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WAR DEPARTMENT

TECHNICAL MANUAL



**GUN AND CARRIAGE, 75-MM,
M1897, ALL TYPES, AND SPECIAL
FIELD ARTILLERY VEHICLES**

April 20, 1942

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WAR DEPARTMENT,
WASHINGTON, April 20, 1942.

ORDNANCE MAINTENANCE

GUN AND CARRIAGE, 75-MM, M1897, ALL TYPES, AND SPECIAL FIELD ARTILLERY VEHICLES

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SECTION I GENERAL

	Paragraph
Purpose.....	1

1. **Purpose.**—*a.* This manual is published for the information and guidance of ordnance maintenance personnel. It contains instructions for the inspection, maintenance, and repair of the following 75-mm guns and carriages, and special field artillery vehicles:

(1) *75-mm guns and carriages.*

<i>Gun</i>	<i>Recoil mechanism</i>	<i>Mounted on 75-mm gun carriage</i>
M1897	M1897A3	M1897
M1897A1	M1897A6	M1897A2
M1897A2		M1897MI
M1897A3		M1897MIA2
M1897A4		M1897A4
M1897A2	M1897A5	M2A1
M1897A4		M2A2
M1897A2	M1897A7	M2A3
M1897A4		
M1897A2	M2	M2A1
M1897A4		M2A2
		M2A3

*This manual supersedes TM 9-1305, October 27, 1941, and TR 1410-126, July 31, 1925, including changes No. 1, January 3, 1927, and changes No. 2, January 2, 1934.

(2) *Special field artillery vehicles.*

- 75-mm gun caisson M1918.
- 75-mm gun caisson limber M1918.
- 75-mm gun carriage limber M1918.
- Battery reel M1917A1.
- Artillery reel M1909MI.
- Artillery cart M1918A1.

b. These instructions are supplementary to those in the Field and Technical Manuals prepared for the using arm. Additional descriptive matter and illustrations are included to aid in providing a complete working knowledge of the matériel.

SECTION II

DATA

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2. **General.**—Inspection is for the purpose of determining by critical examination the condition of the matériel, whether repairs or adjustments are required, that all modifications authorized by field service modification work orders (FSMWO) have been made, and to insure that the matériel is in such serviceable condition that it will function properly.

3. **Artillery gun book (O. O. Form 5825).**—*a.* Complete instructions for the use of this book are contained in instructions therein.

NOTE.—The gun book should accompany the gun at all times, and inspectors should insist on seeing it. They should make sure that instructions therein are being carried out and that it is posted up to date.

b. In the event the gun book should become lost and the original star-gage report of the gun cannot be obtained, the inspector may assume that the lands of the gun, 87.375 inches from the muzzle, are within the manufacturing limit of plus 0.004 on the normal dimension of 2,950 inches. If a star-gage reading of 2.964 is obtained (an increase of 0.010 over the maximum size of 2.954 for a new gun), the remaining life of the gun may be appraised between 5,000 to 6,000 rounds.

4. **Average life of gun.**—The average life of the gun is approximately 10,000 rounds. The guns in service should be star-gaged after approximately 10 percent and 90 percent of their estimated accuracy life, and thereafter at each 10 percent during the remainder of their service.

5. Reference.—The inspection of the gun and carriage as outlined in section IV, chapter 2, TM 9-305, should be followed. Those regulations also outline the inspection of the sighting equipment.

SECTION III

DESCRIPTION

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6. 75-mm gun M1897.—*a. General.*—(1) The gun (fig. 3) is of the built-up type, consisting of the tube, breech hoop, inner locking hoop, outer locking hoop, muzzle hoop, and jacket, the latter being a bronze casting in which the gun barrel is supported.

(2) The breech hoop is shrunk on the rear end of the tube and the inner locking ring is screwed on the tube directly in front of the breech hoop. The outer locking ring screws on the exterior of the inner locking ring and also screws on the forward end of the breech hoop, securely coupling the parts. The jacket covers approximately the middle third of the tube, its rear end screwed on the forward portion of the inner locking ring. It is secured in position at its rear end by four jacket locking screws. The muzzle hoop is screwed on the muzzle end of the tube and is secured in position with four muzzle hoop set screws.

b. Tube.—The tube, 11A (fig. 3), is a forging and extends from the muzzle to the rear end of the powder chamber. Pockets in the rear face form seats for the arms of the extractor.

c. Breech hoop.—(1) A portion of the breech hoop, 8A (fig. 3), extends to the rear of the tube to form the breech recess, the interior of which is threaded for the reception of the breechblock. In the forward face of the recess, pockets are formed to correspond with the contour of the arms of the extractor and form a clearance to permit the extractor to pivot on the extractor spindle, which passes through the hole in the left side of the hoop.

(2) Between the two projections on the left side of the breech hoop (fig. 5), the breechblock stop swings on the block stop hinge screw and is locked in position by the breechblock stop pin. The projecting lug at the lower right on the breech face forms a stop

against which the breechblock arm strikes when rotating the breechblock to the fully closed position. Just above the latter stop surface, the breechblock latch catch is inserted and secured by the three latch catch screws.

(3) The dovetailed seat at the top center line of the rear face of the breech hoop is for the rear sight. This rear sight is secured by the rear sight blind screws. Two leveling plates are located on the top center line near the breech end and form a surface in alinement with the bore for the application of the gunner's quadrant.

(4) A recoil lug on the under side of the hoop contains a rectangular hole for the piston rod coupler key, by means of which the gun is attached to the piston rod coupler assembly. The hole which extends upward through the recoil lug into the breech recess is for the safety bolt. The recess in the front face of the recoil lug is for the piston rod cushion. The right and left cradle protection plates, 14L (fig. 3), are attached with seven screws each to the sides of the hoop. They form the continuation of a similar shape on the sides of the jacket for the purpose of protecting the slides and roller paths on the cradle from the entrance of foreign matter.

d. Jacket.—(1) The jacket envelops the middle portion of the tube. It has on its under side a box-like extension which supports the gun in the cradle. The lower faces of the right and left sides of this extension are inclined slightly, with relation to the center of gun, inclining farther from the center at the breech than at the muzzle end of the jacket. These lower faces are fitted with the front, intermediate and rear slides riveted to the jacket and these slides rest upon the inclined slide surfaces in the cradle, while the gun is in battery. In recoiling, the gun moves off the inclined surfaces onto the jacket rollers.

(2) Between the front and intermediate slides, a jacket roller (fig. 3) is housed in a jacket roller upper bearing, and intermediate roller lower bearing. Between the intermediate and the rear slides, a jacket roller, 19K (fig. 3, sec. C-D), is housed in a jacket roller upper bearing and rear roller lower bearing. These are retained in the jacket by the jacket roller bearing screws and the latter are secured with the jacket roller bearing screw locking screws.

(3) Two roller oiler nozzles are located in each side of the jacket above the rollers to facilitate oiling the upper and lower bearings. Each nozzle contains a valve and valve spring.

(4) The rectangular hole through the sides of the jacket receives the jacket crosspiece, the upper side of which bears against the upper

roller paths when the gun is in battery. This prevents the gun from whipping upward in the cradle when it is fired.

(5) The T-slot in the muzzle end of jacket receives the sweeper plate guide assembly. The sweeper plate is held against the sweeper plate guide and the front end of the jacket. Both are secured in position by the sweeper bolt and its pin.

(6) The dovetailed slot in the top at the rear end of the jacket receives the front sight which is secured in position by the front sight pin.

e. Muzzle hoop.—On the bottom of the hoop a projecting lug extends from the right and left sides. A round hole in each at right angles to the bore of gun receives the two muzzle roller trunnions, which are secured on the inner side of the projections with the trunnion nuts. These are pinned in position permanently with the trunnion nut pins. Directly above the trunnions a rectangular hole passes through the hoop into each end of which a muzzle roller cover, 12A (fig. 3, sec. G-H), is inserted. Between the two covers a muzzle roller cover spring guide is placed with a roller cover spring on each end. The springs act to force the covers apart and the latter are retained in the hoop by a muzzle roller with its assembled bushing placed on the outer end of each trunnion. The rollers in turn are retained by a muzzle roller side plate placed on the end of each trunnion and secured with a muzzle roller center screw. The rectangular hole which passes through the hoop, being open on the under side between the two projecting lugs, is covered with the muzzle hoop bottom plate, secured with six muzzle hoop bottom plate screws, to hold the covers in position.

f. Sweeper plate guide.—The guide is assembled into the T-slot in the under side of the muzzle end of the jacket and is formed to fit over the arched and flat surfaces of the cradle. It is provided with a sweeper plate guide felt lining secured to the guide with the six sweeper plate guide lining rivets, the felt lining sweeping the surfaces during recoil and counterrecoil.

g. Sweeper plate.—(1) The plate, 16A (fig. 3, sec. J-K), together with the sweeper plate guide, is secured to the muzzle end of the jacket with the sweeper bolt and its pin. The plate is for the purpose of excluding dust and dirt from the roller paths and inclined slide surfaces of the cradle, and at the same time distributes the lubricant by wiping the surfaces each time the gun recoils. It also helps to center the gun in the cradle.

(2) The plate carries at each end a felt-pad holder, 15D (fig. 3), each secured to the sweeper plate with two felt-pad holder rivets. The

roller path felt-pads (right and left) are carried on the stem of the holders and compressed between the surfaces of the sweeper plate and the felt-pad plates. The latter are provided with four felt-pad plate points in each and these project into the pads at the four corners, tending to preserve their shape and position. The pads are held between the plates and secured in position by the felt-pad holder nuts.

(3) The slide sweeper blocks, 15A (fig. 3, sec. J-K), assemble in the plate against the pressure of the slide sweeper block springs, and are retained by cotter pins. The outer ends or surfaces of the blocks sweep the inclined slide surfaces of the cradle.

7. 75-mm guns **M1897A3**, **M1897A4**, and **M1897A2**.—*a.* The M1897A3 and M1897A4 guns are M1897 guns modified. This modification consists of removing a portion of the jacket forward of the front sight, all parts attached thereto including the rollers and sweeper plates. Four supports are then assembled over the tube and locked in position by tangential pins. To these supports are fitted steel rails on which are assembled bronze bearing strips.

b. Except for the above mentioned modification, these guns are duplicates of the M1897 in all respects.

c. The 75-mm gun M1897A2 is similar to the M1897A3 and M1897A4, and is now standard for future manufacture.

8. **Breech mechanism**.—*a. General*.—The breech mechanism of the 75-mm gun M1897, M1897A3, M1897A4, and M1897A2 (figs. 5 and 6), consists of the breechblock assembly, breechblock latch assembly, breechblock latch spring, firing hammer assembly, firing hammer pin, firing rack assembly, firing rack spring, firing rack spring assembling pin, operating handle plunger, operating handle plunger block, operating handle plunger screw, and safety piece assembly.

b. Breechblock.—The breechblock, D1789 (13C) (fig. 6), is cylindrical in shape with threads on its outer circumference. Two holes extend through the breechblock just above the center and are spaced 156° apart. The larger or loading hole is cut through to the exterior of the block on one side, making a U-shaped passage for the insertion of the ammunition into the chamber of the gun. The smaller hole receives the firing pin, B 8378 (24E), by means of which the primer is exploded. A small vent hole extends upward at an angle from the breech face of the block to the forward interior of the firing pin hole. This gives vent to any gases that may escape to the interior of the breechblock due to a punctured primer or from other causes.

c. Loading hole.—The forward portion of the loading hole is beveled on one side by forming upon it a helix of approximately 15° angle. This bevel acts on the base of the cartridge case, forcing it into the chamber of the gun.

d. Circular groove.—The circular groove and circular incline in the muzzle face of the block form a clearance for the extractor, C3746 (27B) (fig. 5), and the extractor tang, B8381 (14C), the latter protruding from the rear of the extractor. At the termination of the circular groove the extractor cam is inserted, which actuates the extractor by striking the extractor tang near the end of the opening movement of the block, thus ejecting the cartridge case.

e. Oval recess.—An oval recess is located in the exterior near the front face of the breechblock. This opening is used to engage the safety bolt in locking the block in the open position to prevent its operation while the gun is uncoupled from the recoil mechanism.

f. Safety bolt assembly.—The safety bolt, 23L (fig. 7), is a device to prevent the gun from being fired when the piston rod coupler key, 15B, is not in place. The safety bolt lug projecting from the muzzle side of the bolt, engages in the sloping groove of the coupler key and when the key is removed this action causes the head of the safety bolt to engage in a slot in the breechblock. The breech side of the bolt contains a leaf spring (the safety bolt spring is secured with the safety bolt spring screw), which locates the bolt in its two positions by means of notches in the bolt seat into which the spring engages. Before attempting to remove the coupler key, place the breechblock in the open position.

g. Extractor.—The extractor, C3746 (27B) (fig. 5), is a hollow shaft having on its exterior two vertical projecting arms which lie in the pockets in the face of the breech recess. Between the arms is a projection containing a channel to receive the extractor tang, B8381 (14C). The hole through the shaft portion receives the extractor spindle which passes through it from the left exterior of the breech hoop, the spindle forming the pivot on which the extractor moves. Near the extremity of the arms, tangent to the bore of the chamber, lips are formed which engage the rim of the cartridge case in extraction.

h. Extractor spindle.—The spindle, C3751 (27A) (fig. 5), is a cylindrical shaft on one end of which is a curved projecting arm at right angles. The end of the arm is formed to enter upward into a hole in the projection which houses the breechblock stop and a groove in the end of the arm engages with the stop when the latter is swung into place. This securely locks the extractor spindle in position.

i. Extractor tang.—The tang, B8381 (14C) (figs. 5 and 6), slides into the channel or groove in the extractor. An oval projection on the tang acts as a key and enters into an oval hole in the extractor.

The extractor tang is retained in position by the extractor spindle passing through the parts from the exterior of the breech hoop. The tang is so formed that it projects to the rear and has a beveled surface on one side, which contacts with the extractor cam near the end of the opening movement of the breechblock. A semicircular notch is provided on the opposite side to facilitate the removal of the tang in case of difficult disassembly.

j. Breechblock arm.—(1) The breechblock arm, D1788 (18A) (fig. 5), is set into a depression in the breech face of the breechblock and is secured thereto by five breechblock arm tap rivets. An oval hole in the outer end of the arm receives the breechblock latch pawl catch, A25057 (24A) (fig. 6). A threaded hole at the lower end of the arm receives the operating handle, C3748 (25K) (fig. 6), which is secured against turning by a steel pin. In the breech face of the breechblock arm a threaded recess in line with the hole for the firing pin receives the safety piece, C3749 (26A), assembly.

(2) Between the two projecting lugs on the breech face of arm the firing hammer, C3747 (24B) (fig. 6), is pivoted on the firing hammer pin, A25064 (24H). The hollow projection adjacent receives the firing rack spring, A25081 (24G), and the firing rack, C3750 (24C), which are retained by the firing rack spring assembling pin. The eye on the exterior of the projection is for the lanyard to pass through. A recess in the forward face of the arm receives the breechblock latch spring and breechblock latch, the latter containing the pawl spring and the pawl. These are retained in the recess by the breechblock latch pin passing through the arm and the breechblock latch.

k. Operating handle.—The handle, C3748 (25K) (fig. 6), is a hollow cylinder having a threaded end to screw into the outer end of the breechblock arm. It is secured therein by the handle pin. The opposite end is threaded to receive the operating handle plug, A25066 (25N), which retains the plunger cushion. The plug is secured in position with the handle plug locking screw. The interior receives the operating handle plunger, B8379 (25C), and the opening in the side is for the insertion of the operating handle plunger block, B8371 (25A).

l. Operating handle plunger.—The plunger, B8379 (25C) (fig. 6), has a sliding fitted inside the operating handle. The rectangular hole in the rear end is located in line with the opening in the operating handle and receives the operating handle plunger block when the latter is inserted through the opening in the handle. The hole in the rear end of the plunger receives the operating handle plunger

screw which passes through the plunger block, retaining the parts in the operating handle.

m. Operating handle plunger block.—The block, B8371 (25A) (fig. 6), is a flat piece having two projections, and is assembled into the operating handle plunger, as previously explained. It moves with the plunger as the latter slides forward and rearward in the handle. The projection on its outer side protruding to the rear of the breechblock latch pawl, B8376 (26H), engages the latter when the forward movement of the handle plunger occurs in the recoil of the gun. The projection on the forward side covers the forward end of the elongated opening in the handle.

n. Breechblock latch spring.—The spring, A25079 (26G) (fig. 6), is flat, having two leaves formed in the shape of a V. It assembles in the breechblock arm to the rear of the breechblock latch and presses the latter into engagement with the breechblock latch catch in the breech face of the gun.

o. Breechblock latch and pawl.—The breechblock latch, B8375 (26M) (fig. 6), pivots in the breechblock arm on the breechblock latch pin. It has a projection on its inner end toward the gun, which engages in the groove in the breechblock latch catch when the breech is closed. Its outer end projects forward of the projection on the operating handle plunger block. A hole and a slot in this same end receive the pawl spring and pawl, respectively. The pawl pivots on the pawl pin and is actuated by its spring when the handle plunger moves forward as the gun recoils. This causes the rear end of the pawl to engage against the latch pawl catch and holds the breechblock latch disengaged from the breechblock latch catch in the breech face of the gun.

p. Breechblock latch pawl catch.—The catch, A25057 (24A) (fig. 6), is an oval section having a flattened portion at its middle against which the pawl engages. It is inserted into the outer end of the breechblock arm and secured by the latch pawl catch screw passing through the arm into the hole in the end of the catch.

9. Firing mechanism.—*a. General.*—This mechanism is of the percussion type and is assembled in the breechblock arm and breechblock.

b. Firing rack spring.—This is a helical coiled spring assembled in the hollow projection on the breech face of the breechblock arm. It is retained therein by the firing rack and by the firing rack spring assembling pin, the latter passing through the parts. The spring, A25081 (24G) (fig. 6), when compressed by pulling on the lanyard, furnishes the necessary force to the firing hammer to explode the

primer. The rack also assembles in the projection on the breechblock arm, one end of it passing through the firing rack spring. The outer end, which protrudes from the projection, is furnished with a rack having seven teeth which engage with the spur teeth of the firing hammer. Between the second and third teeth from the end a small screw (rack screw) is inserted in the space and a corresponding gap is made in a tooth of the firing hammer. This compels the correct assembly of hammer to the rack. A slot crossing the outer end of the hole through the rack engages the projecting keys on the firing rack spring assembling pin.

c. Firing rack spring assembling pin.—The pin, A25065 (24F) (fig. 6), passes through the hollow projection on the breechblock arm, the firing rack spring, and the firing rack. It has two projections or keys on its smaller end, and on the opposite end a head containing a slot for the purpose of assembly and disassembly. The projection or keys are opposite one another and pass through keyways in the extremity of the hole in the firing rack. When the pin is inserted and turned 90°, it engages in depressions in the rack and holds the parts together.

d. Firing hammer.—The hammer, C3747 (24B) (figs. 5 and 6), is pivoted between the lugs of the breechblock arm on the firing hammer pin. On its pivot end a number of spur teeth are formed in the shape of a small gear, its teeth meshing into those of the firing rack. The outer end forms the hammer portion and has attached to it the firing hammer link.

e. Firing hammer link.—The link, A25062 (25D) (figs. 5 and 6), forms a swinging connection between the firing hammer and the lanyard. It is secured to the hammer by the firing hammer link pin passing through the parts.

f. Lanyard.—This consists of approximately 25 inches of seven-strand chord, one end of which is passed through a pear-shaped hardwood handle and tied in a knot. The other end is passed through the eye on the breechblock arm and then looped in the firing hammer link.

g. Firing hammer pin.—The pin, 24H (fig. 6), is cylindrical at each end with a projecting key at about its middle portion. One end being larger than the other in diameter, it can be inserted only through the arm into the hammer in one direction. It forms the pivot on which the firing hammer swings.

h. Firing pin.—The firing pin, 24E (fig. 6), passes through the hole in the breechblock arm and breechblock and is retained in position by the safety piece. It has a slight longitudinal movement which

is limited by a shoulder near its breech end. This movement allows the conical point of the firing pin to protrude through the muzzle face of the breechblock sufficiently to strike the primer cap when the firing pin receives the impact of the firing hammer.

i. Safety piece.—(1) The safety piece, 26A (figs. 5 and 6), screws into the threaded recess in the breechblock arm and can be located at the two different points by means of the safety piece plunger. These two points are marked "Safe" and "Fire" on the outer surfaces of the breechblock arm. (On guns of French manufacture, these two points are marked "Tir" and "Route.") In either position, the plunger engages into a suitable depression or recess in the arm. The plunger is assembled in the safety piece together with the plunger spring and is retained therein by the plunger knob and plunger knob pin. Opposite the plunger a projection is fitted which forms the firing hammer lock.

(2) On the breech face of the safety piece a circular incline is formed which acts on the firing hammer when the safety piece is turned and located at the "Safe" position. The hammer is then drawn away from contact with the firing pin. In addition, the hammer is locked against operation by the firing hammer lock, which enters into a hole in the side of the hammer by reason of the safety piece being turned to the point "Safe." When located at the point "Fire," the hammer is free to function in firing.

10. Piston rod coupler.—*a.* The piston rod coupler, 14A (fig. 7), is a forging having two arms and a seat for the piston rod nut. The arms have rectangular slots which line up with the rectangular slot in the gun lug. The gun lug and coupler are connected by the coupler key which is inserted through the rectangular slots in the coupler and gun lug. On the side of the coupler is attached a plate reading "Open breech before withdrawing key." On the recoil mechanism of French manufacture the plate reads as follows: "OUVRIR LA CULASSE AVANT DE RETIRER LA CLAVETTE." Due to the mounting of the gun and of the angular movement of the piston rod with respect to the gun during recoil, it is necessary that its attachment to the gun permit a certain amount of play. This play is taken care of by the coupler.

b. The rear face of the piston rod coupler key, 15B (fig. 7), has a sloping groove in which a lug on the safety bolt engages. The lower face of the coupler key has a spring to lock it when in position.

11. 75-mm gun carriages M1897 and M1897M1A2.—*a. Cradle.*—(1) The cradle is a steel forging, the ends and lower diagonal sides of which are covered by plates. Trunnions project from

the sides about midway of the length and rest in the hollow trunnion bearings of the rocker. Extended lengthwise in the upper part of the cradle body are two channels, one on each side of the gun and opening toward it. The inner surfaces of the upper and lower sides of each channel provide a path for the rollers or bronze bearing strips of the gun.

(2) In addition to the lower roller paths on the cradle there are two slightly inclined planes which slope downward to the rear upon which the gun rests when in battery. Bearings for the elevating yoke of the elevating mechanisms are attached by screws to the lower side toward the rear of the cradle body.

(3) Two circular openings, with a connecting hole between the two near the rear end, run lengthwise in the body of the cradle. The smaller opening, which is the recoil cylinder, houses the recoil mechanism and the larger, called the recuperator cylinder, houses the recuperator or counterrecoil mechanism.

(4) The front end of the recoil cylinder is closed by means of the respirator assembly. The rear end is closed by means of the recoil stuffing box head through which the recoil piston rod slides.

(5) The forward end of the recuperator cylinder is closed by means of the recuperator cylinder front head. The rear end is closed by means of the oil index assembly and the recuperator cylinder rear head assembly.

b. Shield.—(1) (a) The 4-piece shield of American manufacture is for use on the 75-mm gun carriage M1897MIA2, and consists primarily of a right shield, a left shield, a right apron, and a left apron. An additional shield is provided for the protection of the sight.

(b) The 4-piece shield of French manufacture is used with the 75-mm gun carriage M1897MIA2 (French). It is identical with the 4-piece shield of American manufacture, except that it is thinner. Shims are riveted to the shield at the points where the brake worm support and the left shield bracket come in contact with the shield. These shims increase the thickness of the shield to that of the American 4-piece shield at these points. This shield can be used on the 75-mm gun carriage M1897 (French), using additional shims, if necessary.

(2) The right and left shields are stiffened across the top and bottom by shield angles which are riveted thereto. Reinforcing strips are riveted to the edges of the opening in the shields which are made for the gun, cradle, and trail. Projections on the edges of the openings are reinforced and fit in sockets provided in the trail side plates for supporting the shield.

(3) The aprons, right and left, are hinged to the lower edges of the right and left shields. When in action, they hang down, protect-

ing the space below the axle. For traveling they are swung up against the front face of the shields, slots in their faces engaging with apron latch staples riveted to the front face of the shields. They are secured in traveling position by keys through the staples, retained in place by leather thongs. The apron latch keys are attached to the shields by chains. The apron hinges are different in design from those used on the 7-piece shield; they are not interchangeable.

(4) Sight case hooks for supporting the sight and quadrant cases are riveted to the rear face of the right shield; two eyes, at the top of the case, hook over the two upper hooks, and a spring-controlled hook at the bottom of the case snaps over the sight case lower hook. A strap also passes through holes in the shield and secures the sight and quadrant case in place.

(5) Brackets for the sight extension case are riveted to the rear face of the left shield. The lower sight extension bracket forms a pocket for the lower end of the case; the two upper sight extension brackets form ears which support the case on each side. A strap around the upper sight extension brackets secures the case in place.

(6) The spare parts pouch carrier, consisting of an upper and a lower bracket, is riveted to the front of the left shield.

(7) The tool roll carrier, consisting of a built-up frame, is riveted to the front of the right shield.

(8) The 7-piece shield of French manufacture is for use on the 75-mm gun carriage M1897 (French), and consists of a right and left shield, a connecting shield, a right and left extension shield, and a right and left apron keyed and bolted together. An additional shield is provided for the protection of the sight.

(a) The connecting shield is riveted to the right and keyed to the left shield. The extension shields are bolted to the lower ends of the shields, right and left. The aprons are hinged to the lower ends of the extension shields. The apron hinges are different in design from those used on the 4-piece shields. They are not interchangeable.

(b) The sight shield, 48B (fig. 2), is attached by screws and nuts to a bracket on the left side of the rocker, forward of the main shield. An eyebolt in the sight shield carries a chain which secures the sight bracket cover.

(c) The method of attaching the shield to the carriage is the same as that used for the 4-piece shields.

(d) The armor plate of this shield is thicker than that of the 4-piece shield.

c. Trail, single, for carriages M1897MIA2 and M1897A4.—(1) *General.*—The trail is of the built-up type and consists of two side plates, a top plate, an axle housing, five transoms, two flask plates,

two spade flasks, a spade, and a float, all rigidly bolted and riveted together.

(a) The upper forward parts of the side plates are provided with bearings for the rocker trunnions. Each trunnion bearing has a trunnion cap hinged thereto and held closed by a key. The keys are attached by chains and eyebolts to the trail side plates. Leather thongs retain them in position after assembly. Lugs are provided on the outer face of each side plate for supporting the shield.

(b) The axle housing forms a support for the axle and also acts as a stiffener for the front end of the trail. The axle housing is located between and attached to the lower front of the trail side plates, to the left plate by rivets and to the right plate by bolts.

(c) The axle brackets, 40A and 41A (fig. 2), right and left, form supports for the axle, 42A. They are attached by bolts to the trail side plates and project at right angles therefrom. The right axle bracket is held in place by the bolts securing the axle housing. The left axle bracket is bolted independently. The outer ends of the axle brackets are threaded, the right receiving the brake worm quadrant housing assembly, 32A, the left the shield bracket, left, 44A.

(d) An axle housing bushing, 39E (fig. 8), and axle bracket bushings, 44E and 44G, right and left, form bearings for the axle which slides in them during traverse.

(e) A key in the right axle bracket engages a keyway in the axle and prevents the latter from turning.

(f) The brake worm quadrant housing, 32A (fig. 8), forms a support for the right shield and also a housing for the brake worm. It is screwed on the right axle bracket.

(g) The left shield bracket, 44A (fig. 8), forms a support for the left shield. It is screwed on the left axle bracket.

(h) Dust guards and wipers composed of leather washers and copper gaskets, which protect the axle bearings and traversing surfaces, are assembled in the outer ends of the brake worm quadrant housing (right side) and the shield bracket (left side).

(i) The trail front plate (armor) covers the opening at the front of the trail.

(j) The tubular angle of site worm gear shaft housing, which forms a bearing for the angle of site worm gear shaft, is riveted between the trail side plates behind the axle housing.

(k) The transoms are used to reinforce and strengthen the trail; they are also used as bases for attaching brackets, etc.

(l) The lunette provides a means for towing the carriage. It connects with the pintle of the limber. It consists of a ring with a

straight shank, is held in a lug located on the float, and is secured in position by a nut. A collar, called the lunette locking cap, engages the lunette and the lug on the float, preventing rotation of the lunette. This locking cap must always be retained in position. Carriages equipped for high speed transport are provided with lunette M5.

(m) The traveling lug is a rest for the rear end of the cradle in traveling position and is riveted to the trail top plate over transom No. 1.

(n) A name plate giving the serial number, name of carriage, model, name of manufacturer, year of completion, and initials of the inspector is riveted to each carriage. The name plate is located on the right trail flask plate on carriages of American manufacture and on the trail front plate of those manufactured by the French.

(2) *Axle*.—(a) The axle assembly, 42A (fig. 8), is hollow and forged from a single piece of steel, the ends being closed by means of axle plugs. The exterior of the left central part is threaded for engagement with the traversing nut. To allow application of the traversing nut, the outside diameter of the body of the axle to the right of the screw threads is the same as the outside diameter of the thread, while the diameter to the left of the threads is the same as the diameter of the bottom of the thread.

(b) With the traversing nut, 56F (fig. 8), in place, the portion of the axle to the left of the traversing nut is covered with the axle sleeve, 42C, the outside diameter of which is the same as that of the thread on the axle. Thus, bearing surfaces of the same diameter, right and left, are provided for supporting the trail. The axle sleeve, 42C, has a key riveted to its interior which fits a corresponding keyway in the axle, preventing rotation.

(3) *Rocker assembly*.—(a) The rocker assembly of the M1897, M1897MIA2, and M1897A4 carriages makes it possible to change settings in elevation without disturbing the angle of site setting. It is the intermediate part between the trail and the cradle and is composed essentially of two rocker arms and the rocker segment.

(b) The rocker arms, right and left, terminate at the front in hollow half trunnions resting in corresponding trunnion bearings in the trail side plates.

(c) The rocker segment, which has a segmental rack with its center at the axis of the hollow trunnions, is between and riveted to the rear ends of the rocker arms. The lower end of the rocker segment passes through the curved opening in the angle of site worm gear shaft housing of the trail. Two lugs for the attachment of the elevating screw, 68A (fig. 10), project from the rear of the rocker segment.

(d) The elevating screw pin, which connects the lugs on the rocker and the elevating screw, is attached to the rocker segment by a chain and eyebolt.

(e) The range rack, 65H (fig. 10), pivots on the range rack screw, which in turn is screwed into the face of the right rocker arm at the rear.

(f) The hollow half trunnions of the rocker support the solid trunnions of the cradle; thus the cradle has the same axis of rotation as the rocker.

(g) Rocker arm caps fit the tops of the hollow half trunnions of the rocker arms, inclosing the solid trunnions of the cradle, and completing the rocker trunnions.

(h) An extension, integral with the left rocker arm and outside of the trunnion thereof, forms a base for the sight bracket. Integral with the extension are two lugs and a stud. The sight bracket pivots on the stud and is retained in position thereon by means of a nut. The two lugs contain adjusting screws by means of which the sight bracket is adjusted.

d. Elevating mechanism.—(1) The elevating mechanism consists principally of an elevating yoke, 61A (fig. 10), an elevating screw, 68A, and an elevating nut, 68B, mounted on the elevating yoke. Also an elevating crank, 62A, crankshaft, 65A, and elevating bevel pinion, 68C.

(2) The elevating yoke has trunnions at its upper end, which rest in bearings fastened to the cradle. An opening is bored vertically through its right lower portion, forming a bearing for the elevating screw nut.

(3) The elevating nut has a cylindrical exterior, fitting the bearing in the elevating yoke, in which it rotates. Its interior bore is threaded for the elevating screw and its upper end forms a bevel gear. The elevating nut is restrained from endwise movement by a shoulder under the bevel gear portion and by the elevating nut collar screwed and pinned on its lower end.

(4) The elevating screw is threaded with a left-hand thread to take the threads of the elevating nut. Its lower end has an eye fitting between the lugs on the rocker segment and connected thereto by the elevating screw pin.

(5) The elevating bevel pinion, mounted on the inner end of the elevating crankshaft, meshes with the bevel gear on the elevating nut. The elevating crankshaft rotates in a hollow bearing in the right trunnion of the elevating yoke; its inner end is also supported in a bearing in the right elevating yoke bearing, which is screwed to the

cradle. The outer end of the elevating crankshaft has an elevating crank and handle for operating the mechanism.

(6) The elevating crank locking plate, 64A (fig. 10), a stationary disk with notches in the back of its rim, is retained by a pin on the right trunnion of the elevating yoke, just behind the elevating crank.

(7) A claw on the crank hooks around the crank locking plate and engages with the notches. An elevating crank spring, 62C (fig. 10), located between the end of the elevating crankshaft and the elevating crank maintains the engagement. The claw is released from the notches by pressing inward on the elevating crank handle, then the crank can be freely turned. The object of the claw and notches is to lock the elevating mechanism when the desired elevation of the gun has been obtained.

(8) The elevating crankshaft oiler nozzle, 65D (fig. 10), located in the end of the elevating crankshaft provides means of lubricating the various bearings of the mechanism.

(9) The range scale, 64E (fig. 10), is located above the elevating mechanism on the right side of the cradle. It is firmly secured to the range scale fixed pinion, 64C, by the range scale washer, 62K, which in turn is retained in place on the range scale shaft by the range scale shaft nut, 67A. The range scale shaft, 62H, is screwed to the side of the cradle and has mounted thereon the range scale fixed pinion, which has a bushing bearing on the shaft. The toothed portion of the fixed pinion is only half as wide as the range rack with which it meshes. Another pinion called the range scale movable pinion 64D, having teeth matching those of the range scale fixed pinion, is mounted on the fixed pinion with its teeth adjacent to those of the latter and also meshing with the range rack. A screw through the two pinions and the bushing retains them in relative position. The screw hole in the movable pinion is larger than the screw, allowing a little play. The range scale shaft oiler nozzle located at the end of the range scale shaft provides a means of lubricating the various bearings.

(10) The range rack is a segmental piece curved to a radius struck from the center of the rocker and cradle trunnions, the teeth of which mesh with the fixed and movable pinions of the range scale. The lower end is connected to the rocker by the range rack screw. The upper end is guided by the front and rear range rack guides screwed to the side of the cradle; thus the teeth of the range rack are held in engagement with the teeth of the range scale pinions. To eliminate any backlash in the pinions and rack, the range scale movable pinion spring which engages with a notch in the range scale

movable pinion is attached to the back of the range scale. This spring keeps the teeth of the pinion in contact with the teeth of the rack.

e. Angle of site mechanism.—(1) The angle of site worm gear shaft, 60G, is mounted in the angle of site worm gear shaft housing, 53G (fig. 9). It has a hexagon-shaped portion carrying the angle of site worm gear shaft pinion, which meshes with the segment of the rocker. The angle of site worm gear shaft oiler nozzle, located in the right end of the angle of site worm gear shaft, provides means for lubrication.

(2) A worm wheel on the left end of the angle of site worm gear shaft (worm wheel and shaft integral) is inclosed in the angle of site worm gear housing, 53G (fig. 9), which is bolted to the left axle bracket.

(3) The angle of site worm, 53D (fig. 9), is located in the rear of the angle of site worm gear housing, 53G, meshing with the worm wheel of the worm gear shaft. It is mounted on and rotates with the shaft of the angle of site gear, 53C.

(4) The angle of site gear case, 52E (fig. 9), containing bushings in which the angle of site gear, 53C, rotates, is screwed into the top of the angle of site worm gear housing, 53G.

(5) A plug, screwed into the bottom of the angle of site worm gear housing, serves as a lower bearing for the angle of site worm.

(6) The angle of site handwheel shaft, 52K (fig. 9), on which the angle of site pinion, 53A, rotates, is mounted in the top of the angle of site gear case. The angle of site pinion and angle of site gear with which it meshes are beveled gears.

(7) The top of the angle of site gear case is closed by a gear cover, 56E (fig. 9), secured in place by the gear cover screw which is screwed into the gear cover key, 57B, passing through the angle of site gear case.

(8) The angle of site handwheel latch cover, 52N (fig. 9), screwed on the side of the angle of site worm gear housing, incloses the angle of site handwheel latch, which engages with the holes in the handwheel rim. A handle, having a cam portion which operates against the lower surface of the angle of site latch cover, releases the angle of site latch from engagement with the handwheel.

(9) The handwheel oiler nozzle, located in the end of the angle of site handwheel shaft, provides means for lubricating the gears.

f. Traversing mechanism.—(1) The carriage is traversed by sliding the front of the trail laterally on its bearing on the axle, describing an arc about the spade as a pivot. Thus, during traverse, one

wheel advances slightly while the other backs up. The traversing mechanism consists principally of the threaded axle, a traversing nut to which is attached a bevel gear, a vertical shaft (traversing intermediate gear), the ends of which are formed into bevel gears, a pinion, and a traversing handwheel.

(2) The traversing nut, 56F (figs. 8 and 9), is screwed on the threaded portion of the axle, 42A, and retained in its lateral position in the carriage by two traversing nut thrust washers, 56G and 57G (fig. 9). The right thrust washer bears against the end of the axle housing bushing, the left against the left axle bracket, the traversing nut being thus retained laterally in the trail. Any rotation of the traversing nut on the screw of the axle must move the front of the trail either to the right or left on the axle.

(3) The traversing nut gear, 57C (fig. 9), which meshes with the bevel gear on the lower end of the intermediate traversing gear, 58D, is attached to the rim of the traversing nut by screws.

(4) The intermediate traversing gear, 58D (fig. 9), rotates in vertical half bushings in the traversing gear case, 57A, which is riveted to the left axle bracket. The upper end of the intermediate traversing gear is formed into a bevel gear which meshes with the traversing pinion attached to the handwheel. The lower end is formed into a bevel pinion which meshes with the traversing nut gear on the end of the traversing nut.

(5) The traversing pinion, 58C (fig. 9), rotates on the traversing handwheel shaft, 58A, which is mounted in the upper part of the traversing gear case.

(6) The top of the traversing gear case is closed by a gear cover, 56E (fig. 9), secured in place by the gear cover screw, 57E, which, after passing through the handwheel shaft, is screwed into the traversing gear cover key, 57B.

(7) A traversing handwheel is keyed on the shank of the traversing pinion which projects through the left side of the traversing gear case.

(8) A handwheel oiler nozzle, 58G (fig. 9), located in the end of the traversing handwheel shaft, 58A, provides means for lubricating the gears.

g. Wheels.—(1) The American type of steel-tired wheel is a modified form of the Archibald pattern, 1,334 mm (52 inches) in diameter, with a 90-mm (3.5 inches) width tire. As no change was made in the brake mechanism to accommodate the American type wheel, the tire projects about $1\frac{1}{4}$ inches beyond the brake shoe. This condition is not to be corrected.

(a) The hub consists of the hub box and a hub ring, between the flanges of which the upper ends of the spokes are held in position by means of seven carriage bolts.

(b) The hub box is fitted with a hub liner, forced into place and secured at the inner end with the hub liner retaining ring, which in turn is fastened to the hub box by six screws. The outer end of the hub liner is held in position by a hub liner screw located in the arm of the hub box.

(c) The inner ends of the spokes seat in the hub; the outer ends in the spoke shoes, which in turn are riveted to the fellies.

(d) The fellies are curved segments of wood which form the rim of the wheel.

(e) The tire is held in position on the fellies by shrinkage and by means of eight tire bolts.

(f) The wheel is lubricated by means of an opening, closed by a wheel grease plug, through the hub ring, hub box, and liner to a recess in the interior of the liner.

(g) The wheel grease plug is secured to the hub ring by a leather thong and eyebolt.

(2) The American type solid rubber-tired wheel is a modified form of the Archibald pattern, 1,360 mm (53 inches) in diameter, with a 90-mm (3.5 inches) tire, similar in many respects to the steel-tired wheel. A steel felly band is held in position on the fellies by shrinkage and by bolts. The tire base band, in which the rubber tire is secured, is pressed onto the felly band.

(3) The steel-tired type of wheel of French manufacture is 1,334-mm (52 inches) in diameter, with a 65-mm (2.5 inches) tire.

(a) The hub is fitted with a hub liner, forced into place and secured at the inner end with the hub liner retaining ring, which in turn is fastened to the hub box by six screws. The outer end of the liner is held in position by a hub liner screw located in the arm of the hub box.

(b) The inner ends of the spokes seat in the hub; the outer ends in openings cut in the fellies.

(c) The tire is held in position on the fellies by shrinkage and by means of seven tire bolts.

(d) No lubrication opening is provided in this type of wheel; it is necessary to remove the wheel to lubricate the axle.

12. High speed adapter for 75-mm gun carriage M1897A4.—

a. There are two designs of high speed adapters. The first 496 carriages modified to take these adapters were designated as M1897MIE7. Later their designation was changed to M1897A4.

b. (1) The left- and right-hand brake and axle brackets, group assemblies (fig. 24) bear on the axle of the carriage. The radius rods, group assemblies (fig. 11), one on each side of the trail, are attached at their ends to the radius rod ball studs assembled to the spindle brackets (fig. 11), and to the ball ends of the compensator shaft, restraining the brackets that bear on the carriage axle.

(2) To the machined face of the spindle bracket (fig. 24), there is attached by means of six cap screws, the housing plate assembly, consisting of the internal brake mechanism.

(3) The wheel spindle, C45203 (fig. 24), is pressed into the tapered hole in the spindle bracket, and the inner wheel spindle washer, A130413, slotted nut, BBHX2B, and cotter pin are attached to secure it.

(4) The brake drum inner packing, A130452 (fig. 24), is composed of a steel sleeve, two steel washers, and a ring of hard felt. This assembly is placed over the wheel spindle with the hard felt portion inserted into the recess of the brake drum, C62525. The purpose of this packing is to provide a seal for the grease within the hub and to keep all grease from the braking surface of the brake drum.

(5) The hub, C62505 (fig. 24), is a malleable iron casting. The inner flange is machined on its outer face for the brake drum, C62525, which is attached by eight screws, BCBX1DD, nuts, BBBX1D, and lock washers, BECX1L. The outer flange is also machined, and the outer rim is drilled for six wheel studs to which is assembled the disk and rim wheel on which the tire, 7.50 by 24, is mounted. The disk and rim wheel is secured by six conical-shaped nuts. The bore of the hub is recessed at its inner and outer ends for the taper roller bearings.

(6) The brake drum, C62525 (fig. 24), is a casting machined on its inner face to provide a bearing surface for the brake shoes.

(7) The hub cap, B144454 (fig. 24), is a pressed steel plate that is dome shaped. The hub cap and hub cap gasket, B144356, are secured to the outer flange of the hub by three round head machine screws and lock washers. The hub cap protects the outer roller bearing from grit, and acts as a seal for the grease within the cavity of the hub. It also provides an opening to allow adjustment for end play of the wheel.

c. (1) The radius rod group is composed of the radius rod, which is hollow, threaded internally at each end for a short distance to provide seats for the inner and outer radius rod compression spring plugs. Openings are milled on opposite sides of the rod a short distance from each end.

(2) The radius rod forms a housing for the ball seats, the ball seat compression springs, the ball seat compression spring plugs, inner, the ball seat compression spring plugs, outer. Two straight button head grease fittings are screwed through the rod and into the reservoirs.

(3) The ball seat compression spring plug, outer, is cylindrical in shape and threaded externally. Its faces are flat and the rear face has a slot milled in it for a screw driver.

(4) The ball seat compression spring plug, inner, is cylindrical in shape with both ends chamfered. The faces of the plug are flat.

(5) The ball seats are so shaped that they fit the radius rod ball studs and the ball ends of the compensator shaft.

(6) The ball seat compression spring, of $\frac{1}{4}$ -inch square steel, is helical in shape. The outside diameter of the spring is approximately $1\frac{1}{2}$ inches and the inside diameter $\frac{7}{8}$ inch.

(7) The reservoirs are cylindrical in shape and hollowed out to retain the lubricating grease. They are drilled and tapped to receive the grease fittings.

d. The left- and right-hand compensator shaft support brackets are castings bushed with compensator shaft support bracket bushings and drilled and tapped to receive straight button head grease fittings.

e. The compensator shaft, C45099 (fig. 11), is 1.76 inches in diameter and 45 inches long. Ball-shaped knobs are machined at each end. The shaft is drilled at the center and counterbored for the compensator ball stud.

f. The wishbone, C45202 (fig. 11), is of angle iron, bent into an irregular U-shaped piece. The ball socket bracket is riveted at the bottom of the U. Riveted to the left and right ends of the U are the left and right brackets which fit into the grooves of the axle collars. They are clamped into position by means of the axle clips.

g. (1) The left-hand brake lever assembly is composed of the brake lever, to which are riveted the bracket and guide. The head of the brake lever is bushed with the brake lever bushing. The head of the lever is also drilled and tapped for a straight button head male grease fitting.

(2) The right-hand brake lever assembly is composed of the lever, to which is riveted the guide. The head of the brake lever is bushed with a long steel tube. On the opposite end of the tube is assembled the brake connecting lever. The tube is bushed at each end with the brake lever bushing. The head of the brake lever is drilled and tapped for a straight button head male grease fitting.

h. The wheel assembly is composed of the disk and rim wheel to which is assembled the 7.50 by 24 balloon tire group assembly. The

balloon tire, group assembly is composed of a puncture proof inner tube and a 7.50 by 24 8-ply casing. The balloon tire group assembly is retained on the disk and rim wheel assembly by the locking ring.

i. In all other respects the 75-mm gun carriage is the same as the 75-mm gun carriage M1897 or M1897MIA2.

13. **75-mm gun carriages M2A1 and M2A2.**—The carriage is of the split trail type. A trail lock is provided to lock the two trails together for travel. When the trails are in the closed position the ball portion of the drawbar end bearing, B144201 (fig. 15), welded to the right trail, seats into the socket portion of the drawbar end bearing bracket, B144200, welded to the left trail. The trails are locked together by a toggle type clamp actuated by the trail connection hook handle, C62484.

a. *Recoil mechanism holding cradle.*—The cradle trunnions (fig. 18) are assembled with trunnion bushings, B144265, which rotate on self-aligning type bearings, consisting of trunnion balls, A156944, and caps, B107013 (fig. 17). The latter are alined in the top carriage by a projection seating in mating grooves in the trunnion bearings of the top carriage. The assembly is locked to the cradle trunnions by the cradle trunnion nut, A143912, locked by screw, A167444, trunnion ball spacer, A156943, against trunnion bushing, B144265, and is secured to the trunnion bearing of the top carriage by the trunnion ball outer and inner retainers, B144268 and B143600, with the inner and outer trunnion bearing plates, B144266 and B144267, connected by screws, BCKX1FU.

b. *Elevating mechanism.*—(1) By means of the elevating mechanism, the recoil mechanism holding cradle, recoil mechanism and gun are elevated or depressed to the various firing angles from 10° (178 mils) depression to 45° (800 mils) elevation. The elevating arc, D6658 (fig. 17), a segment gear of 42–20° involute teeth, is an integral part of the recoil mechanism holding cradle assembly. This elevating arc is actuated by the elevating pinion, B142227 (fig. 20), mounted on roller bearings housed in the elevating gear case, the latter being welded within the frame of the top carriage. On the right of the elevating pinion, B142227, is fixed the elevating worm wheel, B141439. It meshes with the elevating worm that is actuated by the elevating handwheel through the medium of the elevating handwheel gear assembly, B107062, and elevating shaft gear, B107043, which are mounted on ball bearings.

(2) The elevating handwheel gear case, C58657 (fig. 20), is bolted to the outer right side of the top carriage. A straight button head fitting, CLDX1A, is assembled in the side of the case for lubricating purposes.

c. Traversing mechanism.—(1) Traverse is accomplished by turning the top carriage about its pivot, the pintle pin. Movement of the traversing handwheel supported by the traversing handwheel shaft bracket is transmitted by the flexible joint, A138006 (fig. 22), to the traversing worm, B109247, which drives the traversing worm wheel, B109248 (fig. 21). The traversing worm wheel is assembled on the traversing pinion, B109246, and meshes with the teeth of the traversing rack, C59949, bolted to the axle. The traversing rack is stationary and the traversing mechanism is assembled to and moves with the top carriage.

(2) Rotating members of the traversing mechanism are mounted on antifriction bearings. Lubrication of the traversing handwheel shaft bearing and the traversing worm is through button head fittings, CLDX1A, assembled in the traversing handwheel shaft bracket and the traversing gear case.

(3) Control of maximum traverse is by means of stops, A141605 (fig. 22), one on each end of the traversing rack, C59949 (fig. 21). Assembled to the traversing gear case is a mechanism that controls the 45° traverse of the gun. By turning the spring plunger knob, A141655 (fig. 21), to lower the spring plunger, A141592, it engages with a stop welded to the axle bracket.

(4) Bolted to the left side of the top carriage is the traveling lock mechanism which is provided to secure the top carriage to the axle when traveling. This is accomplished by lifting up on the lock knob assembly, releasing it from its latched position, and swinging the traveling lock shaft to the rear. Maneuver the traversing handwheel until the traveling lock shaft can engage the traveling lock socket, which is bolted to the traversing rack.

d. Equilibrators.—(1) Two spring type equilibrators (fig. 23) are provided to neutralize unbalanced weight and reduce the manual effort required to elevate the gun through the elevation mechanism.

(2) Each unit is composed of an outer cylinder assembly, an inner cylinder assembly, and an equilibrator spring, A155906.

(a) The outer cylinder assembly is composed of a cylinder, B143542 (fig. 23), and an end, B143540, which is welded to the cylinder. The rod, A155908, passes through the end, B143541, is screwed into the end, B143540, and secured with a straight steel pin.

(b) The inner cylinder assembly is composed of a cylinder, B143543, to which is welded an end, B143541.

(c) The equilibrator spring, A155906, is placed inside of the inner spring cylinder assembly and the outer cylinder assembly slides over the inner cylinder assembly. The equilibrator trunnion pin, A141451,

is screwed into the end, B143540, secured by lock A3552, and is used for adjustment as described in paragraph 18.

e. Axle.—The axle is of welded steel construction and consists of an axle bracket assembly, axle bracket, left, assembly, axle bracket, right, assembly and axle tube assembly, welded into one complete unit. The disk and rim wheel spindles, C62266 (fig. 25), are assembled and secured by slotted nuts, washers, and a split cotter pin, to the axle brackets, left and right. They transmit the weight of the top carriage, gun and recoil mechanism to the disk and rim wheels and the firing jack.

f. Brake mechanism.—(1) The brakes, C64675 (fig. 25), are of the internal expanding type. The brake shoes are actuated by hand brake levers, C64752, which are connected to the brake cam shaft, B150693.

(2) The movement of the brake levers (fig. 25) is controlled by the brake rack catch, engaging teeth in the brake ratchet rack, B150685.

(3) The brake shoe (fig. 26) is a flanged segment, the outside diameter of which is covered with a brake lining and secured by ten tubular brass rivets. The brake consists of an assembly made of the brake shoes secured to the brake housing plate, assembly, C62668, by brake cam roller pins, B144962, and connected with the brake shoe adjusting wedge, B144959, by brake shoe links, B144960. The brake cam rollers, B144955, are held in contact with the brake cam, B144968, and the links are held in contact with the wedge by means of the three retracting springs.

g. Brakes.—(1) When engaging the brakes, the movement of the hand brake lever, C64752 (fig. 25), through the linkage rotates the brake cam, B144968, causing the brake cam rollers, B144955 (fig. 26), to ride toward the high point of the brake cam and thereby forcing the brake shoes against the brake drum which is secured to the hub of the disk and rim wheel.

(2) When the brake lever is released the tension of the retracting spring and the spring on the brake rod causes the brake cam to rotate to the released position. This action forces the brake cam rollers to the low point of the brake cam and thereby releases the pressure of the brake shoes against the brake drum.

h. Disk and rim wheels.—The assembly consists of a commercial disk and rim, upon which is mounted a commercial 7.50 by 24 heavy duty truck and bus balloon tire. The inner tube of the tire is a commercial 7.50 by 24 puncture sealing tube equipped with a Schrader valve. The tire is secured to the disk and rim by a locking ring.

SECTION IV

INSPECTION OF GUNS, CARRIAGES, AND SPECIAL FIELD ARTILLERY VEHICLES

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14. Inspection of M1897 gun mounted on 75-mm gun carriages M1897, M1897MIA2, and M1897A4.—*a.* Accidents, and local defects of the bore, such as scratches, nicks, pitting, scoring, etc., cannot be passed on by any definite rule. The effect of all such defects is either to allow leakage of gas past the rotating band of the projectile and thereby promote further erosion of the forcing cone, or to wear away the rotating band so that the projectile does not attain its proper rotational velocity. Such defects should, therefore, be smoothed and rounded and, on the basis of their location, character, and extent, determination should be made as to whether they are apt to be injurious from the point of view of gas leakage and wear on rotating bands. Guns badly scored beyond the forcing cone should be reported to the Chief of Ordnance for final action.

b. The effect of pastilles upon the safety and accuracy of the gun is negligible so far as can be determined. It is realized, however, that definite facts are lacking and that the presence of pastilles is annoying to the battery personnel, and it has been decided to withdraw from service the guns having more than three pastilles the size of a 5-cent piece.

c. Deformation of the rifling at the origin in general consists of sheared lands and a flow of the metal in the grooves so that the pitch of the rifling for the first inch or two is considerably reduced. This is considered a serious defect and guns showing it to a marked degree will not be reissued.

d. The advance of the forcing cone is measured with the forcing cone gage or by means of a projectile. The normal distance from the

edge of the chamber to the face of the projectile when shoved with the usual force of loading is 12 inches. When this distance (as checked by the use of several projectiles) has increased to 12.3 inches, or when the forcing cone gage shows the advance of the forcing cone 0.25 inch and the gun exhibits the usual amount of other defects, it should be withdrawn from service.

e. Experience has shown that the wear of a gun of small caliber, such as the 75-mm. is a factor of so many variables that condemnation on any single basis is unwise. The limits previously given should be used only as a general guide and a gun should be condemned only after careful consideration of each of the factors involved. It is evident that a gun is still serviceable in spite of numerous bore defects if its dispersion is not great enough to endanger troops advancing under cover of a barrage or to cause waste of ammunition.

f. Check the wear of the sweeper plate guide in the cradle ways. Insert a screw driver blade between the sweeper plate and the cradle slide face and force the gun to one side. Draw a fine vertical pencil line over the face of the sweeper plate and the face of the cradle. Push the gun to the opposite side. The movement of the gun is indicated by the amount the line on the sweeper plate has separated from the line on the cradle front. Mark on the cradle the new position of the line of the sweeper plate. If the distance between the two lines on the cradle is as much as 0.06 inch, put in a new sweeper plate guide assembly.

g. Examine for missing sweeper bolt pin, condition of the threads of the sweeper bolt, worn or fouled condition of the roller path felt pads, worn slide sweeper blocks, broken spring, pins, etc.

h. Examine for worn or fouled guide felt lining and condition of the threads of the jacket and guide for the sweeper bolt. These threads are frequently stripped by firing with the slide sweeper blocks incorrectly assembled so that they overhang the front of the cradle when the bolt is excessively loose in its seat. See that the jacket crosspiece is firmly secured and that it is modified in accordance with FSMWO C4-W15.

i. The inclined intermediate slides of the gun and cradle are subjected to wear, especially if there is lost motion endways between the gun and piston rod, which allows a slight movement of the gun and cradle when traveling. Check the wear of the slides by means of the clearance, gage 10 (fig. 36), in the following manner: Remove the gun and thoroughly clean the rollers and the slides of the gun and the roller paths and slides of the cradle. Replace the gun and see that it is fully in battery. With the sweeper plate and sweeper plate

guide removed, force the gun over to one side. Insert the leaf of the clearance gage between the intermediate rollers and the lower roller path; it should go in easily. If it does not, or if the rollers are touching the cradle, it indicates that the cradle or the gun slides are worn and should go to a heavy shop for repairs. Look for flat spots on the rollers and see that the rollers revolve easily. Correct the rollers and refit (shim) the roller bearings, if necessary. Test the rear rollers and correct, if necessary, in the same manner as outlined for the intermediate rollers.

(1) In using the gage, pass it sideways between the intermediate roller and the side of the cradle. Turn the rod so as to place the thickness gage flat on the roller path. When the index mark on the handle of the gage is flush with the front edge of the cradle, it indicates that the gage is under the roller.

(2) Examine the muzzle rollers to see that they turn freely and have no flat spots. See that the spring covers are not damaged and that they function properly.

(3) Normally there is a clearance of 0.02 inch (manufacturing limit) between the gun rollers and the roller paths on the cradle when the gun is fully in battery. If the inclined planes show a wear of 0.01 inch and the blade of the clearance gage is 0.004 inch thick, it is readily seen there remains but 0.006 inch for wear of the gun slides. Therefore, it is important to determine the amount of wear of the inclined slides of the cradle when using the clearance gage in order to obtain a maximum wear of 0.016 inch of gun slides. Jacket rollers that are loose in the bearings will reduce the desired clearance between the rollers and the roller paths. Roller bearings must be corrected if looseness exceeds 0.002 inch. If the looseness of roller bearing should exceed 0.01 inch, the gun should be returned to an arsenal for repair.

j. The rear end of the piston rod will be found to have a flat cone point, which protrudes into a recess in the gun breech hoop apron in which piston rod pellets (disks of leather) are fitted. These pellets, between the rod and recoil lug, take up all looseness in the coupler and key. The point prevents the loss of the pellets which should not be allowed to become too hard.

NOTE.—It is important that all looseness between the gun and piston rod be taken up to prolong the life of the gun slides, the cradle inclined paths, and the surfaces at the front end of the cradle. These surfaces which are in contact with the guide sweeper blocks and sweeper guide wear rapidly during road travel of carriages if there is any looseness present.

k. Examine the breech end for scores and bruises in the threads of the breech recess and at the edge of the chamber, wear of the rear

sight by the pawl, loose or worn latch catch, and operation of the hinged breechblock stop.

l. Breech mechanism.—(1) *Breechblock and breechblock arm assembly.*—Examine for scored or bruised threads on exterior of breechblock, worn, roughened, or loose extractor cam, bruised threads in the breechblock arm and deformed threads of the safety piece. Check fit of safety piece in breechblock arm to see that it is not loose or unserviceable and that it does not allow the hammer to strike the firing pin. See that the gas vent hole is not clogged and that no looseness exists in the breechblock arm and the operating handle, and that the latch pawl catch is not worn or loose. Examine the firing pin and see that it is not deformed or bent.

(2) *Breechblock stop pin assembly.*—Examine for bent or missing pins or breechblock stop pin head.

(3) *Safety bolt assembly.*—Examine for deformed upper end of bolt, lug sheared off, or broken spring. Test the safety bolt by attempting to push it down after the piston rod coupler key is removed. If it can be pushed out of the way by ordinary pressure of the hand, the cause of the defective action must be ascertained and corrected.

(4) *Extractor tang.*—Examine for deformation or breakage.

(5) *Extractor spindle.*—Examine for bending or scoring.

(6) *Extractor.*—Examine for binding or breakage.

(7) *Safety piece assembly.*—Examine for bruised threads and deformed hammer stop screw.

(8) *Firing pin.*—Examine for deformed point or rear end.

(9) *Firing hammer assembly.*—Examine for condition of gear teeth or deformed hammer.

(10) *Firing rack spring assembling pin.*—Examine for deformed projections.

(11) *Firing rack assembly.*—Examine for condition of rack teeth and rack dowel screw.

(12) *Firing rack spring.*—Examine for weakness or breakage.

(13) *Breechblock latch pin.*—Examine for bending or breakage.

(14) *Breechblock latch assembly.*—Examine for wear or breaks, worn breechblock latch pawls, weakened or broken pawl spring.

(15) *Breechblock latch spring.*—Examine for weakness or breakage.

(16) *Operating handle plunger screw.*—Examine for condition of threads.

(17) *Operating handle plunger block.*—Examine for worn or broken projections.

(18) *Operating handle plunger.*—Examine for condition of threads and scores on exterior.

15. 75-mm guns M1897A3, M1897A4, and M1897A2, mounted on 75-mm gun carriages M2A1, M2A2, and M2A3.—*a.* Examine the position of the supports encircling the gun tube and note if they have moved from their original position. If supports have moved, a report should be submitted to the Chief of Ordnance. Examine the bearing strips (fig. 4) for rough or scored surfaces. Inspect for clearance between the front support and the bottom of the ways of the recoil mechanism. If the clearance found is less than 0.056 inch modify in accordance with FSMWO C12-W3.

b. Examine the breech mechanism as outlined in paragraph 14(1) to (18), inclusive.

16. Inspection of gun carriages M1897, M1897M1A2, and M1897A4.—*a. General.*—Try the smoothness of action in the trunnions in the following manner:

(1) Swing back to the trunnion caps, take off the rocker arm caps, and note whether the trunnions and caps are dirty, rusted, or show evidence of friction. Clean and lubricate the surfaces and then replace the caps.

(2) Remove the elevating screw pin and range rack screw. See that the cradle rocks freely in the zone of travel and that when the breech is raised, the rocker, although disengaged from the elevating pinion, is not drawn up with it.

(3) With the elevating screw pin and the range rack screw replaced, bring the range scale to 5,500. Run the rocker off the angle of site pinion and tilt the whole mechanism—rocker, cradle, and gun—without turning the elevating screw.

(4) When the parts are well kept, the breech preponderance should be such that the breech will move downward if the gun is approximately horizontal.

b. Maneuvering mechanism.—Examine the traversing and angle of site mechanism to see that they are not damaged and that they function as they should. Measure the lost motion of the traversing hand-wheel—it must not exceed one-sixth of a turn. Measure the space between the elevating nut collar and yoke—it must not exceed 0.04 inch. See that the yoke oscillates freely and is not excessively loose in trunnion bearings. See that the angle of site worm gear shaft housing is not loose in the trail. Examine the rammer staff and sponge staff, make sure that they can be removed, replaced, put together easily, and that they are securely held by the chain.

(1) Examine for loose pinions on the elevating crankshaft and range scale shaft.

(2) Examine for excessive wear as evidenced by end play and looseness of pinions on either of traversing or angle of site handwheel shafts.

(3) Examine for bent or loose handwheels, loose keys, and spherical covers.

(4) Examine for proper functioning of the angle of site handwheel latch and note if the latch enters the holes in the rim of handwheel.

(5) Examine axle spindles of the 75-mm gun carriages M1897 and M1897MIA2, for wear, scoring, and improper lubrication.

(6) Look over the shields to see that they are firmly secured, that the keys are equipped with thongs, and that the hinges of the aprons are in serviceable condition. Examine the sight case to insure that it is not torn or ripped, that it is held firmly by the locking catch, and that it contains the articles intended to be there. The packing should be properly covered with leather. See that the sight shield does not strike the bracket. Try the sights in the sight bracket.

(7) Examine brake worm quadrant housing for looseness on axle bracket and loose locking screws.

(8) Examine wheels for loose steel tires, broken, cracked, or loose spokes and fellies, excessive dish, and longitudinal play on axle.

17. Inspection of high speed adapter of 75-mm gun carriage M1897A4.—*a.* It is necessary periodically to disassemble the high speed adapter in order to make an inspection of parts that are subjected to wear by the accumulation of sand and dirt getting into movable parts. Disassembly and assembly are covered in TM 9-305.

b. Examine all springs to see that they have not lost their flexibility or taken a set.

c. Examine all ball and sockets for wear.

d. Examine bushing in the compensator shaft brackets and see that they are receiving proper lubrication.

e. Examine all the rods and shafts for bending and misalignment.

18. Inspection of 75-mm gun carriages M2A1, M2A2, and M2A3.—*a.* The force required to revolve the elevating handwheels should not exceed 10 pounds and the force required to revolve the traversing handwheels should not exceed 8 pounds. These forces will exceed the limits if bearings, bushings, gears, or worms are binding or insufficiently lubricated. The elevating handwheel might require excessive force due to improper adjustment of the equilibrators.

b. Examine all welds of the recoil mechanism and holding cradle for broken or cracked welds.

c. Examine the elevating arc for burred or deformed teeth.

d. Test the elevating and traversing mechanism for backlash by turning the handwheels back and forth, noting the amount of play. If it exceeds one-quarter turn of the handwheel, make the proper adjustments.

e. Examine all fastenings welded to trails and top carriage for broken or cracked welds.

f. Examine the lifting jack of the M2A1 carriage, and note that there is no malfunction in the raising or lowering of jack.

g. Examine all traveling locks and see that they perform their function without binding or undue force in their maneuvering.

h. Examine the traversing rack and note whether the teeth are burred or deformed.

i. Elevate and depress the gun to test the action of the equilibrators. If the turning of the elevating handwheel requires more force than is prescribed in *a* above, make adjustment in the following manner: Depress the cradle until the equilibrator assembling nut, A137149 (fig. 23), carried as an accessory in the tool box, can be assembled at full length on the equilibrator spring rod, A155908, thereby retaining the equilibrator spring in compression. Elevate the gun until the equilibrator trunnion pin, A141451, is clear of its bearing. Release the trunnion pin lock and make the desired adjustment by screwing the equilibrator trunnion pin in or out. After making the adjustment, reengage the trunnion pin lock and lower the cradle until the equilibrator trunnion pin is seated in its bearing. Then remove the equilibrator assembly nut and place it in the tool box.

j. Examine the automobile balloon tires for wear of the treads.

k. Test the air pressure in the tires. The air pressure should be maintained at 30 pounds per square inch, regardless of the marking on the tires. Examine the side of the tire for broken wall.

19. Recoil mechanisms and their modifications.—The following is a brief history of modifications that have been made to the M1897 and M1897MI recoil mechanisms. It is imperative, when making reports that the model designation of the recoil mechanism be given.

a. *Recoil mechanism M1897.*—This mechanism is the original “French” designed recoil mechanism and is designated as 75-mm gun recoil mechanism M1897.

b. *Recoil mechanism M1897A1.*—This mechanism is a modification of the 75-mm gun recoil mechanism M1897. This modification consisted of removing certain packing and substituting metallic packing.

c. *Recoil mechanism M1897A2.*—This mechanism is a modification of 75-mm gun recoil mechanism M1897. This modification consisted

of removing certain packings of the recoil piston, stuffing box and floating piston and substituting X6 type metal packing. (The decision to make the above change in packing was revoked.)

d. Recoil mechanism M1897A3.—This mechanism is a modification of 75-mm gun recoil mechanism M1897. This modification consisted of eliminating the pump filling mechanism and some other parts of the mechanism.

e. Recoil mechanism M1897A4.—This mechanism is a modification of the 75-mm gun recoil mechanism M1897A1 and M1897MIA1. This modification consisted of eliminating the pump filling mechanism and some other parts of the mechanism.

f. Recoil mechanism M1897A5.—This mechanism is a modification of the 75-mm gun recoil mechanisms M1897 and M1897MI. This modification consisted of substituting Duprene for certain packing, the elimination of trunnion connections for the oil pump M1A1, and the elimination of the elevating mechanism. This mechanism is to be used when mounting the 75-mm gun M1897A3 on 75-mm gun carriages M2A1 and M2A2.

g. Recoil mechanism M1897A6.—This mechanism is a modification of the 75-mm gun recoil mechanism M1897 and M1897MI. This modification consisted of converting the mechanism to the 75-mm gun M1897A3, mounted on 75-mm gun carriage M1897A4.

h. Recoil mechanism M1897MI.—This mechanism is the original recoil mechanism of American manufacture.

i. Recoil mechanism M1897MIA1. This mechanism is a modification of the 75-mm gun recoil mechanism M1897MI. This modification consisted of removing certain packings and substituting metallic packings.

j. Recoil mechanism M1897MIA2.—This mechanism is a modification of the 75-mm gun recoil mechanism M1897MI. This modification consisted of removing certain packing from the recoil piston, stuffing box and floating piston and substituting a new type packing known as X6. This modification was rescinded and the use of metallic packing abandoned.

k. Recoil mechanism M1897MIA3.—This mechanism is a modification of the 75-mm gun recoil mechanisms M1897MI and M1897MIA1. This modification consisted of elimination of trunnion connections for the oil pump M1A1.

20. Inspection of recoil mechanisms.—*a. General.*—(1) In order to make an intelligent and consistent inspection of the recoil mechanism, it is essential that the inspector be informed not only as to its action, but also to certain technical peculiarities of the mechanism with which he will come in contact. The front and rear cylinder

packings, recoil piston and rear stuffing box, oil index, and filling valve, should be examined for oil leaks. The recoil piston and rear stuffing box packings normally indicate a very slight leakage of oil, which insures lubrication. The leakage from the rear stuffing box is utilized to lubricate the elevating nut of the 75-mm gun carriage M1897, and modifications.

(2) The oil reserve or "reserve oil" are terms applied to that portion of the oil which normally separates the floating piston from the regulator. In the sectioned view (fig. 13) it is apparent that the compressed nitrogen will act to put pressure on the oil only as long as there is oil between the front of the regulator and the floating piston. After these pieces come in contact, further movement of the floating piston is prevented and consequently the pressure of the oil may drop to zero. In amount, the reserve oil represents a volume corresponding to a movement of the floating piston of about one-half inch or exactly the same as the travel of the oil index between its extremes of movement.

(3) In determining the gas pressure, the operator is actually measuring the pressure on the oil transmitted to it by the compressed nitrogen through the medium of the floating piston. The gas pressure is originally established with the oil reserve in the recuperator and, therefore, it is necessary that a full reserve be present or its equivalent, if correct readings are to be obtained. The difference in pressure when full reserve is present and when there is barely sufficient reserve to indicate any pressure at all will be about 30 pounds per square inch.

(4) The friction of the floating piston to be considered is the sliding friction and not the standing friction. Therefore, the floating piston must be in motion when the reading is taken on the pressure gage.

(5) The oil in passing from the vicinity of the pressure gage to the vicinity of the floating piston, or vice versa, must pass through very small orifices. Because of the resistance offered in these orifices, if the recoil piston jack is operated rapidly in either direction, a misleading pressure will be generated in the vicinity of the gage and be registered thereon. For this reason the recoil piston jack screw must be operated *at not over four turns per minute*.

(6) Since the oil within the recuperator becomes sluggish at a low temperature its action through the small orifices is erratic, and the reliability of gas pressure measurements with the recoil mechanism at a low temperature is always doubtful. Therefore, if pressure must be tested in cold weather, it is necessary that the mechanism and extra oil be in a room warmed to at least 50° F. for 24 hours preceding the test.

(7) Since the amount of nitrogen originally placed in the recuperator cannot increase, the pressure at any given temperature cannot become higher except by moving the floating piston forward so as to reduce the volume. This can occur if an excess of oil is introduced, as may be the case if the oil index is stuck and the sticking not noticed. Make sure the oil index *is registering properly* by draining the reserve oil and restoring some of it. The oil index will move in when the oil is drained and should move out as the reserve is reestablished. Failure of the oil index is almost invariably on the outward movement.

(8) If nitrogen leaks past the floating piston it may be detected by *sputtering* and *the foamy appearance of the reserve oil* when draining out.

b. Manometer test.—(1) When measuring the nitrogen pressure and friction of the counterrecoil mechanism, the gun must be in the horizontal position, disconnected from the piston rod, and the muzzle even with the front of the recoil mechanism.

(2) Remove the filling and drain plug located near the rear end of the right side of the cradle and insert the recoil pressure gage connection, C67579 (fig. 37). Before inserting, make sure that the valve release handle of the pressure gage connection is in the full open position. Secure the pressure gage, C6529, in the upright position by means of nut, A169748. In order to drain reserve oil from the cylinder, open the drain handle, A174168, and then screw in valve release handle, A174168. Oil will flow from the shaft of the drain handle and should be caught in a suitable receptacle until the flow practically ceases. The oil index should move in beyond the rear face of the cradle.

NOTE.—If the oil index is binding and has not moved the full distance, it should be repaired.

(3) Place the thermometer in the reserve oil drained from the mechanism and make a record of the temperature. Keep the thermometer out of the sun. The thermometer should represent the temperature inside the recoil mechanism.

(4) The pressure gage connection described in (2) above, will be used for reading the pressure within the recoil cylinder. In this case the drain handle will be kept closed and the valve release handle turned all the way in so that the pressure will be transmitted to the pressure gage.

(5) To determine the nitrogen pressure of the mechanism and the friction of the floating piston—

(a) Move the recoil piston to the rear by means of the recoil piston jack (fig. 37), inserted in place of the respirator, until a

pressure of approximately 100 kg. per sq. cm. (1420 psi) at 68° F. is registered on the pressure gage.

NOTE.—1 kg. per sq. cm.=14.2 psi.

(b) Slowly turn the jackscrew (at a rate of 4 rpm) ten complete revolutions and while slowly making the tenth revolution read the pressure gage, tapping the gage lightly to overcome the effect of friction in the gage itself. This gage reading represents the gas pressure plus the friction of the floating piston ($Ap + F$). (Make a note of the gage reading.)

(c) Turn the jackscrew five more revolutions. Then reverse the direction, unscrewing for five revolutions, moving slowly the fifth time. Read the gage for the second time. This reading represents the gas pressure minus the friction of the floating piston ($Ap - F$). (Make a note of the gage reading). Repeat this procedure and take the proper readings until uniform results are obtained.

(d) The gas pressure in the mechanism is one-half the sum of the high and low reading:

$$Ap = \frac{(Ap + F) + (Ap - F)}{2}$$

Example:

Gage reading, (b) above..... 133 kg. per sq. cm. (1,888 psi).
 Gage reading, (c) above..... 107 kg. per sq. cm. (1,519 psi).
 Add these gage readings together.. 240 kg. per sq. cm. (3,407 psi).
 Then divide the answer by two... 120 kg. per sq. cm. (1,703.5 psi).
 120 kg. per sq. cm.=gas pressure of mechanism.

(e) In eliminating the friction of the floating piston it must be remembered that it is the *sliding* friction and not the standing friction that is to be deducted; therefore, *the floating piston must be in motion when a reading is taken on the pressure gage.*

(f) Since the pressure of the nitrogen depends on its temperature, the table below will be used to determine whether the measured pressure is acceptable. The correct pressure at any temperature may be found by referring to the following table of variations of pressure with change in temperature. If using the centigrade and kg. per sq. cm. table, the allowable limits of pressure are 6 kg. per sq. cm. above or below that shown in the table. If using the Fahrenheit and psi table, the allowable limits will be 85 psi above or below that shown in the table. If not within these limits, the recoil mechanism must be reported to the Chief of Ordnance.

Temperature centigrade	Pressure (kg. per sq. cm.)	Temperature Fahrenheit	Pressure (psi)	Temperature Fahrenheit	Pressure (psi)
- 15	106	5	1, 508	75	1, 729
- 10	108	10	1, 524	80	1, 745
- 5	110	15	1, 539	85	1, 761
0	112	20	1, 554	90	1, 777
5	114	25	1, 571	95	1, 792
10	116	30	1, 587	100	1, 808
15	118	35	1, 603	105	1, 825
20	120	40	1, 619	110	1, 840
25	122	45	1, 635	115	1, 856
30	124	50	1, 650	120	1, 872
35	126	55	1, 666	125	1, 888
40	128	60	1, 681	130	1, 903
45	130	65	1, 697	135	1, 918
50	132	70	1, 713	140	1, 934
55	134				
60	136				

c. To determine friction of floating piston.—(1) The friction of the floating piston is one-half of the difference between the high reading ($Ap + F$), *b*(5) (*b*) above, and the low reading ($Ap - F$), *b*(5) (*c*) above.

$$F = \frac{(Ap + F) - (Ap - F)}{2}$$

Example:

Gage reading, *b*(5) (*b*) above..... 133 kg. per sq. cm. (1,888 psi).

Gage reading, *b*(5) (*c*) above..... 107 kg. per sq. cm. (1,519 psi).

Subtract the second gage reading from
the first reading which equals twice
the friction of the floating piston---

26 kg. per sq. cm. (369 psi).

Divide the answer by two-----

13 kg. per sq. cm. (185 psi).

NOTE.—13 kg. per sq. cm. (185 psi) is the friction of the floating piston.

(2) Normal value of *F*. is 13 kg. per sq. cm. (185 psi). The friction of the floating piston may vary between the limits of 10 kg. per sq. cm. (142 psi) to 30 kg. per sq. cm. (426 psi). If not within these limits, the recoil mechanism must be reported to the Chief of Ordnance.

d. To determine friction of recoil piston and recoil piston rod stuffing box.—(1) Perform the operations outlined in *b* (1), (2), and (3) above.

(2) Force the recoil piston to the rear by means of the jackscrew until the pressure gage registers a pressure of 1,200 to 1,500 psi (84.5 to 105.6 kg. per sq. cm.). Then turn the jackscrew fifteen revolutions.

(3) Reverse the motion of the jackscrew until the jackscrew head leaves the recoil piston. The recoil piston follows the jack until the friction between the cylinder and the recoil piston rod equals the pressure in the cylinder. At this point the friction will keep the piston from moving back with the jack, the pressure will stop decreasing and remain stationary, and the jack will be moved away from the piston.

(4) Read the gage. The gage reading at this point represents the sum of the friction of the recoil piston and the friction in the recoil stuffing box.

(5) Obtain three uniform readings.

NOTE.—Exercise the recoil piston by repeating operations in (1), (2), (3), and (4) above a sufficient number of times until the last three gage readings are practically uniform. This is important since true friction readings cannot be obtained until the packings are well lubricated.

Example:

First reading, pressure gage-----	53 kg. per sq. cm. (752.6 psi)
Second reading, pressure gage-----	51 kg. per sq. cm. (724.2 psi)
Third reading, pressure gage-----	51 kg. per sq. cm. (724.2 psi)
Add these three readings together--	155 kg. per sq. cm. (2201 psi)
Then divide by three-----	51.6 kg. per sq. cm. (733.7 psi)

The result 51.6 kg. per sq. cm. (733.7 psi), is the friction of the recoil piston and the recoil rod stuffing box. Normal pressure necessary to overcome the combined friction of the recoil piston and the recoil rod stuffing box is 48 kg. per sq. cm. (681.6 psi). This may vary between 28 kg. per sq. cm. (397.6 psi) and 60 kg. per sq. cm. (852 psi).

(6) If the reading of the friction is *high*, that is, in excess of 60 kg. per sq. cm. (852 psi), adjustment will first be made by unscrewing the piston rod nut, front, slightly, if this nut is not found to be loose before unscrewing.

(7) Care must be exercised not to unscrew the nut in excess of one-fourth of a turn and that it is not loose after being unscrewed that amount.

(8) Again check the reading of the friction and if still high, the recoil stuffing box head may be unscrewed a maximum of one-tenth of a turn, providing the recoil stuffing box head is not loose before unscrewing and is not loose after unscrewing one-tenth of a turn and does not protrude $\frac{1}{4}$ of an inch.

(9) After the above adjustments, if the friction is not between the limit of 28 kg. per sq. cm. (397 psi) and 60 kg. per sq. cm. (852 psi), the mechanism must be reported to the Chief of Ordnance.

(10) (a) If the reading of the friction is *low*, force the recoil piston to the rear with the recoil piston jack, and allow the reserve oil to escape through the pressure gage connection. Remove the jack and examine the wall of the cylinder and the exposed surface of the piston rod for excessive oil leaks and scoring.

(b) Low friction is caused by breakage of the flange of the silver ring bearings, cracking of Belleville springs or deterioration of the rubber, due to the action of sulphur in the ring. Any effort made to increase the friction by increasing pressure on the Belleville spring is likely to result in breaking the spring into small pieces, which would probably cause damage to the interior of the cylinder and piston rod.

(c) Experiments have determined that frictions of the recoil piston and the recoil rod stuffing box, which are slightly low, will not appreciably affect the length of recoil of the gun. However, low frictions usually indicate, according to tests made, that some portion of the packing has broken or deteriorated.

(d) Recuperators having low friction should be reported to the Chief of Ordnance.

e. Instructions for use of stuffing box gage, A136420 (special repair tools) (fig. 47).—(1) When checking the friction of the recoil piston and the recoil rod stuffing box as outlined in *d* above, and it is found that the recoil stuffing box head, C68921 (30B), is loose after it is turned one-tenth of a turn, the threads of the recoil stuffing box head, C68921 (30B), will be tested with the stuffing box gage, A136420.

(2) The removal of the head, C68921 (30B), disturbs the adjusted friction of the stuffing box, which it will be necessary to restore in case the threads are still serviceable.

(a) Check the combined friction of the recoil piston and stuffing box, *d* above. If the friction is within the limits allowed, inscribe a line on the head and face of the cradle as a reassembling guide and measure the distance the head extends beyond the face of the cradle. As the jack moves the piston rod to the rear, the piston rod coupler is released and is to be taken off and laid to one side.

(b) Extract the reserve oil and remove the oil extractor. Drive out the 0.236 diameter pin through the piston rod nut and take off the nut. It will be necessary to hold the rod due to its friction with the nut.

(c) Dismount the recoil mechanism and securely place it rear end up (to prevent loss of oil when the head is removed).

(d) Unscrew the recoil cylinder rear head, using the special wrench, A8161 (fig. 47), and carefully avoid any marking or other damage to the piston rod.

(e) Apply the gage, A136420, to those threads of the head that have been engaged. The gage is a "Not go on" gage. The threads when worn are narrower at the top than at bottom. If the gage goes on for one-third the height of the thread, the recoil mechanism must be returned to an arsenal for repair.

NOTE.—It is possible, but not necessary, to measure the threads in the cradle as experience shows that they will be worn equally with those of the head.

(f) Should the threads prove to be still serviceable, reassemble the head to its original position by the aid of the inscribed line and measurement taken in e(2)(a) above.

(g) Add a full reserve of oil and make a recheck of the friction. If it is too high, it may be reduced by backing out the head a very little. Do not attempt to adjust the friction by screwing the head in further, as then only unworn threads will be assuming the load. Be sure to replace the piston rod nut pin before reassembling the piston rod coupler. *Under no circumstances should any of the stuffing box packing be disturbed.*

21. **Checking distance from roller paths to inclined planes of cradle on carriages M1897, M1897MIA2, and M1897A4.—a.** With the gun removed from the carriage wipe the roller path and inclined planes *clean* and place the depth gage, C58358 (fig. 47), squarely across the roller path with the nearest side of the gage 20.16 inches from the rear end of that part of the cradle containing the bores. (The center of the micrometer head of the gage is then 20.16+.813 ($1\frac{3}{16}=20.973$ from the rear end.) The depth from the roller path to the incline should here be 0.2747 inches.

b. Move the gage forward by 6-inch stages with the exception of the eighth or last station, which is moved 4 inches. The taper of the inclined plane is 0.64 in 100. In 6 inches it is $0.0064 \times 6 = 0.0384$ inch. At successive stations the depth of the incline must be between the following limits:

With gage at—	<i>Inch</i>
20.16 from rear end.....	0.2747-0.2847
26.16 from rear end.....	.2363- .2463
32.16 from rear end.....	.1979- .2079
38.16 from rear end.....	.1595- .1695
44.16 from rear end.....	.1211- .1311
50.16 from rear end.....	.0827- .0927
56.16 from rear end.....	.0443- .0543
60.16 from rear end.....	.0187- .0287

(1) Reverse the gage and take corresponding measurements of the other incline. If measurements fall outside of the above limits, the recoil mechanism must be returned to an arsenal for relining.

(2) The micrometer of the gage may be calibrated by backing the head out until the reading is less than zero, placing the gage on a perfectly flat plate and turning the head until the ram just contacts with the plate. The reading should be exactly zero. Zero reading may be obtained by adjusting the threaded bushing, using a suitable screw driver.

22. Nitrogen pressure and floating piston friction of recoil mechanism mounted on 75-mm gun carriages M2A1, M2A2, and M2A3.—*a.* To determine the nitrogen pressure and the floating piston friction of the recoil mechanism of the 75-mm gun carriages M2A1, M2A2, and M2A3—

(1) Disconnect the gun from the piston rod and move the gun to the rear until the gun muzzle is even with the front of the recoil mechanism. With the gun at 0° elevation, remove the filling and drain plug, insert the pressure gage connection, and draw off the reserve oil.

(2) Remove the respirator and assemble the recoil piston jack (fig. 37).

(3) Turn the recoil piston jack handle about ten revolutions to create a reserve oil pressure.

(4) All revolutions of the jackscrew from now on must be made slowly (at the rate of four revolutions per minute). Continue to turn the jack five revolutions and read the pressure on the pressure gage as the piston is being moved on the fifth revolution.

(5) Continue to turn the recoil piston jackscrew three revolutions and then reverse the motion three revolutions and read the pressure on the pressure gage. Make all readings while the piston is in motion.

(*a*) Nitrogen pressure=one-half of the sum of the high gage reading and the low gage reading.

(*b*) For use of the temperature-pressure table, refer to paragraph 20*b*(5)(*f*).

(*c*) Floating piston friction=one-half of the difference between the high gage reading and the low gage reading.

(6) Repeat operations in (3), (4), and (5) above until three uniform gage readings are obtained.

b. To determine the friction of the recoil piston and stuffing box packings—

(1) Repeat operations in (1) and (2) above.

(2) Turn the screw of the recoil piston jack slowly until the gage shows from 1,200 to 1,500 psi pressure.

(3) Reverse the motion of the jack until the jack head leaves the piston (the piston follows the jack head until the sum of the friction of the recoil mechanism and the friction in the recoil rod stuffing box equals the pressure within the cylinder). Since the oil pressure in the cylinder is greater than the friction (until equalized), the pressure gage hand drops without fluctuating, and then remains stationary when the piston rod stops moving.

(4) Read the pressure gage. The gage reading at this point represents the sum of the friction of the recoil piston and the friction in the recoil rod stuffing box.

(5) Repeat operations in (2), (3), and (4) above until three uniform pressure gage readings are obtained.

NOTE.—Uniform readings will not be attained until packings are well lubricated. This is accomplished by repeating operations in (2), (3), and (4) above a number of times.

23. Inspection of special field artillery vehicles.—*a. General.*—(1) Inspection of the matériel is made with three objects in view. The first is to make certain that the matériel is in serviceable condition. The second is in a measure a check upon the personnel as to the care taken of the matériel. The third includes selection of data of performance which may be used for future designs. Inspectors will be careful to record on inspection blanks all the information specifically required as well as any other unusual circumstances observed in the matériel.

(2) No tools are required for the inspection of the vehicles other than such as form the regular equipment of the battery. These include two lifting jacks (or one jack and proper blocking) for raising both wheels of a vehicle, a small hammer, a graduated steel scale (12-inch), a 4-foot steel or hardwood straightedge, hub cap, and carrying spring bolt nut wrenches, and a few complete rounds of ammunition.

b. Ammunition chests.—The chest should hold the complete rounds without excessive end play, which would loosen the projectiles in the cases and induce wear of the rotating bands and chest diaphragms. In manufacture, the distance between the face of the diaphragm next to the door and the bearing strips on the door is made $\frac{1}{8}$ inch (the thickness of the cartridge case given as 0.106 inch). Wear on the door hinges and lock bars may increase this distance or the door may be sprung. Lay the straightedge on and parallel to the tees or sur-

faces of the door which contacts with the cartridge cases and prove their straightness. Put at least five (and as many more as desired) complete rounds in the chest, separated by placing one round in each corner and the rest in the center, and leave each round out of its seat about $\frac{1}{4}$ inch. Carefully close the door and engage the lock bar without putting any other pressure on it other than that exerted by its fastenings. The lost motion in the cartridge cases may then be measured by opening the door, placing a long straightedge across the rear of the chest sides, measuring from the straightedge to the cartridge case, then shoving the particular case home by hand and measuring again from the straightedge. If this movement is anywhere greater than 0.062 ($\frac{1}{16}$) inch (maximum in new chest is 0.029 inch), the hinges need replacement or refitting with larger pins or the door should be straightened. Make note on the report of any case in which the measurement exceeds 0.04 inch. Try a complete round of ammunition in each compartment. Select the one having the greatest end movement and see if the rotating band of the projectile will go through the second diaphragm. If it does, new ammunition connecting pieces are required.

c. Chests other than ammunition chests.—Inspect for defective or missing packings. Note that the various spring-supported packings function properly. See that the lock bars, hasps, and shot bolts are in serviceable condition and function properly. Check the presence and condition of the accessories and their holders on each vehicle. Inspect for missing padlocks and bolt snaps.

d. Carrying springs.—With the vehicle fully loaded and the axle level, the carrying springs should still shove the chest up until all the Belleville springs are tight, with $\frac{3}{4}$ inch between the side rail and axle stop surfaces. If one carrying spring may be turned by the hand while its mate is tight, that spring has taken a set and should be replaced. Raise the chest on blocks, remove the spring bolt nuts of caisson or cart and dismount the springs. No carrying spring should be used which is cracked or broken or which has a free height of less than $5\frac{1}{4}$ inches.

e. Fasteners.—The inspector will examine carefully the ends, front, rear, top, and bottom of the chests for cracks. His attention will be drawn to missing straps or implement fasteners by vacant rivet holes in the chest. He should note particularly the ax and hatchet blade brackets to see that the handle rest is present. Note that the handrails are properly riveted and fairly solid on their shanks.

f. Frames.—(1) The frames will be inspected for loose and broken rivets, also for missing rivets particularly at the joints of braces. Inspect for loose or missing bolts, nuts, lock washers, and cotter pins. Get the numbers of the vehicles from the name plates rather than from previous reports.

(2) Test limbers and reels equipped with the automatic pole support by raising the prop and bearing down on the front end of the pole, the vehicle being limbered to one having a pole supporting lunette. The pole supporting spring will raise the pole to its normal position of $29\frac{1}{4}$ inches from the ground if the automatic pole support is in proper adjustment. The mechanism should not squeak. Engage and disengage the lunette with the pintle. It should be possible to open the pintle latch by using the hand only, no bar. Turn the pintle over while unlimbered. It should not bind anywhere except as restrained by the pintle bearing spring. Try each spring cover and oil valve by opening them. See that all moving parts are clean and properly lubricated.

g. Brakes.—Check the adjustment of the brakes as outlined in paragraph 25*d*. Note whether all possible adjustment of the link has been made which indicates that the brake bands have been worn to the limit.

h. Wheels.—In inspecting wheels, jack up each wheel in turn. Spin the wheel to see that it turns freely. Tap the tires lightly with a hammer for evidences of looseness. Look closely for cracked spokes or evidence of working of the spokes at the hub. See that the hub bolts are tight by trying the nuts with a hammer. Open and close the oil valve. Take off the hub cap, grasp the spokes, and force the wheel back and forth on the axle arm. The maximum end play of a new axle may be, but very seldom is, as much as $\frac{1}{16}$ inch. If this has been increased by wear on the wheel fastening or the hub liner to $\frac{5}{32}$ inch, assemble a new wheel fastening, and if it is then as much as $\frac{3}{32}$ inch and the wheel is in otherwise good condition, direct the replacement of the hub liner. The allowable wear in the diameter of the hub liner as far as safety is concerned may be more than that which will increase the diameter $\frac{1}{32}$ inch, but after this much wear the hub box will rub the base of the axle arm, the hub cap will rub the wheel fastening, and the loss of the lubricating oil will be excessive. It is customary to replace the hub liner of any wheel which begins to rub the under side of the axle arm base. Note the presence and condition of the wheel dust guards.

be noted on the inspection report. Each fuze setter bracket should be maneuvered and any unusual condition noted on the report.

j. Reels.—The general inspection of both the artillery and battery reels as to oilholes, paint, accessories, etc., will be along the lines as indicated for the other vehicles.

(1) *Artillery reel, M1909M1.*—(a) Jack up the right wheel until it is clear of the ground and turn the handwheel in a clockwise direction as far as it will go.

(b) Spin the wheel, moving the top of the tire forward; the jack-shaft and chains should move freely without dragging at the clutch.

(c) Set the clutch, disengage the drum latch and clutch rod, and turn the rod wheel, thus causing the right drum to revolve. It should not require any considerable pull. If more power seems to be required when some particular spoke is vertical than when the spoke is horizontal, take off the wheel and turn it 90° thus engaging the driving pins in other openings of the driving sprocket.

(d) The left drum should spin freely on its bearings. Again connect the clutch rod, start both drums revolving with considerable speed, and apply the drum brakes. They should positively stop the revolving of the drums. With the right drum brake only engaged, have a man stand on the outer end of a horizontal spoke. No revolution should result. Note any rubbing of chains on the chain guards and have the condition corrected. Note the tension of the driving chains. Neither should be so slack as to threaten to catch and run off the sprocket. One chain or the other should have an offset connecting link.

(2) *Battery reel M1917A2.*—(a) Jack up the left wheel until it is clear of the ground.

(b) Put the hand lever in neutral position. Turn the wheel slowly and then spin it for evidences of badly meshing or broken gears. Afterward take off the left wheel and gear covers and examine the gears.

(c) Engage the driving gear, spin the wheel, and attempt to stop the revolution of the drum by throwing out the driving gear and engaging the brake. A smooth and efficient action should occur.

(d) Stand on the rear chest and try the action of the chest supporting springs and the guides on each end. If they respond as if well-lubricated, pass them; if not, have them dismantled for examination and compare the free height of the springs on each side. The proper functioning of these springs is essential for the safety of the valuable instruments carried in the chest.

SECTION V

INSTRUCTIONS FOR MAINTENANCE AND REPAIR

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24. 75-mm gun M1897.—*a. General.*—A description of and detailed instructions on the dismounting and replacing of the gun, breech mechanism, and firing mechanism mentioned in this manual are given in TM 9-305.

b. Jacket and bore.—The gun, being dismounted from the carriage, any apparent movement of the jacket, crack, or rupture in the bore that is not readily understood should be reported to the ordnance inspector of artillery. In time of peace report it to the corps area ordnance officer.

c. Gun travels stiffly in cradle.—This may be caused by a twist in the jacket extension of the M1897 gun resulting in one side of the crosspiece riding heavily on the upper roller path, by vertical misalignment of roller, or by the sweeper plate or the sweeper plate guide, or by the condition of the slides. Remove the sweeper plate and guide piece. If travel is still stiff, remove the gun and carefully

examine the jacket slides, the inclined planes of the cradle and the roller paths. Carefully remove any burrs or seizure marks which may exist on the surface. See that the rollers turn freely. Check the muzzle rollers and jacket rollers to see if diameters of rollers are within the tolerances of 2.26 (+0.000) (-0.005) inches, shown on drawing 52-85-19. Replace the gun. If the defects still persist, try the gun on several cradles or several guns on the suspected cradle. If the defect cannot be located, send the gun and cradle to an arsenal for repair. In replacing the sweeper plate be sure that the slide sweeper blocks are raised and rest on the cradle. It has happened that these blocks have been allowed to lap over the cradle front end with disastrous results.

d. Defects in bore or powder chamber.—(1) Defects in the bore cannot be repaired. Grooves or furrows in the powder chamber are repaired by filling in with tin and leveling flush with the surrounding surface. These grooves are usually of very small depth, not exceeding 0.002 inch. When a defect in the powder chamber causes the cartridge case to crack and blow out, the gun should be returned to an arsenal for repair.

(2) The application of tin is to be carried out as follows:

(a) Clean carefully and scrape thoroughly the bottoms and edges of grooves.

(b) Remove all grease from the surface, using a hot (boiling solution of soda ash. Then apply a small hemp brush (a piece of rope will do) wet with a saturated solution of zinc chloride.

(c) Tin with a soldering iron, using very pure tin. (Spec. QQ-T-371.)

(d) Scrape off the excess tin and finish by forcing in the chamber a slight conical oak block, rotating the block until the surfaces are flush. The block may be covered with a thin sheet of zinc. Emery cloth should never be used, as emery will stick in the tin. If the tin does not stick, do the work all over, using in place of the zinc chloride, a 10 percent solution of sulphuric acid, slightly warm.

(e) Smooth the bruises at edge of chamber by filing and polishing, removing the least amount of metal possible to make the condition satisfactory.

e. Jacket crosspiece loose.—(1) The jacket crosspiece should be modified in accordance with FSMWO C4-W15 and shown on drawing B104897.

(2) If the setscrew is loose, the crosspiece should be salvaged by welding to close up the setscrew hole and then redrilled and tapped to obtain a neat fit. If the recess for the setscrew or the point of the screw is out of shape, reform it to get perfect contact. When

the gun is in battery, the clearance between the upper roller path and the jacket cross-piece should be such that the clearance gage, 10 (fig. 36), will not pass. As the jacket slides wear, the clearance between the crosspiece and the upper roller path must be corrected by adding shims to the crosspiece as directed by FSMWO C4-W15.

f. Leveling plates damaged.—The leveling plates on top of the breech end must be exactly parallel with the bore of the gun. If they have been damaged or are not true with the bore, they should be repaired by filing or scraping by a skilled mechanic. To test their accuracy, insert in the muzzle of the gun the master level rest, 1 (fig. 44), and check the readings of the master level, 4 (fig. 45), placed on the level rest, with those of the same level placed on the leveling plates. If the master level rest is not available, use a straightedge wedged tightly against the top of the bore with wood, set the master level on the protruding end of the straightedge, then bring the gun exactly to the horizontal position. Transfer the level to the leveling plates and remove metal from the seat toward which the bubble moves until the bubble is exactly central. Test by reversing the level.

g. Breechblock stuck in breech recess.—Release the breechblock stop and swing it back; move the arm of the extractor spindle down and withdraw sufficiently to remove the extractor tang. After its removal push the spindle back into its seat again. Oil the threads liberally, where exposed, with oil, lubricating, for aircraft instruments and machine guns, and unscrew the block. Apply oil frequently while unscrewing. If necessary, use some force and if this fails, pry with a bar under the operating handle close to the arm, resting the end of the bar on the gun or breechblock, care being taken not to bend the operating handle. Use some protective means between the bar and the gun parts to prevent injury.

h. Breech recess threads scored or bruised.—Smooth by filing with the breech thread file, 2 (fig. 36), and polish. Scores and bruises on the pressure or rear side of the threads can never be entirely removed due to destroying the relation of the surfaces. The removal of metal by filing and polishing must be limited to just enough to remove the raised metal and restore the original contour of the thread.

i. Breechblock threads scored or bruised.—Smooth by filing with a 3-square file and polishing. Scores and bruises on the pressure side of the threads can never be entirely removed due to destroying the relation of the surfaces. The removal of metal by filing and polishing must be limited to just enough to remove the raised metal and restore the original contour of the thread.

j. Safety bolt.

<i>Malfunction</i>	<i>Correction</i>
(1) Safety bolt is bent, burred, or broken.	(1) Straighten and smooth by filing and polishing.
(2) Boss sheared off.	(2) Replace the bolt assembly.
(3) Spring broken.	(3) Replace the spring.
(4) Bolt does not remain in upper position when the piston rod coupler key is removed.	(4) Replace the safety bolt assembly with the aid of a screw driver and pry the spring up until the desired tension is obtained.

k. Safety piece.—If the threads are bruised, smooth by filing; if worn, return to Rock Island Arsenal for repair.

l. Firing hammer lock broken.—Remove the end of lock from safety piece by carefully drilling through its center. Chisel out or countersink the riveted end. Unscrew by driving a square drift in hole and turning it with a wrench. Replace with new lock. Rivet over the end and finish to prescribed dimensions of 0.315 (+0.000) (−0.004) inch in diameter and 0.138 ± 0.02 inch projection to enter the hole in the firing hammer, as shown on 52-85-26F.

m. Firing pin.—The rear end may be deformed and worn or the point broken. A worn point shortens the protrusion of the firing pin. Normally it should be 0.2 beyond the front face of the breechblock. If necessary, compensation may be made for a small amount of wear by facing off at the shoulder on firing pin. Correct the rear end and worn point by grinding and polishing. Do not remove metal from the bottom of the safety piece recess in the arm to compensate for wear of firing pin point.

n. Breechblock arm bent, loose, or cracked, and thread bruised.—Return to an arsenal for repairs.

o. Latch pawl catch.—Broken or loose in arm and working surface worn, resulting in improper functioning of breechblock latch to be held in unlatched position. Replace with new part if found cracked, broken, or excessively worn.

p. Operating handle bent.—Remove and replace with new part. Operating handle loose. Shim to sufficient thickness to correct looseness when handle is replaced in correct position. A new operating handle pin may be required.

q. Breechblock latch assembly.—Latch cracked and worn; pin loose or broken, and pawl worn and inoperative due to weak, broken, or cramped spring. Replace with new parts.

r. Operating handle plunger screw.—Threads stripped or screw is bent. Replace with new part.

s. Operating handle plunger block projections broken.—Replace with new part.

t. Operating handle plunger.—Bent or threads stripped. Straighten if bent, and replace with new part if threads are seized or stripped.

u. Extractor tang.—Working surface roughened. Smooth by polishing with emery cloth or oilstone. If cracked, replace with new tang.

v. Extractor spindle bent.—Heat to a faint red in a darkened place and straighten with a mallet or in a vise. Check shape with a new spindle.

w. Extractor bent.—Replace with new part.

x. Grooves for muzzle bore sight.—The cross string type of muzzle bore sight is considered preferable to the metal bore sight and arrangements are now made to cut the necessary vertical and horizontal grooves in the muzzle of the gun as outlined in FSMWO C4-W2.

y. Threads in sweeper plate guide and jacket stripped.—Drill and tap the hole deeper and assemble a sweeper bolt not more than 1.25 inches longer than standard. Oversize bolt is not issued. It should be made from stock equal to steel, WD (SAE) 4140.

z. Gun book (O. O. Form 5825).—The commanding officer of each shop to which the gun is sent will total the rounds fired and will note in the battery commander's daily record any observations concerning the condition of the gun. Each time the gun passes into the custody of another organization, the organization commander receiving the gun will acknowledge receipt by affixing his initials. A record of all repairs will be noted by the officer commanding.

25. 75-mm guns M1897A3, M1897A4, and M1897A2.—*a.* For defects in bore or powder chamber; leveling plates damaged; breechblock stuck in breech recess; breech recess threads scored or bruised; breechblock threads scored or bruised; safety piece threads bruised; firing pin deformed; worn or broken point; breechblock arm bent, loose, cracked, or thread bruised; latch pawl catch broken or loose in arm; operating handle bent; breechblock latch cracked and worn; operating handle plunger screw threads stripped; operating handle plunger block projections broken; operating handle plunger bent or threads stripped; extractor tang roughened; extractor spindle bent; extractor bent; the procedure of repair will be the same as that outlined in paragraph 24.

b. Burs or rough spots should be removed from the bronze slides.

26. Recoil mechanisms M1897 and modifications.—*a. General.*—The work on the recoil mechanism by the maintenance company is purposely limited. Operations prescribed in TM 9-305, the replacement of spare parts furnished the maintenance company and battery, and such adjustments as are herein described, are permitted.

With the exception of the recoil stuffing box head and the respirator, the removal of any cylinder head is forbidden.

b. Oil leaks into front of recoil cylinder.—(1) The cause is due to looseness or failure of the piston packing or wear of the cylinder wall. Measure the friction of the recoil piston and recoil rod stuffing box as directed in paragraph 20*d*.

(2) Should the friction of the piston and stuffing box be high, the condition of the cylinder and rod must be ascertained before any adjustment is made. The procedure of operation is as follows:

(*a*) Remove the respirator.

(*b*) Insert the pressure gage connection. Assemble the recoil piston jack in the hole occupied by the respirator. Force the recoil piston to the rear approximately 5 inches with the recoil piston jack, permitting the reserve oil to escape through the pressure gage connection.

(*c*) Remove the recoil piston jack and examine the cylinder and rod for scoring.

(*d*) If the scoring is deep on the wall of the cylinder or recoil rod, oil leakage will be in evidence and the mechanism will be returned to an arsenal for repair.

(*e*) If the scoring should be light and is general over the cylinder wall and surface of the recoil rod, it is an indication that the silver rings are being forced under too much pressure against the wall of the cylinder, and the adjustment in *f* below should be made.

(*f*) Unscrew the recoil piston disk screw in the front end of the piston.

(*g*) Remove the recoil cylinder sweeper, using extractor, 14 (fig. 36), if necessary.

(*h*) Apply the piston rod front nut wrench, A8765 (fig. 47), to the slots in the piston rod nut and unscrew approximately one-fourth of a turn. Prevent turning of the piston rod by holding a wrench on the piston rod nut in the rear of the cylinder.

(*i*) Remove the pressure gage connection and add a full reserve of oil.

(*j*) Check the friction. (See par. 20*d*.)

(*k*) If the friction is not within the limit set forth in paragraph 20*d*(5), namely, between 28 and 60 kg. per sq. cm. (397 psi and 852 psi), reduce the friction of the stuffing box by unscrewing the head, C68921 (30B), with the stuffing box head and follower wrench, A8161 (fig. 47), approximately one-tenth of a turn. Discontinue the adjustment if the head protrudes more than a quarter of an inch.

(*l*) Again check the friction as in (*j*) above.

(*m*) If the combined friction is not within the limits prescribed, reduce the piston friction as in (*h*) above.

(*n*) Again check the friction.

(*o*) If the combined friction is not within limits prescribed, reduce the stuffing box friction as in (*k*) above.

(*p*) Again check the friction.

(*q*) If the combined friction is not within the limits specified, the mechanism should be turned in to an arsenal for repair.

(3) In replacing the recoil cylinder sweeper and piston disk assembly, make sure that the screw is tight; then lock it by setting the metal of the plate into the screw slot. Replace the respirator.

c. Oil leaks into filling and drain plug recess.—The cause is due to the valve leaking. Take out the filling and drain plug housing. This involves the dismantling of the cradle rear side plate.

(1) *To dismount and assemble cradle rear side plate.*—Some of the cradle side plates are attached with slotless countersunk head screws which are properly finished flush and painted over to prevent unauthorized tampering with the mechanism. In case of accident to the plates or when necessary to disturb the filling and drain plug housing or other parts concealed by the plates, it will be necessary to scrape off the paint, locate the screws and chip slots in the heads or devise other means for getting the screws out. The rear right side plate is tightly fitted in its seat and it may be advisable to improvise the special tool shown in figure 46 in order to dismount it. In replacing cradle side plates there must be no springing of the cradle by forcing the plates into their seats. Each screw should be well locked in position and finished flush and hidden under paint as when originally issued.

NOTE.—When painting the recoil mechanism, see that the safety line cut in the right side at rear end of cradle is again filled in with black paint. The line in conjunction with the two lines on the right side of the breech of the gun shows how far out of battery it is safe to fire.

(2) *To dismount filling and drain plug housing, C69193 (fig. 27).*—
(*a*) Remove the filling and drain plug, B158713.

(*b*) Take out screw, A172171, holding filling and drain plug housing locking plate and take off the plate, A172141.

(*c*) Remove the six screws of the right rear cradle side plate and pull off the plate.

(*d*) When the rear right side plate is removed, the elevating screw oiling pipe, 2-97-22A (C57121), can be seen lying just over the filling and drain plug housing. This pipe picks up the waste oil from the piston rod and carries it to the elevating screw. The pipe can be removed by removing the screw, 2-97-44U (A173736).

(e) Unscrew the filling and drain plug housing, C69193, using a monkey wrench. To remove the filling and drain plug housing gasket, A19767 (85B), valve, and spring, assemble the piston rod jack and force the piston back a short distance. In no case should attempt be made to pull out the gasket with a hooked tool, which might damage the valve or housing. Replace the filling and drain valve spring, A172181, filling and drain valve, A172151, and filling and drain plug housing gasket, A19767 (85B).

(3) *To replace filling and drain plug housing.*—(a) If the oil filling and drain plug housing is to be reassembled, a shim, A5164, of the correct thickness will be required in order that the housing may be tight when the flat is in the correct position for the assembly of the locking plate, A172141.

(b) If a new filling and drain plug housing is to be assembled, the flat surface on the housing provided for the locking plate, A172141, will not be filed until the housing is screwed in place and the position of the flat marked, after which the housing will be removed for the purpose of cutting the flat.

(c) Put the valve and its spring in place, triangular stem forward, after having cleaned all of the parts with greatest care. Place on the seat of the housing the leather housing gasket, A19767, which has been thoroughly cleaned and soaked for several hours in recoil oil. Screw the housing in tight. Put on the right rear cradle cover plate temporarily in order to mark on the housing the two flat sides required. Also mark the top part of the housing which will have to be cut to receive the housing locking plate. Back the housing out, cut the flats, and return the housing to place. Fill the reserve and retain the recoil mechanism for observation for 24 hours to ascertain that no leakage takes place. If at the end of that time there is no leakage, reassemble the right rear cover plate, the six cover plate screws, valve housing lock plate, and screw.

(4) *To remove filling and drain valve housing.*—(a) With the parts removed as indicated in (2)(a), (b), and (c) above, remove the elevating screw oiling pipe, 2-97-22A (C57121), by removing the screw, 2-97-44U (A173736).

(b) Remove the filling and drain valve housing support screw, A172194 (fig. 27). In removing this screw the gun will have to be dismantled, as the screw goes in through the top of the recoil mechanism.

(c) Pull the filling and drain valve housing support off of the housing.

(d) Remove the filling and drain valve housing screws, 2-97-44W (A172448), figure 27. Tap the housing gently with the copper ham-

mer until it loosens and then it can be completely removed by inserting a screw driver between it and the recoil mechanism and prying gently.

d. Leakage around oil index.—(1) Tighten the oil index follower with the oil index follower wrench, A7488 (fig. 47). If the leakage does not stop, take out the follower and assemble new packing. Test the action of the index by draining and replenishing the reserve oil.

(2) If any defects in the oil index cannot be corrected by the above methods, the recoil mechanism will have to be sent to an arsenal for repairs.

e. Jerky action in returning to battery.—(1) Dirty or worn gun slides and rollers will cause this trouble. These parts should be corrected.

(2) Dirty oil or small particles interfering with valves, scored cylinders or piston rod. Return to an arsenal for repair.

(3) Recoil oil may contain air. This is due either to the escape of the nitrogen past the floating piston, or pumping air into the cylinder when refilling or replenishing with recoil oil. If air is introduced with the oil, the oil when drawn off, will contain large bubbles instead of the foamy appearance when nitrogen has escaped past the floating piston.

(4) If the presence of air in the recoil oil is due to the escape of nitrogen past the floating piston, the recoil mechanism must be returned to an arsenal for repair.

(5) When the presence of air in the recoil oil is due to the introduction of air with the oil when refilling or replenishing, proceed as follows: Drain off the reserve oil. Remove the air vent plug, A154552 (fig. 27), on top and near the rear of recoil cylinder. Raise the rear end of the recoil mechanism slightly and, using the oil pump, pump oil into the system, using slow and continuous strokes until the air bubbles cease to flow. Replace air vent plug. (If new air vent plug is required it will have to be made locally.)

f. Retraction test.—A final test may be given the recoil mechanism as follows: With one end of a sufficiently strong cable passed through the gun bore and looped securely around a hardwood block at the muzzle and the other end secured to a 2-ton chain block or tractor, the gun may be carefully retracted a maximum of 45 inches. A piece of sound 2 by 4 timber, exactly 44 inches long, and placed between the gun breech lug and the rear end of the cradle so that it does not bear upon the oil index, will hold the gun in the retracted position. Be sure the timber is securely set against gun and cradle. Carefully detach the chain block or tractor from the cable and, standing well to one side of the gun, pull out the hardwood block at

the muzzle, draw the cable out of the gun through the breech, and close the breech. Allow no one to stand in front of the gun or to project an arm in front of it while the cable is disconnected. Elevate to maximum elevation and jerk out the rear end of the 2 by 4 timber with a piece of rope. Note that the gun returns smoothly and fully into battery without shock. It will require approximately 4,400 pounds pull to retract the gun.

g. Repair of worn trunnions.—(1) When it is found that the oil grooves in the trunnion bearings of the rocker arms have worn ridges on the trunnions, the trouble should be corrected as follows:

(a) Remove the recoil mechanism and place it on a work bench or trestle bottom side up. With a flat file smooth off the ridges caused by the oil groove and finish with fine emery cloth. No effort should be made to true up the trunnions, as they only have a movement of 29° and a true circle is not absolutely necessary for a repair job. When time is not a factor the recoil mechanism should be returned to an arsenal where the trunnions can be turned down and a split steel liner applied.

(b) Replace the recoil mechanism in the rocker trunnion bearings. Before replacing the rocker arm caps, place on each trunnion, a piece of lead about $\frac{1}{16}$ inch thick, $\frac{1}{8}$ inch wide, and $1\frac{1}{4}$ inches long. Put on the rocker arm caps and force them all the way down with the trunnion bearing caps. Remove the rocker arm caps and measure the thickness of the leads with a micrometer. The thickness of the leads represent the amount to be planed off the edges of the rocker arm caps to bring them to a bearing on the trunnions. Remove this amount from the edges of the caps.

(2) The space between the rocker arm caps and the trunnion caps should be filled in by welding or by brazing on sufficient metal to allow them to be bored to the correct diameter to form a bearing on the rocker arm caps. The boring should be done in a lathe.

(3) It is advisable to use a file with two safe edges so that the shoulders of the trunnions will not be marred. Care must be taken to insure that no more than the required amount of metal is removed from the edges of the rocker arm caps. Remove only enough metal to give a proper bearing and to take up the lost motion without binding. It is advisable to make a tool steel key for forcing the trunnion caps down on the lead instead of using the regular trunnion cap keys.

27. Recoil mechanism M2.—*a.* The recoil mechanism M2 combines the cradle and recoil and counterrecoil mechanisms. The cylinders which house the recoil and counterrecoil mechanism are

attached to the cradle by screws and dowel pins as indicated in figure 16.

b. The recoil and counterrecoil parts of the mechanism function in the same manner as described for the M1897 recoil mechanism.

c. The manometer test should be made in the same manner as prescribed in paragraph 20*b*, *c*, and *d*.

28. Elevation mechanism and range scales of carriages M1897, M1897MIA2, and M1897A4.—*a. General.*—The elevating mechanism controls the angular relation of the cradle and rocker. As the frame or yoke of the elevating mechanism is fitted and attached to the cradle, it is regarded as a part of the recoil mechanism.

b. To replace elevating yoke bearings.—After considerable use the elevating yoke bearings may become worn and require adjustment.

(1) Dismount the elevating yoke as outlined in *c* below.

(2) Replace bearings and reassemble.

c. To dismount elevating yoke.—It will be found much more convenient to dismount the recoil mechanism and turn it upside down upon trestles or other suitable support.

(1) Remove the screws from the elevating yoke bearing, right, having previously marked the screws to insure their return to original holes.

(2) Likewise remove the screws from the elevating yoke bearing, left.

(3) The elevating yoke is then free from the cradle.

(4) Examine the bearings for excessive wear.

d. To dismount elevating crank.—(1) Remove the cotter pin from the elevating crank pin.

(2) Remove the crank pin, being careful not to lose the washer, spring, and cotter pin.

(3) The crank will then lift off.

e. To dismount elevating crankshaft.—(1) Dismount the elevating crank as described in *d* above.

(2) Using a screw driver behind each end of the crosspiece of the shaft, apply enough leverage to remove it. Be careful not to lose the elevating crankshaft washer.

(3) It is well to mark the position of the shaft on the elevating crank locking plate when the crank is vertical or in some noted position so that the pinion can be reassembled on its hexagon seat exactly as before.

f. To dismount elevating crank locking plate.—(1) Drive out the elevating crank locking plate pin.

(2) Tap gently on the rear of the plate with the copper hammer until it moves off.

(3) Do not straighten the pin as the bend in it is to hold it in place.

g. To dismount elevating nut.—(1) The elevating crank, shaft, and bevel pinion must be dismounted before the nut can be removed.

(2) Drive out the elevating nut collar taper pin.

(3) Unscrew the elevating nut collar.

(4) Lift out the elevating nut.

h. To remove range scale.—(1) With the gun horizontal, set the range scale at zero.

(2) Take off the elevating crank locking plate.

(3) Take off the range scale shaft nut, 67A (fig. 10), and slide the range scale assembly off the shaft. Note that it is the function of the range scale movable pinion spring, 67B, to push the movable pinion to slightly mismatch the teeth of the fixed pinion and thus take up any lost motion in the range rack.

i. To dismount range rack, range scale being dismounted.—(1) Set the range rack to about 2,000 meters.

(2) Remove the elevating screw pin and let the cradle down upon the rocker.

(3) Remove cotter pin from range rack screw and remove the screw.

(4) Raise the rear of the cradle and take hold of the rack to prevent its falling. The rack will slide downward and clear of the guides. Let the cradle rest on the rocker.

(5) When the hole for the range rack bushing and the range rack becomes worn sufficiently to warrant replacement, the oversize bushing, 2-97-71A, will be used and the range rack reamed to fit.

(6) When it becomes necessary to replace the range scale shaft, the shaft, 62H (fig. 10), will be issued with a blank flange and will have to be marked and drilled at assembly, as the holes in the cradle for the retaining screws are not equally spaced.

j. To remove range rack and range scale—cradle and gun being as left by preceding operation.—(1) Lift the rear of the cradle, place the range rack between its guides, the lower end of the rack resting in its place on the rocker, and let the cradle down on the rocker.

(2) Assemble the elevating screw pin and set gun horizontally with the angle of site handwheel.

(3) Set the range rack at zero by means of the elevating crank and shaft assembled momentarily for this purpose.

(4) Turn the range scale so that the zero faces the index and slip the range scale assembly into place. Note that it is only when rack and scale are at zero that the four beveled teeth of the movable

pinion are opposite the four upper teeth of the rack which are beveled to suit.

(5) Screw the range scale shaft nut on tightly, care being taken not to break it.

(6) Slide the rack up and down to make sure there is no stiffness in the motion.

(7) Screw in the range rack screw and put in cotter pin.

(8) Assemble the elevating crank shaft and locking plate and pin.

k. To dismount range rack only.—(1) The range scale nut may be unscrewed and the range scale slid outward sufficiently far to disengage the pinions from the rack without dismounting the elevating crankshaft locking plate.

(2) The scales on the range scale and range rack are supposed to come to zero when the bubble of the angle of site level (angle of site dial being at zero degrees) and of a master level placed on the leveling plates of the gun are centered. When the gun is in normal horizontal position, movement below zero is prevented by contact of the lug on the elevating yoke with a projection on the rocker. If, in changing either range scale or range rack, the zeros on range scale and range rack do not agree, the difference measured on the scale should not exceed 2 mm. If it does, try first another rack, then, if necessary, a new scale. If the range scale zero coincides fairly well with that of the range rack, but neither moves as far as the index, file the upper face of the lug on the elevating yoke, being careful to keep the lug straight and in contact over its whole surface. After any change in range scale or rack, test the sight bracket setting.

l. Lost motion in elevating nut.—Note that firing stresses tend to force the elevating nut upward through the yoke. Looseness, therefore, probably represents wear of the contact surface of the elevating nut collar against the elevating yoke. Vertical play of the elevating nut often results in chattering in the beveled gearing. The maximum end play allowable has been fixed at 0.04 inch. Note also that the stop on the elevating nut collar is located with reference to the start of thread on the elevating screw. With the stop in contact it is convenient to have the 5,500 graduations on the range scale and range rack fall opposite their indices. Obviously the stops must not be advanced so as to prevent the range scales coming to full elevation. A little further movement does no great harm. The principal object of the stop is to prevent the locking together of the elevating screw and elevating nut by forcing the nut against the shoulder. To eliminate the lost motion in the elevating nut, measure the existing end motion of the elevating nut and subtract this amount from the thick-

ness (nominally 1 mm) of a washer, 2-97-69B. Take off the elevating nut collar, 68D (fig. 10), using the clamp wrench, 1 (elevating nut collar) (fig. 36), true up in the lathe chuck and face off from the upper edge the difference so found. Assemble the washer and collar and the elevating nut should turn freely in the yoke without any end play. Put a new taper pin in the elevating nut collar, correcting the hole for it, if necessary, with No. 2 taper reamer, 5 (fig. 36).

m. To install new elevating nut collar, 2-94-70A.—Remove the collar, 68D (fig. 10), to be discarded and any adjusting washers which may have been added and screw on the new collar until the elevating nut rotates freely without play. Trace on the collar the shape of the radial stop. File that stop to shape. File flush, if necessary, the lower face of the collar. Place the elevating nut collar so prepared in the elevating nut collar jig, 9 (fig. 36). Ascertain whether the collar is well seated in the jig and the vertical face of its radial stop is in contact with the corresponding vertical face of the jig. Fix the collar in this position by means of the clamp and tightening screw. Start the hole in the nut collar with the end milling cutter to avoid starting the drill on an oblique surface, then drill the hole with the 4-mm twist drill, 3 (fig. 36). Mount the collar on the elevating nut and ream with the taper reamer, 5 (fig. 36). Cut a recess in the collar for the head of the pin. Assemble the pin.

29. Trails M1897, M1897MIA2, and M1897A4.—*a. Angle of site worm gear shaft housing loose.*—Tighten and lock (center punch) the screws, except three on the French carriage M1897, which are to be removed for the insertion of rivets having heads 20-mm diameter, which function to oppose the shearing stress. The heads of these rivets go through the housing and enter by 1 mm in the side plate. The American-built carriages M1897MIA2 have these rivets already set. Figure 28 shows the rivet hole on the right side and the two on the left side of the French carriages M1897, which are to be fitted with the housing rivets, 2-94-60M. The square-faced counterbore, which it may be necessary to improvise for enlarging the rivet holes in the housing and side plate of French carriages to 20-mm ($2\frac{5}{32}$ inch) diameter, should have a guide to center the counterbore with the old rivet hole. In setting the rivets lay the trail on the side. Do not brace the bucking-up bar against the opposite side plate. Set it against a block of wood. Set rivets hot after checking the location of the housing. The rocker rack must not come in contact with the rack guide of the housing.

b. Axle bracket bolts.—The axle bracket bolts may become loose or broken.

(1) *Loose bolts.*—Remove cotter pin, tighten nut, and replace cotter pin. It may be required to file the face of the nut slightly to bring the slot in the nut around opposite the cotter pin hole in the bolt to permit assembly on the pin.

(2) *Broken bolts.*—Broken bolts must be removed and replaced. Neglecting to do so may result in the cracking of the axle brackets. To replace the lower bolts of the left axle bracket it is necessary to remove the rammer sheath nearest the left side plate; remove the two bolts securing the mouthpiece to the front plate and then withdraw the sheath and mouthpiece as a unit from the trail.

c. Left axle bracket cracked.—If the sum of the lengths of the cracks on each side of the trail of the traversing gear case is greater than 40-mm ($1\frac{5}{16}$ inches) replace the bracket.

d. To dismount left axle bracket.—(1) Mark the bolts and their respective nuts in order that the cotter pin holes match as desired in remounting.

(2) Remove both shields and the brake worm quadrant shaft socket nut directly under the left axle bracket. Place a lifting jack in the center of the axle housing and raise the carriage high enough to get a trestle or blocking crosswise under the shield lower sockets. The trestle or blocking should be high enough to raise the wheels about 2 inches clear of the ground. Remove the left wheel and drop the brake mechanism. With a socket wrench remove the nuts, and with a screw driver under the front end pry off the angle of site worm gear housing. Take out the locking screw and take off the angle of site worm gear shaft nut, 2-94-60E, on right side of trail. Pull angle of site worm gear shaft out to the left, being careful not to let the angle of site worm gear pinion drop. Remove the axle bracket bolt nuts and draw the axle bracket to the left along the axle. If it is desired to remove the axle bracket completely, remove the right wheel and right axle collar and withdraw the axle.

(3) Before replacement of the bracket, inspect, and if necessary, improve the fit of the gear cover, 2-94-56E (fig. 9), on the gear case and of the handwheel shaft, shaft brace and gear cover key assembly. Examine the traversing gear case half bushings for wear and for end play of the traversing intermediate gear and refit or replace the bushing to secure a running fit of the gear. Try the traversing nut for wear on the axle threads; if necessary, replace with a new traversing nut assembly (par. 31 d).

e. Axle housing rivets loose.—Put in new rivets. The heads must fit the countersink exactly. On the side plate form a half button head, 3 to 4 mm high (0.14 inch).

f. Axle housing or axle bracket distorted and out of line.—If distortion is in the direction which tends to bring the trunnion bearings closer together and persists after tightening all the bolts, the rails may be spread by a jack improvised from a 0.75-inch bolt cut to length, and a nut. Peening the axle housing on the side it is desired to lengthen may be necessary in extreme cases.

g. Trunnion caps loose.—The rocker arm caps (fig. 1) and trunnion caps must be kept in good condition, free from rust and scores. The rocker arm caps may be just loose enough to allow full and easy movement without play. Oversize trunnion cap keys, 2-94-73D, are issued for fitting in worn key slots. These keys are hardened and must be ground to fit. If trunnion cap pins are to be replaced, refer to FSMWO C4-W8.

h. Bent or broken tail handles.—Straighten or replace. New tubes with plugs may be pinned in the old handle brackets. Replace any loose or sheared rivets in handle bracket. Entire trail handle assemblies are included in the list of organization spare parts.

i. Float damaged.—The float may be cracked or lunette seat stretched. Replace the damaged float with a new one fitted in place.

j. Float bushing worn.—Replace the float bushing, 2-94-22F, when the lunette is loose in the bore and when wear, evidenced by end play of lunette, is in excess of $\frac{1}{32}$ inch. In replacing the new bushing, the chamfered end must be beaded over after assembly and its flange should contact solidly with float. (This applies to M1897MIA2 carriage only.)

k. Lunette bent, ring worn or broken, and threads worn.—Replace the lunette when the metal of the eye is reduced to 1 inch in thickness and threads are worn excessively as evidenced by end play of the nut on threads. To dismount the lunette take out the float protection plate pin, 2-94-22C, and remove the float protection plate assembly. Take out the lunette nut locking screw, 2-94-23M, and unscrew the lunette nut, 2-94-23F, with the lunette nut wrench, 6 (fig. 39). In replacing a lunette be sure that the small table in the eye which contacts with the spur of the limber pintle hook, to hold up the pole, is underneath. If a spare nut only is to be assembled, the locking screw holes are drilled and tapped after the lunette nut has been set up. If, after reassembling the removed nut, the locking screw notches go beyond their former positions, the locking screw must be relocated. The lunette nut must be set up tight enough to prevent the lunette from moving. (This applies to M1897MIA2 carriage only.)

l. Spade distorted.—If the distortion is greater than 10-mm (about $\frac{3}{8}$ inch), change the spade. The spare spade 2-94-73K, is issued

without bolt holes and must be fitted to the spade flasks, 2-94-39C and 39D. The condition of the bolt holes in the flasks may require special spade bolts.

30. Angle of site mechanism of carriages M1897, M1897MIA2, and M1897A4.—*a. General.*—The angle of site mechanism controls the angular relation of the rocker and the trail. Description and detailed information on the angle of site mechanism are given in TM 9-305.

b. To dismount angle of site worm gear shaft.—(1) Take out the gear cover screw, 2-94-57E (fig. 9), and lift off the cover, handwheel shaft, and pinion. Slide the gear cover key, 2-94-57B, to one side.

(2) Take out the worm gear case plug locking screw and tag it; unscrew the angle of site worm gear housing plug, 2-94-53E (fig. 9), and drift the angle of site gear up through the worm clear of the gear case.

(3) Remove the worm gear housing and worm gear shaft (par. 29a).

c. Angle of site pinion (at handwheel) worn.—Replace. Same procedure as outlined for the traversing pinion (par. 31e).

d. Angle of site gear too low, leaving bevel gears loose.—Replace the upper bushing, 52D.

e. Angle of site gear case loose and key loose in cover.—The gear case, 2-94-52E (fig. 9), screws into the worm gear housing, 2-94-53G, and its shoulder should contact solidly with that of the housing when the handwheel shaft comes parallel to the axle. The headless gear case locking screw, 2-94-52C, prevents unscrewing the case. Should the gear case become loose, enough metal is faced off the underside of the shoulder to allow the assembling of a steel washer, 1 mm thick, under the shoulder. If the key is loose in its seat, weld stock on side of key for a distance of $\frac{3}{8}$ inch from the ends and then fit to slots so that it will be necessary to drive it lightly in place. If the gear case cover persists in being loose, face off the shoulder of the cover screw adjacent to the threads.

f. To test planeness of sight bracket seat on left rocker arm.—Use a surface plate with red lead, prussian blue, or similar marking material and true up the surfaces with a file or scraper. The seat should be perfectly flat to get good contact with the sight bracket and should have its surface perpendicular to the cradle trunnion. The sight bracket nut 2-94-55E, must screw on the threaded stud of the sight bracket seat without undue friction and must not be loose as evidenced by end play. If the stud is worn, true it up carefully and try a spare nut. If the spare nut is loose, return the rocker to the shop for a new stud.

31. Traversing mechanism.—*a. General.*—Description and detailed instructions on the traversing mechanism are given in TM 9-305. The axle mounting sleeve, 6 (fig. 40), should be used when reassembling an axle to guide the axle through the bearings. The tapered end of the sleeve will prevent damage to gaskets, bearings, and the threads of the traversing nut.

b. Axle traverses hard.—(1) The axle housing or axle bracket may be distorted or the axle bent. (See par. 29*f.*)

(2) The threads of the traversing nut may strike high spots in the bottom of the axle thread spaces. The rubbed spots will show and may be carefully dressed down with a smooth file. This fault is not unusual.

c. Axle collars loose on axle.—Fit oversize key.

d. Lost motion in traversing mechanism.—Repairs are necessary as soon as it exceeds a sixth of a turn of the traversing handwheel. If due to wear of axle housing bushing, or ends of traversing nut, the replacement of the housing bushing and nut requires the dismounting of the left axle bracket. (See par. 29*d.*) When ready to reassemble the axle bracket, determine the thickness of the traversing nut thrust washers by the use of special test washers (fig. 40) as follows: Remove the traversing handwheel shaft, leaving in place the intermediate gear and bushings. Hold the bracket in a vise with its inner face turned upward, place in the bracket a left traversing nut thrust test washer of medium thickness, set the new nut against it, and try the fit of the gear teeth. Beginning with a test washer obviously too thin, try successively thicker washers until the gears have the slightest perceptible play. Lay aside the traversing nut and measure the distance between a straightedge held against the inner face of the bracket and the right face of the tentatively accepted left test washer by stacking up the special thickness gages, 5 (fig. 40). Return to the carriage, place a trial test "right traversing nut thrust test washer" against the shoulder of the axle housing bushing, 2-94-39E (fig. 8), and follow it with the traversing nut. Lay a straightedge, thin enough to pass between two teeth of the gear wheel, against the outer face of the traversing nut and endeavor to pass the stack of thickness gages previously determined between the straightedge and the face of the trail side plate. Begin with a right test washer obviously too thick and decrease the thickness progressively by 0.3-mm and adopt provisionally the first washer that will not allow the passage of the thickness gages. Assemble the whole mechanism, including the axle, and bolt the bracket tight with three or four bolts. Change the test washers, if necessary, to

obtain finally thickness which results in the least possible lost motion, which must not exceed one-eighth turn of the handwheel. Then take out the test washers and replace them with steel washers of the same thickness, made by facing down, if necessary, the thick repair washers, 2-94-70F and 70D, listed under special spare parts for field repair.

e. Excessive wear of traversing pinion, 2-94-58C (fig. 9), causing looseness on the traversing handwheel shaft.—This will show usually when the gears do not run smoothly, but will chatter. To replace the pinion, take out the locking screw and unscrew the shaft nut, 2-94-58K. Unscrew the gear cover screw, 2-94-57E, and remove the gear cover. Lift off the handwheel shaft and pinion assembly. Before replacing the new pinion, examine the outer face of the hub of handwheel for wear. Assemble a new handwheel if the pinion protrudes beyond the face of the hub. If the shoulder on the handwheel shaft, 58A, does not protrude just enough beyond the end of the pinion to allow the pinion free movement without end play, replace the shaft. Examine the rivets securing the shaft brace to the handwheel shaft to see that they are tight. This fault is not unusual.

32. Brake mechanism, wheels, and shield of carriage M1897MIA2.—*a. General.*—Description and detailed instructions on the dismantling and replacing of the brake, wheels, and shield are given in TM 9-305.

b. Brake operating mechanism pertaining to 75-mm gun carriage M1897MIA2.—(1) *Brake worm quadrant shaft socket nut, 2-94-33Q (fig. 8), damaged, cover lost.*—Use a new nut and adjust it so as to bring the cover pivot to the top. The weight of the cover tends to keep it closed. It may be necessary to file the face of the nut to bring the cover around. Spare nuts, 2-94-72A, having extra thickness to provide for this fitting and extra long cover pivots, 2-94-70G, are issued under special spare parts for field repair for use where the regular nut or pivot does not work satisfactorily. Make sure the cover pivot is properly riveted.

(2) *Brake worm quadrant cover, 2-94-31F (fig. 8), loose.*—Take out the locking screw and screw cover in tight. Mark and tap a new hole for the locking screw. Cut out a new bevel to clear the worm. The worm must be out before the cover can be removed.

(3) *Brake worm support, 2-94-40F (fig. 8), loose.*—The support screws into the brake worm quadrant housing, 32A, and its position when tight against the brake worm support washer 2-94-31K, should be such that the hole for the bolt matches that in the housing. Use a

worm support washer of the right thickness for this. A spare washer, 2-94-72C, provides the extra stock necessary. If the brake worm is then tight in the support, take a little metal from the flat side of the bronze brake worm thrust block, 2-94-31N (fig. 8).

(4) *Brake worm shaft.*—The brake worm shaft was formerly made in sections, the worm quadrant bracket being a separate part screwed into the shaft with a square right-hand thread. Some carriages having this construction are still in the service and note should be made of the condition of this joint whenever the carriage is taken down or opportunity offers.

(5) *Brake worm quadrant housing lock screws loose.*—Assemble new locking screws or if necessary make oversize screws sufficiently tight.

c. Slide rack mechanism.—(1) *To dismount pawl shaft.*—(Note that the slide rack pawl, 2-94-34C, and the pawl lever, 2-94-34K (fig. 2), lie nearly in the same plane.) Pull the cotter pin from the collar on the left end of the pawl shaft and the pawl shaft will come out to the right. To assemble a new pawl shaft put the lever on the shaft as nearly as possible in the plane which passes through the diagonals of both the square lever seat and the hexagonal pawl seat of the shaft.

(2) *Pawl loose on pawl shaft.*—The hub of the pawl is probably stretched. If no new pawl is at hand, the old one may be heated to cherry red and closed in. In refitting the pawl do all the filing in the pawl and none on the shaft except that the corners of the hexagon on the shaft may be lightly dressed so that the bearing is on the flat faces. The fit should be tight.

(3) *To dismount slide rod.*—(a) Take off the slide rack nut and drop the compensating beam. Note the slide rod locking screw, 2-94-35L, lying vertically in the slide rod support, rear, the upper end being bent. Straighten it and unscrew from below. Remove the slide rod stud nut, 2-94-35K, from the front end of the slide rod and the slide rod screw, 2-94-35D, which enters the rear end of the slide rod through transom No. 4, 2-94-20E. The rod can now move to the rear and be taken out. In reassembling do not overlook the small pin in the slide rod stud which enters a notch in transom No. 2.

(b) If the slide rod is made in two pieces, these can be removed by removing only the slide rod screw and stud nut.

(4) *To disassemble tie rod shackle.*—Punch out the two rivets which hold the shackle in the tie rod block and drive out the shackle. The rivets should have a good tapping fit in their holes.

d. Maintenance of wheels.—(1) Field repairs to wheels are practically confined to tightening hub and tire bolts, renewing liners, and repainting.

(2) Hub and tire bolts should be kept tight at all times. After tightening up the nuts, the bolts should be slightly peened over to prevent movement or loss of the nuts.

(3) When the wooden wheels of the gun carriages become un-serviceable they will no longer be shipped to arsenals for repair. When these wheels have reached a state where local repairs cannot be economically effected, they will be disposed of in accordance with existing regulations governing the disposition of un-serviceable property.

(4) The hub of the French manufactured 1,334-mm wheel will no longer be reamed for the one-piece hub liner, C212. French manufactured wheels that have been fitted with a one-piece hub liner may have un-serviceable liners replaced as long as the remainder of the wheel is serviceable. Otherwise these wheels will be disposed of in accordance with existing regulations governing the disposition of un-serviceable property.

(5) The hub of the American manufactured 1,334-mm wheel is reamed to the correct size and tapered to take the one-piece hub liner, C212. To renew the hub liner, turn the wheel, large end of the liner down, inner end of the hub resting on a solid block of wood, and drive the old liner out with the hub liner driving tool, 12 (fig. 39). Clean and lightly oil interior of the hub before tapping the new liner into place with a block of wood.

(6) A fairly efficient replacement of a spoke can be made in the field. Take out the hub ring carriage bolt which holds the particular spoke to be replaced. Saw the old spoke into two or three pieces and get it out of the wheel. Detach the spoke shoe and spoke shoe plate. Make the new spoke about $\frac{3}{32}$ of an inch longer than the old one, bevel the hub end on the inside so that it can be driven in, and tightly wedge the other spokes together just as the end strikes the barrel of the hub box. Slip the spoke shoe over the outer end of the spoke and give the inner end a coat of white lead. See that the opening in the hub box is clean. Enter and drive home the spoke. Drive in the spoke shoe plate (it may be necessary to take off the end of the spoke to get room), put white lead on all the surfaces covered by the spoke shoe, bring the spoke shoe into place and set the rivets. Cut the hole for the hub box carriage bolt so that the bolt in bearing against the wood tends to force the spoke toward the wheel center.

(7) The end play of the wheel is taken up by varying the thickness of the axle washers and by taking advantage of the steps on the axle cap. Before a carriage leaves the ordnance repair shop, sufficiently thick axle washers will have been assembled to take up the end play allowed by the lowest steps of the axle cap.

(8) It is prohibited to soak a wheel in water to tighten the fellies. The wheels should be kept well painted to exclude water. A water-soaked wheel soon dries out and becomes worse than it was before being soaked.

e. Maintenance of shields.—(1) There are three types of shields, the description and detailed instructions on the dismantling and replacing of which are given in TM 9-305.

(2) The openings in the shield and apron latch staples wear large. Whenever the regular shield or apron latch keys are found too loose, the oversize key should be fitted. These keys must be ground for fitting as they are too hard to file. See that the thongs are assembled in the apron latch keys.

(3) Shields must not be heated. If they cannot be straightened cold, replace with a new shield.

33. 75-mm gun carriage M1897A4.—Description and detailed instructions on the dismantling and replacing of the high speed adapter are given in TM 9-305.

34. 75-mm gun carriages M2A1, M2A2, and M2A3.—*a. Top carriage.*—The top carriage is of built-up and welded steel construction. Maintenance of the top carriage consists mainly of noting cracks that may develop in the welded joints. If appreciable cracks should develop to the extent of $\frac{1}{4}$ inch each side of the weld, and if when tapped with a hammer it does not sound solid, and if parts are subjected to firing stresses, the carriage should be withdrawn from service.

b. Bearings.—The gun and recoil mechanism are housed in the cradle which pivots in the trunnion bearing of the top carriage. These bearings should be removed and examined for burrs and scoring. If the ball and cup have a series of scored places they should be replaced by new parts.

c. Elevating mechanism.—Lateral adjustments of the elevating worm are made by means of the ball bearing retainer, A138027 (fig. 20), which is assembled in the elevating gear case and which bears against the ball bearing assembled on the end of the elevating shaft gear, B107043. The adjustment made by the ball bearing retainer is secured by means of the ball bearing retainer lock screw which engages a slot in the retainer.

d. Traversing mechanism.—Control of maximum traverse is by means of stops, one on each end of the traversing rack. The screw holding the stops to the traversing rack should be replaced if bent.

e. Equilibrator.—(1) In replacing the spring in the equilibrator it is necessary to depress the cradle until it is possible to assemble the equilibrator assembling nut, A137149 (fig. 23), its full length on the equilibrator rod. (Spring pressure is approximately 1,200 pounds in this position. Measure the distance from the top of the equilibrator to the bottom face of the trunnion of the equilibrator trunnion pin, A141451. Elevate the cradle and remove the equilibrator trunnion pin and then the equilibrator assembly.

(2) If an arbor or drill press is not available for disassembly of the equilibrator, equipment should be made locally for its disassembly. The equipment should consist of two $\frac{1}{4}$ -inch by 6-inch square steel plates drilled at each corner to receive a $\frac{3}{8}$ -inch by 44-inch steel rod, and in the center a hole drilled large enough to pass over the equilibrator assembly nut. The rods are to be threaded on one end to receive a $\frac{3}{8}$ -inch nut and the other end to be threaded about 12 inches to receive $\frac{3}{8}$ -inch nuts.

(3) Set the equilibrator in the fixture and screw the nuts on the rod until the plates bear against each end of the equilibrator. Then remove the equilibrator assembly nut, A137149. Unscrew the $\frac{3}{8}$ -inch nuts on the long threaded end of the rods until all tension of the equilibrator spring is released.

(4) Reassemble the equilibrator in the reverse order of disassembly.

(5) After assembling the equilibrator assembly in its position on the carriage, assemble the equilibrator trunnion pin in the same position as before disassembly and screw the equilibrator assembly nut its full length on the equilibrator rod.

(6) Depress the cradle until the equilibrator trunnion pin is seated in its bearing, and then remove the equilibrator assembly nut from the equilibrator rod.

f. Brake.—The procedure for adjusting the brakes is as follows:

(1) Set hand brake lever at full release position.

(2) Jack up wheel. Adjust the adjusting wedge by means of a wrench until a drag is felt on the wheel.

(3) Then back off the adjusting wedge just enough so that brake does not drag.

(4) Brakes must be cold when making adjustment.

(5) The position of the brake lever can be adjusted by removing it from its splined shaft and setting it in a different position on the shaft.

35. Differences between sights of French and American manufacture of M1897, M1897MIA2, and M1897A4 gun carriages.—*a.* (1) The auxiliary angle of site levels of French manufacture are inclined at an angle of 200 infantry mils, while those of American manufacture are inclined at an angle of 200 artillery mils.

(2) The angle of site scales on sights of French manufacture are graduated in infantry mils, while those of American manufacture are graduated in artillery mils.

(3) The elevation scales on carriages of American manufacture are graduated in artillery mils and meters, while those of French manufacture are graduated in meters only. The French scales are being modified when carriages are overhauled.

(4) The deflection drum on sight brackets of both French and American manufacture are graduated in artillery mils.

b. An inclination of 200 infantry mils is $11^{\circ}27'32''$. An inclination of 200 artillery mils is $11^{\circ}15'$. The difference is $12'32''$.

c. In testing and adjusting the sights, all of the differences noted, with the exception of the auxiliary angle of site levels, will be disregarded.

d. The setting of the sight on the 75-mm gun and carriages M1897, M1897MIA2, and M1897A4 is the most difficult field maintenance operation carried out on field artillery. However, when it is thoroughly understood it is relatively easy, but at no time does it become a maintenance problem that can be entrusted to any but the best of workmen. After the artillery section has been put through several days' training, it would be well to choose four or five men who have shown the best mechanical ability and a knowledge of elementary algebra, and give them special training in sight setting. Before the setting of the sight can be correctly performed, a number of facts will have to be known. Due to the inaccuracies in manufacturing and other causes, all sights and levels contain inherent errors which cannot be removed but can be compensated for if they do not exceed certain limits.

e. The following information will have to be obtained before the sight can be correctly set:

- (1) Accuracy of the master level.
- (2) Accuracy of the line sights with the bore of the gun.
- (3) Trunnion friction.
- (4) Errors in the sight.
- (5) Error in the angle of site level.
- (6) Lost motion of the deflection drum.

f. When the above information has been obtained the following must be determined:

- (1) Sight bracket adjustment for elevation.
- (2) Sight bracket adjustment for deflection.

36. Master level test.—*a.* The master level, 4 (fig. 45), is a sensitive instrument and should be corrected each time before being used. With the master level key in place and the indicator set at zero, place the master level on the leveling plates of the gun. Elevate the breech until the bubble is centered between the lines on the level vial. Turn the master level end for end. If the level is properly adjusted, the bubble will still be centered. If not, center the bubble by means of the indicator.

b. The reading on the indicator will be twice the error of the level. If it exceeds $\frac{1}{4}'$ (one-fourth of a minute) the level should be adjusted.

c. To eliminate the error, set the indicator at one-half the error noted and center the bubble of the level by elevating the breech. Set the indicator at zero and center the bubble by the adjusting screw, then the level will be properly adjusted. The adjusting screw is in a recess in the level foot directly under the indicator and is locked by a screw in the end of the level.

37. Testing line sights.—*a.* Set up the testing target approximately 54 yards from the gun. Have the target about 3 feet higher than the gun and true with a plumb line.

b. With the gun pointed in the direction of the target, level the axle, jacking up one wheel if necessary. The wheels should be on hard ground or a firm base of some description.

c. Place the bore sights, 12, 13 (fig. 36), in position and line on the bore sight target by means of the traversing and angle of site handwheels.

d. If the line of sight through the front and rear sights falls midway between the two horizontal bars on the testing target and the points of front sight parallel the sides of the vertical bar, the line sights will be true with the bore of the gun.

e. If the points of the front line sight are too high, they must be set down with a punch. If too low, they must be raised with a drift. The distance between the points must be $\frac{1}{16}$ inch. If to one side, not more than $\frac{1}{32}$ inch, it may be driven over with a punch. This will partially shear the pin but will do no harm. If it has to be moved more than $\frac{1}{32}$ inch, drive out the pin, turn the sight end for end and set it correctly. Drill a new hole and ream for a new pin.

f. It may be necessary to replace the rear line sight. Drill out the rear line sight blind screw and drive the sight upward and out. Fit

the new sight so that it will be necessary to drive it in place lightly, using the copper hammer. Fit a piece of stiff paper to the front side of the sight slot and cut out the screw hole. Transfer the paper to the sight and lay out the hole. Drill the hole and countersink it on the rear side. After putting in a new sight set the line sights as described above.

38. Trunnion friction test.—*a.* Before proceeding with the test to determine the trunnion friction, examine for distortion of the angle of site worm gear shaft housing or rubbing of rocker segment in the curved guides of the housing. This might happen when wear is greater on one trunnion bearing than the other, or there is a distortion of the upper end of the trail, which tends to bring the trunnion bearings out of alinement. For a given range, a gun might be laid either by means of the angle of site level or by means of the sight by *elevating* the breech (the angle of the gun being measured with a master level, 4 (fig. 45), placed upon the leveling plates). If the same operation were performed by *lowering* the breech, it would generally be found that the master level gives a different reading. The difference between the readings of the angles so measured after raising and after lowering the breech gives the value that is called the trunnion friction.

b. Trunnion friction is imposed by friction of the cradle trunnions in the bearings of the rocker and by friction of the rocker trunnions in the trail trunnion bearings. The proportion of friction in each case must be determined separately since the motion of the gun in elevation is governed by two independent mechanisms. The measure of trunnion friction must never be in excess of 3' (3 minutes).

c. (1) Set up the testing target and gun as outlined in paragraph 37*a* and *b*. By means of the range crank, operate the elevating mechanism so as to raise the breech and bring the axis of the bore, by means of the bore sights, on the bore sight of target without overpassing the position, that is, without having to lower the breech after having raised it.

(2) Place the master level, 4 (fig. 45), on the leveling plates of the gun with the indicator to the rear, remove the master level key, place the indicator at zero, and turn the thumb nut so as to bring the bubble between the index lines. Raise the breech by two or three turns of the crank, then lower it slowly so as to again bring the bore on the target without overpassing the position. Turn the indicator of the master level without touching the thumb nut and bring the bubble between its index lines. The angle, or the reading of the indicator, so found, is the measure of cradle trunnion friction.

(3) This defect is reduced by a careful cleaning of the wearing parts, trunnion bearings, caps, half bearings, by using very fine emery cloth on rusty and painted surfaces, and by a careful dressing down of burs and high spots.

d. (1) Set the range scale at about 1,000 meters and the angle of site at zero. These figures are not compulsory but will be found convenient as angle readings are sure to be positive.

(2) By means of the angle of site handwheel, raise the breech (it may be sometimes necessary first to lower and then raise) so as to bring the bubble of the angle of site level between its index lines, without overpassing the position, that is, without having to lower the breech after having raised it. Otherwise, the operation has to be repeated.

(3) Place the master level, 4 (fig. 45), on the leveling plates of the gun with the indicator to the rear, remove the master level key, place the indicator at zero, and turn the thumb nut so as to bring the bubble between the index lines.

(4) Leave the master level in place on the leveling plates.

(5) Raise the breech by two or three turns of the angle of site handwheel, then lower it slowly so as to bring the bubble of the angle of site level between its index lines without overpassing its position.

(6) Turn the indicator of the master level without touching the thumb nut, and bring the bubble between its index lines. Take the reading of the indicator.

(7) The angle, or the reading of the indicator, so found, is the measure of the trunnion friction. If this reading is not greater than 3' (3 minutes), the condition is acceptable, but if time permits, it should be reduced as much as possible.

39. Testing sight.—*a.* As previously stated, all sights have inherent errors. There are errors for elevation and deflection, and to be able to adjust the sight to the gun, these errors must be known. They are determined by comparison with the master service sight, the errors of which are known. Before taking up this test, the following facts should be understood:

b. When the master sights, 3 (fig. 44), are received, it will be found that one of the sights has its known elevation and deflection errors engraved on the flat surface of the sight shank directly below the rear end of the collimator, in characters approximately $\frac{1}{8}$ inch high. (Example: E= +0.7 minute, D= -0.0 mil.) The other master sight is unmarked, as the measuring of the errors of this sight is performed in the field. The engraved sight is known as the master test sight, the other as the master service sight. The master test sight should

be used only for testing the master service sight and the master service sight for testing the battery sights. Both sights should be handled carefully and always carried in their proper places when not in use. The master test sight should be returned to an arsenal for correction about every 3 months during the time of war and about every 6 months in time of peace. In peacetime the master service sight should be compared with the master test sight each time before being used, and about every 2 weeks in time of war.

c. The error of a sight, the line of which points too high, is expressed with the minus (−) sign, as it causes the gun to point too low. If the sight line points too low, it is expressed with the plus (+) sign, as it causes the gun to be pointed too high. These are the elevation errors and are expressed in minutes.

d. If the sight line points to the left, it is expressed with the plus (+) sign, because it causes the gun to point to the right. If the sight line points to the right, it is expressed with the minus (−) sign, because it causes the gun to point to the left. These are deflection errors and are expressed in mils.

e. Testing the master service sight is carried on by comparison with the master test sight in exactly the same manner as for measuring the errors of the battery sight (par. 40) with the exception that, as greater accuracy is required, nine comparisons are made instead of five.

40. Testing battery sight for elevation.—*a.* With the gun and testing target set up as explained in testing the line sights (par. 37), remove the angle of site level and put in place the level testing seat, 8 (fig. 45).

b. Place the master service sight, 3 (fig. 44), in the sight bracket and set the angle of sight dial at zero. Set the deflection drum at 100, and lay the sight on its corresponding target of the testing target by elevating the breech with the angle of site handwheel.

c. Set the indicator of the master level, 4 (fig. 45), at zero and place it on the level testing seat with the indicator to the rear. Center the bubble of the master level by means of the angle of site worm wing knob. This marks the position of the master service sight.

d. Remove the master service sight, put in place the battery sight, and bring the sight on its target as was done with the master service sight. Center the bubble of the master level by means of the indicator. Take the reading of the indicator and record it with its sign.

e. Repeat the operation with the two sights five times, recording each reading. The mean of the five readings will give the relative

error of the battery sight. However, the master service sight has an error, and to get the absolute error of the battery sight this error must be added to it algebraically. For example, the known error of the master service sight is $+0.2'$ (plus $\frac{2}{10}$ of a minute), and the relative error of the battery sight is $-0.3'$ (minus $\frac{3}{10}$ of a minute). This will give a correct error of $-0.1'$ (minus $\frac{1}{10}$ of a minute) for the battery sight.

f. An error not to exceed $\pm 3'$ (plus or minus 3 minutes) is permissible. Rule for adding two algebraic numbers:

(1) If the numbers have like signs, find the sum of their absolute values, and prefix the common sign to the result.

(2) If the numbers have unlike signs, find the difference of their absolute values, and prefix the sign of the greater number to the result.

g. In comparing the master service sight with the master test sight, the operation is carried out nine times, as greater accuracy is required.

41. Testing battery sight for deflection.—*a.* With the testing target and the gun set up as for the elevating test, put in place the master service sight, 3 (fig. 44), and set the deflection drum at 100 by rotating from zero to 100 without passing the index line.

b. Lay the sight on its corresponding target of the testing target by means of the traversing handwheel. This marks the position of the master service sight.

c. Remove the master service sight and put in place the battery sight. Bring the battery sight on its target by rotating the deflection drum knob from 0. Do not pass the final setting and do not use the traversing handwheel for this part of the test.

d. Take a reading on the deflection drum and record it. Repeat this operation with both sights five times, recording each reading. Determine the mean reading. Record the difference between the mean reading and 100, using the minus (−) sign if the mean reading is below 100, and the plus (+) sign if it is greater than 100. For example, if the mean reading is 98 mils the value to be recorded is -2 mils. The result is the relative deflection error of the battery sight with respect to the master service sight.

e. To get the absolute error, the known deflection error of the master sight must be added algebraically.

f. An error not to exceed ± 2 (plus or minus 2) mils is permissible.

g. In comparing the master service sight with the master test sight, this operation must be carried out nine times, as greater accuracy is required.

42. Angle of site level test.—*a.* Place the level testing seat, 8 (fig. 45), on the leveling plates of the gun.

b. Place the angle of site level on the level testing seat with the cover open to the left. This is the position in which it sets on the sight bracket.

c. Bring the bubble of the angle of site level between its index lines by means of the angle of site handwheel.

d. Remove the angle of site level and the level testing seat.

e. With the master level key in place, set the master level, 4 (fig. 45), on the leveling plates of the gun with the indicator to the rear.

f. Level the master level by means of the indicator.

g. The reading of the indicator with its sign will be the error of the angle of site level.

43. Auxiliary angle of site level test.—The auxiliary angle of site levels of French manufacture are inclined at an angle of 200 infantry mils ($11^{\circ}27'32''$), those of American manufacture are inclined at an angle of 200 artillery mils ($11^{\circ}15'$), the difference being $12'32''$.

a. French manufacture.—(1) Place the auxiliary level testing seat ($11^{\circ}27'32''$), 6, (fig. 45), on the leveling plates of the gun.

(2) Place the auxiliary angle of site level ($11^{\circ}27'32''$) on the auxiliary level testing seat in the same position in which it sets on the sight bracket.

(3) Bring the bubble of the auxiliary angle of site level between its index lines by means of the angle of site handwheel.

(4) Remove the auxiliary angle of site level and the auxiliary level testing seat.

(5) With the master level key in place, set the master level, 4 (fig. 45), on the leveling plates of the gun with the indicator to the rear.

(6) Level the master level by means of the indicator.

(7) The reading of the indicator with its sign will be the error of the auxiliary angle of site level.

b. American manufacture.—Using the auxiliary level testing seat ($11^{\circ}15'$), 7 (fig. 45), test the auxiliary angle of site level ($11^{\circ}15'$) in the same manner as prescribed (*a* above) for testing the auxiliary angle of site level of French manufacture.

44. Testing sight bracket for lost motion of deflection drum.—*a.* If the lost motion of the deflection drum exceeds 4 mils, the sight bracket cannot be used.

b. Place the gun in the center of the cradle, using the following method: Place a screw driver between the side of the recoil mechanism

and the sweeper plate and pry the gun as far to one side as it will go, then back as far as it will go to the other side, then to the center of the two extreme positions.

c. With the testing target in position as described in the preceding tests, put the master service sight, 3 (fig. 44), in the sight bracket.

d. Lay the line sights of the gun on their corresponding target on the testing target.

e. Bring the vertical line of the sight on its corresponding line on the testing target by revolving the deflection drum from zero.

f. With a sharp pencil and the deflection drum index scribing guide, 3 (fig. 45), draw a line on the sight support opposite the 100 division of the deflection drum.

g. Revolve the deflection drum until the 200 division is reached, then in the opposite direction until the vertical line of the sight again rests on its line on the testing target.

h. As before, scribe a line with a pencil opposite the 100 division.

i. The distance between these two liners represents the lost motion of the deflection drum. If it exceeds 4 mils, the sight bracket cannot be used.

j. Revolve the deflection drum so as to bring the 100 division midway between the two pencil marks and draw a third line.

k. To this line add algebraically the known deflection error of the battery sight.

l. This position will indicate the index line to be scribed on the sight bracket for the zero position of the deflection drum. However, do not scribe this line permanently until the test for elevation has been made, as that test may show that the sight bracket will have to be changed. After the test for elevation is made, if it is found that the sight bracket can be used, the line must be permanently scribed.

45. Testing sight bracket for elevation.—*a.* This test is intended to determine errors in laying for elevation due to defects of the sight bracket, or its adjustment on the seat of the rocker arm. The adjustment will not be undertaken if the trunnion friction exceeds 3' (3 minutes) or the lost motion of the deflection drum exceeds 4 mils.

b. The test requires the working out of an algebraic example such as is shown in example A (table of examples, par. 48). In going through this test the first time, it will be well to have example A before you and to use the figures shown on it instead of the actual figures obtained.

c. As the sight and angle of site level are both on the sight bracket, and are both moved when the angle of site handwheel is turned, they

both have to be taken into consideration in this test. It must be remembered that the errors of both have been determined in preceding tests.

d. As the test is for elevation, the deflection need not be taken into consideration.

e. The gun and testing target being in position as previously described, place the battery sight in the bracket and the angle of site level on the level holder.

f. Set the range scale at zero (do not use the range rack), the sight at zero and the deflection drum at 100.

g. Lay the bore sight on its target of the testing target by elevating the breech with the angle of site handwheel. If the target is passed, lower the breech and start again.

h. Place the master level, 4 (fig. 45), with the indicator to the rear, on the leveling plates of the gun. Remove the master level key and set the indicator at zero.

i. Turn the thumb nut of the master level so as to bring the bubble between the index lines. Leave the master level on the leveling plates of the gun and lower the breech by two or three turns of the angle of site handwheel.

j. Raise the breech until collimator sight rests on its corresponding target of the testing target. If the target is passed, lower the breech and start again.

k. Turn the indicator of the master level until the bubble is centered. Do not touch the thumb nut. Take the reading of the indicator and record it with its sign, say for instance $+0.3'$.

l. Again lay the bore sight on its target of the testing target. Set the master level indicator at zero and center the bubble by the thumb nut. Raise the breech by means of two or three turns of the angle of site handwheel.

m. Lower the breech until the collimator sight rests on its target of the testing target. Do not pass the final point.

n. Turn the indicator of the master level until the bubble is centered. Do not touch the thumb nut. Take the reading of the indicator and record it with its sign, say for instance $+0.9'$.

o. It will be noted that one reading was obtained by raising the breech and one by lowering it. This is done to get the mean point of friction that may remain in the angle of site mechanism.

p. Set the angle of site worm wheel index at zero. By lowering the breech two or three turns with the angle of site handwheel, then raising it, bring the bubble of the angle of site level between its index lines.

q. Put the master level key in position and center the bubble by means of the indicator. Take the reading of the indicator and record it with its sign, say for instance, $+0.1'$.

r. Bring the bubble of the angle of site level between its index lines by first raising and then lowering the breech by means of the angle of site handwheel. Center the master level bubble by means of the indicator. Take the reading of the indicator and record it with its sign, say for instance, $+1.1'$. This will give an example like the one shown in example A, column 3 (par. 48).

s. By taking the mean of the sight readings S , $+0.6'$ is obtained as shown in column 4. By the same method the level reading L , $+0.6'$ is obtained.

t. This has to be further corrected, however, as in column 2, it is shown that there is a known error of $-0.6'$ for S (obtained from par. 41) and $+1.3'$ for L (obtained from par. 43). By subtracting column 2 from column 4 algebraically, a mean reading after correction of known errors is obtained for S of $+1.2'$ and $-0.7'$ for L , as shown in column 5.

u. By subtracting L from S algebraically and dropping the sign, error B of the sight bracket is obtained in column 6.

v. For example A shown in table of examples (par. 48), S is $+1.2'$, L is $-0.7'$, and B is $1.9'$. Since these values are within the limits shown below, no adjustment is necessary.

w. The limits of errors allowed are—

For S , $\pm 3'$ (plus or minus 3 minutes).

For L , $\pm 2'$ (plus or minus 2 minutes).

For B , $3'$ (3 minutes).

x. Should B exceed 6, the bracket will have to be exchanged if another sight or level on hand does not bring it within the prescribed limits. As the permissible error in the sight is $\pm 3'$ (plus or minus 3 minutes) and the limit to which the angle of site index can be moved is $\pm 3'$ (plus or minus 3 minutes), it will be seen why the limit of the permissible error in the bracket is six (6).

y. Before taking up the other examples in which adjustments are required, it will be necessary to understand what adjustments mean and how they are made.

46. Adjusting sight bracket.—*a.* As previously explained, adjusting the sight bracket can be undertaken only if the trunnion friction does not exceed $3'$ and if the lost motion of the deflection drum does not exceed 4 mils. If these conditions are not fulfilled, it is necessary to reduce the trunnion friction, change the bracket, or use another sight or another level that has a different error.

b. Adjusting the bracket consists of two distinct operations:

- (1) Adjusting the level holder.
- (2) Adjusting the bracket on the rocker arm.

c. From the preceding it will be seen that an error can exist by means of the bracket on the rocker arm or of the level holder in the bracket.

d. The defect in the bracket itself is shown by error *B*. If this exceeds 3', an adjustment is necessary; if it exceeds 6, see paragraph 45*a*.

e. As error *B* is the algebraic difference between errors *S* and *L*, it is evident that this error is due to a defect in the relative position of the sight on the bracket and of the level on the bracket when the angle of site worm wheel is set at zero. To correct the defect, means altering these relative positions, and due to the construction of the bracket this can only be done by altering the zero setting of the angle of site worm wheel by moving the angle of site worm wheel index line.

f. On account of the eccentric position of the level holder on the angle of site worm wheel, the index line can be moved only to a small extent, the limits of which are determined by the thickness (0.6 mm) of the reference line etched on the bracket to the rear of the index line. Since the divisions of the worm wheel are not equidistant, it is evident that the correction made for the division of zero would not be the same correction necessary for extreme divisions. Therefore, the index line can be displaced only within close limits, beyond which readings made at some distance from the reference line would be too inaccurate. The limit within which the index line may be displaced is 0.6 mm. Moving the index line 0.6 mm corresponds to an alteration of 3' in the position of the level. Thus 3' is the maximum correction given to error *B* by changing the position of the level. After correction of *L*, *B* should not exceed 3'. A bracket with an error *B* of more than 6' is beyond correction. The 6-mm reference line is etched on the bracket by the manufacturer and must not be moved. Should a bracket be received on which this line is not etched, the bracket cannot be used.

g. It should be understood that a correction of 3' is not always possible. It depends upon the original position of the index line in relation to the reference line. Should the index line be exactly in the middle of the reference line, a correction of only 1½' is possible either way.

h. A correction which is intended to elevate the gun means moving the index line up, to depress the gun, down.

i. The movement of the index line adjusts the level holder and is made as follows: When the errors of S , L , and B have been determined, the amount and the direction of the necessary correction in the support will be known. Suppose that the correction of minus $2'$ has been found necessary, that is, a correction such that the use of a level on the bracket will depress the gun by an additional $2'$. Set the angle of site worm wheel scale exactly at zero, remove the angle of site level from the bracket, and place on the level holder the level testing seat, 8 (fig. 45). With the master level key in place, set the index knob at zero, and place the master level, 4 (fig. 45), on the level testing seat and center the bubble by means of the angle of site handwheel. Adjust the indicator at plus $2'$. Moving the index line down corresponds to elevating the level holder; then center the bubble by means of the angle of site worm wheel knob. This will lower the zero line of the angle of site worm wheel to the position where the new index line should be scribed. Should the new position of the index line fall outside the reference line, the zero line should be brought to the extreme lower position within the limit. Bring the bubble of the master level between the index lines by means of the indicator. This will then give the maximum correction possible. By reference to the remaining errors in the example it will be seen whether this correction is sufficient to bring error B within the required limits. If the position for the correction is not sufficient, and if another sight and level on hand do not bring it within the prescribed limits, the support will have to be changed. If the correction required has been plus $2'$, the opposite sign would have been used and the index line would have been moved up.

j. The defect of the adjustment of the bracket on the rocker arm is shown by errors S , sight, and L , level.

k. Adjustment of the bracket on the rocker arm will, of course, change both S and L the same amount, as shown in example B, columns 9 and 10. Column 9 shows the correction of the bracket on the support. This correction is added algebraically to S and L of column 6 giving the new values of S and L in column 10. If S and L had the same value, a correction would bring them both to zero. As S and L usually differ, the best correction would be that which brings one above and one below zero about the same amount. The adjustment is made by altering the thickness of the lower shim, which determines the position of the bracket on the rocker arm. This shim is under the tailpiece of the bracket and rests on the bottom lug of the rocker arm.

l. A correction which is intended to elevate the gun means moving the tail of the bracket up by use of a thicker shim. To depress the

gun means moving the tail of the bracket down by use of a thinner shim. A difference of 0.1-mm thickness of the shim corresponds approximately to a difference of 2' in the position of the bracket.

m. If the correction is intended to depress the gun, which requires the use of a thinner shim, proceed as follows:

(1) The consideration of the errors S and L will determine the amount and direction of the necessary correction of the bracket on the rocker arm. (This will be explained further on.)

(2) Suppose a correction of minus 4' has been found necessary; that is, a correction such that the use of either the sight or the angle of site level on the bracket will depress the gun by an additional 4'.

(3) This correction may be made by filing down the shim by 0.2 mm, measured with a micrometer, or as follows: Remove the sight from the bracket and place in the sight socket the sight testing seat, 2 (fig. 44). Loosen slightly the upper adjusting screw in the rocker arm upper lug. Loosen the sight bracket clamping nut and the sight bracket center nut enough to allow the bracket to be moved stiffly up and down. Tighten the upper adjusting screw enough to insure contact of the tailpiece on the shim.

(4) With the master level key in place, set the indicator at zero and place the master level, 4 (fig. 45), on the sight testing seat with the indicator to the rear. Then center the bubble by elevating the breech of the gun by operating the angle of site handwheel.

(5) Release the upper adjusting screw, remove the lower shim and file it down approximately 0.2 mm. At frequent intervals place the shim on the rocker lug, tighten the upper adjusting screw to insure contact and center the master level bubble by means of the indicator. The reading will give the value of the correction corresponding to the filing of the shim. Thus filing should be (in this case) carried on until the reading is plus 4'. Filing down the shim corresponds to elevating the sight.

n. If the correction is intended to elevate the gun, which requires the use of a thicker shim, or if a new support is to be put in place, the selection of the shim is to be made as follows:

(1) The bracket to be adjusted, or the new bracket, should be held on the rocker arm by the sight bracket center nut, tightened just enough to allow the bracket to rock stiffly.

(2) Set the range scale at zero and lay the bore sights on their respective target of the testing target by means of the angle of site handwheel.

(3) Raise the sight bracket as high as possible. The collimator sight is then directed below its corresponding target on the testing target.

(4) Bring the sight on its target by slowly turning the upper adjusting screw.

(5) Insert successively between the lower lug of the rocker arm and the tail of the bracket different thickness shims until one is found that is just a little too thick to be used. Use this shim to fix the bracket on the rocker arm. Go through the regular test to get the errors S , L , and B , and proceed for adjustment as previously explained.

o. The foregoing operation for adjustment of the bracket on the rocker arm should always be followed by a complete new test with the bracket tightly secured to the rocker arm. Very often errors for S , L , and B will be found, and should they be beyond the permissible limits they will have to be corrected.

47. Table of examples in sight testing.—The four examples following are typical of conditions that will be found. Headings of the columns are self-explanatory. (See par. 48.)

a. Example A.—As has been stated before, the permissible error allowed for the sight is plus or minus 3', for the angle of site level, plus or minus 2', and for the bracket, 3'. From this it will be seen that the results obtained in this example are within the limits and no adjustment is necessary.

b. Example B.—Column 6 shows that error B is within the limits; so no adjustment in the bracket is necessary. Error L is also within the limit, but error S is not. Therefore, the position of the bracket has to be changed which will also change L . As both errors elevate the gun, the correction should be made to depress it. This means moving the tailpiece downward by using a thinner shim. Column 9 shows that changing the position of the bracket by $-2.5'$ brings all errors near the center line of the gun and within the prescribed limits. The value of $-2.5'$ is found by trying different figures and then working out the example to get satisfactory results in column 10. After a reasonable amount of practice, these figures can be guessed so closely that the example need only be worked out once.

c. Example C.—As errors L and B are larger than the permissible limits, it is necessary to reduce error L and bring it nearer S , which would reduce B . By reducing L minus 2' by means of changing the angle of site index, the results shown in column 8 are obtained, which bring all the errors within the prescribed limits.

d. Example D.—Column 6 shows that S and B are larger than the prescribed limits. By bringing L nearer S , as shown in column 7, the results shown in column 8 are obtained. This brings B within and leaves S greater than the prescribed limits, which necessitates

an adjustment of the bracket on the rocker arm of plus $2\frac{1}{2}'$ for the reduction of S . This adjustment will then give the results shown in column 10. Thus the errors of S and B are within the prescribed limits.

48. Summary.—*a.* It is important to understand the use of all the handwheels, adjustments, sights, and tools used for the sight bracket inspection and adjustment.

b. A careful study and understanding of the testing and adjustment of the sights are necessary before attempting to carry out the procedure.

c. Summary of procedure for testing and adjusting sights:

- (1) Master level test (par. 36).
- (2) Testing the line sights (par. 37).
- (3) Trunnion friction test (par. 38).
- (4) Testing the battery sight for elevation (par. 40).
- (5) Testing the battery sight for deflection (par. 41).
- (6) Angle of site level test (par. 42).
- (7) Testing the auxiliary angle of site levels (par. 43).
- (8) Testing the sight bracket for lost motion of the deflection drum (par. 44).
- (9) Testing the sight bracket for elevation (par. 45).
- (10) Adjusting the sight bracket (par. 46).
- (11) Scribe index mark for zero position of the deflection drum (par. 44L).

d. Error B is obtained by performing the algebraic subtraction between L and S and dropping the sign.

e. The values of L and B are changed by adjusting the angle of site level support.

f. The value of S is changed by adjusting the sight bracket on the rocker arm. This also changes L by the same amount as it does S , thereby not changing the value of B .

g. The values in column 8 are obtained by the algebraic addition of the value in column 7 to L of column 6. B is then recalculated from S and L of column 8.

h. Changes in the sight bracket setting are shown in column 9. Since these changes affect both S and L , the figure in column 9 is added algebraically to the previous values of S and L to give their new values shown in column 10. B is not changed by this adjustment.

i. A final check should be made with all sights, levels, and adjustments, making certain that these parts are secured by their respective bolts, nuts, or locking screws.

TABLE OF EXAMPLES

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10
	Known errors	Readings	Mean readings	Mean readings after correction of known errors	Remaining errors	Necessary adjustment of level support	Mean readings after adjustment of level support	Necessary adjustment of bracket on its support	Mean readings after adjustment of bracket on support
Example A	(Sight, -0.6) (Level, +1.3)	Sight— { 1st reading +0.3 2d reading +0.9 } Level— { 1st reading +0.1 2d reading +1.1 }	+0.6 +0.6	+1.2 -0.7	S+1.2 L-0.7 B1.9	None None		None	
Example B	(Sight, -0.6) (Level, +0.8)	Sight— { 1st reading +3.0 2d reading +3.4 } Level— { 1st reading +1.8 2d reading +2.6 }	+3.2 +2.2	+3.8 +1.4	S+3.8 L+1.4 B2.4	None		-2.5	S+1.3 L-1.1 B2.4
Example C	(Sight, -1.6) (Level, -0.8)	Sight— { 1st reading -3.6 2d reading -2.0 } Level— { 1st reading +1.2 2d reading +3.2 }	-2.8 +2.2	-1.2 +3.0	S-1.2 L+3.0 B4.2		S-1.2	None	
Example D	(Sight, +1.2) (Level, -1.6)	Sight— { 1st reading -3.0 2d reading -2.2 } Level— { 1st reading -1.8 2d reading -0.2 }	-2.6 -1.0	-3.8 +0.6	S-3.8 L+0.6 B4.4		S-3.8	+2.5	S-1.3 L+1.1 B2.4

49. Special field artillery vehicles.—*a. General.*—The personnel of the organization to which a vehicle is issued is responsible for its general upkeep and is, therefore, authorized to perform a limited amount of repair work. Detailed instructions for this work appear in TM 9-305. However, through accident and general wear and deterioration, conditions will arise which cannot be corrected by such personnel and vehicles will therefore have to be turned over to an ordnance maintenance company. In any event, ordnance personnel will render all possible assistance in the performance of repair work and will, when necessary, do work outlined in TM 9-305 as well as the special repairs given in *b* to *g*, inclusive, below.

b. Repair of ammunition chests.—(1) *General.*—In the manufacture of the 75-mm gun caisson and caisson limber chests M1918, the building up of the body is completed by the rolling in of the thin brass connecting pieces in the ammunition holes of the diaphragm. These effectually prevent the replacement of some riveted attachments to the chest and are destroyed if removed. It is, however, sometimes possible to reach rivets, as for example, the inner rivets of the caisson front handrail brackets, by cutting a hole in the connecting piece. Such holes will have to be at least 1 inch in diameter to suit the dolly or rivet set which will be used on the rivet, and are best cut or burned by use of the acetylene torch. The functions of the ammunition chest connecting pieces are to guide and support the projectiles when the complete rounds are inserted, and to support the empty cartridge cases. It is obvious that a connecting piece might be considerably dented or otherwise deformed between the diaphragms without seriously affecting either of these functions. Therefore, these pieces are not to be removed unless positively necessary. It is not expected that the expanding tools for resetting connecting pieces will be frequently required and they are not at present issued to divisional maintenance companies. Request for the loan of the expanders from the next higher maintenance organization should be made as soon as the need is evident.

(2) *To disassemble ammunition chest connecting piece.*—Break or tear the narrow brazed joint in the connecting piece at the top of the openings in the diaphragms and, grasping the broken ends with tongs or pliers, collapse the connecting piece by twisting until it comes out.

(3) *To assemble and roll ammunition chest connecting piece* (described as for caisson).—(a) If the replacement of the lower right caisson connecting piece or the next higher is being made, first cut the holes for assembling brake parts, duplicating the existing holes in the old connecting piece.

(b) The spare connecting pieces as supplied are rolled into tube form, with joints brazed and reinforces in place. If an excess of the spelter used in attaching the reinforces is present, it must be filed or ground away to give a good bearing. In order to get the nearer reinforce through the hole in the front (caisson) diaphragm, this end of the connecting piece must be slightly sprung in, care being taken not to break the brazed joint. Wipe the seats for the connecting piece in the diaphragm clean. Slip the connecting piece into place with the open side up and thumb notches matching those in the diaphragm, then spring the section at the reinforce back to shape. The near end should protrude exactly $\frac{1}{8}$ inch and the thumb notches correspond to those in the diaphragm. Peen the metal of the connecting piece into the thumb notches to hold it in place. Insert the expander (24-10-57) (fig. 49) until the body projects $\frac{3}{32}$ inch from the front face of the front diaphragm and expand the connecting piece into place. With a ball-peen hammer upset the near end of the connecting piece until a flange is formed against the diaphragm. Finish the flange with the square end set and remove the expander.

(c) Insert the inner expansion roller, the rollers being loose, until the collar bears fairly against the turned-out flange of the connecting piece. Then turn the knurled feed nut, drawing the inner shaft out until the rollers are in contact. Revolve the tool with the ratchet and continue to turn the feed nut slowly until it can be turned no farther. The tool will have formed the bead in the connecting piece just forward of the rear diaphragm and turned the farther end out. Loosen the feed nut and withdraw the tool.

(d) Insert the outer expansion roller and similarly roll the bead and seat in the front diaphragm. Remove the tool.

(e) Insert the short expander (without trimming tool) so that the front of the body is $\frac{3}{16}$ inch inside the front face of the connecting piece, tightening it as tightly as practicable with a small wrench on the outer end, $\frac{7}{16}$ inch square. This tool holds the front end rigidly while the thumb notch set is used to flange the brass into the thumb notch. Trim around the thumb notch with a sharp chisel and finish with a file.

(f) With the short expander still in place, assemble the trimming tool, sleeve wrench, ratchet wrench, and feed nut. Manipulate the cutter by turning it with the ratchet wrench, feeding it by slowly turning the feed nut until the surplus stock around the front end is removed. Remove and clear the tools.

(g) The shop inspection of this job will consist of entering a complete round, the cartridge case of which has a maximum thickness of flange, and closing the door which has first been checked for

straightness and which should not bear hard against the case. If it does, reroll the farther end (projectile seat) and try again. Criticize the general neatness of the job. Examine the brazed joints, crimping of the farther end and rolling by using a small circular mirror fixed at an angle of 45° on the end of a lath or similar stick.

(4) *To insert $\frac{3}{16}$ -inch implement fastener rivets in ammunition chest body.*—While it is always advisable to drive rivets hot if possible, the awkward situation and consequent loss of time in getting those rivets in place and the dolly bar adjusted will make it advisable to do the riveting cold. For inserting the rivet, a piece of heavy wire or wooden stick having a forked spring to hold the rivet while working it into place is required. An electric light placed inside the chest will be of aid in locating the hole or rivet. Where work is being done by sense of touch it sometimes helps to push a stick through the rivet hole from the outside. The rivet may be brought up against the stick and follow it as the stick is withdrawn. When the rivet is in place and held by pliers from the outside the dolly bar is adjusted. This must be improvised from any convenient steel bar, $\frac{5}{8}$ to 1 inch in diameter. Make a depression in the end to take the rivet head by drilling with a $\frac{5}{16}$ inch blunt point drill, $\frac{1}{8}$ inch deep. Bend the bar so that the drilled end may be forced against the inner rivet head and held there securely, generally by bearing or wedging against the opposite side of a diaphragm opening. With the dolly bearing solid and the rivet protruding exactly 0.3 inch, drive the head. For driving larger rivets in the ammunition chest, similar dollies or bucking bars may be improvised. Drive the larger rivets hot.

(5) *To replace ammunition chest handrail.*—Ammunition chest handrails project above the chest and are sometimes broken off. Take off the wheel to get room to work; have one man hold a sledge against the inside of the handrail bracket while the old rivet is driven out. After removing the rivets and stub ends of the old handrail and straightening the handrail brackets, it may be found that the new handrail is too tight to assemble without driving. In such case make two pairs of hardwood clamps by bolting two pieces about 2 by 2 by 4 inches together with a $\frac{1}{4}$ -inch strip between and boring a $\frac{7}{8}$ -inch hole cutting the strip in two, and draw these notched blocks tightly about the vertical ends of the new rail. Remove all burrs that might interfere with the perfect seating of the handrail, oil the inside of the tube and the bracket shank, and assemble by driving against the clamps. Line up the pin holes, insert the rivets and head them up cold, finishing the head with the proper rivet set.

(6) *To assemble turnbuckle pin.*—The turnbuckle pins used on the caisson and caisson limber chests are attached by two rivets and present no difficulties in assembling either before or after the turnbuckles are attached. For the straight turnbuckle pins used on battery reels, a special bucking tool is necessary which may be made of a bar of steel about $\frac{3}{4}$ inch in diameter and 2 feet long. Drill a $\frac{3}{8}$ -inch hole at least 1 inch deep in one smoothly squared end and countersink it to $\frac{1}{2}$ -inch diameter. These pins must be set cold as, if set hot, the turnbuckle side will be upset and damaged. After setting the turnbuckle pin, oil the turnbuckle, place it on the pin followed by the turnbuckle pin washer, and lightly rivet over the washer. Finish with a fine file. The turnbuckle must be free to turn without excessive end shake. The turnbuckle pin washer must not be cracked. Try the hasp, lock bar, or whatever fits over the turnbuckle to see that it functions properly.

c. Replacement of axles.—(1) *General.*—The necessity for replacement of an axle usually comes from a broken or damaged outer end at the seat for the wheel fastener. This light section may be cracked by workmen carelessly driving against the end in assembling.

(a) No great difficulty is found in getting out the through or one-piece axles of the caisson, caisson limber, or the cart. Take off the wheels and turn the vehicle over, supporting the chest on blocking, not on the handrails.

(b) For the limber axle take out the four axle bracket bolts, hold a sledge or other heavy article against each side rail at the axle clamp lugs, place the end of a 2- by 4- by 12-inch hardwood block against the shoulder at the base of one of the axle arms and drive out the axle.

(c) For the vehicles on springs and with brakes, one brake hanger must be dismantled, and while for a rush job it is not usually necessary to dismantle the carrying springs, if time is available, it is always better to do so, taking advantage of the opportunity to examine and correct, if necessary, the condition of the axle brackets and side rail slides. The caisson brake hanger bolt is assembled from below, and if it is rusted in, soaking with a penetrating oil may help to loosen it. Do not drive directly against the threaded end of any bolt with a steel drift. Unscrew the nut one or two turns and drive against the nut, interposing a piece of copper, brass, or babbitt. Remove all burrs and rust from the fittings which are to be transferred from the old axle to the new.

(2) *Assembling.*—First oil and put on the axle brackets, tighten the clamping bolts, and try the fit of the axle brackets in the ways

of the side rail and assembly of the spring bolts. To be sure that the axle is not reversed, it will be noted that the brake hanger key of the caisson and artillery cart axle is to the rear. The axle bracket keys should insure alinement of the axle brackets, but if any twist occurs, it should be corrected by dressing the proper side of one axle key. Before final assembly, all nonbearing parts of the axle, if not painted, must be given a coat of red lead paint and, after assembling, two coats of synthetic olive-drab lusterless enamel, Specification No. ES-474. In driving the axle in, drive against the shoulder at the base of the axle arm. Oil the bolts and the bearing surfaces of every bracket before assembling. Get the notches in the axle keys exactly matching the holes in the bracket before driving the clamping bolts. It is possible to assemble the left hanger on the right end of the axle and vice versa. Shop inspection should include a check to insure that this has not occurred and that the axle is not bound in any way which prevents the proper functioning of the springs so that the wheel fastening seats are not damaged.

(3) *To cut out and replace axle arm of artillery reel M1909MI or battery reel M1917A2.*—Remove the wheels and drums and interfering gearing. Through the outer end of the axle arm introduce a rod and knock out the axle arm plug. Chip off the riveted inner end of the unserviceable axle arm and for the artillery reel drive out the $\frac{3}{8}$ -inch pin in the axle bracket hub. Place a steel plug, 2 inches in diameter, by 12 inches long, in the axle arm of the battery reel or one, $2\frac{7}{8}$ inches in diameter by 3 inches long, against the inner end of that of the artillery reel. Arrange the 10-ton jack between a 4- by 6-inch block chained to the axle bracket and the steel plug so as to push the axle arm out. The chain should be a heavy log chain so arranged over the axle bracket that the latter is not distorted by the stress. Heavy bolts may be used instead of the chain. A sharp blow with a heavy hammer on the outside of the axle bracket while the jack is pushing will start the arm. Smooth off any scoring of the axle bracket bore and caliper the bore. The new axle arm should be 0.002 inch larger. If it is more than that, file it down; then reduce the end for about 1 inch so that the arm will start in. Clear away the chain and jack and provide a timber or weight of some kind to back up the axle bracket when tapping in the new arm. Oil the bore and the mating part of the arm. Expand the hub of the axle bracket with the acetylene torch, moving the flange constantly, and getting the hub just hot enough to hiss when a drop of water is placed on it. Set the axle arm so that the cuts of the wheel fastening are vertical and tap into place with a hardwood

block. Be sure that it goes clear home. Let the bracket cool, then rivet the inner end and set the $\frac{3}{8}$ -inch pin and reassemble. Do not drive hard against the wheel fastening end of the axle arm.

d. Repairs to brake bands.—(1) *Linings.*—When brake-band linings are worn beyond further service, which will be when no further adjustment to tighten the band on the drum is practicable or when several rivets attaching them to the brake band are loose, the battery personnel will turn in the unserviceable band to the ordnance maintenance company for relining. It will be observed that each brake band end is attached to the band by four steel rivets which do not pass through the lining and hence need not be disturbed. Use no other than flathead copper rivets in attaching the lining. The flatheads must be well set into the lining so as to minimize wear on the heads. All rivets must be tight. A spare brake drum may be used in assembling to insure proper curvature of the lining between rivets. Punch the rivet holes in the fabric with a long pointed punch, if possible, which will have the effect of spreading the fiber rather than cutting them as by using a twist drill. Start at one end, punch the end holes and set the rivets, then punch for the next pair of rivets and set them, etc. Make the lining between the rivets too long rather than too short, so that it will be crowded out against the band.

(2) *To dismount caisson brake lever shaft.*—(a) In the early design the brake lever shaft was a separate shaft from the hollow brake crankshaft and drove the latter through spline keys. A few of the older type may still be in service; dismounting of both types is done in the same manner.

(b) Take off the right wheel, disconnect the front brake rod ends, take out two bolts securing the brake segment guard and brake segment rack to the chest and footrest, and four bolts securing the brake lever shaft bearing to the chest and foot rest assembly. Drive out the $\frac{3}{16}$ -inch rivet pin holding the front brake crank to the brake shaft, and drift the shaft out to the right. The brake lever shafts of the artillery cart M1918A1 come to the left.

(3) *To replace caisson brake crankshaft bearing.*—It will be necessary to cut out the ammunition chest connecting piece immediately over the bearing to be replaced. Dismount the brake lever shaft and cut out the five rivets of the old bearing. Test the brake lever shaft for straightness. Clean the under side of the side rail where the new bearing is to seat and paint it with red lead paint. Put the new bearing on the lever shaft and the shaft temporarily in the remaining bearings and make sure the new bearing beds down fairly. The red

lead will show any high spots of contact. Then bolt up the new bearing with temporary bolts in each rivet hole and try the shaft again. When satisfied that the new bearing is properly fitted, remove the shaft, take out one bolt, and set that rivet. A special bent dolly bar will be required, and the rivet should be set hot. Then take out the bolt farthest from the rivet just placed and set that rivet. Try the shaft to make sure the rivets have not drawn the bearing out of line; if not, set the remaining rivets. Rub the boxes of all three bearings thoroughly with lubricating cup grease before final assembling of the brake lever shaft. Replace the destroyed ammunition chest connecting piece.

(4) *To adjust brake bands.*—The braking effect should be the same for both wheels. It should be possible to lock both wheels and then secure the proper release of the brake band. When the band lining becomes worn, jack up the axle to raise one wheel, disconnect the brake adjusting nut from the brake band end and screw the nut up on the adjusting link a definite number of half turns. Reconnect the adjusting nut to the band and set the brake. It should hold the wheel when a man of ordinary weight stands on the outer end of one of the horizontal spokes. Then throw the brake lever to the extreme released position and see if the brake band drags when the wheel is turned. If it does, the band is too tight and must be readjusted. The brake lever should not come to the last notch in the segment rack when the brake is set. Leave a little movement in reserve for wear. Turn the adjusting nut at the other wheel the same number of turns as the first or until proper action is obtained. The greatest braking effect is obtained when the wheels are about to skid but are still revolving.

e. Fuze setter bracket.—Spare fuze setter brackets and spare fuze setter bracket anchors are included in the list of organization spare parts for caissons. (The functions of the bracket are described in par. 57, TM 9-305.) No directions as to assembly of standard parts are required, but the following should be noted. There are in service several models of the American bracket fuze setters which may be encountered. In 1920 it was found necessary to modify the M1916 bracket fuze to overcome certain interferences between the fuze setter and the bracket by assembling new range worm cranks and corrector worm knobs and changing the holding bolts. In mounting the fuze setter it was necessary to file the anchor bracket filler and reduce the heads of certain rivets. As temporary expedients for adapting the unmodified fuze setters M1916, on a number of caissons, a maple block

4 inches square and $\frac{15}{16}$ inch thick was introduced between the fuze setter and the anchor bracket, in which position the two short bolts acted as dowels in the block and the two long bolts secured the fuze setter. In addition, a block of softwood $2\frac{3}{4}$ by $3\frac{3}{4}$ by $4\frac{3}{4}$ inches was bolted to the under side of the foot rest with three $\frac{1}{4}$ by 5 inch carriage bolts. This block rested on the top of the guide ring of the fuze setter in traveling position and was necessary because that part of the fuze setter anchor bracket supposed to engage the footrest was out of position. Later instructions directed the lashing of the fuze setter in traveling position to prevent pounding.

f. Poles and drawbars.—(1) Bent poles and drawbars are straightened as follows:

(a) Place the pole, the top surface of the bend up, on blocks or jacks so arranged that they support the pole at each end of the bend.

(b) Place a jack, suitably braced, against the top of the bend midway between the supporting blocks or jacks.

(c) Apply pressure to the bend by slowly operating the jack.

(2) It will be necessary to devise different methods of supporting and applying the blocks and jack to the pole according to the location of the bend.

(3) The drawbar, having a thicker wall and being shorter in length than the pole, must be heated to a dull red glow before attempting to straighten it.

g. 56-inch wheel.—(1) *General.*—In the repair of the wooden parts of the 56-inch wheel, it is well to know that in the manufacture and assembly of the wheel a machine press is used which bears against the outer end of each spoke, forcing them all toward the center and securing solid contact of each spoke before the boring is made for the hub box. This solidity of the arch of the wheel is very essential to the life of the wheel, and in setting a repair spoke it must be firmly fitted at the arch. Because of the conical shape of this arch, the spoke is slightly wider on the inside, which is an advantage in assembling a repair spoke. The notches in the sides of the spoke for the carriage bolts are cut slightly too far from the center so that the bolts tend to draw the spoke in. Spare spokes and fellies can be obtained by requisition. Soaking wheels in water is forbidden.

(2) *To replace spoke.*—(a) Cut the unserviceable spoke in three parts and dismount the spoke shoe by removing the rivet.

(b) Remove the carriage bolt involved and back the nuts off the others until only two threads are engaged on each. Lay the wheel hub down with each spoke resting on blocking (a spare brake drum reversed and raised a few inches on pieces of wood will do), and start

the hub box out with a hardwood block. About $\frac{1}{2}$ to $\frac{3}{4}$ inch is sufficient movement of the hub, as it is not desirable to disturb any spoke in the arch other than the one being replaced.

(c) Cut the spoke just long enough to enter (spoke shoe plate not in place) and fit it in the arch. When satisfied that proper contact is secured, slip the spoke shoe on, paint the contact surfaces at the hub with white lead, place the spoke, and drive a wedge between the spoke and felly. The spoke will now hold the arch while the hub box is driven out. If necessary, dress the inner end of the new spoke with a half round file to fit, cut the notch for the carriage bolt, clean and paint all surfaces. Reassemble the hub box, the hub ring, and the carriage bolts.

(d) Take out the wedge, if necessary, but back the spoke end a little so that the spoke shoe plate can be driven in. Paint the surfaces, drive in the plate, slide the spoke shoe into place, and assemble the spoke shoe rivet.

(e) Give the new spoke two coats of synthetic, olive-drab, lusterless, enamel.

(3) *To replace felly.*—(a) Drive off the tire, first taking out all the tire bolts and laying the wheel, hub cap down, with the remaining felly segments resting solidly on blocks.

(b) Take out the five spoke shoe rivets involved and slip the spoke shoes down on the spokes, laying the spoke shoe plates to one side.

(c) Fit in the segment so as to get squarely bearing joints with the abutting felly segments. The new segment will be drawn toward the center about $\frac{1}{32}$ to $\frac{1}{16}$ inch by the pressure of the tire and should project beyond the outer circle of the other segments accordingly. This means that the three spoke shoe plates which bear against this segment exclusively will slip in freely, but without more than $\frac{1}{64}$ -inch shake, between the spoke and felly. Paint the ends of the felly and seats of the spoke shoes and plates with white lead.

(d) Turn the wheel with the inside down as if to set the tire and put the freshly painted spoke shoe plates and spoke shoes in position without drilling the holes for the spoke shoe rivets. Set the tire as described in (4) below. Then, after making sure that the spoke shoe plates are tight, drill the holes for the spoke shoe rivets and the tire bolts. Paint and assemble the tire bolts and rivets. Lightly peen over the tire bolts after the nuts are in place.

(4) *To set tire.*—(a) Place the wheel in the horizontal position with inside of the hub down and the fellies resting on pieces of plank which are of an even height and which are disposed radially around the wheel. Insert pieces of metal $\frac{1}{8}$ inch thick between the felly

sections and the planks to allow for the overhang of the tire. With the fellies well closed in toward the center, measure the circumference with a tire settler's measuring wheel or a steel tape.

(b) Make the circumference of the inside of the tire from $\frac{9}{16}$ to $1\frac{1}{16}$ inch shorter than the circumference of felly according to the condition of the felly. A tire machine secures the necessary reduction of tire circumference by an upsetting operation while the tire is hot. In emergency the tire may be cut and scarf-welded. The amount to be cut out should be about $\frac{1}{8}$ inch less than the difference between the desired and the actual circumference of the tire; that is, if the tire is $\frac{5}{8}$ inch too long, cut out $\frac{1}{2}$ inch. The welded section must not be thinner nor narrower than the rest of the tire.

(c) After the tire has been sized, it is heated evenly all over to a very low red or to a lower temperature which, in the judgment of the experienced mechanic, will expand it sufficiently, and while hot, it is assembled in place over the felly. It should not be so hot as to burn the wood. Subsequent slow cooling (use a little water if the wood starts to burn) will cause the tire to contract, firmly binding the felly segments and producing a slight bend in each spoke, increasing the "dish" of the wheel. The tire bolt holes will not match well with the old holes in the felly and new ones must be drilled. Plug the old holes with hardwood plugs, white leaded. After tightening the tire bolt nuts, lightly rivet or peen the ends of the bolts to prevent the nuts from coming loose.

(5) *To remove hub liner.*—(a) Remove the wheel.

(b) Place the hub liner driving tool against the small end of the liner and strike it a smart blow with a heavy hammer.

(6) *To assemble new hub liner.*—(a) Wipe the bore of the hub box and the outside of the liner absolutely clean.

(b) Lightly oil the bore and see that the oil is distributed over the whole surface before introducing the liner.

(c) Drive the hub liner in tight. Use the hub liner driving tool to avoid marring the liner, or, if no driving tool is available, use a fitted hardwood block.

(d) The liner should come flush with the smaller end of the hub box or may project beyond it not to exceed $\frac{1}{64}$ inch. If it does not, drive it out and see if dirt or lint is not responsible for the trouble. The wheel must revolve freely on the axle arm when the wheel fastening is in place.

SECTION VI

TOOLS FOR INSPECTION

Paragraph

Tools for inspection..... 50

50. Tools for inspection.—The following tools are issued to ordnance maintenance companies for use in inspection of the 75-mm gun matériel M1897, M1897MIA2 M1897A4, M2A1, and M2A3:

NOTE.—Items indicated by an asterisk (*) are used with the 75-mm gun carriage M1897 and modifications only.

- | | |
|--|---|
| * a. Chest, sight testing tool. | a. The sight testing tool chest (fig. 43) contains the following tools used for testing and adjusting the sight, level, and sight bracket: |
| * (1) Glass, magnifying, 1 (fig. 45). | (1) Used principally to enlarge visibility of sight graduations and index lines in order to obtain greater accuracy in adjustment; also an aid for examining flaws or cracks. |
| * (2) Guide, scribing, angle of site index, 2 (fig. 45). | (2) Used as a guide when scribing new angle of side index line. |
| * (3) Guide, scribing, deflection drum index, 3 (fig. 45). | (3) Used as a guide when scribing new deflection drum index line. |
| * (4) Level, master, 4 (fig. 45). | (4) Used to level the gun and sight when checking the accuracy of the sight bracket M1901, in relation to bore of gun and index lines on sight bracket and to determine the angle of trunnion friction. |
| * (5) Scriber, 5 (fig. 45). | (5) Used when scribing new angle of site and deflection drum index lines. |
| * (6) Seat, testing, auxiliary site index, 2 (fig. 45). | (6) Used when testing the accuracy of the auxiliary level of French manufacture. |
| * (7) Seat, testing, auxiliary level, 11°15', 7 (fig. 45). | (7) Used when testing the accuracy of the auxiliary level of American manufacture. |

- * (8) Seat, testing, level, 8 (fig. 45). (8) Used when testing the accuracy of the level.
- * (9) Seat, testing, sight, 2 (fig. 44). (9) Used when leveling the sight bracket in relation to bore of gun (previously leveled) for the purpose of checking the accuracy of sight adjustments.
- * (10) Shield, protection, 9 (fig. 45). (10) Used to protect the graduated scales on the deflection drum when removing the index line.
- * (11) Sight, master, 3 (fig. 44). (11) The master service sight is used to check the accuracy of the battery sight; the other, the master test sight, is used to check the accuracy of the master service sight.
- * *b.* Gage, clearance, 10 (fig. 36). *b.* The clearance gage is used to determine the clearance between the gun roller and roller path on the cradle and to check the clearance between the jacket crosspiece and the upper roller path.
- * *c.* Gage, depth (fig. 47). *c.* This gage, C58358, is used for checking the distance from the roller paths to inclined planes of the cradle. It should be kept well covered with lubricating oil when not in use.
- d.* Gage, forcing cone 11 (fig. 36). *d.* Use to measure the advance of the forcing cone of the gun.
- e.* Gage, pressure (fig. 37). *e.* The pressure gage, C6529, is used for testing the gas pressure in the recuperator.
- * *f.* Gage, stuffing box threads (fig. 47). *f.* This gage, A136420, is used for testing the wear of threads of the recoil stuffing box head.
- * *g.* Gage, thickness, set, 5 (fig. 40). *g.* The thickness gage, consisting of 10 leaves, is used in measuring distances between mating shoulders and the thickness of shim needed to set the sight

- h. Target, testing (fig. 48).
- i. Tester, pressure gage, complete (fig. 34).

bracket. The several leaves are used either singly or stacked.

h. The testing targets are used in testing and adjusting sights.

i. (1) The pressure gage tester is used for testing the accuracy of the service pressure gage with the master gage. It is filled with liquid which is subjected to pressure by a screw, pressure being transmitted equally to both pressure gages, thereby causing both to read the same if in adjustment. Figure 38 shows the tester reservoir in assembled position. Figure 37 shows the tester reservoir disassembled and packed in the chest.

(2) To use the pressure gage tester, clamp it securely in a vise by means of the lug on the under side. The screw is withdrawn and the apparatus filled with recoil oil before assembling the pressure gage in order to eliminate possible air bubbles in the connections. The master gage is screwed into one arm and the gage to be tested into the other arm. Apply pressure by means of the operating screw and compare readings over the entire range of the gages. If the gages are not in agreement, proceed as outlined in paragraph 78.

(3) Figure 35 shows the pressure gage tester and the following equipment for use therewith:

(a) *Adapter, 9.*—The adapters, 9, are used to connect the pressure gages to the tester.

(b) *Adapter, 8.*—The adapter, 8, is issued with all outfits but is

used only with the 155-mm and 240-mm howitzer matériel.

(c) *Gage, pressure, master.*—The master pressure gage, 5, is used to check the accuracy of the service pressure gage. It is graduated in pounds per square inch as well as kilograms per square centimeter. This instrument should be returned to an arsenal every 3 months for verification of its accuracy.

(d) *Gaskets and glasses.*—The gaskets, 6, 7, and 10, and the glasses, 11, are spare parts.

(e) *Jack, gage hand.*—The gage hand jack, 3, is used in removing the pressure gage indicator hand when it is not in agreement with the master gage.

(f) *Set, gage hand.*—The gage hand set, 4, is used when replacing the pressure gage indicator hand in agreement with the master pressure gage.

j. Thermometer, Fahrenheit (graduated -10° to $+220^{\circ}$).

j. The thermometer is used for testing the temperature of oil in the recoil mechanism when taking pressures.

* *k.* Washer, test, left traversing nut thrust, set (fig. 40).

k. The set of left traversing nut thrust test washers, 1 (fig. 40), are used to determine the correct thickness of the traversing nut thrust washer, left.

* *l.* Washer, test, right, traversing nut thrust, set (fig. 40).

l. The set of right traversing nut thrust test washers, 2 (fig. 40), are used to determine the correct thickness of the traversing nut thrust washer, right. The washers are serially numbered 1 to 8 inclusive, each washer increasing in thickness, 0.012 inch.

- m.* Jack, recoil piston, with bar (fig. 37). *m.* The recoil piston jack (fig. 37) when screwed into the seat for the respirator is used to force the recoil piston and piston rod to the rear when taking pressure.
- * *n.* Rest, master level 1 (fig. 44). *n.* The master level rest, 1 (fig. 44), is a support for the master level. It is designed to fit into the muzzle end of the bore of the gun.
- o.* Sight, bore, complete (fig. 36). *o.* The bore sight, complete, consists of a muzzle bore sight, 13, and breech bore sight, 12 (fig. 36). They are used in checking the alinement of the sight with the centerline of the bore of the gun.
- p.* Gage, fuze setter. *p.* The fuze setter gage is used for checking accuracy of fuze setters and is carried in the special repair tool chest.

SECTION VII

TOOLS FOR MAINTENANCE AND REPAIR

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51. Chest, special repair tool.—*a.* (1) The special repair tools pertaining to the 75-mm guns and carriages M1897MIA2, M1897A4, M2A1, M2A2, and M2A3 are listed in SNL C-18.

(2) The special repair tools for the 75-mm guns and carriages M1897MIA2, and M1897A4 are carried in the special repair tool chest, D2386, and the special repair tools for the 75-mm guns and carriages M2A1, M2A2, and M2A3 are carried in the special repair tool chest, D31986. These chests each occupy a space of approximately 5.7 cubic feet, the dimensions being 29 inches long, 19½ inches wide, and 18 inches deep.

b. There are a number of tools provided for the maintenance, repair, and adjustment of the matériel, such as taps, dies, chisels, drifts, files, hammers, pliers, screw drivers, wrenches, and punches, the names or general characteristics of which indicate their uses and application. Therefore, detailed descriptions and methods for their use are not outlined herein. Those tools, however, which are of special design and not commonly used are described and their uses outlined in the paragraphs following.

52. Clamp, axle sleeve.—The axle sleeve clamp, 4 (fig. 40), is used to grip the sleeve during disassembly and assembly of the axle.

53. Counterbore 4-mm.—The 4-mm counterbore, 7 (fig. 36), is used with the elevating nut collar jig for starting the hole to be drilled in the elevating nut collar when relocating the pin hole.

54. Drill, twist, 4-mm.—The 4-mm twist drill, 3 (fig. 36), is used in the elevating nut collar jig for drilling the pin hole in the elevating nut collar when relocating the pin hole.

55. Extractor, sweeper plate.—The sweeper plate extractor, 14 (fig. 36) is a hook for aiding in the removal of the sweeper plate and sweeper plate guide.

56. File, breech thread.—The breech thread file, 2 (fig. 36), is a special file for smoothing the threads of the breech recess.

57. Filler, oil screw.—The oil screw filler (fig. 37) is used to replenish the oil in the recoil mechanism. For description, use, and operation of the screw filler see TM 9-305.

58. Gun, grease.—The grease gun, 9 (fig. 39), is used for injecting grease into holes Nos. 4, 6, 9, 10, and 11 of the carriage. Detailed instructions on lubrication are given in TM 9-305.

59. Gun, oil.—The gun, 15 (fig. 36), is used to force oil into the oiler nozzles on the carriage. Detailed instructions on its use and operation are given in TM 9-305.

60. Jig, elevating nut collar.—The elevating nut collar jig, 9 (fig. 36), is used when relocating the pin hole in the elevating nut collar in changing the collar.

61. Nut, assembling, equilibrator.¹—The equilibrator assembling nut is an elongated hexagonal nut which is used for retaining the equilibrator as an assembled unit while removing or replacing the equilibrator. This applies to the 75-mm gun carriages M2A1, M2A2, and M2A3 only.

62. Puller, gear.¹—The gear puller (fig. 47), consists of a plate and three screws, two of which have cotter pins. It is used to remove the elevating worm wheel, B141439 (fig. 20), and traversing worm wheel, B109248 (fig. 21), from their shafts. This applies to the 75-mm gun carriages M2A1, M2A2, and M2A3 only.

63. Pump, oil, M1A1.²—The oil pump M1A1 (fig. 38) is used to replenish the oil in the recoil mechanism. The oil pump is attached to the right trail and its pipe connection is screwed into the filling and drain plug hole.

64. Reamer, taper (Nos. 1, 2, and 3).—The reamers 4, 5, and 6 (fig. 36) are used in resetting the elevating nut collar pin.

65. Roll, tool with contents.—The tool roll M4 (fig. 33) contains an assortment of tools for general use in work on the matériel. SNL C-18 lists the proper tools to be carried in this tool roll.

66. Screw driver, oiler nozzle.—The oiler nozzle screw driver, 8 (fig. 36), is used only for removing the gun roller oiler nozzles.

67. Sleeve, axle mounting.—The axle mounting sleeve, 6 (fig. 40), should be used when reassembling an axle to guide the axle through the bearings. The tapered end of the sleeve will prevent damage to gaskets, bearings, and the traversing nut threads.

68. Tap, 16 by 1.5-mm (PX) (filling and drain plug hole).²—The 16 by 1.5-mm (PX) tap, 19 (fig. 41), is used for re-resizing the filling and drain plug hole.

69. Set, gage hand.²—The gage hand set, 4 (fig. 35), is used in replacing the gage indicator hand when repairs are made to the pressure gage.

¹ For M2A1, M2A2, and M2A3 carriages.

² Common to all carriages.

70. Tool, hub liner driving.—The hub liner driving tool, 12 (fig. 39), is used in replacing liners in the hub of wheels.

71. Wrench, axle dust washer gland.—This wrench, 3 (fig. 40), is used on the axle dust washer gland.

72. Wrench, clamp (elevating nut collar).—This clamp wrench, 1 (fig. 36), is used to turn the elevating nut collar.

73. Wrench, hook spanner, 47-mm (worm gear shaft nut).—This wrench, 8 (fig. 39), is used on the angle of site worm gear shaft nut, 2-94-60E.

74. Wrench, oil index follower.²—The oil index follower wrench, A7488 (fig. 47), is used in the disassembling or assembling of the oil index follower. It is turned with the handle, A6788.

75. Wrench, pintle and trail.¹—The pintle and trail wrench, B108514 (fig. 47), has on one end an open end wrench used for assembling and disassembling the pintle pin slotted nut, A140574 (fig. 14), and on the other end a hexagonal box wrench used for assembling and disassembling nut, A136607 (trail hinge pin nut). This applies to the 75-mm gun carriages M2A1, M2A2, and M2A3 only.

76. Wrench, piston rod nut, front.²—The piston rod front nut wrench, A8765 (fig. 47), is used for tightening the front nut of the piston rod. It is turned with handle, A6788.

77. Wrench, socket 24-mm.—The 24-mm socket wrench, 3 (fig. 39), is used on the 14-mm (French) nuts. It is turned with the wrench handle 24-10-LH37L, 4 (fig. 39).

78. Wrench, socket, 26-mm.—The 26-mm socket wrench, 2 (fig. 39), is used on the 16-mm (French) nuts. It is turned with the wrench handle, 24-10-LH 37L, 4 (fig. 39).

79. Wrench, stuffing box head and follower.²—The stuffing box head and follower wrench, A8161 (fig. 47), is used for adjusting the recoil piston rod stuffing box. It is turned with the wrench handle, 4 (fig. 39).

80. Repair tools for special field artillery vehicles.—*a. General.*—The special repair tools pertaining to special field artillery vehicles are listed in SNI C-18.

b. Standard tools.—The names of a number of tools required for maintenance, repair, and adjustment of this matériel, such as chisels, drifts, files, hammers, pliers, screw drivers, wrenches, and punches indicate their use. Detailed descriptions of them and methods of use are not outlined herein. Nor are these standard tools included

¹ For M2A1, M2A2, and M2A3 carriages.

² Common to all carriages.

in the set of special repair tools for the vehicles covered here as they are included in such sets for the various guns and carriages, and in the general equipment of ordnance maintenance companies. Those tools, however, which are of special design and not commonly used are described and their uses outlined in *c* to *o*, inclusive.

c. Expander.—The expander, 1 (fig. 49), is similar to an expansion mandrel; that is, the outside diameter is increased or decreased by the mechanism assembled inside the expander. The purpose of the expander is to expand the connecting pieces into place in the ammunition chest.

d. Expander, short.—The short expander, 6 (fig. 49), is composed of the same parts as the expander, except that the body of the latter is $\frac{1}{4}$ inch longer. The purpose of the short expander is to hold the connecting pieces rigidly in place, in order that they may be set into the thumb notches of the diaphragm and also act as a guide for the trimming tool (*m* below).

e. Mandrel, driving.—The purpose of the driving mandrel (24-10-47) is to drive the connecting pieces into place.

f. Nut, feed.—The feed nut, 9 (fig. 49), is used in conjunction with the trimming tool. Its purpose is to force the ratchet wrench, sleeve wrench, and cone of the trimming tool forward, thus forcing the cutter into the work.

g. Pin, adjusting.—The adjusting pin, 4 (fig. 49), is used for turning the long knurled feed nut on the inner and outer expansion rollers.

h. Roller, expansion, inner.—The rollers inserted into the cage mounted in the head of the expansion roller, 3 (fig. 49), are operated by the movement of the rear roller shaft, which is controlled by the adjusting nut assembled to the rear roller body and bearing against the crank attached to the rear end of the rear roller shaft. The purpose of the inner expansion roller is to form the bead in the connecting piece just forward of the rear diaphragm and turn the farther end out.

i. Roller, expansion, outer.—The rollers inserted into the cage mounted in the head of the expansion roller, 5 (fig. 49), are operated in the same manner as described for the inner expansion roller. The purpose of the outer expansion roller is to roll the bead and set in the front diaphragm.

j. Set, square end.—The square end set, 12 (fig. 49), is used to finish the flanging of the connecting piece at the front face of the front diaphragm.

k. Set, thumb notch.—The thumb notch set, 11 (fig. 49), is for the purpose of flanging the metal of the connecting piece in the thumb notch.

l. Shell, dummy.—The dummy shell, shown on drawing (24-10-55), is for the purpose of resizing and removing the dents in the connecting pieces of the ammunition chest.

m. Tool, trimming.—The trimming tool, 7 (fig. 49), is for the purpose of removing the surplus stock of the connecting piece after it has been assembled in the ammunition chest.

n. Wrench, ratchet.—The ratchet wrench, 10 (fig. 49), is utilized in revolving the expanders.

o. Wrench, sleeve.—The sleeve wrench, 8 (fig. 49), is used as an extension on the short expander to connect the ratchet wrench with the trimming tool.

SECTION VIII

INSPECTION AND REPAIR OF SPECIAL TOOLS

	Paragraph
Inspection and repair of special tools.....	81

81. Inspection and repair of special tools.

<i>Condition</i>	<i>Cause</i>	<i>Correction</i>
<i>a.</i> Pressure gage inaccurate.	<i>a.</i> Accidental movement of the hand upon the spindle. Wear or distortion of the linkage. Applying pressure suddenly causing the hand to strike the stop pin.	<i>a.</i> Repair consists of pulling the hand off the spindle using the gage hand jack (fig. 35), and resetting it in agreement with the master gage utilizing the pressure gage tester (par. 50 <i>i</i>). The most effective readings that are involved lie between 30 and 160 kg. per sq. cm. (430 to 2,300 psi). The master gage should be returned to an arsenal periodically for the verification of its accuracy.

b. The inspection and special repair tools are of such design that, with proper handling and storage in their respective retainers, they

should require very little care. Each tool should be inspected before and after use and all burs removed with a smooth file or oilstone. When placed in their container, they should receive a light coat of oil, engine, SAE 30.

SECTION IX

FIELD SERVICE MODIFICATION WORK ORDERS (FSMWO)

Paragraph

Field service modification work orders..... 82

82. Field service modification work orders.—Field service modification work orders are issued from time to time authorizing the modification of matériel. When making inspections and repairs to matériel covered by the manual, it is essential to check the matériel against existing field service modification work orders to keep the matériel up-to-date.

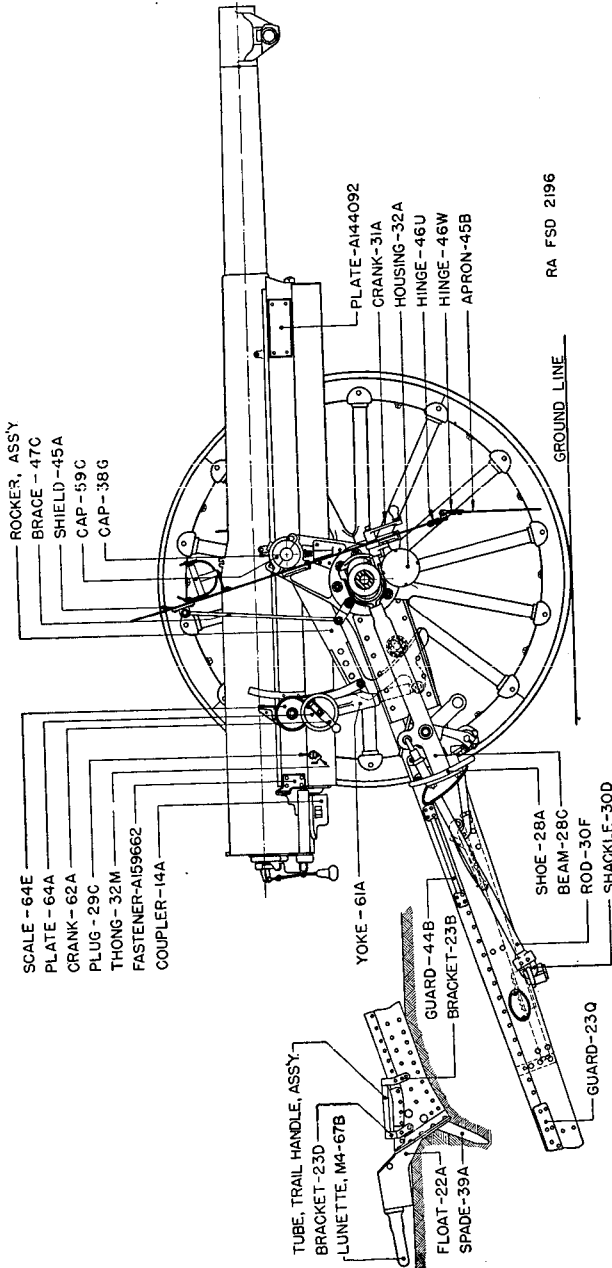
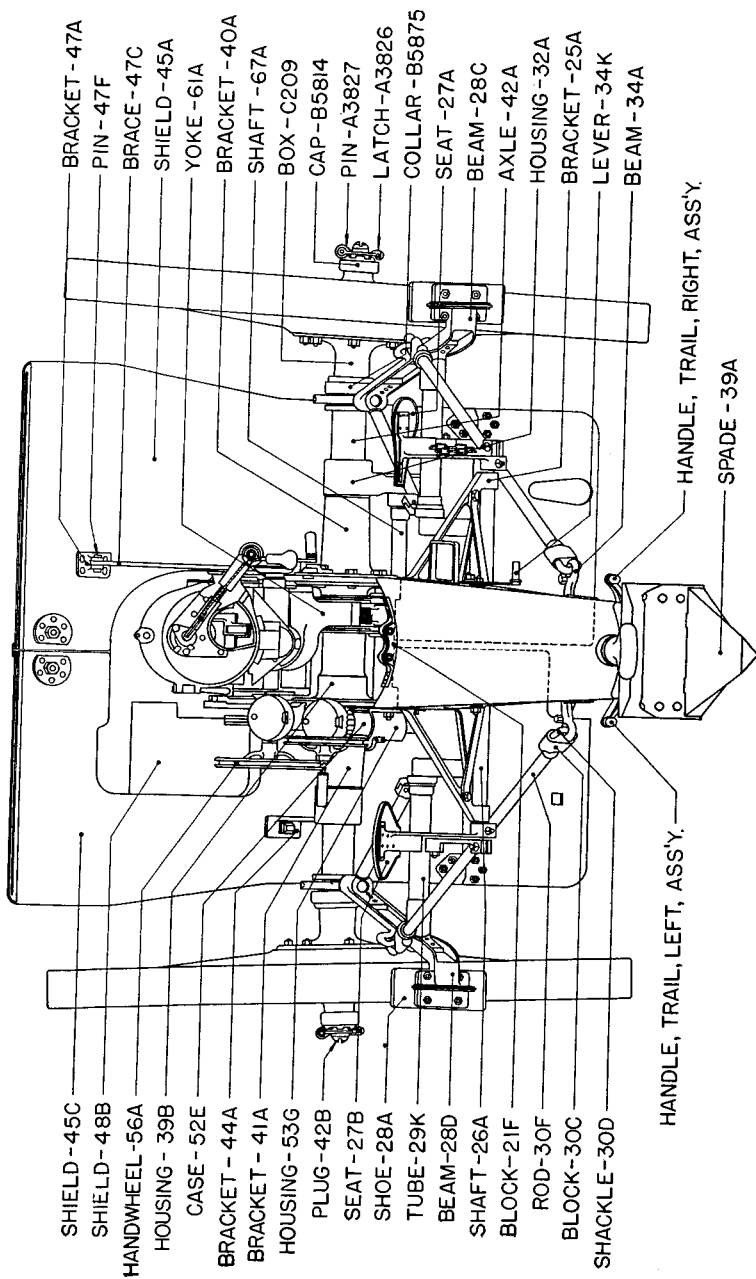


FIGURE 1.—75-mm gun carriage M1S97MI—right side.



RA FSD 2195

FIGURE 2.—75-mm gun carriage M1897MI—rear view.

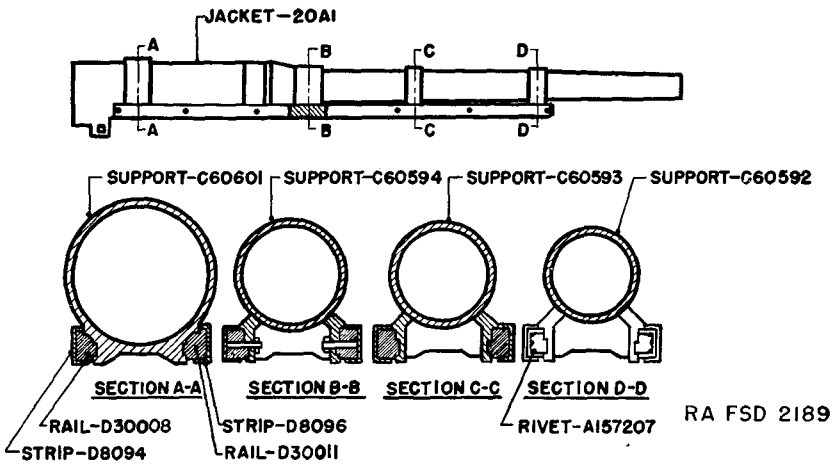


FIGURE 4.—75-mm gun M1897A3.

RA FSD 2189

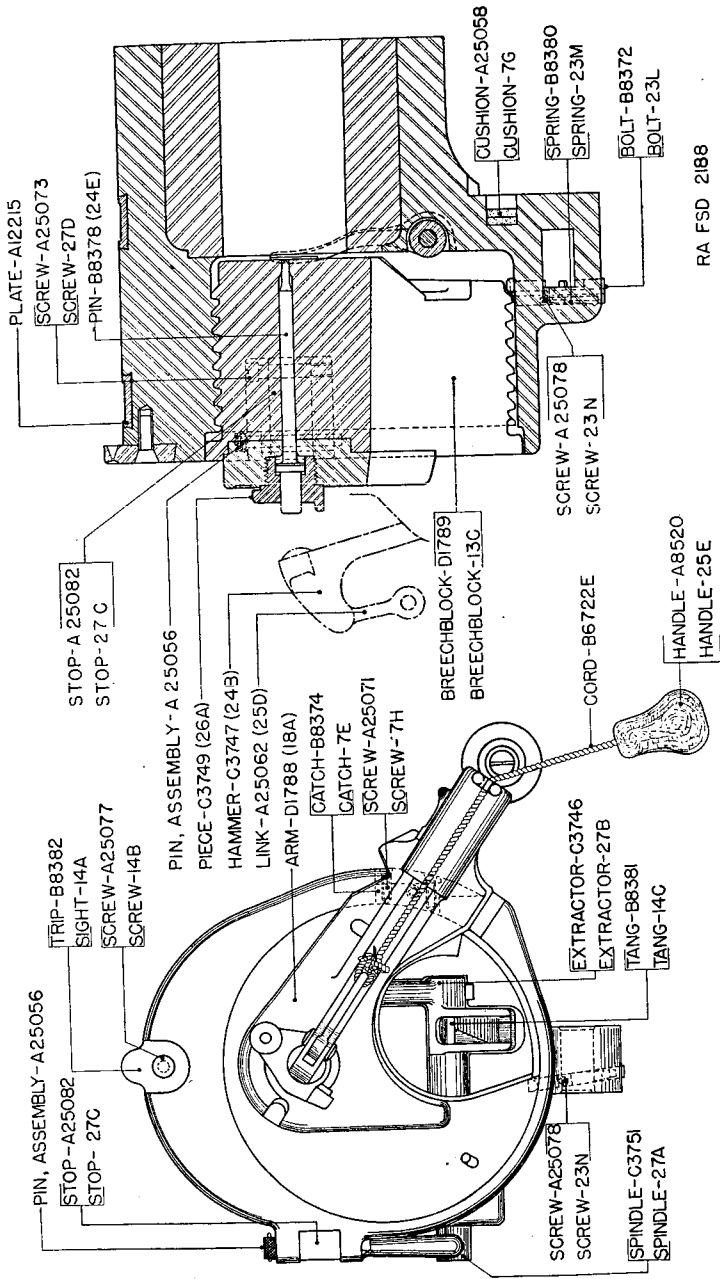


FIGURE 5.—Breech mechanism- side and rear assembled and sectioned views (75-mm gun M1897).

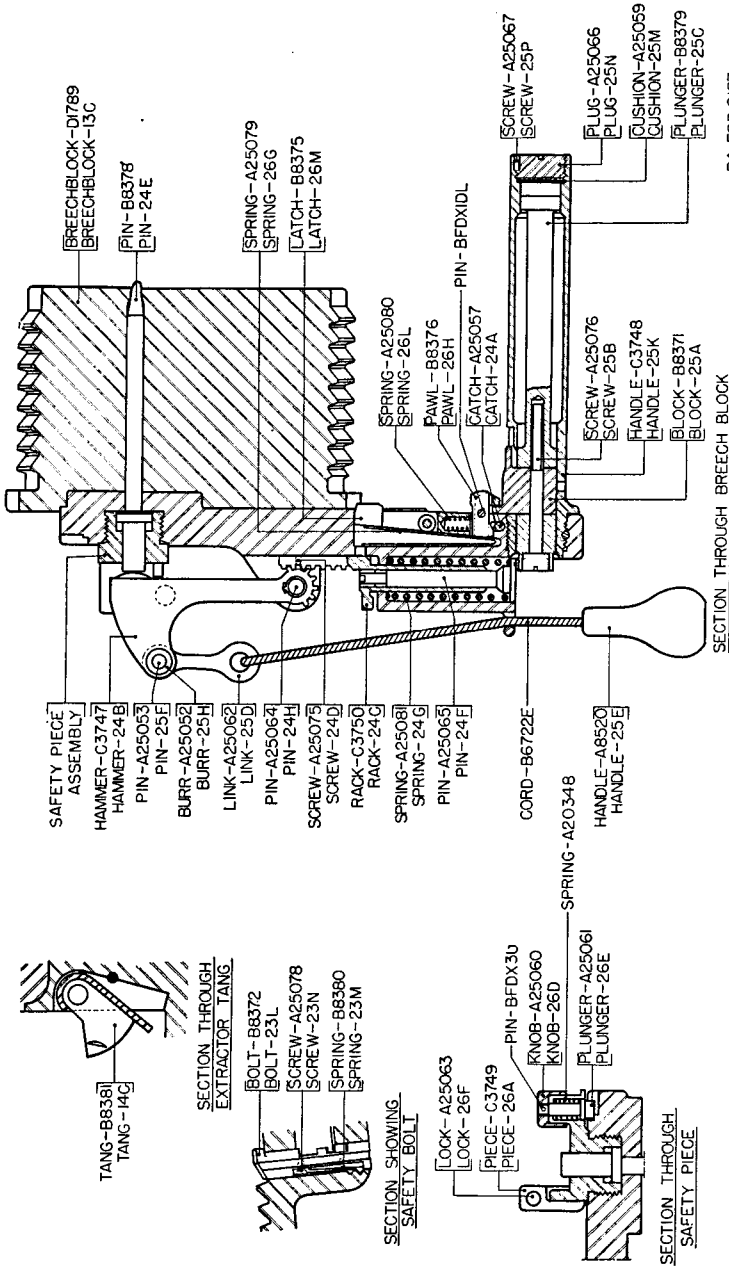


Figure 6.—Breech mechanism—sectioned view (75-mm gun M1897).

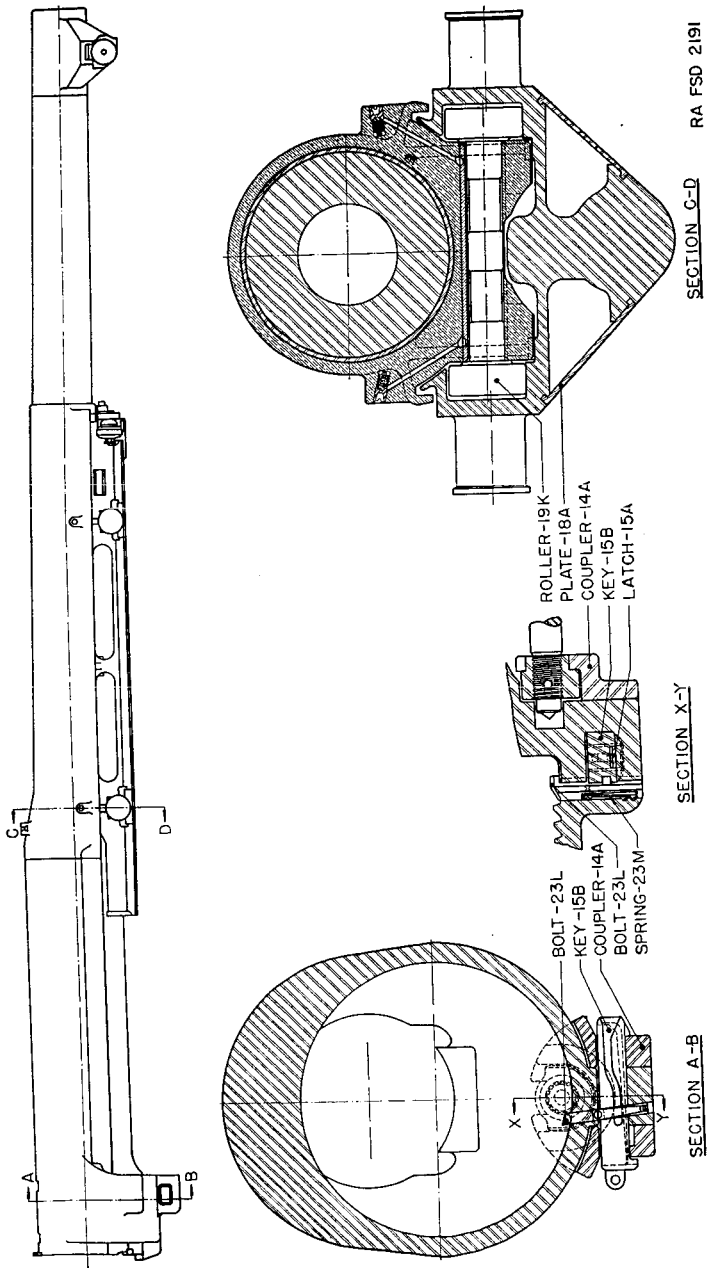


FIGURE 7.—Connections between gun and carriage (M1897MI and M1897MIA2).

SECTION C-D RA FSD 2191

SECTION X-Y

SECTION A-B

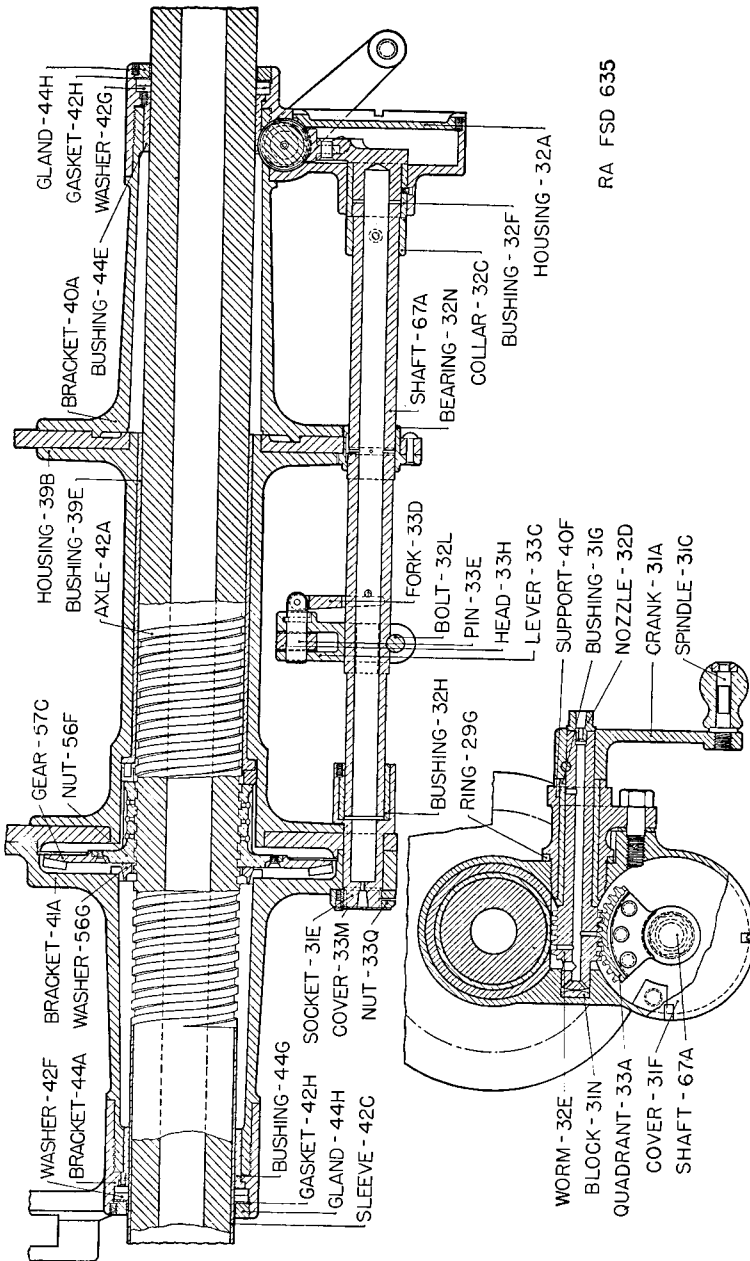
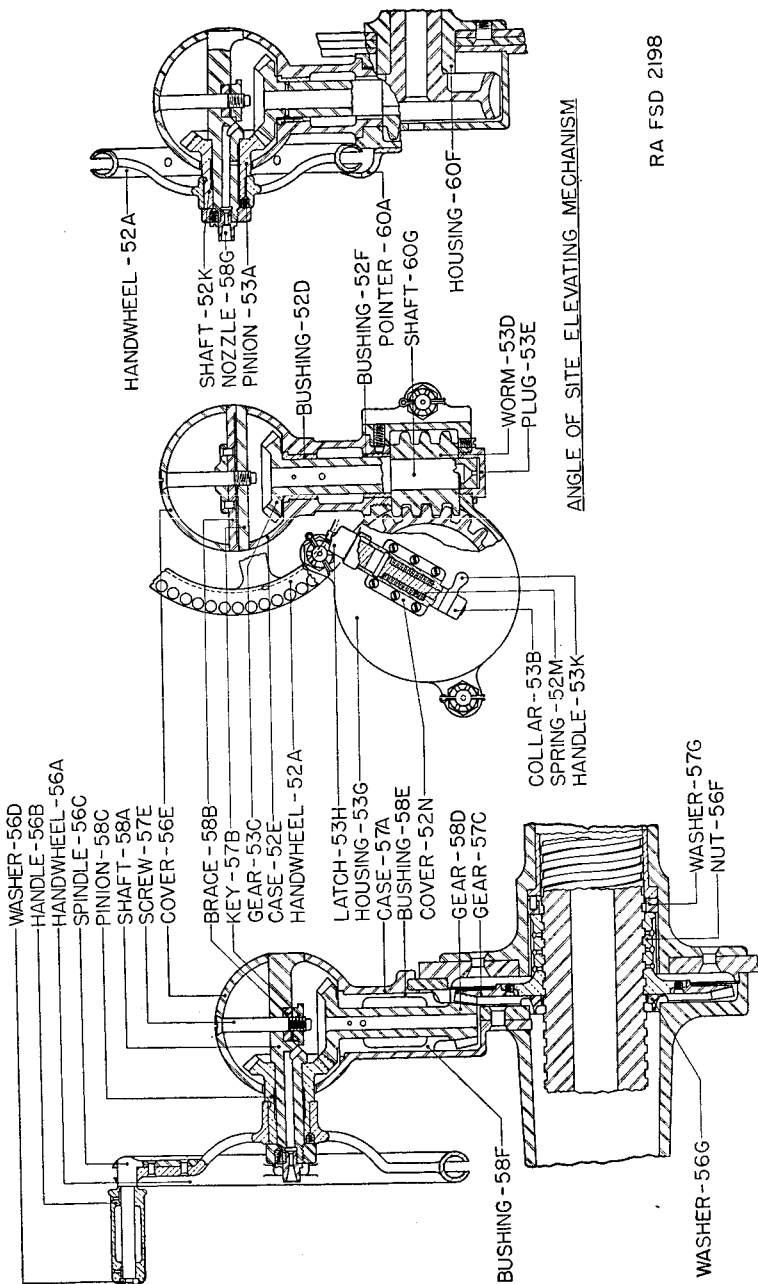


FIGURE 8.—Traversing and brake operating mechanism—(M1897MI and M1897MIA2).



RA FSD 2198

TRAVERSING MECHANISM

Figure 9.—Traversing and angle of site mechanism—-assembled views (M1897 and modifications).

RA FSD 2197

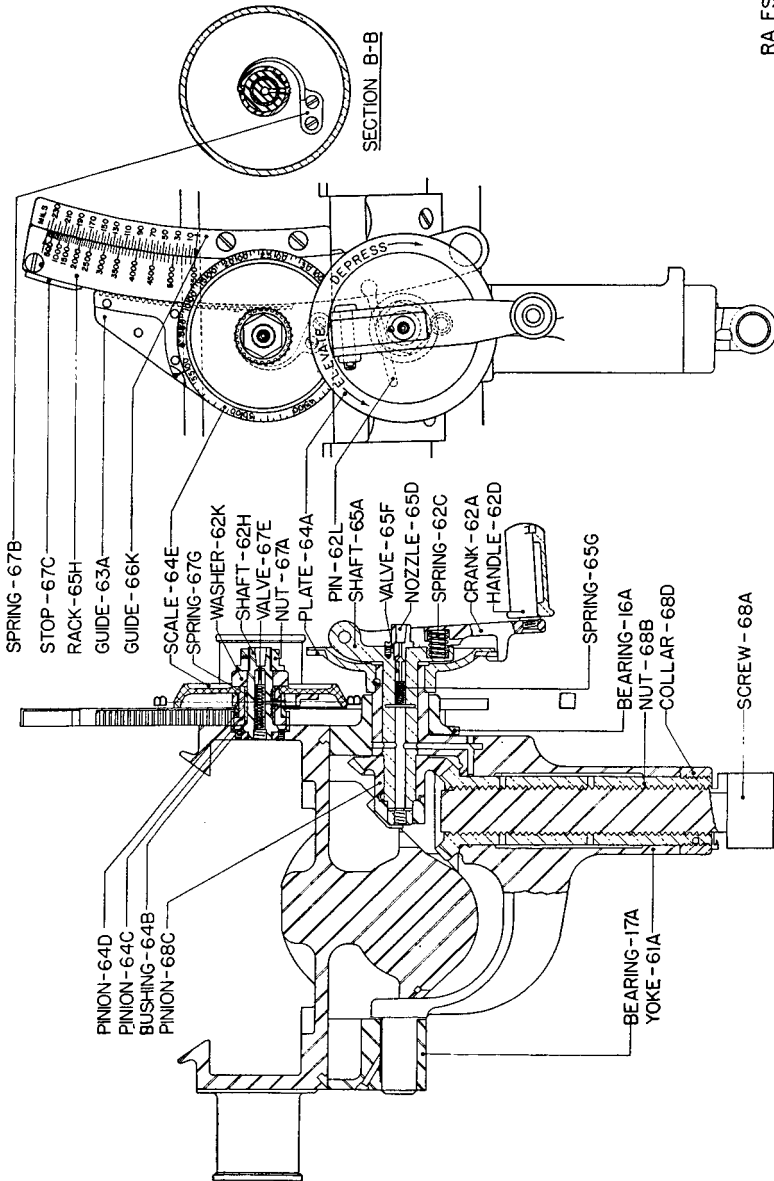
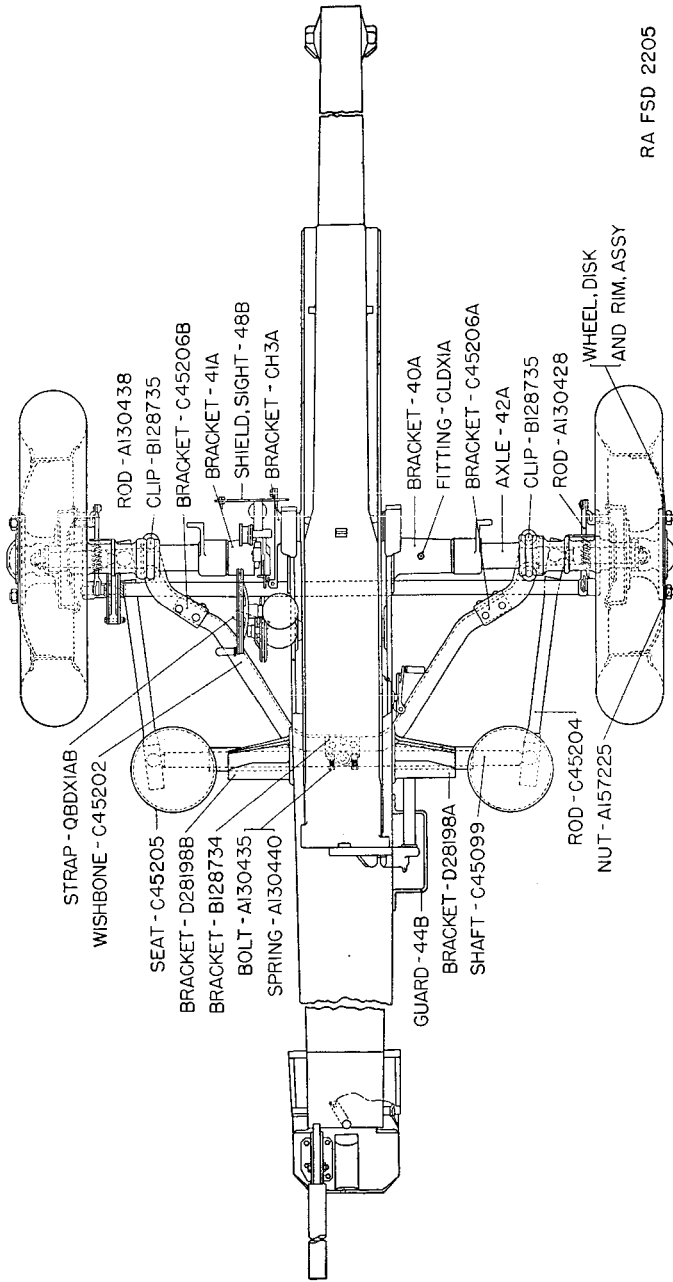


FIGURE 10. -Range elevating mechanism—assembled views (M1897 and modifications).



RA FSD 2205

FIGURE 11.—75 mm gun carriage M1897A4—plan view.

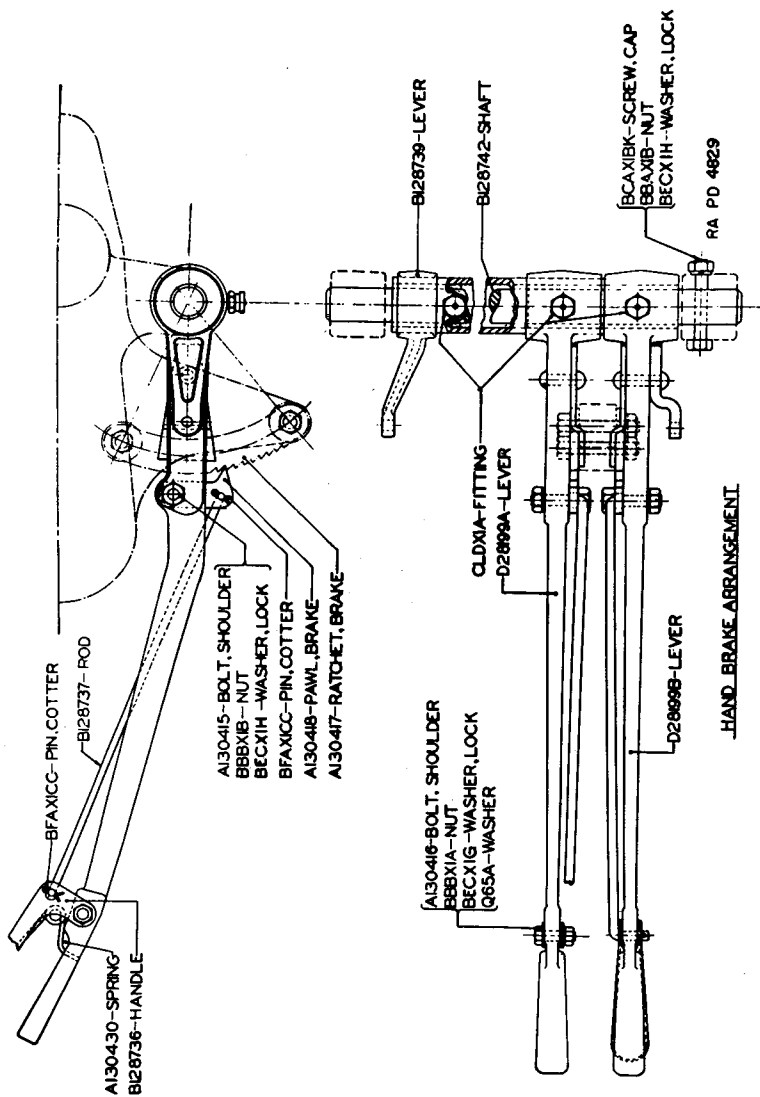


FIGURE 12.--Hand brake arrangement--75-mm gun carriage M1897A4.

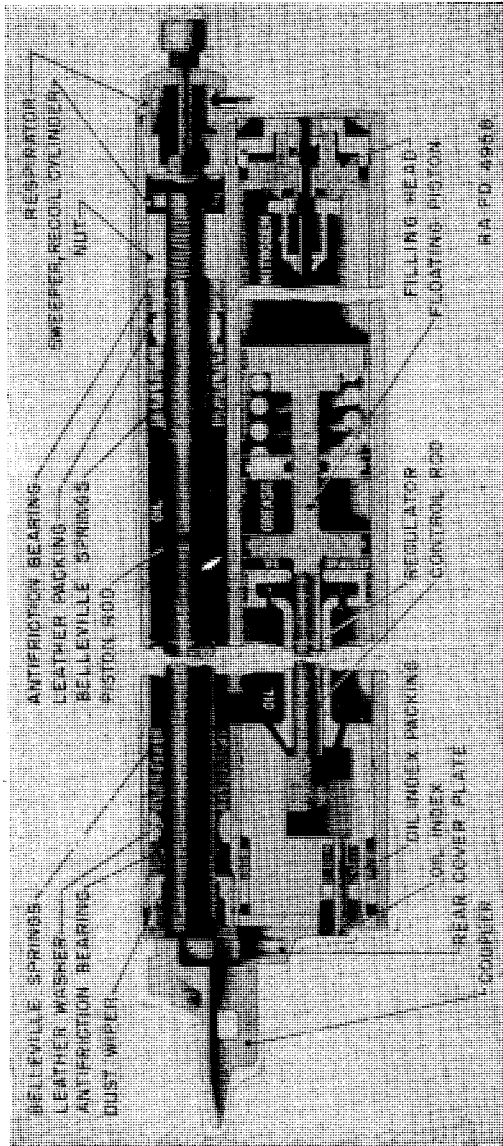


FIGURE 13.—Schematic diagram of recoil mechanism for 75-mm gun carriage M1897, all types.

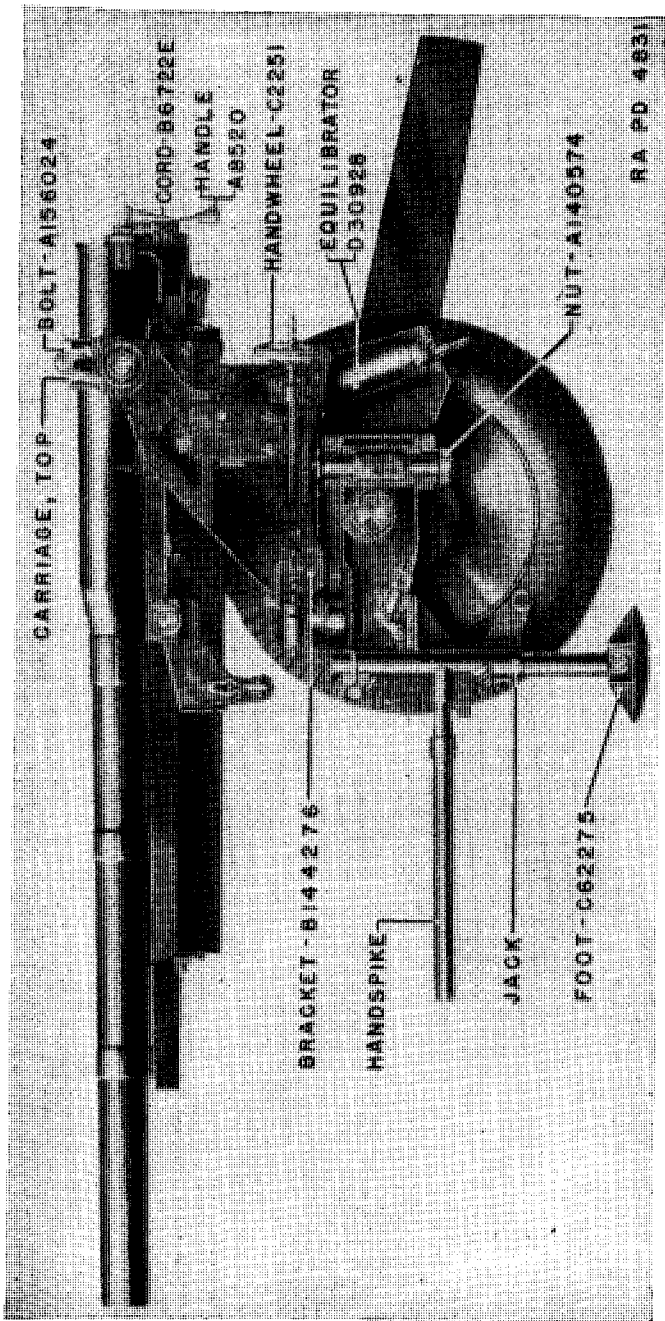


FIGURE 14.—75-mm gun carriage M2—left elevation.

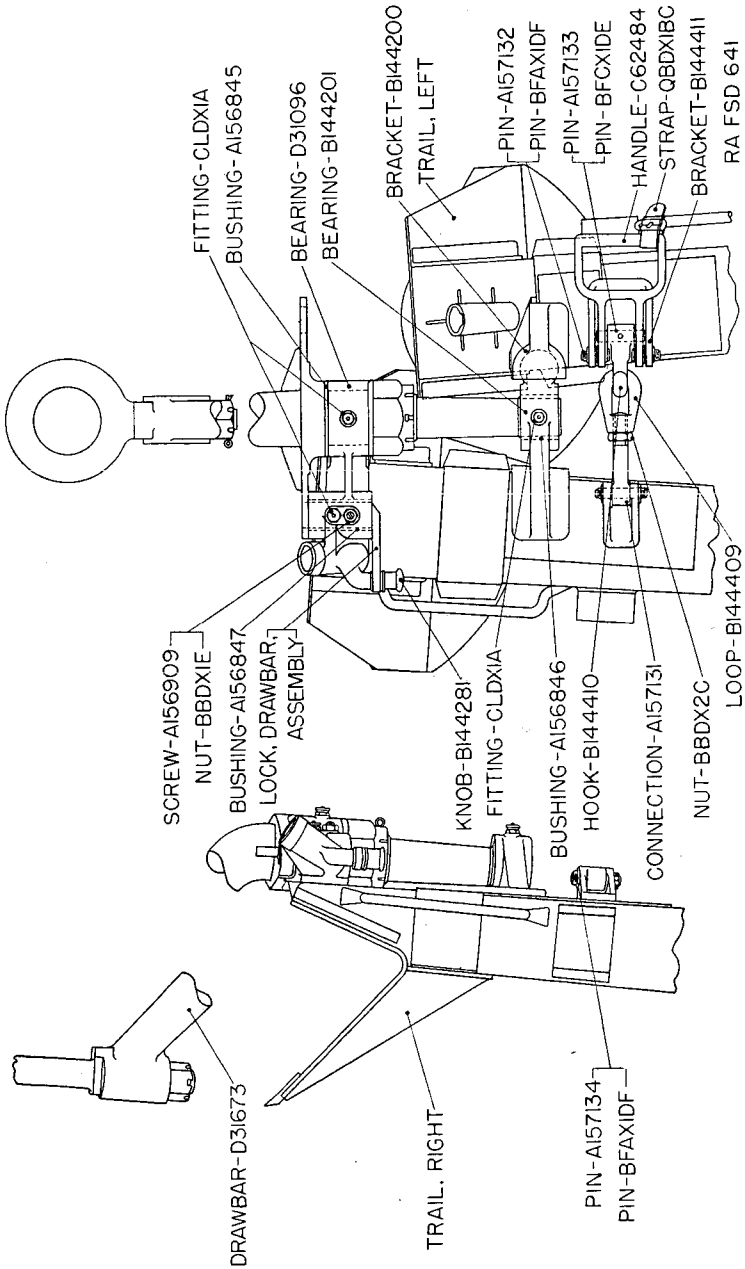
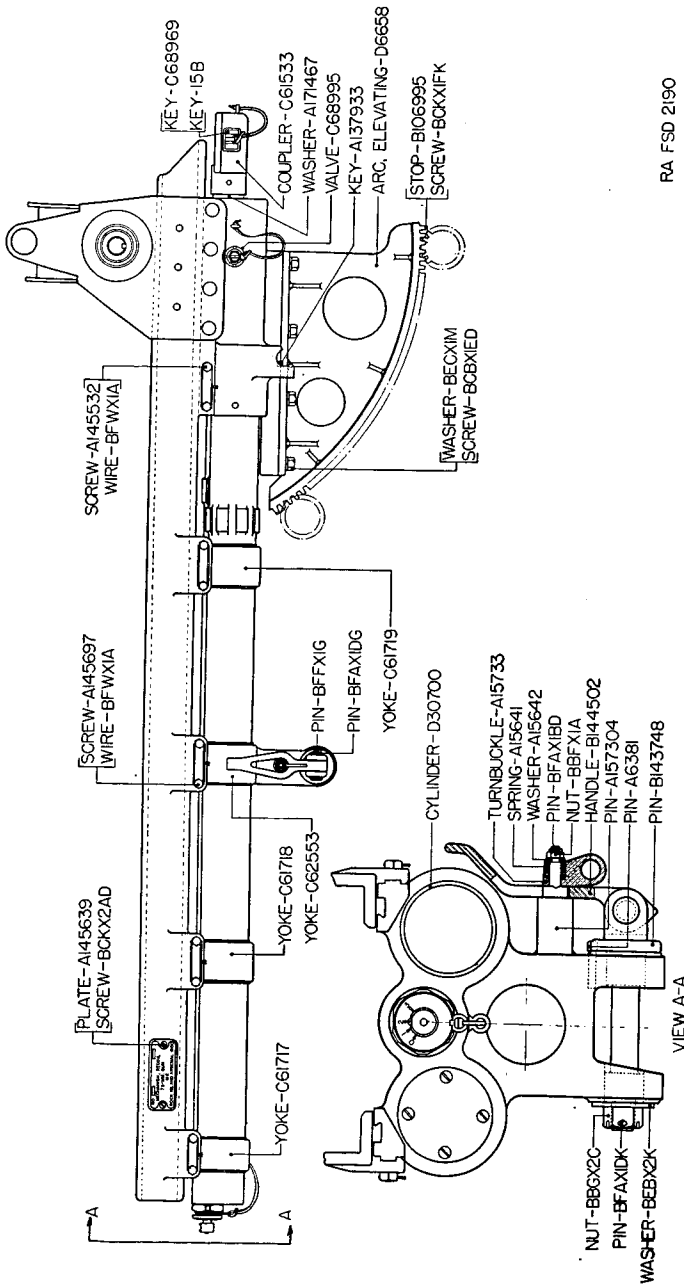
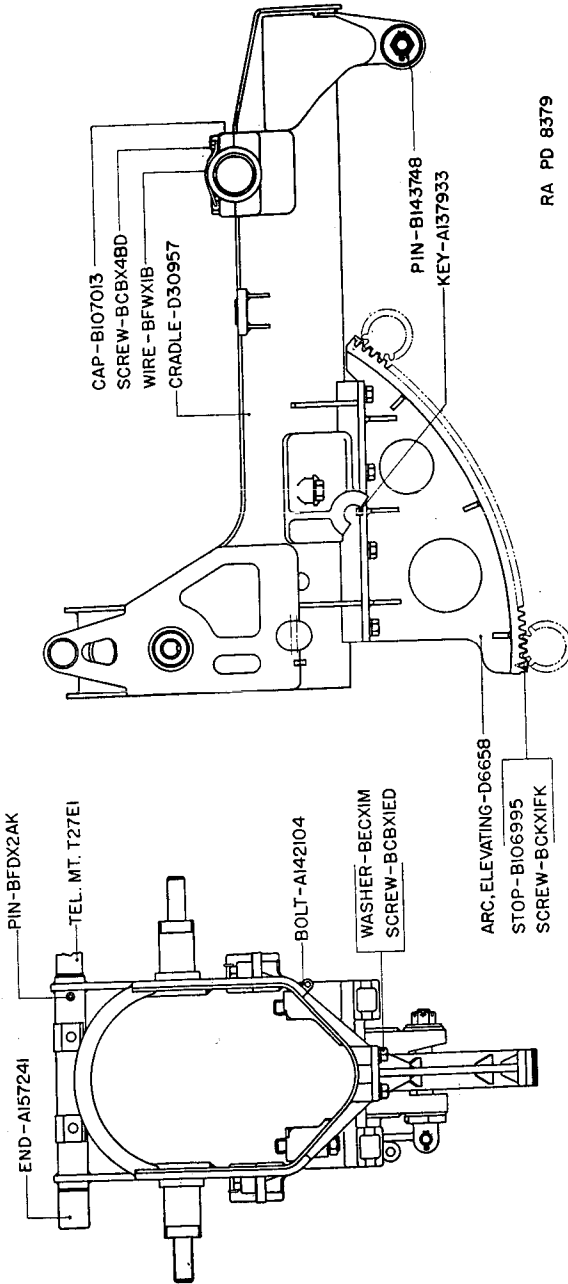


Figure 15.—Trail and spades.



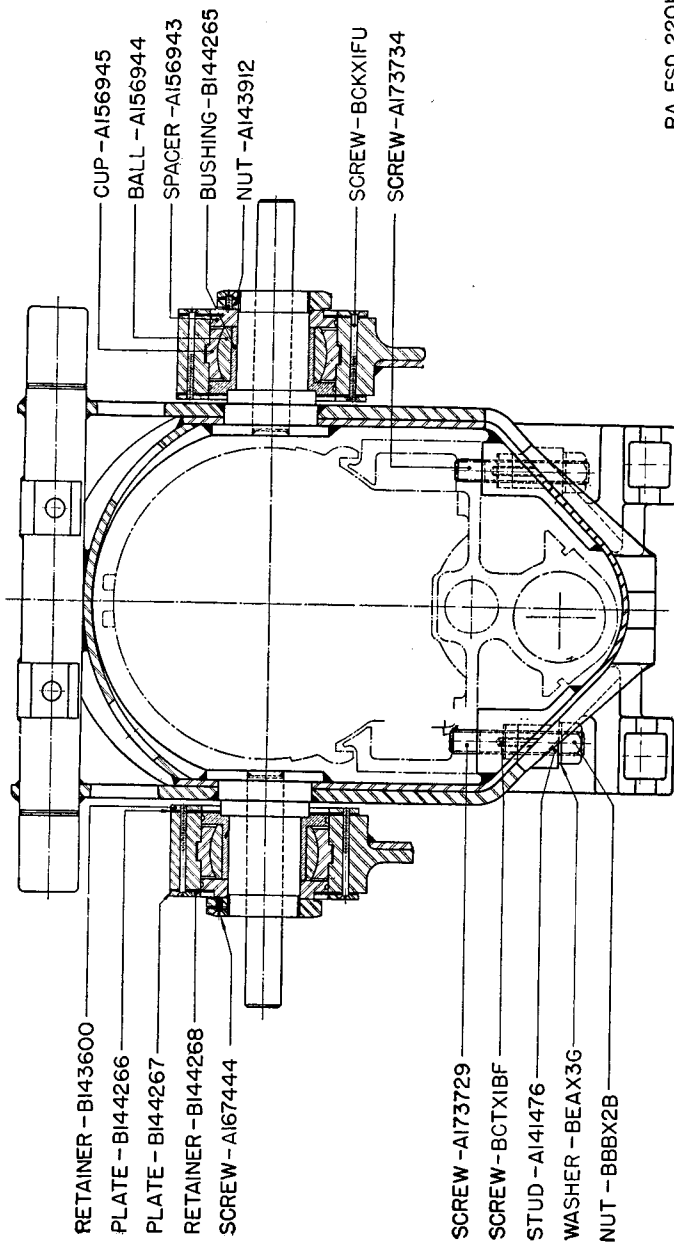
RA FSD 2190

Figure 16. Mechanism, recoil, 75-mm gun, M2.



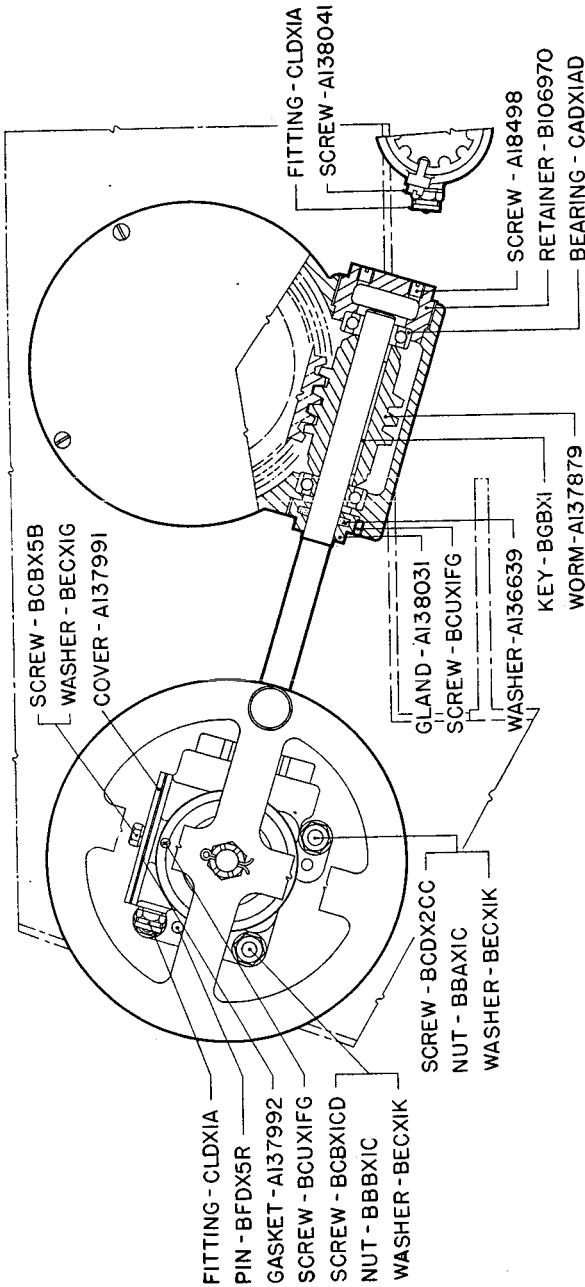
RA PD 8379

FIGURE 17.—Cradle and arc-elevating.



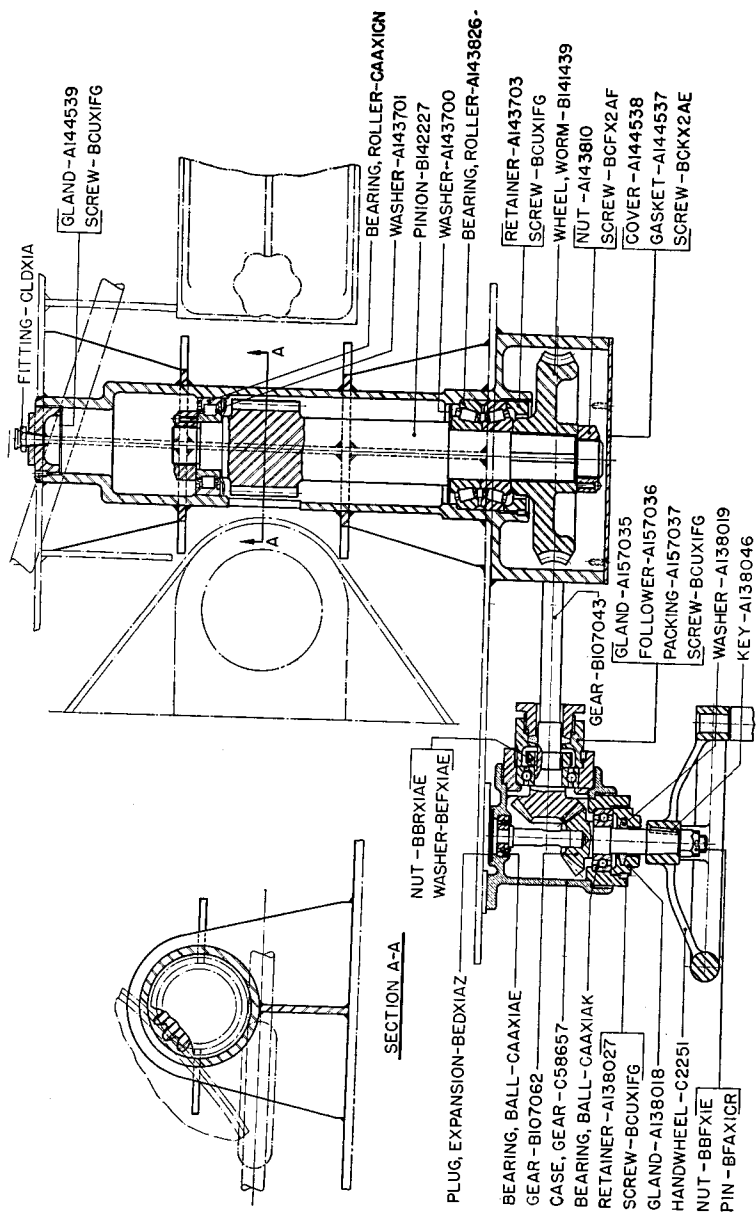
RA FSD 2201

FIGURE 18.—Trunnions.



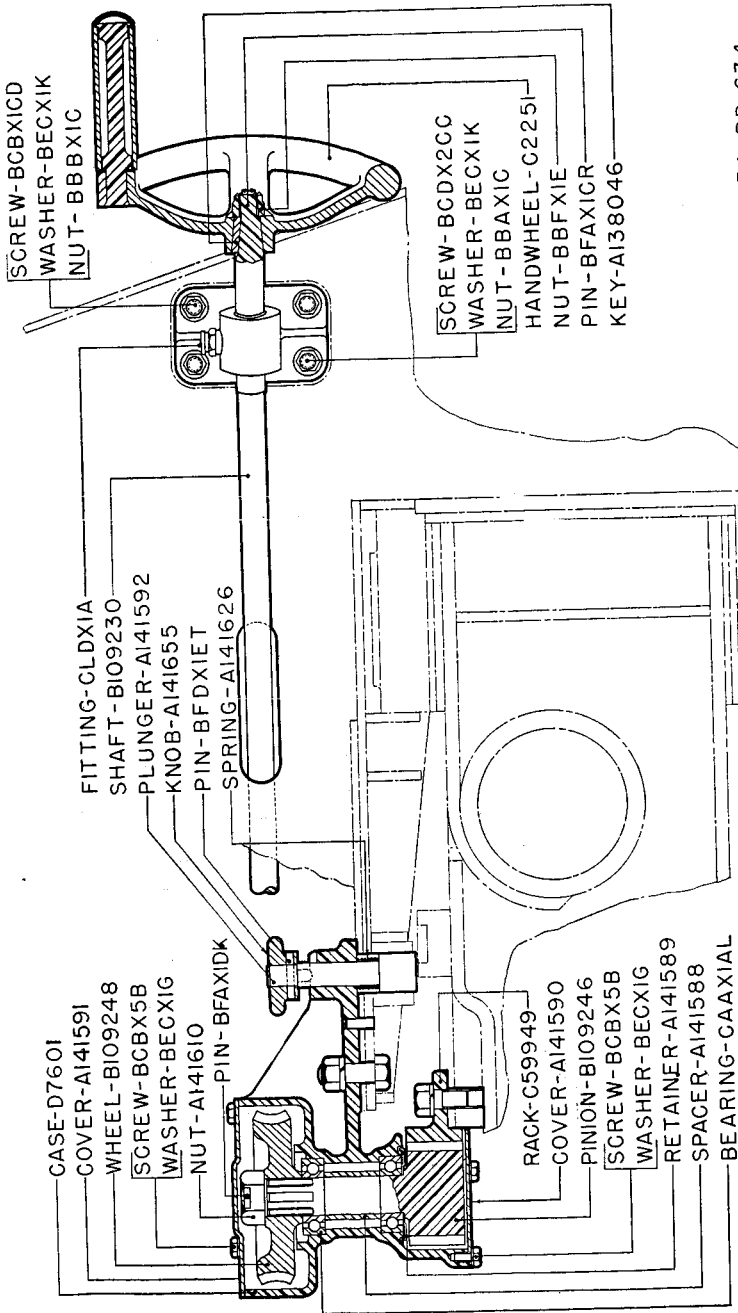
RA PD 734I

FIGURE 19.—Elevating mechanism.



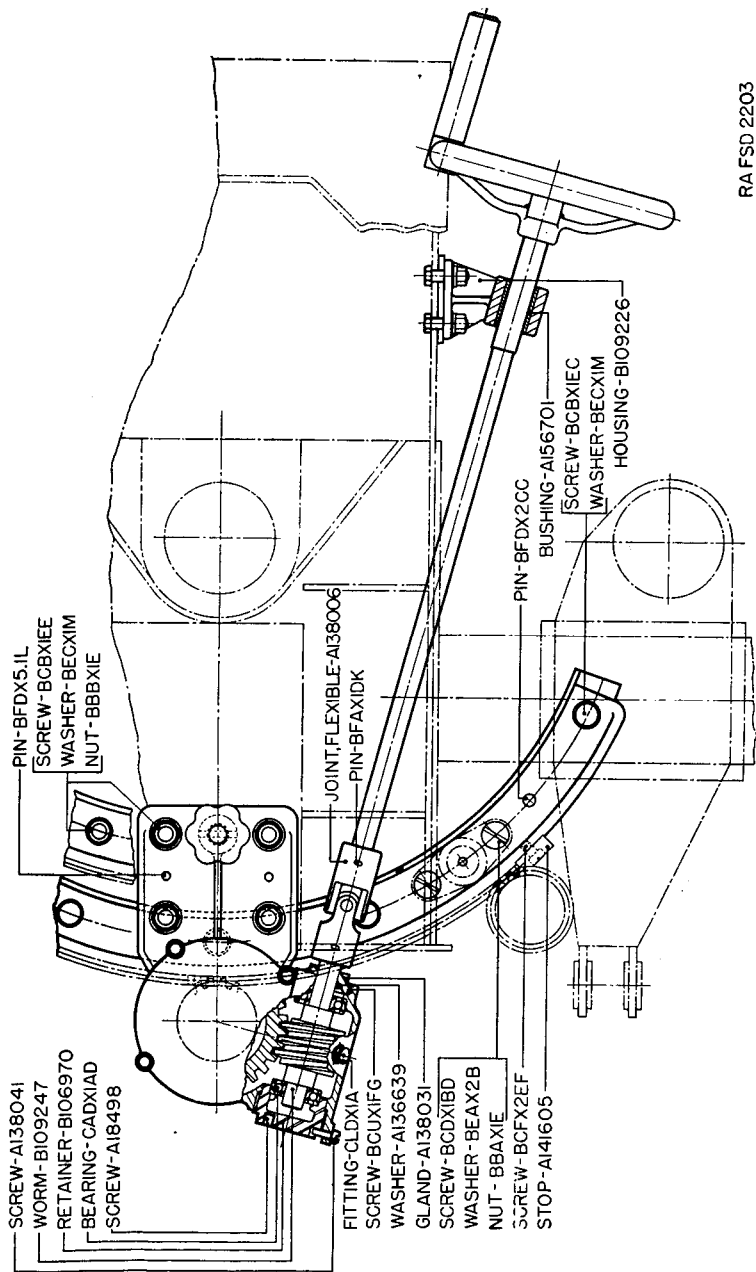
RA FSD 2202

FIGURE 20.—Elevating mechanism—sectioned views.



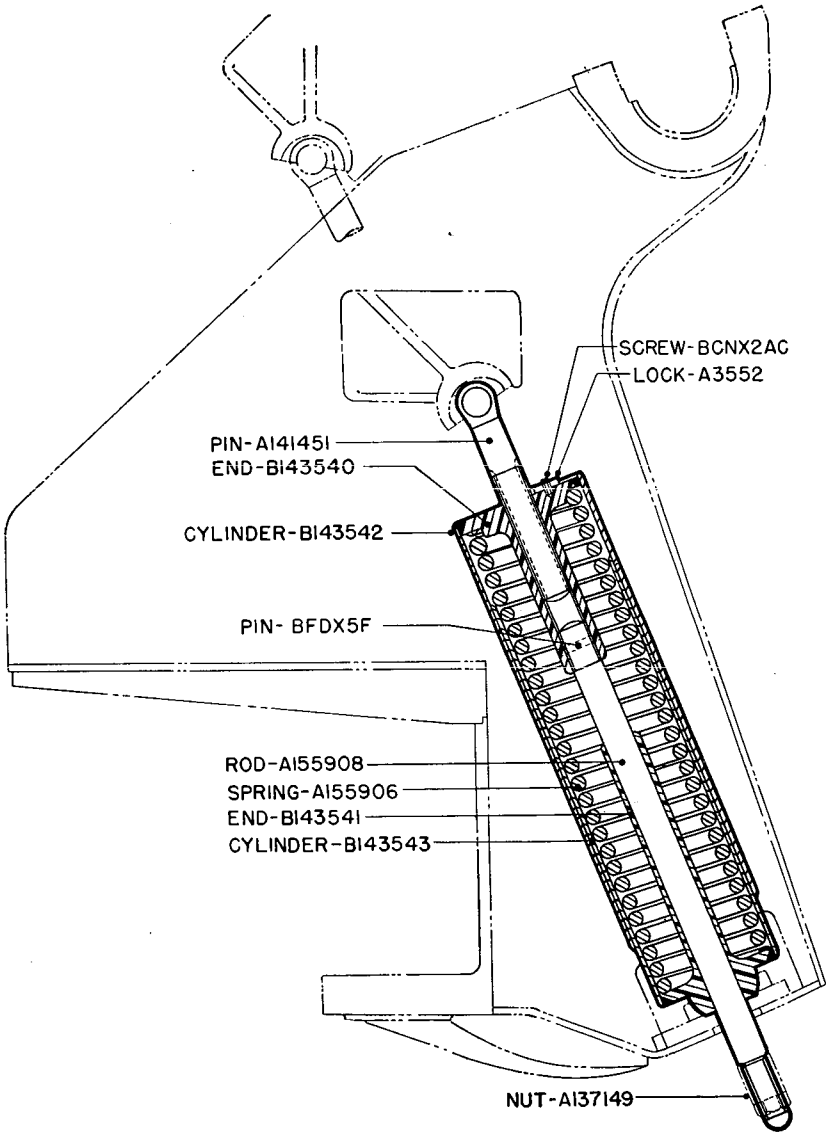
RA PD 634

FIGURE 21.—Traversing mechanism.



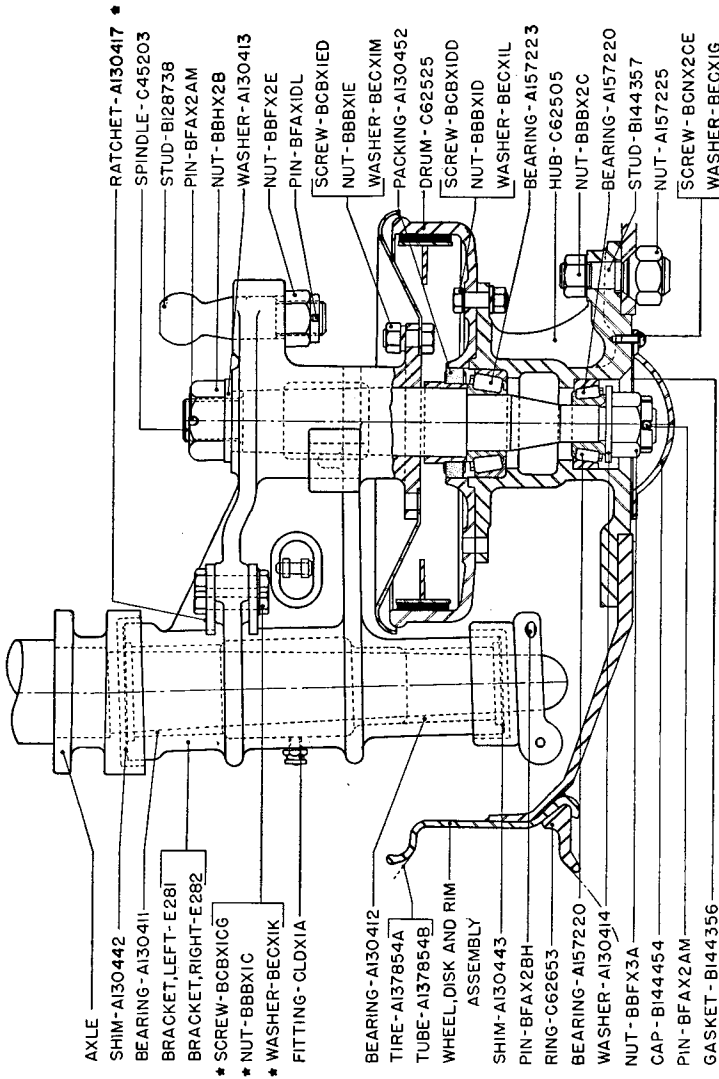
RAFSD 2203

FIGURE 22.—Traversing mechanism—sectioned views.



RA PD 638

FIGURE 23.—Equilibrator assembly.



* USED ON LEFT SIDE ONLY

Figure 24.—Brake and axle bracket, R. H., group assembly—75-mm gun carriage M1897A4.

RA FSD 2206

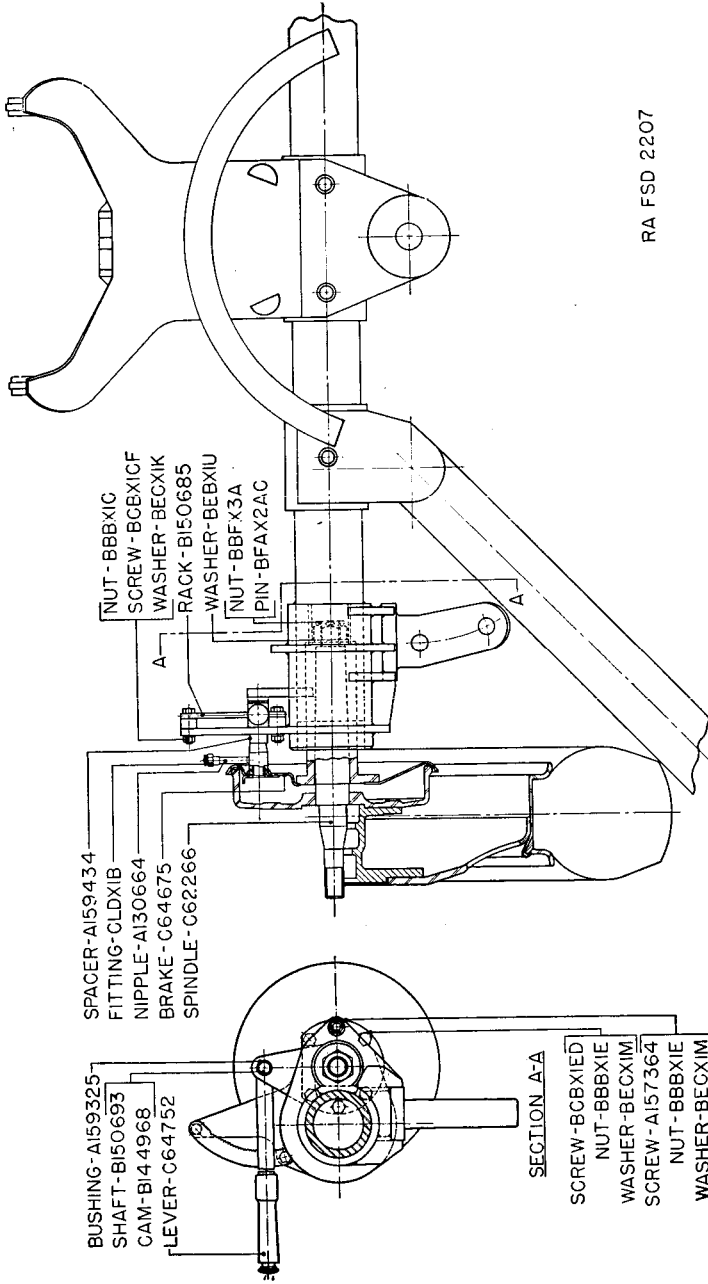
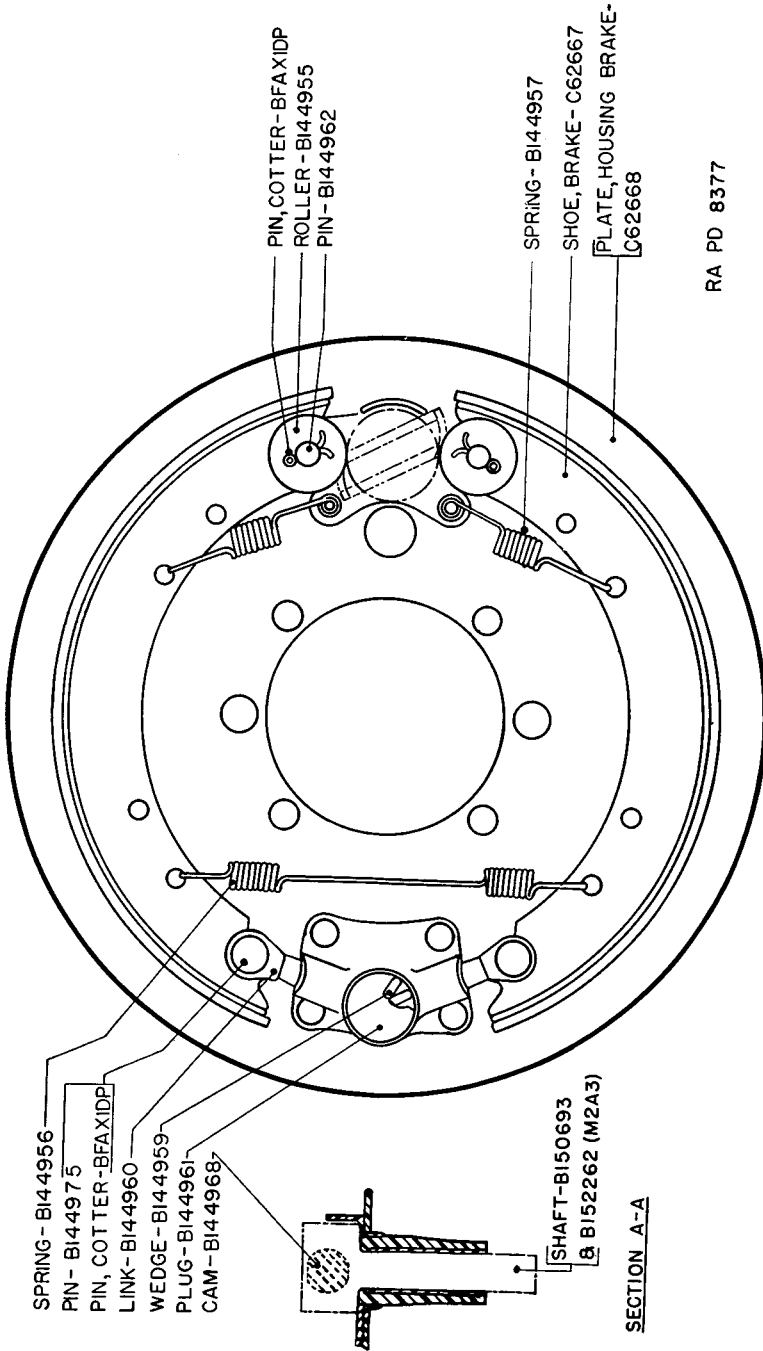


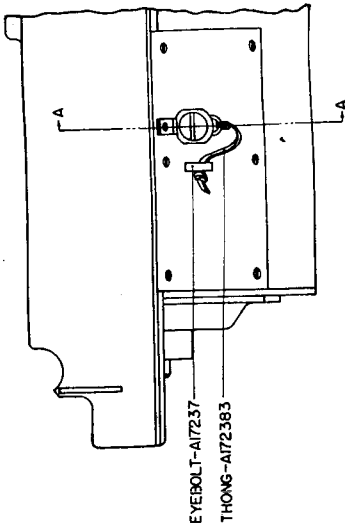
Figure 25.—Brake and axle.



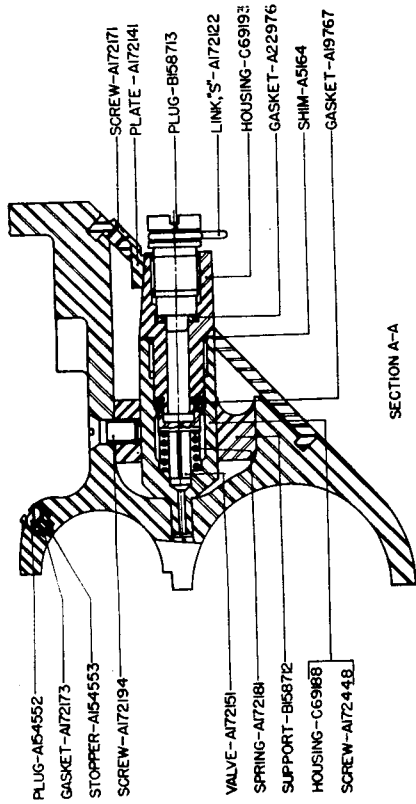
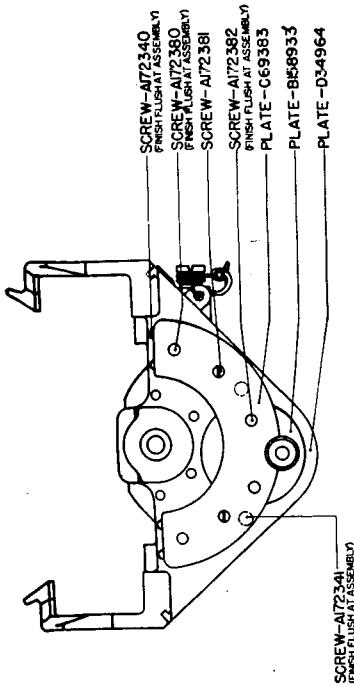
RA PD 8377

FIGURE 26. Brake assembly.

SECTION A-A



RA PD 4824



VALVE OIL FILLING

SECTION A-A

FIGURE 27.—Recoil mechanism, filling and drain mechanism.

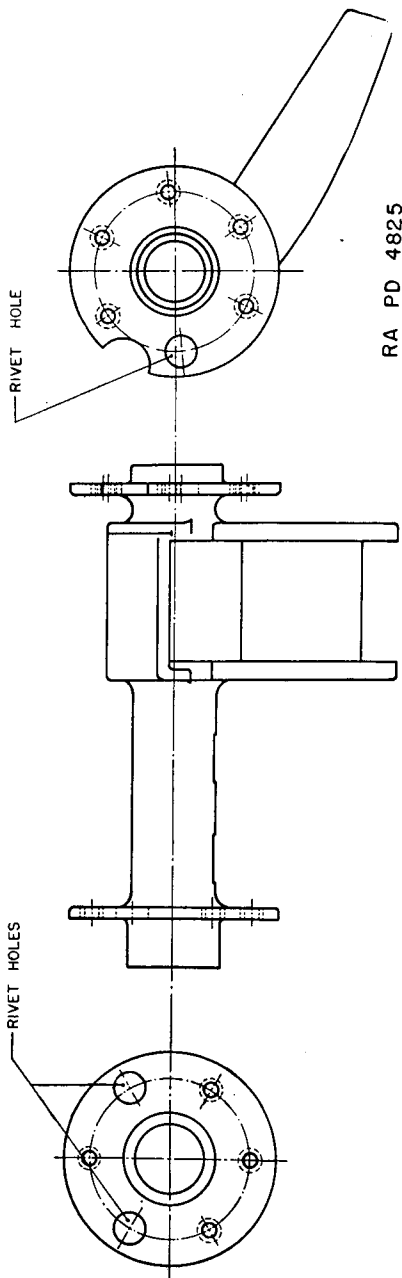


FIGURE 28.—Angle of site worm gear shaft housing, 75-mm gun M1897.

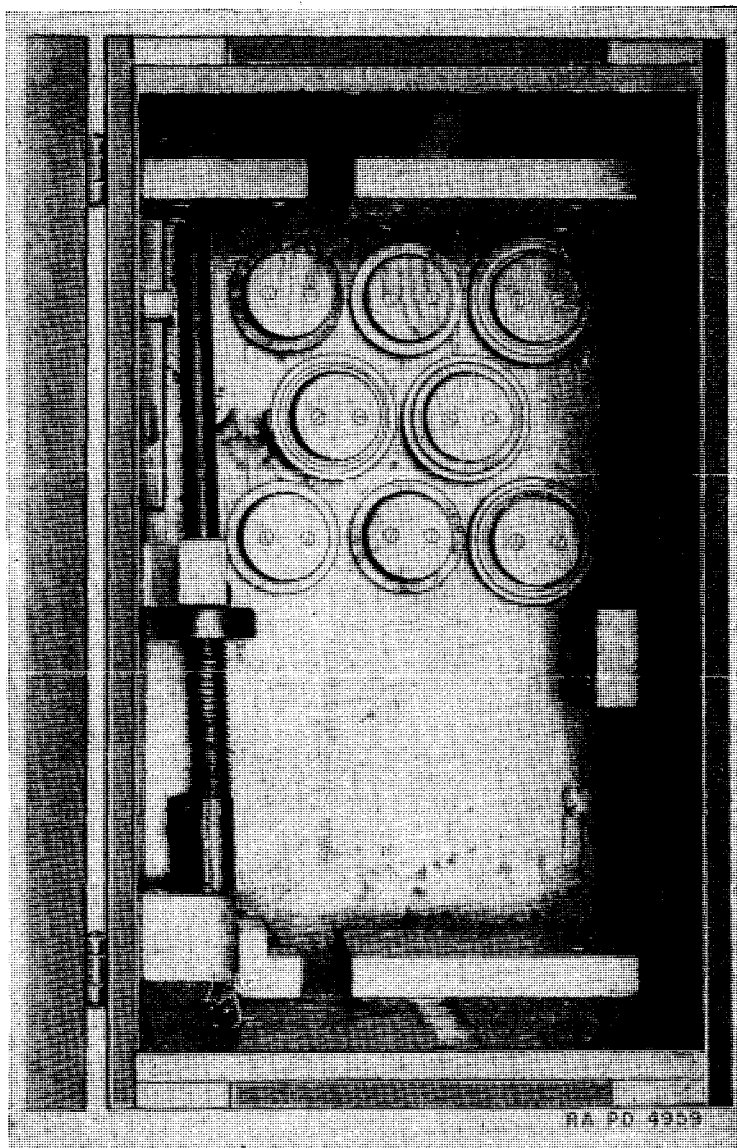


FIGURE 29.—Special repair tool chest, arrangement of tools in bottom of chest (without metal trays).

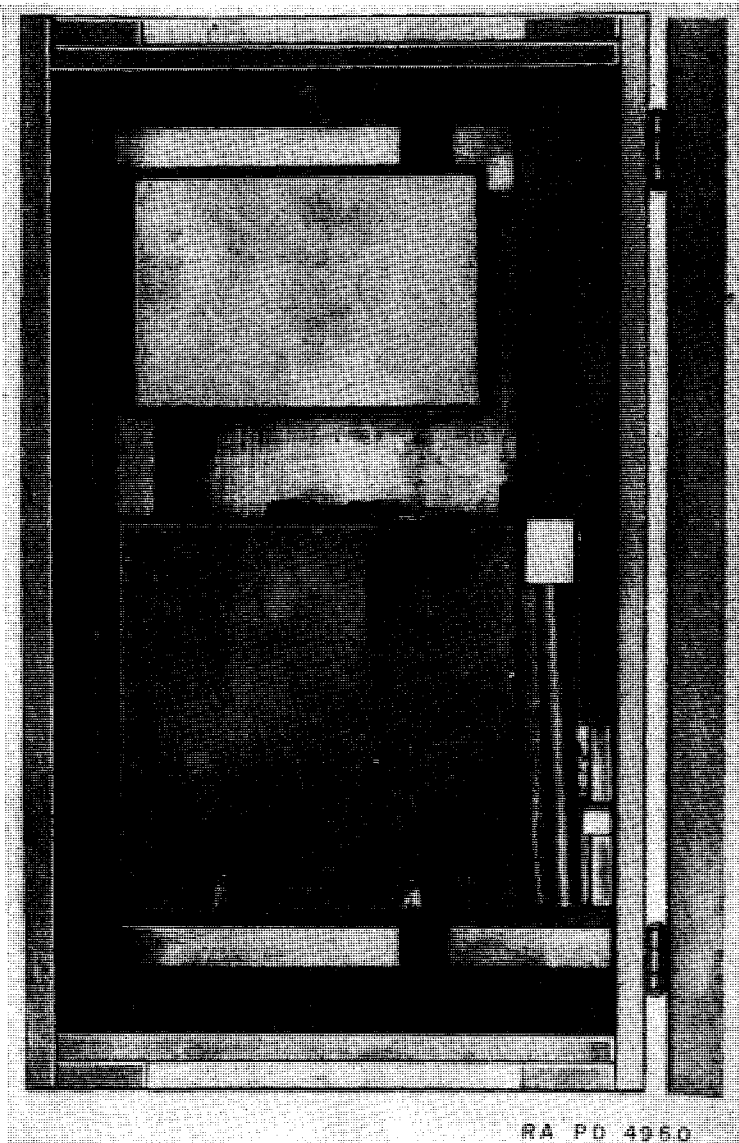


FIGURE 30.—Special repair tool chest, arrangement of tools in bottom of chest (with metal trays).

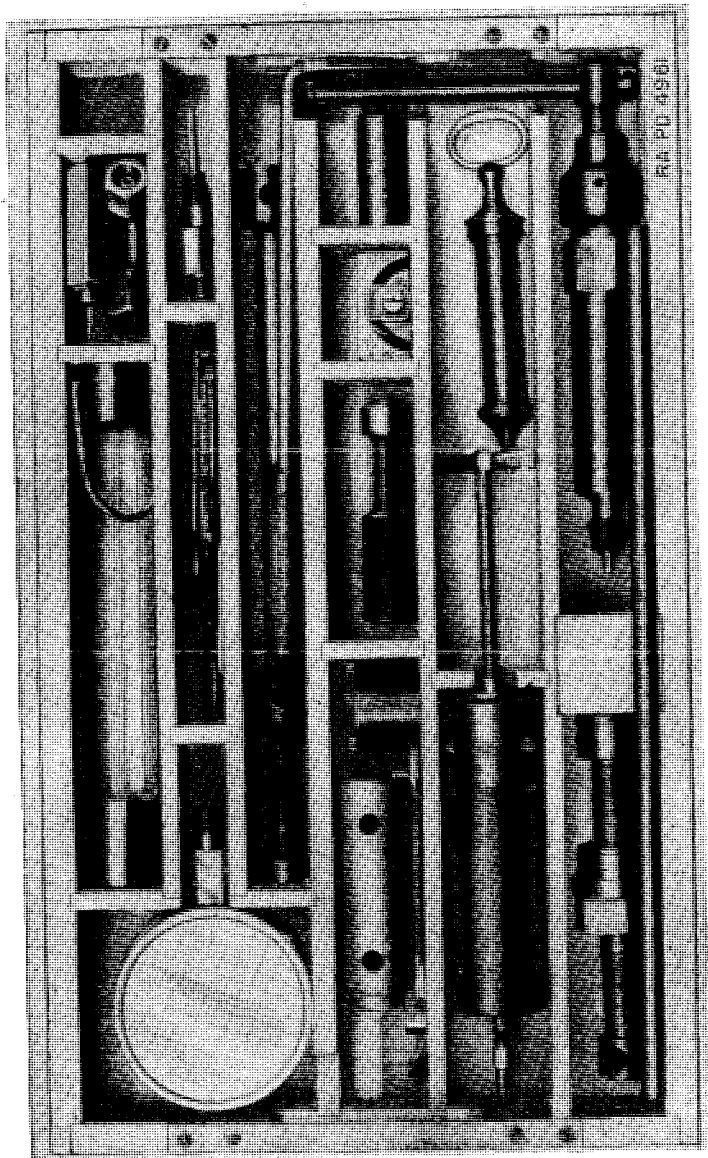


FIGURE 31.—Special repair tool chest, arrangement of tools in lower tray.

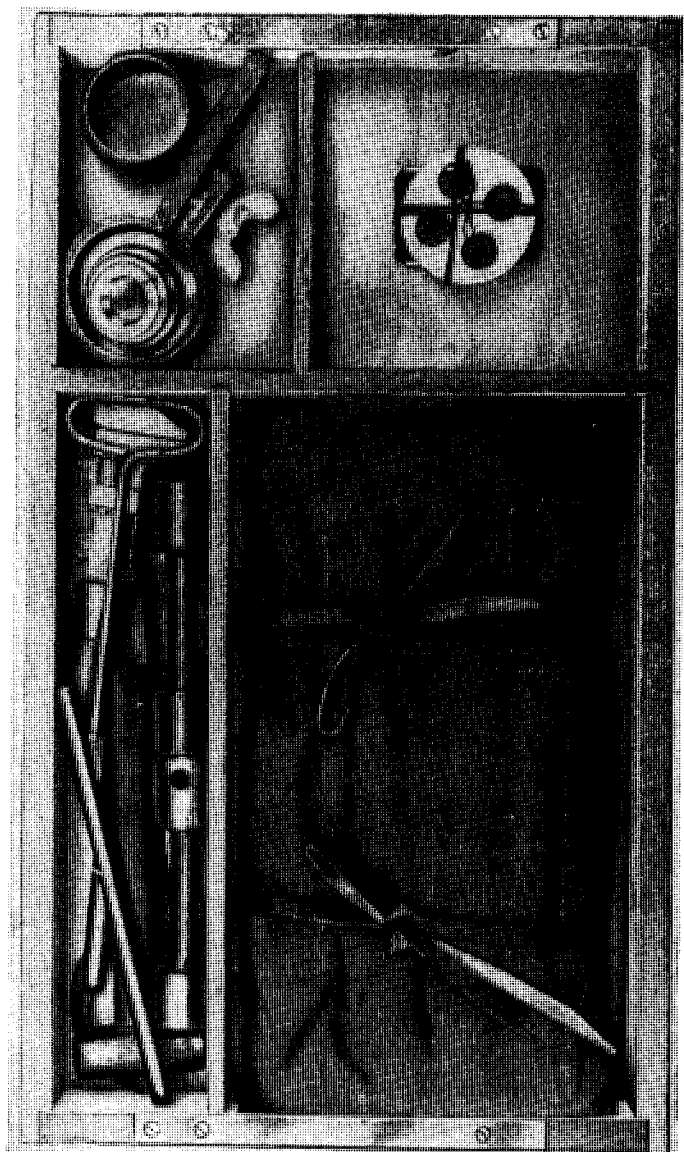
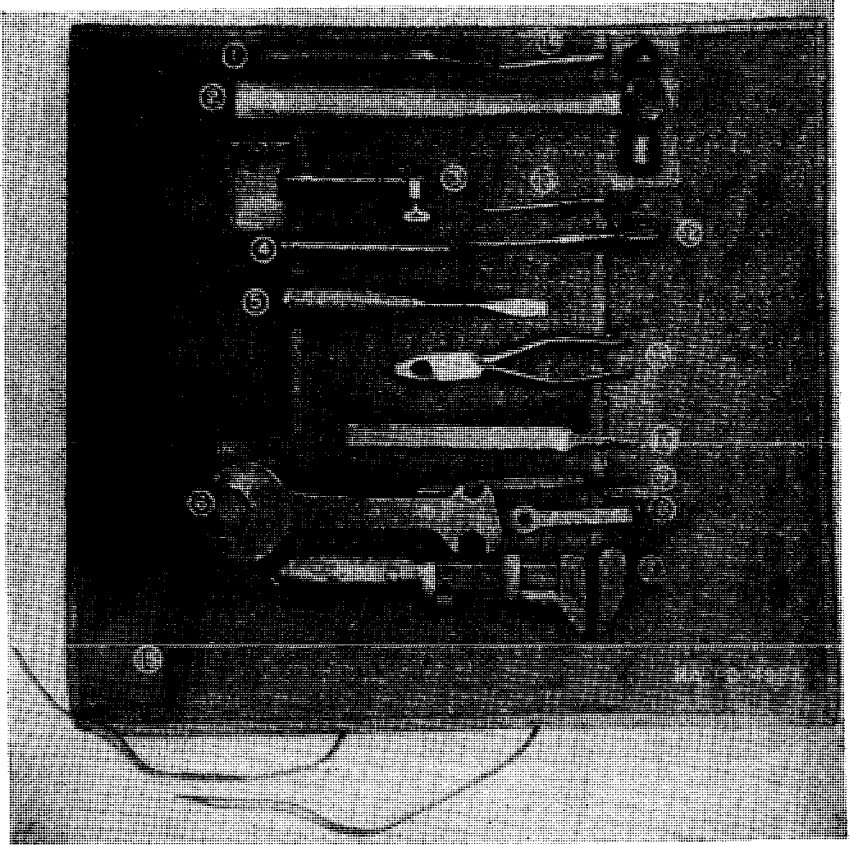


FIGURE 32.—Special repair tool chest, arrangement of tools in upper tray.



1. Chisel, machinists', cold, $\frac{3}{4}$ inch.
2. Hammer, machinists', ball-peen, $1\frac{1}{4}$ pound.
3. Handle, file, $1\frac{1}{4}$ by $4\frac{1}{4}$ inches.
4. Drift, tapered, br. $\frac{3}{4}$ by 6 inches.
5. Screw driver, extra-heavy-duty, with insert handle, $4\frac{1}{2}$ inches.
6. Wrench (no longer issued).
7. Wrench, screw, monkey, knife-handle.
8. Screw driver (no longer issued).
9. File, three-square, smooth.
10. File, hand, section.
11. Plier, side-cutting, flat nose.
12. Screw driver, common.
13. Punch, drive-pin. $\frac{1}{8}$ point, 5 inches long.
14. Drift, tapered, br. $\frac{1}{2}$ by 4 inches.
15. Roll, tool, M4.

FIGURE 33.—Tool roll with contents.

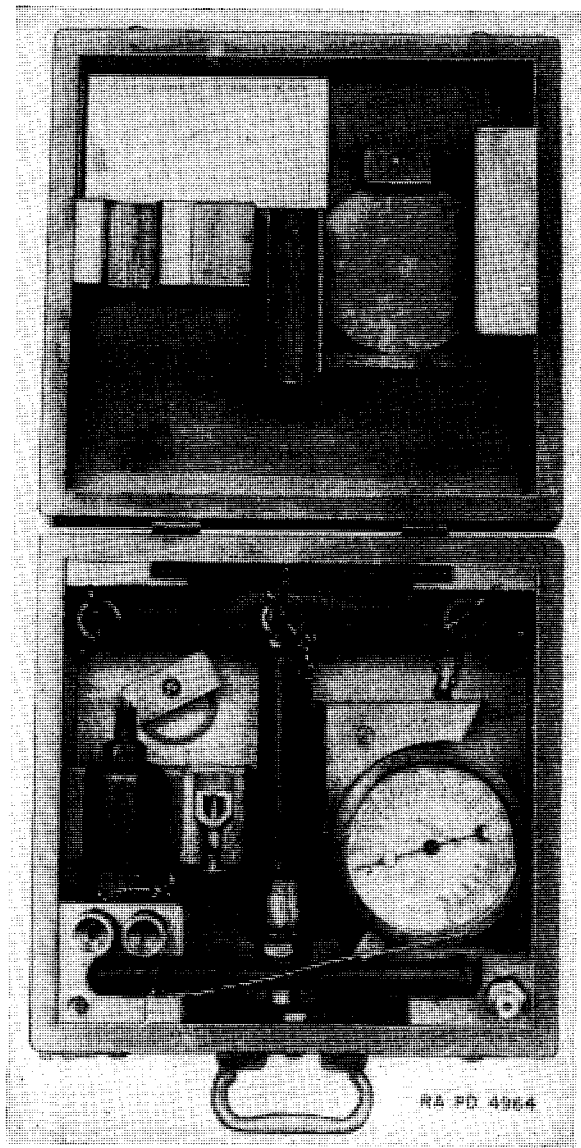


FIGURE 34.—Pressure gage tester chest, arrangement of contents.

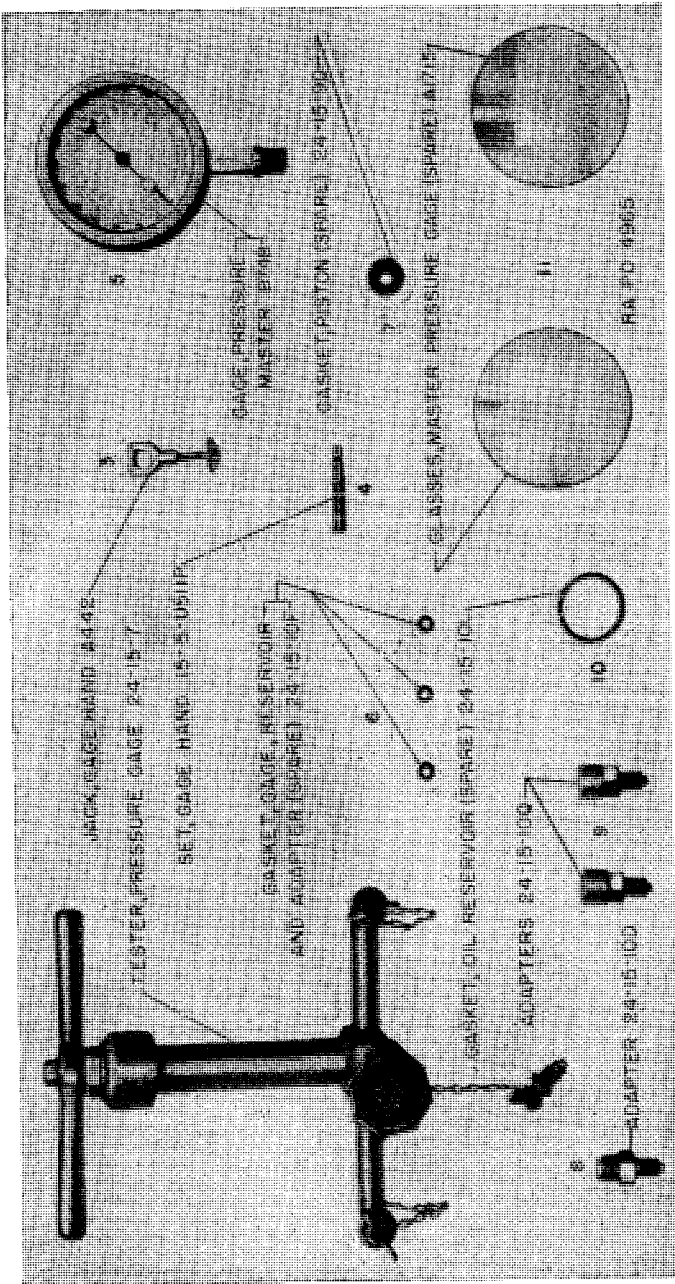


FIGURE 33.—Tools and spare parts for testing and repairing pressure gage M1923.

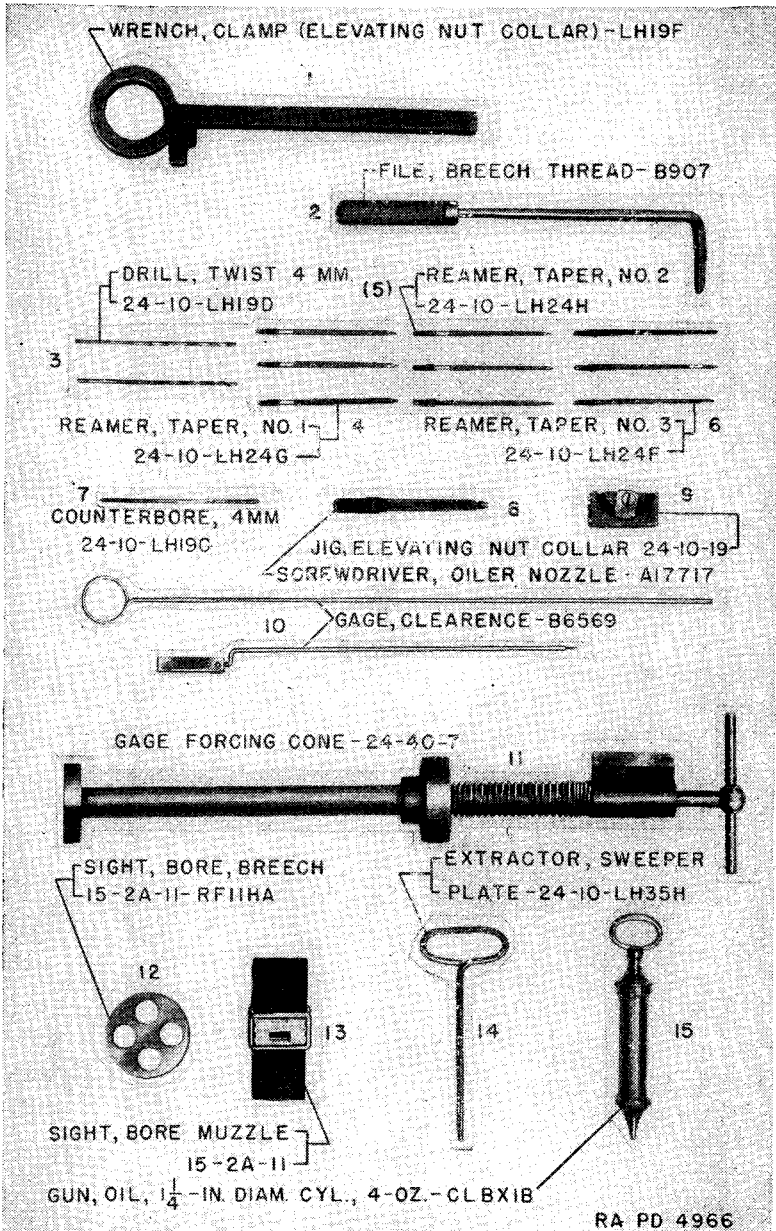
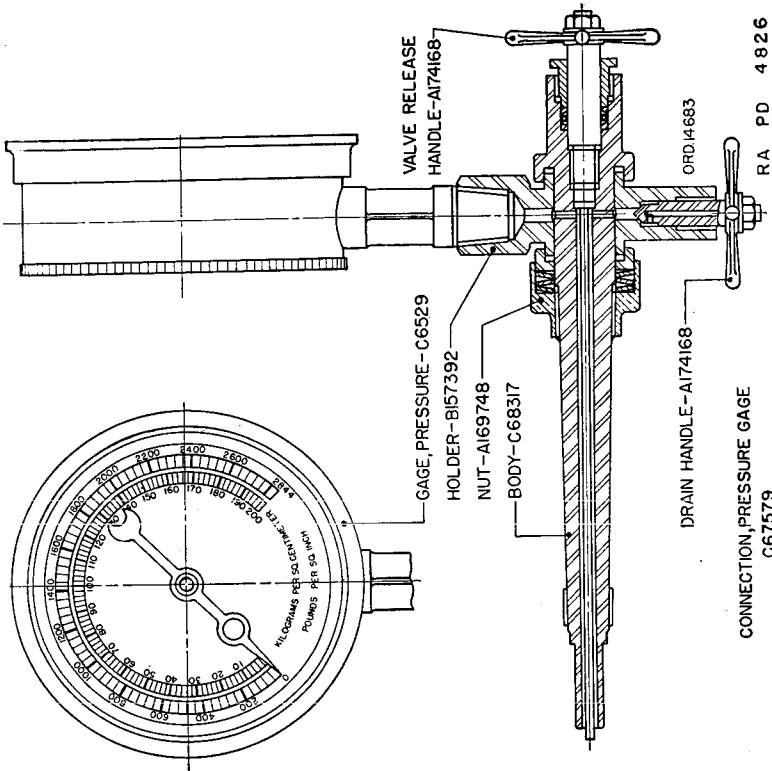
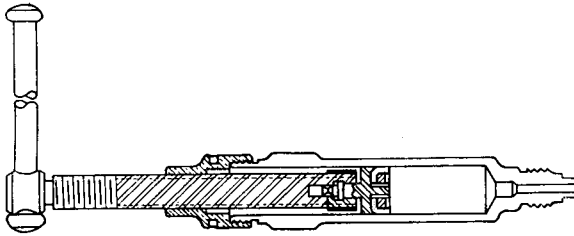


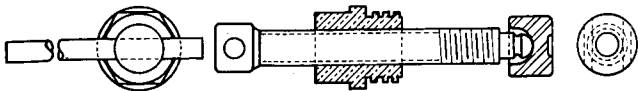
FIGURE 36.—Tools used for inspection and maintenance of gun and elevating nut collar.



RA PD 4826
 CONNECTION, PRESSURE GAGE
 C67579



FILLER, OIL SCREW
 15-5-373



JACK, RECOIL PISTON
 24-13-41

FIGURE 37.—Tools used for testing recoil mechanism.

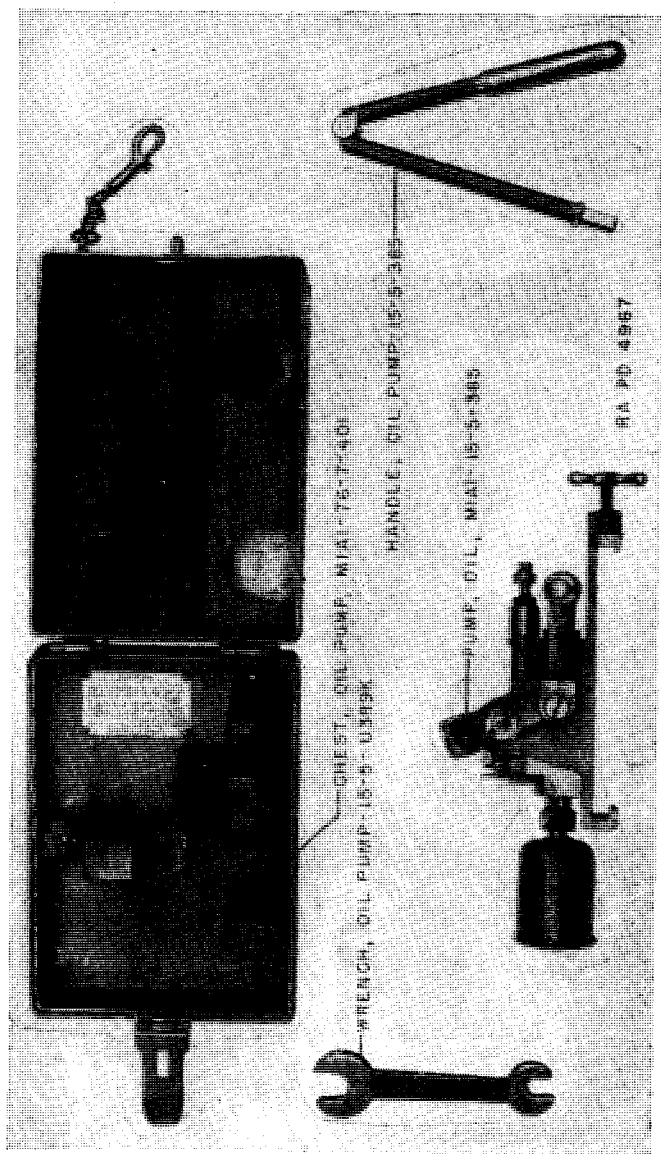


FIGURE 38.—Oil pump chest and contents.

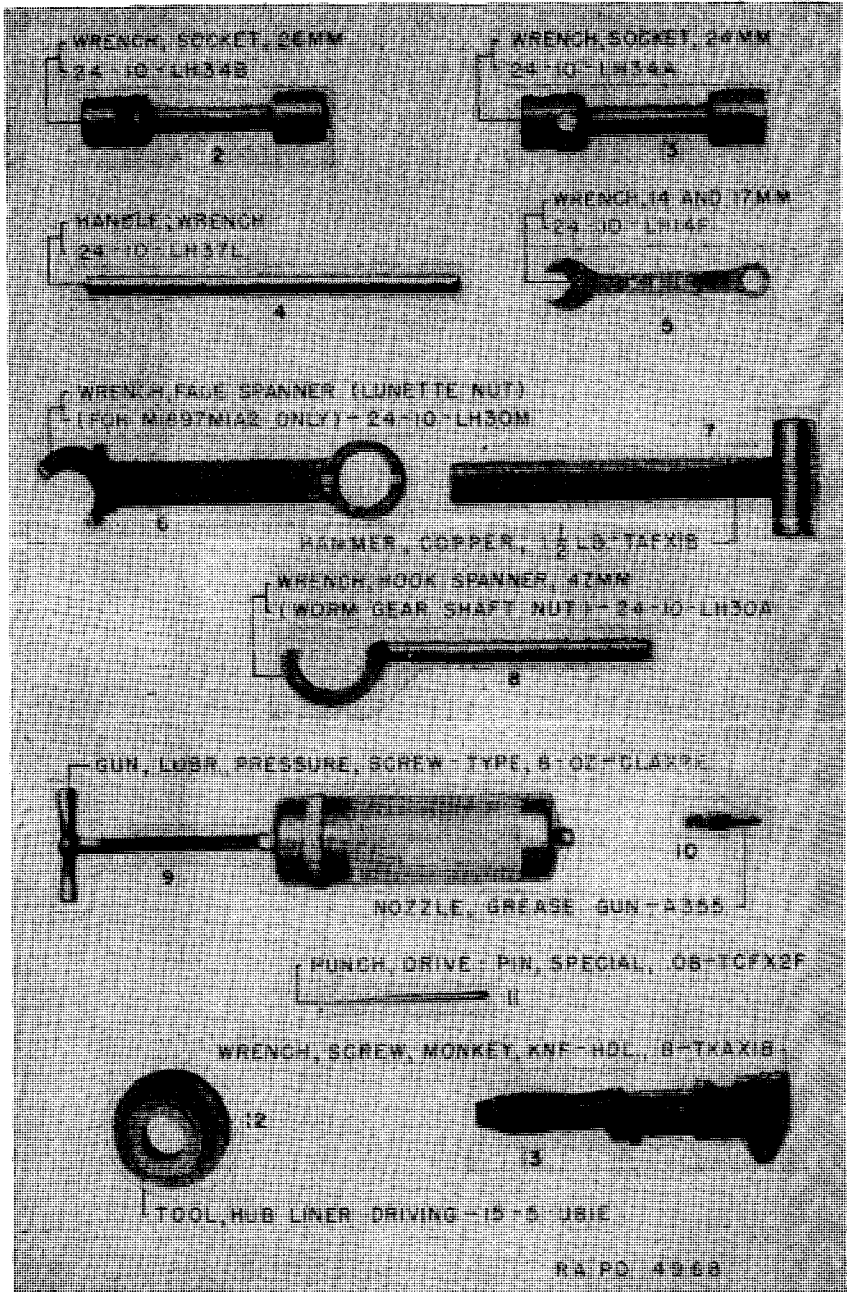


FIGURE 39.—Tools used for maintenance of carriage.

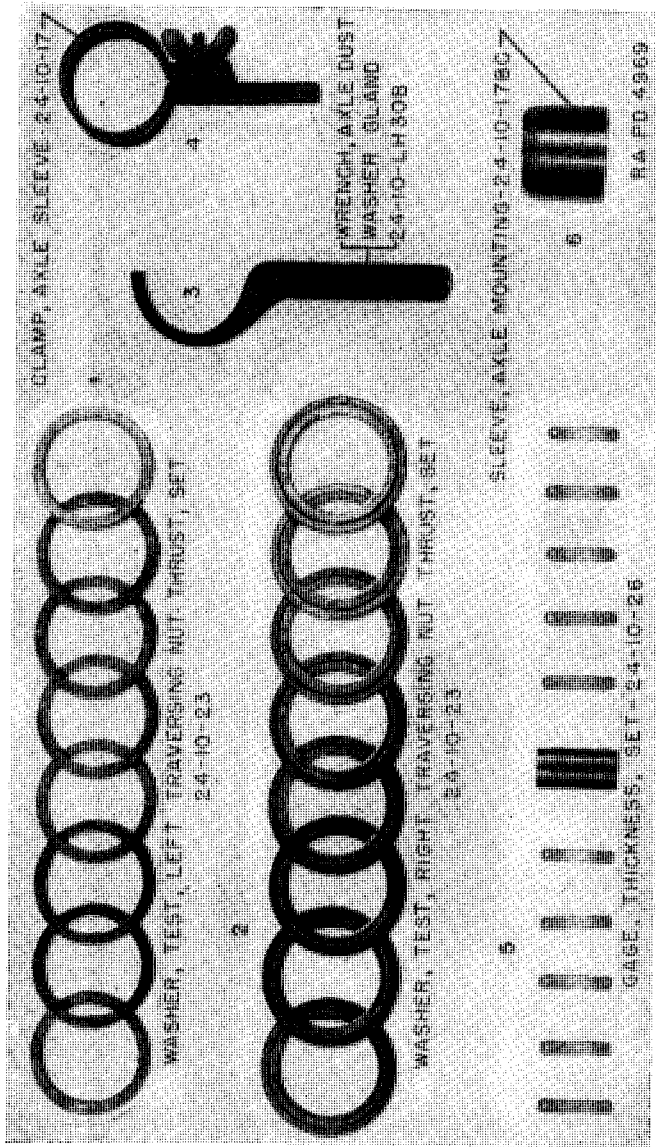
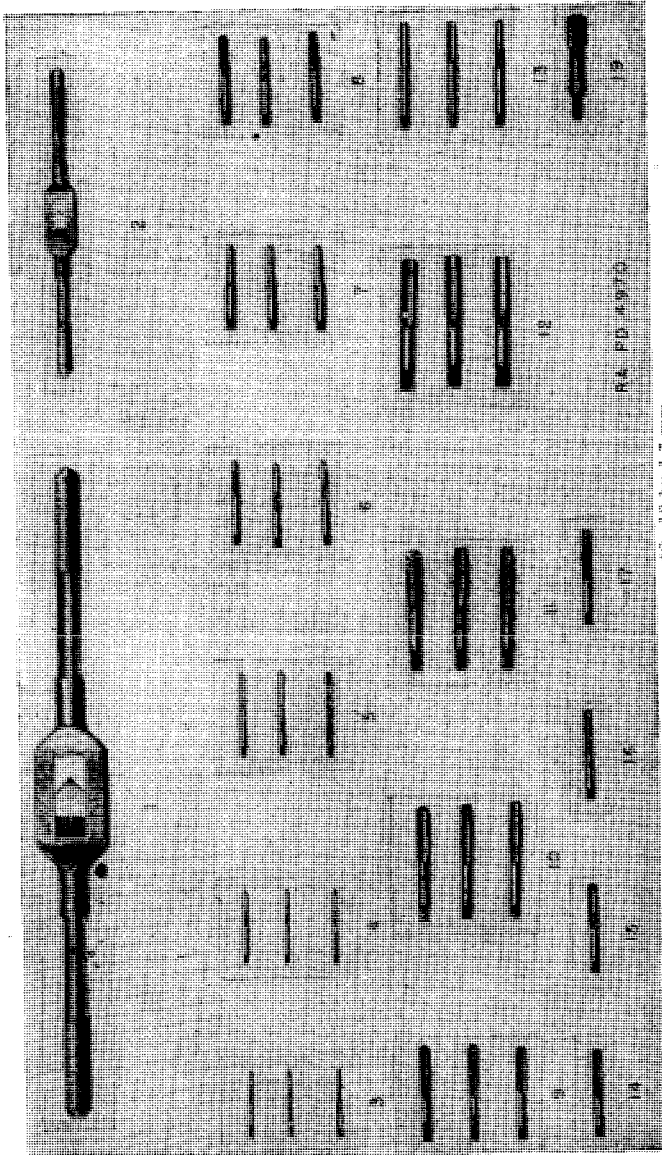


FIGURE 40.—Tools used on axle and traversing mechanism.



- 1 and 2. Wrench, tap and feather, adjustable.
- Taps, bottoming, plug and taper:
- 3. 3 by 0.5-mm.
 - 4. 4 by 0.5-mm.
 - 5. 5 by 1-mm.
 - 6. 6 by 1-mm.
 - 7. 7 by 1-mm.
 - 8. 8 by 1-mm.
 - 9. 10 by 0.5-mm.
 - 10. 12 by 1.5-mm.
 - 11. 14 by 2-mm.
 - 12. 16 by 2-mm.
 - 13. 8 by 1-mm (long).
 - 14. Taps: 8.2 by 1-mm retapping.
 - 15. 8.4 by 1-mm retapping.
 - 16. 8.6 by 1-mm retapping.
 - 17. 10.1 by 1-mm retapping.
 - 18. 16 by 1.5-mm (PX) filling and drain plug hole).
 - 19. 16 by 1.5-mm (PX) filling and drain plug hole).

Figure 41.—Taps and tap wrenches.

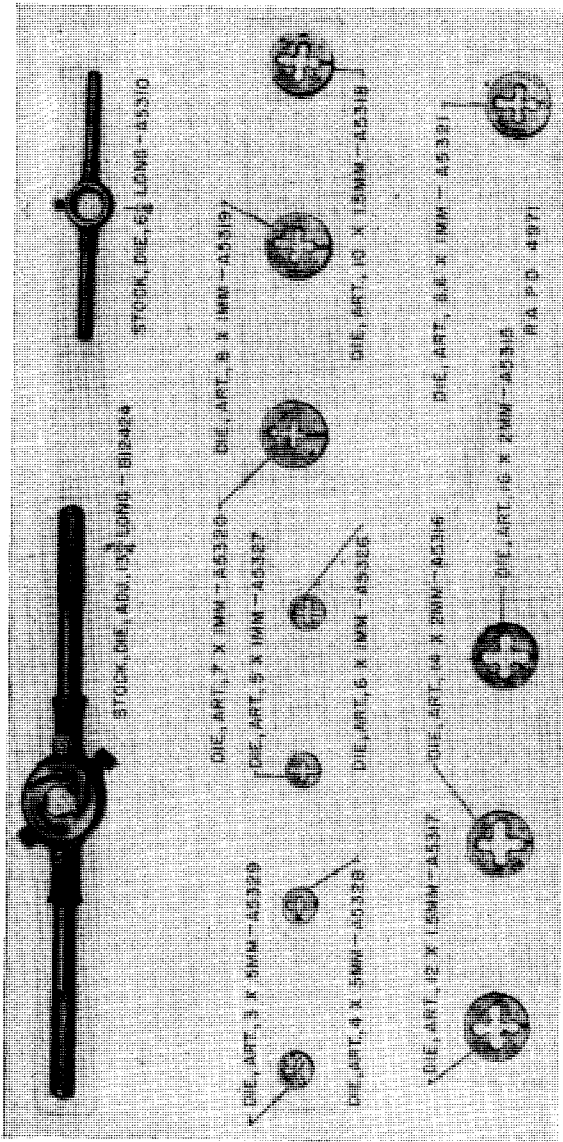


Figure 42. - Dies and stocks.

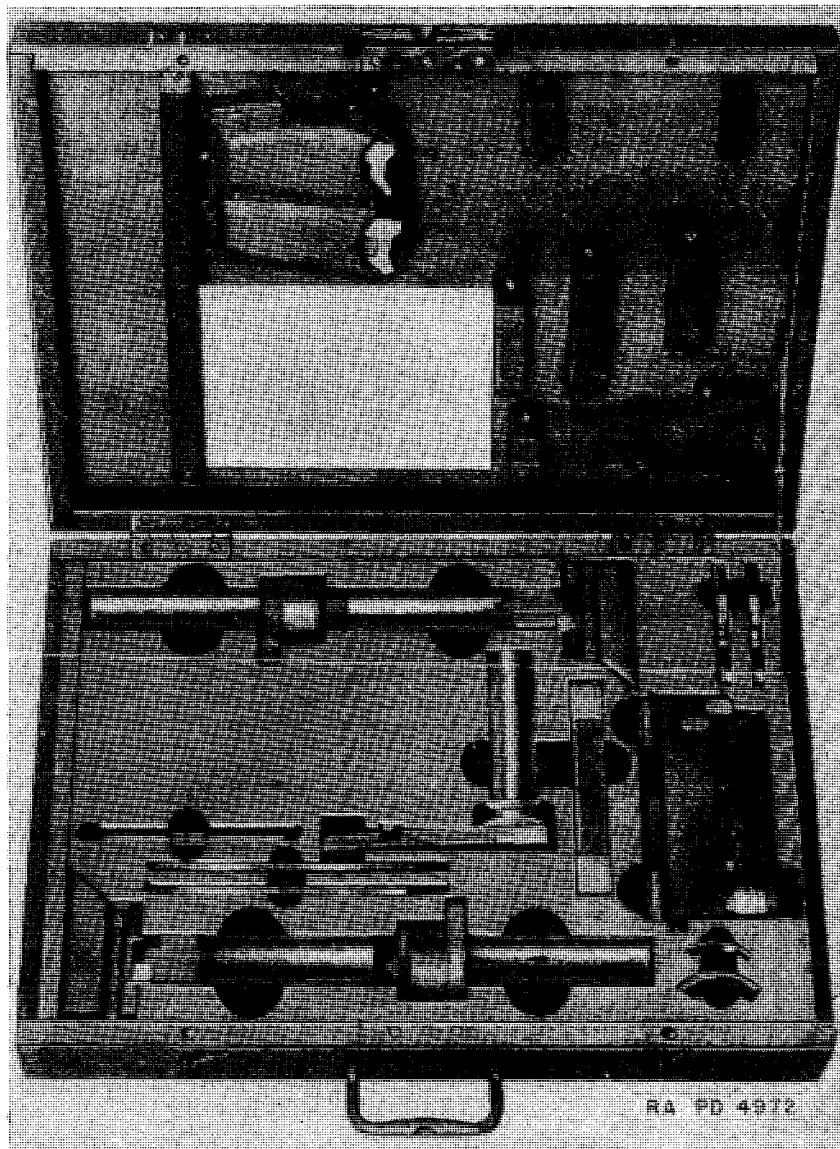


FIGURE 43.—Arrangement of contents in sight testing tool chest.

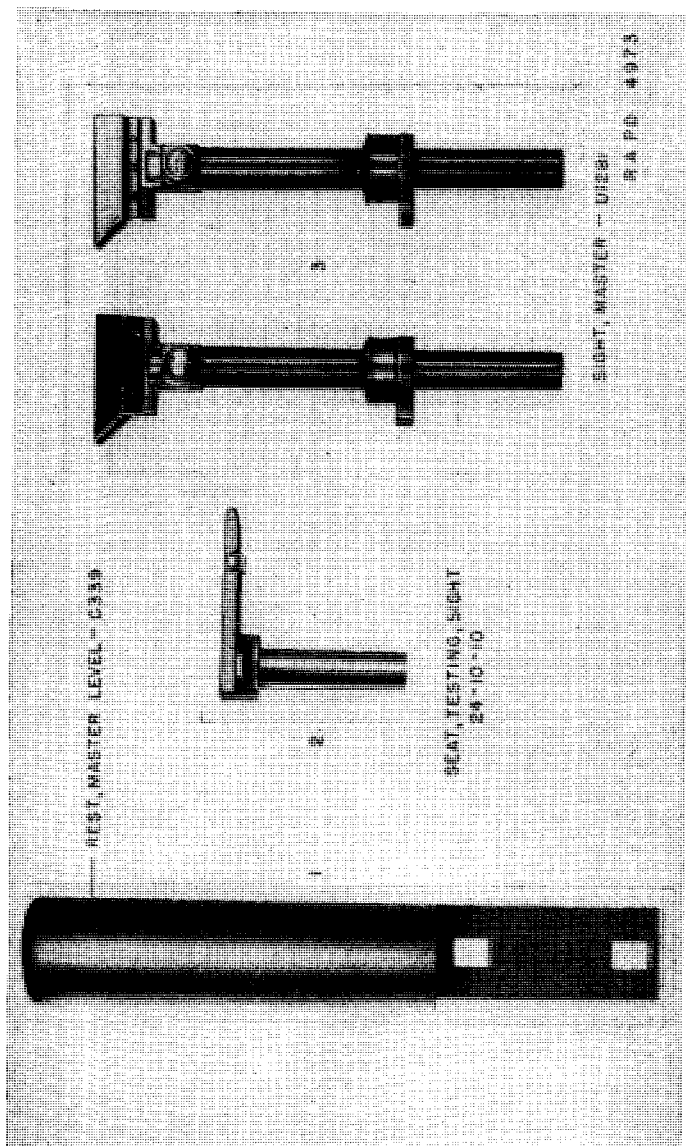


FIGURE 44.—Tools used in testing and adjusting sights.

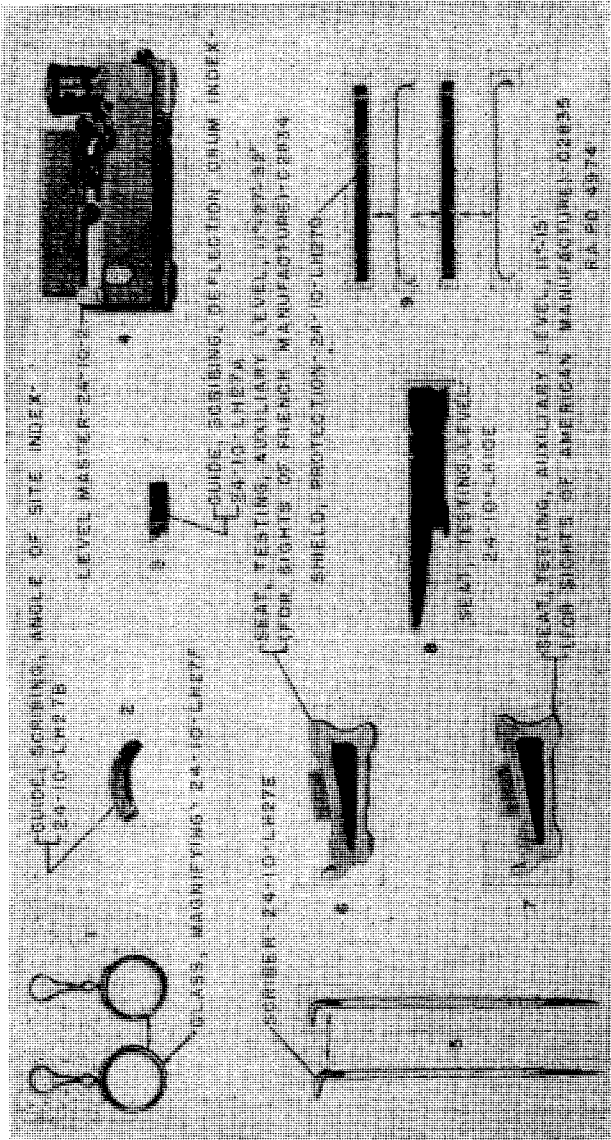


FIGURE 45.—Tools used in testing and adjusting sights.

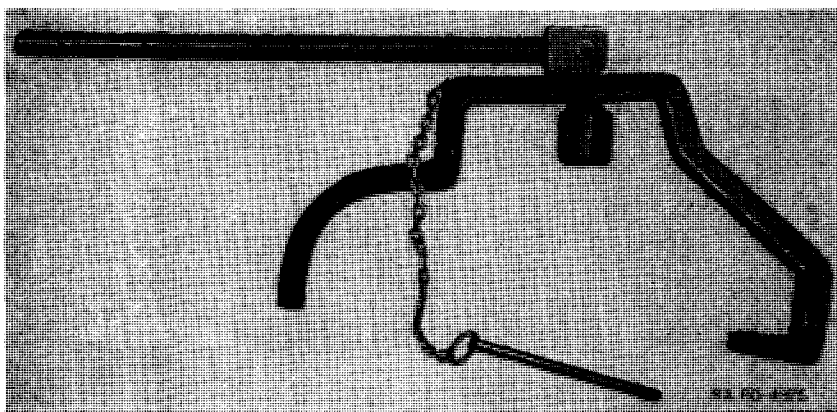


FIGURE 46.—Tool for dismounting cradle right rear side plate (not issued).

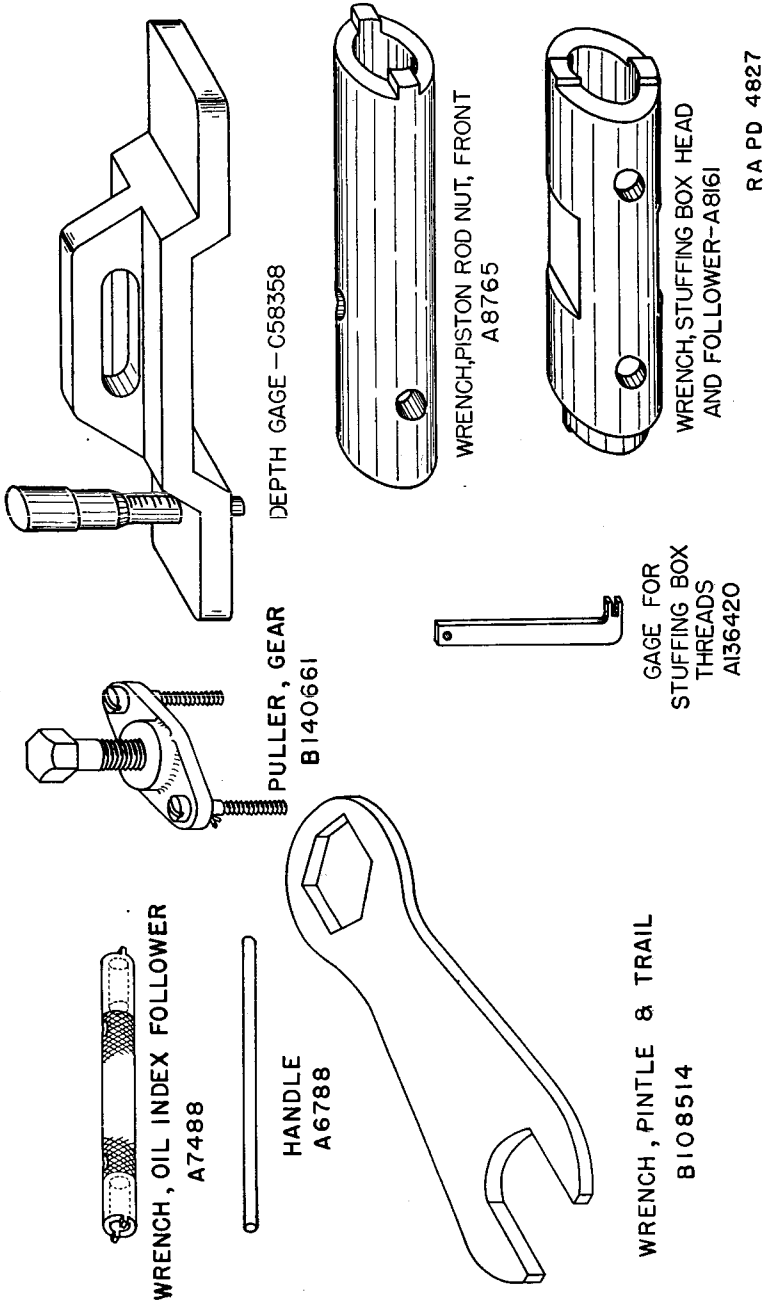
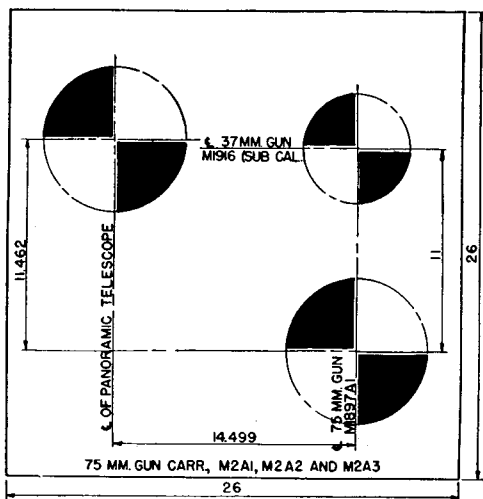
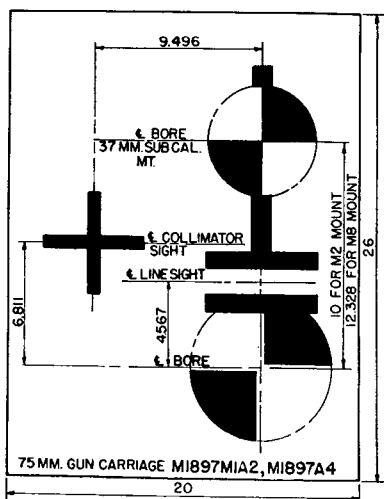


FIGURE 47.—Inspection and repair tools used on gun carriages.



①



RA PD 4828

②

FIGURE 48.—Testing targets used with 75-mm gun M1897, all types.

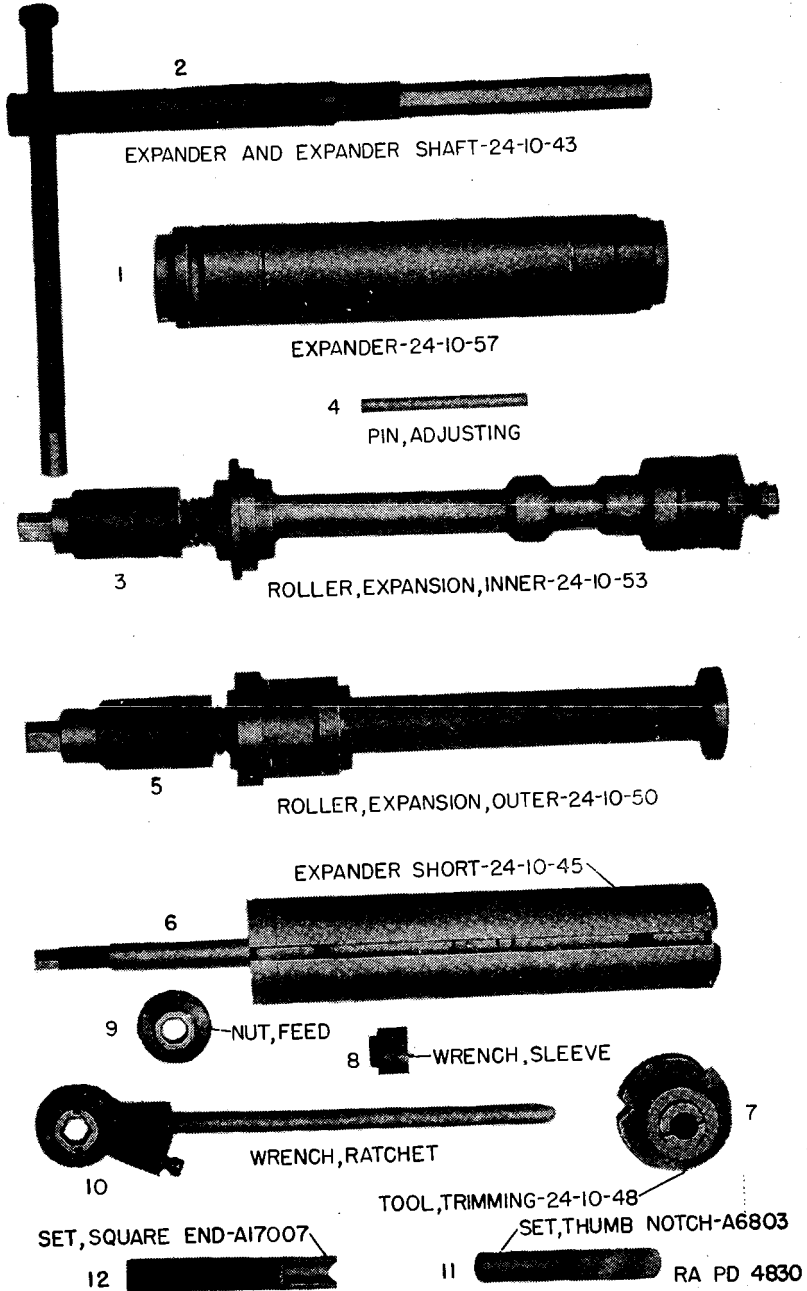


FIGURE 49.—Tools for assembling ammunition chest connecting pieces.

APPENDIX

LIST OF REFERENCES

1. Standard Nomenclature Lists.

a. Cleaning, preserving and lubricating materials----- SNL K-1

b. Gun matériel.

Caissons and limbers----- SNL C-5
 Cart, artillery, M1918, and M1918A1, and reel,
 artillery M1909M1----- SNL C-11
 Gun and carriage, 75-mm, M1897M1 and
 M1897M1A2----- SNL C-4
 Gun and carriage, 75-mm, M2A1, M2A2 and
 M2A3----- SNL C-12
 Gun and carriage, 75-mm, M1897A4----- SNL C-25
 Reel, battery M1917----- SNL C-10
 Tools, special repair----- SNL C-18

c. 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. Ammunition, general----- TM 9-1900

b. Cleaning, preserving and lubricating materials----- TM 9-850

c. Fire control.

Ordnance maintenance, circles, aiming, M1918
 (French), M1916, M1916M1----- TM 9-1530
 Ordnance maintenance, sight, M1901 (French)-- TM 9-1550
 Ordnance maintenance, mount, telescope, M22--- TM 9-1552
 Ordnance maintenance, telescope, battery commander's, M1915, M1915A1----- TM 9-1580
 Ordnance maintenance, finders, range, 1 meter
 base and 80-cm base, all types----- TM 9-1585
 Ordnance maintenance, setters, fuze, bracket,
 M1916 and setters, fuze, hand, M1912 and
 M1913----- TM 9-1590
 Ordnance maintenance, compass, prismatic,
 M1918----- TM 9-1595

<i>d.</i> 75-mm gun matériel.....	TM 9-305
<i>e.</i> Maintenance.	
Electric and oxyacetylene welding.....	OFSB 5-2
Maintenance of matériel in hands of troops	OFSB 4-1
Ordnance maintenance proce- dure—matériel, inspection and repair.....	TM 9-1100
Star-gaging equipment and gutta- percha impressions.....	TM 9-1860
<i>f.</i> Miscellaneous.	
Artillery gun book.....	O. O. Form 5825
Ordnance proof manual (proof of guns and carriages)	
<i>g.</i> Ordnance drawings.	
75-mm gun M1897.....	Class 52, Div. 85
75-mm gun M1897A2.....	Class 52, Div. 221
75-mm gun M1897A3.....	D30033
75-mm gun M1897A4.....	D33000
75-mm gun carriages M1897M1A2 and M1897A4.....	Class 2, Div. 94 Class 2, Div. 97 Class 2, Div. 262
Equipment and special repair tools	Class 2, Div. 301 Class 27, Div. 22

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[A. G. 062.11 (8-16-41).]

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