shaft nut. Five teeth are cut on the outside of the pinion to engage corresponding teeth on the rack. A hole is bored in the rack pinion to enable a tommy bar to be applied for hand opening of the breech.

The actuating shaft sleeve and collar are mounted on the shaft between the rack pinion and the right-hand extractor and act as distance pieces.

The spring case is of bronze and is dovetailed to the right-hand side of the breech ring, being secured in position by two screws. The upper end of the case is screw-threaded internally for the spring case cap which, when screwed up, applies initial compression to the actuating spring, a disk being interposed between the spring and the cap. A check screw prevents the cap from turning. At the bottom, the case is cut away to allow the rack pinion to engage the rack.

The rack is accommodated in the bottom of the spring case, teeth being cut on it to mate with those of the rack pinion. The upper end of the rack has a small spigot which serves to center the actuating spring in the spring case.

The breechblock actuating spring is spiral in form, initial compression being applied by the cap and further compression by the action of the rack pinion and rack, when the former is rotated by the actuating shaft on opening the breech.

EXTRACTORS. The extractors are mounted, one on each side of the crank, on the actuating shaft about which they pivot. They are left handed, otherwise they are similar. The upper end of each extractor lever has a lip to engage the rim of the cartridge, and below the lip a hook is formed to engage the stops at the top of the breechblock when the breech is open. The lower end of the extractor is enlarged and has a hole bored through it for the actuating shaft. In rear of the hole is a lug which operates on the inclined surface and against the shoulder on the breechblock to unseat and eject the cartridge case.

STRIKER MECHANISM. The striker mechanism consists of a striker case with trigger sear, retaining catch, and safety catch; striker spindle with firing pin and main spring; cocking sleeve and cocking handle.

The striker case is in the form of a block with a front tubular extension, and is suitably bored and machined to accommodate the remainder of the mechanism. Accommodated in the top of the case are two rollers, which facilitate easy action of the trigger sear. Behind the rollers a slot is cut to accommodate the trigger sear, the right-hand end of the slot being closed by the trigger sear spring seat which is retained by a split pin. A hole is bored through the case on the left for the safety catch, a vertical hole being bored for the safety catch re-

taining pin. On the right is a hole for the striker retaining catch plunger. A hole is bored through the block and the tubular extension for the striker spindle, the tubular extension being counterbored to accommodate the main spring. Above the hole for the striker spindle is a rectangular slot in which the cocking sleeve operates. To the left of this slot is a safety catch stop. The top of the case is closed by a plate to which is welded a block, the top of the block being curved to conform to the contour of the top of the breechblock, thus forming an extension of the shell guide. At the rear of the tubular portion, interrupted thrust collars are cut to mate with those in the rear of the breechblock and hold the striker in position.

The trigger sear is in the form of a small bar and slides transversely in the top of the striker case, friction being reduced by the rollers. The rear face of the trigger sear has a recess cut in it to form a stop face to engage the cocking sleeve and hold the striker in the cocked position. The recess terminates in a slot which allows the cocking sleeve to move forward on firing. The right-hand end of the trigger sear is recessed to accommodate one end of the trigger sear spring, the other end of the spring being accommodated in the trigger sear spring seat which is pinned to the striker case. The left-hand end of the trigger sear is enlarged to form a bearing for the firing lever and to limit the stroke of the trigger sear.

The retaining catch consists of a spring-loaded plunger and is prevented from turning in the striker case by a feather and featherway. To the rear of the plunger is taper-pinned a head which has a lug to form a finger grip. When the striker is assembled in the breechblock, the plunger engages the hole in the rear of the block and prevents disengagement of the thrust collars.

The safety catch consists of a spindle, on the outer end of which is formed a head. Accommodated in the head is a small spring-loaded plunger which is retained by a split pin. The inner end of the plunger engages one of the two small recesses in the rear of the striker case to retain the safety catch in the SAFE or FIRE position, a finger piece being welded to the head to facilitate operation. The inner end of the spindle is shaped to prevent the striker from being removed unless the safety catch is set to SAFE. On the spindle is a flat which permits operation of the trigger sear when the catch is set to FIRE, while the rounded portion of the spindle prevents movement of the trigger sear when the catch is set to SAFE. A groove at the rear of the spindle accommodates the retaining pin.

The striker spindle has an integral head which forms a bearing for the main spring. Two slots are cut in the head to form gas-escape channels, and the front of the head is recessed to accommodate the firing pin which is retained by a staple. The spindle is prevented from turning by being keyed to the cocking sleeve, and its rear end is threaded for the cocking handle.

The main spring is accommodated on the striker spindle and bears between the head of the spindle at the front and a shoulder formed inside the tubular portion of the striker case at the rear.

The cocking sleeve fits on the rear of the striker spindle where it is retained by the cocking handle. On the front of the sleeve are two arms, the upper of which engages the trigger sear and the lower the cocking link. The upper arm passes through the rectangular recess in the striker case and is relieved to clear the trigger sear on firing. The lower arm bears against the underside of the striker case and prevents the cocking sleeve from turning.

The cocking handle screws on to the end of the striker spindle, serves as an assembly nut, and places the main spring under initial compression. A cross handle enables the striker to be recocked in the event of a misfire, when firing is taking place on the ground.

Firing Mechanism. The firing mechanism consists of a firing lever, locking lever, bell-crank operating lever, and firing-lever support plate.

The firing lever is pivoted on an axis stud which is screwed into the breech ring on the left of the mortice, the lever being held in position by a slotted nut and split pin. A flange is formed on the side of the lever to prevent it from being operated until the breechblock is closed when a recess in the block is opposite the flange. An upper arm of the lever is enlarged and bored to accommodate a spring-loaded plunger which engages a stop stud on the breech ring and returns the firing lever to its normal position after firing. The right-hand end of the arm engages the trigger sear, and the left-hand end carries a roller which is engaged by the bell-crank operating lever. A recess in the underside of the arm accommodates a flange on the top of the sup-

port plate, which steadies the firing lever and limits its movement.

The locking lever is mounted on an extension on the firing lever roller axis and projects through a slot in a bracket which is attached to the left-hand round guide of the breech ring. When the breech is open, the locking lever engages the bottom of the slot; in this position the locking lever is held by a spring and prevents operation of the firing lever. When the breech is closed, the locking lever is lifted clear of the slot by a stud on the left-hand packing plate.

The bell-crank operating lever pivots between projections which are welded to the left-hand register plate of the automatic loader. The rear arm of the bell-crank lever engages the roller of the firing lever, and the front arm is engaged by the release lever of the firing solenoid when the gun is in the firing position.

The firing-lever support plate is held in position by four screwed studs and supports the upper arm of the firing lever. The studs project to the rear and are provided with integral distance pieces. Mounted on the outer ends of the studs is a block which carries a left-hand round guide. This guide projects to the rear and provides an extension to the breechblock left-hand packing plate. The locking lever bracket is welded to the round guide.

Semiautomatic Gear. The semiautomatic gear is mounted on a cam bracket, which is bolted to the left-hand side of the cradle rear transom. It consists of a semiautomatic cam, breech cam, and breech cam plunger and spring. The semiautomatic gear opens the breech during runout and assists in closing the breech after the gun has been loaded.

Semiautomatic Cam Bracket. The semiautomatic cam bracket is keyed to the rear cradle transom and is secured by four bolts and, in addition to carrying the semiautomatic gear, it provides a support for the magazine support. A slot is cut in the top of the cam bracket to receive the magazine support which is secured by bolts. A slot is cut in the cam bracket near the bottom to facilitate removal of the breech mechanism actuating shaft. On the outside of the semiautomatic cam bracket near the rear is a small projection to which the lower end of the firing solenoid bracket is secured and on the inside at the bottom is a stop for the gun.

Semiautomatic Cam. The semiautomatic cam is mounted on a pivot on the inside of the cam bracket and projects to the rear. The end of the cam is suitably curved on its upper surface to engage a roller on the breech mechanism actuating shaft during runout and to open the breech. The front of the semiautomatic cam is cut away on the inside to allow the actuating shaft roller to rotate during hand operation and also when the breech is closing. Downward movement of the rear of the semiautomatic cam is limited by the stop on the cam bracket. During recoil, the semiautomatic cam is lifted off the stop by the actuating shaft roller which travels along the under side of the cam. When the roller is clear, the semiautomatic cam is returned to its position on the stop by the breech cam plunger spring.

Breech Cam. The breech cam is mounted on a pivot on the inside of the semiautomatic cam bracket in front of the semiautomatic cam and projects to the rear above this cam. In its normal position, the rear of the breech cam bears on the semiautomatic cam, contact being maintained by the breech cam spring plunger which bears against a projection on the breech cam near the pivot. When the actuating shaft roller lifts the semiautomatic cam, the breech cam spring is further compressed and returns the components as soon as the roller is clear. When the roller rides along the top of the semiautomatic cam on runout, it passes under the breech cam and lifts this to further compress the breech cam spring, the reaction of the spring assisting to close the breech.

Breech Cam Spring and Plunger. The breech cam spring and plunger are housed in a tube which is mounted in the semiautomatic cam bracket. The plunger head projects to the rear and bears against the breech cam, the spring bearing between the plunger head at the rear and the inside of the tube at the front. On the front of the plunger is a spacer and nut which secure the plunger and enable initial compression to be applied to the spring.

Buffer Pump. The pump for use in filling the buffer consists of a base, suction valve and hose, delivery valve and hose, barrel, and plunger with rod and handle.

The base is a casting which has two bars hinged to it for the operator to stand upon. In the center of the base is an opening to accommodate the lower

end of the barrel, both barrel and base being bored to form seatings for the suction and delivery valves. The base is prepared with nozzles which are screw threaded externally for the attachment of the suction and delivery hoses. Protecting caps are provided for the nozzles.

The valves consist of spring-loaded balls, the springs retaining the balls on their seatings and closing the outlets to the hoses.

The hoses are of flexible metal tubing, the suction hose being of 3-inch bore and having a strainer fitted to its outer end. The delivery hose is of ½-inch bore and has a union at its outer end for attachment to the buffer adapter. Both hoses are fitted with unions at their inner ends for attachment to the pump nozzles.

A pump adapter is provided for connecting the delivery base to the buffer cylinder filling hole, being screw threaded at each end for the attachment of the hose and for screwing into the filling hole.

The pump barrel is cylindrical and fits into a recess in the base to which it is secured. The upper end is closed by a screwed cover through which projects the plunger rod. Externally the barrel is surrounded with protecting gills.

The plunger consists of two cup-shaped leather washers attached to the lower end of the rod. At its upper end the rod is fitted with a handle by means of which the pump is operated.

Automatic Loader

The automatic loader is mounted on brackets which are bolted to the gun cradle, the loader projecting to the rear of the gun where it is supported by being bolted to the aircraft structure. In addition to an automatic feed and loading mechanism, the loader provides accommodation for 23 rounds of ammunition.

The principal parts of the automatic loader are: magazine support and slide channel; feed mechanism; magazine; magazine drive mechanism; pusher arm mechanism; brake and switch mechanism; drive motor.

Magazine Support and Slide Channel. The magazine support and slide channel are mounted at the front on brackets, which are bolted to the gun cradle and carry the feed mechanism, magazine, magazine drive, and their associated components and fittings. The magazine support is on the left-hand side and the slide channel on the right-hand side of the gun.

The magazine support is of channel construction and is secured by four bolts to the top of the cam bracket which has a slot cut in it to accommodate the magazine support. Any tendency of the magazine support to move in a longitudinal direction is prevented by hooked pieces welded to the magazine support and engaging the cam bracket. To the underside of the magazine support is welded a slide which fits in a bronze guide block bolted to the top of a register plate. A key on the register plate engages a slot in the breech ring. When the gun recoils and runs out, the guide block slides to and fro. Welded to the magazine support in front of the guide block is a small projection to which is bolted the upper end of a bracket which carries the firing solenoid.

At the front end of the magazine support is bolted a front tie bracket which is also bolted to the front end of the slide channel. Bolted to the rear ends of the magazine support and the slide channel is a slide channel spacing bracket. The magazine support and slide channel with the tie bracket and channel spacing bracket thus form a rigid assembly.

An anchorage for the magazine pusher arm spring is provided at the front end of the magazine support. Bolted to the top of the magazine support on the inside are three brackets which form bearings for a feed arm shaft. Pivoted on the center of these brackets is a spring-loaded, round-retaining pawl, the tension of the right-hand-wound spring being adjustable by a collar. The center bracket also carries a round nose guide. Bolted to the rear of the magazine support and in front of the channel spacing bracket, there is a left-hand cartridge rim guide with a welded plate at the rear to prevent the round slipping back and a welded plate underneath to prevent the base of the case from moving to the left during feed.

The slide channel is secured at the front by six bolts to the top of a support bracket which has a slot cut in it to accommodate the slide channel. The support bracket is secured by eight bolts to the right-hand side of the cradle in the rear of the cradle trunnion. Any tendency of the slide channel to move in a longitudinal direction, due to the action of the rammer mechanism, is prevented by hooked

pieces welded to the slide channel and engaging the support bracket at the front and rear.

A bracket is welded to the top of the slide channel toward the front, and to this bracket is bolted an angle support. To the rear of this bracket are welded tow-arm guide supports to which is bolted a center support plate. To the center support plate is bolted a center angle support which carries a round support, the latter supporting the ammunition in the magazine. A rear angle support is bolted to the channel spacing bracket with a packing piece interposed. To the three angle supports is bolted the right-hand side of the magazine. On the inside of the slide channel toward the rear is bolted a plate which prevents the base of the cartridge case from moving to the right during feed.

The rear of the slide channel spacing bracket is shaped to provide a means of attachment to the aircraft structure, four holes being provided for the securing bolts. To the front of the spacing bracket is bolted a support bracket, to which is welded a right-hand cartridge rim guide. Carried on the support bracket is a spring-loaded cartridge stop pawl, and a spring-loaded cartridge rim check lever.

The space between the magazine support and the slide channel forms a feedway through which the ammunition is fed to the gun, various pawls and guides in addition to those already mentioned being provided to control the movement of the rounds.

Feed Mechanism. The feed mechanism consists of a cam track, nose separator, feed-arm shaft, rammer and return springs, rammer lifting cam, and the conventional pawls and levers.

The cam track of steel is mounted on the top of the breech ring, being secured by five bolts, and projects to the front of the magazine. It is provided with two cams to engage the rollers of the round-nose separator, the left-hand track in addition engaging the roller of the feed-arm shaft. Bolted to the front of the camshaft is a support piece which bears on the left-hand gun guide key and supports the front end of the cam track.

The projectile nose separator consists of a hollow steel boss to which is welded a driving arm which projects to the rear. The separator controls the nose of the round on loading and separates it from the following round to prevent double loading. On the hollow boss are two arms, one of which projects to the front and the other to the rear. Each of these arms carries a roller, the rollers being of different diameters. As the gun recoils and runs out, the front roller rides along the left-hand cam track and the rear roller along the right-hand cam track. Bronze bearings are fitted in the ends of the hollow boss, which is mounted on an eccentric cross-shaft passing through bearings on the magazine support and slide channel. The cross-shaft is adjusted in manufacture and is secured to the magazine support by screws. Interposed between the separator and the magazine support is a distance collar.

On the right-hand side of the separator is a tension tube which carries a torsion spring. Tension is applied to the spring by means of the tube, which, after adjustment, is locked to the separator by an anchor. The anchor is bolted to the driving arm of the separator and has a spigot which engages one of several holes in the tension tube. On the outside of the driving arm at the rear is a projection which engages between two projections on a projectile retaining lever mounted in a bracket on the inside of the slide channel.

The projectile retaining lever is attached by a connecting link to a projectile check lever that in turn pivots in the retaining lever bracket. The retaining lever bracket also carries a projectile nose guide which prevents the round moving to the right as it is pushed down. The two levers are shaped to engage the nose of the projectile in the bottom of the feedway and control its movement during loading and are operated by the driving arm of the separator through the engagement of their respective cams.

A separator connecting rod is connected to the front of the projectile nose separator by a separator fork joint. The rear end of the connecting rod is connected to the rammer release pawl link. Secured by screws and doweled to the connecting rod end is a check lever pusher which operates the spring-loaded cartridge rim-check lever situated on the support bracket at the rear.

The feed-arm shaft is carried in the brackets on the inside of the magazine support. Welded and keyed to the feed-arm shaft near the middle is a retract lever, and near the front end of the shaft is an integral collar. Between the collar and the retract lever is mounted a feed-arm spring. One end of the feed-arm spring engages a hole in the collar, the other end bears on the magazine support. Keyed

and pinned to the front end of the feed-arm shaft is a roller bracket carrying a roller which rides along the left-hand cam track. The retract lever carries a spring-loaded retract pawl, the tension of the left-hand-wound spring being adjustable by a collar. At the rear end of the feed-arm shaft is a feed arm carrying a spring-loaded feed pawl, the tension of the left-hand-wound spring being adjustable by a collar. The feed arm rides on a small roller on the top of the magazine support when the feed-arm shaft is rotated.

When the gun recoils, the feed-arm shaft roller rides down the front of the left-hand cam track and the feed arm spring is free to rotate the feed-arm shaft so that the retract lever and feed arm move inward and downward into the feedway. As the gun runs out, the feed-arm shaft is repositioned by the roller riding up the cam track. The feed-arm shaft roller and feed-arm spring thus act in opposition.

The rammer slides along the slide channel, being pushed to the rear when the gun recoils by a rammer slide pawl and being returned to the forward position at the end of runout by the rammer return springs. While the gun is running out, the rammer is supported by a catch and retained by a release pawl and link. The rammer consists of a slide, arms, claw, and a pawl connecting the slide to the return springs.

The rammer slide is a steel plate which is shaped to slide in the slide channel, its rearward movement being limited by a rammer stop block, which is bolted to the outside of the slide channel at the rear. On the top of the rammer slide is a rectangular projection the top front edge of which is beveled to engage the rammer release pawl toward the end of recoil. On the underside of the rammer slide at the front is a projection which is engaged by the rammer slide pawl during recoil. Felt lubricators are provided to lubricate the rammer slide in the slide channel.

The rammer arms are situated on the outside of the rammer slide and are mounted on pins about which they pivot. The arms are loosely connected at their lower ends by an arm tie link. On the inside of each arm at the bottom is a projection upon which the rammer claw is mounted. At the top of the rammer front arm is a small extension which projects to the rear and carries a small stud. The extension and stud, in conjunction with an arm guide and hinge guide, help to control the movement of the arms and claw during the operation of the rammer.

The arm guide is bolted to supports which are welded to the slide channel, and carries the hinge guide which is spring loaded by a torsion spring. A stop on the arm guide limits the outward movement of the hinge guide while the spring keeps it pressed inward against the arm guide.

The rammer claw is secured in position on the rammer arms by Simonds nuts, the claw projecting to the front and being suitably shaped to loosely engage the base of the cartridge case. On the left of the claw, a small projection engages the rammer catch when the rammer is lifted at the end of recoil.

The spring-loaded rammer catch is bolted to the underside of the slide channel spacing bracket.

A shock absorber, to take the blow when the rammer is lifted, is bolted to the underside of the slide channel spacing bracket to the rear of the rammer stop block. The upward movement of the shock absorber is limited by a projection at the rear of the stop block to protect the rubber comprising the absorber.

Two rammer return springs are accommodated in tubes on the outside of the slide channel at the front. The tubes are held in position at the front by a tube clamp and clamp plate, and at the rear by a block welded to the slide channel. The block is suitably recessed to accommodate and form an abutment for the ends of the spring tubes. The return springs are mounted on rods which project through the rear of the spring tubes and the securing block. The springs bear between the ends of the tubes at the rear and the spring rod nuts at the front. The front ends of the tubes are closed by screwed caps. The rear ends of the spring rods are enlarged to form an abutment for a spring rods plate. On the plate is a projection which is engaged by the rammer return springs pawl.

The rammer return springs pawl is in the form of a hinged latch which pivots on a pin at the side of the rammer slide. At the front of the pawl a hook engages the projection on the return spring rods plate, in which position the pawl is held by a spring-loaded plunger. This arrangement enables the rammer to be disengaged from the return springs and moved to the rear by hand. An arm tie is at-

tached to the pivot of the rammer return springs pawl and to the pivot pin of the rammer front arm. The arm tie has a curved end to form a handle for hand movement of the rammer.

The rammer release pawl is mounted on a pivot on the top of the slide channel at the rear and is spring loaded by a torsion spring enclosed by a cover. On the outside, the pawl is hook-shaped to engage the rammer slide, and on the inside is a small projection which is engaged by the separator connecting rod end, to disengage the pawl from the rammer slide.

A magazine regulator, or positioner, is mounted on the inside of the slide channel at the rear. The regulator is integral with its spindle which is spring loaded, to the top of the spindle being secured to a regulator stop. The regulator holds the base of the cartridge case ready for engagement by the rammer claw during feed.

The rammer lifting cam is secured to the right-hand side of the breech ring by four bolts, a key on the cam engaging a slot in the breech ring. The rear of the lifting cam is suitably shaped to lift the rammer into engagement with the rammer catch toward the end of recoil.

The spring-loaded rammer slide pawl is mounted on a bearing at the top of the rammer lifting cam. The rear of the pawl is shaped to engage the rammer slide, and on the inside a roller engages a ramp on the underside of the slide channel, toward the end of recoil, and disengages the pawl from the rammer slide. An extension at the front of the pawl engages the rammer slide pawl ramp toward the end of runout.

The rammer slide pawl ramp is bolted to the slide channel below the rear ends of the return springs tubes. Its function is to reposition the rammer slide pawl ready to engage the rammer slide when this is returned by the return springs.

A right-hand round nose guide is bolted to a bracket which is welded to the inside of the rammer lifting cam at the rear. Welded to the round nose guide is a shock absorber, which takes the blow of the rammer at the end of the loading stroke.

Magazine. The magazine consists of a frame, shell, and cartridge clips, and clip guides. The frame carries the drive mechanism, which brings the ammunition clips into position over the feedway ready for loading the gun, and also operates the pusher mechanism.

The magazine frame consists of four steel plates bolted together, stiffening angles being bolted to the outside edges of the left-hand and right-hand plates, the whole forming a rigid assembly. The right-hand plate of the magazine frame is bolted to the three angle supports; the left-hand plate is bolted to a bracket on the magazine support at the front and to the channel spacing bracket at the rear. Packing pieces are interposed between the left-hand plate and its supports. When mounted, the magazine frame is inclined at an angle of 30° to the horizontal.

At the front right-hand corner of the magazine frame is bolted a drive front bearing bracket and at the rear a drive rear bearing bracket. At the front left-hand corner of the magazine frame on the inside is bolted a shell clip shaft bearing bracket (this bracket also provides an inner bearing for a cam gear), and on the outside a pusher arm bearing bracket (this bracket also provides an outer bearing for the cam gear). At the rear left-hand corner of the magazine frame is bolted a cartridge clip shaft bearing bracket.

Pivoted on a bracket on the inside of the left-hand frame plate is a spring-loaded round catch of bronze which prevents the round from lifting during feed.

The clip guides consist of upper and lower shell clip guides, and upper and lower cartridge clip guides with shell clip track and cartridge clip track. The shell and cartridge lower clip guides are bolted to the front and rear plates of the magazine, respectively; the shell clip track is bolted to the left-hand plate and the cartridge clip track to the rear plate. The shell upper clip guide is bolted to the tops of the two front bearing brackets and the cartridge upper clip guide to the tops of the two rear bearing brackets. On the right-hand side, the upper clip guides are connected by a tie angle piece. Supported on posts above the shell clip track is a box guide which forms an extension of the shell upper-clip guide.

Five shell clips, which are almost identical in shape, are supported between the shell clip guides and accommodate the noses of the shell, a shell retainer being brazed to the top of each clip. On the front of each clip are two projections having slots cut in them to mate with the upper and lower

shell clip guides. The upper projection is engaged by the brake bar which holds the clips during feed. The clips are hinged together at the top and bottom by hinge pins, the hinge lugs being integral with the clips. On the underside of the left-hand clip is a guide pin which, in conjunction with an extension on each lower hinge pin, guides the clips along the shell clip track when the clips are moved to the left by the drive and leave the shell clip guides. On the front of the right-hand shell clip is bolted an Acme bearing which travels along the shell clip drive shaft to move the clips to the left or to the right, depending upon the direction of drive.

Five cartridge clips are supported between the cartridge clip guides and accommodate the bases of the cartridge cases. On the rear of each clip are two projections having slots cut in them to mate with the upper and lower cartridge clip guides. The right-hand cartridge clip is in one piece, the remainder being in two pieces and hinged together to facilitate movement. The cartridge clips are hinged together at the top and bottom by hinge pins, the hinge lugs being integral with the clips. A hollow boss is secured to the top of the right-hand clip by three screws and accommodates a spring-loaded plunger cartridge retainer, a similar device being provided at the top of the second clip. The next two clips are provided with a cartridge retainer in the form of spring clips. The pusher arm serves to retain the cartridge in the last clip.

Attached to the right-hand and left-hand cartridge clips by clamps is a short piece of cable which passes around cable guides bolted to the top of the upper cartridge clip guide. The cable steadies the tops of the clips when they leave the top guide during their movement to the left. At the bottom of the left-hand clip is a small roller which travels along the clip track during this movement. On the rear of the right-hand cartridge clip is bolted an Acme bearing which travels along the cartridge clip drive shaft to move the clips to the left or to the right, depending upon the direction of drive.

The shell and cartridge clips convey the ammunition to the feedway and provide accommodation for 21 rounds which, with 2 rounds in the feedway itself, gives the loader a total capacity of 23 rounds of ammunition.

Magazine Drive Mechanism. The magazine drive mechanism moves the shell and cartridge clips into position ready for feeding as soon as a pair of clips is empty, and it lifts the pusher arm ready to engage the top round in the next pair of clips. It is coupled to an electric motor which is automatically controlled by the brake and switch mechanism.

Front and rear coupling shafts are mounted in sealed ball-bearing brackets. The two coupling shafts are connected by a steel coupling tube, and each shaft carries a steel spiral gear having 18 teeth. Keyed to the front coupling shaft is a brake coupling which is connected to the drive motor by a motor coupling. Keyed to the rear coupling shaft is a handle clutch with flanged distance piece. Mounted on the distance piece, between the flange and the clutch, is a loose handle which has a small projection at its inner end to engage 1 of 2 slots in the clutch. Secured to the handle by a plate and two screws is a spring which retains the handle in the disengaged position. When the pusher arm is raised to the inoperative position, the handle clutch enables the shell and cartridge clips to be moved by hand for loading and unloading the magazine or for cleaning.

Drive shafts for the shell and cartridge clips are mounted in sealed ball bearings at the front and rear in their respective bearing brackets. Each shaft has an Acme thread cut in it throughout its length, and to the right-hand end of each shaft is keyed a gun metal spiral gear having 60 teeth. The drive shafts pass through the Acme bearings, on the shell and cartridge clips, and the gun metal spiral gears mate with the steel spiral gears on the coupling shafts. Keyed to the left-hand end of the shell-clip drive shaft is a cam drive gear which mates with the pusher arm cam gear.

Pusher Arm Mechanism. The pusher arm mechanism is mounted at the front left-hand corner of the magazine frame being supported between the shell clip shaft bearing bracket and the pusher arm bearing bracket. It consists of a pusher arm with spring, lifting cam, and ratchet lever.

The pusher arm is a straight bar mounted on a pivot which passes through the front of the bearing brackets at the top. Mounted on the inside of the pusher arm near the pivot is a cam roller which rides on the pusher arm lifting cam. Welded to the outside of the pusher arm and in rear of the cam roller, is a pusher arm ratchet pawl which normally engages the ratchet lever and prevents the pusher

arm from lifting. To the rear of the ratchet pawl is mounted a depressor roller which operates a depressor arm, when the pusher arm reaches the bottom of its travel, after pushing the last round into the feedway. To the free end of the pusher arm is welded a post to which is welded a pusher arm extension. The extension carries the pusher roller, of steel and rubber, which is mounted on a pin and secured by a cap. The roller presses on the top cartridge case in the clips which are in position for feeding.

A welded projection on the pusher arm near the pivot is attached to a spring rod by a connecting rod end. The spring rod carries the pusher arm spring which is housed in a tube, the front end of which is anchored to the front of the magazine support. The reaction of the spring causes the free end of the pusher arm to bear upon the rounds in the left-hand magazine clips.

The pusher arm lifting cam is mounted on a cam shaft which runs in sealed ball bearings carried in the bearing brackets. The lifting cam is bolted to the cam gear, which is keyed to the cam shaft, and is engaged by the cam drive gear on the end of the shell clip drive shaft. The lifting cam is cut away to give a clearance for the cam roller as the pusher arm moves downward when loading the gun. When the last round has passed from the clips into the feedway, the magazine drive rotates the lifting cam, causing it to engage the cam roller and lift the pusher arm clear of the ammunition clips, so that the next pair of full clips can be brought into position ready for feed. The cutaway in the cam again comes opposite to the cam roller and the pusher arm spring brings the pusher arm down on to the ammunition.

The ratchet lever pivots on a bracket bolted to the pusher arm bearing bracket, engagement between the teeth on the rear of the ratchet lever and the pusher-arm ratchet pawl being maintained by a torsion spring. To the top of the ratchet lever is welded a pusher arm support, which has a notch cut in it at the front to engage the ratchet pawl and hold the pusher arm clear of the clips to facilitate loading the magazine, the pusher arm being raised to this position by hand. A projection on the rear of the ratchet lever near the pivot is provided to disengage and hold the brake bar while the clips are being loaded or moved by hand. The engagement of the projection with the brake bar coincides with the engagement of the pusher arm ratchet pawl with the pusher arm support.

At the bottom of the ratchet teeth is a ramp, which engages the pusher arm ratchet pawl as the pusher arm reaches the bottom of its loading stroke, and causes the ratchet lever to pivot forward slightly. The ratchet lever is retained in this position as the pusher arm lifting cam, rotated by a camming stud on the inside of the ratchet lever, engages the ratchet lever cam. This cam is keyed to the end of the lifting cam shaft. At the lower end of the ratchet lever is an extension which projects to the front and locks the safety lever of the brake bar mechanism until the last round is taken from the clips, in position for feeding.

Brake and Switch Mechanism. The brake and switch mechanism is situated at the front of the magazine and controls the drive motor. The mechanism consists of a brake and spring, switch bar and spring, brake bar and spring, depressor arm, locking and safety levers.

The brake is carried on a bell-crank operating lever, which is pivoted in a brake bracket bolted to the front of the magazine frame on the right, and operates between flanges on the brake coupling. The upper end of the operating lever is connected by a pin to the end of the brake spring rod. The other end of the brake spring rod passes through a slide pin bracket which is welded to the switch bar. The brake is applied through the medium of the brake spring, which enables the load to be adjusted. One end of the brake spring bears against a collar on the spring rod which abuts the slide pin bracket; the other end of the spring bears against an adjustable collar on the end of the spring rod, the collar being secured by a nut.

The switch bar has a slot cut in its right-hand end which engages the pin at the top of the brake operating lever to release the brake. The slide pin bracket, which is situated near the middle of the switch bar, also operates a switch slide to open and close the motor switch. The left-hand end of the switch bar is pinned to a connecting link which pivots on a bracket bolted to the top of the upper shell clip guide. Welded to the connecting link is a cocking lever for hand setting after the magazine has been loaded.

The switch bar return spring is attached at one end to a pin secured to the brake bar and at the other end to a pin which is welded to the upper end of the shell clip guide.

The brake bar is attached at one end to the connecting link by a pin, the other end of the brake bar projecting to the left of the magazine between the projection at the rear of the ratchet lever and the end of the safety lever. Near the middle of the brake bar is a notch which engages in turn the projection on the front of each shell clip, to hold the clips while the rounds are being fed to the gun. Below the notch is a stop which limits the total travel of the clips by engaging the Acme bearing. A projection toward the outer end of the brake bar bears on a sleeve which is supported by the brake-bar spring. The spring and sleeve are mounted on the front post of the box guide and lift the brake bar into engagement with the projections on the shell clips when the clips are in position ready for feeding.

The depressor arm is pivoted to a bracket which is bolted to the left magazine frame plate toward the front. The front end of the depressor arm rests on the top of the brake bar, the other end of the arm being suitably shaped to be engaged by the pusher arm depressor roller, as the pusher arm reaches the end of its downward stroke, and causes the front end of the arm to bear on the brake bar and disengage it from the shell clips.

The locking lever is pivoted on the outside of the pusher arm bearing bracket and can be set to HAND for loading the magazine and to AUTO (automatic) for firing. The locking lever, when set, is held in position by a spring-loaded plunger.

The safety lever is pivoted on an extension of the locking levers. The rear end of the safety lever engages under the brake bar and holds the brake-bar notch in engagement with the projection on the shell clip when the locking lever is set to AUTO, preventing premature disengagement of the brake and closing of the switch. The safety lever is locked in this position by the projection at its front end engaging the extension at the front of the ratchet lever. When the ratchet lever pivots at the end of the downward stroke of the pusher arm, the safety lever is released and falls away from the brake bar allowing this to be disengaged from the shell clips by the depressor arm. When the locking lever is set to HAND, it carries the safety lever clear of the ratchet lever extension and allows the ratchet lever to pivot to the rear to support and hold the pusher arm when this is lifted to the inoperative position.

Drive Motor. The drive motor is a special 24-volt d. c. compound wound machine giving 0.6 h. p. at 1,820 r. p. m. It is mounted at the front right-hand corner of the magazine frame and is secured by bolts.

The motor switch is mounted at the right-hand end of the upper shell clip guide, being operated by the switch bar and switch slide, through the action of the brake bar and the switch-bar spring. The movement of the brake bar is governed by the position of the magazine pusher arm and the brake-bar spring.

A special junction block is mounted on the magazine frame to the left of the motor, connections being made to the switch and motor by short lengths of cable. The junction block is connected to the firing solenoid by two lengths of cable, to which is attached a two-pin plug for connecting with the two-pin socket of the solenoid. On the top of the junction block is mounted a socket to take the plug from the aircraft supply.

SECTION 2. CYCLIC ACTIONS

Preparation for Firing

To fire the gun, the pilot must first close the main switch and set the firing button to FIRE.

To fire single shots, press and release the firing button.

To fire a burst, press the firing button and maintain the pressure until the required number of rounds have been fired.

WARNING.

1. The pilot must set the firing button to SAFE and open the main switch before coming in to land, and he must report stoppages.

2. The pilot must also set the firing button to SAFE, and must open the main switch immediately after a stoppage occurs.

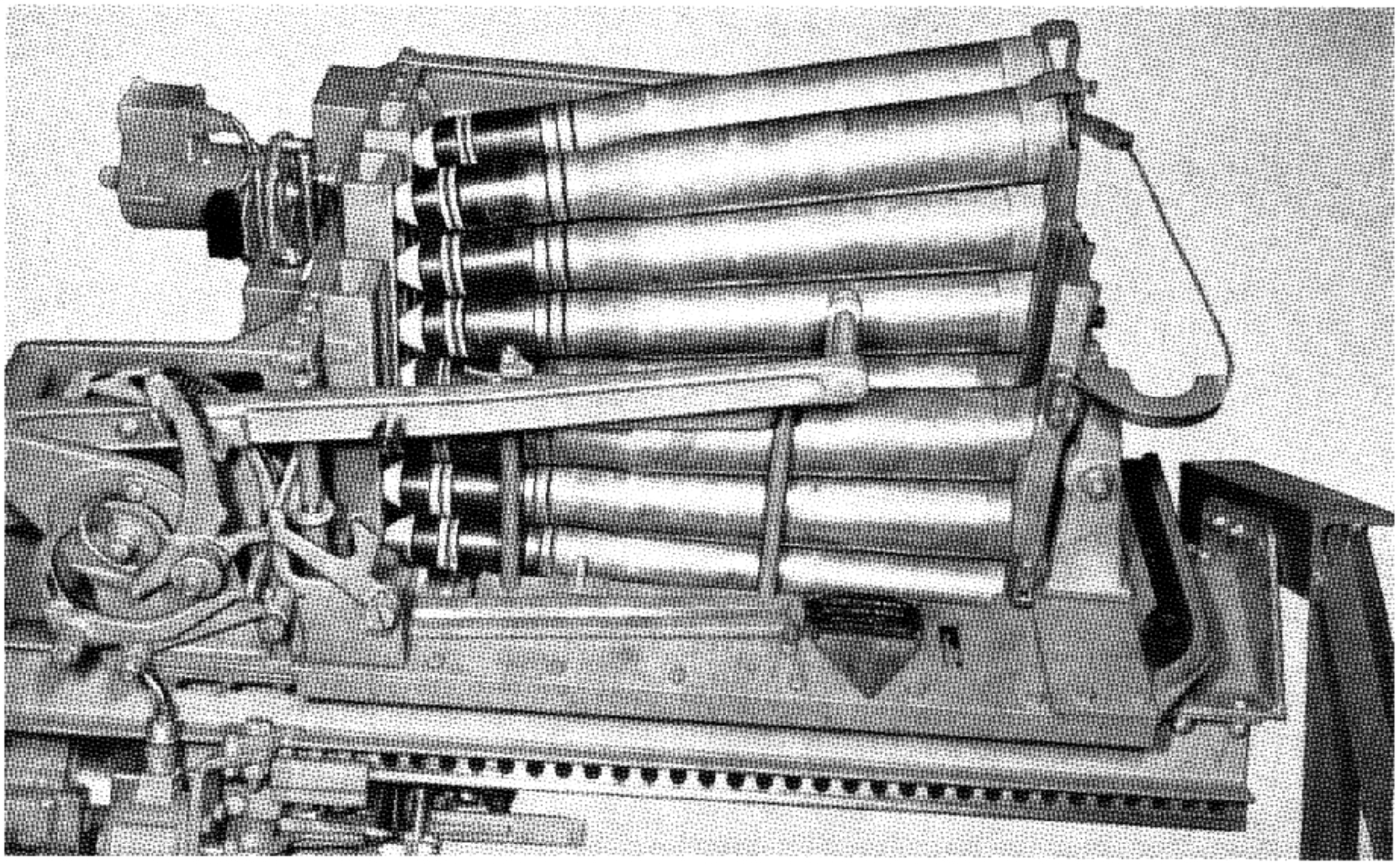


Figure 17–4. British 57-mm Automatic Aircraft Cannon. Closeup view of automatic loader, with ammunition.

Action of the Automatic Loader

Action of the Feed Mechanism During Recoil. When the magazine is loaded, the bottom round in the feedway is positioned with the nose of the shell resting against the retaining lever and the cartridge case resting against the release pawl link and displacing the bronze stop pawl. The round is retained in this position by the weight of the rounds above and the pusher arm, the second round in the feedway bearing directly on the first round. The separator connecting rod is in the rear position and is engaging the rammer release pawl, and the connecting rod end has moved the release pawl link so that it projects into the feedway to hold the first round. The check lever pusher is engaging the cartridge rim check lever to hold the lever clear of the base of the cartridge case. The magazine regulator is in its normal position, ready to engage the first round when this is pushed down by the feed arm shaft.

As the gun recoils, the left-hand roller of the separator rides along the left-hand cam track and the right-hand roller along the right-hand cam track, the separator spring maintaining the contact between the left-hand roller and the cam track until the right-hand roller comes into operation.

After the gun has recoiled about 4½ inches, the separator begins to rotate and lift the driving arm, the movement of the separator being controlled by the rollers and the separator spring. The movement of the separator causes the connecting rod to move to the front, the connecting rod end rotating the rammer release pawl link away from the cartridge case. The lug on the connecting rod end moving away from the rammer release pawl allows the rammer release pawl spring to react and rotate the release pawl, ready to reengage the rammer. The check lever pusher moves away from the cartridge rim check lever and allows the rim check lever to pivot under the influence of its spring, the rim check lever passing over the top of the first round and toward the second round.

After the gun has recoiled about 9 inches, the rammer release pawl is fully revolved and ready to

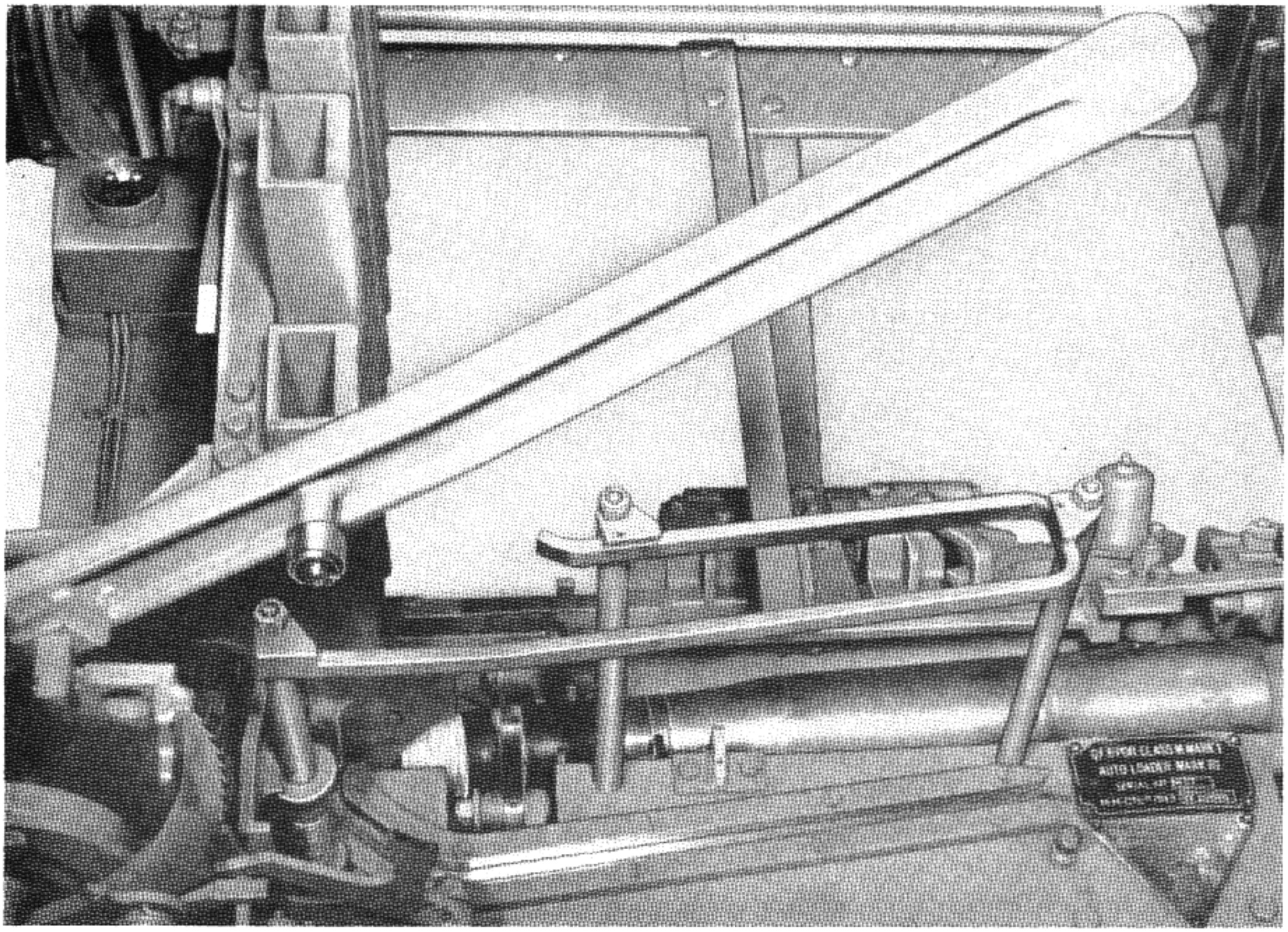


Figure 17–5. British 57-mm Automatic Aircraft Cannon. Oblique view of round in feeding position.

engage and hold the rammer. The rammer release pawl link is entirely clear of the first round, and the cartridge rim check lever has completed its movement and is holding the base of the cartridge case of the second round. At about this time, the separator driving arm commences to lift the retaining lever which lifts the check lever, the retaining lever moving clear of the nose of the first round. At the same time, the feed-arm shaft roller rides down the left-hand cam track and the feed arm spring rotates the feed-arm shaft. The feed arm in rotating carries the retract pawl and the feed pawl into the feedway toward the first round, the pawls passing under the second round.

When the gun has recoiled about 14 inches, the separator driving arm has lifted the retaining lever entirely clear of the nose of the first round, the round retaining pawl preventing the round from lifting during the upward movement of the separator driving arm. The feed-arm shaft has continued to rotate under the influence of its spring and has pushed the first round to the right and downward until the nose of the shell is resting between the check lever, which has been lifted by the retaining lever and the left-hand nose guide. The base of the cartridge case is resting between the magazine regulator and the cartridge rim guide. The stop pawl, reacting as the round moves down, engages over the top of the cartridge case to prevent this from lifting. The pressure of the pusher arm on the rounds and the weight of the rounds themselves, if there is no negative *g* force being applied, causes the second round to follow the first, the nose of the shell resting on the first round and the base of the cartridge case against the cartridge rim check lever. (At about this time, the rammer slide pawl is disengaged from the ram-

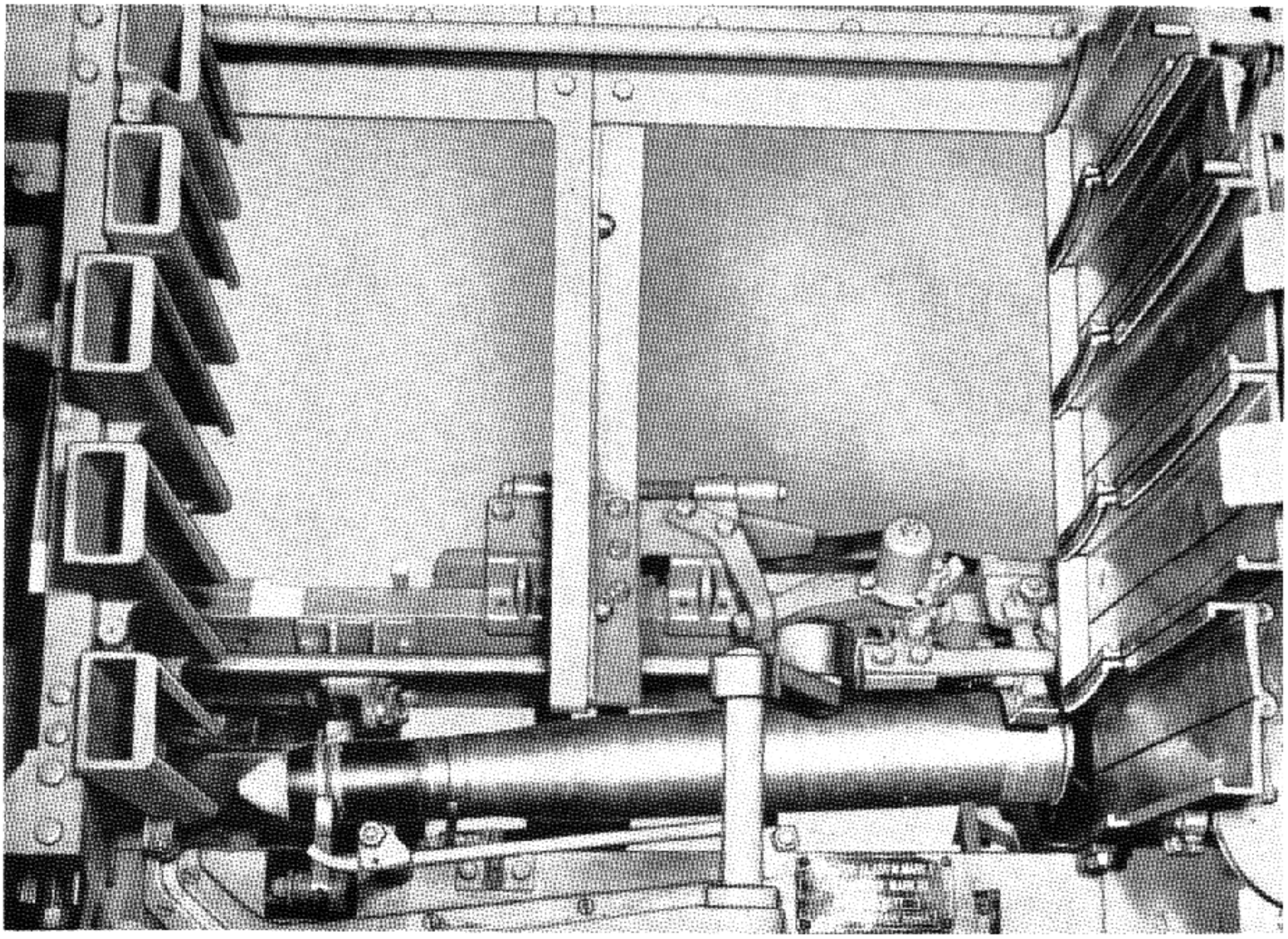


Figure 17–6. British 57-mm Automatic Aircraft Cannon. Vertical view of round in feeding position.

mer slide and the rammer slide is engaged and held by the release pawl.) The gun continues to recoil but no further movement of the above components takes place.

Action of the Feed Mechanism During Runout. During the first part of runout, no movement takes place in the feed mechanism. When the gun is about 14 inches from the firing position, the feed arm shaft roller commences to ride up the left-hand cam track and rotate the feed arm shaft. This action carries the retract pawl and feed pawl away from the first round and back to their normal positions. As the pawls pass the second round, their springs are compressed but react when the pawls are clear to reposition the pawls ready to engage the round on the next recoil stroke. The left-hand roller of the separator commences to ride up the left-hand cam track and rotate the separator, compressing the separator spring. The separator driving arm moves downward and, engaging the retaining lever, pushes the retaining lever and the check lever downward. This action clears the check lever from the nose of the first round, which drops on to the top of the breech ring when the gun is about 6 inches from the firing position. The retaining lever being brought into contact with the nose of the second round prevents this from following the first round on to the breech ring.

In the meantime the breech has been opened by the semiautomatic gear.

Further movement of the gun toward the firing position allows the nose of the round to drop on to the top of the breechblock, the nose guides preventing the round from rolling to the left or right. The first round is now inclined at an angle with the nose of the shell resting on the top of the breechblock and

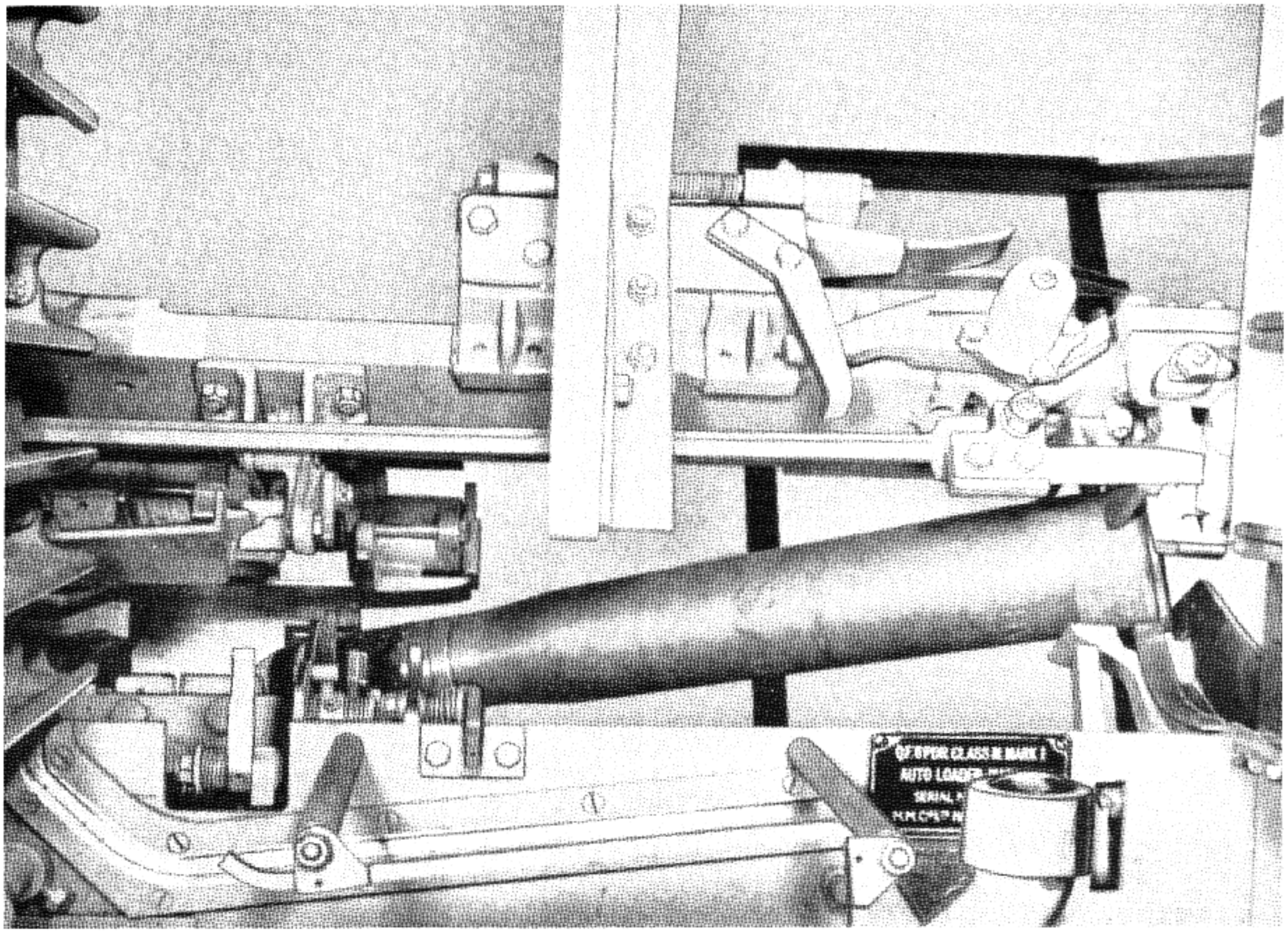


Figure 17-7. British 57-mm Automatic Aircraft Cannon. View through magazine showing round released from feedway into ramming position.

the base of the cartridge case supported between the magazine regulator and the cartridge rim guide, from which position it is rammed home toward the end of runout.

While this action of the separator is taking place, the connecting rod moves to the rear and the connecting rod end rotates the rammer release pawl link into position ready to engage the cartridge case of the second round when the round is released from the cartridge rim check lever. The lug on the connecting rod end, engaging the rammer release pawl, causes the rammer release pawl to pivot, compressing its spring and releasing the rammer which is returned by its springs to ram home the round. The check lever pusher engaging the cartridge rim check lever pushes this clear of the second cartridge case, which drops against the release pawl link as the first round is rammed home.

The second round is now in the position which was occupied by the first round, resting against the retaining lever and the rammer release pawl link, and the bottom round in the left-hand pair of clips is pushed into the feed way by the magazine pusher arm to take the place of the second round.

Action of the Rammer on Recoil. When the gun recoils, the rammer slide pawl engaging the rammer slide pushes the rammer to the rear. The rammer slide, being connected to the return spring rods plate by the return spring pawl, pulls the rods to the rear and compresses the rammer return springs.

When the gun has recoiled about 12 inches, the rammer slide pawl roller contacts the end of the ramp, on the underside of the slide channel, and

causes the rammer slide pawl to pivot. By the time the gun has recoiled about 15 inches, the rammer slide pawl is completely disengaged from the rammer slide. By this time the rammer slide has passed the rammer release pawl. The slide is returned by its spring ready to engage and hold the rammer as soon as the rammer slide pawl is disengaged by the ramp, the rammer slide being brought into engagement with the rammer release pawl by the rammer return springs. During this part of the recoil, the rammer arms have been kept in a vertical position by the extension and stud on the front arm, engaging the underside of the arm guide and hinge guide, respectively. When the rammer release pawl engages the rammer slide, the extension and stud are clear of the arm guide and hinge guide and the rammer arms are free to pivot.

As the gun continues to recoil, the rammer lifting cam, engaging the rammer front arm, lifts the arms and rammer claw, the movement being completed by the time the gun has recoiled about 24 inches. The rammer claw engages the rammer catch, on the underside of the channel spacing bracket, and no further movement of the rammer takes place during the remainder of recoil.

Action of the Rammer on Runout. No movement of the rammer takes place until the gun is about 9 inches from the firing position, when the rammer release pawl begins to pivot under the action of the separator and its connecting rod, being completely disengaged from the rammer slide when the gun is about 4 inches from the firing position.

As soon as the rammer release pawl is disengaged from the rammer slide, the rammer return springs

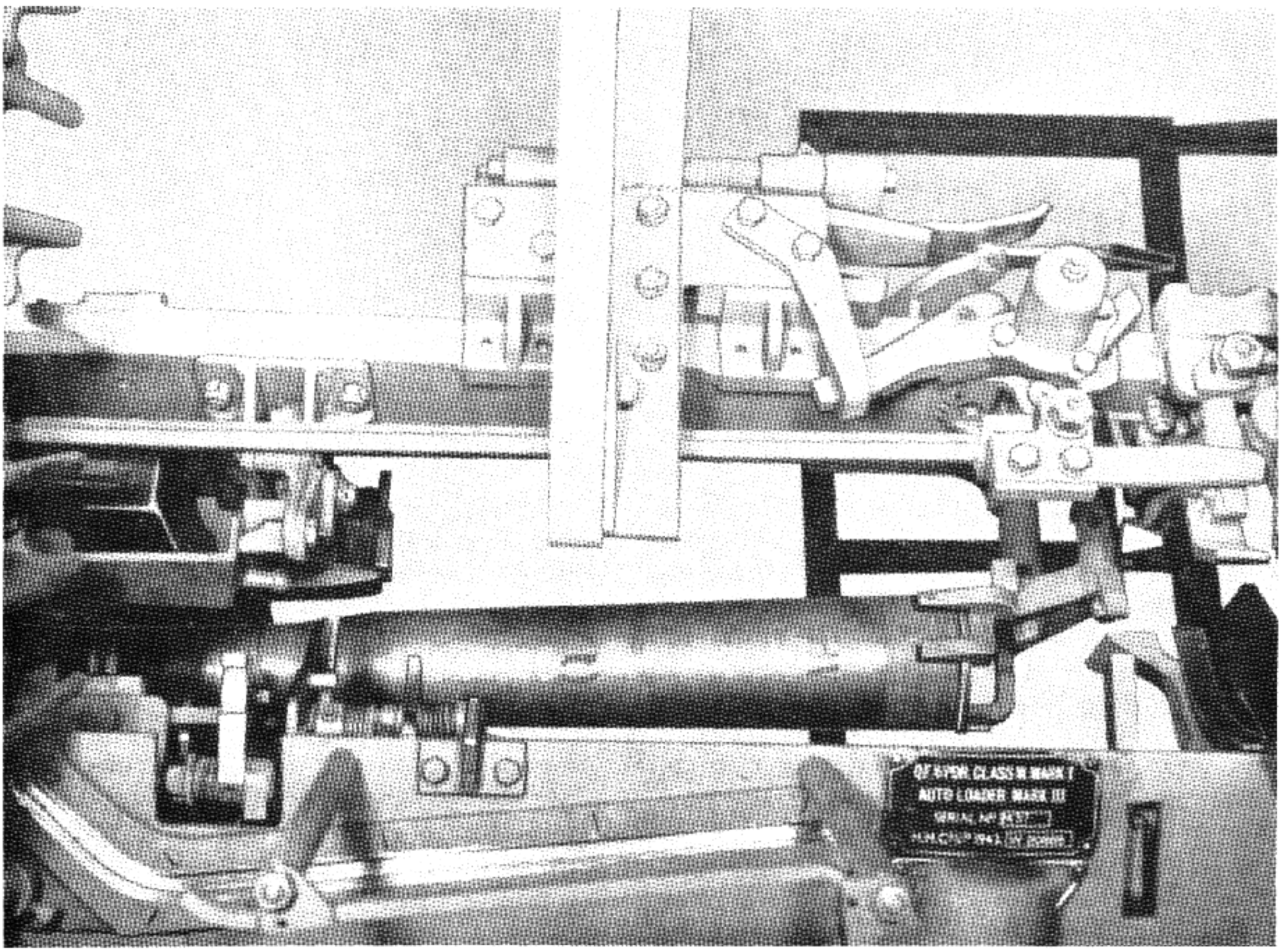


Figure 17–8. British 57-mm Automatic Aircraft Cannon. View through magazine showing round cleared from feedway by rammer.

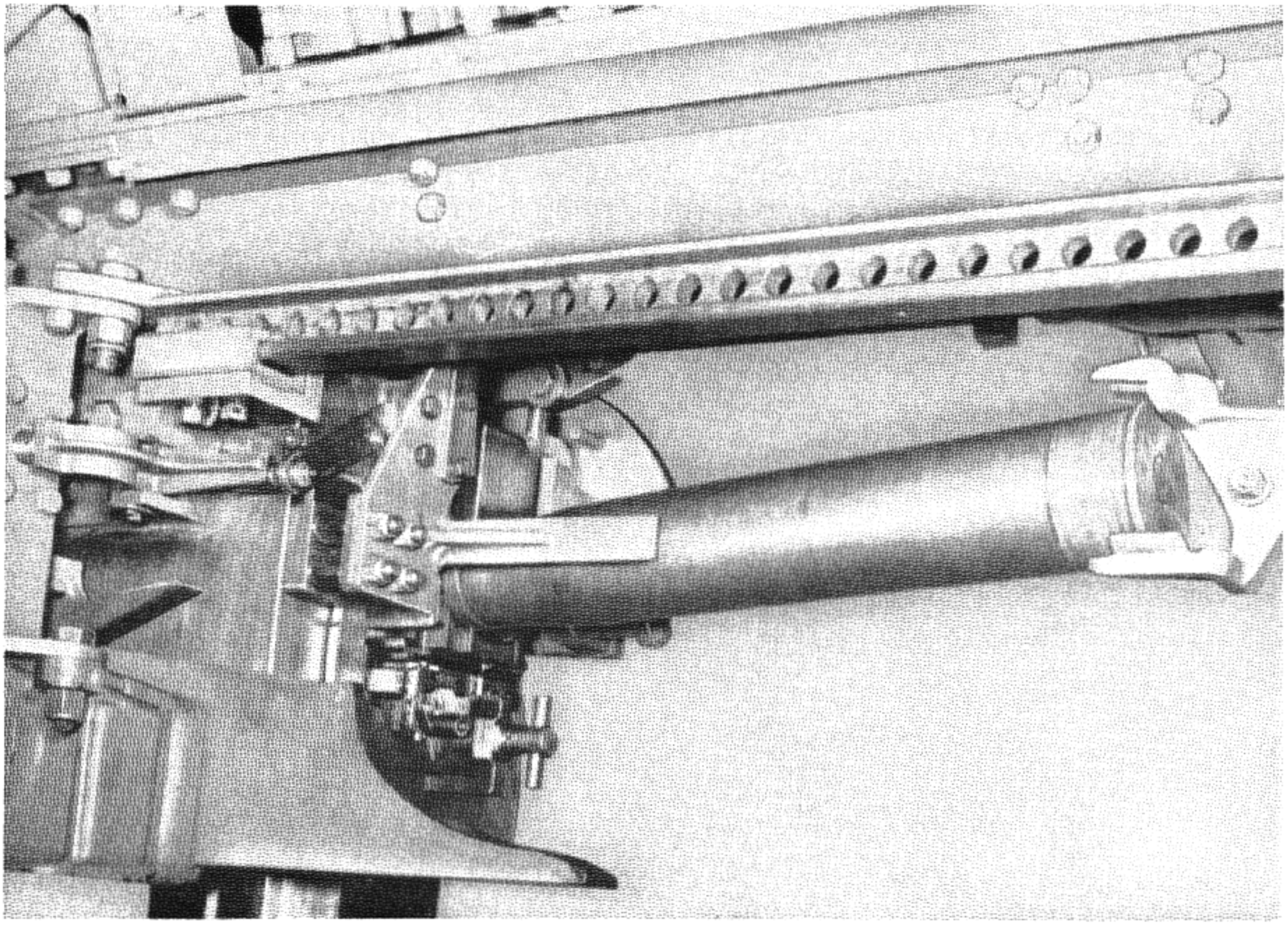


Figure 17–9. British 57-mm Automatic Aircraft Cannon. Left side view of breech showing ramming.

react and pull the rammer to the front. During the first few inches of its travel, the rammer retains its horizontal position, due to its engagement with its catch and to the front arm extension stud which rides along the top of the hinge guide at the rear. This movement enables the rammer claw to become accommodated around the base of the cartridge case of the first round. A projection on the right of the rammer claw now disengages the magazine regulator from the base of the case, and the stud on the front arm extension contacting an inclined piece on the hinge guide pushes the guide outward to release the rammer arms. The rammer swings down to the vertical position bringing the round into line with the chamber, the vertical position of the rammer being maintained by the extension and stud on the front arm engaging the underside of the arm guide and hinge guide. The rammer continuing to move forward, under the influence of its return springs, rams the round into the chamber. The force of the blow of the rammer at the end of the stroke is taken on the shock absorber. The loading of the round closes the breech.

Action of the Pusher Arm, Brake, and Drive Mechanism. When the magazine is loaded, the pusher arm roller bears on the top round in the left-hand pair of clips, in which position it is retained by the ratchet pawl engaging the ratchet lever. The engagement between the ratchet pawl and the lever is maintained by the ratchet lever spring. The cut-away portion of the pusher arm lifting cam is underneath the cam roller, providing a clearance for the downward movement of the pusher arm, and the ratchet lever cam clears the stud on the ratchet lever. The brake is ON, the notch in the brake bar engaging the projection on the front of the left-hand

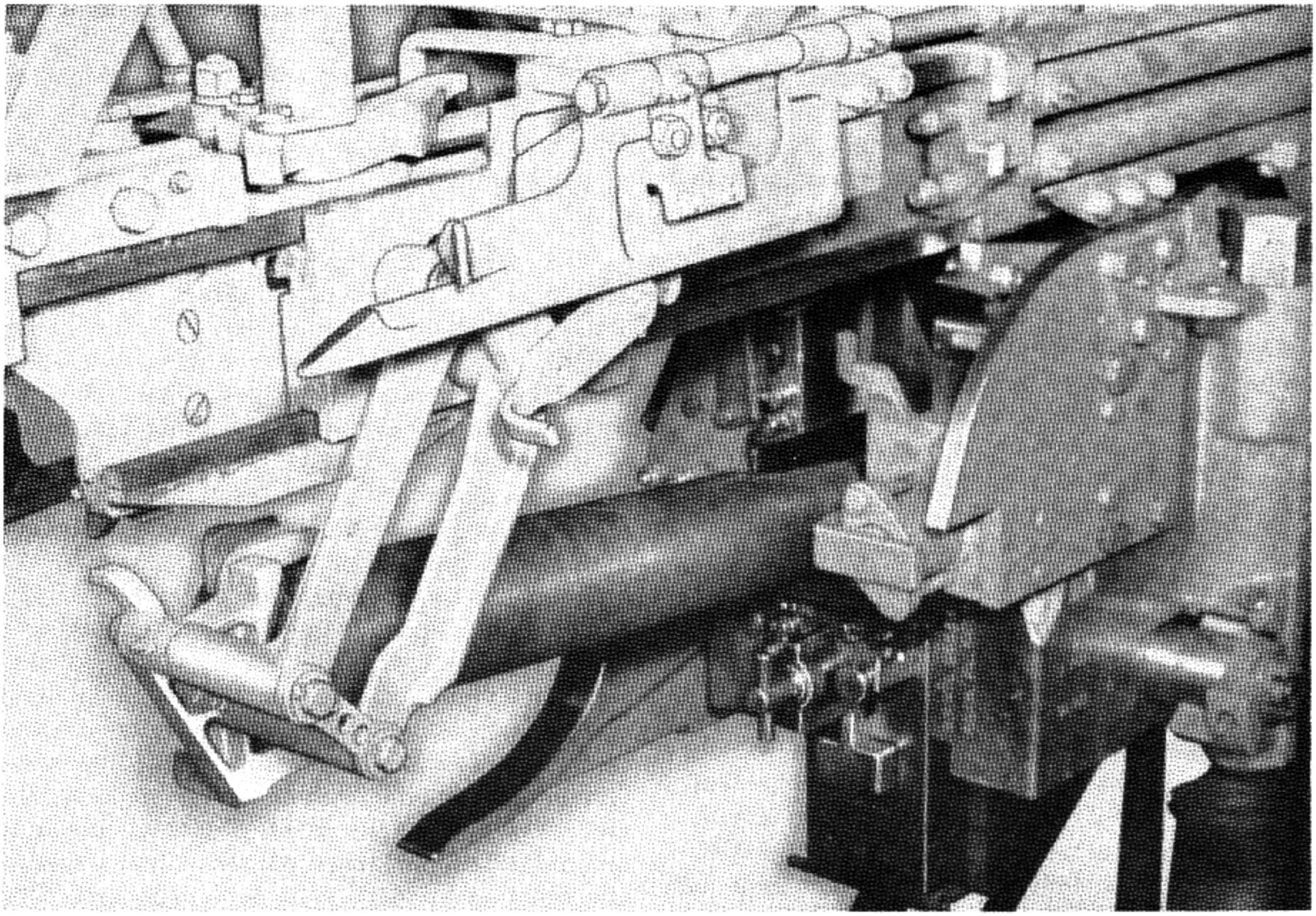


Figure 17–10. British 57-mm Automatic Aircraft Cannon. Right side view of breech showing ramming.

shell clip. The switch is OFF. The depressor arm rests on the top of the brake bar and the safety lever bears against the underside of the brake bar. The safety lever is prevented from moving by the projection at the front end of the ratchet lever engaging the small bracket on the extension of the safety lever, and by the locking lever which is held in the AUTO position by its spring-loaded plunger. The safety lever thus prevents any tendency of the brake bar to move downward and prematurely close the motor switch.

As the rounds are loaded into the gun from the feedway, the pusher arm spring causes the pusher arm to push the rounds in the left-hand pair of clips downward until the last round has passed from the clips into the feedway. When the pusher arm reaches the end of its downward stroke, the ramp at the bottom of the ratchet lever teeth is engaged by the ratchet lever pawl, and the ratchet lever pivots forward slightly; the movement disengages the ratchet lever teeth and brings the stud on the inside of the ratchet lever into position ready to be engaged by the ratchet lever cam and also disengages the projection at the front end of the ratchet lever from the safety lever which falls away from the brake bar. The depressor roller engaging the depressor arm causes this to pivot forward and its front end to press downward on the brake bar and disengage the brake bar from shell clip, further compressing the brake bar spring. As soon as the brake bar is disengaged, the switch bar spring moves the brake bar and switch bar to the left, releasing the brake and closing the motor switch.

The motor now drives the coupling shafts which, through the spiral gears, drive the shell and cartridge clip drive shafts, causing the Acme bearings to travel to the left and move the next pair of full clips toward the feedway and the empty pair toward the clip

tracks. At the same time, the gear on the end of the shell clip drive shaft drives the pusher arm cam gear and the lifting cam, which in turn engages the cam roller. As soon as the depressor arm is freed by the lifting of the pusher arm, the brake bar spring tends to lift the brake bar but is prevented from so doing by the projection on the front of the empty shell clip.

When the projection on the front of the empty shell clip is clear, the brake bar is lifted by its spring ready to engage the projection on the front of the next shell clip. When this engagement takes place, the brake bar is forced to the left extending the switch bar spring and carrying with it the switch bar. The movement of the switch bar to the left opens the switch and compresses the brake spring, which reacts on the spring rod and applies the brake to stop the drive and arrest the movement of the shell and cartridge clips. The next pair of full clips are now in position ready for feeding, and the cutaway portion of the pusher arm lifting cam is once more under the pusher arm roller. As the roller leaves the end of the lifting cam, the pusher arm spring brings the presser clear of the stud, and the ratchet lever spring returns the ratchet lever to bring the teeth into engagement with the ratchet lever pawl. The front end of the ratchet lever engaging the small bracket on the front of the safety lever causes the safety lever to pivot slightly and bring its rear end once more into contact with the under side of the brake bar to lock this against premature disengagement.

PRECAUTIONS. The handling of ammunition must be done with great care, especially when actually loading or unloading the magazine. After the safety clips have been removed, the hand must be placed over the base of the cartridge case to afford maximum protection to the primer cap. The safety clip must be replaced as soon as a round is unloaded.

Two men are required to load the gun: one stands inside the gun bay to the port of and facing the installation and does the actual loading; the other removes the ammunition from the containers, takes off the safety clips, and hands the rounds one at a time to the loader. The reverse procedure is adopted when unloading.

All coating must be removed from the ammunition before it is loaded. Two special decoppering rounds must be loaded into each magazine. Both the decoppering rounds and their ammunition boxes are marked "D. E. C."

Be sure that the gun is pointing in a safe direction, all personnel being warned to keep clear of the front of the aircraft.

Action of the Recoil and Recuperator Systems

When the gun and slipper recoil, the buffer cylinder, which is attached to the slipper, recoils with it while the piston, which is attached to the cradle, remains stationary. The piston head is at the rear of the buffer cylinder when the gun is in the firing position, the space in front of the piston head being filled with oil.

During Recoil. The movement of the buffer cylinder causes the oil in front of the piston head to be forced through the longitudinal grooves in the buffer cylinder to the rear of the piston head. The work done in displacing the oil absorbs a portion of the recoil energy. As the greatest cross-sectional area of the grooves is at the rear, the least opposition to the passage of the oil takes place at the commencement of recoil, when the energy of recoil is greatest. As the buffer cylinder continues to move, the tapered grooves move past the piston head and present a diminishing opening to the oil; the oil flow is gradually restricted, resistance to motion increases, the energy of recoil is gradually absorbed, and the gun is brought to rest. The movement of the buffer cylinder draws the rear plug cylinder and throttle bushing off the control plunger, and oil enters the rear plug cylinder to take the place of the control plunger. At the same time, the runout springs compressor compresses the runout springs against the buffer cylinder bearing and the rest of the recoil energy is absorbed by the runout springs.

During Runout. As soon as the gun is brought to rest the runout springs reassert themselves and return the gun to the firing position. The oil behind the piston head now flows through the grooves in the buffer cylinder to the front, the runout being practically uncontrolled until the control plunger enters the control chamber. When the control plunger enters the throttle bushing and the rear plug cylinder, the oil therein is displaced and escapes over the tapered flat on the plunger and through the holes in the runout adjusting valve. The tapered flat gradually arrests the escape of oil through the throttle bushing until finally the hole in the bushing

is closed by the rear of the control plunger; at this time, the only passage hole in the bushing is closed by the rear of the control plunger and the only passage open to the escape of oil is past the runout adjusting valve. The last part of the runout is thus controlled, and the gun is gradually brought to rest, the shock as the gun reaches the firing position being absorbed by the bearing face ring packing at the rear of the cradle, which is struck by the lug on the gun slipper.

Action of the Breech Mechanism and Semiautomatic Gear

Opening the Breech, Hand Operation. To open the breech by hand, place the tommy bar in the hole in the rack pinion and press it downward until the breechblock is held by the extractors.

As the rack pinion is actuated, it rotates the actuating shaft and also causes the rack to move upward and further compress the actuating spring against the spring cap. At the same time, the roller on the end of the actuating shaft, engaging the under side of the breech cam, lifts the breech cam which compresses the breech cam spring. The rotation of the actuating shaft rotates the crank, which is feathered to it. The rotation of the crank is in a downward direction and the bosses on the crank, bearing on the bottom of the cocking link recess, lower the breechblock, which moves to the rear slightly by reason of its inclined guides. When the block is almost clear of the base of the cartridge case, the inclined surfaces on its front face, engaging the lugs at the bottom of the extractors, cause them to pivot slightly and unseat the cartridge. As the breechblock clears the base of the cartridge case, the shoulders on its front face strike the lugs on the extractors a sharp blow, causing the extractors to pivot and eject the empty case from the chamber. The downward movement of the breechblock is arrested when the crank meets the breech ring. When the pressure is removed from the tommy bar, the actuating spring reacts and lifts the breechblock into engagement with the hooks on the extractors, which will hold the breechblock open until a round is loaded or until the hooks are released by hand.

Opening the Breech, Automatic Operation. When the gun fires, it recoils. The recoil takes place in approximately 0.25 second, the runout taking place in approximately 0.75 second. As the gun recoils, the actuating shaft roller rides against the underside of the semiautomatic cam and lifts it upward. The semiautomatic cam lifts the breech cam which compresses the breech cam spring. When the roller leaves the end of the semiautomatic cam, the breech cam spring reasserts itself and repositions the cams ready for the runout stroke, the semiautomatic cam resting on the stop at the rear of its bracket.

During the runout movement, the actuating shaft roller meets and rides up the semiautomatic cam, causing the actuating shaft, crank, and rack pinion to rotate. The engagement between the actuating shaft roller and the semiautomatic cam takes place when the gun is about 18 inches from home. The rotation of the crank is in a downward direction; and the bosses on the crank, bearing on the bottom of the cocking link recess, lower the breechblock, the breechblock moving to the rear slightly by reason of its inclined guides. When the breechblock is almost clear of the base of the cartridge case, the inclined surfaces on its front face, engaging the lugs on the extractors, exert a powerful leverage on the extractors, causing them to pivot and eject the empty cartridge case from the chamber. The downward movement of the breechblock is arrested when the crank meets the breech ring.

The rotation of the rack pinion causes the rack to move upward and further compress the actuating spring against the spring case cap. After it has opened the breech, the actuating shaft roller travels along the top of the semiautomatic cam and then engages under the breech cam to lift this and further compress the breech cam spring. When the actuating shaft roller reaches the front of the semiautomatic cam, the breechblock is lifted by the springs into engagement with the hooks on the extractors which hold it in the open position against the weight of the springs.

Closing the Breech. The breech is always closed when a round is loaded, no matter whether it has been opened by hand or automatically.

When the round is loaded into the gun, the rim of the cartridge case engages the extractor lips, the extractors are forced forward causing their hooks to be disengaged from the stops on the front of the breechblock, and the breechblock is free to close. The actuating spring, reasserting itself, forces the rack downward, the movement of the rack being transmitted through the rack pinion to the actuat-

ing shaft which rotates the crank. The rotation of the crank is in an upward direction; and the bosses on the crank, bearing against the top of the cocking link recess, raise the breechblock to the closed position. The breech cam spring assists the actuating spring to close the breech by reacting on the breech cam, which bears on the actuating shaft roller.

During the upward movement of the breechblock, the bevel on the top and the forward movement of the block due to the inclined guides cause the cartridge to seat in the chamber, the upward movement of the block being limited by the stops at the bottom of the guides engaging the breech ring. After the breech is closed, the crank, by reason of the flats on the top and the concentric surface at the top of the cocking link recess, continues to move forward until its movement is arrested by the breech ring. This forms a positive lock, as any tendency of the breech to open accidentally would press the crank harder against the breech ring.

Action of the Striker and Firing Mechanism

Cocking. As the crank rotates to the rear on opening the breech, it travels in the concentric portion of the cocking link recess and no movement of the breechblock takes place. The cocking link actuating pin, however, moving in the hole in the cocking link, forces the cocking link to the rear. The cocking link, engaging the lower arm of the striker sleeve, forces back the striker sleeve and striker spindle, compressing the main spring and withdrawing the firing pin inside the firing-hole bushing. The continued movement of the crank in opening the breech forces the cocking link further to the rear, and the cocking sleeve and the striker spindle are brought to the cocking position. The sear spring now moves the trigger sear to the left to engage the upper arm on the cocking sleeve and hold the striker in the cocked position. As the breechblock moves downward, the recess in the breechblock moves away from the firing lever flange and the stop piece moves away from the end of the locking lever. The locking lever is returned by its spring and engages the bottom of the slot in its bracket to lock the firing lever against operation. As the crank rotates to the front on closing the breech, the cocking link moves away from the cocking sleeve, but the cocking link would be in a position to prevent the striker from going fully forward, until after the breechblock is home, because of the idle movement of the crank in the concentric. When the breechblock is home, the locking lever is lifted clear of the bottom of the slot in its bracket by the stop piece and the firing lever, the flange of which is now opposite the recess in the breechblock, is free.

Firing. When the firing button is pressed, the firing solenoid is energized and the bell-crank operating lever is actuated by the solenoid plunger. The bell-crank lever, pivoting about its pin, engages the end of the firing lever arm and pushes the arm to the right, the flange on the firing lever entering the recess in the breechblock. The firing lever arm engages the trigger sear and pushes this to the right also, compressing the trigger sear spring. The trigger sear is released from engagement with the cocking sleeve, and the main spring drives the striker spindle forward; the firing pin protrudes through the hole in the firing-hole bushing to strike and fire the primer. The gun recoils, the bell-crank lever is disengaged from the solenoid plunger after being returned with the firing lever by the firing lever plunger and spring. The flange on the firing lever is disengaged from the recess in the breechblock and, as the breechblock opens on runout, the stop piece moves away from the end of the locking lever, allowing the locking lever to be returned by its spring to engage the bottom of the slot in its bracket and lock the firing lever against operation.

The striker is cocked during the opening of the breech as previously described and, if the pressure is maintained on the firing button, the above cycle will be repeated, the breech being closed at the end of runout by the loading of a round.

Safety Arrangements. Unless the breech is properly closed, the gun cannot fire for the following reasons:

1. The flange on the firing lever is not opposite its recess in the breechblock, and the locking lever will be engaged with the bottom of its slot and will lock the firing lever; therefore, the firing lever cannot be operated to release the sear.

2. The crank will not be at the front of its recess in the breechblock, and the cocking link will, therefore, prevent the cocking sleeve and striker spindle from going fully forward.

3. The firing pin will not be in line with the primer.

Even when the breechblock is home, the gun cannot be fired unless the crank is right home, because unless the crank is at the front of its recess the cocking link will prevent the cocking sleeve and striker spindle from going fully forward.

SECTION 3. PRECAUTIONARY CHECKS

Visual Checks Prior to Loading

Insure that all switches are OFF and that the batteries are connected.

Set the brake bar locking lever to HAND, press the ratchet lever forward, raise the pusher arm and rest it on the support at the top of the ratchet lever, insuring that the notch engages the ratchet pawl.

Operate the handle clutch until all the ammunition clips are within the magazine.

Lift the pusher arm, press the ratchet lever forward, lower the pusher arm, and allow the ratchet pawl to engage the tooth at the top of the ratchet lever. Do not release the pusher arm.

NOTE. From here on, the pusher arm must be held against the weight of its spring; otherwise damage to the mechanism will result.

Cock the feed by lifting the cocking lever, insuring that the brake bar engages the projection on the front of the left-hand shell clip. Set the brake bar locking lever to AUTO.

Switch ON the gun master switch.

Carefully lower the pusher arm until it operates the depressor arm, holding it so that the hand is clear of the box guide. Maintain the hold on the pusher arm as it is lifted by the cam and then lower it, ready to engage the top tooth on the ratchet lever.

Repeat preceding paragraph until the clips have moved through a complete cycle, then switch OFF the gun master switch and lower the pusher arm.

Loading the Magazine and Gun

Insure that the main switch is OFF and the firing button at SAFE.

Open the gun-bay doors and secure the rear struts.

Test the efficiency of the retract lever, shell retainer, pawl, and stop springs by depressing the components and observing that the springs react and that the movement of the component is not sluggish.

Open the breech using the tommy bar, and insure that the breechblock is held by the extractors. Remove the tommy bar and place it in its housing at the rear of the magazine.

Set the safety catch of the striker to SAFE.

Set the brake bar locking lever to HAND.

Press the ratchet lever forward and raise the pusher arm. Rest the pusher arm on the support at the top of the ratchet lever, and insure that the notch engages the ratchet pawl.

Operate the handle clutch and wind back the shell and cartridge clips until there are three pairs of clips in position on the right of the feedway. If the gun is removed from the airplane, all the clips should be brought into position.

Carefully place 3 rounds in the right-hand pair of clips, then place 4 rounds in the second pair of clips and 5 rounds in the third pair of clips. The last round in the third pair of clips must be a special decoppering round. The decoppering rounds are marked "D. E. C." Insure that the noses of the top rounds are under the retainer plates and the bases of the cartridge cases under the catches.

Operate the handle clutch until all clips are in position inside the magazine.

Place five rounds in the fourth pair of clips. Insure that the nose of the top round is under the retainer plate and the base of the cartridge case under the catch.

Pass the next round through the last pair of clips and press the round into the feedway until the nose of the shell rests against the retaining lever and the cartridge case against the release pawl link, then place another round on the top of this one, and then four rounds in the last pair of clips. The last round in the last pair of clips must be a special decoppering round.

NOTE. There should now be 21 rounds in the magazine and 2 rounds in the feedway.

Lift the pusher arm, press the ratchet lever forward and carefully lower the pusher arm until the presser roller rests upon the top cartridge.

Lift the cocking lever to position the brake bar and safety lever, insuring that the brake bar engages the projection on the front of the left-hand shell clip.

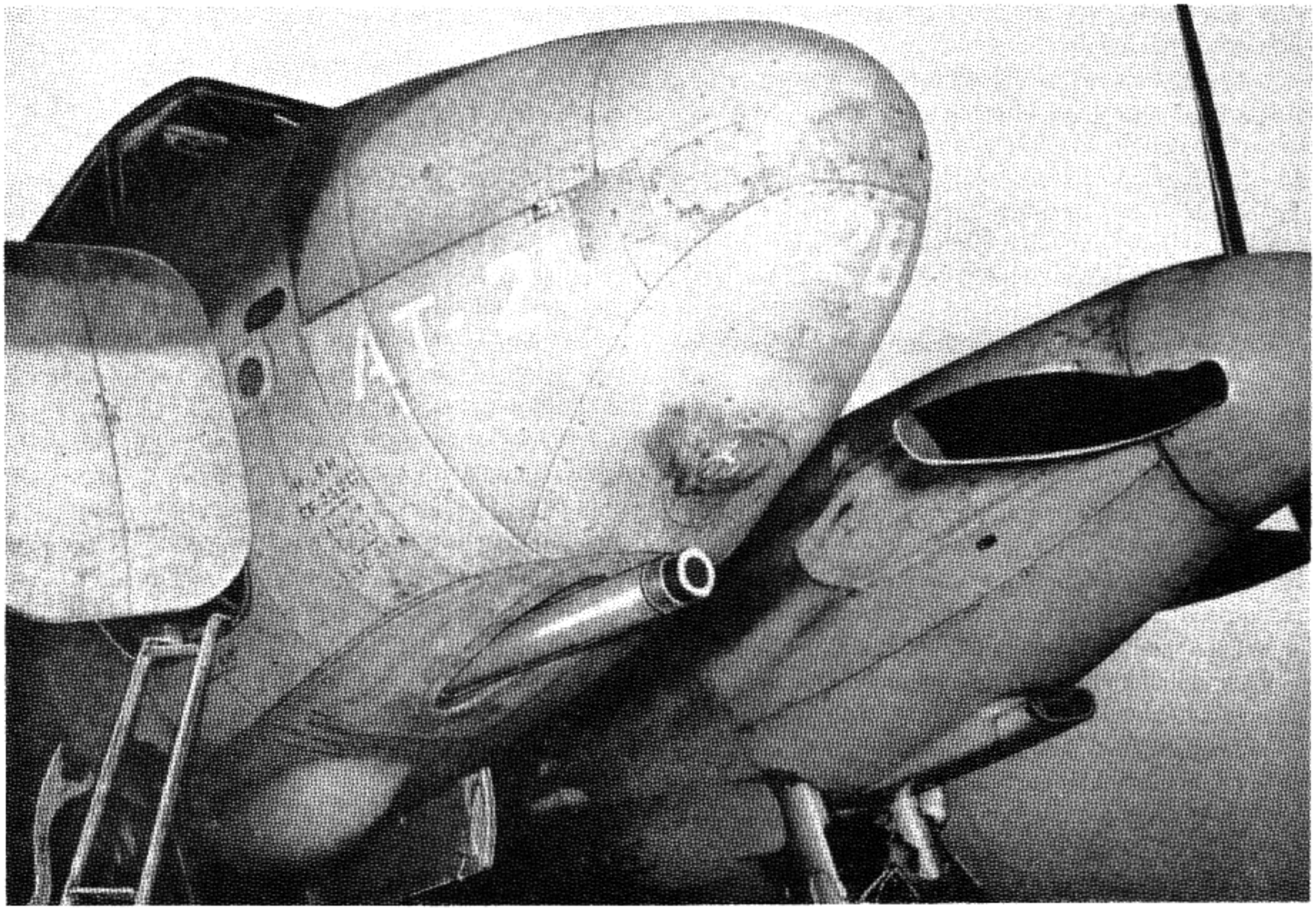


Figure 17–11. British 57-mm Automatic Aircraft Cannon mounted in an aircraft.

Set the locking lever to AUTO and insure that the extension on the front of the ratchet lever engages and locks the safety lever.

Just prior to takeoff of the aircraft, disengage the rammer slide from the spring rods plate by withdrawing the plunger and lifting the rammer return springs pawl, and slide the rammer to the rear. Place the nose of a round on the top of the breechblock and engage the base of the cartridge in the rammer claws. Place the hand behind the rammer and push it forward to load the round and close the breech.

Insure that the breech is fully closed by applying the tommy bar to the rack pinion and lifting it upward.

Engage the rammer return springs pawl with the spring rods plate and insure that the plunger engages its recess.

WARNING. The round must not be loaded in the gun until just before takeoff of the aircraft.

Set the safety catch of the striker to FIRE and close the gun bay doors.

Unloading the Gun and Magazine

WARNING. The gun must be unloaded as soon as the aircraft lands.

Insure that the firing button is set to SAFE and that the main switch is OFF.

Set the safety catch of the striker to SAFE.

Disengage the rammer return springs pawl and slide the rammer to the rear.

Open the breech carefully, using the tommy bar, and receive the live round as it is ejected.

WARNING. Do not open the breech too quickly, otherwise the live round may be thrown clear with possible danger of the primer being struck and the round fired.

Set the brake bar locking lever to HAND.

Press the ratchet lever forward and raise the pusher arm. Rest the pusher arm on the support

at the top of the ratchet lever and insure that the notch engages the ratchet pawl. Remove the rounds from the left-hand pair of clips and from the feedway.

Remove the rounds from the remaining clips in order. If it is not possible to empty the right-hand pair of clips because of fouling the aircraft structure, the clips should be wound to the left by operating the handle clutch.

Inspect the bore to see that it is clear.

Release the extractors from engagement with the breechblock by taking the weight of the actuating spring with the tommy bar and pressing the extractor lugs upward from the underside of the breech ring. Allow the breechblock to close by easing the pressure on the tommy bar. Remove the tommy bar and place it in its housing at the rear of the magazine frame.

Set the striker safety catch to FIRE and operate the bell-crank lever by hand to ease the striker.

If the breech is closed, examine the gun to see:

1. If it is properly run out or not.

2. If the gun is properly run out, inspect to see if the breechblock is right home and whether the striker has been released or not. (This will have been indicated by failure to set the safety catch to SAFE.)

If the gun is not properly run out, the striker will be cocked due to failure of the solenoid plunger to engage the bell-crank operating lever, and there will be a live round in the chamber, the stoppage being due to incomplete run-out. Proceed as follows:

1. Unload the gun.

2. Push the gun into the firing position and check the recoil. Take necessary action.

If the gun is run out, but the breechblock is not right home, the striker will be cocked due to the firing lever being inoperative and there will be a live round in the chamber. The stoppage is probably due to fouling in the chamber, fouling on the breechblock, or breech ring, or to a weak breechblock actuating spring. Proceed as follows:

1. Unload the gun.

2. Remove the breechblock; clean the chamber; clean the breechblock, paying particular attention to the front face and the cocking link recess, clean the breech ring; and test the breech mechanism actuating spring and adjust as necessary.

If the gun is run out and the breech is closed, but the striker is cocked, there will be a live round in the chamber. The stoppage is due to a fault in the firing mechanism. Proceed as follows:

1. Unload the gun.

2. Test the firing mechanism and take necessary action.

If the gun is run out, the breechblock closed, and the striker released, there will be a live round in the chamber, the primer cap of which has probably been struck. The stoppage is due to a misfire. Proceeds as follows:

1. Unload the gun and inspect the cap to see whether it has been struck or not.

2. If the cap has been struck, the misfire was caused by defective ammunition or by a weak force of blow. Take necessary action.

3. If the cap has not been struck, the misfire was caused by a faulty striker. Remove the striker and examine it for a broken firing pin; clean the striker recess in the breechblock and the striker; gage the protrusion of the firing pin; test the force of blow; take necessary action to correct the fault.

If the breech is open, examine the gun to see—if the rammer is right home; if a round is supported by the rammer and the breechblock; if the rammer is in the extreme rear position.

If the rammer is right home, there will be a loose round on the breechblock, the stoppage being caused by failure to ram with sufficient force to release the extractors due to excessive friction. Proceed as follows: unload the gun; test the rammer slide for freedom of movement by sliding it to and fro along the slide channel, and inspect the slide channel and rammer slide for burrs, which if present must be removed by stoning; clean and lubricate the slide channel and rammer slide.

If the rammer is not right home and there is a round supported by the breechblock and rammer, the stoppage is caused by failure to ram. Proceed as follows:

1. Take the weight off the rammer return springs by pressing against the rammer return springs rod plate with the handle of a mallet and disengage the rammer slide from the plate; release the return springs.

2. Remove the round from the rammer claws and unload. If it is necessary to work the separator

mechanism to clear the jam, take out the split pin and unscrew the gun securing nut. If the gun is not fully run out, the runout adjusting valve should be unscrewed one-sixth turn. Carefully push the gun to the rear by hand and insure that it does not travel more than 30 inches, otherwise there is danger of it slipping out of the cradle. As soon as the round is clear, return the gun to the firing position and replace the gun securing nut and split pin.

3. Inspect the feed mechanism for breakages and damage, and take necessary action.

If the rammer is in the extreme rear position, the stoppage is caused by failure to feed. Proceed as follows:

1. Take the weight off the rammer return springs by pressing against the rammer return springs rod plate with the handle of a mallet and disengage the rammer slide from the plate. Release the return springs.

2. If a round has become jammed in such a position that it cannot be removed until the feed and separator mechanisms are operated, take out the split pin, remove the gun securing nut and push the gun to the rear. Take care to insure that the gun is not allowed to travel more than 39 inches to the rear, otherwise there is danger of it falling out of the cradle. As soon as the round has been cleared, return the gun to the firing position and replace the gun securing nut and split pin. If the gun is not right home, the runout adjusting valve should be closed to insure that the buffer cylinder does not spring forward with excessive force before removing the gun securing nut.

3. Inspect the magazine and feed mechanism for breakages and damage, and take necessary action.

SECTION 4. PREVALENT MALFUNCTIONS IN RECOIL AND RECUPERATOR SYSTEMS

Faults in the Recoil and the Recuperator Systems

Fault	Cause	Remedy
Violent excessive recoil	Air in buffer cylinder	Release air and refill buffer.
	Insufficient oil	Refill buffer.
	Weak or broken runout springs	Exchange defective springs.
	Piston head worn	Exchange piston.
Short recoil	Damaged gun slipper or cradle slides	Examine and repair.
	Gland packings too tight	Slacken gland; if oil leaks, exchange packing.
Incomplete runout	Adjusting valve incorrectly set	Open the valve.
	Damaged gun slipper or cradle slides	Examine and repair; remove obstructions.
	Defective springs	Exchange springs.
Violent runout	Insufficient oil	Refill buffer.
	Adjusting valve incorrectly set	Close the valve.
	Buffer too full	Drain off 1/36 pint of oil.
Failure to runout	Runout adjusting valve closed	Open valve.
	Defective springs	Exchange springs.
	Gland packing too tight	Push gun to firing position; slacken gland. If oil leaks, exchange the packing.

NOTE. Should the gun fail to run out completely, it is nearly always possible to bring it to the firing position by depressing and pushing it forward; then any necessary adjustment can be made to the runout adjusting valve.

SECTION 5. INSTALLATION, DISASSEMBLY, AND ASSEMBLY

Dismantling and Assembling, Removing and Installing the Gun and Automatic Loader

The removal and installation of the gun and automatic loader must be undertaken when the aircraft is on level ground.

A type D or E bomb trolley should be used as a mobile platform on which to lower the gun and the loader, the breech of the gun and the cradle being rested upon suitable blocks of wood placed across the floor of the bomb trolley.

When the gun is raised or lowered, great care must be taken to insure that the starboard extremity of the automatic loader does not catch on and damage the petrol pipes running down the starboard side of the gun bay.

Removing the Gun and Loader. Insure that the gun master switch is OFF.

Open the gun-bay doors and secure the rear struts.

Unload the gun and close the breech.

Disconnect the electrical supply cable from the automatic loader.

Remove the front detachable panel by undoing the securing screws and sliding the panel forward over the muzzle.

If the gun is to be moved away from the aircraft, position a mobile trolley under the gun bay ready to receive the gun.

Connect the shackle on the end of the lifting cable to the lifting eye of the gun and loader.

Take in the slack of the cable on the winch.

Remove the securing bolts which attach the channel spacing bracket of the loader to the fork end of the vertical rear suspension rod.

Loosen the lateral locknuts on the trunnion mountings and remove the clamping bolts from each of the two trunnion mounting caps so that their lower sections are free to swing downward about their pivots. The weight of the gun and loader is now being taken on the winch cable.

Lower the gun slowly and carefully, steadying and guiding the gun and loader as they descend.

Detach the winch cable from the lifting eye.

Installing the Gun and Loader. Open the gun-bay doors and secure the rear struts.

Remove the front detachable panel.

Run the gun and loader under the gun bay, insuring that it is correctly positioned for lifting, and attach the winch cable to the lifting eye.

Raise the gun slowly and carefully, steadying and guiding the gun and loader into the gun bay.

When the gun is correctly positioned, secure the two trunnion mounting caps with their clamping bolts and tighten the lateral locknuts.

Replace the channel spacing bracket securing bolts to secure the loader to the fork end of the vertical rear suspension rod.

Lock all nuts with new split pins.

Disconect the winch cable from the lifting eye.

Replace the front detachable panel and secure it.

Pulling Back the Gun Body. Place the gun in a horizontal position or at a slight angle of depression.

Disengage the rammer return springs pawl, slide the rammer to the rear, and engage it with its catch.

Take out the split pin and remove the gun securing nut from the rear of the buffer cylinder.

Carefully pull or push the gun body to the rear a distance of not more than 30 inches.

WARNING. Great care must be taken to insure that the 30 inches is not exceeded, otherwise the gun slipper will become disengaged from the cradle. The gun should not be kept in this position longer than is necessary to complete any cleaning or inspection, unless it is supported under the breech ring.

To return the gun to the firing position, carefully push it forward; replace the gun securing nut and the split pin.

Buffer and Recuperator

NOTE. Before any of the following operations can be carried out the gun and automatic loader must be removed from the aircraft.

Removing the Buffer and Recuperator from the Cradle. Place the gun at an angle of depression and secure it to the cradle. Remove the split pin and piston rod nut, and the cradle front cap.

Remove the split pin and the gun securing nut from the rear of the buffer cylinder, using the spanner provided. Remove the buffer and recuperator from the front of the cradle.

Removing the Runout Springs. Remove the buffer and recuperator from the cradle.

Replace the gun securing nut and split pin, and remove the stuffing box key.

Using the spanner provided, unscrew the runout springs compressor, holding the gun securing nut with its spanner to prevent the buffer cylinder from turning.

Remove the runout springs compressor, runout springs, parting plates, and buffer cylinder bearing.

Assembling the Runout Springs. Assemble the buffer cylinder bearing over the front of the buffer cylinder with the flanged portion toward the front.

Assemble the rear parting plate against the bearing, then the left-hand wound spring, a parting plate, and the right-hand wound spring.

Place the front parting plate over the runout springs compressor from the rear, then the other left-hand-wound spring and parting plate.

Smear the threads with graphited lubricating grease, and place the runout springs compressor, as assembled in the previous paragraph, over the front of the buffer cylinder and screw it home, using the spanner provided and holding the gun securing nut with its spanner to prevent the buffer cylinder from turning. Replace the stuffing box key.

Assembling the Buffer and Recuperator in the Cradle. Smear the runout springs with graphited lubricating grease, and remove the gun securing nut if it is in position.

Lubricate the left and right cradle slides with antifreezing grease.

Place the buffer and recuperator in the cradle from the front, taking care not to damage the guide keys on the runout springs compressor when engaging them with the left and right cradle slides. Care must also be taken to insure that the rear of the buffer cylinder is not damaged when passing it through the hole in the gun slipper.

Replace the gun securing nut and split pin.

Replace the cradle front cap and the piston rod nut and split pin.

Breech Mechanism

NOTE. The breech mechanism can be dismantled and assembled with the gun installed in the aircraft.

Dismantling the Breech Mechanism. Apply the tommy bar to the rack pinion and open the breech by pressing the tommy bar downward.

Set the safety catch to SAFE, withdraw the retaining catch plunger, rotate the striker through an angle of 60° to the right, and remove it from the breechblock.

Take the weight of the actuating spring by pressing the tommy bar downward, release the extractors from engagement with the breechblock by pressing the extractor lugs upward from underneath the breech ring. Allow the breechblock to close by carefully easing the pressure on the tommy bar.

WARNING. Never attempt to release the extractors unless the weight of the actuating spring is taken on the tommy bar.

Remove the split pin and actuating shaft nut. Remove the rack pinion and collar.

Support the breechblock and extractors and withdraw the actuating shaft to the left. Remove the breechblock with crank and the extractors from the breech ring.

Disconnect the cocking link from the crank by removing the actuating pin and remove the cocking link from the rear of the breechblock.

Remove the two fixing screws and tap the actuating spring case downward. Remove the actuating shaft sleeve.

To dismantle the spring case, turn the check screw, unscrew the spring case cap, remove the bearing disk, actuating spring, and rack.

To remove the round retaining piece, depress the spring plunger through the access hole, using a drift, and slide the retaining piece out of its recess. Take care to restrain the plunger spring by placing the thumb over the plunger as the retaining piece is removed.

Dismantling the Firing Mechanism. Turn the safety catch to FIRE.

Release the striker by grasping the cocking handle in one hand and the striker case in the other and pressing the trigger sear. Remove the split pin and unscrew the cocking handle. Remove the cocking sleeve from the rear, and the striker spindle and main spring from the front, of the striker case.

To remove the safety catch, take out the retaining pin and remove the catch.

To remove the trigger sear, take out the split pin, remove the trigger sear spring seat, spring, and trigger sear.

To remove the retaining catch, remove the split pin and the retaining catch head from the rear, and the plunger and spring from the front.

Assembling the Firing Mechanism. Place the retaining catch plunger and spring in the front of the case, replace the head and split pin.

Insert the trigger sear, spring, and trigger sear spring seat in the striker case, and replace the split pin.

Insert the safety catch and secure it with its retaining pin. Set the safety catch to FIRE.

Press the trigger sear to the right, insert the cocking sleeve and push it home.

Assemble the main spring on the striker spindle and insert the spindle in the striker case from the front, taking care to engage the key and keyway. Replace the cocking handle and secure it with its split pin.

Cock the striker by holding the striker case in one hand and pulling the cocking handle with the other. Set the safety catch to SAFE.

Assembling the Breech Mechanism. Coat the actuating spring with antifreeze grease, place the rack and actuating spring in the spring case, place the bearing disk on the top of the spring, and screw home the cap.

Replace the actuating shaft sleeve and the spring case, and secure the case with its two fixing screws.

Place the crank in the front of the breechblock with the arm toward the rear of the block. Assemble the cocking link in the rear of the breechblock and connect it to the crank with the actuating pin.

To assemble the round retaining pin, insert the spring and plunger, engage the retaining piece in its recess, depress the plunger, and slide the retaining piece into position. Insure that the plunger engages and holds the retaining piece.

Enter the actuating shaft in the left of the breech ring.

Hold the two extractors against the breechblock and crank, insert the assembly in the breech ring from the underside, push the breechblock into the closed position, and hold it.

Insure that the cocking link is flush with the rear of the breechblock, push the actuating shaft into position, and assemble the collar and rack pinion. Replace the actuating shaft nut and split pin, and open the breech.

Insure that the striker is cocked and the safety catch is at SAFE. Insert the striker in the breechblock, press it forward, and turn it through 60° to the left; at this point, the retaining catch plunger will engage in its recess.

Adjust the tension of the actuating spring by releasing the check screw and turning the cap. The actuating spring must be adjusted so that it closes the breech smartly but without undue violence. When the spring is correctly adjusted, lock the spring case cap with the check screw.

Examine the bore to see that it is clear, release the extractors, and close the breech. Operate the firing gear to ease the striker main spring.

SECTION 6. TESTS OF THE BRITISH 57-MM AND AMERICAN 75-MM AT UNITED STATES NAVAL AIR TEST CENTER

The 57-mm Gun Installation in the Mosquito

The 57-mm gun in the Mosquito Mk XVIII is mounted in the gun bay in lieu of the four 20-mm gun installations of the normal Mosquito fighter-bomber aircraft.

The axis of the gun is $3\frac{15}{16}$ inches to the starboard of the aircraft centerline. The muzzle projects a distance of 2 feet $1\frac{1}{2}$ inches beyond the fuselage beneath the nose of the aircraft. The gun is installed parallel to the fore-and-aft line of the aircraft and depressed 3° downward from the rigging datum line. A small, limited range of vertical and horizontal adjustments of the gun is provided to compensate for manufacturing tolerances.

The nearest point of the starboard and port propeller blade planes to the axis of the gun is 2 feet $1\frac{3}{4}$ inches and 2 feet $9\frac{1}{4}$ inches, respectively.

The weight of the gun is carried directly on the center section of the main spar. The side loads are carried by 2 struts, 1 of which is connected to the port extremity of the armor plating beneath the pilot's cockpit, and the other is connected to the starboard side of the fuselage toward the rear of the gun bay. The main recoil and runout loads are carried by other struts which are fitted to the horizontal armor plating beneath the pilot's cockpit. The rear of the gun and the feed mechanism are steadied by a further attachment to a strong point in the overhead of the rear part of the gun bay compartment. This

Comparative Data: 6-Pounder Class M 57-mm British High-Velocity Field Gun and 75-mm Aircraft Gun AN–Mk 5 (T31E1)

Gun Specification	57-mm	75-mm
Gun length	116.95 inches	129.238 inches.
Gun weight:		
Unloaded	1,073 pounds, without loader	763 pounds (no automatic loader).
Unloaded	1,400 pounds with loader (approximate)	
Loaded	1,712 pounds with loader (approximate)	1,189 pounds (no automatic loader but includes weight of crewmen).
Rate of fire	55-60 rounds/minute	20 rounds/minute for 4- to 5-round bursts.
Muzzle velocity	3,000 feet/second	1,970 feet/second.
System of operation	Long recoil	Semiautomatic, long recoil.
System of locking	Sliding vertical block	Sliding vertical block.
System of feeding	Automatic loader	Manual.
Method of headspace	Breechblock so designed as to take up excessive headspace.	Factory established.
Location of feed opening	Right rear	Rear of breech.
Location of ejection opening	Rear of breech	Do.
Method of charging	Manual and pneumatic.	Manual.
Method of cooling	Air	Air.
Barrel length	112.2 inches (50 calibers)	37.5 calibers.
Barrel weight	616 pounds	628 pounds.
Rate control	None	None.
Barrel removal	Not quick disconnect	Not quick disconnect.
Chamber pressure	46,000 p. s. i	38,000 p. s. i.
Bore:		
Number of grooves	24	24.
Groove depth	0.026	0.02.
Groove width	0.147	0.248.
Pitch	1 turn in 30 calibers	Sloping 7°.
Length of rifling	94.18 inches	96.22 inches.
Direction of twist	Right hand	Right hand.
Form of twist	Constant	Constant.
Recoil system	Hydraulic buffer with spring recuperator	Hydraulic spring, concentric.
Quantity of oil in buffer	3 pints	Data not available.
Length of recoil	30 inches (approximate)	21 inches.
Firing mechanism	Percussion (electrically controlled)	Percussion (electrically controlled).
Distance the CG, gun unloaded, is forward of the rear face of breech.	20 inches	No data available.
Distance the CG, gun loaded, is forward of the rear face of breech.	15 inches	Do.

attachment also serves to carry the loads of the moment introduced by the offset of the recuperator mechanism from the main gun mounting points.

The gun may be raised and lowered into position by means of a winch, which weighs 25 pounds and is installed in the overhead of the gun bay.

The normal ground gun has been suitably modified for installation with aircraft mountings and for the attachment of the automatic loader.

Access to the gun bay is obtained through two gun-bay doors which are similar in principle to those on the normal Mosquito fighter-bomber. They are not, however, hydraulically operated. The starboard door is wider than the port door, permitting the installation of the ejection chute on the starboard side of the gun bay.

A detachable panel immediately ahead of the gun-bay doors is provided to allow the gun to be removed

Comparative Data: Loaders, Ammunition, and Mountings for 6-Pounder Class M 57-mm British High-Velocity Field Gun and 75-mm Aircraft Gun AN–Mk 5 (T31E1)

Loader Specification	57-mm	75-mm
Capacity	23 rounds	21 rounds carried in racks.
Method of operation	Electrical and mechanical	Hand loaded.
Weight	322 pounds	Weight allowed for crewman loader, 170–200 pounds.
Height, maximum, with pusher arm up	32 inches	Not pertinent.
Length	72 inches	Do.
Width	32 inches	Do.

Ammunition Specification	57-mm	75-mm
One round	13 pounds	19.3 pounds.
Full load of ammunition	312 pounds	426 pounds.

Mounting Specification	57-mm	75-mm
Overall length	149 inches	129.24 inches.
Width	32 inches	No data available.
Height, maximum, with breech open and pusher arm up.	49 inches	Do.

or installed. A blister is formed in the panel and in the forward part of the starboard gun-bay door to provide clearance for the gun buffer.

The nosc of the aircraft is protected by a metal blast plate, 0.126 inch thick, which incorporates a circular metal access panel for the removal of empty cases and links from the caliber 0.303 guns.

The ejection chute, incorporating a deflcctor plate, is fitted to the upper side of the starboard door. The bases of the ejected cases strikc this dcflector plate and are deflected base downward through the opening in the door and out into thc slipstream.

A firing solenoid is fitted to the gun and operates the firing pin mechanism through a system of rollers and levers. A solenoid-operating relay is incorporated in the circuit. Firing is controlled by a firing lever at the top of the control column.

A gun-and-feed master switch protected by a safety flap is installed on the instrument panel.

The standard Mosquito fighter-bomber installation consisting of 4-caliber .303 guns in the nose of the aircraft has becn retained. This installation is fired by means of a firing button on top of the control column. For the purpose of the tests described here, this installation was removed.

The standard British gun sight Mk 2L was retained and used throughout the tests. This sight is similar in principle to the United States Navy Mk 8 illuminated sight.

Automatic Loader of 57-mm Installation

The magazine is a component of the automatic loader and consists of a rectangular framework securcd to the feedway. The magazine is set at an angle of 30°, sloping to the left-hand side of the feedway. The automatic loader has several main parts, which are described in paragraphs which follow.

Cartridge Clips. There are five sets of cartridge clips, which are made of phosphor-bronze. The forward clip houses and positions the projectile nose, the rear clip guides the rim of the cartridgc. The loader is rearmed by an ordnanceman, who stands inside the bomb bay and places the rounds in the clips.

Pusher Arm. The pusher arm is situated on the forward left-hand side of the magazine. The

pusher arm is lightly spring loaded on a cam and pushes the rounds downward from the clips into position over into the feedway.

Motor Drive, Brake, and Switch Mechanism. The electric motor (24-volt d. c., specially wound) operates the clips and repositions the pusher arm. Its intermittent operation is controlled by the brake and switch mechanism. The motor is automatically switched on at the bottom of the downward stroke of the pusher arm and is switched off by the completion of one movement of the cartridge clips.

75-mm Gun Installation in the PBJ–1H Airplane

The gun used in the PBJ–1H installation is the 75-mm aircraft gun AN–Mk 5 (T13E1). This is a special light-weight gun developed for aircraft use. The gun is located in the lower forward section of the fuselage. The muzzle protrudes from a 12- by 16-inch recess in the nose and is approximately flush with the contour of the nose of the aircraft. The main gun loads are carried on trunnions which are connected into the fuselage structure through a set of heavy brackets.

The gun is jigged into the airplane parallel to the longitudinal axis of the fuselage and is located 10¼ inches to port of the centerline. It cannot be bore sighted in azimuth. The elevation adjustment is made on the rear mount. Powder gases are prevented from entering the airplane by a micarta partition and baffle aft of the muzzle opening in the fuselage.

The ejected cases strike a deflector, which is built into the fuselage. They then drop through a pair of spring-loaded doors into the slipstream.

Loading System of the 75-mm Gun

This installation is hand loaded. Twenty-one rounds are carried in a rack on the left-hand side of the gun. The loader, or cannoneer, picks the rounds out of the rack and throws it forward into the breech. It is possible for an experienced cannoneer to load 5 rounds in 14 to 15 seconds.

The effort required to throw the 20 pounds into the breech and trip the extractors is quite high in view of the fact that ram air is coming down the barrel at 170 to 220 knots.

Automatic Loader Operation for 57-mm Gun Installation

During firing, the following sequence of operations takes place.

During recoil, the lower round in the feedway drops into the ramming position. The round above it in the feedway has been retained by a series of pawls, thus preventing double feed. The pressure applied to the rounds in the feedway during recoil is applied indirectly by the pusher arm and directly by the feed-arm shaft. The rammer is forced to the rear by the recoiling barrel, rotated, and stowed in a horizontal position. It is retained by a pawl controlled from the connecting rod indirectly driven by the cam tracks on the top of the breech ring, through the separator mechanism.

During counterrecoil, when the gun has moved forward sufficiently, the breech opens, the empty case ejects, and the nose of the round in the ramming position drops down into the top of the breechblock. The rammer is released by the retaining pawl and moves forward, contacting the cartridge and driving it into the breech. The extractors are tripped, the breech closed, and, if the firing mechanism is being operated, the gun will fire. At the same time, the rounds in the feedway will move down one position. When the pusher arm is at the bottom of its stroke, indicating that the clip in position over the feedway is empty, the operation of the magazine mechanism takes place concurrently with the cycle of operation just described. The motor is switched on automatically, the pusher arm is raised, and the next clip slides down into position over the feedway. The pusher arm rides down on the top round. The switch mechanism is recocked, and the driving motor is switched off.

Object of the Tests

The tests described here were arranged at United States Naval Air Test Center, Patuxent River, Md., as a material evaluation of the 57-mm gun installation in the RAF Mosquito Mk XVIII airplane in comparison with other installations of comparable weight, size, and effectiveness of fire. The one comparable American installation is the 75-mm gun in Model PBJ–1H airplane.

Summary. The installation of the 57-mm gun in the Mosquito aircraft appears to be the result of a military exigency, as the gun is basically a ground

weapon which has been adapted for aircraft use without major redesign. The installation is well adapted to the aircraft and is, in general, an excellent one. It is particularly free from malfunctions. In contrast to this, it is heavy and cumbersome. The automatic loader is of special interest in comparison with the hand loading of the 75-mm gun. No tactical evaluation was conducted as such; however, it was noted that this installation, like all present large-caliber gun installation in aircraft, suffers from the lack of effective fire control. A fixed reticle for mil-ring sighting is the sighting method employed.

Conclusions

It was concluded that the 57-mm gun operated satisfactorily both as installed in the RAF Mosquito Mk XVIII airplane and as set up for ground-stand firing, and that the following topics indicate relative comparisons between the 57-mm gun installation in the RAF Mosquito Mk XVIII and the 75-mm gun installation in the PBJ–1H type aircraft.

Reliability. Both installations were equally reliable.

Rate of Fire. The automatic loader of the Mosquito installation made possible a more rapid rate of fire.

Complement of Crew. Since the 57-mm installation on the Mosquito airplane is automatically loaded, no loading crew is required. In the 75-mm installation, one cannoneer for loading the gun is required.

Ease of Gun Removal. The removal of the 57-mm installation from the Mosquito airplane can be accomplished in considerably less time than the removal of the 75-mm gun from the PBJ–1H airplane. The 57-mm gun may be removed by 2 men in 25 to 30 minutes; whereas, the 75-mm gun may be removed by 3 men in 10 to 12 hours.

Weight. The 75-mm installation is 620 pounds lighter in the loaded condition and 637 pounds lighter in the unloaded condition.

Maintenance. The 57-mm and the 75-mm gun installations are each comparatively easy to maintain. The automatic loader of the 57-mm requires but little added maintenance.

Rearming. The 75-mm installation is more quickly rearmed (the 75-mm installation may be rearmed in 5 to 7 minutes while rearming the 57-mm installation requires about 15 minutes).

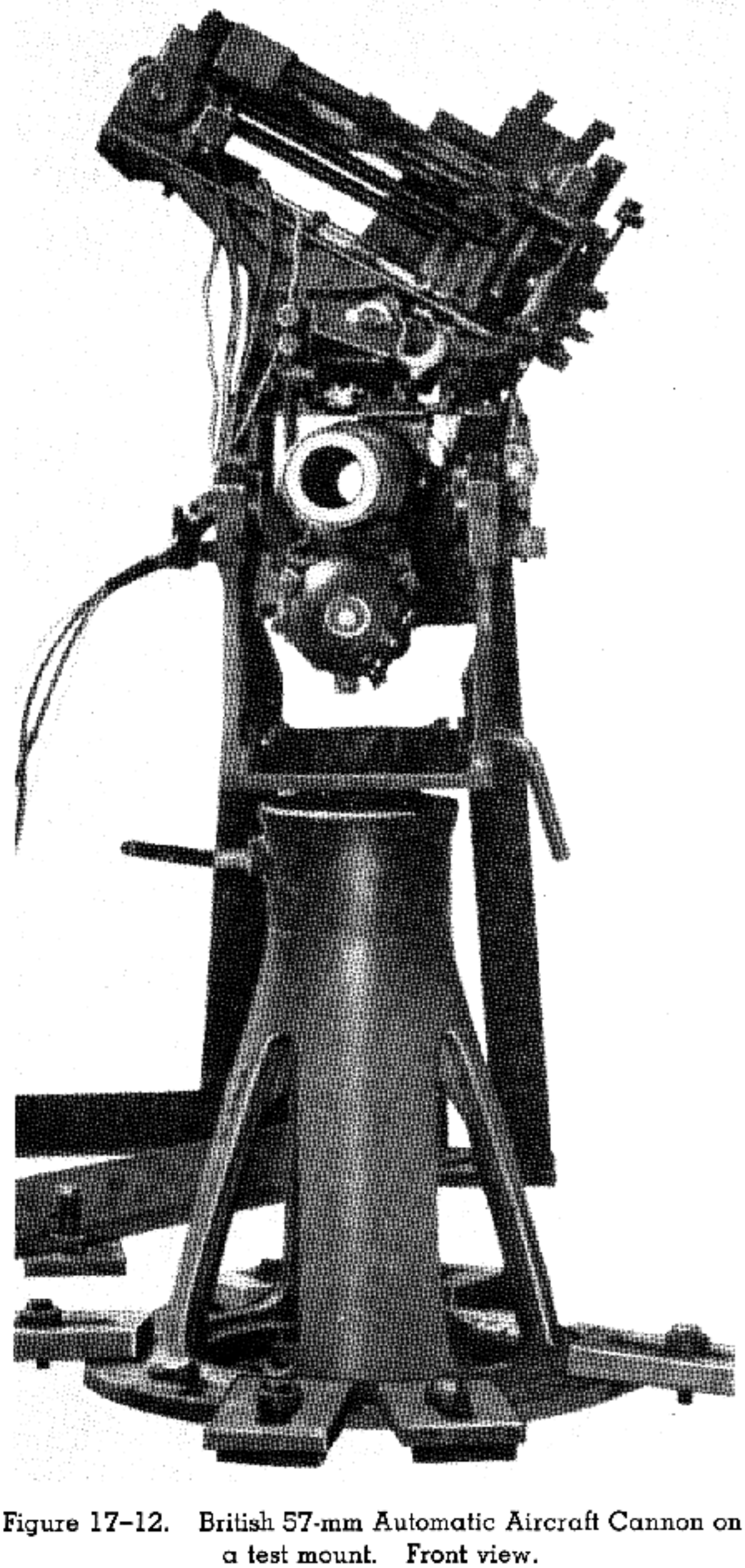


Figure 17–12. British 57-mm Automatic Aircraft Cannon on a test mount. Front view.

Tactical Use. The PBJ 75-mm cannon installation is considerably restricted in a tactical approach because of the difficulties encountered in manually loading the ammunition during evasive maneuvers or under the effects of *g*'s. Fairly violent evasive action and 2.5 positive *g*'s does not cause stoppages in the Mosquito installation.

Recommendations

Recommendations were: (1) That if future tactical trends in combat aircraft demand a large caliber, automatically loaded gun, the principle of the 57-mm automatic loader be considered satisfactory for such use; and (2) that the principle of the Mosquito 57-mm loader be considered for adaptation to the use of spin stabilized rocket or recoilless cannon installations.

Discussion of Tests of the 57-mm Gun

Arrival of Equipment. The Mosquito airplane incorporating the 57-mm installation was delivered on 30 April 1945, and the gun installation was inspected. The project, however, was inactive until the ammunition and special tools arrived from England.

It was stated by the RAF gunner assigned to the project that ground firing of the gun in the airplane would not be advisable. Steps were accordingly taken to procure a second gun, and the necessary ground mounting for the Naval Proving Ground, Dahlgren, Va. A special ground stand was manufactured for purposes of cleaning and studying the cannon.

Ground Firing. Between 9 and 11 August 1945, 209 rounds were ground fired from the gun.

There were two stoppages during the first load which were caused by incorrect firing procedure and one other stoppage which was caused by an overfilled buffer system which did not allow the gun to return to battery. These faults were corrected.

Rates of fire were observed on 10-round bursts with a stopwatch. The rate of fire varied between 50 and 55 rounds per minute.

Motion pictures on 35-mm film at 125 frames per second in 18- to 20-cycle sequences were obtained of both sides of the gun during firing. Both sequences

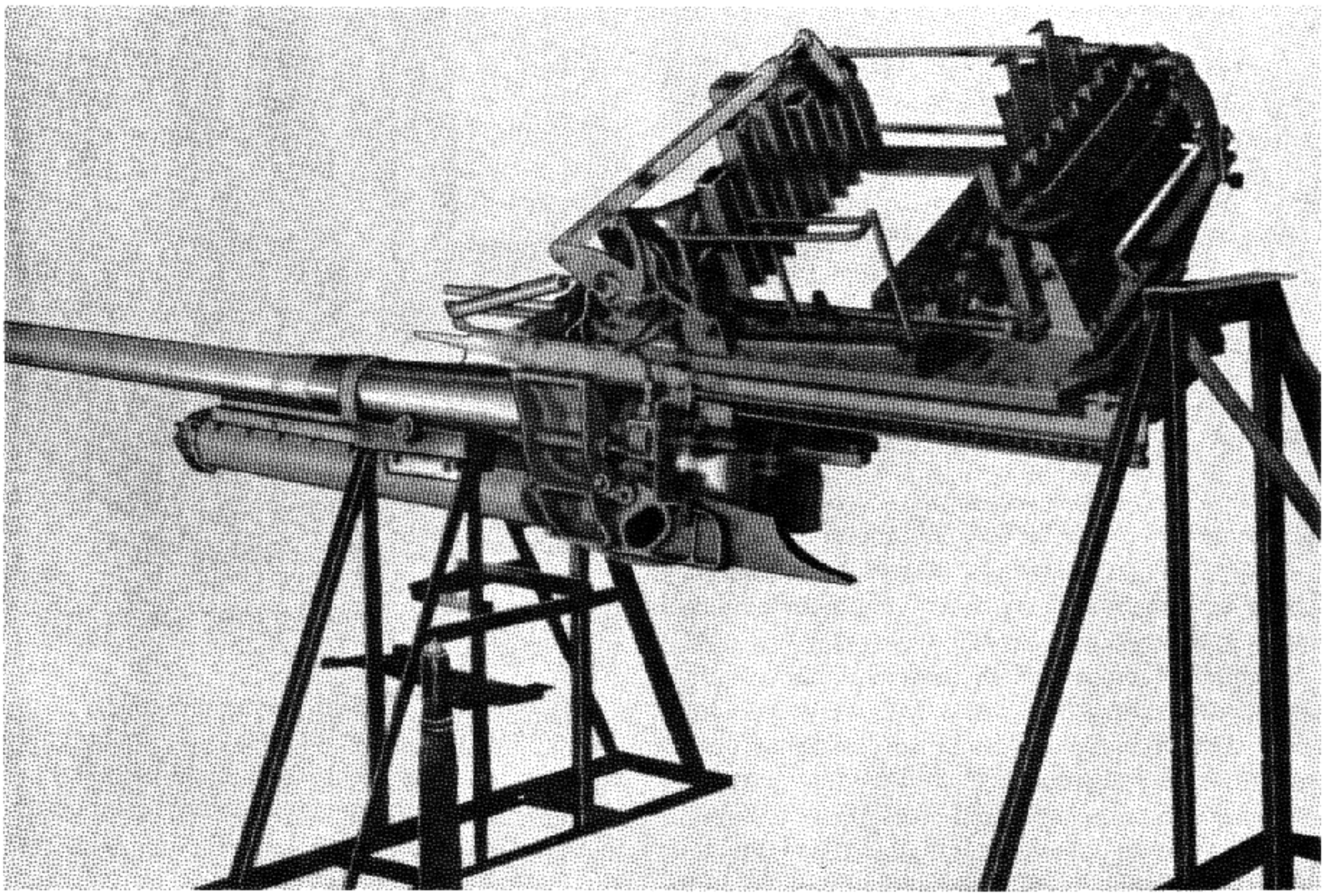


Figure 17–13. British 57-mm Automatic Aircraft Cannon. General view of gun and loader on maintenance stand.

give a comprehensive picture of the gun and feeder in operation.

Jump cards of the ground mounted 57-mm gun were fired at a 500-yard target. Two firings were attempted. On the first, the sighting point was too low and one shot was lost. The data for the second target is as follows:

Rounds fired: 5.

80 percent circle: 2.5 mils diameter.

100 percent circle: 3.9 mils diameter.

Air Firing. Air firing was started on 6 July 1945. A total of 240 rounds were air fired. Four rim-lock stoppages occurred in six flights; then this defect was corrected. A rim lock occurs when the cartridge rim jams in the rear cartridge clip, because of burred or bent clip surfaces. These clips are made of soft bronze and should be replaced by harder clips made of soft steel. One other stoppage was caused by a broken solenoid plunger. The remainder of the air firing was without malfunction.

The rate of air firing was calibrated during 6-, 7-, 8-, and 10-round bursts by a stopwatch. The rate of fire of the 57-mm gun in the air varied between 50 and 55 rounds per minute.

All attacks were made in relatively shallow dives of 15 to 35 degrees. Speeds during firing were between 260 and 300 miles per hour. The altitudes of entrance into the attack varied from 2,000 to 4,000 feet. The number of rounds fired in any one attack ranged from single rounds to 6- or 8-round bursts.

Test firing during flights in all instances was satisfactory. The most outstanding observation was that while the gun recoil was noticeable, it did not affect the flight altitude of the plane. After each shot, the pilot was able to hold his point of aim.