TM 9-748

WAR DEPARTMENT TECHNICAL MANUAL

90-MM GUN MOTOR CARRIAGE M36B1

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 23*b*, AR 380-5, 15 March 1944.)

WAR DEPARTMENT • *20 JANUARY 1945*

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This Technical Manual supersedes the following publications insofar as they apply to this manual. These publications remain in force until such time as they are incorporated in other affected manuals or specifically rescinded: OFSTB 700-90, dated 11 August 1943; OFSTB 700-107, dated 15 November 1943; OFSTB 731G-8, dated 14 September 1943; OFSTB 731G-10, dated 24 November 1943; WDTB ORD 20, dated 24 January 1944; WDTB ORD 60, dated 13 March 1944; WDTB ORD 83, dated 25 April 1944; WDTB ORD 88, dated 4 May 1944; WDTB ORD 95, dated 22 May 1944; WDTB ORD 125, dated 22 July 1944; WDTB ORD 126, dated 19 July 1944; WDTB ORD 130, dated 1 August 1944; and WDTB ORD 217, dated 8 November 1944.

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WAR DEPARTMENT
Washington 25, D.C., 20 January 1945

TM 9-748, 90-mm Gun Motor Carriage M36B1, is published for the information and guidance of all concerned.

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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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PART ONE — INTRODUCTION

Section I

GENERAL

1. SCOPE.

a. These instructions* are published for the information and guidance of all concerned. They contain information on operation and maintenance of the equipment as well as descriptions of major units and their functions in relation to other components of this vehicle. They apply only to the 90-mm Gun Motor Carriage M36B1 and are arranged in four parts: Part One, Introduction; Part Two, Operating Instructions; Part Three, Maintenance Instructions; and Part Four, Auxiliary Equipment.

b. The Appendix at the end of the manual contains instructions for shipment and limited storage, and 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 the 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. 165 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

*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.

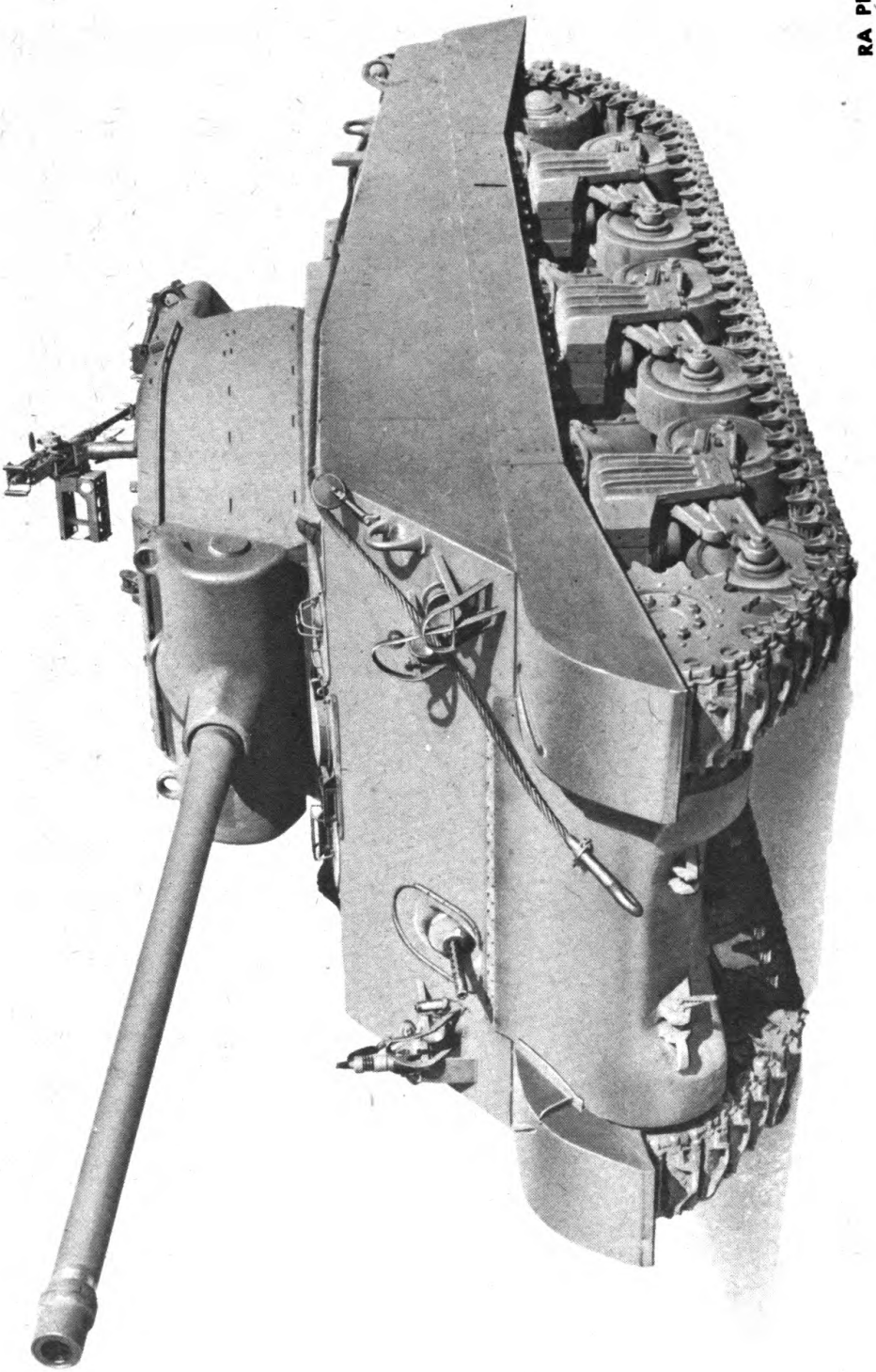

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Figure 1 — Left Front View of 90-mm Gun Motor Carriage M36B1

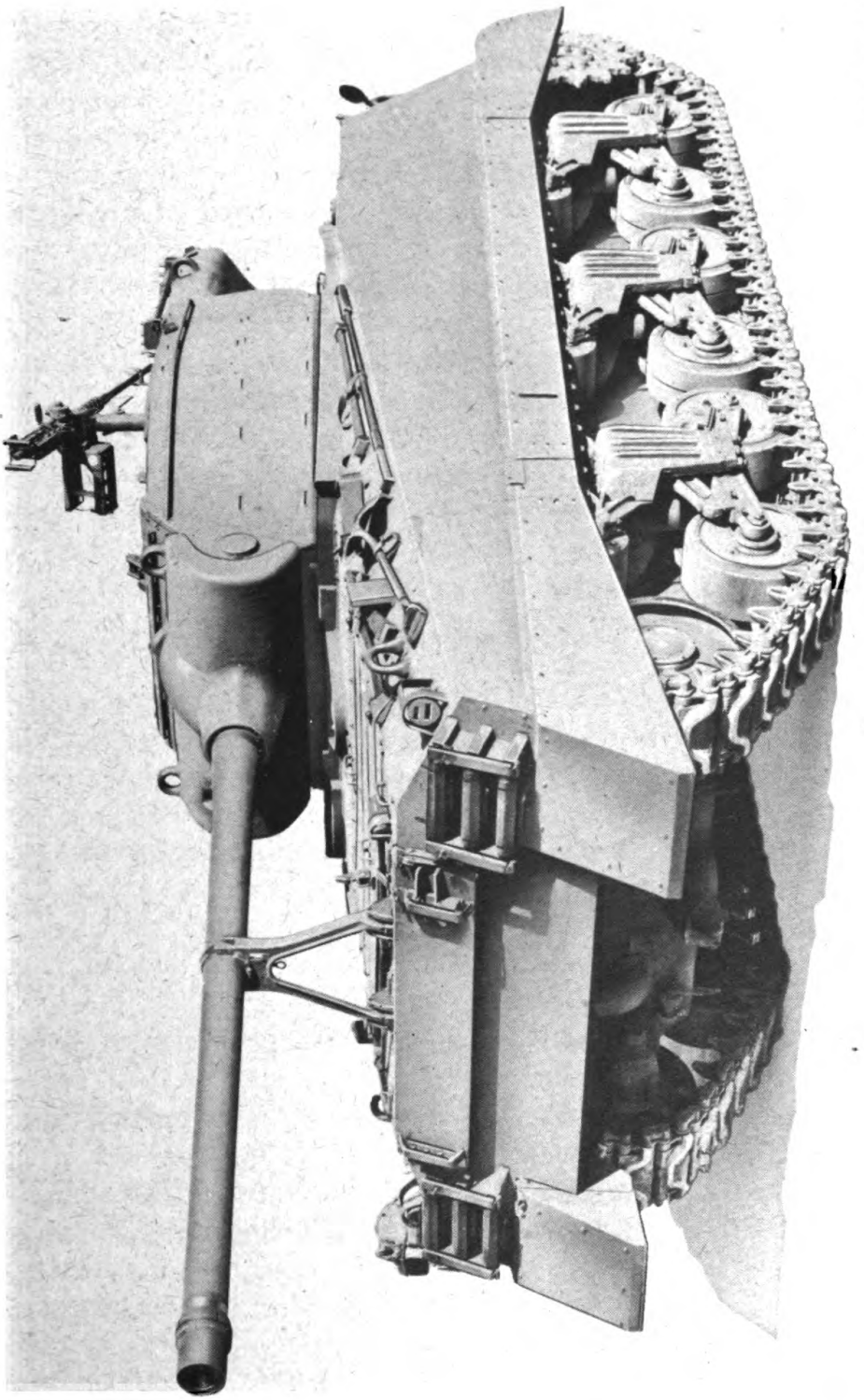

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Figure 2 — Right Rear View of 90-mm Gun Motor Carriage M36B1

the vehicle at all times. In case of accident resulting in injury or property damage, it will be filled out by the driver on the spot, or as promptly as possible 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 the 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 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, M.W.O. AND MAJOR UNIT ASSEMBLY REPLACEMENT RECORD. This form, carried on the vehicle, will be used by all personnel completing a modification or major unit assembly (engine, transmission, transfer case, and tracks) 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 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 defect, 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. DESCRIPTION (figs. 1, 2, 3, and 4).

a. The 90-mm Gun Motor Carriage M36B1 is an armored full-track laying, open-turret vehicle powered by a 500-horsepower, V-type, 8-cylinder, liquid-cooled tank engine. The engine is located in the rear of the hull. The vehicle is steered by two levers located in the driver's compartment in the front of the hull. It has five speeds forward and one reverse. The vehicle is wired for radio and for an interphone system within the tank. The turret can be rotated through 360 degrees. An auxiliary generator, driven by a 1-cylinder 2-cycle gasoline engine, is installed to charge the batteries when the main generator is not operating, or when the electrical units in the vehicle draw large amounts of current.

4. DATA.

a. Vehicle Specifications.

Length, over-all (gun in firing position)	24 ft 6½ in.
Length, over-all (gun in traveling position)	23 ft 10 in.
Width, over-all (with sand shield)	8 ft 8½ in.
Height, over-all	8 ft 8⅝ in.
Tread (center-to-center)	83 in.
Crew	5 men
Weight of vehicle (empty) (approximate)	65,500 lb
Weight of vehicle (loaded) (approximate)	68,000 lb
Ground clearance	17⅛ in.
Octane rating of gasoline	80
Approach angle	38 deg
Departure angle	25 deg

b. Performance.

Maximum sustained speed (on hard road surface)	26 mph
Expected cross-country speeds (varying terrains)	4 to 26 mph
Maximum allowable engine speed (no load)	2,800 rpm
Maximum engine idling speed	500 rpm

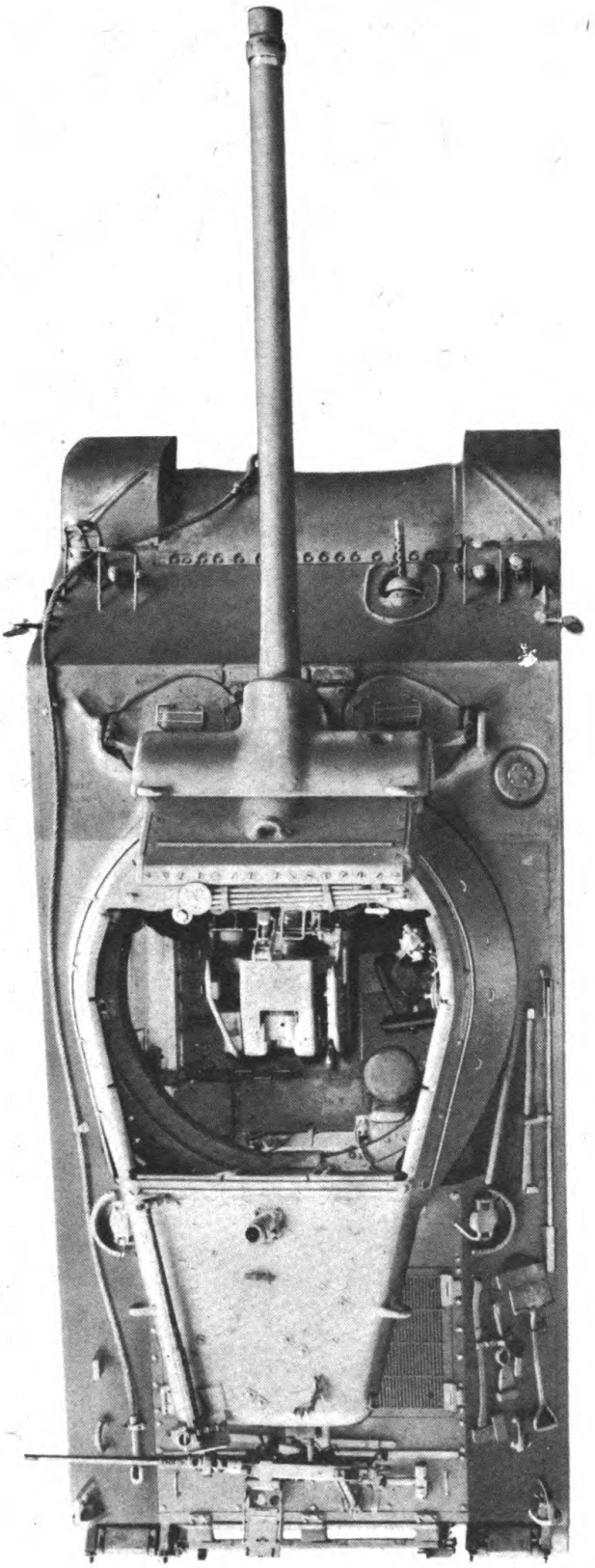

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Figure 3 — Top View of 90-mm Gun Motor Carriage M36B1

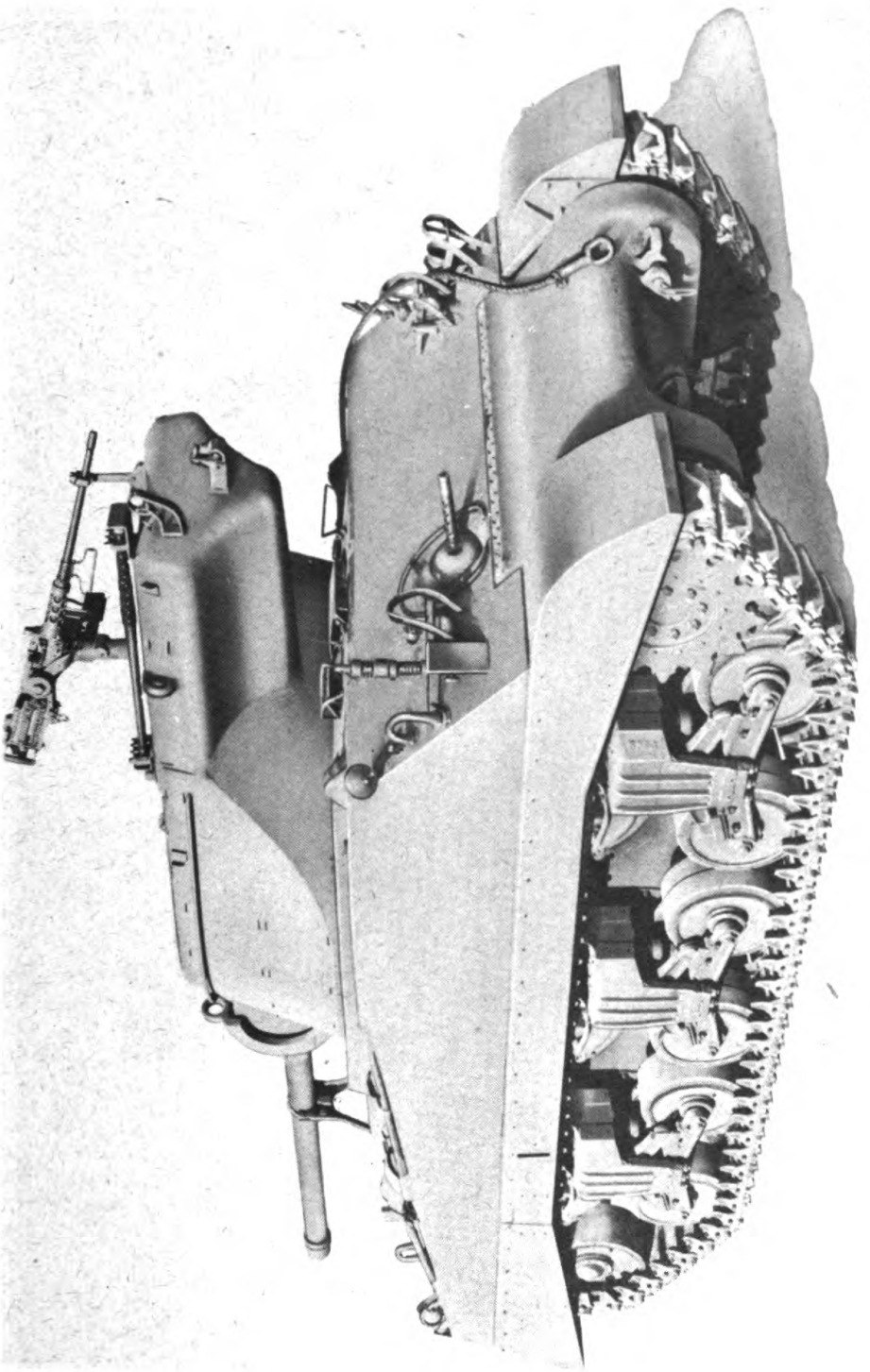

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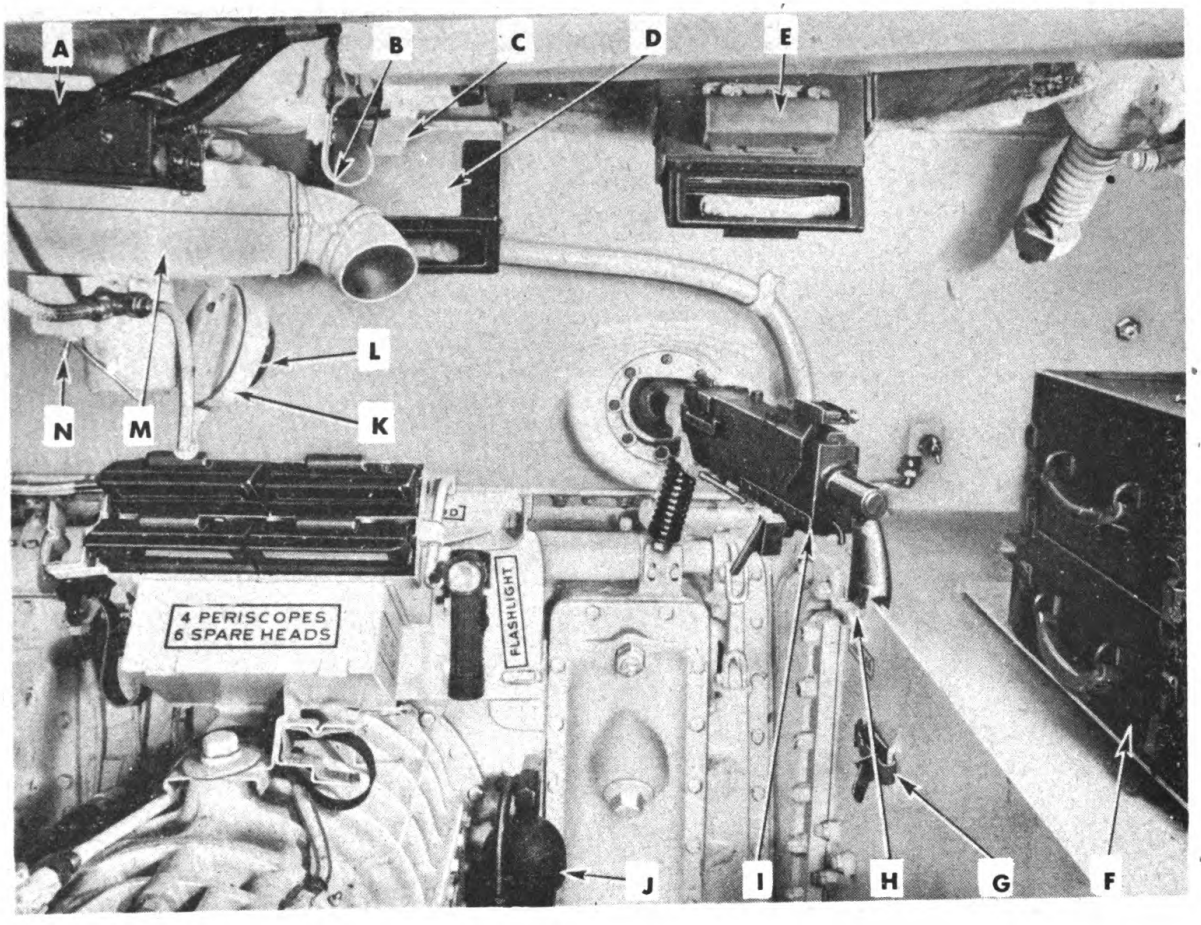
Figure 4 — Right Front View of 90-mm Gun Motor Carriage M36B1



A—RADIO AND INTERPHONE CONTROL BOX
B—INTERPHONE HOOK
C—LOCK RELEASE LEVER
D—AUXILIARY PERISCOPE
E—ASSISTANT DRIVER'S PERISCOPE
F—SCR 610 RADIO
G—.30 CALIBER BARREL STOWAGE STRAP
H—CANTEEN HOOK
I—.30 CALIBER MACHINE GUN
J—PORTABLE FIRE EXTINGUISHER
K—ASSISTANT DRIVER'S COMPARTMENT LIGHT
L—LIGHT SWITCH
M—BLOWER
N—BLOWER SWITCH

RA PD 335635

Figure 5 — Assistant Driver's Compartment

Maximum grade ascending ability	60 pct
Maximum grade descending ability	60 pct
Maximum width of ditch that tank will cross	90 in.
Maximum vertical obstacle, such as wall, that tank will climb over	24 in.
Maximum fording depth (at lowest forward speed)	36 in.
Number of miles without refueling (approximate)	100 mi
Oil consumption (approximate)	50 mi per gal

c. Capacities.

Fuel capacity	168 gal
Power train lubricant capacity	164 qt
Cooling system capacity	14 gal
Crankcase capacity	32 qt

d. Communications.

Radio	SCR-610
Interphone	BC-667

Section III

TOOLS, PARTS, AND ACCESSORIES

5. PURPOSE.

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

6. ON-VEHICLE TOOLS.

a. Pioneer.

Quantity per Vehicle	Item Name and Stock Number	Stowage Location
1	AX, chopping, 4-lb	Brackets on rear plate
1	CROWBAR, 5-ft, pinch point	Bracket on rear plate
*	CUTTER, wire, M1938, w/carrier	Tool box under sub-floor
1	HANDLE, mattock	Bracket on rear plate
1	MATTOCK, pick M1 (without handle)	Bracket on rear plate
1	SHOVEL, short-handled	Bracket on rear plate
1	SLEDGE, blacksmith, dble-face, 10-lb	Bracket on rear plate

b. Vehicle.

Quantity per Vehicle	Item Name and Stock Number	Stowage Location
1	BAR, cross, socket wrench, round, $\frac{7}{16}$-in. dia. x 8 in. long (41-B-154)	Tool bag
1	BAR, socket wrench, extension, handy grip, ½-in. sq drive, 5 in. long (41-B-311-200)	Tool bag
1	BAR, socket wrench, extension, ½-in. drive, 10 in. long (41-B-309)	Tool bag
1	CHISEL, cold, ¾-in. cut, 8-in. (41-C-1124)	Tool bag
1	FILE, hand, smooth, 10-in. (41-F-1030)	Tool bag
1	FILE, 3-sq. smooth, 6-in. (41-F-1572)	Tool bag
1	FIXTURE, set, track connecting (41-F-2997-86)	Tool bag
1	HAMMER, machinist, ball peen, 32-oz (41-H-527)	Tool bag
1	HANDLE, combination, tee, ½-in. sq drive, 11 in. long (41-H-1509-55)	Tool bag
1	HANDLE, combination, tee, ¾-in. sq drive, 17 in. long (41-H-1509-60)	Tool bag
1	HANDLE, flexible, ½-in. drive, 12 in. long (41-H-1502)	Tool bag
1	HANDLE, ratchet, reversible, ½-in. sq drive, 10 in. (41-H-1505)	Tool bag
1	HANDLE, speeder, ½-in. sq drive, 17 in. (41-H-1508)	Tool bag
1	JOINT, universal, ½-in. sq drive, (41-J-380)	Tool bag
1	OILER, trigger-type, 9-in. spout, 1 pt. (13-0-900)	In bracket on floor by ass't driver
1	PLIERS, combination, slip-joint, 8 in. (41-P-1652)	Tool bag
1	PLIERS, side-cutting, 8 in.	Tool bag
1	SCREWDRIVER (nonmagnetic) (41-S-1067-700)	On compass mount
1	SCREWDRIVER, machinist's, 5-in. blade (41-S-1385)	Tool bag
1	SCREWDRIVER, special purpose, 1¾-in. blade (41-S-1063)	Tool bag

Tools, Parts and Accessories

Quantity per Vehicle	Item Name and Stock Number	Stowage Location
1	SCREWDRIVER, special purpose, 1½-in. blade (41-S-1117-50)	Tool bag
1	WRENCH, adjustable, single-end, 8 in. (41-W-486)	Tool bag
1	WRENCH, adjustable, single-end, 12 in. (41-W-488)	Tool bag
1	WRENCH, engineer, dble hd, alloy, steel, 5/16 in. x 3/8 in. (41-W-990)	Tool bag
1	WRENCH, engineer, dble hd, alloy steel, 7/16 in. x ½ in. (41-W-1000)	Tool bag
1	WRENCH, engineer, dble hd, alloy steel, 9/16 in. x 11/16 in. (41-W-1005-5)	Tool bag
1	WRENCH, engineer, dble hd, alloy steel, 5/8 in. x 3/4 in.	Tool bag
1	WRENCH, engineer, dble hd, alloy steel, 13/16 in. x 7/8 in. (41-W-1015)	Tool bag
1	WRENCH, engineer, dble hd, alloy steel, 15/16 in x 1 in. (41-W-1021)	Tool bag
1	WRENCH, plug, 9/16 in. hex (for transmission and drain plug) (41-W-1960-175)	Tool bag
1	WRENCH, plug, 3/4-in. hex (for differential filler and drain plug) (41-W-1960-236)	Tool bag
1	WRENCH, safety screw, 3/32-in. hex (41-W-2449)	Tool bag
1	WRENCH, safety screw, 1/8-in. hex (41-W-2450)	Tool bag
1	WRENCH, safety screw, 3/16-in. hex (41-W-2452)	Tool bag
1	WRENCH, safety screw, 1/4-in. hex 41-W-2454)	Tool bag
1	WRENCH, safety screw, 5/16-in. hex (41-W-2455)	Tool bag
1	WRENCH, safety screw, 3/8-in. hex (41-W-2456)	Tool bag
1	WRENCH, safety screw, 5/8-in. hex (41-W-2458-55)	Tool bag
1	WRENCH, socket, ½-in. sq drive, 3/8-in. sq (41-3001-200)	Tool bag

Quantity per Vehicle	Item Name and Stock Number	Stowage Location
1	WRENCH, socket, ½-in. sq drive, 7/16-in. hex (41-W-3005)	Tool bag
1	WRENCH, socket, ½-in. sq drive, ½-in. hex (41-W-3007)	Tool bag
1	WRENCH, socket, ½-in. sq drive, 9/16-in. hex (41-W-3009)	Tool bag
1	WRENCH, socket, ½-in. sq drive, ⅝-in. hex (41-W-3013)	Tool bag
1	WRENCH, socket, ½-in. sq drive, ⅜-in. hex (41-W-3017)	Tool bag
2	WRENCH, socket, ½-in. sq. drive, ⅞-in. hex (41-W-3023)	Tool bag
2	WRENCH, socket, ½-in. sq drive, 15/16-in. hex (41-W-3025)	Tool bag
1	WRENCH, socket, ½-in. sq drive, 1-in. hex (41-W-3027)	Tool bag
1	WRENCH, socket, ½-in. sq drive, 1 1/16-in. hex (41-W-3029)	Tool bag
1	WRENCH, socket, ½-in. sq drive, 1⅛-in. hex (41-W-3031)	Tool bag
1	WRENCH, socket, ¾-in. sq drive, 1½-in. hex (41-W-3046)	Tool bag
1	WRENCH, track-adjusting (41-W-640-400)	Rear cover plate

c. Gun.

(1) 90-MM GUN M3.

1	EYEBOLT, breechblock-removing	Tool box
1	TOOL, breechblock-removing	Tool box

(2) CAL. .30 MACHINE GUN.

1	SCREWDRIVER, common, 3-in. blade (41-S-1101)	Spare parts box
1	WRENCH, combination, M6	Spare parts box
1	WRENCH, socket, front barrel bearing plug	Spare parts box

(3) CAL. .50 MACHING GUN.

1	WRENCH, combination, M2	Tool box

7. ON-VEHICLE EQUIPMENT.

a. Communications.

Quantity per Vehicle	Item Name and Stock Number	Stowage Location
1	PROJECTOR, pyrotechnic, hand, M9	Under floor
18	SIGNALS, pyrotechnic, 16-in. 6—Green M15 6—Red M11 6—White M16	Two cal. .30 M1 amm boxes on sponson right of ass't driver, two under floor
1	FLAG SET, M238, composed of: 1—Case, CS-90 1—Flag, MC-273 (red) 1—Flag, MC-274 (orange) 1—Flag, MC-275 (green) 3—Flagstaffs, MC-270	Right turret wall
1	RADIO SET, SCR-610 or BRITISH RADIO No. 19	Right sponson by assistant driver
1	INTERPHONE SYSTEM RC-99	At each crew member's station
1	PANEL SET, consisting of: 2—Cases, CS-150 1—Panel, AL-140 1—Panel, AL-141	On rack on rear plate

b. Fire Extinguishers.

2	EXTINGUISHER, fire, 4-lb, CO_2	Brackets by driver, bracket in turret

c. Rations.

30 boxes	TYPE "K," 2 days' rations for 5 men	Ration box under right subfloor
2 cans	Type "D," 1 day's rations for 5 men	Rations box under right subfloor

d. Gun.

(1) 90-MM GUN M3.

1	BAG, empty, shell case	On recoil guard
1	BOOK, arty gun, O.O. Form 5825	Instruction bag

Quantity per Vehicle	Item Name and Stock Number	Stowage Location
1	BRUSH, bore, M19, w/staff and wiper ring, composed of: 1—Brush, bore, M19 1—Ring wiper 2—Staff, middle section 1—Staff, end section	Bracket on engine bulkhead
1	COVER, bore brush, M518	On gun brush
1	COVER, breech	On gun breech
1	COVER, muzzle	On gun muzzle
1	GUN, lubricating, oil (2 oz)	Tool box
1	HOSE, assembly	Tool box
1	OIL, recoil, special (spec AXS-808) (in 1-qt container, type 1, class D, spec 100-13)	In can
1	RAMMER, cleaning and unloading	Bracket on engine bulkhead
1	SETTER, fuze, M14	Tool box under subfloor
1	SIGHT, bore (muzzle, RF11CD) (breech, RF11ZB)	Tool box
1	TABLE, firing	Instruction bag
1	TARGET, testing (set of 4)	Tool box
1	WRENCH, fuze, M7	Tool box
(2)	CAL. .30 MACHINE GUN.	
1	BAG, empty cartridge, cal. .30 (flex bow gun)	On gun
8	BELT, ammunition, 250 rounds	In cal. .30 ammunition box M1 D44070
8	BOX, ammunition, cal. .30, M1	See ammunition stowage
1	BRUSH, chamber-cleaning, M6	Spare parts box in right front sponson
3	BRUSH, cleaning, cal. .30, M2	Spare parts box in right front sponson
1	CASE, cleaning rod, M1	Spare parts box in right front sponson
1	CASE, cover group	
3	CASE, spare bolt, M2 (w/o contents)	Spare parts box in right front sponson

Quantity per Vehicle	Item Name and Stock Number	Stowage Location
1	COVER, muzzle, cal. .30 (flex bow gun)	On gun
1	COVER, receiver, cal. .30 (flex bow gun)	On gun
1	COVER, spare barrel, cal. .30	On spare barrel
1	ENVELOPE, spare parts, M1 (w/o contents)	Spare parts box in right front sponson
1	EXTRACTOR, ruptured cartridge, Mk IV	In small tool box—1 in turret, 1 in right sponson
1	HOOD, cal. .30, Lt MG tripod mount	On tripod, M2
1	MOUNT, tripod, machine gun, M2	On floor next to wall —under ass't driver
1	OILER, rectangular, 12-oz	Spare parts box
1	REFLECTOR, barrel, cal. .30	Spare parts box
1	ROD, cleaning, jointed, cal. .30, M1	One in each of two cleaning rod cases, M1-C6573
1	ROLL, spare parts, M13 (w/o contents)	Spare parts box
1	ROLL, tool, M12 (w/o contents)	Spare parts box
(3)	CAL. .50 MACHINE GUN.	
1	BAG, metallic belt link	Tool box under sub-floor
10	BOX, ammunition, M2	Bracket under sub-floor
4	BRUSH, cleaning, cal. .50, M4	Tool box under sub-floor
1	CASE, cleaning rod, M15	Tool box under sub-floor
1	CHUTE, metallic belt link, M1	Tool box under sub-floor
1	COVER, cal. .50, machine gun	On cal. .50 MG
1	COVER, cal. .50, barrel	On spare barrel
1	COVER, mount tripod, cal. .50, M3	Bracket on turret bustle
2	ENVELOPE, spare parts, M1 (w/o contents)	Tool box under sub-floor
1	EXTRACTOR, ruptured cartridge	Tool box under sub-floor

Quantity per Vehicle	Item Name and Stock Number	Stowage Location
1	HOOD, cal. .50, machine gun mount	On mount
1	MOUNT, tripod, cal. .50, M3	Strapped to top of rear bustle
1	OILER, filling, oil buffer	Tool box under subfloor
1	ROD, cleaning, jointed, M7, cal. .50	Tool box under subfloor
(4)	CAL. .30 CARBINE M1A2.	
	e. Ammunition.	
450	CAL. .30 rounds (for M1 carbine)	Bandolier right front side plate
2000	CAL. .30 rounds (in box M1 D440701 and belt C3951)	1 box on gun 7 boxes left sponson over battery
1000	CAL. .50 rounds	Boxes under subfloor
47	90-mm rounds	36 rounds sponson, 11 rounds turret
12	GRENADES, hand:	
	6—GRENADES, fragmentation, Mk 11	In cal. .50 M2 ammunition boxes under floor
	6—GRENADES, smoke, W P M15	Rear of driver
	SMOKE, pots, HC, M1	In longitudinal compartment under floor
	f. Sighting.	
1	ASSEMBLY, headrest	On gun mount
2	BINOCULAR, M3, complete, composed of: 1—Binocular, M3 1—Case, carrying, M17	In sponson right of assistant driver 1—Bracket in turret
1	BOX, assembly, battery and bulb stowage	
10	BULB, lamp (for elevation quadrant and azimuth indicator)	In box C101039
1	CASE, carrying, gunner's quadrant, M1	Bracket in turret
1	CASE, panoramic telescope	On turret basket floor

Quantity per Vehicle	Item Name and Stock Number	Stowage Location
1	CASE, carrying, M51	On right side of hull subfloor
1	COVER, telescope	On telescope bracket
9	HEAD, (for periscope M6) (spare)	In boxes by assistant driver
2	LAMP, electric (for telescope reticle lights)	In instrument light
1	LIGHT, aiming post, M14, complete, composed of: 8—Cell, flashlight 1—Chest, packing, M14 2—Lamp, electric, 3-volt 2—Light, aiming post, M14	
1	LIGHT, instrument, M30 (for elev quad)	On gun mount
1	LIGHT, instrument, M31 (for panoramic telescope, M12)	On panoramic telescope
1	LIGHT, instrument, M33 (for telescope M76D or M76F)	On telescope mount
	LIGHT, instrument, M32 or M39C (for telescope M70P)	
1	MOUNT, panoramic telescope, T104E1	On bracket on right turret plate
1	MOUNT, telescope (T-92)	
3	PERISCOPE, M6	In housing
3	PERISCOPE, M6 (spare)	In boxes by assistant driver
1	POST, aiming, M1, complete, composed of: 1—Cover, aiming post, M401 2—Post, aiming, M1	
1	QUADRANT, elevation, M9	Bracket in turret
1	QUADRANT, gunner, M1	Bracket in turret
1	RANGE FINDER, M9A1	In case M51
2	TELESCOPE M76F (standard) or M76D or M70P (sub-standard)	1—Mounted on 90-mm gun 1—In stowage bracket in bustle

Quantity per Vehicle	Item Name and Stock Number	Stowage Location
1	TELESCOPE, panoramic, M12	In case, panoramic telescope, D40871
	g. Miscellaneous.	
1	ADAPTER, ext, hose-type, lubr	
2	APPARATUS, decontaminating, 1½ qt, M2 (spec. 197-54-113)	1—In left front turret 1—Under right rear subfloor
1	BAG	On rack on rear of tank
5	BAG, canvas field, O D M1936	Strap on to turret
1	BAG, instruction book	In bracket with books
1	BAG, tool	Tool box
28	BATTERY (10—To be put in flashlights, 6—To be put in instrument lights, 12—Spares)	
2	BELT, safety	On driver's and assistant driver's seat
1	BUCKET, canvas, folding, 18 qt	On 90-mm rear ammunition rack
1	CABLE, towing, 1⅛-in. x 20-ft	On upper hull
5	CANTEEN, M1910, with cup and cover, M1910	2 on front plate, 3 in turret
1	CATALOG, service parts, SNL G-233	Instruction bag
2	CONTAINER, water, 5-gal. (QMC standard)	Brackets under subfloor
1	COVER, azimuth indicator	On azimuth indicator
5	FLASHLIGHT (spec 1553)	In brackets: 2—left of driver, 1—turret front, 1 — right sponson, 1 — left sponson
26	GROUSER (when track D48076 or D48067 is used)	Brackets on upper hull side plates
1	GUN, lubr, pressure (hand-operated)	Tool bag
1	HOOD, hatch, driver's	Bracket left upper side plate

Tools, Parts and Accessories

Quantity per Vehicle	Item Name and Stock Number	Stowage Location
2	WAR Dept. A.G.O. Form No. 478-1 No. 478 in container	1—In manual tray 1—Attached to outside of turret
1	KIT, accessories, Homelite, consisting of: 3—Plug, spark 1—Rope and grip, starting 1—Screwdriver 1—Socket, spark plug 1—Wrench, double-end	In tool bag
1	KIT, first-aid (24-unit) (spec. 1583)	Bracket to left of driver
5	LAMP, (spare for flashlight)	
1	LAMP, bulb, inspection	Behind instrument panel
1	LAMP, inspection	Bracket to right of driver
1	LIST, organization spare parts and equipment, SNL G-210	Instruction bag
1	LURBICATION Order, War Department	Bracket left of driver
1	MANUAL, field, for cal. .30, FM-23-65	
1	MANUAL, field, for cal. .50, MG M2 FM-23-65	Instruction bag
1	MANUAL, technical, for 90-mm, TM 9-748	Instruction bag
2	MIRROR assembly, rear-view	In mirror brackets
2	MITTENS, asbestos, pairs	In gun tool box
1	NET, camouflage, cotton shrimp, 45-ft x 45-ft (spec T-1669)	On turret
1	PAULIN, 12-ft x 12-ft	Bracket on turret
5	ROLL, blanket	On turret
1	STOVE, cooking, gasoline, M1941, 1-burner, consisting of: COLEMAN military burner No. 520 with accessory cups	Under subfloor
4	STRAPS, canvas, 1½-in. x 50-in.	On turret

Quantity per Vehicle	Item Name and Stock Number	Stowage Location
1	TAPE, adhesive, 4 in. wide (OD), 15 yds long	Tool box
1	TAPE, friction, ¾ in. wide, 30-ft roll	Tool box
1	TOP, turret, GMC M36	In place on turret
2	TUBE, flexible, nozzle	Tool box
1	WIRE, soft iron, 14-ga, 10-ft roll	Tool box
1	SHEET, instruction, for compass	Instruction bag

8. ON-VEHICLE SPARE PARTS.

a. Gun.

(1) 90-MM GUN M3.

1	CHAIN	Tool box
2	GASKET, recoil cylinder filling plug	Tool box
1	MECHANISM, percussion, assembly, composed of: 1—Guide, firing pin 1—Pin, firing 1—Pin, straight, $\frac{3}{32}$-in. x ⅝-in., firing pin guide 1—Spring, firing pin retracting 1—Stop, firing spring	Tool box
3	PIN, cotter, ⅛-in. x 1¾-in.	Tool box
1	PIN, firing	Tool box
1	PIN, link	Tool box
2	PLUG, filling, recoil cylinder	Tool box
1	PLUNGER, cocking lever	Tool box
1	RETAINER, sear	Tool box
1	SPRING, cocking lever plunger	Tool box
1	SPRING, extractor, plunger	Tool box
1	SPRING, firing pin retracting	Tool box
2	SPRING, firing	Tool box
1	SPRING, sear	Tool box

Quantity per Vehicle	Item Name and Stock Number	Stowage Location
(2)	CAL. .30 MACHINE GUN.	
1	BAND, lock, front barrel bearing	Spare parts box in right front sponson
1	BARREL	Lower hull—mounted vertically next to ass't driver
1	BEARING, barrel, front	Spare parts box—right front sponson
1	BOLT, group, consisting of: 1—Bolt, assembly 1—Extractor, assembly 1—Lever, cocking 1—Pin, cocking lever 1—Pin, firing, assembly 1—Rod, driving spring, assembly 1—Sear 1—Spring, driving 1—Spring, sear assembly	1 each in small spare parts boxes located near each cal. .30 gun
1	COVER, group, consisting of: 1—Cover, assembly 1—Lever, feed belt 1—Pawl, feed belt 1—Pin, belt feed pawl, assembly 1—Pivot, belt feed lever, group assembly 1—Slide feed belt, assembly 1—Spring, cover extractor 1—Spring, feed belt pawl	Spare parts box
1	EXTENSION, barrel, group, consisting of: 1—Extension, barrel, assembly 1—Lock, breech 1—Pin, breech lock, assembly 1—Spring, locking barrel	Spare parts box
1	FRAME, lock, group, consisting of: 1—Accelerator 1—Frame, lock, assembly 1—Pin, accelerator, assembly 1—Pin, trigger 1—Plunger, barrel, assembly 1—Spring, barrel plunger 1—Spring, trigger pin 1—Trigger	Spare parts box

Quantity per Vehicle	Item Name and Stock Number	Stowage Location
1	LEVER, cocking	Spare parts box
1	LEVER, feed belt	Spare parts box
1	PAWL, holding belt	Spare parts box
1	PAWL, feed belt	Spare parts box
1	PIN, accelerator assembly	Spare parts box
1	PIN, belt holding pawl, split	Spare parts box
1	PIN, cocking lever	Spare parts box
1	PIN, firing assembly	Spare parts box
1	PIN, trigger	Spare parts box
1	SPRING, belt holding pawl	Spare parts box
1	SPRING, locking barrel	Spare parts box
1	SPRING, sear, assembly	Spare parts box
1	TRIGGER	Spare parts box
(3)	CAL. .50 MACHINE GUN.	
1	BARREL, assembly	Bracket on turret bustle
1	DISK, buffer	Tool box
1	EXTENSION, firing pin assembly	Tool box
1	EXTRACTOR, assembly	Tool box
1	LEVER, cocking	Tool box
1	PIN, cotter, belt feed lever pivot stud	Tool box
1	PIN, cotter, cover pin	Tool box
2	PIN, cotter, switch pivot	Tool box
1	PIN, firing	Tool box
1	PLUNGER, belt feed lever	Tool box
1	ROD, driving spring w/spring assembly	Tool box
1	SLIDE, belt feed group, consisting of: 1—Arm, belt feed pawl, B8914 1—Pawl, feed belt, assy, B8961 1—Pin, belt feed pawl, assy, B8962 1—Slide, belt feed, assy, B261110 1—Spring, belt feed pawl, A9351	Tool box
1	SLIDE, sear	Tool box
1	SPRING, belt holding pawl	Tool box

Quantity per Vehicle	Item Name and Stock Number	Stowage Location
1	SPRING, belt feed lever plunger	Tool box
1	SPRING, cover extractor	Tool box
1	SPRING, locking barrel	Tool box
1	SPRING, sear	Tool box
1	STUD, bolt	Tool box

b. Vehicle.

4	BULB, lamp, 3-co, 24-28V	Behind instrument panel
4	BUSHINGS, rubber	Tool box
12	CONNECTION, end (to match track furnished)	Tool box
3	FITTING, lubr, straight, 1/8-in.	Stowed w/lub gun
3	FITTING, relief, 1/8-27 NPT, male	Stowed w/lub gun
16	NUT, safety, 5/8-18 NF-3	Tool box
6	TRACK (shoe) ass'y (to match track furnished)	On rear of turret
12	WEDGE (to match track furnished)	Tool box

PART TWO — OPERATING INSTRUCTIONS

Section IV

GENERAL

9. SCOPE.

a. Part Two contains information for the guidance of the personnel responsible for the operation of the equipment. It contains instructions on operation with description and locations of controls and instruments.

Section V

SERVICE UPON RECEIPT OF EQUIPMENT

10. PURPOSE.

a. 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 they 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.

11. CORRECTION OF DEFICIENCIES.

a. 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. RUN-IN TEST PROCEDURES.

a. **Preliminary Service.**

(1) FIRE EXTINGUISHERS. See that portable and fixed fire extinguishers are present, fully charged, and securely mounted. Fixed extinguisher tubes must be firmly supported, nozzles properly aimed,

and not clogged. Be sure red safety seals on fixed fire extinguisher cylinders are intact (fig. 189).

(2) FUEL, OIL, AND WATER. Fill main engine and auxiliary generator fuel tanks, allowing room for expansion. Also see that engine oil is at the correct level. CAUTION: *Mix 3/8 pint of SAE 30 engine oil with each gallon of fuel to be used in auxiliary generator engine unit.* If there is a warning tag attached to engine oil filler cap, follow the instructions on tag before starting the engine when item 19 is reached. Examine coolant level in radiator surge tank and replenish as needed, allowing room for expansion of coolant. During period when antifreeze is used, check value of antifreeze and add as needed (par. 25 **d**).

(3) FUEL FILTER. On auxiliary engine unit, close fuel valve and remove sediment bowl and screen (fig. 13). Wash in dry-cleaning solvent, dry, and install. Open fuel valve and check filter for leaks.

(4) BATTERIES. Make a gravity and voltage test of batteries (par. 97 **b**). Add clean water as necessary to bring electrolyte level to 3/8 inch above plates. Inspect terminal connections to be sure they are in good condition and secure.

(5) AIR CLEANERS AND OIL PAN FILTER. Remove carburetor air cleaners and oil pan filter. Wash elements and oil cups in dry-cleaning solvent and inspect them to see that they are in good condition. Fill oil cups to correct level with new or clean used oil (par. 33), reoil filter element (par. 33), and reassemble these units securely. Remove auxiliary generator engine air filter and wash element in dry-cleaning solvent. Dry with compressed air and examine to see that it is in good condition. Reoil element (par. 33) and reassemble securely.

(6) ACCESSORIES AND BELTS. Examine all accessible accessories, such as carburetors, fans, water pump, oil filter, main and auxiliary generators, and starter to see that they are in good condition and securely mounted. Inspect drive belts to see that they are in good condition and properly adjusted. Fan belts should have 1-inch finger-pressure deflection (par. 83 **b**) halfway between pulleys.

(7) ELECTRICAL WIRING. Examine all exposed wiring and conduits to see that they are clean, in good condition, and securely supported and connected.

(8) TRACKS. Clean all foreign material from tracks and suspension units. Inspect tracks for damage, loose wedge nuts, connectors and/or lock pins. See that tracks are correctly assembled and adjusted. Vehicles equipped with vertical volute spring suspension should have not less than 1/2-inch, or more than 3/4-inch track sag halfway between center and rear support rollers (par. 149 **c**).

(9) BOGIE ASSEMBLY AND FLANGE NUTS. See that all sprocket,

idler, bogie wheel, and support roller assembly, mounting, and flange nuts are present and secure.

(10) FENDERS AND SAND SHIELDS. Examine fenders, sand shields, lamp and brush guards to see that they are in good condition and securely mounted.

(11) TOWING CONNECTIONS. Inspect cable, pintle hook, pintle hook lock, and all towing connections to see that they are in good condition, securely mounted and connected:

(12) HULL, TARPAULIN, AND CAMOUFLAGE NET. See that all hull attachments, hardware, doors, and escape door are in good condition and secure. Examine door hinges and latches and escape door latch to see that they are not excessively worn and are adequately lubricated. CAUTION: *Do not fully open escape door.* Be sure hull drain valves open and close freely. Make sure there are no bright spots to cause glare or rust and markings are legible. Examine paulin and camouflage net to see that they are in good condition and properly stowed.

(13) VISION DEVICES. Inspect periscope heads and elbows to see that they are in good condition, clean, and securely attached to the bodies. Make sure periscopes are securely mounted in holders. Rotate and tilt holders to test for wear or bind and see that locking screws hold periscopes in desired position. Examine spare periscopes and heads and their stowage boxes to see that they are in good condition, clean, and secure. CAUTION: *Periscope windows must be cleaned only with a soft cloth or brush.*

(14) LUBRICATION. Perform a complete lubrication of the vehicle according to instructions on Lubrication Order, paragraph 32, except gear cases and units lubricated or serviced in items (1) to (13). Check all gear case levels and add oil as necessary to bring to correct levels. Change the oil only if condition indicates the necessity, or if oil is not of proper grade for existing atmospheric temperatures. NOTE: *Perform items (15) to (17) during lubrication.*

(15) SPRINGS AND SUSPENSIONS. Inspect all suspension brackets, arms, springs, links, and guides to see if they are in good condition, correctly assembled, and secure. See that wheels and rollers are not leaking excessively at seals. Examine roller and suspension wheel tires for damage or separation from wheels.

(16) STEERING LINKAGE. Examine all shafts, arms, rods, connections, levers, and grips to see that they are in good condition, correctly assembled and adjusted. Check released 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 (fig. 139).

(17) PROPELLER SHAFTS AND UNIVERSAL JOINTS. See that pro-

peller shafts and universal joints are properly alined, securely mounted, and not leaking excessively at seals.

(18) VENT. Examine transmission and differential unit breather vent to be sure it is in good condition, securely mounted, and not clogged.

(19) ENGINE WARM-UP. Start engine, observing all precautions in paragraph 15 c. Observe action of starter to see that it engages and disengages without unusual noise and has adequate cranking speed. Set hand throttle so that engine will run at 800 to 1,000 revolutions per minute during warm-up. Start and test auxiliary generator engine to see that it operates properly.

(20) INSTRUMENTS AND GAGES.

(a) Oil Pressure Gage. Engine oil pressure must be indicated when engine is idling and must show 60 to 100 pounds pressure at 2,600 revolutions per minute. Stop engine immediately when low oil pressure signal light comes on above 1,000 revolutions per minute.

(b) Engine Temperature Gage. Reading should be approximately 90° F above atmospheric temperature. High water temperature signal light comes on at maximum safe operating temperature, 235° F. CAUTION: *Do not drive vehicle until engine temperature is above 100° F.*

(c) Ammeter. Ammeter may register a high positive (+) charge for a period after starting engine until generator restores to batteries the current used in starting. Only a slight charge or zero reading is registered with lights and accessories turned off and batteries fully charged.

(d) Fuel Gage. With selector switch in relative positions, fuel gage should register level of fuel in each tank.

(e) Tachometer. Tachometer should indicate engine speed in revolutions per minute and revolutions counter register accumulating revolutions.

(21) ENGINE CONTROLS. Observe whether engine responds to hand throttle and foot throttle promptly and properly, and if there is any looseness or binding in controls. Make sure engine idles smoothly at 500 revolutions per minute.

(22) HORN AND WINDSHIELD WIPER. See that these units are in good condition. If tactical situation permits, test horn for proper operation and tone. If windshield (driver's hood) is in use, be sure it is not loose or damaged. Test wiper to see if it operates properly, and that blade contacts glass evenly and firmly through its full stroke.

(23) LAMPS (LIGHTS). See that units are in good condition and secure. If tactical situation permits, open and close all switches and see if lamps respond properly.

(24) LEAKS — GENERAL. Look under vehicle and in engine, fighting, and driver's compartments for indication of fuel, oil, or coolant leaks. Correct or report any leaks found.

(25) TOOLS AND EQUIPMENT. Check tools and equipment against paragraphs 7 and 8 to be sure all items are present, serviceable, and properly mounted or stowed.

CAUTION: *Before driving vehicle, be sure that turret control lever is in manual position. Also see that gun breech and barrel travel locks and turret lock are engaged to prevent injury to personnel and damage to equipment.*

b. Run-in Test. Perform the following procedures (1) to (10) inclusive during the road test on 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 observation 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 INSTRUMENTS AND GAGES. CAUTION: *Do not drive vehicle until engine temperature reaches 100° F.* Observe all pertinent instruments to be sure they register the proper function of the units to which they apply. With vehicle in motion, speedometer should indicate vehicle speed and odometer should register accumulating mileage.

(2) STEERING BRAKES. Test steering levers to see if they have 4 to 5½ inches of free travel at top (fig. 139) and see that lever locking device holds levers in applied position for parking. With vehicle in motion, test brakes to see if they stop vehicle effectively and steer vehicle properly when applied independently before levers reach vertical position (fig. 139).

(3) CLUTCH. Clutch pedal free travel must not be less than 2 inches or more than 3½ inches (fig. 114). Clutch should not grab, drag, squeal, or chatter on engagement or slip when engaged under load.

(4) TRANSMISSION. Shift through each speed range of transmission. Observe whether gearshift 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.

(5) ENGINE. Be on the alert during test run for any unsatisfactory engine operating characteristics, such as stalling, misfiring, lack of power or acceleration, or any unusual noise that might indicate loose, damaged, excessively worn, or inadequately lubricated engine parts or accessories.

(6) UNUSUAL NOISES. Be on the alert for any unusual noise from tracks, suspensions, or power train that might indicate looseness, damage, excessive wire, or improper lubrication.

HALT VEHICLE AT 10-MILE INTERVALS FOR SERVICES (7) TO (10) BELOW.

(7) TEMPERATURES. 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 transmission and final drives for overheating or excessive oil leaks.

(8) LEAKS (ENGINE OIL, FUEL, AND WATER). After stopping engine, look in engine compartment, fighting and driving compartments, and under vehicles for fuel, oil, or coolant leaks. Examine all fuel and oil tubes, radiator hoses, and connections for leaks.

(9) GUN (ELEVATING AND TRAVERSING MECHANISM). Disengage gun traveling locks, place vehicle on a 10-degree lateral incline (tilted sideways), disengage turret lock, and proceed with the following tests. Using both the hand and power controls, traverse the turret through its full 360-degree range and observe whether there is any indication of binding. With the gun pointed forward or rearward, elevate gun through its entire range to see if there is any binding, excessive lash, or erratic action. At completion of tests, be sure that turret shift lever is in manual position, and gun breech and barrel traveling locks and turret lock are engaged.

(10) TRACK TENSION (FINAL ROAD TEST). After making the final road test with vehicle on hard level surface, inspect tracks to see that tension adjustment is satisfactory. On vehicles equipped with vertical volute spring suspension, tracks should have not less than ½-inch or more than ¾-inch sag (fig. 151) halfway between center and rear track support wheels (par. 149 c).

c. Vehicle Publications and Reports.

(1) PUBLICATIONS. See that vehicle Operator's Manual, Lubrication Order, Standard Form No. 26 (Driver's Report—Accident, Motor Transportation), and W.D., A.G.O. Form No. 478 (MWO and Major Unit Assembly Replacement Record) are in the vehicle, are 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 noted. Report general condition of the vehicle to designated individual in authority.

Section VI

CONTROLS AND INSTRUMENTS

13. CONTROLS.

a. General. This paragraph contains description, location, and information on the operation of each of the controls used in driving the vehicle. Instructions on operation of the vehicle, however, are not contained herein. Use of the instruments and controls in vehicular operation are contained in Section VII.

(1) STEERING LEVERS (K, fig. 6). Two steering levers, one to brake each track, are located immediately in front of the driver. To steer the vehicle, pull the steering lever on the side toward which it is desired to turn. Pulling back on one of the levers slows down the track on that side while the speed of the other track is automatically increased. Pulling back on both levers at once slows down or stops both tracks, depending on the amount of pull exerted. Thus, the steering levers are also the brake control levers of the vehicle.

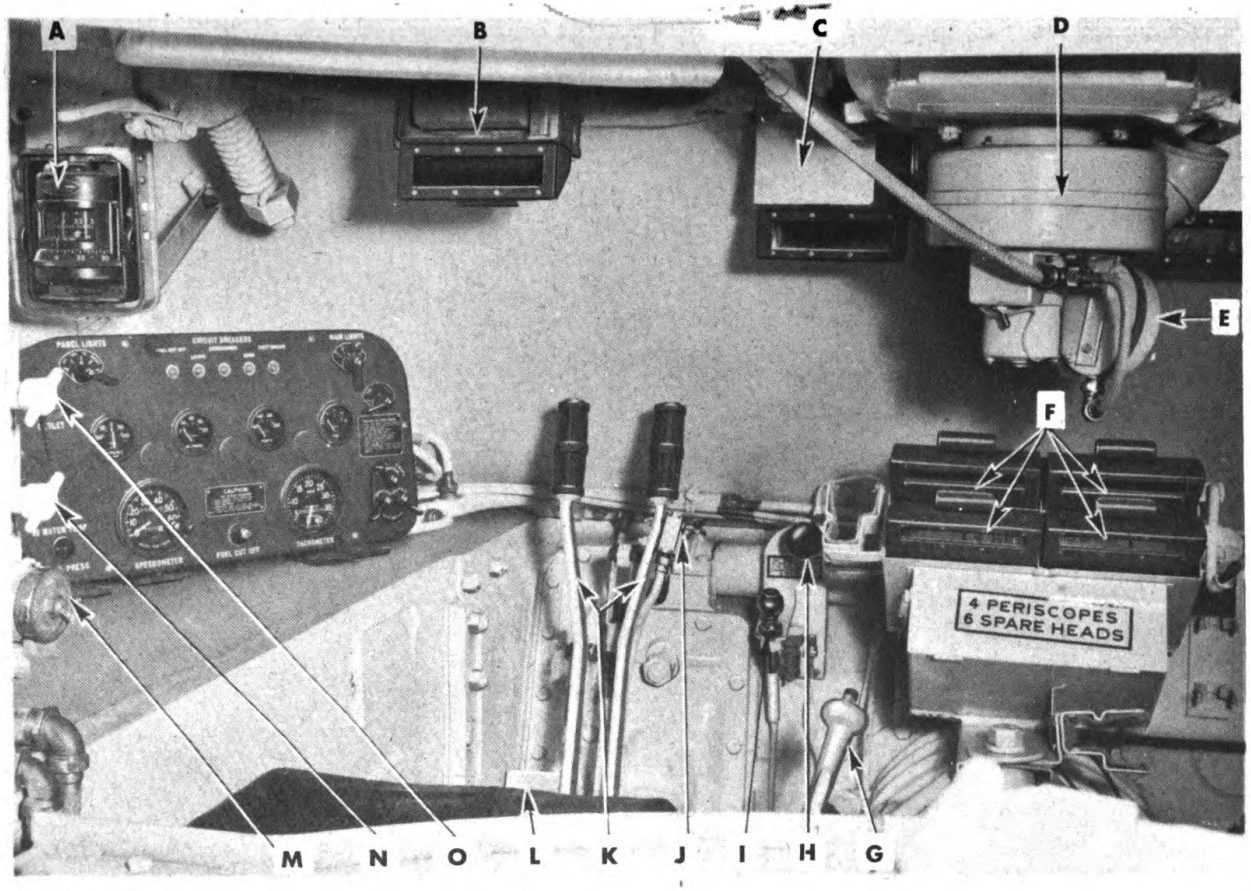
(2) PARKING BRAKE PEDAL (fig. 7). The parking brake pedal, mounted just to the right of the steering levers, raises and lowers pawls which contact the quadrants on the steering levers. When the pedal is pushed to the forward position and the steering levers are pulled all the way back, the brakes are locked in parking position. To release the brakes, pull back on the steering levers and push the pedal to its rear position to allow the steering levers to be moved forward.

(3) FOOT THROTTLE PEDAL (fig. 7). The foot throttle pedal, located on the floor to the right front of the driver, is depressed to increase engine speed and released to decrease engine speed down to idling speed.

(4) HAND THROTTLE (I, fig. 6). The hand throttle is bracket-mounted to the differential case above the foot throttle. Pulling out on the hand throttle increases engine speed. To lock the hand throttle in a desired position, push in on the lock button in the center of the hand throttle control.

(5) CLUTCH PEDAL (L, fig. 6). The clutch pedal, located on the floor in front of the driver, is convenient to the driver's left foot. To permit shifting of the transmission gears, the clutch is disengaged by depressing the clutch pedal.

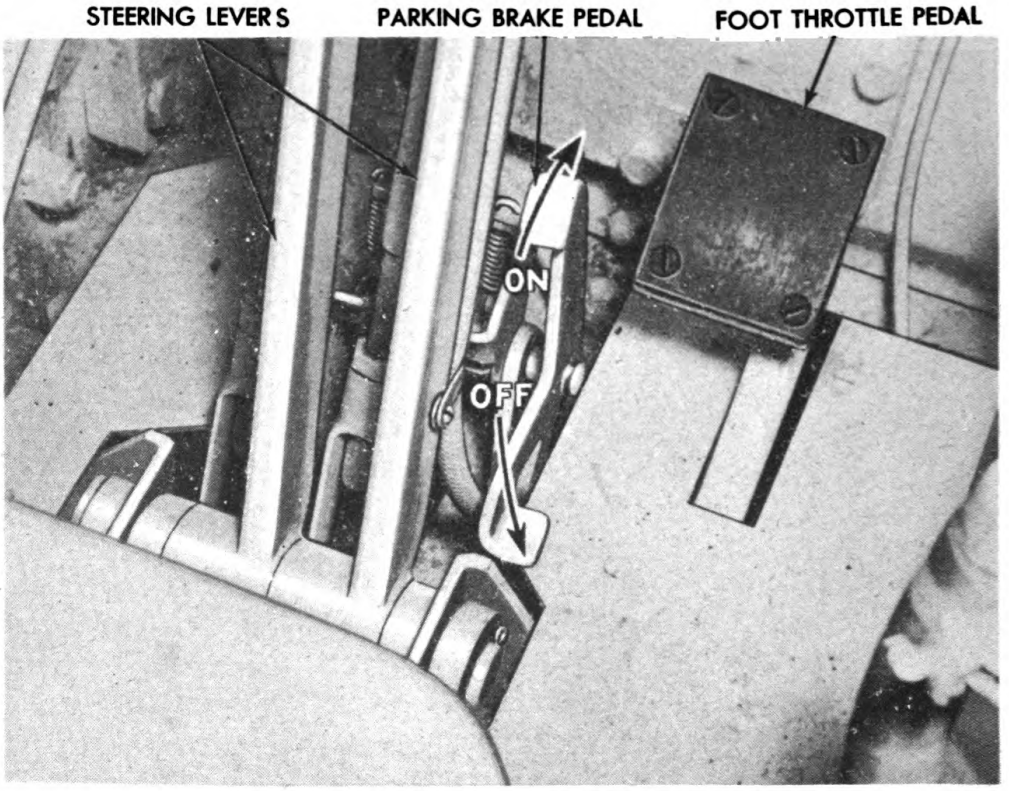
(6) PRIMER (H, fig. 6). The priming pump is bracket-mounted above the hand throttle. To prime the engine, pull out on the primer knob, then briskly push it back in, thus pumping fuel to the intake manifold.



A—COMPASS
B—DRIVER'S PERISCOPE
C—DRIVER'S AUXILIARY PERISCOPE
D—BLOWER
E—ASSISTANT DRIVER'S COMPARTMENT LIGHT
F—SPARE PERISCOPES
G—GEARSHIFT LEVER
H—PRIMING PUMP CONTROL KNOB
I—HAND THROTTLE CONTROL
J—HORN OR SIREN BUTTON
K—STEERING LEVERS
L—CLUTCH PEDAL
M—BATTERY CHARGING RECEPTACLE
N—12-VOLT MASTER SWITCH
O—24-VOLT MASTER SWITCH

RA PD 335636

Figure 6 — Driver's Compartment



RA PD 329245

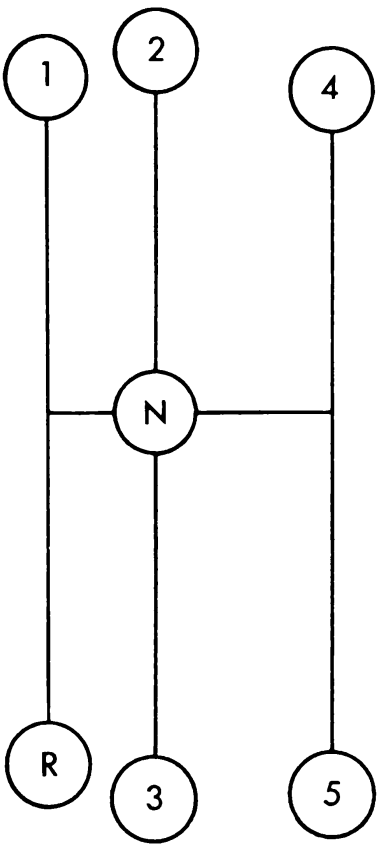
Figure 7 — Parking Brake Pedal

(7) GEARSHIFT LEVER (G, fig. 6). The gearshift lever, located to the driver's right, has six positions and neutral for shifting the transmission gears (fig. 8). The button in the top center of the gearshift lever must be pressed to release a latch before the transmission may be shifted into first speed or reverse.

(8) FUEL SHUT-OFF VALVES (fig. 9). Two shut-off valves, one for each set of fuel tanks, are located on the right and left sides of the bulkhead at the rear of the fighting compartment. To open the valves, turn counterclockwise to vertical or "ON" position and to close, turn to horizontal or "OFF" position.

(9) 24-VOLT MASTER SWITCH (O, fig. 6). The 24-volt master switch is located to the left of the driver in the master switch box. To close or turn on the switch, pull out on the switch handle enough to allow it to be turned so that the handle is in a vertical position. Then release the switch allowing the spring to pull it all the way in, or to its "ON" position. To open or turn off the switch, pull the handle all the way out and turn it to the right or left, thus locking it out, or in its "OFF" position.

(10) 12-VOLT MASTER SWITCH (N, fig. 6). The 12-volt master



RA PD 12401

Figure 8 — Gearshift Lever Positions

switch is below the 24-volt master switch in the main switch box and is operated in the same manner.

(11) MAGNETO SWITCH (Q, fig. 10). The magneto switch is a rotary-type four-position switch. At its extreme left or counterclockwise position, the switch is "OFF." Turning it to the next position clockwise, marked "L," allows only the left-hand magneto and left-hand 4-cylinder bank of the engine to operate. Turning it to the next position clockwise, marked "R," allows only the right-hand magneto and cylinder bank to operate. Turning the switch to its extreme clockwise, or "BOTH" position, turns magnetos on and allows the full engine to function. This is the normal operating position to be used except when checking magneto and engine operation.

(12) STARTER SWITCH (S, fig. 10). The starter switch, at the extreme lower right of the instrument panel, is turned on by pushing the wing-type lever to the left. The switch will automatically return to its "OFF" position when released.

(13) BOOSTER SWITCH (R, fig. 10). The booster switch, located to the left of the starter switch, has no function on this vehicle.

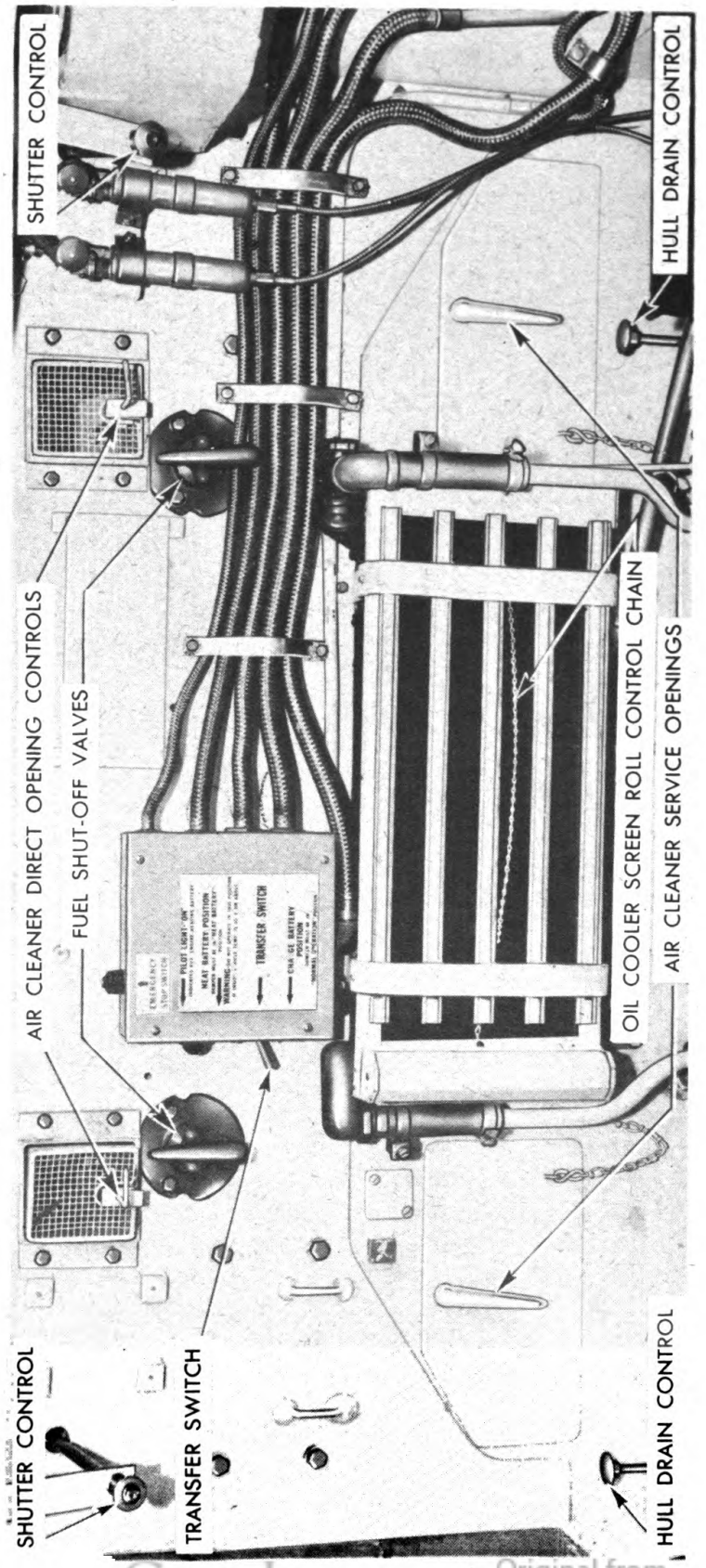


Figure 9 — Bulkhead — Fighting Compartment Side

(14) FUEL CUT-OFF SWITCH (N, fig. 10). The fuel cut-off is a push-button type switch located at the bottom center of the instrument panel. To operate, push in on the button and hold in this position until the engine comes to a complete stop.

(15) FUEL TANK GAGE SELECTOR SWITCH (J, fig. 10). The fuel tank gage selector switch is a rotary-type switch used to select the tanks that the fuel gage is to meter. When the switch is turned to "L" position, the fuel gage will indicate the amount of fuel in the left-hand tanks, and when turned to "R," the gage will indicate the amount of fuel in the right-hand tanks.

(16) MAIN LIGHT SWITCH (H, fig. 10). The vehicle service and blackout lights are controlled by a rotary-type switch at the upper right corner of the instrument panel. The switch is equipped with a button-operated lock to prevent its being turned to other than "BO DR" (blackout driving and taillights) or "BO MK" (blackout marker and taillights). To release the lock, push it with the thumb, at the same time turning the switch through "STP LT" position to "HD LTS" (all service lights).

(17) INSTRUMENT PANEL LIGHT SWITCH (B, fig. 10). The instrument panel light switch is a five-position, rotary-, rheostat-type switch which increases the brilliance of the panel and compass lights as it is turned clockwise.

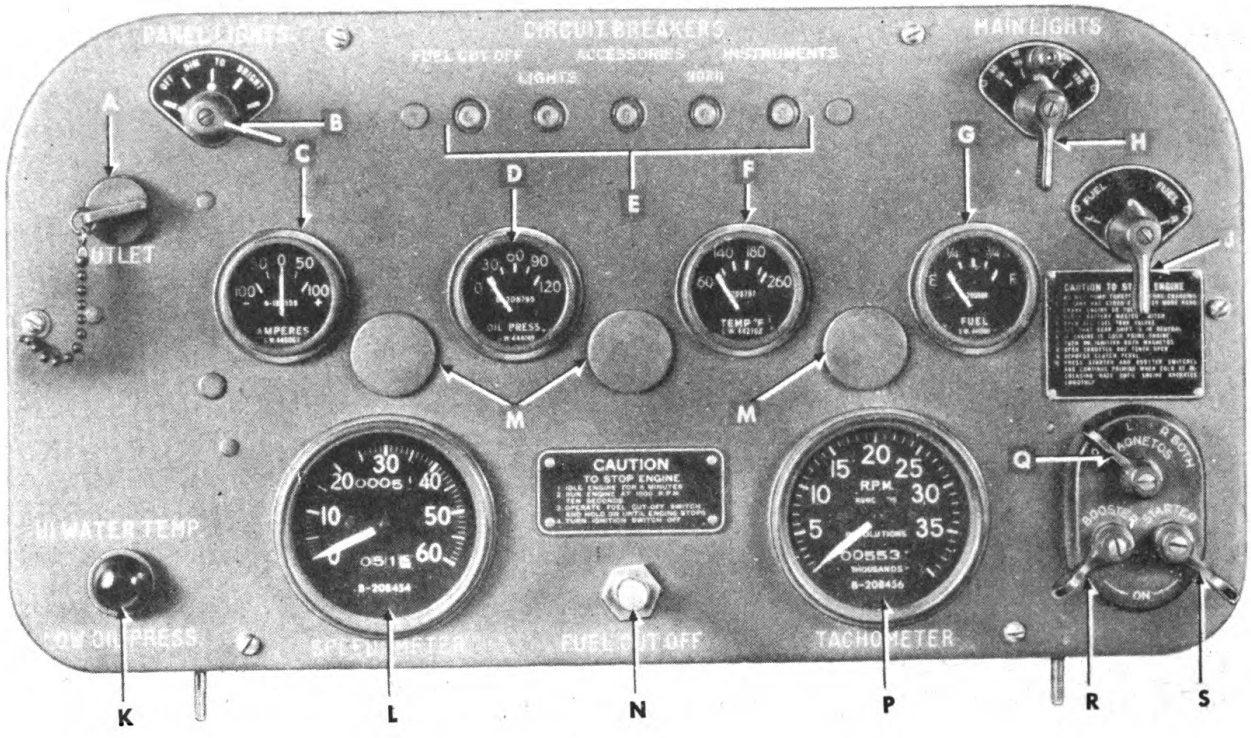
(18) EMERGENCY ENGINE STOP SWITCH (fig. 9). The emergency engine stop switch is a push-button type switch mounted on the bulkhead terminal box. It provides a means of stopping the engine in emergency situations from the fighting compartment.

(19) HORN OR SIREN BUTTON (J, fig. 6). A push button for sounding the horn or siren is located on the right-hand steering lever.

(20) CIRCUIT BREAKER RESET BUTTONS. Five circuit breaker reset buttons in the upper part of the instrument panel (E, fig. 10) and two on top of master switch box (fig. 74) control the circuit breakers in the various circuits of the vehicle. In each instance when a circuit is overloaded, the circuit breaker in that circuit will open. To reset the circuit breaker in a particular circuit, simply push the circuit breaker button for the circuit involved.

(21) TRANSFER SWITCH (fig. 9). The toggle-type transfer switch, located on the side of the bulkhead terminal box, is in normal (batteries charging) position when pushed down. When the switch is in upper position, the output of the auxiliary generator is switched to the battery heater coil.

(22) OIL COOLER SCREEN ROLL CONTROL (fig. 9). The screen roll over the oil cooler on the bulkhead is operated as a window shade. The chain pull control may be locked to hold the screen roll



A—UTILITY OUTLET
B—INSTRUMENT PANEL LIGHT SWITCH
C—AMMETER
D—OIL PRESSURE GAGE
E—CIRCUIT BREAKER RESET BUTTONS
F—TEMPERATURE GAGE
G—FUEL GAGE
H—MAIN LIGHT SWITCH
J—FUEL TANK GAGE SELECTOR SWITCH
K—HIGH WATER TEMPERATURE AND LOW OIL PRESSURE WARNING LIGHT
L—SPEEDOMETER
M—PANEL LIGHT COVERS
N—FUEL CUT-OFF SWITCH
P—TACHOMETER
Q—MAGNETO SWITCH
R—BOOSTER SWITCH (NOT USED)
S—STARTER SWITCH

RA PD 335638

Figure 10 — Instrument Panel

in any position by simply pulling the chain down so that it engages the slotted bracket provided for this purpose.

(23) ENGINE COMPARTMENT DOOR SHUTTER CONTROLS (fig. 9). The engine compartment top doors are provided with shutters controlled by cables. The cable control knobs are mounted on the bulkhead in the fighting compartment. These shutters should be closed only when operating the engine in cold weather. To open the shutters, push in the control cable knobs. To close the shutters, press in the lock buttons and at the same time pull out the knobs.

(24) AIR CLEANER DIRECT OPENING CONTROLS (fig. 9). An air cleaner direct opening vent and a control are located on each side of the bulkhead at the rear of the fighting compartment. They are used to regulate the source of air to the air cleaners. When controls are pushed in, air is drawn from the fighting compartment. When controls are pulled out, warmed air is drawn from the engine compartment and hastens the warming of the engine.

(25) DRIVERS' SEATS (fig. 181). The driver's seat and assistant driver's seat are adjustable in height and horizontal position. They are provided with removable seat backs and seat cushions. Counterbalance springs in the seat base assist in raising the seat to the desired position. To adjust the seat height for a more comfortable driving position, operate the locking handle in the seat base. The seat can be raised 1 inch at a time for a total of 3 inches by pulling out on the locking handle, raising the body to the desired position, and releasing the handle in locked position. For driving with the door open, the seat can be raised 4½ inches at a time for a total of 9 inches by pulling up on the vertical release handle to the right, raising the body to the desired position, and releasing the handle in locked position. The seat is adjustable in 4 horizontal positions for a total of 4 inches. To move seat forward or backward, press in on horizontal release lever to the left, slide the seat to the desired position, and release the lever in locked position. The assistant driver's seat can be folded over forward to provide easy access to the 90-mm ammunition stowage box at the rear of the seat. To fold seat, first place seat in lowest position, then remove locking pin from sub-base and swing seat forward and down. In this position the seat pad is used as a seat and the sub-base cushion serves to prevent injury to the hands when withdrawing ammunition from the stowage box.

(26) COMPARTMENT LIGHTS. There are 3 compartment lights to provide illumination in the drivers' compartment. Two of the lights are attached inside to the hull top plate, one above the master switch box (fig. 14) and another over the auxiliary generator (fig. 13). The third light is attached to the hull ventilating fan (fig. 6). Each light is controlled by its own toggle-type switch. The circuits are protected by the smaller circuit breaker on top of the switch box.

14. INSTRUMENTS.

a. Ammeter. (C, fig. 10). An ammeter with a range of 100-ampere discharge to 100-ampere charge is located in the left center section of the instrument panel. If, during normal operation when little current is being used, the ammeter consistently indicates discharge, refer to paragraph 35 **b** (8).

b. Oil Pressure Gage (D, figure 10). The oil pressure gage is located to the right of the ammeter on the left center section of the instrument panel. At normal temperature the oil pressure should be between 60 and 100 pounds. If, during operation, the oil pressure suddenly drops off, stop the engine immediately. The fault may be due to low oil level. If oil pressure drops off slowly, it may be due to a change in the viscosity of the oil caused by overheating. Check the engine temperature.

c. Temperature Gage (F, fig. 10). The temperature gage, which indicates the temperature of the liquid in the cooling system, is located in the right center section of the instrument panel and has a scale ranging from 60° F to 260° F. The cooling system is sealed with the result that the boiling point of the coolant is raised, and overheating does not occur until a temperature of approximately 235° F is reached. In normal operation under maximum power on a level, hard surface, the temperature should not be greater than 90° F above atmospheric temperature.

d. Fuel Gage and Selector Switch (G and J, fig. 10). The fuel gage in the right center section of the instrument panel works only in conjunction with the fuel gage selector switch. The switch has two "ON" positions, "L" and "R," to permit checking of the fuel level in either the left or right fuel tanks. With the switch in the "OFF" position, the fuel gage will read "E" (empty).

e. Speedometer (L, fig. 10). The speedometer, which is located at the bottom of the instrument panel to the left of center, indicates the speed of the vehicle in miles per hours. The scale ranges from 0 to 60. The upper odometer registers total mileage. The lower odometer registers trip mileage and has a reset knob directly behind it on the back of the instrument panel.

f. Tachometer (P, fig. 10). The tachometer, which registers the revolutions per minute of the engine, is located at the bottom of the instrument panel to the right of center. The circular scale is divided into 40 units, each of which indicates 100 revolutions per minute. The tachometer is operated by the transmission and so will not register with the clutch disengaged. The horizontal row of numbers at the bottom of the dial record the total revolutions of the engine in thousands.

g. Periscopes (B and C, fig. 6). Periscopes, mounted one each in the driver's and assistant driver's doors and two in the hull between the doors, provide vision from the driving compartment when the doors are closed. The periscopes may be tilted to raise or lower the field of vision. The periscopes mounted in the doors may be turned in any direction as well as tilted (par. 23).

h. High Water Temperature and Low Oil Pressure Warning Light (K, fig. 10). The high water temperature and low oil pressure warning light is located on the extreme lower left corner of the instrument panel. It is a red, jewel-type light which flashes on when the oil pressure drops below 8 pounds, or when the water temperature is higher than 235° F.

i. Compass (A, fig. 6). The driver's compass, which indicates directions, is bracket-mounted on the sloping armor plate above the left corner of the instrument panel.

Section VII

OPERATION UNDER ORDINARY CONDITIONS

15. USE OF INSTRUMENTS AND CONTROLS IN VEHICULAR OPERATION.

a. New Vehicle Run-in Test. Before a new or reconditioned vehicle is placed in service, be sure that the new vehicle run-in test described in paragraph 12 has been performed.

b. Before-operation Service. Perform the services in items (1) through (6) in paragraph 35 before attempting to start the engine. Start and warm up the engine (subpar. c below), and complete the before-operation services.

c. Starting the Engine.

(1) PRELIMINARY INSTRUCTIONS. Before attempting to start the engine, become familiarized with all the various instruments and controls as outlined in paragraphs 13 and 14. Make sure that the function of each instrument and control is thoroughly understood, and that the significance of the readings on the various instruments is appreciated.

(2) WARM WEATHER STARTING. Make sure the engine compartment door shutters are open. If the fuel tanks are full, open both fuel shut-off valves (fig. 9). NOTE: *After 30 minutes operation, close either fuel shut-off valve.* Turn the 24-volt master switch to the "ON" position. Put the gearshift lever in neutral. Press the foot throttle pedal, and pull the hand throttle out about ¼ inch. Turn

the magneto switch to the "BOTH" position. If the engine is cold, prime it with one to three quick strokes of the primer. Turn the starter switch lever to the left. The engine should start readily. If it does not continue to run, repeat the priming.

(3) COLD WEATHER STARTING. If the temperature is lower than 10° F and the vehicle is equipped with engine compartment door shutters, make sure the shutters are closed. Start auxiliary generator and heat batteries (par. 19 **b**). Close the 24-volt master switch. Put the gearshift lever in neutral. Press the foot throttle pedal, and pull the hand throttle out about ¼ inch. Turn the magneto switch to the "BOTH" position. Prime the engine with five or six quick strokes of the primer. Turn the starter switch lever to the left. Hold the clutch pedal all the way down while the starter is turning the engine. As the engine starts, two or three quick strokes of the foot throttle pedal will assist in keeping the engine running by supplying additional fuel. If temperature is below 0° F, it may be necessary to continue priming until carburetor cuts in (as evidenced by consistent firing).

d. Operation of the Vehicle.

(1) PRELIMINARY INSTRUCTIONS. Before attempting to drive the vehicle, be thoroughly familiar with all the instruments and the significance of their readings. Know the function and operation of all the controls in this compartment. Review of paragraphs 13 and 14 will be helpful.

(2) SETTING THE VEHICLE IN MOTION. With the engine at idling speed and all instruments showing normal readings, the driver may now operate the vehicle. Disengage the clutch by pressing the clutch pedal down to the floor and holding it down. Move the gearshift lever into second gear position for normal operation (first gear will be used only when operating vehicle in buildings or over obstacles). Gradually release the clutch pedal, at the same time depressing the foot throttle. When the vehicle has started and is moving with an engine speed of 1,200 revolutions per minute, release the foot throttle, depress the clutch again, and move the gearshift lever into the third gear position. Release the clutch and again depress the throttle to pick up the load of the vehicle. Repeat the above procedure until the highest gear is reached which will enable the vehicle to proceed at the desired speed without causing the engine to labor. Do not ride the clutch. The driver's left foot must be completely removed from the clutch pedal while driving, to avoid unnecessary wear and burning out the clutch.

(3) STEERING THE VEHICLE. To steer the vehicle, pull back the right-hand steering lever to make a right turn, or the left-hand lever for the left turn. This action applies the brake to the track on the inside of the turn and speeds up the outside track. The driver should anticipate each turn and be ready to apply more power as it is needed

to compensate the braking effort. The hands should be free of the steering levers when not actually steering the vehicle.

(4) BACKING THE VEHICLE. Backing the vehicle should never be attempted unless an observer is stationed in front to guide the driver. To place the vehicle in reverse gear, a complete stop must be made. The throttle must be closed until the tachometer reads 500 revolutions per minute (lowest idling speed). Depress the clutch pedal and move the gearshift lever to the reverse position.

(5) USE OF GAGES ON THE INSTRUMENT PANEL. The tachometer and the oil pressure gage give the most satisfactory indications of the engine's performance. Should the indications of these instruments appear to be irregular, the engine should be stopped and the cause investigated.

(6) STOPPING THE VEHICLE. To stop the vehicle, release the throttle and pull back on both steering levers at the same time. Depress the clutch pedal when the vehicle has slowed down to approximately 2 to 5 miles per hour, depending upon which gear is being employed before stopping.

(7) STOPPING THE ENGINE. After completing a run, the engine must be allowed to operate at 500 revolutions per minute for 2 minutes to assure a gradual and uniform cooling of the valves and other engine parts. To stop the engine, press the fuel cut-off button until the engine stops, then turn the magneto switch to the "OFF" position.

16. TOWING THE VEHICLE.

a. Equipment. A towing shackle is mounted on each corner of the hull. Two of these shackles are mounted in front and two in the rear (fig. 11). These shackles provide a quick method of attaching either a towing bar or cables.

b. Towing a Disabled Vehicle.

(1) PRECAUTIONS. If there are tracks on the vehicle to be towed, always disconnect the propeller shaft at the transmission companion flange and leave the vehicle in fifth gear. This procedure insures adequate circulation of the transmission oil while the vehicle is in motion. If the tracks are removed before towing the vehicle, this precaution is not necessary. In towing, there are several precautions that the driver must take to avoid trouble or unnecessary delay. Changes of direction are always to be made by a series of slight turns so that the vehicle being towed is, as nearly as possible, directly behind the one doing the towing, or "tracking." NOTE: *This will prevent the cable from contacting the track which might ruin both the cable and the track blocks.* The maximum speed when towing should be not more than 12 miles per hour, and then only with an operator for steering and braking the towed vehicle. If no operator is available to steer

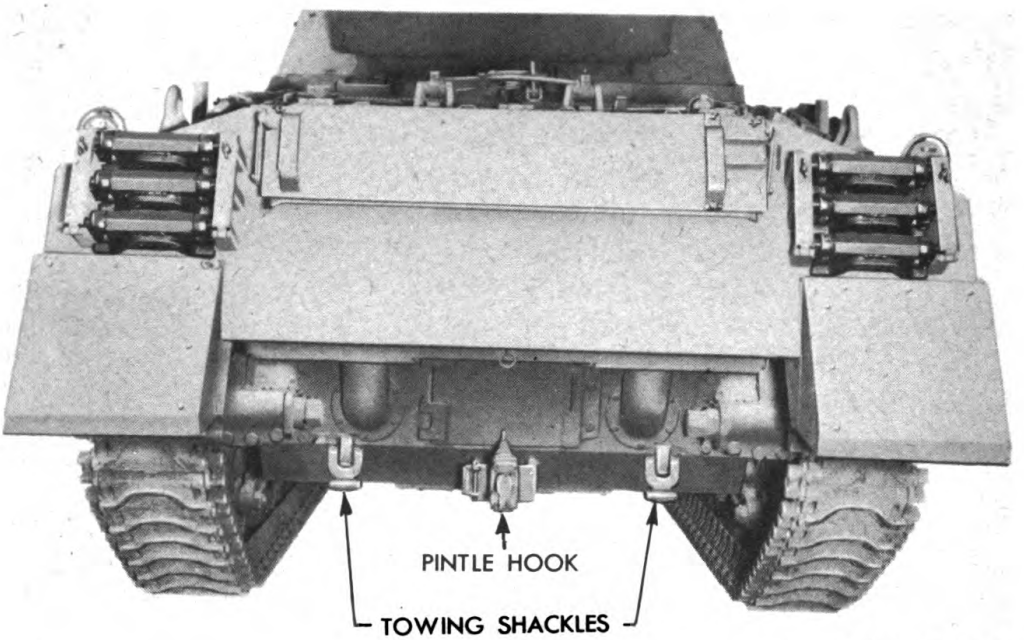


Figure 11 — Towing Shackles and Pintle Hook

the disabled vehicle, one cable will facilitate tracking of the towed vehicle. NOTE: *When turning, take care not to get the cable tangled up with the track of either vehicle. Except in cases where a "short hitch" is absolutely necessary, a towing cable will not be coupled to another vehicle by other than the thimbled eyes provided at both ends.* Doubling the cable causes sharp bends in the wire rope which will cause rapid failure of the strands, and will leave the cable extremely dangerous to handle.

(2) TOWING ON MUDDY OR IRREGULAR TERRAIN. Soft muddy ground is to be avoided since the tracks may slip on such a surface. If it is necessary to cross a muddy area, the driver should be careful to straighten out both vehicles before entering it, as it is more difficult to pull a vehicle at an angle than when following in tow. On vehicles equipped with rubber block tracks, grousers may be installed as required.

c. Towing to Start. If the engine is forced to turn over while there is water or antifreeze in the cylinder above the pistons (as a result of condensation or leakage), breakage of internal parts of the engine will result. Turn the engine over 2 complete revolutions by hand prior to towing. Never use other than fifth gear when towing the vehicle to start the engine.

(1) TURN ENGINE OVER. Turn the magneto switch off. Tow the vehicle several feet with the transmission in neutral to remove

the slack from the towing cable and to break the track loose from the ground. Depress the clutch pedal and place the gearshift lever in fifth gear. Tow the vehicle at 1 mile per hour, and engage the clutch gradually (permitting it to slip) until two complete revolutions of the engine have been made. If the engine will not turn over with the clutch slipping, discontinue attempting to start and notify higher authority.

(2) START THE ENGINE. After the engine has been turned over as outlined above, turn the magneto switch to "BOTH" position and engage the clutch. Increase towing speed to from 3 to 5 miles per hour (in fifth gear) and make from three to five strokes with the priming pump. If the engine does not start, see paragraph 41 **b**.

d. General Towing. When towing vehicles other than other tanks or gun motor carriages, and the vehicle being towed has a gross weight of 5 tons or less, the towing pintle may be used instead of the towing shackles.

Section VIII

TURRET CONTROLS AND OPERATION

17. CONTROLS AND INSTRUMENTS.

a. Armament Controls. For description and operation of the armament controls, refer to Part Four.

b. Turret Lock. The turret can be secured against accidental rotation by operation of the turret lock which is mounted on the turret ring at the right of the gunner (fig. 12). To disengage the turret lock, pull the handle straight out and turn left, or counterclockwise. To lock the turret, turn the handle to the right, or clockwise. If necessary, manually traverse the turret slightly to make sure gear teeth are meshed with turret lock.

c. Turret Traversing Shift Lever (fig. 12). The gear shifting lever, mounted under the gear box, enables the operator to select either hydraulic or manual traversing. When the shifting lever is moved to lower position it engages the gears for manual traversing. If necessary, move the manual traverse brake handle slightly to fully mesh the gears. Move the gear shifting lever to upper position for hydraulic traversing.

d. Hand Traversing Brake Control. The hand traversing brake control handle is mounted on the gear box ahead of, and to the right of, the gunner's station (fig. 12). The gear shifting lever must be placed in manual operating position (subpar. **c** preceding) and the turret lock released (subpar. **b** preceding) before traversing turret.

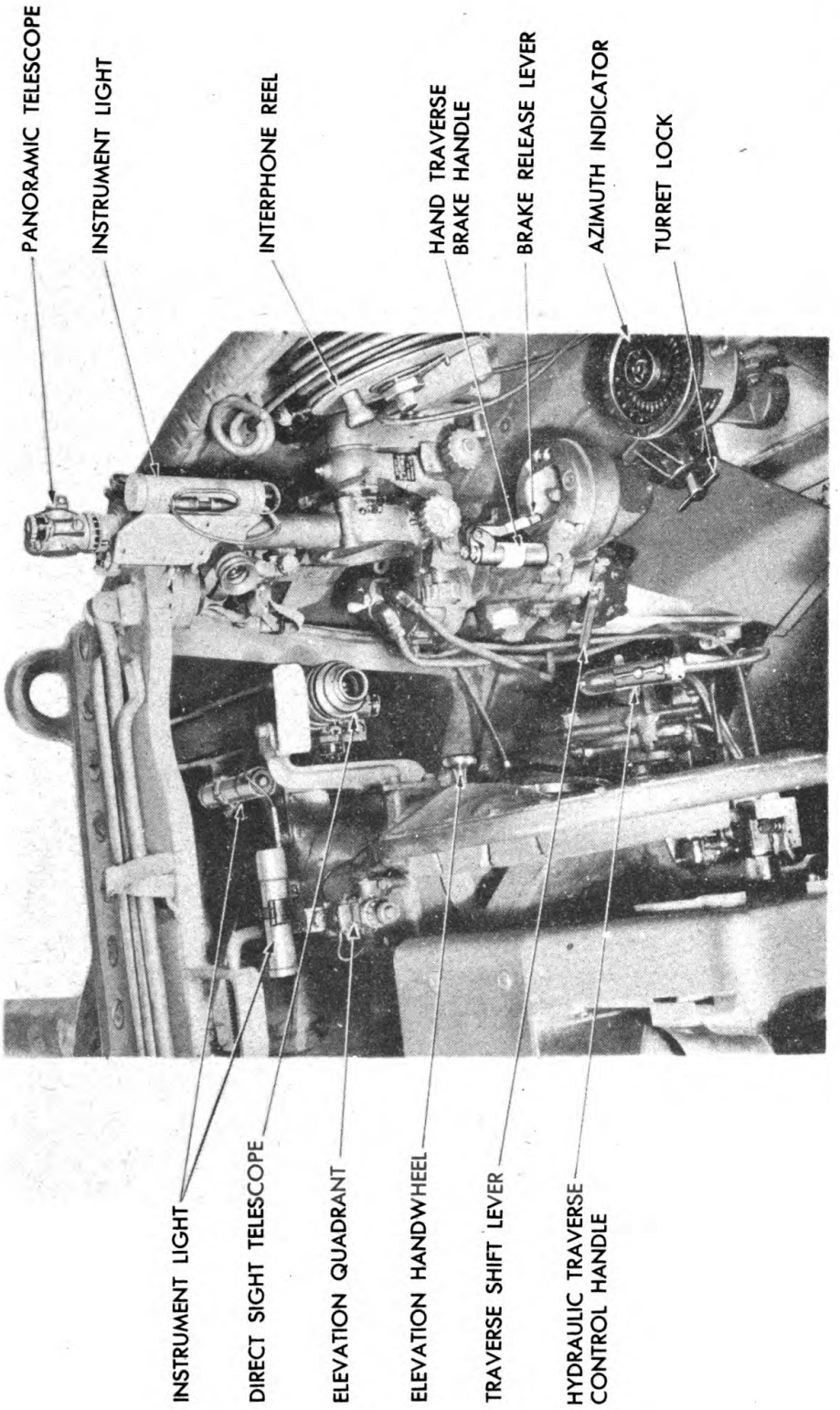


Figure 12 — Turret Controls

Gripping the brake handle and brake release lever will release the brake. Turning the handle to the left, or counterclockwise, turns the turret to the left. Turning the handle to the right, or clockwise, traverses the turret to the right. When the brake release lever is released, spring action applies the turret brake. NOTE: *Always leave gear shifting lever in manual position except when hydraulic operation is desired.*

e. Hydraulic Traversing Control. The hydraulic traversing control handle on the traverse pump to the right of the gun elevating handwheel (fig. 12) controls the speed and direction of turret rotation. To traverse the turret to the right, rotate the control handle to the right. To traverse the turret to the left, rotate the control handle to the left. Maximum traversing speed is obtained by turning the control handle to the extreme right or left. NOTE: *Turret rotation can be reversed instantly without damage to the power mechanism.*

f. Seats. The gunner's seat, mounted on the turret platform at the right side of the 90-mm gun, is provided with a detachable back and can be raised or lowered or adjusted horizontally (fig. 181). The commander's seat is the pad-type, adjustable in height, and is mounted on a frame at the rear side of the turret. It can be folded down out of the way when not in use. The loader's seat, at the left side of the 90-mm gun, is similar to the commander's seat and is demountable.

18. OPERATION.

a. General. The turret can be traversed 360 degrees in either direction by operating the hydraulic or manual traversing mechanisms.

b. Before-operation Service. Perform the inspections in items 1, 2, 4, and 6 of Before-operation Service (par. 35) before traversing the turret.

c. Manual Operation. Move the gear shifting lever to lower or manual traversing position. Disengage the turret lock (subpar. b preceding). CAUTION: *Before traversing the turret, be sure both drivers' doors are closed, and the gun will clear all obstructions.* Grip the brake control handle and brake release lever to release the brake in the gear box. Turn the brake control handle to the right or left as desired. NOTE: *The speed of turret rotations depends upon the speed with which handle is operated.* Release the brake control handle and brake release lever to hold turret stationary. Lock turret in position with turret lock when there is no further need for traversing.

d. Power Operation. Place gear shifting lever in its upper or power position. Disengage the turret lock. Turn battery master switch to "ON" position. Turn on the turret traversing motor switch (located on turret control box) to start the electric drive motor. Grasp the hydraulic traverse control handle and twist to the right or left according to direction of turret rotation desired. CAUTION: *Before turning the turret traversing motor switch off, move the gear shifting lever to its manual position to prevent accidental rotation of the turret.* Lock turret in position with turret lock when need for traversing is completed.

Section IX

OPERATION OF AUXILIARY EQUIPMENT

19. AUXILIARY GENERATOR (fig. 13).

a. Description. The auxiliary generator is a self-contained unit consisting of a 30-volt, 50-ampere (1,500-watt) generator, driven by a single-cylinder, two-cycle, air-cooled gasoline engine. This unit is mounted on the left sponson near the bulkhead with a separate 6-gallon fuel tank mounted above in the left rear corner of the fighting compartment. The fuel tank is filled through a hole in the hull roof behind, and to the left of, the turret. The auxiliary generator is cranked electrically by means of an integral starter winding, or manually by means of a starting rope wound around the starting plate of the engine. The auxiliary generator can be used in cold weather to heat the batteries or engine compartment, or as a charging generator to recharge the batteries and to furnish power for operation of the electrical units when the main generator is running slowly or is not in operation.

b. Operation.

(1) FUEL. Fill the auxiliary generator fuel tank with a mixture of ⅜ pint of engine oil to 1 gallon of gasoline. The engine is lubricated by the oil in the gasoline. Mix the fuel thoroughly to assure proper lubrication and prevent fouling of the spark plug.

(2) STARTING THE ENGINE. Close the 24-volt master switch and open the fuel valve. Close the choke (the lever on top of the carburetor) and press the button marked "START." When the engine starts, release the "START" button and open the choke. If the batteries are too low to crank the auxiliary generator engine, wind the rope around the starting plate and crank the engine by pulling the rope quickly.

(3) USE OF AUXILIARY GENERATOR AS A HEATER. The auxiliary generator engine muffler and a heater coil is housed in an air duct

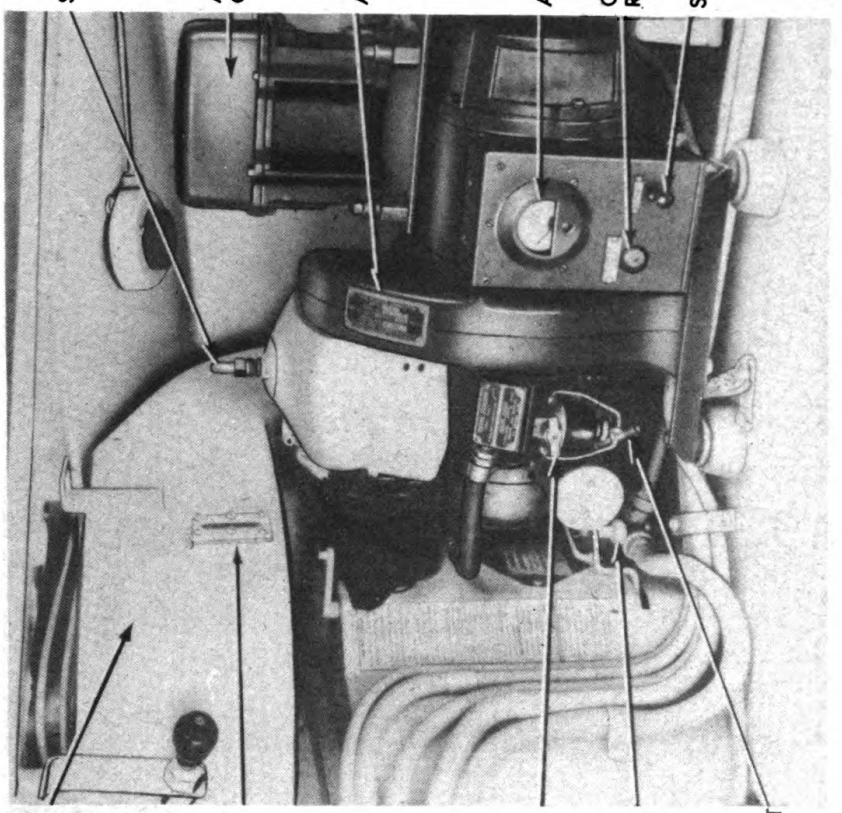


Figure 13 — Auxiliary Generator

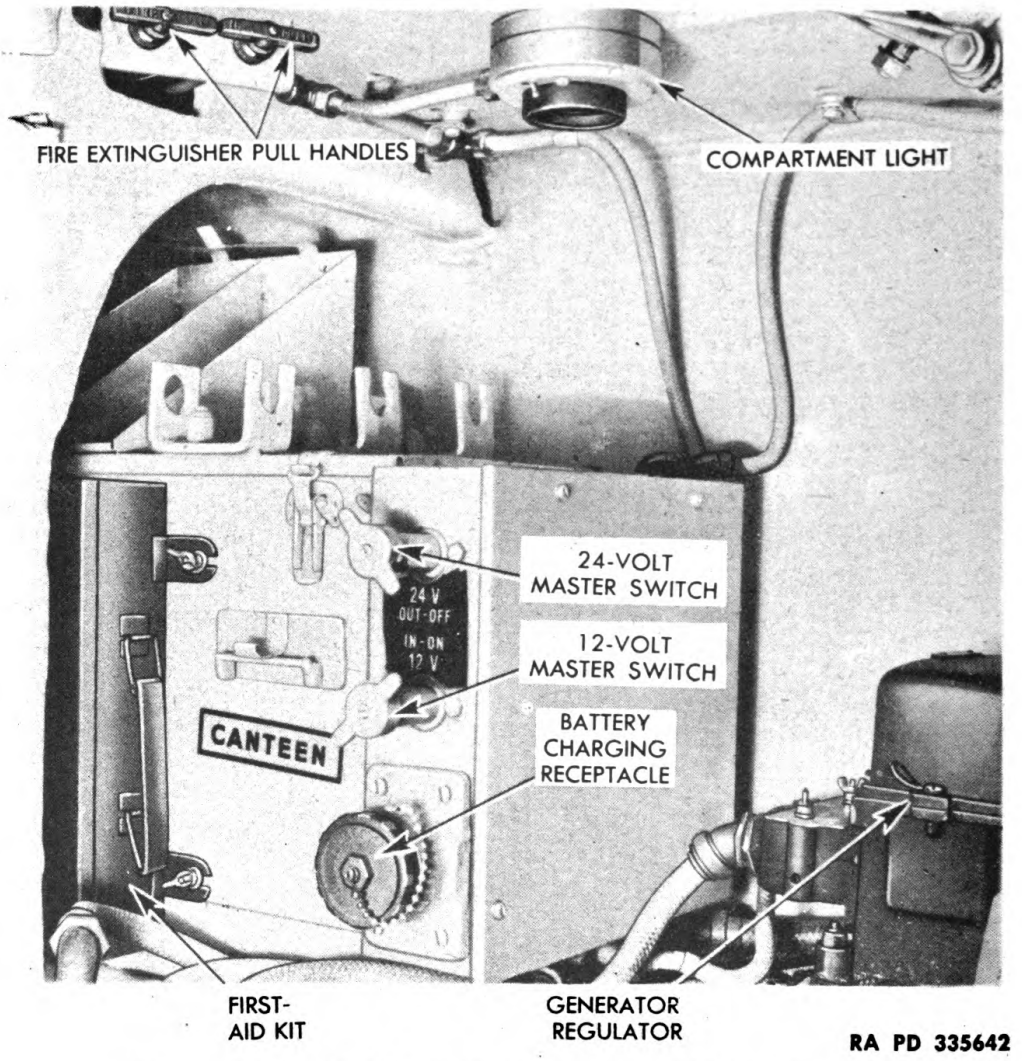


Figure 14 — Fixed Fire Extinguisher Interior Controls

on the bulkhead behind the auxiliary generator. The heater coil is connected to the output of the generator through a transfer switch on the bulkhead terminal box. Circulation in the air duct is created by the generator cooling fan and is controlled by a damper on the left sponson. Turn the transfer switch (fig. 9) to position marked "**HEAT BATTERIES**," push the damper handle in, and start the engine (step (2) above). As soon as auxiliary generator has been operating for about 2 minutes, pull out the damper handle to direct the heat to the battery compartment. A red warning light on the right side of the bulkhead terminal box will burn when the transfer switch is on the "**HEAT BATTERIES**" position. **CAUTION**: *Do not operate the auxiliary generator as a heater if the temperature in the fighting compartment is above 40° F.*

(4) USE OF AUXILIARY GENERATOR TO CHARGE BATTERIES. Close the 24-volt master switch, start the engine (step (2) above), and place the transfer switch on the bulkhead terminal box in the position marked "CHARGE BATTERIES." The damper should be in normal operation position. The ammeter on the auxiliary generator control panel will show the rate of charge. If the batteries are very low, the ammeter will show approximately 50-amperes charge and the needle will return towards zero as the batteries become charged.

(5) STOPPING THE AUXILIARY GENERATOR. Press and hold the stop button on the magneto housing until the engine stops. Shut off the fuel valve.

20. FIRE EXTINGUISHERS.

a. Description. The fire extinguisher equipment consists of a fixed system which is piped to nozzles in the engine compartment, with internal and external controls. There are two portable extinguishers; one located in the turret and one in the driving compartment (figs. 15 and 218). These extinguishers are the carbon-dioxide gas type and should be handled carefully. CAUTION: *Do not drop or expose cylinders to unnecessary heat.* The net weight of the fixed fire extinguisher cylinders should not be less than 9 pounds; for the portable cylinders, not less than 3.6 pounds. The full and empty weights are stamped on the control heads of the fixed cylinders, and on the discharge valve of the portable cylinders.

b. Operation.

(1) FIXED EXTINGUISHERS. In case of fire in the engine compartment, the fixed fire extinguisher cylinders can be discharged as follows:

Pull one of the pull handles directly above, and to the left of, the driver (fig. 14).

Operate the control head lever on one of the cylinders (fig. 189).

Pull one of the two pull handles on the outside of the hull to the left and behind the turret (fig. 182).

If fire is not extinguished, discharge the other cylinder by operating the other control from any one of the above three positions.

(2) PORTABLE EXTINGUISHERS. To operate the portable fire extinguishers, direct the nozzle at the base of the flame and press the trigger on the pistol grip (fig. 15).

c. Maintenance. Replace the fire extinguisher cylinders (fixed or portable) immediately after use. Weigh the cylinders every 4 months, if not used, to determine the amount of carbon dioxide gas in the cylinders, and replace them if below the proper net weight.

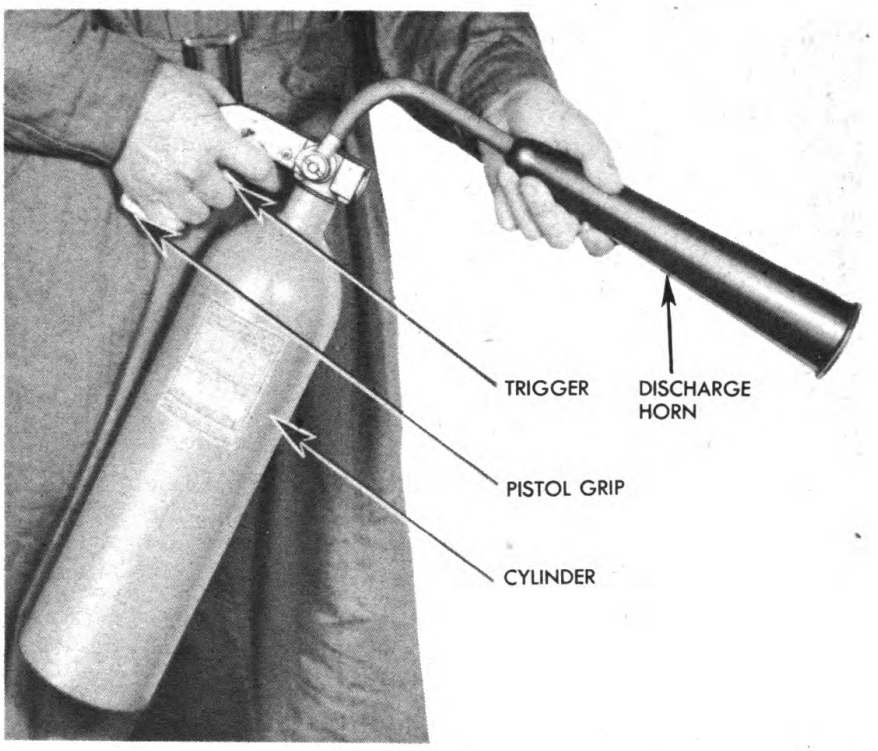


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Figure 15 — Portable Fire Extinguisher

21. CREW COMPARTMENT BLOWER.

a. Description (fig. 192). The crew compartment blower is a centrifugal fan-type blower mounted under the front ventilator directly above the transmission. The blower is driven by a 24-volt electric motor controlled by a toggle switch on the side of the blower. Drainage for the ventilator base is provided by a rubber hose leading to the outside of the hull in front of the assistant driver to prevent water from reaching the blower. Two universal outlet elbows, which direct the flow of air as desired in the driver's compartment, are a part of the blower assembly.

b. Operation. Turn on the 24-volt master switch. Turn on the blower switch and direct the outlet elbows to secure the desired ventilation. The small circuit breaker on top of the battery switch box is connected in series with the blower circuit to protect the equipment against short circuits, grounds, or overloads.

22. DRIVER'S HOOD AND WINDSHIELD.

a. Description. The driver's hood is used to protect the driver in inclement weather when driving with the door opened. The hood is provided with an electric windshield wiper and defroster wires.

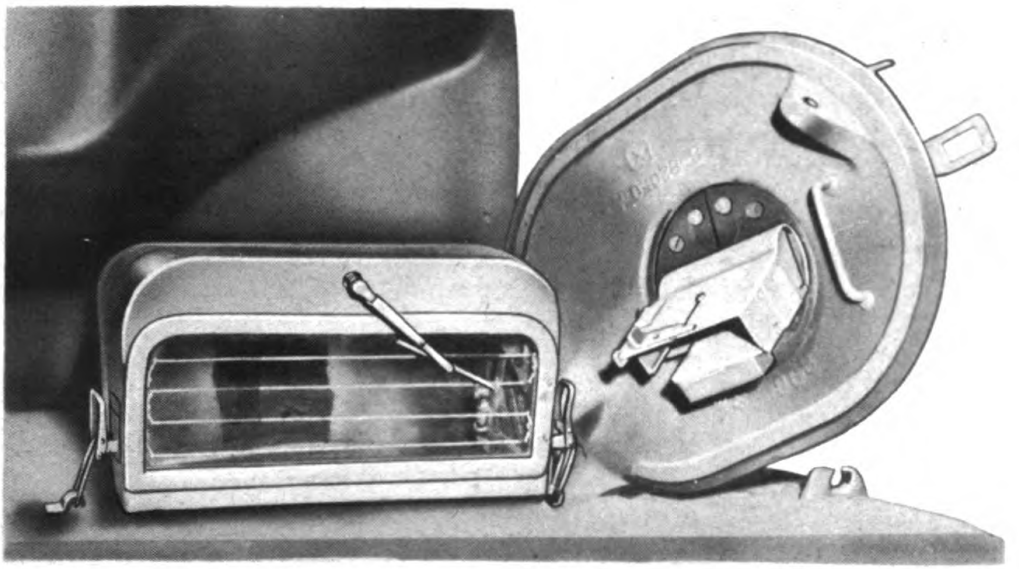

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Figure 16 — Driver's Hood and Windshield Installed

b. Operation. Position the driver's hood over the door opening with the door locked in opened position (fig. 16). Make sure the gasket seats evenly around the opening and lock the hood in position with the two catches, one on each side. Remove the utility outlet cap from the instrument panel (fig. 10) and plug the wire from the hood into the outlet. Turn on 24-volt master switch and switch marked "WIPER" to operate the windshield wiper. The switch marked "DEFROSTER" controls the heater wires in the windshield. Make sure defroster switch is turned off when not in use. When the hood is no longer needed, release the catches, carefully fold the hood, and stow it in bracket at front of driver's compartment.

23. PERISCOPES.

a. Description. Four periscopes are used to provide indirect vision; two for the driver and two for the assistant driver (figs. 5 and 6). The periscopes can all be tilted to raise or lower the field of vision, and the two in the driver's and assistant driver's doors can be rotated in any direction. Spare periscopes and heads are stowed in the driver's compartment (fig. 6). The heads are designed to shatter, when struck, without deflecting the projectile down into the interior of the vehicle.

b. Installation and Operation of Periscopes. Remove the periscope from the stowage box. Loosen the knurled nut at the front of the periscope. Slide the catch on the holder back out of the way. Insert periscope into holder and secure it in uppermost position by

tightening the knob. Slide the catch into locked position to prevent the periscope from dropping out should the knob become loosened. To rotate the periscope, loosen the housing knob at the edge of housing segment (fig. 180) and turn periscope to desired position. The knob can then be tightened to hold it in this position. To tilt the periscope, loosen the knob at the side of the holder just below the segment and tilt periscope as required. The periscope can be secured in the desired position by tightening the knob. To clean the periscope head while it is in use, loosen the knob at the front of the holder and move the periscope up and down so that wiper blade will clean the outer surface of the glass in the upper head. When not in use, stow the periscopes in the boxes in the front of the driver's compartment.

c. **Replacement of Heads.** With the periscope out of the holder, turn the half-ring latches at both sides of the periscope nearest the head to be removed counterclockwise as far as possible and pull out the head. Press a new head into end of periscope until firmly seated, and turn both latches clockwise as far as possible to lock the head in position. Fold the catches down against the sides of the periscope.

Section X

OPERATION UNDER UNUSUAL CONDITIONS

24. GENERAL.

a. **Purpose.** The purpose of this section is to augment the lubrication, maintenance, and operating instructions for ordinary conditions given in this manual. The instructions given herein cover cold weather operation at temperatures ranging between 0° F and –65° F. These instructions cover the cold weather operation of the cooling system at temperatures below +32° F. They cover the operation under extreme dust conditions and the special precautions necessary to prevent permanent damage to the vehicle resulting from submersion.

25. COLD WEATHER OPERATION.

a. **General.** Since sub-zero temperatures affect both metals and lubricants, operation of automotive equipment at sub-zero temperatures presents problems that demand special precautions. Extremely careful servicing from both operating and maintenance personnel is required if poor performance and total functional failure are to be avoided.

b. Fuels. The winter grade of motor fuels procured under U. S. Army Specification 2-103, grade C, latest revision, will be used for sub-zero operation.

(1) STORAGE AND HANDLING. Due to condensation of moisture from the air, water will accumulate in tanks, drums, and containers. At low temperatures, this water will form ice crystals that will clog fuel lines and carburetor jets unless the following precautions are taken.

(a) Be sure all containers are thoroughly clean and free from rust before storing fuel in them.

(b) If possible, after filling or moving a container, allow the fuel to settle for 24 hours before filling the vehicle tank from it.

(c) Keep all closures of containers tight to prevent the entrance of snow, ice, dirt, and other foreign matter.

(d) Wipe all snow and ice from dispensing equipment and from around the fuel tank fill cap before removing the cap for refueling.

(e) Add 1 quart of denatured alcohol, grade 3, to each fuel tank at the start of the winter season, and ½ pint at each refueling. This will reduce the chance of ice formation in the fuel tank.

(f) Strain the fuel through any type of filter that will prevent the passage of water. CAUTION: *Gasoline flowing over a surface generates static electricity that will result in a spark unless means are provided to ground the electricity. A metallic contact between the container and the tank must be provided to insure an effective ground.*

(g) Keep tanks full if possible. The more fuel there is in the tank, the smaller will be the volume of air from which moisture can be condensed.

c. Preparation of Vehicle for Continued Operation Below 0° F.

(1) ENGINE LUBRICATING SYSTEM. Use SAE 30 engine oil in the oil pan for operation at temperatures below 0° F. Several methods are used to keep the engine oil fluid for proper lubrication. Preference should be given to the different methods in the order listed below, according to facilities available.

(a) Keep the vehicle in a heated inclosure when it is not being operated.

(b) If vehicle is equipped with an Evans engine heater and it is desired to maintain the vehicle for instant starting, light the heater as soon as the vehicle is parked and leave it burning until the vehicle is again operated. If vehicle is known to be out of use for more than 5 hours, do not light the heater until 5 hours before the vehicle is to be started.

(c) When engine is stopped, drain the engine oil and while it is still hot store in a warm place until vehicle is to be used again. If warm storage is not available, heat the oil before refilling the oil pan, being careful to heat the oil only to the point where the bare hand may be inserted without burning. CAUTION: *If engine oil is drained, place a tag on one of the steering levers, warning the personnel that the oil pan is empty.*

(d) Fill engine oil pan with SAE 30 engine oil to the "FULL" mark. Add 9½ quarts of gasoline to oil pan. Run engine to thoroughly mix the diluent. Stop the engine and note that the level of the diluted oil is above the "FULL" mark on the oil pan oil gage. Mark this level on the gage for future reference. If engine is operated 4 or more hours, redilution will be necessary upon stopping. When rediluting, fill oil pan to "FULL" mark with engine oil and add gasoline to the dilution mark scribed on the dip stick as described above.

(e) Drain the crankcase while engine is still warm and refill to "FULL" mark on gage with engine oil, SAE 30, diluted with 9½ quarts of grade X Diesel fuel oil. Keep crankcase lubricant up to manufacturer's "FULL" mark by addition of engine oil diluted with grade X Diesel fuel oil in the proportion of 1½ quarts of Diesel fuel oil to each 5 quarts of engine oil.

(f) If vehicle is to be kept outdoors and crankcase cannot be drained, shelter the engine compartment with a paulin and about 3 hours before engine is to be started, place fire pots under the paulin. With due consideration given to the fire hazards involved, the flame may be applied directly to the oil pan below the oil level.

(2) TRANSMISSION AND FINAL DRIVES. When temperatures below 0° F are immediately anticipated, and if the transmission and final drives do not already contain the specified grade of engine oil, drain the transmission and final drives immediately after use and while lubricant is still warm. Refill with SAE 30 engine oil. After standing overnight or an equivalent length of time at sub-zero temperatures, warm up the transmission as follows.

(a) Close transmission oil cooler screen roll and warm up engine at 1,000 revolutions per minute for about 5 minutes, or until clutch can be engaged without stalling engine. Engage clutch and maintain engine speed for 2 minutes, or until gears can be engaged. Put transmission in low (first) gear and drive vehicle 100 yards, being careful not to stall engine. This will heat gear lubricants to the point where normal operation can be expected.

(3) OTHER LUBRICATION POINTS.

(a) Suspension Wheels and Track Rollers. If vehicle has been operated 1,000 miles with No. 0 general purpose grease in the sus-

pension wheel and track roller bearings, no special precautions are necessary. If No. 1 general purpose grease is still in these bearings, disassemble and wash in dry-cleaning solvent, dry, and then relubricate with No. 0 general purpose grease.

(b) All other points for which No. 0 general purpose grease is prescribed for temperatures from +30° F to 0° F shall be lubricated with the same lubricant below 0° F.

(c) When extremely low temperatures are encountered and No. 0 general purpose grease is not satisfactory where specified, No. 00 O.D. grease, Tentative Specification AXS-1169, may be used.

(d) For oilcan points where engine oil is prescribed above 0° F, use special preservative lubrication oil.

(4) BATTERIES. When air temperatures fall below −20° F for periods longer than 10 hours during which time the vehicle is inoperative, the auxiliary generator unit should be started with the transfer switch turned to "HEAT BATTERIES" position, and the battery heat damper in position to direct heat to the battery compartment. Operation of the auxiliary generator under full load for a period of approximately 45 minutes will raise the temperature of the battery sufficiently to protect it for an additional 10-hour period. However, the batteries should be fully charged before attempting to operate.

d. Cooling System. The cooling system will be protected with antifreeze compound (ethelyne-glycol type) for operation below +32° F. The following instructions apply to use of new antifreeze compound. For use of reclaimed antifreeze solutions refer to TM 9-850.

(1) Before adding antifreeze compound, it is necessary that the cooling system be clean and completely free from rust. If the cooling system has been cleaned recently, it may be necessary only to drain, refill with clean water, and again drain. Otherwise, clean the system with cleaning compound in accordance with instructions in paragraph 78 **a** (2).

(2) All hoses are to be inspected and replaced if deteriorated. Hose clamps, plugs, and petcocks are to be inspected and tightened if necessary. Radiator leaks will be repaired before adding antifreeze compound. Exhaust gas or air leakage into the cooling system will be corrected. If there are indications of a coolant leakage at the cylinder head, it will be corrected by tightening the cylinder head nuts as specified in paragraph 56 **c** (3). Replace the cylinder head gasket if necessary.

(3) Inspect thermostat to see that it closes completely at temperatures below 140° F. Look for evidence of sticking in open or closed position. If thermostat does not open or close completely, does not function freely, or is badly rusted, it should be replaced.

(4) When the cooling system is clean and tight, fill the system with water to about one-third capacity. Then add antifreeze compound, using the proportion of antifreeze compound to the cooling system capacity indicated below. The system should be protected to at least 10° F below the lowest expected temperature to be experienced during the winter season.

ANTIFREEZE TABLE

Lowest Expected Temperature	*Pints of Antifreeze Compound*
+10° F	28
0° F	35
−10° F	42
−20° F	49
−30° F	56
−40° F	63
−50° F	70

(5) After adding antifreeze compound, fill with water to the prescribed level; then start and warm the engine to normal operating temperature.

(6) Stop the engine and check the solution with a hydrometer, adding antifreeze compound if required.

(7) In service, inspect coolant weekly for strength and color. Drain any rusty solution and thoroughly clean the cooling system. Add new solution of the required strength.

(8) CAUTIONS.

(a) Antifreeze compound is the only antifreeze authorized for ordnance materiel.

(b) It is essential that antifreeze solutions be kept clean. Use only containers and water that are free from dirt, rust, and oil.

(c) Use an accurate hydrometer. To test a hydrometer, use 1 part antifreeze compound to 2 parts water. This solution should produce a hydrometer reading of 0° F.

26. OPERATION IN DUSTY CONDITIONS.

a. General. When operating the vehicle in dry, dusty, or sandy terrain, special precautions are necessary to reduce overheating and prevent damage to moving parts due to accumulation of dust and grit.

b. Air Cleaners and Breathers. Clean the carburetor air cleaners and the crankcase breather filter every 4 hours, or oftener if inspection shows the need. If the air cleaners are kept clean and their oil level maintained, they will be capable of cleaning the air

entering these openings and little chance of damage will result. However, if the elements become saturated with dust, the air cleaner will no longer act as a filter to fine sand or dust, and considerable damage or destruction to the engine bearings, pistons, and other wear surfaces will result. The differential breather must also be serviced (par. 33) more frequently than under ordinary conditions.

c. Use of Lubricants. Avoid the excessive use of lubricants in shaft and bearing grease fittings and wipe off excessive lubricant. Exposed grease and oil become dust-laden and may work into fittings or relief openings causing unnecessary wear. Clean all dust and sand from fittings and other lubrication points before lubricating.

d. Cooling Systems. Make sure air passages in radiator cores of engine cooling system and transmission oil cooling system are kept clean and free from accumulation of dust and dirt so there will be no interruption to the free flow of air through the radiators. Clean with water, brush, or compressed air. CAUTION: *Do not attempt to dislodge dirt between the core passages with a sharp instrument as the metal forming the core may be easily punctured.*

27. SUBMERSION.

a. General. If an engine or vehicle has been submerged in either salt or fresh water, the problem of arresting corrosion is difficult and calls for immediate action. Corrosion which has already started must be stopped and further corrosion prevented.

b. Arresting Corrosion. In order to completely arrest corrosion, remove water from every part of the unit. Due to inaccessibility of many parts it may be impossible to dry all parts without disassembly of a unit. If proper equipment and personnel to do this are not immediately available, take temporary steps to arrest corrosion until such time as complete disassembly, inspection, and cleaning or repair may be done. Dry the unit as much as possible and coat all parts, inside and outside the unit, with preservative oil. If preservative compounds are not immediately available, ordinary engine oil may be used temporarily, or unit may be left submerged to keep air from the wet metal parts until preservative compounds are made available.

c. Permanent Protection. As soon as possible, the vehicle or unit should be delivered to higher echelons for disassembly and cleaning or repair of all components affected. This inspection should pay particular attention to possible damage caused by the sudden cooling effect of the water to parts of the engine or transmission of a vehicle which was at operating temperature at the time of submersion. If submerged in salt water for any length of time, aluminum or magnesium parts will probably be unfit for further use and should be discarded and replaced.

Section XI

DEMOLITION TO PREVENT ENEMY USE

28. 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.

29. DETAILED INSTRUCTIONS.

a. Methods. The following instructions apply to the 90-mm Gun Motor Carriage M36B1.

b. Destruction of 90-mm Gun.

(1) Insert four unfuzed incendiary grenades, M14 end to end halfway down the gun tube, with tube at 0 degrees elevation. Ignite these grenades with a fifth grenade equipped with a 15-second safety fuze. Elapsed time: 2 to 3 minutes.

(2) The metal from the grenades will fuze with the tube and fill the grooves.

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.

PART THREE — MAINTENANCE INSTRUCTIONS

Section XII

GENERAL

30. 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 units and systems and their function in relation to other components of the equipment.

Section XIII

SPECIAL ORGANIZATIONAL TOOLS AND EQUIPMENT

31. PURPOSE.

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

b. Special Tools.

Name	Federal Stock Number	Manufacturer's Tool Number	Fig. 17 Item
CABLE, extension, rubber-covered, 2-conductor, stranded #1 gage, with plug on each end	17-C-568		A
COMPRESSOR and RETAINER, suspension volute spring, consisting of:	41-C-2562-5		
COMPRESSOR, suspension volute spring	41-C-2556-25		
RETAINER, suspension volute spring	41-R-2454-75		
COMPRESSOR, suspension volute spring	41-C-2556	MTM-M3-3	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	
GUIDE, bogie wheel gudgeon, installing	41-C-1235-505	MTM-M3-5	C
HOLDER, magneto drive flange	41-H-2350	KRW-T-31	
INDICATOR, top dead-center	41-I-115	KRW-T-77	D
LIFT, bogie wheel, medium tank	41-L-1375	MTM-M3-813	E
LIGHT, timing Bosch magneto, complete with battery and neon bulbs	41-L-1439	TSE-5230	
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	

Special Organizational Tools and Equipment

Name	Federal Stock Number	Manufacturer's Tool Number	Fig. 17 Item
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	
PULLER, magneto drive flange	41-P-2941-750	KRW-T-43	
PULLER, idler wheel	41-P-2940-800	MTM-M3-8	F
PULLER, slide hammer-type, bogie gudgeon	41-P-2957-27		G
SCREWDRIVER, special, adjusting gudgeon	41-S-1652-500	KRW-T-59	H
SLING, battery lifting	41-S-3829-50		Z
SLING, radiator lifting	41-S-3832-86	TEC-50-63	AA
TOOL, idler wheel installing	41-T-3216-150	MTM-M3-9	I
WRENCH, box, double-offset, long, double-hex, size 9/16 in. x 5/8 in.	41-W-601	BF-2806L	J
WRENCH, box, special offset, carburetor heat box nuts	41-W-639-850	KRW-T-40	K
WRENCH, cylinder head nut, long	41-W-866-200	KRW-T-9	L
WRENCH, cylinder head nut, short	41-W-866-250	KRW-5-29	M
WRENCH, engineers' 40 deg and 90 deg angle, double-head, open-end	41-W-1059		N
WRENCH, plug, male, 5/8 in.	41-W-1960	MTM-M3-10	O
WRENCH, set, socket, 1-in. sq. drive, extra-heavy-duty, consisting of:	41-W-2622	MTM-M3-16A	
BAR, socket wrench, extension, 8 in. long, 1-in. sq. drive (formerly 41-B-310-100)	41-B-310	SN-L-63	Q
BAR, socket wrench, sliding, 22 in.	41-B-312-200	MTM-M3-16L	Y
HANDLE, tubular, 36 in. long, 1 1/8-in. inside diameter, 1 7/16-in. outside diameter	41-H-1498-50	MTM-M3-16C	X
HEAD, ratchet, socket wrench, 1-in. sq. drive	41-H-1838	MTM-M3-16M	W
HEAD, square, 1-in., male	41-H-1779-50	MTM-M3-16	V
WRENCH, socket, hex., 1-in. sq. drive, 2 5/8 in.	41-W-3058-480	MTM-M3-16K	P
WRENCH, socket, hex., 1-in. sq. drive, 2 3/8 in.	41-W-3058-450	MTM-M3-16H	R
WRENCH, socket, hex., 1-in. sq. drive, 2 1/4 in.	41-W-3058-430	MTM-M3-16F	S
WRENCH, socket, hex., 1-in. sq. drive, 1 13/16 in.	41-W-3058-300	MTM-M3-16N	T
WRENCH, socket, hex., 1-in. sq. drive, 1 1/2 in.	41-W-3058-200	MTM-M3-16J	U
WRENCH, socket, spark plug	41-W-3336-300	KRW-T-5	AC
WRENCH, socket, splined camshaft turning	41-W-2964-300	KRW-T-80	AB
WRENCH, socket, 1-in. sq. drive, 12-point, double-hex. opening, size 2 1/8 in.	41-W-3059-40	SN-LDH-683	AF
WRENCH, spanner, track support roller lock ring	41-W-3260	MTM-M3-19	AD
WRENCH, spanner, track support, roller retainer	41-W-3261	MTM-M3-11	AE

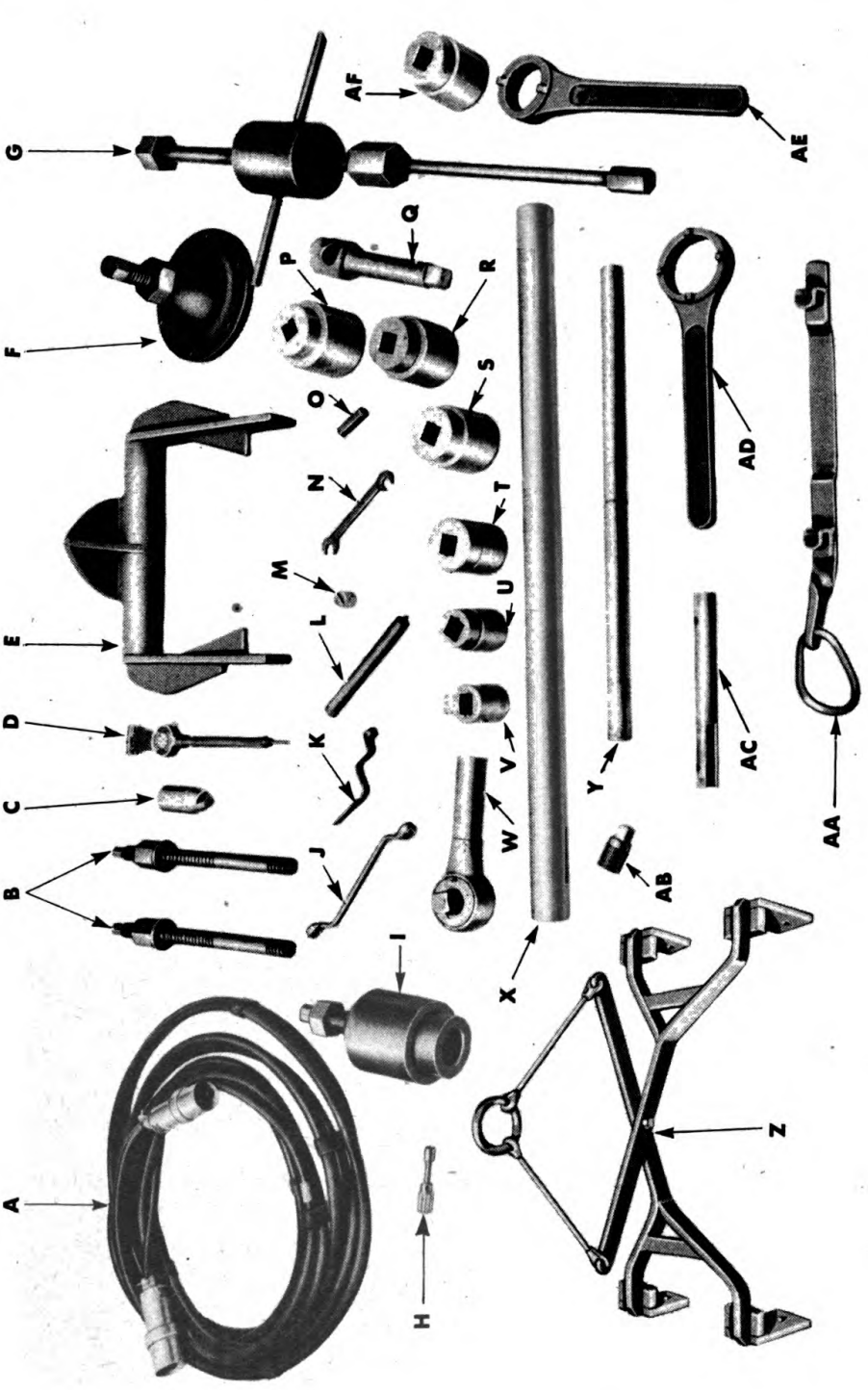

Figure 17 — Organizational Special Tools and Equipment

A—EXTENSION CABLE (17-C-568)
B—VOLUTE SPRING COMPRESSORS (41-C-2556)
C—BOGIE WHEEL GUDGEON INSTALLING GUIDE (41-G-1235-505)
D—TOP DEAD CENTER INDICATOR (41-I-115)
E—BOGIE WHEEL LIFT (41-L-1375)
F—IDLER WHEEL PULLER (41-P-2940-800)
G—SLIDE HAMMER TYPE BOGIE GUDGEON PULLER (41-P-2957-27)
H—SPECIAL ADJUSTING SCREWDRIVER (41-S-1652-500)
I—IDLER WHEEL INSTALLING TOOL (41-T-3216-150)
J—DOUBLE OFFSET BOX WRENCH 9/16 IN. x 5/8 IN. (41-W-601)
K—CARBURETOR HEAT BOX NUTS SPECIAL OFFSET BOX WRENCH (41-W-639-850)
L—LONG CYLINDER HEAD NUT WRENCH (41-W-866-200)
M—SHORT CYLINDER HEAD NUT WRENCH (41-W-866-250)
N—DOUBLE-HEAD OPEN-END ENGINEERS WRENCH (41-W-1059)
O—MALE PLUG WRENCH (41-W-1960)
P—SOCKET WRENCH, 2 5/8 IN. (41-W-3058-480)
Q—EXTENSION BAR (41-B-310)
R—SOCKET WRENCH, 2 3/8 IN. (41-W-3058-450)
S—SOCKET WRENCH, 2 1/4 IN. (41-W-3058-430)
T—SOCKET WRENCH, 1 13/16 IN. (41-W-3058-300)
U—SOCKET WRENCH, 1 1/2 IN. (41-W-3058-200)
V—MALE HEAD (41-H-1779-50)
W—RATCHET HEAD (41-H-1838)
X—TUBULAR HANDLE (41-H-1498-50)
Y—SLIDING BAR (41-B-312-200)
Z—BATTERY LIFTING SLING (41-S-3829-50)
AA—RADIATOR LIFTING SLING (41-S-3832-86)
AB—CAMSHAFT TURNING SPLINED SOCKET WRENCH (41-W-2964-300)
AC—SPARK PLUG SOCKET WRENCH (41-W-3336-300)
AD—SUPPORT ROLLER LOCK RING SPANNER WRENCH (41-W-3260)
AE—SUPPORT ROLLER RETAINER SPANNER WRENCH (41-W-3261)
AF—SOCKET WRENCH, 2 1/8 IN., 12 POINT (41-W-3059-40)

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Legend for Figure 17

Section XIV

LUBRICATION

32. LUBRICATION ORDER.

a. War Department Lubrication Order No. 165 (figs. 18 and 19) prescribes first and second echelon lubrication maintenance above 0° F. For lubrication below 0° F., refer to paragraph 25. Lubrication to be performed by ordnance maintenance personnel is covered in paragraph 33.

b. A Lubrication Order is placed on or 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 Lubrication Order, the using arm shall immediately requisition a replacement from the 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. These intervals will be reduced under extreme conditions such as excessively high 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.

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.*

33. DETAILED LUBRICATION INSTRUCTIONS.

a. Lubrication Equipment.

(1) Each piece of materiel is supplied with lubrication equipment adequate to maintain the materiel. This equipment will be cleaned both before and after use.

(2) Lubrication guns will be operated carefully and in such manner as to insure a proper distribution of the lubricant.

b. Points of Application.

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

d. Lubrication Notes on Individual Units and Parts. The following instructions supplement the notes on the Lubrication Order.

(1) ACCESSORY DRIVE SHAFT HOUSINGS, UNIVERSAL JOINTS, AND SLIP JOINTS. Weekly and before operation, check oil level. Filler plug in housing is fitted with bayonet gage; fill to "FULL" mark on gage. Drain and refill at intervals indicated on the Lubrication Order. Lubricate universal joints through fittings with general purpose grease No. 1 above +32° F, or No. 0 below +32° F. There is no relief valve in these joints. Do not use excessive pressure. To lubricate slip joints, apply general purpose grease No. 1 above +32° F, or No. 0 below 32° F, to fitting until lubricant is forced from end of spline.

(2) AIR CLEANERS. (Oil-Bath Type) Daily, check oil level and refill engine air cleaner oil reservoirs to bead level. Every 500 miles, remove air cleaners and wash all parts. (Mesh Type) Every 500 miles, remove auxiliary generator air cleaner, clean, and oil filter element. Used crankcase oil or engine oil SAE 50 above +32° F or SAE 30 from +32° F to 0° F will be used in all air cleaners. Below 0° F, use only engine oil SAE 10. (Breathers) Every 500 miles, remove filtering medium from transmission and differential breathers, wash thoroughly, dry, and reoil with used crankcase oil or engine oil SAE 50 above +32° F or SAE 30 from +32° F to 0° F. Below 0° F, use only engine oil SAE 10.

(3) AUXILIARY GENERATOR. The two-cycle, air-cooled engine, mounted on left sponson at the rear, is lubricated with oil mixed with fuel. Mix thoroughly ⅜ pint engine oil (crankcase grade) with each gallon of gasoline before pouring into tank. CAUTION: *Do not pour gasoline and oil separately into tank.* Keep fuel strainer clean. Monthly, lubricate magneto cam follower sparingly with general purpose grease No. 2.

(4) BELL HOUSING CLUTCH SHAFT BEARING. Apply lubricant to fitting reached through throttle control rod hole in clutch housing.

(5) BREECH AND FIRING MECHANISM. Daily and after firing, clean and oil all moving parts and exposed metal surfaces with engine

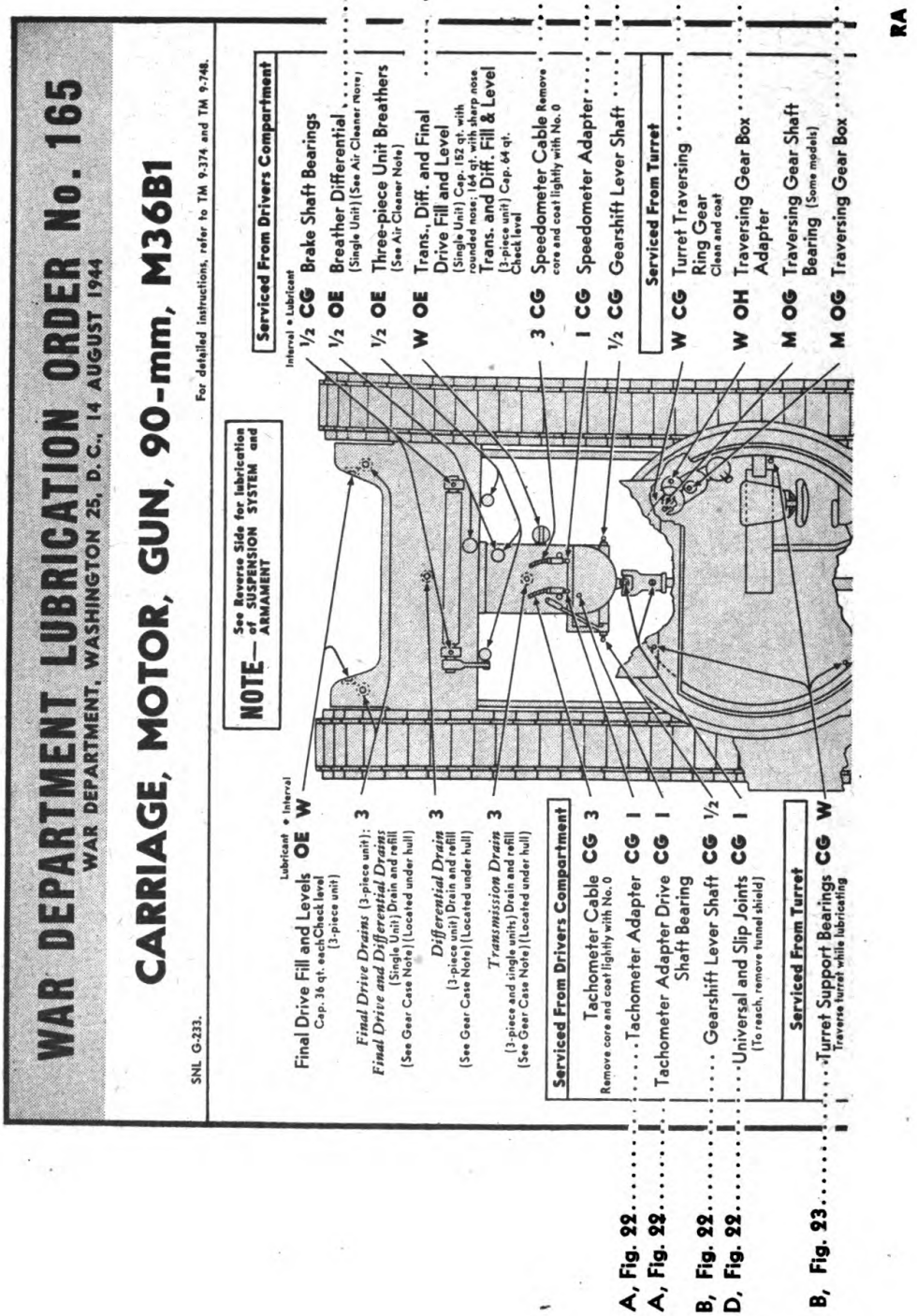
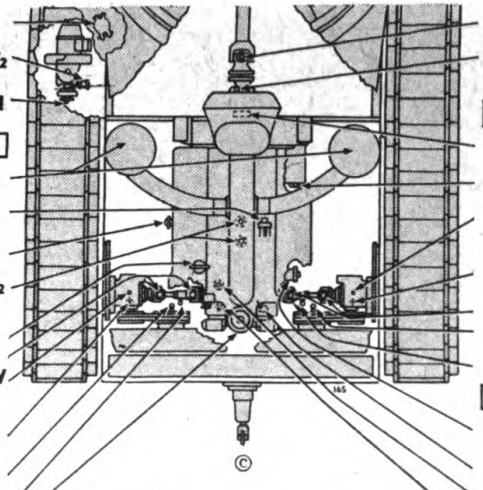


Figure 18 — War Department Lubrication

Auxiliary Generator Fill (See Note) (Reached from top of hull) — OE ½
Auxiliary Generator Air Cleaner (See Note) — OE ½
D, Fig. 26 — Magneto Cam Follower — WB M
Sparingly

Serviced From Engine Compartment

A, Fig. 23 — Air Cleaners — OE D
Check level (See Note)
Accelerator Control Rod Bearing — CG I
E, Fig. 20 — *Crankcase Level* — D
(Some models) Check level
Crankcase Drains (Some models) — ½
Remove 2 plugs, drain and refill Cap. 32 qt. (See Note)
F, Fig. 20 — Crankcase Fill (Some models) — OE
B, Fig. 20 — Universal Joints Sparingly — CG I
A, Fig. 20 — Accessory Drive Shaft Housing Fill and Level — OE W
Use only SAE 30, check level
Accessory Drive Shaft Housing Drain Drain and refill (See Gear Case Note) — I
C, Fig. 20 — Fan Shaft Bearing Sparingly — CG I
B, Fig. 20 — Slip Joint — CG I
Crankcase Breather — OE D
Wash and recoil (See Air Cleaner Note)



See Reverse Side for Notes

I CG Universal Joint (To reach, lift floor plate)
I CG Bell Housing Clutch Shaft Bearing (To reach, lift cover) — C, Fig. 22

Serviced From Engine Compartment

BR Clutch Pilot Bearing (See Note)
I OE Starter SAE 30 (Some models) — D, Fig. 20
W OE Accessory Drive Shaft Housing Fill and Level — A, Fig. 20
Use only SAE 30, check level
I *Accessory Drive Shaft Housing Drain* Drain and refill (See Gear Case Note)
I CG Universal Joints Sparingly — B, Fig. 20
I CG Fan Shaft Bearing Sparingly — C, Fig. 20
I CG Slip Joint — B, Fig. 20

Serviced Through Rear Door

D *Oil Filter* Check operation
Weekly, remove element, clean and inspect
OE Crankcase Fill (Some models)
½ *Crankcase Drain* (Some models)
Cap. 32 qt. Drain and refill (See Note)
D *Crankcase Level*
(Some models) Check level

—KEY—

LUBRICANTS	LOWEST ANTICIPATED AIR TEMPERATURE			LUBRICANTS	INTERVALS
	above +32°F.	+32°F. to 0°F.	below 0°F.		
OE— OIL, engine				RS— OIL, recoil, special	¼—250 miles ½—500 miles I—1,000 miles 3—3,000 miles D—Daily W—Weekly M—Monthly
Crankcase	SAE 50	SAE 30	See TM		
Trans., Diff. and Final Drives	SAE 50	SAE 30	SAE 30	BR— GREASE, ball and roller bearing	
Auxiliary Generator Engine Crankcase	SAE 50	SAE 30	SAE 10	WB— GREASE, general purpose, No. 2	
Other Points	SAE 30	SAE 10	PS	OH— OIL, hydraulic	
OG— GREASE, O.D.	No. 0	No. 00	No. 00		
CG— GREASE, general purpose	No. 1	No. 0	No. 0	PS— OIL, lubricating, preservative, special	

COLD WEATHER: For Lubrication and Service below 0°F., refer to TM 9-748.

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CARRIAGE, MOTOR, GUN, 90-mm, M36B1

Clean fittings before lubricating. Lubricate after washing.
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.

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

To clean parts use SOLVENT, dry cleaning or OIL, fuel, Diesel. Dry before lubricating. See Notes below for cleaning Gun Bore and Machine Gun Bore.

	Lubricant	Interval
B, Fig. 24 ..... Elevating Worm Housing	OG	M
C, Fig. 23 ..... Cradle Liner	OG	W
C, Fig. 24 ..... Cradle Trunnion Bearing	OG	M
E, Fig. 23 ..... Gun Tube (Finished surface) Daily and before firing, clean and coat	OG	D

	Interval	Lubricant
Elevating Gear Case ..... A, Fig. 24	M	OG
Hydraulic Traverse Oil ..... D, Fig. 24	W	OH
Reservoir Fill Check level, keep ½ full		
Firing Cable Conduit ..... A, Fig. 26	M	OG
Track Support Rollers	¼	CG

F, Fig. 22 ..... Bogie Wheels CG ¼

¼ CG Suspension System Idler ..... E, Fig. 22

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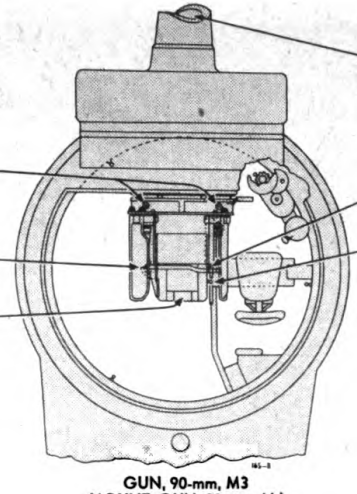
Figure 19 — War Department Lubrication

F, Fig. 24 — Recoil Chamber Fills — RS D
Check daily and before firing
Cap. 17 pt. each cylinder

B, Fig. 25 — Ejector Cam — OE D

D, Fig. 25 — Breech Mechanism — OE D
Daily and after firing, clean and oil

See Reverse Side for Key



GUN, 90-mm, M3
MOUNT, GUN, 90-mm, M4

D OE — Gun Bore — E, Fig. 25
Wipe clean before firing
(See Note)

W OG — Breech Closing Chain — A, Fig. 25

D OE — Firing Mechanism — C, Fig. 25
Daily and after firing, clean and oil

NOTES

AIR CLEANERS AND BREATHERS—*(Oil Bath Type)* Every 500 miles, disassemble, wash all parts and refill. *(Mesh Type)* Wash and recoil crankcase and gear case breathers and auxiliary generator air cleaner at intervals indicated on Lubrication Order. Used crankcase oil or OE will be used in all cleaners above 0°F.; below 0°F., use OE SAE 10.

AUXILIARY GENERATOR—Mix thoroughly ½ pt. OE with each gallon of gasoline before pouring into tank.

CLUTCH PILOT BEARING—Before replacing engine after inspection or overhaul, clean and repack bearings.

CRANKCASE—Drain only when engine is hot. Every 500 miles, drain and refill. Refill to FULL mark on bayonet gage, run engine a few minutes and recheck level.

GEAR CASES—Drain only after operation. Fill through transmission filler to mark on bayonet gage with fill cap resting on top of fill pipe. Fill final drives (3-piece unit) to plug levels before operation and after draining. Accessory drive shaft housing will be filled to FULL mark on gage. Every 3,000 miles, clean transmission filler strainer.

GUN BORE—Immediately after firing and on three consecutive days thereafter, swab with a solution of ½ lb. of SODA ASH to each gallon of warm water. Rinse with clear water, dry thoroughly before oiling. When gun is not fired, renew oil film daily. Every 5 days, swab with SOLVENT, dry cleaning, dry and recoil.

MACHINE GUN BORE—Immediately after firing, and on 3 consecutive days thereafter, swab with CLEANER, rifle bore, dry thoroughly and oil. Every 5 days, when gun is not being fired renew oil film.

OIL CAN POINTS—Every 250 miles, lubricate Parking Brake Shaft (some models), Door and Shield Hinges, Peep Hole Protector Slides, Door Latches, Lever Bushings, Control Rod Pins, Throttle and Gear Linkage Ball Joints, Pintle Hook, Escape Hatch Mechanism, Seat Supports and Clevises with OE. (Gun Mount) Weekly, lubricate Handwheel Handles, Firing Button, Firing Lever Link, etc., with OE.

DO NOT LUBRICATE—Water Pump, Clutch Release Bearing, Engine Governor, Bogie Wheel Suspension Linkage, Sprocket Drive Shaft Bearings, Auxiliary Generator Bearings.

DISASSEMBLED PERIODICALLY BY ORDNANCE PERSONNEL—Generator, Engine Magnetos, Traversing Gear Box, Turret Traversing Electric Motor and Breech Operating Shaft Bearings. (Refer to TM 9-748.)

Copy of this Lubrication Order will remain with the equipment at all times; instructions contained therein are mandatory and supersede all conflicting lubrication instructions dated prior to 14 August 1944.

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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oil SAE 30 above +32° F, SAE 10 from +32° F to 0° F, or special, preservative lubricating oil below 0° F. To clean firing mechanism, remove and operate pin in dry-cleaning solvent. Use special, preservative lubricating oil for machine guns at all temperatures.

(6) CLUTCH PILOT BEARING. Before replacing engine after inspection or overhaul, clean and lubricate with ball and roller bearing grease.

(7) CRANKCASE. Daily, check oil level and add oil to "FULL" mark if necessary. Every 500 miles, drain and refill. Drain only when engine is hot. Refill to "FULL" mark on gage. CAUTION: *Be sure pressure gage indicates that oil is circulating.*

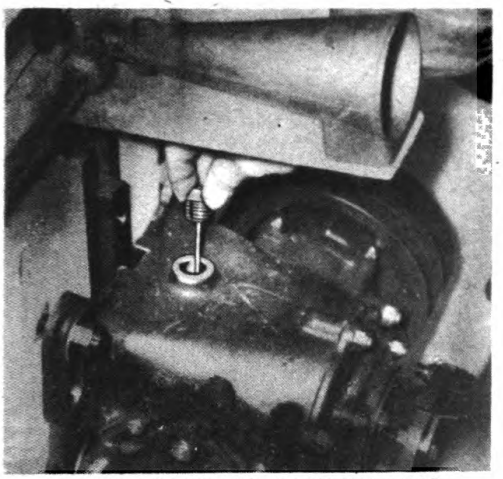
(8) GEAR CASES. Transmission, differentials, and final drives. On some assemblies, the transmission, differential, and final drives are combined in one unit. Fill through transmission filler to mark on bayonet gage with filler cap resting on top of filler pipe. Drain through transmission and final drive drain plug holes. Other assemblies use 3-piece units. Fill through transmission filler to mark on bayonet gage with filler cap resting on top of filler pipe, and through each final drive filler to plug hole level of hole before operation and after draining. Drain through transmission, differential, and final drive drain plug holes. Weekly and before operation, check oil level with tank on level ground and, if necessary, add lubricant. Every 3,000 miles, drain and refill. Drain only after operation when oil is warm. Refill with engine oil SAE 50 above +32° F or SAE 30 below +32° F.

(9) GUN BORE. Immediately after firing and on 3 consecutive days thereafter, swab bore with a solution of ½ pound soda ash to each gallon of warm water. Rinse with clear water and dry thoroughly before oiling. When gun is not fired, renew oil film daily. Every 5 days, swab with dry-cleaning solvent, dry, and reoil.

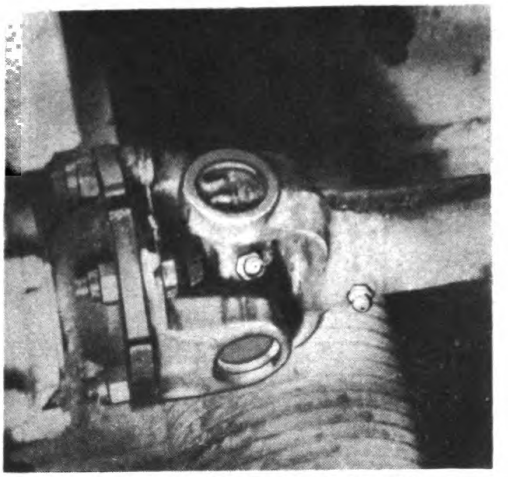
(10) MACHINE GUN BORE. Immediately after firing and on 3 consecutive days thereafter, clean with rifle-bore cleaner, dry, and reoil. Every 5 days, when machine gun is not being fired, renew oil film.

(11) OIL FILTER. The oil filter is of the self-turning type and is located in the engine oil pan. Daily, check operation of self-turning mechanism. Weekly, remove filter element from housing, clean, and inspect.

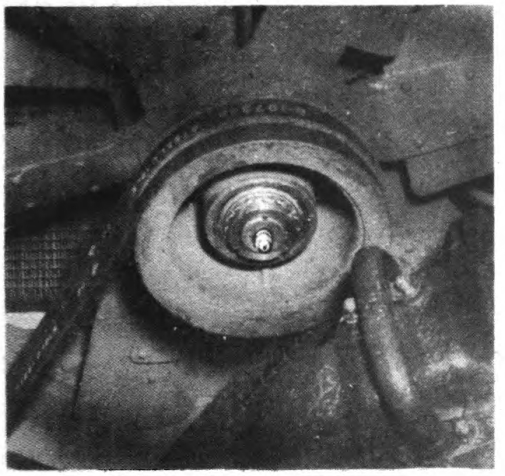
(12) OIL CAN POINTS. Every 250 miles, lubricate parking brake shaft door and shield hinges, door latches, lever bushings, control rod pins, throttle and gear linkage ball joints, pintle hook, escape door mechanism, seat supports, and clevises with engine oil SAE 30 above +32° F; SAE 10 from +32° F to 0° F; and special, lubricating, preservative, oil below 0° F. (Gun Mounts). Weekly, lubricate hand-



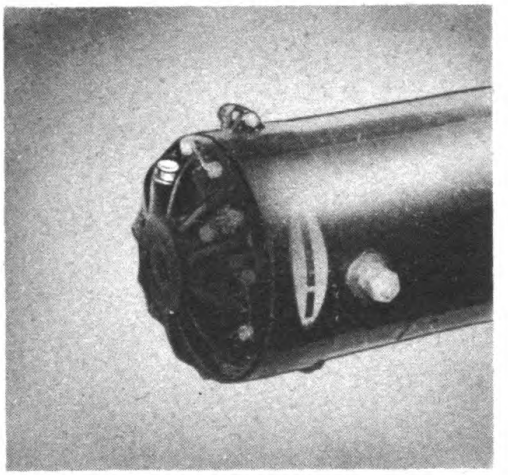
A—FAN DRIVE HOUSING FILL PLUG AND BAYONET GAGE



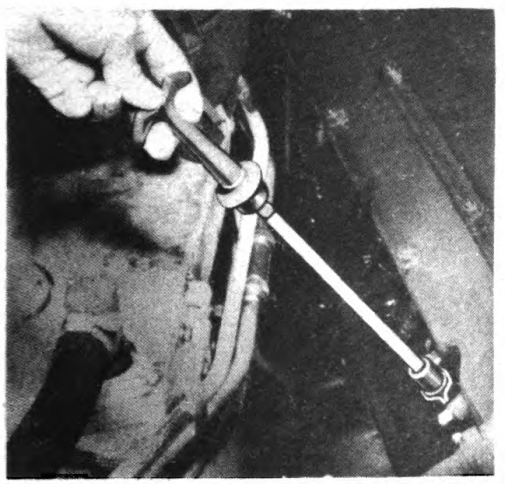
B—FAN DRIVE SHAFT SLIP JOINT AND UNIVERSAL JOINT



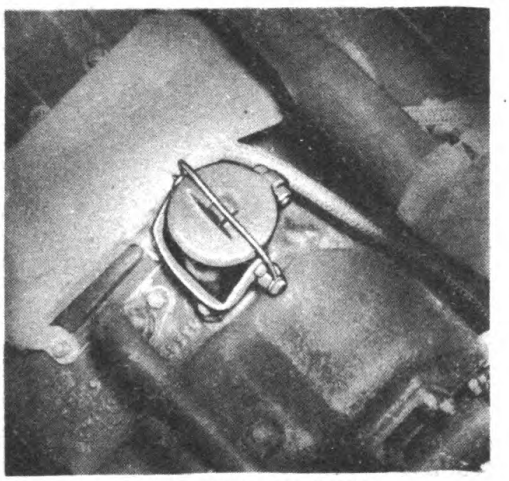
C—FAN SHAFT BEARING



D—STARTER



E—ENGINE CRANKCASE BAYONET GAGE



F—ENGINE OIL FILLER

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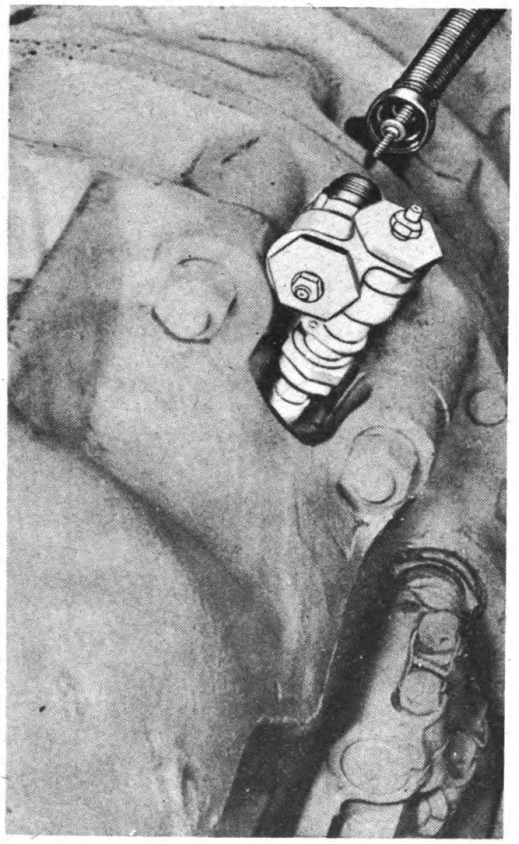
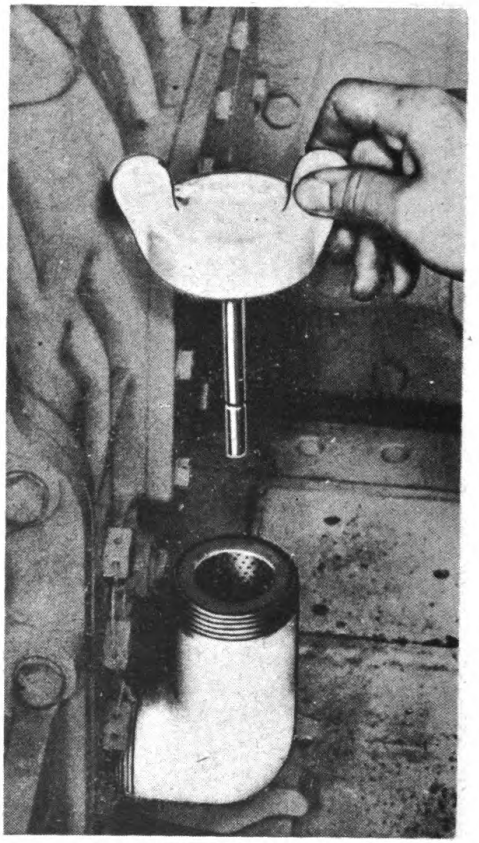
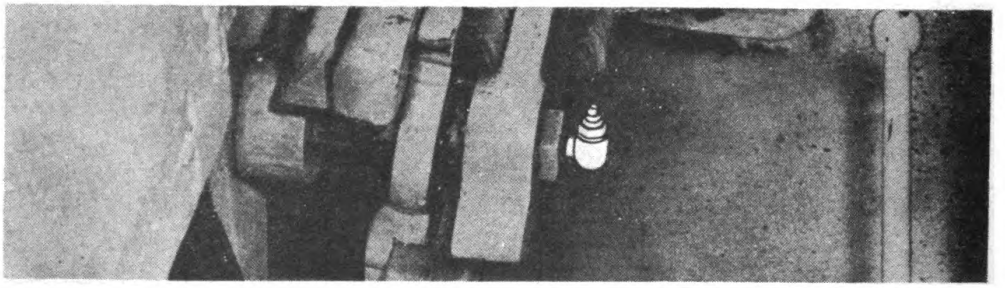
Figure 20 — Localized Lubrication Views — A



A—SPEEDOMETER ADAPTER AND CABLE



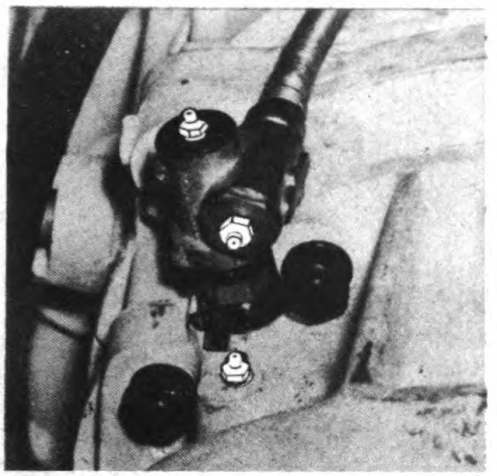
B—TRANSMISSION FILL AND BAYONET GAGE



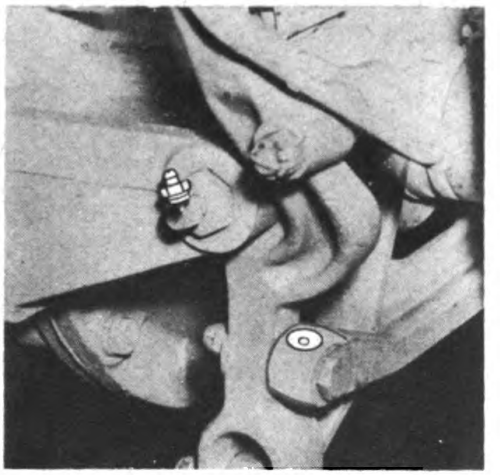
C—GEARSHIFT LEVER SHAFT

RA PD 335648

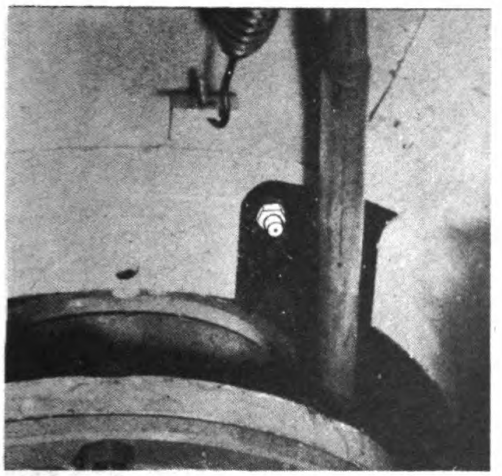
Figure 21 — Localized Lubrication Views — B



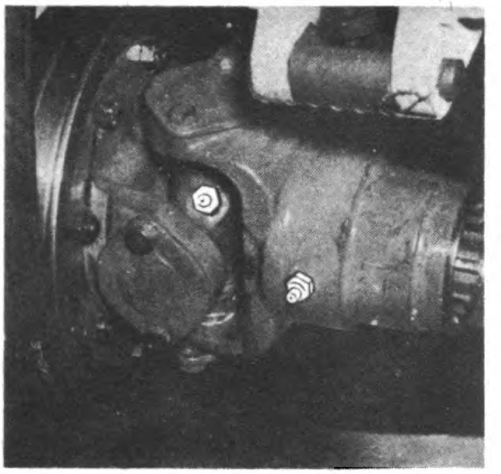
A—TACHOMETER ADAPTER AND SHAFT



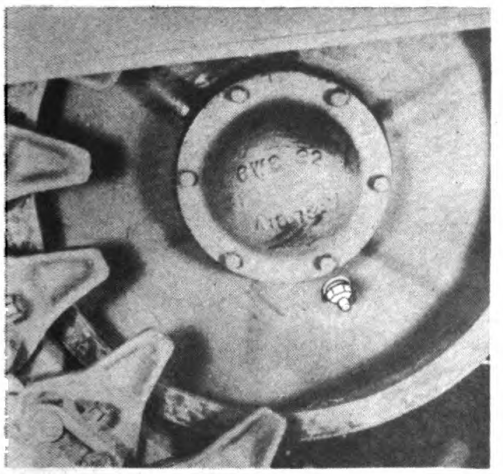
B—GEARSHIFT LEVER ADAPTER



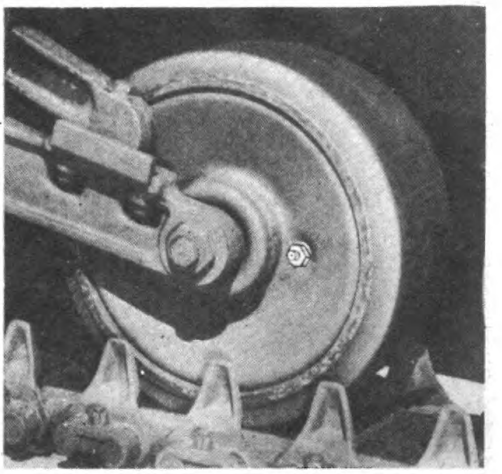
C—CLUTCH SHAFT BEARING



D—UNIVERSAL AND SLIP JOINTS



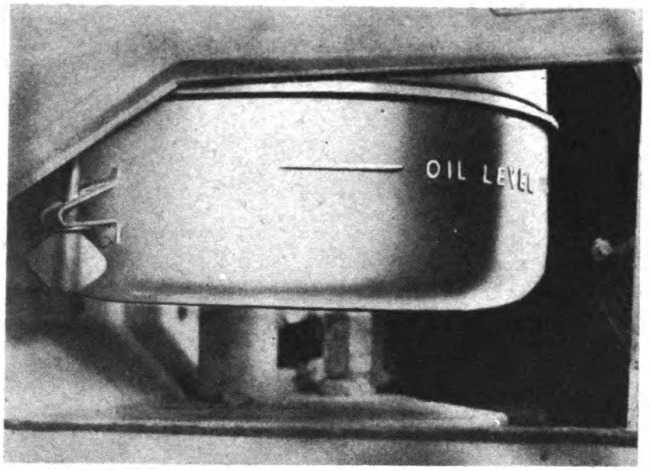
E—REAR IDLER



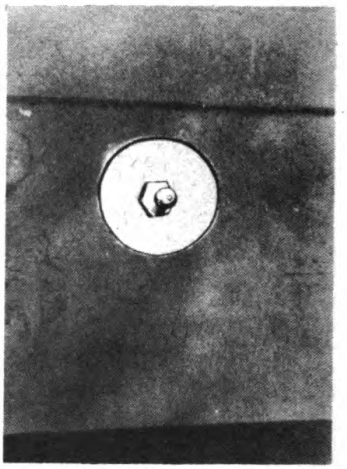
F—BOGIE WHEELS

RA PD 335649

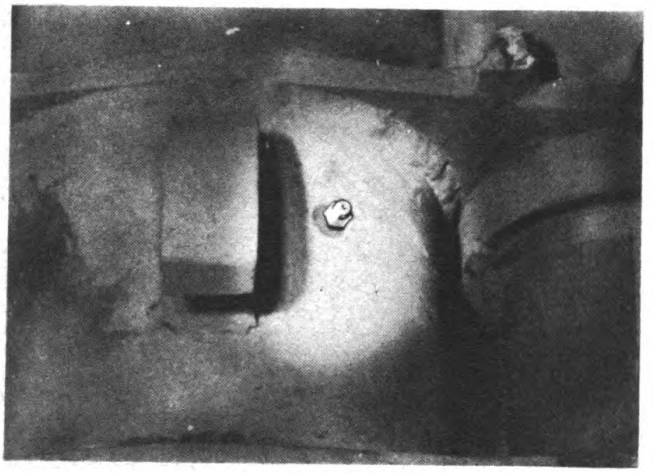
Figure 22 — Localized Lubrication Views — C



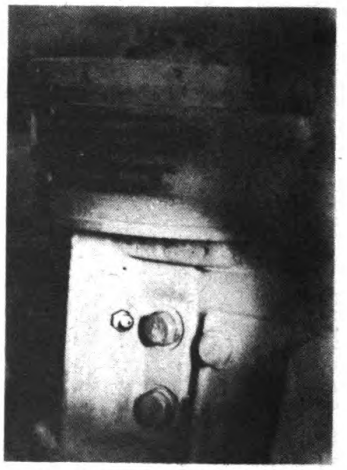
A—AIR CLEANER



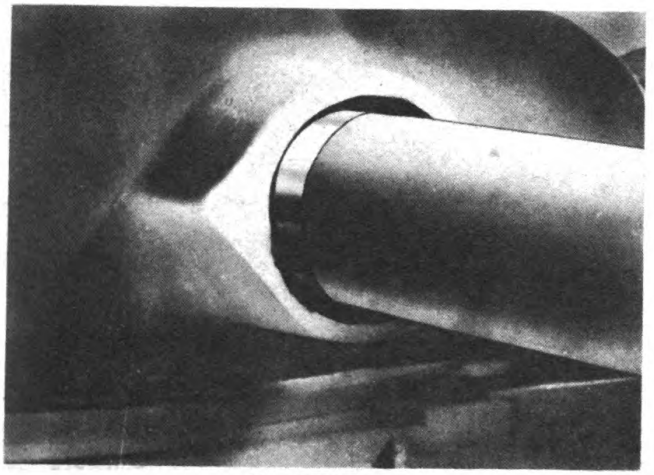
B—TURRET SUPPORT BEARINGS



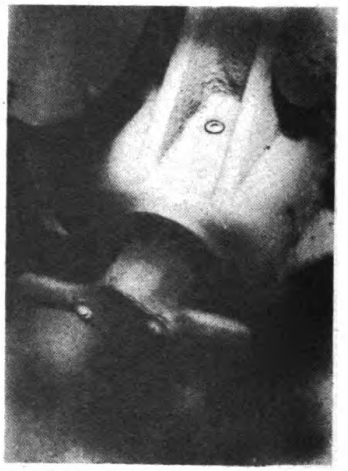
C—CRADLE LINER



D—AZIMUTH INDICATOR



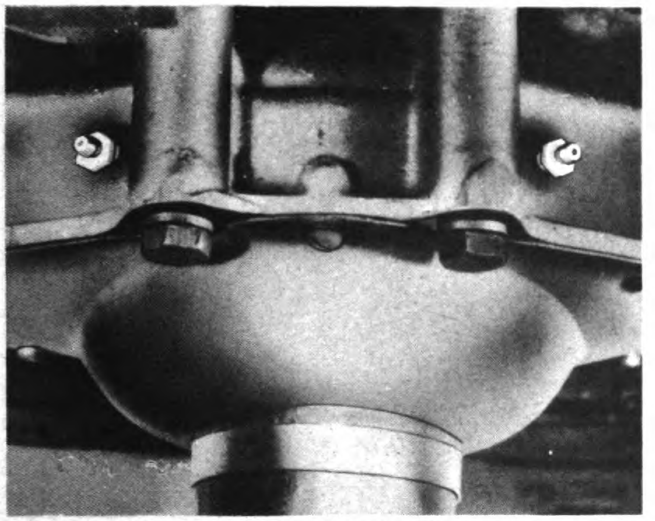
E—GUN TUBE



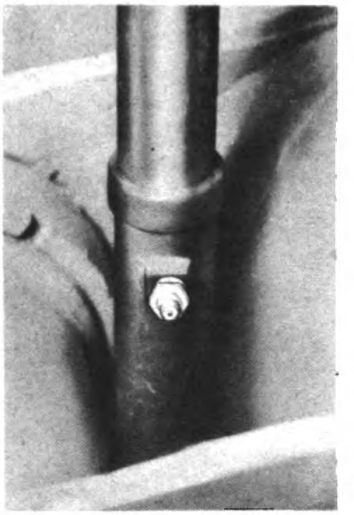
F—TURRET LOCK

RA PD 335650

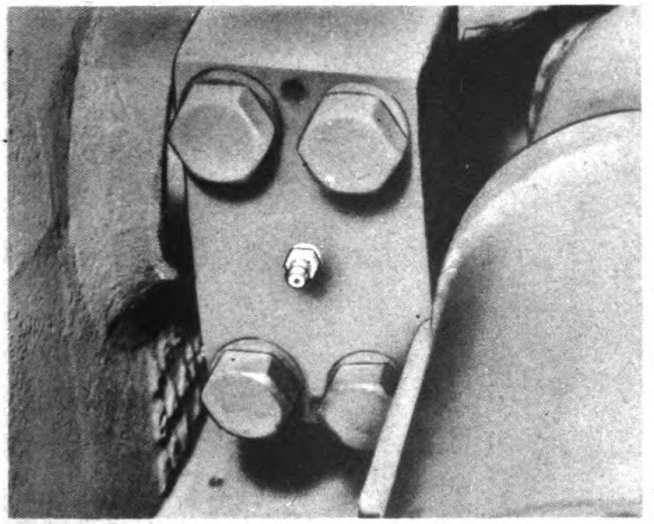
Figure 23 — Localized Lubrication Views — D



A—ELEVATING GEAR CASE

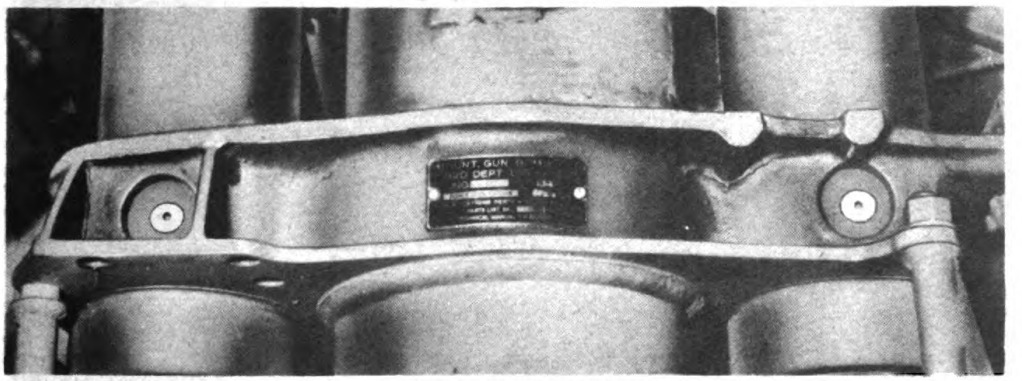


B—ELEVATING WORM HOUSING



C—CRADLE TRUNNION BEARING

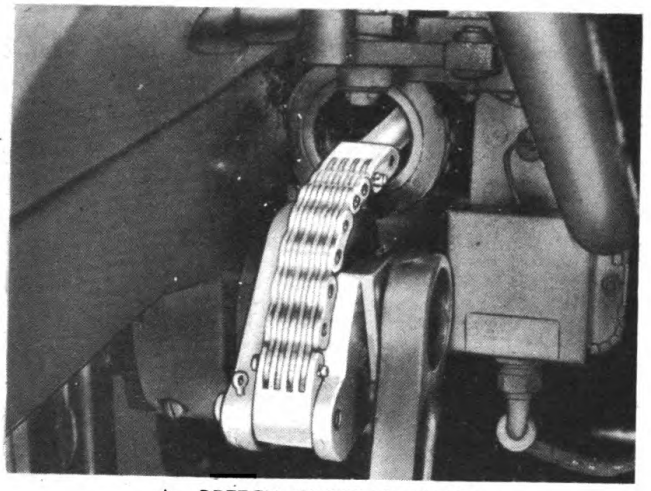
D—HYDRAULIC TRAVERSING OIL RESERVOIR



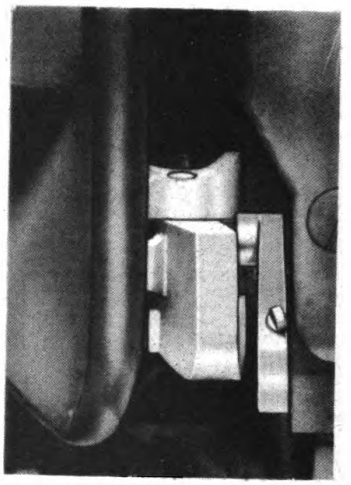
E—RECOIL CHAMBER FILLS

RA PD 335651

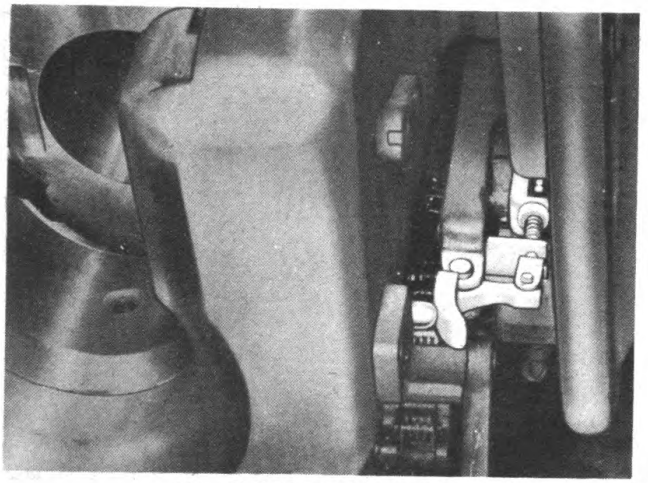
Figure 24 — Localized Lubrication Views — E



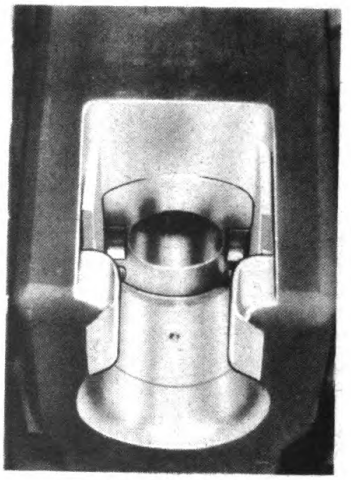
A—BREECH CLOSING CHAIN



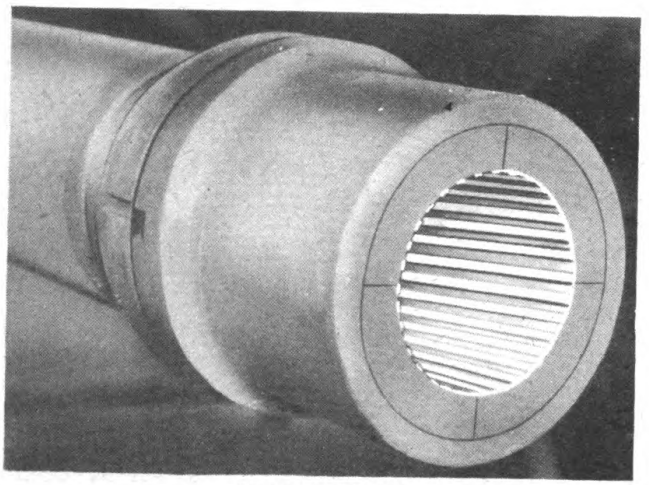
B—EJECTOR CAM



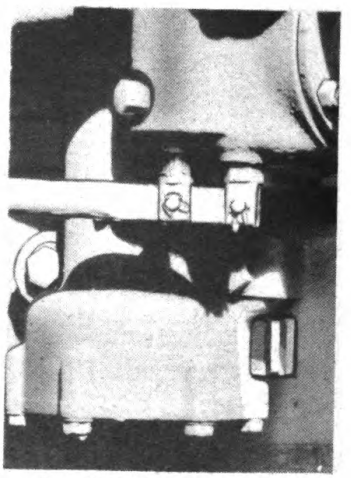
C—FIRING MECHANISM



D—BREECH



E—GUN BORE



F—TURRET TRAVERSING RING GEAR

RA PD 335652

Figure 25 — Localized Lubrication Views — F

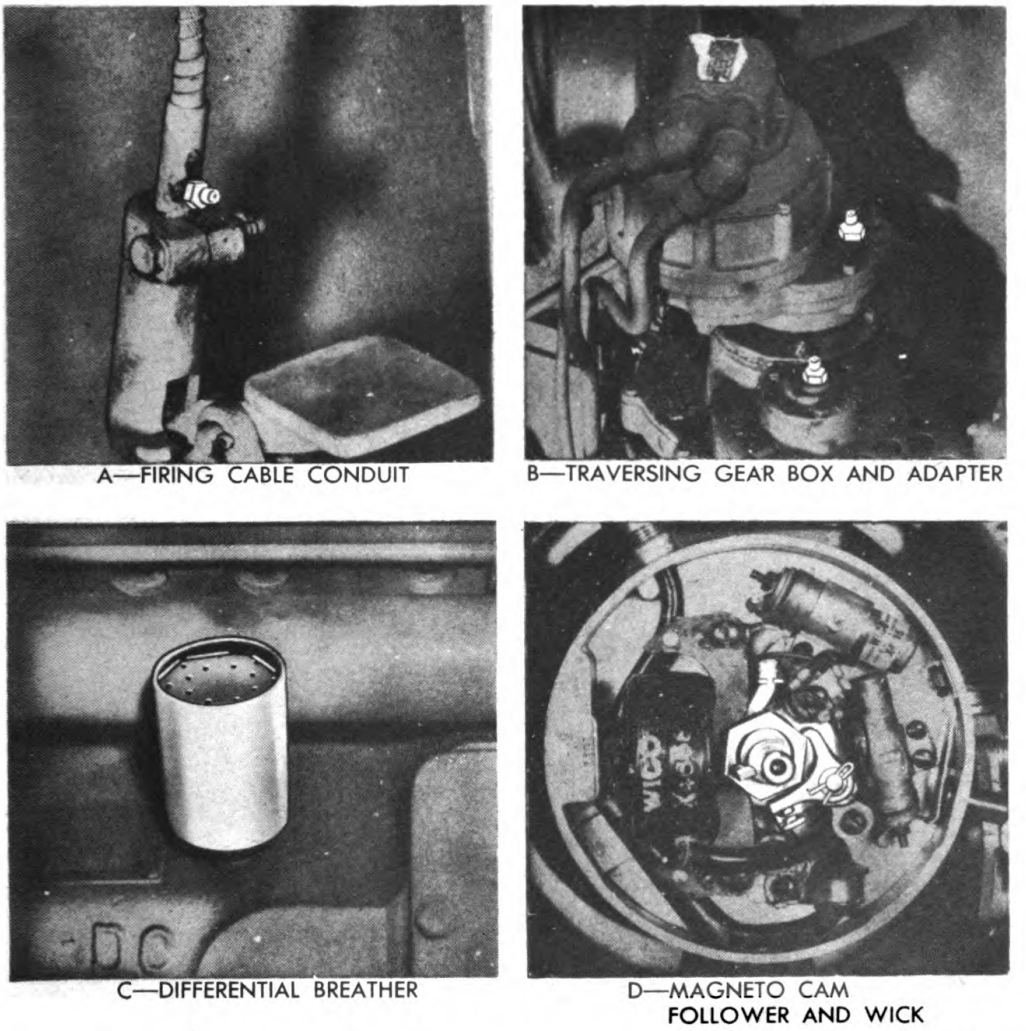


Figure 26 — Localized Lubrication Views — G

wheel handles, firing button, firing lever link, etc., with engine oil SAE 30 above +32° F; SAE 10 from +32° F to 0° F; and special, pre-preservative, lubricating oil below 0° F.

(13) **DO NOT LUBRICATE.** Water pump, bogie wheel suspension linkage, sprocket drive shaft bearings, clutch release bearing, auxiliary generator bearings, and engine governor.

(14) DISASSEMBLED PERIODICALLY BY ORDNANCE PERSONNEL.

(a) Generator. Once each year, remove generator and clean and repack bearings with ball and roller bearing grease.

(b) Engine Magnetos. When disassembled, clean and repack bearings with ball and roller bearing grease. Lubricate cam wick with 1 or 2 drops of engine oil SAE 10.

(c) Turret Traversing Gear Box. Every 6 months, disassemble, clean, and repack gears with O.D. grease No. 0 above +32° F, or No. 00 below +32° F.

(d) Turret Traversing Electric Motor. When disassembled, clean and repack bearings with ball and roller bearing grease.

(e) Breech Operating Shaft Bearings. At initial assembly and every 6 months thereafter, remove shaft, clean shaft and bearings, and coat with O.D. grease No. 0 for above +32° F, or No. 00 for below +32° F.

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 for the carriage may be maintained in the Duty Roster (W.D., A.G.O. Form No. 6). A record of seasonal changes of lubricants and recoil oils for the guns will be kept in the Artillery Gun Book for the materiel.

Section XV

PREVENTIVE MAINTENANCE SERVICES

34. 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-operation, During-operation, At-halt, After-operation, and Weekly services performed by the operator, driver, or 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 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 assem-

bled" 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.

c. Crew Maintenance (First Echelon).

(1) 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 35, 36, 37 and 38 are those performed by the operator, driver, or crew Before-operation, During-operation, At-halt, and After-operation and Weekly.

(2) 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 driver 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 driver 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.

35. 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 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 operator, driver, or 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, armament, and special equipment for injury caused by tampering or sabotage, collision, falling debris, or shell fire since parking. Look within engine compartment for evidence of these conditions, and for loose or damaged engine accessories or drive belts, loose fuel, oil, or coolant lines, or disconnected control linkage. Dry the ignition parts if wet.

(2) ITEM 2, FIRE EXTINGUISHERS. See that fixed and portable extinguishers are in good condition and secure. Inspect valves and controls to see if cylinders have been discharged and, if so, report for exchange or refill. Be sure nozzles are not clogged.

(3) ITEM 3, FUEL, OIL, AND WATER. Check supply of fuel, oil, and coolant and add as necessary to bring to proper levels. During freezing weather when antifreeze solution is in use, if an appreciable addition of water is needed, have antifreeze value checked and add antifreeze as necessary to protect cooling system against freezing. NOTE: *Any unusual drop in levels since After-operation Service must be investigated and the cause corrected or reported.*

(4) ITEM 4, ACCESSORIES AND DRIVES. Examine all units, such as carburetors, generator, regulators, starter, traversing motor, hydraulic traversing pump, air cleaners, fans, shrouds, and auxiliary generator for looseness, damage, or leaks. Be sure all drive belts are in good condition and are adjusted to have the correct tension. All drive belts should have ½-inch finger-pressure deflection halfway between pulleys.

(5) ITEM 6, LEAKS — GENERAL. Check under the vehicle and in engine compartment for fuel, oil, and coolant leaks. Inspect engine accessory mountings, oil cooler, oil lines, radiator, and water hose for leaks. Trace any leaks found to source and correct or report them.

(6) ITEM 8, PRIMER. As engine is being started, observe if primer action is satisfactory, and note any leakage at pump or connections.

(7) ITEM 7, ENGINE WARM-UP. At normal temperatures follow instructions in paragraph 15 **c** (2), and in cold weather refer to paragraph 15 **c** (3) to start engine. Starter must have adequate cranking speed, and engage and disengage without unusual noise. CAUTION:

If oil pressure gage does not indicate satisfactory pressure immediately, stop engine and correct or report the trouble. With clutch engaged and transmission in neutral, set throttle so engine will run at a speed of 800 to 1,000 revolutions per minute during warm-up period, and proceed with the following Before-operation Services.

(8) ITEM 9, INSTRUMENTS.

(a) Oil Pressure Gage and Low Oil Pressure Signal Light. Oil pressure gage should register 60 to 100 pounds when engine is operating at 2,600 revolutions per minute. Stop engine immediately if low oil pressure signal light comes on at engine speeds above 1,000 revolutions per minute.

(b) Ammeter. With batteries fully charged and all electrical units turned off, the ammeter will show a high charging rate until current used in starting is restored to batteries. A high charging rate for an extended period indicates discharged batteries or defective regulator. A discharge reading with all electrical units turned off indicates a ground or short circuit or defective regulator.

(c) Tachometer. Tachometer should indicate engine crankshaft revolutions per minute and register accumulating revolutions.

(d) Engine Temperature Gage and Hi-water Temperature Signal Light. Engine temperature gage reading should increase gradually during warm-up period to normal operating range, approximately 90° F above atmospheric temperature. NOTE: *Do not drive vehicle until engine temperature has reached 100° F. Stop engine if hi-water temperature signal light comes on.*

(e) Fuel Gage. With selector switch in relative positions, fuel gage should register level of fuel in each tank. Ordinarily, tanks will be full before operation and gage should register "FULL."

(f) Compass. Examine compass to see that it is in good condition and securely mounted, and liquid is at proper level. Test light by operating instrument panel light switch. Compensate for error due to local magnetic variations as required by change of station (par. 117 c).

(9) ITEM 10, HORN. Inspect horn for damage. If tactical situation permits, test horn for proper operation and tone.

(10) ITEM 11, GLASS. Inspect periscope windows and heads for damage and clean if dirty.

(11) ITEM 12, LIGHTS. Examine all lights to see if they are clean, in good condition, and secure. If tactical situation permits, open and close all light switches and see if lamps respond properly.

(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. Inspect tracks for damage or evidence of tampering or sabotage since the After-operation Service.

(14) ITEM 15, SPRING AND SUSPENSIONS. Inspect volute springs, arms, and all bogie suspension units to see that they are in good condition and securely mounted.

(15) ITEM 16, STEERING BRAKE LINKAGE. Inspect steering levers, cross shafts, rods and connections, brackets and mounting to see if they are in good condition and secure. Test lever locking devices to be sure they hold levers in applied position.

(16) ITEM 17, FENDERS AND SHIELDS. Inspect fenders and sand shields for looseness and damage.

(17) ITEM 18, TOWING CONNECTIONS. See that all tow loops, towing cable, and pintle hook are in good condition and secure, and that pintle latch operates properly and locks securely.

(18) ITEM 19, HULL, TARPAULIN, AND CAMOUFLAGE NET. Inspect hull for damage, loose attachments, and proper operation of entrance and escape doors. Examine paulin and camouflage net to see that they are in good condition and properly lashed or stowed. CAUTION: *Do not fully open escape door latches at the time of this inspection.*

(19) ITEM 20, DECONTAMINATOR. Examine decontaminator for closed valve, full charge, and secure mountings.

(20) ITEM 21, TOOLS AND EQUIPMENT. Be sure all vehicle and pioneer tools, and items of standard or special equipment are present, in good condition, and properly stowed or mounted. Be particularly sure the radio communication equipment and demountable guns are not loose or damaged.

(21) ITEM 22, ENGINE OPERATION. Before driving vehicle, be sure engine temperature is 100° F or above and oil pressure is satisfactory. Move throttle to idling position to see that engine idles smoothly at 500 revolutions per minute. Accelerate and decelerate engine a few times to be sure it responds to all controls and to test for any unusual noise, vibration, or excessive exhaust smoke. See that engine compartment doors are closed and secure. CAUTION: *To prevent damage to equipment or injury to personnel, before driving the vehicle make sure turret lock is engaged, traversing shift lever is in manual position, and that gun is secured by turret traveling lock and gun barrel traveling lock if gun is not to be operated.*

(22) ITEM 23, DRIVER'S PERMIT AND FORM NO. 26. Driver must have his operator's permit on his person. See that Standard Form No. 26, Driver's Report — Accident, Motor Transportation, W.D., A.G.O. Form No. 478, MWO and Major Unit Assembly Replacement Record, vehicle and equipment manuals, and Lubrication Order are present, legible, and properly stowed.

36. 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 indications of trouble in cooling system and 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.

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. When vehicle is put in motion, but before attaining any appreciable speed, test steering brakes to see if the vehicle can be stopped effectively; that levers meet resistance evenly, and brakes are fully applied when levers are slightly ahead of vertical position. See that there is a reserve of lever travel available. Operate levers independently to see if vehicle steers satisfactorily.

(2) ITEM 28, CLUTCH. Test free travel of clutch pedal. It should not be less than 2 inches or more than 3½ inches. Clutch must fully release and must not slip or chatter. While releasing clutch for shifting gears, listen for noisy release bearing.

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

(4) ITEM 31, ENGINE AND CONTROLS. Be on the alert for deficiencies in engine performance such as lack of power, misfiring, unusual noise, stalling, indications of engine overheating, or unusual exhaust smoke. See that all controls operate freely and are in proper adjustment.

(a) Governor must limit engine speed to 2,600 revolutions per minute. If radio noise was observed with vehicle in operation, the driver will cooperate with the radio operator in locating the interference according to instructions in paragraph 52.

(5) ITEM 32, INSTRUMENTS. Observe the readings of all pertinent instruments frequently during operation to see whether they are indicating proper functioning of units to which they apply, and

that speedometer registers vehicle speed and records accumulating mileage.

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

(7) ITEM 36, GUNS (MOUNTINGS, ELEVATING, TRAVERSING AND FIRING CONTROLS). Before testing operation of gun, make sure gun is not loaded and turret lock and gun traveling and gun barrel traveling locks are released. After tests are made, lock the turret and secure the gun unless it is to be used. While vehicle is in operation, but before it is used in combat, check manual and hydraulic turret traversing controls, manual gun elevating controls and electric and manual firing controls to be sure that all mechanism responds properly.

37. 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 deficiencies 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, OIL, AND WATER. Check to see that there is adequate fuel, engine oil, and coolant to operate vehicle to next scheduled stop, or replenish supply as tactical situation permits.

(2) ITEM 39, TEMPERATURES (HUBS, TRANSMISSION, DIFFERENTIAL, AND FINAL DRIVES. Cautiously hand-feel all sprockets, idler, bogie wheel, and support roller hubs for abnormal temperatures. Examine transmission, differential, and final drive units for overheating and note any excessive oil leaks at seals or gaskets.

(3) ITEM 41, PROPELLER SHAFT. Investigate or report any unusual noise or vibration noted in propeller shaft or universal joints during operation.

(4) ITEM 42, SPRINGS AND SUSPENSION. Inspect volute spring, brackets, arms, levers, support roller, track skids, and gudgeons for looseness or damage. Remove any objects lodged in suspension units or between units and tracks. Investigate or report any unusual noise or condition noticed during operation.

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

(6) ITEM 44, WHEEL AND FLANGE NUTS. Examine all sprocket, idler, bogie wheel, and roller assembly and mounting nuts to be sure they are all present and secure.

(7) ITEM 45, TRACKS AND BOGIE WHEEL TIRES. Inspect tracks for damage, dead links, loose connectors, wedge nuts, or lock pins. See that suspension wheel and support roller tires are not cut or separated from wheel rims. Remove all stones or other foreign objects from between links and tracks or wheels and rollers. Examine tracks for correct tension.

(8) ITEM 46, LEAKS — GENERAL. Look under vehicle and in engine and fighting compartments, for indications of fuel, oil, or coolant leaks. Trace any leaks found to their source and correct or report them.

(9) ITEM 47, ACCESSORIES AND BELTS. Investigate any unusual noise or unsatisfactory operation of engine or vehicle accessories noticed during operation. Inspect them for looseness or damage. Be sure generator and fan belts are in good condition. All drive belts must have ½-inch finger-pressure deflection half way between pulleys. If radio noise due to operation of vehicle is noticed, examine all accessible condensers, wiring conduits, bond straps, and connections. Be sure they are in good condition and all mounting clips or brackets and connections are secure.

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

(11) ITEM 49, FENDERS AND SHIELDS. Inspect fenders and sand shields for looseness and damage.

(12) ITEM 50, TOWING CONNECTIONS. See that all connections are properly fastened and securely locked. Make sure that supports hold cable in a way to prevent chafing, and that pintle hook latches and locks securely.

(13) ITEM 51, HULL AND TARPAULIN. Inspect for damage to hull or attachments. See that entrance doors and escape door operate freely, and that paulin or camouflage net is in good condition and secure. CAUTION: *Do not fully open escape door.*

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

38. AFTER-OPERATION AND WEEKLY SERVICE.

a. Purpose. After-operation servicing is particularly important because at this time the operator, driver, or 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 operator, driver, or 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 56, INSTRUMENTS. Before stopping engine, check all pertinent instruments to be sure they are operating properly and continue to register or indicate correct performance of units to which they apply.

(2) 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 and correct or report any deficiencies noted during operation. CAUTION: *Allow engine to run at idle speed 2 to 3 minutes before stopping with fuel shut-off switch. Turn the ignition switch to the "OFF" position and close the fuel valves.*

(3) ITEM 54, FUEL, OIL, AND WATER. Fill all fuel tanks. Check engine oil level with dip stick and add sufficient oil to bring to correct level. If necessary, add coolant to bring to correct level. NOTE: *During freezing weather if any appreciable amount of coolant is necessary, also add antifreeze of proper strength and quantity.* CAUTION: *Do not fill fuel tanks or radiator to overflowing. Allow room for expansion.*

(4) ITEM 57, HORN AND WINDSHIELD WIPER. If tactical situation permits, test horn for proper operation and tone. If in use, see that windshield wiper operates properly, and inspect blade and arm 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, nozzles, red safety seals, and cylinders to see that they are in good condition, secure, and not leaking. If extinguishers have been used, valves opened, or red safety seals blown, report for exchange or refill.

(8) ITEM 61, DECONTAMINATORS. Examine decontaminators for damage, full charge, and secure mountings.

(9) ITEM 62, *BATTERIES.

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

(b) Weekly. Clean batteries and box, 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 ⅜ inch above plates. NOTE: *In freezing temperatures, do not add water until just before vehicle is to be operated.*

(10) ITEM 63, *ACCESSORIES AND BELTS.

(a) Examine all units such as carburetors, main and auxiliary generators, regulators, starter, air cleaners, fans, shrouds, oil cooler, and drive belts to see that they are in good condition and securely mounted.

(b) Weekly. Clean all trash from in and around oil cooler air passages. Check auxiliary generator for good condition and proper operation. See that all drive belts have ½-inch finger-pressure deflection halfway between pulleys.

(11) ITEM 64, *ELECTRICAL WIRING.

(a) Examine all accessible wiring and wiring conduits for looseness or damage. Tighten all loose connections and clean all accessible wiring.

(b) Weekly. Be sure all accessible radio noise suppression bond clips, straps, filters, and condensers are securely connected or mounted. Tighten wiring conduit coupling nuts and wiring connections.

(12) ITEM 65, AIR CLEANERS. Examine engine air cleaners and auxiliary generator air filter for looseness and damage. Check engine air cleaners for leaks. If vehicle has been operated under extreme conditions of dust or sand, clean and service all air cleaners according to Lubrication Order (par. 32).

(13) ITEM 66, *FUEL AND OIL FILTERS.

(a) Inspect fuel filter on auxiliary generator and service as required. Test operation of main engine oil filter (par. 33 **d** (11)).

(b) Weekly. Remove main engine oil filter element and clean as required (par. 33 **c**). Remove and clean auxiliary generator fuel filter sediment bowl and screen.

(14) ITEM 67, ENGINE CONTROLS. Examine accelerator, hand throttle, and all controls for worn or disconnected linkage. Investigate any improper action of control linkage noted during operation.

(15) ITEM 68, *TRACKS.

(a) While inspecting tracks for damage and loose connections, remove all stones and foreign objects from between links and tracks or wheels and rollers. Check track tension. On vehicles equipped with vertical volute springs, track sag should be not less than ½ inch or more than ¾ inch halfway between center and rear support rollers at sand shield inspection opening (fig. 151).

(b) Weekly. Tighten loose wedge nuts and look for bottomed wedges, worn connectors, and broken guide lugs. Check for dead track links (par. 149 d).

(16) 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. Make sure levers in released position are parallel and 7 to 7½ inches from face of steering brake cover (fig. 139).

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

(18) ITEM 72, *TRANSMISSION VENT.

(a) See that differential breather is present, in good condition, secure, and not clogged.

(b) Weekly. Clean differential breather as instructed on Lubrication Order (par. 32).

(19) ITEM 73, LEAKS. Inspect all fuel, oil, and coolant lines and connections, gas tanks, radiator, surge tank, final drives, differential, and transmission for indication of leaks. Trace any leaks found to their source and correct or report them.

(20) ITEM 74, *GEAR OIL LEVELS (WEEKLY ONLY). Check the oil level in transmission, differential, and final drive assembly (par. 33). Report if low.

(21) ITEM 76, FENDERS AND SHIELDS. Examine fenders and sand shields for looseness and damage.

(22) ITEM 77, *TOWING CONNECTIONS.

(a) Inspect cable, lugs, pintle hook, and all connections for looseness and damage.

(b) Weekly. Examine tow cable for broken strands and see that supports hold cable securely. Inspect pintle hook drawbar and spring and make sure pintle lock pin is securely attached by chain.

(23) ITEM 78, HULL, TARPAULIN, AND CAMOUFLAGE NET. In-

spect entire hull for damage, and be sure that escape door is alined and that it opens properly and latches securely. See that hull drain valves open easily and close securely and that all hull inspection covers are in place and secure. CAUTION: *Do not fully open escape door.* Examine paulin and camouflage net for damage and stow them properly.

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

(25) ITEM 80, VISION DEVICES. Inspect the periscope heads and windows to see that they are in good condition, clean, secure in holders, and that holders are securely mounted. Make sure periscopes can be traversed, elevated, and depressed through their full range and locked in desired position. Check the spare heads and their stowage boxes to see if they are in good condition, clean, and secure. CAUTION: *Windows should be cleaned only with a soft cloth or brush.*

(26) ITEM 81, TURRET AND GUNS (MOUNTINGS, ELEVATING, TRAVERSING, AND FIRING CONTROLS). Be sure that all mounted guns are secure in their mounts, clean, lightly oiled, and in condition for immediate use. Release gun from turret traveling lock and gun barrel traveling lock and also disengage turret lock until tests are completed. Make sure gun is not loaded, and test manual gun elevating mechanism and all firing controls for proper operation. Be sure that manual and hydraulic traversing mechanisms are in good condition and operate satisfactorily. Be sure radio suppression bonding strap and bonding cable at turret slip ring box are in good condition and securely connected. NOTE: *Recoil tests can be made only under firing conditions. Investigate and correct or report any unsatisfactory operating characteristics of these units during operation.* CAUTION: *To prevent damage to equipment or injury to personnel, move traversing shift lever to manual position, secure the gun in turret traveling rest and gun barrel traveling rest, and engage the turret lock unless gun is to be used.*

(27) ITEM 82, *TIGHTEN.

(a) Tighten any unit mounting or assembly nuts or screws when inspection has indicated a necessity.

(b) Weekly. Tighten sprocket and idler flange nuts, universal joints, gun mounts, tool and equipment mountings, ammunition racks and clips, air cleaner, exhaust and muffler connections, and any other items that inspection or experience indicates is necessary on a weekly or mileage basis.

(28) ITEM 83, *LUBRICATE AS NEEDED.

(a) Lubricate all points where inspection indicates necessity and

points requiring daily attention as instructed on Lubrication Order (par. 32).

(b) Weekly. Lubricate all points necessary on a weekly or mileage basis in accordance with instructions on Lubrication Order (par. 32).

(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, turret, and engine compartment. Remove excess dirt, stones, and grease from tracks and suspensions. See that engine compartment doors are clear of obstructions.

(b) Weekly. Wash exterior of vehicle and remove all dirt, mud, and excess grease. If washing is impractical, wipe as clean as possible and watch for bright spots on finish or camouflage pattern that might cause glare. If compressed air is available, blow out all dust or insects from within compartment and from in and around radiator core air passages.

(30) ITEM 85, *TOOLS AND EQUIPMENT.

(a) Check all on-vehicle tools, equipment, and spare parts against stowage lists (Section III) to be sure all items are present and in serviceable condition and properly stowed or mounted. Report deficiencies for replacement.

(b) Weekly. Clean tools and equipment. See that tools with cutting edges are sharp and properly protected. Be sure tools and equipment are mounted or stowed securely in proper location on or in vehicle.

39. 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 operators, drivers, or crews should accompany their vehicles 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 paragraph d or the specific procedures in paragraph 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.

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 34 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 the 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 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 should be performed in con-

nection 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 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 the 50-hour (500-mile) and 100-hour (1,000-mile) maintenances procedures, whichever shall occur first, are described in the following chart. Each page of the chart has two columns at its left edge corresponding to the 100-hour and the 50-hour 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 100-hour operation.*

MAINTENANCE	
1,000-mile (100-hour)	500-mile (50-hour)

ROAD TEST

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 for preferably 2 miles and not over 4 miles.*

1 | 1 **Before-operation Service.** Perform the Before-operation Service as outlined in paragraph 35.

2 | 2 **Instruments and Gages.**

OIL PRESSURE GAGE. Engine oil pressure must be indicated when engine is idling and should be 60 to 100 pounds pressure at 2,600 revolutions per minute. Stop engine immediately when low oil pressure signal light comes on at engine speeds above 1,000 revolutions per minute.

ENGINE TEMPERATURE GAGE. Reading should be approximately 90° F above atmospheric temperature. High water temperature signal light comes on at maximum safe operating temperature, 235° F. CAUTION: *Do not drive vehicle until engine temperature is above 100° F.*

AMMETER. The ammeter may show a high charging rate after starting engines until generator has restored to the batteries the current used in starting. A high charge for an extended period may indicate a low battery or faulty generator regulator. With batteries fully charged and all lamps and electrical accessories turned off, a slight charge or zero reading is normal.

FUEL GAGE. With selector switch in relative positions, fuel gage should register level of fuel in each tank

TACHOMETER. Tachometer should indicate engine speed in revolutions per minute and register accumulating revolutions without excessive noise or fluctuation.

3 | 3 **Windshield Wiper and Horn.** Test horn for proper operation and tone. Test operation of driver's hood windshield wiper and defroster. Make sure wiper blade is in good condition and contacts windshield evenly through entire stroke.

MAINTENANCE		
1,000-mile (100-hour)	500-mile (50-hour)	
5	5	**Brakes (Steering and Parking Levers, Braking Effect, and Steering Action).** Pull back on both steering brake levers and observe whether they stop the vehicle effectively and meet resistance slightly before the vertical position. With vehicle on an incline, apply parking brake lock and pull back on both levers. Brakes should hold vehicle securely and levers remain in applied position. Apply steering brakes independently and observe whether they steer the vehicle properly.
6	6	**Clutch (Free Travel, Drag, Noise, Grab, Chatter, and Slip).** Clutch pedal free travel must not be less than 2 inches or more than 3½ inches. Clutch should not grab, drag, squeal, or chatter on engagement or slip when fully engaged under load.
7	7	**Transmission (Lever Action, Vibration, Noise).** Shift through each speed range of transmission. Observe whether gearshift 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, Oil Consumption).** IDLE. With 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. 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 2,600 revolutions per minute. During road test, look for excessive smoke from exhaust or engine compartment. OIL CONSUMPTION. At completion of road test, a

MAINTENANCE		
1,000-mile (100-hour)	500-mile (50-hour)	
		check should be made to see if engine has been consuming an excessive amount of oil.
10	10	**Unusual Noise (Propeller Shaft, Universal Joints, Differential, Final Drives, Sprockets, Idlers, Bogie Wheels, Supports, and Rollers).** During road test, listen for an unusual noise in these units that might indicate loose, damaged, inadequately lubricated, or improperly adjusted parts.
11	11	**Temperatures (Transmission, Differential, Final Drives, Hubs, Sprockets, Bogie Wheels, and Support Rollers).** After operation, check by hand-feel for any abnormal temperatures of the above units. NOTE: *If proper location is selected for above check, time will be saved in performing item 12.*
12	12	**Gun (Elevating and Traversing Mechanism).** Place vehicle in position where it is tilted (sidewise) about 10 degrees. Before making test, release turret lock, turret gun traveling lock, and gun barrel lock. After completing test, again secure the gun and lock the turret. Traverse turret through its full 360-degree range by both hand and power controls; check for binding, excessive lash, or erratic action. Be sure turret lock operates properly. With gun pointed forward, elevate it through its entire range with hand controls and check for binding, excessive lash, or erratic action. Then move vehicle to level ground.
13	13	**Leaks (Engine Oil, Fuel, and Water).** Stop engine. Look under vehicle and in engine and fighting and driving compartments for fuel, oil, or coolant leaks. Examine all fuel and oil lines, surge tank, radiator, radiator hose, and connections for leaks. This completes road test.
		MAINTENANCE OPERATIONS
17	17	**Crankcase (Leaks and Level).** Run engine at idling speed for 4 to 6 minutes to cool engine gradually when water temperature exceeds 190° F. Stop engine. Remove engine compartment floor plate. Inspect all accessible points of engine crankcase and oil pan for damage or leaking oil seals or gaskets. Check oil level with indicator.

MAINTENANCE		
1,000-mile (100-hour)	500-mile (50-hour)	
		SERVE. While oil is hot, examine sample on indicator and if condition warrants or oil change is due, drain engine oil pan unless engine is to be removed as in item 30. Add oil as required or refill oil pan as instructed on Lubrication Order (par. 32).
78	78	**Transmission.** Examine transmission for damage, and gaskets and seals for leaks. Make sure all attaching bolts are tight. Check oil level.
		SERVE. Examine sample of oil on indicator and if condition warrants or oil change is due, drain transmission and final drives while oil is hot. If metal particles on drain plugs indicate internal damage, notify higher authority. Clean drain plugs and install securely. When oil is drained, remove filler elbow screen, clean in dry-cleaning solvent, and install. Add oil as required or refill transmission as instructed on Lubrication Order (par. 32). NOTE: *If tests in item 5 indicate the need for major brake adjustment or new brake shoes, do not refill until item 75 has been performed.*
78		TIGHTEN. Tighten all external assembly and mounting nuts and screws securely.
18	18	**Side Armor (Fenders, Guards, Paint and Markings, Tow Shackles, Pintle, and Horn).** Examine vehicle for damage to side armor, fenders and shields, exhaust deflector, 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 legible. Examine towing handles and pintle for good condition and secure mounting. Test horn for operation and tone.
19	19	**Bottom (Armor, Escape Hatch, Inspection Plates, Drain Plugs, and Valves).** Inspect hull bottom for damage. Open escape door. Oil the latch mechanism (par. 32). Install door, making sure the gasket seals the opening. Test action of all hull drain valves and controls. Make sure all drain plugs and covers are secure.

MAINTENANCE		
1,000-mile (100-hour)	500-mile (50-hour)	
20	20	**Differential and Final Drives.** Examine exterior of differential carrier housing, carrier, and final drive covers for damage, loose attaching screws or nuts, or gasket leaks.
20		TIGHTEN. Tighten all external assembly and attaching nuts and screws securely.
21	21	**Tracks (Links, Connectors, and Wedges).** Inspect tracks for loose, worn, or missing connectors or wedges; also worn, damaged, or dead links. When possible, reverse worn links. Tighten loose wedge nuts with a pull of 75 to 90 foot-pounds. Remove all debris and stones from tracks. NOTE: *Whenever the tracks are disconnected and removed from the sprockets, support rollers, and idlers, or at each third 100-hour 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.*
22	22	**Idler (Wheels, Arms, Eccentrics, Serration Plates, Adjustment, Nuts, and Springs).** Inspect these items to see that they are in good condition, correctly assembled and secure and that grease is not leaking excessively from wheel bearing seals. Be sure spindle locking collar and clamp screws are secure. Tighten all assembly and mounting screws and nuts securely.
22		NOTE: *In addition to the above, at each third 100-hour maintenance service or wherever the tracks are removed from the idlers, check the idler hub bearings for looseness or end play. Spin the idler wheels and listen for any unusual noise that might indicate damaged, excessively worn, or inadequately lubricated bearings.*
23	23	**Bogie Arms, Links, Gudgeons, Collar and Guides, Volute Springs and Seats, Frames and Wearing Plates).** Examine these items to see that they are in good condition, correctly assembled, and secure and that gudgeons, collars and guides, and wearing plates are not excessively worn. Inspect volute springs to see if they have taken a permanent set

MAINTENANCE		
1,000-mile (100-hour)	500-mile (50-hour)	
		with vehicle under normal load on level terrain. Replace any vertical volute springs which have two or more coils with edges even with one another (par. 149 j).
23		TIGHTEN. Tighten all assembly and mounting nuts or screws securely.
24	24	**Wheels (Tires, Rollers, and Skids).** Inspect these items for good condition, correct assembly, and secure mounting. Pay particular attention to see that rubber tire has not separated from rim and that tires are not cut, torn, or excessively worn. Inspect for excessive lubricant leaks from bearings.
24		TIGHTEN. Jack up bogie wheels (par. 156 b (2)) and examine bearings for looseness and end play. Spin wheels and rollers and listen for any unusual noise. Tighten assembly and mounting bolts securely.
25	25	**Sprockets (Hubs, Teeth, and Nuts).** Inspect sprockets to see that they are in good condition and correctly assembled, and attaching screws are secure. Inspect sprocket teeth for excessive wear and drive shaft oil seals for excessive leaks. If sprocket teeth are excessively worn, sprockets should be replaced or reversed (par. 151). Tighten assembly and mounting bolts securely. NOTE: *Whenever the tracks are removed, the above operation should be performed before the tracks are reinstalled.*
25		NOTE: *In addition to the above, at each third 100-hour operation or whenever the track is disconnected and removed from the sprocket, check the drive sprocket shaft bearings for looseness and end play. Check the sprocket teeth for excessive wear and see that sprockets are secured to hubs and that hub nuts are secure. After performing the above, reinstall the tracks and connect them securely.*
26	26	**Track Tension.** Inspect tracks for proper tension with vehicle on hard level surface. On vehicles equipped with vertical volute spring suspension, there should not be more than ¾-inch or less than ½-inch sag at inspection slot in sand shield (fig. 151) or halfway between the two rear support rollers.

MAINTENANCE		
1,000-mile (100-hour)	500-mile (50-hour)	
27	27	**Top Armor (Turret, Deck, Paint and Markings, Grilles, Doors, Covers and Latches, Antenna Mast).** Inspect all applicable items to see if they are in good condition and secure. See that all doors operate properly and latch securely. Be sure hinges are free and that all mechanism is not excessively worn. See that grilles are not obstructed, and inspect paint for rust or polished surfaces that might cause glare or reflections. Unless covered for tactical reasons, all vehicle markings should be legible.
28	28	**Caps and Gaskets (Fuel Tanks and Radiators).** Inspect all filler caps and gaskets to see if they are in good condition, and caps fit filler necks properly. See that they lock securely, that vents are open, and pressure valves are clean and free. Be sure cover hinges and lock pins operate freely and lock properly.
30	30	**Engine Removal (When Required).** Remove engine (par. 61) at 100-hour maintenance service only if inspection made in items 9, 13, and 17 and a check on oil consumptions indicate a definite need. CLEAN. Clean exterior of engine and dry thoroughly, taking care to keep dry-cleaning solvent away from wiring, terminal boxes, and electrical units.
42	42	**Breather Caps and Ventilators.** Inspect crankcase breather to see that it is in good condition, securely mounted, and not leaking. Remove the filter element. Wash in dry-cleaning solvent, dry, reoil, and install securely according to instructions in Lubrication Order (par. 32).
43	43	**Air Cleaners (Carburetor).** Inspect air cleaner units to see that they are in good condition and not leaking. Remove the oil reservoirs and cleaning elements, wash in dry-cleaning solvent, fill reservoirs to proper level with clean engine oil as instructed on Lubrication Order (par. 32), and reinstall securely. Pay particular attention to see that all assembly joints and connections to carburetor are properly sealed and tight.

MAINTENANCE		
1,000-mile (100-hour)	500-mile (50-hour)	
32		**Spark Plugs.** Remove all spark plugs and examine them for cracks or broken insulators, excessive carbon deposits, and burned electrodes. Unserviceable plugs and those having gaps in excess of 0.030 inch must be replaced with new or reconditioned plugs. NOTE: *Perform item 33 before reinstalling plugs.*
33		**Compression Test.** While spark plugs are removed, test compression of each cylinder and record reading on back of Form No. 462. Throttle must be opened during compression test. Normal compression at cranking speed is 155 to 180 pounds. The allowable amount of variation between cylinders is 15 pounds. Install spark plugs.
38	38	**Ignition Wiring and Conduits.** Inspect all ignition wiring and conduits, particularly radio noise suppression shielding from magnetos to spark plugs and instruments panel, to see that they are in good condition, clean, and 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.*
46	46	**Cylinder (Heads and Gaskets).** Inspect externally to see that they are in good condition and secure, and whether or not there are indications of oil leakage or blow-by around studs or gaskets.
37	37	**Magnetos.** Inspect magnetos for good condition and security of mountings, and note whether there is evidence of oil leaks at mounting gaskets. Remove breaker point inspection covers to see that points are not pitted, clean, and properly alined.
37		ADJUST. Adjust magneto breaker point gaps to 0.016 inch according to instructions in paragraph 88 **c**.
67		**Magneto Timing.** Check magneto timing and adjust as required (par. 89 **b**).
54	54	**Engine Oil Filter.** Examine oil filter to see that it is in good condition and not leaking.

MAINTENANCE		
1,000-mile (100-hour)	500-mile (50-hour)	
		CLEAN. Remove filter and clean in dry-cleaning solvent (par. 33). Thoroughly clean interior of housing. Install filter using new gaskets as required. Test operation of filter (par. 59 b).
16	16	**Fuel Pump Test.** Attach a fuel pump gage to fuel line at carburetor. Run engine at idling speed to determine whether the fuel pressure is within the specified limits, 4½ to 6 pounds. Disconnect gage, connect fuel hose, and run engine long enough to test connections for leaks.
44	44	**Carburetor (Linkage and Governor).** Inspect dual carburetors, degassers, and governor unit to see that they are in good condition, correctly assembled, and securely mounted. See that carburetor throttle linkage is properly connected and adjusted (par. 75 d) and not excessively worn. Examine primer pump tubes and hoses to make sure they are in good condition and securely supported.
45	45	**Manifolds.** Inspect to see that all manifolds, manifold gaskets, and connections are securely fastened, correctly assembled, and not leaking.
45		TIGHTEN. Tighten all loose assembly and flange nuts.
34	34	**Generator and Starter.** Inspect these items for good condition and security of mounting. Make sure wiring connections are secure. See that all accessible radio noise suppression shielding, condensers, and bonding straps are securely connected.
34		SERVE. Remove generator cover band and examine commutator for 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 end of generator by blowing out with compressed air. Tighten starter and generator mounting bolts securely.
49	49	**Water Pump, Fans and Shrouds.** Observe whether these items are in good condition, correctly assembled, and secure. See that water pump does

MAINTENANCE		
1,000-mile (100-hour)	500-mile (50-hour)	
		not leak. Note particularly whether there is end play or looseness in fan bearings. Check to see that fan blades and shrouds are properly alined.
50	50	**Accessory Drives (Belts, Pulleys, Shafts, and Couplings).** See that these items are in good condition, correctly assembled, and secure. Make sure fan drive belts and pulleys are alined and not excessively worn, and belts are properly adjusted. Inspect accessory drive universals for grease leaks and test for looseness or wear.
50		ADJUST. Adjust drive belts to the correct tension. All drive belts should have ½-inch deflection under finger-pressure halfway between pulleys. See that adjusting locks are securely fastened.
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. Remove all dirt and refuse, wipe out the engine compartment with cloths soaked in dry-cleaning solvent, and dry thoroughly. Whenever engines are removed, repaint compartment if necessary.
53	53	**Fuel (Tanks, Vents, Lines, and Pump).** Inspect tanks, tubes, and pump to see that they are in good condition, securely mounted and supported, and not leaking. Be sure gage sending unit mountings and connections are secure and vents are open.
53		TIGHTEN. Tighten all accessible fuel tanks, tubes, hoses, fittings, and valves to make sure they are in good condition, secure, and not leaking. Test operation of fuel valves.
53	53	CLEAN. When engines are removed, clean fuel tank filters (par. 70 c (1)). If fuel is contaminated with dirt or water, drain fuel tanks.
57	57	**Exhaust Pipes.** Inspect to see that these items are in good condition and securely mounted and assembled.

MAINTENANCE		
1,000-mile (100-hour)	500-mile (50-hour)	
57		TIGHTEN. Tighten all mounting bolts and connections securely.
58	58	**Engine Mountings.** Inspect all mountings and bonding straps to see that they are in good condition and secure.
58		TIGHTEN. Tighten all mountings and bonding straps securely. NOTE: *When engine is removed for repair or replacement, tighten floor and hull engine mounting brackets while engine is out of vehicle.*
60	60	**Fire Extinguisher System (Tanks, Valves, Lines, Nozzles, and Mountings).** Inspect tubes, connections, and cylinders of fixed fire extinguishers for good condition, secure mounting, and full charge. Full charge may be positively determined only by weighing. Examine control cables of fixed extinguishers to see that they are in good condition and, while cylinders are disconnected, test to see if they are free to operate at a moment's notice. See that all tubes and nozzles are in good condition, securely mounted and connected, with nozzles properly aimed and not clogged.
60		TIGHTEN. Tighten all assembly and mounting bolts securely.
61		**Engine (Install Mountings, Lines and Fittings, Wiring, Oil and Water Supply).** If engine was removed for repair or replacement, install at this time (par. 62). Tighten mountings and bonding straps securely. Connect all fuel, oil, and water tubes, hoses, exhaust pipes, and wiring connections and tighten securely. Be sure oil and coolant supply is adequate.
62	62	**Radiator (Cores, Mountings, Connections, Surge Tank, Antifreeze Record).** Examine above listed applicable units to see that they are in good condition, securely assembled and mounted, and not leaking. See that core external air passages are free of obstructions, and inspect for badly bent cooling fins. See that all air duct seals are in good condition to effectively seal air passages against leaks. Be sure vent cap and gasket are serviceable.

MAINTENANCE		
1,000-mile (100-hour)	500-mile (50-hour)	
		Check coolant for excessive contamination to determine if system should be cleaned. If antifreeze is in use, test its value and record value in space provided on back of Work Sheet, W.D., A.G.O. Form No. 462. Add antifreeze as necessary to ensure against freezing.
62	62	SERVE. Clean out all insects and trash from in and around radiator core air passages. If cooling system must be cleaned, clean according to procedure in paragraph 78 **a** (2). Use only specified cleaners and inhibitors and during freezing weather use only ethylene-glycol type antifreeze compound.
48	48	**Clutch Assembly.** Examine clutch housing to see that it is in good condition and securely mounted. Examine pedal and linkage for excessive wear, improper adjustment, loose or missing attaching parts, or weak return spring or booster. When engine is removed, remove clutch driven disk (par. 134 **h** (1)). Clean all parts and inspect them for excessive wear or damage. Replace unserviceable clutch pilot or release bearings and driven disks.
56	56	**Oil Cooler (Transmission) Core and Lines.** Inspect oil cooler core tubes and hoses to see that they are in good condition, secure, and not leaking. Clean out insects and trash from in and around core air passages.
63	63	**Batteries (Cables, Hold-downs, Box, Record Gravity and Voltage).** Clean top of batteries and inspect them for damage, leaks, loose or corroded bolts, posts, straps, and hold-downs. Test specific gravity and voltage and record on space provided on back of Form No. 462. See hydrometer correction table (par. 97 **b** (3)), and freezing chart (par. 97 **b** (4)).
63		CLEAN. Clean batteries and box. Repaint box if corroded. Clean cables, terminals, bolts, and posts, and grease lightly. Tighten terminals and hold-downs carefully to avoid damage to battery.
63	63	SERVE. Add clean water to bring electrolyte 3/8 inch above plates.

MAINTENANCE		
1,000-mile (100-hour)	500-mile (50-hour)	
64	64	**Accelerator (Linkage and Throttle).** Inspect accelerator pedal and hand throttle control to make sure all parts and linkage are secure, not excessively worn, and are properly adjusted (par. 75). Test action of both pedal and throttle controls to make sure they do not have excessive play and are not binding. Tighten all loose assembly or mounting nuts and screws and replace damaged or missing cotter pins.
65	65	**Starter (Primer and Instruments).** Start engine, observing all starting precautions outlined in paragraph 15 **c**. In cold weather, test operation of primer pump and inspect for leaks. Note particularly if starter engages and disengages properly without unusual noise and develops adequate cranking speed. Check all pertinent instruments to see if they register or record the proper functioning of the units to which they apply. Set throttle control to run engine at 800 to 1,000 revolutions per minute while warming up engine and transmission. CAUTION: *If oil pressure is not indicated in ½ minute, stop engine and investigate cause.*
69	69	**Engine Idle.** With throttle control in idling position, engine must idle smoothly at 500 revolutions per minute. Adjust carburetor idling fuel mixture (par. 64 **b**) and throttle setting (par. 64 **c**) if necessary.
66	66	**Leaks (Engine Oil, Fuel, and Coolant).** With engine running and oil, fuel, and cooling systems under pressure, carefully check all components for leaks. Trace any leaks found to their source. Correct leaks or report them to higher authority. Install engine compartment floor plate securely, using new gaskets if necessary.
68	68	**Regulator Units (Connections, Bond Straps, and Filters).** Inspect generator regulator to see if it is in good condition, securely connected, and mounted. See that radio suppresion bond straps are in good condition, securely connected, and mounted.

MAINTENANCE		
1,000-mile (100-hour)	500-mile (50-hour)	
68		When regulator has reached normal operating temperature, connect the low voltage tester to see if voltage and current regulators and cut-out properly control generator output. Make tests according to instructions which accompany the test instrument.
71		**Fighting Compartment (Paint, Seats, Safety Straps, Crash Pads, Stowage, Ammunition Boxes, Clips, and Racks).** Inspect to see that these items are in good condition and securely assembled and mounted. See that fighting compartment is clean, that paint is in satisfactory condition, and that adjustment mechanisms of the seats 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 and Telescopic Sights.** Examine periscope heads and elbows and telescopic sights to see that they are in good condition, clean, and securely attached to the body. Make sure that periscopes are securely mounted in holders. Rotate and tilt holder to test it for wear or bind. Make sure locking screws hold periscope holders in desired position. Examine spare periscopes and heads and their stowage boxes to see that they are in good condition, clean, and secure. CAUTION: *Windows must 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. Depress clutch pedal slowly to see that clutch disengages freely without binding or excessive clutch pedal pressure and that booster functions properly. With pedal fully depressed, remove foot to make sure return spring will immediately raise pedal to fully release position (par. 134). Pedal free travel must be not less than 2 or more than 2⅞ inches (par. 134 d).

MAINTENANCE		
1,000-mile (100-hour)	500-mile (50-hour)	
75	75	**Steering Brakes (Free Travel, Parking Latch, Levers, and Linkage).** Free travel at top of levers should be 4 to 5½ inches. Brakes should be fully applied before levers reach a vertical position. Inspect levers and all linkage to see if they are in good condition and securely connected. See that connections are free but not excessively worn. Test lever locking mechanism to see if it operates properly to hold levers in applied position.
75		TIGHTEN. Tighten all assembly and mounting nuts or screws securely. ADJUST. Make necessary adjustments to steering brake linkage according to paragraph 139.
77	77	**Differential and Breather.** Examine accessible part of the differential carrier in driver's compartment to see that it is in good condition, that all mounting and assembly bolts or cap screws are secure, and that there are no leaks. Inspect breather to see that it is in good condition, secure, and not clogged.
77		CLEAN AND TIGHTEN. Remove breather and clean thoroughly. Tighten all external assembly and mounting bolts and screws securely.
80	80	**Transmission Control.** Inspect to see that transmission gearshift lever operates properly, is in good condition, correctly assembled, and securely connected.
81	81	**Propeller Shafts (Universal Joints, Alinement, and Flanges).** Inspect propeller shaft to see that it is in good condition. See that universal joints are correctly alined and assembled and properly lubricated. Make pry-bar test for excessive wear.
81		TIGHTEN. Tighten universal joint companion flange cap screws securely.
84	84	**Compass (Fluid and Lamp).** Inspect compass to see that it is in good condition and secure. Examine fluid for proper level. Report any deficiencies to designated authority. Test compass lamp to see that it operates properly.

MAINTENANCE		
1,000-mile (100-hour)	500-mile (50-hour)	
85	85	**Lamps (Lights) and Switches (Head, Tail, Blackout, and Internal).** Test to see that switches and lamps (lights) operate properly. Inspect to see that all lights are in good condition, secure, and do not have broken lenses.
85		ADJUST. Adjust headlight beams.
86	86	**Wiring (Junction and Terminal Blocks and Boxes, Circuit Breakers, and Buttons).** Inspect accessible above listed units to see that they are in good condition, securely mounted and connected, and clean. Inspect all exposed wiring and conduits for damage, and see that they are well supported, securely connected, and clean. Be sure all accessible radio noise suppression bonding straps are in good condition, and that all attaching bolts at terminal or control boxes and wiring support clips are tight.
87		**Collector Ring (Brushes, Heads, Cylinder, and Cover).** With 24-volt and 12-volt master switch off, remove collector ring box (slip ring) cover, and examine to see that above listed items are in good condition and clean. See that brushes contact cylinder evenly under normal spring tension. See that leads are securely connected and not chafing. Be sure cover is reinstalled securely, and that bonding strap is in good condition and securely connected.
88	88	**Radio Bonding (Suppressors, Filters, Condenser, and Shielding).** See that all accessible units not covered in the foregoing specific procedures are in good condition, and securely mounted and connected. Be sure all additional noise suppression bond straps and internal-external toothed washers listed in paragraph 128 **b** (17) are inspected for looseness or damage, and see that contact surfaces are clean. NOTE: *If objectionable radio noise from the vehicle has been reported, make test in accordance with paragraph 52. If cleaning and tightening of mountings and connections, and replacement of defective radio suppression unit does not eliminate the trouble, the radio operator will report the condition to the designated individual in authority.*

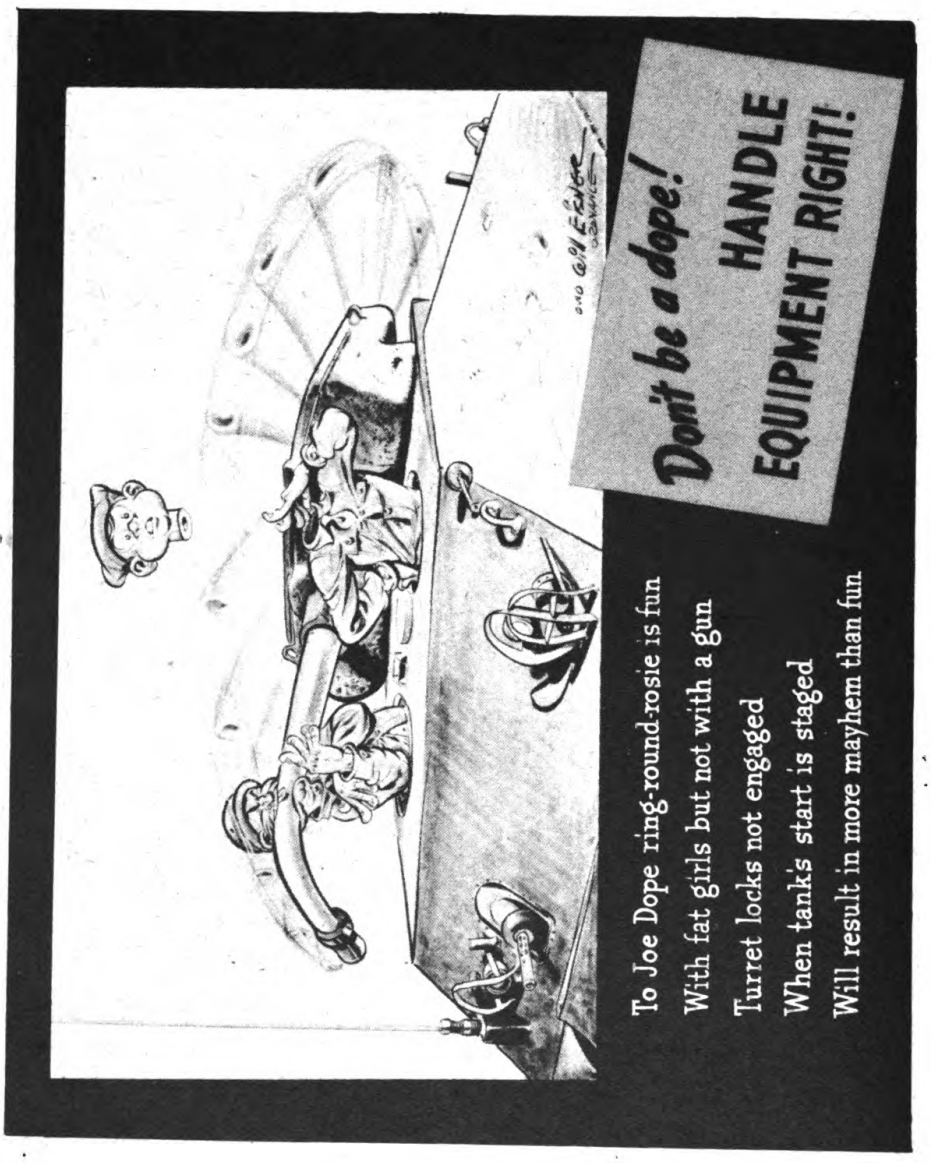
MAINTENANCE		AUXILIARY GENERATOR
1,000-mile (100-hour)	500-mile (50-hour)	
89	89	**Engine (Crankcase, Fan and Housing, Cylinder, Shroud, Mountings, and Exhaust Pipe).** Inspect to see that these items are in good condition and securely mounted. See that there are no leaks in exhaust line or around gaskets and that shroud damper operates freely. See that radio suppression bond straps are in good condition, and securely mounted and connected.
90	90	**Spark Plug.** Remove and inspect spark plug for broken insulator or burned electrodes; gap must be 0.025 inch. Replace unserviceable plug, using new gasket.
91	91	**Magneto (Points, Wiring, and Shield).** Inspect to see that these items are in good condition, correctly assembled, and securely mounted. Make sure the interior of magneto and rotor arm are in good condition and clean. See that breaker points are clean and not uneven or pitted. See that radio noise capacitors are in good condition, and securely mounted and connected.
91		ADJUST. Breakers must be properly alined and not pitted. The gap must be adjusted to 0.020 inch with points fully opened.
92	92	**Carburetor Air Cleaner.** Inspect to see that air filter is in good condition, securely mounted, and not leaking.
92		CLEAN. Remove air filter, clean in dry-cleaning solvent, and dry thoroughly. Dip filter in engine oil, drain, and install.
93	93	**Fuel (Filter, Line, Tank, and Cap).** Examine to see that these items are in good condition, secure, and not leaking. Close fuel tank shut-off valve. Remove and clean fuel filter sediment bowl and screen. Install, using new gasket if necessary. Open fuel supply valve and check for leaks.
94	94	**Generator (Commutator, Brushes, Control Box, and Wiring).** Remove brushhead cover plate and examine commutator to see that it is in good condition, clean, and not excessively worn. See that brushes are clean, free in their holders, properly

MAINTENANCE		
1,000-mile (100-hour)	500-mile (50-hour)	
		spring-loaded, and not excessively worn. Be sure that radio noise suppression condenser in control box is in good condition and securely connected. Inspect control box, buttons, ammeter, and wiring to see that they are in good condition, correctly assembled and connected and secure.
94		CLEAN. At each third 100-hour service, clean commutator (par. 173 g).
95	95	**Operation (Engine, Generator, Regulator, Ammeter, and Leaks).** Start engine, observing whether it starts easily and runs at normal speed. Listen for any unusual noise. See that generator output is 50 amperes with electrical units operating. Examine fuel system for leaks. **NOTE:** *If vehicle is equipped with heater unit and duct, be sure that heater operates and the duct is in good condition, clean, and secure. Check operation of heat damper.*
95		When regulator has reached normal operating temperature, connect the low voltage tester to see if voltage and current regulators and cut-out properly control generator output. Make tests according to instructions which accompany the test instrument.
		ARMAMENT
125	125	**Bow Gun (Mount).** See that mount is in good condition, clean, well lubricated, and secure. Elevate and traverse gun through its entire range to see if mount operates without binding or looseness, and that firing control operates properly.
125		TIGHTEN. Tighten all assembly nuts and screws securely.
126	126	**Gun 90-mm (Mount, Traversing and Elevating Mechanism, and Firing Controls).** Inspect to see that these items are in good condition, clean, well

MAINTENANCE		
1,000-mile (100-hour)	500-mile (50-hour)	
		lubricated, correctly and securely assembled, and not excessively worn. Check to see that manual and hydraulic traversing controls are in good condition and secure, paying particular attention to wiring, switches, and connections. Make sure gun is not loaded. Operate each firing control, both manual and electric, to see that they function properly. Operate hand elevating controls through entire range to see that they function properly. Traverse turret by hand to see that it is not binding and that turret can be turned through its entire 360-degree range. See whether the brake is effective when hand control brake latch is released.
		Inspect power traversing system, including motor, pump, reservoir, wiring, and operating controls to see that they are in good condition, correctly assembled, secure, operate properly, and are not excessively worn. Examine hydraulic system for leaks and for proper level of oil. Add oil if required according to instructions in Lubrication Order (par. 32). Make an operating check of traversing system by closing motor switch, placing clutch lever in power operating position, and turning pistol-grip operating control to right, left, and neutral positions to see if traversing mechanism responds properly without any overrun.
126		TIGHTEN. Tighten gun mount assembly and mounting nuts or screws securely.
127	127	**Recoil Control.** Check recoil cylinders to see that they are in good condition and not leaking. **NOTE:** *Recoil operating tests must be made only under firing condition in accordance with instructions in paragraph 185 of this manual.*
127		TIGHTEN. Tighten all mounting and assembly nuts and screws securely.

MAINTENANCE		
1,000-mile (100-hour)	500-mile (50-hour)	
128	128	**Cal. .50 Antiaircraft Gun (Mount).** Inspect gun and mount to see if they are in good condition, correctly assembled, clean, and secure. Make sure the rest holds barrel securely in traveling position.
128		TIGHTEN. Tighten all mounting and assembly nuts and screws securely.
129	129	**Spare Gun Barrels and Parts.** Check against stowage list (par. 7 **d**) to see that all items are present, and see that they are in good condition and properly stowed.
		TOOLS AND EQUIPMENT
130	130	**Tools (Vehicle Kit and Pioneer).** Check standard vehicle tools against stowage lists (par. 6) to see that all tools are present, in good condition, and properly stowed or mounted. Any tools mounted on outside of vehicle having bright or polished surfaces should be painted or otherwise treated to prevent glare or reflections. Tools with cutting edges should be sharp and the edges protected.
131	131	**Equipment.** Check equipment items against vehicle stowage list (par. 7) to see if all equipment is present, in serviceable condition, and properly stowed or mounted.
132	132	**Grousers and Spare Track Links.** Inspect to see if they are all present, in good condition, and properly stowed or mounted.
133	133	**Spare Oil Supply (Recoil, Hydraulic, 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	**Decontaminator.** Examine to see that it is in good condition, secure, and fully charged. Make latter check by removing filler plug. NOTE: *The solution must be renewed every three months, as it deteriorates.*

MAINTENANCE		
1,000-mile (100-hour)	500-mile (50-hour)	
135	135	**Fire Extinguisher (Portable).** Inspect to see that fire extinguishers are fully charged, in good condition, and securely mounted. Weigh cylinder to determine if it is fully charged (par. 20). If it weighs less than 4 pounds, cylinder should be replaced with a fully charged one.
136	136	**Publications and Form No. 26.** All vehicle and equipment manuals, Lubrication Orders, Standard Form No. 26, Driver's Report-Accident, Motor Transportation, and W.D., A.G.O. Form 478, MWO and Major Unit Assembly Replacement Record, must be in vehicle, legible, and properly stowed.
137	137	**Vehicle Lubrication.** Check lubrication of entire vehicle. On any unit where disassembly was necessary for inspection purposes, lubrication must be performed unless the vehicle is to be deadlined for repair of that unit. If lubrication is due, lubricate all points of vehicle in accordance with instructions in Lubrication Order (par. 32). Use only clean lubricant and keep all lubricant containers covered.
138	138	**Modifications (Modifications Work Orders Completed).** Inspect vehicle to determine that all Modification Work Orders have been properly completed. Enter any modifications or major unit assembly replacements made during this service on Form No. 478.
139	139	**Final Road Test.** Make a final road test, rechecking items 2 to 15 inclusive. Before driving vehicle, make sure turret is locked, shift lever is in manual position, and gun is secured in turret traveling lock and gun barrel traveling lock. Recheck transmission and differential to see that lubricant is at correct level and 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 to designated individual in authority.*



Section XVI

TROUBLE SHOOTING

40. INTRODUCTION.

a. General. This section contains trouble shooting information and tests for the entire vehicle which can help determine the causes of some of the troubles that may develop in the vehicle. Under each unit or system are listed symptoms of the troubles which are most prevalent. Where a symptom may be caused by more than one condition, simple tests are described that will locate the trouble in a particular unit or system, or eliminate a particular unit or system from further consideration.

b. Electrical Wiring. The wires in the electrical circuits are of the same color (natural color). The wires can be identified by a number attached to each wire. A further description of the wiring is covered in paragraph 110.

41. ENGINE.

a. Engine Will Not Crank. Check the starting system (par. 44). Remove the spark plugs and crank the engine with the starter to check for accumulation of water in the cylinders (hydrostatic lock). If the engine can be cranked with the spark plugs removed, and cannot be cranked with the spark plugs in place, this will indicate a water leak into the cylinders. If the engine cannot be cranked with the spark plugs removed, it will indicate that a reciprocating part in the engine has seized. In either case, notify higher authority.

b. Engine Cranks But Will Not Start.

(1) PRELIMINARY INSTRUCTIONS. If the engine is hot, hold the foot throttle open and crank the engine. This will clear away any vapor lock which may be present. If the engine is extremely cold, see paragraph 25.

(2) CHECK FUEL SYSTEM. Check to see that the fuel shut-off valves are open (fig. 9). Remove the outlet fuel line from the fuel pump, and, with the magneto switch in the "OFF" position, crank the engine with the starter. If a free flow of fuel is not evident, fuel is not reaching the carburetor. See paragraph 45 a.

(3) CHECK IGNITION SYSTEM. Turn the magneto switch "ON." Remove a wire from a spark plug, and hold the wire terminal approximately ¼-inch from the cylinder head. Crank the engine. If a spark does not jump the ¼-inch gap, the ignition system is at fault. See paragraph 42.

c. Engine Backfires But Will Not Start. Check to see that the spark plug wires are attached to the magneto distributor plates in their proper firing order (fig. 66). Check ignition timing (par. 89).

d. Engine Will Not Develop Full Power. If the engine does not develop full power, follow preventive maintenance procedure (par. 39).

e. Engine Misfires. If the engine misfires, follow preventive maintenance procedure (par. 39).

f. Engine Runs Unevenly and Black Smoke is Emitted From Exhaust. Check fuel sysem (par. 45 b).

g. Engine Runs Unevenly and Backfires Through the Carburetor After it is Warmed Up. Check to see that the spark plug wires are attached to the magneto distributor plate on the magnetos in their proper firing order (fig. 66). Check ignition timing (par. 89). If the ignition is found to be satisfactory, it can be assumed that the fuel mixture is too lean. Refer to paragraph 45 c.

h. Engine Overheats. If the engine compartment doors are equipped with shutters, make sure they are open. Check for low water in the cooling system and refill with coolant if required. Adjust the fan belts if loose (par. 83 b). If the air flow through the radiator is restricted, clean the radiator fins and air passages. Check the ignition timing and retime if required (par. 89). If the engine continues to overheat, replace the thermostat (par. 82).

i. Excessive Oil Consumption. Examine the oil in the engine and if the viscosity of the oil is found to be low, refill with specified grade. Inspect the engine for external oil leaks. Tighten any oil line connections found leaking. Tighten or replace gaskets as required. If the engine continues to use oil after making the above inspection or replacements, it may be assumed the pistons or piston rings or the intake valve guides are worn or damaged. In this case, notify higher authority.

j. Low or No Oil Pressure. Check the oil supply in the engine and replenish it with specified grade if required (see Lubrication Order par. 32). If the oil in the engine has become overdiluted, it must be replaced with the grade specified.

k. Abnormal Engine Noise. The following procedure for locating abnormal engine noise applies only if the condition of the engine permits its being run. Set the engine speed at approximately 600 revolutions per minute and place a neon-type spark tester on one of the spark plug terminals. The neon light will flash with every other revolution of the engine. If the noise occurs twice for each flash, the source is at some point driven by the crankshaft such as pistons, rings, pins, connecting rod bearings, or main bearings. A loose main bearing knock is usually a dull thud, more noticeable on a hard pull or quick acceleration. If the noise occurs once for each flash, the source is at some point driven by the camshaft such as valves, push rods, etc.

NOTE: *Camshaft backlash noise below 500 revolutions per minute is not to be considered abnormal.*

42. IGNITION SYSTEM (fig. 64).

a. No Spark Delivered to Spark Plugs in Either Right or Left Bank. If no spark is obtained from a magneto under the test outlined in paragraph 41 b (3), remove the magneto switch wire (ground wire) from whichever magneto does not deliver a spark. Crank the engine with the starter. If a satisfactory spark is obtained with the magneto switch wire removed, it will indicate that the magneto switch is faulty, or that the ignition wire extending from the magneto to the switch is short circuited. Replace the switch or wire, whichever is at fault. If no spark is obtained from this test, the magneto on the side being tested is at fault. Replace magneto (par. 88 b).

b. No Spark or Unsatisfactory Spark Obtained at Some Spark Plug Wires, and Satisfactory Spark at Other Wires. Examine all spark plug wires on the side of the engine being tested. Any wires found chafed or with faulty insulation must be replaced. If the spark plug wires are in good condition, it can be assumed the distributor plate in the magneto is at fault. Replace the magneto (par. 88 b).

c. Intermittent Spark at Each Spark Plug Wire. If an intermittent spark is obtained from each of the spark plug wires, it indicates that the magneto on the side of the engine being tested is at fault. Replace the magneto (par. 88 b).

43. BATTERIES AND GENERATING SYSTEM (fig. 71).

a. Batteries Run Down. Excessive use of electrical accessories must be avoided when the generator is not operating. Be sure the 24-volt and 12-volt master switches (fig. 6) are not left on when the vehicle is not in use. Replace the discharged batteries with fully charged units. Disconnect the cable from the positive terminal of the forward battery. Turn the 24- and 12-volt master switches on, and contact the battery cable against the positive post of the battery. If a flash is seen from this test, it will indicate that there is a shorted or grounded wire in the electrical circuits, or that the cut-out points in the generator regulator are stuck together. Refer to subparagraph d (2) below for generator regulator test. If the generator regulator is found satisfactory, it can be assumed the wiring is at fault. Notify higher authority.

b. Batteries Use Excessive Water. See subparagraph f below.

c. Ammeter Does Not Show Charge. If the ammeter fails to show a charge, turn on all lights and observe whether a discharge is shown. If no discharge is observed, connect a new ammeter to the leads in the instrument panel. If a reading is obtained, the ammeter

is faulty and must be replaced (par. 101). If no reading is observed, proceed with the next test (subpar. d below).

d. Engine Generator Does Not Charge the Batteries.

(1) TEST GENERATOR. Remove the armature and battery wire from the "ARM" and "BAT" terminals of the generator regulator and connect an ammeter between them. Remove the field wire from the field terminal of the regulator. Start the engine and, while it is running at idle speed, touch the free end of the field wire to the armature wire. Increase the speed of the engine and note the charging rate. CAUTION: *Do not increase the charge above 50 amperes.* If the charging rate increases as the engine is speeded up, the generator is operating normally. Reconnect the wires to the generator regulator. If the charging rate does not increase, the generator is at fault and must be replaced (par. 99).

(2) TEST GENERATOR REGULATOR. Start the engine and run it at approximately 800 revolutions per minute. Observe the ammeter on the instrument panel. If no charging rate is indicated, connect the terminal marked "BAT" and the terminal marked "ARM" together with a jumper wire and watch the ammeter. If a reading is obtained, the cut-out unit of the regulator is at fault. Replace the generator regulator (par. 100). If no reading is obtained, connect the battery and field terminals together with the jumper wire. If a reading is now obtained, the generator regulator is at fault. Replace the generator regulator (par. 100).

e. Low Charging Rate When Batteries are Low in Charge. Operate the engine at a speed of 2,500 revolutions per minute. If the charging rate does not increase to maximum (50 amperes), the generator regulator is at fault. Replace the generator regulator (par. 100).

f. High Charging Rate When Batteries are Fully Charged. Operate the engine at a speed of 2,500 revolutions per minute. If, after the generator has replaced the current used by the starter and the batteries are known to be fully charged, the ammeter shows a charge in excess of 15 amperes, it can be assumed that the voltage setting of the generator regulator is too high. Replace the generator regulator (par. 100). NOTE: *If the batteries gas freely and use water excessively, this also is an indication of too high charging rate.*

g. Auxiliary Generator Inoperative. If auxiliary generator will not start, check the ignition by removing the spark plug wire from the plug and holding it near the engine while cranking the engine. If no spark is evident, replace auxiliary generator. If spark is present, clean and adjust spark plug (par. 173 e), and attempt starting again. If generator will not start, replace generator (pars. 173 n and o).

h. Auxiliary Generator Does Not Charge Batteries. Perform the tests described in subparagraph **d** above on the auxiliary generator and auxiliary generator regulator.

44. STARTING SYSTEM.

a. Engine Fails to Turn Over When the Starting Switch is Pressed.

(1) TEST BATTERIES. Test the state of charge of the batteries (par. 97 **b**). If the batteries are low in charge, they must be recharged or replaced. Make certain the battery terminals are clean and tight.

(2) TEST STARTER. With a jumper wire made from a piece of battery cable, contact the two terminals on the starter relay (the terminals to which the heavy cables are attached). If the starter fails to run, replace the starter (par. 93). If the starter does run in this test, proceed with test in step (3) below.

(3) TEST STARTER RELAY, STARTING SWITCH, AND STARTING SWITCH WIRE. Use a jumper wire and contact it between the "hot" terminal on the relay and the small terminal at the bottom of the relay to which the small wire is attached (fig. 74). If the relay clicks and the starter cranks the engine, the trouble is in the starting switch or the starting switch wiring. Replace the starting switch or the faulty wiring, whichever is at fault. If the starter does not crank the engine in this test, it will indicate that the starter relay is at fault. Replace the relay (par. 94).

45. FUEL SYSTEM.

a. Fuel Not Reaching the Carburetor. Make sure the fuel shutoff valves (fig. 9) are open and that there is a sufficient fuel supply in the tanks. Clean the fuel filter (par. 70 **c** (1). Remove the outlet fuel line from the fuel pump and, with the magneto switch off, crank the engine with the starter. If a free flow of fuel is not evident, replace the fuel pump (par. 71 **b**). If a free flow of fuel is obtained in the above test, the fuel system up to the carburetor is satisfactory.

b. Engine Runs Unevenly, and Black Smoke is Emitted from Exhaust. Check the fuel pump pressure (par. 71). If the pressure is too high, replace the fuel pump (par. 71 **b**). If the pump pressure is satisfactory, run the engine at idle speed and remove the fuel level checking plug from each carburetor (fig. 51). Observe the fuel level in the carburetors. If the fuel runs from the inspection hole on either carburetor, the fuel level is too high in that carburetor. Replace the carburetor (pars. 64 **e** and **f**).

c. Fuel Mixture Too Lean. Run the engine at idle speed and remove the fuel level checking plug from each carburetor (fig. 51).

If the fuel level is below the bottom threads of this hole, the float level is too low due to incorrect carburetor float setting or a restriction in the fuel lines or fuel filter. Remove any restriction to a free flow of fuel. Check the fuel pump pressure (par. 71). If the pressure is low, replace the fuel pump (par. 71 **b**). If this does not correct the low level, replace the carburetor (pars. 64 **e** and **f**).

d. Engine Slows Down but Does Not Stop When Fuel Cut-Off Button is Pressed. Press the fuel cut-off circuit breaker button at the top of the instrument panel. Start the engine and turn the magneto switch to the "R" position which will cause the engine to run on the right bank of cylinders. Press the fuel cut-off button. Turn the magneto switch to the "L" position and press the fuel cut-off button. The bank of cylinders which continue to fire after the fuel cut-off button is pressed will show that either one of the degassers on the side of the engine is defective. To determine which one of the two suspected degassers is at fault, close the idling adjusting screw in the rear carburetor on the side which supplies fuel to whichever bank of cylinders continue to fire after the fuel cut-off button is pressed. Run the engine and if the engine stops when the fuel cut-off button is pressed, the defective degasser is in the rear carburetor. If the engine does not stop when the fuel cut-off button is pressed, the defective degasser is in the front carburetor. Replace the degasser (par. 66 **b**).

e. Pressing the Fuel Cut-Off Button Has No Effect on Engine. Press the fuel cut-off circuit breaker button at the top of the instrument panel. If the circuit breaker will not stay in contact, check for grounded wire in the degasser circuit. Remove the fuel cut-off switch from the instrument panel. Start the engine and connect the two wires running to the switch together. If engine stops, the fuel cut-off switch is defective.

46. COOLING SYSTEM.

a. General Instructions. Difficulties in the cooling system are usually reflected in loss of coolant from the system and overheating. When overheating is evident and the cooling system inspection procedure in subpar. **d** below fails to locate the cause, follow instructions as outlined in paragraph 78.

b. Engine Overheats. Refer to paragraph 41 **h**.

c. Engine Runs Too Cold. Replace the thermostat (par. 82 **a**).

d. Loss of Coolant.

(1) INSPECT HOSE CONNECTIONS AND EXTERNAL GASKETS. Inspect all hose and hose connections and tighten or replace hose. Inspect for leakage at drain plug (fig. 28) and tighten or replace if required. Inspect external gaskets for leaks and replace any gaskets found leaking.

(2) INSPECT WATER PUMP. If water is leaking from the drilled hole at the bottom of the water pump, it indicates that the pump shaft seal is leaking. Replace the water pump (pars. 81 **b** and **c**).

(3) INSPECT PRESSURE FILLER CAP. With the engine at normal operating temperature, loosen the pressure filler cap at the top of the expansion tank (fig. 61) by turning the cap counterclockwise to the first notch. Listen for pressure escaping from the cooling system. If the pressure is audible, the filler cap is functioning properly. If no pressure is escaping, the filler cap or gasket is at fault. Replace the upper and lower gaskets, run the engine until it is again at operating temperature, and repeat the test. If the new gaskets failed to correct the condition, replace the filler cap.

(4) INSPECT RADIATOR. Clean the exterior of the radiator core, remove all grease, dirt, and insects. Inspect the radiator for leaks. If it is found leaking, replace the radiator (par. 79).

(5) INSPECT FOR INTERNAL WATER LEAKS. If the cooling system still loses coolant, drain the oil from the engine oil pan and observe whether there is water in the oil. If an abnormal amount of water is found in the oil, it will indicate an internal water leak in the engine. Notify higher authority. Remove all spark plugs and, with the magneto switch off, crank the engine with the starter. Observe if water is evident at the spark plug holes. If water is evident, it can be assumed the cylinder head gaskets are leaking. Replace the cylinder head gaskets (par. 56).

47. LIGHTS AND HORN.

a. No Lamps Will Light and No Electrical Units Will Operate.

(1) PRELIMINARY TEST. Turn on the 24-volt master switch. Push all the circuit breaker reset buttons located on the instrument panel (fig. 10). Test the state of charge of the batteries. If the batteries are discharged, they must be recharged or replaced. Clean and tighten the battery terminals securely. If the lamps still fail to light, press the starter switch. If the starter fails to turn, test the 24-volt master switch (step (2) below). If the starter turns, omit test in subparagraph (2) below and proceed with subparagraph (3) below.

(2) TEST 24-VOLT MASTER SWITCH (fig. 74). Remove the cover from the 24-volt master switch box. Turn on the light switch. Use a jumper wire and contact across the terminals of the 24-volt master switch. If the lamps now light, replace the 24-volt master switch.

(3) TEST CIRCUIT BREAKER. Disassemble the instrument panel (par. 111 **b**). Turn on the light switch. Use a jumper wire and contact across the terminals on the circuit breaker marked "LIGHTS." If the lamps now light, the circuit breaker is at fault and must be replaced. If the circuit breaker fails to stay in contact (kicks out),

check the light circuit for grounded or shorted wires. If the lamps still fail to light proceed with step (4) below.

(4) TEST MAIN FEED WIRES TO INSTRUMENT PANEL. Turn on the instrument light switch. If the instrument panel lights come on, the main feed wire circuit is complete. If the panel lights do not come on and the lamps are known not to be burned out, it will indicate that the current is not being delivered to the instrument panel.

(5) TEST AMMETER SHUNT FOR LOOSE CONNECTIONS. Remove the cover from the battery master switch box and tighten any connections found loose on the ammeter shunt and terminal bar (fig. 72).

b. Instrument Panel Lamps Light But No Other Lamps Will Light. Remove the instrument panel and test the circuit breaker marked "LIGHTS" (subpar. a (3) above). Examine the wire marked "50" which extends from the circuit breaker marked "LIGHTS" to the terminal marked "BAT" on the light switch (B, fig. 85). If this wire is in good condition and the terminals are tight, it may be assumed that the light switch is at fault and must be replaced.

c. Individual Lamps Do Not Light. Check any lamps burned out and replace (pars. 103, 104, 106, 107, and 108). Check for loose connections at lights and tighten connections. Check for damaged wires to the individual unit giving trouble. If the lamp still fails to light, replace the light switch.

d. One or More Lamps Burn Out Repeatedly. Most lamp failures are due to vibration when the vehicle is operated over rough terrain. These failures occur more frequently in 12- and 24-volt systems than they do in a 6-volt system, due to the smaller lamp filament used with higher voltages. Clean and tighten all connections, including the battery cable connections, and replace all broken ground straps (bond straps). If the generator has replaced the current used in starting the engine, the batteries are known to be fully charged, and the ammeter shows a charge in excess of 15 amperes, it can be assumed that the voltage setting of the generator regulator is too high. Replace the generator regulator.

e. Short Circuits or Grounded Wires (Circuit Breaker Marked "LIGHTS" Kicks Out). Turn the light switch to the "BO MK" position. If the circuit breaker kicks out, it indicates that the shorted or grounded wire is in the blackout marker light or the blackout taillight wires. Turn the light switch to the "HD LTS" position. If the circuit breaker kicks out, it indicates that the shorted or grounded wire is in the circuit to the service headlights or in the service taillight wires. Replace or repair the damaged wires. If the damage to the wires is caused by a damaged conduit, replace the damaged section of the conduit.

f. Horn or Siren Will Not Sound.

(1) PRELIMINARY STEPS. Be sure the horn or siren circuit breaker reset button is pushed in. Turn on the instrument panel light switch. If the panel lights come on, it will indicate that current is being delivered to the instrument panel and to the horn or siren circuit breaker. Remove the horn or siren from its mounting bracket and clean the base free from paint or corrosion to establish a good ground contact for the horn or siren. Reinstall the horn or siren. If the horn or siren fails to sound after establishing a good ground, proceed with the next test.

(2) TEST HORN OR SIREN BUTTON. Remove the cover from the horn or siren switch box and contact a jumper wire across the contacts inside the box. If the horn or siren now sounds, the switch assembly is at fault and must be replaced. If the horn or siren does not sound, replace the horn or siren.

48. CLUTCH AND PROPELLER SHAFT.

a. Clutch Drag. If the gears clash when shifting into first or reverse gears, or if the vehicle has a tendency to roll when the clutch is disengaged, adjust the clutch (par. 134). If adjusting the clutch does not correct the trouble, replace the clutch driven disks or the clutch itself, whichever the inspection of the disks shows is necessary (par. 134).

b. Pedal Pressure Too Stiff. If the pedal pressure is too stiff, lubricate the clutch linkage. If lubricating the clutch linkage does not correct the stiffness of the clutch pedal equipped with a clutch booster spring, adjust the spring (par. 135). If the spring is broken, replace (par. 135). If stiffness still prevails on vehicles with or without the booster, adjust the linkage (par. 135).

c. Clutch Slips. If the clutch slips, adjust the clutch as outlined in paragraph 134. If the clutch continues to slip after being adjusted, inspect the clutch disks and replace if necessary (par. 134). If this does not correct the slippage, replace the clutch (par. 134 **h**).

d. Clutch Grabs. If the clutch grabs or chatters, replace the clutch disk or pressure plate, whichever is required (par. 134).

e. Backlash. If the universal joint trunnion bearings are worn or damaged, replace propeller shaft and/or universal joint (par. 136). Tighten the universal joint flange bolts if they are loose.

f. Propeller Shaft Vibration. If the universal joints are worn or damaged, replace the propeller shaft and/or universal joint (par. 136). Tighten the universal joint flange bolts if they are loose.

49. POWER TRAIN (TRANSMISSION, DIFFERENTIAL, AND FINAL DRIVE).

a. Lubricant Leakage. Tighten the filler cap and drain plugs. Check the flexible hose and cooler tube connections, and tighten if necessary. Replace if they are damaged. Check the final drive cover gasket and tighten the cap screws, or replace the gasket if damaged. Check the brake and transmission inspection covers. Tighten the cap screws, or replace the gaskets if damaged. Check the input and output shaft oil seals or gaskets. Notify higher authority if these oil seals or gaskets are damaged.

b. One Side of Track Will Not Move (Engine Running and Transmission in Gear). Check for broken final drive shaft or drive sprocket shaft. Check the final drive shaft pinion and drive sprocket shaft gears for stripped teeth. Check for broken final drive assembly parts. If any parts are damaged or broken, replace the final drive assembly (par. 144).

c. Hard Shifting (Severe Gear Clash). Hard shifting can be caused by incorrect clutch linkage adjustment (par. 135). Check for clutch drag (par. 48 a). Check the transmission gearshift lever for binds. Clean and lubricate gearshift lever. If the above correction does not correct hard shifting, the transmission has worn or damaged parts. Notify higher authority.

d. Backlash. Backlash is caused by worn or damaged final drive or transmission. Notify higher authority.

e. Poor Steering. Adjust the steering brakes (par. 139 e). Remove the brake cover, and replace the brake shoes if worn (par. 139).

50. HYDRAULIC TRAVERSING SYSTEM.

a. General. Before investigating troubles in vehicles equipped with hydraulic turret traversing mechanism, place the turret traversing shift lever in the down position, and traverse the turret by hand to make sure the turret will rotate smoothly in both directions.

b. Turret Fails to Turn.

(1) ELECTRIC MOTOR FAILS TO RUN. Push the turret circuit breaker reset button. Replace or tighten any loose or broken wires. Test the battery. Recharge or replace the batteries if they are low in charge. Replace motor if burned out (par. 121). A burned out motor can often be detected by smell of burned wires.

(2) PUMP INOPERATIVE BUT MOTOR RUNS. If the motor shaft to pump coupling is broken, replace the coupling. If the coupling is not broken, the pump is at fault and must be replaced (pars. 119 c and d).

(3) PUMP RUNS BUT TURRET DOES NOT OPERATE. Move the

traversing shift lever to the hydraulic traversing position. Release the turret lock. Fill the reservoir to the proper level (par. 119 **b** (3)). If the batteries are low, recharge or replace them. If the high pressure relief valve is sticking or has a broken spring, clean it or replace the spring (par. 119 **b** (4)). If the control handle is not turning the eccentric, tighten the control handle set screw. Remove the inspection plate. Replace shaft if broken. Clean the turret ring gear and race if required. If the control cam pistons are sticking, remove the inspection plate and clean the assembly. If the pistons are still sticking, replace the pump (pars. 119 **c** and **d**).

c. Turret Will Traverse in One Direction Only. Clean the gear box if required. If the back-up slide block piston is stuck, clean or replace the pump. Remove the two plugs, and examine the check valves on the pump. Clean or replace the check valves.

d. Turret Creeps in One Direction. If the turret creeps in one direction with the vehicle level, adjust the control handle position (par. 119 **b** (8)).

e. Turret Moves with Control Handle in Neutral. If the pilot valve plunger is stuck, clean or replace pump. Reset the position of the pump control handle if required. If the control cam pistons are stuck, free them up or replace the pump (pars. 119 **c** and **d**).

f. Turret Turns Excessively on a Slope.

(1) PUMP SUCKING AIR. Fill the reservoir to proper level. Tighten the gear pump suction tube connection if required. If the trouble is still not corrected, replace the pump (pars. 119 **c** and **d**).

(2) HIGH PRESSURE RELIEF VALVE STICKING. If the return line is hot, clean or replace the high pressure relief valve (par. 119 **b** (4)).

g. Unsteady or Sluggish Turret Operation. Fill the reservoir to proper level. Recharge or replace the batteries if required. Traverse the turret manually to check the ring gear and pinion for binds. Clean any foreign matter in the turret ring gear. Reset the clearance between the ring gear and pinion if required. Tighten any loose wire connections. Remove the relief valve caps. If the relief valves are sticking, clean or replace the valves (par. 119 **b** (4)). If the pinion shaft is broken or has a sheared key, replace the unit at fault. Tighten all loose gear pump suction tube connections. If trouble is not corrected, replace the pump (pars. 119 **c** and **d**).

h. Slow Traverse in One Direction. If the back-up slide block piston and spring is stuck or broken, report to higher authority. Clean and free-up the check valves if leaking. Readjust the control handle adjustment if necessary (par. 119 **b** (8)).

i. Oil Leaks From Pump to Motor. Replace worn shaft oil seals or damaged gaskets if necessary. Tighten or replace loose tube connections if necessary.

j. Abnormal Noise in Pump Motor or Adapter. Fill oil reservoir to proper level. If this does not correct the fault, the parts are excessively worn or damaged. Replace the units.

51. TRACKS AND SUSPENSION.

a. Suspension Wheel Tire Wear. Replace any bent, broken, or missing track connectors. Replace dead track links (par. 150 e). Remove any mud or stones from between the end connectors. Replace the suspension wheel arm if the gudgeon bushing is excessively worn.

b. Suspension Spring Breakage. Replace worn gudgeons if necessary. If the upper or lower edge of any one coil in either spring is even with the same edge of another coil, the suspension springs are weak. Replace the suspension spring. When replacing suspension springs in any suspension, replace both springs regardless of the condition of the other spring. Replace broken or cracked spring seats.

c. Thrown Tracks. Adjust track tension if necessary (par. 150 b). Tighten the idler wheel bracket bolts if necessary. Clean out rocks which might have wedged between the idler and track. If the idler shaft is loose on the bracket, lock the idler adjustment.

d. Inoperative Track Support Rollers. Clean any mud from between the support roller and track. Raise the track off the support roller, and rotate the roller. If the roller does not turn, remove and inspect for damaged or worn bearings (par. 154). Lubricate the rollers if necessary.

e. Inoperative Idler Wheel. Disconnect the track at the idler wheel (par. 150 g), and rotate the idler wheel. If the idler wheel does not turn freely, remove wheel and inspect for damaged or worn bearings (par. 152 b).

52. RADIO INTERFERENCE SUPPRESSION SYSTEM.

a. Preliminary Instructions. When radio interference resulting from the operation of this vehicle is reported or experienced, the vehicle should be moved to a place which is comparatively free from high-tension lines or other vehicles or machinery which could be a source of interference. Turn on the radio and check the noise level with the engine and all vehicle equipment turned off. Notice the type of noise evident under this condition so that, when checking vehicle equipment, the presence of new noise or interference can be detected and also so that noise already present in the receiver will not be attributed to lack of vehicle suppression. If noise level without any of the vehicle equipment in operation is too high due to atmospherics

or other outside causes, and if tactical situation will permit, delay further checking until such time as a moderate noise level prevails. NOTE: *If the vehicle to be checked for insufficient radio interference suppression is not radio-equipped, another vehicle which is radio-equipped, kept within 5 feet of the vehicle to be tested, may be used.* Disconnect the sponson and turret radio terminal box capacitors (terminal end) (par. 131 **a**). If radio interference does not increase when these capacitors are disconnected, replace them. If interference does increase as it should, leave the terminal box capacitors disconnected for the remainder of the tests until the defective equipment has been located, replaced, and tested. Examine all shielded conduits and cables to make sure couplings are tight and conduits and cables are clamped or bonded to hull at least every 2 feet.

b. Radio Interference When Vehicle is Not in Motion, But Engine is Running. With engine running at 1,500 revolutions per minute, shut off magnetos one at a time. If interference is eliminated with either one of the magnetos off, interference may be attributed to the ignition system of that half of the engine. Tighten all magneto conduit coupling connections and see that magneto ground wire is tightly secured at magneto ground terminal. Adjust breaker points (par. 88 **c** (3)) or replace magneto (par. 88 **b**), whichever is necessary to eliminate interference. If turning off only one of the magnetos does not eliminate interference, turn both magnetos off at the same time with the engine running at 1,500 revolutions per minute. If interference ceases immediately, the ignition system is at fault. Further checking by Signal Corps personnel will be required to correct the interference if tightening of shielding couplings and magneto ground wire connection does not correct the trouble. If interference in the form of an irregular clicking noise which continues a few seconds after the magnetos are turned off, it may be attributed to the generator regulator. Inspect the generator regulator bond straps to make sure a good electrical ground is being made. Replace generator regulator filter and capacitor (par. 129 **a** and **b**). If interference is in the form of a whining noise that varies in pitch with engine speed and continues but at a lowering pitch a few seconds after the magnetos are turned off, it may be attributed to the generating system. Check the generator ground cable by using a jumper wire with sharp prods attached to each end to make connection between the generator frame and the generator mounting bracket. If a good ground corrects the interference, clean and tighten connections at each end of the ground cable. If the interference does not cease when a good generator to bracket ground is established, replace generator regulator capacitor and filter (par. 129 **a** and **b**). If the interference still persists, the generator positive brush capacitors are at fault, or the brushes and commutator are in need of maintenance and/or adjustment. Replace generator (pars. 99 **c** and **d**).

c. Radio Interference With Auxiliary Generator Operating. Examine auxiliary generator bond strap for good electrical connection between auxiliary generator assembly and sponson. If interference is in the form of a regular clicking noise occurring at the same frequency as the exhaust reports and stopping when the auxiliary generator stop button is pressed, the auxiliary generator spark plug suppressor is at fault and must be replaced (par. 173 **e**). If the interference is in the form of a whining noise which continues for a few seconds after the stop button is pressed but at a lowering pitch, replace the generator control box capacitor (par. 129 **c**). If whining noise still persists, replace the auxiliary generator (par. 173 **n** and **o**), or notify higher authority that the generator brushes are causing interference so that maintenance to the brushes and commutator or replacement of the positive brush capacitors may be performed. If interference in the form of an irregular clicking noise which continues but slows down for a few seconds after the auxiliary generator stop button has been pressed, replace the auxiliary generator regulator filter and capacitor (par. 129 **a** and **b**).

d. Radio Interference When Turret is Power Traversed. Check turret ground strap to make sure it is securely mounted and making good electrical contact both at the slip ring connection and at the mounting legs. See that toothed lock washers are used under the heads of the mounting screws securing the section of the fighting compartment floor plate involved to the hull crossmember. Tighten couplings at all junction points of shielded conduit and see that conduits are bonded to hull at least every 2 feet. Replace turret switch box capacitor (par. 132 **a**). If interference still persists, traversing motor is at fault. Notify higher authority or replace traversing motor.

e. Radio Interference When Windshield Wiper Motor is Operating. If noise is present when windshield wiper motor is operated, but stops as soon as motor is turned off, replace the motor capacitor and if necessary to completely eliminate the interference, replace the capacitor at the utility outlet of the instrument panel (par. 130 **a**). If noise still persists, replace the windshield wiper motor (par. 130 **b**).

f. Radio Interference When Crew Compartment Blower is Operating. If noise is present when crew compartment blower is operating, but stops as soon as blower is turned off, inspect the shielding on blower leads and tighten couplings of shielded conduits to blower. If interference persists, replace the blower and motor assembly (par. 175), or notify higher authority so positive brush of motor may be inspected for presence of capacitor to eliminate interference.

g. Excessive Noise Present in Radio When Vehicle is in Motion. If noise caused by motion of vehicle is believed to be excessive, examine all bond straps and toothed lock washer fastenings between vehicle components to make sure they are secure and making good electrical connection. If noise persists, notify higher authority so that tracks may be inspected for excessive electrical resistance between track components.

Section XVII

ENGINE DESCRIPTION AND MAINTENANCE IN VEHICLE

53. DESCRIPTION AND DATA.

a. Description (figs. 27 through 30). This vehicle is powered with a 60-degree, V-type, 8-cylinder, 4-cycle, valve-in-head, liquid-cooled engine. The cylinder block and crankcase are cast integral of aluminum with steel dry-type sleeves in cylinder bores. The water jackets extend the full length of the cylinders. Four overhead camshafts are used, one exhaust and one intake for each bank of cylinders. There are two exhaust and two intake valves for each cylinder. Two 4-cylinder magnetos are used. These are located at the rear of the engine, one mounted at each end of a cross shaft driven by gears. The water pump (fig. 29) is driven from the end of the crankshaft. Two fan drive housings, located on the side walls of the engine compartment, are each driven through fan drive propeller-shaft and universal joints by the accessory drive gears in the engine. Two pusher-type fans are driven through double V-type belts by the fan drives (par. 84).

b. Location and Mountings. The engine is mounted at the rear of the vehicle and is supported by four brackets. The two front brackets are mounted on the engine compartment bulkhead. The two rear brackets are mounted on the engine compartment floor. Rubber mounts are used between the brackets and the engine.

c. Definition of Terms. The flywheel end of the engine will be referred to as the "front" of the engine as the engine is mounted in the vehicle with the flywheel forward. The terms "right" and "left" are used with reference to the engine as viewed from the rear looking toward the front of the vehicle.

d. Tabulated Data.

GENERAL:	
Make and type	Ford V-type, 8-cylinder, liquid-cooled
Model	GAA
Dimensions, over-all (including clutch)	59.02 in. long 33.25 in. wide 47.78 in. high
Weight without accessories	1,470 lb
Weight with accessories	2,350 lb
Net horsepower at 2,600 revolutions per minute	450
Net torque at 2,100 revolutions per minute	950 ft-lb
Number of cylinders	8
Bore	5.4 in.
Stroke	6 in.
Piston displacement	1,100 cu in.
Compression ratio	7.5 to 1
DIRECTIONS OF ROTATION (VIEWED FROM REAR OF ENGINE):	
Crankshaft	Clockwise
Starter	Counterclockwise
Magnetos:	
Right-hand rotor	Clockwise
Left-hand rotor	Counterclockwise
ACCESSORY SPEEDS:	
Fan	1.4 crankshaft speed
Magneto rotors	½ crankshaft speed
MAGNETOS:	
Make	Bosch
Model:	
Right-hand	MJF4A-308
Left-hand	MJF4A-307
Breaker point gap	0.014 to 0.016 in.
SPARK PLUG GAP:	
New	0.011 to 0.014 in.
Service maximum limit	0.030 in.
Valve clearance (nonadjustable)	0.025 to 0.030 in.
CARBURETOR (2 USED):	
Make	Bendix-Stromberg
Model	NA-Y5G
NUMBERING OF CYLINDERS FROM REAR TO FRONT:	
Right bank	1-2-3-4
Left bank	1-2-3-4
Firing Order	1-R, 2-L, 3-R, 1-L, 4-R, 3-L, 2-R, 4-L

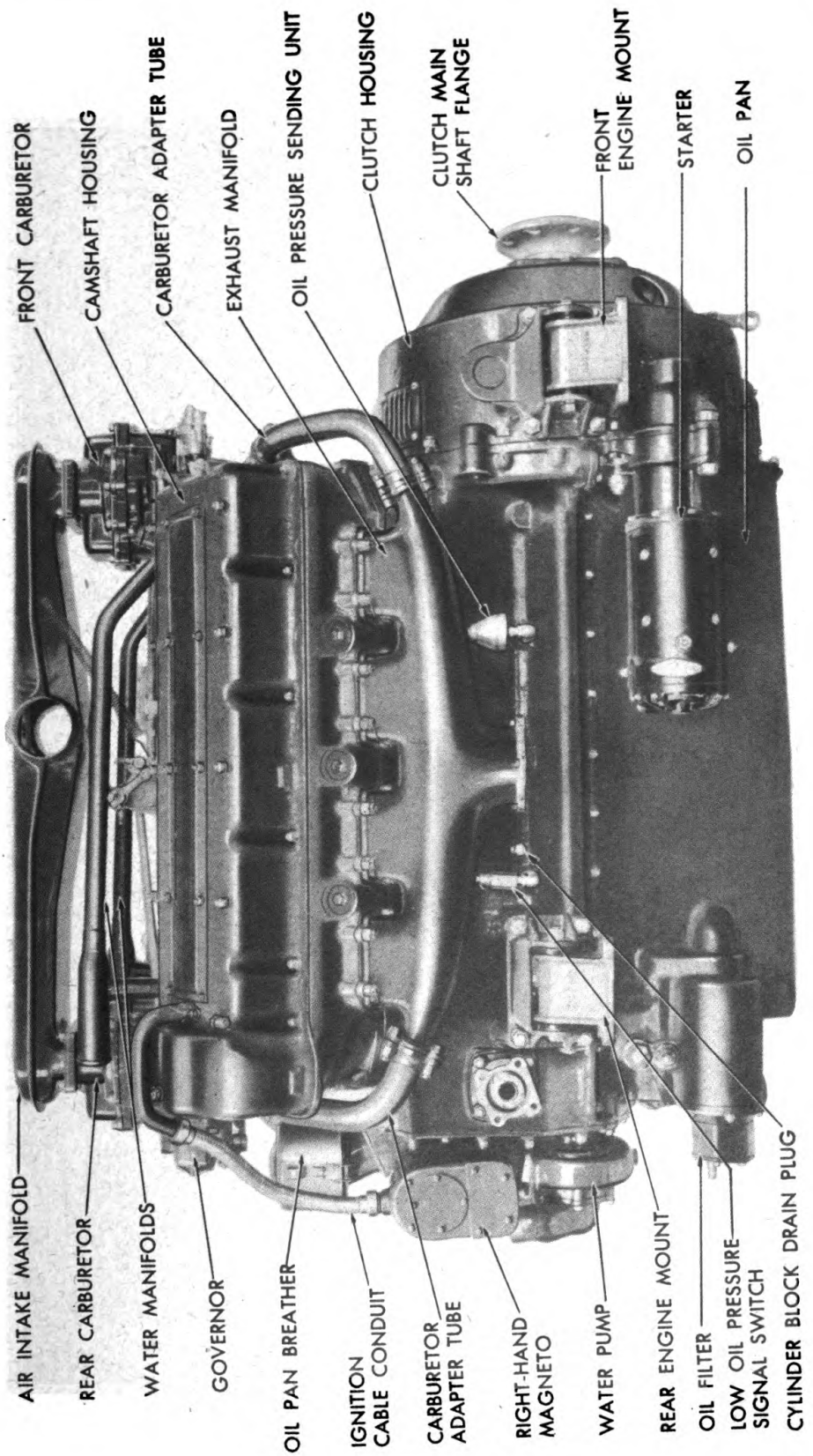


Figure 27 — Engine — Right Side

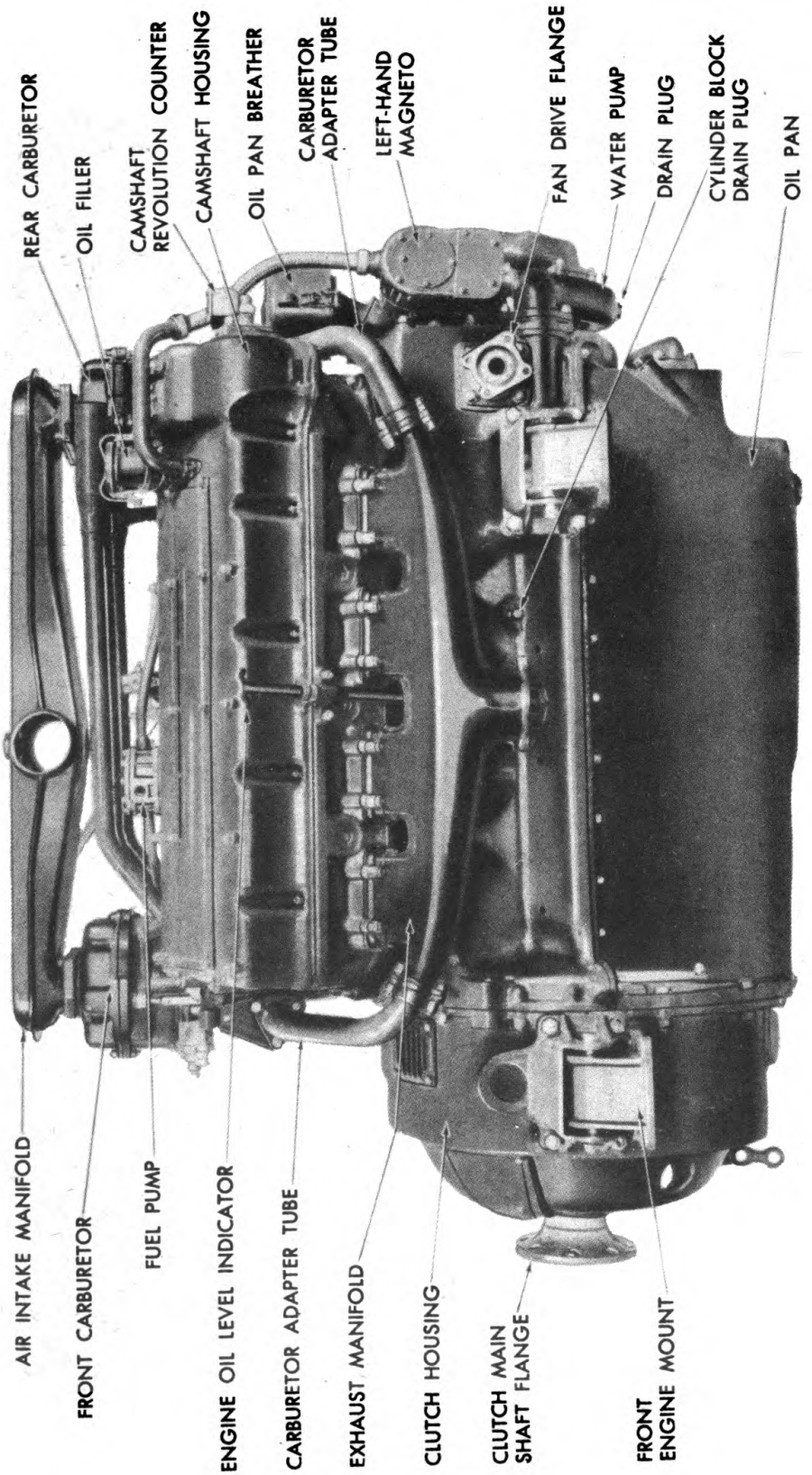


Figure 28 — Engine — Left Side

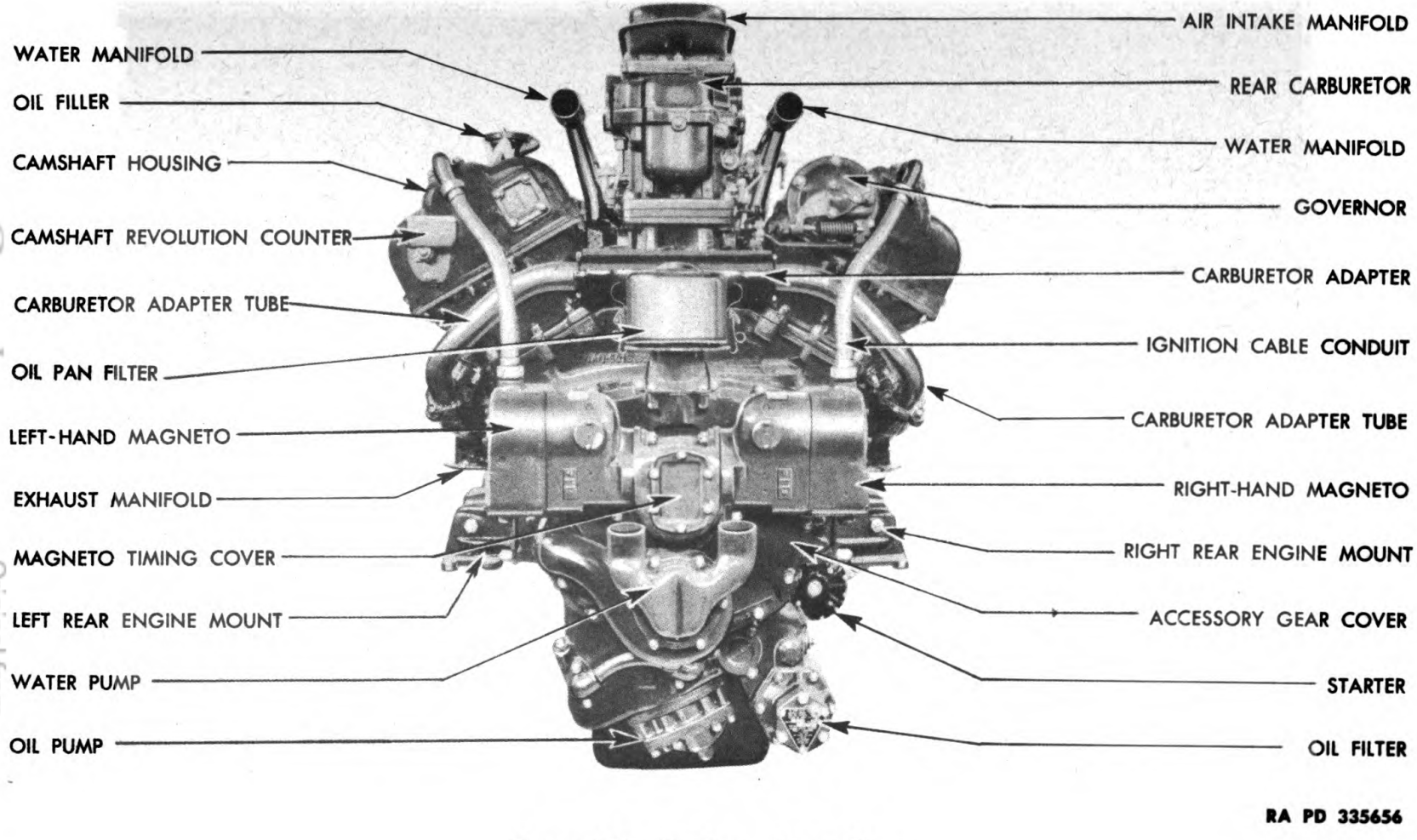


Figure 29 — Engine — Rear View

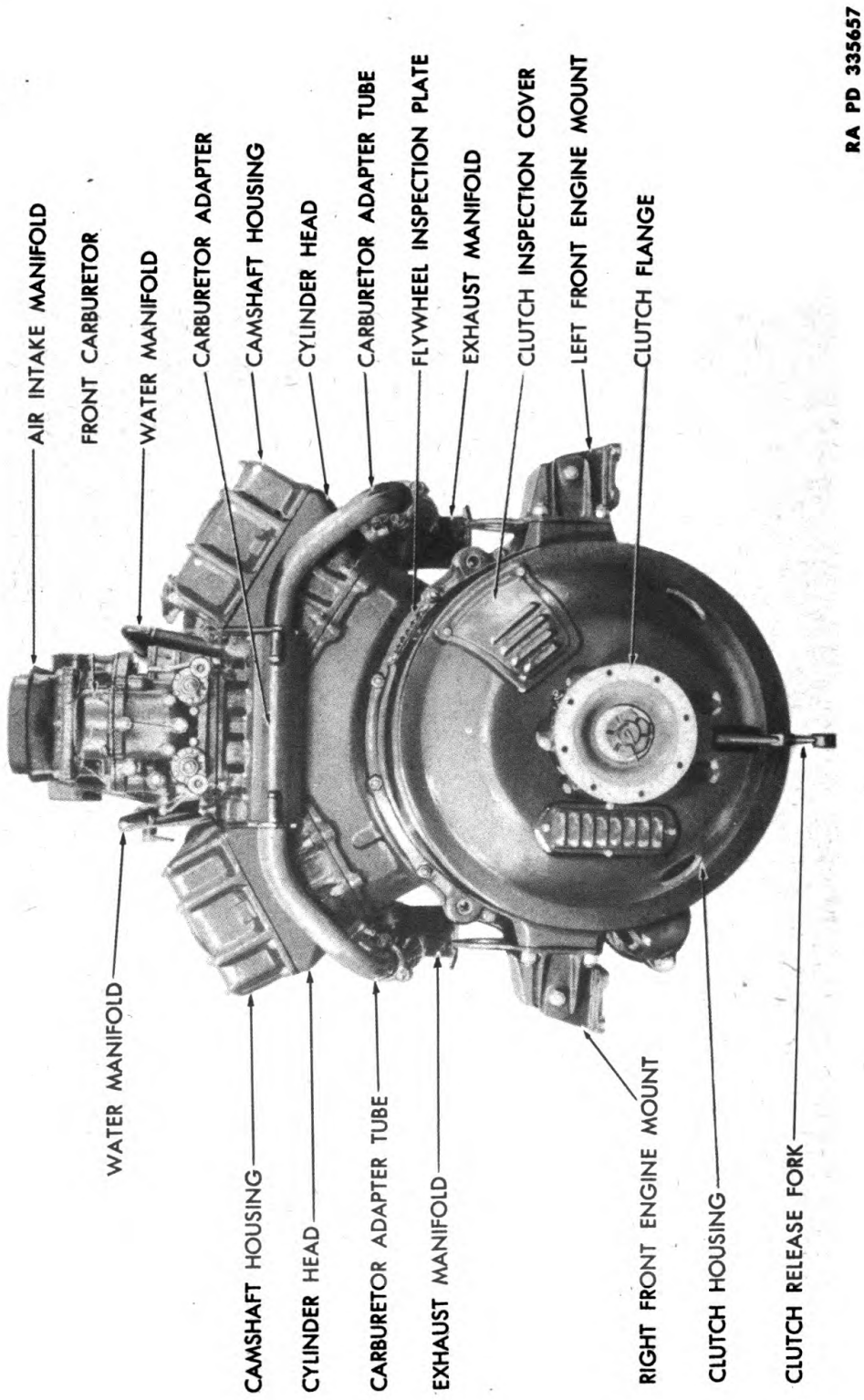


Figure 30 — Engine — Front View

54. INTAKE AND EXHAUST MANIFOLDS.

a. Intake (fig. 27). The intake manifolds are cast integral with the cylinder heads and are open at each end. Carburetor adapters are installed between the carburetors and the intake manifolds. These adapters are likewise connected to the exhaust manifolds which permit the exhaust gases to heat the fuel air mixture as it comes from the carburetors. These adapters each contain two butterfly valves operated by the engine speed governor.

b. Exhaust.

(1) DESCRIPTION (fig. 27). Two exhaust manifolds are used, one attached to each cylinder head. The end of each manifold is attached to the carburetor adapter housing by means of a connecting pipe.

(2) REMOVAL. Open the engine compartment door. Remove the locking wire and the three bolts from carburetor adapter tube upper flanges using special offset box wrench (41-W-639-850). Remove the locking wire and the three nuts from the lower flange of both carburetor adapter tubes, and remove the tubes. Remove the six bolts at the center flange to the exhaust pipe. Remove the locking wire and 16 brass nuts securing the manifold to the cylinder head, and remove the manifold. The above procedure applies to either the right or left manifold.

(3) INSTALLATION. Place new gaskets and the manifold in position, and tighten the 16 manifold to the cylinder head brass nuts evenly and securely with locking wire. Using new gasket, install the six bolts at the center flange of the exhaust pipe with safety nuts. Install new gaskets at both ends of the adapter tubes using special offset box wrench (41-W-639-850). Fasten the ends to the manifold with three nuts. Fasten each of the adapter tubes to the carburetor adapter housings with three bolts. Secure the nuts and bolts with locking wire. Close and fasten the engine compartment doors.

55. ENGINE MOUNTS.

a. Description (figs. 28, 29, 30 and 31). The four engine mounts, used to support the engine, provide flexible rubber insulation between the engine and its mounting brackets.

b. Front Engine Mount Removal (Right or Left Side). Remove the engine compartment floor plate (par. 164). Place a jack under the front of the engine oil pan using a wood block between the oil pan and jack. Raise the jack to take the weight off the engine front mounts. Use double offset box wrench (41-W-601) to remove the four bolts which hold the mount to the support bracket. Two of these bolts are accessible through the inspection opening in the bulkhead, and two through the engine floor plate opening. Remove the

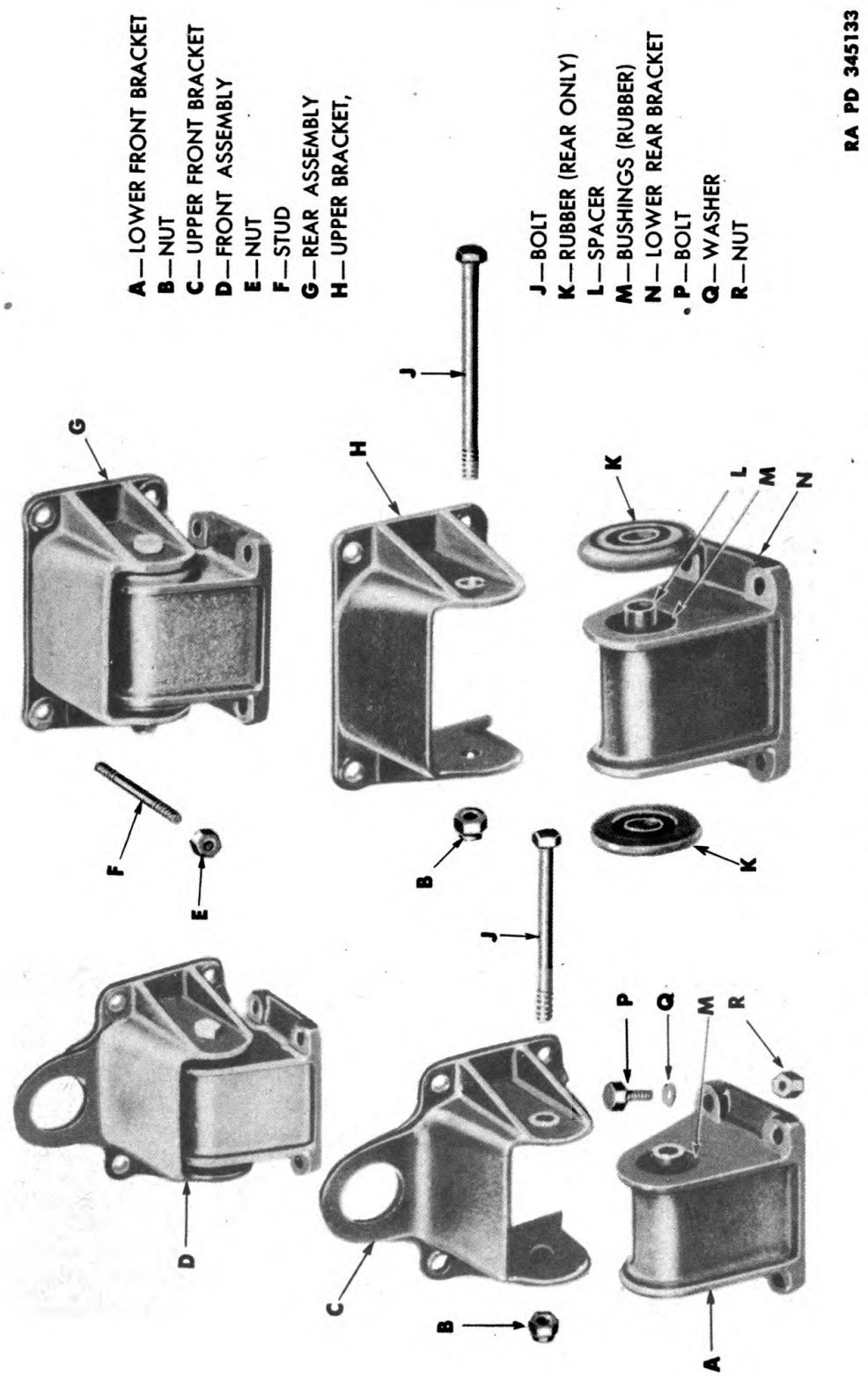


Figure 31 — Engine Mounts Assembled and Disassembled

long bolt which holds the halves of the mount together (J, fig. 31). Remove the four nuts which hold the upper bracket portion of the mount to the clutch housing. The two rear nuts are accessible through the engine floor plate opening and the two front nuts through the inspection opening in the bulkhead.

c. Install Engine Front Mount. Position the upper bracket portion of the mount on the clutch housing and secure it with four nuts. Fasten the mount to the support bracket with four bolts using double offset box wrench (41-W-601). Install long bolt which holds halves of mount together. Remove the jack and install the engine compartment floor plate (par. 164).

d. Remove Engine Rear Mounts (Right or Left Side). Follow the steps in subparagraph **b** above, except place the jack under the rear of the engine oil pan. Remove the four bolts which hold the mount to the support bracket. Remove the four nuts which hold the mount to the engine and remove the mount.

e. Install Engine Mounts (Rear). Secure the mount to the engine with four nuts and to the support bracket with four bolts. Remove the jack and install the floor plate (par. 164).

56. CYLINDER HEAD GASKETS.

a. Removal.

(1) PRELIMINARY STEPS (par. 164). Remove the engine compartment floor plate. Open the engine compartment rear door. Place a large pan under the engine compartment floor plate opening. Remove the lock wire and drain plug from the bottom of the water pump and allow the water to drain. Remove the cap screws that hold the engine compartment doors closed, and open the doors. Remove the cap screws that hold the engine compartment front cover plate to the hull, and remove the plate.

(2) REMOVE AIR CLEANERS. Refer to paragraph 74 **c**.

(3) REMOVE WATER MANIFOLDS. Loosen the hose clamps on the hose that connect the water manifold and radiator, and remove the hose. Loosen the clamps on the hose that connect the water manifold and the expansion tank, and remove the hose. Remove the four nuts and flat washers that hold each water manifold to the cylinder head, and remove the manifolds.

(4) REMOVE JUNCTION BOX. To remove the junction box, unscrew the collar on each of the plug connectors and pull the two plugs out of the junction box. Remove the two screws that hold the conduit bracket to the upper part of the junction box. Remove the four nuts that hold the junction box to the camshaft housing and lay the box to one side where it will not interfere when removing the camshaft housing or cylinder head.

(5) REMOVE FUEL PUMP AND DISCONNECT FUEL LINES. Close all of the fuel shut-off valves. Disconnect the three fuel lines at the fuel pump. Remove the two nuts and flat washers that secure the pump to the camshaft housing. Slide the fuel pump off the studs. Disconnect the primer tubes at the connection.

(6) REMOVE THROTTLE AND GOVERNOR CONTROLS. Disconnect the throttle control rod at each carburetor (fig. 59). Disconnect the rear accelerator rod at the lever mounted on the engine compartment bulkhead. Remove the two nuts and flat washers that hold the throttle rod bracket assembly to the cylinder head and remove the assembly. Disconnect the governor control rod at each carburetor adapter and remove the rod.

(7) REMOVE EXPANSION TANK. Disconnect the two overflow tubes at the expansion tank. Remove the four cap screws that secure the expansion tank to the bulkhead and remove the tank.

(8) REMOVE CARBURETORS. Disconnect the fuel cut-off solenoid (degasser) electrical connections at each carburetor. Remove the four nuts that secure each carburetor to the adapter housings. Lift the air intake manifold and carburetors from the engine.

(9) REMOVE GOVERNOR (fig. 53). Remove the cotter pin from the ball joint connection on the governor arm, unscrew the ball seat plug from the ball connection on the governor arm, and disconnect the connecting link. Remove the six nuts which hold the governor to the camshaft housing and remove the governor.

(10) REMOVE REVOLUTION COUNTER. Remove three safety nuts securing camshaft revolution counter on left camshaft housing and remove revolution counter.

(11) REMOVE SPARK PLUGS, WIRES, AND CONDUIT ASSEMBLY. Remove the 10 nuts from each cover over the spark plugs and remove the covers. With special wrench (41-W-3336-300), unscrew the spark plug terminal nuts from the spark plugs. Remove the four nuts holding each conduit to the camshaft housing and lift the wire and conduit from the housing. Remove the spark plugs with special wrench (41-W-3336-300) (fig. 69).

(12) REMOVE CAMSHAFT HOUSINGS. Remove all nuts from the top and lower edge of each camshaft housing and remove the housings from the cylinder heads. CAUTION: *Lift the housings evenly so that the long studs will not be bent.*

(13) CHECK PUSH ROD CLEARANCE. Before removing the camshafts, check the push rod clearance. The proper clearance is 0.025 to 0.030 inch taken between the top of the push rod and the heel of the cam. Use a feeler gage for checking the clearance. Make a record of the clearances. If any are found that are not within the recommended limits, notify higher authority.

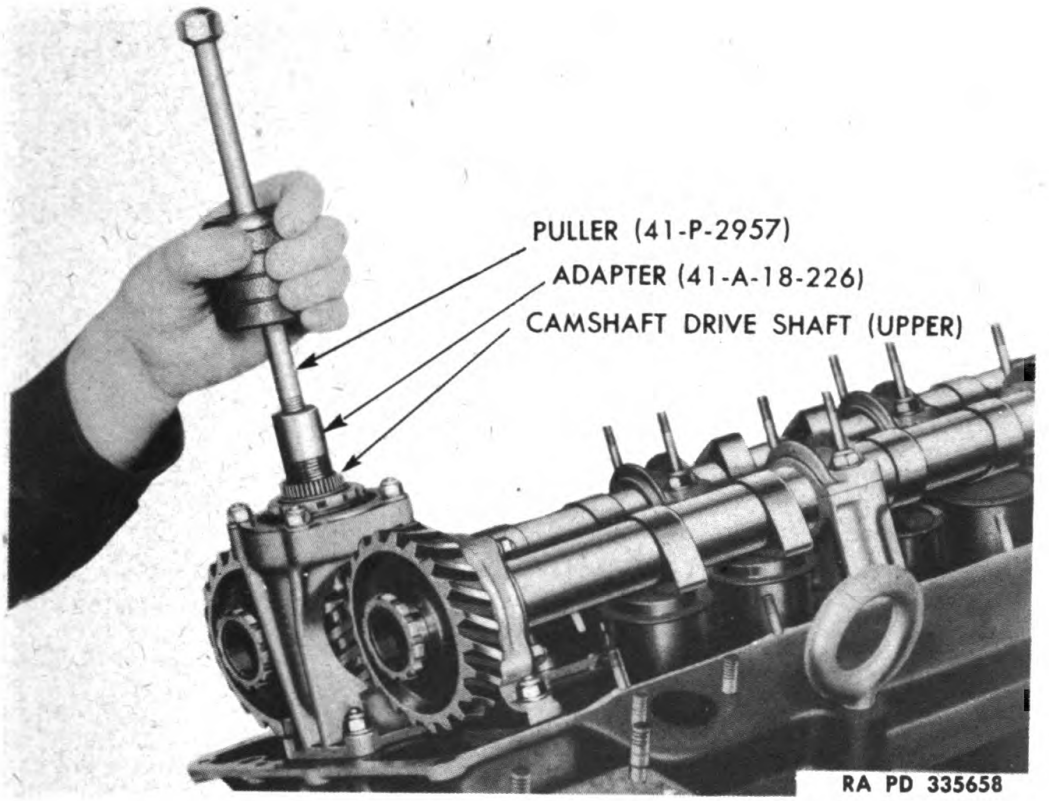


Figure 32 — Pulling Camshaft Upper Drive Shaft

(14) REMOVE CAMSHAFTS. Remove the two nuts from each bearing cap and remove the caps from the camshaft bearings. Remove the four nuts holding the camshaft support to the cylinder head. NOTE: *Nuts from the bearing caps and the supports must be loosened evenly to prevent undue strain on the camshafts due to the valve spring pressure.* Remove the snap ring at the top of the camshaft drive worm gear on each block and lift the upper drive shaft from the gear using the puller (41-P-2957), with adapter (41-A-18-226) as shown in figure 32. Lift the camshaft from the cylinder heads. The intake and exhaust camshafts and the rear support are to be removed as an assembly. Lift the camshaft bearings from the studs.

(15) SECURE PUSH RODS. Secure the push rods in the guides with tape or wire so as not to disturb them when removing the cylinder heads. They must be kept with the push rod guide to which they were originally fitted.

(16) REMOVE CARBURETOR ADAPTER TUBES AND ADAPTER HOUSINGS. Remove the lock wire and three cap screws from the upper flange, and the lock wire and the three nuts from the lower flange of each tube. Remove the four adapter tubes which connect the exhaust

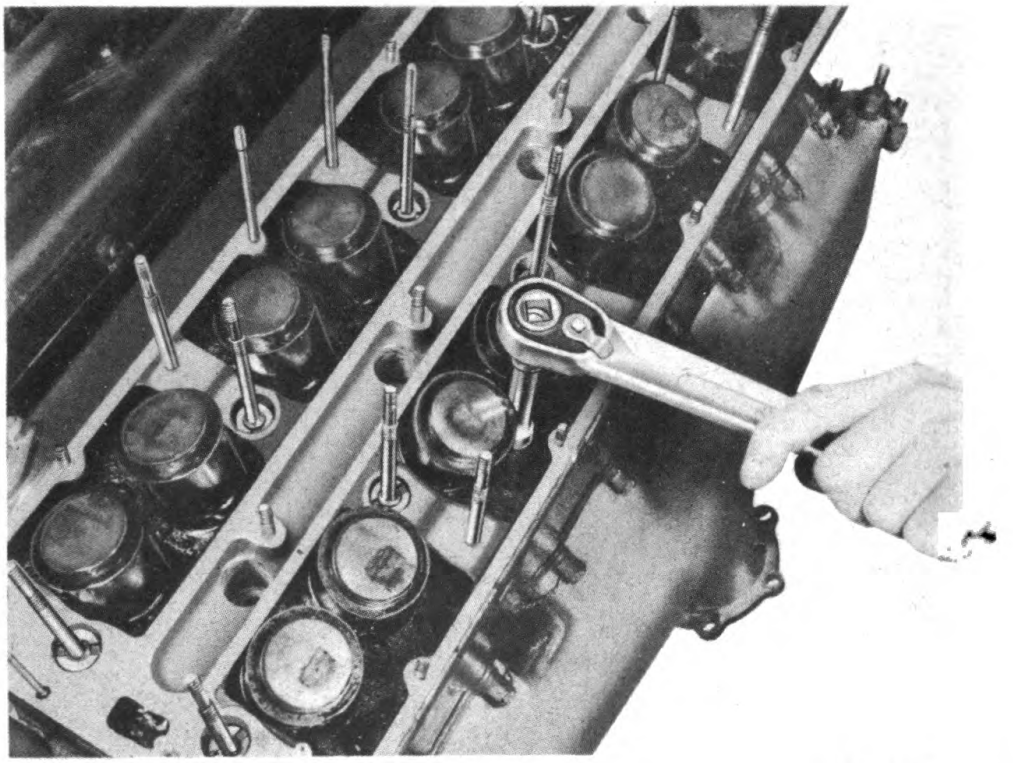


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Figure 33 — Removing Short Cylinder Head Stud Nuts Using Wrench (41-W-866-250)

manifold to the carburetor adapter. Remove the six nuts securing each of the adapters to the cylinder heads and remove the adapter housings. A special offset wrench (41-W-639-850) is provided for removing the nuts which are located behind the heater tube flanges on each side (fig. 52).

(17) REMOVE DIP STICK ASSEMBLY. Remove two self-locking nuts from clamp and studs at top of dip stick tube. Remove two self-locking nuts from studs at bottom of dip stick tube and remove dip stick, tube, and gasket.

(18) REMOVE CYLINDER HEADS. Remove the 18 nuts securing each cylinder head to the cylinder block. Use special wrench (41-W-866-200) for removing the long cylinder head nuts (fig. 35). The long nuts are the eight nuts on each head which have the camshaft bearing studs screwed into them. Use special wrench (41-W-866-250) for the balance of the cylinder head nuts (short nuts) (fig. 33). Lift the heads from the cylinder block and remove the head gaskets.

(19) REMOVE CARBON. Remove the carbon from the heads and each cylinder block.

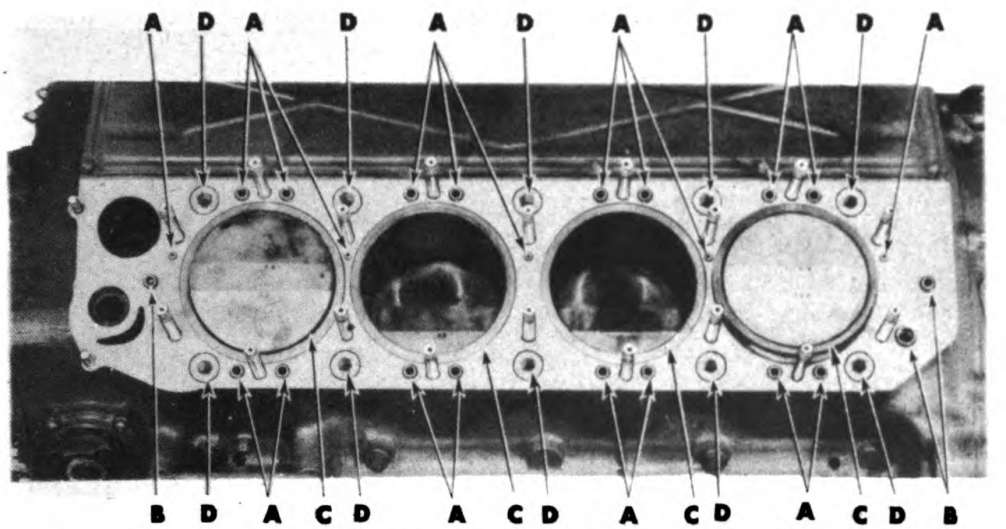


Figure 34 — Top of Cylinder Block

b. Installation.

(1) INSTALL CYLINDER HEAD GASKETS. Place a new metal gasket on the top of each cylinder sleeve; then install the cylinder head gasket in place on the cylinder block (fig. 34).

(2) INSTALL CYLINDER HEADS. With a man at each end of the head, place the head over the studs and lower it evenly on the cylinder block. Care must be used when putting the head over the studs so as not to mar or damage the bottom face of the head.

(3) TIGHTEN CYLINDER HEADS. Place a washer and nut on each cylinder head stud. Eight long nuts are used on the two center rows of studs, and 10 short nuts are used on the outer rows of studs. The center row of nuts, over which the camshaft bearings set, are longer than the balance of the nuts in order to accommodate the studs for the camshaft bearings. Use cylinder head nut wrench (41-W-866-200) to tighten the long nuts (fig. 35) and wrench (41-W-866-250) for tightening the short nuts (fig. 33). These wrenches are to be used in connection with a torque wrench. Tighten each nut to 60 foot-pounds tension, starting with a centrally located nut and working alternately each way (fig. 35). Connect primer tubes to the connection.

(4) RELEASE PUSH RODS. Remove the holding tape or wire from the push rods.

(5) INSTALL CAMSHAFT BEARINGS. The camshaft bearings and bearing caps are numbered from 1 to 8 for each cylinder head. A

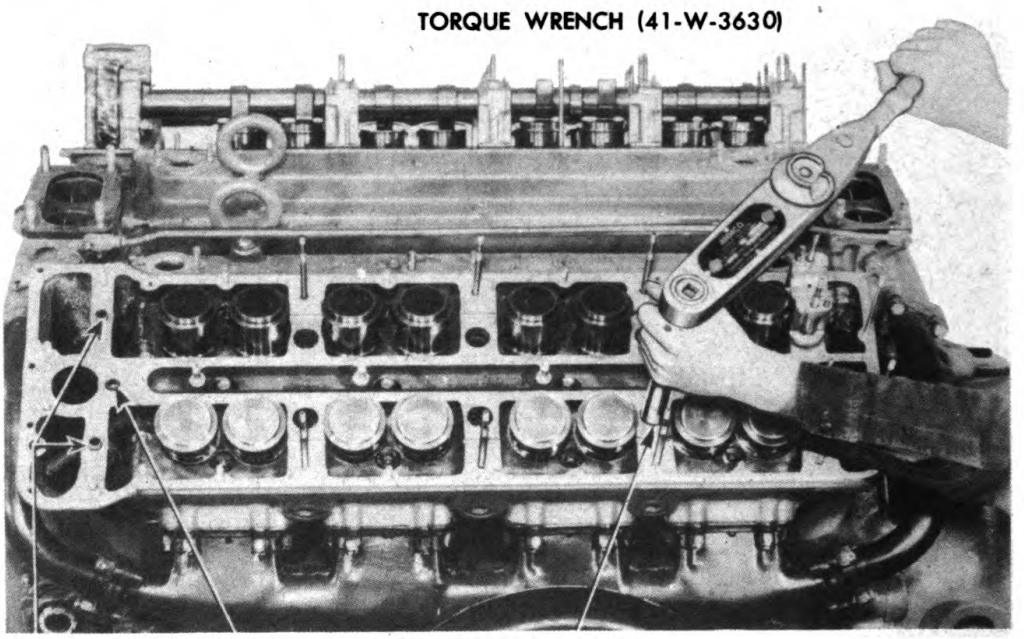


Figure 35 — Tightening Cylinder Head Long Stud Nuts

corresponding number is stamped on the cylinder head at each bearing location. Place the eight bearings in position on the cylinder head to correspond with the number stamped on the cylinder head. Make certain that the bearings set firmly on the cylinder head.

(6) INSTALL CAMSHAFTS AND GEAR ASSEMBLIES (fig. 36). NOTE: *The camshaft and gear assemblies consist of the intake and exhaust camshafts, the camshaft gears, and the rear support.* The assemblies are right and left hand and can be identified by the markings etched on the camshafts. Place each assembly in the camshaft bearings. Place the rear support over the studs. Put each camshaft bearing cap on the bearing carrying a corresponding number, making sure the number on the cap is on the same side as the number on the bearing. Put a flat washer and a self-locking nut (boot nut) on each stud and tighten all nuts evenly so as not to spring the camshafts as a result of the valve spring pressure. Use a torque wrench and tighten the nuts to 16 foot-pounds.

(7) TIME CAMSHAFTS.

(a) Time Right-hand Camshafts. Remove the flywheel inspection plate on the top left side of the flywheel housing. Remove the circular plate from the right-hand magneto. Turn the engine in direction of rotation until the arrow in the window of the distributor plate of the right-hand magneto (fig. 66) is pointing to the terminal

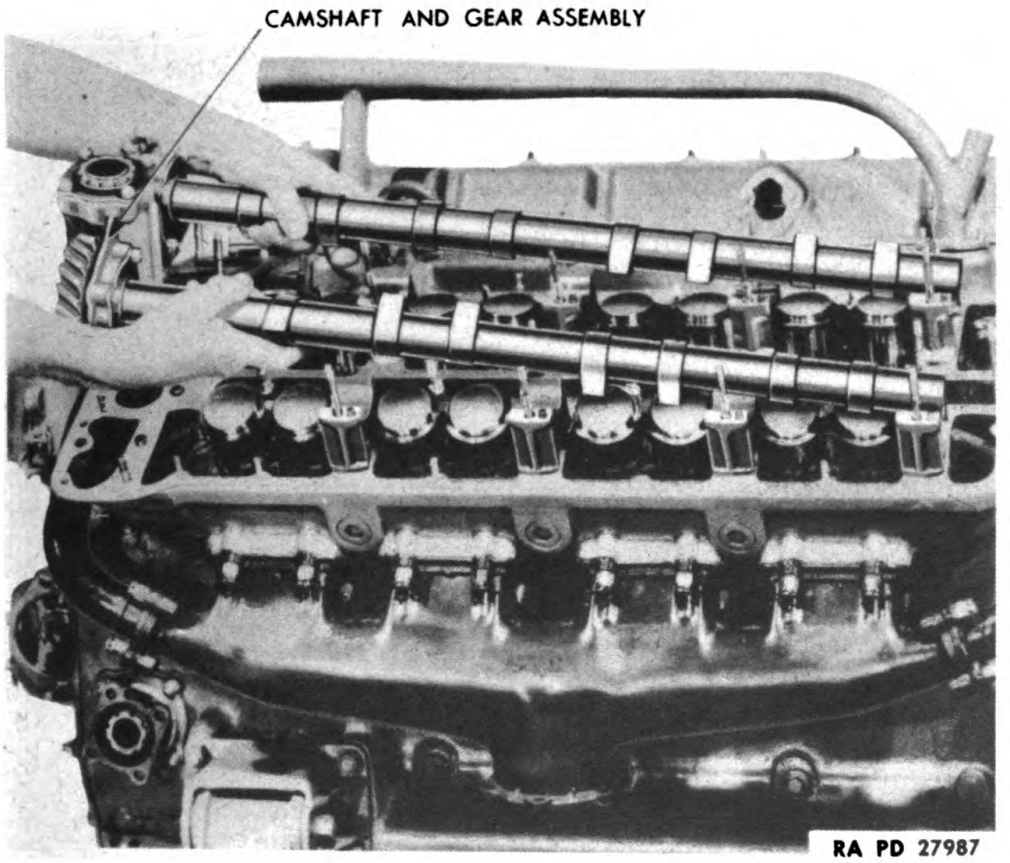


Figure 36 — Installing Camshaft and Gear Assemblies

to which the No. 1 spark plug wire (red wire) is attached; then continue to turn one complete engine revolution until the flywheel mark "INTAKE OPEN R.H." is at the pointer on the flywheel housing (fig. 40). Insert the camshaft turning wrench (41-W-2964-300) in the top of the worm gear (fig. 37) and turn the camshafts in direction of rotation until No. 1 intake valve is just starting to open. The direction of rotation of the right- and left-hand intake camshafts is the same as the direction of rotation of the crankshaft. The valve opening point can be determined by placing the thumb and forefinger on No. 1 intake valve push rod. Turn the camshaft slowly (fig. 37), and at the same time, rotate No. 1 push rod. The moment the push rod begins to turn hard indicates the valve has just started to open. With the flywheel still setting at the mark "INTAKE OPEN R.H.," insert the upper camshaft drive shaft (fig. 39). When inserting the upper camshaft drive shaft, it may be necessary to try it in several positions until the splines on each end of the shaft line up, at which time it will drop in place freely.

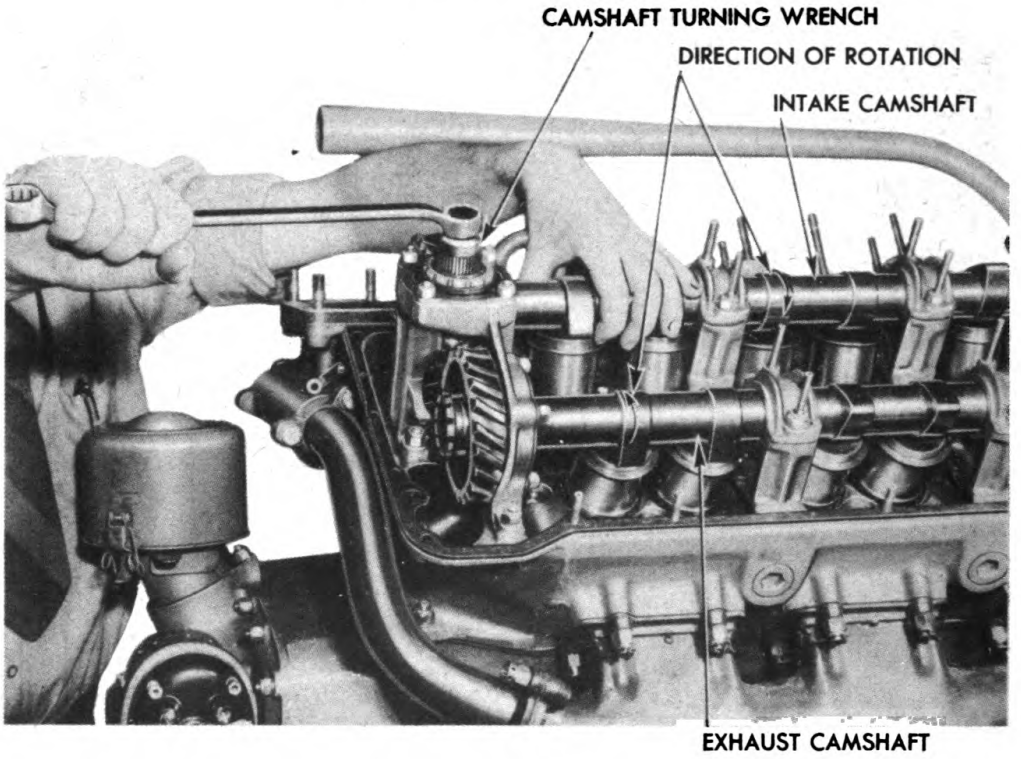


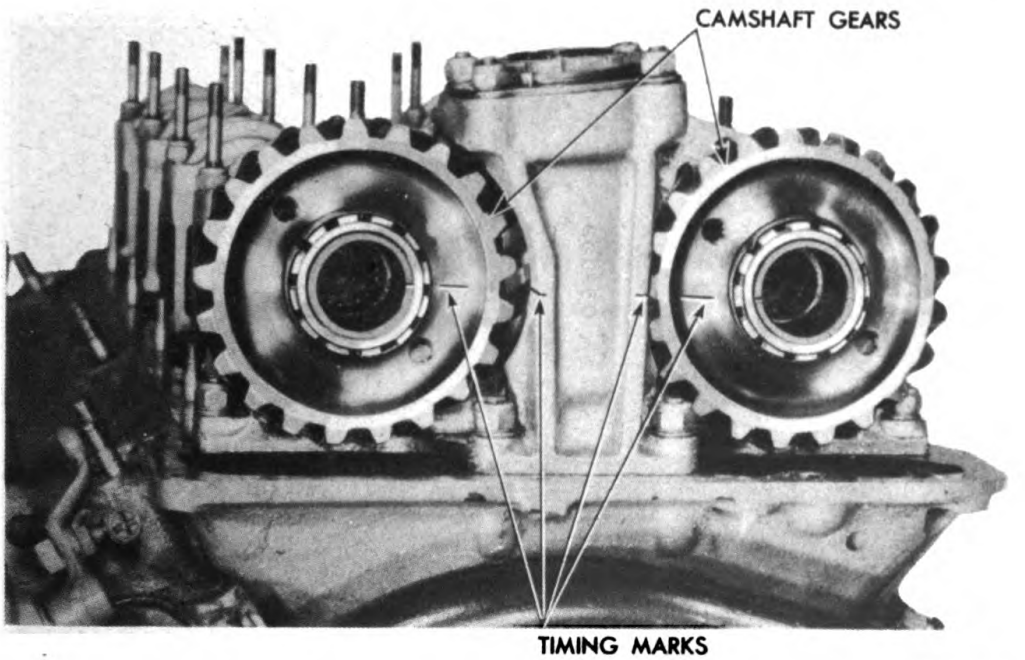
Figure 37 — Setting Camshaft Timing With Camshaft Turning Wrench (41-W-2964-300)

(b) Recheck Timing. Turn the flywheel backward approximately 30 degrees, then turn it in the direction of rotation until the timing mark "INTAKE OPEN R.H." (fig. 40) again appears at the pointer. No. 1 intake valve should have just started to open. If not, repeat the procedure outlined in step (1) above more carefully.

(c) Time Left-hand Camshafts. Turn the flywheel 300 degrees (five-sixths of a turn) in the direction or rotation until the mark "INTAKE OPEN L.H." on the flywheel appears at the pointer. From this point, the procedure for timing the left-hand camshafts is the same as described for the right-hand camshafts. The opening of the No. 1 intake valve is used when establishing the timing of the camshafts on the left side also.

(d) Install Snap Ring. Install a snap ring in the top of each camshaft worm gear to hold the upper camshaft drive shaft in place.

(8) INSTALL DIP STICK ASSEMBLY. Install gasket over studs at dip stick opening in cylinder block. Position dip stick tube on studs, and install two self-locking nuts on studs and tighten. Install clamp and two self-locking nuts over studs to secure top of tube to cylinder block and tighten.



RA PD 27725

Figure 38 — Camshaft Gear Index Marks

(9) INSTALL CARBURETOR ADAPTER HOUSINGS. Install the carburetor adapter housings on each end of the cylinder heads using new gaskets. The rear housing differs from the front in that it has two holes in the throttle plate lever. Secure each housing to the cylinder heads with six safety nuts and flat washers. Use box offset wrench (41-W-639-850) for tightening the nuts located behind the heater flanges (fig. 52).

(10) CARBURETOR ADAPTER TUBE INSTALLATION. NOTE: *Four adapter tubes are used, and are connected between the carburetor adapter housings and the exhaust manifolds.* The four pipes vary in length and shape; therefore, they must be tried in place when selected for installation. Use a new gasket and attach the lower end of one carburetor or adapter tube exhaust manifold using three brass nuts, and flat washers. Lock the nuts with wire. Use a new gasket and attach the upper end to the carburetor adapter housing with cap screws and lock the cap screws with wire. Repeat the above procedure for the other three carburetor adapter tubes.

(11) INSTALL CAMSHAFT HOUSINGS. Use new inner and outer gaskets on the top of both cylinder heads. Place the housing over the studs and secure it with ¼-inch safety nuts. Use copper washers under all nuts on the top of the housings, and steel flat washers under the remainder of the nuts. The spark plugs and the spark plug

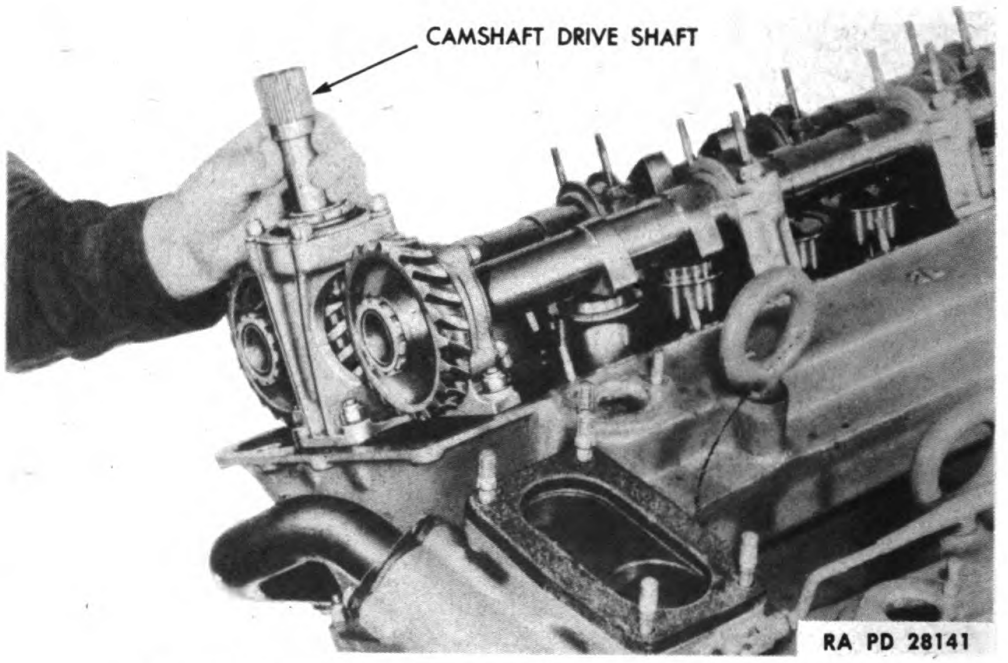


Figure 39 — Inserting Camshaft Upper Drive Shaft

wires are to be installed later; therefore, the spark plug covers must not be secured to the housing at this time. CAUTION: *Corks should be inserted in the spark plug holes to prevent dirt or other foreign material from falling into the cylinders.*

(12) INSTALL WATER OUTLET MANIFOLDS. NOTE: *The manifolds are right and left; however, it is possible to install them on the wrong side of the engine.* For proper installation, the manifolds should tilt toward the camshaft housings. Use new gaskets and secure the manifolds to the cylinder heads with safety nuts.

(13) INSTALL CAMSHAFT REVOLUTION COUNTER. Position revolution counter over opening provided in left camshaft housing making sure quill is properly engaged, and secure with three safety nuts.

(14) INSTALL SPARK PLUGS, WIRES, AND CONDUIT ASSEMBLIES. Insert the four spark plug wires through the hole in the top of the camshaft housing and secure the conduit mounting flanges to the housing with four safety nuts. This same procedure applies for both of the assemblies. Install the spark plugs in the cylinder head with the special wrench (41-W-3336-300) (fig. 69) using not more than 25 to 30 foot-pounds of torque. Use other end of spark plug wrench (41-W-3336-300) for tightening the spark plug wire terminals on the spark plugs (A, fig. 69). Install the spark plug covers.

(15) INSTALL FUEL PUMP. Attach the fuel pump over the studs on the left-hand camshaft housing and secure it with two safety nuts and flat washers.

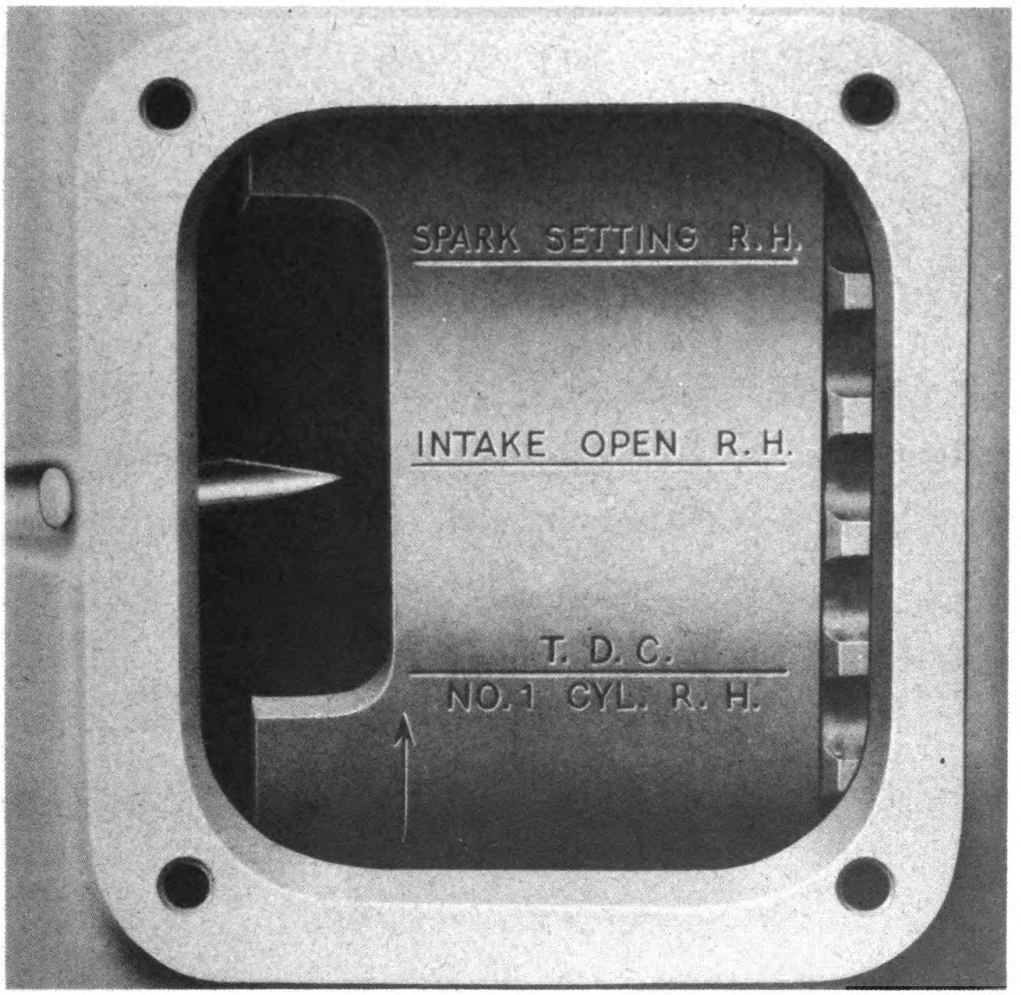


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Figure 40 — Flywheel Timing Marks for Camshaft Timing

(16) INSTALL CARBURETORS. Place the carburetors and air intake manifold on the engine. Secure each carburetor to the carburetor adapters with four safety nuts and flat washers. Connect the degasser (fuel cut-off solenoid) wires to the degasser.

(17) CONNECT FUEL LINES. Connect the two carburetor fuel lines and fuel inlet line to the fuel pump. Connect hose to primer tube connection.

(18) INSTALL THROTTLE ROD ASSEMBLY (fig. 59). Install the center bracket on the studs at the top center of the right-hand cylinder head and secure it to the cylinder head with two safety nuts. Both throttle rods which attach to the throttle plate arm of the carburetors must be adjusted to 16⅝ inches long (measure from the center of the ball to the center of the pinhole at the other end of the rod). Attach the ball joint stud to the carburetor arm and lock the

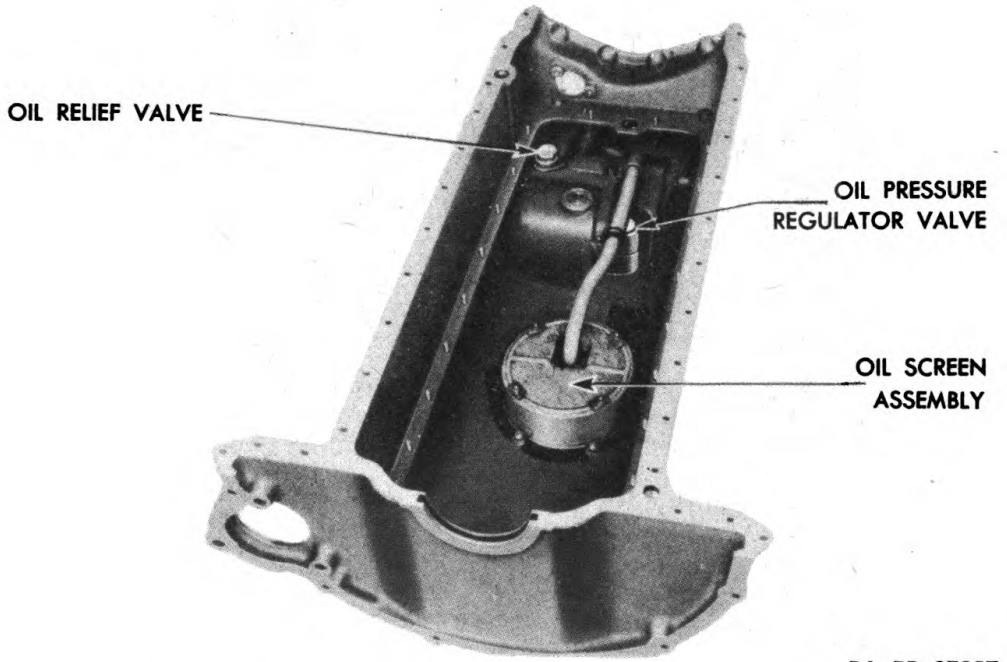

Figure 41 — Oil Pan Assembly — Baffles Removed

ball stud with a lock nut. Attach the other end of the rods to the arm at the center bracket with a clevis pin. Secure the clevis pins with cotter pins. Hook the spring as shown in figure 59.

(19) INSTALL GOVERNOR. Use a new gasket on the mounting flange of the governor and place the governor over the studs at the rear end of the right camshaft housing. It may be necessary to turn the governor shaft slightly in order to line up the splines on the shaft with the splines in the camshaft. Secure the governor to the housing with six safety nuts and flat washers. Adjust the connecting link between the governor arm and the arm on the carburetor adapter so the throttle plates are wide open when the engine is at a standstill. Attach the link to the throttle plate arm and the governor arm, and lock the ball joints with cotter pins. Adjust the length of the engine speed governor throttle rod (fig. 59) so that the throttle arms in both the front and rear adapters are against the stops. After the proper length is attained, connect the rods to the arms with clevis pins and secure with cotter pins.

(20) INSTALL EXPANSION TANK. Position the expansion tank on the bulkhead and install the four cap screws and lock washers. Connect the two overflow tubes.

(21) INSTALL HOSE. Install the hose that connects the water manifolds and rediator and tighten the hose clamps. Install the hose

that connects the water manifolds and expansion tank and tighten the hose clamps.

(22) INSTALL JUNCTION BOX. Secure the junction box to the left-hand camshaft cover with four safety nuts. Connect the small conduit bracket at the top underside of the box with two screws. Connect the two large conduits to the junction box.

(23) INSTALL AIR CLEANERS. Refer to paragraph 74 c.

(24) FINAL STEPS. Install the drain plug and lock wire in the water pump. Install the coolant in the cooling system. Close the engine compartment rear door and install the three cap screws. Install the engine compartment floor plate (par. 164 g). Install the engine compartment front cover. Close and fasten the engine compartment doors.

57. OIL PAN ASSEMBLY.

a. Description (fig. 41). The engine oil pan is an aluminum casting. The assembly includes an oil screen secured to the bottom of the pan, an oil pressure regulator, and an oil relief valve, all of which are accessible only when the pan is removed from the engine. Two oil baffles are provided in the oil pan to hold the oil at the bottom of the pan when the vehicle is operated on steep inclines. A disk-type oil filter (hydraulically operated by means of the engine oil pressure) is located in the oil pan. The filter is accessible for removal from the outside of the pan.

b. Removal.

(1) PRELIMINARY STEPS. Remove engine compartment floor plate (par. 164 f). Open engine compartment rear door (par. 164). Place a pan with an 8-gallon capacity under the oil pan drain plug, and remove the plug draining the oil.

(2) REMOVE OIL PUMP. Remove the four oil pump mounting nuts and remove the oil pump and gasket. NOTE: *It may be necessary to tap the body of the pump lightly to release it from the gasket and driving quill.*

(3) REMOVE STARTER. Refer to paragraph 93 b.

(4) REMOVE OIL PAN ASSEMBLY. Remove the four cap screws securing the oil pan to the accessory gear assembly cover. Remove the six nuts and bolts securing the oil pan to the flywheel and clutch housing. Remove the 28 nuts securing the oil pan to the cylinder block. Loosen the remaining nine nuts securing the accessory gear assembly cover, and pry the cover assembly away from the block slightly in order to break the oil pan and gaskets loose from the rest of the engine assemblies to allow room for installation of oil pan and gaskets.

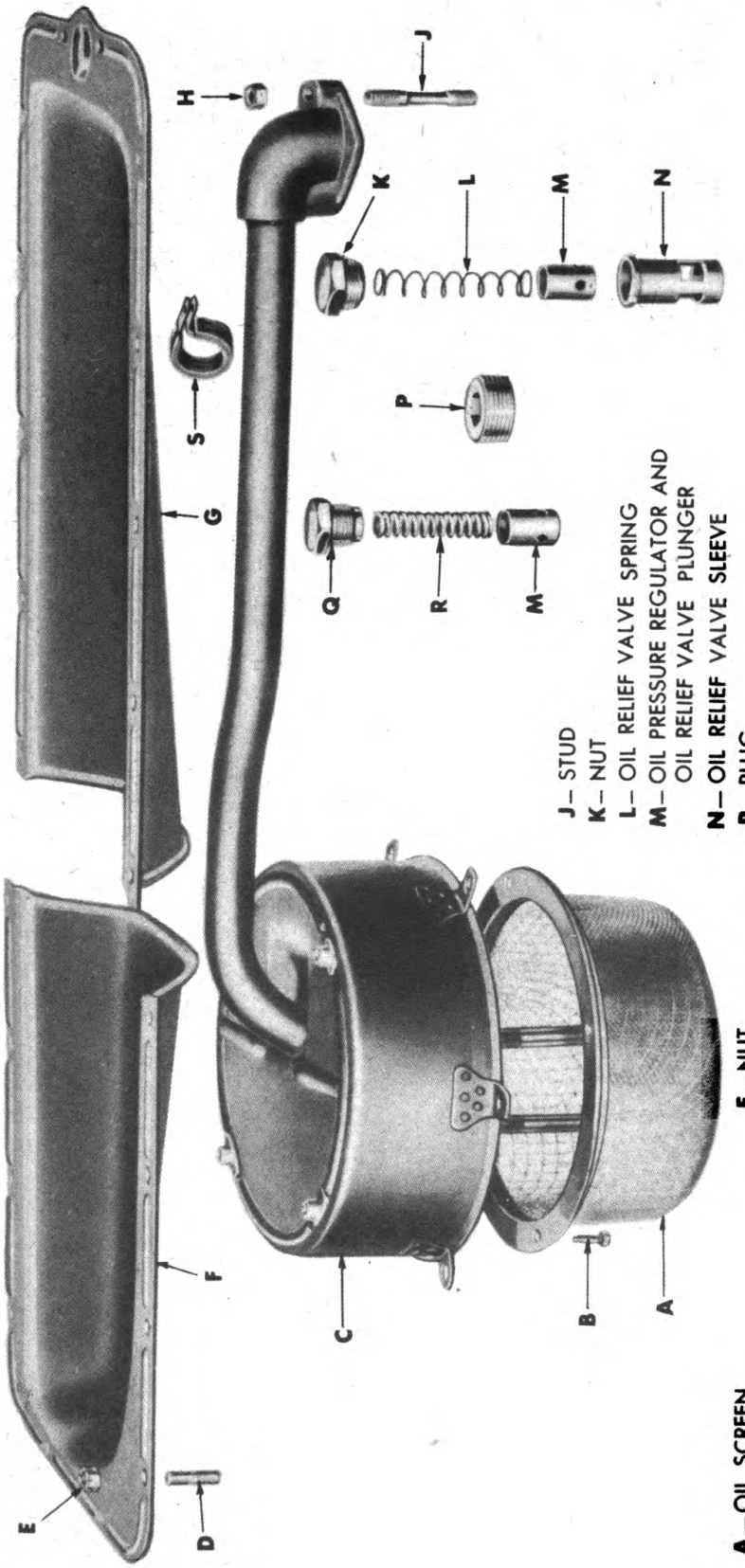

Figure 42 — Oil Pan Assembly Parts

c. Disassembly, Cleaning, Inspection, and Assembly.

(1) REMOVE BAFFLES. Remove the 22 nuts securing front and rear baffles in the oil pan and remove the baffles (F and G, fig. 42).

(2) REMOVE OIL SCREEN ASSEMBLY. Take out screws securing oil screen assembly to bottom of oil pan. Remove screw from clip (S, fig. 42) and lift oil screen assembly from oil pan.

(3) REMOVE OIL PRESSURE REGULATOR ASSEMBLY. Remove nut from top of pressure regulator assembly and remove spring and plunger (R and M, fig. 42) from the cylinder.

(4) REMOVE OIL RELIEF VALVE ASSEMBLY. Remove nut from top of relief valve and lift spring, plunger, and sleeve (L, M, and N, fig. 42) from recess in oil pan.

(5) CLEAN OIL PAN ASSEMBLY PARTS. Remove plates covering oil passages on the outside of oil pan and clean the oil pan and passages by first brushing and scraping, then washing in dry-cleaning solvent. Dry with compressed air. CAUTION: *Do not clean with caustic soda bath as this would be injurious to the aluminum.* Clean oil screen, relief valve, and pressure valve parts with dry-cleaning solvent and dry thoroughly.

(6) INSPECT PARTS (fig. 42). Examine oil screen and all oil passages to make sure they are clean. Examine the oil pan for cracks or bent studs. Replace pan if damaged. Examine oil pressure regulator and relief valve plungers for excessive wear and scars. Check to make sure oil pressure regulator plunger slips freely in its recess in oil pan, and oil relief valve slips freely in its sleeve. Oil pressure regulator valve spring should support a 38- to 40-pound weight with the spring compressed to 1.48 inches. Oil pressure relief valve should support a 4.4- to 4.7-pound weight when compressed to 1.62 inches.

(7) INSTALL OIL PRESSURE REGULATOR VALVE ASSEMBLY. Install plunger spring and nut in recess in end of oil filter housing and tighten nut firmly against housing.

(8) INSTALL OIL PRESSURE RELIEF VALVE ASSEMBLY. Install sleeve, plunger, spring, and nut of oil pressure relief valve in opening provided at top of oil filter housing. Tighten nut firmly against housing.

(9) INSTALL OIL SCREEN ASSEMBLY. Place the oil screen in the cover on the tube assembly and secure with four screws. Place new gasket and oil screen assembly over the studs provided at the bottom of the oil pan and secure with self-locking nuts.

(10) INSTALL OIL PASSAGE PLUGS AND PLATES. Install the oil passage plugs and plates which were removed for cleaning purposes.

(11) INSTALL CRANKSHAFT OIL SEAL. A new crankshaft oil seal must be soaked in engine oil for 2 hours before installing. Posi-

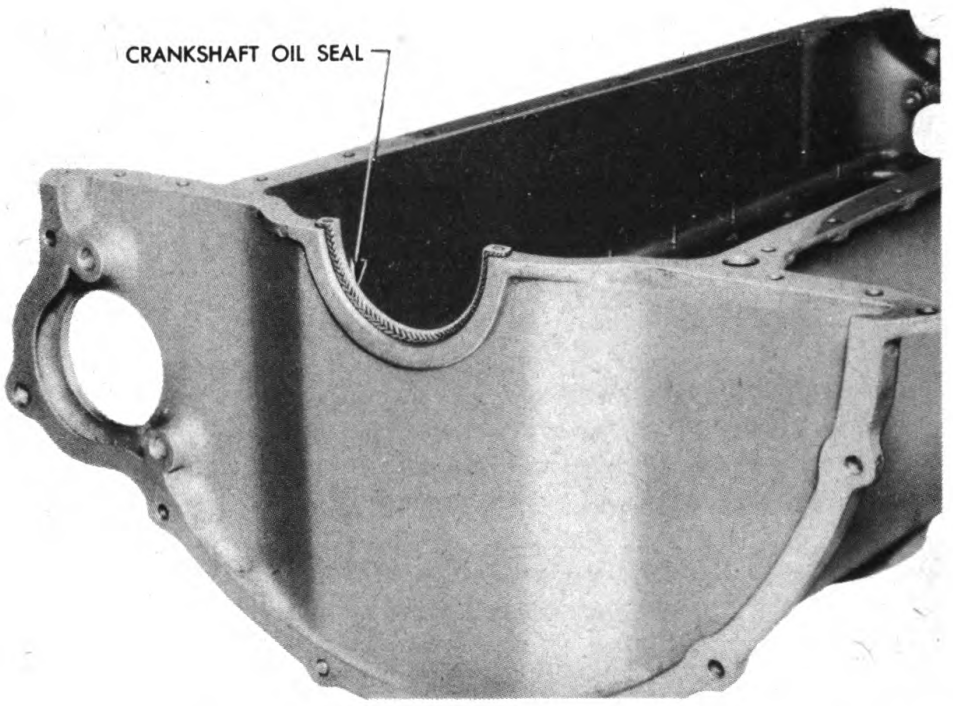

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Figure 43 — Crankshaft Oil Seal

tion oil seal in groove in oil pan and press firmly into groove so that the ends of the seal protrude above the machined surface of the pan an equal amount at each end of the seal (fig. 43).

d. Installation.

(1) Insert a rubber seal on the oil tube. Place the oil pan gaskets in position on the cylinder block. Position the oil pan using shim stock to assist in sliding the rear of the pan into position so as not to damage the oil pan to accessory gear assembly cover gasket. Install the 28 nuts on the studs securing the oil pan to the cylinder block and tighten. Install and wire the four accessory gear assembly cover to oil pan studs and tighten the remaining safety nuts around the accessory gear assembly cover, drawing it up tightly into position. Install and tighten the six nuts and bolts securing the oil pan to the flywheel and clutch housing.

(2) INSTALL STARTER. Refer to paragraph 93 c.

(3) INSTALL OIL PUMP. Use a new gasket and place the pump over the studs. The engine may have to be turned over slowly so the spline on the pump shaft will line up with the splines in the accessory gear worm gear shaft. Secure the pump to the oil pan with four safety nuts.

(4) FINAL STEPS. Install and tighten the oil pan drain plug. Install 8 gallons of specified grade oil. Install the engine compartment floor plate (par. 164 g). Close the engine compartment rear door (par. 164).

58. OIL PUMP AND PRESSURE INDICATING SYSTEM.

a. Description (fig. 44). The gear-type oil pump, mounted at the rear of the oil pan (fig. 29), is driven by a splined quill from the camshaft lower left worm gear. The oil pressure gage sending unit (fig. 27), connected to the main oil gallery at the side of the engine, is a pressure-operated variable resistance unit. As the oil pressure varies, the amount of current flowing through the gage varies causing the gage to register the oil pressure in pounds per square inch. The low oil pressure warning signal switch is also connected to the main oil gallery (fig. 27). This pressure-operated switch remains closed until the oil pressure exceeds 11 pounds per square inch when it opens and turns out the warning signal light on the instrument panel.

b. Removal of Oil Pump. Remove the engine compartment floor plate (par. 164 f). Place a pan with at least an 8-gallon capacity under the oil pan drain plug and remove the plug. Remove the four nuts holding the oil pump to the oil pan and remove the pump. It may be necessary to tap the body of the pump lightly to release it from the gasket and the driving quill.

c. Installation of Oil Pump. Use a new gasket and place the pump over the studs. The engine may have to be turned over slowly so that the spline on the pump shaft will line up with the splines in the accessory gear worm gear shaft. Secure the pump to the oil pan with four safety nuts. Install the engine compartment floor plate (par. 164 g). Install 8 gallons of the specified grade oil (par. 33).

d. Removal of Oil Pressure Sending Unit and Switch. Disconnect conduit and wire from the sending unit or switch. Unscrew the unit from elbow at side of engine.

e. Installation of Oil Pressure Sending Unit and Switch. Screw the unit into elbow at side of engine (fig. 27) and connect wire and conduit to the unit. Run engine long enough to check operation of oil pressure gage and warning signal. Check engine oil level.

f. Replacement of Low Oil Pressure Warning Lamp. Pry out the ruby-colored lens at lower left corner of the instrument panel (fig. 10). Push in on lamp and turn counterclockwise to release lamp from bayonet socket. To install lamp, insert lamp in socket, push in and turn clockwise, and release in locked position. Snap the colored lens back into position. Turn 24-volt master switch on to test lamp.

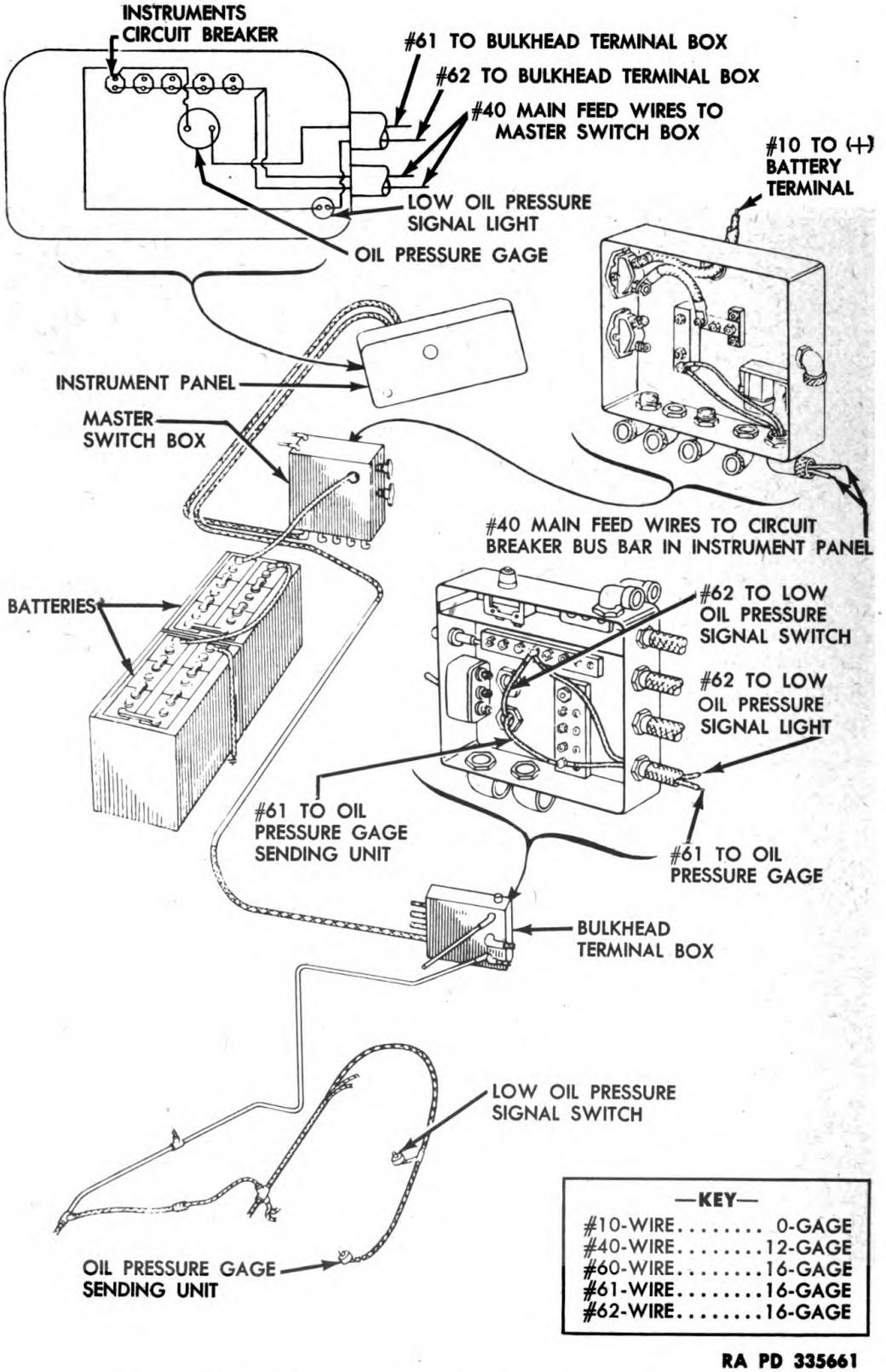

Figure 44 — Oil Pressure Indicating System Diagram

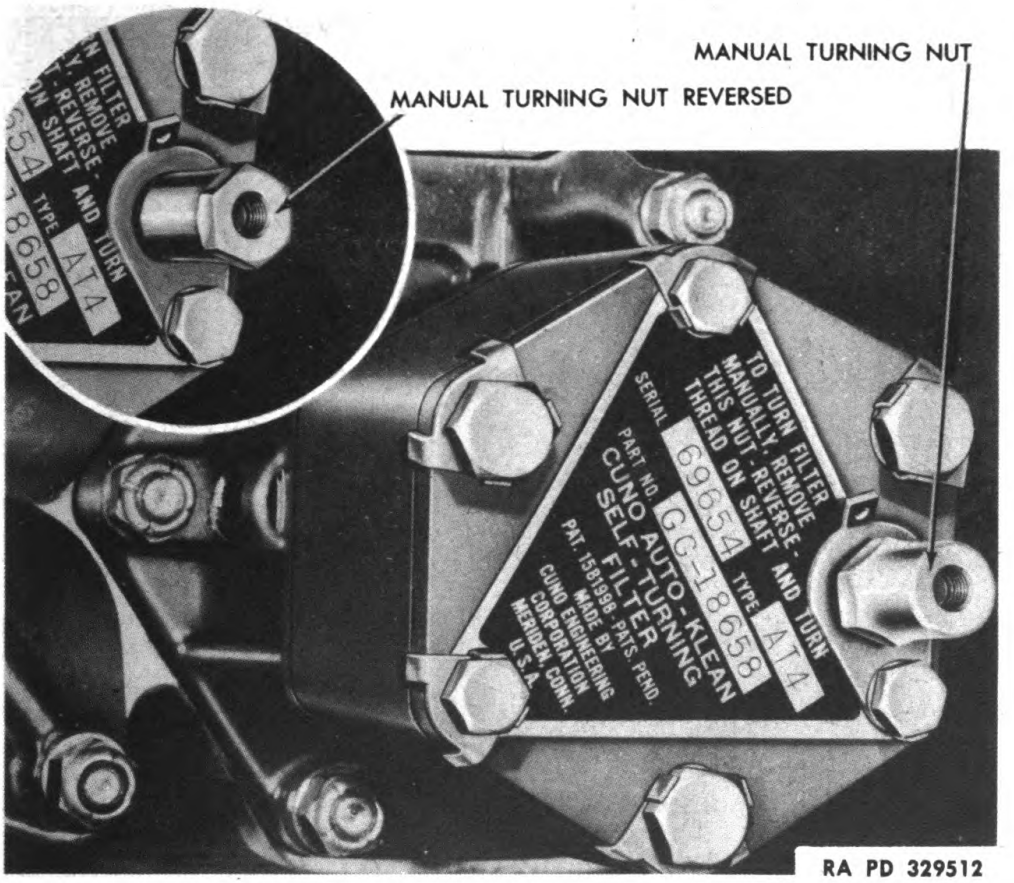

Figure 45 — Oil Filter

59. OIL FILTER.

a. Description (fig. 45). The oil filter consists of a stack of wheel-shaped disks, separated from each other by spoked spacer pieces, and is mounted on a rotary spindle. Located adjacent to this stack of disks and spacers is a stack of cleaner blades mounted on a rod in such a manner that each cleaner blade enters the space between adjacent disks. Solids, too large to pass between the disks, remain on the outer surface until such time as the disks are rotated past the cleaner blades. Accumulated solids are removed from the surface by the combing action of the cleaner blades and collect in the sump around the filter. The filter disks are rotated by a hydraulic motor operated by oil pressure from the engine. The oil filter is located on the right side of the oil pan at the rear, accessible through the engine compartment rear door.

b. Operation Check. To check the operation of the filter, remove the manual turning nut, turn end for end, and install on the

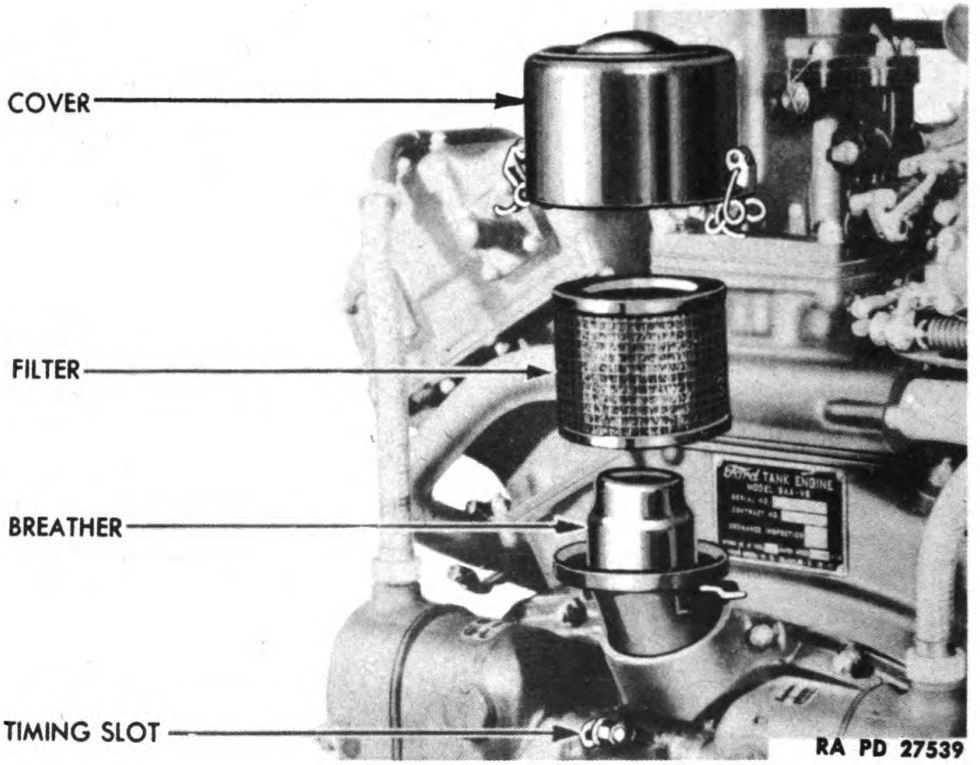

Figure 46 — Oil Pan Filter Assembly

shaft from which it was removed (fig. 45). Run the engine at speed which shows an oil pressure of approximately 30 pounds. The manual turning nut will rotate very slowly if the filter is operating. Mark the nut, and check position of this mark after the engine has been running for 5 minutes to see if it has rotated. After the check is made, install the manual turning nut in the original position and secure it with locking wire. If the filter nut fails to turn, remove the unit from the engine for examination or replacement.

c. Removal (fig. 45). Remove the engine compartment floor plate (par. 164 f). Remove the six nuts from the mounting flange of the oil filter and remove the oil filter from the engine oil pan.

d. Cleaning Filter. Remove locking wire and manual turning nut. Reverse the nut and install it on shaft. Slush the element in dry-cleaning solvent. Rotate disks by turning manual turning nut with element immersed in dry-cleaning solvent until all dirt and solids are removed. When thoroughly clean, allow element to drain dry. CAUTION: *Do not use wire brush on element and do not blow element dry with compressed air.* Thoroughly clean filter housing by wiping inside with cloth soaked in dry-cleaning solvent. Remove manual turning nut and install it in original position. Secure the nut with locking wire through nut and clip.

e. Installation. Use a new oil filter gasket and set it in place so that the oilhole in the gasket lines up with the drilled oilhole in the oil pan. Insert the oil filter in the opening provided in the oil pan. Secure the filter to the oil pan with six safety nuts. Install the engine compartment floor plate (par. 164 g).

60. OIL PAN FILTER ASSEMBLY.

a. Description (fig. 46). The oil pan filter assembly is located directly above the water pump, accessible either from above or through the engine compartment rear door. Figure 46 shows the cover and the filter element.

b. Servicing Filter Element (fig. 46). To remove the filter element for cleaning, release the two holding clips and lift off the cover. Lift off the filter element. The filter should be cleaned by washing it in dry-cleaning solvent. Blow out with compressed air and when dry, dip in seasonal grade engine oil. Reinstall the filter element and the cover.

Section XVIII

ENGINE REMOVAL AND INSTALLATION

61. REMOVAL.

a. Turn Master Switch Off. Make certain that the 24-volt master switch is in "OFF" position.

b. Open Engine Compartment. Remove engine compartment top doors, front and rear cover plates, and floor plate (par. 164). Raise the exhaust deflector and latch it in raised position. Remove the three securing cap screws and open engine compartment rear door.

c. Remove Rear Fighting Compartment Floor Plate. Remove cap screws securing floor plate to floor supports. Lift out floor plate.

d. Drain Cooling System, Fuel System, and Engine Oil Pan. Drain cooling system (par. 78 a (1)), fuel tanks, and engine oil pan.

e. Disconnect Rear Universal Joint. Mark flanges so that they will be assembled in the same relative position. Remove lock wire, nuts, and bolts securing rear universal joint flange to clutch shaft flange.

f. Disconnect Clutch Rod. Remove cotter pin and clevis pin attaching clutch rod to clutch release shaft fork.

g. Remove Expansion Tank (fig. 47). Disconnect vent pipes. Loosen two rubber hose clamps on end of water manifolds and pull hoses from manifolds, leaving them attached to the expansion tank.

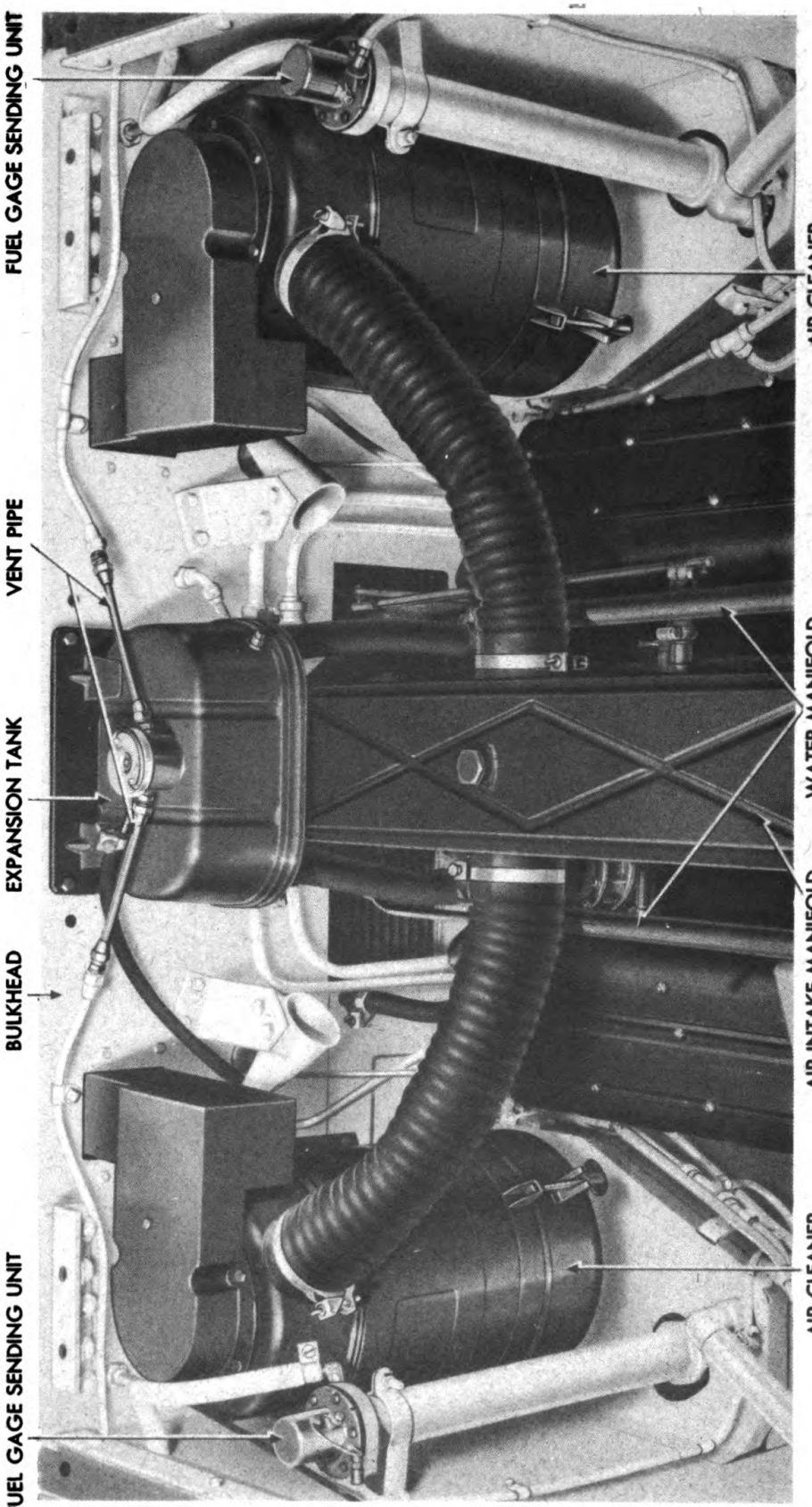

Figure 47 — Front End of Engine Compartment

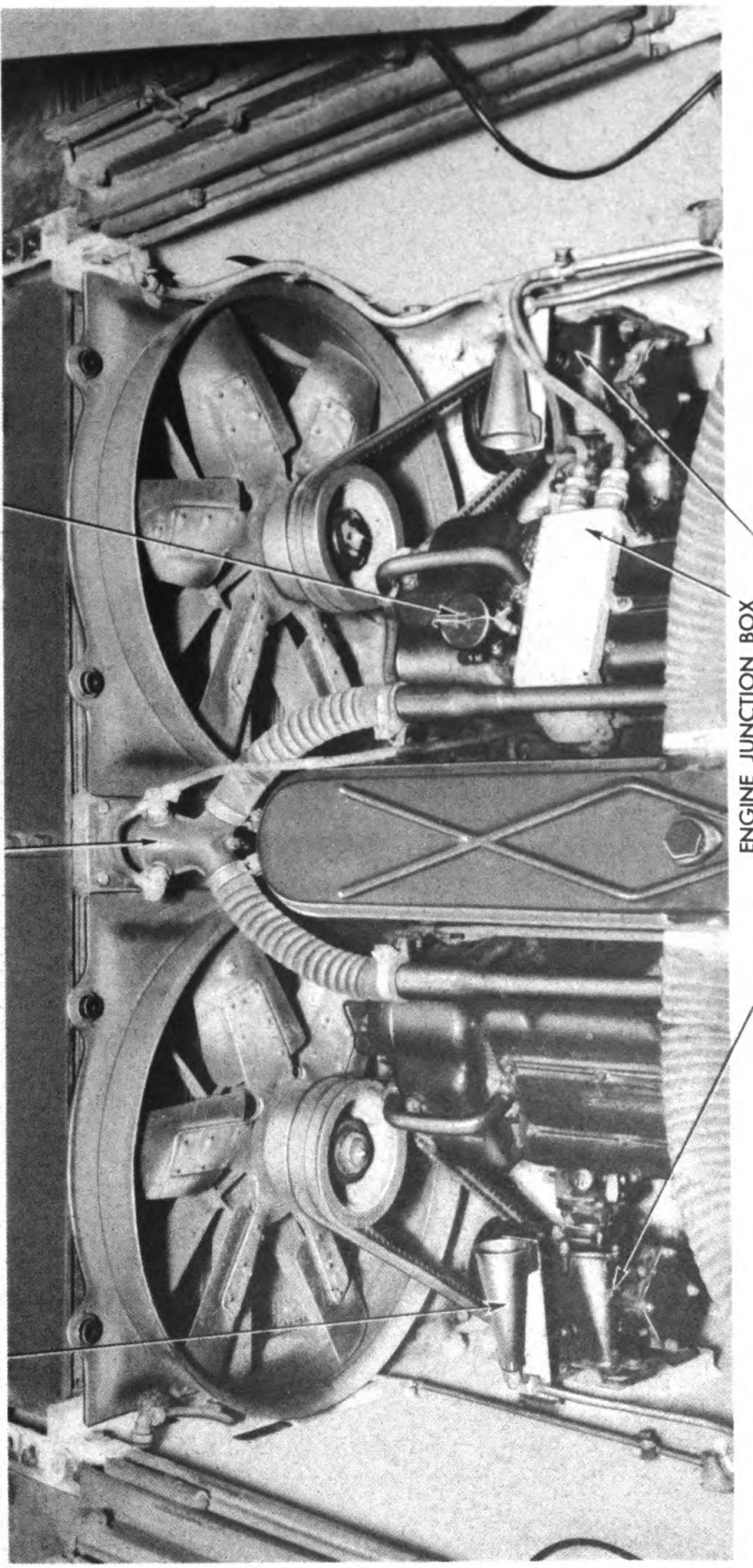

Figure 48 — Rear End of Engine Compartment

Remove four nuts and bolts securing expansion tank to bulkhead. Lift off expansion tank. NOTE: *Seal the openings in water manifolds and all other openings which will be exposed in the process of removing the engine with tape to prevent entrance of dirt.*

h. Remove Fire Extinguisher Brackets and Nozzles from Bulkhead. Back off tube retaining nut at elbow on nozzles. Remove two cap screws and lock washers attaching nozzle brackets to bulkhead. Lift off brackets with attached nozzles.

i. Remove Air Cleaner Assemblies (fig. 47). Remove clamp securing engine compartment door shutter control rod to top of air cleaners. Remove air intake hose by loosening clamps securing hose to intake manifold and to air cleaners. Lift out hose. From fighting compartment side of bulkhead, remove four cap screws and lock washers which retain air cleaner bracket to bulkhead. Lift out air cleaners and attached brackets.

j. Remove Fuel Shut-Off Valves and Linkage (fig. 56). Pull cotter pin, unscrew ring plug, and lift top of linkage off ball joint on valve control. Remove cotter pin and clevis pins at top of valves and remove linkage. Remove fuel hose from elbow on right fuel shut-off valve; then remove elbow. Remove three fuel hose tubes from three-way connector on left fuel shut-off valve. Unscrew three-way connector out of valve. Unscrew and remove both fuel shut-off valves from top of fuel filters.

k. Disconnect Fuel and Primer Lines. Disconnect primer tube from rubber hose line at engine adjacent to forward carburetor. Disconnect rubber fuel line at fuel pump.

l. Disconnect Conduit Tube. Unscrew knurled conduit retaining nut from left side of tee which extends from bulkhead terminal box. Push conduit tube up and over elbow directly above the tee.

m. Remove Throttle Rods. Disconnect rod from throttle arm extending through bulkhead by unscrewing ball stem from arm. Disconnect other end of rod from bell crank at center of engine by removing cotter pin, unscrewing plug, and pulling end of rod from ball on bell crank. Disconnect rear carburetor throttle rod adjacent to left rear engine lifting eye bolt in the same manner. This is to prevent bending of the rod when engine is lifted.

n. Remove Carburetor Air Intake Manifold (fig. 47). Remove five nuts securing each end of air intake manifold to tops of carburetors. Lift off manifold.

o. Remove Radiator Inlet Connection and Thermostat. Disconnect rubber hose from water manifolds. Remove connectors from sending units and pull wires out of single sockets. Remove four cap screws and lock washers which retain inlet connection to top of radia-

tor. Pull off the connection and gasket, and remove thermostat and gasket from inlet opening in radiator.

p. Remove Shroud and Fan Assemblies. Loosen adjusting nuts on fan drive assemblies. Lift up fan drives and remove belts. Remove lock wire from shroud retaining cap screws. Remove nuts, bolts, and cap screws securing shrouds to hull. Lift out shroud and fan assemblies.

q. Disconnect Conduits at Engine Junction Box. Back off knurled flange nuts and pull connectors out of receptacles at engine junction box (fig. 48).

r. Ground Magnetos. Remove cap screws and lock washers from magneto breaker inspection plate. Lift off inspection plate and gasket. Attach a short wire to the ground terminal of the magneto and attach other end of wire to one of the distributor cover screws on the magneto. Repeat operation on other magneto. **NOTE:** *Grounding of the magnetos in this manner will prevent engine from starting in case it is accidentally cranked.*

s. Remove Radiator Outlet Connection and Hose. Disconnect hose from water pump. Remove four cap screws and lock washers which secure connection to bottom of radiator. Lift out connection with attached hose and remove gasket.

t. Remove Radiator Baffle Plates. Remove two cap screws and lock washers attaching bypass plate to center of radiator. Lift off plate and gasket. Remove two screws and lock washers from upper baffle plate above bypass opening. Remove two screws and lock washers from lower baffle plate. Lift out baffle plates.

u. Disconnect Fan Drive Shafts. Remove locking wire, nuts, and bolts attaching fan drive universal joint flange to flange on fan drive quill extending from sides of engine.

v. Disconnect Starter Cable. Remove nut, lock washer, and flat washer which secure cable to terminal on starter. Lift off cable.

w. Disconnect Exhaust Pipes. Disconnect both exhaust pipes from exhaust manifold flanges by removing six nuts and bolts which secure each pipe.

x. Remove Water Pump. Remove four nuts and flat washers securing water pump to engine. Lift pump and gasket off engine and out through rear engine compartment opening.

y. Remove Engine Mounting Bolts. Remove plates from both sides of the clutch housing shroud which extends into the fighting compartment. Through plate openings, remove four nuts, bolts, and flat washers from the two front engine mounts using double offset box wrench (41-W-601). Remove nuts, bolts, and flat washers from

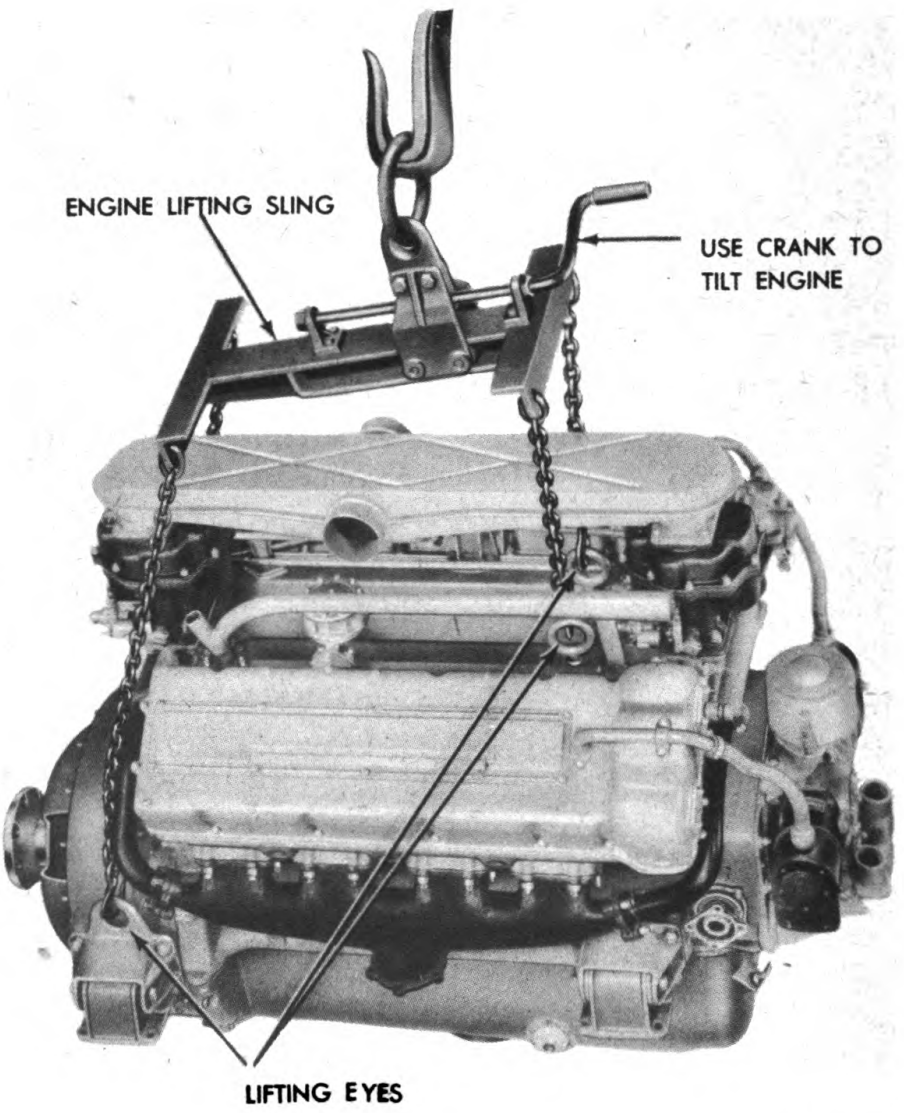

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Figure 49 — Removing Engine Using Special Sling (41-S-3831)

rear engine mount. Remove toothed lock washer and bond strap from right rear mount.

z. **Remove Engine** (fig. 49). Install engine sling (41-S-3831) with short chains on rear lifting eye bolts and long chains through lifting eyes on front engine mounting brackets. Lift engine with available lifting equipment. It will be necessary to adjust the sling so that engine will tilt sufficiently for clearance at the clutch housing and magnetos. Lift engine slowly and cautiously. As soon as sufficient clearance is available between magnetos and radiator, turn magneto end of engine toward right rear corner of engine compart-

ment. NOTE: *Some slings are not adjustable. It will be necessary to tilt the engine by foot pressure if a stationary sling is used.*

62. INSTALLATION.

a. Lower the Engine Into Engine Compartment (fig. 49). Install engine sling (41-S-3831) with short chains on rear lifting eye bolts and long chains through lifting eyes on front engine mounting brackets. Lift engine with available lifting equipment. Turn engine so that magneto end is toward right rear corner of engine compartment. Turn handle on sling to tilt clutch end of engine down. Lower engine slowly and cautiously. As the clutch housing enters detent in bulkhead, straighten engine and level it with sling adjusting crank. Continue lowering engine until it is seated on the engine mounts. Remove sling.

b. Install Engine Mounting Bolts. Secure engine to engine mounts with bolts, flat washers, and nuts using double offset wrench (41-W-601). Attach bond strap to right rear engine mount with toothed lock washer and one of the mounting bolts.

c. Install Water Pump. Position water pump gasket and attach pump to engine with flat washers and stud nuts.

d. Connect Exhaust Pipes. Attach exhaust pipes to exhaust manifold flanges with bolts and nuts.

e. Connect Starter Cable. Attach starter cable to terminal on starter with flat washer, lock washer, and nut.

f. Connect Fan Drive Shafts. Attach fan drive universal joint flange to fan drive quill flange extending from sides of engine with bolts, nuts, and lock wire.

g. Install Radiator Baffle Plates. Position gasket and attach by-pass plate to center of radiator with two lock washers and cap screws. Install upper and lower baffle plates.

h. Install Radiator Outlet Connection and Hose. Position gasket and attach outlet connection to bottom of radiator with four lock washers and cap screws. Connect hose to water pump.

i. Remove Temporary Magneto Ground Wire. Remove temporary ground wire, then tighten magneto ground terminal screw. Install gasket and magneto breaker inspection plate.

j. Connect Conduits at Engine Junction Box. Plug connectors into receptacles at engine junction box and secure with knurled flange nuts.

k. Install Fan and Shroud Assemblies. Position fan and shroud assemblies and secure assemblies to hull with bolts, nuts, and cap

screws. Install lock wire through cap screw heads. Lift up fan drives and install fan belts. Adjust fan belts (par. 83 b).

l. **Install Thermostat and Radiator Inlet Connection.** Insert gasket and thermostat into inlet opening of radiator. Position gasket and attach inlet connection to radiator with four lock washers and cap screws. Push sending unit wires into sockets and attach connectors to sending units. Connect hoses to water manifolds.

m. **Install Carburetor Air Intake Manifold.** Attach each end of manifold to tops of carburetors with five stud nuts.

n. **Install Throttle Rods** (fig. 59). Connect rear carburetor throttle rod to rear carburetor by inserting socket over ball, adjusting plug to free fit over ball, and installing cotter pin. Connect front throttle rod to bell crank at center of engine in the same manner. Connect opposite end of front rod to throttle arm extending through bulkhead by threading ball stem into throttle arm.

o. **Connect Conduit Tube.** Attach conduit to tee extending from bulkhead terminal box with knurled conduit retaining nut.

p. **Connect Fuel and Primer Lines.** Connect rubber fuel hose to fuel pump. Connect primer line to rubber hose at engine adjacent to forward carburetor.

q. **Install Fuel Shut-off Valves and Linkage** (fig. 56). Screw fuel shut-off valves into tops of fuel filters. Install elbow in top of right shut-off valve (three-way connector on left valve) and attach fuel hose to elbow (three fuel hoses to connector on left valve). Connect linkage to valves with clevis pins and cotter pins. Connect upper ends of linkage to shut-off valve control by sliding joint on ball, adjusting plug to a free fit, and installing cotter pin.

r. **Install Air Cleaner Assemblies.** Position air cleaners against bulkhead in engine compartment. Install retaining cap screws and lock washers through bulkhead from fighting compartment side. Attach air intake hoses to intake manifold and to air cleaners. Attach engine compartment door shutter control rods to tops of air cleaners.

s. **Install Fire Extinguisher Nozzles and Brackets.** Attach brackets (with nozzles attached) to bulkhead. Connect fire extinguisher tubes to elbows on nozzles with tube retaining nuts.

t. **Install Expansion Tank.** Attach expansion tank to bulkhead with four bolts and nuts. Connect rubber hose from expansion tank to water manifolds. Connect vent tubes to filler neck.

u. **Connect Clutch Rod.** Attach clutch rod to clutch release shaft fork with clevis pin and cotter pin.

v. **Connect Rear Universal Joint.** Aline marks scribed on flanges, then attach rear universal joint flange to clutch shaft flange with bolts, nuts, and locking wire.

w. Fill Cooling System and Fuel System, and Install Engine Oil. Fill cooling system (par. 78) and fuel tanks, and install specified engine oil (par. 32).

x. Test Operation and Check for Leaks. Turn 24-volt master switch to "ON" position. Operate main light switch to test taillight circuits. Operate fuel gage control switch to test fuel gage circuits. Start engine. Make sure throttle is properly adjusted for correct idling speed. Operate degassers to make sure they stop engine. Again start engine and, while it is running, check all fuel, water, and oil connections and gaskets for leaks. Tighten connections as required. Make sure all drain plugs are tight and not leaking. When engine is warmed-up, test carburetor adjustment (par. 64). Stop engine.

y. Install Rear Fighting Compartment Floor Plate. Attach rear floor plate to floor supports with flathead screws.

z. Close Engine Compartment. Close and secure engine compartment rear door with three securing cap screws. Release and lower exhaust deflector. Install engine compartment floor plate, front and rear cover plates, and top doors (par. 164).

aa. Record Installation of Engine. Make proper entry on W.D., A.G.O. Form No. 478, MWO and Major Unit Assembly Replacement Record.

Section XIX

FUEL, AIR INTAKE, AND EXHAUST SYSTEMS

63. DESCRIPTION (figs. 47 and 50).

a. The fuel and air intake system consists of two carburetors equipped with degassers (fuel cut-off solenoids push button operated from instrument panel), two air cleaners, a fuel pump, four fuel tanks with shut-off valves and fuel supply lines, fuel gage with right and left tanks sending units, two fuel filters, and a priming pump with fuel supply lines to the intake manifolds. The total capacity of the fuel tanks is 168 gallons. The exhaust system consists of two exhaust pipes, one attached to each manifold on the engine and running through the rear wall of the engine compartment, and two external pipes bolted to the rear wall of the engine compartment.

64. CARBURETORS.

a. Description (fig. 27). Two Stromberg Model NA-Y5G carburetors are mounted on carburetor adapters connecting the two intake manifolds at each end of the engine. The carburetors are dual (double-barrel) downdraft type. Each carburetor has two floats

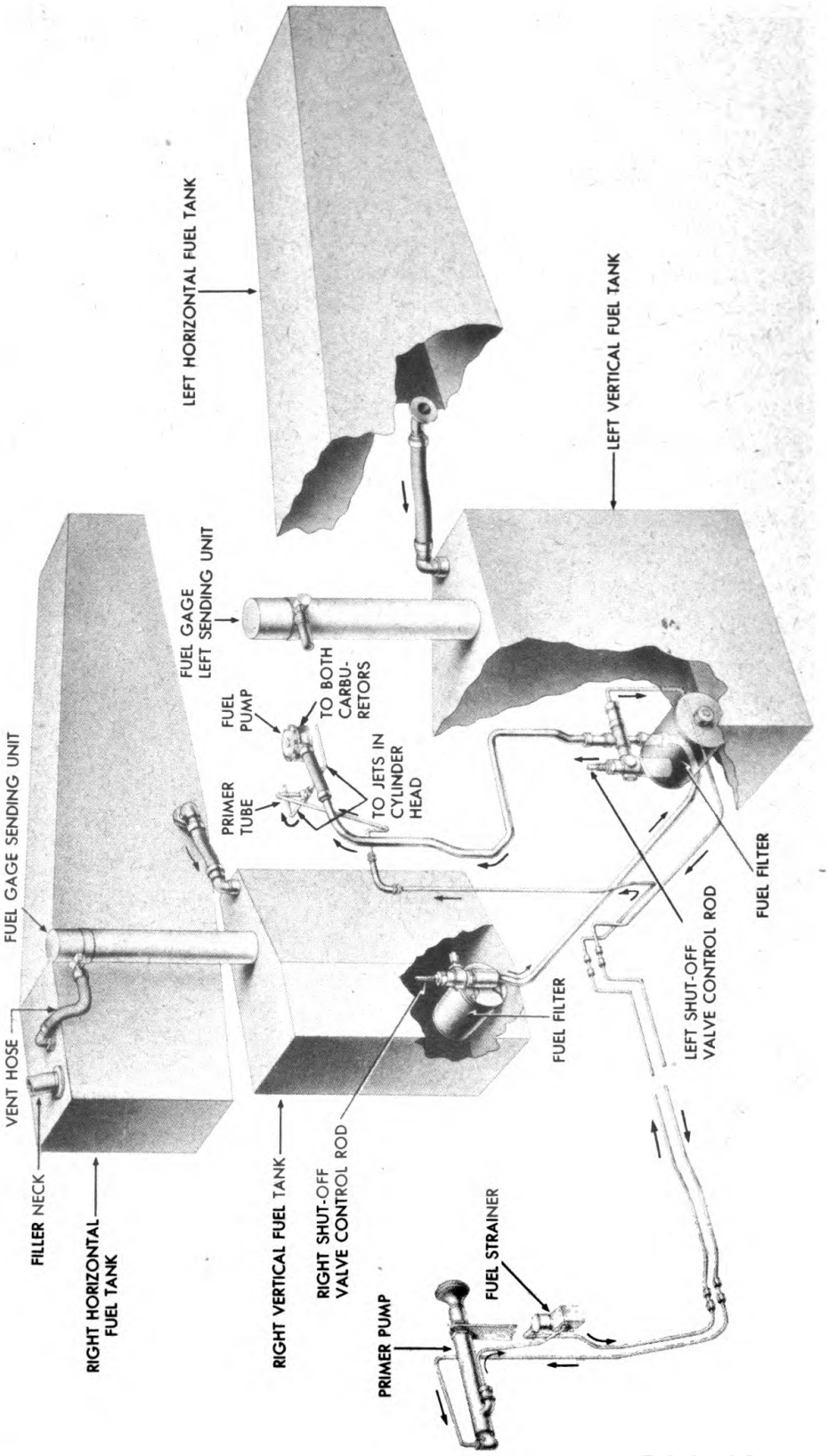

Figure 50 — Fuel System

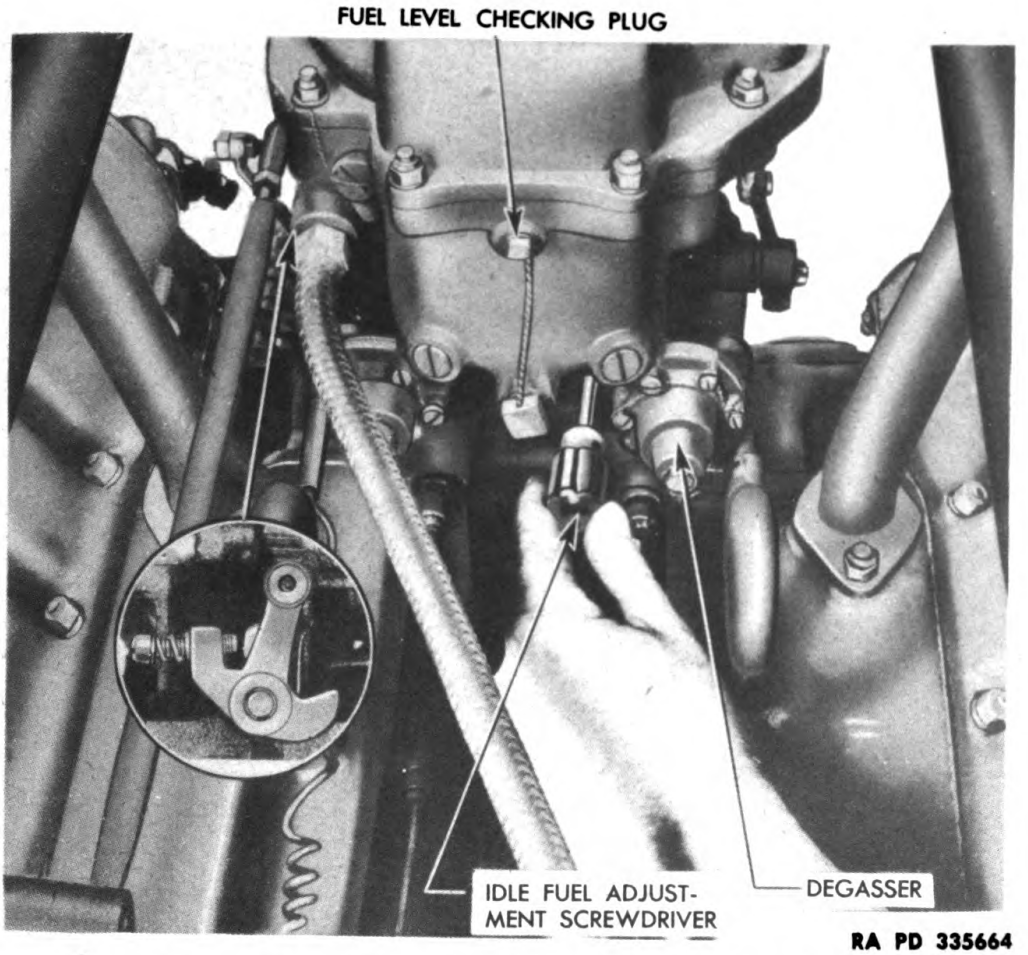

Figure 51 — Adjusting Idling Fuel Mixture Using Special Screwdriver (41-S-1652-500)

connected by one lever and operating on one needle valve. A separate main metering and idling system is provided for each barrel. Each barrel is equipped with a fuel cut-off solenoid (degasser) (par. 66). An accelerating pump, which operates with the throttle, provides an extra quantity of fuel for rapid acceleration. The throttle linkage is arranged so that the forward carburetor remains closed until the rear carburetor is approximately half open.

b. Idle Fuel Adjustment (fig. 51). Two idle fuel adjustment screws are provided on each carburetor, one for each barrel. The idle adjustments on these carburetors are extremely uniform and can be adjusted when either cold or hot. Make the idle fuel adjustments with the engine stopped. Turn each idle fuel adjusting screw in (clockwise) until it seats lightly; then turn it out one-quarter turn from the closed position. A special screwdriver (41-S-1652-500) will be required for making this adjustment on the forward carburetor.

c. Idle Speed Adjustment (fig. 59). Start the engine and run it until it reaches normal operating temperature. Back off the idle speed adjustment at each carburetor until the engine idle speed is below 500 revolutions per minute. Set the idle speed adjustment at the rear carburetor until the engine idle speed is 500 revolutions per minute. Set the idle speed adjustment at the front carburetor until the engine speed just starts to increase; then back off the adjustment slightly.

d. Fuel Level Check. Each carburetor is provided with fuel level checking plugs (fig. 51), one at the front of the carburetor and one at the rear. To check the fuel level, remove the locking wire and plug from the inspection hole in the front side of the rear carburetor, or the rear side of the forward carburetor. Start the engine and run it at idling speed. The fuel should be visible at the bottom of the threads of the inspection hole. If fuel is not visible, the fuel level is too low. If the fuel runs out of the inspection hole, the level is too high. In either case, the carburetor should be replaced (subpars. **e** and **f** below).

e. Removal (Either Carburetor). Open the engine compartment doors. Loosen the clamps at the two carburetor air intake manifold tubes and remove the tubes from the manifold. Remove the nuts at the top of each carburetor which attach the carburetor air intake manifold to the carburetors. Remove the manifold. Disconnect the carburetor fuel feed line at the fuel pump. Disconnect the degasser (fuel cut-off solenoid) electrical connections on the carburetor. Disconnect the throttle rod from the ball joint at the carburetor. Remove the four carburetor base nuts holding the carburetor to the adapter and remove the carburetor and gasket. Remove the fuel hose from the carburetor.

f. Installation (Either Carburetor). Place a new gasket and carburetor on the adapter studs. Install the four nuts to secure the carburetor to the adapter. Connect the degasser (fuel cut-off solenoid) wires. Connect the carburetor fuel hose to the carburetor and fuel pump. Connect the throttle rod to the ball joint on the carburetor. Place the air intake manifold on the carburetors and install the nuts. Place the two intake manifold tubes over the manifold connections and tighten the clamps. Close the engine compartment doors and install the cap screws.

65. CARBURETOR ADAPTERS.

a. Description (figs. 29 and 53). A carburetor adapter is connected to each end of the intake manifolds. These adapters are also connected to the exhaust manifolds by heater tubes which provide heat for the fuel-air mixture as it comes from the carburetors. These

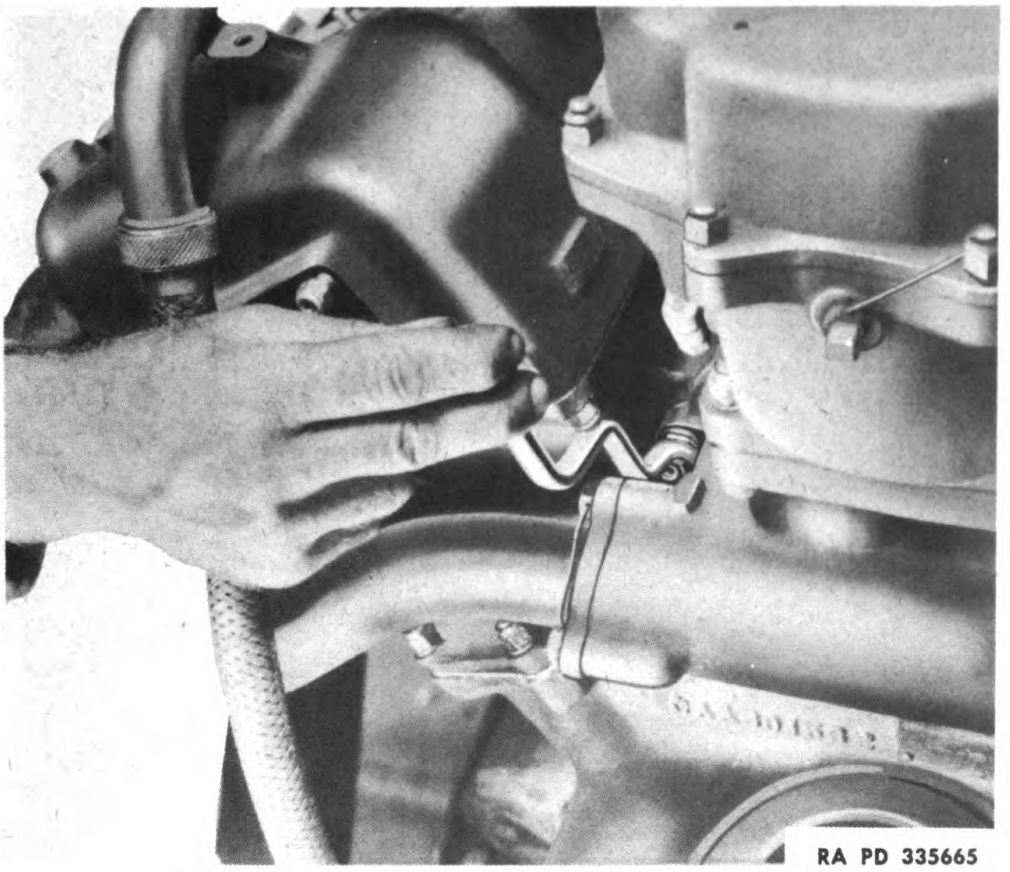

Figure 52 — Removing Carburetor Adapter Using Wrench (41-W-639-850)

adapters each contain two throttle plates operated by the engine speed governor.

b. Replacement. Open the engine compartment doors. Remove the heater pipe. Remove the carburetor (par. 64 e). Disconnect the clevis at the end of the governor throttle rod. When removing the rear adapter, disconnect the ball joint at the governor arm. Using wrench (41-W-639-850), remove the six nuts which hold the adapter to the manifold (fig. 52). Remove the adapter. To install the carburetor adapter, place it in position on the intake manifold studs and install the six nuts to secure it to the manifold. When installing the rear adapter, connect the ball joint at the governor arm. Connect the clevis at the end of the governor throttle rod.

66. DEGASSERS AND SOLENOIDS.

a. Description. Each barrel of both carburetors is equipped with a vacuum-operated degasser with an electric solenoid control for positive shut-off of the idle fuel mixture when stopping the engine (fig.

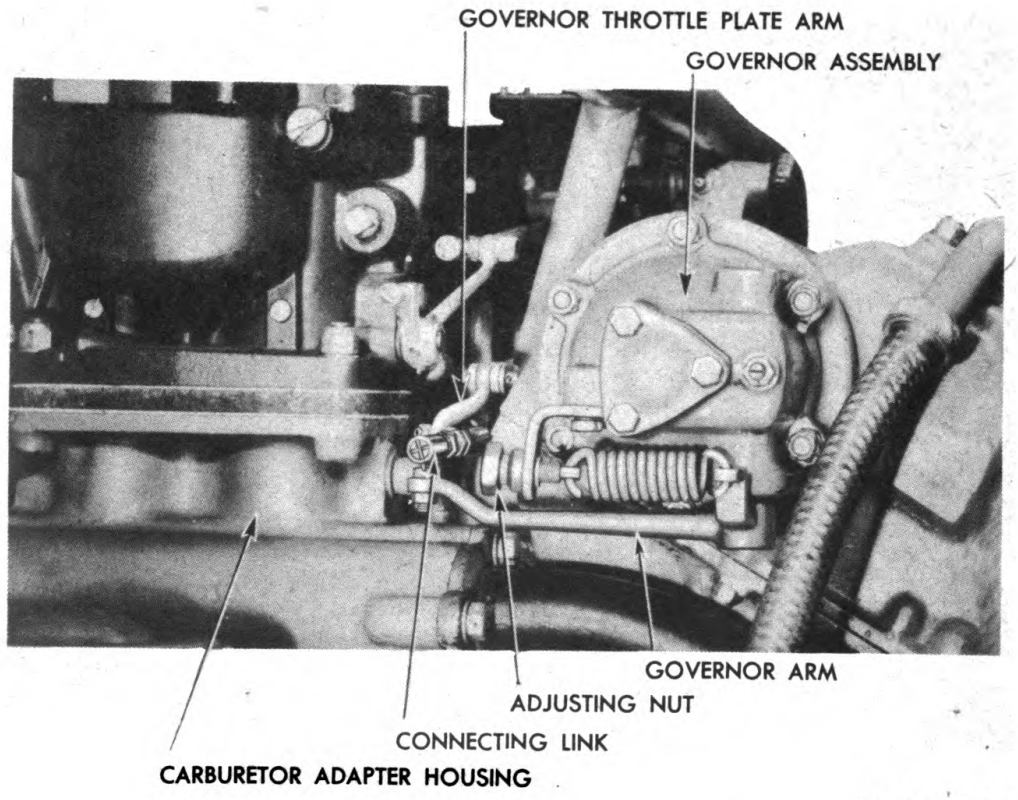

Figure 53 — Throttle Governor

51). All fuel flowing through the idle discharge holes passes through the degasser needle valve seat. The purpose of the degasser is to shut off the idle fuel supply when high manifold vacuum is present during deceleration thus preventing flame and backfire through the exhaust. The electric fuel cut-off portion of the degasser works independently of the vacuum-operated portion, although it is in the same assembly and operates the same needle valve. A solenoid built into each degasser closes the needle valve when the fuel cut-off button on the instrument panel is pressed. The purpose of the fuel cut-off is to shut off the idle fuel mixture just before stopping the engine, to prevent the fuel from reaching the cylinders, and to prevent the engine from continuing to run on preignition after the ignition switch has been turned off.

b. Replacement. To remove the degasser, open the engine compartment doors. Remove the two screws from the conduit shield cap and remove the cap. Pull the degasser wire out of its terminal socket. Remove the locking wire and the three screws which hold the degasser to the carburetor, and remove the degasser. To install the degasser, place it in position on the carburetor, and install three

screws to secure it to the carburetor. Install the locking wire in the screws. Connect the degasser wire and install the conduit shield cap. Close the engine compartment doors and install the cap screws.

c. Fuel Cut-Off Switch.

(1) REMOVAL. Separate the two halves of the instrument panel to gain access to the switch (par. 111 b). Disconnect two wires from lugs on rear of switch. Remove hex switch retaining nut from face of panel. Pull switch out through rear of panel face.

(2) INSTALLATION. Insert switch into opening through rear of panel face. Install hex retaining nut. Connect wires (fig. 85) to lugs on switch. Secure wires to lugs with toothed lock washers and screws. Assemble the two halves of the instrument panel and complete the installation (par. 111 c).

67. GOVERNOR.

a. Description. The speed of the engine is regulated and limited by the use of additional dual throttle plates located in each of the carburetor adapters directly under each carburetor. These carburetor adapter throttle plates are connected by a rod, which in turn is connected to the governor located at the rear of the right-hand camshaft housing and is driven by the right-hand intake camshaft (fig. 53). With the engine idling, these governor-actuated throttles are in the wide-open position. As the engine speed is increased, the action of the governor partially closes the throttles, thus limiting the maximum engine speed to approximately 2,600 revolutions per minute under full load. All maintenance on the governor must be referred to ordnance maintenance personnel.

b. Link Adjustment. The governor throttle connecting link (fig. 53) should be adjusted by means of the clevis on the forward end so that, with the engine stopped, both throttle levers are against the stop on both carburetor adapters (fig. 59).

c. Removal. Remove the cotter pin from the governor link at the governor. Loosen the governor link lock screw and disconnect the link from the governor. Remove the six nuts that hold the governor to the accessory cover and remove the governor.

d. Installation. Install a new gasket on the governor. Hold the governor in place on the camshaft cover and install the six nuts. Connect the governor link to the governor arm (fig. 53) and tighten the governor link lock screw; then back off the screw one-half turn. Install a cotter pin in the governor link. Adjust the governor throttle connecting link as outlined in subparagraph b above.

A—FUEL GAGE SENDING UNIT
B—ENGINE COMPARTMENT DOOR SHUTTER CONTROL
C—SPONSON COVER PLATE
D—TAILLIGHT CONDUIT
E—VENT HOSE
F—SENDING UNIT STANDPIPE
G—SENDING UNIT CONDUIT
H—HORIZONTAL TO VERTICAL TANK FUEL HOSE
I—HULL SIDE PLATE
J—FUEL FILTER
K—VERTICAL COVER PLATE
L—TOP COVER PLATE
M—ENGINE COMPARTMENT REAR DRAIN VALVE

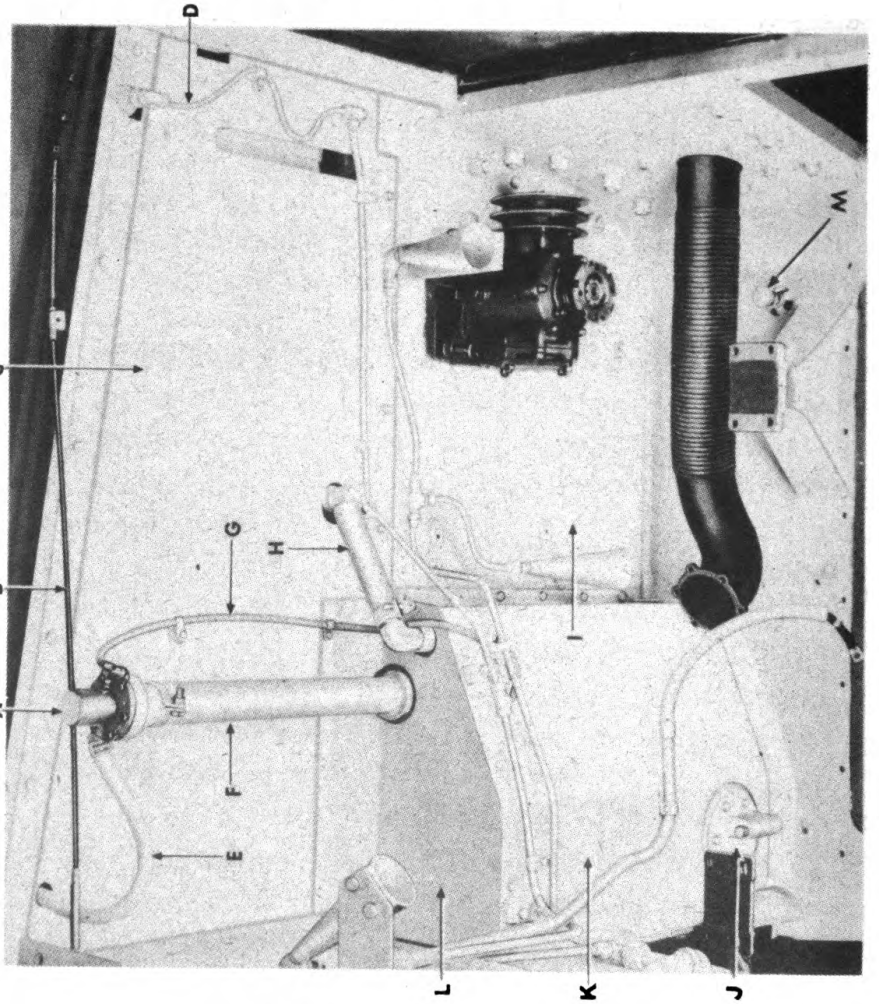

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Figure 54 — Right Side of Engine Compartment — Engine Removed

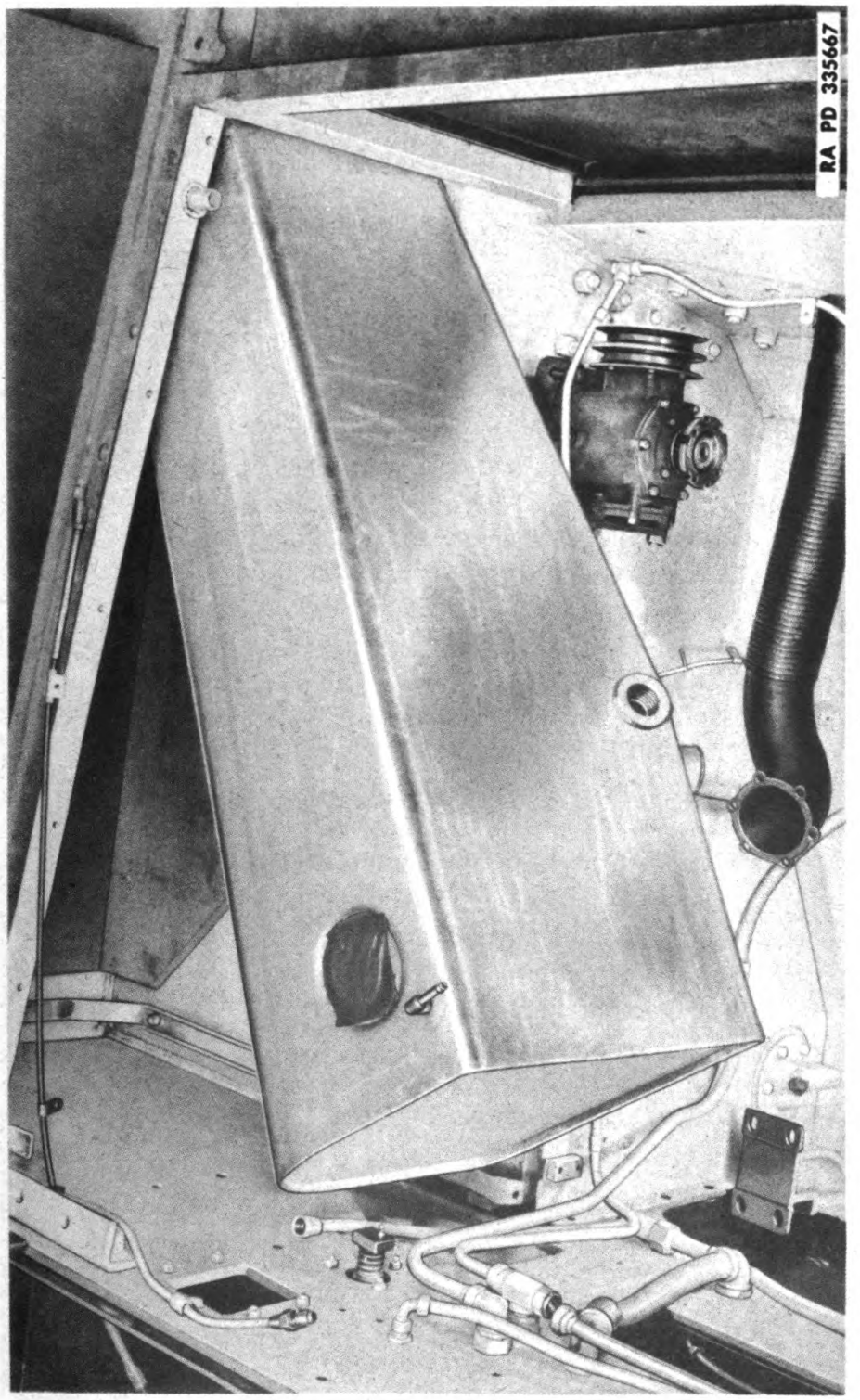


Figure 55 — Removing Horizontal Fuel Tank

68. FUEL TANKS.

a. Description (fig. 50). Two horizontal and two vertical fuel tanks are located on each side of the engine compartment. The horizontal tanks are on the sponson behind an engine compartment side wall plate on each side. The vertical tanks are at the front of the engine compartment beneath the air cleaners. The horizontal tanks are connected to the vertical tanks and, as long as they contain fuel, they automatically replace fuel used from the vertical tanks. No shut-off valve is provided for the horizontal tanks. However, a shut-off valve and drain plug is provided for each vertical tank (fig. 56).

b. Removal (figs. 54 and 55).

(1) HORIZONTAL FUEL TANKS.

(a) Remove Engine. Refer to paragraph 61.

(b) Remove Conduits from Sponson Cover Plate. Disconnect wire at fuel gage sending unit. Unscrew knurled nut and pull plug out of nipple at taillight harness. Remove cap screws and toothed lock washers which secure conduit clamps to sponson cover plate.

(c) Remove Rear Fire Extinguisher Nozzle and Bracket. Disconnect tubing from tee at bottom center fire extinguisher nozzle. Remove two cap screws and lock washers securing rear fire extinguisher nozzle bracket to sponson cover plate. Lift out rear bracket with attached nozzle and short length of tubing.

(d) Remove Fuel Gage Sending Unit. Loosen clamp and remove vent hose from sending unit. Remove cap screws and lock washers from top of sending unit. Lift out sending unit.

(e) Disconnect Engine Compartment Door Shutter Control Cable. Remove hex nut and toothed lock washers securing control cable to bulkhead. Push cable into fighting compartment until only flexible part of cable remains in engine compartment.

(f) Remove Horizontal to Vertical Tank Fuel Hose. Loosen clamps and remove rubber hose; then unscrew elbow from top of vertical tank. Unscrew fitting extending from horizontal tank.

(g) Remove Vertical Tank Top Cover Plate and Sending Unit Standpipe. Remove nut and bolt from clamp surrounding sending unit standpipe. Spread clamp apart. Remove cap screws and toothed lock washers which secure top cover plate to sponson cover plate and to vertical cover plate of the vertical fuel tank. Lift up top cover plate and screw sending unit standpipe out of vertical tank. Lift out sending unit standpipe and top cover plate.

(h) Remove Rear Sand Guard. Remove one cap screw and toothed lock washer; then release lock screws which attach rear sand guard to hull and to center sand guard. Lift off rear sand guard.

(i) Remove Sponson Cover Plate. Remove cap screws and flat washers which secure the plate to hull. Hold bolt heads located just above the track at rear of vehicle, and remove nuts along bottom edge of the plate in engine compartment. Push bolts out of bolt holes in the plate and lift out plate.

(j) Remove Filler Neck. Open filler cover. Loosen eight screws around grommet retaining ring. Pry out grommet assembly. Remove six screws retaining filler neck to horizontal fuel tank and lift out filler neck, spacer, and gaskets.

(k) Remove Horizontal Tank. Remove nuts and bolts from tank retaining straps. Using a short screwdriver, remove two rear strap retaining screws located above the track at rear of vehicle. Pry tank up, and remove wood spacers from beneath tank. Slide rear strap forward, then pull it out. Lift tank into engine compartment and out. Remove vent hose from elbow at forward end of tank.

(2) VERTICAL TANKS.

(a) Turn 24-volt Master Switch Off. Make certain that 24-volt master switch is in "OFF" position.

(b) Drain Fuel Tanks. Remove the plug in bottom of engine compartment floor opposite center of rear bogie wheel assembly, right and left. Use a 1-inch socket head set screw wrench for removal of plug. Remove tank plug with a $\frac{5}{16}$-inch socket head set screw wrench. Drain fuel into a clean container.

(c) Open Engine Compartment. Remove engine compartment top doors, front cover plate, and floor plate (par. 164).

(d) Remove Fuel Filter. Remove cotter pin and clevis pin at top of valve and disconnect linkage from valve. Remove fuel hose from elbow on right fuel shut-off valve; then remove elbow (three fuel hoses and a three-way connector on left shut-off valve). Unscrew and remove fuel shut-off valve from top of fuel filter. Remove cap screws and lock washers which secure filter to vertical fuel tank. Lift out filter, and remove gasket.

(e) Remove Air Cleaner Assembly. Refer to paragraph 74 c.

(f) Remove Sending Unit. Loosen clamp and remove vent hose from elbow at top of standpipe. Disconnect wire from sending unit and remove cap screws and lock washers securing sending unit to sending unit standpipe. Lift out sending unit.

(g) Disconnect Horizontal to Vertical Tank Fuel Hose. Loosen clamp and remove fuel hose from elbow at top of vertical tank. Screw elbow out of fuel tank.

(h) Remove Sending Unit Standpipe Clamp. Remove nut and bolt from clamp surrounding sending unit standpipe. Remove clamp from sponson cover plate by removing two attaching cap screws and lock washers.

(i) Detach Tubing and Conduits from Cover Plates. Disconnect fire extinguisher tube at tee above bottom center fire extinguisher nozzle. Remove cap screws and toothed lock washers from conduit and tube retaining clamps; then pull conduits and tubes away from vertical cover plate of the vertical fuel tank and sponson cover plate.

(j) Remove Top Cover Plate and Vertical Cover Plate Screws. Remove cap screws and lock washers which attach the top and vertical cover plates to bulkhead, hull side plate, and sponson cover plate.

(k) Remove Sending Unit Standpipe. Lift up top cover plate, and screw sending unit standpipe out of top of vertical tank. Remove top cover plate.

(3) REMOVE VERTICAL FUEL TANK. Remove wood spacers which surround tank. Screw sending unit standpipe back into opening in top of tank and using it as a lift, pull tank up and out.

c. Cleaning and Servicing. Remove foreign matter (gravel, scale, rust, etc.) from fuel tank. Rinse tank with dry-cleaning solvent. Inspect tank carefully for leaks or other damage done by foreign matter. Replace tank if damaged.

d. Installation.

(1) HORIZONTAL FUEL TANKS.

(a) Position Horizontal Fuel Tank. Secure rubber vent hose to elbow at forward end of tank with hose clamp. Lift tank into approximate position. Raise tank as much as possible; then slide rear wood spacers underneath tank and back behind rear tank retaining strap location. Slide rear strap under and over tank; do this at forward end of tank, then work strap back to its position. Insert remaining three wood spacers underneath the tank. Install two rear strap retaining screws through bottom of hull above the track at rear of vehicle. Fasten sides of retaining straps together with bolts and nuts, but do not tighten until filler neck has been installed (step *(b)* below).

(b) Install Filler Neck. Position gasket around filler opening in tank; then place spacer on gasket and place another gasket on spacer. Position filler neck on gasket and secure with six screws. Insert grommet assembly into filler cover opening and around filler neck. NOTE: *It may be necessary to move the tank in order to center the filler neck and grommet assembly in the filler cover opening.* Tighten screws around grommet retaining ring, as well as forward and rear tank retaining strap nuts and bolts.

(c) Install Sponson Cover Plate. Attach top of plate to hull with cap screws and flat washers. Push bolts through hull and plate; then hold bolt heads while installing nuts to secure bottom edge of plate.

(d) Install Rear Sand Guard. Attach rear sand guard to hull

and center sand guard with cap screw, toothed lock washer, and lock screws.

(e) Install Sending Unit Standpipe and Vertical Tank Top Cover Plate. Place sending unit standpipe through opening in vertical tank top cover plate. While holding up cover plate, thread sending unit standpipe into opening in top of vertical tank; then secure top cover plate to sponson cover plate and to vertical cover plate of the vertical fuel tank with toothed lock washers and cap screws.

(f) Install Horizontal to Vertical Tank Fuel Hose. Thread fitting into opening at bottom center of horizontal tank. Thread elbow into opening in top of vertical fuel tank. Attach rubber hose to elbow and to fitting with clamps.

(g) Secure Engine Compartment Door Shutter Control. Pull shutter control cable into engine compartment. Secure control to bulkhead with toothed lock washer and nut.

(h) Install Fuel Gage Sending Unit. Insert sending unit through top of sending unit standpipe into vertical fuel tank. Attach sending nut to top of sending unit standpipe with lock washers and cap screws. Attach rubber vent hose extending from top of horizontal tank to fitting extending from sending unit standpipe.

(i) Install Rear Fire Extinguisher Nozzle and Bracket. Secure bracket with rear fire extinguisher nozzle attached to sponson cover plate lock washers and cap screws. Connect tubing, which is attached to rear nozzle, to tee at bottom center fire extinguisher nozzle.

(j) Secure Conduits. Attach sending unit wire to terminal on sending unit with lock washer and nut. Insert taillight harness plug into receptacle in nipple at upper rear corner of engine compartment; then secure conduit to nipple with knurled conduit retaining nut. Secure conduits to sponson cover plate by securing conduit clamps to plate with toothed lock washers and cap screws.

(k) Install Engine. Refer to paragraph 62.

(2) VERTICAL FUEL TANKS.

(a) Position Tank. Lower the fuel tank into position in engine compartment. Place wood spacers around tank.

(b) Secure Vertical Cover Plate. Secure vertical cover plate to engine hull side plate and to bulkhead with cap screws and lock washers.

(c) Install Sending Unit Standpipe and Top Cover Plate. Position top cover plate over top of fuel tank; then hold plate up and screw sending unit standpipe into opening in top of fuel tank. Install top cover plate retaining cap screws and lock washers.

(d) Install Sending Unit Standpipe Clamp. Attach sending unit standpipe clamp to sponson cover plate with two lock washers and

cap screws. Secure camp around sending unit standpipe with bolt and nut.

(e) Install Sending Unit. Insert sending unit into sending unit standpipe and secure with lock washer and cap screws, using one of the cap screws to retain sending unit conduit clamp. Connect wire to terminal on sending unit. Attach vent hose to elbow on sending unit.

(f) Connect Horizontal to Vertical Tank Fuel Hose. Install elbow in top of fuel tank and attach horizontal to vertical fuel hose to elbow.

(g) Attach Tubing and Conduits. Connect fire extinguisher tube to tee above bottom center fire extinguisher nozzle. Secure conduit and tube retaining clamps to sponson cover plate hull side plate and the vertical cover plate of the vertical fuel tank.

(h) Install Air Cleaner Assembly. Refer to paragraph 74 c.

(i) Install Fuel Filter. Position gasket around filter opening. Insert filter into vertical fuel tank and secure with lock washers and cap screws. Screw fuel shut-off valve into top of fuel filter. Install elbow in top of right fuel shut-off valve (three-way connector on left valve) and attach fuel hose to elbow (three fuel hoses to connector on left side). Connect linkage to valve with clevis pin and cotter pin.

(j) Close Engine Compartment. Install engine compartment top doors, front cover plate, and floor plate (par. 164).

(k) Install Fuel Tank Drain Plugs. Install tank plug with a $^{5}/_{16}$-inch socket head set screw wrench. Install plug in engine compartment floor with a 1-inch socket head set screw wrench.

(l) Record Installation. Make proper entry on W.D. A.G.O. Form No. 478, MWO and Major Unit Assembly Replacement Record.

69. FUEL SHUT-OFF VALVES.

a. Description (figs. 50 and 56). Fuel shut-off valves are located on top of each of the filters at the bottom of the vertical fuel tanks. Control of these valves is brought up in the engine compartment and through the bulkhead into the fighting compartment by linkage attached to each valve.

b. Controls and Linkage Replacement.

(1) REMOVAL. Open engine compartment top doors. Remove cotter pin and loosen plug from ball joint of fuel shut-off linkage; then slide joint off ball on control. Remove cotter pin and clevis pin attaching bottom of linkage to shut-off valve. Lift out linkage. Remove the control attaching nuts, lock washers, and bolts from fighting compartment side of bulkhead and lift off the control.

(2) INSTALLATION. Secure control to bulkhead with bolts, lock washers, and nuts. Attach fuel shut-off linkage to control in engine

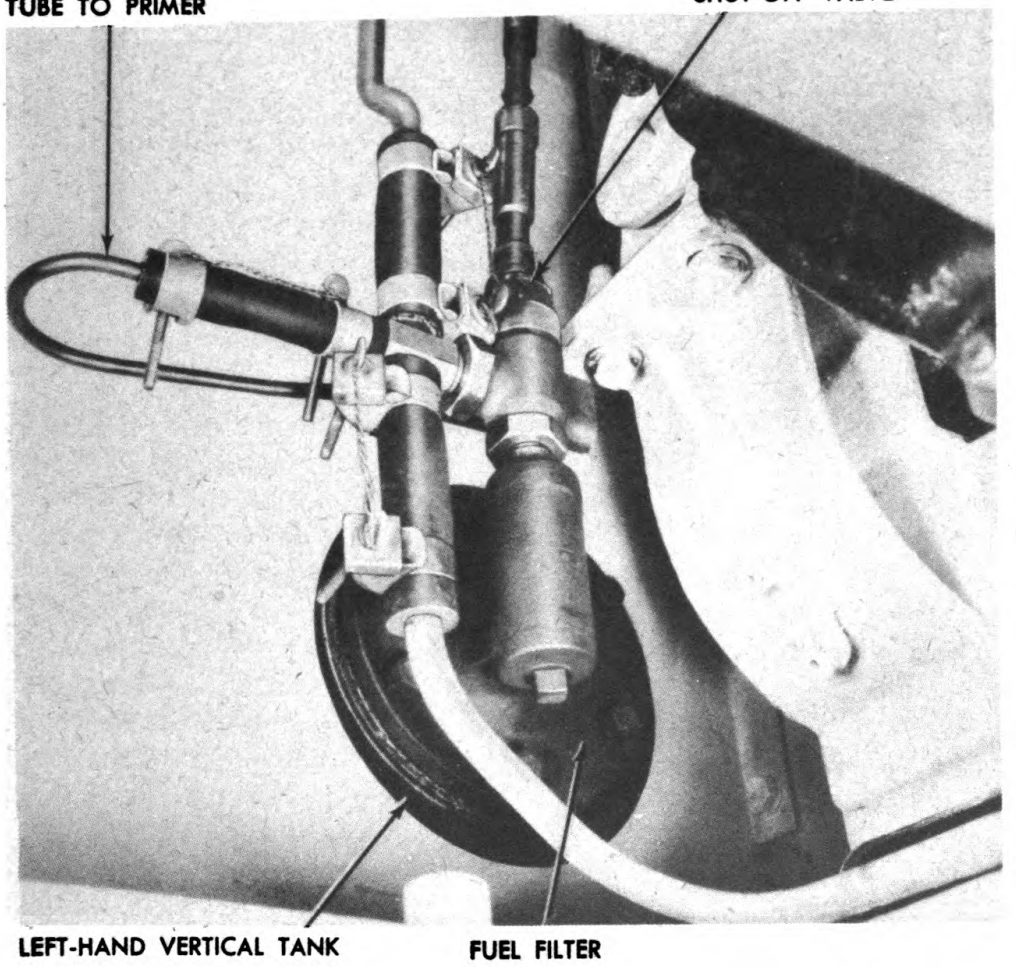


Figure 56 — Fuel Shut-Off Valve and Connections

compartment side of bulkhead by sliding joint on ball, adjusting plug to a free fit, and installing cotter pin. Attach lower end of linkage to fuel shut-off valve with clevis pin and cotter pin.

c. Valve Replacement. Refer to paragraph 61 **j** and 62 **q**.

70. FUEL FILTERS.

a. Description. Each vertical fuel tank is provided with a disk-type filter located inside the bottom of the tank (fig. 56).

b. Removal (fig. 56).

(1) DRAIN FUEL TANKS. Remove plug in bottom of engine compartment floor opposite center of rear bogie wheel assembly using a 1-inch socket head set screw wrench. Remove tank plug with a

5/16-inch socket head set screw wrench and drain fuel into a clean container.

(2) REMOVE ENGINE COMPARTMENT FLOOR PLATE. Refer to paragraph 164 f.

(3) REMOVE FILTER. Remove cotter pin and clevis pin at top of valve and disconnect linkage from valve. Remove fuel hose from elbow on right fuel shut-off valve; then remove elbow (three fuel hoses and a three-way connector on left shut-off valve). Unscrew and remove fuel shut-off valve from top of fuel filter. Remove cap screws and lock washers which secure filter to vertical fuel tank. Lift out filter and remove gasket.

c. Installation (fig. 56).

(1) CLEAN FILTER ELEMENT. Wash filter element with dry-cleaning solvent. CAUTION: *Do not damage the disks. Do not scrape or scrub, and do not disassemble the filter element.* If element cannot be cleaned satisfactorily, replace entire element assembly.

(2) INSTALL FUEL FILTER. Position gasket around filter opening. Insert filter into vertical fuel tank and secure with lock washers and cap screws. Screw fuel shut-off valve into top of fuel filter. Install elbow in top of right fuel shut-off valve (three-way connector on left valve) and attach fuel hose to elbow (three fuel hoses to connector on left side). Connect linkage to valve with clevis pin and cotter pin.

(3) INSTALL ENGINE COMPARTMENT FLOOR PLATE. Refer to paragraph 164 g.

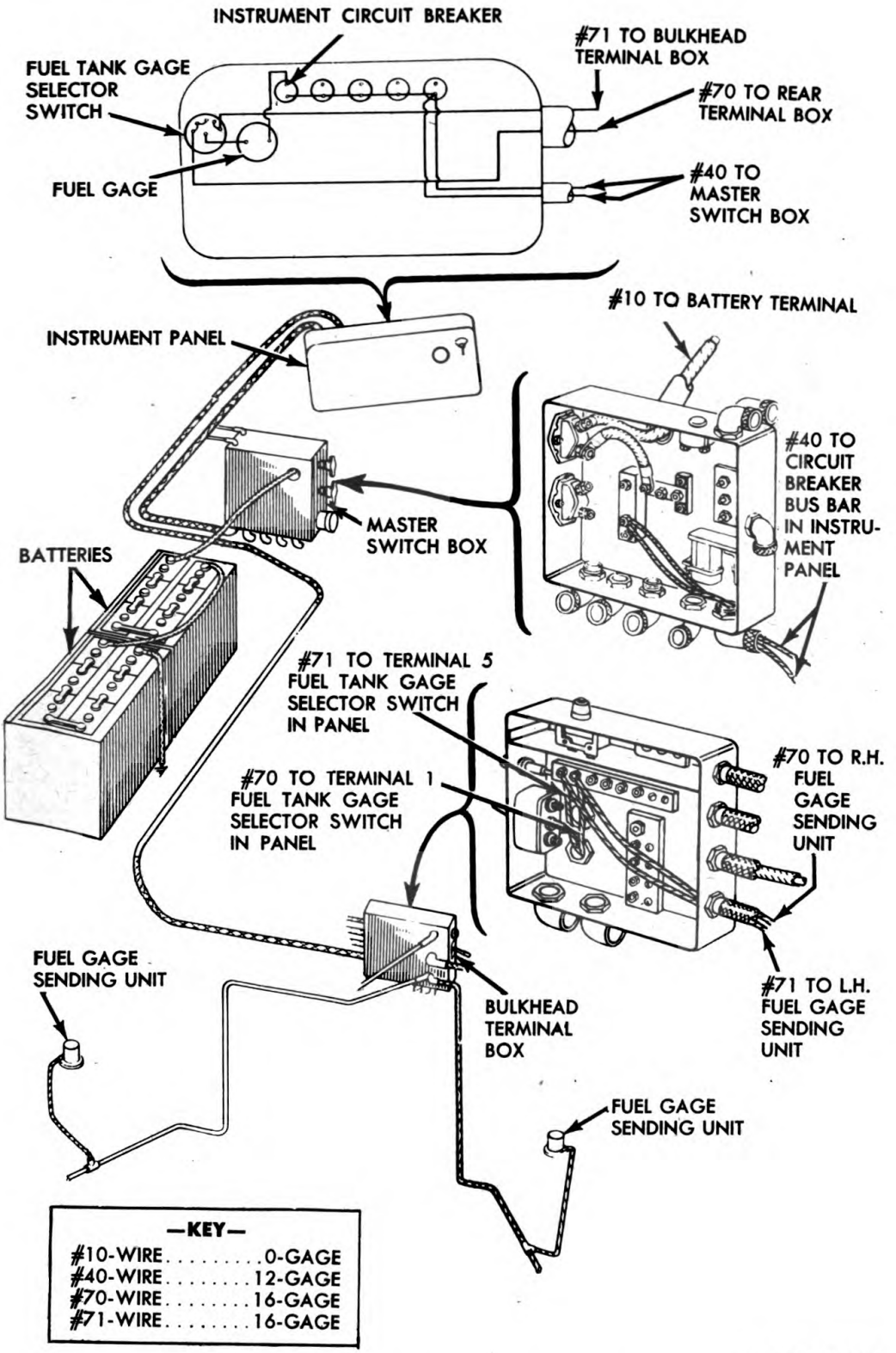
71. FUEL PUMP.

a. Description. The fuel pump is of the conventional diaphragm type and is mounted on the left-hand camshaft cover. The pump is driven by the left intake camshaft. The pump maintains from 4½- to 6-pounds fuel pressure to the carburetors.

b. Replacement. Close all of the fuel shut-off valves. Disconnect the fuel inlet hose connection at the pump. Disconnect the outlet fuel hose at the pump. Remove the two nuts and washers which secure the pump to the camshaft housing and remove the fuel pump. To install the fuel pump, place it in position on the camshaft cover with a new gasket and install the two flat washers and nuts. Connect the inlet and outlet fuel hose connections to the pump. Open the fuel shut-off valves.

72. FUEL GAGE, SWITCH, AND TANK UNITS (fig. 57).

a. Description. The fuel gage in the instrument panel measures the fuel in the right or left tanks, depending on the tank unit to which the fuel gage switch is turned. The rotary-type switch



RA PD 335669

Figure 57 — Fuel Gage Wiring Diagram

mounted beside the fuel gage on the instrument panel has two positions each side of its center or "OFF" position. However, the switch is wired so that either position on the "L" side of the switch reads the amount of fuel in both left tanks and either position on the "R" side reads the fuel in both right tanks.

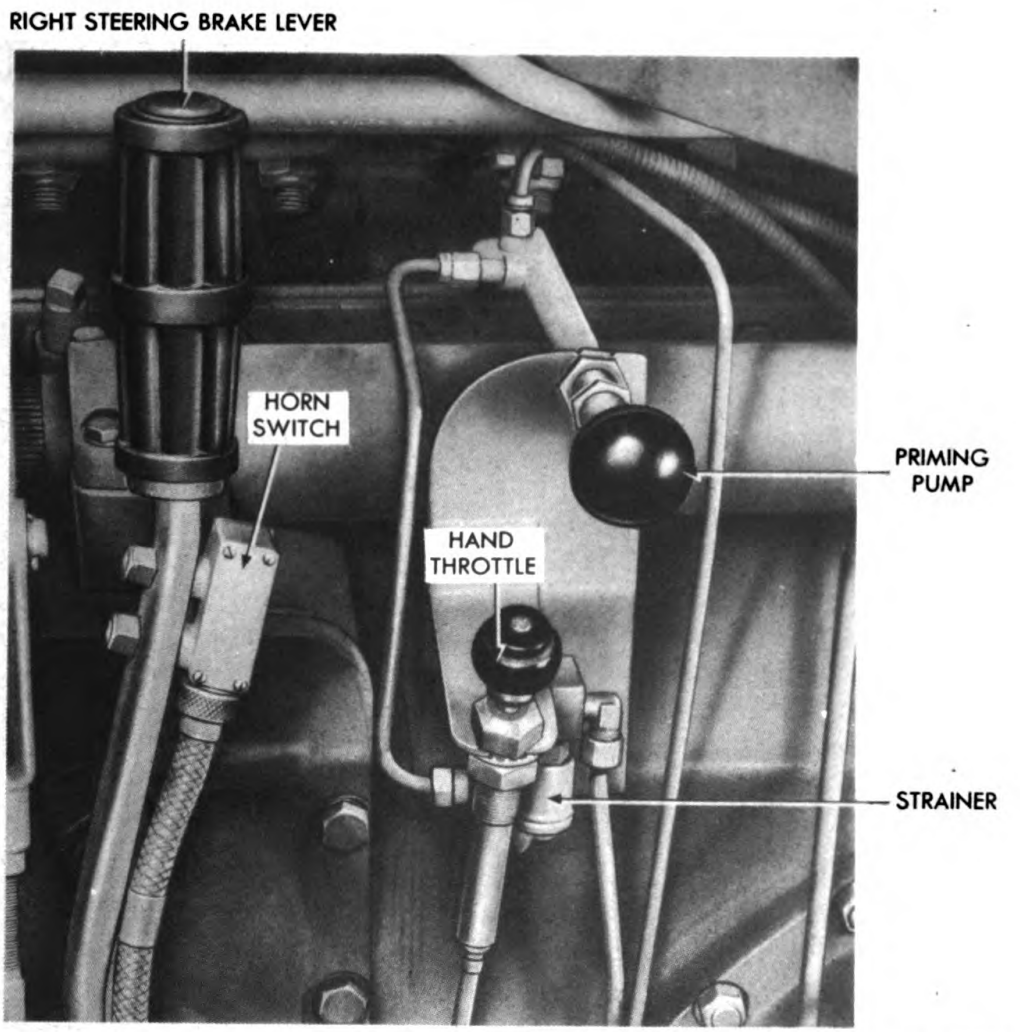
b. Fuel Gage Replacement. To remove the fuel gage, first separate the two halves of the instrument panel (par. 111 b). Then remove the three screws and toothed lock washers which secure receptacle case to mounting posts above fuel gage. Push receptacle case aside. Remove wires and insulator from back of gage. Remove four mounting studs with toothed lock washers. Lift off mounting bracket. Remove gage through face of panel. To install gage, insert through front of panel and secure with bracket and four mounting studs. Install four toothed lock washers and stud nuts. Secure insulator with wires attached to back of gage using toothed lock washers and nuts. Position receptacle case on mounting posts over gage and secure with toothed lock washers and nuts. Assemble the two halves of the instrument panel (par. 111 c) and complete the installation.

c. Fuel Gage Switch Replacement. Separate the two halves of the instrument panel to gain access to switch (par. 111 b). Disconnect wires from back of switch. Remove screw and lock washer from center of switch control handle. Pull off control handle. Remove switch retaining nut, toothed lock washer, and the fiber face plate. Remove switch. Position new switch through rear of instrument panel face. Install the fiber face plate, toothed lock washer, and switch retaining nut. Press switch control handle into position and secure with lock washer and screw. Connect wire No. 70 to lug No. 1, wire No. 71 to lug No. 5, and wire No. 74 to lug "GA". Secure wires with toothed lock washers and screws. Assemble the two halves of the instrument panel (par. 111 c) and complete the installation.

d. Fuel Gage Tank Unit Replacement (Either Unit). Disconnect wire from sending unit and remove cap screws and lock washers securing sending unit tube to standpipe. Lift out unit. Insert new unit into sending unit standpipe and secure with lock washer and cap screws, using one of the cap screws to retain the conduit clamp and another to hold the engine compartment door shutter cable. Connect wire to terminal on unit.

73. PRIMING SYSTEM.

a. Description. The priming system is controlled by a priming pump located on a bracket attached to the differential housing in front of the driver (fig. 58). When priming pump handle is drawn out, fuel is drawn from the left vertical fuel tank through a tube into



RA PD 322725

Figure 58 — Priming Pump and Hand Throttle

the pump. Pushing in on priming pump handle forces fuel out of the pump through tubing to the primer jets located in the intake manifold. Fuel is thus forced to each cylinder.

b. Priming Pump Replacement.

(1) REMOVAL. Disconnect inlet and outlet tubes from pump by backing off hex retaining nuts. Back off hex nut retaining priming pump to bracket. Lift off priming pump.

(2) INSTALLATION. Position priming pump in slot at top of bracket and secure with hex retaining nut. Connect inlet and outlet tubes.

c. Strainer.

(1) DESCRIPTION (fig. 58). A strainer, located at the bottom of

the priming pump bracket adjacent to the hand throttle, serves to strain fuel forced through the outlet priming lines.

(2) SERVICE. Unscrew wing cap with attached strainer screen from strainer bowl. Remove foreign matter from screen and wash with dry-cleaning solvent. Position washer on wing cap and thread strainer into strainer bowl.

d. Priming Tubes and Fittings.

(1) DESCRIPTION. Priming tubes from the priming pump are located beneath the propeller shaft and extend through the bulkhead into the engine compartment. The outlet tube is joined to a rubber hose above the engine. This hose is attached to a tee from which the small tubes running to the intake manifold are joined. Tee and elbow fittings which retain jets are threaded into the intake manifold.

(2) CLEANING PRIMING TUBES AND JETS. Disconnect tubes at priming pump. Disconnect outlet tube at junction tee near forward carburetor. Disconnect inlet tube above fuel filter at bottom of left vertical fuel tank. Blow air through tubes. To clean jets, remove priming tubes from tees and elbows extending into intake manifold. Unscrew and remove tees and elbows. Unscrew jets from tees and elbows. Blow air through jets to clean jet openings.

74. AIR CLEANERS.

a. Description. Two air cleaners of the oil-bath type are mounted on the bulkhead in the engine compartment (fig. 47). An air cleaner duct assembly is provided for each air cleaner. These ducts lead into the fighting compartment (fig. 9). A control handle is located at each duct opening into the fighting compartment. When the handle is pushed in, the air is drawn into the air cleaner from the fighting compartment. When the handle is pulled out, the air is drawn from the engine compartment. Two air cleaner inspection doors, located in the fighting compartment at either side of the bulkhead are provided for the servicing of the air cleaner (figs. 9 and 23).

b. Servicing. Open the air cleaner inspection door in the fighting compartment. Remove the two wing nuts from the bottom plate of the cleaner and remove the cup assembly through the inspection opening. Remove the two wing nuts that secure the filter screen to the cleaner. Remove the filter screen and wash it with dry-cleaning solvent. Place the screen in the cleaner and secure it with two wing nuts. Clean the cup thoroughly and refill the cup to the mark with specified oil (par. 32). Care should be taken not to fill the cup above the oil level mark (fig. 23). Place the cup assembly in position on the bottom of the cleaner and secure it with two wing nuts. Close the inspection doors.

c. Replacement. To remove either air cleaner assembly, remove the cap screws which secure the air duct to the top of the air cleaner and remove the duct. Loosen the clamps at each end of the carburetor intake to air cleaner tube and remove the tube. Remove the four cap screws which hold the mounting band and remove the cleaner. To install the air cleaner, place it in position on the bracket. Place the mounting band in position and secure it to the bracket with four cap screws. Install the air intake tube on the carburetor air intake manifold and the air cleaner connections. Place the air duct on top of the air cleaner and in the opening in the bulkhead. Secure it to the cleaner with the cap screws.

75. THROTTLE CONTROLS AND LINKAGE.

a. Description. The hand throttle, mounted on a bracket attached to the differential housing (fig. 58), is connected with the foot throttle linkage to the carburetors. The accelerator cross shaft sleeve moves on bearings over the clutch cross shaft (fig. 124) located at the rear of the driver's seat. A slip connection at the sleeve allows either the hand throttle or the accelerator pedal to be operated independently of the other. The carburetor throttle linkage (fig. 59) is arranged to permit the rear carburetor throttle plates to open approximately halfway before the forward carburetor throttle plates start to open. The rate of opening of the throttle plates in the forward carburetor is approximately twice that of the rear carburetor, with the result that both reach the wide-open point together.

b. Hand Throttle.

(1) REMOVAL. Remove driver's seat and floor plates (par. 162 b). Back off nut at bottom of hand throttle support bracket and lift hand throttle up and out of bracket (fig. 58). Disconnect throttle control cable rod at sleeve; then remove the clevis and nut from end of rod. Remove rear nuts at throttle control bracket on hull floor (fig. 124) and pull throttle control cable rod out of opening in bracket.

(2) INSTALLATION. Insert end of hand throttle control cable rod through opening in bracket on hull floor (fig. 124). Slide nuts over end of rod. Install nut and clevis on end of rod; then attach rod to sleeve with clevis pin and cotter pin. Secure rod to bracket on hull floor. Secure hand throttle to hand throttle support bracket. Check operation of hand throttle and adjust if necessary (step (3) below). Install driver's floor plates and seat.

(3) ADJUSTMENT. With sleeve in full rear position, the hand throttle control should be down in full closed position and have a free play of approximately ⅛ inch. To adjust, disconnect hand throttle control cable rod at sleeve and turn clevis to lengthen or shorten the rod as necessary. Connect rod and check position of hand throttle control and sleeve.

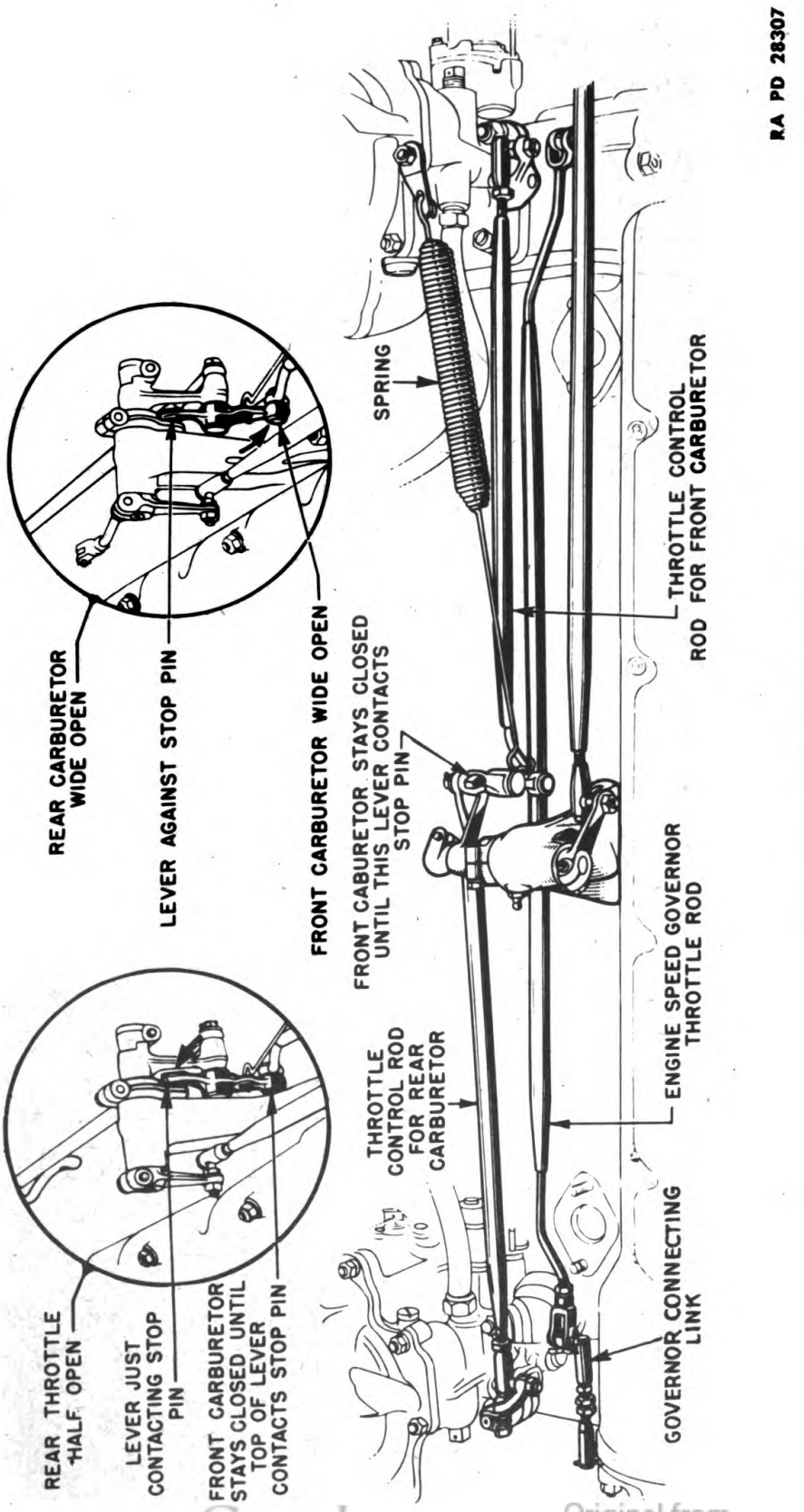


Figure 59 — Throttle Linkage

c. Foot Throttle Pedal.

(1) REMOVAL (fig. 124). Remove driver's seat and floor plates. Remove foot throttle pedal return spring. Remove cotter pin and clevis pin securing accelerator front rod to pedal. Remove locking wire and screw pedal shaft bolt out of bracket and pedal. Lift out pedal.

(2) INSTALLATION (fig. 124). Position pedal between brackets and install pedal shaft bolt and locking wire. Install pedal return spring. Attach accelerator front rod to pedal with clevis pin and cotter pin. Install driver's floor plate and seat (par. 162 c).

(3) ADJUSTMENT. Adjust pedal stop screw so it will permit pedal to return without hitting the floor plate. Then adjust accelerator front rod length to permit installation of clevis pins without turning the sleeve.

d. Carburetor Throttle Linkage (fig. 59).

(1) ADJUSTMENT. Screw the ball and socket joint on each throttle control rod until a length of 16⅝ inches, measured from the center of the ball to the center of the pin hole at the other end of the rod, is obtained. Adjust the length of the rod connecting the lever at the center bracket to the cross shaft on the bulkhead to attain a length of 22 inches, measuring it from the end of one ball joint to the other end of the rod. After all controls are connected, adjust the stop on the inner end of the center bracket cross shaft so that the rear carburetor will start to open with a slight movement of the throttle rod.

76. EXHAUST PIPE REPLACEMENT.

a. Removal. To remove either the right- or left-hand exhaust pipe, remove the six bolts that secure the exhaust pipe to the exhaust manifold on the engine. Loosen the nut on the clamp bolt at the exhaust pipe at rear of engine compartment. Remove the exhaust pipe. Remove the bolts from the external exhaust pipe on rear of hull and remove the pipe.

b. Installation. To install the exhaust pipe, use new bolts, nuts, and gaskets and assemble the exhaust pipe to the exhaust manifold. Using new packing, install the bolts securing the external exhaust pipe to the rear of the hull.

Section XX

COOLING SYSTEM

77. DESCRIPTION AND DATA.

a. Description. The engine is cooled by circulation of water through water jackets which extend the full length of the cylinder bores. The water is circulated through the engine blocks and radiator by a centrifugal pump (fig. 29). The entire cooling system is sealed by means of a pressure filler cap (fig. 61). A valve in the filler cap remains closed until a pressure of 12 pounds is reached, which raises the boiling point of the coolant and reduces loss of water or antifreeze. An expansion tank (fig. 47) permits steam or antifreeze vapors to condense and return to the cooling system, effecting further saving of water or antifreeze.

b. Data.

Capacity of cooling system ..... 14 gal.

78. SERVICING COOLING SYSTEM.

a. Draining, Cleaning, and Flushing.

(1) DRAINING. Open engine compartment rear and top doors. Remove drain plugs at bottom of water pump (fig. 28) and expansion tank (fig. 61). Remove drain plugs at the rear of each bank of cylinders, located approximately 6 inches ahead of the rear engine mounts (figs. 27 and 28).

(2) CLEANING.

(a) Allow engine to cool. Install all drain plugs. Remove filler cap and open air bleeder valve in radiator inlet connection to rid the system of air (fig. 63). Pour water into system until it is approximately half full; then run the engine at idling speed. Add cleaning compound in proportion of one container of cleaner to every 4 gallons of cooling system capacity. Then complete filling the system with water. CAUTION: *Never mix the water and cleaning compound before putting them into the system. Do not spill the solution on skin, clothing, or painted portions of the vehicle. Never mix cleaning compound with antifreeze solutions or with inhibitors.*

(b) Place a clean drain pan in position under the expansion tank overflow pipe to collect the overflow. Use the overflow to maintain the level in the system if necessary. Check level by opening air bleeder cock in radiator inlet connection (fig. 63). NOTE: *Do not fill above this point.*

(c) Install filler cap and run engine at fast idling speed until the coolant reaches a temperature of 180° F, but not over 200° F. Do not drive the vehicle. Recheck system level frequently.

(d) Stop the engine after it has run for 30 minutes at a temperature of at least 180°, but not over 200° F; then drain the system completely (step (1) above).

(3) NEUTRALIZING.

(a) Allow engine to cool. Install all drain plugs. Remove filler cap, open air bleeder cock, and pour water into system until it is approximately half full; then run the engine at idling speed. Add neutralizing compound in proportion of one container of neutralizer to every 4 gallons of cooling system capacity; then fill system with water.

(b) Let engine idle for at least 5 minutes at normal operating temperature; then stop the engine.

(c) Drain system completely (subpar. a (1) above).

(4) FLUSHING.

(a) Allow engine to cool. Install all drain plugs. Remove filler cap and pour water into system until it is approximately half full; then run engine at idling speed and fill system completely.

(b) Run the engine until coolant is heated to normal operating temperature.

(c) Drain system completely (subpar. a (1) above). Repeat flushing operation until the drain water is clear.

(5) LEAKS. After completing the flushing operation, make certain that the engine has been allowed to cool again. Install all drain plugs. Remove filler cap and pour water into system until it is approximately half full; then run the engine at idling speed and fill system to level of air bleeder cock in radiator inlet connection. Stop the engine and examine entire system for leaks. This is important because the cleaning solution uncovers leaks which already exist but may have been plugged with rust or corrosion.

b. Inhibitor. To control rusting of the iron in the cooling system and corrosion of the aluminum cylinder block and cylinder heads, a soluble oil corrosion inhibitor must be used. When servicing the vehicle for summer, fill the system nearly full with clean water. Add corrosion inhibitor compound in proportion of one container of compound to each 4 gallons of cooling system capacity. Then complete filling of the system to level of the air bleeder cock in the radiator inlet connection.

c. Antifreeze. When servicing for winter, fill the system about one-quarter full of clean water. Add sufficient antifreeze compound for protection against the lowest anticipated temperature (par. 25 d). Add water until the system is nearly full; then run the engine until normal operating temperature is reached. Add sufficient water to fill the system to the proper level.

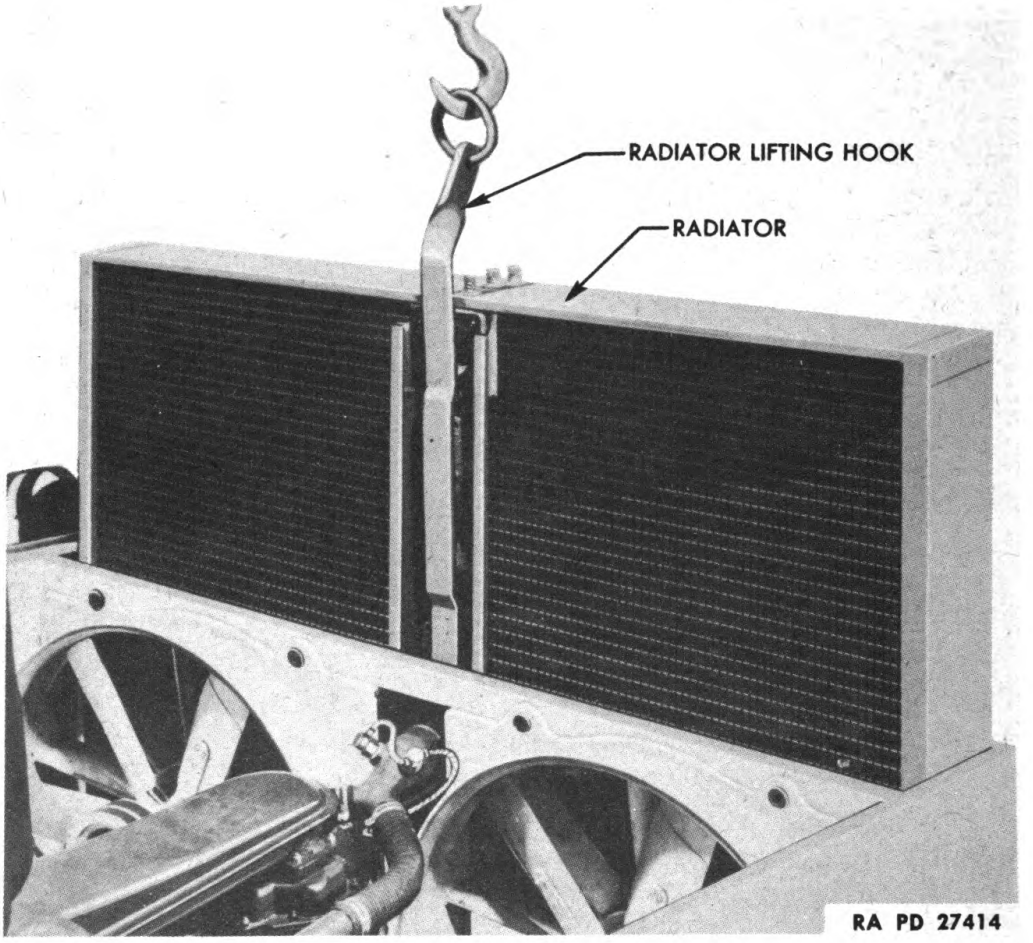


Figure 60 — Removing Radiator Using Sling (41-S-3832-86)

79. RADIATOR.

a. Description. The radiator is located at the rear of the vehicle behind the fans. It is a tube-and-fin cross-flow type, using flat horizontal tubes. Hot water flows through the tubes to which thin vertical copper fins are attached. Air forced between these fins by the fans carries the heat away, thus cooling the water.

b. Removal.

(1) OPEN ENGINE COMPARTMENT AND REMOVE REAR COVER PLATE. Remove four door-securing cap screws and open engine compartment top doors. Remove cap screws which secure rear cover plate to hull and lift off rear cover plate.

(2) DRAIN COOLING SYSTEM. Remove three engine compartment rear door-securing cap screws and open rear door. Remove drain plug at bottom of water pump and drain cooling system.

(3) REMOVE RADIATOR HOLD-DOWN PLATE. Remove two top nuts and bolts from each fan shroud. Lift out radiator hold-down plate and felt pad.

(4) REMOVE UPPER AIR BAFFLE CAP SCREWS. Remove upper air baffle cap screws, flat washers, and lock washers from each end of air baffle.

(5) DISCONNECT VENT TUBES. Back off tube retaining nut and remove nipple from radiator top on each side.

(6) REMOVE THERMOSTAT. Disconnect hoses from radiator inlet connection. Remove four cap screws and lock washers which retain connection to top of radiator. Pull off connection and remove gasket. Lift thermostat and thermostat gasket out of inlet opening in radiator.

(7) REMOVE CRANKCASE BREATHER. Release two holding clips and lift out cover and crankcase breather element.

(8) REMOVE RADIATOR OUTLET CONNECTION. Disconnect hoses from water pump. Remove four cap screws and lock washers which secure connection to bottom of radiator. Lift out connection with attached hoses and remove gasket.

(9) REMOVE EXHAUST DEFLECTOR. Remove bolt, nut, and flat washer securing each end of exhaust deflector to hull. Lower the deflector to floor. Slide bushing from seats in both ends of deflector.

(10) REMOVE AIR BAFFLE. Remove nuts, bolt, and flat washer from each bottom end of air baffle and lower the air baffle to ground.

(11) REMOVE RADIATOR. Tip radiator backward and install radiator lifting sling (41-S-3832-86) (fig. 60) with hooks in radiator inlet and outlet openings. Using available lifting equipment, lift radiator up and out.

c. Inspection and Repair. Inspect radiator for bent fins, cracked or kinked tubes, and fractured seams. Straighten fins with a pair of pliers. Solder the cracked tubes and seams. Use air hose to remove dirt clogged between tubes and fins. If radiator leaks and source of leak cannot be determined visually, test as follows: Flush radiator out thoroughly. Plug all inlet and outlet connections except one. Attach air hose, submerge tank in water, and fill with air using not more than 5 pounds per square inch pressure. If source of leak is easily accessible, repair as described above. If not, install new radiator.

d. Installation.

(1) LOWER THE RADIATOR INTO RADIATOR COMPARTMENT. Install radiator lifting sling (fig. 60). Check to see that felt pad at bottom of radiator compartment is in good condition and in place. Lower radiator into compartment and remove lifting sling.

(2) INSTALL AIR BAFFLE. Lift air baffle into position and secure to hull sides with flat washer, bolt, and nut at lower ends of air baffle.

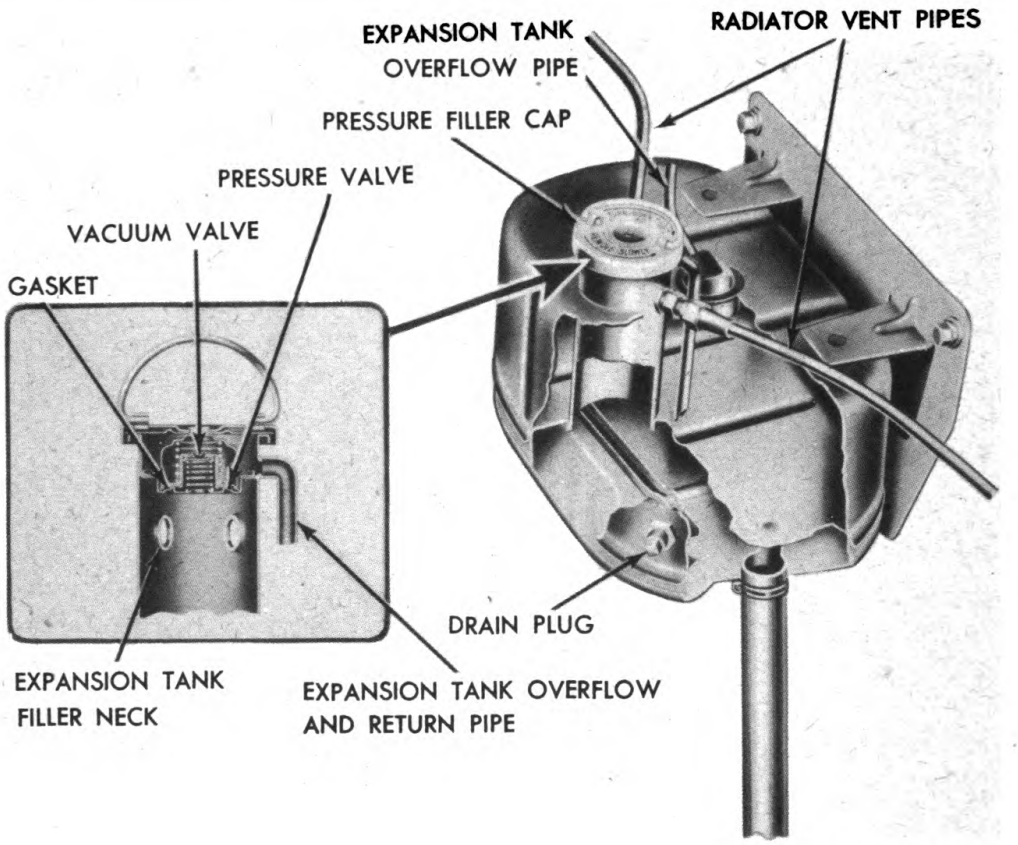


Figure 61 — Radiator Filler and Expansion Tank

(3) INSTALL EXHAUST DEFLECTOR. Slide bushings into seats at each end of deflector. Lift deflector into position and secure to hull sides with flat washer, bolt, and nut.

(4) INSTALL CRANKCASE BREATHER. Position breather element on breather. Install cover and secure with holding clips.

(5) INSTALL RADIATOR OUTLET CONNECTION. Position connection gasket and attach connection to bottom of radiator with four lock washers and cap screws. Connect hoses to water pump.

(6) INSTALL THERMOSTAT AND RADIATOR INLET CONNECTION. Position thermostat gasket and thermostat in inlet opening at top of radiator. Position connection gasket and secure connection to radiator with four lock washers and cap screws. Connect manifold hoses to inlet connection.

(7) CONNECT VENT TUBES. Install nipples in openings at upper ends of radiator. Connect vent tubes to nipples with tube retaining nuts.

(8) INSTALL UPPER AIR BAFFLE CAP SCREWS. Secure upper ends of air baffle to hull sides with flat washers, lock washers, and cap screws.

(9) INSTALL RADIATOR HOLD-DOWN PLATE. Position felt pad across top of radiator. Position hold-down plate on pad and secure with top two fan shroud bolts and nuts on each side.

(10) FILL COOLING SYSTEM. Install drain plug at bottom of water pump. Fill cooling system.

(11) INSTALL REAR COVER PLATE AND CLOSE ENGINE COMPARTMENT DOORS. Secure rear cover plate to hull with cap screws. Close engine compartment top and rear doors and install securing cap screws.

(12) RECORD INSTALLATION. Make proper entry on W.D., Form No. 478, MWO and Major Unit Assembly Replacement Record.

80. EXPANSION TANK AND FILLER.

a. Description. The expansion tank, located on the bulkhead at the front of the engine (fig. 47), catches the water or steam that may be forced out of the cooling system. When a pressure of 12 pounds is built up in the cooling system by expansion of the coolant, the pressure valve in the filler cap (fig. 61) opens and the excess water or steam goes into the expansion tank. As the engine cools, a vacuum is formed in the sealed cooling system drawing water back into the cooling system through a vacuum valve in the pressure cap (fig. 61).

b. Servicing.

(1) DRAINING. To drain, remove drain plug from bottom right side of the expansion tank (fig. 61).

(2) CLEANING FILLER NECK SCREEN. Remove filler cap and lift screen out of filler neck. Remove all foreign matter from screen. Install screen and filler cap.

c. Removal. Remove engine compartment front cover plate (par. 164 **f**). Open air bleeder cock at radiator inlet connection and drain water to level of cock. Disconnect water manifold hoses at bottom of expansion tank. Disconnect vent tubes at filler neck. Remove four nuts and bolts securing expansion tank to bulkhead. Lift out expansion tank. Disconnect overflow hose from tank.

d. Installation. Secure tank to bulkhead with four bolts and nuts. Attach overflow hose to tank. Attach the two manifold hoses to bottom of tank. Connect vent tubes to fittings on filler neck. Install engine compartment front plate (par. 164 **g**).

81. WATER PUMP.

a. Description. The water pump (fig. 29) is a centrifugal type driven by a splined shaft from the rear of the crankshaft. The cooling system drain plug is located at the bottom of the pump. The water pump is lubricated from the engine, and since a permanent water seal is used, no attention is required.

b. Removal. Open the engine compartment rear door. Remove the drain plug at the bottom of the water pump (fig. 28) and drain the cooling system. Loosen hose clamps; then remove hoses which run from radiator outlet connection to the water pump. Remove four nuts and lock washers which hold the water pump to the crankcase (two nuts at the center connection and two at the left water connection). Lift off the water pump and gasket.

c. Installation. Using a new gasket, place the water pump in position over four studs on the crankcase and install lock washers and nuts. Install water pump to radiator outlet connection hoses and tighten hose clamps. Install drain plug and fill cooling system. Close the engine compartment rear door.

82. THERMOSTAT AND WATER MANIFOLDS.

a. Thermostat.

(1) DESCRIPTION. The thermostat is located in the inlet connection of the radiator. It is the bypass, bellows type and is nonadjustable. The thermostat prevents circulation of water through the radiator until the water reaches a temperature of 140° F.

(2) REMOVAL. Open the engine compartment rear and top doors. Remove drain plug at bottom of water pump and drain out enough water (approximately 2 gallons) to bring the level below the thermostat. Disconnect hoses from radiator inlet connection. Remove four cap screws and lock washers which retain connection to the top of radiator. Pull off connection and remove gasket. Lift thermostat and thermostat gasket out of inlet opening in radiator.

(3) INSTALLATION. Position thermostat gasket and thermostat in inlet opening of radiator. Position inlet connection gasket; then secure connection to radiator with four lock washers and cap screws. Connect manifold hoses to inlet connection. Install drain plug and fill cooling system to level of air bleeder cock in inlet connection. Close the engine compartment doors.

b. Water Manifolds (figs. 29 and 47).

(1) REMOVAL. Open engine compartment rear and top doors. Remove drain plug at bottom of water pump and drain approximately 5 gallons from the cooling system. Disconnect inlet hose from rear of manifold, and expansion tank hose from the front. Remove nuts and washers which secure manifold to cylinder head; then lift off manifold and gaskets. Repeat operation for opposite manifold.

(2) INSTALLATION. NOTE: *The manifolds are right and left; however, it is possible to install them on the wrong side of the engine. For proper installation, the manifolds should tilt toward the camshaft housings* (fig. 47). Use new gaskets and secure manifold to cylinder head with washers and nuts. Connect inlet hose and expansion tank

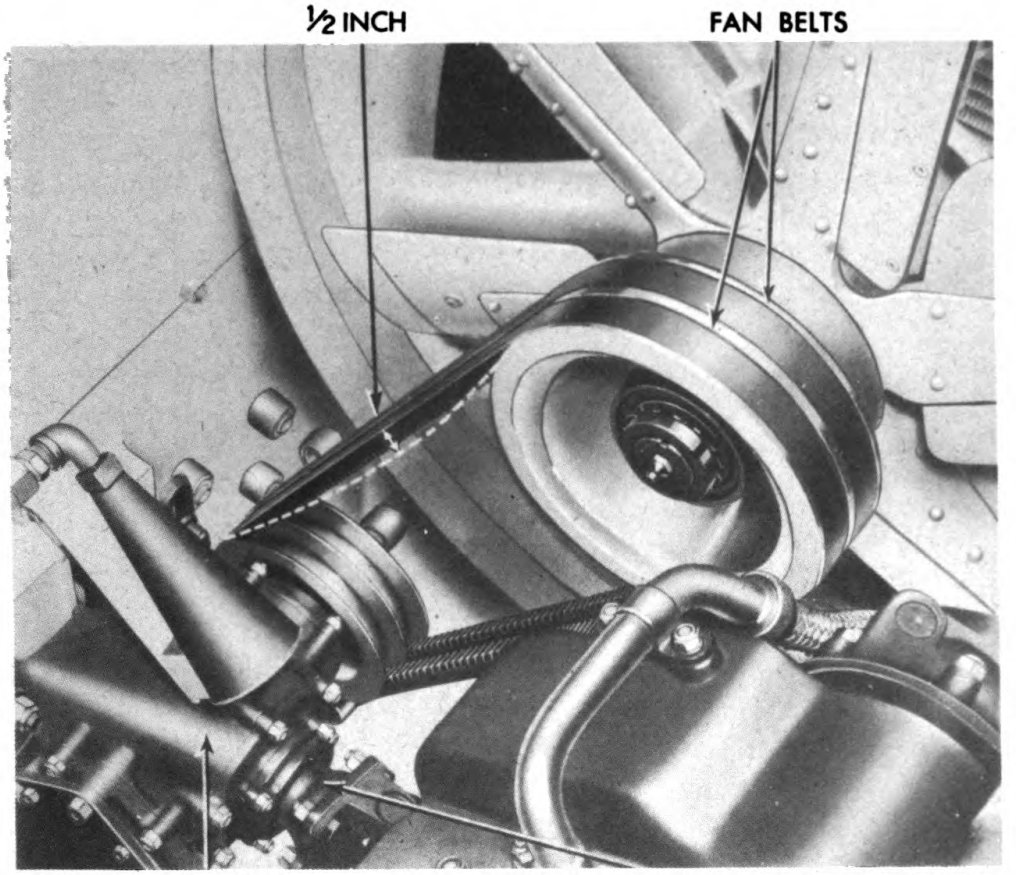


Figure 62 — Fan Belt Adjustment

hose to manifold. Fill cooling system to proper level and close engine compartment doors.

83. FANS.

a. Description. Two 26-inch diameter, six-blade blower or pusher-type fans are used. They are mounted in the front of the radiator (fig. 48). The fans draw air in through the openings in the engine compartment doors (or from the fighting compartment), and force the air out through the radiator and air baffles back of the radiator. Each fan is driven by two matched V-belts from pulleys on the fan drives mounted on the sides of the hull toward the rear of the engine compartment (fig. 62).

b. Fan Belt Replacement or Adjustment (fig. 62). Replacement or adjustment of the fan belts is accomplished by moving the fan drive housing up or down in slots provided for this purpose, after loosening the four nuts which secure the housing to the hull side

plates. The belts are correctly adjusted when approximately ½-inch deflection can be obtained with the fingers at a point midway between the fan and accessory drive pulleys. NOTE: *When replacement of one belt is necessary, always replace both belts running on the set of pulleys involved.*

c. Fan and Shroud Assembly Replacement. To remove the fans and shrouds, open the engine compartment doors and remove the engine compartment rear cover plate. It is not necessary to remove the engine compartment doors. Loosen and remove the fan belts (subpar. **b** above). Remove the two bolts and four cap screws from each fan shroud and remove the assemblies. To install the fan and shroud assembly, place them in position and secure them to the hull with four cap screws and two bolts. Install the fan belts (subpar. **b** above). Install the engine compartment rear cover plate. Close the engine compartment doors.

84. FAN DRIVES.

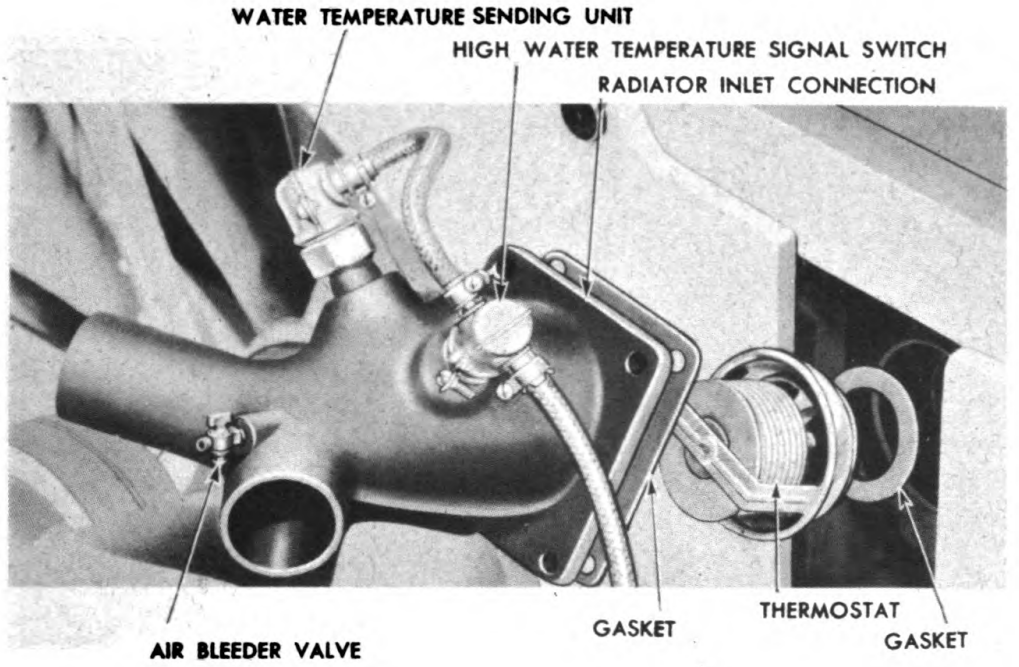
a. Description (fig. 48). The fan drives are located on the right- and left-hand engine compartment side walls. These drives contain bevel gears, running in engine oil, which transmit power from the fan drive shafts to the fans. The fan drives are provided with bayonet-type oil level gages which are a part of the filler plugs (A, fig. 20).

b. Removal (Either Side) (figs. 48 and 62). Open the engine compartment top doors. Disconnect fire extinguisher tube at tee above bottom center fire extinguisher nozzle. Remove rear fire extinguisher bracket with attached nozzle. Remove lock wire, nuts, and bolts which secure fan drive shaft flange to flange on fan drive assembly. Remove four fan drive assembly retaining nuts and washers. Hold assembly up and remove belts from pulley. Lift out fan drive assembly.

c. Installation (Either Side). Position fan drive over studs in engine compartment side wall and loosely install washers and nuts. Hold assembly up and slide belts on pulley. Adjust belts (par. 83 **b**). Attach fan drive shaft flange to flange on fan drive assembly with bolts, nuts, and lock wire. Install rear fire extinguisher bracket and nozzle, and connect tube to tee above bottom center fire extinguisher nozzle. Close engine compartment top doors.

85. WATER TEMPERATURE GAGE AND WARNING SIGNAL.

a. Description. Engine water temperature is recorded on an electric-type gage on the instrument panel (F, fig. 10). The gage is operated by a sending unit mounted in the radiator inlet connect (fig. 63). The engine water temperature warning signal on the instrument panel (K, fig. 10) turns on when the temperature exceeds



RA PD 335671

Figure 63 — Radiator Inlet Connection

235° F. The signal is operated by a thermostatic switch or sending unit mounted in the radiator inlet connection.

b. Gage Replacement. To remove the temperature gage, disassemble the instrument panel as outlined in paragraph 111 **b**. Remove the hold-down screws from the instrument and disconnect the wires. Lift the instrument from the panel. To install the instrument, connect the wires to the instrument and install the instrument in the panel. Assemble the instrument panel as outlined in paragraph 111 **c**.

c. Water Temperature Gage Sending Unit. Remove the shield from the water temperature gage sending unit (fig. 63). Open air bleeder cock in inlet connection to drain water from radiator. Disconnect the wire. Unscrew the unit from the radiator inlet connection. To install the unit, screw it into the radiator inlet connection. Connect the wire to the unit. Install the shield.

d. High Water Temperature Indicator Switch. Remove the shield from the high water temperature signal switch (fig. 63). Disconnect the wire from the switch and unscrew the switch from the radiator inlet connection. To install the high water temperature signal switch, screw it into the radiator inlet connection. Connect the wire and install the shield.

Section XXI

IGNITION SYSTEM

86. DESCRIPTION AND DATA.

a. Description (figs. 64 and 65). The ignition system consists of two magnetos, aircraft-type spark plugs, and the necessary connecting high-tension wires. The ignition is turned off when the magnetos are grounded by means of the magneto switch on the instrument panel. If at any time the ground wires running from the magnetos to the magneto switch were broken, the ignition could not be turned off with the magneto switch. On the other hand, if these wires become grounded, it would be impossible to turn the ignition on with the magneto switch. The numbering of the cylinders and the firing order are shown in figure 65.

b. Data.

(1) MAGNETO.

Make	Bosch
Model:	
Right-hand	MJF4A-308
Left-hand	MJF4A-307
Interrupter point gap	0.014 to 0.016 in.
Direction of rotation:	
Right-hand rotor	Clockwise
Left-hand rotor	Counterclockwise
Magneto rotor speed	½ crankshaft speed

(2) FIRING ORDER.

Numbering of cylinders from rear to front:	
Right bank	1-2-3-4
Left bank	1-2-3-4
Firing Order	1R-2L-3R-1L-4R-3L-2R-4L

(3) SPARK PLUGS.

Spark advance	Automatic
Spark plugs (type)	Champion C88-S
Spark plug gap:	
Manufacturing limit	0.011 to 0.014 in.
Service maximum limit	0.030 in.

87. MAGNETO SWITCH REPLACEMENT.

a. Removal. Separate the two halves of the panel to gain access to the instruments (par. 111 b). Pull wire No. 18 (fig. 87) out of wire connector. Disconnect wire No. 19 (fig. 87) from circuit breaker bar. Remove two nuts from top of mounting bracket and lift off bracket. Lift switch out through front of instrument panel face.

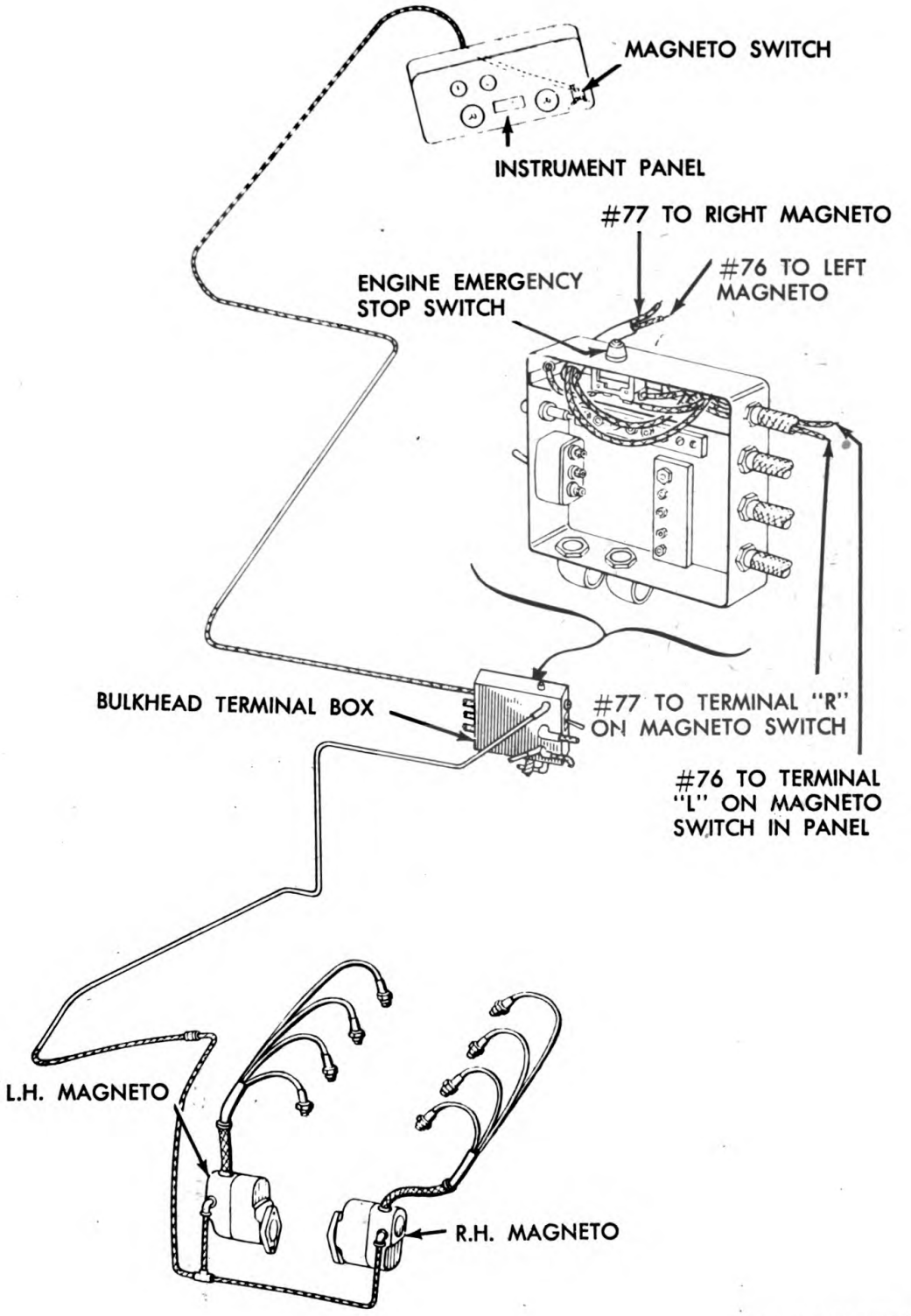


Figure 64 — Ignition System Diagram

b. Installation. Insert switch through opening in panel face. Install mounting bracket. Insert wire No. 18 (fig. 87) into wire connector. Connect wire No. 19 (fig. 87) to circuit breaker bar. Secure wire to bar with toothed lock washer and screw. Hold the two halves of the instrument panel together and install the six equally spaced screws in the panel. Connect the speedometer and tachometer drive cables to the speedometer and tachometer heads at the rear of the panel.

88. MAGNETOS.

a. Description. Two magnetos are used, one firing the cylinders in the right bank and the other firing the cylinders in the left bank. The magnetos are driven through the accessory gear assembly and magneto drive gear and shaft. The automatic spark advance mechanism is a part of the engine and is not a part of the magnetos. One governor assembly advances the spark of both magnetos together.

b. Magneto Replacement.

(1) PRELIMINARY INSTRUCTIONS. Before removing either magneto, observe the position of the rotor arrow in the center of the distributor plate (fig. 66). If the engine has not been cranked during the time the magnetos are off the engine, the replacement magneto is installed with its arrow pointing in this same direction. Then the only ignition timing required will be to adjust the magnetos by means of the adjusting slots in the magneto mounting flange as outlined in paragraph 89 **c**. If the engine has been cranked while the magnetos are off the engine and the timing is lost, a major timing adjustment will be required (par. 89 **d**).

(2) OPEN ENGINE COMPARTMENT DOORS. Open the doors over the engine compartment. Open the engine compartment rear door.

(3) REMOVAL (EITHER MAGNETO). Remove the four screws securing the distributor gap cover and remove the cover. Remove the four screws securing the distributor accessory plate and remove the plate. Remove the ground wire terminal screw. Unscrew the hex nut securing the ground wire conduit to the magneto radio shield. Remove the ground wire and conduit from the shield. Remove the four screws securing the four ignition (high-tension) wires to the magneto distributor plate and lift the wire terminals out of the recesses. Unscrew the knurled nut securing the ignition wire conduit to the magneto radio shield and remove the conduit and wires. Remove the lock wire and upper and lower nuts securing the magneto to the engine and remove the magneto.

(4) INSTALLATION (EITHER MAGNETO). If the engine has been turned over while the magnetos were removed, proceed as outlined in paragraph 89 **d**. The magnetos must be installed with the rotor arrow

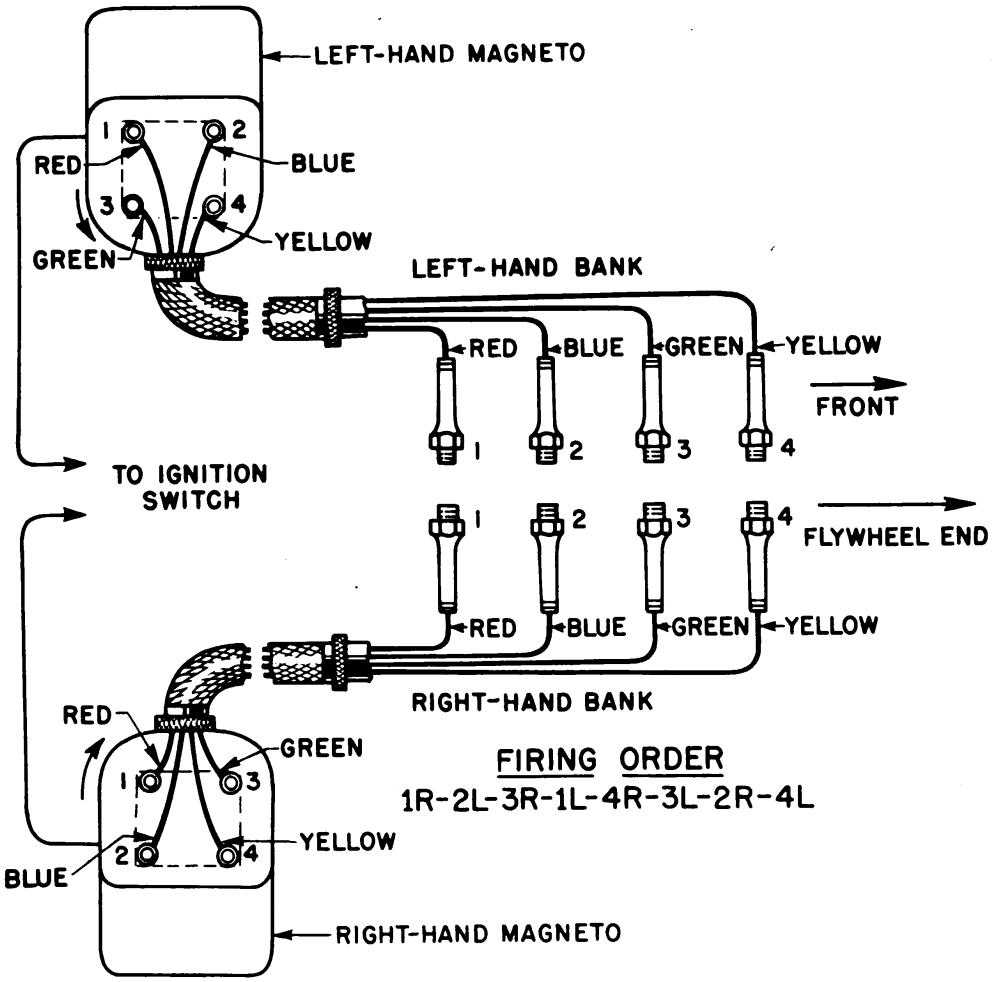


Figure 65 — Cylinder Numbering and Firing Order

(fig. 66) pointing to the same terminal as when removed. Place the magneto in position and enter the groove in the magneto drive flange over the tang on the magneto drive shaft flange. Shift the magneto so that the studs are in the center of the adjusting slots of the magneto mounting flange. Install the upper and lower nuts to secure the magneto to the engine. Install the ignition wire conduit to the magneto housing and connect the four ignition wires to the proper terminals (fig. 66). Attach the ground wire conduit to the magneto housing and the ground wire to the magneto ground wire terminal. Install the distributor accessory plate, the distributor cap, and cover. Check the timing as outlined in paragraph 89 b and shift the magneto in the adjusting slots if necessary. Record replacement of magneto on W.D., A.G.O. Form No. 478, MWO and Major Unit Assembly Replacement Record.

c. Interrupter Point Replacement.

(1) REMOVAL. Remove the magneto as outlined in subparagraph b above. Remove the four screws and lock washers from the interrupter inspection cover (lower plate) and remove the cover and gasket. Disconnect the ground wire from the interrupter cap. Remove the two screws and lock washers that secure the interrupter cap to the distributor plate and remove the interrupter cap and gasket. Remove the cap screw and lock washer that holds the interrupter lever spring to the breaker plate. Remove the cotter pin and flat washer that holds the interrupter lever to the breaker plate. Lift the interrupter lever off the breaker plate. Remove the contact bracket lock screw (fig. 67) and contact bracket from the breaker plate.

(2) INSTALLATION (fig. 67). Slip the contact bracket into the slots in the breaker plate provided for it. When the holes are alined, fasten the bracket and grounding wire to the breaker plate with the screw and lock washer. Screw the interrupter lever spring screw and lock washer part way into the interrupter lever, holding bracket with an open-end wrench. Apply a liberal film of engine oil on the interrupter lever stud and slip the interrupter lever over it. Place the spring attached to the lever behind the interrupter lever bracket so that the slot in the spring fits over the interrupter lever spring fastening screw. This item was previously screwed part way into the interrupter lever holding bracket. At this time, the interrupter point of the interrupter lever should be flush against the interrupter point in the contact bracket. Slip the washer over the post and fasten with cotter pin. Adjust the points as outlined in subparagraph (3) below. Place a new gasket and the interrupter cap on the distributor plate and secure them to the distributor plate with two screws and lock washers. Install the magneto as outlined in subparagraph b above.

(3) BREAKER POINT ADJUSTMENT. The magnetos must be removed from the engine before attempting to adjust the breaker points. Breaker points are adjusted to an opening of from 0.014 to 0.016 inch when the breaker arm fiber rubbing block rests on the high point of the cam. Adjust the breaker point bracket by means of the eccentric adjusting screw (fig. 67) until the correct gap is obtained. Lock the bracket with the contact bracket lock screw (fig. 67). Contact points must be free from oil and grease and in proper alinement so that the surfaces of both contacts meet squarely.

89. IGNITION TIMING AND GOVERNOR ADVANCE.

a. Flywheel Timing Mark Data. The flywheel marks on present production engines are 10 degrees before dead-center mark and are stamped "SPARK SETTING RH" for setting the timing on the right-hand cylinders, and "SPARK SETTING LH" for the left-hand cylinders (fig. 40). NOTE: *On early production engines, timing marks are only five degrees before the dead-center mark and are stamped*

"SPARK RETARD RH" for the left-hand cylinders. When setting the spark timing on early production engines, the timing should be set five degrees in advance of the "SPARK RETARD" mark. Measure 7/8 inch ahead of these marks (equivalent to five degrees) and scribe a mark on the flywheel. Set the flywheel with the scribed mark at the pointer when timing engines with the early-type flywheel markings. After this line has been scribed on the flywheel, ignore the marking "SPARK RETARD." In the following instructions, this scribed line will be considered as the "SPARK SETTING" mark on these early engines.

b. Procedure for Checking Timing and Governor Advance.

(1) PRELIMINARY STEPS. Open the doors over the engine compartment. Remove the clamp securing the carburetor intake to air cleaner tube to the air intake manifold and remove the tube from the manifold to make working space. Remove the four screws from the flywheel inspection plate on the top left side of the flywheel housing and remove the plate (fig. 30). CAUTION: **Make certain the magneto switch is off.** Insert a bar through the yoke of either fan drive shaft universal joint and turn the engine by hand until one of the "SPARK SETTING" timing marks appears at the opening in the flywheel housing from which the plate has been removed (fig. 40). Draw a line across the face of the flywheel at this mark with chalk. Turn the engine until the other "SPARK SETTING" timing mark appears and draw a line at this mark with chalk.

(2) CONNECT TIMING LIGHT. Remove the nuts from the spark plug covers on each side of the engine and remove the cover plates. Remove the spark plug wire from No. 1 spark plug in the right bank to check right-hand magneto. Use No. 1 spark plug in the left-hand bank to check the left-hand magneto. Attach one lead of the timing light to the terminal of No. 1 spark plug wire. Connect the other timing light lead to any convenient ground.

(3) USE OF TIMING LIGHT. Start the engine and allow it to warm up. Set the engine idling speed at 500 revolutions per minute. Hold the timing light over the opening in the flywheel housing so that it can flash on the timing marks (fig. 40). If the "SPARK SETTING" mark on the flywheel appears at the left of the pointer, the timing is advanced. If the mark appears to the right of the pointer, the timing is retarded. NOTE: *It may be necessary to use a periscope through the left air cleaner service opening in the bulkhead to see the timing marks without dismantling or removing the engine.* If adjustment is required to correct the timing, refer to subparagraph **c** following. Repeat the above procedure for the other magneto.

(4) CHECKING MAGNETO GOVERNOR ADVANCE. With the timing light still connected, start the engine, increase its speed, and observe the mark on the flywheel. The governor will start to advance when

the engine speed reaches 600 revolutions per minute and will be fully advanced when it reaches 1,400 revolutions per minute. The timing mark should move to the left of the pointer as the speed of the engine increases, until the spark timing reaches maximum advance. At this time, the flywheel mark will be approximately 2⅝ inches to the left of the pointer. If the timing mark does not change its position in relation to the pointer when the engine speed is increased, the magneto governor is faulty and should be replaced. Notify higher authority.

c. Minor Timing Adjustment. Remove the lock wire and loosen the upper and lower holding nuts on one magneto. Rotate the magneto in the adjusting slots so the top of the magneto moves toward the front (flywheel end of the engine) to advance the timing, or toward the rear to retard the timing. Recheck the timing with the timing light as outlined in subparagraph **b** (3) above. After the correct timing has been obtained, tighten the magneto holding nuts and secure them with locking wire. Follow the same procedure in adjusting the timing on the other magneto. Connect the wires to the spark plugs and install the spark plug cover plates. If the correct timing cannot be obtained in the range provided in adjusting slots on the magnetos, it will be necessary to reset the timing by resetting the magneto drive gears (subpar. **d** below).

d. Major Timing Adjustment.

(1) GENERAL. A major timing adjustment consists of resetting the magneto drive gears, and is required when the correct timing cannot be obtained by the range provided by the adjusting slots in the magneto mounting flange.

(2) SET ENGINE FLYWHEEL MARK AT POINTER. Turn the engine in direction of rotation until the No. 1 piston on the right-hand side is on its compression stroke (use a compression gage in No. 1 cylinder spark plug hole to determine the compression stroke) and the "SPARK SETTING RH" mark or, on early production engines, the scribed mark (par. 89 **a**) on the flywheel is at the pointer (fig. 40).

(3) SET TIMING. Remove the left-hand magneto (par. 88 **b** (3)). Loosen, but do not remove, the two nuts which secure the right-hand magneto to the engine. Loosen the nut which secures the left-hand drive flange (C, fig. 68) on the magneto drive shaft and separate the drive flange from the serrations on the magneto drive gear (D, fig. 68). Remove the distributor accessory plate and the distributor cap cover from each magneto. Turn the right-hand magneto by means of the driving flanges on the left end of the shaft in direction of rotation until the arrow in the rotor window (fig. 66) is opposite the terminal to which No. 1 red wire is attached. **NOTE:** *A lobe of the interrupter cam will be approaching the rubbing block on the interrupter lever when the magneto is set in this position. Also*

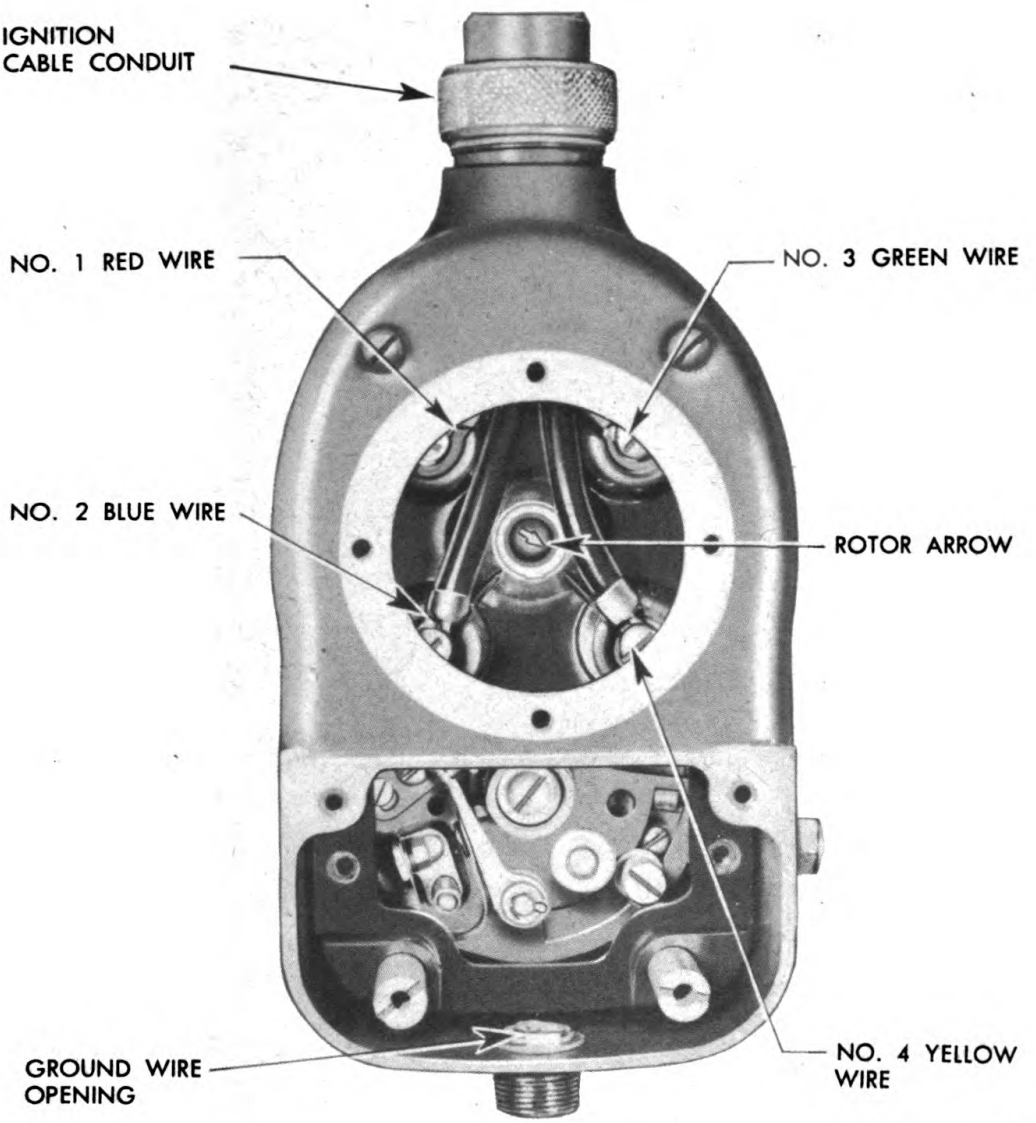


Figure 66 — End View of Magneto

note the arrow showing the direction of the interrupter cam as shown in figure 66. Separate the interrupter points in the right-hand magneto and place a narrow strip of cellophane between the points. Turn the magneto backward slightly to make sure the points are closed. Exert a slight pull on the cellophane with the fingers while the magneto is being turned slowly in direction of rotation. The cellophane will release at the instant the points start to separate. The nut securing the left-hand driving flange (C, fig. 68) must then be tightened while the magneto is setting in this position.

(4) RECHECK TIMING OF THE RIGHT-HAND MAGNETO. Again place a strip of cellophane between the points on the right-hand mag-

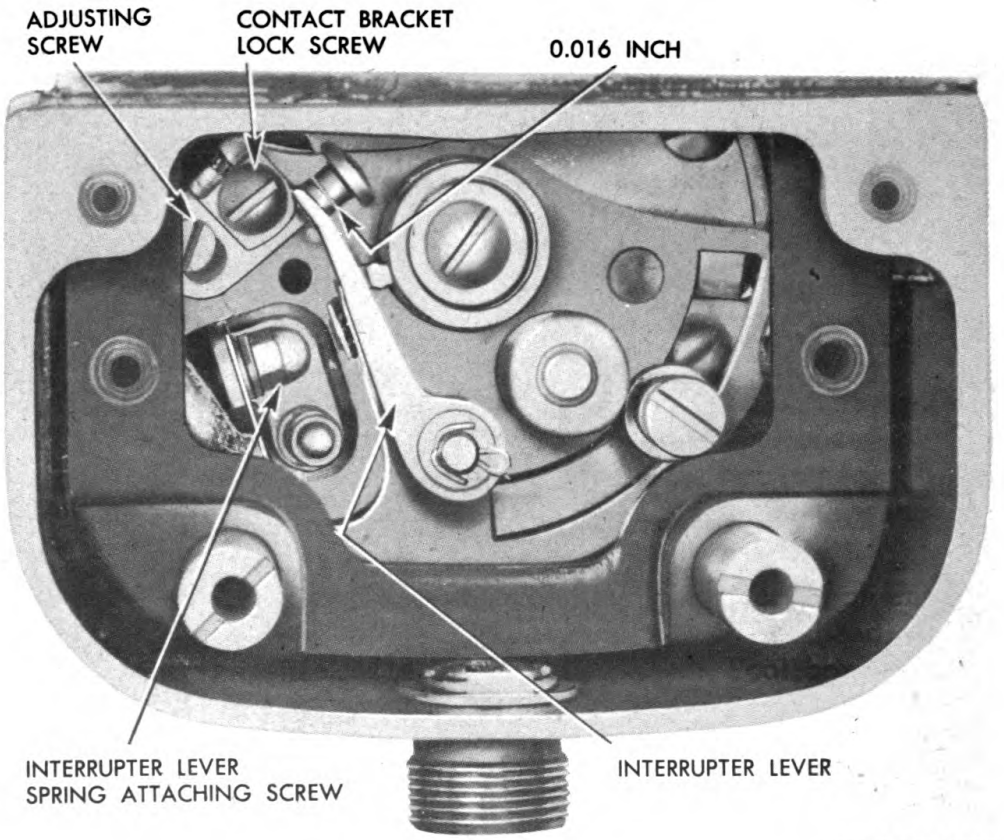
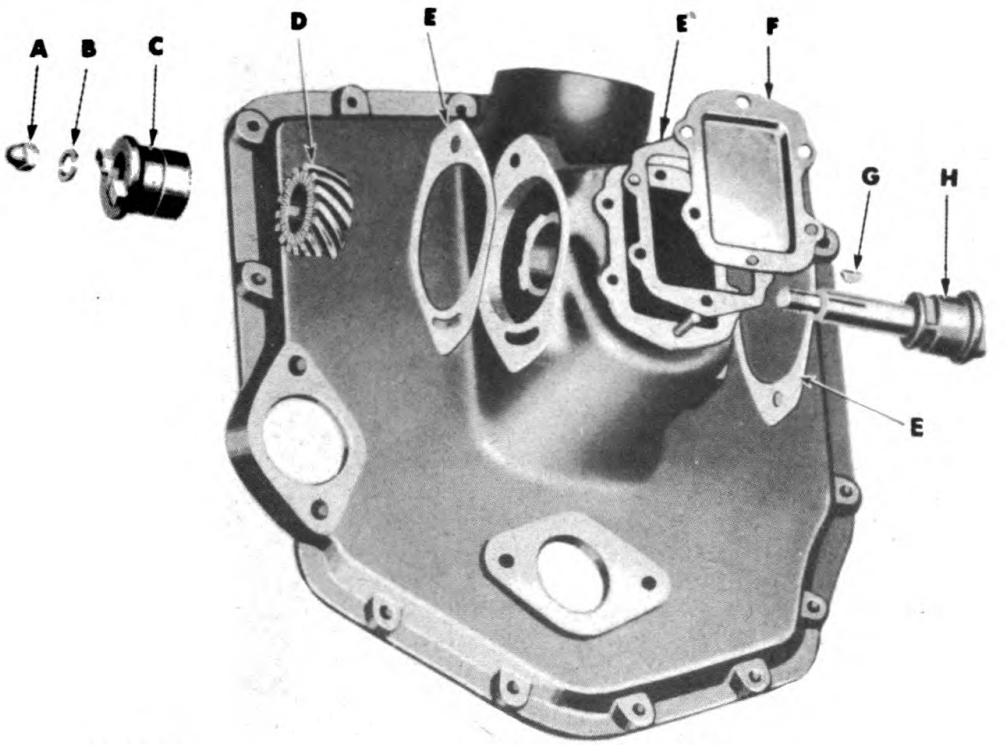


Figure 67 — Magneto Interrupter Assembly

neto. Turn the flywheel backward approximately one-quarter of a revolution; then turn it in direction of rotation until the cellophane releases by a slight pull on the cellophane with the fingers. Note whether the timing mark on the flywheel is opposite the pointer. If a minor correction is necessary, tilt the magneto forward or backward as required. Tilting the magneto toward the front of the engine advances the spark; tilting it toward the rear of the engine retards the spark. In case of a major correction, it will be necessary to again loosen the nut securing the left-hand driving flange (C, fig. 68) to move shaft forward or backward. Tighten the nut and recheck the timing. NOTE: *One serration on the flange and the driven gear is equal to 5 degrees at the flywheel.*

(5) INSTALL LEFT-HAND MAGNETO AND SET TIMING. Turn the flywheel in direction of rotation 300 degrees (five-sixths of a turn) until the "SPARK SETTING LH" mark appears opposite the pointer. Turn the magneto until the arrow in the rotor window (fig. 66) is opposite the terminal to which No. 1 red wire (fig. 65) is attached. NOTE: *A lobe of the interrupter cam will be approaching the rubbing block on the breaker arm when the magneto is set in this posi-*



A—NUT
B—WASHER
C—MAGNETO DRIVE FLANGE
D—MAGNETO DRIVE GEAR
E—GASKETS
F—INSPECTION COVER
G—KEY
H—MAGNETO DRIVE SHAFT

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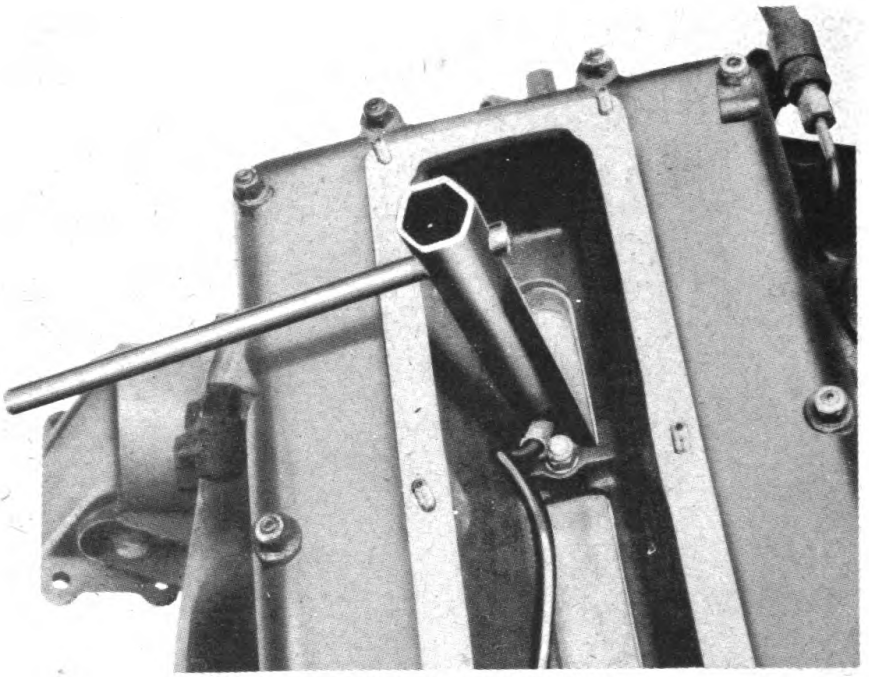
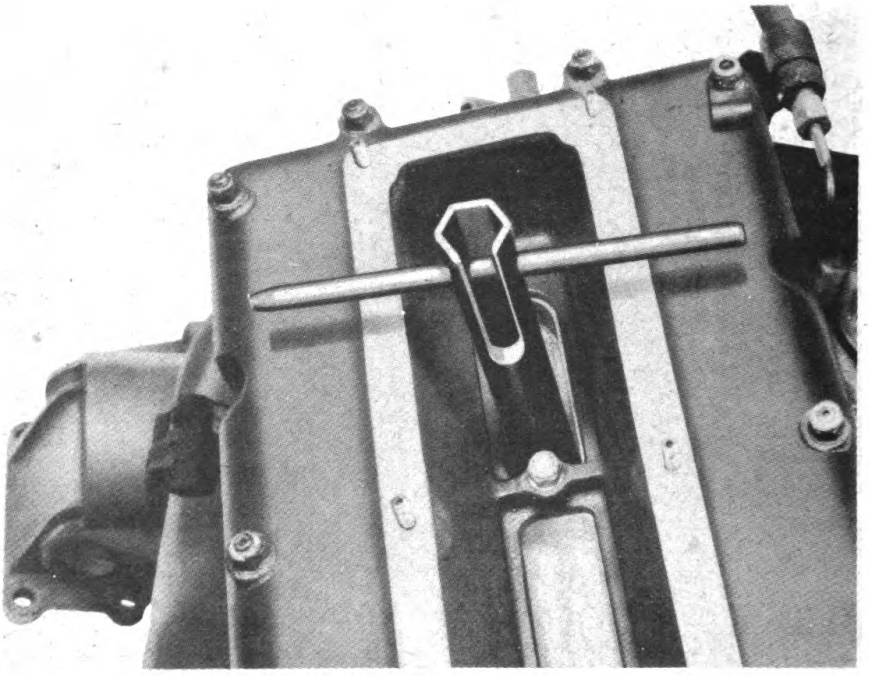
Figure 68 — Magneto Drive — Disassembled

tion. Also note the arrow showing the direction of the interrupter cam as shown in figure 66. Install the magneto (par. c (4)) and tilt the magneto so that the mounting studs are approximately midway in the slots (fig. 46) of the magneto mounting flange. Separate the interrupter points in the left-hand magneto and place a narrow strip of cellophane between the points. Turn the flywheel backward approximately one-quarter revolution; then turn in direction of rotation until the cellophane releases with a slight pull on the cellophane with the fingers. Note whether the timing mark on the flywheel is at the pointer. The reason for turning the engine backward before bringing it up to the timing mark is to compensate for the backlash in the magneto drive mechanism. Any correction in the timing for the left-hand magneto can be made by tilting the magneto forward or backward. NOTE: *Place a narrow strip of paper between the interrupter points on each magneto and withdraw the paper from the points. This will remove any particles of cellophane which may have scuffed off while the opening of the points were being checked.*



A—REMOVING SPARK PLUG WIRE



B—REMOVING SPARK PLUG

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Figure 69 — Removing Spark Plug and Wire Using Spark Plug Wrench (41-W-3336-300)

(6) LOCK MAGNETOS IN PLACE. After both magnetos have been properly set in the mounting slots and the correct timing established, lock the mounting nuts with wire.

90. SPARK PLUGS.

a. Description. The spark plugs used are the aircraft-type, Champion C88-S. The spark gap between the electrodes of the spark plug when new should be 0.011 inch to 0.014 inch. Do not attempt to adjust the spark gap. Replace the plugs when the gap increases to 0.030 inch.

b. Replacement. To remove the spark plugs, remove the cover plates over the spark plug compartment. Remove the retainer nuts with the special wrench (41-W-3336-300) (fig. 69) and lift the wires from the spark plugs. Remove the spark plugs with the special wrench (41-W-3336-300) (fig. 69). To install the spark plugs, examine each spark plug to make sure the spark gap is within the limits outlined above, insert the plugs with gaskets in the spark plug holes, and tighten each spark plug using 25 to 30 foot-pounds of torque with the special wrench (41-W-3336-300) (fig. 69). Insert the spark plug wires in the spark plugs and tighten the spark plug wire retainers moderately with the special wrench (41-W-3336-300) (fig. 69).

91. SPARK PLUG WIRES AND CONDUITS.

a. General (fig. 64). The wires leading from the magneto to the spark plugs may be identified for both the right- and left-hand magneto by colors marked on the wires as follows: No. 1 red, No. 2 blue, No. 3 green, and No. 4 yellow. Spark plug wires having cracked or damaged insulation must be replaced, as such wire may cause misfiring of the spark plug to which they are attached. If the flexible conduit becomes damaged or frayed, it also must be replaced to avoid chafing of the spark plug wires.

b. Spark Plug Wire Removal. To remove one or more spark plug wires, remove the spark plug cover plates. Remove the distributor accessory plate covering the spark plug wire terminals on the magneto (fig. 66). Remove the retainer nut from the spark plugs of the wires to be changed (par. 90 **b**) and disconnect the terminals at the other end of the wires from the magneto. Attach a strong cord to the terminal at the magneto end of the wire and pull the wire out of the conduit. Leave the cord in the conduit, as it is used later to pull a new wire through the conduit.

c. Spark Plug Wire Installation. Attach the cord described in subparagraph **b** above, and pull a new wire through the conduit. Attach the spark plug retainer nut and fitting to the end of the wire and install the wire to the spark plug. Attach the other end of the wire to the proper terminal on the magneto (fig. 66).

d. Flexible Conduit Replacement. To remove the flexible conduit, unscrew the knurled nut at each end. Disconnect the spark plug wires from the magneto and slip conduit from the wires. Install the flexible conduit, using new gaskets at each end of the flexible conduit. Attach the spark plug wires to the correct terminals in the magneto (fig. 66).

Section XXII

STARTING SYSTEM

92. DESCRIPTION.

a. Description (fig. 70). The starting system consists of a starter switch on the instrument panel, a starter relay in the master switch box, the starter mounted on the right-hand side of the oil pan and flywheel housing, and the wiring which connects these units.

93. STARTER.

a. Description. A 24-volt starter is mounted on the right-hand side of the oil pan. Its power is transmitted to the engine through an automatic drive. When the switch on the instrument panel is closed, the starter relay (fig. 74) closes the electrical circuit of the starting motor. Rotation of the motor shaft forces the pinion of the automatic drive to advance and mesh with the flywheel ring gear. After the engine starts and the flywheel speed exceeds that of the automatic drive pinion, the pinion releases from the flywheel automatically.

b. Removal. Turn 24-volt master switch off. Disconnect cable from positive terminal post on the starter. Remove nut, lock washers, bolt, and cap screws attaching the starter to oil pan and flywheel housing flange. Lift out starter.

c. Installation. Secure starter to oil pan and flywheel housing flange with bolts, lock washers, nuts, and cap screws. Attach cable to positive terminal post on starter with lock washer and nut. Record replacement of starter on W.D., A.G.O. Form No. 478, MWO and Major Unit Assembly Replacement Record.

94. STARTER RELAY.

a. Description. The circuit from the batteries to the starter requires heavy cables, due to the large amount of current used. In order to avoid running the heavy cables to the instrument panel, a solenoid or starter relay is installed in the circuit. This relay, located in the master switch box (fig. 74), closes magnetically when the starter switch on the instrument panel is closed.

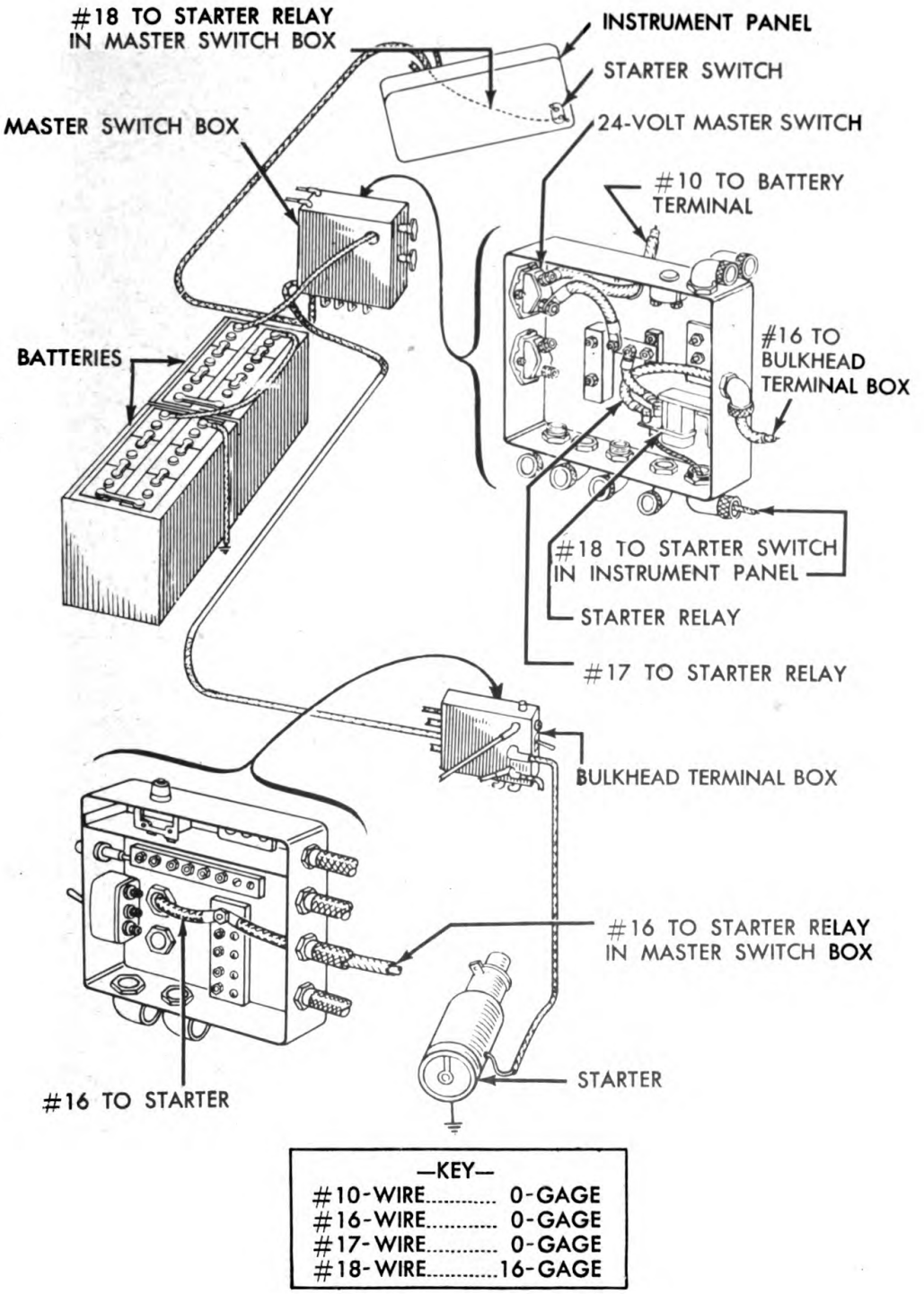

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Figure 70 — Starting System Diagram

b. Removal. Turn the 24-volt master switch off. Disconnect batteries (par. 97 **d**). Remove master switch box cover. Remove cap screw, lock washer, and flat washer attaching relay to bulkhead terminal box cable (No. 16, fig. 70) to front relay terminal. Remove relay to bus bar cable (No. 17, fig. 70) from left-hand solenoid terminal. Remove wire (No. 18, fig. 70), leading from starter switch to relay, from the center terminal on the relay. Remove two nuts and internal toothed washers which attach solenoid to master switch box. Lift out relay.

c. Installation. Attach relay to master switch box. Attach wire (No. 18, fig. 70) to center terminal, bus bar cable (No. 17, fig. 70) to left-hand terminal, and cranking motor cable (No. 16, fig. 70) to right-hand terminal on solenoid. Connect batteries (par. 97 **e**) and test circuit for operation. Install master switch box cover.

95. STARTER SWITCH REPLACEMENT.

a. Replacement. Follow same procedure used to replace magneto switch (par. 87).

Section XXIII

BATTERY AND GENERATING SYSTEM

96. DESCRIPTION.

a. General. The battery and generating system consists of two 12-volt batteries connected in series to produce 24 volts, a generator, a generator regulator, and the necessary wiring to connect these units (fig. 71). An auxiliary generator and regulator are provided for charging the batteries when turret and radio operation impose greater current requirements. These units are covered in paragraph 173. These units supply the current necessary to operate the starting and lighting systems and to maintain a charge in the batteries.

97. BATTERIES.

a. Description. Two 12-volt storage batteries are located on the left sponson in the fighting compartment (fig. 73). The batteries are connected in series and provide 24-volt current by a direct and separate connection between the batteries and the battery master switch. A separate connection for the rear battery, only to the 12-volt master switch, provides 12-volt current for the radio equipment. A battery-charging receptacle, located directly under the master switches, is provided for charging the batteries when required.

b. Servicing.

(1) ELECTROLYTE LEVEL. Add distilled water to keep the electrolyte (battery fluid) 3/8 inch above the top of the battery plates at all times.

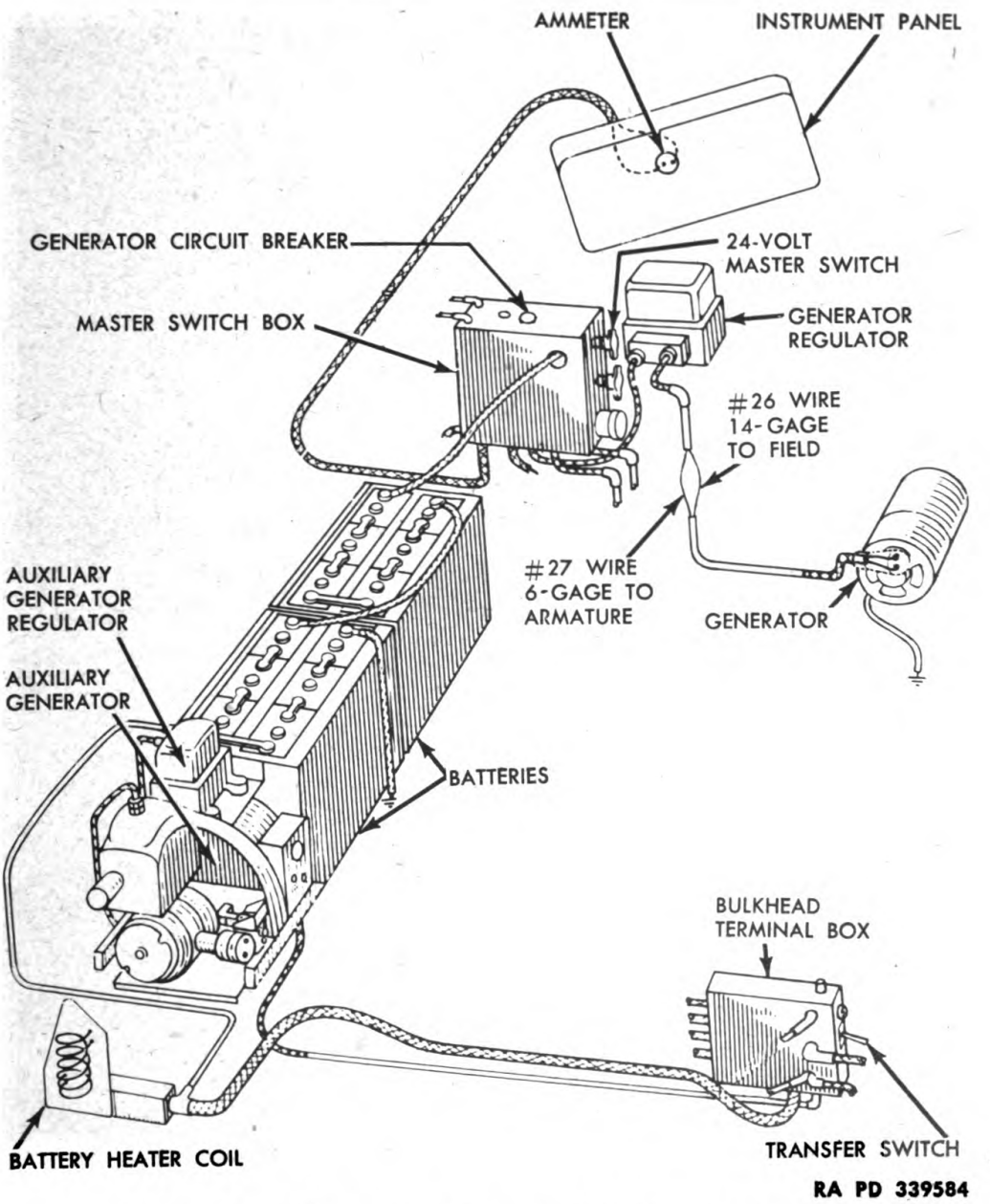

Figure 71 — Battery and Generating System Diagram

(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 figures on the small tube which shows just above the level of the solution. Add to, or subtract from, the reading in accordance with the temperature scale on the

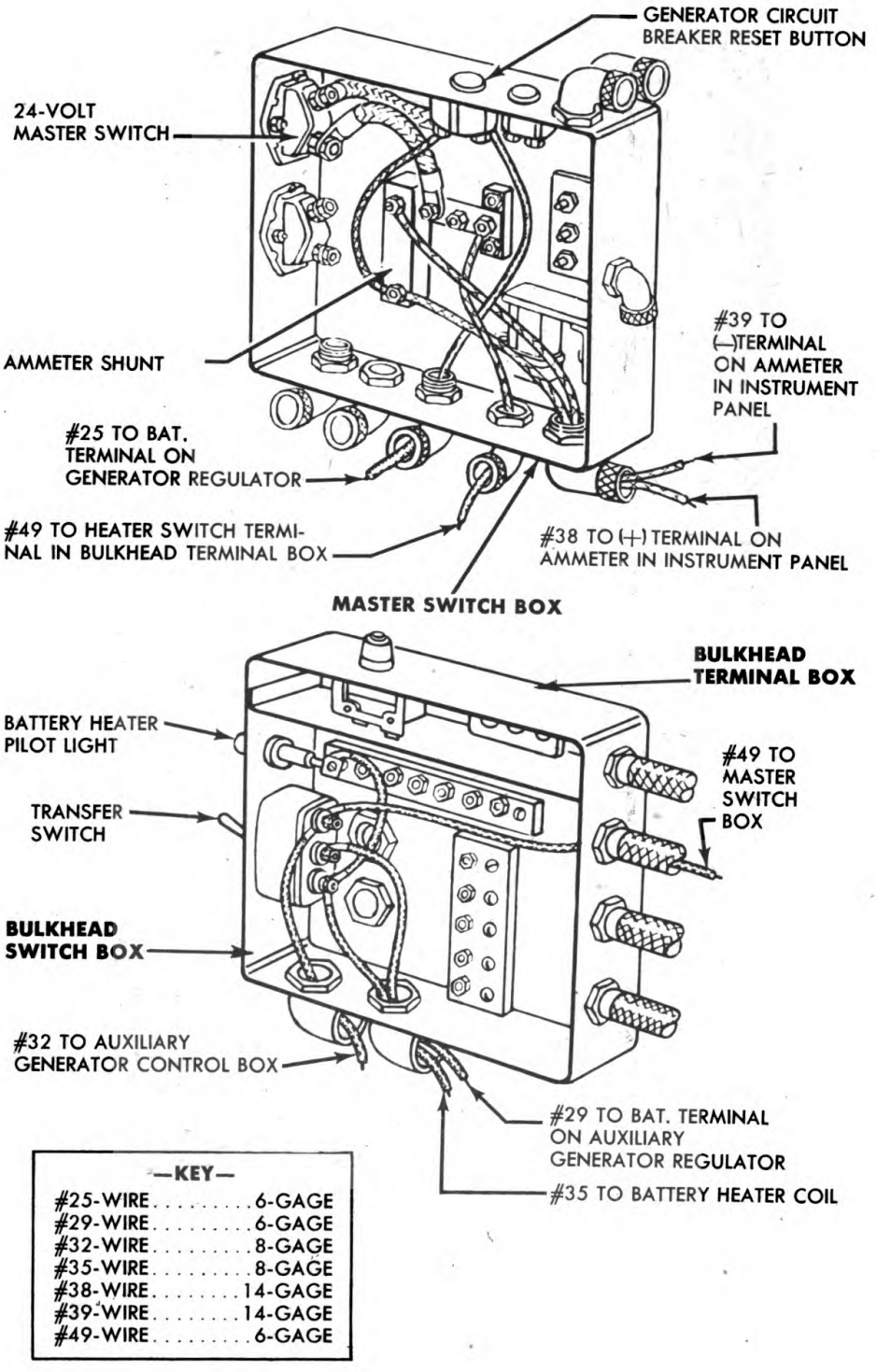

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Figure 72 — Battery and Generating System Terminal Box Connections

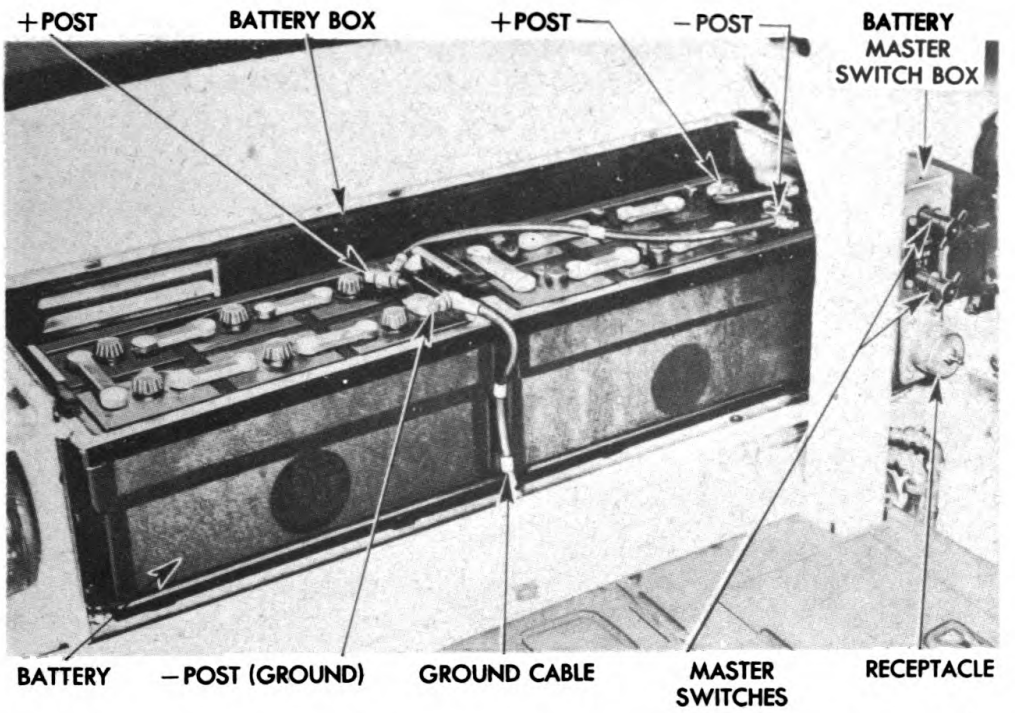


Figure 73 — Batteries

hydrometer to obtain the actual specific gravity. The following hydrometer readings show the condition of the battery at normal operating temperatures (80° F):

Fully charged	1.275 to 1.300
Half charged	1.220
Discharged	1.130

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

(4) BATTERY FREEZING TEMPERATURES. A fully charged battery will not freeze in temperature where the vehicle will be operated, but a battery with a specific gravity of 1.120 will freeze at +14° F. The following table shows the freezing temperature of batteries for various specific gravity readings.

Specific Gravity	Freezing Temperatures
1.150	+5° F
1.200	−16° F
1.230	−40° F
1.280	−90° F

(5) SPECIFIC GRAVITY FOR HOT CLIMATES. In hot climates (95° F and above) lower specific gravity electrolyte (1.245) is rec-

ommended to avoid excessive deterioration of plates and separators. To 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 3/8 inch above the plates. Charge the battery until a specific gravity of 1.245 is obtained.

c. Preparing Dry Charged Batteries for Service. Plates in batteries shipped dry are in a partly charged condition. It is important that vent plugs be left tightly in place until battery is to be filled. The electrolyte to be used for filling is diluted sulphuric acid. It must be pure, suitable for storage battery use, and of 1.270 specific gravity. CAUTION: *The temperature of the filling electrolyte must not exceed 90° F (32° C).* To prepare battery for service proceed as follows:

(1) REMOVE PLUGS. Remove masking tape over small hole in vent plug, leaving the small hole open. Unscrew vent plugs.

(2) FILL CELLS. Fill each cell with prepared electrolyte to the protector on top of the separators.

(3) ADD ELECTROLYTE. Allow battery to stand at least one hour after filling with electrolyte. If level has fallen, add electrolyte to restore it. Replace vent plugs in cells. Remove any electrolyte spilled on battery with a cloth slightly dampened with a solution of bicarbonate of soda and water.

(4) PRELIMINARY BATTERY CHARGE. A freshening charge of 13 amperes must be given the battery before placing it in service. Make certain that the positive terminal of battery is connected to the positive terminal of the charging circuit and negative terminal of battery is connected to the negative terminal of the charging circuit.

(5) CHARGE BATTERY. Charge unit until four consecutive hourly readings show no rise in specific gravity and voltage for the lowest cell. If above rate is maintained, length of charging time will be at least 12 hours; lower rates will increase the time proportionately. If temperature exceeds 110° F, reduce charging rate. If necessary to restore electrolyte level during charge, use only approved water.

(6) SPECIFIC GRAVITY. After completion of charge, the gravity should be between 1.270 and 1.285, corrected to 77° F, and with the level 3/8 inch above protector on top of separators. If it is not, adjust by removing some solution and replacing with approved water or electrolyte as required. Charge to mix solution before testing again.

d. Removal. Turn both the 24- and 12-volt master switches off. Remove stowage from battery box and remove top and side covers. Disconnect the battery cables at the batteries and remove the hold-down bolts and hold-down brackets. Remove the batteries.

e. Installation. Place the batteries in the battery compartment. Install the battery hold-down brackets and bolts and connect the

battery cables. Install the battery box side and top covers. Record the replacement of batteries on W.D., A.G.O. Form No. 478, MWO and Major Unit Assembly Replacement Record.

f. Battery Heater Unit.

(1) DESCRIPTION. The battery heater unit is located on the left sponson, directly under the auxiliary generator fuel tank. The battery heater unit is connected in series with the auxiliary generator and is used to heat the batteries for cold weather starting (par. 25).

(2) REMOVAL. Remove the six screws holding the unit in the heater compartment. Remove the wire connections from the terminal posts and remove the unit.

(3) INSTALLATION. To install the coil, place it in position and connect the two wires to the coil. Fasten the coil to the sponson with the six screws.

98. MASTER SWITCHES.

a. 24-Volt Master Switch. The battery master switch box is located to the left of the driver on the left sponson (fig. 14). When the switch is off, all electrical power is shut off at the battery with the exception of the power used by the interphone system. This system is controlled by a separate 12-volt master switch.

b. 12-Volt Master Switch. The 12-volt master switch is located below the 24-volt master switch and is used to control battery supply to the interphone system.

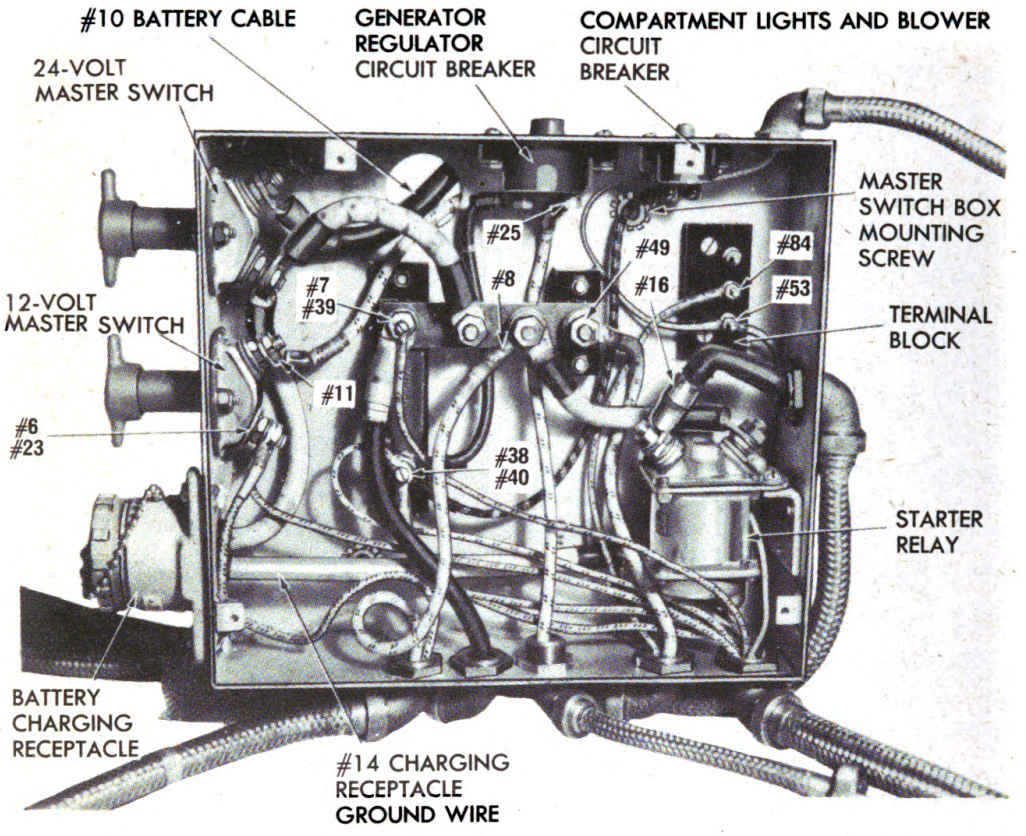
c. Removal (Either Switch). Disconnect the positive battery terminal at the battery. Remove the four screws from the master switch box cover and remove the cover. Remove the cable and wire connections from the switch. Remove the screws holding the switch to the switch box and remove the switch.

d. Installation. To install either switch in the master switch box, fasten the switch to the box with four screws. Attach the cables and wire connections to the switch. Secure the cover to the switch box with four screws.

99. GENERATOR.

a. Description. One generator is used and is bracket-mounted on the rear of the transmission. It is belt-driven from the propeller shaft as shown in figure 128. The generator has a 24-volt, 50-ampere capacity and is equipped with a generator regulator for current control. A radio interference filter is located in the generator regular and filter housing.

b. Belt Adjustment. The generator belts are adjusted correctly when they have ½-inch maximum movement midway between pul-



RA PD 339587

Figure 74 — Battery Master Switch Box — Cover Removed

leys with approximately 10 pounds of pressure applied. To adjust the belts, loosen the lock nut on the generator belt adjustment bolt. Turn the bolt counterclockwise to loosen the belts, and clockwise to tighten the belts. Tighten the lock nut after the adjustment is made.

c. Removal. Remove the cover from the generator terminal shield base (fig. 75). Disconnect the field and armature terminals, and disconnect the ground wire at the generator. Loosen the conduit lock nut and pull wires from the terminal shield base. Remove the bolts holding the generator to the mounting bracket or accessory drive housing and remove the generator.

d. Installation. Install the generator on the mounting bracket or accessory drive housing. Install the field and armature leads in the terminal shield base and connect them to the generator. Tighten the conduit lock nut. Connect the ground wire to the generator. Install the terminal shield cover. Adjust the drive belt to ½-inch free play (subpar. b above). Record the replacement of generator on W.D., A.G.O. Form No. 478, MWO and Major Unit Assembly Replacement Record.

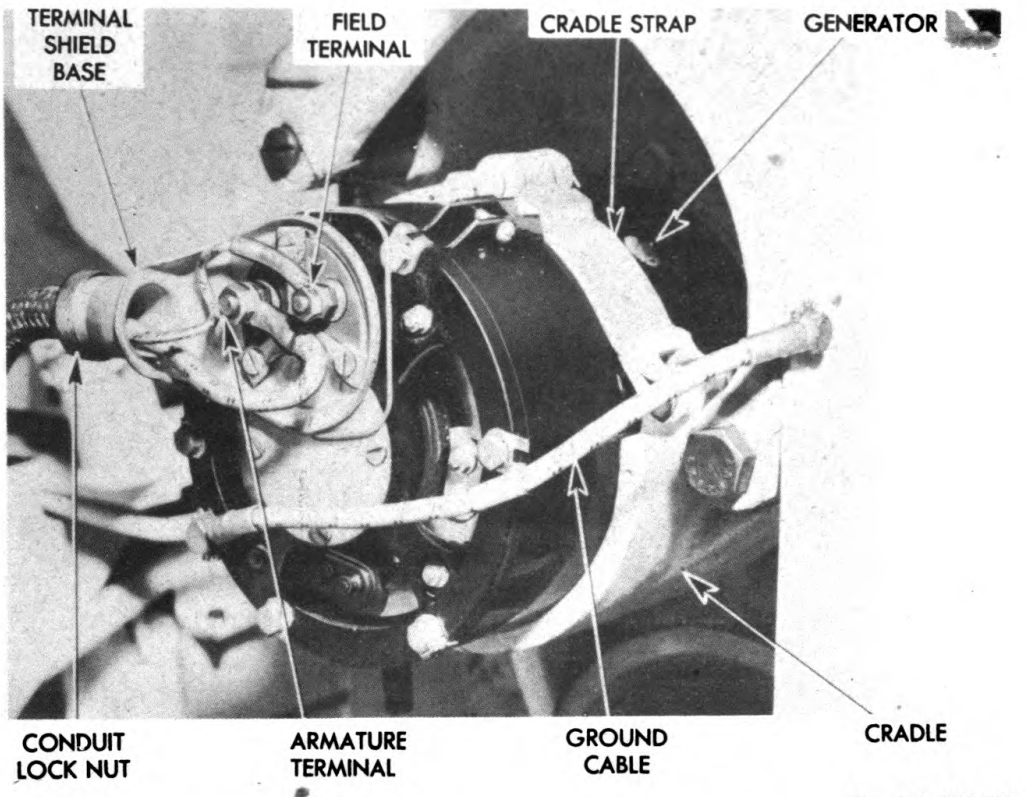


Figure 75 — Generator Terminal Shield — Cover Removed

100. GENERATOR REGULATOR.

a. Description. The generator regulator (fig. 76) is of the three-unit type which includes a voltage regulator, current limitator, and a reverse-current relay or cut-out. The voltage regulator unit maintains the output of the generator at a constant predetermined voltage of 30 volts. The current limitator automatically varies the output of the generator in accordance with the state of charge of the battery and the amount of current being used throughout the vehicle. Thus, the proper charge is delivered to the battery at all times without danger of overcharging. The current limitator unit limits the maximum current output of the generator to 50 amperes. The reverse-current relay, or cut-out, prevents the battery from discharging through the generator when the generator is at rest or when it is not developing its normal voltage.

b. Removal. Disconnect the battery ground cable at the battery. Remove the terminal housing cover. Disconnect all wires from the regulator terminals. Remove the conduit connection and wires from the terminal housing. Remove the four stud nuts holding the regulator to the vehicle and remove the regulator and bond straps.

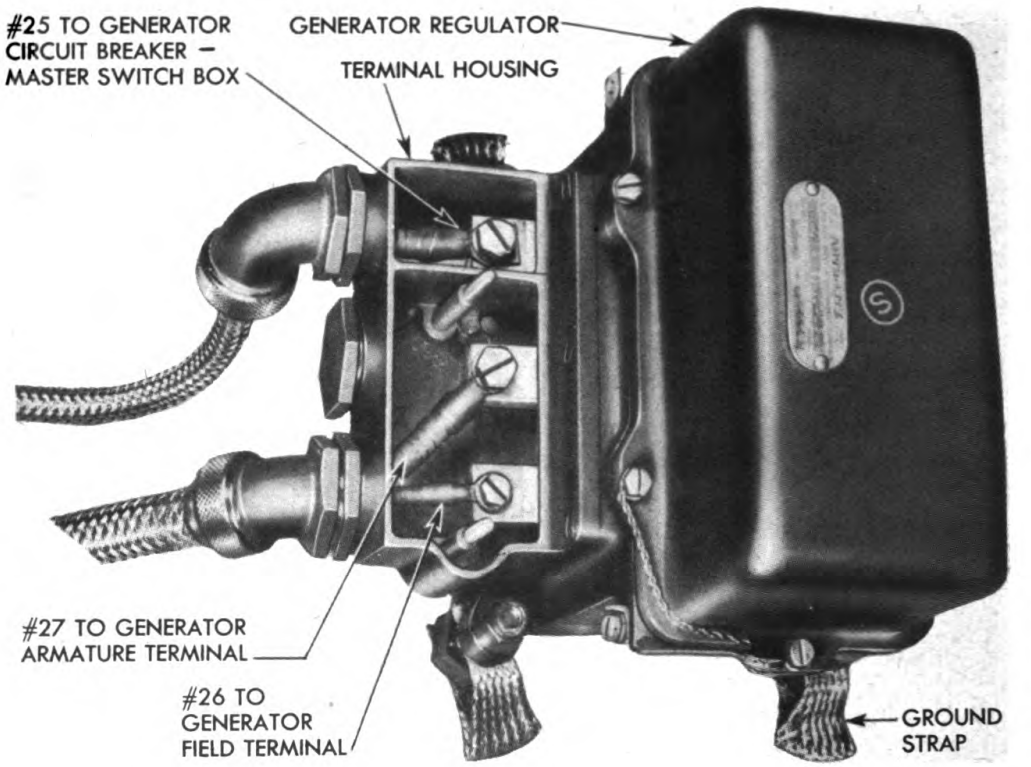


Figure 76 — Generator Regulator

c. Installation. To install the regulator, fasten the regulator to the vehicle with the studs and stud nuts, making sure to install the bond straps under the regulator as they were found. Install the conduit and wires to the regulator terminals in the terminal housing. Install the terminal housing cover. Connect the battery ground cable. Record the replacement of the regulator on W.D., A.G.O. Form No. 478, MWO and Major Unit Assembly Replacement Record.

101. AMMETER.

a. Description. The ammeter is mounted in the left center section of the instrument panel (fig. 10). It indicates the rate of charge delivered to the batteries by the generator, or shows discharge when the generator is stopped with the lights or other electrical units in operation.

b. Removal. Turn off 24-volt master switch. Remove the instrument panel from the case (par. 111 b). Remove screws from plug-in receptacle case above the ammeter and move receptacle to one side (fig. 85). Disconnect wires to ammeter. Remove nuts and toothed lock washers from ammeter mounting studs, remove brackets, and push instrument through face of instrument panel from the rear.

c. Installation. Position ammeter in the instrument panel and install mounting brackets. Connect wires to terminals as shown on instrument panel wiring diagram (fig. 87). Install plug-in receptacle to instrument panel. Install instrument panel in case (par. 111 c).

Section XXIV

LIGHTING SYSTEM AND HORN

102. DESCRIPTION.

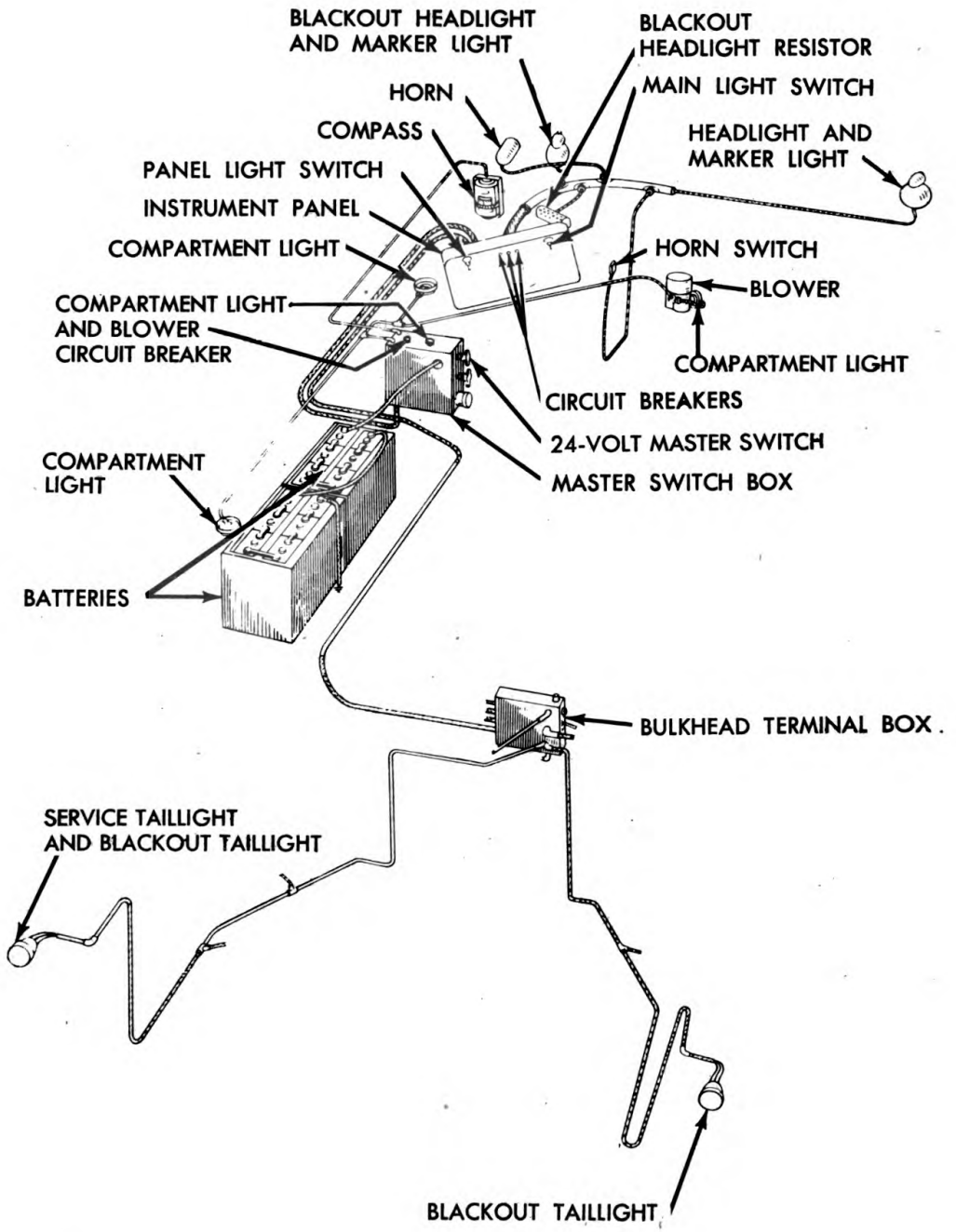
a. Description. The headlights, blackout driving light, blackout marker lights, service taillight, and blackout taillights are controlled through the main light switch on the instrument panel. The compartment lights are controlled individually by a switch on each light. A circuit breaker in the instrument panel protects the system in the event of a short circuit. The current for the blackout driving light is passed through a resistor, located on the left sponson behind the instrument panel, which reduces the voltage for operation of the blackout driving light to 6 volts. All other lights operate on the 24 volts supplied by the batteries.

103. HEADLIGHTS.

a. Description. The two headlights are the sealed-beam lamp-unit type. Blackout marker lights are mounted on top of the headlight body. Headlights are inserted into mounts in the hull and are secured by retaining pins. The retaining pin for the left headlight extends through the hull into the upper left corner of the driver's compartment. The retaining pin for the right headlight extends through the hull into the upper right corner of the assistant driver's compartment. Hole plugs are provided for installation into the headlight mounts to protect the sockets from dirt and moisture when headlights are removed.

b. Replacement of Headlight Lamp-unit (fig. 79). Remove retaining screw at base of headlight door. Pull door out of bottom and lift up. Remove wire from back of lamp-unit. Unhook retainer spring which is attached to the mounting ring. Lift out mounting ring and lamp-unit. To install, place lamp-unit in headlight door with "TOP" mark on lens up. Secure with mounting ring and spring. Attach wire to terminal on back of lamp-unit. Install headlight door.

c. Replacement of Blackout Marker Lamp (fig. 79.) Remove retaining screw at base of blackout marker light door. Lift off door. Press lamp in; then turn counterclockwise and pull out. To install,



RA PD 339590

Figure 77 — Lighting System and Horn Circuit Diagram

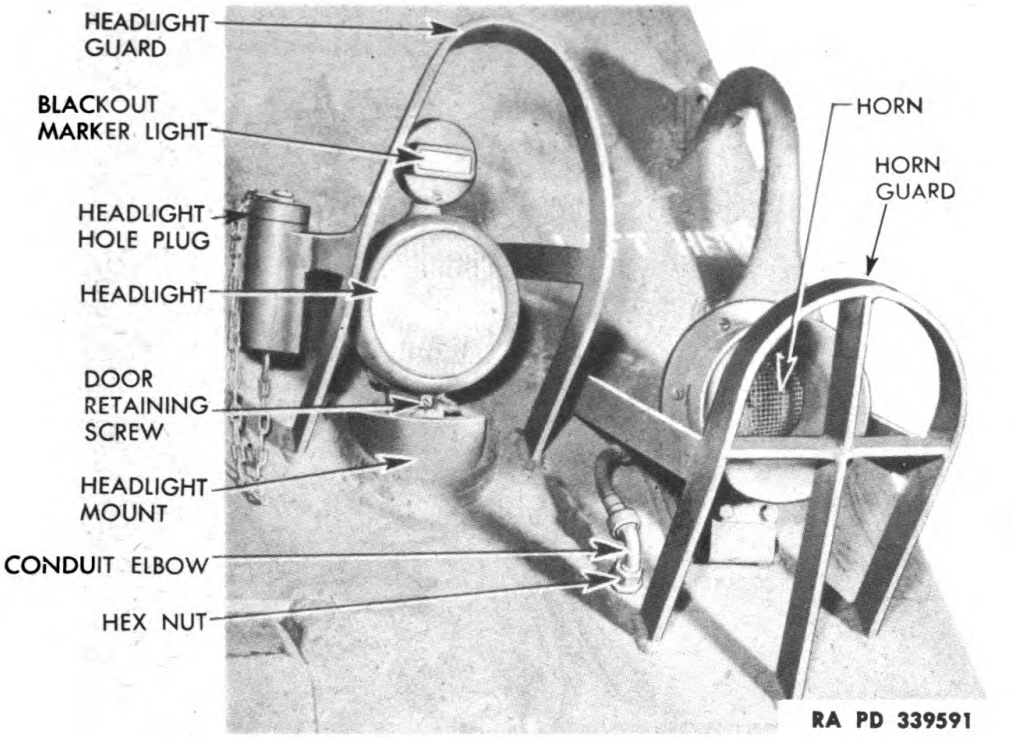


Figure 78 — Horn and Headlight Assembly

insert lamp into socket, press in, and turn clockwise. Hook lip on top of door into slot in light body, press door into position, and install door retaining screw.

d. Replacement of Headlight Assembly (fig. 81). Unscrew headlight retaining pin. Lift headlight assembly up and out. To install, insert headlight assembly into mount in hull and secure with retaining pin.

104. BLACKOUT DRIVING LIGHT.

a. Description (fig. 80). The blackout driving light is designed to operate in the left headlight socket only. A diffused beam of light is emitted through a small portion of the lens. A hood over the top of the lens prevents visibility of the light rays from above. The lamp-unit is a sealed-beam type. A blackout marker light is mounted above the driving light.

b. Replacement of Lamp-unit. See paragraph 103 b.

c. Installation of Blackout Driving Light Assembly. (fig. 80). Remove left headlight assembly (par. 103 d). Insert blackout driving light into mount in hull and secure with retaining pin in driver's compartment.

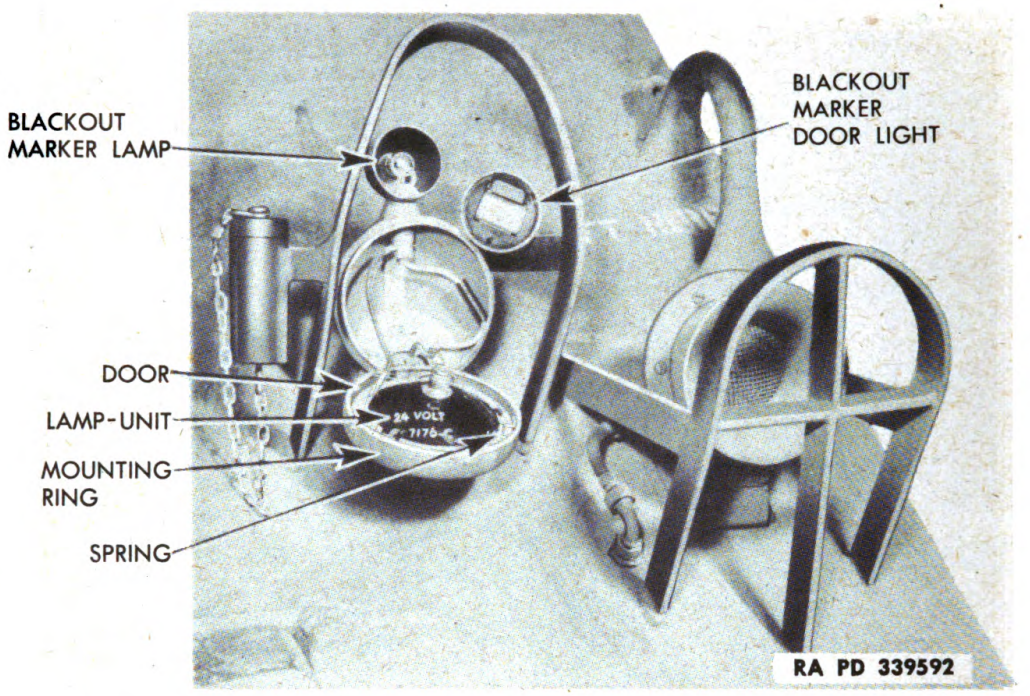


Figure 79 — Headlight and Blackout Marker Light — Doors Removed

105. BLACKOUT DRIVING LIGHT RESISTOR.

a. Description. The blackout driving light resistor is mounted on the sponson in back of the instrument panel (fig. 86). The resistor is used to reduce the current in the blackout driving light circuit from 24 volts down to 6 volts since a low candlepower lamp is used in the light.

b. Removal. Remove the instrument panel as an assembly (par. 111 b). Remove the four cap screws which attach resistor cover to mounting pad (fig. 81). Withdraw the resistor from the housing. Disconnect the two wires from the resistor.

c. Installation. Connect the two wires to terminals on the resistor as shown in figure 81. Position the resistor on the mounting pad and install the cover with four cap screws and lock washers. Install the instrument panel (par. 111 c).

106. TAILLIGHTS.

a. Description. The two taillights are mounted at the top rear corners of the hull. The left taillight contains a service and blackout unit. The right taillight contains a blackout unit only.

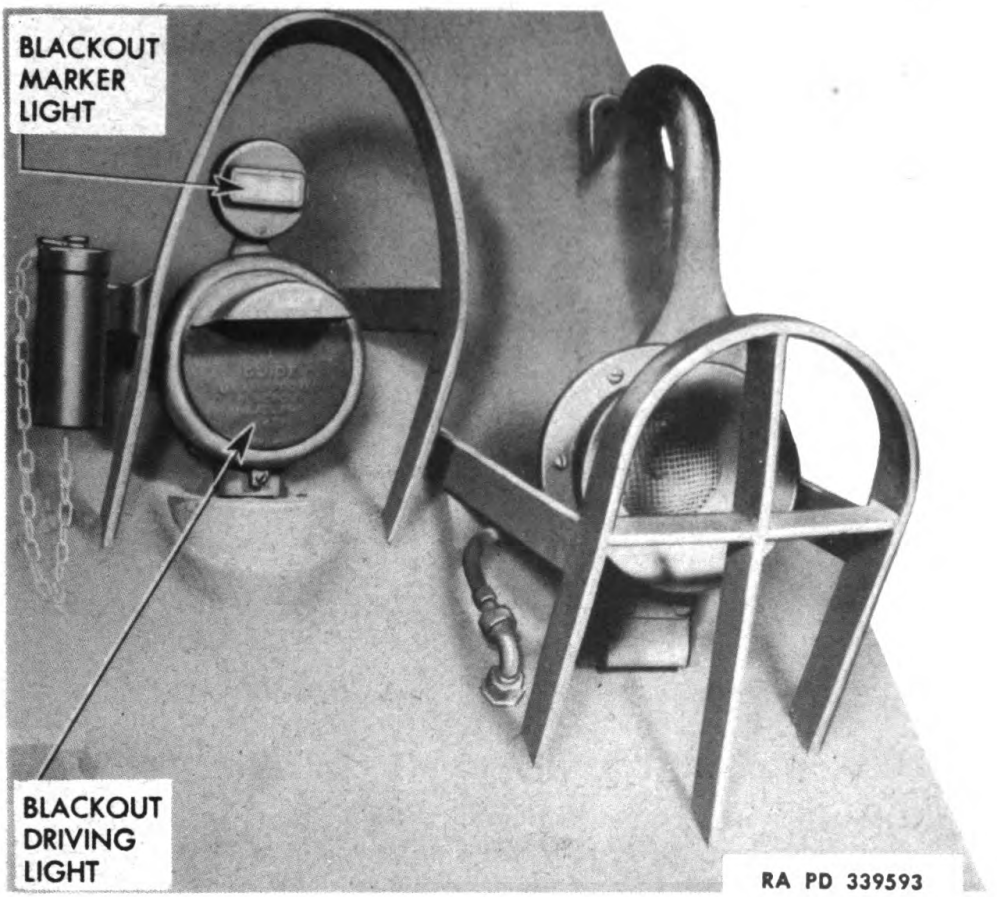


Figure 80 — Blackout Driving Light Installed

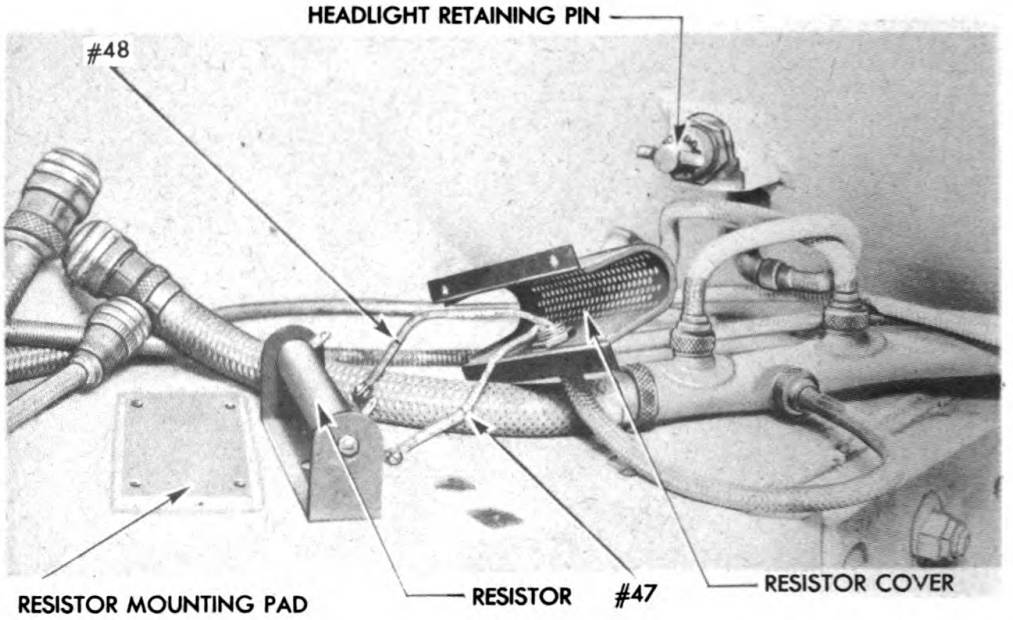
b. Replacement of Lamp-units.

(1) SERVICE TAILLIGHT LAMP-UNIT. Remove door retaining screws from left taillight and lift off door. Pull upper lamp-unit out of socket in taillight housing. To install, insert lamp-unit into socket and install door.

(2) BLACKOUT TAILLIGHT LAMP-UNIT. Remove door retaining screws and lift off door. Pull lower lamp-unit out of socket. To install, insert lamp-unit into socket and install door.

c. Removal of Taillight Assembly (fig. 82). Remove cap screws and lock washers attaching taillight to hull. Lift up taillight assembly and unscrew knurled conduit retaining nut. Pull socket out of taillight base.

d. Installation of Taillight Assembly (fig. 82). Insert socket into plug in taillight base and secure by installing knurled conduit retaining nut. Insert assembly into opening in hull and install lock washers and cap screws.



RA PD 339594

Figure 81 — Blackout Driving Light Resistor — Cover Removed

107. COMPARTMENT LIGHTS.

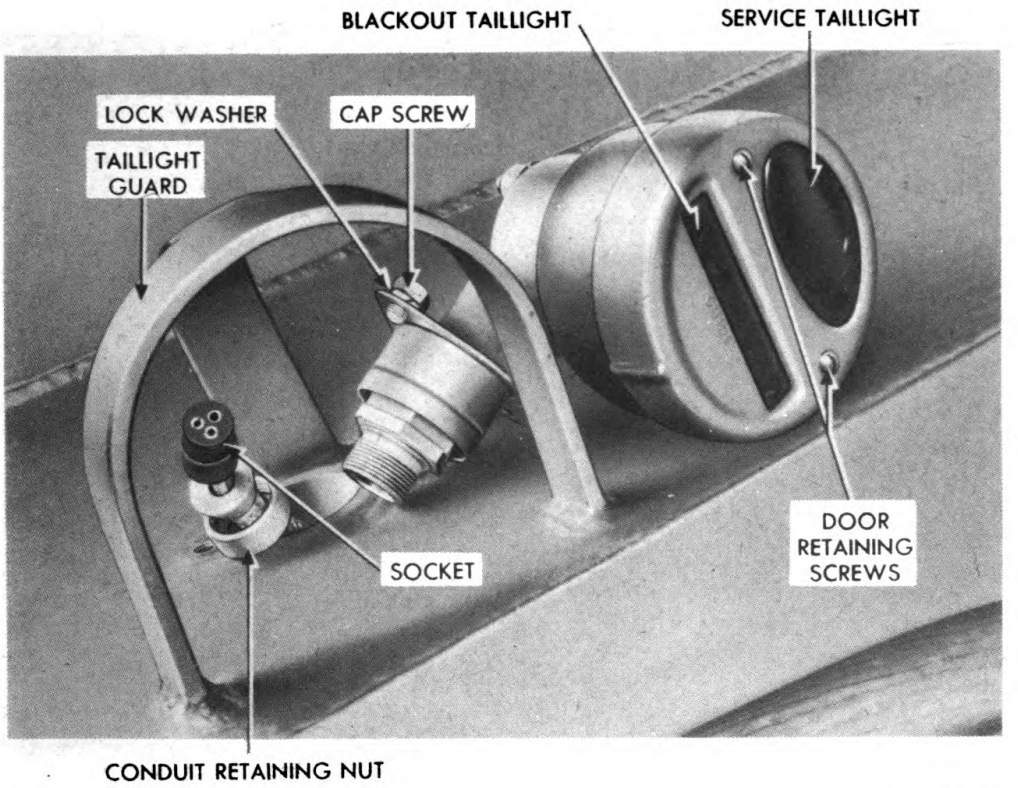
a. Description. Four compartment lights are used in the hull and turret; one over the auxiliary generator (fig. 13), one over the battery switch box (fig. 14), one on the right side of the crew compartment blower (fig. 192), and one in the right front of turret.

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 Compartment 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).

108. INSTRUMENT LAMPS.

a. Replacement of Instrument Panel Lamps (fig. 10). 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,



RA PD 322708

Figure 82 — Taillight Assembly Removed

place the lamp into the socket, push in, and turn clockwise until it locks into the bayonet socket. Install the cover plugs.

109. HORN (SIREN).

a. Description (fig. 78). The horn is mounted on the hull adjacent to the left headlight. It is operated by the horn switch on the right-hand steering brake lever (fig. 58). A circuit breaker in the instrument panel protects the system in the event of a short circuit.

b. Switch Replacement. Make sure 24-volt master switch is turned off. Unscrew conduit coupling nut from switch. Remove the cover plate from back of switch (fig. 58). Disconnect the wires from switch terminal and remove wires and conduit. Remove the two attaching nuts and pull switch off steering lever. To install the switch, position the switch on the steering lever and install the attaching safety nuts. Connect wires to the switch and tighten the conduit coupling nut. Turn 24-volt master switch on, and operate switch to test horn circuit. Install the switch cover plate.

c. Horn (Siren) Replacement. Disconnect the conduit coupling on the inside of the hull leading from the horn or siren and remove the wire from the bullet connection. Remove the two cap screws that secure the horn or siren to the horn bracket. Remove the conduit connection on the outside of the hull and lift off the horn or siren (fig. 78). To install, position the horn or siren to the hull with two cap screws. Insert the wire from the horn or siren through the coupling in the hull and fasten the coupling in the hull. Tighten the coupling on the outside of the vehicle. Attach the bullet connection to the horn or siren wire on the inside of the hull. Fasten both ends of the bullet connection together and connect conduit couplings.

Section XXV

WIRING SYSTEM

110. DESCRIPTION.

a. General. Wiring harnesses are shielded in rigid tubing and flexible metal conduits to protect the wiring against wear, abrasion, oil, and water. The lengths of the harnesses are adapted to the location and purpose for which the harnesses are used. Multiple pin connectors and standard terminal-post type connections are used throughout. Conduits are bonded to the hull by clamps or clips at frequent intervals for support and to minimize radio interference. The wiring of the hull is shown in figure 83 and the turret wiring in figure 84. The instrument panel wiring diagram is shown in figure 87. NOTE: *All wiring is numbered to correspond with the wiring diagrams. However, tagging of the wires and their attaching points at the time of removal will ensure proper installation, and limit the necessity of constant reference to the wiring diagrams.* CAUTION: *Turn off the 24- and 12-volt master switches before attempting any repairs to terminal boxes or the wiring system.*

111. INSTRUMENT PANEL.

a. Description. The instrument panel is located on the sponson to the left of the driver (fig. 6). It is shock-mounted and contains the gages, lights, switches, and other instruments necessary for the operation and control of the vehicle. For full description and use of instruments, refer to paragraph 14. The instrument panel units discussed in this section are only those having no direct relation to any one system of the vehicle.

b. Disassembly. To gain access to the instruments, the instrument panel cover can be removed from the case at the rear of the

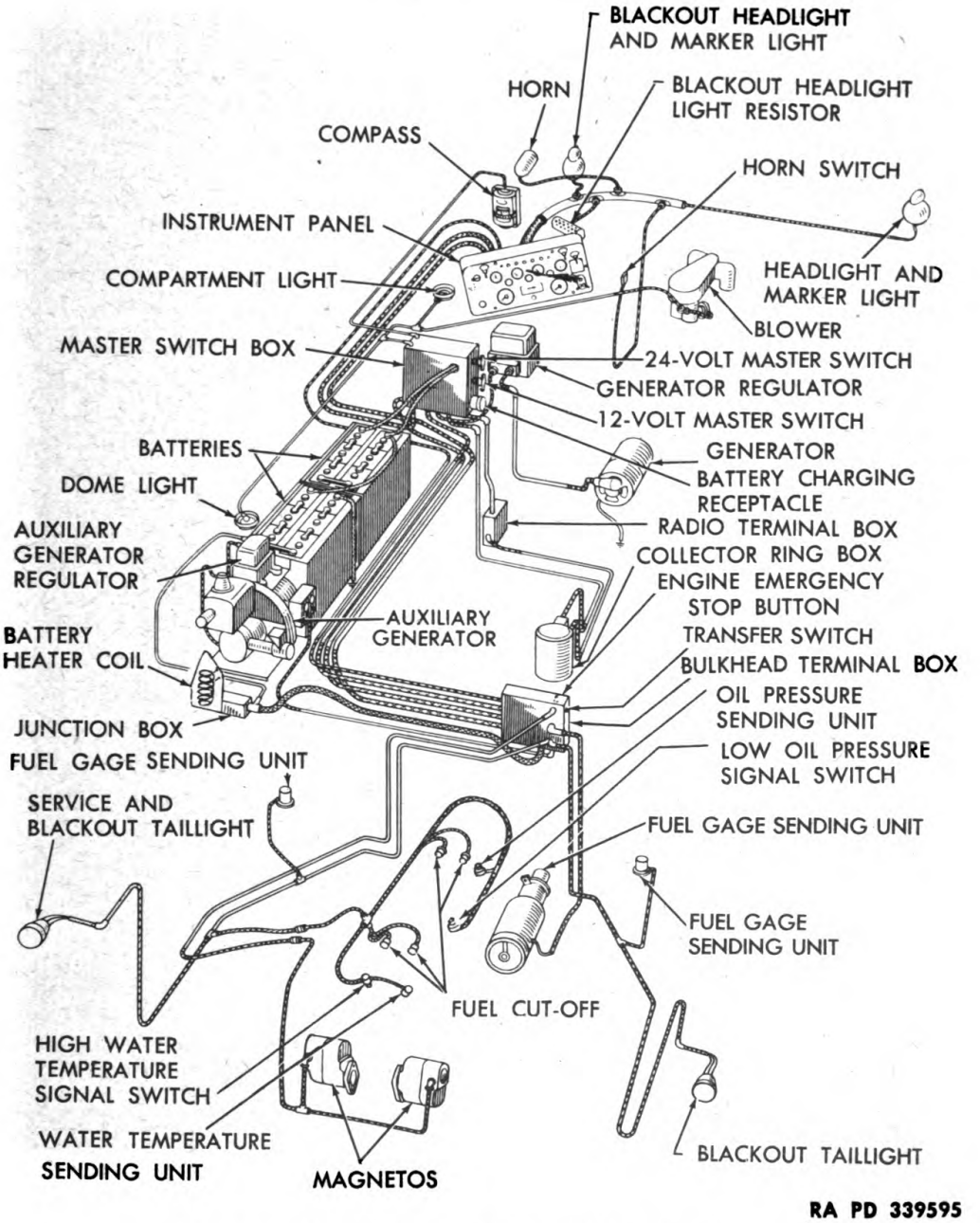
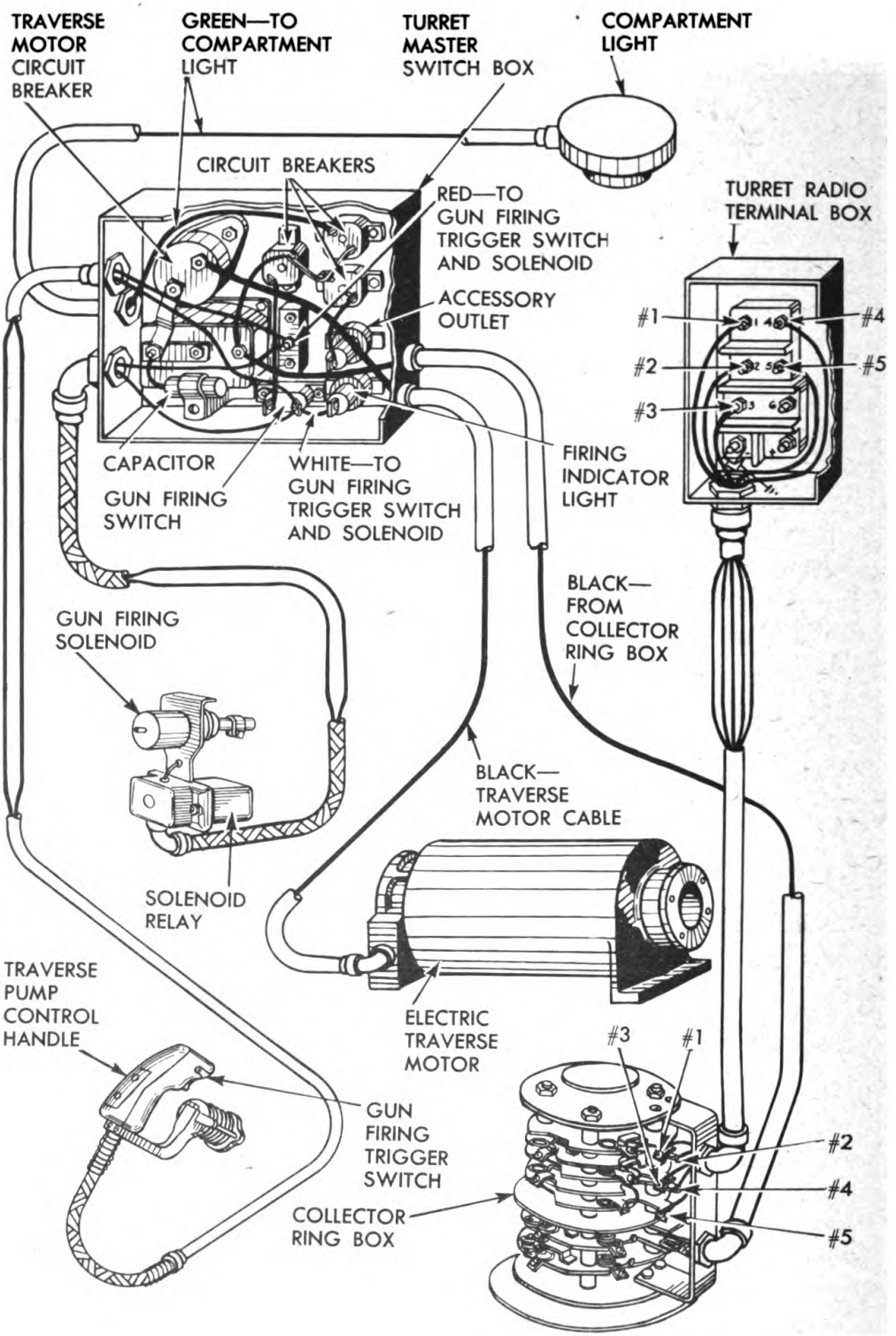


Figure 83 — Hull Electrical System Diagram

panel (fig. 85). Unscrew coupling rings on the speedometer and tachometer flexible shafts and pull shafts from instrument panel (fig. 86). Remove six equally spaced screws from the outer edge of the cover. Pull the cover from the case.

c. Assembly. Position the cover on the case and install attaching screws. Connect the speedometer and tachometer flexible shafts to the speedometer and tachometer heads at the rear of the panel.



RA PD 339596

— *Turret Electrical System Diagram*

d. Removal. Unscrew coupling rings from speedometer and tachometer flexible shafts and pull shafts from panel. Unscrew the three plug-in receptacle coupling rings and pull the receptacles from their sockets. Remove the three screws and washers that secure the panel to the sponson and remove the panel.

e. Installation. Position the instrument panel on the sponson and install attaching screws and washers. Install the three plug-in receptacles in their sockets and tighten coupling rings. Install the speedometer and tachometer flexible shafts to heads in panel and tighten coupling rings.

112. BULKHEAD TERMINAL BOX.

a. Description. The bulkhead terminal box houses the battery heater transfer switch, heater pilot (warning) light, the engine emergency stop switch, and terminal blocks (fig. 88). The box is mounted on the center of the bulkhead in the fighting compartment (fig. 9).

b. Removal.

(1) BULKHEAD TERMINAL BOX. Turn off the 24-volt master switch. Remove the terminal box cover and disconnect the wires from all terminals inside terminal box. Remove the conduit fitting lock nuts and pull the wiring out of the box. Remove the mounting screws which secure the box to the bulkhead.

(2) ENGINE EMERGENCY STOP SWITCH. Remove terminal box cover and disconnect wires to switch. Remove switch button rubber shield and spring from button. Unscrew switch retainer at top of switch and pull switch down out of its bracket.

(3) TRANSFER SWITCH. Remove terminal box cover. Disconnect wires at switch terminals, remove nuts and washers from outside of terminal box, and remove switch.

(4) PILOT LIGHT — CHANGE LAMP. The red shield and fiber retainer can be pried off with screwdriver. To remove the lamp, press in and turn left one-quarter turn. Install new lamp by reversing removal procedure.

(5) TERMINAL BLOCKS. Disconnect wires at block terminals. Remove screws and lock washers attaching blocks to box.

c. Installation.

(1) ENGINE EMERGENCY STOP SWITCH. Position switch in bracket and install switch retainer, spring, and rubber shield. Connect wires to switch and tighten terminal nuts. Run engine and test operation of switch.

(2) TRANSFER SWITCH. Position switch in terminal box and install nuts and washers to switch studs. Connect wires, run auxiliary generator engine, and test operation of transfer switch. Install terminal box cover.

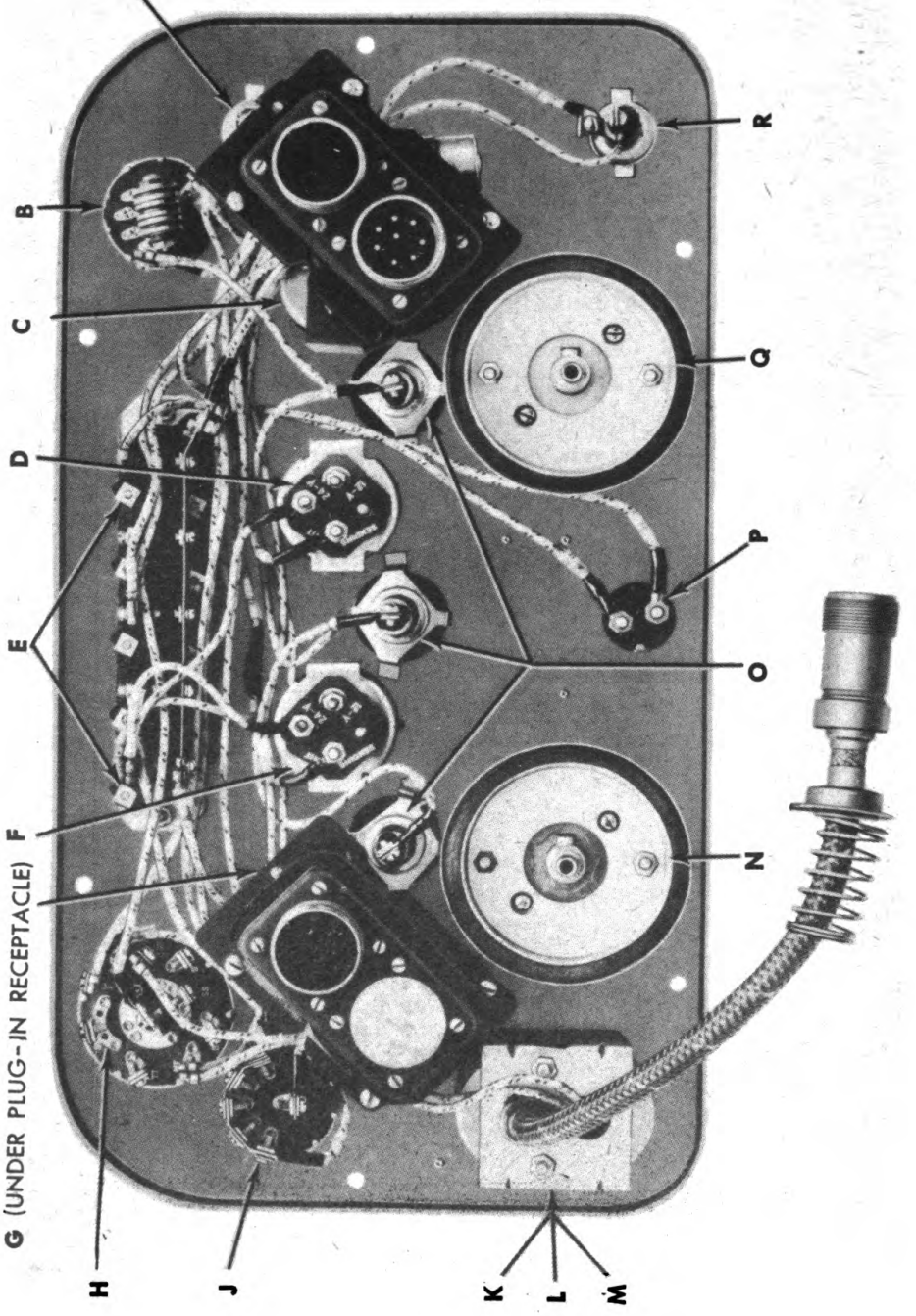


Figure 85 — Back of Instrument Panel — Cover Removed

A—UTILITY OUTLET (UNDER PLUG-IN RECEPTACLE)
B—INSTRUMENT PANEL LIGHT SWITCH
C—AMMETER
D—OIL PRESSURE GAGE
E—CIRCUIT BREAKERS
F—TEMPERATURE GAGE
G—FUEL GAGE (UNDER PLUG-IN RECEPTACLE)
H—MAIN LIGHT SWITCH
J—FUEL TANK GAGE SELECTOR SWITCH
K—MAGNETO SWITCH
L—STARTER SWITCH
M—BOOSTER SWITCH (NOT USED)
N—TACHOMETER
O—PANEL LIGHTS
P—FUEL CUT-OFF SWITCH
Q—SPEEDOMETER
R—HIGH WATER TEMPERATURE AND LOW OIL PRESSURE WARNING LIGHT

RA PD 329515D

Legend for Figure 85

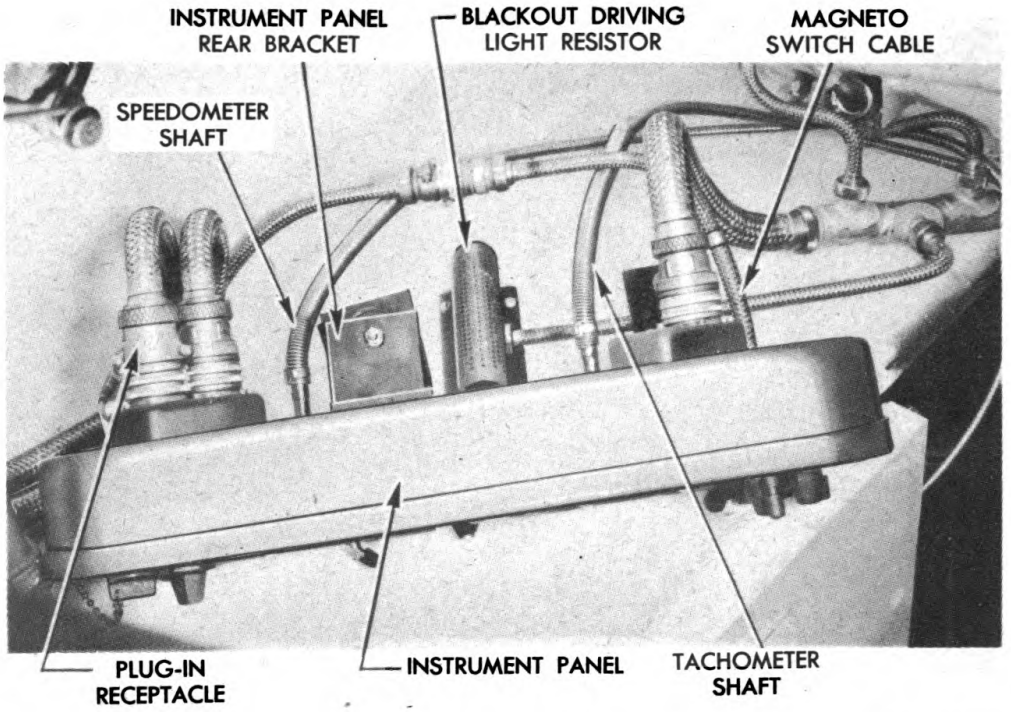


Figure 86 — Instrument Panel Connections

(3) BULKHEAD TERMINAL BOX. Insert wires in box and connect to terminals from which they were removed. Install conduits and tighten lock nuts (fig. 88). Position terminal box on the bulkhead, install mounting screws with toothed washers, and tighten securely. Turn on 24-volt master switch. Run engine and test operation of emergency stop switch. Run auxiliary generator engine and test operation of transfer switch and pilot light.

113. MASTER SWITCH BOX.

a. Description. The master switch box is mounted on the forward end of the battery box to the left of the driver (fig. 14). It provides a housing for the 24-volt and 12-volt master switches, the starter solenoid, main generator and compartment light circuit breakers, and terminal blocks for connecting the wires of the corresponding circuits together (fig. 74).

b. Removal. Remove the battery box cover and disconnect the battery ground cable. Remove the switch box cover and disconnect all wiring leading from the box. Remove the four screws attaching switch box to battery box and disconnect conduits from the fittings. Pull wires out of the fittings and remove the box. Remove all switches, fittings, and terminal blocks from the switch box.

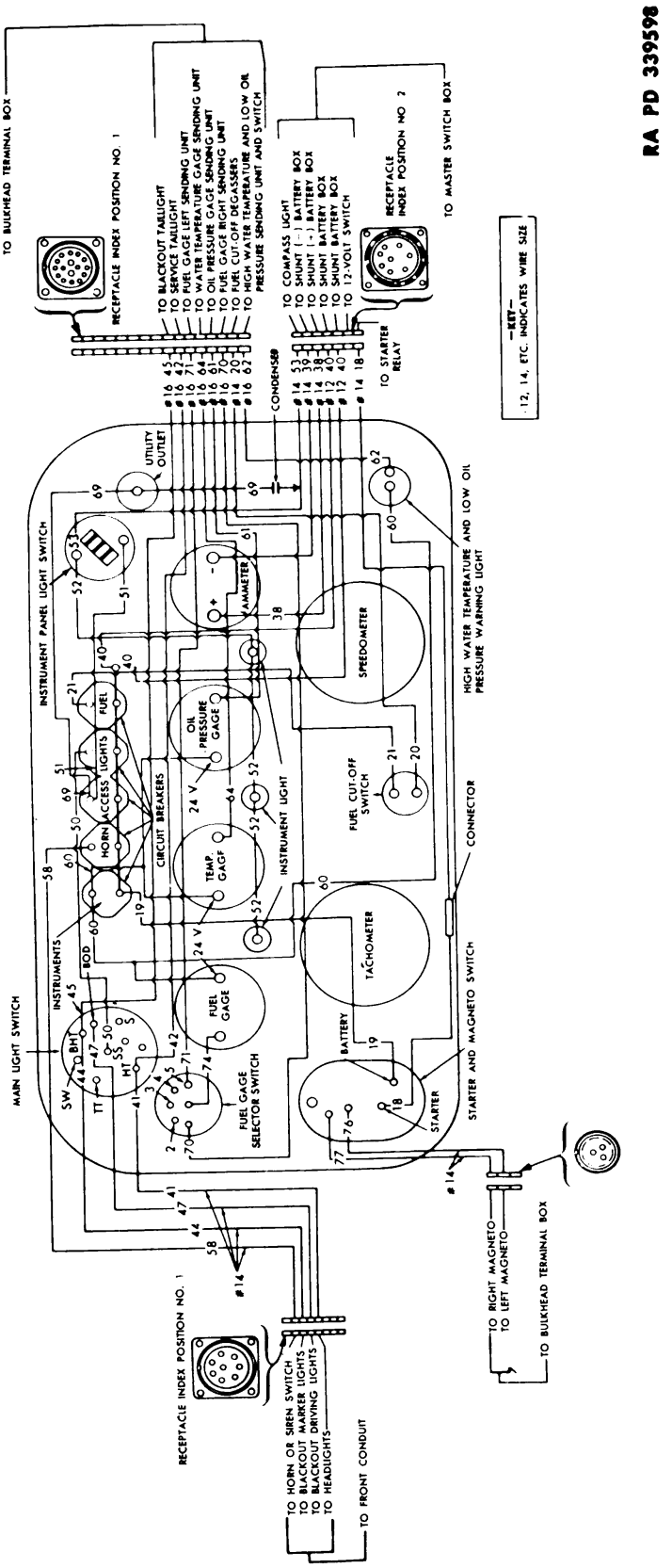


Figure 87 — Instrument Panel Wiring Diagram

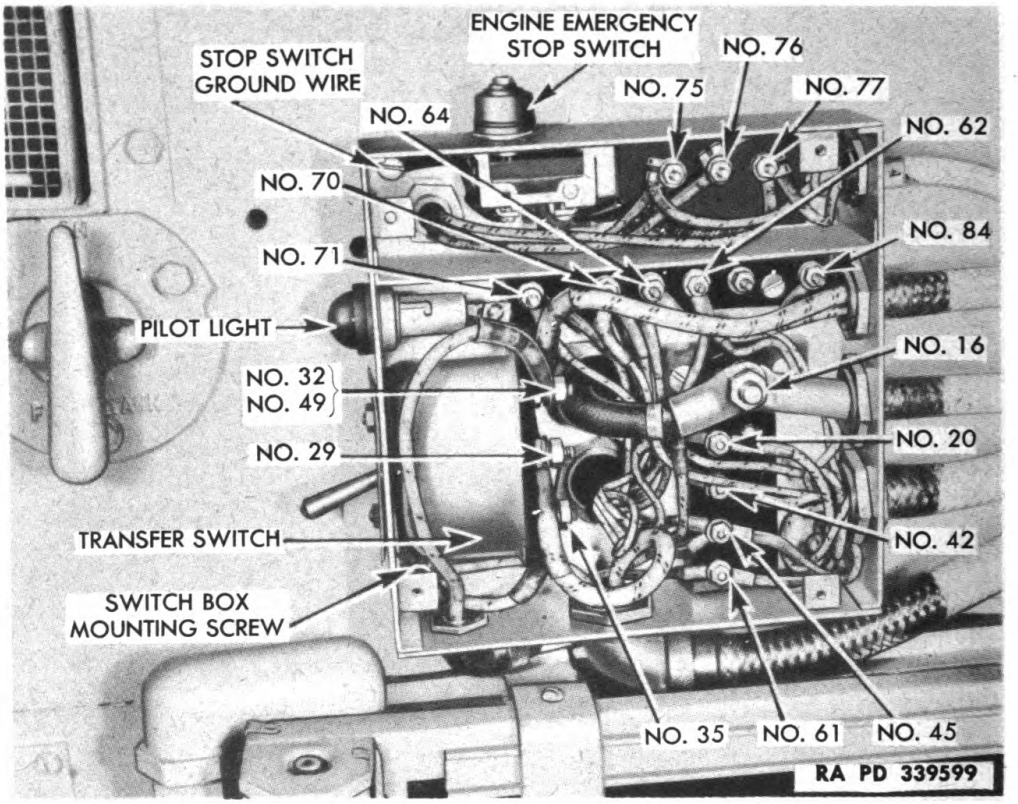


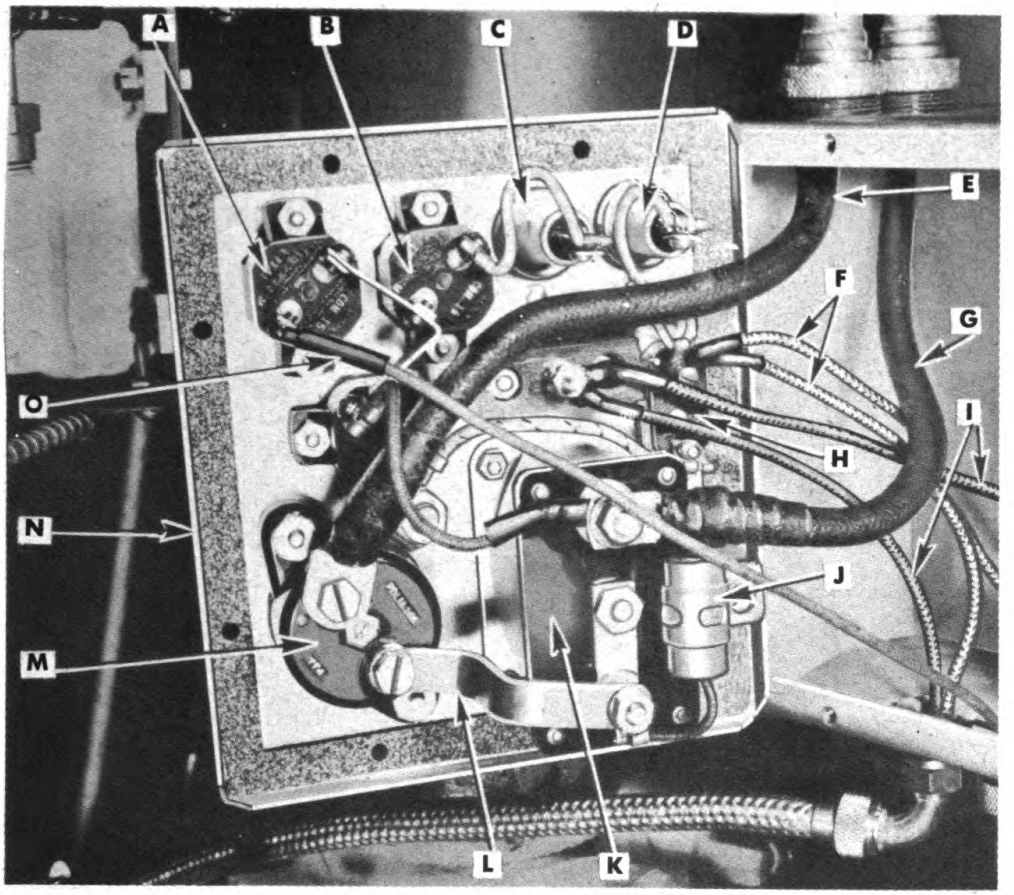
Figure 88 — Bulkhead Terminal Box — Cover Removed

c. Installation. Install all fittings, switches, and terminal blocks. Insert wires in the proper fittings and attach conduits. Position switch box on battery box and install toothed lock washers and mounting screws. Connect the starter solenoid ground wire to the lower mounting screw under the solenoid, and the battery charging receptacle ground cable to the mounting screw below the receptacle. Tighten screws securely. Connect all wiring as shown in figure 74. Connect the battery ground cable. Install the switch box and battery box covers.

114. TURRET SWITCH BOX.

a. Description. The turret switch (or control) box is mounted on the turret basket above the traverse motor (fig. 201). It contains the traverse motor switch and circuit breaker, firing switch and circuit breaker, compartment light and inspection light circuit breaker, accessory outlet, and firing indicator (red signal) (fig. 89).

b. Removal. Turn off both 12- and 24-volt master switches. Remove the switch box cover and pull it out away from the box (fig. 89). Disconnect all wires leading from the box and cover and re-



A—CIRCUIT BREAKER FOR COMPARTMENT LIGHT
B—CIRCUIT BREAKER FOR ACCESSORY OUTLET
C—ACCESSORY OUTLET SOCKET
D—GUN FIRING CIRCUIT INDICATOR LIGHT SOCKET
E—CABLE TO TRAVERSE MOTOR
F—WHITE—TO GUN FIRING SWITCHES
G—CABLE TO COLLECTOR RING
H—GUN FIRING SWITCH
I—RED—TO GUN FIRING SWITCHES
J—CAPACITOR
K—TRAVERSE MOTOR SWITCH
L—BUS BAR
M—TRAVERSE MOTOR CIRCUIT BREAKER
N—TURRET SWITCH BOX COVER
O—GREEN—TO COMPARTMENT LIGHT

RA PD 339600

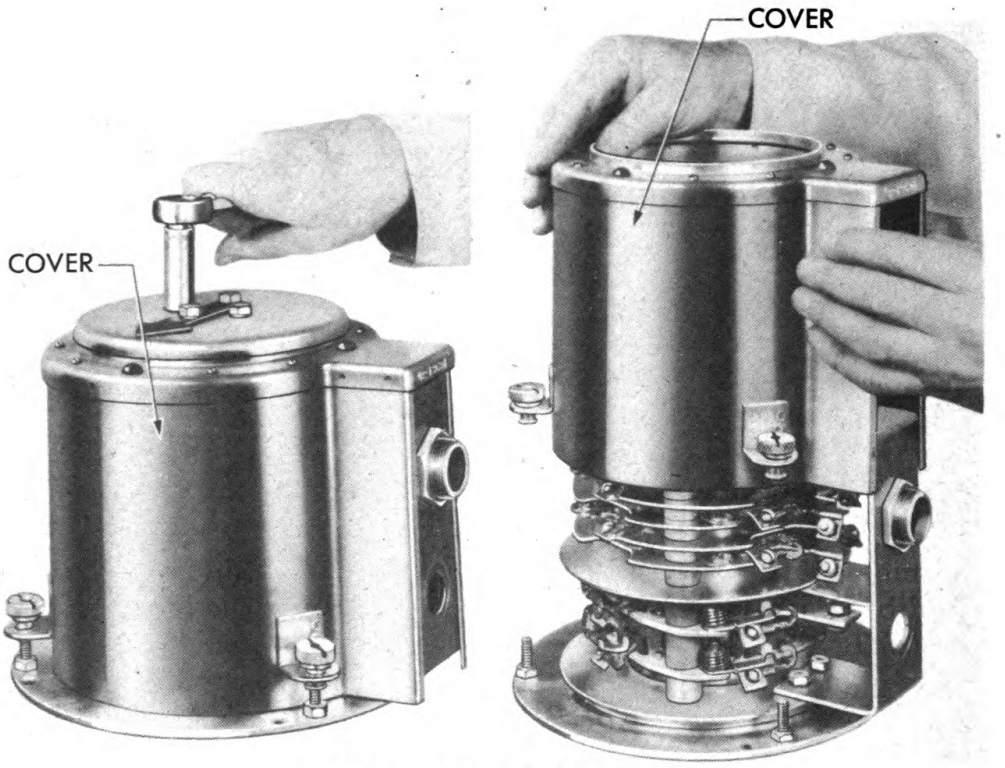
Figure 89 — Turret Switch Box — Cover Removed

move the cover. Disconnect conduits from fittings and pull the wires from the box. Remove the mounting screws and lift off the box.

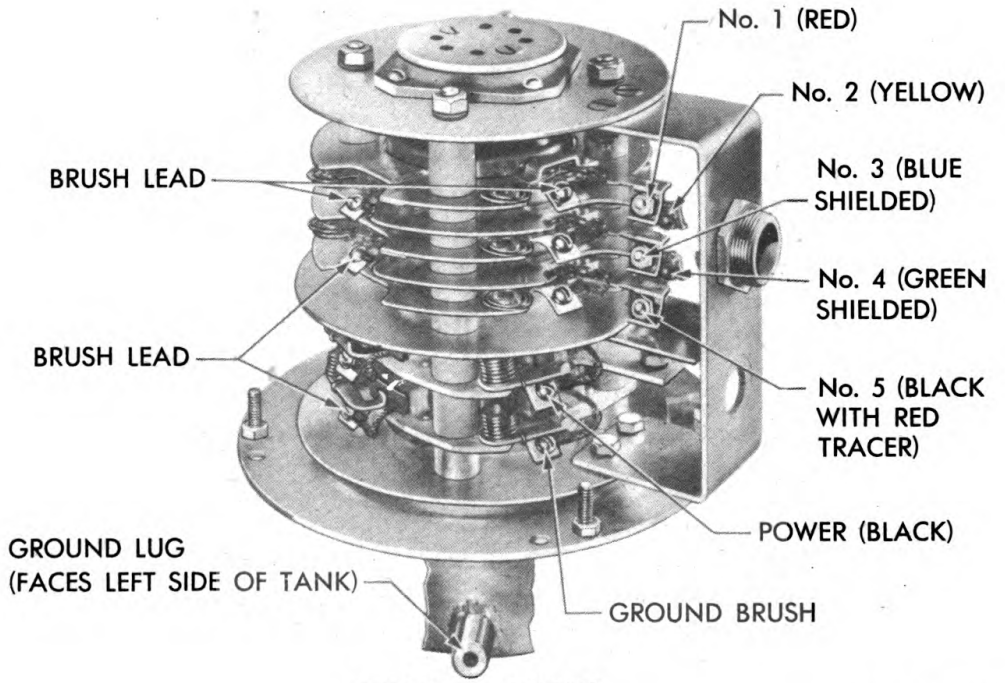
c. Installation. Position switch box on turret basket and install mounting screws. Insert wires in the proper openings, attach conduits, and connect wires as shown in figure 89. Install the switch box cover and test all circuits by operating the units.

115. COLLECTOR RING BOX.

a. Description. The collector ring assembly is a group of rings, brushes, and terminals contained within a dust-proof housing (fig. 90).



1. REMOVING COVER



2. WIRE LOCATIONS

RA PD 53649

Figure 90 — Collector Ring Box

The brush-holding part of assembly revolves with the turret basket and the ring part is stationary. Both the 12- and 24-volt circuits are supplied through the collector ring to the turret switch box. The upper rings and brushes carry the 12-volt current for the radio and interphone systems. The lower rings and brushes carry the 24-volt current for the turret traversing system.

b. Removal. Turn off both master switches. Remove the four screws and lock washers from the collector ring cap and remove the cap and arrow. Loosen the knurled thumb screws at base of cover and remove the cover. Disconnect the wires leading to the radio terminal box. Disconnect the 24-volt cable leading to the turret switch box at the collector ring terminal. Disconnect the conduit and remove bolts attaching the collector ring to the turret platform. Remove screws from collector ring guide lugs and disconnect the ground strap. Lift the assembly and loosen the two knurled thumb screws which secure the bottom cover. Disconnect the 24-volt feed wire and unscrew conduit lock nut. Disconnect the 12-volt feed wires at their terminals and unscrew conduit lock nut. Remove the collector ring.

c. Installation. Pull the feed line conduit with wires up through opening in fighting compartment floor. Connect the 24-volt wire in bottom of collector ring. Install the 12-volt feed wire through opening in collector ring lower housing and attach to terminal posts. Do not attach conduit lock nuts until collector ring is mounted in place. Install the bottom cover and tighten thumbscrews. Position the collector ring on the platform and install mounting bolts. Install the ground strap. Tighten the conduit lock nuts. Install the 24-volt cable from turret switch box and connect to terminal (fig. 104). Insert the five 12-volt feed wires through fitting in collector ring box and connect to terminals as shown on figure 90. Connect the conduit, install collector ring box cover, and tighten thumbscrews. Install collector ring cap with arrow pointing toward front of vehicle. Turn on master switches and operate turret electrical equipment to test collector ring installation.

Section XXVI

SPEEDOMETER, TACHOMETER, AND COMPASS

116. SPEEDOMETER AND TACHOMETER.

a. Instruments.

(1) REMOVAL. Remove instrument panel and instrument panel cover (par. 111 b). Remove two nuts and toothed lock washers from speedometer (or tachometer) mounting studs. Lift off mount-

ing bracket. Remove speedometer (or tachometer) through front of instrument panel cover. Lift off gaskets.

(2) INSTALLATION. Position gaskets around instrument body, cable connector post, and both mounting studs. Position gasket over speedometer trip reset stem. Insert speedometer (or tachometer) through opening in panel cover. Position mounting bracket over mounting studs and secure with toothed lock washers and nuts. Assemble cover to case and connect shafts (par. 111 c).

b. Adapters.

(1) TACHOMETER (fig. 10).

(a) Removal. Back off flexible shaft coupling nut and pull cable out of adapter. Back off hex nut at bottom of adapter and lift adapter off sleeve. Straighten ears of lock washer under the sleeve; then back sleeve out of transmission case. Lift tachometer drive shaft out of seat in transmission case.

(b) Installation. Install drive shaft. Position lock washer over opening in transmission case and install the sleeve. Bend one ear of lock washer over hex on sleeve and other ear over edge of transmission case. Attach adapter to sleeve with hex nut at bottom of adapter. Insert tachometer cable into adapter; then secure flexible shaft to adapter.

(2) SPEEDOMETER (fig. 10).

(a) Removal. Back off flexible shaft coupling nut and pull cable out of adapter. Back off hex nut at bottom of adapter and lift adapter off drive extension shaft sleeve. Lift drive extension shaft out of sleeve. Back drive extension shaft sleeve out of driven gear sleeve. Remove two cap screws and lock washers which attach driven gear sleeve to transmission case and lift off the sleeve and gasket. Lift speedometer driven gear out of seat in transmission case.

(b) Installation. Install speedometer driven gear in seat in transmission case. Position gasket and attach driven gear sleeve to transmission case with two lock washers and cap screws. Thread drive extension shaft sleeve into driven gear sleeve. Attach adapter to sleeve with hex nut at bottom of adapter. Insert cable into adapter and secure flexible shaft to adapter with coupling nut.

117. COMPASS.

a. Description. A combat-vehicle type Sherril compass Model AEG-1 is supported in a bracket above the instrument panel (fig. 6). The compass is lighted by a small lamp screwed into a socket at the top of the compass.

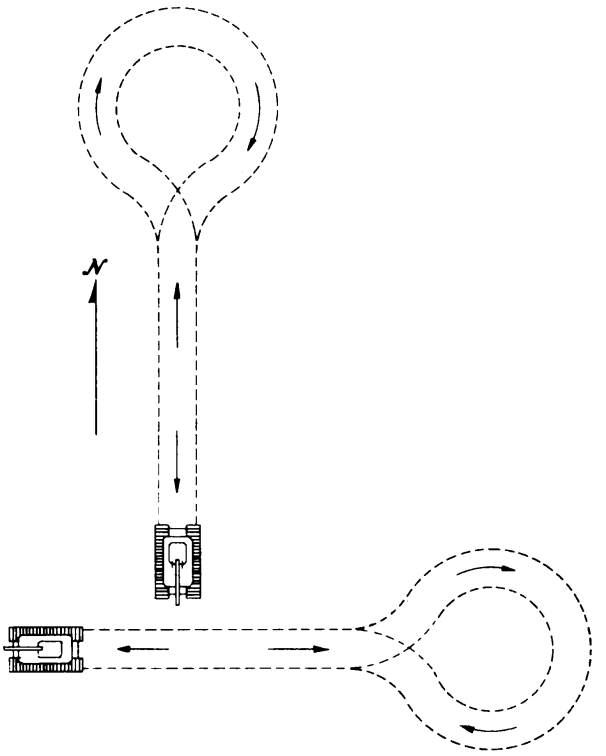
b. Replace Compass Lamp. Unscrew knurled cap at top. Lift off the cover at the front (fig. 91). Unscrew the lamp and socket. Install the new lamp. Position the cover on the compass and screw

RA PD 339601

Figure 91 — Compass — Cover Removed

on the cap. Turn on battery master switch and instrument panel light switch to test lamp.

c. Check Compass Deviation. Compass readings may deviate from the true reading due to magnetic influences within or outside the vehicle. Select a relatively level terrain and drive the vehicle forward a short distance with the compass indicating north. Turn around and drive back over the tracks just made (fig. 92). The compass will read south if no error or deviation exists. This error will be represented by the amount the "S" on the card moves away from



RA PD 304283

Figure 92 — Diagram for Checking Compass

the pointer. Note the maximum error or deviation. Stop the vehicle. Remove the knob and cover from the top of the compass. Slowly turn the north-south thumb wheel or adjuster (fig. 91) until the "S" has moved back exactly halfway to the pointer. Turn the vehicle and drive so compass reads east. Return over the same tracks. The compass should indicate west. Note the maximum deviation or error. Correct the deviation by turning the east-west adjuster until the "W" has moved exactly halfway back to the pointer. Install the cover and knob. If deviation is excessive or cannot be corrected, refer to the instruction book furnished with each compass or notify higher authority to compensate the compass. Replace the compass if it cannot be compensated or is not operating properly.

d. Removal. Disconnect conduit from compass. Loosen both knobs, one at each side of compass (fig. 91). Tilt compass and remove the two mounting cap screws.

e. Installation. Screw the two mounting cap screws into the compass and push the compass into place. Plug in the connector at back of compass and connect the conduit. Tighten the knob on each side of the compass.

Section XXVII

TURRET

118. DESCRIPTION.

a. General. The turret is a one-piece casting of armor steel. It is open at the top, and has an extended section in the rear which forms a stowage compartment and also acts as a balance weight for the 90-mm gun (fig. 1). The turret is supported on the hull by means of a ball bearing race. The upper race ring is attached to the turret and the lower race ring is anchored to the hull. A ball race ring is attached to the lower ring and forms the retainer for the ball bearings. The turret may be rotated to the right or left through 360 degrees by either the hydraulic or hand traversing mechanism (fig. 198). The turret may be locked in position by means of the turret lock (fig. 12).

119. HYDRAULIC TRAVERSING MECHANISM.

a. Description. The hydraulic traversing mechanism includes the electric motor which drives the hydraulic pump, the control valve, hydraulic motor, oil reservoir, and tubes (fig. 93). Oil from the reservoir is pumped under pressure to the control valve by the hydraulic pump driven by the electric motor. The valve controls the volume and direction of flow of the oil to the hydraulic motor on the manual traversing mechanism. The hydraulic motor is coupled to the manual traversing mechanism by the action of the shift lever, and traverses the turret by driving the manual traversing mechanism. The oil from the hydraulic motor is returned to the reservoir.

b. Servicing Hydraulic Traversing Mechanism. The hydraulic traversing mechanism will be serviced and inspected at regular intervals given in paragraph 33 and according to instructions in the following steps. When servicing the system, every precaution must be taken to prevent dirt or foreign matter from entering the system or contaminating the hydraulic oil.

(1) CHECK OIL LEVEL IN RESERVOIR. Check oil level and condition of oil on sight gage at side of reservoir. Maintain oil level at two-thirds full.

(2) DRAIN HYDRAULIC OIL RESERVOIR. When oil becomes discolored, drain the reservoir (fig. 94). Wipe off outside and bottom of reservoir. Place a clean container of suitable capacity under reservoir. Disconnect tube at port No. 13 (fig. 93) at bottom of reservoir. Allow reservoir to drain dry. Connect tube and tighten fitting.

(3) FILL HYDRAULIC OIL RESERVOIR (fig. 94). Clean top of reservoir. Remove filler cap and pour 4 quarts of hydraulic oil into reservoir. Inspect filler cap gasket and install new gasket as re-

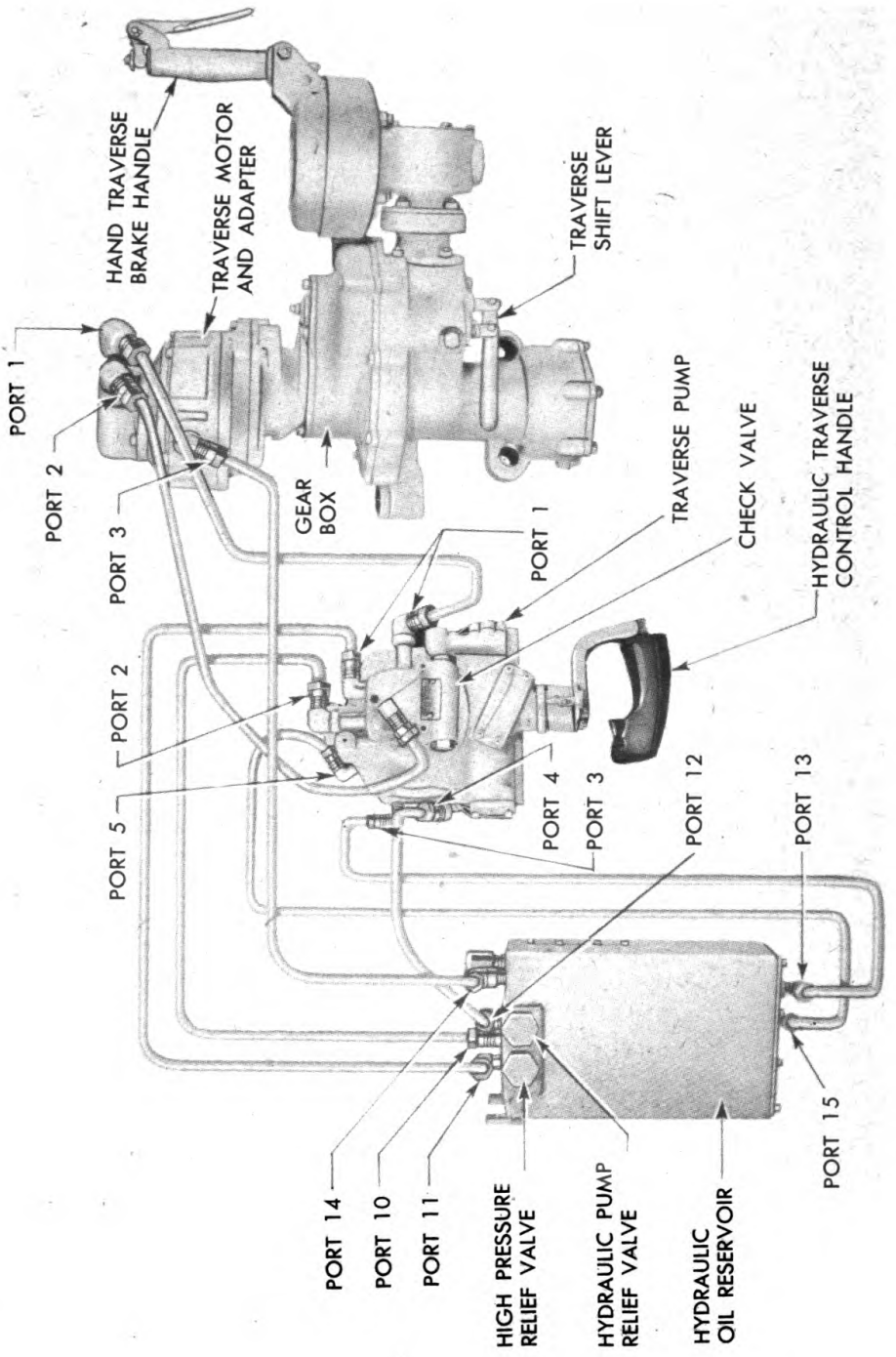


Figure 93 — Hydraulic Traversing Mechanism

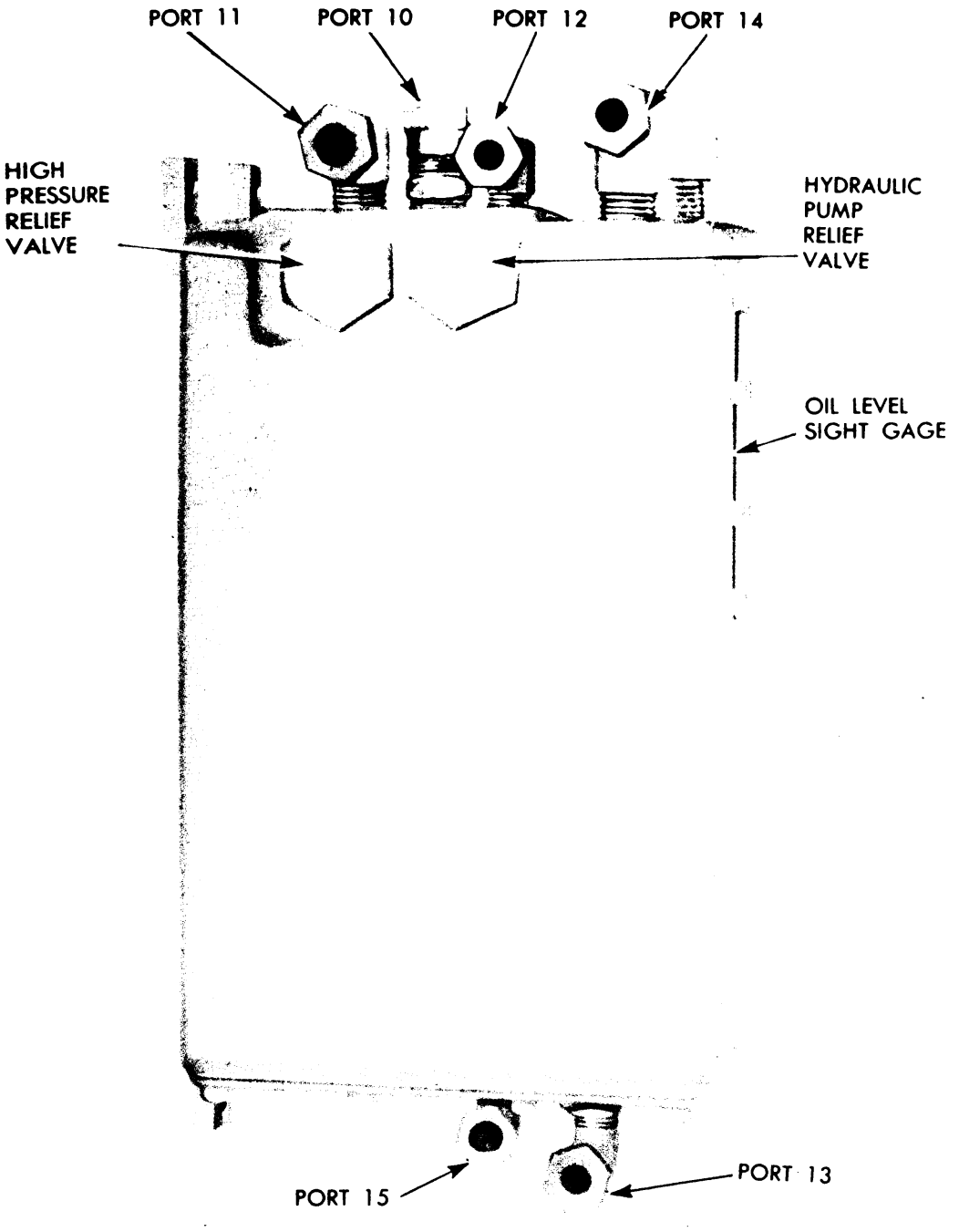
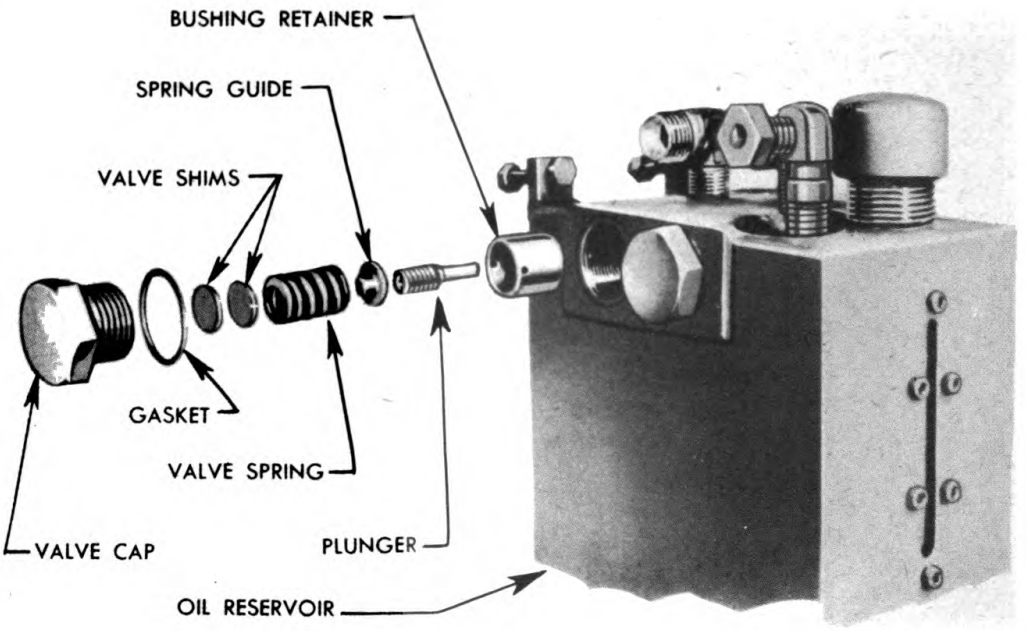


Figure 94 — Oil Reservoir

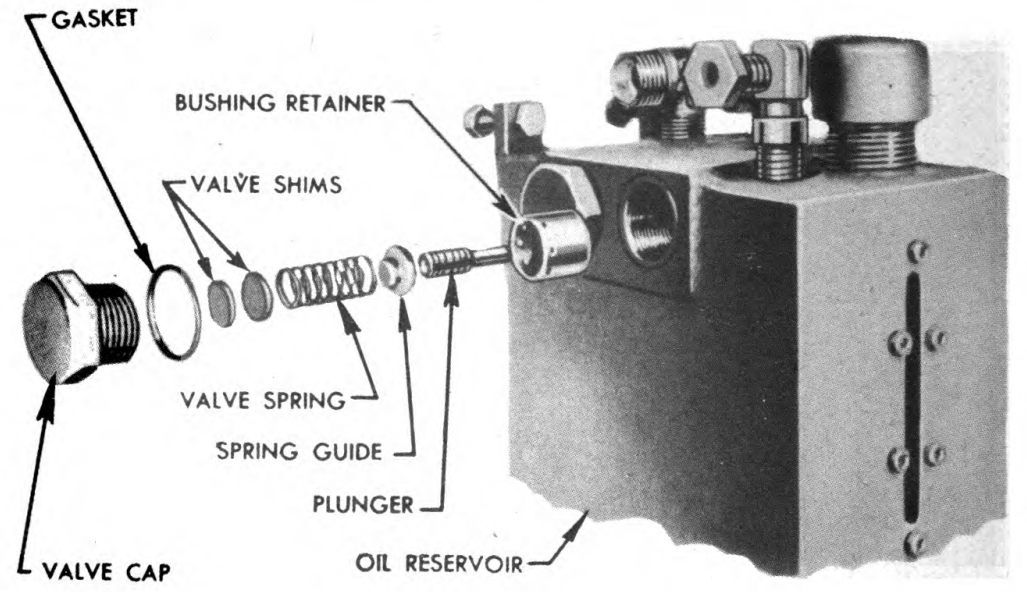
quired. Install filler cap. Operate mechanism for several 30-second intervals and recheck level of oil (subpar. b (1) preceding). Add hydraulic oil as required to maintain level at two-thirds full.

(4) CLEAN HIGH PRESSURE RELIEF VALVE (figs. 94 and 95). Lock the turret. Place container under reservoir. Remove high



RA PD 339604

Figure 95 — High Pressure Relief Valve Parts



RA PD 339605

Figure 96 — Hydraulic Pump Relief Valve Parts

pressure relief valve cap marked No. 1. Lift out gasket, shims (if used), retainer, relief valve spring, and plunger. Clean all parts thoroughly in dry-cleaning solvent. Examine valve plunger seat for scores, and spring for weakness. Turn traversing control handle all the way to the right and hold it in this position. Turn traversing

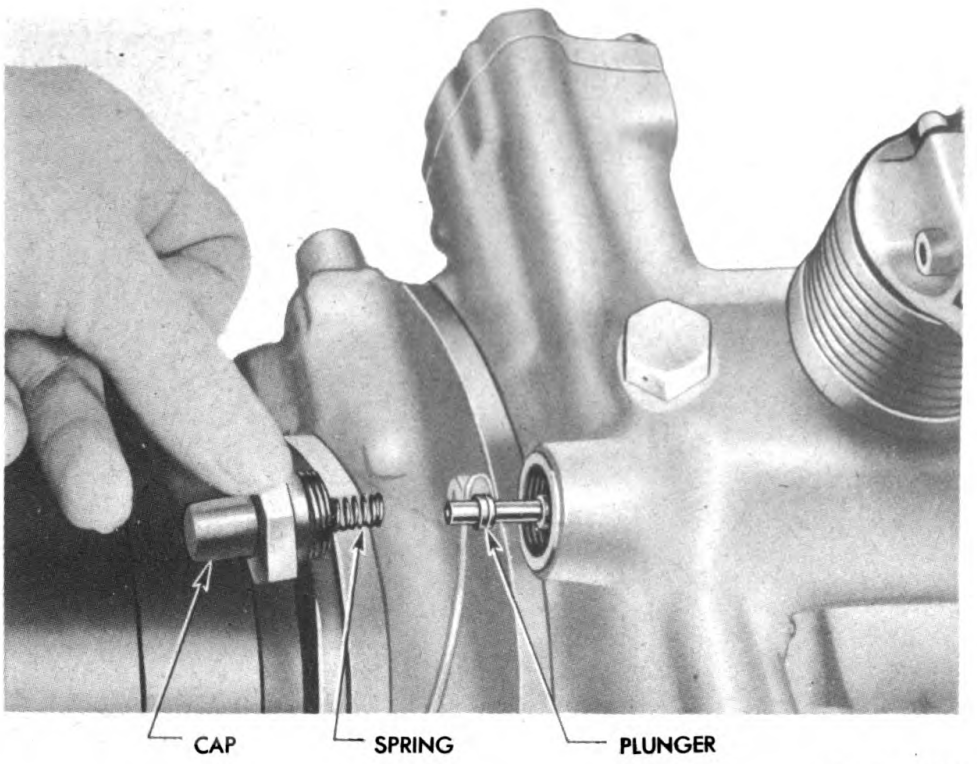
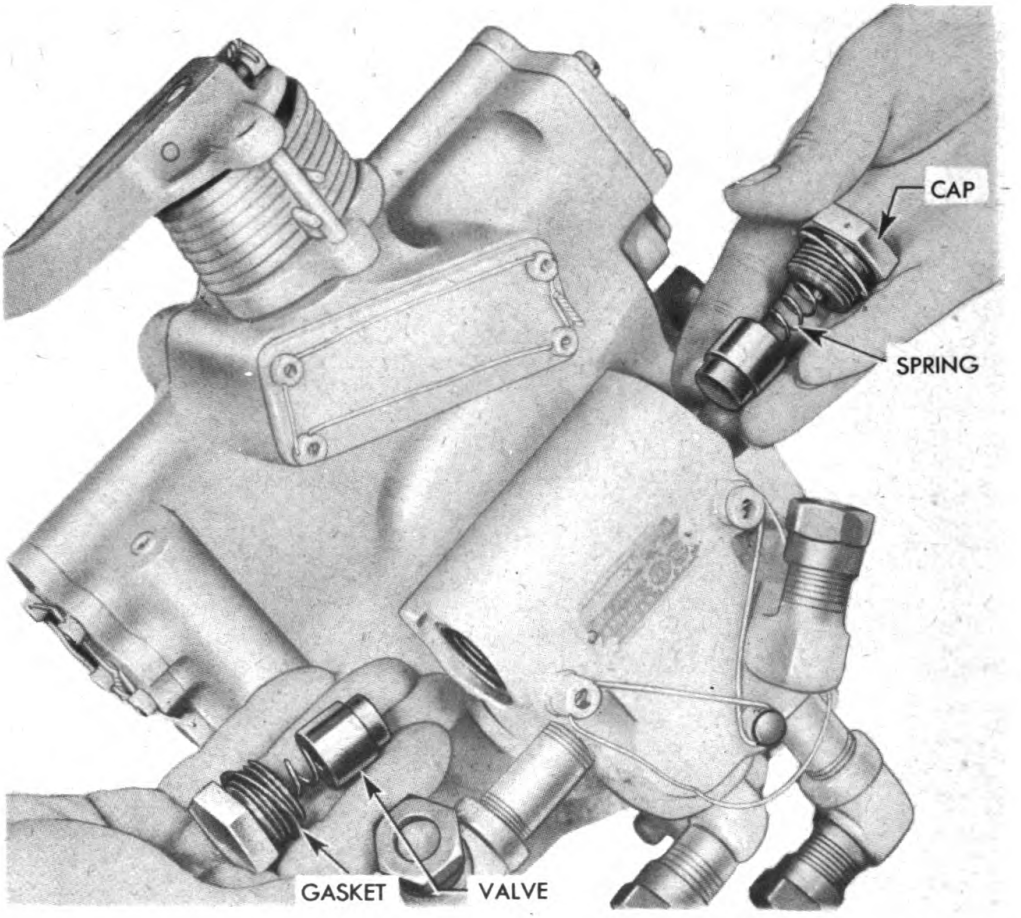


Figure 97 — Removing Hydraulic Pump Pilot Valve

motor switch on only long enough to force sufficient oil from valve port to thoroughly flush out any foreign matter. Turn switch off and release handle. Assemble valve parts by inserting spring guide into bushing retainer with flat side of guide down against bottom of retainer. Place spring in retainer on top of spring guide. NOTE: *Pressure relief valve spring has fewer coils of heavier wire than the pump relief valve spring.* If shims were used, place them in the cap. First insert the plunger into the valve seat bushing; then install the assembled parts, using new gasket on cap. Tighten cap securely. If pump relief valve is to be cleaned, do not fill reservoir until valve has been cleaned. Release turret lock and test operation of mechanism.

(5) CLEAN HYDRAULIC PUMP RELIEF VALVE. Remove and clean the valve (fig. 96) by following procedure in step (4) above. NOTE: *Pump relief valve spring has more coils of smaller wire than pressure relief valve spring.* Install parts in the order shown in figure 96. Fill hydraulic system. Release turret lock and test operation of mechanism.

(6) CLEAN HYDRAULIC PUMP PILOT VALVE. Lock the turret and move shifter lever down. Remove locking wire and unscrew the valve cap. Pull gasket, spring, and plunger out (fig. 97). If plunger

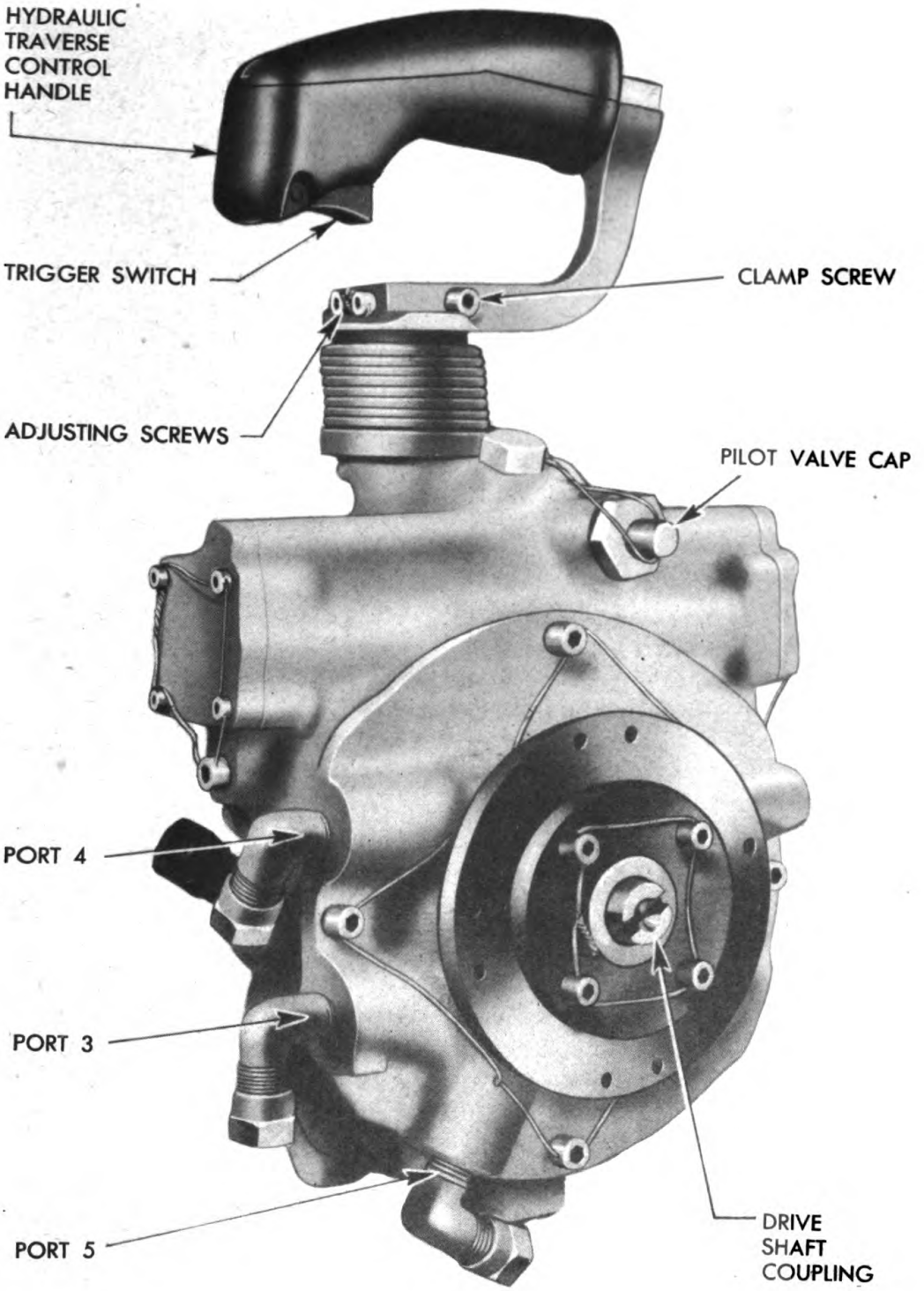


RA PD 339607

Figure 98 — Removing Hydraulic Pump Check Valve

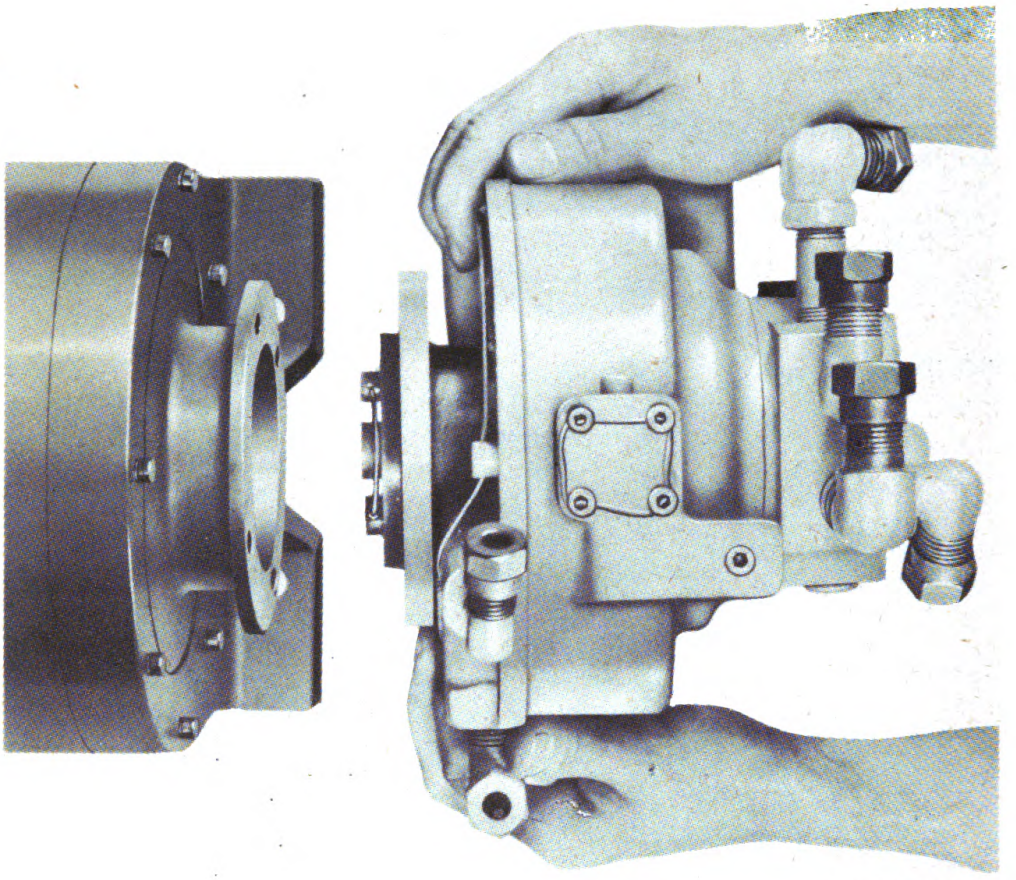
does not pull out easily, push lightly on end with blunt instrument ⅛ inch in diameter while turning control handle to the left until plunger is free in housing. Then turn handle to the right to move plunger down. Repeat as required to work plunger out of housing. Hold cloth or container under valve opening and snap traversing motor switch on and off quickly several times to flush the valve and valve seat. Thoroughly clean the parts removed in dry-cleaning solvent. Place spring on plunger and install valve cap, using new gasket. Tighten cap and secure locking wire (fig. 99). Release turret lock and check level of hydraulic oil (step (1) above). Test operation of hydraulic traversing mechanism.

(7) CLEAN HYDRAULIC PUMP CHECK VALVES. Lock the turret. Remove locking wire from check valve cap. Place cloth to catch oil and remove check valve cap and gasket (fig. 98). Lift out spring and disk check valve. Thoroughly clean all parts removed in dry-cleaning solvent. Examine all parts for scores and clean the valve seat in pump body. Insert valve and spring in body and install cap,



RA PD 339608

Figure 99 — Rear View of Traverse Pump



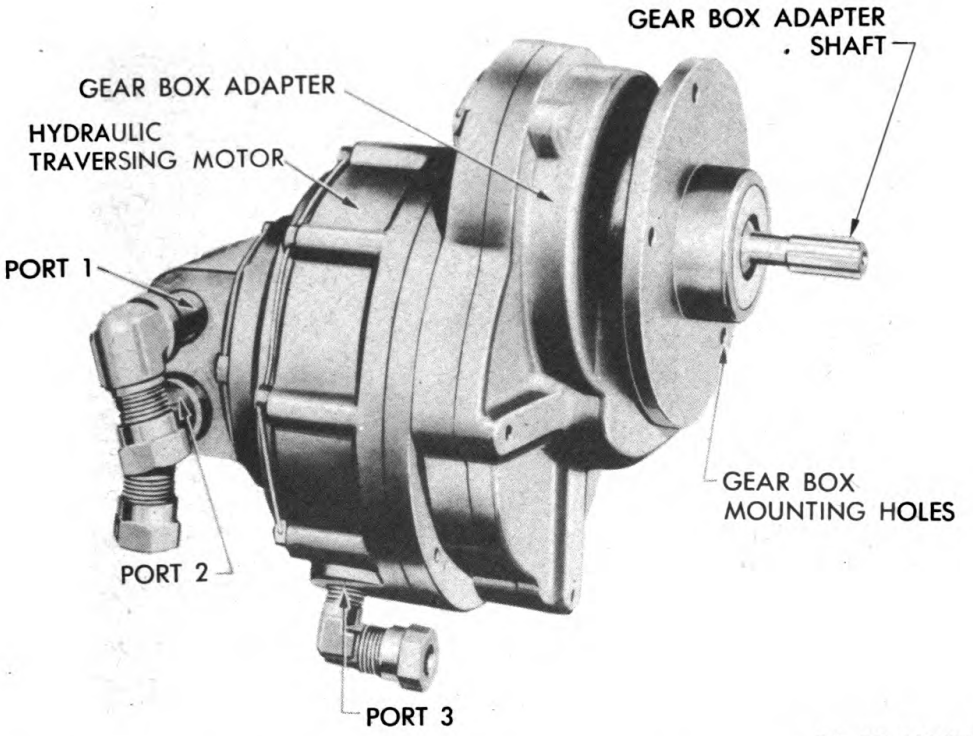
RA PD 339609

Figure 100 — Installing Traverse Pump on Electric Motor

using new gasket. Tighten cap and secure with locking wire. Repeat procedure for other valve. Check oil level (step (1) above). Release turret lock. Test operation of traversing mechanism.

(8) ADJUST CONTROL HANDLE POSITION. Loosen the socket head clamp screw at left side of handle frame (fig. 99). Remove locking wire from heads of adjusting screws at top of handle frame. Make a scribe mark across shaft and base of handle frame to check movement of shaft in handle as adjustment is made. Turn traversing mechanism electric motor on, and place shift lever in power traversing position. If turret creeps to the right, loosen the right adjusting screw and tighten the left adjusting screw an equal amount. Check adjustment with control handle in released position. Repeat adjustment as required to stop turret from creeping. Tighten both adjusting screws and secure with locking wire. Tighten the handle clamp screw. If turret creeps to the left, follow the same procedure except to loosen the left screw and tighten the right adjusting screw.

c. Removal of Hydraulic Traversing Mechanism Pump. The hydraulic traversing mechanism pump can be removed from the elec-



RA PD 335626

Figure 101 — Hydraulic Traversing Motor and Gear Box Adapter

tric motor without removing the motor (fig. 100). Drain hydraulic system (subpar. **b** (2) preceding). Disconnect oil tubes from pump. Loosen the two screws which attach traverse control handle to metal frame, remove cable clamp screws at base of handle, and slide handle off frame. Remove locking wire, and remove cap screws which attach pump to electric motor while supporting pump. Carefully pull pump off motor until drive shaft is clear.

d. Installation of Hydraulic Traversing Mechanism Pump. Install the brass coupling on motor armature shaft. Aline groove in pump drive shaft with tongue on brass coupling and attach pump to motor with cap screws (fig. 100). Tighten cap screws alternately and secure with locking wire. Place control handle on frame and install and tighten the attaching screws. Connect oil tubes to pump and tighten all fittings moderately. Fill oil reservoir (subpar. **b** (3) above). Operate mechanism and inspect all connections for leaks.

e. Removal of Hydraulic Traversing Mechanism Hydraulic Motor (fig. 101). Disconnect oil tubes from hydraulic motor. Tape ends of tubes. Remove the nuts from studs which attach adapter to gear box. Lift off hydraulic motor and adapter as a unit.

f. Installation of Hydraulic Traversing Mechanism Hydraulic Motor. Place new gasket on studs on gear box. Rotate adapter

shaft (fig. 101) to aline splines, and slide adapter and motor assembly down on gear box. Install the castellated safety nuts and tighten alternately to compress gasket uniformly. Connect oil tubes to motor and tighten fittings. Fill hydraulic system (subpar. **b** (3) above). Operate mechanism and inspect for leaks.

g. Removal of Hydraulic Traversing Mechanism Reservoir. Drain hydraulic traversing system (subpar. **b** (2) above). Disconnect all tubes from reservoir (fig. 93) and tape ends of tubes. Support reservoir and remove nuts and bolts which attach it to bracket. Lift off reservoir.

h. Installation of Hydraulic Traversing Mechanism Reservoir. Position reservoir on bracket and install the attaching bolts and nuts. Connect all tubes to proper fittings (fig. 93) and tighten fittings moderately with 6-inch wrench. Fill reservoir (subpar. **b** (3) above). Operate hydraulic traversing mechanism and check for leaks.

120. OIL TUBES.

a. Description. Oil tubes transfer the oil from the oil reservoir to the traverse pump, from traverse pump to the traverse motor, and from traverse motor back to traverse pump and drain tubes, into reservoir (fig. 93). Shear-type fittings are used and, if properly installed and tightened, will not require retightening. All tubes must be connected to the correct port; otherwise the system will not function. Each port has a number stamped near it to indicate tube to be connected to it. Tube fitting nuts should be drawn up securely with a 6- or 8-inch wrench when tightening, as abnormal tightening will damage fittings.

b. Removal. Turn turret lock handle to lock position, and traverse motor switch to "OFF" position. Drain reservoir into a clean container by disconnecting tube at port marked "13" on the bottom of oil reservoir (subpar. 119 **b** (2)). If oil is to be used again, cover container to keep out dirt and foreign matter. Disconnect the tubes, one at a time, and tag each tube with number of port from which it was disconnected. Clean the fitting and end of tube. Cover tube openings with tape.

c. Installation. Place all tubes in position, checking the installation diagram (fig. 93) and tags to determine correct connections. Remove tape and clean off end of tubes and fittings to be sure no dirt or lint enters system. Examine all tubes and fittings carefully. If any are crimped, bent, or damaged, replace with a new tube of equal size and length. Cut ends of new tube square, and remove all burs. Grease tube end, ring, and fitting. Place nut and ring over tube with blunt end of ring facing nut. Press tube firmly into fitting and tighten

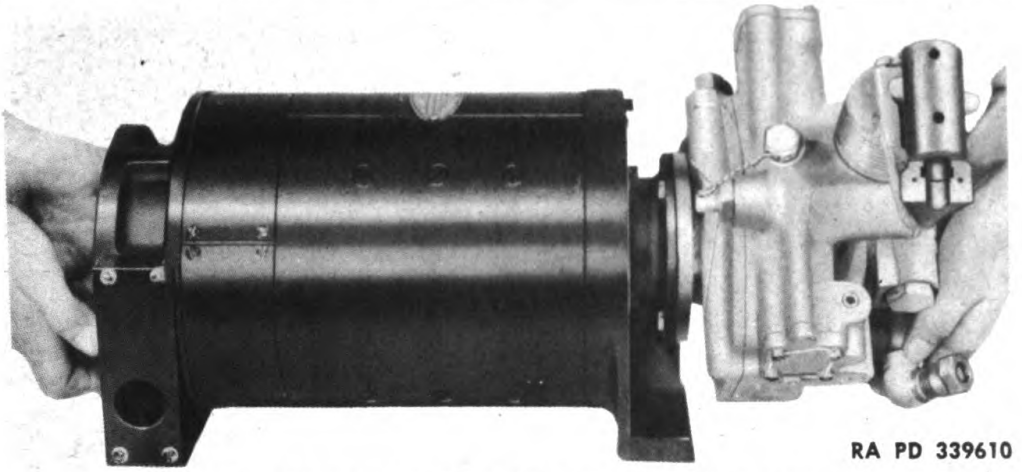


Figure 102 — Removing Electric Traverse Motor and Pump

nut securely. Fill oil reservoir with hydraulic oil (subpar. 119 b (3)). Place traverse shift lever in manual control position and turn traverse motor switch to "ON" and "OFF" positions several times to permit pump to deliver oil throughout system before operating pump continuously. Check oil level and refill with hydraulic oil. If level has dropped appreciably, clean all units and check for oil leaks.

121. TRAVERSE MOTOR.

a. Description. A 24-volt, 1¾-horsepower electric motor furnishes the power to operate the turret traversing mechanism (fig. 102). The motor is mounted on a bracket in front of the gunner's station and is directly connected to the traversing hydraulic pump.

b. Removal. The traverse motor can be removed from the traverse pump satisfactorily only when the motor and pump have been detached from the mounting bracket as a unit (fig. 102).

(1) REMOVE TRAVERSE MOTOR AND PUMP. Turn turret lock handle to locked position and traverse motor switch to "OFF" position. Drain oil reservoir (par. 119 b (2)). Disconnect tubes at traverse pump. Clean the tubes and fittings, and cover ends with masking or friction tape to prevent dirt from getting into system. Remove traverse pump control handle. Loosen conduit coupling nut, remove terminal cover, and disconnect lead-in wire at left end of electric motor. Remove the four cap screws at bottom of motor and remove pump and motor assembly (fig. 102). NOTE: *Since pump and electric motor are heavy, a rope sling may be used to advantage in lifting motor away from bracket.*

(2) REMOVE TRAVERSE MOTOR FROM PUMP. Remove locking wire and the four cap screws attaching motor to pump. Lift pump straight out to clear coupling (fig. 100).

c. Installation. Install the brass coupling in place on the armature shaft. Aline groove in pump drive shaft (fig. 99) so that it will mate with tongue on brass coupling. Lower pump into place on motor. Install and tighten the four cap screws and locking wire. Place a rope sling around motor and anchor rope to top of turret so that motor can be lifted into place on mounting bracket. Line up holes in mounting bracket with a punch, and install and tighten the mounting cap screws and washers. Connect the electric lead-in wire to the connection in left end of motor, install terminal cover, and connect conduit to motor. Connect oil tubes to pump, being sure that tubes are connected to proper port (fig. 93). Fill oil reservoir (par. 119 **b** (3)). Install traverse pump control handle (par. 119). Move traverse shift lever to manual control position. Turn traverse motor switch to the "ON" position and check system for oil leaks.

122. TRAVERSE MOTOR SWITCH.

a. Removal. Turn off both master switches. Remove switch box cover screws and pull cover out for access to wiring (fig. 104). Remove two bolts, nuts, lock washers, switch plate, and rubber boot from front of switch box cover (fig. 200). Disconnect the bus bar and remove the capacitor with wire attached. Disconnect the traverse motor cable and circuit breaker connecting wire. Remove the switch mounting screws and switch.

b. Installation. Position the traverse motor switch in turret switch box and install attaching screws. Install switch face plate with rubber boot to front of turret switch box and tighten mounting bolts. Connect circuit breaker connecting wire and traverse motor cable (fig. 84). Connect circuit breaker bus bar and install capacitor. Install switch box cover on turret switch box. Turn on the master switches and test operation of traverse motor switch.

123. HAND TRAVERSING MECHANISM.

a. Description. The hand traversing mechanism consists of the gear box, gear box extension, and manual drive with brake (fig. 198). The gear box contains the gear train which transmits the power from the hydraulic motor or manual drive through the action of the traverse shift lever to the drive pinion which engages the turret ring gear. The manual drive is equipped with a two-shoe expanding brake which is operated by the brake lever at the side of the brake handle.

b. Removal. Remove hydraulic traversing mechanism hydraulic motor with adapter (fig. 101) from the hand traversing mechanism gear box only if necessary. If the motor does not need to be removed, disconnect oil tubes from motor and proceed as follows. Remove locking wire, and remove the two cap screws and split washers which attach gear box to side of turret flange. Remove cap screw and gunner's

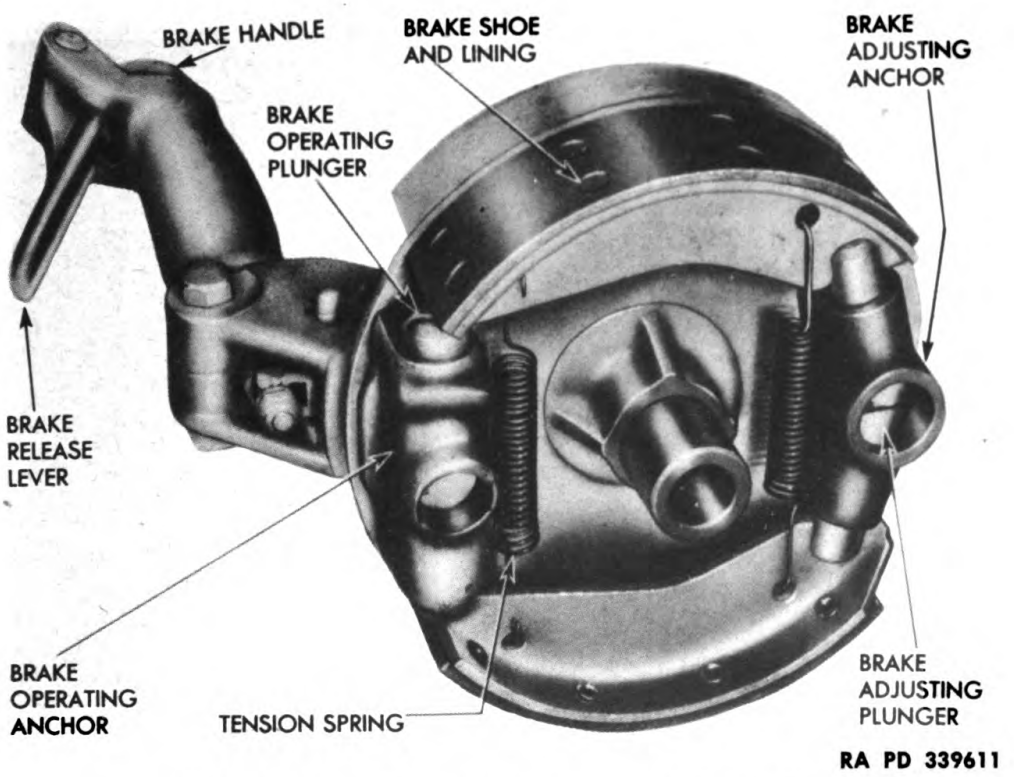


Figure 103 — Turret Hand Traversing Brake

knee guard plate. Support the mechanism and remove the cap screws which attach gear box to top of turret flange. Lift mechanism from base of turret. Count shims, if used, and save for installation.

c. Installation. Position mechanism on base of turret. If shims were used, install the same number in the same locations as previously installed. Insert the two vertical cap screws with lock washers and tighten screws. Install knee guard plate and place the cone-shaped split washers on the two horizontal cap screws. Tighten cap screws. Test rotation of turret by operating hand mechanism before securing lower cap screws with locking wire, as shims may be required if pinion binds on turret ring gear. Connect oil tubes to hydraulic motor (fig. 95) and tighten fittings moderately. Add oil to reservoir if necessary (par. 119 **b** (3)). Test operation of hydraulic mechanism and inspect all connections for leaks.

d. Manual Traversing Mechanism Brake. The manual traversing control handle and brake lever are mounted on the gear box (fig. 198). The brake consists of two shoes and a spreader attached to the manual control cover, a release lever on the brake handle, and a spring inside the handle (fig. 103). Brake is applied by the spring when lever is released. Manual traversing is accomplished by grasping

both the brake handle and the brake release lever and pressing them together while rotating the unit in the direction desired.

e. Adjustment of Manual Drive Brake Shoes. Adjustment for brake shoe wear is accomplished by turning the square-headed screw below the hole in top of drive mechanism clockwise to expand the shoes closer to the drum. Adjust position of shoes so that they first contact the drum with lever depressed ½ inch.

f. Removal of Brake Shoes. Remove brake assembly by removing nut from splined shaft in the center of the cover. Press release lever against brake handle to release brake, while moving cover back and forth until cover assembly can be removed from the housing. Disconnect springs from the shoes and remove shoes (fig. 103). Remove shoe-spreading plungers and adjusting screws.

g. Installation of Brake Shoes. Coat anchor plungers (fig. 103) lightly with general purpose grease before installing. Assemble shoe-spreading anchor plungers in anchor assemblies, place shoes in position, and install the two brake shoe springs. Press the brake lever against the brake handle to release the brake. Assemble cover and shoe assembly over splined shaft. Install nut and washer and adjust brake shoes (subpar. **e** preceding).

124. GUN FIRING SYSTEM.

a. Description. The gun firing system consists of the solenoid and relay unit, the trigger switch on the power traverse handle, and the cable connecting these units (fig. 104). The solenoid unit is mounted at the breech of the gun where it contacts the firing lever which operates the gun firing mechanism. When the trigger switch (fig. 99) is depressed, the gun firing circuit is closed and the solenoid operates to fire the gun. A foot-operated firing pedal, located on the turret floor in front of the gunner's station (fig. 104), is used to fire the gun when the electrical system fails.

b. Gun Firing Handle Switch.

(1) REMOVAL. Remove two screws from cap at the base of the handle (fig. 105). Remove the handle mounting screws and lift the handle from the pump bracket. Remove the screw at the top of the handle and compress the flexible spring on the conduit. Pull the handle top with switch and wires attached out of the handle far enough to expose switch terminals. Remove terminal screws, pull wires back through, and remove the gun firing handle.

(2) INSTALLATION. Insert the wires into the handle and connect them to the switch terminals. Tighten the terminal screws securely Install the screw at top of handle and position the assembly on the pump bracket. Install handle mounting screws and install the cap and attaching screws at the base of the handle. Operate trigger switch and

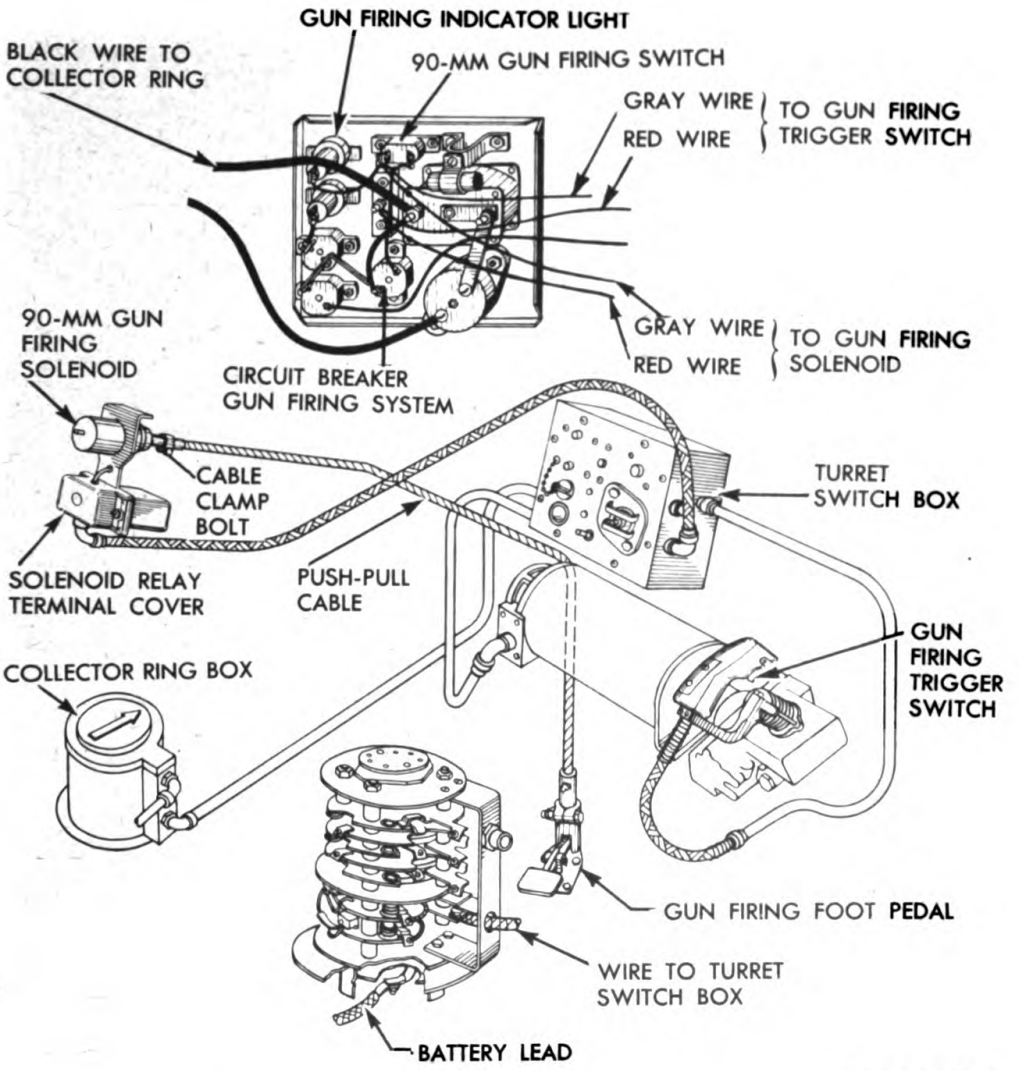


Figure 104 — 90-mm Gun Firing System

note if 90-mm gun firing solenoid is in working order. CAUTION: *Open breech to make sure gun is not loaded before operating gun firing switch.*

c. 90-mm Gun Firing Solenoid.

(1) REMOVAL. Turn off 24-volt master switch. Remove screws and nuts attaching solenoid to bracket. Remove clamp screw and nut from push-pull cable and remove cable from solenoid. Remove lock nuts from conduit box cover, unscrew conduit lock nut, and pull cover back enough to disconnect wire from solenoid (fig. 106). Remove wire conduit and cover. Remove solenoid.

(2) INSTALLATION. Connect the wire to relay terminal, install conduit cover, and tighten conduit lock nut. Install push-pull cable

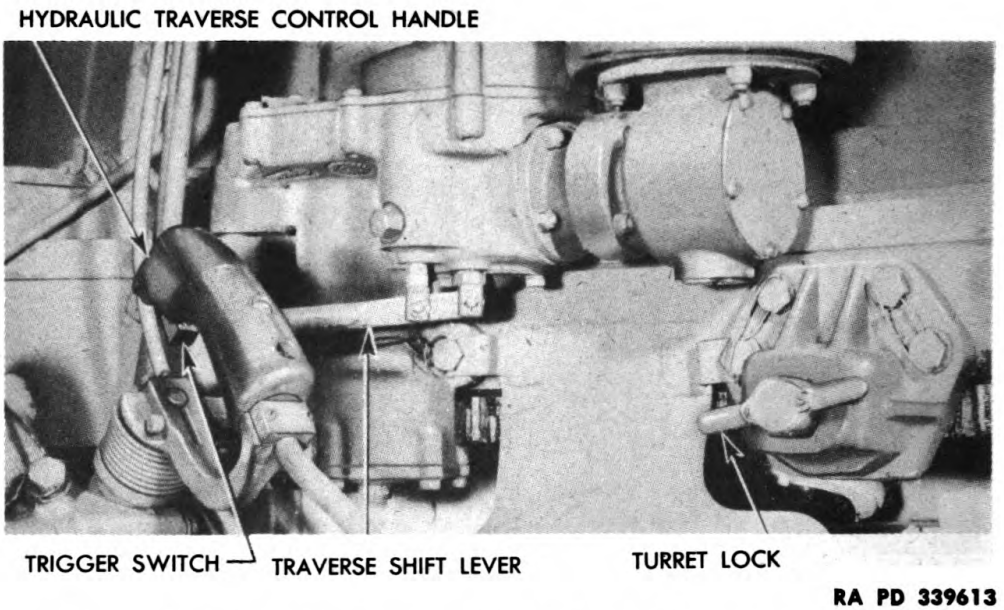


Figure 105 — Power Traverse Control Handle and Turret Lock

to solenoid and tighten clamp screw. Position solenoid on the gun and install attaching screws and lock nuts.

d. Gun Firing Switch.

(1) REMOVAL. Turn off 24-volt master switch. Remove turret switch box cover mounting screws and pull cover aside. Disconnect the two gray wires leading to gun firing trigger switch and solenoid (fig. 104). Disconnect wires to firing indicator light and circuit breaker. Remove switch mounting screws from face of turret switch box cover and remove gun firing switch.

(2) INSTALLATION. Position gun firing switch on turret switch box cover and install attaching screws. Connect wires to switch as shown in figure 84. Turn on 24-volt master switch and test operation of gun firing switch and circuit by operating the trigger switch on the traverse pump control handle (fig. 105). CAUTION: *Open the gun breech and make sure the chamber is empty before operating gun firing switch.*

e. Foot Firing Pedal.

(1) REMOVAL. Remove clamp screw and nut from push-pull cable at solenoid and remove cable from solenoid. Remove bolt and nut attaching cable clip to reservoir bracket. Remove four screws holding foot firing pedal base to turret platform (fig. 104). Remove pedal and cable.

(2) INSTALLATION. Reverse the removal procedure and test operation of pedal and cable.

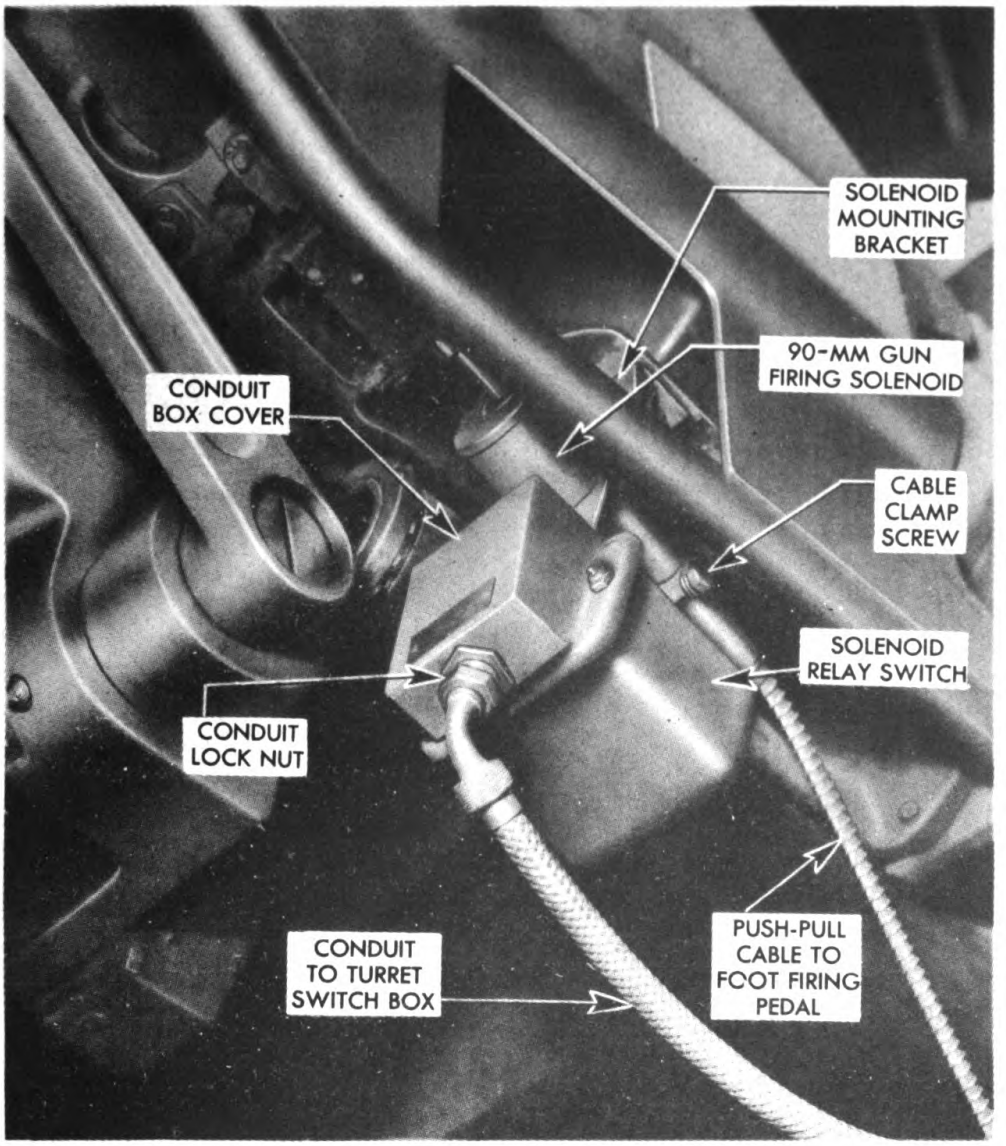


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Figure 106 — 90-mm Gun Firing Solenoid

125. BASKET.

a. Description. A semicircular metal platform, or half-basket, is suspended from the right side of the turret (fig. 12). The basket rotates with the turret and provides a platform for the commander and gunner. It covers about one-half of the turret floor area, permitting access to the 90-mm ammunition stowage compartments under floor plates of the fighting compartment. Adjustable seats for the commander and gunner are mounted on frames in the basket and revolve with the turret. A turret traversing lock is attached to the upper ball race ring at the right of the gunner (fig. 105).

b. Seats.

(1) DESCRIPTION. The commander's seat is the pad-type, adjustable in height, and may be folded down out of the way (fig. 216) or removed from its frame when not in use. The gunner's seat, which is provided with a detachable back, can be raised or lowered and adjusted vertically. The loader's seat (fig. 218) is the same construction as the commander's seat and is demountable.

(2) REMOVAL. Remove cap screws which attach the gunner's seat frame assembly to turret platform. Release back rest locking pin by pulling release lever up, and lift commander's seat from frames. Remove seats through opening in top of turret. Remove cap screws which attach gun loader's seat bracket to upper race ring and remove seat.

(3) INSTALLATION. Place rope sling around gunner's seat frame assembly and lower into turret. Aline holes in frame bracket with punch, install washers and cap screws, and tighten securely. Install commander's seat by reversing removal procedure outlined in subparagraph b (2) above. To install gun loader's seat, place supporting ring in place on turret race ring, install washers and cap screws, and tighten securely.

c. Turret Traversing Lock.

(1) DESCRIPTION. The turret traversing lock incorporates a pawl which engages with the teeth of the turret ring gear to hold the turret stationary. The pawl is held in engagement by a spring and is disengaged by turning the handle to the right, pulling it out, and turning it to the left (fig. 105).

(2) REMOVAL. Place gun in the traveling lock. Disengage the turret lock. Remove the locking wire and attaching screws (fig. 105). Lift the lock from the turret ring.

(3) INSTALLATION. Place lock assembly in position and tighten cap screw. Install locking wire (fig. 105). NOTE: *Should lock bind on turret ring, it may be necessary to place shims between the lock bracket and the turret ring.*

126. AZIMUTH INDICATOR.

a. General. The operating instructions for the azimuth indicator are given in paragraph 194 b.

b. Replacement. To remove the azimuth indicator, remove the four cap screws and washers securing the indicator to the turret (fig. 216). Remove the azimuth indicator and shims (if used). To install the indicator, first traverse the turret by hand until the gun can be locked in traveling position (fig. 197). Turn the pinion gear on the azimuth indicator until the bottom pointer of the indicator reads 32 on the inner scale (fig. 207). Then position the azimuth indicator

against the race guard so that the gears mesh with the turret ring gear. CAUTION: *There should be sufficient clearance between the indicator pinion gear and the turret ring gear so that the indicator gear teeth do not bottom in the teeth of the turret ring gear. This clearance may be obtained by shimming between the indicator and the turret.* Install and tighten the four cap screws and washers securing the indicator to the turret.

127. PROTECTIVE PADDING.

a. Description. Protective padding is installed on the base of the turret at the rear to prevent injury to the loader's hand when serving the gun.

b. Removal. Remove the two cap screws which attach padding mounting plate to turret base and lift off padding.

c. Installation. Position the padding on turret base. Install cap screws and washers and tighten securely.

Section XXVIII

RADIO INTERFERENCE SUPPRESSION SYSTEM

128. INTRODUCTION.

a. Purpose. Radio interference suppression is the elimination or minimizing of electrical disturbance which would interfere with radio reception or disclose the location of the vehicle to enemy detection equipment. It is important that all vehicles, with or without radio equipment, be properly suppressed to prevent interference with reception of neighboring radio equipment.

b. Description and Data. Suppression is accomplished in this vehicle by use of bond straps and toothed lock washers (fig. 113), resistor suppressors (fig. 110), filter units (fig. 107), and single condensers or capacitors (fig. 111) in all circuits or systems where shielding of wires and units does not completely confine or dissipate electrical disturbances which would otherwise cause radio interference. Suppression units used in specific assemblies or units of the vehicle are listed below.

(1) GENERATOR. Two 0.1 microfarad capacitors are mounted internally, one from each positive brush to ground. The generator ground cable, mounted from the generator to the generator mounting bracket, serves also as a bond strap.

(2) GENERATOR REGULATOR (figs. 107 and 108). One FL-19 filter is mounted in the generator regulator filter case and connected in the battery circuit of the regulator. One 0.5 microfarad capacitor

is mounted in the same case and connected from the armature terminal of the regulator to ground. Two bond straps are mounted, one from each leg on the terminal box side of the generator regulator and filter case, from the case to the mounting pad on the sponson.

(3) AUXILIARY GENERATOR. Two 0.1 microfarad capacitors are internally mounted, one from each positive brush of the generator to ground.

(4) AUXILIARY GENERATOR REGULATOR (fig. 13). The auxiliary generator regulator is treated for suppression the same as the generator regulator (subpar. b (2) above).

(5) AUXILIARY GENERATOR CONTROL BOX (fig. 109). One 0.1 microfarad capacitor is connected from the armature terminal at the starting switch to ground in the auxiliary generator control box.

(6) AUXILIARY GENERATOR AND ENGINE ASSEMBLY (fig. 13). One bond strap is mounted from the base of the auxiliary generator and engine assembly to ground (sponson).

(7) AUXILIARY GENERATOR SPARK PLUG LEAD (fig. 110). One 10,000-ohm resistor suppressor is mounted inside the magneto housing of the auxiliary generator engine and connected in series with the high-tension lead running from the magneto coil to the spark plug.

(8) ENGINE. One bond strap is mounted from the right rear engine mount to the support bracket.

(9) INSTRUMENT PANEL (fig. 87). One 0.5 microfarad capacitor is mounted inside the instrument panel box and connected from the utility outlet lead at the socket to ground.

(10) WINDSHIELD WIPER MOTOR (fig. 111). One 0.1 microfarad capacitor is mounted under the windshield motor and connected from the positive lead of the wiper motor to ground (windshield wiper mounting bracket).

(11) CREW COMPARTMENT BLOWER. One 0.005 microfarad wafer-type capacitor is mounted inside the blower motor end cover and connected from the positive brush to ground.

(12) SPONSON RADIO TERMINAL BOX (fig. 213). Two 0.1 microfarad capacitors are mounted in the sponson radio terminal box. One is connected from the 12-volt battery supply terminal (No. 5) to ground, and one from the 24-volt battery supply terminal (+) to ground.

(13) TURRET RADIO TERMINAL BOX (fig. 217). One 0.1 microfarad capacitor is mounted in the turret radio terminal box and connected from the 12-volt battery supply terminal (No. 5) to ground.

(14) TURRET SWITCH BOX (fig. 89). One 0.1 microfarad capacitor is mounted in the turret switch box and connected from the load side of the traversing motor switch to ground.

(15) TURRET TRAVERSING MOTOR. Two 0.1 microfarad capacitors are mounted internally on the traversing motor frame and connected one from each positive brush to ground.

(16) TURRET SLIP RING (fig. 112). One ground strap which also acts as a suppression bond strap is mounted on legs welded to the fighting compartment floor and connected to the turret slip ring ground terminal.

(17) MISCELLANEOUS MOUNTINGS AND FASTENINGS. Toothed lock washers are used throughout the vehicle for the purpose of insuring a good electrical connection between components or parts of components (fig. 113). Cable clamps are used to secure conduits and wiring harnesses of the vehicle in place and at the same time serve as a bonding connection between the conduit and the hull or other part of the vehicle to which it is secured (fig. 13). These are to be located every 2 feet along any shielded conduit or wiring cable.

c. Maintenance. If radio interference resulting from the operation of this vehicle is reported or encountered, faulty equipment will have to be traced down by referring to the tests described in the trouble shooting section of this manual (par. 52), then replaced as described in the following paragraphs. If replacement of suspected faulty radio suppression equipment is not described in this section, its replacement is the responsibility of a higher echelon of maintenance or Signal Corps personnel and will not be attempted by using personnel without specific permission of the personnel responsible.

129. BATTERY AND GENERATING SYSTEM.

a. Generator Regulator or Auxiliary Generator Filter (fig. 76).

(1) REMOVAL. Remove lock wire, cap screws, and lock washers which secure regulator cover to filter case and lift off the cover. Remove five cap screws which secure regulator assembly to filter case; then lift and tilt regulator assembly clear of filter case as shown in figure 108. Remove screws, lock washers, and flat washers which secure plates to inside of filter case. Lift out plates, leaving capacitor attached to the smaller plate. Disconnect filter from copper bar by removing screw and lock washer. Disconnect wire from upper filter connection by removing screw and toothed lock washer; then lift filter out of filter case.

(2) INSTALLATION. Position small plate against opening in partition and against side of filter case. Insert filter (fig. 107). Secure copper bar in small compartment to filter with screw and lock washer. Secure wire to upper filter connection with toothed lock washer and screw. Install cover plates over both partitions. Secure regulator assembly to filter case using forward corner cap screws to secure yellow

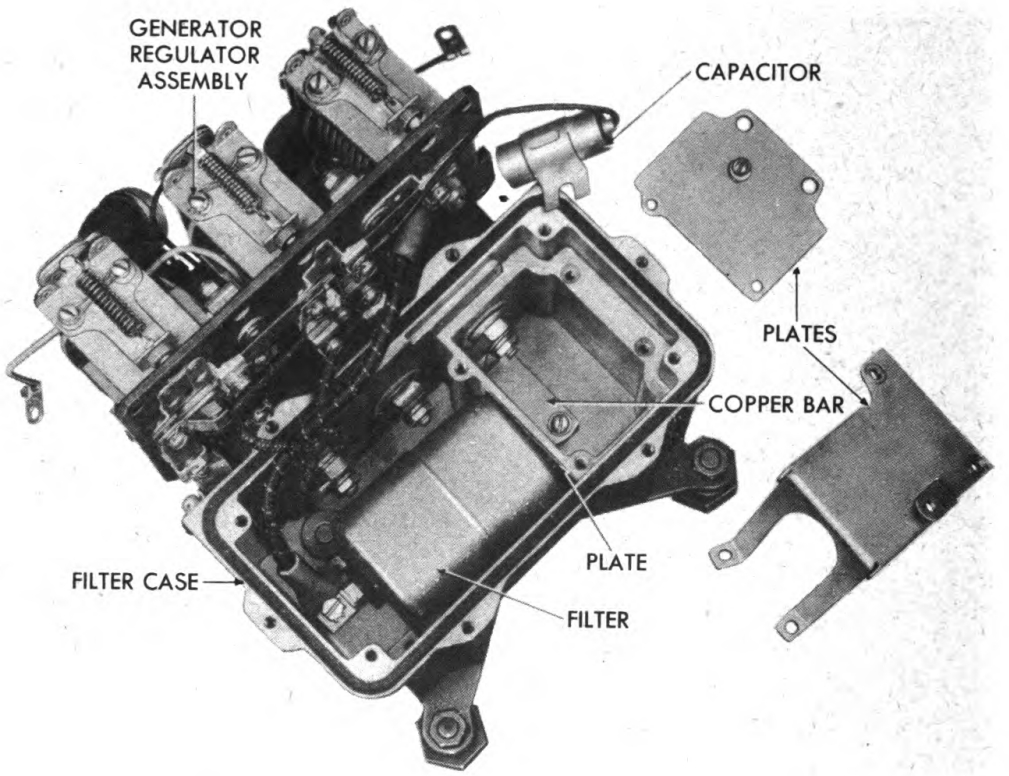

Figure 107 — Regulator Filter in Filter Case

and black wires extending from regulator assembly. Install regulator cover.

b. Generator Regulator or Auxiliary Generator Regulator Capacitor (fig. 108).

(1) REMOVAL. Remove lock wire, cap screws, and lock washers which secure regulator cover to filter case and lift off cover. Remove five cap screws and lock washers which secure regulator assembly base to filter case; then lift and tilt regulator assembly clear of filter case. Remove lock wire and loosen the screw which secures capacitor to plate. Disconnect capacitor wire from terminal on regulator assembly.

(2) INSTALLATION. Attach capacitor to plate with toothed lock washer and screw. Install lock wire through screw head and behind capacitor clamp. Secure wire extending from capacitor to armature terminal of regulator assembly. Attach regulator assembly to filter case, using forward corner cap screws to secure yellow and black wires extending from regulator assembly. Install regulator cover.

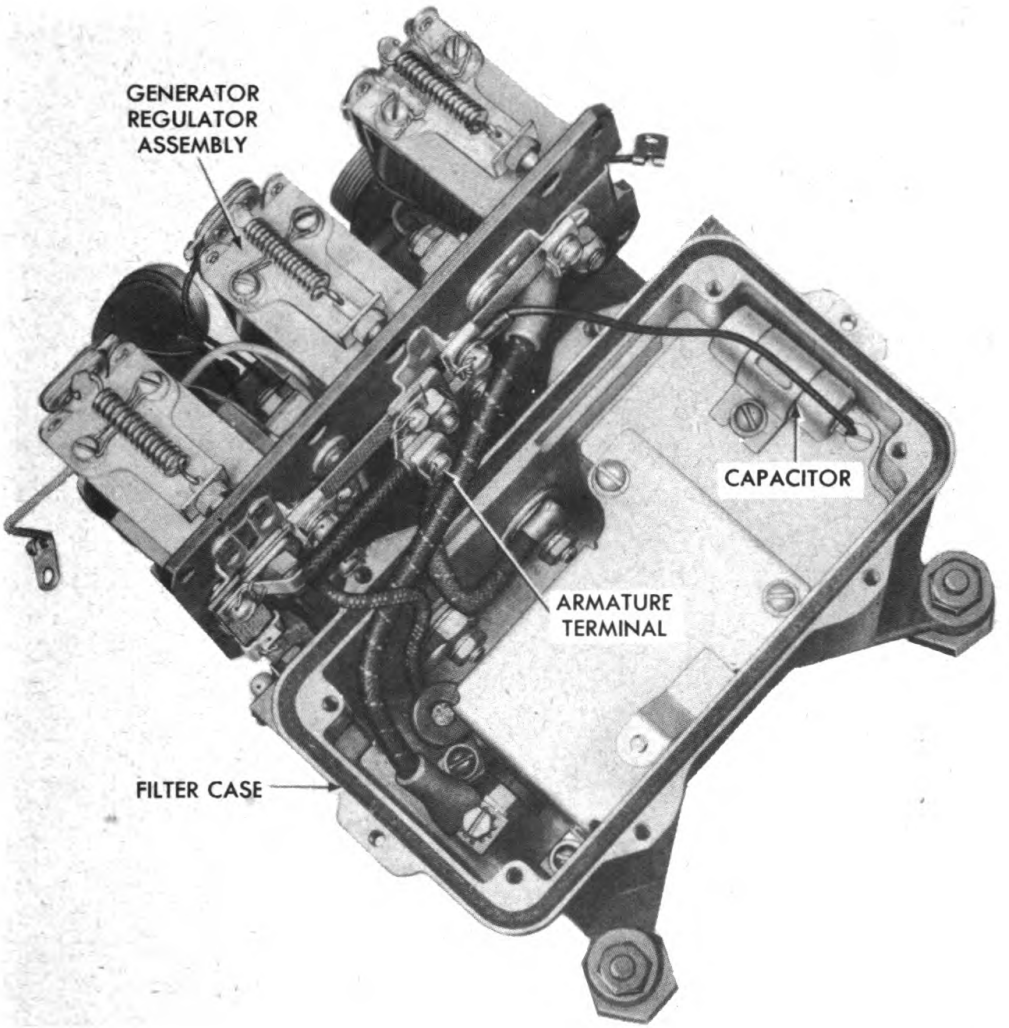

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Figure 108 — Regulator Capacitor Installed in Filter Case

c. Auxiliary Generator Control Box Capacitor (fig. 109).

(1) REMOVAL. Remove the cover screws and toothed lock washers; then remove the auxiliary generator control box cover. Disconnect the capacitor lead wire from the armature terminal and remove the capacitor mounting screw and toothed lock washer. Remove capacitor.

(2) INSTALLATION. Secure capacitor in place with mounting crew, using toothed lock washer under mounting screw head. Connect capacitor lead wire to armature terminal. Install control box cover with cover screws, using toothed lock washers under head of each screw.

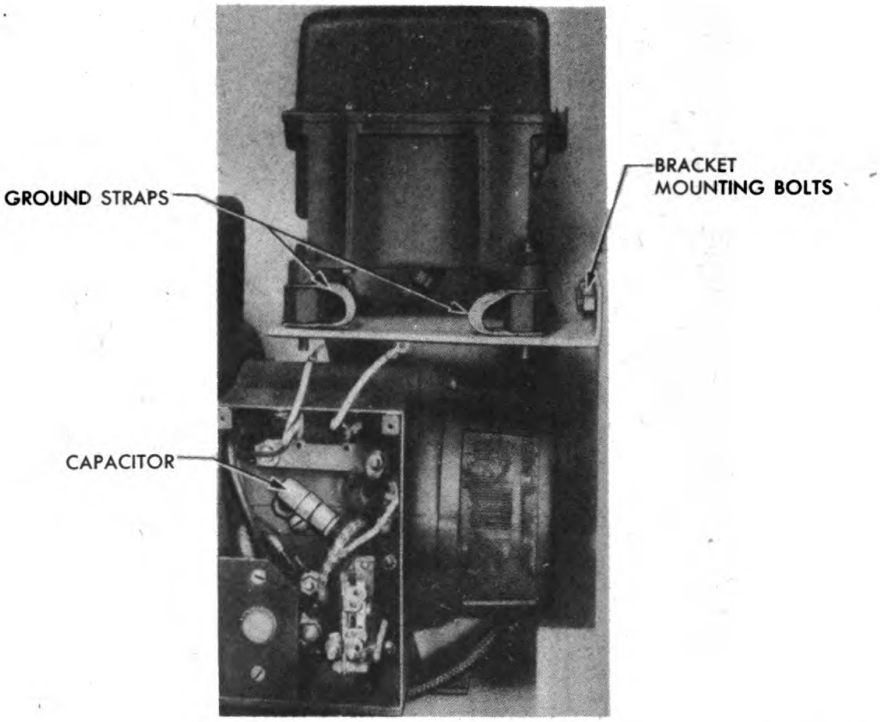

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Figure 109 — Auxiliary Generator Control Box — Cover Removed

d. Auxiliary Generator Spark Plug Suppressor (fig. 110).

(1) REMOVAL. Remove auxiliary generator engine magneto rotor by unscrewing the puller nut at the rear of the engine. Remove cable clamp screw from clamp securing high-tension lead in place inside magneto housing and pull high-tension lead out so suppressor is accessible. Pull high-tension lead from each end of suppressor and remove suppressor.

(2) INSTALLATION. Install new suppressor by reversal of removal procedure (subpar. (1) above).

130. ACCESSORIES.

a. Instrument Panel Utility Outlet Capacitor.

(1) REMOVAL. Remove instrument panel cover to gain access to capacitor (par. 111 b). Disconnect capacitor lead from utility outlet terminal. Remove capacitor by unscrewing mounting screw.

(2) INSTALLATION. Secure new capacitor in place with mounting screw, using toothed lock washer under head of screw. Connect capacitor lead to utility outlet terminal. Install instrument panel cover (par. 111 c) and connect speedometer and tachometer drives.

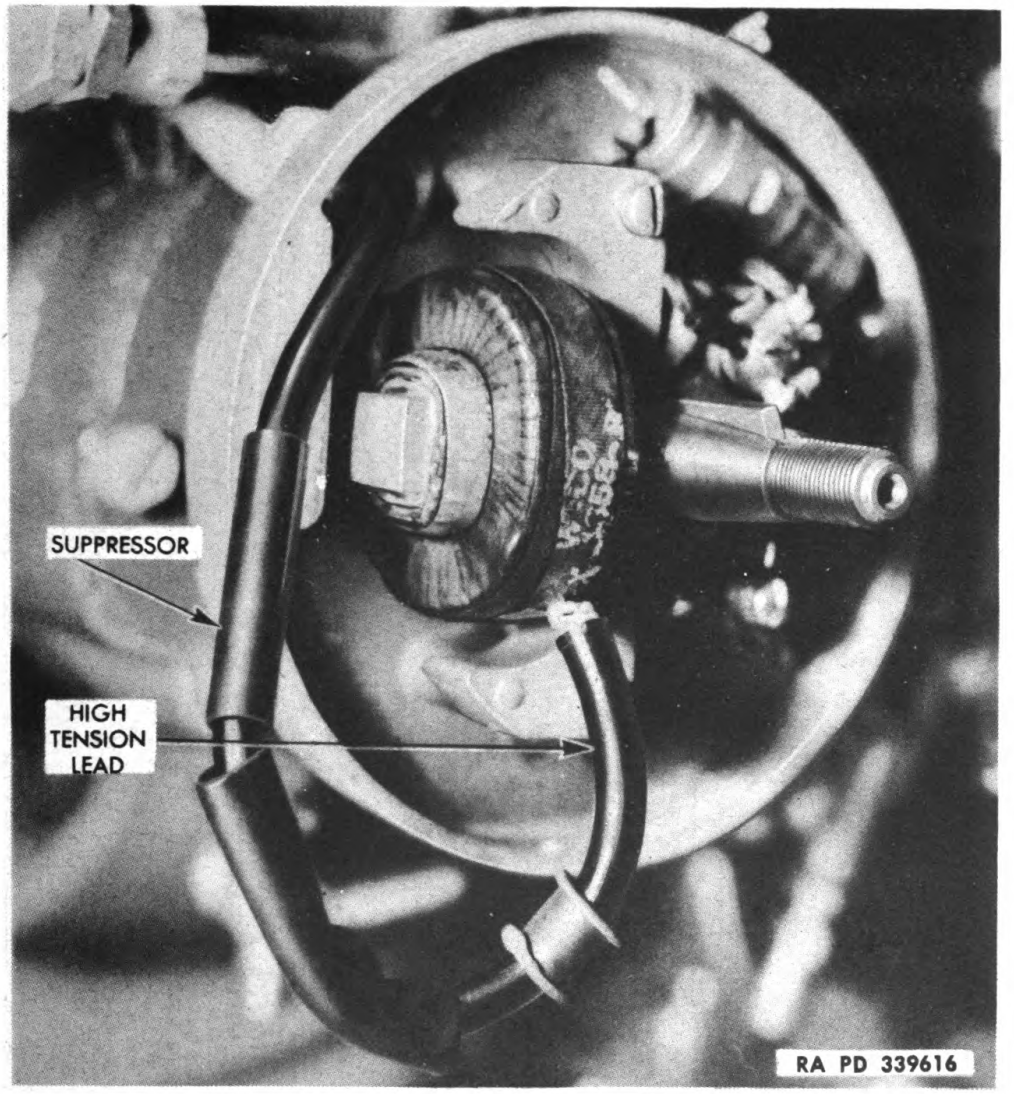

Figure 110 — Auxiliary Generator Spark Plug Suppressor

b. Windshield Wiper Motor Capacitor (fig. 111).

(1) REMOVAL. Remove two windshield wiper motor attaching screws and lock washers. Disconnect capacitor lead from positive terminal of wiper motor. Cut conduit shield from capacitor clamp and remove capacitor.

(2) INSTALLATION. Solder the conduit shield to capacitor clamp of new capacitor. Connect capacitor lead to wiper motor positive terminal. Position capacitor and wiper motor against windshield frame and install attaching lock washers and cap screws.

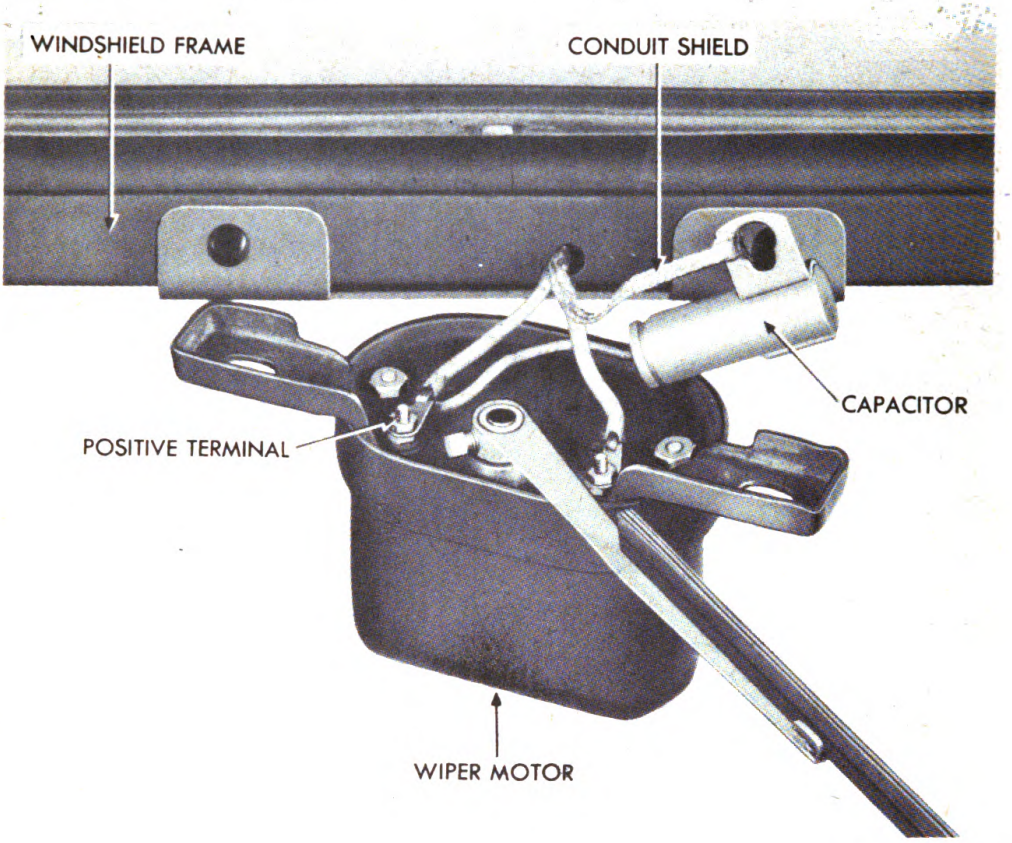

Figure 111 — Windshield Wiper Motor Connections

131. RADIO AND INTERPHONE SYSTEM.

a. Sponson or Turret Radio Terminal Box Capacitors (figs. 213 and 217).

(1) REMOVAL. Remove terminal box cover retaining scews and lock washers; remove cover. Disconnect capacitor lead of capacitor to be replaced from terminal block. Remove capacitor mounting screw and toothed lock washer and remove capacitor from terminal box.

(2) INSTALLATION. Secure new capacitor in place in terminal box with mounting screw, using toothed lock washer under head of screw. Connect capacitor lead to terminal on terminal block from which lead of defective capacitor was removed (terminal No. 5 in turret terminal box; terminal No. 5 or (+) terminal in sponson terminal box, whichever was removed). Install terminal box cover with cover screws, using toothed lock washer under head of each screw.

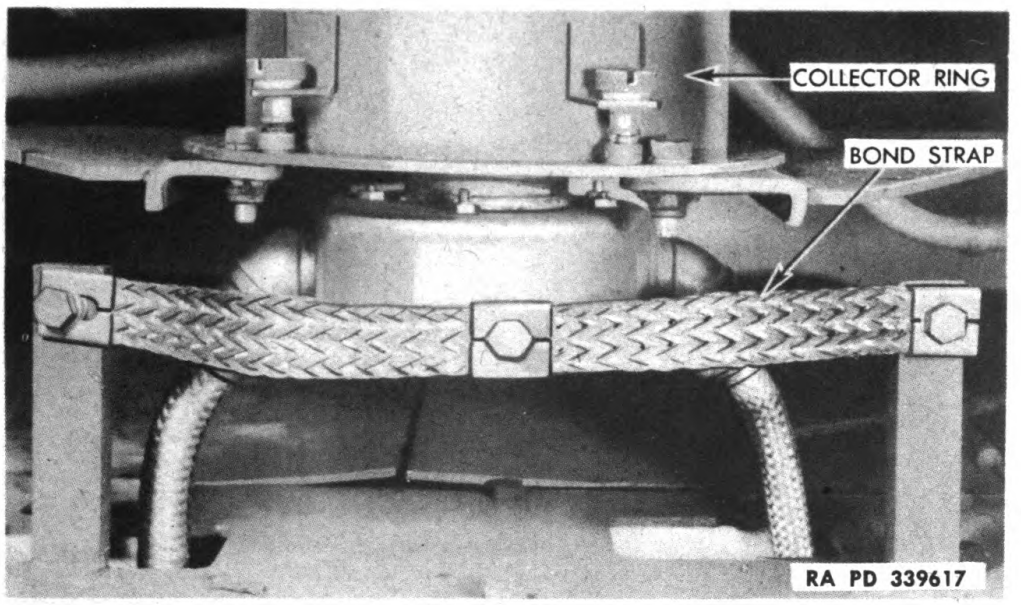

Figure 112 — Turret Ground Strap

132. TURRET ELECTRICAL SYSTEM.

a. Turret Switch Box Capacitor (fig. 89).

(1) REMOVAL. Remove turret switch box cover retaining screws and toothed washers; pull cover out to a position where the capacitor is accessible. Disconnect capacitor lead from terminal on lead side of traverse motor switch. Remove capacitor mounting screw and lock washer; remove capacitor.

(2) INSTALLATION. Install new capacitor by reversing procedure in subparagraph a (1) above, making sure toothed lock washers are installed under the heads of capacitor and cover mounting screws.

133. BOND STRAPS, MOUNTINGS, AND FASTENINGS.

a. Replacement. When replacing components or accessories of the vehicle, be sure to replace toothed lock washers in exactly the same order or pile-up in which they were found at the time of removal (fig. 113). When replacing bond or ground straps or when replacing units which are grounded by means of braided wire straps, be sure the contact surfaces of the strap as well as the surface to which it is to be secured are clean and free from paint so that a good electrical connection will be made (fig. 112). When securing conduits or cables in place, be sure to effect a good ground or bond at least every 2 feet along the conduit or cable by use of cable clamps or solder.

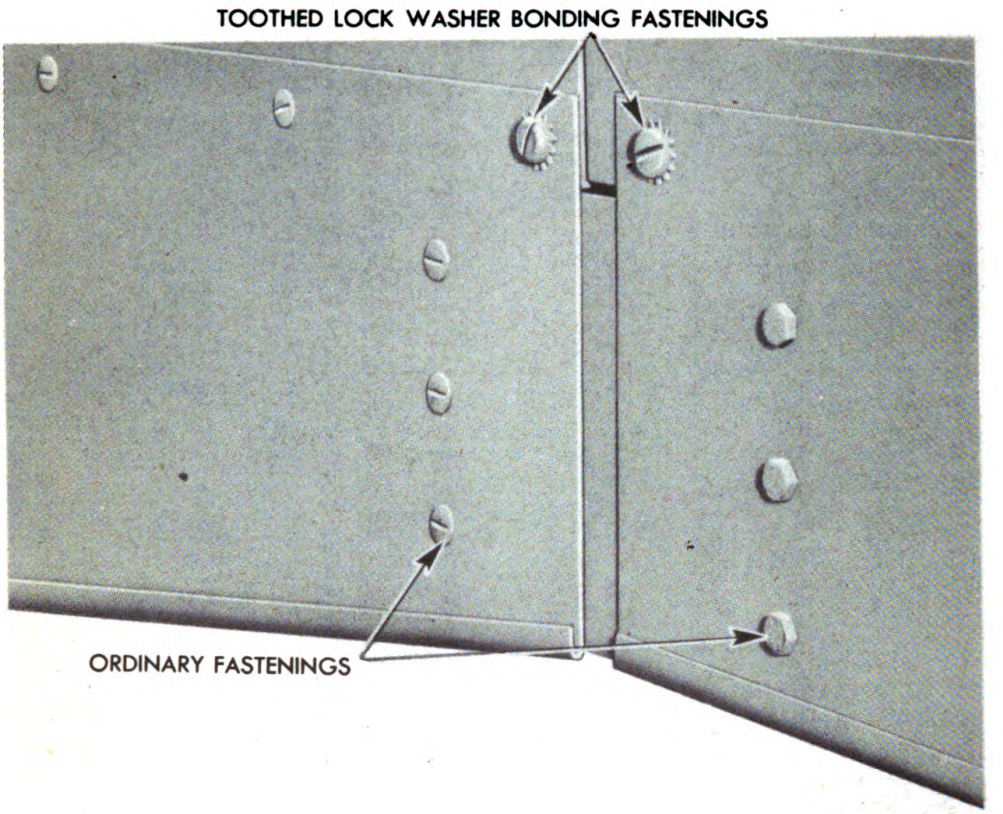

Figure 113 — Method of Bonding Sand Shields to Hull

Section XXIX

CLUTCH, SHAFTS, AND UNIVERSAL JOINTS

134. CLUTCH.

a. Description. The clutch is of the double-disk type composed of three major units; the pressure plate assembly, the center plate, and the two driven plates or disks (fig. 120). The two driven plates have friction facing riveted on each side. The release fork and the release levers are mounted on needle roller bearings. A clutch booster is provided to reduce the stiffness in the clutch pedal (fig. 116).

b. Pedal Stroke Adjustment (fig. 114). Set the pedal stroke adjusting stop screw so that the highest point of the clutch pedal pad is 15¼ inches (± ⅛ in.) from the hull floor.

c. Clutch Pedal Rod Adjustment (fig. 114). Check the length of the rod running from the clutch pedal to the cross shaft dimension

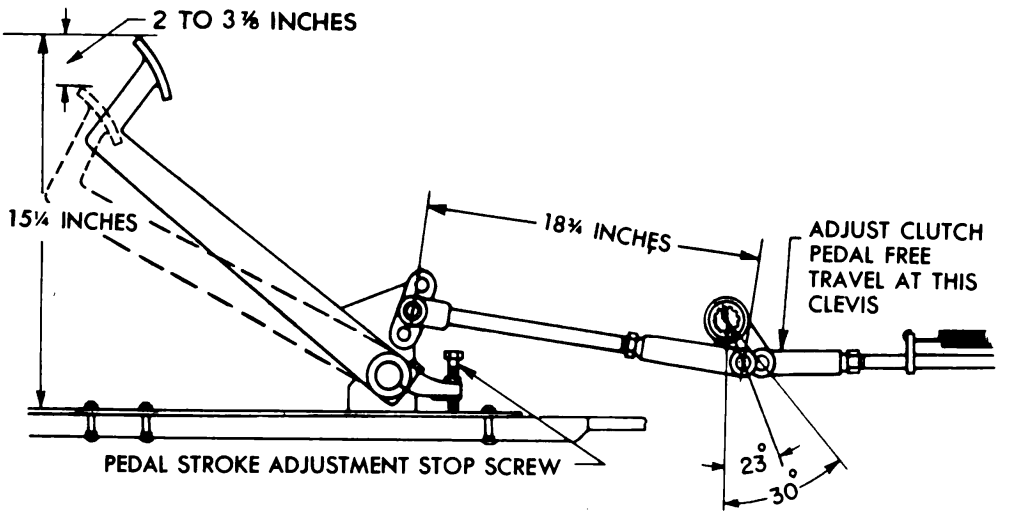

Figure 114 — Clutch Pedal Adjustments

"A," and readjust its length if necessary. This rod should be 18¾ inches long, measured from the center of one clevis pin hole to the other. If this length is not held to the above measurements, the angle of the levers on the cross shaft will be changed and this will affect the operation of the clutch pedal.

d. Free Travel of Clutch Pedal Adjustment. The free travel of the clutch pedal is determined by the clearance between the clutch release bearing and the clutch release fork. Clearance must exist between these parts at all times; otherwise, the clutch will slip and burn out. As the clutch disk facings become worn, the pedal free travel decreases. The free travel of the pedal should not be more than 3½ inches or less than 2 inches (fig. 114). The adjustment is made by lengthening or shortening the rod connecting the clutch cross shaft to the front end of this rod. Screwing in the adjusting screw decreases the free play of the pedal; backing off the adjusting screw increases free travel. If the correct free play cannot be obtained by this adjustment, the clutch plates are worn and must be replaced.

e. Adjustment if the Clutch Drags.

(1) GENERAL. If, after holding the pedal all the way down for a few seconds, the gears clash when shifting into first or reverse gear, the clutch is dragging. NOTE: *There is a tendency for the clutch driven shaft to turn over slowly when clutch is released. This is normal and will not cause any noticeable clashing.* Check the pedal stroke adjustment (subpar. **b** above) and the free travel of pedal adjustment (subpar. **d** above). If these adjustments are satisfactory,

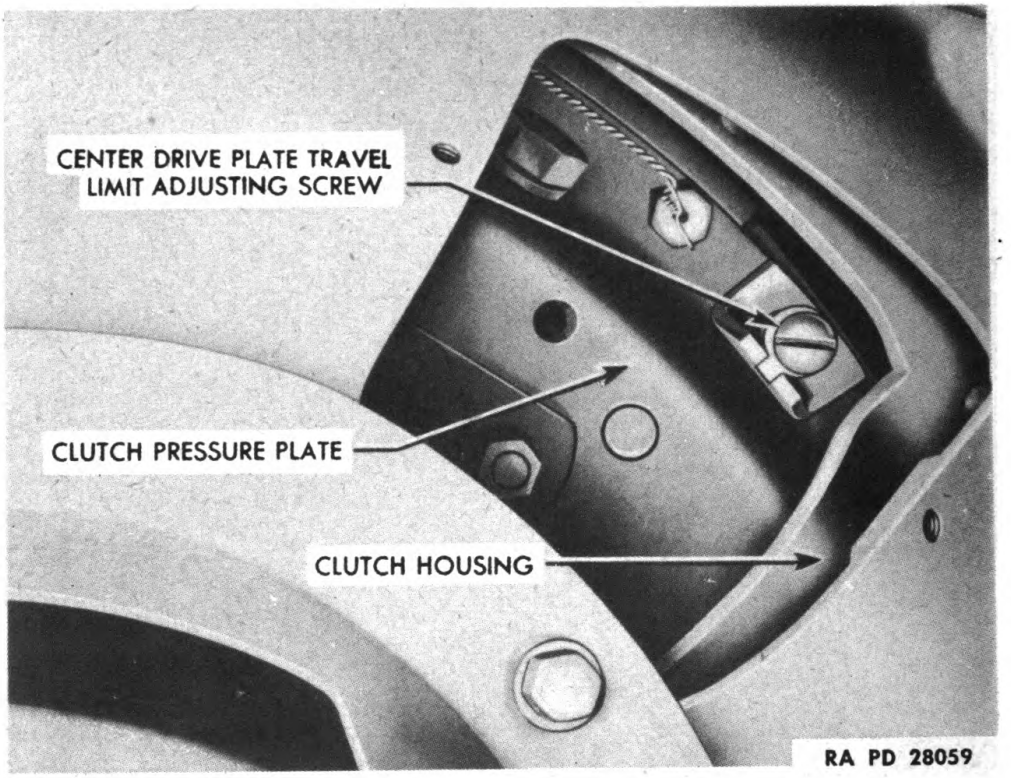

Figure 115 — Clutch Inspection Opening

check the adjustment of the three center drive plate travel limit screws (fig. 115).

(2) PRELIMINARY STEPS. Remove the inspection plate from the cover over the left side of the clutch housing (accessible from the fighting compartment). Make sure the engine ignition switch is off. Turn the engine over until one of the center drive plate limit screws appears at the opening as shown in figure 115.

(3) CENTER DRIVE PLATE TRAVEL LIMIT ADJUSTMENT (fig. 115). With a screwdriver, turn the center drive plate travel limit adjusting screw in (clockwise) until it bottoms lightly, then turn it back four notches (counterclockwise). Repeat the above procedure for the two remaining adjusting screws. If this adjustment fails to correct the trouble, repeat the adjustment, backing off the screws 5 notches instead of 4. If still unsatisfactory, it is probable that the center plate is binding on the flywheel drive lugs, the pilot bearing in the flywheel is binding, the clutch disk splined hubs are too tight on the clutch shaft, or that the driven plates are warped, any one of which will require the removal of the clutch (subpar. **h** below).

f. Adjustment if the Pedal Pressure is Too Stiff. Check the length of the clutch pedal to clutch cross shaft rod (measuring from

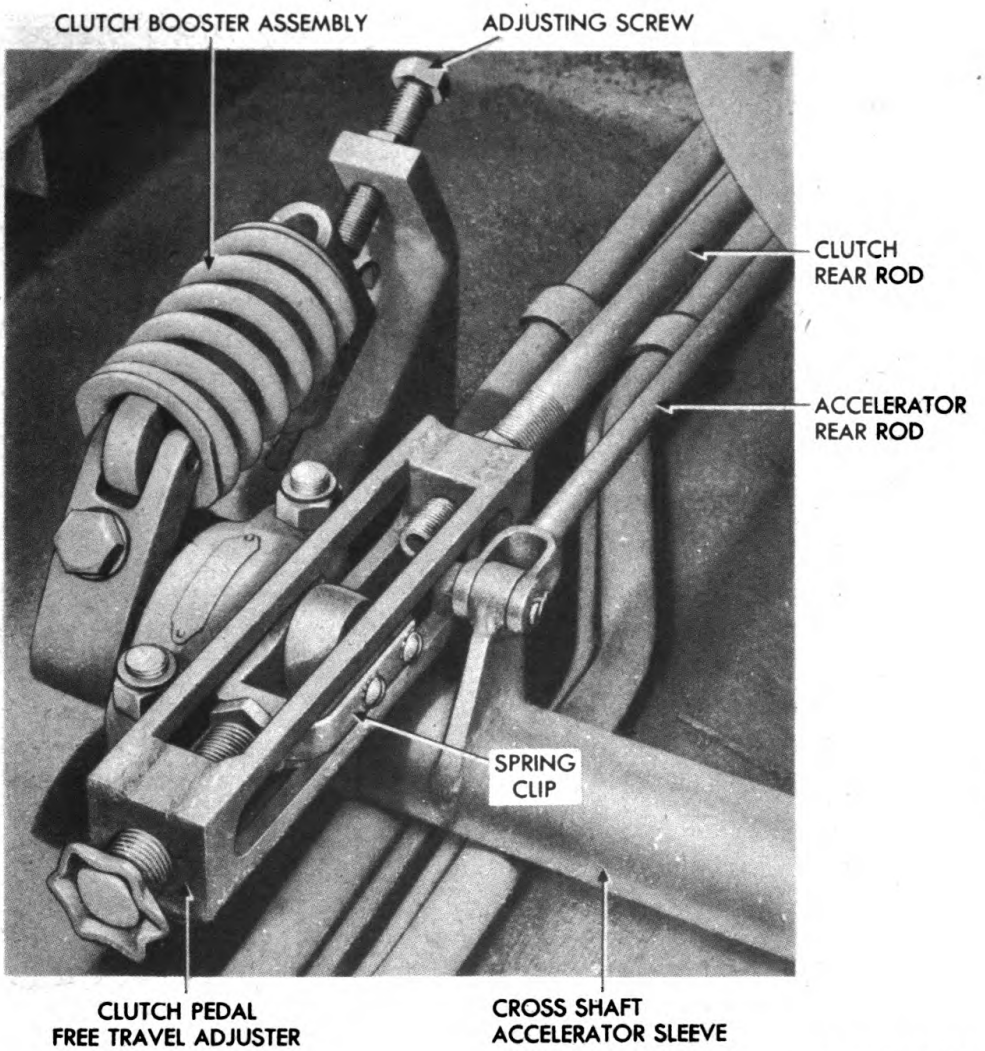

Figure 116 — Booster and Free Travel Adjuster

the center of one clevis hole to the other) and if incorrect, adjust to approximately 18¾ inches (fig. 114). Replace the booster spring (fig. 116) if it is broken or weak, or adjust the booster (subpar. g below). Make sure that the linkage is not binding from lack of lubrication. Check the positions of the levers at inner or outer end of clutch cross shaft to make certain that they are not at too forward an angle. The index mark on the right end lever of the cross shaft should be vertical at the end of the clutch pedal free play. The other levers on the cross shaft will be vertical in this pedal position.

g. Clutch Booster Replacement (fig. 116).

(1) REMOVAL. Loosen the two cap screws that hold the adjustable bracket to the booster frame. Loosen the adjustment bolt lock

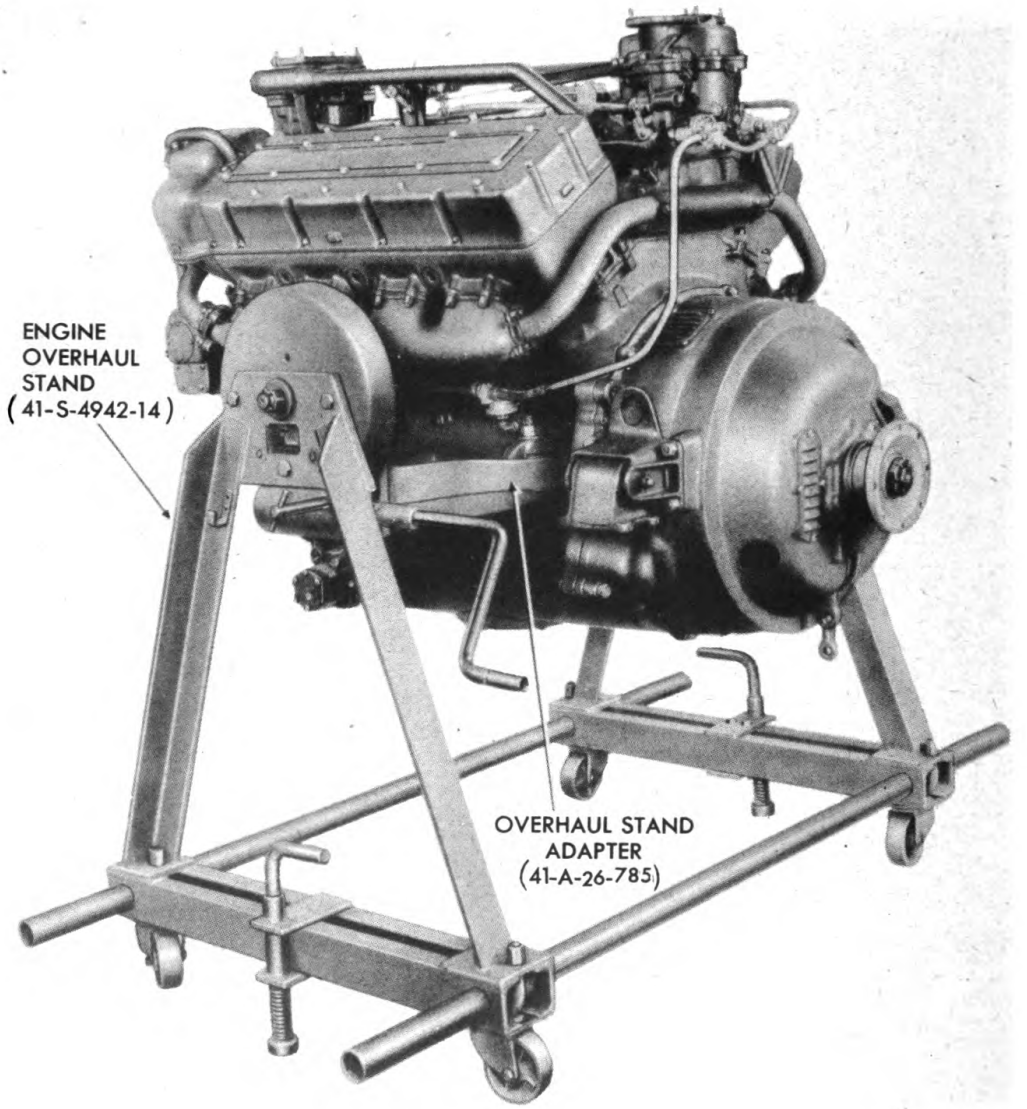

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Figure 117 — Engine Mounted in Stand

nut. Back off the adjustment bolt until the spring is in a released position. Remove the booster spring and washers.

(2) INSTALLATION. Place the booster spring in position between the two rollers (fig. 116). Slide a washer between each roller and the booster spring. Turn the adjusting bolt clockwise until three-fourths of the adjustment bolt is entered into the frame. Tighten the adjustment bolt lock nut. Tighten the two bracket screws.

h. Clutch Replacement.

(1) REMOVAL. Remove the engine as outlined in paragraph 61. Remove the starter as outlined in paragraph 93. Place the engine

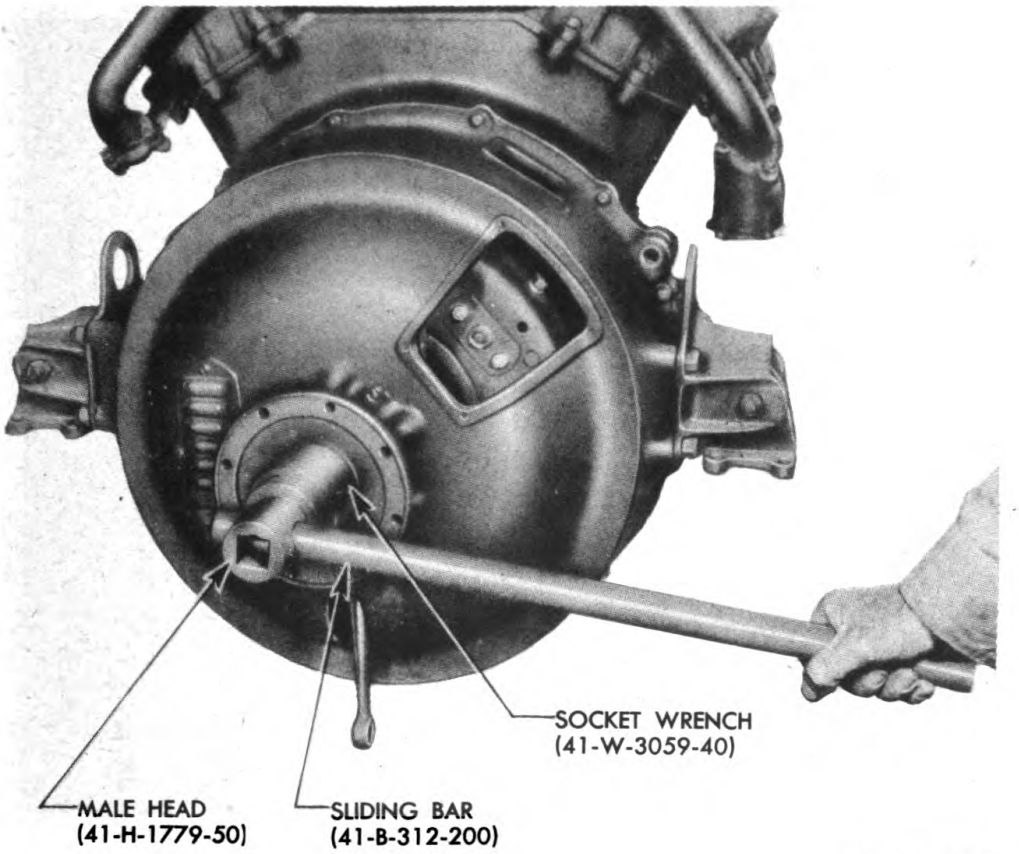

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Figure 118 — Removing Clutch Mainshaft Flange Nut

on a stand (41-S-4942-14), using adapter (41-A-26-785) as shown in figure 117, so that the front end will be supported after the clutch housing is removed. Remove clutch mainshaft flange nut as shown in figure 118 and remove the flange. Remove the clutch housing (fig. 119) by removing the 12 flange nuts. To hold the clutch springs compressed while the clutch pressure plate is removed, use six ⅜-inch, 16-thread, 1½ inches long cap screws, screwing them into the holes in the pressure plate assembly until the heads just bottom. Install the clutch alining tool (41-T-3083-75) to keep the clutch disk splines in alinement and also to prevent the clutch disks from falling. Remove the lock wire from the 18 cap screws holding the pressure plate to the flywheel, and remove the cap screws and pressure plate. Remove the center drive plate from the driving lugs in the flywheel. The clutch mainshaft can then be removed from the housing, if necessary, by the following procedure. Remove the nuts which attach the bearing retainer to the inside of the clutch housing. Remove the retainer and drive the shaft to the inside of the housing, taking care not to damage threads on end of shaft.

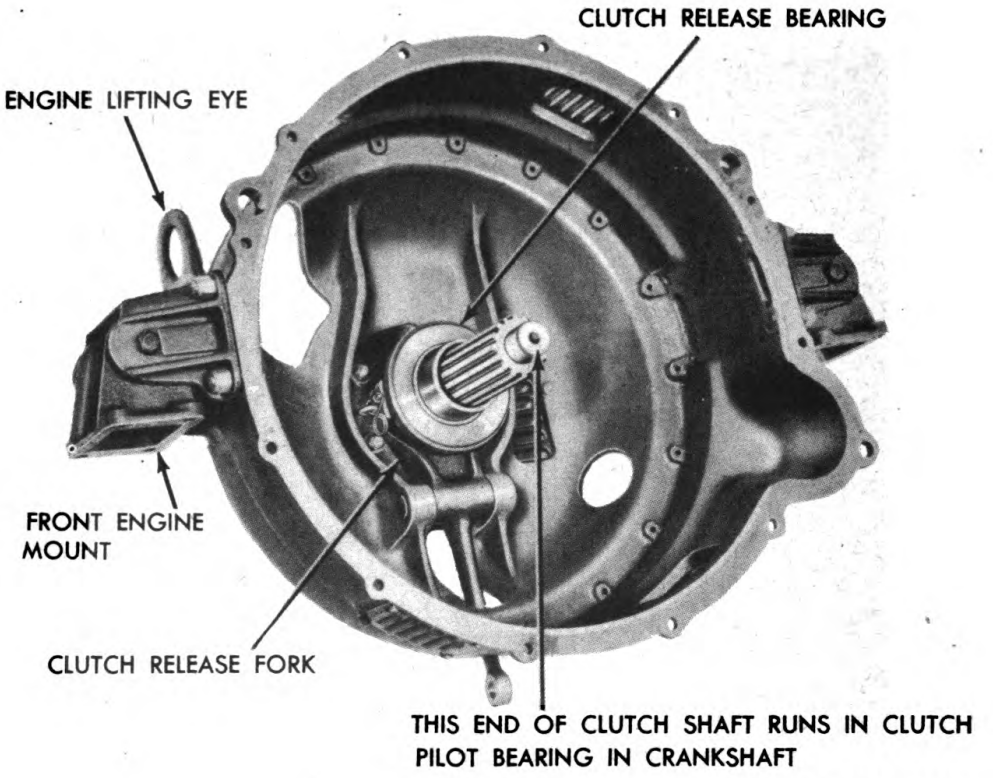

Figure 119 — Clutch Housing

(2) INSTALLATION.

(a) Preliminary Steps. See that the friction surface of the flywheel is smooth and clean. Any deposits on the friction surface must be sanded down and the surface cleaned with dry-cleaning solvent. If the clutch shaft pilot bearing is in good condition, repack it with ball and roller bearing grease.

(b) Install Clutch Disks and Center Drive Plate. Place one driven plate (disk) in place with the long end of the hub toward the flywheel (fig. 120). Insert the center drive plate with the retractor spring (fig. 120) toward the flywheel, making sure the driving lug slots fit freely on the driving lugs in the flywheel. Install the center drive plate on the flywheel lugs. This will place the retractor springs in line with the three openings in the flywheel nearest the three dowel pins in the flywheel rim, and bring the springs in line with the three adjusting screws in the pressure plate assembly. Using the clutch alining tool (41-T-3083-75), (fig. 121), slip it through the splined hub of the disk and into the clutch shaft pilot bearing. Remove the handle from the alining tool. Slip the second disk on the pilot with the long end of its hub away from the flywheel. This

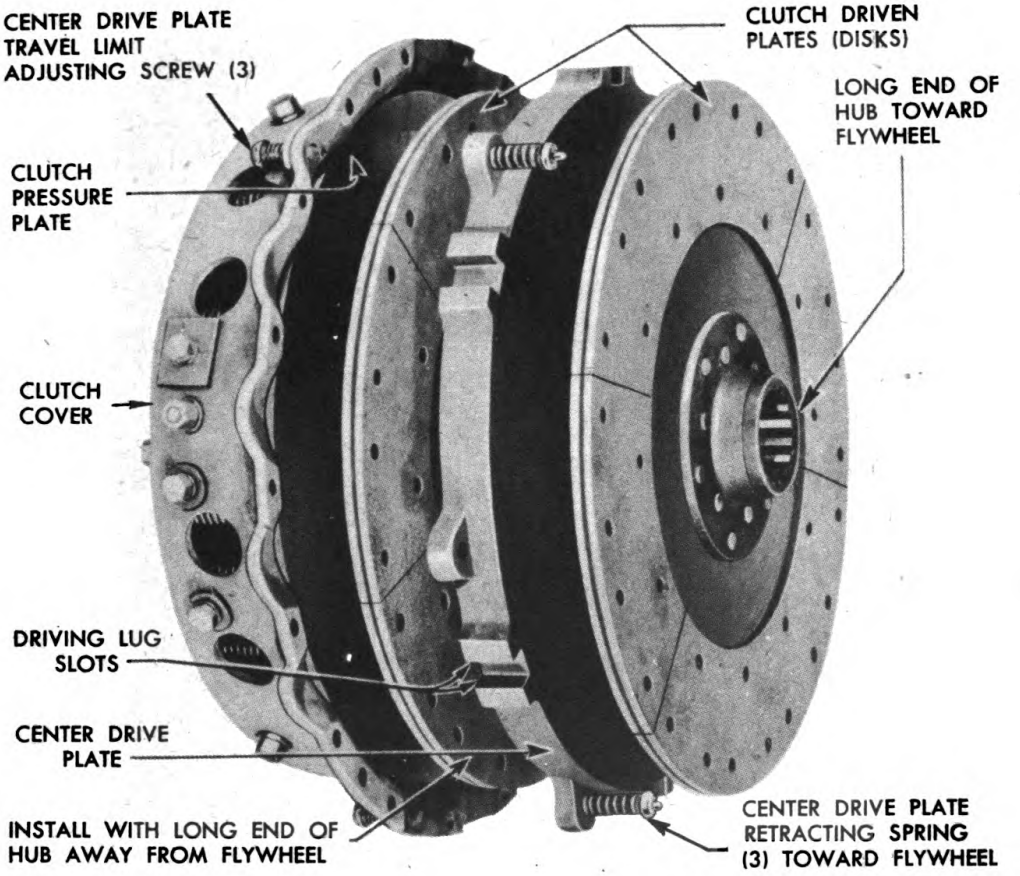

Figure 120 — Clutch Disassembled

alines both driven members with each other and with the clutch shaft pilot bearing, while the pressure plate assembly is being attached.

(c) Install the Clutch Pressure Plate (fig. 121). Install the clutch pressure plate assembly so that the dowel holes line up, and install the 18 cap screws which hold it to the flywheel. Wire the cap screws to prevent loosening. Start the wire at the cap screw nearest the cluch center drive plate travel limit adjusting screw, and lock it with the next nearest cap screw. Proceed with the next two until they all have been locked together in pairs. Remove the six $\frac{3}{8}$-inch cap screws used to hold the pressure plate compressed.

(d) Adjust Center Drive Plate Travel Limit. Adjust the three center drive plate travel limit adjusting screws (fig. 120) with a screwdriver by turning clockwise until they bottom lightly; then turn back 4 notches.

(e) Install Clutch Housing. If clutch mainshaft was removed,

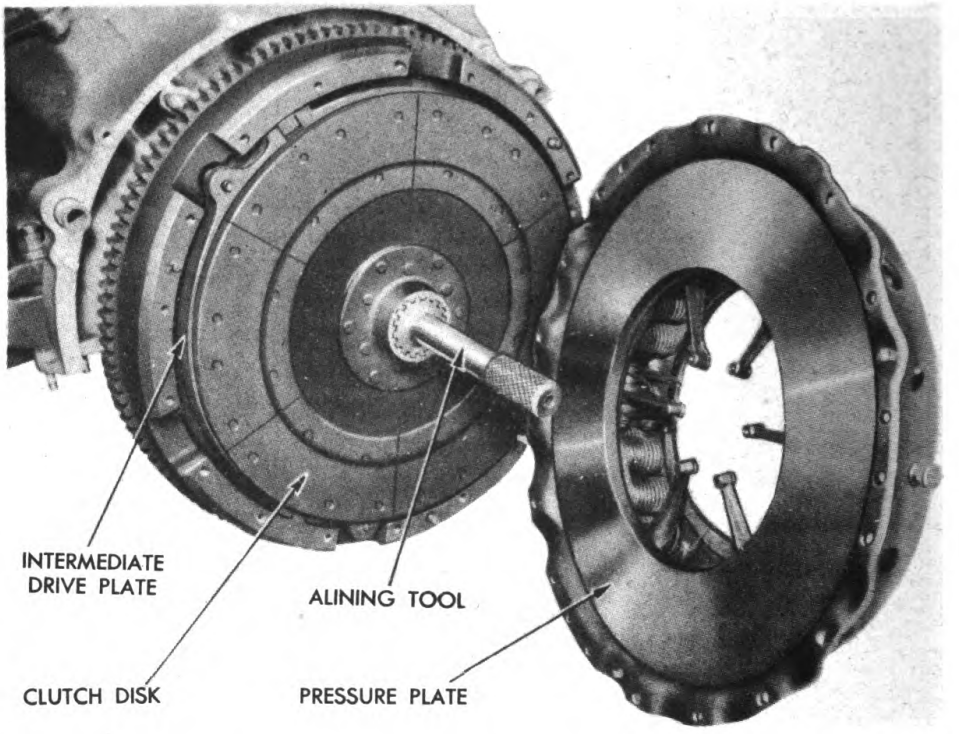

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Figure 121 — Clutch With Alining Tool (41-T-3083-75) Installed

insert it into bearing squarely and drive it into place using brass drift as shown in figure 123. Install the bearing retainer and tighten the nuts evenly. Remove the clutch alining tool (41-T-3083-75) as shown in figure 122. Raise housing into position and enter main shaft in splined hubs of clutch disks. Carefully move the housing into position on dowels in cylinder block. Install the attaching nuts and tighten them evenly. Position the flange on mainshaft and tighten and secure the nut (fig. 118). Remove the engine from the stand and install the starter (par. 93). Install engine in vehicle (par. 62). Make proper entry on W.D., A.G.O. Form No. 478, MWO and Major Unit Assembly Replacement Record.

i. Clutch Release Bearing or Fork Replacement (fig. 119).

(1) REMOVAL. Remove the engine (par. 61). Remove the clutch housing (subpar. **h** above). Disconnect the two springs which hold the release bearing and fork in contact. Slide the release bearing off the hub. To remove the clutch fork, remove one lock ring on either end of the shaft running through the clutch fork and slide the shaft out of the housing. Remove the fork from the housing.

(2) INSTALLATION (fig. 119). Place the clutch release fork in the housing, and insert the clutch release shaft through the needle

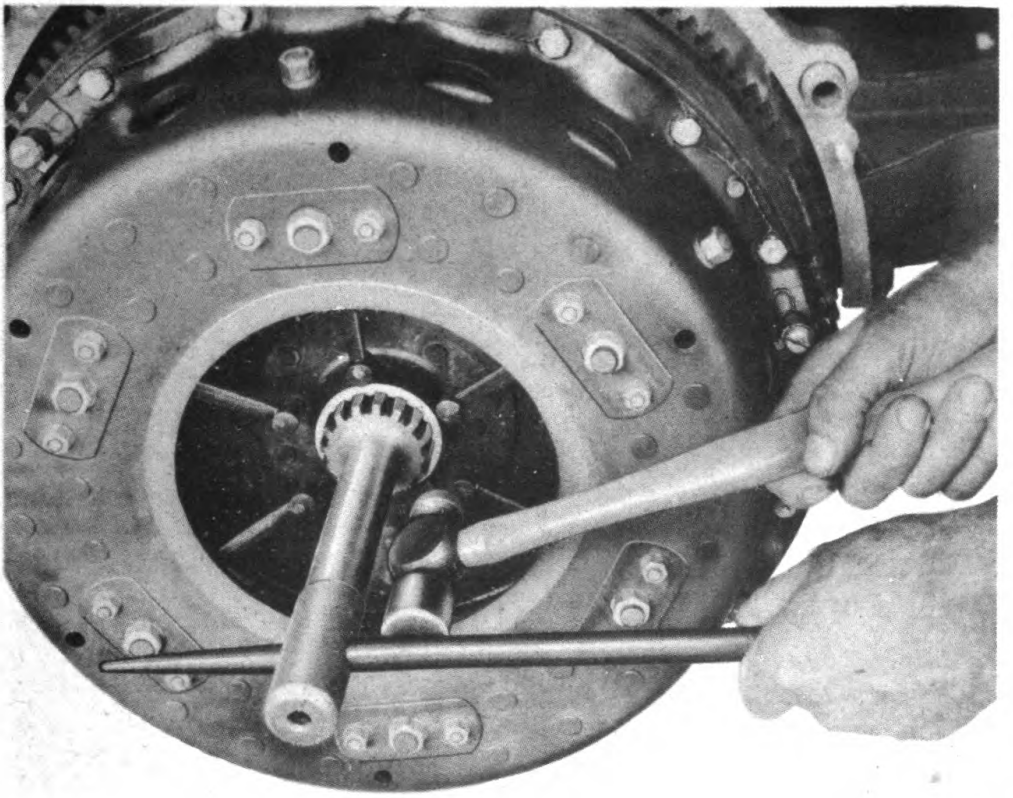

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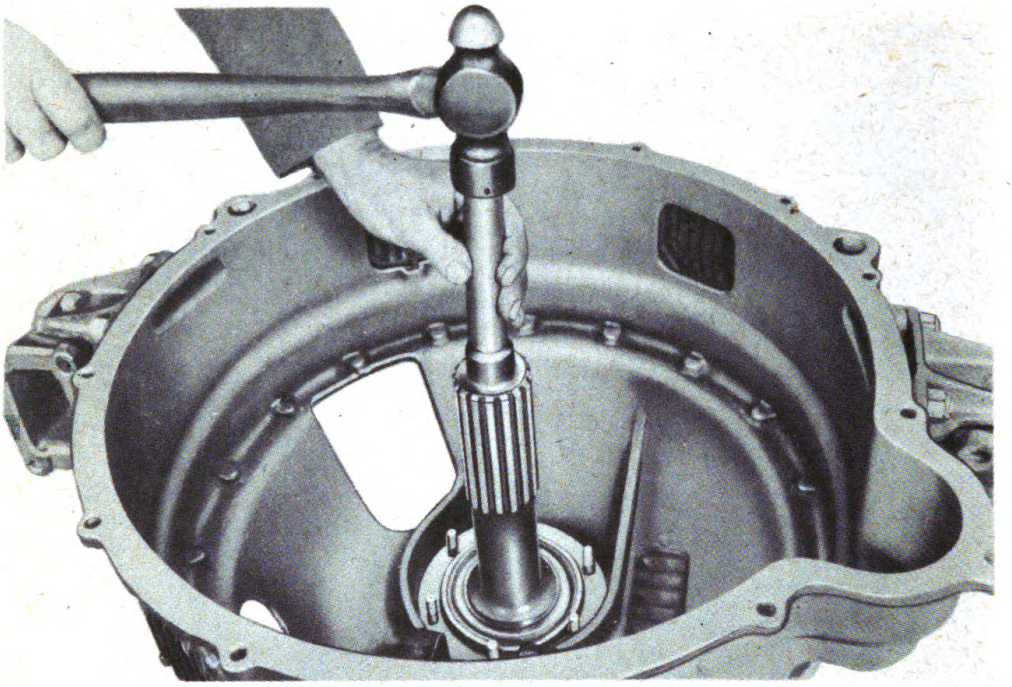
Figure 122 — Removing Clutch Alining Tool (41-T-3083-75)

roller bearings and fork. Place the snap ring retainer in the housing at each end of the shaft. Slip the hub and bearing assembly over the hub of the bearing retainer, and hook the two springs to the clutch release fork and the hub of the release bearing.

(3) RECORD INSTALLATION OF CLUTCH PARTS. Make proper entry on W.D., A.G.O. Form No. 478, MWO and Major Unit Assembly Replacement Record whenever clutch release bearing, clutch driven disks, or clutch pressure and drive plates are removed or replaced.

135. CLUTCH PEDAL AND LINKAGE.

a. Description (fig. 124). The clutch linkage consists of a pedal, pedal return spring, clutch rod, cross shaft, and a clutch rod assembly connected to the release shift fork of the clutch throw-out mechanism. A booster assembly, adjustable for pedal pressure, is attached to a bracket on the hull floor and the end of the cross shaft. An adjuster, for pedal free travel, is also attached to the cross shaft and to the clutch rod assembly, leading to the release shift fork of the clutch throw-out mechanism.



RA PD 339625

Figure 123 — Installing Clutch Mainshaft in Housing

b. Clutch Pedal.

(1) REMOVAL. Remove driver's seat. Remove driver's floor plate by disconnecting high idling rods from back of plate and removing screws which retain plates to the brackets on the hull floor (fig. 124). Remove pedal return spring. Remove cotter pin and clevis pin from clutch rod at the pedal. Loosen cap screw which secures pedal to pedal shaft. Pull shaft from pedal and out of bracket. Lift out flat washer and clutch pedal. Loosen jam nut and remove pedal stop screw from pedal.

(2) INSTALLATION. Install pedal stop screw and jam nut. Position pedal at left of shaft bracket. Slide flat washer on pedal shaft; then insert shaft through bracket and pedal. Tighten pedal retaining cap screw. Attach clutch rod to pedal with clevis pin and cotter pin. Install pedal return spring. Install driver's floor plate. Check pedal rod adjustment and adjust if necessary (subpar. **c** below). Adjust pedal stroke (par. 134 **b**). Replace driver's seat.

c. Clutch Rod.

(1) REMOVAL. Remove driver's seat and floor plate. Remove pedal return spring (G, fig. 124). Remove cotter pins and clevis pins attaching rod to pedal and to arm on cross shaft. Lift out rod.

(2) INSTALLATION. Adjust length of clutch rod (fig. 114) to 18¾ inches from center of one clevis hole to the other (par. 134 **c**).

Attach rod to arm on cross shaft and to pedal with clevis pins and cotter pins (fig. 124). Install pedal return spring. Install driver's floor plate and seat.

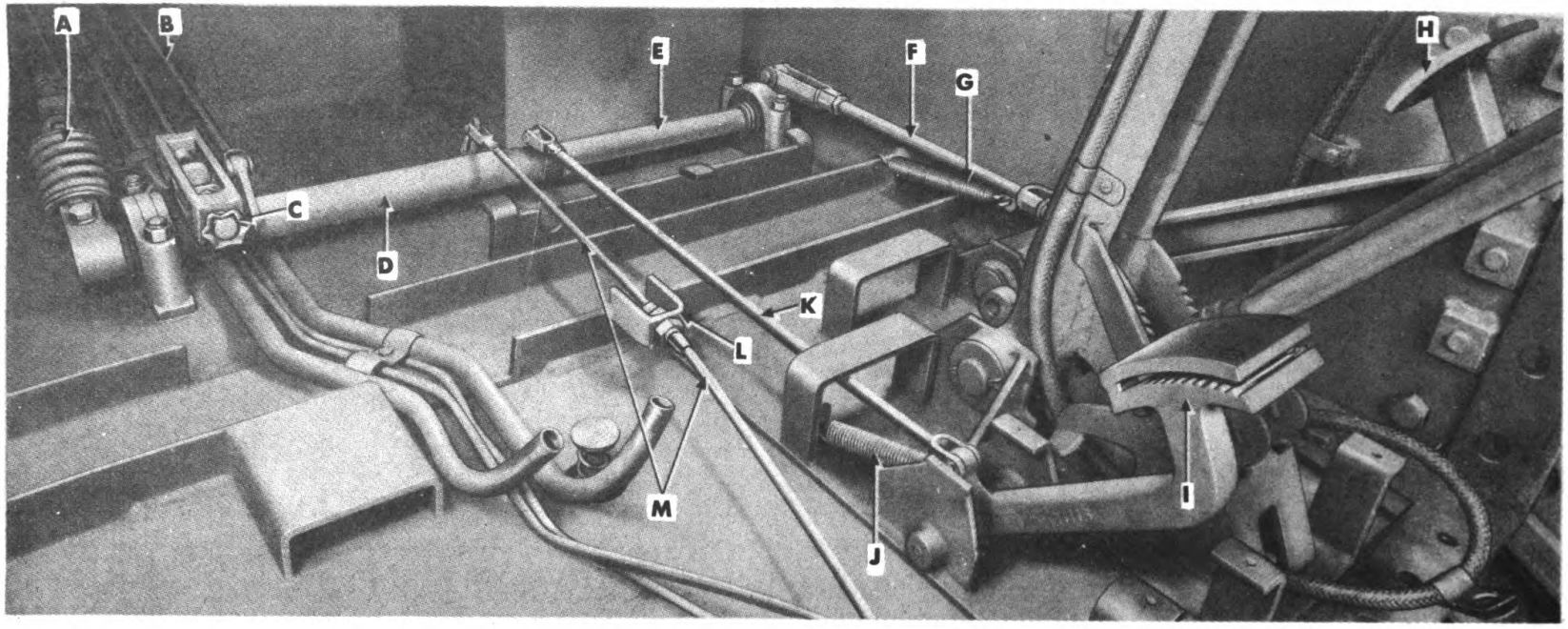
d. Cross Shaft Assembly.

(1) REMOVAL. Remove driver's seat and floor plate. Block clutch pedal in full forward position. Remove clip retaining screws and lock washers from side of clutch pedal free travel adjuster (F, fig. 125) and lift off clip. Push retaining pin out of adjuster and adjuster arm on clutch cross shaft. Loosen two cap screws which lock booster spring support to booster support body; then loosen jam nut and back off adjusting screw to relieve tension on spring. Pry out spring and remove spring seats. Remove block and permit clutch pedal to return to normal position. Remove two booster support body retaining nuts and bolts, and lift out support body. Disconnect accelerator and throttle rods from accelerator cross shaft tube. Disconnect clutch rod from arm on end of cross shaft. Remove nuts and bolts securing bearing brackets to hull floor and lift out the cross shaft assembly.

(2) DISASSEMBLY OF CROSS SHAFT (fig. 125). Mark clutch rod arm and end of cross shaft so they may be assembled in the same position. Loosen cap screw on clutch rod arm and tap off arm. Slide bearing assembly off end of cross shaft. Loosen idling rod retaining cap screw; then slide rod and accelerator cross shaft tube off cross shaft. Lift oil seals from each end of tube. Loosen cap screw on booster assembly arm. Tap off arm and remove Woodruff key from shaft keyway. Slide bearing assembly off cross shaft.

(3) ASSEMBLY OF CROSS SHAFT (fig. 125). Slide right-hand bearing assembly on cross shaft. Insert Woodruff key into keyway and tap booster assembly arm over key onto cross shaft. Tighten arm retaining cap screw. Position oil seals on each end of accelerator cross shaft tube. Clean and lubricate bearings in tube; then slide tube on clutch cross shaft against flat side of clutch pedal free travel adjuster arm. Slide idling rod on shaft against end of accelerator cross shaft tube and tighten rod retaining cap screw. Slide left bearing assembly on cross shaft. Aline marks on end of cross shaft and clutch rod arm, and tap arm on cross shaft. Tighten arm retaining cap screw.

(4) INSTALLATION (fig. 124). Position cross shaft assembly on hull floor. Secure bearing brackets to hull floor with bolts and nuts. Attach clutch rod arm on end of cross shaft. Block clutch pedal in full forward position. Install booster support body assembly. Compress spring in a vise and hold it in compressed position with wire. Remove spring from vise. Position spring seats on end of spring; then position assembly between booster assembly arm on cross shaft and the spring support in the booster support body. Turn adjusting screw



A—CLUTCH BOOSTER ASSEMBLY
B—ACCELERATOR REAR ROD
C—CLUTCH PEDAL FREE TRAVEL ADJUSTER
D—CROSS SHAFT ACCELERATOR SLEEVE
E—CLUTCH RELEASE CROSS SHAFT
F—CLUTCH PEDAL ROD
G—PEDAL RETURN SPRING
H—CLUTCH PEDAL
I—FOOT THROTTLE PEDAL
J—PEDAL RETURN SPRING
K—ACCELERATOR FRONT ROD
L—BRACKET
M—HAND THROTTLE CONTROL

RA PD 339626

Figure 124 — Clutch and Throttle Linkage

until spring is supported; then remove wire from spring. Clean and lubricate adjuster arm bearing. Position clutch pedal free travel adjuster over arm and install retaining pin. Install spring clip. Remove block and permit clutch pedal to return to normal position. Connect throttle and accelerator rods to accelerator cross shaft tube. Install driver's floor plate. Check pedal free travel and adjust if necessay (par. 134 **d**). Install driver's seat (par. 162 **c**).

c. Clutch Rod Assembly.

(1) REMOVAL. Remove fighting compartment floor plates (par. 137 **a**). Remove cotter pin and clevis pin attaching clutch rod to release shaft fork clutch throw-out mechanism. Block clutch pedal in full forward position. Remove clip retaining screws and lock washer from side of clutch pedal free travel adjuster (F, fig. 125). Lift off clip. Push adjuster pin out of adjuster and arm on cross shaft. Then lift the adjuster assembly off cross shaft. Lift clutch rod assembly out through fighting compartment.

(2) INSTALLATION. Block clutch pedal in full forward position. Clean and lubricate bearing in adjuster arm on cross shaft. Push adjuster over arm and install retaining pin. Install spring clip. Remove block and permit clutch to return to normal position. Connect clutch rod to release shaft fork of clutch throw-out mechanism with clevis pin and cotter pin. Check clutch pedal free travel and adjust if necessary (par. 134 **d**). Replace fighting compartment floor plates.

136. PROPELLER SHAFTS AND UNIVERSAL JOINTS.

a. Propeller Shafts.

(1) DESCRIPTION (fig. 126). The propeller shaft transmits power from the engine in the rear of the vehicle to the transmission at the front of the vehicle.

(2) REMOVAL. Remove the engine from the vehicle (par. 61). Remove the escape hatch from the floor plate. Working through the opening in the floor plate, unscrew the oil seal retainer (H, fig. 126) at the front universal slip joint. Pull the propeller shaft to the rear out of the "tunnel" (the front end of the shaft will pull out of the slip joint in the front universal joint, leaving the front universal on the transmission). Loosen the generator belt adjustment (par. 99 **b**). Remove the nuts from the front universal and remove the universal joint.

(3) INSTALLATION. Remove the front universal from the propeller shaft and install it on the transmission. Slip the propeller shaft in between the ammunition racks and connect the front universal joint to the propeller shaft at the splined slip joint. Arrow marks are placed on both the front and rear universal joints and on the propeller shaft. These arrows must be lined up before assembly of the uni-

versal joint to the propeller shaft. This is to make certain that the front and rear universal joint yokes are in alinement to prevent propeller shaft vibration. Screw the oil seal retainer cap (fig. 126) on the front universal joint, making sure that the cork ring and snap ring washers are not damaged. Adjust the generator belts (par. 99 **b**). Install the engine (par. 62) and bolt the rear universal joint to the clutch flange. Depress the clutch and turn the propeller shaft to install all the bolts.

b. Propeller Shaft Universal Joints.

(1) DESCRIPTION. Two universal joints are used with the propeller shaft, one at each end. The front one is connected to the shaft through a splined slip joint. The yoke for the rear universal joint is part of the shaft (fig. 126). Four needle roller bearings are used in each universal joint. The bearings and seals in the universal joints are the parts most likely to wear out. Excessive bearing wear is indicated by propeller shaft vibration. When vibration develops, notify higher authority before the universal joints require replacement. Universal joint bearings can be replaced by ordnance maintenance personnel without removing the universal joints if the need is detected in time, thus saving the removal of the engine.

(2) PROPELLER SHAFT UNIVERSAL JOINT BEARING REPLACEMENT.

(a) Removal (fig. 126). To remove the bearings in the propeller shaft universal joint front or rear, remove the escape hatch at the forward end of the hull floor. This is necessary in order to work on the forward universal joint. Hold the clutch pedal down, and have the transmission in neutral to free the propeller shaft. Turn the shaft until the universal joint lubrication fitting is accessible. Remove the fitting. Remove the universal joint bearing cover plate by bending down the locking ears and removing the bolts. Hold down the clutch pedal and turn the propeller shaft one-half turn. Remove the opposite bearing cover which now faces up. Using a brass or copper drift, tap the bearing down until the trunnion forces the bottom bearing to drop out. Hold the clutch pedal down and turn propeller shaft one-half turn. Using a brass or copper drift, drive the universal joint trunnion down until the other bearing is forced out of the yoke. Follow the same procedure to remove the other two bearings.

(b) Installation (fig. 126). Examine the cork seal and retainer of each bearing and replace if necessary. Place the trunnion in the yoke and push it through the yoke so that the bearing can be set in place on the trunnion; then drive the bearing lightly into the yoke on the propeller shaft until the bearing is flush. Assemble the cover plate to the slot in the bearing and line up the bolt holes in the cover with the holes in the yoke. Install the two cap screws and lock plate.

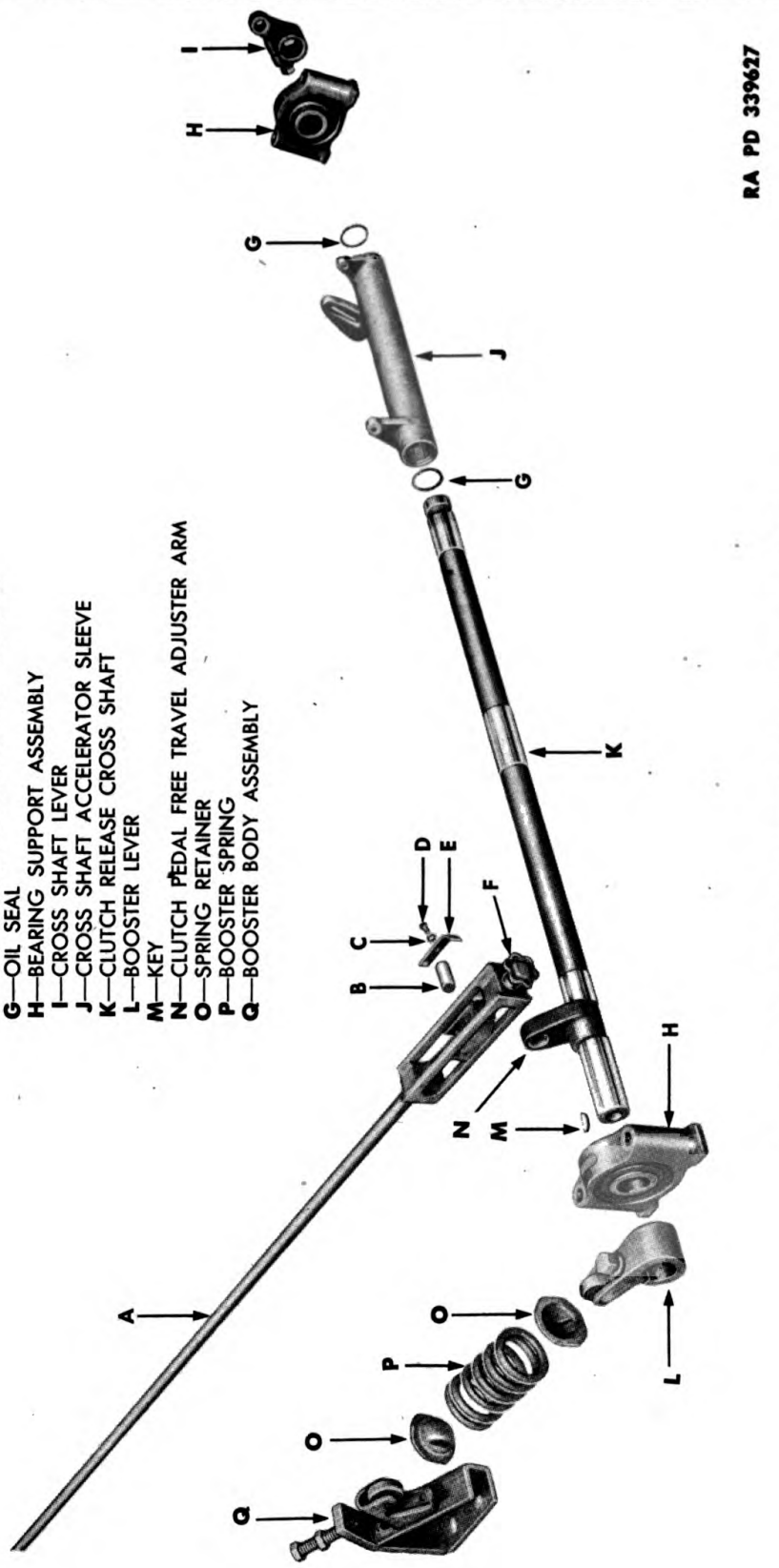
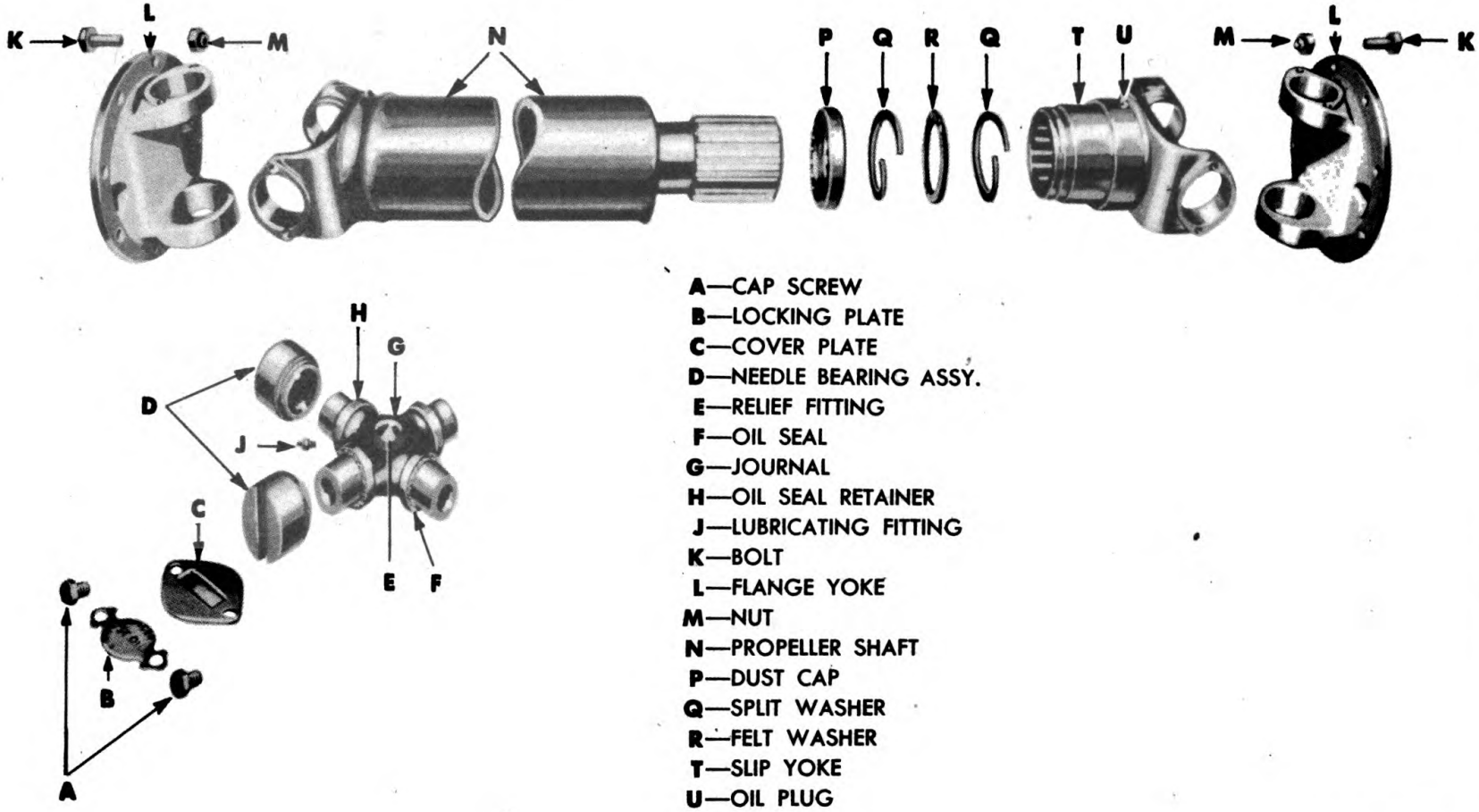


Figure 125 — Clutch Cross Shaft — Disassembled



A—CAP SCREW
B—LOCKING PLATE
C—COVER PLATE
D—NEEDLE BEARING ASSY.
E—RELIEF FITTING
F—OIL SEAL
G—JOURNAL
H—OIL SEAL RETAINER
J—LUBRICATING FITTING
K—BOLT
L—FLANGE YOKE
M—NUT
N—PROPELLER SHAFT
P—DUST CAP
Q—SPLIT WASHER
R—FELT WASHER
T—SLIP YOKE
U—OIL PLUG

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Figure 126 — Propeller Shaft and Universal Joints — Disassembled

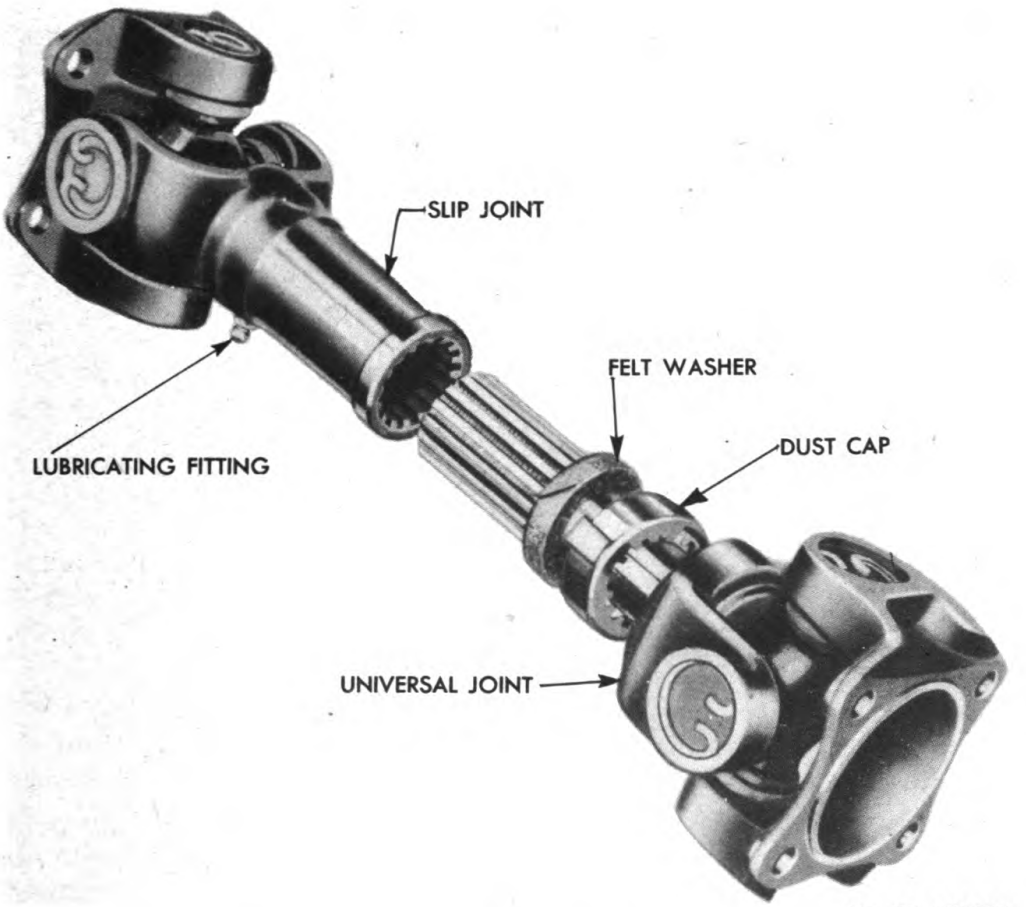

Figure 127 – Accessory Drive Shaft – Disassembled

Turn the universal joint and enter the opposite bearing on the trunnion. Drive the bearing lightly into the yoke. Line up the slot in the bearing and the cover and install the cover. Bend up one ear of the lock plate against each of the cap screw heads (at each plate). Repeat the procedure for the other two bearings.

(c) Record Installation of Propeller Shaft or Universal Joints. Make proper entry on W.D., A.G.O. Form No. 478, MWO and Major Unit Assembly Replacement Record whenever propeller shaft or universal joints are replaced.

137. FAN DRIVE SHAFTS AND UNIVERSAL JOINTS.

a. Fan Drive Shafts (fig. 127). The fan drive shafts provide a connection between the driving flange on the accessory gear assembly at the rear of the engine and the flange on the accessory drive housing, one on each side of the engine. To remove the shaft, remove the four bolts from each flange.

b. Fan Shaft Universal Joint (fig. 127). Two universal joints are used on each shaft, one at each end. Four needle roller bearings are provided in each universal joint. Fan drive shafts are supplied as an assembly with the universals in place.

c. Replacement. Disconnect the fan drive shaft at the accessory drive housing. Disconnect the shaft at the engine and remove the fan drive shaft. To install the fan drive shaft, connect the shaft to the engine and then to the accessory drive housing.

Section XXX

POWER TRAIN ASSEMBLY

138. DESCRIPTION.

a. General (fig. 128). The power train assembly consists of the transmission, controlled differential with steering brakes, and the final drives to which the track driving sprockets are attached. The units are bolted to, and assembled in, a large one-piece casting called the differential housing. This housing is bolted to the hull and forms the front part of the vehicle. The final drive units can be removed as separate assemblies with the power train in the vehicle. The steering brakes are adjusted and brake shoe assemblies can be replaced with the power train in the vehicle. The transmission and the differential housing assembly are usually removed or installed after the power train is removed from the vehicle.

b. Transmission (fig. 128). The transmission is an extra heavy duty type with five forward speeds and one reverse. The transmission case is bolted to the differential carrier. The pinion which drives the differential bevel drive gear (ring gear) is mounted on the forward end of the transmission output shaft.

c. Differential. The differential permits the outer track to travel faster than the inner track on turns, or one track to travel faster than the other on uneven ground. Because the differential is the controlled type, it also provides a means of steering and stopping the vehicle. When the brake on either brake drum is applied, it puts a planetary gear train on that side of the differential into motion. As a result, the track on the side of the vehicle on which the brake is being applied is slowed down, and the track on the opposite side speeded up; and the vehicle steers to the side of the slower moving track.

d. Final Drive (fig. 128). The two final drive assemblies are bolted to the ends of the differential housing. The track driving

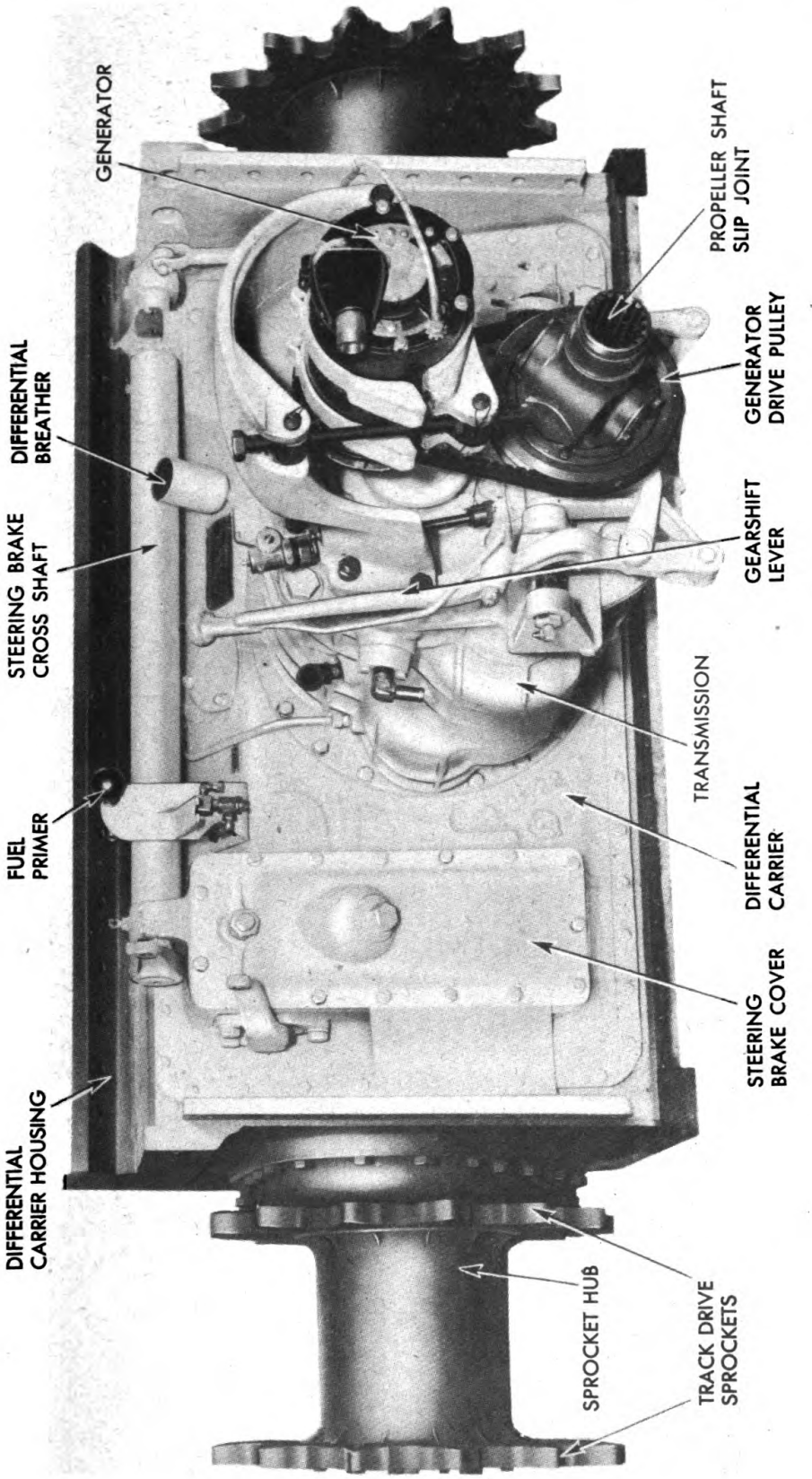

Figure 128 — Power Train Assembly

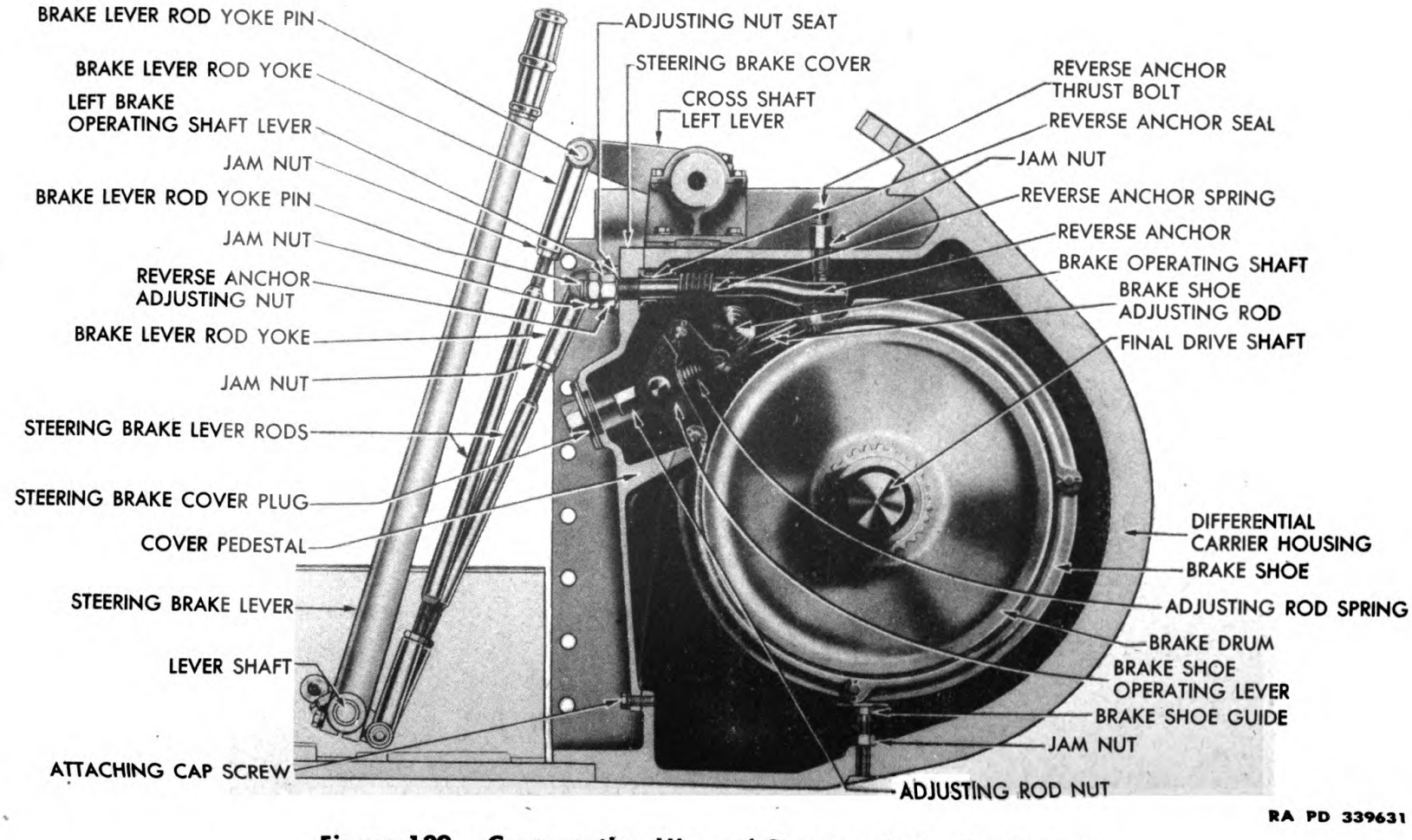

Figure 129 — Cross-section View of Steering Brake Mechanism

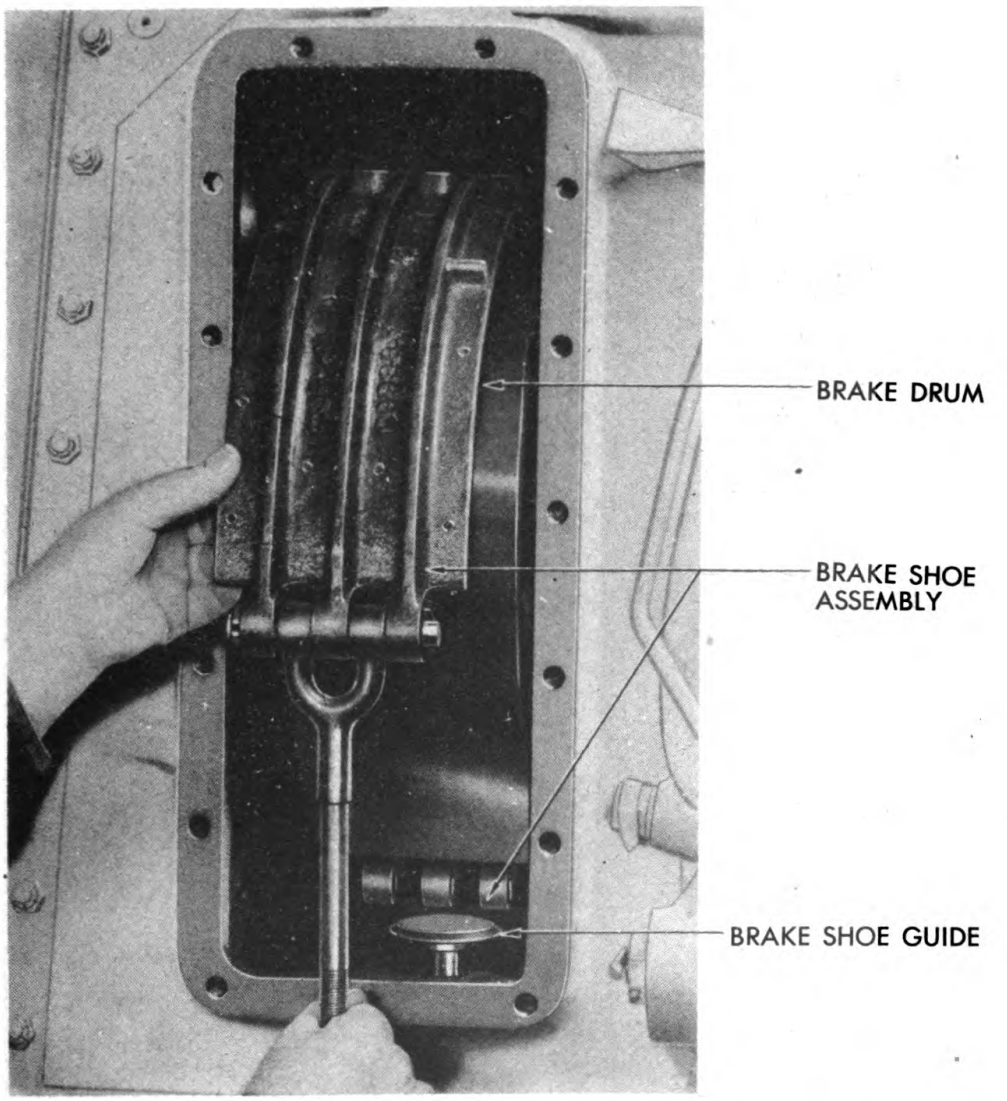

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Figure 130 — Installing Brake Shoe in Housing

sprockets are attached to a hub on each end of the final drive assemblies.

139. STEERING BRAKES.

a. Description. Steering brakes are incorporated in the differential sub-assemblies located on both sides of the differential. One track cannot be stopped independently of the other; thus some movement occurs in both tracks during turning. The two steering brakes are three-shoe, double-anchor, external contracting brakes, one on each side of the differential assembly.

b. Removal of Assemblies.

(1) DRAIN TRANSMISSION AND FINAL DRIVE. Refer to paragraph 33.

(2) DISCONNECT STEERING BRAKE CONTROL RODS. Refer to subparagraph e (2) below.

(3) REMOVE STEERING BRAKE COVERS. Refer to subparagraph e (3) below.

(4) REMOVE STEERING BRAKE REVERSE ANCHOR. Loosen reverse anchor thrust bolt nut. Back out thrust bolt until flush with inside of differential carrier. Lift out the reverse anchor. Remove seal and spring (fig. 129) from reverse anchor.

(5) LOWER THE BRAKE SHOE GUIDE. Loosen the brake shoe guide screw nut and screw the guide down as far as possible (fig. 129).

(6) REMOVE ADJUSTING ROD LEVER. Remove the adjusting rod adjusting nut with socket wrench (41-W-2573-400) and remove clip from the adjusting rod (fig. 135). Remove cotter pins from inner end of brake shoe long pin and adjusting rod lever pin (fig. 135). Pull top of rear shoe out of differential carrier (fig. 130) and withdraw long pin. Lower the shoe to bottom of opening. Withdraw the adjusting rod lever pin and lift out the lever.

(7) REMOVE STEERING BRAKE SHAFT. At the right, remove the cotter pin from clevis pin at lower end of steering brake shaft lever connecting rod and remove clevis pin. Examine outer ends of brake shafts to make sure both shafts and levers are marked. If marks are not visible, use a prick punch to mark the parts for reassembly in same positions. Remove the bolt and lock washer from the brake shaft lever and drive the lever off the shaft. Remove the three bolts and lock washers from the brake shaft trunnion (fig. 131). Slide trunnion and shaft out of carrier until inner end of shaft clears the bushing. Tip the inner end of brake shaft down, and move it toward center of vehicle. Pull trunnion off shaft. Remove the shaft through the brake cover opening (fig. 131).

(8) REMOVE BRAKE SHOE ASSEMBLY. The brake shoe assembly can now be removed by pulling the shoes out over the top of the drum while lifting the shoes over the brake shoe guides at the bottom (fig. 131). Wipe out differential carrier housing to remove any dirt.

(9) DISASSEMBLE BRAKE SHOES. Remove cotter pins from one end of the two steering brake shoe long pins and the short pin (fig. 135). Withdraw the pins to separate shoes and disconnect the adjusting rod.

(10) INSPECT STEERING BRAKE PARTS. Inspect brake drums and if found to be deeply scored, notify higher authority. Examine levers, pins, shafts, and bushings for wear. Replace worn parts. If lining is loose, damaged, glazed, or worn down to $\frac{3}{16}$-inch thickness or less, replace shoes.

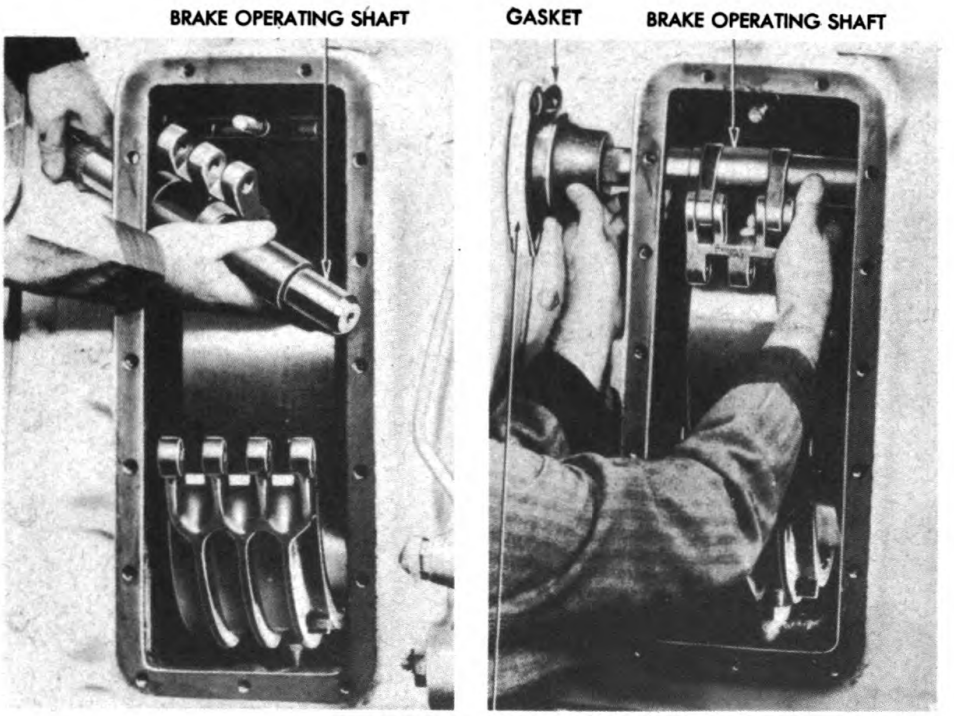

Figure 131 — Installing Brake Operating Shaft and Trunnion

c. Installation of Double Anchor Brake Shoe Assemblies.

(1) ASSEMBLE STEERING BRAKE SHOE. Attach adjusting rod to end of forward shoe, using short pin (fig. 130). Insert and spread new cotter pin. Connect the other two shoes together and attach them to forward shoe, using long pins. Insert and spread new cotter pins.

(2) INSERT BRAKE SHOE ASSEMBLIES IN DIFFERENTIAL CARRIER. Place the upper end of the rear shoe on top of the brake drum (fig. 130). Feed the brake shoes around the drum and guide the shoes over the brake shoe guide at the bottom.

(3) INSTALL BRAKE SHAFT. Position a new gasket on flange of brake shaft trunnion with general purpose grease. Insert serrated end of brake shaft into brake cover opening and out through trunnion hole (fig. 131). Slide trunnion over end of shaft. Move shaft outward, and insert inner end in bushing in differential carrier. Slide trunnion against differential carrier. Install three bolts with lock washers, and tighten bolts.

(4) INSTALL ADJUSTING ROD LEVER. Connect the upper end of adjusting rod lever to brake shaft to lever link with the adjusting rod lever pin. Insert and spread new cotter pin. Connect the lower

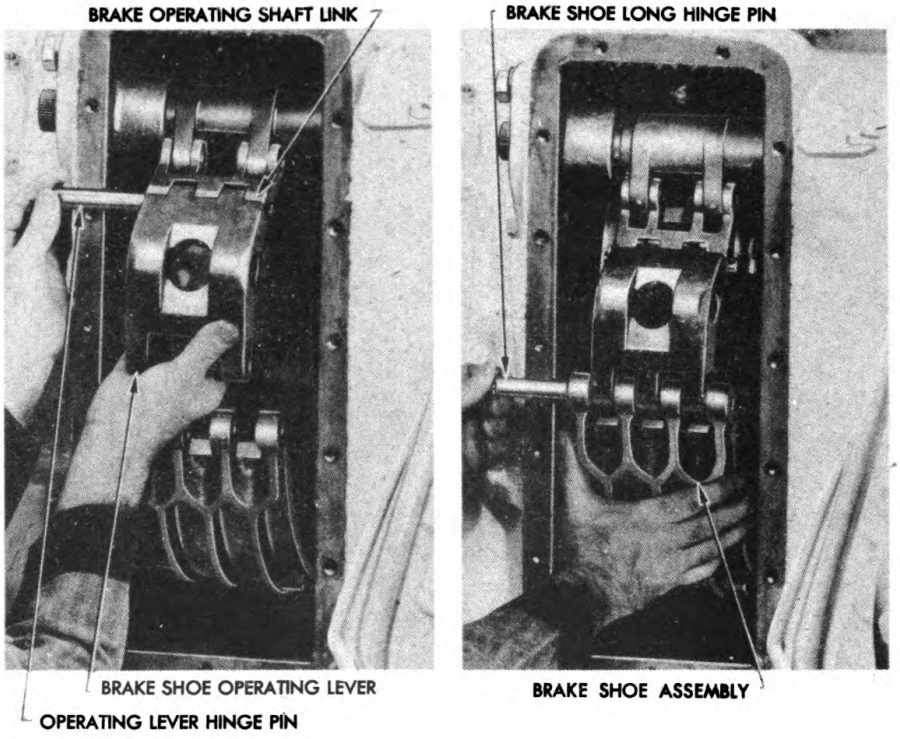

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Figure 132 — Connecting Brake Operating Shaft Link

end of lever to brake shoe assembly with brake shoe long pin (fig. 132). Insert and spread new cotter pin.

(5) INSTALL ADJUSTING ROD SPRING AND WASHERS. Slide adjusting rod spring down on rod against shoulder. Place washer on rod against spring. Insert brake shaft pin in lever with flat of pin turned to rear (fig. 133). Center the hole in pin with opening in lever, and insert steering brake adjusting rod through hole in brake shaft pin. Place adjusting nut clip on rod with fingers vertical and flat side against brake shaft pin. Screw adjusting rod adjusting nut on rod with tapered end against clip (fig. 135).

(6) INSTALL BRAKE SHAFT LEVERS. Place brake shaft lever on shaft with reference marks in alinement to assure correct angularity of brake operating mechanism. Drive lever onto shaft so bolt hole registers with groove in shaft. Install bolt with lock washer, and tighten bolt. Attach the brake shaft lever connecting rod to the right brake shaft lever with clevis pin. Insert and spread new cotter pin.

(7) COMPLETE ASSEMBLY AND PERFORM MAJOR ADJUSTMENT. Refer to paragraph d (1) through (18). Record brake shoe replace-

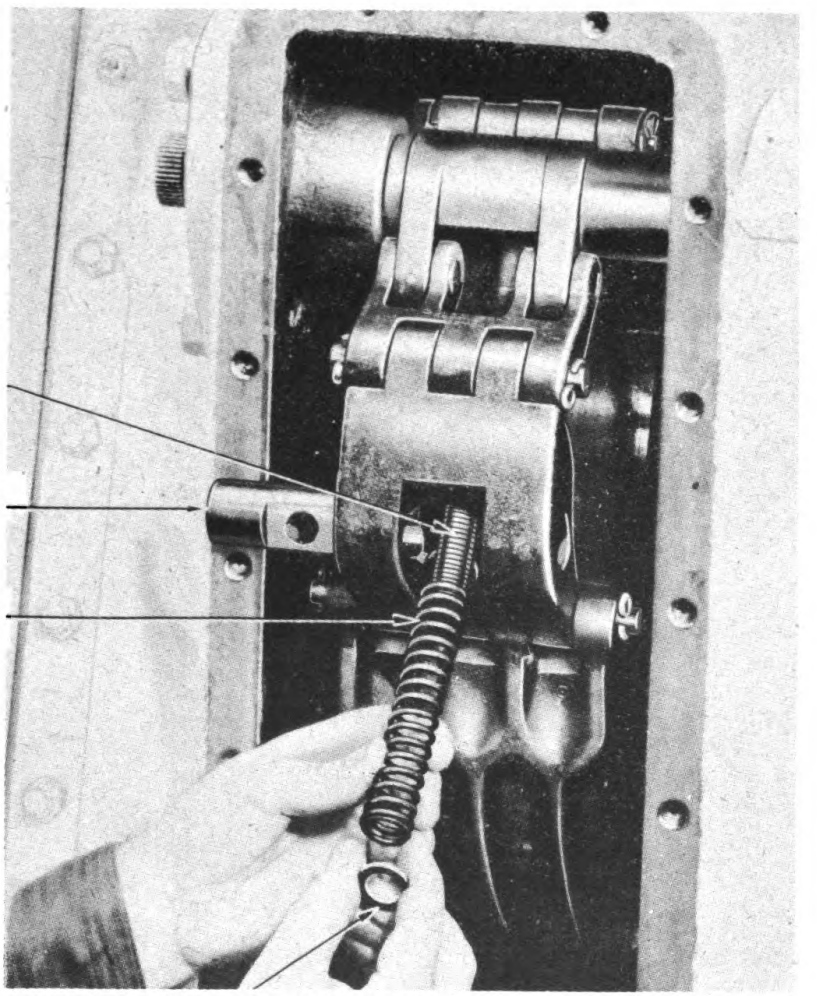


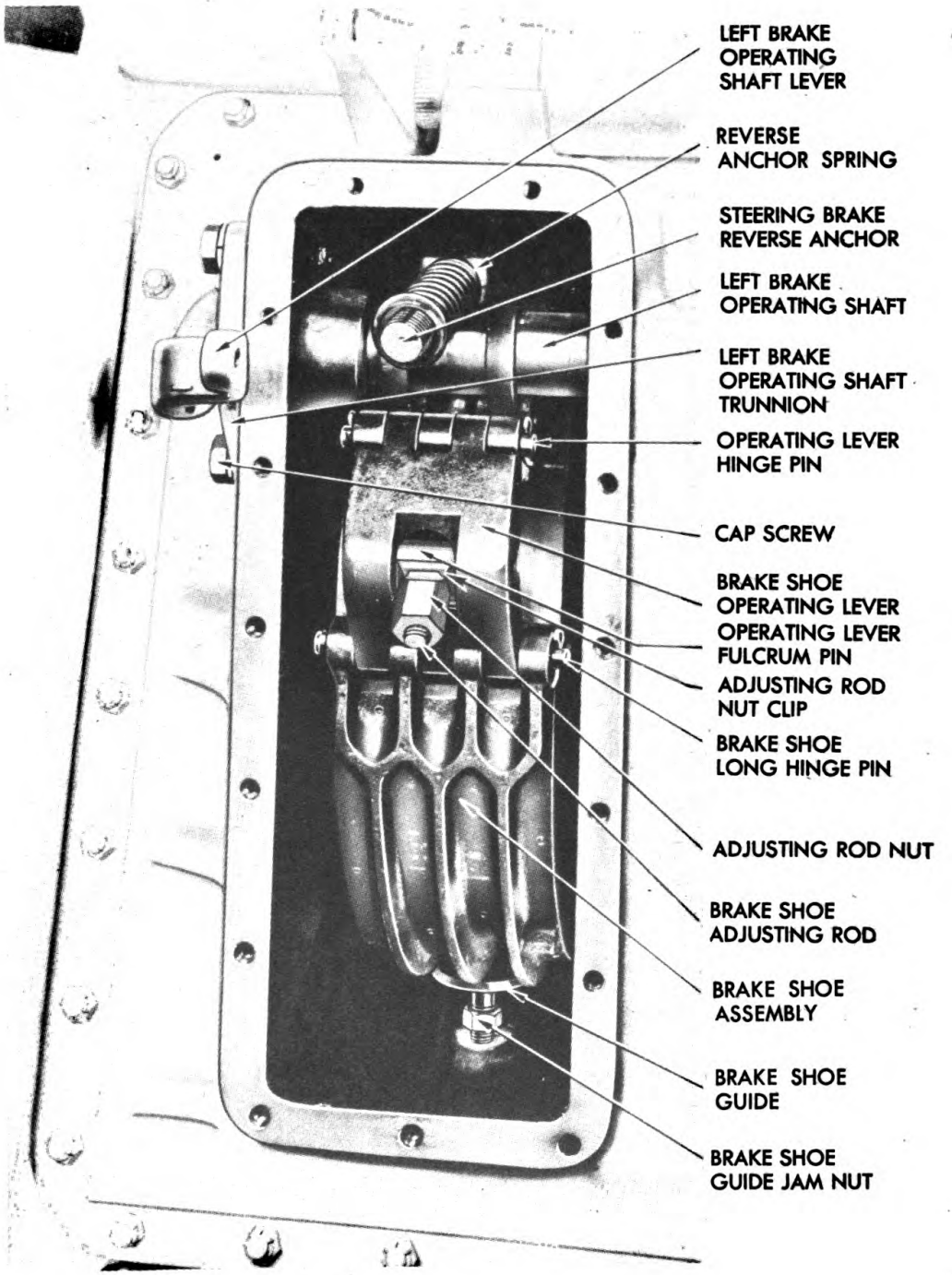
Figure 133 — Installing Adjusting Rod Spring and Washer

ment on W.D., A.G.O. Form No. 478, MWO and Major Unit Assembly Replacement Record.

d. Minor Adjustment of Double Anchor Brake.

(1) ADJUST STEERING BRAKE CONTROL LEVER FREE TRAVEL. Remove the two adjusting hole cover plugs and gaskets (fig. 129). If adjusting rod nut does not have a spring clip, disconnect brake control rod upper yokes from the levers; otherwise, nut will be damaged. Tighten the adjusting rod adjusting nut (fig. 137) on each brake until both steering brake control levers have 4- to 5½-inches free travel (fig. 139). CAUTION: *Adjusting nuts must be turned so flats are in contact with clip to lock the nut.*

(2) CHECK STEERING BRAKE CONTROL LEVERS FOR EQUAL TRAVEL. Pull both levers back with equal force and check for equal



RA PD 339635

Figure 134 — Steering Brake Cover Removed Showing Brake Operating Mechanism

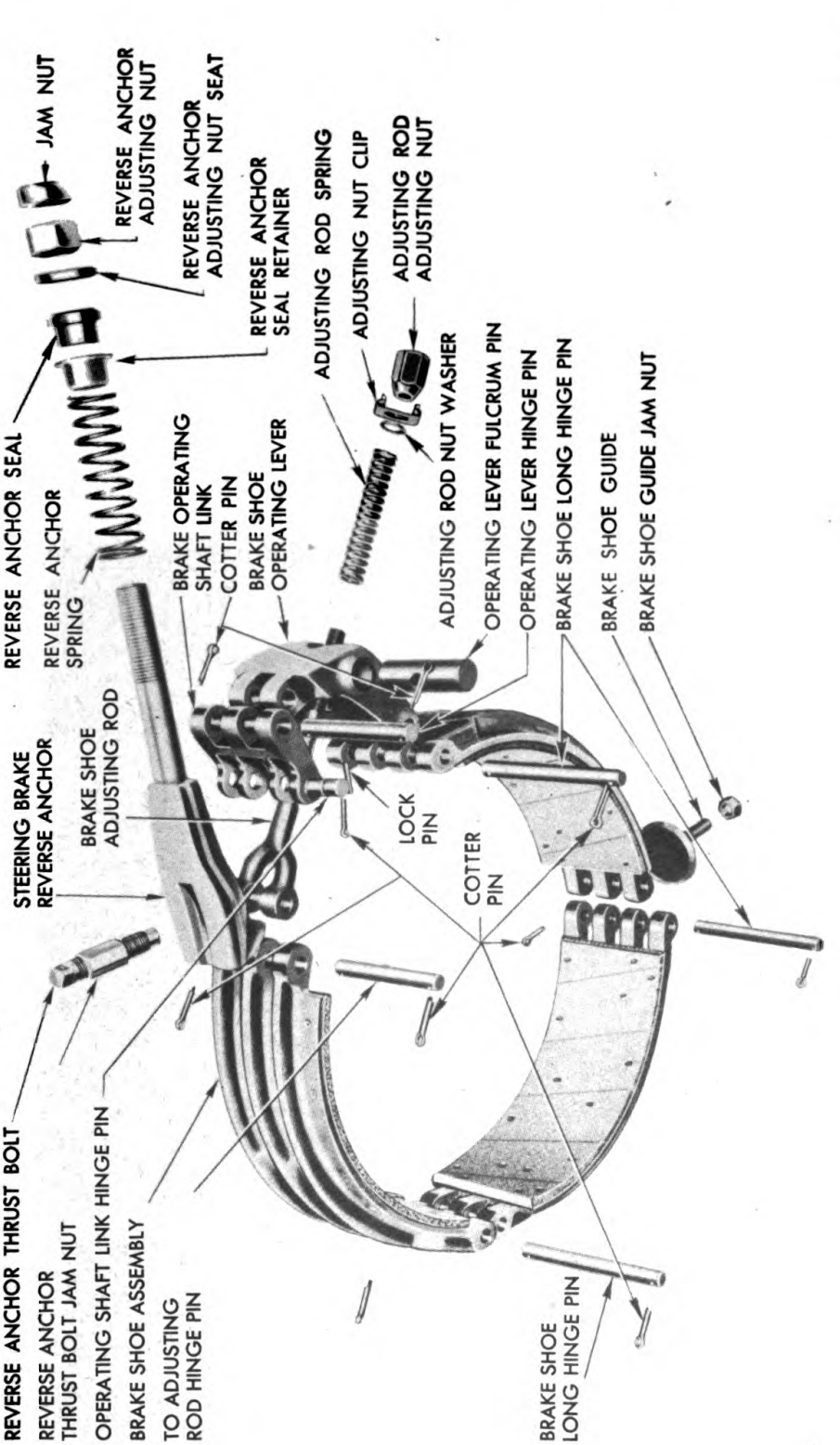


Figure 135 — Steering Brake Shoe Mechanism — Disassembled

lever travel. If travel is not equal, tighten the adjusting nut on the brake controlled by the lever having greater travel until the travel of both levers is equal.

(3) INSTALL ADJUSTING HOLE COVER PLUGS. Inspect gasket and if damaged, replace. Position gasket on cover plug and install plug. Repeat for cover plug on opposite side.

c. Major Adjustment of Brakes.

(1) DRAIN POWER TRAIN ASSEMBLY. Remove drain plug and drain oil from power train (par. 33). If oil is to be used again, drain into clean containers having 45-gallon capacity.

(2) DISCONNECT STEERING BRAKE LEVER RODS. Remove cotter pins and clevis pins from yokes on upper ends of brake lever rods (fig. 129). Pull the levers and rods back out of the way.

(3) REMOVE STEERING BRAKE COVERS. Make sure 24-volt master switch is off. Remove jam nut, adjusting nut, and seat from reverse steering brake anchor (fig. 129). Take out bolts with lock washers which attach toe guard on left side. Remove toe guard. Take out the remaining bolts with lock washers which attach brake cover to differential carrier. Lift out brake cover and gasket. Repeat procedure to remove brake cover on opposite side.

(4) PARTIALLY REMOVE RIGHT BRAKE SHOE TO INSPECT LINING. Swing rear end of anchor down, and lift out reverse steering brake anchor with spring, seal retainer, and seal (fig. 135). Loosen brake shoe guide screw nut and screw the guide all the way down (fig. 134). Remove adjusting rod adjusting nut and remove clip. Remove cotter pin from inner end of long pin at top of rear brake shoe (fig. 134). Pull top of brake shoe back out of carrier and withdraw the long pin.

(5) INSPECT BRAKE LINING. Inspect the brake shoe lining (fig. 135). If the lining measures $^{3}/_{16}$ inch thick, or less, or if it is glazed and shiny, replace all brake shoes. Examine brake drums. If it is deeply scored, notify higher authority before proceeding further.

(6) REASSEMBLE RIGHT BRAKE. If the brake drum and lining are serviceable, reassemble the right brake. Connect lower shoe to steering brake shoe adjusting rod lever with long pin. Insert new cotter pin, and spread. Install spring and washer on adjusting rod (fig. 133) and insert rod through brake shaft pin. Place adjusting nut clip on rod with flat against brake shaft pin. Screw adjusting rod adjusting nut, tapered end first, on rod two to three full turns (fig. 135).

(7) ADJUST BRAKE SHOE GUIDE CLEARANCE. The lower shoe on each brake rests on a brake shoe guide (fig. 134). Tighten adjusting rod adjusting nut until shoes are snug against drums. Loosen brake shoe guide jam nut (fig. 134). Adjust height of brake shoe

guide so that a 0.010-inch feeler will pass, with slight drag, between the guide and the lowest point of the brake shoe. Tighten nut and recheck clearance. This adjustment will provide 0.010-inch clearance between the lining and the drum with the brakes in released position. Repeat for opposite brake.

(8) INSTALL REVERSE STEERING BRAKE ANCHOR. Install spring on reverse steering brake anchor. Place the reverse anchor seal retainer on the anchor with the flat side against the spring. Slide the reverse anchor seal on anchor so that shoulder is seated in the retainer with sleeve projecting through the retainer and into spring (fig. 135). Place the anchor in position under thrust bolt with end hooked over the adjusting rod yoke (fig. 129). Loosen nut; then tighten reverse anchor thrust bolt as required to hold anchor in place.

(9) INSTALL BRAKE COVERS. Make sure gasket surfaces of differential carrier and both steering brake covers are clean. Position new gasket on cover with general purpose grease. Start reverse steering brake anchor through hole in cover. Guide the cover into position on differential carrier so that the pedestal on inside of cover supports lower end of adjusting rod lever (fig. 129). It may be necessary to raise up on the brake shaft lever or raise the cover up with a drift to aline the bolt holes. Install bolts and lock washers at top and bottom, but do not tighten. On left side, attach the toe guard to cover with the second, third, and fourth bolts from the bottom. Install the remaining bolts with lock washers. Tighten cover bolts evenly to compress gasket uniformly. Place reverse anchor adjusting nut seat on end of anchor with flat side against steering brake cover (fig. 128). Screw reverse anchor adjusting nut on anchor with beveled side against the seat. Screw the jam nut on anchor against the adjusting nut.

(10) ADJUST REVERSE STEERING BRAKE ANCHOR. Turn reverse anchor thrust bolt down until it is felt to contact the anchor; then back off the thrust bolt one full turn to provide proper clearance. Hold bolt, and tighten thrust bolt nut (fig. 129). Turn reverse anchor adjusting nut down until anchor is felt to contact forward brake shoe; then back off 1½ turns. Hold adjusting nut, and tighten jam nut.

(11) ADJUST BRAKE CROSS SHAFT LEFT LEVER HEIGHT. Remove adjusting hole cover and gasket from right steering brake cover. Turn adjusting rod adjusting nut. Pull up on lever, and turn adjusting nut to position the brake cross shaft left lever so the center of clevis pin hole is $\frac{9}{16}$ inch above machined edge of differential carrier housing (fig. 139) with brake shoes in contact with drum.

(12) ADJUST LEFT STEERING BRAKE SHAFT LEVER HEIGHT. Remove adjusting hole cover and gasket from left steering brake

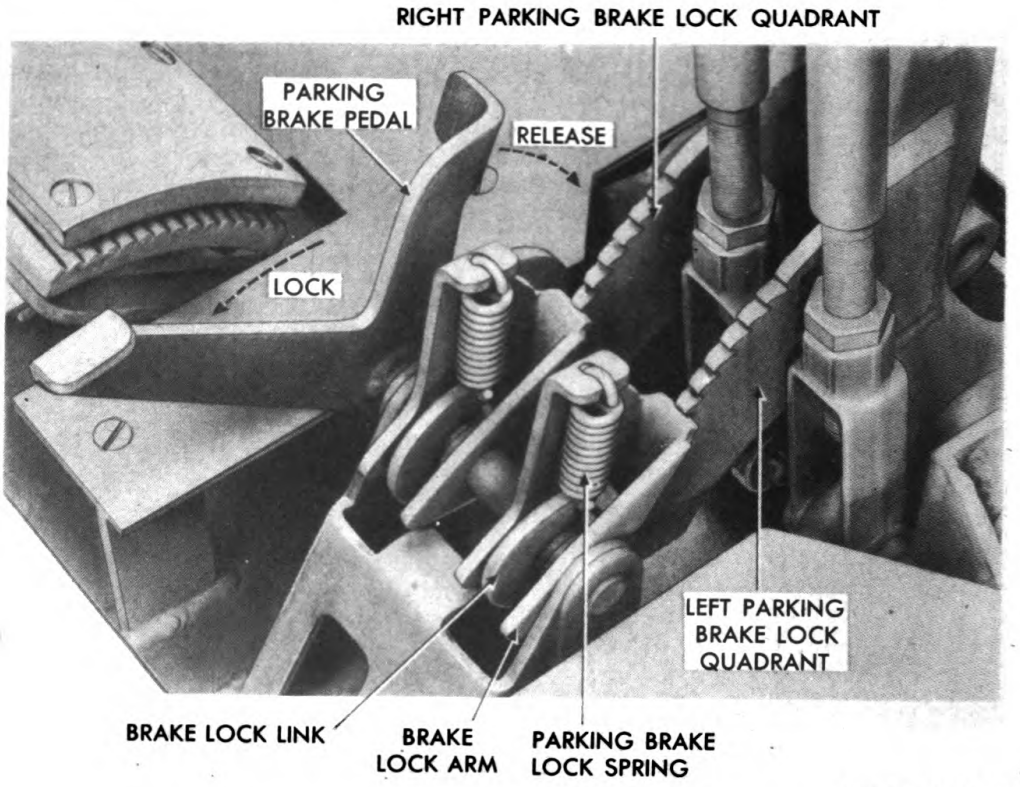
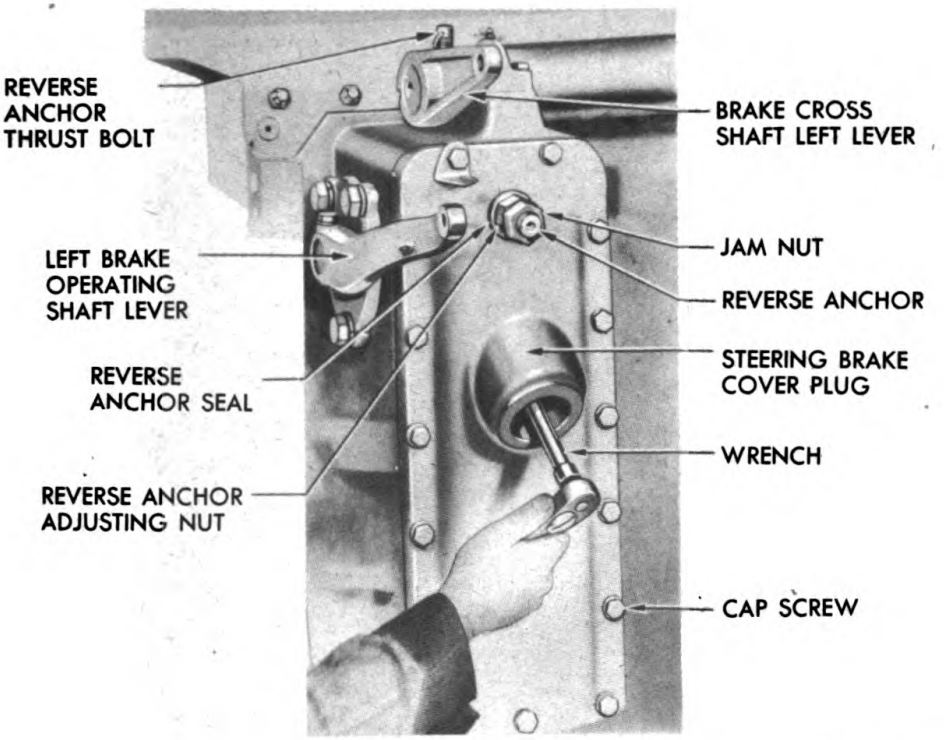


Figure 136 — Parking Brake Lock Mechanism

cover. Pull up on lever, and turn adjusting rod adjusting nut to position the left steering brake shaft lever so the center of clevis pin hole is 4½ inches below machined edge of differential carrier housing (fig. 139) with brake shoes in contact with drum.

(13) ADJUST STEERING BRAKE CONTROL LEVER STOP SCREWS. Loosen lock nuts on steering brake control lever stop screws (fig. 138). Adjust screws so distance from face of left brake cover at top of the centerline of the levers is 7 to 7½ inches with levers in forward position (fig. 139). Tighten lock nuts.

(14) ADJUST STEERING BRAKE CONTROL ROD LENGTH. Loosen steering brake control rod yoke jam nuts at top of rods. Position control levers forward against stop screws (J, fig. 138). Adjust yoke so holes in left rod in yoke are alined with hole in left brake shaft lever when center of the lever hole is 4½ inches below edge of differential carrier housing (fig. 139) and brake shoes are in contact with the drum. Insert clevis pin through rod yoke and lever. Install and spread new cotter pin in clevis pin. Tighten control rod yoke nut. Adjust yoke on right control rod so holes in yoke are alined with hole in brake cross shaft left lever when center of the lever hole is 9/16 inch above edge of differential carrier housing (fig.



RA PD 339638

Figure 137 — Adjusting Steering Brake

139) and brake shoes are in contact with the drum. Insert clevis pin through rod yoke and lever. Install and spread new cotter pin in clevis pin. Tighten control rod yoke nut.

(15) ADJUST STEERING BRAKE CONTROL LEVER FREE TRAVEL. Refer to subparagraph **d** (1) above.

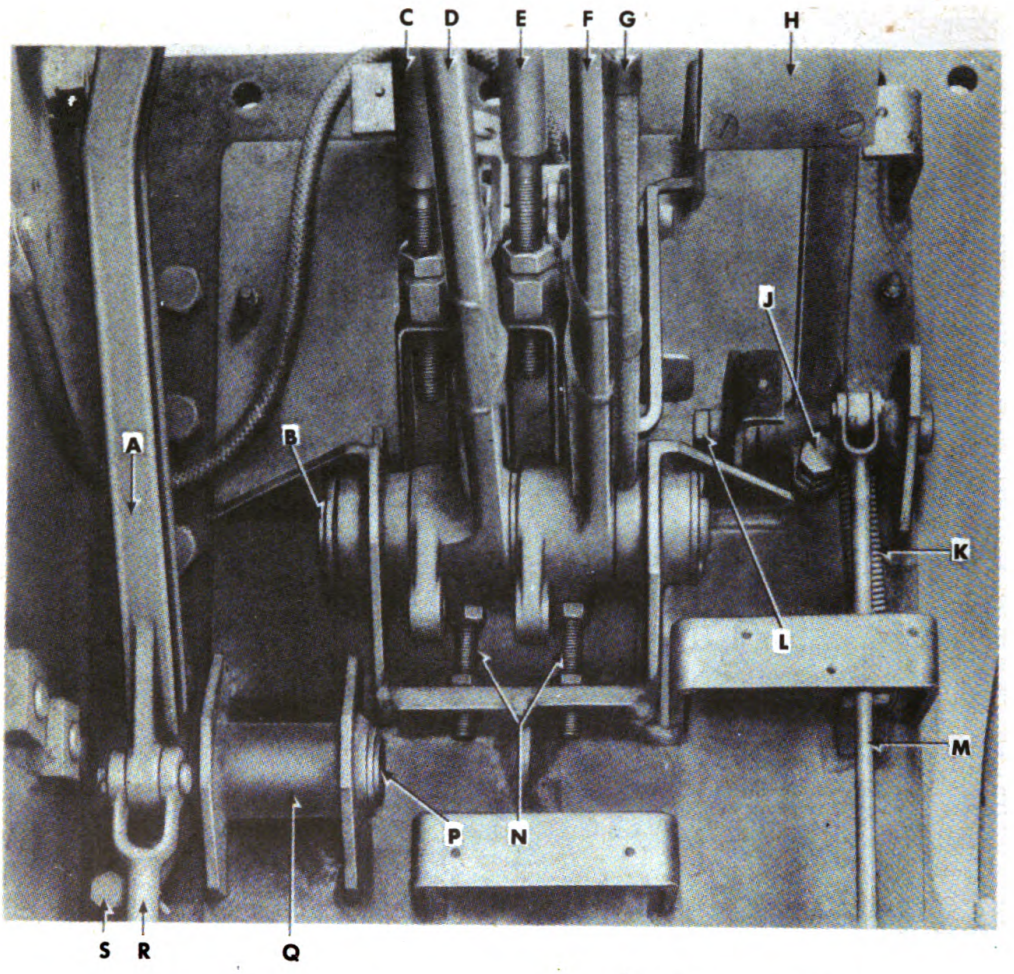
(16) CHECK STEERING BRAKE CONTROL LEVERS FOR EQUAL TRAVEL. Refer to subparagraph **d** (2) above.

(17) INSTALL ADJUSTING HOLE COVERS. Refer to subparagraph **d** (3) above.

(18) FILL POWER TRAIN WITH OIL. Refer to paragraph 33.

140. PARKING BRAKES.

a. Description. The parking brake consists of two toothed quadrants (fig. 136) one on the forward side of each steering brake lever which is engaged by pawls when a foot pedal is operated, thus holding the steering brake levers in pulled-back position. Kicking the pedal forward sets the brakes, and kicking the pedal back releases them.



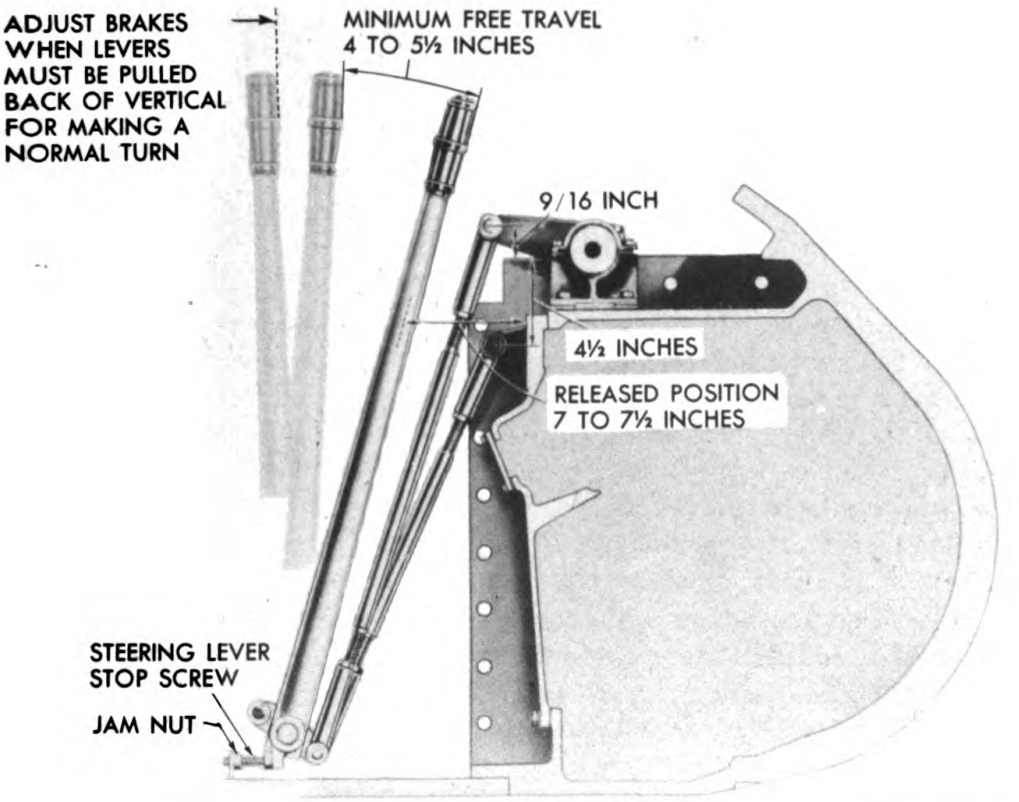
A—CLUTCH PEDAL
B—STEERING LEVER SHAFT
C—LEFT STEERING LEVER ROD
D—LEFT STEERING LEVER
E—RIGHT STEERING LEVER ROD
F—RIGHT STEERING LEVER
G—HORN SWITCH HARNESS
H—FOOT THROTTLE PEDAL
J—PEDAL STOP SCREW
K—PEDAL RETURN SPRING
L—PEDAL SHAFT BOLT
M—FOOT THROTTLE FRONT ROD
N—STEERING LEVER STOP SCREWS
P—CLUTCH PEDAL SHAFT
Q—BRACKET
R—CLUTCH ROD
S—CLUTCH PEDAL STOP SCREW

RA PD 339639

Figure 138 — Clutch Pedal, Steering Brake Levers, and Accelerator Pedal Installations

b. Removal of Brake Lock Mechanism (fig. 136). Kick the brake lock pedal back and push the steering brake levers forward. Pry down and forward on the brake lock pawls to release them. Remove the pawls and extension springs from the brake lock arms.

c. Installation of Brake Lock Mechanism. Assemble the extension springs and the brake lock pawls. Attach the extension springs to the brake lock arms. Force the pawls into position where they



RA PD 339640

Figure 139 — Steering Brake Lever and Brake Shaft Lever Adjustment

are seated at their lower end. Operate the brake lock pedal and steering brake control levers to make sure mechanism is working satisfactorily.

141. STEERING BRAKE CONTROL LEVERS AND LINKAGE.

a. Description. The steering brake levers (K, fig. 6), which are used to steer and stop the vehicle, operate the brake shoes on the two brake drums, one on each side of the differential. The brake is applied when the steering lever is pulled back and the brake shaft levers moves up.

b. Inspect Steering Brake Lever Free Travel. Steering brake control lever free travel is measured at the tops of the levers (fig. 139). Brake control lever free travel is the distance the lever travels when pulled back (with light pressure only) from fully released position until the brake shoes are felt to seat against the brake drum. On double-anchor brakes, the recommended minimum free travel is 4 to 5½ inches. When, due to lining wear, the free travel has increased sufficiently to allow the control lever to come back of the

vertical position before the shoes contact the drum, a minor brake adjustment must be made (par. 139 d).

c. Removal of Controls and Linkage.

(1) REMOVE DRIVER'S FLOOR PLATE. Remove driver's seat. Remove floor attaching screws; then lift out the floor plate.

(2) REMOVE HORN SWITCH. Remove two stud nuts which attach horn switch to right steering brake lever (fig. 58), remove three conduit clamps (fig. 124), and lay switch and conduit aside.

(3) REMOVE STEERING BRAKE LEVERS AND RODS. Disconnect both brake rods at brake arms by removing cotter pins and clevis pins. Disconnect accelerator rod at accelerator pedal (fig. 124) and cross shaft tube; then pull rod back to provide clearance for removal of steering brake lever shaft (fig. 129). Remove cotter pin and flat washer at left end of steering brake shaft. Tap shaft out, being sure that spacers between levers and at end of shaft are not lost. Lift out levers with attached rods. Remove brake rods from brake levers by removing cotter pin and clevis pins.

(4) REMOVE STEERING BRAKE CONTROL RODS. Remove yoke pins which connect steering brake control rods to cross shaft lever and left brake shaft lever (fig. 129). Lift out control rods. CAUTION: *Do not change the length of the rods by adjusting the yokes except when making major adjustments (par. 139 e).*

(5) REMOVE STEERING BRAKE CROSS SHAFT LEVERS. Remove steering brake lever screws and lock washers. CAUTION: *Pull screws all the way out.* Tap brake cross shaft levers from ends of cross shaft and brake operating shafts.

d. Installations.

(1) INSTALL STEERING BRAKE CROSS SHAFT LEVERS. Slide cross shaft levers on serrated ends of brake cross shaft and brake operating left and right shaft. CAUTION: *Make sure reference marks on ends of shafts and on levers are in alinement or brakes cannot be adjusted properly.* Install brake lever screws and lock washers.

(2) INSTALL STEERING BRAKE CONTROL LEVERS AND RODS. Place one spacer on the steering brake shaft and aline the right steering brake lever with hole in bracket. Insert the shaft through the bracket and lever just far enough to allow the other steering brake 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 spacer on the shaft, and the cotter pin in end of shaft. Install the yoke pins which connect the steering brake rods to the steering brake levers (fig. 129). Install the yoke pins which connect the rods to the cross shaft lever and left brake shaft lever. Connect accelerator rod to accelerator pedal and cross shaft tube.

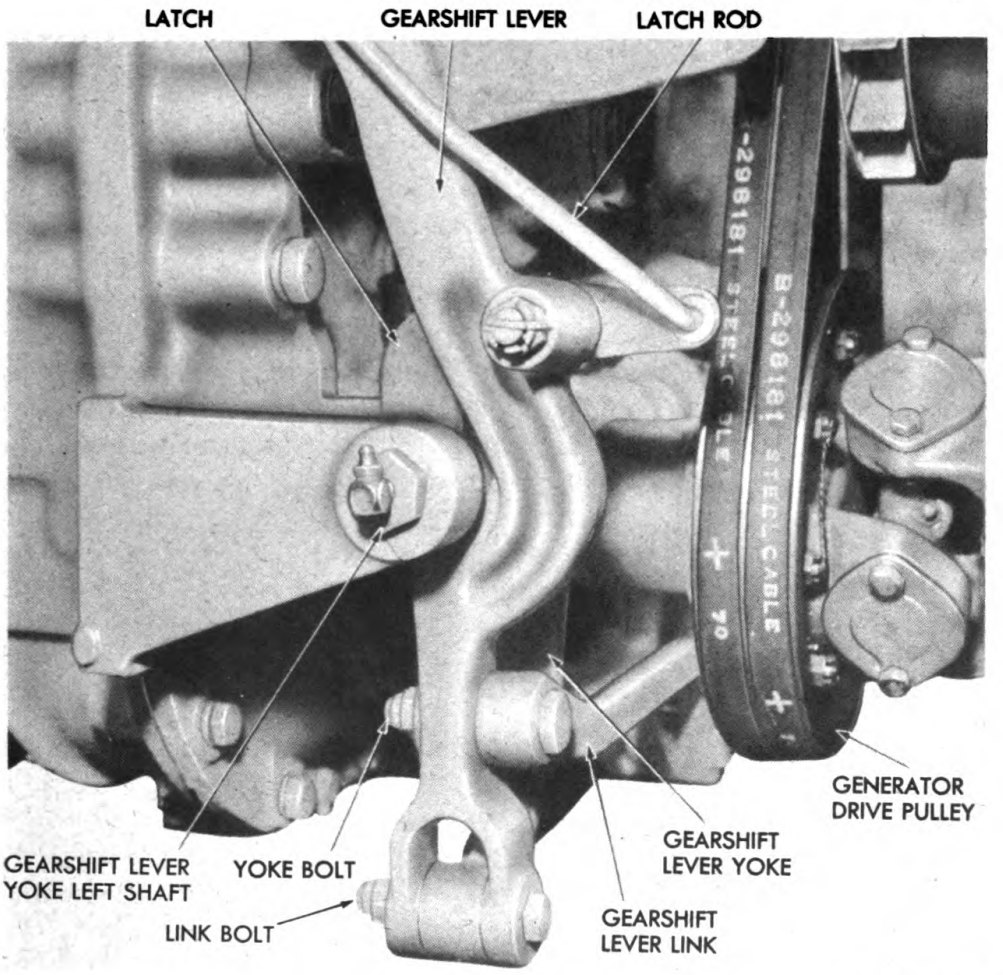


Figure 140 — Gearshift Lever Linkage

(3) INSTALL HORN (SIREN) SWITCH. Attach horn switch and horn conduit to right steering brake lever (fig. 58).

(4) INSTALL DRIVER'S FLOOR PLATE. Position driver's floor on supports and install the attaching screws. Install driver's seat.

142. GEARSHIFT LEVER REPLACEMENT.

a. Removal (fig. 140). Remove gearshift lever yoke nut and bolt. Remove fulcrum link nut and bolt. Remove cotter pin, nut, and flat washer from end of lever shaft. Pull out lever shaft and lift off gearshift lever.

b. Installation (fig. 140). Hold gearshift lever in position and insert lever shaft. Install lever shaft washer, nut, and cotter pin. Attach fulcrum link to gear shift lever with fulcrum link bolt and nut. Install yoke bolt and nut.

143. POWER TRAIN ASSEMBLY LUBRICATION SYSTEM.

a. Description. An oil cooling system is provided to absorb heat generated by the power train gears, and especially by the steering brakes. A cooler, the construction of which is similar to that of an automobile radiator core, is located in front of the bulkhead fighting compartment side (fig. 9). Air is drawn through the cores by the cooling system fans. A curtain can be drawn across the front of the cooler to shut off this circulation of air when slower cooling of the oil is desired. A thermostatic by-pass valve in the inlet opening of the cooler permits the oil to bypass the cooler core by flowing through a header, then back to the transmission when the oil temperature is low. An oil pump mounted inside the transmission draws oil from the sump in the bottom of the differential housing and forces it through an outlet on the side of the transmission case into loose lines and tubes to the cooler. After circulating through the cooler, it flows through tubes and hose lines back to the transmission. From the transmission, the oil passes through openings in the front wall of the transmission case to the differential housing, from which it is again drawn out by the oil pump to begin another cycle. The power train lubricating system has a capacity of 43 gallons.

b. Checking Power Train Oil Level. Before checking the oil level in the power train, the vehicle must be driven sufficiently to warm up the oil, and afterwards must stand on level ground for at least 5 minutes to permit oil to drain back so that the level can be checked accurately. To check the oil level, unscrew and remove filler cap with attached gage and wipe gage with a clean cloth. Insert gage into filler opening so that the cap rests on filler opening. Do not screw cap on. Lift gage out (B, fig. 21) and check level with mark on gage. Oil must be added when required to maintain the level to this mark as instructed on Lubrication Order (par. 32).

c. Draining Power Train Lubrication System. If lubricating oil is to be changed, it must be drained only after vehicle has been driven sufficiently to warm the oil. Provide suitable containers with a capacity of 43 gallons to catch the oil. If the oil is to be used again, the containers must be clean and all drain plugs and surrounding areas must be wiped clean before removing plugs. From beneath vehicle, remove drain plug cover in hull floor. Use transmission drain plug wrench (41-W-878) and remove drain plug from transmission. Beneath each final drive housing, remove the drain plug with final drive plug wrench (41-W-877). Clean magnetic drain plugs, and install and tighten plugs after power train has drained. Install transmission drain plug cover in hull floor.

d. Flushing Power Train Lubrication System. Operate vehicle sufficiently to warm the oil. Drain power train (subpar. **c** above).

Refill power train with 19 gallons of SAE 10 engine oil. Drive vehicle at not over 15 miles per hour for 3 to 5 minutes. Drain flushing oil (subpar. c above). Refill power train (par. 33 and subpar. e below).

e. Refilling Power Train Lubrication System. Unscrew and remove filler cap with attached gage. Fill with grade of engine oil prescribed in paragraph 33. CAUTION: *Do not remove screen. If drained oil is to be used again, it must be thoroughly strained before it is poured into transmission.* Screw filler cap on tightly. Drive vehicle until oil temperature reaches at least 100° F. Stop vehicle on level surface, wait approximately 5 minutes so oil level can be checked accurately, and recheck the oil level (subpar. b above).

f. Transmission and Differential Breather (C, fig. 26).

(1) DESCRIPTION. Breathers are provided for the differential housing and the transmission case to allow entrance of air and to permit escape of air whose volume has been built up by circulation of the lubricant.

(2) SERVICE. Push breather cover down; then tilt it sufficiently to permit removal. Lift breather element out of breather body. Wash breather element with dry-cleaning solvent. Soak element in used crankcase oil or engine oil; then replace element and cover. Lubricate as prescribed in paragraph 33.

g. Oil Cooler (fig. 9).

(1) REMOVAL. Remove cap screws and toothed lock washers which attach guard and screen roll assembly to brackets on bulkhead and lift off assembly. Remove lock wire and loosen hose clamps at inlet and outlet elbows of cooler; then pull hoses of fittings in elbows. Remove nuts and bolts which secure cooler to brackets on bulkhead and lift off the cooler.

(2) CLEANING AND SERVICING. Flush out the cooler with dry-cleaning solvent or Diesel fuel oil. Examine cooler cores for leaks. Replace cooler if badly damaged. Repair small leaks with solder.

(3) INSTALLATION. Attach cooler to brackets of bulkhead with bolts and nuts. Connect hoses to fittings on inlet and outlet elbows. Tighten hose clamps and install lock wire. Attach guard and screen roll assembly to brackets on bulkhead with toothed lock washers and cap screws.

h. Valves and Lines.

(1) BY-PASS VALVE (fig. 9).

(a) Removal. Disconnect oil at inlet elbow. Remove four valve attaching cap screws and lock washers from top of cooler. Lift off by-pass valve and gasket. Unscrew elbow from valve.

(b) Installation. Install elbow in valve. Position gaskets and

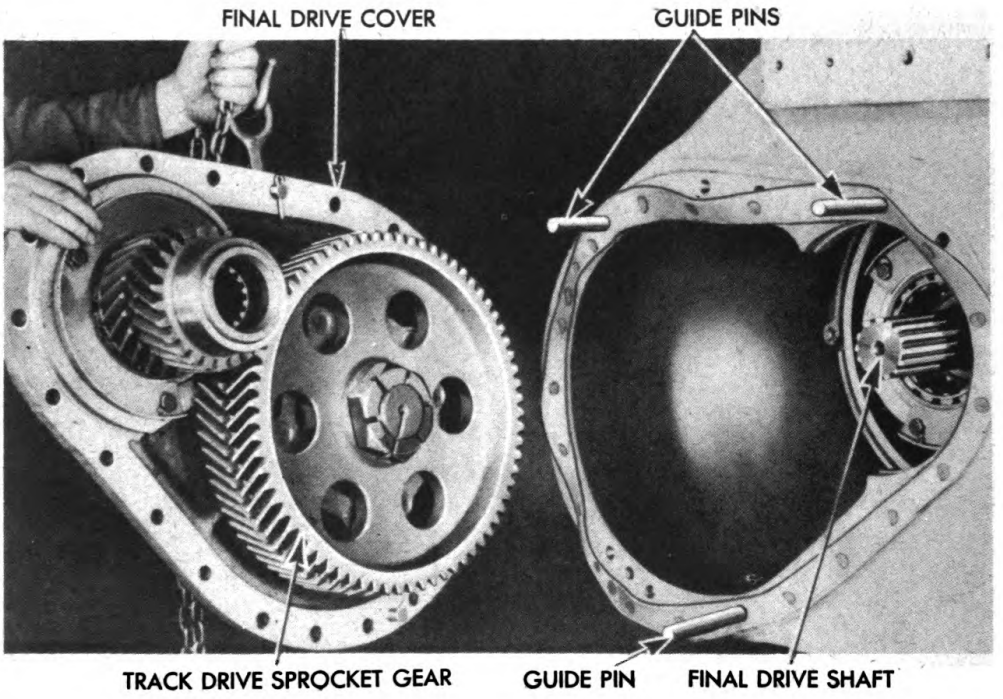


Figure 141 — Final Drive Removed From Differential Housing

attach by-pass valve to top of cooler with lock washer and cap screws. Connect oil hose to fitting in elbow.

(2) OIL COOLER LINES.

(a) Removal. Working through fighting compartment floor plates, disconnect throttle rod from bell crank under rear universal joint. Disconnect rubber hose from tubing at transmission and cooler. Remove clips that attach tubing to hull floor, then lift tubing out through fighting compartment.

(b) Installation. Position tubing on hull floor. Secure tubing to floor with clips. Connect rubber hose to tubes at transmission and cooler. Connect throttle rod to bell crank under rear universal joint.

(3) SCREEN ROLL ASSEMBLY REPLACEMENT (fig. 9). To remove the screen roll, remove the cooler guard attaching cap screws and toothed lock washers, and lift off the guard with attached screen roll. Remove four nuts and bolts which attach screen roll to cooler guard. Lift off the screen roll. To install, attach screen roll to cooler guard; then attach the assembly to brackets on the bulkhead with toothed lock washers and cap screws.

144. FINAL DRIVE REPLACEMENT.

a. General. Final drive assemblies can be removed, and installed, with the power train assembly in the vehicle.

b. Removal (fig. 141). Drain transmission and final drive assembly (par. 143 **c**). Disconnect track below sprocket (par. 150 **g**) and remove sprocket and hub assemblies (par. 151 **c**). Support final drive assembly with a hoist to take the weight off the cap screws. Remove one cap screw and lock washer from each side at top of flange and one cap screw and lock washer from bottom of flange. Thread a long guide pin into each of these cap screw holes, so final drive cover can be drawn squarely off the differential housing. Remove remaining cap screws and lock washers and pry final drive cover off the two dowel pins. Pull final drive assembly out squarely on the long guide pins until the pinion is completely disengaged from the splines on the final drive shaft in the differential housing. Remove final drive to differential housing gasket.

c. Installation (fig. 141). Position a new gasket around opening in differential housing. See that guide pins used in removal of the assembly are in position. Raise final drive assembly with a hoist, slide over the three guide pins, and mesh splines on final drive shaft with splines in final drive pinion. Install at least four of the attaching lock washers and cap screws, spacing them equally around the flange. Tighten cap screws to pull the assembly into position. Remove guide pins and install remaining lock washers and cap screws. Install sprocket and hub assembly (par. 151 **f**) and connect the track (par. 150 **g**). Install lubricant (par. 33 and 143 **e**).

145. POWER TRAIN ASSEMBLY REMOVAL.

a. Remove Front Sand Guards and Fenders. Release 10 lock screws and remove one cap screw and toothed lock washer attaching front sand guard to center guard, hull, and front fender. Loosen two final drive cover cap screws which retain front sand guard to final drive cover, and lift off the front sand guard. Remove nuts, bolts, cap screws, and lock washers which attach front fender to hull and power train housing, and lift off fender. Remove opposite front sand guard and fender in the same manner.

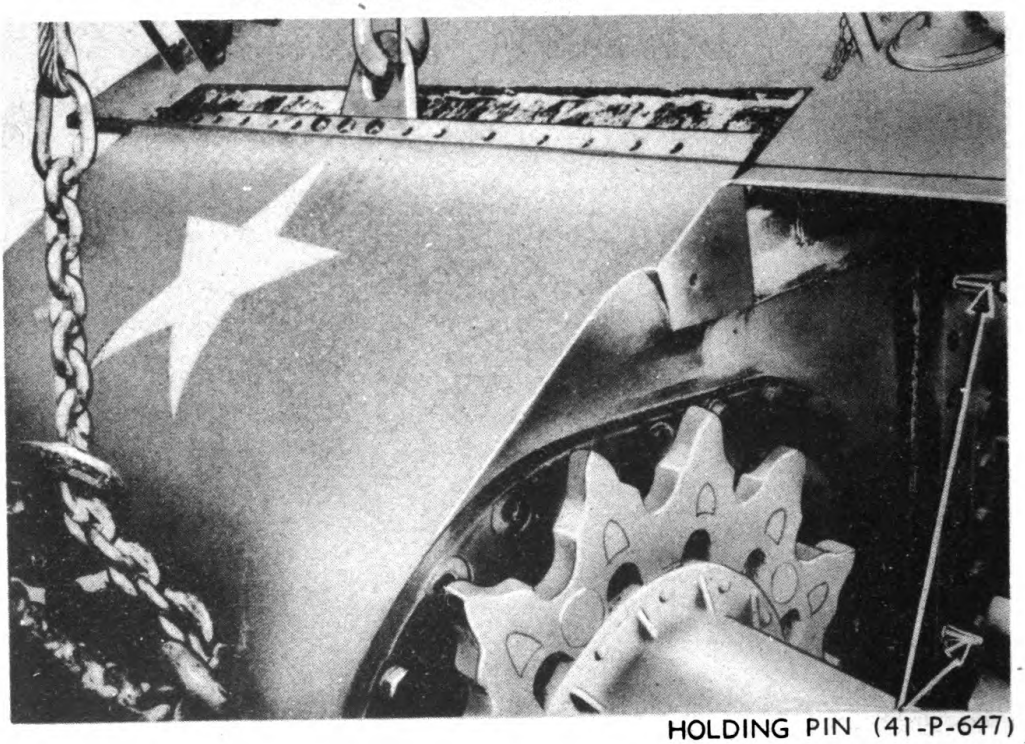
b. Disconnect Tracks on Both Sides. Refer to paragraph 150 **g**.

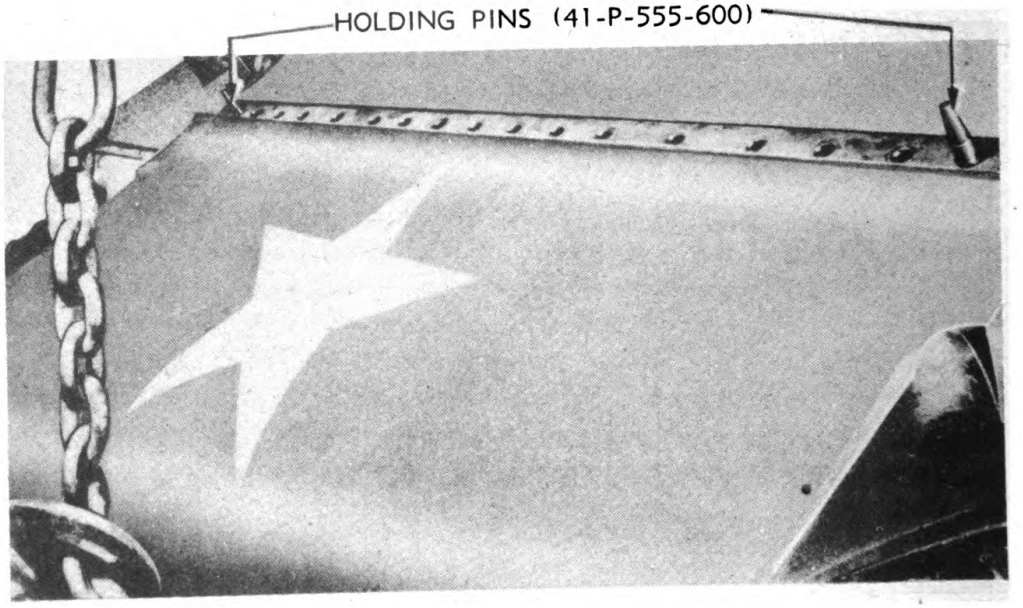
c. Drain Transmission and Final Drive Assembly. Refer to paragraph 143 **c**.

d. Remove Sprocket and Hub Assemblies. Refer to paragraph 151 **c**.

e. Remove Drivers' Seats. Remove four stud nuts which secure base of seat to floor plate and lift out seat.

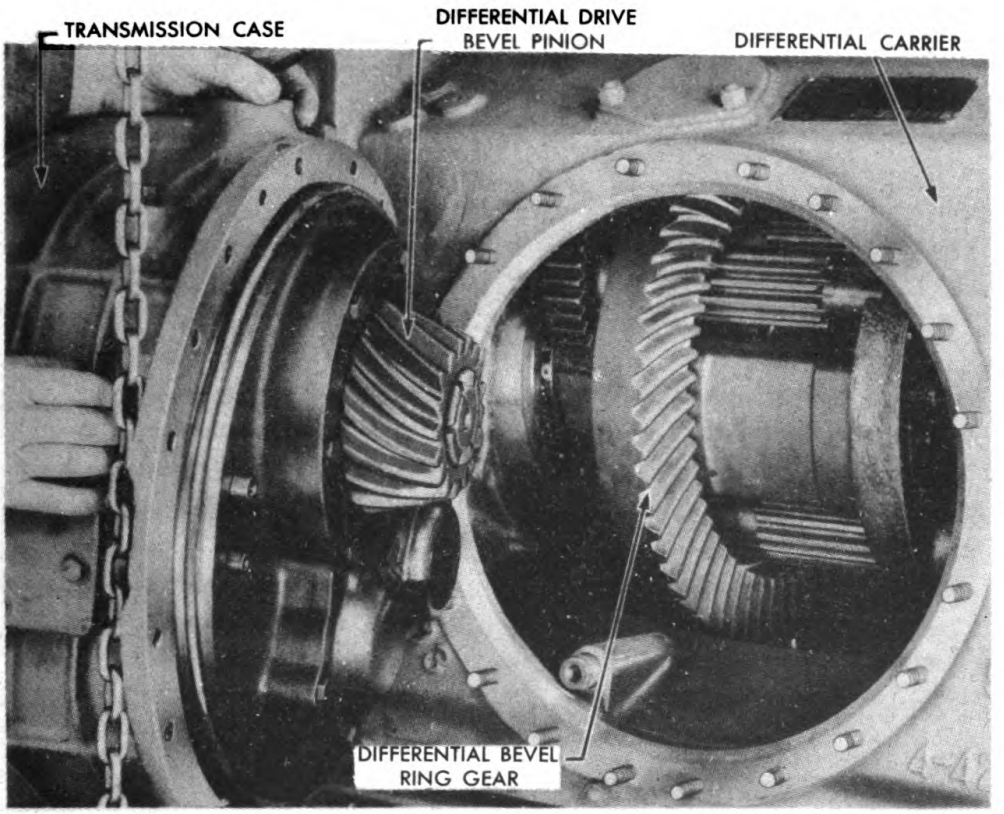
REMOVING AND REPLACING
FIXTURE (41-F-2997-220)





RA PD 339642

Figure 142 — Removing Power Train Assembly



RA PD 35901

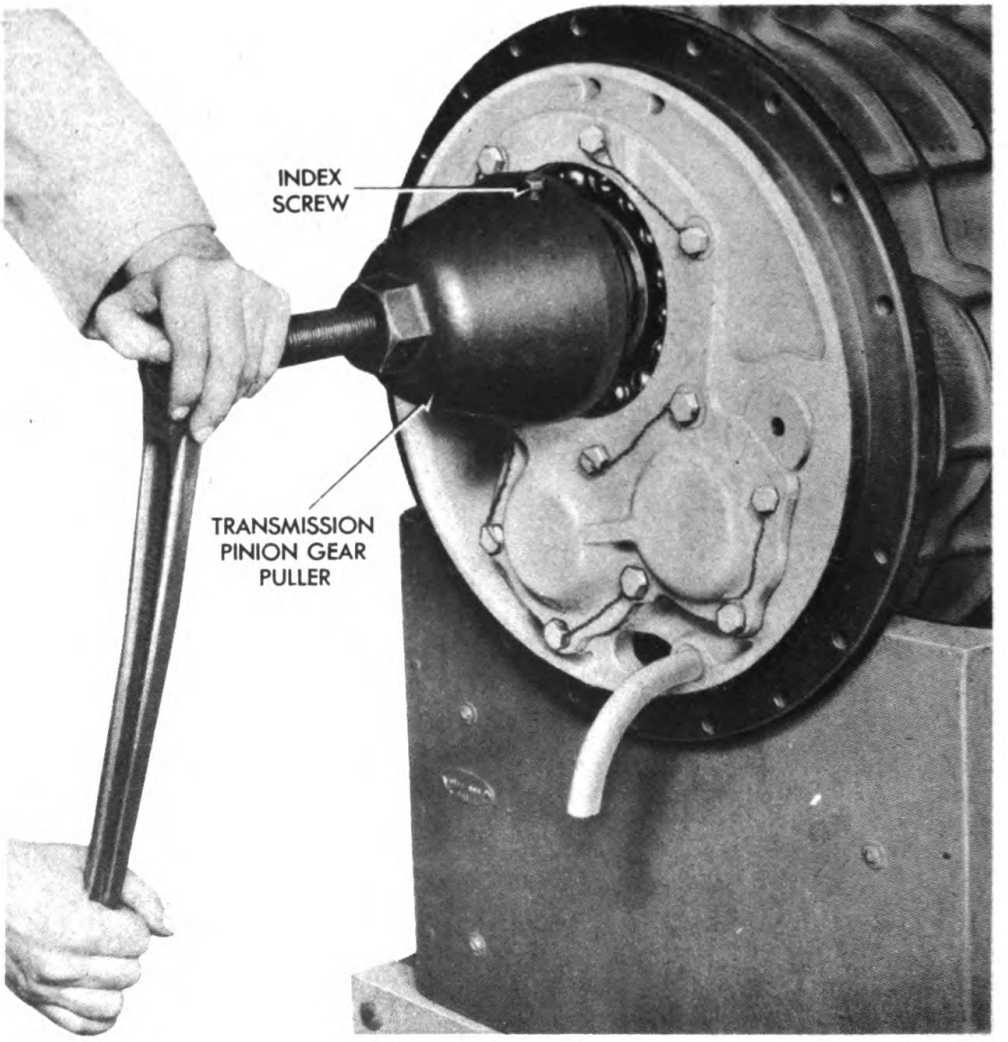
Figure 143 — Removing Transmission From Differential

f. Disconnect Tachometer and Speedometer Cables. Back off knurled nuts which secure cable housings to adapters. Pull cables out of adapters. Remove nuts, bolts, and clamps which secure cable housings to top of transmission case.

g. Disconnect Transmission to Cooler Oil Hose. Loosen hose clamps at elbows extending from left side of transmission case and pull hose off elbows.

h. Remove Priming Pump and Hand Throttle (fig. 58). Loosen lock nut on hand throttle bracket, and lay hand throttle and cable aside. Remove primer line clamp from transmission case and disconnect both primer lines near bottom left side of transmission. Remove three cap screws and lock washers which secure priming pump and hand throttle bracket to power train housing. Lift off the bracket with priming pump and lines attached.

i. Remove Stowage Boxes. Remove four cap screws and lock washers which attach stowage tray to transmission. Replace cap screws.



RA PD 322672

Figure 144 — Removing Pinion Gear With Puller (41-P-2956-12)

j. Remove Fire Extinguisher and Oilcan Stowage Brackets. Remove screws securing brackets and remove brackets.

k. Disconnect Steering Brake Rods. Remove the two clevis pins at the top of the steering brake rods and pull both rods back.

l. Remove Horn Switch Conduit. Remove cap screw and lock washer which secures horn switch conduit clamp to bottom of left brake inspection plate.

m. Disconnect Front Universal Joint and Generator Drive Pulley (fig. 140). Remove generator drive belt covers. Loosen gen-

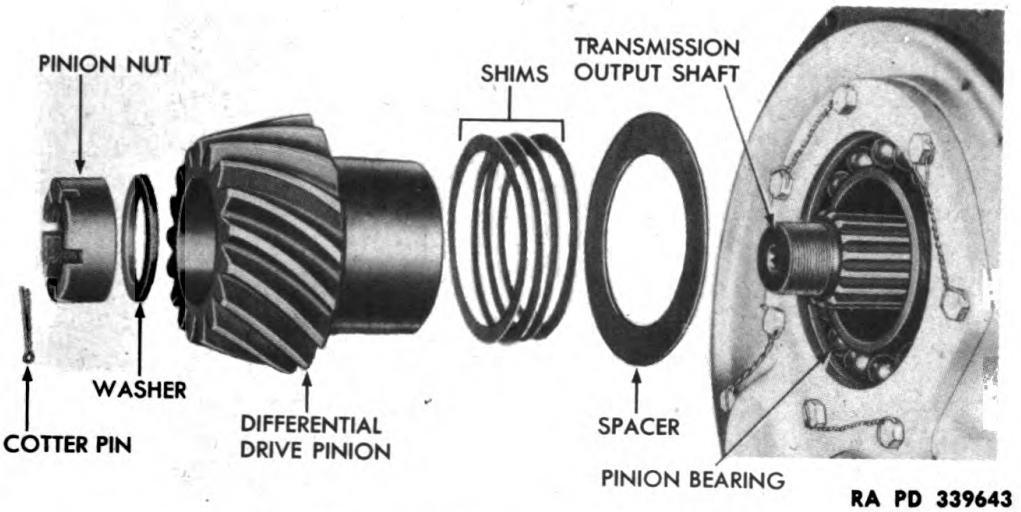


Figure 145 — Pinion Gear Removed From Transmission

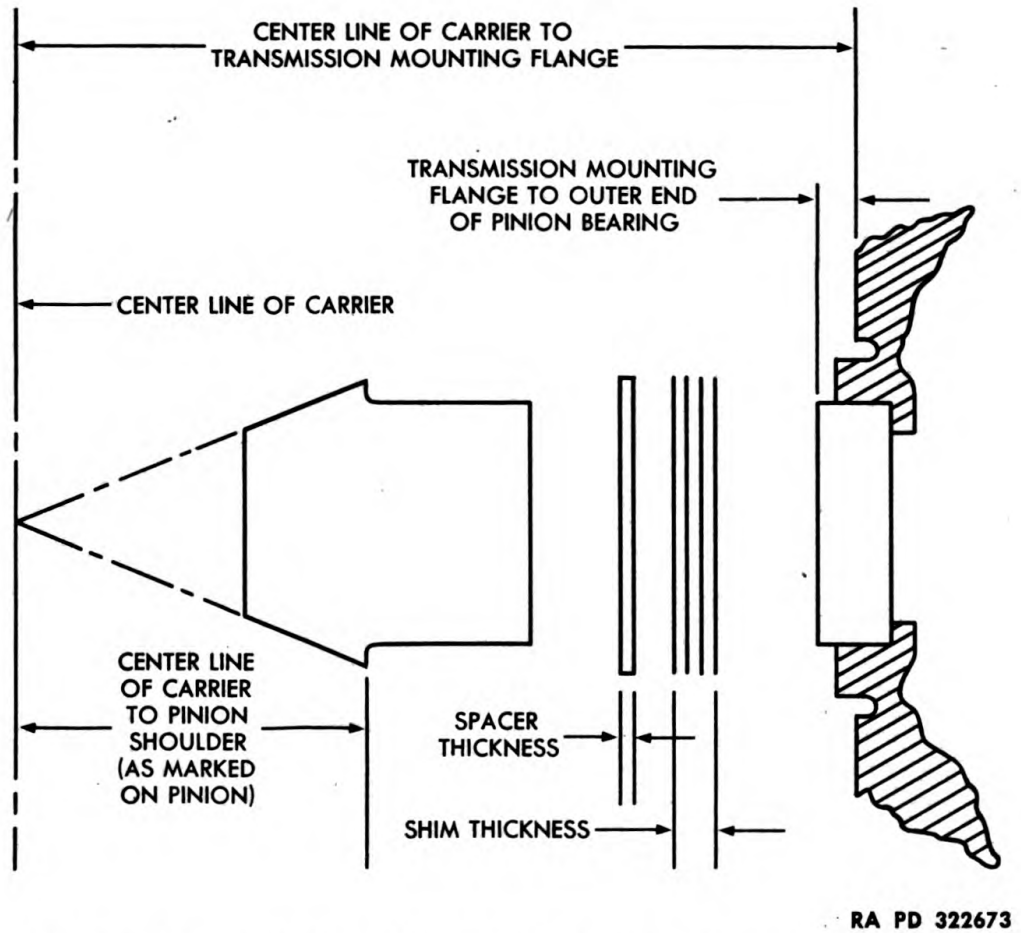


Figure 146 — Instruction Drawing for Determining Shim Thickness Between Transmission Pinion and Bearing

erator belt adjusting nut to relieve tension on belts. Mark position of transmission input shaft flange and front universal joint so they may be assembled in the same relative position. Remove safety wire and front universal joint to transmission input shaft flange nuts. Tap bolts back until they are out of the input shaft flange.

n. Remove Transmission and Final Drive Assembly (fig. 142). 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 small alining pins of special fixture (41-F-2997-220) in the holes. Attach a chain to 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 chain, and take up the slack. Remove all the bolts which secure 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 center top edge of the power train (fig. 142). Hitch the wrecker boom cable to the fixture, drive out the alining pins, and carefully remove the assembly. Guide the assembly from inside the vehicle to prevent damaging the oil tubes.

146. DIFFERENTIAL OR TRANSMISSION REPLACEMENT (POWER TRAIN ASSEMBLY OUT OF VEHICLE).

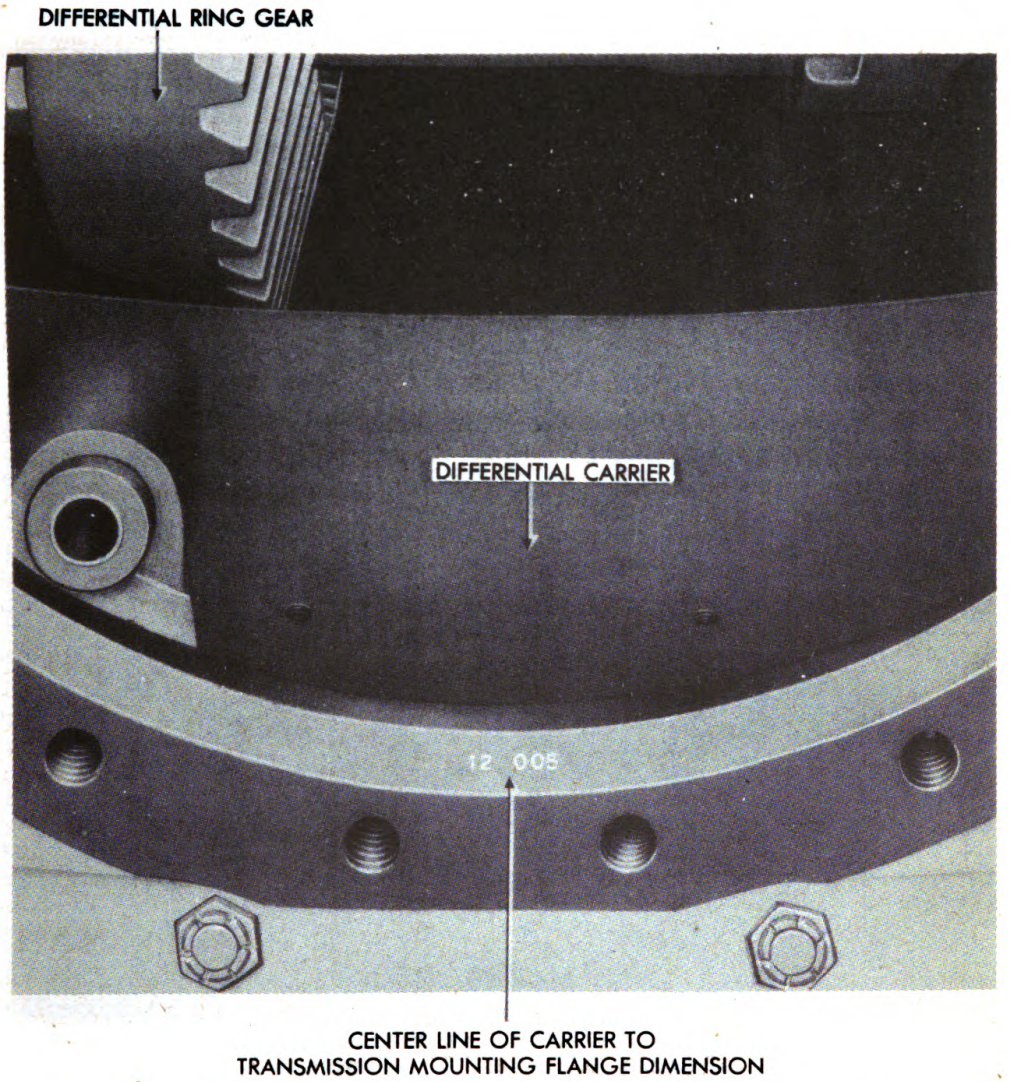
a. General. Whenever a new transmission is assembled to a differential carrier, the pinion gear must be removed and the proper amount of shims installed between the pinion gear and the pinion bearing of the transmission. This is necessary to seat the pinion at the correct depth in the teeth of the differential ring gear. **NOTE:** *This operation is not necessary if a transmission is removed and then reinstalled to the same differential carrier.*

b. Remove Final Drives (par. 144 b). **NOTE:** *Omit this step for transmission replacement.*

c. Remove Transmission From Differential (fig. 143). 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 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 gaskets.

d. Remove Transmission Pinion Gear (fig. 144). Remove cotter pin from end of pinion shaft (fig. 145). Remove pinion shaft nut (fig. 145) and lift out pinion shaft washer. Pull off pinion gear, using gear puller (41-P-2956-12) as shown in figure 144. Lift off shims and spacer.

e. Determine Required Thickness of Shims Between Pinion and Pinion Bearing (fig. 146). The following dimensions must be obtained to determine the number of shims required:

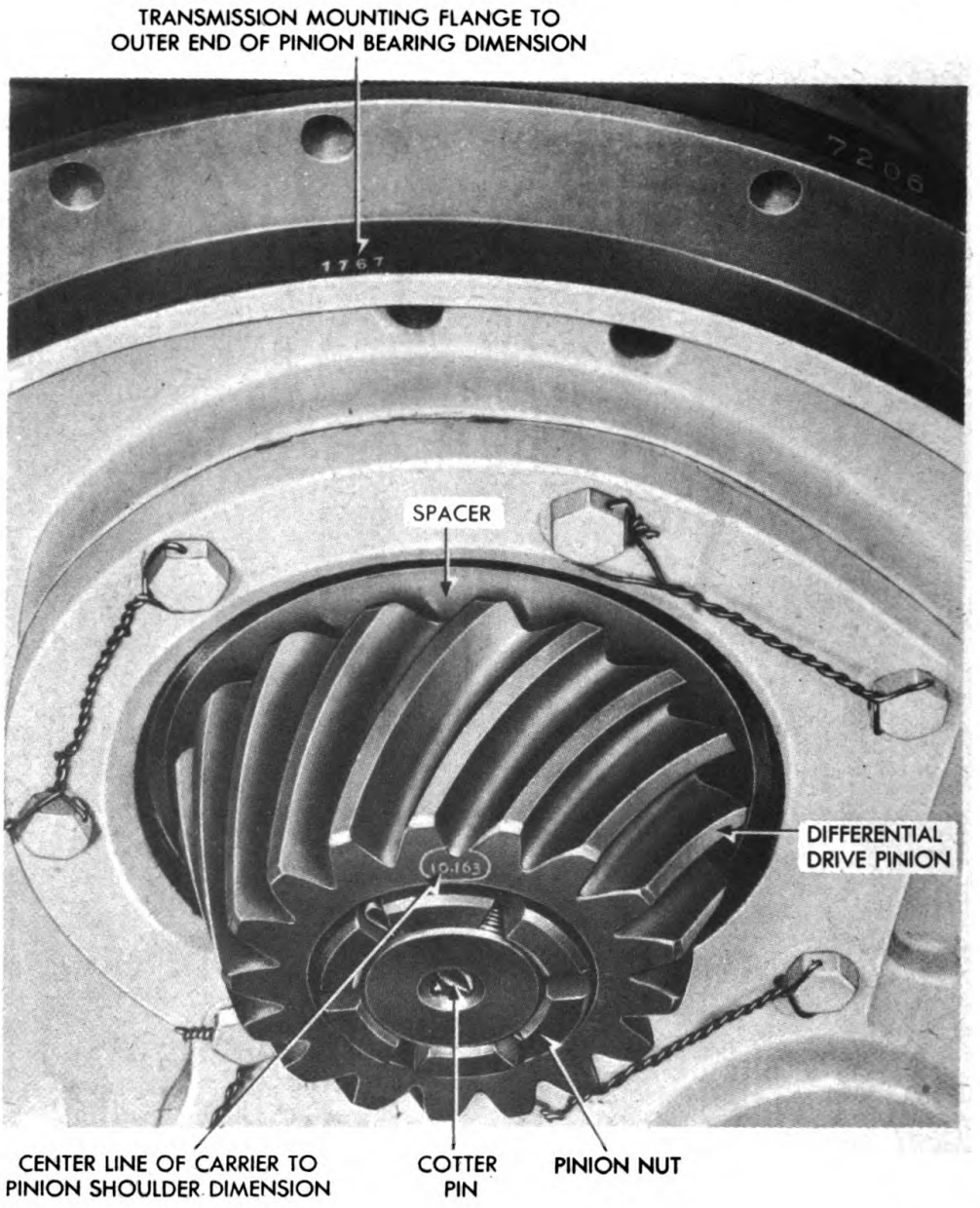


RA PD 339644

Figure 147 — Dimension Marking on Differential Case

(1) CENTERLINE OF CARRIER TO TRANSMISSION MOUNTING FLANGE. This dimension is normally 12 inches. Each carrier will have a figure stamped somewhere on the machined surface to which the transmission is attached (fig. 147). 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.

(2) CENTERLINE OF CARRIER TO PINION SHOULDER. This dimension is marked on the toe of the pinion with an electric pencil (fig. 148).



RA PD 339645

Figure 148 — Dimension Marking on Pinion and Transmission Case

(3) SPACER THICKNESS. Measure spacer thickness with a micrometer. (The usual measurement is 0.020 inch.)

(4) TRANSMISSION MOUNTING FLANGE TO OUTER END OF PINION BEARING. This dimension is stamped on the transmission case (fig. 148) 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*

RA PD 339646

Figure 149 — Using Transmission to Differential Shim Checking Gage (41-G-217-150)

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, the correct dimension is obtained as follows:

(a) Hold the short legs of the shim checking gage (41-G-217-150) firmly against the outer face of the inner bearing race (fig. 149). 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 shim checking gage (1.773 inch).

(b) 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 shim checking gage (1.773 inch).

(c) 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 inch as etched on the side of the gage. CAUTION: *When using this gage, make certain that the pinion bearing cap bolts are tight, thus holding the pinion bearing securely in place.*

f. Final Computation. The following example shows the method of determining required shim thickness:

Centerline of carrier to transmission mounting flange (step (1) above and figure 147)	12.005 in.
–Transmission mounting flange to outer end of pinion bearing (step (4) above and figures 148 and 149)	1.767 in.
	=10.238 in.
Centerline of carrier to pinion shoulder (step (2) above and figure 148)	10.163 in.
+Spacer thickness (step (3) above)	0.020 in.
	=10.183 in.
Difference of two calculations: 10.238 – 10.183 =	0.055 in.
Subtract extra clearance allowance	*0.005 in.
Shim thickness required	0.050 in.

*This extra clearance value is constant, and is 0.005 inch in any problem.

g. 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. 145). Spread cotter pin at center (fig. 148).

h. Install Transmission to Differential. Position rubber gasket around transmission mounting 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.

i. Install Final Drives. Refer to paragraph 144 c if final drives were removed when replacing differential.

j. Record Installation of Transmission or Differential. Make proper entry on W.D., A.G.O. Form No. 478, MWO and Major Unit Assembly Replacement Record whenever transmission and/or differential assemblies are removed or replaced.

147. TRANSMISSION AND FINAL DRIVE INSTALLATION.

a. Install Transmission and Final Drive Assembly (fig. 142). Place the two long spacer shims in position in each side of the hull with sealing compound, and insert two bolts through the hull so the threaded ends of the bolts enter the shims far enough to prevent them from falling out of place. Apply sealing compound to other contacting surfaces. Attach the lifting fixture (41-F-2997-220), chain, and wrecker to the power train. Move the wrecker, with the assembly suspended, to the hull opening, and aline the assembly with the hull. Back 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 small alining pins in the lower holes (one on each side) making sure the pins pass through the hull and the power train holes. Suspend the weight of the power train from the winch cable which is hitched to the towing clevises. Slack off the boom winch cable and remove the lifting eye. Tilt the power train back until the top edge is fitted into the hull. Insert the two large alining pins of special lifting fixture (41-F-2997-220) through holes along the top edge of the hull in order to aline the holes.

b. Connect Front Universal Joint and Generator Drive Pulley. Line up marks on transmission input shaft flange and front universal joint by depressing clutch pedal, and turning propeller shaft if necessary. Tap bolts through bolt holes in input shaft flange. Install nuts and lock wire. Adjust generator drive belts (par. 99 b).

c. Secure Horn (Siren) Switch Conduit. Attach horn switch conduit to bottom of left brake inspection plate with conduit clamp, inspection plate cap screw, and toothed lock washer.

d. Connect Steering Brake Rods. Connect steering brake rods to levers with clevis pins and cotter pins (par. 139 e (14)). Check steering brake linkage and adjust if necessary.

e. Install Stowage Boxes and Stowage Brackets. Attach stowage boxes to transmission with lock washers and cap screws. Secure fire extinguishers and oilcan brackets to floor with screws.

f. Install Priming Pump and Hand Throttle (fig. 58). Secure priming pump and hand throttle bracket, with attached pump and lines, to power train housing with lock washers and cap screws. Connect primer lines near bottom left side of transmission; then clamp lines to transmission case with one of the transmission stud nuts. Position hand throttle on bracket and install lock nut.

g. Connect Transmission to Cooler Oil Hose. Secure oil hose to elbows extending from transmission with hose clamps.

h. Connect Tachometer and Speedometer Cables. Insert cables into adapters; then secure cable housings to adapters with knurled retaining nuts. Attach cable housings to ridge on top of transmission case with clamp, bolt, and nut.

i. Install Drivers' Seats. Position drivers' seats over studs on floor and install stud nuts.

j. Install Sprocket and Hub Assemblies. Refer to paragraph 151 f.

k. Connect Tracks on Both Sides. Refer to paragraph 150 g.

l. Install Front Sand Guards and Fenders. Attach front fenders to power train housing and hull with lock washers, cap screws, bolts, and nuts. Attach front sand guards to center guard, front fender, hull, and to the final drive covers.

m. Install Towing Cable. Install towing cable in its stowage position on right side of vehicle. Secure end of cable to power train housing with hinged retaining clamp.

n. Install Lubricant. Refer to paragraphs 33 and 143 e.

o. Record Installation of Power Train. Make proper entry on W.D., A.G.O. Form No. 478, MWO and Major Unit Assembly Replacement Record.

Section XXXI

SUSPENSION AND TRACKS

148. DESCRIPTION.

a. General. The volute spring suspension system (fig. 150) includes the suspension assemblies equipped with vertical volute springs, the rear idler wheels, track drive sprockets and hubs, and the tracks used with this type of suspension. The vehicle is propelled by two endless tracks. The track drive sprockets bolted to the hubs, which are attached to the track drive sprocket shafts at the front, pull the tracks up and over the idler wheels at the rear and lay them down in front of the advancing suspension wheels. The intermediate upper section of each track is supported by the rollers and skids at the top of three suspensions. The vehicle is supported on the six suspensions bolted to the hull. Two large vertical volute springs in each suspension rest on a spring seat which slides up and down in the suspension bracket. The two suspension levers, which rest at each end on the wheel arms, are pivoted at the center on the spring seat bosses. Each pair of wheel arms is supported at the inner end by a gudgeon through the suspension bracket and at the outer end by a gudgeon through the suspension wheel. The suspension wheel

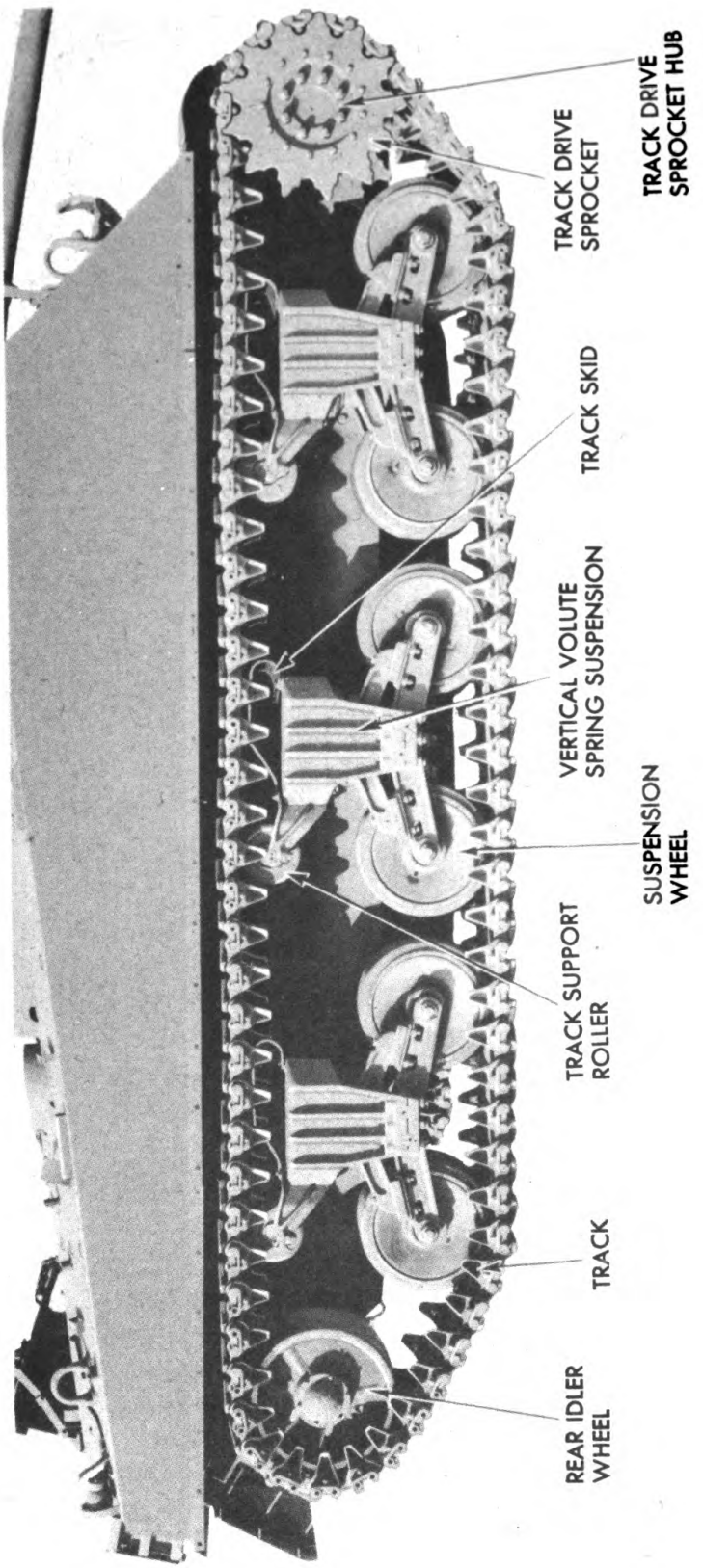
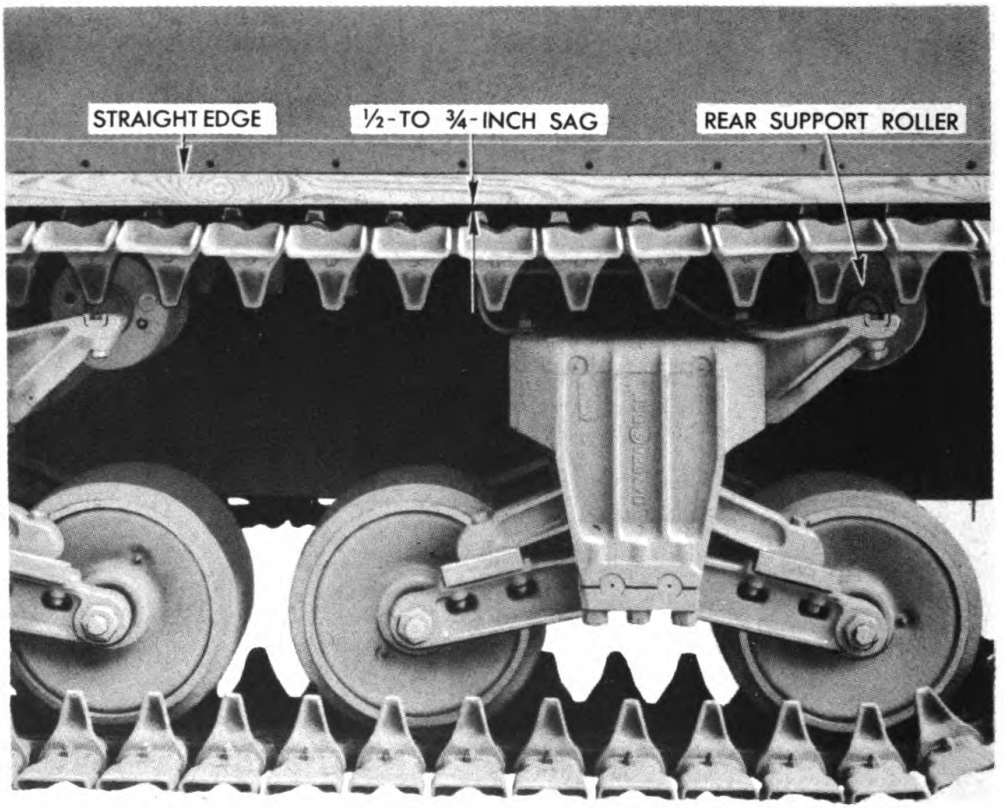


Figure 150 — Volute Spring Suspension System



RA PD 339648

Figure 151 — Using Straightedge to Check Track Tension

rolls on the inner surface of the section of track in contact with the ground. The track is guided by the end connectors as it passes under the suspension wheels and over the idler wheel and rollers. Several different types of interchangeable rubber or steel tracks are available. Only like tracks made up entirely of the same type links must be used on both sides of the vehicle. The proper track tension is maintained by adjusting the position of the rear idler wheel.

149. INSPECTION.

a. General. The suspension system and tracks will be inspected as directed in Preventive Maintenance Services, Section XV. The suggested methods, limit of wear, and corrective measures to be taken for the various components of the suspension system are given in the following subparagraphs.

b. Clean the Suspension and Tracks. The tracks and suspension must be kept as clean as possible. Clean off mud and remove stones, debris, or other material, including ice in freezing weather,

which would interfere with the operation of the tracks and suspension. Clean the parts sufficiently to reveal any exterior damage or wear.

c. Inspect Track Tension. With the vehicle on hard level ground and brakes released, determine the amount of sag in section of track between center and rear track support roller. Use a straightedge (fig. 151) or cord stretched along the top of the track. Measure sag at lowest point through inspection slot in sand shield (fig. 151). If sag is more than ¾ inch or less than ½ inch, adjust track tension as instructed in paragraph 150 **b**.

d. Inspect Track Links. Move vehicle as required to observe inner and outer side of track links. Replace damaged, dead, or excessively worn links (par. 150 **e**). Track links will be considered damaged beyond serviceable limits if the steel blocks are broken or cracked, welds are cracked for more than ½ inch, if chevron on steel tracks is less than 75 percent intact, or in the case of rubber tracks, the rubber has separated or been torn off sufficiently to expose the steel tubes in the block. Links will be considered unserviceable or dead if the rubber bushing extends out around the pin more than 3/16 inch beyond end of block, if track has stretched, if pin bushings have worn so that the center-to-center measurement between the front or rear pin in one link to the front or rear pin in the adjacent link is more than 6⅛ inch (fig. 153), or if pin turns or twists in block so that block drops below level of adjacent blocks when at top of track. Permissible limits of wear on track links vary with the type of link for both domestic or foreign service as shown in the following chart.

TRACK LINK WEAR LIMIT CHART

Track Model	Ordnance Drg. No.	Description	Original		Min. Grouser Hgt. or Shoe Thickness for overseas use (Removal Point)	Min. Grouser Hgt. or Shoe Thickness for domestic use (Removal Point)
			Grouser Height	Shoe Thickness		
T-48	D-48067	Rubber, nonreversible, chevron	1½ in.		1 in.	½ in.
T-51	D-48076	Rubber, non-reversible, smooth block		3¾ in.	3½ in.	2⅞ in.
T54E1	D-58628	Steel, fabricated, chevron grouser	1 in.		⅞ in.	½in.
T-74	D-7067581	Rubber-backed, steel chevron	1 in.		⅞ in.	½in.

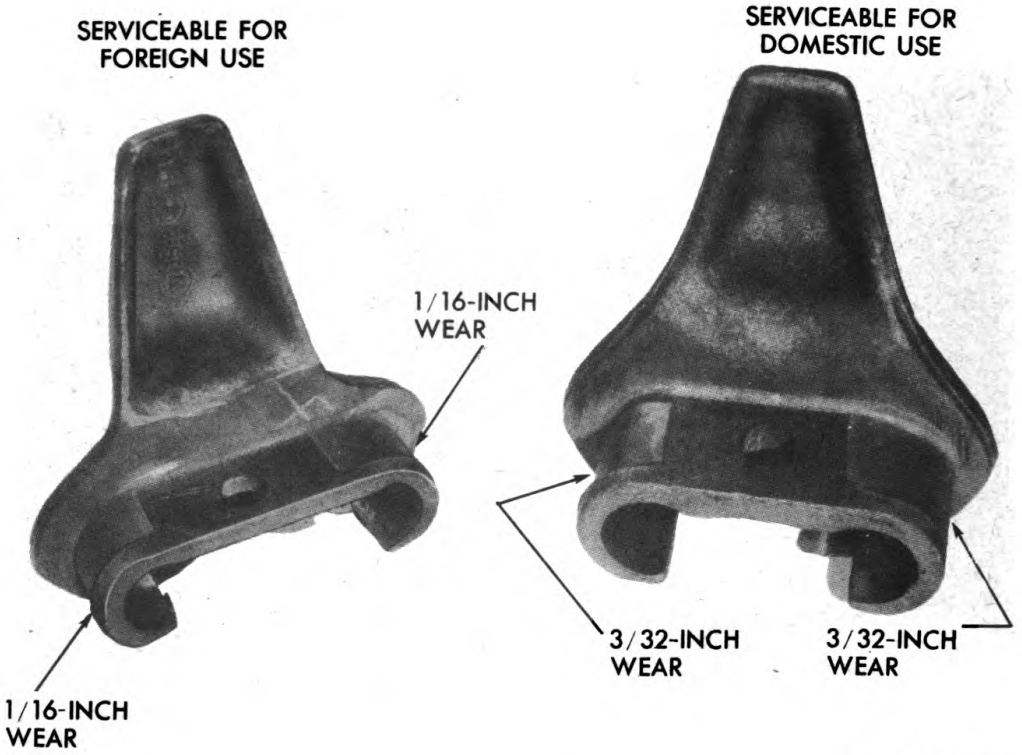
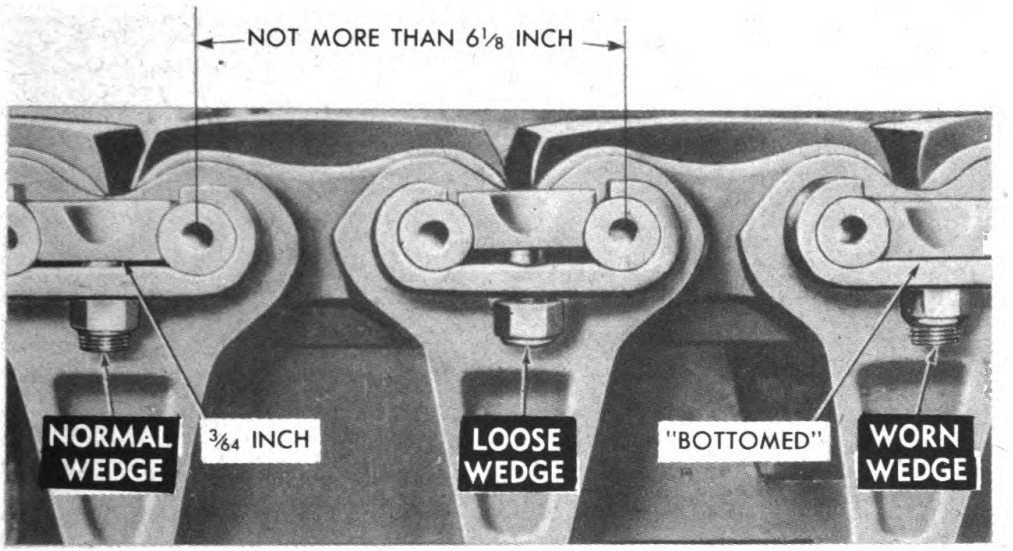


Figure 152 — Worn Track Link Connectors

Replace rubber links when rubber has separated or worn down on the inner surface sufficiently to expose the steel tubes. Replace steel links when inner surface in contact with suspension wheels is worn or "dished" more than $\frac{1}{16}$ inch.

e. Inspect Connectors and Wedges. Move the vehicle as required to observe both sides of the inner and outer track link connectors. Replace any cracked, broken, or bent connectors (par. 150 **c**). Examine the inner guiding surface of the connectors where they contact the support rollers and rear idler wheel. If this surface is cupped or worn to a depth exceeding $\frac{1}{8}$ inch, replace the connector. Also examine the ends of the connectors where they contact the track drive sprocket teeth (fig. 152). Replace connectors in foreign service when wear at this point exceeds $\frac{1}{16}$ inch, and in domestic service if wear exceeds $\frac{3}{32}$ inch. Inspect connector wedges to be sure they are not damaged, excessively worn, or loose. Replace damaged, broken, or missing wedges (par. 150 **c**). Replace excessively worn wedges which, when tightened, are spaced $\frac{3}{64}$ inch or less away from the flange on the connector (fig. 153). Loose wedges can be detected by rapping with a hammer on the nut, the presence of a ring around the nut showing it has been moving, and by excessive gap between the wedge or nut and the connector flange. Tighten loose wedges,



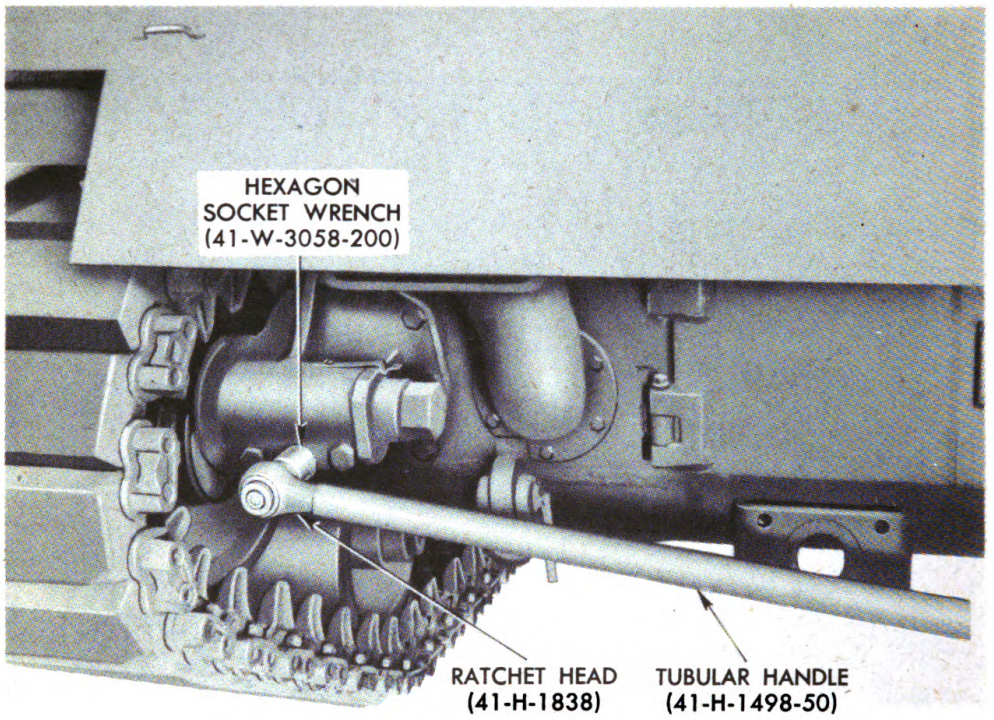
RA PD 339650

Figure 153 — Loose and Worn Connector Wedges

using 80 foot-pounds of torque. When wedges are removed, replace connectors which have enlarged wedge stud hole.

f. Inspect Track Drive Sprockets and Hubs. Examine sprockets for worn, bent, cracked, or broken teeth. Replace damaged sprocket (par. 151). Inspect sprockets for excessive wear. If teeth of one sprocket are worn on driving faces sufficiently to permit the wedge nuts to strike the teeth or bottom between the teeth, remove and reverse the sprockets (par. 151 **d**). If both sprockets on the hub are worn, interchange the hub and sprocket assemblies (par. 151 **d**). Sprocket cap screws and hub nuts must be kept tight. Tighten sprocket cap screws using 100 to 110 foot-pounds of torque. Tighten sprocket hub nuts evenly and securely.

g. Inspect Rear Idler Wheels. Inspect rear idler wheel for bent wheel or spindle, damaged or cracked wheel, and bearing failure. Inspect the flanges on each side of the wheel rim. If the flange shows excessive wear on part of its surface, it indicates the wheel is bent and must be replaced (par. 152 **b**). If the flange on one side is worn much more than the other, the wheel spindle may be bent. Sight along the edges of the wheel rim and if wheel is out of line due to bent spindle, replace spindle (par. 153 **b**). Examine wheel for excessive grease leaks at hub cap or oil retainers at inner side of wheel. If leaking, replace hub cap gasket or oil retainers (par. 152 **b**). Test bearings for excessive end play and wear whenever tracks are removed from idler wheel by spinning and rocking the wheel. Replace worn or damaged bearings (par. 152 **b**). Make



RA PD 339651

Figure 154 — Spreading Idler Wheel Bracket

sure both the lubricating and relief fittings are in good condition. Replace damaged or missing fittings.

h. Inspect Track Support Rollers. Examine track support rollers or brackets. Raise track off rollers, and spin and rock rollers to test bearings for bind, wear, or looseness. Replace unserviceable bearings (par. 162 **b**). Examine rollers for indication of excessive grease leaks at oil retainers. Replace leaking retainers. Make sure lubricating and relief fittings are in good condition. Replace damaged or missing fittings. See that all attaching nuts and cap screws are tight and secure.

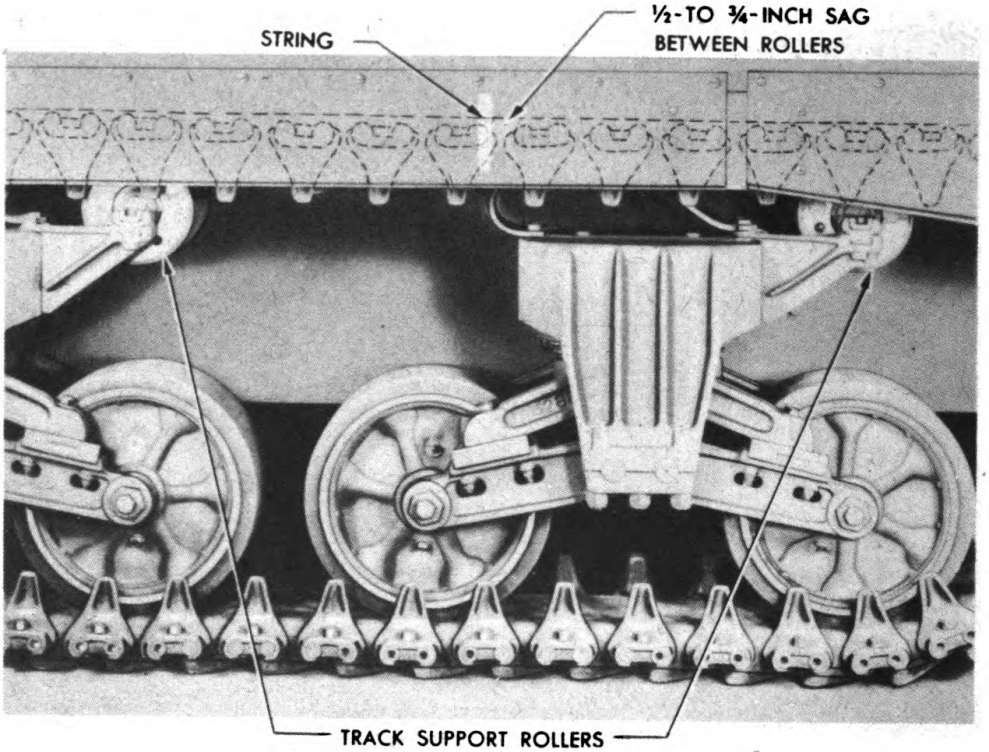
i. Inspect Suspension Wheels. Move the vehicle as required to observe the suspension wheels and tires. Inspect wheels and tires for damage or excessive wear. If tires have deep cuts, grooves, or cracks in the tread, if it has separated from the rim due to blowouts or failure, or if the sidewalls are gouged out by the connectors, replace the suspension wheel (par. 156). If tires are worn so that minimum outside diameter is 19½ inches or less, or tread width is 7 inches or less, replace the suspension wheel. Examine wheels for indication of excessive grease leaks at oil seals. Replace leaking oil

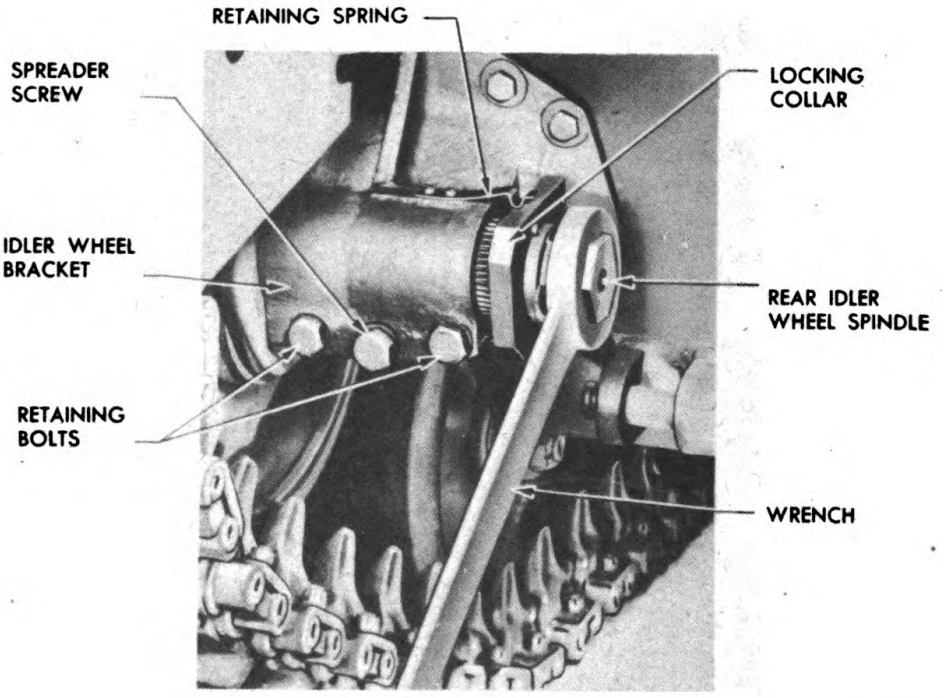
seals (par. 156 **c**). Raise wheels (par. 156 **b** (2)) and spin and rock wheels to test bearings for wear, bind, damage, or looseness. Adjust or replace loose or damaged bearings (par. 156). Make sure lubricating and relief fittings are in good condition. Replace damaged or missing fittings.

j. Inspect Suspension Assemblies. Inspect suspension mounting bracket, arms, levers, springs, and spring seats for cracks, damage, or bent and broken parts. Replace unserviceable parts (par. 157). Examine rubbing plates on arms and levers (fig. 170), and replace excessively worn or damaged plates (par. 159). With vehicle on hard level surface, inspect volute suspension springs for weak or broken springs. If spring has weakened, taken a permanent set, or broken so that either the upper or lower edge of any one coil is even with the same edge of another coil, the spring must be replaced (par. 157). Inspect all gudgeon nuts and attaching cap screws to make sure they are tight. Inspect track skid to make sure it is not damaged and is securely mounted.

150. TRACKS.

a. Description. When new, each track consists of 79 links joined by the track link connectors into an endless tread (fig. 150). Tracks made up of four different types of links are currently used depending on the locale and conditions under which the vehicle is to be operated. These various types of tracks are listed and identified on the track link wear limit chart (par. 149 **d**). The center-to-center measurements between the link pins are identical and, therefore, the same connections and wedges are used with each type link. The T54E1 track is used in production. This type link is made up of a steel block to which a chevron-type hardened steel grouser is welded. Nine rubber bushings are bonded to the pins. These bushings are tightly compressed when the pins are pressed into the two holes bored through the block. The twisting action of the pins as the track bends or flexes is absorbed within the rubber bushings. Slots, cut at an angle in the ends of the pins to receive the tapered wedges, cause the pins to twist the bushings so that the track tends to turn inward as it passes around the sprocket and idler wheel. A metal clip between the second and third bushing on each end of the track pin acts as a bond between the pin and block to dissipate or ground static electricity and thus reduce radio interference. The hardened steel track link connectors join the links together and guide the track as it passes under the suspension wheels and over the support rollers and rear idler wheels. The sprocket teeth engage the replaceable connectors which thus receive the driving wear instead of the link pins. The connectors are held in place by the tapered forged wedges.





RA PD 339652

Figure 155 — Adjusting Track Tension with Wrench (41-W-640-400)

b. Adjust Track Tension.

(1) RELEASE TRACK TENSION. Place vehicle on hard level ground with parking brakes released. Raise and lock exhaust deflector. Assemble wrench for use on bracket retaining bolts and spreader screw by inserting ratchet head (41-H-1838) into tubular handle (41-H-1498-50) and installing socket wrench (41-W-3058-200) on head. Turn the two retaining bolts in the idler wheel mounting bracket counterclockwise several turns (fig. 154). CAUTION: *Do not back the bolts out of threads in bracket.* Turn the spreader screw counterclockwise as required to spread the bracket (fig. 154). CAUTION: *Avoid using force on spreader screw.* Position track adjusting wrench (41-W-640-400) on hex end of spindle (fig. 155). Raise end of adjusting wrench slightly to relieve load on locking collar. Raise the collar retaining spring and drive collar off serrations on spindle. If necessary slide collar back onto serrations to hold spindle while repositioning the adjusting wrench. Turn the spindle until idler wheel is lowered into neutral position and track tension is fully released.

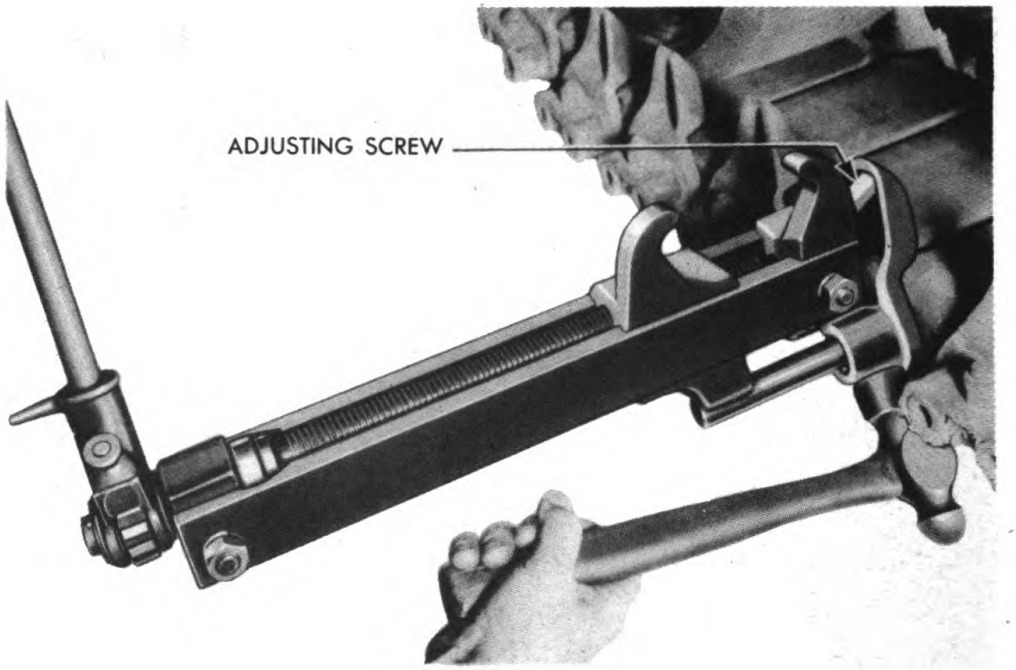
(2) ADJUST POSITION OF IDLER WHEEL. When track tension is properly adjusted, the center of the idler wheel will be below the horizontal and to the rear of the vertical axis of the spindle in the bracket. Stretch a cord along the top of the track (fig. 155), or remove sand shield, if necessary, and place a straightedge on top of the track (fig. 151). Raise adjusting wrench handle until sag at lowest point in track between center and rear track support rollers is not more than ¾ inch nor less than ½ inch.

(3) LOCK IDLER WHEEL SPINDLE. Aline serrations on spindle with locking collar. Raise retaining spring and drive collar onto spindle against bracket. Recheck track tension. Back out spreader screw until it does not project into slot in bracket. Tighten both retaining bolts evenly and securely. Then tighten spreader screw sufficiently to keep it from working loose. Lower and lock exhaust deflector.

c. Replace Track Connectors.

(1) GENERAL. When a different track link connector is to be installed, select one which has been worn nearly equal to the average connector in the track or which has wear equal to the connector on the opposite side of the link. If this is not done, the unequal wear will cause excessive strain on the link pin bushings and wear on the newer connector when it is engaged by the sprocket teeth.

(2) REMOVE TRACK CONNECTOR. Follow procedure in subparagraph g (2) below to remove the connector, except do not release track tension. Install the connector on one side before removing the other connector.



RA PD 339653

Figure 156 — Removing Track Connector With Left-hand Connecting Fixture (41-F-2997-289)

(3) INSTALL TRACK CONNECTOR. Follow procedure in subparagraph g (5) below and install the connector. Check track tension (subpar. b above).

d. Reverse Track Connectors.

(1) GENERAL. When the driving wear on one end of the track connector flanges has reached the serviceable limit (fig. 152), the track connectors will be reversed to equalize the wear by exchanging them with the connectors on the opposite side of the track or by reversing the tracks (subpar. h below).

(2) REMOVE TRACK CONNECTORS. Mark the connectors on one side of the track with paint. Disconnect track at rear idler (subpar. g (2) below) and lay track on the ground in front of vehicle. Remove the connectors from each side of the section of track at the front of the vehicle by driving them off the pins after removing the wedges.

(3) REVERSE AND INSTALL CONNECTORS. Install connectors which were marked and removed from outer side of track on the inner side of the track. Then install the other connectors on the outer side of the track. Connect track sections and move vehicle forward. Repeat operations until all connectors are interchanged.

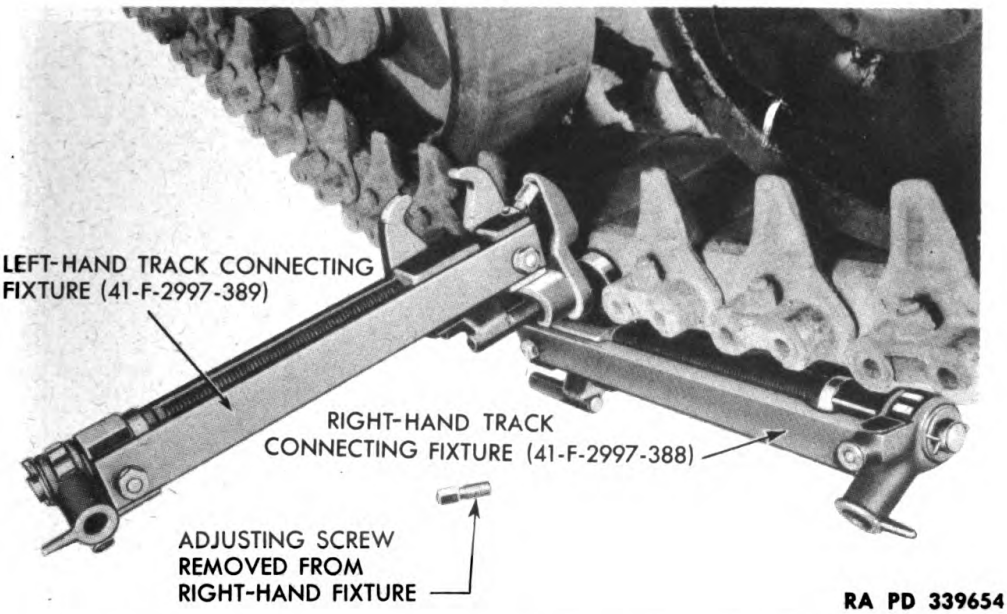


Figure 157 — Holding Link Pins While Pulling Track Connector

Connect track (subpar. g (5) below). Adjust track tension (subpar. b above).

e. Replace Track Links.

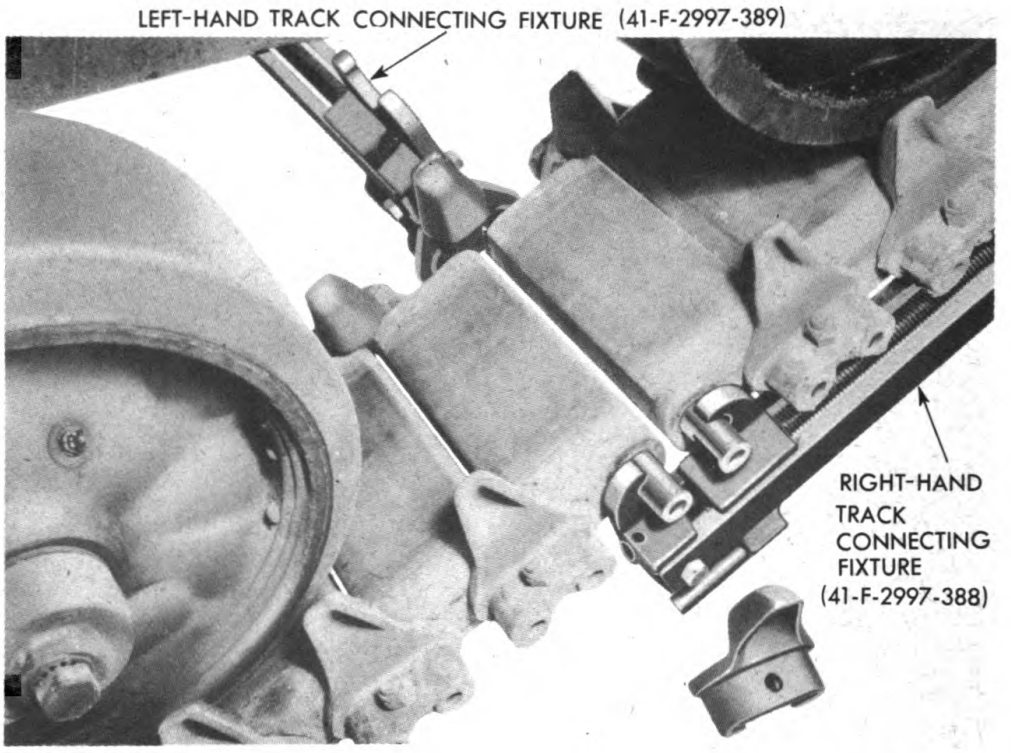
(1) GENERAL. When a different track link is to be installed, select one of the same type having wear nearly equal to the average link in the track. If necessary, trim the tread from new rubber links to the approximate height of the other links in the track. If this is not done, the height of the new link will subject it and the suspension system to excessive shocks and wear and cause the vehicle to ride roughly.

(2) REMOVE TRACK LINK. Move vehicle to position link to be removed midway between rear idler wheel and the ground. Disconnect track (subpar. g (2) below). Remove connectors from the adjacent link by pulling them or driving them off.

(3) INSTALL TRACK LINK. Install the connectors to join the link to the lower end of the track. Connect the track (subpar. g (5) below). Adjust track tension (subpar. b above).

f. Reposition Thrown Tracks.

(1) GENERAL. A thrown track is the term commonly used to mean that the link connectors on one side have climbed up onto the idler wheel or climbed over the teeth on the drive sprocket. The major contributing cause in almost every case is insufficient track tension. If the track has climbed the idler wheel, it often can be repositioned without disconnecting the track. If the track has climbed the sprocket teeth, it must always be disconnected. Pro-



RA PD 339655

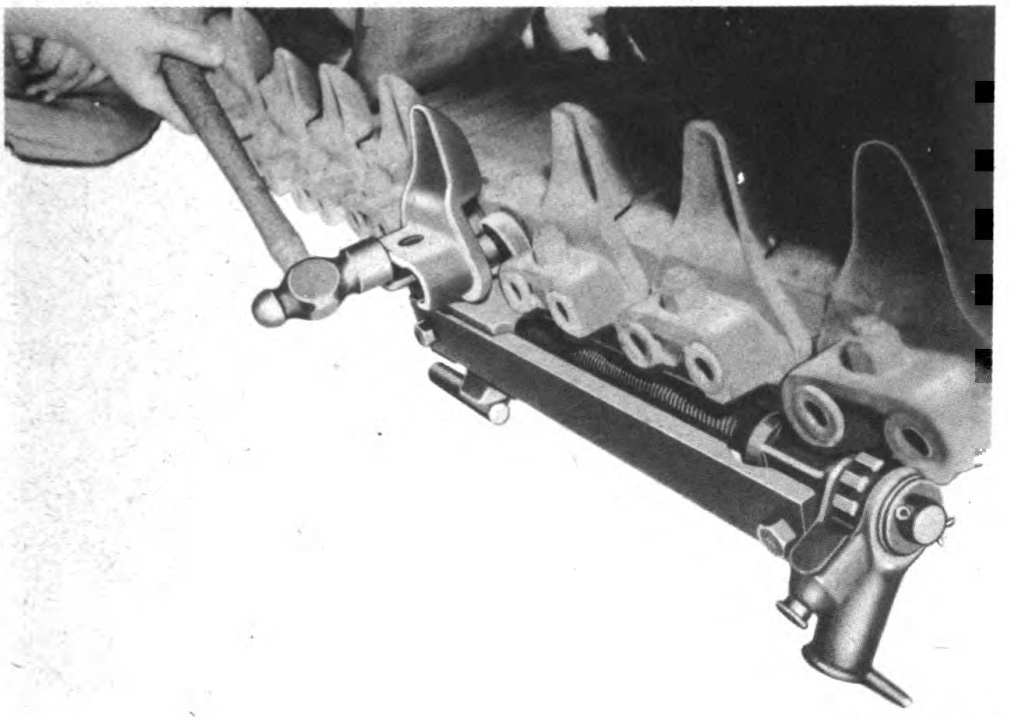
Figure 158 — Pulling Connector on Inner Side of Track

cedure for repositioning a thrown track also depends upon the accessibility of the track in case the vehicle is bogged.

(2) REPOSITION THROWN TRACK. If vehicle is located so that track is not accessible for disconnecting between sprocket and suspension wheel or idler and suspension wheel, disconnect track at the most convenient place. Tow vehicle onto dry solid ground and install track (subpar. **g** below). When vehicle is located so work can be done, release track tension (subpar. **b** (1) above). If the track has climbed idler wheel, try repositioning it with crowbars. If this can be done, then adjust track tension (subpar. **b** above). In case track cannot be repositioned, disconnect track midway between idler wheel and suspension wheel (subpar. **g** (2) below). Then connect track (subpar. **g** (5) below) and adjust track tension. When the track has climbed drive sprocket, disconnect track between drive sprocket and front suspension wheel. Reposition track and adjust track tension.

g. Replace Tracks.

(1) GENERAL. The tracks can be disconnected midway between either the track drive sprockets (fig. 160) or the rear idler wheel and the ground (fig. 158). If the tracks are to be disconnected



RA PD 337079

Figure 159 — Holding Link Pins With Right-hand Connecting Fixture (41-F-2997-388) While Installing Connector

to remove one of the connectors or links, it is usually done at the rear. If the entire track is to be removed, the track is usually disconnected at the front. Remove the fenders and sand shields as required.

(2) DISCONNECT TRACK. Release track tension (subpar. b (1) above). Remove wedge nut from outer wedge and drive out wedge. Install the left-hand track connecting fixture (41-F-2997-389) on the outer track connector as shown in figure 157. Aline the fixture with the link pins to pull connector straight off and take up slack. Secure the fixture in this position by turning the adjusting screw. Operate fixture jack to pull connector about half-way off while striking connector sharply with hammer. Remove adjusting screw from right-hand fixture (41-F-2997-388). Install fixture as shown in figure 157 to hold link pins. Tighten jack until fixture is snug but not enough to bind connector as it is removed. Pull off the outside connector. Remove wedge from inside connector. With right-hand fixture holding outside ends of pins, install the left-hand fixture on the inside connector as shown in figure 158. Pull the connector off to within ½ inch of ends of pins. Remove the left-hand fixture and take out the adjusting screw. Install the fixture to hold the pins together in the same manner as the right-hand fixture in figure

158. Drive the inside connector off the pins. Operate the fixture jacks in unison to separate the track links until track tension is released and fixtures can be lifted off the pins.

(3) REMOVE TRACK. Pull top half of track to the rear of the vehicle and lay it on the ground.

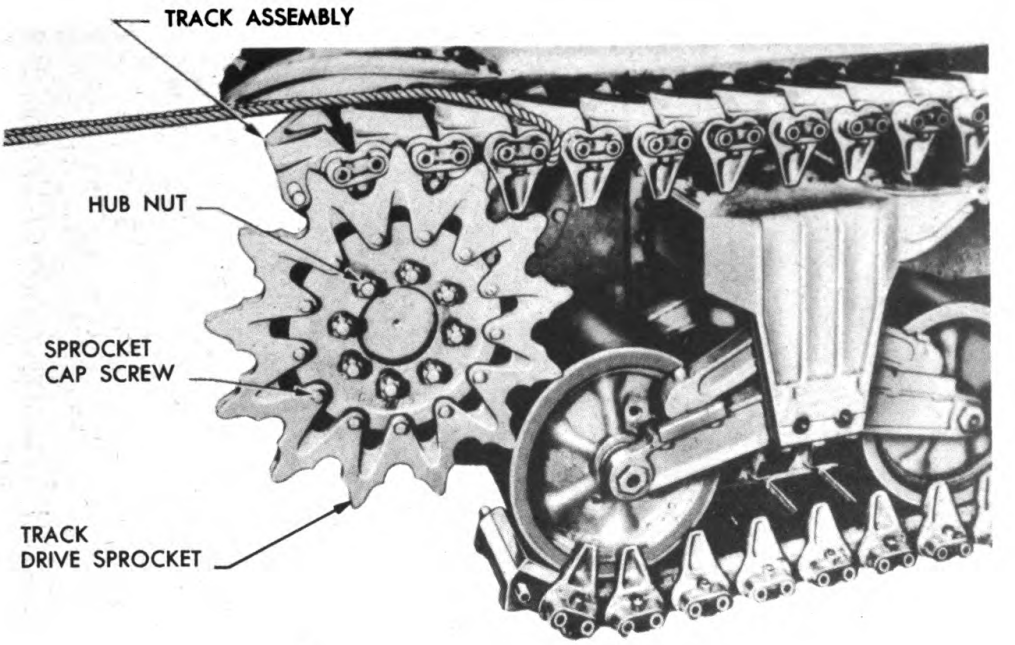
(4) POSITION TRACK. Place the new track ahead of the vehicle in line with the track removed. Temporarily join the tracks by driving the connectors on part way. If old track is completely thrown off so that the suspension wheels are resting on the ground, dig a sloping trench ahead of the front suspension wheel deep enough to receive the rear end of the new track. Use a board or crowbars laid in the track to act as a ramp when the vehicle is towed onto the new track. Tow the vehicle forward onto the new track to within 16 inches of the front end. Block suspension wheels to keep vehicle from moving. Disconnect the new track from the old. Move the rear idler wheel into the extreme forward position. Temporarily lock the spindle and tighten the retaining bolts. Attach cable to rear end of new track. Use a towing vehicle and pull the track up and over the rear idler wheel and rollers until it engages the sprockets (fig. 160). Disconnect the cable. Turn the sprocket hub with the engine or with bars to bring the ends of the track together. Remove blocks from track.

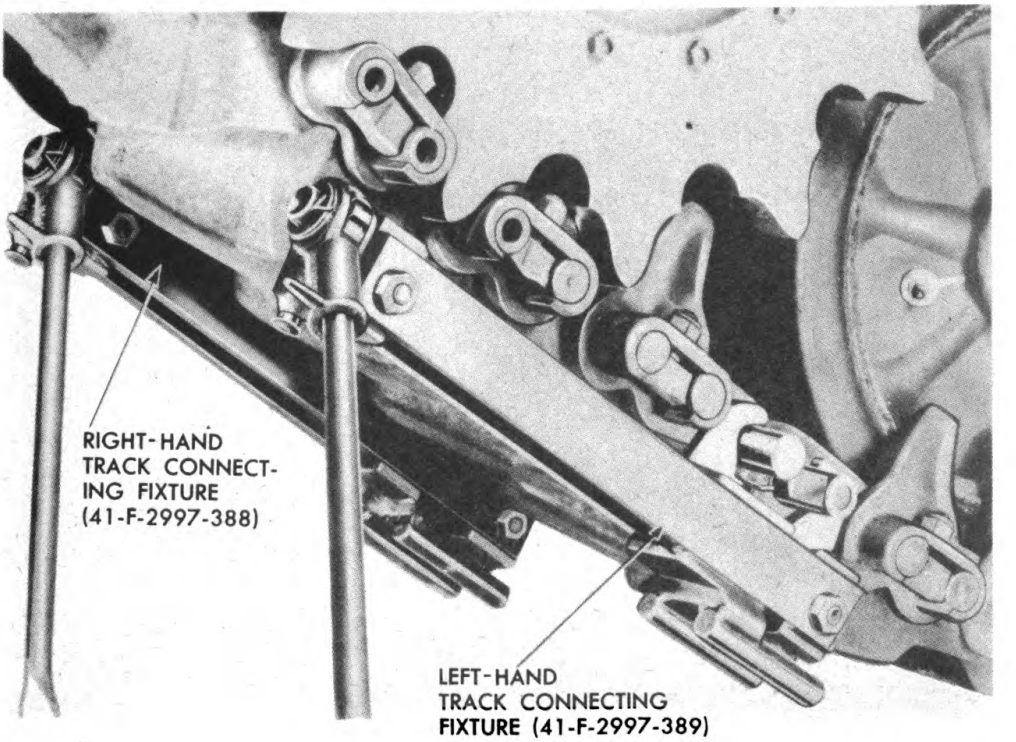
(5) CONNECT TRACK. Remove the adjusting screws from the track connecting fixtures (41-F-2997-86). Place the fixtures in line with the tracks to pull the ends together as shown in figure 160. Operate jacks evenly until connectors will slide onto pins. Drive the connectors part way on, and remove the fixtures. Then drive the connectors into place against link. Insert the track connector wedge and screw on safety nut. Tighten nut, using 80 foot-pounds of torque while tapping lightly on wedge to seat it securely. Repeat for opposite side. Adjust track tension (subpar. **b** above). Install fenders or sand shield previously removed (par. 166 **c**).

h. Interchange or Reverse Tracks.

(1) GENERAL. Tracks with links showing greater wear on the outer ends of the links can be interchanged with the track on the opposite side to equalize the wear. Rubber track, model T51, with smooth blocks can be reversed or turned end for end to equalize the wear on the end connectors or blocks. All chevron-type tracks cannot be reversed.

(2) INTERCHANGE TRACKS. With the vehicle on a hard level surface, disconnect both tracks at the front and tow the vehicle off the tracks. Drag the left track into position with the rear end of the track in front of the right front suspension wheel. Position the right track at the left front suspension wheel. Tow vehicle onto tracks. Connect tracks and adjust track tension.





RA PD 339656

Figure 160 — Installing and Connecting Track

(3) REVERSE TRACKS. Follow same procedure as in step (2) above only the tracks are turned end for end and installed on the same side of the vehicle from which they were removed.

151. TRACK DRIVE SPROCKETS AND HUBS.

a. Description. One drive sprocket is bolted to the outer, and one to the inner side of each track drive sprocket hub (fig. 150). Teeth on the sprockets engage the track end connectors to support and drive the track. Sprockets can be interchanged on the hubs or the hub and sprocket assembly on one side of the vehicle can be interchanged with the assembly on the other side to equalize wear on the driving faces on the sprocket teeth. When replacing or exchanging sprockets, select a pair which have nearly equal wear so as to equalize the driving force. The track drive sprocket hub is attached to the drive sprocket shaft flange by six studs and safety nuts (fig. 160). Dowels (tapered wedge rings) are used on the studs under the nuts, and fit the taper in holes in hub. When the nuts are tightened, the wedges take up any clearance between the studs and holes to prevent the hub from working on the studs and wearing the holes.

b. Replacement of Outer Drive Sprocket.

(1) REMOVE OUTER DRIVE SPROCKET. If only the outer track drive sprocket is to be removed, it is not necessary to disconnect the track. Remove front fender (par. 166 **b**). Release track tension (par. 150 **b**). Take out the cap screws which attach sprocket to hub, supporting the sprocket while the last cap screw is being removed. Pull track clear of the sprocket and lower the sprocket to the ground.

(2) INSTALL OUTER DRIVE SPROCKET. Set parking brakes. Raise the sprocket into position and while it is being held, screw in one of the cap screws at the center of the upper rear quarter of the hub. Using this cap screw as a pivot, force the sprocket into place with a bar and line up holes. Screw in several cap screws, then remove bar. Screw in the remainder of the cap screws and tighten them, using 100 foot-pounds of torque to draw sprocket up evenly and securely. Adjust track tension (par. 150 **b** (2)). Install front fender (par. 166 **c**).

c. Removal of Hub and Sprocket Assembly. If hub and sprocket assemblies are to be interchanged, the following procedure usually is performed on both sides of the vehicle at the same time. Remove front fender and sand shield (par. 166). Loosen all hub nuts and back them off three or four turns. Disconnect track midway between sprocket and front suspension wheel (par. 150 **g** (2)). Move track back until track clears sprocket. Rap with hammer on

flange as required to jar the hub stud dowels (wedge ring) loose. Use hoisting equipment to support hub. Pry evenly against inner sprocket at top and bottom to force hub off studs. Remove hub and sprocket assembly.

d. Interchange Sprockets or Hub and Sprocket Assemblies. If only the sprockets on one hub are being interchanged, remove sprocket cap screws and interchange sprockets. Tighten cap screws with pull of 100 foot-pounds of torque. If hub and sprocket assemblies are to be interchanged, replace old style cap screws with new self-locking type if possible. Tighten all sprocket cap screws with torque pull of 100 foot-pounds. Shift hub and sprocket assemblies to opposite sides of vehicle.

e. Inspect Final Drive. The final drive must be inspected for oil leaks or loose bolts. Tighten bolts or replace gasket (par. 144 **b**).

f. Install Hub and Sprocket Assembly. Raise the assembly and move it onto the track drive sprocket shaft studs. Place dowel (wedge ring) on each stud, install new safety nuts, and tighten nuts evenly and securely. Connect track (par. 150 **g**). Install fenders and sand shield previously removed.

152. REAR IDLER WHEELS.

a. Description. The rear idler wheels, which support the tracks at the rear, turn on large heavy-duty ball bearings mounted on large spindles. The wheel end of spindle is eccentric with the inner end which fits into the mounting bracket (fig. 161). This provides a means of changing the position of the idler wheel to adjust track tension (par. 150).

b. Removal.

(1) DISCONNECT THE TRACK. Remove rear fender (par. 166). Release the track tension (par. 150 **b**). Disconnect the track below the idler wheel to be removed (par. 150 **g**) and move upper section of track forward on track support rollers.

(2) PULL IDLER WHEEL. Take out six cap screws and remove cap and gasket. Remove the cotter pin from spindle nut. Unscrew nut with socket wrench (41-W-3058-480) as shown in figure 162, and remove the plain washer. Attach the idler wheel puller (41-P-2940-800) to hub, using all six cap screws and washers. Hold puller from turning with wrench on body of puller, and turn the puller screw clockwise (fig. 163). When wheel is free, lift it straight off spindle to avoid damaging oil retainers. Remove idler wheel puller.

c. Disassembly (fig. 161). Support idler wheel, outer side up, on blocks spaced to clear the hub bore. Pry bearing spacer to one side. Drive out inner bearing and oil retainers by working drift

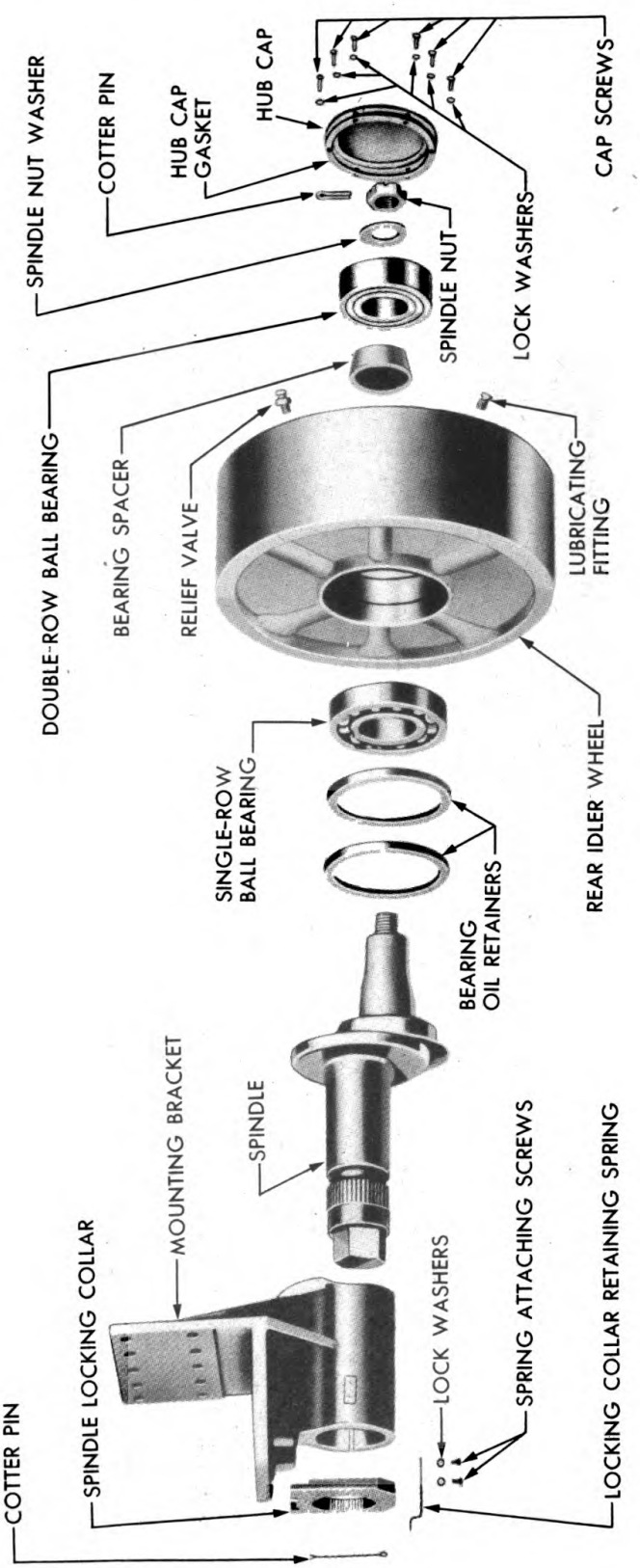


Figure 161 — Rear Idler Wheel Parts

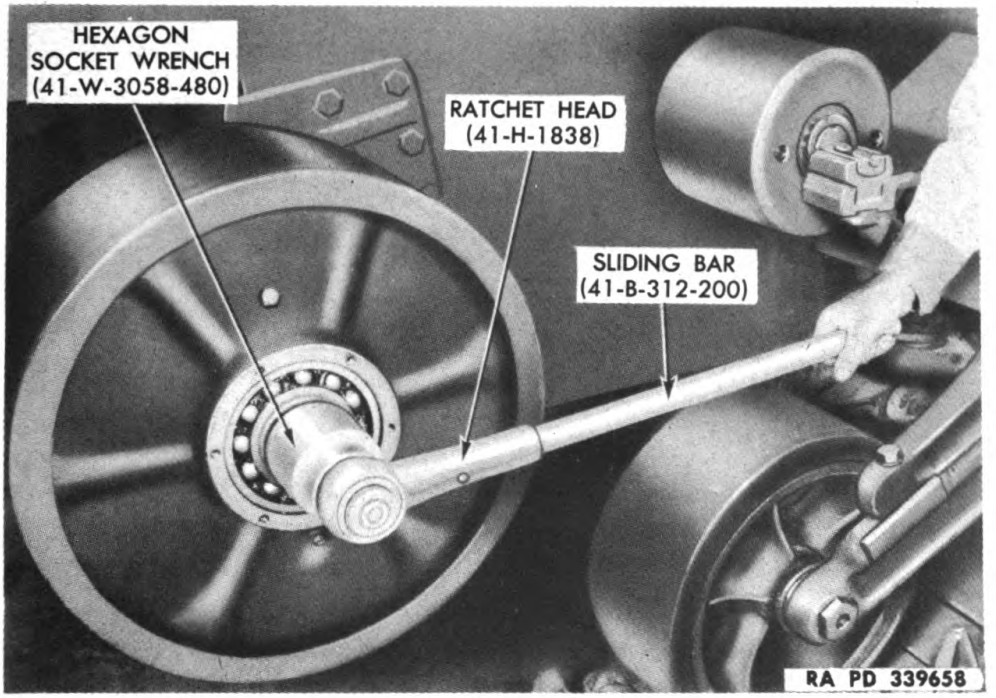
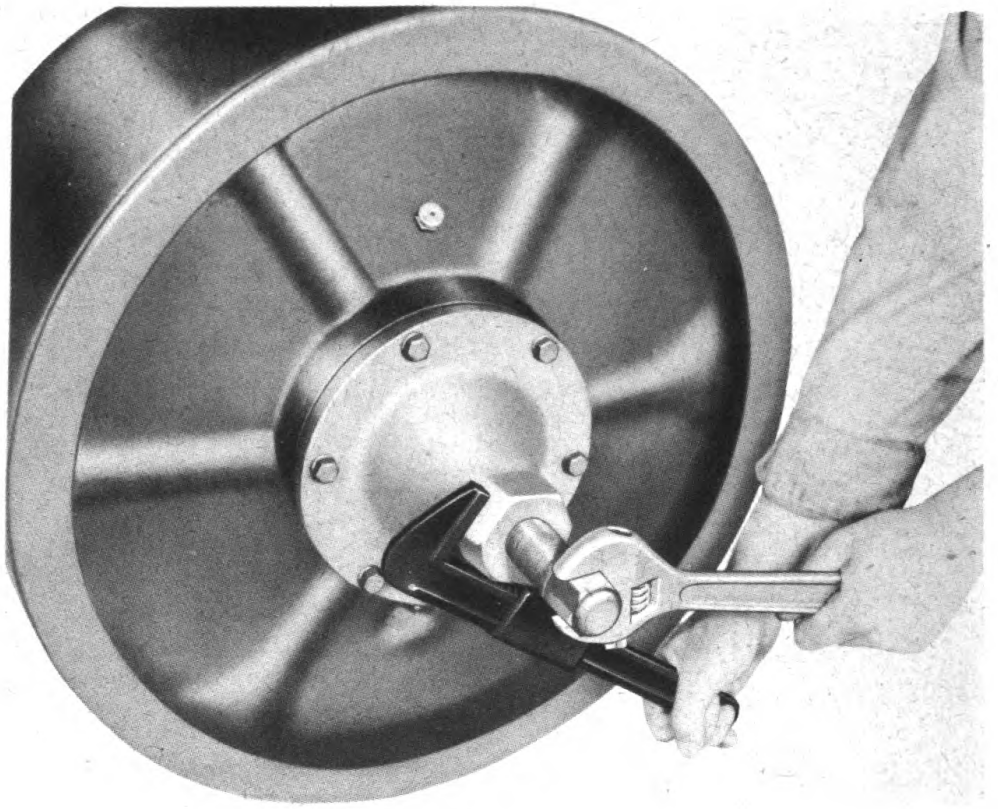


Figure 162 — Removing Rear Idler Wheel Nut

around the bearing race. Turn wheel over on blocks and lift out bearing spacer. Install the bearing race puller (41-P-2905-60) and pull out the double-row outer bearing, or drive it out by working drift around the bearing outer race.

d. Inspection. Thoroughly clean the spindle and the inside of the wheel hub. Wash bearings and oil retainers in dry-cleaning solvent. Inspect wheel for cracks or damage, and hub bore for wear. Examine bearings for damage or cracked or chipped balls, and spin them to see that they are free and not worn. Make sure bearing spacer is not cracked or damaged or galled on the ends. Examine spindle for cracks or damage. Make sure ground surfaces in contact with oil retainers and bearing inner races are not scuffed or scored. Replace all damaged, worn, or unserviceable parts.

e. Assembly. Place idler wheel, outer side up, on blocks. Pack double-row ball bearing (fig. 161) with general purpose grease (par. 33). Start bearing squarely into hub by tapping lightly on outer race. Drive bearing into hub until it seats against the shoulder by working the brass drift around the bearing outer race. Turn wheel over and place the bearing spacer, smaller end down, in the hub. Pack the inner bearing with general purpose grease (par. 33). Start the bearing squarely in the hub by tapping lightly on the outer race.



RA PD 339659

Figure 163 — Pulling Rear Idler Wheel With Idler Wheel Puller (41-P-2940-800)

Drive bearing into hub until it seats against the shoulder by working the brass drift around the bearing outer race (fig. 164).

f. Installation.

(1) INSTALL OIL RETAINERS ON SPINDLE. Soak the retainers to be installed for at least 30 minutes in warmed engine oil to soften the leather seals. Make a two-piece spacer not over $\frac{1}{16}$ inch thick to be used to firmly seat both oil retainers in the hub to provide clearance between the outside retainer and the flange on spindle. A suitable spacer easily can be made by removing the thick ring from a worn idler wheel oil retainer (grease seal) and sawing it in half. Lightly coat the spindle and oil retainer leather seals with general purpose grease. Place oil retainer on the spindle with the leather lip facing the spindle flange and carefully work it onto the shoulder next to the flange. Next, position the second oil retainer (grease seal) the same way with leather lip facing the spindle flange. Insert the halves of the spacer, previously made, between the first oil retainer and flange on spindle so the outer edges are even with the oil

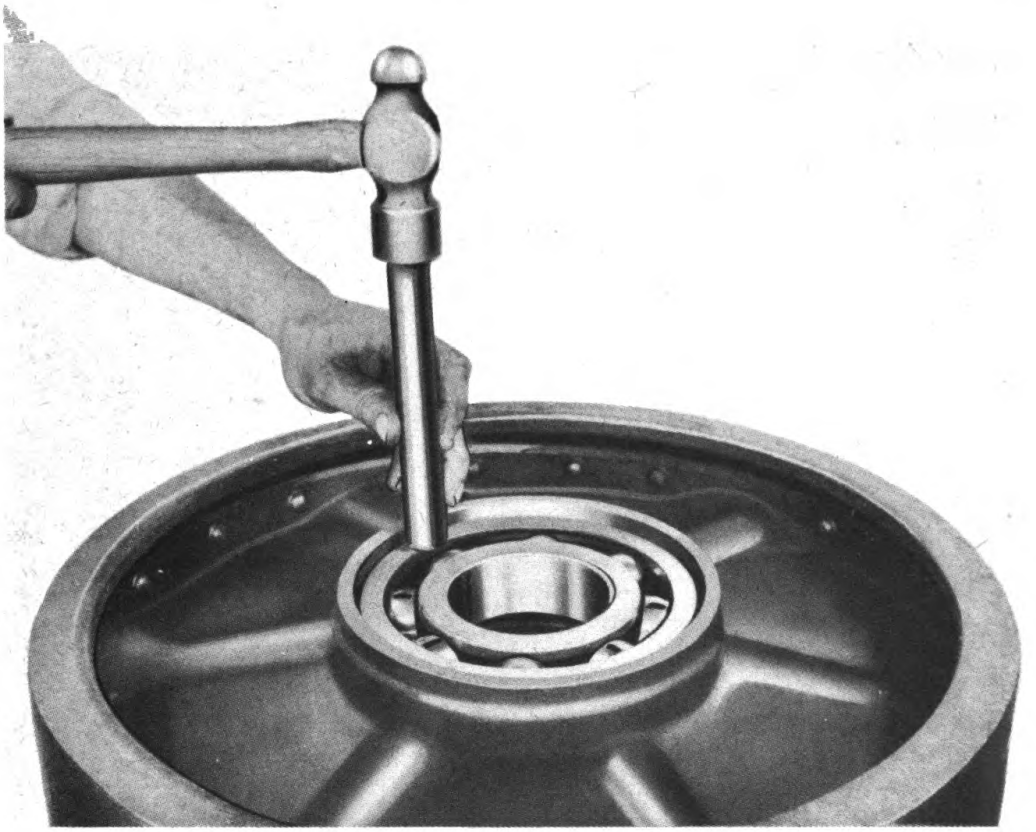


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Figure 164 — Installing Rear Idler Wheel Inner Bearing

retainer, and push both retainers tightly against spacer to hold it in position.

(2) INSTALL IDLER WHEEL ON SPINDLE. Screw the pilot of installing tool (41-T-3216-150) on spindle (fig. 165). Push the idler wheel onto spindle as far as it will go by hand. Slide the cup of the idler wheel installing tool (41-T-3216-150) onto the screw and install the nut. Turn nut on installing tool screw (fig. 166) and push idler wheel into place on spindle, watching to see that the oil retainers enter the bore in the hub evenly as wheel is being pushed on. Stop turning the nut when bearings are felt to seat firmly against shoulders on spindle and back off on nut at least three full turns. Using a wood block to protect idler wheel inner flange, drive the wheel outward sufficiently so the halves of the split spacer used to seat the oil retainers (grease seals) can be removed with a screwdriver. Again screw down the installing tool nut to seat the bearings on the spindle. Unscrew tool from end of spindle. Install flat washer and nut on spindle. Tighten the nut (fig. 162), using socket wrench (41-W-3058-480). Insert and spread new cotter pin. Using new

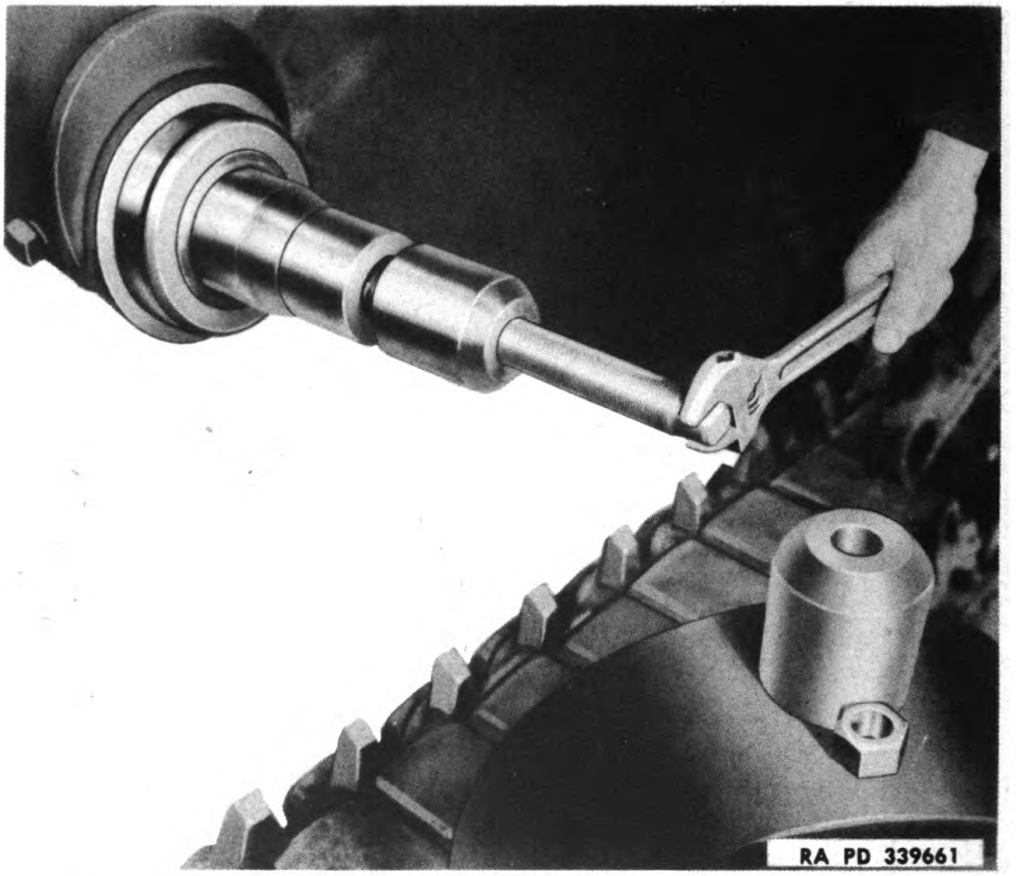


Figure 165 — Installing Pilot of Tool (41-T-3216-150) on Rear Idler Wheel Spindle

gasket, install the idler wheel hub cap with six cap screws and lock washers and tighten cap screws. Fill hub with general purpose grease (par. 33). Connect track (par. 150 g) and adjust track tension (par. 150 b).

153. REAR IDLER WHEEL MOUNTING BRACKETS.

a. Description. The rear idler wheel mounting brackets are heavy castings bolted to the rear corner of the hull, one on each side (fig. 154). The idler wheel spindle housing is split at the bottom so the spindle can be tightly clamped in the bracket.

b. Removal. Remove rear fender (par. 166). Release track tension (par. 150 b). Disconnect track below rear idler wheel (par. 150 g). Pull upper section off track forward of idler wheel. Remove the inner spindle retaining bolt (fig. 154) from the bracket. Remove cotter pin from end of spindle and slide off the locking collar. Sup-

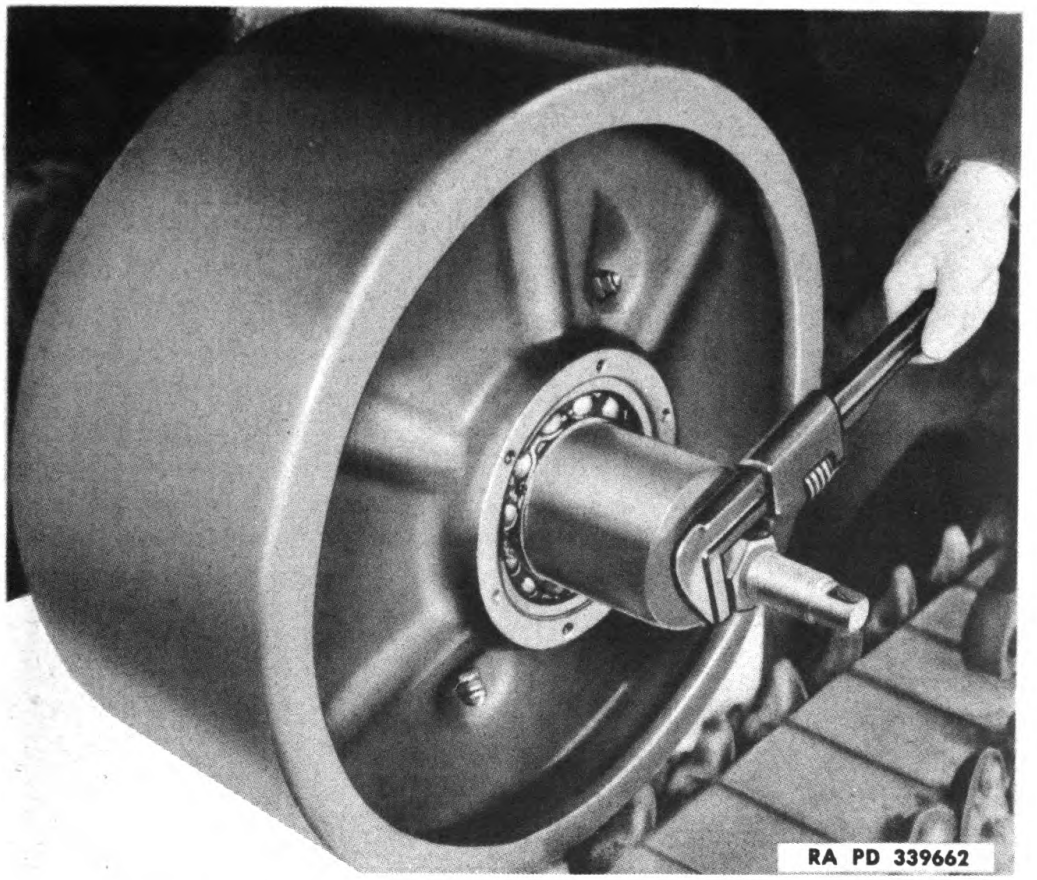


Figure 166 — Installing Rear Idler Wheel With Installing Tool (41-T-3216-150)

port the idler wheel and work spindle out of bracket. Remove the attaching bolts and mounting bracket.

c. Installation. If shims were used to aline bracket with hull, coat shims with joint sealing compound (51-C-1616) and position shims on hull. Raise bracket into position. Coat threads of bolts and holes in bracket with joint sealing compound (51-C-1616). Install bolts and safety nuts. Raise idler wheel and spindle, and insert spindle into bracket. Install the inner retaining bolt. Slide the locking collar onto end of spindle and install a new cotter pin. Pull the upper section of the track back over the rear idler wheel. Connect the track (par. 150 g). Adjust track tension (par. 150 b). Install rear fender (par. 166).

154. TRACK SUPPORT ROLLERS.

a. Description. The six track support rollers (fig. 150) are of heavy cast construction. The rollers turn on ball bearings (fig. 167)

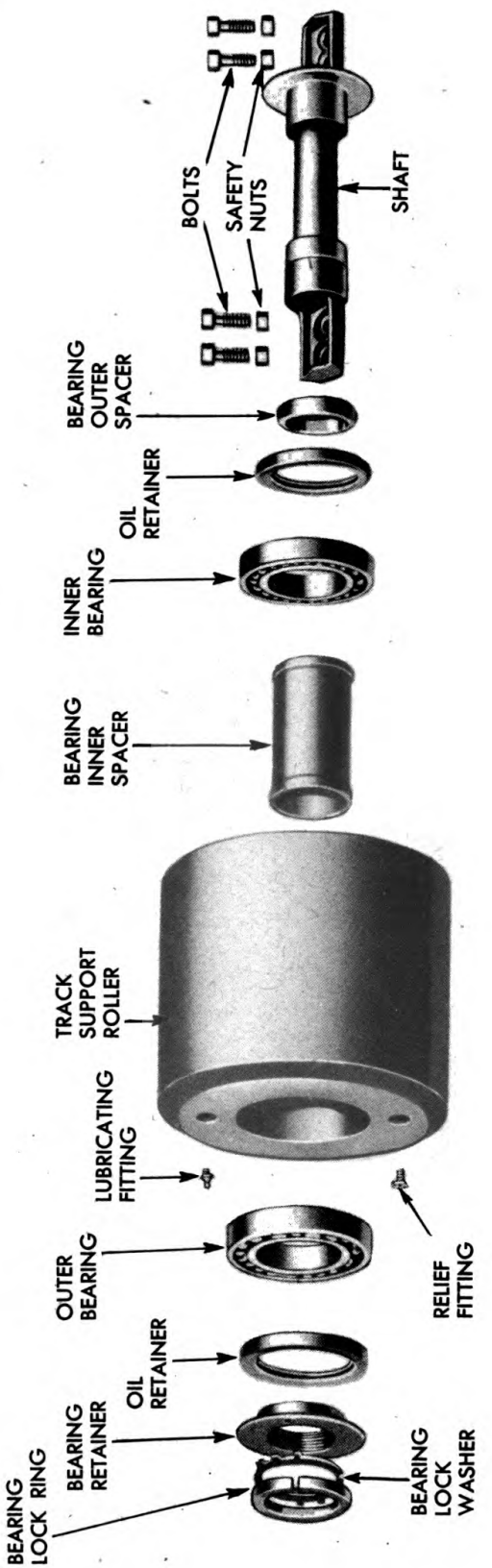
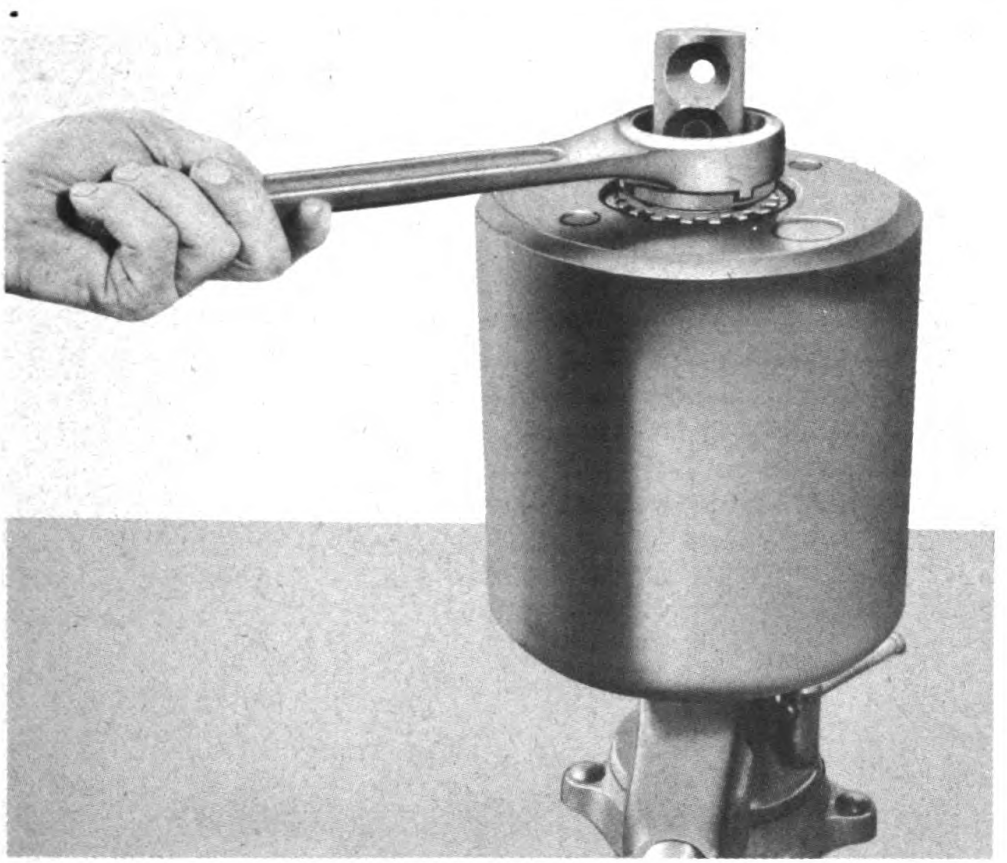


Figure 167 — Track Support Roller Parts



RA PD 339664

Figure 168 — Removing Support Roller Bearing Lock Ring With Spanner Wrench (41-W-3260)

mounted on a shaft supported in the roller bracket. Each roller is provided with a lubricating and a relief fitting.

b. Removal. Follow procedure in paragraph 155 and remove the bracket with the roller from the suspension mounting bracket. Remove the four bolts which attach roller shaft to the bracket and lift off the roller.

c. Disassembly (fig. 167). Place roller shaft in vise, inner end down. Bend ear on lock washer down out of notch in lock ring. Remove lock ring with spanner wrench (41-W-3260) as shown in figure 168. Lift off lock washer. Remove bearing retainer with spanner wrench (41-W-3261) as shown in figure 169. Lift roller off shaft and remove outer bearing spacer. Place roller on blocks spaced to clear the center bore. With long drift, drive out the lower bearing and oil retainer by working drift around bearing outer race. Turn roller over, and lift out the bearing inner spacer. Drive out the other bearing and oil retainer.

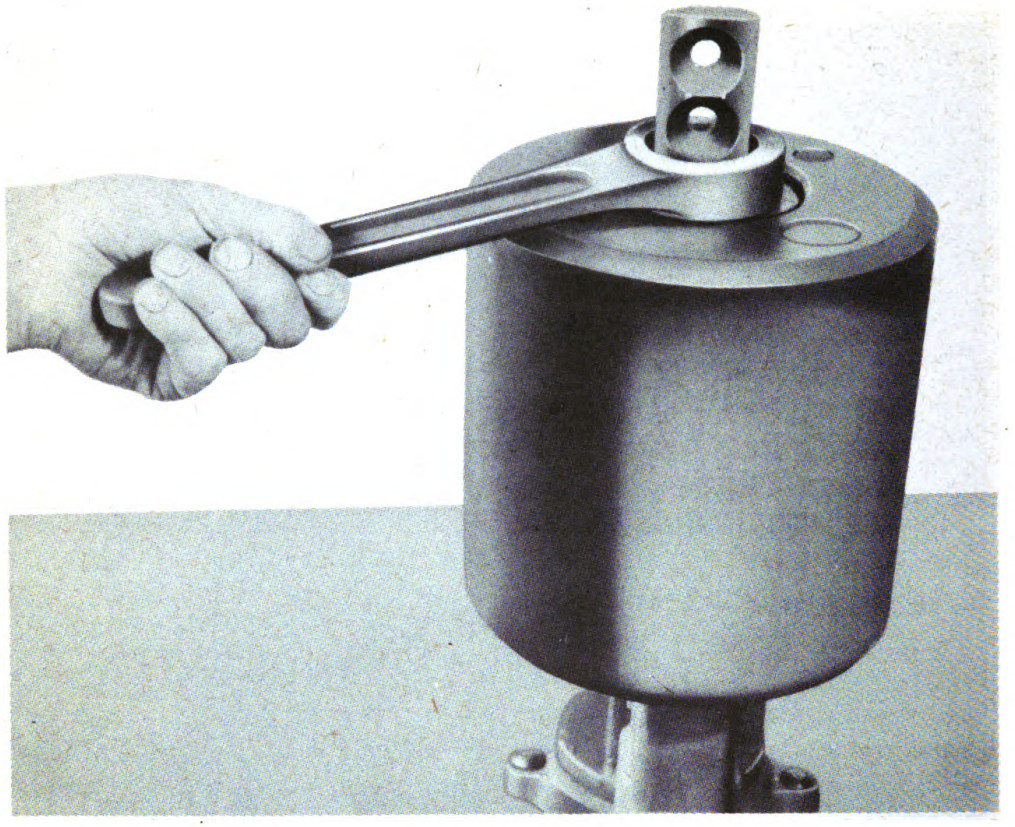


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Figure 169 — Removing Roller Bearing Retainer With Spanner Wrench (41-W-3261)

d. Inspection. Clean all parts and center bore of roller. Carefully inspect bearings for excessive wear or damage. Make sure bearing outer races have not been turning in roller bore and that roller is not damaged. Inspect shaft for damage or wear on surfaces contacted by the oil retainers. Try fit of bearings on shaft to see that there is no excessive play. Inspect bearing spacers for damage or wear. Make sure the lubricating and relief fittings are in good condition. As oil retainers are usually damaged when removed, they must be replaced.

e. Assembly (fig. 167). Soak oil retainers in warmed engine oil for 30 minutes. Place shaft in vise with inner or flanged end down. Place roller on blocks with inner end up. Pack bearing, and coat leather seal in oil retainer with general purpose grease (par. 33). Start bearing squarely into roller bore. Drive bearing into place against shoulder in roller bore by working drift around the bearing outer race. Coat outer surface of oil retainer with antiseize compound (52-C-3032). Start oil retainer squarely into roller bore with lip of leather seal turned up. Using a punch with a square end, drive oil

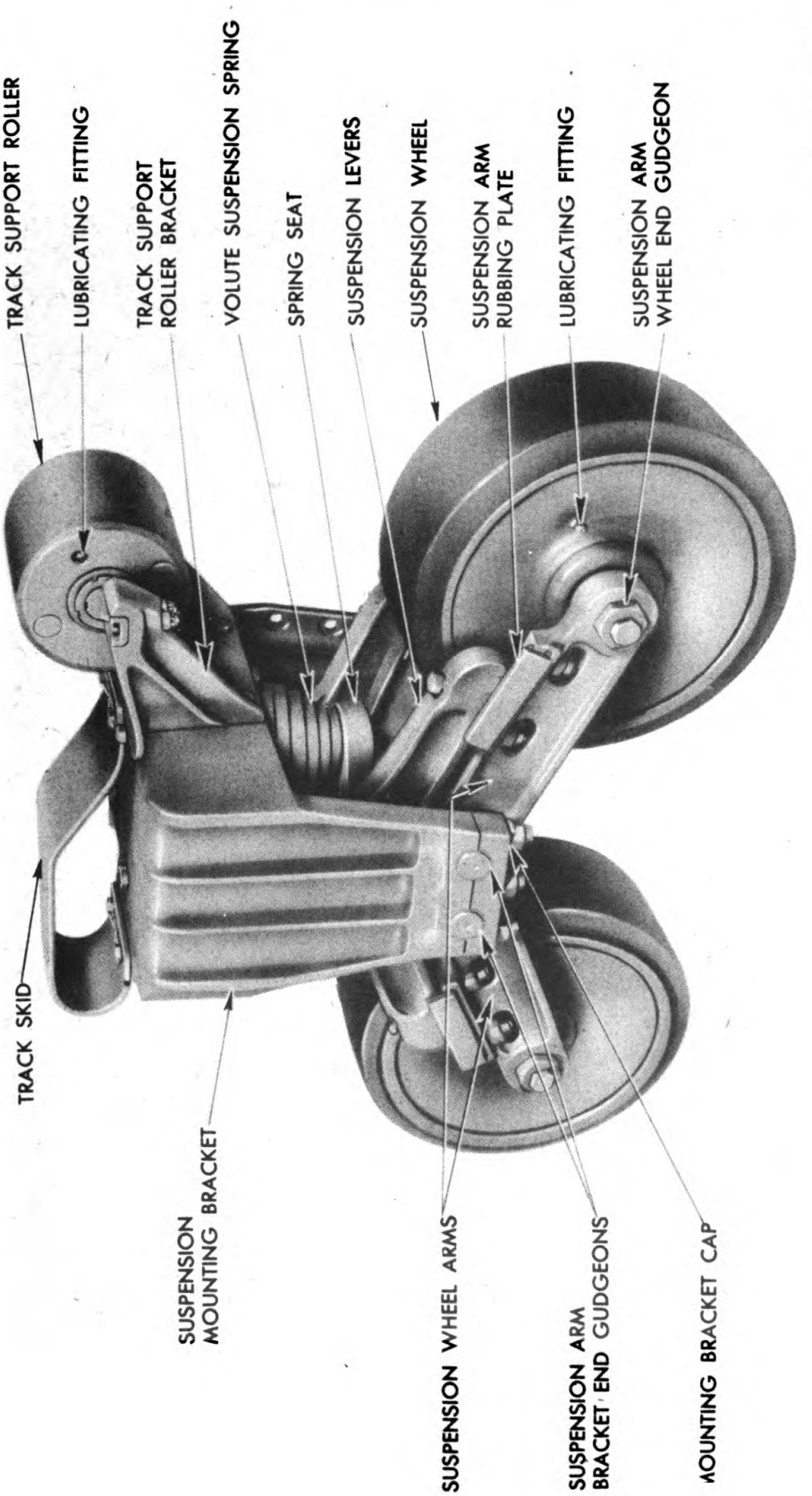

Figure 170 — Volute Spring Suspension Assembly

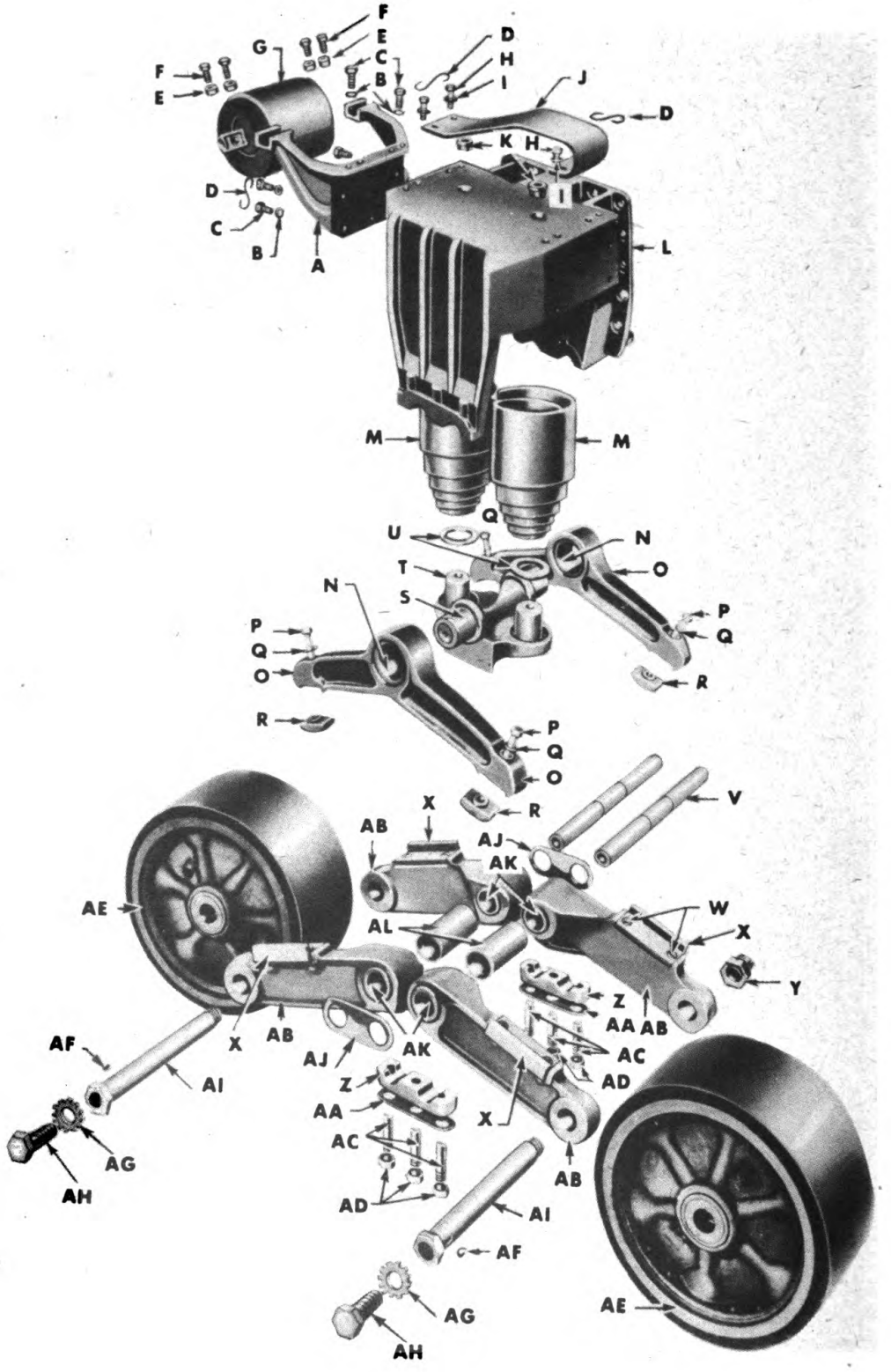

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Figure 171 — Volute Spring Suspension Assembly Parts

A—TRACK SUPPORT ROLLER BRACKET
B—LOCK WASHER
C—BRACKET CAP SCREW
D—LOCKING WIRE
E—SAFETY NUT
F—ROLLER BOLT
G—TRACK SUPPORT ROLLER
H—TRACK SKID CAP SCREW
I—LOCK WASHER
J—TRACK SKID
K—MOUNTING BRACKET PLUGS
L—SUSPENSION MOUNTING BRACKET
M—VOLUTE SUSPENSION SPRING
N—SUSPENSION LEVER BUSHING
O—SUSPENSION LEVER
P—LEVER RUBBING PLATE CAP SCREW
Q—LOCK WASHER
R—SUSPENSION LEVER RUBBING PLATE
S—SPRING SEAT BUSHING
T—SUSPENSION SPRING SEAT
U—SPRING SEAT RINGS
V—SUSPENSION ARM BRACKET END GUDGEONS
W—ARM RUBBING PLATE SCREWS
X—SUSPENSION ARM RUBBING PLATE
Y—GUDGEON SAFETY NUT
Z—MOUNTING BRACKET CAP
AA—MOUNTING BRACKET CAP LOCK
AB—SUSPENSION ARM
AC—MOUNTING BRACKET CAP STUDS
AD—STUD NUTS
AE—SUSPENSION WHEEL
AF—WOODRUFF KEY
AG—LOCK WASHER
AH—GUDGEON CAP SCREW
AI—SUSPENSION ARM WHEEL END GUDGEON
AJ—SUSPENSION ARM SPACING PLATE
AK—SUSPENSION ARM BUSHINGS
AL—SUSPENSION ARM SPACERS

RA PD 339667B

Legend for Figure 171

retainer into place against shoulder in roller bore, taking care not to damage or distort oil retainer. Insert outer bearing spacer into the oil retainer with the chamfered edge down. Turn roller over on blocks and insert the inner bearing spacer. Install the other bearing and oil retainer. Carefully lower the roller down onto the shaft. Screw the bearing retainer onto shaft with spanner wrench (41-W-3261). Place a new lock washer on the shaft. Install and tighten the bearing lock ring with spanner wrench (41-W-3260). Secure the lock ring by bending ear on lock washer into notch in ring.

f. Installation. Lift roller into place on bracket. Install and tighten the four attaching bolts with safety nuts. Apply lubricant as directed on Lubrication Order (par. 32). Follow procedure in paragraph 155 and install the bracket with roller.

155. TRACK SUPPORT ROLLER BRACKETS AND SKIDS.

a. Description. The track support roller brackets are heavy castings bolted to the rear of each suspension mounting bracket (fig. 170). The suspension mounting bracket track skids, at the top of each bracket, support the track when it drops below the roller when the vehicle is in motion.

b. Remove Track Skid. Remove sand shields (par. 166). Remove the four cap screws which attach track skid to the suspension mounting bracket. Slide the skid out from under the track.

c. Remove Support Roller Bracket. With a hydraulic jack placed on top of suspension bracket, raise the track sufficiently to clear the support roller. Support the bracket and roller and remove the cap screws which attach it to the suspension mounting bracket. Lift off track support roller bracket.

d. Install Support Roller Bracket. Raise bracket and roller into position and install the two cap screws with internal-toothed lock washer in the top of the suspension bracket. Install the other cap screws with washers. Tighten cap screws evenly, and secure them with a loop of locking wire through the three screws on each side (fig. 170). Lower and remove hydraulic jack.

e. Install Track Skid. Slide track skid into position. Install the four attaching cap screws with internal-toothed lock washers. Tighten screws and secure with a loop of locking wire through each pair (fig. 170).

156. SUSPENSION WHEELS.

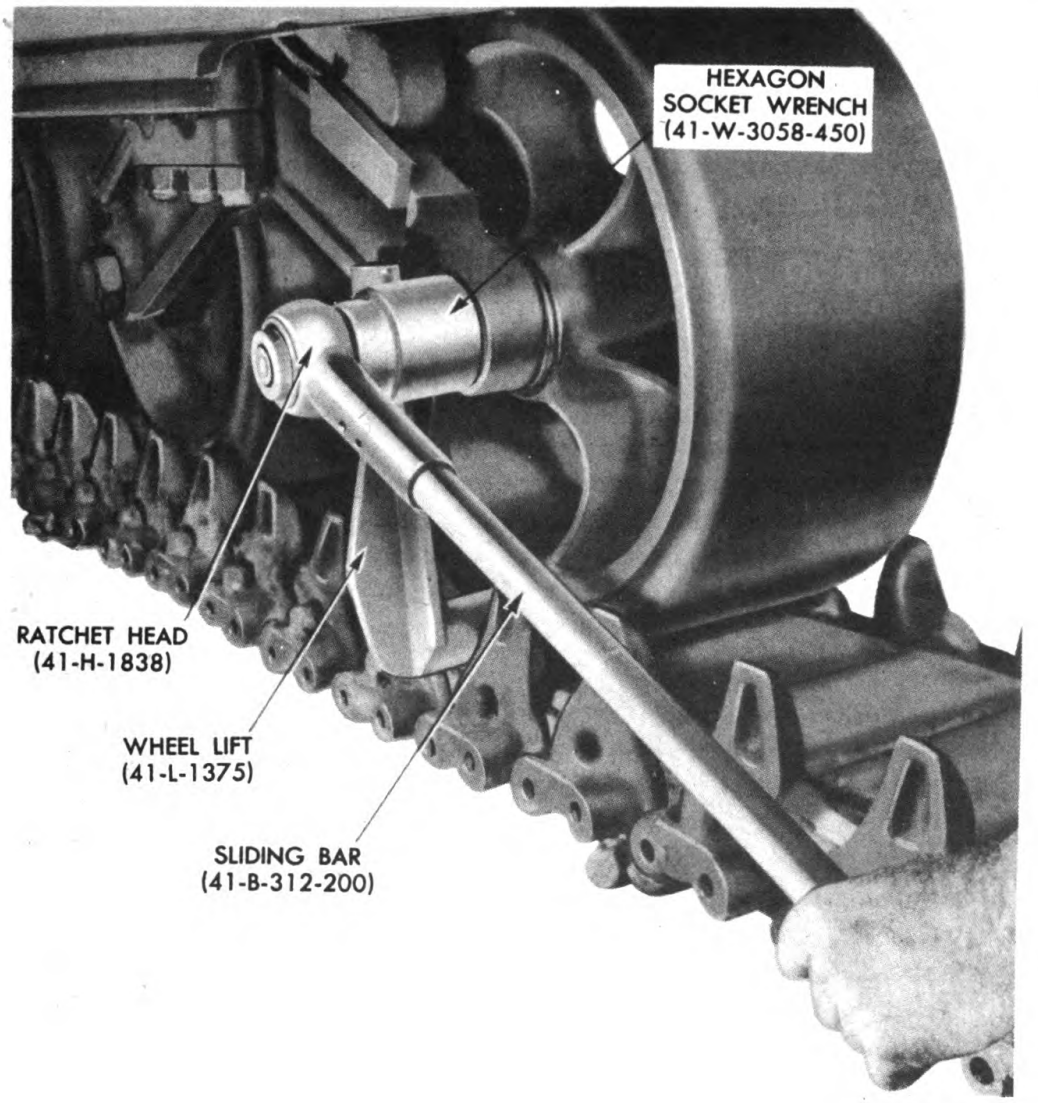
a. Description. The 12 suspension wheels support the vehicle on the inner surface of the track (fig. 150). The wheels are of welded construction. They turn on tapered roller bearings supported on the arm wheel end gudgeon through the ends of the arms. The rubber tires are vulcanized to rims which are pressed onto the wheels under tremendous pressure. Only the latest type wheels with tapered roller bearings are discussed in the following subparagraphs.

b. Removal.

(1) REMOVE GUDGEON NUT. Remove arm wheel end gudgeon nut as shown in figure 172. If necessary, pry wrench handle down with crowbar placed across wrench handle and under edge of hull from outside the vehicle.

(2) RAISE SUSPENSION WHEEL. Place the bogie wheel lift (41-L-1375) on the track under the arms of the wheel to be lifted and with the foot of the lift pointing away from the wheel (fig. 173). Slowly move the vehicle either forward or backward, depending upon which wheel is to be removed, to push the lift into a vertical position. Raise the wheel (fig. 173). NOTE: *It will be necessary to disconnect the track below the sprocket when using lift to raise front wheel.* Set the parking brake.

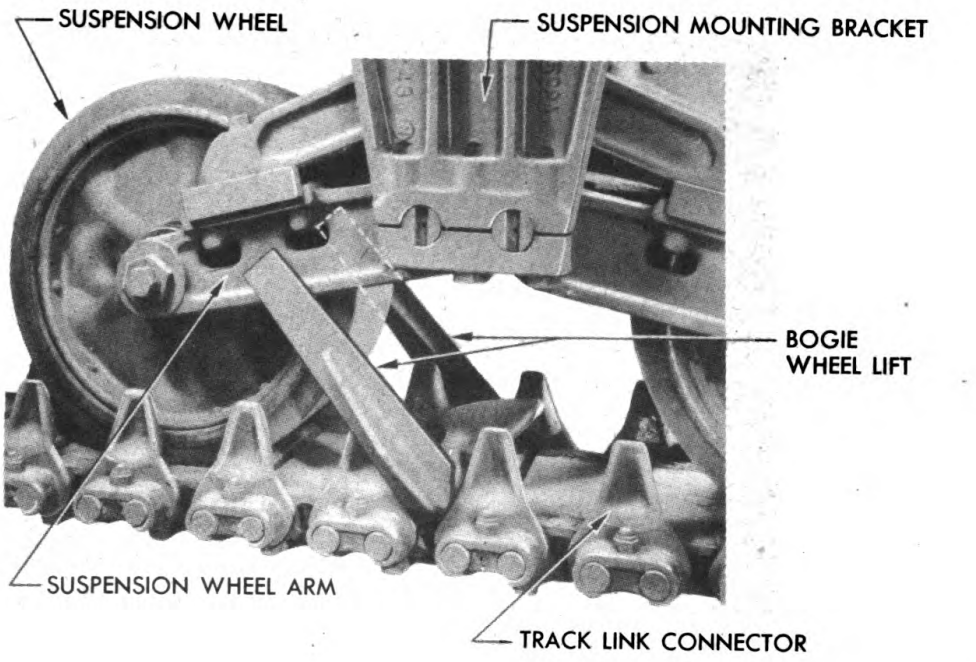
(3) REMOVE GUDGEON. At outer end of arm wheel end gudgeon, remove the cap screw and washer used to protect the threads on the end of the gudgeon. Screw threaded end of slide-hammer type gudgeon puller (41-P-2957-27) into end of the gudgeon (fig. 174). Bump the hammer (weight) out hard against nut on end of puller as required to pull the gudgeon. Roll wheel away from arms and lift out.



RA PD 339668

Figure 172 — Removing Suspension Arm Wheel End Gudgeon Nut

c. Disassembly. Place wheel, outer side up, on blocks. Bend ear on bearing lock washer down out of notch in bearing lock nut. With hammer and punch, unscrew lock nut from bearing sleeve while holding oil flinger to keep sleeve from turning. Remove nut, lock washer, oil flinger, and locking plate (fig. 175). Remove pin from adjusting nut. Using punch in pin holes in adjusting nut, unscrew the nut. Take care not to damage threads on sleeve while holding it from turning. Remove the adjusting nut. Turn wheel over and pull out the sleeve. The other lock nut, lock washer, oil flinger, and adjusting nut can now be removed in the same manner while holding sleeve in a vise. Use a long drift through the upper bearing cone and rollers, working it around the lower bearing cup to drive out the



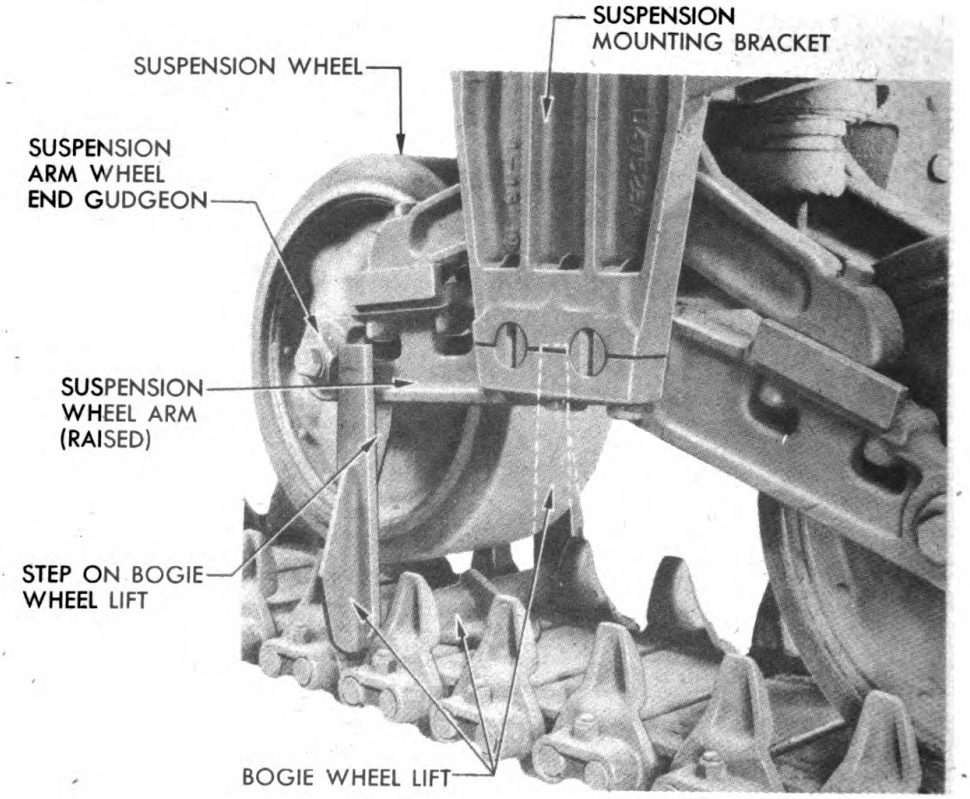


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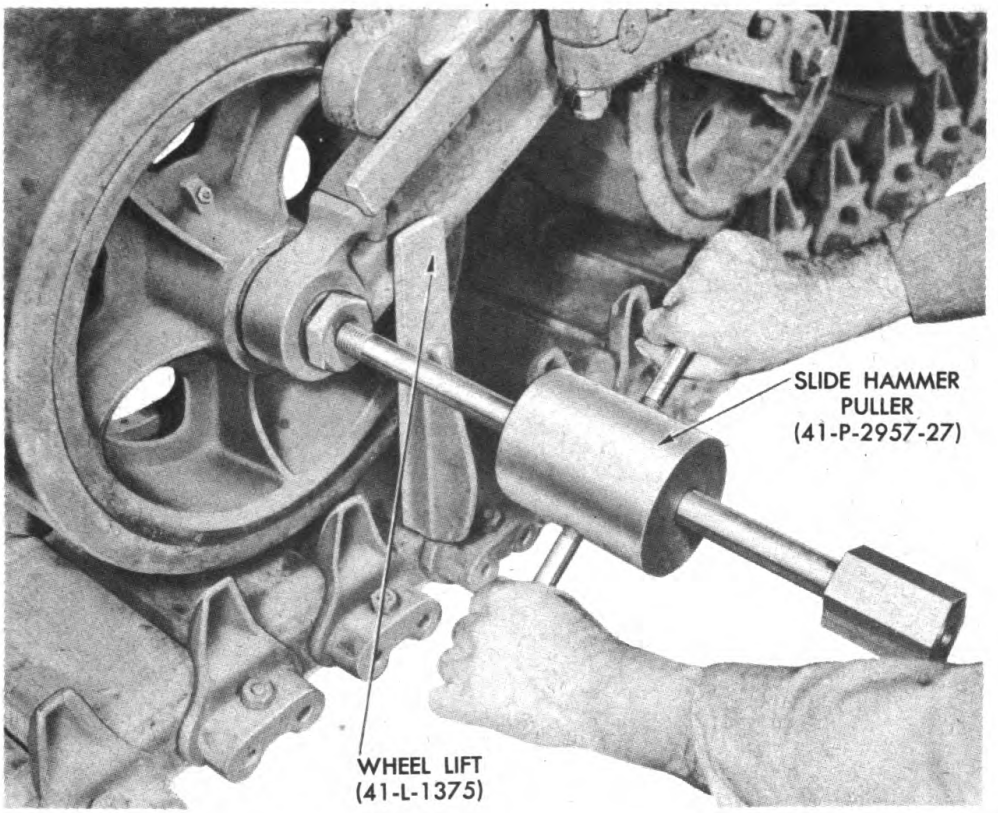
Figure 173 — Raising Suspension Wheel With Lift (41-L-1375)



RA PD 339670

Figure 174 — Pulling Suspension Arm Wheel End Gudgeon With Slide Hammer Puller (41-P-2957)

lower bearing and oil seal. Turn wheel over and drive out the other bearing and oil seal.

d. Inspection (fig. 175). Thoroughly clean all parts and the inner bore of the suspension wheel hub. Carefully inspect bearing cone and rollers and cup for excessive wear or damage. Inspect bore of hub to make sure bearing cup has not been turning in the hub. Oil seals are usually damaged when removed and must be replaced. Inspect adjusting nuts to make sure oil seal contact surfaces are smooth and not worn. Try fit of bearing cone and rollers on sleeve to make sure sleeve is not excessively worn. Inspect gudgeon for wear and damaged threads on keyway. Make sure wheel is serviceable and the lubricating and relief fittings are in good condition.

e. Assembly (fig. 175). Soak oil seals in warmed engine oil for 30 minutes. Thoroughly coat the inner surface of the bearing sleeve with antiseize compound or general purpose grease. With wheel on blocks, inner side up, start bearing cup squarely into hub bore with thin edge up. Drive cup into place by moving the drift around the

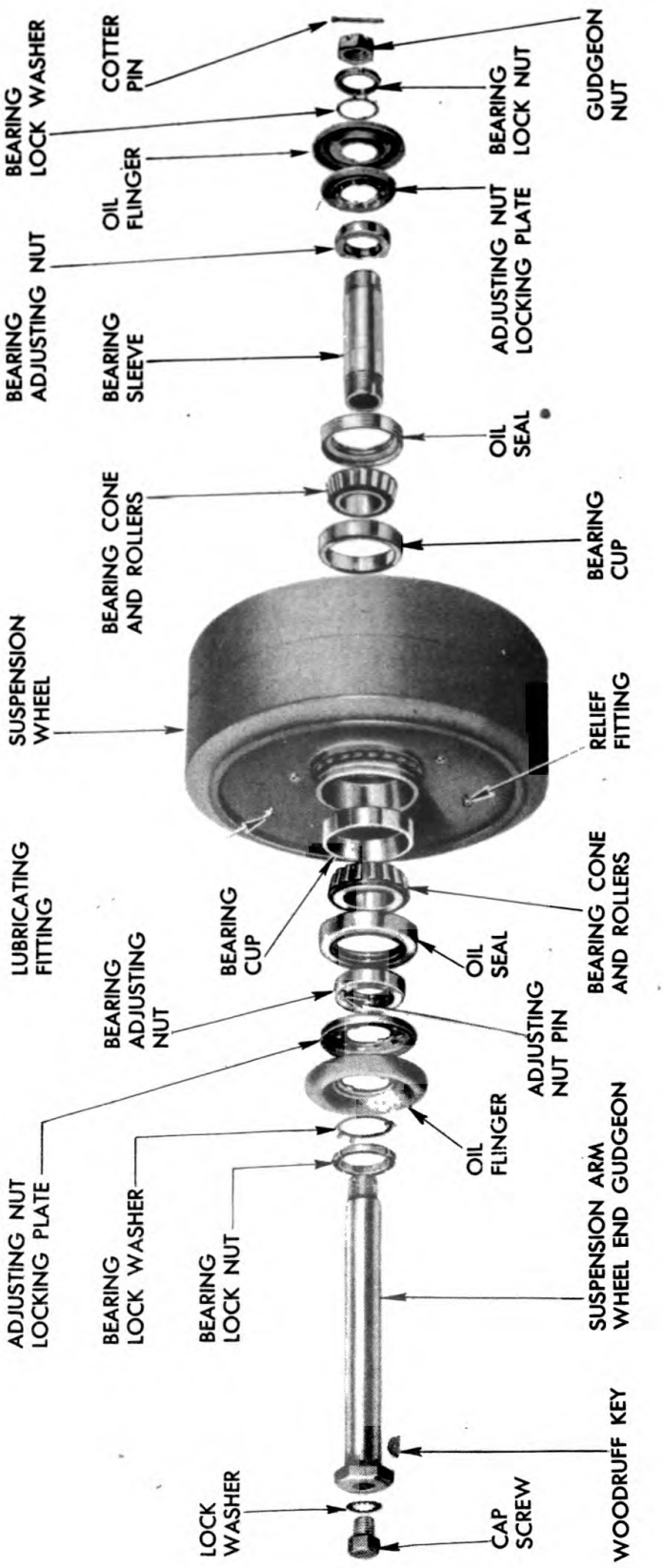
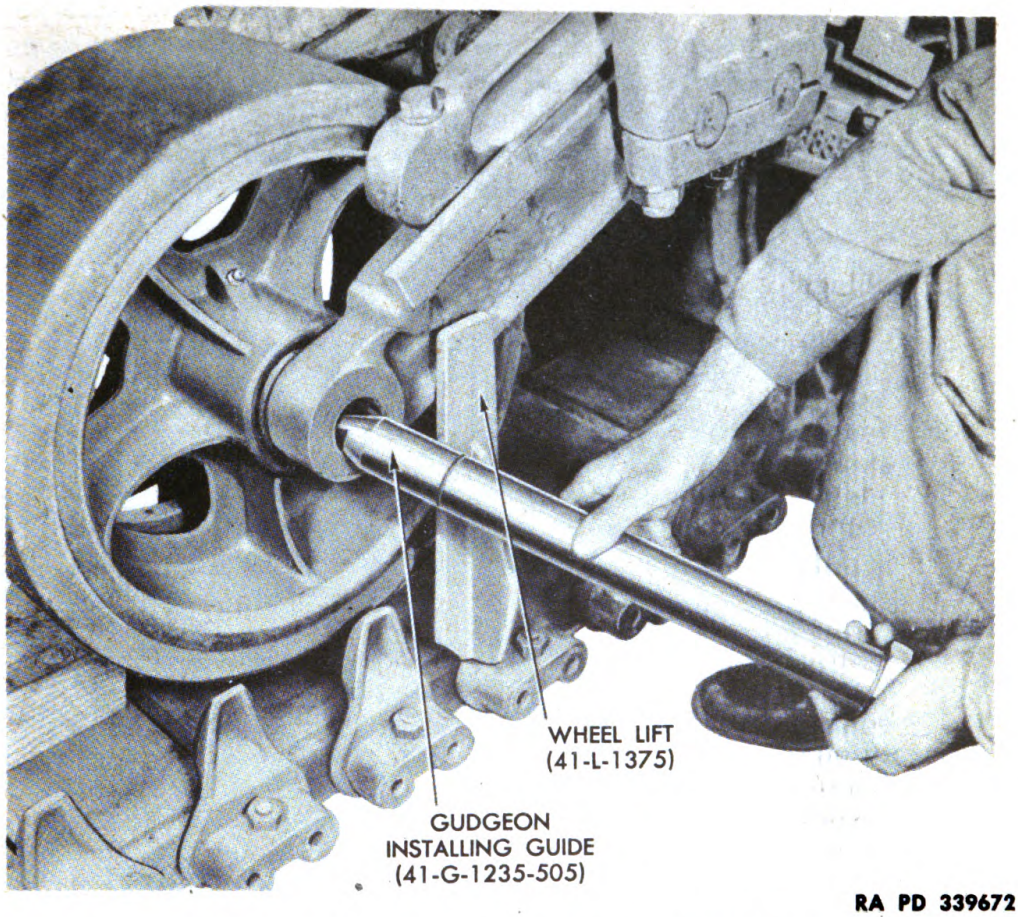


Figure 175 — Suspension Wheel Parts



RA PD 339672

Figure 176 — Installing Suspension Arm Wheel End Gudgeon

edge of the cup until it seats against the shoulder in hub. Pack the cone and rollers and coat the cup with general purpose grease. Run adjusting nut up the full length of the threads on sleeve. Place the cone and rollers in the cup and insert the sleeve through the cone and rollers. Coat sealing surfaces on oil seal and adjusting nut with general purpose grease. Start the oil seal squarely into hub bore with large diameter side down and rubber seal side up. Use a square pointed drift and work it around the oil seal taking care not to distort or damage oil seal while driving it into place against bearing cup. Place locking plate on sleeve with lip side up. Turn adjusting nut to aline one of the holes in nut with a hole in the plate (fig. 175). Insert pin through locking plate into adjusting nut. Install oil flinger with lip side down. Place new lock washer on sleeve with inner tang turned up. Screw on the lock nut and tighten with punch and hammer while holding oil flinger from turning. Bend one of the lock washer tangs up into notch in lock nut. Turn wheel over. Install bearing cup and cone and rollers. Screw the adjusting nut onto sleeve until it contacts cone. Install guide (41-G-1235-505) on arm

wheel end gudgeon as shown in figure 176. Insert the gudgeon through the bearing sleeve. Use blocks to support gudgeon so wheel is free to turn. Turn wheel in both directions while tightening adjusting nut until bearings are seated and a slight drag is felt. Then back off adjusting nut one-sixth to one-quarter turn to allow wheel to rotate freely without excessive end play. Remove the gudgeon. While taking care not to disturb the adjusting nut, install the oil seal, locking plate and pin, oil flinger, lock washer, and lock nut. Tighten lock nut and secure it with lock washer.

f. Installation. Make sure Woodruff key is securely installed in gudgeon. Lift wheel into position and insert gudgeon (fig. 176) through arms and wheel hub. Aline key in gudgeon with keyway in arm and drive gudgeon into place. Coat cap screw threads with general purpose grease, and install cap screw with lock washer in end of gudgeon. Remove gudgeon guide (41-G-1235-505). Install the safety nut on end of gudgeon. Apply lubricant to wheel as instructed on Lubrication Order (par. 32). Move vehicle forward or backward, depending on which side of wheel the lift was placed, to lower the wheel onto track. Remove wheel lift (41-L-1375). Before driving vehicle, use crowbar on wrench, if necessary, to tighten gudgeon nut securely.

157. VOLUTE SUSPENSION SPRINGS.

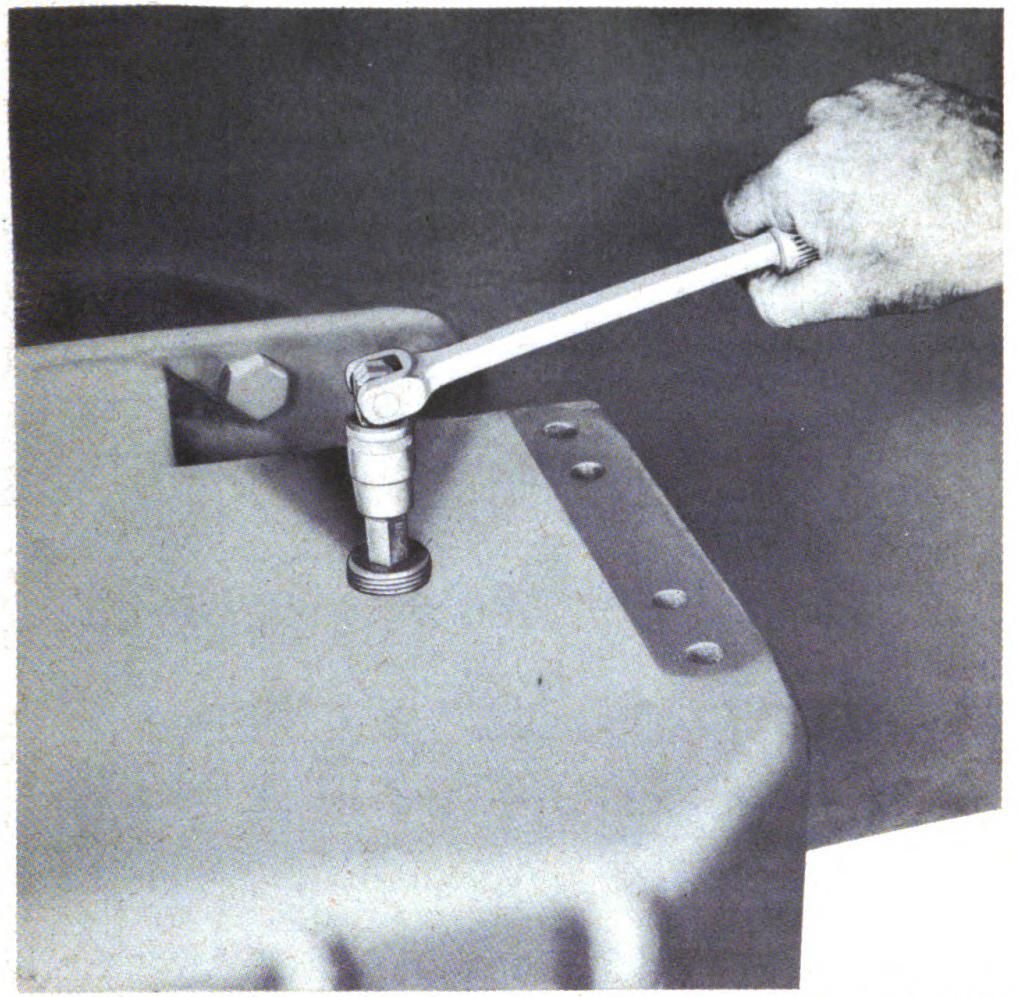
a. Description. Two heavy steel volute springs are used in each suspension. The springs are held in a vertical position between the movable spring seat at the bottom and the suspension mounting bracket at the top (L, fig. 171). No center guide is necessary since each coil overlaps or is nested within another coil.

b. Removal.

(1) REMOVE TRACK. Remove fenders and sand shields (par. 166). Disconnect track (par. 150 g) and drive vehicle slowly forward until end of track clears suspension. Apply parking brake and block vehicle.

(2) COMPRESS SPRINGS. Place hydraulic jack under edge of hull in line with center of suspension mounting bracket. Operate jack to support vehicle until vehicle is seen to raise slightly. Remove the cap screws and lift off track skid. Remove both plugs from top of suspension bracket with plug wrench (41-W-1960) (fig. 177). Insert the two spring compressors (41-C-2556) into the bracket holes and screw them tightly into the spring seat. Compress the springs by turning the compressor nuts evenly (fig. 178) until suspension levers are raised clear of wheel arms.

(3) DISCONNECT WHEEL ARMS. Place a hydraulic jack on the track and center it under the two suspension arm spacers. Operate



RA PD 339673

Figure 177 — Removing Suspension Bracket Plugs Using Plug Wrench (41-W-1960)

jack until it almost contacts the spacers. Bend ears on bracket cap stud lock away from cap stud nuts. Remove the stud nuts and pull caps off studs. Lower the jack. Remove both suspension arm spacers from the suspension arm bracket end gudgeons (fig. 171). Roll the suspension wheels as far apart as possible.

(4) REMOVE VOLUTE SPRINGS. Raise jack under spring seat until compressor nuts are raised slightly off washer on top of bracket. Back off both nuts about ½ inch at a time and lower jack until both springs are extended to their full length. CAUTION: *Hold compressors from turning to make sure they are not unscrewed from spring seats while backing off the nuts.* Remove both spring compressors (41-C-2556). Support the suspension levers with a crowbar under each end resting on blocks under the vehicle. Remove jack, and

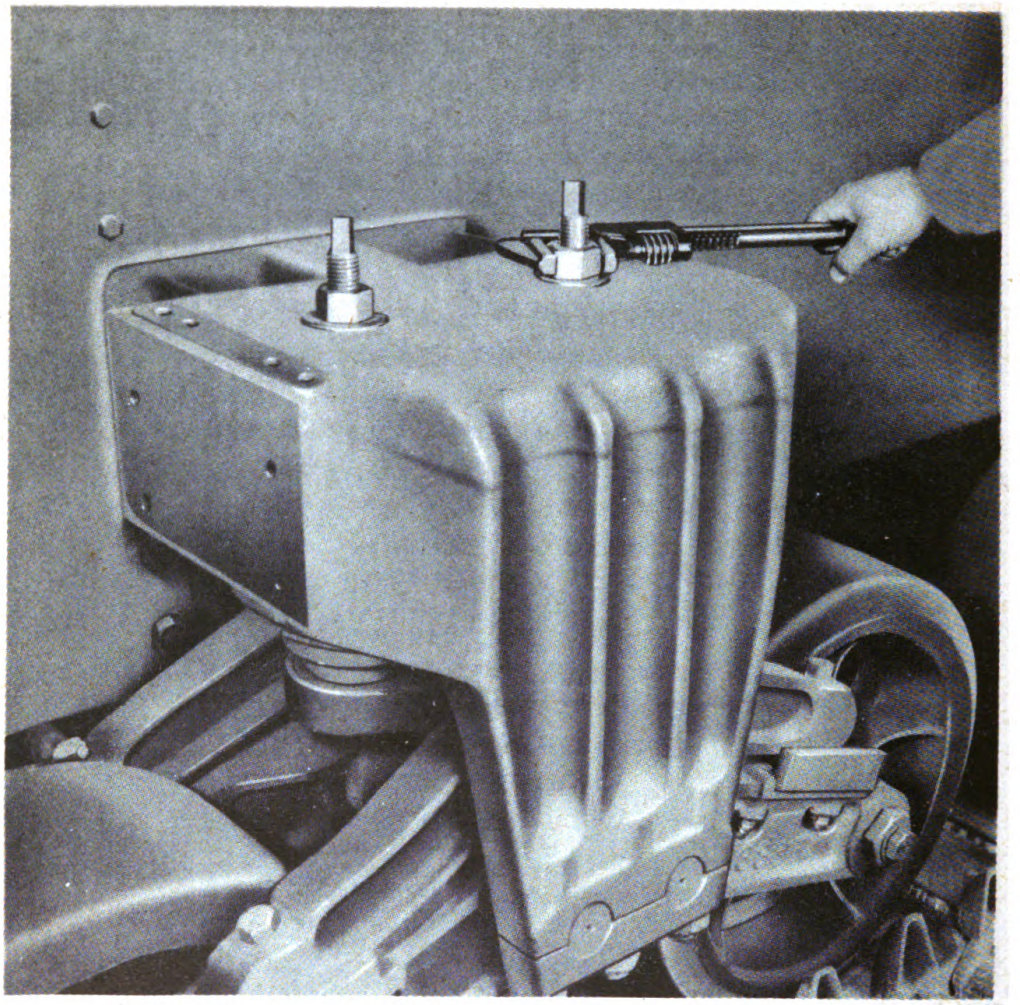


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Figure 178 — Compressing Volute Spring With Spring Compressors (41-C-2556)

lower the levers and springs. Lift springs out of sides of mounting bracket and remove suspension levers.

c. **Inspection.** Wipe all wearing surfaces clean. Inspect all parts for damage. Inspect bushings on ends of spring seat and if excessively worn, replace spring seat. Remove rings from spring seat bosses and if excessively worn, reverse or replace the rings. Examine bushings in suspension levers and if bushings are excessively worn, replace the levers. Try levers on spring seat to make sure bushings have a clearance of at least 0.020 inch. Examine rubbing plates on both the levers and arms and if excessively worn or damaged, replace the rubbing plates (par. 159). Drive the gudgeons out of the suspension arms. Examine gudgeons and bushings and if excessively worn, replace the gudgeons on arms. Also inspect the suspension arm spacers

for wear. While track is removed, spin the support roller to test the bearings for wear or damage. Examine the volute springs for wear or cracks. If inspection of springs, when installed (par. 149 j), revealed springs are weak, replace both springs unless the springs have been in service for only a short time; in which case, only the weak spring need be replaced.

d. Installation (fig. 171).

(1) INSTALL VOLUTE SPRINGS. Make sure rings are in place on spring seat. Position the two springs on the spring seat under the suspension bracket. Insert the two spring compressors (41-C-2556) into bracket. Place the two suspension levers on the spring seat trunnions. Raise the spring seat and hold it in place in bracket by screwing compressors into spring seat. With a hydraulic jack, raise the spring seat and, at the same time, turn compressor nuts to compress springs evenly. Remove the jack.

(2) ATTACH SUSPENSION ARMS. Move wheels and arms into place under suspension bracket. Insert gudgeon, with hole in end to the outside, through the outer arm and through a spacer into the inner arm. Repeat for other pair of arms. Raise arms and place a spacing plate on the two gudgeons at each end. Support the arms by placing a hydraulic jack on the track under the spacers. Turn gudgeons so grooves in ends are vertical. Raise the asesmbly until gudgeons fit snugly in ends of bracket. Position the caps on ends of bracket and install nuts with new locks. Tighten nuts, and secure by bending ear on locks down against flat on nut. Remove jacks from track and from under hull.

(3) CONNECT TRACK. Remove spring compressors. Install suspension mounting bracket plugs, using plug wrench (41-W-1960). Install track skid (par. 155 e). Connect track (par. 150 g) and adjust track tension (par. 150 b). Install fenders and sand shields previously removed.

158. VOLUTE SPRING SUSPENSION ASSEMBLIES.

a. General. The vertical volute spring suspension assembly (fig. 170) can be removed as a unit. However, if the mounting bracket and other components are to be replaced, it is more convenient to disassemble the unit while attached to the vehicle (par. 157 b).

b. Removal. Disconnect track (par. 150 g) and pull it off support roller. Block suspension wheels on both sides of vehicle. Raise the side of vehicle with hydraulic jacks until suspension wheels are above track connectors. Place blocking, level with the connectors, under the two suspension wheels. Lower the hull until wheels rest lightly on blocking. Remove the nuts and bolts which attach mounting bracket to hull. Attach hoist to suspension assembly. Raise hull

sufficiently to clear flange at inner side of bracket. Slide and lift suspension out from under hull.

c. Installation. Lower the suspension assembly onto blocking and slide it into place on hull. Lower the hull as required to aline bolt holes. Coat bolts and bracket holes with joint sealing compound (51-C-1616). Install and tighten nuts securely. NOTE: *Make sure bolts of the same length are installed in the same positions and direction as those removed to prevent interfering with or damaging units inside the vehicle.*

159. RUBBING PLATES.

a. Description. Hardened steel removable rubbing plates are installed on the ends of the suspension levers and on each suspension arm (fig. 170). Replace plates when they are damaged or excessively worn. Do not lubricate plates at any time.

b. Removal. Pry up the suspension lever and block it in raised position. Remove cap screw which attaches rubbing plate to suspension arm. Drive plate out of arm. Remove nuts from screws which attach rubbing plate to suspension arm. Drive out the screws and remove rubbing plate.

c. Install. Position rubbing plate on suspension arm. Install screws and tighten safety nuts. Drive rubbing plate into position in suspension lever. Install and tighten cap screw with internal-toothed lock washer. Remove block.

Section XXXII

HULL

160. DESCRIPTION.

a. General. The hull of the vehicle is made of welded armor plate. The hull is divided into two sections by a bulkhead. The engine compartment is located in the rear section, the fighting compartment and driver's and assistant driver's stations are located in the front section.

161. DRIVER'S AND ASSISTANT DRIVER'S DOORS.

a. Description (fig. 179). The driver's doors, located at the front of the hull, permit entrance into the driver's and assistant driver's compartment. A periscope is mounted in each door on a ball bearing race permitting a 360-degree rotation.

b. Removal. Operate release lever and raise door to full open position. Support the door with lifting tackle. Remove hinge pin

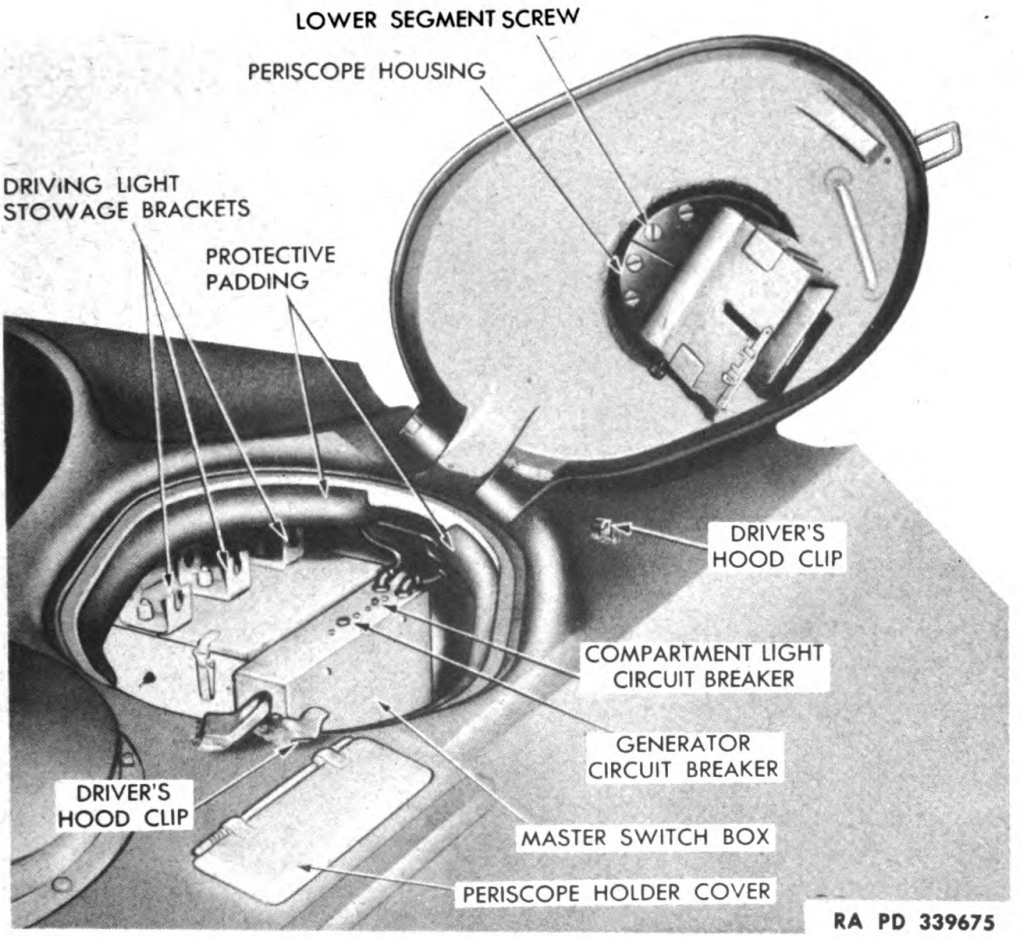


Figure 179 — Driver's Door and Periscopes

nut, lock washer, and special washer. Remove hex retainer and key from door hinge pin, releasing door spring. Remove door spring and bushing. Drive door hinge pin up out of door hinge, depress release lever, and remove door.

c. Installation. Position door on hull and install hinge pin in door. Install door spring, bushing, and retainer with key. Install washers and nut.

162. DRIVERS' SEATS.

a. Description. Form-fitting adjustable seats with removable backs and cushions are provided for the driver and assistant driver (fig. 181). The seats are adjustable in height or in horizontal positions. Counterbalance springs in the seat base assist in raising the seat to the desired height. The assistant driver's seat can be folded

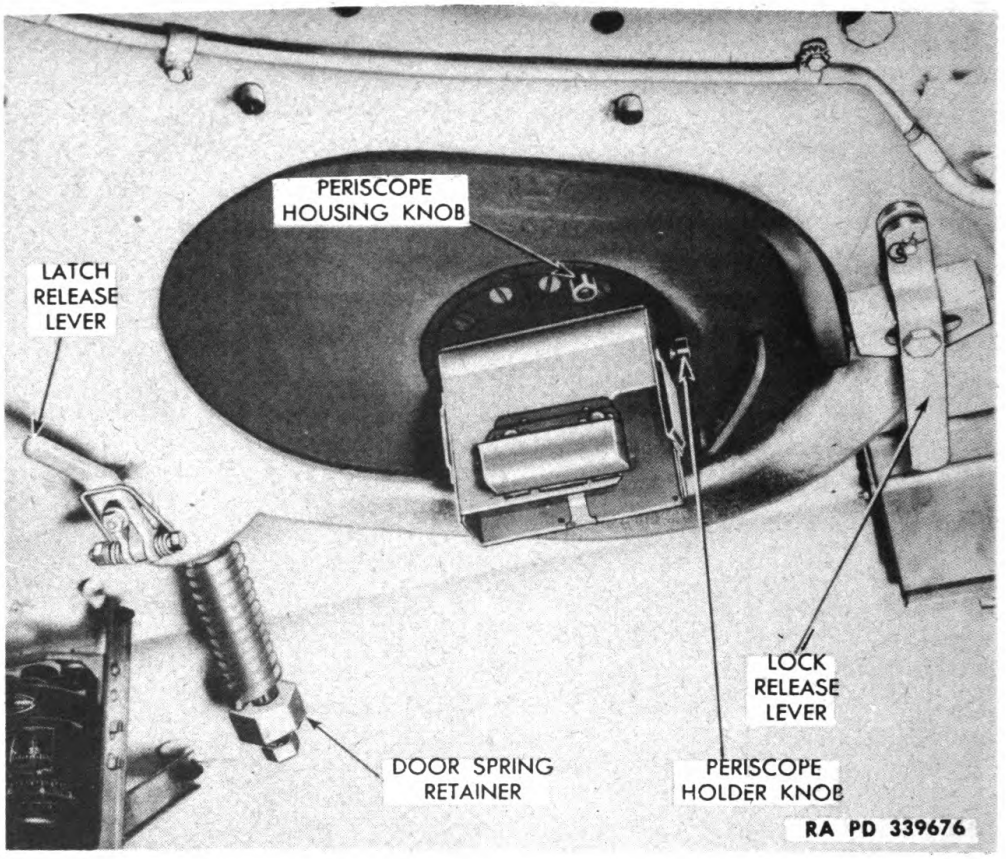


Figure 180 — Driver's Door — Interior View

over forward to provide access to the 90-mm ammunition stowage box at rear of seat. For operation of seat controls refer to paragraph 13 a (25).

b. Removal. Remove the seat back. Operate release lever and raise seat to highest position. Remove seat mounting screws and nuts with lock washers, and remove the seat assembly.

c. Installation. Position seat on drivers' compartment floor and install attaching screws and lock washers. Install seat back.

163. PERISCOPE AND HOLDERS.

a. Description. Four periscopes are located in the drivers' compartment (figs 5, 6); two which are stationary and two, mounted in the drivers' doors, that can be rotated and tilted. A rotation set screw can be tightened to hold the periscope in position. The periscope mount can be tilted to elevate the line of vision and can be locked in position by a knurled nut on the back of the periscope. A safety lock prevents the periscope from falling out if the knurled nut becomes loosened.

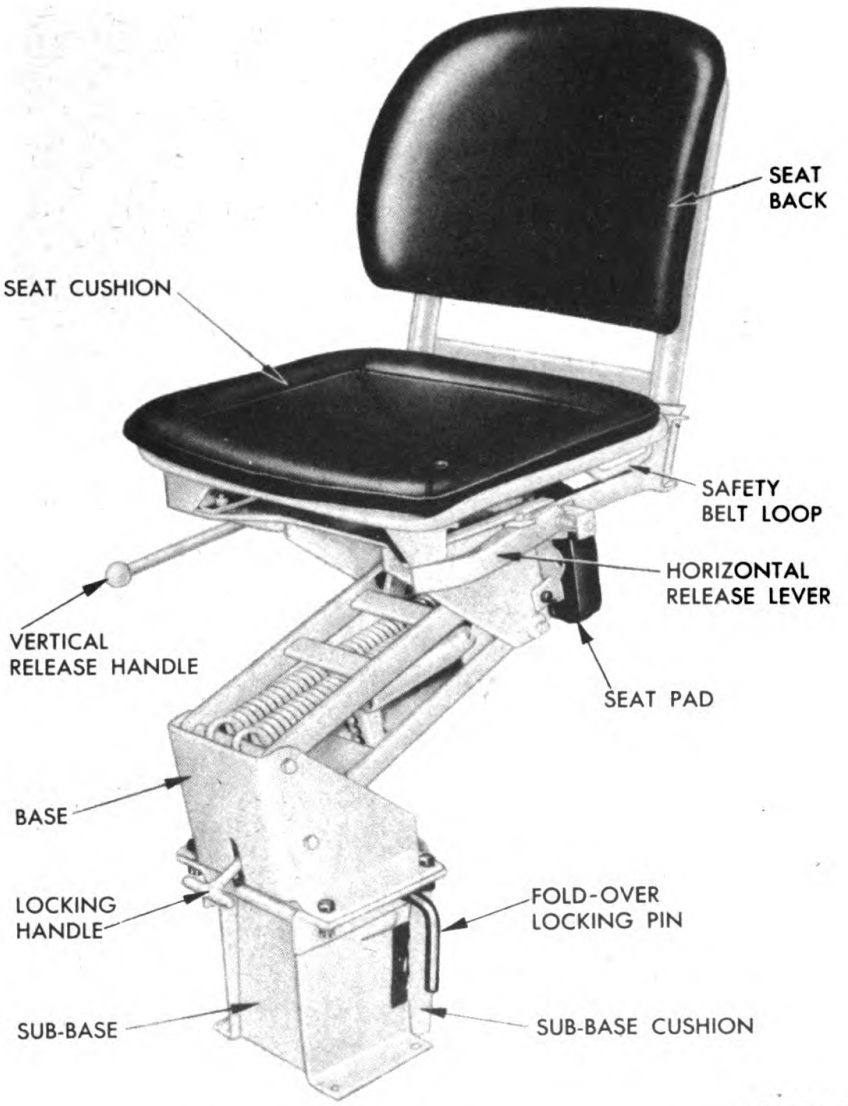


Figure 181 — Assistant Driver's Seat

b. Removal. Slide the safety lock back, loosen the knurled nut, and remove the periscope from holder.

c. Installation. Insert the periscope in the holder, tighten the knurled nut, and secure the safety lock.

164. ENGINE COMPARTMENT DOORS AND COVER PLATES.

a. Description (fig. 182). The engine compartment covers consist of front and rear covers, two doors, and an engine compartment floor plate. The engine compartment doors are mounted directly to the hull. The doors are provided with shutters under the grilles, and are controlled by a cable operated in the fighting compartment.

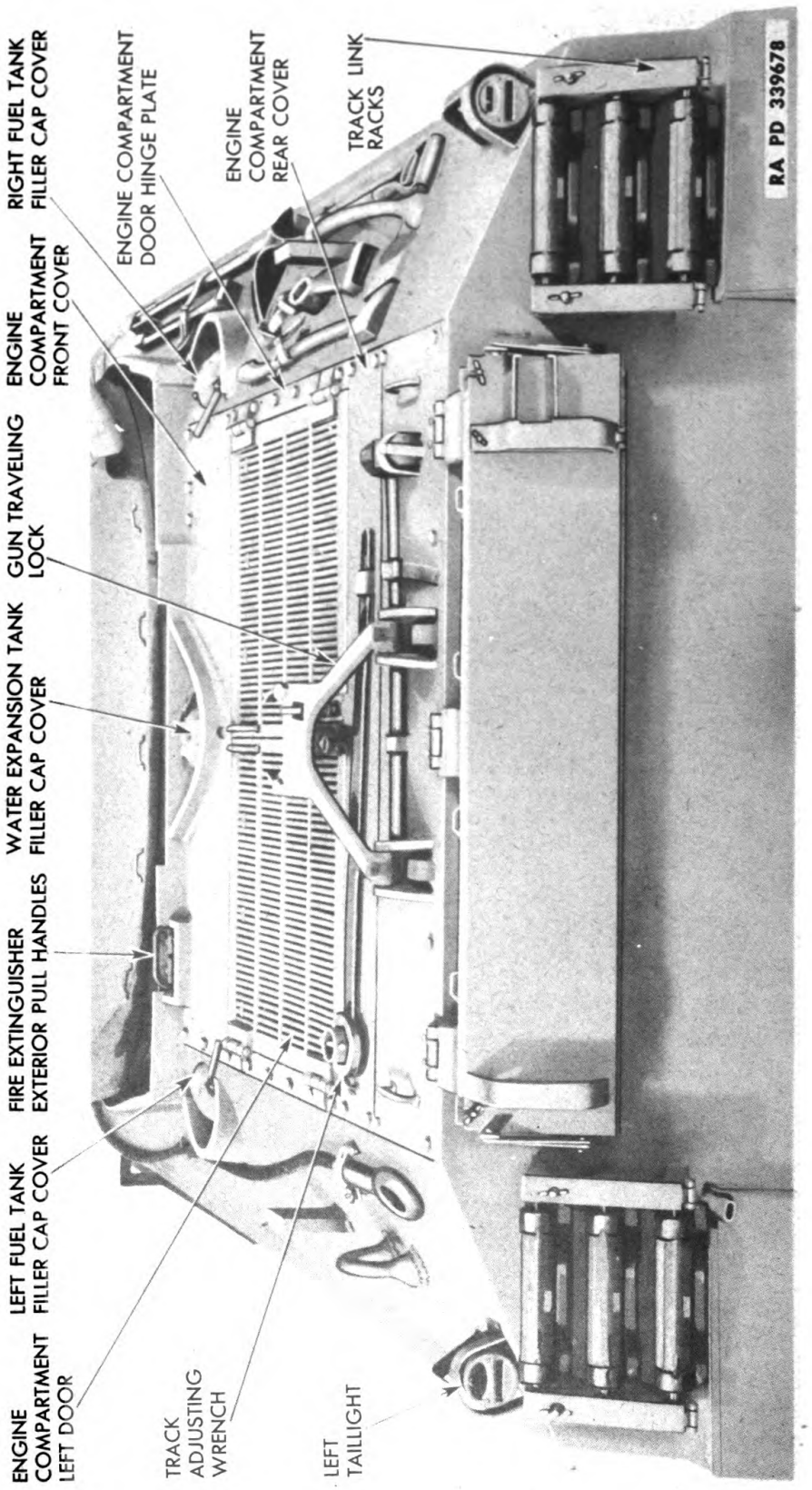


Figure 182 — Engine Compartment Doors and Covers

b. Removal of Doors (fig. 182). Remove the two bolts that secure each door at the lifting handles. Open both doors and disconnect both shutter control cables at the hinged ends of the doors. Remove the six bolts that secure each of the hinge plates to the hull. Remove the doors and hinge plates from the hull. Remove the cotter pin at each of the four hinges and remove the hinge pins.

c. Installation of Doors (fig. 182). Install the hinge pins and cotter pin. Place the door in position on the hull. Use a long-nose drift to line up the holes in the hinge plate with the holes in the hull. Install the six bolts that secure the hinge plate and door to the hull. Connect the shutter control cable at each door. Close both doors, and install the four bolts at the lifting handles.

d. Removal of Cover Plates (fig. 182). Remove the engine compartment doors and hinge plates (subpar. **b** above). Remove screws attaching cover plates to hull and remove the plates.

e. Installation of Cover Plates (fig. 182). Position plates on the hull and install screws. Install doors and hinge plates (subpar. **c** above).

f. Removal of Engine Compartment Floor Plates (fig. 186). Remove the locking wires from cap screws attaching floor plate to hull. Remove the screws, leaving one at each corner of the floor plate. Place a roll-away jack at center of the plate, remove the remaining screws, and lower the floor plate.

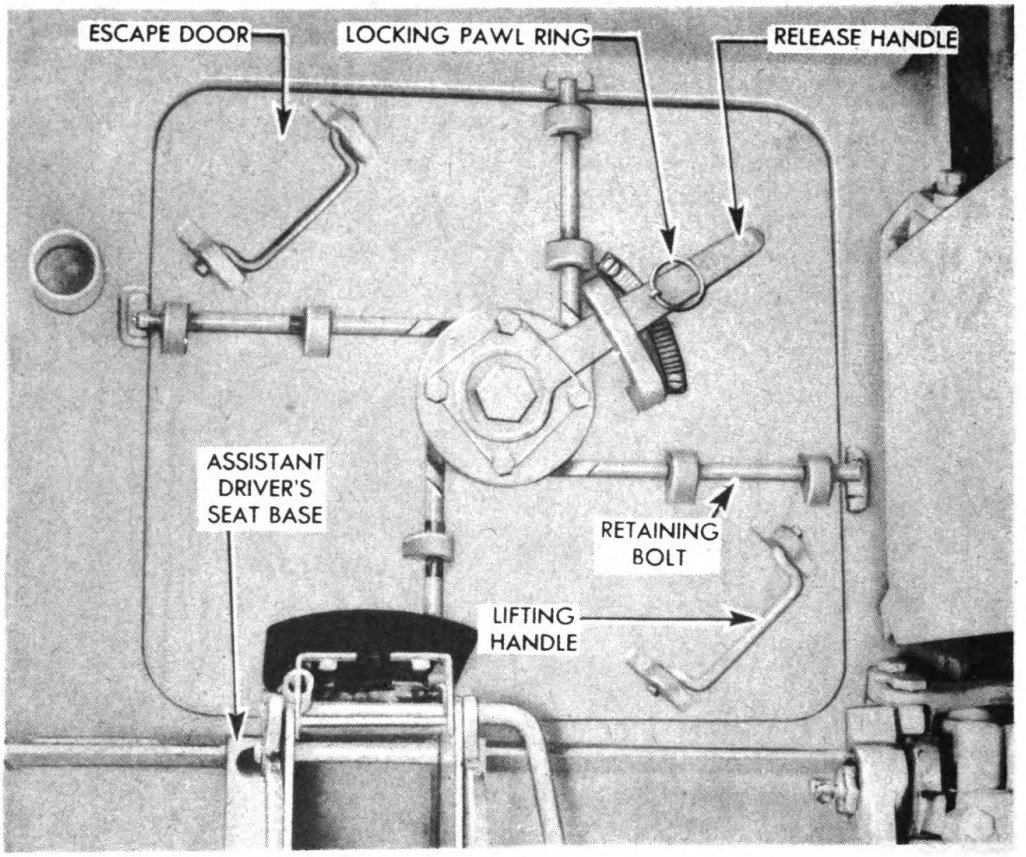
g. Installation of Engine Compartment Floor Plate (fig. 186). Place a jack at the center of floor plate and raise the plate in position against the bottom of hull. Install a screw at each corner of the plate and remove the jack. Install the remaining screws and secure with locking wire.

165. ESCAPE DOOR.

a. The escape door is located in the vehicle floor back of the assistant driver's seat (fig. 183). The escape door is important to the safety of the crew and should be checked frequently for ease of operation. It should be removed, cleaned of dirt and rust, and its working parts lubricated at regular intervals.

166. SAND SHIELDS AND FENDERS.

a. Description. The tracks are covered by removable sand shields and fenders at the front and rear of the vehicle and by skirt plates along the sides (fig. 1). The sand shields are attached to the hull by quick-action, slotted fastening studs and joined to the skirt plates by a reinforcing slip joint. The fenders serve as a support for the front sand shields and are bolted to the hull.



RA PD 339679

Figure 183 — Escape Door — Installed

b. Removal.

(1) FRONT AND REAR SAND SHIELDS. Release all slotted fastener studs, and remove bolts and radio ground fasteners at the middle ends of shields. Remove the sand shields.

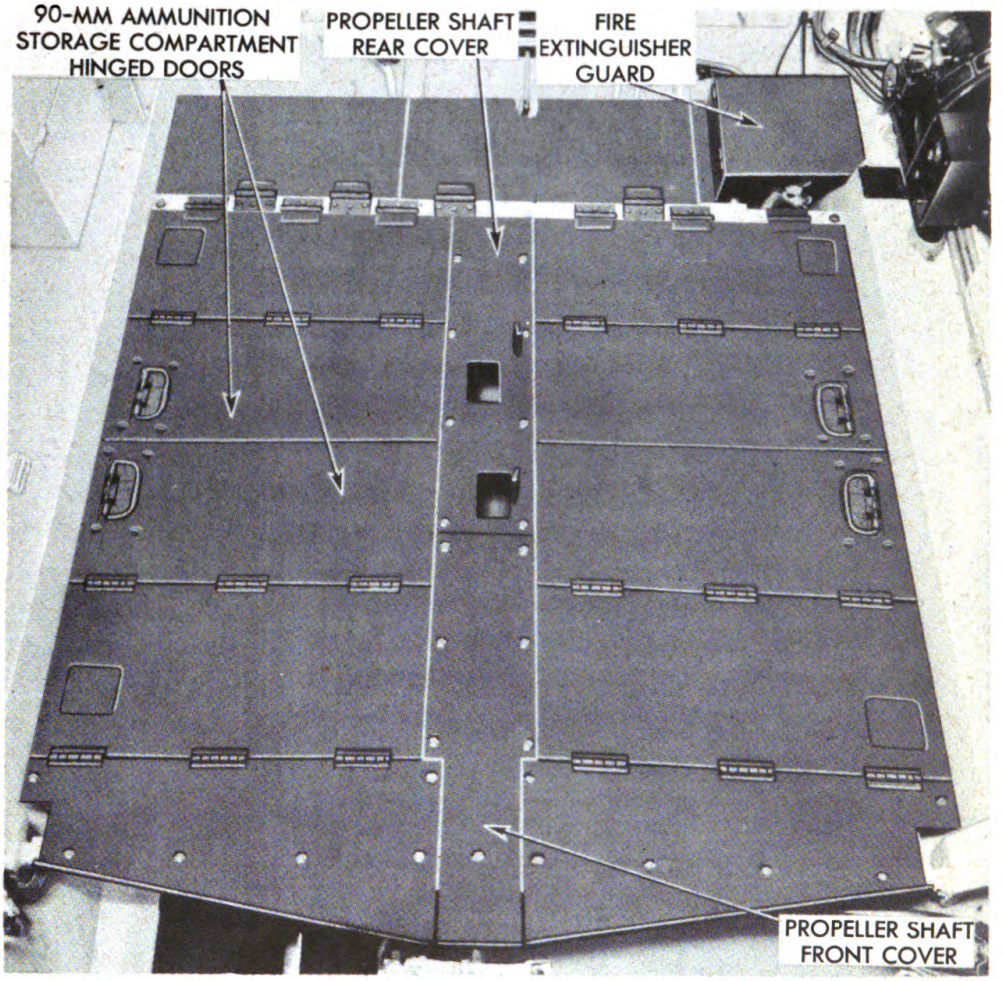
(2) SKIRT PLATES. Remove three bolts and nuts at each end of the skirt plate and release slotted fastening studs attaching plate to hull. Remove radio ground fastener at upper corner of skirt plate and slide the skirt plate down from the slip joint.

(3) FENDERS. Remove the front sand shield (subpar. (1) b above). Remove screws and bolts attaching fender to differential housing and hull. Remove the fender.

c. Installation.

(1) FRONT AND REAR SAND SHIELDS. Position sand shields on hull, install bolts and nuts, and tighten slotted fastening studs. Install radio ground fastener at middle ends of shields and tighten securely.

(2) SKIRT PLATES. Slide skirt plates in position on sand shield slip joint plates, install bolts and nuts at each end and tighten fastening studs.



RA PD 339680

Figure 184 — Fighting Compartment Floor

(3) FENDERS. Position fender on differential housing, install bolts, nuts and lock washers. Install front sand shields (subpar. (1) preceding).

167. FIGHTING COMPARTMENT FLOOR.

a. Description. The fighting compartment floor consists of metal plates which cover the 90-mm ammunition storage boxes (fig. 184). These plates are hinged to each other or to supports. They are readily removable or can be folded back for quick access to the ammunition boxes. The center narrow floor plates cover the propeller shaft and are bolted to center supports.

168. GUN TRAVELING LOCK.

a. Description. The gun traveling lock is hinged to brackets mounted on the rear engine compartment cover plate (fig. 197). To release the gun from the gun traveling lock, pull down on the release ring and, at the same time, raise the gun. To lock the gun in the gun traveling lock, hold the gun traveling lock jaws in a halfway open position and, at the same time, lower the gun into the gun traveling lock.

b. Replacement. Drive the lock pin from the right-hand side of each bracket. Drive both hinge pins from the brackets and remove the gun traveling lock. Position the gun traveling lock in the brackets and install the two hinge pins, making sure the lock pin hole in the hinge pin is in line with the lock pin hole in each bracket. Install the lock pin in each bracket.

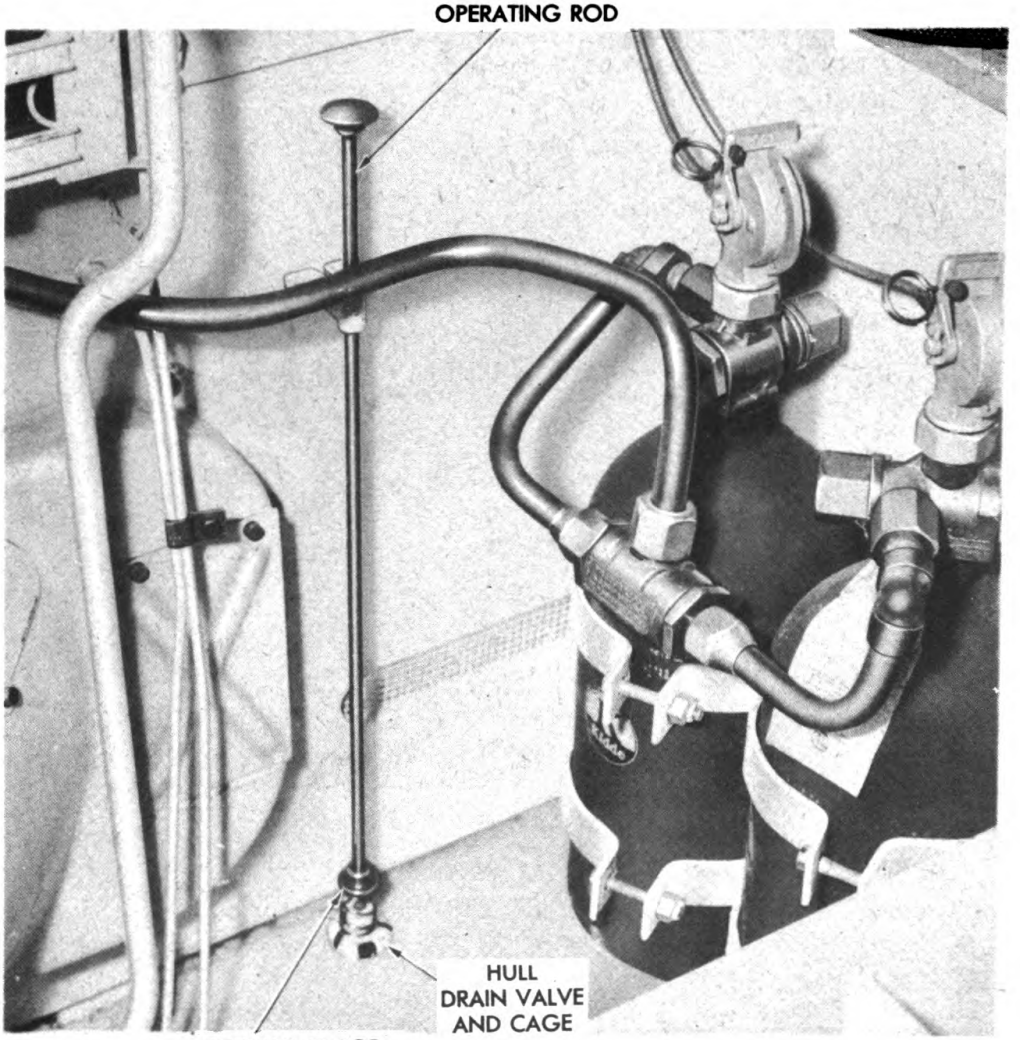
169. HULL DRAIN VALVES.

a. Description (fig. 185). Six spring-loaded, poppet-type valves are mounted in the hull floor to drain the vehicle of accumulated water, oil, or fuel. The valves in the driver's compartment are located in front of the assistant driver's seat and at the rear side of the driver's seat. Two valves with operating rods are located on either side at the rear of the fighting compartment. The two valves in the engine compartment have no operating rods.

b. Removal. Block valve in closed position from below. Depress spring to clear taper pin in valve stem below knob. Drive lightly on small end of pin to remove it from knob. Remove knob and spring. If valve is equipped with operating rod, remove screws attaching rod bracket to hull, and lift rod and rod retainer out as a unit. Remove blocks and withdraw valve from below.

c. Reseating Drain Valves. If drain valves leak due to corroded seat, they can be repaired by reseating the valve on the valve seat. Remove the valve and coat surface of seat with coarse valve grinding compound. Turn valve on its seat with reciprocating motion to grind valve and seat. Wipe clean and test for seating, using prussian blue to show high spots. Install valve (subpar. **d** below).

d. Installation. Insert valve in cage, and block in closed position from below. Install spring and knob. Depress spring and install taper pin. If valve operating rod was removed, install rod in rod returner and replace locking pin. Remove blocking from below valve. Lubricate valve stem with engine oil and operate the valve several times.



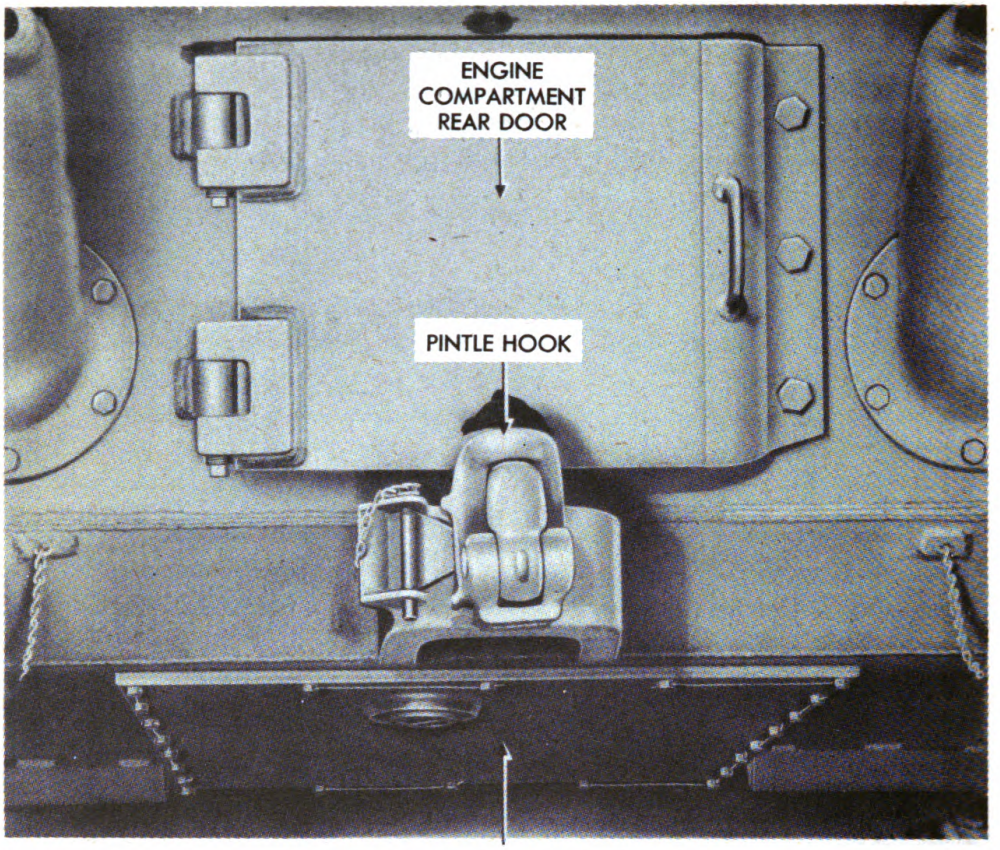
RA PD 339681

Figure 185 — Hull Drain Valve — Fighting Compartment

170. MISCELLANEOUS STOWAGE BOXES AND RACKS.

a. Description. Boxes and racks for ammunition and other equipment are located on the right and left sponsons. Boxes for 90-mm ammunition stowage are under the fighting compartment floor (fig. 184).

b. Replacement. Remove bolts or screws attaching boxes and racks to their supports or to the sponson. To install, place box or rack in its proper position and install attaching bolts or screws.



RA PD 320932

Figure 186 — Pintle Hook and Engine Compartment Rear Door

171. PROTECTIVE PADDING.

a. Description. Sponge-type protective padding is attached around the inside of drivers' door openings (fig. 179).

b. Replacement. Padding retainer is spot-welded to under side of door openings. Remove old padding with chisel and clean the surface of door openings. Install new padding and spot-weld to hull.

172. TOWING SHACKLES AND PINTLE HOOK.

a. Description. Two towing shackles are provided at the front of the vehicle and two at the rear. A pintle hook is mounted at the rear and is used for towing a trailer only (fig. 186). The pintle hook is attached to the hull bracket by means of a large nut on the end of the pintle stud.

b. Replacement. Remove the cotter pin and castellated nut that secure the pintle hook to the bracket and remove the pintle. To

install, position the pintle on the bracket and install the castellated nut and cotter pin.

Section XXXIII

AUXILIARY EQUIPMENT

173. AUXILIARY GENERATOR.

a. Description. The auxiliary generator (fig. 13) is a Homelite unit, Model HRUH-28, consisting of a single-cylinder, two-cycle, air-cooled gasoline engine directly connected to a 30-volt, 50-ampere (1,500-watt) shunt wound generator with integral starting windings. High-tension ignition current is supplied to the spark plug by a magneto at the rear of the engine. The engine is air cooled by a flywheel fan. The generator has a separate control box with an ammeter, starting switch, and circuit breaker. The carburetor is equipped with a sediment bowl and air filter. The generator output is controlled by a generator regulator similar to the engine generator regulator (par. 100 a). A separate fuel tank, above the generator, supplies a mixture of gasoline and oil to the generator engine by gravity.

b. Clean Air Filter. As directed on Lubrication Order (par. 32), clean air filter. Remove the two mounting screws in end of filter. Pull filter off carburetor. Thoroughly clean filter in dry-cleaning solvent. Dip filter in engine oil, seasonal grade, and allow it to drain dry. Position the filter on the carburetor and install the screws with lock washers.

c. Clean Sediment Bowl. Clean sediment bowl when water or foreign material has collected in the bowl. If fuel in bowl soon again becomes contaminated, it may be necessary to drain the fuel tank (subpar. l (1) below). Close fuel valve at bottom of fuel tank. Loosen the knurled nut at the bottom of the glass sediment bowl (fig. 13). Swing bail up out of the way and remove bowl. Empty the bowl and wipe it dry. Remove the wire mesh screen, wipe it clean, and blow dry with compressed air. Install the screen, using new gasket if necessary. Center the bowl against the gasket and secure it by tightening bail nut. Open fuel valve at bottom of tank.

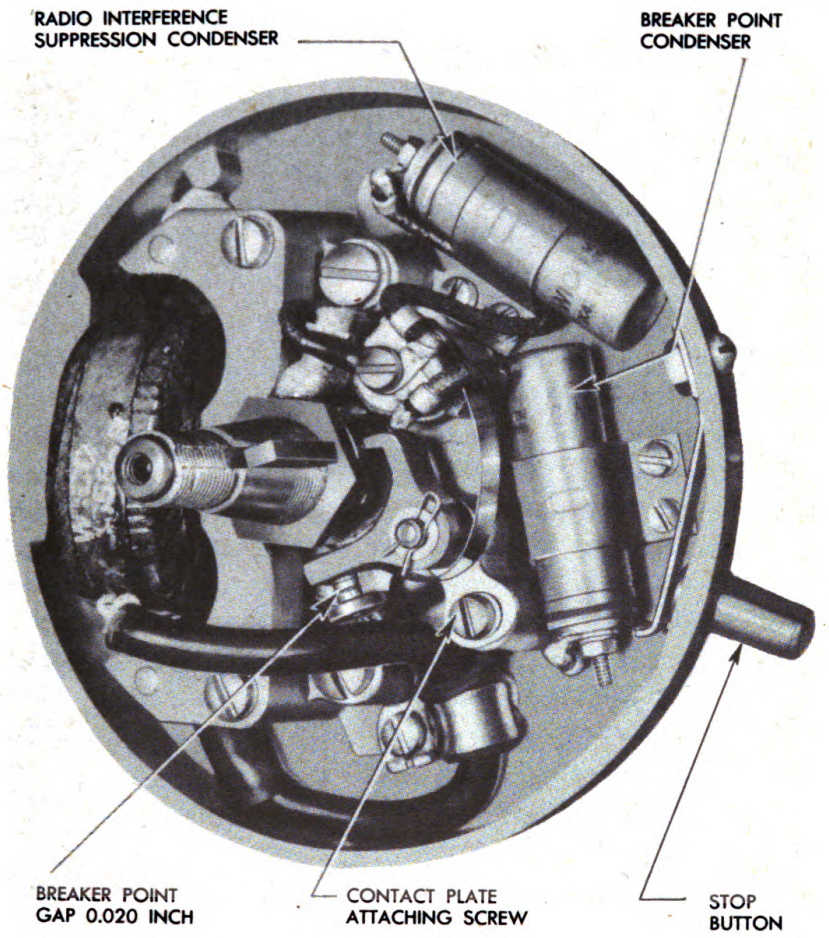
d. Adjust Carburetor Fuel Mixture. If engine runs slow, lacks power, or is hard to start, it may be necessary to adjust carburetor fuel mixture. Start and run engine until it has reached normal operating temperature. Remove plug screw from bottom of stuffing box nut (fig. 13). Hold gland from turning, and loosen stuffing box nut. With narrow-bladed screwdriver, turn the needle valve adjusting screw inside the stuffing box nut clockwise for a leaner mixture, and counterclockwise for a richer mixture. If engine cannot be started,

turn adjusting screw in until it seats lightly, and then back it out 1¾ turns to supply sufficient fuel for starting. CAUTION: *Never force screw into seat as to do so will damage needle valve seat.* With engine warmed up and running under full load, turn adjusting screw clockwise until engine speed just starts to fall off. Then slowly turn adjusting screw counterclockwise until engine reaches maximum governed speed. Give screw ⅛ turn more for correct fuel mixture setting at average temperatures, or from ⅛ to ¼ turn for operation in extremely cold weather. Hold the adjusting screw from turning while tightening the stuffing box nut. Readjust screw setting if engine speed is affected when stuffing box nut is tightened. Install the plug screw with gasket. Stop engine.

e. Inspect and/or Replace Spark Plug. Unscrew coupling nut and remove connector from spark plug. Remove spark plug. Using wire gage, check spark plug gap. If gap is more than 0.035 inch, replace with a new champion HO-14S spark plug. Clean the plug if it is not replaced. Clean carbon from spark plug adapter in top of cylinder. If holes are erroded or edges are burned, notify higher authority to replace baffle. Install spark plug with new gasket without using excessive force. Connect conduit to plug.

f. Inspect and/or Adjust Breaker Points. Remove the magneto rotor by unscrewing the puller nut at rear end of engine. Remove spark plug (subpar. e above) to relieve compression. Turn flywheel counterclockwise until breaker is on peak of cam and points are wide open (fig. 187). Inspect condition of points to see that they are not excessively dirty, pitted, or burned. Clean the points with a cloth soaked in dry-cleaning solvent, and wipe with a clean dry cloth. Uneven points, and ones not too badly pitted, can be dressed with a fine hone. Wipe points clean with dry cloth after honing. Notify higher authority to replace excessively worn or unserviceable breaker points. Measure breaker point gap with a 0.020-inch feeler gage. If required, adjust gap by slightly loosening the screw which attaches the contact plate to the stator plate. Slowly move the contact away from or toward cam until only a slight drag is felt when gage is drawn straight through the gap with breaker in contact with peak of cam. Tighten screw and recheck adjustment. Again wipe points with clean cloth to remove all trace of oil. Install the magneto rotor and tighten puller nut securely. Install spark plug and connect conduit.

g. Clean Generator Commutator. When inspection reveals commutator is excessively dirty and there is excessive arcing at the brushes, clean generator commutator. Remove attaching screw and lift off brush head cover plate. Cut a piece of wood shaped to fit squarely against commutator between the two brush holders. Place a clean piece of flint paper, grade 2/0, abrasive side out, over end of stick. Start engine and gently press paper against commutator. Be



RA PD 339682

Figure 187 — Auxiliary Generator Magneto With Rotor Removed

sure to hold stick square with commutator and move it back and forth across commutator until commutator is thoroughly clean and bright. Stop engine. Blow dust out of end of generator. Install cover plate.

h. Replace Starting Switch. Remove the screws from upper corners of control box cover. Slide cover up and swing it up on top of box. Make sure 24-volt master switch is turned off. Disconnect wires from terminals on switch (fig. 109). Remove the two screws which attach switch to control box and lift out switch. Install switch by reversing the removal procedure. Install cover on box.

i. Replace Ammeter. Remove the three screws which attach ammeter to control box cover. Remove cover from box. Disconnect wires from terminals on ammeter and lift out ammeter (fig. 109).

When installing ammeter, first attach it to control box cover, then connect the wires and install the cover on the box.

j. Replace Circuit Breaker. Remove control box cover. Make sure 24-volt master switch is turned off. Remove the screws which attach circuit breaker to bracket in control box (fig. 109). Slide circuit breaker out of bracket. Disconnect wires from terminals and lift out circuit breaker. To install circuit breaker attach wire No. 31 to lower terminal, and the lead to the shunt to the other terminal. Complete the installation by reversing the remainder of the removal procedure.

k. Replace Auxiliary Generator Regulator. Remove safety nuts which attach regulator to support (fig. 109). Lift regulator off studs and tip the top in to reach terminal box. Remove terminal cover and remove wires from terminals. Disconnect conduits from regulator. To install regulator, connect wire No. 30 to terminal "F", wire No. 31 to terminal "A", and wire No. 29 to terminal "B". Connect the conduits to the regulator, install terminal cover, secure the wing nuts with locking wire. On each of the mounting studs place one internal-external toothed lock washer, one end of a grounding strap, one mounting cushion, the other end of the grounding strap, and another internal and external teeth lock washer. Position the regulator on the studs and install the safety nuts.

l. Remove Fuel Tank.

(1) DRAIN FUEL TANK. Remove sediment bowl (subpar. **c** above). Place suitable container with 6-gallon capacity under fuel filter. Open fuel valve at bottom of tank and permit it to drain dry. Close drain valve and install sediment bowl.

(2) REMOVE FILLER NECK. Raise filler cap cover. Remove filler cap. Remove screws from upper filler neck adapter. Remove adapter, filler neck, and spacers. Remove screws which attach lower adapter and remove adapter.

(3) REMOVE FUEL TANK. Follow procedure in subparagraph **n** below and remove the auxiliary generator. Remove cap screws which attach tank to bulkhead and hull (fig. 109). Slide the tank forward to clear fire extinguisher controls and lower inner end, and lift tank out.

m. Install Fuel Tank. Raise the fuel tank into position and slide it back against bulkhead. Install the attaching cap screws with lock washers. Attach the lower adapter and spacers. Position the upper adapter and filler neck so neck is centered in hull opening, and install attaching screws. Connect fuel hose to valve at bottom of tank. Follow procedure in subparagraph **o** below and install auxiliary generator. Open valve at bottom of tank. Fill fuel tank

as directed on Lubrication Order (par. 32). Install filler cap, and close and lock the cover.

n. Removal of Auxiliary Generator.

(1) DISCONNECT FUEL AND EXHAUST LINES. Position the turret so that the generator is accessible, and open the 24-volt master switch. Shut off the fuel at the carburetor and fuel tank. Disconnect the flexible fuel line at the carburetor. Remove the boot around the air duct and disconnect the flexible exhaust line from the engine flange under the edge of the duct. These screws are the safety-type, necessitating the use of a safety screw wrench.

(2) REMOVE REGULATOR ASSEMBLY. Remove the attaching nuts and cap screw which hold the auxiliary generator regulator bracket to the battery box and sponson. Raise the regulator and bracket, and rest the assembly on top of the battery box. NOTE: *Do not disconnect the regulator wiring.*

(3) DISCONNECT WIRING. Remove the cover from the control box on the generator and swing it up over the top of the control box. Disconnect the three wires from studs marked "A", "F", and "B" which lead from the conduits attached to the bottom of the control box.

(4) REMOVE AUXILIARY GENERATOR ASSEMBLY. Remove the four mounting nuts which hold the angle mountings of the generator to the rubber mounting cushions, and disconnect the ground strap from the sponson (fig. 109). Raise the generator off the mounting studs and tip it back to provide clearance to disconnect the two conduits from the bottom of the control box. Pull the conduits and wires away from the box and remove the auxiliary generator assembly from the sponson. Attach a sling to the assembly and lift it out through the turret.

o. Installation of Auxiliary Generator.

(1) PLACE ASSEMBLY ON SPONSON AND CONNECT CABLES. Lower the auxiliary generator assembly through the turret with a sling and place it on the sponson. Remove the cover from the control box on the generator and swing it up over the box. Tip the generator assembly back and insert the wires from the two conduits into the respective openings in the box. Be sure the wires are inserted far enough through the control box to make the connections. Then attach the conduits to the box and tighten.

(2) INSTALL MOUNTING NUTS AND CONNECT EXHAUST PIPE. Place the generator on the mountings and install the attaching nuts (fig. 109). Connect the flexible exhaust pipe flange to the engine with the four safety screws. Attach ground strap to sponson.

(3) INSTALL REGULATOR ASSEMBLY. Position the regulator and bracket assembly over the mounting studs on the battery box. Install the nuts and cap screw in the sponson (fig. 109).

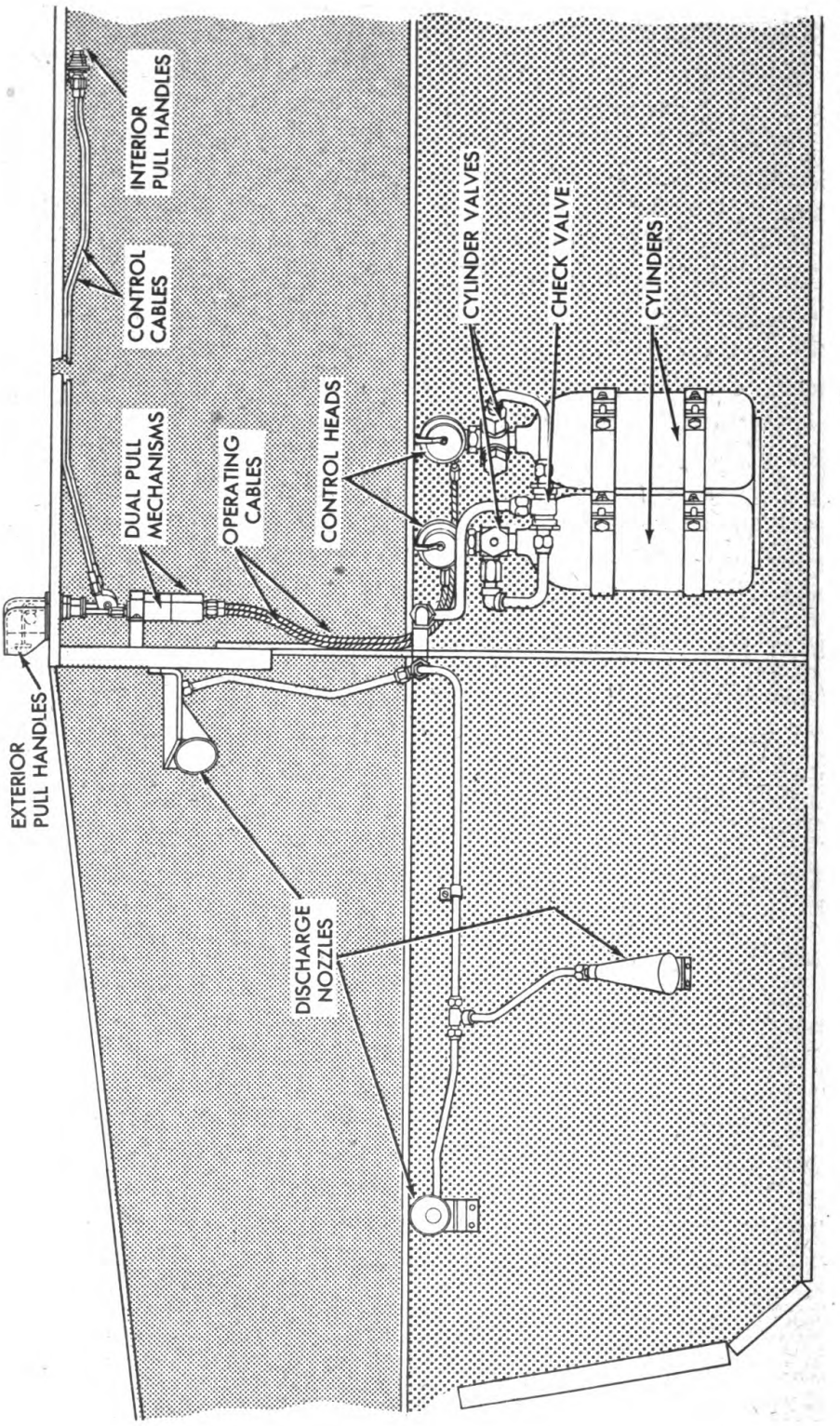


Figure 188 — Fixed Fire Extinguisher System

(4) CONNECT FUEL LINE. Connect the flexible fuel hose to the carburetor and install the rubber boot over the air duct (fig. 13).

(5) CONNECT WIRING. Connect wire No. 29 to the "B" terminal, wire No. 31 to the "A" terminal, and wire No. 30 to the "F" terminal in the control box. Install the control box cover.

(6) START GENERATOR AND TEST OPERATION. Turn on the fuel at the tank and carburetor, close the 24-volt master switch, and start the generator. If the generator does not operate satisfactorily, refer to paragraph 43. After testing, stop the generator engine, turn off the fuel at the carburetor, and open the 24-volt master switch.

(7) RECORD INSTALLATION OF AUXILIARY GENERATOR. Make proper entry on W.D., A.G.O. Form No. 748, MWO and Major Unit Assembly Replacement Record, whenever auxiliary generator or regulator is replaced.

174. FIRE EXTINGUISHER SYSTEM.

a. Description. The vehicle is equipped with a carbon-dioxide fixed fire extinguisher system for use in smothering fires in the engine compartment (fig. 188). The system consists of two fixed fire extinguisher cylinders, each containing 10 pounds of carbon dioxide when fully charged. The cylinders are clamped vertically in brackets located in the left rear corner of the fighting compartment beneath the subfloor. Cylinders are connected by tubing to six nozzles in the engine compartment. The valves are equipped with removable control heads and can be operated by two pull handles mounted on the underside of the hull roof, above and to left of driver's seat (fig. 14), or by two pull handles on outside of hull at left rear of turret (fig. 182). A check valve in the connection between the two cylinders and the main discharge tube prevents the gas from escaping into the compartment if one cylinder is operated with the other removed.

b. Removal of Fire Extinguisher Cylinders. Remove guard plate over control heads (fig. 184). Unscrew the control head swivel nut from the cylinder and remove the head (fig. 189). 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 (fig. 189). Install the control head on the cylinder. Install fire extinguisher guard plate.

d. Removal of Conduit and Cable (Dual-pull-to-control-head).

(1) REMOVE CONDUIT (fig. 190). Unscrew the large swivel nut and remove the control head from the cylinder. Disconnect the conduit at both ends and remove the clamp from the bulkhead. Screw

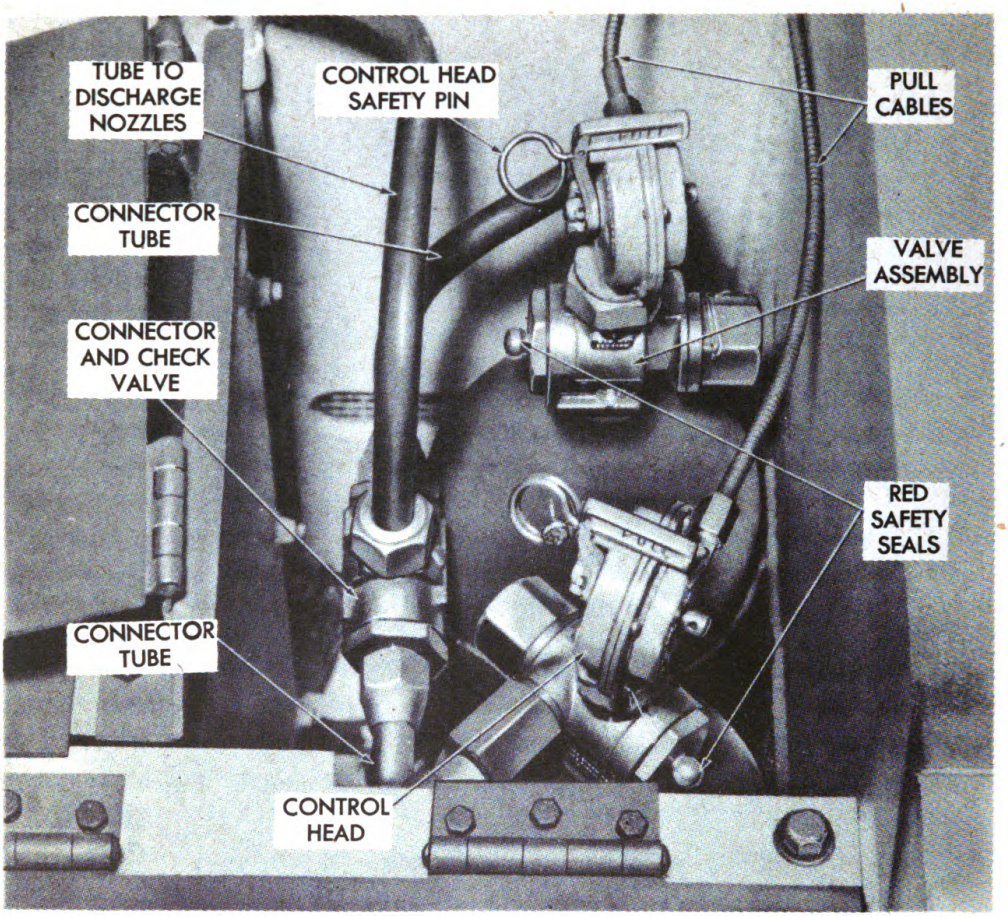


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Figure 189 — Fire Extinguisher Cylinders and Connections

off the lower half of the dual pull mechanism and disconnect the cables (fig. 190). Slide the conduit off the upper end of the cable.

(2) REMOVE CABLE. Remove the lock wire and three screws which attach the cover plate to the control head and remove the cover. Disconnect the cable and pull it out of the control head.

e. Installation of Conduit and Cable (Dual-pull-to-control-head).

(1) CONNECT CABLES. Insert the ends of the two pull cables and the end of the control cable into a 2-inch piece of copper tubing. Pull the upper cables tight and slide the copper tube up to the upper half of the dual pull mechanism. Crimp each end of the copper tube around the cables, then hold the upper end of the tube and twist the lower end two complete turns to securely connect the cables.

(2) INSTALL CONDUIT. Slide the lower half of the dual pull barrel and the conduit over the cable. Screw the barrel into place

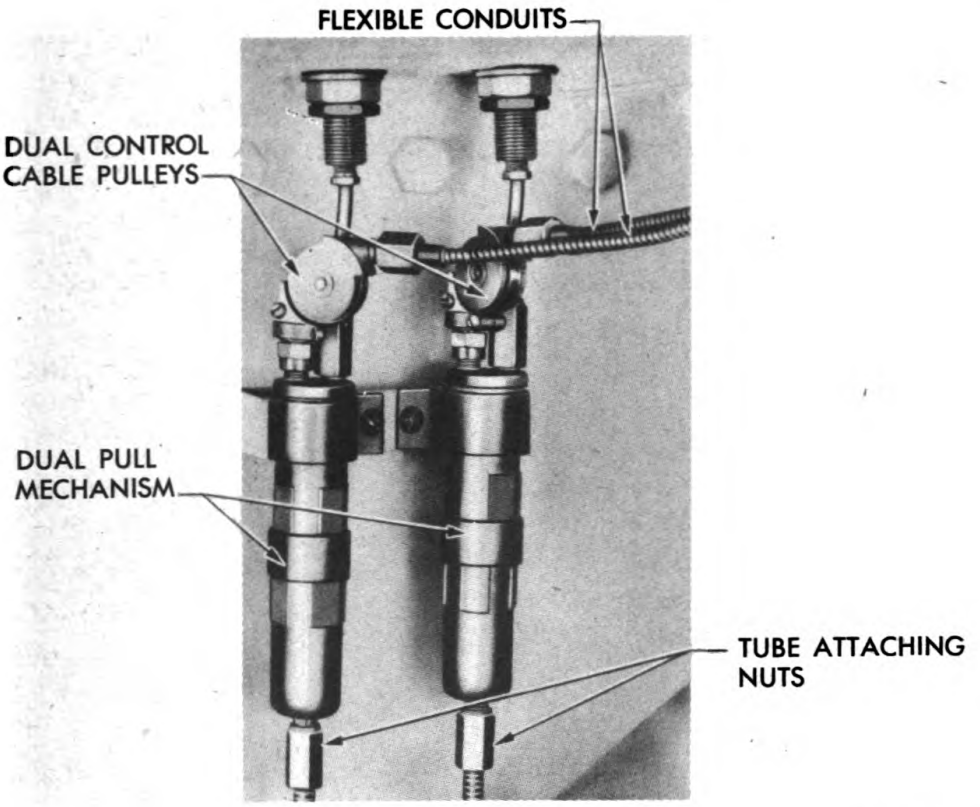

Figure 190 — Dual Pull Mechanism

and connect both ends of the conduit. Install the conduit clamp to the bulkhead.

(3) CONNECT CABLE TO CONTROL HEAD (fig. 191). Place a ½-inch pin between the pull cable and the pulley on top of the dual pull barrel to provide the proper slack in the cables. Turn the pulley in the control head clockwise until the pin contacts the stop and is in line with the arrow on the control body. With the pulley in that position, pull the cable tight over the ½-inch pin and connect it to the pulley in the control head, then remove the pin. Install the control head cover, then install the head on the cylinder.

f. Removal of Pull Cable (To Control Box on Top of Hull). Unscrew the large nut and remove the control head from both fire extinguisher cylinders. Remove the lock wire and three screws which attach the cover plate to the control head, and disconnect the cable from the head. Disconnect the conduit from the bottom of the dual pull barrel. Unscrew the lower half of the barrel and disconnect the cables. Pull the handle and cable out of the control box.

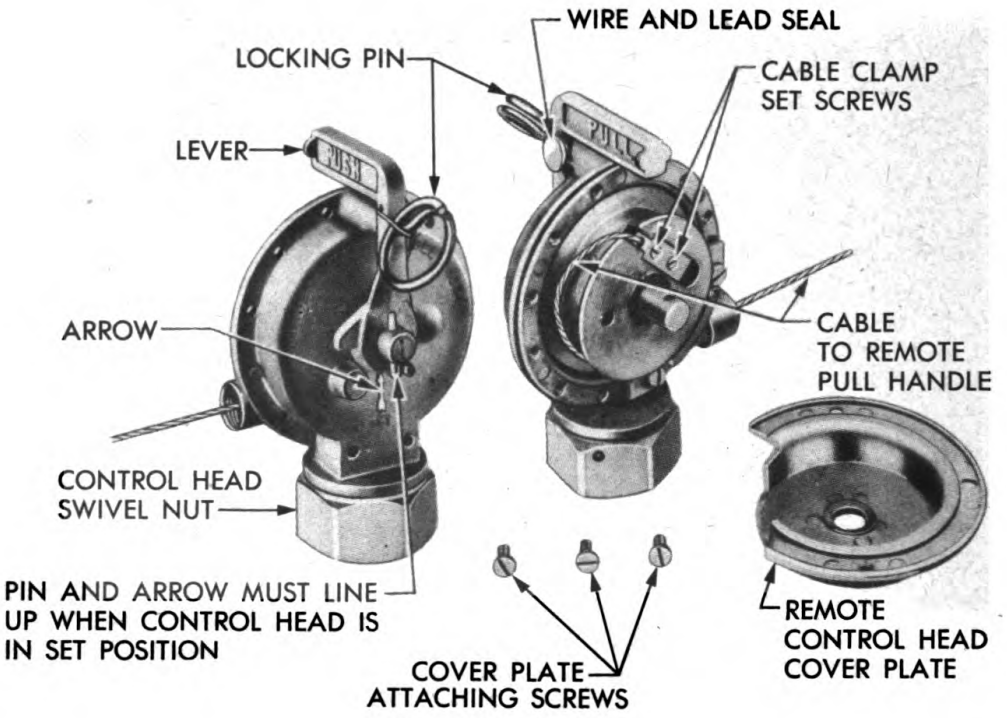

Figure 191 — Control Head Assembly

g. Installation of Pull Cable (To Control Box on Top of Hull).

(1) INSTALL CABLE. Remove the plate and pulleys from the control box. Attach cable to pull handle and thread cable over pulley and down through tube to dual pull barrel. Pull both cables tight while installing the plate in control box.

(2) CONNECT CABLES. Refer to subparagraph e (1) above.

(3) CONNECT LOWER HALF OF DUAL PULL BARREL AND CONDUIT. Screw the lower half of the dual pull barrel into place and connect the conduit to the barrel.

(4) CONNECT CABLE TO CONTROL HEAD. Refer to subparagraph e (3) above.

h. Removal of Pull Cable or Conduit (To Bracket Over Driver's Seat). Unscrew the large nut and remove the control head from the fire extinguisher cylinder. Remove the lock wire and three screws which attach the cover plate to the control head and disconnect the cable from the head. Disconnect the conduit from the bottom of the dual pull barrel. Unscrew the lower half of the barrel and disconnect the cables. Pull the handle and cable out of the bracket above the driver's seat. Disconnect the conduit at both ends. Remove the conduit clamps from the hull and remove the conduit.

i. Installation of Pull Cable or Conduit (To Bracket Over Driver's Seat).

(1) INSTALL CABLE AND CONDUIT. Attach the cable to the pull handle and insert the cable through the bracket above the driver's seat. Thread the cable through the conduit and pulley, and down through the dual pull barrel. Connect both ends of the conduit and install the clamps to the hull.

(2) CONNECT CABLES IN DUAL PULL BARREL. Refer to subparagraph e (1) above.

(3) CONNECT LOWER HALF OF DUAL PULL BARREL AND CONDUIT. Refer to subparagraph g (3) above.

(4) CONNECT CABLE TO CONTROL HEAD. (Refer to subparagraph e (3) above.

j. Removal of Tubes and Nozzles. Use preformed flared copper tubes (fig. 54) with fittings installed when making replacements. When removing tubes, use snug fitting wrenches and hold elbow or fitting from which the connector is being removed. To remove tube and nozzle, first remove tube clamps from engine compartment walls. Remove nozzle from bracket and unscrew tube coupling nut at nearest connection. Remove tube and nozzle, and disconnect the tube from nozzle.

k. Installation of Tubes and Nozzles. Attach one end of tube to nozzle and opposite end to tube connection, but do not tighten coupling nuts. Secure nozzle to bracket and install tube and clamps to engine compartment walls. Tighten all coupling nuts and connections.

175. CREW COMPARTMENT BLOWER.

a. Description. The crew compartment blower is a centrifugal fan-type blower mounted in the drivers' compartment directly above the transmission (fig. 192). The blower is driven by a 24-volt electric motor controlled by a toggle switch on the side of the blower. The flow of air is directed by two universal outlet elbows which are part of the blower assembly.

b. Removal. Turn off 24-volt master switch. Remove compartment light and bracket from blower. Remove toggle switch from blower and disconnect switch wire to blower motor. Remove three nuts and toothed lock washers attaching blower to ventilator base, and remove blower.

c. Installation. Position blower to hull ventilator base and install toothed lock washers and nuts. Connect blower switch wire to switch, and install switch to blower. Install compartment light and

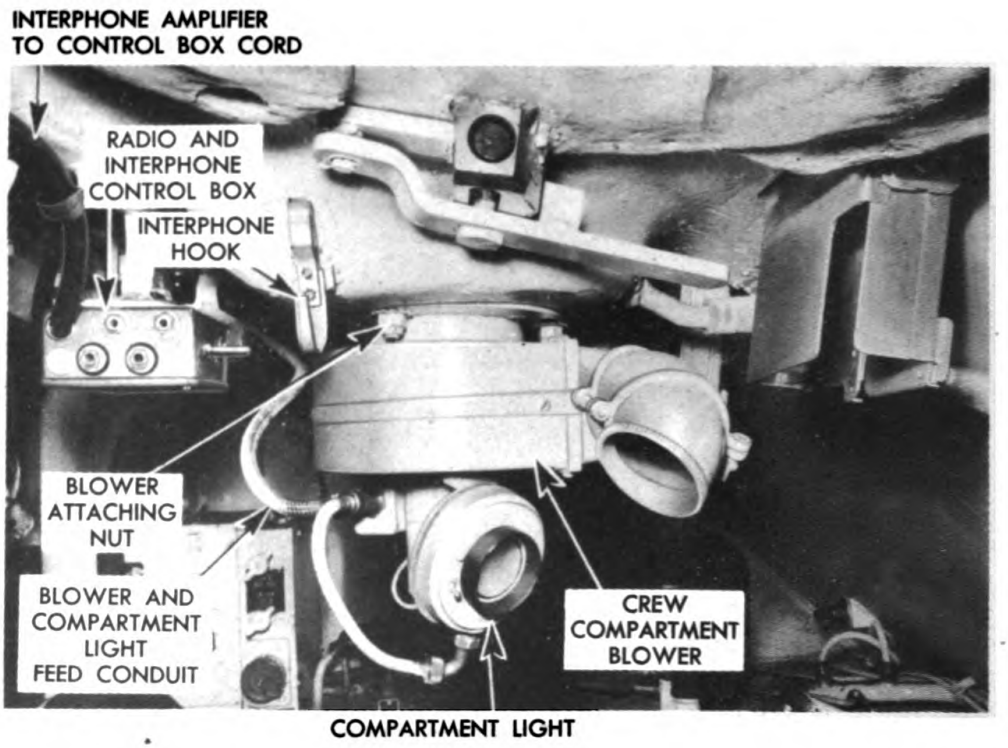

Figure 192 — Crew Compartment Blower

bracket to blower. Turn on 24-volt master switch. Turn on blower switch and operate blower to test installation.

176. DRIVERS' HOOD AND WINDSHIELD.

a. Description. Refer to paragraph 22 for description and operation of drivers' hood and windshield.

b. Removal of Windshield Wiper (fig. 111). Unhook the wiper blade and remove the holding screw just above the wiper arm hinge. Pry the wiper arm off the shaft. Unscrew nut on center of shaft and remove nut and collar. Remove lock nut, rubber washer, and retainer. Remove the two mounting bolts and nuts on each side of the wiper body on inside of frame. Disconnect two wires to wiper switch and remove the motor.

c. Installation of Windshield Wiper (fig. 111). Position wiper motor on windshield frame, connect wires to wiper switch, and install mounting bolts and nuts. Install lock nut, rubber washer, and retainer. Slide the wiper arm hinge on end of motor shaft and tighten screw in the center of the hinge. Install wiper blade.

PART FOUR — AUXILIARY EQUIPMENT

Section XXXIV

GENERAL

177. SCOPE.

a. Part Four contains information for guidance of personnel responsible for operation of this equipment. It contains only the information necessary to using personnel to properly identify, connect, and protect such auxiliary equipment while being used or transported with the main equipment. Detailed instructions on this equipment are contained in separate technical manuals.

Section XXXV

ARMAMENT INTRODUCTION

178. SCOPE.

a. Sections XXXV through XXXVIII contain instructions for the operation of the 90-mm Gun M3 in the Gun Mount M4 (T8). It lists the authorized ammunition, and contains information on the sighting equipment, for the 90-mm gun. For lubrication instructions on gun and mount, refer to Section XIV. For preventive maintenance, malfunction and correction, disassembly and assembly, and general maintenance, refer to TM 9-374. Lubrication instructions are contained in Section XIV.

b. The other armament on the 90-mm Gun Motor Carriage M36B1 is a Machine Gun, cal. .50 HB M2 mounted on a pedestal on top of turret bustle (fig. 193), and a Machine Gun cal. .30 M1919A4 mounted in the front of the tank on the right side (fig. 193).

179. CHARACTERISTICS.

a. The armament on the 90-mm Gun Motor Carriage M36B1 is employed chiefly against enemy tanks and other ground objectives. The 90-mm Gun M3 is mounted in the turret. The turret can be traversed 360 degrees manually or by a hydraulic traversing mechanism. The 90-mm gun can be elevated 30 degrees and depressed 10 degrees.

b. The cal. .30 machine gun in the front of the gun motor carriage on the right side is elevated and depressed manually, and fired by a

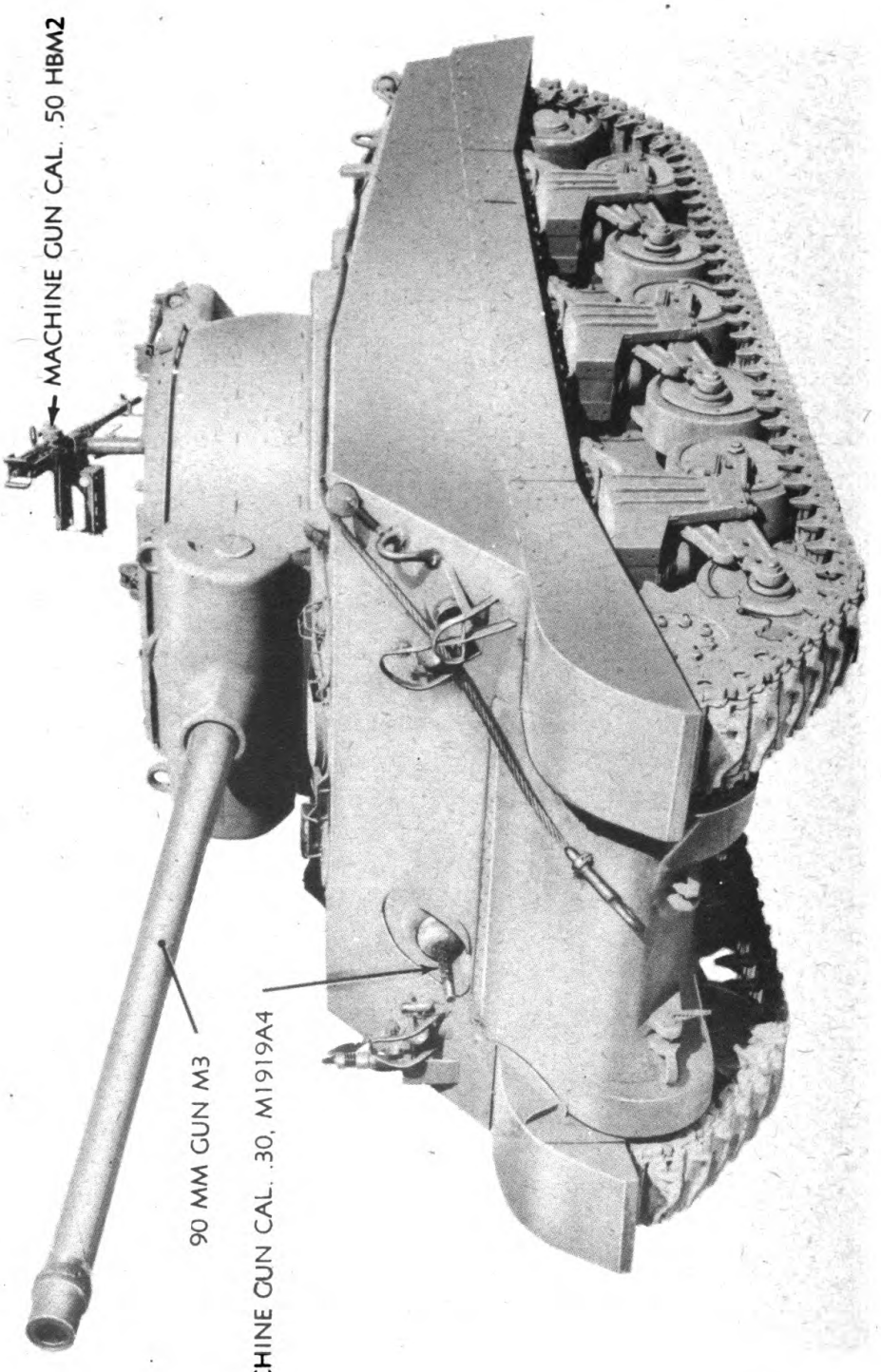

Figure 193 — 90-mm Gun Motor Carriage M36B1 — Three-quarter Right Front View

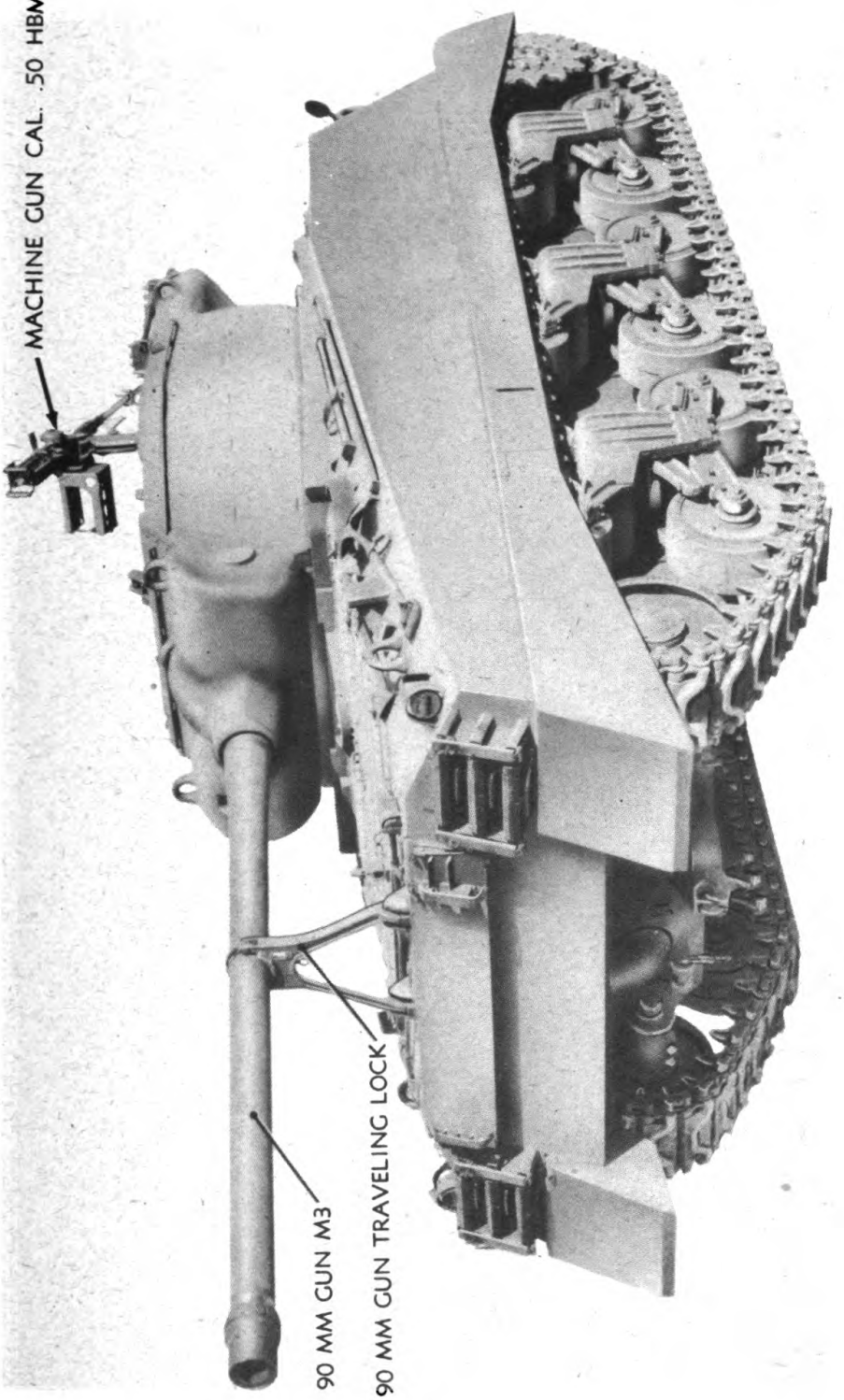

Figure 194 — 90-mm Gun Motor Carriage M36B1 — Three-quarter Right Rear View

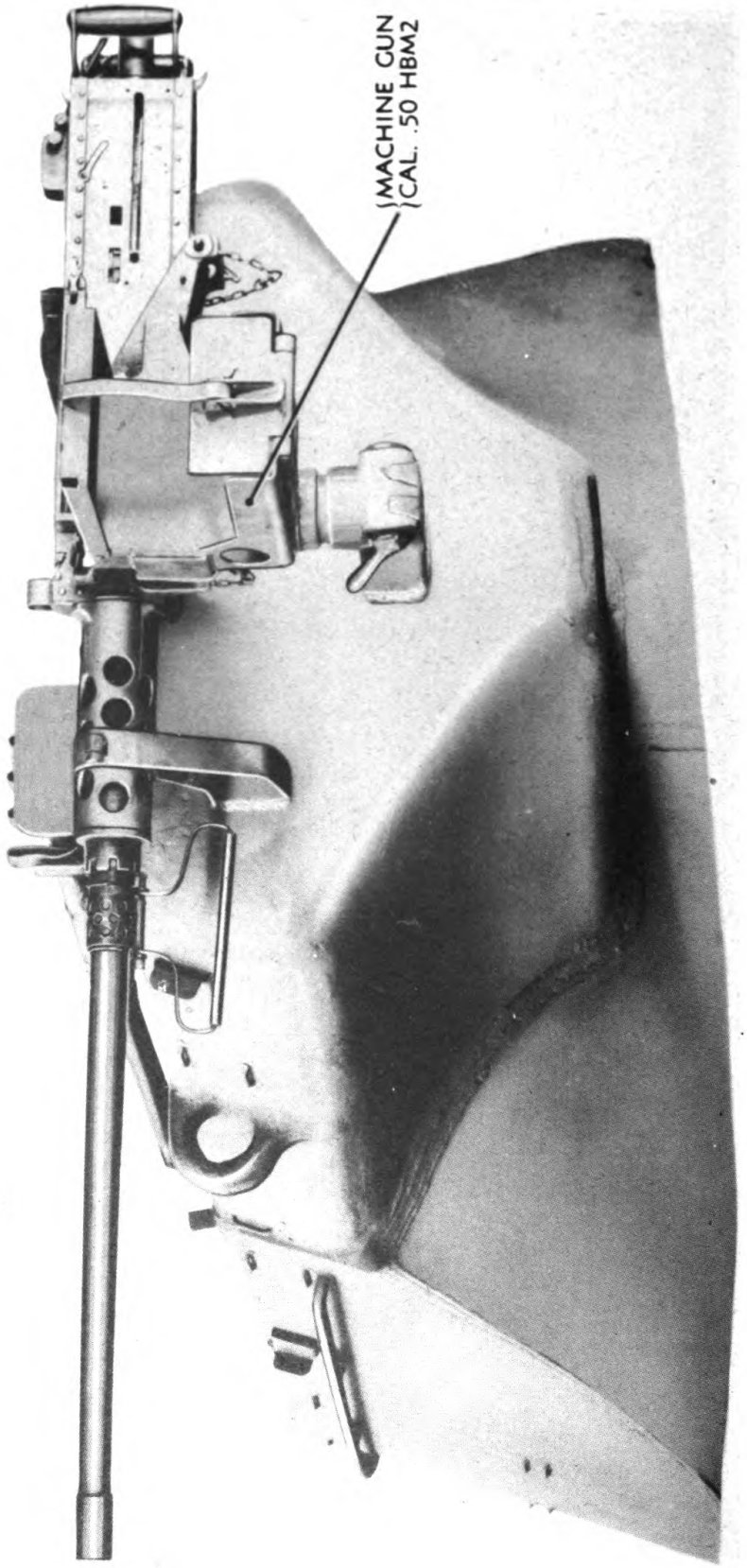

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Figure 195 — Cal. .50, HB, Machine Gun — Stowage Position

conventional trigger. Refer to FM 23-50 for complete information on its operation.

c. The cal. .50 machine gun is employed chiefly against enemy aircraft and is elevated and traversed manually, and fired by a conventional trigger. The machine gun can be traversed independently of the turret. Refer to FM 23-65 for the complete information on its operation.

Section XXXVI

ARMAMENT OPERATING INSTRUCTIONS

180. PLACING THE 90-MM GUN IN FIRING POSITION.

a. Remove muzzle and breech covers.

b. Disengage the gun traveling lock, pull release spring down on gun traveling lock, then elevate the gun. The gun traveling lock is then latched to the deck of the gun motor carriage (fig. 197).

c. Pull hand lever up which in turn releases the cradle traveling lock body; then elevate the gun in order to disengage the cradle lock from the hook on the cradle (fig. 196).

d. Disengage turret lock by turning the handle, pulling it out, and rotating one-quarter turn clockwise (fig. 198).

e. Engage equilibrator assembly by bolting equilibrator to the recoil cylinder (fig. 203). NOTE: *Equilibrator assembly is used only when muzzle brake is installed to overcome the preponderance of weight.*

181. INSPECTION BEFORE FIRING.

a. Check Oil Level in Recoil Cylinder. To check oil level, depress gun 5 degrees and remove top plugs at the rear of the cylinder. The oil level in the cylinder should reach bottom of hole. If oil level does not reach this level, fill until level is reached. Replace plugs. Recoil mechanism uses special recoil oil. Take care not to use any other than that prescribed. Special recoil oil will be used for all temperatures.

b. Check path of recoil to make sure it is free from all obstructions.

c. Open breech and return operating handle to latched position. Inspect bore of gun for cleanliness.

d. Boresighting. Refer to paragraph 195.

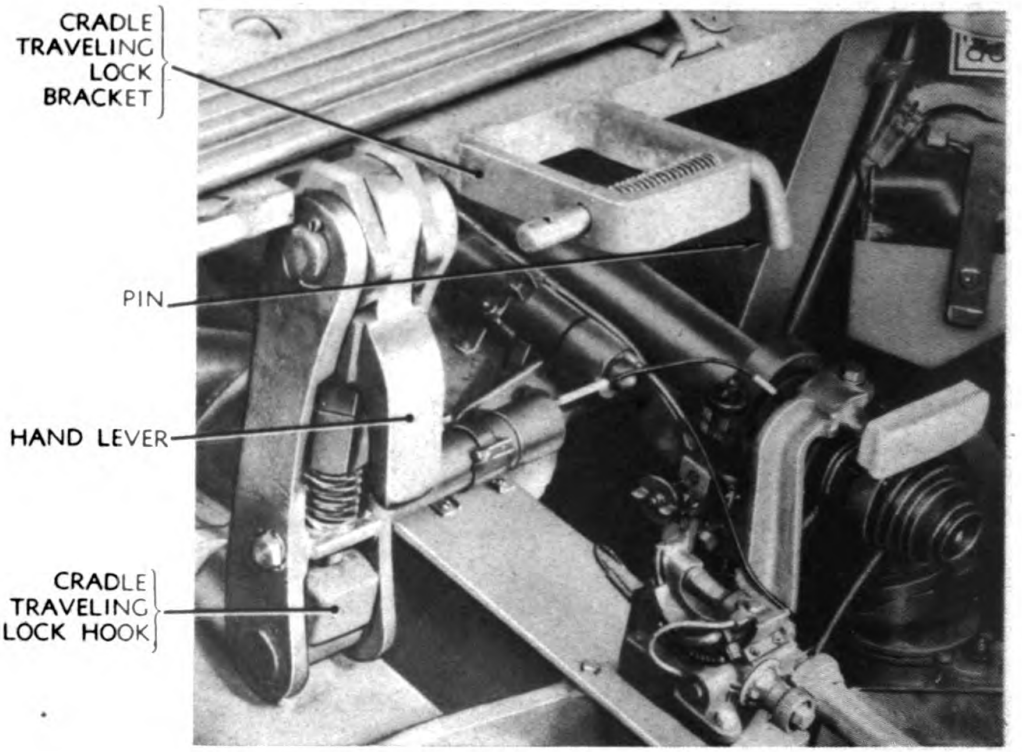


Figure 196 — Cradle Traveling Lock — Locked Position

182. TRAVERSING TURRET.

a. Description. The hydraulic turret traversing mechanism enables the operator to traverse the turret quickly and accurately with a minimum of effort. It permits quick reversal for changing targets. It permits slow rotation in either direction for following a stationary target when gun motor carriage is in motion or when gunner is making fine adjustment with telescopic sight. Through a single hand grip, the gunner can keep guns accurately sighted on a stationary or moving target when the gun motor carriage is in motion.

b. Power Operation. Before traversing turret by means of the hydraulic traversing mechanism, make sure personnel are clear of rotating parts. Move gear shift lever in front of gunner and under gear mechanism to the power position (pull lever up toward top of turret). It may be necessary to slightly turn the manual traverse control handle on top of gear mechanism to engage gears. Turn traversing motor switch to the "ON" position to start electric drive motor. Disengage turret lock. NOTE: *It is important to have turret lock completely disengaged before traversing turret, and to lock in position if need for traversing is completed.* The power traverse control handle (fig. 198) on the traverse pump to the right of the gun

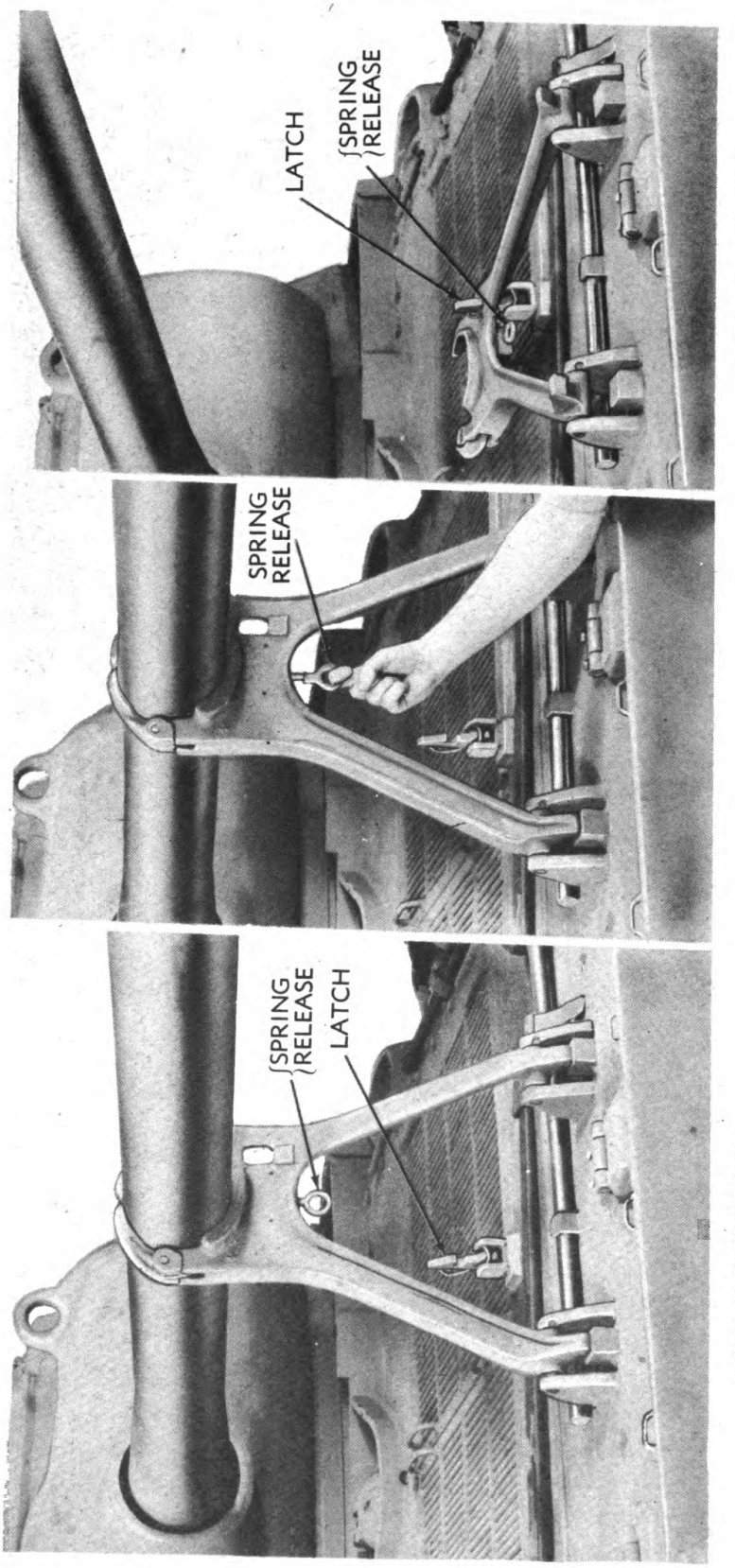


Figure 197 — 90-mm Gun Traveling Lock

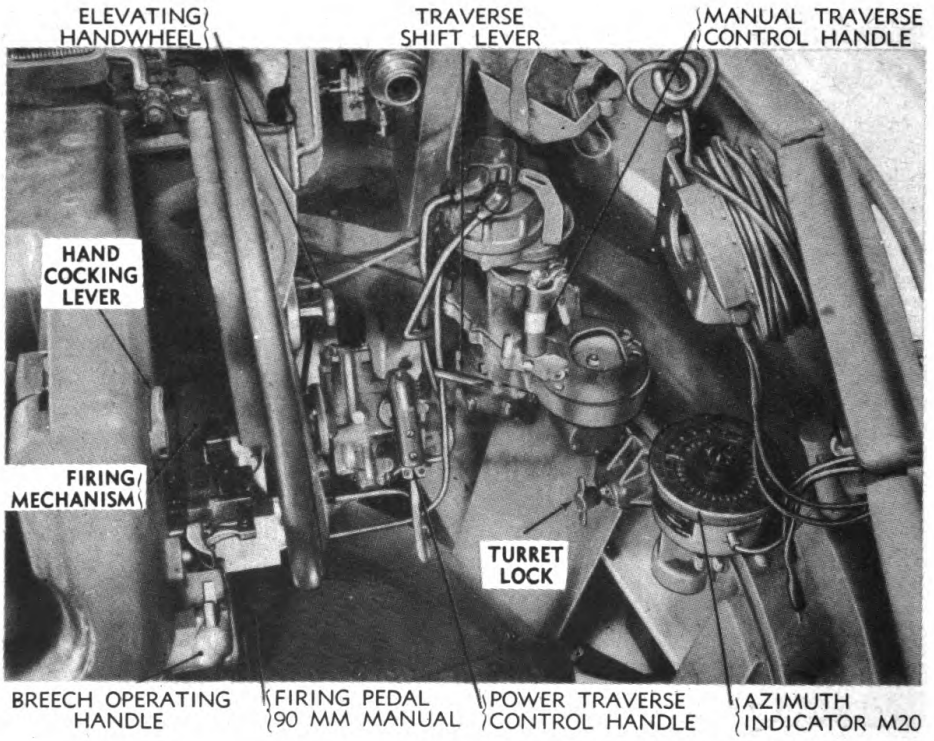


Figure 198 — Traverse Controls

elevating handwheel controls the speed and direction of the turret rotation. To traverse turret to the right, turn the power traverse control handle so the top is to the right. To traverse turret to the left, turn the power traverse control handle so the top is to the left. To increase the traverse speed, turn the power traverse control handle farther to the right or left, depending upon the direction of the traverse desired. To stop turret traverse, release power traverse control handle or bring it to the upright or natural position. Turret rotation can be reversed instantly without damage to the fluid power mechanism.

c. Manual Operation (fig. 198). If electric power fails or if hydraulic traverse system will not operate due to some other cause, the turret can be rotated by the manual traverse control handle located on top of the gear mechanism to the right of the gunner's seat. Disengage turret lock. Move gear shift lever under gear mechanism to the manual position (turn lever down toward turret floor). It may be necessary to slightly turn the manual traverse control handle on top of the gear mechanism to engage gears. The manually operated gears are then engaged with the turret ring gear and pinion. Grip the manual traverse control handle and its associate lever on top of the gear mechanism in front of the gunner to release

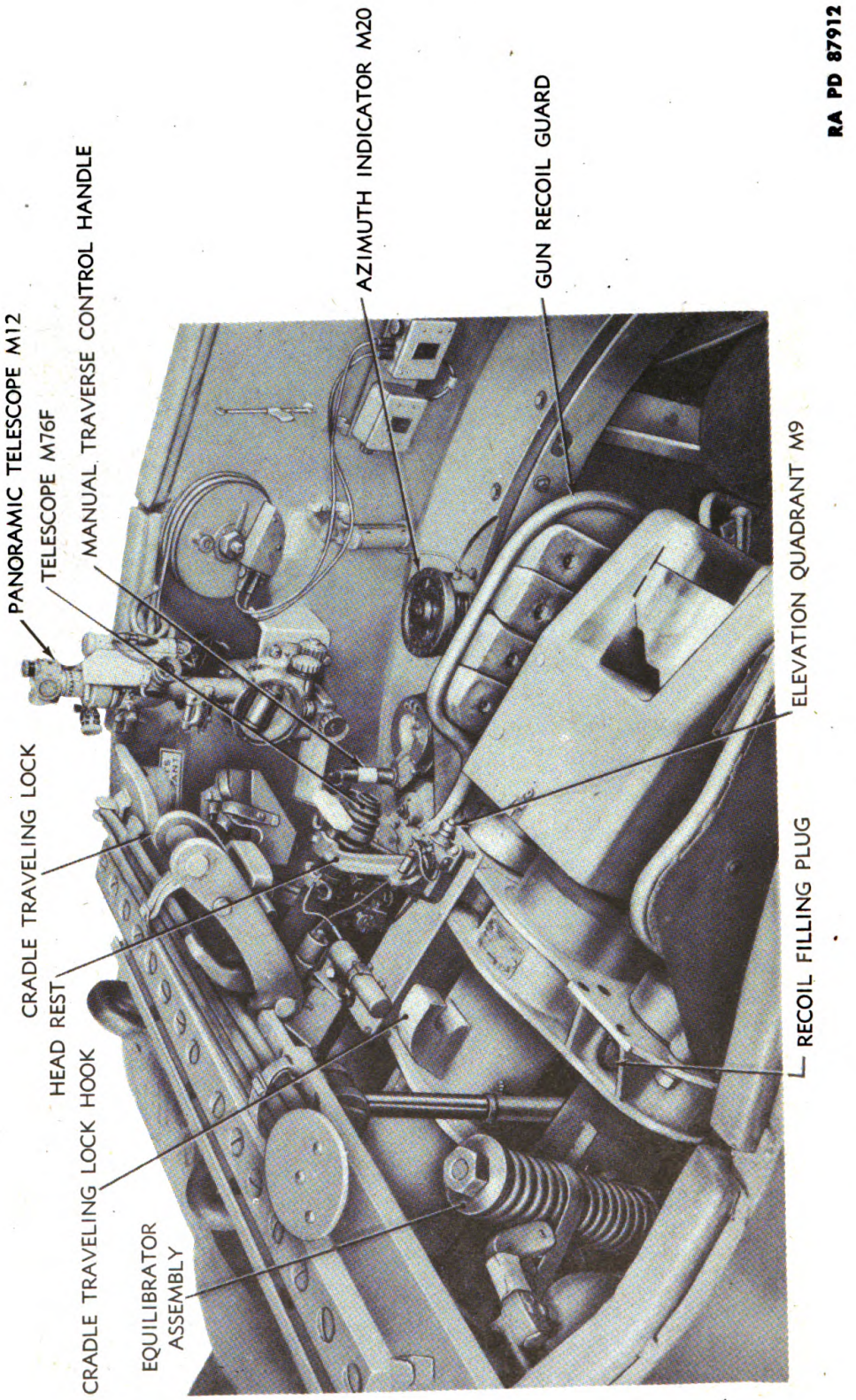


Figure 199 — 90-mm Gun Motor Carriage M36B1 — Left Side View of Turret

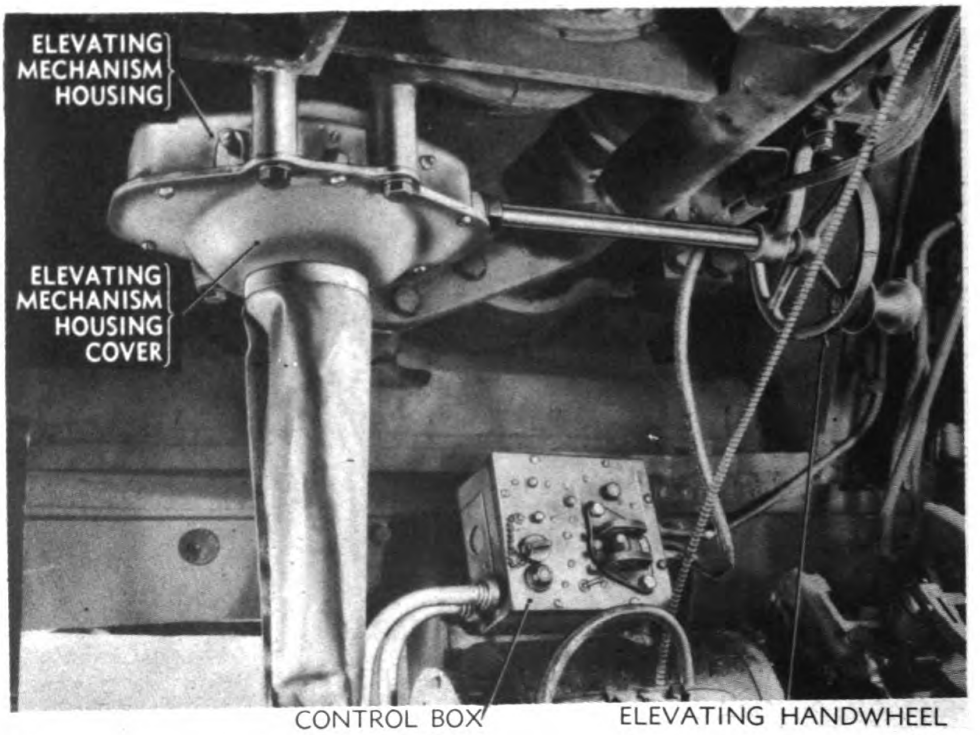


Figure 200 — Elevating Mechanism

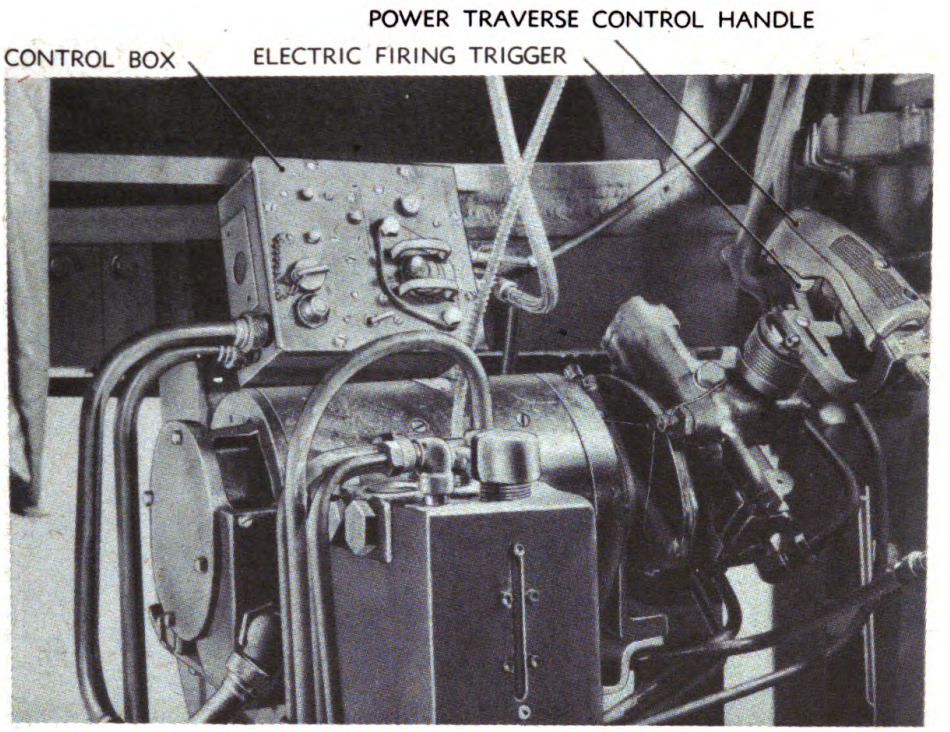
brake in gear box. Turn manual traverse control handle to the right or clockwise to rotate turret clockwise, and to the left or counterclockwise to rotate turret counterclockwise. The rate of speed of turret operation is dependent upon the speed at which handle is operated. If the manual traverse control handle turns freely and fails to move the turret, the shift lever under the gear mechanism must be in power traverse position, and should be moved to manual traverse position.

d. An azimuth indicator is mounted to the rear of the manual traverse control (fig. 199) and gives position of gun in traverse. For operating instructions, refer to paragraph 194 **b.**

183. ELEVATING AND DEPRESSING THE GUN.

a. The gun is elevated or depressed by turning the elevating handwheel located on the right side of the mount (fig. 200). Maximum elevation is 30 degrees and maximum depression is 10 degrees.

b. An elevation quadrant is located on the top right side of the mount and gives position of the gun in elevation (fig. 199). Refer to paragraph 192 for information on its operation.



RA PD 87910

Figure 201 — Control Box Installation

184. OPERATING THE BREECH MECHANISM.

a. Opening Breech. To open breech, grasp the grip portion of the breech operating handle and press the handle down until the extractors lock the breech in open position (fig. 198). CAUTION: *Keep hands out of gun when breech is open. Return breech operating handle to the closed position immediately after opening breech in order to avoid injury to personnel and mechanism.*

b. Loading the Gun.

(1) Before loading, examine the bore of the gun to see that it is clear and free from foreign material.

(2) To load the gun, place a round in the breech with the nose protruding in the bore. Impel the round into the chamber with sufficient force to cause the flange of the cartridge case to drive the extractors forward and automatically close the breech. The loader's hand should be moving upward as he shoves the projectile home in order to clear breechblock as it is automatically closed.

c. Closing Breech.

(1) Close the breech by unlatching the breech operating handle and pressing it down. Bear sufficient weight on the handle to over-

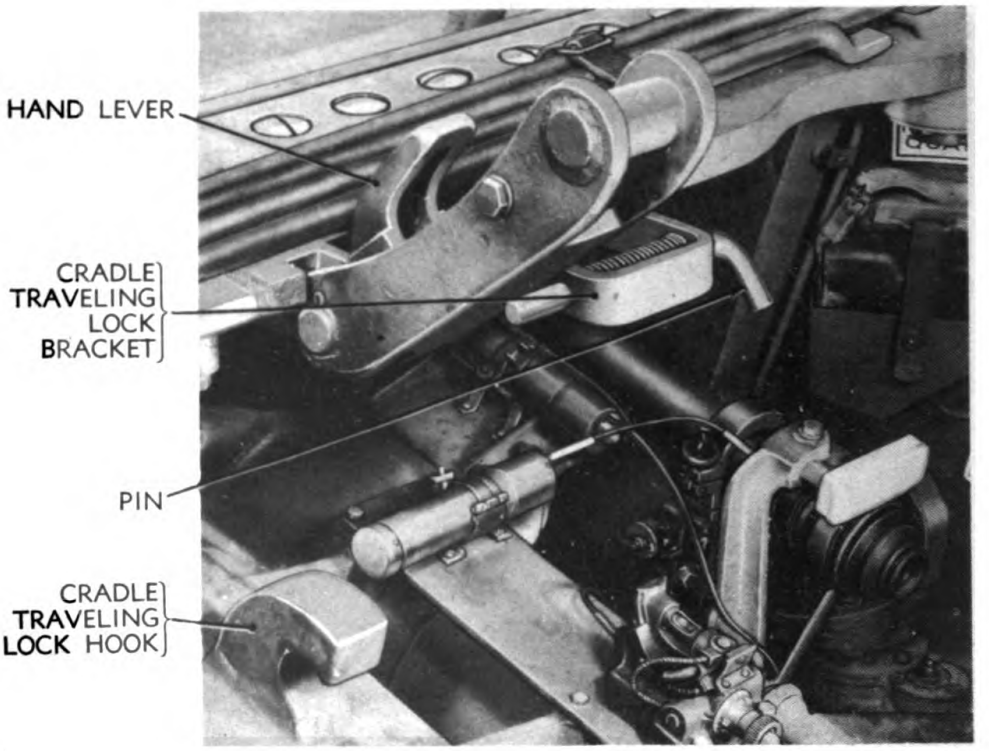


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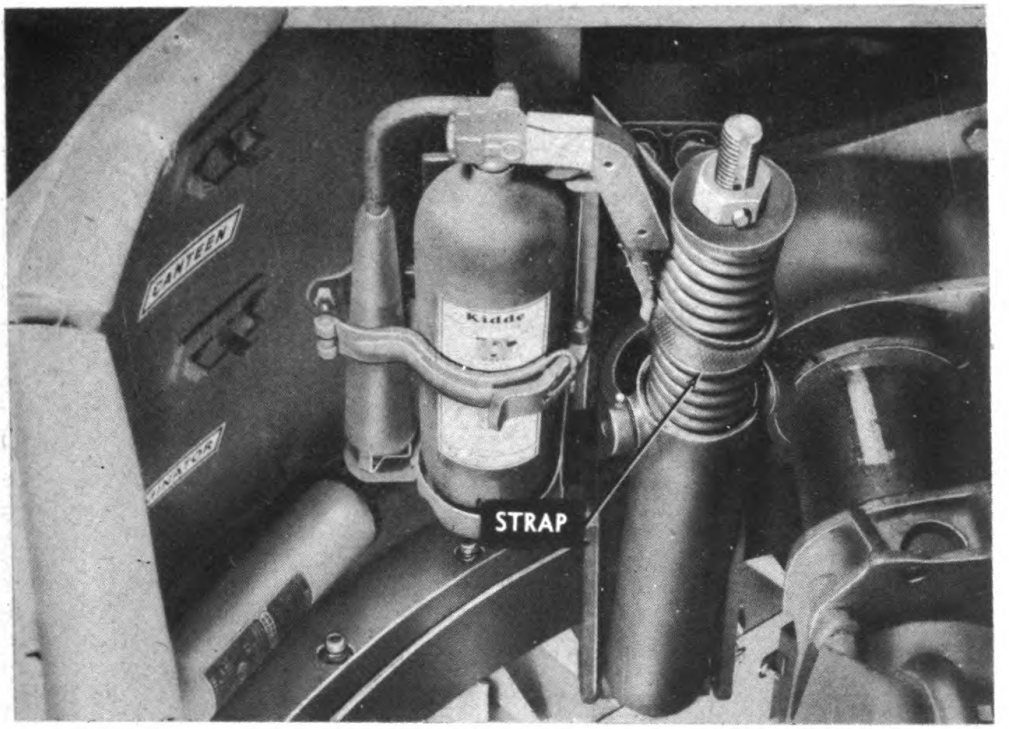
Figure 202 — Cradle Traveling Lock — Unlocked Position

come the tension of the closing spring, and release the extractors from their locking position by pressing them forward with the base of an empty cartridge case or a block of wood. The breechblock is then free to be eased into its closed position by means of the operating handle which should be finally latched in place. CAUTION: *Do not use hands to release extractors.*

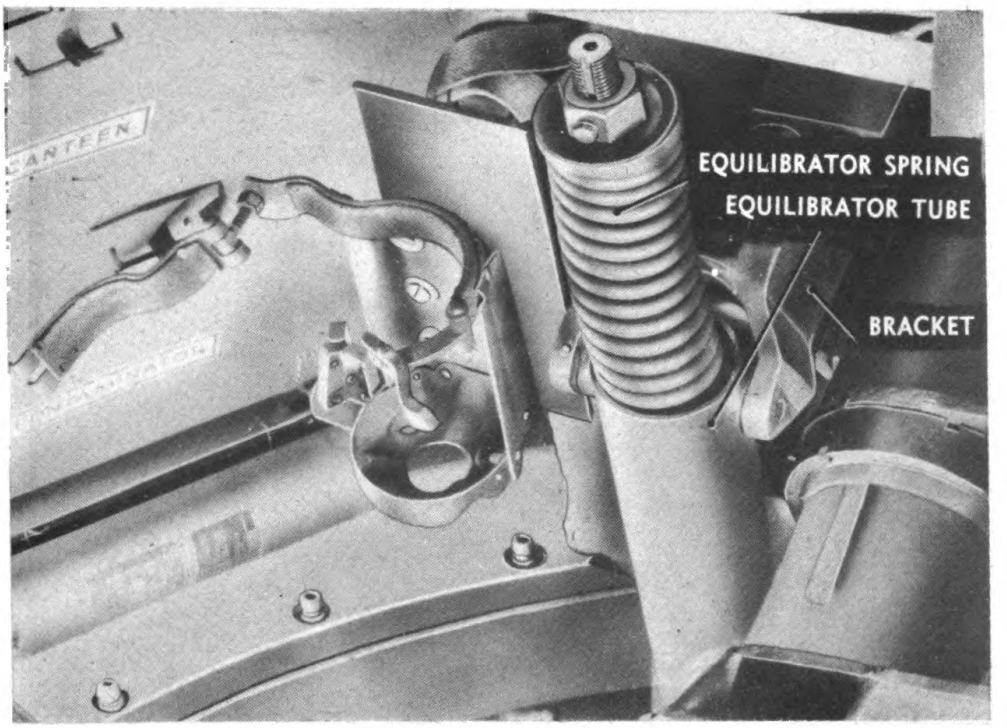
(2) SEMIAUTOMATIC OPERATION. Under ordinary circumstances it will be necessary to manually open the breech only at the start of firing operations. A cam, attached to the gun mount, contacts the breech operating crank during counterrecoil of the gun after firing and opens the breech to extract the empty cartridge case.

185. FIRING THE GUN.

a. Throw the firing switch to the "ON" position. The gun may be fired electrically by means of a firing trigger on the power traverse control handle. If the round fails to fire, do not open the breech. The firing mechanism may be recocked by hand by pushing downward on the hand cocking lever on the right side of the breech ring. If the click of the firing pin is not heard, the firing trigger should be depressed to note if the solenoid operates. If the solenoid does not



OUT OF POSITION



IN POSITION

RA PD 87914

Figure 203 — Equilibrator Assembly

operate, the gun may be fired manually by depressing a pedal located on the turret floor in front of the gunner (fig. 198).

b. If the gun fails to fire after check in subparagraph a above, the position of the safety lever should be checked. The failure to fire may be due to the gun staying out of battery position, failure of the firing mechanism, failure of the breech to close, or defective ammunition. If the gun is in battery, recock by means of the cocking lever on the right side of the breech, and attempt to fire (fig. 198). If the gun still fails to fire after three attempts, wait 30 seconds before opening the breech; then remove round, reload, and attempt fire again.

186. PLACING THE GUN IN TRAVELING POSITION.

a. Open breech to be sure that the breech is clear and a round has not been left in gun. Close breech.

b. Place gun in traveling position by taking traveling lock out of latched position. Open the links of the lock by pulling the spring release down. Depress the gun into the lock and then release the spring release (fig. 197).

c. Push safety lever down to its "SAFE" position. This locks the firing shaft in position so that the gun cannot be fired.

d. Clean and lubricate the gun, and install breech and muzzle covers.

e. Pull pin back in order to release cradle traveling lock from firing position. Elevate the gun so that the hook on the cradle engages the lock, then press down on the hand lever (fig. 202).

f. Lock the turret in traveling position by pulling, turning, and rotating the handle one-quarter turn counterclockwise (fig. 198).

g. Take equilibrator assembly out of position by strapping it to turret (fig. 203).

Section XXXVII

SIGHTING AND FIRE-CONTROL EQUIPMENT

187. CHARACTERISTICS.

a. **90-mm Gun Motor Carriage M36B1.** The sighting and fire control equipment for the 90-mm Gun M3 and 90-mm Gun Mount T8 used on the 90-mm Gun Motor Carriage M36B1 includes the Telescope M76F and Instrument Light M33 or Telescope M70P with Instrument Light M32 or M39C, Panoramic Telescope M12, and Telescope Mount T104E1 (M69) with Instrument Light M31, the Elevation Quadrant M9 with Instrument Light M30, and the Azimuth

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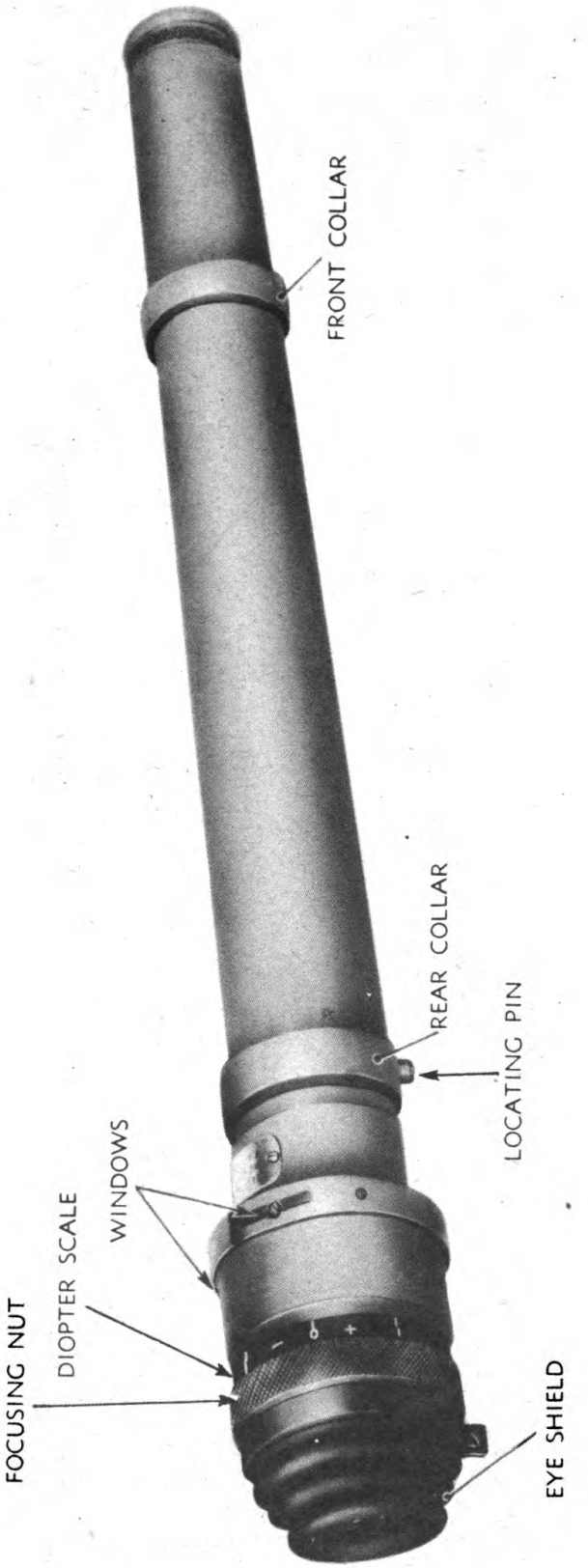

Figure 204 — Telescope M76F

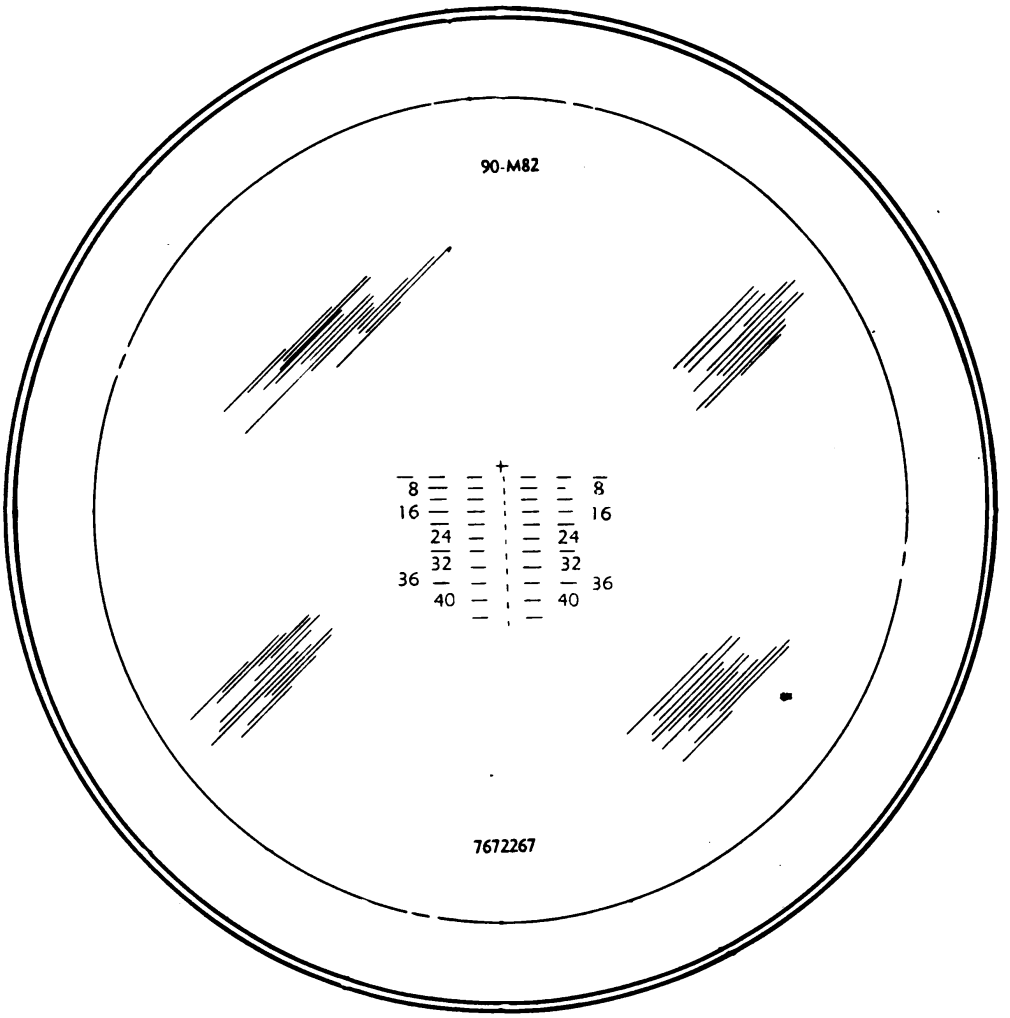

Figure 205 — Reticle Pattern for Telescope M76F

Indicator M20. The Periscope M6 is furnished for observation by the driver and assistant driver of the vehicle.

188. TELESCOPE M76F.

a. The Telescope M76F (fig. 204) is used for direct laying of the 90-mm Gun M3. It is mounted in the Telescope Mount M64 (T92) on the right-hand side of the gun cradle, and moves with the gun. Windows above the reticle provide for illumination of the reticle pattern.

b. To operate the Telescope M76F for direct laying, bring the image of the target to the point on the reticle (fig. 205) representing the required range and deflection by rotating the elevating handwheel and traversing the turret. The gunner's eye should be approximately

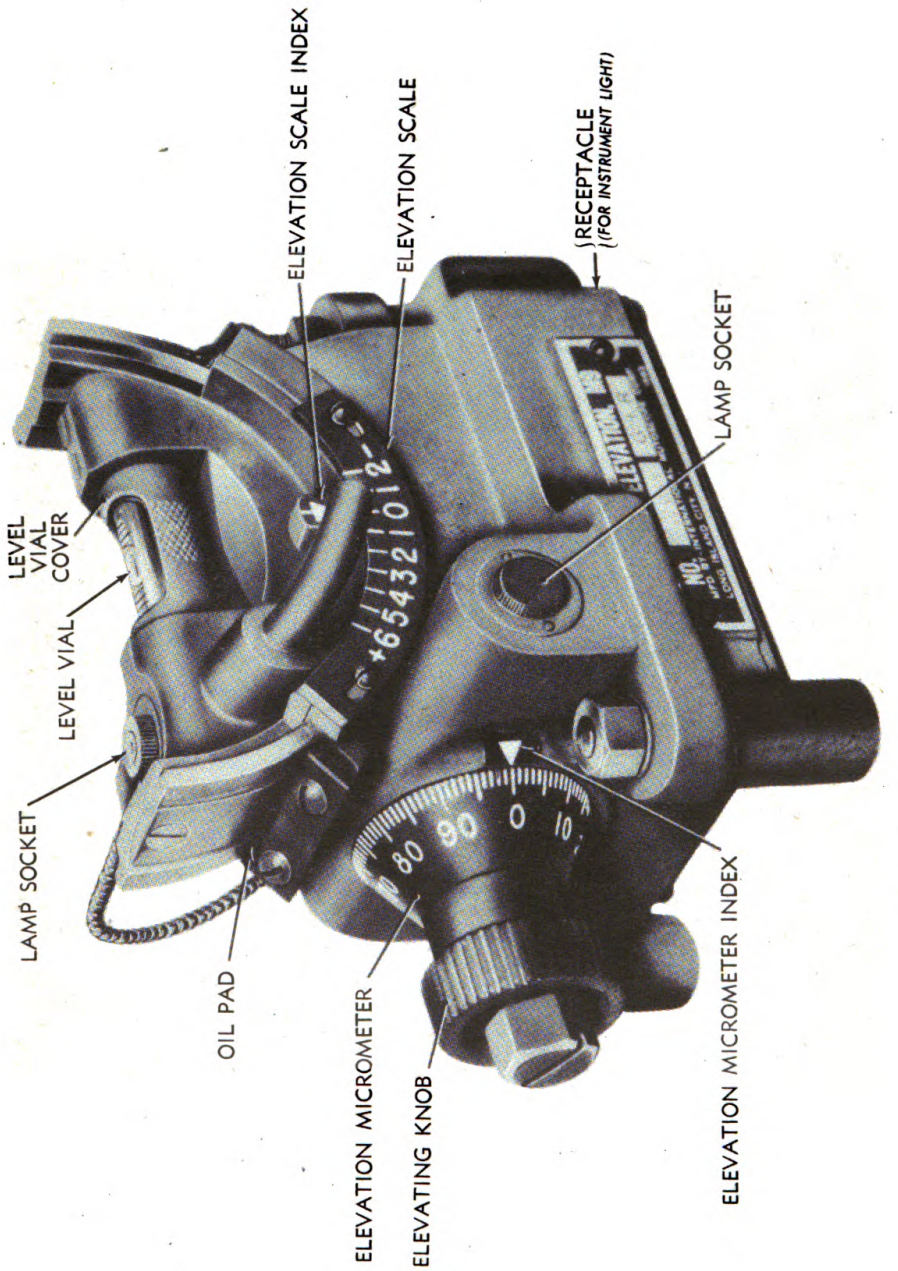

Figure 206 — Elevation Quadrant M9 — Right Side View

1¼ inches from the telescope eyelens when observing. For night observing, turn the rheostat knob on the end of the instrument light until the reticle pattern is seen clearly.

189. ELEVATION QUADRANT M9.

a. The elevation quadrant M9 (fig. 206) is used to lay the 90-mm gun in elevation for indirect fire.

b. To lay the gun in elevation, set the elevation angle on the coarse scale (100-mil intervals) and on the micrometer (1-mil intervals). The quadrant has two scales and two micrometer indexes. Use the micrometer index on the side corresponding to the scale in use.

190. PANORAMIC TELESCOPE M12 AND TELESCOPE MOUNT T104E1 (M69).

a. The Panoramic Telescope M12 (fig. 208) and Telescope Mount T104E1 (M69) are used for laying the 90-mm gun in azimuth for indirect fire. The reticle pattern seen when looking through the panoramic telescope is shown in figure 209. The line of sighting can be elevated or depressed by the elevation knob at the top of the telescope. Coarse and fine indexes indicate the normal (zero elevation) position. The line of sighting is moved in azimuth by the azimuth worm knob. A throwout lever, when depressed, permits rapid motion of the azimuth worm. The azimuth scale (100-mil intervals) is supplemented by the azimuth micrometer (10-mil intervals). The micrometer index can be set for deflection right (R) or left (L) on the deflection scale. The elevation scale and micrometer on the telescope mount must be set to the same elevation as the gun before setting in azimuth in order to compensate for errors in azimuth when the trunnions are out of level. A longitudinal level (angle of site) and across level indicate when the azimuth scale is in a horizontal plane.

b. To operate the instrument, set the azimuth of the target with respect to the aiming point on the azimuth scale and micrometer. Set the deflection by rotating the azimuth micrometer index in the proper direction through the required number of mils as indicated on the deflection scale. Rotate the azimuth knob until the original micrometer reading is indicated opposite the new position of the micrometer index. Maintain the angle of site scale and micrometer at normal (3). Transfer the elevation angle of the gun from the elevation quadrant to the elevation scale and micrometer on the mount using the elevating knob. Keeping the telescope mount leveled longitudinally and cross leveled by means of the rock knob and the cross leveling knob, traverse the gun carriage until the vertical cross

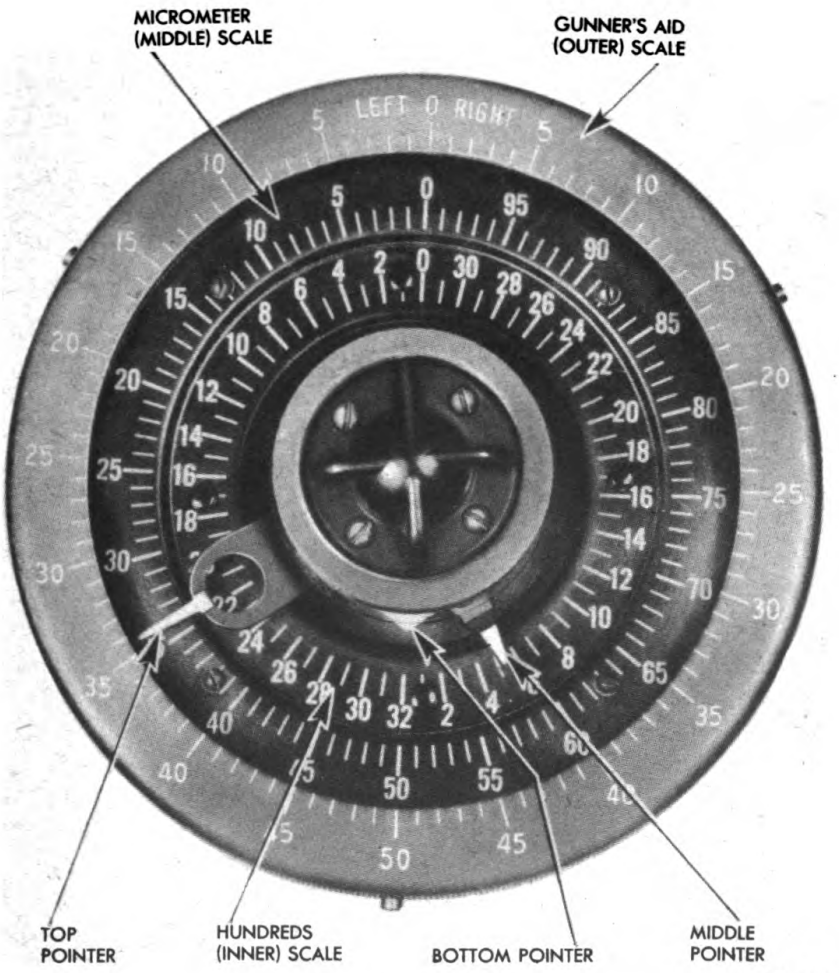

Figure 207 — Azimuth Indicator Dials With Gun in Traveling Position

hair in the reticle falls on the aiming point. It may be necessary to rotate the elevation knob on the telescope in order to bring the aiming point within the field of view.

191. AZIMUTH INDICATOR.

a. Description (fig. 199). The azimuth indicator, mounted in the turret just to the right or rear of the hand traversing control and brake, will be used under certain tactical situations instead of, or in conjunction with, the panoramic telescope M12 for laying the 90-mm gun in azimuth. The indicator is a dialed instrument with three systems of pointers designed to assist in obtaining deflection in mils to the right or left in the horizontal plane. The bottom and top pointers, reading on the inner and middle scales, respectively, indicate the number of mils the turret is traversed from the longitudinal axis

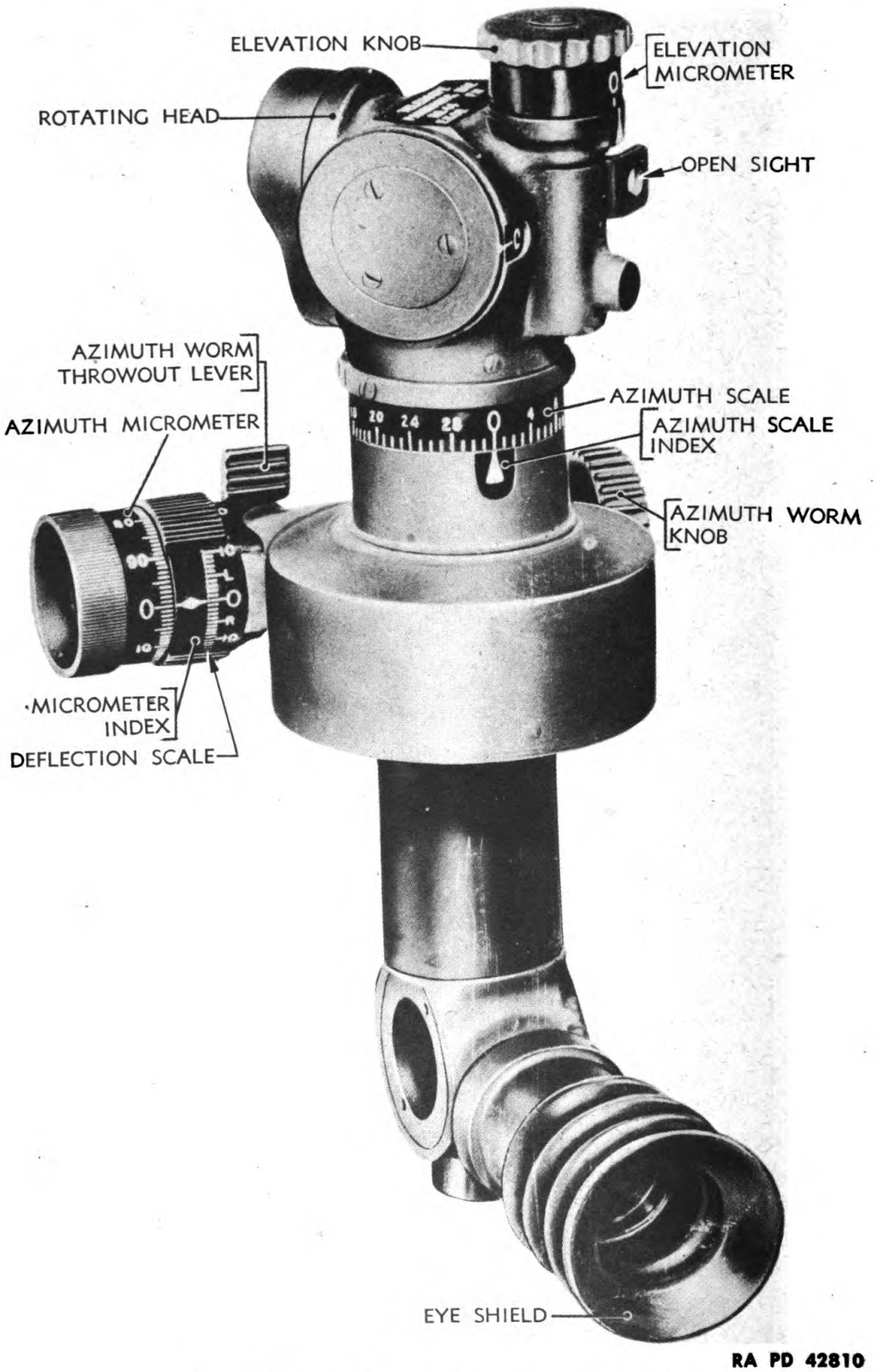

Figure 208 — Panoramic Telescope M12

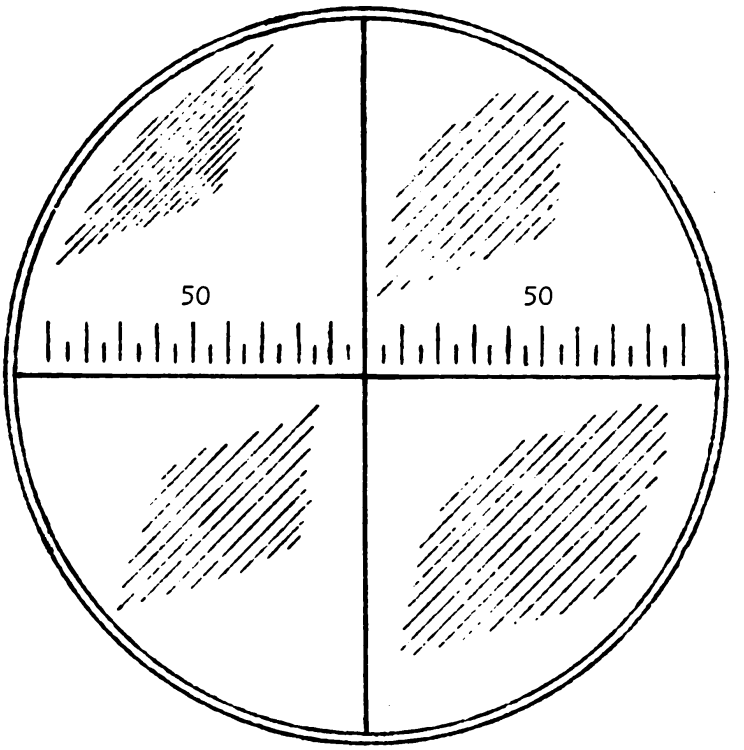

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Figure 209 — Reticle Pattern for Panoramic Telescope M12

of the vehicle. When the gun points straight forward, these pointers read zero. The second system of pointers (middle and top pointers) is adjustable by means of the knob in the center of the instrument. Reading on the inner and middle scale, these pointers indicate the number of mils the gun or turret has been traversed from any originally set position. The top pointer, reading on the outer or gunner's aid scale, is used for the purpose of aiding the gunner in making corrections of less than 50 mils in deflection to the right or left.

b. Operation (fig. 207). To set the top pointer, simply turn the knob either to the right or left until the pointer reaches the desired setting. To set the middle pointer, turn the top pointer until it approaches the middle pointer, then press down on the knob and both pointers will turn simultaneously. When the middle pointer reaches the desired setting, release pressure on the knob and continue to turn the top pointer until it reaches the desired setting in a single mil. The gunner's aid dial or ring may be moved around to any position simply by taking hold of the ring and turning it until it reaches the desired position from which corrections in mils are to be made.

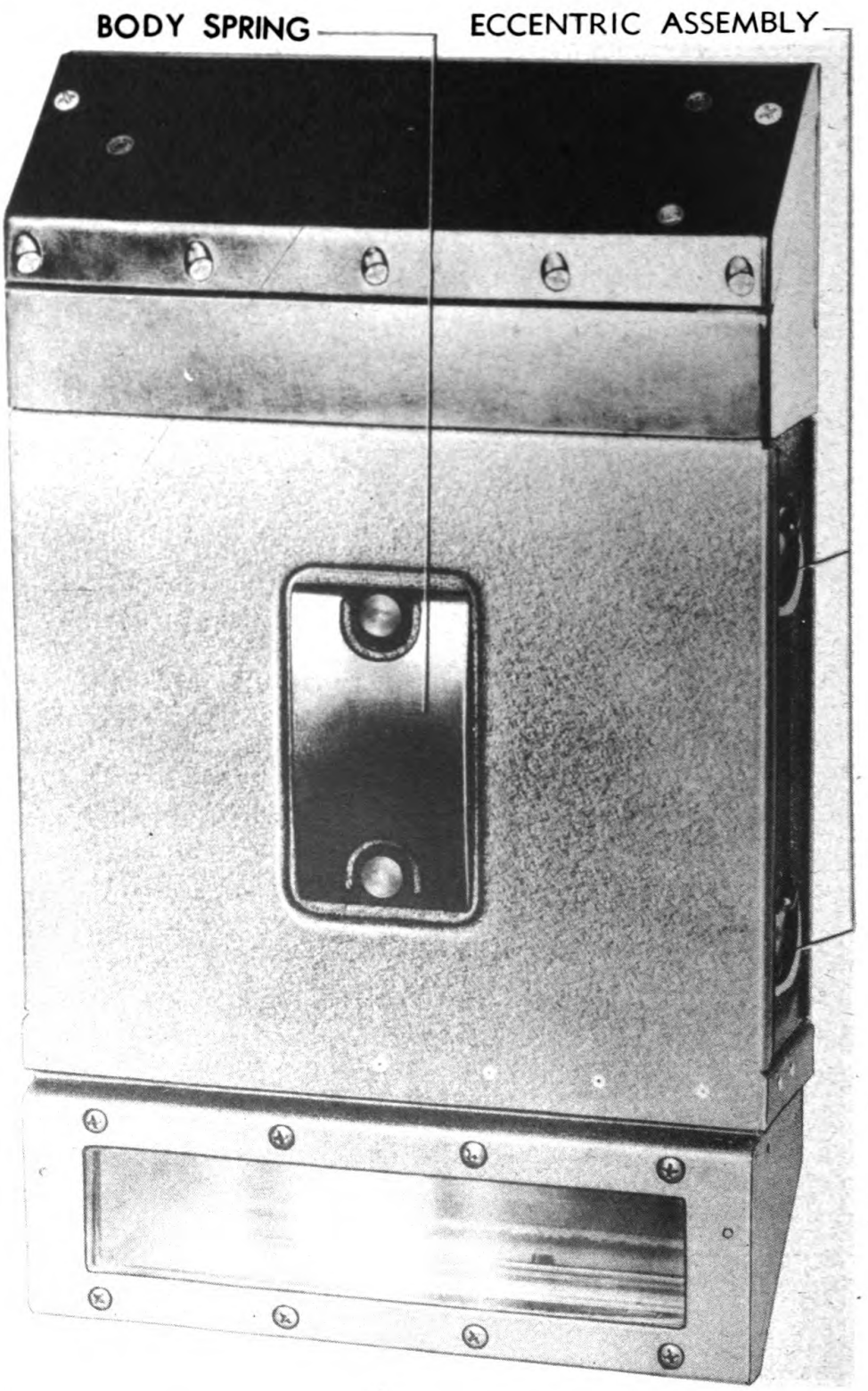

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Figure 210 — Periscope M6 — Rear View

192. BORE SIGHTING.

a. The purpose of the bore sighting operation is to test the alinement of the sighting equipment for parallelism with the bore of the gun. For expediency, it may be performed by sighting on a well defined object at least 1,000 yards distant.

b. Open the breech of the gun and, while looking through the barrel, aline the gun on the distant object. With the Telescope M76F in position in its mount, observe through the eyepiece and note the position of the cross on the reticle with respect to the aiming point. If they do not coincide, move the line of sighting of the telescope with the adjusting knobs on the rear of the mount until coincidence is obtained.

c. To bore sight on the Panoramic Telescope M12 proceed in the following manner:

(1) Set the azimuth scale and micrometer to read zero simultaneously.

(2) With the gun bore sighted on the aiming point, read the elevation angle on the elevation quadrant. Transfer this angle to the elevation scale and micrometer on the mount.

(3) Keep the mount cross leveled, using the cross leveling knob.

(4) Look through the panoramic telescope and bring the target into the field of view, using the elevation knob on the telescope.

(5) If the vertical cross hair on the reticle falls on the aiming point, the line of sighting is laterally parallel to the gun bore and nothing further is to be done.

(6) If the vertical cross hair does not fall on the aiming point, shift the panoramic telescope in its socket by loosening the headless locking screws in the telescope socket and adjusting the tangent screws until coincidence is obtained. Tighten the headless locking screws.

193. PERISCOPE M6.

a. The Periscope M6 (fig. 210) is used by the driver and assistant driver of the vehicle for observation from the interior of the

tank. The periscope is secured in a holder by a latch mechanism and a locking knob. The heads of these periscopes are constructed of plastic material so they will shatter into small pieces if struck by a projectile. The heads are secured to the periscope body with an eccentric mechanism which is so arranged that the heads are readily replaced with the spare heads which are provided.

b. To remove the periscope from the holder, open the latch on the front of the holder and loosen the locking knob on the front of the periscope. Pull the periscope straight out of the holder.

c. To remove the head from the periscope body, turn the two eccentric assemblies located on the sides and upper part of the periscope body until the head clamp is completely disengaged from the latches of the eccentric mechanism. Lift the head from the periscope body. When replacing the head, position it on top of the periscope body with the window facing the front side of the periscope. Turn the eccentric assemblies until the reference arrow on each eccentric matches the corresponding arrow on the periscope body. See that the handles of the eccentric mechanism lie flat on the sides of the periscope body.

d. To operate the periscope, grasp the sides of the periscope and rotate, elevate, or depress the holder and periscope until the desired panorama is brought into the field of view.

Section XXXVIII

AMMUNITION

194. AUTHORIZED AMMUNITION.

a. Authorized ammunition for the 90-mm Gun M3 is listed in Table I. 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 the round itself and on packing in accordance with the basic scheme described in TM 9-1900.

TABLE I. AUTHORIZED AMMUNITION

STANDARD NOMENCLATURE [1]	ACTION OF FUZE	NOMINAL WEIGHT of PROJECTILE AS FIRED (LB.)
Service Ammunition		
Projectile, fixed, A.P.C., M82, NH, w/Fuze, B.D., M68, and Tracer, 90-mm guns[2]	Delay	24.11
Projectile, fixed, A.P.C., w/Tracer, 90-mm guns[2]	None	23.40
Shell, fixed, H.E., M71, NH, w/Fuze, P.D., M48, 90-mm guns	SQ & delay[3]	23.29
Shell, fixed, H.E., M71, NH, w/Fuze, P.D., M48A2, SQ & 0.05-sec. delay, 90-mm guns	SQ & delay[3]	23.29
Shell, fixed, H.E., M71, NH, w/supplementary bursting charge and Fuze, P.D., M48A2, SQ & 0.05-sec. delay, 90-mm guns[4]	SQ & delay[3]	23.20
Shot, fixed, A.P., M77, NH, w/Tracer, 90-mm guns	None	23.40
Practice Ammunition		
Shell, fixed, practice, insert-loaded, M71, NH, w/Fuze, dummy or inert, M[5] 90-mm guns	Inert	23.40
Blank Ammunition		
Ammunition, blank, 90-mm guns	—	—
Drill (dummy) Ammunition		
Cartridge, drill, M12, w/Fuze, dummy, M44A2, 90-mm guns	Inert	

A.P.—armor-piercing
A.P.C.—armor-piercing-capped
B.D.—base detonating
H.E.—high-explosive
NH—nonhygroscopic (flashing)
P.D.—point detonating
SQ—superquick

[1]—Nomenclature listed in this table refers to current standard rounds for use against ground targets. Earlier rounds were loaded with FNH propellent powder. Such rounds are indicated in nomenclature by the omission of the letters "NH" from the nomenclature. Identification between the types of rounds is provided for by marking "NH" on all packings holding NH-loaded rounds.

[2]—For future manufacture, armor-piercing-capped rounds will be loaded for a muzzle velocity of 2,800-2,850 feet per second. Earlier rounds have 2,650 f/s muzzle velocity. Some rounds with 2,800-2,850 f/s muzzle velocity may have "SC" marked on the cartridge case, signifying super-charge. Marking on the later lots will show the muzzle velocity.

[3]—The M48 fuze has 0.05-second delay. The M48A2 may have either 0.05-second or 0.15-second delay, depending on the lot. Identification is provided for by marking the time of delay on the body of the M48A2 fuze following the nomenclature of the fuze. The short delay is the authorized delay for use in the M3 90-mm gun.

[4]—These shells have a deep fuze cavity which has been adapted for standard fuzes and boosters by inserting a supplementary bursting charge, reducing the fuze cavity to the dimensions of the standard boosters. The shell may be made suitable for use with special fuzes in the field by removing the standard fuze and booster assembly and the supplementary charge.

[5]—Fuze, dummy, M73, or Fuze, dummy, M44A2, or an inert service fuze of the M48 series may be fitted to the shell as shipped.

195. PREPARATION FOR FIRING.

a. General. The rounds are ready for firing upon removal of packing material except for adjustment of fuzes as described below. Rounds prepared for firing, but not fired, should be restored to the original condition and packing, and appropriately marked. Such rounds should be used first in subsequent firings in order to keep stocks of opened packings at a minimum.

b. P.D. Fuzes, M48, M48A1, and M48A2. These fuzes are fitted with a slotted setting sleeve and two registration lines—one marked "S.Q." (superquick) and the other "DELAY"—for fuze setting. As shipped, the fuzes are set "S.Q." and need no adjustment for this action. To set for delay, it is only necessary to turn the setting sleeve so that the slot is alined with "DELAY." (A delay pellet incorporated in the delay-action train provides for the delay action.) Delay action is always operative and will function if the superquick action fails when the fuze is set "S.Q." The setting may be made or changed at will with fuze wrench M7A1 or similar instrument at any time before firing. This can be done in the dark by noting the position of the slot—parallel to the fuze axis for "S.Q.", at right angles thereto for "DELAY".

c. B.D. Fuze M68. This fuze requires no adjustment.

Section XXXIX

RADIO AND INTERPHONE EQUIPMENT

196. DESCRIPTION.

a. Radio. The American radio equipment (SCR-610) for this vehicle consists of a transmitter and receiver unit with power supply

unit shock-mounted to the right of the assistant driver in the sponson (fig. 5) and antenna mast mounted on the hull above the right front fender (fig. 4). The British radio equipment (BR-19) consists of both radio and interphone equipment.

b. Interphone Equipment. The American interphone system (RC-99) consists of amplifier and power supply unit (BC-667) mounted in the sponson just to the rear of the radio equipment, and control boxes for the drivers and crew, mounted convenient to the crew members using them (figs. 5, 216, and 218).

c. Data.

Equipment	Model
Transmitter and receiver	BC-659
Power supply	PE-120
Base	FT-250
Interphone amplifier	BC-667
Driver's and co-driver's control box	BC-739
Crew control boxes	BC-606
Antenna mast base	AD-15-GR
Interphone reel assembly	RL-106-VI

197. PRECAUTIONS.

a. Antenna. Tie the antenna back securely when not in use, especially when tank is in motion. Make sure antenna is untied, in a vertical position, and not touching anything when the radio is in use.

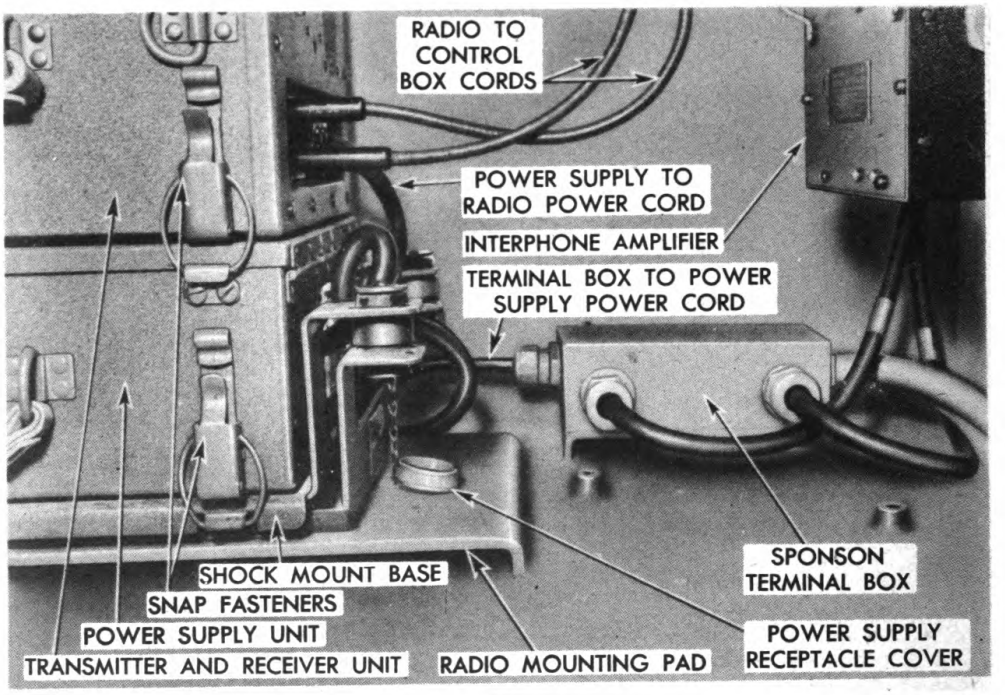
b. Covers. See that cover for protection of the radio equipment is available in the vehicle and that fasteners and zippers are in working condition at all times. Install the cover on the radio when it is not being used.

c. Switches. Do not turn off the 24-volt master switch when radio is in use. If 24-volt master switch should get turned off under these circumstances, warn radio operator and wait for his signal to turn 24-volt master switch on again, or damage to radio equipment will result.

d. Stowage. Do not store equipment of any kind behind or against the radio where it could prevent free motion of the shock mountings or interfere with connections.

e. Starting Engine. Do not start engine with radio turned on.

f. Vehicle Maintenance. Do not steam the vehicle clean without first removing the radio (par. 201). Do not do any vehicle maintenance during which the equipment might be interfered with without first removing the radio, interphone equipment, control boxes, or



RA PD 339687

Figure 211 — Radio and Interphone Installation Details

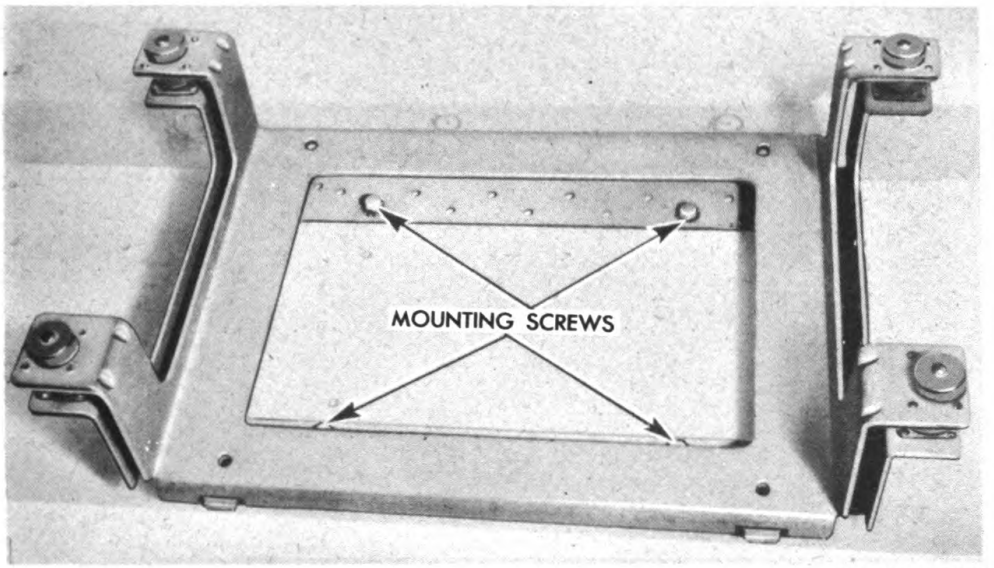
whatever equipment is involved in the vicinity of the work being done.

198. REMOVAL, INSTALLATION, AND CONNECTION OF EQUIPMENT.

a. General. In order to avoid the possibility of damage to equipment during removal and installation, and to insure proper connection for operation, certain units or groups of units with cables attached will be removed without disconnection from each other. For this reason, even though the removal of only one unit may be required to do a specific maintenance job, if the unit is removed as one of a group in the following instructions, the whole group will be removed without disconnecting units, one from the other. If color coding of wires does not agree with that given in the following procedures it will be necessary to tag the wires when removed from terminals.

b. Transmitter and Receiver Assembly.

(1) REMOVAL (fig. 211). Pull out control box cords if plugged in. With 24- and 12-volt master switches off, separate power supply to radio power cords at receptacle and screw power supply receptacle cover on female section of receptacle to protect it from moisture and dirt. Remove sponson terminal box cover and disconnect terminal box to



RA PD 339688

Figure 212 — Radio Shock Mount Base

power supply power cord from the positive (+) and negative (−) terminals in the box, and pull cord from box (fig. 213). Disconnect antenna at knurled nut on forward end of radio. Release snap fasteners securing transmitter and receiver unit to power supply, and remove transmitter and receiver unit. Release snap fasteners securing power supply to base and remove power supply. Base may be removed by removing base mounting screws (fig. 212).

(2) INSTALLATION AND CONNECTION FOR OPERATION (fig. 211). Secure shock mount base in position with four mounting screws. Position power supply on base with carrying handle toward the left of the vehicle and secure with snap fasteners. Position transmitter and receiver unit on top of power supply and secure with snap fasteners. Make sure 24- and 12-volt master switches are off. Connect antenna lead to transmitting and receiving unit with knurled nut on front end of unit. Feed the terminal box to power supply power cord through the opening provided in front end of sponson terminal box and connect the black and green wires to the negative (−) terminal and the red and white wires to the positive (+) terminal. Install cover on terminal box with screws provided. Remove power supply receptacle cover from female receptacle of power supply to radio power cord. Plug radio section of the cord into the power supply section of the cord, and secure by screwing the knurled collar up tight. Plug the radio to control box cords into the jacks provided as shown in figure 211, putting the plug marked "PL-55" in the top jack. Check to make sure all radio switches are off before turning on 24- and 12-volt master switches.

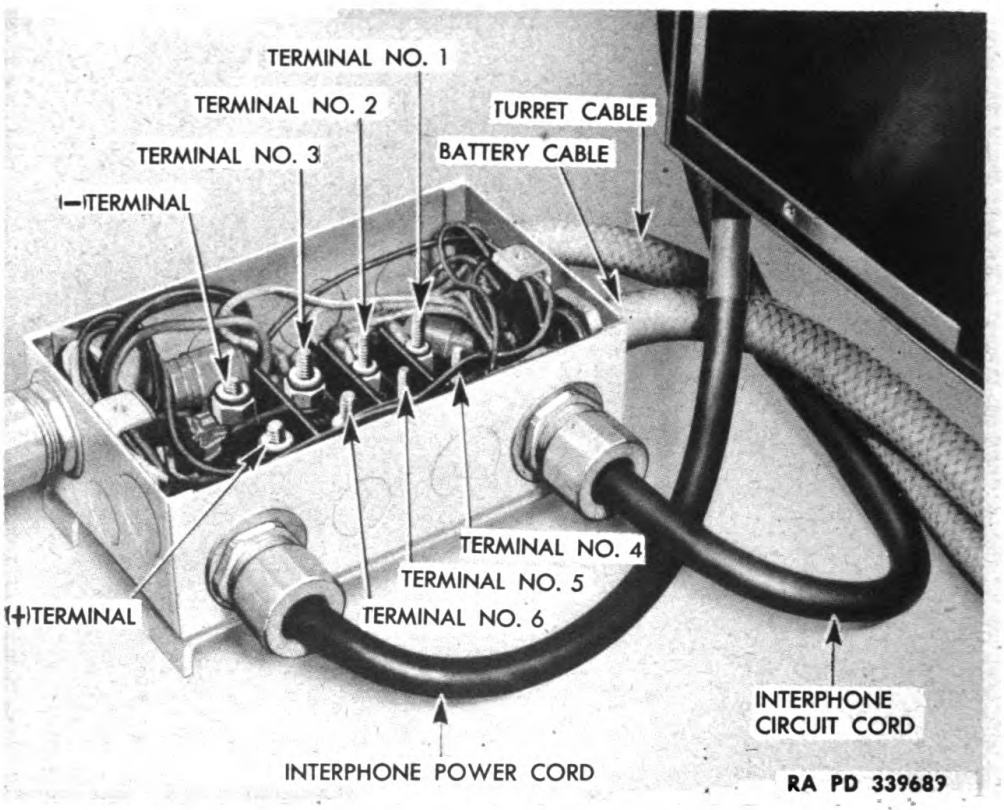
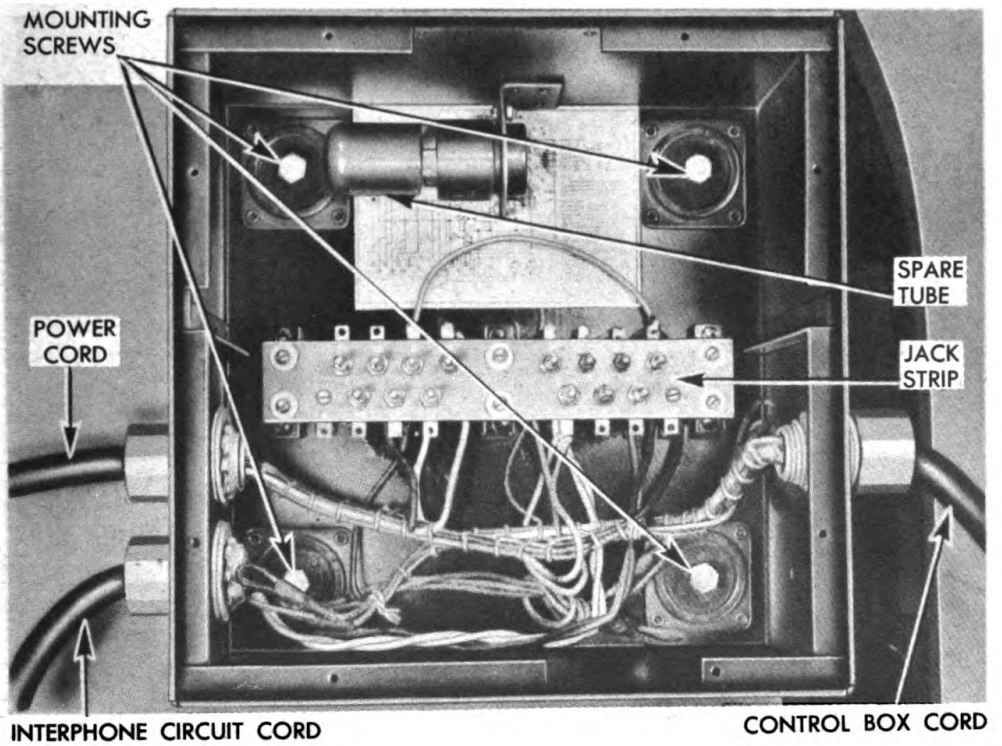


Figure 213 — Sponson Radio Terminal Box — Cover Removed

c. Interphone Amplifier and Control Box Assembly.

(1) REMOVAL. With 24- and 12-volt master switches off, remove cover from sponson terminal box and disconnect interphone circuit cord wires as follows: Disconnect white wire from No. 1 terminal, yellow wire from No. 2 terminal, green wire from No. 3 terminal, blue wire from No. 4 terminal, and black wire from negative (—) terminal (fig. 213). Pull interphone circuit cord from terminal box. Disconnect interphone power cord wires as follows: Disconnect brown and black wires from negative (—) terminal, and white and yellow wires from positive (+) terminal. Pull interphone power cord from terminal box. Pull control box plugs from transmitting and receiving unit. Remove cable clamps securing radio to control box cords and interphone amplifier to control box cord to hull. Remove eight screws with washers securing interphone amplifier in interphone amplifier box and, using the two handles provided on the interphone panel, pull interphone amplifier from jack strip and box (fig. 214). Remove four mounting cap screws from inside of box and set box down on sponson. Remove two screws and washers securing cover to control box, and remove control box from mounting pad by removing mounting screws and washers from inside of control box (fig. 215). Inter-

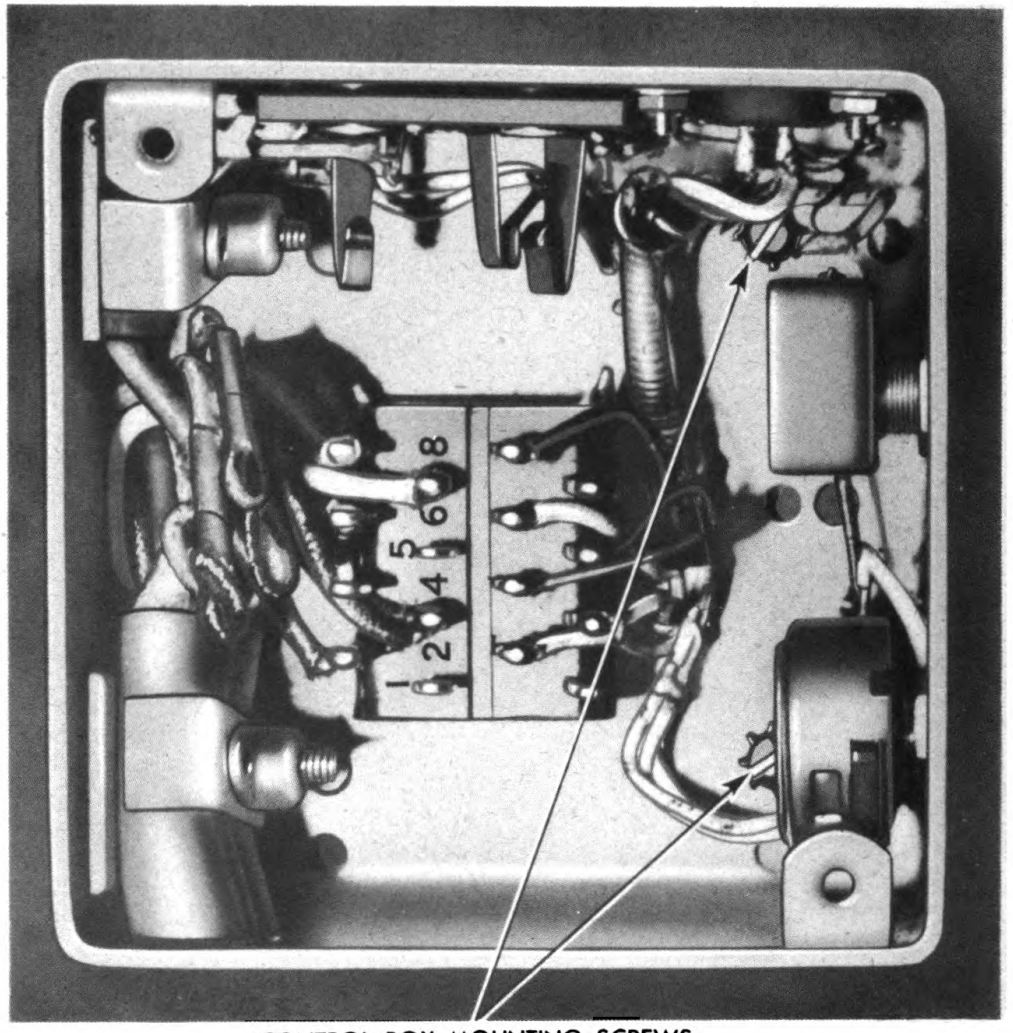


RA PD 339690

Figure 214 — Radio Interphone Box — Amplifier Removed

phone amplifier box, control box, and cords may now be removed as an assembly.

(2) INSTALLATION AND CONNECTION FOR OPERATION. Position interphone box and install mounting cap screws (fig. 215). Secure cover on control box with two screws and toothed lock washers. Position control box and install mounting screws and toothed washers (fig. 215). Secure cords in place with cable clamps which were removed. Make sure 24- and 12-volt master switches are off. Plug radio to control box cords in transmitting and receiving unit as shown in figure 211. Plug interphone amplifier onto jack strip in interphone box (fig. 214) and install eight screws with washers securing interphone amplifier in box. Feed interphone power cord through opening provided in sponson terminal box, and connect brown and black wires to negative (−) terminal and white and yellow wires to positive (+) terminal. Feed interphone circuit cord through opening provided in sponson terminal box, and connect white wire to No. 1 terminal, yellow wire to No. 2 terminal, green wire to No. 3 terminal, blue wire to



RA PD 339691

Figure 215 — Control Box — Cover Removed

No. 4 terminal, and black wire to negative (−) terminal. Place cover on terminal box and secure with screw and toothed lock washers.

d. Commander's and Gunner's Control Boxes.

(1) REMOVAL. With 24- and 12-volt master switches off, remove the cover from the turret terminal box (fig. 216). Disconnect the terminal box to commander's control box cord from terminals in terminal box as follows (fig. 213): Disconnect white wire from No. 1 terminal, yellow wire from No. 2 terminal, green wire from No. 3 terminal, blue wire from No. 4 terminal, and black wire from the negative (−) terminal. Pull cord from terminal box. Remove cable clamps securing cord to turret. Pull interphone reel to control

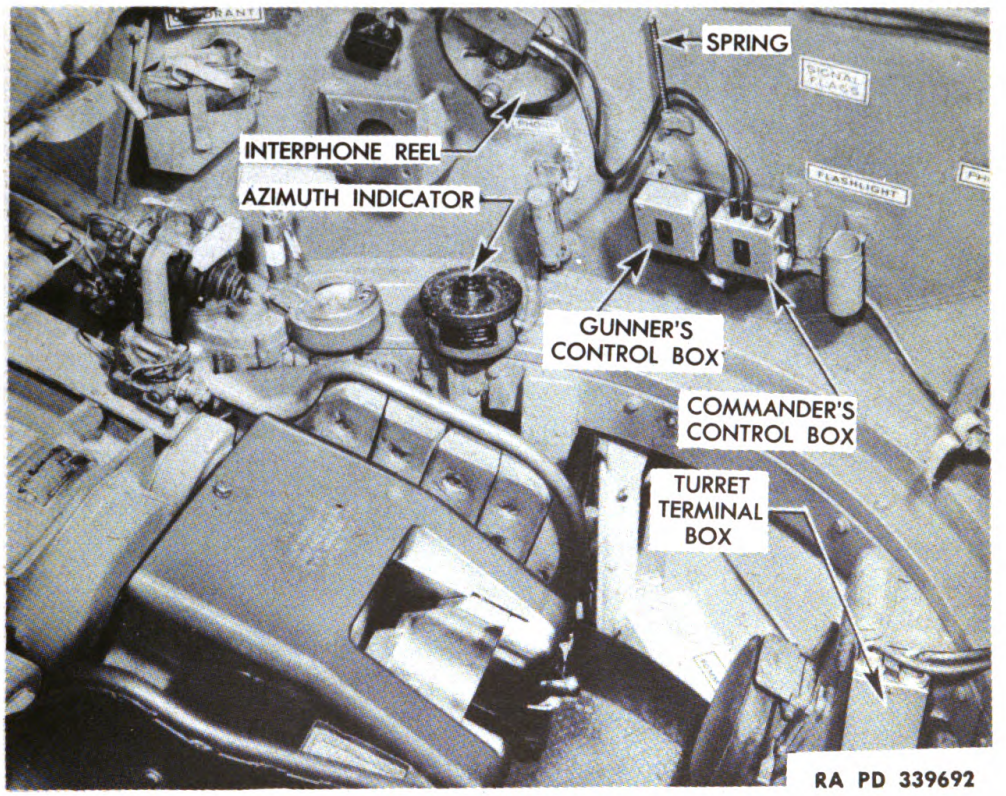


Figure 216 — Interphone Equipment — Right Side of Turret

box plugs from control box. Remove cover retaining screws and washers from gunner's and commander's control boxes and remove covers (fig. 216). Remove control box mounting screws and washers from inside boxes (fig. 215). Remove control boxes and connecting cords as an assembly.

(2) INSTALLATION AND CONNECTION FOR OPERATION. Make sure 24- and 12-volt master switches are off. Position interphone control boxes as shown in figure 216 and secure to mounting pad with screws and toothed lock washers (fig. 215). Feed commander's control box to turret terminal box cord through opening provided in top of terminal box (fig. 216) and connect wires to terminals according to color and terminal number as specified in subparagraph d (1) above. Position cover on terminal box and secure with screws and toothed lock washers. Plug interphone reel to control box cords into commander's control box. Install cable clamps which were removed.

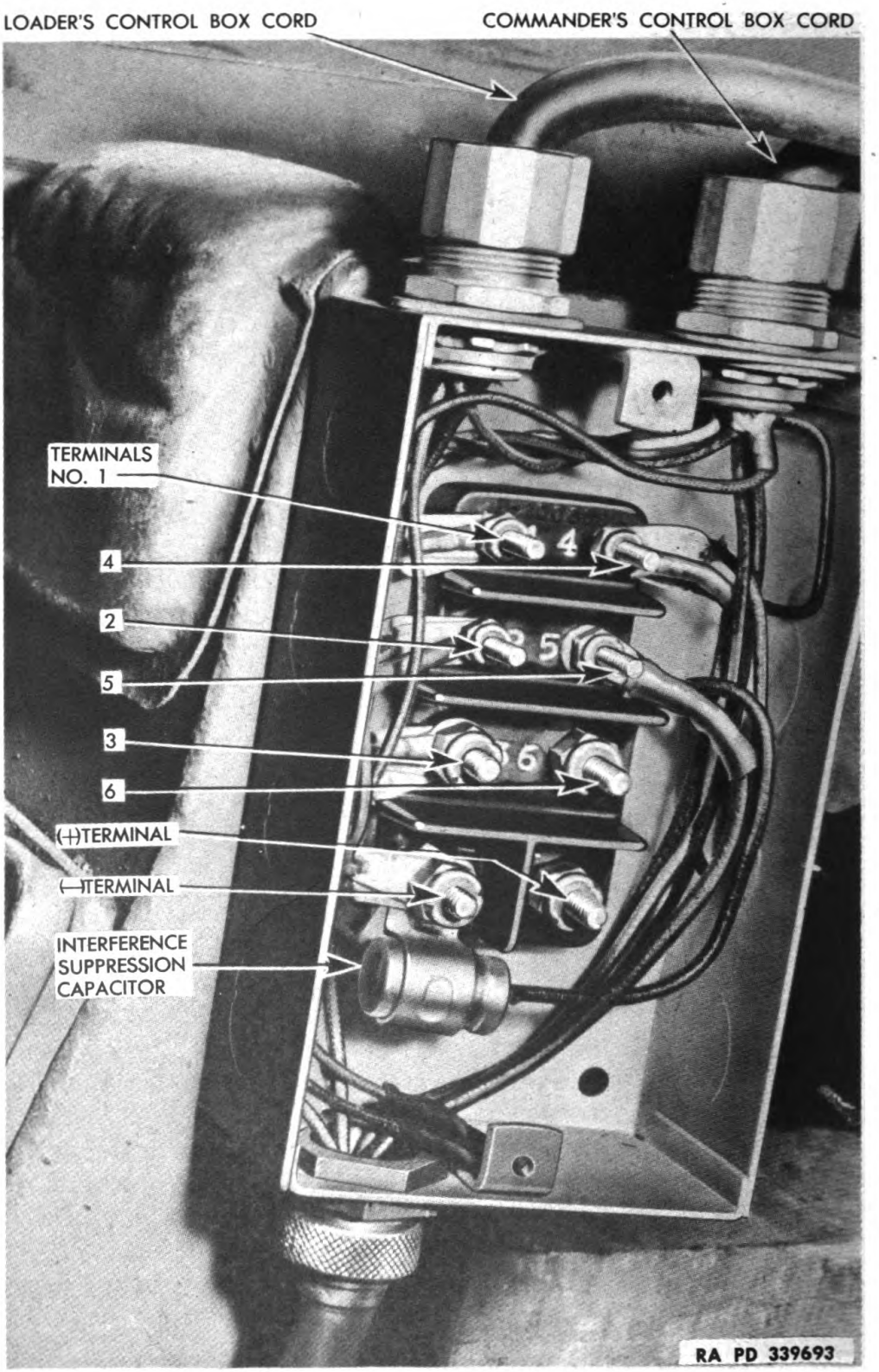


Figure 217 — Turret Radio Terminal Box — Cover Removed

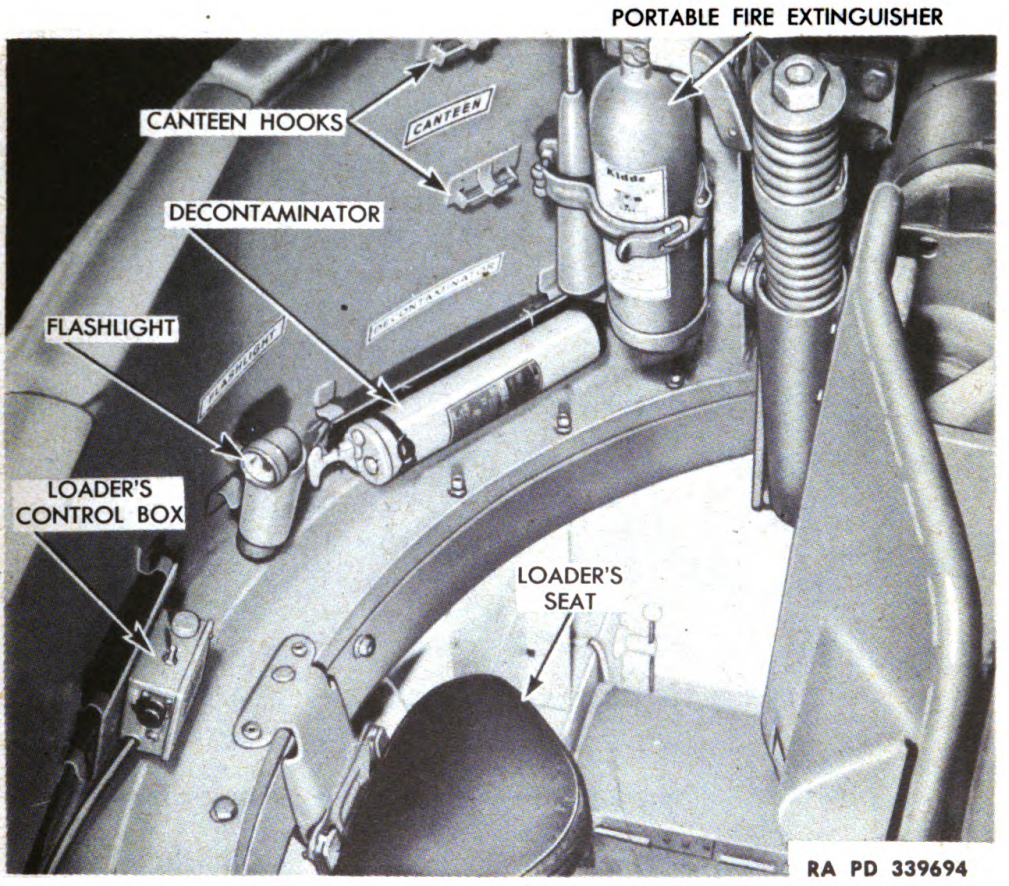


Figure 218 — Turret Interior — Right Side

e. Loader's Control Box (fig. 218).

(1) REMOVAL. Remove loader's control box, using same procedure as used to remove commander's and gunner's control boxes (subpar. **d** (1) above) with the exception that it is not necessary to remove interphone reel to control box cords.

(2) INSTALLATION AND CONNECTION FOR OPERATION. Install the loader's control box, using the same procedure as used to install commander's and gunner's control boxes (subpar. **d** (2) above).

f. Interphone Reel Assembly.

(1) REMOVAL. Pull all four plugs, and remove reel to control box cords. Remove interphone reel cord from the spiral guide mounted just to the front of the reel. Using a wrench on the square-headed spindle, unscrew the spindle from the brake and remove the spindle and reel as an assembly. Remove lock washer from brake end of spindle (fig. 219).

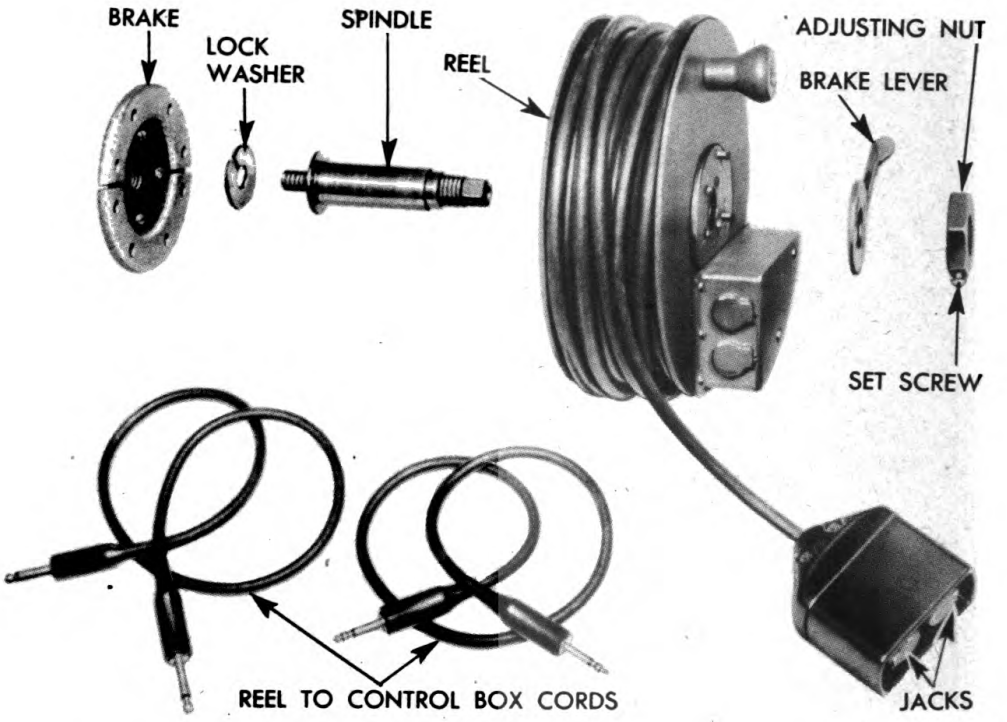


Figure 219 — Interphone Reel — Partially Disassembled

(2) INSTALLATION AND CONNECTION FOR OPERATION. Install lock washer on end of spindle and reel assembly (fig. 219). Screw spindle into brake mounted on side of turret and tighten securely, using wrench on square end of spindle. If adjustment is necessary for proper operation of reel brake, loosen the set screw on the adjusting nut and tighten or loosen the adjusting nut for more or less breakage whichever is needed. Secure with the adjusting nut by tightening the adjusting nut set screw. Rotate reel cord into spiral guide mounted on side of turret just to the front of the reel. Plug reel to control box cords into protected jacks provided in reel and jacks at top of commander's control box.

APPENDIX

Section XL

SHIPMENT AND LIMITED STORAGE

199. GENERAL INSTRUCTIONS.

a. Preparation for domestic shipment of the vehicle is the same as preparation for limited storage. Preparation for shipment by rail includes instructions for loading and unloading the vehicle, blocking necessary to secure the vehicle on freight cars, clearance, weight, and other information necessary to properly prepare the vehicle for rail shipment. For more detailed information and for preparation for indefinite storage refer to AR 850-18 and FM 9-25.

200. PREPARATION FOR LIMITED STORAGE OR DOMESTIC SHIPMENT.

a. Vehicles to be prepared for limited storage or domestic shipment are those temporarily out of service for less than 30 days, or vehicles that must be ready for operation on call. If vehicles are to be indefinitely stored after shipment by rail, they will be prepared for such storage at their destination.

b. If the vehicles are to be placed in limited storage, take the following precautions.

(1) LUBRICATION. Completely lubricate the entire vehicle, except the engine (par. 33). For preparation of the engine, see step (9) below.

(2) COOLING SYSTEM. If freezing temperature may normally be expected during the limited storage or shipment period, test the coolant with a hydrometer and add the proper quantity of antifreeze compound (par. 25) to afford protection from freezing at the lowest temperature anticipated during the storage or shipping period. Completely inspect the cooling system for leaks.

(3) BATTERIES. Check batteries and terminals for corrosion and if necessary, clean and thoroughly service batteries (par. 97).

(4) ROAD TEST. The preparation for limited storage will include a road test of at least 5 miles, after the battery, cooling system, and lubrication services have been performed, to check on general condition of the vehicle. Correct any defects noted in the vehicle operation, before the vehicle is stored or note on a tag attached to the steering levers, stating the repairs needed or describing the condition present. A written report on these items will then be made to the officer in charge.

(5) FUEL IN TANKS. It is not necessary to remove the fuel from the tanks during temporary storage or shipment within the United States, nor to label the tanks under Interstate Commerce Commission Regulations. Leave fuel in the tanks except when

storing in locations where fire ordinances or other local regulations require removal of all gasoline before storage. If vehicle is to be maintained ready for operation on call in excess of 30 days, the following precautions against gum formation must be taken:

(a) The fuel system must be free from accumulated gum. Unless the vehicle is entering its first storage and has never been issued for use, inspect and clean the fuel pump valve; carburetor accelerator pump plunger, venturi tube, choke and throttle valves, float mechanism; fuel lines; fuel tanks; fuel filters; fuel shutoff valves; and screens.

(b) If gum is present in the above parts, it can best be removed by benzol, acetone, alcohol, or a mixture of these solvents. Deposited gum is not readily soluble in fresh gasoline. When gum has dried, it may be necessary to resort to mechanical means to remove it.

(c) Parts which cannot be thoroughly cleaned and freed from the gum deposit without damage should be replaced.

(d) After cleaning and reassembling, fill fuel tank half full of fresh gasoline which has not been long in storage.

(e) Add three containers (12 oz.) of gum-preventive compound to each set of fuel tanks.

(f) Fill fuel tanks to capacity and operate the vehicle for at least 5 minutes.

(6) BREECH MECHANISM. When possible, partially disassemble the breech mechanism and dip, spray, or brush the parts with light rust preventive compound. Assemble the breech mechanism.

(7) GUN TUBE. Clean the bore of the 90-mm gun with dry-cleaning solvent and thoroughly dry. Swab the bore with light rust preventive compound. Seal the muzzle with non-hygroscopic adhesive tape. Install the muzzle cover, if available, and seal with non-hygroscopic adhesive tape. If a muzzle cover is not available, wrap waterproof barrier wrapping paper over the tape and seal with non-hygroscopic adhesive tape.

(8) EXTERIOR OF VEHICLE. If practicable, remove rust appearing on the vehicle exterior with flint paper. Repaint painted surfaces whenever necessary to protect wood or metal. Coat exposed polished metal surfaces susceptible to rust with light rust preventive compound. Close firmly all doors, hatches, and vision slots. Make sure paulins are in place and firmly secured. Leave rubber mats, such as floor mats, where provided, in an unrolled position on the floor, and not rolled or curled up. Equipment such as pioneer tools and fire extinguishers will remain in place on the vehicle. For treatment of small arms carried on or within vehicles, refer to the pertinent technical manuals.

(9) ENGINE.

(a) Remove spark plugs and spray into tops of cylinders with preservative engine oil, SAE 30 (grade II), while slowly rotating engine. Replace spark plugs.

(b) If spark plugs cannot be removed, spray preservative oil into air intake with engine running at a fast idle until smoke comes from exhaust pipe. CAUTION: *Preservative oil should never be poured through carburetor.* After spraying preservative oil into air intake, shut off engine and allow to cool for about 15 minutes. Start engine and again spray preservative oil into air intake for several minutes only. The second spraying is necessary in order to coat exhaust valves. Do not run engine for more than several minutes as exhaust valves will become so hot that preservative oil will not adhere properly. Perform this treatment when further running of the engine is not necessary.

(c) If it becomes necessary to run the engine after treatment, it should not be operated at over 1,600 revolutions per minute. Hold operation to a minimum, and spray cylinders again after operation.

(10) INSPECTION. Make a systematic inspection, just before shipment or temporary storage, to insure all above steps have been covered and that the vehicle is ready for operation on call. Make a list of all missing or damaged items and attach it to one of the steering levers. Refer to "Before-operation Service" (par. 35).

(11) BRAKES. Release brakes and chock tracks.

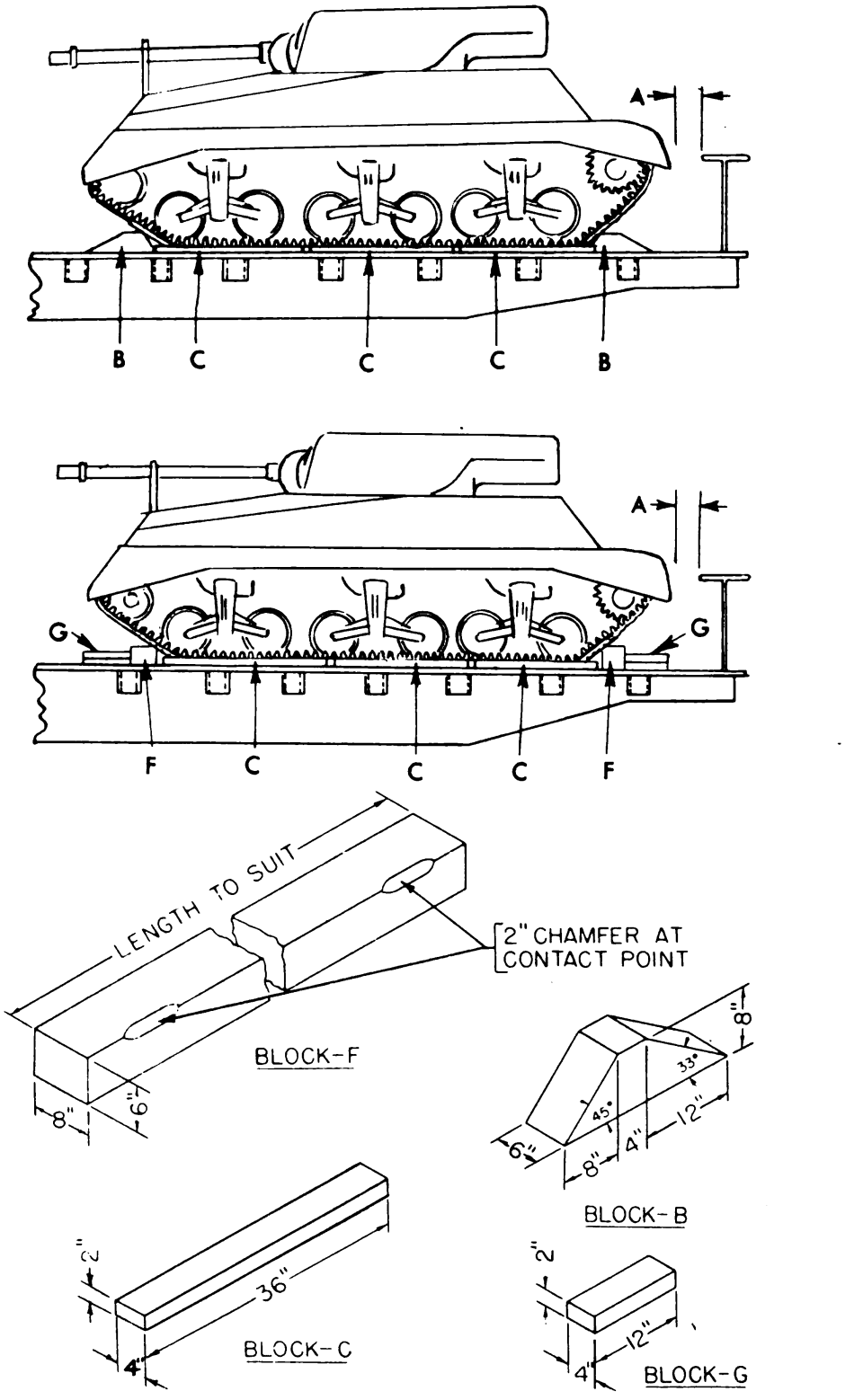
c. Inspections in Limited Storage. Vehicles in limited storage will be inspected weekly for conditions of batteries. If water is added to batteries when freezing weather is anticipated, recharge the batteries with a portable charger or remove the batteries for charging. Do not attempt to charge the batteries by running the auxiliary generator. If freezing temperature is expected, add the proper quantity of antifreeze compound (par. 25) to cooling system to afford protection from freezing. Remove any rust from vehicle with flint paper.

201. LOADING AND BLOCKING FOR RAIL SHIPMENT.

a. Preparation. In addition to the preparation described in paragraph 203, when Ordnance vehicles are prepared for domestic shipment, the following preparation and precautions will be taken.

(1) EXTERIOR. Cover the body of the vehicle with a canvas cover ordinarily supplied as an accessory.

(2) BATTERIES. Disconnect the batteries to prevent its discharge by vandalism or accident. This may be accomplished by disconnecting the positive lead, taping the end of the lead, and tying it back away from the battery.



RA PD 344898

Figure 220 — Blocking Requirement for Rail Shipment

(3) MARKING CARS. All cars containing Ordnance vehicles must be placarded "DO NOT HUMP".

b. Placing Vehicles on Cars.

(1) TYPES OF CARS. Ordnance vehicles may be shipped on flat cars, end door box cars, side door cars, or drop end gondola cars, whichever type is the most convenient.

(2) FACILITIES FOR LOADING. Whenever possible, load and unload vehicles from open cars, using permanent end ramps and spanning platforms. Movement from one flat car to another along the length of the train is made possible by crossover plates or spanning platforms. If no permanent end ramp is available, an improvised ramp can be made from railroad ties. Vehicles may be loaded in gondola cars without drop ends by using a crane.

(3) BRAKE WHEEL CLEARANCE. If flat cars are used, position the vehicle with a railroad car brake wheel clearance of at least 6 inches (A, figs. 202 and 203). Locate the vehicles on the car in such a manner as to prevent the car from carrying an unbalanced load. Apply the brakes and place the transmission in low gear.

c. Securing Vehicles. In securing or blocking a vehicle, three motions, lengthwise, sidewise, and bouncing must be prevented. There are two approved methods of blocking the vehicles on freight cars, as described below.

(1) METHOD ONE. Place four blocks (B, fig. 220), one to the front and one to the rear of each track. Nail the heel of each block to the car floor with five 40-penny nails. Nail the portion of each block which is under the track to the car floor with two 40-penny nails. Locate three blocks (C) on each side of the vehicle on the outside of each track. Nail each block to the car floor with three 40-penny nails. These blocks may be located on the inside of the tracks if conditions warrant.

(2) METHOD TWO. Place two blocks (F, fig. 220), one to the front and one to the rear of the tracks. These blocks are to be at least as long as the over-all width of the vehicle at the car floor. Locate eight blocks (G) against the blocks (F) to the front and to the rear of each track. Nail the lower block to the floor with three 40-penny nails and the top block to the lower block with three 40-penny nails.

d. Shipping Data.

Length, over-all, (gun in traveling position)	23 ft $10\frac{3}{32}$ in.
Width, over-all	8 ft $8\frac{1}{2}$ in.
Height, over-all	8 ft $8\frac{5}{8}$ in.
Area of car floor occupied per vehicle	209.12 sq ft
Volume occupied per vehicle	1830 cu ft
Shipping weight per vehicle (approx.)	65,500 lb

Section XLI

REFERENCES

202. PUBLICATIONS INDEXES.

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 material covered in this manual:

a. Introduction to Ordnance Catalog (explaining SNL system) ..... ASF Cat. ORD 1 IOC

b. Index (index to SNL's) ..... ASF Cat. ORD 2 OPSI

c. Index to Ordnance Publications (listing FM's, TM's, TC's, and TB's of interest to ordnance personnel, FSMWO's, OPSR, BSD, S of SR's, OSSC's, and OFSB's, and including alphabetical listing of ordnance major items with publications pertaining thereto) ..... OFSB 1-1

d. List of Publications for Training (listing MTP's, MR's, TR's, FM's, TM's, TB's, MWO's, SB's, WDLO's, and FT's) ..... FM 21-6

e. List of administrative and supply publications (listing MR's, MWO's, SB's, RR's, and War Department Pamphlets) ..... W.D. Pamphlet 12-6

f. List of Training Films, Film Strips, and Film Bulletins (listing TF's, FS's, and FB's by serial number and subject) ..... FM 21-7

g. Military Training Aids (listing graphic training aids, models, devices, and displays) ..... FM 21-8

203. STANDARD NOMENCLATURE LISTS.

a. Ammunition.

Ammunition, blank, for pack, light and medium field, tank, and antitank artillery ..... ORD 11 SNL R-5

Ammunition, fixed and semifixed, including subcaliber, for pack, light and medium field, aircraft, tank, and antitank artillery, including complete round data ..... ORD 11 SNL R-1

Ammunition instruction material for pack, light and medium field, aircraft, tank, and antitank artillery.	ORD 11 SNL R-6

b. Armament.

Gun, machine, cal. .30, Browning, M1919A4, fixed and flexible, M1919A5, fixed and M1919A6, flexible	SNL A-6
Gun, machine, cal. .50, Browning, M2, heavy barrel, fixed and flexible; and ground mounts	SNL A-39
Gun, 90-mm, M3	SNL C-69
Mount, gun, 90-mm, M4, and Mount, combination, gun, T99, T99E1, and T99E2	SNL D-39

c. Carriage, motor, 90-mm gun, M36B1 ..... SNL G-233

d. Maintenance.

Cleaning, preserving and lubricating materials, recoil fluids, special oils, and miscellaneous related items	ORD 5 SNL K-1
Soldering, brazing and welding materials, gases and related items	ORD 5 SNL K-2
Tools, maintenance, for repair of automatic guns, automatic gun aircraft materiel, automatic and semiautomatic cannon, and mortars	ORD 6 SNL A-35
Tool-sets, for ordnance service command automotive shops	SNL N-30
Tool-sets (common), specialists' and organizational	SNL G-27 (Section 2)
Tool-sets (special), automotive and semi-automotive	SNL G-27 (Section 1)

e. Sighting Equipment.

Periscopes, telescopes for periscopes, and direct sighting telescopes for use in tanks	SNL F-235
Quadrant, gunner's, M1 (mils)	SNL F-140

204. EXPLANATORY PUBLICATIONS.

a. Fundamental Principles.

Ammunition, general	TM 9-1900

Automotive electricity	TM 10-580
Auxiliary fire-control instruments (field glasses, eyeglasses, telescopes, and watches)	TM 9-575
Basic maintenance manual	TM 38-250
Browning machine gun, cal. .30, HB, M1919A4 (mounted in combat vehicles)	FM 23-50
Browning machine gun, cal. .50, HB, M2 (mounted in combat vehicles)	FM 23-65
Driver selection and training	TM 21-300
Driver's manual	TM 10-460
Electrical fundamentals	TM 1-455
Field artillery and field motor ammunition	OFSB 3-3
Fuels and carburetion	TM 10-550
Gun, 90-mm, AA, M1, firing shell, H.E., M71; projectile, A.P.C., M82; and shot, A.P., M77	FT 90-C-3
Instruction guide: Small arms, light field mortars and 20-mm aircraft guns	TM 9-2200
Military motor vehicles	AR 850-15
Motor vehicle inspections and preventive maintenance services	TM 9-2810
90-mm gun M3 mounted in combat vehicles	TM 9-374
Ordnance service in the field	FM 9-5
Precautions in handling gasoline	AR 850-20
Qualification in arms and ammunition training allowances	AR 775-10
Radio fundamentals	TM 11-455
Radio sets SCR-609-A and SCR-610-A	TM 11-615
Range regulations for firing ammunition for training and target practice	AR 750-10
Shell, H.E., M71, w/FUZE, time, mechanical, M43 (all modifications)	FT 90AA-B-3
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
The radio operator	TM 11-454
U. S. rifle, cal. .30, M1903	FM 23-10

b. Maintenance and Repair.

Cleaning, preserving, sealing, lubricating and related materials issued for ordnance materiel	TM 9-850
Maintenance and care of pneumatic tires and rubber treads	TM 31-200
Ordnance maintenance: Accessories for tank engine, model GAA V-8 (Ford)	TM 9-1731C
Ordnance maintenance: Ford tank engine, model GAA V-8	TM 9-1731B
Ordnance maintenance: Hydraulic traversing mechanism (oil gear) for medium tanks M4 and modifications	TM 9-1731G
Ordnance maintenance: Power train unit, one-piece differential case, for medium tanks M4 and modifications and related gun motor carriages	TM 9-1750B
Ordnance maintenance: Speedometers, tachometers, and recorders	TM 9-1829A
Ordnance maintenance: Tracks and suspension, turret and hull for medium tank M4 and modifications	TM 9-1750K

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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