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TECHNICAL MANUAL

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ORDNANCE MAINTENANCE

**BREEZE CARTRIDGE STARTER
FOR RADIAL DIESEL ENGINES**

August 25, 1942

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By NNHP NARS 3-3-78

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**BREEZE CARTRIDGE STARTER FOR RADIAL DIESEL
 ENGINES**

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SECTION I

GENERAL

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Scope.....	1

1. **Scope.**—This manual is published for the information and guidance of ordnance maintenance personnel. It contains detailed instructions for inspection, disassembly, assembly, maintenance, and repair of the breeze starter unit G-1153R, type L4A, and the breeze starter breech assembly G-1155, type A, supplementary to those in TM 9-726, which was prepared for the using arm. Additional descriptive matter and illustrations are included to aid in providing a complete working knowledge of the matériel. The breeze cartridge starter G-1154R is used on the Diesel engined light tanks M2A4, M3, M3A1, and the Diesel engined medium tanks M3, M3A1, and M3A2.

SECTION II

DESCRIPTION, OPERATION, AND ALLOCATION OF
MAINTENANCE OPERATIONS

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2. **General.**—The type A breech assembly and the type L4A starter assembly are standard equipment on the Guiberson radial Diesel engine for light and medium tanks M3.

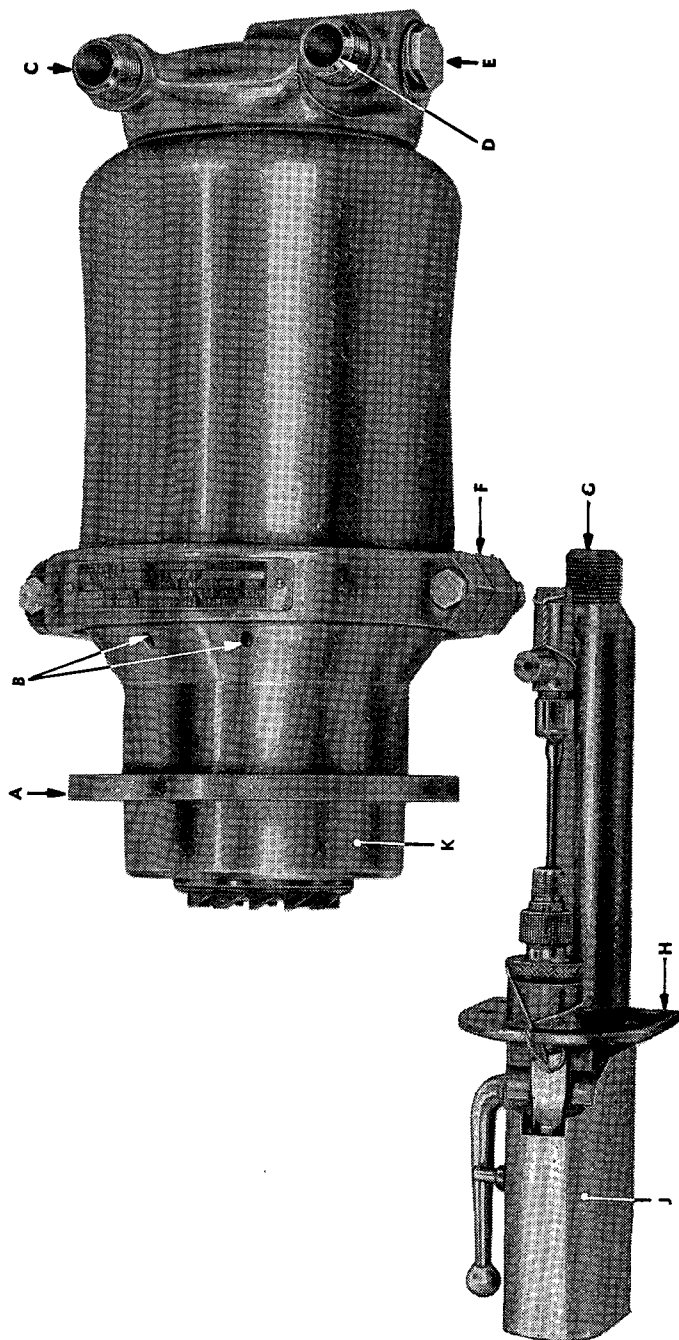
3. **Description.**—*a.* Cartridge engine starters derive their power for operation from the gas pressure developed when a cartridge is fired. A fresh cartridge is required for each start. The complete starter and breech assemblies consist of—

(1) *Starter unit* (fig. 1).—The starter unit is attached to the engine accessory case and utilizes the gas pressure developed by the firing of the cartridge to revolve the crankshaft of the engine.

(2) *Breech assembly* (fig. 1).—This assembly is in the fighting compartment and is the mechanism in which the cartridge is fired.

(3) *Intake tube assembly.*—This assembly transmits the gas pressure from the breech assembly to the starter unit.

RA PD 5878



A. Starter unit mounting flange.
 B. Vent holes.
 C. Intake connection.
 D. Exhaust connection.
 E. Safety disk holder assembly.
 F. Cylinder clamp split ring set.
 G. Intake connection.
 H. Breech assembly mounting flange.
 J. Type A breech assembly.
 K. Type L4A starter unit.

FIGURE 1.—Breeze type A breech assembly and type L4A starter unit.

(4) *Exhaust tube*.—The exhaust tube releases the gas pressure from the starter unit to the atmosphere.

(5) *Safety disk and holder* (fig. 2).—This screw plug assembly screws into the combustion chamber of the starter. When the pressure in the starter unit exceeds 3,000 pounds per square inch, the safety disk ruptures and the pressure is transmitted to the atmosphere.

b. At present the Ordnance Department issues the "102" cartridges for summer use, and the "104" cartridges for winter use. Figure 15 illustrates the 102 starter cartridge.

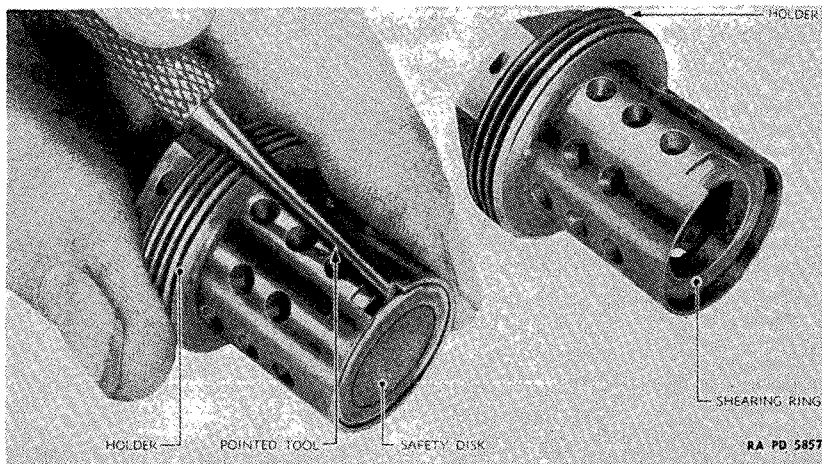


FIGURE 2.—Cartridge starter safety disk holder.

4. Starter unit construction (fig. 1).—The starter unit consists of the following assemblies and parts:

a. *Safety disk holder assembly* (fig. 2).—This stainless steel assembly, composed of a holder and shearing ring, screws into the combustion chamber near the exhaust tube. Its function is to provide a holder for the easily removable safety disk. The shearing ring is a light press fit in the holder. Replace the shearing ring if it is nicked or scratched. This is necessary because a pressure of 3,000 pounds per square inch is required to shear the copper safety disk which seats on the shearing ring. Scratches or nicks on the shearing ring will cause the safety disk to shear at a lower pressure, and full torque will not be obtained from the starter unit.

b. *Safety disk assembly* (fig. 2).—This assembly is composed of light sheet copper on one side and asbestos on the other side. Install a new safety disk when the starter unit is overhauled. Install with the asbestos side out (toward the flame in the combustion chamber). The

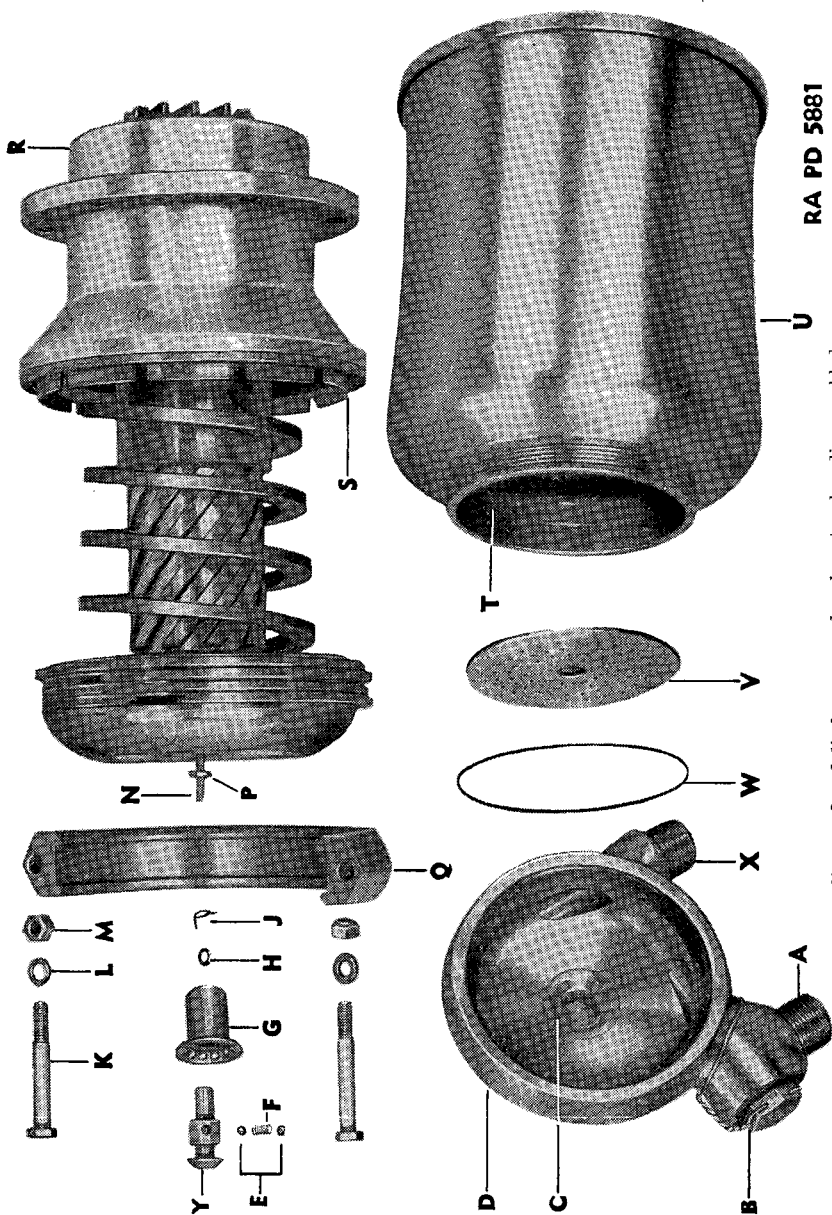


FIGURE 3.—Cylinder removed, exhaust valve disassembled.

RA PD 5881

copper side must make good contact with the shearing ring in order that the copper may shear at the correct pressure.

c. Fuel combustion chamber (fig. 3).—This stainless steel forging is attached to the cylinder by a milled thread. A soft copper gasket between the cylinder and combustion chamber forms a seal for the pressure developed when a cartridge is fired. The exhaust valve seat, exhaust and intake tubes, and safety disk holder assembly are attached to the combustion chamber.

d. Cylinder (fig. 3).—This part is machined from a stainless steel forging. A male milled thread is on the smaller end for attaching the fuel combustion chamber. A perforated disk is held in place against a shoulder by the exhaust valve housing. This disk prevents unburned pellets of powder from the cartridge from becoming wedged between the piston head and cylinder. The larger end of the cylinder has a flange which permits the cylinder to be attached to the starter unit by a clamp ring set.

e. Cylinder clamp split ring set (fig. 1).—These half circle rings are made of stainless steel forgings and are furnished in pairs. If one part of the set becomes defective, replace with a new set. This is necessary because each half is mated to the other. A wide groove machined in the inside surface of the ring set permits the housing cylinder (fig. 3) and the hub assembly to be attached together. The ring set is held in place by two bolts and safety nuts. The deeper shoulder formed by the groove in the ring set is *always* placed toward the housing. The force against the flanges of the housing and cylinder is approximately 30 tons when a cartridge is fired. This same force is exerted against the shoulders of the split ring set. Improper installation of the split ring set may result in destruction of the starter unit.

f. Exhaust valve mechanism (fig. 3).—The exhaust valve, housing, and bolt are made of stainless steel. The bolt screws into the valve and is locked in place by a spacer, clip, and jam nut. The exhaust valve closing and opening springs control the amount of force exerted upon the bolt and seat of the valve. A hole drilled through the stem of the exhaust valve provides a guide for two steel balls and an exhaust valve control compression spring. The housing of the exhaust valve provides a guide for the exhaust valve stem, and a groove in which the balls are forced by the spring provides a means of keeping the exhaust open until the piston returns to its original position. The exhaust valve housing is held in place between the perforated disk and combustion chamber. The housing is held in alignment with the exhaust valve seat by the small end of the housing

passing through the hole in the center of the perforated disk; the larger end of the housing fits into a counterbored recess in the combustion chamber which is concentric with the exhaust valve seat.

g. Piston, piston rings, starter jaw bolt, and spiral coil spring (fig. 4).—The piston is a bronze forging, carrying four conventional piston rings and is attached to the bronze internal and external helical splined shaft by a lock ring. Thus the splined shaft which is attached to the piston is free to turn on the piston head.

(1) The following procedure is used in assembling the starter jaw bolt to the piston (fig. 5) :

(a) The bolt is screwed into the under side of the piston head until the threaded end of the bolt seats firmly against the head of the piston.

(b) Working from the combustion chamber side of the piston head, drill a hole, parallel with the axis of the bolt, through the piston head and into the bolt in such a way that half the drill diameter is in the bolt and half in the boss of the piston.

(c) The hole is then counterbored to a sufficient depth to permit the head of the set screw to be flush with the head of the piston.

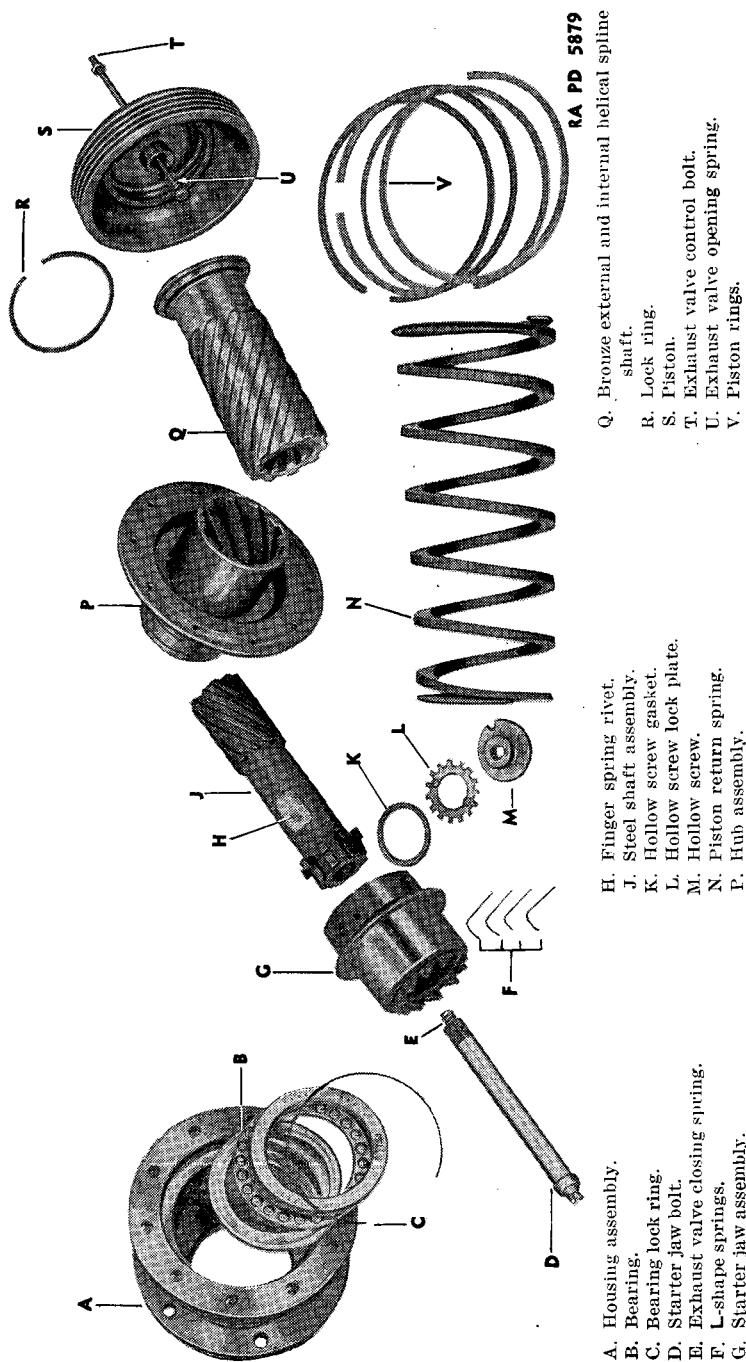
(d) The started jaw bolt is removed and the hole in the piston is tapped with a 8-32NC-2 tap.

(e) This procedure makes the starter jaw bolt mated with the piston. The head of the starter jaw bolt prevents the piston from striking the cylinder head and has a screw driver slot to permit assembly to the piston head.

(2) The large taper spiral coil spring (fig. 4), which returns the piston to its original position when the exhaust valve opens, requires a pressure of approximately 675 pounds to collapse its coils. This spring exerts 290 pounds against the piston head with the piston in the normal position. The larger end of the spring rests against the piston head and the smaller end against the housing. Cold drawn annealed steel is used to make this spring. The free length varies between $9\frac{3}{4}$ and $10\frac{1}{2}$ inches.

h. Bronze internal and external helical splined shaft (fig. 4).—This shaft, made of case manganese bronze, is loosely attached to the piston head by means of a lock ring. The exterior helical splines mesh with the interior helical splines of the hub assembly. The interior helical splines of the shaft mesh with the exterior splines of the steel shaft assembly.

i. Hub assembly (fig. 4).—This assembly consists of a steel forging and a pressed-on bronze bearing. The exterior surface of the bronze bearing is machined concentric with the internal helical



RA PD 5879

- A. Housing assembly.
- B. Bearing.
- C. Bearing lock ring.
- D. Starter jaw bolt.
- E. Exhaust valve closing spring.
- F. L-shape springs.
- G. Starter jaw assembly.

- H. Finger spring rivet.
- J. Steel shaft assembly.
- K. Hollow screw gasket.
- L. Hollow screw lock plate.
- M. Hollow screw.
- N. Piston return spring.
- P. Hub assembly.

- Q. Bronze external and internal helical spline shaft.
- R. Lock ring.
- S. Piston.
- T. Exhaust valve opening spring.
- V. Piston rings.

FIGURE 4.—Parts of starter unit BZ-G1153R.

splines of the steel forging after being pressed in place. Ten hollow stainless steel dowel pins are pressed into the hub of the flange to prevent rotation of this unit during operation of the starter unit. This assembly is placed between the cylinder and housing assembly. The dowel pins fit in holes in the housing assembly. The bronze internal and external helical splined shaft which is attached to the piston head meshes with the internal helical splines of the hub assembly.

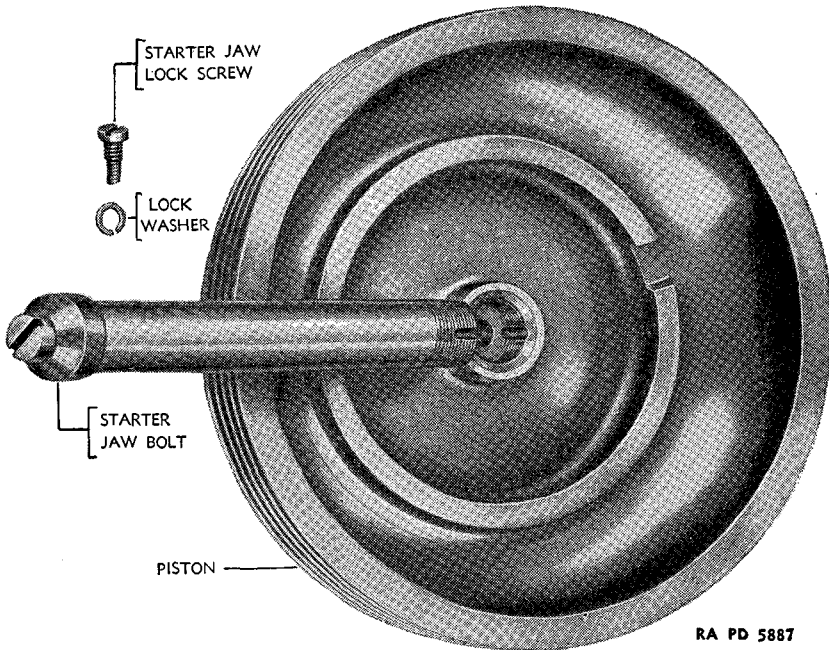


FIGURE 5.—Piston and starter jaw bolt.

j. Shaft assembly (fig. 4).—This assembly consists of a hollow steel shaft and a tubular spring held by a rivet. The shaft has external helical splines at one end which mesh with the internal splines of the internal and external helical splined shaft attached to the piston. The opposite end of the shaft assembly has external straight splines which mesh with the starter jaw assembly. The tubular spring attaches to the inside of the hollow steel shaft and is held in place by a rivet through the wall of the shaft. The head of the rivet is filed flush with the outside of the shaft after installing the rivet. The internal thread at the straight splined end of the shaft assembly permits the shaft to be loosely connected to the starter jaw

assembly by a hollow locking screw. A tab of the steel hollow screw locking plate prevents the locking screw from turning when folded into a notch on the edge of the locking screw. The thickness of the copper gasket between the hollow screw and the starter jaw assembly controls the flexibility of this connection.

k. Starter jaw assembly and L-shaped springs (fig. 4). This assembly consists of a steel forging, four starter jaw drive screw sleeves, screws, and a steel washer. The screws pass through the washer and the sleeves and retain the L-shaped springs in position. The L-shaped springs are made of spring steel wire. Ratchet-shaped teeth on the face of one end of the starter jaw mesh with corresponding teeth on the end of the crankshaft. The other end of the starter jaw slips over the bronze bearing pressed on the hub assembly. A shoulder of the starter jaw contacts the ball thrust bearing in the housing assembly to prevent any thrust against the end of the engine crankshaft during operation of the starter.

l. Housing assembly (fig. 4).—This assembly includes the aluminum forging and pressed-in bronze sleeve. The aluminum forging incorporates a flange for attaching the starter unit to the engine, the vent holes for the interior of the starter unit, and a flange on the larger end of the casting to permit the split clamp ring set to hold the starter unit together. A groove cut in the bore of the housing permits locking the thrust ball bearing assembly in position by a lock ring. The pressed-in bronze sleeve is machined concentric with the bore of the housing after being pressed in place.

5. Breech assembly construction (fig. 1).—The breech assembly consists of the following assemblies and parts:

a. Barrel assembly (figs. 6 and 7).—The barrel in which the cartridge is fired is made from a stainless steel forging. The complete assembly consists of the cartridge ejector, ejector pin, ejector lever, ejector lever spindle, ejector lever spindle washer, two cotter pins, and the barrel. All of these parts are of stainless steel or steel that has been treated to prevent corrosion.

b. Flange assembly (figs. 8 and 9).—This assembly is attached to the barrel assembly by a screw which passes through a hole in the contact blade, insulator strip, flange, or body, and screws into the barrel assembly. Holes in the body of this assembly permit the breech assembly to be bolted to the bulkhead of the tank. A tapped hole in the body provides a means of installing the various electrical fittings that supply current to the contact blade. The body is made of die-cast aluminum alloy.

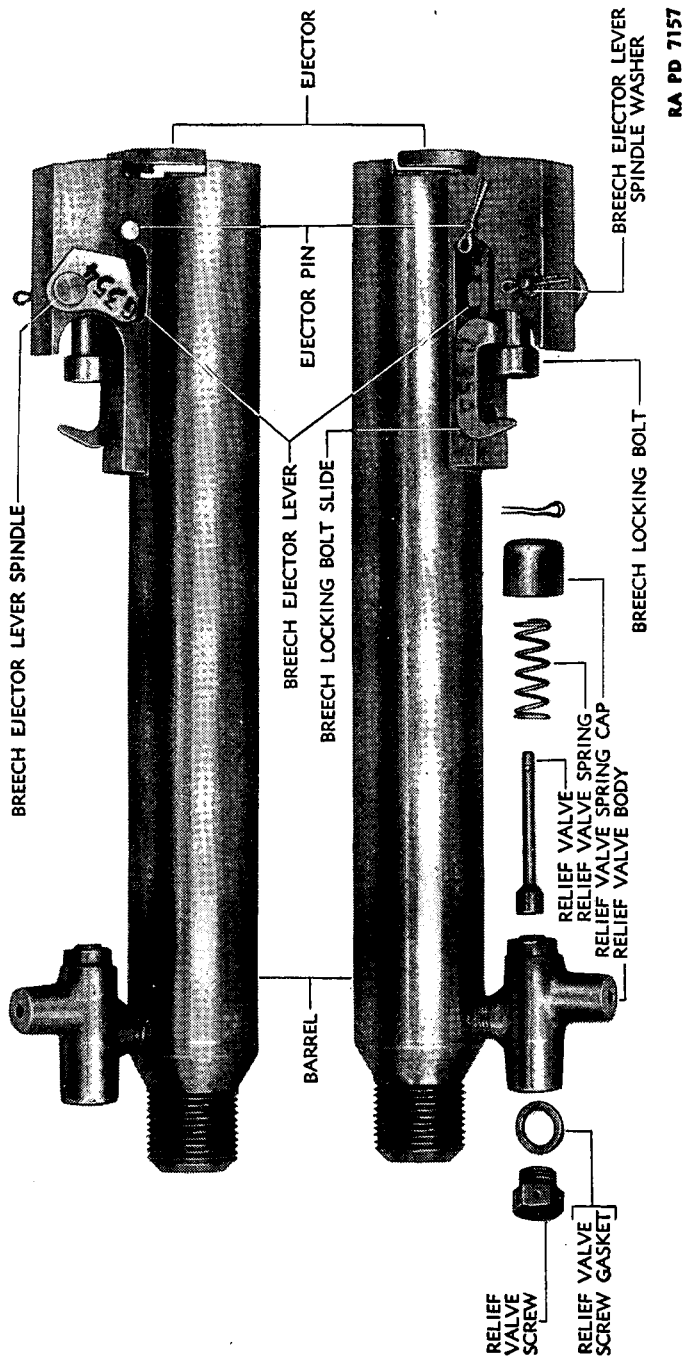
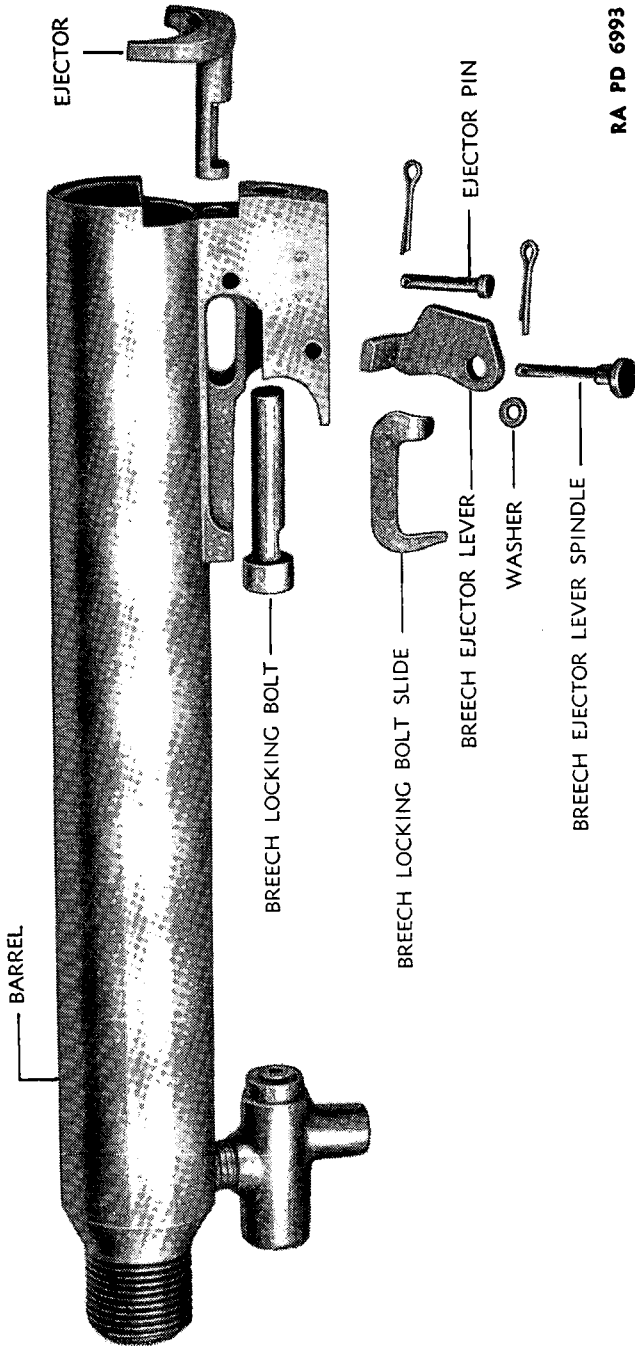
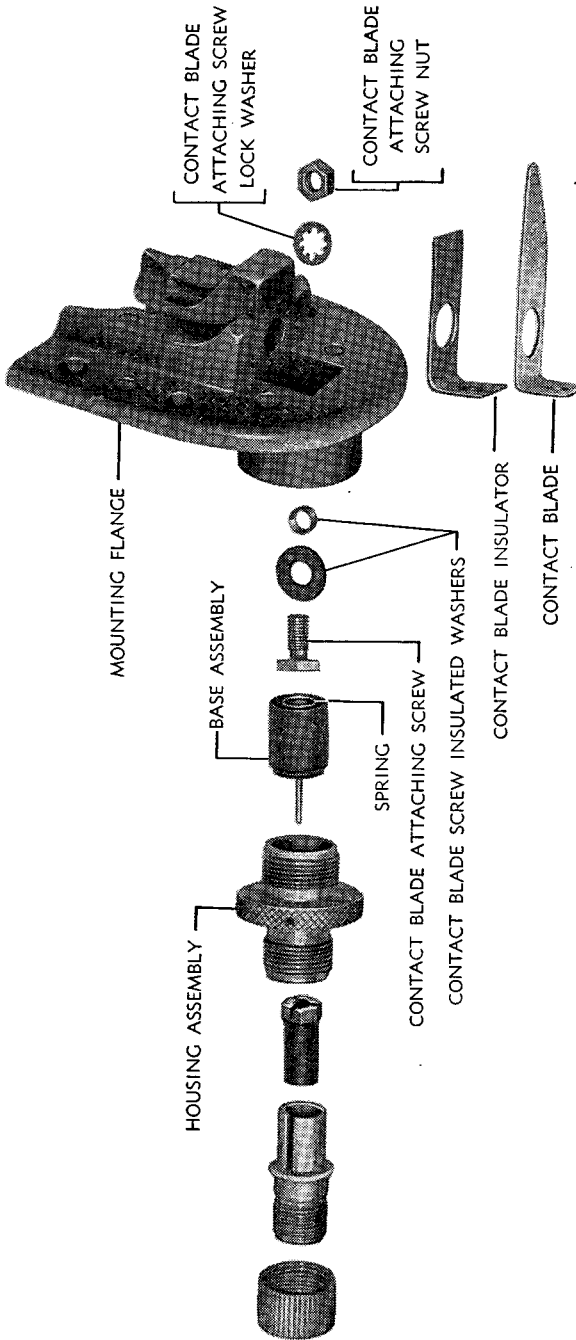


FIGURE 6.—Barrel assembly and relief valve disassembly of breech assembly BZ-G1155.



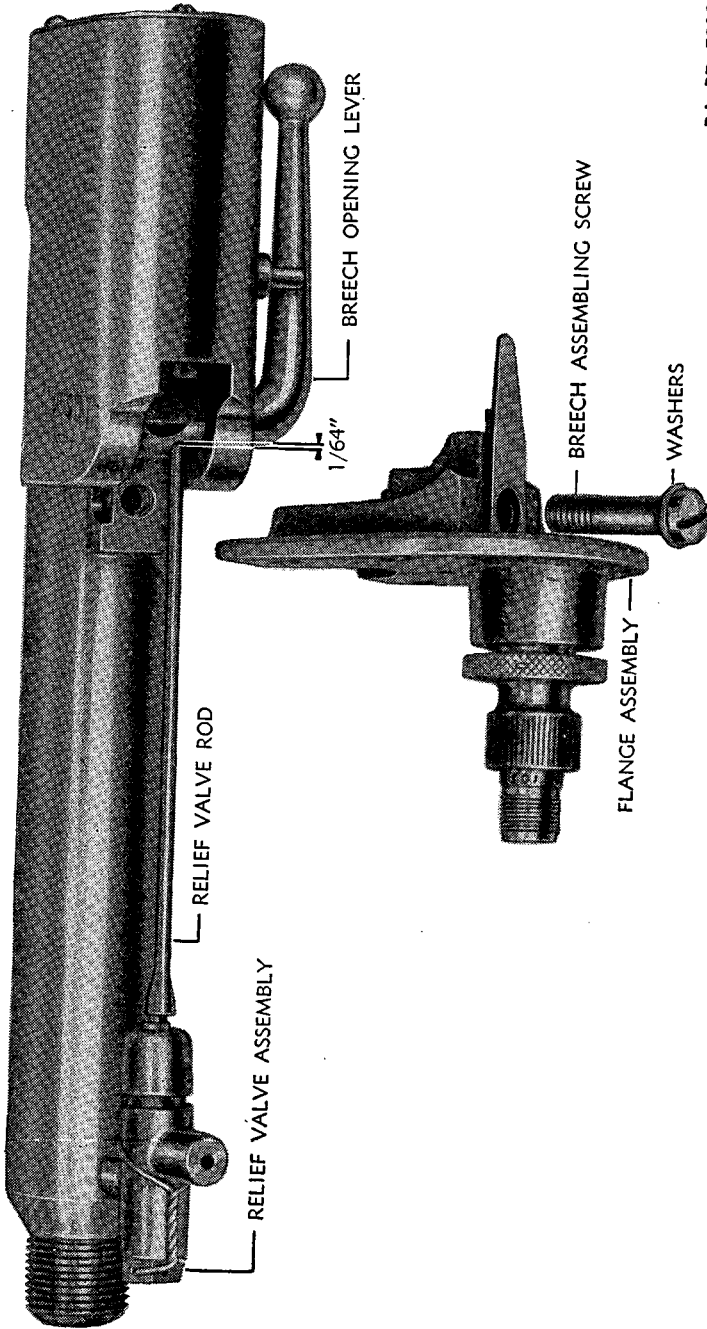
RA PD 6993

FIGURE 7.—Barrel disk assembly of breech assembly BZ-G1155.



RA PD 7160

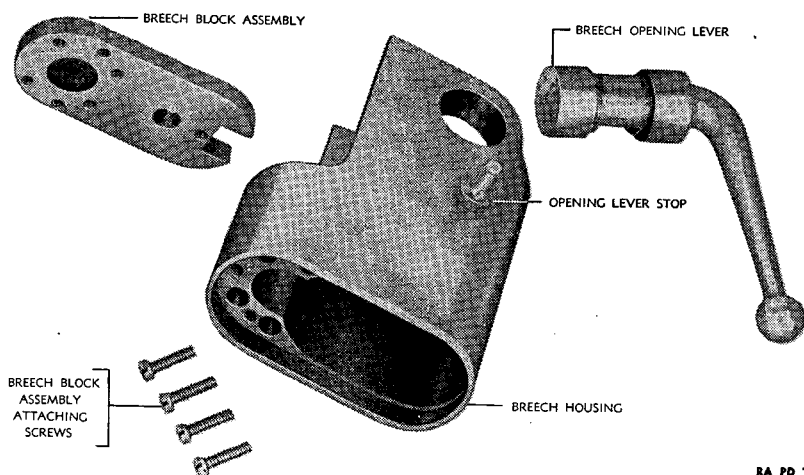
FIGURE 8.—Mounting flange disassembly of breech assembly BZ-G1155.



RA PD 5888

FIGURE 9.—Clearance between relief valve rod and breech opening lever of breech assembly
BZ-G1155.

c. *Complete breech housing assembly and breech opening lever* (figs. 10 and 11).—This assembly consists of the breech housing assembly, the center block assembly, the breech end and end cover plates, a spring, stud, screws, and lock washers for holding the assembly together. The breech housing assembly is composed of the block assembly and the housing. These two parts are fastened together with screws. The housing incloses the center block assembly and the breech end plate. The breech end and end cover plates are fastened to the housing with screws. The block assembly has a “molded in position” bakelite insulating bushing for the contact pin to pass through. The block of the center block assembly is made of bakelite. The contact stem, lever, shaft, pin, spring, seat and nuts are made of corrosion-resistant



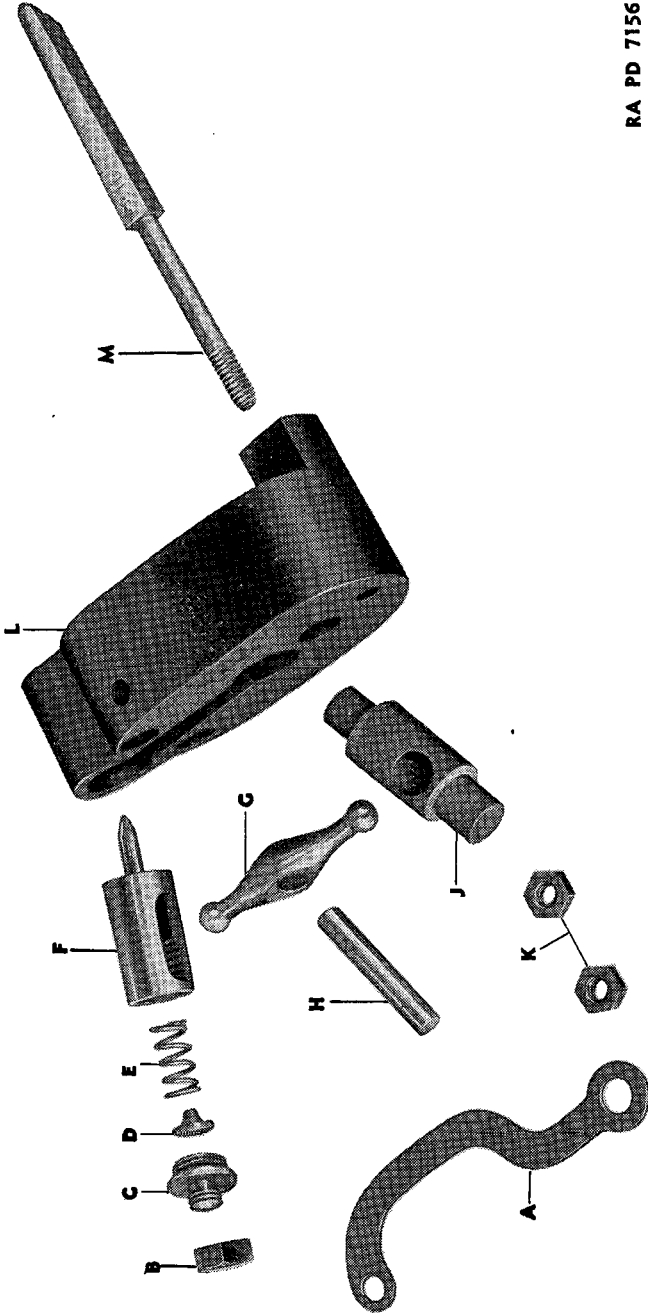
RA PD 7159

FIGURE 10.—Disassembly of breech housing of breech assembly BZ-G1155.

steel. After the contact pin lever shaft is assembled in the center block, the ends of the shaft are covered with sealing wax to prevent moisture from entering the mechanism and the shaft from “creeping” out of the hole in the center block which would cause a short circuit in the electrical circuit if the shaft contacted the housing of the housing subassembly. The electrical connector is made of plated copper. The plunger is made of micarta. The breech opening lever is a steel forging, treated to prevent corrosion.

d. *Relief valve assembly and rod* (figs. 6 and 9).—The screw, body, valve and rod are made of stainless steel. The relief valve is attached to the barrel by a $\frac{1}{8}$ -inch pipe thread. It is held on its seat by the compression spring. The spring is held in the assembly by the cotter pin which passes through the hole in the valve stem. The cap acts as a

RA PD 7156



- J. Center block plunger.
- K. Contact stem nuts.
- L. Center block.
- M. Contact stem.

- E. Contact pin spring.
- F. Contact pin.
- G. Contact pin lever.
- H. Contact pin lever shaft.

- A. Electrical connector.
- B. Contact pin screw nut.
- C. Contact pin screw.
- D. Contact pin spring seal.

FIGURE 11.—Disassembly of center block of breech assembly BZ-G1155.

spring guide. One end of the relief valve rod passes through a hole in the mounting flange and thus is held in position in the breech assembly; the other end is bell-shaped with a drilled hole of sufficient depth to permit the stem of the relief valve to enter a short distance and support the end of the rod.

e. Breech locking bolt and slide (fig. 6).—These parts are made of corrosion-resistant steel. The bolt passes through a hole in the barrel assembly and breech block assembly to lock the two parts together when the breech opening lever is set in the closed position. The slide works in a recessed face of the barrel assembly.

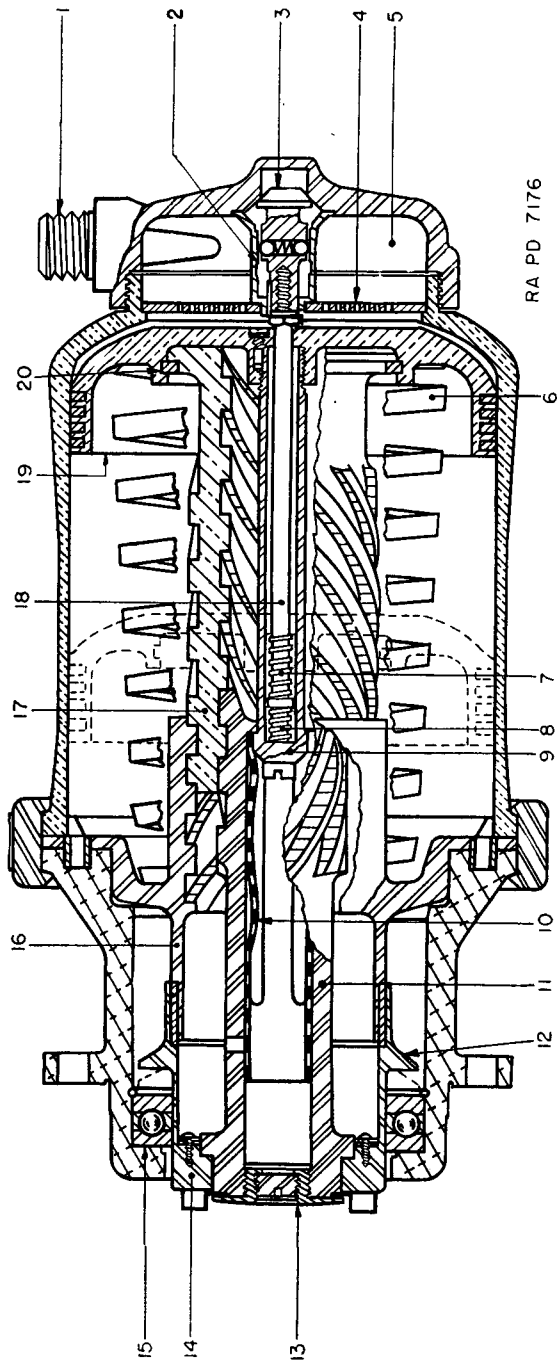
f. Electrical connections.—Two types of electrical connections for the flange assembly are used. Either type is similar in construction to the shielded cable conduit used in various other electrical connections throughout the vehicle.

6. Starter unit operation.—All references in this paragraph are to figure 12, unless otherwise stated.

a. When a cartridge is fired in the breech assembly, a gas pressure not exceeding 3,000 pounds per square inch is transmitted to the combustion chamber of the starter unit through the intake tube connecting the breech assembly to the starter unit. This pressure enters through the intake tube connection, passes through the holes of the disk, and forces the piston to the position in the cylinder outlined by the dotted lines.

b. Rotation and engagement of the starter jaw with the engine crankshaft jaw are accomplished as follows:

(1) The hub assembly is fixed and does not rotate during the travel of the piston. The internal splines of the hub assembly match the external splines of the external and internal helical splined shaft. A retaining ring attaches this shaft to the piston and permits the piston to rotate freely on the head of the shaft. During the movement of the piston from the top to the bottom of the cylinder, approximately $\frac{5}{12}$ of a revolution is imparted to the external and internal helical splined shaft. The internal splines of the external and internal helical splined shaft match the external splines of the shaft assembly. During the initial travel of the piston, the shaft assembly receives a linear motion sufficient to engage the starter jaw assembly with the jaw of the engine crankshaft. This operation is accomplished as follows: The starter jaw bolt is rigidly attached to the piston. By compressing the finger spring, the head of the starter jaw bolt imparts a linear force to the shaft assembly. This linear motion is transmitted to the starter jaw assembly by the shoulder of



RA PD 7176

- 1. Intake tube connection.
- 2. Groove.
- 3. Exhaust valve.
- 4. Disk.
- 5. Combustion chamber.
- 6. Piston return spring.
- 7. Exhaust valve opening spring.

- 8. Exhaust valve closing spring.
- 9. Starter jaw bolt.
- 10. Finger spring.
- 11. Shaft assembly.
- 12. Shoulder of starter jaw assembly.
- 13. Hollow screw.
- 14. Starter jaw assembly.

- 15. Thrust ball bearing.
- 16. Hub assembly.
- 17. External and internal helical splined shaft.
- 18. Exhaust valve bolt.
- 19. Piston.
- 20. Retaining ring.

FIGURE 12.—Cross-section view of starter unit.

the step-cut straight splines of the shaft assembly bearing against the hub assembly.

(2) The linear motion of the shaft assembly ceases when the shoulder of the starter jaw assembly contacts the race of the thrust ball bearing. The torque exerted by the shaft assembly is transmitted to the hub assembly by the smaller diameter straight splines of the shaft assembly fitting into matching internal splines of the hub assembly. The difference between the width of the external splines and the width of the grooves of the internal splines of this fit is about $\frac{3}{32}$ inch. The L-shaped springs (fig. 20) are placed in the starter jaw assembly so that the torque exerted by the shaft assembly during the travel of the piston from the top to the bottom of the cylinder must compress the L-springs in order that a solid connection will be established between the shaft assembly and the starter jaw assembly. The hollow screw tightens against the shaft assembly and not against the hub assembly, thereby securing a flexible attachment between the two assemblies. The L-springs and the fit of straight splines take care of the possibility of the two jaws contacting one another on the exact top of their teeth. The relative rotation between the shaft assembly and the external and internal splined shaft is about $\frac{5}{12}$ of a revolution in the direction of rotation of the external and internal splined shaft. Since the rotation between the fixed hub assembly and the external and internal splined shaft is $\frac{5}{12}$ of a revolution, the total rotation applied to the starter jaw is $\frac{5}{12} + \frac{5}{12}$ or $\frac{5}{6}$ of a revolution.

c. To permit the starter jaw to disengage from the engine crankshaft jaw, a means is provided to release the pressure in the cylinder when the piston has reached the position shown in the dotted lines. The hole in the piston through which the exhaust valve bolt passes is a free fit. The exhaust valve bolt is rigidly attached to the exhaust valve. When the piston reaches the position outlined by the dotted lines, further movement of the piston causes compression of the exhaust valve opening spring, which opens the exhaust valve. The exhaust valve moves sufficiently to allow the two balls in the stem of the exhaust valve to drop into the groove of the exhaust valve holder. When the pressure in the cylinder decreases sufficiently, the piston return spring forces the piston to return to its normal position. During the last $\frac{1}{4}$ inch of travel, the starter jaw bolt compresses the exhaust valve closing spring and seats the exhaust valve. The starter is now ready to receive the pressure developed by firing a fresh cartridge in the breech assembly.

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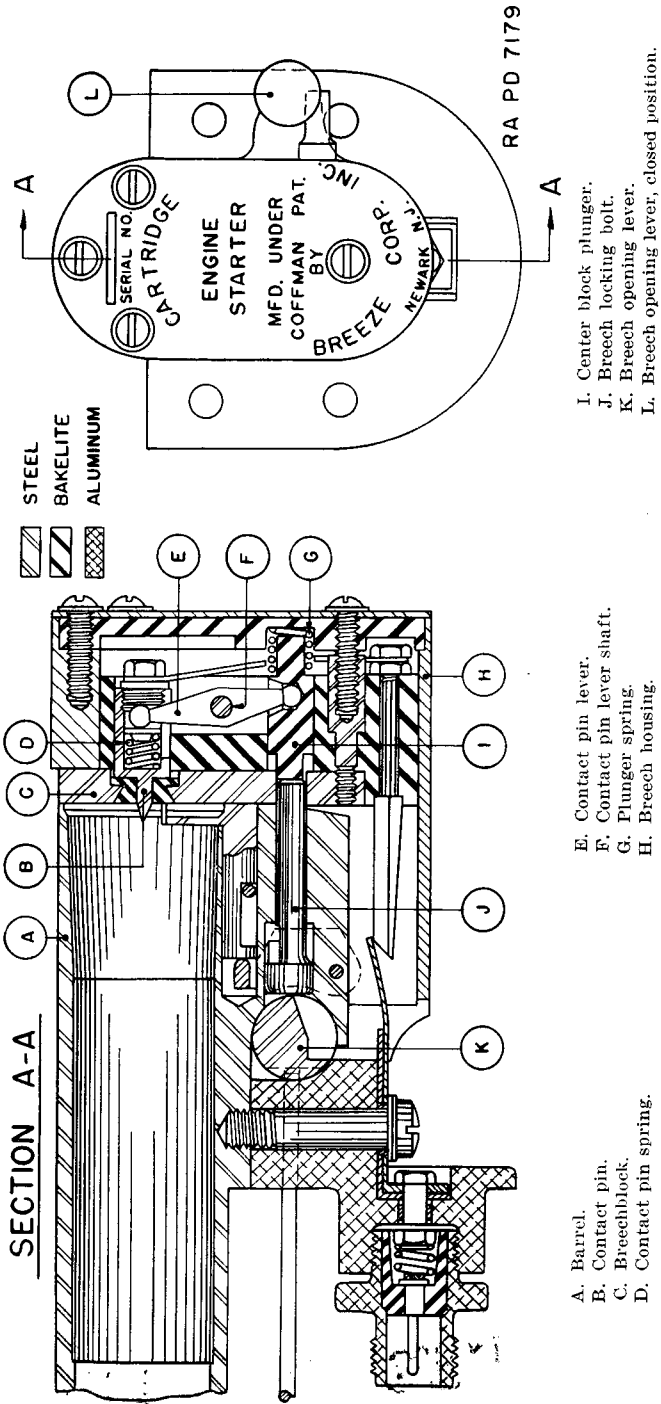


FIGURE 13.—Sectionalized view of breech assembly BZ-G1155.

7. Breech assembly operation.—All references under this title are to figure 13, unless otherwise stated.

a. The breech opening lever is a locking device. Gravity opens the breech when the lever is moved from a horizontal to a vertical position. To close the breech, the breech housing is returned to the closed position by hand, and the breech opening lever is moved to the horizontal position, thereby locking the breech housing in the closed position.

b. The breech opening lever functions within the breech housing when it is moved from the horizontal to the vertical position. The breech opening lever has three slots which act as cams. The slot nearest the handle opens the relief valve by moving the relief valve rod with a linear motion (fig. 9). The middle slot provides a recess to allow the breech locking bolt to move on a linear motion away from its hole in the breechblock. The movement of the breech locking bolt allows rotation of the breech housing assembly about the axis of the breech opening lever. The slot in the breech opening lever farthest away from the handle operates the breech locking bolt slide (fig. 6) which transmits the linear motion necessary to move the breech locking bolt away from its hole in the breechblock.

c. As the breech locking bolt moves out of its hole in the breechblock, the plunger spring (which is under compression) moves the center block plunger. A reversal of the linear movement of the center block plunger is transmitted to the contact pin by the contact pin lever rotating on the contact pin lever shaft. This withdraws the contact pin from contact with the cartridge case before the breech locking bolt is out of its hole in the breechblock.

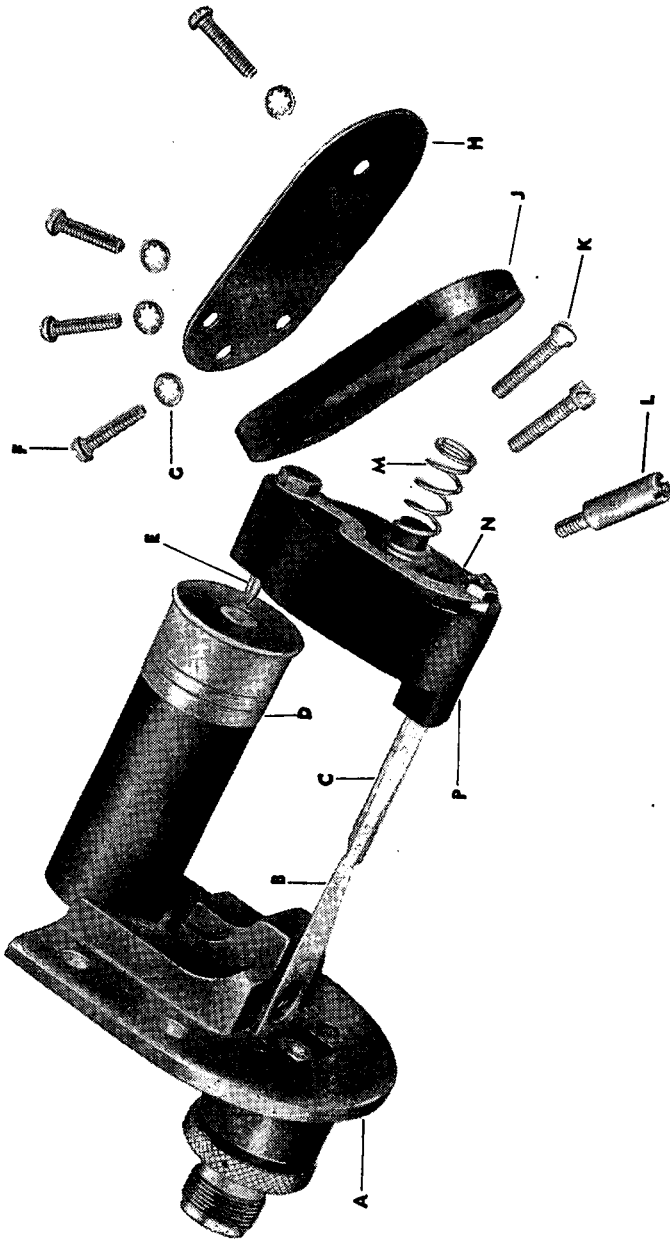
d. Opening the breech moves a shoulder inside the breech which operates the breech ejector lever (fig. 6) which moves the ejector with a linear motion, thereby loosening the fired cartridge and permitting the cartridge case to be removed by hand.

e. Holding the breech housing in the closed position and moving the breech opening lever from the vertical to the horizontal position reverses the operations outlined above with these two exceptions:

(1) The middle slot of the breech opening acts as a cam to force the breech locking bolt into its hole in the breechblock.

(2) The motion of the contact pin lever is transmitted to the contact pin through the contact pin spring, which keeps the contact pin firmly against the cartridge case, thereby assuring good electrical contact.

f. Figure 14 illustrates all the parts involved in the breech assembly between the conduit connection and the cartridge. All parts are in-



RA PD 5889
 L. Center block attaching stud.
 M. Center block plunger spring.
 N. Electrical connector.
 P. Center block assembly.

F. Breech end cover plate attaching screws.
 G. Lock washers.
 H. Breech end cover plate.
 J. Breech end plate.
 K. Center block attaching screws.

A. Flange assembly.
 B. Contact blade.
 C. Contact stem.
 D. Cartridge.
 E. Contact pin.

FIGURE 14.—Parts of electrical circuit of breech assembly BZ-G1155.

sulated, either by air, insulating strips or washers, or bakelite blocks. The flexible connector provides a positive circuit between the contact stem and pin.

8. Maintenance operations performed by using arm.—The following operations on the breech assembly and starter unit are performed by the first and second echelon, and instructions for them are to be found in TM 9-726.



RA PD 38870

FIGURE 15.—Cartridge for cartridge starter.

a. Replacement of—

- (1) Breech assembly.
- (2) Starter unit.
- (3) Inlet tube.
- (4) Exhaust tube.
- (5) Safety disk and holder.

(6) All parts of the electrical system to the mounting flange of the breech assembly.

b. Cleaning the barrel of the breech assembly.

c. Emergency firing method for a cartridge in the breech assembly.

9. Echelon break-down of maintenance operations.—*a. Definitions.*—The definitions given below are included so that the operation name may be correctly interpreted by those doing the work.

(1) *Service.*—Consists of cleaning, lubricating, tightening bolts and nuts, and making external adjustments of subassemblies or assemblies and controls.

(2) *Repair.*—Consists of making repairs to, or replacing a part, subassembly or assembly that can be accomplished without completely disassembling the subassembly or assembly, and does not require heavy welding or riveting, machining, fitting and/or alining.

(3) *Replace.*—Consists of removing the part, subassembly, or assembly from the vehicle and replacing it with a new, reconditioned, or rebuilt part, subassembly, or assembly.

(4) *Rebuild.*—Consists of completely reconditioning and placing in serviceable condition any unserviceable part, subassembly, or assembly of the motor vehicle, including welding, riveting, machining, fitting, alining, assembling, and testing.

b. Allocation of repair jobs.—The list below allocates the repair jobs on the cartridge starter.

<i>Unit and operation</i>	
Starter, cartridge type:	<i>Echelons</i>
Clean, service or replace.....	2d
Repair.....	3d
Rebuild.....	4th
Starter, breech and tube:	
Clean, service or replace.....	2d
Repair.....	3d
Rebuild.....	4th

SECTION III

MAINTENANCE AND INSPECTION OF VEHICLE

Schedule.....	Paragraph 10
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10. Schedule.—*a. Maintenance.*—(1) *Breech assembly.*—(a) If a longer cartridge is used than the one previously fired, clean the breech barrel with oil, penetrating, using a cotton swab on a cleaning rod. This operation is necessary to prevent the longer cartridge from sticking in the barrel.

(b) Clean the breech barrel after firing 50 cartridges.

(2) *Starter unit.*—(a) Clean the combustion chamber after firing 100 cartridges.

(b) Disassemble the starter unit for cleaning, inspection, lubrication, and repair after firing between 200 and 300 cartridges.

b. Inspection on vehicle.—(1) *Breech assembly.*—(a) Inspect breech barrel for foreign matter.

(b) Inspect contact pin for foreign matter, keeping in mind the possibility of a short circuit between the contact pin and the breech-block.

(c) Inspect the screw that attaches the mounting flange assembly to the breech barrel for tightness and presence of locking wire.

(d) Inspect the freedom of operation of the breech opening lever; if undue force is required to operate it, remove and overhaul the breech assembly.

(e) Close and lock the breech. Check to make sure current is supplied to the toggle switch that fires the cartridge. Close toggle switch and observe ammeter. If no current is being used from the battery of the tank, the ammeter will not show discharge. If the ammeter shows a discharge, a short circuit exists between the toggle switch and the contact pin of the breech assembly. (See par. 11.)

(f) Load the breech with a discharged cartridge case in which a direct electrical connection has been made between the portion of the case the contact pin contacts and the shell of the case. Close the starter toggle switch. If the test in (e) above showed no discharge on the ammeter, the ammeter should now show between 2 and 3 amperes discharge if the electrical system is satisfactory. If the ammeter shows no discharge, an open circuit exists. (See par. 11.)

(2) *Starter unit.*—(a) Check intake and exhaust tube connecting nuts for tightness.

(b) Check intake and exhaust tube for kinks or restrictions. Replace these tubes if a restriction is found.

(c) Check clamp support around cylinder. The clamp should be just tight enough around the cylinder so that a moderate tap of an ordinary hammer will move the clamp. If the support clamp is tighter than this the piston may stick in the cylinder.

(d) Inspect the starter vent holes (fig. 1) to make certain they are open.

(e) Check starter mounting flange nuts for tightness and presence of safety wire.

(f) Remove safety disk holder and inspect safety disk. If the original safety disk is blown, inspect the shearing ring for nicks before installing a new disk (G-22). Safety-wire the holder after installing the safety disk holder in the starter unit.

SECTION IV

TROUBLE SHOOTING ON VEHICLE

Breech assembly-----	Paragraph 11
Starter unit-----	12

11. **Breech assembly** (fig. 14).—*a. Cartridge fails to fire.*—(1) After making 3 attempts to fire the cartridge, wait 5 minutes and remove the cartridge from the breech barrel. If foreign matter is present in the recess in the cartridge base and the contact pin, clean these parts and fire another cartridge. If the cartridge fails to fire,

wait 5 minutes, remove the cartridge and proceed with the operation in step (2).

(2) Test the electrical circuit to the breech assembly for a short or open circuit by disconnecting the conduit coupling at the mounting flange assembly. While one man keeps the cartridge starter toggle switch on the front instrument panel closed, ground the exposed wire. If the circuit is satisfactory the ammeter should show between 2 and 3 amperes discharge, if no current is being used elsewhere. If no movement of the ammeter occurs, an open circuit exists between the hot wire to the switch and the grounded wire. If the ammeter reads between 2 and 3 amperes discharge when the switch is closed whether the exposed wire is grounded or not, a short circuit exists between the switch and the exposed wire. If this circuit is defective, repair it. Consult TM 9-726 for the necessary information.

(3) If the electrical circuit to the mounting flange was defective and has been repaired, connect the conduit to the flange mounting and attempt to fire another cartridge. If the cartridge fails to fire, wait 5 minutes, remove the cartridge, and proceed with step (4).

(4) Remove the four screws attaching the breech end plate cover and breech end plate to the breech housing. Remove the breech end plate cover, breech end plate and center block plunger spring. With the breech open, check the operation of the contact pin by moving the center block plunger in and out with the fingers. If the contact pin does not move smoothly, and easily, through its hole in the center block, proceed with the disassembly in step (5) and all of step (6). If moisture or foreign matter in sufficient quantity is present to cause a short circuit between the center block assembly and the breech housing, proceed with step (5). If the electrical connector is broken, and the above checks are satisfactory, replace the electrical connector, reassemble the housing assembly and attempt to fire a fresh cartridge. If the cartridge does not fire, wait 5 minutes, remove the cartridge, and proceed with step (7).

(5) Remove the two screws and the stud attaching the center block assembly to the breech block. Before removing the center block assembly, close the breech and lock it in the closed position. If the center block assembly springs away from the housing assembly slightly, the contact between the contact stem of the center block assembly and the contact blade of the mounting flange assembly is satisfactory. If this action is not felt or observed, remove the center block assembly and bend the contact blade down slightly until a spring contact is made between the center block assembly contact stem and the mounting flange assembly contact blade. Remove,

clean, dry, and inspect the center block assembly for possibilities of a short circuit between this assembly and the breech housing. Reassemble the breech housing assembly and attempt to fire a cartridge. If the cartridge fails to fire, wait 5 minutes, remove the cartridge, and proceed with step (6).

(6) Remove the four screws attaching the breechlock to the breech housing. With the breech in the open position, remove the breechblock. Reverse the above sequence of operations to install a new breechblock. Reassemble the housing assembly and attempt to fire a fresh cartridge. If the cartridge does not fire, wait 5 minutes, remove the cartridge, and proceed with step (7).

(7) The electrical trouble has now been traced down to either a short or open circuit in the flange assembly. (fig. 8). Remove the breech assembly from the vehicle (par. 13), and remove the flange assembly (par. 15) from the breech assembly. Inspect the flange assembly for possible short or open circuits. Disassemble and inspect each part of the flange assembly. Reassemble the breech assembly, install in vehicle, and fire a fresh cartridge.

b. Reasons for complete breech assembly overhaul.—(1) Relief valve leaks or does not function.

- (2) Breech opening lever jams.
- (3) Broken breech assembling screw.
- (4) Broken or bent ejector.

12. Starter unit.—*a. Insufficient torque to start engine.*—(1) Inspect cartridge for size. Use the proper size cartridge (see par. 3b).

(2) Inspect intake tube and exhaust tube connecting nuts; tighten if necessary.

(3) Inspect intake tube for restrictions (kinks, flat places, or holes). The intake tube should be not less than 0.656-inch outer diameter after bending. If a severe restriction or broken intake tube is found, replace the tube and fire another cartridge.

b. Repeated blowing of safety disk.—(1) Remove the safety disk holder and inspect the shearing ring of the safety disk for nicks before installing a new safety disk G-22. The shearing ring is a light press fit in the holder. If the shearing ring is defective, replace it. Install the safety disk holder. Fire another cartridge. If the disk blows again, proceed with step (2).

(2) Disconnect the inlet and exhaust tube and remove the combustion chamber from the cylinder. Pull the exhaust valve holder away from the disk. Pull the disk away from the cylinder, letting it rest on the exhaust valve bolt. Clean the disk, taking particular care to remove all the foreign matter in the holes of the disk. Clean the

interior of the combustion chamber. Reassemble the starter unit. Fire another cartridge. If the safety disk blows, remove the starter unit from the vehicle and give it a complete overhaul.

c. Piston sticks or is sluggish in return to normal position.—(1) Inspect exhaust tube for restriction. The end of the exhaust tube must be wide open and the outer diameter of the tube must not be less than 0.656 inch at any point.

(2) See paragraph 10*b*(2)(*c*) for adjustment and tightness of the support clamp. If the piston action is not normal after firing another cartridge, remove the starter unit from the vehicle and give it a complete overhaul.

SECTION V

REMOVAL OF CARTRIDGE STARTER FROM VEHICLE

	Paragraph
Removal of breech assembly-----	13
Removal of starter unit-----	14

13. Removal of breech assembly.

NOTE.—This removal procedure is for the light tank M3. Structural differences of the light and medium tanks using cartridge starter G-1154R may vary this procedure slightly.

- a.* Disconnect the intake tube from the breech assembly.
- b.* Disconnect the conduit from the breech assembly at the conduit coupling on the mounting flange assembly.
- c.* Remove the bolts and nuts attaching the mounting flange assembly to the bulkhead of the tank.
- d.* Remove the breech assembly.

14. Removal of starter unit.—Use the following procedure:

- a.* Disconnect intake and exhaust tubes from the starter unit.
- b.* Loosen support clamp bolt and nut on starter.
- c.* Remove bolts and nuts from clamp end of support arms.
- d.* Remove nuts from accessory case studs attaching starter unit to engine.
- e.* Remove starter with support clamp.

SECTION VI

DISASSEMBLY OF COMPONENTS

	Paragraph
Breech assembly-----	15
Starter unit-----	16

15. Breech assembly.—*a. Equipment.*—Use the following equipment to disassemble the breech assembly:

Pliers.	Wrench, 1/4-inch, opened or socket.
Punch, 3/32-inch.	Wrench, 5/16-inch, socket with handle.
Screw driver.	Wrench, 3/8-inch, open-end.
Small hammer.	Wrench, 3/8-inch, socket with handle.
	Wrench, 1/2-inch box or socket with handle.

b. Procedure.

- (1) *Separate mounting flange assembly from breech assembly (fig. 9).* Pliers.
Screw driver.

Use a pair of pliers to remove the locking wire from breech assembling screw. With a screw driver, remove the breech assembling screw from the breech assembly, together with the breech assembling screw brass washer, and fiber washers. Separate the flange assembly from the breech assembly. Remove the relief valve rod from the flange assembly.

- (2) *Disassembly of mounting flange assembly (fig. 8).* Pliers.
Wrench, 3/8-inch, socket with handle.
Wrench, 5/16-inch, socket with handle.

Use a pair of pliers to remove the locking wire from the conduit housing assembly, and to remove the housing assembly from the flange. Lift out the base assembly from the housing assembly. Hold the head of the contact blade attaching screw with a 3/8-inch socket wrench with handle, and remove the contact blade attaching screw nut from the screw, using a 5/16-inch socket wrench with handle. Remove lock washer, contact blade, and contact blade insulator from the screw. Remove the contact blade attaching screw from the flange. Remove washers from the contact blade attaching screw.

- (3) *Separate barrel assembly from complete breech housing assembly.* Pliers.

Open the breech opening lever halfway and separate the barrel assembly from the complete breech housing assembly. Remove the breech locking bolt slide and the breech locking bolt from the barrel assembly.

- (4) *Disassembly of barrel assembly (fig. 7).* Pliers.

Remove one cotter pin from the breech ejector lever spindle and one from the ejector pin. Remove the breech ejector lever spindle washer from the breech ejector lever spindle. Remove the breech ejector lever spindle from the barrel, together with the breech ejector lever. Remove the breech ejector lever from the spindle. Remove the ejector pin from the barrel. Remove the ejector from the barrel.

(5) *Disassembly of the relief valve assembly* (fig. 6).

Pliers.

Wrench, $\frac{1}{2}$ -inch, box or socket with handle.

Do not remove the relief valve body if it is firmly attached to the barrel. With a pair of pliers, remove the cotter pin from the stem of the relief valve. Remove the locking wire from breech relief valve screw. Use a $\frac{1}{2}$ -inch box or socket wrench to remove the breech relief valve screw from the breech relief valve body. Remove the breech relief valve screw gasket from the breech relief valve screw. Remove the breech relief valve from the breech relief valve body.

(6) *Separate center block assembly from complete breech housing assembly* (fig. 14).

Screw driver.

With a screw driver, remove from the complete housing assembly the four screws which attach the breech and cover plate to the complete housing assembly. Remove the breech end cover plate, the breech end plate and the center block plunger spring from the complete breech housing assembly. Remove one lock washer from each of the four screws. Using a screw driver, remove from the complete housing assembly the two screws and one stud which attach the center block assembly to the complete housing assembly. Remove the center block assembly from the housing assembly.

(7) *Separate breech block assembly from breech housing* (fig. 10).

Screw driver.

Remove four screws from the breech housing which attach the breechblock assembly to the housing. Remove the breechblock assembly from the housing.

(8) *Remove opening lever stop from breech housing.*

Wrench, $\frac{3}{8}$ -inch, open-end.
Pliers.

Use a $\frac{3}{8}$ -inch open-end wrench to remove the breech opening lever stop nut from the breech opening lever stop. With a pair of pliers remove the breech opening lever stop from the breech housing.

(9) *Disassembly of center block assembly* (fig. 11).

Wrench, $\frac{1}{4}$ -inch, open-end or socket.

Wrench, $\frac{5}{16}$ -inch, socket.

Punch, $\frac{3}{32}$ -inch.

Small hammer.

Screw driver.

With a $\frac{1}{4}$ -inch open-end or socket wrench, remove the nut from the contact stem, and lift the end of the electrical connector away

from the contact stem. With a 1/4-inch wrench remove the second nut on the contact stem and remove contact stem from the center block. With a 5/16-inch socket wrench, remove the contact screw nut from the contact pin screw, and remove the electrical connector from the contact pin screw. With a 3/32-inch punch and a small hammer, drive the contact pin lever shaft out of the center block and remove the contact pin plunger, contact pin lever, and contact pin with contact pin spring, contact pin spring seat, and contact pin screw. Separate the plunger from the lever. With a screw driver remove the contact pin screw from the contact pin. Remove the lever from the contact pin. Remove the seat and spring from the contact pin.

16. Starter unit.—*a. Equipment* (fig. 16).—Use the following equipment to disassemble the starter unit:

- | | |
|---|--|
| Clamp, special. | Rod, 3/8-inch diameter, 1 inch long. |
| Exhaust valve control bolt clamp. | Screw driver. |
| Hammer. | Special screw driver for starter jaw bolt. |
| Pliers. | Spring compressor. |
| Pin punch with end ground to an angle or screw driver blade for removing safety disk. | Vise, soft metal jaws. |
| Wire with end bent into a small hook for removing exhaust valve closing spring. | Two wrenches, 1/2-inch open-end. |
| Punch, drift, 5/32-inch. | Two wrenches, 1 1/2-inch open-end. |
| Rod, 5/8-inch diameter, 14 inches long or dummy nut for combustion chamber intake connection. | Wrench, 5/16-inch open-end. |
| | Wrench, 3/8-inch open-end. |
| | Wrench, 7/8-inch, box or socket. |
| | Wrench, spanner for hollow screw. |

b. Procedure.

(1) *Clamping starter unit in vise* (fig. 1).

- | |
|--------------------------------------|
| Rod, 3/8-inch diameter, 1 inch long. |
| Vise, soft metal jaws. |

Cover the jaws of the vise with soft metal. Insert a piece of rod 3/8-inch diameter and about 1 inch long in a hole of the mounting flange. Clamp the mounting flange of the starter unit in the vice, permitting the piece of rod inserted through a mounting flange hole

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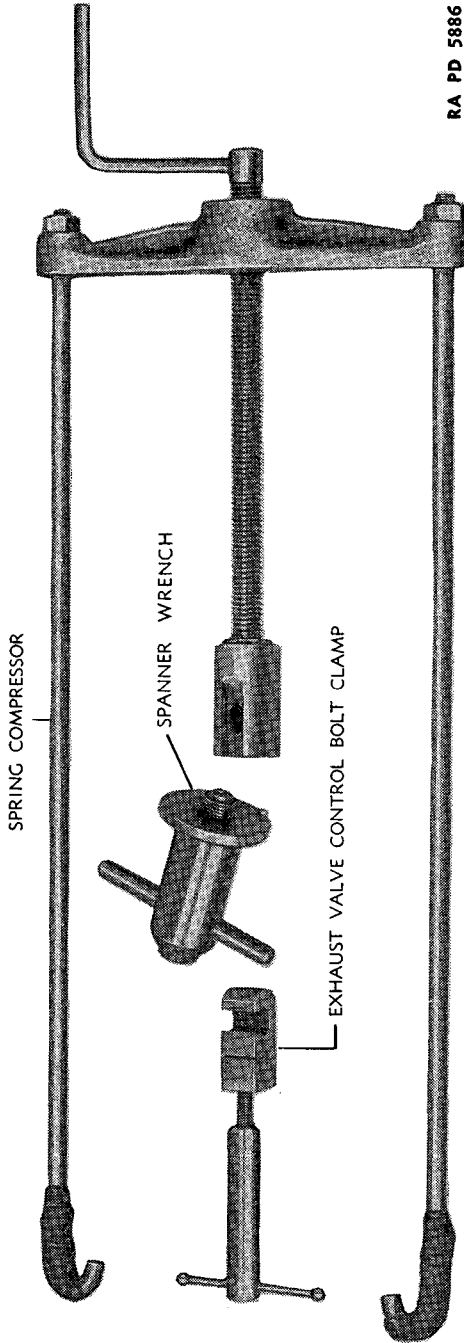


FIGURE 16.—Special overhaul tools for starter unit 13Z-G1153R.

to rest on the jaws of the vise on the left side of the starter unit when viewed from the combustion chamber end.

(2) *Remove safety disk holder assembly from combustion chamber.* Wrench, $\frac{7}{8}$ -inch box or socket.
Pliers.

With pliers remove the locking wire from the safety disk holder assembly. Use a $\frac{7}{8}$ -inch box or socket wrench to remove the holder from the combustion chamber.

(3) *Removing safety disk from holder assembly (fig. 2).* Pin punch with end ground to an angle, or a screw driver blade.

Using the punch or screw driver, remove the safety disk from the holder assembly. Do not scratch or nick the shearing ring.

(4) *Remove shearing ring from safety disk holder.*

If the shearing ring is nicked or scratched, remove it from the holder. The shearing ring is a light press fit in the holder.

(5) *Remove combustion chamber from cylinder (fig. 3).* Rod, $\frac{5}{8}$ -inch diameter, 14 inches long or dummy nut from combustion chamber intake connection.
Hammer.

Insert a $\frac{5}{8}$ -inch rod 14 inches long in the intake connection of the combustion chamber. Tap rod with a hammer in such a direction as to rotate combustion chamber counterclockwise when viewed from combustion chamber end. Seizing or sticking of the threads rarely occurs. If seizing does occur, soak this part in oil, penetrating, for $\frac{1}{2}$ hour. Work combustion chamber back and forth to free the thread. Remove the combustion chamber with copper gasket from the cylinder. Remove the gasket from the combustion chamber.

(6) *Remove exhaust valve from exhaust valve control bolt (fig. 3).* Screw driver.
Wrench, $\frac{3}{8}$ -inch open-end.
Clamp, special.

Slide the exhaust valve bolt away from the perforated disk using a screw driver. Fold the ear of the clip away from the exhaust valve bolt lock nut. With a clamp similar to the one illustrated in figure 16, prevent the exhaust valve control bolt from turning. Use a $\frac{3}{8}$ -inch open-end wrench to loosen the exhaust valve bolt lock nut. Remove the exhaust valve with exhaust valve housing from the exhaust valve

control bolt. From the exhaust valve control bolt, remove spacer, the lock clip, and the lock nut.

(7) *Remove perforated disk from cylinder.*

Lift disk away from cylinder.

(8) *Remove exhaust valve from exhaust valve housing* (fig. 3).

Push the exhaust valve out of its housing. From the exhaust valve stem, remove two balls and one spring.

(9) *Remove cylinder from Wrench, 1/2-inch open end. starter unit* (fig. 3).

Hold cylinder clamp ring bolt with a 1/2-inch open-end wrench and remove cylinder clamp ring bolt safety nut. Remove the plain steel washer from the cylinder clamp ring bolt. Repeat the above procedure to remove the second nut and washer from the second clamp ring bolt. Remove the two cylinder clamp ring bolts from the clamp ring set. Remove the clamp rings from the starter unit. To prevent disengagement of the hub assembly from the aluminum housing assembly, hold piston in position with a piece of wood, for example, a hammer handle, and slide the cylinder off the piston.

(10) *Remove piston with bronze external and internal helical splined shaft from starter unit* (fig. 17).

Screw driver.
Small pliers.

With a screw driver, remove the lock screw from the piston head that locks the starter jaw bolt to the piston. Remove lock washer from the lock screw. With a screw driver and a pair of small pliers remove the group assembly plug locking ring from the hollow screw which attaches the starter jaw assembly to the shaft assembly. With a screw driver remove the group plug assembly from the hollow screw. Install spring compressor by hooking the hooks 180° apart in the aluminum housing assembly mounting flange holes. Keep the axis of the threaded rod of the compressor parallel with the axis of piston travel and the end of the rod bearing on the center of the piston head. Tighten up on the spring compressor until the piston travels about 1 inch toward the mounting flange of the aluminum housing assembly. Insert a special screw driver through the hole in the hollow screw left by the removal of the plug group assembly. (This screw driver has the following dimensions: blade, 1 1/32 inch wide, 3/64 inch thick; shank, 6 1/2 inches long, and a maximum diameter of 1 1/32 inch.) Twist screw driver around until the bit of the screw

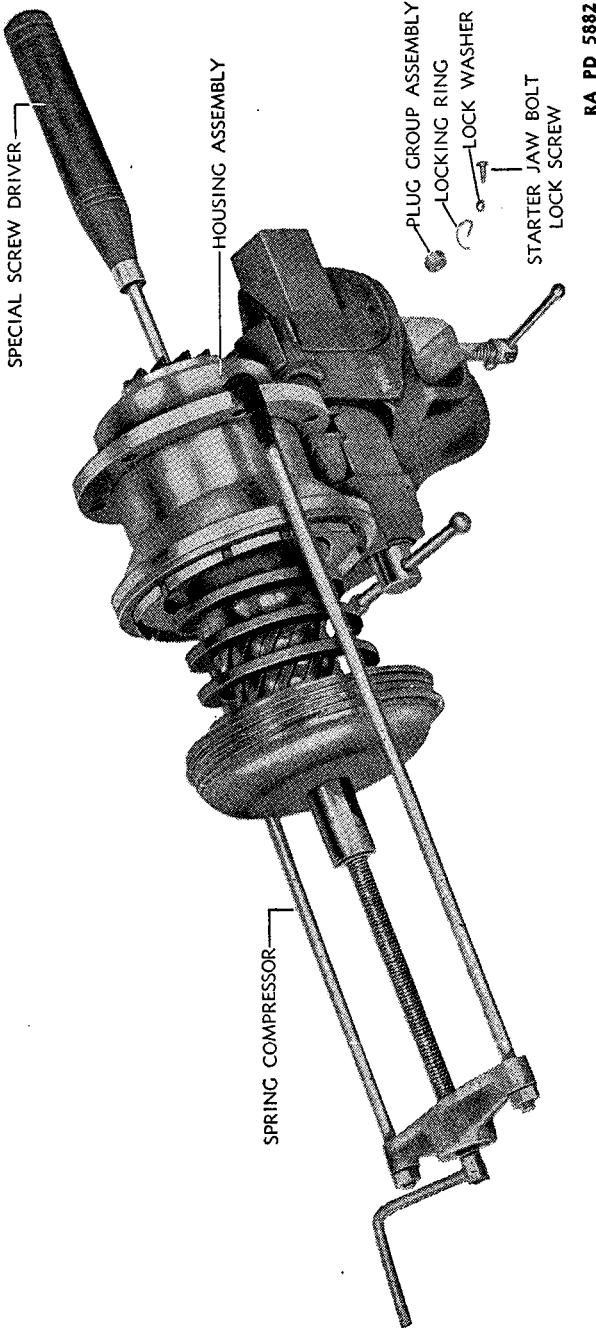


FIGURE 17.—Removal of piston from starter unit BZ-G 1153R.

driver enters the slot of the starter jaw bolt. Unscrew the starter jaw bolt until it is free of the piston. Unscrew spring compressor and remove the piston with the bronze external and internal helical splined shaft attached. Remove the exhaust valve control bolt with exhaust valve opening spring from the starter jaw bolt. Remove the piston return spring from the starter unit. Remove the exhaust valve opening spring from the exhaust valve control bolt. Remove the rings from the piston.

(11) *Remove exhaust valve closing spring from starter jaw bolt.* Wire with end bent into a small hook.

Insert the hooked wire in the starter jaw bolt and withdraw the exhaust valve closing spring.

(12) *Separate piston from bronze external and internal helical splined shaft.* Screw driver.

Lay piston head down on table. With a screw driver remove the lock ring from the groove of the piston. Remove the bronze shaft from the piston.

(13) *Separate hub assembly from housing assembly.*

Hold steel shaft assembly in place by hand and remove the hub assembly from the aluminum housing assembly.

(14) *Remove steel shaft assembly with starter jaw assembly from aluminum housing assembly.*

Pull steel shaft away from housing.

(15) *Separate starter jaw assembly from steel shaft assembly.* Screw driver. Wrench, spanner for hollow screw.

With a screw driver bend back the ear of the hollow screw locking plate sufficiently to clear the hollow screw, then with special spanner wrench remove the hollow screw from the steel shaft assembly. Remove the locking plate and the hollow screw copper gasket from the recess of the starter jaw assembly. Remove the steel shaft assembly from the starter jaw assembly. Remove the starter jaw bolt from the steel shaft assembly. Remove the starter jaw assembly from the steel shaft assembly.

(16) *Remove steel shaft finger spring from steel shaft assembly.* Hammer. Punch, drift, 5/32-inch. (fig. 4).

With a hammer and a 5/32-inch drift punch, drive the finger spring rivet out of the side wall of the steel shaft. Remove the finger spring from the steel shaft.

(17) *Remove L-shaped spring from the starter jaw assembly.*

With the fingers, push the short end of each of the four springs into the groove of the starter jaw assembly. Clasp the long end of the spring with fingers, pull and rotate spring clockwise. Remove four springs from the starter jaw assembly.

(18) *Remove starter jaw thrust ball bearing from aluminum housing assembly.* Scriber or scratch awl.

With a scriber or awl remove lock ring from the aluminum housing assembly. Remove the bearing from the housing.

SECTION VII

INSPECTION, REPAIR, AND ADJUSTMENT

	Paragraph
Cleaning of parts.....	17
Breech assembly.....	18
Starter unit.....	19

17. Cleaning of parts.—Remove the grease, oil, carbon, and foreign matter from all the metal parts of the breech assembly and starter unit. Use solvent, dry-cleaning, or kerosene. It is extremely important that all carbon deposits be removed from the inside of the starter jaw bolt and the outside of the exhaust valve control bolt. Clean all parts of the breech assembly used for insulation purposes thoroughly, using a rag moistened with dry-cleaning solvent.

18. Breech assembly.—*a. General.*—Inspect all metal parts to ascertain if any bending, scratching, or distortion has occurred. Carefully inspect the center block, plunger, breech end plate, and all insulating strips, and washers for the presence of cracks or foreign matter detrimental to the insulating properties of these parts.

b. Relief valve rod clearance (fig. 9).—If a new relief valve rod, breech opening lever, barrel, relief valve body, relief valve, or breech housing is used on assembling the breech assembly, the clearance of the relief valve rod with the slot when the breech and breech opening lever are closed must be checked. Figure 9 illustrates the point where the clearance may be measured. The new relief valve rods are made a little long. Grind the end contacting the breech opening

lever until 1/64 inch clearance is obtained. When any of the above-mentioned parts are replaced, use a new rod, if the old rod is too short.

19. Starter unit.—*a. General.*—Make a visual inspection of all parts to ascertain if any bending, scratching, or distortion has occurred. Replace those parts whose malfunction is evident. Using a fine file, remove all burrs and sharp edges from splined shafts. If the cylinder is distorted, not smooth, or shows score marks, replace it. If the tool marks cannot be seen on the old piston rings, replace them. The walls of the piston ring grooves rest on the bottom of the cylinder. Due to the weight supported by this small surface, sometimes the outer diameter of the piston if measured at this point will be 0.005 inch or more, less than the diameter of the piston measured at another point. If this has occurred, replace the piston. The piston and starter jaw bolt are mated to each other as described in paragraph 4g. If either the piston or starter jaw bolt are defective, both must be replaced. Paragraph 21b(10), gives instructions necessary to perform this operation. Examine all internal and external threads for deformation.

b. Parts that must be replaced each time starter unit is given major overhaul (fig. 18).—Replace all parts listed, regardless of condition, each time the starter unit is given a major overhaul.

- (1) Clip, exhaust valve control bolt lock nut, BZ-G1543.
- (2) Disk, safety, BZ-G22.
- (3) Gasket, hollow screw, BZ-G130.
- (4) Gasket, combustion chamber, BZ-G131.
- (5) Plate, hollow screw locking, BZ-G1290.
- (6) Ring, hollow screw group plug assembly locking, BZ-G54.
- (7) Rivet, BZ-G9.
- (8) Screw, starter jaw bolt lock, BZ-G11.
- (9) Spring, exhaust valve closing and opening, BZ-G140.
- (10) Spring, exhaust valve locking, BZ-G139.
- (11) Spring, starter jaw assembly L-shaped, BZ-G123.
- (12) Spring, tubular, BZ-G8.
- (13) Washer, lock, BECX1D.

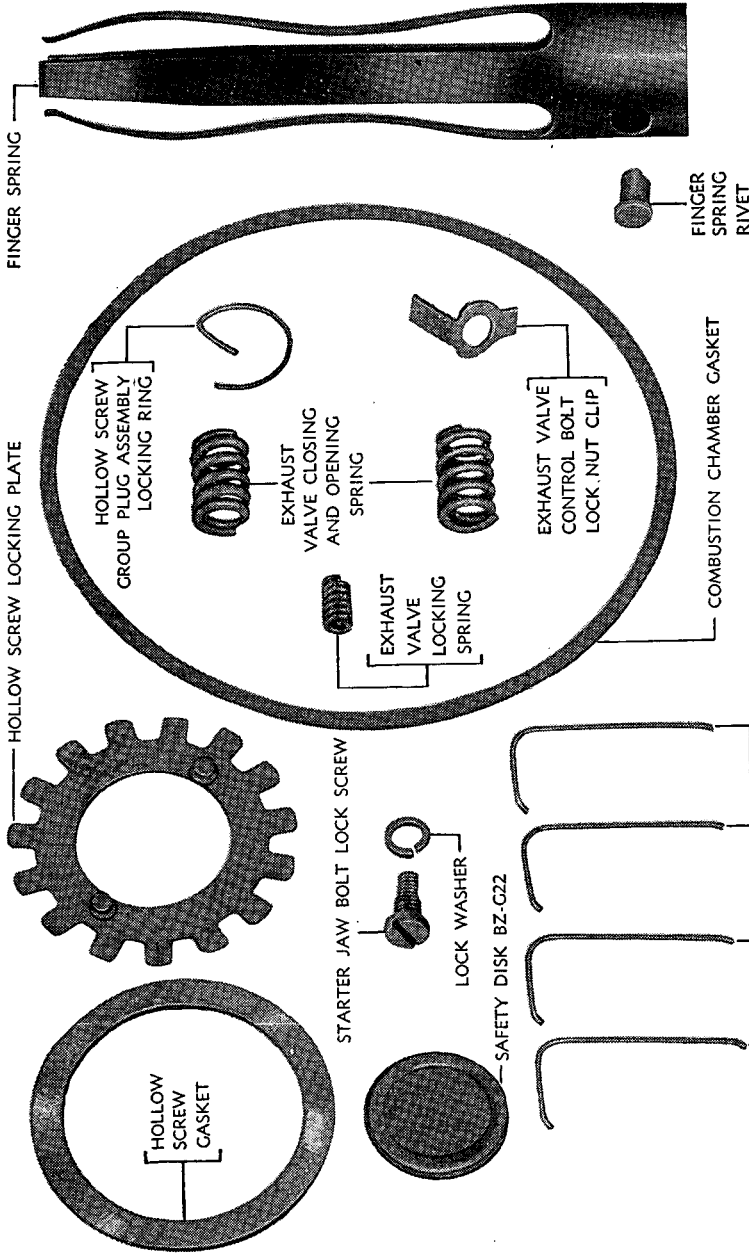


FIGURE 18.—Parts of starter unit to be replaced at every major overhaul.

SECTION VIII

ASSEMBLY OF COMPONENTS

Breech assembly-----	Paragraph 20
Starter unit-----	21

20. Breech assembly.—a. Equipment.

- | | |
|-------------------------|--|
| Pliers. | Wrench, 1/4-inch, open-end or socket w/handle. |
| Punch, 3/32-inch. | Wrench, 5/16-inch socket w/handle. |
| Rod, 1/4-inch diameter. | Wrench, 3/8-inch, open-end. |
| Screw driver. | Wrench, 3/8-inch socket w/handle. |
| Small hammer. | Wrench, 1/2-inch, box or socket w/handle. |

b. Procedure.—(1) Lubrication.—(a) thoroughly grease the following parts with grease, general purpose, No. 0, before proceeding:

1. Breech locking bolt.
2. Cartridge ejector.
3. Contact pin lever.
4. Ejector pin lever.
5. Ejector pin.
6. Contact pin.
7. Contact pin spring seat.
8. Ejector lever spindle.
9. Contact pin spring.

(b) Apply a few drops of oil, engine, SAE 10, on the contact pin lever shaft before installing it in the center block.

(2) *Assembly of center block assembly (fig. 11).*

- Small hammer.
- Punch, 3/32-inch.
- Screw driver.
- Wrench, 1/4-inch, socket.
- Wrench, 5/16-inch, socket.

Install the following parts in the contact pin in the order named. Install the contact pin spring, seat lever, and, with a screw driver, install the contact screw. Place the other end of the contact pin lever in the recess of the contact pin lever plunger, with the longer end of the plunger pointing in the same direction as the contact pin and parallel to it. Place these parts as a unit in the recess and holes provided for them in the center block. Line up the hole in the contact pin lever with the hole provided for the contact pin lever shaft in the center block. Using a hammer and a 3/32-inch punch,

install the contact pin lever shaft so that its ends are equidistant from the outside of the center block. Seal both exposed ends of the contact pin lever shaft with a good grade of nonconducting sealing wax; otherwise an electrical short circuit may occur. Install the contact stem in the center block, pointing the square section parallel with the contact pin and in the same direction. Place the slanting end toward the contact pin and parallel with the axis of the breech opening lever. With a $\frac{1}{4}$ -inch wrench, install the nut necessary to hold the contact pin to the center block. Connect the contact screw and contact stem by installing the electrical connector, the threaded portion of the contact stem passing through the hole in the curved end of the electrical connector. Socket wrenches $\frac{1}{4}$ -inch and $\frac{5}{16}$ -inch are necessary to install the nuts on the contact stem and contact screw, respectively, to hold the electrical connector in place. Install these nuts.

(3) *Install breech opening lever stop in breech housing.* Pliers.
Wrench, $\frac{3}{8}$ -inch, open-end.

With a pair of pliers, install the stop in the breech housing. With a $\frac{3}{8}$ -inch open-end wrench, install the nut on the stop necessary to hold the stop in place.

(4) *Install breechblock assembly in breech housing assembly.* Screw driver.

Place breechblock in housing. Match tapped holes of breechblock with screw slip holes in housing. With a screw driver, install four screws to hold the breechblock to the housing.

(5) *Install center block assembly in breech housing assembly.* Screw driver.

Place the center block in the housing. With a screw driver install two screws and a stud to hold the center block to the breech housing assembly.

(6) *Install contact plunger spring breech end and cover plates to breech housing assembly.* Screw driver.

The end of the contact pin plunger acts as a guide for the contact pin plunger spring. Install the spring on the plunger with the end of the spring resting against the shoulder of the plunger. Place the breech end plate in position, so that the spring drops into the flat bottom hole of the end plate. Place the breech end cover plate with the label outside against the breech end plate. Match up the holes in the plates with the corresponding holes in the breech

housing. With a screw driver install four screws in the breech housing to fasten these parts to the housing.

(7) *Assembly of relief valve assembly.* Rod, $\frac{1}{4}$ -inch diameter.
Wrench, $\frac{1}{2}$ -inch, box or socket w/handle.

Pliers.

Place the relief valve in the relief valve body. With a piece of rod of $\frac{1}{4}$ -inch diameter to hold the relief valve on its seat, install the relief valve spring and cap, holding them in position by inserting a cotter pin through the hole of the valve stem with the spring and cap between the body and cotter pin. Place relief valve screw gasket on relief valve screw. With a $\frac{1}{2}$ -inch wrench, install screw with gasket to relief valve body. Install relief valve assembly to barrel, with axis of valve parallel to barrel and cotter pin toward breech opening lever. With pliers, safety-wire the relief valve screw.

(8) *Assembly of barrel assembly*
(figs. 6 and 7).

Place the cartridge ejector in its hole in the barrel. Place ejector pin in its hole in barrel with the head of the pin on right side when looking at the breech of the barrel. Install cotter pin through the cross hole of the ejector pin to attach the ejector and ejector pin to the barrel. Slip the breech ejector lever spindle through the hole of the breech ejector lever with the prong away from the head of the spindle. Place the spindle with lever in its hole in the barrel, with the head and lever of the spindle on the same side of the barrel as the head of the ejector pin. Make sure that the bent prong of the ejector lever contacts the ejector. Install the plain steel washer on the spindle and attach to the barrel by installing the cotter pin through the cross hole in the spindle. Insert the breech locking bolt in its hole in the barrel as shown in figure 6. Place the breech locking bolt slide as shown in figure 6.

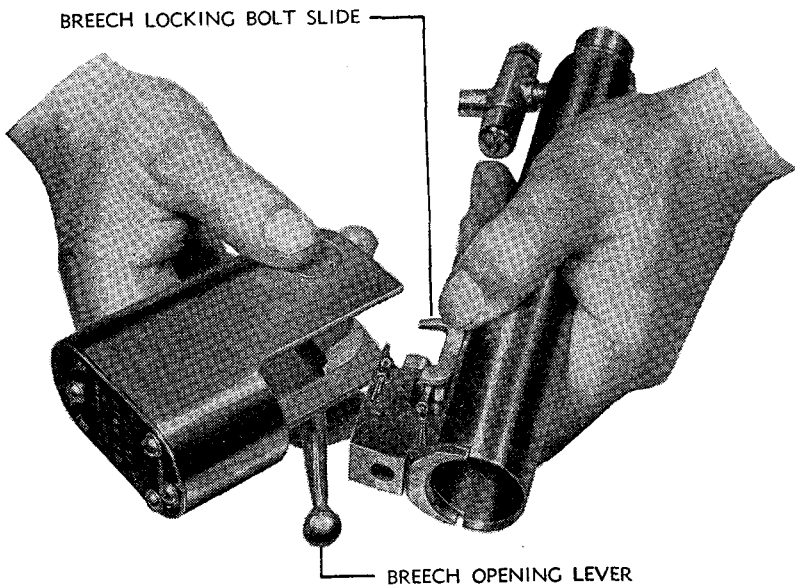
(9) *Join barrel assembly and complete breech housing assembly* (fig. 19).

Place the breech opening lever in its hole in the complete breech housing assembly. Grasp the housing assembly with lever in the right hand and hold the opening lever in the halfway position (midway between closed and open) with the first and second fingers. Hold the housing with lever so the axis of the lever is vertical, and the handle of the lever is beneath the housing. Grasp the barrel assembly with breech locking bolt and slide in the position shown in figure 19, with the left hand, keeping breech locking bolt slide in position with the tip of the thumb. From about a 45° angle between the axis of the

barrel and the axis of the contact pin of the complete breech housing assembly, join the barrel assembly with the breech housing assembly. Slight movement of the breech opening lever aids this process. Be careful that the breech locking bolt slide stays in its recess in the barrel assembly, otherwise it will be impossible to pass this slide around the shaft part of the breech opening lever. Hold the breech in the closed position and close the breech opening lever.

(10) *Assembly of mounting flange assembly* (fig. 8). Wrench, $\frac{5}{16}$ -inch, socket.

Insert the contact blade attaching screw through the holes in the insulating washer and collar in the order mentioned. Insert the screw



RA PD 7181

FIGURE 19.—Joining barrel and breech housing—breech assembly BZ-G1155.

in its hole in the mounting flange so that the head of the screw is in the large tapped hole of the mounting flange. Hold the screw in position with a finger; place the contact blade insulator, strip, and lock washer, and with a $\frac{5}{16}$ -inch socket wrench, install the nut on the contact blade attaching screw to hold these parts together. The parts are assembled in the order named. Two types of electrical conduit connectors are used. Both types are similar in nature to other electrical fittings used throughout the vehicle. Install these electrical connectors.

(11) *Relief valve rod adjustment* (fig. 9).

With the breech housing and opening lever closed, hold the relief valve rod in the position shown in figure 9. The correct amount of clearance between the slot in the breech opening lever and the end of the rod is $\frac{1}{64}$ inch. If the clearance is more, use a new rod ground to the correct length. If the clearance is less, grind the rod to the correct length.

(12) *Attach mounting flange assembly to breech assembly* (fig. 9). Screw driver.
Pliers.

Assemble the washers under the head of the breech assembling screw in this order: brass washer, flat insulating washer, and insulating collar or washer. Insert the relief valve rod through its hole in the relief valve, with the head of the relief valve rod on the same side of the mounting flange as the large tapped boss for the electrical connection. First, place the stem in the hole of the relief valve rod head, slide the mounting flange far enough toward the relief valve for the contact blade to clear the contact stem, and lower the relief valve rod into its slot in the breech lever. Keep the contact blade between the cartridge ejector and the contact stem and slide the mounting flange toward the complete breech housing assembly until the tapped hole in the barrel lines up with the slip hole for the breech assembling screw. Install the breech assembling screw. Safety-wire the breech assembling screw and be careful that no part of the safety wire touches the contact blade. If that happens a short circuit will result.

21. Starter unit.—*a. Equipment* (fig. 16).

Arbor press.	Rod, $\frac{3}{8}$ -inch diameter, 1 inch long.
Drill press.	long.
Exhaust valve control bolt clamp.	Screw driver. Sealing tape.
File.	Soft hammer.
Hammer.	Special screw driver for starter jaw bolt.
Lathe.	
Narrow machinist's scale, 6 inches long.	Special wrench. Spring compressor.
Piston ring compressor.	Steel rod, $\frac{5}{8}$ -inch diameter, 12 inches long.
Pliers.	
Pointed instrument.	Two screw drivers.
Rod, $\frac{5}{8}$ -inch diameter, 14 inches long or dummy nut for combustion chamber intake connection.	Wrench, $\frac{3}{8}$ -inch, open-end Wrench, $\frac{1}{2}$ -inch, open-end. Wrench, $\frac{7}{8}$ -inch, box or socket w/handle. Wrench, spanner for hollow screw.

b. Procedure.—(1) *Lubrication.*—(a) Use grease, graphite, light, to grease all of the internal parts of the starter unit thoroughly *except* the following:

1. Head of the piston.
2. Piston rings.
3. Inside of the cylinder.
4. Exhaust valve, balls, locking spring and holder.
5. Safety disk holder.
6. Fuel combustion chamber.

(b) When starter unit is assembled inject approximately 1 liquid ounce of oil, engine, SAE 10, through one of the air vent holes of the starter. Unless these air vent holes are kept upward at all times, cover them with sealing tape after testing the starter.

(2) *Install starter jaw thrust ball bearing in aluminum housing assembly.*

Install bearing in housing. Install the lock ring in the groove of the housing to hold the bearing in place.

(3) *Install L-shaped springs in starter jaw assembly* (fig. 20).

Grasp the longer straight section of a spring with the thumb and forefinger of the right hand and install a spring beneath the washer and around each of the four pivots as shown in figure 20.

(4) *Install finger spring in steel shaft.* Hammer.

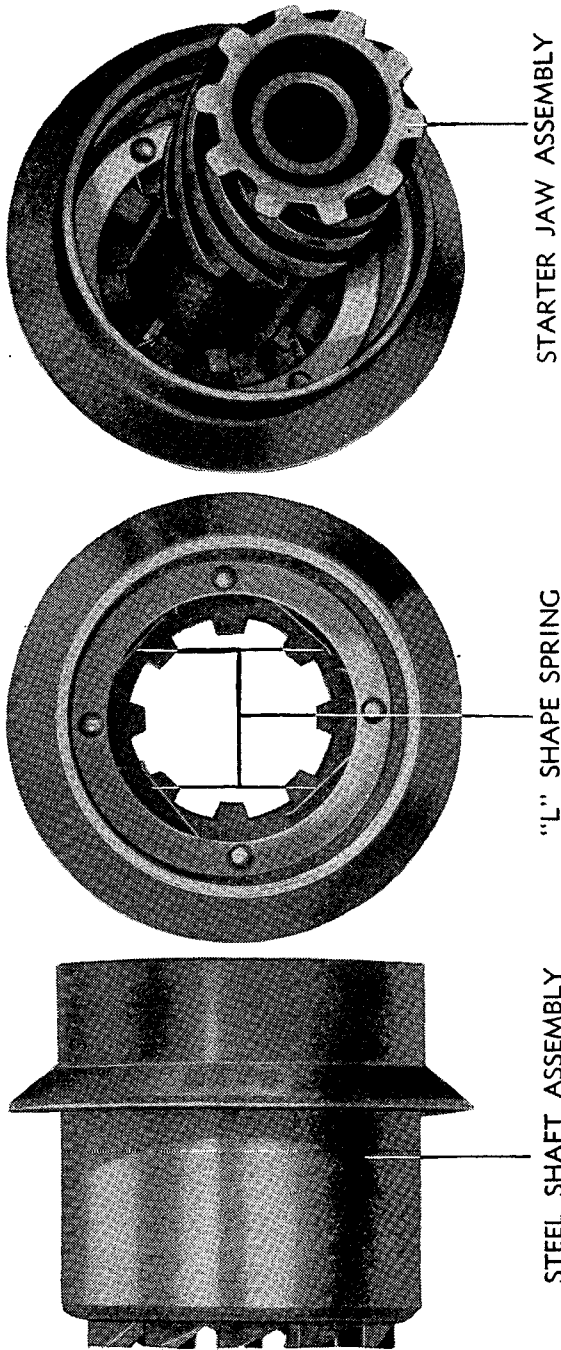
Rod, $\frac{5}{8}$ -inch diameter, 12 inches long.

File.

Clamp a $\frac{5}{8}$ -inch diameter steel rod about 12 inches long in a vise, with about 6 inches of the rod projecting from the jaws of the vise. Slip the finger spring into the steel shaft with the finger end toward the external helical splines of the shaft. Line up the hole in the finger spring with the hole in the steel shaft. Install a rivet in this hole with the finger spring under the head of the rivet. Slip this assembly over the $\frac{5}{8}$ -inch diameter steel rod and, with the ball end of a ball-peen hammer, peen the exposed head of the rivet. The rod acts as a support for the head of the rivet. File the peened head of the rivet flush with the shaft.

(5) *Assemble steel shaft assembly in starter jaw assembly.* Scriber or scratch awl.
Special spanner wrench.

(a) Place the starter jaw assembly with L-shaped springs installed on a table with the teeth of the jaw against the table.



STARTER JAW ASSEMBLY

"L" SHAPE SPRING

STEEL SHAFT ASSEMBLY

RA PD 7155

FIGURE 20. Position of L-shaped springs for BZ-G1153R starter unit.

(b) With scriber or awl bear against the short end of the spring in a clockwise direction until the long end of the spring is concealed behind the washer and bears against the bottom of the groove.

(c) While preventing the jaw assembly from turning with one hand, lower the shaft assembly with the straight splined end first into the starter jaw assembly.

(d) A slight clockwise rotation of the shaft assembly is necessary to compress the springs sufficiently to allow the internal straight splines of the starter jaw assembly to engage with the external straight splines of the shaft assembly.

(e) If the ends of the shorter side of the L-springs are not all bearing against the sides of the straight splines of the shaft assembly, they are either between the starter jaw and the shoulder of the shaft assembly or have disappeared into the groove.

(f) In either event, correct the condition by removing and tipping the shaft assembly slightly so as to keep the L-springs that are properly engaged in place, and release the springs that are out of place from the straight splines of the shaft assembly.

(g) In this position a scriber or awl may be inserted between the side of shaft assembly straight spline and the end of the spring.

(h) Compress the spring sufficiently to allow the straight splines of the shaft to engage the splines of the starter jaw.

(i) This process may have to be repeated for a total of three springs.

(j) Insert the starter jaw bolt into the steel shaft assembly, threaded end first. Attach the steel shaft assembly to the starter jaw assembly by installing in the order named, the copper gasket, hollow screw locking plate, and hollow screw.

(k) Tighten the hollow screw by using the special wrench provided for that purpose.

(l) Lock the hollow screw in position by bending an ear of the locking plate into the notch cut in the rim of the hollow screw.

(6) *Clamp aluminum housing* Rod, $\frac{3}{8}$ -inch diameter; 1 inch assembly in vise. long.

Install soft metal pads over the jaws of the vise. Insert a piece of $\frac{3}{8}$ -inch diameter rod about 1 inch long in a hole of the mounting flange. Clamp the mounting flange of the aluminum housing assembly in the vise, permitting the piece of rod inserted through the hole of the mounting flange to rest on the jaws of the vise and to the right of the aluminum housing assembly.

(7) *Insert starter jaw assembly with steel shaft assembly in aluminum housing assembly.*

Insert starter jaw assembly with steel shaft assembly in the aluminum housing so that the shoulder of the starter jaw assembly rests on the thrust ball bearing in the aluminum housing assembly. Insert the exhaust valve closing spring in the starter jaw bolt.

(8) *Install hub assembly to aluminum housing assembly.*

Install hub assembly to aluminum housing assembly and line up the punch mark on the hub flange with the punch mark on the clamp ring set flange of the aluminum housing assembly.

(9) *Install external and internal helical splined shaft to piston.*

Two screw drivers.

If a new starter jaw bolt and piston are being installed, perform step (10) before proceeding with this step. Lay the piston, head down, on a table. Place the head of the external and internal helical splined shaft in its recess in the piston. With two screw drivers, install the locking ring which attaches the two parts together. Install the rings on the piston.

(10) *Install piston with bronze external and internal helical splined shaft to starter unit (fig. 17).*

Spring compressor.

Special screw driver for starter jaw bolt.

Screw driver.

(a) Slip the exhaust valve opening spring under the head of the exhaust valve control bolt.

(b) Slip the bolt through its hole in the piston, with the head of the bolt and spring on the external and internal helical splined shaft side of the piston.

(c) Place the piston return spring in position, with the smaller end resting against the recess provided for it in the hub assembly.

(d) Place the piston with external and internal splined shaft in position.

(e) Hold this assembly with one hand and proceed to install spring compressor as follows:

1. Hook the hooks 180° apart in the aluminum housing assembly mounting flange holes.
2. Keep the axis of the threaded rod of the compressor parallel with the axis of piston travel and the end of the rod bearing on the center of the piston head.
3. Tighten the spring compressor and line up the helical splines of the shaft and hub assemblies so they engage properly with the helical splines of the bronze shaft.

4. During this lining-up process, it may be necessary to rotate slightly the steel shaft assembly and the external and internal helical splined shaft.

(f) Tighten the spring compressor until the measurement shown in figure 21 is $4\frac{1}{8}$ inches.

(g) Insert a special screw driver through the hole in the hollow screw left by the removal of the plug group assembly. Twist the screw driver around until the bit of the screw driver enters the slot of the starter jaw bolt. Screw the starter jaw bolt into the piston head until the threaded end of the bolt stops against the piston.

(h) Remove the spring compressor.

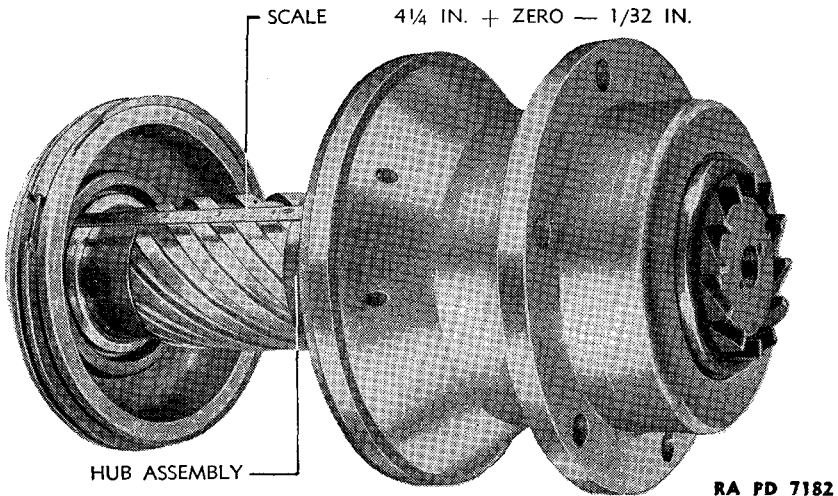


FIGURE 21.—Measuring starter jaw bolt length—starter unit BZ-G1153R.

(i) With a screw driver lock the piston to the starter jaw bolt by installing the lock screw with a lock washer under the head in its tapped hole in the piston head.

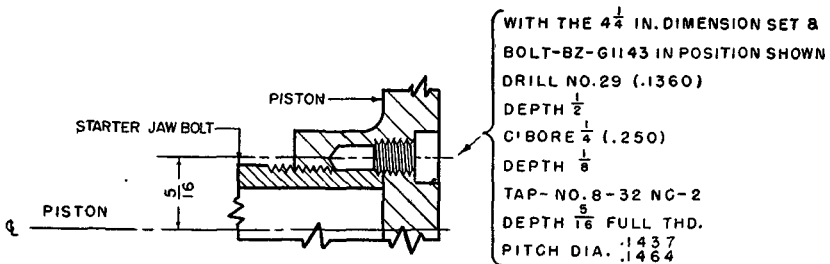
(j) With a screw driver install the plug group assembly in the hollow screw. With a screw driver lock this plug in position by installing the plug group assembly locking ring in its groove in the hollow screw. Proceed with step (12).

(11) *Mating of new starter jaw bolt and piston (fig. 22).*

- Special screw driver.
- Narrow machinist's scale, 6 inches long.
- Special wrench.
- Lathe.
- Drill press.

(a) If a new starter jaw bolt and piston are being installed, proceed as follows:

1. Note the markings on the bottom of the tapped hole of the new piston.
2. Screw the new starter jaw bolt into this tapped hole until it stops or hits the bottom of the piston head.
3. When the starter jaw bolt is removed from the piston, if the markings on the bottom of the tapped hole of the piston indicate that the bolt has stopped against the bottom of the hole, the bolt is satisfactory.



RA PD 7160

FIGURE 22.—Machine operations necessary to attach starter jaw bolt to piston.

4. If the threaded end of the starter jaw bolt does not strike the piston head, examine the threads of the starter jaw bolt and piston for the cause.
 5. If the threads are perfectly clean and a second try does not mark the bottom of the tapped hole of the piston, turn the defective part or parts back to the stockroom.
- (b) The starter jaw bolt must contact the head of the piston to be properly installed. Proceed as follows:

1. Engage the helical splines of the bronze shaft with the helical splines of the hub and steel shaft assemblies.
2. Insert a special screw driver through the hole in the hollow screw left by the removal of the plug group assembly. Twist this screw driver around until the bit of the screw driver enters the slot in the starter jaw bolt. Screw the starter jaw bolt into the piston head until the threaded end of the bolt stops against the piston.
3. Clamp the hub and aluminum housing assemblies together with one hand and use the other hand to pull the piston as far away as it will travel from the hub assembly. The piston will stop when the head of the starter jaw

bolt strikes the shoulder of the hole in the steel shaft assembly.

4. With a narrow machinist's scale 6 inches long, measure the distance between the exposed side of the locking ring that attaches the piston to the bronze external and internal helical splined shaft and the internal helical splined end of the hub assembly as shown in figure 21. This dimension should be $4\frac{1}{4}$ inches plus zero, minus $\frac{1}{32}$ inch. Write down the observed dimension. Subtract $4\frac{17}{64}$ inches from the observed dimension to obtain the amount that must be removed from the threaded

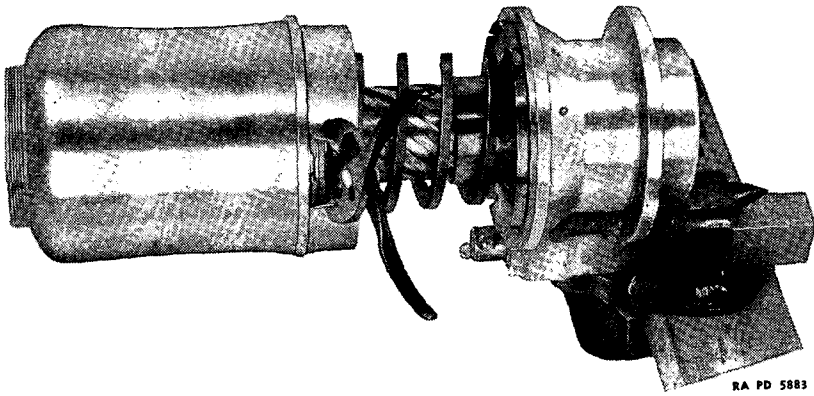


FIGURE 23.—Installing cylinder—starter unit BZ-G1153R.

end of starter jaw bolt. Write this dimension down on paper.

5. With a special screw driver, remove the starter jaw bolt from the piston. Remove the piston with the bronze external and internal helical splined shaft. Separate the piston and bronze shaft from each other by removing the locking ring attaching these parts together.
6. With a screw driver fold the ear of the hollow screw locking plate away from the notch in the rim of the hollow screw. With a special wrench remove the hollow screw, locking plate, and copper gasket in the order named.
7. Remove the starter jaw bolt from the hole in the steel shaft assembly. Use a lathe to remove the necessary amount from the threaded end of the starter jaw bolt and keep the end flat and perpendicular to the axis of the bolt.

8. Screw the starter jaw bolt into the piston until the threaded end of the bolt strikes the head of the piston. With a drill press, perform the drilling and threading operations outlined in figure 22.
9. Remove the starter jaw bolt from the piston, and remove the sharp edges left by the tap drill and tap from the piston and starter jaw bolt. Insert the starter jaw bolt into the steel shaft assembly, threaded end first.
10. Attach the steel shaft assembly to the starter jaw assembly by installing in the order named: copper gasket, hollow screw locking plate, and hollow screw.
11. Tighten the hollow screw by using the special wrench provided for that purpose.
12. Lock the hollow screw in position by bending an ear of the locking plate into the notch cut in the rim of the hollow screw.

(12) *Install cylinder on starter unit* (fig. 23). Piston ring compressor.
Soft hammer.

Wrench, 1/2-inch, open-end.

With a piston ring compressor, slide the cylinder over the piston. With a soft hammer, install the clamp ring set with the deeper shoulder toward the aluminum housing. Install the clamp ring set bolts through the slip holes in the ends of the clamp ring set. Use a 1/2-inch open-end wrench to install the safety nut with a plain steel washer beneath it on each bolt. Tighten these nuts together in order that the gaps between the ends of the ring set are equal.

(13) *Install perforated disk in cylinder.*

Install the disk in its place in the cylinder.

(14) *Install exhaust valve in exhaust valve housing.*

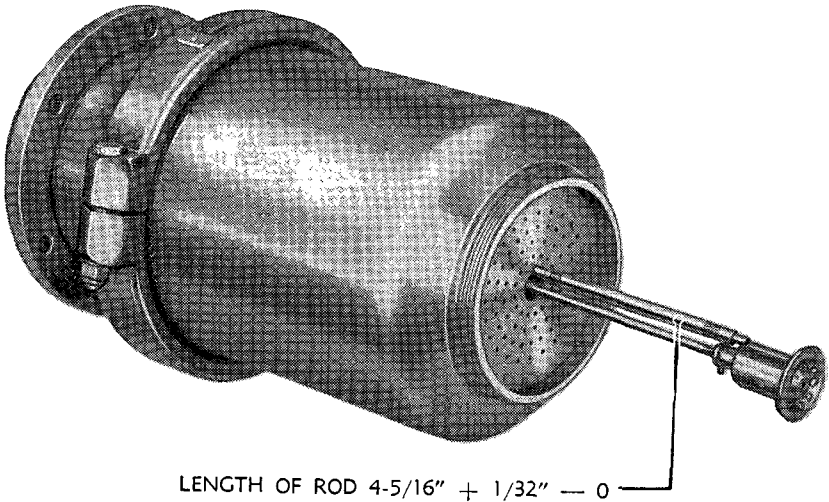
Insert the two steel balls and spring in the cross hole of the valve stem with the spring between the two balls. Insert this assembly in the exhaust valve housing far enough for the balls to drop in the groove cuts in the bore of the housing.

(15) *Attach exhaust valve housing to exhaust valve control bolt* (fig. 24). Wrench, 3/8-inch, open-end.
Pliers.

Exhaust valve control-bolt clamp.

Install the exhaust valve control bolt lock nut, spacer, and clip on the exhaust valve control bolt in the order named. The long tab of the clip fits on the flat surface of the exhaust valve stem to prevent the clip and spacer from turning. Screw the exhaust valve

stem on the exhaust valve control bolt. With the exhaust valve opening spring fully compressed, adjust the position of the exhaust valve on the control bolt by rotation of the bolt with relation to the valve, so that the distance between the perforated disk and the face of the exhaust valve housing that rests against the face of the perforated disk is $4\frac{5}{16}$ inches plus $\frac{1}{32}$ inch, minus zero. If a new exhaust valve control bolt is used, it may be necessary to cut off a little of the threaded end of the control bolt to obtain this dimension.



LENGTH OF ROD $4\frac{5}{16}'' + \frac{1}{32}'' - 0$

RA PD 5884

FIGURE 24.—Exhaust valve adjustment—starter unit BZ-G 1153R.

Lock the exhaust valve control bolt to the exhaust valve by using a $\frac{3}{8}$ -inch open-end wrench to tighten the lock nut against the exhaust valve stem. With pliers, fold the short tab of the clip over the lock nut.

(16) *Attach combustion chamber to cylinder.* Rod, $\frac{5}{8}$ -inch diameter, 14 inches long.

Coat the milled threads of the cylinder with a mixture of white lead and linseed oil. Place the combustion chamber copper gasket in its place in the combustion chamber. Use a hammer against a dummy nut installed on the intake connection, or a $\frac{5}{8}$ -inch diameter rod, 14 inches long in the intake connection and install and tighten the combustion chamber on the cylinder.

(17) *Assembly of safety disk holder.* Arbor press.

Press the shearing ring in the holder. Install the safety disk asbestos side out in the holder.

(18) *Install safety disk holder* Wrench, 7/8-inch, box or socket assembly in starter unit. w/handle.

With a 7/8-inch box or socket wrench, install the safety disk holder in the combustion chamber. Safety-wire the holder in place.

(19) *Oiling starter unit.* Sealing tape.

In addition to the parts greased before assembly of this unit, it is necessary to inject a quantity of lubricating oil into the starter unit. Proceed as follows: With the vent holes of the starter in the vertical position, inject 1 liquid ounce of oil, engine, SAE 10, into the starter unit through one of the vent holes. The vent holes should now be sealed with sealing tape if there is any risk that they will not be kept facing upward between the completion of the oiling operation and the testing of the starter unit.

SECTION IX

TEST

	Paragraph
Breech assembly-----	22
Starter unit-----	23

22. Breech assembly (fig. 14).—*a. Method.*—Test the electrical circuit of the breech assembly after overhauling it. Load the breech assembly with a fired cartridge having a direct electrical connection between the recess in the cartridge base, which the contact pin strikes, and the outer shell of the cartridge case. If no open circuits exist in the breech assembly, a direct electrical circuit now exists between the insulated wire extending from the flexible shielded conduit assembly and the breech barrel. Place an electrical indicating device, that is, a lamp, bell, or circuit tester, in series with the wire leading to the conduit assembly. Connect one wire bearing the source of electrical energy to the electrical indicating device and keeping the breech assembly insulated from the ground, touch the breech barrel with the wire necessary to complete the electrical circuit. A continuous flow of current should now be registered on the electrical indicating device. If it is not, disassemble the breech assembly and look for an open circuit. If a continuous flow of current is indicated with the breech and breech opening lever in the closed position, open the breech opening lever. If the electrical indicating device registers no flow of current, the breech assembly is satisfactory. If the electrical

indicating device registers a flow of current, disassemble the breech assembly and look for a short circuit.

b. Causes of short circuit.—Look for the following items in the disassembly of the breech assembly causing a short circuit:

(1) The locking wire of the breech assembling screw touching the contact blade.

(2) Any misplaced or missing insulating washer.

23. Starter unit.—*a. Functional test of starter.*—Use the following procedure for testing the starter unit:

(1) *Equipment.*—(a) Air pressure of 125 pounds per square inch.

(b) Means of connecting the air line to the intake connection of the combustion chamber.

(2) *Procedure.*—If the vent holes are sealed with sealing tape, remove tape, keep the vent holes upward after removing the tape. Clamp the starter unit in a vise, holding it with the mounting flange of the aluminum housing assembly. Face the vent holes upward. Connect the air line to the intake connection of the combustion chamber. Turn on the air pressure. The starter jaw should move forward and rotate. During the return stroke of the piston, the starter jaw should retract into the aluminum housing assembly. If no air leakage is detected from the exhaust valve during the forward motion of the piston, the exhaust valve is satisfactory. If the exhaust valve leaks, remove the combustion chamber, and grind the exhaust valve into its seat in the combustion chamber using a fine valve grinding compound. If the movement of the starter jaw and the seating of the exhaust valve are satisfactory, proceed with the following operation.

b. Measurement of starter jaw linear travel.—(1) *Equipment.*—A straightedge, 6 inches long or longer, and a 6-inch machinist's scale.

(2) *Procedure* (fig. 25).—Turn off the air supply to the combustion chamber. The distance between the outermost part of the teeth of the starter jaw and the contact face of the aluminum housing assembly mounting flange must be $1\frac{1}{16}$ inches plus or minus $\frac{1}{64}$ inch when measured parallel to the axis of rotation of the starter jaw. Plug the exhaust tube connection of the combustion chamber. Turn on the air. The distance between the outermost part of the teeth of the starter jaw and the contact face of the aluminum housing assembly mounting flange must be $1\frac{7}{8}$ inches plus zero, minus $\frac{1}{64}$ inch when measured parallel to the axis of rotation of the starter jaw. If the starter unit conforms to the above test, seal the vent holes with sealing tape. The starter unit is now satisfactory. If either of these starter jaw measurements is defective, dismantle the starter unit and substitute new parts for the defective ones.

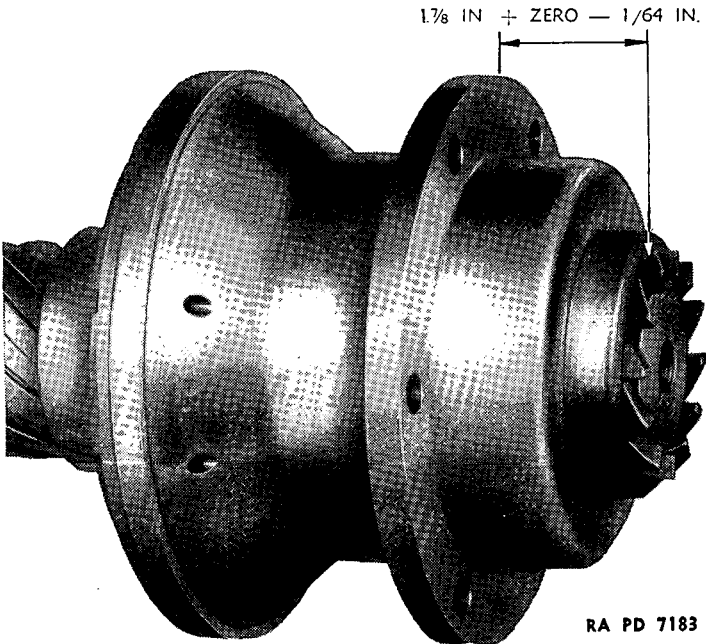
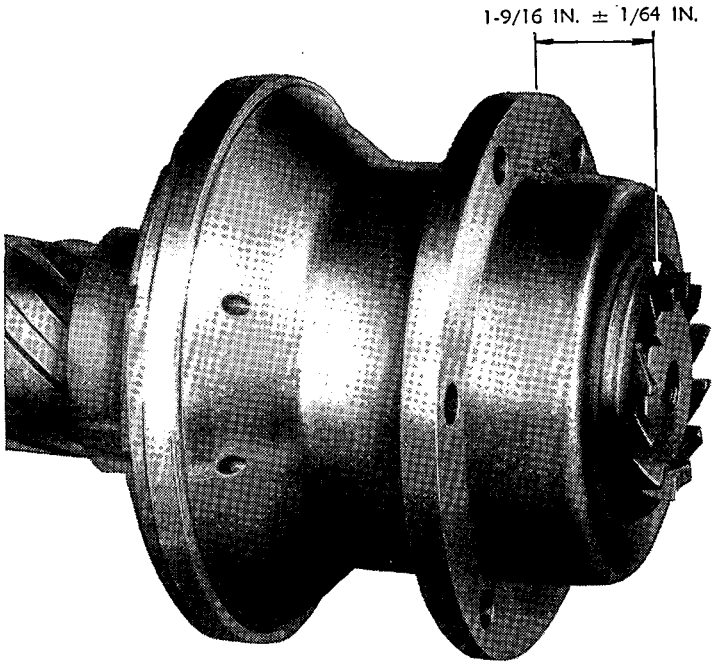


FIGURE 25.—Measurement of starter jaw linear travel—starter unit BZ-G1153R.

SECTION X

INSTALLATION IN TANK

	Paragraph
Breech assembly.....	24
Starter unit.....	25

24. Breech assembly.—This installation procedure is for the light tank M3. Structural differences of the light and medium tanks, using cartridge starter G-1154R, may vary this procedure slightly.

a. Place the breech assembly in position and attach the mounting flange to the bulkhead by installing four bolts and nuts.

b. Connect the conduit assembly to the mounting flange assembly.

c. Connect the intake tube to the barrel of the breech assembly.

25. Starter unit.—Use the following procedure:

a. Install starter unit support clamp around cylinder.

b. Using a new gasket, place starter unit on engine accessory case mounting. Install nuts and locking wire to attach starter unit to engine.

c. Attach support arms to starter unit support clamp by installing a bolt and nut through the toggle end of each support arm with each bolt passing through the hole of the ear of the support clamp.

d. Tighten the support clamp slightly and tap the support clamp toward the combustion chamber end of the starter unit. When a moderate tap of the hammer no longer moves the starter unit support clamp, tighten the supports, arm bolts and nuts. The support clamp should be tightened just enough so that a moderate tap of the hammer will move it slightly. If the support clamp is tightened too much the piston may stick.

e. Connect intake and exhaust tube to the starter unit.

f. Remove sealing tape over vent holes.

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APPENDIX

LIST OF REFERENCES

1. **Standard Nomenclature Lists.**

- a. Cleaning, preserving, and lubricating materials. SNL K-1
- b. Light tank M3..... SNL G-103
- c. Medium tank M3..... SNL G-104
- d. Current Standard Nomenclature Lists are as tabulated here. An up-to-date list of SNL's is maintained as the Ordnance Publications for Supply Index (OPSI).

2. **Explanatory publications—**

a. *Lubrication.*

Cleaning, preserving, and lubricating materials..... TH 9-850

Lubrication instruction for light tank M3.... OFSB 6-G-103

b. *Tank matériel.*

Light tank M3..... TM 9-726

Medium tank M3..... TM 9-750

[A. G. 062.11 (5-19-42).]

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