

TM 9-1325

WAR DEPARTMENT TECHNICAL MANUAL

ORDNANCE MAINTENANCE

105-MM HOWITZERS M2 AND M2A1; CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4

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This Technical Manual supersedes TM 9-1325, dated 28 November 1942, and Changes No. 1, dated 30 August 1943. This Technical Manual also supersedes TB ORD 49, dated 6 May 1943; TB ORD 110, dated 22 June 1944; and TB ORD 138, dated 10 August 1944 insofar as they apply to TM 9-1325. TB ORD 49, TB ORD 110, and TB ORD 138 remain in force until such time as they are incorporated in other affected manuals or specifically rescinded.

ORDNANCE MAINTENANCE
105-MM HOWITZERS
M2 AND M2A1;
CARRIAGES M2A1 AND M2A2;
AND COMBAT VEHICLE
MOUNTS M3 AND M4



WAR DEPARTMENT

21 SEPTEMBER 1944

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WAR DEPARTMENT
Washington 25, D. C., 21 September 1944

TM 9-1325, Ordnance Maintenance: 105-mm Howitzers M2 and M2A1; Carriages M2A1 and M2A2; and Combat Vehicle Mounts M3 and M4, is published for the information and guidance of all concerned.

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[O.O. 300.7/994]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

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The Adjutant General.

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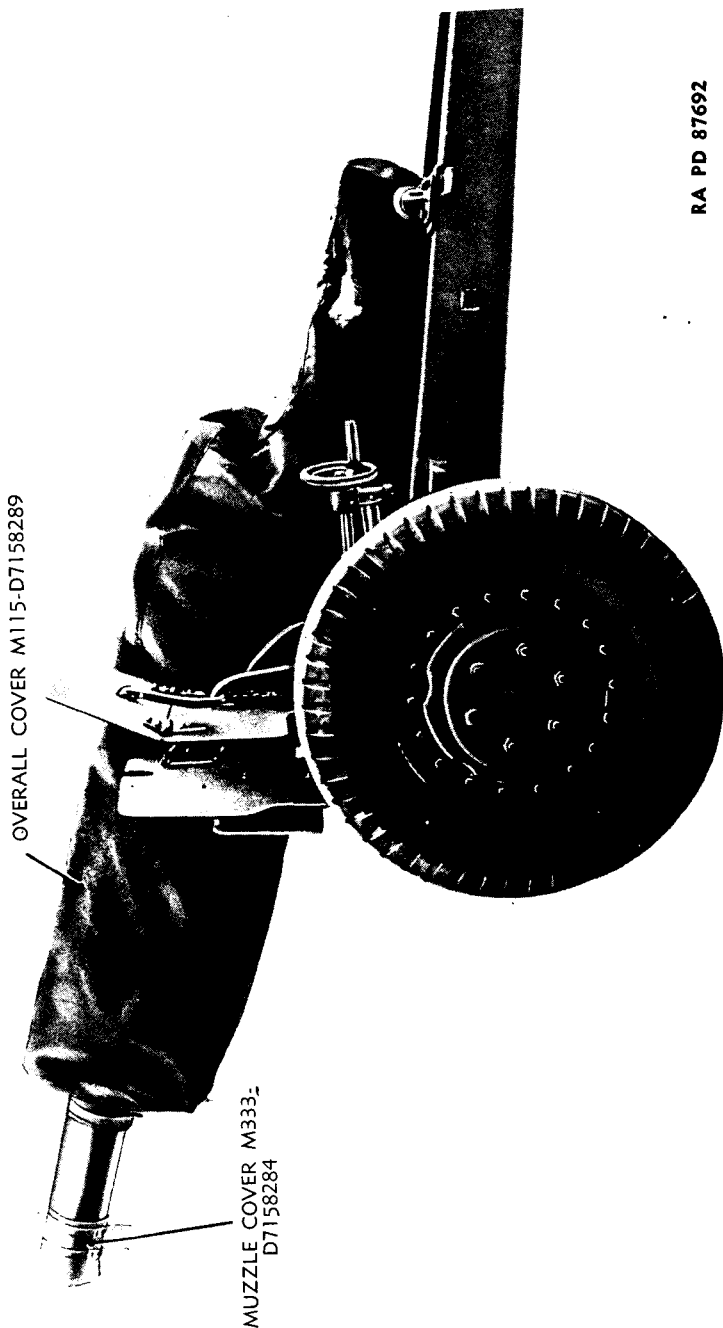
IC 9—T/O 9-17; T/O & E 9-7; 9-9; 9-57; 9-67; 9-316; Hq & Sv Co, Ord Base Auto Maint Bn; 9-318; 9-377.

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

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**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



OVERALL COVER M115-D7158289

MUZZLE COVER M333-
D7158284

RA PD 87692

Figure 1 — 105-mm Howitzer M2A1 and Carriage M2A2 With Covers Installed

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This Technical Manual supersedes TM 9-1325, dated 28 November 1942, and Changes No. 1, dated 30 August 1943. This Technical Manual also supersedes TB ORD 49, dated 6 May 1943; TB ORD 110, dated 22 June 1944; and TB ORD 138, dated 10 August 1944 insofar as they apply to TM 9-1325. TB ORD 49, TB ORD 110, and TB ORD 138 remain in force until such time as they are incorporated in other affected manuals or specifically rescinded.

Section I

INTRODUCTION

1. SCOPE.

a. This manual is published for the information and guidance of ordnance maintenance personnel. It contains detailed instructions for inspection, disassembly, assembly, maintenance, and repair of the 105-mm Howitzers M2 and M2A1, Recoil Mechanism M2A1, and 105-mm Howitzer Carriages M2A1 and M2A2, supplementary to instructions in TM 9-325. This manual does not contain information on operation, adjustment, and maintenance normally performed by the using arm, since such information is available to ordnance maintenance personnel in TM 9-325.

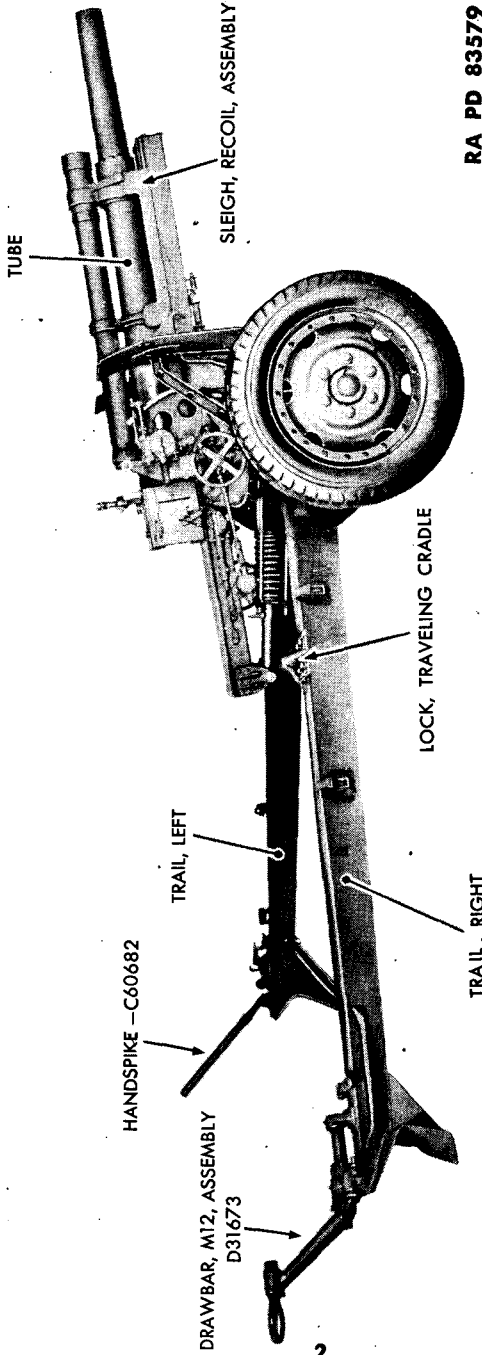
2. CHARACTERISTICS.

a. **Howitzer.** The 105-mm Howitzer M2A1 may be employed for direct or indirect fire. It may be used with effect against nearly all types of targets. The howitzer uses semifixed ammunition of several classifications: H.E.; H.E., A.T.; Smoke, B.E.; H-Gas; and Smoke (bursting charge). The weight of the high-explosive projectile is 33 pounds, and the maximum range with the high-explosive ammunition is 12,205 yards.

b. **Carriage.** The 105-mm Howitzer Carriages M2A1 and M2A2 are field carriages of the single-axle, split-trail type. In addition to having all the features of a howitzer carriage, the carriages are used for low angle (long range) firing. The carriages may be towed at speeds up to 35 miles per hour. They may be maneuvered rapidly in and out of firing position. An equalizing mechanism facilitates firing from uneven terrain.

c. In direct laying, a one-man, one-sight system may be used, wherein the gunner lays the piece both for direction and elevation, using the panoramic telescope located on the left side of the carriage. When a more rapid rate of fire is desired, the two-man, two-sight system is used. In this case, the gunner lays for direction only, and the number 1 cannoneer lays for elevation, employing the elbow telescope attached to the right side of the carriage.

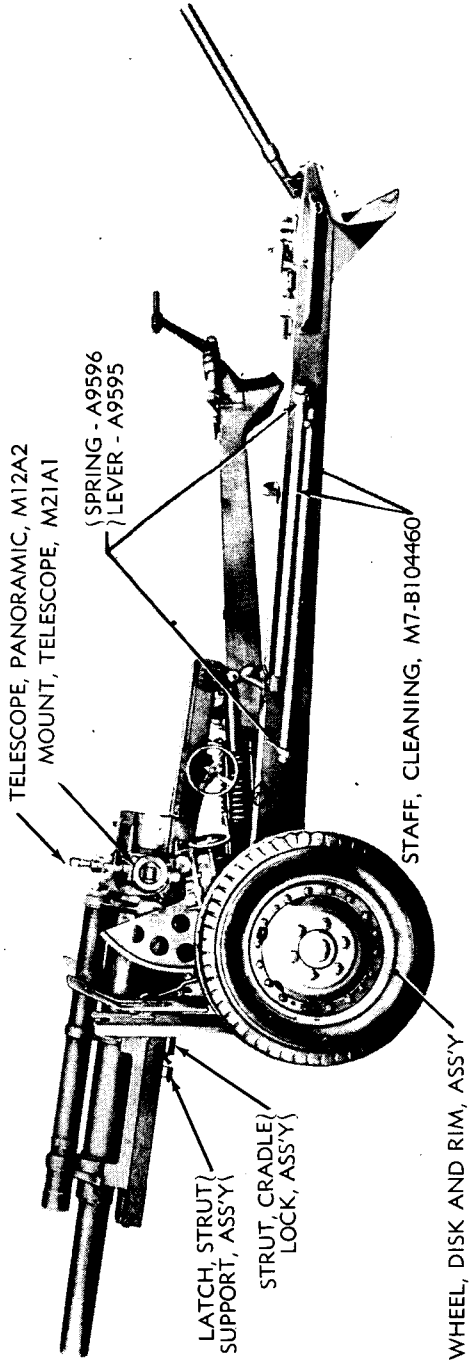
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Figure 2 — 105-mm Howitzer M2A1 and Carriage M2A2 — Right Side

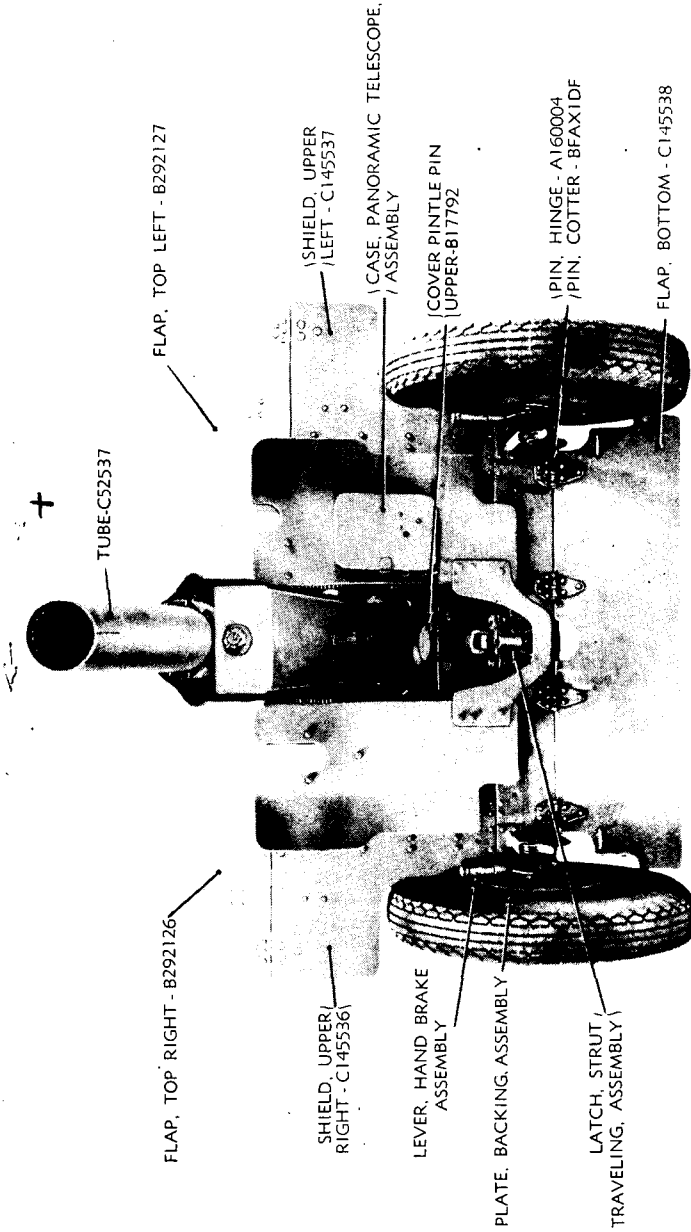
INTRODUCTION



RA PD 83580

Figure 3 — 105-mm Howitzer M2A1 and Carriage M2A2 — Left Side

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CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 19391

Figure 4 — 105-mm Howitzer M2A1 and Carriage M2A2 — Front View

INTRODUCTION

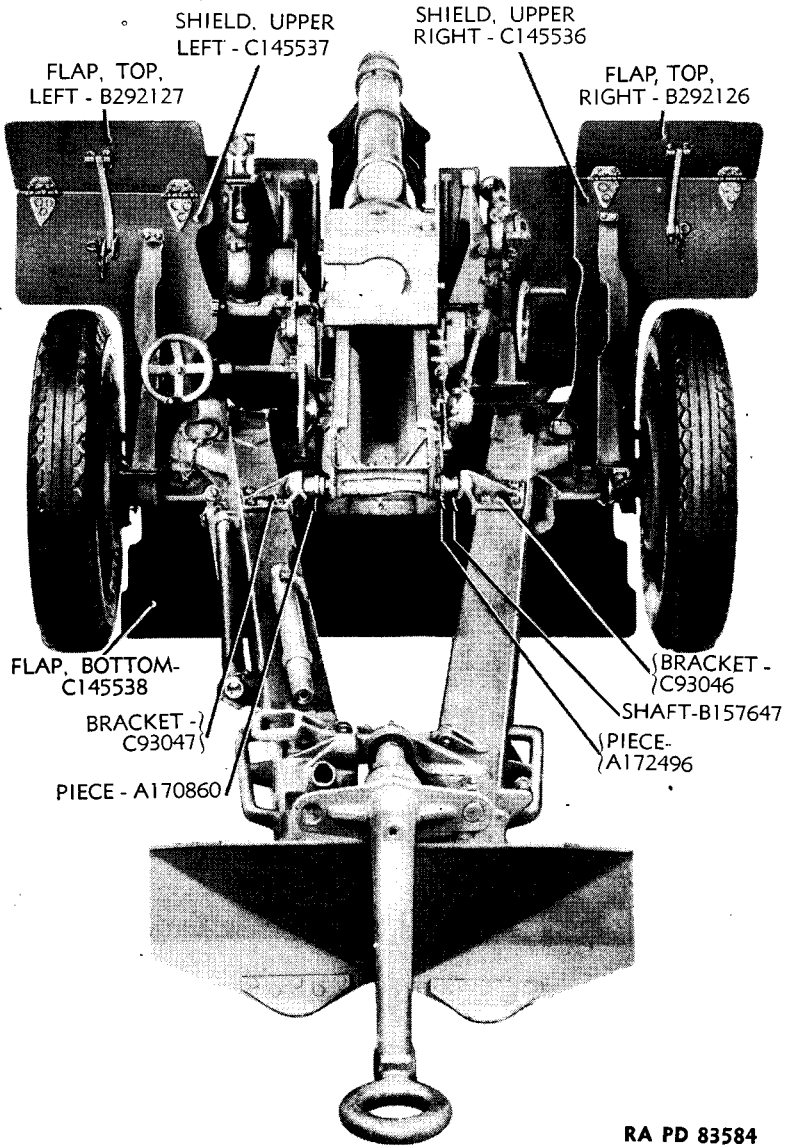
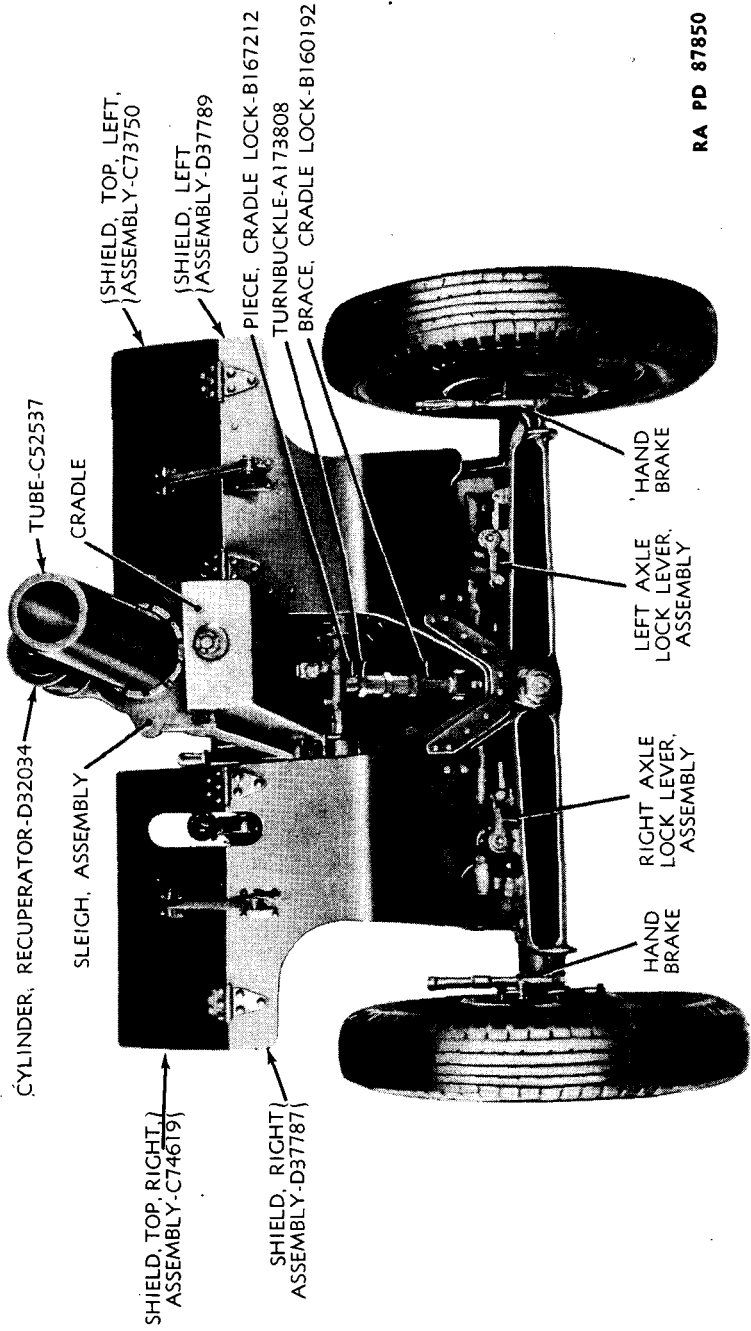


Figure 5 — 105-mm Howitzer M2A1 and Carriage M2A2 — Rear View

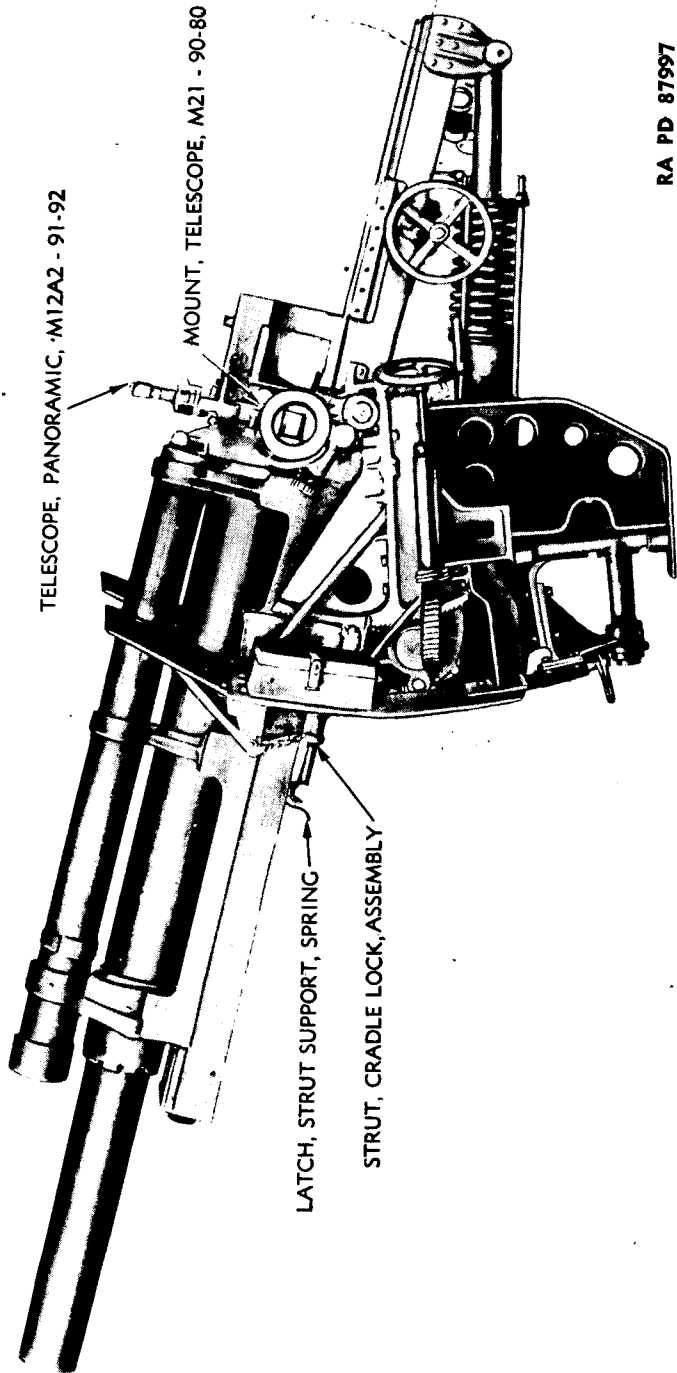
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CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 87850

Figure 6 — 105-mm Howitzer M2A1 and Carriage M2A1 — Front View

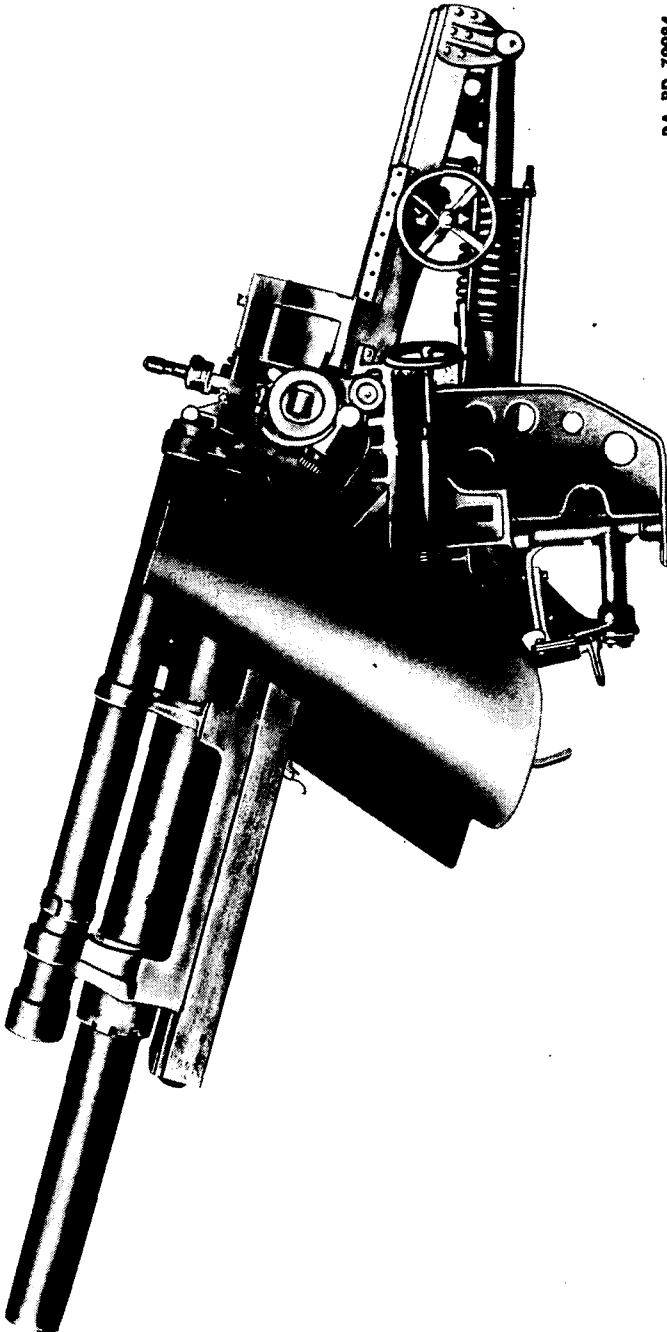
INTRODUCTION



RA PD 87997

Figure 7 — 105-mm Howitzer M2A1 and Mount M3 — Left Side

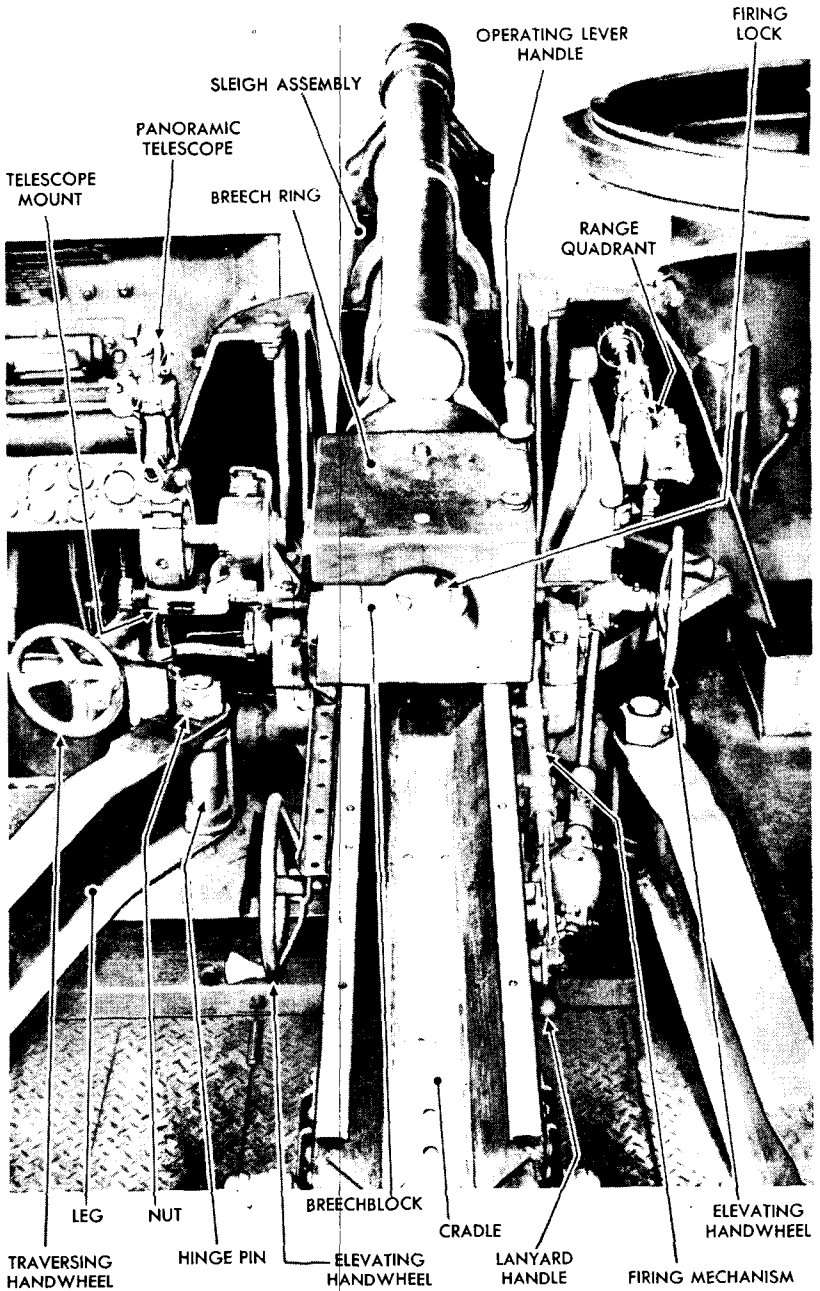
**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 79984

Figure 8 — 105-mm Howitzer M2A1 and Mount M4 — Left Side

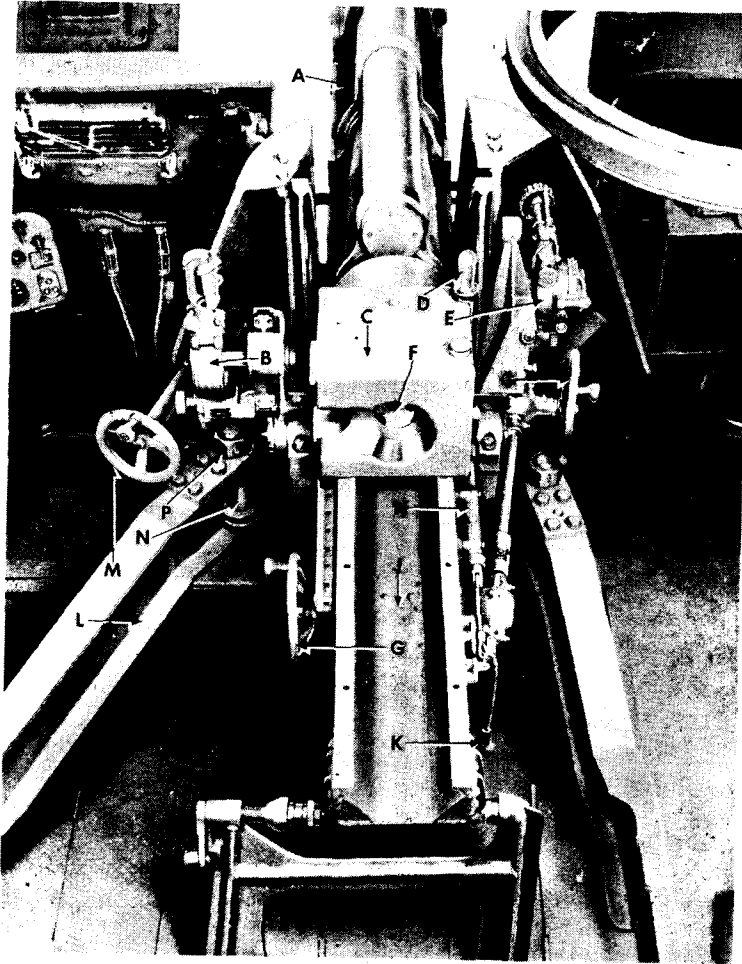
INTRODUCTION



RA PD 45842

Figure 9 — Howitzer Installed in Motor Carriage M7 — Rear View

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



- A—SLEIGH, ASSEMBLY
- B—TELESCOPE MOUNT
- C—BREECH RING
- D—OPERATING LEVER HANDLE
- E—RANGE QUADRANT
- F—FIRING LOCK
- G—ELEVATING HANDWHEEL
- H—FIRING MECHANISM
- J—CRADLE
- K—LANYARD HANDLE
- L—LEG
- M—TRAVERSING HANDWHEEL
- N—HINGE PIN
- P—NUT

RA PD 322345

Figure 10 — Howitzer Installed in Motor Carriage M7B1 — Rear View

INTRODUCTION

3. DIFFERENCES AMONG MODELS.

a. **Howitzers.** The only difference between the Howitzer M2A1 and the Howitzer M2 is that the M2A1 model has two bearing strips on the bottom of the breech ring which are not present on the M2 model.

b. **Recoil Mechanisms.** The chief difference between Recoil Mechanism M2A1 and Recoil Mechanism M2 is the respirator provided at the rear end of the M2A1 Recoil Cylinder. The M2 model is being changed to M2A1 by MWO ORD C21-W10 or (FSMWO C21-W10). The Recoil Mechanism M2 is not covered in this manual.

c. **Carriages.**

(1) The Carriage M2A2 differs from the other models most notably in having two shields, a main shield and an auxiliary shield (figs. 1, 2, 3, 4, and 5). New M2A2 Carriages have the screw-type traversing mechanism. However, M2A2 Carriages which have been modified from M2A1 or M2 Carriages have a worm and rack traversing mechanism. Hand parking brakes, only, are provided. New hand parking brakes are equipped with clasptype brake levers.

(2) The Carriage M2A1 has the old type of shield and a worm and rack traversing mechanism (fig. 6). Hand parking brakes, only, are provided.

(3) M2 Carriages have electric brakes, operated from the prime mover, as well as hand parking brakes. M2 Carriages are being converted to M2A1 Carriages by the removal of the electric brakes. This modification is being made by MWO ORD C21-W9. The M2 Carriage is not described in this manual.

d. **Mounts.** The 105-mm Howitzer Mount M3 (fig. 7), together with Howitzer M2A1, is mounted in the Motor Carriage T.19. The 105-mm Howitzer Mount M4, together with Howitzer M2A1, is mounted in the Motor Carriage M7 or M7B1 (figs. 8, 9, and 10). Some of the differences between the mounts and carriages are noted below.

(1) The elevating arcs for the mounts have been cut to allow for only 30 degrees 45 minutes elevation, the equalizing support and axle have been shortened, the axle is secured to the chassis of the vehicle, and different shields are used.

(2) Sighting and fire control instruments used with Mounts M3 and M4 are different from those used with Carriages M2A1 and M2A2.

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

4. DATA.

a. Howitzer, 105-mm.

| | MODEL M2A1 |
|---|--------------------------|
| Caliber of howitzer | 105-mm (4.134 in.) |
| Total weight of howitzer (tube and breech mechanism) (approx) | 1,064 lb |
| Weight of tube (approx) | 706 lb |
| Weight of tube and breech ring (approx) | 973 lb |
| Weight of tipping parts (howitzer, recoil mechanism, cradle, sight mount, and range quadrant) (approx) | 2,028 lb |
| Length of howitzer (muzzle to rear face of breech ring).... | 101.35 in. |
| Length of tube | 93.05 in. |
| Length of bore | 78.02 in. |
| Muzzle velocity (average velocity with a new howitzer) | |
| Shell, H.E. (maximum zone charge, Carriage M2 or Motor Carriage M7) | 1,550 ft per sec |
| Shell, H.E., A.T. (Carriage M2 or Motor Carriage M7) | 1,250 ft per sec |
| Range (maximum): | |
| Shell, H.E. (maximum zone charge at 778.6 mils, Car- riage M2) | 12,205 yd |
| Shell, H.E., A.T. (154.6 mils, Carriage M2)..... | 3,500 yd |
| Shell, H.E., A.T. (778.1 mils, Carriage M2)..... | 8,590 yd |
| Shell, H.E., A.T. (152.5 mils, Motor Carriage M7)..... | 3,500 yd |
| Rate of fire: | |
| Normal | 2 rounds per min |
| Maximum | 4 rounds per min |
| Type of breechblock | Horizontal sliding wedge |
| Weight of breechblock (approx) | 74 lb |
| Type of firing mechanism | Continuous pull |

b. Carriage, Howitzer, 105-mm.

| | Model | |
|--------------------------------|-------|-------|
| | M2A1 | M2A2 |
| Time to emplace (normal) | 3 min | 3 min |

INTRODUCTION

| | Model | |
|--|-----------------------|-----------------------------|
| | M2A1 | M2A2 |
| Weights: | | |
| Howitzer and carriage (complete with accessories, traveling position) (approx) | 4,475 lb | 4,980 lb |
| Wheel with combat tire (9.00 x 20) (approx) | 287 lb | 287 lb |
| Wheel with combat tire and hub (approx) | 345 lb | 345 lb |
| At lunette (approx) | 235 lb | 235 lb |
| Dimensions in traveling position, over-all: | | |
| Length (approx) | 19 2/3 ft | 19 2/3 ft |
| Width (over hub caps) (approx) | 84 1/2 in. | 84 1/2 in. |
| Height (approx) | 60 in. | 62 in. |
| Road clearance (approx) | 15 1/2 in. | 13 in. |
| Turning radius (approx) | 11 ft | 11 ft |
| Towed by prime mover: | | |
| 2 1/2 ton | 6 x 6 cargo truck | 6 x 6 cargo truck |
| 13 ton | High speed tractor M5 | High speed tractor M5 |
| Limits of elevation: | | |
| Maximum (approx) | 1,180 mils | 1,180 mils |
| Depression (approx) | -84 mils | -84 mils |
| Elevation per turn of handwheel | 10 mils | 10 mils |
| Limits of traverse (degrees right or left (approx)) | | |
| | 23 deg | 23 deg |
| Diameter of circle of emplacement (approx) | | |
| | 21.1 ft | 21.1 ft |
| Traverse per turn of handwheel (screw-type traversing mechanism) | | |
| | 19 mils | 19 mils |
| Traverse per turn of handwheel (worm and rack traversing mechanism) .. | | |
| | 21 mils | 21 mils |
| M2A1 and M2A2 | | |
| Recoil mechanism: | | |
| Model | | M2A1 |
| Normal length of recoil @ 65° | 42 in. | 42 in. (zone Z) (17-25") |
| Maximum allowable recoil | | 44 in. |
| Elevation at which maximum recoil occurs maximum elevation) | | 1,180 mils |
| Type | | Hydropneumatic |
| Weight (complete with sleigh and filled)—pounds (approx) | | 463 |
| Initial gas pressure at 70° F, w/o reserve oil | | 1,100 lb per sq in. |

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**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

| | M2A1 and M2A2 |
|---|----------------------------|
| Recoil oil: | |
| Type | See par. 33 |
| Reserve in recuperator (fills of oil screw (filler) gun) | 1½ |
| Type of equilibrator | Spring |
| Tires: | |
| Type and size | 9.00 x 20 combat |
| Type and size tubes | 9.00 x 20 combat |
| Type and size | (8-ply) 7.50 x 24 standard |
| Type and size tubes | 7.50 x 24 standard |
| Pressure (combat or standard) | 40 lb per sq in. |
| Brakes, type | Hand parking |

c. On-carriage Sighting Equipment.

Range Quadrant M4.

Telescope Mount M21A1 with Panoramic Telescope M12A2 or M5A3.

Telescope Mount M23 with Elbow Telescope M16.

d. Off-carriage Sighting and Fire Control Equipment.

Aiming circle M1 or M1918.

Aiming post M1.

Aiming post light M14.

B.C. telescope M1915A1.

B.C. telescope M65.

Binoculars.

Compass M2.

Compass (prismatic) M1918.

Firing table 105-H-3.

Firing table (graphical) M4.

Fuze setter M14.

Fuze setter M22.

Gunner's quadrant M1 or M1918.

Range finder (1 meter base) M1916.

Range finder M7.

Testing target C76012.

Watch.

e. Subcaliber Equipment—Gun, Subcaliber, 37-mm, M13.

| | |
|----------------------|-----------|
| Weight of gun | 86 lb |
| Length of gun | 33.4 in. |
| Length of bore | 29.11 in. |

INSPECTION

Range:

| | |
|---|----------|
| SHELL, practice, M63—Mod. 1, w/FUZE, base, practice, M58 | 4,980 yd |
| SHELL, practice, M92, w/FUZE, P.D., M74 | 5,165 yd |

Muzzle velocity:

| | |
|---|------------------|
| SHELL, practice, M63—Mod. 1, w/FUZE, base, practice, M58 | 1,100 ft per sec |
| SHELL, practice, M92, w/FUZE, P.D., M74 | 1,276 ft per sec |

Section II

INSPECTION

5. PURPOSE.

a. Inspection of the weapon is vital. Thorough, systematic inspection is the best insurance against an unexpected breakdown at a critical moment when maximum performance is absolutely necessary. Never let materiel run down. Keep it in first class fighting condition by vigilant inspection.

b. The immediate aims of inspection are:

(1) To determine by critical examination the condition of the materiel.

(2) To detect faulty or careless preventive maintenance, especially inadequate lubrication.

(3) To determine whether adjustments, repair, or replacement of parts is necessary.

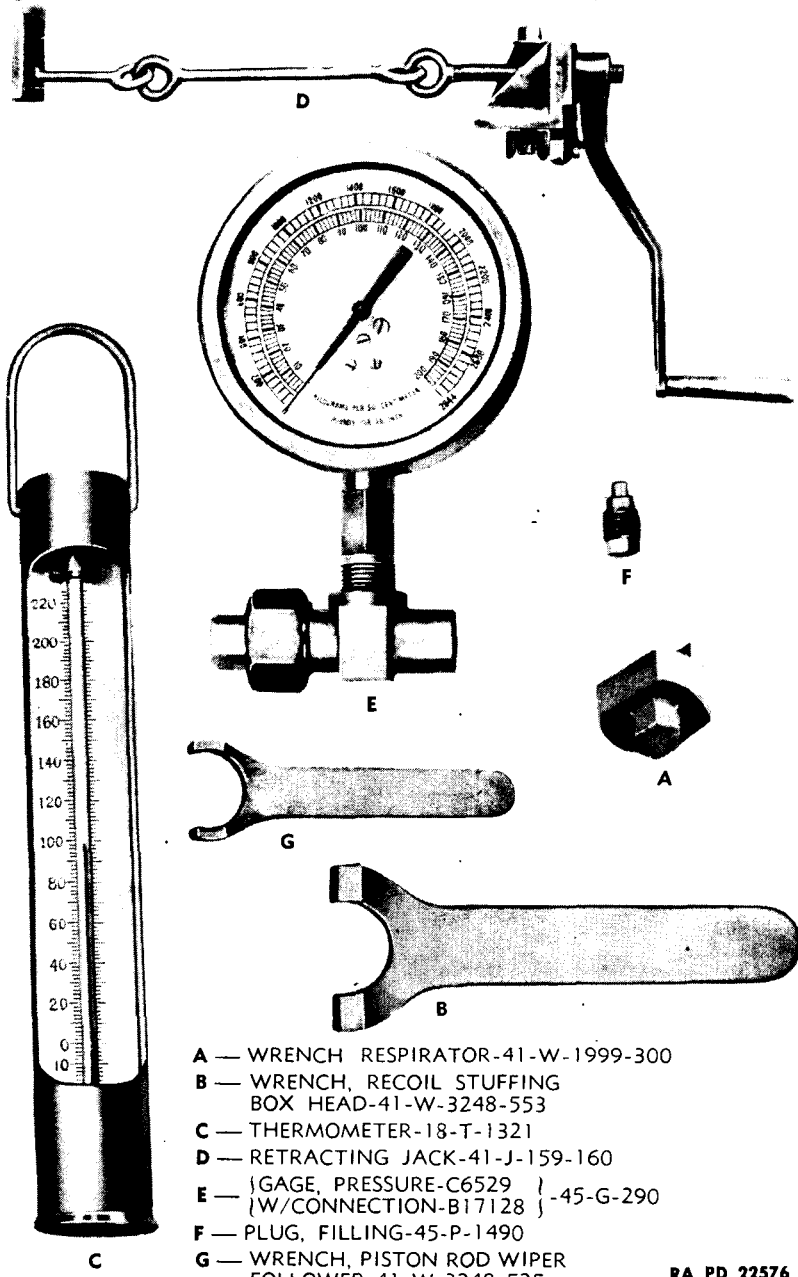
(4) To verify that all modifications authorized by Modification Work Orders have been made.

c. Inspection should always be accompanied by corrective measures to remedy any deficiencies or defects found. When properly carried out, inspection and necessary corrective maintenance will insure the maximum performance of the materiel.

d. The results of inspection should be noted in the Artillery Gun Book (O.O. Form 5825). Any unusual condition which might result in improper operation, damage to materiel, or injury to personnel, will be remedied immediately.

e. Suggested improvements in design, maintenance, safety, and efficiency of operation prompted by chronic failure or malfunction of the weapon, spare parts, or equipment should be forwarded to the Office of the Chief of Ordnance, Field Service Division, Maintenance Branch, with all available pertinent information. Such suggestions are encouraged in order that other organizations may benefit.

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- A — WRENCH RESPIRATOR-41-W-1999-300
- B — WRENCH, RECOIL STUFFING
BOX HEAD-41-W-3248-553
- C — THERMOMETER-18-T-1321
- D — RETRACTING JACK-41-J-159-160
- E — { GAGE, PRESSURE-C6529 }
 { W/CONNECTION-B17128 } -45-G-290
- F — PLUG, FILLING-45-P-1490
- G — WRENCH, PISTON ROD WIPER
 FOLLOWER-41-W-3248-525

RA PD 22576

Figure 11 — Tools for Inspection and Maintenance of Recoil Mechanism

INSPECTION

CAUTION: *No modification of materiel will be made unless authorized.*

6. TOOLS FOR INSPECTION.

a. Tools for ordnance maintenance of the 105-mm howitzer materiel are listed in SNL C-18. No special tools are issued to ordnance maintenance personnel for inspection of the howitzer and carriage. Special tools are issued for inspection of the recoil mechanism, and those tools are illustrated in figure 11 and described below.

b. Tools for Inspection of Recoil Mechanism.

| Tools | Use |
|---|--|
| GAGE, pressure, w/connection, 45-G-290 (fig. 11). | Used for testing gas pressure in recuperator cylinder. This gage is calibrated from zero to 2,844 pounds per square inch. |
| JACK, retracting, 41-J-159-160 (fig. 11). | Used to retract the howitzer when performing the manometer test (par. 11). |
| PLUG, filling, 45-P-1490 (fig. 11). | This is a spare recoil cylinder plug for use with pressure gage connection B17128. |
| THERMOMETER, Fahrenheit, 18-T-1321 (fig. 11). | Used to measure the temperature of the recoil oil when performing the manometer test. The thermometer is calibrated from minus 10° F to plus 220° F. |
| WRENCH, respirator, 41-W-1999-300 (fig. 11). | Used to remove recoil cylinder respirator in manometer test and in maintenance of recoil mechanism. |
| WRENCH, piston rod wiper follower, 41-W-3248-525 (fig. 11). | Face-spanner-type wrench used to adjust piston rod wiper follower. |
| WRENCH, recoil stuffing box head, 41-W-3248-553 (fig. 11). | Face-spanner-type wrench used to adjust recoil stuffing box head. |

c. Tools for Checking Pressure Gage Used in Manometer Test.

(1) The contents of the pressure gage tester chest (fig. 12) are used when checking the service pressure gage against a master gage. The pressure gage tester is filled with recoil oil which is subjected to pressure by a screw. The pressure is transmitted equally to both pressure gages, thereby showing whether the service pressure gage is reading properly.

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(2) The following equipment is provided:

| Tools | Use |
|--|---|
| ADAPTER, pressure gage tester, 45-A-199-501 (fig. 12). | Used to connect pressure gage to tester. |
| ADAPTER, pressure gage tester, 45-A-199-500 (fig. 12). | Issued with all outfits but not used with master gage 45-G-288. This adapter is used only with 155-mm and 240-mm howitzer materiel. |
| GAGE, pressure, hydraulic, 0 Kg. -200 Kg., master, 45-G-288 (fig. 12). | Used to check accuracy of service pressure gage. It is graduated from zero to 2,844 pounds per square inch. The gage should be returned to an arsenal once a year for verification of its accuracy. Care must be exercised not to jar instrument at any time. This gage is <i>never</i> used to perform a manometer test. |
| GASKETS and GLASSES (fig. 12). | GASKET, oil reservoir, 33-G-999-30; GASKET, suction piston, 33-G-999-20; GASKET, adapter, 33-G-999-10; and GLASS, gage, 45-G-1903-50 are spare parts. |
| JACK, gage hand, 41-J-105 (fig. 12). | Used to remove service pressure gage indicator hand when service gage is not in agreement with master gage. |
| SET, gage hand, 41-S-2135 (fig. 12). | Used to place service gage indicator hand in agreement with master gage. |

(3) **USE OF PRESSURE GAGE TESTER.** Clamp tester securely in the vise by means of the lug on the under side. Withdraw the screw and fill the apparatus with recoil oil before assembling the pressure gage in order to eliminate possible air bubbles in the connections. Screw the master gage into one arm of the tester and the gage to be tested into the other arm, using the adapters 45-A-199-501 (fig. 13). Apply pressure by means of the operating screw and handle, and compare readings over the entire range of the gages. If the gages are not in agreement, pull the hand off the *service* pressure gage spindle, using the gage hand jack (fig. 14), and reset the hand in agreement with the master gage. Use a small hammer and the gage hand set when resetting the hand (fig. 15). Tap very lightly. The

INSPECTION

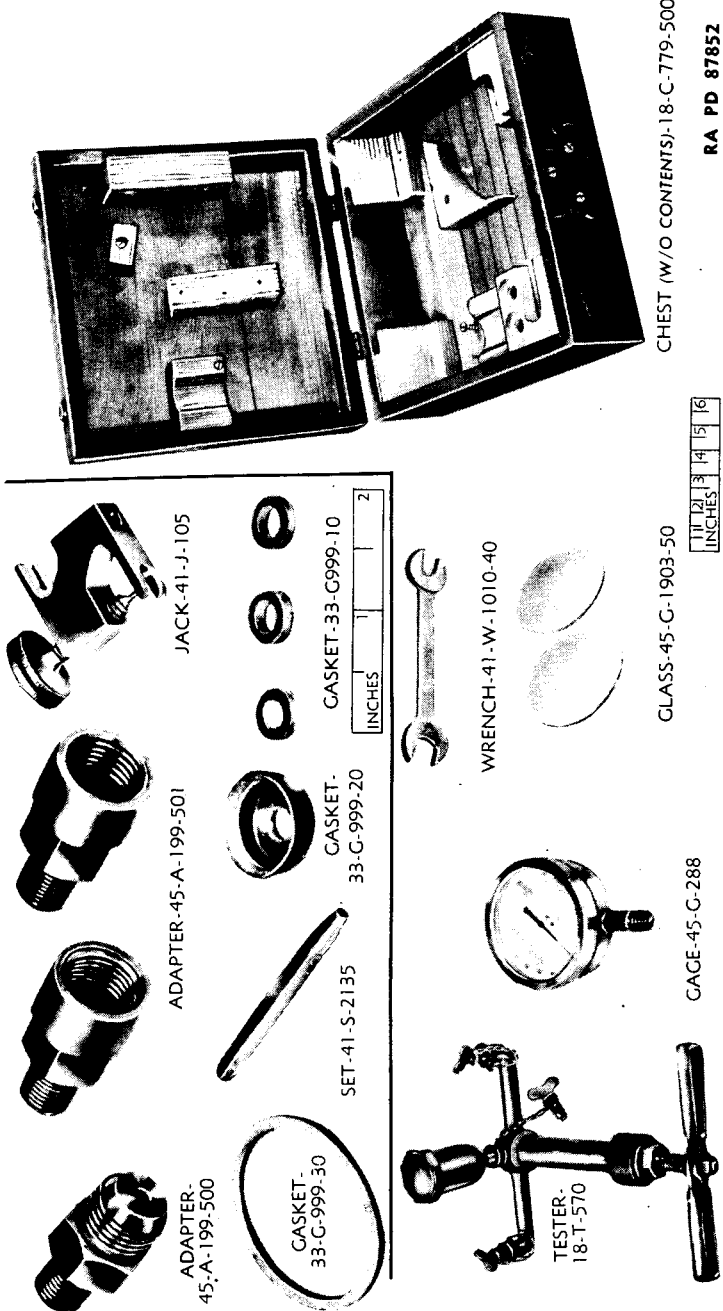
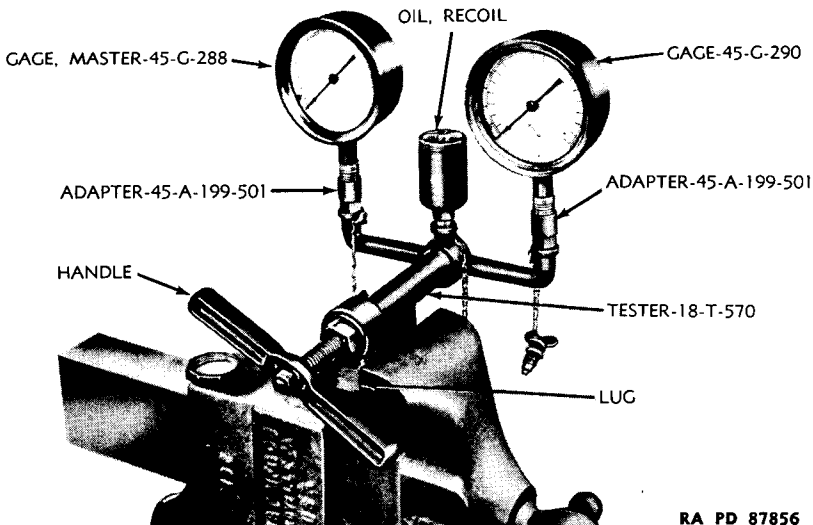


Figure 12 — Gage Testing Outfit 18-G-367

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 87856

Figure 13 — Testing Service Pressure Gage

most effective readings are between 430 and 2,300 pounds per square inch.

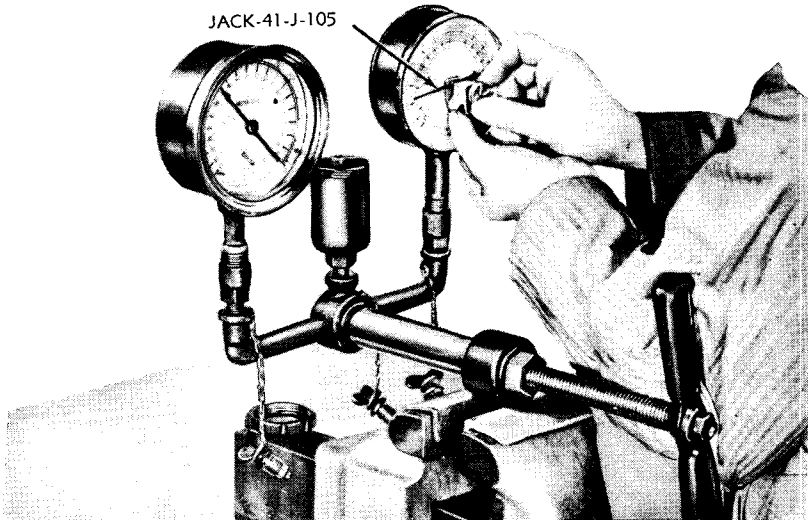
7. BORE.

a. **General.** The bore should be free from dirt, grit, rust, and powder fouling. Do not confuse powder fouling with coppering of the bore. A clean bore is not necessarily a shiny bore and might frequently have a dull gray appearance. A shiny, polished bore may indicate that abrasives have been used in cleaning operations.

b. **Damage to Forcing Cone.** Scratches, nicks, pitting, and scoring of the bore may permit leakage of gas past the rotating band of the projectile which will cause erosion of the bore, loss of velocity, and consequently loss of range. Such defects must be smoothed and rounded and, depending on their location, character, and extent, decision must be made as to whether the weapon is serviceable from the standpoint of gas leakage. No definite rules of thumb on serviceability of the weapon can be given.

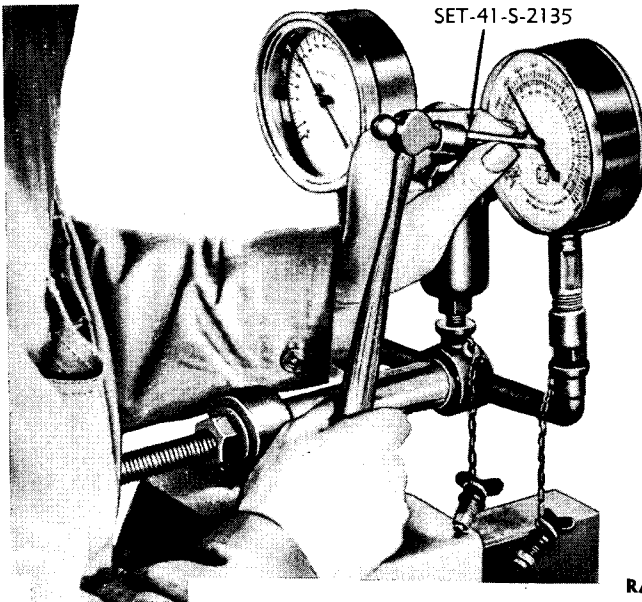
c. **Deformation of Rifling.** Particular attention should be paid to deformation at the origin of rifling. In general, it consists of sheared lands and a flow of metal in the grooves so that the pitch of the rifling for the first inch or two is considerably reduced and pressures increased. This is a serious defect and howitzers showing it to

INSPECTION



RA PD 87857

Figure 14 — Removing Service Pressure Gage Hand



RA PD 87858

Figure 15 — Resetting Service Pressure Gage Hand

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a marked degree are not to be reissued. Stripping or gouging of lands occurs especially at or near the origin of rifling.

d. **Pastilles.** These are small depressions occasionally found in the howitzer tube. The effect of pastilles upon the safety and accuracy of the piece is thought to be negligible. However, as a precautionary measure, tubes having more than three pastilles the size of a 5-cent piece will be withdrawn from service, if practicable.

e. **Star-gaging.** The average life of the tube is approximately 7,500 rounds. Howitzers in service should be star-gaged after approximately 90 percent of their estimated accuracy life, and thereafter at each 10 percent during the remainder of their service. Tubes may be star-gaged any time an inspector finds it advisable. Decopering of bores of tubes is prohibited. Instructions for star-gaging are given in TM 9-1860.

8. TUBE AND BREECH RING (par. 30).

a. Examine the breech ring and howitzer tube for proper assembly and tightness. The breech recess should be clean and free from rust, pits, burs, scores, or other damage. The leveling plates should be free from dirt, burs, scratches, roughness, and paint, and parallel with the axis of the bore. The operating lever catch should be tight and free from wear or damage. Remove the screw from the recoil mechanism bracket locking ring, remove the locking ring, and inspect the condition of locking ring threads on tube and in ring. Also examine the condition and tightness of the recoil mechanism bracket seat ring before replacing locking ring and screw.

9. BREECH MECHANISM AND FIRING LOCK (pars. 28 and 29).

a. The breechblock should open and close without binding and lock positively in the closed position. All sliding surfaces, threads, etc., should be smooth and free from burs or scratches. Parts must be clean and properly lubricated. Examine the breechblock bushing for worn firing pin hole and tightness in breechblock. The surface of the breechblock bushing should be flush with the surface of the breechblock. Screw should be secure and flush with or below surface. Inspect the following specific parts for satisfactory operation, scores, deformation, cracks, breakage, wear, or other damage; breechblock operating lever assembly, operating lever pivot, extractor, trigger shaft, trigger shaft detent and trigger shaft detent spring, firing lock, and firing spring. Examine condition and check protrusion of firing pin. Firing pin must not be broken or deformed and must have sufficient force to fire primer.

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10. RECOIL MECHANISM.

a. The howitzer should recoil the prescribed distance smoothly and return to battery completely and without shock.

b. Check that recoil slides are clean, free from rust, burs, and scratches, and properly lubricated. Note that sleigh rails fit cradle guides snugly. See that the threads on the piston rod and outer nut are not burred or stripped. See that the piston rod outer nut is secured by a cotter pin. Examine filling hole threads and recoil cylinder filling plug threads for stripping and burs. See that purge plugs are tight. Note that respirator in recoil cylinder is clean and operating.

c. The prescribed recoil oil should be used. (Refer to paragraph 33 for changing from heavy recoil oil to special recoil oil.) Test the recoil oil for water (TM 9-325). Check for leakage of nitrogen, as shown by emulsified appearance of reserve oil drained from the recoil mechanism (par. 12). Note whether the oil index functions smoothly and indicates the proper reserve.

d. Check for excessive oil leakage at oil index, filling plug, and recoil stuffing box head. **NOTE:** *The recoil stuffing box packings normally permit a slight leakage of oil which insures lubrication. However, if clear oil leaks past the packings, the leakage is excessive.*

e. Check tightness of recuperator and recoil cylinders in front sleigh yoke. Two special box-spanner wrenches (fig. 23) are provided for tightening the cylinders. **CAUTION:** *The spanner wrenches 41-W-3294-100 and 41-W-3294-75 are to be used for tightening the cylinders only, not for dismantling the cylinders.*

f. Measure pressure of compressed nitrogen (par. 11).

11. MANOMETER TESTS.

a. **Purpose.** The manometer test determines the nitrogen pressure in the recuperator cylinder. Friction of the floating piston and combined friction of the recoil piston and stuffing box will not be considered as affecting serviceability. Previously, inspection of the recoil mechanism has provided for the determination of frictions by the manometer test, and when above or below certain limits the mechanism was declared unserviceable. Present regulations prescribe that mechanisms will not be declared unserviceable because of friction determinations. The nitrogen pressure is determined in the field by the indirect method, that is, by measuring the pressure transmitted to the oil by the compressed nitrogen through the medium of the floating piston. The gas pressure, when determined by the direct method, that is, with the gage tapped directly into the nitrogen chamber (arsenal operation only), will differ by approximately 15 pounds per

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square inch from pressure obtained by the indirect method, due to the fact that the volume of the nitrogen chamber is decreased slightly when the oil reserve is present in the mechanism, as it is when the indirect method is used. In amount, the reserve oil represents a volume corresponding to the movement of the floating piston of about one-half inch. "Reserve oil" normally separates the floating piston from the regulator. Compressed nitrogen within the system forces the floating piston against the reserve oil, creating pressure on the oil. Oil pressure exists only as long as there is oil between the regulator and floating piston; therefore, the oil reserve must be present when making the indirect test.

b. Nitrogen Pressure.

(1) The initial nitrogen pressure in the mechanism is 1,100 pounds per square inch at 70° F *without* reserve oil. *With* reserve oil, the initial pressure will be approximately 15 pounds per square inch higher or 1,115 pounds per square inch at 70° F. Variation is approximately 2.07 pounds per square inch for each degree (Fahrenheit) change in temperature. The table below represents normal nitrogen pressure with the reserve oil present:

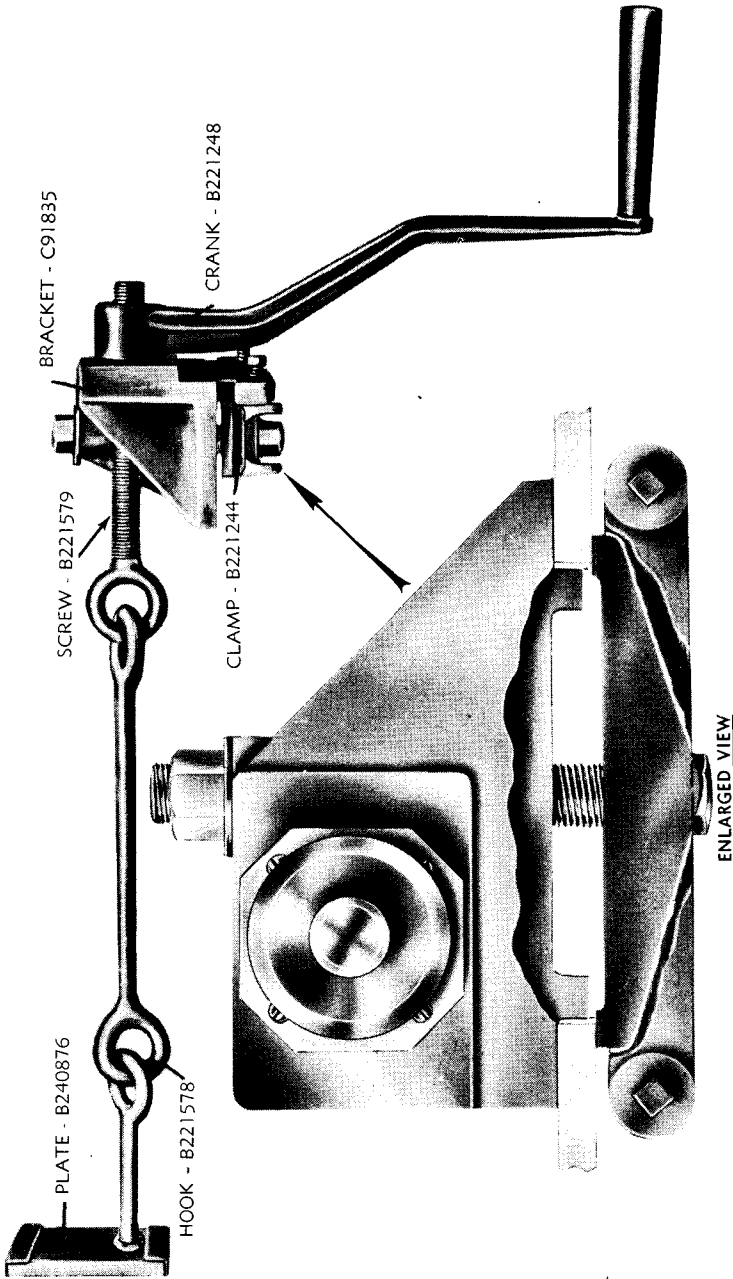
TABLE I
Nitrogen Pressures at Different Temperatures with Reserve Oil

| Temperature (Centigrade) | Temperature (Fahrenheit) | Pressure (pounds per square inch) |
|-----------------------------|-----------------------------|--------------------------------------|
| 0 | 32 | 1,036 |
| 5 | 41 | 1,055 |
| 10 | 50 | 1,073 |
| 15 | 59 | 1,092 |
| 20 | 68 | 1,111 |
| 25 | 77 | 1,130 |
| 30 | 86 | 1,148 |
| 35 | 95 | 1,167 |
| 40 | 104 | 1,186 |
| 45 | 113 | 1,204 |
| 50 | 122 | 1,223 |
| 55 | 131 | 1,242 |
| 60 | 140 | 1,260 |

c. Procedure.

(1) **GENERAL.** Oil within the mechanism becomes sluggish at low temperatures, hence its action through the small orifices is erratic and the reliability of measurements is doubtful. When pressure must be measured in cold weather, both the recoil mechanism and extra recoil oil must be kept in a room warmed to at least 50° F for 24 hours preceding the test. Provide a clean place to lay all tools and equipment required. See that all tools, containers, and oil are free from sand or dirt. Contaminated oil *must not* be put into the mechanism.

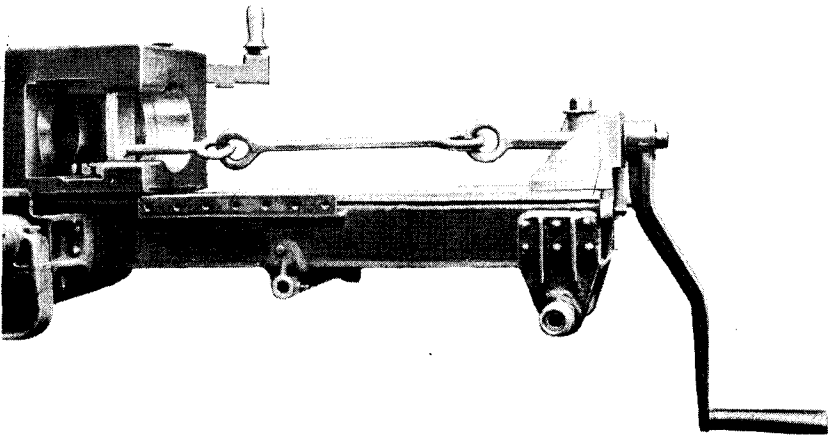
INSPECTION



RA PD 85030

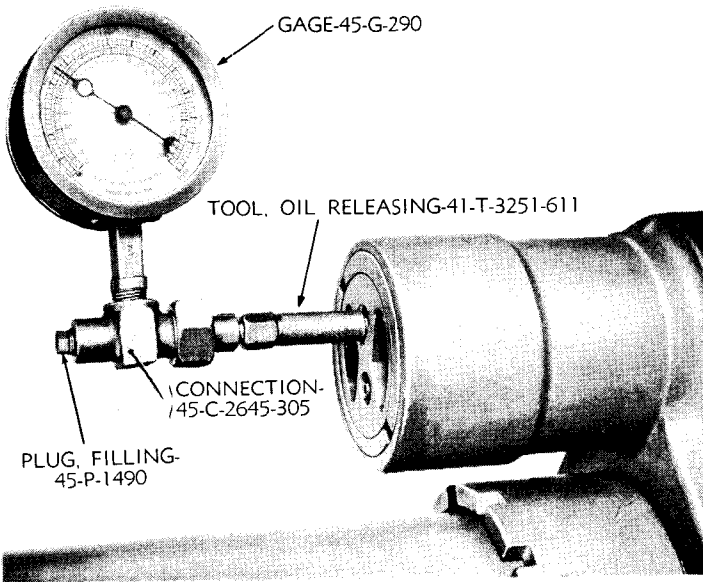
Figure 16 — Retracting Jack and Method of Clamping to Cradle

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CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 45009

Figure 17 — Retracting Jack in Position for Retracting Howitzer Tube



RA PD 87859

Figure 18 — Measuring Nitrogen Pressure With Howitzer Tube in Place

INSPECTION

(2) USING THE RETRACTING JACK.

(a) Bring the howitzer to zero degree elevation. See that the recoil slides are clean and well lubricated.

(b) Connect the retracting jack 41-J-159-160 (figs. 16 and 17).

(c) Remove the plug from the recuperator cylinder front head and screw in its place oil releasing tool 41-T-3251-611 (fig. 18). Draw off any oil reserve that may be in the mechanism and catch it in the thermometer cup. After several minutes, read and record the temperature. The thermometer reading is the temperature inside the recoil mechanism.

(d) Attach the pressure gage connection and the pressure gage 45-G-290 to the end of the oil releasing tool but do not tighten.

(e) Turn the crank until oil leaks from around the threads of the plug. This will "purge" the line (remove air from the oil). Tighten the plug.

NOTE: *All joints must be absolutely oil tight when making the test.*

(f) At this point, the end of the oil index in recuperator cylinder head will be near the bottom of the counterbore which indicates no reserve. By turning the crank, retract the howitzer until the oil index stops moving. At this point, the oil index will be slightly beyond the face of the cylinder head which indicates full reserve. While turning slowly—at the rate of four turns per minute—read the gage. The gage hand will be stationary and the reading will represent $P + F$, or gas pressure plus floating piston friction. **CAUTION:** *Readings must be taken as close to the exact time the index stops moving as possible, and the gage should be tapped lightly with fingers to insure that the gage hand movement is complete.* Continue to turn the crank approximately five more turns.

(g) Reverse the motion of the crank to counterclockwise and while turning at the same rate—four turns per minute—read the gage when the gage hand becomes stationary (at approximately the fifth turn). This reading represents $P - F$ or gas pressure minus floating piston friction.

(h) Example—computation of gas pressure:

| | |
|---|------------|
| Temperature of recoil oil (step (c), above) | 68° F |
| Gage reading, $P + F$ (step (f), above) | 1,235 psi* |
| Gage reading, $P - F$ (step (g), above) | 1,037 psi* |
| Add these gage readings together | 2,272 psi* |
| Then divide by 2 | 1,136 psi* |

Gage pressure is considered satisfactory at 125 pounds per square inch above or below the pressure shown in table I for corresponding temperature readings. The table shows that at 68° F the pressure should be 1,111 pounds per square inch. Allowable limits for this

*Pounds per square inch.

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temperature are from 986 pounds per square inch to 1,236 pounds per square inch. The reading 1,136 pounds per square inch falls within this range and is therefore acceptable. Should the pressure not come within this range, replace the recoil mechanism.

(3) USING SCREW JACK.

(a) Level the sleigh and cradle and remove the howitzer from the carriage.

(b) Disconnect recoil piston rod by removing recoil piston rod outer nut.

(c) Push sleigh back on cradle guides until rear ends of sleigh rails project back of the rear end of the cradle about 5 or 6 inches.

(d) Remove recoil cylinder respirator assembly B195116, using wrench 41-W-1999-300 (fig. 19).

(e) Assemble screw jack in the rear of the recoil cylinder and screw the nut up firmly against the recoil cylinder (fig. 20). *NOTE: Before installing, be sure the screw of the jack is backed out until the jack head contacts the nut.*

(f) Drain the reserve oil, install the pressure gage (fig. 21), and proceed as described in subparagraphs c (2) (c) through c (2) (h), above. *NOTE: Operation of the screw jack will retract the recoil mechanism only, since the howitzer was removed from the carriage in step (3) (a), above.*

d. Determination of Serviceability or Unserviceability of Recoil Mechanisms. Recoil mechanisms will not be condemned as unserviceable because of low nitrogen pressure until the mechanism has been test-fired, except when the loss in pressure is such that firing might result in damage to the recoil mechanism. The following detailed steps will be taken in analyzing the serviceability of a recoil mechanism with low pressure.

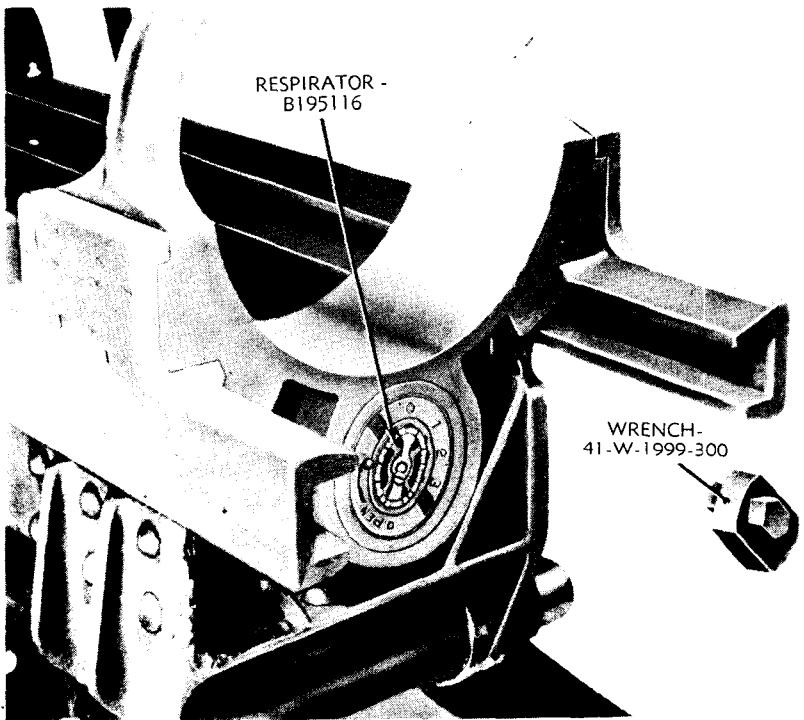
(1) If results of the manometer test indicate that the minus deviation from normal pressure (table I) is less than -100 pounds per square inch, the mechanism will be considered serviceable without further test.

(2) If the minus deviation is greater than -100 pounds per square inch, the mechanism will be test-fired, except when the deviation is greater than -150 pounds per square inch.

(3) Mechanisms with pressure loss greater than -150 pounds per square inch will be considered unserviceable without further tests.

(4) To test-fire, the mechanism will be fired one round maximum charge at 10 degrees elevation. If the length of recoil exceeds 42 inches, firing will cease and the mechanism will be considered unserviceable. If the mechanism functions satisfactorily when fired at

INSPECTION



RA PD 80075

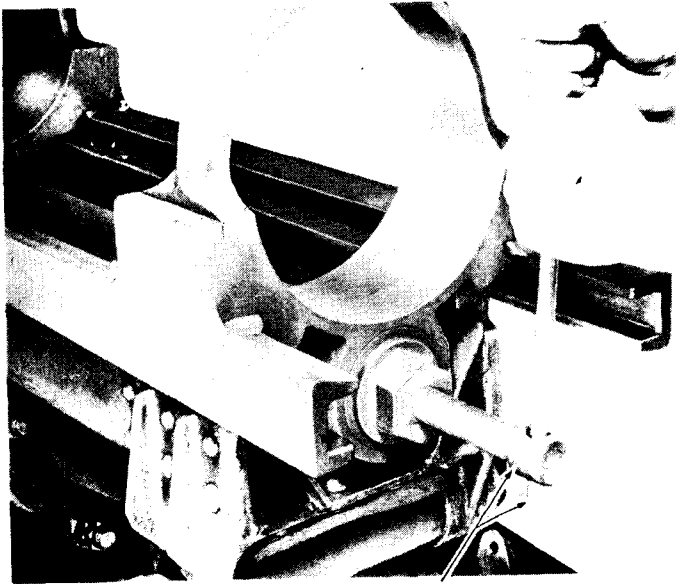
Figure 19 – Recoil Cylinder Respirator

10 degrees elevation, it will then be fired at 50 degrees elevation. If the length of recoil exceeds 43¼ inches, the mechanism will be considered unserviceable.

(5) The length of recoil will be measured on all test rounds and counterrecoil action should be carefully observed, since the usual effect of low nitrogen pressure is failure to return to battery. Counterrecoil should be smooth, and return into battery should be complete and with smooth buffer action, that is, without slam or shock. If the mechanism functions satisfactorily as determined by test-firing, it will be considered serviceable. A mechanism which fails to function satisfactorily will be declared unserviceable. If doubt as to serviceability exists, further rounds should be fired as deemed necessary.

(6) If the length of recoil is 44¼ inches or more, permanent damage will occur due to metal-to-metal contact between the recoiling parts and the nonrecoiling parts.

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JACK, SCREW-41-J-159-100

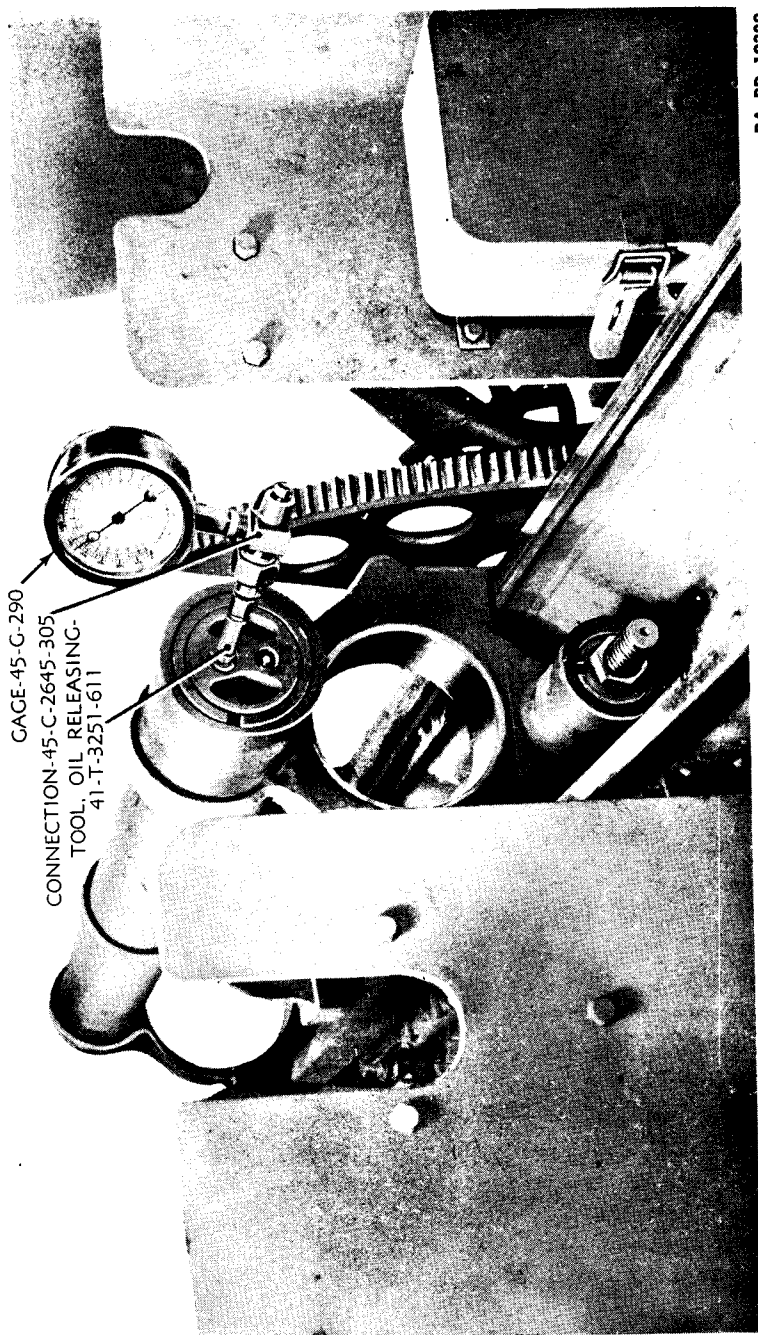
RA PD 19390

Figure 20 — Using Screw Jack in Manometer Test

(7) If test-firing cannot be accomplished because of inadequate facilities, disposition will be requested of the Chief of Ordnance (Zone of Interior) or Chief Ordnance Officer (Theater of Operation) on all mechanisms which require test-firing within the provisions of the above paragraphs.

e. **Evacuation of Recoil Mechanisms.** Immediate evacuation of unserviceable recoil mechanisms through normal ordnance channels is to be accomplished, as a continuing supply of mechanisms depends on prompt evacuation of unserviceable mechanisms to overhaul facilities. Precautions will be taken to see that the assembly arrives undamaged from corrosion or handling. All exposed and threaded portions of the mechanism, including the recoil piston rod, will be covered with preservative material. The respirator will be sealed with tape. The recoil piston rod will be wired in place to prevent displacement in transit. Recoil mechanisms will be evacuated in crates or boxes similar to those in which they are received. Crates are to include supports to prevent bending of recoil piston rod.

INSPECTION



RA PD 19389

Figure 21 — Measuring Nitrogen Pressure With Howitzer Tube Removed

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CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4****12. EMULSIFIED OIL.**

a. Emulsified oil in a hydropneumatic recoil mechanism may be due to either or both of the following causes:

(1) **IMPROPER FILLING TECHNIQUE.** Reestablishing of the reserve oil may cause some air to be forced into the mechanism. In this case, the emulsion will usually not be excessive and will not affect the serviceability of the mechanism. Repeated forcing of air into the recoil oil during reestablishment of the reserve oil will result in a serious emulsification of the oil which will affect the recoil and counterrecoil action of the mechanism.

(2) **NITROGEN LEAKAGE PAST THE FLOATING PISTON.** In cases where the nitrogen is leaking past the floating piston, the degree of the emulsion may be such as to cause overrecoil and an unsteady throttling effect resulting in sudden and serious strains to the recoil mechanism.

b. If the oil released from the recoil mechanism comes out sputtering and foaming, there is probably a leakage of nitrogen past the floating piston. If there is any doubt as to whether the emulsification is due to a leakage of nitrogen past the floating piston, the mechanism should be completely drained of the emulsified recoil oil and refilled. If the recoil oil again becomes emulsified, nitrogen is leaking past the floating piston.

c. Leakage of nitrogen past the floating piston resulting in emulsification of the recoil oil may or may not be indicated by low nitrogen pressure. A combination of low nitrogen pressure and excessive emulsification of the recoil oil is a good indication of leakage past the floating piston. Leakage of nitrogen past the floating piston is a progressive condition which can only be corrected by overhaul in authorized recoil overhaul shops. If it is established that emulsification of the recoil oil is due to leakage past the floating piston, the recoil mechanism will be declared unserviceable.

13. MAINTENANCE OF RECORDS FOR RECOIL MECHANISMS.

a. A complete and accurate record of recoil mechanisms must be kept in the Artillery Gun Book (O.O. Form 5825). The following information should be entered:

(1) The serial number, model number, complete designation, manufacturer, date of manufacture, and period of service.

(2) Record of all Modification Work Orders performed on recoil mechanism.

(3) Record of all parts broken, repaired, or replaced.

(4) Complete record of all inspections.

INSPECTION

b. If the recoil mechanism is separated from the howitzer, the records pertaining to it shall be extracted and kept with the item. These records will be entered on a plain sheet of paper, headed "Recoil Mechanism Record," and will include the following information:

(1) Serial number, model number, complete designation, manufacturer, date of manufacture, and period of service.

(2) Caliber, serial number, model number, designation, manufacturer, and date of manufacture of weapon with which the recoil mechanism was used.

(3) Number of rounds fired while recoil mechanism was in use.

(4) All entries made in gun book pertaining to subject recoil mechanism.

c. At the time a recoil mechanism is declared unserviceable, the cause will be entered in the records and signed and dated by the condemning officer.

d. When the recoil mechanism is to be shipped, the recoil mechanism record will be placed in a waterproof envelope and attached securely to the mechanism with waterproof tape.

e. The recoil mechanism record will be attached to the recoil mechanism when it is placed in storage.

f. When the recoil mechanism is again mated with a weapon, the information contained on the recoil mechanism record will be entered in the gun book for that weapon.

14. CARRIAGE IN GENERAL.

a. Examine condition of all welds and rivets. See that there are no loose, broken, or missing plates, bolts, nuts, screws, or cotter pins. Check that all exposed parts are clean, free from rust, and properly lubricated. See that all parts are properly adjusted and tightened. Note when the carriage was last exercised.

b. Pay particular attention to condition of paint and general state of preservation. Note that paint has not deteriorated or become damaged, leaving exposed portions of bare or shiny surfaces and necessitating repainting. See that prescribed surfaces are well coated and that there is no paint on the bearing surfaces. Necessary lettering should be in blue-drab lusterless synthetic enamel. Lettering on name plates and direction plates should be legible.

c. Lubricating fittings should be clean and should function properly. They should be identified by $\frac{3}{4}$ -inch red circles.

d. Note whether all Modification Work Orders have been performed.

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15. LUNETTE AND DRAWBAR (par. 75).

a. Inspect the lunette for condition, particularly for excessive wear of loop, and tightness in drawbar.

b. Check rotational movement of drawbar assembly. This assembly should be free and movement should be unobstructed. Examine drawbar for cracks in metal and for bent portions. Try drawbar lock for hard places and for obstructions or undue looseness in the back and forth movement.

16. SPADES AND TRAILS (sec. XIV).

a. Examine spades for cracks and distortion, condition of welding and reinforcements, loose rivets, and excessive wear of metal in points.

b. Examine trails for straightness and welding along the seams. Examine trail handle, handspike bracket, cleaning staff supports, aiming post supports, handspike body, and cleaning staff bracket for condition of welding. Inspect trail traveling lock loop, pin, and cotter pins for wear and damage. Try trail traveling lock handle, hook, and latch. Latch should be free, but not loose. Note that handles and levers of staff supports press down without effort and go all the way down. Note that quick opening devices which hold handspike in traveling position function properly.

c. Check traveling lock brackets for proper adjustment and correct alinement with traveling lock shaft pieces.

d. Move left trail to open and closed position by use of handspike. Move right trail to open and closed position using drawbar. The trails should open and close without excessive play or binding at trail hinge pins. See that hinge pins are properly lubricated and not scored or badly worn.

e. Check tolerances of trail hinge pins as follows: Unlock trail traveling lock assembly and open trails to a parallel position, making sure that traveling lock shaft pieces and traveling lock brackets are not engaged. Fasten a rope loop around the rear end of the trail. Attach to hoist and raise until trail clears the floor approximately 2 inches. Take hold of spade and move trail up and down. If any movement is noted other than the natural spring in the trail, measure clearance between trail hinge pin and equalizing support (par. 73).

f. Clearance between the bearing surface on the front end of the trail and the axle lock lever assembly should be 0.004 inch. A piece of notebook paper is approximately 0.004 inch thick.

INSPECTION

17. AXLE, EQUALIZING SUPPORT, WHEELS, AND TIRES.

a. Inspect axle and equalizing support for alinement. A bent axle or equalizing support should be replaced (sec. XV).

b. Inspect welding around tow hooks and all machined surfaces noting burs and rust spots.

c. Rotate axle lock lever assemblies to open and closed positions. Assemblies should operate freely. Note any burs, rust spots, or excessive looseness. Lock shaft guide screw A157025 and nut BBDX1E sometimes become loose and work down, obstructing movement of the traveling lock assembly. These are to be adjusted in the manner prescribed in paragraph 83.

d. Clearance between equalizing support gib bearings should be approximately 0.004 inch for ease of movement during firing. This may be determined by inserting a piece of notebook paper between the bearing surfaces.

e. To check the hand brakes, it is necessary to jack up the wheels. Using one hand, spin the wheel vigorously; at the same time, using the other hand, slowly pull back on the hand brake lever assembly, "feeling" the brake take hold and observing the reaction on the wheel. The brake when properly adjusted should begin to take hold when the lever assembly has moved about 1 inch from the "off" position and the wheel should be completely stopped in approximately one more inch of travel.

f. Wheels will first be checked for alinement. Wheels out of alinement will cause uneven wear of the tires. (This is usually the first indication.) The straightness of the wheels and rims and tightness of the lug nuts are to be noted. Note that valves are serviceable and have valve caps.

g. Tires are to be inspected for breaks in the side walls and uneven wear of the tread. Correct inflation is very important. Low air pressure will cause the side wall to break down and the rim to cut the tube. Commercial tires size 7.50 x 24 are inflated 40 pounds per square inch. Combat tires 9.00 x 20 are inflated 40 pounds per square inch.

18. PINTLE.

a. The general inspection of the pintle bearings and bearing surfaces may be done by spreading the trails. Unlock traveling lock strut assembly and level the tube. Traverse the piece to the right and left. Undue binding or obstruction of movement may be caused by pintle pin being too tight, burs on the bearing surfaces, rust, and improper lubrication (par. 65). NOTE: *In the early production of*

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105-mm Howitzer M2A2 Carriages, the pintle bushings B167152 and B167151 have not been doweled to the top carriage. This allows the bushings to rotate, causing misalignment of the lubricating holes. Subsequent lack of lubrication results in seizing.

b. The pintle support bracket will be inspected for looseness of the pintle support nut and screw. The pintle support screw may work free and be lost during traveling. This will allow the pintle support nut to work loose.

19. TRAVERSING MECHANISM.

a. **General.** Traverse the howitzer through complete range, noting whether mechanism operates freely—no “high spots.” Check traversing handwheel for tightness on shaft, by attempting to move it along the shaft, and for backlash. Backlash should not exceed one-quarter turn of the handwheel (pars. 61 and 63). Check bolts and screws for tightness. Check brackets for tightness, cracks, or other damage.

b. Worm and Rack Traversing Mechanism.

(1) Check traversing rack top face for trueness, by clamping a bracket on the equalizing support and suspending a dial indicator from bracket. Swing the rack around its complete travel. The surface should not be out of level more than 0.001 inch.

(2) Check rack for worn or damaged teeth. Note that pointer is not worn or damaged. Check worm shaft for wear or damage.

20. ELEVATING MECHANISM.

a. Elevate and depress howitzer through complete range, noting whether mechanism operates freely—no “bind.” Check right and left elevating handwheels for tightness on shafts and backlash. Maximum allowable backlash in each elevating handwheel controlling relative motion of spur pinions and arcs is one-quarter turn (par. 48).

b. Inspect gear cases and gear case screws for cracks and tightness. Examine flexible joints for wear on shafts. Check worm wheel shaft and gears for worn bushing and bearings. Check elevating cross shaft for wear in elevating cross shaft housing bushing.

c. Inspect elevating arcs for damaged teeth and for wear.

21. EQUILIBRATOR.

a. Check action of equilibrator by depressing and elevating howitzer through complete range.

INSPECTION

b. Inspect inner and outer springs and spring seats for cracks and proper placement (par. 34). Inspect fulcrum for cracks and other defects. Inspect nuts on equilibrator guide rods for fit on threads.

22. FIRING MECHANISM.

a. Check operation by pulling lanyard cord. Note operation of firing shaft pawl. Inspect firing shaft and lanyard for wear or damage (par. 44). Examine firing shaft guide bracket for wear and alinement with firing shaft.

23. SHIELDS.

a. Inspect the auxiliary shield for loose nuts in panoramic telescope case. All brackets are to be kept tight at all times. Inspect all hinges for worn or broken units. Hinge pins must be inspected for wear and missing cotter pins. Examine the surface of the shield for cracks. These are to be welded as prescribed in paragraph 39. The traveling lock latches for the bottom flap are to be inspected for wear of the pin and weakness of the spring.

24. CRADLE LOCK STRUT.

a. Inspect brace which locks strut in traveling position for cracks and excessive wear. Inspect turnbuckle for cracks. Examine nuts for burrs and thread fit. Examine cradle lock piece for burred threads and for excessive wear on strut hinge pin. See that strut support latch assembly operates properly.

25. SIGHTING AND FIRE CONTROL EQUIPMENT.

a. Check for completeness. Any missing, broken, or bent parts should be noted and action should be initiated for immediate replacement. Note condition of paint and freedom from dirt. Check instruments for security on carriage and alinement with howitzer bore. Check that clamp and wing nuts are serviceable.

b. Note that bearing surfaces are clean and only lightly lubricated. Check graduations and indexes for legibility. Note that watertight seals are unbroken. Check to see that level vials are serviceable, unbroken, tight in mounting, and covered when not in use.

c. Check handwheels and knobs for ease of operation. Operate cross leveling and longitudinal leveling mechanisms through entire range. Mechanisms should work freely without excessive lost motion and should be free from binding.

d. Look through instrument noting any evidence of chipping, fungus, separation, dirt, grease, finger prints, moisture, and scratches on lenses or prisms. Note condition of horizontal and vertical cross lines and scales on reticle. Looking through eyepiece, note if reticle

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hairs are vertical and horizontal, respectively, and if field of view is clear. Looking through objective end, check for dirt or fungus growth inside system. Check for frost patterns. Check eyepiece assembly for looseness and note condition of eyeshield, covering caps, and filters.

e. Check instruments for parallax. Focus telescope on a sharply-defined object at least 100 yards distant. Move eye from side to side and up and down, while observing the target and the reticle simultaneously. If there is any apparent jump or flicker of the reticle in relation to the target, parallax exists.

f. Operate azimuth worm through entire range. Check amount of backlash, binding, or looseness. Operate worm release lever, noting if spring holds worm in mesh as worm knob is operated. Measure amount of backlash in the following manner: Zero all scales, fix cross hairs on definite target, turn azimuth knob until head rotates approximately 600 mils, turn azimuth knob in opposite direction until cross hairs return to target (*do not overpass*), and read micrometer scale. The difference in reading is amount of backlash. Repeat in opposite direction. If instrument has 1½ mils or more backlash, it should be repaired.

g. Operate elevating worm knob through entire range. Check for binding or looseness and number of turns above and below center (should rotate three each way). Check for backlash.

h. Check instrument light cables and sockets for looseness and short circuits. Remove battery holder caps and examine for corrosion or broken or missing parts. Check for proper illumination of scales, level vials, and reticle.

i. **Gunner's Quadrant.** Check gunner's quadrant for completeness, legibility of scales, freedom from dirt and grit, condition of paint, security of vial in holder, and operation of micrometer knob.

(1) With the tube at zero elevation, check the error of the gunner's quadrant at zero setting as determined from the end-for-end test. Quadrant which has a difference in reading of approximately 1 mil when reversed should be adjusted. Note condition of four shoes as to burs, dents, rust, etc. Place each set of shoes, in turn, on leveling plates on howitzer tube. Shoes must prevent rocking of instrument and hold it in vertical plane.

(2) The arm and plunger on gunner's quadrant must operate without noticeable binding. Arm and plunger springs must have sufficient tension to hold arm and plunger rigidly in position. Teeth on plunger and frame must be clean and not damaged.

(3) Micrometer on gunner's quadrant should operate through entire range without binding or unnecessary looseness.

MAINTENANCE, GENERAL

(4) Collect all gunner's quadrants in a battery or battalion and check them against each other by comparing readings, after bubbles are leveled, when quadrants are placed on one piece. Make comparison at a low, medium, and high elevation. Any quadrant varying more than 0.3 mil from average reading should be corrected.

j. Using the gunner's quadrant as a test level, check the correctness of the cross and longitudinal level bubbles and of the elevation and site scales and indexes.

k. Bore sight on a testing target for adjustment of the sights for range, elevation, and direction. See that a serviceable testing target of correct dimensions for the weapon and sights is used.

l. Check carrying case for missing or broken straps and buckles and condition of leather and seams.

Section III

MAINTENANCE, GENERAL

26. GENERAL REPAIR NOTES.

a. Information and instructions contained herein are supplementary to instructions for the using arms contained in TM 9-325; however, operations covered in TM 9-325 are sometimes performed by ordnance maintenance personnel who should refer to TM 9-325 for proper instructions.

b. In this manual, the howitzer, recoil mechanism, and carriage are each covered as major units. Each major unit is further broken down into its main subassemblies. Each subassembly is completely disassembled. The subassemblies are then reassembled and replaced in their proper position on the major unit.

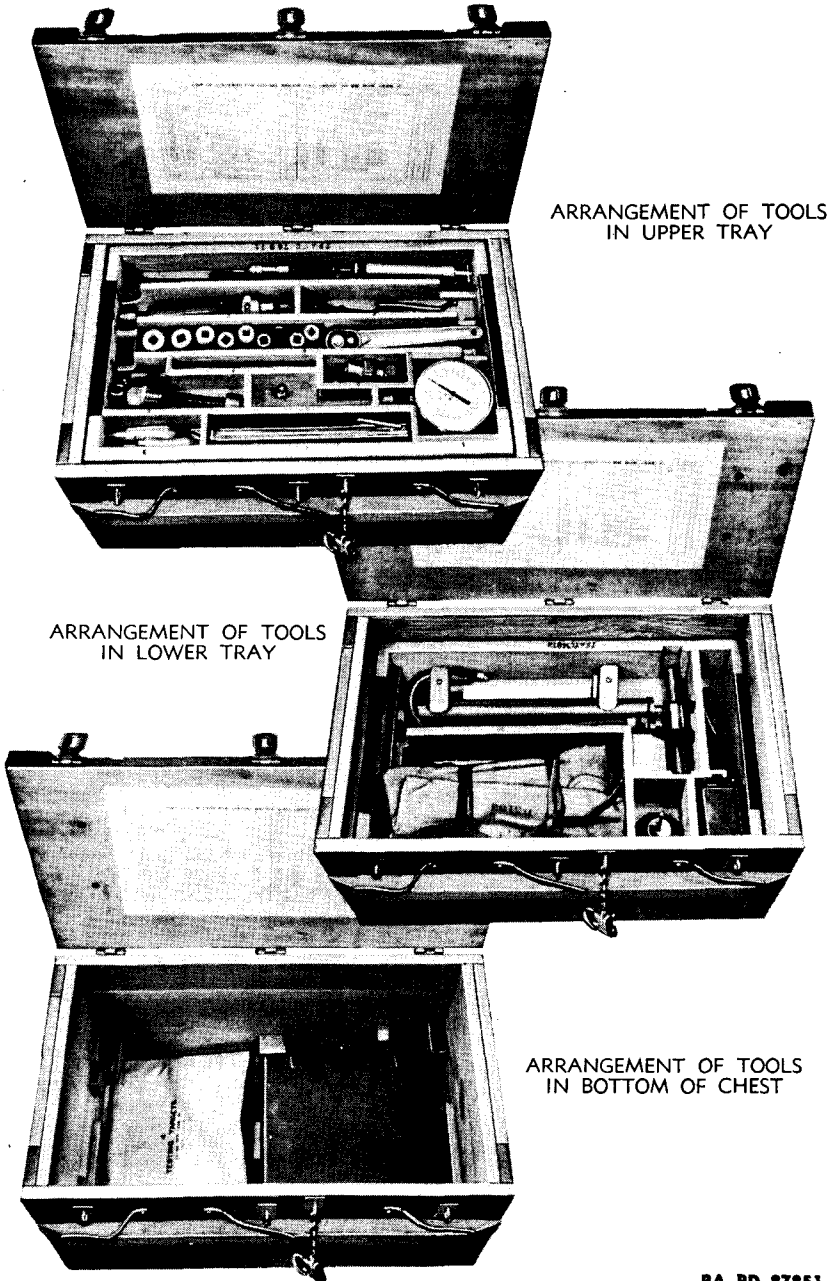
c. Assemble subassemblies before mounting them on the weapon. As a part of all assembly and mounting operations, clean and lubricate bearings, slide surfaces, threads, etc.

d. Where lubrication is indicated in the following instructions, refer to War Department Lubrication Order No. 5 for appropriate lubricants.

e. Use only wrenches that fit snugly on parts. Tools that do not fit will fail to tighten the part properly or cause damage to the corners of nuts, bolt heads, etc. There is also danger of spreading the wrenches and rendering them useless.

f. Except in emergencies, work requiring welding, riveting, and the making of new parts for major replacements will not be undertaken in the field.

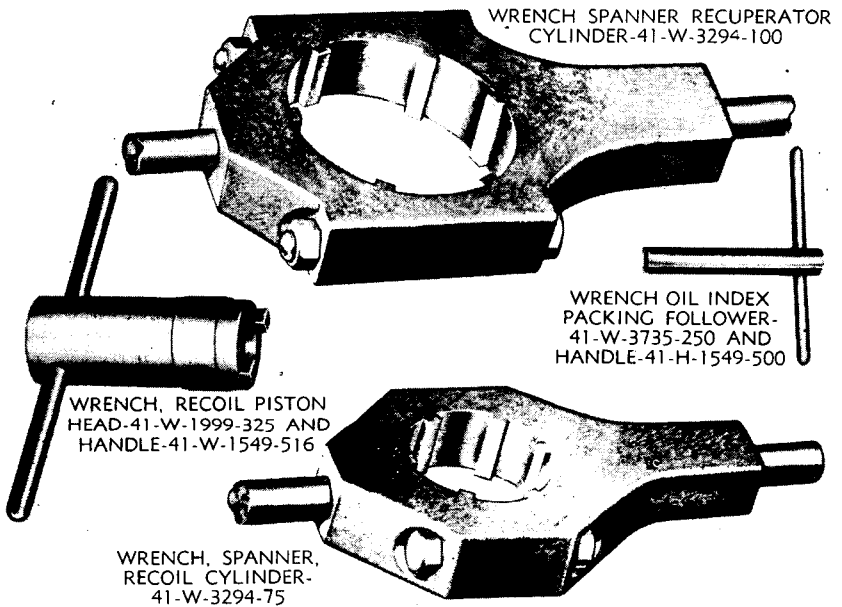
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RA PD 87851

Figure 22 — Special Repair Tool Chest

MAINTENANCE, GENERAL



RA PD 19388

Figure 23 — Tools for Maintenance of Recoil Mechanism

27. TOOLS FOR MAINTENANCE.

a. Special repair tools used for ordnance maintenance of the 105-mm Howitzer M2A1 and Carriage M2A2 are listed in SNL C-18. They are carried in special repair tool chest 41-C-868. The chest occupies a space of approximately 6 cubic feet. Dimensions over cleats and handles are approximately 19½ x 18 x 29½ inches (fig. 22).

b. Common tools used in maintenance and repair operations, such as chisels, drifts, files, hammers, pliers, screwdrivers, wrenches, and punches, the names or general characteristics of which indicate their uses and application, are not described or illustrated in this section.

c. **Tool Roll With Contents.** The Tool Roll M4 contains an assortment of tools for general use in work on the materiel. SNL C-18 lists the proper tools to be carried in this tool roll.

d. Tools of special design, not commonly used, are listed and their uses outlined below.

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| Tool | Use |
|--|---|
| WRENCH, oil index packing follower, 41-W-3735-250, with HANDLE 41-H-1549-500 (fig. 23) | Used to remove and install oil index follower when adjusting oil index packing (fig. 33). |
| WRENCH, recoil piston head, 41-W-1999-325 with HANDLE 41-H-1549-516 (fig. 23) | Used to adjust recoil piston head when correcting for oil leakage (fig. 36). |
| WRENCH, spanner, recoil cylinder, 41-W-3294-75 (fig. 23) | Special box-type spanner used for tightening recoil cylinder in recoil sleigh front yoke. Not used for disassembling cylinder, as this is prohibited. |
| WRENCH, spanner, recuperator cylinder, 41-W-3294-100 (fig. 23) | Special box-type spanner used for tightening recuperator cylinder in recoil sleigh front yoke (fig. 36A). Not used for disassembling cylinder, as this is prohibited. |

Section IV

HOWITZER

28. SCOPE OF MAINTENANCE.

a. Dismounting and mounting the howitzer is a using-arm operation and is described in TM 9-325.

b. Disassembly, replacement of parts, lubrication, and assembly of the breech mechanism and firing lock (figs. 24 and 25) is primarily the function of the using arm (TM 9-325).

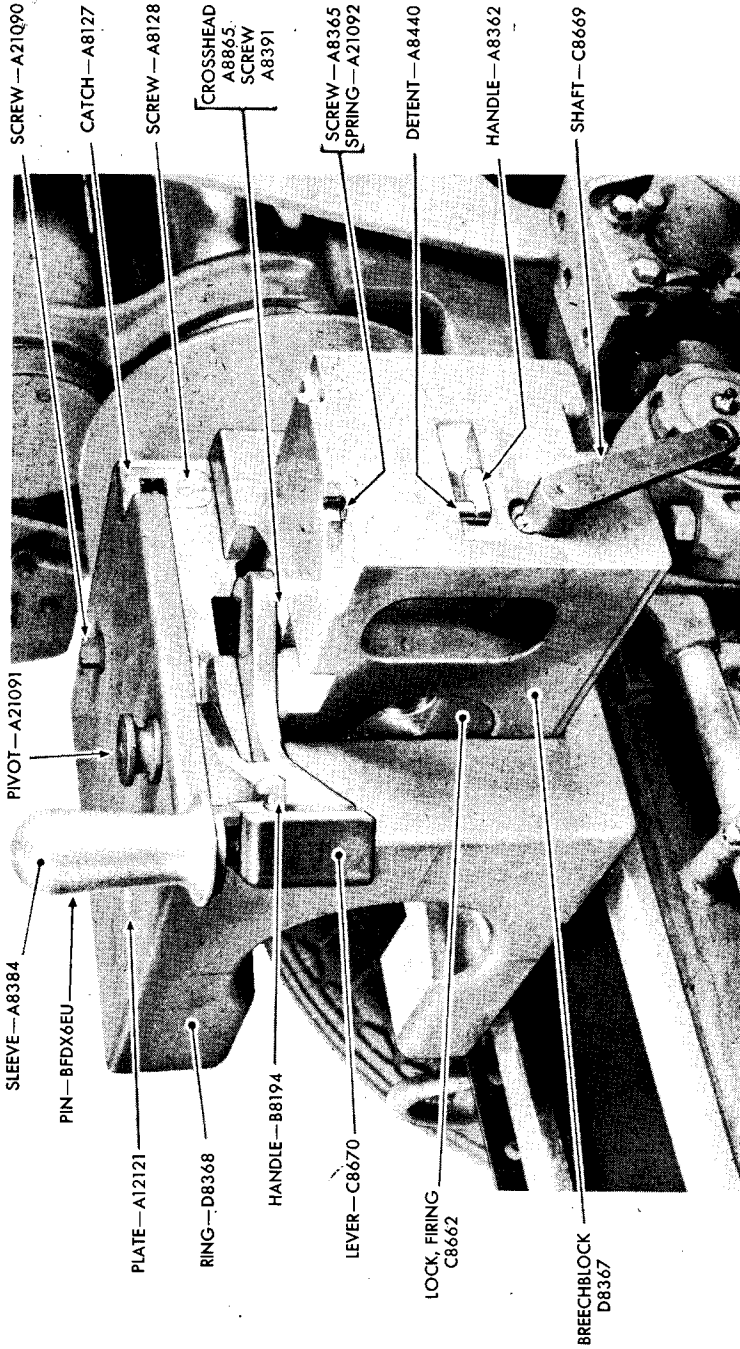
c. The maintenance and repair operations prescribed for ordnance maintenance personnel are given in paragraphs 29 and 30.

29. BREECH MECHANISM.

a. Failure of the breechblock to slide freely in the breech recess may be due to burs on the breechblock or in the breech recess. Remove burs with a smooth file and crocus cloth. *File and polish lightly, just enough to remove raised metal and to restore surface smoothness.* NOTE: *If breechblock assembly is replaced, examine new part carefully, as the breechblock for the 3-inch gun will install and is similar in appearance, but will not allow the insertion of a 105-mm cartridge case. The proper breechblock for the 105-mm howitzer is D8367A.*

b. Fouling of the firing pin may be caused by a worn firing pin hole in the breechblock bushing. Replace worn bushing.

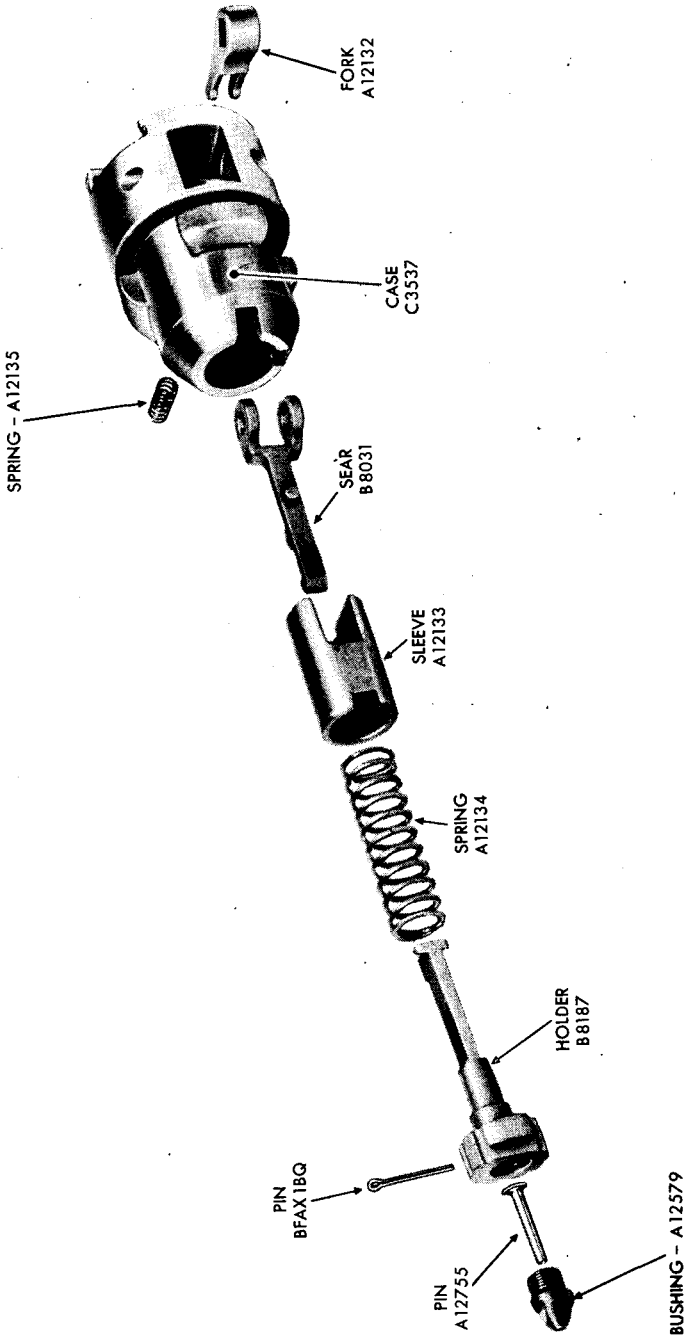
HOWITZER



RA PD 14482

Figure 24 — Breech Mechanism

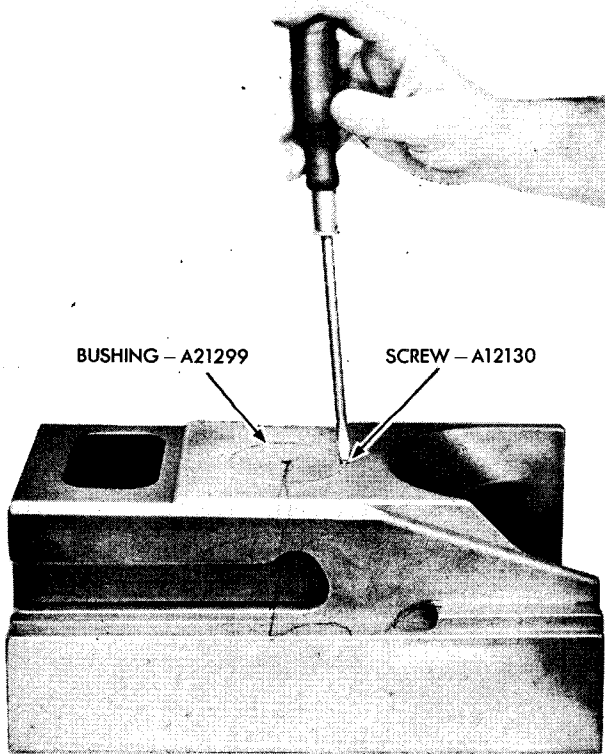
ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 13553

Figure 25 — Firing Lock — Exploded View

HOWITZER



RA PD 14744

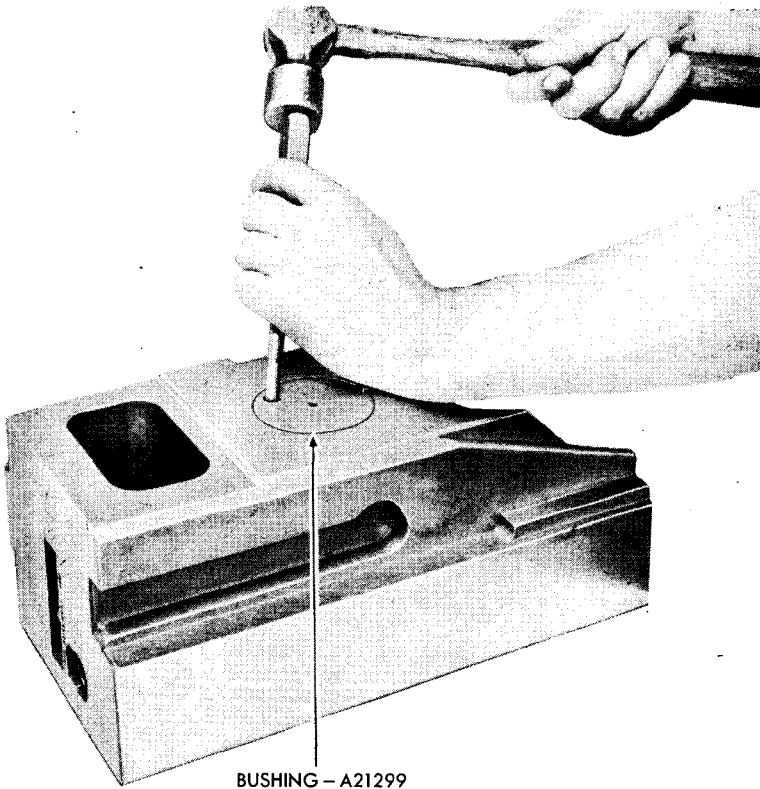
Figure 26 – Removing Breechblock Bushing Screw

- (1) Remove screw A12130 from breechblock bushing A21299 (fig. 26).
- (2) Remove bushing. If bushing is too tight to unscrew from breechblock, drill a hole in face of bushing large enough to insert a $\frac{3}{8}$ -inch drift. Unscrew by tapping drift with a hammer (fig. 27).
- (3) Install new bushing. Saw or mill bushing head flush with surface of breechblock. Drill and tap a hole (half in bushing and half in breechblock) for a 0.190-32NF-3X 0.40 screw.
- (4) File and polish the bushing face flush with the breechblock face.

30. TUBE AND BREECH RING.

- a. Damage to forcing cone, deformation of rifling, excessive number of pastilles, and other malfunctions make necessary replacement

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RA PD 14694

Figure 27 — Removing Breechblock Bushing

of tubes. *Unserviceable tubes* may be removed and replaced with spare tubes in accordance with the following instructions:

(1) Remove breech mechanism from the breech ring as described in TM 9-325.

(2) Remove the howitzer from the sleigh.

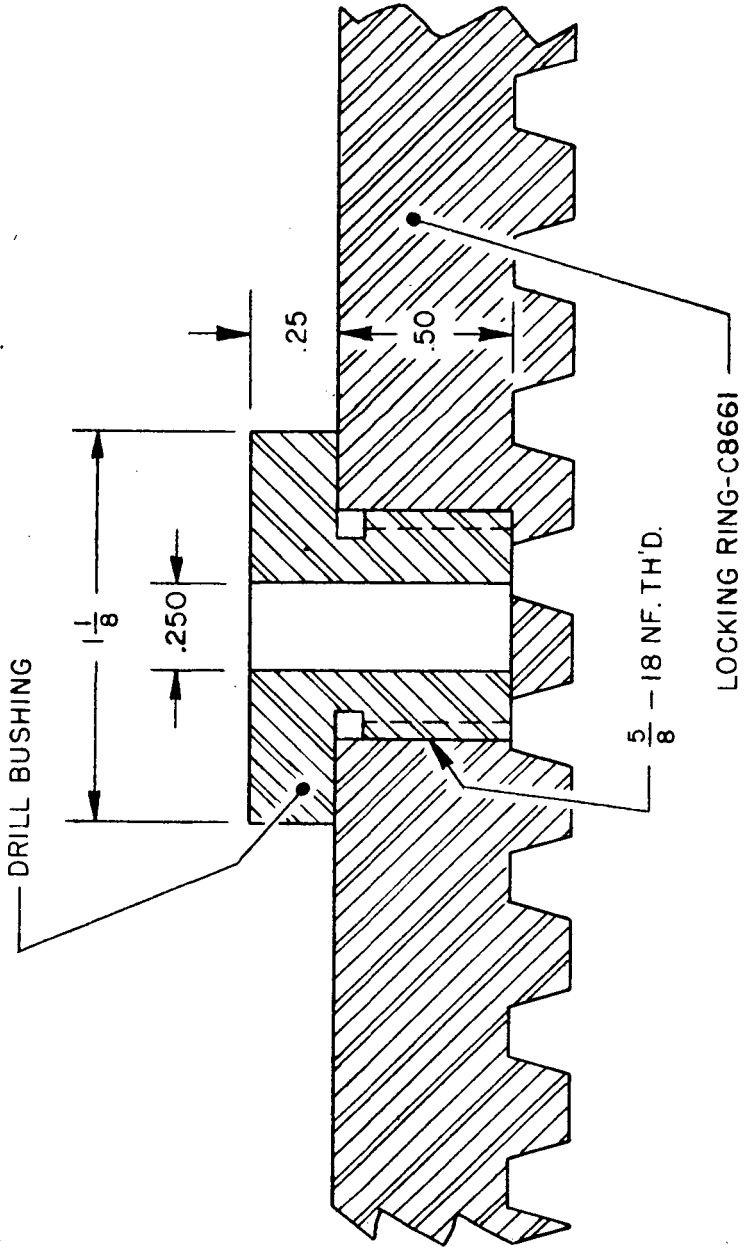
(3) With howitzer set up on blocks, remove lock screw A21090 from breech ring. Insert a suitable piece of timber through breechblock recess and strike the top side of the timber near the end sharply with a sledge to loosen the thread in a counterclockwise direction.

(4) To assemble spare tube, reverse the above procedure.

(5) Assemble howitzer to sleigh.

(6) After locking ring C8661 is seated, screw drill bushing (fig. 28) into one of the $\frac{5}{8}$ -18NF threaded holes in the ring (drill bushing

HOWITZER



RA PD 50375

Figure 28 — Dimensions of Drill Bushing for Drilling Hole in New Tube for Locking Ring Lock Screw

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CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4

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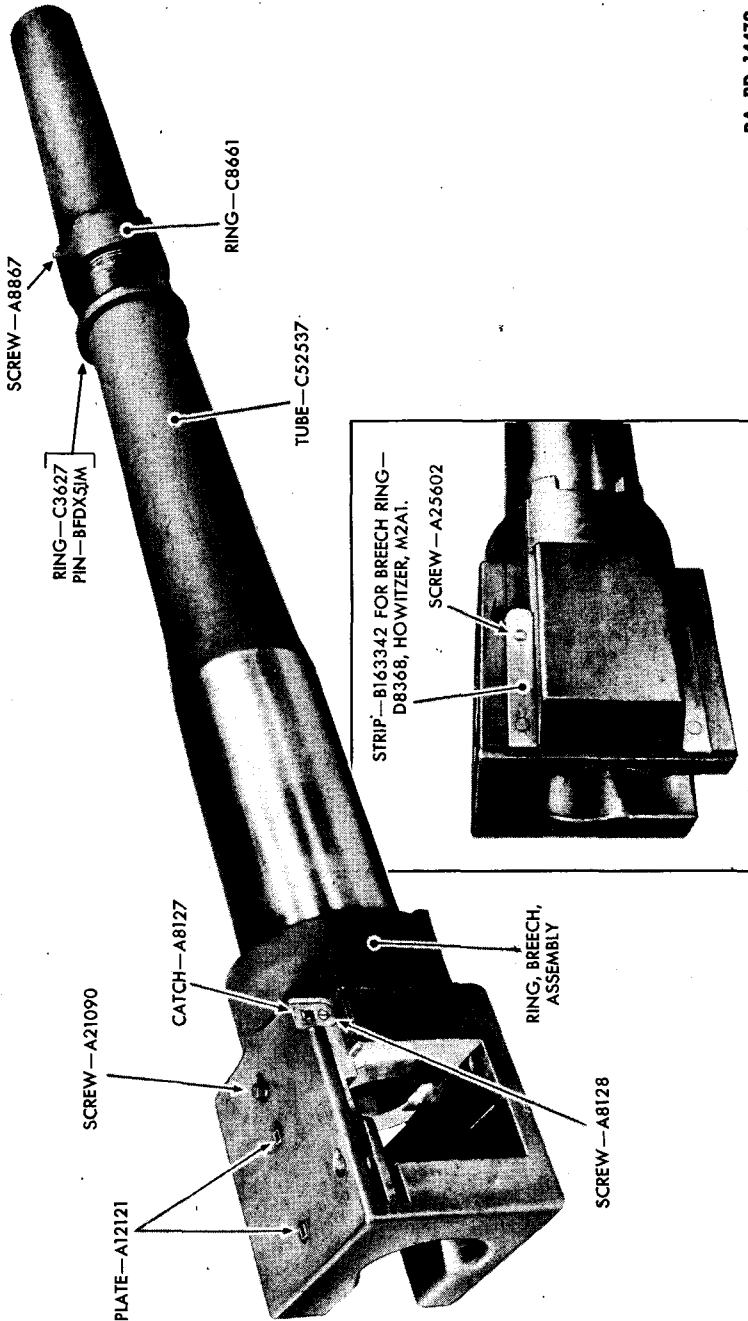
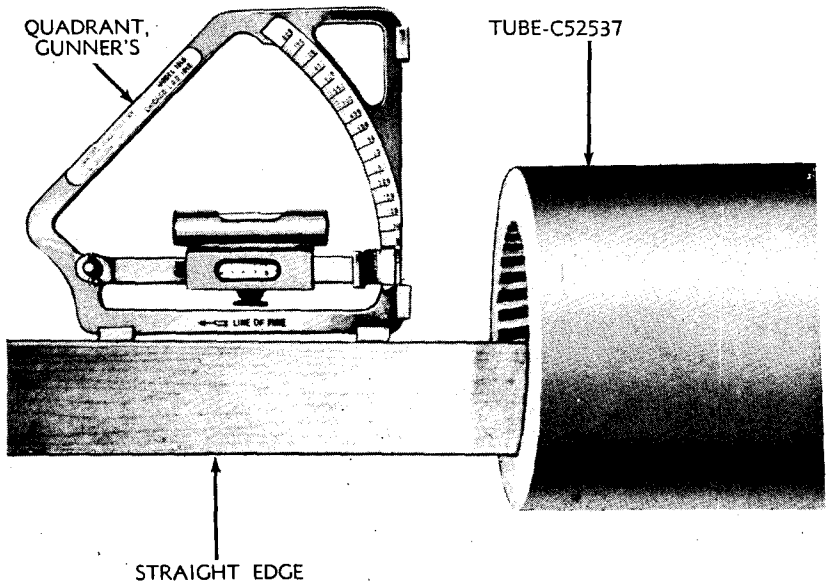


Figure 29 — Howitzer Tube and Breech Ring

HOWITZER



RA PD 87931

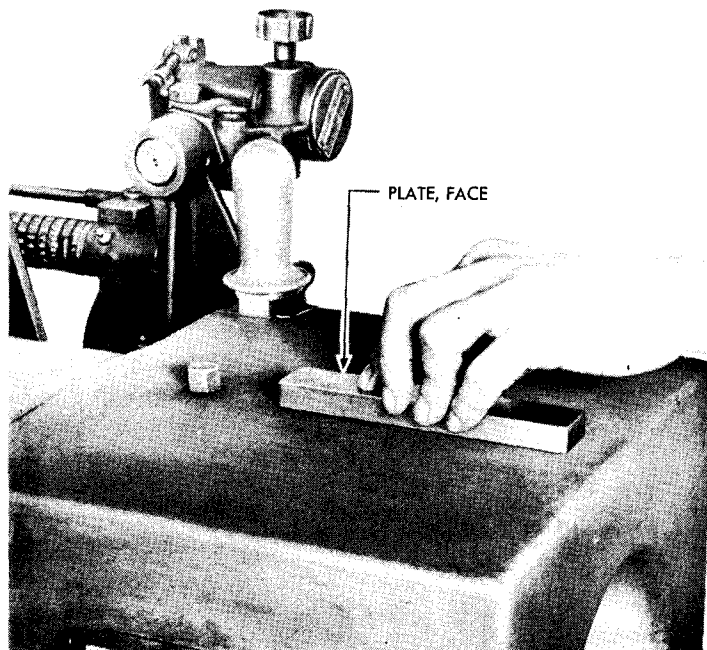
Figure 30 — Checking Alinement of Bore and Breech Ring Leveling Plates with Gunner's Quadrant

to be made locally). Drill centering hole to a depth of 0.375 inch, measuring from outside diameter of thread of tube, using 0.250 drill. Remove chips, then remove locking ring. Chip out any interfering threads to prevent the 0.500 size drill from walking. Use 0.500 + 0.002 reamer, and ream 0.500 hole to a depth of 0.375 inch to square up bottom of hole drilled in tube. The lock screw A8867 should bottom in the hole just before the thread portion is fully seated.

b. In mounting and dismounting the howitzer, the threads in the locking ring and the mating threads on the tube may be damaged. To repair, clean locking ring threads on tube and in locking ring thoroughly with dry-cleaning solvent. Remove burrs from threads on tube with smooth file and polish with crocus cloth. Replace a damaged locking ring.

c. The bronze bearing strips assembled in dovetailed slots in the bottom face of the breech ring (fig. 29) may become worn, pitted or scored, due to a foreign substance, such as dust, sand, etc., between bearing strips and cradle slides. Smooth off strips with a flat scraper and polish with crocus cloth in case of burrs. **CAUTION: Wash bearing strips with dry-cleaning solvent before and after polishing.** Replace worn or distorted bearing strips as follows: Remove screws

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RA PD 14727

Figure 31 — Checking Leveling Plates for High Spots

A25602 (fig. 29) and tap out bearing strip B163342. Drive new bearing strip in place with a small wood block and hammer. Insert screws and stake in place in three places. Using a flat scraper, scrape tops of screws flush with bearing strip. Polish with crocus cloth and clean with dry-cleaning solvent.

d. Leveling plates A12121 (fig. 29) in the top surface of breech ring are sometimes damaged by accident. Correct by filing or scraping as follows:

- (1) Bring the howitzer to zero elevation.
- (2) Place parallel straightedge in muzzle end of tube on lower side of bore (fig. 30). Place gunner's quadrant on the protruding end of the parallel straightedge and bring the howitzer exactly level. Turn the quadrant end for end and check the level.
- (3) Transfer gunner's quadrant to the leveling plates, taking a double reading by reversing quadrant on leveling plates. Remove metal, by filing and polishing, from the leveling plate toward which the bubble moves, until bubble is exactly centered.

RECOIL MECHANISM

(4) A flat, true surface or face plate large enough to cover both leveling plates (fig. 31), coated with prussian blue or white lead pigment, should be used to detect high spots, to insure that entire surface of each leveling plate is true, and that leveling plates are true one with the other.

Section V

RECOIL MECHANISM

31. SCOPE OF MAINTENANCE.

a. Dismounting and mounting the recoil mechanism—recoil cylinder, recuperator cylinder, and sleigh as a unit (fig. 32)—are using arm operations (TM 9-325).

b. Removal of the recoil cylinder or recuperator cylinder from the recoil sleigh may be performed at an arsenal or specially equipped base shop *only*. High pressures, present in the system at all times, make it extremely dangerous to attempt unauthorized disassembly. *Under no circumstances may an attempt be made to take the mechanism apart.*

c. The maintenance and repair operations prescribed for ordnance maintenance personnel are given in paragraphs 32 and 33. *All work on the recoil mechanism must be performed under the direction of an officer especially designated for this purpose.*

32. TROUBLE SHOOTING.

a. The most usual troubles requiring repair or adjustment by ordnance maintenance personnel are: oil index sticking, oil leakage, and failure of howitzer to return to battery.

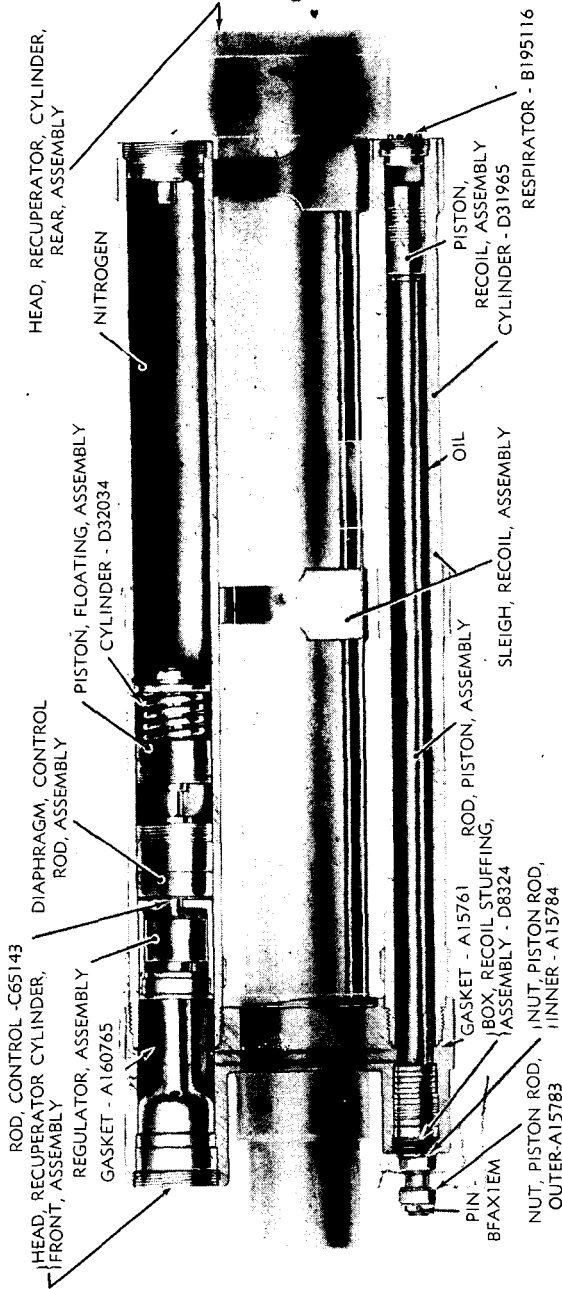
b. **Oil Index Sticking.** Failure of the oil index to move in or out as oil is added or withdrawn from the recoil mechanism is probably caused by too tight packing or defective packing.

(1) Elevate howitzer to maximum elevation. Drain off all reserve oil, then insert approximately one and one-half fills of the recoil oil (filler) gun. Tap oil index lightly with a clean stick as oil is being added. If this does not remedy the sticking, loosen follower (fig. 33). If the index still sticks, replace the packing as described below.

(2) Remove follower (fig. 33). Then insert recoil oil (filler) gun (fig. 34) and force the parts shown in figure 35 from the oil index recess.

(3) Install new packing and reassemble, making certain that the convex surface of the last spring removed (just to be replaced) faces outward, and that the convex surface of the middle spring is toward

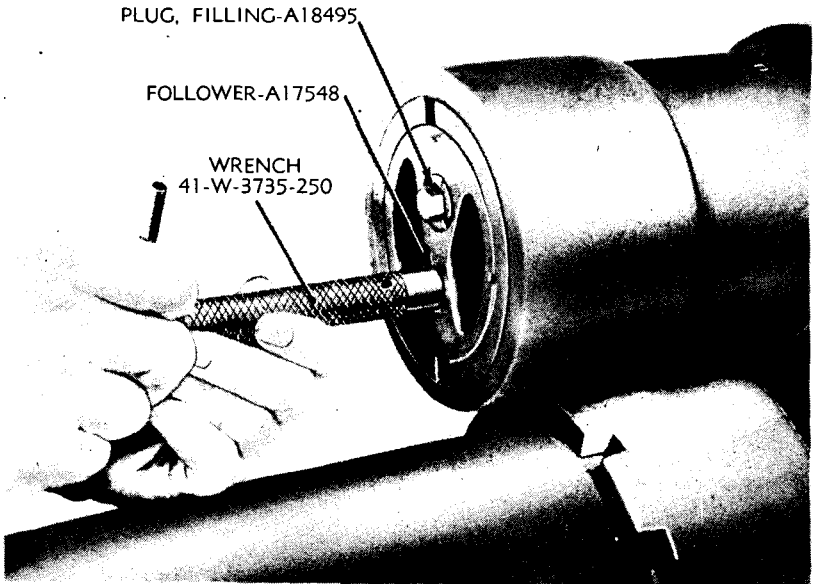
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RA PD 80077

Figure 32 — Recoil Mechanism M2A1 — Sectional View

RECOIL MECHANISM



RA PD 87860

Figure 33 — Unscrewing Oil Index Follower

the convex surface of the spring just inserted; and that the convex surface of the third spring is toward the outside and next to flat surface of the gland which follows. The concave surfaces of the glands follow the packing.

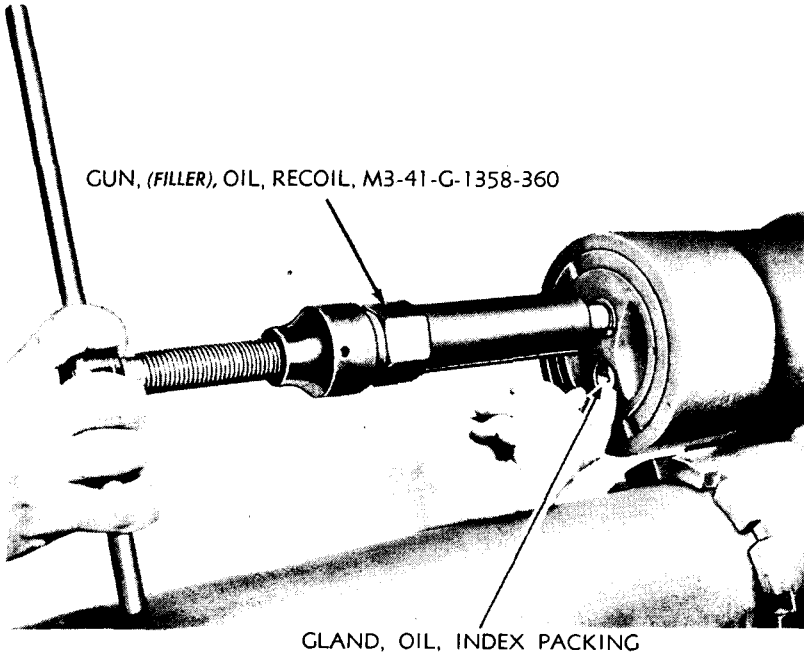
(4) Add reserve oil and observe action of oil index. If oil index still sticks, replace recoil mechanism with a new one.

c. **Oil Leakage.** Oil may leak past the recoil piston (at the rear of the recoil cylinder), past the recoil stuffing box (at the front of the recoil cylinder), past the filling plug (at the front of the recuperator cylinder), or at the union of the recoil and recuperator cylinders with the front yoke. **NOTE:** *Leakage alone will not affect the efficiency of recoil or counterrecoil, as long as reserve oil is present.*

(1) **OIL LEAKAGE PAST THE RECOIL PISTON.**

(a) Remove recoil cylinder respirator with respirator wrench 41-W-1999-300 (fig. 19). Remove screw from recoil cylinder wiper and remove wiper. Tighten recoil piston head *slightly* with recoil piston head wrench 41-W-1999-325 (fig. 36). **CAUTION:** *The recoil piston head must not be rotated more than one-fourth of a turn. Observe the original adjustment marked on the head to insure that the head is not turned more than one-fourth of a turn.*

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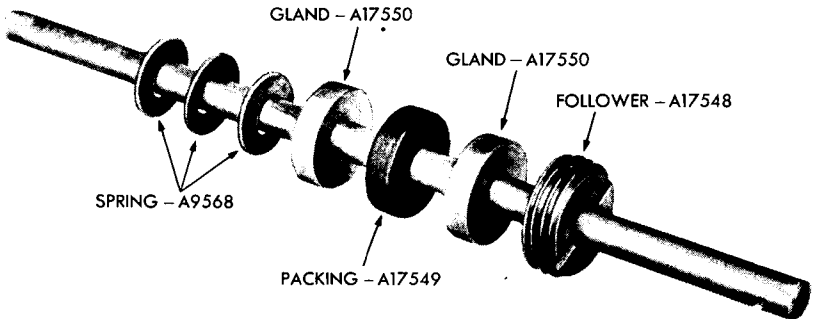


RA PD 87861

Figure 34 — Removing Oil Index Packing Gland

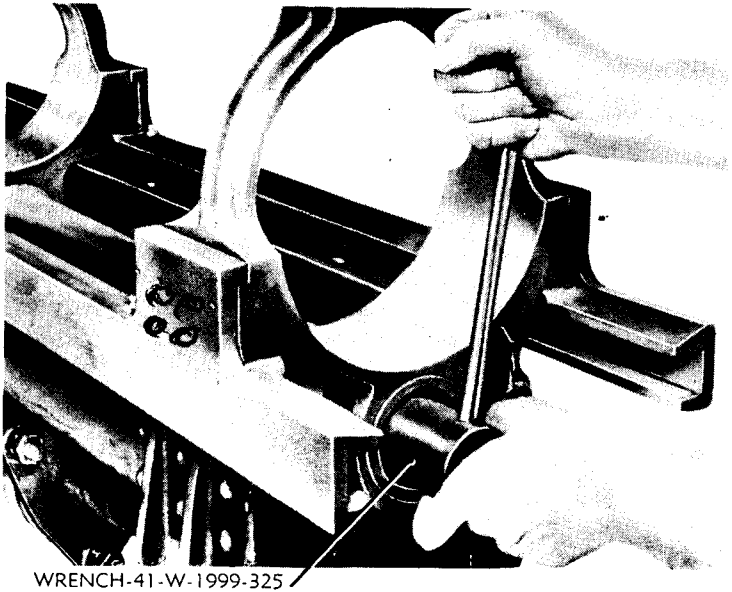
- (b) Replace wiper and screw and respirator.
- (c) Continuation of leakage indicates broken rings, deteriorated packing, or scored cylinder walls. Replace the recoil mechanism if it is necessary to add recoil oil so frequently that normal operation is hampered.
- (2) **OIL LEAKAGE PAST RECOIL STUFFING BOX.** Replace the recoil mechanism if it is necessary to add recoil oil so frequently that normal operation is hampered.
- (3) **OIL LEAKAGE PAST THE FILLING PLUG.**
 - (a) Elevate howitzer to maximum elevation and drain off reserve oil. Remove filling plug (fig. 33).
 - (b) Remove screw from retainer (fig. 37).
 - (c) Remove retainer. Use a strip of steel and an adjustable wrench (fig. 38).
 - (d) Remove gasket, valve, and spring (fig. 39). If examination shows gasket to be unservicable, replace it.
 - (e) Install parts exactly in the order shown in figure 39.

RECOIL MECHANISM



RA PD 14716

Figure 35 – Oil Index Follower, Glands, Packing, and Springs



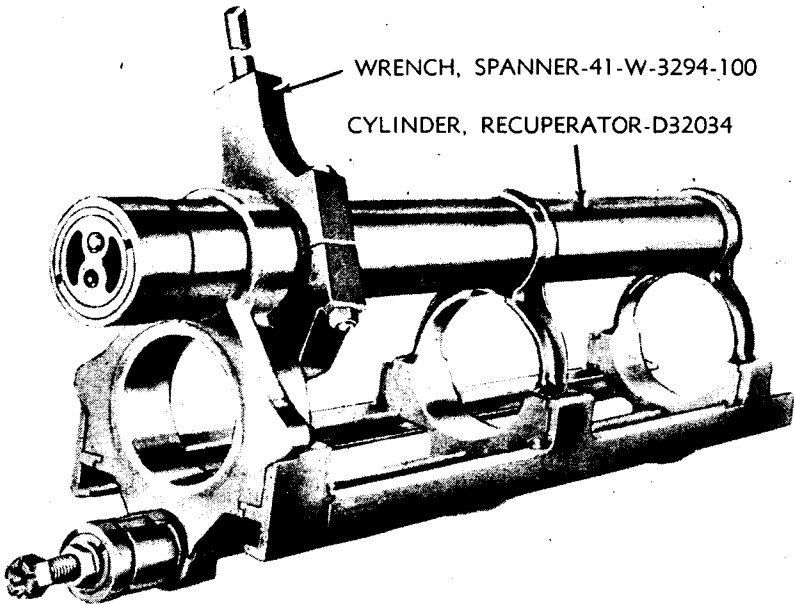
RA PD 87862

Figure 36 – Adjusting Recoil Piston Head

CAUTION: *Be extremely careful that no dirt gets into the mechanism. Take care that not a bit of dirt sticks on the valve and that its highly polished surfaces are not scratched at assembly.*

(4) **OIL LEAKAGE AT UNION OF RECOIL AND RECUPERATOR CYLINDERS WITH FRONT YOKE.** Loose cylinders will be detected by oil leakage at the union with the front yoke. Correct leakage by screw-

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RA PD 87933

**Figure 36A — Tightening Recuperator Cylinder in
Recoil Sleigh Front Yoke**

ing cylinders in tighter. Use wrenches provided for this purpose (figs. 23 and 36A). Do *not* attempt to remove cylinders from front yoke.

d. Howitzer Fails To Return Into Battery. The most usual cause is no oil reserve. Three other possible causes are: low nitrogen pressure, excessive frictions, and damaged slides, piston rod, or piston.

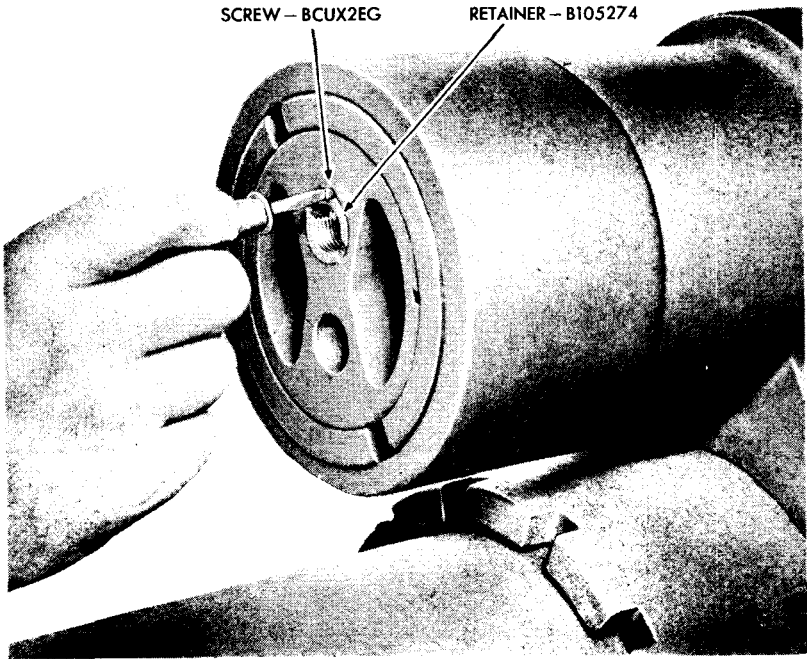
(1) **LOW NITROGEN PRESSURE.** The loss of gas pressure may occur either through cylinder head or past the floating piston. In the latter case, the reserve oil drained off will appear emulsified, the recoil oil (filler) gun will work easily (unopposed by pressure), and the oil index will fail to move out when oil is injected. If it is established that nitrogen is leaking past the floating piston, the recoil mechanism will be replaced (par. 12 e).

(2) **EXCESSIVE FRICTIONS IN RECOIL PISTON, FLOATING PISTON AND STUFFING BOX PACKINGS.** These will not be considered as affecting serviceability.

(3) **DAMAGED SLIDES, PISTON ROD, OR PISTON.**

(a) Repair damaged cradle guides as described in paragraph 54.

RECOIL MECHANISM



RA PD 14710

Figure 37 — Removing Filling Plug Retainer Screw

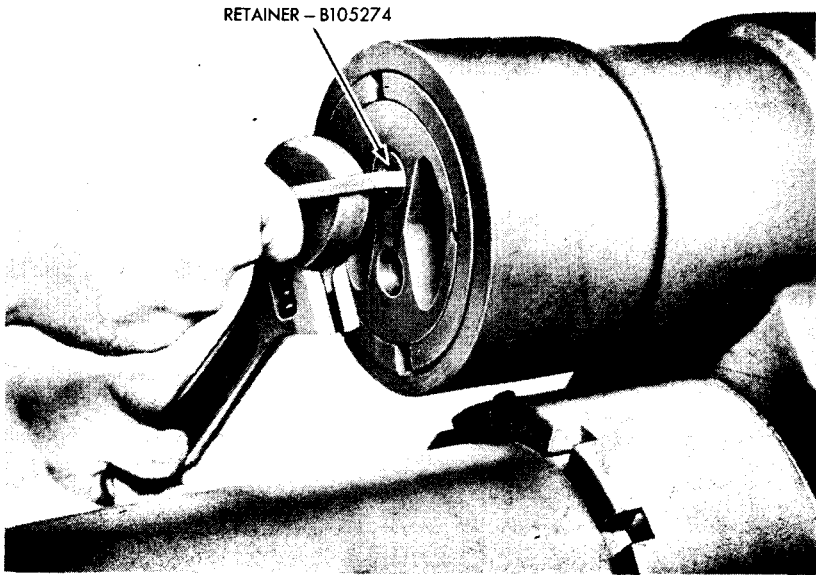
(b) To repair damaged sleigh rails, remove the recoil mechanism from the piece. Clean the bearing surfaces of the rails thoroughly with dry-cleaning solvent. Remove scores or bruises (fig. 40). After scraping, again clean rails thoroughly with dry-cleaning solvent. Check operation of lubricating fittings on rails to see that they are clean and open.

(c) If piston or rod is so scored that operation is hampered by excessive oil leakage or excessive friction, the recoil mechanism will be replaced.

33. REPLACEMENT OF RECOIL OIL.

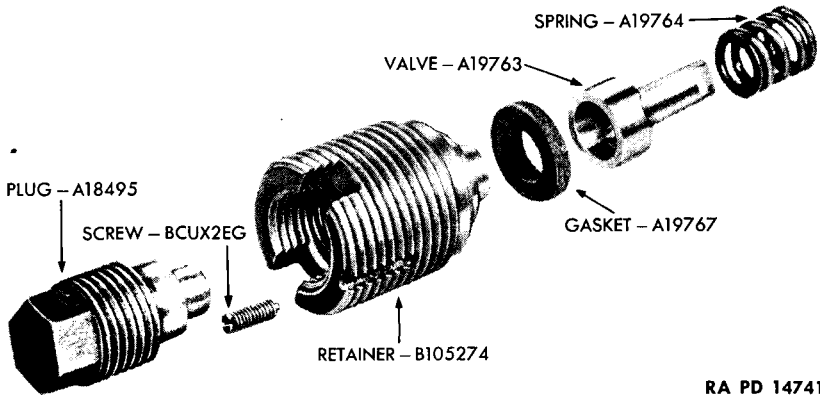
a. **General.** Recoil oil (special) is now available as an all-temperature recoil oil for use in the recoil mechanism. It has a distinctive bright green color for easy identification. When current stocks of recoil oil (heavy) are exhausted, recoil oil (special) will be used in its place by simple addition, as normal replenishment to recoil mechanisms already containing recoil oil (heavy). It will be unnecessary to remove recoil oil (heavy) from a recoil mechanism before adding recoil oil (special) for temperatures above 0° F. When

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RA PD 14782

Figure 38 — Removing Filling Plug Retainer

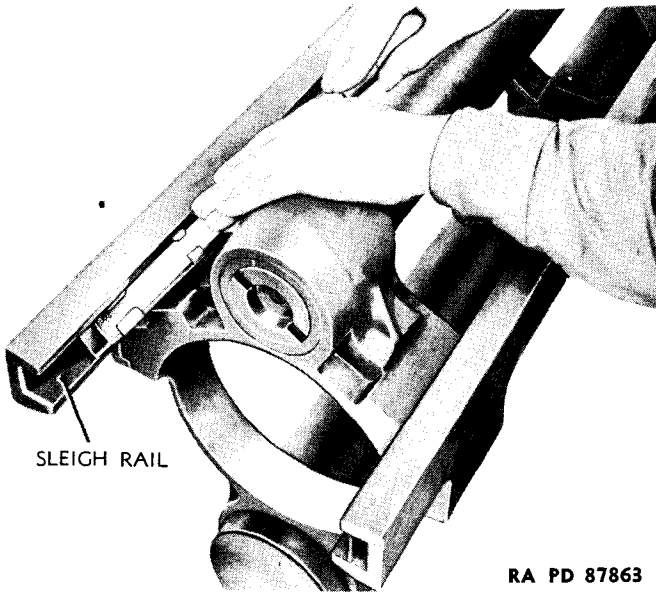


RA PD 14741

Figure 39 — Filling Plug and Retainer Parts

operating temperatures below 0° F are expected, it will be necessary to remove as much as possible of the recoil oil (heavy) from the recoil mechanism in accordance with the following instructions, and to change completely to recoil oil (special).

RECOIL MECHANISM



RA PD 87863

Figure 40 — Scraping Sleigh Rail

(1) Recoil oil (special) permits satisfactory recoil action of hydropneumatic recoil mechanisms at all temperatures down to at least -20° F or -30° F. At temperatures below -20° F, the howitzer is apt to hang out of battery at high angles of elevation on the first few rounds fired. This condition does not seriously impair the accuracy of fire, nor will it be the cause of damage to the materiel if corrected after the first few rounds fired. Such correction will usually occur automatically due to the warming up of the recoil oil by firing.

(2) Recoil mechanisms which are received filled with recoil oil (special) or which have been completely drained of recoil oil (heavy) and refilled with recoil oil (special) should not have recoil oil (heavy) added to them, as this will affect performance at temperatures below 0° F. Recoil mechanisms already filled with recoil oil (special) have the oil filling and drain plug painted green to indicate the presence of recoil oil (special). To aid in ready identification, the plug should be encircled with No. 322 green quick-drying lusterless enamel whenever a complete change-over is made from recoil oil (heavy) to recoil oil (special), and the change-over should be recorded in the Artillery Gun Book.

NOTE: *A yellow circle on some mechanisms of recent manufacture denotes that the recoil mechanism has been filled with recoil*

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oil (heavy). This yellow circle will be replaced by a green circle after the change-over.

b. Points To Observe During the Draining and Filling Process.

(1) Cleanliness is essential when working on any recoil mechanism. The smallest particle of dirt lodged between a packing and piston rod or cylinder wall will cause scratches on the piston rod or cylinder wall, and will score the rings and packing, causing leaks at the affected points. A small particle of dirt between a valve and its seat will cause leakage. When working on recoil mechanisms, only clean, dry-cleaning solvent and clean, lint-free cotton or linen will be used for cleaning any parts, tools, or equipment. Do not use cotton or wool waste, as the lint from these materials is excessive.

(2) The oil pumps will be drained of all oils contained in them, disassembled, and cleaned with dry-cleaning solvent. Do not wash the pistons in the oil pump with dry-cleaning solvent. Refill the oil-pump with recoil oil (special). Make sure during the filling and purging process that there is at all times sufficient oil in the oil pump to prevent pumping air into the mechanism. The tire pump used for pumping air into the mechanism must be disassembled, and the metal cylinders thoroughly cleaned with dry-cleaning solvent before using.

(3) When removing and installing purge plugs, always make sure that the gaskets are in place and serviceable. If an unserviceable gasket is observed when the purge plug is removed, it should be removed before any drainage is attempted, and replaced with a new gasket. Serviceable gaskets need not be removed for draining. When installing leather gaskets, the hair side (smooth side) of the leather goes into the purge hole first, with the flesh side (rough side) next to the purge plug. Have spare purge plugs and gaskets on hand when working on these mechanisms. When purge plugs have been removed and installed later, they must be tightened several times at succeeding intervals to prevent leakage. Tighten carefully to prevent damage to purge plugs and threads.

c. Tools. Tire pump adapter B222030 and purge pipe B170509 will be available for issue at Rock Island Ordnance Depot, Rock Island, Illinois, after 15 July 1944. Adapter A191033, assembled on purge pipe B170509, has $\frac{5}{16}$ -24NF-3 threads and is directly applicable, therefore, to the 105-mm howitzer recoil mechanisms M2 and M2A1. The authorized allowance is one tire pump adapter, one purge pipe, and one adapter per ordnance company and ordnance shop servicing mobile field artillery.

d. Procedure.

(1) The work described in the following subparagraphs is to be performed under the direction of an ordnance officer.

RECOIL MECHANISM

(2) DRAIN THE RECOIL MECHANISM.

(a) Remove the howitzer from the sleigh and remove the sleigh from the cradle.

(b) Clean the mechanism of dirt and sand, especially around the filling and purge holes.

(c) Turn the mechanism upside down and place in a horizontal position.

(d) Remove filling plug from the filling valve in the recuperator cylinder front head. Attach the oil releasing tool 41-T-3251-611 and draw off the oil reserve. Attach the tire pump adapter B222030 to the oil releasing tool.

(e) Remove the purge plug from the front end of the recuperator cylinder. Place a clean container under the purge hole to catch the oil. *NOTE: There are two purge plugs in the yoke. With the mechanism in the firing position, one is on the center line at the top, 6 inches from the front end of the recuperator cylinder (large diameter cylinder); the other is at the top, slightly to the right of the center line, 3¾ inches from the front end of the recoil cylinder (small diameter cylinder).*

(f) Attach the tire pump to the tire pump adapter. Pump air into the mechanism with the tire pump. The oil will be forced from the purge hole. Tip the mechanism sidewise (approximately 30 to 35 degrees) in order to permit the oil from the recoil cylinder to drain into the bypass in the yoke. The rear end should also be elevated approximately 45 degrees to facilitate draining as much oil as possible from the mechanism. Approximately 8½ pints of oil, exclusive of the oil reserve, should be drained from the mechanism. As soon as air begins to flow from the purge hole, slowly lower the rear end of the sleigh to allow the last part of the oil to drain.

(g) Remove the tire pump, tire pump adapter, and oil releasing tool, and install the purge plug in the recuperator cylinder.

(3) REFILL THE RECOIL MECHANISM.

(a) Turn the mechanism right side up, and elevate the front end of the sleigh to an angle of approximately 45 degrees.

(b) Install adapter (A189876 for use with copper pump tubing or B221724 for use with rubber pump hose) into the filling valve of the recuperator cylinder. Attach the oil line connection firmly in place in the adapter.

(c) Remove the purge plug from the front end of the recoil cylinder. Assemble the purge pipe firmly in place by hand (use no wrench). Open the pet cock on the purge pipe.

(d) Pump oil into the mechanism until oil escapes from the purge pipe in a clear stream.

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(e) Remove the purge pipe from the recoil cylinder and install the purge plug. Remove the purge plug from the recuperator cylinder and install the purge pipe.

(f) Open the pet cock on the purge pipe and pump oil into the mechanism until it escapes in a clear stream from the pipe. Close the pet cock and build up a pressure on the oil. Open the pet cock and permit the oil and air to escape. Repeat the operation as often as required. In the meantime, the mechanism should be rocked back and forth through an arc of approximately 20 degrees. Also raise and lower each end of the mechanism from the horizontal position. The mechanism is sufficiently purged when the oil index begins to move during the first two or three strokes of the oil pump. Approximately 45 minutes will be required to fill and purge the mechanism.

(g) Remove the purge pipe and assemble the purge plug. Establish a full oil reserve in the mechanism.

(h) Remove the oil pump and connection, and assemble the filling plug in the filling valve.

Section VI

EQUILIBRATOR

34. TROUBLE SHOOTING.

a. The most usual troubles in the equilibrator causing difficult elevation or depression are: improper tension in equilibrator springs, weak or broken springs, loose fit of traveling lock shaft in needle bearings, and loose fit of headless pin at fulcrum end (figs. 41 and 42).

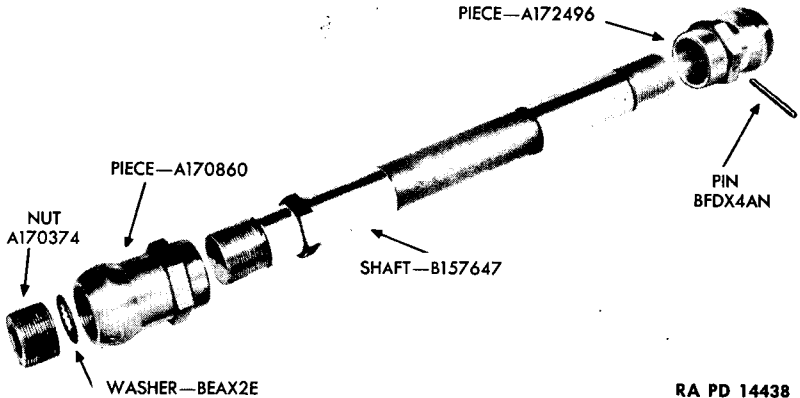
b. **Improper Tension in Equilibrator Springs.** Tighten nuts on guide rods at rear seat equally, to aid in elevating. Reverse procedure to aid in depressing. Set properly by trial and error.

c. **Weak or Broken Springs.** Replace broken springs (par. 36 or 37). When all adjustment fails, replace weak springs.

d. **Loose Fit of Traveling Lock Shaft in Needle Bearings.** Upon disassembly, replace needle bearings A172499 at rear of equilibrator (fig. 42) if play is more than 0.003 inch between them and the traveling lock shaft (par. 36 c).

e. **Loose Fit of Headless Pin at Fulcrum End.** Replace headless pin A175650 at forward or fulcrum end of equilibrator if play between it and roller bearing A9187 is more than 0.003 inch (fig. 49). Bearing must be a press fit in fulcrum. See that brass washers A7491 between fulcrum and cradle allow for a working fit.

EQUILIBRATOR



RA PD 14438

Figure 41 — Traveling Lock Shaft

35. METHODS OF DISMOUNTING EQUILIBRATOR.

a. Equilibrator springs lose their elasticity and require replacement quite frequently. Equilibrator springs for the 105-mm howitzer have the following characteristics:

| | Outer Spring A172634 | Inner Spring A172635 |
|--------------------------|----------------------|----------------------|
| Assembled height | 9.83 in. | 9.84 in. |
| Load at assembled height | 3,500 ± 165 lb | 1,380 ± 65 lb |
| Extended height | 23.63 in. | 23.64 in. |
| Load at extended height | 530 ± 53 lb | 210 ± 21 lb |
| Free height (approx) | 26.125 in. | 26.125 in. |

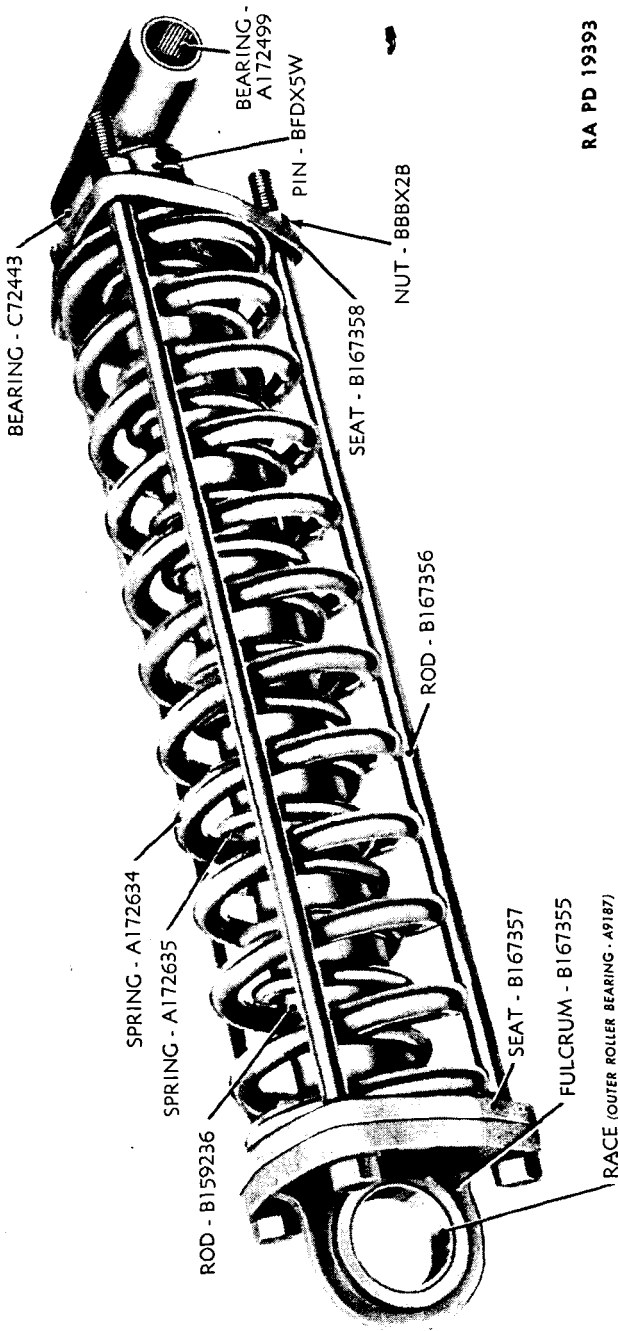
b. There are two methods of relieving the spring tension when removing the equilibrator from the carriage. If the equilibrator is to be disassembled, the weapon can be elevated so that the equilibrator, when dismounted from the carriage, will have the springs extended (par. 36). If the equilibrator is to be dismounted as an assembly for the purpose of further disassembly of the carriage, it may be blocked with the springs in the compressed position (par. 37).

36. DISMOUNTING AND MOUNTING EQUILIBRATOR (SPRINGS EXTENDED).

a. Dismounting the Equilibrator.

(1) Elevate weapon to maximum and secure in this position to some overhead member such as a tree or roof truss (fig. 43).

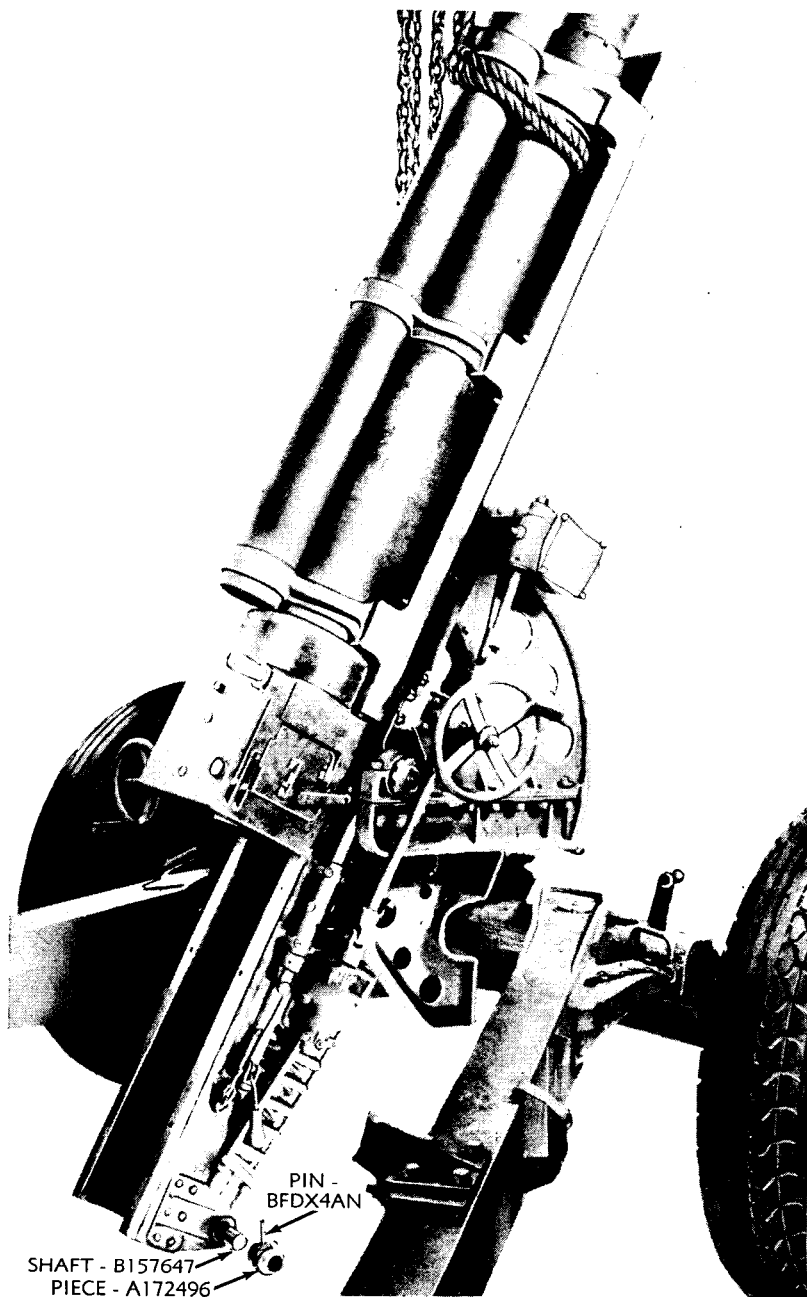
ORDNANCE MAINTENANCE — 195-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 19393

Figure 42 — Equilibrator — Assembled View

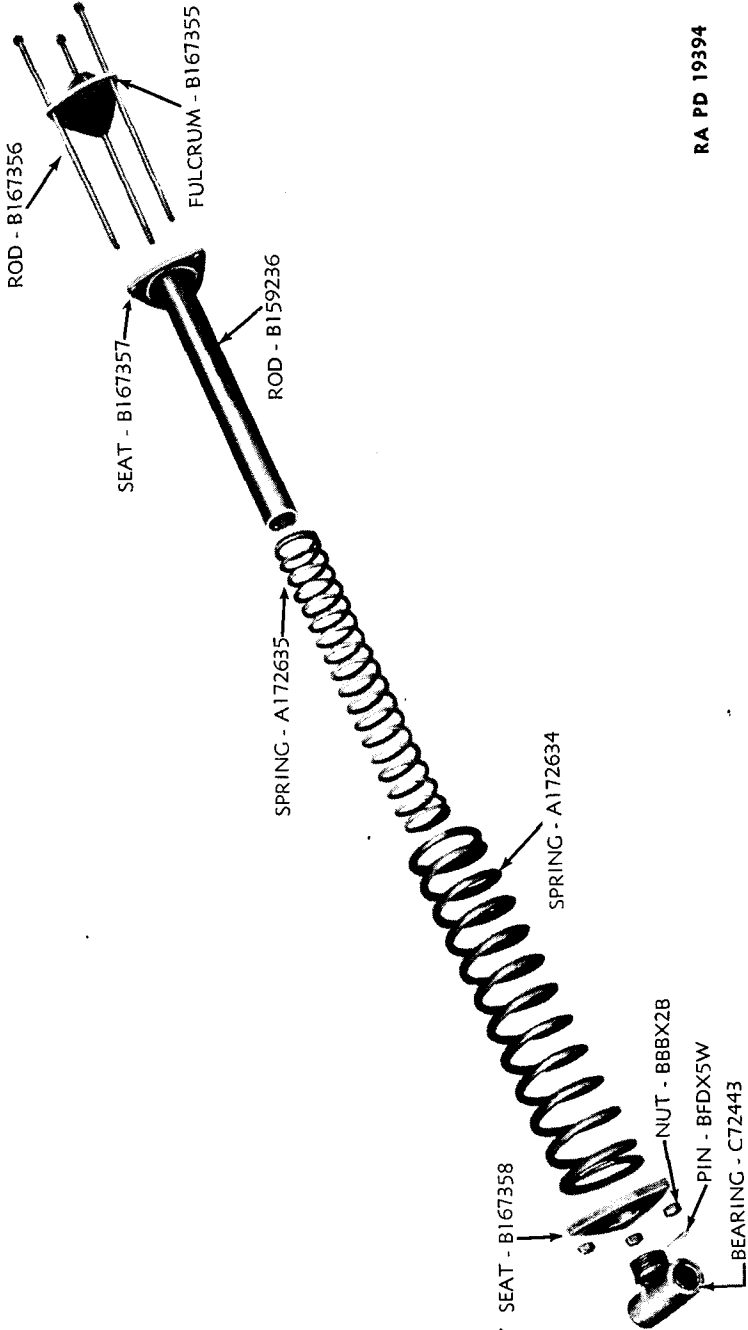
EQUILIBRATOR



RA PD 19392

Figure 43 - Weapon in Position for Removing Equilibrator

ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 19394

Figure 44 — Equilibrator — Exploded View

EQUILIBRATOR

(2) Drive straight pin out of traveling lock shaft (ball) piece and traveling lock shaft. Remove ball piece by unscrewing from shaft (fig. 43).

(3) Use a copper hammer to drive traveling lock shaft from cradle and equilibrator a short distance. Then use a copper drift and hammer to drive the shaft completely out of the cradle. A second man should guide the shaft at the left end to be sure it comes out true. The second man also supports the equilibrator assembly while the shaft is removed. **CAUTION:** *Care must be taken not to gall traveling lock shaft when removing it or allow the needle bearings to fall out. The traveling lock shaft is removed from right to left.*

(4) Place a wood block under the rear end of the equilibrator.

(5) Remove two cotter pins from the fulcrum pin, working through the holes in the top carriage. Drift out fulcrum pin. **NOTE:** *The fulcrum pin can be removed from either side of the top carriage.*

(6) Pull the equilibrator from the top carriage.

(7) Two brass washers will come away when the equilibrator is disconnected from the top carriage. One of these washers is in each side of the fulcrum eye and serves as a dust cover for the roller bearing.

(8) Push roller bearing out of equilibrator fulcrum.

b. Disassembly.

(1) Drive the ¼-inch straight pin BFDX5W from the equilibrator spring rod B159236 and bearing C72443 (fig. 42).

(2) Unscrew the bearing from the rod.

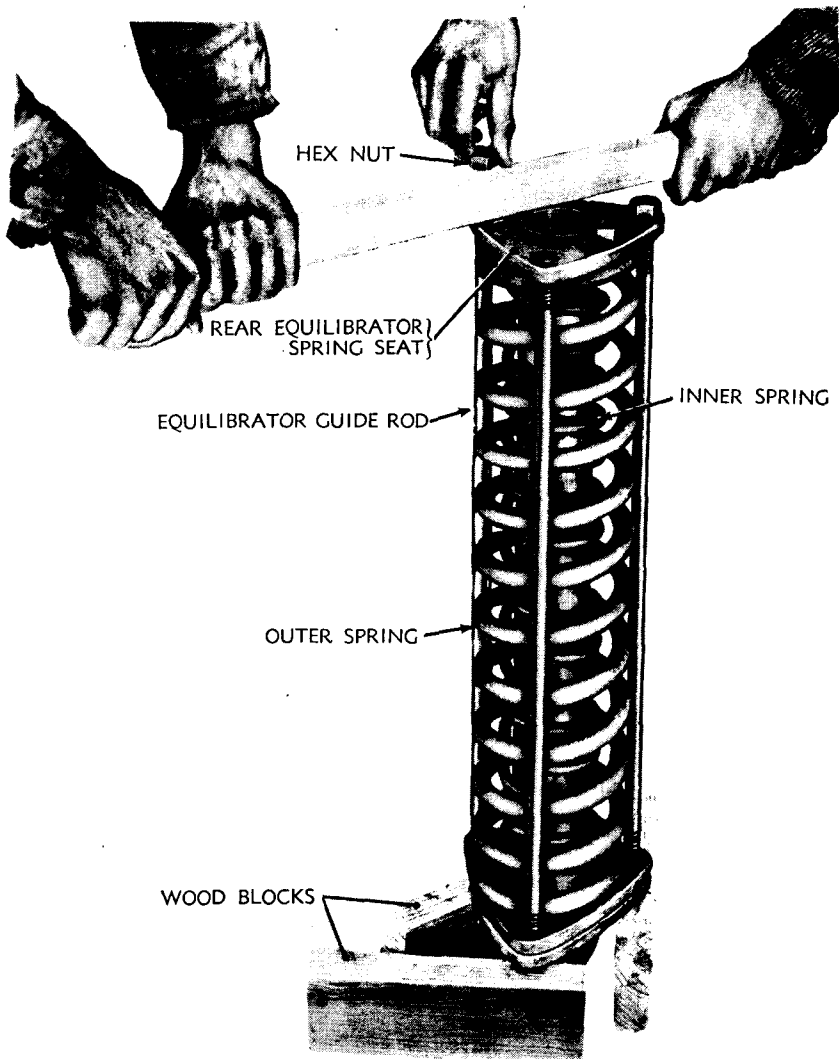
(3) Back off the three nuts BBBX2B from the equilibrator guide rods B167356 at the bearing end (rear end) *carefully and evenly*. (Prevent the rods from turning by holding the nuts at the fulcrum end with a wrench.) Lift off rear equilibrator spring seat B167358 and inner and outer springs A172635 and A172634.

CAUTION: *The rear end of the equilibrator should be directed toward an open space when the nuts are backed off the guide rods because the springs may still be under some tension when the last nut is removed.*

(4) Remove the guide rods B167356 from the equilibrator fulcrum B167355 and front equilibrator spring seat B167357 (fig. 44).

c. **Replacement of Needle Bearings** (fig. 42). There are two needle bearings A172499 in the equilibrator spring rod bearing C72443. Bearings of this type, when removed, cannot be reinstalled. A new needle bearing must be used. The bearings will be replaced if play is more than 0.003 inch between them and traveling lock shaft. Drive out needle bearing with a ½-inch brass punch and hammer.

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RA PD 19395

Figure 45 — Assembling Nuts on Equilibrator Rods

EQUILIBRATOR

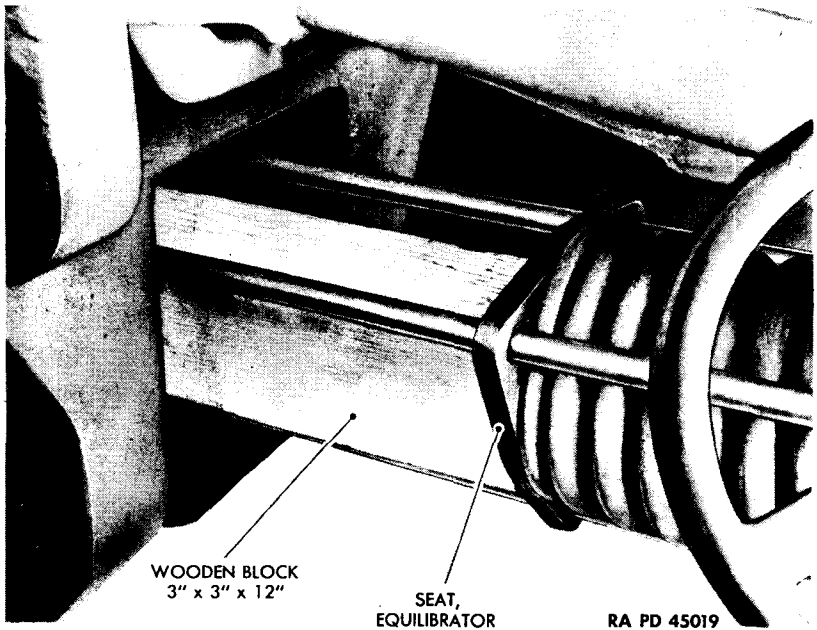


Figure 46 — Wood Block Installed in Equilibrator

Clean the equilibrator spring rod bearing C72443 thoroughly. Drive new needle bearing into place with a wood block and hammer. Outer end of needle bearing must be flush with the end of equilibrator spring rod bearing. Lubricate the needle bearing as prescribed in section XVI.

d. **Replacement of Roller Bearing Outer Race (fig. 42).** If the race is damaged, remove it with a wood block and hammer. Clean the new race and the inside of the fulcrum. Drive the race into position using a wood block and hammer. This race must be centered in fulcrum. The width of the race is $1\frac{1}{8}$ -inches, and the width of the fulcrum is $1\frac{1}{4}$ -inches. The race, when properly centered, will be one-sixteenth inch on each side of fulcrum.

e. **Assembly.**

(1) Install three guide rods in fulcrum and front equilibrator spring seat. Stake nuts on fulcrum end of equilibrator guide rods. Install the springs on the equilibrator spring rod. **NOTE: Be sure to replace weak or defective springs.**

(2) Place spring rod in a vertical position with rod nuts at fulcrum end resting on three wood blocks as shown in figure 45. In-

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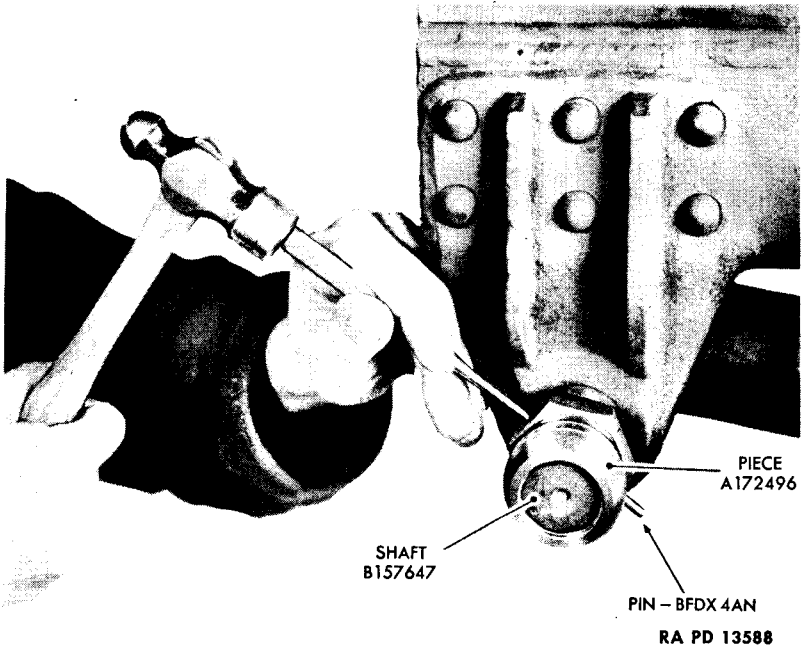


Figure 47 — Removing Straight Pin From Piece and Shaft

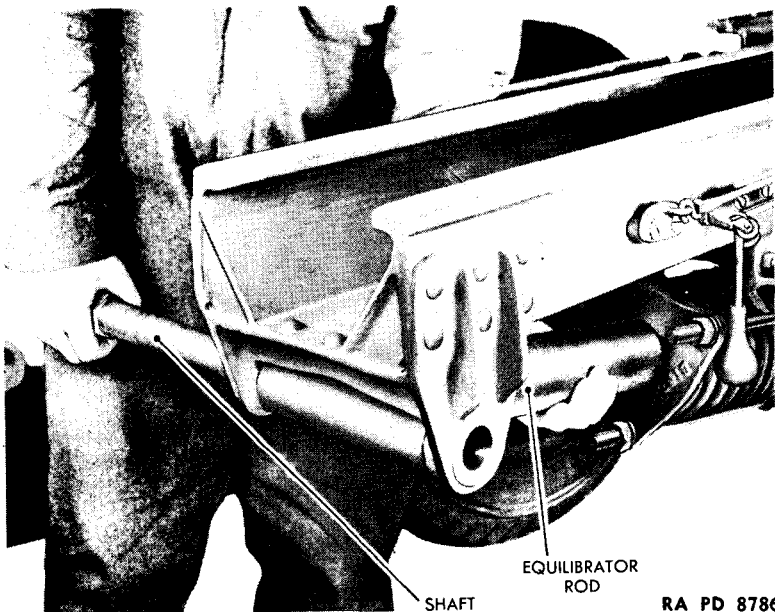
stall rear equilibrator spring seat on guide rods. While two men press down on the seat with a wood block, a third man starts the rear hex nuts on the guide rods. Tighten up on the rear nuts until there is approximately 1½ inches between the rear end of each nut and the rear end of the guide rods. Final adjustment of the position of the nuts is made after the equilibrator is installed on the weapon.

(3) Remove the equilibrator from the wood blocks. Screw the equilibrator spring rod bearing into the equilibrator spring rod and install the straight pin. Peen both ends of the pin. **NOTE: Equilibrator spring rod bearing C72443 must be perpendicular to fulcrum B167355 (fig. 42).**

f. Mounting the Equilibrator.

(1) Elevate the howitzer to maximum. See that the roller bearing is properly lubricated and in place in the equilibrator fulcrum. Apply a film of O.D. grease to the fulcrum pin A175650 (fig. 49). Secure the fulcrum end of the equilibrator assembly to rear of top carriage by inserting fulcrum pin through lugs of top carriage and

EQUILIBRATOR



RA PD 87865

Figure 48 — Removing Shaft From Cradle Bracket and Equilibrator Assembly

fulcrum. (One of the three equilibrator guide rods must be down and two up.) See that brass washers between fulcrum and cradle allow for a working fit. *NOTE: The fulcrum pin will be replaced if play between it and roller bearing bore is more than 0.003 inch.*

(2) Lift rear end of equilibrator into position between bracket projections at rear of cradle. It may be necessary to elevate or depress cradle to line up "T" end of rod with bracket holes.

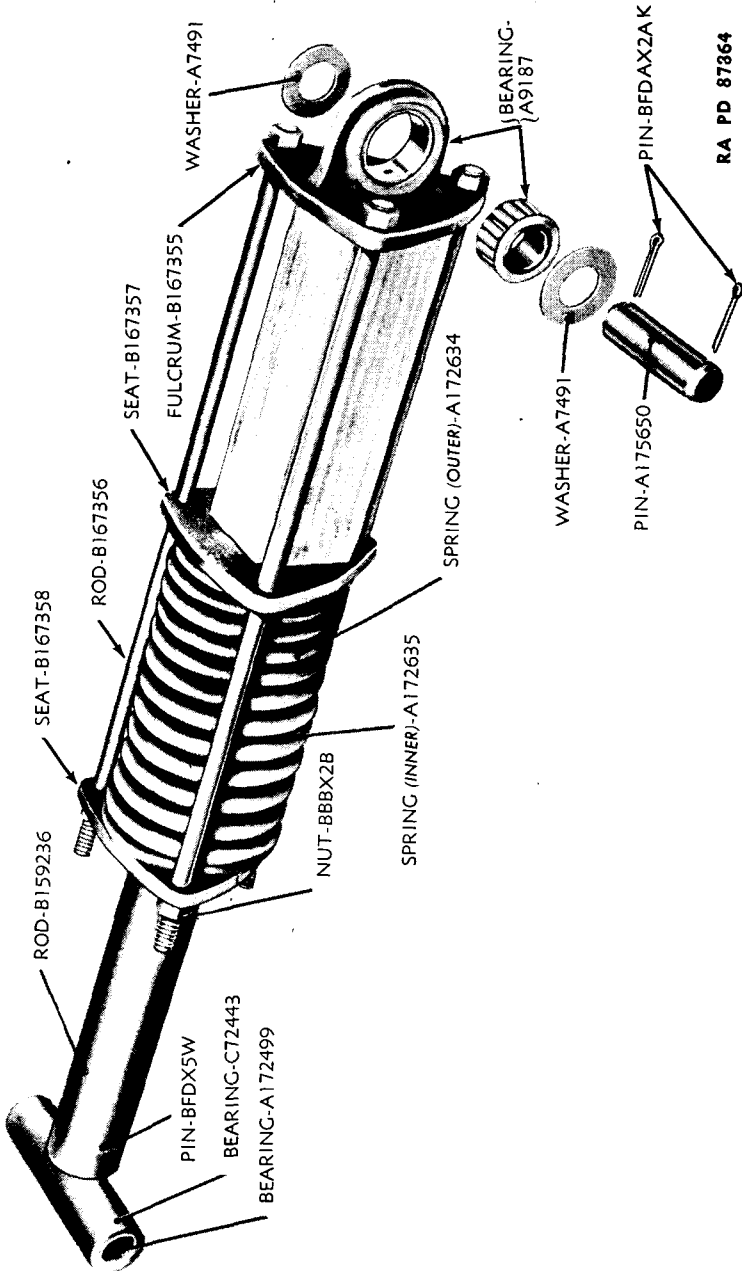
(3) Slide the traveling lock shaft through cradle bracket and "T" from left side of carriage.

(4) Apply rust-preventive compound (thin film) to the threaded ends of the shaft at right. Screw the ball piece on the right end of shaft with hexagonal part next to cradle. Line up holes in piece and shaft, and drive pin in after applying white lead pigment.

(5) If a new traveling lock shaft is installed, drill and ream the hole for pin in shaft (0.1875-inch diameter pin).

(6) Elevate and depress the piece and tighten or loosen up on the three equilibrator guide rod nuts as necessary.

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CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 87864

Figure 49 — Equilibrator With Wood Block in Place

EQUILIBRATOR

37. DISMOUNTING AND MOUNTING EQUILIBRATOR (SPRINGS BLOCKED).

a. Dismounting the Equilibrator.

(1) Depress howitzer, compressing equilibrator springs enough to insert a 3 x 3 x 12-inch wood block (fig. 46). Elevate the howitzer enough to lock wood block firmly in place. NOTE: *The block used must be perfectly square at each end in order to prevent damage to the needle bearings in the "T" end of the equilibrator due to misalignment, when inserting the traveling lock shaft.*

(2) Make certain the wood block is firmly in position between the equilibrator front seat and the fulcrum. Then remove the equilibrator from the weapon as shown in figures 47 and 48 and described in subparagraphs 36 a (2) through a (8).

CAUTION: *Use care in handling equilibrator when blocked as it is under great pressure.*

b. Disassembly and Assembly.

(1) Should springs need replacement because of fatigue or breakage, replace the equilibrator with a new or rebuilt equilibrator, or replace the springs. The springs may be replaced with a planer bed, with a special compressor tool, or with the equipment described in the following subparagraph.

CAUTION: *Because of the great spring pressure, replacement of springs in a blocked equilibrator should never be attempted without suitable equipment.*

(2) Drive the ¼-inch straight pin BFDX5W from equilibrator spring rod B159236 and bearing C72443 (fig. 49). Unscrew bearing from rod. Clamp fulcrum securely. Assemble a heavy tube or pipe, at least 27 inches long, over equilibrator spring rod so that it bears against spring seat B167358. At the end of the tube or pipe, place a jack of at least 3-ton capacity, with the base of the jack against a wall or immovable block. NOTE: *The screw of the jack must be extended at least 27 inches BEFORE the jack is placed behind the pipe or tube.* Screw up on the jack slightly, thereby compressing the equilibrator springs enough to remove hex nuts BBBX2B from equilibrator guide rods. Next, back off the jack until the tube or pipe, equilibrator springs, and spring seat B167358 have moved out to the end of the equilibrator spring rod. Remove the jack, and tube or pipe, and remove the springs.

(3) To install new springs, reverse the procedure described in step (2), above.

c. Mounting Equilibrator.

(1) Elevate howitzer to a position a little short of maximum elevation. Then mount equilibrator with wood block in place (par. 36 f

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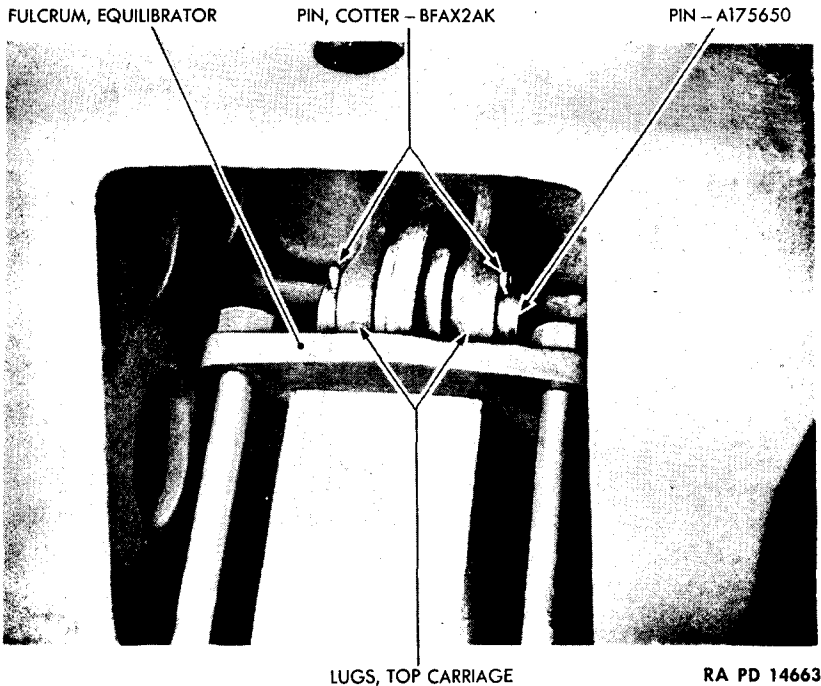


Figure 50 -- Attaching Equilibrator to Top Carriage

and fig. 50). **CAUTION:** Use care in handling equilibrator when blocked.

- (2) Depress the howitzer to release the wood block.

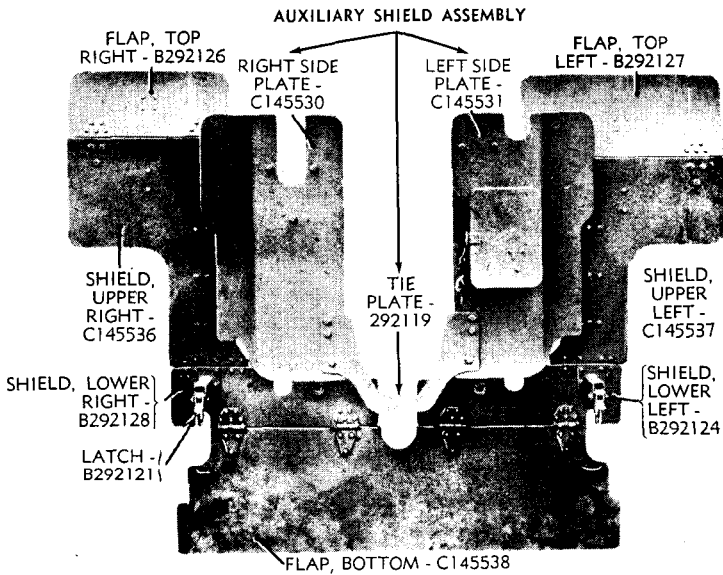
Section VII

SHIELDS AND BRACKETS

38. GENERAL.

a. The shield assembly composed of four sections of armor plate was used on M2 and M2A1 Carriages. This assembly has been replaced with two assemblies (figs. 4 and 51): (1) a main shield assembly consisting of seven sections of armor plate and attached to the axle by four brackets; (2) an auxiliary shield assembly consisting of three sections of armor plate and attached to the top carriage by four brackets. The auxiliary shield assembly travels with the cradle

SHIELDS AND BRACKETS



RA PD 85142

Figure 51 — Main and Auxiliary Shields

in full traverse. The top right and left flaps of the main shield assembly are fastened to their respective upper shields by means of heavy hinges. These hinges permit the two top flaps to be lowered rearward, instead of forward as on the former shield assembly. A lever, fitted with brackets and locking pins, supports the top flap when in the lowered position (fig. 53).

39. TROUBLE SHOOTING.

a. **Shields.** Repair and maintenance of the shield generally pertains to the brackets. It is sometimes necessary, however, to repair the shield itself. Damage to the shield is generally caused by road vibration or enemy action. Repair of the shield may be undertaken only by third-, fourth-, or fifth-echelon maintenance organizations, and as prescribed in TM 9-2852.

b. **Bent or Broken Brackets.**

(1) Brackets may be straightened to their original form by using a blacksmith's forge or an acetylene torch and heating bent portions to cherry red. Straighten by using hammer and anvil.

(2) Broken brackets may be welded by a competent ordnance welder, preferably using the oxyacetylene process. However, the arc process may be used.

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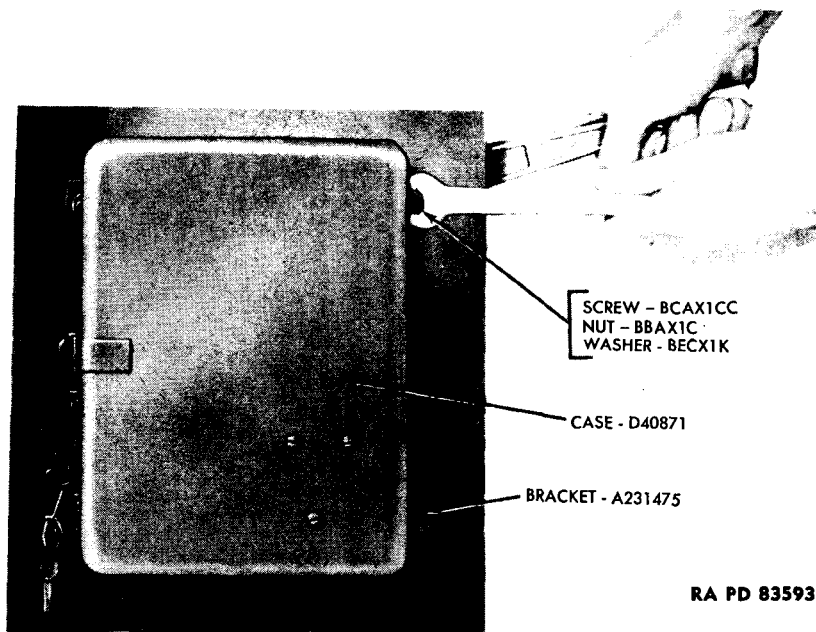


Figure 52 — Removing Panoramic Telescope Case From Auxiliary Shield

c. **Hinge Pins—Natural Wear.** When hinge pins show excessive wear, new hinge pins and cotter pins, A160004, BFEX1CU, BFAX1CD, and BFAX1DF (fig. 53), may be made by competent ordnance machinists as a field expedient when new ones are not available for issue. Old pins will be used for patterns.

d. **Loose Rivets.** Vibration and enemy action may cause loose rivets. All loose units will be heated to cherry red. Using a ball-peen hammer, swage rivets until tight.

e. **Worn or Broken Hinges.** Vibration causes loose rivets. Repair as described in subparagraph d, above. Hinges which show excessive wear, or broken hinges, must be replaced with new ones. Lock the new hinges in place in the manner described in subparagraph d, above.

40. DISMOUNTING AND MOUNTING AUXILIARY SHIELD.

a. Dismounting and mounting the auxiliary shield is a using-arm operation and is described in TM 9-325.

SHIELDS AND BRACKETS

b. The removal of the panoramic telescope case assembly is shown in figure 52.

41. DISMOUNTING AND MOUNTING MAIN SHIELD.

a. Dismounting Main Shield (figs. 4, 53, 54, and 55).

- (1) Remove the auxiliary shield (TM 9-325).
- (2) Remove the main shield in three parts as follows:
 - (a) Remove four cotter pins and hinge pins and lift off the bottom flap (figs. 4 and 54).
 - (b) Remove one machine screw (adjacent hand brake lever) and thirteen hex screws and nuts from right shield and right shield bracket C145539A (figs. 53 and 55). Have one man support the right shield while another man moves two hex screws and nuts from right shield and welded bracket on axle. Lift off lower right shield, top right flap, and upper right shield as a unit.
 - (c) Remove the lower left shield, top left flap and upper left shield in the same manner.

b. Mounting Main Shield.

- (1) The three parts, left shield, right shield, and bottom flap are mounted on the piece in the reverse order to dismounting.
- (2) Mating surfaces of shields and brackets should be cleaned and then painted with white lead pigment. Rust-preventive compound (thin film) should be applied to all exposed screw threads.

42. DISMOUNTING AND MOUNTING MAIN AND AUXILIARY SHIELD BRACKETS.

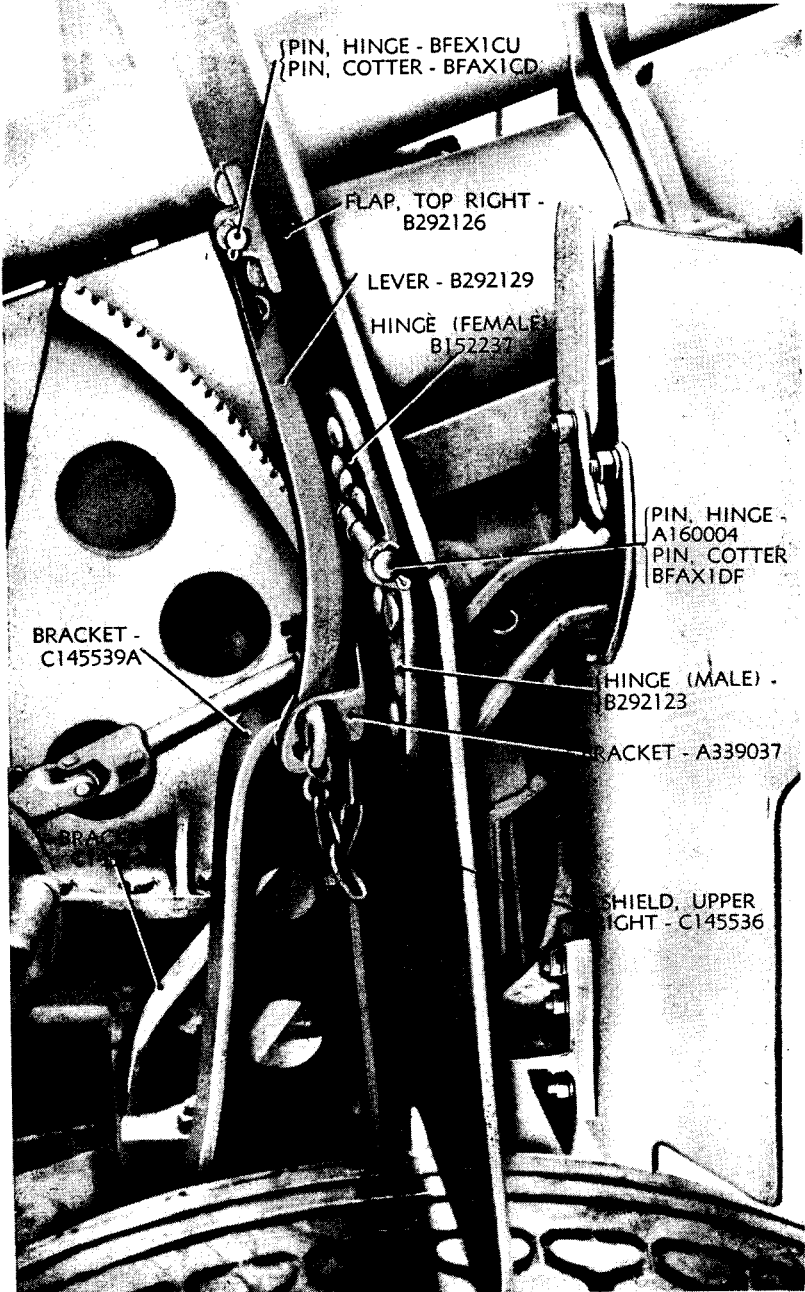
a. Dismounting Main Shield Brackets.

- (1) Remove nuts from four screws welded to axle plate and lift off right shield bracket C145539A (fig. 55).
- (2) Remove left shield bracket C145539B in same manner.

b. Dismounting Auxiliary Shield Brackets.

- (1) Remove three nuts, washers, and hex screws, and lift right auxiliary shield upright bracket C145532 from lower bracket C145533 (fig. 55). Remove three nuts, washers, and cap screws, and lift left auxiliary shield upright bracket C145534 from traversing rack. *NOTE: Before removing screws, mark them with a center punch for assembly in their original positions. This will insure proper alignment of traversing rack with traversing worm.*
- (2) Remove four nuts, washers, and screws, and remove right auxiliary shield lower bracket C145533 from top carriage.

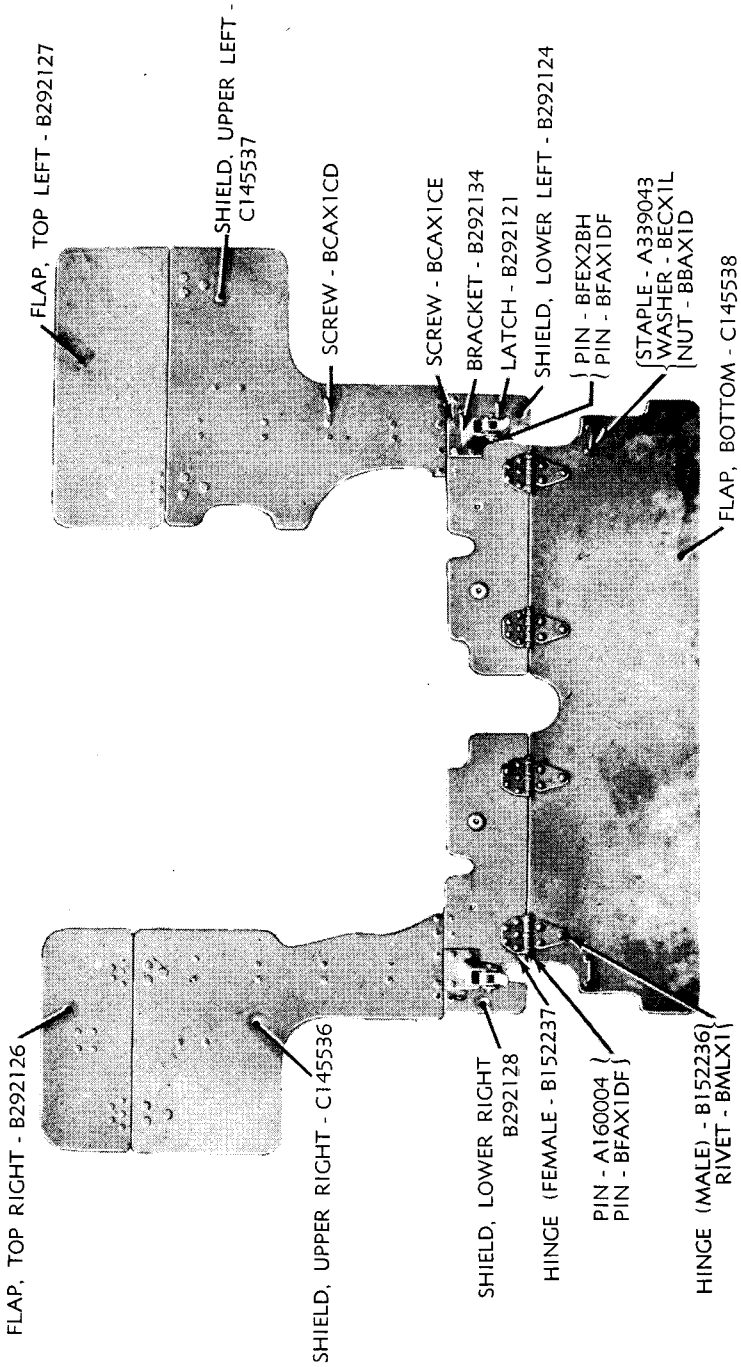
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RA PD 19396

Figure 53 — Right Shields and Brackets — Rear View

SHIELDS AND BRACKETS



RA PD 83590

Figure 54 — Main Shield Assembly — Front View

ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4

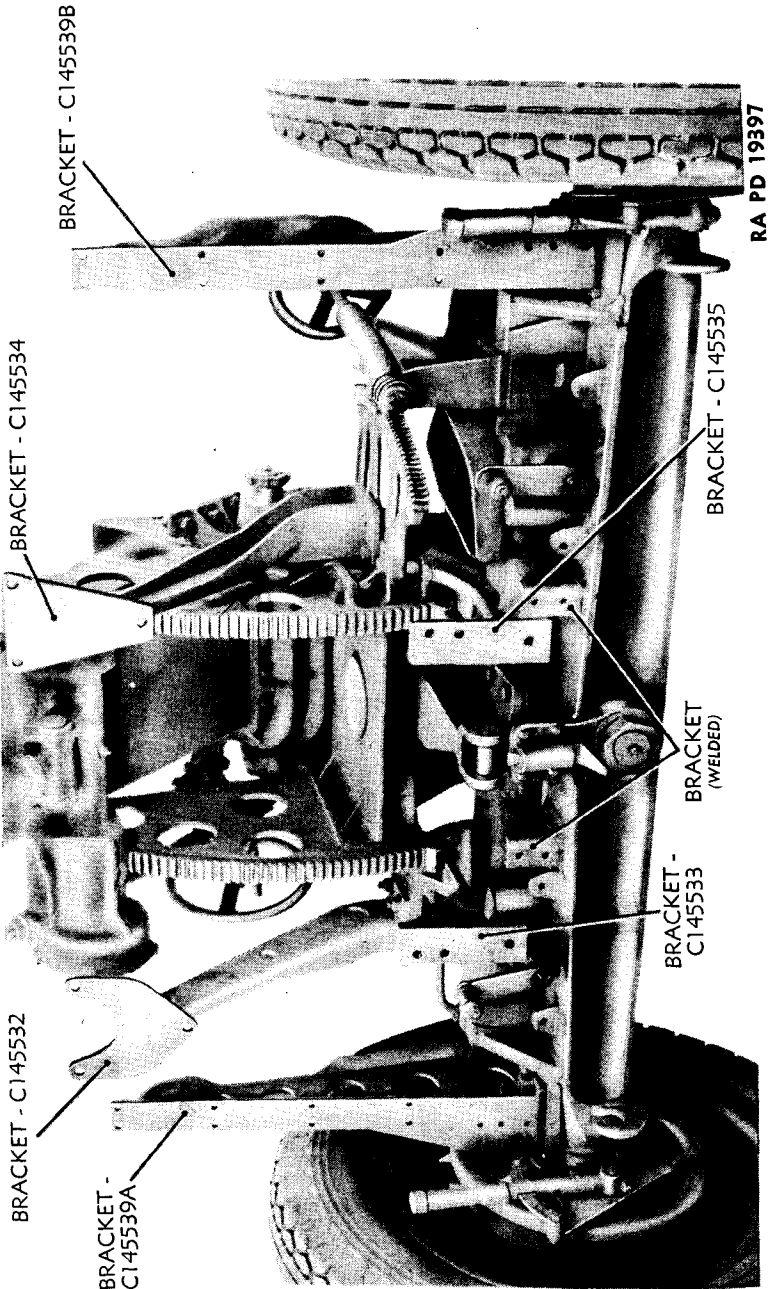


Figure 55 — Main and Auxiliary Shield Brackets

FIRING MECHANISM

(3) Remove two nuts, washers, and screws, and remove left auxiliary shield lower bracket C145535 from top carriage.

c. Mounting Shield Brackets.

(1) The auxiliary shield and main shield brackets are mounted on the piece in the reverse order to dismounting (subpars. b and a).

(2) Mating surfaces of brackets and top carriage, or traversing rack and brackets and axle, should be cleaned and then painted with white lead pigment. Rust-preventive compound (thin film) should be applied to all exposed screw threads.

Section VIII

FIRING MECHANISM

43. GENERAL.

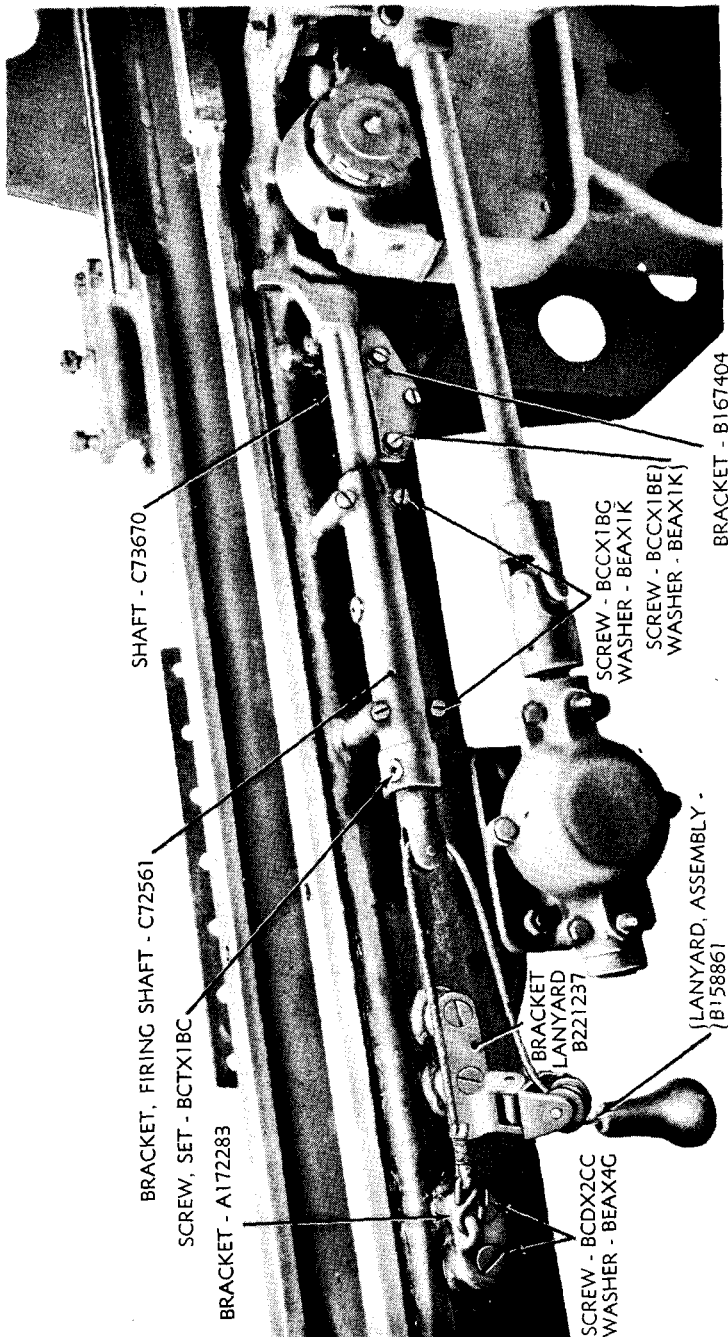
a. The firing mechanism is attached to the right side of the cradle (fig. 56). It is the means by which the firing lock is actuated to fire the gun. The firing mechanism can be dismounted and mounted on the cradle without disturbing any other part of the weapon.

44. TROUBLE SHOOTING.

a. Unsatisfactory operation of the lanyard may be due to a weak or broken spring, excessive play between firing shaft and firing shaft bracket bushing A172889, or loose bushing (fig. 59). Replace the spring if it is weak or broken (pars. 45 and 46). Replace the bushing if clearance between it and firing shaft is more than 0.003 inch (pars. 45 and 46). Replace the bushing if its threads are stripped or burred, or replace the firing shaft bracket C72561 if its threads are stripped or burred. See that set screw is firmly in place in bushing. **NOTE:** *MWO C21-W13 (section A), dated 30 May 1944, prescribes spotting and drilling firing shaft bracket to a maximum depth of one-eighth inch to give more positive locking of firing shaft bracket bushing in bracket.*

b. Failure of primer to fire may be due to poor contact between firing shaft pawl and trigger shaft. Check alinement between firing shaft guide bracket and firing shaft. Check that distance between contacting surface of pawl and trigger shaft is not less than one-eighth inch. **NOTE:** *MWO C21-W13 (section A) prescribes that the contacting surface of the pawl be built up from three-eighths inch to five-eighths inch by using coated welding rod.*

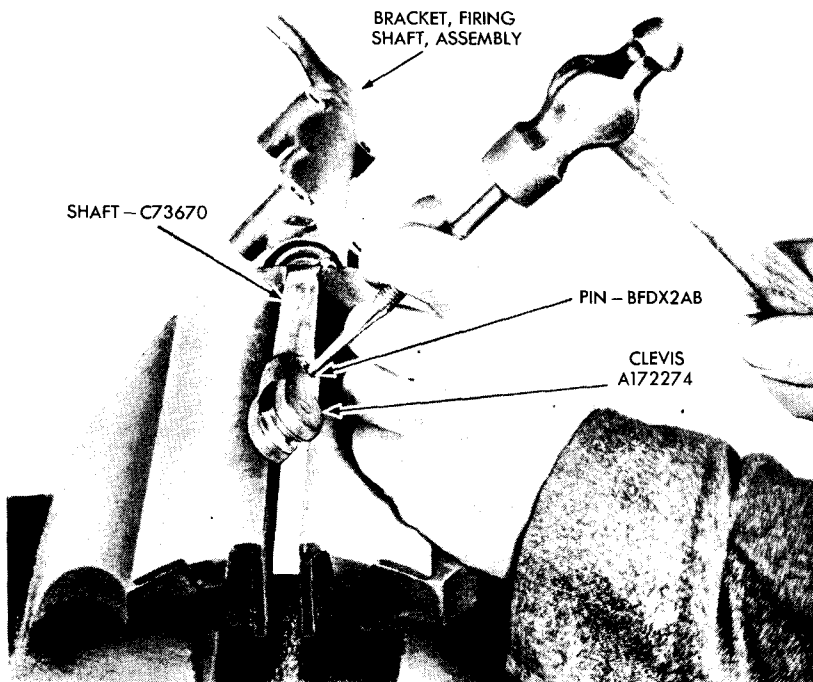
ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 19399

Figure 56 — Firing Mechanism

FIRING MECHANISM



RA PD 13571

Figure 57 – Removing Lanyard Clevis

45. REMOVAL AND DISASSEMBLY.

a. Removal.

(1) Slide lanyard handle up on lanyard cord and untie knot in cord (fig. 56). Remove lanyard handle. Remove lanyard S-hook from lanyard S-hook bracket A172283 and pull cord away.

(2) Remove four screws BCDX2CC and washers BEAX4G from lanyard S-hook bracket A172283 and lanyard bracket B221237, and brackets will come away.

(3) Remove four screws BCCX1BG and washers BEAX1K from firing shaft bracket. The firing shaft bracket and firing shaft will come away as a unit.

(4) Remove three screws BCCX1BE and washers BEAX1K from firing shaft guide bracket B167404 and lift bracket off.

b. Disassembly.

(1) Place firing shaft bracket assembly in a vise equipped with copper jaws (fig. 57). Drive pin BFDX2AB from clevis A172274 and firing shaft C73670. Tap clevis from shaft.

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

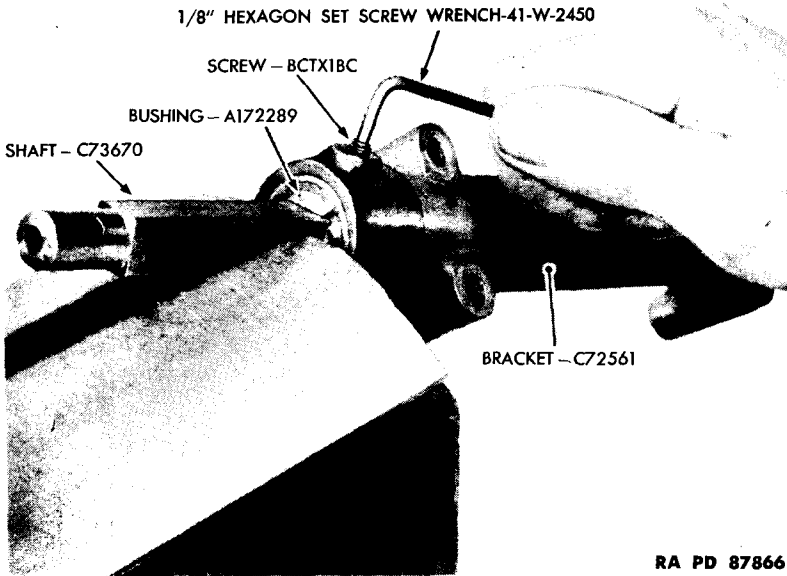


Figure 58 — Removing Firing Shaft Bracket Bushing

(2) Remove set screw BCTX1BC (fig. 58). Unscrew firing shaft bracket C72561 from bushing A172289. *NOTE: The spring in the bracket is under compression.*

(3) Release shaft from vise and separate the parts. Firing shaft and spring will come out through rear of bracket (fig. 59).

(4) Should it be necessary to remove clevis pulley A172275 from the clevis, drive out straight pin BFDX2AB.

46. ASSEMBLY AND INSTALLATION.

a. Assembly.

(1) If clevis pulley has been removed from the lanyard clevis, place thin film of oil on sides of pulley and secure in place in clevis with straight pin. Spread thin coating of white lead pigment on pin before inserting. Stake pin (both sides) in three places.

(2) Screw firing shaft bracket bushing part way in end of firing shaft bracket. Slide firing shaft spring onto firing shaft and insert shaft and spring into bracket.

(3) Clamp bracket and shaft in vise equipped with copper jaws (fig. 58). Turning the bracket, screw the bushing in flush with end

FIRING MECHANISM

RA PD 19398

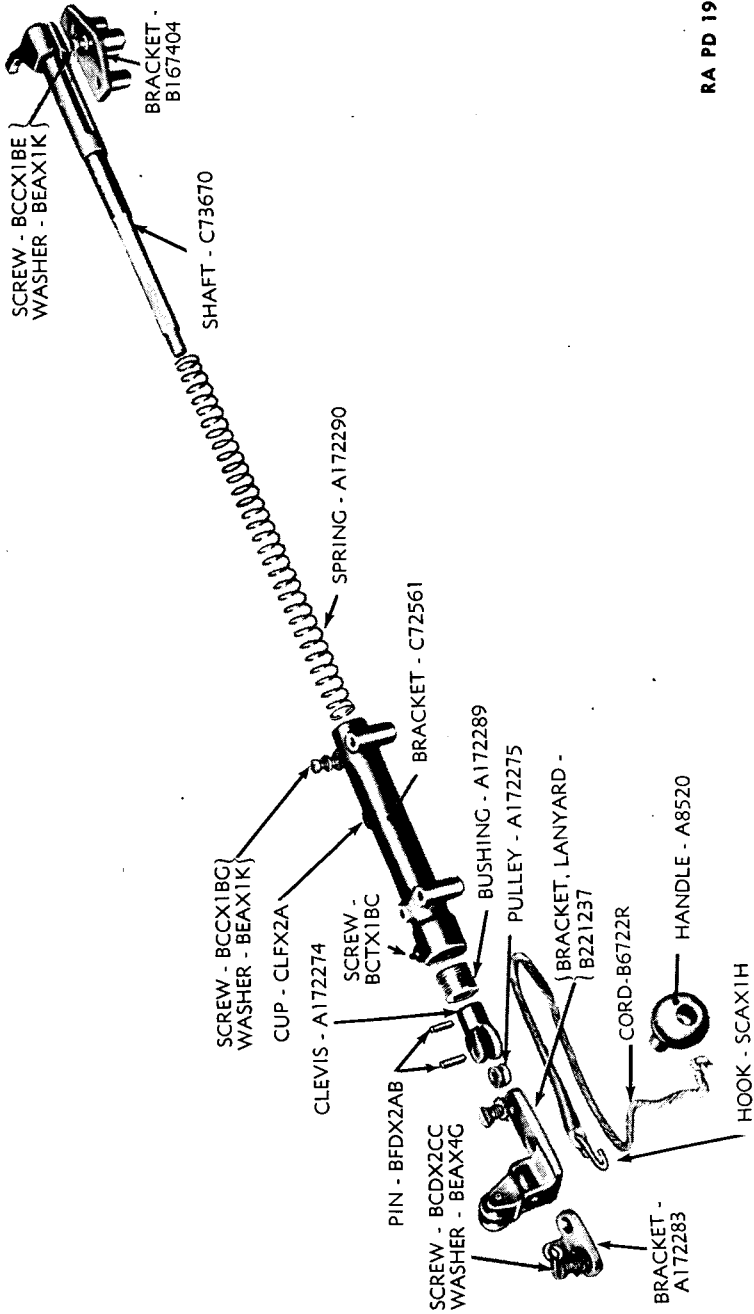


Figure 59 — Firing Mechanism — Exploded View

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

of bracket, making certain that the pawl on the end of the shaft is upright and in a straight line with top center of bracket (oil cup is in center of top). Screw set screw into bracket to lock the bushing.

(4) Tap lanyard clevis assembly in position on end of firing shaft. Line up hole in clevis with hole in shaft and tap straight pin into place. Stake pin (both sides) in three places.

b. Installation.

(1) Secure lanyard "S" hook bracket to side of cradle with screws and washers (fig. 56). Coat screws with white lead pigment before installing. Secure lanyard bracket to side of cradle in same manner.

(2) Secure firing shaft guide bracket to side of cradle with three screws and washers. Coat screws with white lead pigment before installing.

(3) Fasten firing shaft and bracket assembly in place on side of cradle with four screws and washers. The firing shaft must slide freely on the guide bracket. Coat screws with white lead pigment.

(4) Hook lanyard cord "S" hook in eye of lanyard "S" hook bracket. Run lanyard cord through clevis and pulley and then through clevis of lanyard bracket. Push cord through handle and tie knot in cord. Pull handle down over knot.

(5) Try firing mechanism for freedom of operation by pulling lanyard. **CAUTION:** *Be sure the piece is not loaded.*

Section IX**ELEVATING MECHANISM****47. GENERAL.**

a. The principal parts of the elevating mechanism include the handwheels; cross shaft, bevel pinion shaft, and cradle and elevating mechanism housing; handwheel shaft, worm shaft, and elevating gear case; and worm wheel shaft and spur pinion (figs. 60 and 61). The elevating mechanism is assembled to the cradle which pivots about trunnion pins. The elevating arcs are bolted to the top carriage.

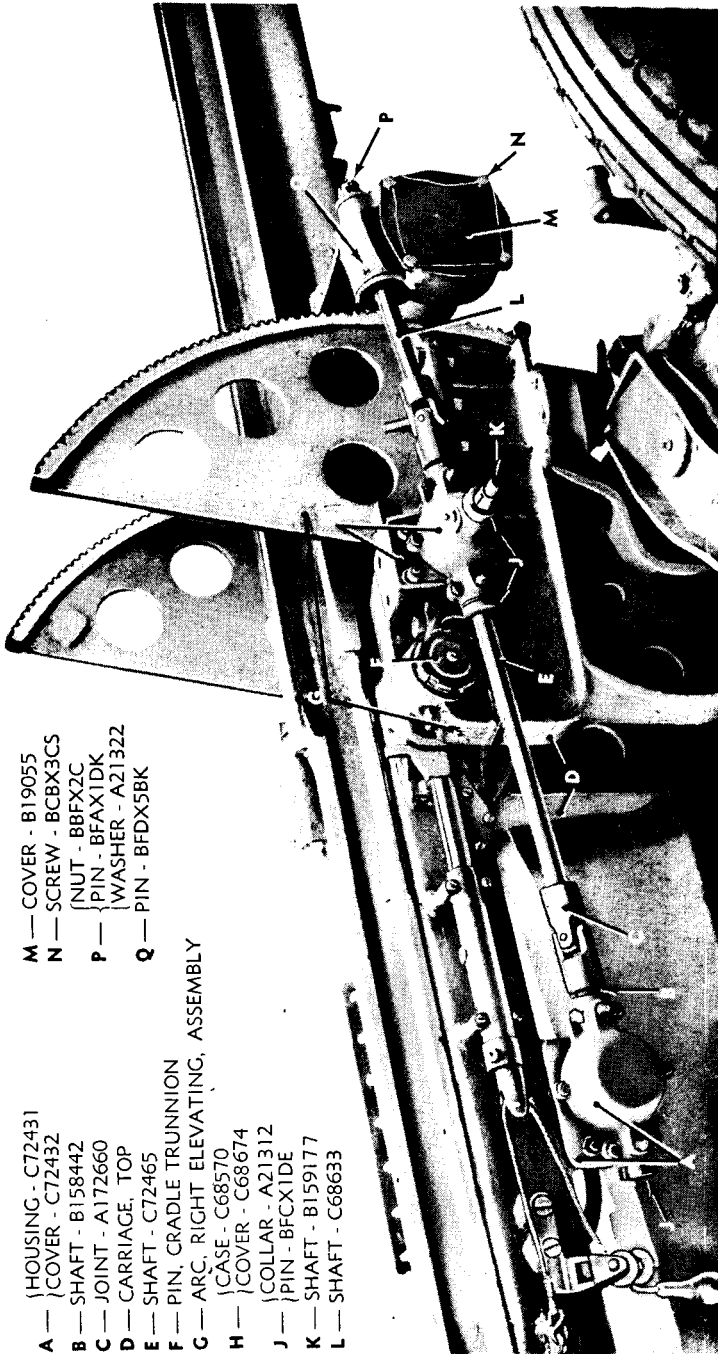
48. TROUBLE SHOOTING.

a. The most usual troubles in the elevating mechanism (figs. 60 and 61) are backlash in excess of one-quarter turn of the elevating handwheels and difficult elevation.

b. Excessive Backlash and Difficult Elevation—Causes.

(1) Excessive backlash in the elevating handwheel on the left side of the cradle may be due to end play caused by: worn or dam-

ELEVATING MECHANISM

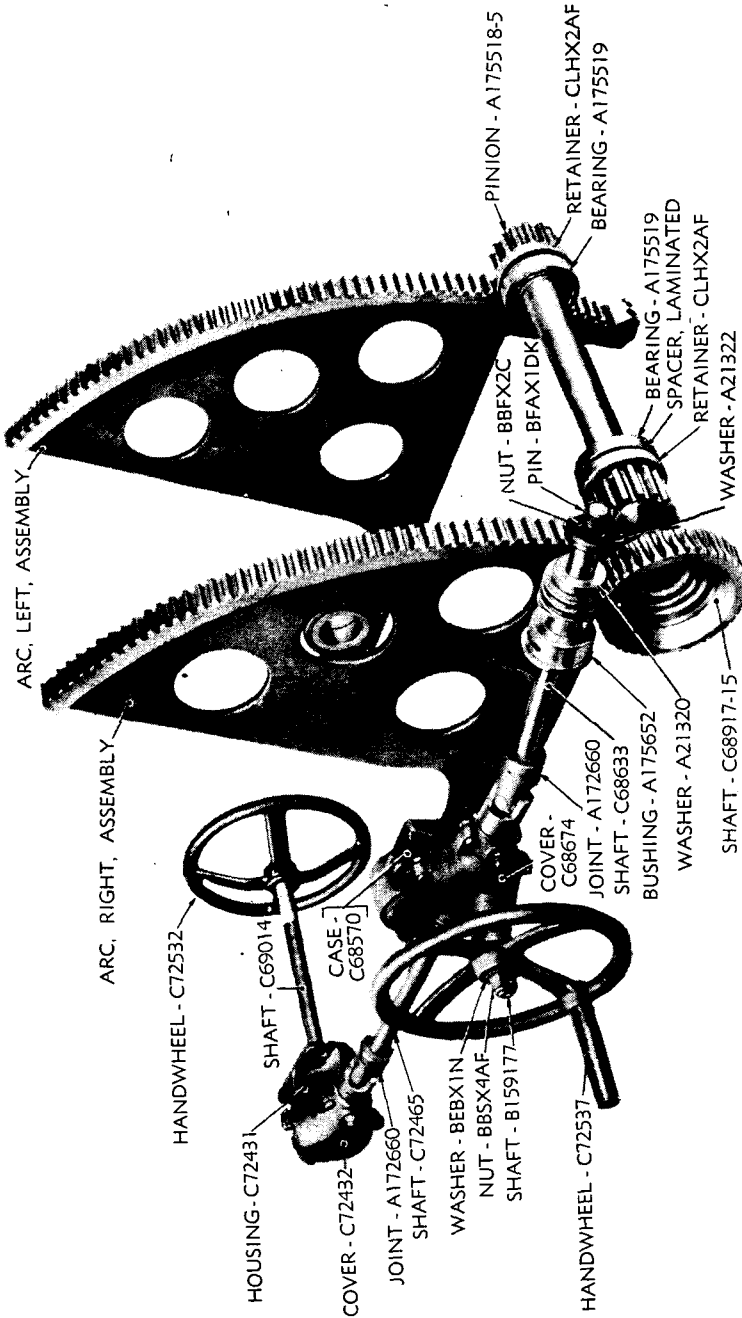


RA PD 19400

- A — { HOUSING - C72431
 } COVER - C72432
- B — SHAFT - B158442
- C — JOINT - A172660
- D — CARRIAGE, TOP
- E — SHAFT - C72465
- F — PIN, CRADLE TRUNNION
- G — ARC, RIGHT ELEVATING, ASSEMBLY
 { CASE - C68570
 } COVER - C68674
- H — { COLLAR - A21312
 } PIN - BFCX1DE
- K — SHAFT - B159177
- L — SHAFT - C68633
- M — COVER - B19055
- N — SCREW - BCBX3CS
 { NUT - BBFX2C
 } PIN - BFAX1DK
 } WASHER - A21322
- Q — PIN - BFDX5BK

Figure 60 — Elevating Mechanism — Elevating Handwheel Removed

ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 19329

Figure 61 — Elevating Mechanism

ELEVATING MECHANISM

aged bevel gears in cradle and elevating mechanism housing (fig. 64); loose or worn bushings or washers A172467 behind the bevel gears (fig. 66); and loose or worn bushing in the cross shaft bracket (fig. 62). Excessive backlash in the elevating handwheel on the right side of the cradle may be due to end play caused by worn or damaged bevel gears in elevating gear case (fig. 68), or loose or worn bushings or washers A172467 behind the bevel gears (fig. 69). Excessive backlash in both elevating handwheels may be due to: worn or damaged worm and worm wheel, bearings, or spur pinions and elevating arcs; and loose trunnion pin bushings.

(2) Difficult elevation may be due to: improper adjustment of equilibrator; galled or damaged bevel gears, bushings, or washers in cradle and elevating mechanism housing or elevating gear case; galled or damaged worm and worm wheel, spur pinions and elevating arcs; bind in worm and worm wheel; and galled or scored trunnion pin bushings.

c. Excessive Backlash in Elevating Handwheel on Left Side of Cradle. Grasp the elevating handwheel and attempt to move it along its shaft. If the handwheel is not loose, proceed as in step e, below. If there is looseness, end play is probably causing the backlash. Disassemble the cradle and elevating mechanism housing and cover (par. 49 a and b).

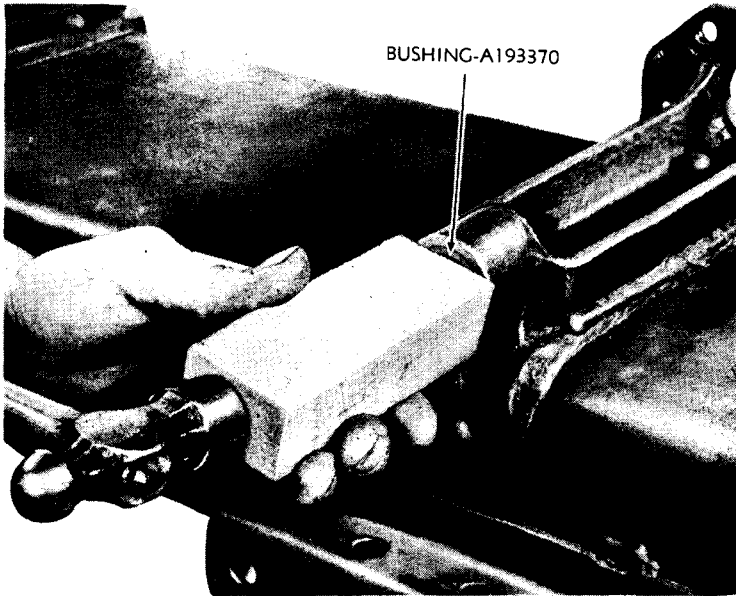
(1) Check parts for wear, nicks, and burs. Repair gears by filing, or replace the shafts. Note in particular whether washers A172467 behind the bevel gears or bushings A172658, A172659, and A172598 are loose or worn (fig. 66). Worn washers and bushings must be replaced. When replacing washers, gears must mesh evenly across faces without any end play.

(2) Replace a loose or worn bushing in the cross shaft bracket on the cradle (fig. 62). Remove cradle from top carriage. Place cradle, bottom side up, on two wood horses. Drive the bushing out with a punch and hammer. Apply white lead pigment to the new bushing and install it with a hammer and wood block. **NOTE:** *When a new bushing A193370 is installed in the cross shaft bracket, drill an oil hole through the bushing. Also, it will be necessary to line-ream the bushing with bushing A172598 in cradle and elevating mechanism housing (fig. 66).*

(3) Assemble cradle and elevating mechanism housing and cover (par. 49 c).

d. Excessive Backlash in Elevating Handwheel on Right Side of Cradle. Grasp the elevating handwheel and attempt to move it along its shaft. If the handwheel is not loose, proceed as in step e, below. If there is looseness, disassemble elevating gear case and cover (par. 50 a). Check parts for wear, nicks and burs. Repair

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 87869

Figure 62 — Installing Bushing in Cross Shaft Bracket

gears by filing, or replace the shafts. Note whether washers A172467 and bushings A172658 and A172659 are loose or worn (fig. 69). Replace worn washers and bushings. Assemble the shafts, making sure that gears mesh evenly without end play and install the cover on the gear case (par. 50 b).

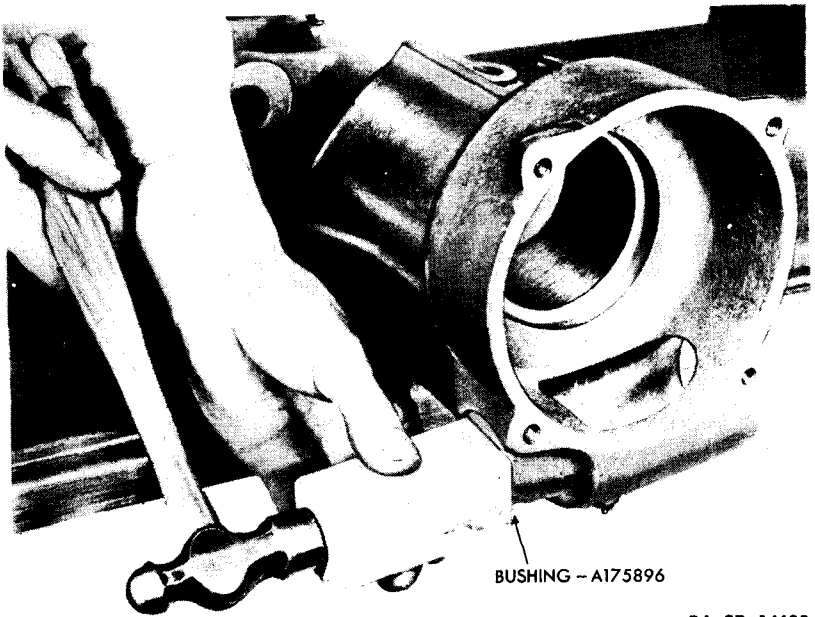
e. Backlash Due to Worn or Damaged Worm and Worm Wheel, Spur Pinions and Elevating Arcs, or Bearings.

(1) Disconnect bevel pinion shaft C72465 (fig. 69) from worm shaft C68633 (fig. 71) and rotate the worm shaft by hand to elevate and depress the howitzer. If the gears mesh smoothly and there is no appreciable looseness, proceed as in step f, below. If there is evident looseness or lost motion, remove the worm shaft (par. 51).

(2) Examine bushing A175652, washers A21320 and A21322, and worm for wear and damage (figs. 61 and 87). Check for nicks and burs. Repair worm shaft by filing. Replace worm shaft if it cannot be repaired. Replace worn bushing A175652 and worn washers A21320 and A21322. Reassemble worm shaft and test for lost motion.

(3) If lost motion is still present after the worm shaft is checked, remove worm wheel shaft (par. 51) and examine parts for wear or

ELEVATING MECHANISM



RA PD 14628

Figure 63 — Installing Bushing in Worm and Worm Wheel Housing

damage. Note whether bushing B171045, roller bearing cups, and oil retainers are firmly in place in housing in cradle (figs. 73 and 74). Replace worn or damaged bushing B171045, oil retainers and roller bearings (par. 52 a). Replace worn bushing A175896 in housing as shown in figure 63 and described in subparagraph c (2), above. Note whether spur pinions and elevating arcs are worn or damaged. Repair worm wheel shaft, spur pinions, and elevating arcs by filing. Replace these parts if they cannot be repaired (par. 52). Install worm wheel shaft as described in paragraph 53. Take care to use a working thickness for the worm wheel shaft laminated spacer that will not cause bind of the worm wheel and worm. Adjust slotted nut at left end of worm wheel shaft to eliminate end play, while permitting the shaft to rotate freely. Install cotter pin.

f. **Backlash Due to Loose Trunnion Pin Bushings.** Remove cradle trunnion pin nut and washer as described in paragraph 56 b (1). Measure clearance between cradle trunnion pin and bushings A171325 and A170697 in elevating arcs (fig. 93). Replace bushings if clearance is more than 0.003 inch (pars. 56 b (5) and 56 c (7)). **NOTE:** Care must be taken when replacing bushings. The holes in the bushings must aline with the lubricating fittings. When bushing A171325 is replaced, install the new bushing on outer side of left elevating arc.

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

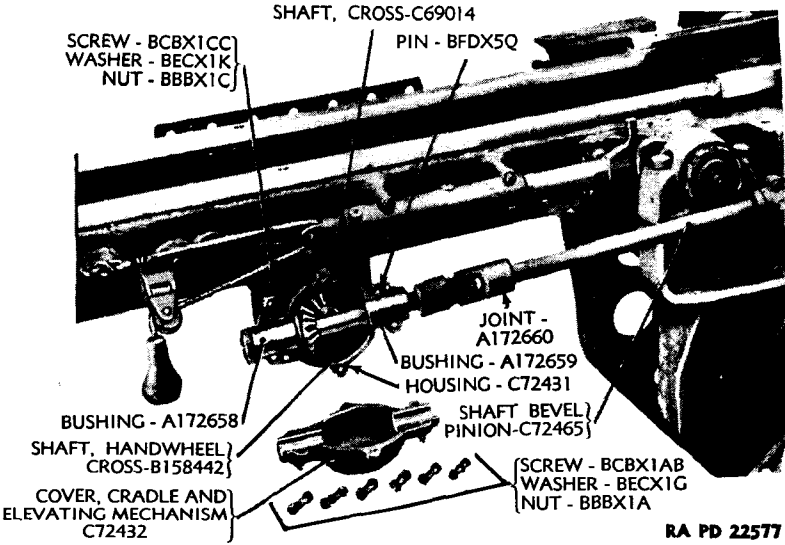
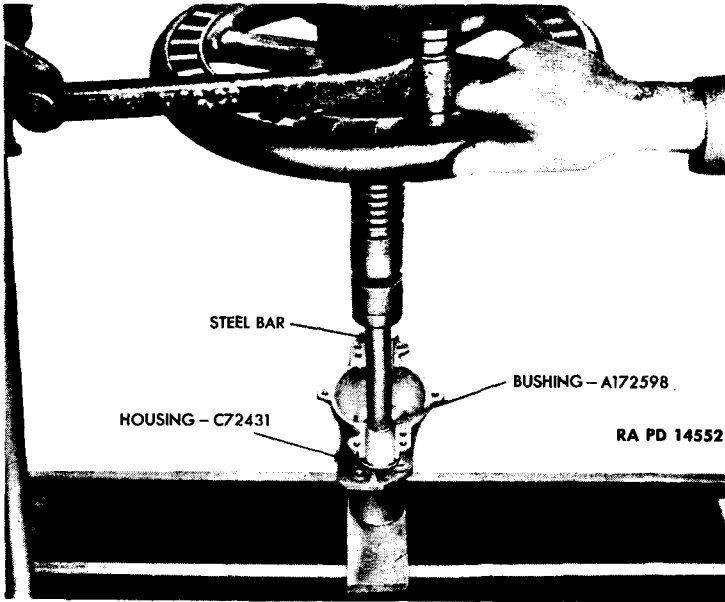
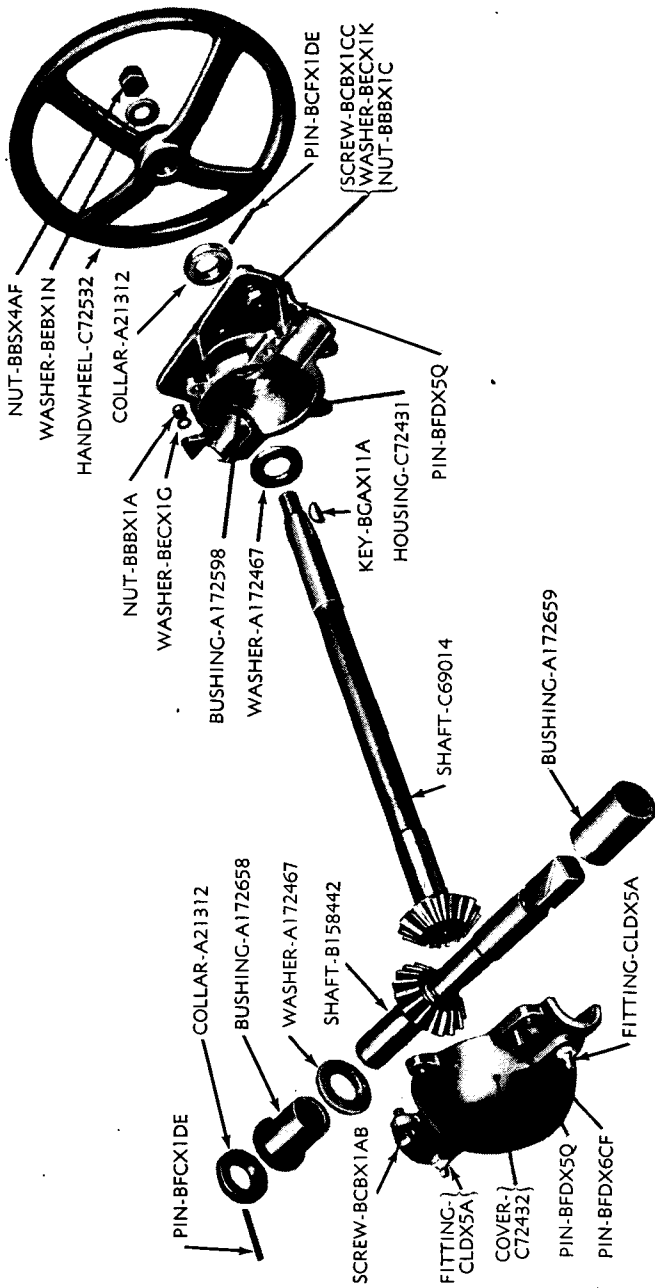


Figure 64 — Cradle and Elevating Mechanism Housing and Cover



**Figure 65 — Removing Bushing From Cradle and Elevating
Mechanism Housing**

ELEVATING MECHANISM



RA PD 87867

Figure 66 — Cradle and Elevating Mechanism Housing, Cross Shaft, and Handwheel Cross Shaft — Exploded View

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

g. Difficult Elevation Due to Improper Adjustment of Equilibrator. Tighten nuts on three guide rods at rear seat. Set properly by trial and error. *NOTE: Difficult depression may be corrected by loosening the nuts.*

h. Difficult Elevation Due to Galled or Damaged Bevel Gears, Bushings, or Washers. Disassemble the cradle and elevating mechanism housing and cover. Repair or replace parts as described in subparagraphs c (1), (2), and (3), and d, above.

i. Difficult Elevation Due to Galled or Damaged Worm and Worm Wheel, Spur Pinions, and Elevating Arcs. Disconnect bevel pinion shaft C72465 (fig. 69) from worm shaft C68633 (fig. 71) and rotate the worm shaft by hand to elevate the howitzer. If elevation is difficult, remove the worm shaft. Then proceed as in subparagraph e (2) and (3), above.

j. Difficult Elevation Due To Bind in Worm and Worm Wheel. Repair or replace as described in subparagraph i, above.

k. Galled or Scored Trunnion Pin Bushings. Replace trunnion bushings as described in subparagraph f, above.

49. DISASSEMBLY AND ASSEMBLY OF CRADLE AND ELEVATING MECHANISM HOUSING AND COVER.

a. General. The entire elevating mechanism can be removed from the weapon after the shields are removed. If the elevating mechanism is to be overhauled completely, however, it is advantageous to remove the howitzer, recoil mechanism, and equilibrator, as well as the shields.

b. Disassembly.

(1) Remove six screws BCBX1AB, washers BECX1G, and nuts BBBX1A from cradle and elevating mechanism housing C72431 and cover C72432 and lift off cover (fig. 64). Two small brass pins BFDX6CF (not shown in figure 64) will come away with the cover. These pins engage the small holes in bronze bushings A172658 and A172659.

(2) Mark handwheel cross shaft B158442, flexible joint A172660, and bevel pinion shaft C72465 with a center punch for assembly in the same places. Drive two taper pins from flexible joint and shafts.

(3) Remove flexible joint, handwheel cross shaft, bronze bushings, and steel collar as a unit. Remove flexible joint and straight bronze bushing A172659 from handwheel cross shaft. To remove flanged bushing A172658, drive taper pin BFCX1DE from collar and shaft.

(4) Remove safety nut and washer from cross shaft C69014 (left

ELEVATING MECHANISM

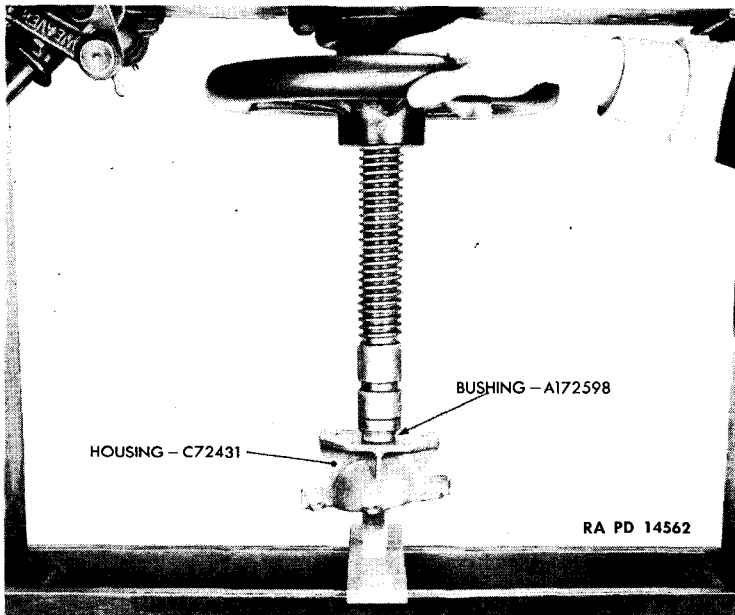


Figure 67 – Installing Bushing in Cradle and Elevating Mechanism Housing

side of cradle) and tap off cross shaft handwheel C72532 (fig. 61). Remove Woodruff key BGAX11A from shaft.

(5) Remove taper pin BFCX1DE from steel collar A21312 and cross shaft C69014. This collar fits snugly against the inside surface of the housing mounting flange on the right side of the cradle (fig. 66).

(6) Drive cross shaft C69014 through right side of cradle. Bronze washer A172467 will come out on shaft.

(7) Remove four screws BCBX1CC, washers BECX1K, and nuts BBBX1C from cradle and elevating mechanism housing C72431 and cradle (fig. 64). Tap housing off straight pins BFDX5Q and cradle.

(8) If bushing A172598 needs to be replaced, remove it from the cradle and elevating mechanism housing with an arbor press, using a 1-inch diameter steel bar, 4 inches long (fig. 65).

c. Assembly.

(1) If bushing was removed from housing, install bushing with an arbor press. Use steel bar 1½ inches diameter by 4 inches long (fig. 67). Place bar between arbor press bed and inside of housing. The end inside the housing must be up square against the inside end surface of the housing.

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

(2) Grease both sides of bronze washer A172467, and slide washer on the cross shaft with the fillet side of the washer up against the bevel gear. Slide shaft down bushing in housing (fig. 66).

(3) Coat mounting flange on cradle and mating surface of housing with white lead pigment. Install housing with cross shaft C69014 on cradle. Apply white lead pigment to the threads of the retaining screws and install the four screws, washers, and nuts. See that the two straight pins BFDX5Q are in place in the housing and mounting flange on the cradle (figs. 64 and 66).

(4) Install the steel collar on the cross shaft and insert the taper pin. *NOTE: This collar fits snugly against the inside surface of the housing mounting flange on the cradle.*

(5) Grease handwheel cross shaft (short shaft), two bushings, and bronze washer. Be sure to grease both sides of bronze washer. Place bronze washer on shaft with fillet side of washer against bevel gear (fig. 66). Slide flanged bushing and steel collar on shaft, next to bronze washer. Insert taper pin in collar. Place straight bushing on forward end of shaft.

(6) Assemble handwheel cross shaft to bevel pinion shaft C72465, making sure that punch marks on flexible joint and shafts are lined up (fig. 64). Insert the two taper pins in the shafts and joint. Then mesh handwheel cross shaft B158442 with cross shaft C69014.

(7) Lubricate the gears and install the cover on the housing. Make certain that bushings A172658 and A172659 are seated on the two small brass pins BFDX6CF in the cover. Apply white lead pigment to the threads of the screws and secure the cover to the housing with six screws, washers, and nuts. See that the two straight pins BFDX5Q are in place in the cover and housing. Install the two lubricating fittings in the cover, if these were removed.

(8) Insert Woodruff key in cross shaft. Grease threads and taper of shaft. Slide cross shaft handwheel in place on shaft and secure with washer and nut.

(9) Try mechanism for freedom of operation.

**50. DISASSEMBLY AND ASSEMBLY OF ELEVATING GEAR
CASE AND COVER.****a. Disassembly.**

(1) Remove handwheel cross shaft B158442 (fig. 64).

(2) Remove safety nut and washer from elevating handwheel shaft B159177 and tap off elevating handwheel C72537 (fig. 61). Remove Woodruff key BGAX11A from shaft. Drive out taper pin and slide steel collar A21312 off elevating handwheel shaft (fig. 60).

ELEVATING MECHANISM

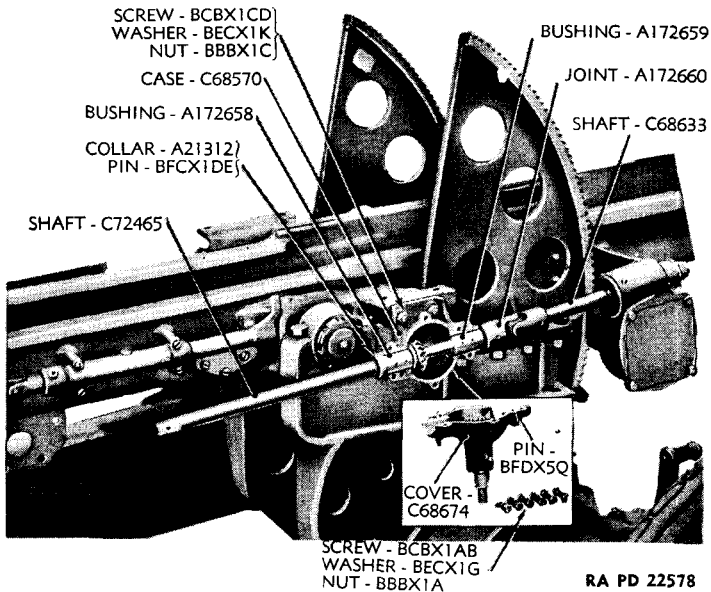


Figure 68 – Elevating Gear Case and Cover

(3) Mark worm shaft C68633, flexible joint A172660, and bevel pinion shaft C72465 with a center punch for assembly in the same place (fig. 60). Drive two taper pins from flexible joint.

(4) Remove six screws BCBX1AD, washers BECX1G, and nuts BBBX1A from elevating gear case cover C68674 (fig. 68). Remove cover and elevating handwheel shaft B159177 (fig. 69). Two small brass pins BFDX6CF will come away with the cover. These pins engage the small holes in bronze bushings A172658 and A172669. Two straight pins BFDX5Q may come away in the cover or may remain in the case.

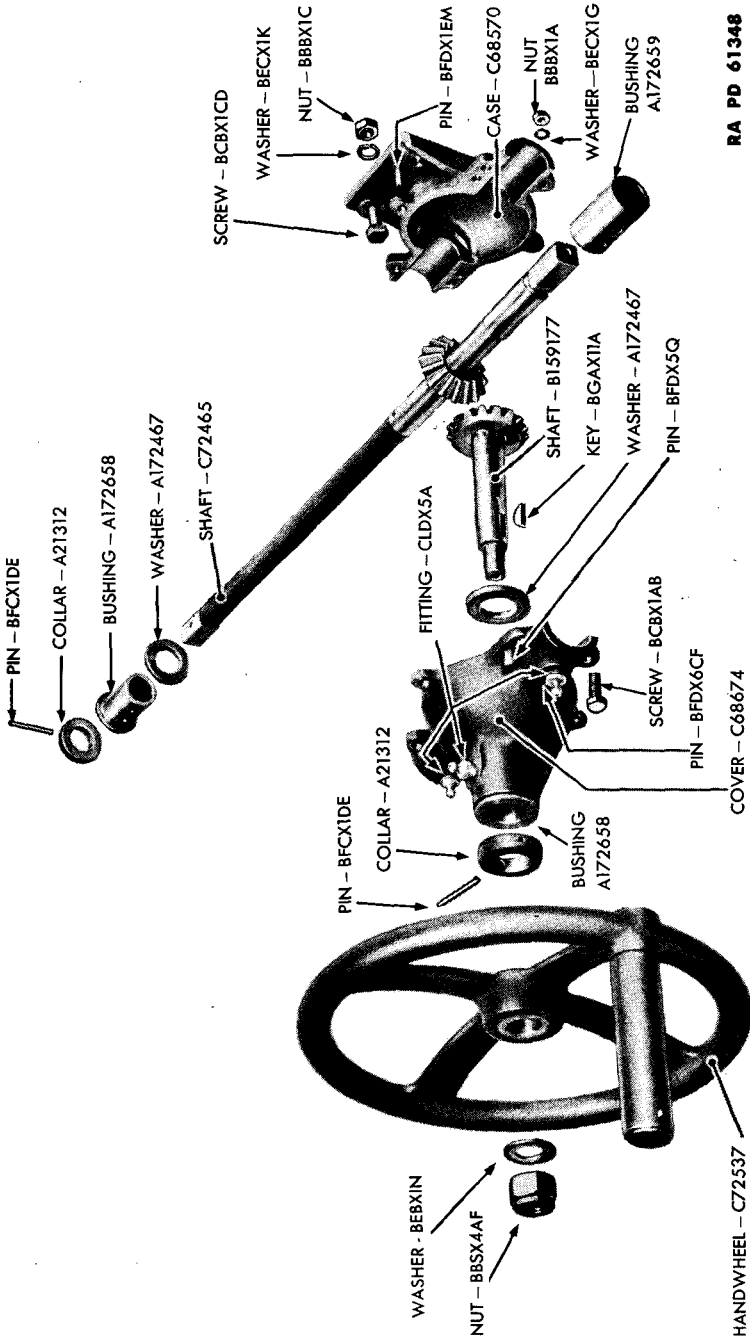
(5) Slide elevating handwheel shaft B159177 and bronze washer A172467 from cover.

(6) If bronze bushing A172658 (fig. 69) needs to be replaced, remove it from the cover with an arbor press or wood block and hammer.

(7) Remove bevel pinion shaft, bronze bushings, steel collar, and flexible joint as a unit. Remove flexible joint and straight bronze bushing A172659 from bevel pinion shaft. To remove flanged bushing A172658, drive taper pin from steel collar A21312 and shaft.

(8) Remove two screws BCBX1CD, washers BECX1K, and nuts BBBX1C. Tap case off straight pins BFDX1EM and cradle.

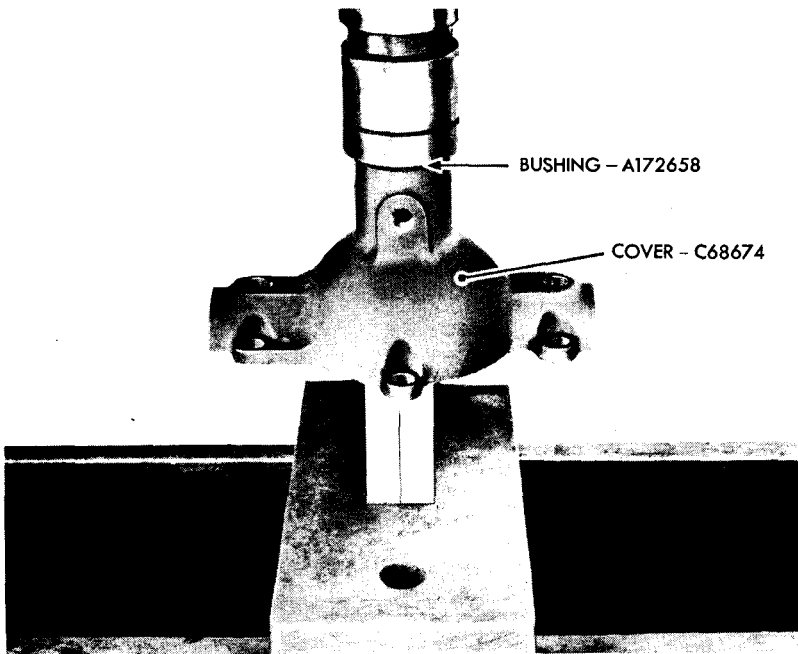
**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 61348

**Figure 69 — Elevating Gear Case and Cover, Bevel Pinion Shaft, and Elevating Handwheel
Shaft — Exploded View**

ELEVATING MECHANISM



RA PD 14561

Figure 70 — Installing Bushing in Elevating Gear Case Cover

b. Assembly.

(1) Coat mounting flange on cradle and mating surface of elevating gear case with white lead pigment. Install elevating gear case on cradle (fig. 68). Apply white lead pigment to the threads of the retaining screws and install the two screws, washers, and nuts. See that the two straight pins BFDX1EM are in place in the case and mounting flange on the cradle.

(2) Lubricate bevel pinion shaft (long shaft), two bushings, and bronze washer. Be sure to lubricate both sides of bronze washer. Place bronze washer on shaft with fillet side of washer against bevel gear (fig. 69). Slide flanged bushing and steel collar on shaft, next to bronze washer. Insert taper pin in collar. Place straight bushing on forward end of shaft.

(3) Assemble the bevel pinion shaft to worm shaft C68633, making sure that punch marks on flexible joint and shafts are lined up. Insert the two taper pins in the joint and shafts.

(4) If bushing A172658 was removed from elevating gear case cover and is to be replaced with a new bushing, press new bushing in place in cover with an arbor press. Use a 1½-inch diameter steel

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

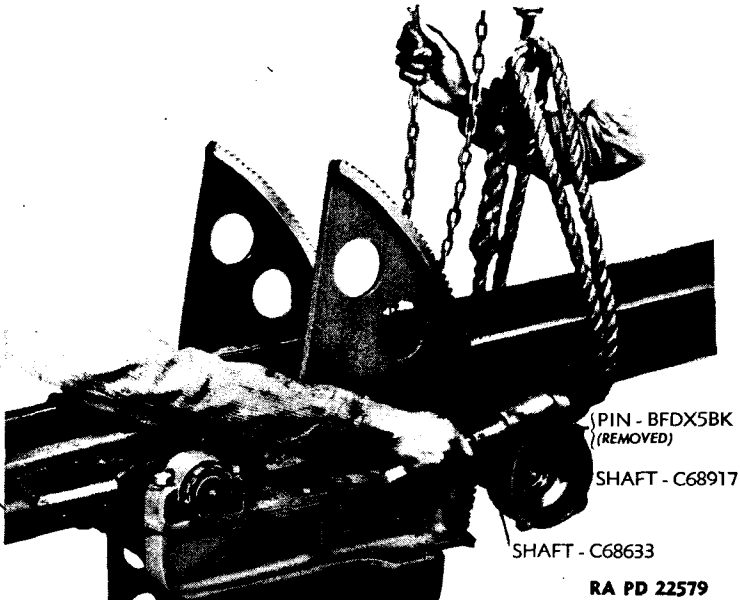


Figure 71 — Removing Elevating Worm Shaft

bar 4 or 5 inches long (fig. 70). Place bronze washer between the inside of cover and the steel bar. Drill a ¼-inch hole through bushing, using lubricating fitting hole in cover as a guide.

(5) Grease elevating handwheel shaft, bushing, and bronze washer. Place bronze washer on elevating handwheel shaft with fillet side of washer next to bevel gear and slide shaft in position in gear case cover.

(6) Lubricate the elevating gear case and cover. Mesh the elevating handwheel shaft and bevel pinion shaft. Be sure that bushings A172658 and A172659 are seated on the two small brass pins in the cover.

(7) Apply white lead pigment to the threads of the retaining screws and secure the cover to the case with two screws, washers, and nuts.

(8) Slide steel collar on elevating handwheel shaft and drive in taper pin. Install Woodruff key in shaft. Mount the elevating handwheel and secure with washer and nut.

(9) See that the three lubricating fittings are in place in the cover.

ELEVATING MECHANISM

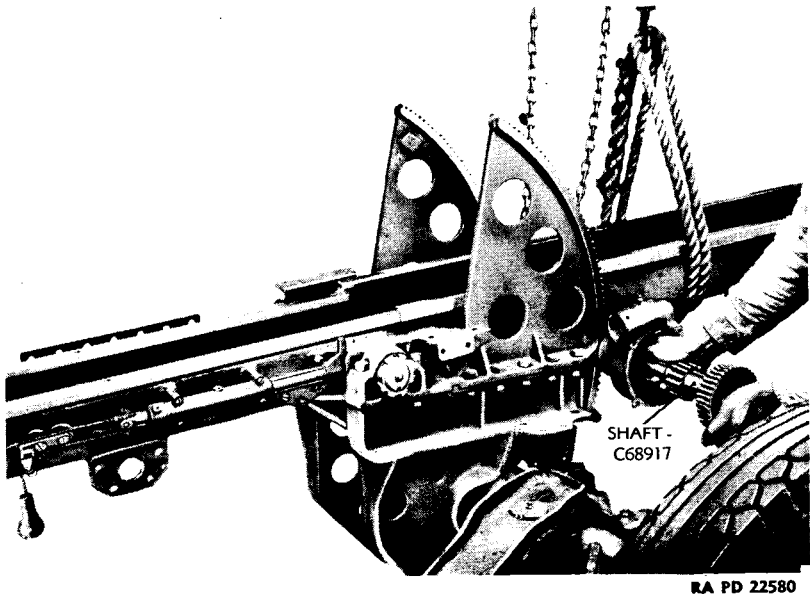


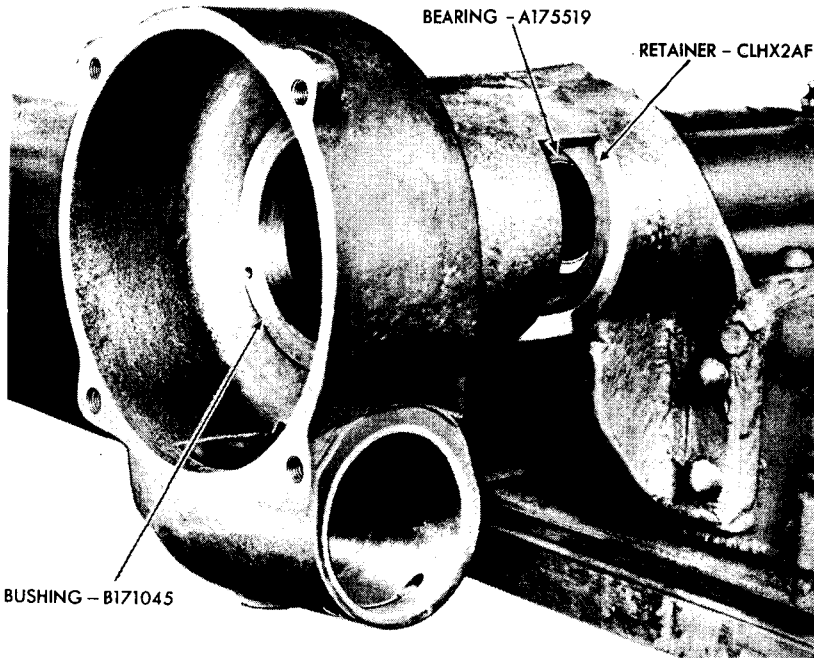
Figure 72 – Removing Elevating Worm Wheel Shaft

- (10) Install handwheel cross shaft B158442 (fig. 64).
- (11) Try the mechanism for freedom of operation.

51. REMOVAL OF WORM SHAFT AND WORM WHEEL SHAFT.

- a. Remove handwheel cross shaft (par. 49 b (1) through (3)) and bevel pinion shaft (par. 50 a (2) through (7)).
- b. Drive straight pin BFDX5BK from worm and worm wheel housing and flanged bushing A175652 (fig. 60). Pry bushing from housing and remove it from the shaft. Remove locking wire, four screws BCBX3CS, and worm and worm wheel housing cover B19055.
- c. Remove cotter pin BFA1DK, castle nut BBFX2C, and bronze, square-holed washer A21322 from worm shaft (fig. 60).
- d. Lift front end of cradle slightly and withdraw worm shaft C68633 from housing (fig. 71). Bronze washer A21320 will come away with worm shaft.
- e. Mark for assembly: slotted nut, spur pinion, and elevating worm wheel shaft (left side of weapon) with a chisel and hammer (fig. 82).

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 14599

Figure 73 — Location of Bushing and Right Bearing and Retainer in Worm and Worm Wheel Housing

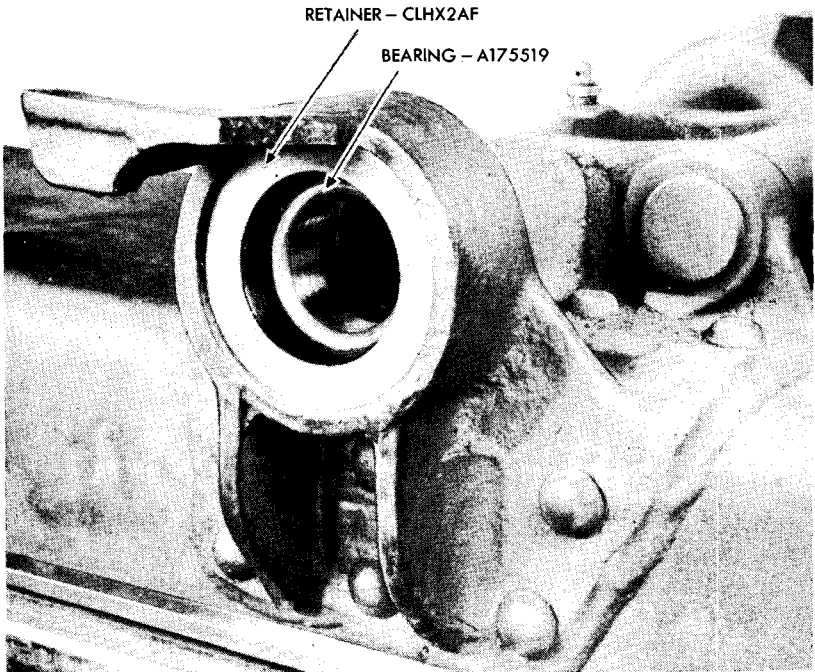
f. Remove cotter pin and loosen nut. Using a copper or hide-faced hammer, tap loosened nut to drive worm wheel shaft C68917 out of the spur pinion. Remove nut. Then drive shaft out of its housing in cradle through right side. *Be sure front end of cradle is lifted up slightly.* Steady shaft and guide it carefully during removal in order to avoid damage to bearings and retainers in housing (fig. 72). Laminated shim will come out on shaft.

NOTE: Ordinarily no further disassembly will be required. However, if it is necessary to replace the roller bearings or retainers, proceed as outlined in paragraph 52 a.

52. FITTING NEW PARTS FOR WORM SHAFT AND WORM WHEEL SHAFT.

a. **Removal and Installation of Worm Wheel Shaft Bushing, Roller Bearings, and Oil Retainers.** Figure 73 shows the location of large bronze bushing B171045, oil retainer CLHX2AF, and roller bearing A175519 in right side of worm and worm wheel housing.

ELEVATING MECHANISM



RA PD 14609

Figure 74 – Location of Left Retainer and Bearing in Worm and Worm Wheel Housing

Figure 74 shows the location of oil retainer CLHX2AF and roller bearing A175519 in the left end of the housing.

(1) REMOVAL.

(a) Using a brass rod and hammer, tap out bushing B171045 (fig. 75). Using the same rod, tap out retainer CLHX2AF and cone and roller of bearing A175519 (fig. 76). The rod must be placed behind the cone and roller. The cone and roller will force the retainer ahead of it. Remove other retainer and cone and roller in the same manner.

(b) If a bearing cup must be replaced, use a round steel or brass rod and hammer to tap it from housing (fig. 77). When removing bearing cups, place rod in different locations around cups in order to drive them out evenly.

(2) INSTALL BEARING CUPS. Use a wood block and hammer to replace left bearing cup (fig. 74). Use a brass rod and hammer to replace right bearing cup (fig. 73). Install the bearing cups carefully. When a rod and hammer are used, be sure to tap at several places around the circumference of the cup.

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

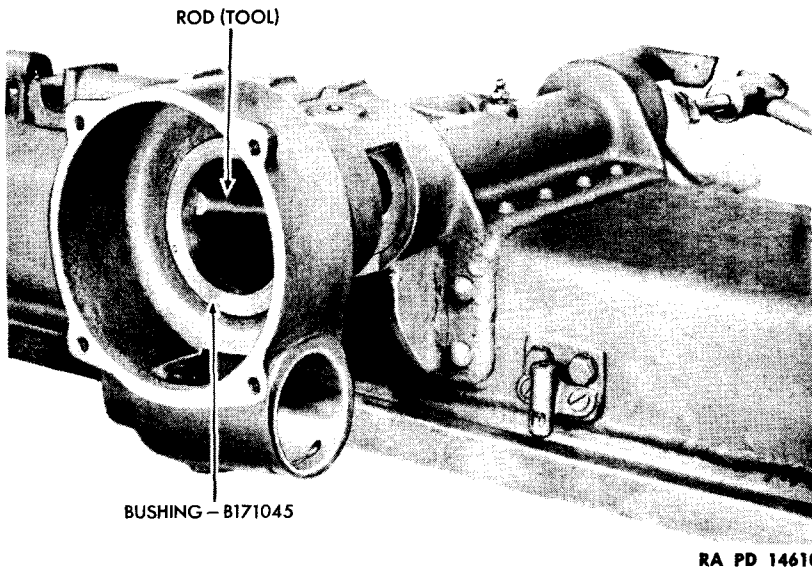


Figure 75 — Removing Bushing From Worm and Worm Wheel Housing

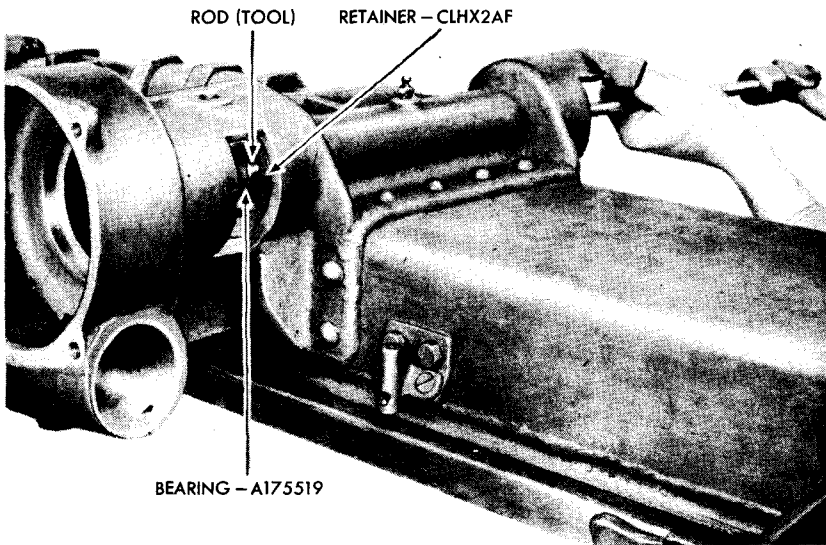
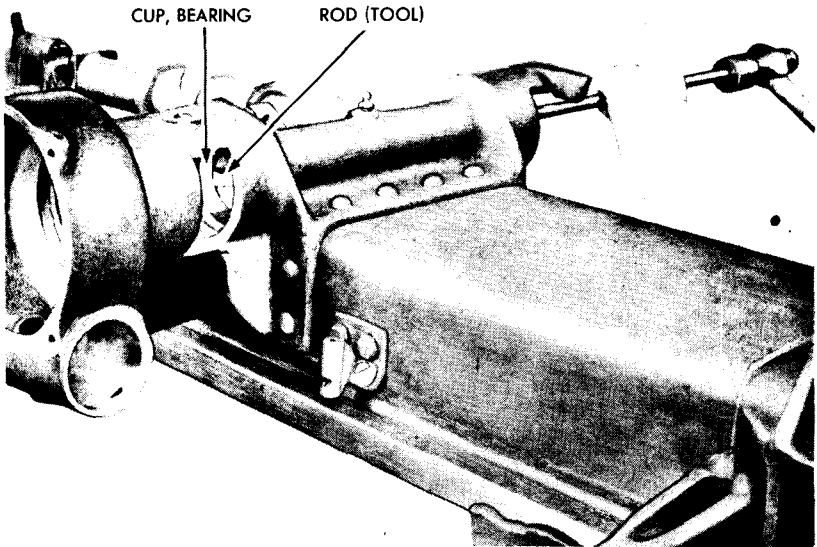


Figure 76 — Removing Right Bearing and Retainer From Worm and Worm Wheel Housing

ELEVATING MECHANISM



RA PD 14612

Figure 77 — Removing Right Bearing Cup From Worm and Worm Wheel Housing

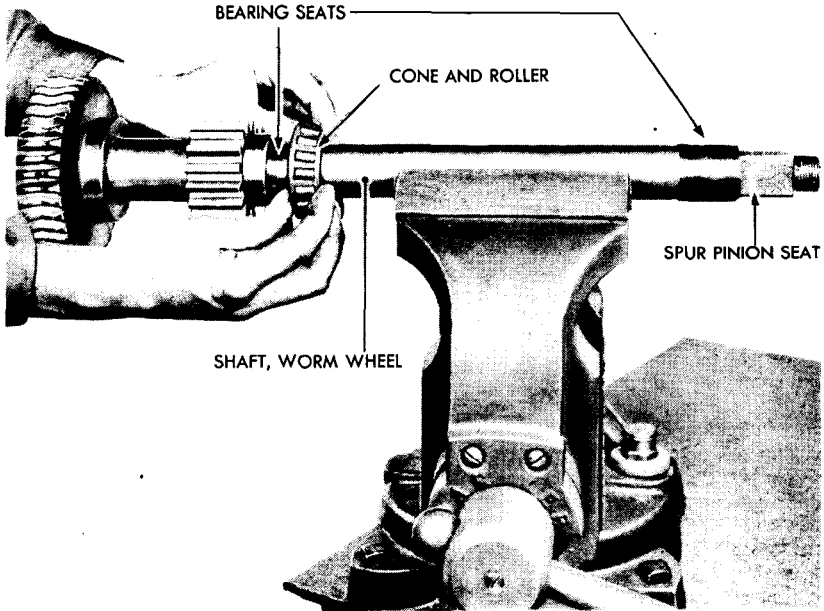
(3) **TRY FIT OF CONES AND ROLLERS ON WORM WHEEL SHAFT.** Place cone and roller of bearing on worm wheel shaft and place shaft in vise equipped with copper jaws. Try fit of cone and roller on the seat of the shaft. This must be a push fit (fig. 78). If shaft is new, this seat will have to be polished evenly all around with crocus cloth to obtain the desired push fit. Perform same operations with regard to outer bearing and seat. Remove cones and rollers.

(4) **INSTALL RIGHT CONE AND ROLLER AND OIL RETAINER.** Turn the cradle on its left side, right side up. Lubricate cone and roller (nearest worm wheel) and place in position in housing. The small diameter of the cone must be toward the inside. Follow the cone and roller with oil retainer, placing leather edge of retainer next to bearing. Tap the oil retainer in place (fig. 79). Always tap around the outside edge of retainer in order not to damage it. Make certain retainer is seated against shoulder in housing. After retainer is in position, check bearing for freedom of operation. Use fingers. Make certain the bearing is not "cocked" in housing.

(5) **INSTALL LARGE BRONZE BUSHING.**

(a) Apply white lead pigment to bronze bushing B171045 (fig. 73). Press bushing in place, or tap in place by using a block of hard wood to exert pressure over the entire face of bushing. Bushing must be tight and seated all around. Check seat all around with a 0.0015-

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 14543

Figure 78 — Checking Fit of Cone and Roller on Worm Wheel Shaft

inch feeler gage. If gage can be inserted, tap bushing down until firmly seated. The outside diameter of the bronze bushing must be 0.003-inch larger than the counterbore for proper fit.

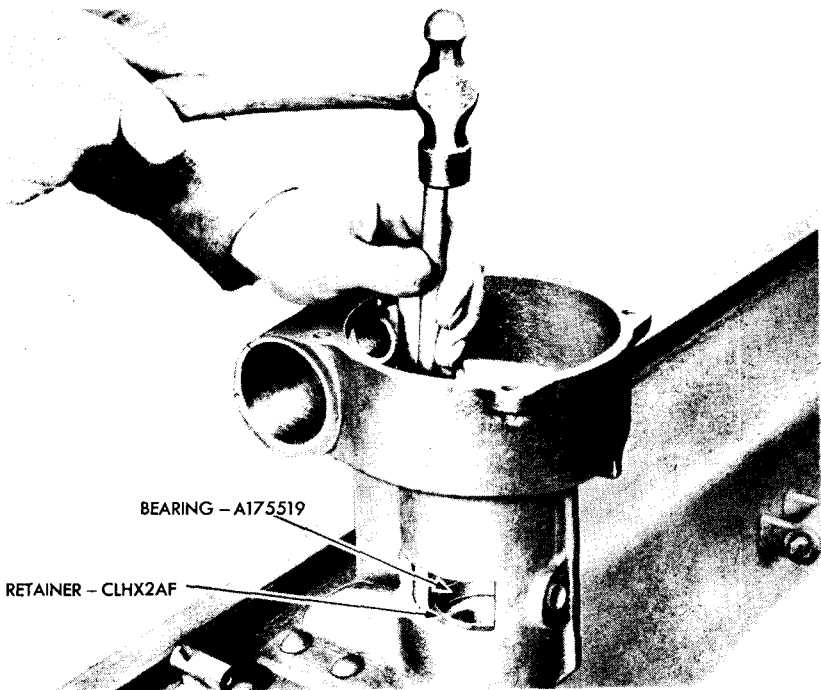
(b) Install worm wheel shaft in order to try fit of shaft in bushing. It may be necessary to scrape high spots on bushing. If so, withdraw shaft and place a clean piece of cloth in housing in front of oil retainer to keep metal scrapings out of bearing (fig. 80). When proper clearance is obtained, clean metal scrapings from housing. (Use compressed air, if this is available.)

(6) **INSTALL LEFT CONE AND ROLLER AND OIL RETAINERS.** Turn cradle on its right side, left side up. Lubricate cone and rollers in accordance with Lubrication Order No. 5 and install the left cone and roller and oil retainer (fig. 81). **NOTE:** *The small diameter of the cone must be toward the inside.*

(7) **CHECK ACTION OF ELEVATING ARCS.**

(a) Install laminated spacer or worm wheel shaft and slide shaft into housing. Line up chisel marks on spur pinion and end of shaft, and tap spur pinion into position on shaft. **CAUTION:** *Unless assembly marks are in line, the elevating arcs, when assembled to cradle,*

ELEVATING MECHANISM



RA PD 14699

Figure 79 — Installing Right Cone and Roller and Oil Retainer

will be out of line, one with the other, causing binding and making it impossible to elevate or depress the howitzer.

(b) Install washer and nut on worm wheel shaft, taking care to line up assembly marks (fig. 82).

(c) Place right or left elevating arc in position on proper cradle trunnion pin. Follow with washer and nut. Run elevating arc in mesh with spur pinion and work arc up and down, checking for freedom of operation (fig. 83). If arc binds in spur pinion, stone or file high spots on arc. When properly fitted, the arc will swing down of its own weight. Remove arc from cradle. Repeat same operations with other arc; then remove arc from cradle.

(d) Remove nut, washer, and spur pinion from left side of worm wheel shaft. Then remove the worm wheel shaft. If the roller bearings have been seated properly in the housing, they will *not* come out when the shaft is removed.

b. Fitting a New Spur Pinion on Worm Wheel Shaft.

(1) When a new spur pinion or shaft is installed, it may be neces-

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CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

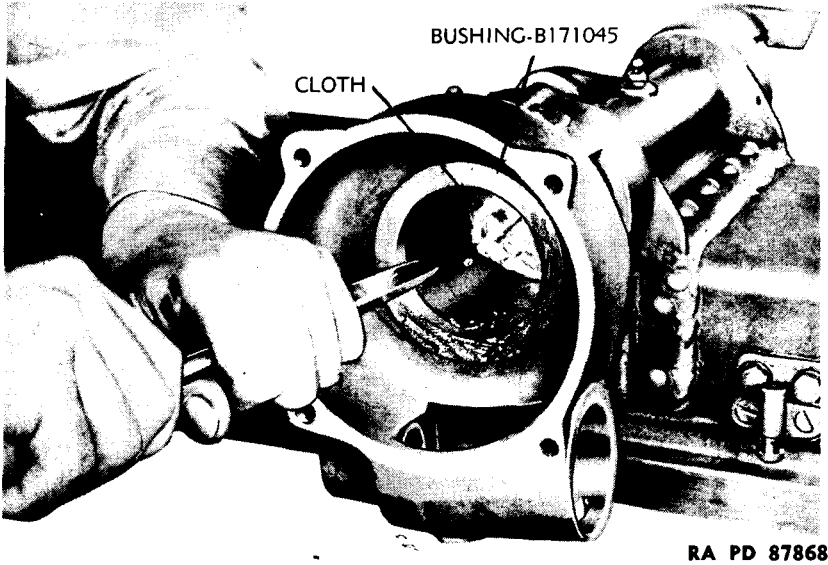


Figure 80 — Scraping Large Bushing

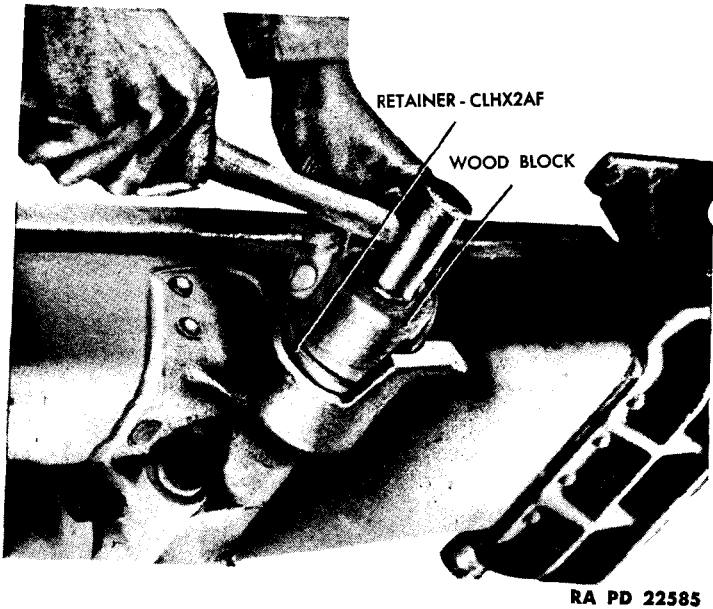


Figure 81 — Installing Left Cone and Roller and Oil Retainer

ELEVATING MECHANISM

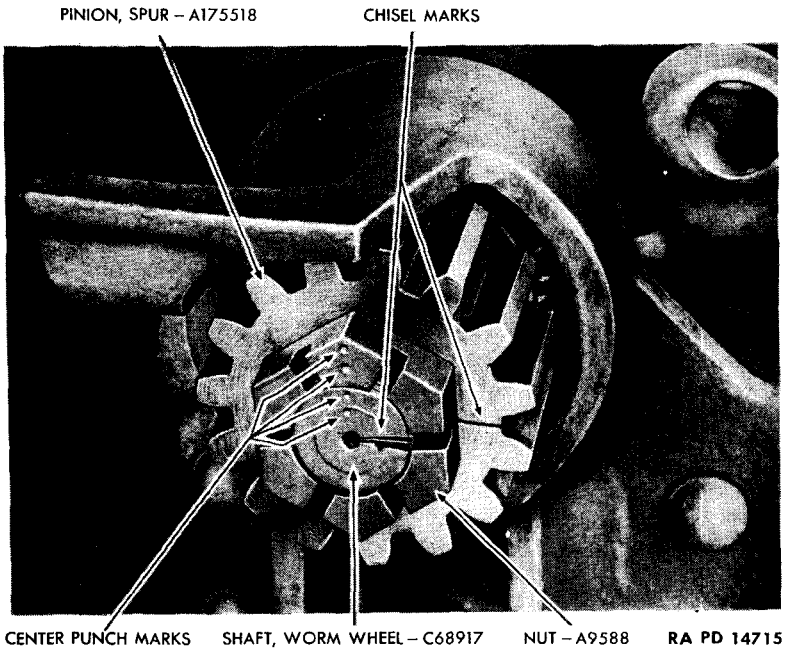


Figure 82 — Assembly Marks on Worm Wheel Shaft, Spur Pinion, and Nut

sary to scrape square portion of shaft (fig. 78) to obtain the proper fit. Scrape "high spot" with a flat scraper until the proper fit is obtained—with the spur pinion up against the bearing shoulder on the shaft. If the spur pinion and shaft have no assembly lines on the outer ends, try the spur pinion on the shaft in different positions, until teeth of both pinions line up (fig. 84). Then mark shaft and spur pinion with a chisel and hammer. Figure 85 shows improper alinement of spur pinions.

(2) Remove spur pinion from left end of shaft.

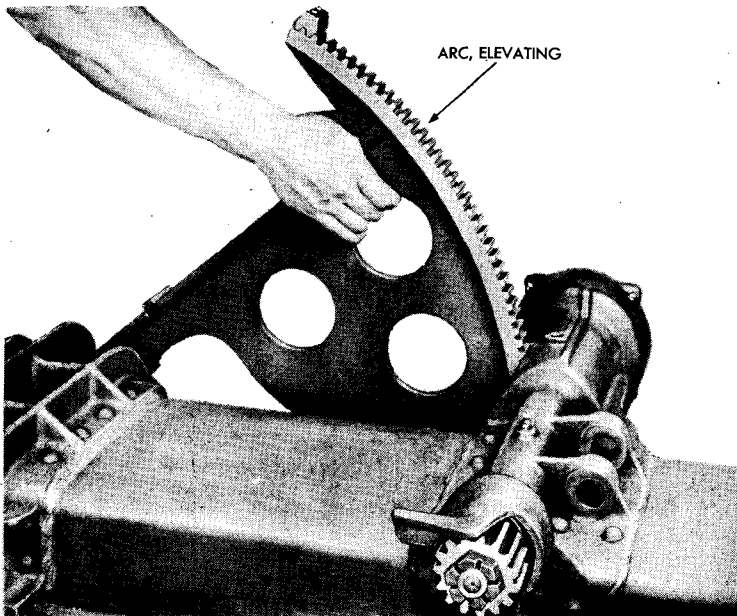
c. Fitting a New Inner (Round-hole) Washer or Worm Shaft.

If a new worm shaft or inner bronze washer is installed, it may be necessary to scrape the face of the washer to obtain proper fit of mating surfaces of washer and worm. Seat washer on shaft (fig. 86) and try for fit. Scrape as necessary.

d. Alining a New Worm Wheel Shaft and Worm Shaft.

(1) Place shim on worm wheel shaft and install shaft in housing. Install spur pinion, washer, and nut on shaft. Draw the nut up tight

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 14665

Figure 83 — Checking Action of Elevating Arc

and then back the nut off slightly to permit free rotation of the shaft.

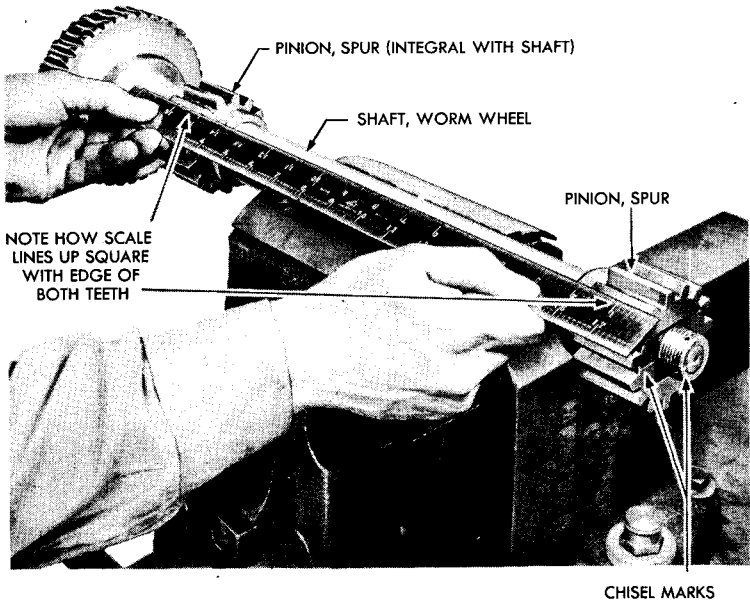
(2) Apply prussian blue to the worm of the worm shaft. Place inner (round-hole) washer on worm shaft and insert worm shaft in housing. Hold washer in place inside housing while inserting worm shaft through it (fig. 87). Install outer washer and nut on the worm shaft and tighten nut until there is no end motion of shaft. Line up cotter pin hole and insert cotter pin temporarily.

(3) Using a $1\frac{3}{16}$ -inch socket, universal joint, and speed handle, rotate worm shaft one complete revolution, then rotate in the other direction one complete revolution. Remove cotter pin, nut, and washer from worm shaft and withdraw worm shaft from housing.

(4) Remove nut and spur pinion from worm wheel shaft and withdraw the worm wheel shaft from the housing. Examine teeth of worm wheel for proper centering (alining) of worm with worm wheel.

(5) Adjustment for proper alinement of worm and worm wheel is made by removing laminations from the laminated shim which is located between the spur pinion (right side) and inside cone and roller of worm wheel shaft. Remove shim and peel off one lamination 0.002-inch thick (fig. 88). Repeat operations outlined above and

ELEVATING MECHANISM



RA PD 14682

Figure 84 — Spur Pinion Properly Mounted on Worm Wheel Shaft



RA PD 14689

Figure 85 — Spur Pinion Improperly Mounted on Worm Wheel Shaft

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

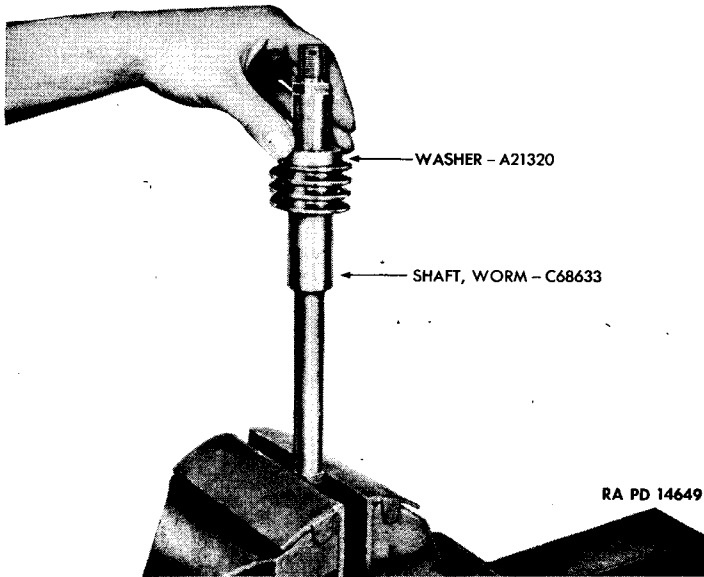


Figure 86 — Checking Fit of Inner (Round-hole) Washer Against Worm Face

check again. Remove 0.002-inch laminations, singly, until proper worm and worm wheel alignment is obtained. Remove prussian blue from the worm each time a check is made. In the event the worm wheel and worm are off center the other way, try a thicker shim. These shims, when new, are approximately 0.070 inch thick.

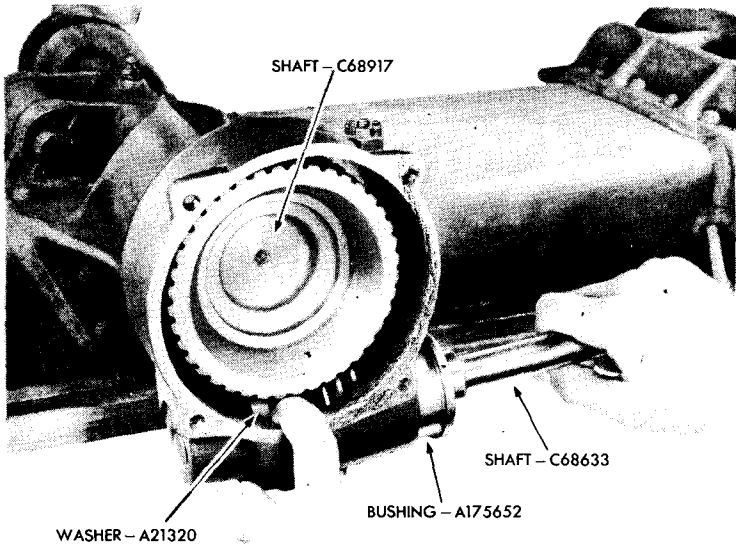
e. **Trying Worm and Worm Wheel for High Spots.** After the worm and worm wheel have been aligned, again install the worm shaft and worm wheel shaft in their housing on the cradle. Operate the worm shaft to see whether there is any binding between the worm and worm wheel. Remove high spots. Use an oilstone on the worm and crocus cloth on the worm wheel.

f. Remove the worm shaft and worm wheel shaft and wash thoroughly with dry-cleaning solvent.

53. INSTALLATION OF WORM SHAFT AND WORM WHEEL SHAFT.

a. If new parts are to be installed, fit new parts as outlined in paragraph 52 d. If the parts removed are to be reinstalled, proceed as outlined below.

ELEVATING MECHANISM



RA PD 14728

Figure 87 — Installing Worm Shaft

b. See that roller bearings and oil retainers are correctly seated in the housing in the cradle. Lubricate the worm wheel shaft lightly. Place shim on shaft against the shoulder behind the spur pinion (right side). Install shaft in its housing on the cradle from the right side.

c. Install spur pinion on left side of shaft, taking care to line up punch marks made during disassembly. Tap pinion into place with a copper or hide-faced hammer. Install slotted nut on shaft. *Draw the nut up tight and then back the nut off slightly to permit free rotation of the worm wheel shaft.* Use the chisel marks made on nut and shaft during disassembly as a guide for proper location of nut on shaft threads. Do not insert the cotter pin yet (subpar. f, below).

d. Lubricate worm shaft and bronze washers lightly. Place (round-hole) washer A21320 on its seat at the forward end of the worm. Install worm shaft in housing, engaging worm and wheel. Slide flanged bushing over worm shaft and seat it in the worm and worm wheel housing. **NOTE:** *When a new bushing is installed, drill and ream a hole in the bushing for a 1/4-inch (0.250) straight pin, using the hole in the housing as a guide.* Install straight pin through bushing and housing.

e. Apply white lead pigment to the threads of the worm shaft

ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4

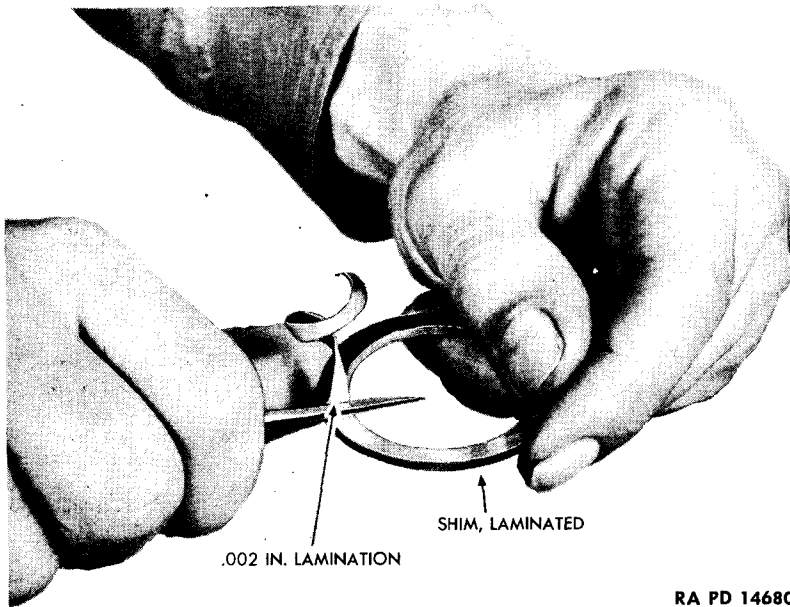


Figure 88 — Peeling Worm Wheel Shaft Laminated Shim

castle nut. Install square-hole bronze washer and castle nut on front end of worm shaft. Try shaft for binding, smooth engagement of pinions with elevating arcs, and end play. Check for lateral motion or end play in the shaft by taking hold of each end of the shaft and attempting to slide it back and forth in the housing. If lateral motion exists, tighten the nut slightly. Be sure that the shaft rotates freely and the slot in the nut lines up with the cotter pin hole in shaft. Insert the cotter pin.

f. After the worm and wheel are engaged properly, insert the cotter pin in the slotted nut on the worm wheel shaft.

g. Lubricate the worm and worm wheel. Place cover in position and secure with four screws and locking wire (fig. 60).

h. Install bevel pinion shaft (par. 50 b) and handwheel cross shaft (par. 49 c).

Section X

CRADLE AND ELEVATING ARCS

54. TROUBLE SHOOTING.

a. The most usual troubles in the cradle and elevating arcs are: damaged or worn teeth in elevating arcs; worn trunnion pin bushings in elevating arcs; scored or bruised cradle guides; weak or broken spring in recoil marker; and worn or damaged cradle lock strut or strut support latch.

b. Elevating Arcs.

(1) To repair a bruised or nicked tooth in the elevating arc, use a fine knife-blade file or oilstone. File tooth smooth and finish with a scraper and crocus cloth. Worn or broken teeth cannot be repaired. Replace the arc.

(2) Replace trunnion pin bushings A171325 and A170697 in elevating arcs if clearance is more than 0.003 inch (par. 56).

c. Damaged Cradle Guides or "Sprung" Cradle.

(1) Damaged cradle guides may be the cause of lack of smooth-

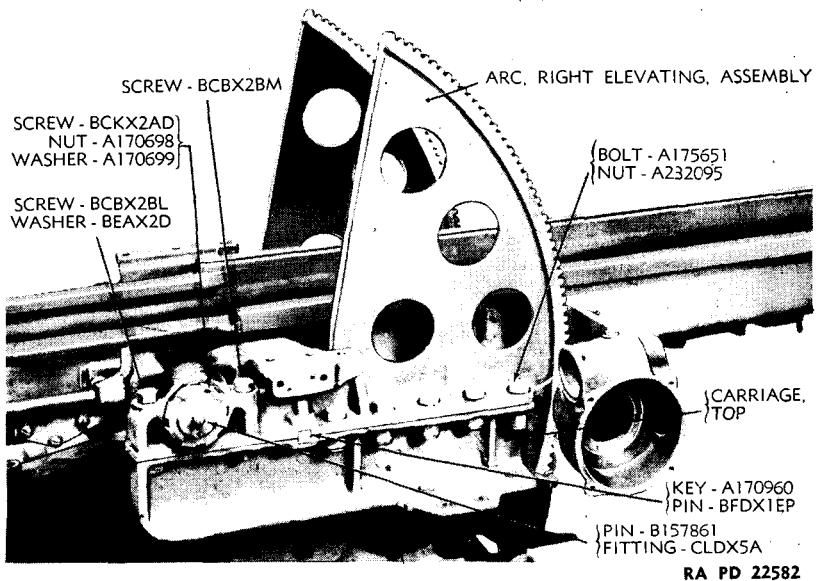
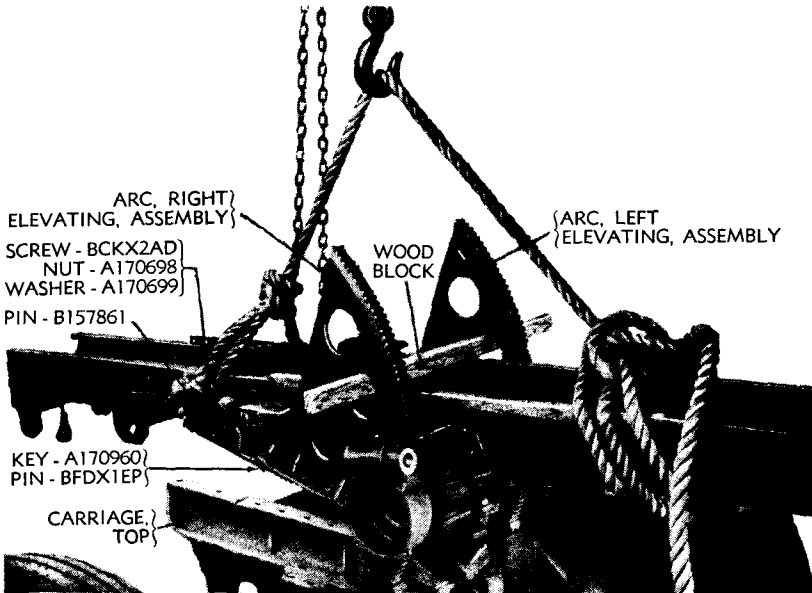


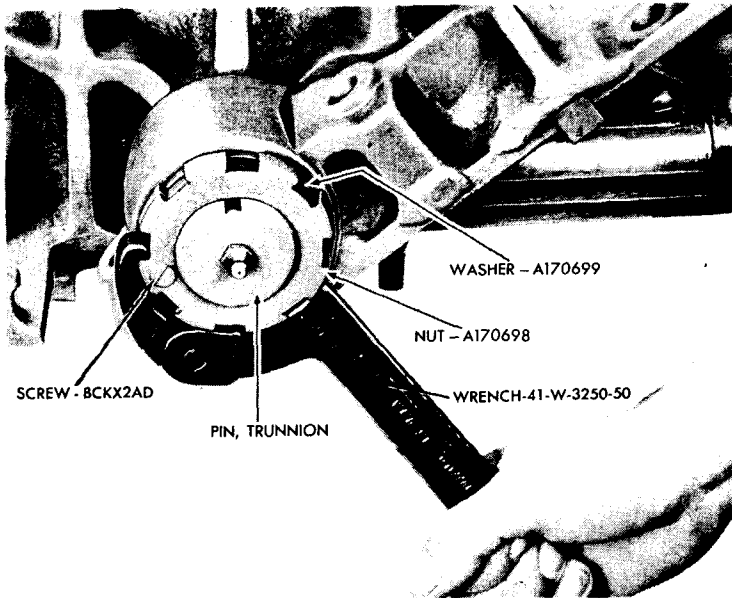
Figure 89 — Right Side of Carriage — Elevating Mechanism Removed

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 22581

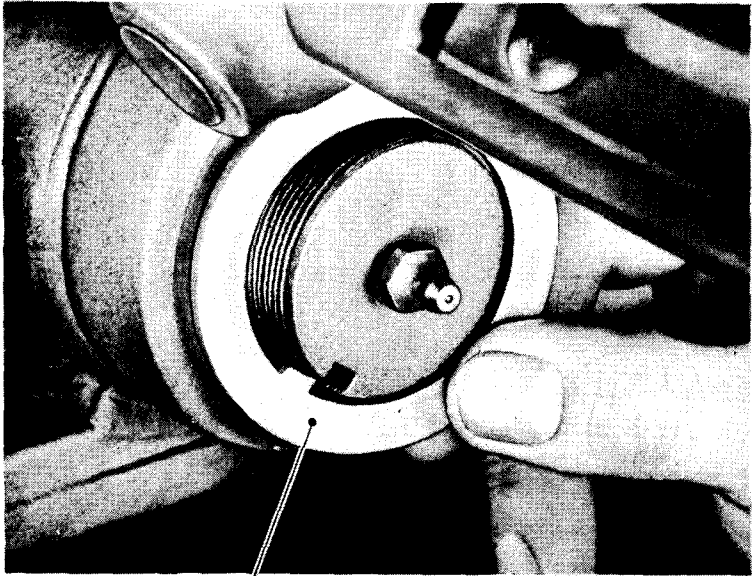
Figure 90 — Removing Cradle and Elevating Arcs



RA PD 22586

Figure 91 — Removing Nut From Cradle Trunnion Pin

CRADLE AND ELEVATING ARCS



WASHER - A170699

RA PD 13527

Figure 92 - Removing Cradle Trunnion Pin Washer

ness in recoil and counterrecoil. Remove cradle from weapon (par. 55). If the cradle guides are not scored, bruised, or damaged beyond repair, remove high spots and burs with a flat scraper. Remove only enough metal to level the surface. Polish with crocus cloth. Always clean guides with dry-cleaning solvent after scraping and polishing. Otherwise, small particles of metal will act as an abrasive when the howitzer and sleigh are in operation. Replace any cradle having deeply scored slides.

(2) Replace a "sprung" cradle.

d. **Recoil Marker.** Replace weak or broken spring with a new one. If nose of indicator is bruised, repair with a fine file and polish with crocus cloth. Replace worn indicator (par. 57).

e. **Cradle Lock Strut.** Replace strut hinge pin A172619 if play is more than 0.004 inch between pin, cradle lock piece B167212, and bracket on cradle (par. 58). Maintain 0.020-inch minimum clearance between cradle lock brace B160192 and strut traveling latch body and pintle support bracket. Adjust by trial and error when in traveling position.

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

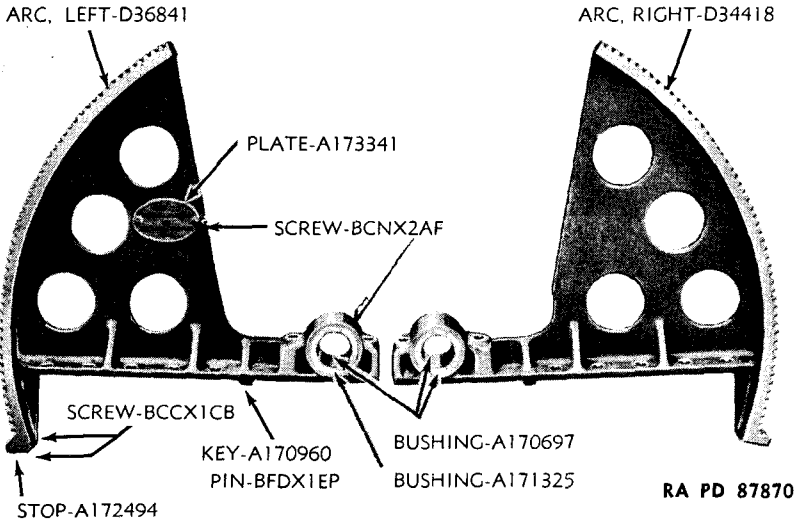
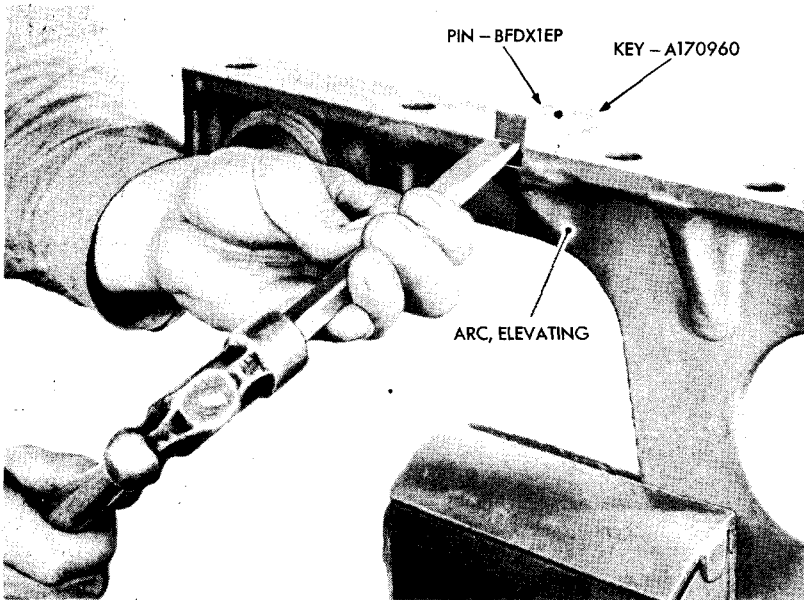


Figure 93 — Elevating Arcs



RA PD 14659

Figure 94 — Removing Key From Arc

CRADLE AND ELEVATING ARCS

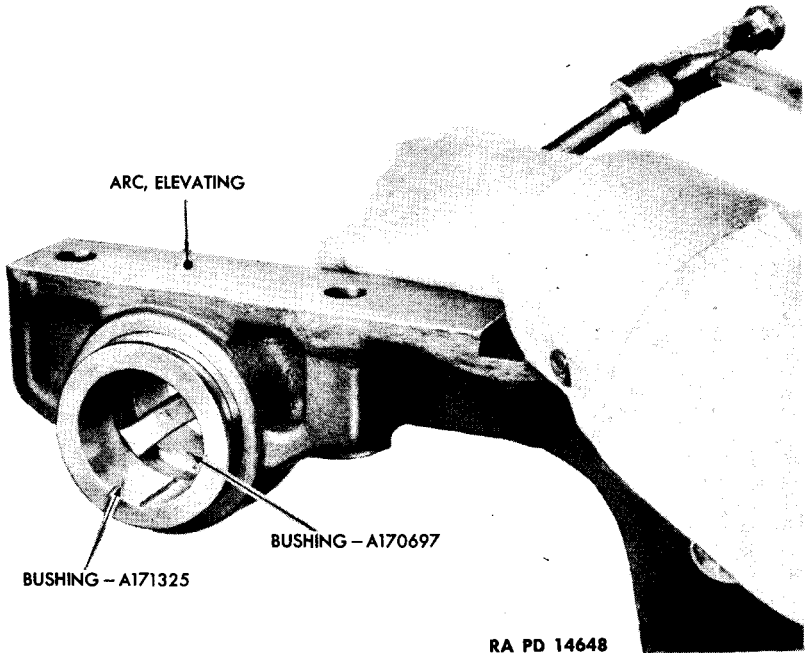


Figure 95 — Removing Bushing From Arc

f. **Strut Support Latch.** Check the plunger guide and the square portion of the strut support latch plunger for smooth operation (fig. 108). If roughened or burred, smooth with small file, polish with crocus cloth, and clean in dry-cleaning solvent. Examine nose of plunger for wear or distortion. Examine latch plunger cam. If bent or damaged, install a new one.

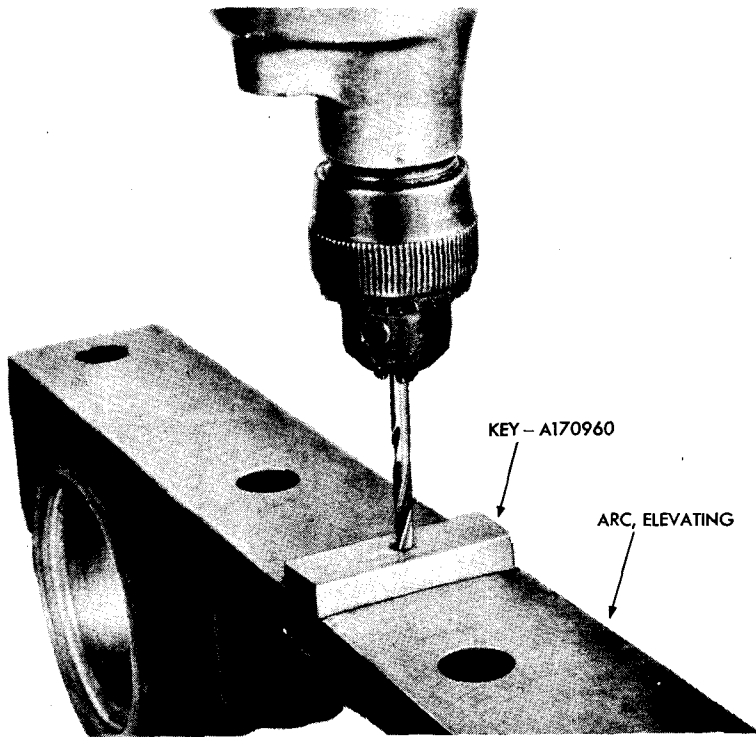
55. DISMOUNTING AND MOUNTING CRADLE.

a. **General.** The cradle may be removed from the weapon with the elevating mechanism assembled to the cradle, or the elevating mechanism may be removed first as described in paragraphs 49, 50, and 51. Whether the elevating mechanism is removed first or not, the elevating arcs and cradle trunnion pins are removed with the cradle.

b. Dismounting Cradle.

- (1) Remove the howitzer, recoil mechanism, and shields.
- (2) Disconnect the equilibrator from the cradle.

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 14651

Figure 96 — Drilling Arc for Installation of Key

(3) Remove bolts A175651 and nuts A232095, screws BCBX2BM, and screws BCBX2BL and washers BEAX2D from the elevating arcs and top carriage (fig. 89).

(4) Place a wood block through corresponding holes in the elevating arcs as shown in figure 90. Then, using suitable rigging and a chain hoist, lift the cradle from the top carriage and place it on two wood horses. Key A170960 will come away in each arc.

c. Mounting Cradle.

(1) Paint mating surfaces of elevating arcs and top carriages with white lead pigment.

(2) Place a wood block through corresponding holes in the elevating arcs as shown in figure 90. Then, using suitable rigging and a chain hoist, install the cradle on the top carriage.

CRADLE AND ELEVATING ARCS

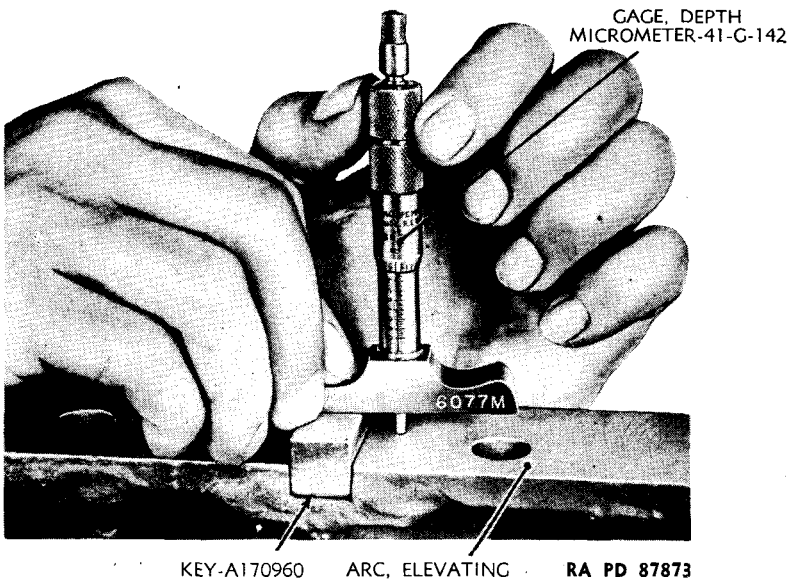


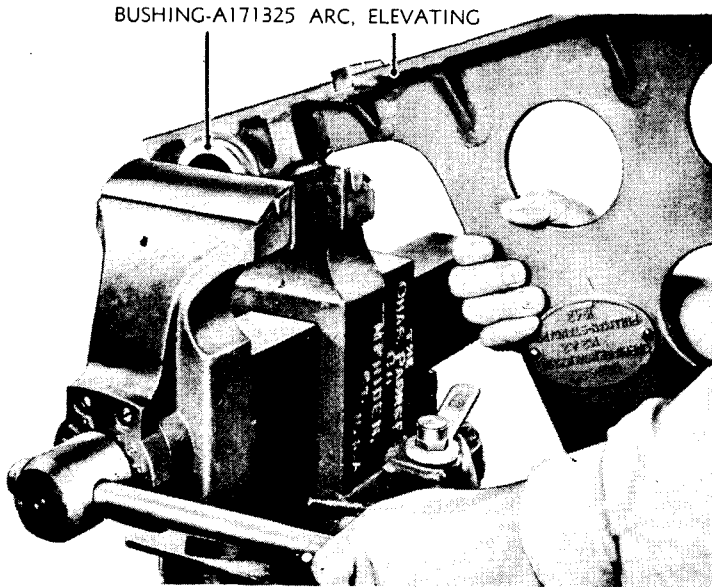
Figure 97 – Checking Installation of Elevating Arc Key

(3) Line up the bolt and cap screw holes in arcs and in top carriage. Check to see that arcs are down tight on top carriage and keys are not binding at bottom. Apply white lead pigment to the bolts and screws. Tap the bolts and screws in place with a copper hammer. Insert the two cap screws and washers at rear of trunnions (one on each side) (fig. 89). *NOTE: The three center bolts and nuts on the left side need not be installed until the auxiliary shield left upright bracket is installed.*

(4) Using a 0.0015-inch feeler gage, attempt to insert it between the arc and top carriage the full length of the joint. Repeat on other side of carriage. Should the 0.0015-inch feeler gage go in, look for trouble at key and seat. There must be at least 0.012-inch clearance between key and seat. Use a 0.012-inch feeler gage between key and seat to check.

(5) If the weapon is to be assembled completely, install the elevating mechanism; connect the equilibrator to the cradle; and mount the recoil mechanism, howitzer, and shields.

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 87872

Figure 98 — Installing Bushing in Elevating Arc

56. DISASSEMBLY AND ASSEMBLY OF ELEVATING ARCS.

- a. Dismount cradle (par. 55 a and b).
- b. Disassembly of Elevating Arcs.

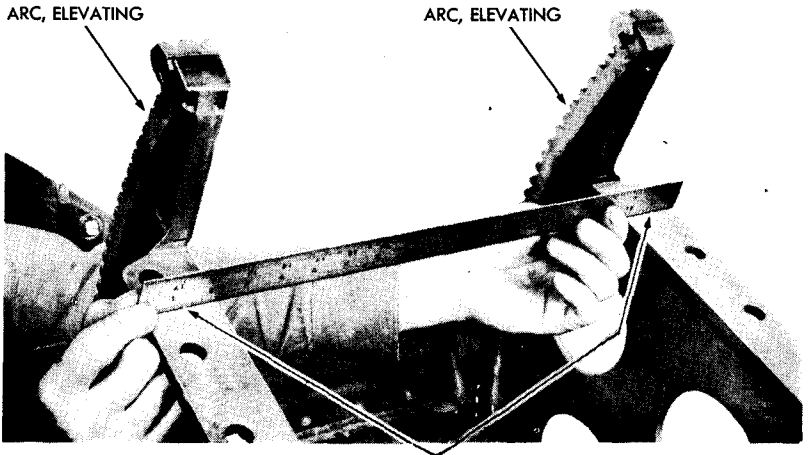
(1) Loosen, but do not remove screw BCKX2AD from trunnion pin nut A170698. Remove the nut with an adjustable hook spanner wrench (fig. 91), and then remove washer A170699 (fig. 92) from cradle trunnion pin. Take hold of right elevating arc assembly and remove it from trunnion pin.

(2) Repeat operation to remove left elevating arc assembly (fig. 93).

NOTE: *If the cradle is removed with the elevating mechanism in place, it will be necessary to run the elevating arcs out of engagement with the spur pinions before removing them.*

(3) Place elevating arc in a vise equipped with copper jaws. Remove the two screws BCCX1CB from elevating arc stop A172494, and the stop will come away.

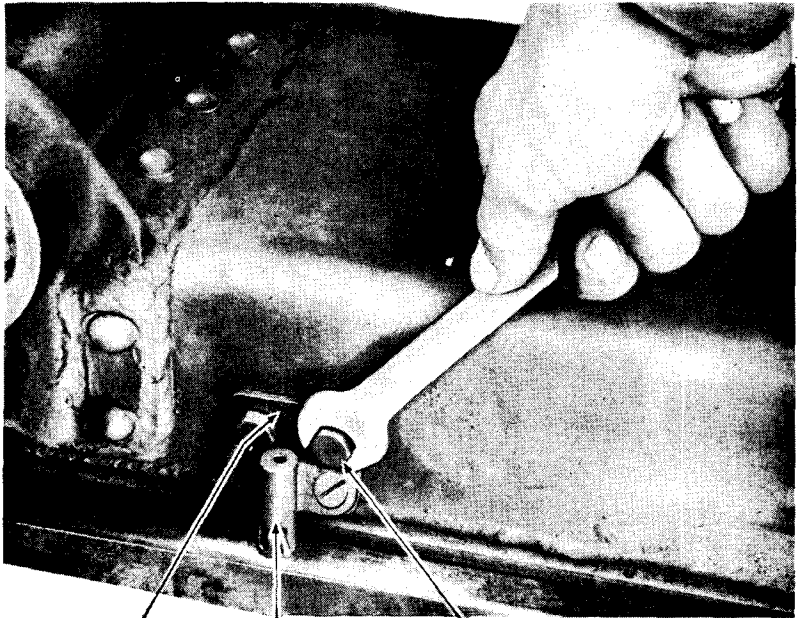
CRADLE AND ELEVATING ARCS



NOTE - SCALE FLAT ACROSS SURFACES

RA PD 14697

Figure 99 - Checking Elevating Arc Timing



BRACKET - A173424

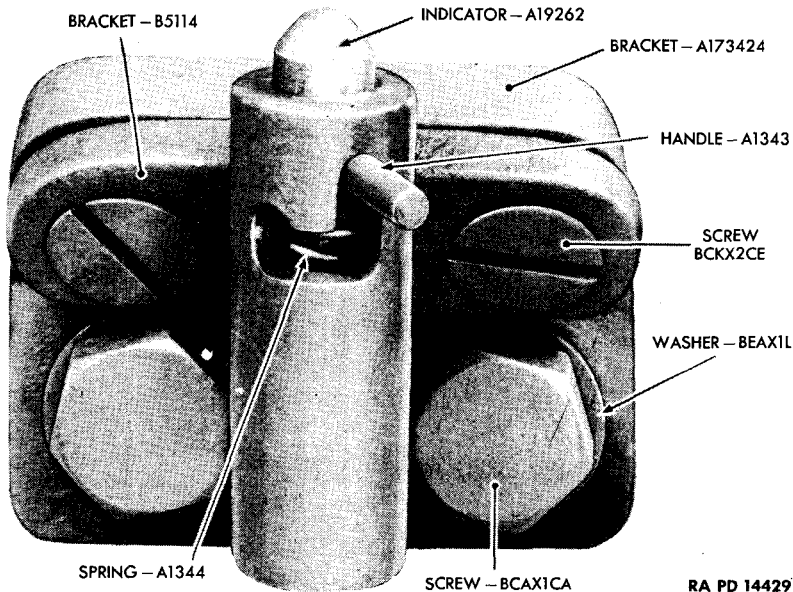
MARKER, RECOIL,
ASSEMBLY

SCREW - BCAX1CA
WASHER - BEAX1L

RA PD 14618

Figure 100 - Removing Recoil Marker Assembly From Cradle

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 14429

Figure 101 — Recoil Marker Assembly

(4) Using a small chisel and hammer, drive key A170960 upward and out of slot in arc. Pin BFDX1EP will come out in the key (fig. 94).

(5) Drive bushing A171325 from arc with a ½-inch punch, ground flat, and a hammer (fig. 95). The other bushing A170697 is removed in the same manner.

(6) Disassemble right arc in same manner as left arc.

(7) The two bushings A170697 in right arc are the same as the inside bushing in left arc (fig. 93). The one bushing A171325 in left arc (the outside bushing) is different from the other three bushings in the arcs. This bushing has a thicker thrust collar integral with it to provide proper spacing for the telescope mount.

c. Assembly of Elevating Arcs.

(1) Place elevating arc in vise equipped with copper jaws.

(2) Coat key slot and bottom and side surfaces of the key with white lead pigment. Tap key into slot with a copper hammer.

CRADLE AND ELEVATING ARCS

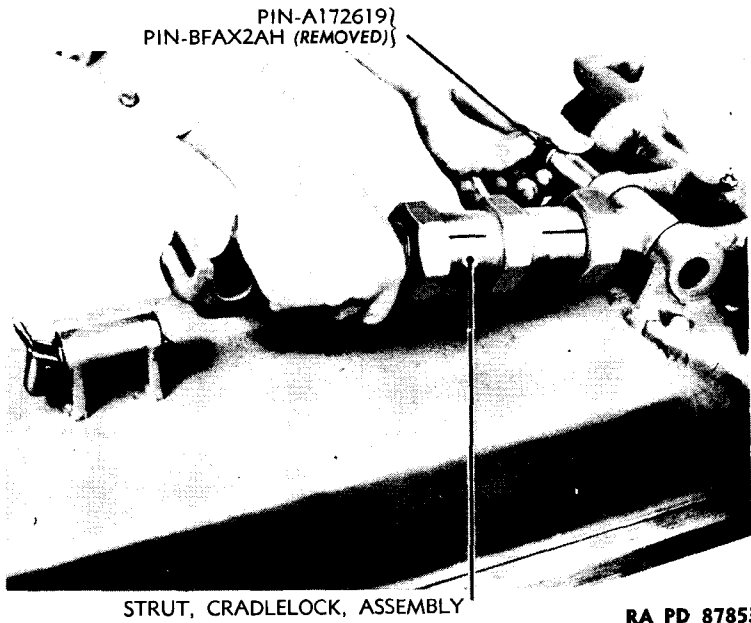


Figure 102 — Removing Cradle Lock Strut

(3) Using the hole in the key as a guide, drill and ream the arc (when new arc is being installed) for $\frac{3}{16}$ - by $\frac{7}{8}$ -inch pin (fig. 96). Drive pin in place with a copper hammer and file end of pin flush with surface of key.

(4) Using a depth micrometer gage and 1-inch stem, measure the height of key above arc (fig. 97). This must not measure over 0.300 inch. The *key slot in the top carriage* is machined to a depth of 0.312 inch. It is absolutely necessary to have a minimum clearance of 0.012 inch between key and bottom of slot in top carriage, otherwise the elevating arc will not fit down tightly against the mounting surface of the top carriage.

(5) Coat elevating arc stop, where it mates with the arc, with white lead pigment. Coat stop screws with white lead pigment.

(6) Secure elevating arc stop to arc with two screws. Stake each screw in place with a staking chisel and hammer.

(7) Install bushings by pressing them into position in a vise (fig. 98). Make certain that the bushing with the thicker collar is installed in the outside side of the left arc (fig. 93). Line-ream bushings.

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CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4

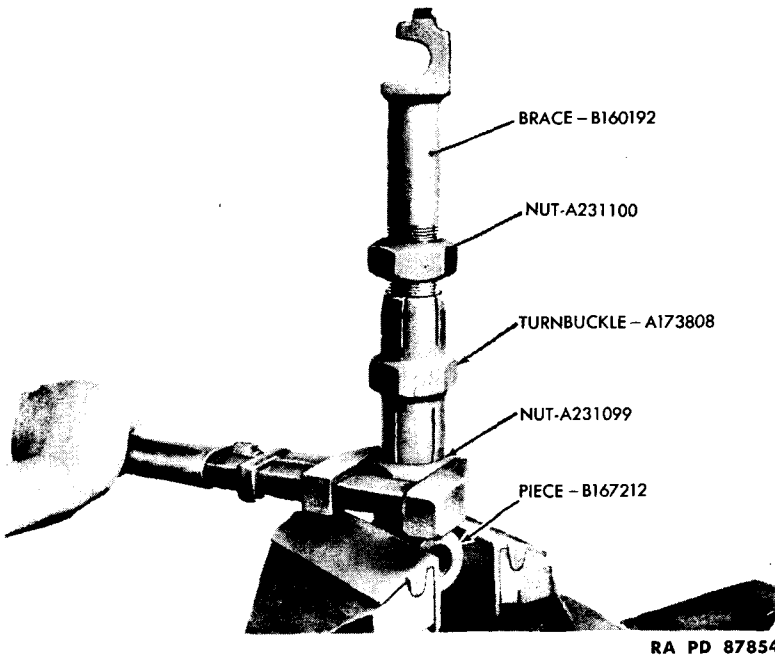


Figure 103 — Disassembling Cradle Lock Strut

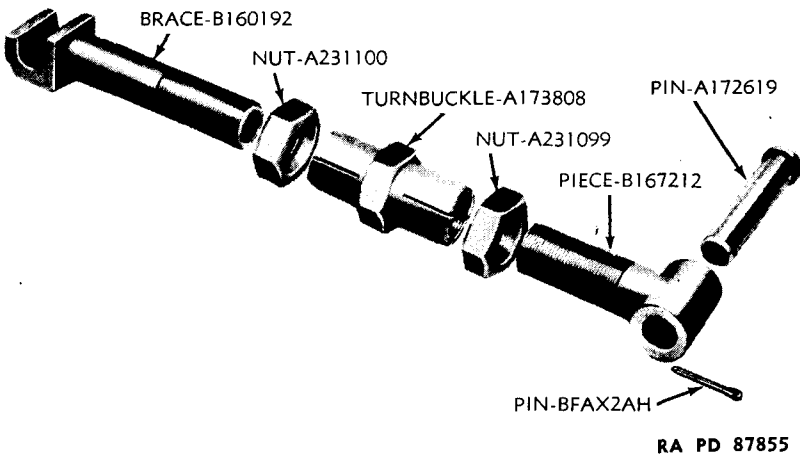


Figure 104 — Cradle Lock Strut — Exploded View

CRADLE AND ELEVATING ARCS

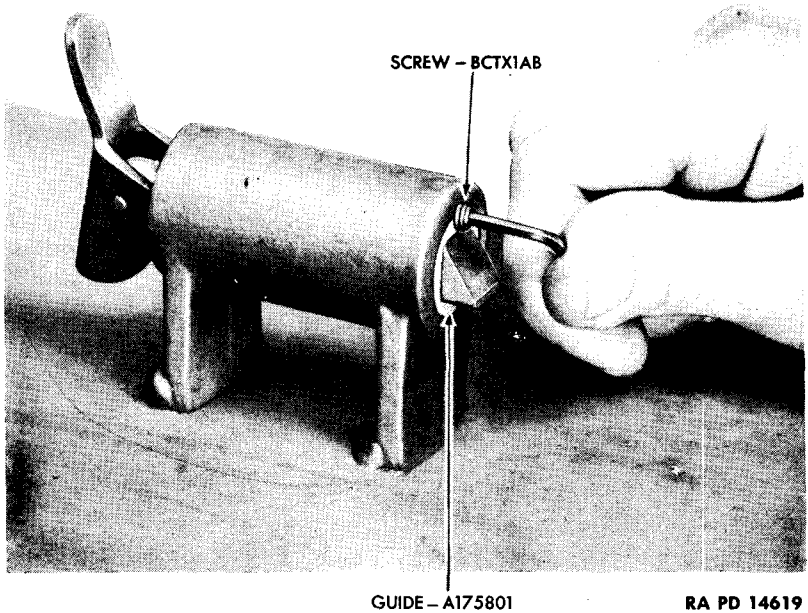


Figure 105 — Removing Screw From Strut Support Latch Guide

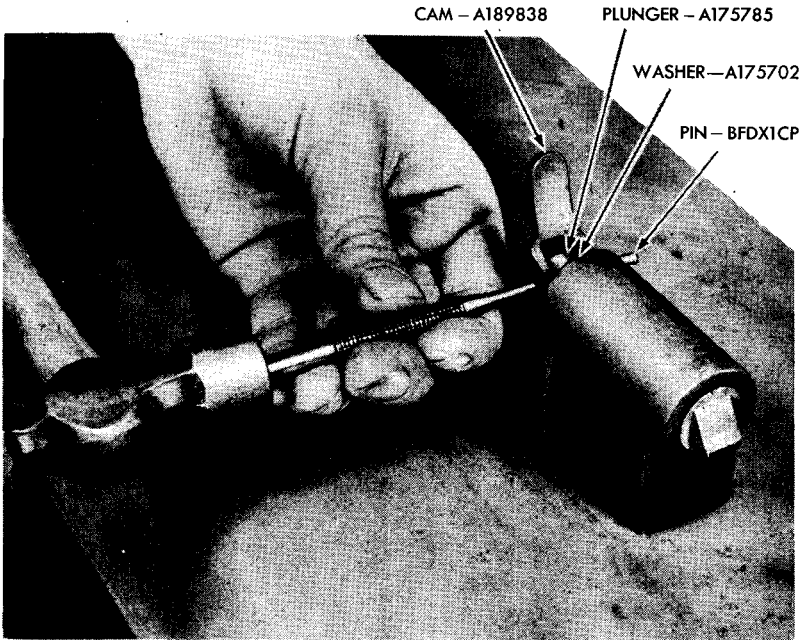
d. Mounting Arcs on Trunnion Pins.

(1) Grease cradle trunnion pins and trunnion pin bushings in each elevating arc. Place elevating arcs in position on cradle trunnion pins. **NOTE:** *If the elevating mechanism is in place on the cradle, it will be necessary to mesh the arcs with the spur pinions on the worm wheel shaft.*

(2) Coat trunnion pin and nut threads with white lead pigment. Place the washer in place on trunnion pin (fig. 92). Screw trunnion pin nut on, but do not tighten nut on right side too much or it will bind the arc; if too loose, there will be “play” between the arc and cradle. Tighten set screw in the nut.

e. If the elevating mechanism is in place on the cradle, the arc timing can be checked with an 18-inch steel scale or straightedge. Place straightedge or 18-inch steel scale across mounting surface of each arc (fig. 99). When arcs are in proper mesh with spur pinions, the edge of the scale or straightedge will be flat against both surfaces. When arcs are not in proper time with spur pinions, the elevating

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CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 14549

Figure 106 — Removing Pin From Strut Support Cam Latch and Plunger

mechanism will be placed under terrific strain and may be damaged. These two arcs must be started evenly in mesh in the spur pinions.

57. DISASSEMBLY AND ASSEMBLY OF RECOIL MARKER.

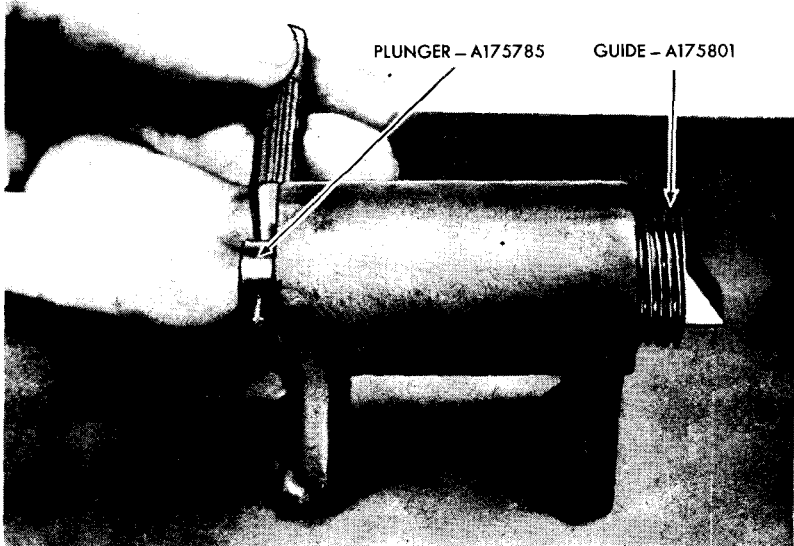
a. Disassembly of Recoil Marker.

(1) Remove two screws BCAX1CA and washers BEAX1L from recoil marker holding bracket A173424. Holding bracket and recoil marker will come off as a unit (figs. 100 and 101).

NOTE: *The recoil marker assembly can be removed from the holding bracket without removing the holding bracket from the cradle. This can be done by removing two screws which secure the recoil marker assembly to the holding bracket.*

(2) Place recoil marker and holding bracket assembly in a vise equipped with copper jaws. Unscrew the small handle A1343. Hold indicator A19262 while unscrewing handle.

CRADLE AND ELEVATING ARCS



RA PD 14620

Figure 107 – Removing Plunger From Strut Support Latch

- (3) Remove indicator and spring A1344.
- (4) Remove two screws BCKX2CE from bracket B5114 and bracket A173424, and remove bracket B5114.

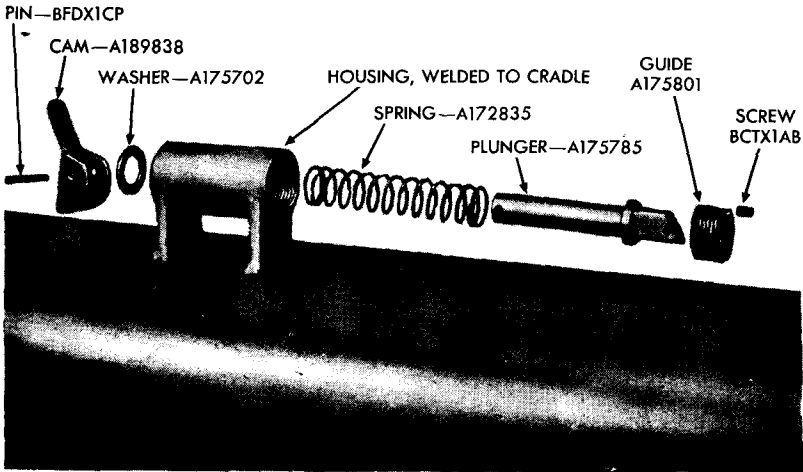
b. **Assembly of Recoil Marker.** Reverse procedure described in subparagraph a, above. Be sure to replace the two washers BEAX1L and make sure handle A1343 is screwed in tight. Apply white lead pigment to the screw threads and oil the recoil indicator and recoil indicator spring.

58. DISASSEMBLY AND ASSEMBLY OF CRADLE LOCK STRUT AND LATCH.

a. Disassembly of Cradle Lock Strut and Latch.

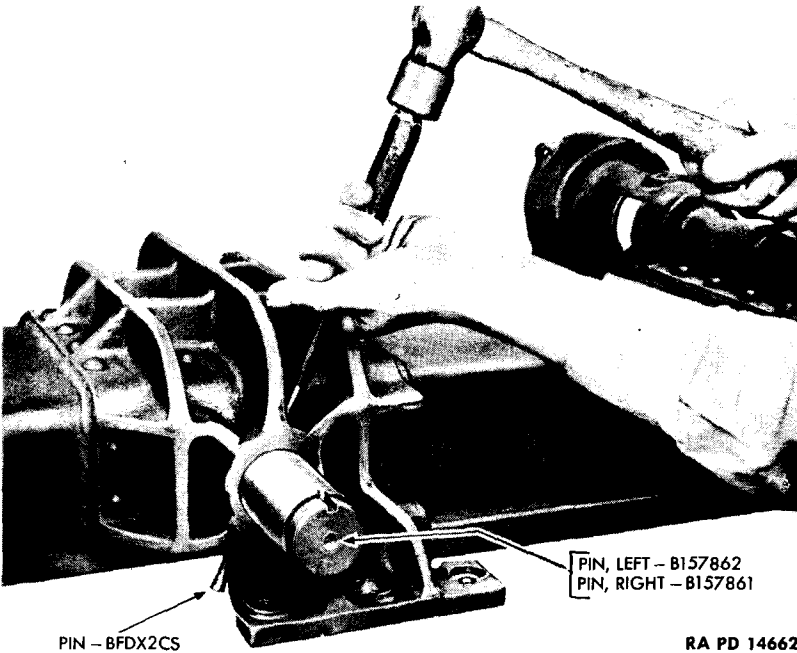
- (1) Remove cotter pin BFAK2AH and pull out strut hinge pin A172619 (fig. 102). Lift cradle lock strut assembly away from cradle.
- (2) Place cradle lock strut assembly in a vise equipped with copper jaws and loosen two nuts A231099 and A231100 (fig. 103). Un-

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CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 14430

Figure 108 — Strut Support Latch — Exploded View



RA PD 14662

Figure 109 — Removing Straight Pin From Cradle Trunnion Pin

CRADLE AND ELEVATING ARCS

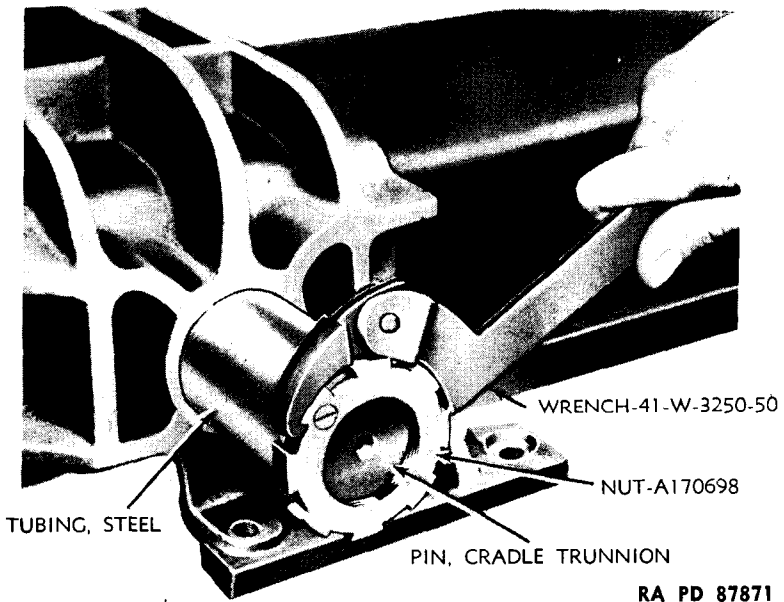


Figure 110 – Removing Cradle Trunnion Pin From Cradle

screw brace B160192 from turnbuckle A173808 and unscrew nut from brace. Unscrew piece B167212 from turnbuckle and then unscrew nut from piece (fig. 104).

(3) The strut support latch is assembled in a housing which is welded to the under side of the cradle near the front. Disassemble strut support latch as shown in figures 105, 106, 107, and 108. To unscrew guide, insert punch in hole in plunger as shown in figure 107.

b. Assembly of Cradle Lock Strut and Latch. Reverse procedure described in subparagraph a, above. When a new guide is installed in the latch housing, it will be necessary to drill and tap a new hole for the $\frac{3}{16}$ -inch set screw, half in the guide and half in the housing. Oil latch plunger and spring. Oil latch cam pin before installing and rivet both ends after installing. Apply white lead pigment to the threads of cradle lock strut before assembling. Adjustment of cradle lock strut is performed after the weapon is assembled. Coat exposed threads with rust-preventive compound (thin film).

ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4

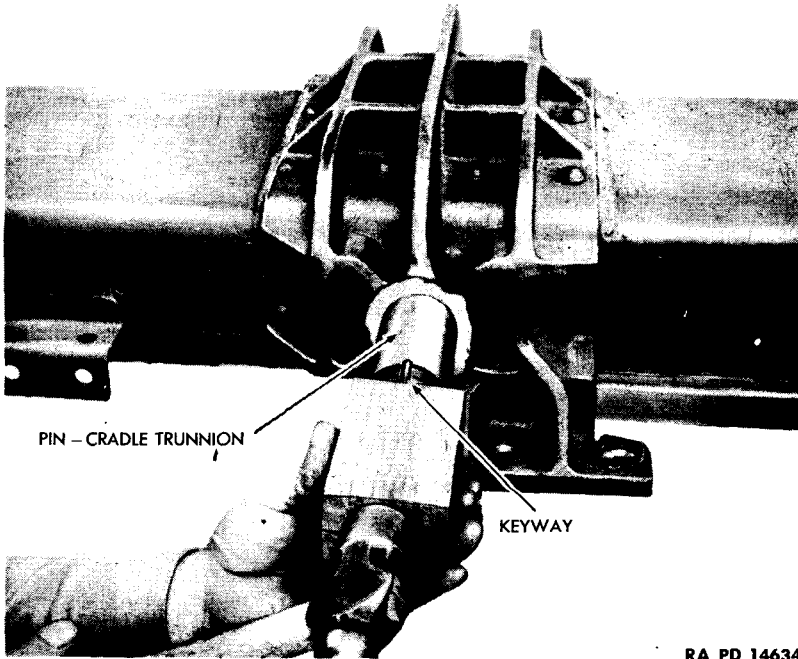


Figure 111 — Driving Cradle Trunnion Pin in Cradle

59. REMOVAL AND INSTALLATION OF CRADLE TRUNNION PIN.

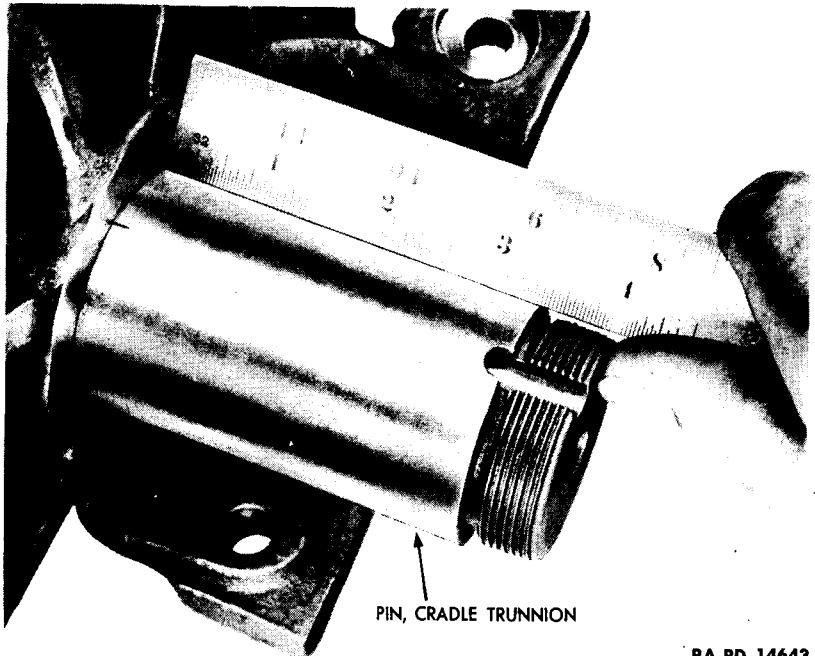
a. Seldom, if ever, should it be necessary to remove a cradle trunnion pin. However, if required, proceed as follows:

b. Removal of Cradle Trunnion Pin.

(1) Remove lubricating fitting from end of trunnion pin. Drive straight pin BFDX2CS from cradle bracket and trunnion pin (fig. 109).

(2) If removing the left trunnion pin B157862 (the longer pin), place a piece of steel tubing ($2\frac{3}{8}$ -inch OD x $2\frac{1}{16}$ -inch ID x $3\frac{1}{2}$ -inches long) over the pin. Screw trunnion pin nut (170698 on the spin and draw pin from cradle bracket with an adjustable hook spanner wrench (fig. 110). When pin is withdrawn as far as it will come with the steel tubing, add spacer washers between steel tubing and nut.

CRADLE AND ELEVATING ARCS



RA PD 14643

Figure 112 – Measuring Projection of Cradle Trunnion Pin

(3) When removing the right trunnion pin B157861, use steel tubing ($2\frac{3}{8}$ -inch OD x $2\frac{1}{16}$ -inch ID x $2\frac{1}{2}$ -inches long). The operations are the same as in step (2), above.

c. Installation of Cradle Trunnion Pin.

(1) Place cradle on wood horses with bottom of cradle facing upward.

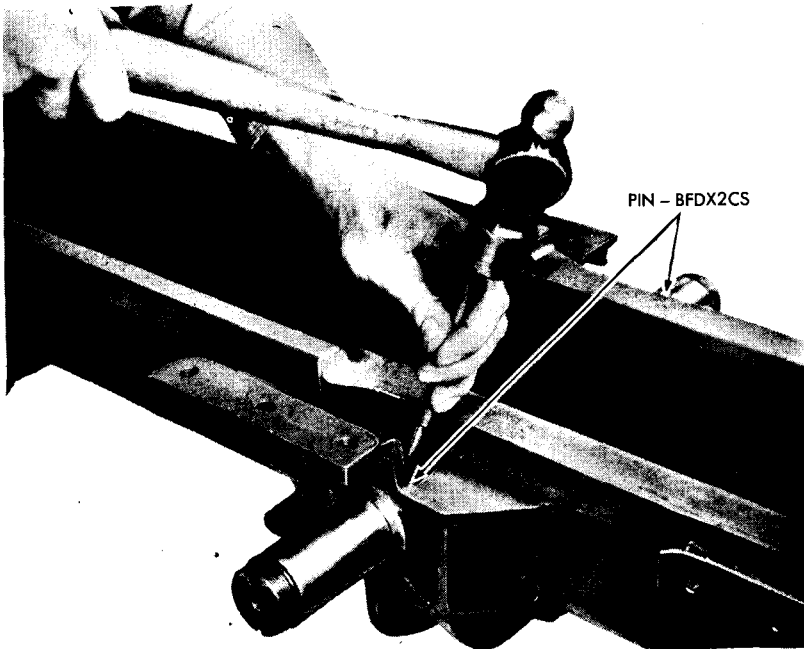
(2) Place thin coating of white lead pigment on end of cradle trunnion pin and in trunnion pin hole of cradle bracket.

(3) Drive cradle trunnion pin into position with hardwood block and heavy hammer. Be sure that oilhole in pin is toward top of cradle, and keyway is toward the bottom of the cradle (fig. 111).

(4) Scale the distance the trunnion pin projects from trunnion bracket with a steel scale (fig. 112). This must be $3.27 - 0.01$ inches on long pin (left side) and $2.20 - 0.01$ inches on short pin (right side).

(5) When pin is properly installed as to measurement, turn cradle over on wood horses.

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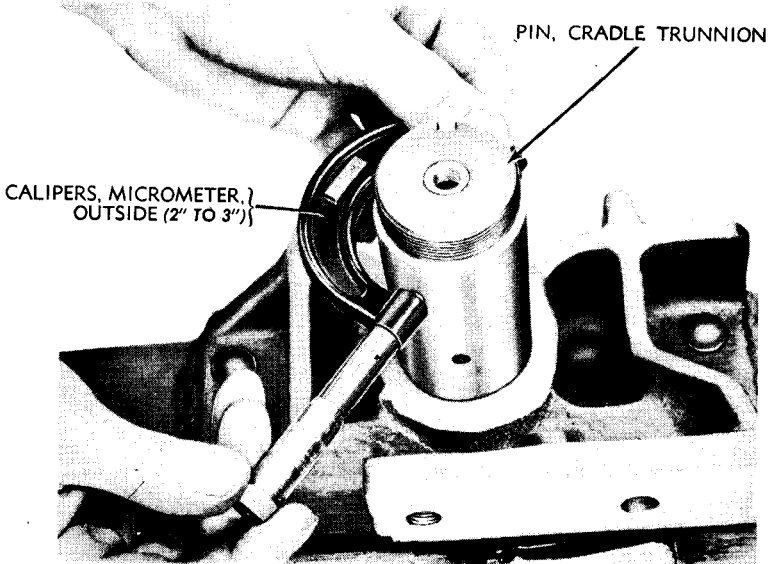
Figure 113 — Installing Straight Pin in Cradle and Cradle Trunnion Pin

(6) Drill and ream a hole through the trunnion pin (assuming a new trunnion pin is being installed) for a $\frac{3}{8}$ -inch (0.375) straight pin. Use hole in cradle bracket as a guide.

(7) Place white lead pigment on $\frac{3}{8}$ -inch straight pin. Drive pin in place (fig. 113).

(8) Measure diameter of trunnion pin (2- to 3-inch outside micrometer calipers) (fig. 114). Then measure the distance from face of cradle bracket (left side only) to top of trunnion pin (depth micrometer with 2-inch stem) (fig. 115). Add this last measurement to one-half the diameter of trunnion pin. The total must be 3.375 ± 0.001 inch; otherwise the panoramic sight mount will not fit properly. If measurement is greater than 3.376 inches, scrape the face of the bracket down not more than 0.002 inch and check again. When measurement is less than 3.374 inches, build up the bracket by laying on a thin metal bead by electric welding. Machine to correct meas-

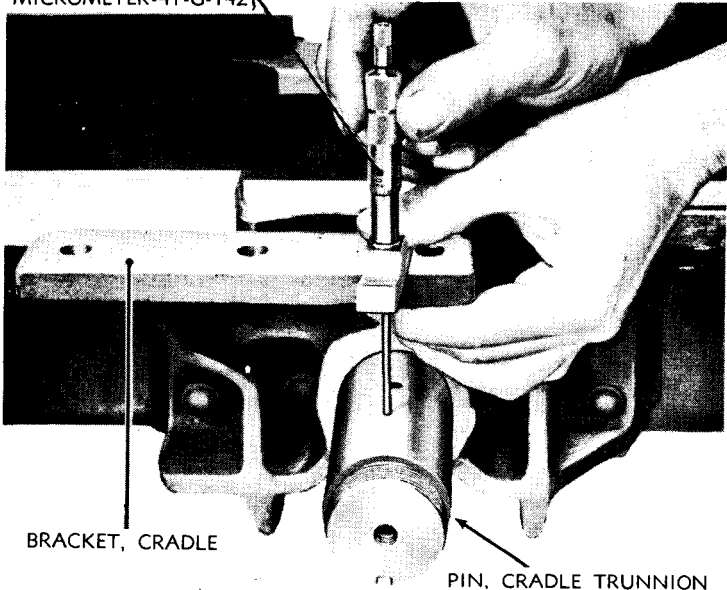
CRADLE AND ELEVATING ARCS



RA PD 87875

Figure 114 — Measuring Diameter of Cradle Trunnion Pin

GAGE, DEPTH }
MICROMETER-41-G-142 }



RA PD 87874

Figure 115 — Checking Distance From Cradle Bracket to Cradle Trunnion Pin

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

urement, 3.375 inches. If machine tools are not available, the bracket will be built up by the use of shims of correct thickness.

- (9) Screw lubricating fitting in the end of cradle trunnion pin.

Section XI

TRAVERSING MECHANISM

60. TYPES OF TRAVERSING MECHANISM.

a. The worm and rack traversing mechanism is used on M2A2 Carriages of early manufacture and on M2A1 Carriages. The screw-type traversing mechanism is used on new M2A2 Carriages.

61. WORM AND RACK TRAVERSING MECHANISM—TROUBLE SHOOTING.

a. **General.** Troubles usually found in the worm and rack traversing mechanism (figs. 116 and 117) are backlash in excess of one-quarter turn of the handwheel, and difficult traverse.

b. **Excessive Backlash.** Backlash in excess of one-quarter turn of the handwheel may be due to end play, worn rack and/or worm shaft, worn bushings in traversing shaft bracket, or worn pintle pin bushings in top carriage.

(1) **END PLAY.** Grasp the traversing handwheel and attempt to move it along the shaft. If there is looseness, end play is probably causing the backlash. To correct the end play, loosen screw BCKX2AD and tighten traversing shaft collar A237000 on traversing worm shaft so as to provide a working fit for worm shaft. Retighten screw.

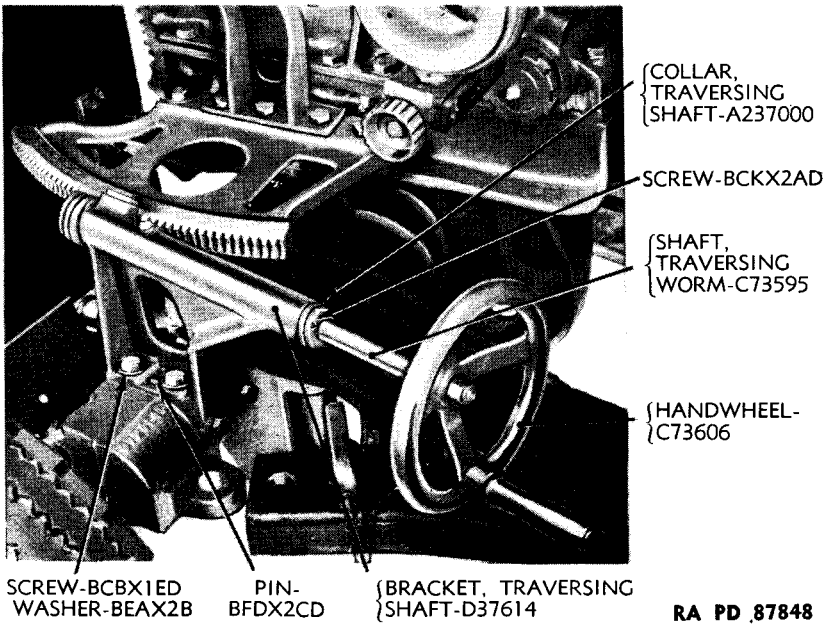
(2) **WORN RACK AND/OR WORM SHAFT.** Attempt to move the shaft from side to side. If there is looseness, a worn rack and/or worm is probably causing the backlash.

(a) Before adjusting or replacing a rack because of excessive backlash, inspect and, if necessary, replace the pintle pin bushings in the top carriage (par. 65 b).

(b) Check face of rack teeth with an indicator for trueness to center of pintle pin. If true, then rack may be shimmed. **NOTE:** *Maximum amount of allowable shimming to move rack out from center of pintle pin is 0.0015 inch.*

(c) Disassemble traversing mechanism as described in paragraph 62 a.

TRAVERSING MECHANISM



RA PD 87848

Figure 116 – Worm and Rack Traversing Mechanism

(d) In repair or replacement of parts, correct dimensions and tolerances should be maintained. Measurement between far edge of top carriage and rack must not exceed 0.0015 inch (fig. 118). If 0.0015-inch thickness gage can be inserted, shift rack inward to obtain correct fit.

(e) Traversing shaft bracket must measure 6.000 inches (fig. 119).

(f) Distance between the under surface of the traversing rack and the traversing shaft bracket mounting surface on the equalizing support should measure 6.004 inches \pm 0.002 inch. (Check full travel of rack.)

(g) Top surface of traversing rack must be level throughout its complete travel within 0.001 inch.

(h) A 0.004-inch feeler gage should slide freely between bottom face of traversing rack and traversing shaft bracket (fig. 120).

(3) **WORN BUSHINGS IN TRAVERSING SHAFT BRACKET.** Remove the handwheel and traversing shaft collar. Check clearance between traversing worm shaft and bushings A174975 and A174976 with a feeler gage. Replace bushings if clearance is more than 0.003 inch. Remove bushings with a hammer and 1-inch diameter steel or brass bar about 14 inches long. Press new bushings into the bracket on an

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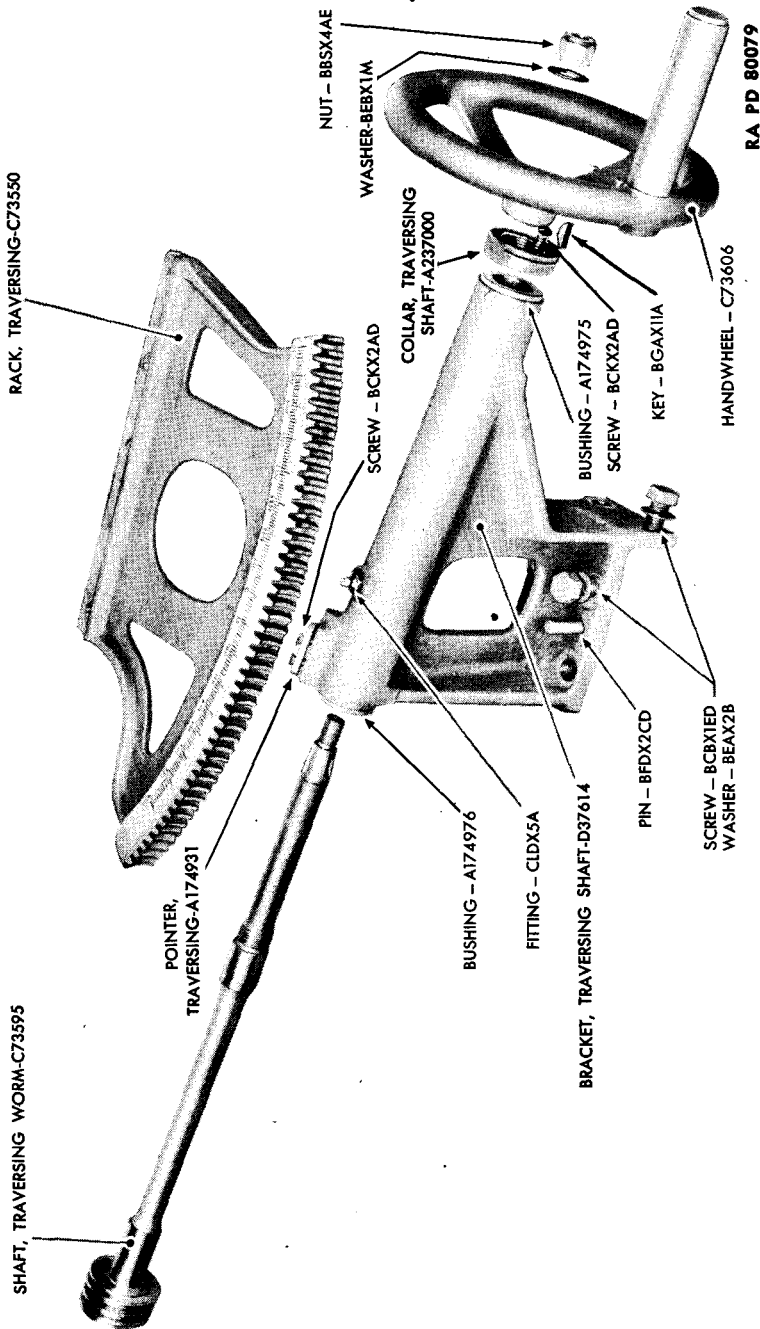
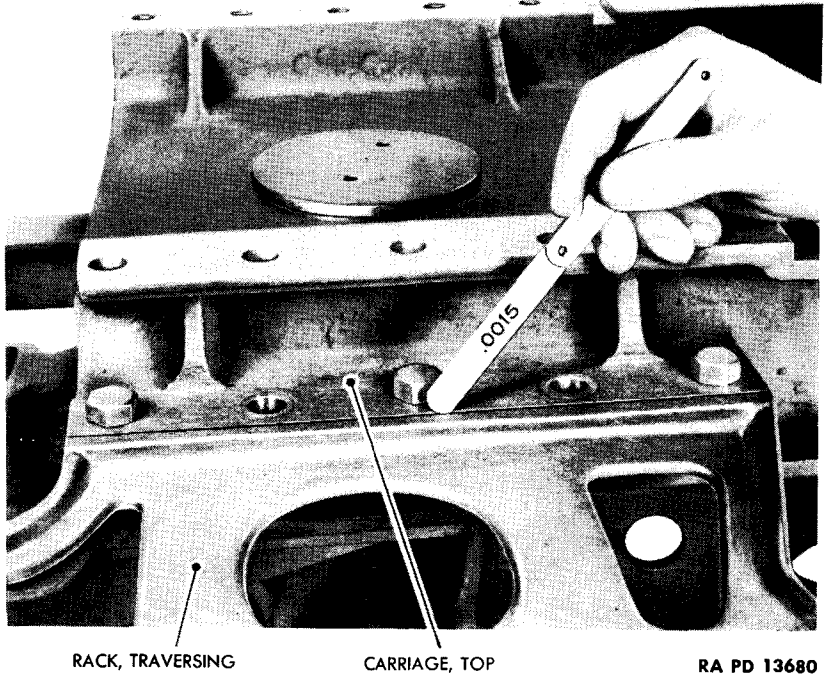


Figure 117 — Worm and Rack Traversing Mechanism — Exploded View

TRAVERSING MECHANISM



RACK, TRAVERSING

CARRIAGE, TOP

RA PD 13680

Figure 118 — Gaging Fit of Traversing Rack to Top Carriage

arbor press, or drive in with a wood block and hammer. Always coat the outside surface of a new bushing with white lead pigment before installing in the bracket. Bushings must be installed straight and true. Line-ream new bushings, when installed, to $1.000 + 0.001$ inches ID.

(4) **WORN PINTLE PIN BUSHINGS.** Remove auxiliary shield, auxiliary shield left upright bracket, handwheel, traversing shaft collar, and traversing worm shaft (par. 62 a). Grasp any convenient part of the weapon and traverse the weapon manually. Any lost motion is due to worn or loose pintle pin bushings in the top carriage. Refer to paragraph 65 b for replacement of worn pintle pin bushings.

c. **Difficult Traverse.** This may be due to traversing shaft collar on traversing worm shaft being too tight, binding between rack and worm shaft, galled or scored bushings in traversing shaft bracket, galled or scored pintle pin and/or pintle pin bushings.

(1) **TRAVERSING SHAFT COLLAR TOO TIGHT.** Adjust to provide a working fit for worm shaft without end play.

(2) **BIND IN RACK AND WORM SHAFT.** First check to be sure

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CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

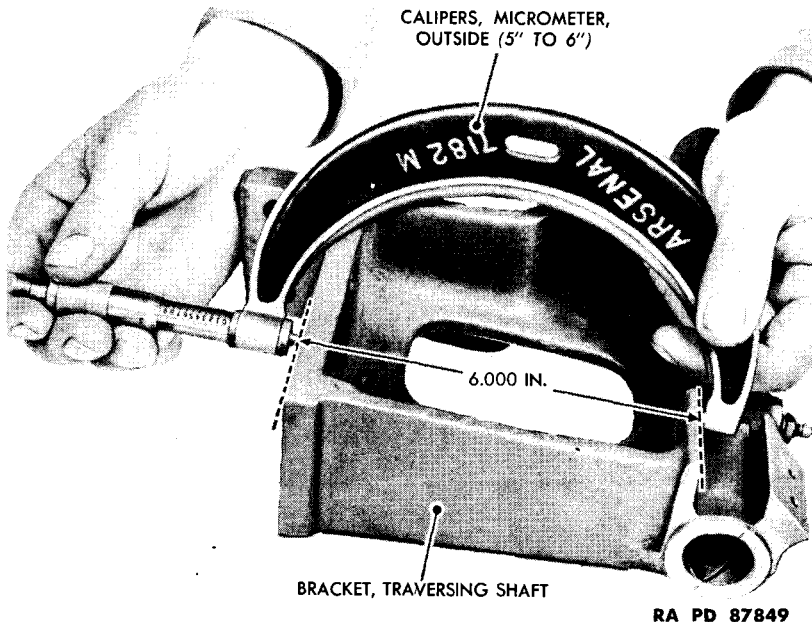


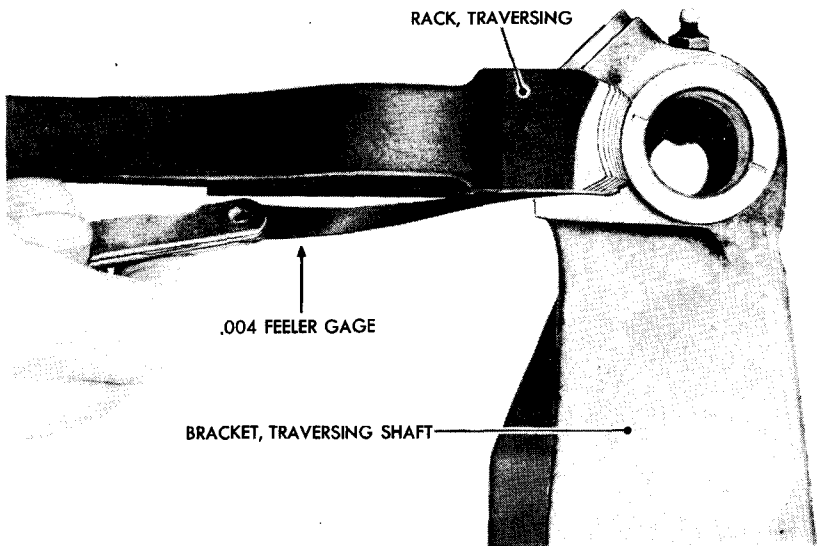
Figure 119 — Correct Measurement of Traversing Shaft Bracket

the arc and bracket are in proper position (subpar. b (2) (f) and (g), above). Use a file or oilstone to remove any burrs on the worm of the worm shaft. Use crocus cloth or aluminum-oxide abrasive cloth to remove burrs from the teeth of the traversing rack. Lap out high spots using lapping compound and cutting oil. Be sure to clean thoroughly before final assembly.

(3) **GALLED OR SCORED BUSHINGS IN TRAVERSING SHAFT BRACKET.** Remove auxiliary shield, left upright bracket, handwheel, collar, and worm shaft. Examine bushings A174975 and A174976 installed in traversing shaft bracket. Replace galled or scored bushings (subpar. b (3), above).

(4) **GALLED OR SCORED PINTLE PIN AND/OR PINTLE PIN BUSHINGS.** Remove auxiliary shield, upright bracket, shaft collar, and traversing worm shaft (par. 62 a (1) through (5)). Grasp any convenient part of the weapon and attempt to traverse the weapon manually. If hard spots or bind is evident, the pintle pin and/or pintle pin bushings are probably galled or scored. Remove the pintle pin from the top carriage and equalizing support (par. 66 a). Replace damaged pintle pin and/or bushings.

TRAVERSING MECHANISM



RA PD 13691

Figure 120 — Checking Clearance Between Traversing Rack and Traversing Shaft Bracket

62. WORM AND RACK TRAVERSING MECHANISM—DISASSEMBLY AND ASSEMBLY.

a. Disassembly.

(1) Remove auxiliary shield.

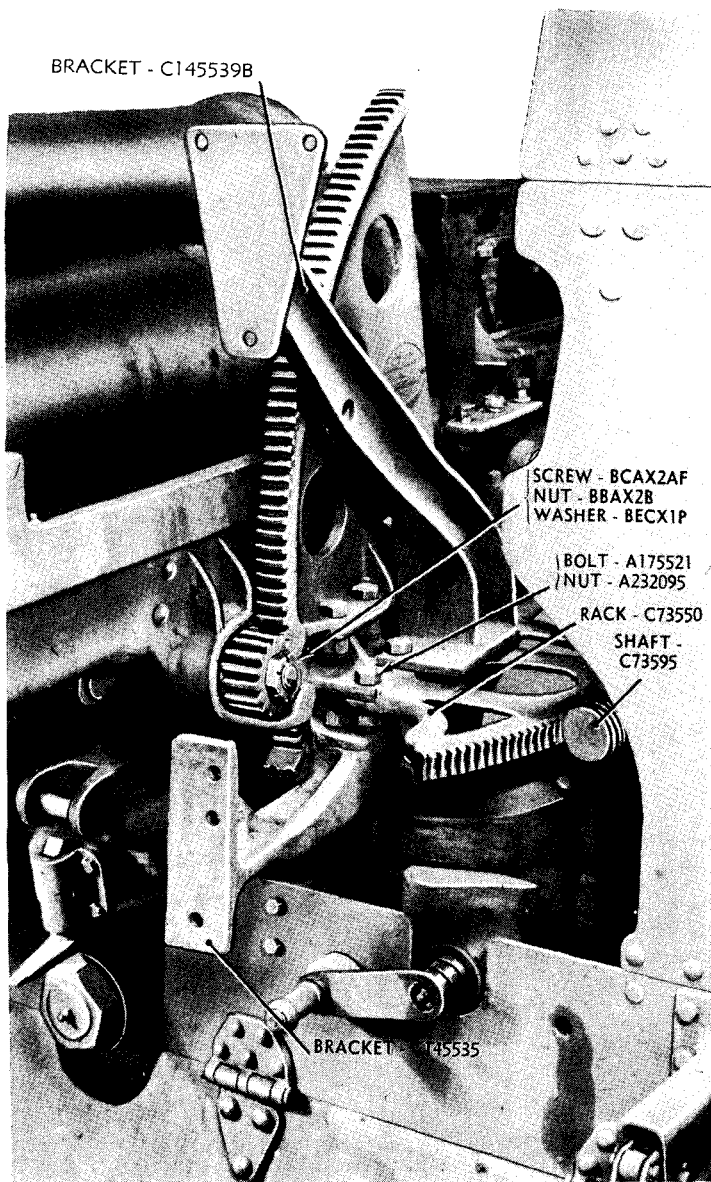
(2) Remove three screws, nuts, and washers and remove auxiliary shield left upright bracket C145539B (fig. 121). *NOTE: Before removing screws, mark them with a center punch for assembly in their original positions; this will insure proper alignment of traversing rack with traversing worm.*

(3) Remove safety nut and washer, and tap handwheel off traversing worm shaft. Remove Woodruff key BGAX11A from worm shaft (fig. 117).

(4) Loosen set screw and unscrew traversing shaft collar from worm shaft.

(5) Mark mating teeth of worm and rack to insure proper alignment and full right and left traverse when the parts are reassembled. Turn worm shaft with hands and unscrew worm out of engagement with the traversing rack. Pull worm shaft out of traversing shaft bracket. *NOTE: The worm is integral with the shaft, and the shaft must be withdrawn from the front of the bracket (fig. 121).*

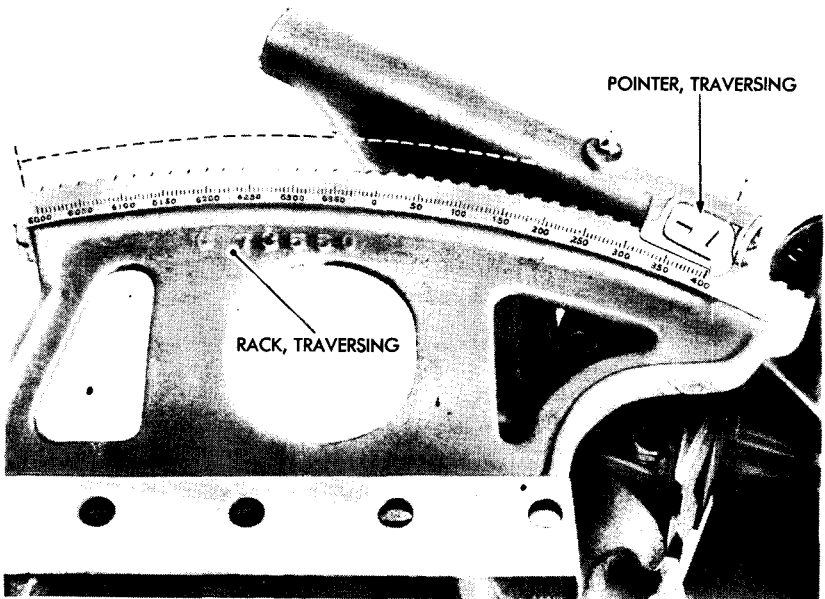
**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 22574

**Figure 121 — Auxiliary Shield Removed, Preparatory to Removing
Worm and Rack Traversing Mechanism**

TRAVERSING MECHANISM



RA PD 13690

Figure 122 – Checking Traversing Rack Travel

(6) Remove two bolts A175521 and nuts A232095 from traversing rack and top carriage and remove traversing rack C73550 (fig. 121).

(7) Remove six cap screws BCBX1ED and washers BEAX2B which secure the traversing shaft bracket to the equalizing support (fig. 116). Tap traversing shaft bracket loose from equalizing support. Two pins BFDX2CD will come away when the bracket is removed.

b. Assembly.

(1) Coat mating surfaces of traversing rack and top carriage with white lead pigment. Apply white lead pigment to the threads of the bolts, screws, and nuts. Place traversing rack in position on top carriage. Line up the five holes and install the two bolts and nuts. Place auxiliary shield left upright bracket in position on traversing rack and secure with three screws, washers, and nuts, taking care to install the screws in the holes from which they were removed. Tighten nuts. Then check fit of rack to top carriage with 0.0015-inch feeler gage. If gage can be inserted, shift rack inward to obtain tight fit.

(2) Coat the mating surfaces of traversing shaft bracket and equalizing support with white lead pigment. Apply white lead pigment to the threads of cap screws. Secure traversing shaft bracket in

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

position on the equalizing support with the six cap screws and washers. Install two steel pins if these were removed from the bracket. After mounting bracket, insert a 0.004-inch feeler gage between bottom face of traversing rack and bracket. This gage should slide through freely.

(3) Grease bearing surfaces of traversing worm shaft and insert worm shaft in traversing shaft bracket from the front. Screw worm end into mesh with the traversing rack. Line up marks made on worm and rack teeth during disassembly.

(4) Apply white lead pigment to the threads on worm shaft and screw on collar A237000. Tighten the set screw only enough to lock the collar on the worm shaft thread.

(5) Place Woodruff key in shaft. Grease the threads and taper at end of shaft. Install traversing handwheel; follow with washer and nut.

(6) Try the traversing mechanism for smoothness of operation and for complete travel with pointer passing through complete range of graduations on rack (fig. 122).

(7) Relubricate the mechanism.

(8) Mount the auxiliary shield.

63. SCREW-TYPE TRAVERSING MECHANISM — TROUBLE SHOOTING.

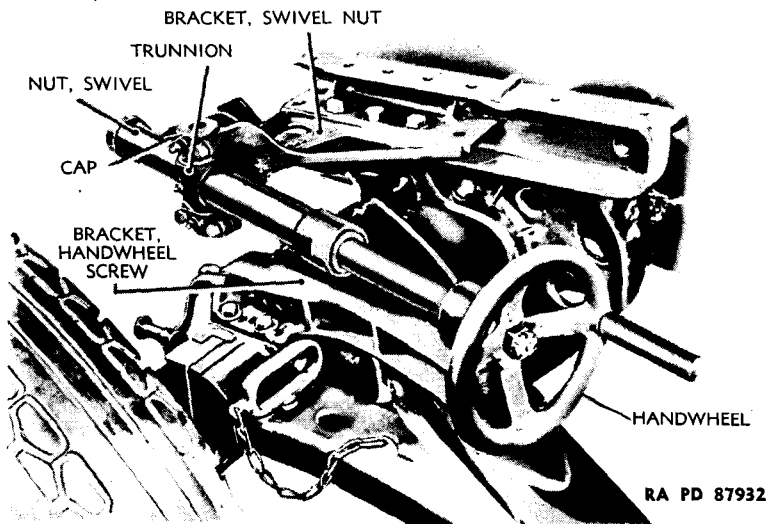
a. **General** The most usual troubles in the screw-type traversing mechanism (figs. 123 and 124) are backlash, in excess of one-quarter turn of the traversing handwheel, and difficult traverse.

b. **Excessive Backlash.** Backlash in excess of one-quarter turn of the handwheel may be caused by: end play, loose pivot, swivel nut loose in swivel nut bracket, worn swivel nut, and worn pintle pin bushings.

(1) **END PLAY.** Grasp the traversing handwheel and attempt to move it along the swivel nut screw C93165. If there is looseness, end play is probably causing the backlash. End play may be due to a loose ball bearing CABX1AF or to a loose fit between swivel nut screw and bushing A234935 in swivel nut collar B221811. The ball bearing must be a drive fit in pivot and on swivel nut screw. The collar bushing will be replaced if the clearance between it and the swivel nut screw exceeds 0.005 inch.

(2) **LOOSE PIVOT.** Remove swivel nut screw. Grasp the pivot and try to move it up and down and sideways. Replace bushings A235274 in handwheel screw bracket D41426 if play between them and pivot is more than 0.003 inch. Replace bushings if they are not a drive fit in bracket. Coat the outside surface of a new bushing with

TRAVERSING MECHANISM



RA PD 87932

Figure 123 — Screw-type Traversing Mechanism

white lead pigment before installing it. Drive new bushings into place with a wood block and hammer. Bushings must be installed straight and true. Line-ream new pivot bushings A235274 after installation to $1.250 + 0.001$ inches ID.

(3) **SWIVEL NUT LOOSE IN SWIVEL NUT BRACKET.** Remove the swivel nut screw. Attempt to move the swivel nut from side to side and up and down. Replace bushings A230279 on studs of swivel nut if play is more than 0.005 inch.

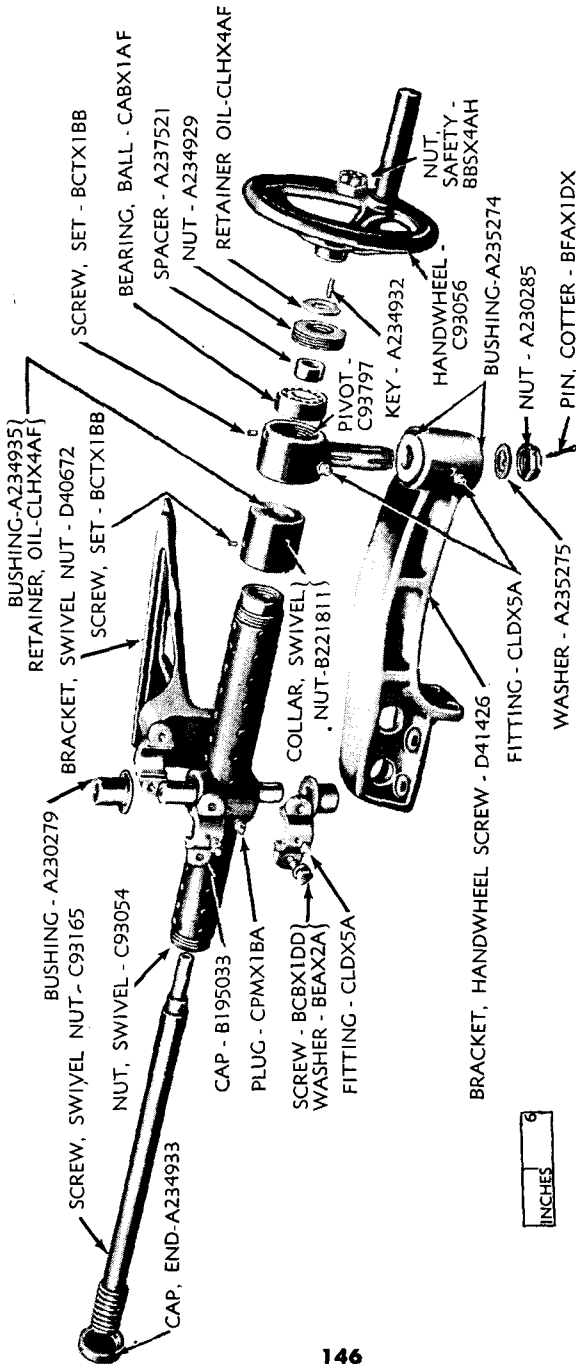
(4) **WORN SWIVEL NUT.** Attempt to move the swivel nut screw from side to side. If there is looseness, a worn swivel nut is probably causing the backlash. Replace a worn nut.

(5) **WORN PINTLE PIN BUSHINGS.** With the traversing handwheel, pivot, and swivel nut screw removed from the piece, grasp any convenient part of the piece and traverse manually. Any lost motion is due to worn or loose pintle pin bushings in the top carriage. Refer to paragraph 65 b for replacement of worn pintle pin bushings.

c. **Difficult Traverse.** This may be due to bind in screw and swivel nut; galled or scored bushings in the traversing mechanism; and galled or scored pintle pin and/or pintle pin bushings.

(1) **BIND IN SCREW AND SWIVEL NUT.** Operate the traversing handwheel through the complete range of traverse. If hard spots or bind is evident, disassemble the traversing mechanism (par. 64 a, b,

ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 22573

Figure 124 — Screw-type Traversing Mechanism — Exploded View

TRAVERSING MECHANISM

and c), and attempt to repair the threads of the nut with crocus cloth. If the hard spots cannot be eliminated, replace the nut.

(2) **GALLED OR SCORED TRAVERSING MECHANISM BUSHINGS.** Disassemble traversing mechanism (par. 64 a, b, and c) and examine the several bushings. Repair or replace galled or scored bushings.

(3) **GALLED OR SCORED PINTLE PIN AND/OR PINTLE PIN BUSHINGS.** With the traversing handwheel, pivot, and swivel nut screw removed from the piece, grasp any convenient part of the piece and traverse manually. If hard spots or bind is evident, the pintle pin and/or pintle pin bushings are probably galled or scored. Remove the pintle pin from the top carriage and equalizing support (par. 66 a). Replace damaged pintle pin and/or bushings.

64. SCREW-TYPE TRAVERSING MECHANISM—DISASSEMBLY AND ASSEMBLY.

a. The entire screw-type traversing mechanism may be removed from the weapon for repairs without removing any other part of the weapon, except the auxiliary shield and auxiliary shield left upright bracket.

b. Removal (fig. 124).

(1) Remove cotter pin BFA1DX, nut A230285, and washer A235275 from swivel nut screw pivot C93797.

(2) Remove safety nut BBSX4AH and tap handwheel C93056 from swivel nut screw C93165. Remove the square key from the swivel nut screw.

(3) Remove the upper and lower swivel nut bracket caps B195033. These are held in place by four cap screws and lock washers. Mark the caps for assembly.

(4) Drive out the swivel nut screw pivot from the handwheel screw bracket D41426 and remove swivel nut C93054, screw C93165, and pivot C93797 as a unit.

(5) Remove the handwheel screw bracket D41426 from the equalizing support. The bracket is fastened to the support by six cap screws and lock washers.

(6) Remove the auxiliary shield and the auxiliary shield left upright bracket (not shown on figure 124).

(7) Remove the two bolts and nuts, and lift swivel nut bracket D40672 off the top carriage.

c. Disassemble Swivel Nut, Screw, and Pivot (fig. 124).

(1) Slide the swivel nut screw pivot off the swivel nut screw.

(2) Remove the set screw from the pivot. Remove the oil re-

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

tainer and bearing nut A234929. Lift out the ball bearing and spacer.

(3) Loosen the set screw in swivel nut collar B221811 and unscrew the collar from the swivel nut.

(4) Unscrew and remove the swivel nut end cap A234933.

(5) Unscrew the swivel nut screw from the swivel nut and remove the screw.

d. Assemble Swivel Nut, Screw, and Pivot.

(1) Grease the threads of the swivel nut screw and screw the swivel nut screw into the swivel nut.

(2) Apply white lead pigment to the threads and screw the swivel nut end cap onto the swivel nut.

(3) Screw the swivel nut collar onto the swivel nut. Secure with set screw.

(4) Lubricate and install ball bearing and spacer in pivot.

(5) Replace the screw bearing nut in pivot. Secure with set screw.

NOTE: *Be sure the oil retainer is in place.*

e. Installation.

(1) Apply with lead pigment to the mating surfaces of the hand-wheel screw bracket and the equalizing support. Mount the bracket in place on the equalizing support and install the six cap screws and lock washers.

(2) Apply white lead pigment to the mating surfaces of the swivel nut bracket and top carriage. Mount the bracket in place on the top carriage and install two bolts and nuts. Place the auxiliary shield left upright bracket on the swivel nut bracket and install three screws, washers, and nuts.

(3) Place the assembled unit—swivel nut, screw, and pivot—in position in the handwheel screw bracket.

(4) Install the upper and lower caps, as marked at disassembly, on the swivel nut bracket, and install the four cap screws and lock washers.

(5) Install the washer, nut, and cotter pin on the swivel nut screw pivot.

(6) Install the key in the swivel nut screw. Replace the hand-wheel and safety nut.

(7) Check the mechanism for freedom of action.

(8) Mount the auxiliary shield.

(9) Relubricate the mechanism.

Section XII
TOP CARRIAGE AND PINTLE PIN

65. TROUBLE SHOOTING.

a. The most usual troubles in the pintle pin (fig. 125) and top carriages (figs. 126 and 127) are excessive play when top carriage is rotated about pintle pin, difficult traverse, and difficult removal of pintle pin.

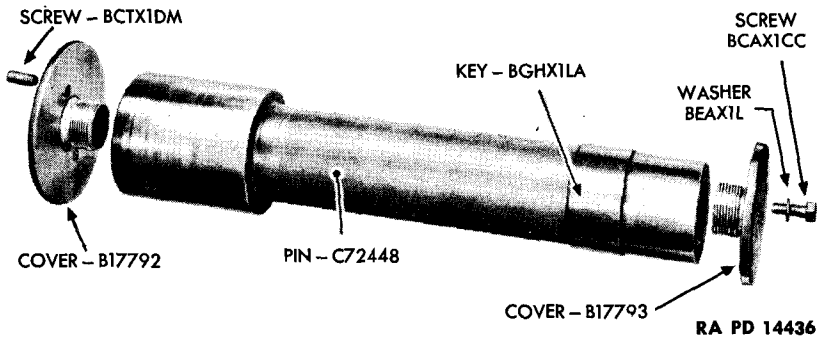


Figure 125 - Pintle Pin - Exploded View

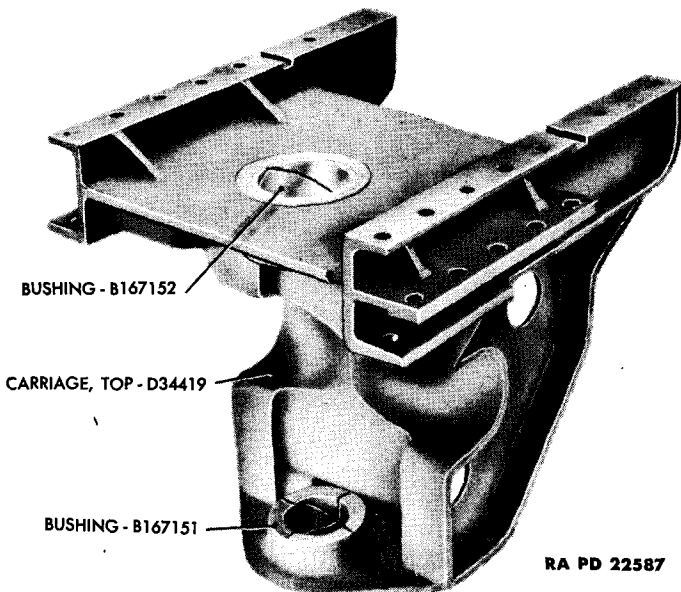


Figure 126 - Top Carriage - Front View

ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4

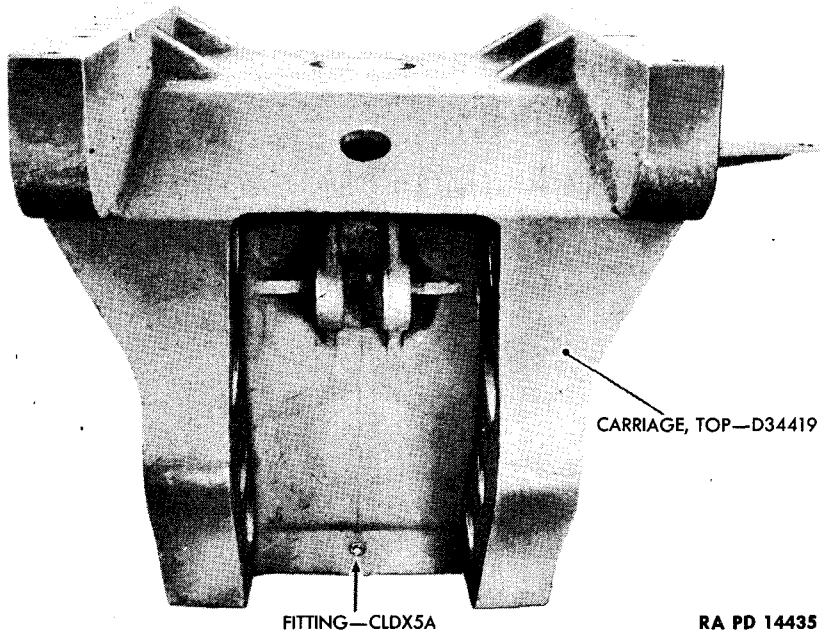
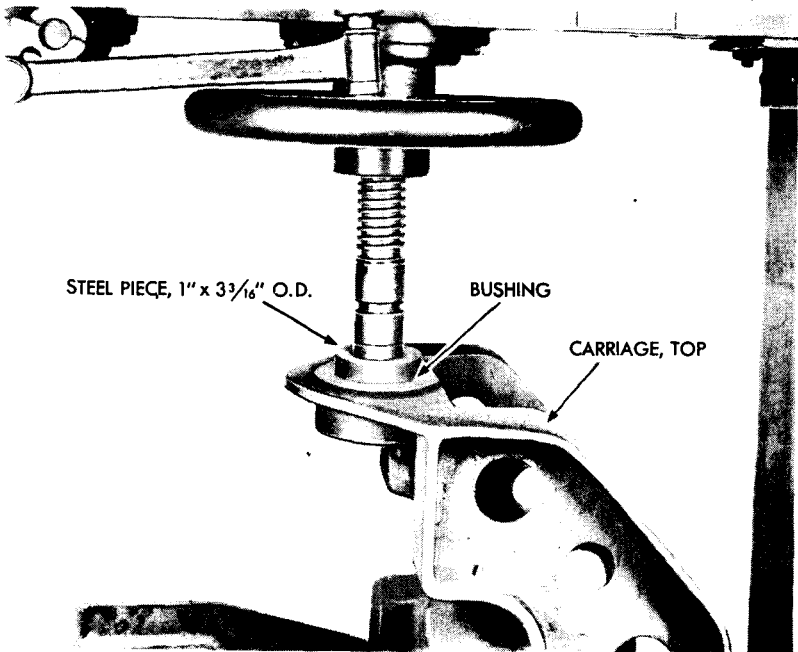


Figure 127 — Top Carriage — Rear View

b. Excessive play, equivalent to backlash in excess of one-quarter turn of the traversing handwheel, may be caused by worn pintle pin bushings. Replace bushings B167152 and B167151 for pintle pin C72448 if play is more than 0.003 inch.

- (1) Remove top carriage and pintle pin (par. 66 a).
- (2) Press lower bushing down and out of the top carriage with an arbor press (fig. 128). Turn top carriage over in arbor press and remove upper bushing in same manner.
- (3) Spread thin coat of white lead pigment in bushing holes in top carriage and on mating surfaces of bushings. Place top carriage in arbor press and install bushings. Use a flat piece of steel and a steel extension bar for this operation.
- (4) Check bushings for proper seating in top carriage with a 0.0015-inch feeler gage (fig. 129). It should be impossible to insert gage between bushing collar and top carriage when bushing is properly installed.

TOP CARRIAGE AND PINTLE PIN



RA PD 13673

Figure 128 — Pressing Lower Bushing out of Top Carriage

(5) Check distance between bushing faces. Shim or replace to maintain 0.004-inch limit between bushings and equalizing support.

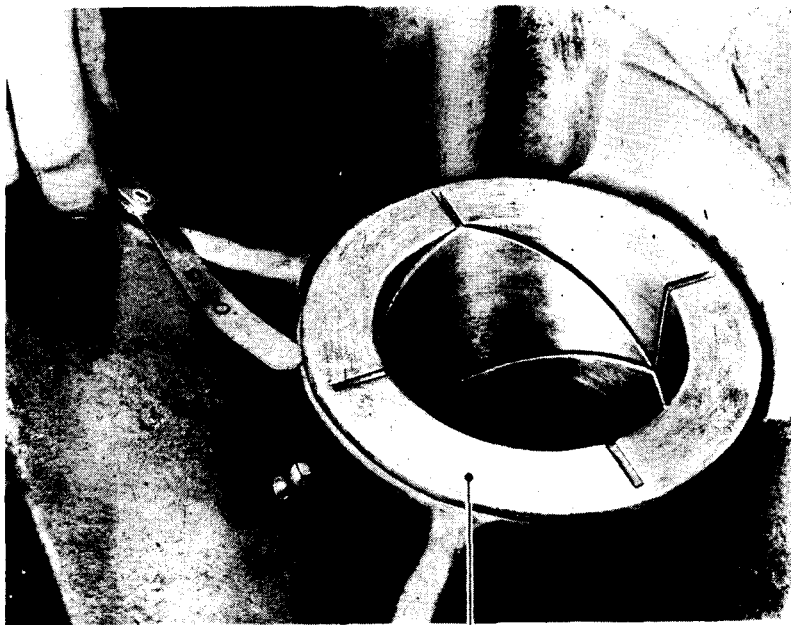
(6) Line-ream bushings to following inside diameters: top bushing, $3.750 + 0.001$ inch; bottom bushing, $2.875 + 0.001$ inch.

c. Difficult traverse or difficult removal of pintle pin may be caused by galled or scored pintle pin bushings and/or pintle pin. **NOTE:** *There is no motion between the pintle pin and equalizing support as the pin is keyed in position.*

(1) Scored bushings can be remedied by careful scraping, filing, and polishing with crocus cloth. Whenever crocus cloth is used, the bushing must be washed clean in dry-cleaning solvent. Small particles from the crocus cloth will act as an abrasive when the pintle pin is assembled in the top carriage and cause excessive wear of bushings. Do not exceed 0.003-inch clearance between bushings and pintle pin.

(2) During disassembly, the pintle pin may be galled or scored. Remove scores, burs, and rust spots with a file and crocus cloth.

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



BUSHING

RA PD 13675

Figure 129 — Gaging Bushing Fit in Top Carriage

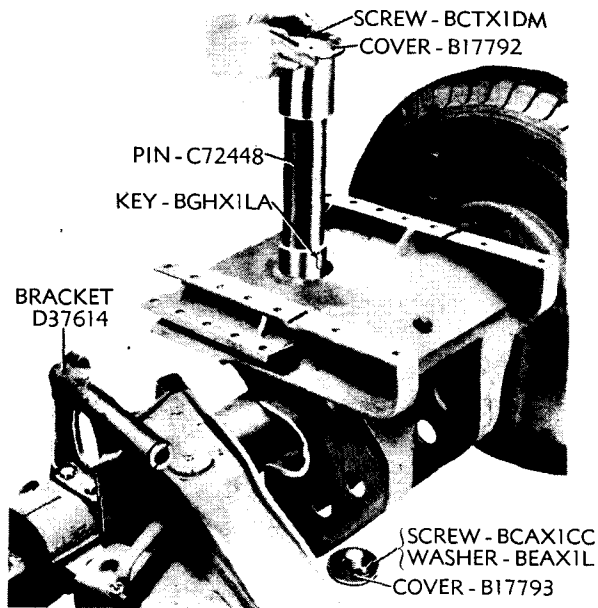
Maintain a 0.003-inch working fit between pintle pin and pintle pin bushings in top carriage, and between pintle pin and equalizing support. If necessary, replace the pintle pin. Key BGHX1LA must be a press fit in pintle pin and a slide fit in equalizing support.

66. DISMOUNTING AND MOUNTING TOP CARRIAGE.

a. Dismounting Top Carriage.

- (1) Remove the tube and recoil mechanism.
- (2) Remove the shields and shield brackets.
- (3) Remove the equilibrator.
- (4) Remove the cradle and elevating mechanism.
- (5) Remove the traversing mechanism. **NOTE:** *It is not necessary, however, to remove the traversing shaft bracket from the equalizing support.*

TOP CARRIAGE AND PINTLE PIN



RA PD 22583

Figure 130 – Removing Pintle Pin

- (6) REMOVE THE PINTLE PIN.
 - (a) Move the top carriage to zero traverse.
 - (b) Remove screw BCAX1CC and washer BEAX1L from pintle pin lower cover B17793 (fig. 130). Uncrew lower cover.
 - (c) Mark the upper cover and top carriage to aid in assembly.
 - (d) Tap the bottom of the pintle pin upward with a copper hammer to free it. Then lift the pintle pin straight up and out of the top carriage. Square key BGHX1LA will come out with the pin.
- (7) Slide the top carriage off from the rear, taking care to keep the top carriage level as it is removed. Place the top carriage on a clean surface. Two or three men will be required. **NOTE:** *If a chain hoist is available, place rope rigging around the top carriage and lift it straight up from the equalizing support.*

b. Mounting Top Carriage.

- (1) Check top carriage for cleanliness.
- (2) Install top carriage in place on equalizing support. Two or three men will be needed to lift the top carriage.

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

(3) Lubricate bearing surfaces of pintle pin and install pintle pin in top carriage and equalizing support. While the pintle pin is being installed, line up the marks made on the pintle pin upper cover and top carriage during disassembly, to insure that the pintle pin key engages with its keyway.

(4) Apply white lead pigment to the pintle pin lower cover threads and screw the lower cover into the pin. Line up holes in cover and pin, and secure cover in place with washer and screw. Apply white lead pigment to threads of screw.

(5) Swing top carriage around on pintle pin and check for freedom of motion.

Section XIII**WHEELS, HUBS, TIRES, AND BRAKES****67. TYPES OF BRAKES.**

a. Two types of hand-operated parking brakes have been used on the M2A1 and M2A2 Carriages. On carriages modified from M2 Carriages, the brakes are the original brakes used with the M2 Carriage less all the electrical parts not necessary to the operation of the hand brake. On carriages manufactured as M2A1 or M2A2 models, the brakes were designed for hand operation only.

b. All replaceable parts on the two brake mechanisms are interchangeable.

68. SCOPE OF MAINTENANCE.

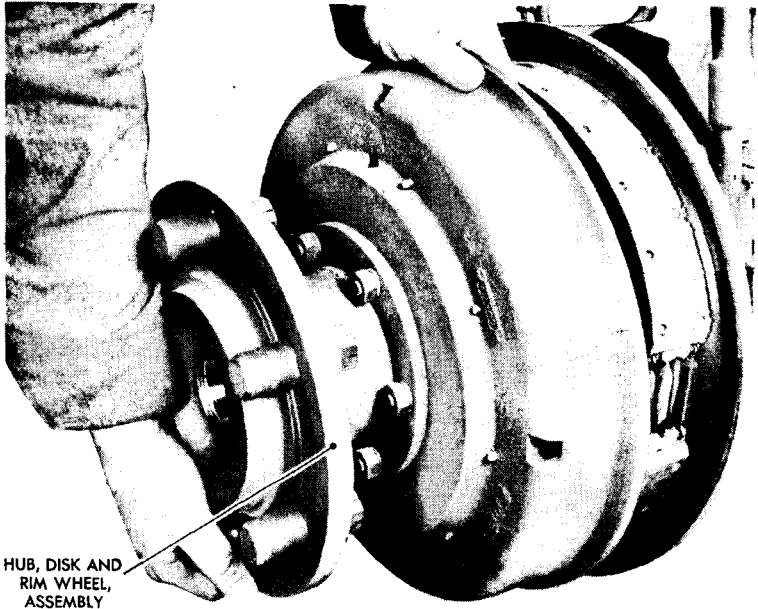
a. Adjustment, disassembly, and assembly of the hand brake levers are primarily functions of the using arms and are described in TM 9-325.

b. Dismounting and mounting the wheels and changing tires are using-arm operations and are described in TM 9-325.

c. Dismounting and mounting the disk and rim wheel hub assemblies (fig. 131) are using-arm operations and are described in TM 9-325.

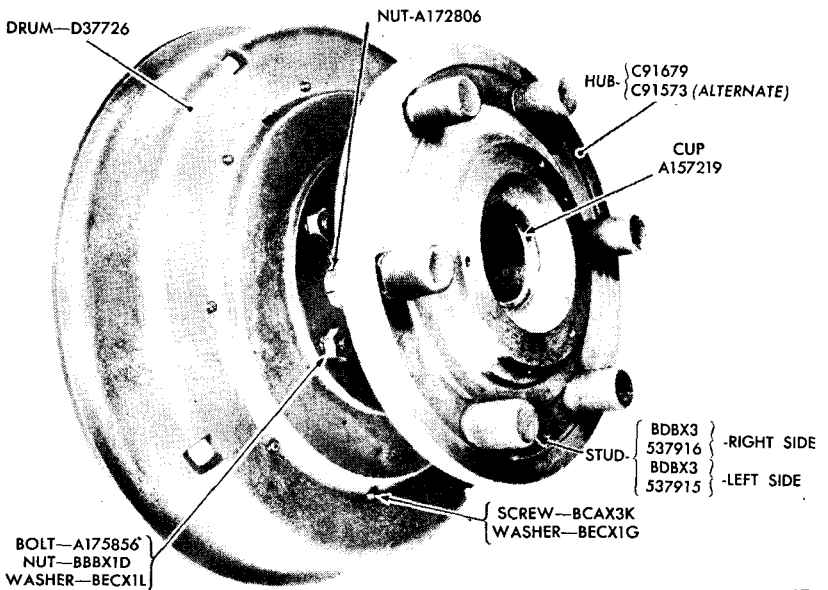
d. Maintenance and repair operations prescribed for ordnance maintenance personnel are given in paragraphs 69, 70, and 71.

WHEELS, HUBS, TIRES, AND BRAKES



RA PD 13605

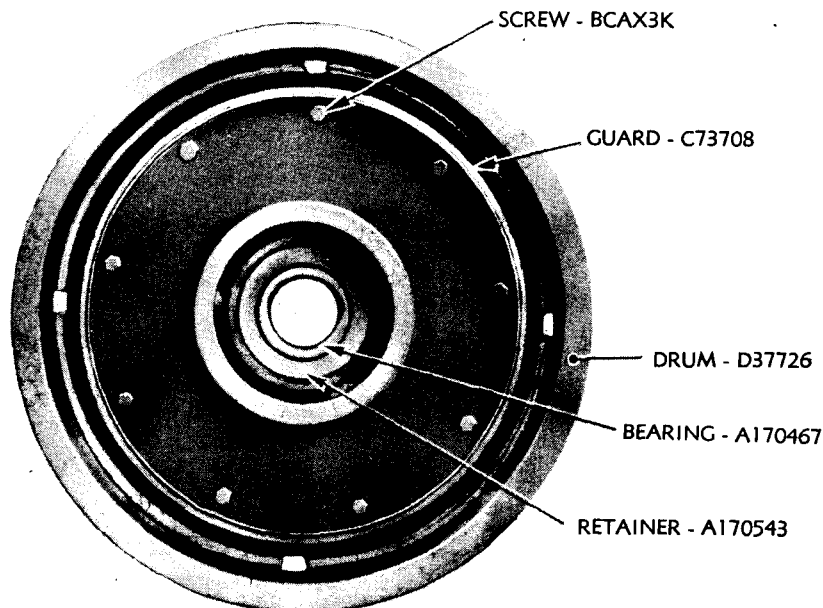
Figure 131 — Removing Disk and Rim Wheel Hub Assembly



RA PD 87876

Figure 132 — Disk and Rim Wheel Hub Assembly — Front View

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 72987

Figure 133 — Disk and Rim Wheel Hub Assembly — Rear View

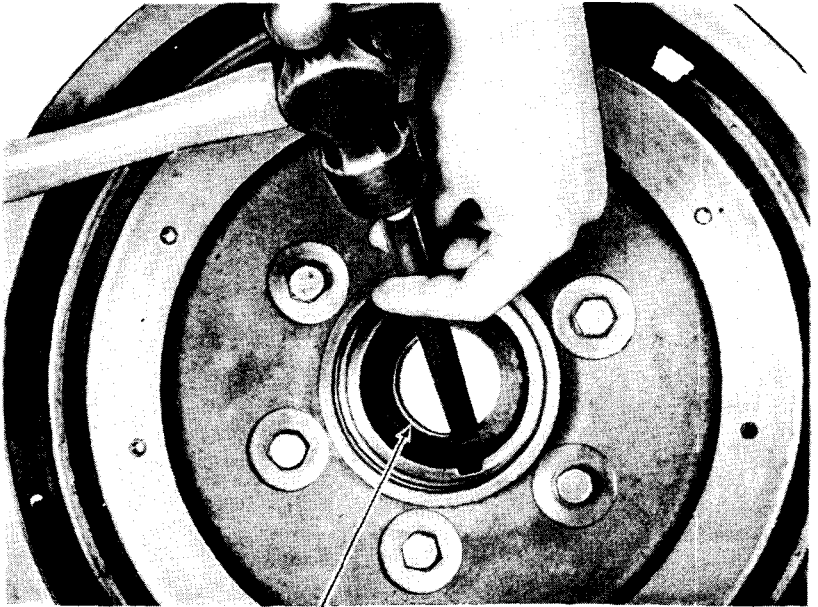
69. TROUBLE SHOOTING.

a. **General.** The most usual troubles are: worn or damaged bearings; bent oil retainers; worn or damaged spindles; scored brake drums; scored brake bands; and worn cam shaft bushings.

b. **Bearings and Spindles.** General inspection of bearings, oil retainers, and spindles will reveal whether or not they are to be replaced. Replace bearings if rollers or cups are scored (par. 70). If cups are loose in hubs, remove them and reinstall the same cups, with proper clearances, if possible. Replace cups if necessary. Replace bent oil retainers. Repair scored spindles with an oilstone and crocus cloth. Replace spindles if they cannot be repaired (par. 81). Bearings must be a push fit on the spindles. The following clearances must be held: 0.0012 inch between inner bearing and spindle; minus 0.0018 inch between hub and inner cup; 0.0012 inch between outer bearing and spindle; and minus 0.0015 inch between hub and outer cup.

c. **Brake Drums and Brake Bands.** General inspection of brake drums and brake bands will reveal whether they are to be repaired or replaced. Check braking surface of each brake drum for scoring.

WHEELS, HUBS, TIRES, AND BRAKES



CUP - A157219

RA PD 14582

Figure 134 - Removing Roller Bearing Cup From Wheel Hub

Repair scored brake drums by refacing the braking surface on brake drum refacing machine or lathe. Cut just deep enough to remove score and restore full-surface contact between lining and drum. Replace brake drum if it cannot be repaired (par. 70). Replace worn or badly glazed brake bands (par. 71). If bands are moderately glazed, roughen braking surface.

d. Brake Cam Shaft Bushings. Replace cam shaft bushings A171331 if clearance between cam shaft and bushings is greater than 0.0045 inch (par. 71).

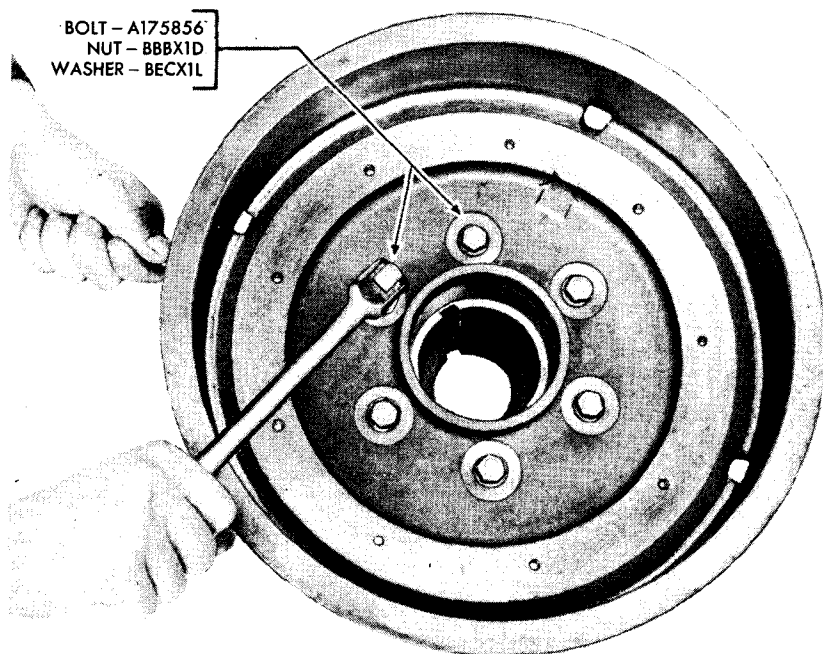
70. DISASSEMBLY AND ASSEMBLY OF WHEEL HUB AND BRAKE DRUM.

a. Disassembly.

(1) Remove wheel (TM 9-325). Remove disk and rim wheel hub assembly (fig. 131).

(2) Place the disk and rim wheel hub assembly (figs. 132 and 133) on a clean work bench with the drum side down.

ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 14598

Figure 135 — Removing Wheel Hub From Brake Drum

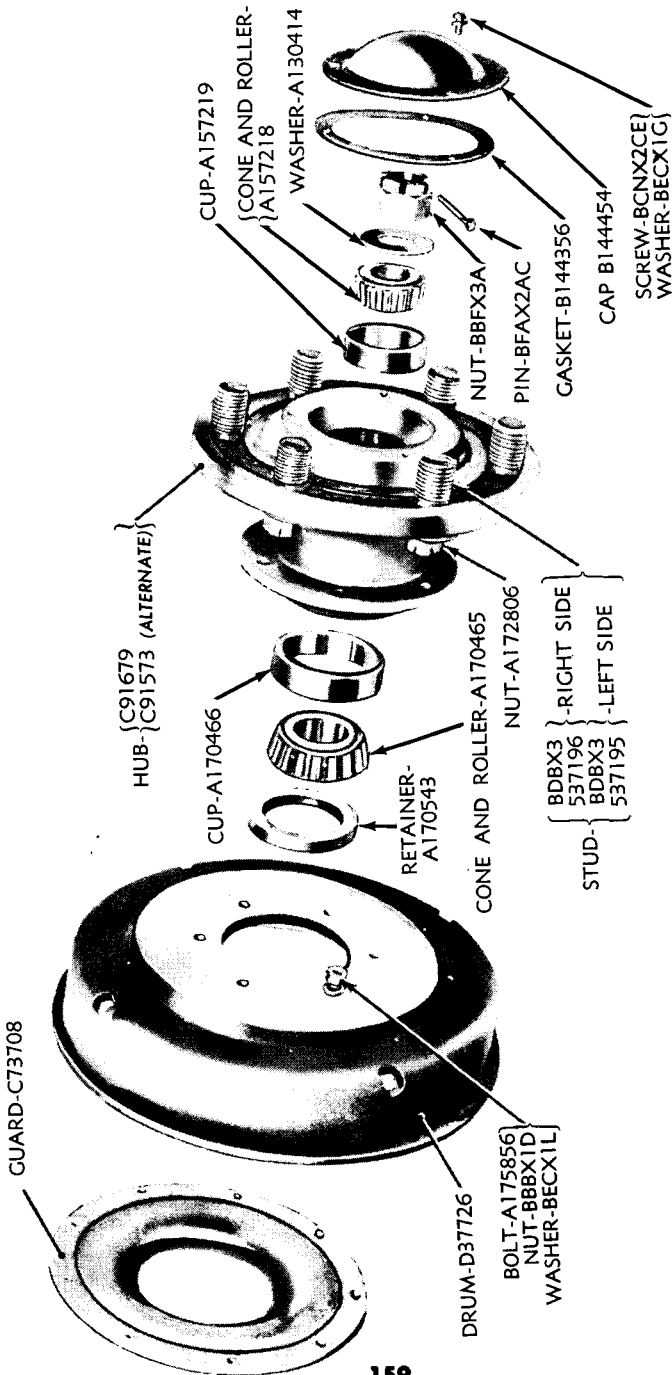
(3) Drive against inner bearing cup A170466 with a $\frac{5}{8}$ -x 10-inch brass rod and hammer. As cup is forced out of hub, cone and roller A170465 and retainer A170543 will also be removed (fig. 136).

(4) Turn hub and drum over so that drum is up, and with same tools and in same manner, remove outer bearing cup A157219 from hub (fig. 134). *NOTE: Cone and roller part of this outer bearing was removed when wheel hub and drum were removed from wheel spindle.*

(5) Remove six bolts A175856, nuts BBBX1D, and washers BECX1L (fig. 135) and separate hub from drum D37726.

NOTE: There are two types of hubs which may be found on this carriage. Carriages of early manufacture were equipped with a hub which will not mount the 9.00 x 20 combat tire because of insufficient side-wall clearance since this tire is larger than the original 7.50 x 24 tire. The hubs otherwise are interchangeable.

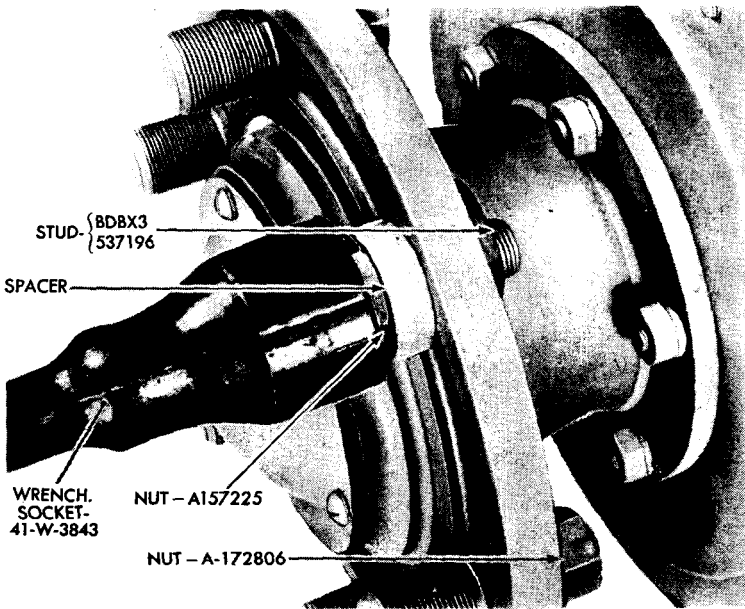
WHEELS, HUBS, TIRES, AND BRAKES



RA PD 87877

Figure 136 — Brake Drum and Hub Group — Exploded View

ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 87924

Figure 137 — Removing Wheel Stud

(6) REMOVE WHEEL STUD (fig. 137).

(a) Remove nut A172806 from damaged wheel stud with a 12-inch adjustable wrench.

(b) Remove nut A157225 (right wheel) or nut A174196 (left wheel) from damaged stud with wheel stud nut wrench and handle.

(c) Place a spacer (1¼ ID x 1¾ OD x ½ inch thick) on stud, then replace nut A157225 to force stud out. If necessary, add another spacer to force stud out.

b. Assembly.

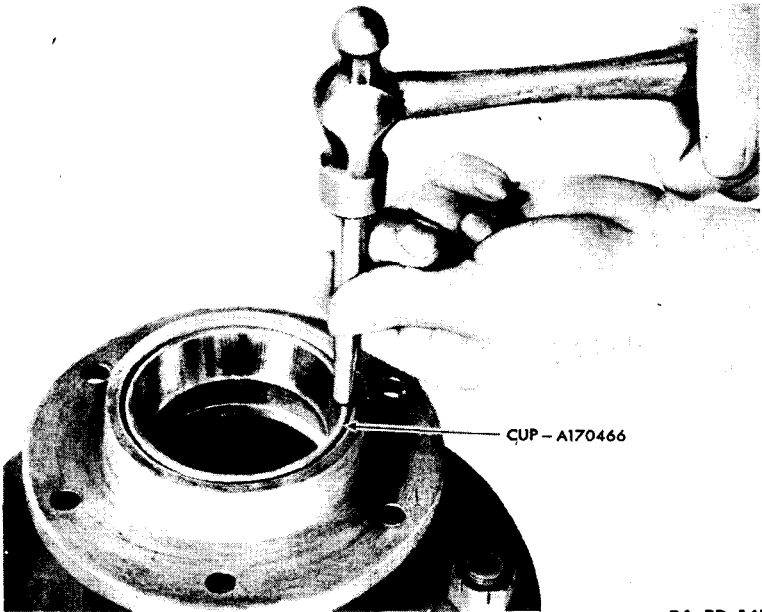
(1) Check inside of disk and rim wheel hub. All surfaces must be perfectly clean.

(2) Install new wheel stud and replace the inside nut A172806.

(3) Place hub on work bench with small end of hub upright. Give seating surface of inner roller bearing cup a thin coat of grease before inserting cup. This will make it easier to drive cup in place and prevent possible scoring of seating surface in hub.

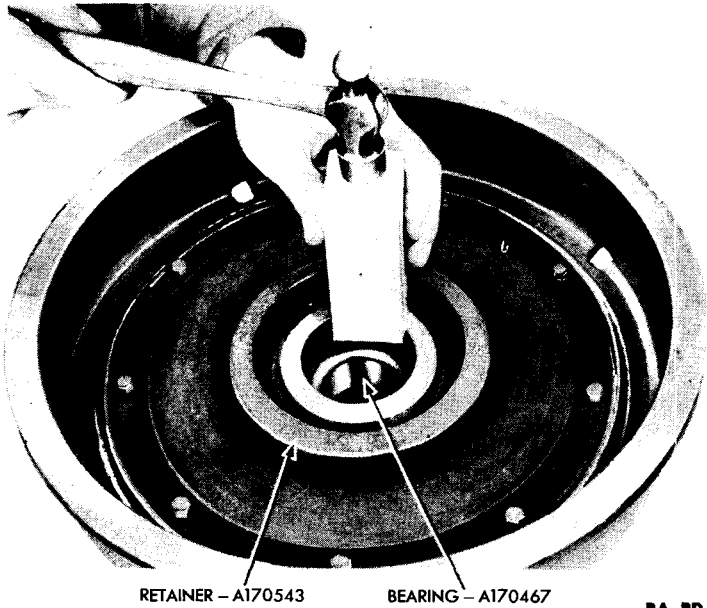
(4) Tap inner roller bearing cup in position with a ½-inch brass punch and hammer (fig. 138). Drive cup in evenly by striking dif-

WHEELS, HUBS, TIRES, AND BRAKES



RA PD 14583

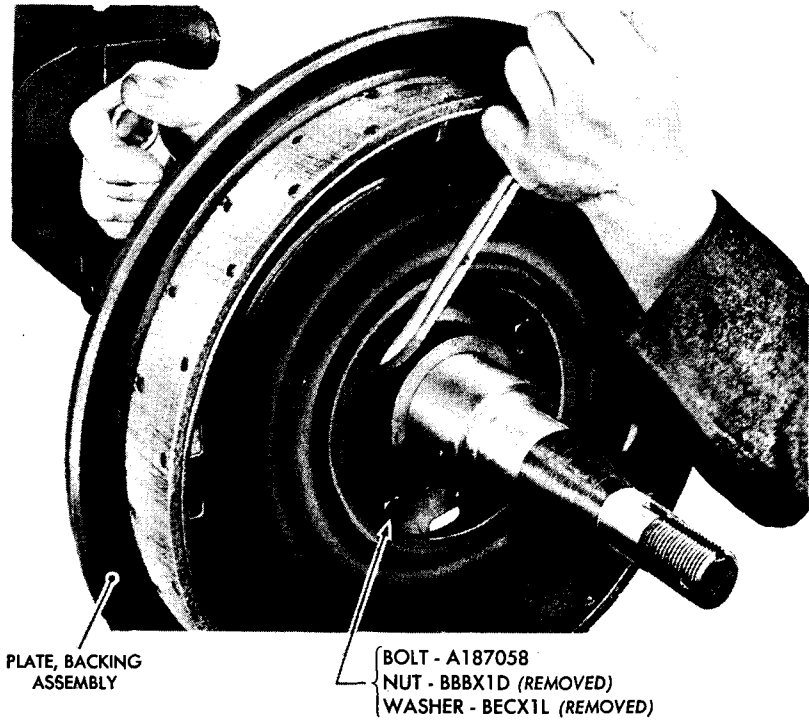
Figure 138 — Installing Inner Roller Bearing Cup in Wheel Hub



RA PD 72996

Figure 139 — Installing Inner Roller Bearing and Oil Retainer

ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 72973

Figure 140 — Removing Brake Backing Plate From Axle

ferent points around edge of cup. Check to see that cup is in straight and down against shoulder in hub.

(5) Turn hub over on work bench and install outer roller bearing cup in same manner.

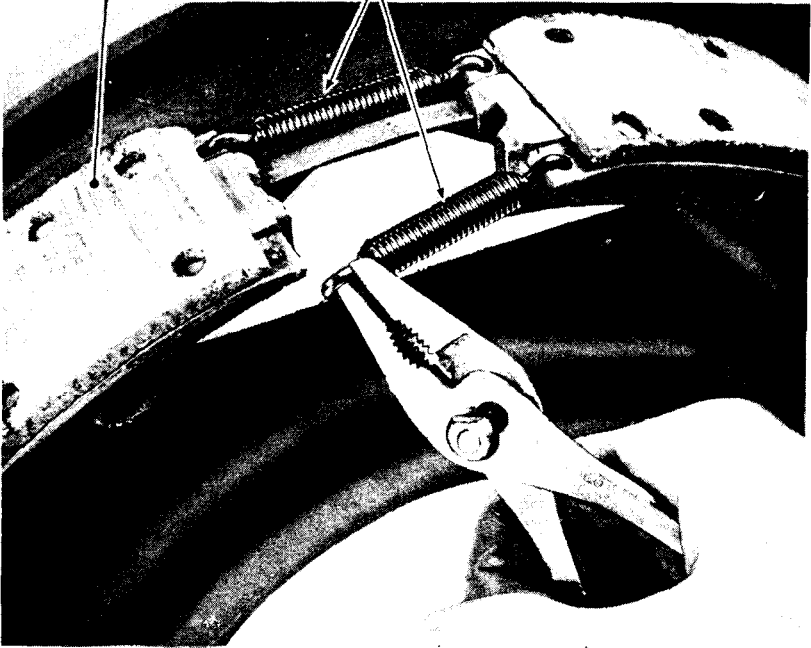
(6) Turn hub over again with small end upright. Paint mating surfaces of hub and brake drum with white lead pigment. Lightly coat bolt threads with white lead pigment. Place brake drum on hub and insert six bolts from drum side. Place lock washers on bolts; install and tighten nuts. Use a $\frac{3}{4}$ -inch open-end wrench, $\frac{5}{8}$ -inch socket, and flexible "L" handle.

(7) Coat mating surfaces of brake drum and brake drum guard with cement-type, joint-and-thread compound. Allow coating to become slightly "tacky" before placing guard in position in drum. Line up holes in guard with holes in drum and install nine cap screws and lock washers.

WHEELS, HUBS, TIRES, AND BRAKES

BAND, BRAKE ASSEMBLY

SPRING - A173230



RA PD 72984

Figure 141 – Removing Brake Band Return Spring From Brake Band

NOTE: *Outer and inner cones and rollers, and oil retainer (used behind inner bearing), are installed when the disk and rim wheel hub assembly is mounted on the wheel spindle.*

c. If the disk and rim wheel hub assembly is to be mounted on the wheel spindle, proceed as follows:

(1) Thoroughly clean inner bearing surfaces. Place inner cone and roller in inner cup in hub. Rotate cone and roller to make certain cone is properly seated. Remove cone and roller.

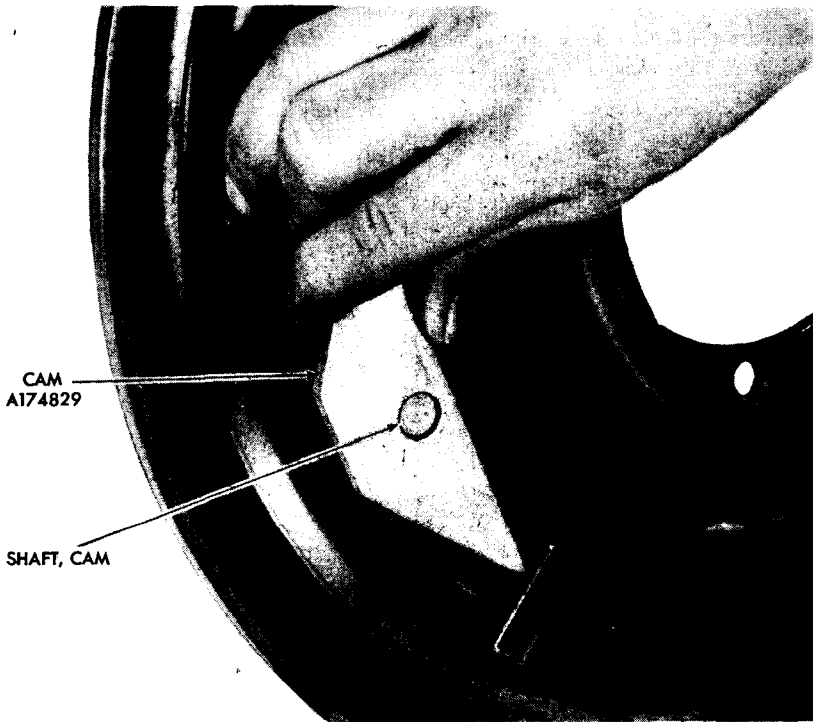
(2) Lubricate the cone and roller. Place cone and roller back in cup in hub.

(3) Tap the oil retainer in position behind roller bearing, with the leather edge of the retainer down toward the bearing. Use a wood block and hammer (fig. 139).

(4) Slide disk and rim wheel hub assembly into position on wheel spindle (fig. 131).

(5) Check the outer cone and roller for cleanliness. Lubricate and insert bearing in hub and on spindle. Follow with washer and

ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 14587

Figure 142 — Removing Brake Cam From Brake Cam Shaft

nut. Tighten nut tight and back off just enough to permit drum to rotate freely without end play. Install cotter pin.

(6) Secure gasket and hub cap in place on hub with three screws and lock washers (fig. 136).

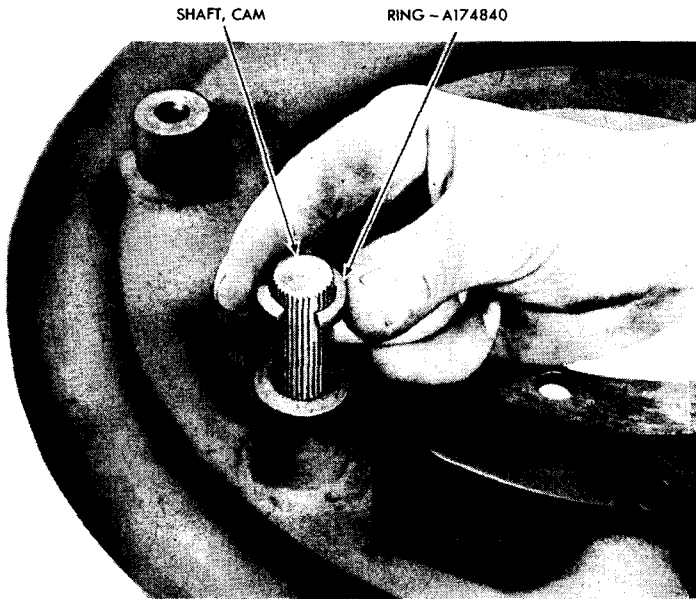
(7) Rotate brake drum and check freedom of action. Apply hand brake several times. Check travel of hand brake lever on rack when brakes are fully on. If lever travels too far before brakes take hold, reset hand brake lever on serrations of cam shaft (compare paragraph 17 e). Then tighten the clamp screw at bottom of lever and secure nut with cotter pin.

71. DISASSEMBLY AND ASSEMBLY OF BRAKE BACKING PLATE.

a. Removal and Disassembly.

(1) Remove eight nuts BBX1D and washers BECX1L from bolts A187058. Push bolts back out of flange on the axle and lift backing

WHEELS, HUBS, TIRES, AND BRAKES



RA PD 14579

Figure 143 – Removing Locking Ring From Brake Cam Shaft

plate assembly from axle. The eight bolts will come away with the assembly (fig. 140). (Note that backing plate assembly has been rotated forward (approximately 45 degrees) from original position, to provide additional clearance between brake lever and the new shields.)

(2) Remove eight bolts A187058. Tip bolts and turn them so that flat of head will clear inside edge of backing plate.

(3) Remove two brake band return springs A173230 from brake band (fig. 141).

(4) Take hold of brake band assembly and remove it from backing plate.

(5) Mark brake cam and backing plate with a center punch to insure proper assembly. Remove brake cam from cam shaft (fig. 142).

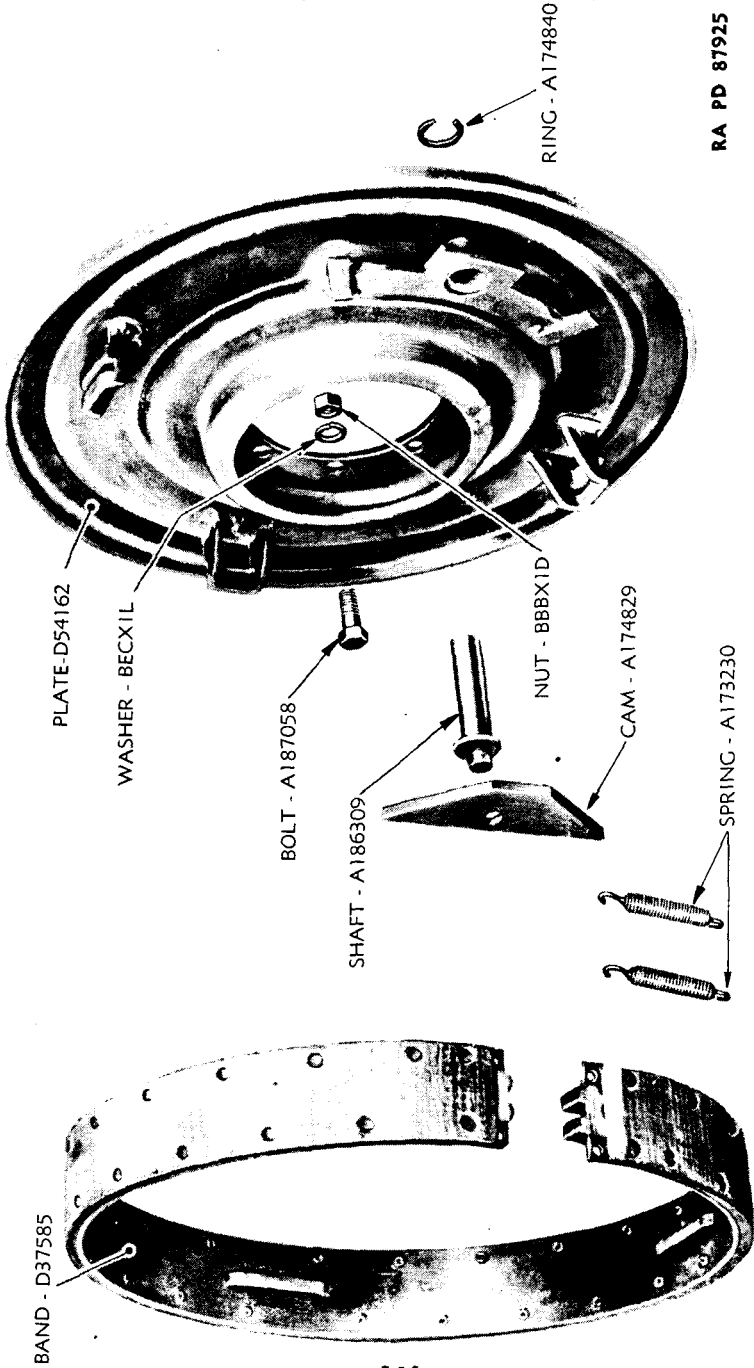
NOTE: *A cam accidentally bent, but not cracked, can be straightened cold in a vise.*

(6) Spread and remove locking ring A174840 from cam shaft (fig. 143).

(7) Remove cam shaft A186309 from backing plate (fig. 144).

(8) Replace worn brake cam shaft bushings. Cam shaft bush-

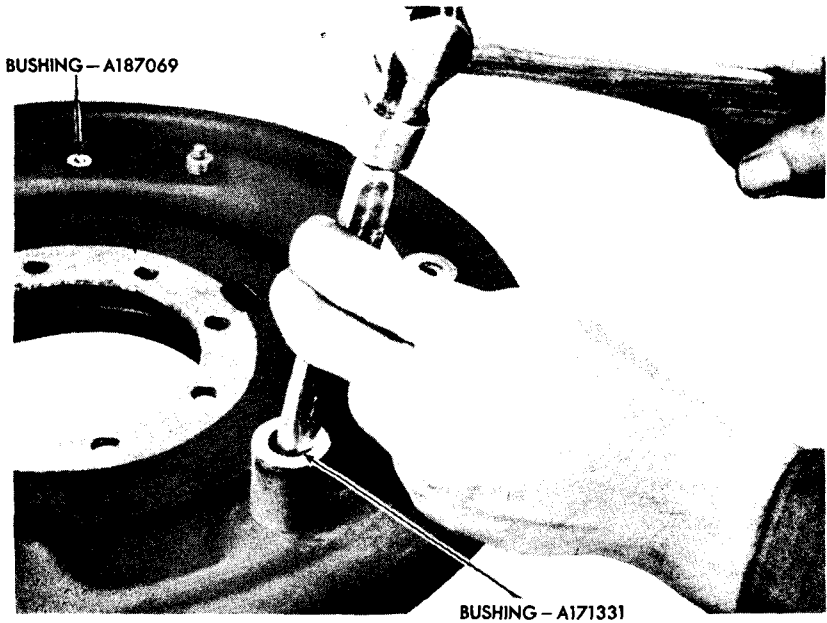
ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 87925

Figure 144 — Brake Backing Plate — Exploded View

WHEELS, HUBS, TIRES, AND BRAKES



RA PD 14586

Figure 145 — Removing Brake Cam Shaft Bushing From Backing Plate

ings A171331 can be removed, if necessary, by tapping them out with a $\frac{3}{8}$ -inch punch and hammer (fig. 145).

b. Assembly and Installation.

(1) Install new cam shaft bushings if old ones were removed.

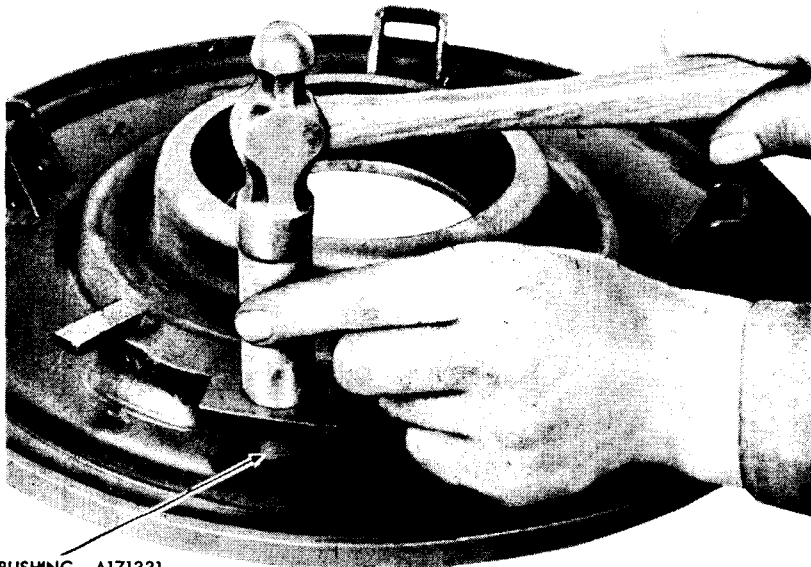
(a) Before a new bushing is installed, coat its outside surface with white lead pigment.

(b) Drive outside bushing in place with a wood block and hammer. Install inside bushing from inside of backing plate, making certain that edge of bushing is flush with counterbored surface. Use a hammer and $\frac{15}{16}$ -inch diameter brass rod, 3 or 4 inches long (fig. 146). **NOTE:** *When new bushings are installed they must be line-reamed to size ($0.687 + 0.002$ inch).*

(2) Slide cam shaft through bushings with serrated end of cam shaft to outside of backing plate. Lock cam shaft in backing plate by sliding cam shaft locking ring into place on shaft (fig. 143). Squeeze locking ring in groove in cam shaft.

(3) With small eccentric on top of cam shaft toward center of backing plate, slide cam into position on eccentric. The center punch marks made at disassembly must coincide (fig. 142).

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



BUSHING - A171331

RA PD 14581

Figure 146 — Installing Brake Cam Shaft Bushing in Backing Plate

(4) Install brake band in position on backing plate with ends of brake band on each side of lug. Secure brake band by hooking brake band return springs into both ends of brake band with hook ends of springs down (fig. 141).

(5) Coat threads of backing plate retaining bolts with light film of white lead pigment. Insert bolts in place in backing plate. **NOTE:** *It is necessary to turn the flats of bolt heads next to the edge of the backing plate and to tilt the bolts in order to get them in.*

(6) Secure backing plate assembly to mounting flange on axle with the brake cam shaft directly forward. Place lock washers on bolts and install nuts.

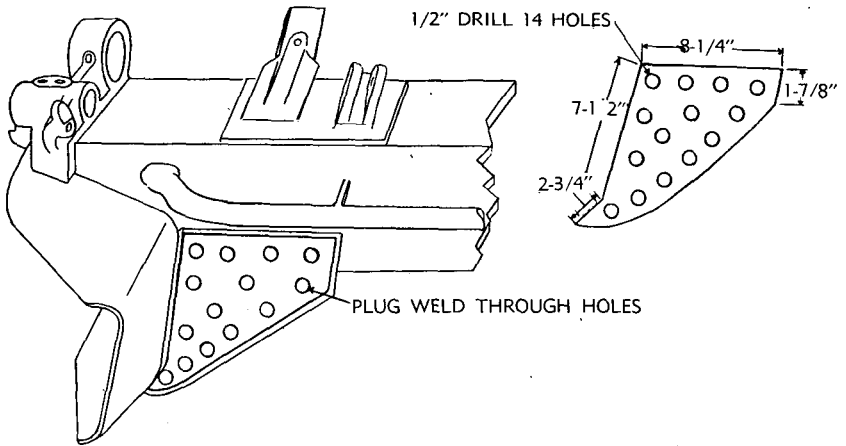
Section XIV

TRAILS

72. GENERAL.

a. The right and left trails are tapered, box-construction, welded-steel members attached to the equalizing support by means of trail hinge pins and nuts. Trail hinge pins permit trails to be pivoted in

TRAILS



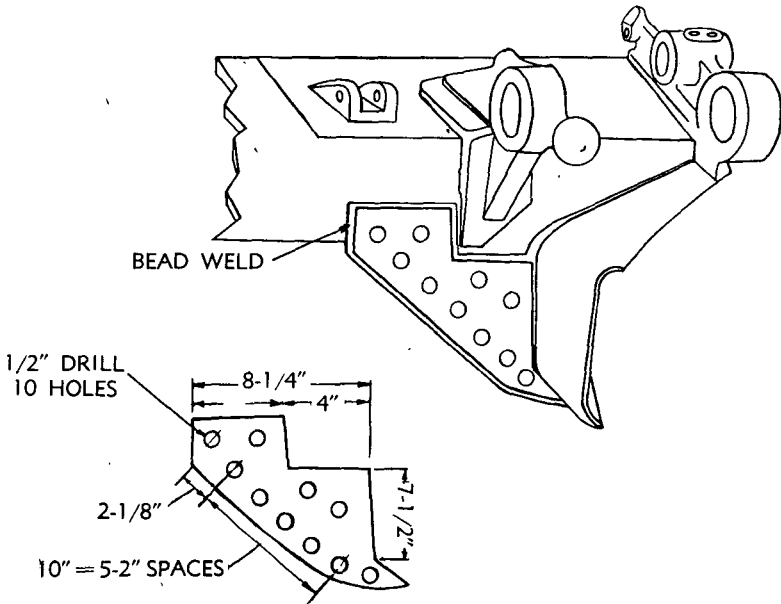
RA PD 87938

Figure 147 – Plate To Be Welded to Both Sides of Left Trail and to Outside of Right Trail

order to place the trails in firing or traveling positions. Handles and spades are welded to each trail at the rear. The drawbar and drawbar lock are assembled to the right trail at the rear, as are the connection and loop of the trail traveling lock. The handle and hook parts of the trail traveling lock and the traveling lock latch are assembled to the left trail. Two brackets, forming a ball and socket for alining trails in locked position, are welded to the trails at the rear. Each trail is fitted at the front with a trail locking pin fastened to the trail with a chain. These are used for locking the trails in firing position. The handspike is carried on the top of the left trail when not in use. When in use, it is inserted in a socket welded to the top of the left trail at the rear. Three supports, fitted with flat springs and levers, are welded to the left trail. Two supports on the side of the left trail are used for carrying the cleaning staff; the support on top carries the handspike. Two similar supports, fitted with flat springs and levers, are welded to the side of the right trail. These are used for carrying the aiming post. Traveling lock brackets are provided toward the front of the trails to engage the (cradle) traveling lock shaft. On carriages of late manufacture these brackets are adjustable.

b. Two right trails have been used with the M2A1 and M2A2 Carriages. Carriages of recent manufacture have right trail D54159. Carriages of early manufacture have right trail D36983. The two right trails are interchangeable at the hinge pin.

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 87939

Figure 148 — Plate To Be Welded to Inside of Right Trail

73. TROUBLE SHOOTING.

a. General. The most usual troubles are: excessive movement between trail and equalizing support; bent spades; scored or galled trail hinge pins; looseness of lunette, drawbar body, or drawbar lock shaft; worn or damaged rail traveling lock; and misalignment of traveling lock brackets and traveling lock shaft (ball) pieces.

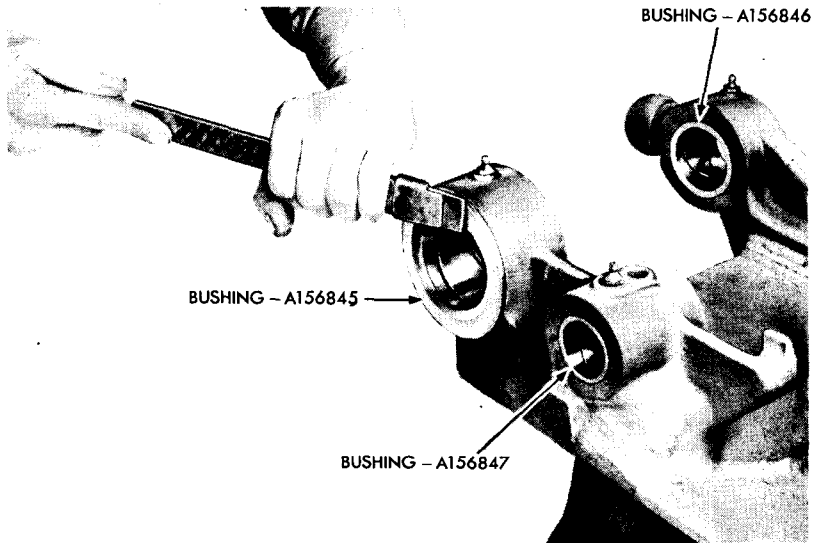
b. Excessive Movement Between Equalizing Support and Trail. This will occur when the over-all clearance between support and trail is greater than 0.007 inch. Weld pad on equalizing support or replace trail to maintain 0.007 inch clearance.

c. Bent Spades.

(1) The trail spades on the 105-mm Howitzer Carriages M2, M2A1, and M2A2, manufactured before 21 September 1943, often bend when the howitzers are fired on hard ground or coral. These spades can be identified by a single plate, welded from the spade to each side of the trail, while the carriages of later manufacture have two plates welded together on each side of the trail.

(2) The following field expedient may be used to overcome this malfunction in the earlier models. The trail spades should be rein-

TRAILS



RA PD 13668

Figure 149 — Scraping Drawbar Bushing

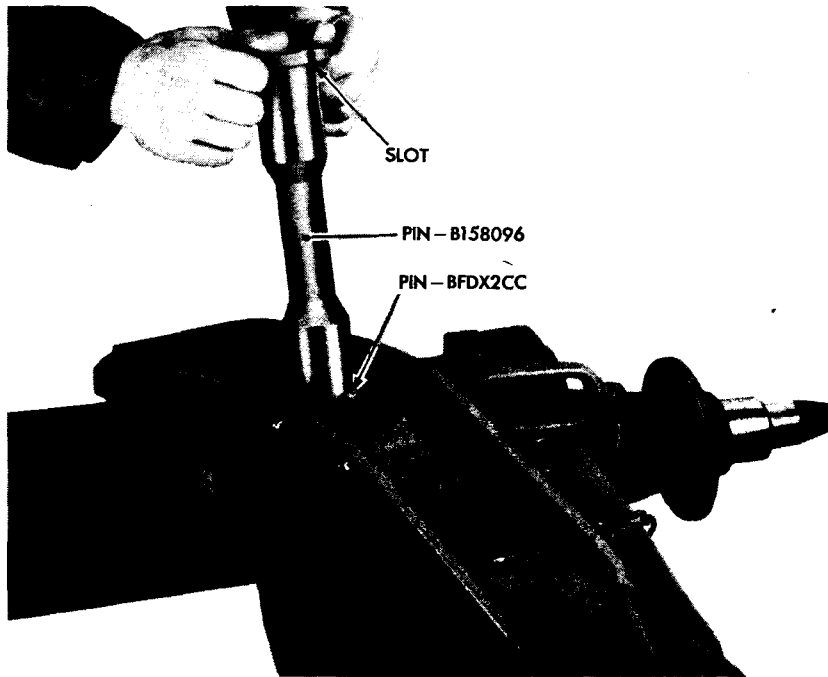
forced with web steel plates three-sixteenths to one-quarter inch thick, welded to the present brace between the under side of the trail and the forward surface of the present spade. Steel should be procured locally, and four plates should be made of low-alloy steel, grade 2, if available. If this steel is not available, any steel that will weld satisfactorily may be used.

(3) Three of the plates made will be identical; two of them will be welded to the left trail, and one to the outside of the right trail (fig. 147). The fourth plate (fig. 148) must be cut to fit on the inside edge of the right trail and provide clearance for the drawbar bracket. The plates should be drilled with several holes (figs. 147 and 148) so that they can be plug-welded to the present webs, and then welded to each trail flush with the outer edge of the trail.

(4) The following procedure is suggested to apply the braces to the trails:

- (a) Spread and brace the trails upon blocks.
- (b) If necessary, grind down the high bead weld where the present brace is attached to the trail.
- (c) Clamp the plates to the braces and plug-weld them through the drilled holes, using electric welding equipment.
- (d) Run a bead weld along the edges of each plate where it comes in contact with the trail and spade.

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 72951

Figure 150 — Removing Hinge Pin

NOTE: *If the present web has buckled, it should be straightened before a new web is welded on. If the brace is not flush with the edge of the trail, it will be necessary to bend the plate at the top, allowing it to lie flat on the brace before welding.*

d. Damaged or Worn Trail Hinge Pins. Remove scores and burs from trail hinge pins with a smooth file and crocus cloth. Replace trail hinge pin if play is more than 0.003 inch between pin and equalizing support.

e. Loose Lunette, Drawbar Body, or Drawbar Lock Shaft.

(1) Replace the lunette if clearance between it and drawbar body is greater than 0.001 inch (par. 75 a). Replace bushings A156845 and A156846 if clearance between them and drawbar body is greater than 0.003 inch (par. 75 c). Replace bushing A156847 if clearance between it and drawbar lock shaft is greater than 0.003 inch.

(2) End play between drawbar body and thrust face of drawbar rear bushing is caused by uneven wear of bushing face. Locate high spots on bushing and remove by scraping with a flat scraper (fig. 149).

TRAILS

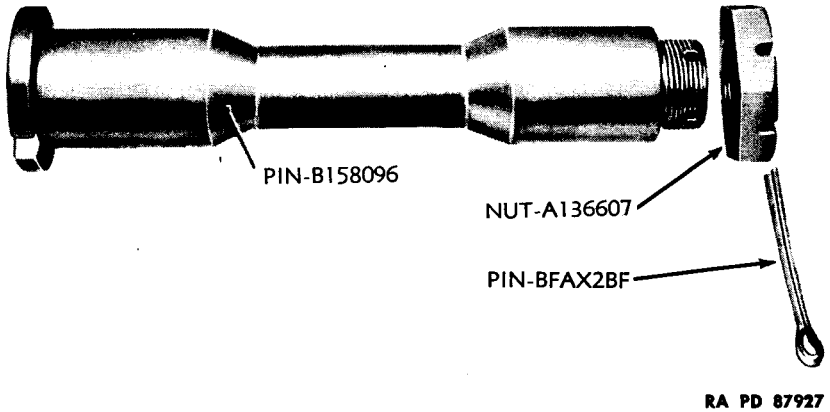


Figure 151 — Trail Hinge Pin — Exploded View

Remove just enough metal to get contact on entire surface of bushing. Clean with dry-cleaning solvent.

f. **Damaged or Worn Trail Traveling Lock.** Disassemble trail traveling lock. Replace damaged or worn parts. Note particularly whether trail traveling lock loop is worn. Replace pin A157133 connecting traveling lock hook and handle if play is more than 0.005 inch (par. 76 a). Replace pin A157134 securing traveling lock connection to bracket welded to right trail if play is more than 0.005 inch (par. 75 d). Replace pins A157132 securing traveling lock handle to bracket welded to left trail if play is more than 0.005 inch (par. 76 a).

g. **Misalignment of Traveling Lock Brackets and Traveling Lock Shaft (Ball) Pieces.** Aline correctly (TM 9-325).

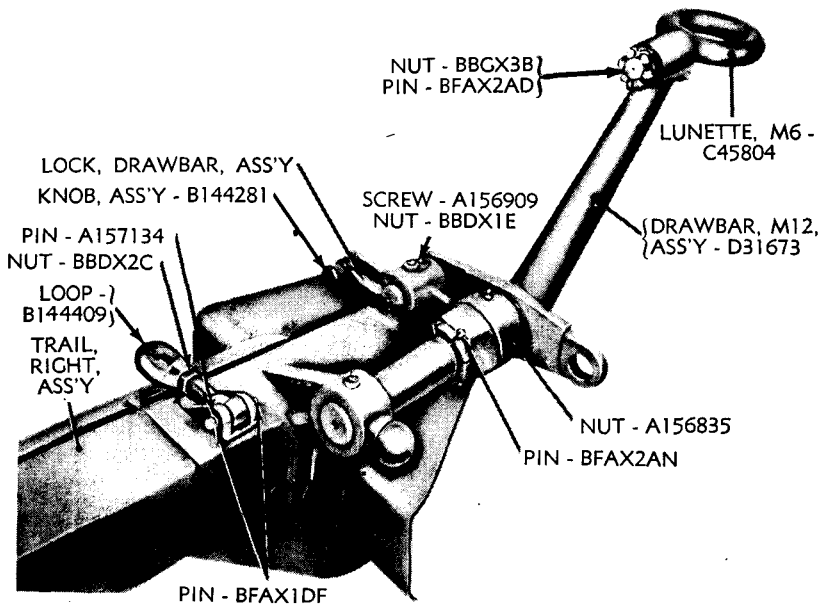
74. REMOVAL AND INSTALLATION OF TRAILS.

a. Removal.

(1) The trails may be removed from the weapon without removing any other part of the weapon. It is necessary, however, to provide blocking under the axle on the side from which the trail is removed.

(2) Remove cotter pin and trail hinge pin nut from bottom of

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 22588

Figure 152 — Drawbar and Drawbar Lock Group

pin. Remove trail hinge pin (fig. 150). Two or three men will be required to lift and pull trail away from equalizing support.

b. Installation.

(1) Grease mating surfaces of trail and equalizing support. Place the hinge (front) end of trail in position on equalizing support.

(2) Line up trail hinge pin holes in trail and equalizing support. Grease bearing surfaces of trail hinge pin (fig. 151) and insert pin. Be sure to line up slot in trail hinge pin head with straight pin in trail (fig. 150). Tap trail hinge pin down into position with a copper hammer.

(3) Apply white lead pigment to the threads of trail hinge pin. Install nut and secure with cotter pin.

(4) Adjust the cradle traveling lock bracket on carriages equipped with bolted brackets.

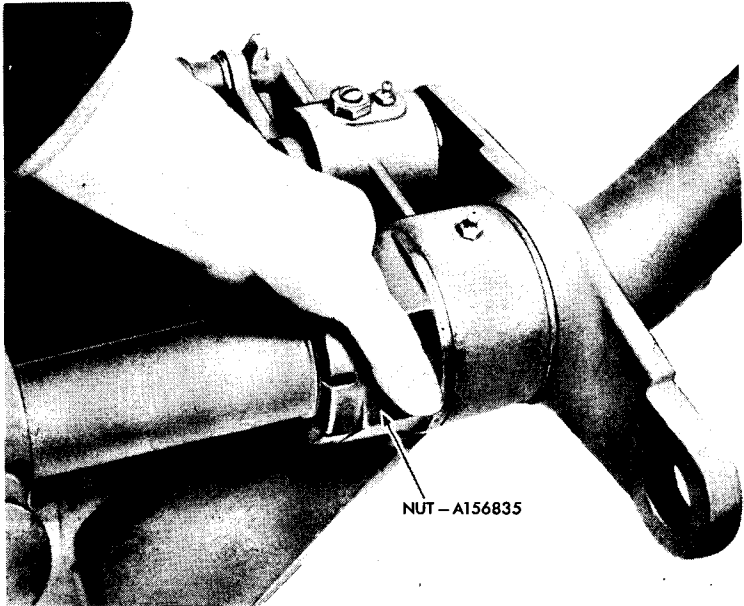
75. DISASSEMBLY AND ASSEMBLY OF RIGHT TRAIL.

a. Drawbar (fig. 152).

(1) **DISASSEMBLY.**

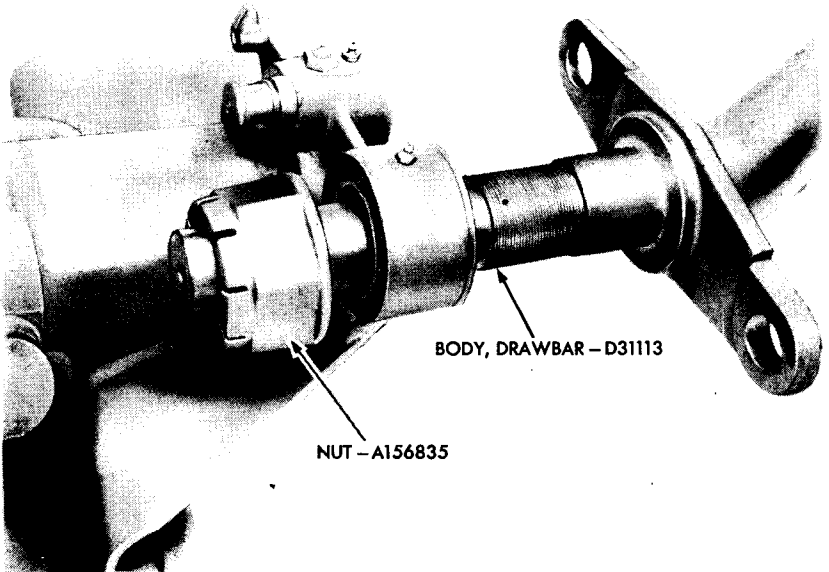
(a) Remove large cotter pin BFAX2AN from (drawbar body)

TRAILS



RA PD 13645

Figure 153 – Removing Nut From Drawbar Body



RA PD 13646

Figure 154 – Removing Drawbar From Right Trail

ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4

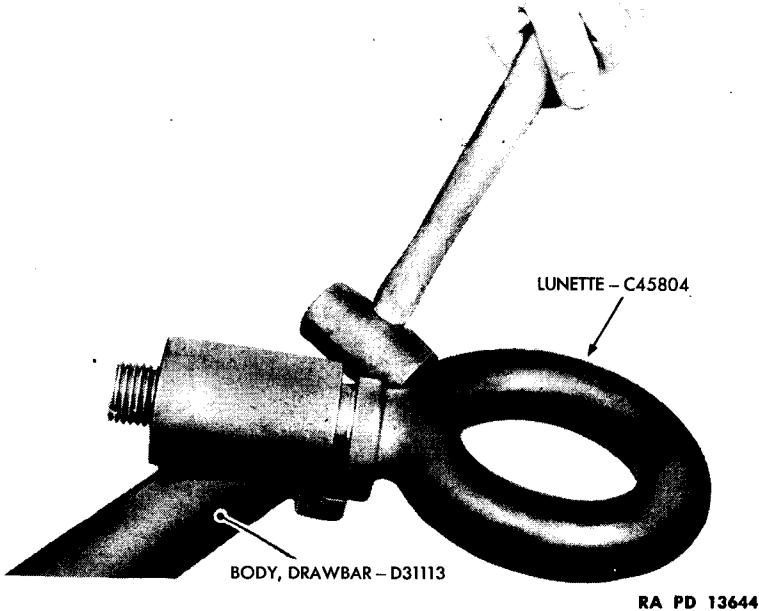


Figure 155 — Removing Lunette From Drawbar Body

nut A156835 and drawbar body. Unscrew nut A156835 (fig. 153). If necessary, tap lightly with copper hammer to loosen.

(b) Place drawbar lock in unlocked position. Then pull Drawbar Assembly M12 from the two drawbar bearings far enough to remove the nut from the drawbar body D31113 (fig. 154). Remove drawbar assembly from right trail.

(c) Support drawbar assembly in vise equipped with copper jaws, and remove cotter pin and nut from lunette.

(d) Drive Lunette M6 from drawbar body with a copper hammer (fig. 155). This is a tight, drive fit.

(2) ASSEMBLY (figs. 152 and 156).

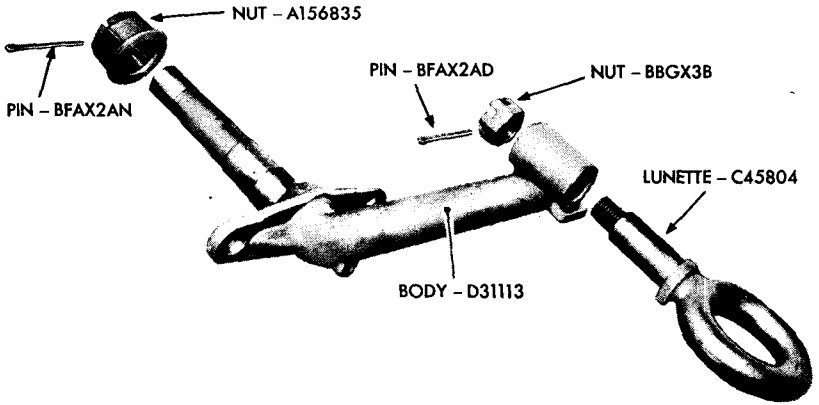
(a) Apply a film of oil to lunette shaft and apply white lead pigment to the threads and assemble lunette to drawbar.

(b) Grease both bearing surfaces of drawbar body.

(c) Slide drawbar through rear bushing and bracket. Slide nut on drawbar (fig. 154), then push drawbar body into position through front bushing and bracket.

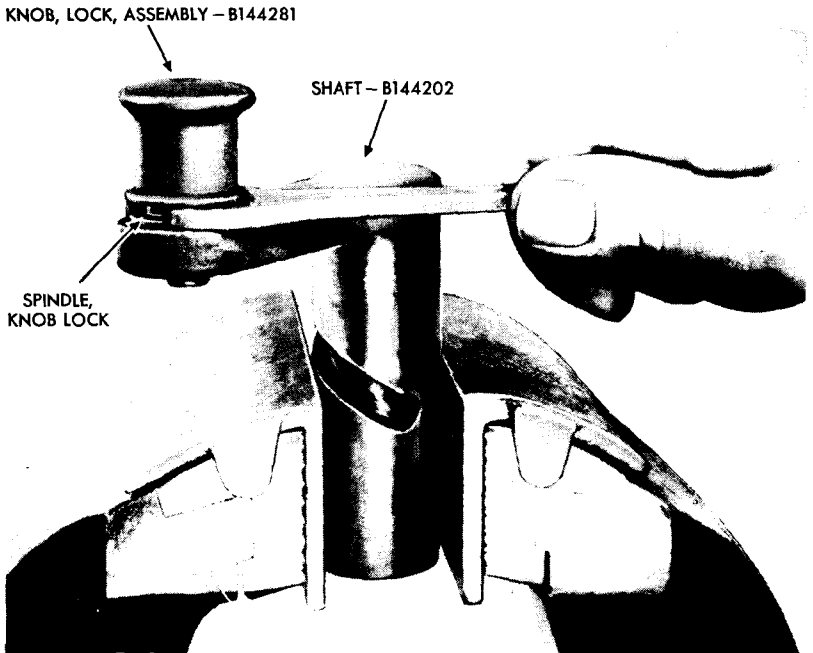
(d) Apply white lead pigment to threads of drawbar body and screw large nut up against front face of rear bracket (fig. 153). Check drawbar for binding and end play. Insert cotter pin.

TRAILS



RA PD 14443

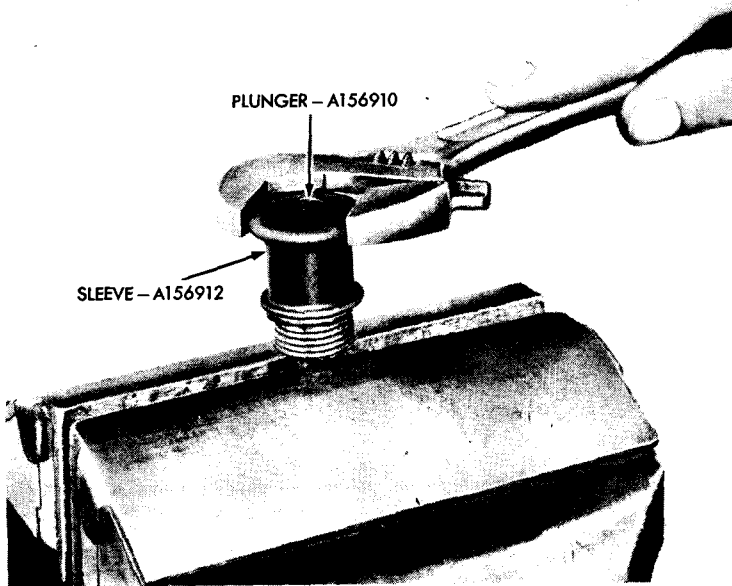
Figure 156 - Drawbar - Exploded View



RA PD 13651

Figure 157 - Removing Drawbar Lock Knob Assembly From Shaft

ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 13652

Figure 158 — Removing Sleeve From Drawbar Lock Lever Knob

b. Drawbar Lock.

(1) **DISASSEMBLY.**

(a) Remove nut BBDX1E and screw A156909 (fig. 152). (Use a 10-inch adjustable wrench and heavy screwdriver.) Slide the drawbar lock assembly out of the drawbar lock bracket.

(b) Place drawbar lock assembly in a vise equipped with copper jaws. Pull out knob assembly B144281, insert thin $\frac{7}{8}$ -inch open-end wrench on spindle (fig. 157), and unscrew knob assembly from shaft B144202.

(c) Place knob assembly in vise and unscrew sleeve A156912 from plunger A156910 (fig. 158). Lift sleeve from spindle, then remove spindle from spring and plunger. Slide spring A156908 off plunger (fig. 159).

(2) **ASSEMBLY.**

(a) Oil lock lever knob plunger, spring, and spindle, and apply white lead pigment to threads of spindle before assembling (fig. 159).

(b) Place lock lever knob plunger upright in vise with copper jaws. Slide spring on plunger and follow with spindle. Place the

TRAILS

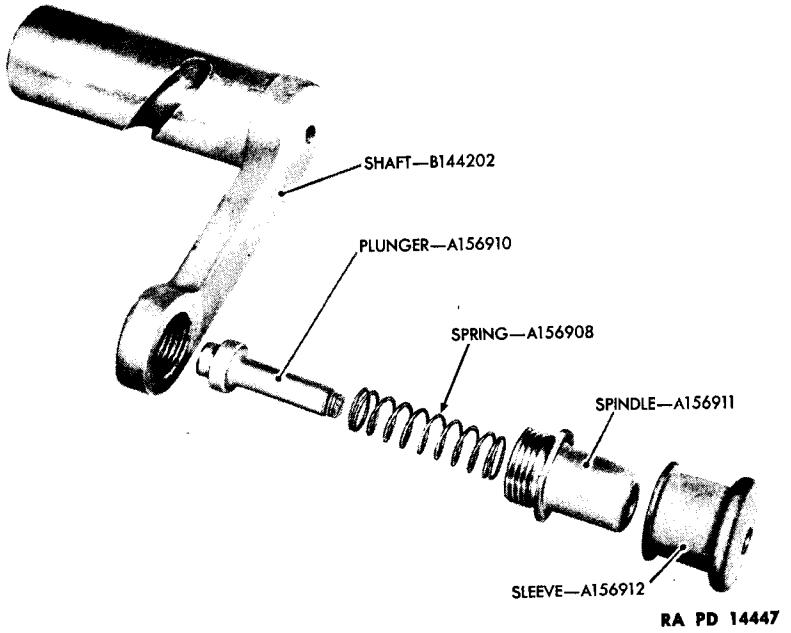


Figure 159 — Drawbar Lock — Exploded View

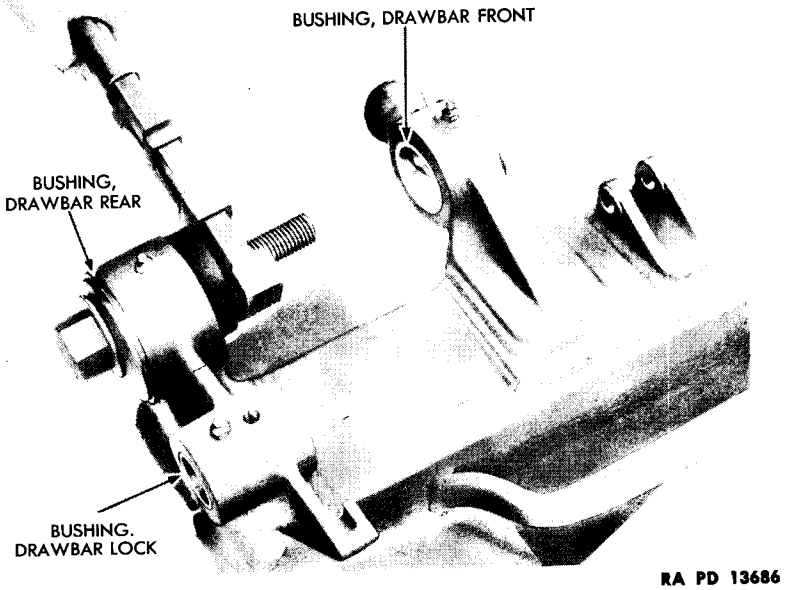
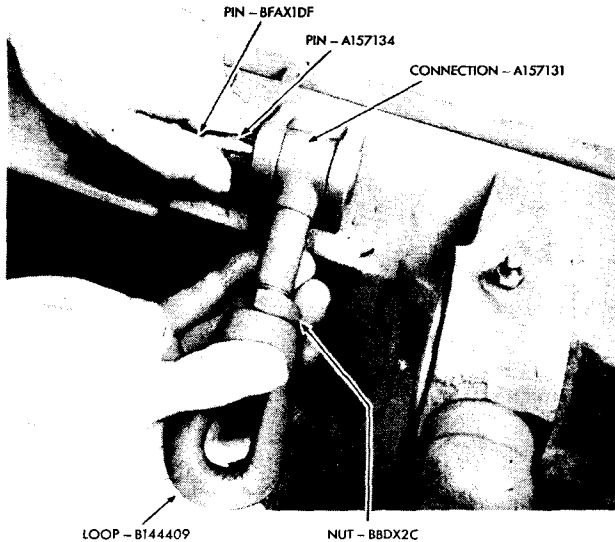


Figure 160 — Installing Drawbar Rear Bushing

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 13649

Figure 161 — Removing Trail Traveling Lock Connection Pin

sleeve in position over spindle and stake the sleeve to plunger in three places.

(c) Place drawbar lock shaft in vise and screw lock knob assembly into shaft (fig. 157). Stake spindle to shaft in four places with a center punch and hammer.

(d) Slide shaft end of drawbar lock assembly into trail bracket from front (fig. 152). Install screw, being careful not to run in screw so far that it will bind shaft. Install jam nut and tighten.

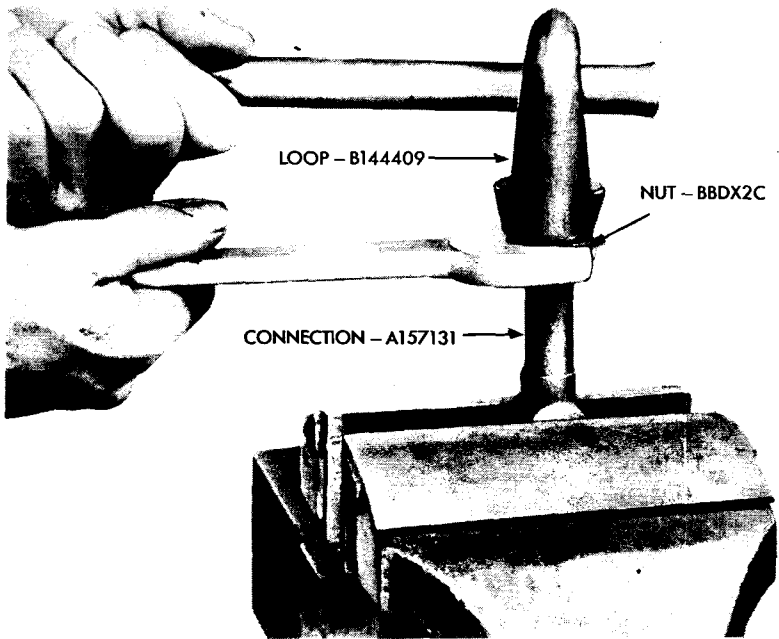
c. Replacement of Worn Drawbar and Drawbar Lock Bushings.

(1) Drive out worn bushings with a hammer and steel bar (same diameter as outside diameter of bushing).

(2) Install new drawbar bushings A156845 and A156846. Use bolt, nut, large washer, and 12-inch adjustable wrench (figs. 149 and 160). Line up oil hole in bushing with hole in housing. Line-ream drawbar bushings.

NOTE: *MWO C21-W13, 30 May 1944, Part B, provides for retaining pins to secure the drawbar bushings.*

TRAILS



RA PD 13654

Figure 162 — Removing Trail Traveling Lock Loop From Connection

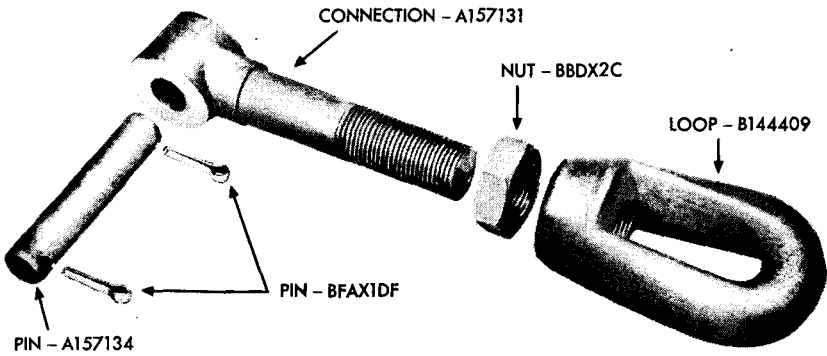
(3) When a new drawbar lock bushing A156847 is installed, line up oil hole and lock screw hole in bushing with holes in housing. Tap lock screw hole using $\frac{1}{2}$ -20NF-2 tap.

d. Trail Traveling Lock Loop and Connection.

(1) **DISASSEMBLY.** Remove either one of the two cotter pins BFAX1DF from headless pin A157134. Push headless pin out of connection A157131 and remove the connection and loop B144409 as an assembly (fig. 161). Place the connection in a vise provided with copper jaws and, holding the loop from turning with a bar, loosen nut BBDX2C (fig. 162). Remove loop and nut.

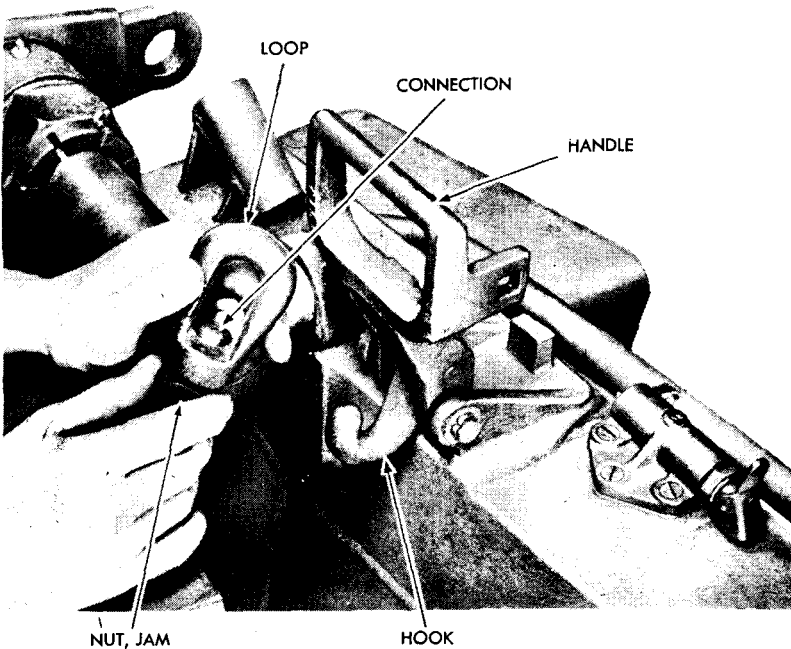
(2) **ASSEMBLE AND ADJUST TRAIL TRAVELING LOCK LOOP AND CONNECTION.** Put white lead pigment on threads of connection before assembling. Assemble as shown in figure 163. Depress howitzer, so that rear end of cradle will be above trails when trails are closed. Bring trails together at rear, with ball and socket joint properly engaged. Engage the hook with loop, and press handle down. If handle can be pressed down without effort, or will not go all the way down, adjust loop on connection to proper position, and lock by tightening jam nut (fig. 164).

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 14444

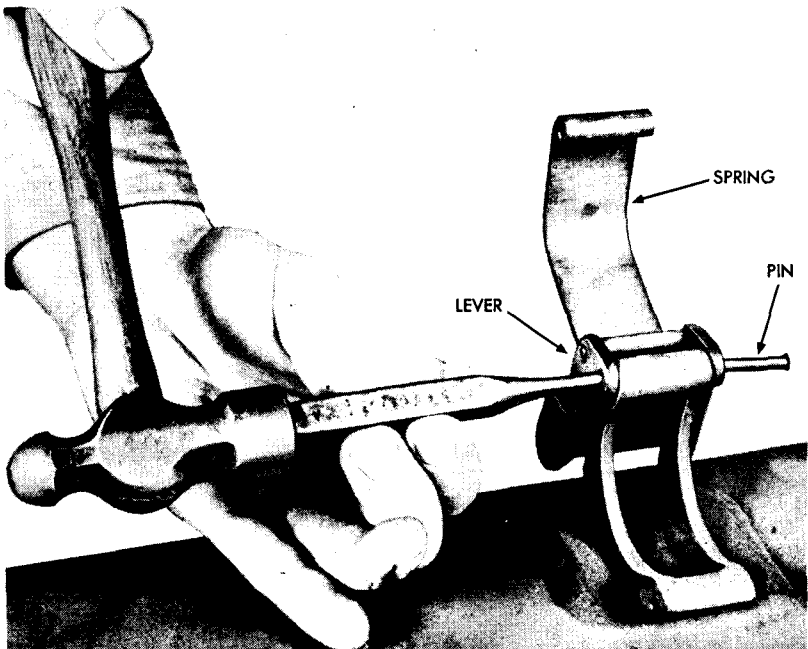
**Figure 163 — Trail Traveling Lock Connection and Loop —
Exploded View**



RA PD 14630

Figure 164 — Adjusting Trail Traveling Lock

TRAILS



RA PD 13664

Figure 165 – Removing Pin From Aiming Post Support

e. **Aiming Post Support Lever and Spring.** To disassemble, drive out the pins as shown in figure 165 and remove the spring and lever from each support. To assemble, drive in the pins with a hammer and peen over to rivet in position.

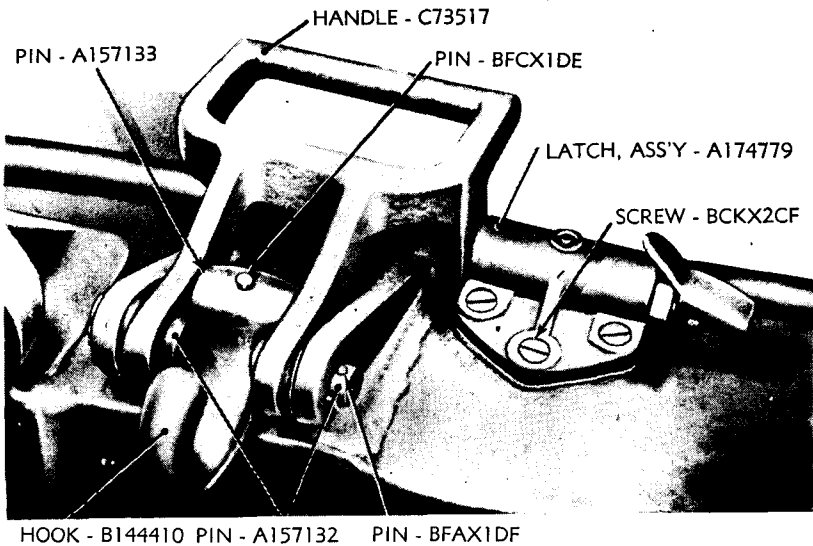
76. DISASSEMBLY AND ASSEMBLY OF LEFT TRAIL.

a. **Trail Traveling Lock Handle and Hook.**

(1) **DISASSEMBLY.** Remove two cotter pins BFX1DF from two rod end pins A157132 (fig. 166). Slide rod end pins out, and lift off handle and hook as an assembly. Place assembly in vise with copper jaws. Drive out taper pin BFCX1DE (fig. 167) and tap out pin A157133 with a punch and hammer. Remove hook B144410 from handle C73517.

(2) **ASSEMBLY.** Place trail traveling lock hook in vise with copper jaws. Slide trail traveling lock handle in position, making sure latch eye on side of handle is opposite hook opening. Oil and insert pin A157133. Fasten this pin in hook with taper pin after applying white lead pigment to taper pin. Place trail traveling lock handle and hook assembly in position in trail bracket. Oil both rod end pins, and

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 22589

Figure 166 — Trail Traveling Lock Handle, Hook, and Latch Assembly

insert pins through handle and bracket on trail from inside handle (fig. 166). Secure rod end pins with cotter pins.

b. Trail Traveling Lock Handle Latch Assembly.

(1) DISASSEMBLY.

(a) Remove the three screws BCKX2CF (fig. 166). Remove latch assembly from trail.

(b) Place assembly in vise with copper jaws (fig. 168). Drive out straight pin BFDX1CP. Lift off cam A189838, collar A174764, and washer A175701.

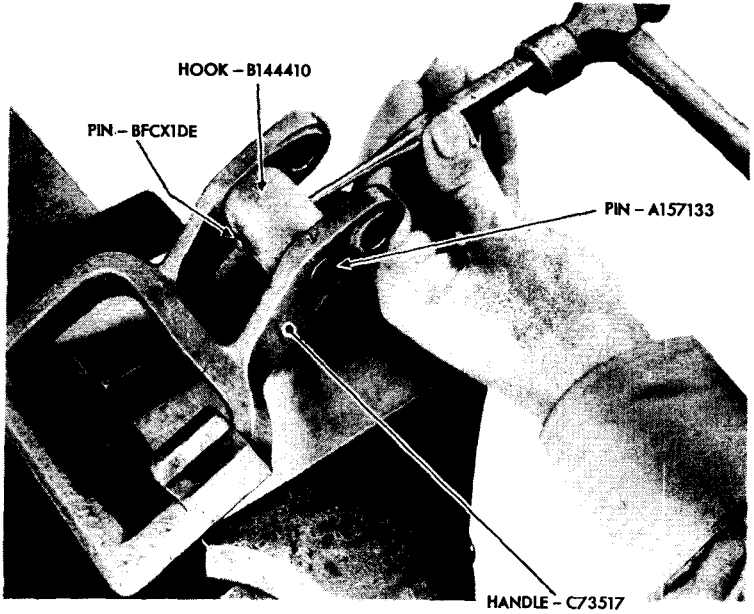
(c) Unscrew guide A174762 from housing B167114. Remove housing from vise. Spring A174766 and plunger A174765 will fall out (fig. 169).

(2) ASSEMBLY.

(a) Oil latch spring and plunger. Slide spring over latch plunger and place in position in housing with point of plunger next to bottom of housing. Screw guide into housing.

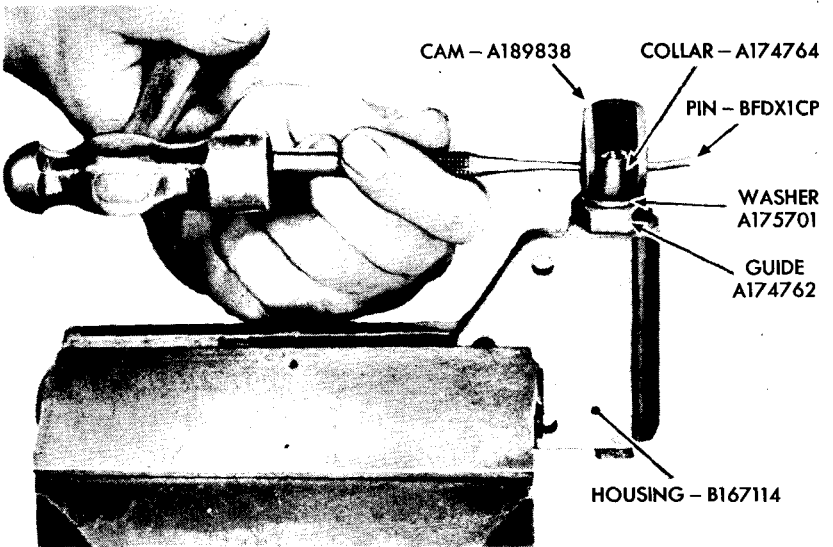
(b) Place latch housing in vise. Slide washer, plunger collar, and cam into position on plunger. Secure cam to collar and plunger with steel pin. Rivet pin at both ends with a hammer.

TRAILS



RA PD 13665

Figure 167 - Removing Pin From Trail Traveling Lock Hook



RA PD 13666

Figure 168 - Removing Pin From Trail Traveling Lock Latch Assembly

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

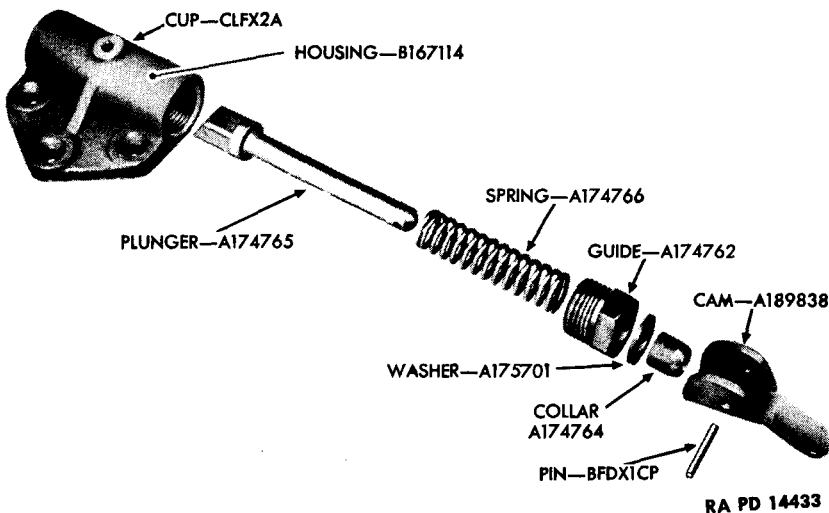


Figure 169 — Trail Traveling Lock Latch — Exploded View

(c) Paint latch housing seating surface on trail with white lead pigment. Apply white lead pigment to three retaining screws and secure latch assembly to trail (fig. 166). Stake screws at each end of screw slot.

c. **Handspike and Staff Supports.** These supports are very similar to the aiming post supports. Disassemble as shown in figure 165. To assemble, drive the straight pin or pins in with a hammer and peen over to rivet in position.

Section XV

AXLE AND EQUALIZING SUPPORT

77. GENERAL.

a. **Axle.**

(1) The axle is a heavy "I" beam steel forging with a wheel spindle driven into each end (fig. 170). These spindles are pinned solidly into position by steel taper pins. A hole through the axle forging at the center accommodates two bronze bushings which serve as bearings for the pintle support pin.

(2) Two large screws on the rear face of the axle, one near each end, serve as stops that limit the extent to which the equalizing support can pivot on the axle.

AXLE AND EQUALIZING SUPPORT

RA PD 22584

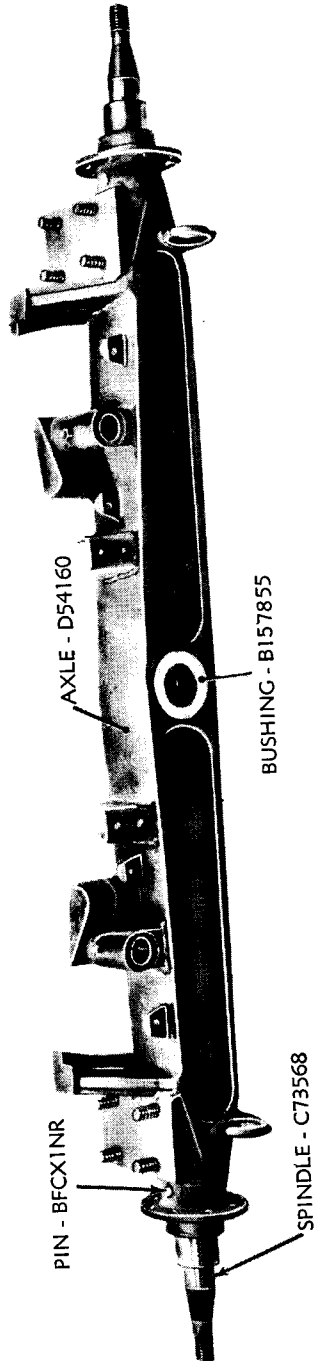


Figure 170 — Axle

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

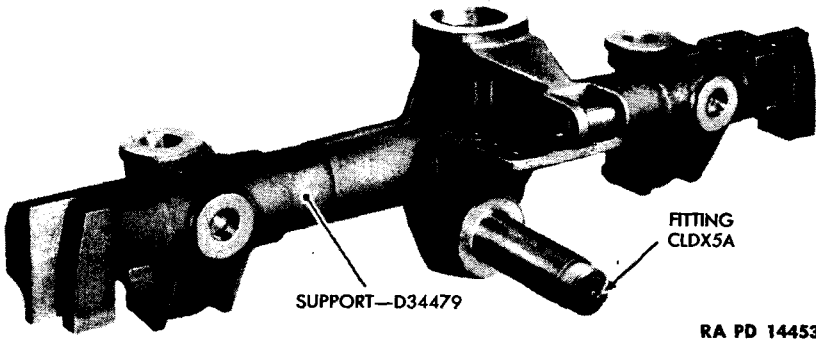


Figure 171 — Equalizing Support

RA PD 14453

(3) Brackets, welded to the top of the axle, serve as bearings for the axle lock levers. These levers are always placed in the locked position when the howitzer and carriage are traveling. Additional vertical brackets, near the central hole, are provided for the main shield.

(4) The necessity for repair or adjustment of the axle assembly is limited. Malfunctions are more likely to be caused by damage than by wear. However, lack of lubrication of the axle lock levers will cause wear and, in time, require replacement of the crank portion of the axle lock lever assembly. Lack of lubrication of the two axle bushings will likewise score and wear the bushings and require replacement. Proper lubrication instructions for these parts are given in Lubrication Order No. 5.

b. Equalizing Support (fig. 171).

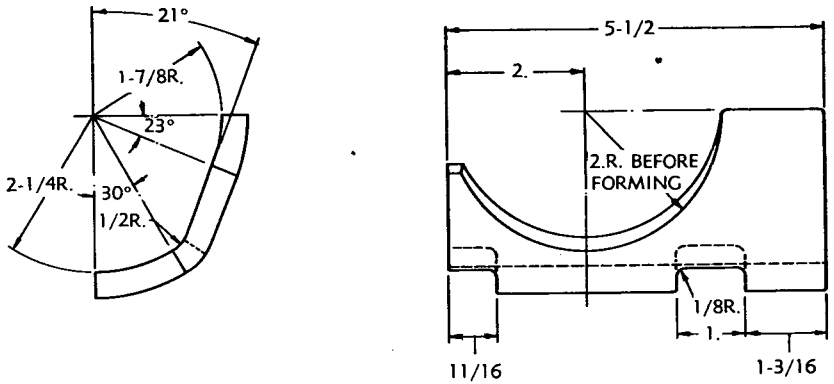
(1) The equalizing support is a heavy, tubular steel casting to which brackets are welded for attaching the trails, the top carriage, and the pintle support bracket. A large pin (pintle support pin) at the front of the support passes through the axle at the center. This is the pivot for the rotation of axle or equalizing support that compensates for unevenness of terrain.

(2) A grooved section is welded at each end of the support to receive the guides on the axle.

(3) Recesses are bored into bosses welded on the front of the support near each end. The axle lock levers slide into these recesses when the axle and support are in the locked or traveling position.

(4) The equalizing support requires little attention other than periodical inspection. Should the equalizing support become cracked or broken it would have to be replaced with a new equalizing support.

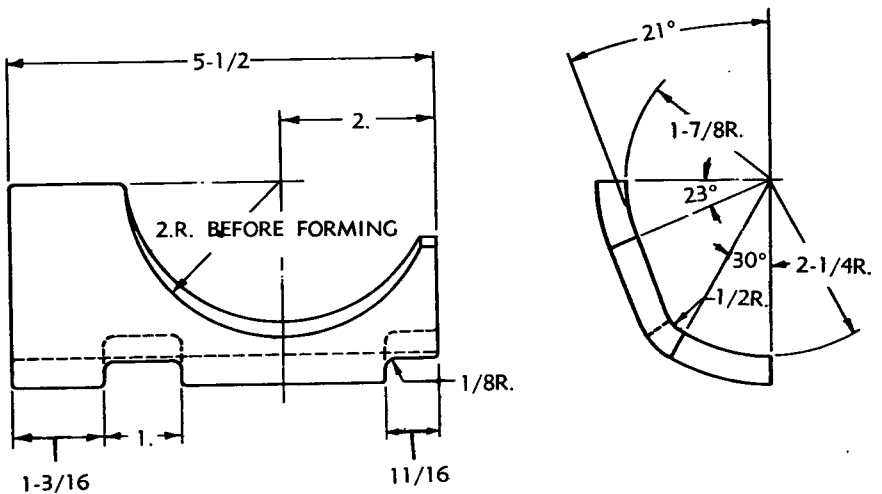
AXLE AND EQUALIZING SUPPORT



REINFORCE
LOW ALLOY STEEL, GRADE 2.
3/8 THICK

RA PD 87928

Figure 172 – Reinforce B195738

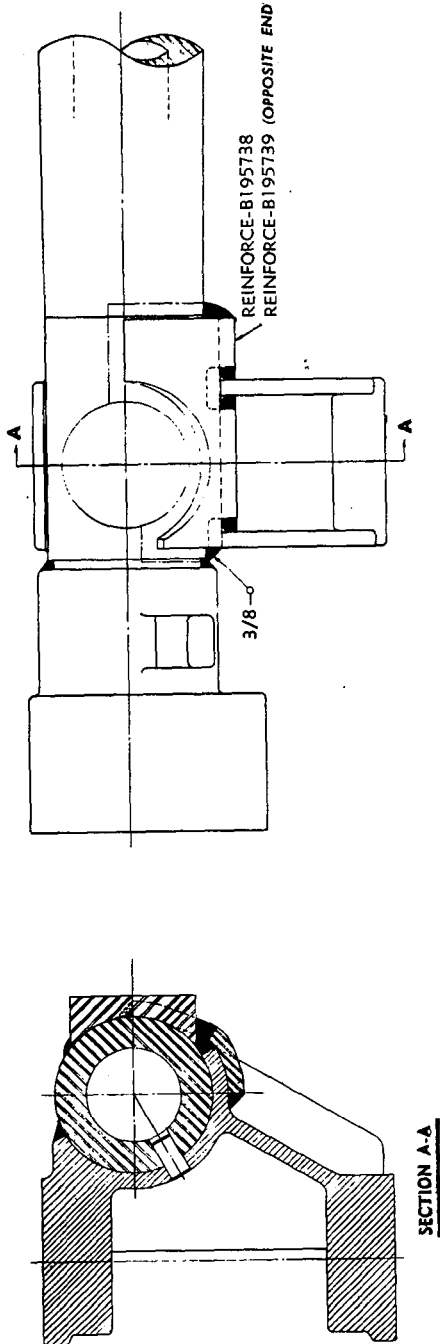


REINFORCE
LOW ALLOY STEEL, GRADE 2
3/8 THICK

RA PD 87929

Figure 173 – Reinforce B195739

ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 87930

Figure 174 — Support D40930

AXLE AND EQUALIZING SUPPORT

Should the ball and socket of the trail traveling lock mechanism fail to mate properly, the support should be checked for deformation. This condition is sometimes attributed to deformation of trails when the support is the cause of nonmating.

(5) The strut traveling latch and pintle support bracket are removed from the equalizing support and axle when the equalizing support and axle are separated.

78. TROUBLE SHOOTING.

a. **General.** The most usual troubles are: worn or damaged axle lock levers; binding or looseness of axle on pintle support pin; galled or scored gibs between equalizing support and axle; broken weld joining bracket and body of equalizing support; and bent or broken wheel spindles on axle.

b. Worn or Damaged Axle Lock Levers.

(1) Disassemble axle lock lever (par. 83 a). Check for galled or scored bearing surface on crank. Repair by filing with a fine file and polishing with crocus cloth. Replace cranks B292136 or B292137 if play is more than 0.014 inch between crank plunger (cammed arm) and axle. **NOTE:** *The cranks are not interchangeable from left to right or vice versa.*

(2) Replace broken or weak spring in knob assembly with a new spring. Replace bent or damaged plunger in knob assembly with a new plunger if old plunger cannot be straightened or repaired.

(3) Replace broken or damaged lock shaft guide screw A157025 (fig. 190) with a new screw.

c. Binding or Looseness of Axle on Equalizing Support Pin.

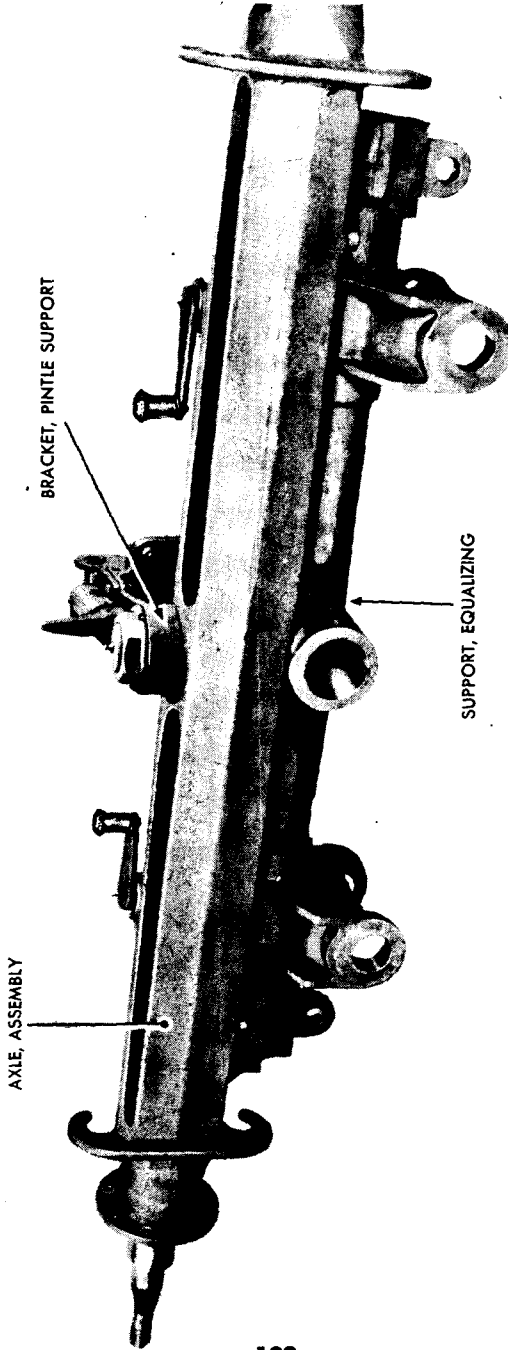
(1) Replace bushings B157855 in axle if play is more than 0.005 inch between bushings and pintle support pin on equalizing support (par. 80). **NOTE:** *The pintle support pin or stud on the equalizing support is integral with the equalizing support body.*

(2) When replacing any of the following parts that rotate on the pintle support pin or stud of the equalizing support, maintain a 0.003-inch over-all working fit when assembled: axle thrust inner ring A170695, axle D54160, axle thrust outer ring A170781, pintle support bracket D37621, and pintle support nut A170782 (par. 79 c (7)).

d. **Galled or Scored Gibs Between Equalizing Support and Axle.** Maintain a 0.004-inch working fit on gibs between equalizing support and axle. Check for galled or scored surfaces. To maintain 0.004-inch fit, weld and rework gibs on axle.

e. **Broken Weld Joining Bracket and Body of Equalizing Support.** Failure of weld on bracket C72460 and body D36739 of equalizing support may be repaired by the following procedure:

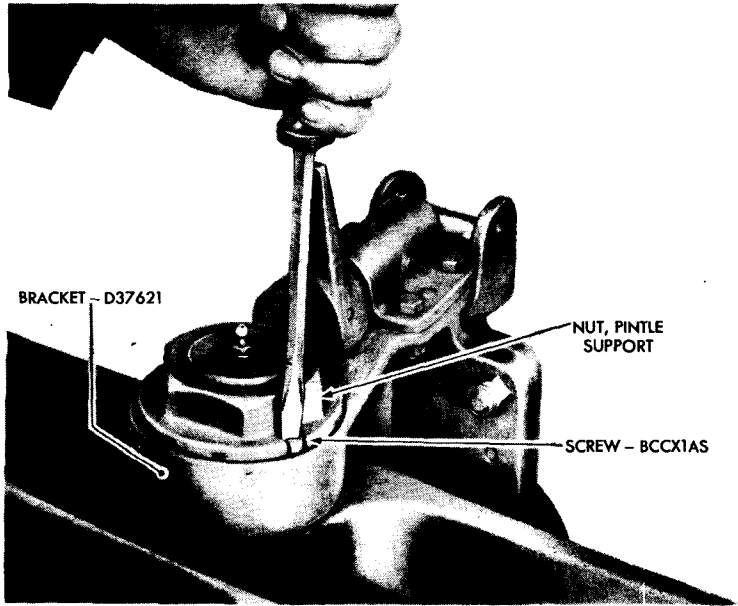
ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 83632

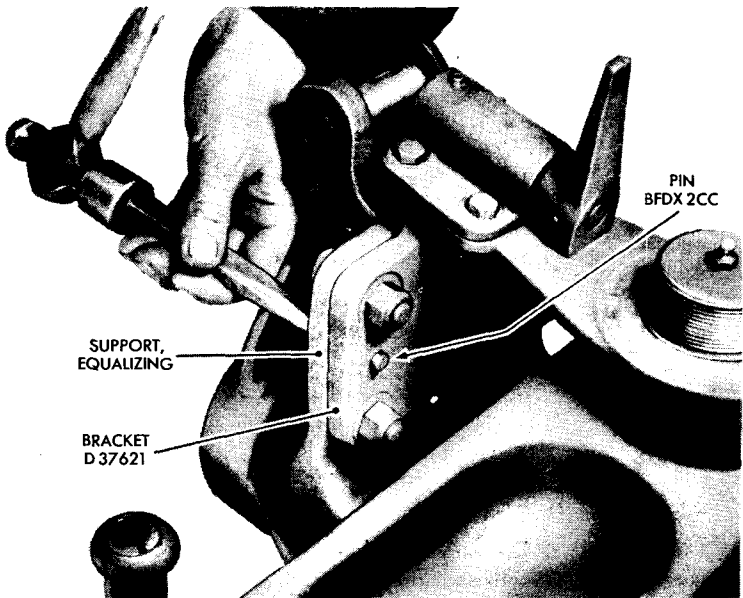
Figure 175 — Axle and Equalizing Support

AXLE AND EQUALIZING SUPPORT



RA PD 72977

Figure 176 — Removing Screw From Pintle Support Bracket



RA PD 72979

Figure 177.— Removing Pin From Pintle Support Bracket

ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4

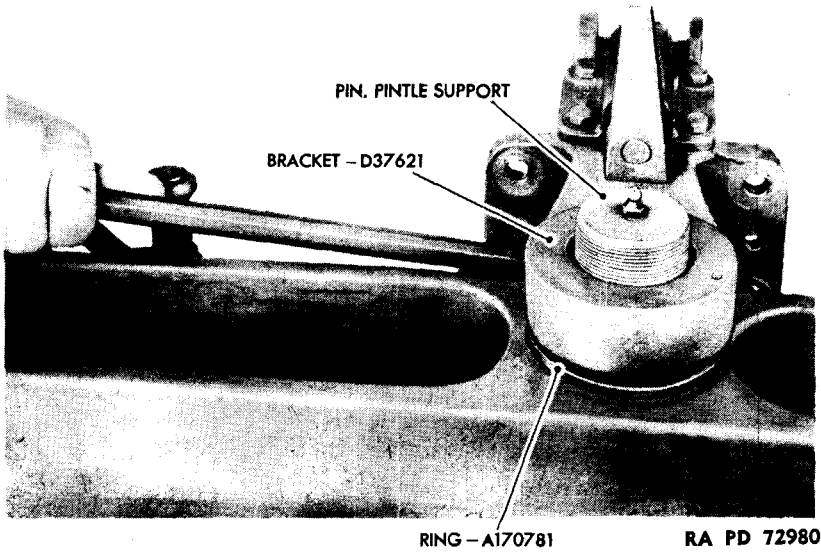


Figure 178 — Removing Pintle Support Bracket From Equalizing Support

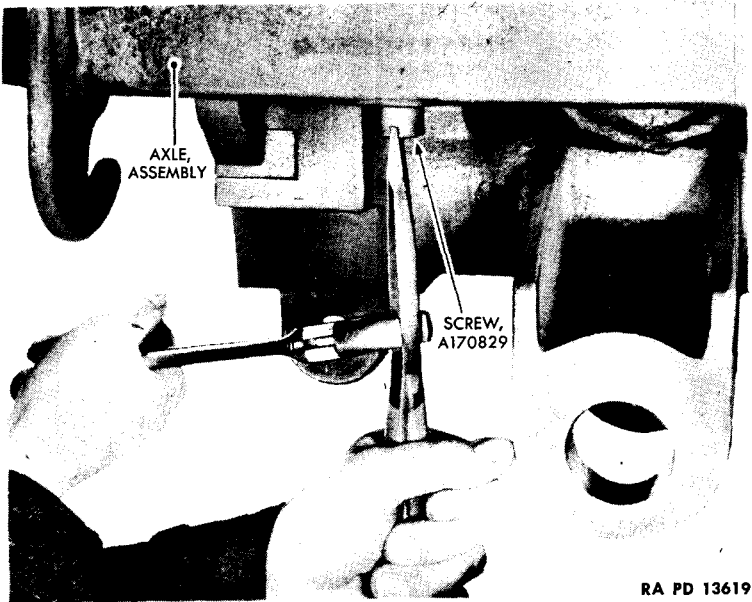
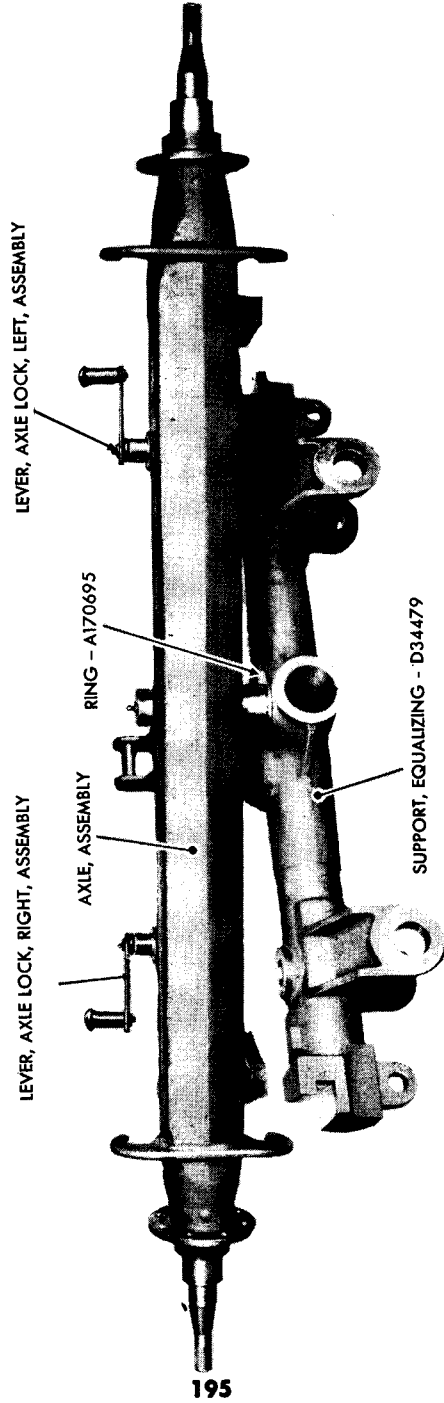


Figure 179 — Removing Stop Screw From Axle

AXLE AND EQUALIZING SUPPORT

RA PD 83589



LEVER, AXLE LOCK, LEFT, ASSEMBLY

LEVER, AXLE LOCK, RIGHT, ASSEMBLY

AXLE, ASSEMBLY

RING - A170695

SUPPORT, EQUALIZING - D34479

Figure 180 — Removing Axle From Equalizing Support

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

(1) Reinforce B195738 (right) and B195739 (left) will be cut from $\frac{3}{8}$ -inch thick mild steel stock, low-alloy steel grade 2, or cold rolled steel, whichever is available. All old welding will be removed by chipping or grinding. (Bracket C72460 is cast steel class No. 2, and body D36739 is SAE 4130 steel, and while weldability is good, *preheating of from 400 degrees to 500 degrees is required. NOTE: When area is hot enough to melt solder readily, the desired heat is obtained.*)

(2) Disassemble weapon leaving trails assembled to equalizing support D36740. Referring to figures 172 and 173, lay out and cut reinforcements. Referring to figure 174, weld bracket C72460 to body D36739 at points indicated. Preheating can be accomplished either with a blow torch or oxyacetylene welding equipment. (For arc welding, use an all-purpose or mild-steel electrode. For oxyacetylene welding, use a mild-steel rod.) Clamp reinforcement into position and weld as indicated in figure 174. **CAUTION:** *Allow welded area to cool naturally. Too sudden cooling will crack weld. Allow to cool before reassembling weapon.*

f. **Bent or Broken Wheel Spindles.** Replace bent or broken wheel spindles C73568 (par. 81). **NOTE:** *The following clearances must be held: 0.0012 inch between (wheel) inner roller bearing and spindle, and 0.0012 inch between (wheel) outer roller bearing and spindle (compare paragraph 69).*

79. DISMOUNTING AND MOUNTING AXLE.**a. Preliminary Steps to Dismounting Axle.**

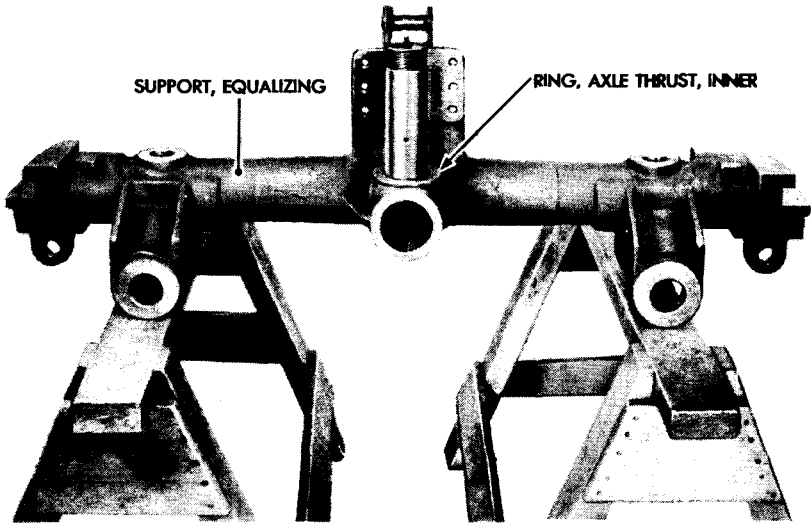
- (1) Place weapon in firing position.
- (2) Remove howitzer and remove recoil mechanism.
- (3) Remove shields.
- (4) Remove cradle and elevating mechanism as a unit.
- (5) Remove traversing mechanism.
- (6) Remove pintle pin and top carriage.
- (7) Remove wheels and brakes.
- (8) Remove trails.

b. Remove Axle From Equalizing Support.

(1) Place axle and equalizing support assembly on two wood horses with the front of the axle upright (fig. 175). It will take at least two men to do this.

(2) Remove screw BCCX1AS that locks pintle support nut in place (fig. 176). Unscrew pintle support nut A170782 with an 18-inch adjustable wrench.

AXLE AND EQUALIZING SUPPORT



RA PD 13669

Figure 181 — Equalizing Support With Axle Thrust Inner Ring in Position

(3) Drive out the two $\frac{3}{8}$ -inch straight pins BFDX2CC that maintain alinement between equalizing support and pintle support bracket D37621 (fig. 177). There is one on each side of pintle support bracket. Remove four nuts and screws.

(4) Place a pinch bar under pintle support bracket D37621 as shown (fig. 178), and pry bracket away from pintle support pin. Lift axle thrust outer ring A170781 from support pin.

(5) Remove two stop screws A170829 from axle (fig. 179). There is one near each end of axle.

(6) Place right and left axle lock levers in unlocked position. Swing axle out of the tongue and groove slides of equalizing support, and lift axle from equalizing support (fig. 180). *NOTE: Axle can be removed by two men or by use of chain hoist and rope sling placed in lifting hooks on axle.*

(7) Lift axle thrust inner ring A170695 from support pin (fig. 180).

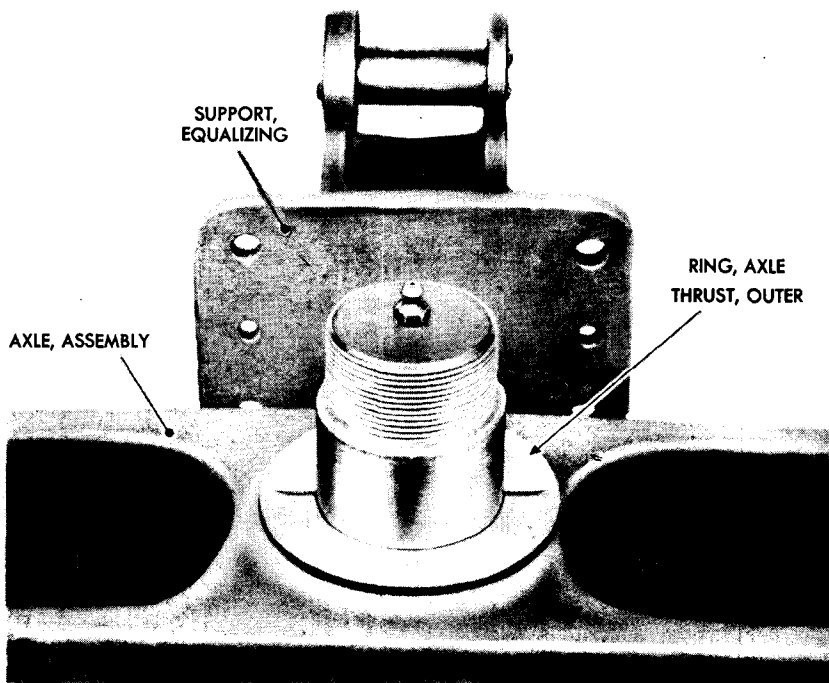
c. Assemble Axle to Equalizing Support.

(1) Place equalizing support on two wood horses (fig. 181).

(2) The equalizing support pin must be thoroughly clean. Place thin film of grease on pin (all but threads). Grease both sides of axle thrust inner ring and slide ring on pin, fillet side of ring down.

(3) With right and left axle lock levers in unlocked position, lift

ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 72994

Figure 182 — Axle Thrust Outer Ring in Position

and place axle in position on the equalizing support (two men) (fig. 180). The gib bearings near each end of axle must fit in the grooved sections of the equalizing support. Coat grooved sections with film of grease.

(4) Swing axle lock levers into the locked position (fig. 175).

(5) Apply white lead pigment to the threads of equalizing support stop screws and install in axle (fig. 179).

(6) Grease both sides of the outer thrust ring and place in position on equalizing support pin, next to front face of axle (fig. 182).

(7) **MOUNT PINTLE SUPPORT BRACKET AND NUT TO GIVE 0.003-INCH WORKING FIT.**

(a) Paint mating surfaces of pintle support bracket and equalizing support with white lead pigment. Slide pintle support bracket in place on pintle support pin and against mating surface of equalizing support until pin holes in bracket and equalizing support line up. Insert four small screws and nuts to secure the bracket and equalizing support temporarily. Then install two $\frac{3}{8}$ -inch straight pins.

AXLE AND EQUALIZING SUPPORT

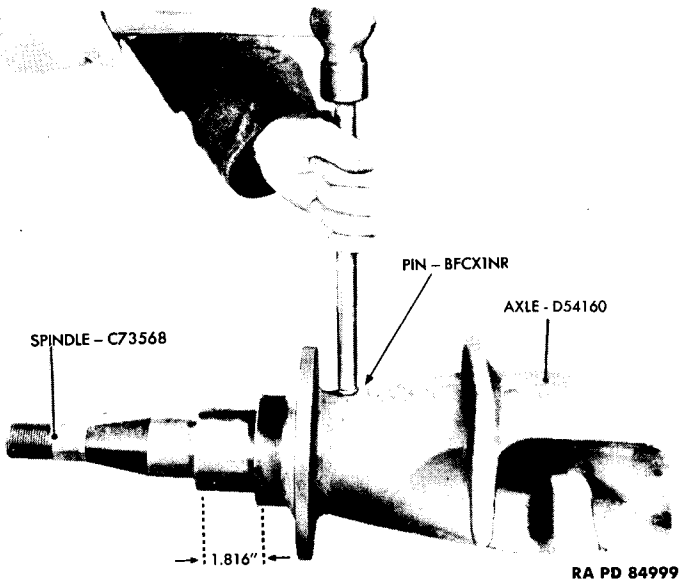


Figure 183 — Driving Taper Pin From Axle and Spindle

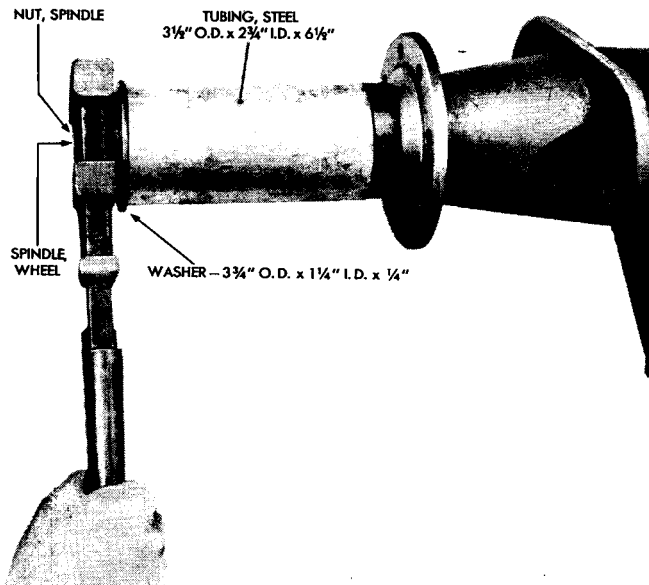
NOTE: If a new bracket is used, it will be necessary to drill pin holes, using oversize pins. Remove temporary screws and nuts, ream four screw holes, and install prescribed $\frac{5}{16}$ -inch-24NF cap screws from the equalizing support side. Apply white lead pigment to the threads of screws. Install the nuts.

(b) Measure the distance from the shoulder on the stud to the forward face of the bracket. The shoulder on the stud should extend 0.003 inch ahead of the forward face of the bracket. Remove the bracket and finish off the forward face of the bracket to obtain this clearance. Then replace the bracket.

(c) Apply white lead pigment to the threads of pintle support bracket pin. Install pintle support nut so that it bears against shoulder of stud. The slot in the nut must line up with the hole in pintle support bracket. **NOTE:** If a new pintle support bracket is installed, this hole will not be in the bracket. Tighten nut just enough to permit a slight drag, mark the bracket, and remove the nut. Drill and tap a hole in the bracket for a $\frac{1}{4}$ -inch 20NC thread, using slot in nut as a guide. Reinstall the nut. Secure nut in place with cap screw, after applying white lead pigment to threads of cap screw.

NOTE: The 0.003-inch over-all working fit when nut is screwed up against shoulder of stud is necessary to permit rotation of axle about stud, thereby providing the equalizing action.

ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4



RA PD 13627

Figure 184 — Removing Wheel Spindle

d. To reassemble the weapon, reverse the steps given in subparagraph a (2) through (8), above.

80. REPLACEMENT OF PINTLE SUPPORT BUSHINGS IN AXLE.

a. **Removal** (fig. 170). Place axle in an arbor press and insert a round steel bar ($2\frac{3}{16}$ inches OD by 5 inches long) between top bushing in axle and arbor press screw. Press two axle bushings B157855 from axle. **NOTE:** *When only one bushing needs to be replaced, it can be driven from the axle with a 1/2-inch punch and hammer.*

b. Installation.

(1) Apply white lead pigment to the outside surfaces of new bushings.

(2) Place one new bushing in position on axle and press into axle. A steel bar (3/4-inch OD by 5 inches long) will be required for this operation. **NOTE:** *The outside diameter of the steel bar should be larger than the outside diameter of the bushing. This prevents the bushing from being pressed too far into the axle.*

AXLE AND EQUALIZING SUPPORT

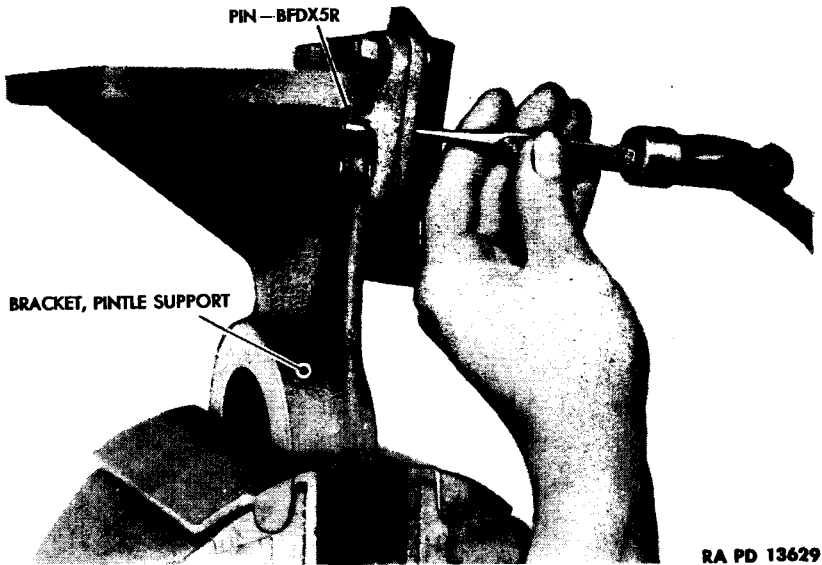


Figure 185 — Removing Dowel Pin From Strut Traveling Latch Body and Pintle Support Bracket

(3) The other bushing is replaced in the same manner after the axle is turned over in the arbor press. Ream if necessary.

81. REPLACEMENT OF WHEEL SPINDLES.

a. Removal.

(1) Place axle on two wood horses, bottom side up. Drive taper pin BFCX1NR from bottom of axle (fig. 183).

(2) Place section of steel tubing (3½-inch OD by 2¾-inch ID by 6½ inches long) on spindle C73568 (fig. 184).

(3) Place steel washer or steel plate with a 1½-inch diameter hole, on spindle next to steel tubing. Screw axle spindle nut on spindle. Pull spindle from axle with a 12-inch adjustable wrench.

b. Installation.

(1) Apply prussian blue to spindle and fit into axle with keyway in spindle toward top of axle. Remove spindle and scrape high spots to obtain maximum surface contact. Remove prussian blue.

(2) Apply white lead pigment to the end of the spindle which goes into the axle, and to the axle surface in which it is to be installed.

(3) Drive new spindle into position in axle with a hardwood

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CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

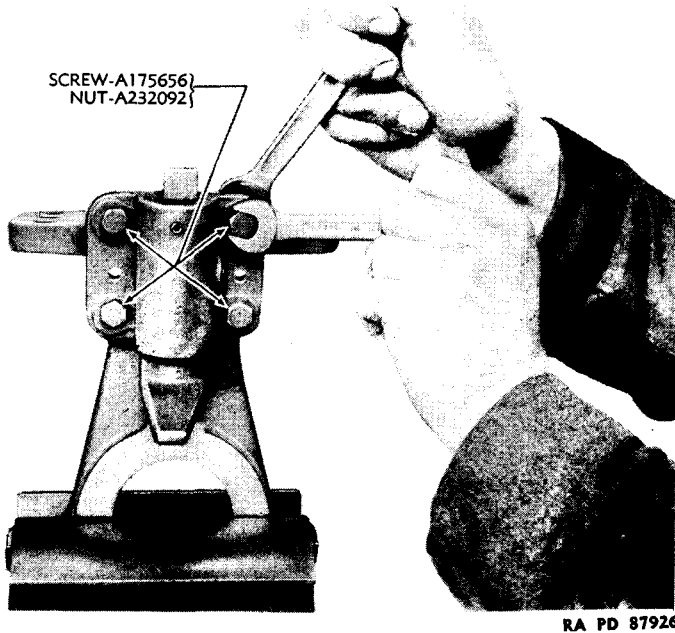


Figure 186 — Removing Screws From Strut Traveling Latch Body and Pintle Support Bracket

block and heavy hammer. Make certain that keyway in spindle is toward top of axle.

(4) Check distance from the outer bearing shoulder on the spindle to the end of the axle. This must be 1.816 inches (fig. 183).

(5) When the spindle is in its exact position, drill a hole through the spindle for a tapered reamer No. 10. Use the hole in the axle as a guide. Ream the hole through the axle and spindle to size for a No. 10 taper pin (0.706 inch large end x 0.623 inch small end x 4 inches long).

(6) Drive a new No. 10 taper pin into position in axle and spindle.

82. DISASSEMBLY AND ASSEMBLY OF STRUT TRAVELING LATCH.

a. Disassembly.

(1) Remove strut traveling latch from pintle support bracket by driving out the two straight pins (fig. 185) and removing the four screws and nuts (fig. 186).

AXLE AND EQUALIZING SUPPORT

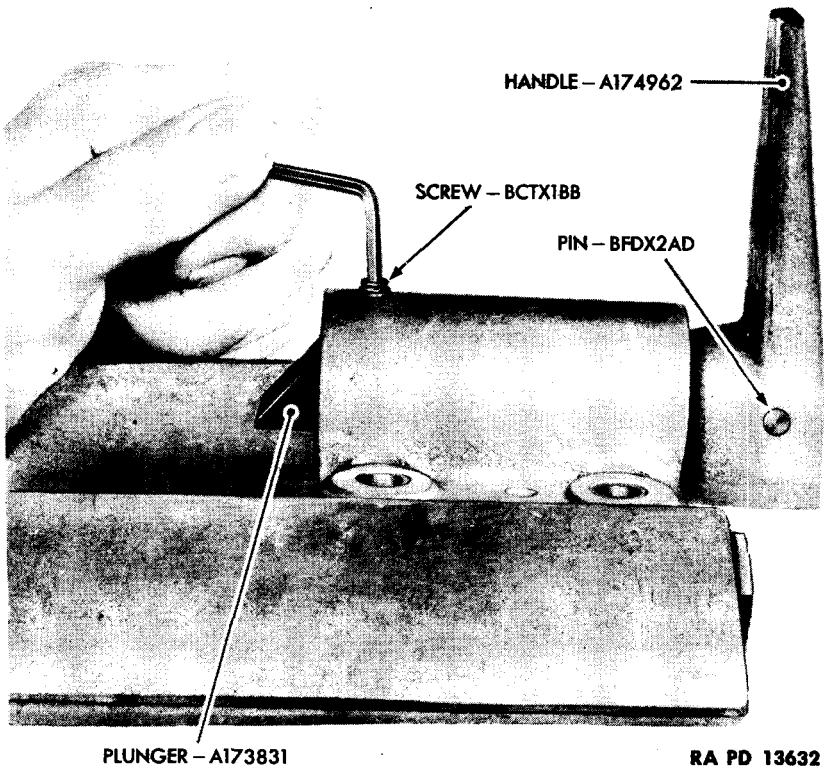


Figure 187 – Removing Set Screw From Strut Traveling Latch Body

- (2) Remove set screw BCTX1BB (fig. 187).
- (3) Drive out the straight pin BFDX2AD.
- (4) Lightly tap handle from plunger. Unscrew guide A173835 from body (fig. 188). Remove plunger and spring.

b. Assembly.

- (1) Oil plunger and spring (fig. 188). Slide spring on plunger and insert in body.
- (2) Screw guide into body with outside face of guide flush with end of body, and long point of plunger next to bottom surface of body.
- (3) Install set screw to lock guide (fig. 187).
- (4) Place white lead pigment on handle end of plunger and tap handle in place on plunger with handle pointing directly away from bottom of body (fig. 187). Drive pin in place after coating with white lead pigment.
- (5) Paint latch mounting surface of pintle support bracket with

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CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4

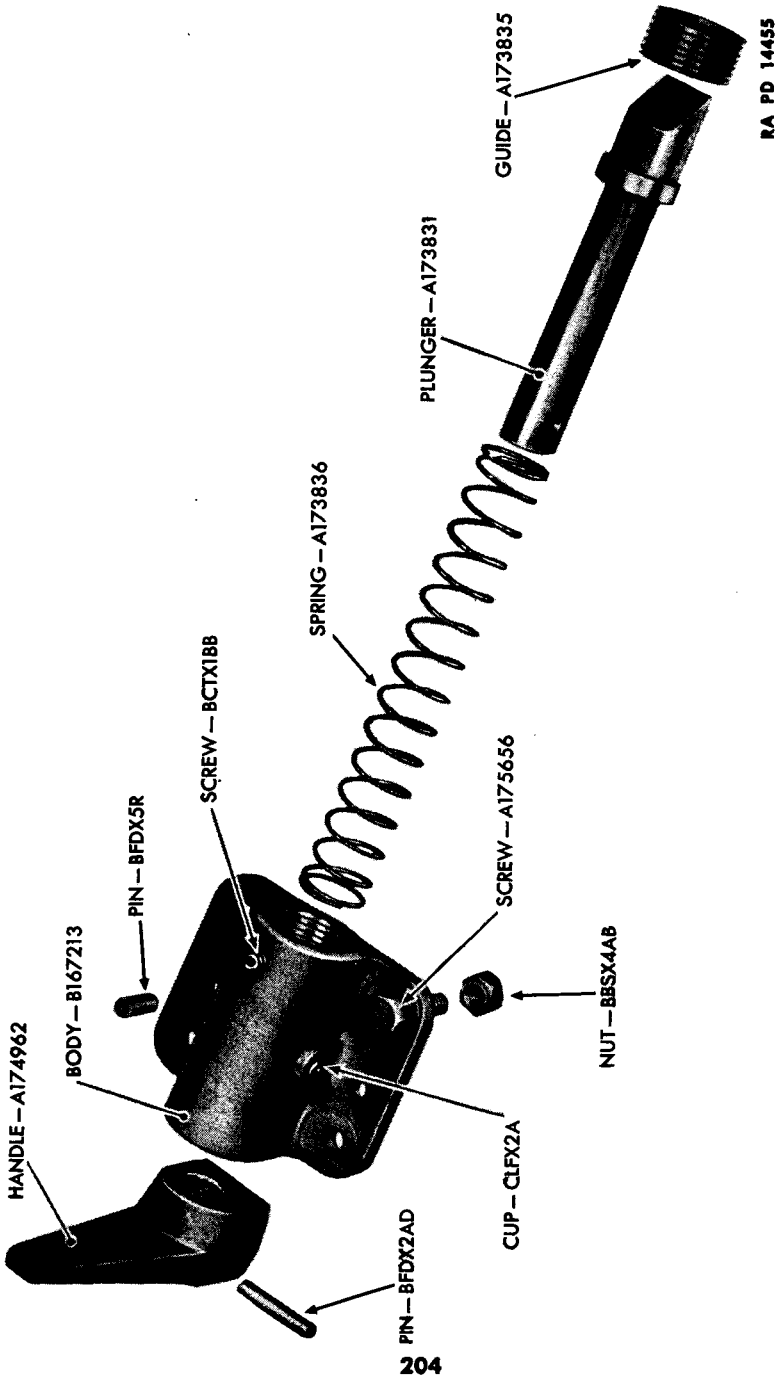
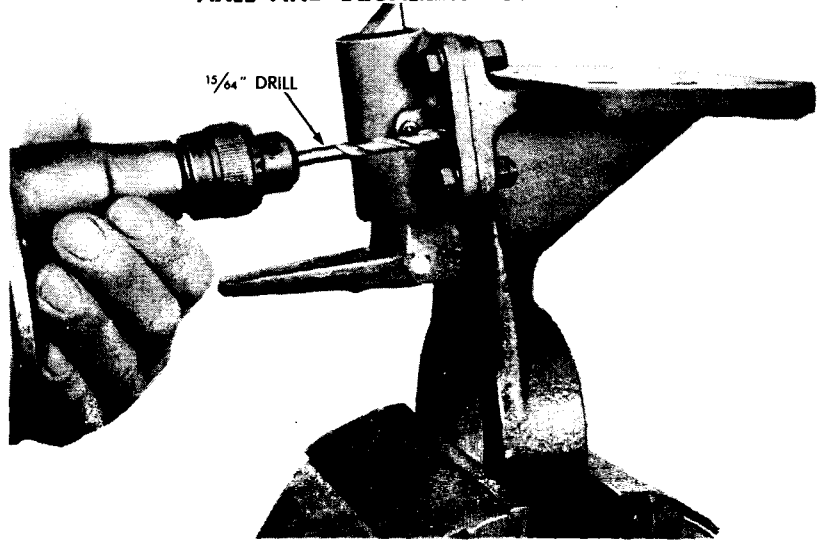


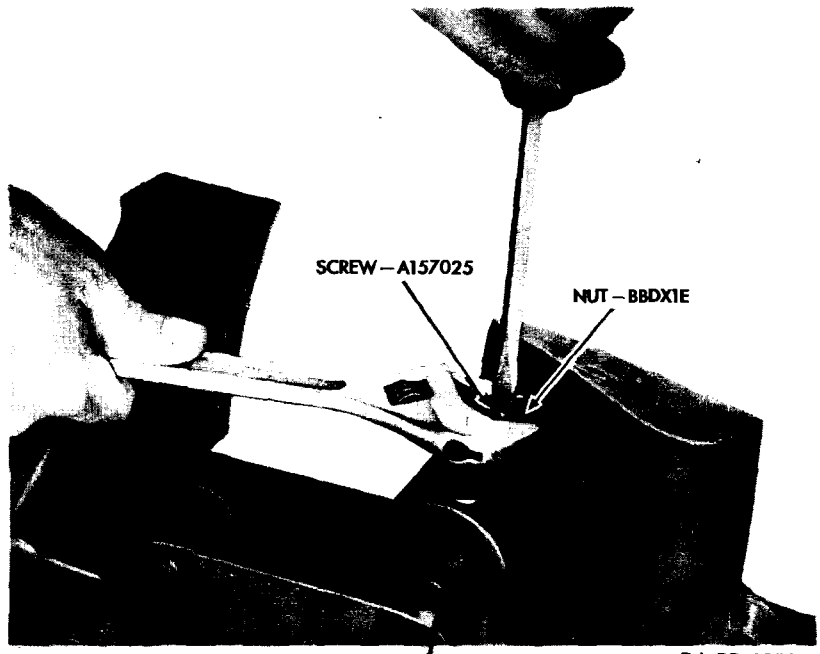
Figure 188 — Strut Traveling Latch — Exploded View

AXLE AND EQUALIZING SUPPORT



RA PD 13634

Figure 189 — Drilling Dowel Pin Hole in Pintle Support Bracket

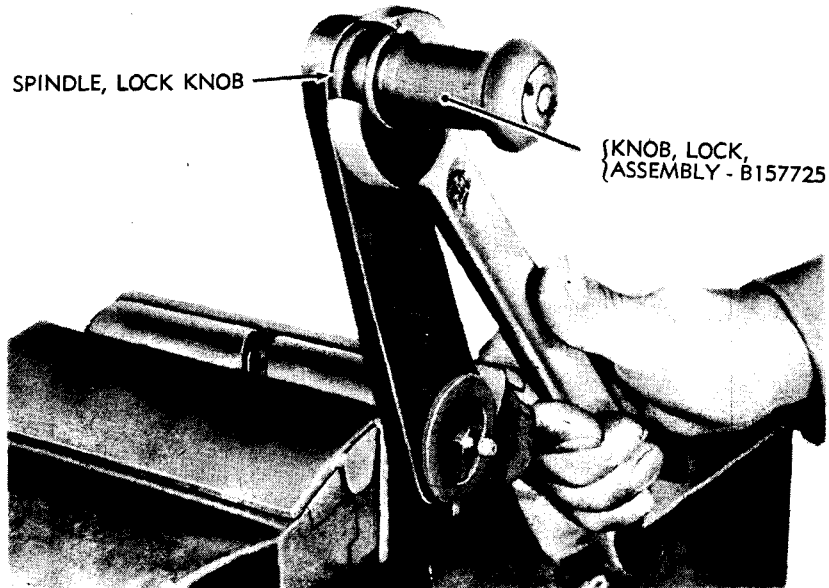


LEVER, AXLE LOCK, RIGHT, ASSEMBLY

RA PD 83598

Figure 190 — Removing Axle Lock Lever

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**



RA PD 83599

Figure 191 — Removing Axle Lock Knob Assembly From Axle Lock Crank

white lead pigment. Secure latch assembly to pintle support bracket with four screws and nuts and two straight pins, after applying white lead pigment to screws and pins.

(6) If a new pintle support bracket is installed, drill the bracket for the two pins with a $1\frac{5}{8}$ -inch drill, then ream for $\frac{1}{4}$ -inch pins. Use holes in latch body as guide (fig. 189).

83. DISASSEMBLY AND ASSEMBLY OF AXLE LOCK LEVER.

a. Disassembly.

(1) Remove lock shaft guide screw A157025 and nut BBDX1E (fig. 190). Slide the axle lock lever out of its bearing on the axle.

(2) Place axle lock lever assembly in a vise provided with copper jaws. Pull out and unscrew knob assembly from crank as shown in figure 191.

(3) Place knob assembly in vise (fig. 192) and remove nut A170306. This nut is staked to the plunger in three places.

(4) Lift sleeve A158830 from spindle A170304. Remove spring A158827 from plunger A170305 to complete disassembly (fig. 193).

AXLE AND EQUALIZING SUPPORT

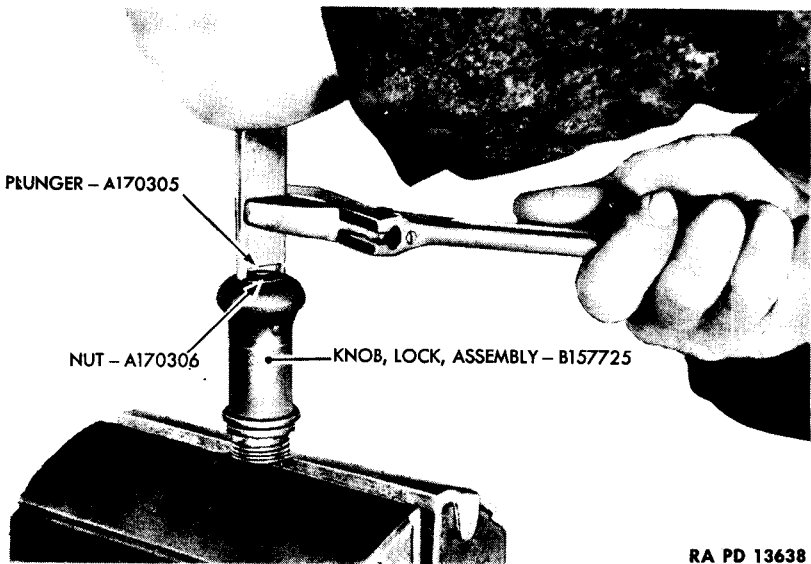


Figure 192 - Removing Nut From Plunger

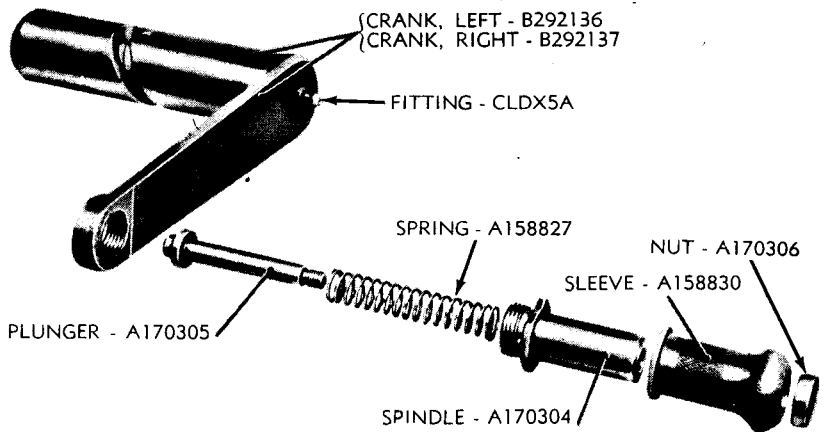


Figure 193 - Axle Lock Lever - Exploded View

b. Assembly.

(1) Oil spring and plunger. Place spring on plunger and insert spring and plunger in position in spindle. Place sleeve over spindle (fig. 193).

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

(2) Screw nut on sleeve end of the plunger (fig. 192). Stake nut to plunger in three places.

(3) Screw spindle of knob assembly into crank. Tighten spindle in crank (fig. 191). Stake spindle to crank in four places.

(4) Grease bearing surface of axle lock crank and slide crank into position in bracket bearing on the axle.

(5) Fasten the lever assembly in the bracket with the lock shaft guide screw and jam nut. Adjust and lock in position. Check lever operation. If screw is in too far, it will cause the screw to drag in slot in the crank.

Section XVI

LUBRICATION

84. LUBRICATION.

a. **General.** Refer to Lubrication Order No. 5, TM 9-325, for lubrication which may be done by the using arm. Lubrication which must be done only by ordnance maintenance personnel is described below.

b. **Cradle Trunnion Bushings.** Every 6 months, remove trunnion pin nuts and washers. Remove elevating arcs and clean all lubricant from cradle trunnion bushings. Coat with a film of O.D. grease No. 0 above +32° F, or No. 00 below +32° F. Clean all lubricant from cradle trunnion pins and reassemble elevating arcs. Lubricate through lubricating fittings as prescribed by Lubrication Order No. 5.

c. **Traversing Swivel Nut Screw.** Every 6 months, the traversing swivel nut screw will be disassembled from housing, all parts cleaned and coated with O.D. grease No. 0 above +32° F, or No. 00 below +32° F.

d. **Equilibrator Spring Rod Bearing Needle Bearings and Fulcrum Bearing.** Every 6 months, the equilibrator will be removed. Remove, clean, and repack the equilibrator fulcrum bearing. Clean and repack the equilibrator spring rod bearing needle bearings (disassembly is not prescribed). Use O.D. grease No. 0 above +32° F, or No. 00 below +32° F.

e. **Brake Cam Shaft Bearings.** At time of ordnance inspection, the brake camshaft bearings should be cleaned and coated sparingly and the cavity between bushings filled with O.D. grease No. 0 above +32° F, or No. 00 below +32° F.

REFERENCES

f. **Elevating Worm Gear.** Every 6 months, disassemble and wash inside of housing and enclosed parts to remove all lubricant. At the same time, remove the bevel gears located in the elevating gear case and elevating mechanism housings, and clean all lubricant from gears, bushings, and inside of housings. Pack roller bearings and coat gear teeth and bushings with O.D. grease No. 0 above +32° F, or No. 00 below +32° F, and reassemble in housings. Lubricate through fittings as prescribed by the Lubrication Order.

NOTE: *A complete record of seasonal changes of lubricants and recoil oils will be kept in the Artillery Gun Book for the materiel.*

Section XVII

REFERENCES

85. PUBLICATIONS INDEXES.

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

- a. Introduction to Ordnance Catalog (explaining SNL system) ASF Cat.
ORD 1 IOC
- b. Index (index to SNL's)..... ASF Cat.
ORD 2 OPSI
- c. List of Publications for Training (listing MR's, MTP's, FM's, TM's, TR's, TB's, SB's, MWO's, WDLO's, and FT's)..... FM 21-6
- d. List of Training Films, Film Strips, and Film Bulletins (listing TF's, FS's, and FB's by serial number and subject)..... FM 21-7
- e. Military Training Aids (listing graphic training aids, models, devices, and displays)..... FM 21-8

86. STANDARD NOMENCLATURE LISTS.

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

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

- b. Howitzer, 105-mm, M2 and M2A1; Carriage, howitzer, 105-mm, M2A1 and M2A2; and Mount, howitzer, 105-mm, M3 and M4..... SNL C-21
- c. Major items of pack, light, and medium field artillery; and armament of these calibers for airplane and combat vehicles..... ORD 3 SNL C-1
- d. Tools, maintenance, for repair of pack, light, and medium field artillery; and armament of these calibers for airplane and combat vehicles ORD 6 SNL C-18

87. EXPLANATORY PUBLICATIONS.

- a. Ammunition, general TM 9-1900
- b. Ammunition inspection guide..... TM 9-1904
- c. Artillery ammunition TM 9-1901
- d. Armored command field manual: service of the piece, 105-mm howitzer, self-propelled..... FM 17-63
- e. Auxiliary fire-control instruments..... TM 9-575
- f. Basic maintenance manual..... TM 38-250
- g. Cleaning, preserving, sealing, lubricating and related materials issued for ordnance materiel.... TM 9-850
- h. Decontamination TM 3-220
- i. Defense against chemical attack..... FM 21-40
- j. Dictionary of United States Army terms..... TM 20-205
- k. Field artillery field manual: 105-mm howitzer, M2, truck-drawn FM 6-75
- l. **Film Strips.**
 - Howitzer, 105-mm, M2A1 and carriage howitzer, 105-mm, M2.
 - Part I—Basic disassembly and assembly..... FS 9-26
 - Howitzer, 105-mm, M2A1 and carriage, M2.
 - Part II—Nomenclature, disassembly and assembly of units, inspection..... FS 9-27

REFERENCES

- The 105-mm howitzer M2.
Part I—Description and characteristics..... FS 6-31
- The 105-mm howitzer M2.
Part II—Mechanical functioning..... FS 6-32
- The 105-mm howitzer M2.
Part IV—Care, cleaning, and lubrication..... FS 6-35
- m. 105-mm howitzers M2 and M2A1; carriages
M2A1 and M2A2; and combat vehicle mounts
M3 and M4..... TM 9-325
- n. Inspection of ordnance materiel..... TM 9-1100
- o. Lubrication..... War Dept. Lubrication Order No. 5
- q. Maintenance and care of pneumatic tires and
rubber treads TM 31-200
- q. Maintenance; general OFSB 4-1
- r. Motor vehicle inspections and preventive main-
tenance services TM 9-2810
- s. Ordnance maintenance: Star-gaging equipment,
impression outfits and pressure gages..... TM 9-1860
- t. Ordnance maintenance: Tire repair and re-
treading TM 9-1868
- u. Preparation of ordnance materiel for deep water
fording TM 9-2853
- v. **Sound Training Films.**
The 105-mm howitzer.
Part I—Mechanical functioning of howitzer.... TF 6-611
- The 105-mm howitzer.
Part II—Service of the Piece..... TF 6-612
- w. Standard artillery and fire control materiel..... TM 9-2300
- x. Standard military motor vehicles..... TM 9-2800
- y. Vehicular general purpose unit equipment..... TM 9-834
- z. Welding theory and application..... TM 9-2852

**ORDNANCE MAINTENANCE — 105-MM HOWITZERS M2 AND M2A1;
CARRIAGES M2A1 AND M2A2; AND COMBAT VEHICLE MOUNTS M3 AND M4**

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