TM 9-747

WAR DEPARTMENT TECHNICAL MANUAL

155-MM GUN MOTOR CARRIAGE T83 AND 8-INCH HOWITZER MOTOR CARRIAGE T89

RESTRICTED DISSEMINATION OF RESTRICTED MATTER—No person is entitled solely by virtue of his grade or position to knowledge or possession of classified matter. Such matter is entrusted only to those individuals whose official duties require such knowledge or possession. (See also paragraph 23b, AR 380-5, 15 March 1944.)

WAR DEPARTMENT *26 FEBRUARY 1945*

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WAR DEPARTMENT
Washington 25, D. C., 26 February 1945

TM 9-747, 155-mm Gun Motor Carriage T83 and 8-inch Howitzer Motor Carriage T89, is published for the information and guidance of all concerned.

[A.G. 300.7 (23 Feb. 45)]
BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

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

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

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CONTENTS

PART ONE—GENERAL

			Paragraphs	Pages
SECTION	I.	Introduction	1–2	5–8
	II.	Description and data	3–5	8–11
	III.	Tools, spare parts, and accessories	6–9	11–21

PART TWO—OPERATING INSTRUCTIONS

			Paragraphs	Pages
SECTION	IV.	General	10	22
	V.	Service upon receipt of equipment	11–13	22–27
	VI.	Controls and instruments	14–15	27–33
	VII.	Operation under ordinary conditions	16–17	34–37
	VIII.	Operation under unusual conditions	18–21	37–41
	IX.	Demolition to prevent enemy use	22–23	41–42

PART THREE—MAINTENANCE INSTRUCTIONS

			Paragraphs	Pages
SECTION	X.	General	24	43
	XI.	Special organizational tools and equipment	25	43–45
	XII.	Lubrication	26–27	46–53
	XIII.	Preventive maintenance services	28–34	53–82
	XIV.	Trouble shooting	35–47	82–97
	XV.	Engine description and data	48–49	97–99
	XVI.	Engine removal and installation	50–51	99–108
	XVII.	Engine maintenance	52–53	108–111
	XVIII.	Engine lubrication system	54–62	111–120
	XIX.	Ignition system	63–69	121–132
	XX.	Fuel and air intake and exhaust systems	70–80	133–141

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PART THREE—MAINTENANCE INSTRUCTIONS (Cont'd)

			Paragraphs	Pages
SECTION	XXI.	Starting system	81–83	142–143
	XXII.	Battery and lighting system	84–93	143–154
	XXIII.	Clutch	94–100	154–167
	XXIV.	Instruments and horn	101–102	167–172
	XXV.	Propeller shaft and universal joints	103–104	172–173
	XXVI.	Transmission and final drive assembly	105-115	173–200
	XXVII.	Horizontal volute spring suspension	116–123	201–220
	XXVIII.	Hull	124–127	220–221
	XXIX.	Vehicle wiring	128–130	221–224
	XXX.	Radio interference suppression	131–136	224–226
	XXXI.	Auxiliary equipment	137–138	226–227
		PART FOUR—ARMAMENT		
SECTION	XXXII.	Introduction	139–143	228–230
	XXXIII.	Operating instructions	144–152	230–238
	XXXIV.	Sighting and fire control equipment	153–161	238–249
	XXXV.	Ammunition	162–164	249–260
		APPENDIX		
SECTION	XXXVI.	References	165–167	260–264
		INDEX		265

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PART ONE—GENERAL

Section I

INTRODUCTION

1. SCOPE.

a. These instructions* are published for information and guidance of personnel charged with the operation and maintenance of this equipment, and are supplemented by descriptions of major units and their functions in relation to other components of this vehicle. They apply only to the 8-inch Howitzer Motor Carriage T89, and to the 155-mm Gun Motor Carriage T83, and are arranged as follows: Part One, Introduction; Part Two, Operating Instructions; Part Three, Maintenance Instructions; and Part Four, Armament.

b. The Appendix at the end of the manual contains a list of references including standard nomenclature lists, technical manuals, and other publications applicable to the vehicle.

2. RECORDS.

a. Forms and records applicable for use in performing prescribed operations are listed below, with a brief explanation of each.

(1) W.D., A.G.O. FORM NO. 7360, ARMY MOTOR VEHICLE OPERATOR'S PERMIT. This form will be issued by commanding officers of posts, camps, stations, or organizations to all operators of military vehicles who have passed the driver's examination (TM 21-300) and are qualified to drive the particular vehicles noted on the permit.

(2) WAR DEPARTMENT LUBRICATION ORDER. War Department Lubrication Order No. 9-747 prescribes lubrication maintenance for this vehicle. A Lubrication Order is issued with each vehicle and is to be carried with it at all times.

(3) STANDARD FORM NO. 26, DRIVER'S REPORT—ACCIDENT, MOTOR TRANSPORTATION. One copy of this form will be kept with the vehicle at all times. In case of an accident resulting in injury or property damage, it will be filled out by the driver on the spot, or as promptly as practical thereafter.

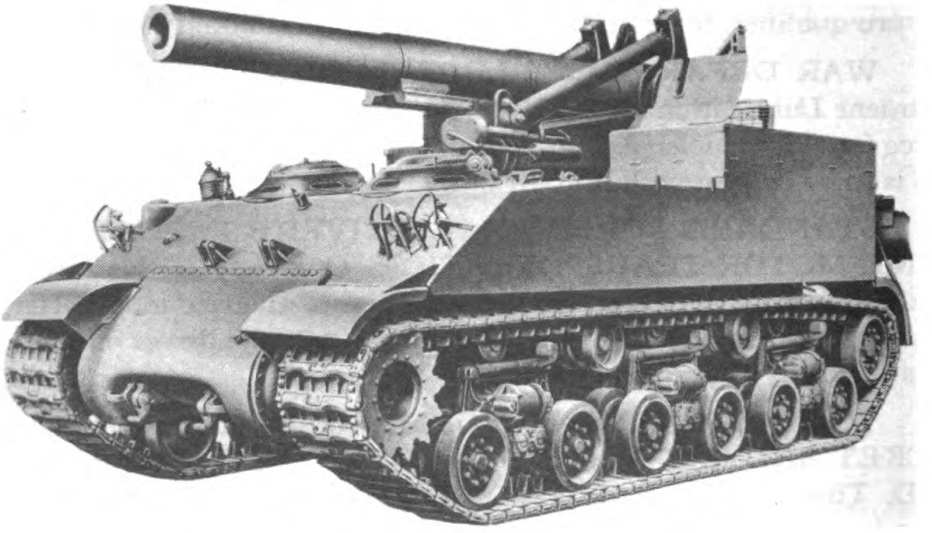
(4) WAR DEPARTMENT FORM NO. 48, DRIVER'S TRIP TICKET AND PREVENTIVE MAINTENANCE SERVICE RECORD. This form, properly executed, will be furnished to the driver when his vehicle is dispatched on nontactical missions. The driver and official user of the vehicle will complete in detail appropriate parts of this form. These forms need not be issued for vehicles in convoy or on

*To provide operating instructions with the materiel, this technical manual has been published in advance of complete technical review. Any errors or omissions will be corrected by changes or, if extensive, by an early revision.

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A—155-mm Gun Motor Carriage T83

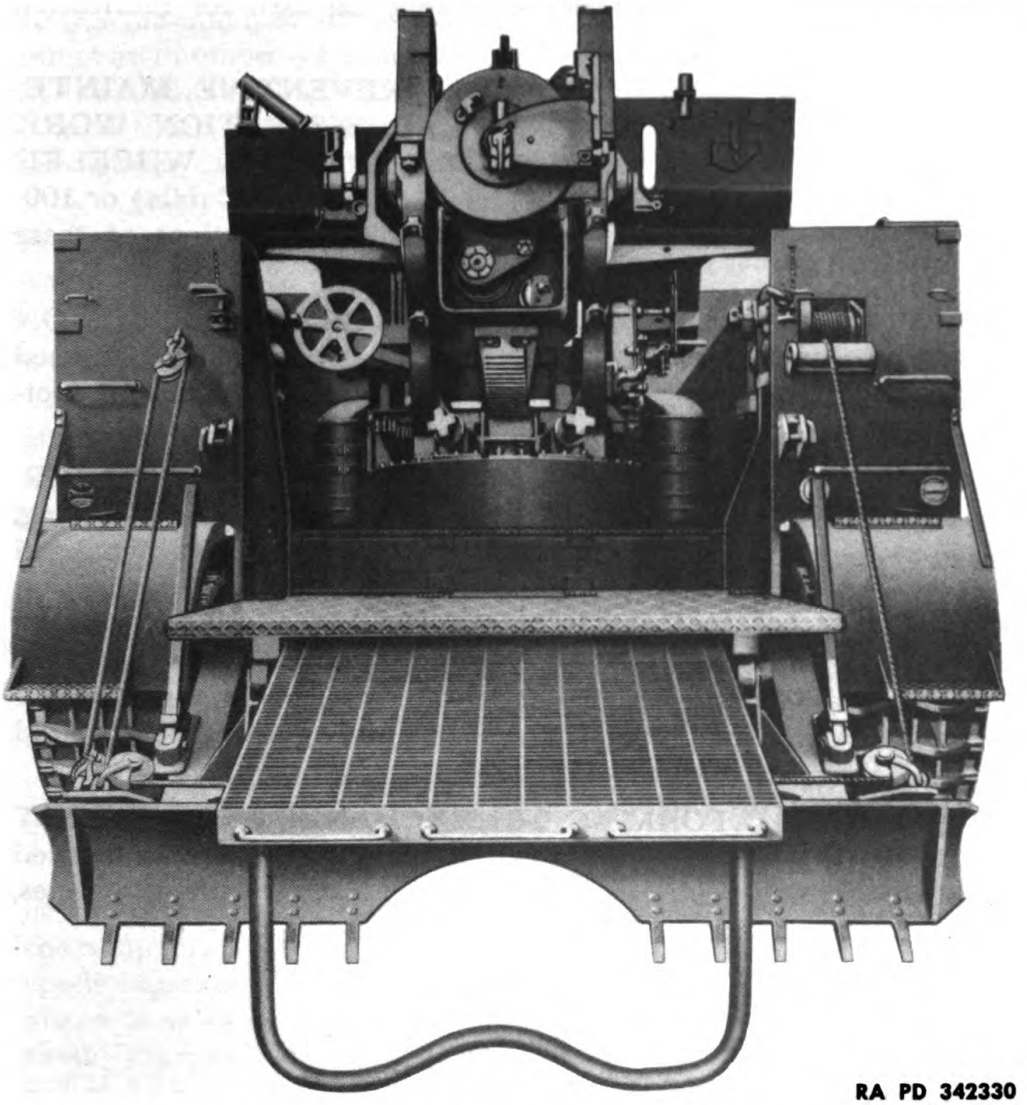


RA PD 342321

B—8-Inch Howitzer Motor Carriage T89

Figure 1—155-mm Gun Motor Carriage T83, and 8-Inch Howitzer Motor Carriage T89

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RA PD 342330

Figure 2—Rear View of 8-inch Howitzer Motor Carriage T89

tactical missions. The reverse side of this form contains the driver's daily and weekly preventive maintenance service reminder schedule.

(5) W.D., A.G.O. FORM NO. 478, MWO AND MAJOR UNIT ASSEMBLY REPLACEMENT RECORD. This form, carried with the vehicle, will be used by all personnel completing a modification or major unit assembly (engine, transmission, transfer case, tracks, etc.) replacement to record clearly the description of work completed, date, vehicle hours and/or mileage, and MWO number or nomenclature of unit assembly. Personnel performing the operation will initial in the column provided. Minor repairs, parts, and accessory replacements will not be recorded.

(6) W.D., A.G.O. FORM NO. 6, DUTY ROSTER. This form, slightly modified, will be used for scheduling and maintaining a record

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of vehicle maintenance operations. It may be used for lubrication records.

(7) W.D., A.G.O. FORM NO. 462, PREVENTIVE MAINTENANCE SERVICE AND TECHNICAL INSPECTION WORK SHEET FOR FULL-TRACK AND TANK-LIKE WHEELED VEHICLES. This form will be used for all 50-hour (500 mile) or 100-hour (1,000 mile) services, and for technical inspections of these vehicles.

(8) W.D., A.G.O. FORM NO. 9-70, SPOT-CHECK INSPECTION REPORT FOR ALL MOTOR VEHICLES. This form may be used by all commanding officers or their staff representatives in making spot-check inspections on all vehicles.

(9) W.D., A.G.O. FORM NO. 468, UNSATISFACTORY EQUIPMENT REPORT. This form will be used for reporting manufacturing, design or operational defects in materiel with a view to improving and correcting such defects, and for use in recommending modifications on materiel. This form will not be used for reporting failures, isolated materiel defects, or malfunctions of materiel resulting from fair wear and tear or accidental damage; nor for the replacement, repair, or the issue of parts and equipment. It does not replace currently authorized operational or performance records.

(10) W.D., A.G.O. FORM NO. 9-81, EXCHANGE PART OR UNIT IDENTIFICATION TAG. This tag, properly executed, may be used when exchanging unserviceable items for like serviceable assemblies, parts, vehicles, and tools.

Section II

DESCRIPTION AND DATA

3. DIFFERENCES BETWEEN MODELS (figs. 1 and 2).

a. Difference Between Models. The 155-mm gun motor carriage T83 and the 8-inch howitzer motor carriage T89 are identical vehicles except for gun tubes and sighting equipment. Both vehicles have universal type ammunition carrying racks to carry 155-mm or 8-inch ammunition. The gun tube may be changed from the 155-mm to the 8-inch howitzer, or vice versa, and the recoil and equilibrator mechanism adjusted accordingly. The tube installed is, therefore, the only factor which determines whether the vehicle carries a T83 or T89 designation.

4. DESCRIPTION (figs. 1 and 2).

a. The motor carriage is an armored, full-track laying vehicle which mounts the 155-mm gun M1 or M1A1, or the 8-inch howitzer M1 or M2, with seats provided for a crew of 8 men. The 155-mm gun or the 8-inch howitzer, is mounted on the rear of the gun motor carriage similar

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to the 155-mm gun motor carriage M12. The T83 or T89 vehicle is in effect an improved version of the M12, based on the major components of the medium tank M4A1. The vehicle is designed with the driver's compartment at the front, the engine compartment in the middle, and the fighting compartment at the rear.

b. Hatch Doors. Turret-type hatch doors are mounted on top and at the front of the vehicle, and provide access to the driver's and assistant driver's seats.

c. Emergency Escape Door. The vehicles are equipped with an escape door located in the hull floor behind the assistant driver's seat.

d. Vision Devices. When both hatches are closed, direct vision is provided by vision blocks in the hatch cupola, and indirect vision is provided through the hatch door.

e. Communication. The vehicles are equipped with radio for intertank, and telephone for intratank, communication.

f. Engine, T83 or T89 Vehicle. The vehicles are powered by a 485-horsepower, 9-cylinder, radial gasoline engine. The engine is mounted in the center of the vehicle, and is accessible through a hinged section of the top armor and two inspection plates in the floor of the hull under the engine compartment.

g. Tank Serial Numbers. The tank serial number is located on a plate in front and above the driver's seat.

h. Spade Assembly. The spade assembly is anchored to the rear of the hull on the rear idler bracket. When the spade is in "UP" position the ramp forms the rear of the fighting compartment in the vehicle. The spade assembly (fig. 2) in lowered position forms a ramp assembly and also acts as an anchor to keep the vehicle in position when the gun is fired. It is raised and lowered by a hand-operated winch, located in the left rear corner of the vehicle.

i. Hand-operated Winch. The hand-operated winch is used to raise and lower the spade assembly.

5. DATA (T83 AND T89).

a. General.

Purpose	Gun carriage
Type	Full-track laying
Crew	8 men
Fighting weight	83,000 lb (T83)
	83,000 lb (T89)
Length	357 in. (T83)
	289 in. (T89)
Width, over-all	124 in.
Height, over-all	129¾ in.
Ground clearance	19¼ in.

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b. Engine.

Manufacturer	Continental
Model	R975-C4
Type	Single-row, static radial, air-cooled
Number of cylinders	9
Bore and stroke	5:00 x 5:50
Piston displacement	973 cu in.
Compression ratio	5.7 to 1
Rated bhp	485 at 2,400 rpm
Governor speed	2,300 rpm
Cruising speed	2,100 rpm
Crankshaft rotation (from rear)	Clockwise
Crankshaft spline size	SAE 30
Clutch assembly:	
Manufacturer	Borg & Beck
Mounting bracket:	
Diameter of circle	23⅜ in.
Number of bolts	9
Size of bolts	7/16 in.
Dry weight of engine	750 lb
Weight, with accessories	1,550 lb

c. Fuel and Oil Capacity.

Fuel capacity, gallons	215
Number of miles without refueling	107
Octane rating of fuel	80 or higher
Oil consumption (approximate quarts per hour)	2
Engine oil capacity	52 qt
Transmission and differential oil capacity	38 gal

d. Performance.

Maximum sustained speed on hard road	24 mph
Cruising speeds:	
First speed	2 mph
Second speed	5 mph
Third speed	9 mph
Fourth speed	14 mph
Fifth speed	21 mph
Maximum allowable engine speed	2,400 rpm
Minimum engine idling speed	800 rpm
Maximum grade ascending ability	60%
Maximum grade descending ability	60%
Maximum fording depth	36 in.
Maximum turning diameter	83 ft
Maximum vertical obstacle (forward and backward)	34 in.
Maximum width of ditch (forward and backward)	92 in.

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e. Suspension.

Type	Horizontal volute
Track shoe width	23 in.
Track pitch	6 in.
Ground contact area of both tracks	7,544 sq in.
Number of blocks per track	86
Weight of track	3,698 lb
Ground pressure (pounds per square inch)	10.2

f. Power Train (One-piece Differential).

Manufacturer	Iowa Transmission

Section III

TOOLS, SPARE PARTS, AND ACCESSORIES

6. PURPOSE.

a. The lists in this section are for information only and must not be used as a basis for requisition.

b. These lists are for the T83 only, the lists for the T89 will vary for those items peculiar to the 8-inch howitzer.

7. ON-VEHICLE TOOLS.

Quantity per Vehicle	Item Name and Stock Number	Stowage Location
	a. Pioneer.	
1	AX, handled, 4-lb (41-A-1277)	On engine deck left sponson
1	BAR, crow, pinch pt, 1¼ x 60 in. (41-B-175)	On engine deck center
1	HANDLE, mattock, 36 in. (41-H-1286)	On engine deck right sponson
1	MATTOCK, pick, w/o handle, 5-lb (41-M-722)	On engine deck left sponson
1	SHOVEL, D-handle (41-S-3170)	On engine deck right sponson
1	SLEDGE, blacksmith, dble. faced, 10-lb (41-S-3726)	On engine deck right sponson
	b. Vehicle.	
1	BAG, tool (41-B-9-250)	In ass't. driver's compartment
1	BAR, cross, socket wrench, round, 7/16 x 8 in. (41-B-154)	In tool bag
1	BAR, socket wrench, ext., ½ in. sq drive, 5 in. long (41-B-307)	"

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Quantity per Vehicle	Item Name and Stock Number	Stowage Location
1	BAR, socket wrench, ext., ½ in. sq drive, 10 in. long (41-B-309)	In tool bag
1	BAR, socket wrench, ext., ¾ in. sq drive, 8 in. long (41-B-309-20)	"
1	CHISEL, machinist's, hand, cold, ¾ in. (41-C-1124)	"
1	CORD, light, ext., 15-ft, 12-V, S.C. w/fuse (17-C-35079-32)	"
1	FILE, A.S., 3-in. sq, smooth cut, 10-in. (41-F-1030)	"
1	FILE, A.S., 3-in. sq, smooth cut, 6-in. (41-F-1572)	"
1	HAMMER, mach., ball peen, 2-lb (41-H-527)	"
1	HAMMER, mach., ball peen, 1-lb (41-H-523)	"
2	HANDLE, file, wood (41-H-1115)	"
1	HANDLE, socket wrench, hinged ½-in. sq drive, 18-in. (41-H-1502)	"
1	HANDLE, socket wrench, ratchet, ½-in. sq drive, 10-in. (41-H-1505)	"
1	HANDLE, socket wrench, ratchet, ¾-in. sq drive (41-H-1506)	"
1	HANDLE, socket wrench, speeder, 18-in. (41-H-1508)	"
1	HANDLE, socket wrench, T-sliding, ½-in. sq drive, 10-in. (41-H-1509-54)	"
1	JOINT, socket wrench, universal, ½-in. sq drive (41-J-380)	"
1	PLIERS, comb. slip joint, wire-cutting, 6-in. (41-P-1650)	"
1	PLIERS, lineman's, side-cutting, 8-in. (41-P-1839)	"
1	SCREWDRIVER, close quarter, 1½-in. blade (41-S-1062-90)	"
1	SCREWDRIVER, close quarter, 1¾-in. blade (41-S-1063)	"
1	SCREWDRIVER, common, normal duty, 6-in. blade (41-S-1104)	"
1	SCREWDRIVER, mach., extra-heavy duty, 5-in. blade (41-S-1385)	"

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Quantity per Vehicle	Item Name and Stock Number	Stowage Location
1	WRENCH, adj., crescent, 8-in. (41-W-486)	In tool bag
1	WRENCH, adj., crescent, 12-in. (41-W-488)	"
1	WRENCH, box, 3-in. hex., 44 5/8-in. length (41-W-640-400)	On engine deck center
1	WRENCH, engr., 15-deg dble. head, O.E., 5/16 x 3/8-in. (41-W-990)	In tool bag
1	WRENCH, engr., 15-deg dble. head, O.E., 7/16 x 1/2-in. (41-W-1000)	"
1	WRENCH, engr., 15-deg dble. head, O.E., 9/16 x 11/16-in. (41-W-1005-5)	"
1	WRENCH, engr., 15-deg dble. head, O.E., 5/8 x 3/4-in. (41-W-1008)	"
1	WRENCH, engr., 15-deg dble. head, O.E., 13/16 x 7/8-in. (41-W-1015)	"
1	WRENCH, engr., 15-deg dble. head, O.E., 15/16 x 1-in. (41-W-1021)	"
1	WRENCH, engr., 15-deg dble. head, O.E., 1 1/8 x 1 3/8-in. (41-W-1028-10)	"
1	WRENCH, set screw, hex. 5/32-in. (41-W-2451)	"
1	WRENCH, set screw, hex., 1/4-in. (41-W-2454)	"
1	WRENCH, socket, 1/2-in. sq drive, 12-pt, 7/16-in. (41-W-3005)	"
1	WRENCH, socket, 1/2-in. sq. drive, 12-pt, 1/2-in. (41-W-3007)	"
1	WRENCH, socket, 1/2-in. sq. drive, 12-pt, 9/16-in. (41-W-3009)	"
1	WRENCH, socket, 1/2-in. sq. drive, 12-pt, 5/8-in. (41-W-3013)	"
1	WRENCH, socket, 1/2-in. sq. drive, 12-pt, 11/16-in. (41-W-3015)	"
1	WRENCH, socket, 1/2-in. sq. drive, 12-pt, 3/4-in. (41-W-3017)	"
1	WRENCH, socket, 1/2-in. sq. drive, 12-pt, 7/8-in. (41-W-3023)	"
1	WRENCH, socket, 1/2-in. sq. drive, 12-pt, 15/16-in. (41-W-3025)	"
1	WRENCH, socket, 1/2-in. sq. drive, 12-pt, 1-in. (41-W-3027)	"

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Quantity per Vehicle	Item Name and Stock Number	Stowage Location
1	WRENCH, socket, ½-in. sq drive, 12-pt, 1 1/16-in. (41-W-3029)	In tool bag
1	WRENCH, socket, ½-in. sq drive, 12-pt, 1⅛-in. (41-W-3031)	"
1	WRENCH, socket, ¾-in. sq drive, 12-pt, 1 3/16-in. (41-W-3037)	"
1	WRENCH, socket, ¾-in. sq drive, 12-pt, 1½-in. (41-W-3046)	"
	c. Gun.	
1	BAR, jimmy, 24-in. long (41-B-225)	In gun chest
1	DRIFT, brass, tapered, 4-in. long (41-D-1530)	"
1	DRIFT, brass, tapered, 6-in. long (41-D-1533)	"
1	GAGE, head space (41-G-200-700)	"
1	HAMMER, hide-faced, 2-lb (41-H-473)	"
1	PUNCH, drive pin, ¼-in. pt (41-P-3606)	"
1	ROLL, tool, M4 (w/o contents) (41-R-2705-5)	"
1	ROLL, tool, M16 (w/o contents) (41-R-2705-41)	"
1	SCREWDRIVER, offset, 0.046 x ⅜	"
1	SCREWDRIVER, jeweler's wood handle, 2-in. blade (41-S-1399)	"
1	WRENCH, ratchet, ¾-in. sq drive, 18-in. long (41-W-1989-320), consisting of:	"
	1 Gear, wrench, ratchet, ¾-in. sq drive (41-G-586-40)	
	1 Handle, wrench, 18-in. long (41-H-1548-100)	
1	WRENCH, set screw, hex., 3/32-in. (41-W-2449)	"
1	WRENCH, set screw, hex., ⅛-in. (41-W-2450)	"
1	WRENCH, set screw, hex., 3/16-in. (41-W-2452)	"
1	WRENCH, socket, pintle bolt head, 2 3/16-in. open (41-W-1637)	"
1	WRENCH, socket, recoil rod nut, 4½-in. hex. open (41-W-2625)	"

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Quantity per Vehicle	Item Name and Stock Number	Stowage Location
1	TOOL, vent cleaning drill bit type (No. 3 drill) (41-T-3081-120)	In gun chest
1	WRENCH, crankshaft nut	"
1	WRENCH, firing mech. (41-W-3248-251)	"
1	WRENCH, fuse, M7A1 (41-W-1596-50)	"

8. ON-VEHICLE EQUIPMENT (T83 ONLY).

a. Gun.

1	BELT, primer, M8 (7225490)	"
1	BRUSH, bore, M13 (38-B-992-659)	"
1	BUCKET, water, galv, 14 qt (42-B-25520)	In bracket on spade
1	CHEST, oil pump, M16 w/contents, composed of:	In bracket—left rear corner of engine compartment roof
	1 Adapter (metric thd) (oil hose to filling valve) (41-A-26-500)	
	1 Cap, thread protector (41-C-395-625)	
	1 Chest, oil pump, M16 (w/o contents) (41-C-738-550)	
	1 Funnel, cap, w/strainer, ¼ pt (41-F-3570)	
	1 Hose, rubber, 10-ft (oil) (33-H-535)	
	1 Pump, oil, M3 (11-P-576-300)	
	1 Release, filling and drain valve (41-R-3650)	
	1 Rule, steel flexible, 30 cm (41-R-2909)	
	1 Wrench, engr's, dble. head, O.E., ¾ x 13/16-in. (41-W-1012)	
1	COVER, bore brush (24-C-1058-875)	On bore brush M13
1	COVER, clutch	On clutch on mount T14
1	COVER, muzzle, M314 (24-C-1847-367)	On muzzle
1	HEAD, rammer, cleaning and unloading, M7 (41-H-1826-600)	In gun chest
1	HEAD, rammer, loading (41-H-1826-360)	"
4	HOOK, lifting shell (B280389)	"
1	LANYARD, M12, assembly (21-L-106-200)	"
1	LANYARD, firing (B109018)	"
1	REAMER, cleaning, primer seat (41-R-501-80)	"

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Quantity per Vehicle	Item Name and Stock Number	Stowage Location
1	REFLECTOR, muzzle (8-R-184-240)	On muzzle over muzzle cover
1	SETTER, fuse, M14 (B176535)	In gun chest
1	SETTER, fuse, M22 or M23 (73-3A44)	"
8	STAFF, cleaning, section (41-S-4658-120)	"
1	TRAY, loading (155-mm howitzer M1) (41-T-3851-260)	"
1	FORM, W.D., Artillery Gun Book, O.O Form 5825 (28-F-67990)	In pamphlet box (D75994)
2	OIL, recoil, heavy, gal (D167298)	In right rear hull compartment

b. Armament and Ammunition.

(1) AMMUNITION (SEPARATE LOADING) FOR 155-MM GUN M1 OR M1A1.

20	CHARGE, propelling, N.H. powder—155-mm gun M1 (stowed in container) M16	8 in powder compt, right side hull 12 in powder compt, left side hull
25	FUZE, P. D., M51A3 w/Booster M21A2	In box (76-7-620) (76-7-623) stowed in right rear corner of hull
50	PRIMER, percussion, 21-grain, Mk. IIA4	In boxes (D703-2913) to right and left of 155-mm gun base
20	SHELL, H. E., unfuzed, 155-mm gun M101 or M101B	10 in shell rack left sponson 10 in shell rack right sponson

(2) GRENADES, HAND.

4	FRAGMENTATION, Mk. II (82-0-41)
2	OFFENSE, Mk. III (w/Fuze det. H.G. M6) (82-0-70)
4	SMOKE, M8 (82-0-11)
2	THERMITE, incendiary (C13-17-3)

(3) GRENADES, RIFLE.

10	GRENADE, rifle, M9A1	In boxes (07032-913) to right and left of gun base

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Quantity per Vehicle	Item Name and Stock Number	Stowage Location
(4)	ARMAMENT.	
8	CARBINE, cal. .30, M1 (42-36-1A)	4 on lids of powder compartment, 2 on top carriage, 2 in driver's compartment
1	LAUNCHER, grenade, M8	In box (D7032-913) under sub-floor
1	GUN, 155-mm M1 or M1A1	In mount T14
c.	***Sighting Equipment.***	
1	BINOCULAR, M13, complete, composed of: 1 Binocular, M13 (22-382) 1 Case, carrying, M17 (D44160)	In bracket (7055-706)—ass't. driver's compartment
1	CASE, carrying, gunner's quadrant, M18 (38-8-26)	On rear of right gun shield
1	CASE, carrying, M66 (T28) (for fuze setter M22 or M23) (7691403)	In gun chest
1	CASE, carrying, T16 (for telescope M69E1)	In brackets on rear of left and right gunner's shield
1	CASE, panoramic telescope (D40871)	On mount T14
1	LIGHT, instrument, M12 (for quadrant M1)	In chest M21
1	LIGHT, instrument, M19 (for panoramic telescope) (D43648)	"
2	LIGHT, instrument, M33 (for telescope M69E1) (7690132)	"
1	LIGHT, instrument, M36 (for telescope M16A1F)	"
1	MOUNT, quadrant, M1	On mount T14
1	MOUNT, telescope, T122 (left) (telescope M69E1 and panoramic telescope M12)	"
1	MOUNT, telescope, T124 (right) (telescope M16A1F)	"
2	PERISCOPE, M6 (22-331)	1 in driver's cupola 1 in asst. driver's cupola

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Quantity per Vehicle	Item Name and Stock Number	Stowage Location
1	POST, aiming, M1, complete, composed of:	Vertical rack on right shell rack
	1 Cover, aiming post, M401 (D37993)	
	2 Post, aiming, M1 (D2472)	
1	QUADRANT, gunner's, M1 (15-12M)	In bracket on right shield
1	SET, lights, aiming post, M14, composed of:	In chest M21 in gun chest
	8 Battery, flashlight (BA-30)	
	1 Chest, light, M21 (D45472)	
	2 Lamp, electric, 3 V (A179389)	
	2 Light, aiming post, M14	
1	SIGHT, bore, 155-mm gun M1 or M1A1, complete, composed of:	In gun chest
	Sight, bore, breech, w/Cord (RF-11-ED)	
	Sight, bore, muzzle (RF-11-WB)	
1	TABLE, firing (155-S-1)	"
1	TARGET, testing (set of 4) (1-T-283-375)	"
1	TELESCOPE, elbow, M16A1F	In case (D40871) on top carriage
1	TELESCOPE, M69E1 (91-222)	In case T16 on left shield
1	TELESCOPE, panoramic, M12 (91-92)	In case (D40871) on mount T14

d. Publications.

1	CATALOG, Ord, standard nomenclature list (SNL G-232)	In pamphlet box
1	FORM No. 478, W.D., A.G.O. (in container W.D. 478-1) (TM 9-1725)	"
1	MANUAL, technical, for 155-mm gun M1 (TM 9-350)	"
1	MANUAL, technical, R975-C4 engine	"
1	MANUAL, technical, vehicle (for operator) (TM 9-747)	"
1	ORDER, Lubr., War Department, No. 9-747 (LO 9-747)	In technical manual TM 9-747

e. Communications.

1	ANTENNA, complete w/cover	
1	INTERPHONE, equipment RC 99	In right sponson, asst. driver's compartment

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Quantity per Vehicle	Item Name and Stock Number	Stowage Location
5	MICROPHONES, TD-45	Shipped loose with vehicle
1	RADIO, set (SCR-608, SCR-610, SCR-619, SCR-628, or BR No .19)	In right sponson, asst. driver's compartment
5	SET, chest, TD-4	Shipped loose with vehicle
5	SET, head, H-16/u	Shipped loose with vehicle
	f. Fire Extinguishers.	
2	EXTINGUISHER, fire, CO_2, 4-lb (58-E-200-65)	1 in driver's compartment, 1 in left rear corner of hull
	g. Miscellaneous.	
2	APPARATUS, decontaminating, 1½-qt	1 in bracket, asst. driver's compartment, 1 in bracket below winch
1	BAG, spotlight arm (C123777)	In asst. driver's compartment
26	BATTERY (BA-30) 6 in flashlights 11 in instrument lights 9 spares	In chest, lighting, M21
8	BELT, safety (B154723)	On crew seats
1	BUCKET, canvas, folding, 19-qt (34-B-1500)	Rear of engine compartment bulkhead between air cleaners
5	CONTAINER, water, 5-gal, std. (64-C-281)	On hull floor under chests
1	CRANK (engine)	Right corner front engine compartment roof
1	EXTENSION, lubr., gun, hose type, 12-in. long (41-E-485-12)	

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Quantity per Vehicle	Item Name and Stock Number	Stowage Location
3	FLASHLIGHT (17-F-13485)	2 in brackets in driver's compartment, 1 in brackets in fighting compartment
1	GREASE, general purpose, No. 2, 5-lb, w/container (14-G-1230-5)	In gun chest
1	GUN, lubr., hand oper., 15-oz cap (41-G-1344-40)	In tool bag
3	KIT, first aid, motor vehicle, 12 unit	2 in bracket right sponson, 1 in box on left rear fender
3	LAMP (spare for flashlight) (LM-35A)	In tool bag
1	NET, camouflage, 45 ft x 45 ft	On gun tube between trunnion caps
1	OILER, steel, dump, 9 in. spout, 1 pt (13-0-900)	In bracket on floor of driver's compartment
10	OIL, engine, in container, 1 qt	Right rear hull compartment
2	PAULIN, 12 ft x 12 ft (24-P-29)	On top of left shell rack
1	STOVE, cooking, gasoline, 1 burner, consisting of: Coleman, military burner, No. 520 w/accessory cups	In bracket under winch
1	TAPE, friction, ¾-in. wide, 30-ft roll (17-T-805)	In tool bag
2	TUBE, flexible nozzle (42-T-13600)	"
1	WIRE, steel, annealed, black, 14-ga., 10-ft (22-W-1633-160)	
h.	***Rations.***	
48	TYPE "K"—16 (2 days for 8 men) *or*	Left front chest
96	TYPE "C"—16 (2 days for 8 men)	Left rear chest
2	TYPE "D"—8 (1 day for 8 men)	Left front chest

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9. ON-VEHICLE SPARE PARTS.

Quantity per Vehicle	Item Name and Stock Number	Stowage Location
	a. Spart Parts—Vehicle.	
6	BLOCK, direct-vision (for driver's cupola) (B300790)	In box (B82340) left of driver
6	BOLT, center guide (T80 track) (7069543)	In right front chest
4	BULB, lamp, 3 cp. 24—28 volts, M21251 (190877)	In tool bag
6	CAP, center guide (T80 track) (7069545)	In right front chest
6	CENTER, guide (T80 track) (7069549)	"
12	CONNECTOR, end (T80 track) (C139817)	"
3	FITTING, lubr., straight, ⅛-in. (504208)	In tool bag
4	HEAD (for periscope M6) (7669401)	In box (D82340) left of driver
2	PERISCOPE, M6 (22-331)	In driver's compartment
	b. Spare Parts—Gun.	
8	LAMP, bulb (for telescope reticle light) (A179389)	In chest, light, M21
2	MECHANISM, firing, assembly, M1 (C70485)	In gun chest
3	PAD, gas check (obturator) (C70484)	"

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PART TWO—OPERATING INSTRUCTIONS

Section IV

GENERAL

10. SCOPE.

a. Part Two contains information for guidance of personnel responsible for operation of this equipment. It contains information on operation of equipment, with description and location of controls and instruments.

Section V

SERVICE UPON RECEIPT OF EQUIPMENT

11. GENERAL.

a. Purpose. When a new or reconditioned vehicle is first received at the using organization, it is necessary for second echelon personnel to determine whether or not the vehicle will operate satisfactorily when placed in service. For this purpose, inspect all accessories, subassemblies, assemblies, tools, and equipment to see that all are in place and correctly adjusted. In addition, they will perform a run-in test of at least 50 miles as directed in AR 850-15, paragraph 25, table III, according to procedures in paragraph 12 below.

b. Correction of Deficiencies. Deficiencies disclosed during the course of the run-in test will be treated as follows:

(1) Correct any deficiencies within the scope of the maintenance echelon of the using organization before the vehicle is placed in service.

(2) Refer deficiencies beyond the scope of the maintenance echelon of the using organization to a higher echelon for correction.

(3) Bring deficiencies of serious nature to the attention of the supplying organization.

12. SPECIFIC PROCEDURES.

a. Preliminary Service.

(1) FIRE EXTINGUISHER. See that portable and fixed tanks are fully charged, that tanks, lines, and nozzles are securely mounted, and that all nozzles are properly aimed, and not clogged.

(2) FUEL AND OIL. Check fuel in tank, and see that oil is at proper level. If there is a tag attached to the tank filler cap concerning contents, follow the instructions on the tag before starting the engine, when item 22 is reached.

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(3) BATTERIES. Make hydrometer test, and add clean water to ½ inch above plates, if needed. Inspect terminal connections and bolts to be sure they are clean and secure.

(4) AIR CLEANERS AND BREATHER CAPS. Examine crankcase breather cap and carburetor air cleaners to see if they are in good condition and secure. Remove oil cups, wash cup and elements in dry-cleaning solvent, and refill reservoirs to proper depth with fresh engine oil (par. 27). Be sure air ducts and air horn connections are tight.

(5) ACCESSORIES AND BELTS. See that accessories such as carburetor, magnetos, starting motor, generator, and filters are securely mounted. See that generator belt is adjusted to ½-inch deflection under finger-pressure. Remove silica gel bags from engine compartment.

(6) ELECTRICAL WIRING. Examine all accessible wiring and conduits to see if they are in good condition, securely connected, and properly supported.

(7) TRACKS (TIRES, BLOCKS, CONNECTORS, WEDGES, AND LOCK PINS). See that these items are in good condition, correctly assembled, and secure. On vehicles equipped with horizontal volute springs, there should be no bulge in tracks between the idler wheels and the rear suspension wheels. CAUTION: *Do not adjust tracks on vehicles equipped with horizontal volute springs too tightly.*

(8) SPROCKETS, IDLERS, AND FLANGE NUTS. Examine these items for good condition, proper assembly, and security.

(9) FENDERS. Examine fenders for good condition and secure mounting.

(10) TOWING CONNECTIONS. Inspect pintle hook, cables, and all connections for good condition and proper operation.

(11) SIDE AND BOTTOM ARMOR PLATE (ENTRANCE AND ESCAPE HATCHES, DRAINS, PAINT, AND MARKING). Inspect these items to see that armor plate is securely welded, that entrance and escape hatches operate properly, and that they are well lubricated.

CAUTION: *Do not fully open escape hatch latch during inspection.* See that hull drains open and close freely, that there are no bright spots to cause glare or to rust, and that markings are legible.

(12) RAMPS, SPADE, AND WINCH. Inspect these items to see that they are in good condition and that all attaching mechanism is securely mounted. Examine the winch cables to see that they are not frayed or worn and that the cables, sheaves and roller are properly alined. Be sure the loading ramp slides freely when ramp is in lowered position and that the locking pins hold ramp securely when in raised position.

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(13) GUN, TARPAULIN, AND BOWS. Be sure that all protective tape and rust and corrosion material has been removed from gun and mount. With gun traveling lock released test traversing and elevating mechanism to see that it operates properly. Be sure to lock gun securely in traveling lock after testing. If in use, see that bows are properly mounted and that the tarpaulin is securely fastened, if not in use, tarpaulin and bows must be properly stowed.

(14) VISION DEVICES. Be sure all protective tape has been removed and see that periscopes are securely mounted in their holders, and that spares are in good condition and properly stowed. CAUTION: *Prisms should be cleaned only with a soft cloth or brush.*

(15) LUBRICATE. Perform a complete lubrication of the vehicle, covering all intervals according to instructions on Lubrication Order, paragraph 26, except gear case oil levels. Add oil to gear cases as necessary to bring to correct levels. Change only if condition of oil indicates the necessity, or if oil is not of proper grade for existing atmospheric temperature. NOTE: *Perform items* (16) *to* (19) *during lubrication.*

(16) SPRINGS AND SUSPENSIONS. Inspect volute springs, mounting brackets, suspension wheels, support wheels, and wheel tires for looseness and damage. On vehicles equipped with horizontal volute springs, inspect the shock absorbers, and see that the above items are in good condition, correctly assembled, and securely mounted. See that oil seals and gaskets are not leaking excessively.

(17) STEERING BRAKES. Apply the levers together and independently; free travel should be 4 to 4½ inches, and levers should meet resistance slightly before the vertical position. Check released position of levers. Levers are correctly positioned when horizontal distance from face of brake drum housing cover to front edge of lever is 7 to 7½ inches. Examine the linkage and connections for good condition and security.

(18) PROPELLER SHAFT, UNIVERSAL JOINTS, AND VENTS. Inspect propeller shaft and universal joints to see that they are in proper alinement, securely mounted, and that vents are present and not clogged.

(19) ENGINE WARM-UP. Turn crank 50 times to check for hydrostatic lock. Operate primer, if necessary, and start engine, observing if starting motor has satisfactory speed and engages and disengages properly. Set hand throttle to run engine at a fast idle.

(20) PRIMER. While starting engine, observe if primer action is satisfactory, and look for leaks at pump or connections.

(21) INSTRUMENTS.

(a) Oil Pressure Gage. Engine oil pressure must be indicated when engine is idling. Oil pressure must be 40 to 70 pounds at 1,800 to 2,400 revolutions per minute. Stop engine immediately when "low oil" red light comes on.

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(b) Ammeter. After starting, ammeter may show high charge until current used in starting is restored to batteries; then, if battery is full, and lights and accessories are turned off, a zero, or slight charge reading is normal.

(c) Engine Oil Temperature Gage. Reading should rise gradually during warm-up period, to normal range, which should not exceed 190°F. CAUTION: *Do not move vehicle until temperature is 100°F to 120°F as indicated by gage.*

(d) Tachometer. Tachometer should register engine speed in revolutions per minute, and record accumulating revolutions.

(e) Fuel Gage. Operate selector switch in relative position; gage should indicate approximate amount of fuel in each tank. Ordinarily, tanks will have been filled and gage should register "FULL."

(22) ENGINE CONTROLS. Observe whether or not engine responds to hand throttle and accelerator promptly and properly, and if there is excessive looseness or binding in controls.

(23) SIREN. Test siren for tone and operation.

(24) LAMPS (LIGHTS) AND REFLECTORS. Be sure all protective tape has been removed and observe whether or not all lights, including blackout and stop lights, respond to the switches in both the "OFF" and "ON" positions.

(25) LEAKS (GENERAL). Examine the inside of engine compartment and under vehicle, and check all accessible lines and seals for fuel and oil leaks.

(26) TOOLS AND EQUIPMENT. Check tools and On-vehicle Stowage List, section III, to be sure all items are present, and see that they are serviceable and properly mounted or stowed.

13. RUN-IN TEST.

a. Perform the following procedures (1) to (10) inclusive, during the road test of the vehicle. On vehicles which have been driven 50 miles or more in the course of the delivery from the supplying to the using organization, reduce the length of the road test to the least mileage necessary to make observations listed below. CAUTION: *Continuous operation of the engine at speeds approaching the maximum indicated on the caution plate should be avoided during the test.*

(1) DASH INSTRUMENT AND GAGES. Do not move vehicle until engine oil temperature reaches 110°F. Observe readings of oil pressure gage, ammeter, fuel gage, and tachometer to see if they register the proper function of the units to which they apply. With the vehicle in motion, the speedometer should register vehicle speed, and the odometer should register accumulating mileage.

(2) BRAKES: STEERING AND PARKING. Steering brakes must stop vehicle effectively with ½ ratchet travel in reserve. With

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vehicle on incline, trip parking brake lock, depress clutch, and pull back on brake levers. Parking brake must hold vehicle with ½ ratchet travel in reserve and levers remain in applied position. Apply steering brakes independently and notice whether or not they steer the vehicle properly.

(3) CLUTCH. Clutch must not drag, and should engage without unusual noise, grab, or chatter. Test clutch for slippage under load. Pedal free travel should be approximately 1¾ inches. Shoe to release bearing clearance should be ⅛ inch.

(4) TRANSMISSION. Gearshift mechanism should operate easily without unusual noise, and not slip out of mesh.

(5) ENGINE. The engine must respond to controls, and have maximum pulling power without unusual noise, stalling, overheating, or exhaust smoke.

(6) UNUSUAL NOISES. Be on the alert continually for unusual noises that would indicate looseness of tracks, bogies, sprockets, or idler wheels.

(7) HALT VEHICLE AT 10-MILE INTERVALS FOR SERVICES (8) AND (9) BELOW.

(8) TEMPERATURES. Place hand cautiously on each support wheel and suspension wheel hub, to feel whether or not they are abnormally hot. If wheel hubs are too hot to touch with the hand, bearings may be inadequately lubricated, damaged, or improperly adjusted. On vehicles equipped with horizontal spring suspension, shock absorbers should feel warm when the vehicle is being operated. If shock absorbers do not become warm during operation, it is an indication that the fluid is low or that shock absorbers are not functioning. Check transmission and final drives for overheating or excessive oil leaks.

(9) LEAKS. Inspect within engine and fighting compartments, underneath the vehicle, and all visible lines, for fuel or oil leaks. Trace any leaks to their sources, and remedy or report them.

(10) TRACK TENSION. Inspect tracks for satisfactory tension. On vehicles equipped with horiontal volute springs, there should be no track bulge between the idler wheels and rear suspension wheels, and between the sprockets and the forward suspension wheels. CAUTION: *Tracks should not be adjusted too tightly on vehicles equipped with horizontal volute springs. Be sure adjustment locking devices are secure.*

b. Vehicle Publications and Reports.

(1) PUBLICATIONS. See that vehicle technical manuals, Lubrication Order, Standard Form No. 26 (Driver's Report—Accident, Motor Transportation) and W.D., A.G.O. Form No. 478 (MWO and Major

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Unit Assembly Replacement Record), are in the vehicle, legible, and properly stowed. NOTE: *U.S.A. registration number and vehicle nomenclature must be filled in on Form No. 478, for new vehicles.*

(2) REPORTS. Upon completion of the run-in test, correct or report any deficiencies found. Report general condition of the vehicle to designated individual in authority.

Section VI

CONTROLS AND INSTRUMENTS

14. CONTROLS.

a. Fuel Shut-off Valves (fig. 3). Two fuel shut-off controls are mounted on the right and left sides of the front bulkhead in the driver's compartment. These controls are connected by linkage to the fuel shut-off valves located near the bottom of the vertical fuel tanks in the engine compartment. "OFF" and "ON" positions are indicated on the valve handle flange.

b. Priming Pump. A plunger-type priming pump is bracket-mounted to the final drive at the right, and in front of the driver. The pump draws fuel from the fuel tank, and forces it to the primer distributor on the engine, where a charge of fuel is distributed to the top seven cylinders to facilitate starting.

c. Hand Throttle. The push-pull type hand throttle is bracket-mounted with the priming pump, and connected by a cable to an arm on the cross shaft to control the carburetor throttle, which opens manually. The control button is equipped with a spring catch so that the carburetor throttle opening can be set in a fixed position.

d. Foot Accelerator (fig. 4). The foot accelerator is mounted on the subfloor to the right of the driver, and is connected by linkage to the cross shaft, through which the carburetor throttle is regulated to control the speed of the engine.

e. Clutch Pedal. The clutch pedal, which is mounted on the subfloor, is connected by adjustable linkage to the cross shaft, through which the engine clutch can be disengaged to disconnect the engine from the drive line when shifting gears. A linkage connection with the accelerator allows the engine to idle more slowly than normal to reduce gear clashing when shifting. The pedal is spring-loaded and will return to the engaged position when foot pressure is relieved. An overcenter (booster) spring is provided for easier operation of the clutch pedal.

f. Transmission Gearshift Lever. The gearshift lever is mounted on the left rear side of the transmission. It is used to change gear ratios in the transmission during operation of the vehicle. The lever is

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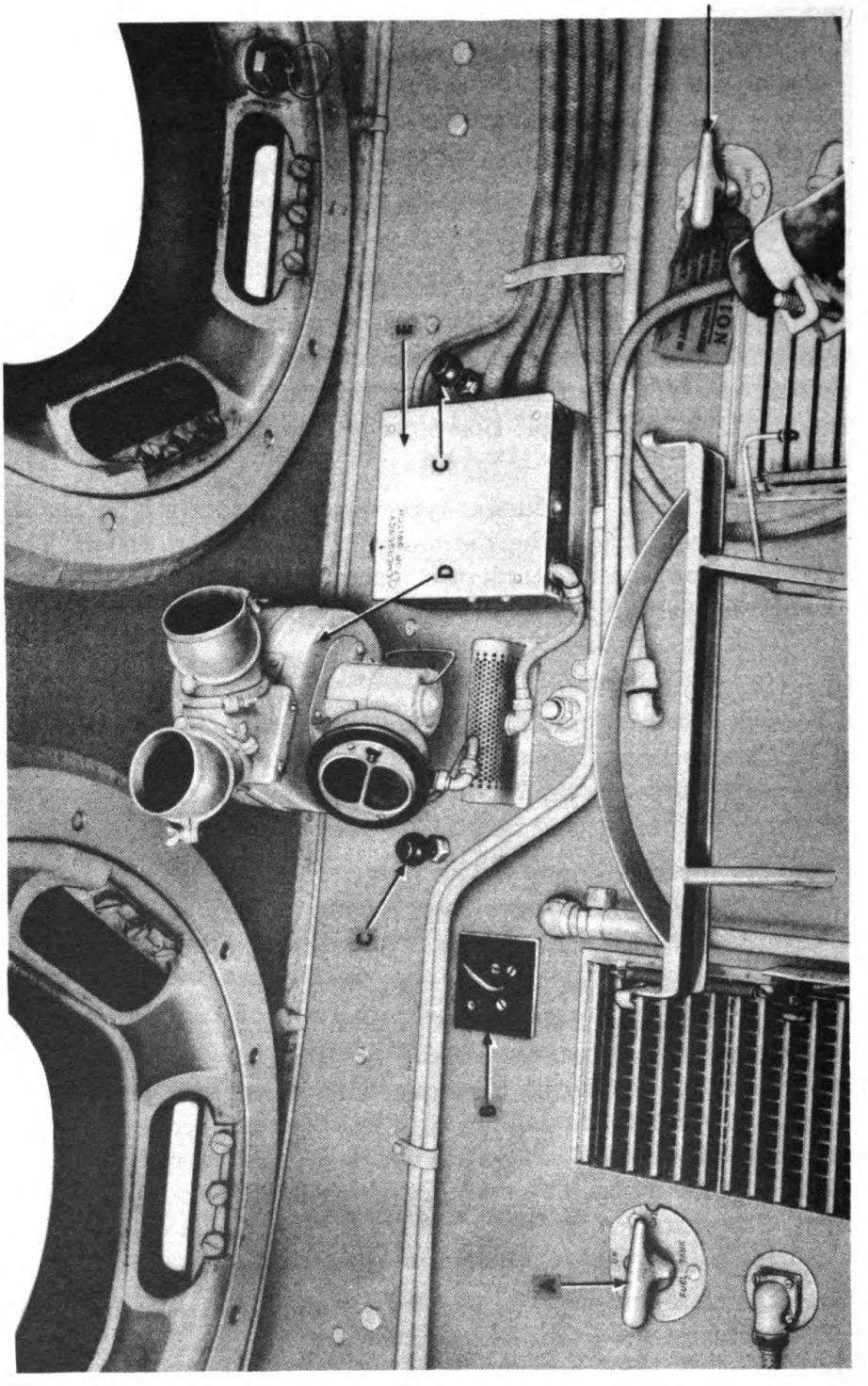
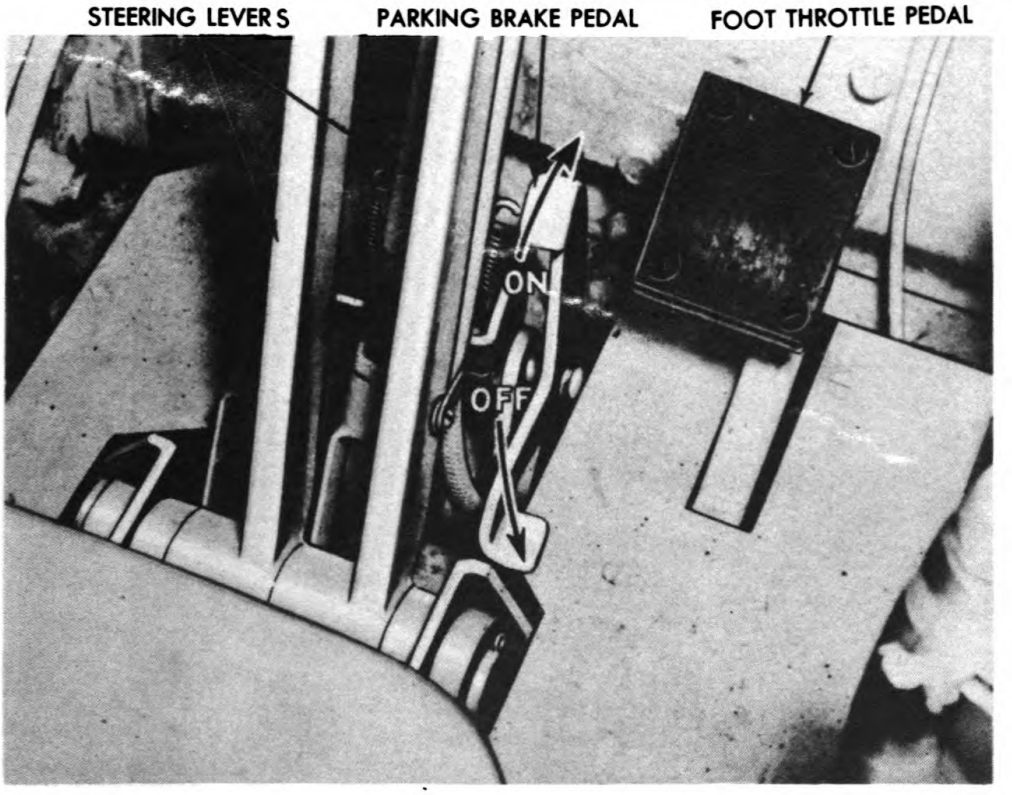


Figure 3—Controls on Front Bulkhead—Driver's Compartment

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Figure 4—Parking Brake Controls

equipped with a safety latch to prevent accidental shifting into first, or reverse gear.

g. ***Steering Levers*** (fig. 4). Two hand-operated levers mounted on the subfloor are connected by linkage to the brake shafts which operate the brake shoes in the final drive. The right lever controls the right track, and the left lever controls the left track. When one lever is pulled back, the track is slowed down and the speed of the other track is increased. The vehicle can be slowed down, or stopped, by pulling both levers back simultaneously.

h. ***Parking Brakes*** (fig. 4). When the parking brake pedal is kicked forward, the steering brake levers are held in any set position. To release the parking brake, kick the pedal to the rear.

i. ***Battery Switches.*** The 24-volt and 12-volt battery switches are located on the face of the master switch box which is mounted on the forward end of the battery box on the left sponson. Operating instructions and identification information appear on the face of the switch box.

j. ***Starter and Magneto Switch Assembly*** (fig. 5). This assembly is located on the lower right corner of the instrument panel.

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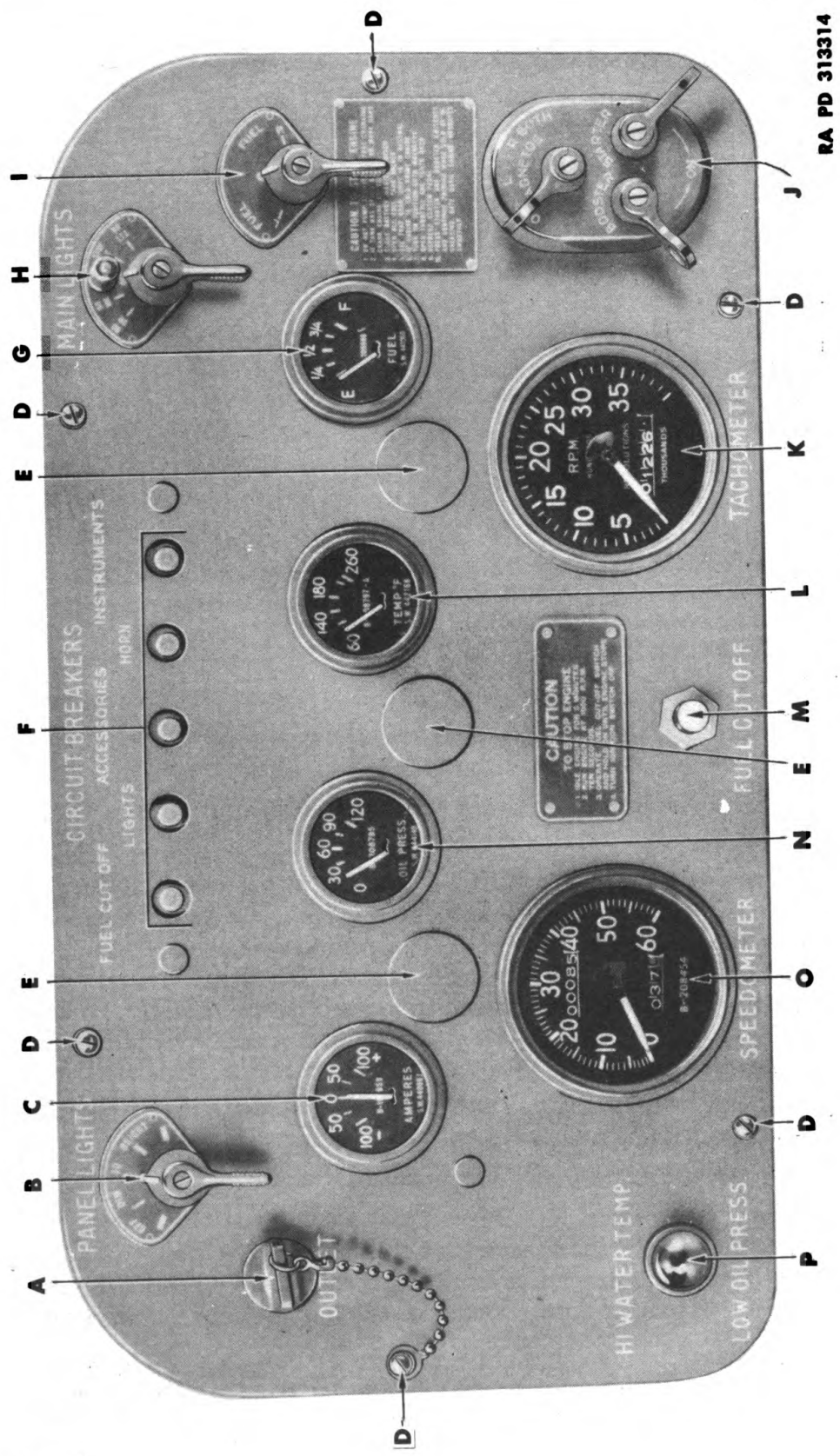


Figure 5—Instrument Panel

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A—UTILITY OUTLET SOCKET

B—PANEL LIGHT SWITCH—C102763

C—AMMETER—G104-05-00030

D—PANEL ATTACHING SCREW

E—PANEL LIGHT COVER

F—CIRCUIT BREAKERS

G—FUEL GAGE—B209888

H—MAIN LIGHT SWITCH

I—FUEL GAGE SELECTOR SWITCH—C102762

J—CRANKING MOTOR AND MAGNETO SWITCH—G104-05-04369

K—TACHOMETER

L—ENGINE OIL TEMPERATURE GAGE—B208797A

M—FUEL CUT-OFF SWITCH—A298391

N—OIL PRESSURE GAGE—B208795

O—SPEEDOMETER

P—LOW OIL PRESSURE WARNING LIGHT

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Legend for Figure 5—Instrument Panel

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(1) The upper lever controls the magnetos, and is marked "OFF," "L" for left magneto, "R" for right magneto, and "BOTH" for both magnetos.

(2) The lower levers, which are marked "BOOSTER" and "STARTER," control the operation of the booster coil and the cranking motor (starter) when starting the engine. NOTE: *The booster is used only with Scintilla magneto-equipped engines.*

(3) Both switches are spring-loaded, and will return to the "OFF" position when released. The booster switch is operated in conjunction with the switch marked "STARTER" to produce sufficient ignition during cranking to start the engine.

k. Fuel Cut-off Switch (fig. 5). The fuel cut-off switch is controlled by a push button mounted on the lower center of the instrument panel. It operates the idle cut-off (degasser) solenoid valve on the carburetor to cut off the fuel to stop the engine.

l. Main Light Switch (fig. 5). The main light switch is mounted in the upper right corner of the instrument panel. A safety button is provided to prevent accidental lighting of unwanted lights under certain tactical maneuvers. The switch has five positions marked as follows:

"BO DR"—blackout driving light
"BO-MK"—blackout markers
"OFF"—off position
"STOP LT"—stop light (not used)
"HD LTS"—headlights

m. Panel Light Switch (fig. 5). This switch is located in the upper left corner of the instrument panel and has an "OFF" position and four positions from "DIM" to "BRIGHT," to control the indirect lighting of the instrument panel and the compass.

n. Circuit Breakers (fig. 5). Circuit breakers are provided for the various circuits of the vehicle to protect the wiring and equipment from damage caused by grounds or short circuits. The circuit breakers are mounted on the inside of the instrument panel, with five reset buttons exposed at the upper center of the panel. Identification of the circuit is plainly marked above each button.

o. Utility Outlet (fig. 5). An outlet is located at the upper left of the instrument panel, and is protected from dirt and damage by a plug latched into the bayonet-type socket. The outlet is used for connecting windshield wipers, trouble lights, etc.

p. Emergency Stop Switch. An emergency stop switch is located in the bulkhead terminal box and its function is to ground the magnetos and bring the engine to an immediate stop.

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15. INSTRUMENTS.

a. Fuel Gage (fig. 5). The fuel gage is mounted to the extreme right of the group of gages in the center of the instrument panel. The selector switch which connects the gage to the right or left fuel tanks is mounted to the right of the gage. The gage will indicate the amount of fuel in the right or left tanks, when the selector switch is turned to "R" or "L" respectively.

b. Oil Pressure Gage (fig. 5). The oil pressure gage is mounted on the instrument panel immediately to the right of the ammeter, and records the oil pressure electrically through a varying resistance, controlled by the engine oil pressure against the end of the oil pressure sending unit, mounted in the oil passage on the engine.

c. Low Oil Pressure Warning Light (fig. 5). A ruby warning light is located in the lower left corner of the instrument panel to indicate low oil pressure. This light is connected to a switch-type sending unit installed on the engine. When the 24-volt battery switch is turned on, the low oil pressure warning light will burn until the engine starts and oil pressure is built up. If the trouble exists in the oiling system, allowing the oil pressure to drop, the warning light will burn.

d. Engine Oil Temperature Gage (fig. 5). The engine oil temperature gage is mounted on the instrument panel between the oil pressure and the fuel gages. This gage is marked in degrees Fahrenheit from 60 to 260, and indicates the temperature of the engine oil. The gage is electrically operated by a resistance-type sending unit mounted on the engine. The sending unit is actuated by the temperature of the engine oil, and causes the gage to indicate the oil temperature.

e. Ammeter (fig. 5.) The ammeter is calibrated to a shunt located in the battery switch box and reads directly in amperes on a zero center scale. The scale is marked from 50 to 100 on each side of the center zero. The figures are identified as negative (—) to the left of zero, and positive (+) to the right of zero. The amount of charge (+) or discharge(—) applied to the battery is indicated on the meter, depending on the speed of the generator, condition of the batteries, or the number of electrical accessories in use.

f. Speedometer (fig. 5). The speedometer is mounted on the lower left face of the instrument panel. It indicates the speed of the vehicle and records total miles and trip mileage. The speedometer is driven by a cable mounted on an adapter in the transmission.

g. Tachometer (fig. 5). The tachometer is located on the lower right face of the instrument panel. It indicates the revolutions per minute, and also records the total revolutions of the engine when the clutch is engaged. The tachometer is driven by a cable from an adapter connected to the input shaft of the transmission.

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Section VII

OPERATION UNDER ORDINARY CONDITIONS

16. USE OF INSTRUMENTS AND CONTROLS IN VEHICULAR OPERATION.

a. Service Upon Receipt of Equipment. Before a new or a reconditioned vehicle is placed in service, be sure the new vehicle run-in test described in paragraphs 11, 12 and 13 has been performed.

b. Before-operation Service. Perform the services in items 1 to 6 in paragraph 29 before attempting to start the engine. Start and warm up engine (subpar. *c* below) and complete the Before-operation Service.

c. Starting the Engine.

(1) If the engine is cold, or has stood for 6 hours or more, test for hydrostatic lock before attempting to start the engine. Attempt to crank the engine with hand crank. If the engine will not turn, refer to paragraph 36.

(2) Place the gearshift lever in neutral.

(3) Place both the fuel shut-off valve controls on the bulkhead in the "ON" position.

(4) Close the 24-volt battery switch.

(5) Pull the hand throttle out about ½ inch.

(6) Pull the primer pump handle out slowly, and push it in briskly several strokes to prime the engine. The number of strokes required will depend on the temperature of the engine.

(7) Depress the clutch pedal all the way down.

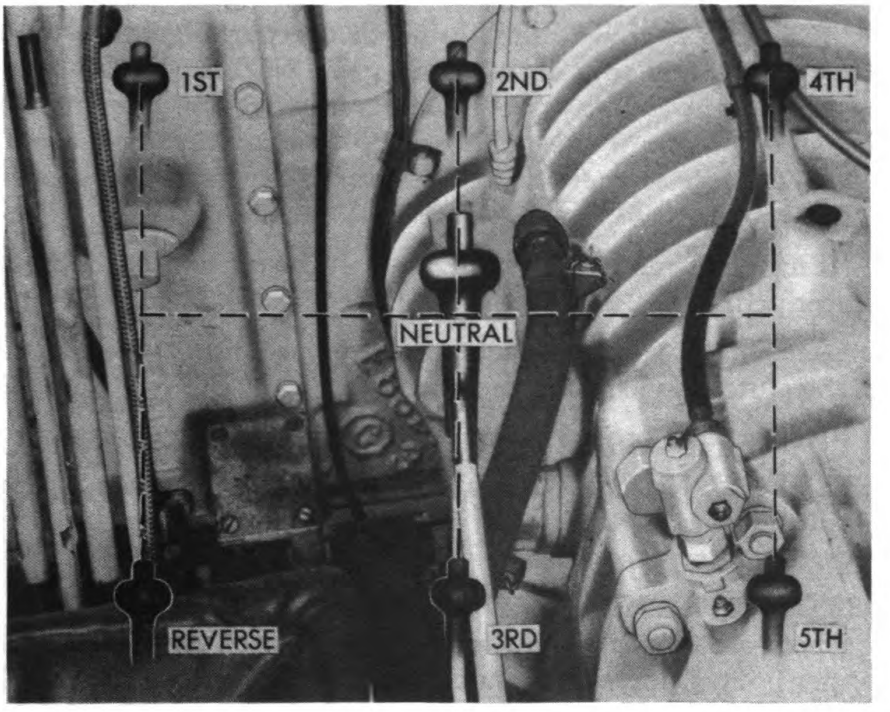
(8) Place the magneto switch in position marked "BOTH" (fig. 5).

(9) Press the switch handles (fig. 5) marked "STARTER" and "BOOSTER" together to the "ON" position and hold them in this position until the engine starts, but for not longer than 10 seconds. If the engine fails to start, release the switches and allow the cranking motor to cool, then pull the hand throttle all the way out, turn off the magneto switch, and press the switch marked "STARTER." Crank the engine several revolutions to eliminate the possibility of flooding or overpriming and then attempt to start the engine again. After the engine has started, operate the primer as required until the engine runs smoothly.

(10) Release the clutch pedal.

(11) Run the engine for 5 minutes at 800 revolutions per minute and check the oil pressure gage. The oil pressure should be 40 pounds. If the pressure does not come up immediately after the engine starts, or

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Figure 6—Gearshift Lever Positions

does not show 40 pounds on the gage, stop the engine and report the condition to higher authority. CAUTION: *Do not run the engine with improper oil pressure.*

(12) Increase the engine speed to 1,000 revolutions per minute and note whether or not the oil pressure remains at 40 pounds. If the pressure drops off when the speed is increased, reduce the speed and allow the engine to warm up more thoroughly.

(13) When the engine is warmed up, try operating first on one magneto and then on the other, by placing the magneto switch lever in "R" and then "L" positions. CAUTION: *Do not operate the engine on one magneto for long periods.* If the engine runs properly on the individual magnetos, place the switch in the position marked "BOTH."

(14) Observe all instruments to see that they are indicating properly (par. 15).

Operation of Vehicle.

(1) GENERAL. The engine is equipped with a governor to limit the road speed of the vehicle in all gears as shown on the plate on the left hull wall. CAUTION: *Do not permit the vehicle to exceed these speeds when driving down grade, to avoid damage to power train and engine.*

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(2) PLACING VEHICLE IN FORWARD MOTION (fig. 6).

(a) With the engine running, release the parking brake, depress the clutch pedal, and shift into second gear. NOTE: *Under ordinary driving conditions, such as over hard-surfaced roads, start in second speed gear. However, if the vehicle is to be operated over obstacles, rough or extremely soft terrain, or in confined areas, start in low-speed gear.*

(b) Engage the clutch gradually and, at the same time, depress the accelerator pedal.

(c) Accelerate to governed speed, release the accelerator, disengage the clutch, and shift to the third gear.

(d) Repeat this procedure through each shift to higher gears.

(3) REVERSING VEHICLE (fig. 6). Depress the latch button on the end of the gearshift lever and shift to the reverse gear. Engage the clutch gradually and, at the same time, depress the accelerator pedal.

(4) STOPPING THE VEHICLE. Release the accelerator and pull back on both steering brake levers to slow the vehicle down to about 3 miles per hour. Depress the clutch pedal and shift into neutral. Kick the parking brake pedal forward, and pull the steering brake levers back as far as possible to hold the vehicle.

e. Stopping the Engine. If the engine is overheated or thoroughly heated during operation, idle for 5 minutes at 800 revolutions per minute and then press the fuel cut-off switch on the instrument panel. Hold the switch closed until the engine stops, then turn the magneto switch to the position marked "OFF." CAUTION: *Do not stop the engine with the magneto switch.* Shut off the fuel valves and open the 24-volt battery switch.

f. Driving Precautions.

(1) Shift to a lower gear, if the engine speed drops below 1,800 revolutions per minute, to avoid unnecessary strain on the engine and drive line.

(2) Keep the power up when making a turn; shift to a lower gear if necessary.

(3) Do not turn while climbing or just after shifting to a higher gear without allowing the engine to regain speed, as a slight turn will reduce vehicle speed.

(4) Shift to the proper gear before starting down grade, and do not allow the engine to exceed 2,400 revolutions per minute.

(5) Remove the foot from the clutch when driving, except during shifting. Do not disengage the clutch while going down grade, to avoid losing control of the vehicle.

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(6) When driving into, or out of, a trench or ditch, select the proper gear and allow the vehicle to settle gradually to the bottom and then apply full power to drive out.

(7) When driving over an obstacle, select the proper gear and apply sufficient power to negotiate the climb; then allow the vehicle to roll gradually over the obstacle.

(8) Do not operate the vehicle at maximum speed except in an emergency. Operate at maximum sustained speed of 21 miles per hour.

(9) Do not idle the engine at less than 800 revolutions per minute except when shifting gears.

(10) Do not stop the engine by turning off the magneto switch. Press the stop button and hold it until the engine stops; then turn off the magneto switch.

17. TOWING THE VEHICLE.

a. General. Cables or tow bars can be attached to the towing lugs mounted on the front and rear of the vehicle. If cables are used, a driver must operate the steering brake levers in the vehicle being towed, to steer and stop the towed vehicle as required.

b. Towing Precautions.

(1) When using a cable, see that it does not become fouled with the tracks.

(2) Do not tow a vehicle more than a few lengths without following the preparation procedure described in subparagraph *c* below.

(3) If the tracks are off, use a tow bar if the vehicle is to be moved more than a short distance.

c. Towing a Disabled Vehicle.

(1) If the vehicle is to be moved a considerable distance, block the clutch pedal down with a piece of wood or remove the bolts from the front universal joint companion flange, slide the universal joint and generator drive pulley back as far as possible, and block the pulley away from the companion flange. Place the gearshift lever in fifth gear position. This will assure circulation of the lubricant and avoid damage to the transmission and final drive.

(2) Start the towing vehicle in first gear and accelerate until both vehicles are moving freely—then, *and then only*, shift to higher speeds.

(3) Do not tow a disabled vehicle above 12 miles per hour.

Section VIII

OPERATION UNDER UNUSUAL CONDITIONS

18. GENERAL.

a. This section of the manual contains information pertaining to the operation of the vehicle under conditions which involve factors that do not exist in usual operation.

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b. For further information, refer to FM 31-25, Desert Operation; and FM 31-15, Operation in Snow and Extreme Cold.

19. SAND, DEEP MUD, AND SLIPPERY TERRAIN.

a. Tracks and Suspension. Inspect volute springs, suspension wheels and arms, track support rollers, pins, wedges, and track shoes for worn or damaged parts. Remove all mud, ice, or sand which might cause the tracks to be thrown, or damage to the suspension mechanism.

b. Track Tension. Inspect track tension and adjust slack to ½ to ¾-inch between track support rollers. Make sure that the track idler and adjusting mechanism are in good condition and locked securely.

c. Air Cleaners and Air Intake Tubes. Clean air cleaners more frequently when operating under dusty conditions. Inspect all carburetor intake tubes and clamps; replace damaged tubes and clamps. If the vehicle is camouflaged, be sure that the air inlet grille is not covered or obstructed.

d. Lubrication. Check lubrication record and see that all points are lubricated frequently in accordance with the Lubrication Order (par. 26).

e. Operation of Vehicle. Select the proper gear for the existing condition and operate the engine at a speed to insure a steady pull. Make gear changes in accordance with the instruction plate on the left hull wall, using the tachometer as a guide rather than the speedometer. If the tank is equipped with rubber shoe tracks, install the grousers to insure positive traction when needed.

20. COLD WEATHER OPERATION.

a. Fuel. Use winter grade gasoline procured under U. S. Army Specifications 2-103 (grade C) latest issue. To reduce the possibility of condensation forming ice in the fuel lines, add ½ pint of grade 3 denatured alcohol to each tank when filled.

b. Storage and Handling of Fuel.

(1) CONDENSATION. Rapid and extreme changes in temperature cause condensation in fuel tanks and containers. Keep the fuel tanks full when not in use to reduce the air space on top of the fuel, and to avoid condensation of moisture in the air. Drain fuel tank sumps daily to remove water and dirt.

(2) CLEANLINESS. Be sure all containers are clean. Before filling vehicle fuel tanks from storage containers that have been moved, allow the containers to set long enough so that any sediment in the fuel will settle to the bottom. Clean all dirt, snow, and ice from and around the fuel tank caps before removing them. Strain or filter the fuel when filling the tanks.

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(3) FIRE HAZARD. Keep containers closed and avoid exposure to open flame when pouring or handling fuel. Fuel flowing over a surface generates static electricity which will cause a spark. Keep the filler hose or the container in good metallic contact with the hull when filling the fuel tanks.

c. Lubrication.

(1) ENGINE OIL. Use SAE 30 engine oil for temperatures consistently below 0°F. Three methods of keeping the engine oil sufficiently fluid for proper starting below 0°F are listed below. Give preference in the order listed according to available facilities:

(a) Keep Vehicle Warm. If possible, keep the vehicle in a heated enclosure when it is not in operation.

(b) Remove Engine Oil. When the engine is stopped, drain the engine oil and store it in a warm place until vehicle is to be operated again. If warm storage is not available, heat oil before installing it (subpar. *e* (1) below). CAUTION: *Attach a tag to the vehicle instrument panel to warn personnel that the engine oiling system is empty.*

(c) Dilute Engine Oil.

1. Remove the oil level gage and check the oil level. Add 2½ pints of gasoline for each gallon of oil contained in the system, immediately after operation.

2. Run the engine 5 to 10 minutes to mix the oil and gasoline thoroughly.

3. Stop the engine and remove the oil level gage. Note that the oil level is above the level determined in step *1* above. Record the amount of gasoline and oil contained in the system for future reference.

4. The presence of gasoline in the oiling system will increase oil consumption; therefore, check the oil level frequently. Use SAE 30 engine oil to maintain the oil level during operation.

5. If the vehicle is operated 4 hours or more at operating temperature, redilute the engine oil, if it is anticipated that the vehicle will be left standing 5 hours or more, by following the same procedure outlined in steps *1* through *4* above.

(2) TRANSMISSION AND FINAL DRIVE. Use SAE 30 engine oil for temperatures below 0°F. If the transmission and final drive contains heavier engine oil (SAE 50), drain the unit immediately after operation, while the oil is still warm, and refill with SAE 30 engine oil.

(3) TRACK SUPPORT ROLLERS, IDLER AND SUSPENSION WHEELS. When operating in temperatures below 0°F, use No. 0 general purpose grease at intervals specified on the Lubrication Order (par. 26).

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(4) ALL OTHER LUBRICATION POINTS. Use lubricants specified on the Lubrication Order (par 26).

d. Electrical System.

(1) BATTERIES. Do not try to start the engine when the batteries have been chilled in temperatures below —30°F until the batteries have been heated, unless warm slave batteries are available. A fully charged battery will not freeze at temperatures likely to be encountered even in arctic climates, but a discharged battery will freeze at temperatures above zero. Battery freezing temperatures are shown below:

Specific Gravity	Freezing Temperatures
1.160	+1.5°F
1.200	—17°F
1.240	—50°F
1.280	—96°F

Do not add water to the batteries unless they are immediately put on charge, as the water will freeze on top of the plates.

(2) IGNITION. Make sure that all ignition wires are secure and not damaged. Check the spark plugs frequently to see that they are clean and adjust the gap to 0.017 to 0.019-inch. Replace if necessary. Test booster coil (if so equipped) before cranking the engine by depressing the booster switch on the instrument panel and listening for a buzzing sound at the coil. Crank the engine with the magneto switch off. The engine will fire unevenly on booster current if the coil is functioning.

(3) WIRING. Inspect, clean, and tighten all cable connections and inspect all "AN" connectors to see that they are dry and properly tightened.

e. Preparation for Starting and Operation.

(1) HEAT ENGINE OIL. If the engine oiling system has been drained (subpar. *c* above), heat the engine oil before filling the system. Do not allow the oil to get too hot; heat only to the degree that the bare hand can be inserted in the oil without burning.

(2) CHANGE OIL IN AIR CLEANERS. Remove the engine oil in the air cleaners and refill with hydraulic oil (U. S. Army Specification No. 2-79A) for operation from 0°F to —40°F. For operation below —40°F, remove oil and operate dry.

(3) START ENGINE. Start the engine, as described in paragraph 16 *c*, with the clutch released to relieve the load of turning the transmission with the cranking motor. Keep the engine compartment cover on until the engine temperature rises.

(4) WARM UP LUBRICANT IN ENGINE AND TRANSMISSION. When the engine runs smoothly at approximately 1,000 revolu-

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tions per minute, make sure the gearshift lever is in neutral, then engage the clutch. Operate the engine until it is thoroughly warmed up. This will actuate the pump in the transmission and circulate the lubricant. When the transmission lubricant has been warmed sufficiently to allow engagement of the gears, drive the vehicle in first gear for a short distance to warm up the lubricant in the final drive. When gear changes can be made normally, proceed to operate the vehicle in the usual manner (par. 16 *d*).

21. FLOOD AND SUBMERSION.

a. If it becomes necessary to ford streams, or unexpected flooding occurs, move the vehicle to a higher level, and open all floor drain valves. Dry out the interior of the tank and clean out all mud and sediment accumulation. Make a thorough inspection of wiring, ignition, and fuel systems.

b. If such units as the engine, clutch, or electrical apparatus have been obviously damaged, notify higher authority.

Section IX

DEMOLITION TO PREVENT ENEMY USE

22. GENERAL.

a. Destruction of the vehicle when subject to capture or abandonment in the combat zone will be undertaken by the using arm only when, in the judgment of the military commander concerned, such action is necessary.

b. The instructions which follow are for information only. Certain of the methods of destruction outlined require TNT and incendiary grenades which may not be normal items of issue. The issue of these materials, and the conditions under which destruction will be effected *are command decisions in each case,* according to the tactical situation.

c. If destruction is resorted to, the vehicle must be so badly damaged that it cannot be restored to a usable condition in the combat zone either by repair or cannibalization. Adequate destruction requires that all parts essential to the operation of the vehicle be destroyed or damaged beyond repair. Equally important, the same essential parts must be destroyed on all like vehicles so that the enemy cannot construct one complete operating unit from several partially damaged ones.

23. DETAILED INSTRUCTIONS.

a. ***Methods.*** The following instructions apply to the 155-mm Gun Motor Carriage T83 and 8-inch Howitzer Motor Carriage T89.

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b. Destruction of 155-mm Gun or 8-inch Howitzer.

(1) Place unfuzed M14 incendiary grenades on their sides, one on top of another in the chamber. NOTE: *Use six to eight grenades in destroying the 155-mm gun and 10 to 12 grenades in destroying the 8-inch howitzer.* Close the breech. Equip another incendiary grenade with a 15-second Bickford fuze, ignite, and toss it in the muzzle. Quickly elevate the gun to its maximum elevation. Elapsed time: 3 to 5 minutes.

(2) The metal from the grenades will fuze with the interior of the breechblock, making it impossible to open the breech.

c. Destruction of Vehicle. Two methods of destroying the vehicle are given below in their order of effectiveness.

(1) METHOD NO. 1—BY EXPLOSIVES.

(a) Remove and empty portable fire extinguishers. Discharge fixed fire extinguisher system. Puncture the fuel tanks. Place a 3-pound TNT charge against the right vertical fuel tank, between engine and bulkhead. Place a 2-pound TNT charge against left side of transmission as far forward as possible. Insert tetryl nonelectric caps with at least 5 feet of safety fuze in each charge. Ignite the fuzes and take cover.

(b) If sufficient time and materials are available, additional destruction may be accomplished by placing a 2-pound TNT charge at about the center of each track assembly. Detonate these charges in the same manner as the others.

(c) If charges are prepared beforehand and carried in the vehicle, keep the caps and fuzes separated from the charges until used.

(2) METHOD NO. 2—BY GUN FIRE.

(a) Remove and empty the portable fire extinguishers. Discharge fixed fire extinguishers. Puncture the fuel tanks. Open all tank doors and hatches if time is available. Fire on the vehicle, using adjacent tanks, antitank or other artillery, or antitank rockets or grenades. Aim at the engine, suspension, and armament in the order named. If a good fire is started, the vehicle may be considered destroyed.

(b) Destroy the last remaining vehicle by the best means available.

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PART THREE—MAINTENANCE INSTRUCTIONS

Section X

GENERAL

24. SCOPE.

a. Part Three contains information for the guidance of the personnel of the using organizations responsible for the maintenance (first and second echelon) of this equipment. It contains information for the performance of the scheduled lubrication and preventive maintenance services, as well as description and maintenance of the major systems and units and their functions in relation to other components of the equipment.

Section XI

SPECIAL ORGANIZATIONAL TOOLS AND EQUIPMENT

25. SPECIAL TOOLS.

a. Purpose. The list of tools in this section is for information only. It is not to be used as a basis for requisition.

b. Special Tool List.

41-T-3568-345 Tool-set, 2nd echelon, special, set A, Tank, medium, M4, 75-mm gun (dry); M4A1, 75-mm gun (dry) M4A1, 76-mm gun (wet); Carriage, motor, 105-mm howitzer, M7; Carrier, cargo, M30; Carriage, motor, 155-mm gun, M12; Vehicle, tank recovery, M31; M32; M32B1.

41-T-3569-345 Tool-set, 2nd echelon, special, set B, Tank, medium, M4, 75-mm gun (dry); M4A1, 75-mm gun (dry); M4A1, 76-mm gun (wet); Carriage, motor, 105-mm howitzer, M7; Carrier, cargo, M30; Carriage, motor, 155-mm gun; M12, Vehicle, tank recovery, M31; M32; M32B1.

Name	Federal Stock Number	Mfr's. Tool Number	Tool-Sets	
BAR, socket wrench, extension, ⅜-in. sq drive, 3 in.	41-B-304-800	SN-F-2		B
CABLE, extension, rubber covered, two conductor, stranded, No. 1 gage, with plug on each end	17-C-568	B-257839	A	B
DISK, timing engine	41-D-1265-35	TEC-50-29		B
DRIVER, stud, ¼ in.—28	41-D-2984	MTM-M3-386		B
FIXTURE, removing and replacing, power train assembly. (Use with 41-P-555-600 and 41-P-647)	41-F-2997-220	MTM-M3-165		B

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Name	Federal Stock Number	Mfr's. Tool Number	Tool-Sets
GAGE, thickness, special, thickness 0.006 in. and 0.070 in., length 5-11/16 in....	41-G-412-77	MTM-M3-563	B
HANDLE, socket wrench, speeder, brace type, 3/8-in. sq drive, length 17 in....	41-H-1507-95	NBM-NB-85	B
HANDLE, socket wrench, T-sliding, 3/8-in. sq drive, length over-all 8 in.....	41-H-1509-53	NBM-NB-70	B
HOLDER, coupling	41-H-2269-200	TSE-5275	A B
INDICATOR, piston, top dead center, dial type	41-I-73-110	MTM-M3-237	B
PIN, alining, tapered, bolt holes to power train and hull, point diameter 3/8 in., over-all length 7 in. (Use with 41-F-2997-220)	41-P-555-600	MTM-M3-164	B
PIN, holding, tapered, power train assembly, point diameter 1/4 in., length over-all 7 in. (Use with 41-F-2997-220)	41-P-647	MTM-M3-163	B
PLATE, lifting, clutch spindle and cover assembly	41-P-1542-200	MTM-M3-499	B
POINTER, engine timing	41-P-2219-50	TEC-50-30	B
PULLER, magneto gear, screw type	41-P-2941-800	MTM-M3-231	B
SCREWDRIVER, valve clearance adjusting.	41-S-1725	MTM-M3-239	B
SLING, battery lifting.....	41-S-3829-50		B
SLING, engine	41-S-3832-19	MTM-M3-494	B
TOOL, dressing, breaker point, complete..	41-T-3092-77	TSE-5229	B
WRENCH, box, generator attaching, 1/2-in., special	41-W-636-550	MTM-M3-506	B
WRENCH, box, oil relief valve body check nut and cap. (Formerly 41-W-1577-400)	41-W-636-620	MTM-M3-341	B
WRENCH, box (split), single end, double hexagon, flare nut, pipe and tubing, size of opening 1 3/8 in. (Formerly 41-W-636-590)	41-W-637-455	SN-RX-44	B
WRENCH, crowfoot, starter attaching, 9/16-in. special	41-W-871-45	MTM-M3-505	B
WRENCH, engine support nut, 1-5/16-in. hexagon	41-W-906-25	MTM-M3-254	B
WRENCH, intake pipe packing nut.....	41-W-1537	MTM-M3-210	B
WRENCH, oil pump to crankcase rear section attaching nut, 7/16-in. hexagon..	41-W-1577-500	MTM-M3-299	B
WRENCH, power jet valve.....	41-W-1866	Z-C-161-9	A B
WRENCH, set, socket, 1-in. sq drive, extra heavy duty. Consisting of:.....	41-W-2622	MTM-M3-16A	A B

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Special Organizational Tools and Equipment

Name	Federal Stock Number	Mfr's. Tool Number	Tool-Sets
Bar, socket wrench, extension, 8 in. long, 1-in. sq drive	41-B-310	SN-L-63	
Bar, socket wrench, sliding, 22-in.	41-B-312-200	MTM-M3-16L	
Handle, tubular, 36-in. long, 1⅛-in. I.D. 1-7/16-in. O.D.	41-H-1498-50	MTM-M3-16C	
Head, square, 1-in. male	41-H-1779-50	MTM-M3-16E	
Head, ratchet, socket wrench 1-in. sq drive	41-H-1838	MTM-M3-16M	
Wrench, socket, hex. 1-in. sq drive, 1½-in.	41-W-3058-200	MTM-M3-16J	
Wrench, socket, hex. 1-in. sq drive, 1-13/16-in.	41-W-3058-300	MTM-M3-16N	
Wrench, socket, hex. 1-in. sq drive, 2¼-in	41-W-3058-430	MTM-M3-16F	
Wrench, socket, hex. 1-in. sq drive, 2⅜-in.	41-W-3058-450	MTM-M3-16H	
Wrench, socket, hex. 1-in. sq drive, 2⅝-in.	41-W-3058-480	MTM-M3-16K	
WRENCH, socket, (detachable), ⅜-in. sq drive, 12-point opening, size 7/16-in., universal joint. (Formerly 41-W-2610-15.)	41-W-2999-90	IMC-101823	B
WRENCH, socket, (detachable), ⅜-in. sq drive, 12-point opening, size ½-in., universal joint. (Formerly 41-W-2610-20.)	41-W-2999-120	IMC-101217	B
WRENCH, socket, tubular, single end, octagon opening, size of opening 1⅜-in., length 2⅝-in.	41-W-3126	MTM-M3-558	B

41-T-3569-175 Tool-set, 2nd echelon, special, set B, supplemental (for vehicles having horizontal volute spring suspension).

ADAPTER, removing and replacing suspension arm bushing and shock absorber pins	41-A-18-298		B
ADAPTER, volute spring, removing	41-A-30-650		B
BLOCK, riser, bogie wheels	41-B-1411-200		B
LOCK, riser block, horizontal suspension	41-L-1616		B
REPLACER, bearing cups, inner bogie and 13-in. idler wheels, inner and outer 10-in. idler wheels	41-R-2384-965		B
REPLACER, bearing cups, track rollers (inner and outer)	41-R-2385-350		B
WRENCH, pipe, chain, flat link, pipe capacity ⅝-in. to 4½-in., length 1⅞-in.	41-W-1781-100	TEC-50-54	B

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Section XII

LUBRICATION

26. LUBRICATION ORDER.

a. Reproduction of War Department Lubrication Order 9-747 (figs. 7 and 8) prescribes first and second echelon lubrication maintenance above 0°F. For lubrication below 0°F, refer to paragraph 20. Lubrication to be performed by ordnance maintenance personnel is covered in paragraph 27.

b. A Lubrication Order is issued with each item of materiel and is to be carried with it at all times. In the event the materiel is received without a copy, the using arm shall immediately requisition a replacement from the closest Adjutant General Depot. See lists in FM 21-6.

c. Instructions on the Lubrication Order are binding on all echelons of maintenance and there shall be no deviations.

d. Service intervals specified on the Lubrication Order are for normal operating conditions during active service above 0°F. These intervals will be reduced under extreme conditions such as excessively high or low temperatures, prolonged periods of high-speed operation, continued operation in sand or dust, immersion in water, or exposure to moisture, any one of which may quickly destroy the protective qualities of the lubricant. Calendar intervals may be extended when the materiel is not in use.

e. Lubricants are prescribed in the "Key" in accordance with three temperature ranges, above +32°F, +32°F to 0°F, and below 0°F. When to change grades of lubricants is determined by maintaining a close check on operation of the materiel during the approach to change-over periods, especially during initial action. Sluggish starting is an indication of lubricants thickening, and the signal to change to grades prescribed for the next lower temperature range. Ordinarily it will be necessary to change grades of lubricants only when air temperatures are consistently in the next higher or lower range.

27. DETAILED LUBRICATION INSTRUCTIONS.

a. Lubrication Equipment. Each piece of materiel is supplied with lubrication equipment adequate to maintain the materiel. This equipment will be cleaned both before and after use. Lubrication guns will be operated carefully, and in such a manner as to insure a proper distribution of the lubricant.

b. Points of Application.

(1) Lubrication fittings, grease cups, oilers, and oilholes are readily located by reference to the Lubrication Order. Wipe these devices and

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the surrounding surfaces clean before lubricant is applied.

(2) Where relief valves are provided, apply new lubricant until the old lubricant is forced from the vent. Exceptions are specified in notes on the Lubrication Order.

c. Cleaning. Dry-cleaning solvent or diesel fuel oil will be used to clean or wash all parts. Use of gasoline for this purpose is prohibited. After washing, parts will be thoroughly dried before applying lubricant. (For exceptions see gun bore note).

d. Lubrication Notes on Individual Units and Parts (figs. 7 and 8).

(1) AIR CLEANERS AND BREATHERS.

(a) Oil Bath Type. Fill oil reservoir to bead level. Every 500 miles, remove and wash all parts. Replace and refill.

(b) Mesh Type. Wash, dry, and reoil the elements of the crankcase breather and the transmission, differential, and final drive breather at intervals indicated on the Lubrication Order. Drain excess oil thoroughly before reinstalling.

(2) CLUTCH PILOT AND HUB BEARINGS. When the engine is removed, clean and repack bearings.

(3) CLUTCH RELEASE BEARING. When the engine is removed, remove plug, install fitting, and lubricate. Replace plug after lubricating.

(4) GEAR CASES. Weekly, before operation, check the level with vehicle on level ground and, if necessary, add lubricant to the full mark. Fill through transmission filler to mark on bayonet gage with fill cap resting on top of fill pipe. Every 3,000 miles, drain and refill. Drain only after operation when gear lubricant is warm. The transmission, differential, and final drives are combined in one unit. Drain through transmission differential and final drive drain plug holes. To completely drain transmission lubrication system, also remove oil cooler drain plugs.

(5) ENGINE OIL TANK. Check level before operation. Every 500 miles, drain and refill. Drain only after operation when oil is hot. Refill to full mark on bayonet gage located under fill cap.

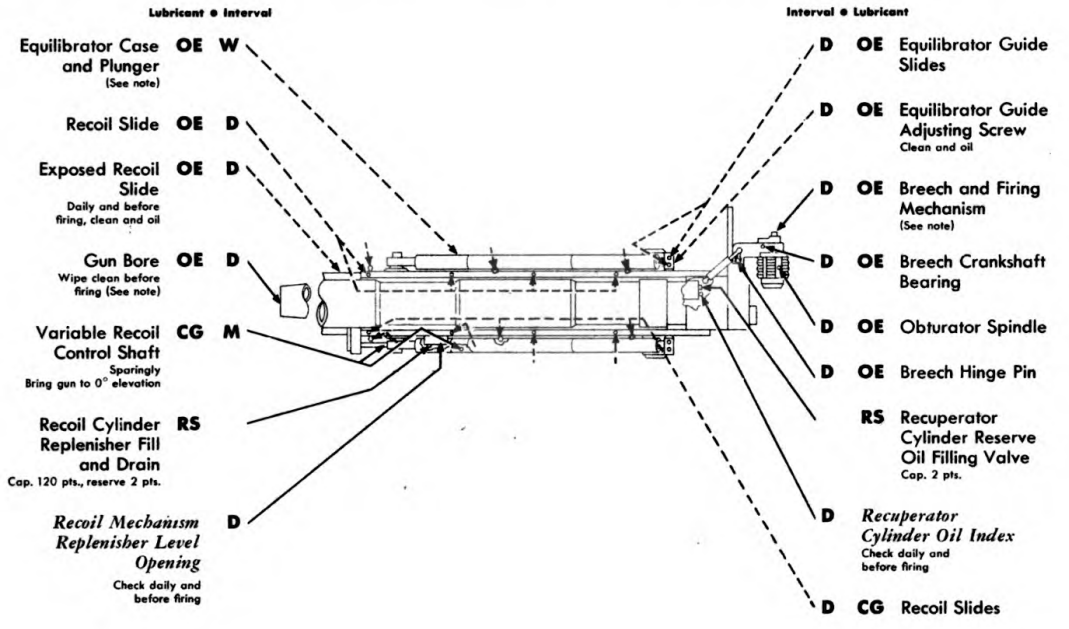
(6) WINCH CABLE. After each use, clean and oil. Weekly, if cable has not been used, coat outer coils. Monthly, unwind entire cable, clean and oil.

(7) EQUILIBRATOR CASE AND PLUNGER. To lubricate, place gun at 0 degree elevation, unscrew cover from front of equilibrator, and slide toward narrow end of case. Wipe all surfaces and apply a thin film of lubricant to all exposed parts including outer surface of both plunger and case.

(8) BREECH AND FIRING MECHANISM. Immediately after firing and on 3 consecutive days thereafter, disassemble the gas check

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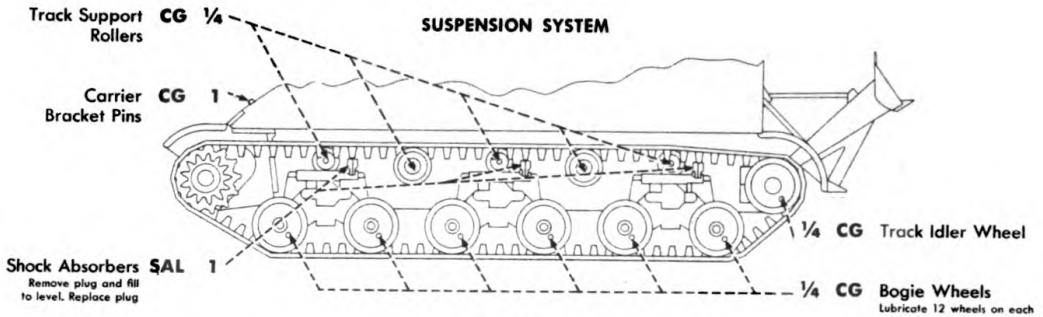
GUN, 155-mm, M1 and M1A1
HOWITZER, 8-INCH, M1 and M2



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—NOTES—

AIR CLEANERS AND BREATHERS—(Oil bath type) Fill oil reservoir to bead level. Every 500 miles, remove and wash all parts. Replace and refill. (Mesh type) Wash, dry and reoil the elements at intervals indicated on the Lubrication Order. Air cleaners and breathers require OE, SAE (crankcase grade) or used crankcase oil above 0° F., or OE (SAE 10) below 0° F.

CLUTCH PILOT AND HUB BEARINGS—When engine is removed, clean and repack bearings with BR.

CLUTCH RELEASE BEARING—When engine is removed, remove plug, install fitting and lubricate with GL. Replace plug.

ENGINE OIL TANK—Check level before operation. Drain only after operation when oil is hot. Every 500 miles, drain and refill. Refill to FULL mark on bayonet gage located under fill cap.

GEAR CASES—Check level weekly, before operation. Fill transmission, differential and final drives through transmission filler to FULL mark on bayonet gage

WINCH CABLE—After each use, clean and oil with used crankcase oil or OE. Weekly, if cable has not been used, coat outer coils. Monthly, unwind entire cable, clean and oil.

EQUILIBRATOR CASE AND PLUNGER—With gun at 0° elevation, unscrew cover from front of equilibrator and slide toward narrow end of case. Wipe all surfaces and apply a thin film of lubricant to all exposed parts including outer surface of both plunger and case.

GUN BORE—Immediately after firing, while the tube is still hot, swab with a bore sponging solution consisting of ½ pound of soda-ash to each gallon of warm water. Rinse with clean water, wipe thoroughly dry and apply a film of OE. Repeat this procedure on three consecutive days thereafter or until there is no longer evidence of sweating. When the gun is not being fired, daily wipe the bore clean and renew the oil film. Every 5 days, swab with SOLVENT, dry cleaning, wipe thoroughly dry and reoil.

OIL CAN POINTS——————— Every 250 miles, lubricate Door Hinges and Latches, Control Lever Bushings, Control Rod Pins and Clevises, Clutch and Accelerator Pedals and Control Shaft Bearings, Seat Slides and Supports, Cable Sheaves, Cable Roller, Spade Arm Linkage, Pintle (Gun and Mount). Weekly, lubricate Handwheel Handles, and other rubbing parts with OE.

DO NOT LUBRICATE—Bogie Wheels Suspension Linkage and Slides, Final Drive Sprocket Bearings, Starter, Clutch Throwout Yoke Bearings.

DISASSEMBLED PERIODICALLY BY ORDNANCE PERSONNEL—Generator, Magnetos (except oilers), Elevating Mechanism, Variable Recoil Gears, Counter Balance, Equilibrator Guide Bearings, Cradle Trunnion Bearings, Traversing Gear Hand Wheel Shaft Bearing, Traversing Gear Pinion Shaft Lower Bearing.

RA PD 342292B

Figure 7—Lubrication Order

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CARRIAGE, MOTOR, GUN, 155-mm, T83
CARRIAGE, MOTOR, 8-INCH HOWITZER, T89

REFERENCES: ORD 7 SNL G-232, TM 9-747

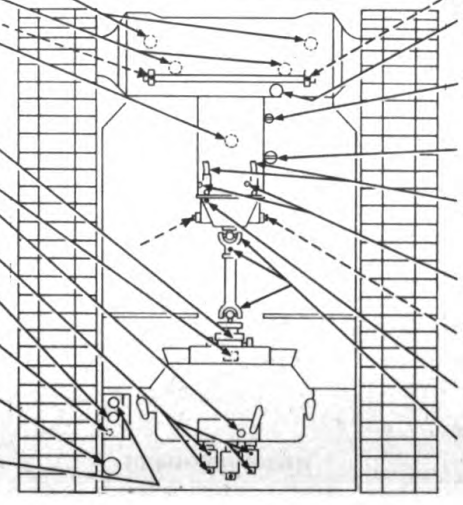
Clean fittings before lubricating. Lubricate after washing and deep water fording.

To clean parts use SOLVENT, dry cleaning or OIL, fuel, Diesel. Dry before lubricating. (For exception see Gun Bore note.)

Requisition additional Lubrication Orders from Adjutant General Depot. See lists in FM 21-6.

Reduce intervals under severe operating conditions. Extend when not in use.

Lubricate dotted arrow points on both sides. Opposite points are shown by short arrows.



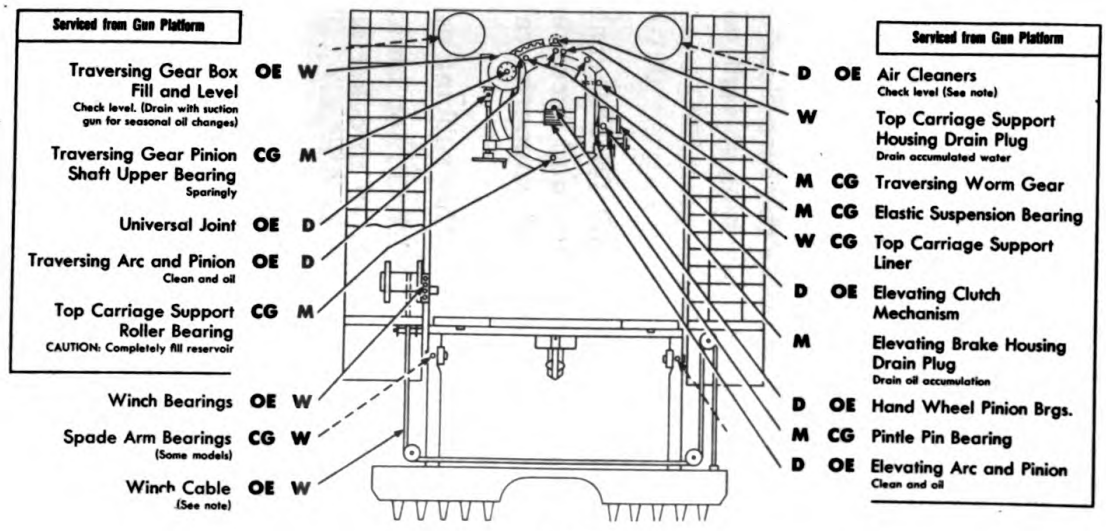
NOTE: This is not an exact reproduction of War Department Lubrication Order No. 9-747 although the same information is included.

Lubricant	Interval	Serviced from Engine Compartment
	3	Final Drive Drains — Drain and refill (See Gear Case note)
	3	Differential Drains — Drain and refill (See Gear Case note)
	3	Transmission Drain — Drain and refill (See Gear Case note)
GL		Clutch Release Bearing (See note)
BR		Clutch Pilot and Hub Bearings (See note)
OE	½	Crankcase Breather (See Air Cleaner note)
OE	1	Magnetos (OE-SAE 10) (For disassembly see Ord. note)
OE	½	Oil Tank Breather (See Air Cleaner note)
	½	Engine Oil Tank Drain — Drain and refill (See note) Cap. 52 qts.
	D	Oil Filter — Turn handle 1 full turn Every 250 miles, drain sediment
OE	D	Engine Oil Tank Fill and Level Check level (See note)

Interval	Lubricant	Serviced from Driver's Compartment
½	CG	Brake Shaft Bearings
½	OE	Trans. Diff. and Final Drive Breather (See Air Cleaner note)
W		Trans. Diff. and Final Drive Level — Check level (See Gear Case note)
	OE	Trans. Diff. and Final Drive Fill Cap. 152 qts.
3	CG	Speedometer and Tachometer Cables — Remove core and clean Coat lightly with No. 0
1	CG	Speedometer and Tachometer Adapters
½	CG	Gearshift Shaft — Lubricate 5 points—2 with CG and 3 with OE
1	CG	Tachometer Adapter Driveshaft Bearing
1	CG	Universal and Slip-Joints (To reach—remove tunnel and bulkhead plates)

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KEY

LUBRICANTS	LOWEST ANTICIPATED AIR TEMPERATURE		
	above +32° F.	+32° F. to 0° F.	below 0° F.
OE—OIL, engine			
Crankcase	OE 50	OE 30	See TM
Traversing Gear Box	OE 30	OE 10	OE 10
Transmission, Diff. and Final Drives	OE 50	OE 30	OE 30
Other Points	OE 30	OE 10	PS
CG—GREASE, general purpose	CG 1	CG 0	CG 0

LUBRICANTS
GL—GREASE, lubricating, special
BR—GREASE, ball and roller bearing
SAL—FLUID, shock absorber, light
RS—OIL, recoil, special
PS—OIL, lubricating, preservative, special

INTERVALS
D—Daily
W—Weekly
M—Monthly
¼—250 miles
½—500 miles
1—1000 miles
3—3000 miles

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Figure 8—Lubrication Order

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pad from the obturator spindle and clean all parts of the breech and firing mechanism, except the gas check pad, with bore-sponging solution. Rinse with clear water, dry thoroughly, and apply a film of oil. Daily, when the gun is not being fired, clean with dry-cleaning solvent, wipe dry, and oil. When disassembled, the gas check pad will be wiped clean (do not use dry-cleaning solvent or bore-sponging solution). Apply thin film of engine oil (SAE 30) or SAE 10 for all temperatures below +32°F.

(9) GUN BORE.

(a) Before firing, wipe clean and dry.

(b) Immediately after firing, while the tube is still hot, swab with a bore-sponging solution consisting of ½ pound of soda-ash to each gallon of warm water. Rinse thoroughly with clean water, wipe thoroughly dry, and apply a film of oil. The gun will not be allowed to remain after firing without cleaning. Repeat this procedure on 3 consecutive days thereafter or until there is no longer evidence of sweating.

(c) Daily when the gun is not being fired, wipe the bore clean and renew the oil film. Every 5 days, swab with dry-cleaning solvent, wipe thoroughly dry, and reoil.

(10) OILCAN POINTS.

(a) Every 250 miles, lubricate door hinges and latches, control lever bushings, control rod pins and clevises, clutch and accelerator pedals and control shaft bearings, seat slides and supports, cable sheaves, cable roller, spade arm linkage, and pintle.

(b) Weekly, lubricate handwheel handles and other rubbing parts.

(11) POINTS REQUIRING NO LUBRICATION. Do not lubricate bogie wheels suspension linkage and slides, final drive sprocket bearings, starter, or clutch throw-out yoke bearings.

(12) TO BE DISASSEMBLED PERIODICALLY BY ORDNANCE PERSONNEL:

(a) Generator. When disessembled for repair or overhaul, clean and repack bearings with ball and roller bearing grease.

(b) Magnetos. When disassembled for repair or overhaul, clean and repack bearings with ball and roller bearing grease.

(c) Equilibrator Guide Bearings. Every 6 months, disassemble, clean, and lubricate with special lubricating grease.

(d) Cradle Trunnion Bearings. Every 6 months, disassemble, clean, and lubricate with special lubricating grease.

(e) Counterbalance. Every 6 months, disessemble, wash all parts, and coat cylinder, piston, piston rod threads, and cylinder head threads with special lubricating grease.

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(f) Variable Recoil Gears. Every 6 months, remove gear housing cover, clean, and lubricate with general purpose grease.

(g) Traversing Gear Handwheel Shaft Bearing. When disassembled for inspection or overhaul, clean and repack with special lubricating grease.

(h) Traversing Gear Pinion Shaft Lower Bearing. When traversing gear box is disassembled for inspection and overhaul, clean and repack the bearing with special lubricating grease.

(i) Elevating Mechanism. When disassembled for inspection or overhaul, wash all parts, dry thoroughly, and repack roller bearings of the elevating pinion shaft and ball bearings of the brake drum gear shaft with special lubricating grease. Apply thin film of No. 0 general purpose grease to all gear teeth and the brake shoe guide bushings, being careful to wipe off all excess lubricant that might reach the brake drum or brake shoe. Fill grease grooves in clutch mechanism with light graphited grease.

e. Reports and Records.

(1) Report unsatisfactory performance of materiel to the Ordnance Officer responsible for maintenance in accordance with TM 38-250.

(2) A record of lubrication may be maintained in the Duty Roster (W.D., A.G.O. Form No. 6).

Section XIII

PREVENTIVE MAINTENANCE SERVICES

28. GENERAL INFORMATION.

a. Responsibility and Interval. Preventive maintenance services as prescribed by AR 850-15 are a function of using organization echelons of maintenance, and their performance is the responsibility of the commanders of such organizations. These services consist generally of before, during, at-halt, after-operation, and weekly services performed by the crew, and the scheduled services to be performed at designated intervals by organizational maintenance personnel.

b. Definition of Terms. The general inspection of each item applies also to any supporting member or connection, and is generally a check to see whether the item is in good condition, correctly assembled, secure, or excessively worn.

(1) The inspection for "good condition" is usually an external visual inspection to determine whether the unit is damaged beyond safe or serviceable limits. The term "good condition" is explained further by

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the following: Not bent or twisted, not chafed or burned, not broken or cracked, not bare or frayed, not dented or collapsed, not torn or cut, not deteriorated.

(2) The inspection of a unit to see that it is "correctly assembled" is usually an external visual inspection to see whether it is in its normal assembled position in the vehicle.

(3) The inspection of a unit to determine if it is "secure" is usually an external visual examination; a wrench, hand-feel, or a pry-bar check for looseness. Such an inspection must include any brackets, lock washers, lock nuts, locking wires, or cotter pins used in assembly.

(4) "Excessively worn" will be understood to mean worn beyond serviceable limits, or to a point likely to result in failure if the unit is not replaced before the next scheduled inspection.

29. CREW MAINTENANCE (FIRST ECHELON)

a. Purpose. To insure mechanical efficiency it is necessary that the vehicle be systematically inspected at intervals each day it is operated and weekly, so defects may be discovered and corrected before they result in serious damage or failure. Certain scheduled maintenance services will be performed at these designated intervals. Any defects or unsatisfactory operating characteristics beyond the scope of first echelon to correct must be reported at the earliest opportunity to the designated individual in authority. The services set forth in paragraphs 30, 31, 32, and 33 are those performed by the crew before operation, during operation, at halt, and after operation and weekly.

b. Use of W.D. Form No. 48. Driver preventive maintenance services are listed on the back of "Driver's Trip Ticket and Preventive Maintenance Service Record" W.D., Form No. 48, to cover vehicles of all types and models. Items peculiar to this vehicle but not listed on W.D., Form No. 48, are covered in manual procedures under the items with which they are related. Certain items listed on the form that do not pertain to this vehicle are eliminated from the procedures as written into the manual. Every organization must thoroughly school each crew in performing the maintenance procedures set forth in this manual, whether they are listed specifically on W.D., Form No. 48 or not. The items listed on W.D., Form No. 48 that apply to this vehicle are expanded in this manual to provide specific procedures for accomplishment of the inspections and services. The services are arranged to facilitate inspection and conserve the time of the crew and are not necessarily in the same numerical order as shown on W.D., Form No. 48. The item numbers, however, are identical with those shown on that form.

30. BEFORE-OPERATION SERVICE.

a. Purpose. This inspection schedule is designed primarily as a check to see that the vehicle has not been damaged, tampered with, or

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sabotaged since the "After-operation Service" was performed. Various combat conditions may have rendered the vehicle unsafe for operation and it is the duty of the crew to determine whether the vehicle is in condition to carry out any mission to which it is assigned. This operation will not be entirely omitted, even in extreme tactical situations.

b. Procedures. Before-operation Service consists of inspecting items listed below according to the procedure described, and correcting or reporting any deficiencies. Upon completion of the service, results will be reported promptly to the designated individual in authority.

(1) ITEM 1, TAMPERING AND DAMAGE. Examine entire vehicle, special equipment and armament, for any damage that may have occurred from falling debris, shell fire, sabotage or collision since parking. Check within engine and fighting compartments for above conditions and disconnected wiring or control linkage, loose drive belts and fuel or oil lines.

(2) ITEM 2, FIRE EXTINGUSHERS. Examine visible fixed extinguisher lines and nozzles in engine compartment for security, damage, and correct aiming. Check portable and fixed extinguisher cylinders for good condition, security and full charge.

(3) ITEM 3, FUEL AND OIL. Check supply of fuel and oil level in transmission and final drive; add as necessary. Check oil level in engine supply tank; add to correct level if necessary. Any appreciable change in level since After-operation Service should be investigated and reported.

(4) ITEM 4, ACCESSORIES AND DRIVES. Inspect carburetor, generator, starting motor and blower unit for looseness or damage. Be sure generator drive belts are in good condition and adjusted to have ½ inch finger pressure deflection.

(5) ITEM 6, LEAKS—GENERAL. Check under vehicle and in engine compartment for any indications of fuel or oil leaks. Inspect engine accessory mountings, oil filter, visible portions of oil coolers and oil and fuel lines for indications of leaks. Trace all leaks to their source and correct or report them.

(6) ITEM 8, PRIMER. As engine is being started, observe if primer functions satisfactorily and inspect for loose lines or brackets and traces of leaks.

(7) ITEM 7, ENGINE WARM-UP. Test for hydrostatic lock by hand cranking method (minimum test 50 revolutions with hand crank). Turn on master battery switch and fuel valves and start engine. Note action of starting mechanism, particularly whether starter has adequate cranking speed and engages and disengages properly without unusual noise. If oil pressure is not indicated immediately, stop engine and correct or report trouble. Set hand throttle so engine will idle at 800 revolu-

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tions per minute during warm-up, see that throttle operates freely and then proceed with following Before-operation Services.

(8) ITEM 9, INSTRUMENTS.

(a) Oil Pressure Gage. Engine oil pressure must be indicated when engine is idling and 40 to 70 pounds at 1,800 to 2,400 revolutions per minute. Stop engine immediately when "low oil" red light comes on.

(b) Ammeter. The ammeter may show high charge until generator has restored to battery the current used in starting the engine; then continue to register slight charge or zero with lights and accessories turned off.

(c) Tachometer and Revolution Counter. Tachometer should register engine revolutions per minute and revolution counter should register accumulating revolutions.

(d) Engine Oil Temperature Gage. Operating temperature as shown by gage should not exceed 190°F and should show 100 to 120°F before vehicle is moved.

(e) Fuel Gage. Gage should register amount of fuel in tanks. Use selector switch to check the amount of fuel in each tank. Normally, tanks will be full before operation and gage should register full.

(9) ITEM 10, SIREN AND WINDSHIELD WIPERS. If tactical situation permits, test siren for proper operation and tone. When used, inspect wiper blades and arms to see that they are in good condition and secure. Start wiper motors and observe if the blades operate through their full stroke and contact surfaces evenly.

(10) ITEM 11, GLASS. Clean all vision device glass and inspect for damage.

(11) ITEM 12, LIGHTS. Clean all lights and examine for looseness and damage. If tactical situation permits, operate all switches and observe if lamps respond satisfactorily.

(12) ITEM 13, WHEEL AND FLANGE NUTS. See that all drive sprocket, idler wheel, bogie wheel and support roller assembly and mounting nuts are present and secure.

(13) ITEM 14, TRACKS AND TIRES. While inspecting tracks for damage and loose connections, remove all stones and foreign objects from between blocks and tracks and wheels and rollers. See that all support and suspension wheel tires are in good condition and check track tension. On vehicles equipped with horizontal volute springs, there should be no bulge in track between idler wheels and rear suspension wheels or between the sprocket and forward suspension wheels.

(14) ITEM 15, SPRINGS AND SUSPENSIONS. Examine to see that volute springs and all bogie suspension units are in good condition and secure. On vehicles with horizontal suspension, see that shock absorbers are secure and not leaking.

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(15) ITEM 16, STEERING BRAKE LINKAGE. Inspect linkage for good condition, secure connections and mountings and free operation. Pull levers back to see whether they meet resistance evenly, slightly before vertical position. Levers released are correctly positioned when the horizontal distance from face of brake drum housing cover to front edge of lever is 7 to 7½ inches.

(16) ITEM 17, FENDERS. Inspect to see that fenders are in good condition and securely mounted.

(17) ITEM 18, TOWING CONNECTIONS. See that tow loops are in good condition and securely shackled. Inspect pintle hook for good condition, secure mounting and proper operation.

(18) ITEM 19, HULL, RAMP, WINCH AND TARPAULIN. Inspect hull for damage, broken welds, loose attachments and proper operation of entrance and escape hatches. Examine winch cables, sheaves and roller to see that they are in good condition and securely mounted. Be sure ramp is securely locked if in raised position. If in use, be sure tarpaulin bows are properly mounted and tarpaulin securely lashed; if not in use, tarpaulin must be securely stowed.

(19) ITEM 20, DECONTAMINATORS. Examine decontaminators for closed valves, full charge and secure mountings.

(20) ITEM 21, TOOLS AND EQUIPMENT. Check tools and equipment to see that all items are present, in good condition, and properly mounted or stowed.

(21) ITEM 22, ENGINE OPERATION. Engine should idle smoothly at 500 revolutions per minute. Accelerate engine several times after it has reached normal temperature, (8) *(d)* above, and note any unusual noises, unsatisfactory operating characteristics, or excessive exhaust smoke.

(22) ITEM 23, DRIVER'S PERMIT, FORM NO. 26. Driver must have his operator's permit on his person. Accident-Report Form No. 26, vehicle manual, Lubrication Order and W.D., A.G.O. Form No. 478, must be present, legible and safely stowed.

31. DURING-OPERATION SERVICE.

a. Observations. While vehicle is in motion, listen for any sounds such as rattles, knocks, squeals, or hums that may indicate trouble. Look for smoke from any part of the vehicle. Be alert for odors indicating overheated components or units (such as generator, brakes, or clutch) leaks in fuel system or exhaust system, or other trouble. When brakes are used, gears shifted, or the vehicle turned, consider this a test and note any unsatisfactory or unusual performance. Watch the instruments constantly for unusual behavior indicating possible trouble in systems to which they apply.

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b. Procedures. During-operation Services consist of observing items listed below according to the procedures following each item, and investigating any indications of serious trouble. Note minor deficiencies to be corrected or reported at earliest opportunity, usually the next scheduled halt.

(1) ITEM 26, STEERING BRAKES. With vehicle in motion. apply each brake independently. Observe if there is normal response without excessive pull or lever travel. Disengage clutch, apply both levers and observe if brakes stop vehicle effectively, meeting resistance slightly before vertical position.

(2) ITEM 27, PARKING BRAKE. Stop vehicle on a reasonable incline and apply parking brake lock to see if brakes hold satisfactorily and lock holds levers securely in the applied position.

(3) ITEM 28, CLUTCH. Clutch release mechanism should operate freely without excessive noise. Clutch should not grab, chatter or squeal upon engagement and should not slip under load when fully engaged. Pedal free travel should be maintained at approximately 1¾ inches.

(4) ITEM 29, TRANSMISSION. Transmission should shift into all gear ranges easily without unusual noise and should not slip out of mesh during operation. Be on the alert for any unusual noise during operation.

(5) ITEM 31, ENGINE AND CONTROLS. Driver should be on the alert for deficiencies in engine performance such as lack of power and acceleration, misfiring, backfiring, unusual noise or indication of overheating or excessive smoke. Observe whether or not engine accelerates satisfactorily and controls operate without excessive looseness or binding. If radio noise during operation of vehicle is reported, driver will cooperate with radio operator in locating the interference.

(6) ITEM 32, INSTRUMENTS. Observe the readings of all pertinent instruments frequently during operation, to see whether they are indicating proper function of units to which they apply, and that speedometer registers vehicle speed and records accumulating mileage.

(7) ITEM 34, RUNNING GEAR. Listen for any unusual noise from tracks, wheels, rollers, bogie wheels and final drives that might indicate looseness, damage, excessive wear or inadequate lubrication.

32. AT-HALT SERVICE.

a. Importance. At-halt Services may be regarded as minimum maintenance procedures, and should be performed under all tactical conditions even though more extensive maintenance services must be slighted or omitted altogether.

b. Procedures. At-halt Services consist of investigating any de-

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ficiencies noted during operation, inspecting items listed below according to the procedures following the items, and correcting any deficiencies found. Deficiencies not corrected should be reported promptly to the designated individual in authority.

(1) ITEM 38, FUEL AND OIL SUPPLY. Make sure that there is adequate fuel and oil to operate vehicle to next scheduled stop; replenish as supply and tactical situation permits.

(2) ITEM 39, TEMPERATURES (HUBS, TRANSMISSION, FINAL DRIVE AND, WHEN SO EQUIPPED, SHOCK ABSORBERS). Place hand cautiously on each track wheel and track support roller hub to see whether they are abnormally hot. If wheel hubs are too hot to touch with the hand, bearings may be inadequately lubricated, damaged or improperly adjusted. Check the transmission and final drives for overheating or excessive oil leaks. On vehicles equipped with horizontal spring suspension, shock absorbers should feel warm. If the shock absorbers do not become warm when the vehicle is being operated, it is an indication that the fluid is low or the shock absorber is not functioning.

(3) ITEM 40, VENTS. Examine vents of transmission and final drives to see that they are present and not damaged or clogged.

(4) ITEM 42, SPRINGS AND SUSPENSIONS. Inspect these items for looseness or damage. Remove stones and other foreign objects embedded in suspension system or between tracks.

(5) ITEM 43, STEERING BRAKE LINKAGE. Inspect linkage for looseness or damage and investigate any irregularities noted during operation.

(6) ITEM 44, WHEEL AND FLANGE NUTS. See that all sprocket, idler and bogie wheel and support roller assembly and mounting nuts are present and secure.

(7) ITEM 45, TRACKS. Examine tracks, bogie wheels, tires and idlers to see that they are secure and not damaged. Make sure that track tension is satisfactory. Clean out stones and trash from track links and connectors.

(8) ITEM 46, LEAKS—GENERAL. Inspect generally for indications of fuel and oil leaks. See whether there are any indications of leaks in gear case, oil tank, oil cooler, filter or lines. Trace any leaks to their source and correct or report them.

(9) ITEM 47, ACCESSORIES AND BELTS. Examine engine accessories, blower and attachments to be sure they are secure, properly alined and that generator drive belts are in good condition and tension satisfactory. Belts should have ½ inch deflection under normal finger pressure. If radio noise caused by operation of the engine was observed, examine all wiring harness and coupling rings and nuts; engine, regu-

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lator and master switch bonding straps and regulator filters for damage and loose connections and mountings.

(10) ITEM 48, AIR CLEANERS. When operating under extremely dusty or sandy conditions, inspect air cleaners and breather caps at each halt to see that they are in condition to deliver clean air properly; service as required.

(11) ITEM 49, FENDERS. Inspect fenders for good condition and secure mounting.

(12) ITEM 50, TOWING CONNECTIONS. Inspect pintle hook for good condition, secure mounting and proper operation.

(13) ITEM 51, HULL, RAMP, WINCH AND TARPAULIN. Inspect these items for damage or loose attachments. If in use, be sure tarpaulin is securely lashed, or if not in use, securely stowed.

(14) ITEM 52, GLASS. Clean all vision devices and light lenses; inspect these items for damage and security.

33. AFTER-OPERATION AND WEEKLY SERVICE.

a. Purpose. After-operation servicing is particularly important because at this time the crew inspects the vehicle to detect any deficiencies that may have developed, and to correct those they are permitted to handle. They should promptly report results of the inspection to the designated individual in authority. If this schedule is performed thoroughly, the vehicle should be ready to roll again on a moment's notice. The Before-operation Service, with few exceptions, is then necessary only to ascertain whether the vehicle is in the same condition in which it was left upon completion of the After-operation Service. The After-operation Service should never be entirely omitted, even in extreme tactical situations, but may be reduced to the bare fundamental services outlined for the At-halt Service, if necessary.

b. Procedures. When performing the After-operation Service the crew must remember and consider any irregularities noticed in the Before-operation, During-operation, and At-halt Services. The After-operation Service consists of inspecting and servicing the following items. Those items of the After-operation Service that are marked by an asterisk (*) require additional Weekly Services, the procedures for which are indicated in subparagraph *(b)* of each applicable item.

(1) ITEM 55, ENGINE OPERATION. Accelerate and decelerate the engine and note any tendency to miss or backfire or any unusual noise or vibration that might indicate worn parts, loose mountings, incorrect fuel mixture or faulty ignition. Investigate any deficiencies noted during operation and correct or report same.

(2) ITEM 56, INSTRUMENTS. Check all pertinent instruments to be sure they are operating properly and continue to register or in-

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dicate correct performance of units to which they apply. Inspect them for looseness or damage. Stop engine.

(3) ITEM 54, FUEL AND OIL SUPPLY. Refill both fuel tanks. Check oil level in engine supply tank and fill to correct level. CAUTION: *Do not fill fuel and oil tanks to overflowing; allow room for expansion.* See that any fuel or oil used from spare supply cans is replenished.

(4) ITEM 57, SIREN AND WINDSHIELD WIPERS. If tactical situation permits, test siren for proper operation and tone. If in use, see that windshield wipers operate properly and inspect blades and arms for good condition and security.

(5) ITEM 58, GLASS. Clean all vision devices and inspect for damage.

(6) ITEM 59, LIGHTS. Clean all light lenses and examine for broken parts and security of mounting. Turn on switches to see that all lamps operate.

(7) ITEM 60, FIRE EXTINGUISHERS. Inspect visible lines and nozzles and all cylinders, fixed and portable, to see that they are in good condition, secure and not leaking. If extinguishers have been used or valve opened, report for exchange or refill.

(8) ITEM 61, DECONTAMINATORS. Inspect decontaminators for damage and security of mounting.

(9) ITEM 61, *BATTERIES.

(a) Inspect batteries for leaks or damage and security of mounting and connections.

(b) Weekly. Clean batteries and carrier and inspect for loose or corroded terminals. If terminals are corroded, remove, clean and apply a thin film of grease. Add clean water to bring level to ½ inch above cell plates. NOTE: *In freezing temperatures, do not add water until just before vehicle is to be operated.*

(10) ITEM 63, *ACCESSORIES.

(a) Examine all accessible items in engine compartment and blower unit to see that they are in good condition, clean and secure. Check generator drive belt tension; they should have ½-inch finger pressure deflection.

(b) Weekly. Inspect all accessible units mounted on engine accessory case for looseness, damage and oil leaks at mounting pads. Clean out all insects or trash from in and around oil cooler core air passages.

(11) ITEM 64, ELECTRIC WIRING. Examine conduits for looseness or damage. Tighten all loose connections and clean all accessible wiring. Be sure all radio noise suppression bond clips, straps, filters,

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condensers and suppressors are securely connected or mounted (pars. 131 to 136). Tighten wiring conduit coupling ring nuts.

(12) ITEM 65, AIR CLEANERS AND BREATHER CAP. Inspect to see that air cleaner and breather cap are in good condition, securely mounted and connected. Examine for excessive dirt and proper oil level and service as necessary, according to paragraphs 26 and 27 in Lubrication Order.

(13) ITEM 66, FUEL FILTER. Inspect to see that main fuel filter is secure and not leaking. (The filter location is such that complete inspection is possible only after engine has been removed.)

(14) ITEM 67, ENGINE CONTROLS. Inspect accelerator, hand throttle and fuel shut-off controls for excessive wear and disconnected linkage.

(15) ITEM 68, TRACKS AND TIRES. Examine tracks for damage, dead blocks and loose or worn connections. Remove all stones or foreign objects from between blocks and tracks and wheels and rollers. Inspect all support and suspension wheel tires to see that they are not cut, torn or loose on the wheels. Inspect tracks for loose lock pins and satisfactory track tension, there should be no track bulge between the idler wheels and rear suspension wheels and between the sprockets and forward suspension wheels. CAUTION: *Do not adjust tracks on vehicles equipped with horizontal volute springs too tight.*

(16) ITEM 69, SPRINGS AND SUSPENSION. Inspect volute springs to see that they are in good condition and properly assembled. See that all mounting bolts are secure and that support and suspension rollers are not damaged or excessively worn. Examine shock absorbers for loose mountings, worn bushings or leaks.

(17) ITEM 70, STEERING BRAKE LINKAGE. Inspect levers, linkage and cross shafts for good condition, security, adequate lubrication and free operation. Investigate any unsatisfactory performance noticed during operation. Steering levers should have 1 to 4½ inches of free travel and meet resistance slightly before the vertical position. Check released position of levers. Levers are correctly positioned when horizontal distance from face of brake drum housing covers to front edge of lever is 7 to 7½ inches.

(18) ITEM 71, PROPELLER SHAFT (WEEKLY ONLY). Examine shaft and universal joints to see that they are in good condition, secure and that joints are not leaking.

(19) ITEM 72, *VENTS.

(*a*) Inspect transmission and final drive vents to see that they are in good condition, secure and not clogged.

(*b*) *Weekly.* Remove vents, clean thoroughly and install securely.

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(20) ITEM 73, LEAKS—GENERAL. Inspect all fuel and oil lines, connections, tanks, coolers, transmission and final drive for indication of leaks. Trace any leaks found to their source and correct or report them.

(21) ITEM 76, FENDERS. Inspect fenders to be sure they are securely mounted and not damaged.

(22) ITEM 77, TOWING CONNECTIONS. Be sure towing loops are in good condition and securely shackled. Examine pintle hook for good condition and proper operation.

(23) ITEM 78, HULL, RAMP, WINCH AND TARPAULIN. Examine hull for broken welds or loose attachments. Test action of spade and ramp winch to be sure it operates properly. Inspect winch cable for worn spots or frayed strands. When ramp is in lowered position, be sure spade contacts the ground securely. When ramp is in raised position, see that it locks securely. Examine tarpaulin and bows to see that they are in good condition and stow them properly.

(24) ITEM 79, ARMOR. Examine armor, and gun mount shields for fractures or damage that would render vehicle unsafe for combat duty.

(25) ITEM 80, VISION DEVICES. Inspect the periscope prisms and windows to see that they are in good condition, clean and secure in holders. CAUTION: *Prisms should be cleaned only with a soft cloth or brush.*

(26) ITEM 81, GUN: MOUNTING, ELEVATING AND TRAVERSING CONTROLS. Be sure that gun is secure on its mount, clean, lightly oiled and in condition for immediate use. Test gun elevating mechanism and controls for proper operation. Be sure that traversing mechanism is in good condition and operates satisfactorily. Correct or report to designated authority any deficiencies noticed during operation.

(27) ITEM 82, *TIGHTEN.

(a) Tighten any unit mountings and assembly nuts or screws where inspection has indicated the necessity.

(b) Weekly. Tighten sprocket and idler flange nuts, track connector wedge nuts, universal joint flange, gun mounts, tool and equipment mountings, ammunition racks and clips or any other item where inspection or experience indicated the necessity on a weekly or mileage basis.

(28) ITEM 83, *LUBRICATION.

(a) Oil or grease escape hatch hinges and locking devices, compartment door hinges and latches, tow shackles and any other point of vehicle where inspection has indicated that it is necessary.

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(b) Weekly. Lubricate all points of the vehicle indicated on the Lubrication Order as necessary on a weekly basis.

(29) ITEM 84, *CLEAN ENGINE AND VEHICLE.

(a) Remove all empty shell casings and refuse from interior of vehicle. Wipe up oil or fuel drippings from driving compartment, and engine compartment. Remove excess dirt, stones and grease from tracks and suspension. See that engine compartment grilles are clear of obstructions.

(b) Weekly. Wash exterior of vehicle and remove all dirt and mud. If washing is impractical, wipe as clean as possible and watch for bright spots that would cause glare. Open engine compartment and wipe out all excess dirt. If compressed air is available, blow all dirt out of cylinder cooling fins and oil cooler core air passages.

(30) ITEM 85, *TOOLS AND EQUIPMENT.

(a) Check vehicle tools and equipment stowage lists, section III, to be sure all items are present and see that they are in serviceable condition and properly stowed or mounted.

(b) Weekly. Clean tools and equipment; mount or stow securely in proper location on, or in vehicle.

34. ORGANIZATIONAL MAINTENANCE (SECOND ECHELON).

a. Frequency. The frequency of preventive maintenance services outlined herein is considered a minimum requirement for normal operation of vehicles. Under unusual operating conditions such as extreme temperatures, severe dust, sandy or extremely wet terrain, it may be necessary to perform certain maintenance services more frequently.

b. First Echelon Participation. The crew should accompany their vehicle and assist the mechanics while periodic second echelon preventive maintenance services are performed. Ordinarily the vehicle should be presented for a scheduled preventive maintenance service in a reasonably clean condition; that is, it should be dry, and not caked with mud or grease to such an extent that inspection and servicing will be seriously hampered. However, the vehicle should not be washed or wiped thoroughly clean, because certain types of defects, such as cracks, leaks, and loose or shifted parts or assemblies, are more evident if the surfaces are slightly soiled or dusty.

c. Sources of Additional Information. If instructions other than those contained in the general procedures in subparagraph ***d***, or the specific procedures in subparagraph ***i***, which follow, are required for proper performance of a preventive maintenance service or for correction of a deficiency, they may be secured from other sections of this manual or from the designated individual in authority.

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d. General Procedures. These general procedures are basic instructions which are to be followed when performing the services on the items listed in the specific procedures. NOTE: *The second echelon personnel must be thoroughly trained in these procedures so that they will apply them automatically.*

(1) When new or overhauled subassemblies are installed to correct deficiencies, care must be taken to see that they are clean, correctly installed, and properly lubricated and adjusted.

(2) When installing new lubricant retainer seals, a coating of the lubricant should be wiped over the sealing surface of the lip of the seal. When the new seal is a leather seal, it should be soaked in SAE 10 engine oil at least 30 minutes. The oil should be warm, if practicable. Then, the leather lip should be worked carefully by hand before installing the seal. The lip must not be scratched or marred.

e. Definition of Terms. Refer to paragraph 28 *b.*

f. Special Services. These are indicated by repeating the item numbers in the columns which show the interval at which the services are to be performed and show that the parts or assemblies are to receive certain mandatory services. For example, an item number in one or both columns opposite a TIGHTEN procedure, means that the actual tightening of the object must be performed. The special services include:

(1) ADJUST. Make all necessary adjustments in accordance with the pertinent section of this manual, special bulletins, or other current directives.

(2) CLEAN. Clean units of the vehicle with dry-cleaning solvent to remove excess lubricant, dirt, and other foreign material. After the parts are cleaned, rinse them in clean solvent and dry them thoroughly. Take care to keep the parts clean until reassembled and be certain to keep cleaning solvent away from rubber or other material which it will damage. Clean the protective grease coating from new parts since this material is usually not a good lubricant.

(3) SPECIAL LUBRICATION. This applies both to lubrication operations that do not appear on the vehicle Lubrication Order and to items that do appear on the Order, but which should be performed in connection with the maintenance operations if parts have to be disassembled for inspection or service.

(4) SERVE. This usually consists of performing special operations, such as replenishing battery water, draining and refilling units with oil, and changing or cleaning the oil filter, air cleaner, or cartridges.

(5) TIGHTEN. All tightening operations should be performed with sufficient wrench torque (force on the wrench handle) to tighten the unit according to good mechanical practice. Use a torque-indicating wrench where specified. Do not overtighten, as this may strip threads

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or cause distortion. Tightening will always be understood to include the correct installation of lock washers, lock nuts, lock wire, or cotter pins provided to secure the tightening.

g. Special Conditions. When conditions make it difficult to perform all preventive maintenance procedures at one time, they can sometimes be handled in sections, planning to complete all operations within the week if possible. All available time at halts and in bivouac areas must be utilized, if necessary, to assure that maintenance operations are completed. When time is limited by the tactical situation, items with Special Services in the columns should be given first consideration.

h. Work Sheet. The numbers of the preventive maintenance procedures that follow are identical with those outlined on W.D., A.G.O. Form No. 462, which is the "Preventive Maintenance Service Work Sheet for Full Track and Tank-like Wheeled Vehicles." Certain items on the work sheet that do not apply to this vehicle are not included in the procedures in this manual. In general, the numerical sequence of items on the work sheet is followed in the manual procedures, but in some instances there is deviation for conservation of the mechanic's time and effort.

i. Specific Procedures. The procedures for performing each item in semimonthly and monthly maintenance procedures, are described in the following chart. Each page of the chart has two columns at its left edge corresponding to the monthly and the semimonthly maintenance respectively. Very often it will be found that a particular procedure does not apply to both scheduled maintenances. In order to determine which procedure to follow, look down the column corresponding to the maintenance due, and wherever an item number appears, perform the operations indicated opposite the number. NOTE: *Those procedures preceded by an asterisk (*) require additional services at each third monthly operation.*

ROAD TEST

MAINTENANCE	
Monthly	Semi-Monthly
1	1
2	2

NOTE: *When the tactical situation does not permit a full road test, perform those items which require little or no movement of the vehicle. When a road test is possible, it should be preferably for 3 miles, but not over 5 miles.*

BEFORE-OPERATION SERVICE. Perform the Before-operation Service as outlined in paragraph 29.

INSTRUMENTS AND GAGES. Check these items as follows:

Oil Pressure Gage. Engine oil pressure must be indicated when engine is idling, and 40 to 70 pounds at 1,800 to

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MAINTENANCE	
Monthly	Semi-Monthly

MAINTENANCE		
Monthly	Semi-Monthly	
		position of steering levers. Levers are correctly positioned when horizontal distance from face of brake drum housing cover to front edge of lever is 7 to 7½ inches.
6	6	CLUTCH (FREE TRAVEL, DRAG, NOISE, GRAB, CHATTER AND SLIP). Test pedal for correct free travel, approximately 1¾ inches (par. 98 *b*). Clutch should not drag, and should engage without unusual noise, grab, or chatter. Test clutch for slippage under load, when fully engaged.
7	7	TRANSMISSION (LEVER ACTION, VIBRATION AND NOISE). Shift through each speed range of transmission. Observe whether control lever operates properly and whether there are any unusual vibrations or noise in any speed range that might indicate damage, excessive wear, loose mountings, or improper lubrication.
9	9	ENGINE (IDLE, ACCELERATION, POWER, NOISE, SMOKE AND OIL CONSUMPTION). *Idle.* With the vehicle stopped, observe if engine runs smoothly at normal idling speed of 500 revolutions per minute. Throughout road test, observe whether there is any tendency of engine to stall when accelerator is released and hand throttle closed. *Acceleration, Power, Vibration and Noise.* Test engine for normal acceleration and pulling power in each speed range. While testing in high range, accelerate engine from low speed with wide open throttle to top speed and listen for unusual engine noise, ping, or vibration that might indicate loose, damaged, excessively worn, or inadequately lubricated engine parts or accessories. Governed engine speed should be approximately 2400 revolutions per minute. During road test, look for excessive smoke from exhaust or engine compartment. *Oil Consumption.* At completion of road test, a check should be made to see if engine has been consuming an excessive amount of oil.
10	10	UNUSUAL NOISE (PROPELLER SHAFTS AND U-JOINTS, FINAL DRIVES, SPROCKETS, IDLERS, BOGIE WHEELS, SUPPORT ROLLERS AND TRACKS). During road test, listen for any unusual noise in any of the above mentioned items indicating damaged, defective or loose parts, or inadequate lubrication.
11	11	TEMPERATURES. (TRANSMISSION, DIFFERENTIAL, FINAL DRIVE, HUB AND, WHEN SO EQUIPPED, SHOCK ABSORBERS). Place hand cau-

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MAINTENANCE		
Monthly	Semi-Monthly	
		tiously on each track wheel and track support roller hub to see whether they are abnormally hot. If wheel hubs are too hot to touch with the hand, bearings may be inadequately lubricated, damaged or improperly adjusted. Check the transmission and final drives for overheating or excessive oil leaks. Shock absorbers should feel warm. If the shock absorbers do not become warm when the vehicle is being operated, it is an indication that the fluid is low or the shock absorber is not functioning.
12	12	GUN ELEVATING AND TRAVERSING MECHANISM. Traverse gun through its full range and check for binding, excessive lash, or erratic action. Test gun elevating controls to see if they operate and all mechanism responds properly.
13	13	LEAKS (ENGINE OIL AND FUEL). Look in engine compartment and under vehicle for indications of oil or fuel leaks. Examine all visible oil lines and connections for leaks.
14	14	NOISE AND VIBRATIONS (ENGINE, MOUNTINGS, ACCESSORIES, CLUTCH AND EXHAUST). While accelerating and decelerating engine, listen for unusual noise in engine or accessories. Notice whether there is excessive vibration that may indicate loose engine mountings or noise that may indicate loose or inadequately lubricated clutch parts or release bearings.
15	15	TRACK TENSION. Inspect tracks for satisfactory tension. There should be no track bulge between idle wheels and the rear suspension wheels and the sprocket and the forward suspension wheels. CAUTION: *Do not adjust tracks on vehicles with horizontal volute springs too tight* (par. 117).
		MAINTENANCE OPERATIONS
16	16	FUEL PUMP TEST. Attach a fuel pump test gage to fuel line to carburetor, and with engine running at idling speed, determine whether the pressure is within the specified limits, approximately 3½ pounds (par. 73).
18	18	SIDE ARMOR (FENDERS, GUARDS, PAINT AND MARKINGS, TOW SHACKLES AND PINTLE AND HORN). Examine vehicle for damage to side armor, fenders, and guards from shell fire or collision; check for broken welds. Look for rust or bright spots in paint that might cause reflections. See that all vehicle markings are

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MAINTENANCE		
Monthly	Semi-Monthly	
		legible. Examine towing shackles and pintle to see that they are in good condition and securely mounted. Test siren for proper operation and tone.
19	19	BOTTOM (ARMOR, ESCAPE HATCH, INSPECTION PLATE AND DRAIN PLUGS). Inspect hull bottom for damage. See that escape hatch latch operates properly and is adequately lubricated and see that all drain plugs are tight. Apply a few drops of oil to escape hatch latches. CAUTION: *Do not fully open escape hatch latch.*
20	20	DIFFERENTIAL AND FINAL DRIVES. Inspect housings to see that they are in good condition and not leaking; check lubricant level. See that all assembly and mounting bolts are secure. NOTE: *If change of lubricant is due, drain and refill with specified oil at this time.*
20		*Tighten.* Tighten all external assembly and mounting bolts securely.
21	21	TRACK (BLOCKS, LINKS, CONNECTORS, AND WEDGES). Inspect tracks to see that these items are in good condition, correctly assembled, and secure. Pay particular attention to loose connectors; bottomed wedges, and dead blocks. Tighten wedge nuts.
21		*NOTE: *Whenever the tracks are disconnected and removed from the sprockets, support rollers, and idlers, or at each third monthly maintenance service, the related items 22 and 25 marked by an asterisk (*) on the Preventive Maintenance Service Work Sheet, W.D., A.G.O. Form No. 462, should be inspected as described below in the asterisk-marked procedures.* On the regular semi-monthly to monthly maintenance services the tracks should not be removed unless repairs are needed. CAUTION: *Whenever tracks are removed for repair or replacement, do not reinstall tracks until the services followed by the asterisk (*) in items 22 and 25 have been completed.*
22	22	IDLER (WHEELS, ARMS, GUIDE PLATES, ADJUSTMENT AND LOCK NUTS AND SPRINGS). Inspect these items to see that they are in good condition, correctly assembled, secure, and that grease is not leaking excessively from wheel bearing seals. Be sure adjusting nut and adjusting pin nut are secure. Tighten all assembly and mounting bolts and nuts securely.
22		*NOTE: *In addition to the above, at each third monthly maintenance service or whenever the tracks are removed from the idlers, check the idler hub bearings for looseness*

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MAINTENANCE		
Monthly	Semi-Monthly	
		or end play. Spin the idler wheels and listen for any unusual noise that might indicate a damaged, excessively worn or inadequately lubricated bearing.
23	23	BOGIE (LEVERS, ARMS, LINKS, GUDGEONS, COLLARS AND GUIDES, VOLUTE SPRINGS AND SEATS, FRAMES AND WEARING PLATES). Inspect to see that these items are in good condition, correctly assembled and secure, and that gudgeons, collars, guides and wearing plates are not excessively worn. Note whether volute springs have taken a permanent set (9 inches between spring seats). Those conditions will be considered a standard for replacement (par. 123).
23		*Tighten.* Tighten all assembly and mounting nuts or screws securely.
24	24	WHEELS (TIRES, ROLLERS AND SKIDS). Inspect these items to see that they are in good condition, correctly assembled and securely mounted. Pay particular attention to see that tire rubber has not separated from rim and that tires are not cut, torn or excessively worn. Inspect for excessive lubricant leaks from bearings.
24		Jack up bogie wheels and examine bearings for looseness and end play. Spin wheels and listen for any unusual noise. Tighten assembly and mounting bolts securely.
25	25	SPROCKETS (HUBS, TEETH, AND NUTS). Examine sprockets to see that they are in good condition, correctly assembled and securely mounted. Inspect sprocket teeth for excessive wear and shaft flange gaskets, or oil seals for excessive lubricant leaks. If sprocket teeth are excessively worn, sprocket should be replaced or reversed. Tighten assembly and mounting bolts securely.
25		*NOTE: *In addition to the above, at each third monthly operation, or whenever the track is disconnected and removed from the sprocket, check the sprocket teeth for excessive wear and see that sprockets are secure. Check the sprocket hub bearings for looseness and end play. After performing the above, reinstall the tracks and connect them securely.*
26	26	TRACK TENSION. Inspect tracks for satisfactory tension. There should be no track bulge between the idler wheels and rear suspension wheels and between the sprockets and the forward suspension wheels. CAUTION: *Do not adjust tracks too tight on vehicles equipped with horizontal volute springs.*
27	27	TOP ARMOR (RAMP, WINCH, DECK, PAINT AND MARKINGS, GRILLES, DOORS, HATCHES,

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MAINTENANCE		
Monthly	Semi-Monthly	
		LATCHES, AND ANTENNA MAST). Inspect these items to see that they are in good condition and secure. See that hatch, door, grille and hatch hinges and latches operate properly, are not excessively worn, and are adequately lubricated, and that grilles are not obstructed. Be sure that the winch raises and lowers the ramp and spade properly, and that ramp extension slides freely and ramp support operates properly. Examine winch cables for worn spots or frayed strands, and cable sheaves and rollers for correct alinement and operation. Examine paint for rust spots or polished surfaces that may cause reflections and see that vehicle markings are legible.
28	28	CAPS AND GASKETS (FUEL TANK). Inspect to see that these items are in good condition, secure and not leaking. Be sure gaskets are in place and serviceable.
30		ENGINE REMOVAL (WHEN REQUIRED). Remove engine on monthly maintenance service, only if inspections made in Items 6, 9, 13, and 14, and a check of records on oil consumption indicated definite need. CAUTION: *Be sure the magnetos are grounded when removing engine.*
30	30	*Clean.* Clean exterior of engine and dry thoroughly, taking care to keep dry-cleaning solvent away from electrical wiring, terminal boxes, and equipment.
31		VALVE MECHANISM (CLEARANCE, LUBRICATION, ROCKER BOXES, AND PUSH ROD HOUSING). NOTE: *Perform Item 31 only when engine is removed from the vehicle.* Adjust valve clearance to 0.006 inch cold; also inspect valve tappets, rocker arms and shafts, and valve springs to see that they are in good condition, correctly assembled, and secure and that oil is going to rocker arms and shafts properly. Inspect rocker arms and shafts for excessive wear and rocker arm rollers for flat spots. Inspect rocker box covers to see that they are in good condition and gaskets are serviceable. See that push rods are in good condition.
32		SPARK PLUGS. Remove spark plugs. Examine insulators for cracks or breaks and electrodes for excessive burning and wide gaps. Adjust and/or replace plugs with gaps in excess of 0.017 to 0.019 inch. Be sure to install new gaskets and do not over-tighten plugs.
34	34	GENERATORS AND STARTING MOTOR. Inspect these items to see that they are in good condition and securely mounted. Make sure wiring connections are

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MAINTENANCE		
Monthly	Semi-Monthly	
		secure. Inspect generator drive belts to see that they are in good condition and properly adjusted to have ½ inch finger-pressure deflection.
34		*Serve.* Remove commutator inspection covers and examine commutators to see that they are in good condition. See that brushes are free in brush holders, clean, and not excessively worn; that brush connections are secure and that wires are not broken or chafing. Clean commutator ends of generator and starter by blowing out with compressed air. Tighten starter and generator mounting bolts securely.
37	37	MAGNETOS. See that magnetos are in good condition and securely mounted, and note whether there is evidence of oil leaks at mounting pad gaskets. Remove breaker point inspection covers to see that points are not pitted, are clean and well alined with mating surfaces and are engaging squarely.
37		*Adjust.* Adjust magneto breaker point gaps to 0.008 to 0.010 inch (par. 64).
67		MAGNETO TIMING. Check and set ignition timing according to instructions in paragraph 64 *c* (3).
38	38	IGNITION WIRING AND CONDUITS. Inspect all ignition wiring and conduits, particularly radio noise suppression shielding from magnetos to spark plugs and instrument panel. See that shielding is in good condition, clean, properly and securely connected and supported so as not to chafe against other parts. Wipe all exposed wiring clean with a dry cloth. NOTE: *Do not disturb connections unless actually loose.*
39	39	BOOSTER COIL. Examine booster coil and conduits to see that they are in good condition, clean and securely mounted.
40	40	ENGINE (OIL PUMPS, SUMP, OIL SCREENS AND LINES, ACCESSORY CASE, CRANKCASE, FUEL SCREENS AND LINES, AND CONTROL LINKAGE). Inspect to see that these items are in good condition and secure, and that oil is not leaking from oil pumps, sump, lines, accessory case or crankcase. Inspect fuel lines to engine for leaks. Remove oil pump screens, clean them thoroughly in dry-cleaning solvent, dry, and reinstall. See Lubrication Order (par. 26 and 27).
40		*Serve.* Drain off oil from the engine sump. Tighten accessible assemblies and mounting bolts and screws securely.

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MAINTENANCE	
Monthly	Semi-Monthly
42	42
43	43
44	44
45	45
46	46
46	
47	47

BREATHER CAP. Inspect crankcase breather cap to see that it is in good condition, securely mounted and not leaking. Remove the cleaner element, wash in dry-cleaning solvent, dry, reoil and reinstall. See Lubrication Order pars. 26 and 27).

AIR CLEANERS (CARBURETOR). Inspect air cleaner parts to see if they are in good condition. Clean the reservoirs and elements in dry-cleaning solvent and drain. Fill reservoirs to correct level with clean or used engine oil. Reassemble cleaners, making certain all gaskets are in good condition and in place; give special attention when mounting to see that cleaners are pressed firmly in place against air horn seals and that cleaners are securely fastened.

CARBURETOR (THROTTLE LINKAGE, GOVERNOR, AND PRIMER). Inspect unit to see that it is in good condition, correctly assembled and securely mounted. See that carburetor does not leak, that throttle control linkage is not excessively worn and operates freely, and that governor is properly sealed. Also, make sure that lines of priming system are in good condition, secure and not leaking. Remove screen from carburetor fuel inlet, clean in dry-cleaning solvent, dry, and reinstall. stall.

MANIFOLDS (INTAKE AND EXHAUST). Inspect to see that manifolds and gaskets are in good condition, correctly assembled, and secure. Tighten intake pipes at their flanges, clamps, and gland-packing nuts. Check for indications of leaks by looking for excessive carbon streaks.

CYLINDERS. Inspect to see that cylinders are in good condition and secure, and note whether there are indications of oil leakage or blow-by around studs or gaskets. Inspect cylinders to see whether the cooling fins are clogged. CAUTION: *Cylinder hold-down nuts should not be tightened, unless there is a definite indication of looseness or leaks.* If tightening is necessary, use a torque indicating wrench and tighten to 30 foot-pounds tension.

Clean. Clean excess deposits of dirt or grease from between and around cylinder cooling fins.

ENGINE (COWLING, AIR DEFLECTORS, FLYWHEEL, FAN, STEADY BAR AND SUPPORT

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MAINTENANCE		
Monthly	Semi-Monthly	
		BEAM). Inspect to see that these items are in good condition, clean, correctly assembled, and securely mounted. *Be sure cowling inspection covers are all in place.*
47		*Tighten.* Tighten all accessible mounting and assembly bolts or screws securely. See that cowling and shrouds are properly alined and do not interfere with fan.
48		CLUTCH ASSEMBLY. On those engines that are removed only, disassemble clutch, clean parts thoroughly, and inspect for excessive wear or damage. If any part is unserviceable, report condition to higher echelon.
50	50	ACCESSORY DRIVES. Inspect generator drive belts to see that they are in good condition. See that drive belts and pulleys are well alined and not bottoming in the drive pulleys. Adjust generator drive belt to have ½-inch deflection from normal finger-pressure.
51	51	ENGINE COMPARTMENT (BULKHEAD AND CONTROL LINKAGE). Check to see that engine compartment, including bulkhead, is in good condition and clean, and that control linkage in engine compartment is in good condition and securely connected and mounted.
51		*Clean.* Clean engine compartment thoroughly.
52	52	ENGINE OIL (TANK, COOLER, LINES AND FITTINGS). Inspect to see that these items are in good condition, correctly assembled, securely mounted and not leaking. Check oil level and inspect sample of oil on dip stick for grit, water or dilution. See that filler cap and gasket are in good condition and seal properly.
53	53	FUEL (TANKS, LINES AND PUMP). Inspect to see that these items (where visible) are in good condition, correctly assembled, securely mounted and not leaking.
53		*Serve.* With tanks nearly empty, drain water and sediment from each fuel tank by removing drain plugs and allow fuel to drain. Tighten all fuel tank mountings and brackets securely.
55	55	FUEL FILTER. Inspect exterior fuel filter to see that it is in good condition, secure and not leaking.
55		*Clean and Serve.* Drain fuel tanks and remove fuel filter cover and element and, without disassembling, clean them in dry-cleaning solvent. Dry and inspect for damage. If element is serviceable, reinstall; if element is not

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MAINTENANCE		
Monthly	Semi-Monthly	
		serviceable, replace entire filter assembly. Tighten drain plugs and connections securely.
54	54	ENGINE OIL FILTER. Inspect oil filter to see that it is in good condition, secure and not leaking. Remove and reverse manual turning nut, operate engine and observe whether filter is operating.
54		*Clean and Serve.* Remove oil filter cover and element and, without disassembling, clean them in dry-cleaning solvent. Dry and inspect these items for damage. If element is not serviceable, replace entire filter assembly.
56	56	TRANSMISSION OIL COOLER. Inspect core and lines of cooler to see that they are in good condition, secure, and not leaking. Clean out insects and trash from in and around core air passages.
57	57	EXHAUST PIPES. Inspect to see that these items are in good condition, securely assembled and mounted and not leaking.
57		*Tighten.* Tighten all mounting bolts and connections securely.
58	58	ENGINE MOUNTINGS. Examine to see that mountings are in good condition and secure.
58		*Tighten.* Tighten all mounting bolts securely. When engine is removed, tighten support ring to crankcase bolts and to engine support assembly bolts.
59	59	CLUTCH RELEASE (YOKE, SHOES, LINKAGE AND MOUNTING). Inspect these parts of clutch mechanism to see that they are in good condition, correctly assembled, secure and not excessively worn. See that yoke is adequately lubricated and that release shoes have ⅛ inch clearance (par. 98).
59		*Tighten.* Tighten all accessible assembly and mounting nuts and screws. NOTE: *When engine is removed, perform the operation before engine is reinstalled.*
60	60	FIRE EXTINGUISHER SYSTEM (TANKS, VALVES, LINES, NOZZLES AND MOUNTINGS). Inspect applicable items of both fixed and portable extinguishers to see that they are in good condition and secure and that nozzles are not clogged or valves corroded.
61		ENGINE INSTALLATION (MOUNTINGS, LINES AND FITTINGS, WIRING, CONTROL LINKAGE AND OIL SUPPLY. If engine was removed for repair

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MAINTENANCE		
Monthly	Semi-Monthly	
		or replacements, reinstall at this time (paragraph 51). Tighten mountings securely and properly connect all fuel and oil pipes, wiring and linkage.
63		BATTERIES (CABLES, HOLD-DOWNS, CARRIER, GRAVITY, AND VOLTAGE). Remove batteries and clean with soda wash, if available, and dry thoroughly. Inspect battery cables and hold-down clamps for good condition. Clean battery carrier with soda solution, and paint, if corroded; clean battery terminals and scrape until bright and grease lightly. Check gravity and voltage and record readings in space provided on back of Form No. 462.
63		Make high rate discharge test of battery to see that all cells are in satisfactory condition. A true test cannot be made if gravity reading is below 1.225. If cells vary more than 30 percent, report condition.
63	63	Bring electrolyte level up to ½ inch above plates by adding clean water. Install battery securely, connect cables and coat with grease.
64	64	ACCELERATOR LINKAGE, FUEL VALVES AND SWITCH. Examine accelerator and connecting linkage to see that it is in good condition, opens throttle fully, is securely connected and operates freely. Open fuel valves and close master battery switch at this time.
65	65	STARTER, PRIMER AND INSTRUMENTS. Observe all starting precautions (par. 16). Start engine to see if primer operation and action of starter are satisfactory. Note particularly whether starter drive engages and operates properly without unusual noise, whether it has adequate cranking speed and whether engine starts readily. As engine starts, see that all instruments operate properly, and particularly that oil pressure and ammeter indications are satisfactory.
66	66	LEAKS (ENGINE OIL AND FUEL). After starting engine, look in engine compartment for indications of leaks in oil and fuel system.
68	68	REGULATOR UNITS (CONNECTIONS, BOND STRAPS AND FILTERS). Inspect both generator regulators to see if they are in good condition and securely connected and mounted and particularly if radio noise suppression filters and bonding straps are loose or damaged.
69	69	ENGINE IDLE. With engine at normal operating temperature, adjust idle stop screw to idle engine at approxi-

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MAINTENANCE		
Monthly	Semi-Monthly	
		mately 400 revolutions per minute. Hand throttle must be in closed position. Adjust mixture control screw until engine runs smoothly (par. 75).
71	71	FIGHTING COMPARTMENT (PAINT, SEATS, SAFETY STRAPS, CRASH PADS, STOWAGE, AMMUNITION BOXES, CLIP AND RACKS). Inspect to see that these are in good condition and securely assembled and mounted. See that fighting compartment is clean, that paint is in satisfactory condition, and that adjusting mechanisms of seat operate properly and are adequately lubricated. Pay particular attention to see that all dividers and shell pads are present and properly installed in ammunition boxes and racks and that clips have sufficient tension to hold shells securely.
73	73	PERISCOPES. Examine periscope prisms and windows to see that they are in good condition, clean and secure in holders; make sure that holders are securely mounted. See that lever and locking devices operate freely and are not excessively worn and that their traversing, elevating and locking devices are free and not excessively worn. Examine spare periscopes and their stowage boxes to see that they are in good condition, clean and secure. CAUTION: *Prisms should be cleaned only with a soft cloth or brush.*
74	74	CLUTCH PEDAL (FREE TRAVEL, LINKAGE, AND RETURN SPRING). Inspect to see that these items are in good condition, securely assembled and mounted, well lubricated and not excessively worn. Be sure return spring will bring pedal to full released position. Adjust pedal free travel to approximately 1¾ inches (par. 98).
75	75	BRAKES (STEERING LEVERS, LINKAGE AND SHAFTS). Inspect steering brake levers, linkage and shafts to see that they are in good condition, securely connected and mounted and not excessively worn. Apply steering brake levers and observe whether they both begin to meet resistance slightly before reaching a vertical position. Released steering levers are correctly positioned when horizontal distance from face of brake drum housing cover to front edge of lever is 7 to 7½ inches.
	75	*Tighten.* Tighten all assembly and mounting nuts and screws securely.
77	77	FINAL DRIVE AND BREATHERS. Examine accessible part of the final drive case in driver's compartment to see that it is in good condition, that all mounting and

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MAINTENANCE		
Monthly	Semi-Monthly	
		assembly bolts or cap screws are secure, and that there are no leaks. Inspect breathers to see that they are in good condition, secure and not clogged.
77		*Clean and Tighten.* Remove breathers and clean thoroughly. Tighten all external assembly and mounting bolts and screws securely.
78	78	TRANSMISSION (VENT AND SEALS). Inspect transmission to see that it is in good condition, that outside parts are securely assembled and mounted and that there are no oil leaks.
78		*Clean and Tighten.* Remove, clean and reinstall vent.
80	80	TRANSMISSION CONTROL. Inspect to see that transmission control lever operates properly, is in good condition, correctly assembled, securely connected and not excessively worn.
81	81	PROPELLER SHAFT (U-JOINTS, ALINEMENT, AND FLANGES). Inspect propeller shaft to see that it is in good condition, that it is correctly and securely assembled and mounted, and that universal joints are properly alined and not excessively worn.
81		*Tighten.* Tighten universal joint assembly and companion flange bolts securely.
84	84	COMPASS (FLUID AND LAMP). Examine compass for good condition and secureness. Look for low fluid level or indications of bubbles in fluid bowl. Fill fluid bowl with ETHYL alcohol, if needed. If alcohol is added, recompensate compass, according to instructions on compass card. See that compass lamp and switch operate properly.
85	85	LAMPS AND SWITCHES (HEAD, TAIL, BLACK-OUT AND INTERNAL). Test to see that switches and lamps operate properly. Inspect all lights for good condition, secureness, for broken lenses or discolored reflectors.
86	86	WIRING (JUNCTION AND TERMINAL BLOCKS AND BOXES, CIRCUIT BREAKERS AND BUTTONS). Inspect all applicable above listed units to see that they are in good condition, securely mounted and connected and clean. Inspect all exposed wiring and conduits for looseness or damage and see that they are well supported, securely connected and clean. Be sure radio

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MAINTENANCE		
Monthly	Semi-Monthly	
		noise suppression bonding strap at turret control box is in good condition and that all attaching bolts at terminal or control boxes and wiring support clips are tight.
88	88	RADIO BONDING (SUPPRESSORS, FILTERS, CONDENSERS AND SHIELDING). See that all units not covered in the foregoing specific procedures are in good condition, securely mounted and connected. Be sure that all additional noise suppression bonding straps and shake-proof lock washers are inspected for looseness or damage and see that all contact surfaces are thoroughly clean. NOTE: *If objectionable radio noise from vehicle has been reported, make tests in accordance with paragraphs 131 to 136.* If cleaning and tightening of mountings and connections and replacement of defective radio suppression units does not eliminate the trouble, the radio operator will report the condition to the designated individual in authority.
		ARMAMENT
126	126	GUN, 155-MM AND 8-INCH HOWITZER (MOUNTS, TRAVERSING AND ELEVATING MECHANISM AND FIRING CONTROLS). Inspect to see that these items are in good condition, clean, well lubricated, correctly and securely assembled and not excessively worn. Check to see that traversing controls are in good condition and secure. Operate firing controls to see that they function properly. Operate elevating controls through entire range to see that they function properly. Tighten all assembly and mounting bolts and screws securely.
126		*Tighten.* Tighten gun mounts securely.
127	127	RECOIL CONTROL. Inspect control unit, and cylinders and pistons to see that they are in good condition, secure, correctly assembled and connected, and not leaking oil. Defects in system should be referred to ordnance personnel for attention.
127		*Tighten.* Tighten all mounting and assembly nuts and screws securely.
		TOOLS AND EQUIPMENT
130	130	TOOLS (VEHICLE KIT AND PIONEER). Check standard vehicle tools against stowage lists to see that they and pioneer tools are present, in good condition and properly stowed or mounted. Any tools mounted on outside of vehicle, having bright or polished surfaces, should

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MAINTENANCE		
Monthly	Semi-Monthly	
		be painted or otherwise treated to prevent glare or reflections. Tools with cutting edges should be sharp and edges protected.
131	131	EQUIPMENT. Check special equipment items against vehicle stowage list to see if they are all present, in serviceable condition and properly stowed or mounted.
132	132	GROUSERS AND SPARE TRACK BLOCKS. Inspect to see if these items are all present, in good condition and properly stowed or mounted.
133	133	SPARE OIL SUPPLY (RECOIL, HYDRAULIC AND ENGINE). Check to see that supply of listed spare oil is present and properly stowed. This supply should be maintained at all times.
134	134	DECONTAMINATORS. Examine to see that decontaminators are in good condition, secure and fully charged. Make latter check by removing filler plugs. NOTE: *The solution must be renewed every three months, as it deteriorates.*
135	135	FIRE EXTINGUISHERS (PORTABLE). Inspect to see that extinguishers are fully charged, in good condition and securely mounted and seal on valve head is intact. Have cylinder weighed to determine if it is fully charged. Replace with a fully charged one; if net weight is less than 4 pounds, see paragraph 137.
136	136	PUBLICATIONS AND FORM NO. 26. All vehicle equipment manuals, Lubrication Order, Accident-Report Form No. 26, and MWO and Major Unit Assembly Replacement Record W.D., A.G.O. Form No. 478 must be present, legible and properly stowed.
137	137	VEHICLE LUBRICATION. If due, lubricate in accordance with Lubrication Order, section XII, and current lubrication directives, using only clean lubricant and omitting items that have had special lubrication during this service. Replace damaged or missing fittings, vents, flexible lines or plugs.
138	138	MODIFICATIONS (MODIFICATION WORK ORDERS COMPLETED). Inspect vehicle and organizational records to determine that all Modification Work Orders have been properly completed. Enter any modifications or replacement of Major Unit Assembly made at the time of this service on W.D., A.G.O. Form No. 478.

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MAINTENANCE	
Monthly	Semi-Monthly
139	139

FINAL ROAD TEST. Make a final road test, rechecking items 2 to 15 inclusive. Check transmission and differential to see that there are no leaks. Confine this road test to the minimum distance necessary to make satisfactory observations. While testing vehicle, operate it in a normal manner. NOTE: *Correct or report any deficiencies found during final road test.*

Section XIV

TROUBLE SHOOTING

35. GENERAL.

a. This section contains trouble shooting information, and tests, which can be made, to help determine the causes of some of the troubles that may develop in vehicles used under average climatic conditions (above + 32°F). Each symptom of trouble given under the individual unit or system is followed by a list of possible causes of the trouble. The tests, necessary to determine which one of the possible causes is responsible for the trouble, are explained after each possible cause.

36. ENGINE.

a. Engine Will Not Turn.

(1) HYDROSTATIC LOCK OR SEIZURE. Remove the rear spark plugs from the two lower cylinders and attempt to turn the engine with the hand crank to expel excess fuel or oil from the combustion chambers and relieve hydrostatic lock. If the engine does not turn, seizure due to internal damage is indicated: notify higher authority.

(2) STARTER INOPERATIVE. See paragraph 82.

(3) INCORRECT OIL VISCOSITY. Drain and refill with proper grade of oil (par. 26).

b. Engine Turns But Will Not Start.

(1) INOPERATIVE FUEL SYSTEM. Open fuel valves, remove outlet line at the fuel pump and, with the ignition switch off, turn the engine with the starter. If free flow of fuel is not evident, fuel is not reaching carburetor. See paragraph 75.

(2) INOPERATIVE IGNITION SYSTEM. Remove a cable from a spark plug and turn on magneto switch. Crank the engine with

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starter and hold the cable terminal ¼ inch from the cylinder casting. If a spark does not jump the ¼-inch gap, the ignition is inadequate. See paragraph 69.

(3) SLOW CRANKING SPEED. See paragraph 82.

c. Engine Does Not Develop Full Power.

(1) IMPROPER IGNITION. See paragraph 69.

(2) OIL TEMPERATURE TOO HIGH. See paragraph 61.

(3) USE OF IMPROPER TYPE OF FUEL. Use proper fuel with octane rating of 80 or higher.

(4) CLOGGED FUEL STRAINER IN CARBURETOR. Clean strainer (par. 75).

(5) PREIGNITION. If the proper octane fuel is being used, and the ignition system is functioning satisfactorily, spark plugs of improper heat range may be the cause of trouble, otherwise, internal engine troubles would be indicated. Notify higher authority.

(6) IMPROPER VALVE ADJUSTMENT. Check clearance and adjust if necessary (par. 52 *d*).

(7) LOW ENGINE COMPRESSION OR IMPROPER VALVE TIMING. If the engine does not develop full power with fuel reaching the combustion chambers, adequate ignition and sufficient oil in the engine lubrication system, low compression or improper valve timing would be indicated. Notify higher authority.

(8) INCORRECT GOVERNOR SETTING. If the engine will not accelerate to 2,400 revolutions per minute after the above items have been checked, disconnect the governor linkage at the carburetor. Start the engine and accelerate gradually (but not above 2,400 revolutions per minute). If speed of 2,400 revolutions per minute is reached with the governor disconnected, the governor operation is at fault. Notify higher authority.

d. Engine Misfires.

(1) FAULTY IGNITION SYSTEM. See paragraphs 63 through 69.

(2) INCORRECT CARBURETOR ADJUSTMENT. Adjust carburetor (par. 75).

(3) RESTRICTED FUEL FLOW. See paragraph 75.

(4) WATER IN FUEL. Remove the two drain plugs at the bottom of the carburetor and inspect for water.

(5) LOW ENGINE COMPRESSION. See subparagraph *c* (7) above.

e. Excessive Oil Consumption.

(1) OIL VISCOSITY TOO LOW. Drain and refill with proper grade of oil (par. 26).

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(2) EXTERNAL OIL LEAKS. Inspect for external oil leakage at oil line connections. Inspect for leaks around the push rod housing adapters and tighten with special tool (41-W-1985).

(3) SUPERCHARGER OIL SEAL RINGS OR PISTON RINGS DAMAGED. Notify higher authority.

f. Engine Will Not Stop.

(1) THROTTLE NOT FULLY CLOSED. Close throttle.

(2) FAULTY FUEL CUT-OFF. Inspect fuel cut-off switch and wiring (par. 14).

(3) DEGASSER ASSEMBLY INOPERATIVE. Replace degasser (par. 77).

g. Tachometer Inoperative.

(1) BROKEN OR KINKED CABLE. Replace cable.

(2) FAULTY TACHOMETER HEAD. Replace head.

(3) TACHOMETER ADAPTER DRIVE GEAR BROKEN. Replace adapter.

37. FUEL SYSTEM.

a. Fuel Does Not Reach Carburetor.

(1) LACK OF FUEL IN TANKS. Replenish fuel supply.

(2) FUEL VALVES NOT TURNED ON. Turn on fuel valves.

(3) CLOGGED FUEL TANK VENTS. Clean out tank units.

(4) CLOGGED FUEL FILTER. Disconnect the fuel line between the filter and the fuel pump and check the flow from the tank. If fuel does not flow freely from the line, service the fuel filter (par. 72).

(5) INOPERATIVE FUEL PUMP. If fuel flows freely from the fuel line (step (4) above) install fuel pump pressure gage in the outlet side of the fuel pump and crank the engine with the starter. If the pressure indicated by the gage is less than 3½ pounds, replace the fuel pump.

b. Fuel Does Not Reach Cylinders.

(1) THROTTLE NOT OPENING. Adjust throttle (par. 75).

(2) PRIMER PUMP STRAINER CLOGGED. Clean or replace (par. 73).

(3) INOPERATIVE PRIMER PUMP. Remove one of the primer tubes from one of the cylinders, and operate the primer pump to see if fuel squirts out of the tube. If fuel reaches pump and no fuel comes out of disconnected tube, replace pump.

(4) CARBURETOR STRAINER CLOGGED. Clean or replace (par. 75).

(5) CARBURETOR JETS CLOSED. Replace carburetor (par. 75).

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38. ENGINE LUBRICATING SYSTEM.

a. Low or No Oil Pressure.

(1) LACK OF OIL IN SYSTEM. Replenish oil supply.

(2) EXTERNAL LEAKS AT TUBES OR FITTINGS. Tighten or replace.

(3) PRESSURE RELIEF VALVE STUCK OR SET TOO LOW. If no pressure is shown by the gage, remove the pressure relief valve assembly, and inspect the valve to be sure it is not stuck, and that it seats in the valve body. If insufficient pressure is shown on the gage, turn the relief valve adjusting screw clockwise, and watch for variation of pressure. If the pressure is increased by turning the screw, adjust the pressure or replace the relief valve assembly.

(4) CLOGGED OIL STRAINER OR TUBES. Disconnect the inlet hose from the strainer at the oil pump, and remove and clean the strainer. Lower the end of the inlet hose and if oil does not flow freely from the supply tank, drain the tank, remove the connections, and blow out tubes with compressed air.

(5) PRESSURE GAGE INOPERATIVE. If the low oil pressure warning light goes out after the engine starts, there is some oil pressure. If the oil pressure gage does not start to register about the time the low pressure warning light goes out, the sending unit, the gage on the instrument panel, or the gage circuit may be at fault. Disconnect the wire from the sending unit and intermittently ground it to the engine. If the gage hand does not fluctuate, the gage or wiring is faulty. If when the wire from the sending unit is intermittently grounded, the gage hand fluctuates to full scale or remains at full scale until the wire is held to ground, the gage and wiring are satisfactory; replace the sending unit (par. 57 *b*).

(6) OIL PUMP INOPERATIVE. If oil pressure is not satisfactory after making all the foregoing tests (steps (1) through (5) above), replace the pressure and suction pump assembly.

b. Oil Temperature Too Low.

(1) OIL TEMPERATURE CONTROL VALVE INOPERATIVE. Remove the cap on top of the temperature control valve, take out the valve, and check it for freedom of operation.

(2) OIL TEMPERATURE GAGE INOPERATIVE. Disconnect No. 64 wire in the bulkhead terminal box and ground the wire to the box. If the gage does not show a full scale reading when the wire is grounded, the gage or wiring is at fault. If the gage shows a full scale reading when the wire is grounded, replace the sending unit (par. 57 *b*).

c. Oil Temperature Too High.

(1) LOW OIL SUPPLY. Replenish oil supply.

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(2) AIR INTAKE GRILLE OR SCREEN CLOGGED WITH FOREIGN MATTER. Remove all obstructions.

(3) ACCUMULATION OF OIL OR DIRT ON EXTERIOR OF ENGINE. Clean engine.

(4) OIL TEMPERATURE GAGE OR SENDING UNIT INOPERATIVE. Stop the engine and allow oil to cool. If gage reading is not reduced as oil cools off, disconnect No. 64 wire in the bulkhead terminal box, and if reading then drops, replace the sending unit (par. 57 *b*). If the gage indicates high oil temperature with wire disconnected, replace the gage (par. 57 *b*).

(5) ENGINE OIL COOLER OBSTRUCTED OR COVERED. Loosen the coupling at the outlet from the engine oil cooler to the oil supply tank. If normal flow of oil is not evident, loosen the inlet line at the bottom of the cooler, and check for flow of oil to the cooler. If normal flow of oil is found at this point, the oil cooler is clogged. Remove and clean (par. 60).

(6) LATE IGNITION TIMING. Reset timing. See paragraphs 64 through 67.

(7) INOPERATIVE OIL TEMPERATURE CONTROL VALVE. See subparagraph *b* (1) above.

(8) INOPERATIVE BY-PASS VALVE. Remove and check operation of valve (par. 61 *b*).

39. STARTING SYSTEM.

a. Starter Will Not Operate. If the 24-volt battery switch is "ON" and the batteries are in good condition, this condition indicates that the starter, or cables and connections to it, are at fault. Make the following tests:

(1) BATTERIES RUN DOWN. If the solenoid in the battery switch box vibrates when the switch on the instrument panel marked "STARTER" is depressed, the batteries are run down. Replace or recharge the batteries (par. 85).

(2) STARTER SOLENOID INOPERATIVE. If no sound is heard from the solenoid when the switch is depressed, remove the cover from the battery switch box, and connect a jumper wire from the bus bar to the nearest terminal on the solenoid, where wire No. 18 from the instrument panel is connected. If the solenoid still does not operate, replace the solenoid (par. 83). If the solenoid operates as evidenced by the sound and the starter turns, the starter switch on the instrument panel or the wiring to it is at fault; refer to step (4) below.

(3) FAULTY STARTER OR WIRING. If the solenoid operates and the starter will not run, open the engine compartment rear doors,

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remove the starter terminal cover plug and connect a test voltmeter between the starter terminal and ground. Press the starter switch and observe the meter. If battery voltage (24 volts) is indicated, replace the starter. If no reading is obtained and no obvious damage or loose connections are found between the starter and the solenoid, replace the solenoid (par. 83 *b*). If the voltage is indicated, refer to step (5) below.

(4) STARTER SWITCH OR WIRING FAULTY. If the tests described in step (2) above indicate that the starter switch or the wiring is at fault, inspect the lower left conduit on the back of the instrument box to see that it is properly connected, and tightened to the receptable. If the conduit connection appears satisfactory, remove the mounting screws from face of instrument panel and pull panel out far enough to give access to the switch assembly and wiring. Inspect the wiring to the switch for loose connections and test with the voltmeter, from wire No. 18 connected to the terminal marked "START" on the back of the switch, to ground. If voltage is present at this point, replace the switch assembly.

(5) LOOSE CONNECTIONS OR FAULTY BATTERY SWITCH. If the voltage test made in step (3) above shows voltage to be low, check all connections at the battery switch, solenoid, and the starter cable terminal post in the bulkhead terminal box for loose connections. If connections are secure, turn on all lights and crew compartment blower. Move the battery switch handle from side to side and observe the brilliance of the lights or the sound of the blower motor. If the lights dim, or the blower motor varies in speed, replace the 24-volt battery switch (par. 86).

b. Starter Runs But Will Not Turn Engine. This condition indicates a faulty drive mechanism or a bent shaft. Replace the starter (par. 82).

c. Slow Cranking Speed. If the engine has the proper lubricant for the temperatures encountered and the test made in subparagraph *a* (3) above indicate that the proper voltage is reaching the starter, replace the starter (par. 82). If low voltage is indicated, test the batteries (par. 85), inspect cables and connections, and make test described in subparagraph *a* (5) above.

40. IGNITION SYSTEM.

a. Engine Will Not Start. If fuel is reaching the cylinders, and the engine will not start after following the instructions on the plate above the magneto switch, test the magnetos, magneto switch, booster coil, or wiring to these units.

(1) MAGNETO SWITCH GROUNDED. Turn the switch to either "R" or "L" position and try to start the engine; if the engine

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starts on either one of these positions but stops on switch position marked "BOTH," disconnect the ignition conduit behind the instrument box. NOTE: *The booster coil wire on the Scintilla magneto is contained in this conduit and the booster will not operate when the conduit is disconnected.* If the engine is cold, magnetos may not fire the engine. See subparagraph *c* for additional information in making the following tests. If the engine will start with the ignition conduit disconnected, replace the magneto switch assembly. If the engine still will not start, and the magnetos are not firing, the emergency stop switch in the bulkhead terminal box may be grounded; refer to step (2) below.

(2) EMERGENCY STOP SWITCH GROUNDED. Remove the cover from the bulkhead terminal box and disconnect wires Nos. 78 and 79 from the emergency stop switch. If the engine will start, replace the emergency stop switch. If the engine does not start, refer to step (3) below.

(3) FRONT SECTION OF IGNITION HARNESS GROUNDED. Remove the two wires Nos. 76 and 77 from the small terminal block in the upper section of the bulkhead terminal box (fig. 85). If the engine starts with these wires removed, replace the ignition harness from the instrument box to the bulkhead terminal box. If the engine does not start with these wires disconnected, refer to step (4) below.

(4) REAR SECTION OF IGNITION HARNESS GROUNDED. Open the rear doors of the engine compartment and disconnect the top (small) conduit from the receptacle on the left side of the engine mounting. If the engine will start, replace the harness from the bulkhead terminal box to the receptacle. If the engine will not start with the harness disconnected at the receptacle, refer to step (5) below.

(5) ENGINE SECTION OF IGNITION HARNESS GROUNDED. If no visible damage or trouble is observed, disconnect the ground wires in the magnetos and again try to start the engine. If the engine starts, or attempts to start, indicating that the magnetos are firing, replace the engine harness. If the engine does not start, see step *(a)* or *(b)* below.

(a) Magnetos (Bosch). If the engine does not start after making tests in step (5) above, remove a spark plug wire, and hold it approximately ¼ inch from the cylinder. Crank the engine with the starter. CAUTION: *Hold the fuel cut-off switch "IN" so that the engine will not start to avoid injury from exhaust flame.* If a good spark is observed during this test, remove the spark plugs, clean, and adjust or replace if necessary (par. 69).

(b) Magnetos (Scintilla). If the engine does not start when performing test in step (5) above, it may be necessary to use the booster. Leave the ground wires off the magnetos, and connect the ignition harness together at the engine receptacle in instrument box so that the

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booster will operate. Try to start the engine in the normal manner. If the engine starts, the wiring harness on the engine is faulty. If the engine does not start, test magneto output and spark plugs as outlined in step (*a*) above. If no spark occurs, the magnetos are at fault; replace magnetos. See paragraph 64 or 65.

b. Booster Coil Inoperative (Scintilla). The "booster" will cause the engine to fire intermittently while the engine is being cranked with the magneto switch "OFF." If this action is not apparent, proceed as follows:

(1) BOOSTER SWITCH INOPERATIVE. Listen for a buzzing sound at the engine compartment. If no sound is heard when the booster switch is depressed, disconnect the ignition harness behind the instrument box, and test from the large hole in the plug on the conduit attached to the instrument box with a voltmeter to ground and with the booster switch depressed. If no reading is obtained, replace the booster switch. If a reading is obtained, connect the conduit again and perform test in step (2) below.

(2) WIRING OR BOOSTER FAULTY. Disconnect the wire No. 75 in the upper section of the bulkhead terminal box and connect the test meter between the 75 wire, coming from the instrument panel, and ground with the booster switch depressed. If no reading is obtained, replace the front section of the ignition harness. If a reading is obtained at the 75 wire, disconnect the rear section of the ignition harness from the engine receptacle box and repeat the test from the large terminal of the plug. If no reading is obtained, replace the rear section of the ignition harness. If a reading is obtained, connect the conduit to the receptacle, and repeat the test at the coil. If the meter indicates that current is reaching this point, replace the booster coil. If no reading is indicated, replace the engine section of the ignition harness.

c. Engine Will Not Stop. If the engine will not stop when the button marked "FUEL CUT-OFF" is pressed and the throttle is fully closed, the degasser solenoid, wiring, circuit breaker, or the fuel cut-off switch is at fault.

(1) DEGASSER UNIT FAULTY. If the circuit breaker marked "FUEL" on the instrument panel is connected, and the panel lights burn, disconnect the wire from the degasser unit on the carburetor and test with a voltmeter to ground while the button marked "FUEL CUT-OFF" is depressed. If the meters show a reading of approximately 24 volts, replace the degasser unit (par. 77 *c*).

(2) FUEL CIRCUIT BREAKER INOPERATIVE. If no reading is obtained, remove the bulkhead terminal box cover and disconnect wire No. 20 coming from the instrument panel (fig. 85). Test from this wire to ground with the test meter while the idle fuel cut-off switch is depressed. If no reading is obtained, inspect the upper left conduit

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plug on the back of the instrument box to see that it is properly connected. If no loose or faulty connections are found, remove the screws from the instrument panel cover, and pull it out far enough to make tests. Test from wire No. 21 on the fuel cut-off switch to ground. If no reading is obtained, replace the fuel circuit breaker.

(3) FUEL CUT-OFF SWITCH INOPERATIVE. If the meter indicates that current is reaching the switch, test from wire No. 20 on the switch while the button is depressed. If no reading is obtained, replace the fuel cut-off switch (par. 14 *k*).

(4) WIRING FAULTY. If current is passing through the switch, examine the contacts "P" for wire No. 20 in the receptacle and plug (upper left) on the panel. If these connections are satisfactory, replace the conduit between the instrument panel receptacle and the bulkhead terminal box. If the contacts in the receptacle are at fault, replace the instrument panel (par. 101 *d*).

d. Engine Fires Intermittently When Cranking (Scintilla Magneto). If the starting instructions are followed (par. 16 *c*) and the engine fires intermittently, the trouble is probably in the magneto circuit or the magnetos. The booster delivers sufficient spark to cause the contacted spark plug to fire and the engine will try to run. Follow the procedure in subparagraph *a* above to isolate the trouble and make the corrections indicated.

e. Engine Lacks Power: One Magneto or Circuit Faulty. If no mechanical trouble is evident (par. 36), one of the magnetos may be faulty. Run the engine on one magneto at a time. If the tachometer shows 300 revolutions per minute, or more, difference in engine speed, and the spark plugs are satisfactory, check the timing of the faulty magneto or replace the unit. See paragraphs 64 and 65.

41. BATTERY CHARGING SYSTEM.

a. No Charge Shown on Instrument Panel Ammeter. If the batteries are fully charged and the cables and connections are satisfactory, the ammeter may not show a charge because the regulator has reduced the amount of charge required. To determine if the generator and regulator are functioning properly, make the following tests:

(1) NO GENERATOR OUTPUT. Press the large circuit breaker on the battery switch box to make sure it is not disconnected. Turn on the dome light over the battery switch box, start the engine (see instruction plate above magneto switch), engage the clutch, and see if the light increases in brilliance momentarily. If the brilliance of the light increases at all the generator and regulator are both functioning. Perform test in step (2) below. If no change is noticed in the light, make test in step (3) below.

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(2) AMMETER INOPERATIVE. Disengage the clutch. Turn on all the lights if permissible and turn on the blower fan. Watch the ammeter when the blower starts to see if a momentary discharge is noticeable. If the meter hand does not move and the wires Nos. 38 and 39 from the bus bar in the battery switch box to the ammeter are securely connected, replace the ammeter (par. 15). If the ammeter does move toward a discharge, the ammeter and wiring are satisfactory. Test the generator and regulator for operation, step (3) below.

(3) GENERATOR OR REGULATOR INOPERATIVE. Stop the engine, check the generator drive belts for proper tension, and remove the terminal cover from the generator. Disconnect the field wire (small) No. 27 from the generator and connect the two generator terminals together with a jumper wire. Connect a voltmeter from the armature terminal (large) to ground. Start the engine, engage the clutch, and observe the meter. If the reading gradually increases to approximately 30 volts at normal engine idle, the generator is satisfactory. Replace the regulator (par. 88). If no reading is obtained, replace the generator. CAUTION: *Do not accelerate the engine while making the test to avoid damage to meter or equipment.*

b. Continuous High Charge (50 Amperes or Over).

(1) AMMETER INOPERATIVE. Release the clutch or stop the engine. If the ammeter remains at a high charge reading, replace the ammeter. If the hand returns to zero, see step (2) below.

(2) BATTERIES LOW OR FAULTY.

(*a*) *General.* If the batteries are low in charge or faulty (shorted or damaged), the internal resistance will be low. This condition allows a high rate of charge to continue until the gravity of the electrolyte has raised or the faulty batteries have been replaced. An abnormally high charging rate will cause the batteries to boil and lower the electrolyte level.

(*b*) *Test and Inspect Batteries.* Test the batteries with a hydrometer and high rate discharge tester to determine the condition. If faulty or damaged, replace the batteries. If the batteries are discharged from excessive use, recharge or replace batteries. Inspect cables and connections to see that they are in good condition and tight.

(3) REGULATOR FAULTY. If the batteries, cables, and connections are satisfactory and the electrolyte level is low, under normal operating temperatures, the regulator is not adjusted to control the output of the generator. Replace the regulator. If the ammeter hand fluctuates from charge to discharge and the wiring and connections are satisfactory, including the generator and regulator ground straps, the regulator is improperly adjusted; replace the regulator (par. 88 *d*).

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42. LIGHTING SYSTEM.

a. Headlights Inoperative.

(1) SEALED BEAM UNITS BURNED OUT. Test the socket or sockets affected with the spare light carried inside the tank. If the light burns in place of the inoperative unit or units, replace the sealed beam units (par. 89 *b*). NOTE: *If both headlights are burned out at the same time the cause may be due to loose connections or faulty generator regulator.* Make the necessary inspections and tests to determine the cause. CAUTION: *Use a voltmeter to make tests. Do not short or directly ground any 24-volt circuits.*

(2) MAIN LIGHT SWITCH OR CIRCUIT BREAKER FAULTY. Make sure the circuit breaker marked "LIGHTS" on the instrument panel is properly set, open the instrument panel and turn the switches to their proper position. Test from contact "BATT" wire No. 50 on the main light switch to ground with a voltmeter. If no reading is obtained, replace the circuit breaker. If a reading is obtained, test from contact "HT," wire No. 41, to ground. If no reading is obtained, replace the main light switch. If a reading is obtained, test the front end harness and connectors. See step (3) below.

(3) FRONT END HARNESS DAMAGED OR FAULTY. If the harness is visibly damaged, replace the harness. If no damage is found, disconnect the harness from the right headlight mounting bushing inside the tank and test from contact of wire No. 41 on the plug to ground. If no reading is obtained, inspect the harness connector at the instrument panel. If voltage is reaching the connector, replace the harness.

b. Taillights Inoperative.

(1) SEALED BEAM LAMP-UNITS BURNED OUT. Test the inoperative units by trying a new unit in its place. NOTE: *If a new lamp-unit is not immediately available for test, use the upper right lamp-unit which is not connected in these vehicles, and which will serve as a test unit.* If the test lamp will burn in the inoperative sockets, replace the faulty lamp-units.

(2) MAIN LIGHT SWITCH OR CIRCUIT BREAKER INOPERATIVE. Repeat the test outlined in subparagraph *a* (2) above from terminal "HT" and "BHT," with the switch in the proper contact positions.

(3) HARNESS FAULTY. Test for continuity of wires 42 and 45 in the bulkhead terminal box and at the taillights. Replace the faulty section of the harness or tighten loose connections, as the case requires.

c. Dome Lights in Hull Inoperative. Test the faulty lights with a new lamp to determine if the unit is burned out. Be sure that the circuit breaker is set and all connections are tight. Test for continuity of the circuit to the light, and inspect the switch in the body of the dome light. Replace the switch or faulty lamp or conduit as required.

d. Instrument Panel and Compass Light Inoperative. The in-

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strument panel and compass lights are connected through the panel light dimmer switch and the circuit breaker marked "ACCESS." If any one of the lights burn the trouble is due to burned out lamp-units; replace as required. If all of the lights are inoperative, the trouble is in either the dimmer switch or the circuit breaker. Test for continuity of the circuit breaker. Test for continuity of the circuit from wire No. 51 on the back of the dimmer switch to ground. If no voltage is indicated, replace the circuit breaker marked "ACCESS." If voltage is reaching the switch, test from the other terminal on the switch where wires 52 and 53 are connected, with the dimmer switch turned on. If no reading is obtained, replace the switch.

43. RADIO INTERFERENCE SUPPRESSION.

a. Radio Interference With Vehicle in Operation. Interference encountered during operation may be traced to any one of several sources. The radio set is designed to automatically suppress ordinary interference experienced in radio reception. Stop the vehicle and isolate the source of the noise. Make sure that the set is properly tuned, adjusted, and installed so that interference normally suppressed will not be detected. When the source of the interference is determined by making the tests outlined in the following subparagraphs, inspect all conduits for damaged, loose, or corroded bond connections, or ground straps. Check all wiring connections in the terminal boxes for loose terminals, corroded, or loose connections. Make sure that the terminal box covers are securely fastened and make good contact with the boxes. Faulty connections, conduits, or bonds in any part of the electrical system may transmit interference to the radio from any source in the vehicle. Test the batteries to be sure that they are properly charged, connected, and not damaged. Faulty batteries can cause improper operation of the radio so that suppression features of the tubes and circuits will not be effective.

b. Radio Interference With Engine Running (Vehicle Stopped).

(1) IGNITION SYSTEM. If a rhythmic "popping" noise is heard in the radio receiver with changes in frequency as the speed of the engine is increased or decreased, the trouble is probably caused by the ignition system (burned magneto points, faulty condenser, loose contacts, broken wiring, or improperly spaced spark plugs). Run the engine on first one magneto and then on the other to determine which unit is at fault. Inspect all shielding, bonding, and wiring for damage or looseness. Replace damaged conduits, tighten loose connections, and correct any faulty bonding as necessary. If interference is still present, test all spark plugs in the faulty circuit for broken porcelains, faulty contacts, and improperly spaced points. Inspect the high-tension contacts in the magnetos. Make the necessary repairs or replacements to correct the trouble.

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(2) GENERATOR. If a "whining" or "squealing" sound is detected in the radio receiver while the engine is running, the trouble is probably in the generator. Depress the clutch and allow the generator to stop. If the interference decreases as the generator slows down, inspect the generator ground cable to see that it is properly connected to clean surfaces with external-toothed lock washers. If satisfactory, remove the cover from the generator terminals and inspect the connections. If the connections are tight and there is no obvious damage to the conduit containing the generator leads, disconnect the field lead (small wire No. 26) from the generator, and allow the generator to run again by engaging the clutch. The noise will disappear while the field lead is disconnected, because there will be no output from the generator. Consequently, the regulator will not function as a field control, eliminating the action of relay contacts and the generator brush noise. Connect the armature and field terminals of the generator together, and allow the generator to build up. CAUTION: *Do not run the engine above normal idle speed.* If the noise is again evident and increases in amplitude as the generator builds up, the condenser in the generator is faulty. Replace the generator (par. 87 ***d***).

(3) REGULATOR.

(a) Faulty Condenser or Relay Contacts. If an intermittent "clicking" sound is heard in the receiver while the engine is running, and disappears when the clutch is depressed, the trouble may be found in the generator regulator. Speed up the engine to approximately 1,000 revolutions per minute with the clutch released (the tachometer will not register), engage the clutch quickly, and note the intensity of the dome light over the battery switch box. If the noise can be heard in the receiver just as the light starts to increase in brilliance, the trouble is in the regulator. Either the regulator reverse current relay (circuit breaker) points are burned, or the suppression condenser is faulty. Replace the regulator (par. 88 ***d***).

(b) Faulty Filter. If a rapid "sputtering" noise is detected, such as a very fast interruption of an electrical circuit might cause, the filter in the base of the regulator is at fault, allowing the high frequency pulsations set up by the action of the regulator contact to feed back into the battery and to other circuits of the vehicle. Replace the regulator (par. 88 ***d***).

44. CLUTCH.

a. Improper Clutch Operation. Idle the engine at 800 revolutions per minute. Push the clutch pedal to the fully released position and allow time for the clutch to stop. Shift the transmission into first or reverse gear. If the shift cannot be made without a severe clash of the gears, or if after engagement of the gears there is a jumping or creeping movement of the vehicle with the clutch still fully released, the clutch is at fault. To remedy a faulty clutch, first check the clutch linkage for

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proper adjustment (par. 98) and make sure linkage is not binding. If linkage is properly adjusted and not binding, and the clutch is faulty, it must be removed from the vehicle, disassembled, cleaned, and inspected, and defective parts replaced (par. 95).

45. PROPELLER SHAFT.

a. Backlash.

(1) WORN OR DAMAGED UNIVERSAL JOINT CROSS BEARING. Replace propeller shaft assembly (par. 104).

(2) LOOSE BOLTS AT UNIVERSAL JOINT COMPANION FLANGES. Tighten bolts.

(3) UNIVERSAL JOINT COMPANION FLANGES LOOSE ON TRANSMISSION INPUT SHAFT OR ON MASTER CLUTCH SPINDLE. Tighten flange bolts or spindle nut.

b. Vibration in Propeller Shaft.

(1) WORN OR DAMAGED UNIVERSAL JOINTS. Replace propeller shaft assembly (par. 104).

(2) LOOSE BOLTS AT UNIVERSAL JOINT COMPANION FLANGES. Tighten flange bolts.

46. TRANSMISSION AND FINAL DRIVE.

a. Lubricant Leakage.

(1) DAMAGED GASKET AT FILLER PLUG. Replace gasket.

(2) LOOSE DRAIN PLUGS. Tighten.

(3) DAMAGED FLEXIBLE HOSE OR COOLER TUBES. Notify higher authority.

(4) DAMAGED FINAL REDUCTION HOUSING COVER GASKET OR LOOSE CAP SCREWS. Tighten cap screws or replace gaskets (par. 111 *b*).

(5) DAMAGED BRAKE INSPECTION COVER GASKET. Replace gasket.

(6) DAMAGED GASKET BETWEEN TRANSMISSION AND FINAL DRIVE HOUSING. Notify higher authority.

(7) WORN OR DAMAGED INPUT OR OUTPUT SHAFT OIL SEALS OR GASKET. Notify higher authority.

(8) DAMAGED GASKET AT TRANSMISSION INSPECTION PLATE. Replace gasket.

b. Track Will Not Move on One Side (Engine Running and Transmission in Gear).

(1) BROKEN FINAL REDUCTION SHAFT OR COMPENSATING SHAFT. Replace final reduction assembly (par. 111 *b*).

(2) TEETH STRIPPED ON FINAL REDUCTION SHAFT GEAR OR COMPENSATING GEAR. Replace final reduction assembly (par. 111 *b*).

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(3) BROKEN FINAL DRIVE ASSEMBLY PARTS. Notify higher authority.

c. Hard Shifting (Severe Gear Clash).

(1) INCORRECT CLUTCH LINKAGE ADJUSTMENT. See paragraph 98 *b*.
(2) CLUTCH DRAGGING. See paragraph 95 *b*.
(3) BINDING OF TRANSMISSION GEARSHIFT LEVER. Free up.
(4) DAMAGED TRANSMISSION PARTS. Notify higher authority.

d. Backlash.

(1) WORN OR DAMAGED FINAL REDUCTION PARTS. Replace final reduction assembly (par. 111 *b*).
(2) WORN OR DAMAGED TRANSMISSION OR DIFFERENTIAL PARTS. Notify higher authority.

e. Poor Steering.

(1) STEERING BRAKES NOT PROPERLY ADJUSTED. Adjust (par. 108 *b*).
(2) STEERING BRAKE SHOE LINING WORN OR DAMAGED. Replace brake shoes (par. 107 *c*).

47. TRACKS AND SUSPENSION.

a. Suspension Wheel Tire Wear.

(1) TRACK CONNECTOR BENT, BROKEN, OR MISSING. Replace connector (par. 117 *c*).
(2) DEAD TRACK SHOE. Replace track shoe (nar. 117 *c*).
(3) DAMAGED TRACK. Replace track (par. 117 *c*).
(4) WORN GUDGEON BUSHINGS IN SUSPENSION WHEEL ARMS. Replace arms (par. 117 *c*).

b. Volute Spring Breakage.

(1) WORN GUDGEONS. Replace gudgeons (par. 123 *c*).
(2) WEAK SPRINGS. Replace both springs (par. 123 *c*).
(3) BROKEN OR CRACKED SPRING SEATS. Replace spring seats (par. 123 *c*).
(4) SEIZED LEVER BUSHINGS. Replace bushings (par. 123 *c*).

c. Thrown Tracks.

(1) IMPROPER TRACK TENSION. Adjust track tension (par. 117 *d*).
(2) ROCKS BETWEEN TRACK AND IDLER. Clean out.
(3) MISALINEMENT OF IDLER WHEEL. Tighten bracket bolts.
(4) IDLER SHAFT LOOSE IN BRACKET. Lock idler adjustment (par. 117 *d*).

d. Inoperative Track Supporting Rollers.

(1) MUD BETWEEN ROLLERS AND TRACK. Remove mud.

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(2) BEARINGS SEIZED. Replace roller assembly (par. 119 *d*, 120 *c*).
(3) INSUFFICIENT LUBRICATION. Lubricate roller (fig. 26).

e. Inoperative Idler Wheel.

(1) BEARINGS SEIZED. Replace bearings.
(2) INSUFFICIENT LUBRICATION. Lubricate bearings (fig. 26).

Section XV

ENGINE DESCRIPTION AND DATA

48. DESCRIPTION.

a. Description (figs. 9 and 10). The engine used in T89 gun motor carriage is a 9-cylinder, air-cooled, radial engine, model R-975-C4. The engine is mounted in the center of the hull. The cooling air is drawn

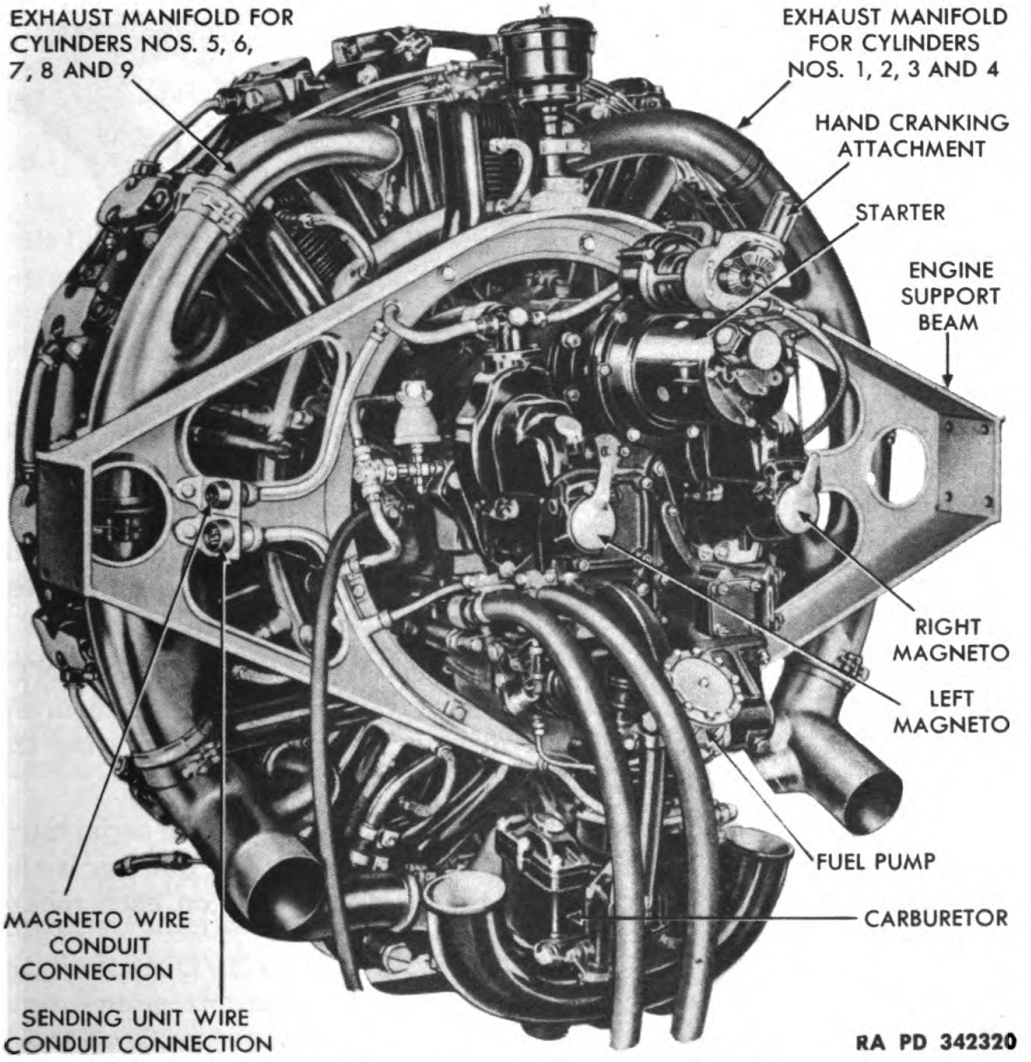


Figure 9—Left Rear View of Engine

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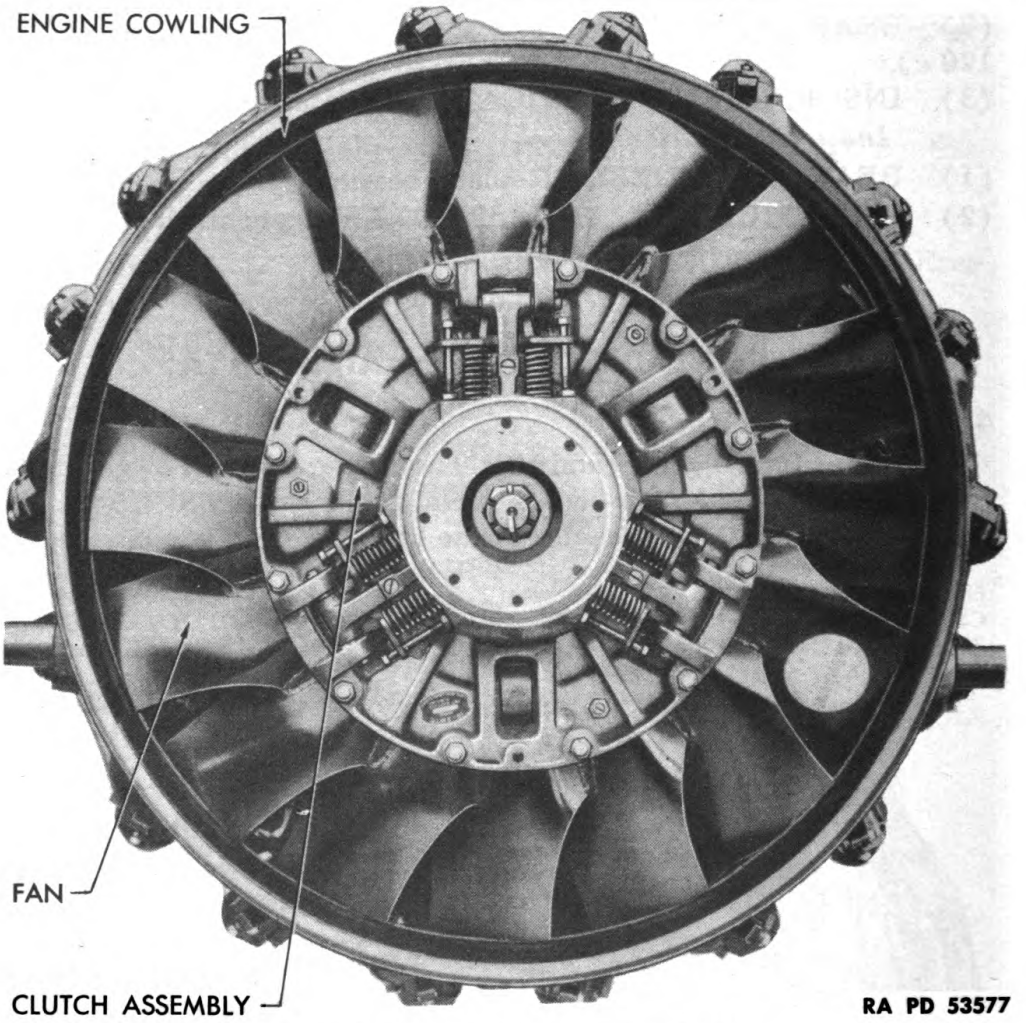


Figure 10—Front View of Engine

from the fighting compartment and through an air inlet grille in the cover of the engine compartment. The engine accessories are mounted on the rear of the engine.

b. Directional Terms. The terms "RIGHT," "LEFT," "FRONT," and "REAR" are used in relation to the driver's position as he sits in the driver's seat. The direction of rotation is determined by viewing the engine from the rear (magneto end).

c. Engine Serial Number. A plate bearing the engine serial number is attached to the front section of the crankcase. The number is also stamped on the starter housing of the crankcase and on each rocker arm box.

49. DATA.

Compression ratio ..... 5.7 to 1
Bore ..... 5.00 in.

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Stroke	5.50 in.
Displacement	973 cu in.
Rated horsepower	380 at 2,400 rpm
Firing order (No. 1 cylinder at top: cylinders numbered clockwise from rear)	1-3-5-7-9-2-4-6-8
Engine oil pressure at operating speed (1,800 to 2,400 rpm)	40 to 70 lb
Engine oil temperature at operating speed	120°F to 190°F
Maximum oil temperature	190°F
Spark plug gap	0.017 to 0.019 in.
Valve clearance (cold engine)	0.006 in.
Crankshaft rotation	Clockwise
Fuel pump rotation	Counterclockwise
Starter rotation	Counterclockwise
Magneto rotation	Counterclockwise

Section XVI

ENGINE REMOVAL AND INSTALLATION

50. REMOVAL (figs. 11 through 16).

a. Open Battery Switch and Close Fuel Valves. Place the 24-volt battery switch in open position and close fuel shut-off valves. Elevate the gun to 55 degrees and traverse it 18 degrees to the left, or if it is not desirable to elevate the gun, remove the stops at the ends of the traverse ring gear, and swing the gun around until it clears the engine compartment.

b. Remove Engine Compartment Cover.

(1) REMOVE MOUNTING CAP SCREWS. Remove cap screws which hold the engine compartment cover to hull. Raise the rear section of cover, and remove the row of cap screws which attach the upper shroud to the compartment cover.

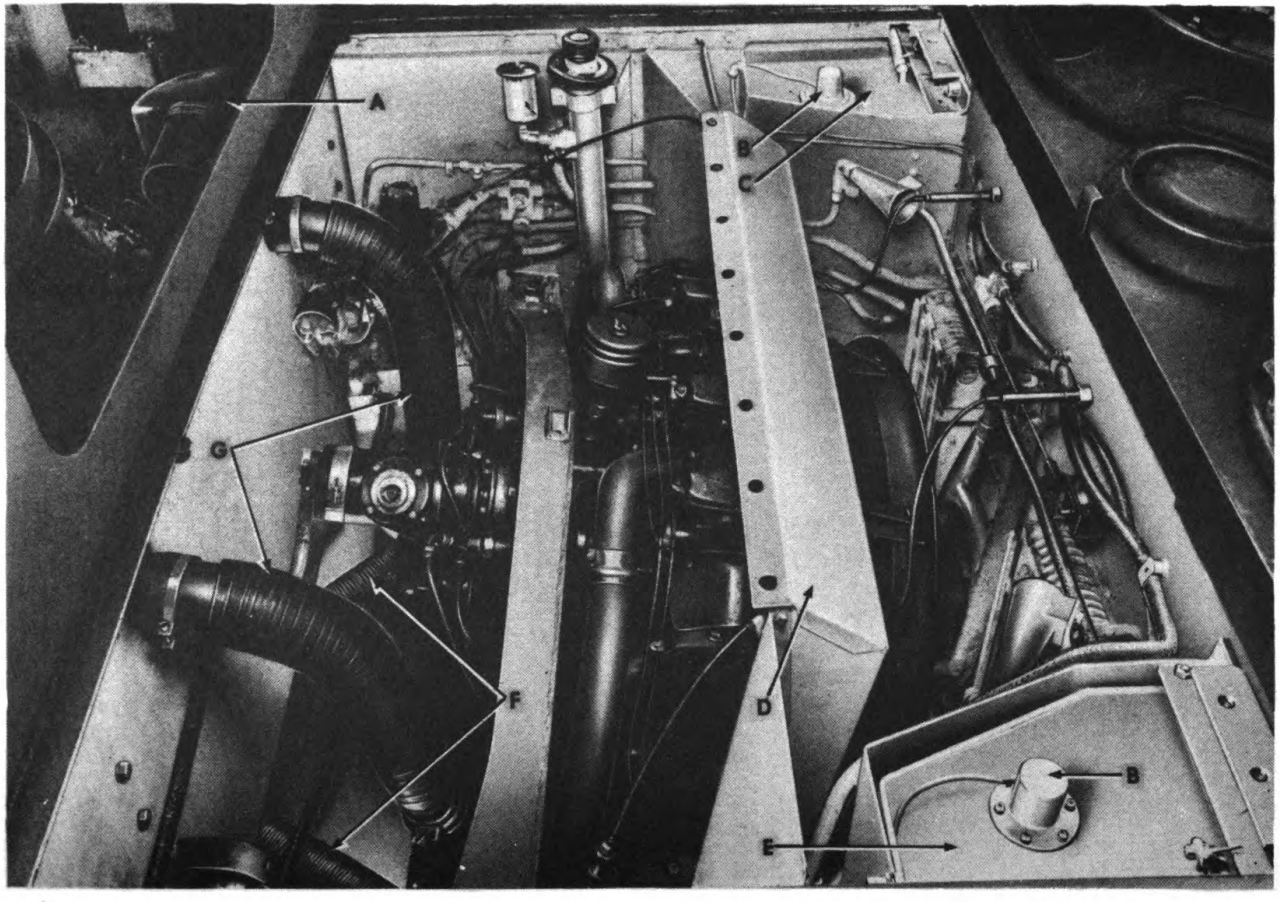
(2) REMOVE AIR INLET SHUTTER. Lower the rear section of the cover and raise the air inlet cover. Unlatch and lift out the air inlet grille assembly. Disconnect the shutter operating rods, remove jam nuts on tubes at front wall of engine compartment, and slide rod tubes forward through the wall out of the way of engine when it is lifted out.

(3) LIFT OFF COVER. Attach a chain to the cover handles, front and back, and lift off cover assembly.

(4) REMOVE UPPER SHROUD. Remove cap screws which hold upper air inlet shroud to side shrouds, and lift off shroud.

(5) REMOVE INLET TUBES (figs. 11 and 12). Loosen the clamps and remove the large tubes between the carburetor and air cleaners. NOTE: *Cover carburetor air inlet pipes to prevent dirt and dust from entering.*

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A—CARBURETOR AIR FILTER

B—FUEL GAGE

C—LEFT FUEL TANK

D—ENGINE UPPER SHROUD

E—RIGHT FUEL TANK

F—EXHAUST PIPE

G—CARBURETOR AIR INTAKE TUBE

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Figure 11—Engine Compartment—Cover Removed (Right Side)

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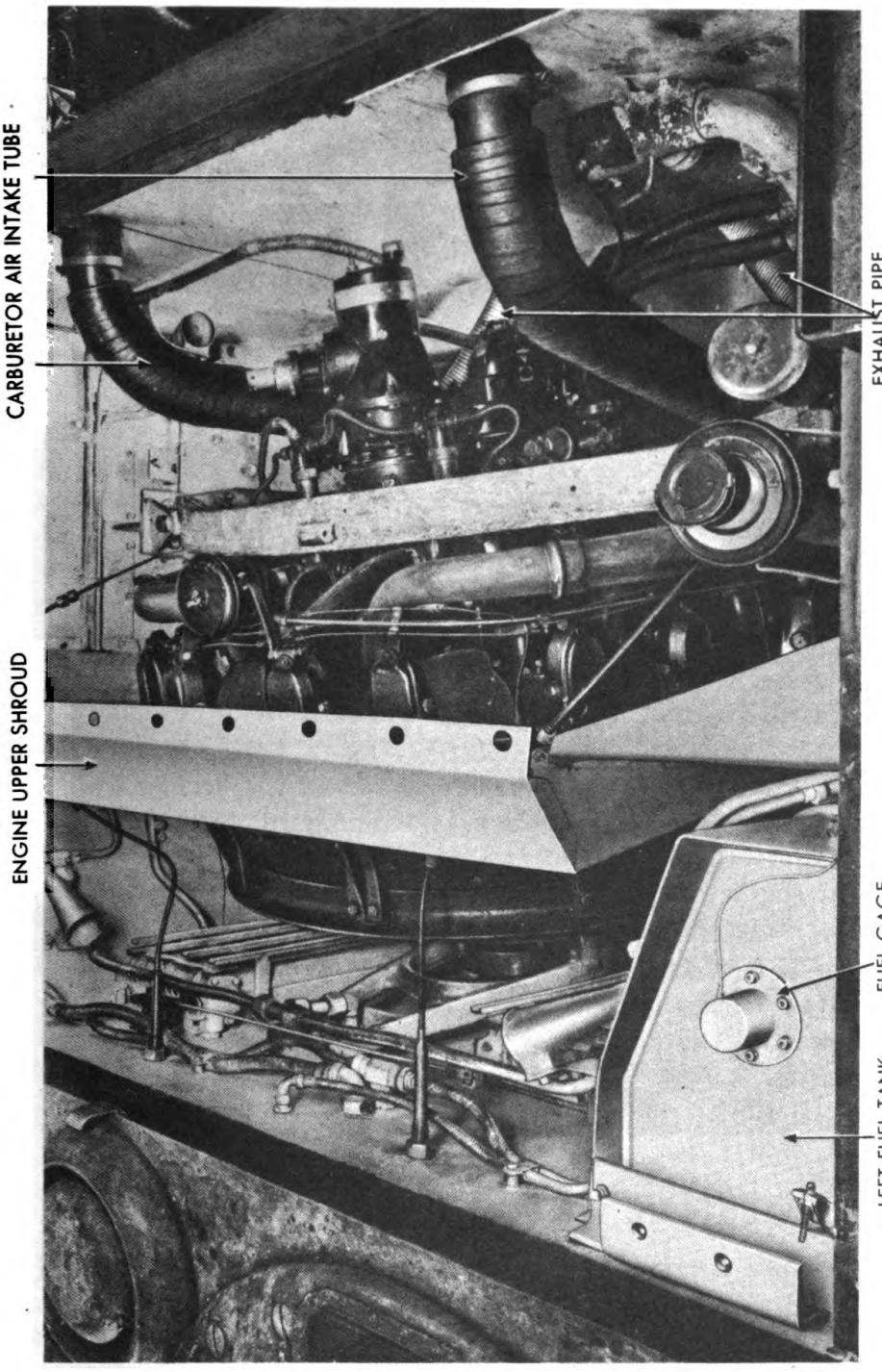


Figure 12—Engine Compartment—Cover Removed (Left Side)

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(6) REMOVE EXHAUST PIPES (figs. 11 and 12). Loosen clamps at manifold and tail pipes. Telescope and remove the exhaust pipes.

(7) DISCONNECT WIRING CONDUITS. Disconnect the two conduits at the engine support. Remove the lock wire and unscrew the cover over the cable connection at the starter. Remove the clamp which holds the starter cable conduit to the engine compartment rear wall and disconnect the cable from the starter. Ground both small contacts in the upper conduit receptacle on engine to avoid accidental starting of engine.

(8) DISCONNECT FUEL TUBES AND ACCELERATOR ROD (figs. 11 and 12). Loosen the clamps and disconnect the fuel hose at the fuel pump. Disconnect the fuel primer tube at the left side of the lower shroud. Remove the clevis pin from the accelerator rod below the carburetor.

(9) DISCONNECT OIL HOSE. Disconnect the oil pump inlet hose from the engine. Disconnect the suction pump and scavenger pump outlet hose from engine. Disconnect the small hose between the oil filter and engine at the filter.

(10) DISCONNECT PROPELLER SHAFT. Remove the section of the subfloor over the rear universal joint. Remove the screws which hold the universal joint cover to the bulkhead. Remove the lock wire from the universal joint flange bolts. With gearshift lever in neutral and the clutch released, rotate the propeller shaft as necessary and remove flange bolts. Before the last bolt is removed from the flange support, the propeller shaft is in normal position.

(11) REMOVE ENGINE HULL FLOOR COVER AND ENGINE SUPPORT BOLTS. Remove the center row of cap screws from hull floor cover. Support cover with a jack and remove remaining cap screws. Remove bolts from engine front supports, and four bolts from each of the engine rear supports. Disconnect ground strap from the left engine mounting bracket.

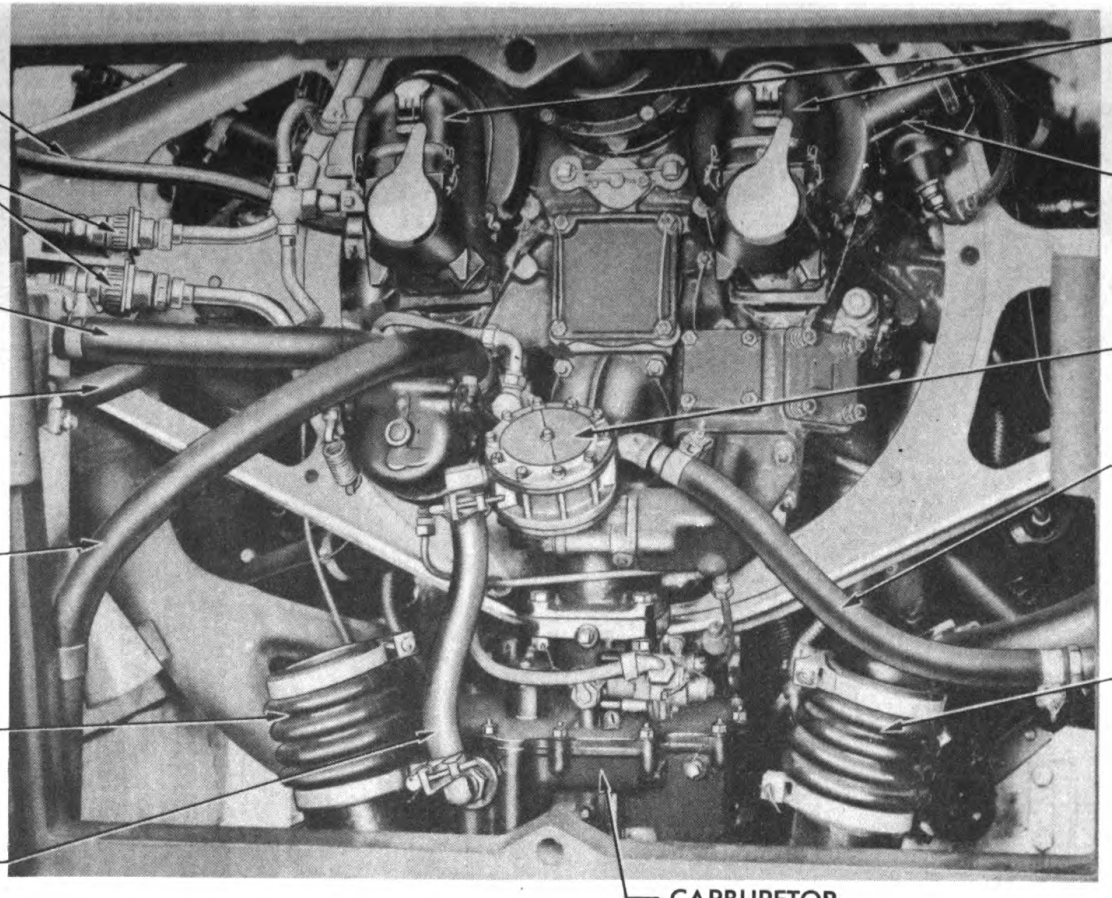
(12) LIFT ENGINE FROM HULL (fig. 14). Attach lifting sling to the engine. Raise the engine enough to allow the clutch release bearing to clear release fork. Move the engine back until the release bearing is out of the yoke; then lift engine from hull. Place the engine in a suitable stand with the engine supports carrying the full weight of the engine.

51. INSTALLATION.

a. Prepare Engine Compartment for Engine Installation (fig. 15). Clean the engine compartment thoroughly. Inspect all fuel, oil, and fire extinguisher lines for damage, and install new lines if necessary. Inspect all fuel, oil, and fire extinguisher line connections for tightness. Inspect wire conduits for damage and replace if necessary.

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Figure 13—Engine Installed—Rear View

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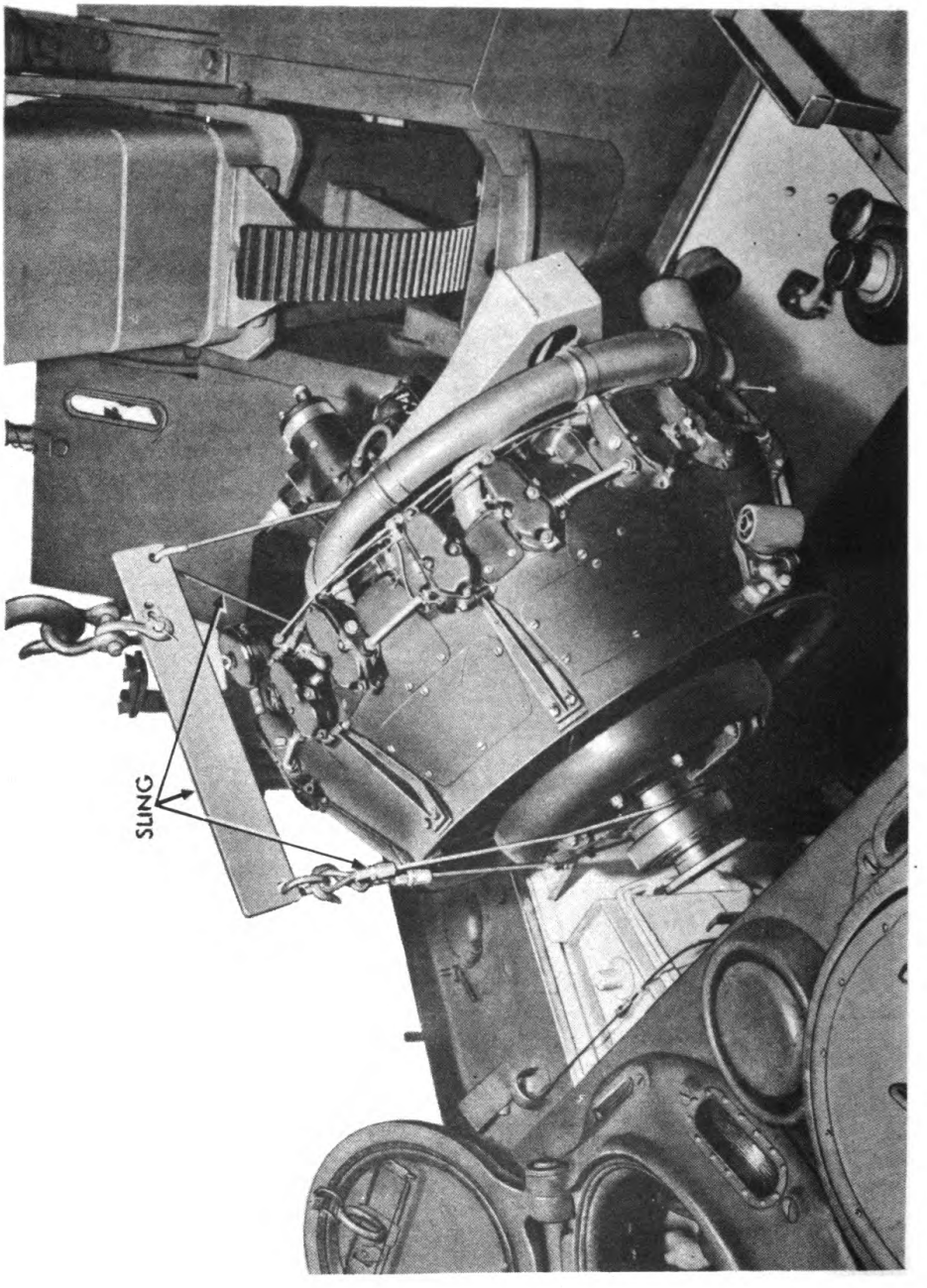
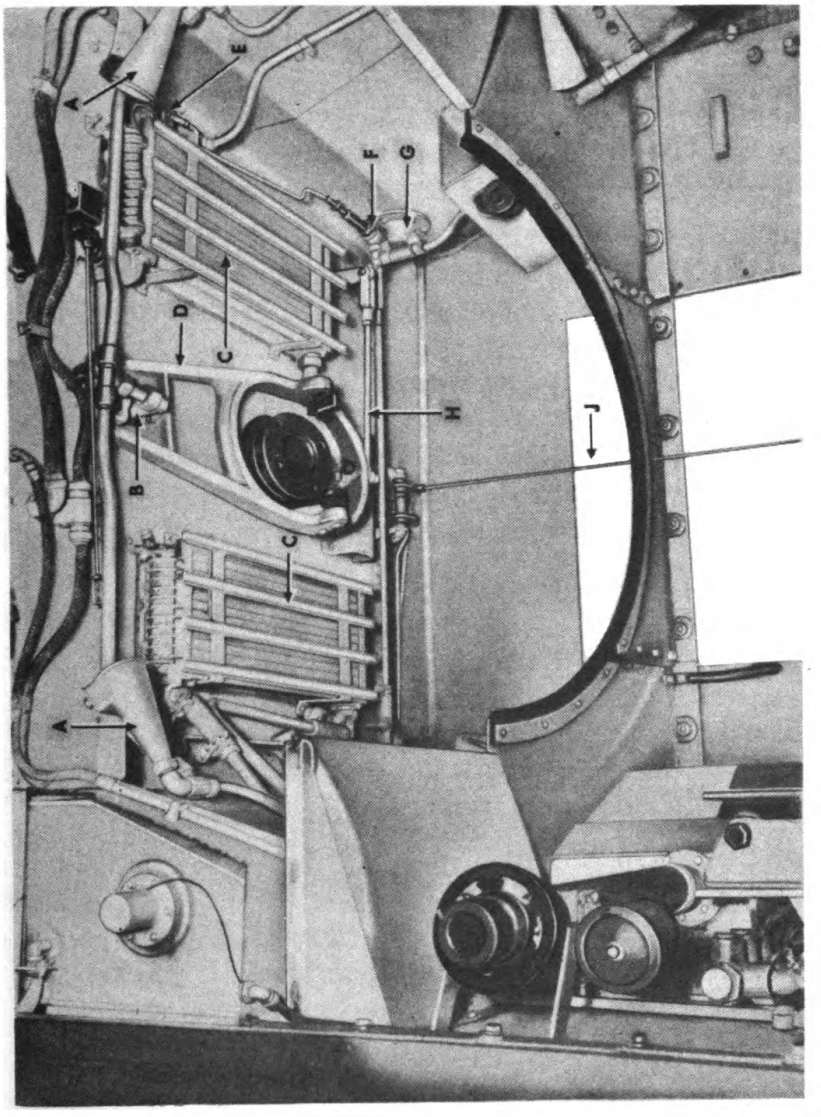


Figure 14—Removing Engine with Sling (41-S-3832-19)

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A—FIRE EXTINGUISHER NOZZLES
B—CLUTCH THROW-OUT BRACKET EQUALIZER RING
C—OIL COOLER SHUTTER
D—CLUTCH THROW-OUT YOKE
E—FUEL SHUT-OFF VALVE CONTROL
F—FUEL SHUT-OFF VALVE
G—FUEL FILTER
H—CLUTCH THROW-OUT BRACKET TIE ROD
J—ACCELERATOR ROD



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Figure 15—Engine Compartment Front Bulkhead

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b. Place Engine in Hull. Attach lifting sling to engine (fig. 14) and hoist the engine into the hull. Lower the engine until the clutch release bearing will enter the clutch yoke. Move the engine forward and guide the clutch release bearing through the yoke. Lower the engine into position and install the mounting bolts. Connect the ground strap to the left rear engine mounting bracket.

c. Connect Propeller Shaft. Turn the propeller shaft so that the bolt holes in the universal joint flange line up with the holes in the companion flange on the engine. Install the flange bolts, nuts, and lock wire. Install the universal joint cover and the subfloor.

d. Install Upper Shroud (fig. 11). Place the upper shroud in position with the felt seal in contact with the engine, and install the attaching screws at each end.

e. Connect Oil Hose. Connect the oil pump inlet hose to the engine. Connect the suction pump and scavenger pump outlet hose to engine. Connect the small hose between the oil filter and the engine.

f. Connect Fuel Lines and Accelerator Rod (fig. 15). Connect fuel hose to the fuel pump. Connect the fuel primer tube to the union at the left end of the lower shroud. Connect the accelerator rod to the throttle lever at the carburetor.

g. Connect the Wiring Conduits. Connect the two conduits at the engine support. Connect the cable to the terminal at the end of the starter. Install the cover and lock wire. Install the clamp which holds the conduit to the engine compartment rear bulkhead. Inspect the magneto breaker points; if insulated to prevent accidental starting of engine, remove the insulation.

h. Install Inlet Tubes (figs. 11 and 12). Place the inlet tubes in position between the carburetor and air cleaners and secure with clamps.

i. Install Exhaust Pipes (figs. 11 and 12). Install the exhaust pipes between the manifold and the tail pipes and tighten the clamps.

j. Install Engine Compartment Cover Assembly.

(1) INSTALL COVER. Hoist the cover and lower it into position. Raise the rear section of the cover and install the cap screws which attach the upper shroud to cover. Lower the rear section of cover and install cap screws which hold compartment cover to hull.

(2) INSTALL AIR SHUTTER. Raise the air inlet cover and connect the air shutter operating rod to shutter. Place air inlet grille assembly in position, and engage fastenings. Close the air inlet cover.

k. Inspect for Oil and Fuel Leakage. Turn on the 24-volt switch and the fuel shut-off valves. Check engine oil level, and add oil if needed. Start engine, and inspect for oil or fuel leaks. Close the engine compartment rear doors when the inspection has been completed.

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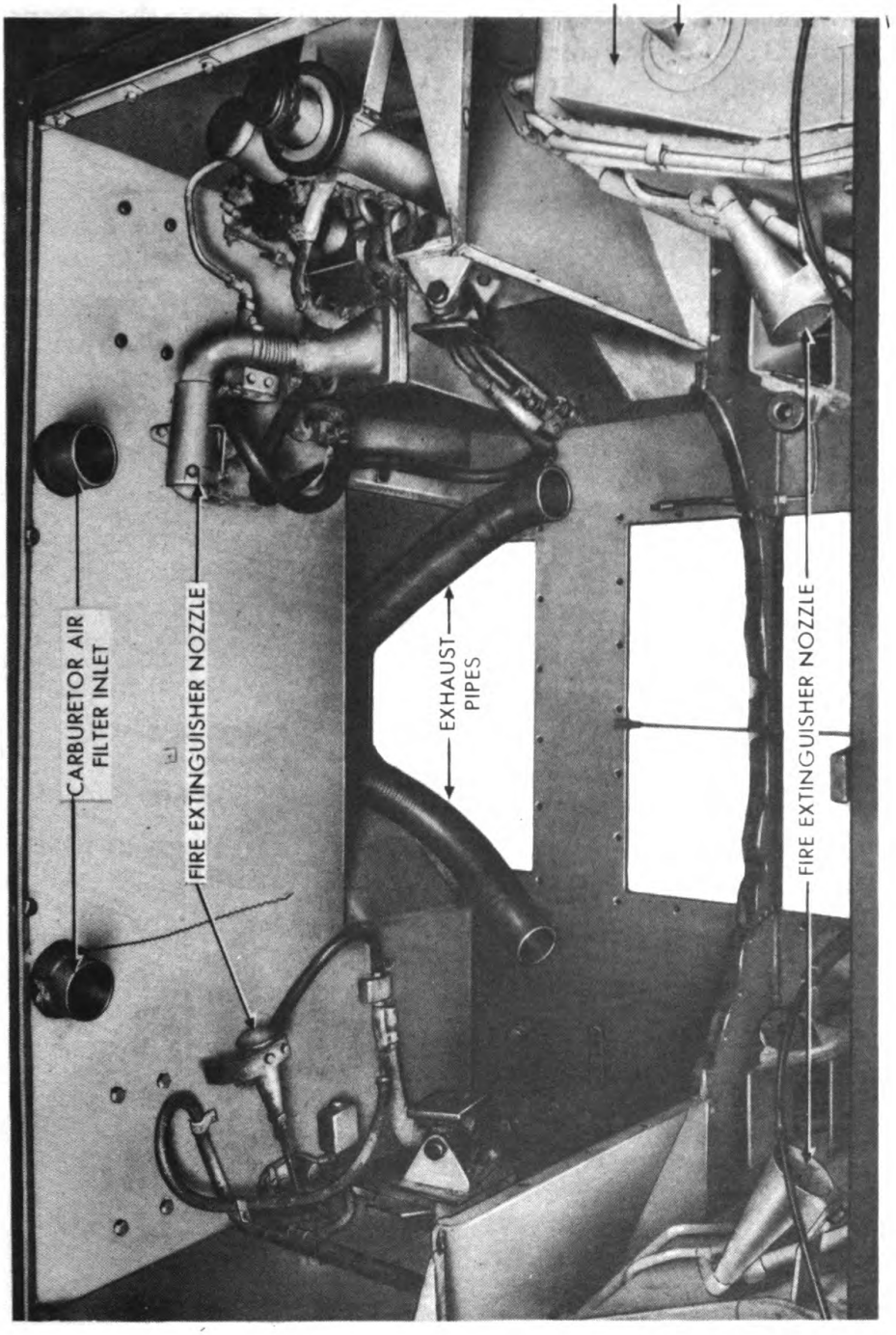


Figure 16—Engine Compartment Rear Bulkhead

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l. Install Engine Hull Floor Cover. Place the hull floor cover into position, and install the attaching cap screws and the row of cap screws which hold the lower shroud to the hull cover.

m. Record Unit Replacement on W.D., A.G.O. Form No. 478. If a new or rebuilt engine assembly has been installed, make the proper entry on "MWO and Major Unit Replacement Record." See paragraph 2 *a* (3).

Section XVII

ENGINE MAINTENANCE

52. VALVE ROCKER ASSEMBLY AND PUSH RODS.

a. Description. The rocker arms are operated by the cam and push rod mechanism. A roller at the valve end of the rocker arm contacts the end of the valve stem. A roller bearing is used where the rocker arm is supported on the rocker hub bolt. The rocker arms and valve stems are lubricated through oil passages in the push rods.

b. Removal.

(1) REMOVE ENGINE. See paragraph 50.

(2) REMOVE ROCKER ARM AND PUSH ROD (fig. 17). Remove the rocker box cover and gasket. Remove the front or rear spark

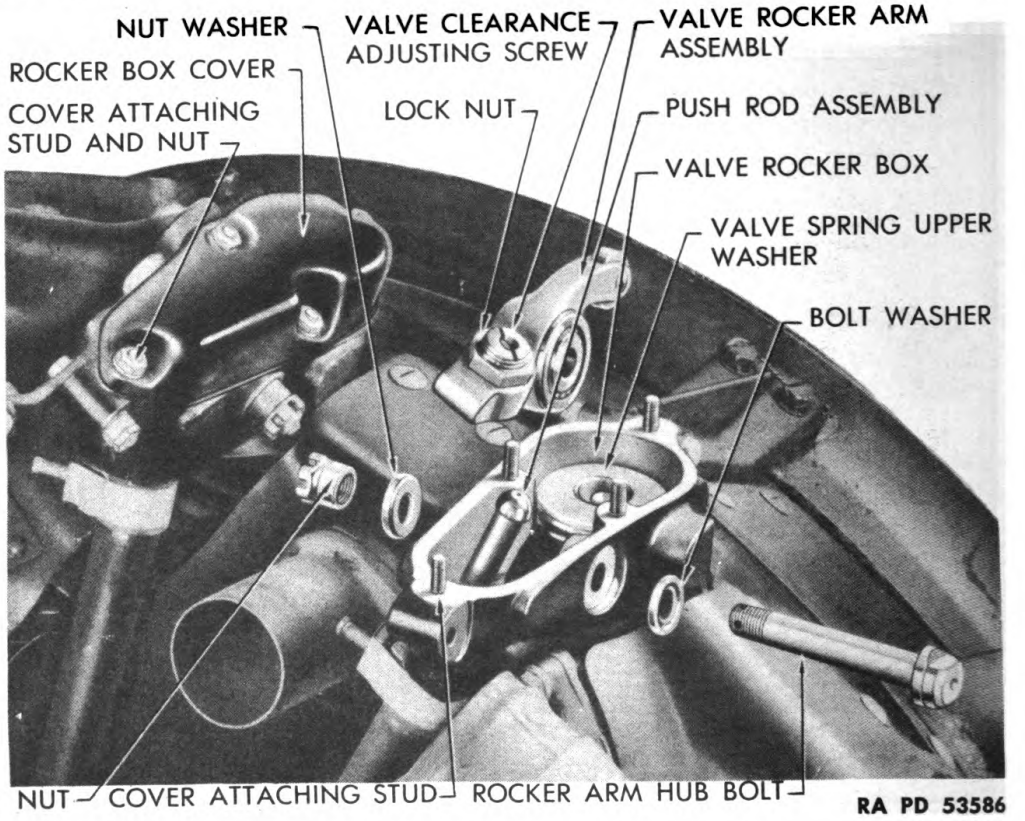
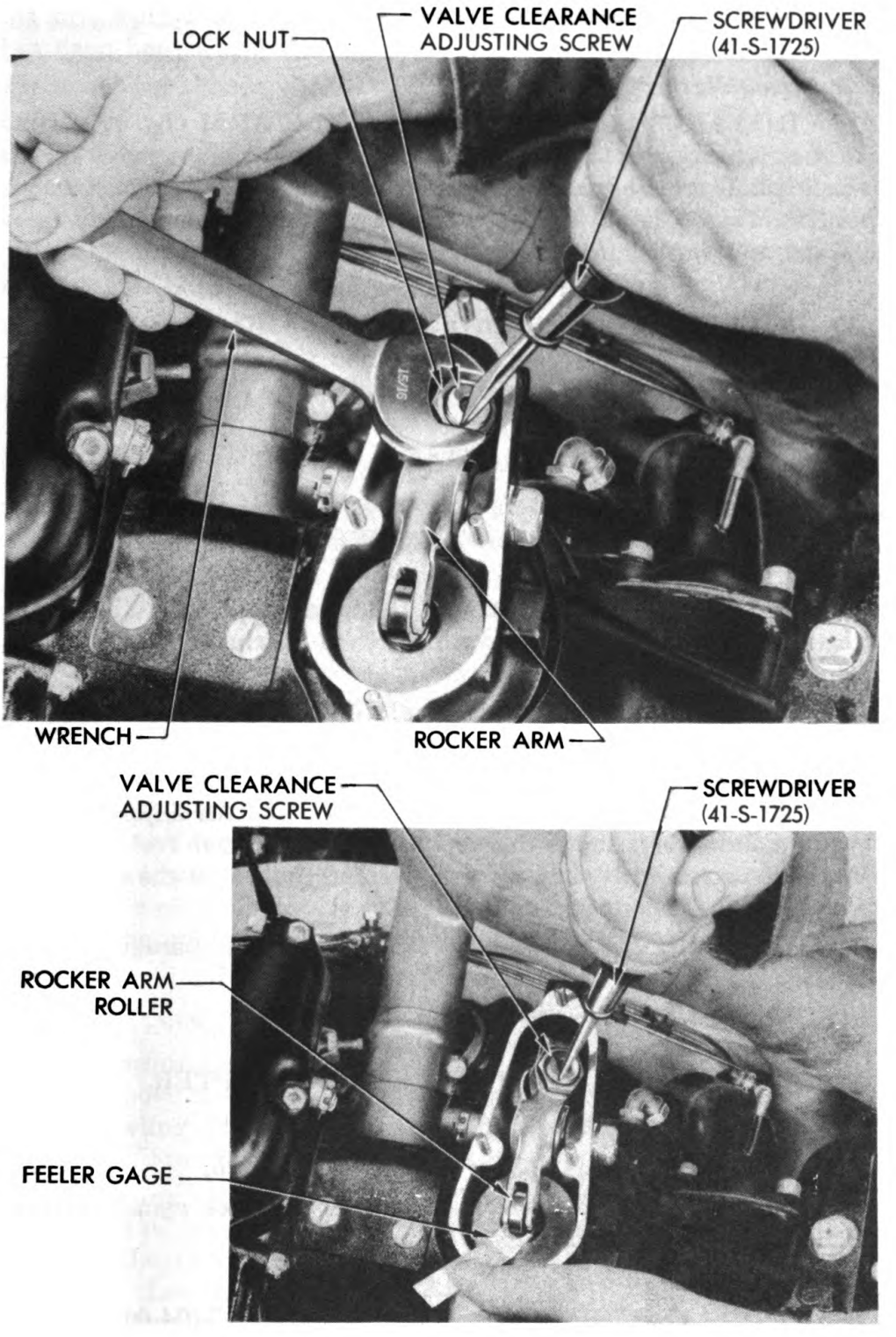


Figure 17—Rocker Arm Removed

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Figure 18—Adjusting Valve Clearance

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plugs, and turn the crankshaft until there is clearance between the rocker arm and the valve stem. Remove the nut and washer from the rocker arm hub bolt, and remove the bolt, rocker arm, and push rod.

c. Installation.

(1) INSTALL PUSH ROD AND ROCKER ARM (fig. 17). Blow out the oil passage in the push rod with compressed air to make certain it is clear. Insert the push rod in the socket and place the rocker arm in position. Install the rocker arm hub bolt with a washer under the head, and another washer under the nut. Secure the nut with a cotter pin.

(2) ADJUST ROCKERS. See subparagraph *d* below.

(3) INSTALL ROCKER BOX COVER AND SPARK PLUGS. Place a new gasket (G104-0127700) over the studs, and install the cover, washers, and nuts. Install the spark plugs.

(4) INSTALL ENGINE. See paragraph 51.

d. Valve Clearance Adjustment.

(1) REMOVE ENGINE. See paragraph 50.

(2) REMOVE ROCKER BOX COVER. See subparagraph *b* (2) above.

(3) INSPECT ROCKER ARMS. Before attempting to adjust valve clearance, inspect the rocker arm roller and bearing, and if either are damaged, replace the rocker arm.

(4) SET PISTON AT TOP OF FIRING STROKE. Remove the front or rear spark plugs and turn the crankshaft until the piston is at the top of its stroke with the intake and exhaust rocker arms free.

(5) ADJUST CLEARANCE (fig. 18). Loosen the adjusting screw lock nut and turn the adjusting screw until a 0.006-inch feeler gage will just slide between the rocker arm roller and the end of the valve stem, and cause the roller to turn.

(6) INSTALL ROCKER BOX COVER. See subparagraph *c* (3) above.

(7) INSTALL ENGINE. See paragraph 51.

53. PUSH ROD GUIDE HOUSING AND ADAPTER.

a. Removal of Push Rod Guide Housing.

(1) REMOVE PUSH ROD. See paragraph 52 *b*.

(2) REMOVE HOUSING. Loosen the two hose clamps on both ends of the housing and remove the housing.

b. Installation of Push Rod Guide Housing.

(1) INSTALL HOSE. Place two hose clamps (G104-0100371) on hose (G104-0100910) and position hose on upper small end of housing (G104-0100930). Place two hose clamps (G104-0100370) on hose (G104-0100921) and position on lower (large) end of housing.

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(2) INSTALL HOUSING. Place the large hose on the lower end of the housing over the adapter in the engine case, and the small hose on the upper end of the housing over the boss on the rocker arm box. Tighten hose clamps securely, and install push rod and rocker arm (par. 52).

c. Replacement of Adapter or Seal. Remove push rod guide housing (subpar. *a* above). Remove adapter. Install new oil seals under adapters as required and install adapter (G104-0100020). Install push rod guide housing (subpar. *b* above) and install push rod and rocker arm (par. 52).

Section XVIII

ENGINE LUBRICATION SYSTEM

54. DESCRIPTION.

a. The engine lubricating system consists of five major units; the main or pressure and suction pump, scavenger pump, oil filter, oil cooler, and oil supply tank (figs. 19 and 20).

b. Oil is drawn from the supply tank through a strainer by the oil pressure pump and is forced to the bearings and other moving parts of the engine. An adjustable pressure relief valve built into the pump housing regulates the pressure by allowing the excess oil to pass to the inlet side of the pump. Oil which passes the lubrication points of the engine collects in the engine oil sump, and is returned by the suction and scavenger pumps through the oil filter to the supply tank.

c. The oil temperature control valve mounted above the oil supply tank allows cold oil to pass directly from the filter to the supply tank; as the oil temperature rises the valve closes and the oil is passed through the oil cooler on the bulkhead before reaching the supply tank.

55. DRAINING AND FILLING SYSTEM.

a. Draining. Remove the hull floor ring plate under the oil supply tank. Remove the engine hull floor cover and the lower section of the engine cowling. Remove the drain plug from the engine oil sump, and allow the oil to drain from the system.

b. Filling (fig. 21). Install the drain plugs in the supply tank and the engine oil sump with gasket (G104-1593925). Remove the filler cap and fill with the proper grade of oil until oil stands in the filler tube (par. 26). Insert the bayonet gage and push it down into place; this will vent the top of the supply tank and allow the oil in the filler tube to run down into the supply tank. After the engine has been run for a few minutes, remove the filler cap and add oil until it again rises in the filler tube, then install the filler cap.

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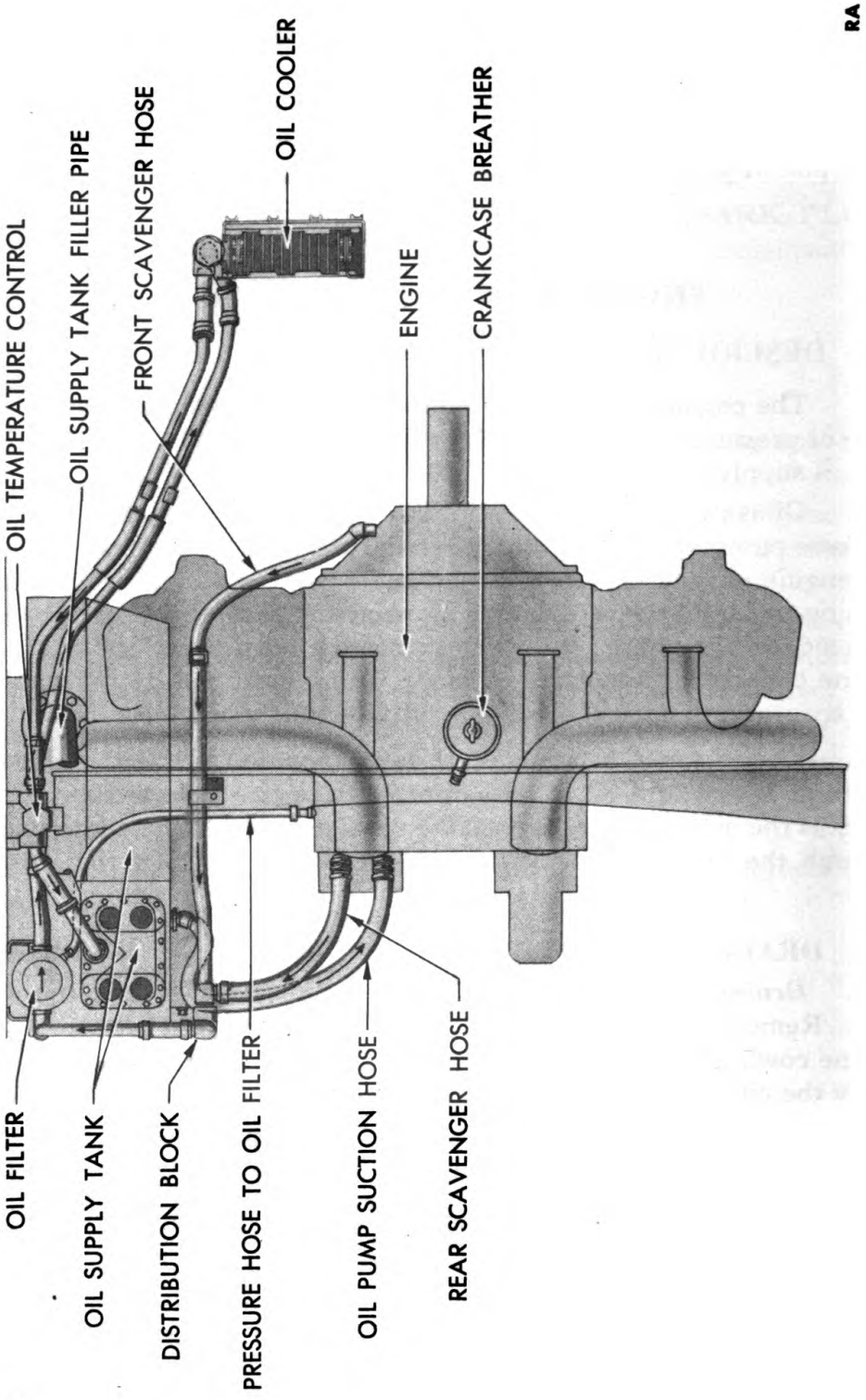


Figure 19—Engine Lubricating System—Top View

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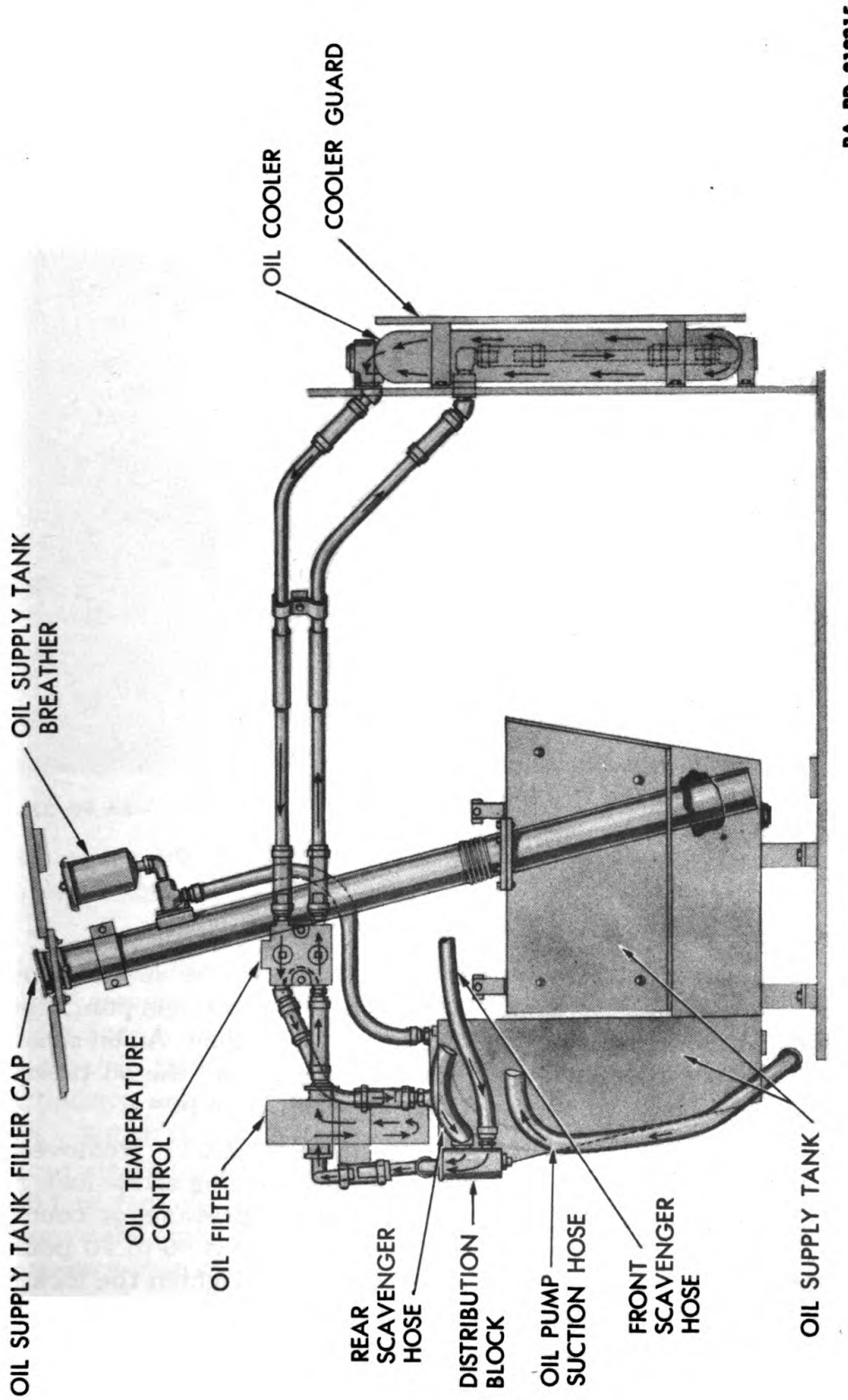
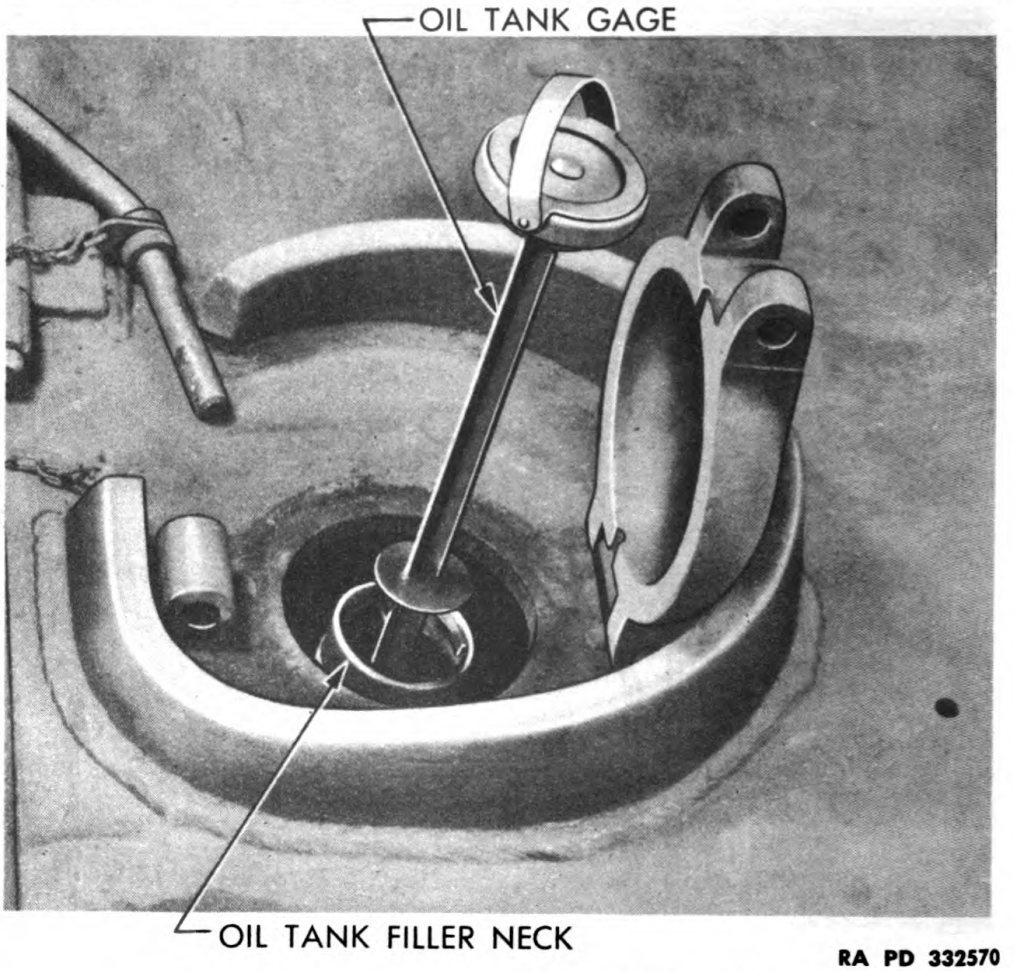


Figure 20—Engine Lubricating System—Side View

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Figure 21—Oil Supply Tank Filler Gage

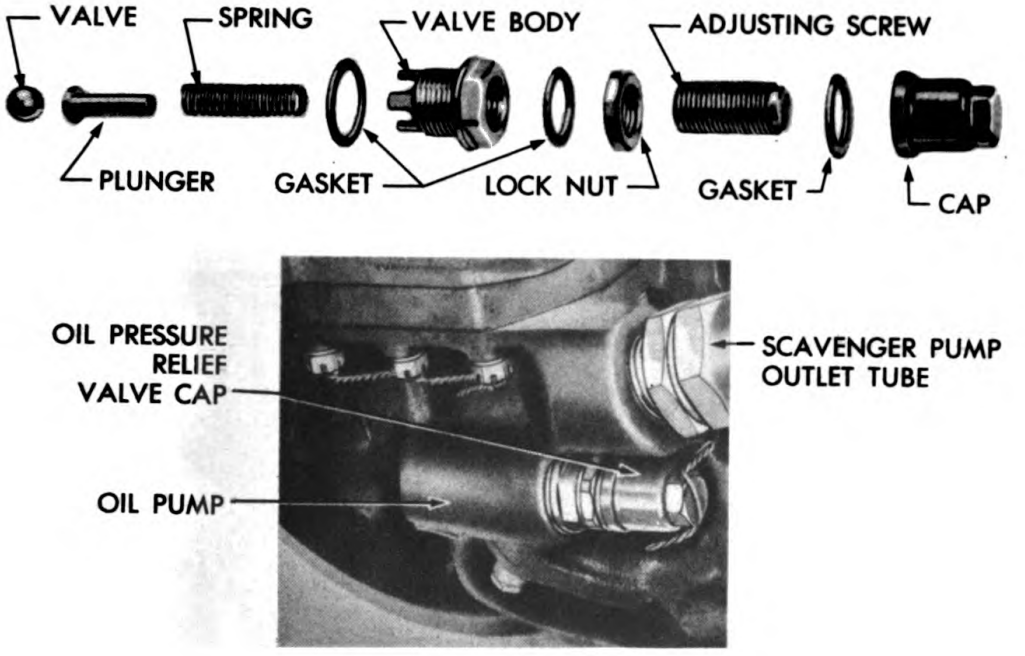
56. OIL PRESSURE AND SUCTION PUMP.

*a. **Description.*** The oil pressure pump and the suction pump operate as separate gear pumps, but are built into a single pump body mounted on the accessory case at the rear of the engine. An oil strainer is built into the inlet side of the pressure pump, and the oil pressure relief valve is built into the pressure side of the pump.

*b. **Adjustment of Pressure Relief Valve*** (fig. 22). Remove the oil pressure relief valve cap, and loosen the adjusting screw lock nut. Turn the adjusting screw clockwise to raise the pressure, or counterclockwise to reduce the pressure. Normal pressure is 40 to 70 pounds at 1,800 to 2,400 engine revolutions per minute. Tighten the lock nut and install the cap and lock wire, after making adjustment.

*c. **Replacement of Oil Pressure Relief Valve*** (fig. 22). Remove the lock wire from the cap, and screw the relief valve assembly from the oil pump body. Place a new gasket over the relief valve body, and screw the assembly into the pump body. Check the engine oil pressure

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Figure 22—Oil Pressure Relief Valve

and adjust if necessary (subpar. *b* above). If no adjustment is required, install the cap lock wire.

d. Removal of Oil Pressure and Suction Pump.

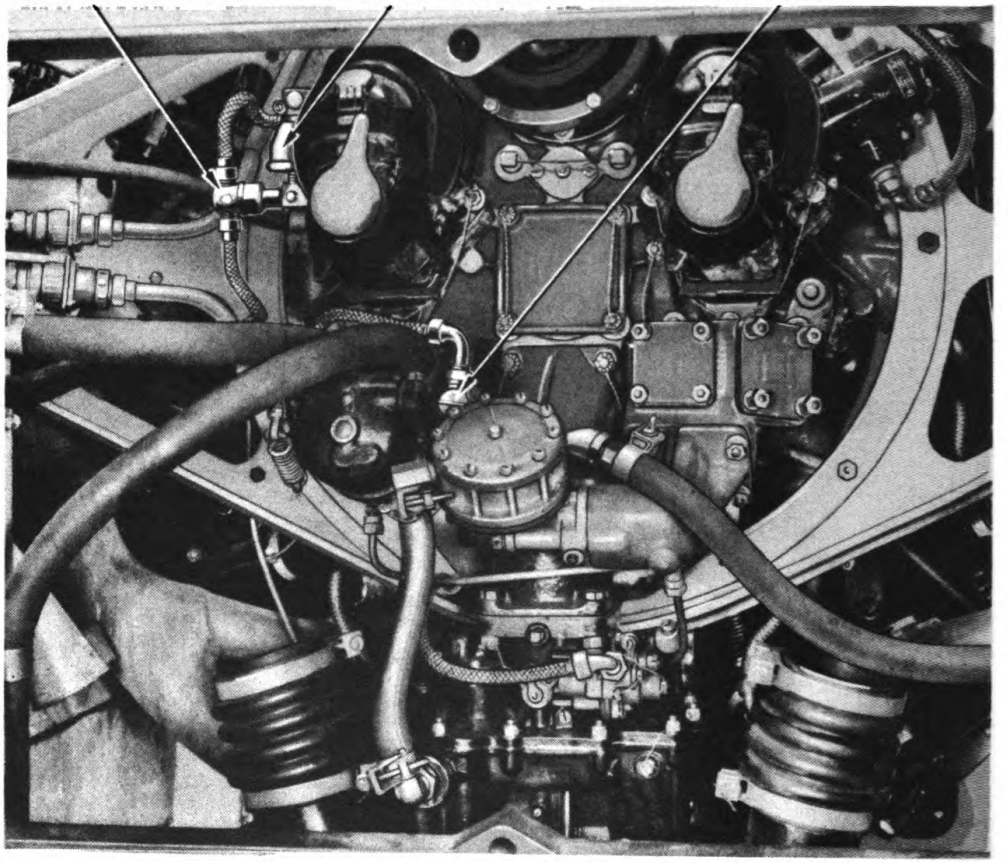
(1) DISCONNECT LINKAGE, CABLE, AND TUBE. Disconnect the oil temperature gage sending unit cable. Disconnect the inlet and outlet hose from the pump, and raise the ends of the hose above the oil level in the supply tank. Disconnect the governor linkage at the carburetor, and disconnect the oil drain tube from the governor.

(2) REMOVE PUMP. Remove lock wire and cotter pins from the pump attaching nuts and remove the nuts, using wrench (41-W-1577-500) to remove the nuts from the right side. Pull out the unit and remove the governor and gage sending unit from the pump. Keep the accessory case opening covered while the pump is off.

e. Installation of Oil Pressure and Suction Pump.

(1) INSTALL PUMP. Attach the governor and gage sending unit to the pump. Place the pump (G104-2994152) in position with gasket (CWR-202-194) and install the attaching nuts and washers (G104-0103310), using special wrench (41-W-1577-500). Install cotter pins

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Figure 23—Oil Gage Sending Units

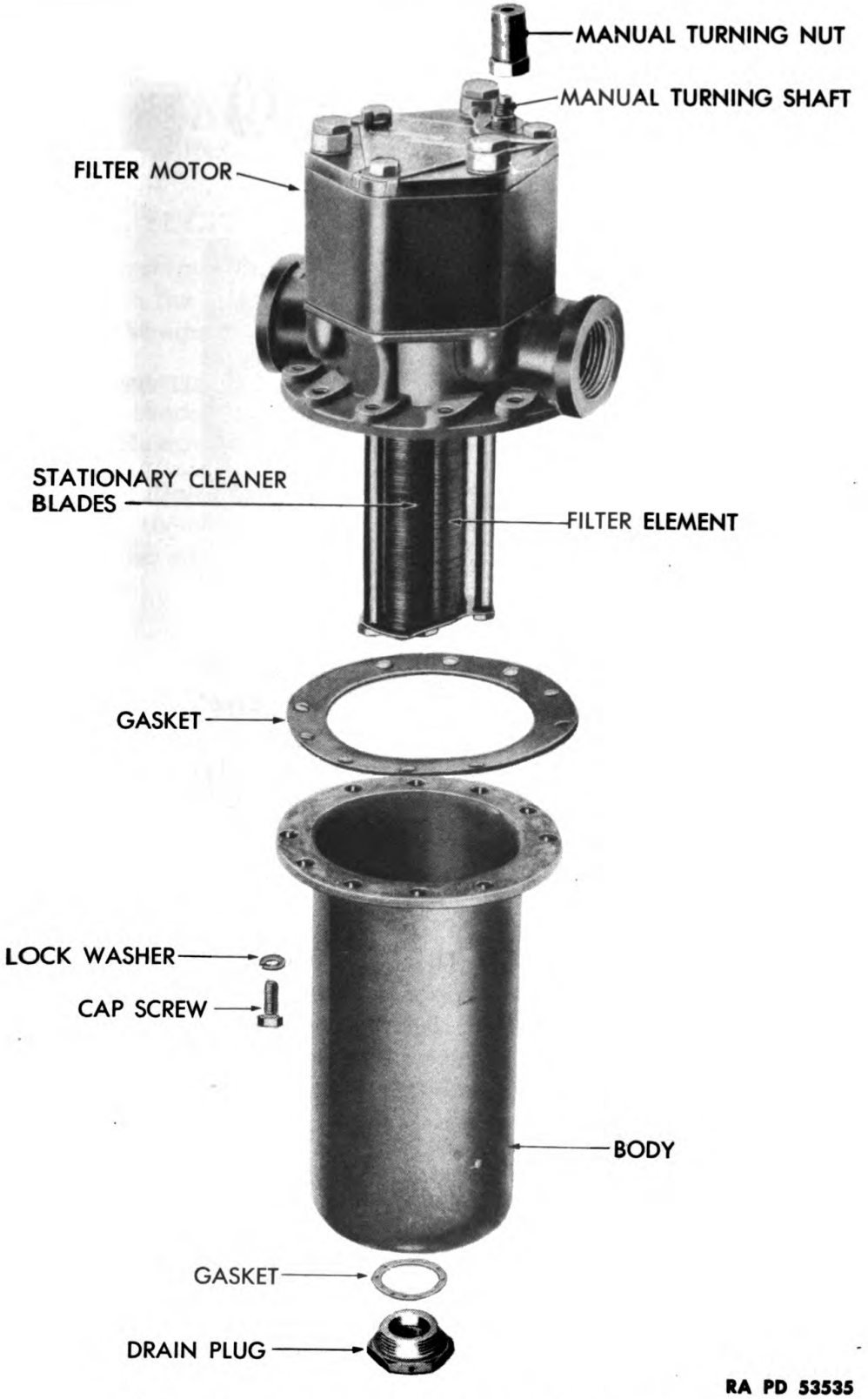
through the attaching nuts on the right side of the pump, and a lock wire through the nuts on the left side.

(2) CONNECT LINKAGE, CABLE, AND TUBE. Connect the governor linkage to the carburetor, and the oil drain tube to the governor. Connect the oil inlet and outlet hose to the pump. Connect the oil temperature gage sending unit cable.

57. GAGE SENDING UNITS.

a. Description (fig. 23). The oil temperature sending unit is attached to the oil pump at the oil strainer. The oil pressure sending unit and the low oil pressure switch are mounted to the same fitting at the left side of the accessory case. The oil pressure sending unit is the larger of the two units, and is mounted in a vertical position. The low-pressure switch is mounted in a horizontal position.

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Figure 24—Engine Oil Filter—Disassembled

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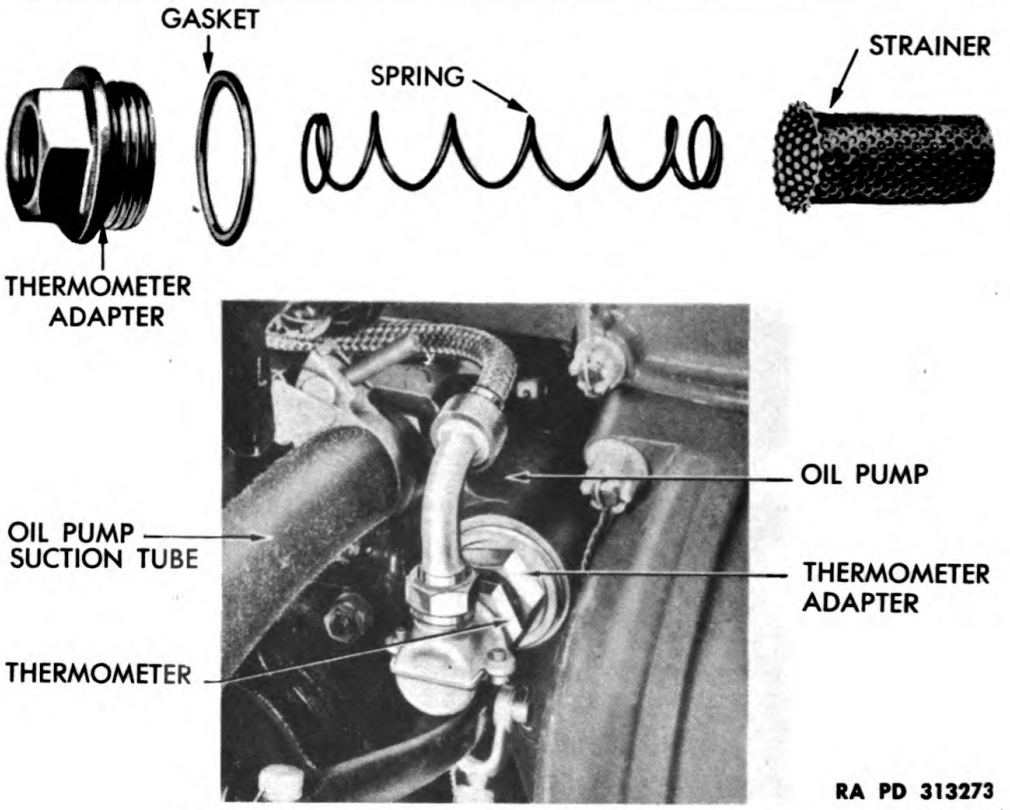


Figure 25—Engine Oil Suction Strainer

b. Replacement. To replace any one of the oil gage sending units, remove the cover, disconnect the wire, and screw the unit out of the fitting. To install, screw the unit into place, connect the wire, and install the cover.

58. OIL FILTER.

a. Description (fig. 24). The oil filter is a revolving disk-type filter, mounted above the oil supply tank in the left rear corner of the engine compartment. The filter disks are rotated by oil pressure from the accessory case.

b. Data.

Manufacturer ..... Cuno
Type AT5

c. Removal (fig. 24). Unscrew the inlet tube on one side and outlet tube on the other side of the oil filter. Disconnect the oil filter to accessory case hose at the filter. Remove the bolt from the bracket that holds the filter body, and lift out the filter. Remove the lock wire, cap screws, and washers. Lift the filter motor assembly and gasket from the filter body. Remove the lock wire, gasket, and drain plug from the bottom of the filter. Thoroughly clean the filter element in dry-cleaning solvent. Do not disassemble the filter element.

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d. ***Installation*** (fig. 24). Place a new filter body gasket in position, and lower the filter motor assembly into the body. Position the cap screws, tighten, and lock wire together. Screw the drain plug in place and lock with wire. Place filter in the bracket, install bolt in bracket, and tighten. Connect and tighten the filter inlet and outlet hose and the filter to accessory case hose at the filter.

59. OIL SUCTION STRAINER.

a. ***Description*** (fig. 25). The oil suction strainer, which is mounted in the inlet side of the oil pressure pump at the right of the governor, strains the oil before it enters the oil pump.

b. ***Removal*** (fig. 25). Disconnect the wire from the oil temperature gage sending unit. Remove the sending unit and thermometer adapter. Remove the spring and strainer.

c. ***Installation*** (fig. 25). Clean the strainer and spring thoroughly and insert them into the pump body. Place a good gasket over the thermometer adapter, and install the adapter and temperature sending unit.

60. OIL COOLER.

a. ***Description*** (fig. 20). The engine oil cooler is mounted on the rear of the front engine compartment bulkhead. Circulation of oil through the oil cooler is controlled by a thermostatic valve mounted in the engine compartment above the oil supply tank. A by-pass valve which is located in the top of the oil cooler is thermostatically and pressure controlled. When the oil starts to reach the cooler, after the thermostatic valve has opened, the by-pass valve in the cooler is partially open. This allows part of the oil to flow through, and part of the oil to by-pass the cooler to maintain proper temperature. As the oil rises in temperature, the by-pass valve closes thermostatically and causes all the oil to flow through the cooler tubes. If the cooler becomes clogged, causing a pressure of 40 pounds or over, the by-pass valve is opened by pressure to avoid damage to the cooler.

b. ***Removal.*** Disconnect the oil inlet and outlet pipes. Remove the cap screws which hold the cooler guard to the bulkhead, and remove the guard. Remove the cooler attaching cap screws and lift out the cooler.

c. ***Installation.*** Place the cooler in position and install the mounting cap screws. Install the cooler guard. Connect the oil inlet and outlet pipes and install the section of the subfloor. Check the oil level in the supply tank and add the amount of oil which was lost when the cooler was removed.

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61. OIL TEMPERATURE CONTROL VALVE.

a. Description (figs. 19 and 20). A thermostatically operated valve is located above the oil supply tank, and in front of the oil filter. When the oil is cold, the valve shuts off the circulation of oil to the oil cooler, and allows the oil to pass directly from the filter to the supply tank. As the oil temperature rises, the valve causes the oil to pass though the oil cooler before reaching the supply tank.

b. Replacement. Disconnect the oil hose from the valve body and remove the attaching cap screws. To install, place the valve in position, and install the attaching cap screws. Connect the oil hose to the valve body.

62. OIL SUPPLY TANK.

a. Description. The oil supply tank is located in the left rear corner of the engine compartment. It consists of a supply tank and an expansion hopper. Air is expelled from the oil in the expansion hopper before the oil passes to the tank. The tank is filled through a filler tube which extends through the engine compartment cover. A bayonet gage (fig. 21) attached to the filler cap indicates the amount of oil in the engine lubricating system. A breather device built into the filler tube is intended to prevent overflowing of the tank. When the tank is filled to the proper level, oil will rise in the filler tube. When the bayonet gage is inserted into the tube, the oil in the tube will run down into the tank.

b. Removal.

(1) DRAIN ENGINE LUBRICATION SYSTEM. See paragraph 55 *a.*

(2) REMOVE ENGINE. See paragraph 50.

(3) REMOVE OIL SUPPLY TANK. Disconnect the supply tank inlet oil hose at the top of the tank. Disconnect the oil hose at the rear of the oil filter. Remove the fire extinguisher nozzle bracket from the supply tank. Remove the nuts from the bolts, which hold the legs of the oil tank to the hull, and remove the tank.

c. Installation.

(1) INSTALL OIL SUPPLY TANK. Place the tank in position and install the attaching nuts. Connect the fire extinguisher nozzle bracket to the oil tank. Connect the oil hose to the tank and oil filter.

(2) INSTALL ENGINE. See paragraph 51.

(3) FILL ENGINE LUBRICATING SYSTEM. See paragraph 55 *b.*

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Section XIX

IGNITION SYSTEM

63. GENERAL DESCRIPTION.

a. Description. The engines in the vehicles covered by this manual are furnished with dual ignition from magnetos mounted on the accessory case. The two magnetos fire two sets of spark plugs mounted in the front and rear sides of the cylinders. When Scintilla magnetos are used, they are supplemented by a booster coil connected through the right-hand magneto to facilitate starting when the engine is cold. The wiring is protected and shielded by metal conduits to minimize radio interference. The control wires for the magneto and booster are connected to a receptacle on the left side of the engine for convenient connection to the switch wires. The spark plugs are aircraft-type, with single-ground electrode which can be cleaned and adjusted.

b. Data.

	Make	Model
Magnetos	Bosch	MJT-9A-306
	or Scintilla	VAG-9-DFA
Booster coil	Auto-Lite	BC 4001
Spark plugs	Champion	CP-63-S

64 MAGNETOS (BOSCH)

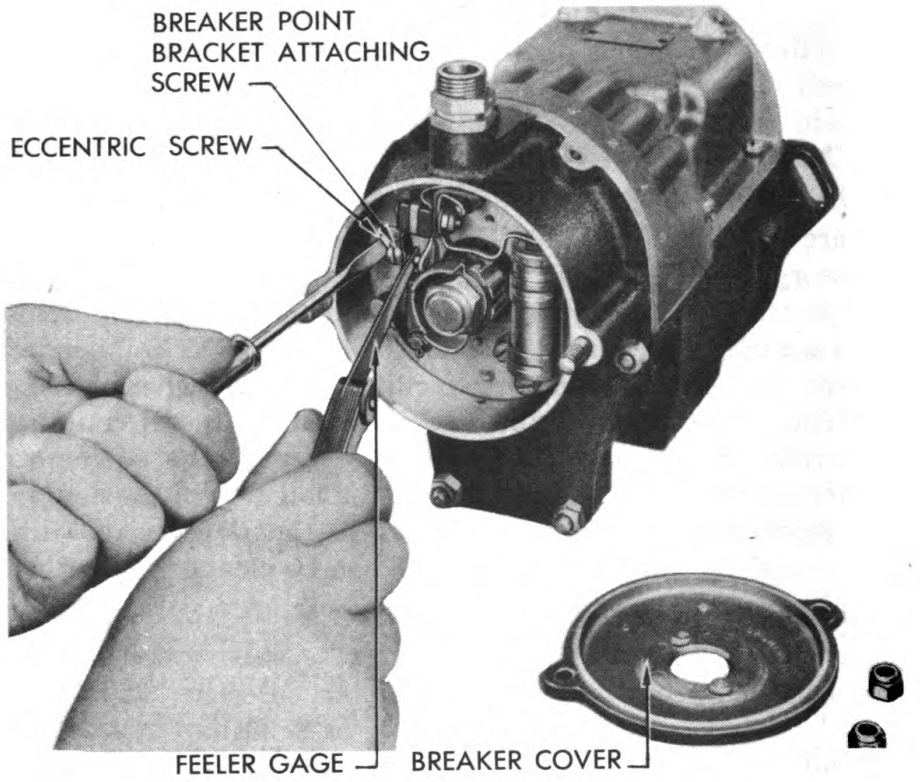
a. Adjustment of Breaker Points.

(1) GENERAL. The adjustment of the magneto breaker points must be maintained to insure proper ignition. If the points are badly burned, indicating a faulty condenser, or if the fiber blocks on the cam followers are badly worn, replace the magneto.

(2) ADJUST BREAKER POINTS (fig. 26). Open the engine compartment rear doors. Remove the breaker housing cover. Crank the engine by hand to open the points to their widest position, and loosen the lock screw which holds the breaker point bracket to the breaker base. Turn the eccentric screw until the gap between the points is 0.008 to 0.010 inch (0.009 inch preferred). Tighten the locking screw. Recheck the gap, and install the breaker housing cover. Close the engine compartment rear doors.

b. Removal of Magnetos (Engine Out of Vehicle). Remove and install one magneto at a time if possible, and use the other magneto to locate the firing position of the engine. When the magnetos are once timed to the engine, this position cannot change unless mechanical failure occurs. CAUTION: *To avoid unnecessary work, do not lose this setting.* If the crankshaft position is changed with both magnetos re-

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Figure 26—Adjusting Breaker Point Gap (Bosch)

moved, or maintenance inspections necessitate removal of both magnetos, use the top dead center indicator (41-I-73-110) and timer (41-T-1598), as described in paragraph 66. Remove magneto from the engine as follows:

(1) **REMOVE DISTRIBUTOR BLOCK** (fig. 27). Remove the two screws which hold the conduit elbow to the radio shield cover, and remove the four screws which hold the cover to the magneto. Remove the four screws which hold the two halves of the cover together, and remove the cover. Remove the two screws from the underside of the distributor block and remove the block. Disconnect the ground wire.

(2) **REMOVE MAGNETO. CAUTION:** *If only one magneto is to be removed, make sure the other unit is grounded. Ground both small contacts in the ignition conduit receptacle and turn the engine with the hand crank until the red dot on the magneto cam is adjacent to the fiber block on the distributor point, so that the point is just starting to open (fig. 28).* This is the firing position on No. 1 cylinder. Both magnetos will be in the same position. Remove the lock wire and magneto mounting nuts, and remove the magneto. Install the new magneto as outlined in subparagraph *c* below, and then remove and install the other unit.

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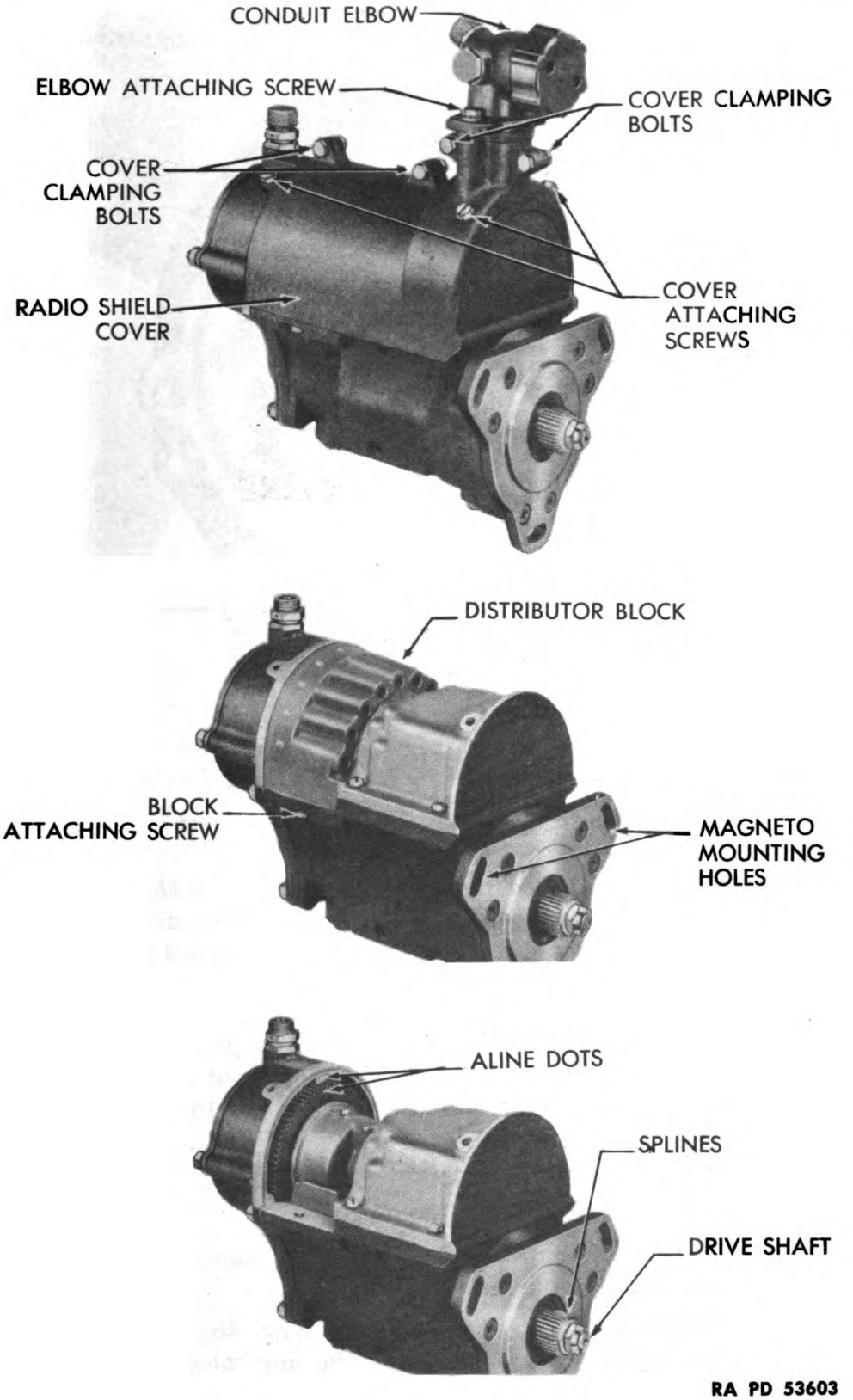


Figure 27—Magneto (Bosch)

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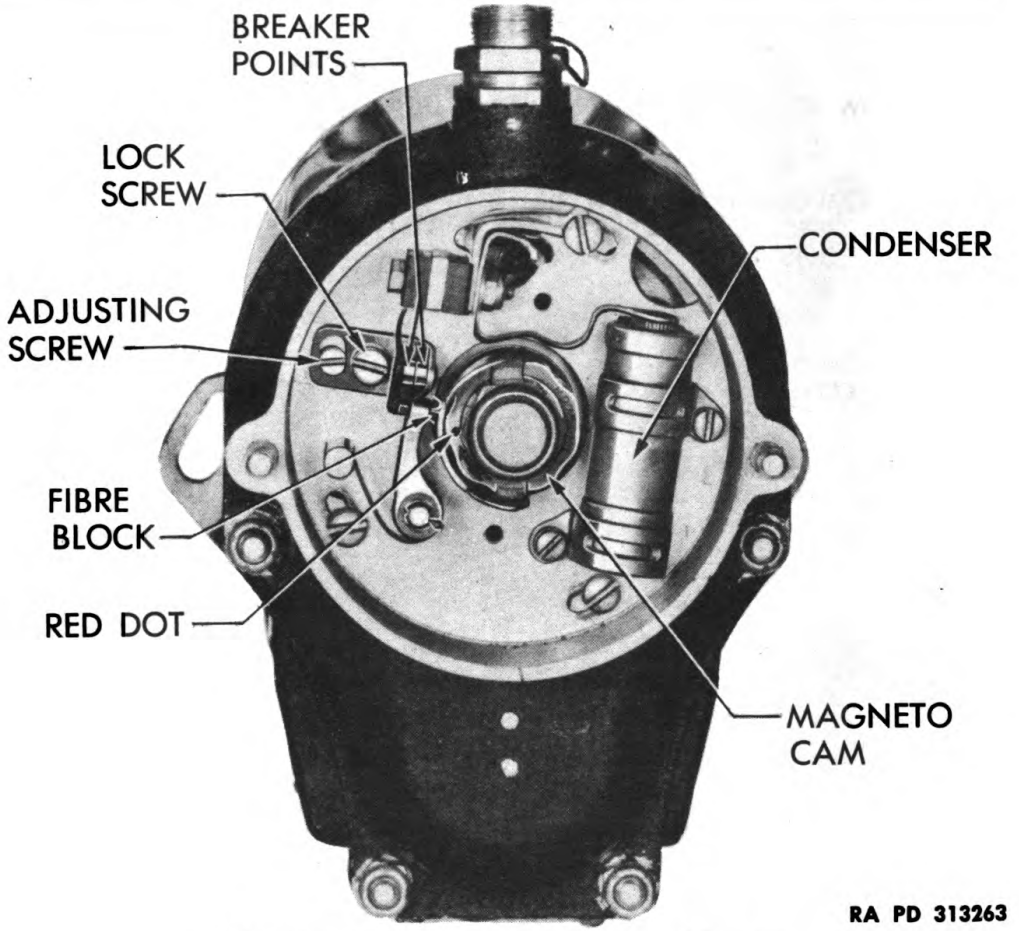


Figure 28—Timing Position (Bosch)

c. Installation of Magnetos (Engine Out of Vehicle). If a new unit is to be installed, remove the covers and the distributor block. CAUTION: *The internal timing of the magneto is set when manufactured or overhauled and must not be changed. Do not move the position of the breaker point mounting base.* The points are spaced at 0.008 to 0.010 inch (0.009 inch preferred) on the high point of the cam. This adjustment can be checked if desired, as outlined in subparagraph *a* (2) above, before installation. Install the magneto on the engine as follows:

(1) INSTALL NEW GASKET. Coat a new gasket with heavy grease and place in position on the magneto.

(2) LUBRICATE SHAFT. Apply a small amount of lubricant to the splined end of the magneto shaft.

(3) TIME MAGNETO TO ENGINE (fig. 28). Position the red dot on the magneto cam, adjacent to the fiber block on the breaker point arm, so that the dots on the distributor gear and case line up. Hold this position and install the magneto on the engine. Start the

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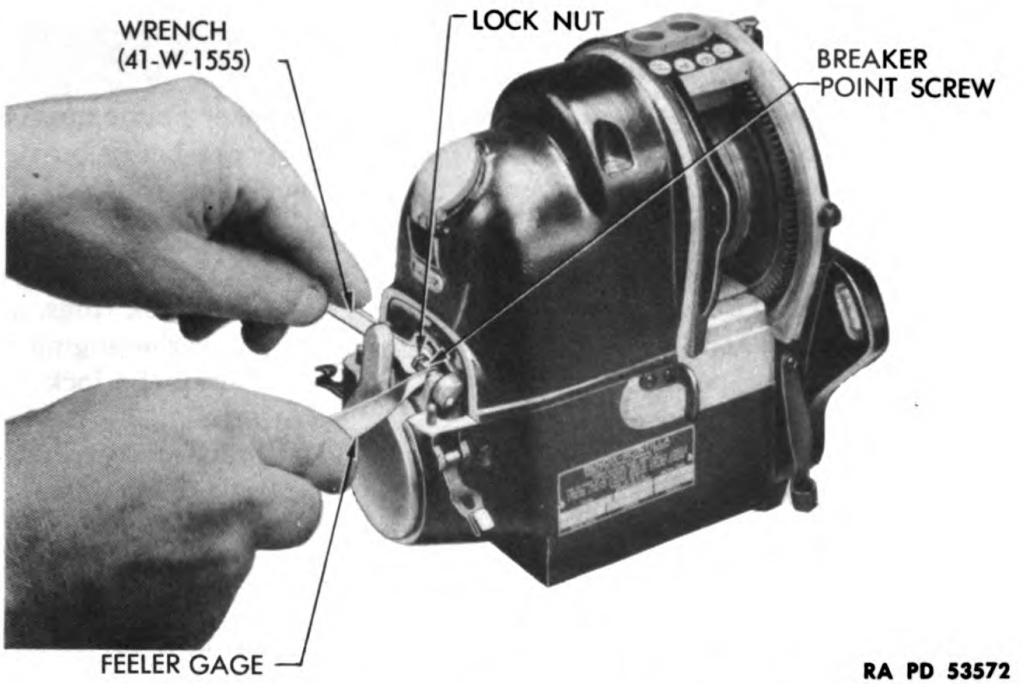


Figure 29—Adjusting Breaker Point Gap (Scintilla)

mounting nuts far enough so that the magneto can still be moved on the elongated mounting holes. Place a 0.001-inch feeler gage between the points, and move the magneto until the gage can just be drawn out. Synchronize the magnetos by checking the points in each unit to see that they open at exactly the same time. If only one magneto is replaced, space the points in the other magneto (subpar. *a* above) and then synchronize the firing of the two units. Tighten the mounting nuts and install the lock wire.

(4) CONNECT WIRING. The numbers on the distributor block, which correspond to the numbers taped on the high-tension wires, indicate the firing order of the magneto. These numbers do not indicate the cylinders to which they are connected. Thus, wire No. 2 is connected to spark plug in cylinder No. 3 as this is the second cylinder to fire in the order of 1-3-5-7-9-2-4-6-8. Connect the high-tension wires to the distributor block and connect the ground wire.

(5) INSTALL DISTRIBUTOR BLOCK AND MAGNETO COVERS. Position the distributor block in the magneto, and secure with screws. Place the two halves of the magneto cover in place and start the four screws which attach the cover to the magneto. Start the four screws which hold the two halves of the cover together, and tighten all screws securely. Install the conduit elbow on the cover with the two attaching screws. Install the breaker cover and attaching nuts.

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65. MAGNETOS (SCINTILLA).

a. Adjustment of Breaker Points.

(1) GENERAL. The adjustment of magneto breaker points must be maintained to ensure proper ignition. If the points are badly burned, indicating a faulty condenser, or if the fiber blocks on the cam followers are badly worn, replace the magnetos.

(2) ADJUST BREAKER POINTS (SCINTILLA) (fig. 29). Open the engine compartment rear doors. Remove the safety lock rings, unhook the clamps, and remove the breaker cover. Crank the engine by hand to open the points to their widest position. Loosen the lock nut on the breaker point screw, and adjust the point spacing by turning the screw with wrench. Space the points to 0.012-inch gap with the gage on the wrench. Tighten the lock nut and recheck the gap. Install the breaker cover.

b. Removal of Magnetos (Engine Out of Vehicle). Remove and install one magneto at a time, if possible, and use the other magneto to locate the firing position of the engine. When the magnetos are once timed to the engine, this position cannot change unless mechanical failure occurs. CAUTION: *To avoid unnecessary work, do not lose this setting.* If the crankshaft position is changed with both magnetos removed or maintenance inspections necessitate removal of both magnetos, use the top dead center indicator (41-I-73-110) and timer (41-T-1598) as described in paragraph 66. Remove magneto from engine as follows:

(1) REMOVE BREAKER COVER AND POINTS (fig. 30). Remove the lock wire rings and unhook the latches which hold the cover over the breaker points. Remove the breaker cover to release the bayonet lock which holds the breaker in the housing. Push the bronze lever to the right. Remove the breaker assembly and spring washer. CAUTION: *Remove the breaker assembly from both magnetos to avoid accidental starting of the engine.*

(2) REMOVE DISTRIBUTOR BLOCK COVERS (fig. 30). Remove the two screws which hold the conduit elbow flange to the top of the cover. Remove the two bolts which clamp the upper ends of the two halves of the cover together. Remove the safety wire pins, unhook the spring latches at the bottom of each half of the cover, and remove the half toward the outside of the vehicle. Loosen the conduit coupling lock rings at the elbow so that they will turn. Unscrew the two bakelite connector nuts, and disconnect the booster (right magneto only) and ground wires from the top of the magneto. Raise the wiring harness, with the distributor blocks attached, up far enough to permit removal of the inside half of the cover.

(3) REMOVE MAGNETO. Remove and install one magneto at a time, if possible, so that the other magneto can be used to locate the fir-

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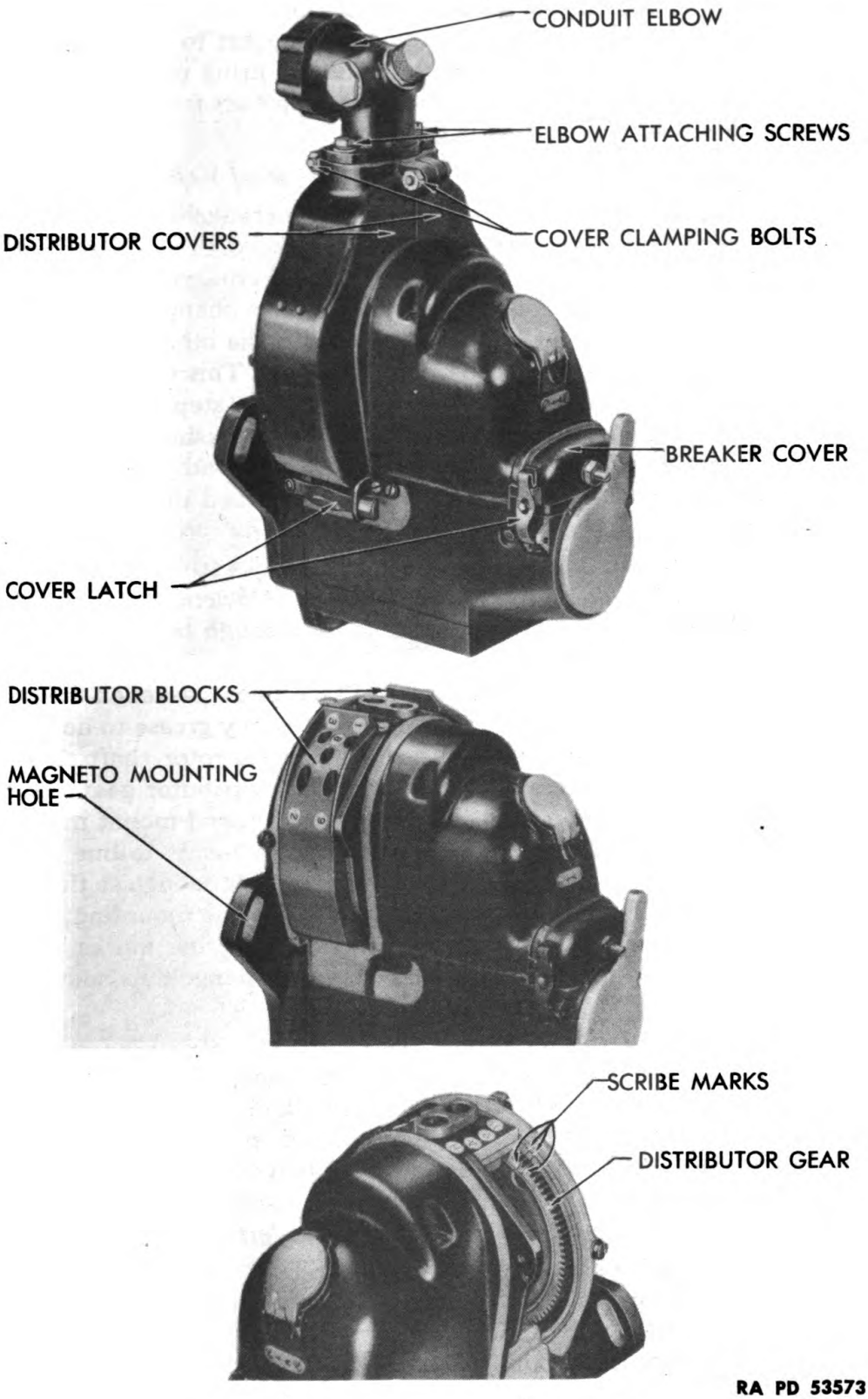


Figure 30—Magneto (Scintilla)

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ing position. Crank the engine by hand and aline the two scribe marks on the distributor gear with those on the case, just to the right of the center web of the magneto frame. This is the firing position of No. 1 cylinder. Remove the lock wire and mounting nuts from the flange of the magneto, and remove the magneto.

c. Installation of Magnetos (Engine Out of Vehicle).

(1) TIME ENGINE. If the position of the crankshaft as set for removal (subpar. *b* (3) above) has not been changed, the new unit can be installed by timing the magneto to the engine as described in step (2) below. If the position of the crankshaft has been changed, remove the covers and raise the right distributor block on the other magneto and crank the engine until the scribe marks line up. This will place No. 1 piston on firing position. Install the new magneto (step (2) below). If both magnetos have been removed, and the crankshaft position has been changed, set the engine timing with the top dead center indicator (41-I-73-110) and timer (41-T-1598) as described in paragraph 66.

(2) TIMING MAGNETO TO ENGINE (fig. 30). Remove the breaker point assembly and the distributor blocks from the new magneto. CAUTION: *The internal timing or "E" (efficiency) gap, which is controlled by the two set screws extending through both sides of the breaker housing, is set when the magneto is manufactured or overhauled. Do not change this adjustment.* Place a new gasket on the magneto mounting flange with a small amount of heavy grease to hold it in place. Lubricate the splined end of the magneto rotor shaft slightly. Turn the shaft until the scribe marks on the distributor gear line up with the marks on the housing. Hold this position and mount the magneto on the engine. Tip the magneto from side to side to line up the shaft with the coupling, and start the mounting nuts enough so the magneto can still be moved on the elongated slots in the mounting. Move the magneto as required to perfectly aline the scribe marks, as the points will not open at this position. Tighten the flange nuts and install the lock wire.

(3) REPLACE DISTRIBUTOR BLOCKS (fig. 30). Loosen the set screws in the distributor blocks, below the contacts, which hold the wires into the blocks, and pull out the wires. To install, push the spark plug wires into the holes which are numbered to correspond with the number on the wire. Use a small amount of powdered talc on the wires to prevent fusing to the block. Tighten the set screws. NOTE: *Install the block with the five wire connections on the left side of the magneto.*

(4) CONNECT GROUND AND BOOSTER WIRES. Place the distributor blocks into position on the magneto and slide the rubber grommet over the ground and booster wire (ground wire only on left magneto). Screw the ground wire into the front hole in the bakelite terminal receptacle on top of the magneto (both magnetos). Screw the booster high-tension wire into the rear hole on the receptacle block

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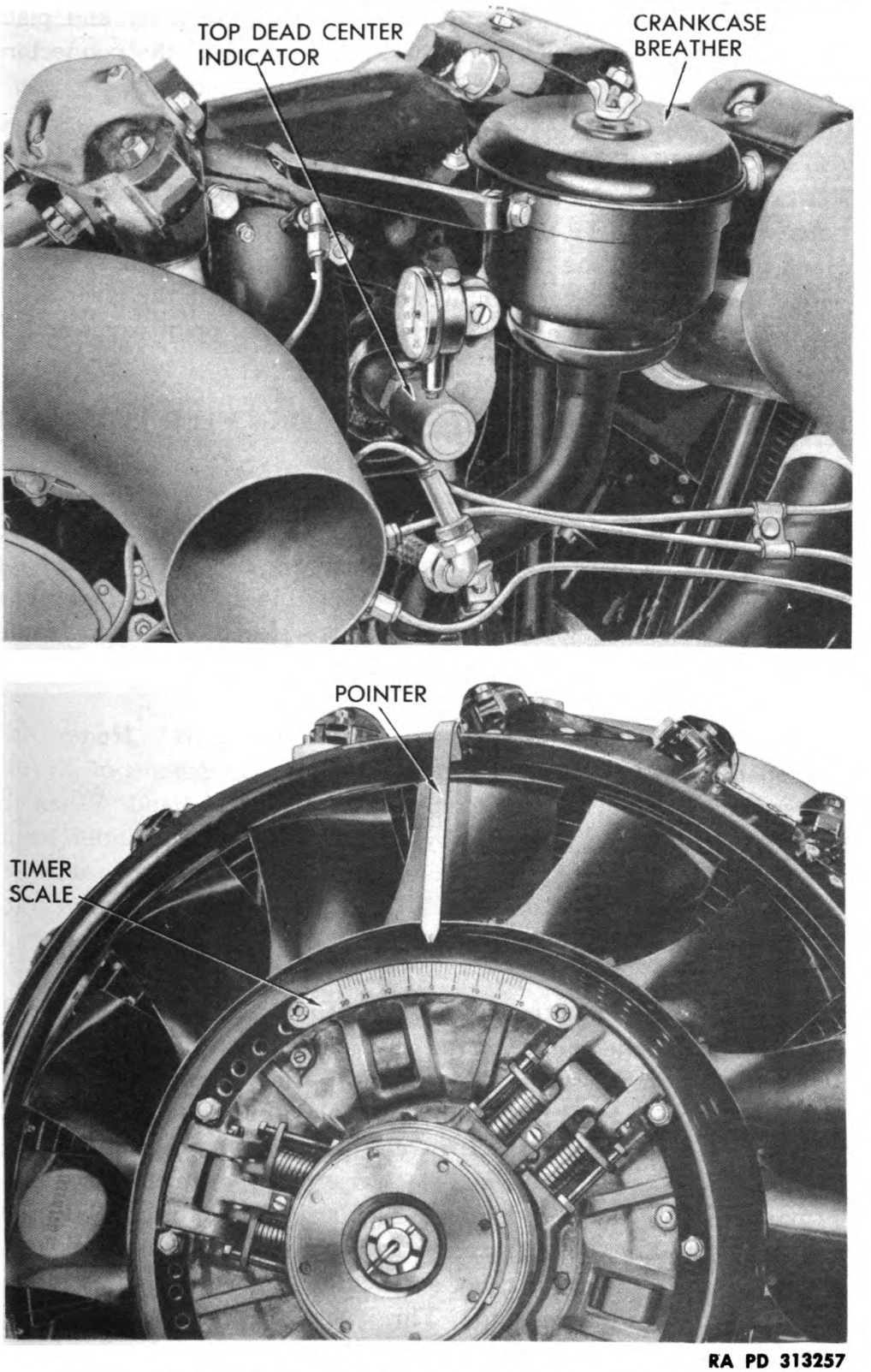


Figure 31—Timer (41-T-1598) and Top Dead Center Indicator, (41-I-73-110)

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(right magneto only). Tighten connector screws securely and place the rubber grommet down over the knurled ends of the connectors. CAUTION: *Do not connect the booster to the front contact; this would damage the magneto.*

(5) INSTALL COVERS AND BREAKER POINT ASSEMBLY. Position the distributor block covers on the magneto and install the two bolts which clamp the top of the two halves of the covers together. Hook the latches at the bottom of the covers and install the safety pin wires. Install the breaker point assembly, and position the lever of the assembly to the extreme right. Install the breaker point cover and install the lock wire rings.

66. TIMING ENGINE WITH TOP DEAD CENTER INDICATOR AND TIMER.

a. Time the Engine for Installation of Magneto (Engine Out of Vehicle). If the position of the crankshaft is changed while both magnetos are removed, it will be necessary to ascertain the proper firing position of No. 1 piston before installing the magneto. The proper firing position is 25 degrees of crankshaft travel before top dead center of the piston for Scintilla magnetos, and 4 degrees before top dead center for Bosch magnetos.

b. Set No. 1 Piston at Top Dead Center (fig. 31). Remove the rear spark plug from No. 1 cylinder and feel for an exhaust of air from the spark plug hole while the engine is cranked by hand. When the compression stroke is indicated by air forced from the cylinder, install the top dead center indicator. Continue to crank the engine until the dial gage indicates that the piston is operating the indicator, then crank very slowly until the indicator hand stops. The piston will then be at top dead center.

c. Set Firing Position (fig. 31). Attach the timer scale on the clutch bolts and the pointer on the cowling. Position the pointer so that it points to 0 on the scale. The timer will then indicate the top dead center position of No. 1 piston, and the scale attached to the clutch will indicate degrees of crankshaft travel. Turn the engine in the reverse direction with the fan blades (clockwise when facing flywheel) approximately ¼ turn to overcome backlash. Then turn the flywheel slowly in the direction of rotation until the timer pointer indicates 4 degrees ahead of 0 on the timer scale (Bosch magneto) or 25 degrees ahead of 0 (Scintilla magneto). This is the firing position of No. 1 piston. NOTE: *The scale is graduated 20 degrees on each side of the 0.* When using the scale on Scintilla-equipped engines, make an additional scribe mark indicating 25 degrees to the right of the 0.

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67. FIELD REPLACEMENT OF MAGNETOS AND EMERGENCY ADJUSTMENTS.

a. Field Replacements. Do not attempt to substitute one make of magneto for another when making field replacements, as the wiring is different for the two installations. The magnetos can be replaced in the field, working through the engine compartment rear doors in exactly the same manner as outlined in paragraph 64 *b* (Bosch) and paragraph 65 *b* (Scintilla). CAUTION: *Do not remove both magnetos at the same time or lose the firing position, as the top dead center indicator and timer cannot be used while the engine is in the vehicle.* Synchonize the two Bosch magnetos so that they fire at the same time, or perfectly

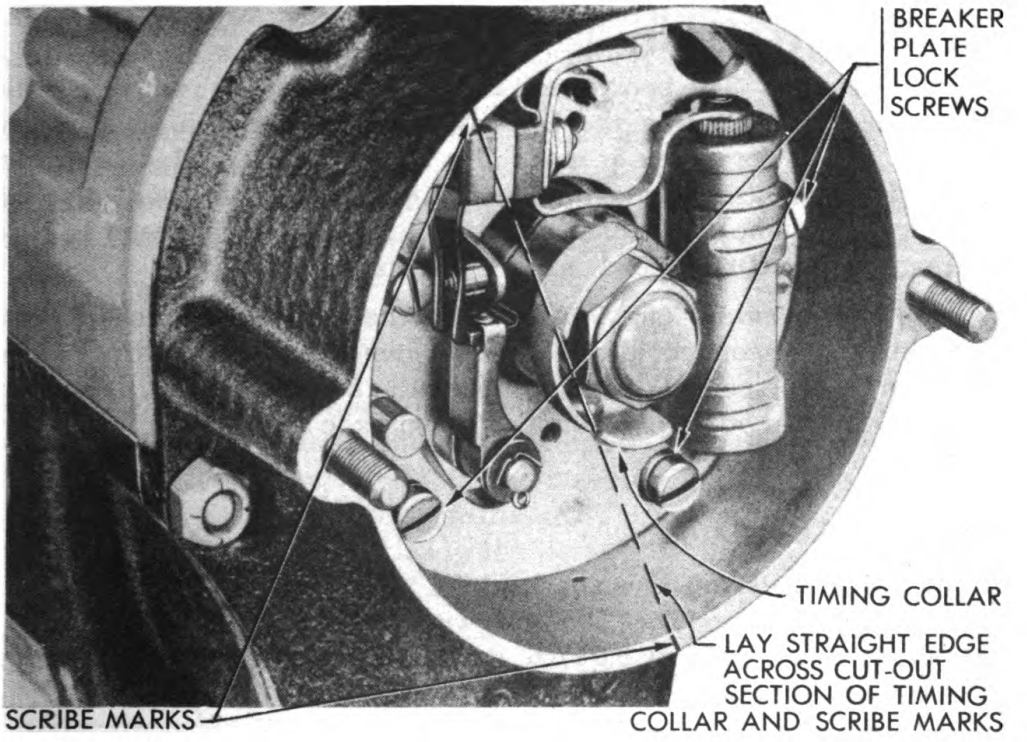


Figure 32—Alining Timing Collar and Scribe Marks (Bosch)

aline the scribe marks on both Scintilla magnetos. NOTE: *Check the engine timing with gage at earliest opportunity.*

b. Replace Points and Set "E" (Efficiency) Gap.

(1) BOSCH. In an emergency, the contact points and condenser can be replaced if the parts are available. This will necessitate setting the "E" gap so that the points open in the proper relation to the position of the magneto rotor. Replace and space the points 0.009 inch, and position the cam with the dot adjacent to the fiber block on the cam follower. Place a scale or straightedge across the cut-out in the timing collar on

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the cam, so that the scale indexes with the notches or scribe marks in the breaker housing, as shown in figure 29. Loosen the three breaker base screws. Aline the timing dots on the gear and case, and shift the base assembly so that the points just start to open (0.001-in. gap). Tighten the breaker base. NOTE: *Check the engine timing with gage at earliest opportunity.*

(2) SCINTILLA. The breaker and point assembly (SCI-2-841) is furnished for the Scintilla magneto, and an emergency replacement can be made. Install and space the new points 0.012 inch. Do not attempt to alter the "E" gap setting, as the allowable tolerance in timing the unit will permit satisfactory performance until the magneto can be replaced and the timing properly checked.

68. BOOSTER COIL.

a. General. The booster coil is a vibrator-type high-tension induction coil supplementing the Scintilla magneto ignition, to facilitate starting when the engine is cold. The output of the coil is connected through the right-hand magneto and "trails," or is later than, the magneto ignition. The action of the booster increases engine speed to assist in reaching the cut-in speed of the magneto.

b. Replacement (fig. 9). Unscrew the conduit coupling rings on the coil and disconnect the leads. Remove the two mounting screws and remove the coil. To install, mount the coil on the engine support frame with the two screws, connect the wires to the coil, and attach the conduit.

69. SPARK PLUGS.

a. Description. The spark plugs (CWR-209-160) are aircraft-type, Champion model (CP-63-S), with single-ground electrode. The electrodes are spaced at 0.017 to 0.019 inch with a round feeler gage. Gaskets are furnished with the plugs.

b. Replacement. Remove the engine compartment top cover and the hull floor cover. Remove the inspection plates from the front engine cowling. Disconnect the spark plug wires and conduits. Remove the spark plugs with a socket wrench. To install, coat the new gasket with a small amount of antiseize compound (mica base) and place it on the plug. Install the plugs in the cylinder and tighten with the special socket wrench to 28 to 30 foot-pounds tension.

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Section XX

FUEL AND AIR INTAKE AND EXHAUST SYSTEMS

70. DESCRIPTION.

a. Fuel is supplied to the carburetor at a pressure of approximately 3½ pounds. The fuel travels from the vertical fuel tanks through built-in filters to shut-off valves, and then is drawn up into the fuel pump located above the carburetor. The fuel pump forces the fuel to the carburetor.

b. A fuel tube connects the left fuel valve to the priming pump. Fuel drawn into the priming pump by the operation of the pump plunger is forced to the priming distributor, and through the tubes into the top seven cylinders of the engine.

c. The exhaust gases pass through right and left manifolds, exhaust pipes, and tail pipes, and are expelled from the rear of the hull. A deflector, mounted on the exterior of the hull, can be set to deflect the exhaust away from the ground to avoid unwanted creation of dust.

71. AIR CLEANERS.

a. ***Description.*** Two oil-bath type air cleaners are located on the outside of the engine compartment, one on either side of the gun mount. Air enters the air cleaners through the upper air intake tubes, passes through a stationary and prefilter element, is cleaned by the oil in the oil cup, and is passed out through the lower intake tubes to the carburetor. The dirt collected drains to the bottom of the oil cup.

b. ***Maintenance.*** When servicing the air cleaners, inspect the complete air intake system for leakage, especially the bellows, tubes, and connections between the air cleaners and the carburetor air horns. Dirt entering at those points is drawn directly into the engine. The amount of sediment in the oil cup should not exceed ½ inch.

c. ***Cleaning and Servicing.*** Loosen the oil cup wing nuts, push the rods away and lower the oil cup. Unscrew the prefilter wing nuts and remove the prefilter. Clean the prefilter, the oil cup, and the disk assembly in dry-cleaning solvent. After cleaning, place the prefilter in position, and tighten the wing nuts. Place the disk assembly inside the oil cup, and fill the oil cup to the level mark with the proper grade of oil (par. 26). Install the cup, and tighten the wing nuts.

72. FUEL FILTERS.

a. ***Description*** (fig. 33). Fuel filters are built into the side of the vertical fuel tanks near the floor. Fuel shut-off valves are screwed into the filter flanges. The filter elements (B201146) are of the full-flow

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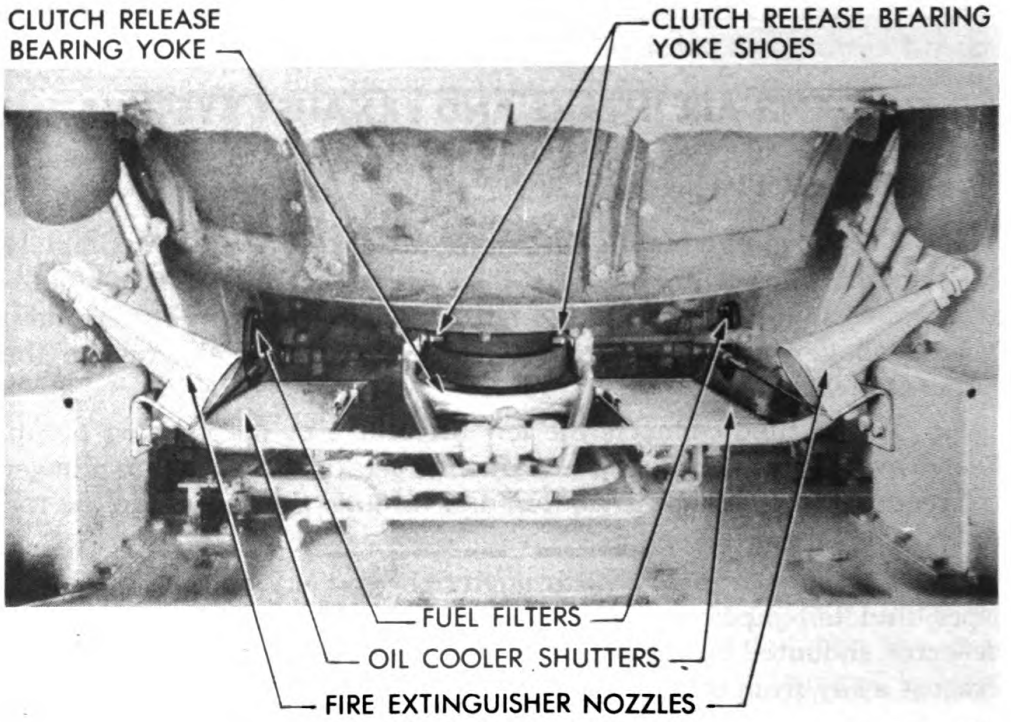


Figure 33—Location of Fuel Filters

type, and cannot be cleaned unless the filter is removed from the fuel tank.

b. Removal and Cleaning. Drain fuel tanks. Remove floor plate in engine compartment. Disconnect fuel lines and shut-off valves. Unscrew shut-off valve from each filter flange. Remove cap screws which hold filter body to fuel tank and remove filter. Do not disassemble the filter. Clean filter elements in dry-cleaning solvent.

c. Installation. Place the filter in the fuel tank with gasket in position, and install lock washers and cap screws. Screw in shut-off valve and connect fuel lines. Install engine compartment floor plate.

73. PRIMER AND FUEL PUMP.

a. Description.

(1) The fuel pump is mounted to the accessory case above and to the right of the carburetor (fig. 35). The pressure is regulated at approximately 3½ pounds.

(2) The primer pump (fig. 34) is bracket-mounted in front of the driver to provide a means of injecting a spray of fuel into the engine intake pipes to facilitate starting. The "pulling" stroke of the primer draws a charge of gasoline into the cylinder. The "push" stroke delivers the gasoline to the primer distributor, then through lines to the top

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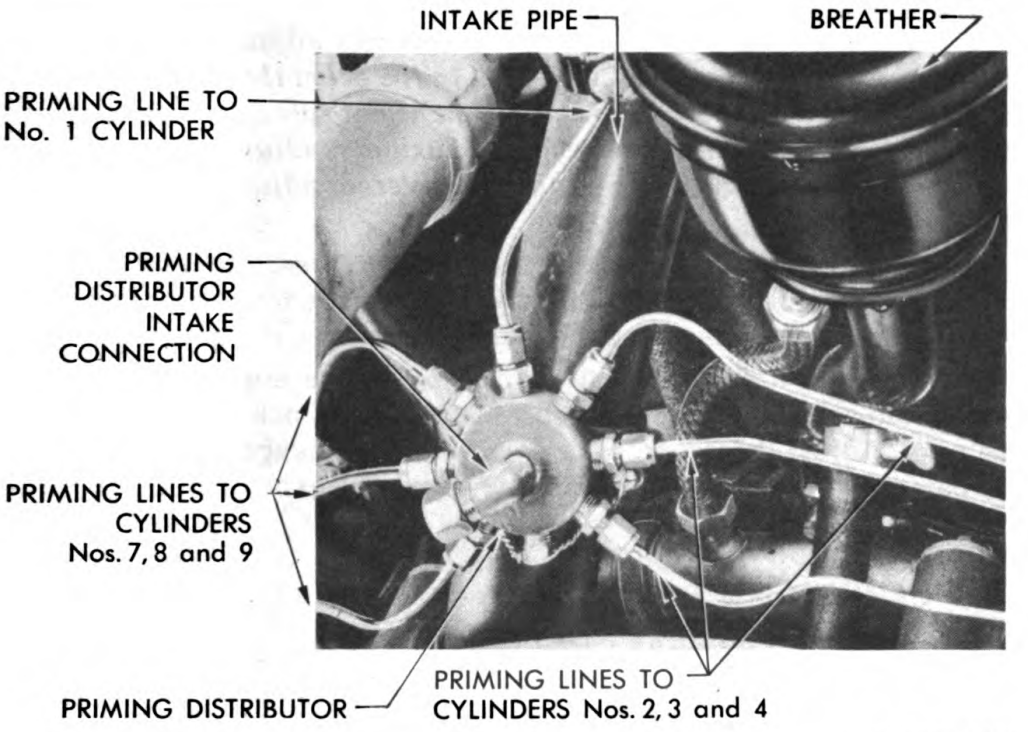


Figure 34—Priming Distributor and Lines

seven cylinders of the engine. The primer pump contains a strainer which may be removed and cleaned.

b. Fuel Pump Replacement (fig. 35). Disconnect the inlet and outlet tubes to the fuel pump. Disconnect the oil drain tubes from the governor and fuel pump body. Remove the nuts that hold the fuel pump body to the accessory case, and remove the fuel pump. To install, place new gasket (G103-1593607) in position and install the fuel pump and attaching nuts. Connect the oil drain tubes and the inlet and outlet tubes.

74. GOVERNOR.

a. Adjust Governor. Disconnect the linkage from the governor butterfly valve arm on the manifold, loosen the governor adjusting screw lock nut, and set the adjusting screw to just start a slight tension on the governor spring. Hold the butterfly arm against the stop on the manifold to maintain wide open position and adjust the linkage to line up the clevis pin hole. Install the clevis pin and cotter pin.

b. Check Governor Setting. Start the engine, warm up if necessary and accelerate to top speed. The governor should control the speed of the engine at 2,400 revolutions per minute. If the speed is not properly controlled, adjust the governor adjusting screw to add more tension

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to the spring to raise the governed speed or reduce the spring tension to lower the governed speed. Lock the governor adjusting screw when the proper setting is obtained. NOTE: *In the event the adjusting screw has been turned all the way in without sufficient speed (revolutions per minute) being obtained, unscrew the auxiliary adjusting screw (eye bolt) several turns and again adjust the governor adjusting screw* (subpar. *a* above).

c. Removal. Disconnect the oil line from the bottom of the governor housing, disconnect the linkage, remove the four mounting nuts which hold the governor on the engine, and remove the governor.

d. Installation. Install the governor on the engine with a new gasket and secure with the four castellated nuts. Lock wire the mounting nuts. Adjust the governor and connect the linkage as explained in subparagraph *a* above, and check the setting as explained in subparagraph *b* above.

75. CARBURETOR.

a. Description (fig. 35). The carburetor is attached to the rear of the engine. Gasoline and air are mixed in the carburetor before entering the supercharger housing. Adjustments are provided for engine idling speeds and for idling fuel mixture. When the clutch pedal is all the way up, the normal engine idling speed of 800 revolutions per minute is controlled by adjustable linkage between the clutch release cross shaft and the accelerator cross shaft. When the clutch pedal is depressed the idling linkage at the cross shafts becomes inoperative, and the engine idling speed is then controlled by the idle speed adjustment screw at the top right side of the carburetor. The idle speed adjustment screw may be adjusted to allow a lower idling speed when shifting transmission gears.

b. Data.

Manufacturer ..... Stromberg
Model NAR9G

c. Adjustment of Engine Idling Speed.

(1) ADJUST NORMAL IDLING SPEED. With the engine running at normal operating temperature and the clutch pedal all the way up, adjust the linkage at the cross shafts below the driver's seat so that the engine will idle at 800 revolutions per minute.

(2) ADJUST LOW IDLING SPEED (fig. 35). After the normal idling speed adjustment has been made (step (1) above), hold the clutch pedal in the depressed position, and adjust the idle speed adjustment screw at the carburetor, so that the engine will idle at approximately 400 revolutions per minute.

d. Adjustment of Idle Fuel Mixture (fig. 36). The idle mixture adjustment lever is located in the center and to the top of the carbu-

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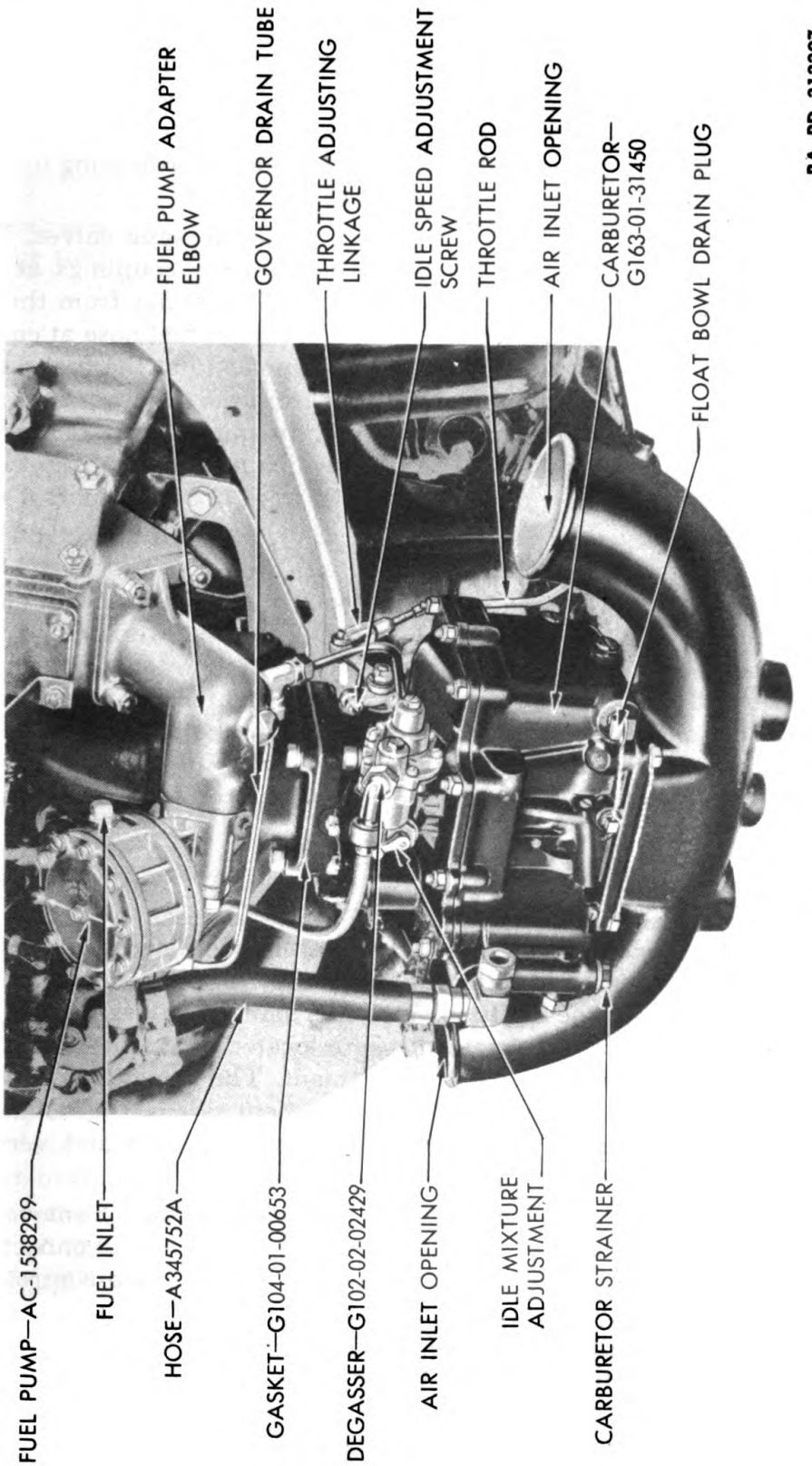


Figure 35—Right Side of Carburetor

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retor. Push the lever to the right to lean the mixture, or to the left to enrich the mixture.

e. Drain Plugs and Strainer (figs. 35 and 36). Two drain plugs are located in each float chamber. Remove the plugs to drain the chamber. The fuel strainer is located at the bottom left side of the carburetor. Remove the plug in the bottom of the strainer housing to take out the screen for cleaning.

f. Removal of Carburetor (fig. 35). Close fuel tank valves. Disconnect the clamps from the bellows-type flexible couplings at the lower end of the air intake tubes, and remove couplings from the air horns. Cover the air horn openings. Disconnect the fuel hose at carburetor. Disconnect oil drain tube at the governor and at the fuel pump elbow. Remove cotter pins and clevis pins from the governor arm and the throttle rod. Unscrew knurled nut and disconnect lead at the idle cut-off and degasser. Take out the bolts which hold the carburetor to the throttle box. Tilt the carburetor toward the doors, and lift it out.

g. Installation of Carburetor (fig. 35). Place a gasket on the carburetor flange, and attach the assembly to the governor throttle box. Position the accelerator rod and governor arm, and secure with clevis and cotter pins. Connect the oil drain tubes to the governor and fuel pump elbow. Connect the fuel inlet hose to the carburetor. Connect the lead wire at the idle cut-off and degasser, and tighten the knurled nut. Uncover the air horn openings. Place the air intake bellows couplings over the ends of the air horn, and tighten clamps in place. Open fuel tank valves. Check for leaks, and adjust carburetor (subpars. *c* and *d* above).

76. FUEL TUBES AND VALVES.

a. Fuel Tubes. All fuel tubes are covered where necessary to prevent damage. When fuel tubes are replaced, bend the new tube to conform to the shape of the old tube. Two fuel shut-off valves, one for the left tanks, and one for the right tanks, are located at the bottom of the vertical fuel tanks in the engine compartment. The valves are operated by controls located on the driver's compartment side of the bulkhead. Control handles are horizontal when valves are closed and vertical when valves are open.

b. Replacement of Fuel Valve. Drain fuel tanks. Remove engine compartment inspection cover from the hull floor. Disconnect the fuel pipes from the fuel valve. Disconnect the fuel valve control rod and unscrew the valve from the filter flange. To install fuel valve, screw the valve into filter flange. Connect the fuel valve control rod and connect the fuel tubes to fuel valve. Check for leaks with a small amount of fuel in the tanks before filling tanks completely.

c. Replacement of Fuel Shut-off Valve Assembly. Remove the cotter pin and disconnect the control rod ball joint on the engine side

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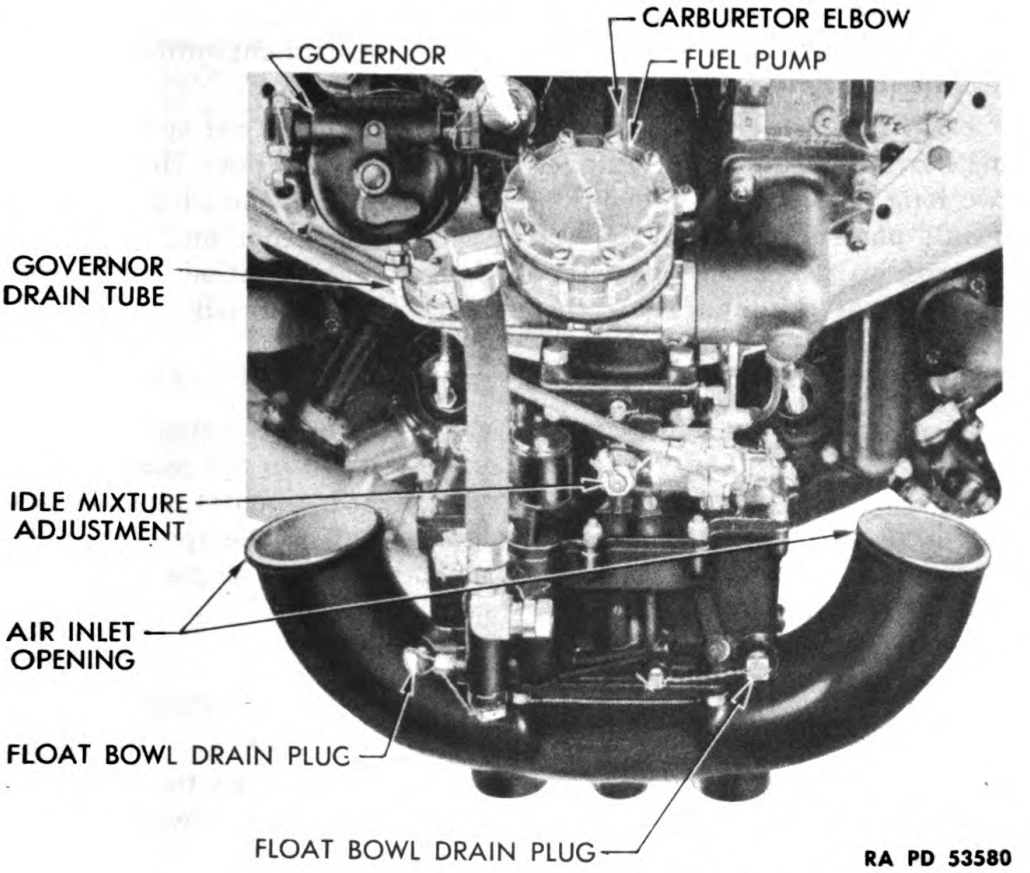


Figure 36—Rear of Carburetor

of the bulkhead. Take out the flange screws and remove the shut-off valve control assembly from the driver's compartment side of bulkhead. To install, position the assembly and attach to bulkhead. Connect and install cotter pins in the control rod ball joint.

77. IDLE CUT-OFF AND DEGASSER.

a. ***Description*** (fig. 35). The idle cut-off and degasser is intended to eliminate backfire and to prevent forming of obnoxious gases caused by an overrich fuel mixture that does not burn during deceleration. The degasser is operated by the variation of vacuum in the intake manifold, and by an electric solenoid which is controlled by a push-button switch on the instrument panel.

b. ***Adjustment.*** Remove the seal cap and turn adjusting screw clockwise until tight. With engine warmed up, and idle speed and idle mixture adjusted properly, back off the adjusting screw about 6 or 8 notches until the engine surges or rolls. Then accelerate the engine to governed speed (2,400 revolutions per minute) with no-load, and suddenly close the throttle and allow the engine to return to idle. If engine

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rolls or stops when normal idle is reached, turn adjusting screw in (clockwise) a notch or two and test. Repeat adjustment until the engine resumes idling in a normal manner.

c. Replacement (fig. 35). Unscrew the knurled nut at the end of the flexible conduit, and remove terminal from the post. Unscrew the two long screws and remove the cut-off body from the carburetor. To install, place a gasket (G104-1593998), on the flange and attach the degasser to the carburetor with two long screws. Position and tighten the terminal in front of the body, and tighten the knurled nut.

78. FUEL TANKS AND GAGE.

a. Description. The four fuel tanks have a total capacity of 172 gallons. Two 30-gallon vertical tanks are located in the front corners of the engine compartment, and two 56-gallon horizontal tanks are located on each side of the engine compartment on the sponsons. The horizontal and vertical tanks are connected with a single fuel valve in each vertical tank.

b. Draining Fuel Tanks.

(1) VERTICAL TANK. Remove the drain cover plate in the floor and unscrew the drain plug at the bottom of the tank.

(2) HORIZONTAL TANK. Unscrew the cap screws that hold the drain plug cover plate under the sponson tank, and remove the drain plug in the bottom of the tank.

c. Removal of Vertical and Horizontal Fuel Tanks.

(1) DRAIN FUEL TANKS. See subparagraph *b* above.

(2) REMOVE ENGINE. See paragraph 50.

(3) REMOVE VERTICAL TANK. Disconnect fuel gage wire. Loosen clamps which hold conduits to gas tank shields, and remove shields. Remove the armor support bracket over the vertical tank. Disconnect fuel pipes and remove the filter at the bottom of the tank and raise tank out of lower pocket. If necessary to replace fuel tank gage unit, remove the screws that hold the unit to the tank and lift out the unit. NOTE: *Mark the position of gage so that new gage will be installed in the same position.*

(4) REMOVE HORIZONTAL TANK. After the vertical tank has been removed, remove oil filter, oil control valve, and filler tube, and disconnect fire extinguisher tubes if left tank is to be removed. Take out the cap screws which hold the tank shield to the hull, and remove the shield. Unscrew the bolts from the tank straps, spread the straps and pull out the tank.

d. Installation of Vertical and Horizontal Fuel Tanks.

(1) INSTALL HORIZONTAL TANK. Position the horizontal tank on the sponson shelf, bend the tank straps back over the tank, and

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tighten with the clamping bolts. Install the tank shield and attaching cap screws. Connect fire extinguisher tubes (if left tank has been installed), install oil control valve, filler tube, and oil filter.

(2) INSTALL VERTICAL TANK. Place vertical tank in position in the lower pocket. Bolt the armor support bracket to the bulkhead and adjust tank hold-down screws. Install shield. Position and secure conduits to tank shield with conduit clamps. Install filter in fuel tank, and connect the fuel pipes.

(3) INSTALL ENGINE. See paragraph 51.

79. EXHAUST MANIFOLDS.

a. General (fig. 9). The exhaust manifolds can be removed in sections or as assemblies. The four upper sections and the three lower sections can be replaced with the engine in the vehicle. To replace the lower sections of the left manifold, it is necessary to remove the plate from the engine compartment floor. If the center sections or the assemblies are to be replaced, it is necessary to remove the engine.

b. Removal.

(1) REMOVE UPPER OR LOWER SECTIONS. If the lower section of the left manifold is to be removed, remove plate from engine compartment floor. Loosen the manifold clamps and slide the clamps away from the junction of the manifold sections. Remove the lock wire and nuts from the flange studs at the cylinder with wrench (41-W-1471), and remove the section of the manifold.

(2) REMOVE CENTER SECTIONS OR ASSEMBLIES.

(a) Remove Engine. See paragraph 50.

(b) Remove Manifold from Engine. Loosen and move the engine mounting beam away from the manifold far enough to allow the manifold to clear the flange studs. Remove the flange stud nuts. If center section only is to be removed, loosen the clamps, and move them away from the junction of the manifold sections.

c. Installation. Remove all traces of gasket from the flanges and place new gasket (G104-0100680), over the flange studs. Place the manifold clamps over the manifold if they were removed. Position the manifold section or assemblies and install the flange stud nuts with wrench (41-W-1471), and lock wire. Slide the manifold clamps into position, and tighten, if only the sections of the manifold were removed. If center section or assembly was removed, install the engine mounting beam and install the engine (par. 51).

80. EXHAUST PIPES AND TAIL PIPES.

a. Removal. Raise the rear section of the engine compartment cover. Loosen the clamps on the exhaust pipe. Telescope and remove

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the pipe. Remove the cap screws which hold the tail pipe brackets to the hull, and remove the tail pipes.

b. Installation. Place the tail pipe in position and install the attaching cap screws. Slide the exhaust pipe over the end of the manifold and into the tail pipe, and tighten the clamps.

Section XXI

STARTING SYSTEM

81. DESCRIPTION.

a. Description of System. The starting system consists of a 24-volt starter, equipped with a hand crank attachment mounted on the engine accessory case (fig. 9). The starter is connected, through the bulkhead terminal box, to a solenoid in the battery switch box (fig. 37) by a cable marked "16." The solenoid is connected to the 24-volt bus bar by a cable marked "17" and the actuating circuit of the solenoid is connected to the switch marked "STARTER" on the instrument panel by a wire marked "18." When the switch is operated, the actuating circuit of the solenoid is energized, which closes the heavy current circuit through the cables to the starter. The solenoid eliminates the necessity of running heavy cables to the front of the tank, and the use of a large capacity switch for completing the circuit.

b. Data.

Manufacturer	Delco-Remy
Model	108685
Voltage	24
Rotation	Clockwise

82. STARTER.

a. Removal. (fig. 9). Open the 24-volt battery switch. Open the rear doors and remove the terminal housing cover from the starter cable terminal housing. Unscrew the conduit coupling ring and remove the conduit clamp from the hull wall. Disconnect the cable from the terminal and pull the cable out of the terminal housing. Remove the lock wire and mounting nuts from the cranking motor flange studs with special wrench (41-W-871-45) and remove the assembly.

b. Installation (fig. 9). Position the starter on the attaching studs with the hand crank attachment up. Install the nuts and lock wire. Connect the cable to the terminal, attach the conduit, and tighten the

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coupling ring. Install the conduit clamp to the hull wall, and screw the terminal housing cover in place. Turn on the 24-volt battery switch. Place the gearshift lever in neutral, and press the starter switch on the instrument panel to test the operation of the starter. If operation is unsatisfactory, refer to paragraph 39. Then turn off the 24-volt battery switch and close the rear doors.

83. STARTER SOLENOID.

a. Removal (fig. 37). Turn off both battery switches. Remove the cover from the battery switch box, and disconnect the wires and cables from the solenoid terminals. Note the identifying numbers on the cables and wires, so that proper connections can be made when installing the solenoid. Remove the attaching screws which hold the solenoid bracket to the switch box, and remove the solenoid.

b. Installation (fig. 37). Position the solenoid in the battery switch box, and install the attaching screws. Connect the cables and wires (according to identifying numbers), and make sure that the solenoid ground wire is secure. Place the gearshift lever in neutral, and warn any personnel who may be working in engine compartment. Turn on the 24-volt battery switch and press the starter switch to test the operation of the solenoid. If solenoid operation is unsatisfactory, refer to paragraph 39. Turn off the battery switch, and install the battery switch box cover.

Section XXII

BATTERY AND LIGHTING SYSTEM

84. GENERAL DESCRIPTION.

a. Battery Charging System. The battery charging system consists of a generator driven from the drive shaft. The output of the generator is controlled by the generator regulator, and the current flow is indicated by an ammeter in the circuit. The charging circuit is protected by circuit breakers.

b. Lighting System.

(1) DESCRIPTION. All lights on the outside of the vehicle are operated through the main light switch on the instrument panel, and the wiring is protected by a circuit breaker on the instrument panel marked "LIGHTS." The dome lights in the hull are controlled by a switch mounted on each light, and these circuits are protected by a circuit breaker on the instrument panel marked "ACCESSORIES."

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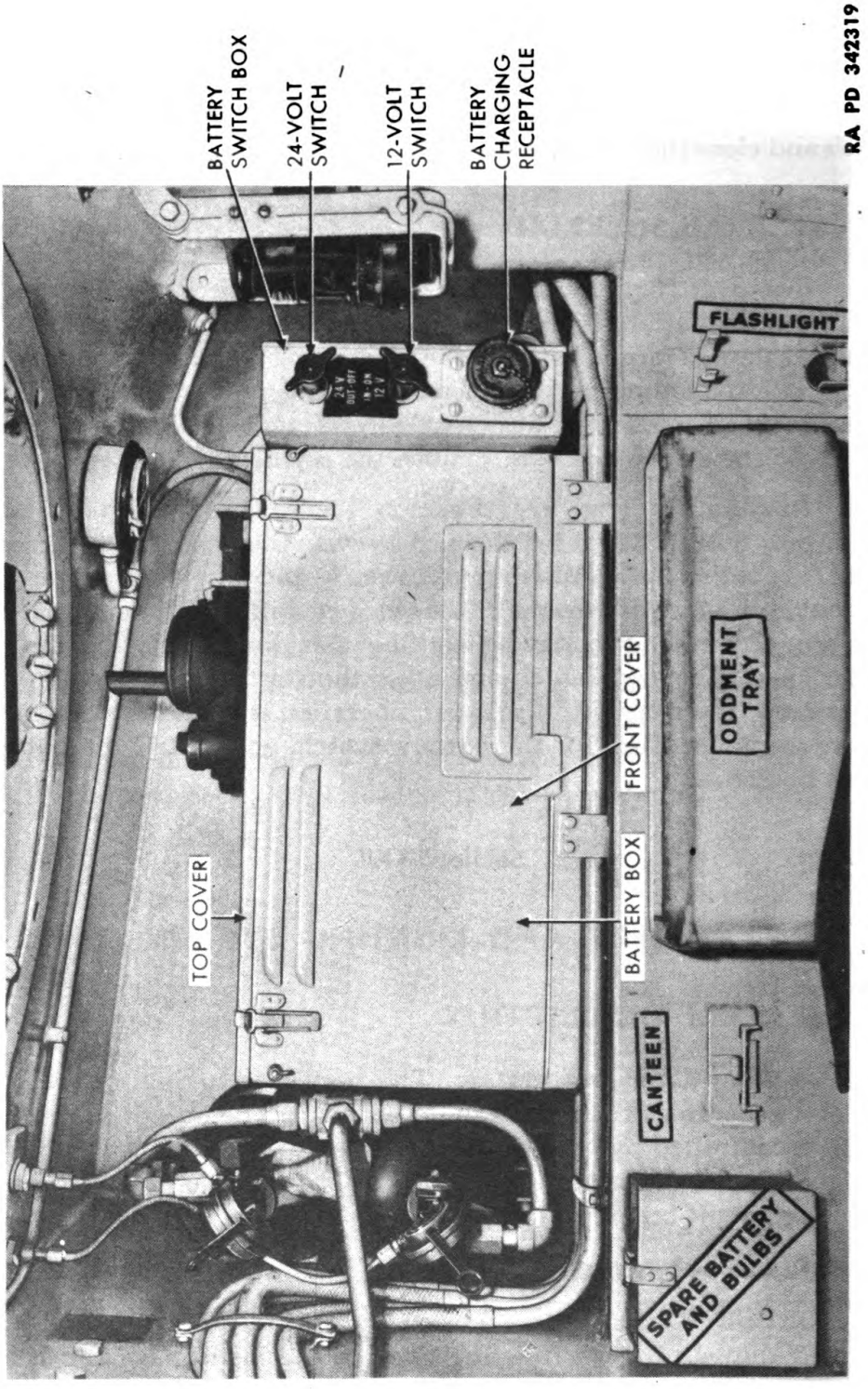


Figure 37—Battery and Switch Box in Left Sponson

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(2) DATA.

Lamp Name	Part No.
Blackout tail sealed beam—right and left	M001-0107403
Blackout driving light sealed beam	M001-0107347
Headlight sealed beam	G104-1819407
Service tail sealed beam	G104-1819401
Spotlight sealed beam	M001-0113039
Instrument panel Low oil pressure signal Dome light Blackout marker	A-213667-A

85. BATTERIES.

a. Description (fig. 37). Two 12-volt lead-acid type batteries are connected in series with the 24-volt switch on the battery switch box. This circuit furnishes 24 volts to the electrical system, and a separate lead from one battery to the 12-volt switch supplies voltage for a radio circuit. The batteries are housed in a box mounted on the left sponson, with the battery switch box mounted on the forward end of the battery box. The negative (−) lead of the system is grounded to the tank hull.

b. Maintenance and Tests.

(1) ELECTROLYTE. The water in the electrolyte solution will evaporate in high temperatures or with excessive charging rates. Inspect the electrolyte level and fill the batteries as required.

(2) VOLTAGE TEST. Test each battery cell separately. Press the prods of the voltage tester firmly against the negative and positive posts of the cell. The voltmeter attached to the tester should indicate 1.9 to 2.2 volts for each cell in the battery.

(3) HYDROMETER TEST. Remove the battery filler caps and test the electrolyte solution with a hydrometer. The charge in the battery (specific gravity) will be indicated by the figure on the small tube which shows just above the level of the solution. Add too, or subtract from, the reading in accordance with the temperature scale on the hydrometer to obtain the actual specific gravity. The following hydrometer readings show the condition of the battery at atmospheric temperature 80°F:

Fully charged	1.275 to 1.300
Half charged	1.225
Very low	1.150

If the battery is less than half charged, recharge, or exchange for a fully charged battery.

(4) SPECIFIC GRAVITY FOR HOT CLIMATES. In hot climates (95°F and above) lower specific gravity electrolyte (1.245) is recommended to avoid excessive deterioration of plates and separators. To

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lower the specific gravity of a fully charged battery, remove the electrolyte to the level of the plates. Add distilled water to bring the battery fluid up to ⅜ of an inch above the plates, then charge the battery until a specific gravity of 1.245 is obtained.

c. Removal.

(1) DISCONNECT CABLES. Turn off the battery switches. Remove the top and side cover from the battery box, disconnect the ground cable from the battery terminal, then disconnect the other cables from the battery terminals. Bend the cables leading into the switch box up out of the way, and pull the jumper cable out of the battery handles.

(2) REMOVE BATTERIES. Remove the battery hold-down frames, and lift the batteries out of the box onto the driver's compartment subfloor. CAUTION: *Secure assistance to handle the batteries; do not tip or handle roughly.* Attach a sling to the batteries and lift them out, one at a time, through the turret hatch.

d. Installation.

(1) INSTALL BATTERIES. Inspect the battery box, trays, and hold-down bolts to see that they are in good condition and free of corrosion. Replace the fireproof pads in the battery trays if necessary. Lower the two batteries with a sling through the hatch onto the compartment subfloor. Lift one battery into the forward tray with the terminal posts forward. Place the wooden spacer across the tray against the end of the forward battery. Then set the rear battery into its tray with the terminal posts forward. Install the hold-down frames over the batteries, and tighten the hold-down bolts securely.

(2) CONNECT CABLES. If the battery terminals have been removed, place them on the battery posts, and tighten them securely. Connect the cables to the terminals with the jumper cable threaded through the two center handles of the batteries. Tighten the terminal nuts securely with a toothed lock washer between the terminal nut and the cable terminal. To prevent corrosion, coat the exposed surfaces of the terminals with a thin film of general purpose grease, and install the covers.

86. BATTERY SWITCH BOX.

a. Description (fig. 37). The battery switch box is mounted on the forward end of the battery box. It provides a housing for the battery switches, starter solenoid, generator circuit breaker, dome-light circuit breaker, battery charging receptacle, and terminal blocks for connecting wires of the corresponding circuits together. The contents of the box are accessible by removing the cover on the forward side.

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b. Removal (fig. 37).

(1) DISCONNECT BATTERIES. Remove the battery box cover and disconnect the ground cable.

(2) DISCONNECT WIRING. Remove the switch box cover and disconnect all wiring leading from the box.

(3) DISCONNECT CONDUITS. Remove the four cap screws which hold the switch box to the battery box and pull the box up so that the conduits can be disconnected from the fittings. Pull the wires out of the fittings and remove the box. Remove all switches, fittings and terminal blocks from the switch box.

c. Installation (fig. 37).

(1) ATTACH CONDUITS. Install all fittings, switches, and terminal blocks removed from the old box. Place the wires through the proper fittings and attach the conduits.

(2) MOUNT SWITCH BOX. Mount the box on the end of the battery box with a toothed lock washer under the heads of the screws and between the switch box and battery box. Connect the starter solenoid ground wire to the lower mounting screw under the solenoid

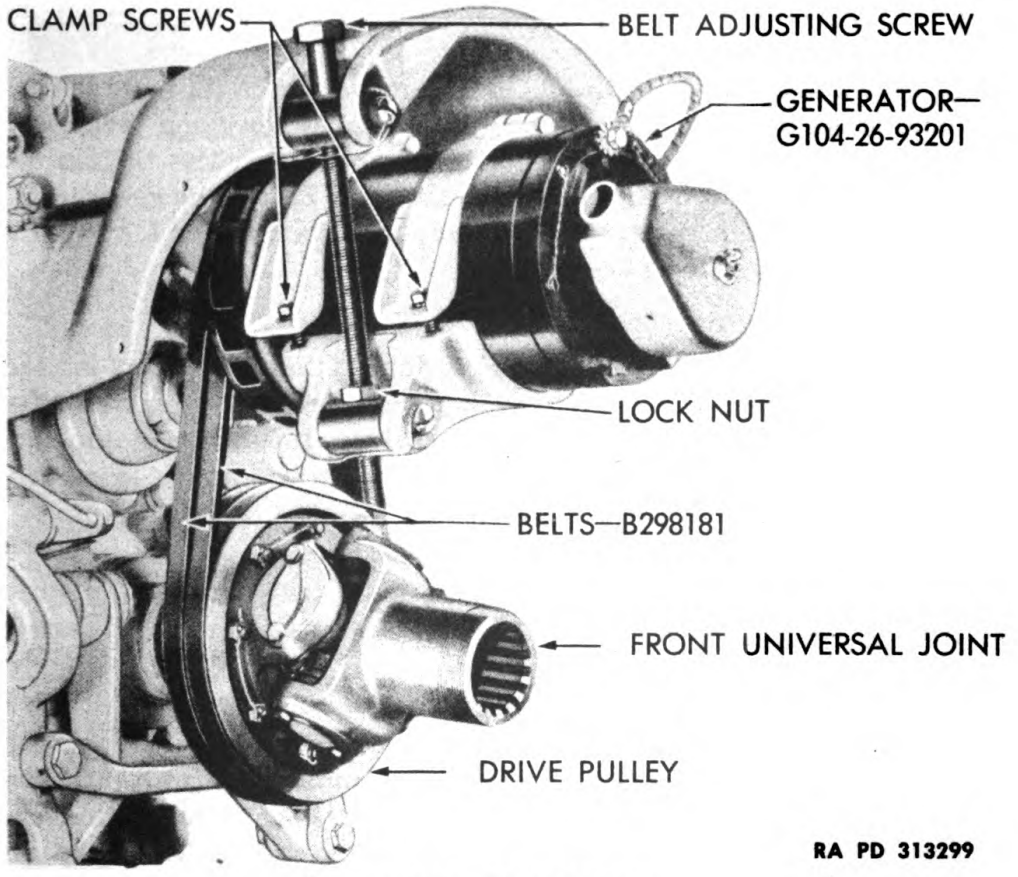


Figure 38—Generator

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and the receptacle ground cable under the mounting screw below the receptacle. Tighten the mounting screws.

(3) CONNECT WIRING AND INSTALL COVERS. Connect all wiring. Connect the battery ground cable. Install the battery box cover and the switch box cover.

87. GENERATOR.

a. Description (fig. 38). The generator is a 30-volt, 50-ampere (1,500 watt), shunt-wound unit, bracket-mounted on the rear end of the transmission. It is driven by two belts from a pulley on the propeller shaft. The belts are adjustable by means of the belt-adjusting screw which holds the generator in the mounting bracket.

b. Data.

Manufacturer ..... Auto-Lite
Model GER-4804B

c. Removal (fig. 38).

(1) DISCONNECT WIRES. Open the 24-volt battery switch. Remove terminal cover from the rear end of generator, disconnect the two wires, and remove conduit from terminal box. Disconnect the ground cable by removing the rear cap screw and lock washer on the right-hand generator guard.

(2) REMOVE GENERATOR. Remove the right-hand and left-hand generator guards by removing the cap screws and lock washers which secure them to mounting bracket. Loosen the belt-adjusting screw and unscrew it out of the lower swivel. Lower the generator, and slide belts off generator pulley. Remove the clamp screws, and lift generator out of bracket.

d. Installation (fig. 38).

(1) INSTALL GENERATOR. Mount the generator in saddle clamps, and aline the dowels to enter the holes in the generator frame with the ground cable screw toward the top. Install the clamp screws, raise the generator, and enter the adjusting screw into the lower swivel.

(2) ADJUST BELTS. Place the belts on the pulleys, and tighten the adjusting screw so that there is ½-inch deflection of the belt with 8 to 10-pounds pull, measured midway between the pulleys. Lock the adjusting screw lock nut. Install the right-hand and left-hand generator guards.

(3) CONNECT WIRING. Place the two wires through the hole in the terminal box, and attach conduit. Connect the two wires to their respective terminals, tighten the terminal nuts, and install the palnuts. Install the terminal cover and lock wire the wing nut. Connect the ground cable to the right-hand generator guard with the cap screw and lock washer provided.

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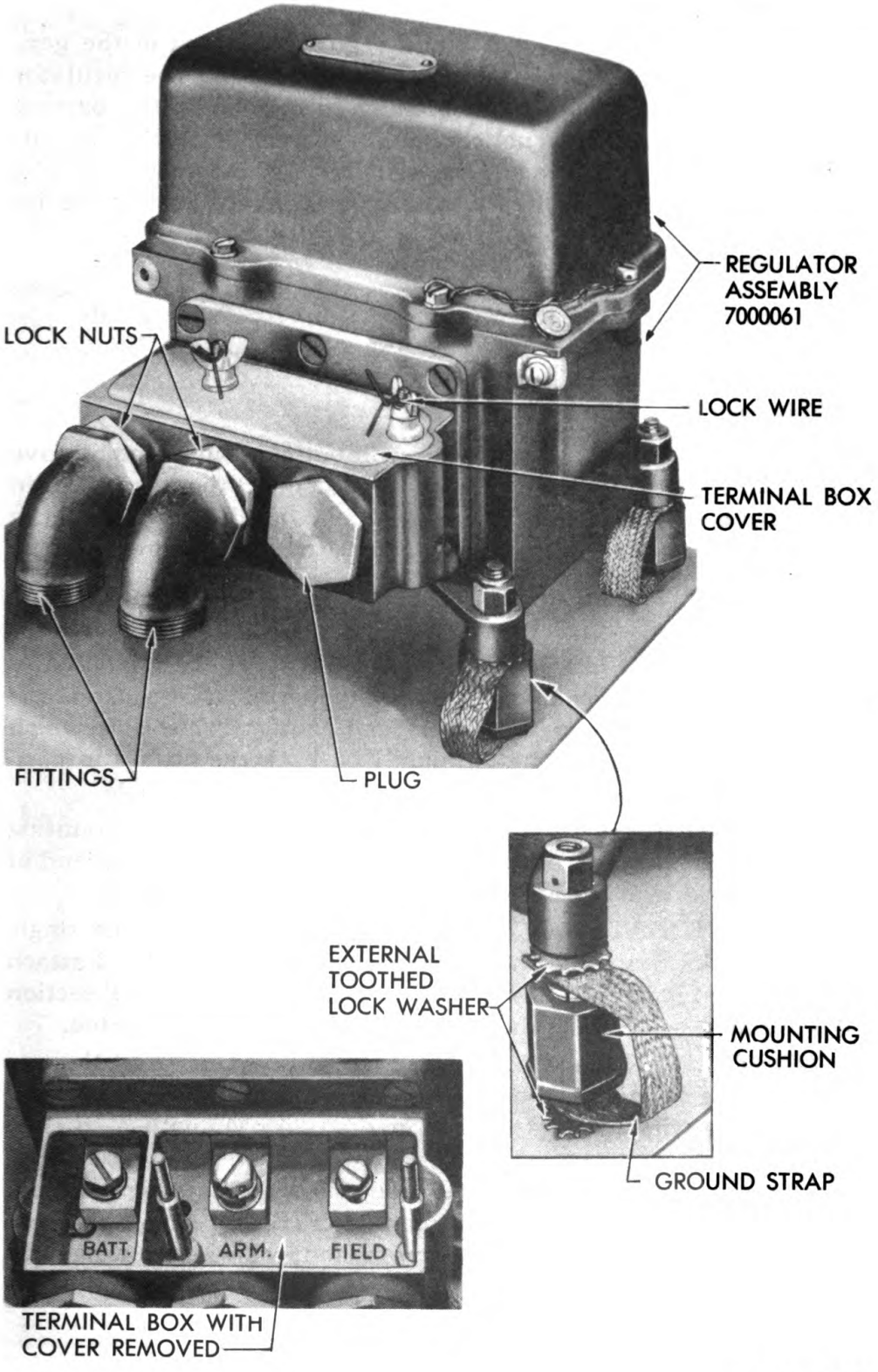


Figure 39—Generator Regulator

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88. GENERATOR REGULATOR.

a. Description. (fig. 39). A 3-unit regulator is used in the generating circuit for controlling the output of generator. The regulator contains a reverse current circuit breaker to disconnect the battery circuit when the generator is not charging, a current limit relay, a voltage control, and a radio filter. The regulator is shock-mounted. The generator regulator is mounted on the sponson to the rear of the instrument panel.

b. Data.

Make	Auto-Lite
Model	D-4106-C
Voltage	24
Amperage	50

c. Removal (fig. 39). Open the 24-volt battery switch and remove the terminal cover from the terminal box. Disconnect the three leads in the terminal box, unscrew the conduits, and pull out the wires. Hold the top end of the mounting cushion to prevent twisting, and remove the four safety nuts which hold the regulator to the mounting cushions.

d. Installation (fig. 39).

(1) INSTALL FITTINGS IN REGULATOR. If the regulator to be installed does not have elbow fittings in the terminal box, install one fitting with lock nut in the center hole, and another in the hole which enters the small section of the terminal box. Lock the fittings in position with the outlet down. Install a plug in the remaining hole.

(2) MOUNT REGULATOR. Set the regulator on the mounting cushions near the left end of the instrument panel. Hold the top end of the mounting to avoid twisting, and install the attaching nuts.

(3) ATTACH BATTERY LEAD. Insert the wire from the single wire conduit (battery) into the fitting toward the hull wall, and attach the wire to the regulator terminal marked "BATT" in the small section of the terminal box. Attach the conduit to the fitting, and tighten.

(4) INSTALL ARMATURE AND FIELD LEADS. Insert the two wires from the remaining conduit through the center elbow, and connect the large wire to the terminal marked "ARM" with a toothed lock washer between the wire terminal and the regulator terminal, and a plain lock washer under the head of the terminal screw. Connect the small wire to the terminal marked "FIELD." Attach the conduit to the elbow, install the terminal cover, and lock wire the wing nuts.

89. HEADLIGHTS.

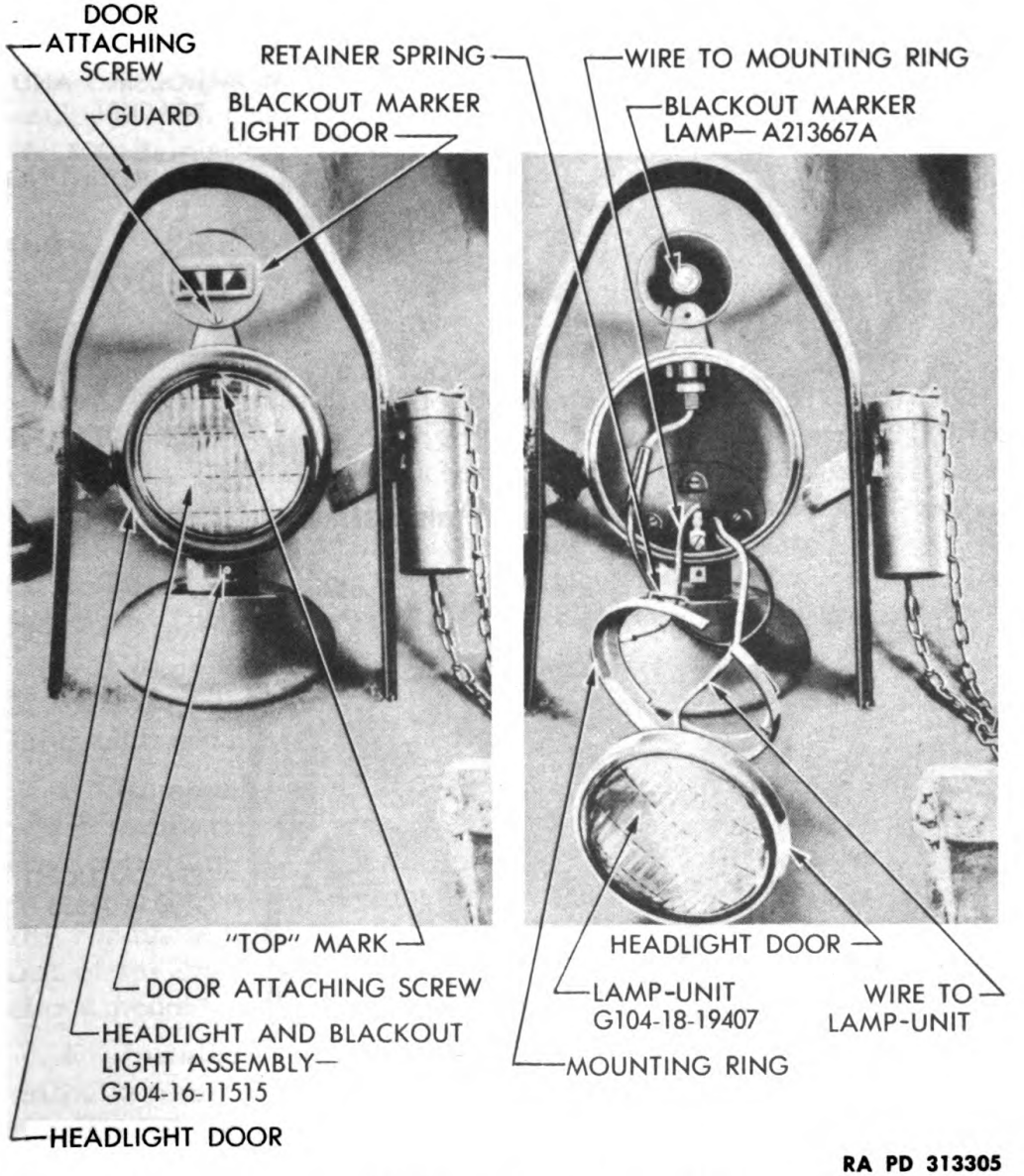
a. Description (fig. 40). The headlights consist of a lamp-unit housed in the body of the light, and a blackout marker light mounted on top of the headlight body. The headlights are carried inside the vehicle

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until their use is required. The lights are installed in sockets through the front of the hull. The socket is weathersealed by a plug, which is chained to the guard and carried in a socket on the side of the guards, when the headlights are installed.

b. Removal and Installation of Headlights. Unscrew the locking pin from the headlight socket inside the hull and lift the lamp out of the guard. To install, place the headlight assembly in the socket, and tighten the locking pin.

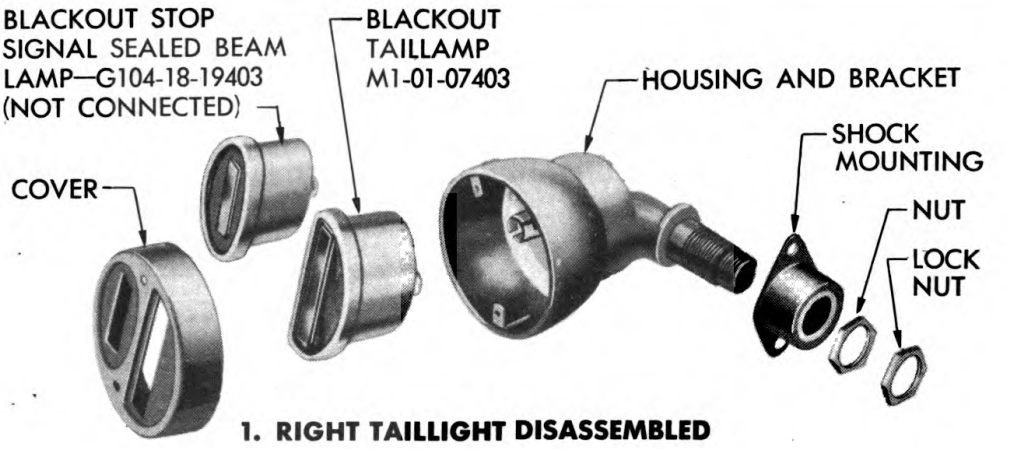
c. Replacement of Headlight Lamp-unit (fig. 40). Remove the attaching screw at the base of the headlight door. Pull the door out at the base and lift up. Disconnect the wire at the back of the lamp-unit.



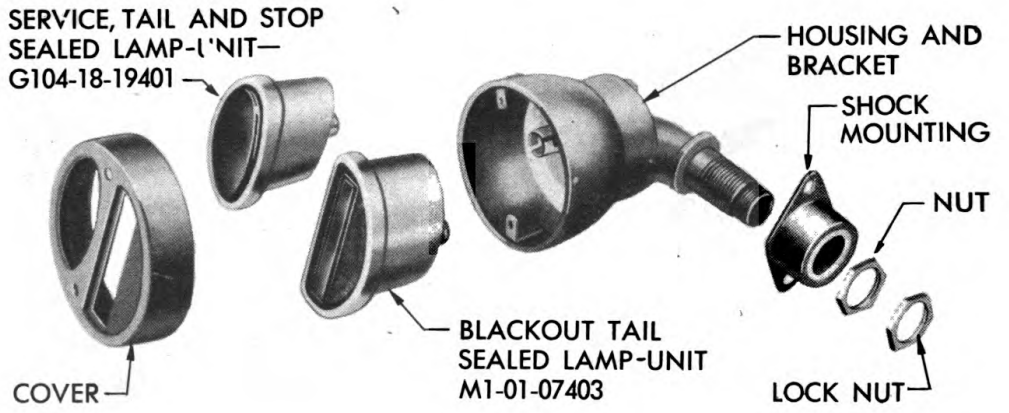
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Figure 40—Headlight and Blackout Marker Light

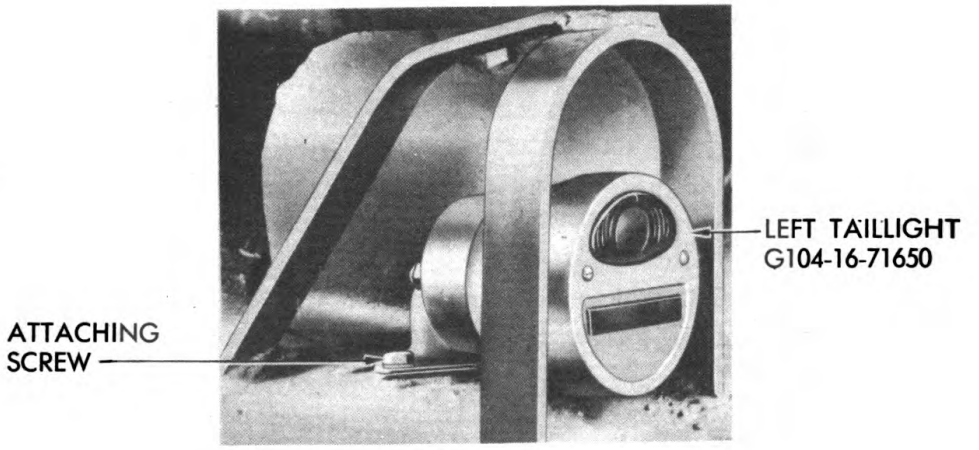
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1. RIGHT TAILLIGHT DISASSEMBLED



2. LEFT TAILLIGHT DISASSEMBLED



3. LEFT TAILLIGHT

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Figure 41—Taillight

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Unhook the retainer springs in the mounting ring on the back of the lamp-unit, and remove the unit. To install, place the lamp-unit in the door, with the top mark on the lens up, and secure with the mounting ring. Attach the wire to the terminal on the back of the lamp-unit, and install the headlight door.

d. Replacement of Blackout Marker Lamp. Remove the attaching screw at the base of the door and lift off the door. Press in on the lamp, turn counterclockwise and pull out. To install, insert the lamp into the socket, press in and turn clockwise. Hook the lip on the top of the door into the slot in the light body, press the door into position, and install the mounting screw.

90. BLACKOUT DRIVING LIGHT.

a. Description. The blackout driving light (G104-1611516) is equipped with a shielded 6-volt lamp-unit to limit the volume of light for use in blackout conditions. The left headlight socket is wired through a resistor to accommodate the use of the blackout driving light.

b. Removal and Installation; Replacement of Lamp-unit. See paragraph 89 *b* and *c*.

91. TAILLIGHTS.

a. Description. Two shock-mounted taillights (G104-1671650, left), and (G104-1671649, right) are located on the rear corners of the vehicle. The left taillight contains a combination service tail and stop light lamp-unit in the upper part of the light (stop light section not used) and a blackout taillight lamp-unit in the lower part of the light. The right taillight contains a blackout stop lamp-unit in the upper part (not used) and blackout taillight lamp-unit in the lower part.

b. Removal of Lamp-units. Remove the two retaining screws and lift taillight covers; pull the lamp-unit out of its socket; install the new lamp-unit; and install the cover.

c. Removal of Taillight Assembly. Remove the attaching screws which secure taillight to the hull. Turn the lamp assembly toward the edge of the hull, and raise the assembly so that the conduit, which is attached to the base of the light, will come out through the hole. Unscrew the conduit coupling ring from the light, and pull the wire connector out of the base. Remove the two conduit lock nuts, which hold the shock mount to the base of the light, and remove the mount.

d. Installation of Taillight Assembly. Place the taillight on the hull and secure it with the attaching screws. Aline the connector into the base of the light (one hole of the connector is larger than the others) and push it onto the terminals. Attach the conduit to the base and tighten the coupling ring.

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92. DOME LIGHTS.

a. Description. Three dome lights are used in the hull; one over the battery switch box, one over the communication equipment at the left sponson, and one on the right side of the crew compartment blower.

b. Replacement of Lamp. Remove the light cover attaching screws, and lift off the cover. Press in on the lamp, turn counterclockwise, and pull out. To install, place the lamp in the socket, press in, and turn clockwise. Position the cover and install the attaching screws.

c. Replacement of Dome Light Assembly. Remove light cover and lamp (subpar. *b* above). Disconnect wires at the switch, and tag, or otherwise identify. Disconnect the conduit at the light. Remove the mounting screws and lift off the light body. To install, position the light body and install the mounting screws. Secure the wires to switch terminals and attach the conduit. Install lamp and cover (subpar. *b* above).

93. INSTRUMENT LIGHTS.

a. Replacement of Compass Lamp. Remove the knurled clamp screw in the center of the course setter disk, and lift off the disk. Unscrew the knurled lamp holder and lift out. To install, screw the knurled lamp holder firmly in place. Position the course setter disk with the locating dowel on the back of the disk in the recess provided on the compass body, and tighten the clamp screws.

b. Replacement of Instrument Panel Lamps. The instrument panel lamps are located behind the cover plugs on the instrument panel. To replace, remove the plugs, push the lamp in, turn it counterclockwise, and pull it out of its socket. To install, place the lamp into the socket, push in and turn clockwise until it locks into the bayonet socket. Install the cover plugs.

c. Replacement of Low Oil Pressure Warning Lamp. The low oil pressure warning lamp is in a bayonet socket behind the ruby lens on the lower left corner of the instrument panel. To replace lamp, remove the lens, and replace as described in subparagraph *b* above.

Section XXIII

CLUTCH

94. DESCRIPTION.

a. The clutch (fig. 42) is a multiple-disk type, mounted inside the flywheel. It consists of two clutch-driven disks (one outer and one inner), one driving plate, one pressure plate, and six springs assembled to the flywheel ring.

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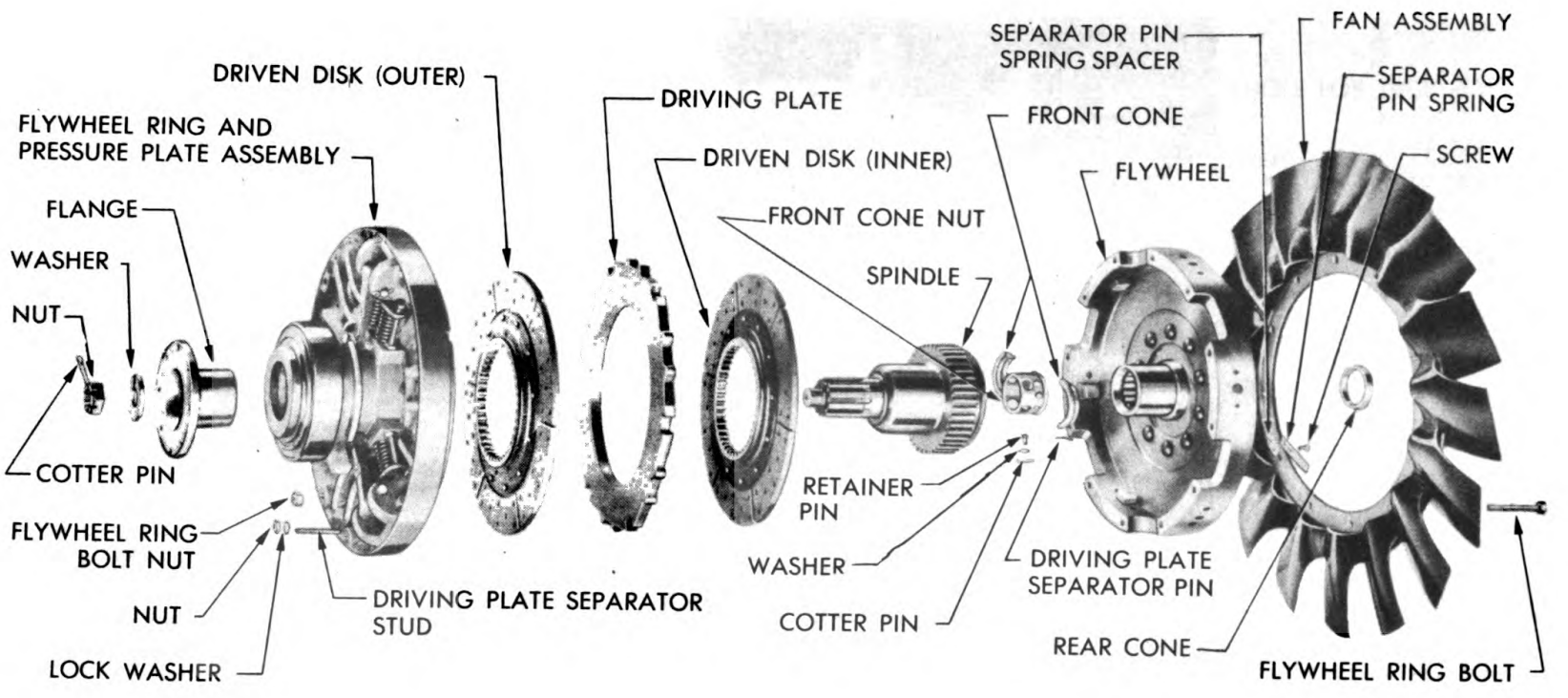


Figure 42—Clutch and Fan—Disassembled

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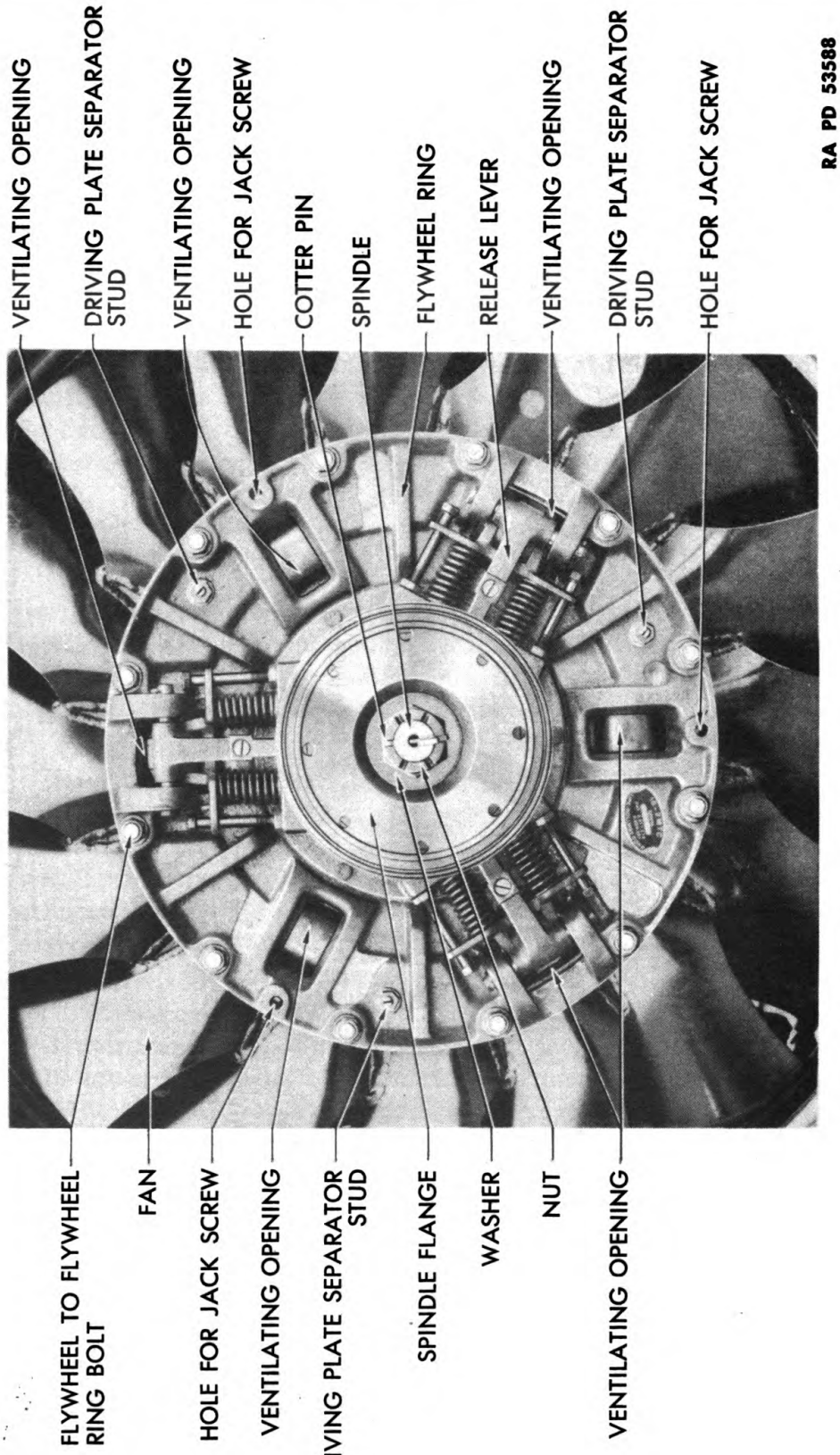
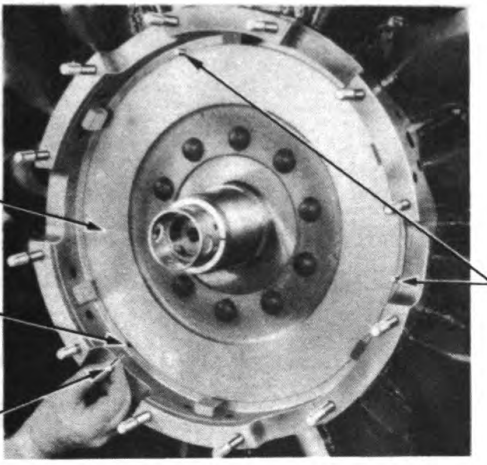
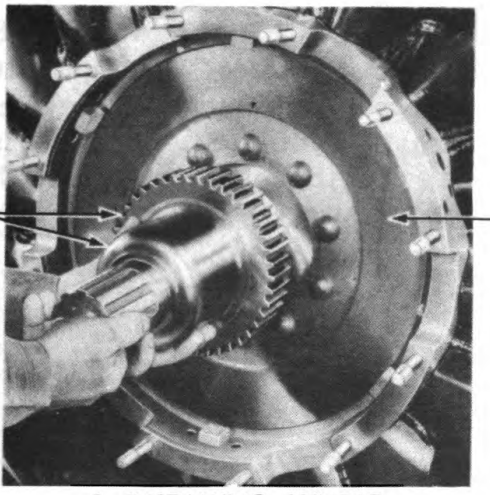


Figure 43—Clutch and Fan—Assembled

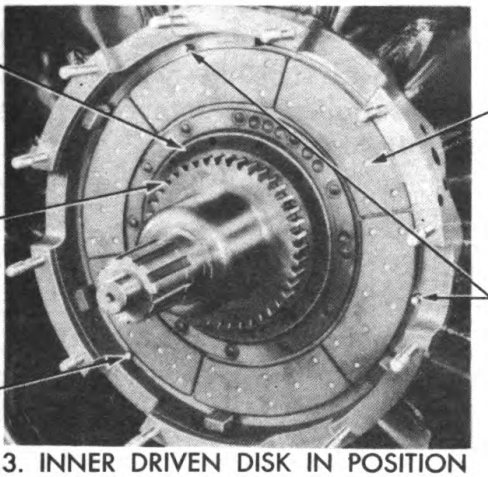
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1. INSTALLING DRIVING PLATE SEPARATOR PINS



2. INSTALLING SPINDLE



3. INNER DRIVEN DISK IN POSITION

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Figure 44—Installing Inner Driven Disk

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b. The openings in the flywheel ring and flywheel allow the passage of air for ventilation. Separator pins provide a means of separating the driven disks and driving plate. An annular release bearing is used.

95. CLUTCH.

a. Removal.

(1) REMOVE ENGINE. See paragraph 50.

(2) REMOVE UNIVERSAL JOINT COMPANION FLANGE AND NUT. Pull the cotter pin and remove the nut, washer, and flange.

(3) REMOVE FLYWHEEL RING TO FLYWHEEL BOLT NUTS (fig. 43). Loosen the lock nuts and screw out the three driving plate separator studs three turns. Unscrew the flywheel bolt nuts around the outer edge of flywheel ring. Punch mark the flywheel and the flywheel ring at one point on each, for identification in assembling parts.

(4) REMOVE FLYWHEEL RING AND PRESSURE PLATE ASSEMBLY (fig. 42). Install three $\frac{3}{8}$ x 4-inch, 16 full-thread (National Coarse) jackscrews in the three holes provided for this purpose, and tighten them, alternately, until the flywheel ring is forced away from the flywheel. Tap the end of the spindle and lift off the flywheel ring.

(5) REMOVE PLATES AND SPINDLE (fig. 42). Lift off the outer driven disk, the driving plate, and the inner driven disk. Pull off the spindle.

b. Installation.

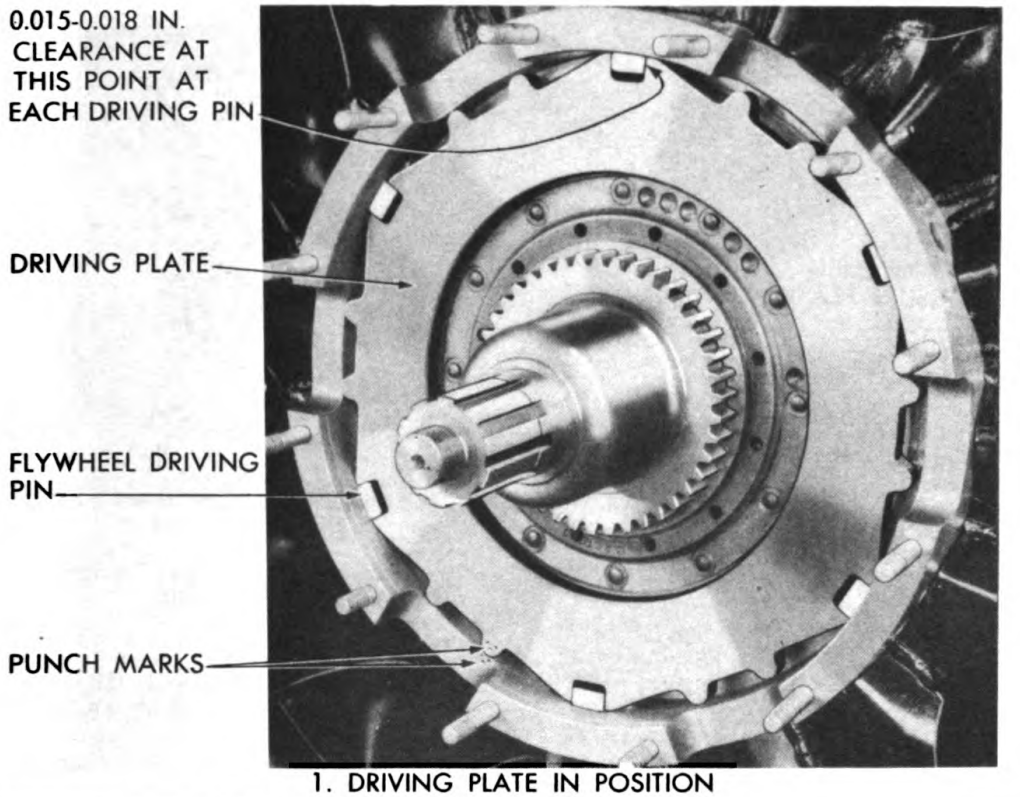
(1) INSTALL SEPARATOR PINS (1, fig. 44). Insert the small end of the three driven plate separator pins in the holes in the flywheel. These pins must be a free fit, and pins must contact the leaf spring on the rear side of flywheel.

(2) INSTALL SPINDLE ON FLYWHEEL HUB (2, fig. 44). Wash the spindle thoroughly in dry-cleaning solvent, and clean all foreign matter from the spindle bearing inside the opening. Apply compressed air to the opening of the spindle, and remove all traces of solvent. Wipe spindle dry, and pack roller bearing with ball and roller bearing grease, then fill cavity in the spindle flush with inside diameter of the bearing. Slide the spindle on the hub.

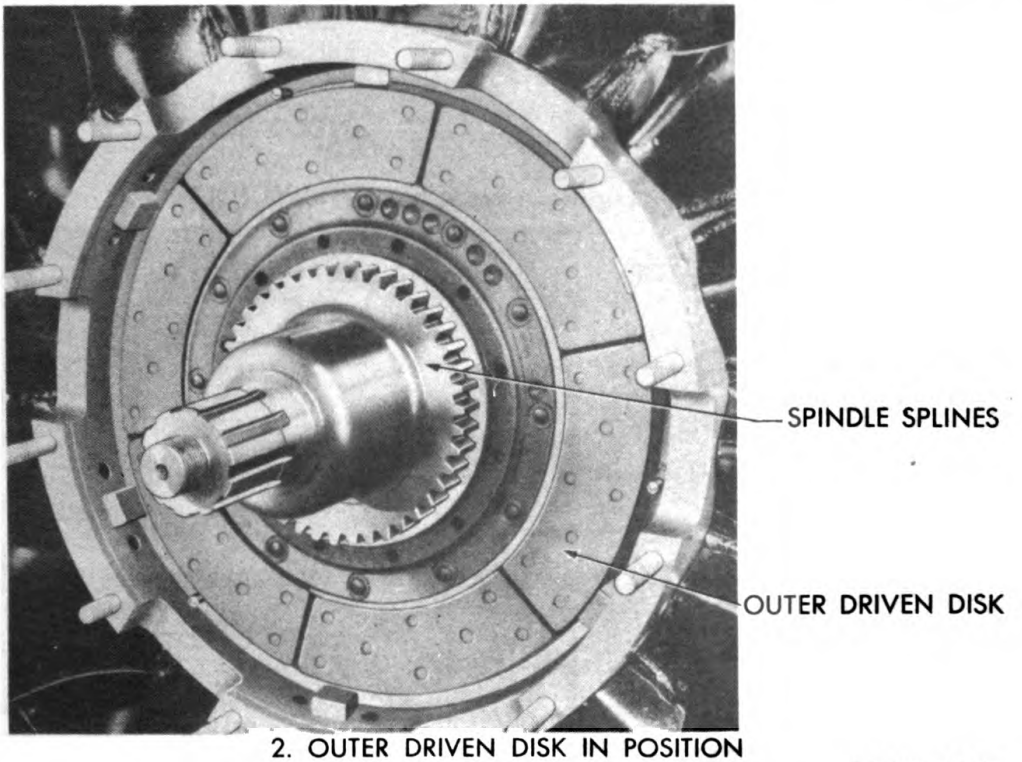
(3) INSTALL INNER CLUTCH DRIVEN DISK IN FLYWHEEL (3, fig. 44). Wipe all surfaces clean and make sure the splines in the hub are free of burs. Be sure the three separator pins are in place in the flywheel. Position disk with body of hub section away from flywheel on the splines of the spindle and push the disk into flywheel.

(4) INSTALL DRIVING PLATE IN FLYWHEEL (1, fig. 45). Wipe all surfaces clean and make sure all burs are removed. Position

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1. DRIVING PLATE IN POSITION

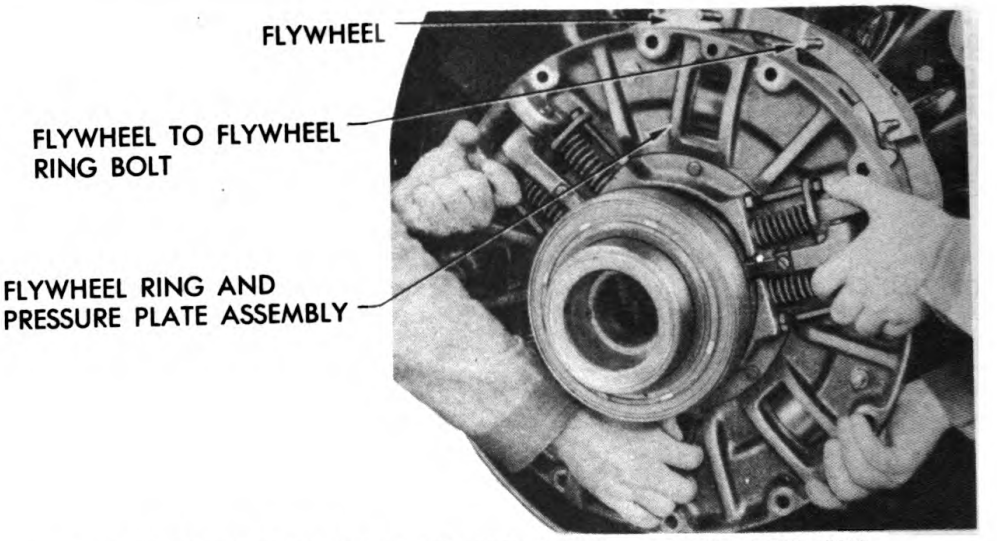


2. OUTER DRIVEN DISK IN POSITION

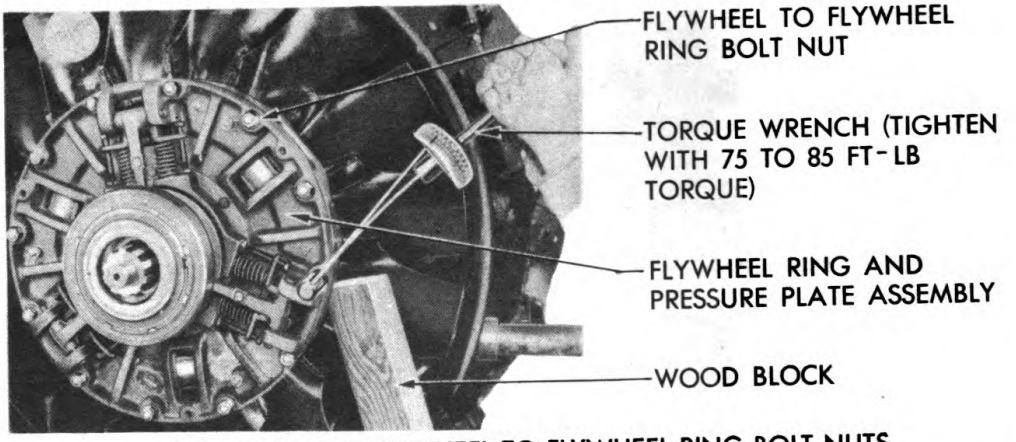
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Figure 45—Installing Driving Plate and Outer Driven Disk

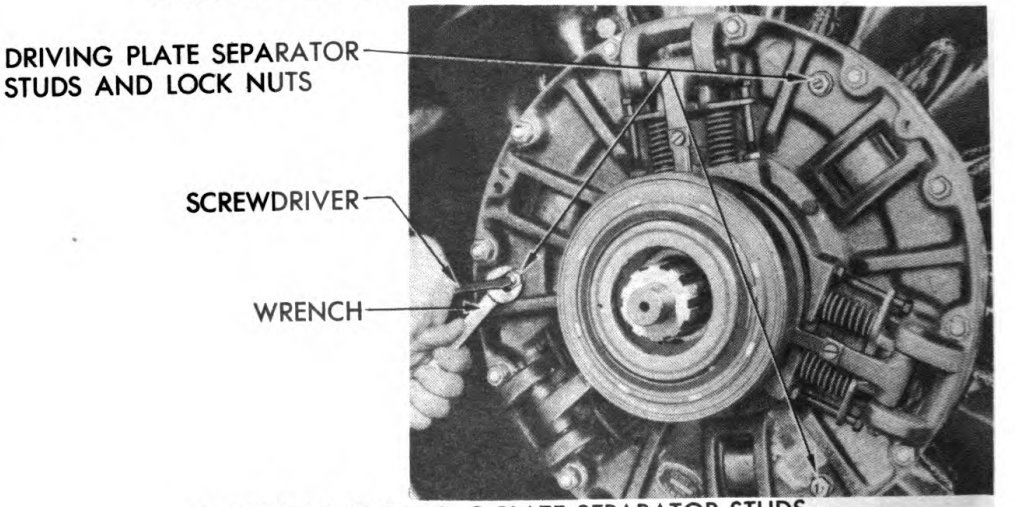
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1. INSTALLING FLYWHEEL RING AND PRESSURE PLATE ASSEMBLY



2. TIGHTENING FLYWHEEL TO FLYWHEEL RING BOLT NUTS



3. ADJUSTING DRIVING PLATE SEPARATOR STUDS

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Figure 46—Installing Flywheel Ring and Pressure Plate Assembly

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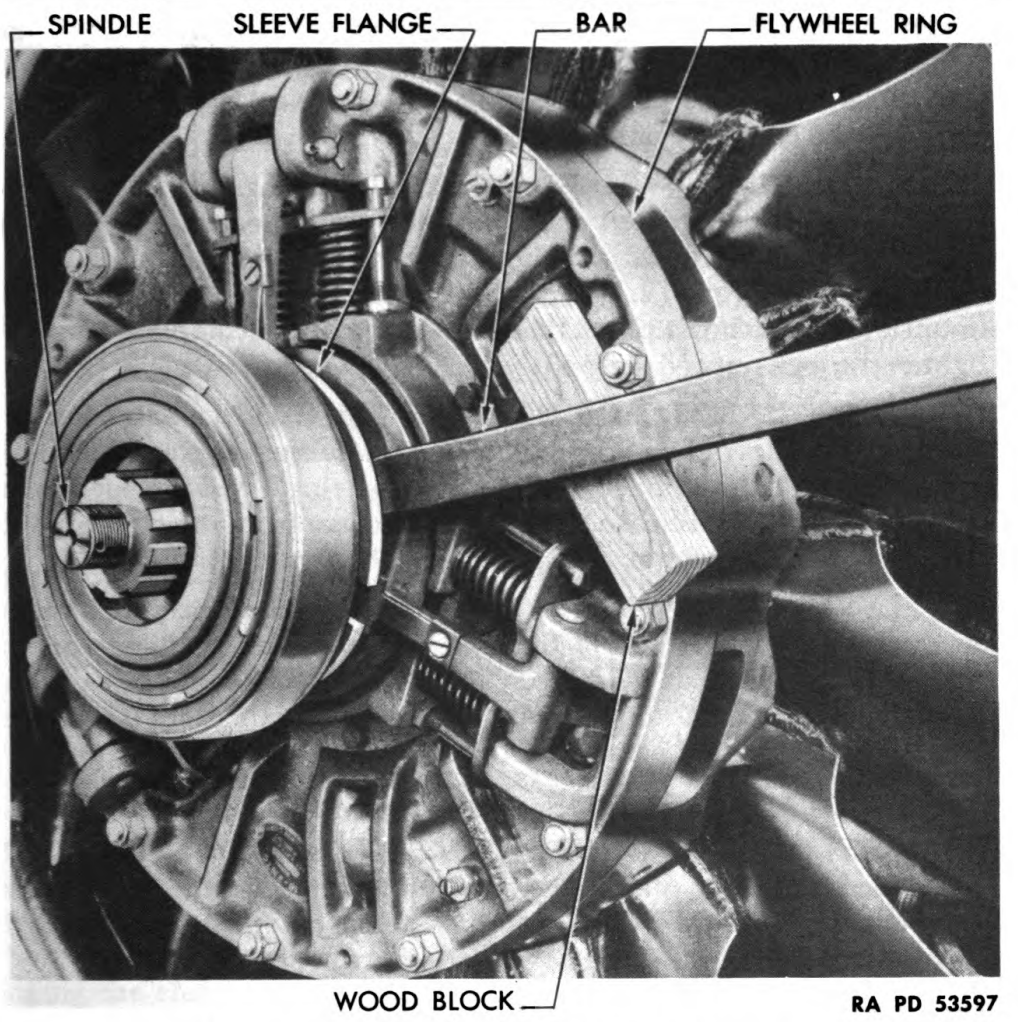


Figure 47—Testing Clutch for Release

the driving plate in the flywheel with the three punch marks on one of the plate projections alined with the marks at one of the flywheel openings if the original plate is used. Aline the six driving pins with the slots in the plate. Check the clearance of the slots at the driving pins with a feeler gage. The correct clearance is 0.015 inch minimum. CAUTION: *Do not install the driving plate if the clearance is less than 0.015 inch.* Press the plate against the separator pins and release the pressure to see if the pins are working correctly.

(5) **INSTALL OUTER DRIVEN DISK** (2, fig. 45). Wipe all surfaces clean and make sure the splines in the hub are free from burs. Position disk on the splines of the spindle with body of hub section away from flywheel. Be sure the disk slides freely on the splines of the spindle.

(6) **INSTALL FLYWHEEL RING AND PRESSURE PLATE ASSEMBLY** (1, fig. 46). Wipe all surfaces clean. Pack the space be-

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tween the ball bearing and the oil retainers in the hub with ball and roller bearing grease. Lift the assembly into position on the end of the spindle and aline the punch marks on the flywheel and flywheel ring and slide the assembly onto the bolts.

(7) INSTALL FLYWHEEL BOLT NUTS (fig. 46). Install the nuts on the bolts and tighten nuts alternately until the assembly is pulled against the flywheel evenly to eliminate binding. Tighten nuts to 75 to 85 foot-pounds torque (2, fig. 46). Screw the drive plate separator studs in until they touch the plate, then loosen them one complete turn and tighten the lock nuts (3, fig. 46).

(8) TEST CLUTCH FOR RELEASE (fig. 47). Place the end of a bar against the front flange of the clutch release sleeve. Rest the bar on a wood block on the outer edge of the flywheel ring. Press the bar against wood, and move the release sleeve ½ inch away from the clutch. With the sleeve in this position, the spindle should turn freely by hand.

(9) INSTALL UNIVERSAL JOINT FLANGE. Aline punch marks on the flange and the end of the spindle, and slide the flange on the spindle. Place the flat washer on the spindle, screw the nut on and tighten to 240 to 280 foot-pounds torque (approximately 150-pound pressure on the end of a bar, 2 feet long), and install a cotter pin.

(10) INSTALL ENGINE. See paragraph 51.

(11) RECORD UNIT REPLACEMENT ON W.D., A.G.O. FORM NO. 478. If a new or rebuilt clutch assembly has been installed, make the proper entry on "MWO and Major Assembly Replacement Record."

96. CLUTCH PILOT BEARING.

a. Removal.

(1) REMOVE CLUTCH SPINDLE. See paragraph 95 *a* (1) through (5).

(2) REMOVE PILOT BEARING. Remove the retainer and the pilot bearing from the spindle.

b. Installation.

(1) INSTALL PILOT BEARING. Coat the pilot bearing with oil and install the bearing and retainer in the spindle with drift (41-D-1540-150).

(2) INSTALL CLUTCH SPINDLE. See paragraph 95 *b* (2) through (11).

97. CLUTCH RELEASE BEARING.

a. Removal.

(1) REMOVE ENGINE. See paragraph 50.

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(2) REMOVE UNIVERSAL JOINT COMPANION FLANGE. Pull the cotter pin, and remove the nut and washer from the end of the clutch spindle. Pull off the companion flange.

(3) REMOVE RELEASE BEARING. Remove the snap ring, lock ring, retainer, and seal from the release sleeve body, and pull the bearing off the sleeve body.

b. Installation.

(1) INSTALL RELEASE BEARING. Press the bearing in place and install the seal, retainer, lock ring, and snap ring.

(2) INSTALL UNIVERSAL JOINT COMPANION FLANGE. Press the flange into place and install the washer, nut, and cotter pin.

(3) INSTALL ENGINE. See paragraph 51.

98. CLUTCH RELEASE LINKAGE.

a. Description (figs. 48 and 49). To assure full spring load on the clutch driving plate and driven disks, it is necessary that the clutch pedal have free travel at all times. This free travel should be approximately 1¾ inches, measured at the clutch pedal pad. As the clutch facings wear, the amount of free travel is reduced. If the clutch facings wear to a point where no free travel of the clutch pedal is present, the clutch will be held partially disengaged, resulting in rapid clutch failure. An adjuster is provided at the front end of the clutch release rod. A booster is also attached to the right end of the clutch control cross shaft outside the propeller shaft housing to assist the driver in disengaging the clutch.

b. Adjustment. Remove right generator belt guard. Turn the handle at the front end of the clutch adjuster counterclockwise to increase the clearance between the shoes and the bearing, and clockwise to decrease the clearance (fig. 48). The clearance between the shoes and the face of the clutch release bearing must be ⅛ inch (fig. 49). A ratchet arrangement in the adjuster will lock the handle with the shoes adjusted to ⅛-inch clearance. The clutch pedal free travel will then be approximately 1¾ inches if the length of the clutch pedal rod has not been changed. Install right generator belt guard.

99. CLUTCH THROW-OUT BEARING SHOES.

a. Removal.

(1) REMOVE FIRE EXTINGUISHER TUBES, GRILLE, AND SHUTTER. Lift air intake cover and remove air inlet grille and shutter, and fire extinguisher tubes.

(2) REMOVE ENGINE COMPARTMENT FLOOR COVER. Remove the cap screws which hold plate to the floor and remove plate.

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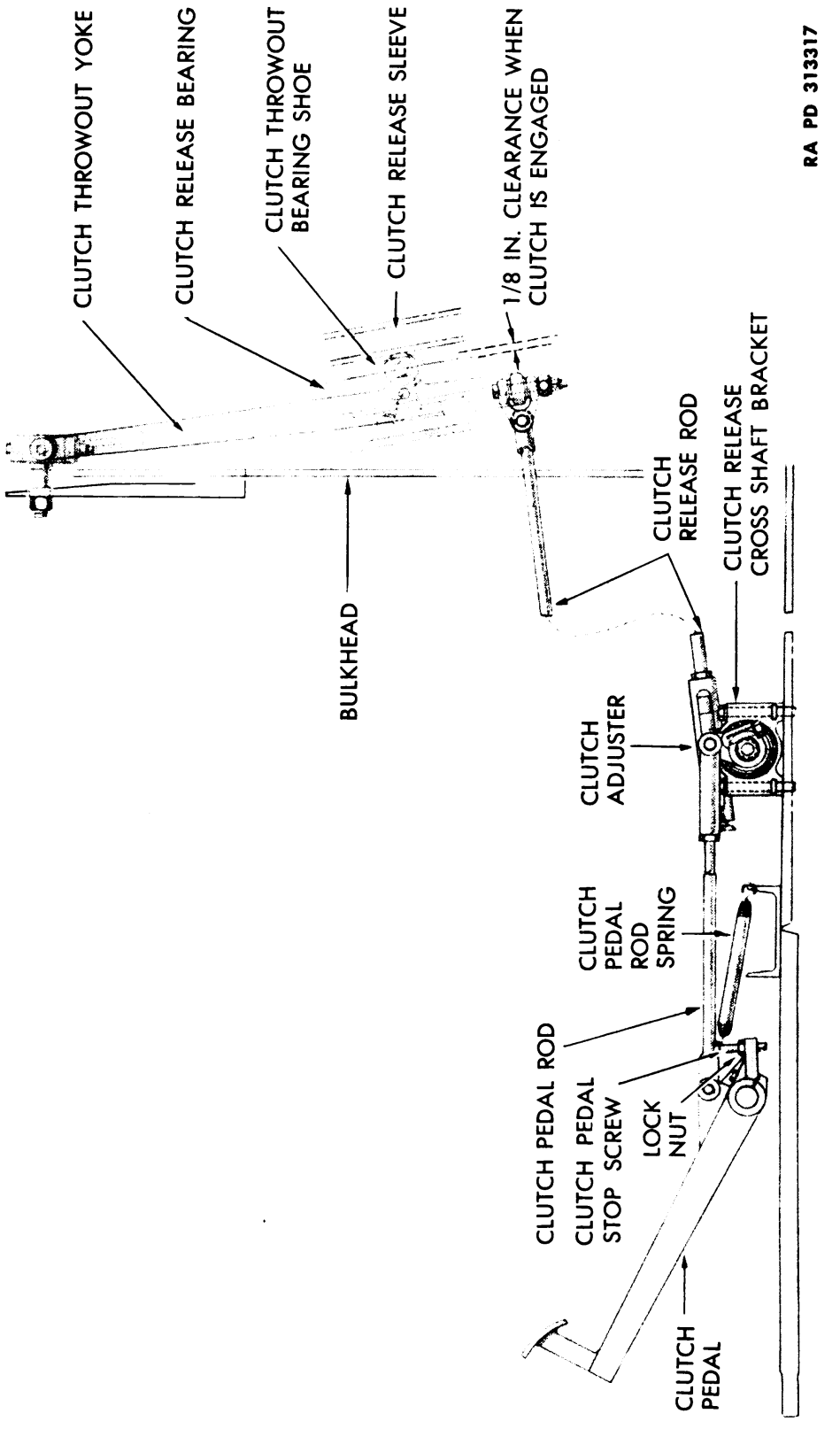


Figure 48—Clutch Controls—Side View

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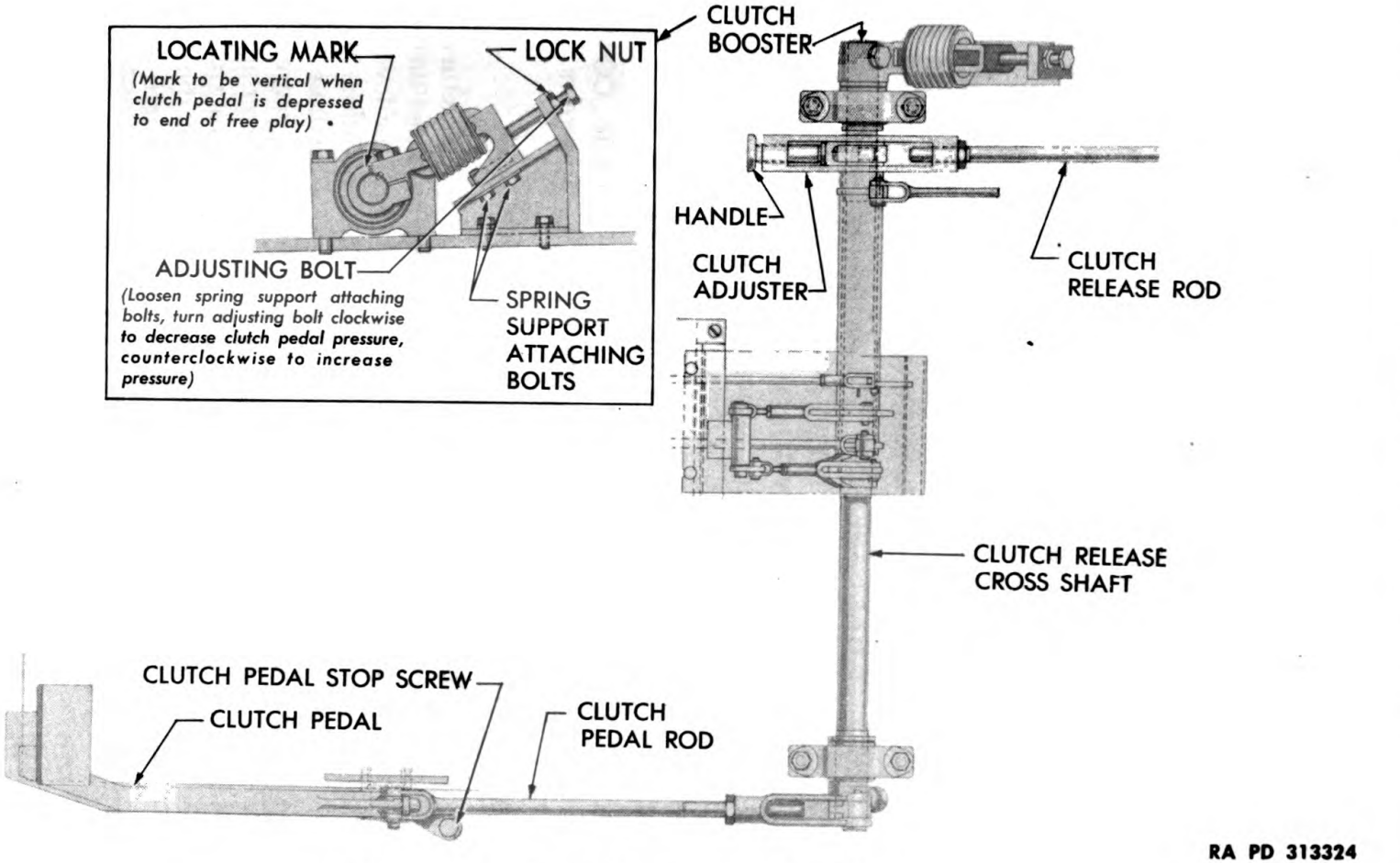


Figure 49—Clutch Controls—Top View

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(3) REMOVE RELEASE ROD CLEVIS PIN (fig. 48). Reach up through the inspection hole in the engine compartment floor and pull out the cotter pin in the release rod clevis pin, then pull out clevis pin.

(4) REMOVE TIE ROD CLEVIS PIN. Working through inspection hole, remove cotter pin from the clevis pin which holds clutch throw-out bracket tie rod to bracket on left vertical fuel tank pocket. Remove clevis pin.

(5) REMOVE CLUTCH THROW-OUT BEARING SHOES. Remove the throw-out yoke trunnion from the bulkhead and lower the yoke. Remove lock plates and drive the bearing shoes from the yoke.

b. Installation.

(1) INSTALL CLUTCH THROW-OUT BEARING SHOES. Insert the shoes in the yoke and install the lock plates. Raise the yoke into place and install the trunnion to the bulkhead.

(2) CONNECT RELEASE AND TIE RODS. Position the release and tie rods and install the clevis pins and cotter pins.

(3) INSTALL FIRE EXTINGUISHER TUBES, GRILLE AND SHUTTER. Install the fire extinguisher tubes at the bulkhead. Connect the air shutter operating rod to the shutter, and install the shutter. Place the air grille over the shutter and engage the latches. Lower the air inlet cover.

(4) INSTALL ENGINE COMPARTMENT FLOOR COVER. Raise the cover into position and install the attaching cap screws.

100. CLUTCH PEDAL.

a. Description. When assembled at the time of manufacture, the clutch pedal and the cross shaft operating lever are mounted on cross shaft by locating it according to the index marks on both the lever and the end of the shaft. This is necessary to assure proper operation. When the lever is properly located on the shaft, the center of the hole in the lever, to which the clutch pedal rod is attached, will rest 7 degrees behind a vertical line drawn through the index marks on the lever and the shaft and to the hull floor below. This may be verified by rotating the lever until index marks are vertical, and noting position of the lower end of the arm. CAUTION: *It is important that the length of the clutch pedal rod remain as set at time of manufacture.*

b. Removal.

(1) UNHOOK PEDAL RETURN SPRING, AND DISCONNECT CLUTCH PEDAL ROD. Unhook the pedal return spring at the clutch pedal. Withdraw the cotter pin which secures the clutch pedal rod clevis pin, and remove the clevis pin. Lift the rod out of the way.

(2) REMOVE CLUTCH PEDAL FROM SHAFT. Remove the cap

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screw at the rear of the pedal boss which clamps the pedal to the shaft. Tap the pedal off the shaft toward the left side of the hull, and lift it out.

c. Installation.

(1) ASSEMBLE CLUTCH PEDAL TO SHAFT. Position the clutch pedal at the end of the pedal shaft, and insert a small bar through the opening in the subfloor around the steering brake levers to hold the shaft, and tap the pedal onto the shaft. Install the cap screw to clamp the pedal boss to the shaft.

(2) ADJUST CLUTCH PEDAL STOP SCREW (fig. 48). If the stop screw has been disturbed, or if a new pedal is being installed, adjust the stop screw to allow ¾-inch clearance between the floor and the bottom edge to the new stop screw projection.

(3) CONNECT CLUTCH PEDAL ROD AND RETURN SPRING. Loosen the clevis lock nut at cross shaft end of the rod and lengthen or shorten the rod to aline the clevis pin holes of the front end of the rod with the hole in clutch pedal when the pedal is all the way up (clutch engaged) and with ⅛-inch clearance between clutch lever shoe and face of clutch release bearing. Insert the clevis pin and secure with a cotter pin. Tighten the clevis lock nut, and hook the return spring to the pedal and hull.

Section XXIV

INSTRUMENTS AND HORN

101. INSTRUMENT PANEL.

a. Description (fig. 50). The instrument panel assembly is a shock-mounted metal box located on the transmission to the right of the driver. The cover of the box forms a panel which carries the instruments and gages.

b. Removal of Instrument Panel.

(1) REMOVE INSTRUMENT PANEL ASSEMBLY. Disconnect the conduits and cables from the back of the box and remove the bracket bolts from the sponson. Remove the panel from the vehicle.

(2) REMOVE THE PANEL COVER WITH INSTRUMENTS. Disconnect the conduits and cables from the back of the assembly. Remove the screws which hold the face of the panel on the box and remove the panel with all instruments attached.

c. Replacement of Instruments (fig 52). Remove the instrument panel (subpar. *b* above). Tag, or otherwise identify, wires to electrical instrument, or gage, that is to be replaced, so that the wires can be connected in the proper position on the replacement unit. Remove the screws or nuts which attach the unit to the assembly, and in the case of

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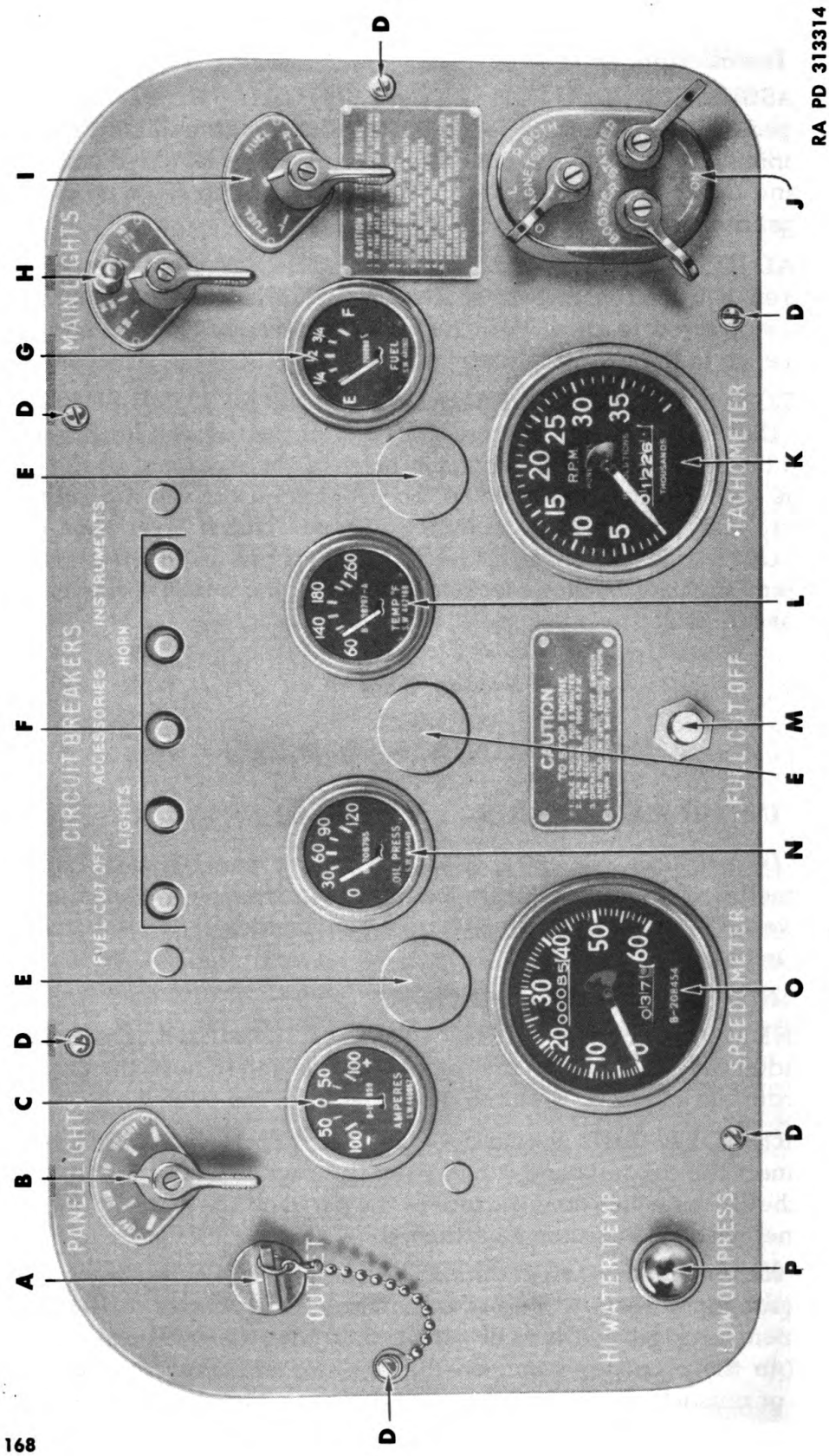


Figure 50—Instrument Panel Assembly

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A—UTILITY OUTLET SOCKET

B—PANEL LIGHT SWITCH—C102763

C—AMMETER—G104-05-00030

D—PANEL ATTACHING SCREW

E—PANEL LIGHT COVER

F—CIRCUIT BREAKERS

G—FUEL GAGE—B209888

H—MAIN LIGHT SWITCH

I—FUEL GAGE SELECTOR SWITCH—C102762

J—CRANKING MOTOR AND MAGNETO SWITCH—G104-05-04369

K—TACHOMETER

L—ENGINE OIL TEMPERATURE GAGE—B208797A

M—FUEL CUT-OFF SWITCH—A298391

N—OIL PRESSURE GAGE—B208795

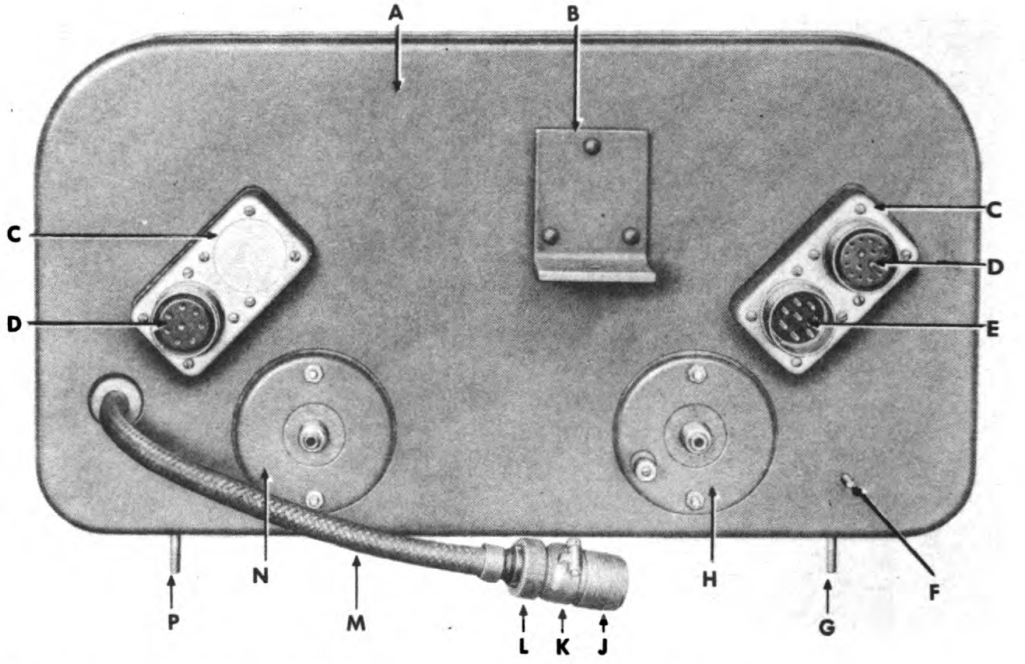
O—SPEEDOMETER

P—LOW OIL PRESSURE WARNING LIGHT

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Legend for Figure 50—Instrument Panel Assembly

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A—INSTRUMENT PANEL HOUSING
B—CENTER SUPPORT BRACKET PLATE
C—RECEPTACLE CASE
D—RECEPTACLE
E—CONNECTOR
F—GROUND WIRE STUD
G—INSTRUMENT PANEL MOUNTING STUD
H—SPEEDOMETER
J—RECEPTACLE RETAINER
K—CONNECTOR
L—KNURLED NUT
M—MAGNETO HARNESS
N—TACHOMETER
P—INSTRUMENT PANEL MOUNTING STUD

RA PD 322710

Figure 51—Rear of Instrument Panel Housing

switches remove the lever from the switch, then remove the unit from the panel. Place the new unit in position and install the attaching nuts or screws. Connect the wires in the proper position. Install the instrument panel (subpar. *d* below).

d. Installation of Instrument Panel (fig. 51).

(1) INSTALL INSTRUMENT PANEL ASSEMBLY. Place the instrument panel assembly on the sponson and connect all the conduits and drive cables for the recording instruments. CAUTION: *Be sure that the conduit plugs index properly when making connections to avoid damage to the plugs and crossing of the circuits.* Position the panel assembly on the sponson and install the shock mounting cap screws.

(2) INSTALL INSTRUMENT PANEL COVER WITH INSTRUMENTS. Place the cover with instruments into the panel box. Make sure that the gaskets (A-347592-B) around the cover and receptacles are in place. Install the screws which hold the cover on the box. Properly index the conduit plugs, and connect the conduits and cables.

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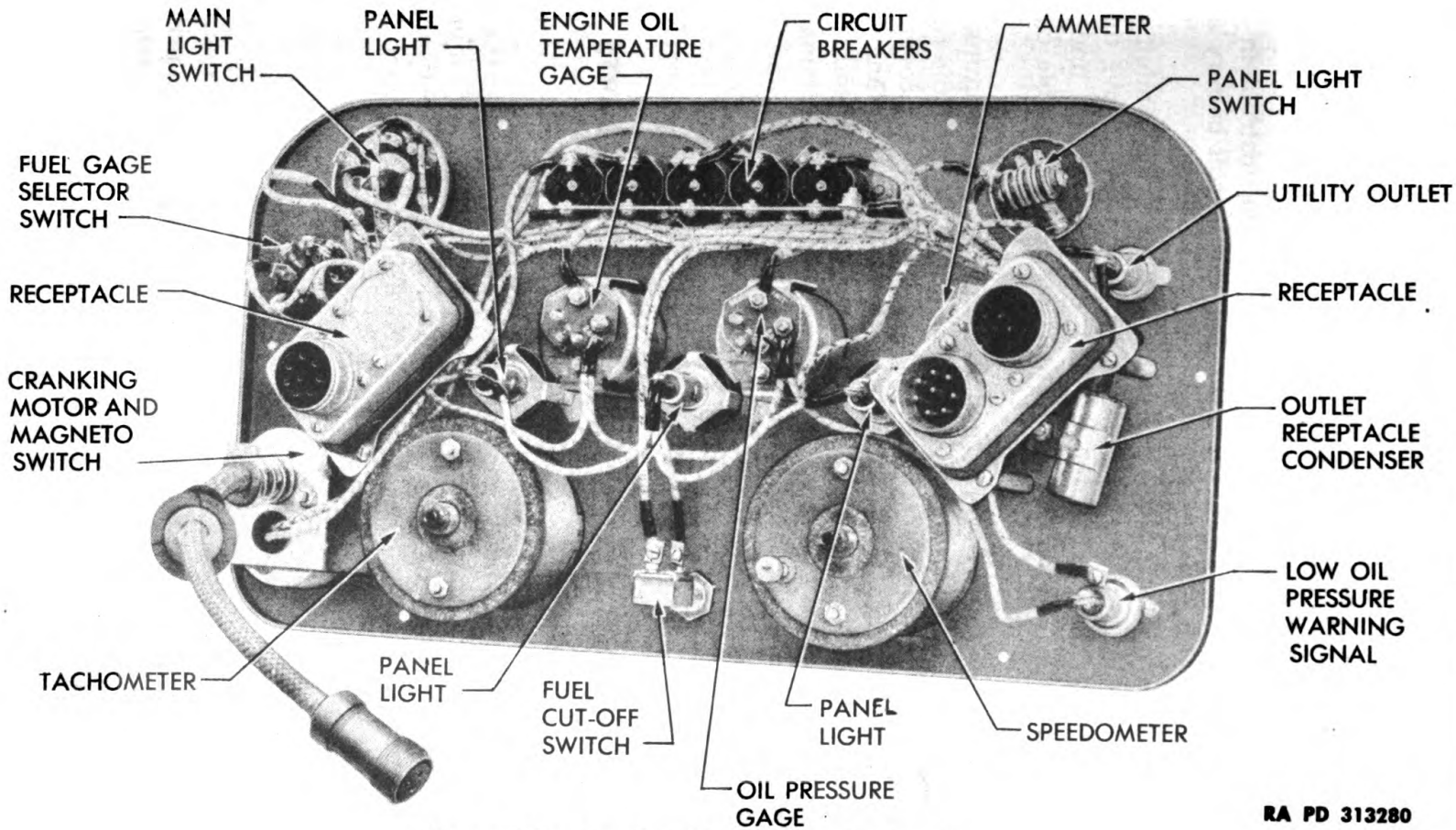


Figure 52—Back of Instrument Panel

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102. HORN.

a. Description. The horn is bracket-mounted under a guard near the left headlight, and is connected by flexible conduit through the front of the hull to a push-button switch mounted on the right steering brake lever just below the rubber grip. The horn operates on 24 volts, and the switch is supplied with current from the instrument panel through the front end wiring harness, when the 24-volt battery switch is closed.

b. Replacement of Horn. Disconnect the flexible conduit at the fitting on the hull, pull the connector plug apart, and remove the two horn mounting screws. Position the new unit on the hull under the guard, and install the mounting screws. Connect the flexible conduit from horn to hull fitting.

c. Replacement of Horn Switch. Remove the mounting bolts which hold the switch to the steering brake lever. Unscrew the conduit coupling ring from the switch assembly, and remove the cover from the switch. Disconnect the wires from the switch, and remove the switch. To install, remove the cover from the new switch, and remove the connector screws. Connect the wires to the switch terminal, and install the switch cover. Attach the conduit to the switch, and mount the switch on the steering brake lever.

Section XXV

PROPELLER SHAFT AND UNIVERSAL JOINTS

103. DESCRIPTION.

a. The propeller shaft transmits power from the clutch to the input shaft of the transmission. It is of one-piece construction, with a universal joint at each end to allow for operation at an angle between the clutch and transmission. The front universal joint is connected to the shaft with a splined slip yoke.

104. PROPELLER SHAFT ASSEMBLY.

a. Removal.

(1) REMOVE CLUTCH CONTROL RODS. Disconnect the clutch release rod from the clutch lever yoke and depress the clutch pedal all the way. Remove the nut which holds the tie rod to the clutch lever yoke, and push the bolt up as far as it will go.

(2) REMOVE SHAFT AND REAR UNIVERSAL JOINT. Remove the bolts from the rear universal joint flange and lower the shaft. Unscrew the dust cap from the front universal joint hub. Slide the shaft under the flange on the engine and out of the spline at the front end. Lower the front end of the shaft and remove the shaft.

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(3) REMOVE FRONT UNIVERSAL JOINT. Remove the lock wire and flange bolt nuts. Slide the joint off the flange bolts.

b. Installation.

(1) INSTALL FRONT UNIVERSAL JOINT. Place the universal joint over the flange bolts and install the nuts and lock wire.

(2) INSTALL PROPELLER SHAFT AND REAR UNIVERSAL JOINT. Slide the rear end of the shaft and the rear universal under the companion flange on the engine. Then move the shaft forward and enter the splined end of the shaft into the front universal joint. The hub of the front joint and the end of propeller shaft tube are marked for proper alinement of the joints. Enter the shaft in the hubs so that the marks are in alinement. Screw the dust cap in place on the front universal joint hub. Install the flange bolts, nuts, and lock wire in the rear flange.

(3) CONNECT CLUTCH CONTROL RODS. Install the nut on the clutch yoke tie rod. Pull the clutch pedal back, and connect the clutch release rod to the release yoke. Install the universal joint cover to the bulkhead.

Section XXVI

TRANSMISSION AND FINAL DRIVE ASSEMBLY

105. DESCRIPTION.

a. Transmission. The transmission has five forward speeds and one reverse speed. The second, third, fourth, and fifth gears are synchronized. The first and reverse gears are in constant mesh and are engaged by a sliding clutch.

b. Final Drive Assembly. The final drive assembly consists of the controlled differential, steering brake assemblies, and final reduction assemblies mounted on the right and left sides of the final drive assembly. The differential is known as a "controlled differential" because it serves not only to transmit power to the final reduction units, but it also contains a brake system for the purpose of steering and stopping the vehicle. The final reduction assembly transmits power from the differential to the hubs of the driving sprockets. Each assembly has a set of reduction gears through which the power is transmitted from the final drive shaft to the sprocket hub. Each set of final drive shaft gears is mounted on a cover which is bolted to the final drive housing at either end. A driving sprocket is bolted to a hub on each final reduction assembly.

c. Final Drive Assembly Lubrication Oil Cooler. Oil flows from the differential through a tube to the sump in the bottom of the transmission housing. It is then drawn into the pump, and forced out the left side of the transmission through a tube to the oil cooler assembly, which

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is located on the fighting compartment side of the bulkhead to the right of the propeller shaft. The oil enters at the bottom of the cooler and flows upward through a by-pass tube to the outlet connection at the top of the cooler, and returns through a tube to the left side of the transmission. When the oil reaches a temperature of 100°F, the by-pass valve closes, causing the oil to flow upward through the oil cooler tubes. Air drawn through the cooler by the engine fan reduces the temperature of the oil, then it is returned to the final drive assembly to lubricate the gears in the transmission, differential, and final reduction assemblies.

d. Final Drive Assembly Serial Number. The serial number of the final drive assembly is stamped on a plate mounted on the differential case directly over the transmission.

106. GEARSHIFT LEVER.

a. Removal. Remove the gearshift lever yoke bolt, fulcrum link bolt, and the lever shaft. Then lift off the gearshift lever.

b. Installation (fig. 53). Wipe the surface of the shaft clean, and cover the bearing surfaces, bolts, and shaft with engine oil. Position lever on left side of the transmission, install gearshift lever shaft, fulcrum link bolt, and fulcrum yoke bolt. Push the shaft in and screw nut on inner end of the shaft. Apply lubricant gun to lubrication fitting, and move gearshift lever back and forth while forcing the lubricant into fitting. Tighten nuts, so that linkage moves freely without excessive play, and insert cotter pins.

107. STEERING BRAKE SHOES.

a. Description (fig. 54). The double anchor steering brake is a three-shoe external contracting steering brake operating in oil. A shoe assembly and brake drum are located in each end of the final drive housing and are actuated by the steering brake control levers.

b. Removal.

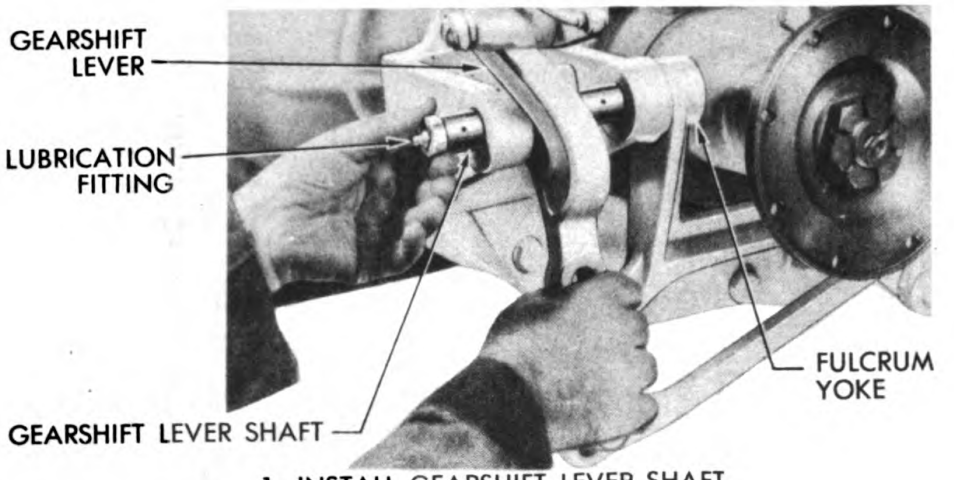
(1) DRAIN FINAL DRIVE HOUSING. Remove the two plugs on the bottom of the final drive housing with wrench (41-W-1960-236), and drain out lubricant.

(2) DISCONNECT STEERING BRAKE LINKAGE. Remove the two clevis pins at the top of the steering brake control rods.

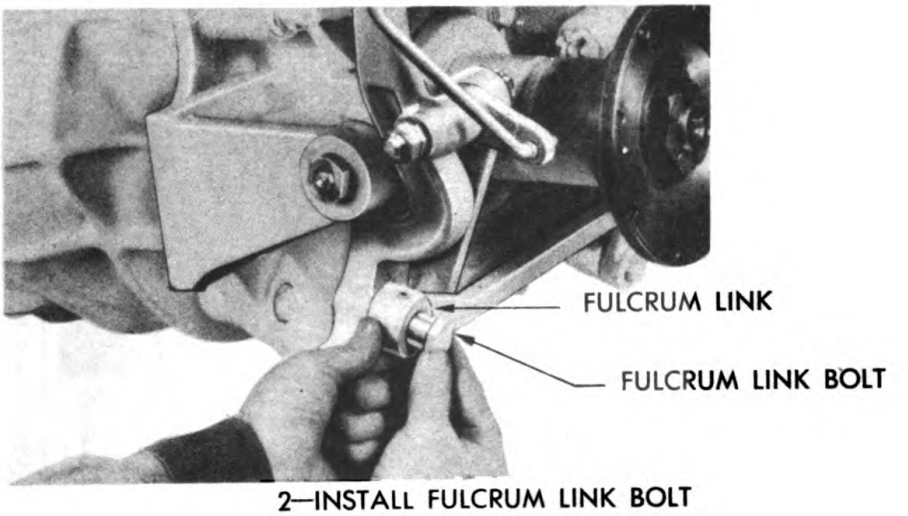
(3) REMOVE REVERSE ANCHOR JAM NUT, ADJUSTING NUT AND HOUSING COVER (figs. 54 and 55). Remove the lock wire and unscrew the jam nut, adjusting nut, and adjusting nut seat from the reverse anchor rod. Remove the steering brake housing cover attaching cap screws and lift off the cover.

(4) REMOVE REVERSE ANCHOR SPRING AND SEAL (figs. 54 and 55). Loosen the reverse anchor thrust bolt lock nut, and the thrust bolt, and lift out the rod.

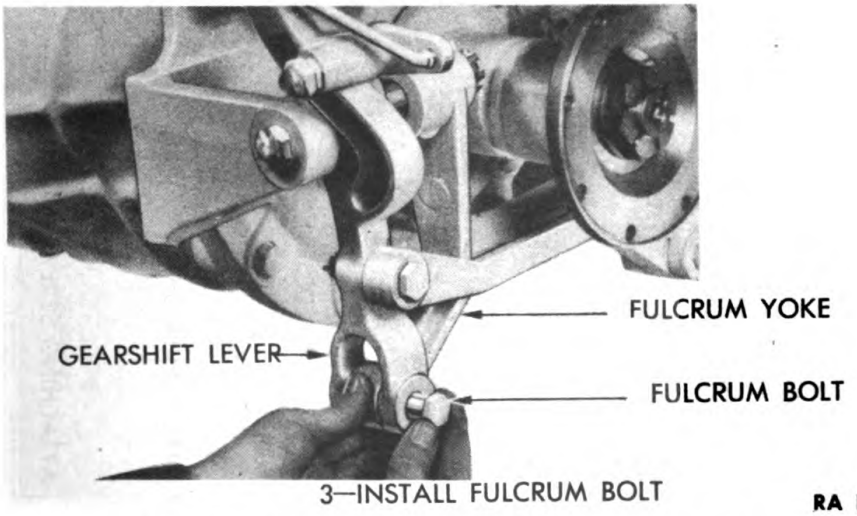
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1—INSTALL GEARSHIFT LEVER SHAFT



2—INSTALL FULCRUM LINK BOLT



3—INSTALL FULCRUM BOLT

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Figure 53—Gearshift Lever Installation

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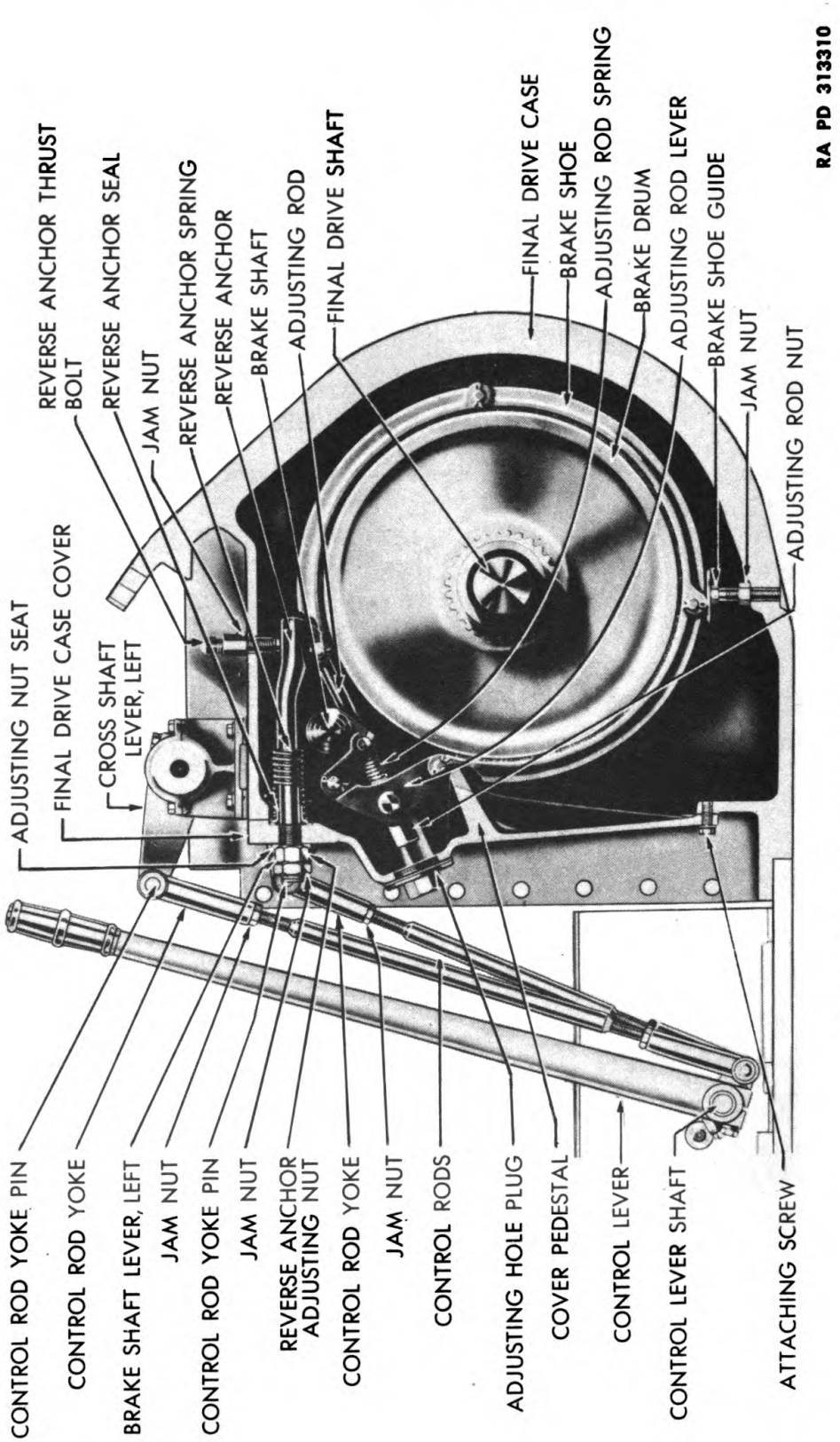
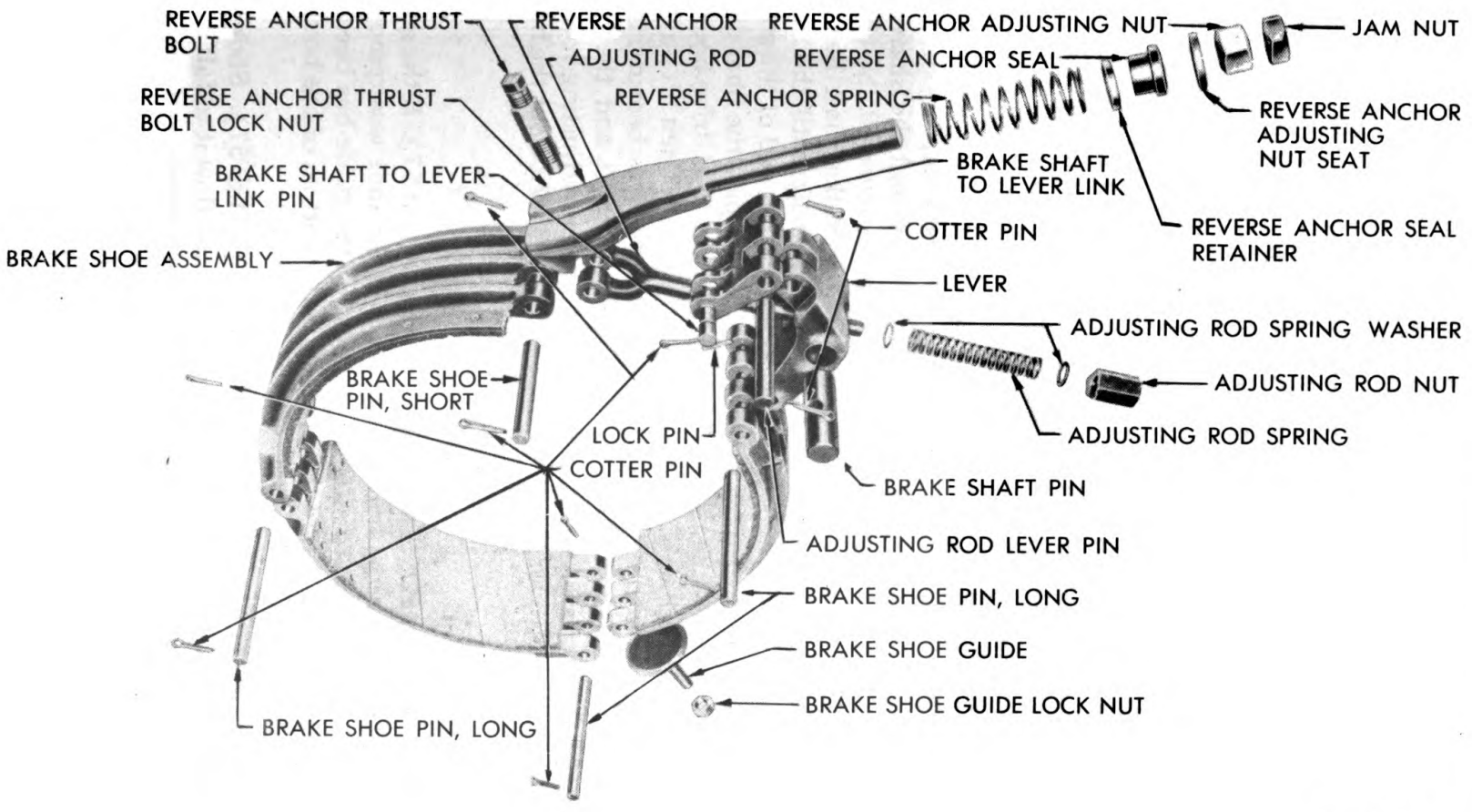


Figure 54—Cross Section of Steering Brake

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Figure 55—Steering Brake Shoe—Disassembled

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(5) LOWER BRAKE SHOE GUIDE (fig. 54). Reach through the opening in the brake housing below the shoe, and loosen the shoe guide jam nut which is located directly below center of shoe. Screw the guide down into the bottom of the housing.

(6) DISCONNECT SHOE ADJUSTING LINKAGE (fig. 54). Unscrew the nut from the adjusting rod and remove the adjusting clip. Push the rod back until the rod is free of the lever. Lift out the spring and washers, and allow the shoe and lever to fall forward. Remove the brake shaft swivel pin from the lever.

(7) REMOVE STEERING BRAKE SHOE ADJUSTING ROD LEVER (fig. 55). Remove the cotter pin and the hinge pin between the shoe and lever. Rotate the brake shaft lever upward and swing the lower end of the brake shoe lever in toward the brake drum to allow the upper hinge pin to clear the brake drum housing. Remove cotter pin and pull out the hinge pin at the top of adjusting lever. Remove lever.

(8) REMOVE THE STEERING BRAKE SHAFT LEVER AND BRAKE SHOES (figs. 55 and 56). Unscrew the steering brake lever clamp screw and remove it. Punch-mark the lever and the shaft for proper assembly, if not already marked. Drive the lever off the shaft. Remove the three cap screws which attach the brake shaft bearing plate to the housing, and pull out the plate and shaft until the inner end of the shaft clears the inner bearing. Tilt the inner end of the steering brake shaft upward to allow the bearing plate to pass the final drive carrier plate nuts. Hold the bearing plate against the final drive housing flange, and move the shaft back into the inner bearing. Then lift out the bearing plate. Rotate the shaft and pull it out of the inner bearing; then drop the inner end of the shaft and remove the shaft and the link, through the large opening. Pull the brake shoes and adjusting rod assembly from housing over the top of the brake drum. Wipe out the housing to remove dirt.

c. Installation.

(1) LOCATE BRAKE SHOE GUIDE (figs. 56 and 57). If the guide was not removed from the housing when the brake shoe was removed, there will be no occasion to alter its location. If the guide has been removed, however, screw it into the opening in the bottom of the housing with the lock nut in place on the screw.

(2) INSTALL BRAKE SHOE IN HOUSING (fig. 57). Slide the end of the shoe over the top of the brake drum and allow it to fall down back of the drum until it contacts the guide. Reach through the housing opening and pull the shoe into place around the brake drum with the steering brake shoe adjusting rod at the top.

(3) INSTALL THE BRAKE SHAFT AND BEARING PLATE (fig. 58). Insert the splined end of the shaft through the brake housing opening and out through the hole in the side of the housing. Rotate the

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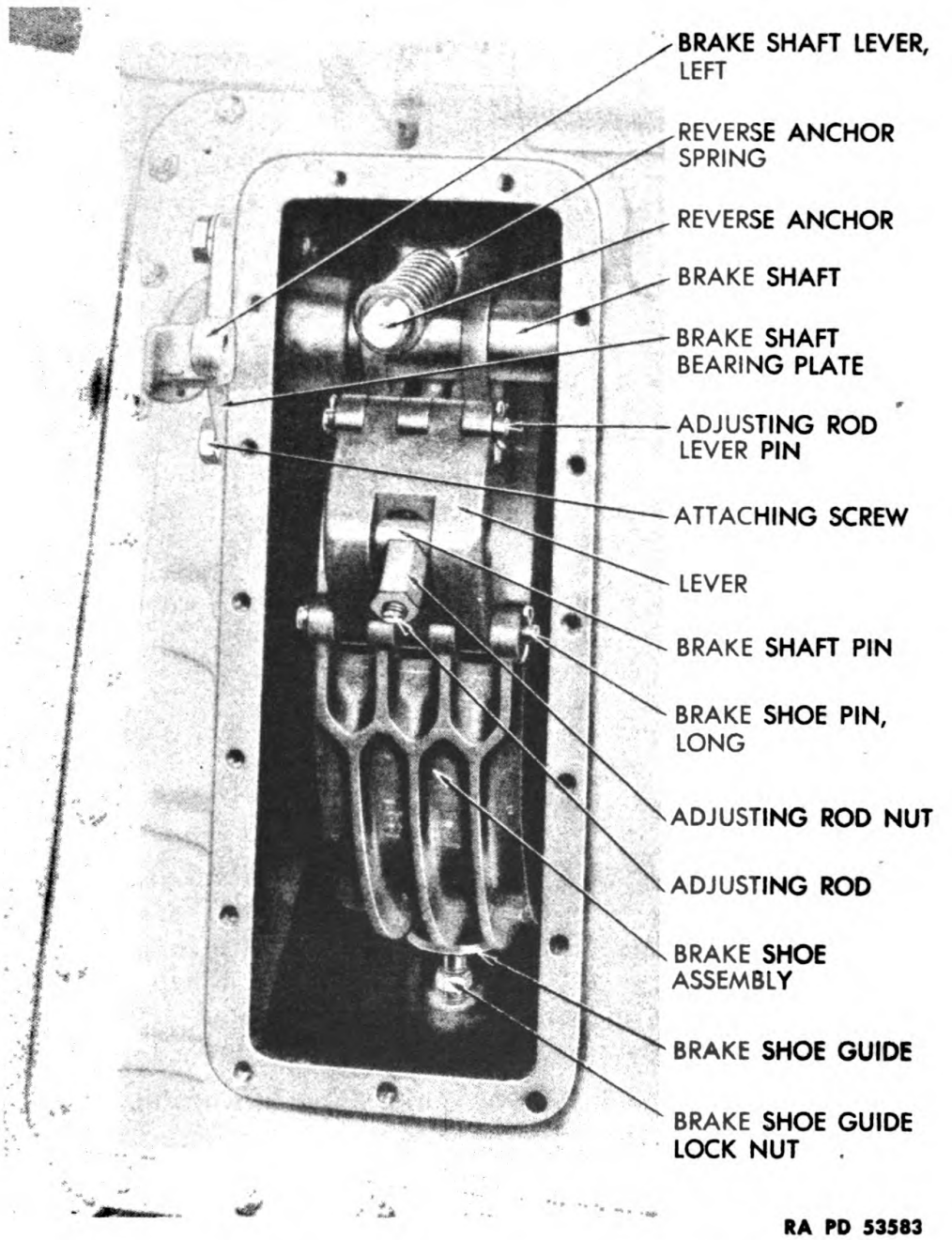
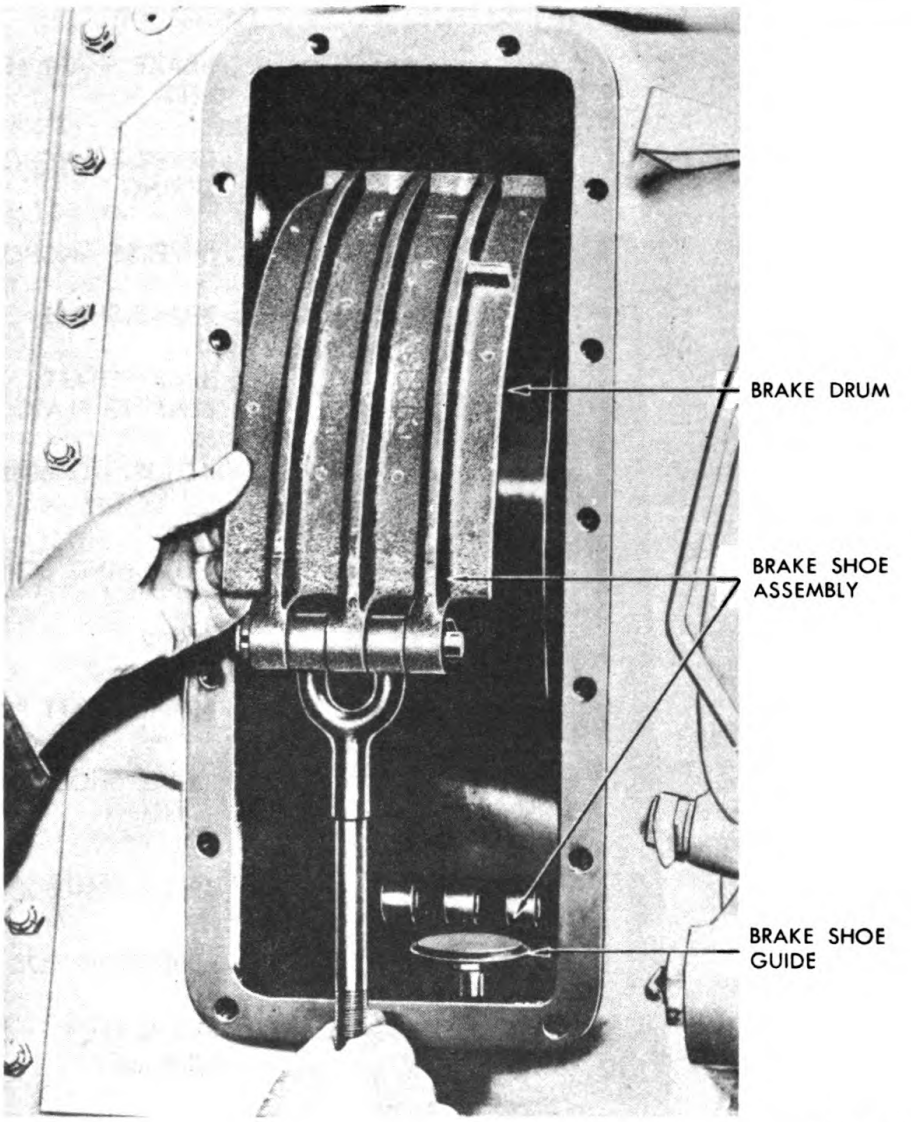


Figure 56—Steering Brake Mechanism

shaft and raise it until the inner end can be started into the inner bearing. Position the outer bearing plate on the splined end of the shaft and slide the shaft out into the bearing plate. Tilt the inner end of the shaft upward and move the bearing plate onto the shaft to clear the differential carrier plate nuts. Move the plate and shaft inward into the inner bearing. Install the bearing plate attaching cap screws. Aline the punch

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Figure 57—Installing Brake Shoe in Housing

marks on the steering brake shaft and the steering brake shaft lever. Secure in place with the clamp cap screw.

(4) INSTALL BRAKE LEVER ASSEMBLY (fig. 59). Aline the holes in the brake shaft link and lever, and insert the hinge pin. Secure with a cotter pin. Lift the lower brake shoe and aline the holes in the lower end of the lever assembly with the holes in the brake shoe. Insert the hinge pin and secure with a cotter pin.

(5) ASSEMBLE ADJUSTING ROD, ADJUSTING WASHERS, AND SPRING (fig. 60). Insert the brake shaft swivel pin in the lever assembly and aline the hole with the adjusting rod. Pull the rod through the brake shaft pin hole and install washers, spring, and adjusting nut.

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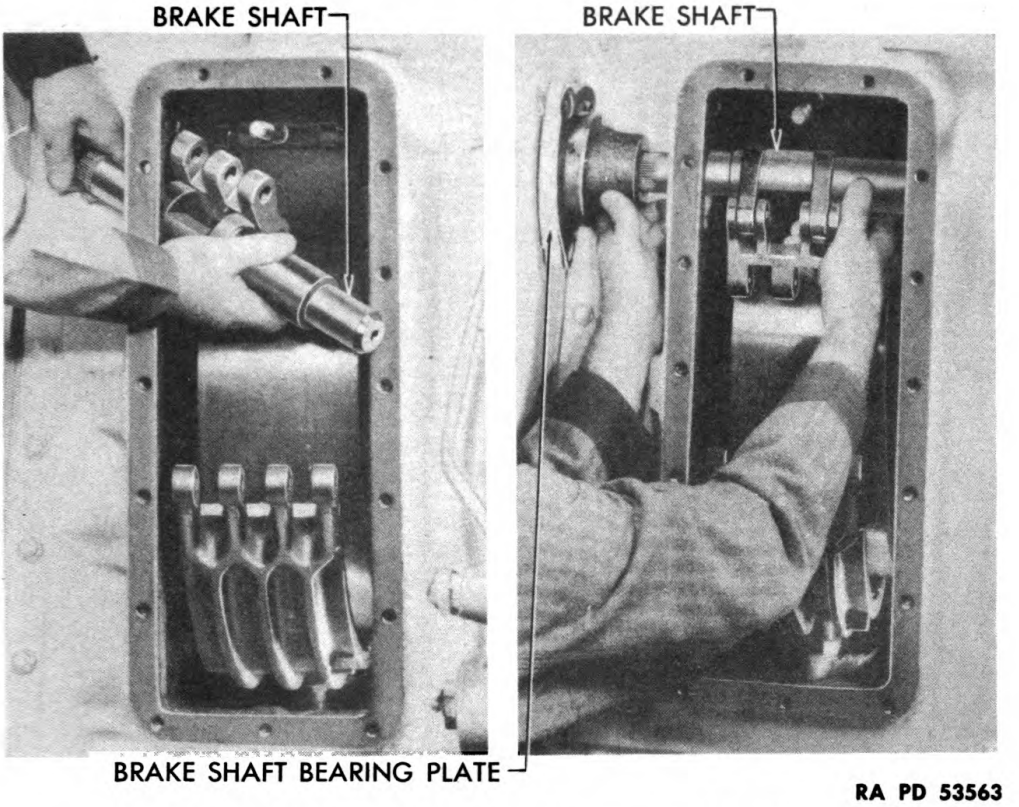


Figure 58—Installing Brake Shaft and Bearing Plate

(6) ADJUST BRAKE SHOE GUIDE (fig. 56). Lift the brake shoe until shoes are in the approximately normal operating position. Apply brakes to tighten shoes against the drum, and move the lower shoe until the connecting pin is over the guide. Reach through the lower part of the opening under the brake shoe, and screw the guide up until it is in light but firm contact with the brake shoe. Then turn down ¼ to ⅓ turn to obtain 0.020-inch clearance between the shoe and guide. Tighten lock nut and release the brake.

(7) INSTALL STEERING BRAKE REVERSE ANCHOR, SPRING, SEAL, AND RETAINERS (figs. 54 and 55). Install reverse anchor spring, reverse anchor to cover seal retainer and seal. Install the reverse anchor, with the hook, over the short brake shoe pin, and hold in place by tightening reverse anchor thrust bolt finger-tight.

(8) INSTALL FINAL DRIVE HOUSING COVER (fig. 54). Lift up on adjusting rod nut, apply the brake, and install cover with a new gasket. This will allow the top of the shoe to rest on the cover pedestal. CAUTION: *Make sure that reverse anchor spring, reverse anchor to cover seal retainer, and seal are in place before entering reverse anchor in the hole in the cover.* Tighten cover cap screws.

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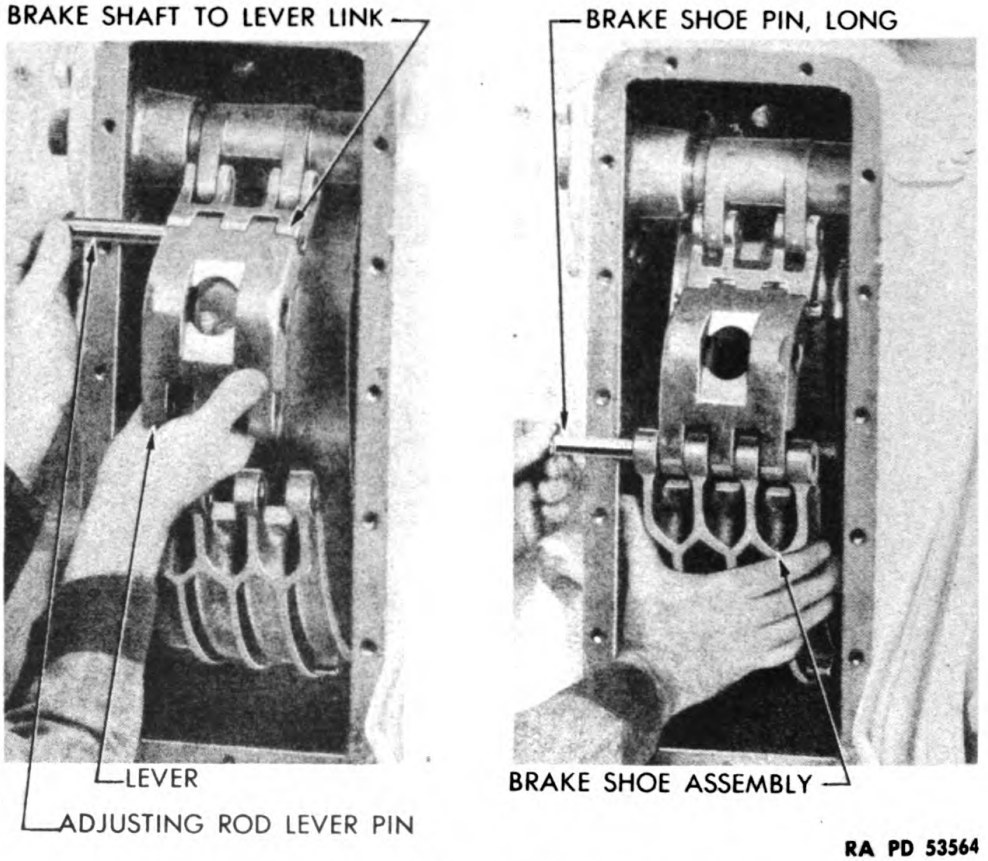


Figure 59—Installing Brake Lever Assembly

(9) **INSTALL REVERSE ANCHOR NUT SEAT, ADJUSTING NUT, AND JAM NUT** (figs. 54 and 55). Install reverse anchor nut seat on reverse anchor with flat side toward the cover. Install adjusting and jam nuts.

(10) **CHECK LINKAGE ADJUSTMENT.** See paragraph 108 *d*.

(11) **ADJUST BRAKES.** See paragraph 108 *b* and *c*.

(12) **CONNECT STEERING BRAKE LINKAGE.** Position the right and left steering brake control rods with the clevis over the end of the steering brake cross shaft lever, insert the clevis pins, and secure with cotter pins.

(13) **FILL FINAL DRIVE HOUSING WITH LUBRICANT.** Refer to paragraph 26.

108. STEERING BRAKE ADJUSTMENTS.

a. General. It is necessary to make a minor brake adjustment to compensate for lining wear whenever the steering brake control levers must be pulled back of a vertical position when making a normal turn with the vehicle (subpar. *b* below). If examination reveals the necessity

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of recentering the brake shoes with relation to the brake drum, a major adjustment will be required (subpar. *c* below). CAUTION: *Never change the length of the control rods or steering brake linkage in an attempt to adjust for brake wear.* If the linkage adjustment has been changed, however, the control linkage should be properly adjusted before the steering brakes are adjusted (subpar. *d* below).

b. Minor Brake Adjustment (fig. 61).

(1) CHECK BRAKE LINKAGE AND ADJUST IF NECESSARY. See subparagraph *d* below.

(2) ADJUST BRAKE SHOES. Remove the clevis pin from the top of the control rods. Remove adjusting hole plugs and turn adjusting nuts ½ turn. Connect the control rods and test the free travel of the levers. Repeat the operation until the brakes are applied when the top of the steering brake control levers are pulled back 4 to 5½ inches from the fully released position. Install the adjusting hole plugs.

(3) ADJUST REVERSE ANCHORS. Remove the lock wire and loosen the reverse anchor jam nut. Adjust the anchor adjusting nut so

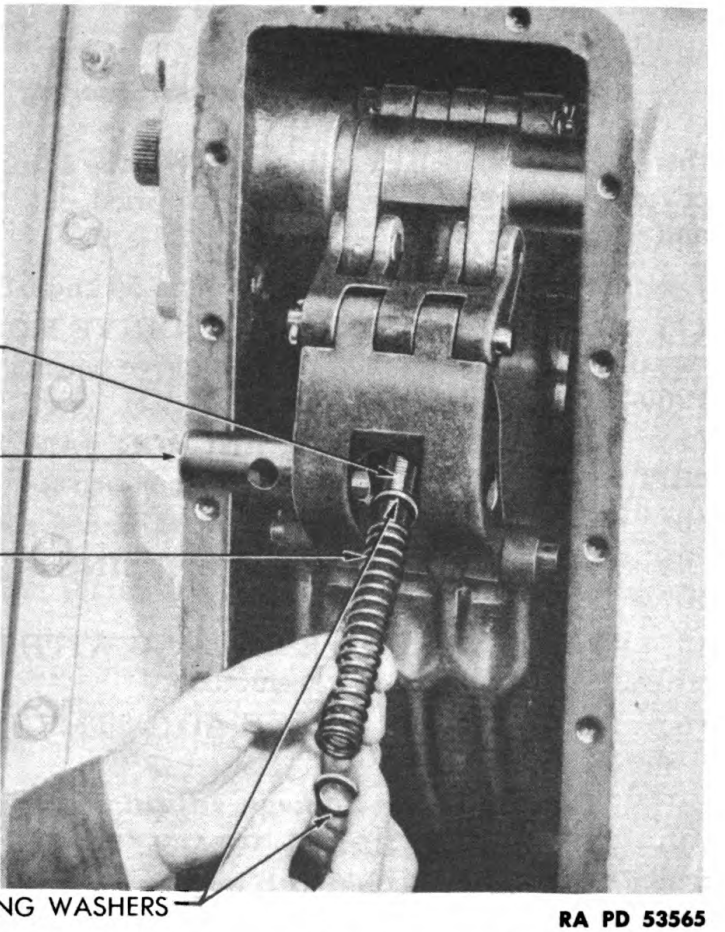


Figure 60—Installing Adjusting Rod Spring and Washers

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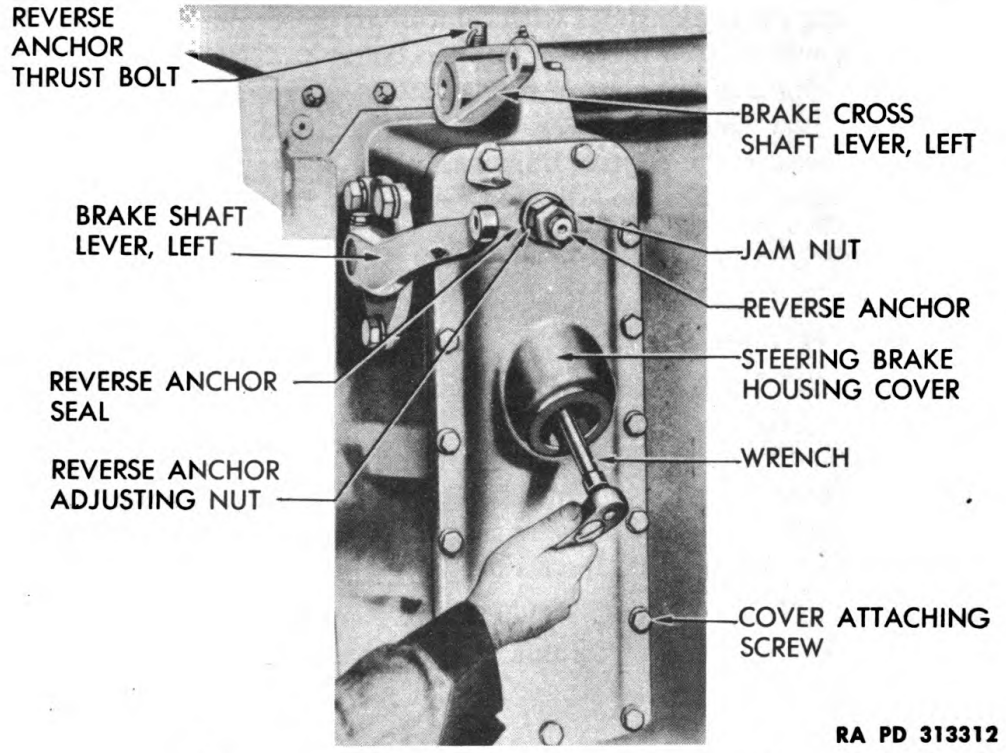


Figure 61—Adjusting Steering Brake

there is 1/16 to 3/32-inch clearance between the adjusting nut seat and the cover when the anchor is pulled or pried out. Tighten the jam nut and install lock wire.

c. Major Brake Adjustment (figs. 56 and 61).

(1) DRAIN OIL FROM FINAL DRIVE HOUSING. Remove the two plugs on the bottom of the final drive housing with wrench (41-W-1960-236), and drain out lubricant.

(2) REMOVE REVERSE ANCHOR JAM NUT, ADJUSTING NUT, AND HOUSING COVER. See paragraph 107 *b* (3).

(3) ADJUST BRAKE SHOE GUIDE. See paragraph 107 *c* (6).

(4) INSTALL FINAL DRIVE HOUSING COVER. See paragraph 107 *c* (8).

(5) FILL FINAL DRIVE HOUSING WITH LUBRICANT. Filler is located on right side of transmission.

(6) MAKE MINOR BRAKE ADJUSTMENT. See subparagraph *b* above.

d. Steering Brake Linkage Adjustment.

(1) ADJUST STEERING BRAKE CONTROL LEVER STOP SCREW (fig. 62). Loosen lock nuts and adjust stop screws until the control levers are 7 to 7 1/2 inches from the face of the final drive housing when in the fully released position, and tighten the lock nuts.

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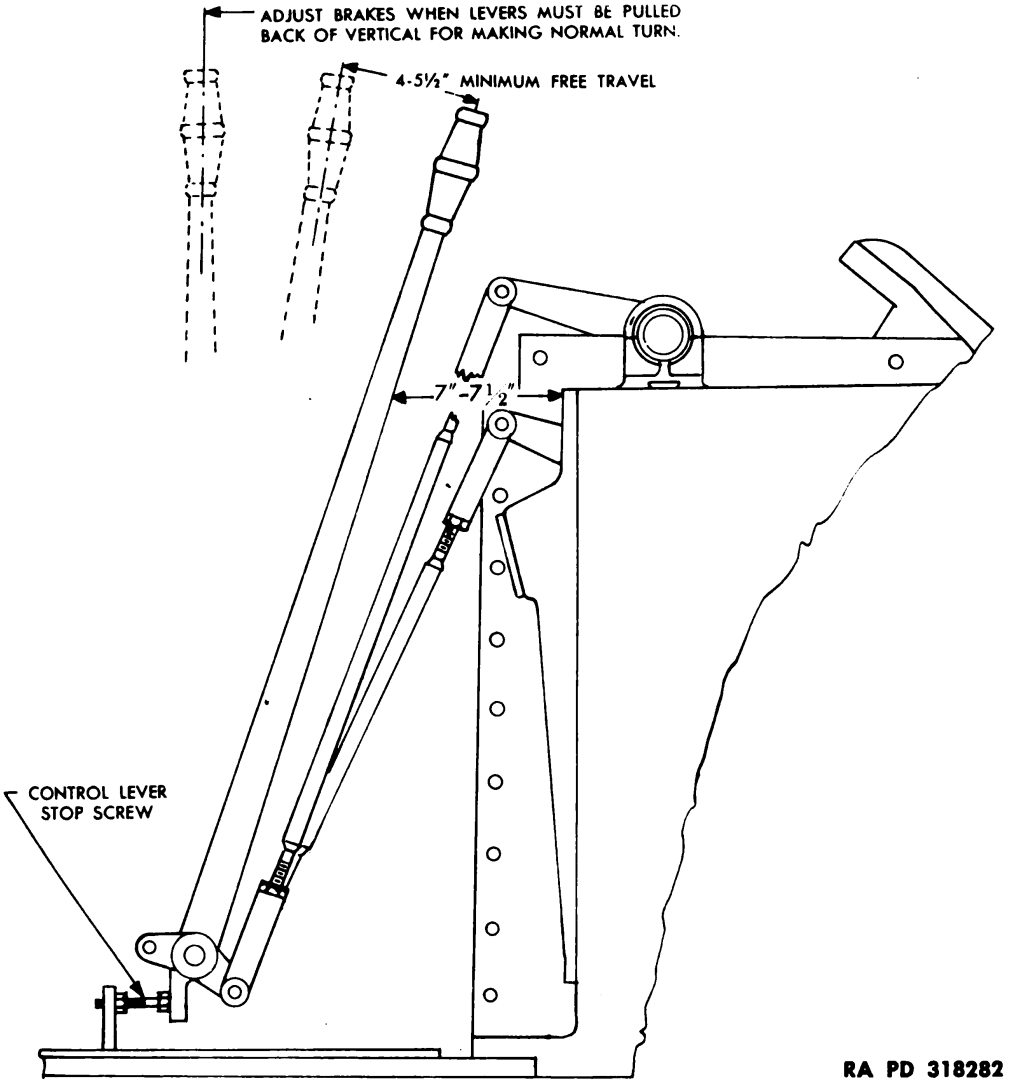


Figure 62—Steering Lever Positions

(2) CHECK POSITION OF LEVERS ON CROSS SHAFT AND BRAKE SHAFT (fig. 63). If marks on the cross shaft and levers do not line up, unscrew the lever clamp screw, and remove the lever. Place the lever on the shaft with the marks in line, and tighten the clamp screw.

(3) ADJUST STEERING BRAKE CONTROL RODS (fig. 63). Remove pin from yoke at upper end of control rods. With the control lever against the stop screws, adjust the yoke on the left control rod so that the yoke pin will pass through the brake shaft lever when the center of the pin hole is 4½ inches from the machined surface of the final drive housing. Install the yoke pin and cotter pin. Adjust the right control rod in the same manner, except that the hole in the rod, when connected to the cross shaft lever, must be 9/16 inch above the machined surface of the final drive housing.

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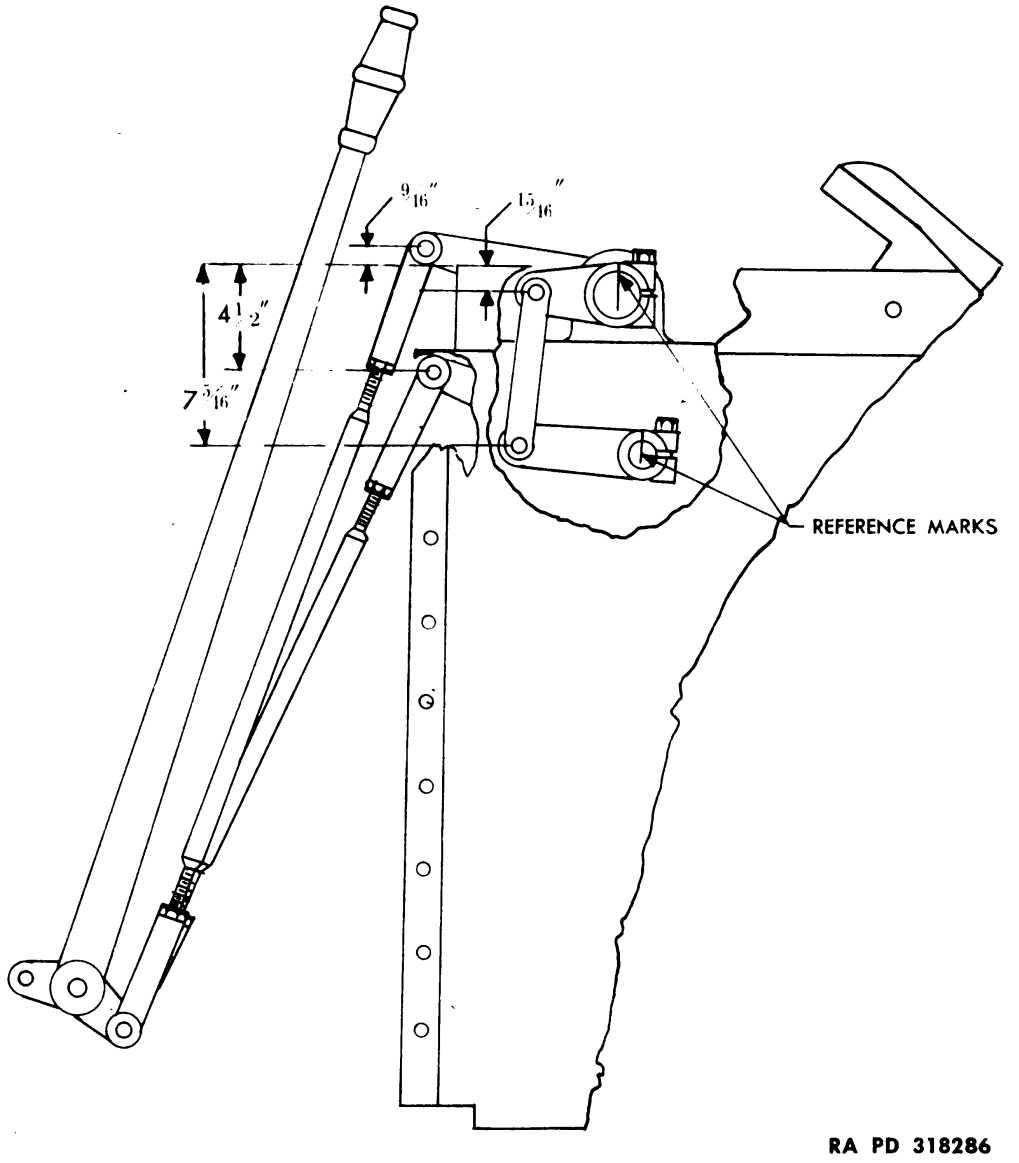


Figure 63—Steering Lever Positions

109. STEERING BRAKE CONTROL LEVERS.

a. Removal.

(1) REMOVE DRIVER'S SEAT. Remove the bolts and nuts which secure the driver's seat to its base, and lift out the seat.

(2) REMOVE SUBFLOOR. Remove the attaching screws and lift subfloor from its supports.

(3) REMOVE STEERING BRAKE CONTROL LEVER. Remove the clevis pins connecting the steering brake control rods to the steering brake control levers. Remove the cotter pin at the left end of steering brake control lever shaft. Drive the shaft out towards the transmission,

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making sure that the spacers between the levers and at either end of shaft are not lost.

(4) CHECK ADJUSTMENT OF STEERING BRAKE CONTROL LEVER STOP SCREWS (fig. 62). Loosen lock nut and adjust the stop screw until the control lever is 7 to 7½ inches from the face of the final drive housing, when in the fully released position.

b. Installation.

(1) INSTALL STEERING BRAKE CONTROL LEVERS. Place one spacer on the lever shaft, and aline the right lever with hole in bracket. Insert the shaft through the bracket and lever just far enough to allow the other lever to be installed on the shaft. Position the left lever, aline the hole with the shaft, and drive the shaft through the lever and bracket. Install the outer space on the shaft and the cotter pin in end of the shaft. Install the clevis pins connecting the steering brake control rods to the steering brake control levers.

(2) INSTALL SUBFLOOR AND DRIVER'S SEAT. Position the subfloor on the supports, install the attaching screws, and tighten securely. Place the driver's seat on its base and attach with the bolts and nuts.

110. PARKING BRAKE.

a. Description. The parking brake mechanism consists of a quadrant welded to each steering brake control lever. Two pawls are mounted to a bracket on the hull floor and are operated by a kick pedal. When the pedal is kicked forward, the pawls engage the quadrants on the steering brake levers and hold the levers in any set position. Kicking the pedal to the rear releases the brakes.

b. Replacement of Quadrant. Replace the steering brake control lever (par. 109).

c. Removal of Pawls and Springs. Remove the subfloor plate to the right of the control levers. Drift out the pins which hold the pawls to the rocker shaft and remove the shaft from the pawls and bracket. Unhook the springs and remove the pawls.

d. Installation of Pawls and Springs. Place the pawls and springs in place and install the rocker shaft. Install the pins through the pawls and rocker shaft. Install the subfloor plate.

111. FINAL REDUCTION ASSEMBLIES.

a. Removal (fig. 70).

(1) DRAIN OIL. Remove the two plugs from the bottom of the final drive housing with wrench (41-W-1960-236), and drain the oil.

(2) DISCONNECT TRACK. See paragraph 117.

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(3) REMOVE DRIVE SPROCKET AND HUB. See paragraph 121.

(4) REMOVE FINAL REDUCTION ASSEMBLY. Support the final reduction assembly with hoist or other means, and remove the cap screws which attach the cover to the final drive housing. Use a small pinch bar to pry the unit away from the housing and continue to manipulate the unit until it is free of the compensating shaft splines.

b. Installation (fig. 70).

(1) INSTALL FINAL REDUCTION ASSEMBLY. Remove all traces of torn gaskets from the mounting faces of the final drive cover and housing, and cover the surfaces with sealing compound. Position gasket on housing and aline all the holes. Lift final reduction assembly into place with a hoist, or other means, and assemble to the final drive housing, rotating the final drive shaft slowly to right and left until the compensating pinion meshes on the compensating shaft splines. Slide the assembly into place over the locating dowels.

(2) INSTALL ATTACHING CAP SCREWS. Install all cap screws and lock washers except the three for the front fender directly over the center of the final drive cover. Tighten evenly around the unit. Fill final drive assembly with lubricant.

(3) INSTALL DRIVE SPROCKET AND HUB. See paragraph 121.

(4) CONNECT TRACK. See paragraph 117.

(5) ADJUST TRACK TENSION. See paragraph 117.

(6) RECORD UNIT REPLACEMENT ON W.D., A.G.O. FORM NO. 478. If a new or rebuilt final drive assembly has been installed, make the proper entry on "MWO and Major Unit Assembly Replacement Record."

112. TRANSMISSION OIL COOLER.

a. Removal.

(1) DRAIN TRANSMISSION AND FINAL DRIVE ASSEMBLY. Remove the two plugs in the bottom of the final drive assembly with wrench (41-W-1960-236). Remove the plug in the hull floor beneath the transmission, remove drain plug and drain lubricant.

(2) REMOVE OIL COOLER. Disconnect the inlet and outlet line from the top and bottom of the cooler. Unscrew the cooler guard to hull attaching cap screws, and remove the guard. Remove the cooler to bracket attaching bolts at each corner, and lift out the cooler.

b. Installation.

(1) INSTALL OIL COOLER. Position the oil cooler in the brackets and install mounting bolts and nuts. Place the cooler guard in position

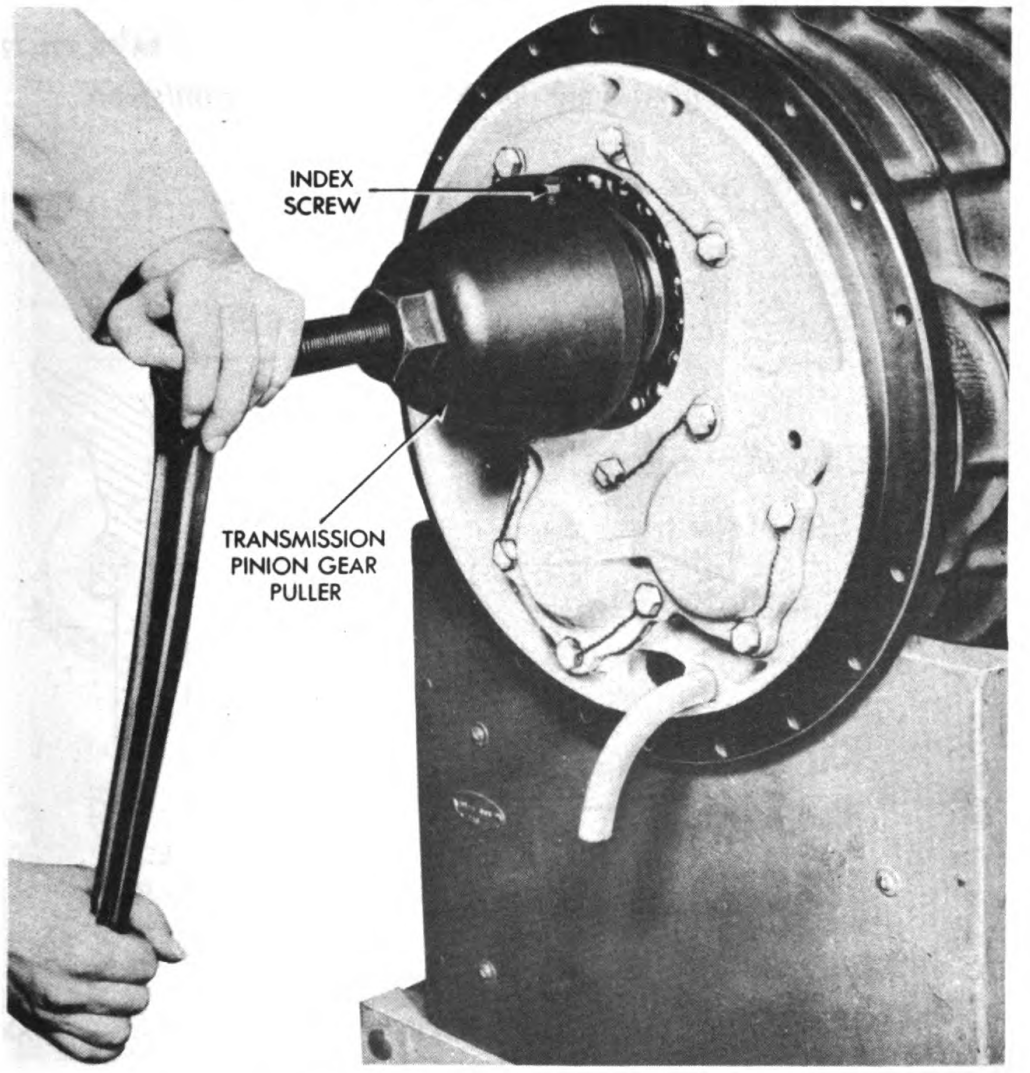
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over the cooler, and install cap screws. Screw the oil tube connectors into the top and bottom connections of the cooler.

(2) FILL FINAL DRIVE ASSEMBLY AND TRANSMISSION WITH LUBRICANT. Fill the transmission and final drive assembly with lubricant, operate the engine with clutch engaged, and inspect cooler and connections for leaks.

113. TRANSMISSION DIFFERENTIAL.

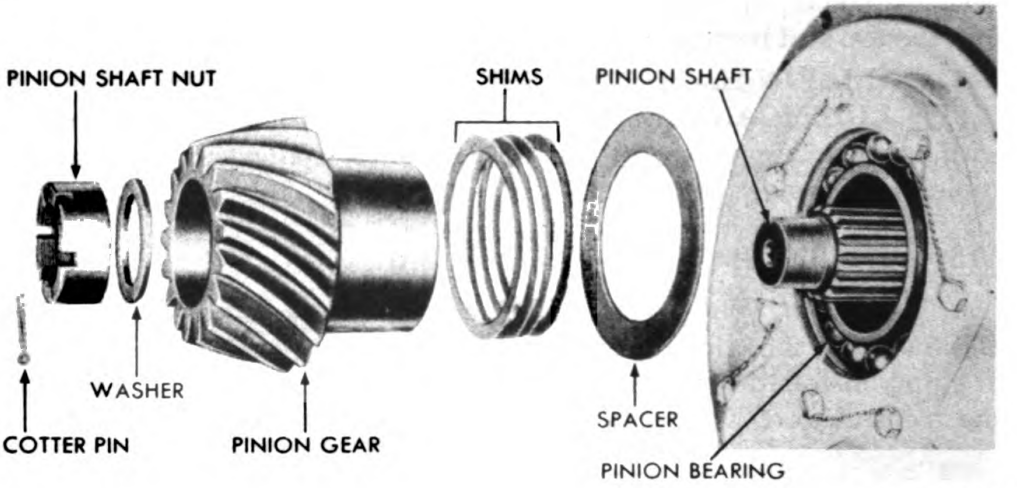
a. General. Whenever a new transmission is assembled to a differential carrier, the pinion gear must be removed, and the proper amount of shims installed between the pinion gear and the pinion bearing of the transmission. This is necessary to seat the pinion at the correct



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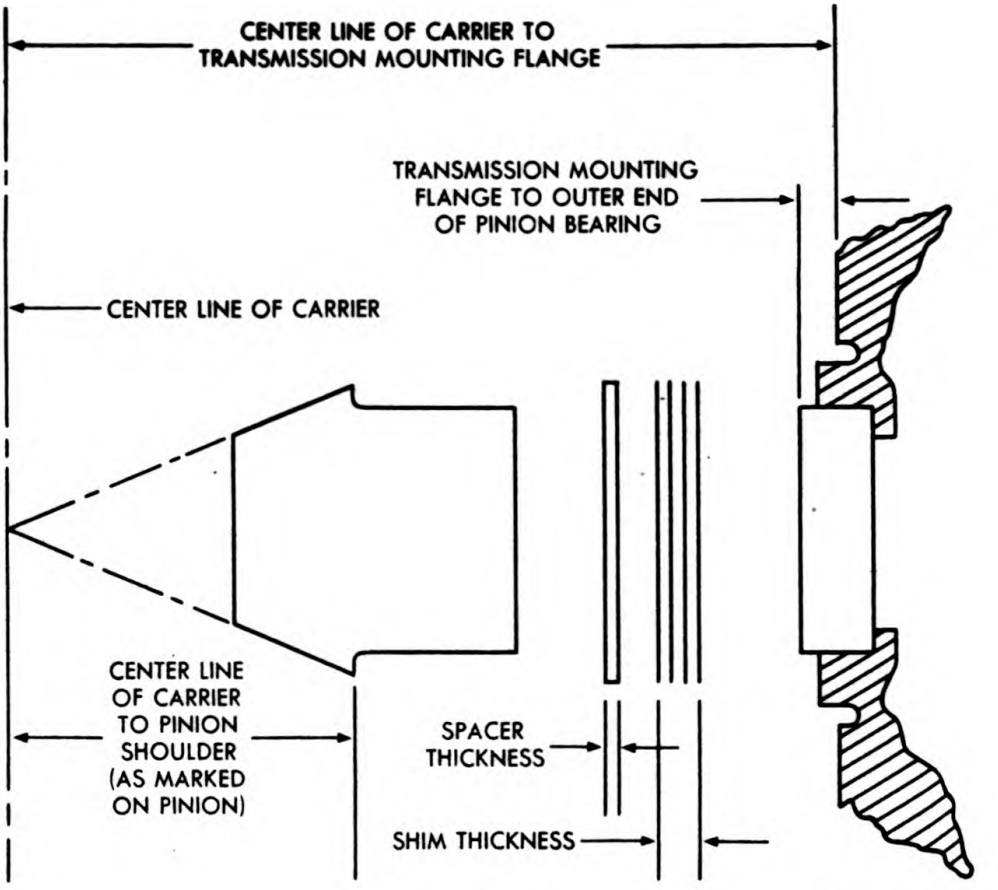
Figure 64—Removing Transmission Pinion Gear with Puller (41-P-2956-12)

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Figure 65—Pinion Gear Removed from Transmission



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Figure 66—Instruction Drawing for Determining Shim Thickness Between Transmission Pinions and Pinion Bearing

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depth in the teeth of the differential ring gear. NOTE: *This operation is not necessary if a transmission is removed and then installed on the same differential carrier.*

b. Disassembly.

(1) **REMOVE TRANSMISSION AND FINAL DRIVE ASSEMBLY.** See paragraph 114.

(2) **REMOVE FINAL REDUCTION ASSEMBLIES.** See paragraph 111 *a*. NOTE: *Omit this step if transmission only is to be replaced.*

(3) **REMOVE TRANSMISSION FROM DIFFERENTIAL.** Thread transmission lifting eye bolts (41-B-1586-350) into bosses on top of transmission case. Loop a chain through the eye bolts, and take

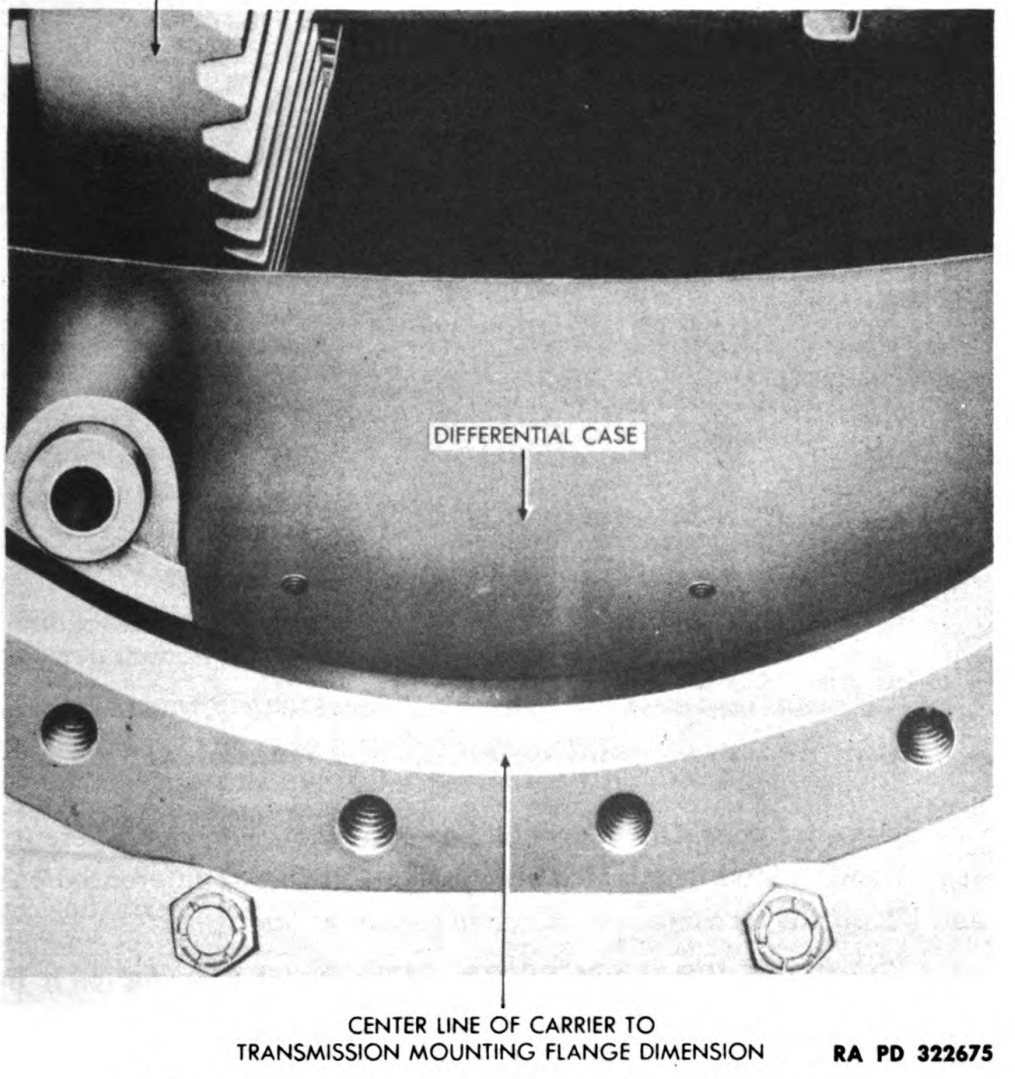


Figure 67—Dimension on Differential Case

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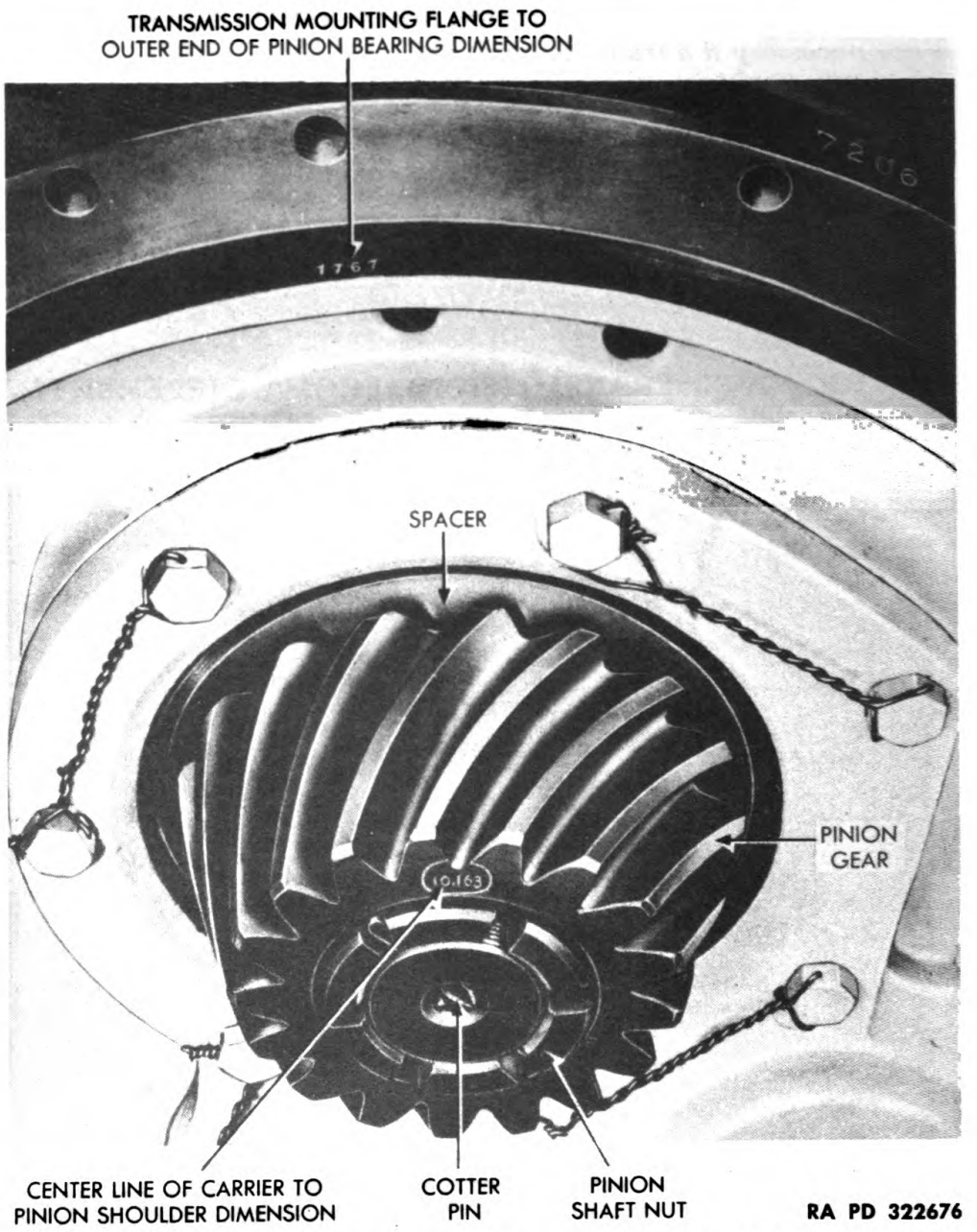


Figure 68—Dimensions on Pinion and Transmission Case

up slack with a hoist. Disconnect oil line at transmission and differential case. Remove stud nuts which secure transmission to differential case, and lift off the transmission. Remove rubber gasket.

(4) **REMOVE TRANSMISSION PINION GEAR** (fig. 64). Remove cotter pin from end of pinion shaft (fig. 65). Remove pinion shaft nut (fig. 69) and lift out pinion shaft washer. Install pinion gear puller (41-P-2956-12) over pinion gear with index screw between gear teeth

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tightened finger-tight only, and pull off the pinion gear. Lift off shims and spacer.

c. Assembly.

(1) DETERMINE SHIM THICKNESS (fig. 66). Determine the required thickness of shims to be used between the pinion and pinion bearing as follows:

(a) Centerline of Carrier to Transmission Mounting Flange. This dimension is nominally 12 inches. Each carrier will have a figure stamped somewhere on the machined surface to which the transmission is attached (fig. 67). This figure may be a decimal figure with a plus or minus sign, in which case it must be added to, or subtracted from, the nominal figure (12 inches). Some carriers will be marked with the actual dimension; for example, "12.005."

(b) Centerline of Carrier to Pinion Shoulder. This dimension is etched on the toe of the pinion (fig. 68).

(c) Spacer Thickness. Measure spacer thickness with a micrometer. (Usually measures 0.020 inch).

(d) Transmission Mounting Flange to Outer End of Pinion Bearing. This dimension is stamped on the transmission case (fig. 68) just above the pinion bearing bore. NOTE: *Figures ranging from 1.012 to 1.052 are stamped on some transmission cases. Such a figure indicates an early model transmission, and cannot be used for computation of required shim thickness.* If the transmission case is not stamped, if the figure is not legible, or if the transmission is an early type, obtain the correct dimension as follows:

1. Hold the short legs of the shim checking gage firmly against the outer face of the inner bearing race (fig. 69). Using a feeler gage, measure the space between the long leg of the gage and the transmission mounting flange. *Add* the thickness of the feeler gage to the dimension etched on the side of the gage (1.773).

2. In some instances the feeler gage will have to be used between the short legs of the gage and the inner bearing race. In this case, *subtract* the thickness of the feeler gage used from the dimension etched on the side of the gage (1.773).

3. If a feeler gage cannot be inserted under either end of the gage, the dimension from the transmission mounting flange to the outer end of the bearing is 1.773 inches as etched on the side of the gage. CAUTION: *When using this gage, make certain that the pinion bearing cap bolts are tight, holding the pinion bearing securely in place.*

(e) Final Computation. The following example shows the method of determining required shim thicknesses:

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Figure 69—Determining Dimension Between Transmission Mounting Flange and Outer End of Pinion Bearing with Shim Checking Gage (41-G-217-150)

Centerline of carrier to transmission mounting flange (step *(a)* above and figure 67)	12.005	in.
Minus (−) transmission mounting flange to outer end of pinion bearing (step *(d)* above and figure 68)	1.767	in.
	10.238	in.
Centerline of carrier to pinion shoulder (step *(b)* above and figure 68)	10.163	in.
Plus (+) spacer thickness (step *(c)* above)	0.020	in.
	10.183	in.

Difference of two sums 10.238−10.183=0.055
*Subtract extra clearance allowance 0.005
Shim thickness required 0.050 in.

* This extra clearance value is constant and is 0.005 in any problem.

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(2) INSTALL TRANSMISSION PINION GEAR. Slide required number of shims and the spacer over the heel of the pinion gear. Tap pinion into bearing. Install washer, pinion, shaft nut, and cotter pin (fig. 65). Spread cotter pin at center (fig. 68).

(3) INSTALL TRANSMISSION TO DIFFERENTIAL. Position rubber gasket around transmission flange. Lift transmission into position against differential case. CAUTION: *Pinion and ring gear must be meshed carefully. Hard bumping is likely to damage the gear teeth.* Install and tighten stud nuts. Connect oil line to fitting on transmission and differential case.

(4) INSTALL FINAL REDUCTION ASSEMBLIES. See paragraph 111 *b*.

(5) INSTALL TRANSMISSION AND FINAL DRIVE ASSEMBLY. See paragraph 115.

114. REMOVAL OF TRANSMISSION AND FINAL DRIVE ASSEMBLY.

a. Disconnect Tracks on Both Sides. See paragraph 117.

b. Drain Oil from Transmission and Final Drive Assembly. Remove the two drain plugs with wrench (41-W-1960-236) from the bottom of the final drive housing and the drain plug (G104-0401365) from the bottom of the transmission housing, and drain off the oil. Clean and install the drain plugs.

c. Remove Front Fenders and Sand Shields (Both Sides). Turn the bayonet-type attaching pins ¼ turn until the pin alines with the slot in the hull and lift off the shields. Remove the front fender attaching bolts and cap screws, and remove the fenders.

d. Open Switches and Disconnect Wires.

(1) Turn the 12-volt and 24-volt battery switches to the "OFF" position. Disconnect the wires from the generator.

(2) Remove the generator shields.

e. Unscrew Universal Joint Yoke Dust Cap. Screw the retainer collar off the universal joint hub so that the joint can slide off the propeller shaft.

f. Disconnect Speedometer and Tachometer Cables. Unscrew the knurled nut which secures the cable housing to the adapter at the upper right rear of transmission, and separate cable and housing from the adapter. Disconnect the tachometer cable located on the top left rear of the transmission in the same manner.

g. Disconnect Transmission to Cooler Oil Tubes. Disconnect oil hose at transmission. Unscrew connections, to which the oil lines were connected, from left side of transmission.

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h. Remove Hatch Hood and Periscope Stowage Rack. Unscrew the cap screws and the nut at the rear of the rack, and lift off rack.

i. Remove Hand Throttle and Primer. Disconnect the fuel tubes from the primer. Loosen the lock nuts, and remove the primer and hand throttle control from the bracket.

j. Loosen Harness. Remove screws from clips clamping harness to final drive housing.

k. Disconnect Steering Brake Linkage. Remove the two clevis pins at the top of the steering brake control rods.

l. Disconnect Portable Fire Extinguisher Bracket. Remove the countersunk head screws attaching the portable fire extinguisher bracket to the floor and remove the bracket.

m. Remove Front Wire Harness Clamps. Remove the screws which secure the front harness clamps to the hull, to allow access to nuts which hold the final drive assembly to the hull.

n. Remove Transmission and Final Drive Assembly. Hold the nuts inside the hull and remove the two lower bolts (one on each side) from the side of the hull on the outside. Insert the two smaller alining pins of power train sling assembly (41-P-647) in the bolt holes. Thread winch cable chain through the two towing clevises in the front of the vehicle. Back a wrecker up to the front of the vehicle, hitch the winch cable to the cable chain, and take up the slack. Remove all the remaining bolts securing the power train to the hull. Slack off the winch cable until the top of the power train is tilted away from the hull far enough for the lifting eye (41-F-2997-220) to be installed. Bolt the lifting eye to the center top edge of the power train (fig. 71). (Use extra nuts for spacers.) Hitch the wrecker boom cable to the lifting eye, lift the front end of the assembly to as nearly normal a position as is possible, and drive out the alining pins. Carefully remove the assembly. CAUTION: *Guide the assembly from inside the vehicle to prevent damaging the oil tubes.*

o. Remove Generator. Remove the generator belt adjusting bolt, and the mounting clamp bolts, and remove the generator.

p. Remove Front Universal Joint and Generator Drive Pulley. Remove the lock wire and the bolts from the universal joint flange, and remove the joint and pulley.

q. Remove Steering Brake Cross Shaft Assembly. Disconnect the right end of the steering brake cross shaft lever from the steering brake control rod. Remove the screws which secure the cross shaft brackets and lift the cross shaft assembly off the final drive housing.

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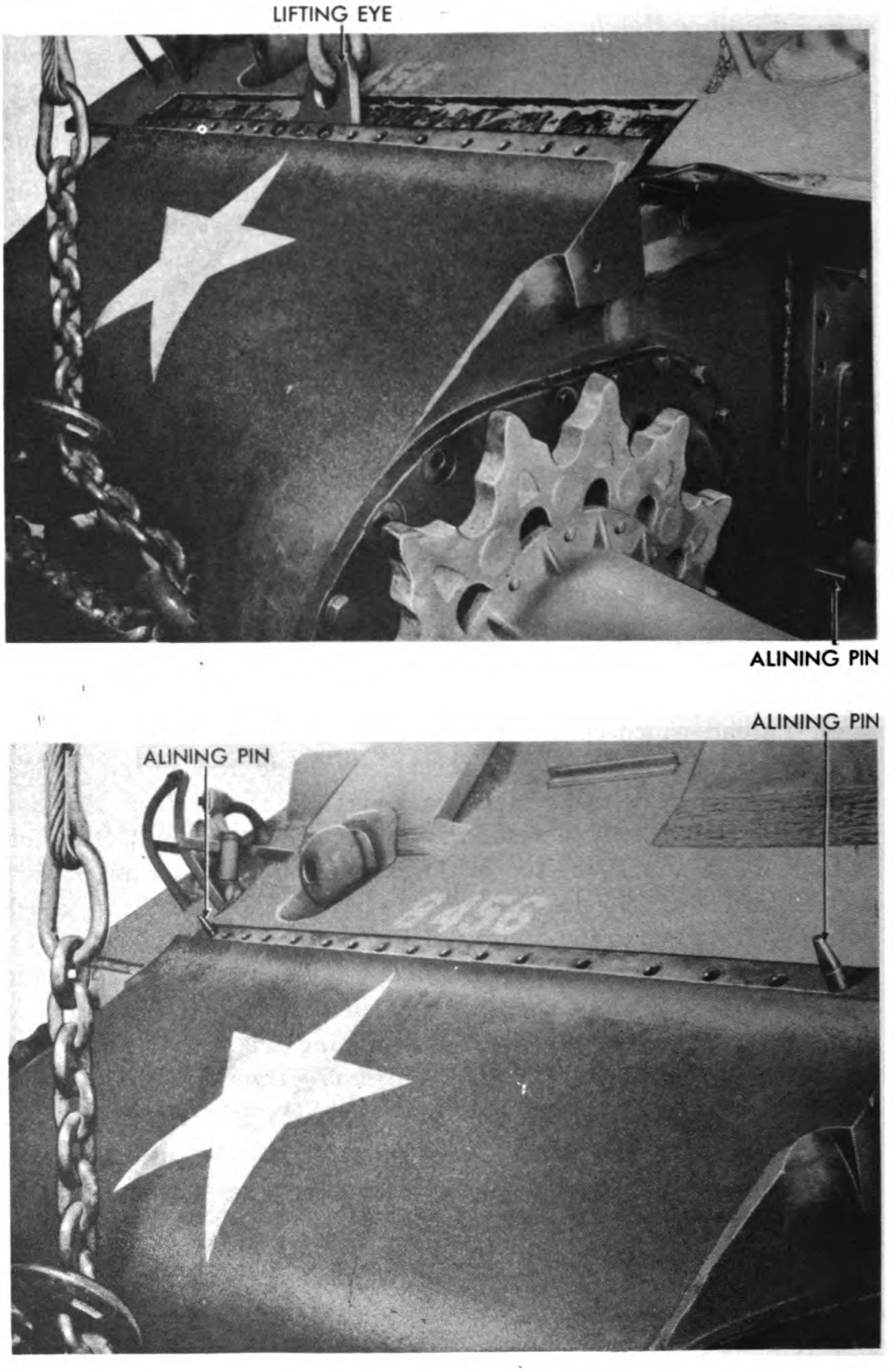


Figure 71—Removing Transmission and Final Drive Assembly

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115. INSTALLATION OF TRANSMISSION AND FINAL DRIVE ASSEMBLY.

a. Install Generator Drive Pulley and Front Universal Joint. Insert the flange bolts through the universal joint companion flange. Place the generator drive pulley and the universal joint flange over the bolts, install the nuts, and lock wire.

b. Install Generator and Belts. See paragraph 87.

c. Install Brake Cross Shaft Assembly. Position the cross shaft assembly on the top of the final drive housing, insert the cap screws with lock washers through the brackets, and tighten securely. Connect the steering brake control rod to the right side of the steering brake cross shaft, and secure with a cotter pin.

d. Install Transmission and Final Drive Assembly (fig. 71). Place the two long spacer shims in position in each side of the hull with sealing compound, and insert two attaching bolts through the side of the hull so the threaded ends of the bolts hold the shims in place, and are flush with the inside face of the shims. Apply sealing compound to other contacting surfaces. Attach the lifting eye (41-F-2997-220), chain and wrecker to the power train (fig. 71). Move the wrecker, with the assembly suspended, to the hull opening and aline the assembly with the hull. Back the wrecker slowly toward the hull, lowering the boom cable until the power train is tipped forward slightly at the top, and carefully guide the lower side into the hull opening. Insert the two alining pins in the lower holes (one on each side), making sure the pins pass through the hull and the power train holes to form a hinge. Suspend the weight of the power train from the winch cable which is hitched to the towing clevises. Slack off the boom cable and remove the lifting eye. Tilt the power train back until the top edge is fitted into the hull. Insert the two larger alining pins of power train sling assembly (41-P-550-600) through two widely separated holes along the top edge of the hull in order to aline the remaining bolt holes.

e. Install Attaching Bolts. It may be necessary to ream some of the holes slightly to install the bolts. Install the bolts across the top with the nuts inside. Install bolt at the lower left end with head outside. Install the next upper four bolts, with heads inside the hull and the nuts outside. Then install the remaining bolts at the left end from the outside. Install the remaining bolts from the outside of the hull, removing the alining pins as the bolts are installed. Hold bolts or nuts from the inside, and tighten from the outside.

f. Install Front Wire Harness. Position the front wire harness along the front hull slope just above the final drive housing attaching bolts and nuts, and attach the clamps to the hull.

g. Connect Harness. Replace the screws in clips for clamping harness to final drive housing.

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h. Install Periscope, Stowage Rack, and Hatch Hood Bracket. Place the stowage rack and hood bracket in position and install the attaching cap screws.

i. Install Primer and Hand Throttle Control. Place the primer and hand throttle control in the bracket and tighten the lock nuts. Connect the fuel tubes to the primer.

j. Connect Steering Brake Control Lever Linkage. Position the right and left steering brake control rods with the clevis over the end of the steering brake cross shaft lever, insert the clevis pins and secure with cotter pins.

k. Connect Transmission Oil Cooler Tubes. Screw the two oil line connections into the openings at the left side of the transmission. Aline and tighten securely. Attach oil tubes to connections, and tighten securely.

l. Connect Hand Throttle, Primer Support, and Bracket. Place the support and bracket in position on the left side of the final drive housing, insert the cap screws and lock washers, and tighten securely.

m. Connect Speedometer and Tachometer Cables. Place end of speedometer cable in opening in the adapter at the right rear side of transmission, and screw the knurled nut onto adapter securely. Connect the tachometer cable in the same manner.

n. Install Fire Extinguisher Bracket. Position the fire extinguisher bracket with the clamp away from the transmission, and attach the bracket to the floor.

o. Connect Generator Wires and Install Shields.

(1) Connect the generator wires (par. 87).

(2) Install shield at each side of the generator.

p. Fill Transmission and Final Drive Assembly With Lubricant. Refer to paragraph 26.

q. Install Front Fenders. Remove the three fender attaching cap screws at the top of the final drive cover. Position fender on hull and final drive housing, install the cap screws and bolts, and tighten securely.

r. Connect Tracks. See paragraph 117.

s. Adjust Track Tension. See paragraph 117.

t. Record Unit Replacement on W.D., A.G.O. Form No. 478. If a new or rebuilt transmission and final drive assembly has been installed, make the proper entry on "MWO and Major Unit Assembly Replacement Record."

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Section XXVII

HORIZONTAL VOLUTE SPRING SUSPENSION

116. DESCRIPTION.

a. Tracks. Two individually driven tracks propel the vehicle forward and backward. The drive sprockets at the front end of the vehicle pull the tracks from the rear and lay them down in front of the advancing suspension wheels. An adjustable idler with dual wheels for each track is mounted at the rear of the hull for adjusting the tension of the tracks. The track is 23 inches wide with a center guide that minimizes the possibility of throwing the track. The upper portion of each track is supported on two dual rollers and three single rollers, all of which are rubber-tired and fitted with adjustable tapered roller bearings.

b. Suspension Assemblies (fig. 79). The vehicle is supported on six suspension assemblies bolted to the hull. Each suspension has four rubber-tired wheels, one pair mounted on each suspension arm. The wheels are of the demountable type, and can be removed from the hubs and installed without disturbing the adjustable tapered roller bearings or any part of the suspension and tracks. The tires are molded directly to the wheels. The suspension wheel support arms are connected to the suspension by rubber-bushed pins. Two horizontal volute springs in each suspension are held in position by spring seats that rest on spring seat pins. The spring seats are free to swivel on the seat pins, allowing the volute springs to compress in true alinement without distortion.

c. Shock Absorbers (fig. 79). A telescopic-type, hydraulic shock absorber is connected between the support arms on each of the suspensions. The shock absorbers reduce the pitching action of the vehicle by stabilizing the vertical movement of the suspension wheels when passing over rough terrain.

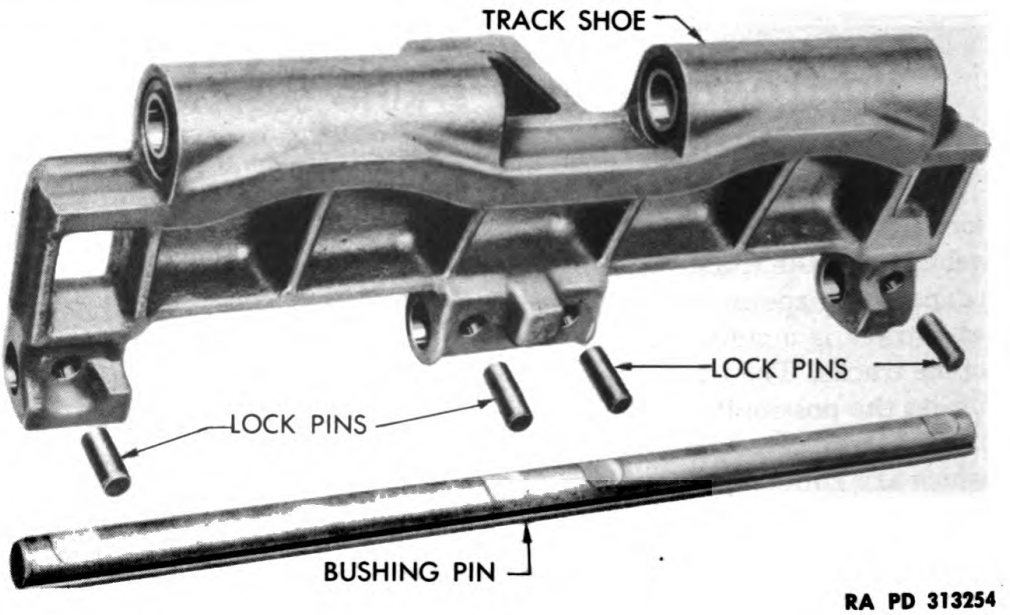
d. Data.

Width of track	23 in.
Weight of track (with 79 shoes)	3,500 lb
Ground contact area of track (approx.)	7,000 sq in.
Ground pressure (pounds per square inch)	10.2
Length of springs (new)	14 in.
Diameter of suspension wheel	20½ in.
Diameter of idler wheel	22 in.
Diameter of dual track roller	13½ in.
Diameter of single track roller	10 in.
Number of lubricant fittings	36

117. TRACKS.

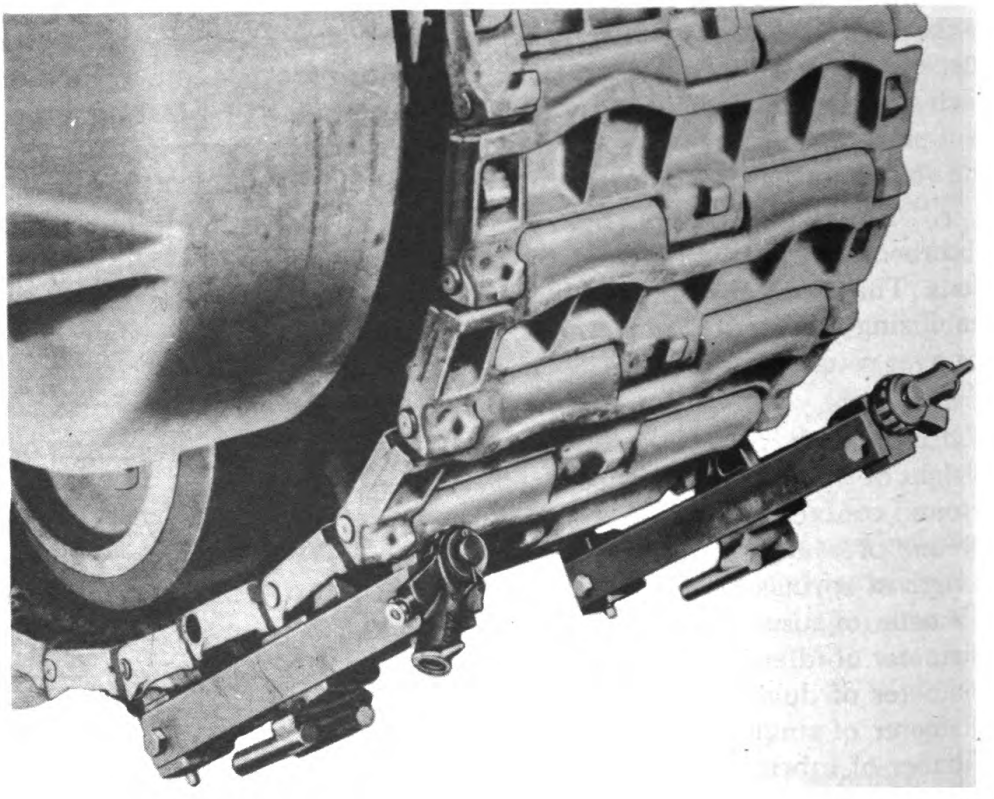
a. Description (fig. 72). Only one pin is used in each shoe. Rubber bushings are bonded to a steel track shoe bushing tube. The tube

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Figure 72—Track Shoe—Disassembled



RA PD 313349

Figure 73—Track Connecting Fixtures (41-F-2997-389) Installed

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and bushings are pressed into the track shoe. The tubes have two keys that engage the two keyways milled in the track shoe bushing pin. The pin is held in position in the shoe by four pins with flat tapered sides that engage depressions machined in bushing pin.

b. Removal (fig. 73). Place the vehicle on level terrain so that it can be moved as required. Release the track tension at the idler adjustment (subpar. *d* (2) below). Disconnect the track between the front suspension wheel and the sprocket. (If the track has been thrown, disconnect the track underneath either the idler or the sprocket, depending on which end of the track has the least twist.) Install the track connecting fixtures. Drive out the lock pins that retain the track shoe bushing pin from the guide side of track shoe. Drive out the shoe bushing pin. Lay the top half of the track on the ground to the front or rear of the vehicle, depending on which end of the track has been disconnected.

c. Installation.

(1) INSTALL TRACK. If a new track is to be installed, lay it in front of, and in alinement with, the old track. If a thrown track is to be installed, dig a trench deep enough for the end of the track so that the suspension wheel can roll directly onto the track. Tow the vehicle onto the track until about 16 inches of the end of the track protrudes beyond the front suspension wheel. Block the suspension wheels in the track to prevent the vehicle from moving. Place the rear idler wheel in the extreme forward position and lock the spindle in the bracket to prevent breakage of the idler bracket. Roll the end of the track over the idler wheel, and pull the track forward over the support rollers and sprocket with a cable attached to a towing unit.

(3) CONNECT TRACK SHOES (fig. 73). Attach the track connecting fixtures to the ends of the track and draw the ends together. Install the track shoe bushing pin. Install the bushing pin retaining lock pins. Drive the pins into the shoe, from the grouser side, until they seat solidly, and stake the shoe around the head of the pins. Remove the track connecting fixtures.

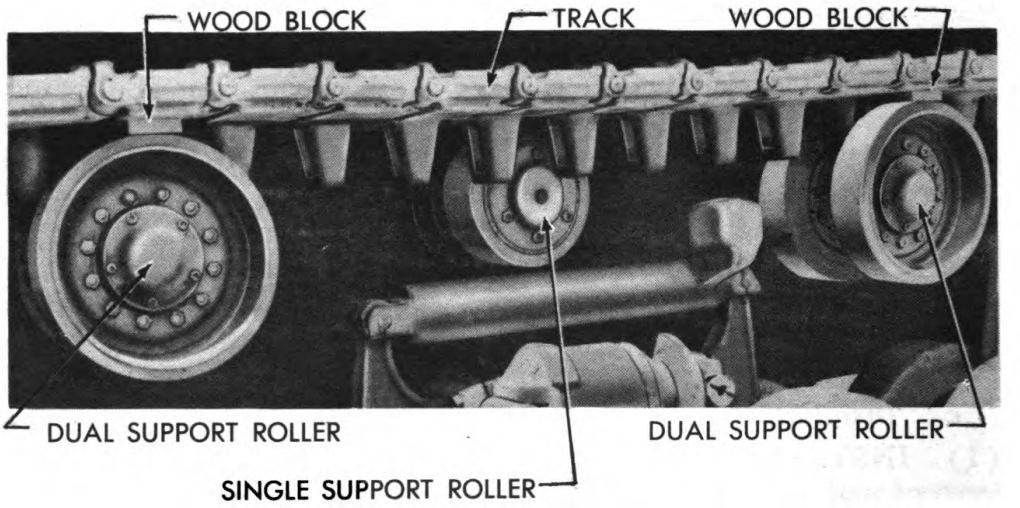
(3) ADJUST TRACK TENSION. See subparagraph *d* below.

d. Adjustment of Track Tension.

(1) POSITION TRACK FOR ADJUSTMENT (fig. 74). Place a wood block ¾ inch thick and 2 inches wide between the track and each dual support roller.

(2) RELEASE TRACK TENSION (fig. 74). Loosen the two outside clamp screws in the idler wheel bracket. Turn the spreader screw counterclockwise to spread the bracket until the spindle is free. CAUTION: *Excessive spreading will crack the bracket.* Place the adjusting wrench on the hexagon at the end of the idler shaft and turn the shaft to release the bind on the adjusting collar. Raise the spring at the end of the bracket and slide the collar off the serrations on the idler shaft.

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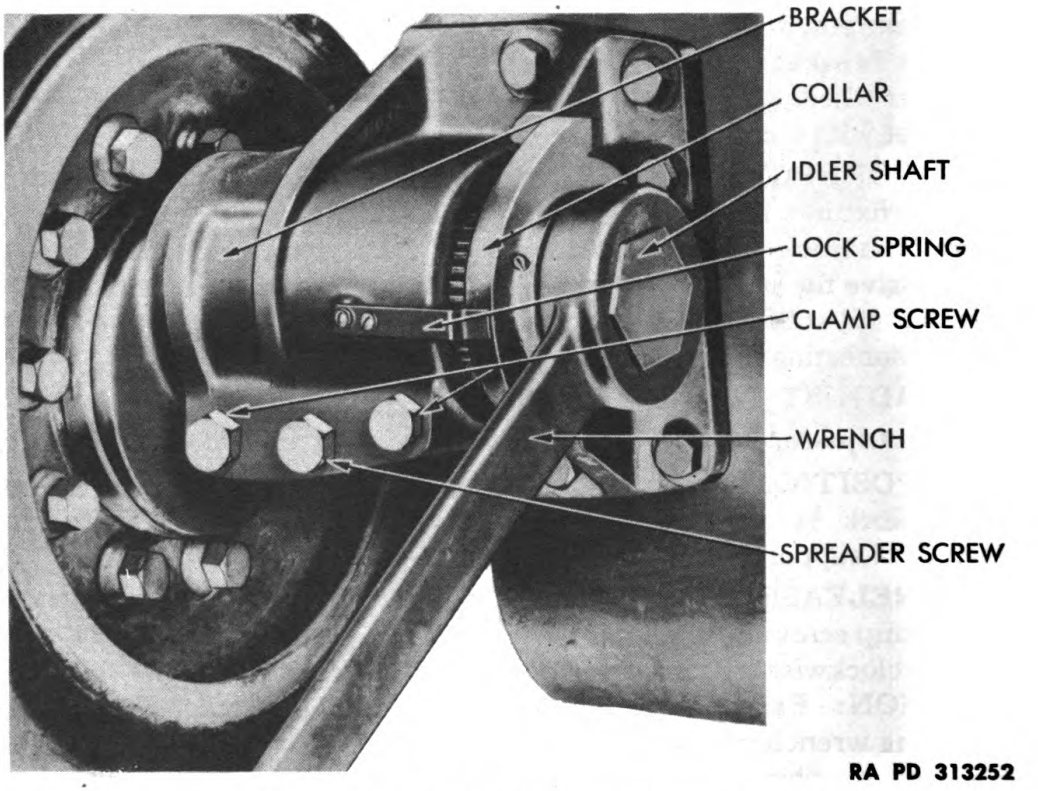


Figure 74—Adjusting Track Tension with Wrench (41-W-640-400)

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(3) ADJUST TENSION (fig. 74). Use a piece of pipe on the handle of the adjusting wrench for leverage and raise the handle of the wrench to tighten the track. Slide the adjusting collar on and off the serrations on the shaft when changing the wrench position. Tighten the track until the track just clears the single support roller.

(4) LOCK IDLER ADJUSTMENT (fig. 74). Slide the adjusting collar onto the serrations of the shaft and lock it in place with the spring. Back out the center spreader screw by turning it clockwise until it does not project through the split in the bracket. Tighten both outside clamp screws securely; then tighten the center spreader screw until it binds sufficiently to hold itself from working loose. Remove the idler adjusting wrench.

118. IDLER WHEELS AND BRACKET.

a. General. The outer idler wheel can be removed without disconnected the track, by releasing the track tension. The inner wheel can be removed without disturbing the hub or bearings by removing the idler shaft from the bracket.

b. Removal and Disassembly (fig. 75).

(1) DISCONNECT TRACK. See paragraph 117 *b*.

(2) REMOVE IDLER WHEEL AND HUB ASSEMBLY. Take out the attaching cap screws and remove the hub cap and gasket. Pry the tongue of the nut lock out of the outer bearing nut. Unscrew the outer bearing nut and remove the nut lock. Unscrew the inner bearing nut and remove the thrust washer. Pull the wheels and hub off the idler shaft.

(3) REMOVE BEARING CONES AND SEAL. Remove the outer bearing cone. Pry the seal out of the hub. Remove the inner bearing cone.

(4) REMOVE IDLER SHAFT AND BRACKET. Remove the cotter pin in the hexagon end of the shaft. Slide the collar off the shaft. Pull the idler shaft out of the bracket. Take out the cap screws that attach the bracket to the hull and remove the bracket.

c. Cleaning of Parts. Clean all parts thoroughly. Use water under pressure to loosen foreign matter, and then remove as much of it as possible. Use a stiff brush and dry-cleaning solvent to remove the remaining grease and dirt. Rotate the bearings while immersed in dry-cleaning solvent until all traces of lubricant have been removed. CAUTION: *Do not spin bearings with compressed air.* Oil the bearings immediately to prevent corrosion of the highly polished surfaces, and wrap them in oiled paper if they are not to be used at once.

d. Inspection of Bearings and Seals (fig. 75).

(1) INSPECT BEARINGS. The condition of a bearing is best determined by the surface condition of the rollers and races. Inspect

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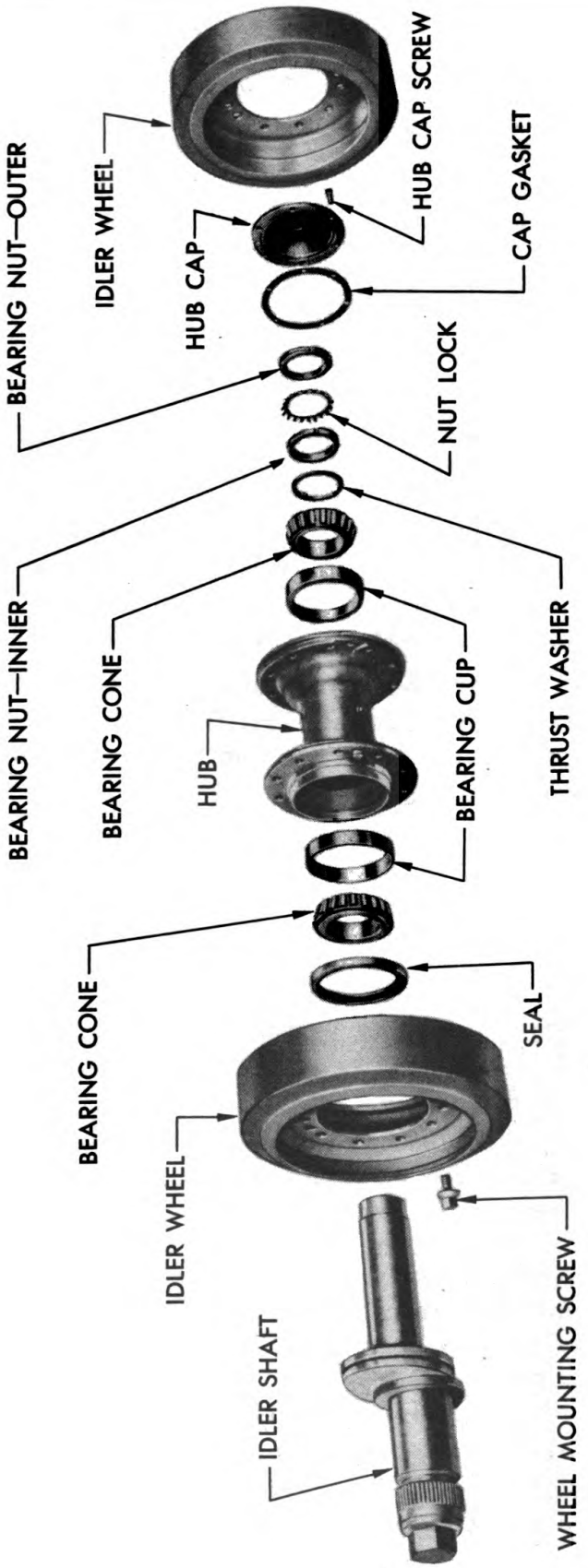


Figure 75—Track Idler—Disassembled

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for wear or pits caused by corrosion. Inspect for discoloration of the rollers or cups, as this is evidence of overheating. Bearings that have been overheated, pitted, or worn, must be discarded. Spinning a bearing while holding it in the hands is not an accurate check for its running qualities, although this test will indicate the presence of dirt or foreign matter, and that the bearing should be rewashed, lubricated, and checked again.

(2) INSPECT BEARING SEALS. If a bearing seal is removed from the hub for any reason, always install a new seal.

(3) REPLACE BEARING CUPS. If a bearing cup is to be replaced, use a drift to drive the cup out of the hub. Keep moving the drift around the entire circumference of the cup and drive the cup out evenly. Position a new cup in the hub. Use a cup drift, and drive the cup into the hub until it seats against the shoulder in the hub.

e. Assembly and Installation (fig. 75).

(1) INSTALL IDLER SHAFT BRACKET AND SHAFT (fig. 74). Position the bracket on the hull, and install the attaching cap screws. Enter the idler shaft into the bracket. Slide the collar on the hexagon end of the shaft, and install the cotter pin.

(2) INSTALL INNER BEARING CONE AND SEAL. Pack the inner bearing cone with general purpose grease, and install the cone in the hub. Position the seal in the hub with the flat side of the seal case out. Using a seal drift, drive the seal into the hub until the flat side of the seal case is flush with the end of the hub (fig. 78).

(3) INSTALL WHEEL AND HUB ASSEMBLY ON SHAFT. Slide the hub onto the shaft. Pack the outer bearing cone with general purpose grease. Install the bearing cone and thrust washer. Screw the inner bearing nut on the idler shaft until the bearing cones are seated but not binding.

(4) ADJUST BEARINGS. Turn the wheel by hand to determine the amount of drag caused by the bearing seal. Tighten the bearing nut until a slight increase in drag is felt when the wheel is turned. Back off the bearing nut ¼ turn.

(5) INSTALL NUT LOCK, OUTER BEARING NUT, HUB CAP, AND GASKET. Install the nut lock and bend a tongue into one of the slots in the inner bearing nut. Screw the outer bearing nut onto the shaft. Tighten the nut to 200 to 300 foot-pounds torque and bend a tongue of the lock washer into one of the slots in the outer bearing nut. If a tongue does not line up with a slot in the outer nut, continue to tighten (do not back off the nut) until a tongue alines with the slot. Install the gasket and hub cap with the attaching cap screws. Fill the hub with grease through the lubricant fitting in the hub cap until grease appears at the seal or relief fitting in the center of the hub.

(6) INSTALL TRACK. See paragraph 117 *c*.

(7) ADJUST TRACK TENSION. See paragraph 117 *d*.

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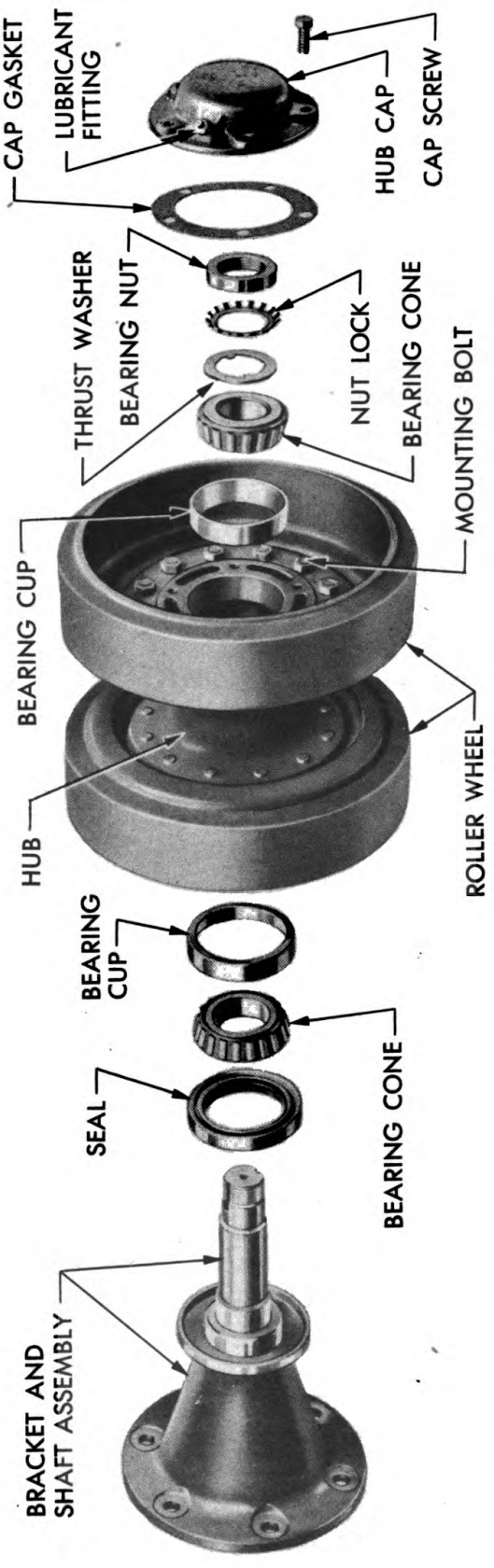


Figure 76—Dual Support Roller—Disassembled

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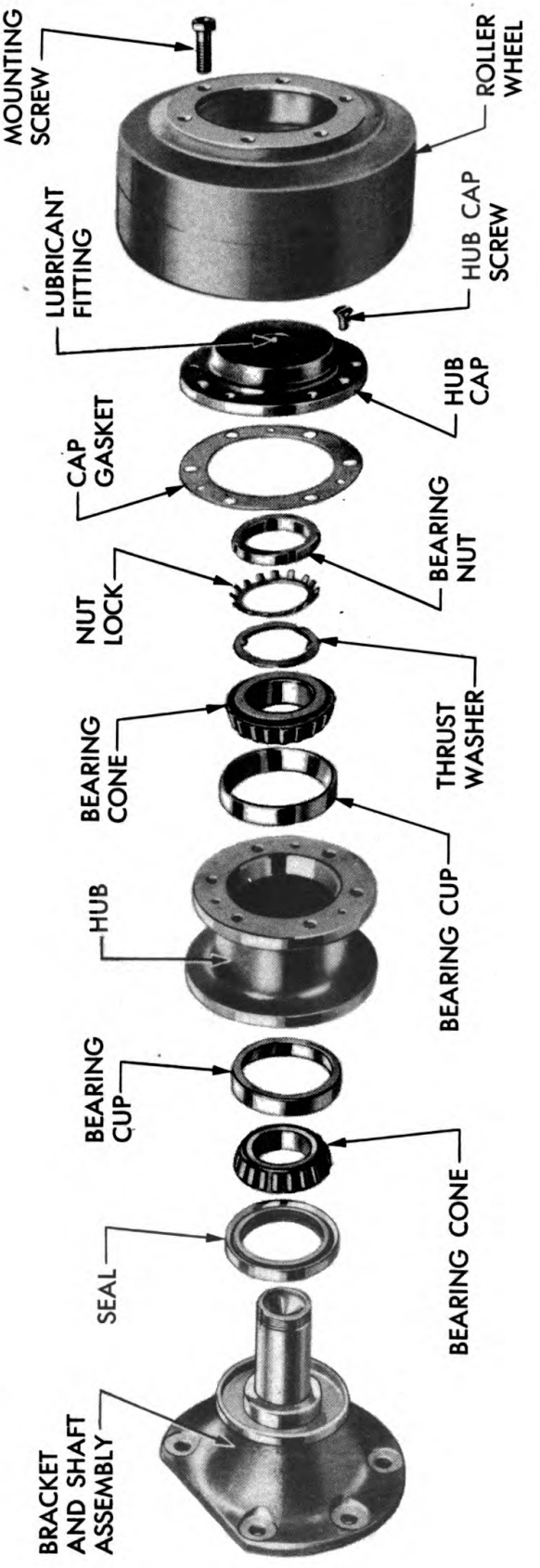


Figure 77—Single Support Roller—Disassembled

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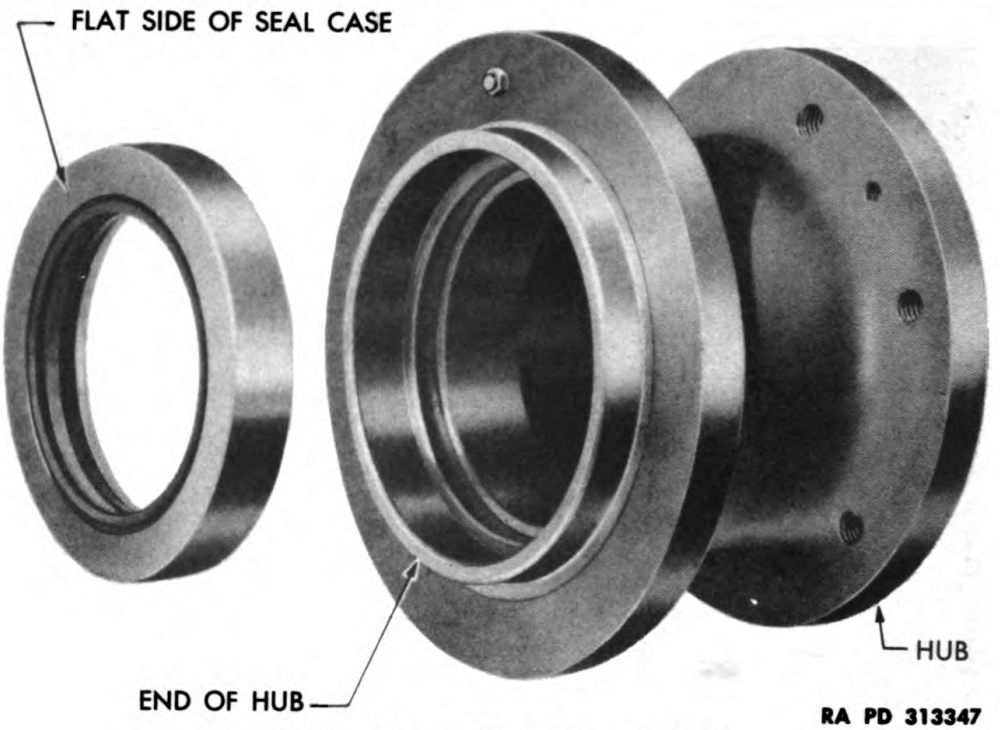


Figure 78—Oil Seal and Hub

119. DUAL SUPPORT ROLLERS.

a. General. Due to the center guide in the track, only the outer wheel of the dual track support rollers can be removed without disconnecting the track.

b. Removal and Disassembly.

(1) RELEASE TRACK TENSION. See paragraph 117 *d.* (2).

(2) DISCONNECT TRACK. See paragraph 117 *b.*

(3) DISASSEMBLE ROLLERS (fig. 76). Take out the cap screws that attach the hub cap to the hub, and remove the cap and gasket. Pry the nut lock tongue out of the recess in the nut and unscrew the nut. Remove the nut lock and thrust washer. Pull the hub off the bracket shaft. Remove the outer bearing cone, seal, and inner bearing cone from the hub.

c. Cleaning and Inspection. See paragraph 118 *c* and *d.*

d. Assembly and Installation.

(1) ASSEMBLE SUPPORT ROLLER (fig. 76). Pack the bearing cones with general purpose grease and install the inner cone. Position the seal in the hub with the flat side of the seal case out. Press the seal into the hub until the flat side of the seal case is flush with the end of the hub (fig. 78). Slide the hub onto the bracket shaft and install the outer bearing cone, thrust washer, nut lock and nut. Tighten the nut

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sufficiently to seat the bearing cones in the cups, but not tight enough to cause a bind in the bearings.

(2) ADJUST BEARINGS. See paragraph 118 *e* (4).

(3) INSTALL HUB CAP. Bend a tongue of the lock into one of the slots in the bearing nut. Attach the gasket and hub cap to the hub with the cap screws. Fill the hub with grease through the lubrication fitting on the hub cap until grease appears at the seal or relief fitting in the center of the hub.

120. SINGLE SUPPORT ROLLERS.

a. Removal and Disassembly.

(1) RELEASE TRACK TENSION. See paragraph 117 *d* (2).

(2) DISCONNECT TRACK. See paragraph 117 *b*.

(3) DISASSEMBLE ROLLER WHEEL (fig. 77). Take out the cap screws that attach the roller wheel to the hub, and pull off the roller wheel. Take out the countersunk head screws that attach the hub cap to the hub and remove the cap and gasket. Pry the nut lock tongue out of the recess in the nut and unscrew the nut. Remove the nut lock and thrust washer. Pull the hub off the bracket shaft. Remove the outer bearing cone, seal, and inner bearing cone from the hub.

b. Cleaning and Inspection. See paragraph 118 *c* and *d*.

c. Assembly and Installation.

(1) ASSEMBLE SUPPORT ROLLER HUB (fig. 77). Pack the bearing cones with general purpose grease and install the inner cone. Position the oil seal in the hub with the flat side of the seal case out. Drift the seal into the hub until the flat side of the seal case is flush with the end of the hub (fig. 78). Slide the hub onto the bracket shaft and install the outer bearing cone, thrust washer, nut lock and nut. Tighten the nut sufficiently to seat the bearing cones in the cups, but not so tightly as to cause a bind in the bearings.

(2) ADJUST BEARINGS. See paragraph 118 *e* (4).

(3) INSTALL ROLLER WHEEL (fig. 77). Depress a tongue of the lock washer into the recess in the nut. Attach the hub cap and gasket to the hub with the countersunk screws. Position the roller wheel on the hub and attach with the cap screws. Fill the hub with grease through the lubricant fitting in the hub cap until grease appears at the seal or relief fitting at the inner end of the hub.

121. DRIVE SPROCKETS.

a. Description. The drive sprockets are bolted to hubs, which in turn are attached to the flanged end of the final drive sprocket shaft with studs, dowels and nuts. The sprockets are interchangeable.

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b. Removal.

(1) RELEASE TRACK TENSION. See paragraph 117 *d* (2).

(2) DISCONNECT TRACK. See paragraph 117 *b*.

(3) REMOVE SPROCKETS. Remove the nuts that attach the sprocket hub to the drive shaft. Pull the hub and dowels off the studs. Remove the nuts and take out the bolts that attach the sprocket to the hub, and remove the sprocket.

c. Installation.

(1) INSTALL SPROCKETS. Position the sprockets on the hub. Install the bolts and tighten with 140 foot-pounds of torque. Hold the heads of the bolts with a wrench, install and tighten the nuts with 100 foot-pounds of torque. Mount the hub and dowels on the drive shaft studs. Install the attaching nuts and tighten securely.

(2) CONNECT TRACK. See paragraph 117 *c* (2).

(3) ADJUST TRACK TENSION. See paragraph 117 *d*.

122. SHOCK ABSORBERS.

a. Description (fig. 79). A telescopic-type hydraulic shock absorber is attached to each of the six horizontal suspension assemblies. A filler hole is provided in the reservoir for adding fluid when required. The fluid capacity of the shock absorbers is 70 ounces. If the shock absorbers do not become warm when the vehicle is being operated, it is an indication that the fluid is low or the shock absorber is not functioning.

b. Removal. See paragraph 123 *c* (1) in part.

c. Installation. See paragraph 123 *c* (2) in part.

d. Filling Shock Absorber on Vehicle. Ordinarily the shock absorbers will not require filling after the vehicle has been put in operation. If leakage is apparent, replace the assembly. If filling is necessary as a temporary expedient, proceed as follows:

(1) Place the vehicle so that the shock absorber is approximately horizontal and near mid stroke. Clean off all mud and dirt at the reservoir filler plug and remove the plug. CAUTION: *Exercise extreme care to prevent dirt entering the filler plug opening.*

(2) Fill the reservoir with shock absorber fluid to the level of the plug opening (fig. 79) and install the plug, using a new gasket, if necessary.

(3) If the loss of fluid has been excessive, operate the vehicle over rough terrain to fill the shock absorber cylinder with fluid. Then repeat steps (1) and (2) above and add more fluid, if required.

123. SUSPENSION ASSEMBLY.

a. Description (fig. 79). The forward support arms on the front suspensions and the rear arms on the rear suspensions are provided

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with stops. The stops limit the downward movement of the arms, therefore these arms are not interchangeable with the other support arms.

b. Removal and Installation of Suspension Wheels.

(1) REMOVE INNER SUSPENSION WHEEL. Place the vehicle on level terrain. Lay a block one inch thick on the track ahead of, or behind, the outer wheel. Move the vehicle until the outer wheel rests on the block. Take out the mounting screws and remove the wheel. In some instances, such as when the vehicle is fully loaded, it may be necessary to place a jack under the hull and raise the hull to provide the necessary clearance for removal of the inner wheel.

(2) INSTALL INNER SUSPENSION WHEEL. Mount the wheel on the pilots in the hub. Install the mounting screws and tighten securely. Move the vehicle and remove the block.

(3) REMOVE OUTER SUSPENSION WHEEL. Place the vehicle on level terrain. Lay a block one inch thick ahead of, or behind, the inner wheel. Move the vehicle until the inner wheel rests on the block. Take out the mounting screws and remove the outer wheel.

(4) INSTALL OUTER SUSPENSION WHEEL. Follow the procedure outlined in step (2) above.

(5) REMOVE BOTH INNER AND OUTER SUSPENSION WHEELS. Remove outer wheel (step (3) above). Place a jack under the outer hub and raise the suspension arm just high enough to remove the block under the inner wheel. Take out the mounting screws and remove the inner wheel. In some instances, such as when the vehicle is fully loaded, it may be necessary to jack up the hull to provide clearance for removal of the wheel.

(6) INSTALL BOTH INNER AND OUTER SUSPENSION WHEELS. Install inner suspension wheel (step (2) above). Place a block one inch thick under the inner wheel and remove the jack under the outer hub. Install the outer wheel in the same manner as described in step (2) above.

c. Replacement of Volute Springs (fig. 80).

(1) REMOVE VOLUTE SPRINGS. Remove the shock absorber clamp bolts. Remove the shock absorber pins and lift off the shock absorber. Place a 30-ton jack under arm support, and raise the suspension assembly until the suspension wheels are clear of the lower portion of track. NOTE: *When removing the springs from either front or rear suspension assembly, place 30-ton jack under center suspension assembly and release track tension* (par. 117 *d* (2)). Remove one mounting screw from each suspension wheel, and attach adapters to wheels. Attach track connecting fixture to adapters and draw the wheels together. Insert a pry bar between the arm support and large coil end of the spring, and pry the spring up until it is clear of the seat, then lift out the spring.

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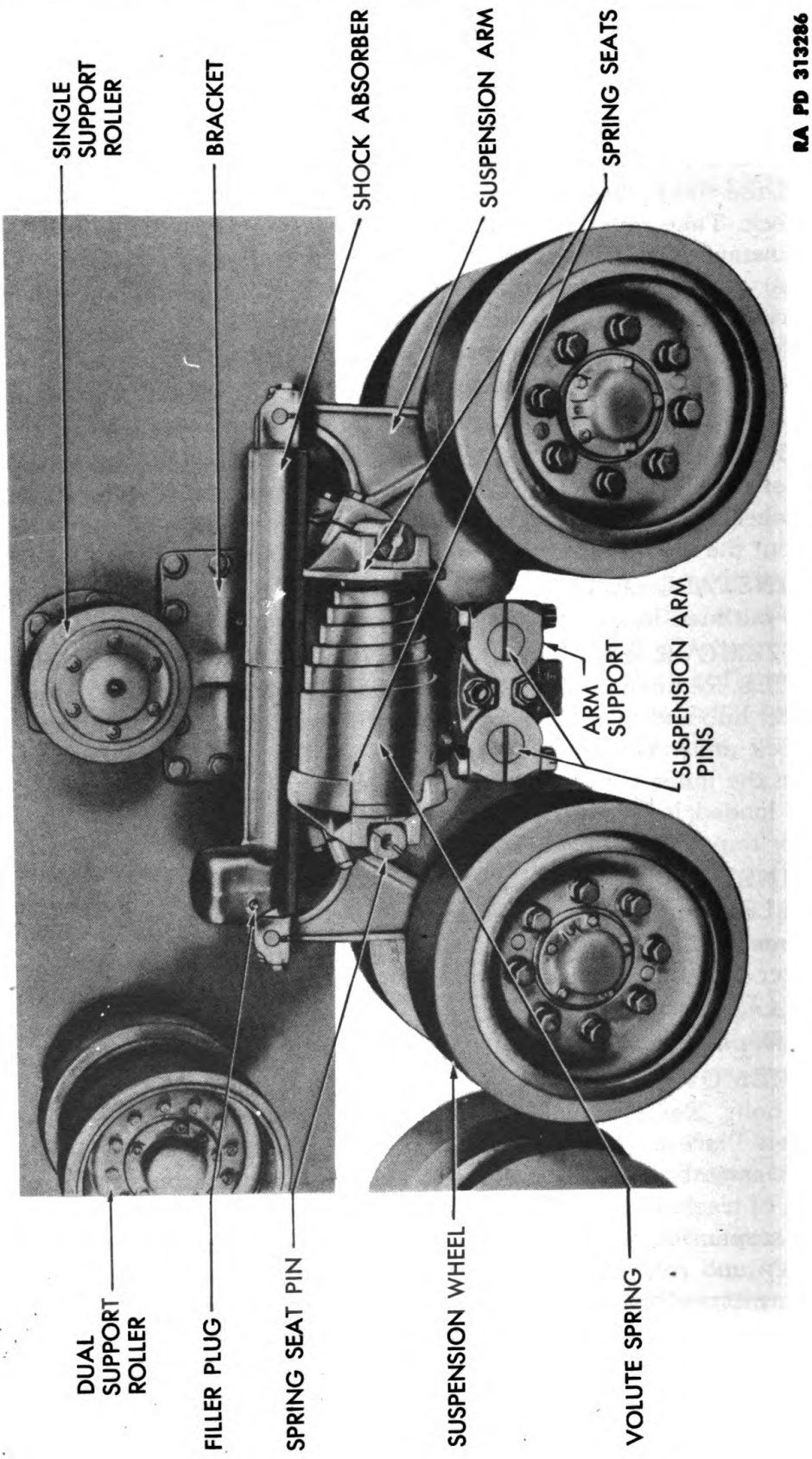


Figure 79—Suspension Assembly—Installed

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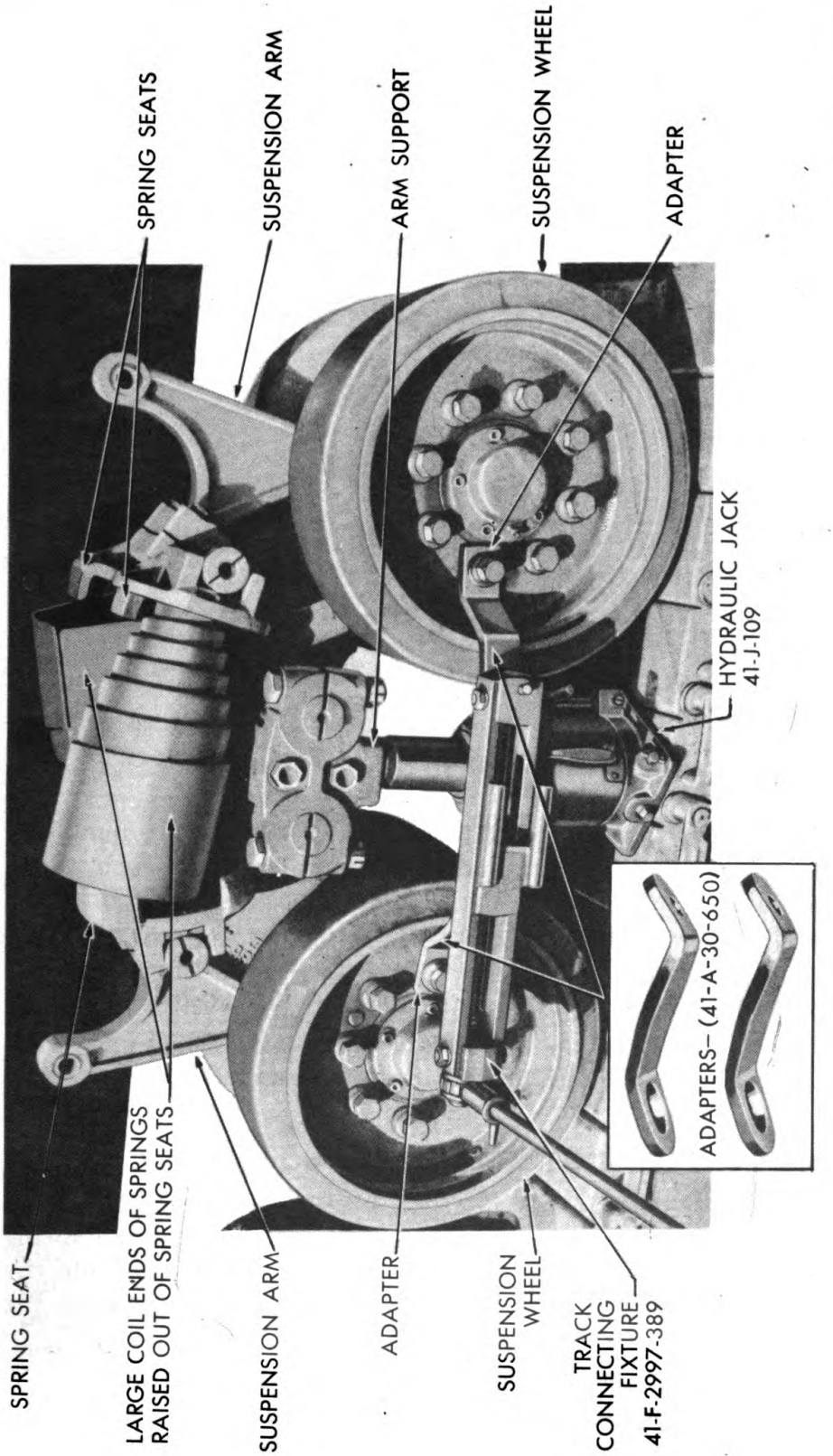
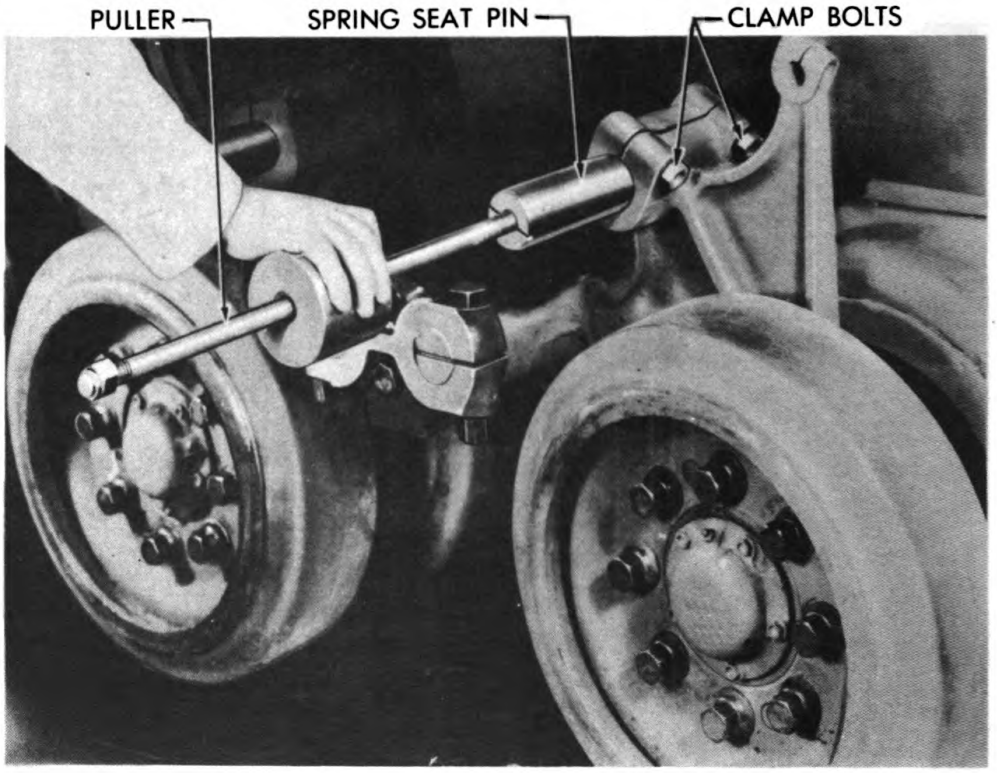


Figure 80—Removing or Installing Volute Springs

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Figure 81—Removing Spring Seat Pin

(2) INSTALL VOLUTE SPRINGS (fig. 80). Enter the small coil end of each spring on the pilot, and force the other end of each spring into position in spring seat. Release the tension on the track connecting fixture, and remove the fixture and adapters from the suspension wheels. Remove the jack. Position the shock absorber on the suspension arms, with the reservoir filler plug to the outside, install the pins and tighten the clamp screws.

(3) ADJUST TRACK TENSION. See paragraph 117 *d*.

d. Disassembly.

(1) RELEASE TRACK TENSION. See paragraph 117 *d* (2).

(2) REMOVE SHOCK ABSORBERS, SPRINGS AND SPRING SEATS. Remove springs (subpar. *c* (1) above). Lift out the spring seats. Loosen the spring seat pin clamp bolts. Screw a puller into the end of the spring seat pin, and remove the pin (fig. 81). Remove the other spring seat pin in the same manner.

(3) REMOVE SUSPENSION ARMS AND HUB ASSEMBLY. Take out the suspension wheel mounting screws and remove the wheels. Remove the four suspension arm pin clamp bolts. Remove the suspension arm support screws and the support. Pull the inner end of

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the suspension arm pin out of the bracket and remove the arm and pin assembly. Remove the other arm in the same manner.

(4) REMOVE SUSPENSION BRACKET (fig. 83). Take out the cap screws that attach the bracket to the hull and remove the bracket.

(5) DISASSEMBLE HUB (fig. 82). Take out the attaching screws and remove the hub cap and gasket. Pry the nut lock tongue out of the wheel outer bearing nut. Remove the nut and the nut lock. Unscrew the wheel inner bearing nut and remove the thrust washer. Pull the hub off the wheel shaft. Remove the outer and inner bearing cones and seal. Disassemble the other hubs in the same manner.

e. Inspection and Repair of Parts.

(1) CLEAN PARTS. See paragraph 118 *c*.

(2) INSPECT BEARINGS AND SEALS. See paragraph 118 *d*.

(3) INSPECT OTHER PARTS (fig. 82). If a suspension bracket is cracked or twisted, replace the bracket. Replace the suspension arm assembly if cracked or twisted. If a suspension arm pin or a wheel shaft is bent, or loose, in the arm, replace the arm assembly. If the spring seat plates are worn excessively turn the plates over or install new plates. Replace the springs if cracked, or broken, or if they measure less than 13 inches in length. Replace the spring seat pins if badly worn or bent. If the shock absorber pins or bushings are worn, replace the bushings and pins.

f. Assembly.

(1) INSTALL INNER BEARING CONE AND SEAL (fig. 82). Pack the inner bearing cone with general purpose grease and install the cone in the hub. Position the seal in the hub with the flat side of the seal case out (fig. 78). Use a seal drift and drive the seal into the hub until the flat side of the seal case is flush with the end of the hub.

(2) INSTALL HUBS (fig. 82). Slide the hub onto the shaft. Pack the outer bearing cone with general purpose grease. Install the bearing cone and thrust washer. Screw the bearing inner nut on the shaft until the bearing cones are seated, but not sufficiently to cause a bind in the bearings.

(3) ADJUST BEARINGS. See paragraph 118 *e* (4).

(4) INSTALL NUT LOCK, BEARING OUTER NUT, HUB CAP, AND GASKET (fig. 82). Install the nut lock and bend a tongue into one of the slots in the bearing inner nut. Screw the bearing outer nut onto the shaft. Tighten the nut to 200 foot-pounds torque, and bend a tongue into one of the slots in the nut. If a tongue does not line up with a slot in the outer nut, continue to tighten (do not back off nut) until a tongue alines with the slot. Install the gasket and hub cap with the attaching screws. Fill the hub with grease, through the lubricant fitting in the hub cap, until grease appears at the seal or relief fitting in the center of the hub.

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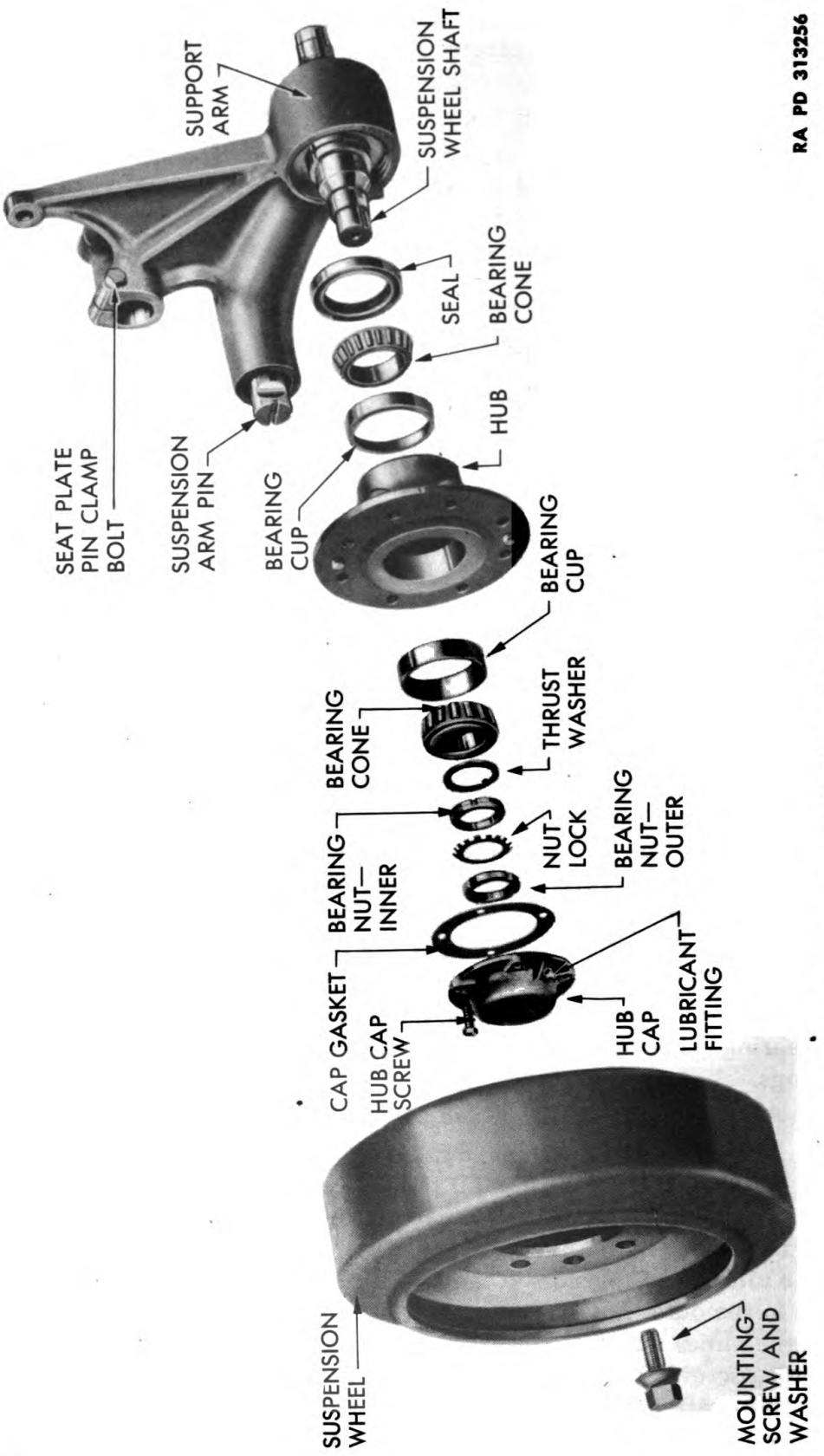
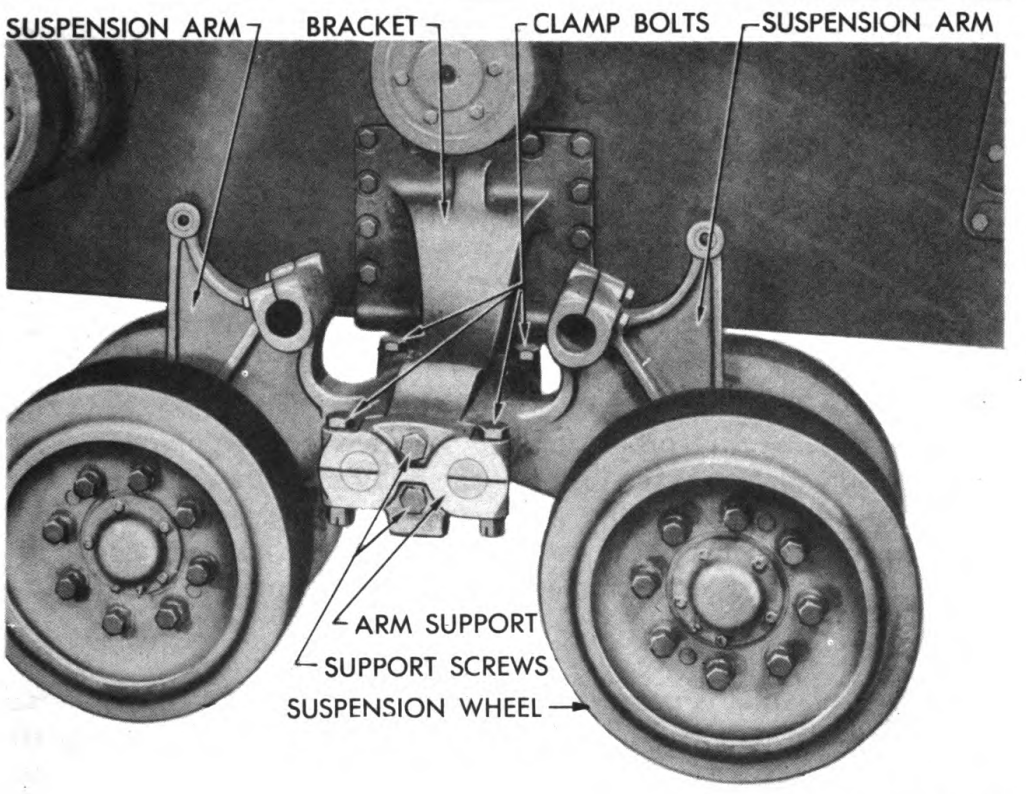


Figure 82—Suspension Wheel and Support Arm—Disassembled

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Horizontal Volute Spring Suspension



RA PD 313336

Figure 83—Suspension Arms and Wheels—Installed

(5) INSTALL SUSPENSION BRACKET (fig. 83). Position the bracket on the hull. Support the bracket with a jack. Install the attaching 1-inch floor bolts, and tighten securely. Then install the attaching ¾-inch side bolts, and tighten securely.

(6) INSTALL SUSPENSION ARMS (fig. 83). Raise the arm into position on the bracket and insert the rear end of the suspension arm pin into the bracket. Install the other arm in the same manner. Position the arm support on the suspension arm pins, and drive the support on the pins until it seats solidly on the end of the suspension bracket. Be sure the key on the end of the bracket is properly entered in the keyway in the arm support. Raise the arm support with a jack until it seats solidly against the bracket, install the support attaching screws and tighten securely. Aline the slots in the outer ends of the suspension arm pins with the slots in the support. Install the clamp bolts, and tighten the nuts securely.

(7) INSTALL WHEELS. Install the wheels on the hubs, and tighten the mounting screws securely.

(8) INSTALL SPRINGS AND SHOCK ABSORBERS (fig. 79). Install the spring seat pins in the support arms. Be sure the pins are centered, so that both ends of the pin are an equal distance from the

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arm. Tighten the clamp bolts. Position the spring seats on the spring seat pins. Install the springs and shock absorber as outlined in subparagraph *c* (2) above.

(9) ADJUST TRACK TENSION. See paragraph 117 *d*.

Section XXVIII

HULL

124. DESCRIPTION.

a. Hull. The hull or body of the vehicle is made of heavy armor plate for housing and protection for the crew and equipment. Two lateral bulkheads across the inside of the hull act as firewalls, enclosing the engine compartment, and also separate the fighting and driver's compartments. An opening in the forward end of the hull is provided for the installation of transmission and final drive assembly.

125. PERISCOPES.

a. Description. Periscopes are provided for the driver and assistant driver. The mounting for each periscope includes a revolving plate which permits the periscope to be aimed in any position. A rotation set screw can be tightened to hold the periscope in any position desired. The periscope mount can be tilted to elevate the line of vision, and can be locked in place by a knurled nut on the back of the periscope. A safety lock prevents the periscope falling out if the knurled nut becomes loosened.

b. Removal and Installation. Slide the safety lock back, loosen the knurled nut, and remove the periscope. To install, insert the periscope in place, tighten the knurled nut, and secure with safety lock.

126. DRIVER AND ASSISTANT DRIVER'S CUPOLA.

a. Description. Each vision cupola consists of stationary ring, bolted to the roof, with a door equipped with a periscope mounted on the cupola. Six direct-vision blocks are mounted, equally spaced, around the stationary ring. The cupola door periscope is mounted on a ball bearing race which permits a 360-degree rotation.

b. Removal. Take out the cap screws that hold the hinge tube caps, drive out the hinge pin and lift off one door section. Repeat the procedure to remove the other half of door. Take out the cap screws that hold the block case and remove the case and seal. From inside the vehicle, unscrew the three block locking screws in each block, and remove the blocks. Remove the bolts that attach the vision door to the turret, and remove the door.

c. Installation. Spread the joint and thread compound around the ring, and lower the door into position on the turret, using guide pins.

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Install and tighten all bolts around the door. From inside the vehicle, push the direct-vision blocks into their respective positions, install the three block locking screws in each block, and tighten securely. From outside the vehicle, place the block cases in position over the direct-vision blocks, using a new gasket, and secure with cap screws. Position one-half of the door, install the hinge pin and secure the hinge tube caps at each end with cap screws. Repeat operation for the other half.

127. FENDERS.

a. Removal.

(1) DISCONNECT TRACK. See paragraph 117 *b*.

(2) REMOVE FENDER. Remove the bolts that hold the fender to the leading edge of the sponson. Loosen the three cap screws that hold the side of the fender to the final drive assembly, and lift off the fender.

b. Installation.

(1) INSTALL FENDER. Place the fender in position over drive sprocket. Install the three cap screws which secure it to the final drive assembly. Install the bolts through the rear of the fender and into the sponson leading edge. Insert the bolts from the under side, and install self-locking nuts. Tighten all bolts and cap screws securely.

(2) CONNECT TRACK. See paragraph 117 *c*.

(3) ADJUST TRACK TENSION. See paragraph 117 *d*.

Section XXIX

VEHICLE WIRING

128. DESCRIPTION.

a. The wiring systems in the T83 and T89 gun motor carriages are identical. All wiring is contained in conduits or flexible shielded cable for protection of the wires, and to effect adequate suppression of radio interference. The harnesses are held in place by clamps or clips which form the necessary bonding to the hull for suppression of radio interference. Junction blocks are provided in the battery switch box and bulkhead terminal box for convenience in connecting the various circuits. Harnesses are fitted with "AN" connectors to join the harnesses to equipment or fittings. These connectors provide accessible points for tests to locate grounds, shorts, or to check the continuity of the circuits. In most instances, several circuits are contained in a single harness, and failure of any individual circuit within the section of harness necessitates replacement of the section involved.

b. The circuits through the instrument panel are all series connected with circuit breakers for protection of the wiring and equipment. The circuit breakers are fed from the bus bar in the battery switch box

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by the two wires marked "40." The use of two wires for this purpose affords ample carrying capacity with more flexibility than a single wire of equal capacity, and allows the use of a standard "AN" connector. All circuits are identified by numbers taped on the wires.

129. HARNESSES.

a. Removal. When removing wiring harnesses, refer to the paragraph pertaining to the equipment involved for information regarding disconnecting and connecting of the harness and wiring to the unit or equipment. Remove the clamps and clips which secure the harness in position, and remove the harness.

b. Installation. Position the harness between the points to be connected and install. All wiring is identified by a numbered tape around each wire near the terminal.

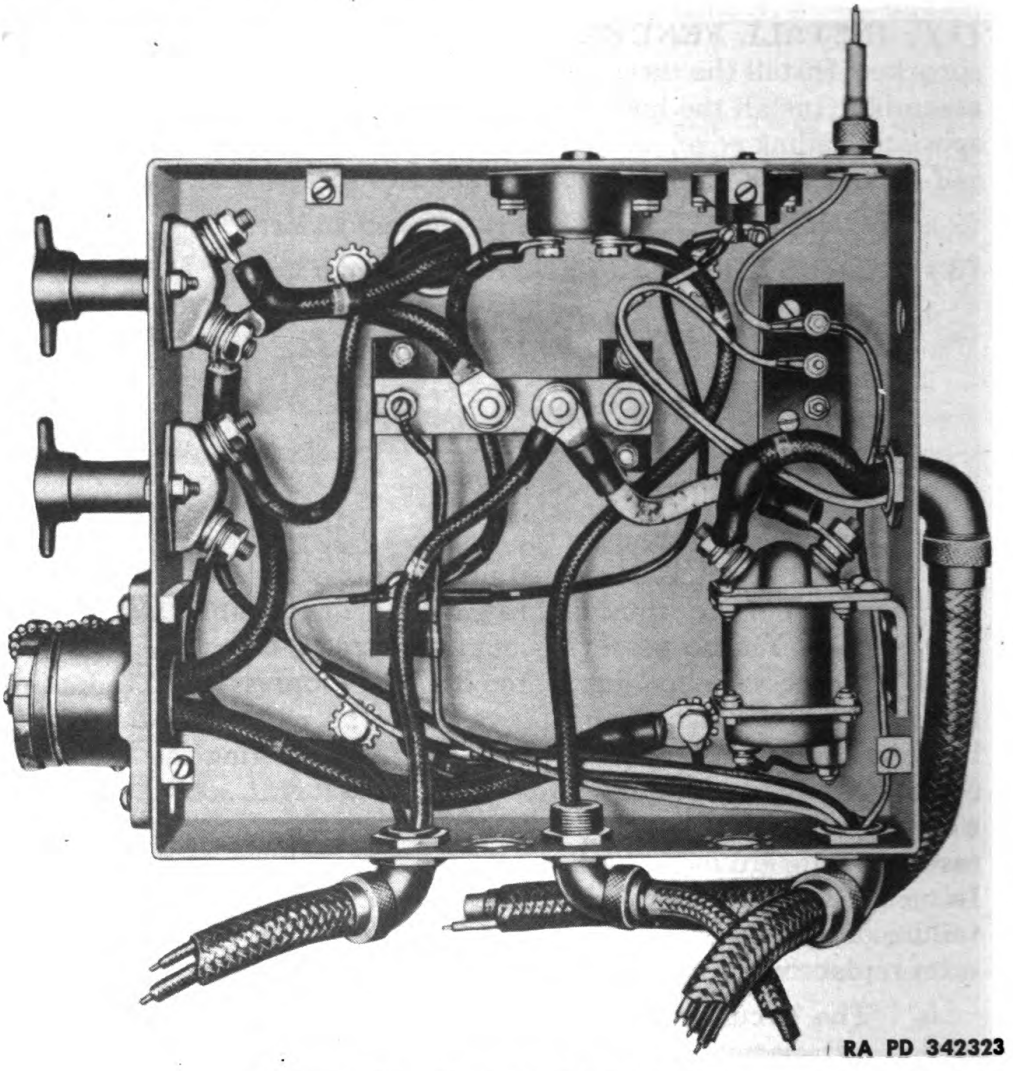


Figure 84—Battery Switch Box

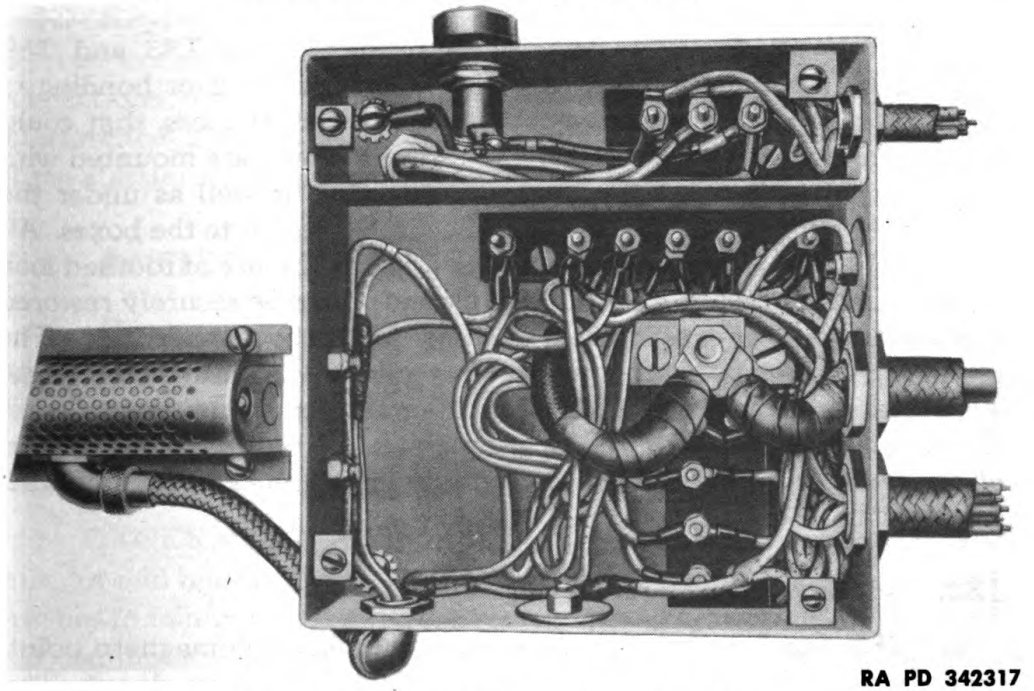
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c. ***Replacement of Wires.*** Where practical, faulty wires may be replaced within the harness by removing the terminal, or by unsoldering the wire from connector plug and attaching a new wire of proper size and length to the old wire. Pull the new wire into the cable or conduit while the old one is drawn out. Solder the wire to the connector or install the terminal as required. When connecting harnesses fitted with "AN" connectors, be sure that the index of the plug matches the index of the receptacle to avoid damage to the connectors and insure proper connections of the circuits. Install all harness clips and clamps in the same manner as removed, with plated screws, bolts and toothed lock washers to insure a positive ground or bond. This is important in order to provide the necessary bonding for grounding of radio interference as well as for protection of the harnesses.

130. TERMINAL BOXES.

a. ***Description.*** Three terminal boxes and a battery switch box are used to house the necessary switches, circuit breakers and insulated terminal blocks for convenience in connecting the wiring. The bulkhead terminal box is located in the center of the bulkhead in the driver's compartment (fig. 85), and radio terminal boxes are located one on the right hull wall behind the assistant driver, and two in the fighting compartment.

b. ***Removal.*** Remove the cover, disconnect the wiring, remove the conduit fitting lock nuts and pull the wiring out of the box. Remove the mounting screws which hold the box to the hull.



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Figure 85—Bulkhead Terminal Box

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c. Installation. Remove the necessary knockout plugs (if so equipped) and install the proper fittings as observed when the box was removed. Use the old fittings if not damaged. Position the box and secure it with the mounting screws, with toothed lock washers between the box and the mounting surface. Enter the wires through the proper fittings and attach the conduits to the fittings. Connect the wires.

Section XXX

RADIO INTERFERENCE SUPPRESSION

131. INTRODUCTION.

a. Purpose. Radio interference suppression is the elimination, or minimizing, of the electrical disturbance which would interfere with radio reception, or would disclose the location of the vehicle to sensitive electrical detectors. The radio set used in the T83 or T89 is designed to meet the requirements of communication under the existing conditions. The placement of tubes, transformers, coils, and condensers, in the various circuits of the equipment, automatically suppress many of the common interferences, and produce a high ratio "signal to noise" reception. However, because of the type of operation of these vehicles, many sources of interference are present, and must be considered to maintain effective suppression. It is important that all vehicles, with or without radio equipment, be suppressed properly to prevent interference with radio-equipped vehicles.

b. General. Suppression is accomplished in the T83 and T89 vehicles by the use of condensers, filters, shielding and/or bonding in all circuits, to confine and dissipate electrical disturbances, that could affect radio reception. All switch and terminal boxes are mounted with toothed washers against the mounting surfaces, as well as under the screw or bolt head, and the covers are securely bonded to the boxes. All sand shields and fenders are securely bonded by the use of toothed lock washers in assembly. CAUTION: *All bonds must be securely restored when replacing any equipment treated for radio suppression.* The ground straps on the engine, generator regulator, and instrument panel are necessary to complete the electrical circuit for proper operation of the units. While these ground straps may be sufficiently tight for operation, they may present a source of radio interference if good contact is not ensured.

132. IGNITION SYSTEM.

a. Description. When the engine is running, the magneto points make and break contact rapidly to interrupt the primary circuit. This interruption causes the high-tension circuit to discharge a spark at the

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spark plugs. Both of these conditions set up impulses or frequencies which could be radiated as radio interference. Suppression of this interference is accomplished as follows:

(1) MAGNETO. A condenser is used across the contact points in each magneto to prevent arcing, and to intensify the high-tension spark. The action of the condenser, in performing its function, also suppresses the radio interference impulses that would be caused by arcing.

(2) SPARK PLUGS AND WIRES. The spark plug wires are enclosed in flexible conduits which form a shield over the wires to dissipate interference.

b. Replacement. The condensers in the magnetos are a part of the ignition circuit and not purposely intended for radio suppression. To eliminate interference from this source, replace the magnetos (pars. 64 and 65). See paragraph 69 for replacement of spark plugs.

133. STARTING SYSTEM.

a. Description. The starter, cable, solenoid, and starter switch are shielded, and grounded where necessary to eliminate interference. When the engine is cranked, a heavy flow of current is drawn over the cable and through the contacts of the solenoid. Suppression is necessary to minimize the interference set up when the circuit is closed and opened, and when the starter is operating.

b. Replacement. A bond strap connects the engine mounting to the hull to ensure a good ground for the engine electrical units. Loose connections, burned commutator, or faulty brushes would cause radio interference. For information pertaining to replacement of components of the starting system, see paragraphs 82 and 83.

134. BATTERY CHARGING SYSTEM.

a. Description. The generator and generator regulator are a constant source of radio interference because of the varying frictional contact of the generator brushes on the commutator, and the rapid action of the contact points in the regulator. Suppression is accomplished as follows:

(1) GENERATOR. A condenser, which is mounted inside the commutator end housing of the main generator, is connected to the positive brushes to minimize the interference caused by worn, or faulty, brushes and commutator. A ground cable connects the generator to the mounting bracket to ensure a good ground for the generator (fig. 38).

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(2) REGULATOR. A filter and a condenser are mounted in the regulator. A ground strap at the shock mount completes the electrical circuits of the regulator, as well as ensuring a good electrical bond for the elimination of radio interference. The filter is connected in series with the battery lead, and the condenser is connected in parallel with the armature circuit.

b. Replacement.

(1) GENERATOR AND REGULATOR SUPPRESSION. The suppression equipment used in the generator and in the generator regulator is an integral part of the units. See paragraphs 87 and 88 for replacement of these units.

135. INSTRUMENTS.

a. Description. All instruments enclosed in the instrument box are bonded to, and shielded by, the box which in turn is bonded to the sponson by a wire. The utility outlet, which is sometimes used to connect the windshield wiper for the driver's door hood, is suppressed by a condenser connected in parallel with the outlet inside the instrument panel.

136. VEHICLE WIRING.

a. Description.

(1) CONDUITS. All wiring is contained in protective conduits which act as shielding for the electrical circuits. These conduits are secured in position with clips or brackets fastened to the hull with toothed lock washers and screws.

(2) RADIO TERMINAL BOXES. Two condensers are used in each radio terminal box in parallel with the 12-volt and (+) 25-volt circuits. The boxes are mounted with toothed lock washers between the hull and the box, as well as under the mounting screw heads.

b. Replacement. See paragraph 129 for removal and installation of harnesses. NOTE: *It is very important that all harnesses be securely clamped when installed.*

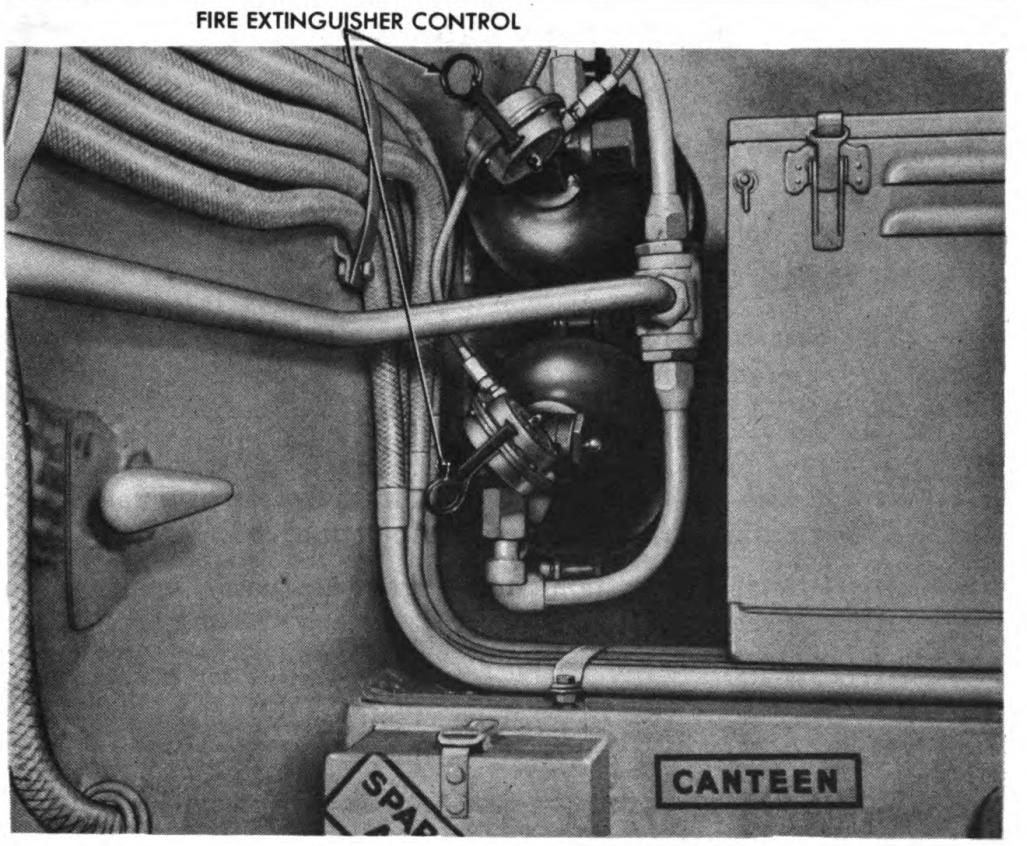
Section XXXI

AUXILIARY EQUIPMENT

137. FIXED FIRE EXTINGUISHER SYSTEM.

a. Description (fig. 86). The two cylinders of the fixed fire extinguisher system are located just aft of the battery box on the left sponson. A control head assembly, accessible to the driver, is attached to each cylinder.

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Figure 86—Fixed Fire Extinguisher Cylinders and Controls

b. Removal of Fire Extinguisher Cylinders. Unscrew the control head swivel nut from the cylinder, and lay the head aside. Loosen the discharge tubes at the check valve, and disconnect the tubes from the cylinders. Remove the cylinder clamp bolts and lift out the cylinder.

c. Installation of Fire Extinguisher Cylinders. Place the cylinder in position and install the clamp bolts. Connect the discharge tubes to the cylinder, and tighten the tubes to the check valve. Install the control head on the cylinder.

138. PORTABLE FIRE EXTINGUISHERS.

a. Description. Two 4-pound CO_2 portable fire extinguishers are carried on the vehicle. They are clamp-mounted, one on the floor to the right of the transmission in the driver's compartment alongside the assistant driver, and the other below the winch assembly in the left rear of the fighting compartment.

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PART FOUR—ARMAMENT

Section XXXII

INTRODUCTION

139. SCOPE.

a. This part of the manual contains a brief description of the functioning and operation of the armament mounted on the 155-mm gun motor carriage T83 and the 8-inch howitzer motor carriage T89 (figs. 1 and 2).

b. It also lists the authorized ammunition for the armament, and contains information on the sighting equipment.

c. For detailed information on the care, preservation, malfunction, maintenance, assembly, and disassembly of the 155-mm gun M1 and the 8-inch howitzer M1, see TM 9-350 and TM 9-335.

140. CHARACTERISTICS.

a. The armament of the 155-mm gun motor carriage T83 and the 8-inch howitzer motor carriage T89 is employed against emplaced battery and other ground objectives. The mount for these weapons is located in the fighting compartment at the rear of the gun motor carriage.

b. The 155-mm gun motor carriage T83 possesses the same general characteristics as the 8-inch howitzer motor carriage T89. The only change required when adapting the 8-inch howitzer tube to the carriage will be to increase the nitrogen pressure in the recoil mechanism from 1,820 pounds per square inch to 2,000 pounds per square inch, and to decrease the nitrogen pressure in the equilibrators from 1,510 pounds per square inch to 1,355 pounds per square inch. Arrangement of the Belleville springs in the mount to conform with Ordnance drawing No. B7033103 will also be necessary.

c. These weapons may be elevated to 55 degrees and depressed to 5 degrees. Traverse is 18 degrees to right and 18 degrees to the left of center. The maximum horizontal range of the 8-inch howitzer is approximately 18,500 yards and of the 155-mm gun 25,300 yards.

141. DIFFERENCES AMONG MODELS

a. There are no differences among models which will affect troop use or care of the armament other than those listed in the preceding paragraphs.

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142. WEIGHTS, DIMENSIONS, AND BALLISTICS OF THE 155-MM GUNS M1 AND M1A1 AND 8-INCH HOWITZER M1.

	155-mm Gun	8-inch Howitzer
Chamber volume	1,596 cu in.	1,485 cu in.
Density of loading	0.63	0.55
Length of bore	45 cal	25 cal
Length of bore	274.5 in.	200 in.
Length (muzzle to face of breech ring)	277.37 in.	202.5 in.
Maximum powder pressure permitted	40,000 lb per sq in.	33,000 lb per sq in.
Muzzle energy	5,169.5 ft-tons	5,278.4 ft-tons
Muzzle velocity	2,800 ft per sec	1,950 ft per sec
Rate of fire:		
For 10-round burst	1 round per min	1 round per min
For sustained fire	1 round per 2 min	1 round per 2 min
Rifling:		
Length	230.57 in	164.8 in.
Number of grooves	48	64
Twist	Uniform, right hand, 1 turn for 25 cal	Uniform, right hand, 1 turn for 25 cal
Travel of projectile in tube	238.315 in.	173.83 in.
Type of breechblock	Interrupted screw	Interrupted screw
Type of firing mechanism	Percussion hammer	Percussion hammer
Weight of barrel	9,595 lb	10,240 lb

143. RECOIL MECHANISM.

	155-mm Gun	8-inch Howitzer
Model	M3	M4
Maximum recoil	65 in.	70 in.
Recoil at minimum elevation	58 in.	60 in.
Recoil at maximum elevation	33 in.	36 in.
Air pressure	1,820 lb per sq in.	2,000 lb per sq in.
Type of recoil mechanism	Hydraulic	Hydraulic
Type of counterrecoil mechanism	Hydropneumatic	Hydropneumatic
Oil	OIL, recoil, heavy	OIL, recoil, heavy

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	155-mm Gun	8-inch Howitzer
Oil reserve in replenisher (recoil)	1 qt	1 qt
Oil reserve in recuperator (counterrecoil)	1 qt	1 qt
Oil required to fill recoil mechanism	15 gal	15 gal
Weight	-	3,925 lb

Section XXXIII

OPERATING INSTRUCTIONS

144. PLACING THE WEAPON IN FIRING POSITION.

a. Remove gun or howitzer covers and store them out of the way in the proper place assigned for them; likewise store the other equipment not required for operation of the weapon.

b. Unlock the tube traveling lock by loosening the nut which secures the upper half of the traveling lock. Rotate the upper half up and off the tube; then elevate tube slightly in order to push traveling lock down in latched position on the hull.

c. Place spade in firing position. Free the top support arms of the spade assembly by removing the locking pins. Release winch ratchet arm and brake to lower spade to ground. Back up vehicle to force spade prongs into ground. When in its proper position, the spade must be flush with the ground and the spade stops seated against the hull. Apply vehicle steering brakes and lock in position.

145. INSPECTION BEFORE FIRING.

a. Prior to firing, inspect the bore and breech to see that no dirt or foreign material has accumulated. If there is foreign matter in the bore, clean the bore thoroughly and wipe it dry. Normally, the bore should be wiped or cleaned to remove the coating applied after the previous firing.

b. Check the replenisher and recuperator oil levels to make certain that there is sufficient oil in the recoil and recuperator cylinders (TM 9-335 or TM 9-350).

c. For ease in elevating the piece, adjust the equilibrators to suit the atmospheric temperature (TM 9-335 or TM 9-350).

d. Inspect to see that there is no leakage of oil, that the howitzer slides are clean and well lubricated, and that the piston rod nuts are properly tightened.

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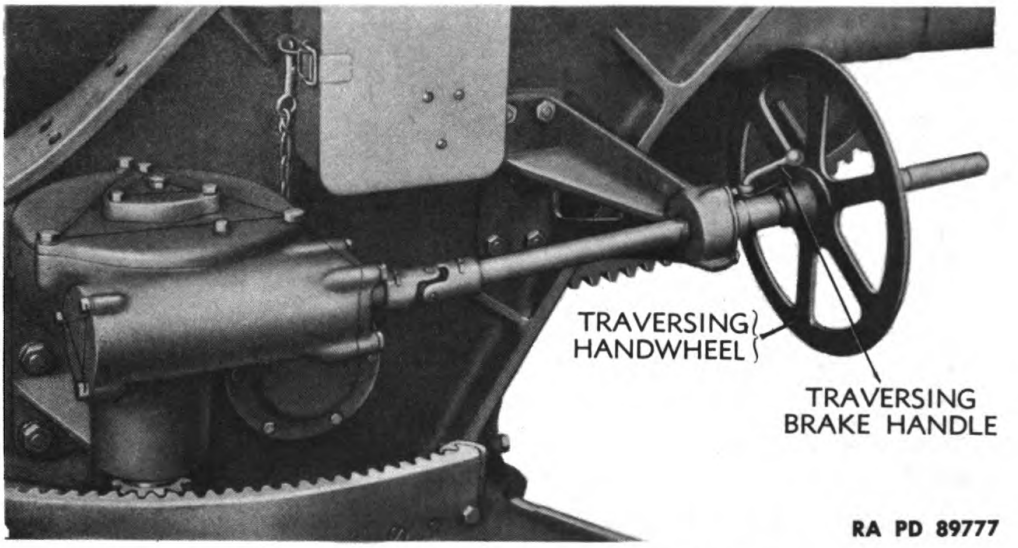


Figure 87—Traversing Handwheel

e. Check path of recoil to make sure that it is free from all obstructions.

146. TO TRAVERSE (fig. 87).

a. When the traversing handwheel, located on the left side of the top carriage, is rotated in a clockwise direction it traverses the muzzle of the howitzer to the right. Traverse is limited to an angle of 18 degrees right or left by stops assembled on the traversing rack. Recently a traversing brake was added to the traverse mechanism to prevent the gun from running down hill if the vehicle is positioned on a side slope. Use this brake during all firing as the 5 degrees tilt on the carriage tends to return the gun to zero degrees traverse even when the vehicle is on level terrain.

147. TO ELEVATE.

a. Turn the elevating handwheel, located on the right side of the top carriage, in a clockwise direction to elevate the muzzle of the weapon. However, before the handwheel may be operated, the brake lever must be pressed down so as to release the brake on the elevating mechanism (fig. 88). For greatest ease of operation in elevation adjust the equilibrators for temperature (TM 9-335 or TM 9-350). CAUTION: *Before grasping the elevating handwheel, release the brake for an instant to determine if the weight of the gun tube is balanced. If the weight of the gun tube is extremely unbalanced, it will cause the handwheel to spin rapidly. It is dangerous to attempt to turn the handwheel when this condition exists.*

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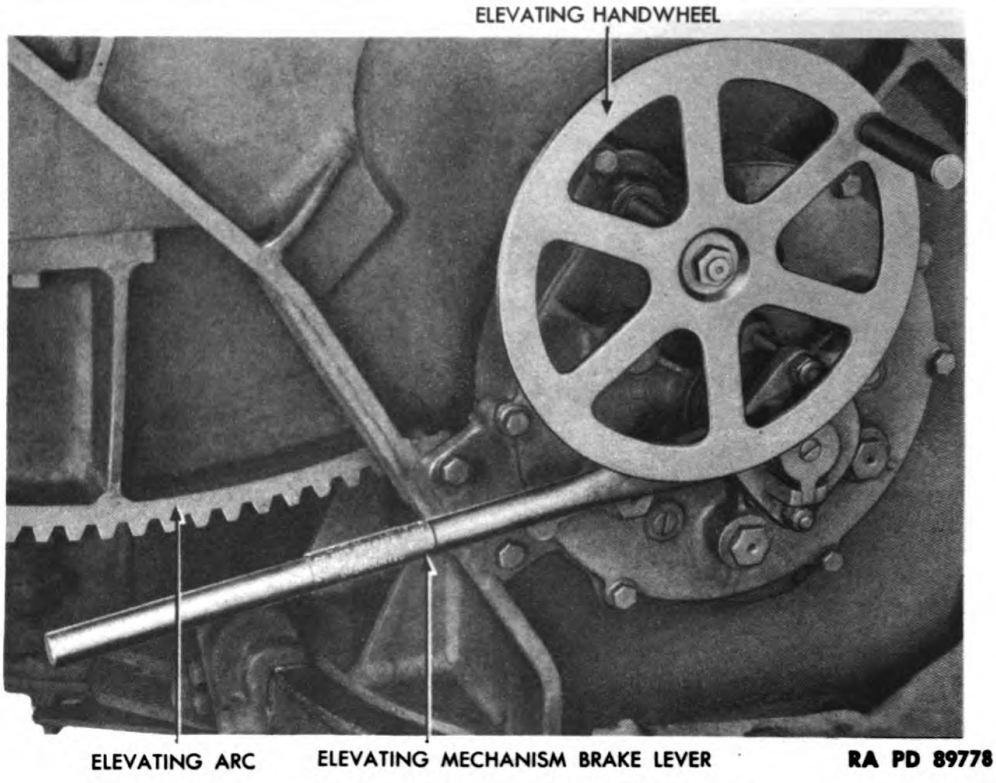


Figure 88—Elevating Handwheel

148. OPERATING BREECH MECHANISM (figs. 89, 90, and 91).

a. To Open the Breech.

(1) Remove the firing mechanism.

(2) Push down on the breechblock operating lever catch and pull the breechblock operating lever down to a horizontal position.

(3) Swing the operating lever toward the muzzle of the weapon.

b. To Close the Breech.

(1) Pull the breech operating lever toward the breech and then push it to a vertical position.

(2) Screw the firing mechanism into place.

149. TO LOAD.

a. If the elevation is too great for convenient loading, lower the weapon to an elevation suitable for easy loading (about 150 mils).

b. Loading the Projectile. A loading tray is furnished to facilitate the loading and to protect the projectile. Place the projectile in the loading tray. The tray is lifted by the gun crew, and the front of the tray placed so that the brass projecting lug rests in a blank portion of the interrupted breech threading. Ram the projectile part way into the

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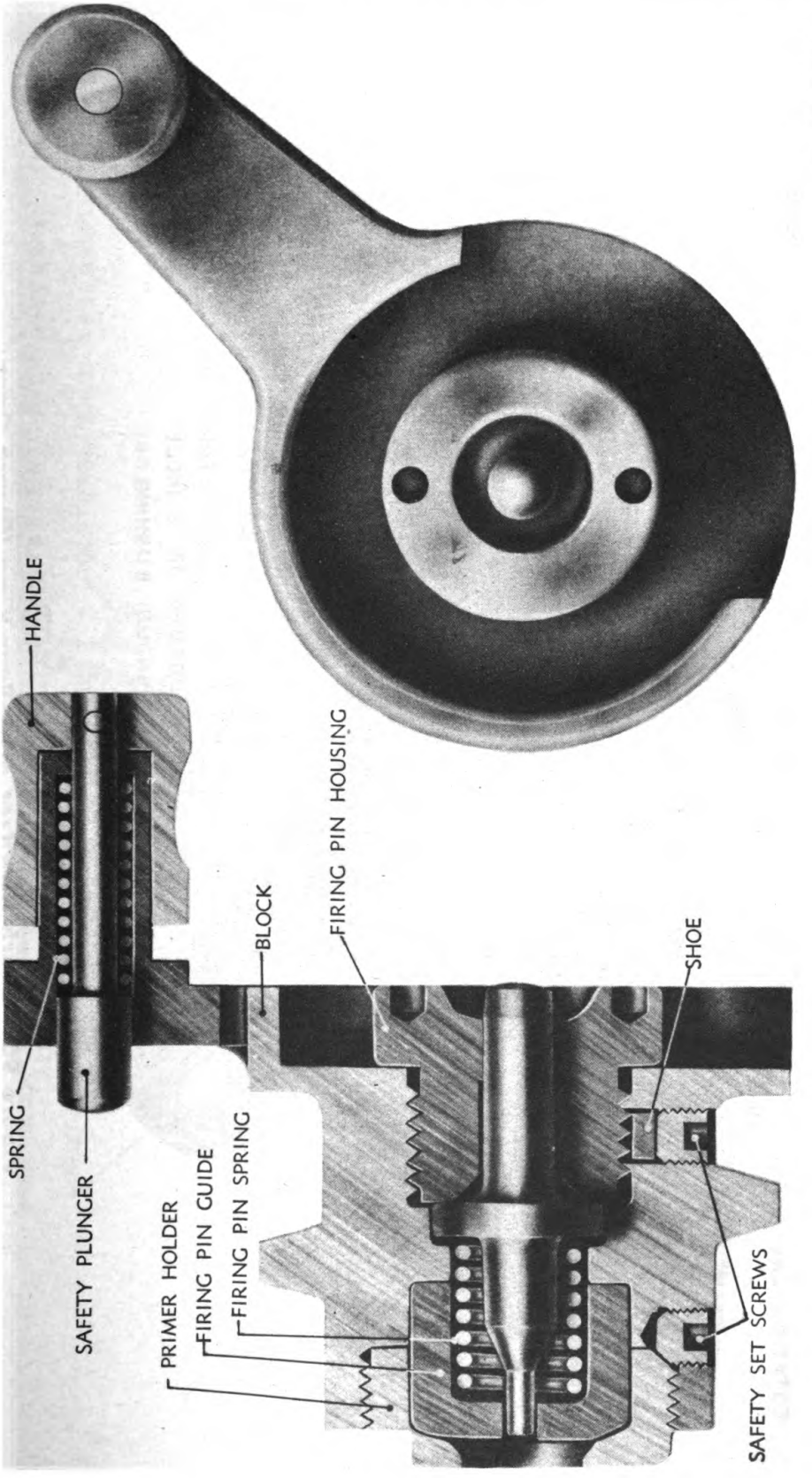


Figure 89—Firing Mechanism

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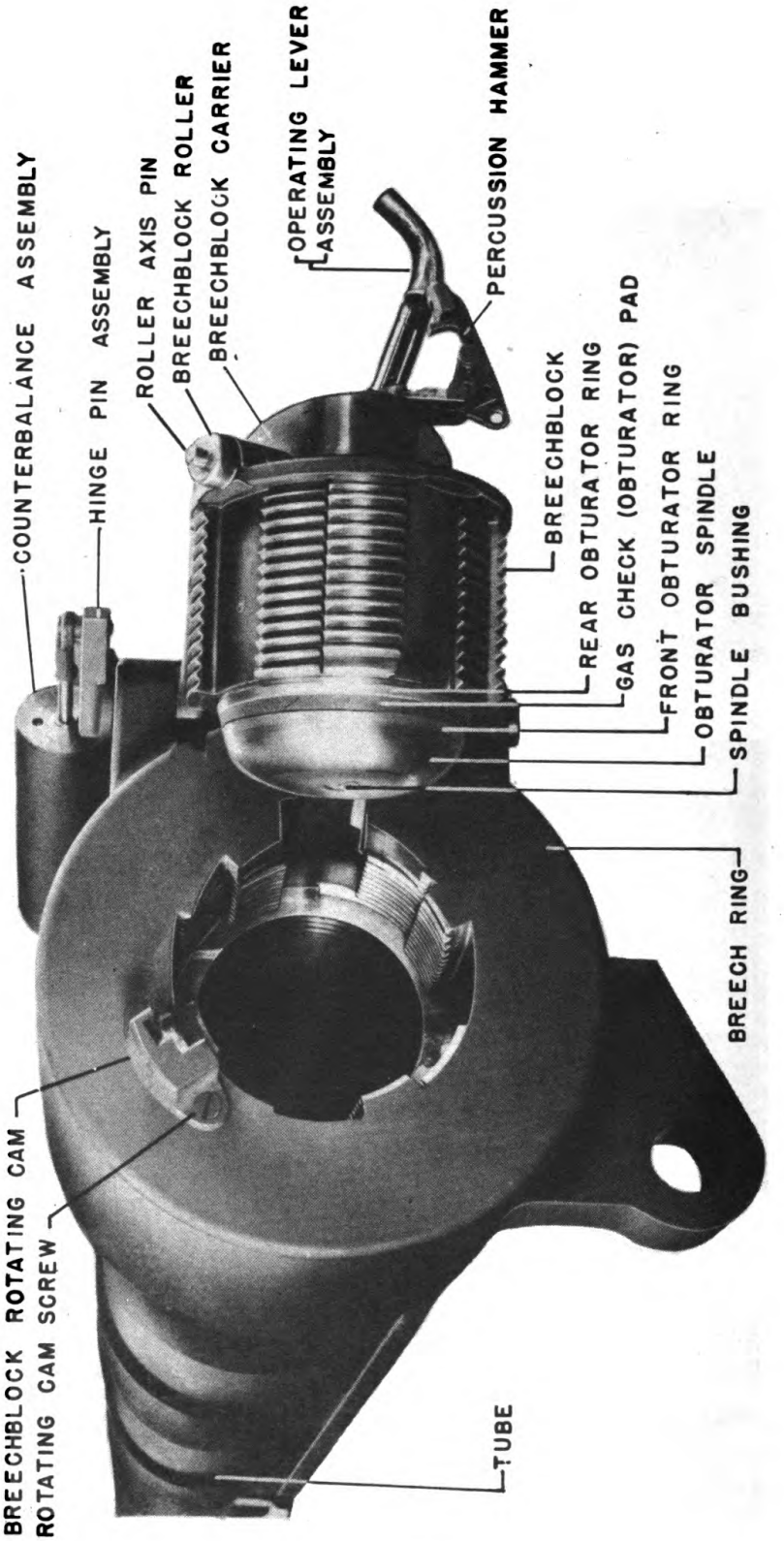


Figure 90—8-inch Howitzer M1—Rear View (Breech Open)

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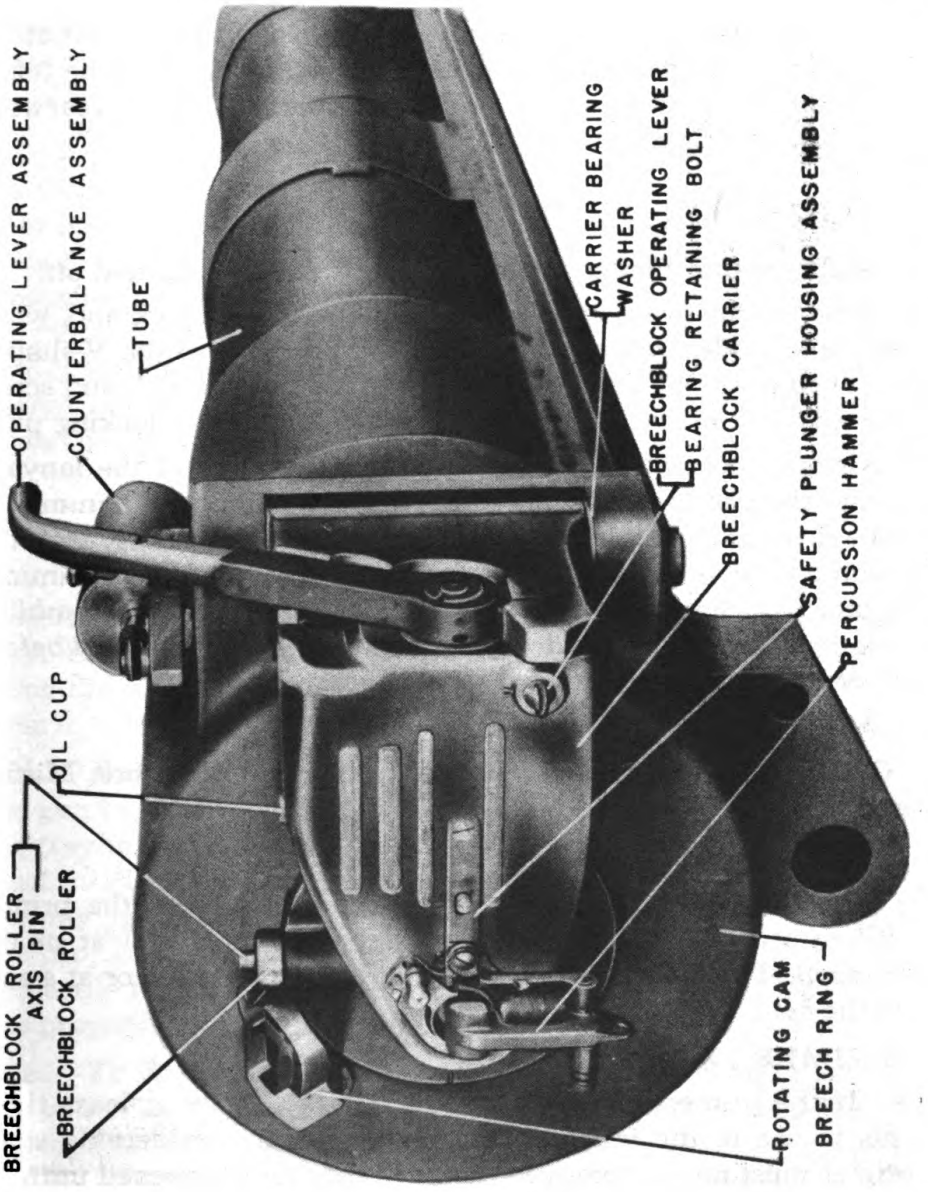


Figure 91—8-inch Howitzer M1—Rear View (Breech Closed)

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breech by use of the rammer. Then remove the tray and ram the projectile into position in the forcing cone. It is important that projectiles be rammed home with a uniform force since variations in the ramming force will cause slight variations in the range. It is also important to avoid damage to the rotating bands on a projectile, as such damage is likely to cause erratic flight of the projectile.

c. Loading the Propelling Charge. The loading tray is not required in placing the powder charge in the breech. Care must be taken to insure that the igniter end of the powder charge is facing rearward toward the breechblock.

150. FIRING THE WEAPON.

a. Make certain that the vehicle battery switch is turned off.

b. Remove the firing mechanism from the breechblock and, while holding the assembly in one hand, slide the primer into the V-shaped groove. Then place the firing mechanism in the breechblock and screw it all the way into place. Release the percussion hammer locking pin.

c. Firing is accomplished by a quick pull or snap of the lanyard attached to the percussion hammer, causing the percussion hammer to strike the firing pin. While traveling, or for reason of safety, lock the percussion hammer in a neutral position with the percussion hammer locking pin. NOTE: *The breechblock must be closed before assembling the firing mechanism, and the firing mechanism must be removed before the breechblock can be opened.*

d. Misfires.

(1) GENERAL. A misfire occurs when the piece fails to fire. Misfire is caused by:

(*a*) Failure of the primer to fire.

(*b*) Failure of the propellant charge to ignite when the primer fires. When a misfire occurs, all personnel must remain clear of the path of recoil. The piece must be kept pointed at the target or at a safe place in the field of fire.

(2) PRIMER FAILURES.

(*a*) If the primer is not heard to discharge, make at least three attempts to fire it, the lanyard being pulled with considerable snap. The primer must not be removed nor the breechblock opened until 10 minutes have elapsed since the last attempt to fire.

(*b*) When removing the firing mechanism, the operator will note whether or not the firing mechanism was fully screwed home. (The primer will not be hit properly unless the firing mechanism is screwed as far beyond the latch as possible.) If the primer is found to have fired, proceed as in step *3* below. If the primer has not been fired, examine the percussion head and:

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1. If the head has been properly indented, handle the primer carefully and dispose of it quickly, because of the possibility of a primer hangfire. Insert a new primer and make another attempt to fire.

2. If the head has not been properly struck, and if the firing mechanism was properly seated, the firing mechanism should be inspected for the following faults: dirty or gummy parts, firing pin or firing pin spring broken, firing pin housing or primer holder loosened. After correction of the fault, insert a new primer and make another attempt to fire.

3. If the primer is heard to discharge but the propelling charge has failed to explode, no attempt will be made to remove the primer or to open the breech until 10 minutes have elapsed after the firing of the primer. After 10 minutes, remove the primer, run a cleaning bit through the vent, insert another primer and repeat the attempt to fire the piece. Failure of the propelling charge to ignite indicates an abnormal condition of the charge, such as a missing igniter, igniter end of charge against the projectile, wet ignition charge, or ignition charge folded over and not accessible to the flash of the primer.

151. TO UNLOAD.

*a. **Service Rounds.*** An unloading rammer is provided with this materiel for use in unloading service rounds of ammunition when necessary. However, for safety reasons it is advisable to unload the piece by firing the weapon, after it has been determined that the field of fire is clear.

*b. **Dummy Projectile.*** To unload the dummy projectile, lower the gun to a convenient elevation (about 150 mils) and with the loading tray in place, remove the projectile with the dummy projectile extractor. Place the hook of the extractor in the recess in the base of the dummy projectile, and engage the hook on the shoulder; then jerk the projectile to release the band stuck in the forcing cone. Push the projectile forward and repeat if necessary. Use the extractor to guide the projectile onto the loading tray.

*c. **To Remove a Fuze from a Shell.*** If, for any reason, a projectile which has been fuzed is not to be fired, the fuze will be removed. The operation of inserting the fuze is reversed for fuze removal. CAUTION: *If the adapter starts to unscrew with the fuze, the unscrewing must be stopped at once and the shell disposed of as directed by the executive.*

152. TO PLACE WEAPON IN TRAVELING POSITION.

*a. **Fix Tube Position.*** Bring the weapon to a horizontal position in the center of traverse.

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b. Clean and Oil Gun. Clean, thoroughly dry, and cover the bore, powder chamber, breech recess, breechblock, and firing mechanism with a thin coat of light oil; oil the top and bottom carriages. Lock the percussion hammer in traveling position.

c. Stow Tools, Equipment, and Ammunition. Return sighting equipment, firing tools, and accessory equipment to their proper stowage position in chests, in brackets, and in clips on the vehicle. Store the ammunition, and close and store the powder containers.

d. Install Gun Covers. Install the breech, muzzle and sight mount covers.

e. Fasten Traveling Lock. Unlatch and swing traveling lock up to a vertical position. Clamp upper half of lock around tube. Tighten nut. Tighten cradle traveling tie rods.

f. Raise Spade. Move the vehicle forward to free the spade from the earth. Crank up spade winch, and lift spade to traveling position. Insert spade support arms through brackets and insert locking pins.

Section XXXIV

SIGHTING AND FIRE CONTROL EQUIPMENT

153. CHARACTERISTICS.

a. General. The sighting and fire control equipment provided for the 155-mm gun motor carriage T83 and 8-inch howitzer motor carriage T89 differ only in respect to the telescopes supplied for direct fire missions. Externally these telescopes are identical; however, internally the reticles differ for the 155-mm gun and 8-inch howitzer. Sighting equipment for the T83 vehicle includes those instruments described in paragraphs 154 through 161 inclusive.

154. TELESCOPE MOUNT M18A1, PANORAMIC TELESCOPE M12, AND INSTRUMENT LIGHT M19.

a. Telescope Mount M18A1. This mount is identical to that supplied with the field piece; however, spacers have been inserted between the mount and left cradle trunnion of the top carriage to permit installation of a direct telescope. See figure 92. Telescope mount M18A1 with panoramic telescope M12 (fig. 92) is the sighting element for laying the gun in azimuth and forms a part of the two-sight, two-man system for indirect fire. No provisions are made in this mount for elevation or range as this is accomplished by means of a gunner's quadrant on the right side of the carriage and is discussed in paragraph 157. The panoramic telescope mount is of the azimuth compensating type, which automatically applies azimuth correction, when the gun is elevated with the trunnions out of level; such as when the vehicle is sitting on a

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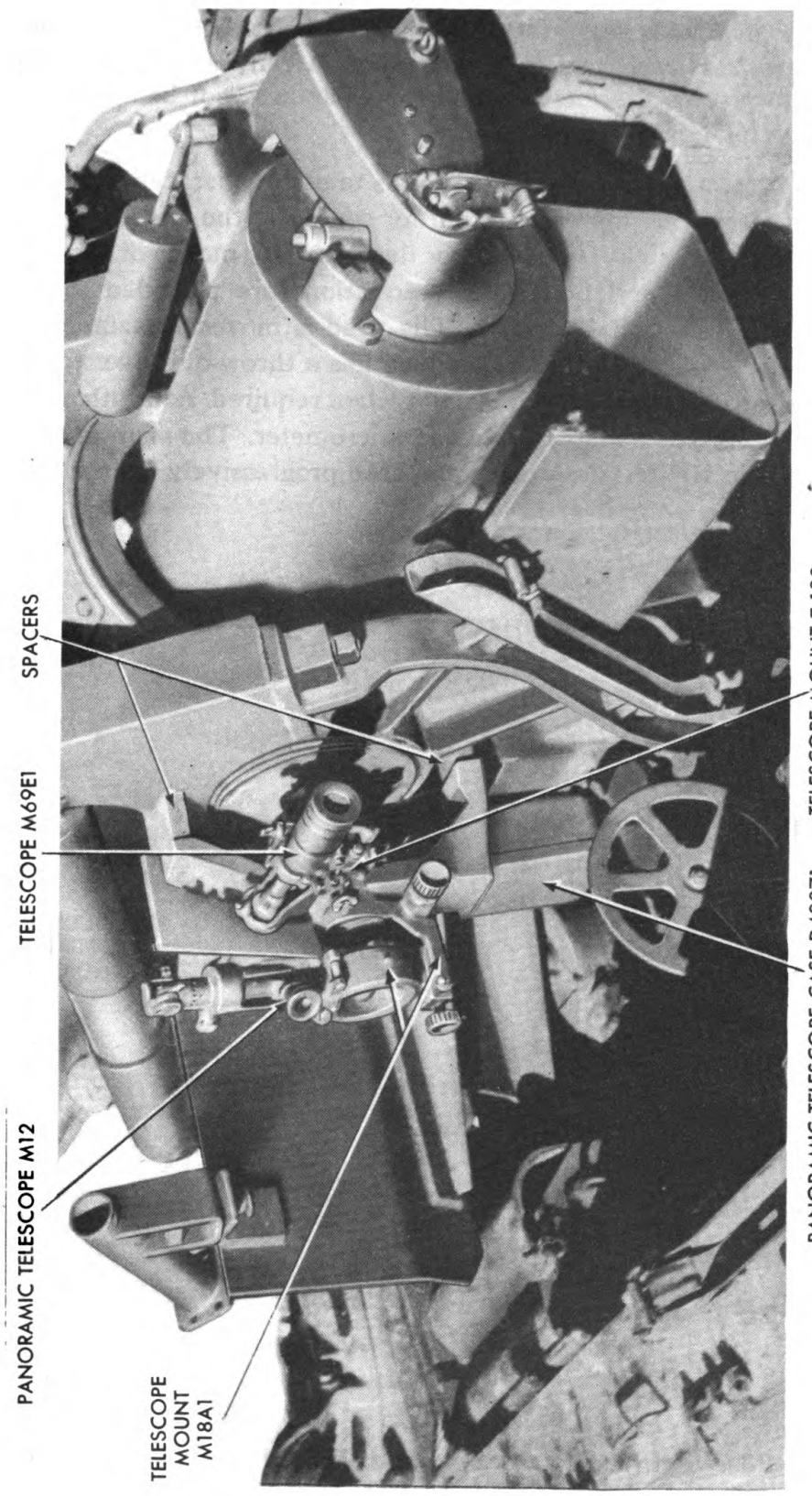
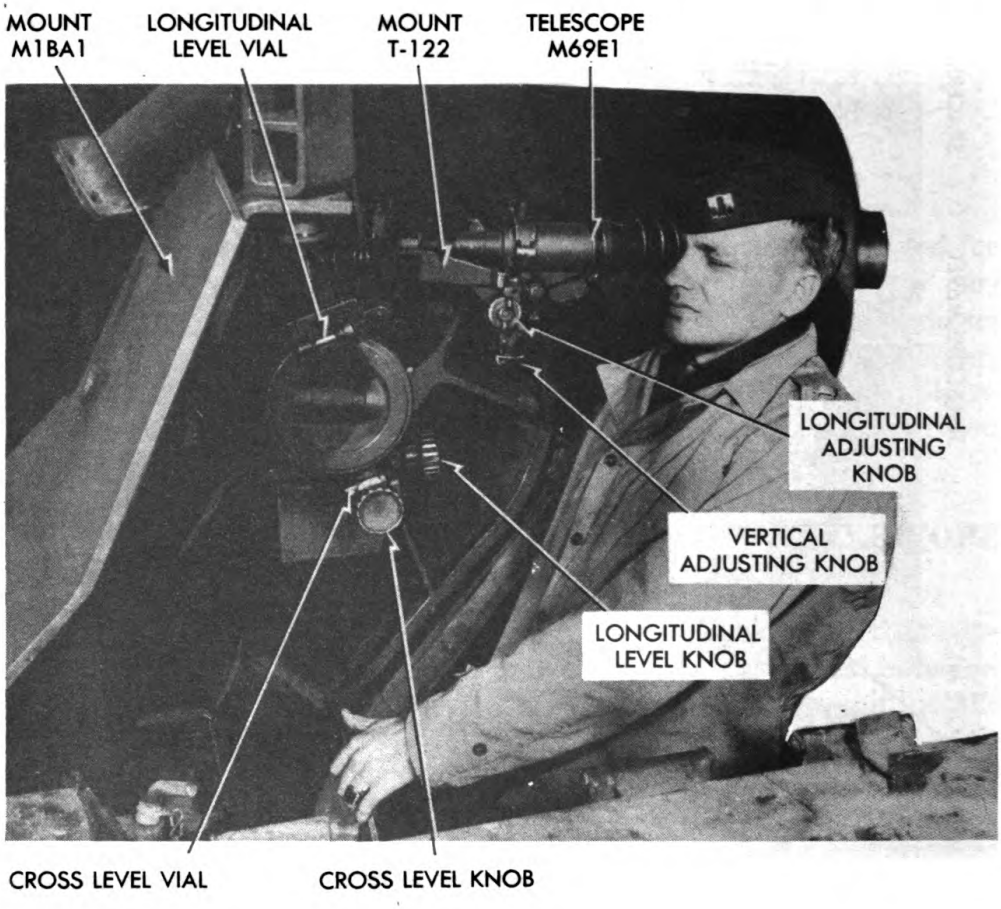


Figure 92—Sighting Equipment on Left Trunnion for 155-mm Gun Motor Carriage T83 - ¾ Rear View

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side slope. Provisions are also made for cross leveling and longitudinal leveling by level vials and knobs, so that the azimuth scale of the panoramic telescope is in a true horizontal plane. A canvas cover has been provided to protect the mount when the weapon is not being fired or when the vehicle is traveling.

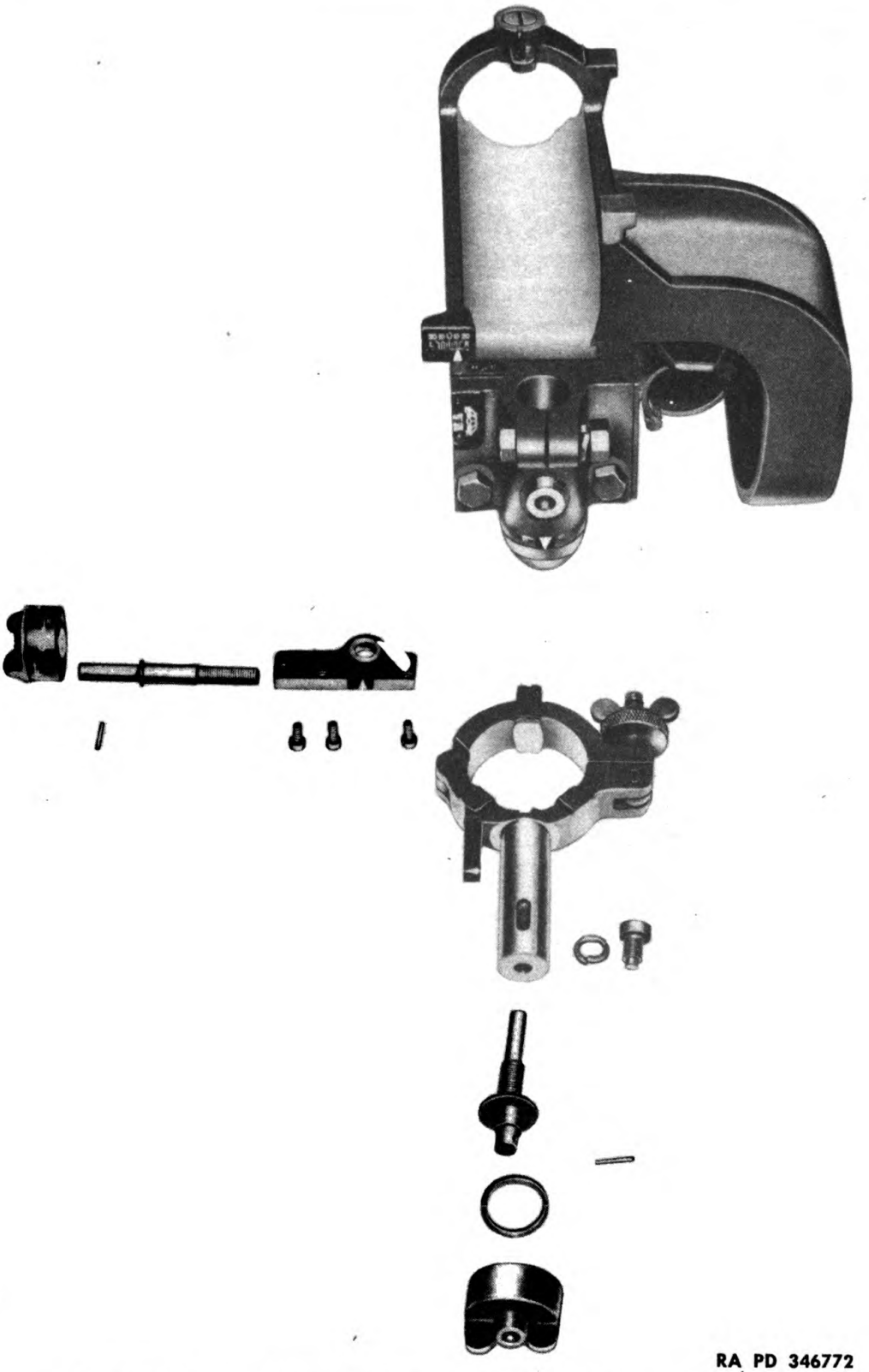
b. Panoramic Telescope M12. This telescope has cylindrical locating surfaces at the top and bottom for centering the telescope in its socket. The line of sight is elevated or depressed by means of the knob at the top. Coarse and fine index graduations are provided for the normal (zero elevations) position. The head is moved in azimuth by means of the azimuth worm knob, which has a throw-out lever to permit disengagement for rapid movement when required. Azimuth angles are measured on the azimuth scale and micrometer. The azimuth scale is graduated in 100-mil intervals, numbered progressively from 0 to 32



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Figure 93—Sighting Equipment on Left Trunnion for 155-mm Gun Motor Carriage T83—Side View

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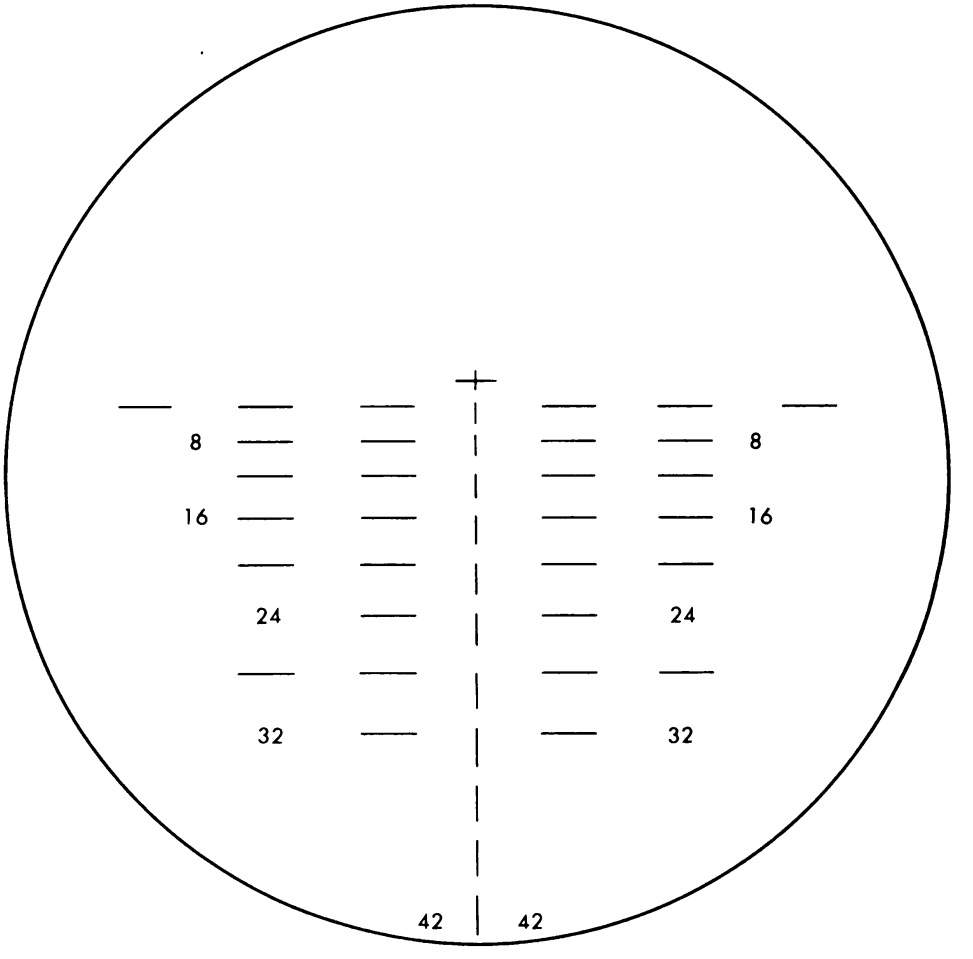
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Figure 94—Mount, Telescope, T122—Disassembled

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in two consecutive semicircles. The micrometer indications (1-mil intervals), on the deflection knob, supplement those on the azimuth scale. A detent causes a click at each 1-mil interval when the deflection knob is rotated. The panoramic telescope M12 is stowed in case D40871 which is located on the left side of the top carriage below the telescope mount (fig. 92).

c. Instrument Light, M19. Instrument light M19, consists of a bracket and battery case, with an electric lead, held firmly against the telescope socket by clamps in such a position that the horizontal leg of the telescope fits into the semitrailer notch in the lamp housing. Illumination is provided for the reticle, azimuth scale, azimuth micrometer, and indexes in the telescope and the cross level and longitudinal level of the mount during night firing. Instrument light M19 is stowed in chest M21, carried in the gun chest at the rear of vehicle.



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Figure 95—Reticle Pattern in Telescope, M69E1

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155. TELESCOPE MOUNT T122, TELESCOPE M69E1 (T117E6), AND INSTRUMENT LIGHT, M36.

a. Telescope Mount, T122. This mount is similar to telescope mounts provided in tanks and combat vehicles. This mount is located on the left cradle trunnion shaft of the top carriage between mount M18A1 and the trunnion bearing (see figs. 92, 93 and 94). Mount T122 with straight telescope M69E1 (T117E6) is the sighting element for laying the gun in azimuth and forms a part of the two-sight, two-man system for direct fire (see fig. 93). Provisions are made in this mount for small adjustments in elevation and azimuth during bore-sight (see figs. 93 and 94). This mount moves in azimuth and elevation with the tube providing direct sights for moving or stationary targets. A canvas cover has been provided to protect the mount when the weapon is not being fired or when the vehicle is traveling.

b. Telescope M69E1 (T117E6). This is a straight telescope similar to types on field carriages, and weighs 3 pounds. The reticle pattern for the 155-mm gun in this telescope is shown in figure 95. Telescope M69E1 is stowed in carrying case M70 (T16) (fig. 96) which is located on the left gunner's shield near mount T122.

c. Instrument Light, M36. Instrument light M36 consists of battery case, switch with electrical lead and lamp held firmly to the telescope mount by clamps. When mounted the light is positioned between

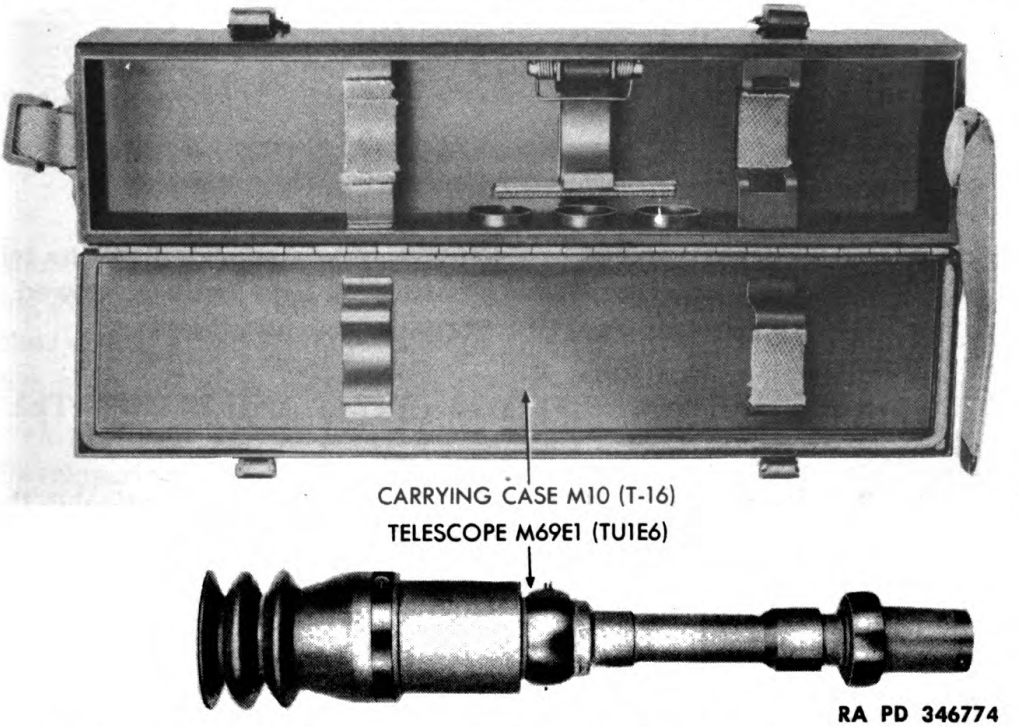
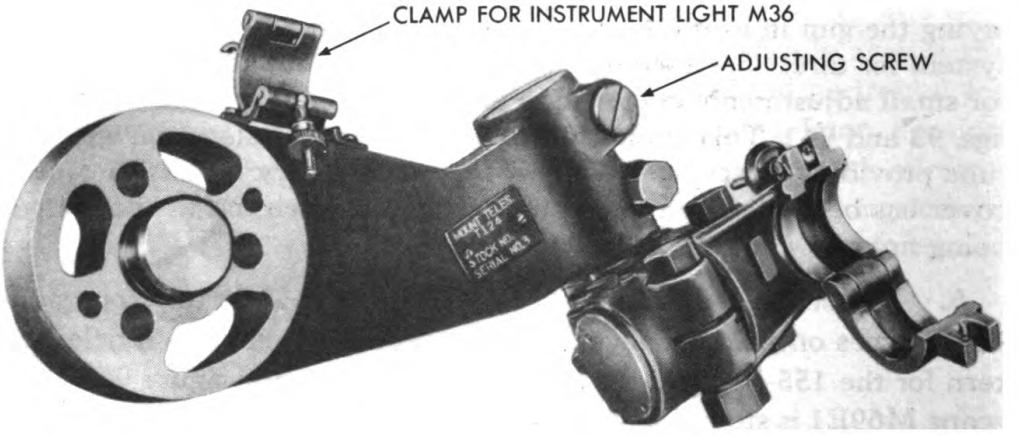


Figure 96—Telescope, M69E1, with Carrying Case, T16

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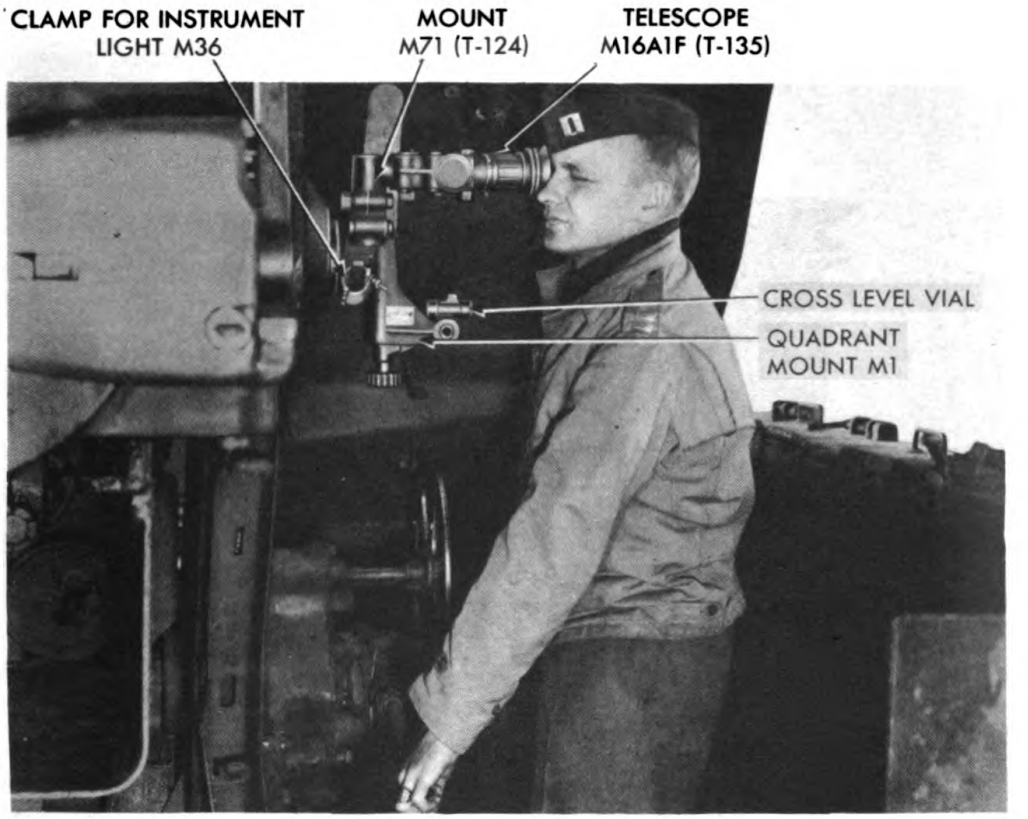
Figure 97—Mount, Telescope, T124 with Bracket Arranged for Mounting Telescope in Front of Trunnion

the mount and trunnion bearing. Illumination is provided for the telescope reticle during night firing. Instrument light M36 is stowed in chest M21 carried in the gun chest at the rear of the vehicle.

156. TELESCOPE MOUNT M71 (T124) AND ELBOW TELESCOPE M16A1F (T135).

a. ***Telescope Mount M71 (T124).*** This mount is identical to that supplied with the field piece and permits the use of an elbow telescope for elevation control during direct fire missions (fig. 97). Mount M71 is attached to the right cradle trunnion shaft and moves in azimuth and elevation with the tube (fig. 98). On the T83 and T89 the bracket mounting is positioned so that elbow telescope M16A1F (T135) is located behind the trunnion bearing. On the field piece the bracket mounting is rotated forward so that the elbow telescope is positioned

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RA PD 346776

Figure 98—Elbow Telescope, T135 on Mount, T124 with Mount Rotated so that Telescope Is in Rear of Trunnion

ahead of the trunnion. Mount M71 with telescope M16A1F is the sighting element for laying the gun in elevation and completes the part of the two-sight, two-man systems for direct fire (fig. 98). A canvas cover has been provided to cover this mount when the weapon is not in use.

b. Elbow Telescope M16A1F (T135). This elbow telescope was developed to permit direct fire of the weapon and is also being issued for the field piece (fig. 99). The reticle pattern for the 155-mm gun in this telescope is shown in figure 100. The elbow telescope is stowed in case D40871 which is located on the left side of the top carriage below mount T122.

c. Instrument Light, M36. This light, described in paragraph 155 *c*, is used to illuminate the reticle in telescope M16A1F during night firing (fig. 99).

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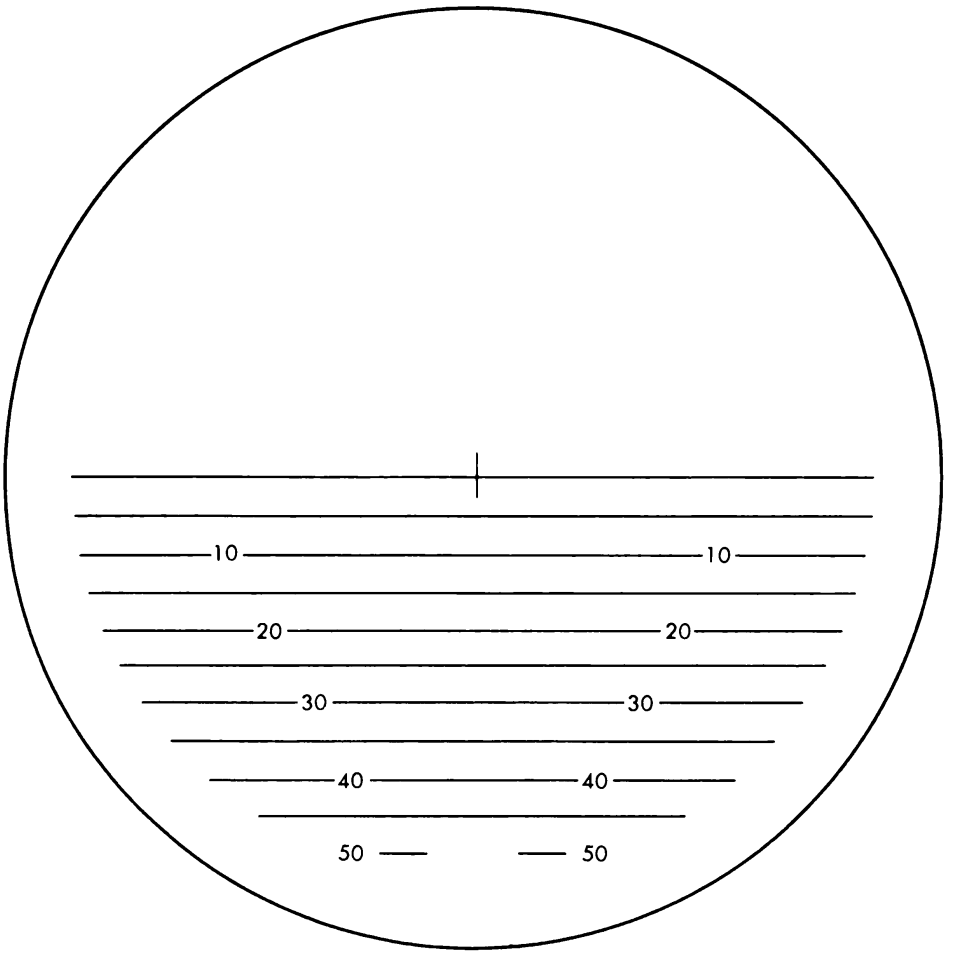
Figure 99—Elbow Telescope, M16A1F (T135) and Light, Instrument, M36

157. QUADRANT MOUNT M1, GUNNER'S QUADRANT M1, AND INSTRUMENT LIGHT M12.

a. Quadrant Mount M1. This mount is identical to that supplied with the field piece; however, it attaches to telescope mount M71 on line with the right cradle trunnion shaft (figs. 97 and 98). Quadrant mount M1 is used in conjunction with a gunner's quadrant for laying the gun in elevation and forms the sighting equipment for the second man for indirect fire. Any motion of the weapon in elevation causes the mount to rotate a like amount about the trunnion axis. A cross leveling mechanism is provided to keep the mount continuously cross leveled during operation.

b. Gunner's Quadrant M1. This quadrant includes a sector-shaped frame to which is pivoted an arm carrying a level. Notches on the frame engaging with a plunger in the arm permit rapid setting of

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Figure 100—Reticle Pattern in Elbow Telescope, M16A1F (T135)

the arm in 10-mil steps. The quadrant is used for laying the weapon in elevation during indirect fire. The quadrant M1 is carried in gunner's quadrant carrying case M18 which is stowed on the right gunner's shield near the quadrant mount.

c. Instrument Light M12. The instrument light M12 is a compact light complete with battery, switch, and a hand light connected to the battery by means of a rubber-covered wire. This instrument light provides illumination for the cross level on the mount and gunner's quadrant during night firing. Instrument light M12 is stowed in chest M21 at the rear of the vehicle when not in use.

158. AIMING POST M1, AND AIMING POST LIGHT M14.

a. Aiming Post M1. Two of these aiming posts are furnished with each vehicle. Each aiming post consists of two tubular sections, each approximately 4 feet long. The lower section has a metal point for

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embedding in the ground. The posts are painted with alternate 4-inch red and white bands. A canvas cover holding both sections is provided and stowed vertically near the right shell rack.

b. Aiming Post, Light M14. The lights consists of a battery case for two BA-30 batteries with a lamp housing and a toggle switch. A metal hood is provided for the lamp, which is carried around the battery case when not in use. A reflector is mounted in the back of the lamp and a color filter can be attached to the front of the lamp housing. These lights are clamped to the aiming post for use during night firing. A chest is provided to carry a section set comprised of two aiming post lights; one with red, one with green filters; eight BA-30 batteries, and two spare lamps. The batteries should always be removed from the battery case when not in use, in order that their deterioration on long standing will not damage the light. When not in use, the various parts of the light should be kept in the chest M21. The chest M21 is stowed in the gun chest at the rear of the vehicle.

159. BORE SIGHT.

a. The bore sighting equipment consists of: a breech bore sight RF-11-BB and muzzle bore sight RF-11-GD, designed for insertion in the corresponding parts of the gun. The purpose of bore sighting is to test the alinement of the sighting equipment for parallelism with the bore of the weapon. With the two elements in place, look through one of the large holes in the breech bore sight and move the gun until the aiming point can be seen through the muzzle bore sight, then look through the small hole and move the gun until the object appears in the opening at the center of the straightedge.

160. TESTING TARGET.

a. The testing target is used during the bore sighting operation for for the alinement of sights and subcaliber equipment with the axis of the bore of the gun. The aiming points are plainly designated. It is essential that the proper aiming points are selected for the materiel and sights employed, and that the target is positioned vertically when in use. The normal distance from the gun at which the target should be located is about 50 yards.

161. BORE SIGHTING (EMERGENCY).

a. For expediency bore sighting, position the vehicle on level terrain and sight on a well-defined object at least 2,000 yards distant. Remove the firing mechanism from the breechblock and while looking through the barrel aline the weapon with the distant object. Cross-level mounts M18A1 and M1, then observe through telescopes M12,

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M16A1F, and M69E1 to see if the respective lines of sight fall on the distant object. If they do not, adjust as follows:

(1) TELESCOPE M69E1 IN MOUNT T122. If the vertical or zero range lines do not fall on the distant object, loosen the clamping bolts in the mount which secure these adjustments. Turn the lateral and vertical adjusting knobs until coincidence is obtained. Tighten clamping bolts and note that coincidence is not lost.

(2) PANORAMIC TELESCOPE M12 IN MOUNT M18A1. With the azimuth worm knob, place the vertical line (optical center) of the reticle on the distant object. Likewise position horizontal cross hair on distant object. The azimuth scale and micrometer scale should both register zero. If either the azimuth scale or the micrometer scale do not register zero they may be brought to zero by loosening the locking screws and slipping the scales into coincidence. Tighten all locking screws securely.

(3) TELESCOPE M16A1F IN MOUNT M71. Correction of this sight is similar to directions outlined for telescope M69E1.

(4) QUADRANT MOUNT M1. Set the gunner's quadrant M1 to zero elevation and cross level the mount. The motion of the cross leveling mechanism is limited by stops in the segment and no attempts should be made to force the mechanism beyond its limits. Place the quadrant on the mount pads. If the bubble is centered turn it end for end to verify the accuracy of the quadrant. If the bubble is not centered, determine the elevation or depression angle necessary to center the bubble. One-half of this angle is the error and a corresponding correction should be applied to all future settings. Adjustments to the quadrant or mount are not permitted by the using arm.

Section XXXV

AMMUNITION

162. AUTHORIZED ROUNDS.

a. Authorized rounds for the 155-mm guns M1 and M1A1 are listed in Table I below. Authorized rounds for the 8-inch howitzer M1 are listed in Table II. It will be noted that standard nomenclature, which completely identifies the ammunition, is used in the listing. The use of standard nomenclature is mandatory for purposes of record except where use of Ammunition Identification Code (A.I.C.) symbols is prescribed to expedite requisitioning and reporting. Identification is provided for by painting and marking on each of the components, and on packing in accordance with the basic scheme described in TM 9-1900. In addition to the projectile, charge, and fuze listed in Table I or II, the Mk. IIA4 17-grain percussion primer is required for each complete round.

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TABLE I—AUTHORIZED ROUNDS FOR 155-MM GUNS M1 AND M1A1

Fig. No.	Projectile	Fuze for Which Adapted	Propelling Charge
	SERVICE AMMUNITION		
	ARMOR-PIERCING		
103	PROJECTILE, AP, 100-lb. M112, w/FUZE, BD, M60, 155-mm guns		CHARGE, propelling, NH powder, 155-mm guns M1 and M1A1
	CHEMICAL		
94	SHELL, gas, persistent, H, M104, unfuzed, 155-mm guns	FUZE, PD, M51 series, w/BOOSTER M21 series*	CHARGE, propelling, NH powder, 155-mm guns M1 and M1A1
—	SHELL, smoke, FS, M104, unfuzed, 155-mm guns		
—	SHELL, smoke, phosphorus, WP, M104, unfuzed, 155-mm guns		
—	SHELL, illuminating, M118B1, w/o fuze, 155-mm guns, all mods., or how. M1	FUZE, TSQ, M54	
—	SHELL, smoke, HC, BE, M117, unfuzed, 155-mm guns		
	HIGH EXPLOSIVE		
102	SHELL, HE, M101, unfuzed, 155-mm guns	FUZE, PD, M51 series, w/BOOSTER M20 or M21 series* or FUZE, TSQ, M55 series, w/BOOSTER M21 series† or FUZE, time, mechanical, M67 series, w/BOOSTER M21 series‡ or FUZE, CP, M78 and BOOSTER M25	

*FUZE, PD, M51, w/BOOSTER M20A1 or M21; M51A1, w/BOOSTER M20A1 or M21A1; M51A3, w/BOOSTER M21A2; or M51A4, w/BOOSTER M21A4.

The following limitations apply to the M51 fuze, and modifications:

FUZE, PD, M51 or M51A1, w/BOOSTER M20A1, for service use until a sufficient supply of M51A3 fuzes with M21A2 boosters or M51A4 fuzes, with M21A4 boosters are available; for practice.

FUZE, PD, M51, w/BOOSTER M21, or M51A1, w/BOOSTER M21A1, for emergency combat use only; must be drop-tested prior to use.

†FUZE, TSQ, M55, w/BOOSTER M21; M55A1, w/BOOSTER M21A1; M55A2, w/BOOSTER M21A2; or M55A3, w/BOOSTER M21A4.

‡FUZE, time, mechanical, M67 or M67A1, w/BOOSTER M21A1; M67A2, w/BOOSTER M21A2; or M67A3, w/BOOSTER M21A4.

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TABLE II—AUTHORIZED ROUNDS FOR 8-INCH HOWITZER M1

Fig. No.	Projectile	Fuze for Which Adapted	Propelling Charge
	SERVICE AMMUNITION**		
	HIGH EXPLOSIVE		
104	SHELL, HE, 200-lb., M106, unfuzed, 8-in. how. M1	FUZE, PD, M51 series, w/BOOSTER M20 or M21 series*; FUZE, time, mechanical, M67 series, w/BOOSTER M21 series† or FUZE, CP, M78 and BOOSTER M25	CHARGE, propelling, M1 (green bag), 8-in. how. M1 or CHARGE, propelling, M2 (white bag), 8-in. how. M1
—	SHELL, HE, 200-lb., M106, w/modified fuze cavity, unfuzed, 8-in. how. M1‡	FUZE, PD, T76E6‡	
—	SHELL, HE, 200-lb., M106, w/modified fuze cavity and supplementary charge, unfuzed, 8-in. how. M1††	FUZE, PD, M51 series, w/BOOSTER M21 series* or FUZE, time, mechanical, M67 series, w/BOOSTER M21 series†	
105	SHELL, HE, 200-lb., Mk. IA1, unfuzed, 8-in. how. M1	FUZE, PD, M51 series, w/BOOSTER M21 series*; FUZE, time, mechanical, M67 series, w/BOOSTER M21 series† or FUZE, CP, M78 and BOOSTER M25	

*FUZE, PD, M51, w/BOOSTER M20A1 or M21; M51A1, w/BOOSTER M20A1 or M21A1; M51A3, w/BOOSTER M21A2; or M51A4, w/BOOSTER M21A4.

The following limitations apply to the M51 fuze, and modifications:

FUZE, PD, M51 or M51A1, w/BOOSTER M20A1 for service until a sufficient supply of M51A3 fuzes with M21A2 boosters or M51A4 fuzes with M21A4 boosters are available for practice.

FUZE, PD, M51, w/BOOSTER M21 or M51A1, w/BOOSTER M21A1, for emergency combat use only; must be drop-tested prior to use.

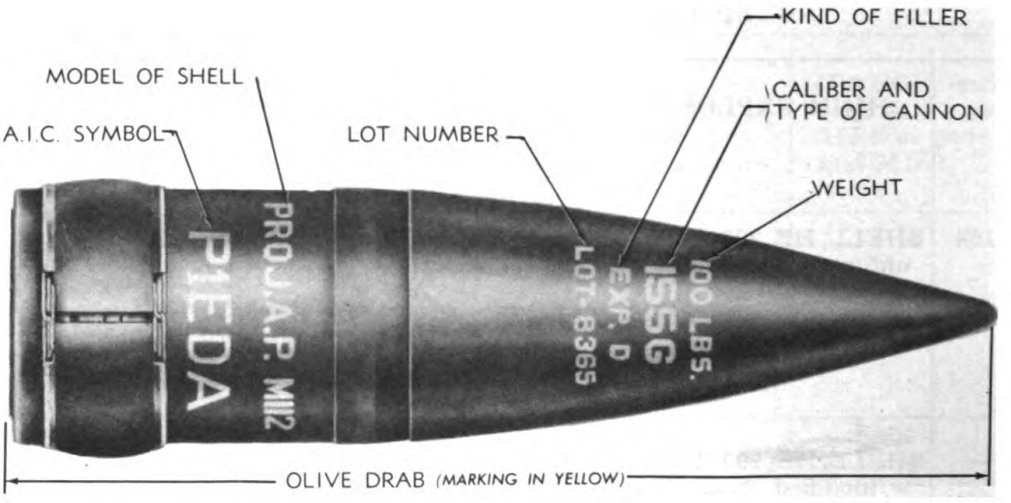
†FUZE, time, mechanical, M67 or M67A1, w/BOOSTER M21A1; M67A2, w/BOOSTER M21A2; or M67A3, w/BOOSTER M21A4.

‡When fitted with supplementary charge, this shell is adapted for FUZE, PD, M51 series, w/BOOSTER M20 or M21 series, or FUZE, time, mechanical, M67 series, w/BOOSTER M21 series.

**Other primers which may be used if PRIMER, percussion, 17-grain, Mk. IIA4 is not available are: PRIMER, percussion, 18-grain, Mk. IIA3, or PRIMER, percussion, 21-grain, Mk. II, Mk. IIA, or Mk. IIA1. PRIMER, percussion, 21-grain, Mk. IIA1, is restricted to use in 155-mm howitzers only, except for certain lots. See ORD 11 SNL R-3.

††Without supplementary charge, this projectile is adapted for FUZE, PD, T76E6.

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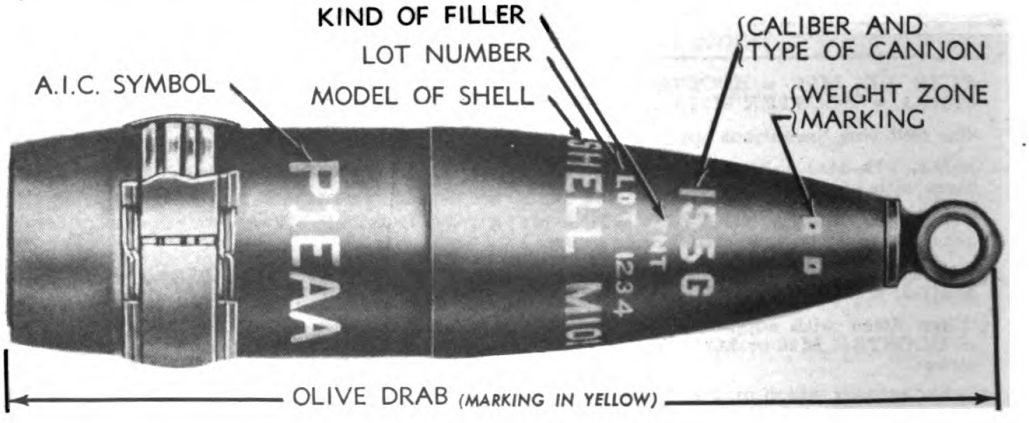
RA PD 26822

Figure 101—100-lb AP Projectile M112 for 155-mm Guns

163. PREPARATION FOR FIRING.

a. Projectiles. Aside from removal of grommet and lifting plug, it is only necessary to fuze those shells which are shipped uncrated and unfuzed. The armor-piercing shell need only be taken from its box and the grommet removed to prepare it for firing.

b. Propelling Charges. After the charge has been removed from its moisture-proof container, it is only necessary to remove the igniter protector cap and data tag. However, in the case of the propelling charge for the 155-mm guns M1 and M1A1, it is necessary to assemble



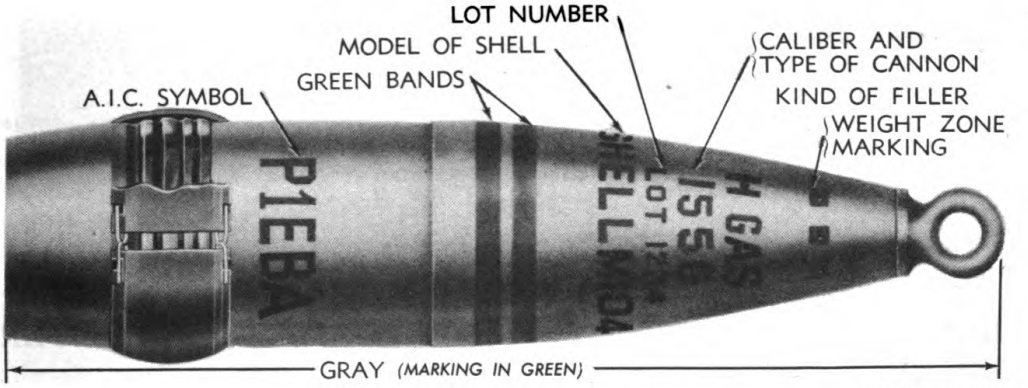
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Figure 102—HE Shell M101 for 155-mm Guns

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the flash reducer M1 to the charge for night firing. The charge must be loaded into the weapon with the igniter (cloth dyed red) toward the breech. When it is desired to fire less than the full charge, the tying straps are tied over the base charge.

c. ***Primers*** (fig. 97). To prepare a primer for firing it is only necessary to insert it into the firing mechanism.



RA PD 65117

Figure 103—H Filled Gas Shell M104



RA PD 80819

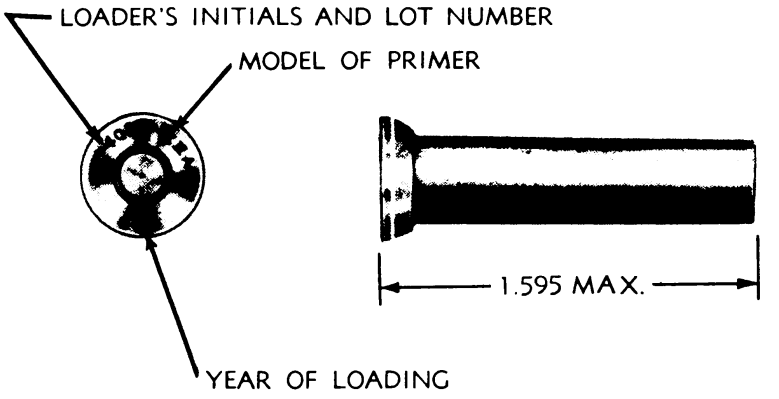
Figure 104—200-lb HE Shell M106 for 8-inch Howitzer M1



RA PD 80820

Figure 105—200-lb HE Shell MK. IA1 for 8-inch Howitzer M1

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Figure 106—17-Grain Percussion Primer MK. IIA4

164. FUZES.

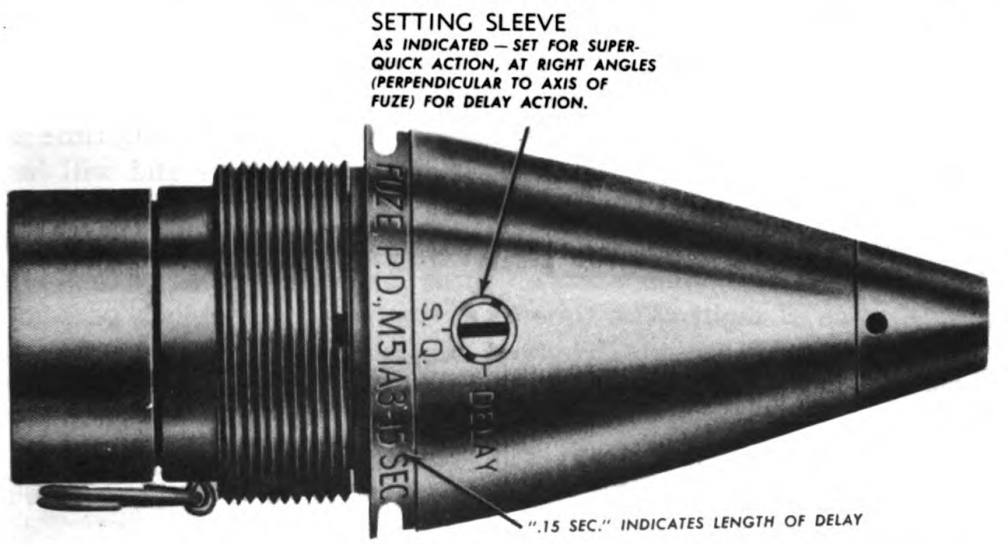
a. FUZES, PD, M51, w/BOOSTER M21; M51A1, w/BOOSTER M21A1; M51A3, w/BOOSTER M21A2; M51A4, w/BOOSTER M21A4*.

(1) GENERAL. The fuzes and boosters making up these assemblies are essentially the same in principle, but differ in various respects due to modifications of either the fuze or the booster, as follows: The M51A1 differs from the M51 only with respect to the booster; the M21A1 booster has a ¼-inch flash hole in its rotor cover as compared with a ⅛-inch flash hole in the M21 booster. In the M51A3 and M51A4, the delay action is further modified to provide for a 0.15-second delay instead of 0.05-second as in the earlier models. The M21A1 booster assembled to the M51A3 fuze is also a modification of the earlier boosters, adding a set-back pin for additional insurance against premature or accidental functioning. The M21A4 is a further modification of the M21A2.

(2) DESCRIPTION. In all of the fuzes (fig. 98) the booster is permanently attached to the fuze at the time of manufacture. Thereafter, the fuze with booster is handled as a unit. The fuze contains two actions, superquick and delay. Although both actions are initiated on impact, the functioning of the shell depends upon the setting of the fuze. When the fuze is set "DELAY," the superquick action is so interrupted that the projectile functions with delay action. It should be noted, however, that if the superquick action malfunctions when the fuze is set "SQ," the projectile will function with delay action rather than become a dud. On the side of the fuze near the base is a slotted "setting sleeve" and two

*FUZE, PD, M51, w/BOOSTER M21; and the M51A1, w/BOOSTER M21A1 are authorized for emergency combat only and must be drop-tested before use. The M51 or M51A1, w/BOOSTER M20A1 is authorized for service use until supplies of M51A3, w/BOOSTER M21A2 and M51A4, w/BOOSTER M21A4 become available.

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RA PD 15053

Figure 107—PD Fuze M51A3 w/Booster M21A2

registration lines; the one parallel to the axis is marked "SQ," the other "DELAY." As shipped, the fuze is set "SQ." To set the fuze for delay action it is only necessary to turn the setting sleeve so that its slot is alined with "DELAY." A delay pellet, 0.15-second in the M51A3 and M51A4, and 0.05-second in the M51 and M51A1 fuzes—incorporated in the delay action train provides for the delay action. The setting may be made or changed at will with a screwdriver or some other similar tool any time before firing. This can be done even in the dark by noting the position of the slot—parallel to the fuze axis for superquick action, at right angles thereto for delay. A cotter pin with pull ring is assembled to the booster to prevent accidental movement of the detonator during shipment. This cotter pin is to be withdrawn just prior to assembling the fuze with booster to the projectile.

(3) PREPARATION FOR FIRING. To fuze the projectile, proceed as follows:

(a) Remove eye bolt lifting plug from projectile.

(b) Inspect fuze cavity and threads. They should be free of foreign matter which would interfere with the proper assembly of the fuze.

(c) Remove cotter pin from booster.

(d) Screw fuze with booster into projectile by hand. Tighten with fuze wrench.

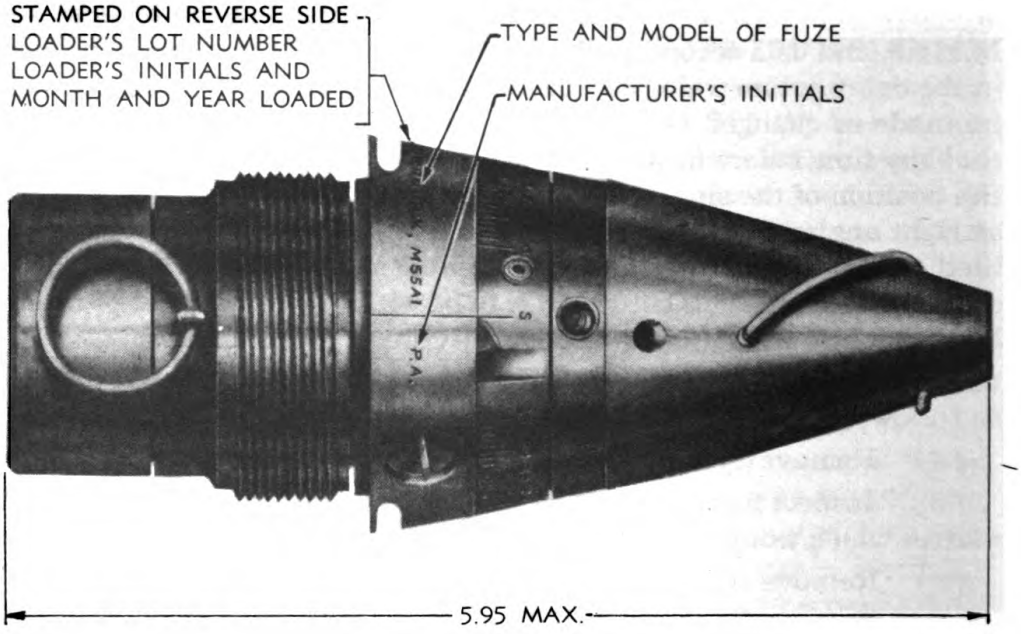
(e) *Set fuze.* If delay action is required, aline slot in setting sleeve with "DELAY"; if superquick, aline slot with "SQ" setting as shipped. Fuze may be reset as required.

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b. *FUZE, TSQ, M54.*

(1) DESCRIPTION. This fuze is a combination time and superquick type. A safety pull wire extends through the fuze to secure the time plunger during shipment. The fuze contains two actions, time and superquick. The superquick action is always operative and will function on impact unless prior functioning has been caused by time action. Therefore, to set the fuze for superquick action, it is required that the time action be set either at safe (S) or for a time longer than the expected time of flight. The time-train ring of pressed black powder is graduated for 25 seconds. To prevent extremely short time action, an internal safety feature prevents the time action from functioning should the fuze be set for less than 0.4 second. Therefore, when setting for time action, the setting should always be greater than this minimum of 0.4 second. The fuze as shipped is set safe (S); prior to firing, fuze is set for required time by means of a fuze setter.

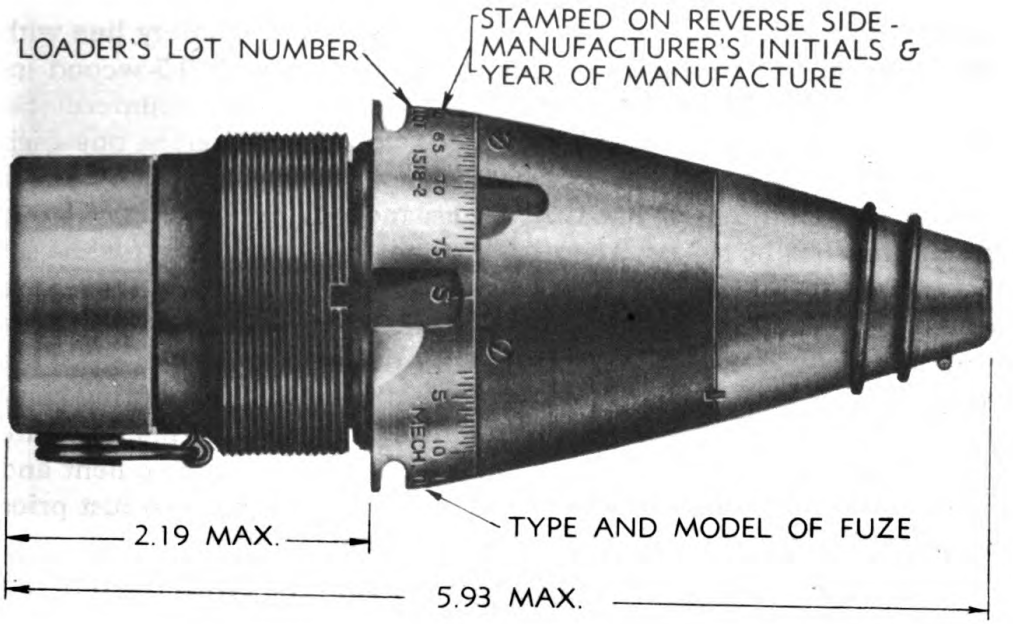
(2) PREPARATION FOR FIRING. After assembly of the fuze to the projectile and prior to firing, the safety pull wire must be withdrawn from the fuze for either superquick or time setting. To do this, pull lower end of the wire from the hole and slide wire off the end of the fuze. If superquick action is required, the graduated time-train ring can be left as shipped (set at safe (S)), or set for a time greater



RA PD 1032A

Figure 108—TSQ Fuze M55A1 w/Booster M21A1

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RA PD 7209

Figure 109—Mechanical Time Fuze M67A1 w/Booster M21A1

than the expected time of flight. If time action is required, the graduated time-train ring is set for the required time of burning by means of a fuze setter. NOTE: *If, after setting the fuze preparatory to firing, the round is not fired, the fuze will be reset "safe" (S) and the safety pull wire replaced in its proper position before the round is returned to its packing container.*

c. FUZE, TSQ, M55, w/BOOSTER M21; M55A1, w/BOOSTER M21A1; M55A2, w/BOOSTER M21A2; M55A3, w/BOOSTER M21A4. This fuze (fig. 99) functions in the same manner as the M54, with the one exception that the M55 series is issued with booster. The body of both the M54 and M55 fuzes are of identical design. The boosters are of the M21 series described in subparagraph *a* above.

d. FUZE, Time, Mechanical, M67 or M67A1, w/BOOSTER M21A1, M67A2, w/BOOSTER M21A2; M67A3, w/BOOSTER M21A4.

(1) DESCRIPTION. The M67 and its modifications (fig. 100) are essentially alike, and are intended to provide a means of high-burst adjustment at longer ranges when firing the high-explosive shell. The primary differences occur in booster modifications as described in subparagraph *a* above. The fuze is of the mechanical (clockwork) time type, and is similar to the M43 type fuze in contour and in design except that the escapement mechanism has been modified to give a longer

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burning time. There is no impact element. The upper and lower caps are staked together and turn as a unit when setting the fuze. A set or register line is stamped on the rim of the lower cap. A safety line with "S" below it, and time graduations to 75 seconds with 0.5-second intervals, are stamped on the body. The graduations run counterclockwise viewed from the point of the fuze. Two setting grooves, one each on the lower cap and body, are provided for setting the fuze. A safety feature incorporated in the fuze is designed to prevent functioning should the fuze be set for 3 seconds or less. As shipped, the fuze is set "safe," that is, the set line in the lower cap is in alinement with the safety line "S" in the body. A pull wire is fitted to the fuze to secure the firing pin prior to firing. A cotter pin with pull ring is assembled to the booster to prevent accidental movement of the detonator during shipment. The booster is assembled to the fuze at the time of manufacture and handled thereafter as a single unit with the fuze, in shipment and assembly to the projectile. The cotter pin is to be withdrawn just prior to assembling the fuze with booster to the shell.

(2) PREPARATION FOR FIRING. To fuze the projectile proceed as follows:

(a) Remove the eye bolt lifting plug from the projectile.

(b) Inspect the fuze cavity and threads. They should be free of foreign matter which would interfere with the proper assembly of the fuze.

(c) Remove the cotter pin from the booster.

(d) Screw the fuze with booster into the projectile by hand. Tighten with the fuze wrench.

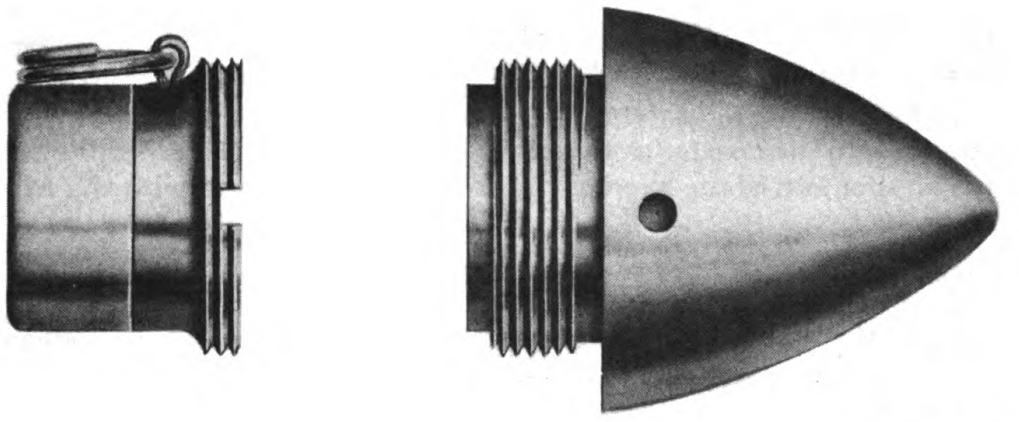
(e) Remove the safety pull wire. This can be done readily by pulling the end of the wire from the hole in the lower cap and sliding the wire off the end of the fuze.

(f) Set fuze by means of fuze setter, the lower cap being turned in a counterclockwise direction as viewed from the point of the fuze. The torque required to set the fuze is between 80 and 100 inch-pounds.

e. FUZE, CP, M78 (T105) and BOOSTER M25 (T1E1)

(1) DESCRIPTION. The M78 (T105) concrete-piercing fuze and M25 (T1E1) booster (fig. 101) are used to convert the HE shell M101 or Mk. IIIA1 into a concrete-piercing shell. In this case both the fuze and booster are shipped in the same container, but as separate components. The fuze is a solid hardened steel nose plug which contains a detonator assembly in its base. It is shorter and heavier than the fuzes described in paragraphs above. The fuze M78 is fitted with either a 0.025-second delay or nondelay element; the amount of delay is as indicated by the stamping on the body of the fuze. NOTE: *All fuzes T105 were equipped with 0.05-second delay detonator assemblies dur-*

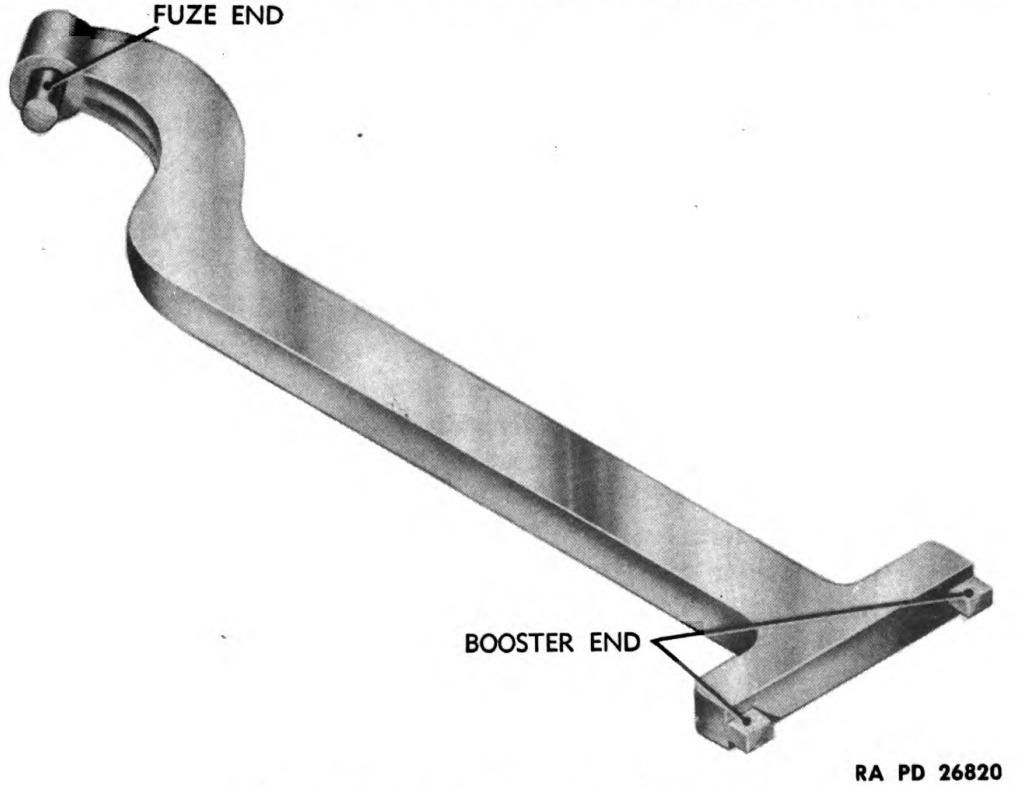
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RA PD 26821

Figure 110—Booster M25 and CP Fuze M78

ing the early development of this fuze. Nondelay fuzes are designed primarily for spotting purposes. Fuzes with 0.025-second delay elements are designed to be used for firing for effect. The booster M25 (T1E1) is a modified M21A2 booster containing approximately 3 external threads rather than 6. A cotter pin with pull ring, which is located



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Figure 111—Wrench for M78 Fuze

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in the booster body, must be removed prior to assembly of the booster to the shell. This booster is intended for use only with FUZE, CP, M78 (T105).

(2) PREPARATION FOR FIRING. After removal of lifting plug from projectile, proceed as follows:

(a) Remove the safety pin from the M25 booster and screw the booster into the booster cavity in the shell. Tighten booster firmly with the booster end of the wrench (fig. 102) which is issued with the M78 fuzes.

(b) Screw the M78 fuze into the fuze cavity and tighten securely with fuze end of wrench. Be sure that the fuze shoulder seats firmly against the nose of the shell—there should be no space between shoulder of fuze and shell. Do not stake fuze to the shell.

APPENDIX

Section XXXVI

REFERENCES

165. PUBLICATIONS INDEXES.

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

Introduction to Ordnance Catalog (explains SNL system)	ASF Cat. ORD-1 IOC
Ordnance publications for supply index (index to SNL's)	ASF Cat. ORD-2 OPSI
Index to ordnance publications (lists FM's, TM's, TC's and TB's of interest to Ordnance personnel, MWO's, OPSR's, BSD, S of SR's, OSSC's and OFSB's. Includes alphabetical listing of Ordnance major items with publications pertaining thereto)	OFSB 1-1
List of publications for training (lists MTP's, TR's, TC's, FM's, TM's, WDTB's, Firing Tables and Charts and Lubrication Orders)	FM 21-6
List of miscellaneous publications (lists MP's, MWO's, SB's, RR's and War Department Pamphlets)	WD Pamphlet 12-6

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List of training films, film strips and film bulletins (lists TF's, FS's and FB's by serial number and subject) ..... FM 21-7

Military training aids (lists graphic training aids, models, devices, and displays) ..... FM 21-8

166. STANDARD NOMENCLATURE LISTS.

a. Ammunition.

Ammunition, fixed and semifixed, including subcaliber, for pack, light and medium field, aircraft, tank and antitank artillery, including complete round data.. SNL R-1

Ammunition instruction material for antiaircraft, harbor defense, heavy field, and railway artillery, including complete round data..... SNL P-8

Ammunition instruction material for grenades, pyrotechnics, and aircraft bombs..... SNL S-6

Ammunition, revolver, automatic pistol, and submachine gun ..... SNL T-2

Ammunition, rifle, carbine, and automatic gun..... SNL T-1

Charges, propelling, separate loading, 6-inch to 240-mm, inclusive, for harbor defense, heavy field, and railway artillery..... SNL P-2

Fuzes, primers, blank ammunition, and miscellaneous items for antiaircraft, harbor defense, heavy field, and railway artillery..... SNL P-7

Grenades, hand and rifle, and fuzing components.... SNL S-4

Packing materials used by field service for small arms service ammunition ..... SNL T-5

Projectiles, separate loading, 6-inch to 240-mm, inclusive, for harbor defense, heavy field, and railway artillery, including complete round data..... SNL P-1

Service fuzes and primers for pack, light, and medium field artillery..... SNL R-3

b. Armament.

Carbine, cal. .30, M1..... SNL B-28

Gun, 155-mm M1 or M1A1..... SNL D-24

Howitzer, 8-in. M1..... SNL D-29

Launcher, grenade, M8..... SNL B-39

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c. Sighting Equipment.

Lights, instrument	SNL F-205
Mount, quadrant, M1 (for 155-mm gun carriage M1 and 8-inch howitzer M1)	SNL F-180
Mount, telescope, M12	SNL F-86
Periscopes, telescopes for periscopes, and direct sighting telescopes for use in tanks	SNL F-235
Post, aiming	SNL F-35
Quadrant, gunner's, M1 (mils)	SNL F-140

d. Maintenance.

Antifriction bearings and related items ORD 5	SNL H-12
Cleaning, preserving and lubricating materials: recoil fluids, special oils, and miscellaneous related items, ORD 5	SNL K-1
Elements, oil filter, ORD 5	SNL K-4
Lubricating equipment, accessories, and related dispensers, ORD 5	SNL K-3
Soldering, brazing and welding materials, gases and related items, ORD 5	SNL K-2
Standard hardware, ORD 5	SNL H-1
Tool-sets for maintenance of sighting and fire control equipment	SNL F-272
Tools, maintenance, for repair of automatic guns, antiaircraft materiel, automatic and semiautomatic cannon, and mortars, ORD 6	SNL A-35
Tools, maintenance, for repair of automotive and semiautomotive vehicles:	
ORD 6, Tool-sets (special) automotive and semiautomotive	SNL G-27 (Section 1)
ORD 6, Tool-sets (common) specialists' and organizational	SNL G-27 (Section 2)

167. EXPLANATORY PUBLICATIONS.

a. Fundamental Principles.

Automotive electricity	TM 10-580
Ammunition, general	TM 9-1900
Auxiliary fire-control instruments (field glasses, eyeglasses, telescopes and glasses)	TM 9-575

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References

Basic maintenance manual	TM 38-250
Browning machine gun, cal. .50, HB, M2 (mounted in combat vehicles)	FM 23-65
Driver's manual	TM 10-460
Driver's selection and training	TM 21-300
8-inch howitzer materiel	TM 9-335
Electrical fundamentals	TM 1-455
Field artillery and field mortar ammuniton	OFSB 3-3
Fuels and carburetion	TM 10-550
Firing tables for: Gun, 155-mm, M1 and M1A1 Shell, H.E. M101, w/fuze, P.D., M51 and mod's., w/fuze, time mech., M67 and M67A1 Shell, chemical, M104, w/fuse, P.D., M51 and mod's.	FT 155-S-2
Firing tables for: Howitzer, 8-inch, M1 Shell, H.E., 200-lb M106 w/fuze, P.D., M51 and mod's., w/fuze, time mech., M67 and M67A1	FT 8-J-1
Instruction guide, small arms data	TM 9-2200
Military motor vehicles	AR 850-15
Motor vehicle inspections and preventive maintenance service	TM 9-2810
155-mm gun materiel	TM 9-350
Ordnance service in the field	FM 9-5
Precautions in handling gasoline	AR 850-20
Qualifications in arms and ammunition training allowances	AR 775-10
Range regulations for firing ammunition for training and target practice	AR 750-10
Small arms ammunition	TM 9-1990
Small arms ammunition	OFSB 3-5
Standard military motor vehicles	TM 9-2800
Targets, target materials, and rifle range construction	TM 9-855
U. S. Carbines, cal. .30, M1 and M1A1	FM 23-7

b. Maintenance and Repair.

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

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Maintenance and care of pneumatic tires and rubber treads	TM 31-200
Ordnance Maintenance: Accessories for Wright R975-EC2 engines for Medium Tanks M3 and M4 (Scintilla magnetos)	TM 9-1750D
Ordnance Maintenance: Auxiliary generator (Homelite Model HRUH-28) for Medium Tanks M4 and modifications	TM 9-1731K
Ordnance Maintenance: Ordnance engine model R975-C4 (Continental)	TM 9-1725
Ordnance Maintenance: Electrical equipment (Auto-Lite)	TM 9-1825B
Ordnance Maintenance: Fuel pumps	TM 9-1828A
Ordnance Maintenance: Power train unit, one-piece differential case, for Medium Tanks M3, M4 and modifications and related gun motor carriages	TM 9-1750B
Ordnance Maintenance: Tank, Medium, M4 and modifications, horizontal volute suspension	TB 9-1750K-2
Ordnance Maintenance: Speedometer, tachometers, and recorders	TM 9-1829A

c. Protection of Materiel.

Camouflage	FM 5-20
Decontamination	TM 3-220
Decontamination of armored force vehicles	FM 17-59
Defense against chemical attack	FM 21-40
Explosives and demolitions	FM 5-25

d. Storage and Shipment.

Ordnance company, depot	FM 9-25
Ordnance storage and shipment chart, group G—Major items	OSSC-G
Registration of motor vehicles	AR 850-10
Rules governing the loading of mechanized and motorized army equipment also major caliber guns, for the United States Army and Navy, on open top equipment published by Operations and Maintenance Department of Association of American Railroads.	
Storage of motor vehicle equipment	AR 850-18

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INDEX

A — Page No.

Accelerator, foot, description and location 27
Accelerator linkage, maintenance operation 77
Accessories and belts, preliminary service upon receipt of equipment 23
Adjustment
  breaker points
    Bosch magneto 121
    Scintilla magneto 126
  clutch release linkage 163
  engine idling speed 136
  governor 135
  idle cut-off and degasser 139
  idle fuel mixture 136
  pressure relief valve 114
  steering brake linkage 184
  track tension 203
  valve clearance 110
Aiming post light M14, description 248
Aiming post M1, description 247
Air cleaners (and breathers)
  after-operation service 62
  at-halt service 60
  cleaning and servicing 133
  description 133
  lubrication 47
  maintenance 133
  maintenance operation 74
  operation under unusual conditions 38
  preliminary service upon receipt of equipment 23
Air inlet shutter
  installation 106
  removal 99
Air intake tubes, operation under unusual conditions 38
Ammeter
  before-operation service 56
  description and location 33
  road test 67
  service upon receipt of equipment 25
Ammunition
  authorized rounds 249
  fuzes 254
  preparation for firing 252
Armament
  characteristics 228
  differences among models 228
  maintenance instructions 80

Page No.

  operation instructions 230
  recoil mechanism 229
  sighting and fire control equipment 238
  weights, dimensions, and ballistics of the 155-mm guns M1 and M1A1 and 8-inch howitzer M1. 229
Armament and ammunition stowed in the vehicle 16
Army motor vehicle operator's permit, description 5
Assembly
  dual support rollers 210
  idler wheels and bracket 207
  single support rollers 211
  suspension assembly 217
  transmission differential 193
Authorized rounds of ammunition. 249
Auxiliary equipment
  fixed fire extinguisher system ... 226
  portable fire extinguisher system 227

B

Batteries
  after-operation and weekly service 61
  care of, in cold weather 40
  maintenance operation 77
  preliminary service upon receipt of equipment 23
Battery and lighting system
  batteries 145
  battery switch box 146
  blackout driving light 153
  description 143
  dome lights 154
  generator 148
  generator regulator 150
  headlights 150
  instrument lights 154
  taillights 153
Battery charging system
  description 225
  replacement 226
  trouble shooting 90
Bearing, clutch release, lubrication 47
Bearings, clutch pilot and hub, lubrication 47
Before-operation service 54
Blackout driving light, description 153
Bogie, maintenance operation 71
Booster coil, replacement 132

Digitized by Google

Original from UNIVERSITY OF CALIFORNIA

B—Cont'd Page No.

Bore sight, description..... 248
Bore sighting..... 248
Brakes, parking and steering
description 29, 187
during-operation service..... 58
maintenance operation 78
preliminary service upon receipt of equipment..... 24
removal and installation of pawls and springs..... 187
road test..... 67
run-in test 25
Breech (and firing) mechanism
lubrication 47
operation 232

C

Carburetor
adjustment
engine idling speed..... 136
idle fuel mixture..... 136
data 136
description 136
installation 138
maintenance operation 74
removal 138
Characteristics:
armament 228
sighting and fire control equipment 238
Circuit breakers, description and location 32
Cleaning
air cleaners..... 133
fuel filters..... 134
idler wheels and bracket parts.. 205
Clutch
clutch pedal
description 166
installation 167
removal 166
clutch pilot bearing
installation 162
removal 162
clutch release bearing
installation 163
removal 162
clutch release linkage
adjustment 163
description 163
clutch throw-out bearing shoes
installation 166
removal 163
description 154

Page No.

during-operation service..... 58
installation 158
removal 158
road test..... 68
run-in test 26
trouble shooting 94
Cold weather operation..... 38
Controls and gages
controls 27
instruments 33
Counterbalance, lubrication..... 52
Cradle trunnion bearings, lubrication 52
Crew maintenance (first echelon). 54
Cylinders, maintenance operation. 74

D

Data
battery and lighting system..... 145
carburetor 136
engine 98
generator 148
generator regulator..... 150
horizontal volute spring suspension 201
ignition system..... 121
oil filter 118
recoil mechanism..... 229
starting system 142
suspension 11
Demolition to prevent enemy use, detailed instructions..... 41
Description
air cleaners..... 133
batteries 145
battery and lighting system.... 143
battery switch box..... 146
blackout driving light..... 153
carburetor 136
clutch 154
clutch pedal..... 166
clutch release linkage..... 163
dome light..... 154
drive sprockets..... 211
engine 97
engine lubrication system..... 111
fuel and air intake and exhaust system 133
fuel filters..... 133
fuel tanks and gage..... 140
gage sending units..... 116
generator 148
generator regulator 150
headlights 150

Digitized by Google

Original from UNIVERSITY OF CALIFORNIA

D—Cont'd

Page No.

Description—cont'd
horizontal volute spring suspension 201
horn 172
hull 220
idle cut-off and degasser..... 139
ignition system 121
instruments and horn..... 167
motor carriage 8
oil cooler 119
oil filter 118
oil supply tank..... 120
oil pressure and suction pump.. 114
oil temperature control valve... 120
periscopes 220
portable fire extinguishers..... 227
propeller shafts and universal joints 172
shock absorbers..... 212
starting system..... 142
steering brake shoes..... 174
suspension assembly 212
terminal boxes..... 223
transmission and final drive assembly 173
valve rocker assembly and push rods 108
vehicle wiring 221
Determining shim thickness..... 193
Differences among models of armament 228
Differences between models of motor carriages..... 8
Differential, maintenance operation 70
Disassembly
dual support rollers..... 210
idler wheels and bracket..... 205
single support rollers..... 211
suspension assembly 216
transmission differential..... 191
Dome lights
description 154
replacement 154
Doors, hatch and emergency escape, description 9
Draining and filling lubrication system 111
Drive sprockets
description 211
installation 212
removal 212
Driver and assistant driver's cupola
description 220
installation 220
removal 220

Page No.

Driver's report—accident, motor transportation, description..... 5
Driver's trip ticket and preventive maintenance service record, description 5
Driving precautions..... 36
Dual support rollers
assembly and installation..... 210
removal and disassembly..... 210
Duty roster, description..... 7

E

Elbow telescope M16A1F (T135), description 245
Electrical system, operation in cold weather 40
Electrical wiring
after-operation service 61
preliminary service upon receipt of equipment..... 23
Elevating mechanism, lubrication. 53
Engine
data 10, 98
description 9, 97
installation 102
maintenance 108
removal 99
run-in test 26
trouble shooting..... 82
Engine and controls, during-operation service..... 58
Engine compartment cover
installation 106
removal 99
Engine lubricating system
description 111
draining and filling system..... 111
gage sending units..... 116
oil cooler 119
oil filter 118
oil pressure and suction pump.. 114
oil suction strainer..... 119
oil supply tank..... 120
oil temperature control valve... 120
trouble shooting..... 85
Engine oil temperature gage
before-operation service..... 56
description and location..... 33
road test..... 67
service upon receipt of equipment 25
Equilibrator case and plunger, lubrication 47
Equilibrator guide bearings, lubrication 52

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

E—Cont'd Page No.

Exchange part or unit identification tag 8
Exhaust manifolds
installation 141
removal 141
Exhaust pipes (and tail pipes)
installation 106, 142
removal 102, 141

F

Fenders, removal and installation. 221
Field replacement of magnetos and emergency adjustments..... 131
Final drive
lubrication in cold weather.... 39
maintenance operation 70, 78
trouble shooting..... 95
Final reduction assemblies
installation 188
removal 187
Fire extinguishers
after-operation service..... 61
before-operation service..... 55
preliminary service..... 22
(*See also* Fixed fire extinguisher system)
Firing the weapon..... 236
Fixed fire extinguisher system
description 226
removal and installation of cylinders 227
Fuel and air intake and exhaust system
air cleaners..... 133
carburetor 136
description 133
exhaust manifolds..... 141
exhaust pipes and tail pipes.... 141
fuel tanks and gage..... 140
fuel tubes and valves..... 138
governor 135
idle cut-off and degasser..... 139
primer and fuel pump..... 134
trouble shooting..... 84
Fuel filters
after-operation service 62
description 133
installation 134
maintenance operation..... 75
removal and cleaning..... 134
Fuel gage
before-operation service..... 56
description and location..... 33
road test..... 67
service upon receipt of equipment 25

Page No.

Fuel shut-off valves, description and location..... 27
Fuel tanks and gage
description 140
removal and installation of vertical and horizontal tanks..... 140
Fuel tubes and valves, replacement 138
Fuel valves, maintenance operation 77
Fuzes 254

G

Gage sending units
description 116
replacement 118
Gages, description and location... 33
Gear cases, lubrication..... 47
Gearshift lever, removal and installation 174
Generator
data 148
description 148
installation 148
lubrication 52
removal 148
trouble shooting..... 94
Generator drive pulley and front universal joint
installation 199
removal 197
Generator regulator
data 150
description 150
installation 150
removal 150
Generators and starting motor, maintenance operation..... 72
Governor
adjustment 135
checking setting..... 135
removal and installation..... 136
Grousers and spare track blocks, preventive maintenance services. 81
Gun
on-vehicle equipment 15
on-vehicle spare parts..... 21
on-vehicle tools 14
Gun, tarpaulin, and bows, preliminary service upon receipt of equipment 24
Gun bore, lubrication 52
Gunner's quadrant M1, description 246

H

Harnesses
removal and installation..... 222
replacement of wires..... 223

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Original from UNIVERSITY OF CALIFORNIA

H—Cont'd

Page No.

Headlights
description 150
removal and installation..... 151
replacement of blackout marker lamp 153
replacement of lamp unit..... 151
Horizontal volute spring suspension
description 201
drive sprockets 211
dual support rollers..... 210
shock absorbers..... 212
single support rollers..... 211
suspension assembly 212
tracks 201
Horn
description 172
replacement 172
Hull
description 220
driver and assistant driver's cupola 220
fenders 221
periscopes 220
Hull floor cover and engine support bolts
installation 108
removal 102
Hydrometer test..... 145

I

Idle cut-off and degasser
adjustment 139
description 139
replacement 140
Idler and suspension, lubrication in cold weather 39
Idler wheels and bracket
assembly and installation..... 207
cleaning of parts..... 205
inspection of bearings and seals. 205
removal and disassembly..... 205
Ignition system
booster coil.....132
description 121, 224
field replacement of magnetos and emergency adjustments... 131
magnetos
Bosch 121
Scintilla 126
replacement 225
spark plugs..... 132
timing engine with top dead center indicator and timer..... 130
trouble shooting..... 87
Inlet tubes
installation 106
removal 99
Inspection
bearings and seals (idler wheels and bracket) 205
suspension assembly 217
Instrument light M12, description. 247
Instrument light M19, description. 242
Instrument light M36
description 243
functioning 245
Instrument panel
description 167
installation 170
removal 167
replacement of instruments.... 167
Instruments
after-operation service 60
before-operation service..... 56
description and location..... 33
during-operation service..... 58
preliminary service upon receipt of equipment..... 24
replacement 226
Instruments and gages, run-in test. 25
Instruments and horn
horn 172
instrument panel 167

L

Lamps and reflectors, service upon receipt of equipment..... 25
Lever, transmission gearshift, description and location..... 27
Levers, steering, description and location 29
Light, low oil pressure warning, description and location..... 33
Lighting system, trouble shooting 92
(*See also* Battery and lighting system)
Lights
after-operation service 61
before-operation service 56
Lubrication
detailed instructions..... 46
Lubrication Order..... 46

M

Magnetos
adjustment of breaker points
Bosch 121
Scintilla 126
installation
Bosch 124
Scintilla 128

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

M—Cont'd Page No.

Magnetos—cont'd
lubrication 52
maintenance operation 73
removal (engine out of vehicle)
Bosch 121
Scintilla 126
Maintenance
air cleaners 133
batteries 145
engine
push rod guide housing and adapter 110
valve rocker assembly and push rods 108
Manifolds, maintenance operation. 74
MWO and major unit assembly replacement record, description... 7

O

Oil cooler, transmission
description 119
installation 119
maintenance operation 76
removal 119
Oil filter
data 118
description 118
installation 119
maintenance operation 76
removal 118
Oil pressure and suction pump
description 114
oil pressure relief valve
adjustment 114
replacement 114
removal and installation 115
Oil pressure gage
before-operation service 56
description and location 33
road test 66
service upon receipt of equipment 24
Oil pressure relief valve
adjustment 114
replacement 114
Oil suction strainer, description, removal, and installation 119
Oil supply tank
description 120
installation 120
removal 120
Oil temperature control valve
description 120
replacement 120
Oilcan points 52

Page No.

On-vehicle equipment
armament and ammunition 16
communications 18
fire extinguishers 19
gun 15
publications 18
rations 20
sighting equipment 17
On-vehicle spare parts
gun 21
vehicle 21
On-vehicle tools
gun 14
pioneer 11
vehicle 11
Operating instructions (armament)
elevating 231
firing the weapon 236
loading 232
operating breech mechanism ... 232
placing weapon in firing position 230
placing weapon in traveling position 237
traversing 231
unloading 237
Operation
under ordinary conditions
towing the vehicle 37
use of instruments and controls in vehicular operation 34
under unusual conditions
cold weather operation 38
flood and submersion 41
general 37
sand, deep mud, and slippery terrain 38
Organizational maintenance (second echelon) 64
Organizational tools and equipment, special 43
Outlet, utility, description and location 32

P

Pedal, clutch, description and location 27
Periscopes
description 220
maintenance operation 78
removal and installation 220
Pipes, exhaust, maintenance operation 76
Pioneer tools 11
Portable fire extinguishers, description 227

Digitized by Google

Original from UNIVERSITY OF CALIFORNIA

P—Cont'd Page No.

Power train, data 11
Primer
before-operation service 55
preparation for firing 253
Primer and fuel pump
description 134
pump replacement 135
Priming pump, description and location 27
Preventive maintenance service and technical inspection work sheet for full-track and tank-like wheeled vehicles 8
Preventive maintenance services
after-operation and weekly service 60
at-halt service 58
before-operation service 54
crew maintenance (first echelon) 54
during-operation service 57
organizational maintenance (second echelon) 64
Projectile, loading 232
Projectiles, preparation for firing. 252
Propeller shafts and universal joints
description 172
maintenance operation 79
preliminary service upon receipt of equipment 24
propeller shaft assembly
installation 173
removal 172
trouble shooting 95
weekly service 62
Propelling charges, preparation for firing 252
Push rod guide housing and adapter
installation 110
removal 110
replacement of adapter and seal 111

Q

Quadrant mount M1, description. 246

R

Radio interference suppression
battery charging system 225
ignition system 224
instruments 226
starting system 225
trouble shooting 93
vehicle wiring 226

Page No.

Ramp, spade, and winch, preliminary service upon receipt of equipment 23
Rations stowed in vehicle 20
Recoil mechanism, data 229
Regulator, trouble shooting 94
Regulator units, maintenance operation 77
Reports and records of lubrication 53
Revolution counter
before-operation service 56
road test 67
Rollers, track support, lubrication in cold weather 39

S

Service ammunition, tables of. 250, 251
Service upon receipt of equipment
run-in test 25
specific procedures 22
Sighting and fire control equipment
aiming post M1 and aiming post light M14 247
bore sight (and sighting) 248
characteristics 238
quadrant mount M1, gunner's quadrant M1, and instrument light M12 246
telescope mount M18A1, panoramic telescope M12, and instrument light M19 238
telepscope mount M71 (T124) and elbow telescope M16A1F (T135) 244
telescope mount T122, telescope M69E1 (T117E6), and instrument light M36 243
testing target 248
Sighting equipment stowed in the vehicle 17
Single support rollers
assembly and installation 211
removal and disassembly 211
Shock absorbers
description 212
filling on vehicle 212
Spade assembly, description 9
Spark plugs
description 132
replacement 132
Speedometer, description and location 33
Sprockets, maintenance operation. 71

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

S—Cont'd Page No.

Sprockets, idlers, and flange nuts, preliminary service upon receipt of equipment 23
Springs and suspension
after-operation service 62
at-halt service 59
before-operation service 56
preliminary service upon receipt of equipment 24
Starter and magneto switch assembly, description and location 29
Starting system
description 142, 225
replacement 225
starter 142
starter solenoid 143
trouble shooting 86
Starting the engine 34
Steering brake adjustments 182
Steering brake control levers
installation 187
removal 186
Steering brake cross shaft assembly
installation 199
removal 197
Steering brake linkage
after-operation service 62
at-halt service 59
before-operation service 57
Steering brake shoes
description 174
installation 178
removal 174
[illegible]pping the engine 36
[illegible]ension assembly
[illegible]sembly 217
data 11
description 212
disassembly 216
inspection and repair 217
removal and installation of wheels 213
replacement of volute springs .. 213
Switches, description and location
battery 29
emergency stop 32
fuel cut-off 32
main light 32
panel light 32

T

Tachometer
before-operation service 56
description and location 33
road test 67

Page No.

service upon receipt of equipment 25
trouble shooting 84
Taillights
description 153
removal and installation 153
Telescope, panoramic, M12, description 240
Telescope M69E1 (T117E6), description 243
Telescope mount M18A1, description 238
Telescope mount M71 (T124), description 244
Telescope mount T122, description 243
Terminal boxes
description 223
installation 224
removal 223
Testing target, description 248
Throttle, hand, description and location 27
Timing engine with top dead center indicator and timer 130
Tools, spare parts, and accessories
on-vehicle equipment 15
on-vehicle spare parts 21
on-vehicle tools 11
Towing precautions 37
Tracks
adjustment of tension 203
description 201
installation 203
preliminary service upon receipt of equipment 23
removal 203
Tracks and suspension
operation under unusual conditions 38
trouble shooting 96
Tracks and tires
after-operation service 62
before-operation service 56
Transmission
during-operation service 58
lubrication in cold weather 39
maintenance operation 79
road test 68
run-in test 26
trouble shooting 95
Transmission and final drive assembly
description 173
final reduction assemblies 187

Digitized by Google

Original from UNIVERSITY OF CALIFORNIA

T—Cont'd Page No.

Transmission and final drive assembly—cont'd
- gearshift lever 174
- installation 199
- parking brake 187
- removal 196
- steering brake adjustments 182
- steering brake control levers 186
- steering brake shoes 174
- transmission differential 189
- transmission oil cooler 188

Transmission differential assembly 193
- disassembly 191

Transmission oil cooler
- installation 188
- removal 188

Traversing gear handwheel shaft bearing, lubrication 53

Traversing gear pinion shaft lower bearing, lubrication 53

Trouble shooting
- battery charging system 90
- clutch 94
- engine 82
- engine lubricating system 85
- fuel system 84
- ignition system 87
- lighting system 92
- propeller shaft 95
- radio interference suppression 93
- starting system 86
- tracks and suspension 96
- transmission and final drive 95

U

Unsatisfactory equipment report 8

Unusual conditions, operation under 37

Page No.

Upper shroud
- installation 106
- removal 99

V

Valve mechanism, maintenance operation 72

Valve rocker assembly and push rods
- description 108
- installation 110
- removal 108
- valve clearance adjustment 110

Valves, fuel shut-off, description and location 27

Variable recoil gears, lubrication 53

Vehicle tools 11

Vehicle wiring
- description 221, 226
- harnesses 222
- replacement 226
- terminal boxes 223

Vertical and horizontal fuel tanks, removal and installation 140

Vision devices
- description 9
- preliminary service upon receipt of equipment 24

Volute springs, replacement 213

W

War Department Lubrication Order, description 5

Weights, dimensions, and ballistics of the 155-mm guns M1 and M1A1 and 8-inch howitzer M1 229

Wheel and flange nuts
- at-halt service 59
- before-operation service 56

Wheels, maintenance operation 71

Winch cable, lubrication 47

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