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TM 9-732 (Light Tank, M5)

This is a copy of a manual from my collection. It was distributed to train crew members of the M5 Stuart Light tank. This manual is somewhat hard to come by, as M5 production was small compared to the M4 Sherman series, or even the M5's upgrade, the M5A1 Tank.

Thank You,

Chris Bailey

RESTRICTED

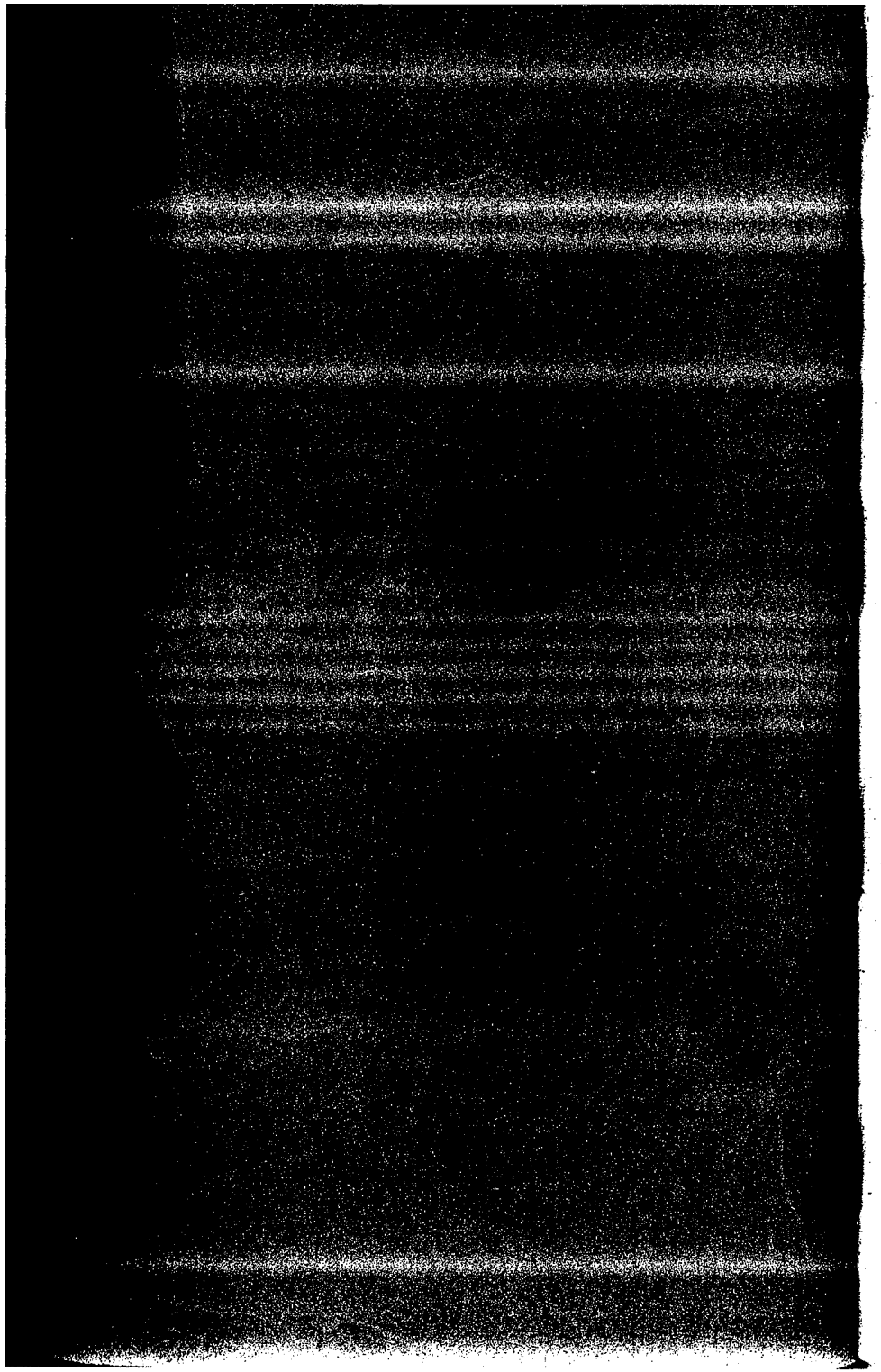
TM 9-732

WAR DEPARTMENT

TECHNICAL MANUAL

LIGHT TANK, M5

APRIL 18, 1942



RESTRICTED

TECHNICAL MANUAL
NO. 9-732

WAR DEPARTMENT
Washington, April 18, 1942

LIGHT TANK, M5

Prepared
under the direction of the
Chief of Ordnance
(with the cooperation of the
Cadillac Motor Car Division
General Motors Corporation)

PUBLICATIONS DEPARTMENT—RARITAN ARSENAL

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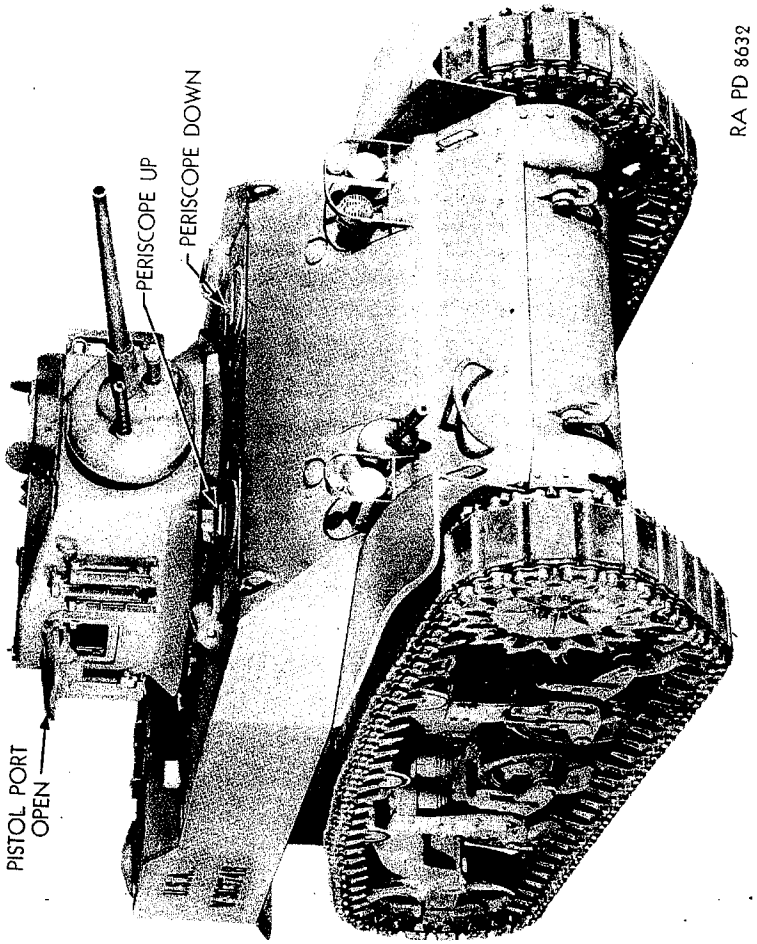


Figure 1—Right Front View of Vehicle

PART I—Operating Instructions

Section I

INTRODUCTION

1. PURPOSE AND SCOPE.

These instructions are published for the information and guidance of the personnel of the using arms charged with the operation, maintenance, and repair of this materiel. They contain descriptions of the major units and their function in relation to the other components of the vehicle, as well as instructions for operation, inspection, minor repair, and unit replacement.

2. CONTENT AND ARRANGEMENT OF THE MANUAL.

Sections I through X contain information chiefly for the guidance of operating personnel. The remaining sections contain information intended chiefly for the guidance of personnel of the using arms doing maintenance work.

3. REFERENCES.

The last section of this Manual lists all Standard Nomenclature Lists, Technical Manuals, and other publications for the materiel described herein.

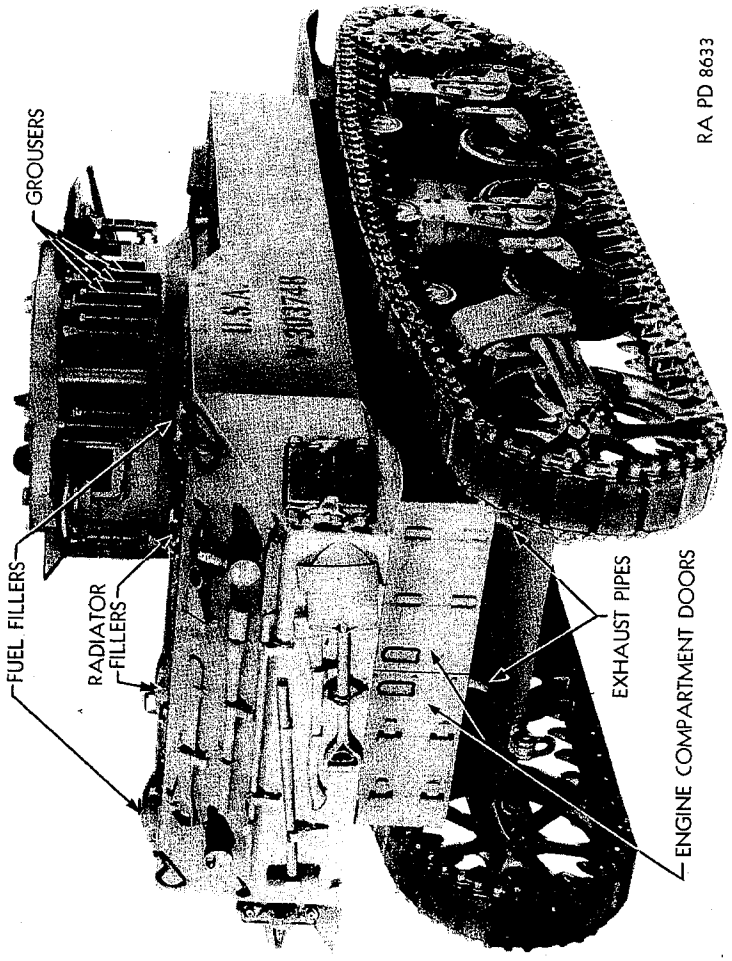


Figure 2—Right Rear View of Vehicle

Section II

DESCRIPTION AND TABULATED DATA

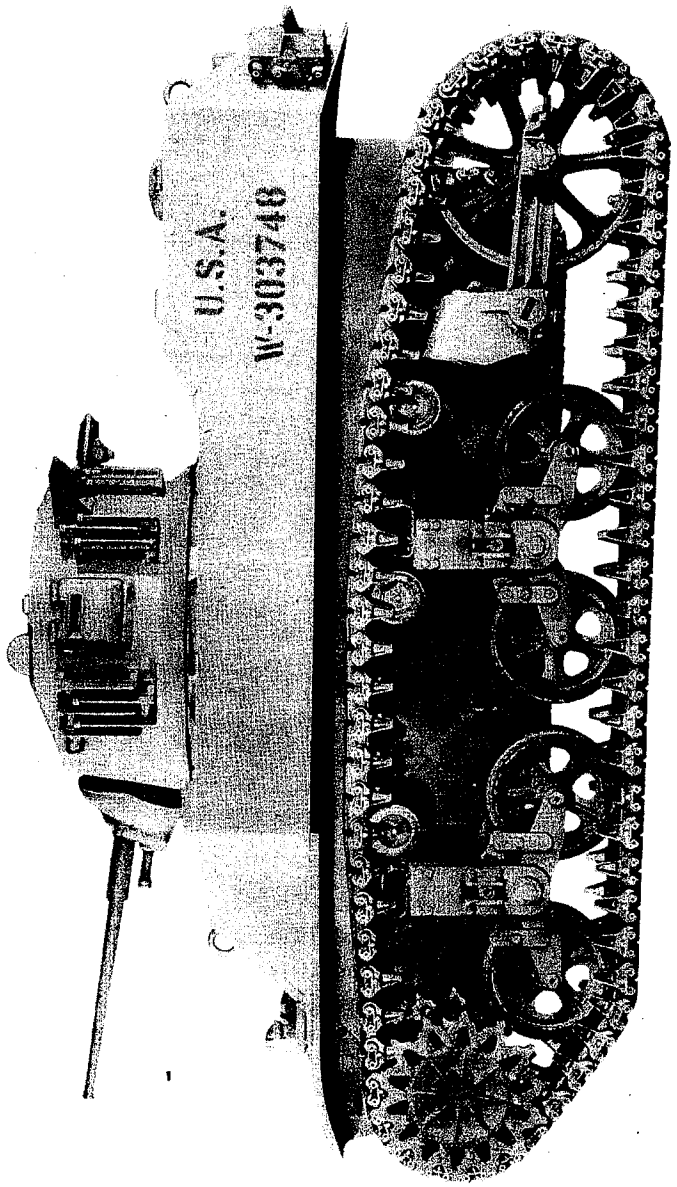
4. DESCRIPTION. (Figs. 1 through 5.)

a. The Light Tank, M5, is an armored, full track-laying combat vehicle carrying a four-man crew, and equipped with dual controls. It is powered by two eight-cylinder, 90°, V-type, liquid-cooled Cadillac engines, located in the rear of the hull. The flywheel end of each engine is connected to a Hydra-Matic Drive. The propeller shaft from each power plant runs forward through the fighting compartment to a transfer unit located just behind the driving axle. The Hydra-Matic Drives, plus the two-speed step-down in the transfer unit, provide six forward speeds and one reverse speed. The vehicle is wired for radio installation and for an intraphone system within the vehicle.

b. The basic hull armor plate is a completely welded structure, except for portions of front, top and rear which are removable for service operations. The armor on the front of the vehicle is 1½″ thick; on the sides of the fighting compartment, it is 1″ thick; on sides and rear of engine compartment it is 1″ thick, while the hull roof is ½″ armor.

c. The turret is 49¾″ outside diameter. Armor plate on front is 1½″ thick; on sides is 1¼″, and on roof is ½″ thick. The turret can be rotated through 360° by means of a hydraulic traversing mechanism or by hand.

d. There is an auxiliary power plant in the vehicle consisting of a generating set powered by a single cylinder gasoline engine. This unit supplements the engine generators for charging the battery.



RA PD 8631

Figure 3—Side View of Vehicle

5. TABULATED DATA.

a. General

Weight without armament, fuel, and crew	31,000 Lbs.
Ground pressure, per sq. in.	11.59 Lbs.
Over-all width	88¼"
Ground clearance	16½"
Tread (center to center of tracks)	73"
Over-all height, including turret	90½"
Over-all length	174¾"

b. Engine

Rated net horsepower at output shaft (each engine)	110 @ 3400 RPM
Number of cylinders (each engine)	8
Weight of engine w/accessories (each engine)	1,300 Lbs.
Firing order	1, 8, 7, 3, 6, 5, 4, 2

c. Armament

1 37 mm (M6) and 1 cal. .30 (M1919A5, fixed) combination gun mounted parallel to each other in turret. (In M-23 mount.)

1 Cal. .30 machine gun (M1919A4, flexible) in ball mount in bow.

1 Cal. .30 machine gun (M1919A4, flexible anti-aircraft) outside turret.

1 Cal. .45 Thompson submachine gun (M1928A1) carried on brackets within vehicle.

2 Mounts, tripod, machine gun, cal. .30, M2.

d. Ammunition carried

39 Rounds, 37 mm ammunition, high explosive.

65 Rounds, 37 mm ammunition, armor piercing.

19 Rounds, 37 mm ammunition, cannister.

6250 Rounds, cal. .30 ammunition, plus 250 in guns.

480 Rounds, cal. .45 in 30-round clips, or 320 rounds in 20-round clips.

12 Hand grenades.

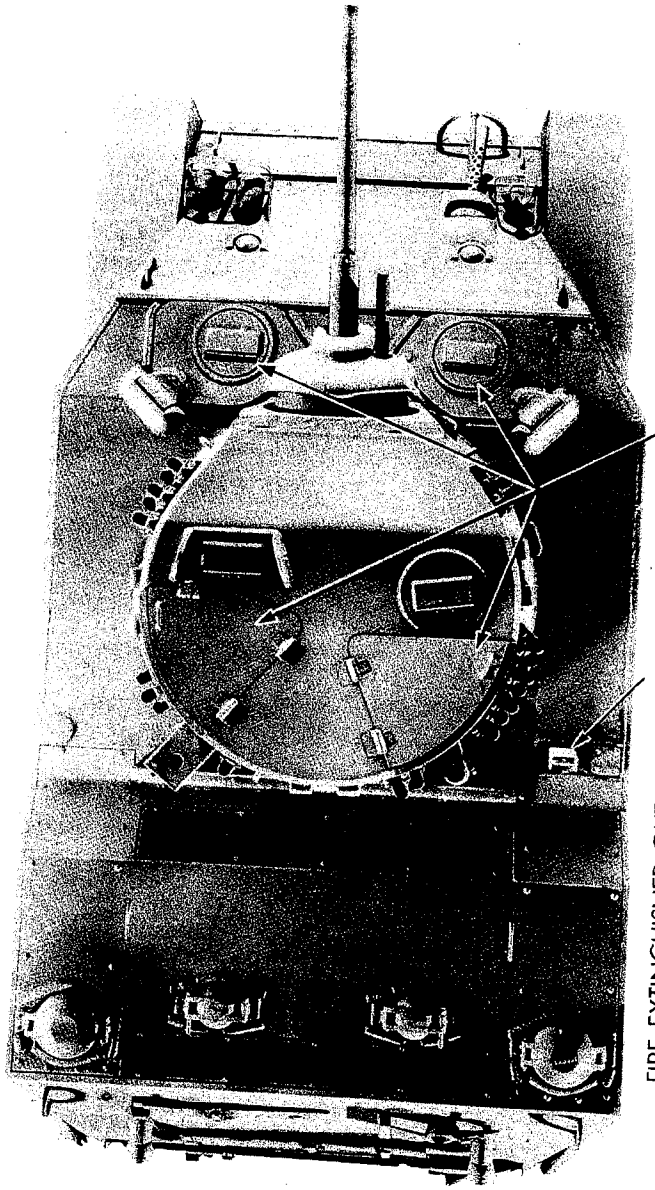


Figure 4—Top View of Vehicle

e. Protected vision. Protected vision is provided for the driver and other members of the crew by seven indirect vision devices, three protectoscopes in the turret pistol ports, and four periscopes; one in each driver's hatch and two in the turret top.

f. Seats, body supports, and safety belts are provided for each of the four members of crew.

g. Portions of the interior are padded with sponge rubber to protect the crew against bumps.

h. Communication

Radio	SCR 508 sending and receiving SCR 506 in command vehicles Voice or Code
Intra-tank	Telephone

i. Armor thickness

Front 1½″
Rear 1″
Sides 1″
Top ½″
Bottom ½″ ahead of front dead axle, ⅜″ behind this point.

j. Turret. Front plate 1½″, side armor plate 1¼″ thick, 360° traverse.

k. Fuel and oil

Fuel capacity (tank in each sponson) 89 Gallons total

	Gasoline Economy in MPG	No. of miles without refueling
25 m.p.h. on straight improved roads	2	180
10 m.p.h. average cross country	1½	135

Octane rating of fuel..... 80 or above
Oil consumption (approx.) 600 miles per gallon (both engines)
Engine oil capacity..... 8 qts. each engine
Lubricants ..... See Lubrication Chart

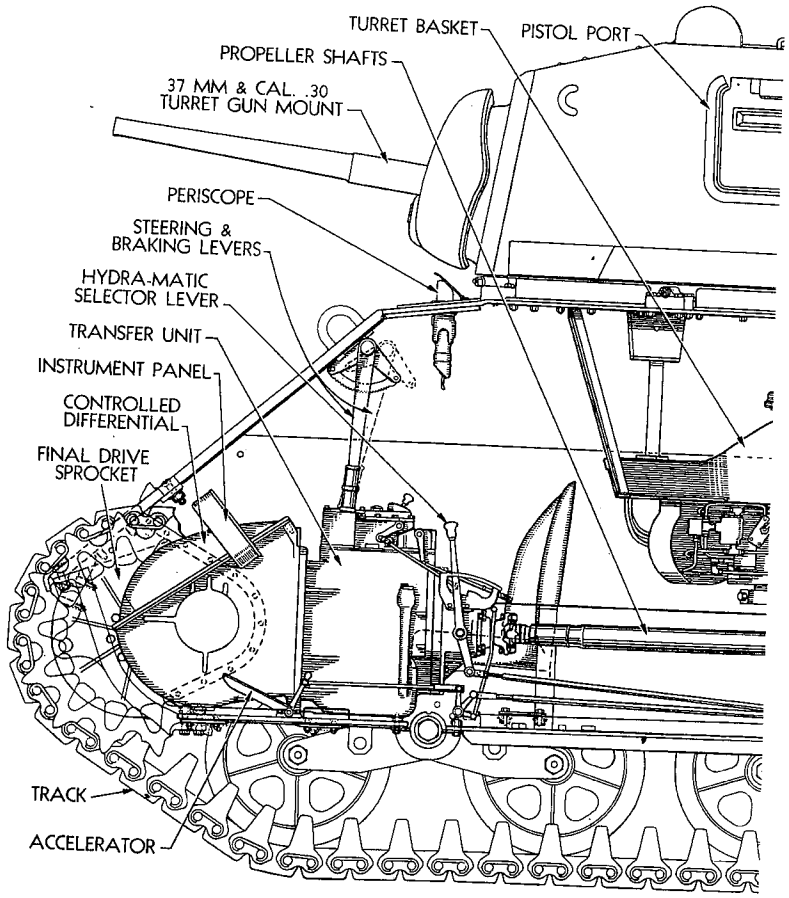


Figure 5—Longitudinal Section of Vehicle

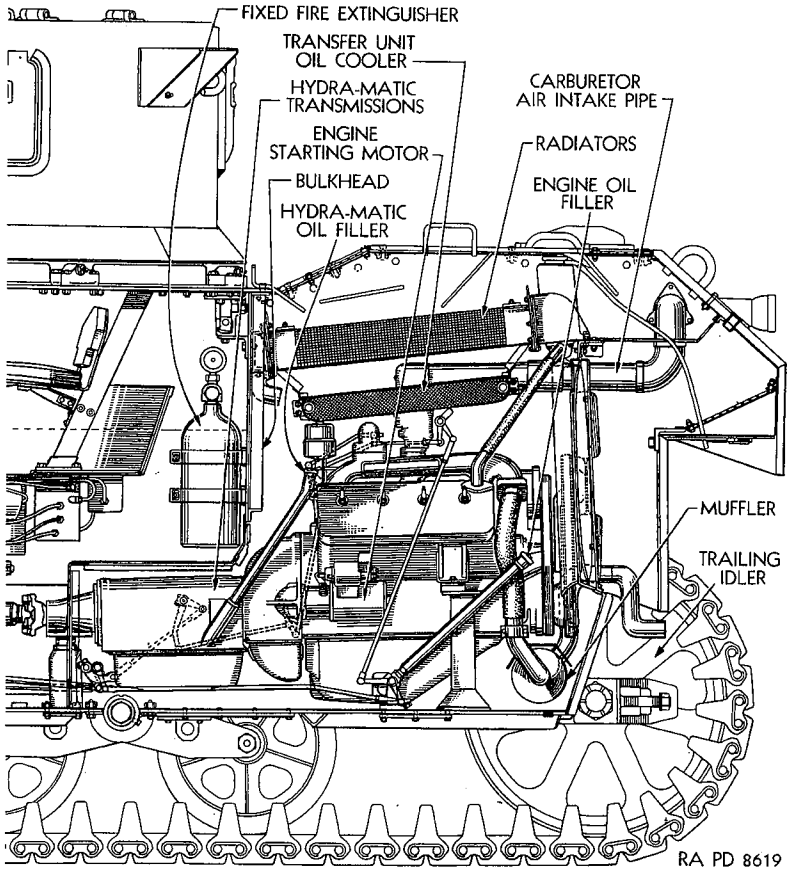


Figure 5—Longitudinal Section of Vehicle

1. Maximum operating characteristics—

Speed, sustained		40 m.p.h.
Speed, short periods		45 m.p.h.
Speed, cross country		Depends upon terrain
Maximum allowable engine speed	Short periods	4250 RPM
	Sustained	3500 RPM
Maximum grade ascending ability		60%
Maximum grade descending ability		60%
Maximum width of ditch vehicle will cross		5′ 5″
Maximum vertical obstacle, such as a wall, that vehicle will climb		24″
Maximum fording depth (at slowest forward speed)		3 feet

m. Crew — 4 men

n. Tracks — Rubber block

Track shoe width	11⅝″
Track pitch	5½″
Ground contact	9′ 7″

Section III

OPERATING INSTRUCTIONS AND CONTROLS

6. GENERAL INFORMATION ON CONTROLS.

The steering brake levers and the accelerators are duplicated for dual control. Other controls are not duplicated.

a. Spark Control. This is entirely automatic and requires no attention from the operator.

b. Choke. An automatic choke combined with an automatic fast idle provide the correct fuel mixture for starting and preliminary engine warm-up (See starting instructions, Paragraph 9, for additional information.)

c. Accelerators. Individual foot accelerators are provided for the driver and assistant driver to complete the dual control system (Fig. 6). The hand throttle is on driver's side, located just above and slightly to the right of the instrument panel, where it can be reached by the assistant driver. The hand throttle is self-locking in any position, and is released by means of a spring button in the center of the control knob.

d. Steering Levers. Dual steering levers for the driver and assistant driver are mounted on the upper front deck of the vehicle. To steer the vehicle, pull the steering lever on the side toward which it is desired to turn. Pulling back either of the levers slows down the track on that side while the speed of the other track is increased. Thus, the vehicle turns with power on both tracks at all times. Either set of levers may be swung forward to provide unobstructed working room for the man not driving.

e. Brakes. Pulling back simultaneously on both steering levers slows down or stops the vehicle, depending on the effort applied. The stop light goes on when both levers are pulled back for slowing down or stopping, providing the lighting switch is in a position that closes a stop light circuit (Fig. 8). Parking brake controls on the left-hand, or driver's, steering levers permit the levers to be locked in "On" position for parking (Fig. 6). Move the controls to right for unlocking, to left for locking.

f. Clutch. There is no clutch pedal. The Hydra-Matic unit eliminates the need for a foot-operated clutch, due to the fluid coupling between the engine and the transmission, and the automatic features of the transmission.

g. Gear Shifting. The driver does not shift gears with the Hydra-Matic transmission. Gear changes are controlled by engine load and accelerator position, and are made automatically by the hydraulic governors. With the Hydra-Matic selector lever at "Dr", all forward speeds are controlled by the driver through pressure on the accelerator pedal. (See Paragraph 11 for full operating information.)

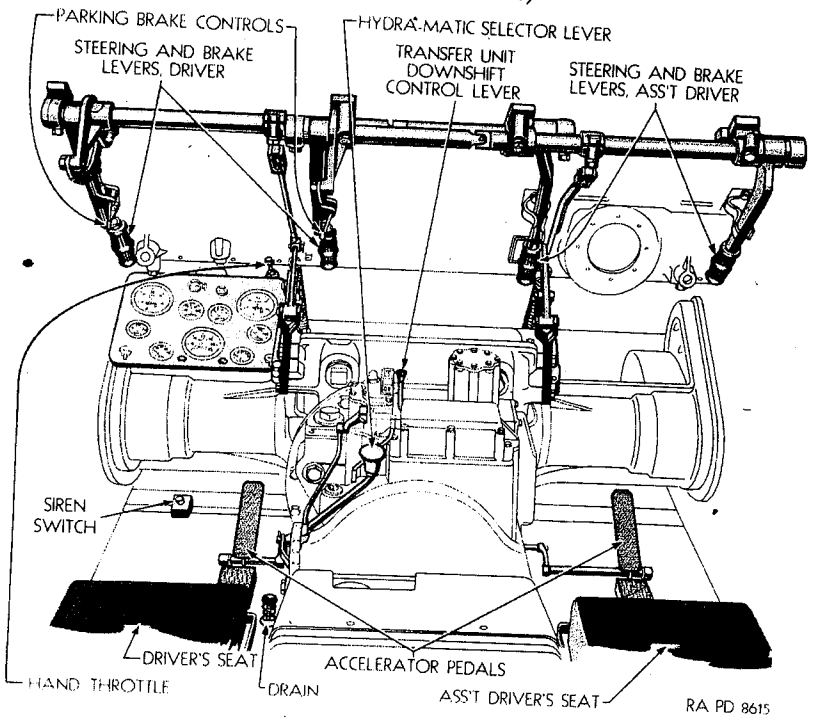


Figure 6—Driving Controls

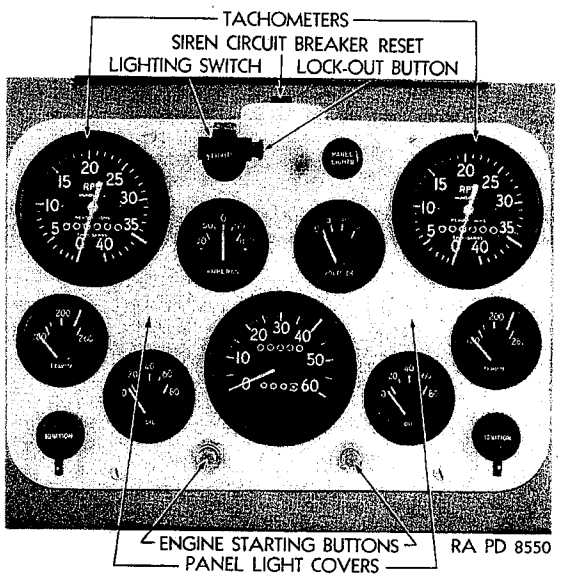


Figure 7—Instrument Panel

7. PRESTARTING INSPECTION.

Before the engines are started, the prestarting inspection outlined in Paragraph 38 must be completed.

8. FUEL REQUIRED.

For the best performance, only gasoline with an octane rating of 80 or above should be used.

9. STARTING INSTRUCTIONS.

The automatic choke and fast idle on these engines make special carburetor settings for starting unnecessary. The starting procedure is as follows:

a. Set the brakes.

b. Depress the accelerator pedal about ¼ of full travel, and then release fully. This assures correct setting of the automatic choke and fast idle for both carburetors.

c. Place Hydra-Matic selector lever at Neutral, "N". This will reduce the load on the starting motors and battery, and prevent the possibility of the vehicle moving.

d. Turn on the ignition switches for both engines (Fig. 7).

e. Press the starter button for each engine until the engine fires. If the engines do not fire promptly, press accelerator

slowly to the floor and hold down while pushing the starter button. Release accelerator gradually as engines begin to fire to minimize "racing."

CAUTION. Both engines should be started at the same time.

10. ENGINE TEST.

a. As soon as the engines are started, the oil gauges should be watched. Pressure at idling speeds should be about 15 pounds; at operating speeds about 30 pounds. If the gauges do not indicate oil pressure within 10 seconds, the engines should be shut down and an investigation made.

b. The ammeters should be watched to see that the generators are charging. If the ammeter does not indicate "+" with engines idling, speed up engines by momentarily depressing accelerator. If ammeter needle does not move to "+" side, look for slipping generator belts or broken connections.

c. The temperature gauges should indicate between 150° and 240° after the engines are warmed up, depending on the operating conditions. If temperature exceeds 240°, stop engine and investigate for loss of coolant.

CAUTION. When removing a filler cap from a hot radiator, always vent the radiator long enough to let all steam pressure escape before removing the cap, otherwise there is a possibility of serious personal injury. To vent radiator, turn the cap to the left (counterclockwise) until the first stop is reached. After the cap has remained in this position half a minute, or long enough to vent radiator thoroughly, press down on cap to clear the stop, and turn further to the left to remove.

d. When installing the radiator cap, always turn all the way to the right (clockwise) so that the entire cooling system will be sealed while operating.

e. Check for loose parts.

f. Check for unusual noises in each power train and engine.

11. OPERATING THE VEHICLE.

Before attempting to drive the vehicle, the operator should become thoroughly familiar with the location, "feel," and use of the various control levers, buttons and pedals.

a. The correct gear for every operating condition (with the exception of reverse) is automatically provided by the Hydra-Matic transmissions. With the engines idling, the selector lever should be moved to Drive position, "Dr," and the lever on the transfer unit to the rearward or "Dr" position. The engines

are then in gear, but to start the vehicle moving forward, the parking brake controls on the driver's levers must be released and the accelerator pedal depressed. The amount the pedal is depressed will determine the speed with which the vehicle moves forward.

b. With Hydra-Matic control set at "Dr" and Transfer Unit control lever (Fig. 6) in rearward position, the mechanism starts out in first and automatically shifts through second, third, fourth, fifth and sixth as speed increases and engine load is reduced.

c. As the vehicle loses speed either because the accelerator pedal is released or due to upgrades, the mechanism will shift down automatically to the proper gear.

d. When it is desirable to prevent the unit from shifting above second speed for better control or for maximum pulling power, move the Hydra-Matic selector lever to "Lo." If the engine is pulling the vehicle, the transfer unit control lever does not need to be moved, as the transfer unit is not operative on "pull" in this range. The transmissions will remain in first or second speed until the selector lever is again moved to "Dr."

e. "Lo" position should also be used to secure maximum engine compression for descending grades. In this instance, the Transfer Unit control lever must be moved to its forward or "Lo" position as it might otherwise upshift while the vehicle is driving the engine. The shift of the selector lever from "Dr" to "Lo" can be made at any speed without harming the transmissions as the gears are always in mesh. The downshift will not occur, however, except at relatively low speeds.

f. In order to shift into reverse, the vehicle must be brought to a complete stop. The selector lever should be moved to "Dr" position, held there momentarily, then tilted toward the driver and pulled straight back into Reverse "R", without hesitation. The Transfer Unit control lever is not moved to secure reverse.

g. To steer the vehicle, pull back the right-hand steering lever to make a right turn or the left-hand lever for a left turn. This action slows down the track on the side toward which the turn is being made while the other track increases in speed. As the driver anticipates making a turn, he should control the speed of the vehicle so that pressure can be put on the accelerator throughout the actual turn.

h. To stop the vehicle, release the accelerator and pull back on both steering levers at the same time. There is no clutch to disengage. The engines will not stall under the most severe braking load.

i. The parking brakes are combined with the steering brake controls on the driver's side. Controls are provided that lock the levers in position.

j. The tachometers, water temperature gauges, and the oil pressure gauges give the most satisfactory indications of the engine's performance. Should the indications of any of these instruments appear to be irregular, the engines should be throttled down and the cause investigated.

k. If one engine should become inoperative and the vehicle must be moved, it will be necessary to disconnect the "dead" engine at the propeller shaft universal joint on the transfer unit (Steps 1 and 2 in Paragraph 96a.), and to cover the radiator and the fan shroud opening of the dead engine with canvas or a blanket. The vehicle should never be operated with one engine except in emergency, but overheating can be kept to a minimum by the foregoing precautions.

12. STOPPING THE ENGINES.

a. To stop the engines, close the throttle until the engines are idling at approximately 400 RPM and run at this speed for three or four minutes, then turn off both ignition switches.

13. TOWING INSTRUCTIONS.

a. Equipment. A towing shackle is mounted on each corner of the hull of the vehicle about 20 inches from the ground. Two of these shackles are mounted in front and two in the rear. These shackles provide a quick method of attaching either the "towing bar" or cables.

b. Precautions. 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." This will prevent the cable from contacting the track, which might ruin both the cable and the track blocks. 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 tank at an angle than when following in tow. Grousers may be installed as required. The maximum speed when towing should not be more than 12 miles per hour and then only with an operator for steering and braking the towed vehicle.

c. NOTE. Except in cases where the "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. When a "short hitch" is desired, the two eyes of the cable are attached to the towing vehicle. The cable with leads **crossed,** is then passed through both shackles of the towed vehicle. This provides an arrangement having a minimum of bending action and movement at the shackles, and furnishes clearance between cable and tracks.

d. Method. If no operator is available to steer the disabled vehicle, it may be towed by using a towing bar, or in an emergency the "short hitch" method outlined under "c" above. In cases where the tracks must be removed from the vehicle, the "short hitch" or towing bar greatly facilitates towing the disabled vehicle. If an operator is available to steer the disabled vehicle, one cable will facilitate tracking of the towed vehicle. Care must be taken on turning not to get the cable tangled up with the track of either vehicle.

e. Towing to Start Engines. The engines can be started in an emergency by towing the vehicle, provided the following procedure is observed:

(1) Release brakes.

(2) Put Hydra-Matic selector lever at "N".

(3) When speed reaches approximately four miles per hour, set automatic chokes by depressing accelerator ¼ of total travel; turn on both ignition switches; and move selector lever to "Dr".

(4) Continue towing until engines fire.

14. SEAT ADJUSTMENT.

Seats for both the driver and the assistant driver have two adjustment ranges:

a. Horizontal. Directly in front of each seat, on the underside, is an L-shaped handle which controls forward and backward movement. Over-all travel is 3", or 1½" either forward or backward from the center position. The seat is locked in the desired position when the handle is released.

b. Vertical. The second adjustment raises the seats a maximum of 9" with a 3" forward swing. The control lever for this adjustment is on the hull side of each seat. To raise the seat, raise the control lever and take weight off the seat. It will move upward and forward into position by spring action. To lower the seat to the "fighting" position, raise control lever and body weight will force the seat down.

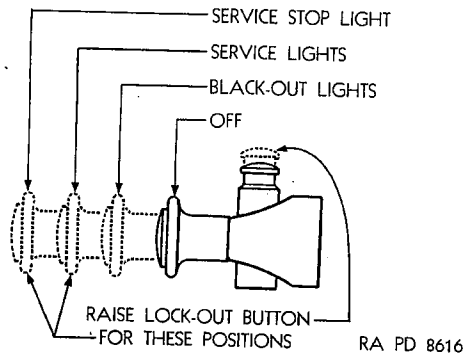


Figure 8—Lighting Switch Positions

c. Turret Seats. Two adjustable seats are located in the turret. On the underside of each seat there is a control lever connected to a plunger that engages graduated slots on the vertical seat runner. Pulling the lever frees the plunger and allows the seat to go up under spring pressure or down under body weight.

15. LIGHTS.

All exterior lights are controlled from a single push-pull button on the instrument panel, Fig. 7. There are three positions in addition to "Off", Fig. 8. A push-button lock on the control itself prevents the service lights from being turned on accidentally. The light switch operates as follows:

a. Pull button out to first stop. This turns on the blackout marker and tail lights, and blackout stop light.

b. Release locking button and pull button out to second position. This turns on service headlights, tail light and stop light.

c. Release locking button and pull button to final stop. This operates service stop lights (with no other lights) for daytime driving.

d. The stop lights operate only when both steering brake levers are pulled back to slow up or stop. When pulling back one lever for a turn, the stop lights do not go on.

e. Instrument panel lights are controlled by a separate push-pull switch. A rheostat, operated by turning the push-pull switch, controls the intensity of the instrument panel illumination.

Section IV

COLD WEATHER OPERATION

16. GENERAL.

a. The operation and maintenance of this vehicle at low temperatures involve factors which do not exist at normal temperatures, and operators and maintenance personnel must spend more time in protective maintenance. Failure to give this extra service will result in actual damage, unnecessary and unwarranted expense, and failure to start.

b. "Low temperatures" have been divided into two ranges——10° F to minus 30° F, and below —30° F. Engines and lubricants undergo changes in their physical properties below —30° F. In many cases, accessory equipment for supplying heat to engine, fuel, oil, and intake air is required.

17. FUELS.

a. A winter grade of motor fuel procured under U. S. Army Specification 2,-103, latest issue, is to be used in the engines.

b. The formation of ice crystals from small quantities of water in the fuel sometimes causes considerable trouble. The following precautions should be followed to keep water out of the fuel tanks:

(1) Strain gasoline through suitable strainer.

CAUTION. A positive metallic contact must be provided between fuel container and gasoline tank unless both fuel tank and container are independently grounded.

(2) So far as possible, always keep the fuel tank full. This will reduce condensation of water from the free air space above the fuel.

(3) Add one-half pint of denatured alcohol to each tank of gasoline. The alcohol will absorb the water and prevent it from freezing.

(4) Do not store fuel in old drums unless they have been **thoroughly** cleaned.

(5) Never pump fuel drums dry when filling vehicle fuel tanks; allow about four inches of fuel to remain. This residue can later be transferred to a settling tank. If time is not an urgent consideration, do not pump fuel from drum to vehicle until it has settled for 16 hours after filling or moving. Keep portable fuel pumps clean and protected from snow and frost.

(6) When a drum has been opened, be sure that the opening is covered or the bung replaced to prevent snow, frost, or other foreign matter from entering. Store drums in a covered building or cover them with tarpaulin.

18. CRANKCASE LUBRICATION.

a. Crankcase lubrication at temperatures above minus 10° F is covered in Chapter VI and in the Lubrication Guide. The following instructions are intended to supplement this information and apply only to instances where the temperature falls below minus 10° F for long periods.

b. Several methods of keeping crankcase oil sufficiently fluid for proper lubrication at temperatures below minus 10° F are listed below. Preference should be given to the different methods in the order listed according to the facilities available.

(1) Keep the vehicle in heated enclosure when it is not being operated.

(2) When engine is stopped, drain crankcase oil while it is hot and store in a warm place until vehicle is to be operated again. If warm storage is not available, heat the oil before reinstalling. (Avoid overheating the oil; heat only to the point where the bare hand can be inserted without burning.) **Tag the vehicle in a conspicuous place in the driving compartment to warn personnel that crankcases are empty.**

(3) If vehicle is to be kept out doors and if the crankcase cannot be drained, cover the engines with a tarpaulin. About three hours before engines are to be started, place fire pots under the tarpaulin. The Van Prag, Primus type, or other type blowtorch, and ordinary kerosene lanterns may be used.

(4) Dilute the crankcase oil. Crankcase oils may be diluted with the following materials according to their availability, with preference given in the order named:

(a) Gasoline.

(b) Kerosene.

(c) Diesel fuel.

(d) Transformer oil, Navy Specification 14-0-12.

(5) The table given below shows the quantities of diluent to be added to the **engine oils prescribed on the Lubrication Guides for use at —10° F.** These quantities of diluent will form mixtures for satisfactory starting at the temperatures indicated:

	−10° F. to −30° F.	Below −30° F.
Gasoline	½ qt. to each 4½ qts. of engine oil	1 qt. to each 5 qts. of engine oil
Kerosene	½ qt. to each 4½ qts. of engine oil	1 qt. to each 5 qts. of engine oil
Diesel Fuel	½ qt. to each 3½ qts. of engine oil	1 qt. to each 4 qts. of engine oil
Transformer Oil	50% transformer oil and 50% engine oil	

(6) When crankcase oils are first diluted, turn the engine over several times to mix fuel and diluent thoroughly.

(7) The presence of a large percentage of light diluent will increase oil consumption, and for this reason, the oil level should be checked frequently.

19. HYDRA-MATIC TRANSMISSIONS, TRANSFER UNIT AND DIFFERENTIAL.

a. The instructions given in the previous paragraph concerning engine oil apply equally to the oil used in the Hydra-Matic transmissions, the transfer unit, and the controlled differential. They also apply to the oil used for all oil can and lubrication points.

20. CHASSIS LUBRICANTS.

a. Chassis lubricants prescribed for use at —10° F. will furnish satisfactory lubrication at temperatures as low as —30° F. For sustained temperatures below —30° F., greases comparable to "Grease, special, low temperature," or "Grease, O.D. No. 00," should be used.

b. Greases normally used cannot be applied at temperatures below 0° F. except in heated buildings. In an emergency, when heated buildings are not available, use oil, and inspect and oil frequently.

21. PROTECTION OF COOLING SYSTEMS.

a. Ethylene glycol (Prestone) is prescribed for use as an antifreeze solution. If ethylene glycol is not available, other materials may be used. The following table gives three permissible materials and the quantity to be added to prevent freezing at the indicated temperatures.

Freezing Point	Pints, Ethylene Glycol, (Prestone) Per Gallon	*Pints, G.P.A. Radiator Glycerine Per Gallon	Pints Denatured Alcohol Per Gallon
10° F.	2	3	2½
0° F.	2½	3	3
−10° F.	3	3½	3½
−20° F.	3½	4	4
−30° F.	4	5	5
−40° F.	4½	–	5½
−50° F.	4½	–	6
−60° F.	5	–	6½
−70° F.	5	–	–

*G.P.A. Denotes Glycerine Producers Association.

b. Do not use denatured alcohol if the other materials are available at the temperatures indicated. Denatured alcohol boils at a temperature of 120° F.

CAUTION. Do not mix antifreeze solutions.

c. The following precautions should be taken before installing the antifreeze solution:

(1) Flush cooling system thoroughly. The radiators and cylinder blocks should be flushed separately in order not to transfer any residue from one to the other.

(2) Check the systems for leaks; tighten the hose connections and replace if necessary.

(3) Recheck the fan belts for adjustment or weakness. Replace belts if necessary.

(4) Be sure that the water pumps are properly lubricated.

22. ELECTRICAL SYSTEMS.

a. Generator and starter. Check the brushes, commutators and bearings. See that the commutators are clean. The large surges of current which occur in starting the cold engines require good contact between brushes and commutators.

b. Wiring. Check and clean all connections, especially battery terminal. Care should be taken that no short circuits are present.

c. Coils and condensers. Check coils and condensers for proper functioning.

d. Distributors. Clean thoroughly, check the points frequently and replace as necessary. In cold weather, the current is heavier and the points may pit and burn more than usual.

e. Spark plugs. Test and replace if necessary. If it is difficult to make the engines fire, reduce the gap .004 or .005. This will make sparking easier at the reduced voltages likely to prevail.

f. Timing. Check carefully.

g. Batteries. The efficiency of batteries decreases sharply with decreasing temperatures, and becomes practically nil at —40° F. Do not try to start the engine with the battery when it has been exposed to temperatures below —30° F. without first warming up battery by running the auxiliary power plant. See that the battery is always fully charged with the hydrometer reading between 1.275 and 1.300. A fully-charged battery will not freeze at temperatures likely to be encountered even in Arctic climates, but a fully-discharged battery will freeze at 5° F.

h. Lights. Inspect the lights carefully.

i. Starting. Before every start, see that there is no ice on the spark plugs, wiring, or other electrical equipment.

23. STARTING AND OPERATION.

a. Temperatures from —10° F. to —30° F.

(1) It is possible to start gasoline engines with batteries at temperatures as low as —30° F. if the engines are properly lubricated and in good mechanical condition.

(2) Prior to attempting a start, see that everything is in readiness so that the engine will start on the first trial. Try to avoid letting the engine fire a few times and then stopping. Water is one of the products of gasoline combustion, and in a cold engine this water may form a frost and make it impossible to start without heating the engine to above 32° F.

(3) Before cranking the engines, depress the accelerator pedal about one-quarter of total travel and release. This will set the automatic choke and fast idle correctly. No further choking is possible or necessary.

CAUTION. Do not "pump" or depress the throttle pedal swiftly to the floor before starting the engine. This would force

raw gasoline into the cylinders, causing flooding, decrease oil film in the cylinders, and would not aid starting.

(4) When the engines have started, allow them to run at 800 to 900 r.p.m. for four or five minutes to allow the oil to warm up before depressing the throttle further. This should be done with the Hydra-Matic selector lever in neutral. Then shift the selector lever to "Dr" and allow the engine to idle for several minutes more to warm up the oil in the Hydra-Matic transmissions. Do not drive the vehicle over 5 miles per hour for at least ten minutes after starting, to permit the oil in the transfer unit and controlled differential to warm up.

b. Temperatures below —30° F.

(1) Cover engine with tarpaulin, tent or portable shed. Place oil stoves, fire pots, or four or five ordinary kerosene lanterns under the covering about three hours prior to the time the start is to be made.

(2) Keep the vehicle in sheltered areas shielded from wind. Cold winds increase starting difficulties.

(3) It is possible for ice to collect in the fuel lines. If the engines do not appear to be getting enough fuel, heat the fuel lines lightly but be very cautious about fire.

c. Stopping. Increase engine speed just before turning off ignition; then turn off ignition switches and release accelerator at the same time. As the engine coasts to a stop, it will blow out all the residual products of combustion, and leave only air and gasoline vapor in the engine.

24. COLD WEATHER ACCESSORIES.

A number of the most commonly used accessories have been mentioned in the preceding sections. These, together with other accessories and attachments used successfully by tractor operators in northern climates, are listed below. The use of these accessories is not mandatory. They are given only as suggestions and are to be employed at the discretion of officers in charge of the materiel.

a. Tarpaulins, tents, or collapsible sheds are useful for covering vehicles, particularly the engines.

b. Fire pots, Primus type, or Van Prag blow-torches, ordinary blow-torches, oil stoves, or kerosene lanterns can be used for heating vehicles.

c. Extra batteries and facilities for changing batteries quickly are aids in starting.

d. Steel drums and suitable metal stands are useful for heating crankcase oil.

e. Insulation of the fuel line will help prevent ice formation inside the line.

f. Small quantities of denatured alcohol, about one-half pint to a tank of fuel, will reduce difficulties from water in gasoline.

g. Radiator covers can be improvised locally, and help to keep the engine running at normal temperatures.

h. For track-laying vehicles, extra wide tracks, 18″ to 24″ wide, should be used if they are available.

i. For operation in snow or ice, "snow shoes" or grousers should be used on the tracks.

j. It is often necessary to cut the center out of ordinary track shoes for operation in snow. Snow and ice have a tendency to become packed between sprocket and track. This will cause the track to be thrown, unless the snow and ice can be pushed out through holes cut in the shoes.

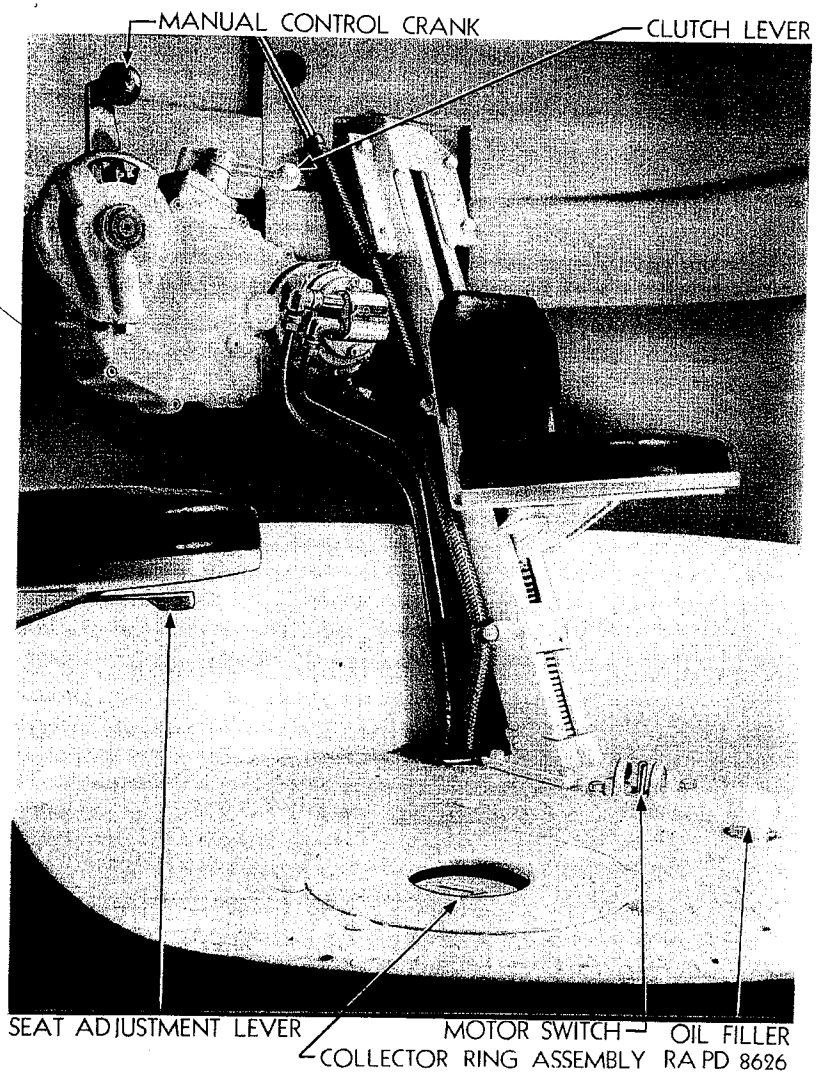


Figure 9—Turret Basket

Section V

ARMAMENT

25. GUNS AND GUN MOUNTS.

For detailed description and information on the operation, care and preservation of the guns and mounts, see Technical Manuals on guns as noted in Section XXVI. For lubrication information, see Section VI.

a. Combination Gun Mount, M23. This gun mount is located in the turret, and mounts a 37 mm gun, M6, and a cal. .30 machine gun, M1919A5, fixed, both of which move together as a single unit. The gunner sits in the left side of the turret basket to the left of the gun mount, while the commander (loader) sits on the right.

(1) Traverse of 360° is secured by turning the entire turret either by the hydraulic mechanism or by hand. Selection of the method of rotation is made by means of a manually operated clutch lever at the top of the hydraulic motor housing between the two seats (Fig. 9). The turret can be locked in any position by means of the cam-type turret lock (Fig. 11).

(a) To rotate the turret with the hydraulic traverse, first move the clutch lever **away** from the turret wall, and turn the motor switch under the gunner's seat (Fig. 9) to the "on" position. Turn the traverse control handle (Fig. 10) toward the center of the turret, or counter-clockwise, to rotate turret to the left. Turn handle toward turret wall, or clockwise, to rotate turret to the right. The amount the handle is turned determines the speed of turret rotation.

(b) The turret can be rotated by the manual control crank (Fig. 9) after moving the clutch lever **toward** the turret wall to engage the manual gears with the turret gears.

(2) Elevation or depression of the combined unit is secured with a hand wheel located on the left side of the gun mount, and is maintained while the vehicle is in motion by means of the Gyro-Stabilizer. Turning the elevating wheel (Fig. 10) counter-clockwise depresses the guns a maximum of 10°, while turning it clockwise elevates them to a maximum of 20°.

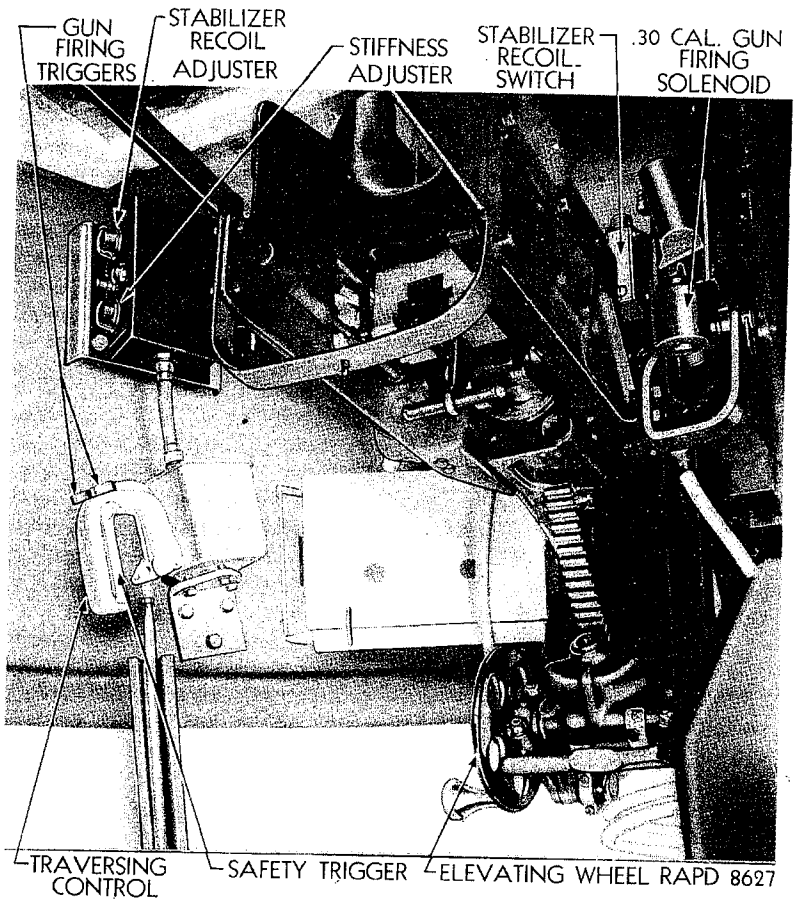


Figure 10—Turret Interior

(3) The electric firing controls are combined with the control handle operating the hydraulic turret traversing system (Fig. 10). Two buttons at the top of the pistol grip handle control the actual firing. The pistol grip must be compressed to release the safety mechanism. The left-hand firing button controls the 37 mm gun, while the button to the right fires the cal. .30 machine gun. The 37 mm gun can be fired manually with button trigger in the hub of the elevating wheel (Fig. 11), while the cal. .30 machine gun can be fired manually with the trigger on the gun itself, located just above the firing solenoid.

b. Gyro-Stabilizer Unit for Combination Gun Mount.

(1) **General.** The stabilizer attached to the combination

gun mount, M23, is used to maintain the positioning of the gun so that the gunner may accurately aim and fire the gun while the vehicle is in motion.

(2) **Starting the Unit.** Set the stiffness control (Fig. 10) at zero, **take the hand-elevating gears out of mesh,** and turn the handwheel until the gyro-control unit is approximately in a vertical position. Start the oil pump motor by turning the switch to the "On" position. This is the same switch as is used for the hydraulic turret traverse (Fig. 9). In cold weather, the oil must be permitted to warm up to obtain full control from the gyro-stabilizer equipment. In sub-zero weather, allow 1½ minutes running time for each degree of temperature below 0°F. or a total running time of 30 minutes at 20°F. below zero.

(3) **Operation.** (a) **Control of the Gun.** It is important that the stabilizer equipment be in operation only when the vehicle is moving and when control of the gun is desired. When the stabilizer equipment is in operation, the gun is elevated or depressed in the usual manner by turning the handwheel. This action changes the angular relation between the gun and the gyro-control unit, and the gun automatically takes up the new desired position. If the stabilizer equipment is operating satisfactorily, it will keep the gun very near its set angular position within its elevating range as limited by its mounting when the vehicle is in use and oscillating or pitching normally. Therefore, when the gun is aimed, the stabilizer must be allowed to control the position of the gun. The handwheel should not be turned after the gun has reached its maximum limits of travel in elevation or depression.

CAUTION: Continued turning of the handwheel with the gun against either stop will only displace the gyro-control unit from its vertical position and the result will be an excessive overload on the battery.

(b) **Adjusting the Stiffness Adjuster.** The stiffness adjuster located in the control box (Fig. 10) provides a means for the gunner to control the operation and effectiveness of the gyro-stabilizer. After the oil has warmed up, the knob of the stiffness adjuster should be turned clockwise slowly. An indication of too stiff an adjustment is a vigorous vibration of the gun. An indication of insufficient stiffness adjustment is the gun "hunting" or slowly elevating and depressing from its aimed or set position. When the gun starts to vibrate or "hunt" as the stiffness control knob is turned, decrease or increase the adjustment by turning the knob in the opposite directions until the "hunting" or vibration is eliminated. To check the operation further, press on the breech of the gun suddenly and re-

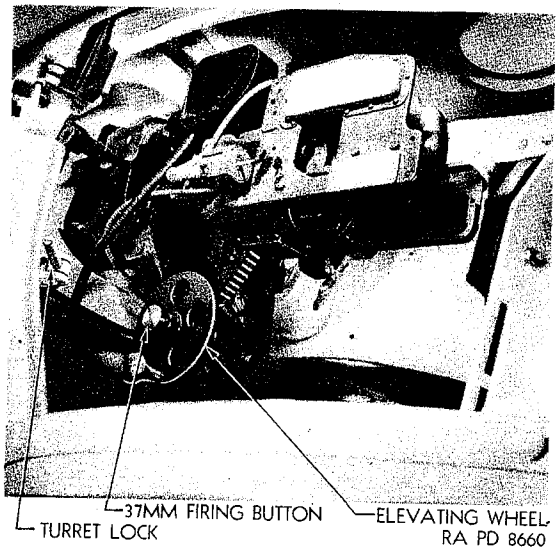


Figure 11—Turret Gun Mount, Left Side

lease. If the gun starts to vibrate, the stiffness adjustment must be decreased slightly. If the gun comes to rest almost immediately after a sharp sudden displacement, it can be considered in proper adjustment. It may be necessary for the operator to change the stiffness adjustment from time to time as the viscosity of the oil changes and after the vehicle is in use.

(c) **Adjusting the Recoil Adjuster.** The recoil adjuster located in the control box (Fig. 10) provides a means for the gunner to control the recoil of the gun. The recoil adjustment must be made by trial and error while the gun is being fired. The recoil adjustment knob should be gradually turned to the right or clockwise until a point is reached where the gun will keep its angular setting during recoil. If faulty operation is being obtained from the gyro-stabilizer during recoil, check for looseness in the mounting of the recoil switch as described in Section XXV.

(d) **Test for Effective Operation.** After the gyro-stabilizer is operating it should be checked for effectiveness or accuracy before the vehicle is used in combat as follows: Start and check the operation of the gyro-stabilizer equipment. Operate the vehicle over average rough terrain at a normal speed. Aim the gun in the usual manner, using the horizon as the target. If the gun does not fluctuate above or below the horizon, the

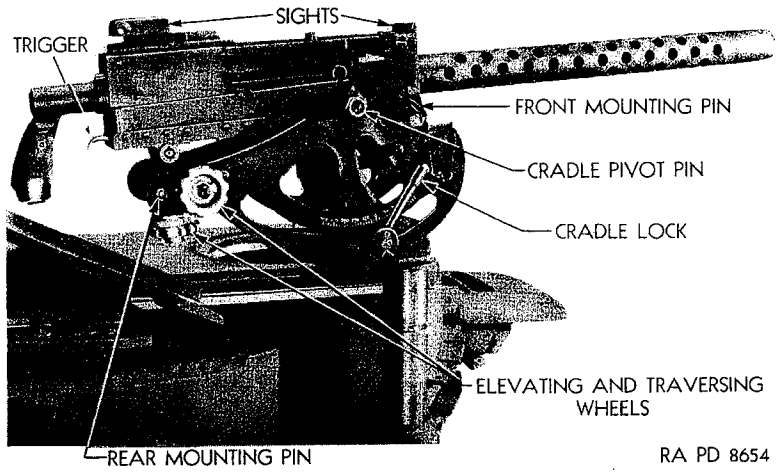


Figure 12—Anti-Aircraft Machine Gun

gyro-stabilizer can be considered to be operating satisfactorily. However, if the gun fluctuates above or below the horizon, check the items as listed under trouble shooting in Section XXV.

(4) **Oil Level.** The level of the oil in the oil reservoir (Fig. 75) should be checked daily and should be maintained 2/3 full of hydraulic oil.

c. Anti-Aircraft Cal. .30 Machine Gun. This gun is located on the outside of the turret on a mount that can be raised or lowered. The gun is carried in the lower position when not in use. The anti-aircraft gun can be used only when the turret hatch cover is open. The mount permits 360° traverse, while maximum elevation is 55° and maximum depression is 35°. Elevation is obtained by loosening the cradle lock and adjusting to desired position. Traverse position is locked and adjusted by means of a locking handle inside the turret. The anti-aircraft gun is fired manually by squeezing the trigger and is aimed by sights on the barrel. In addition, it can be dismounted from the cradle and fired from a portable tripod.

d. Bow Gun. A cal. .30 machine gun is carried in a ball mount on the right of the vehicle in front of the assistant driver. The ball mount allows both traverse, elevation and depression. The gun is fired manually by squeezing the trigger, and is sighted by tracer only. The bow gun can be pulled from its mounting for use on the tripod, which is stowed on the exterior of the vehicle, simply by removing one pin. Fig. 14 shows the method of mounting the bow gun and the anti-aircraft gun on the tripods.

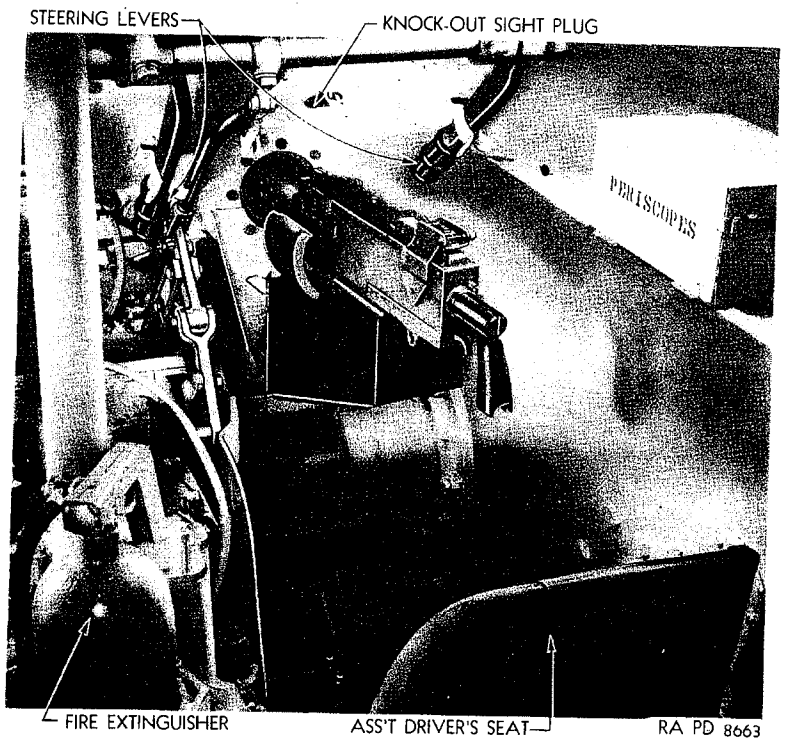


Figure 13—Bow Gun and Mount

e. Submachine Gun. One Thompson cal. .45 submachine gun is carried in brackets on the right side of the hull. It is usable through the pistol ports, opened hatches or outside when dismounting from the vehicle is necessary.

26. SIGHTING EQUIPMENT.

Outside vision is provided by means of four periscopes, one for each member of the crew, three protectoscopes in the turret, and two knock-out plugs covering ports in the front armor plate.

a. Turret Periscopes. (1) One periscope is fixed on the left side of the 37mm gun mount. This unit moves up and down as the gun is elevated and depressed. The combination gun sight is built into right-hand side of the periscope.

(2) One rotating periscope is provided for the commander (loader) in the turret. This periscope has a 360° traverse, 25° elevation and 17° depression from the normal vertical position.

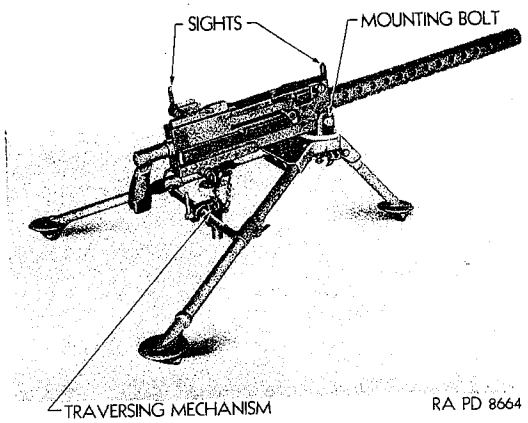


Figure 14—Machine Gun and Tripod

(3) Procedures for changing periscopes are given in Section XXIV, Paragraph 134c.

b. Bow Periscopes. (1) The driver's periscope is fixed in position in the escape hatch cover, directly in front of driver. The periscope can be rotated 360°, elevated 25°, or depressed a maximum of 17°.

(2) The assistant driver's periscope is placed in the escape hatch cover directly in front of assistant driver's seat. This periscope has the same traverse, elevation and depression as the driver's periscope.

c. Protectoscopes. The three protectoscopes are located in the pistol ports in the turret. The construction of the protectoscopes and the replacement of the sighting devices is covered in Section XXIV, Paragraph 135d.

27. AMMUNITION.

The ammunition stowage chart, Fig. 15, shows the location of all ammunition. Ammunition carried is as follows:

6250 rounds— cal. .30, plus 750 in guns

123 rounds— 37 mm as follows:

39 rounds, high explosive

65 rounds, armor piercing

19 rounds, cannister

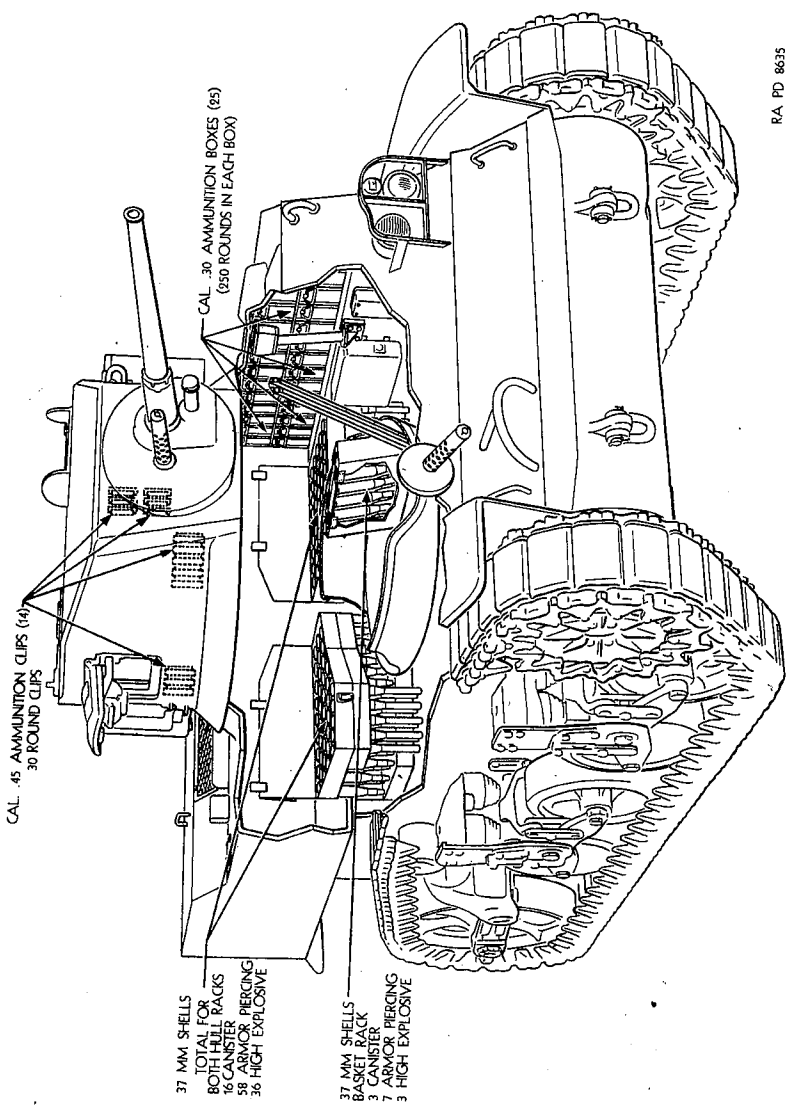


Figure 15—Ammunition Stowage

480 rounds—cal. .45, in 30 round clips
or 320 rounds in 20-round clips

Hand grenades—12, as follows:

Turret—

2—Offensive
2—Defensive

Hull—

2—Smoke
2—Thermite
2—Offensive
2—Defensive

Section VI

LUBRICATION

28. LUBRICATION CHART.

The lubrication schedule and chart (Fig. 17) given in this section show the points to be lubricated, the periods of lubrication and the lubricant to be used. The chart should be carefully followed in order to assure complete service. Oil holes and lubrication fittings are painted red for easy identification.

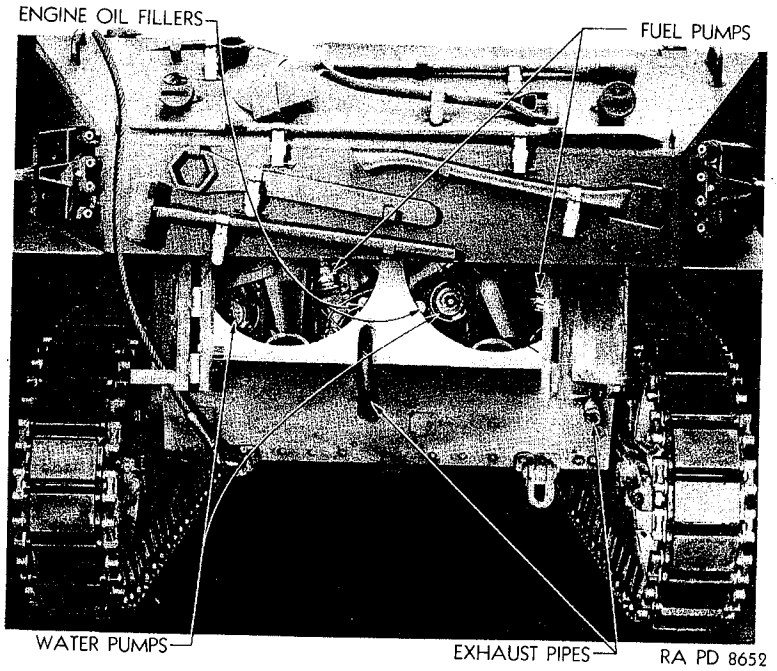


Figure 16—Engine Compartment with Doors Open

29. ENGINE.

a. The oil level in each engine should be checked every day. Plunger-type gauges are fitted into the caps of the filler pipes, which are accessible through the fan shrouds. (See Fig. 16.) Whenever checking oil level or adding oil, **be sure the master battery switch is turned off to minimize the possibility of the engines being started accidentally.** The oil gauges are graduated in quarts and the correct level is at, or just below, the "Full" mark. Never allow the level to fall below the mark specifying "Add 1", and never add oil above the "Full" mark.

b. The oil in each engine should be changed every 1000 miles. The capacity of each engine is eight quarts. Engine oil recommendations are given in the lubrication schedule. The drain plug for each engine is located in the base of the crankcase and can be reached from under the vehicle by removing the cover plate bolted to the engine compartment floor. The crankcase should be drained only when the engine has been heated to normal operating temperatures, as foreign matter will not drain out completely unless the oil flows easily.

c. Once each week the copper gauze in the crankcase ventilator inlet on each engine should be washed in dry cleaning solvent and dipped in engine oil. These inlets provide fresh air for the crankcase ventilating system, and they must be kept clean and oiled.

d. Engine Accessories. Engine accessories which require periodic lubrication include the starting motor, generator, water pump and distributor. See the Lubrication Chart and Schedule for methods, lubricants recommended and frequency of service.

e. Carburetor Air Cleaners. The filtering units should be cleaned every 250 miles, or as frequently as once a day under adverse dust conditions. The cleaning procedure is as follows:

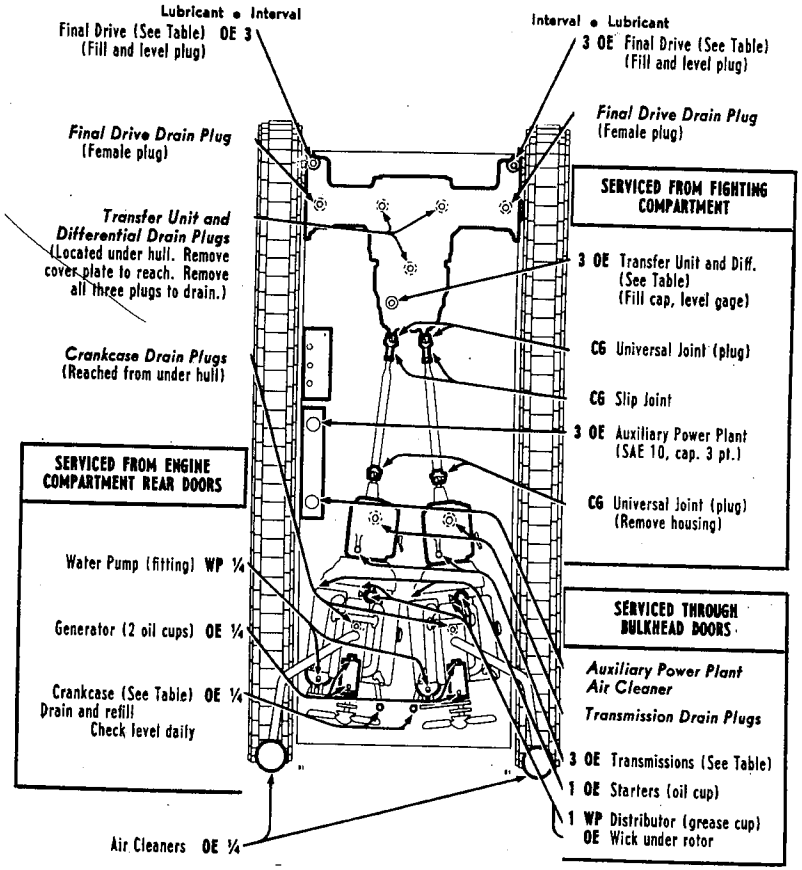
(1) Clean all dirt from around cover plate on underside of extreme rear of each sponson.

(2) Remove cover plates by taking out the cap screws.

(3) Loosen two wing nuts on supporting bolts and swing bolts off reservoir strap at each cleaner unit. Remove reservoir and wire mesh screen from each cleaner (Fig. 18).

(4) Pour old oil out of each reservoir and clean reservoirs and units in dry cleaning solvent. Take particular care to wash away all accumulated dirt.

(5) Dry all units thoroughly with compressed air, if it is available.

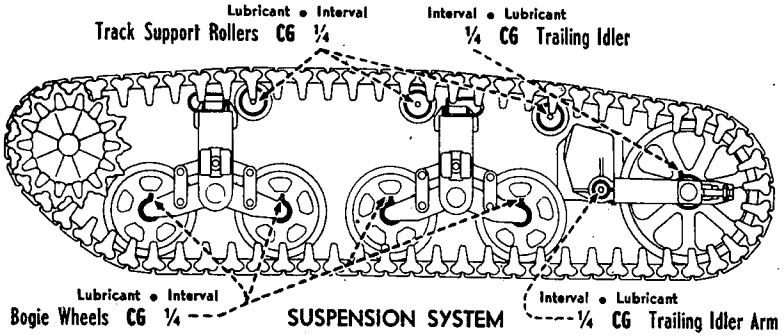


KEY

LUBRICANTS		INTERVALS
OE—OIL, Engine (Spec. 2-104)	CG—GREASE, General Purpose No. 1 (above +32°) No. 1 or No. 0 (+32° to +10°) No. 0 (below +10°)	¼— 250 MILES 1—1,000 MILES 3—3,000 MILES
WP—GREASE, Water pump, Hard		

CHEK-CHART NO. 81

Fig. 17—Lubrication Chart



CAUTION—Lubricate Suspension System Points on BOTH SIDES of Tank.

KEY

LUBRICANTS		INTERVALS
CG—GREASE, General Purpose No. 1 (above +32°) No. 1 or No. 0 (+32° to +10°) No. 0 (below +10°)	OH—OIL, Hydraulic	¼—250 MILES

LUBRICATION INSTRUCTIONS FOR TANK, LIGHT, M5

NOTES Additional Lubrication and Service Instructions on Individual Units and Parts NOTES

COLD WEATHER: For Lubrication and Service below —10°, refer to OFSB 6-11.

1. FITTINGS—Clean before applying lubricant. Lubricate until new grease extrudes from the bearing. CAUTION: Lubricate suspension points after washing tank.
2. INTERVALS indicated are for normal service. For extreme conditions of speed, heat, water, mud, snow, dust, etc., lubricate more frequently.
3. TURRET TRAVERSING GEARS AND RACK — Every 250 miles, clean and coat gear surfaces with CG.
4. OIL CAN POINTS — Lubricate door and shield hinges, pistol port covers, door latches, control rod pins, lever bushings, etc., with OE SAE 30 sparingly every 250 miles.
5. POINTS REQUIRING NO LUBRICATION—Bogie Wheel Suspension Linkage and Guides, Volute Springs, Turret Traverse Rollers, Turret Traversing Mechanism, Turret Hydraulic Drive and Turret Support Bearing.

CHEK-CHART NO. 81

Fig. 17—Lubrication Chart

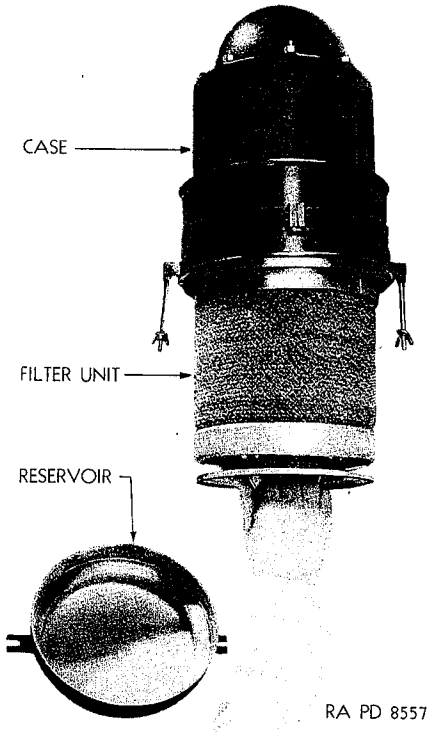


Figure 18—Engine Air Cleaner

(6) Fill each reservoir with 3 pints of engine oil.

(7) Be sure no dirt is lodged between cover plate and sponson floor.

(8) Reattach supporting bolts to reservoir strap and tighten wing nuts.

(9) Reinstall cover plate for each cleaner.

30. HYDRA-MATIC TRANSMISSIONS.

a. Check level every 250 miles. Each Hydra-Matic unit must be checked individually, in the following manner:

(1) Open bulkhead doors to reach combination filler cap and plunger-type gauge. (See Fig. 19.)

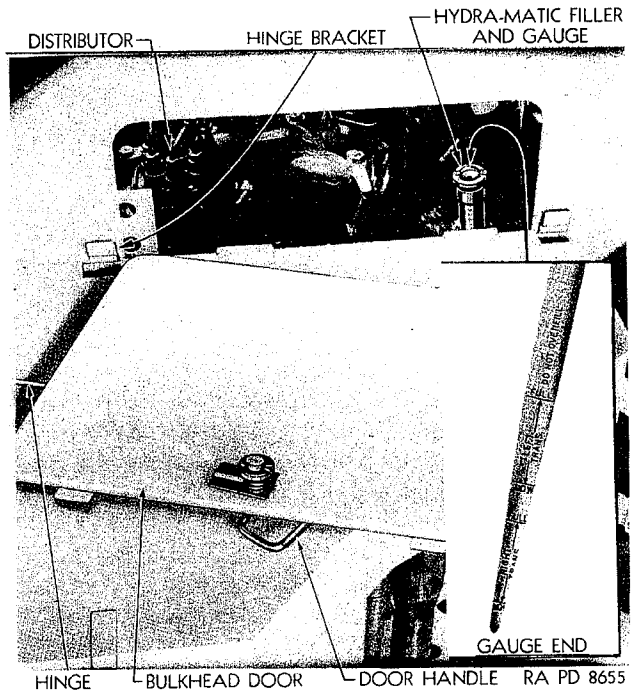


Figure 19—Hydra-Matic Filler and Gauge

(2) Run engines for about 30 seconds, then stop engines and wait for about one minute.

(3) Remove fluid level indicator plunger and wipe clean.

(4) Replace plunger and then check level.

(5) Add fluid if necessary to bring level up to "Full" mark. "Full" to "Low" marking on plunger equals one quart.

b. Each Hydra-Matic transmission should be drained and refilled every 3000 miles according to the following procedure:

(1) Remove the cover plate on the opening in the bottom of the hull at the front of the engine compartment, using ½" and 9/16" wrenches.

(2) Remove the flywheel housing bottom pan from each engine, using ½" wrench.

(3) Remove the two oil drain plugs, one in the front of the flywheel, using a 3/16" Allen wrench, the other in the bottom of the transmission case (marked oil), (See Fig. 20) and allow to drain completely.

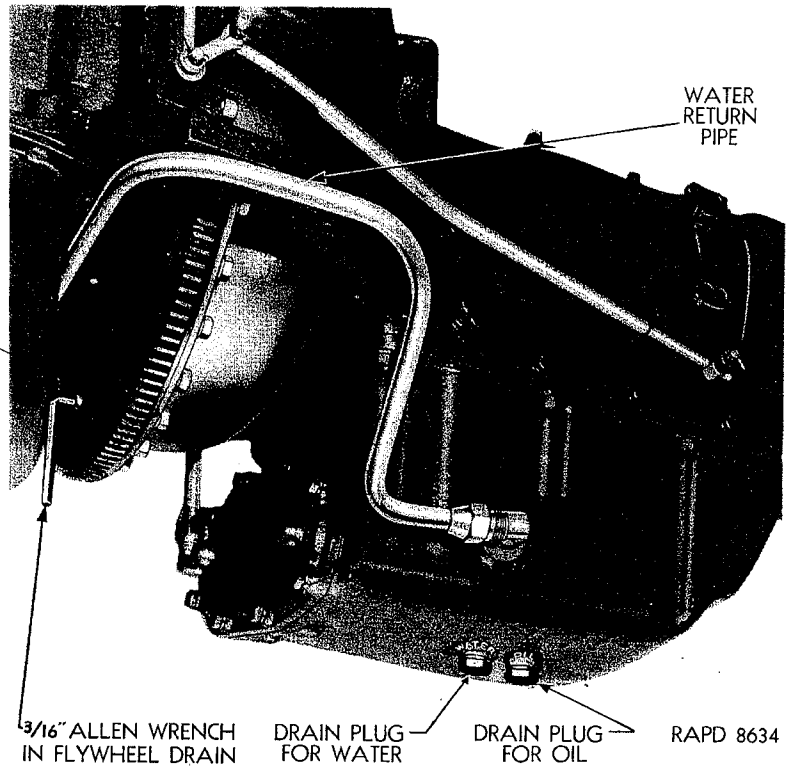


Figure 20—Transmission Oil & Water Drain Plugs

(4) Reinstall drain plugs and reinstall flywheel housing bottom pan and cover plate for hull floor.

(5) Add approximately 15 qts. of heavy-duty engine oil (U. S. Army Specification No. 2-104). The correct level is indicated by the marking on the plunger and not by the quantity of oil added.

(6) Do not pour in entire quantity at once; add 10 qts., start engine and run three or four minutes. Recheck level and then add additional oil to bring level up to "Full."

CAUTION. Each Hydra-Matic transmission is filled at assembly with a special break-in oil. Do not drain and replace before the first 3000 miles.

CAUTION. In the event that heavy-duty engine oil (2-104 specification) is not available, it is possible in an emergency to

use other engine oils of the correct grade, but in this instance the oil must be drained and heavy-duty engine oil installed at the very first opportunity.

31. PROPELLER SHAFTS.

Propeller shaft housing covers must be removed to lubricate universal joints and sliding joint. The sliding joint for each shaft is equipped with a lubrication fitting. Each universal joint has a pipe plug in the cross.

a. Every 3000 miles, or whenever vehicle is overhauled, remove pipe plugs from universal joints and replace with lubrication fittings. (See Fig. 53.) Then apply grease until it is forced out at edges of joint, and also apply chassis grease to the fitting in each sliding joint.

b. After lubricating the universal joints, remove the fittings and reinstall the pipe plugs.

32. TRANSFER UNIT AND CONTROLLED DIFFERENTIAL.

Both the transfer unit and the controlled differential are filled through a single filler located on the left-hand side of the transfer unit at the top. (Fig. 56.) See Lubrication Schedule for grade and quantity of oil.

a. Oil level should be checked every 250 miles and enough added to bring the level to the "Full" mark on the plunger. The oil should be drained and refilled every 3000 miles.

b. The transfer unit and controlled differential are drained through three drain plugs. All three should be removed for complete drainage. Drain plugs are reached from under the vehicle through openings in the hull floor which are covered by protective plates bolted in position with 9/16" head bolts. Clean magnetic plugs; if excessive particles are present, investigate condition of units.

33. FINAL DRIVE.

a. Every 250 miles, the level of oil in the final drive housing on each side of the vehicle should be checked. The filler plug is located at the outer edge of the hull in the front casting. Add oil specified in schedule, using an oil gun, if level is not high enough to run out when the plug is removed. Clean plugs and surrounding area before removing plugs.

b. At 3000-mile intervals, the final drive housing on each side should be drained, flushed out with kerosene and refilled. The drain plugs are located on the outer edge of the hull, directly under the final drive housings and can be reached from the front of the vehicle.

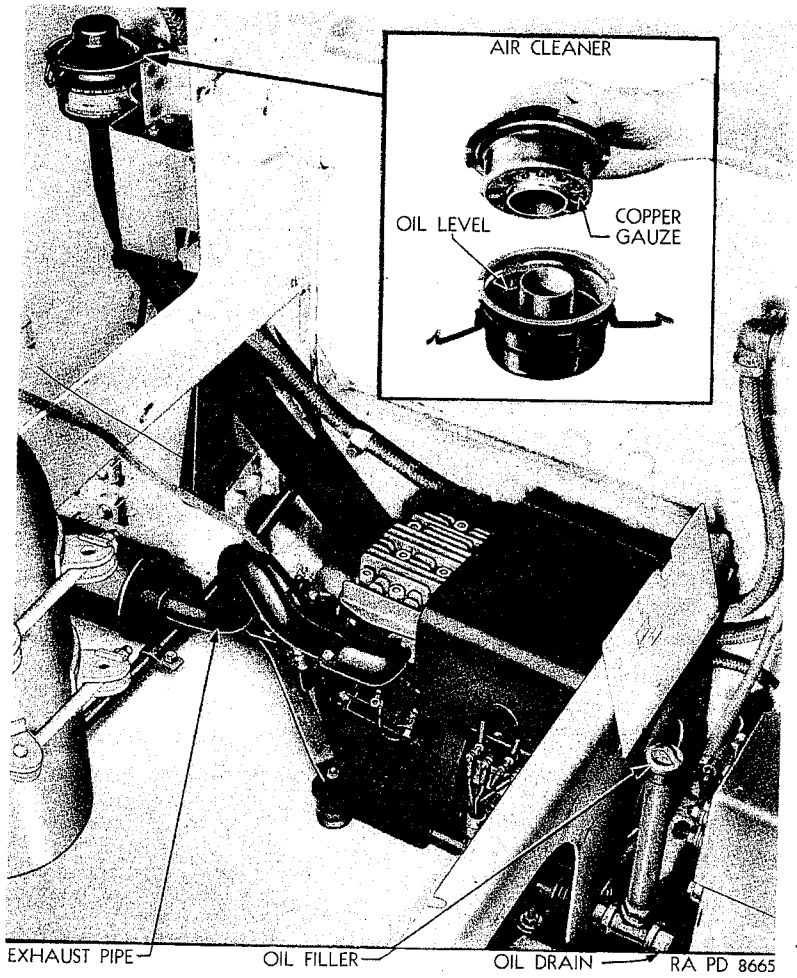


Figure 21—Auxiliary Power Plant Oil Filler and Air Cleaner

34. SUSPENSION.

Lubrication of the suspension system, which includes bogie wheels and component linkages, supporting rollers and trailing idler wheels, should follow the procedures outlined in the Lubrication Schedule and Chart. Methods, lubricants and intervals should be closely followed.

35. TURRET AND GUN MOUNTS.

a. Complete information on the lubrication of these units is provided in the Lubrication Schedule. Instructions should be carefully followed so that no points are overlooked.

b. Moving parts which are not included on the schedule, but which may require some periodic attention, include door and shield hinges, pistol port covers, door latches and locks. The turret traversing device must have regular attention.

36. AUXILIARY POWER PLANT.

a. Lubricant should be maintained at the level shown on the plunger gauge. Gauge is accessible from left of fighting compartment, after lifting cover just behind battery (See Fig. 21). Check regularly once each week and drain and refill every 1000 miles.

b. The air cleaner for this unit should be cleaned once each week, as follows:

(1) Unsnap the two clips holding air cleaner cover to case and remove cover and ring-shaped filter. (See Fig. 21.)

(2) Wash all parts thoroughly in dry cleaning solvent and dry with compressed air, if possible.

(3) Add fresh oil to air cleaner case in sufficient amount to bring oil level up to point marked "Oil Level" on case.

(4) Install filter in case, install air cleaner cover, and snap cover clips in place.

LUBRICATION SCHEDULE
M5 LIGHT TANK

Parts Lubricated	Frequency in Normal Service	Method of Application	Lubricant Above 32°	Lubricant Below 32° Above 10°	Lubricant Below 10°	Amount or Capacity
Auxiliary Power Plant Air Cleaner	Weekly	Clean in solvent and reoil	OE, 30	OE, 30 or OE, 10	OE, 10	Fill reservoir to mark
Auxiliary Power Plant—Add	Weekly	Filler plug	OE, 30	OE, 30 or OE, 10	OE, 10	Add to mark on gauge
Change	1000 Miles	Drain and refill	OE, 30	OE, 30 or OE, 10	OE, 10	2½ pints
Bogie Wheels, Idlers and Supporting Rollers	250 Miles	Grease fittings	CG, #1	CG, #1 or #0	CG, #0	Apply lubricant until forced out of relief valves
Carburetor Air Cleaner	Daily	See Paragraph 29 *e*	OE, 30	OE, 30 or OE, 10	OE, 10	3 pints per cleaner
Control Rods, Linkage and Levers	250 Miles	Oil can	OE, 30	OE, 30 or OE, 10	OE, 10	4 to 5 drops
Crankcase Ventilator Cap	Weekly	Clean with solvent and reoil	OE, 30	OE, 30 or OE, 10	OE, 10	Allow to drain
Distributor	1000 Miles	Turn down grease cup and refill. Apply grease to cam and 3 drops of engine oil to cam wick	WP OE, 30	WP OE, 30 or OE, 10	WP OE, 10	One grease cup full Light film 3 drops
Engine Oil—Add	Daily	Filler neck	OE, 30	OE, 30 or, OE, 10	OE, 10	To "Full" mark on gauge plunger
Change	1000 Miles	R.H. of L.H. Engine L.H. of R.H. Engine	OE, 30	OE, 30 or OE, 10	OE, 10	8 quarts
Final Drive—Add	250 Miles	Filler plug	SAE-50	SAE-50	SAE-50	To level of filler plug
Change	3000 Miles	Drain, flush and refill	SAE-50	SAE-50	SAE-50	Approximately 4½ pints
Generator	250 Miles	2 oil cups	OE, 30	OE, 30 or OE, 10	OE, 10	8 to 10 drops

Parts Lubricated	Frequency in Normal Service	Method of Application	Lubricant Above 32°	Lubricant Below 32° Above 10°	Lubricant Below 10°	Amount or Capacity
Hydra-Matic Transmission—Add	250 Miles	Filler neck (see Par. 30 *a*)	OE, 30	OE, 30 or OE, 10	OE, 10	Add to fill
Change	3000 Miles	Drain and refill (see Par. 30 *b*)	OE, 30	OE, 30 or OE, 10	OE, 10	As required—approximately 15 quarts
Propeller Shaft Slip Joints	3000 Miles or overhaul	Grease fitting	CG, #1	CG, #1 or #0	CG, #0	As required
Propeller Shaft Universal Joints	3000 Miles or overhaul	Substitute grease fitting for pipe plug	CG, #1	CG, #1 or #0	CG, #0	As required
Starter	1000 Miles	One oil cup on brush end	OE, 30	OE, 30 or OE, 10	OE, 10	8 to 10 drops
Steering Lever Linkage	250 Miles	Oil can	OE, 30	OE, 30 or OE, 10	OE, 10	4 to 5 drops
Transfer Unit and Controlled Differential—Add	250 Miles	Filler cap	OE, 30	OE, 30 or OE, 10	OE, 10	To mark on gauge
Change	3000 Miles	Filler cap	OE, 30	OE, 30 or OE, 10	OE, 10	As required—approximately 32 quarts
Turret Traversing Device	Weekly	Filler plug	HO	HO	HO	Fill as needed
Water Pump	250 Miles	Grease fitting	WP	WP	WP	As required
		GYRO-STABILIZER				
Cylinder End Bearings	Weekly	2 fittings	CG, #1	CG, #0 or #1	CG, #0	Several turns on grease gun
Mounting Bracket	Weekly	2 fittings	CG, #1	CG, #0 or #1	CG, #0	Several turns on grease gun
Oil Reservoir	Daily	Plug in top of reservoir	HO	HO	HO	Add as required. (Drained and refilled only at Ordnance overhaul)

Parts Lubricated	Frequency in Normal Service	Method of Application	Lubricant Above 32°	Lubricant Below 32° Above 10°	Lubricant Below 10°	Amount or Capacity
COMBINATION GUN, M23, MOUNT						
Bore, 37 mm Gun	Daily	For care and cleaning, follow prescribed instructions in FM 23-80		Oil, Lubricating and Preserving, Light		Light film
Breech Opening Plate & Mechanism, 37 mm Gun	Daily	Oil can		Oil, Lubricating and Preserving, Light		Light film
Breech Block and Ring, 37 mm Gun	Daily	Oil can		Oil, Lubricating and Preserving, Light		Light film
Elevating Gears	Daily	Oil can		Oil, Lubricating and Preserving, Light		Light film
Elevating Gear Disengaging Mechanism, Plunger and Bushings	Daily	Oil can		Oil, Lubricating and Preserving, Light		Light film
Elevating Gear Housing Bearings	Daily	3 oil cups		Oil, Lubricating and Preserving, Light		Fill
Elevating Sector Gear	Daily	Oil can		Oil, Lubricating and Preserving, Light		Light film
Firing Plunger, Relay Levers and Shaft, and Release Shaft and Stop, 37 mm Gun	Daily	Oil can		Oil, Lubricating and Preserving, Light		Light film
Gun, .30 Caliber Machine	Daily	For care and cleaning, follow prescribed instructions in FM 23-80		Oil, Lubricating and Preserving, Light		Light film
Pins, Fastening, Combination Gun to Mount	Weekly	Oil can		Oil, Lubricating and Preserving, Light		Light film
Recoil Cylinder	As required	See special instructions in TM 9-850		Oil, Recoil, Heavy		Capacity—2½ quarts
Recoil Rails	Daily	Oil can		Oil, Lubricating and Preserving, Light		Light film

Parts Lubricated	Frequency in Normal Service	Method of Application	Lubricant Above 32°	Lubricant Below 32° Above 10°	Lubricant Below 10°	Amount or Capacity
Sleigh Guides	Daily	Oil can		Oil, Lubricating and Preserving, Light		Light film
Trigger Actuator Cable	Monthly	2 grease fittings	CG, #1	CG, #1 or #0	CG, #0	Several turns on grease gun
Trigger Actuator Plunger Shaft	Daily	Oil can		Oil, Lubricating and Preserving, Light		Light film
Trunnion Bearings	Daily	2 oil cups		Oil, Lubricating and Preserving, Light		Fill
FLEXIBLE BOW GUN						
Ball Joint	Monthly	Disassemble—clean ball and socket, and apply grease liberally		Graphite Grease		Heavy film
Gun, .30 Caliber Machine	Daily	For care and cleaning, follow prescribed instructions in FM 23-80		Oil, Cleaning and Preserving, Light		Light film
Pin, Fastening, Gun to Mount	Weekly	Oil can		Oil, Cleaning and Preserving, Light		Light film
ANTI-AIRCRAFT GUN						
Cradle Trunnion	Daily	Oil can		Oil, Cleaning and Preserving, Light		Light film
Elevating & Traversing Mechanism	Daily	Oil can		Oil, Cleaning and Preserving, Light		Light film
Gun, .30 Caliber Machine	Daily	For care and cleaning, follow prescribed instructions in FM 23-80		Oil, Cleaning and Preserving, Light		Light film
Pin, Fastening, Gun to Cradle	Weekly	Oil can		Oil, Cleaning and Preserving, Light		Light film
Pin, Fastening, Gun to Elevating and Traversing Mechanism	Weekly	Oil can		Oil, Cleaning and Preserving, Light		Light film
Pintle Shaft	Daily	Oil can				Light film

Section VII

INSPECTIONS

37. PURPOSE.

a. In order to avoid serious damage, it is essential that these combat vehicles be inspected systematically at regular intervals. Careful inspections will insure maximum operating efficiency.

b. If cracks should develop in castings or other metal parts, they can be discovered at the completion of a run by means of the dust and oil deposits on exterior or interior surfaces.

c. The Chief of Ordnance should be advised, through the local Ordnance officer of any chronic troubles, technical failures or unsatisfactory operation of any parts or units. Any suggestions for the improvement of the inspection procedure or handling technique based on actual operating experience should likewise be forwarded so that all units may benefit.

d. Reports will contain the following:

(1) Identity of vehicle and component assembly:

(a) The ordnance designation of vehicle and component, including the U. S. Registration Number and Ordnance Serial Number.

(b) The name of the manufacturer and the manufacturer's designation, including the model, type, and serial number.

(c) The length of service in miles and months, days or hours.

(d) The date on which the affected component assembly was installed in the vehicle.

(2) Description of failure, defect or improper functioning:

(a) The name of the place and date of failure.

(b) The manner in which the component is damaged, defective or improperly functioning, setting forth the attending circumstances and known causes of the failure, defect or improper functioning, together with pertinent drawings, photographs, sketches, and sample specimens.

(3) Remedial action taken:

(a) The present location of the replaced or defective parts.

(b) The source of the parts used in making the repairs or replacements.

(c) The source of labor used in making the repairs or replacements, if other than ordnance personnel.

e. A separate report will be made for each failure, unless there are a number of identical failures to be reported. In that event, a single report may be submitted, providing each vehicle involved is identical. Reports will not be addressed to an Arsenal, Manufacturer or Contractor, unless such action is specifically authorized.

f. The defective or broken material that has been replaced and reported under this form must be held pending disposal instructions from the Office, Chief of Ordnance.

38. PRESTARTING INSPECTION.

The vehicle has a crew of four men and it is essential that **all** men be utilized to inspect the vehicle under the direction of the commander. The inspection should cover complete vehicle as well as engines.

a. Check for fuel and oil leakage in the fighting and engine compartments as well as on the ground under the vehicle.

b. Check for any leakage in the fuel system and in oil and water lines.

c. Check level of coolant in both radiators.

d. Check oil level for each engine.

e. Check oil level for each Hydra-Matic transmission.

f. Check oil level of transfer unit and controlled differential at plunger gauge on left front of transfer unit cover.

g. Check oil level in each final drive.

h. Check general condition of sprockets, bogies, springs, guides, gudgeons, track supporting rollers and idlers.

i. Check track for wear, tightness and tension, and check end connections for wear.

j. Check for tightness and wear of wedges and wedge nuts.

k. Check grousers (if used), otherwise check to see that set is carried on turret.

l. Check radio antenna for breaks.

m. Check for presence and condition of fire extinguishers and vehicle tools.

n. Check steering levers and selector levers for free operation over complete range.

o. Check instrument panel and see that voltmeter reads zero with battery switch open and other instruments indicate normal shut-off readings.

p. Close battery switch and watch ammeter and voltmeter. If ammeter shows excessive discharge, open battery switch immediately.

q. Check lights and siren.

r. Check to see that fuel valves are open

s. Check oil level in auxiliary power plant.

t. Check operation of turret traverse mechanism and locking mechanism.

u. Check traverse and elevation of vehicle weapons.

v. Check firing mechanism on all guns.

w. Check to see that ammunition supply, spare indirect vision devices, flags, field equipment and rations, if carried, are properly loaded.

39. INSPECTION DURING OPERATION.

a. During operation, the driver should be careful to observe any abnormal functioning or unusual noises. Instrument panel gauges should be observed at frequent intervals for possible sources of trouble. Under some conditions, low oil pressure may be indicated by an unsteady oil gauge when traveling at a fairly constant speed. Oil pressure will read at least 30 pounds at normal driving speeds when oil level is high enough.

b. Engine temperature gauges should be watched for overheating, indicative of fan belt failure or low coolant level in the radiators, and ammeters should be checked for proper charging rate (See Section XXII). Short driving experience with Hydra-Matic will familiarize the driver with the usual speeds for gear changes. During operation, gear changes should be checked for proper functioning. All normal driving should be done with the controls in the Drive, "Dr", position.

c. Only under exceptional circumstances should a vehicle be operated after indications of trouble have been observed. When in doubt, stop the engines and secure assistance. Inspection during operation applies to the entire vehicle.

40. INSPECTION AT THE HALT.

a. At each halt, the crew should make a careful inspection of the vehicle to determine its general mechanical condition. Minor defects discovered during the march, together with minor defects discovered at the halt, should be corrected before resuming the march. If corrections cannot be made during the halt, proper disposition of the vehicle should be made so that unnecessary delays may be avoided and major failure prevented.

b. A suitable general routine for inspection during the halt is as follows:

(1) Allow the engine to run a short time at idling speed. Listen for unusual noises.

(2) Walk around the vehicle carefully looking for fuel, water or oil leaks. The fighting and engine compartments should likewise be inspected for any leaks.

(3) Examine tracks for adjustment and for worn, loose, broken or missing parts. Remove dirt or any foreign material lodged in the suspension units.

(4) Inspect hull and fittings for missing, worn, or loose parts.

(5) Inspect lights for proper operation, if assignment permits use of lights.

(6) Check amount of fuel in both tanks and liquid level in both radiators. Always observe precaution given in Paragraph 10 when removing cap from hot radiator.

(7) Wipe off all vision devices with a clean rag.

41. INSPECTION AFTER OPERATION.

At the conclusion of each day's operation, the tank commander should have an inspection made, similar to that made at halts, but more detailed. The inspection should be followed by preventive maintenance. If defects cannot be corrected, they should be reported at once to the chief of section or other designated individual. The following points should be covered:

a. Examine tracks and bogies.

b. Check track tension.

c. Inspect idler, bogie and roller tires.

d. Examine drive sprockets for worn or broken teeth.

e. Examine the track for worn or unserviceable rubber shoe units.

f. Check oil level in each Hydra-Matic transmission and each engine.

g. Check oil level of differential and transfer unit. Gauge is located at left front of transfer unit cover.

h. Check and clean air cleaners. During extremely dusty operations this should be done at each halt.

i. Inspect lights and siren.

j. Inspect vision and sighting devices for breakage.

k. Inspect guns and mounts for defective performance.

l. Inspect guns, sighting equipment, and accessories to determine whether covers are properly installed.

m. Inspect ammunition and sighting prism boxes for cleanliness and orderly arrangement.

n. Replenish fuel and ammunition.

o. Check fluid level in both radiators, observing precaution in Paragraph 10. In cold weather, check freezing point of solution.

p. During continuous operation in hot weather, check battery water level.

q. Check fan and water pump and generator belt tension.

r. Check exhaust connections and mufflers.

s. Inspect electrical wiring for loose connections and abrasions.

t. Check to see that fuel shut-off valves are closed.

u. Check to see that battery switch is open.

42. PERIODIC INSPECTIONS.

a. The following periodic inspections are prescribed:

After 250 Miles of Operation

Point of Inspection	Remarks
Battery	Replenish water and clean terminals
Cooling system	Inspect all connections for leakage Inspect level of liquid in each radiator
Crankcase ventilating inlet cap	Clean and reoil
Engine air cleaners	Clean and refill (See Paragraph 29 *e*)
Ignition harness	Tighten loose parts
Propeller shafts	Test for vibration and backlash
Turret traverse mechanism	Check oil level

After 1000 Miles of Operation

Points of Inspection	Remarks
Auxiliary power plant	Inspect for dirty condition, loose or faulty connections.
Cooling system	Check and adjust tension of fan and water pump belts. Test strength of antifreeze solution in both radiators at least once a week. If there have been wide variations in temperature or if considerable quantities of water added, the strength of the solution should be tested more frequently.
Distributor contact points	Clean and adjust
Fuel tanks	Drain and inspect for rust
Generator	Check proper functioning
Spark plugs	Clean and adjust
Starter	Check proper functioning

After 3000 Miles of Operation

Hydra-Matic transmissions	Readjust bands
Transfer unit	Readjust bands
Universal joints	Disassemble, repack and reassemble.

Section VIII

GENERAL CARE AND PRESERVATION

43. RECORDS.

a. Use. An accurate record must be kept of each motor vehicle issued by the Ordnance Department. For this purpose, the Ordnance Motor Book (O.O. Form No. 7255), generally called "Log Book", is issued with each vehicle and must accompany it at all times. This book furnishes a complete record of the vehicle, from which valuable information concerning operation and maintenance requirements are obtained, and organization commanders must insist that correct entries are made. This book will habitually be kept in a canvas cover to prevent its being injured or soiled.

b. The page bearing a record of assignment must be destroyed prior to entering the combat zone. All other references which may be posted regarding the identity of the organization must also be removed.

44. CLEANING.

a. Grit, dirt, and mud are the sources of greatest wear to a vehicle. If deposits of dirt and grit are allowed to accumulate, particles will soon find their way into bearing surfaces, causing unnecessary wear, and if the condition is not remedied, will soon cause serious difficulty.

b. When removing engine parts or any other units in making repairs and replacements, or if, in the course of inspection, working joints or bearing surfaces are to be exposed, all dirt and grit that might find its way to the exposed surfaces must be carefully removed. The tools must be clean, and care must always be taken to eliminate the possibilities of brushing dirt or grit into an opening with the sleeve or other parts of the clothing.

c. To remove oil-soaked dirt and grit, hardened grit or road oil, use dry cleaning solvent applied with rags (not waste) or

a brush. The vehicle is so designed that the possibility of interfering with its proper operation by careless application of cleaning fluid is very small. However, care should be taken to keep water from the engines as it might interfere with proper ignition and carburetion.

d. Oil holes which have become clogged should be opened with a piece of wire. Wood should never be used for this purpose, as splinters are likely to break off and permanently clog the passages. Particular care should be taken to clean and decontaminate vehicles that have been caught in a gas attack. See Section X on "Materiel Affected by Gas", for details of this operation.

Section IX

PAINTING

45. GENERAL.

a. Ordnance materiel is painted before issue to the using arms and one maintenance coat per year will ordinarily be ample for protection. With but few exceptions this material will be painted with ENAMEL, synthetic, olive drab, lusterless. The enamel may be applied over old coats of long oil enamel and oil paint previously issued by the Ordnance Department if the old coat is in satisfactory condition for repainting.

b. Paints and enamels are usually issued ready for use and are applied by brush or spray. They may be brushed on satisfactorily when used unthinned in the original package consistency or when thinned no more than 5% by volume with THINNER. The enamel will spray satisfactorily when thinned with 15% by volume of thinner. (Linseed oil must not be used as a thinner since it will impart a luster not desired in this enamel.) If sprayed, it dries hard enough for repainting within ½ hour and dries hard in 16 hours.

c. Certain exceptions to the regulations concerning painting exist. Fire-control instruments, sighting equipment, and other items which require a crystalline finish will not be painted with olive-drab enamel.

d. Complete information on painting is contained in TM 9-850.

46. PREPARING FOR PAINTING.

a. If the base coat on the material is in poor condition, it is more desirable to strip the old paint from the surface than to use sanding and touchup methods. After stripping, it will then be necessary to apply a primer coat.

b. PRIMER, ground, synthetic, should be used on wood as a base coat for synthetic enamel. It may be applied either by brushing or spraying. It will brush satisfactorily as received or after the addition of not more than 5% by volume of THINNER. It will be dry enough to touch in 30 minutes, and hard in 5 to 7 hours. For spraying, it may be thinned with not more than 15% by volume of THINNER. Lacquers must not be applied to the PRIMER, ground, synthetic, within less than 48 hours.

c. PRIMER, synthetic, rust inhibiting, for bare metal should be used on metal as a base coat. Its use and application are similar to those outlined in paragraph "b" above.

d. The success of a job of painting depends partly on the selection of a suitable paint, but also largely upon the care used in preparing the surface prior to painting. All parts to be painted should be free from rust, dirt, grease, kerosene, oil, and alkali, and must be dry.

47. PAINTING METAL SURFACES.

If metal parts are in need of cleaning, they should be washed in a liquid solution consisting of ½ pound of soda ash in 8 quarts of warm water, or an equivalent solution, then rinsed in clear water and wiped thoroughly dry. Wood parts in need of cleaning should be treated in the same manner, but the alkaline solution must not be left on for more than a few minutes and the surfaces should be wiped dry as soon as they are washed clean. When artillery or automotive equipment is in fair condition and only marred in spots, the bad places should be touched with ENAMEL, synthetic, olive-drab, lusterless and permitted to dry. The whole surface will then be sandpapered with PAPER, flint, No. 1 and a finish coat of ENAMEL, synthetic, olive-drab, lusterless applied and allowed to dry thoroughly before the materiel is used. If the equipment is in bad condition, all parts should be thoroughly sanded with PAPER, flint, No. 2, or equivalent, given a coat of PRIMER, ground, synthetic, and permitted to dry for at least 16 hours. They will then be sandpapered with PAPER, flint, No. 00, wiped free from dust and dirt, and a final coat of ENAMEL, synthetic, olive drab, lusterless applied and allowed to dry thoroughly before the material is used.

48. PAINT AS A CAMOUFLAGE.

Camouflage is now a major consideration in painting ordnance vehicles, with rust prevention secondary. The camouflage plan at present employed utilizes three factors: Color, gloss and stenciling.

a. Color. Vehicles are painted with ENAMEL, synthetic, olive drab, lusterless, which was chosen to blend in reasonably well with the average landscape.

b. Gloss. The new lusterless enamel makes a vehicle difficult to see from the air or from relatively great distances over land. A vehicle painted with ordinary glossy paint can be detected more easily and at greater distances.

c. Stenciling. White stencil numbers on vehicles have been eliminated because they can be photographed from the air. A blue drab stencil enamel is now used which cannot be so photographed. It is illegible to the eye at distances exceeding 75 feet.

d. Preserving Camouflage.

(1) Continued friction or rubbing must be avoided, as it will smooth the surface and produce a gloss. The vehicle should not be washed more than once a week. Care should be taken to see that the washing is done entirely with a sponge or a soft rag. The surface should never be rubbed or wiped, except while wet, or a gloss will develop.

(2) It is not desirable that vehicles, painted with lusterless enamel, be kept as clean as vehicles were kept when glossy paint was used. A small amount of dust increases the camouflage value. Grease spots should be removed with SOLVENT, dry cleaning. Whatever portion of the spot cannot be so removed should be allowed to remain.

(3) Continued friction of wax-treated tarpaulins on the sides of a vehicle will also produce a gloss, which should be removed with SOLVENT, dry cleaning.

(4) Tests indicate that repainting with olive drab paint will be necessary once yearly, with blue drab paint twice yearly.

49. REMOVING PAINT.

After repeated paintings, the paint may become so thick as to crack and scale off in places, presenting an unsightly appearance. If such is the case, remove the old paint by use of a lime-and-lye solution (see TM 9-850 for details) or REMOVER, paint and varnish. It is important that every trace of lye or other paint remover be completely rinsed off and that the equipment be perfectly dry before repainting is attempted. It is preferable that the use of lye solutions be limited to iron or steel parts. If used on wood, the lye solution must not be allowed to remain on the surface for more than a minute before being thoroughly rinsed off and the surface wiped dry with rags. Crevices or cracks in wood should be filled with putty and the wood sand-

papered before refinishing. The surfaces thus prepared should be painted according to directions in paragraph 47.

50. PAINTING LUBRICATING DEVICES.

Oil cups, grease fittings, oil holes, and similar lubricating devices, as well as a circle about three-fourths of an inch in diameter at each point of lubrication, will be painted with ENAMEL, red, water resisting, in order that they may be readily located.

Section X

MATERIEL AFFECTED BY GAS

51. PROTECTIVE MEASURES.

a. For materiel in constant danger of gas attacks, whether from chemical clouds or chemical shells, care should be taken to keep all unpainted metal parts of materiel, with the exception of ammunition, lightly coated with oil and protected with covers while not in use. Care must be taken that the oil does not come in contact with the optical parts of the instruments, with leather or canvas fittings, or with ammunition. The ammunition containers should be kept tightly closed and should be cleaned after exposure to gas.

b. Ordinary fabrics offer practically no protection against mustard gas and lewisite. Rubber and oilcloth are penetrated if sufficient time is given. The greater the length of time allowed for penetration, the greater the danger of wearing these articles. For example, rubber boots which have been worn in an area contaminated with mustard gas may offer a grave danger to men who wear them several days after the bombardment. Impermeable clothing will resist penetration for over an hour, but should not be worn longer than that length of time.

52. DECONTAMINATION OF MATERIEL.

a. Cleaning. All unpainted metal parts of materiel that have been exposed to any gas except mustard and lewisite must be cleaned as soon as possible with dry cleaning solvent, or denatured alcohol, and wiped dry. Following this cleaning all parts should be coated with engine oil.

b. In the event ammunition has been exposed to gas, it must be thoroughly cleaned before it can be fired. To clean ammunition, a noncorrosive decontaminating agent, or if this is not available, strong soap and cool water should be used. After cleaning, wipe all ammunition dry with clean rags. **Do not use dry powdered decontaminating agent (chloride of lime) on or near ammunition supplies,** as flaming occurs through the use of the chloride of lime on liquid mustard.

c. Decontamination. The following measures should be taken for the removal of liquid chemicals (mustard, lewisite, etc.) from materiel. For all of these operations, a complete suit of impermeable clothing and a service gas mask must be worn. Immediately after the removal of the suit, a thorough bath with soap and water (preferably hot) must be taken. If any skin areas have come in contact with mustard, if even a very small drop of mustard gets into an eye, or if the vapor of mustard has been inhaled, it is imperative that complete first-aid measures be given within twenty or thirty minutes after exposure. First-aid instructions are given in TM 9-850 and in FM 21-40.

d. Garments exposed to mustard gas can be decontaminated. If impermeable clothing has been exposed to vapor only, it may be decontaminated by hanging in the open air, preferably in the sunlight, for several days. It may also be cleaned by steaming for two hours. If the impermeable clothing has been contaminated with liquid mustard, steaming for six to eight hours will be required. Various kinds of steaming devices can be improvised from materials available in the field.

(1) Commence by freeing materiel of dirt through the use of sticks, rags, etc., which must be burned immediately after this operation.

(2) If the surface of the materiel is coated with grease or heavy oil, this grease or oil should be removed before decontamination is undertaken. Dry cleaning solvent, or other available solvents for oil should be used with rags attached to ends of sticks. Following this, decontaminate the painted surfaces of the materiel with bleaching solution made by mixing one part decontaminating agent (chloride of lime) with one part water. This solution should be swabbed over all surfaces. Wash off with water, dry and oil all surfaces.

(3) All unpainted metal parts and instruments exposed to mustard or lewisite gas must be decontaminated with a decontaminating noncorrosive agent, mixed one part solid to fifteen parts solvent (acetylene tetrachloride). If this is not available, use warm water and soap. Bleaching solution must not be used, because of its corrosive action. Instrument lenses may be cleaned only with lens tissue paper, using a very small amount of Ethyl alcohol. Coat all metal surfaces lightly with engine oil.

(4) In the event that a decontaminating agent (chloride of lime) is not available, materiel may be temporarily cleaned with large volumes of hot water. However, mustard lying in joints or in leather or canvas web is not removed by this procedure and thus will remain a constant source of danger until the materiel can be properly decontaminated. All mustard

washed from materiel in this manner lies unchanged on the ground, necessitating that the contaminated area be plainly marked with warning signs before abandonment.

(5) The cleaning or decontaminating of materiel which has been contaminated with lewisite will wash arsenic compounds into the soil, poisoning water supplies in the locality for either men or animals.

(6) Leather or canvas web that has been contaminated should be scrubbed thoroughly with bleaching solution. In the event this treatment is insufficient it may be necessary to burn or bury such materiel.

e. In the case of vehicles that have been subjected to gas attack with the engines running, the air cleaners should be serviced by removing the oil, flushing with dry cleaning solvent and refilling with the proper grade of oil. Instrument panels should be cleaned in the same manner as outlined for instruments. Seat cushions that are contaminated should be discarded.

Washing the compartments thoroughly with bleaching solutions is the most that can be done in the field. When running under conditions of high temperatures, operators should constantly be on the alert for slow vaporization of the mustard or the lewisite.

Exterior surfaces of vehicles should be decontaminated with bleaching solution. Repainting may be necessary after this operation.

f. Detailed information on decontamination will be found in FM 21-40, TM 9-850, and TC 38, 1941 Decontamination.

PART II—Organization Instructions

Section XI

GENERAL INFORMATION ON MAINTENANCE

53. SCOPE.

a. The scope of maintenance and repairs by the crew and other units of the using arms is determined by the ease with which the job can be accomplished. This depends, of course, upon the time and tools available to do the job, the nature of the terrain, weather conditions, concealment, shelter, proximity to hostile fire, and skill of personnel. All of the conditions are variable and no exact system of procedure can be described or followed.

b. The definitions given below are included in order that the operation name may be correctly interpreted by those doing the work.

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

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

(3) **Replace.** Consists of removing the part, sub-assembly or assembly from the vehicle and replacing it with a new or reconditioned or rebuilt part, sub-assembly or assembly, whichever the case may be.

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

NOTE. The using arm personnel is authorized to remove and reinstall an engine or transmission assembly. However, the replacement of an engine with **another** engine, or the replacement of a transmission assembly with **another** transmission assembly, **must not be done by using arm unless authorization is received from ordnance personnel.**

Engine

Cylinder head gaskets, replace
Cylinder heads, replace
Engine, replace
Engine supports, replace
Exhaust pipe clamps, tighten
Exhaust pipe gaskets, replace
Exhaust pipe, replace
Lifter assemblies, valve, replace
Manifold gaskets, replace
Manifolds, replace and tighten
Muffler, replace
Oil lines to valve lifter brackets, clean and replace
Oil pan and gaskets, replace
Oil pressure gauge unit, replace
Pulley, crankshaft, replace
Springs, valve, replace

Engine Cooling

Belts, fan and water pump, adjust or replace
Engine temperature unit, replace
Fan assembly, replace
Fan shroud assembly, replace
Hoses, clamps and connections, tighten or replace
Radiator, replace
Radiator thermostat, replace
Water pump, replace

Engine Ignition

Coil, replace
Condenser, distributor, replace
Distributor assembly, replace
Distributor contact points, replace
Ignition harness assembly, service or replace
Spark plugs, replace
Tachometer cable assembly, replace
Timing, check and reset

Engine Electrical

Current and voltage regulator, replace
Generator, replace

Starter, replace
Voltage regulator, replace

Fuel System

Air cleaner, service or replace
Carburetor, adjust or replace
Filters, fuel, service or replace
Fuel pump, replace
Fuel lines, clean, repair or replace
Fuel tank, clean or replace
Strainer, fuel pump, clean and replace

Hydra-Matic Transmission

Bands, adjust
Cooler, oil, replace
Controls, Hydra-Matic selector lever, adjust and replace
Controls, steering and braking mechanism, adjust and replace
Linkage, carburetor throttle, adjust or replace
Linkage, Hydra-Matic transmission, adjust and replace
Oil pan and cooler, replace
Transmission, Hydra-Matic, replace

Propeller Shaft

Propeller shaft, replace
Universal joints, replace

Transfer Unit and Controlled Differential

Bands, brake and steering, adjust or replace
Bands, transfer unit, adjust
Oil cooler, transfer unit, replace
Lever, transfer unit control, replace
Lever, Hydra-Matic selector, replace
Lever, steering, replace
Pressure regulator valve, replace
Transfer unit and controlled differential, replace

Final Drive

Final drive assembly, replace
Sprockets, track, reverse or replace

Tracks and Suspension

Axle, front and rear, replace

Bearings, wheel, bogie and idlers, replace
Bogie assemblies, replace
Bogie components, replace
Bogie, wheels, replace
Grousers, install and remove
Idler wheels, replace
Rollers, track support, replace
Track, replace, reverse or adjust

Electrical System and Instruments

Auxiliary power plant, replace
Battery, charge and service, or replace
Cable, speedometer, replace
Conduits and wiring, replace
Current and voltage regulators, replace
Filters, electrical, replace
Headlight and marker light assemblies, replace
Instrument panel assembly, replace
Lights, service, or repair
Siren, replace
Switch, battery, replace
Switch, siren, replace
Wiring, tighten and replace

Hull and Turret

Bolts, nuts and screws, tighten
Cover, engine compartment, replace
Deck, lower front, replace
Doors, bulkhead, replace
Fire extinguisher system, replace and reset
Gyro-Stabilizer units, replace
Housings, transmission and propeller shafts, replace
Insulation, repair or replace
Pads, protective, replace
Pans, floor, replace
Pistol ports, service or replace
Screens, engine compartment roof, replace
Seats, replace
Turret traversing mechanism, replace
Turret rollers, adjust, service, or replace

Miscellaneous

Cleaning
Lubrication
Painting

54. ENGINE TROUBLE SHOOTING.

a. Engine trouble shooting is considered in five major groups; namely: Engine will not start (Group 54 f); Engine stops (Group 54 g); Engine operates unevenly (Group 54 h); Engine overheats (Group 54 i); Engine noises (Group 54 j).

b. When trouble shooting, first turn to the group pertaining to the condition at hand and then perform the various tests in that group **in the order listed.** This is important because the tests which are the easiest to perform, and conditions most likely to occur are listed in their respective order.

c. The conditions, tests and remedies consider one engine only in groups 54 f-2, 54 g, and 54 h, because these items are not likely to occur on both engines at once. Tests on both engines are the same in each instance and should be repeated if the condition occurs on both engines.

d. If the engines are not operating properly and at peak performance, make the following test to determine which engine is at fault. This test should always be made before making any tests in the trouble-shooting chart.

(1) Start one engine only.

(2) Shift Hydra-Matic selector lever to "Dr".

(3) Pull steering levers as far back as possible so that the vehicle will not move.

(4) Gradually depress throttle pedal all the way.

(5) Note speed of engine as indicated on tachometer when throttle pedal is fully depressed.

(6) Repeat this test for other engine.

e. The maximum speed of the engines under these conditions is 1300 RPM. If either engine is operating less than this amount, the engine is not operating properly and the cause should be determined and corrected without delay. Engine speed higher than 1300 RPM is an indication of Hydra-Matic band slippage.

NOTE. Do not perform this test longer than one minute at any one time, to avoid overheating the oil in the Hydra-Matic transmission.

Diagnosis	Inspection	Remedy
f. Engine Will Not Start		
(1) Starters will not crank engine.		
(a) Battery master switch off.	Visual.	Turn on.
(b) Ignition switches off.	Visual.	Turn on.
(c) Discharged battery.	Check with hydrometer.	Replace battery or run auxiliary power plant for one hour.
(d) Loose electrical connection in starter circuit.	Turn on lights and depress starter. If lights become very weak or go out, test all wire connections.	Clean and tighten all electrical connections.
(e) Starter inoperative—grounded or shorted.	Test starter or substitute.	Replace starter.
(2) Engine cranks, but will not start.		
(a) Starter cranks engine too slowly.	Obvious, minimum effective cranking speed is 20 RPM.	Check battery charge, connections, and ground strap. Check for wrong grade of engine oil. Replace starter.
(b) Automatic choke on carburetor not "on."	None.	Be sure to depress accelerator ¼ of full travel, then try again to crank engine.
(c) Fuel lines shut off.	Visual.	Open lines at fuel filter.
(d) Fuel supply exhausted.	Visual.	Replenish supply.
(e) Carburetor flooded.	Usually occurs only after repeated cranking, or when one engine starts and the other does not.	Hold accelerator wide open while cranking engines whenever flooded condition is suspected.
(f) No current to spark plugs.	Hold end of a spark plug wire ¼" from plug.	If strong spark jumps, go down to steps (1), etc. If no spark appears, or spark is weak, proceed with step (g), etc.
(g) Spark plug wires or coil wire wet, shorted, or disconnected.	Visual.	Dry out, reconnect or replace wires, as required.
(h) Distributor cap wet, loose, shorted, cracked or broken.	Visual.	Dry out, reinstall or replace as required.
(i) Condenser or coil inoperative.	A weak, red spark usually means a bad coil or condenser, Check with instruments or by substitution.	Replace one or both units, as required.

Diagnosis	Inspection	Remedy
(j) Distributor contact points inoperative.	Inspect for burnt condition, correct gap and spring tension.	Clean and adjust points, or replace.
(k) Distributor timing out of adjustment.	Check and adjust as explained in Paragraph 67.	Adjust.
(l) No fuel to carburetor.	Check fuel pump output by loosening carburetor line at fuel pump and cranking engine.	If fuel flows properly, go down to steps (p), etc. If little or no fuel flows, proceed with steps (m), etc.
(m) Clogged fuel pump.	Remove bowl and inspect screen.	Clean screen and reinstall.
(n) Fuel filter leaking or clogged.	Visual.	Clean, tighten or replace filter as necessary.
(o) Fuel lines clogged or leaking.	Visual.	Clean, tighten or replace lines as necessary.
(p) Carburetor choke housing loose and out of adjustment.	Visual.	Reset to indicator mark and tighten.
(q) Carburetor dirty or out of adjustment..		Replace, or adjust as outlined in Paragraph 65.
NOTE: If engine still will not start, report to Ordnance personnel.		
g. Engine Stops		
(1) Check all ignition connections for being loose or broken.	Visual.	Tighten or replace.
(2) Check all fuel connections. (See "Engine Will Not Start.")	Visual.	Correct or replace as necessary.
h. Engine Operates Unevenly		
(1) Spark plug misfiring, broken, fouled or loose.	Visual.	Tighten, check gap, or replace.
(2) High tension wires—one or more, broken, burned or water-soaked.	Visual.	Repair or replace.
(3) Distributor timed incorrectly.	Check timing as explained in Paragraph 67.	Adjust as required.
(4) Carburetor incorrectly adjusted.	Check adjustment.	Adjust or replace.
(5) Carburetor choke sticking.	Check choke setting as explained in Paragraph 65.	Readjust.
(6) Dirt in carburetor or fuel pump.	Check by substitution.	Replace.
(7) Throttle adjustment between two engines incorrect.	Check tachometers for difference in speed.	Adjust throttle linkage. (See Paragraph 89.)
(8) Intake manifold loose and gaskets leaking.	Visual; listen for air leaks or test for leak, using light engine oil.	Tighten or replace gasket.

Diagnosis	Inspection	Remedy
(9) Cylinder head gaskets leaking.	Visual; listen for air leaks or test for leak, using light engine oil.	Replace gaskets.
(10) Valves sticking or warped, or piston rings worn, permitting "blow-by."	Check compression pressure.	Replace engine.

i. Engine Overheats

(1) Low water supply.	Visual.	Replenish water and check following: leakage at radiators, tanks, thermostats, hose connections on engine, transmission water pipes, water pump, cylinder heads, radiator cap.
(2) Fan belt loose or broken.	Visual.	Readjust or replace.
(3) Radiator thermostat sticking.	Substitution.	Replace.
(4) Low oil supply.	Visual.	Replenish oil supply.
(5) Distributor timing late.	Check timing.	Adjust as necessary.

j. Engine Noises

Description	Cause	Remedy
(1) Light knock or ping on acceleration.	Low octane gasoline, over-advanced spark, or carbon accumulation in engine.	Reset timing to suit available fuel. Clean carbon.
(2) Clicking or tapping noises synchronized with camshaft speed (½ crankshaft speed).	Dirt in valve silencers, low oil pressure or no oil to silencer mechanism.	Disassemble and clean silencers, or replace silencer units. Blow out oil feed line.
(3) High-pitched squeals.	Under-lubricated or frozen bearings on fan, generator or distributor.	Lubricate or replace unit, as required.
(4) Heavy knocks synchronized with crankshaft speed.	Burned out main or connecting rod bearings.	Replace engine.

Section XII

EQUIPMENT AND SPECIAL TOOLS

55. EQUIPMENT.

a. The items listed below are carried inside the vehicle and fastened in the most convenient available spaces.

List of Equipment	Where Carried
AMMUNITION, all guns	In hull and turret, (See Section V)
BAGS, musette (field bags), 4	In hull
BAR, utility	In hull
BINOCULARS, 1 pr.	In turret
BOX, binocular	In turret
BOX, ottoman	In hull
BUCKET, canvas, folding, 8-qt.	In hull
COMPASSES, 2	1 in hull, 1 in turret
CONTAINERS, water	In hull and turret
DECONTAMINATION APPARATUS, 1½-qt.	In hull
EXTENSION, oil gun, B-194460	In turret
EXTINGUISHER, fire, 1 portable 4-lb. unit, 1 fixed 10-lb. unit	In hull
FLAGS, signal	In turret
FLASHLIGHTS, 3, (Q.M.C. Std.)	1 in hull, 2 in turret
GUN BARRELS, 2, Cal. .30	In hull
HELMETS, 4, C-76072	In hull and turret
INTRAPHONE SYSTEM	In hull and turret
KIT, first aid	In hull
MITTENS, asbestos, 2 pr.	In hull
NOZZLES, 2 flexible	In tool box
OIL, engines and transmissions, 8 1-qt. cans	Together in hull
Recoil, for 37 mm gun 1-qt. can Hydraulic, for stabilizer and traverse mechanism, 1-qt. can	In turret

List of Equipment	Where Carried
PADLOCK, SLAX2A	In turret
PERISCOPES, 4 spares, 3-M5, 1 M3 with telescope, 12 spare heads	One periscope and three heads in box convenient to each man.
PLUGS, direct vision, 2 spares	In hull
PLUGS, headlamp socket, 2	In hull
PRISMS, protectoscope, box of 9	In turret
RADIO	In hull
RATIONS	In hull
RECOIL OIL GUN	In turret
SIGHT, 37 mm. bore	In 37 mm shell rack
SPARE PARTS & EQUIPMENT, box for cal. .30 and .45 guns	In hull
SPARE PARTS & EQUIPMENT, box for 37 mm gun	In hull

b. The following equipment is strapped in convenient locations on the outside of the vehicle.

CAUTION. If other than equipment listed below is carried on outside of vehicle, care must be taken that it is not placed where it will restrict air to radiators.

ANTENNA, spare section	On hull roof
AXE, B-150925	On sloping rear hood
BEDDING ROLLS, 4	On hull roof
BLOCKS, track, 4 spares, C-55574	On end of sponsons
CABLE, towing, B-108777	On engine compartment roof
CONNECTORS, track, 4 spares	On end of sponsons
CROWBAR, 5-foot	On sloping rear hood
GROUSERS, 21 C-73265	On turret wall
NET, camouflage	On engine compartment roof
PICK, mattock, B-101907-B	On sloping rear hood
SHOVEL, B-150926	On sloping rear hood
SLEDGE, 10-pound	On sloping rear hood
STAFF, Cleaning, 37 mm. cannon	On hull roof
TARPAULIN, 12 x 12 ft., D-37589	On engine compartment roof
TRIPOD MOUNT	On hull roof
WRENCH, trailing idler wheel nut, C-105665	On sloping rear hood

56. TOOLS.

a. The tools listed below are carried in a tool box which is stored between the propeller shaft housings.

BAR, cross, ½" square drive, A-189962.

FIXTURE, track connecting, including jack, lever, and two adjustable brackets, B-248215.

HAMMER, machine, ballpeen, TAAX1D.

HANDLE, hinge, 15", ½" square drive, B-169933.

HOSE, lubrication, heavy-duty, CLAX1A.

PLIERS, combination, 8" slip joint, THCX1A.

PUNCH, drive, $\frac{3}{32}$" point x 4" long, TCFX1A.

RATCHET, reversible, ½" sq. drive, TKEX2B.

ROLL, Tool Bag, M-4, D-5103.

SCREWDRIVER, heavy-duty, steel handle, TGBA1A.

SCREWDRIVER, 1¾" blade, TGAX2B.

SOCKET WRENCH, hex $\frac{3}{32}$", set screw, BCTX1G.

(2) SOCKET WRENCHES, double hex., ½" sq. drive, $\frac{15}{16}$", extra thin wall, A-191314.

SOCKET WRENCH, double hex., ½" sq. drive, $\frac{9}{16}$", (alloy steel) TKEX3D.

(2) SOCKET WRENCHES, double hex., ½" sq. drive, ¾", (alloy steel) TKEX3H.

(2) SOCKET WRENCHES, double hex., ½" sq. drive, $\frac{15}{16}$", (alloy steel) TKEX3E.

WRENCH, adjustable, single end, 8", TKAX3A.

WRENCH, Allen, ½", BCTX3K.

WRENCH, Allen, $\frac{9}{16}$", BCTX3M.

WRENCH, engineer's, double head, ⅜" and ½" (alloy steel) TKKX13.

WRENCH, engineer's, double head, ½" and $\frac{9}{16}$" (alloy steel) TKEX2B.

WRENCH, engineer's, double head, ⅝" and ¾" (alloy steel) TKKX2F.

WRENCH, engineer's, double head, ¾" and $\frac{13}{16}$" (alloy steel) TKKX3A.

WRENCH, engineer's, double head, $\frac{15}{16}$" and 1" (alloy steel) TKKX4C.

WRENCH, engineer's, double head, 1¼" x 1⅝" (alloy steel) TKKX6B.

WRENCH, grouser, ratchet, reversible, ½" sq. drive, TKEX2B.

WRENCH, idler, adjusting, $1\frac{11}{16}$" x 24" long.

b. In addition to the preceding list carried in the tool box, a trigger type OIL CAN, B-169931, is carried on engine fan shroud at rear of hull, and a high pressure LUBRICATING GUN, B-169987, is carried in clips located in the hull.

c. The following list contains the special tools employed by the using arms to service the vehicle. In addition, the list shows the source of supply for each tool.

ENGINE

Tool No.	Description	Source of Supply
A-265639	Gauge, spark plug and distributor contact points, spark plug electrode bender.	Company set, regimental crew set, regimental maintenance platoon set.
A-266510	Gauge, valve stem length.	Regimental maintenance platoon set.
B-226790	Installer, valve lifter bracket.	Regimental maintenance platoon set.
B-226787	Lifter, valve remover and replacer.	Regimental maintenance platoon set.
C-107502	Sling, engine assembly.	Company set, regimental maintenance platoon set.
A-265697	Wrench, spark plug.	Company set, regimental crew set, regimental maintenance platoon set.

TRANSMISSION

B-226781	Gauge, transmission pressure checking.	Company set, regimental crew set, regimental maintenance platoon set.
B-226779	Wrench, torque, 0–25 lbs. (band adjusting)	Company set, regimental crew set, regimental maintenance platoon set.

TRANSFER UNIT AND CONTROLLED DIFFERENTIAL

B-226839	Gauge, servo adjusting.	Company set, regimental crew set, regimental maintenance platoon set.
C-105885	Sling, controlled differential and transfer unit assembly.	Company set, regimental maintenance platoon set.

FINAL DRIVE

B-154313	Adapter, slide hammer (for use on Tool No. C-66645).	Regimental maintenance platoon set.

TRACKS AND SUSPENSION

A-195168	Compressor, volute spring, trailing idler.	Company set, regimental crew set, regimental maintenance platoon set.
A-157251	Compressor, volute spring, suspension.	Company set, regimental crew set, regimental maintenance platoon set.
B-152618	Cone assembly, bogie wheel retainer.	Company set, regimental maintenance platoon set.
B-169897	Cone assembly, trailing idler retainer.	Company set, regimental maintenance platoon set.
C-68386	Jack, Simplex, push and pull.	Vehicle set.
C-76085	Lift, bogie wheel.	Company set, regimental crew set, regimental maintenance platoon set.
C-65516	Puller, bogie gudgeon (screw type with ratchet handle).	Regimental maintenance platoon set.

Tool No.	Description	Source of Supply
C-66645	Puller, bogie gudgeon (slide hammer type).	Company set, regimental crew set, regimental maintenance platoon set.
B-226797	Stretcher, track connecting.	Company set, regimental crew set, regimental maintenance platoon set.
B-146061	Wrench, bogie axle cap.	Company set, regimental crew set, regimental maintenance platoon set.
TKBx3C	Wrench, bogie gudgeon nut.	Company set, regimental crew set, regimental maintenance platoon set.
B-193632	Wrench, trailing idler shaft.	Company set, regimental crew set, regimental maintenance platoon set.
C-105665	Wrench, trailing idler wheel nut.	Vehicle set, company set, regimental crew set, regimental maintenance platoon set.

GENERAL MAINTENANCE TOOLS

B-226838	Compressor, flexible bow gun.	Company set, regimental crew set, regimental maintenance platoon set.
A-266522	Gauge pins, throttle controls, adjusting (set of 6).	Company set, regimental crew set, regimental maintenance platoon set.
A-266520	Gauge, throttle, front relay.	Company set, regimental crew set, regimental maintenance platoon set.
A-266521	Gauge, throttle, intermediate relay.	Company set, regimental crew set, regimental maintenance platoon set.
B-226796	Sling, front deck, engine compartment roof and turret.	Company set, regimental maintenance platoon set.
B-226799	Sling, radiator lifting.	Company set, regimental maintenance platoon set.

Section XIII
FIRE EXTINGUISHERS

57. INSTALLATION.

a. Two sizes of carbon dioxide fire extinguishers are carried in each vehicle. A fixed 10-pound unit is clamped in a vertical position on the bulkhead of the fighting compartment (Fig. 22). This unit connects to tubes leading to the engine compartment, and is used for extinguishing fires in the engine compartment only. Its controls are accessible from the turret. In addition, a remote control lever on the top of the fighting compartment just ahead of the right sponson permits operation of the fire extinguisher from outside the vehicle.

b. A 4-pound portable hand-operated extinguisher is strapped in a vertical position behind the transfer unit where it is easily accessible to both the driver and assistant driver.

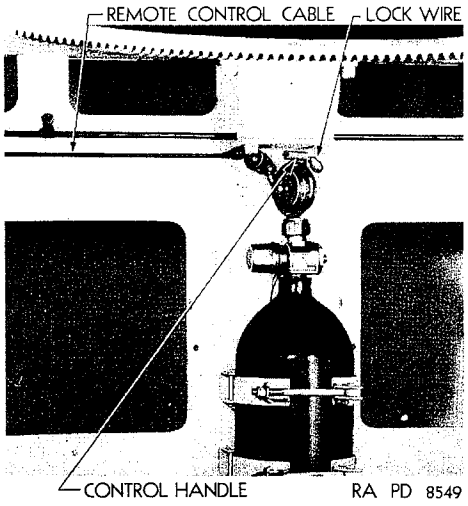


Figure 22—Fire Extinguisher Controls

c. Inasmuch as the pressure of the carbon dioxide increases with increasing outside temperature, the fire extinguishers are equipped with safety valves which blow off when pressure increases over safe limits.

58. OPERATION.

a. The portable extinguisher should be held in the left hand and the hose in the right hand so that the nozzle is at right angles to the cylinder. The discharge should be directed at the base of the flame, **not** at the center of the flame, with the discharge cone as close to the flame as the operator can safely hold it. Continue the discharge for several seconds after the flames are out to prevent recurrence.

b. In case of a fire in the engine compartment, the fixed extinguisher is set in operation by breaking lock wire, removing valve locking pin, and pulling control handle forward and down (Fig. 22). The fire extinguisher can be set in operation from outside the vehicle by pulling the remote control handle backward. This floods engine compartment with carbon dioxide gas, and will extinguish a fire with the engines running up to 1200 RPM. If conditions permit, however, the engines should be stopped.

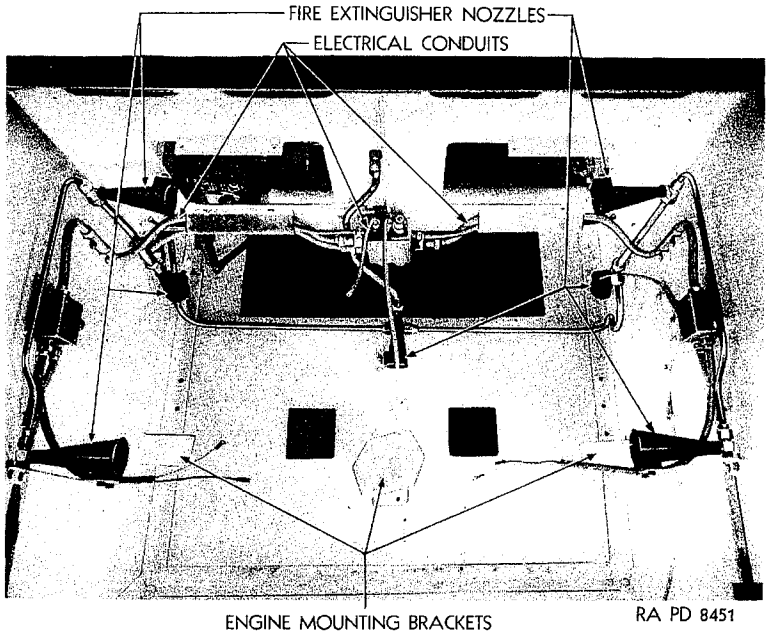


Figure 23—Engine Compartment

59. MAINTENANCE

a. Every four months, or oftener if necessary, weigh each extinguisher, and if weight is less than 3½ pounds (plus container weight marked on cylinder) for the 4-pound extinguisher, or 9 pounds (plus container weight marked on cylinder) for 10-pound extinguisher, the extinguisher should be exchanged for a fully charged one. After each use, the extinguisher should be weighed and, if necessary, exchanged for one that is fully charged.

b. Before installing a fresh cylinder for the fixed fire extinguisher system, the remote control mechanism must be reset as follows:

(1) Remove cover on control head and check to see that control cable clamp screws on cam are tight.

(2) Release remote control handle check springs and push handle into original position.

(3) Insert the lock pin or a nail in the hole in the control head shaft and rotate shaft counter-clockwise until clutch pin on other end of shaft and arrow on manual lever are in line.

NOTE: If system has been operated at cylinder, replace lock pin and seal wire in control head.

60. HANDLING.

a. Any cylinder containing gas under high pressure is as dangerous as a loaded shell. The extinguisher cylinders should never be dropped, struck, handled roughly, or exposed to unnecessary heat.

b. Red safety blow-off seal on valve head indicates if cylinder has been discharged due to high temperature. This should be examined regularly; if it is missing, the cylinder should be replaced.

Section XIV

ENGINE

61. GENERAL DESCRIPTION.

a. This vehicle is powered with two Cadillac 90°, V-type, 8-cylinder engines, mounted side by side in the engine compartment in the rear of the hull. Each engine has a 3½" bore and a 4½" stroke, a piston displacement of 346 cubic inches, and, as installed, develops 110 horsepower at 3400 RPM, measured at the output shaft, or a total of 220 horsepower for both engines.

b. In this section, the fan end of the engines will be referred to as the "front" end, and the flywheel end will be referred to as the "rear" end. The "right" and "left" sides of each engine and Hydra-Matic transmission are as viewed from the fighting compartment facing the rear of the vehicle. Right and left-hand engines are as viewed from the rear of the vehicle facing forward.

62. DESIGN AND CONSTRUCTION. (Fig. 24).

a. The cylinder blocks and crankcase are made in one casting of grey iron. The cylinder heads are also of cast iron.

b. The belt driven fan, water pump and generator, as well as the fuel pump and oil pressure gauge unit, are accessible through the engine compartment doors in the rear of the hull. The carburetor, located on top of the engine, is also accessible through these doors. The distributor is accessible from the fighting compartment through the bulkhead doors. (See Fig. 19.)

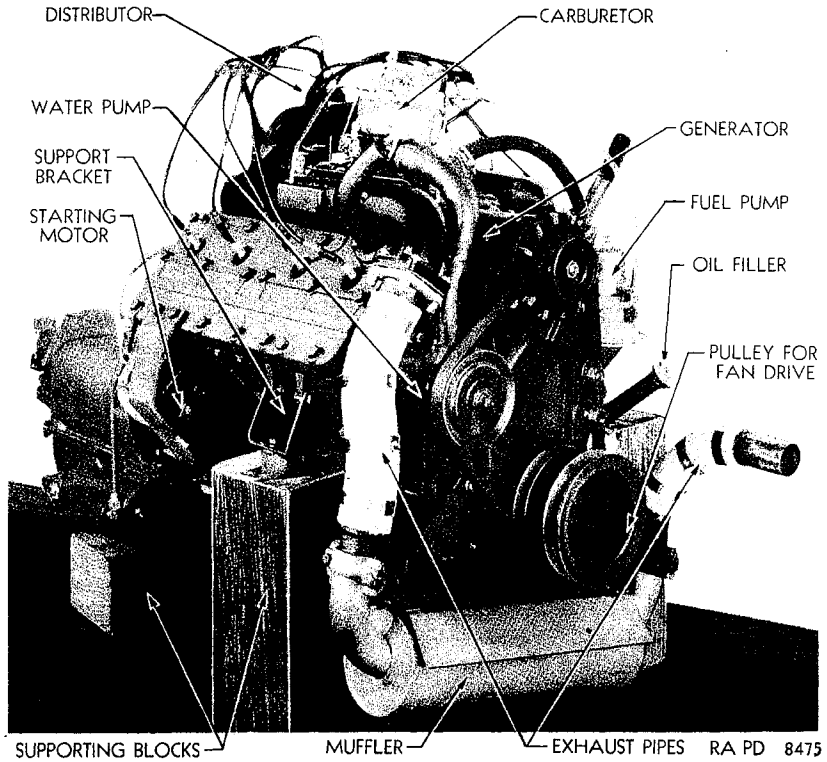


Figure 24—Right Front View of Engine

c. The carburetor on each engine requires no attention from the driver other than periodic inspection and adjustment. The choke is fully automatic in operation.

d. There is a throttle pedal or accelerator for both the driver and the assistant driver. Each pedal is interconnected by relays to both carburetors. This arrangement not only synchronizes the engines, but simplifies the operation of the vehicle.

e. Hydraulic valve lifters are used for maintaining zero clearance between the valve stems and lifters, thereby assuring efficient valve action and eliminating the necessity for valve tappet adjustments.

f. The exhaust pipes and mufflers are carried in the rear of the hull and mounted on the engines as shown in Fig. 24.

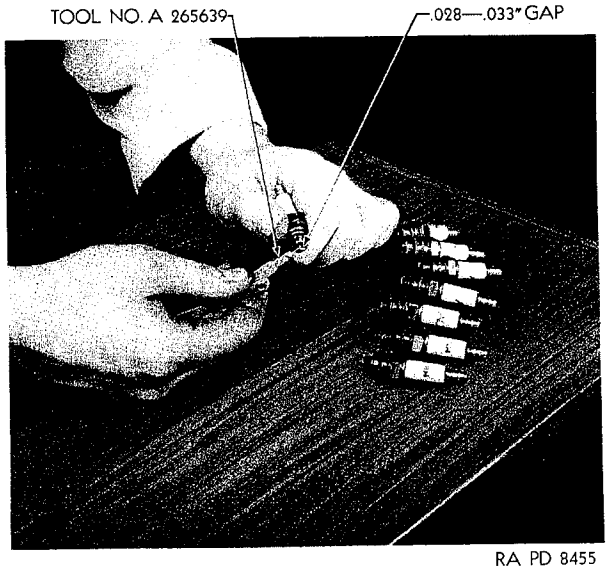


Figure 25—Checking Spark Plug Gap

63. SPARK PLUGS.

a. Spark plugs for cylinders 1 to 4 on each engine are accessible through the rear engine compartment doors. Spark plugs for cylinders 5 to 8 are reached through the bulkhead doors.

b. To replace spark plugs, disconnect spark plug wires at suppressors and remove suppressors. Remove spark plugs and gaskets, using special spark plug wrench, Tool No. A-265697 (10 mm thread).

c. Install spark plugs as follows: Position a **new** spark plug gasket on spark plug. Install plug, using special wrench, and tighten only enough to secure a good gasket seal.

NOTE: No other wrench should be used for installing spark plugs; otherwise plugs may be overtightened and damaged.

d. Spark plug electrode gap should be checked with special spark plug gauge, part of Special Tool No. A-265639, **not** with a feeler gauge, (Fig. 25). The correct gap is .028" to .033" for all spark plugs.

64. DISTRIBUTOR CONTACT POINTS.

a. Distributor contact points can be removed as follows:

(1) Unclip and remove distributor cap.

(2) Remove distributor from engine if in vehicle.

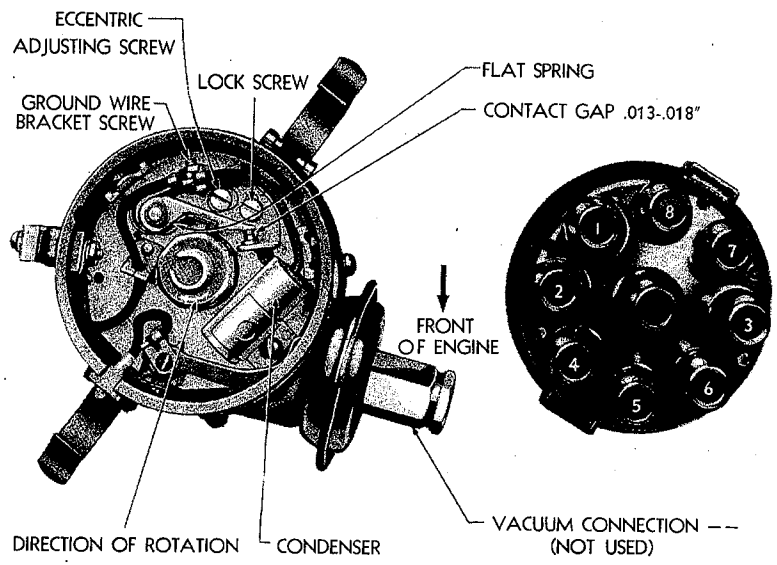


Figure 26—Distributor Timing Mechanism

(3) Pull distributor rotor upward and remove.

(4) Loosen nut on ground wire bracket screw and pull flat spring connection on movable contact point arm upward, (See Fig. 26).

(5) Pull movable contact arm upward off pivot shaft and remove.

(6 Remove locking screw holding fixed contact point arm to distributor backing plate, and remove fixed contact point arm.

b. To install distributor contact points, proceed as follows:

(1) Position fixed contact point arm on distributor backing plate and install locking screw loosely.

(2) Insert movable contact arm spring connection on ground wire bracket locking screw, and push movable contact point arm down over pivot shaft on distributor backing plate.

(3) Tighten ground wire bracket lock screw.

(4) Adjust distributor contact point gap as explained below.

(5) Tighten fixed contact point arm lock screw securely.

(6) Line up distributor rotor so that boss on underside of rotor lines up with notch on distributor cam and install rotor, pushing down as far as possible.

(7) Install distributor on engine, retiming as explained in Paragraph 67.

(8) Install distributor cap.

c. To adjust distributor contact point gap, proceed as follows:

(1) Remove distributor cap and rotor.

(2) Remove distributor from engine if it is in vehicle.

(3) Loosen fixed contact point arm locking screw.

(4) Turn distributor shaft until movable contact arm rubbing block is at exact high point of one of distributor cams.

(5) Check contact point gap with feeler gauge on Tool No. A-265639. Contact point gap should be .013" to .018" when movable contact point arm rubbing block is at high point at cam.

(6) Adjust contact point gap by loosening lock screw and turning eccentric screw on fixed contact point arm as shown in Fig. 26.

(7) Tighten fixed contact point arm locking screw, and recheck contact point gap.

(8) Install distributor in vehicle, install rotor and cap, and retime.

d. The appearance of distributor contact points must be thoroughly understood in order to determine, first, whether the points require any service at all, and, second, whether they should be cleaned or replaced. The appearance of contact points can be classified generally into four different groups as noted below:

(1) A rough, grey surface on the contact points is an ideal condition. Do not clean or replace points with this appearance.

(2) Oil-soaked contact points usually do not require filing. They should be cleaned thoroughly, however, and the source of the oil leakage determined and corrected.

(3) Pitted contact points will not cause ignition failure unless the pitting is in a greatly advanced stage. Minor pits or projections on contact points do not require replacement.

(4) Oxidized distributor contact points which have a blue or a black scale on the contacts usually do not require replacement. The scale, however, should be cleaned off. Oxidized points are usually caused by a faulty condenser or coil. Replace these items if condition recurs frequently.

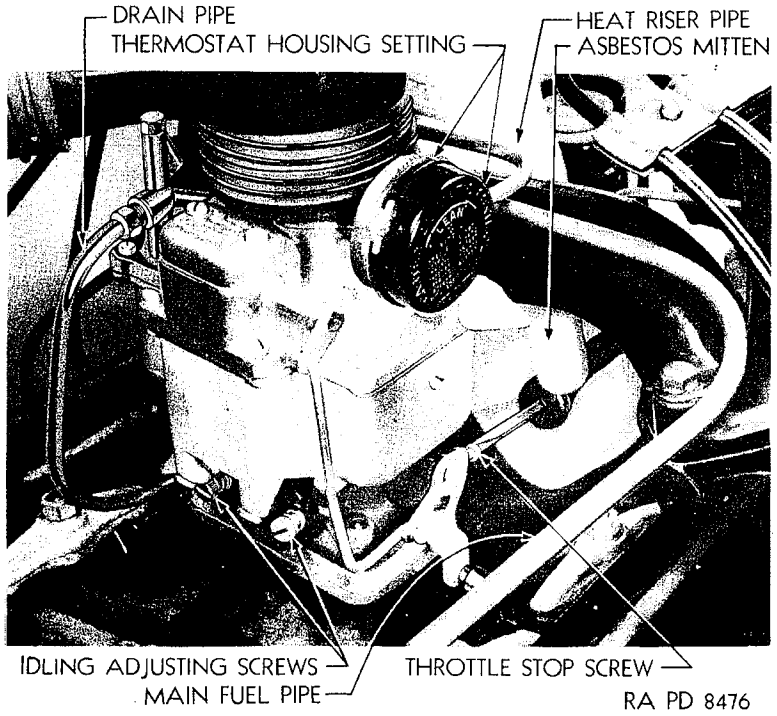


Figure 27—Carburetor Slow Idle Speed Adjustment

(5) After installing contact points which have been filed, check to see that they line up squarely with each other and adjust the gap.

65. CARBURETOR.

a. Adjustments. The only external adjustments which can be made on the carburetor are the slow idle adjustment, fast idle adjustment, and automatic choke thermostat adjustment. Inasmuch as these adjustments usually require very slight changes in throttle position, it is not necessary to disconnect the throttle linkage to the Hydra-Matic transmission or to the accelerator pedal when making these adjustments.

b. Slow Idle Adjustment. Remove 4 screws holding fan blade assembly to hub and remove blade assembly, but leave fan pulley and belt in place. Run engine until it is thoroughly warm so that choke valve is wide open and throttle stop screw is on slow idle. Reaching through bulkhead doors, set throttle stop screw, Fig. 27, so that engine speed is from 400 to 425 RPM, as noted on the instrument panel tachometer.

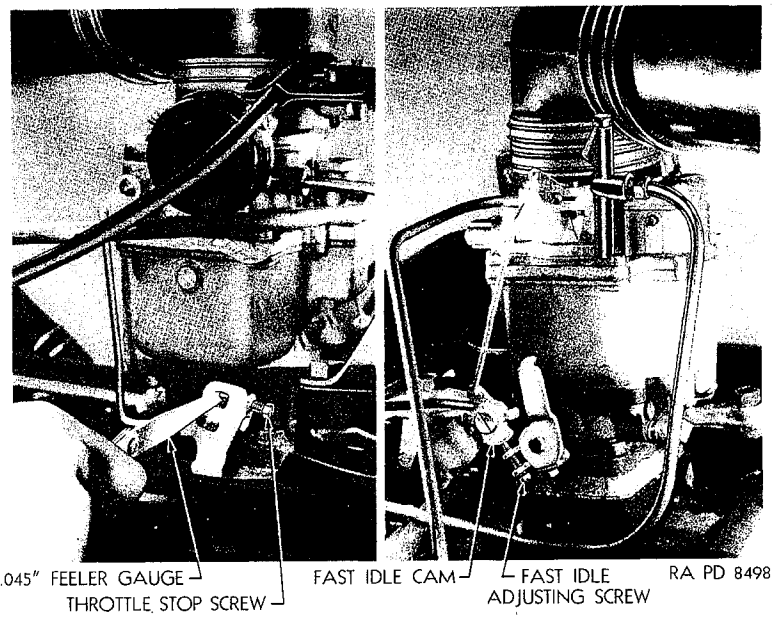


Figure 28—Carburetor Fast Idle Speed Adjustment

When slow idle speed has been set, engines should be stopped and idling mixture should be adjusted. Working through engine compartment doors, turn the two idle mixture adjustment screws, Fig. 27, in as far as possible. Turn screws out (counterclockwise) approximately 1½ turns. Start engine and see that it runs smoothly without loping or stalling. A further slight adjustment of the screws while the engine is running may be necessary in order to secure smooth running.

NOTE: Use a screwdriver with a shank long enough to protrude beyond generator and fan pulley.

c. Fast Idle Adjustment. After adjusting slow idle speed and idling mixture, the fast idle speed may be adjusted as follows:

(1) See that fast idle screw on reverse side of throttle shaft is resting against high lobe of fast idle cam, Fig. 28. Check clearance between throttle lever adjusting screw and carburetor casting stop as shown in Fig. 28. This clearance should be .045", as measured with a feeler gauge.

(2) Reinstall fan blade assembly.

d. Automatic Choke Adjustment. Except for a periodic inspection of the moving parts in the automatic choke to see

that they operate freely, and an occasional cleaning of the hot air line, no adjustment of the automatic choke control unit should be necessary. If the initial or part-throttle mixture is too lean or too rich, revolve the thermostat housing on the carburetor flange. Ordinarily, the choke setting mark on the housing should be set exactly opposite the large mark on the carburetor flange.

e. After the carburetor has been adjusted, check to see that throttle linkage to Hydra-Matic throttle valve and accelerator pedals has not been disturbed, as follows:

(1) Insert Hydra-Matic throttle valve distributor relay gauge pin, Tool A-266522, through relay and hole in distributor support housing. Leave distributor relay gauge pin in place until step No. 2 below is performed.

(2) Insert upper rear throttle relay gauge pin through upper rear relay shaft supports on each engine intake manifold and holes on relay levers. If these gauge pins will not enter levers, adjust linkage as explained in Paragraph 89.

f. Removal of Carburetor.

(1) Shut off gasoline at fuel filter.

(2) Remove fan and fan support as outlined in Paragraph 82.

(3) Disconnect carburetor air intake pipe from top of carburetor.

(4) Remove all pipes from carburetor. These include fuel pipe from fuel pump, heat riser pipe from intake manifold, and carburetor overflow pipe.

(5) Insert special throttle upper rear relay gauge pins, Tool No. A-266522 (long), through cross shaft brackets on each engine intake manifold and into pin holes on relay levers. (See Fig. 50.)

(6) Insert Hydra-Matic throttle valve distributor relay lever gauge pin, Tool No. A-266522 (short), through distributor relay lever and into pin hole on distributor support housing.

(7) Disconnect throttle linkage to accelerator and Hydra-Matic throttle valve lever at carburetor.

(8) Remove four nuts holding carburetor to intake manifold mounting studs and remove carburetor.

g. Installation of Carburetor.

(1) Install carburetor on intake manifold mounting studs and tighten nuts securely.

(2) Install all pipes to carburetor and connect carburetor air intake to carburetor (See Fig. 27).

(3) Adjust carburetor slow idling speed, idling mixture, fast idle speed, and automatic choke thermostat as explained above.

(4) Connect throttle linkage and adjust as explained in Paragraph 89.

(5) Install fan and fan support as explained in Paragraph 82.

(6) Turn on gasoline.

66. BELT ADJUSTMENTS.

a. Fan Belt Adjustment.

(1) Reaching through engine compartment rear doors, loosen mounting nuts holding fan bracket to timing case cover.

(2) Raise or lower fan and bracket assembly until there is between 5/8" and 3/4" slack in belt when measured by pushing inward, midway between fan pulley and crankshaft pulley, (Fig. 29).

(3) Tighten mounting nuts securely and recheck adjustment.

b. Generator and Water Pump Belt Adjustment.

(1) Loosen generator to timing case cover mounting bolts.

(2) Raise or lower generator and bracket assembly by

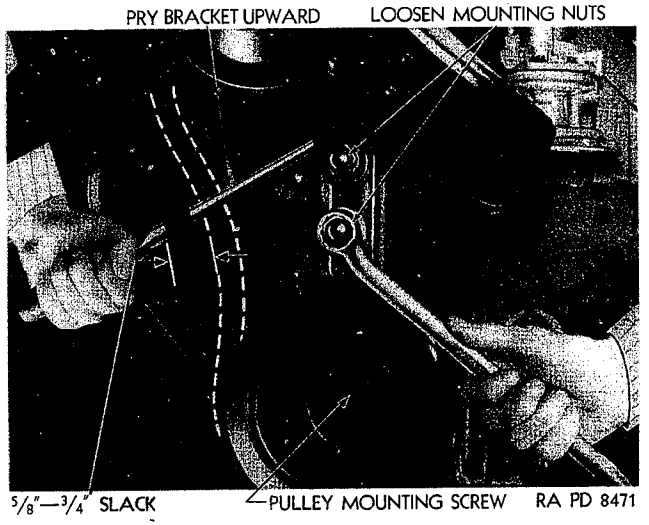


Figure 29—Fan Belt Adjustment

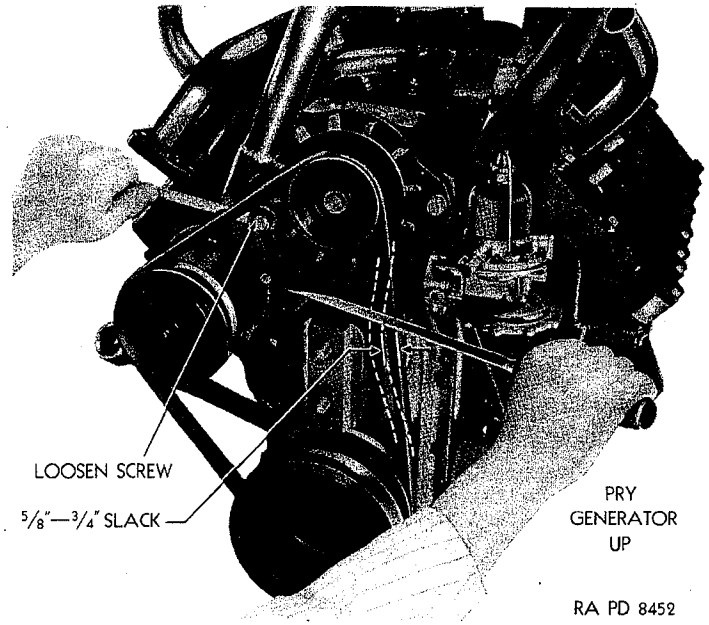


Figure 30—Generator & Water Pump Belt Adjustment

rotating on stationary bolt until there is between 5/8" and 3/4" slack in belt when measured by pushing inward midway between generator and crankshaft pulley, (Fig. 30).

(3) Tighten generator mounting bolts and recheck adjustment.

67. IGNITION TIMING.

a. Distributor timing should be checked with a synchroscope (timing light), if at all possible, by proceeding as follows:

(1) Working through bulkhead doors, install one lead of synchroscope on number one or number 6 cylinder spark plug. This is the front spark plug on the left-hand cylinder block, (Fig. 31).

(2) Connect other terminal of synchroscope to any clean unpainted spot on engine.

(3) Open timing port cover on bell housing and aim synchroscope at timing mark, which is located on flywheel cover, (Figs. 32 and 49).

(4) Start engine and warm up until it is running at slow

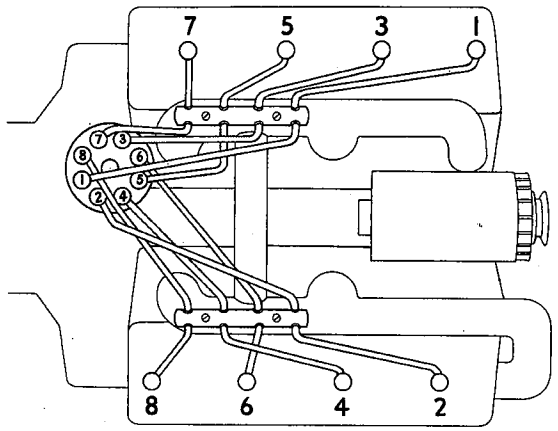


Figure 31—Engine Cylinder Numbering

idle speed of not more than 425 RPM. Note whether the IG/A mark on flywheel cover lines up with pointer on engine bell housing when synchroscope light flashes.

(5) Loosen distributor clamp screw.

(6) Rotate distributor housing until IG/A timing mark lines up with pointer as synchroscope light flashes. (See Fig. 32).

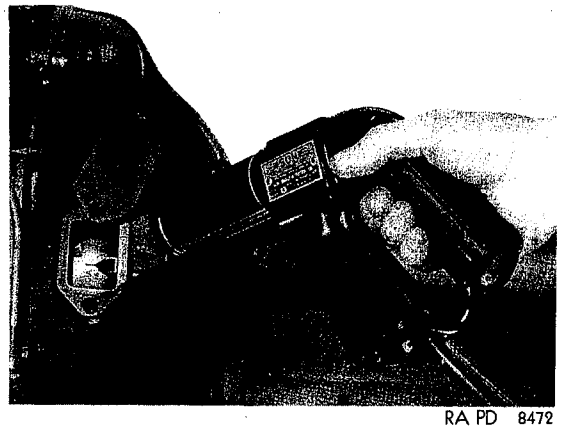


Figure 32—Checking Timing with Synchroscope

(7) Tighten distributor housing clamp screw and remove synchroscope.

b. Adjustment Without Synchroscope.

(1) Reaching through bulkhead doors, remove distributor cap.

(2) Crank engine, using socket wrench on the crankshaft pulley mounting screw (Fig. 29), until IG/A timing mark is opposite pointer.

(3) Check to see whether distributor rotor lines up with number one cylinder spark plug insert in distributor cap (when installed) and contact points are starting to separate.

(4) Loosen distributor housing clamp screw.

(5) Rotate distributor housing until contact points start to separate when IG/A timing mark is opposite pointer, and rotor lines up with number one cylinder spark plug insert in distributor cap when installed.

(6) Tighten distributor housing clamp screw and recheck timing to make sure distributor did not rotate while being tightened.

(7) Install distributor cap.

68. DISTRIBUTOR REPLACEMENT.

(1) Turn main battery switch to "Off" position.

(2) Remove spark plug and coil high tension wires from distributor cap by reaching through bulkhead doors.

(3) Disconnect coil primary wire from distributor housing.

(4) Loosen distributor clamping screw on timing quadrant which holds distributor support flange and lift distributor out of engine.

b. To install the distributor, proceed as follows:

(1) Position tongue on distributor driven shaft coupling so that it will enter slot in upper end of driveshaft coupling. The slot and tongue in this coupling are offset so that the distributor cannot be connected improperly.

(2) Insert distributor in support housing so that driven shaft and driveshaft are connected at coupling.

(3) Tighten distributor timing clamping screw loosely.

(4) Install cap screw, locking distributor timing quadrant to base on distributor support housing loosely.

(5) Connect coil primary wire to filter on side of distributor housing.

(6) Install spark plug and coil high tension wires in distributor cap. Figs. 26 and 31 illustrate the cylinder number of

each wire in the distributor cap and cylinder numbering on the engine.

(7) Check and adjust distributor contact point gap as explained in Paragraph 64.

(8) Turn on main battery switch, and check and reset distributor timing.

(9) After checking timing, be sure to tighten locking screw on timing quadrant and clamping screw on distributor support housing.

69. OIL PRESSURE GAUGE UNIT.

a. The oil pressure gauge unit transforms the pressure of the engine oil in the main oil line into electrical impulses which operate the oil pressure gauge on the instrument panel. It can be removed as follows:

(1) Remove fan shroud assembly.

(2) Disconnect feed wire at terminal on oil pressure unit.

(3) Position wrench on hex-shaped boss on back side of oil pressure unit and turn unit counterclockwise to remove. Hold brass nipple on cylinder block stationary while removing unit, (See Fig 44).

b. The oil pressure unit should be installed in the following manner:

(1) Install oil pressure unit securely on brass nipple.

(2) Connect feed wire to terminal on oil pressure unit.

(3) Install fan shroud assembly.

70. VALVES, REPLACEMENT.

a. Remove valves as follows:

(1) Remove engine as explained in Paragraph 73.

(2) Remove carburetor as explained in Paragraph 65f, and cover manifold opening.

NOTE: All parts removed should be put in a clean, covered place, free from dust.

(3) Remove generator belt and generator.

(4) Remove water pump and by-pass hose as explained in Paragraph 85.

(5) Disconnect distributor and spark plug wires and remove distributor as explained in Paragraph 68.

(6) Remove exhaust and intake manifolds and gaskets.

(7) Take out spark plugs and remove cylinder heads and gaskets.

(8) Cover top of cylinder block over manifold and cylinder openings with clean canvas or tape, to prevent dirt or dust from entering.

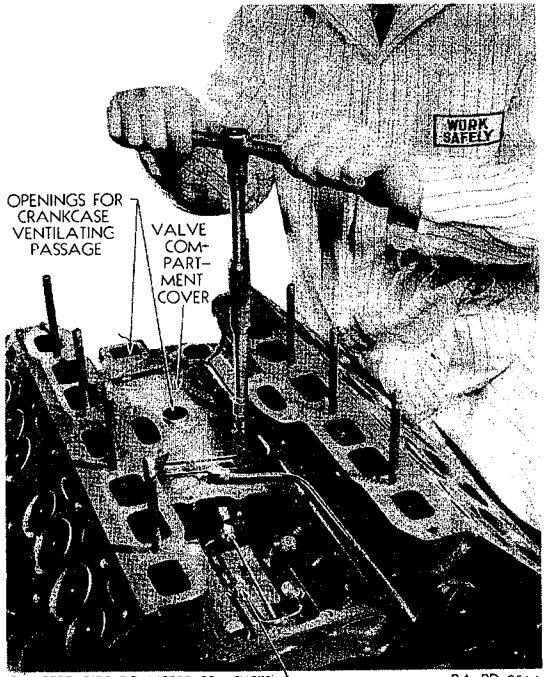


Figure 33—Removing Valve Compartment Cover

(9) Remove crankcase ventilating passage, valve compartment covers, and cover gaskets.

(10) Disconnect both oil feed pipes leading from the center bulkhead to the four valve lifter bracket assemblies, and remove pipes.

(11) Remove cap screws holding each valve compartment baffle to cylinder block and remove both baffles.

(12) Straighten each end of lock plate on each valve lifter bracket assembly; remove bolts holding each lifter bracket assembly to cylinder block and remove bolts and locking plates.

(13) Insert a screwdriver between each lifter bracket assembly and cylinder block, and pry bracket assemblies out from under valves, (Fig. 34).

(14) Insert special valve removing adapter in hollow end of special valve replacer, Tool No. B-226787, and install on a valve as shown in Fig. 35. Adjustable, pointed end of tool

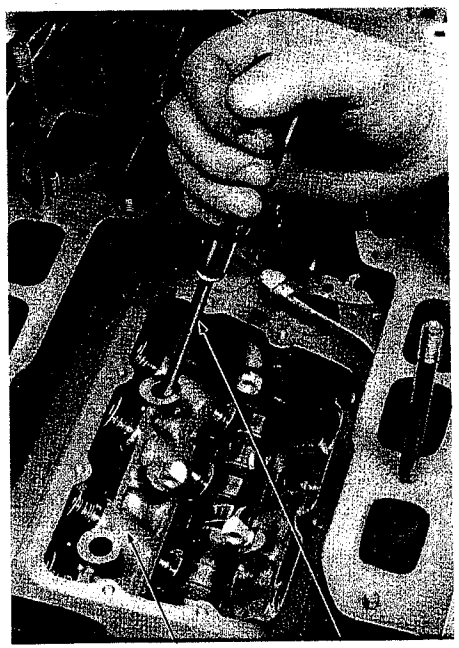


Figure 34—Valve Lifter Bracket Assembly Removal

fits in center hole in valve head, and hollow end of tool fits around valve spring lower seat.

(15) Compress valve spring by rotating handle of tool, and lock in compressed position by tightening large knurled knob opposite handle.

(16) Insert a screwdriver in slot on side of hollow end of valve tool and knock valve locks off end of valve stem.

(17) Loosen valve replacer tool and remove tool while supporting valve spring. Remove valve spring, spring seats, and valve from engine.

(18) Remove valve locks and valve spring lower seat from hollow end of replacer tool.

(19) Put valve in a rack so that each valve will be installed in same valve guide as it was in originally.

(20) Repeat steps 14 through 19 for each of the other fifteen valves.

Figure 35—Valve Removal

b. Valves should be installed as follows:

NOTE: Before installing valves, make certain that each part is thoroughly clean and free from dust and dirt. The covers which were installed over the tops of the cylinder block, on the distributor opening, and other points should not be removed until just before the attaching parts are to be installed. Extreme cleanliness is essential to correct engine operation.

(1) Check each valve stem for proper length, using valve stem length gauge, Special Tool No. A-266510, (Fig. 36), before installing valve lifter bracket assemblies. If valve stems are too long, they should be ground off until tool will slide into place with valve seated.

(2) Insert valve installing adapter in hollow end of valve replacer, Tool No. B-226787, and install valve locks in adapter, see Fig. 37.

(3) Insert valve in valve guide and position valve spring and upper and lower retainers on valve stem.

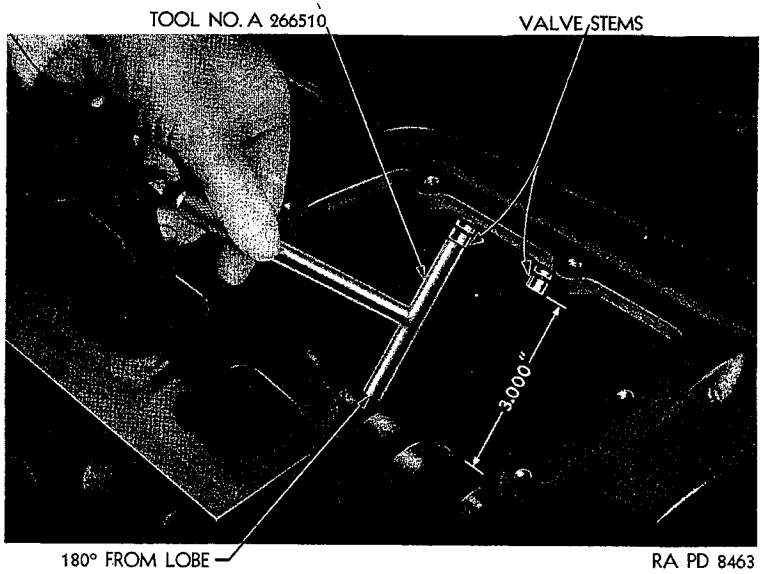


Figure 36—Checking Valve Stem Length

(4) Insert valve replacer tool on valve, and compress valve spring slowly until locks snap into place in grooves in valve stem.

NOTE: In order to facilitate valve installation, the following precautions should be observed: Keep tool in exact alignment with valve. A click will be heard when valve locks enter grooves in valve stem. Do not compress valve spring after hearing click.

(5) Loosen valve replacer by rotating handle clockwise until valve spring pressure is released, and remove tool from valve. Release tool **slowly,** making sure valve spring is in proper position.

(6) Repeat steps 2 through 5 for each of the other fifteen valves.

(7) Place special valve lifter bracket assembly installer; Tool No. B-226790, in position, see Fig. 38.

NOTE: Before installing valve lifter bracket assemblies, they should be disassembled, cleaned and reassembled as explained in Paragraph 72.

(8) Rotate camshaft until lobes which contact valve lifter bracket assembly being installed point away from lifter. Posi-

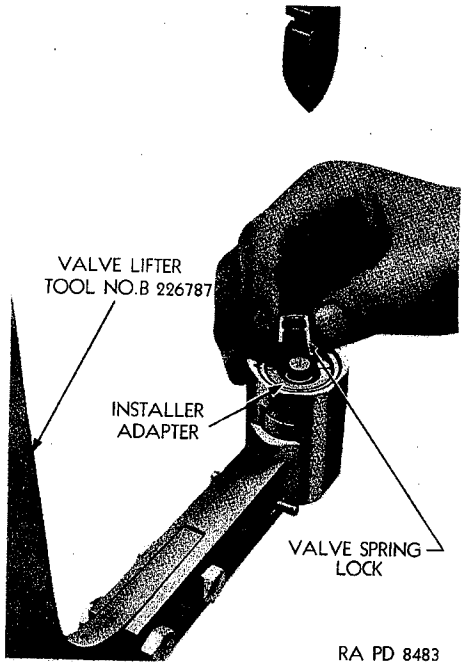


Figure 37—Valve Spring Lock Installation

tion valve lifter assembly and installer tool between ends of valve stems and camshaft and push into place.

(9) While holding valve lifter bracket assembly securely, pull valve lifter bracket assembly installer tool out from between valve lifters and ends of valve stems.

(10) Install valve lifter bracket assembly lock plate and bolts, and bend ends of lock plates up around bolt heads.

(11) Repeat steps 7 through 10 for each of the other valve lifter bracket assemblies.

(12) Position valve compartment baffles on valve lifter bracket assemblies and install mounting cap screws.

(13) Connect both oil feed pipes to center bulkhead only.

(14) Crank engine, using a socket wrench on crankshaft pulley cap screw until oil flows from both feed pipes smoothly and all air is expelled from line, then connect both oil feed pipes to each of the four valve lifter bracket assemblies. Install new valve compartment cover gaskets around openings on valve gear compartment.

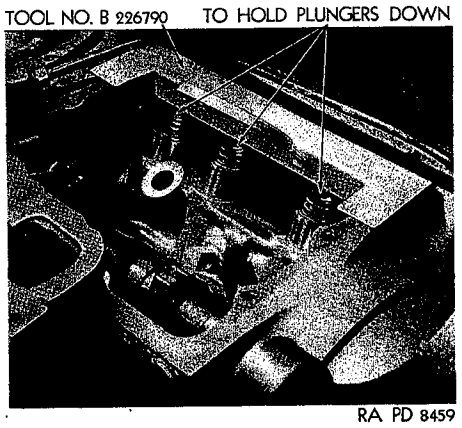


Figure 38—Valve Lifter Bracket Assembly Installation

(15) Install valve compartment covers and crankcase ventilating passage, using new gaskets.

(16) Install intake and exhaust manifolds, using new gaskets.

(17) Install new cylinder head gaskets and hold in place while installing cylinder heads. Tighten cylinder head cap screws to a torque tightness of 70 to 75 foot pounds.

NOTE: The two long bolts with ¾" hex head for each cylinder head must be installed at the cylinder head outlet elbow.

(18) Install water pump and by-pass hose as explained in Paragraph 85, and connect water pump by-pass hose to left cylinder outlet elbow.

(19) Install distributor and spark plug wires as explained in Paragraph 68.

(20) Install generator on mounting bracket.

(21) Install and adjust water pump and generator belt as explained in Paragraph 66.

(22) Install carburetor as explained in Paragraph 65.

(23) Install engine as explained in Paragraph 73.

71. VALVES, GRINDING.

a. When grinding valves, the instructions provided with the valve grinding equipment should be followed exactly in order to assure uniform valve seating.

b. Concentricity of valve seats is of particular importance

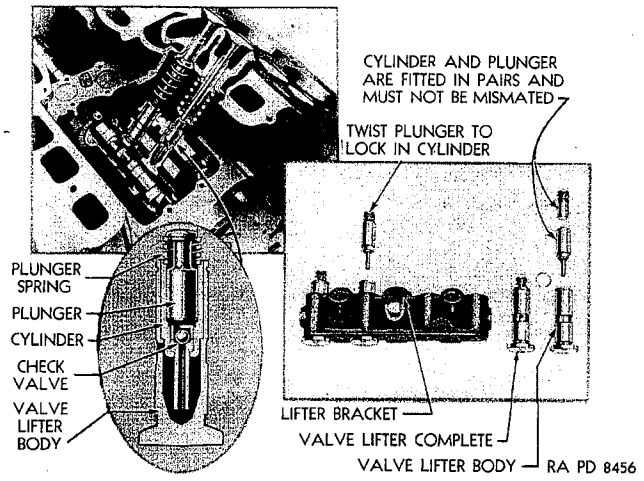


Figure 39—Valve Lifter Bracket Assembly, Disassembled

to assure both good seal and long valve life. Allowable out-of-round of the valve seat must be kept within .0015″ total dial indicator reading.

c. Correct width of valve seats is of equal importance to assure proper heat dissipation and to keep valve seats free of carbon. The seat width must be from $\frac{1}{16}$″ to $\frac{3}{32}$″ to provide adequate cooling of the valve head. In addition, valve seats should be cut so that there is no more than $\frac{1}{32}$″ from the outer edge of the valve seat to the edge of the flange on the valve head. This will allow heat to dissipate and provide maximum life for newly ground valves.

72. VALVE LIFTER ASSEMBLIES. (Fig. 39.)

a. After removal from engine, as covered in Paragraph 70, the valve lifters may be disassembled as follows:

(1) Expand lock ring in small end of valve lifter assembly, remove lock ring, and push assembly out of lower end of valve lifter bracket.

(2) Pull valve lifter cylinder, plunger and spring assembly out of lifter body.

(3) Twist valve lifter plunger spring counter-clockwise to unlock spring in valve lifter cylinder, and pull plunger and spring out of valve lifter cylinder.

(4) Wash all valve lifter parts thoroughly in cleaning solvent and dry with compressed air. Do not use a rag to dry valve

lifter parts, as lint from the rag may be left on the parts and affect their operation.

b. Check operation of valve lifter assemblies as follows:

(1) Ball check valve should rattle when valve lifter cylinder unit is shaken.

(2) Valve lifter plunger should bounce back when pressed quickly into dry cylinder and released.

(3) Valve lifter cylinder should slide smoothly into lifter body when free of oil.

c. Reassembly.

(1) Push valve lifter plunger and spring into cylinder and lock in place by rotating plunger spring clockwise so that it engages in cylinder.

(2) Fill valve lifter body with clean engine oil and push valve lifter cylinder and plunger assembly into valve body, alllowing excess oil in body to leak out between cylinder and body.

NOTE: Do not depress valve lifter plunger after oil has been added to lifter body, because this will pump oil into valve lifter cylinder and prevent installation of valve lifter in engine.

(3) Push valve lifter assembly into valve lifter bracket and lock in place with lock ring.

(4) Repeat above operations for the other 15 valve lifters.

NOTE: Each valve lifter cylinder and plunger has a selective fit for correct operating clearance. For this reason, parts from one assembly should not be used in another assembly, nor should single new parts be used in a lifter assembly. Complete assemblies only should be replaced.

(5) Extreme cleanliness when servicing valve lifters cannot be overemphasized, as dirt in the lifter may cause it to be noisy or inoperative.

73. ENGINE REPLACEMENT.

a. The engines can be removed from the hull as follows:

(1) Remove floor pan underneath Hydra-Matic transmissions and drain cooling system by removing water drain plug in transmission oil pan (see Fig. 20) and the two drain plugs at fan end of each cylinder block.

(2) Open main battery switch, and shut off fuel valves.

(3) Remove engine compartment cover mounting screws.

(4) After removing both fuel tank filler caps, install engine compartment cover sling, Tool No. B-226796, on cover and remove with a hoist (Fig. 40).

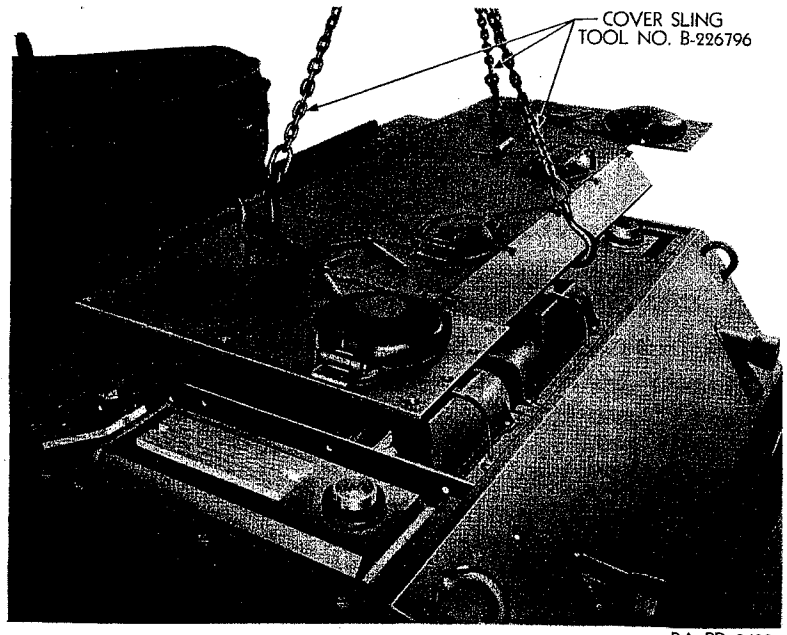


Figure 40—Engine Compartment Cover Removal

(5) Remove transfer unit and controlled differential oil cooler mounting brackets and lower oil cooler onto engines. (Fig. 48.)

(6) Remove both radiators, as explained in Paragraph 84.

(7) Disconnect hoses to transfer unit oil cooler at ends nearest bulkhead and remove transfer unit oil cooler.

(8) Shut off fuel, and remove flexible gasoline hoses from pipe leading from engine compartment wall to fuel pump (right-hand engine) or radiator support bracket (left-hand engine) at both fuel pumps. Also, disconnect fuel pipe where it comes through engine compartment sidewall.

(9) Remove air baffle, mounted on rear radiator support, and remove support with fuel lines attached, from engine compartment.

(10) Remove fan shroud, fan bracket assembly and fan belt as explained in Paragraph 82.

(11) Remove rear fire extinguisher nozzles by removing cap screws holding nozzle to sidewall bracket and unscrewing nozzle from pipe.

(12) Remove auxiliary power plant air cleaner. (Fig. 21.)

(13) Disconnect all electric connections at engine. These include the following:

(a) Oil pressure gauge unit wire.

(b) Heat indicator wire.

(c) Generator connections.

(d) Starter feed cable and jumper from left engine to right engine, at left engine.

(e) Starter relay to junction box wires at junction boxes.

(f) Coil primary and secondary wires, at distributor.

(14) Disconnect tachometer cable from distributor driveshaft housing.

(15) Disconnect carburetor air intake pipe at carburetor and at engine compartment sidewall and remove pipe assembly.

(16) Working through floor pan underneath transmissions, install intermediate relay gauge plate, Tool No. A-266521, on the two intermediate relay cross shafts next to manual and throttle levers and lock manual lever to plate with special gauge pin, Tool No. A-266522. Then lock throttle lever to plate with another gauge pin, Tool No. A-266522. (See Fig. 50.)

(17) Disconnect vertical throttle rod that extends from lower rear relay to throttle control cross shaft above engines, at cross shaft. (See Fig. 50.)

NOTE: Do not disturb position of adjustable clevis on vertical rod.

(18) Disconnect both throttle rods that lead from throttle control cross shaft to Hydra-Matic throttle valve rods (carburetor to distributor relays) at the throttle valve rods, on both engines.

(19) Remove throttle control cross shaft support bracket mounting stud nuts on both engine intake manifolds and remove cross shaft, supports, and throttle rods as a unit.

(20) Disconnect Hydra-Matic manual control rod from manual shift lever on transmission case, but leave rod on intermediate relay cross shaft.

(21) Remove basket guard mounted on top of propeller shaft housing covers.

(22) Remove propeller shaft housing cover and outer wall.

(23) Disconnect rear universal joint from yoke on Hydra-Matic output shaft.

(24) Remove two rear engine support mounting screws from bracket on hull floor underneath Hydra-Matic transmission.

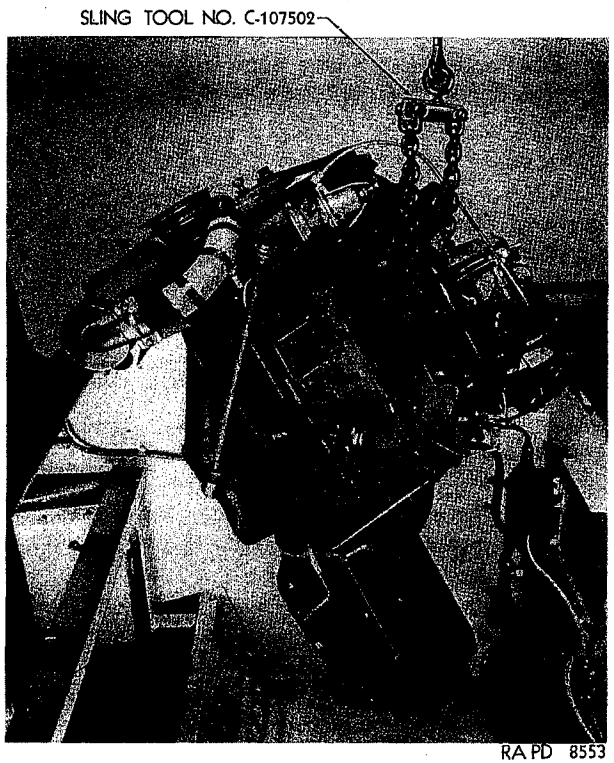


Figure 41—Engine Removal

(25) Remove front engine support mounting bolts on both sides of engine.

(26) Install special engine and transmission sling, Tool No. C-107502, on one engine. Only one engine at a time can be removed. Sling plates should be installed under cylinder head bolts first and third from the rear in center row on each cylinder head. The lip on the plate to which clevis is attached should be toward lower side of cylinder head. (Fig. 41.)

NOTE: The two sling chains are not the same length. Install longer chain on side of engine next to engine compartment wall.

(27) Hold all wires, hoses and other connections back on sides of compartment, so that engine is clear.

(28) Lift engine slightly until engine supports clear studs on center engine support mounting bracket.

(29) Move engine toward rear of vehicle as far as possible; raise front end and lift engine from vehicle. Be very careful to see that transmission filler pipe does not strike junction box on bulkhead.

b. The engine is installed in hull as follows:

(1) Install special engine and transmission sling, Tool No. C-107502, on engine. Sling plates should be mounted under cylinder head bolts first and third from the rear in center row of each cylinder head. The lip on plate, to which the clevis is attached, must be on lower side of cylinder head.

NOTE: The two sling chains are not the same length. Install longer chain on side of engine which is next to engine compartment wall.

(2) Hold all loose wires, hoses and other connections in engine compartment back against sides of compartment so that engine can be installed.

(3) Hoist engine and transmission assembly above engine compartment and lower into place, transmission first at angle shown in Fig. 41.

(4) Line up front engine support with dowel pins on center support mounting bracket, and lower engine onto support bracket.

(5) Install mounting bolts on both front engine supports loosely.

(6) Line up transmission extension housing with support bracket underneath Hydra-Matic transmission and install mounting bolts to a tightness of 50 to 60 foot pounds.

(7) Tighten both front engine supports to a tightness of 50 to 60 foot pounds.

NOTE: After removing sling from engine, be sure to reinstall cylinder head cap screws that held sling plates and tighten them to 70-75 foot pounds.

(8) Connect rear universal joint to yoke on Hydra-Matic output shaft.

(9) Install propeller shaft housing cover and outer wall.

(10) Install basket guard over housing covers.

(11) Position carburetor air intake pipe on carburetor and engine compartment sidewall and install mounting screws securely. Use a new gasket where pipe mounts on sidewall and smear it liberally with gasket paste to obtain an airtight seal.

(12) Connect tachometer cable to distributor driveshaft housing.

(13) Install auxiliary power plant air cleaner.

(14) Install all electrical connections to engine; these include the following:

(a) Oil pressure gauge wire.

(b) Heat indicator wire.

(c) Generator connections.

(d) Starter feed cable and jumper (left-hand engine).

(e) Starter relay to junction box wires.

(f) Coil primary and secondary wires.

(15) Install all fire extinguisher nozzles removed, by screwing on to mounting brackets.

(16) Install rear radiator support and air baffle.

(17) Connect both fuel pump intake hoses to pipes on rear radiator support and connect main pipe on rear support to pipe from left-hand fuel tank on engine compartment sidewall.

(18) Connect transfer unit oil cooler hoses to pipes at firewall.

(19) Install both radiators, using special sling, Tool No. B-226799, and install transfer unit oil cooler.

(20) Make sure water drain plug is installed in transmission oil pan and that drain plugs in cylinder blocks are installed, and fill cooling system.

(21) Fill engine crankcase with 8 quarts of oil.

(22) Install special sling, Tool No. B-226796, on engine compartment cover and hoist cover into place.

(23) Install engine compartment cover screws and install both fuel tank filler caps.

(24) Connect Hydra-Matic manual control rod to manual shaft lever on transmission case and adjust manual control linkage as explained in Paragraph 88.

CAUTION: Do not remove gauge pin, Tool No. A-266522, which locks intermediate relay throttle lever to gauge plate, Tool No. A-266521, during this operation.

(25) Leaving fan shroud and fan assembly off and all throttle linkage disconnected from carburetor, run engine and adjust carburetor idling speed, idling mixture and choke setting as explained in Paragraph 65.

CAUTION: The throttle linkage to accelerator pedals should be locked at intermediate relay, and throttle valve linkage locked at distributor relay during this operation.

(26) Install upper rear throttle control cross shaft and throttle rods as an assembly. Tighten mounting screws in place on both engine intake manifolds securely.

(27) Lock cross shaft relay levers to support brackets, using gauge pins, Tool No. A-266522.

(28) Adjust Hydra-Matic throttle valve and accelerator linkage as explained in Paragraph 89.

(29) Connect vertical throttle rod extending from lower rear relay to upper rear relay cross shaft.

(30) Remove gauge pins, Tool No. A-266522, from upper rear relay cross shaft, distributor relay and intermediate relay. Remove gauge plate, Tool No. A-266521, from intermediate relay.

(31) Install floor pan under Hydra-Matic transmissions.

(32) Install fan, fan belt and fan shroud, and adjust belts as explained in Paragraph 66.

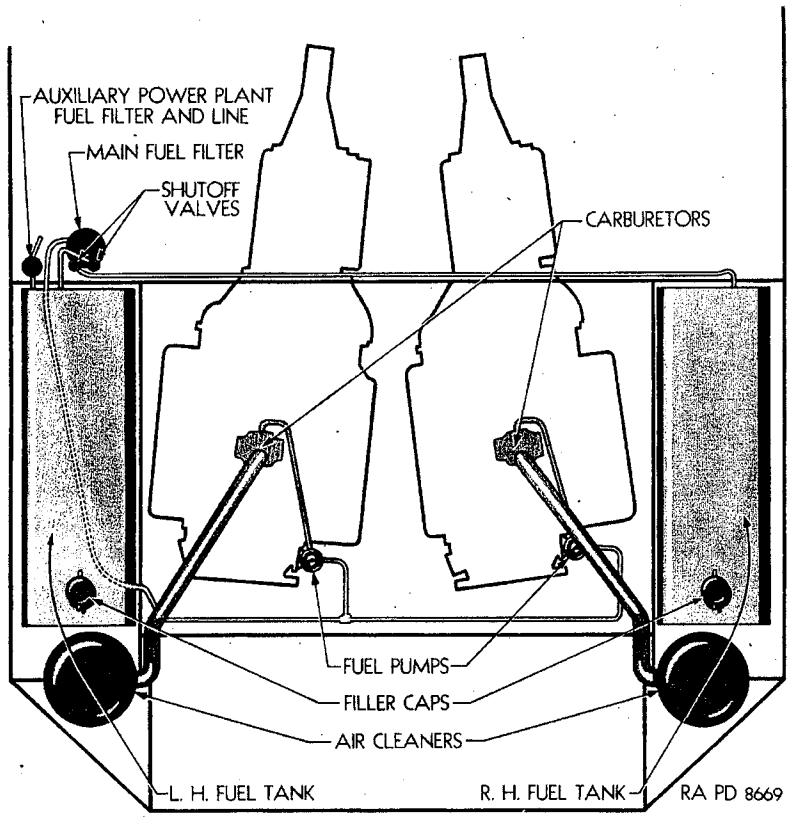


Figure 42—Fuel System

Section XV

FUEL SYSTEM

74. DESCRIPTION.

a. Fuel Tanks. Two fuel tanks with an individual capacity of 44½ gallons are provided for the engine fuel system. These tanks are located in the sponsons just behind the bulkhead and are wedged tightly in place by wooden and paper spacers. Gasoline from each tank is drawn through a screened outlet pipe to a central fuel filter. These tanks supply the fuel for the two engines and for the auxiliary power plant.

b. Fuel Filters.

(1) A disc-type fuel filter is incorporated in the fuel supply system to strain the fuel before it reaches the engines. This filter is located on the upper left-hand corner of the bulkhead in the fighting compartment (Fig. 43). The lines from both fuel tanks lead to this filter, while one fuel line leads from the filter back to a pipe built into the left-hand fuel tank, thence out of the right-hand wall of the fuel tank, near its rear end, to the two engines.

(2) Another screened outlet pipe leads from the left-hand tank to a smaller disc-type filter, located below the main fuel filter. A feed pipe leads from this filter through a notch in the bulkhead extension to the auxiliary power plant.

(3) Shut-off valves in each of the fuel tank lines are located at the filters where they are accessible from the fighting compartment.

c. Fuel Pumps.

(1) Each engine is equipped with a diaphragm-type fuel pump. These fuel pumps have the dual purpose of pumping fuel from the tanks to the carburetors, and further straining the gasoline to remove any dirt or foreign matter in it.

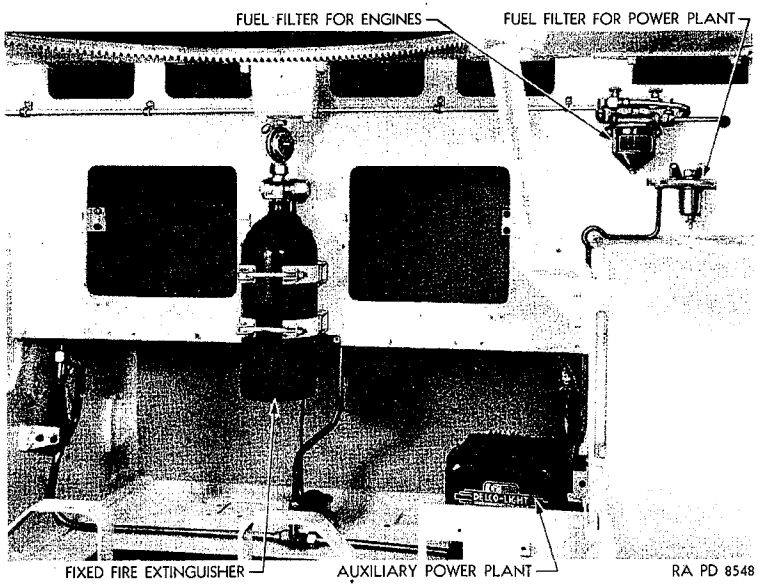


Figure 43—Fuel Filters

(2) The fuel pumps are mounted on the left side of the timing case cover on each engine (Fig. 44). They are driven by arms actuated by removable eccentrics keyed to the front ends of the camshafts.

d. Air Cleaners.

(1) The two engines are equipped with two heavy-duty oil bath air cleaners, which are mounted in the extreme rear of each sponson behind the fuel tanks.

(2) The air cleaners draw air from the fighting compartment. Small port holes in the bulkhead which open into the front ends of the sponson permit air to flow from the fighting compartment, around the fuel tanks, and back to the air cleaners. Servicing the air cleaners is covered in Paragraph 29-e, Lubrication Section.

(3) The auxiliary power plant also has a small oil bath air cleaner mounted on the air intake line to the carburetor. Instructions for servicing this air cleaner are listed in Paragraph 36-b, Lubrication Section.

75. FUEL TANK DRAINING.

a. The fuel tanks can be drained for cleaning without removing the tanks by proceeding as follows:

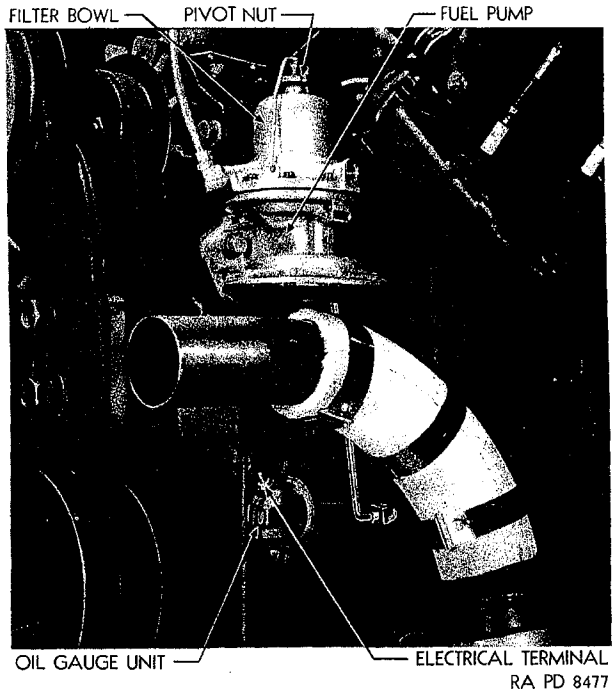


Figure 44—Fuel Pump & Oil Pressure Unit Mounting

(1) Remove six cap screws and lock washers holding fuel tank drain cover plate to floor of sponson and remove plate.

(2) Remove fuel tank drain plug, using a $\frac{9}{16}$" Allen wrench.

b. After tank has been drained and cleaned—

(1) Install fuel tank drain plug tightly, using a $\frac{9}{16}$" Allen wrench.

(2) Install fuel tank drain cover plate and tighten six cap screws and lock washers.

NOTE: When draining fuel tanks, be careful not to allow gasoline to spill on clothing or parts of the vehicle. A spark or a flame may ignite the gasoline before it has dried, causing a dangerous fire. Vehicle should be grounded by placing a metal object in contact with the vehicle and the ground to eliminate fire danger due to static electricity.

76. FUEL TANK REPLACEMENT.

a. The fuel tanks can be removed as follows:

(1) Drain gasoline from tanks.

(2) Remove engine compartment cover, using the special sling, Tool No. B-226796 (Fig. 40).

(3) Remove engine compartment cover brackets on side of sponson.

(4) Loosen fuel tank rear partition and remove rear spacer.

(5) Disconnect fuel tank outlet pipe nipples at forward end of tank, from fighting compartment, and at inner side of left-hand tank near rear end, from engine compartment.

(6) Slide fuel tank back and remove from top of sponson.

(7) Straighten clips holding wooden spacers on top of tank and remove spacers.

(8) Remove bottom, side and front wooden fuel tank spacers from sponson.

b. To install the fuel tank—

(1) Install spacers on top faces of fuel tank and bend clips over to hold spacers in place (Fig. 45).

(2) Position front and bottom fuel tank spacers in sponson and lower fuel tank into place.

(3) Install side and rear spacers.

(4) Connect fuel tank outlet line at nipple.

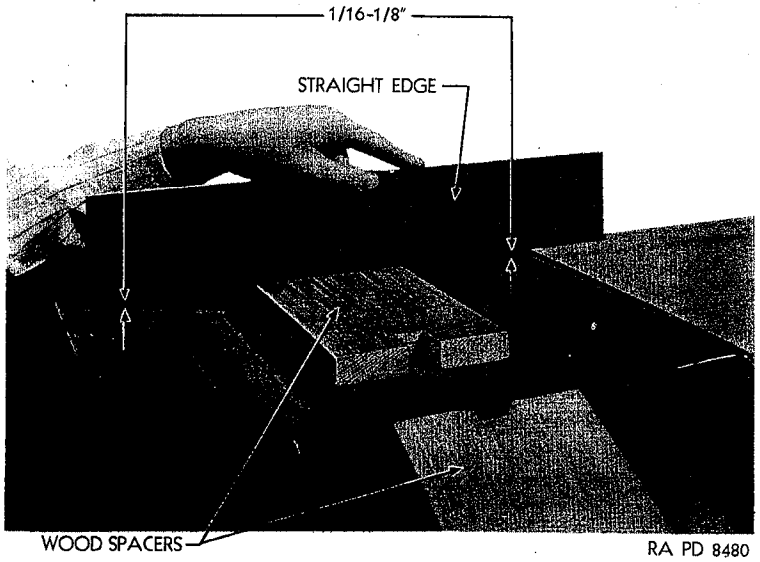


Figure 45—Fuel Tank Spacer Alignment

NOTE: There are three connections at front and one on inner side of left fuel tank.

(5) Press fuel tank down and tighten fuel tank rear partition. This will tighten the fuel tank in place.

(6) Lay a straightedge across top of sponson and check to see whether top of wooden spacer on top of fuel tank contacts the straightedge (Fig. 45). If there is a slight gap between the top of the shims and the bottom of the straightedge, install heavy paper shims until they are slightly higher than the top of the sponson.

(7) Install engine compartment cover brackets.

(8) Install engine compartment cover and tighten securely.

77. FUEL FILTER CLEANING.

a. It is not necessary to remove the large filter in order to clean it. Proceed as follows:

(1) Close valves.

(2) Remove cap screw in center of filter top casting while holding filter case.

(3) Lower filter unit and case and remove.

(4) Wash all parts thoroughly in solvent cleaner.

(5) Install a new filter case top gasket.

(6) Install filter unit and case on filter top casting and tighten cap screw.

NOTE: Filter assembly can be drained to remove sediment in case without removing filter unit and case, by removing the drain plug in the bottom of the case.

(7) The auxiliary power plant fuel filter is cleaned in the same manner as the engine fuel filter.

78. FUEL FILTER REPLACEMENT.

a. To replace the filter, disconnect all fuel line connections at filter: remove two bolts and lock washers holding filter to firewall and remove filter.

NOTE: Fuel tanks must be less than half-full before removing filter.

b. To install the filter, position it on firewall and install bolts and lock washers. Connect all fuel lines to filter.

(1) The fuel filter for the auxiliary power plant is replaced in the same manner.

79. FUEL PUMP STRAINER CLEANING.

a. To remove and clean the fuel pump strainer, proceed as follows:

(1) Loosen pivot nut on top of fuel pump bowl, swing nut and bracket off bowl and remove bowl (Fig. 44).

(2) Slip laminated strainer assembly off top of fuel pump body.

(3) Blow out strainer assembly with compressed air if available. Otherwise wash with cleaning solvent and shake thoroughly to jar off the sediment.

(4) Wash fuel pump bowl in cleaning solvent and dry thoroughly.

(5) Install strainer on top of fuel pump body.

(6) Install a new fuel pump bowl gasket and install bowl.

(7) Tighten bowl in position with pivot nut.

80. FUEL PUMP REPLACEMENT.

a. The fuel pumps can be replaced with the engine in the vehicle as follows:

(1) Remove fan shroud.

(2) Remove fan assembly as explained in Paragraph 82.

(3) After shutting off fuel supply line at fuel filter, disconnect fuel pump inlet and outlet fuel lines at fuel pump.

(4) Using a socket wrench with a short extension, reach around fuel pump body and remove rear bolt holding fuel pump to cylinder block.

(5) Support fuel pump, remove front mounting bolt and remove fuel pump.

b. To replace the fuel pump—

(1) Position fuel pump on cylinder block, using new gasket.

(2) Install front and rear mounting bolts, using wrench as explained in step 4 above.

(3) Connect inlet and outlet fuel lines to fuel pump and open fuel supply line at fuel filter.

(4) Install fan shroud and fan.

(5) Adjust fan belt as explained in Paragraph 66.

Section XVI

COOLING SYSTEM

81. DESCRIPTION.

a. The vehicle is equipped with two identical, but completely independent, cooling systems, one for each engine and Hydra-Matic transmission. Each system contains the following major units: radiator, water pump, thermostat and necessary connections, engine fan, and an oil cooler for the Hydra-Matic transmission.

b. The coolant is drawn from the radiator by the water pump and forced into the engine water jackets. After circulating through both cylinder blocks and cylinder heads, the hot fluid is forced up to the radiator. A thermostat located in the radiator inlet elbow permits free flow when the engine is hot, but causes cold water to recirculate through a by-pass back to the water pump and through the engine until the engine reaches an efficient operating temperature.

c. Cooling fluid is also pumped through an external pipe to an oil cooler located in the Hydra-Matic transmission oil pan where it cools the Hydra-Matic fluid and then is returned to the water pump.

d. The capacity of each cooling system is 30 quarts.

82. FAN REPLACEMENT.

a. Loosen two mounting stud nuts holding fan bracket to timing case cover enough to allow fan to drop down so that fan belt can be removed. Remove stud nuts and washers, while supporting fan, and remove fan assembly.

b. To install fan assembly, position fan support over mounting studs on timing case cover and install two flat and two lock washers and nuts finger tight. Install fan belt and adjust as explained in Paragraph 66. Tighten mounting nuts.

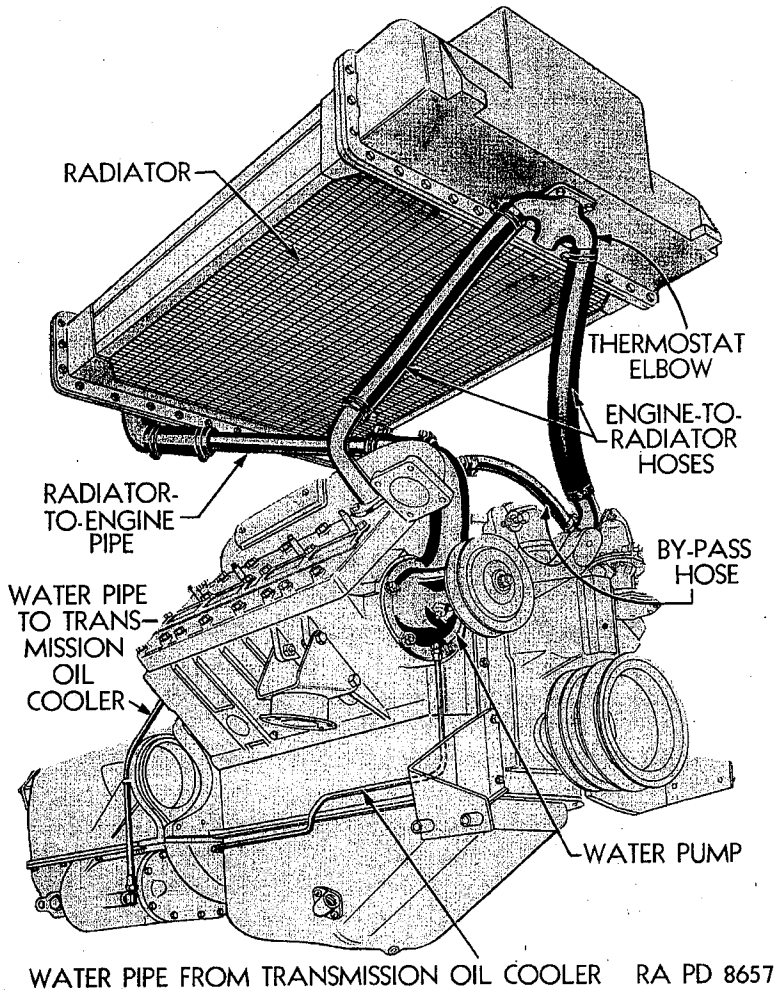


Figure 46—Cooling System

83. RADIATOR THERMOSTAT REPLACEMENT.

a. Remove fan and fan belt as explained in Paragraph 82, and drain cooling system. There is a drain plug on the front of each engine cylinder block and one in the transmission oil pan (Fig. 20). When removing the thermostat or radiator, however, it is only necessary to remove the cylinder block drain plugs. Disconnect hoses at radiator inlet housing and remove radiator inlet housing mounting nuts and lock washers. Remove housing, gasket and radiator thermostat.

NOTE: This operation can be performed more easily by first removing the fan shrouds.

b. The radiator thermostat should be replaced as follows: Install new radiator inlet housing gasket, using gasket sealer, and install thermostat in radiator rear tank. Thermostat and housing should be installed simultaneously. Install housing on tank and connect inlet hoses to housing. Hoses should be painted with white lead to eliminate possibility of water leakage.

c. Install drain plugs on front of cylinder blocks and fill cooling system with water or antifreeze solution in winter. Install fan and adjust fan belt as explained in Paragraph 66.

84. RADIATOR REPLACEMENT.

a. Remove engine compartment roof mounting screws and remove cover, using special sling, Tool No. B-226796, (See Fig. 40).

b. Drain cooling system as explained above.

c. Remove four transfer unit oil cooler mounting bolts and brackets while supporting cooler, and lower transfer cooler until it rests on engine.

d. Disconnect all hoses at radiator.

e. Remove four cap screws holding radiator rear tank to mounting angle plate and front tank to mounting bracket, and remove radiator assembly from top of engine compartment with special radiator sling, Tool No. B-226799, (Fig. 47).

f. Install radiator assembly as follows: Using special radiator sling, Tool No. B-226799, position radiator assembly on radiator mounting angle plates and brackets in engine compartment with radiator filler neck pointing toward upper rear of vehicle. Install loosely the four cap screws holding radiator rear tank to mounting angle plate and front tank to mounting bracket. Paint ends of hoses with white lead to eliminate water leakage at hoses on radiator, and connect hoses.

g. Tighten four cap screws holding radiator to mounting bracket and mounting plate. Raise transfer unit oil cooler into

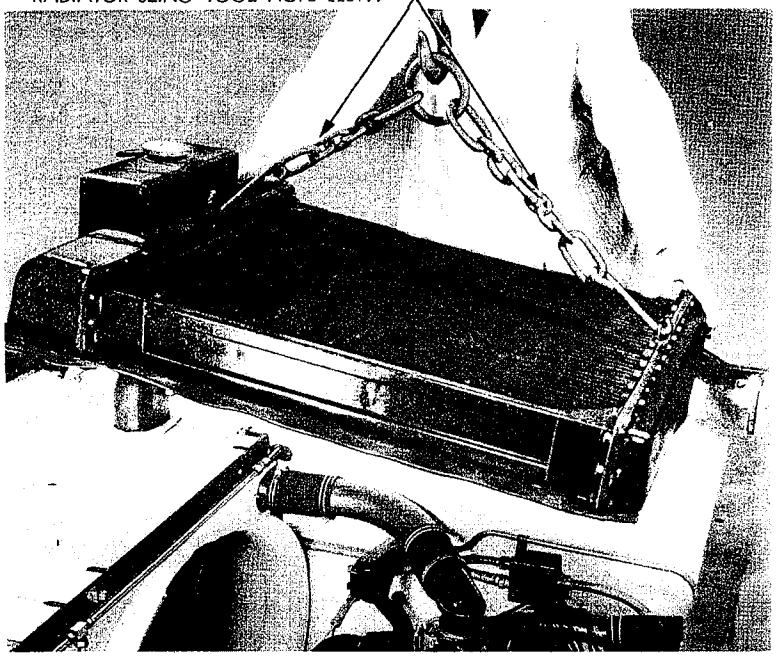


Figure 47—Radiator Removal

position and install mounting brackets and mounting bolts securely (Fig. 48).

h. Install drain plugs and fill cooling system with proper liquid (water in summer, or antifreeze solution in winter).

i. Using special engine compartment cover sling, Tool No. B-226796, lift engine compartment rear cover into place and install mounting screws securely.

85. WATER PUMP REPLACEMENT.

a. Remove fan belt and fan, as explained in Paragraph 82, and drain cooling system. Loosen generator mounting screws and remove water pump and generator belt. Disconnect water pump by-pass hose at left cylinder head outlet elbow and water pump inlet hose, and Hydra-Matic oil cooler pipe at water pump intake (Fig. 46). Remove five water pump mounting screws and water pump assembly.

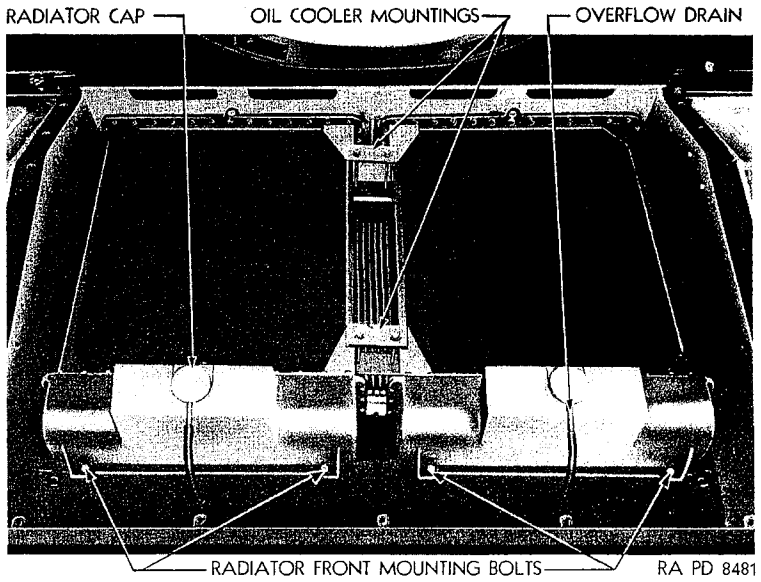


Figure 48—Radiator & Oil Cooler Mounting

NOTE. This operation can be performed more easily by first removing the fan shrouds.

b. The water pump should be installed as follows: Position a new water pump gasket on water pump body and smear liberally with gasket paste. Install water pump and tighten five mounting screws and lock washers securely, using care to tighten water pump body evenly all around flange.

(1) Paint water pump hoses with white lead to prevent leakage, and connect hoses and oil cooler pipe. Install generator and water pump belt, and adjust as explained in Paragraph 66. Install fan and install and adjust fan belt.

(2) Close drain valves at bottom of engine block on each side, and refill cooling system with water, or antifreeze as required.

Section XVII

HYDRA-MATIC TRANSMISSION

86. GENERAL DESCRIPTION.

a. The Hydra-Matic Drive (Fig. 49) consists of a fluid coupling and an automatic transmission having four forward speeds and one reverse speed. Slippage in the fluid coupling at idling speeds eliminates the need for a clutch. Gear changes are made by hydraulic pressure, and are governed by the speed of the vehicle and the extent to which the driver depresses the accelerator.

b. In this section, the fluid coupling end of the transmission will be referred to as the "front" end, and the propeller shaft end as the "rear" end.

87. BAND ADJUSTMENT.

a. The Hydra-Matic bands require readjustment every 3000 miles or when slippage becomes evident. The test for slippage is given in Paragraph 54e. Adjustment is made in the following manner, working from the fighting compartment:

(1) Remove cover over Hydra-Matic transmissions.

(2) Make certain Hydra-Matic selector lever is in Neutral.

(3) Start engine and set hand throttle so that engine is running at approximately 900 RPM.

(4) Remove rear band adjusting screw lock nut on top of transmission case (Fig. 49).

(5) Tighten rear band adjusting screw, using a torque wrench, to a tightness of 7 foot pounds.

(6) Back off rear band adjusting screw two full turns and install and tighten lock nut securely.

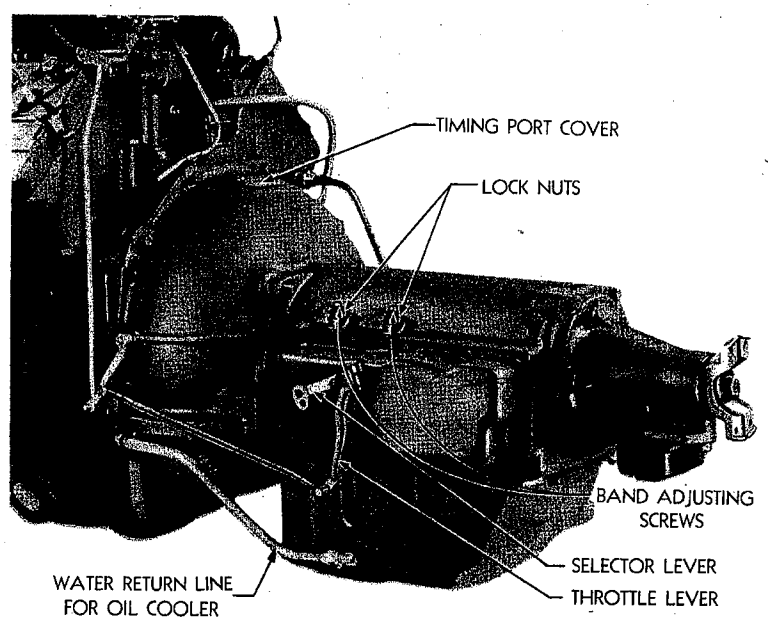


Figure 49—Hydra-Matic Transmission

(7) Stop engine and remove front band adjusting screw lock nut.

(8) Tighten adjusting screw, using a torque wrench with a ¼" square socket, to a tightness of 5 foot pounds.

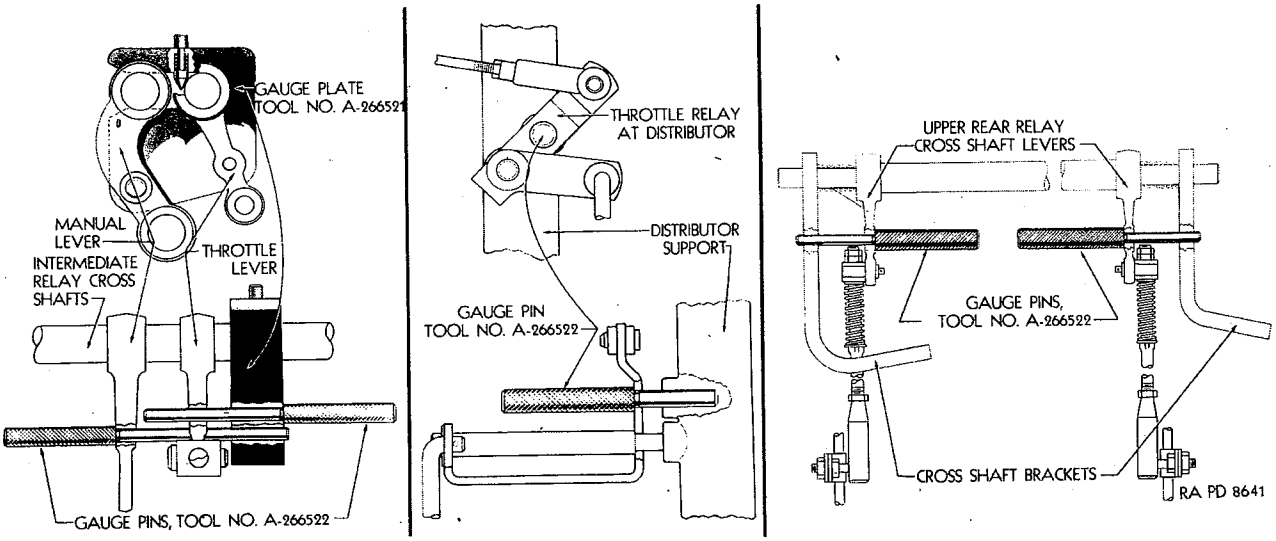
(9) Back off front band adjusting screw eight full turns and install and tighten lock nut securely.

(10) Install cover over Hydra-Matic transmissions.

88. MANUAL CONTROL LINKAGE ADJUSTMENT. (Fig. 50.)

a. Disconnect control rod from selector lever to intermediate relay, at bottom of selector lever, and disconnect rod to transfer unit reverse servo at selector lever. Place selector lever in reverse position.

b. Remove floor pan beneath Hydra-Matic transmissions, and disconnect control rods from intermediate relay to manual levers on transmission side covers. The rod on right-hand transmission (right-hand side of vehicle) should be disconnected at intermediate relay, while rod for left-hand transmission should be disconnected at lever on transmission case.



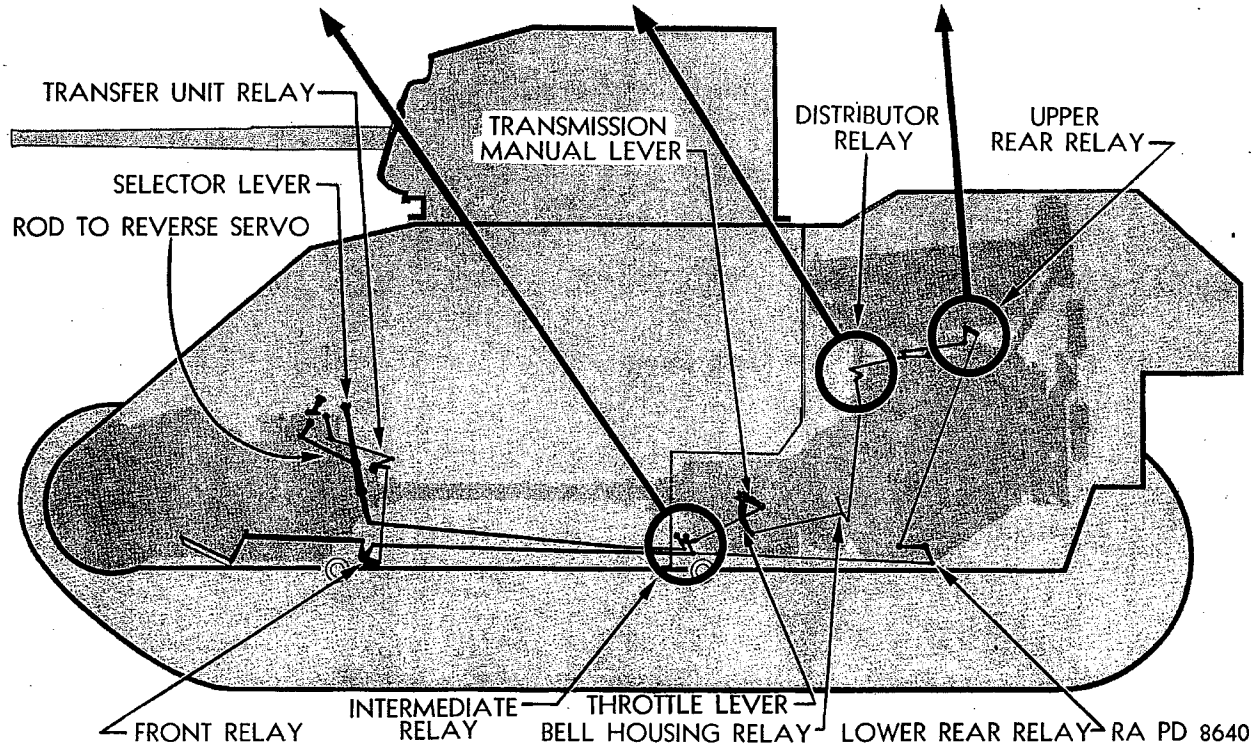


Figure 50—Transmission Control Linkage

c. Install intermediate relay gauge plate, Tool No. A-266521, over intermediate relay cross shafts, and insert two gauge pins, Tool No. A-266522 (long), through intermediate relay manual control levers and into front gauge pin holes on plate.

d. Move manual lever on right-hand transmission into reverse gear position (as far toward front of vehicle as it will go), making sure reverse anchor is engaged. Adjust length of manual rod from intermediate relay to right-hand transmission so that clevis pin will enter intermediate relay manual lever freely. The length of the rod is adjusted by loosening the clevis lock nut and turning clevis in or out. Reconnect rod to intermediate relay lever and tighten clevis lock nut.

e. Move manual lever on left-hand transmission into the reverse position (as far toward front of vehicle as it will go) and adjust length of rod from intermediate relay to manual shift lever, so that clevis pin will enter manual lever. This rod is adjusted in the same manner as the one on the right-hand transmission.

f. Leaving gauge plate and pin in place on intermediate relay, move transmission selector lever to reverse position and adjust length of manual control rod from selector lever to intermediate relay, so that clevis pin will enter lower end of selector lever. The length of this rod is adjusted by rotating clevis on rod. Connect rod to selector lever and tighten clevis lock nut.

g. Move selector lever past reverse position (toward rear of vehicle) as far as it will go and, while holding in that position, adjust length of rod to reverse servo so that, when clevis is inserted, the stop on the reverse servo release lever just contacts stop on servo body.

h. Remove the gauge plate and pins from the intermediate relay and install floor pan beneath Hydra-Matic transmissions.

89. THROTTLE LINKAGE ADJUSTMENT. (Fig. 50.)

a. The following throttle linkage adjustments must be made after replacement of an engine and Hydra-Matic transmission:

(1) Remove floor pan beneath Hydra-Matic transmissions. Disconnect throttle rod from throttle lever on transmission side cover to relay on bell housing, at throttle lever.

(2) Disconnect throttle rod from distributor relay to carburetor throttle bracket, at distributor relay, working through bulkhead door.

(3) Disconnect throttle rod from upper rear relay cross shaft lever to throttle rod (distributor to carburetor), at relay end.

(4) Insert throttle linkage gauge pin, Tool No. A-266522 (short), through hole in distributor relay lever and into pin hole in distributor support housing.

(5) Insert upper rear relay gauge pins, Tool No. A-266522 (long), through upper rear relay cross shaft support brackets and cross shaft relay levers.

(6) Check to see that carburetor throttle stop screw is against stop on carburetor body and in **slow idle position.**

(7) Working from underneath vehicle, pull throttle valve lever on transmission side cover toward front of vehicle as far as possible. Check to see whether trunnion on throttle rod from bell housing relay to lever will enter throttle valve lever freely. Adjust trunnion by rotating it on threaded rod until it will enter throttle lever. Connect throttle rod to lever.

(8) Working through bulkhead doors, adjust length of throttle rod from distributor relay lever to carburetor lever so that clevis will just enter distributor relay lever.

(9) Loosen adjusting nuts on throttle rod trunnion and insert trunnion in upper rear relay cross shaft lever. Tighten adjusting nuts.

(10) Remove throttle valve distributor relay lever gauge pin from distributor support housing and relay lever. Remove gauge pin from upper rear relay supports and levers. Install floor pan underneath Hydra-Matic transmissions.

b. The following throttle linkage adjustments must also be made after replacement of the transfer unit and controlled differential:

(1) Disconnect rod between center lever on upper rear relay cross shaft and lower rear relay lever at upper lever.

(2) Remove cover plate for right engine oil drain plug and, working through this opening, install a gauge pin, Tool No. A-266522 (long), through hole in lower relay lever and mounting bracket.

(3) Adjust length of rod by rotating clevis until clevis pin can be inserted at upper rear relay lever, and reconnect to lever.

(4) Disconnect rod between lower rear relay and intermediate relay at rear relay end.

(5) Install intermediate relay gauge plate, Tool No. A-266521, between throttle and manual levers on left ends of intermediate relay cross shafts, and install one gauge pin, Tool No. A-266522 (long), through throttle lever and gauge plate.

(6) Adjust length of rod by rotating clevis until clevis pin can be inserted in lower rear relay lever, and reconnect to lever.

(7) Disconnect throttle rod between front relay and intermediate relay at front relay and install front relay gauge, Tool No. A-266520 on front relay left lever and mounting bracket.

(8) Adjust length of throttle rod by rotating clevis until clevis pin can be inserted in lever, and reconnect to lever.

(9) Measure vertical distance from tip of accelerator pedal to floor of hull. If it varies more than $\frac{1}{16}$" from 6", disconnect pedal rod from relay end and adjust length of rod by rotating clevis until this dimension is secured. Reconnect rod.

(10) Measure length of transfer unit throttle rod between throttle valve lever and relay on transfer unit case. If it varies more than $\frac{1}{16}$" from 9", adjust length of rod by repositioning trunnion nuts until this dimension is secured.

(11) Disconnect throttle rod between transfer unit relay and front relay on floor of hull, at transfer unit relay, and adjust length of rod by rotating clevis until clevis pin will just

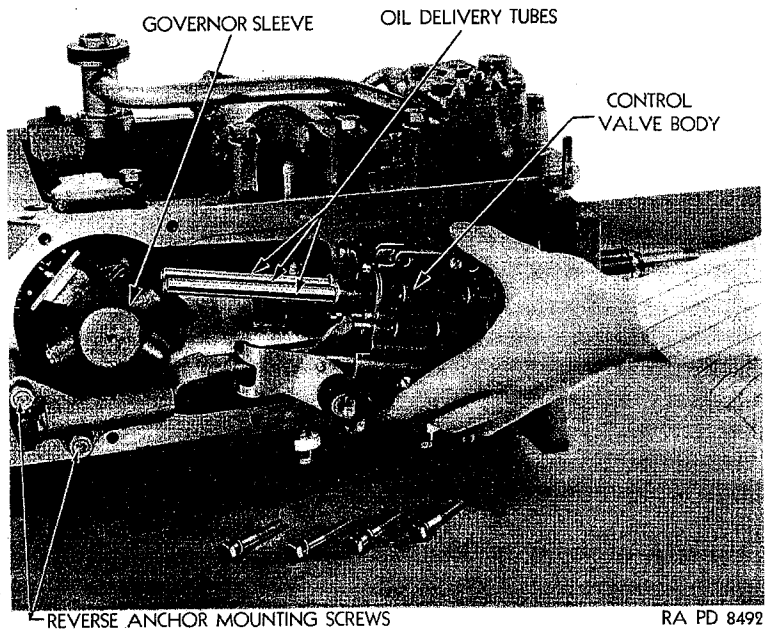


Figure 51—Transmission Control Valve Body Removal

enter lever when lever is held as far down as possible. Reconnect rod to lever.

(12) Remove all gauges and gauge pins from front relay, intermediate relay, lower rear relay and upper rear relay, and install hull cover plates.

90. CONTROL VALVE BODY REPLACEMENT.

Continued failure of a Hydra-Matic transmission to shift in the proper speed ranges is usually due to a clogged or dirty control valve body, which can be replaced with the transmission in the vehicle as follows:

a. Remove control valve body as follows:

(1) Remove floor pan underneath Hydra-Matic transmissions.

(2) Drain Hydra-Matic transmission oil pan as explained in Paragraph 30.

(3) Disconnect manual control rod from manual control lever and throttle valve rod from throttle valve lever.

NOTE. Do not disturb position of adjustable clevises.

(4) Loosen manual control and throttle valve lever clamping screws and remove levers.

(5) Remove transmission case side cover and gasket.

(6) Remove control valve body mounting screws and remove control body and governor oil delivery pipes by sliding control body forward along side of transmission case. (See Fig. 51.)

(7) Remove governor oil delivery pipes from control valve body, by simply sliding them out.

b. Install control valve body as follows:

(1) Insert governor oil delivery pipes in back end of control valve body. These pipes are interchangeable and either end may be inserted in control valve body.

(2) Position governor housing so that holes for oil delivery pipes point forward along case.

(3) Slide valve body backward along transmission case and insert free ends of oil delivery pipes in governor housing.

(4) Position reverse lever on control valve body so that it will engage freely with the reverse crank.

(5) While supporting control valve body, install mounting screws, tightening evenly to avoid strain on valve body.

(6) Install a new felt oil seal on valve body manual and throttle control lever shaft.

(7) Install a new side cover gasket and install side cover. The seven mounting screw copper washers must be installed on seven lower screws.

(8) Install manual control and throttle control levers and tighten clamping screws securely.

(9) Connect throttle and manual control rods to their respective levers.

(10) Adjust manual control and throttle control linkage as explained in Paragraphs 88 and 89 respectively.

(11) Fill Hydra-Matic transmissions with oil as explained in Paragraph 30.

(12) Install floor pan underneath transmissions.

91. REVERSE ANCHOR REPLACEMENT.

a. Remove reverse anchor as follows:

(1) Remove floor pan, throttle and manual levers and side cover as explained in Paragraph 90.

(2) Remove reverse anchor bracket mounting screws using $\frac{9}{16}$" wrench and remove reverse anchor bracket. (Fig. 51.)

(3) Remove reverse anchor pawl and retracting spring.

b. To install the reverse anchor, proceed as follows:

(1) Position reverse anchor pawl retracting spring on pawl bracket with last spring coil toward anchor, and insert pawl and spring in side of transmission case.

(2) Position reverse anchor crank roller in slot in pawl and install anchor bracket assembly and tighten securely.

(3) Install side cover and throttle and manual levers and floor pan as explained in Paragraph 90. Adjust manual and throttle linkages as explained in Paragraphs 88 and 89.

92. HYDRA-MATIC TRANSMISSION REPLACEMENT.

a. Remove transmission as follows:

(1) Remove engine and Hydra-Matic transmission assembly as explained in Paragraph 73.

(2) Drain Hydra-Matic fluid as explained in Paragraph 30.

(3) Remove cap screws holding starter to flywheel bell housing and remove starter.

(4) Remove both oil cooler pipes from engine and transmission.

(5) Disconnect throttle valve rods from flywheel bell housing relay to throttle valve lever and distributor relay lever at both ends and remove rods.

(6) Install transmission hoist "eye," Tool No. A-266327, on top of transmission case.

(7) Connect a hoist and adjust so that it is just beginning to take weight of transmission.

(8) Remove spark plugs so that crankshaft can be turned easily.

(9) Remove flywheel cover-to-flywheel mounting screws and lock washers, rotating flywheel to remove all 30 screws.

(10) Remove mounting bolts holding flywheel bell housing to crankcase.

(11) Slide Hydra-Matic transmission away from engine until bell housing clears end of dowel pins on crankcase.

(12) Remove transmission.

b. To install transmission to engine, proceed as follows:

(1) Place a new flywheel cover gasket on face of flywheel and cement it in place with rubber cement.

NOTE: It is extremely important that gasket be in perfect condition and free from creases; that the flywheel be free of burrs, and that a good seal be made to prevent any possible leaks at this point.

(2) Install hoist "eye," Tool No. A-266327, on top of transmission case and connect to a hoist. Lift Hydra-Matic transmission into position behind engine.

(3) Push transmission forward so that dowels in rear end of crank case are inserted in bell housing.

(4) Install cap screws holding bell housing to crankcase, using a torque wrench, and tightening to 45-50 foot pounds. Tighten lower bolts first, upper bolts last.

(5) Insert a punch through a screw hole in flywheel cover to line up cover holes properly with flywheel holes and dowel pins.

(6) Install all screws holding flywheel cover to flywheel, loosely.

(7) Tighten screws holding flywheel cover to flywheel to 20-25 foot pounds, using a torque wrench.

(8) Install spark plugs.

(9) Install flywheel housing pan.

(10) Remove hoist and "eye" on top of case.

(11) Install both oil cooler pipes.

(12) Install starter on flywheel bell housing.

(13) Connect throttle rod from throttle lever to bell housing relay.

(14) Install engine in vehicle as explained in Paragraph 73.

93. OIL COOLER REPLACEMENT.

a. Remove oil cooler as follows:

(1) Drain cooling system. See Fig. 20 for location of drain plugs.

(2) Remove floor pan underneath Hydra-Matic transmissions.

(3) Drain oil from Hydra-Matic transmissions as explained in Paragraph 30, and drain water from oil cooler in oil pan at drain plug. (Fig. 20.)

(4) Remove water inlet and outlet connections to oil cooler on oil pan and remove oil pan, using special wrench, Tool No. B-226783, on center screw at front of oil pan.

(5) Remove oil pan front cover and metal cover oil intake screen.

(6) Remove bolt holding oil screen to oil pan.

(7) Remove oil cooler unit mounting nuts, using special wrench, Tool No. A-266336, and oil seal packing in oil pan and pull cooler unit from front end of oil pan. (Fig. 52.)

b. To install oil cooler, proceed as follows:

(1) Position water seal packing washers on oil cooler unit and insert cooler into oil pan from front.

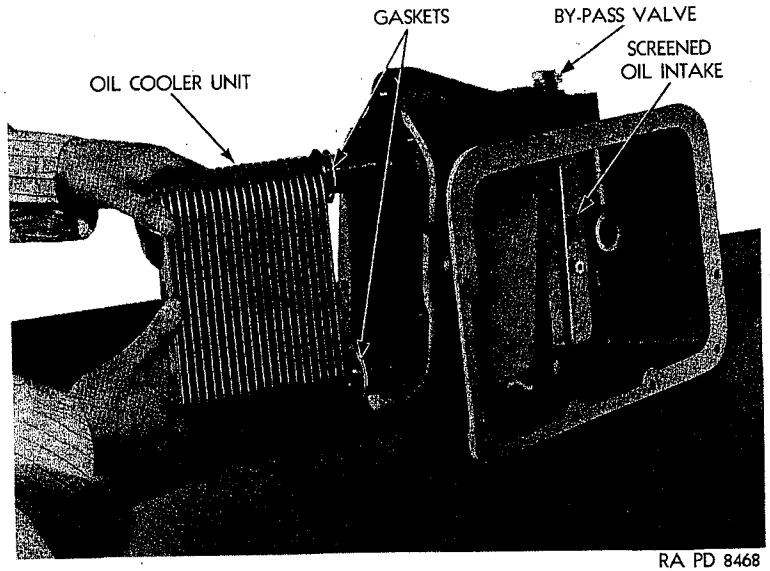


Figure 52—Transmission Oil Cooler Removal

(2) Install oil seal packings on oil cooler pipes and install mounting nuts, using special wrench, Tool No. A-266336.

(3) Install a new oil pan front gasket and install oil pan front cover.

(4) Install oil screen and cover in oil pan on end of oil cooler pipe.

(5) Install oil pan, using special wrench, No. B-226783, on front center screw. Copper washers must be used on all mounting screws.

(6) Connect oil cooler inlet and outlet pipes to oil pan.

(7) Fill Hydra-Matic transmission with Hydra-Matic fluid as explained in Paragraph 30, and fill cooling system with water or an antifreeze solution.

(8) Install floor pan underneath Hydra-Matic transmissions.

Section XVIII

PROPELLER SHAFTS

94. PROPELLER SHAFTS.

a. The propeller shaft on each engine transmits power from its Hydra-Matic transmission to the Transfer Unit which is located in the forward end of the fighting compartment. Each propeller shaft is fitted with a universal joint (Fig. 53), at each end to permit operating at an angle with the Hydra-Matic transmission and the Transfer Unit. A housing on the floor of the fighting compartment encloses each propeller shaft.

95. PROPELLER SHAFT REPLACEMENT.

a. Propeller shafts can be removed as follows:

(1) Remove propeller shaft housing cover after first removing the cap screws.

(2) Straighten out lock plates for the four cap screws that hold the universal joint bearing caps to the yokes on each end of the propeller shaft and remove the cap screws.

(3) Remove shaft after telescoping slip joint.

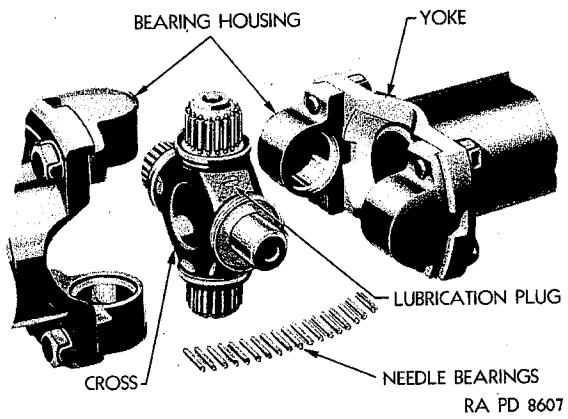


Figure 53—Universal Joint, Disassembled

b. Propeller shafts may be installed as follows:

(1) Position shaft between transmission and the transfer unit, and slide the slip joint outward until the yokes on the propeller shaft line up with the bearing housings on both universal joints.

(2) Install the mounting screw lock plates and the four cap screws holding the universal joint bearing housings to the propeller shaft yokes on each end of the propeller shaft.

(3) Bend the lock plates up around the edge of all mounting cap screws.

(4) Install the propeller shaft housing cover and tighten the mounting screws securely.

96. UNIVERSAL JOINTS.

a. The universal joints can be disassembled as follows:

(1) Remove propeller shaft housing covers.

(2) Straighten out lock plates for the eight cap screws that hold the yokes to the bearing housings and remove the cap screws.

(3) Shorten shaft on sliding joint and remove the joint.

(4) Pull bearing housings from the cross and take out all needle bearings.

(5) Wash all parts in cleaning solvent and dry with compressed air.

b. The universal joints can be assembled as follows:

(1) Pack the universal joint cross with wheel bearing lubricant (CG No. 2).

(2) Position the needle bearings on the cross. The bearings may be held in place with a liberal application of wheel bearing grease.

(3) Install the bearing housings over the bearings using new oil seals and felt washers.

(4) Install the universal joint bearing housings on the transmission and transfer unit yokes, and install the lock plates and mounting cap screws securely.

(5) Install the propeller shaft as explained in Paragraph 95.

Section XIX

TRANSFER UNIT & CONTROLLED DIFFERENTIAL

97. TRANSFER UNIT.

The transfer unit, located at the front of the vehicle just behind the differential housing, combines the power output of the two engines. It also provides a two-speed, hydraulic-controlled gear reduction which, combined with the Hydra-Matic transmissions, provides a total of six forward speeds and one reverse speed.

98. CONTROLLED DIFFERENTIAL.

The "controlled" differential, located at the front of the vehicle, not only transmits the engine power to the final drive units, but in addition contains the brake drums and bands that permit steering and stopping the vehicle.

99. LUBRICATION.

Both the transfer unit and the controlled differential are lubricated from one sump, to which lubricant is added by means of a filler cap on the transfer unit housing. The oil is circulated by pumps in the transfer unit, and is piped back through a cooler mounted between the radiators in the engine compartment. Detailed lubrication instructions are given in Section VI, Paragraph 32.

100. STEERING AND BRAKE BAND ADJUSTMENT.

a. Adjustments of this mechanism should be made according to the following procedure:

(1) Remove plug from brake drum housing cover on each side (Fig. 54).

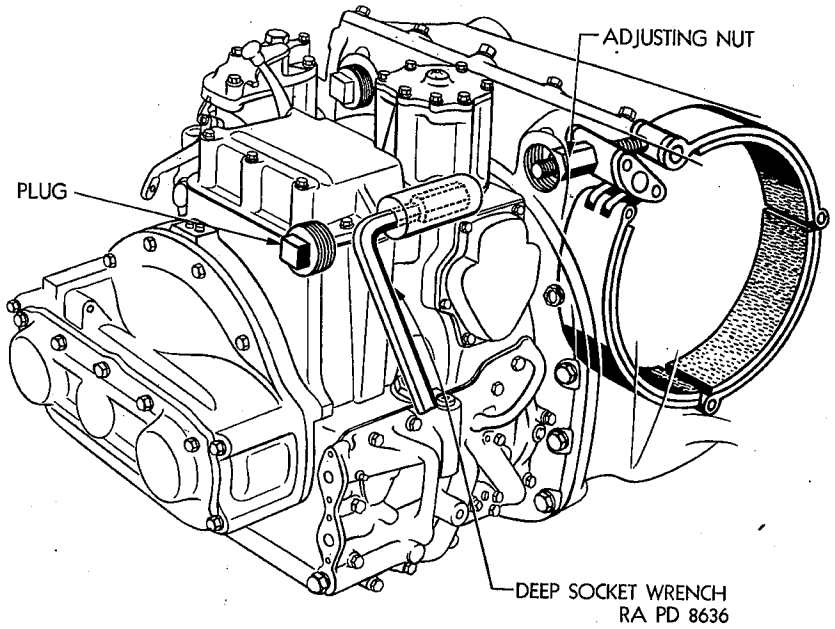


Figure 54—Steering and Brake Band Adjustment

(2) Insert $1\frac{1}{16}$" diameter deep socket wrench through plug hole and engage adjusting nut.

(3) Turn adjusting nut ½ revolution clockwise to tighten brake band.

NOTE. The brake adjusting nut has a cylindrical surface on the pressure side instead of the usual flat face. It is important that this adjustment be made by half-turns only so that this cylindrical surface will always be seated firmly against the cross pin when adjustment is completed.

(4) Check adjustment by pulling back on steering lever which is connected to brake band being adjusted. The adjustment is correct when two conditions prevail; first, the brake band must be free when lever is in full forward position; second, the band should be tight after pulling steering lever back toward driver not more than eight notches on the parking brake ratchet.

(5) Repeat this procedure until correct adjustment is obtained, first on one band, then on the other.

(6) If the results achieved through this adjustment are

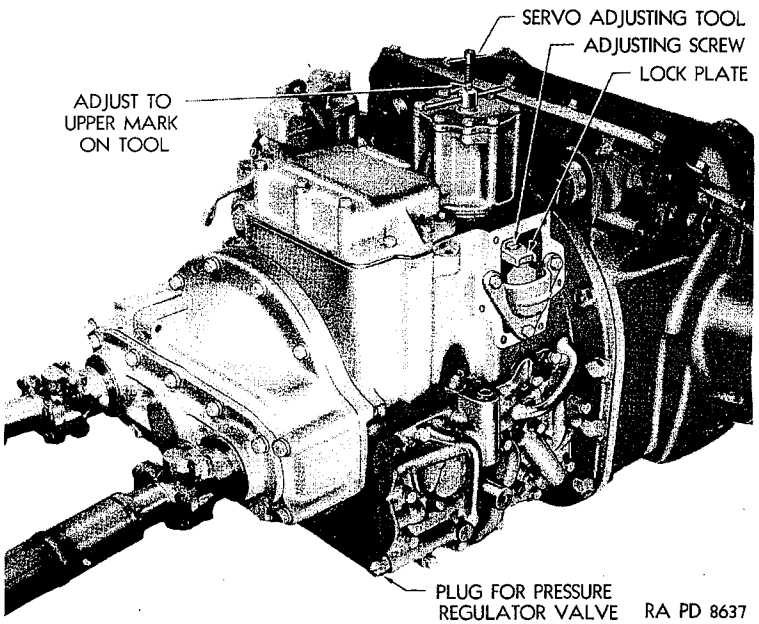


Figure 55—Transfer Unit Low Gear Band Adjustment

not satisfactory, Ordnance personnel should be notified, as other parts of the steering system may be involved.

101. LOW GEAR BAND ADJUSTMENT.

a. The low gear band should be readjusted every 3000 miles, as follows:

(1) Remove cover on right side of transfer case.

(2) Swing back lock plate that holds adjusting screw, and back off adjusting screw two or three complete turns.

(3) Remove plug from top of low speed servo cover (Fig. 55), and screw in servo adjuster, Tool No. B-226839, until it bottoms in tapped hole in upper end of piston shaft.

(4) Adjust T-handle pressure nut on tool to bring "Lo" notch (**upper** notch) on screw flush with top of pressure nut.

(5) If band is properly adjusted, there will be .002" to .005" clearance between pressure nut and servo cover, as measured with a feeler gauge.

(6) If pressure nut is tight against cover, band is too loose. Turn pressure nut down on screw until servo spring pressure is released, freeing band. Then loosen band adjusting screw

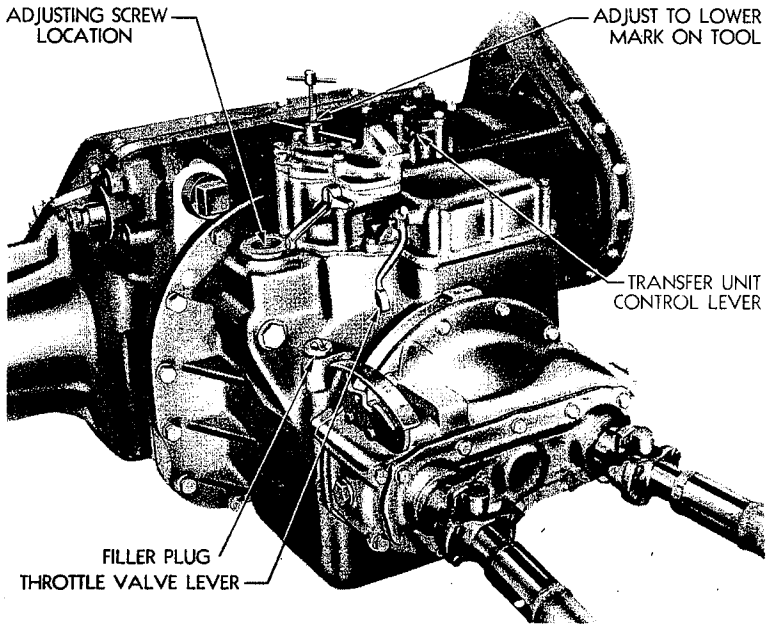


Figure 56—Transfer Unit Reverse Band Adjustment

one-half turn, reposition pressure nut at "Lo" notch and recheck clearance with servo cover. Repeat until correct adjustment is obtained.

NOTE. End of band adjusting screw bears against a concave surface so that it can be turned only in one-half turns.

(7) Remove tool from servo and install plug.

(8) Install cover on side of transfer case, using a new gasket.

102. REVERSE BAND ADJUSTMENT.

a. The reverse band should be adjusted every 3000 miles, as follows:

(1) Shift Hydra-Matic selector lever to "Reverse" position, and leave there until all adjustments are completed.

(2) Remove plug over adjusting screw (See Fig. 56).

(3) Lift up lock plate that holds adjusting screw and back off adjusting screw two or three complete turns.

(4) Remove acorn plug from reverse servo cover and screw in servo adjuster, Tool No. B-226839, until it bottoms in tapped hole in upper end of piston shaft.

(5) Adjust T-handle pressure nut on tool to bring "Reverse" notch (lower notch) on screw flush with top of pressure nut.

(6) If band is properly adjusted, there will be .002" to .005" clearance between pressure nut and servo cover, as measured with a feeler gauge.

(7) If pressure nut is tight against cover, band is too loose. Turn pressure nut down on screw until servo spring pressure is released, freeing band. Then loosen band adjusting screw one-half turn, reposition pressure nut at "Reverse" notch and recheck clearance with servo cover. Repeat until correct adjustment is obtained.

NOTE. End of band adjusting screw bears against a concave surface so that it can be turned only in one-half turns.

(8) Install plug over adjusting screw, using a new gasket.

(9) Remove tool from servo and install plug, using a new gasket.

103. CONTROL VALVE ASSEMBLY REPLACEMENT.

(1) Remove clevis pin from throttle valve lever and rod.

(2) Remove cap screws holding cover on top of transfer case (Fig. 56).

NOTE. It is not necessary to remove cap screw at base of selector lever. This screw is only used to hold tension spring in position and does not hold cover to transfer case.

(3) Remove cover and control lever assembly.

(4) Remove five cap screws holding control valve to base.

(5) Remove control valve.

(6) Replace in reverse order, taking special care to see that the button on the inner selector lever engages in the slot in the valve. To make sure that button is properly engaged, remove the sight plug at the top of the case and see that the button is in proper position.

104. PRESSURE REGULATOR VALVE REPLACEMENT.

(1) The pressure regulator valve is located slightly below normal oil level, therefore, before attempting to replace valve, a receptacle should be placed to catch the oil that drains out.

(2) Unscrew plug located in lower corner of pump and governor housing (Fig. 55).

CAUTION. This operation releases the pressure of a powerful spring. Exercise care to release this plug gradually.

(3) Remove spring.

(4) If valve is not forced out by oil pressure, reach into opening with a piece of bent wire and pull out valve.

(5) Install valve by reversing these operations.

105. TRANSFER UNIT CONTROL LEVER REPLACEMENT.

a. The transfer unit control lever is mounted on top of the transfer unit on the left side near the driver (Fig. 56). In the event of damage, the lever may be removed as follows:

(1) Remove pin from throttle valve lever and rod.

(2) Remove screws holding cover in place.

NOTE. It is not necessary to remove cap screw at base of selector lever. This screw is only used to hold tension spring in position and does not hold cover to the transfer case.

(3) Remove cover and transfer unit control lever assembly.

(4) Drive out pin holding lever to inner shaft.

(5) Remove outside control lever.

(6) Remove inner arm and shaft assembly from cover.

b. To install control lever, proceed as follows:

(1) Insert inner arm and shaft assembly in the cover.

(2) Install outer control lever and press assembly together, compressing spring washer until holes in outer lever and inner shaft line up.

(3) Insert pin in hole and drive into position.

(4) Install cover, making sure that button on inner selector lever engages in slot in valve. To make sure that button is properly engaged, remove the sight plug at the top of the case and see if the button is in proper position.

(5) Install screws holding cover to case.

(6) Install pin for throttle lever and rod.

(7) When installation is completed, the manual lever should operate freely. Any tendency to bind should be checked and corrected.

106. TRANSFER UNIT AND CONTROLLED DIFFERENTIAL REPLACEMENT.

a. Removal from Vehicle.

(1) Break tracks, and remove tracks and sprockets (See Paragraphs 113 and 109).

(2) Drain lubricant from transfer unit and controlled differential at the three points shown in the Lubrication Chart (Fig. 17).

(3) Remove lower front deck plate.

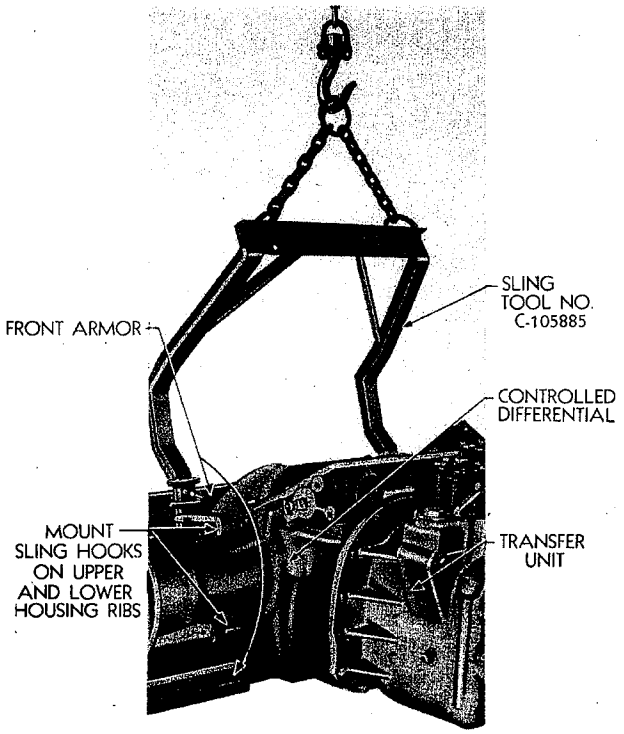


Figure 57—Transfer Unit and Controlled Differential Removal

(4) Disconnect electrical connections and cables from instrument panel and stop light switches, marking them to make correct reinstallation easy, and pull cables out from under differential housing.

(5) Remove stop light switches from top of housing.

(6) Remove siren switch from floor of hull.

(7) Disconnect brake rods and springs at top of differential housing.

(8) Disconnect shifting control rod from selector lever.

(9) Remove housing covers over propeller shafts.

(10) Disconnect universal joints at transfer unit.

(11) Disconnect throttle valve rod at rear of transfer unit.

(12) Disconnect oil cooler pipes at right side of transfer unit.

(13) Place sling, Tool No. C-105885, in position, as shown in Fig. 57.

(14) Remove cap screws holding housing to front armor plate and to hull on each side.

(15) Lift complete assembly up and forward and remove from hull.

NOTE. Remove differential housing to hull shims as assembly clears hull. Keep left-hand shims separate from right-hand shims so that they may be installed on the same side as removed.

b. Installation in Vehicle.

(1) Lift unit with hoist and lower through opening in front of hull until cap screw holes line up.

CAUTION. Be very careful not to let unit swing and damage accelerator rods or other adjacent parts.

(2) Install differential housing to hull shims, making sure they are installed on the same side as removed.

(3) Install and tighten securely the cap screws that hold the unit and the front armor plate to both sides of the hull and floor, and remove hoist.

(4) Connect oil cooler pipes at right side of transfer unit.

(5) Connect throttle valve rod at rear of transfer unit.

(6) Connect universal joints and reinstall universal joint covers.

(7) Connect shifting control rod to selector lever.

(8) Adjust control linkage mechanism as explained in Paragraph 88.

(9) Connect brake rods and springs and adjust brake bands as explained in Paragraph 100.

(10) Install siren switch on floor of hull and stop light switches on top of housing.

(11) Connect electrical wiring and cables to switches and to instrument panel.

(12) Install lower front deck plate.

(13) Install final drive housings, track sprockets and track.

(14) Fill final drive housings with lubricant, as specified in lubrication schedule.

(15) Fill transfer unit with lubricant, as specified in lubrication schedule.

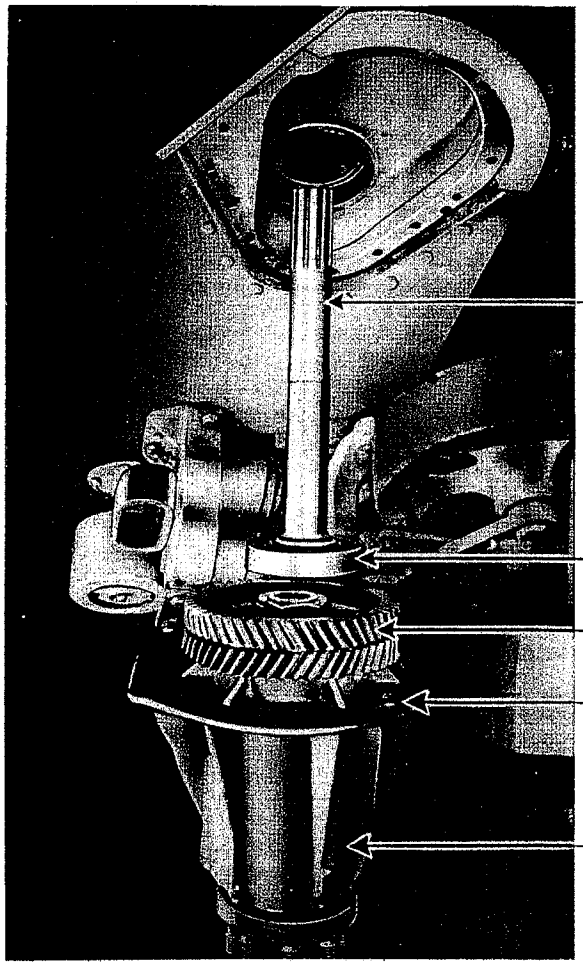


Figure 58—Final Drive

Section XX

FINAL DRIVE

107. GENERAL DESCRIPTION.

a. The final drive units, one on each side, transmit power from the drive gears of the controlled differential to the sprockets which propel the track.

b. The construction is shown in Fig. 58. The position of each final drive housing is set in relation to the hull by means of two dowels, and the housing is bolted both to the hull and to the differential case.

c. The ball and roller bearings for the driveshaft and the sprocket shaft are in the final drive housing. Each splined driveshaft fits into, and is driven by, one of the differential main drive gears. At the outer end of the driveshaft is the small diameter gear which meshes with the larger gear on the sprocket shaft to provide the reduction drive of 2.4 to 1.

d. The track driving sprocket hub is mounted on the outer end of this sprocket shaft, and the sprocket is bolted to the hub.

108. LUBRICATION.

Lubrication of the final drive units is covered in Paragraph 33 of the Lubrication Section.

109. REMOVAL OF FINAL DRIVE.

(1) Break track under drive sprocket as explained in Paragraph 113.

(2) Drain oil from controlled differential and transfer unit through the three drain plugs reached from under vehicle, through covered openings in hull floor.

(3) Drain oil from final drive housing through lower plug.

(4) Remove the eight bolts holding drive sprocket to hub, and remove sprocket from hub.

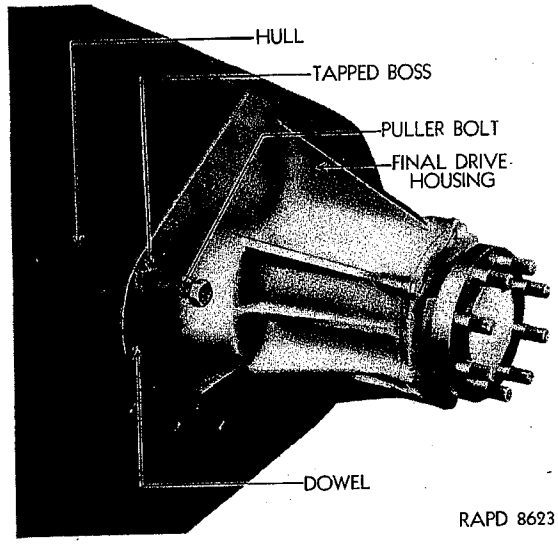


Figure 59—Final Drive Removal

(5) Remove the 17 bolts that hold final drive housing to hull and to controlled differential case.

(6) Remove final drive assembly with one of two types of tools:

(a) Adapter, B-154313, and hammer slide, C-66645, can be applied to assembly and weight of hammer slide swung outward until assembly is free.

(b) A hex head ⅝-11 screw, (used to hold final drive housing to hull), can be inserted into hole in boss at rear of final drive housing, as shown in Fig. 59, and turned down against hull until assembly is free.

110. INSTALLATION OF FINAL DRIVE.

(1) Slide final drive assembly into controlled differential housing, lining up on the two dowels to secure proper alignment. Use new gasket between final drive housing and differential case.

(2) Replace screws and washers holding final drive housing to hull and controlled differential housing.

(3) Install sprocket onto final drive hub, and install mounting stud nuts on flange and hub assembly.

(4) Connect and adjust track as explained in Paragraph 112.

(5) Replace drain plugs in transfer unit and controlled differential and refill with 32 quarts of oil, as explained in Paragraph 32.

(6) Replace lower plug in final drive housing and add SAE-50 engine oil to level of upper plug. Replace upper plug.

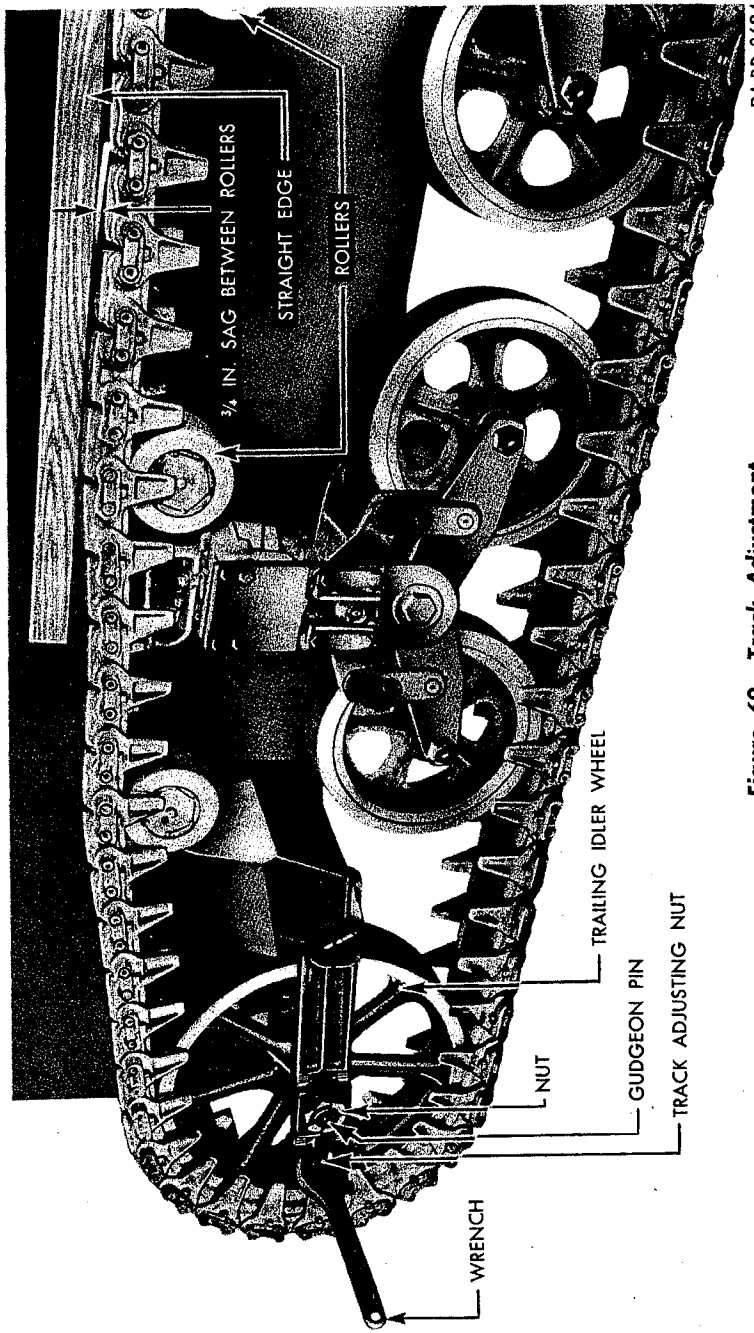


Figure 60—Track Adjustment

Section XXI

TRACKS AND SUSPENSION

111. GENERAL DESCRIPTION.

a. Two individually driven tracks propel the vehicle forward or backward. Each track is composed of 67 separate rubber track shoes which are reversible to provide additional service.

b. Two-wheeled, rubber-tired bogies or suspensions (four in all) are mounted on the protruding ends of the front and rear bogie axles. These bogies support the vehicle on volute springs and convey it on the endless tracks. Two drive sprockets at the front of the vehicle pull the tracks from the rear and lay them down in the path of the advancing bogie wheels.

c. An adjustable trailing idler wheel for each track is mounted at the rear of the hull. A spring compressed by the idler arm maintains constant, correct tension of the tracks. Slack in the track when passing over obstacles is provided by compression of the volute springs in the bogies and idler arms, and articulation of the bogie links.

d. Three rollers mounted on each side of the hull support the upper half of the track as it returns to the drive sprockets.

112. TRACK ADJUSTMENT.

a. The idler wheels should be adjusted so that there is from 5/8" to 3/4" slack in the track midway between the two front track supporting rollers. Before making this check, insert

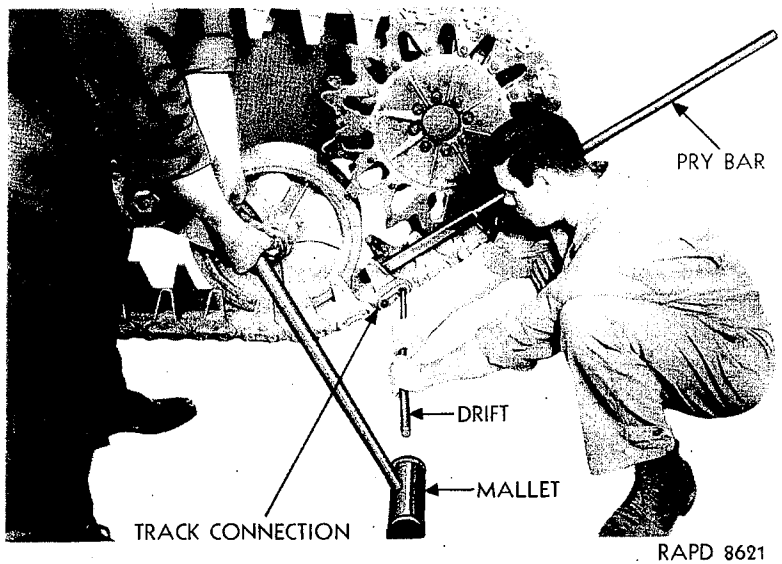


Figure 61—Outside Track Connector Removal

a 4-foot pry bar between the track and the mud guard at the point of measurement and press the track down with at least 175 pounds pressure. Then release the pry bar and allow track to take its normal slack position. The amount of slack should be measured by laying a straightedge on the top track at the rollers and measuring the maximum deflection (See Fig. 60).

b. To adjust the slack, proceed as follows:

(1) Remove cotter pins and loosen nuts that hold serrated ends of idler wheel arms to serrated idler arm guides, using idler wheel nut wrench, Tool No. C-105665 (Fig. 60).

(2) Turn idler arm guide adjusting nuts to draw idler wheels out to point of correct track tension described above, using a $1\frac{1}{16}$" engineer's wrench.

(3) Retighten nuts holding idler arm guides to idler.

NOTE. The idler arm guides on the inner and outer sides of the idler wheel must be in exactly the same position. First, make sure the two guides are in the same serrations on the arms, and then see that the two adjusting nuts are tightened a like amount.

113. TRACK REPLACEMENT.

a. The track can be removed as follows:

(1) Put vehicle on level ground.

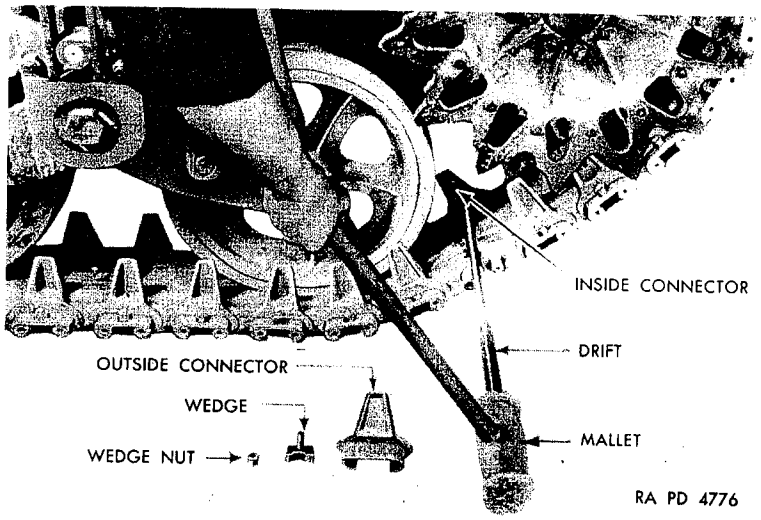


Figure 62—Inside Track Connector Removal

(2) Relieve track tension by loosening nuts at trailing idler wheel, as explained in Paragraph 112.

(3) Remove safety nut and wedge at inside and outside of end connections on track shoe midway between bottom of drive sprocket and ground.

(4) Remove end connections on shoe by prying with a crowbar inserted between track link and end connection, or by driving on end connection with a drift and sledge, if necessary (Figs. 60 and 61).

(5) Lower bottom portion of track to ground.

(6) Lower upper portion of track to ground by pulling it to rear of vehicle over drive sprocket, supporting rollers, and idler wheel.

(7) Move vehicle off track.

b. Install track as follows:

(1) Lay track on ground and push or tow vehicle over it so that front end of track projects out beyond front bogie wheel approximately 16".

(2) Bring other end of track up over idler, supporting rollers and drive sprocket.

(3) Take up slack by revolving drive sprocket forward with a pry bar or by careful application of engine power.

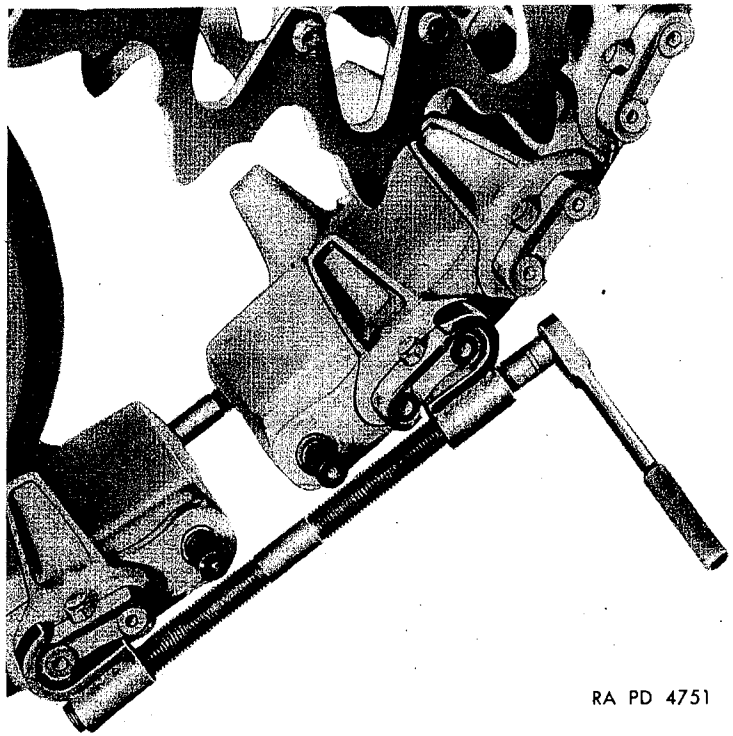


Figure 63—Track Stretcher

(4) Mount track stretcher, Tool No B-226797, on track as shown in Fig. 63.

(5) Bring end shoes together by means of track stretcher and drive end connections on track shoe pins as far as possible.

(6) Install end connection wedges and safety nuts.

(7) Loosen and remove stretcher.

(8) Adjust track tension as explained in Paragraph 112.

114. TRACK REVERSAL.

When the rubber track shoes have worn down considerably, the track should be reversed; that is, the unworn inner side of the track should be installed on the outside where it will contact the ground. The track may be reversed by removing it as explained in Paragraph 113 and separating all track shoes. Then, turn each shoe over, assemble the shoes and install and adjust the track as described in Paragraph 112.

115. IDLER REPLACEMENT.

a. The idler wheel and arm can be removed as follows:

(1) Remove track as explained in Paragraph 113.

NOTE. It is not necessary to pull vehicle off track when replacing the idler wheel assembly.

(2) Remove volute spring plug in end of idler assembly mounting bracket and install special idler volute spring compressor, Tool No. A-195168, through bracket and into spring seat. Tighten locking nut.

(3) Jack up rear end of hull and block securely so that the blocks support hull slightly above the normal position.

(4) Remove idler wheel shaft cotter pins and nuts, using idler wheel shaft nut wrench, Tool No. C-105665. Remove serrated idler arm guides. While supporting idler wheel arm, drive out idler wheel shaft.

(5) Lower idler arm against stops and roll idler wheel backward off tracks.

(6) Loosen idler pivot shaft clamping bolt and remove lubrication fitting in outer end of shaft. Remove pivot shaft locking lug.

(7) Install idler pivot shaft replacer wrench, Tool No. B-193632, and tighten pilot nut around end of shaft. Install ratchet on replacer wrench and turn pivot shaft out of housing while supporting idler arm.

(8) Remove idler arm and loosen volute spring compressor, Tool No. A-195168, until volute spring is free. Remove compressor, spring seat and spring.

b. Install idler assembly as follows:

(1) Position volute spring and spring seat in idler pivot shaft housing and install volute spring compressor, Tool No. A-195168.

(2) Position idler arm in housing and turn pivot shaft through housing into idler arm. Install pivot shaft wrench, Tool No. B-193632, on end of shaft and attach ratchet to wrench. Tighten pivot shaft all the way in place in housing.

(3) Tighten pivot shaft clamping bolt on housing and install lubrication fitting in end of shaft.

(4) Pry rear end of trailing idler arm upward, tightening volute spring compressor lock nut as arm is forced upward.

(5) Roll trailing idler wheel into position on forked trailing idler arm and drive trailing idler wheel shaft through wheel so that shaft protrudes an equal distance each side of the wheel.

(6) Install serrated idler arm guides over end of wheel shaft and install wheel shaft nuts loosely.

(7) Remove volute spring compressor from pivot shaft housing; install plug in housing and lower rear end of vehicle off blocks.

(8) Reconnect track and adjust as explained in Paragraph 112.

116. BOGIE ASSEMBLY REPLACEMENT.

a. Remove bogie as follows:

(1) Remove track as explained in Paragraph 113.

(2) Remove volute spring plugs on top of bogie mounting bracket and install both bogie volute spring compressors, Tool No. A-157251, through mounting bracket and into volute spring seats. Tighten compressor lock nuts to lock springs in compressed position (Fig. 64).

(3) Jack up hull underneath bogie being removed and install support blocks. The hull should be supported enough above its normal position so that bogie is hanging on axle shaft. Remove six bolts holding bogie mounting bracket to side of hull.

(4) Remove axle cap locking screw and remove axle cap using special wrench, Tool No. B-146061.

(5) Pull bogie assembly off end of axle shaft.

b. To install the bogie assembly, proceed as follows:

(1) Lift bogie into position over end of axle shaft with a hoist and push assembly on to axle shaft.

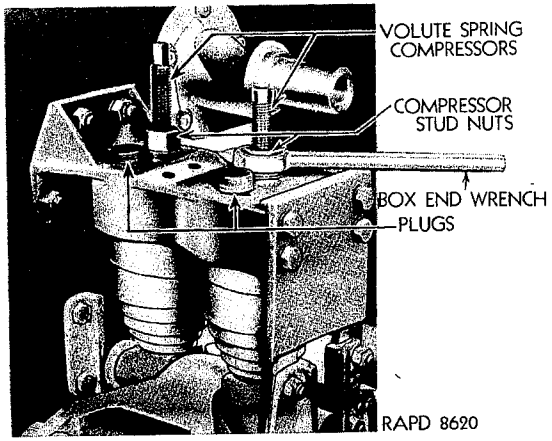


Figure 64—Compressing Volute Springs

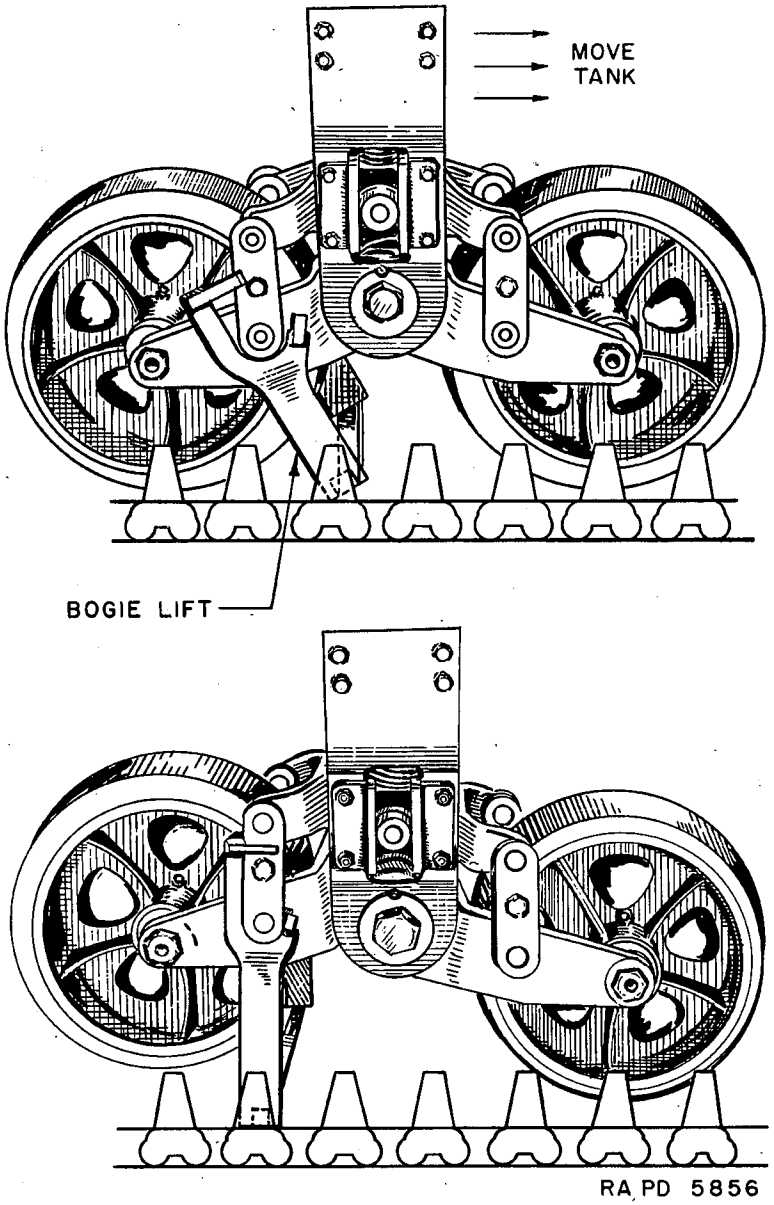


Figure 65—Bogie Wheel Lift

(2) Install axle cap using bogie axle wrench, Tool No. B-146061, and tighten securely. Install axle cap locking screw.

(3) Install six bolts holding bogie mounting bracket to hull.

(4) Remove blocks supporting hull and lower vehicle to normal position.

(5) Remove both bogie volute spring compressors. Install plugs in mounting brackets, and install track and adjust as explained in Paragraph 112.

117. BOGIE WHEEL BEARING AND OIL SEAL REPLACEMENT.

a. It is not necessary to remove track in order to remove a bogie wheel. Proceed as follows:

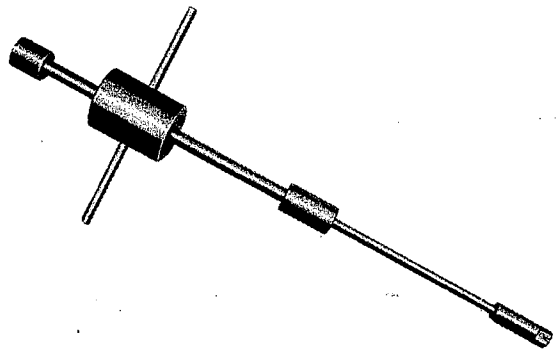
(1) Position special bogie wheel lift, Tool No. C-76085, under bogie arm connecting link as shown in Fig. 65. Drive vehicle forward very carefully until lift has rotated to a vertical position and forced bogie wheel upward.

(2) Remove cotter pin and nut on inner end of bogie wheel gudgeon pin.

(3) Insert end of special bogie wheel gudgeon pin slide hammer puller, Tool No. C-66645 (Fig. 66), through hollow gudgeon pin and install nut on end of puller protruding from inner end of gudgeon pin.

(4) While supporting wheel, remove gudgeon pin, and remove bogie wheel. Care should be exercised not to damage or lose Woodruff key in gudeon pin.

NOTE. Occasionally, a gudgeon pin may be found that is so tight that it is impossible to remove it with the slide hammer



RA PD 4744

Figure 66—Bogie Wheel Gudgeon Pin Puller

puller. In these cases, the screw type gudgeon pin puller, Tool No. C-65516, should be used.

(5) Drive spacer, oil seals, oil seal retainers and bearings out of bogie wheel hub.

b. Install bogie wheel as follows:

(1) Push one wheel bearing into side of bogie wheel hub and install bearing spacer and other bearing from other side of bogie wheel hub.

(2) Assemble bogie wheel oil retainers on one oil retainer spacer. First insert gudgeon pin through one of the spacers and install bogie wheel special oil retainer cone assembler, Tool No. B-152618, on gudgeon pin next to oil retainer spacer. The large end of cone should be against small end of spacer. Push both oil retainers up on cone and from there to oil seal retainer spacer. The sharp ends of leather oil retainers should be toward shoulder on oil seal retainer spacer. Remove gudgeon pin and oil retainer cone assembler from oil retainer.

(3) Assemble oil retainers on other oil retainer spacer.

(4) Tap oil retainer spacers with oil retainers into place in each end of bogie wheel hub.

(5) Position bogie wheel on bogie arms and drive gudgeon pin in place, using the special bogie wheel gudgeon pin slide hammer puller, Tool No. C-66645.

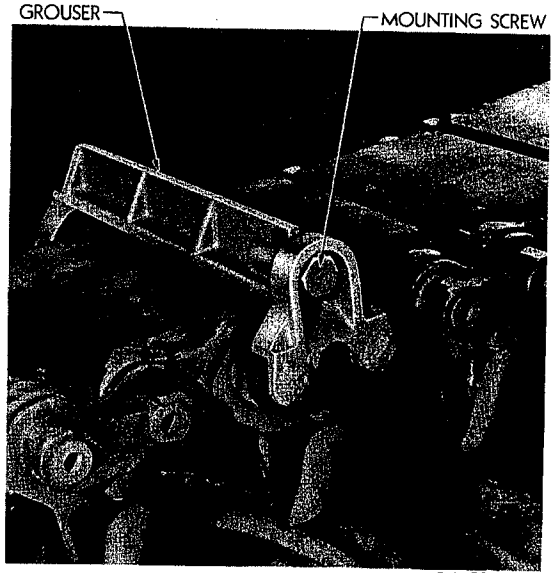


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Figure 67—Grouser Installation

(6) Install nut on inner end of gudgeon pin and lock in place with cotter pin.

(7) Remove bogie wheel lift by driving vehicle backward slowly until wheel is lowered to the track and lift is free.

118. SUPPORT ROLLER REPLACEMENT.

a. Removal:

(1) Break track as explained in Paragraph 113.

(2) Remove five track support roller bracket mounting bolts.

(3) Remove support roller assembly.

b. To install support roller, proceed as follows:

(1) Position support roller assembly on hull and install mounting bolts securely.

(2) Install track as explained in Paragraph 113.

(3) Adjust track as explained in Paragraph 112.

119. GROUSER INSTALLATION.

(1) Hook pins on solid end of grouser in holes in inner end of two track shoe pins.

(2) Hook pins on removable end of grouser on outer end of same two track shoe pins.

(3) Install grouser end connector bolt as shown in Fig. 67.

NOTE. A grouser should be installed on every eighth shoe on each track.

Section XXII

ELECTRICAL INSTRUMENTS AND EQUIPMENT

120. GENERAL DESCRIPTION.

A twelve-volt battery, two generators, and an auxiliary power plant generator unit supply the electrical current required for the operation of the vehicle and its equipment.

121. BATTERY.

a. Description. A single, six-cell, twelve-volt storage battery is located in a compartment on the left side of the fighting compartment back of the driver.

b. Checking. The level and specific gravity reading of the battery fluid should be checked every week and at the completion of every long run. Never use matches or a flame as a light when checking the battery. Distilled water should be added to bring the fluid level just above the battery plates. If the specific gravity of any cell is below 1.200, the battery should be recharged by running the auxiliary power plant.

c. Removal.

(1) Open main battery switch located on the apparatus box (See Fig. 68).

(2) Remove battery box cover.

(3) Remove seat back on driver's seat.

(4) Disconnect battery cables.

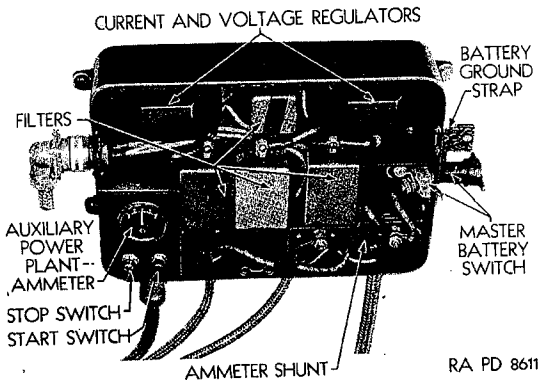

Figure 68—Apparatus Box

(5) Loosen battery retainer bracket hold-down nuts and swing hold-down bolts free of battery box frame.

(6) Lift rear end of battery free from battery case (this operation is most easily performed from the basket), and lift front end of battery free of box.

(7) Remove pad on driver's hatch, and take battery forward over the driver's seat and remove from vehicle through driver's hatch.

d. Installation.

(1) Lower battery into box so that the POSITIVE POST is NEXT to the PROPELLER SHAFT and toward the rear.

(2) Be sure that posts and terminals are clean. Posts should be coated with vaseline or similar material to reduce corrosion.

(3) Connect battery cables. Negative post is grounded through master switch in apparatus box directly above battery box on sidewall.

(4) Install battery retainer bracket hold-down bolts.

(5) Check terminals to be sure they are tight.

(6) Install battery box cover.

(7) Close main battery switch on apparatus box.

e. Battery Terminal Corrosion. Warm water poured slowly over the terminals will loosen any copper sulphate that has been deposited, so that it can be brushed off and flushed away. This should never be done with the battery in the vehicle. Battery posts and terminals should be wiped clean with a cloth saturated in an alkaline solution such as ammonia, or a solution of bicarbonate of soda and water. Corrosion can be retarded by coating with petrolatum or vaseline. (A good mixture is

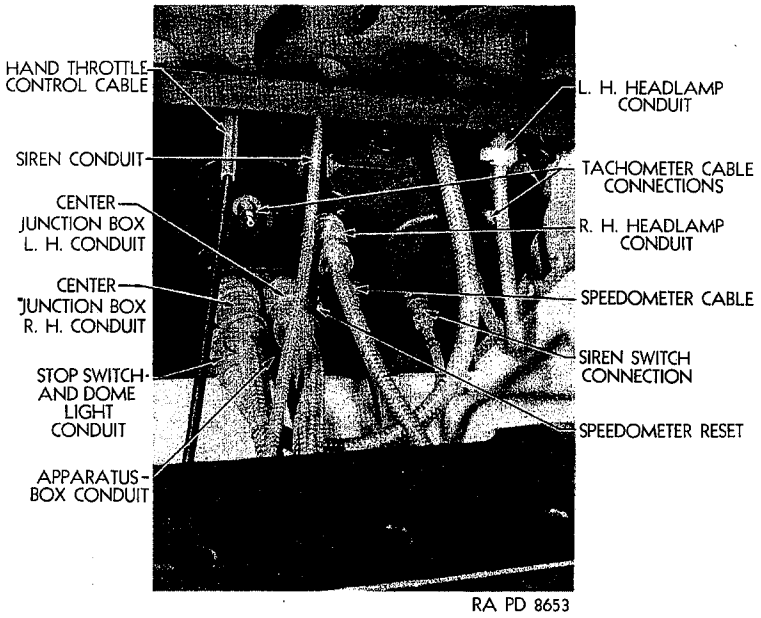

Figure 69—Instrument Panel, Rear View

vaseline and bicarbonate of soda mixed.) If battery fluid has overflowed or has spilled, all affected metal parts should be flushed with an alkaline solution and wiped dry.

122. BATTERY SWITCH.

a. The battery switch, located on the front end of the apparatus box, is provided to cut off the battery power at the source. To cut off the power, pull out and turn the switch handle. To close the circuit, turn handle and release.

b. Replacement.

(1) Remove cover from apparatus box.

(2) Disconnect ground wire from battery at base of switch.

(3) Disconnect ground strap at base of switch.

(4) Remove two screws on switch plate outside of apparatus box.

(5) Remove hex nut holding switch in box and lift out.

123. REGULATORS.

a. The charging circuit from each engine generator to the battery includes a three-unit control mechanism to assure proper functioning of the circuit under all circumstances. The

control boxes, located in the apparatus box, each consist of a cut-out relay, a current regulator and a voltage regulator.

b. The cut-out relay opens the circuit whenever battery voltage exceeds generator voltage, as when the generator is not operating or when it is not being rotated fast enough to develop its normal voltage. This prevents the battery from discharging through the generators. As soon as the generators are rotated fast enough so that generator voltage exceeds battery voltage, the cut-out relays close the charging circuits.

c. The current regulator limits to a specified maximum the amount of current which the generator produces, thus permitting a high current output over a considerable range of speeds, and at the same time guarding against excessive output and consequent generator damage at higher speeds.

d. The voltage regulator varies the output of the generator according to the demands of the various current-using circuits and the state of charge of the battery. The charging rate is high when the battery charge is low, but as the battery approaches full charge, its resistance to the charging current increases and the charging rate is cut down.

e. Inspections and Adjustments. When properly installed and operated, the generator control units should not require any adjustment. If inspection indicates any trouble, the unit should be removed by loosening the three holding screws and disconnecting three wires and a new unit secured as a replacement (See Fig. 68). Mark wires for proper reinstallation.

f. Lubrication. No lubrication is required at any time.

124. ELECTRICAL FILTERS.

a. There are a total of 12 filters provided to keep the electrical system from interfering with radio operation. These filters, which make shielding of high tension wires unnecessary, are located as follows:

2—One on each engine generator.

2—Field filters (as one unit) for the regulators in apparatus box.

2—Ignition coil filters, connected to coils on engine side of firewall.

2—Distributor filters on distributor.

1—Filter for auxiliary power plant.

1—One for both regulators for battery in apparatus box.

2—One for each current regulator in apparatus box.

In addition, ignition suppressors are installed on the spark plugs.

125. STARTER.

a. The starting motor for each engine is operated by a push button on the instrument panel, by means of a solenoid, relay and switch mounted together on the starter housing. When the starter button is depressed, the solenoid first engages the starter pinion with the flywheel gear and then closes the switch for the starting circuit.

b. The instrument panel starter switch is inoperative when the engine is running, as the connection from the starter back to the generator is such that when the generator is charging, a countervoltage develops to oppose current flowing through the starter relay, keeping it open.

c. Replacement of starter is made simply by disconnecting the cable and wires, removing the three attaching cap screws, and pulling off of engine. Installation is simply reverse of removal.

126. INSTRUMENT PANEL.

a. Fig. 7 in Section III shows the location of the various electrical and non-electrical instruments on the instrument panel. The panel is replaced only as a complete unit.

(1) **Tachometers.** The tachometer for each engine is used to register engine revolutions per minute. Total revolutions are also recorded by thosuands. As is the case with all other instruments that are dualed—one for each engine—the dial on the left is for the left-hand engine (facing the panel) while that on the right is for the right-hand engine.

(2) **Speedometer.** The speedometer shows miles per hour. Incorporated in the speedometer is the odometer which is arranged to show total mileage and also the trip mileage. The latter can be set back to zero by means of a knob located behind the instrument panel.

(3) **Voltmeter.** There is a voltmeter which shows the voltage in the charging circuit at the instrument panel at any time.

(4) **Ammeter.** The ammeter indicates the total charge going into the battery from the generators on the engines. It does not indicate the amount of charge from each engine generator separately, nor does it indicate the charge from the auxiliary power plant, which is fitted with an individual unit.

(5) **Oil Pressure Gauges.** One for each engine. Electric in operation.

(6) **Temperature Gauges.** One for each engine. Electric in operation.

(7) **Ignition Switches.** One for each engine. There are no keys used.

(8) **Starter Buttons.** One for each engine.

(9) **Instrument Light Switch.** The instrument light switch is of the rotary-type with a rheostat that controls the degree of illumination. Bulbs can be removed from the front of the instrument panel by removing the snap-on type covers over the bulbs. Mazda No. 67, GM No. 142450, Ordnance No. A-213667-B, bulbs should be used for replacements.

(10) **Light Switch.** The light switch is of the push-pull type, fitted with a protective catch to prevent the possibility of turning on the service lights by mistake. The switch has three positions as described in Paragraph 15.

b. Removal of Instrument Panel. The instrument panel may be removed from the vehicle from the driver's side by the following procedure:

(1) Remove the two nuts holding panel to brackets at the top of the panel.

(2) Remove screws holding panel bracket to hull sidewall at lower left of instrument panel.

(3) Drop panel as far as possible to permit working through space above panel.

(4) Loosen clamp holding conduits and tachometer cables to inside of front hull. This will permit panel to be dropped further to allow more working space.

(5) Disconnect **first**, the left hand headlamp conduit at headlamp.

(6) Disconnect all other conduits and cables at back of instrument panel.

c. Installation of Instrument Panel. The instrument panel may be installed from the driver's seat inside the vehicle as follows:

(1) Place panel in proper position by lining up two top studs on panel with holes in top panel brackets.

(2) Before starting nuts on studs, connect left headlamp conduit and follow by connecting rest of conduits and cables in identical manner in which they were removed.

(3) Next, see that cables and conduits are in clamp on inside of front hull and tighten clamp.

(4) Install two nuts on studs at top of panel and panel bracket to hull sidewall at lower left of instrument panel and tighten all nuts and screws securely.

CAUTION. Be very careful to line up conduit and cable plugs properly before making them secure and never attempt to use severe force if they do not fit easily.

127. LIGHTS.

a. The two headlights, the tail lights and the stop light are all dual purpose in that they consist of both blackout and service type. All exterior lights are operated from a single push-pull control switch on the instrument panel that is equipped with a safety catch. For complete information on operation of the lighting system, see Paragraph 15.

b. All tail lights and main head lights are composite assemblies of bulbs, lenses and reflectors, sealed against dirt and moisture. In case of failure, the complete lighting unit within the light shell is removed and replaced. Replacement units for each type of rear light are distinct in size and shape so errors in installation are not possible.

c. The headlights may be removed whenever desirable and should be removed before going into action. The procedure is as follows:

(1) Pull out and turn release plunger for each light. These are located on forward wall of fighting compartment at end of extreme right and extreme left steering brake levers when they are in their full forward position.

(2) Lift out complete headlight casing and its tubular shaft which fits into socket in hull.

(3) Fit protective filler plug into opening to protect socket in hull against dirt and moisture.

d. Replace the headlights as follows:

(1) Remove protective plug from headlight sockets.

(2) Set headlight into socket and force down until connection is made with the plug at the bottom of shaft.

(3) Turn and release locking levers on inside forward wall of fighting compartment.

128. SIREN.

a. The siren is located on the hull just to the right of the left headlight. It is operated by a foot button convenient to the driver's left foot.

b. Remove the siren as follows:

(1) Open master battery switch on apparatus box.

(2) Disconnect cable from siren switch.

(3) Remove retaining nut on siren support on inside of vehicle near front wall of fighting compartment.

(4) Lift out siren.

c. Install siren as follows:

(1) Set siren into hull socket.

(2) Install retaining nut on siren inside of hull.

(3) Connect cable from siren switch.

(4) Close main battery switch.

d. If siren becomes inoperative due to dirt, it may be turned with a screw driver or other small tool. After turning, reset circuit breaker.

129. CIRCUIT BREAKERS.

Two circuit breakers are included in the electrical system in place of the conventional fuse arrangement.

a. **Siren Circuit Breaker.** Located on top of the instrument panel. If the circuit opens, press red button on circuit breaker to reestablish the connection.

b. **Lighting System Circuit Breaker.** Located behind the instrument panel, connected directly to the light switch. This circuit breaker is thermostatically controlled. An overload in any part of the system causes the circuit to open. If the condition corrects itself, the circuit will close automatically. If the trouble continues, the lights will "flicker" or go out. In this event, the system must be checked to find the source of the trouble.

Section XXIII

AUXILIARY POWER PLANT

130. GENERAL DESCRIPTION.

A one cylinder, gasoline-powered, air-cooled, auxiliary power plant is provided to recharge the battery, operate the turret traversing mechanism in an emergency and for emergency operation of the electrically-controlled guns (Fig. 70). It does not heat the engine oil or engine compartment. It is located under the firewall extension on the left-hand side of the vehicle. The operating controls, consisting of the starting and stopping buttons and the ammeter, are located on the apparatus box on the left wall, behind the driver (See Fig. 68).

131. OPERATION.

a. To start the auxiliary power plant, simply push on the "Start" button. There is no ignition switch, or choke control.

(1) A cranking pulley, located on the front of the unit close to the battery box, is provided for emergency starting. To start the auxiliary power plant manually, wind the starter cord around the cranking pulley in a counter-clockwise direction and give the cord a quick jerk, at the same time depressing the starter button. If the engine does not fire, repeat the process. The automatic choke operates with the cranking pulley as well as with the starting button.

b. To stop the auxiliary power plant, push and hold down the "Stop" (red) button on the apparatus box until the engine stops.

132. FUEL AND OIL.

a. The gasoline supply for the auxiliary power plant is taken off the left fuel tank through a gravity feed. Before entering the carburetor, it passes through a disc-type filter

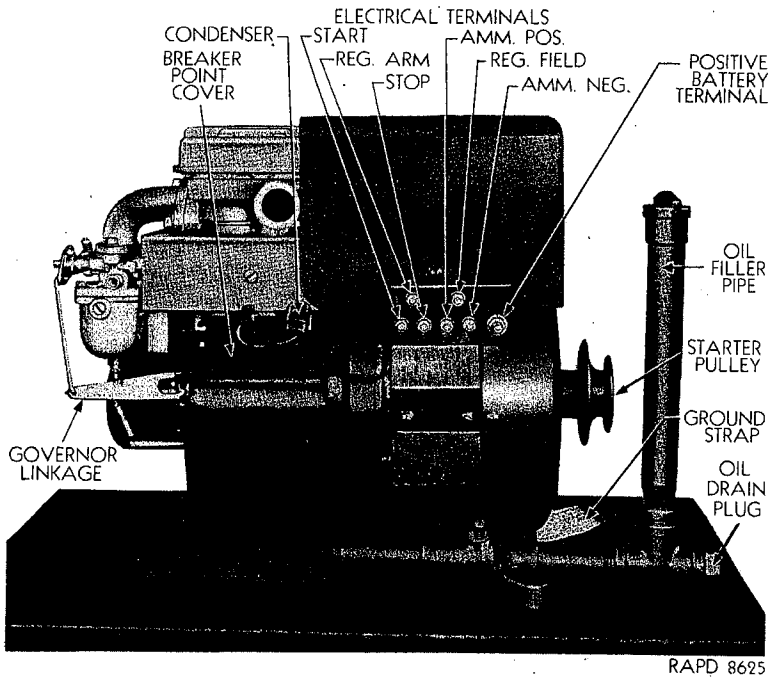

Figure 70—Auxiliary Power Plant

fixed to the fighting compartment side of the firewall on the left-hand side (See Fig. 43).

b. The crankcase has a capacity of three pints of oil. Use 10-W engine oil in temperatures below 32°, and SAE 20 in temperatures above 32°. The intake filler pipe, which is fitted with a plunger type gauge in the cap, is located between the generator and the battery compartment (Fig. 70). The crankcase drain plug is located in the base of the filler pipe and is reached through a hole cut in the hull floor. This hole is covered with a metal plate held in place with three cap screws. The oil level should be checked once a week, and oil changed every 1000 miles or 100 hours of operation. Accurate log book records should be kept on hours of operation.

133. MAINTENANCE.

a. Spark Plug. The gap should be set for .028 to .033 inch.

b. Carburetor. The adjustments should be made only by trained ordnance personnel. Carburetors should be replaced as complete assemblies only.

c. Accessory Bracket. The accessory bracket carries the ignition coil, reverse current, cut-out and magnetic starting

switches. For inspection remove the three screws holding the cover on the power plant and lift off cover (Fig. 70).

d. Air Cleaner. Oil should be changed weekly when auxiliary power plant is being used in even moderately dusty conditions. If oil is not changed, the level should be checked in the prestarting inspection.

e. Entire unit must be removed from the vehicle for any major repairs.

Section XXIV

HULL AND TURRET

134. HULL.

a. General. The basic hull armor plate is a completely welded structure except for portions of the front, top and rear which are removable for service operations. The driver and assistant driver, who is also the bow gunner, occupy compartments at the front of the hull interior. The fighting compartment in the center of the hull is separated from the engine compartment at the rear by a partition or bulkhead. The engine fans draw air from the fighting compartment through hinged openings at the top of the bulkhead to ventilate the fighting compartment when the guns are fired. Sponsons at both sides bring the width of the upper half of the hull nearly even with the width across the tracks.

b. Doors. Two hinged double doors, located in the rear of the hull, provide access to the engine compartment. The driver and the assistant driver each have forward vision provided through periscopes located in the escape hatches directly above them. These hatches are hinged at the top and swing upward. Two escape hatches for the gunner and loader or commander are provided in the top of the turret. Periscopes for vision under fire and pistol port covers fitted with protectoscopes are provided in the turret.

c. Periscopes.

(1) Periscopes for both the driver and the assistant driver are mounted in the escape hatches. These periscopes are illustrated in Fig. 71, which shows them disassembled from their mountings as viewed from the front to reveal the method of installation.

(2) The periscopes have a 360° traverse and elevation of 25° from the vertical or a depression of 17°. These periscopes

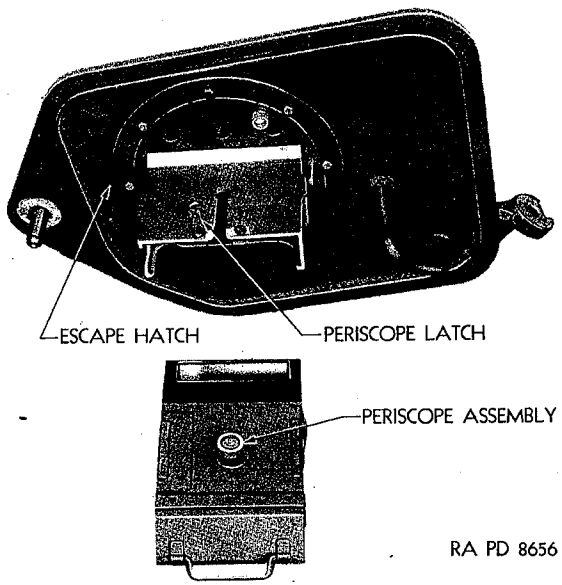

Figure 71—Periscope and Mounting

can be raised to the using position or lowered for complete protection by pulling up or down on the knob.

(3) The periscope units are replaced complete in the event of damage by gun fire. To replace the periscope, turn back the locking latch (Fig. 71) and pull the damaged unit out. Reinstall a new unit by reversing this procedure.

d. Seat Adjustment. The seats for the driver and the assistant driver have the following two adjustment ranges:

(1) Directly in front of each seat on the under side is an L-shaped handle, which controls forward and backward movement, over-all travel is 3″. The seat is locked in the desired position when the handle is released.

(2) When orders permit travelling with open hatches, the vertical adjustment permits raising the seats a maximum of 9″ with a 3″ forward swing. The control lever for this adjustment is on the hull side of each seat. To raise the seat, raise the control lever and take weight off the seat which will then move upward and forward into position by spring action. To lower the seat to the fighting position, raise control lever and body weight will force the seat down.

e. Inspection. Inspect the hull frequently for loose bolts or attaching parts. The using arm is responsible for tightening or replacing all defective threaded fasteners.

f. Painting. The using arm is responsible for the appearance of the vehicle. Follow instructions in Section IX of this Manual in regard to vehicle appearance and painting.

g. Replacement of Hull Components. The using arm replaces damaged or defective insulation, pads, seats, front fenders, periscopes or glass in protectoscopes.

135. TURRET.

a. General.

(1) The turret is of welded, curved-plate, homogeneous armor plate design. The sides of the turret are 1¼" thick, while the roof is ½" thick. The front of the turret is covered by a heavy armor casting which serves as mounting base for the combination gun. The turret rotates through 360° on three ball bearing races that are recessed and covered for protection from direct hits and lead splash.

(2) A "basket" or carrier for two men is mounted on the bottom of the turret and rotates with it. The mechanisms for the hydraulic turret traverse and portions of the gun stabilizer

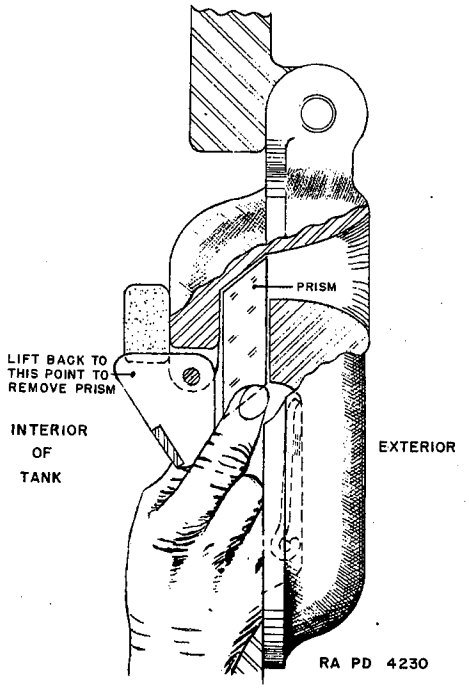

Figure 72—Removal of Prism from Protectoscope

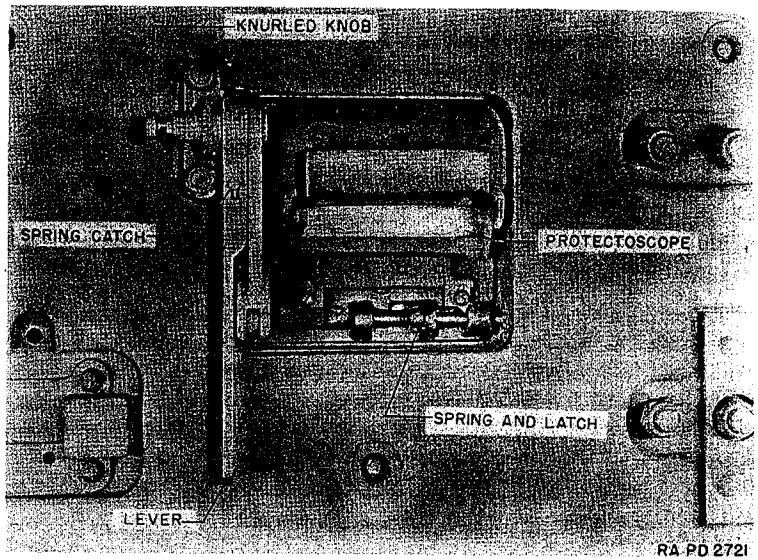

Figure 73—Pistol Port with Protectoscope

mechanism are fastened to the under side of the basket floor (See Fig. 74).

b. Maintenance. In case of failure of the hydraulic turret traverse or of the turret support rollers, notify Odnance personnel.

c. Trouble-Shooting. In case of failure of the turret support rollers, notify the Ordnance personnel. If a turret does not rotate freely, the most common cause is foreign matter that wedges between the turret ring and the hold-down rollers. Clean the upper surface of the turret ring with a cloth or brush after removing one of the eight bearing and roller brackets which gives access to it. If the turret does not rotate freely after cleaning the upper side of the turret ring, loosen the hold-down brackets one at a time, trying the turret for ease of rotation each time a bracket is loosened. If the loosening of a bracket causes the turret to rotate freely, remove the bracket and check the ball and roller bearings. If these are satisfactory, insert a .005" shim between the bracket and hull and install bracket. Try the turret for ease of rotation each time a bracket is installed. Do not oil the turret ring or rollers after cleaning

d. Replacement of Turret Components.

(1) **Protectoscope.** The protectoscope mounted in the pistol port door protects the eye of the user (Fig. 73). The two

optical parts consist of a prism and window. Either part may be replaced without the use of tools. To remove the prism, press on the hinged retainer plate with sufficient force to move the plate away from the support. Swing the support down and remove the prism and window. No adjustment is possible. Keep the prism and window clean and free of oil. To remove the window, remove the two cap screws holding the window frame to the cover frame. Remove two screws from one end of window frame and slide window out.

(2) **Pistol Port Cover.**

a. Description. If the operating mechanism or the cover is defective, notify the Ordnance personnel. To operate the pistol port door, proceed as follows (See Fig. 73):

(1) Move lever locking spring catch downward.

(2) Raise lever to horizontal position, until knurled knob drops in notch in lever.

(3) Unlatch cover bolt.

(4) Pull down on lever until knurled knob drops in place again, locking the cover in the open position.

b. Replacement. Use the following procedure in replacing defective pistol port covers:

(1) Support cover in open position.

(2) Remove pin attaching link of operating mechanism to cover.

(3) Drive out small pin anchoring hinge pin to cover.

(4) Drive out hinge pin and remove door.

(5) Reverse above procedure to install new cover.

(3) **Turret Lock.** The turret lock is bolted to the turret ring. If unserviceable, remove two mounting bolts and nuts and exchange the defective assembly for a new one (Fig. 11).

136. HYDRAULIC AND MANUAL TURRET OPERATION.

a. Preselection of Clutch Position. A manually operated clutch handle lever is fixed to the top of the hydraulic motor housing between the two turret seats (Fig. 9). With the end of the lever turned away from the turret wall, the hydraulic system will rotate the turret. If the handle is turned in toward the turret wall, the gears for manual operation of the turret will operate. The turret can be locked in any position by means of the cam-type turret lock.

b. Manual Turret Rotation. If electric power fails or if the hydraulic system will not operate due to some other cause, the turret can be rotated by the manual control crank located on the side of the hydraulic motor housing between the two turret

seats (Fig. 9). The clutch lever must be moved to the second position (the handle turned toward the turret wall) in order to have the manual gears engage the turret gears. The rate of speed of turret rotation is dependent upon the speed with which the crank is operated.

c. Hydraulic Turret Rotation. To rotate the turret, using the hydraulic traverse, first set the clutch lever to the hydraulic position. Then turn on the electric motor by turning the toggle switch on the floor under the gunner's seat. As soon as the motor starts, it will build up sufficient hydraulic pressure to rotate the turret. A pistol grip handle to the left of the combination gun mount operates the hydraulic traverse control valve (Fig. 10). Turn the grip toward the center of the turret, or counterclockwise, to rotate the turret to the left. Turn the grip toward the turret wall, or clockwise, to rotate the turret to the right. The amount the control handle is turned determines the speed of turret rotation.

d. Hydraulic Traverse System.

(1) There are three principal parts to this mechanism: the pump, the control valve and the hydraulic motor. The pump and an oil reservoir are fastened to the under side of the turret basket. The control valve mechanism is mounted on the turret wall to the left of the gun mount. The pistol grip previously mentioned is connected directly to the valve, and turning the grip directs oil pressure against one side or the other of the hydraulic motor, thus changing the direction of rotation. The hydraulic motor is mounted on the turret wall at the back, between the two seats.

(2) The hydraulic motor is connected indirectly with a pinion engaging the traversing gear around the circumference of the turret. The manual traversing crank is mounted on the side of the hydraulic motor housing as is the clutch which makes the gear conversion from hydraulic to manual.

(3) The oil reservoir which is mounted on the under side of the basket floor holds approximately one gallon of special oil (See Section VI). The reservoir is fitted with a dip stick level indicator which is located on the basket floor, (Fig. 9). It should be kept at a proper level at all times, as the oil not only provides the hydraulic pressure, but also supplies the lubricant. In an emergency, SAE-20 may be used in place of the special oil.

137. ELECTRICAL SYSTEM.

a. A collector ring assembly, mounted on a bracket between the propeller shaft housings, transmits electric power from the hull to the revolving turret. It consists of a cylinder which is fixed to the hull, and sets of brushes which rotate with the

turret. The two lower brushes are power leads, of which the bottom one is grounded. The upper five brushes are for the intraphone communication system. The power lead from the collector ring assembly goes through the motor switch and electric motor. The intraphone system take-off leads come from the collector ring to a junction box on the turret wall.

b. The guns in the turret are fired electrically by switches placed on the pistol grip control handle. A safety switch for the guns is incorporated in the control handle.

Section XXV

GYRO-STABILIZER UNIT

138. GENERAL.

a. The gyro-stabilizer unit must be maintained properly in order to insure the accuracy and sensitivity required for proper operation. Repairs must not be made to the individual assemblies; they should be replaced as complete units.

b. The electric motor which supplies the power for the oil pump is mounted on the under side of the turret basket. This motor supplies the power both for the hydraulic turret traverse mechanism and for the gyro-stabilizer. Figure 74 shows the location of the gyro-stabilizer oil pump, which is mounted at one end of the electric motor.

c. The mounting of the gyro-control unit, the piston and cylinder assembly, and the mounting bracket assembly are shown in Figure 75. The master switch which is located on the floor of the turret basket under the gunner's seat also controls the turret traverse mechanism.

139. MAINTENANCE.

The following items should be checked at each 250-mile inspection.

a. Tighten the packing gland on the oil pump shaft by first removing the cover plate and taking up the gland nut slightly using a screwdriver and turning in a clockwise direction.

b. Check and grease the four zerk type grease fittings on the mounting bracket assembly.

c. Check all external electrical connections for looseness or broken wires.

d. Check all oil line connections for leakage and tighten or replace as required.

e. Check for oil leakage around piston and cylinder assembly. Replace complete assembly if leakage is found.

f. Check for free play between gyro-control unit and hand wheel, and adjust backlash between worm gear and worm wheel

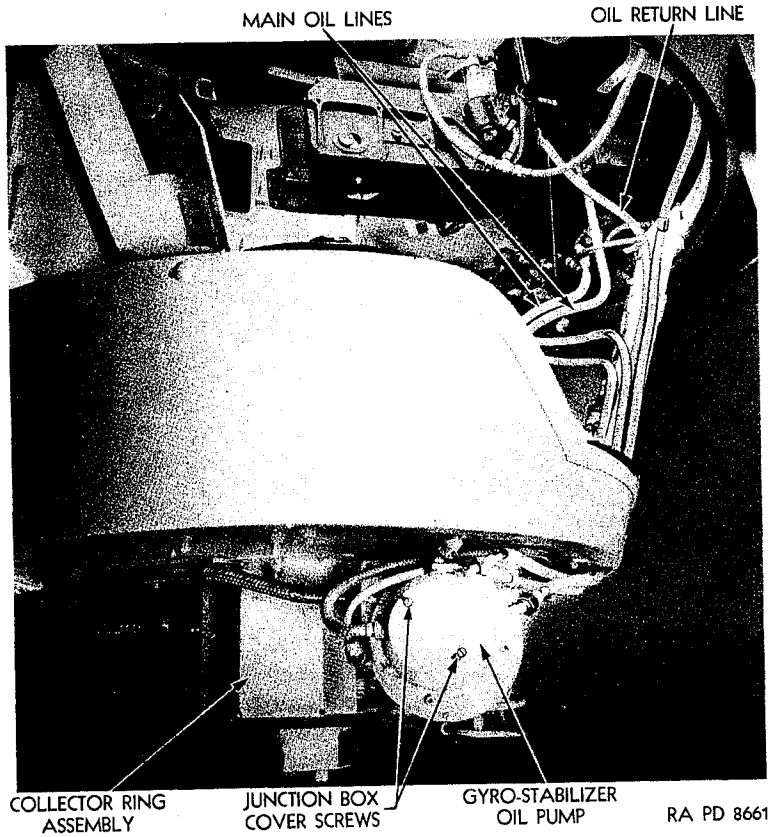

Figure 74—Oil Pump and Connections, Gyro-Stabilizer

if free motion exists. Backlash may be taken up by loosening worm wheel lock nut and washer, Figure 78, and turning backlash adjusting screw. Adjust for $\frac{1}{32}$" maximum movement between worm gear and worm wheel. Use care not to overtighten, and be sure to tighten lock nut and washer when adjustment is completed.

g. Check for free movement in the mounting of the piston and cylinder assembly.

h. Check for end play in worm bracket and adjust by loosening lock nut on top of gear housing (Fig. 78) and turning head of screw clockwise. Retighten lock nut.

140. TROUBLE SHOOTING.

In the event that the gyro-stabilizer does not operate correctly, make the following checks in order.

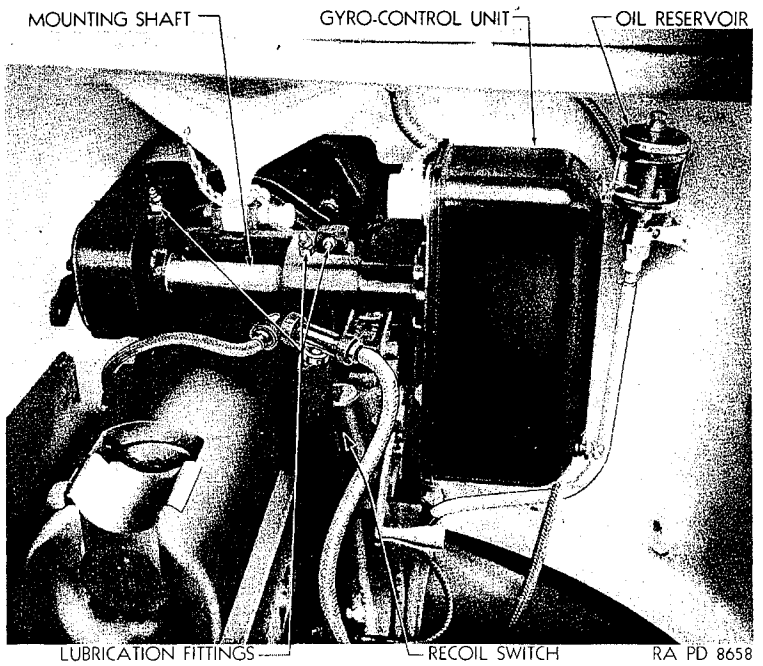

Figure 75—Mounting Shaft and Bracket, Gyro-Stabilizer

a. Check the oil level in the oil reservoir. It must be at least 2/3 full at all times.

b. Check for air in the oil lines, oil pump or piston and cylinder assembly.

c. Grease the four grease fittings on the gyro-stabilizer mounting bracket assembly.

d. Check for free movement between gyro-control unit and hand wheel.

e. Check for free movement between gyro-control unit and gun.

f. Check for free movement in the mounting of the piston and cylinder assembly. **This is important.**

g. Check all external electrical connections for looseness or broken wires.

h. Check the battery voltage.

i. Check for undue friction in the gun mounting or unbalance in the gun, as determined by the gunner.

j. If trouble exists after making the above checks, the

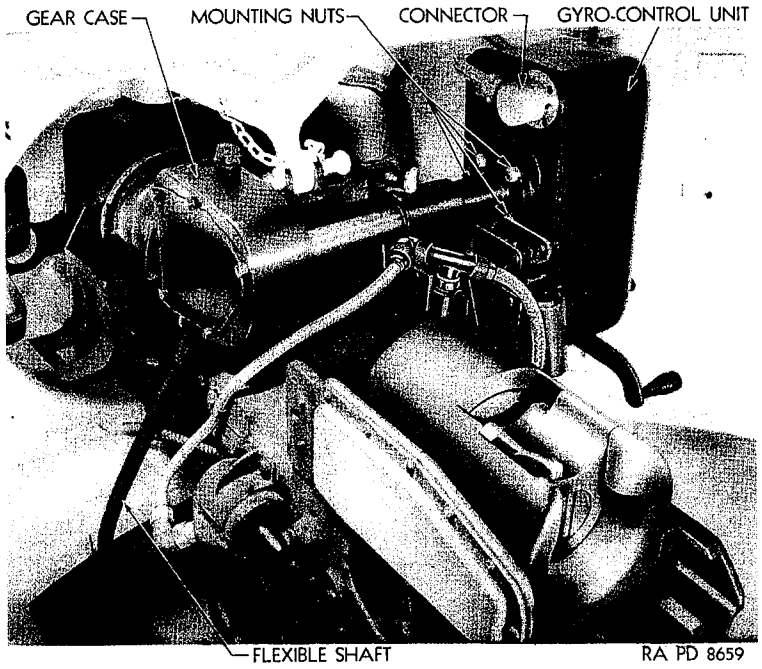

Figure 76—Control Unit and Connector, Gyro-Stabilizer

various assemblies should be replaced in **the following order** until the source of trouble is located:

(1) The gyro-control unit.
(2) The oil pump.
(3) The piston and cylinder assembly.
(4) The recoil switch.
(5) The disengaging switch.
(6) The control box.
(7) The oil pump motor.

141. BLEEDING THE SYSTEM.

The gyro-stabilizer can operate properly only when the system is filled with oil and any air that may be trapped in the system removed by use of the following bleeding procedure.

a. Turn the master switch for the system to the off position.

b. Disconnect the flare nut on the oil return line in the piston, Figure 74. Loosen, but do not remove, the flare nuts at the upper and lower main oil line connections of the cylinder. This will permit venting the air from the oil lines and the cylinder.

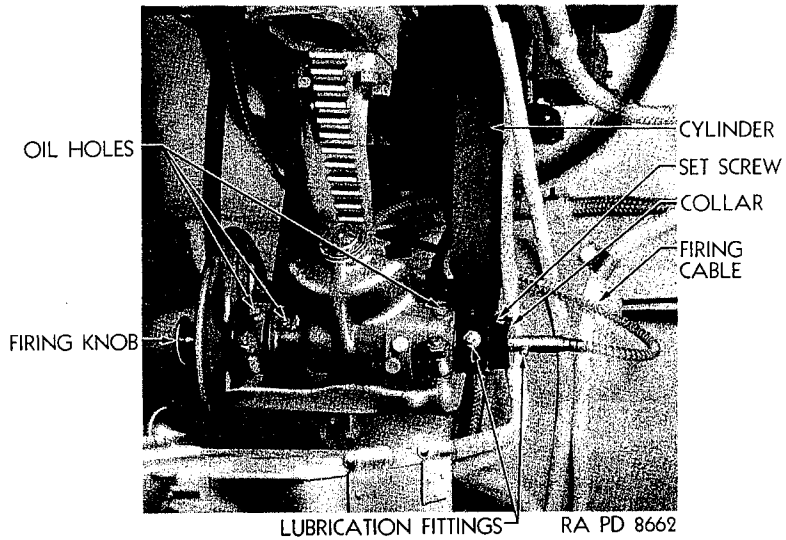

Figure 77—Elevating Gear and Lower Cylinder Bracket

c. Remove the cap from the oil reservoir. (Figure 75).

d. Fill the pump and lines with oil through the oil reservoir until oil drippage is noticed at the upper and lower connections of the cylinder and oil flows freely from the oil return line.

NOTE. The oil should be hot (approximately 200° F) when installing. If necessary, heat the oil before installing.

e. Reconnect the oil return line and tighten the flare nut.

f. Take up the upper cylinder flare nut sufficiently to prevent leakage but do not tighten further.

g. With the hand elevating gear out of mesh, push the breech of the gun all the way down to the end of the piston stroke. This action pushes the air out of the lower side of the cylinder.

h. While holding the breech in the lowest position, tighten the lower flare nut snugly and loosen the upper cylinder flare nut. These are the ⅜″ diameter flare nuts.

i. Slowly move the breech to the uppermost position, raising the piston to the top of the stroke and tighten the upper cylinder flare nut snugly. This action pushes the air out of the upper side of the cylinder.

j. Repeat steps g, h, and i, and tighten both flare nuts securely.

k. Disconnect the multiple prong connector from the gyro-control unit.

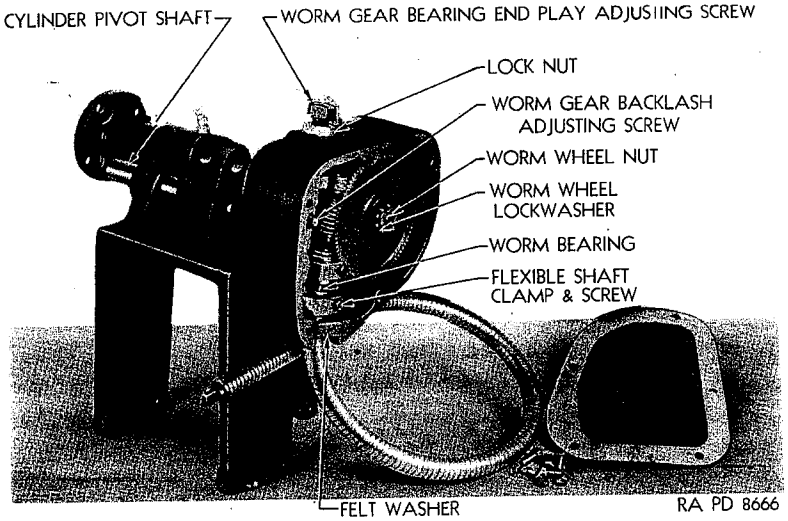

Figure 78—Mounting Bracket Assembly, Gyro-Stabilizer

l. Throw the master switch to the "on" position.

m. Operate oil pump from 15 to 30 minutes, make sure that oil reservoir is kept 2/3 full throughout this period.

n. Throw the master switch to the "off" position.

o. Slowly pump the breech of the gun up and down until no more bubbles appear in the oil reservoir.

p. Replace the oil reservoir cap.

q. Reconnect the multiple prong connector to the gyro-control unit.

r. Start the gyro-stabilizer equipment and check operation.

NOTE. During the 250-mile inspection the gyro-stabilizer oil system must be checked for presence of air by performing step "o" above. Repeat this same checkup to test for air in the system as a cause of erratic operation at any time.

142. REPLACEMENT OF COMPONENTS.

a. Gyro-control unit.

(1) Throw the master switch to the "off" position to shut off the power to the stabilizer.

(2) Disconnect and remove the multiple prong connector from the gyro-control base.

(3) Remove the four nuts on the gyro-control mounting shaft, Figure 76, and remove the gyro-control unit.

CAUTION. The lead seals on the gyro-control unit must **never** be broken except by ordnance personnel.

(4) Replacement is the reverse of the removal operation. The complete gyro-stabilizer should be checked for operation after replacement.

b. Oil pump.

(1) Throw the master switch to the "off" position, disconnecting the power supply.

(2) Loosen two screws and remove cover from junction box on outer end of oil pump, Figure 74.

(3) Disconnect the three wires, green, yellow and white from the terminals inside the junction box.

(4) Disconnect and plug the four oil lines leading to the oil pump.

(5) Remove the four Allen head screws around the oil pump mounting bracket. These are the screws that are not connected by the wire lock.

(6) Tap the pump mounting flange with a light hammer while pulling the oil pump from the electric motor.

CAUTION. The oil pump cover must **never** be removed except by ordnance personnel.

(7) Reassembly of the pump is the reverse of removal with the following precautions.

(8) Exercise care when placing pump on motor so that the shafts will mesh properly.

(9) After remounting pump on motor remake electrical and oil line connections in the reverse of the above procedure.

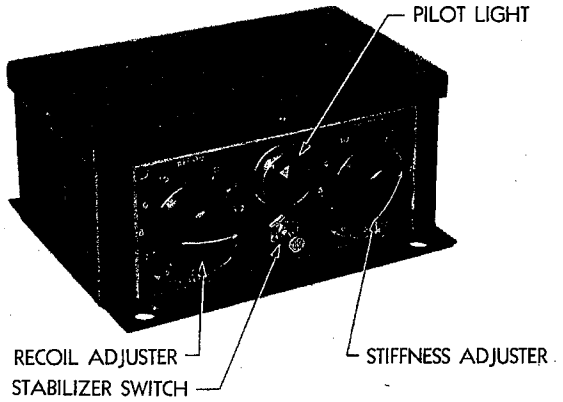

Figure 79—Control Box, Gyro-Stabilizer

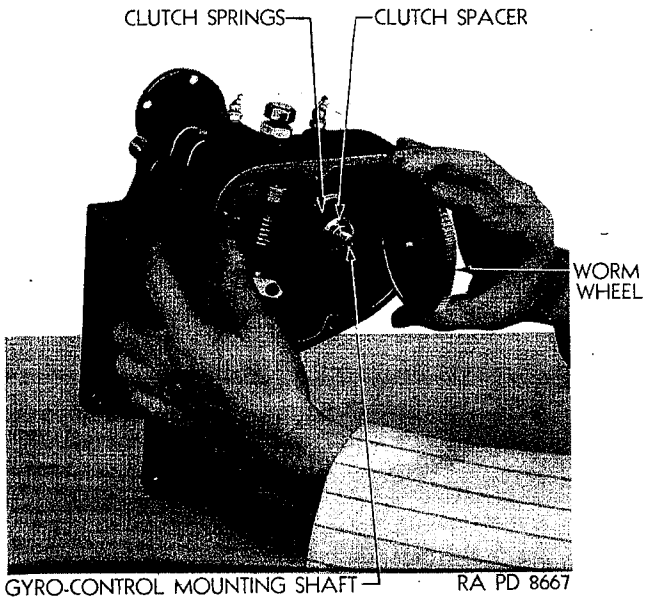

Figure 80—Worm Wheel Installation, Gyro-Stabilizer

(10) Additional oil must be added to the oiling system through the reservoir cap and the system bled to remove air as explained in Paragraph 141.

(11) As a final step, recheck the complete gyro-stabilizer for proper operation.

c. Piston and cylinder assembly.

(1) Throw master switch to "off" position disconnecting power supply to gyro-stabilizer.

(2) Disconnect and plug the oil lines leading to the piston and cylinder assembly. (Figure 74).

CAUTION. Provision should be made to catch the oil that will be lost on disconnecting these lines.

(3) Disconnect and remove the firing pin cable, Figure 77.

(4) Loosen the set screw and remove the collar and the cylinder pivot pin, Figure 77.

(5) While holding the gun in position to keep piston and cylinder assembly free of bind, work the piston rod end, the cylinder end off of their respective pivot pins simultaneously.

(6) Replacement of piston and cylinder assembly is the reverse of the removal except that the system must be recharged

with oil and bled as described in Paragraph 141, and the complete gyro-stabilizer checked for operation as a final step.

d. Recoil switch.

(1) Throw the master switch to the "off" position, disconnecting the power supply to the gyro-stabilizer.

(2) Remove the two screws holding the switch to its mounting bracket.

(3) Remove cover plate from switch.

(4) Disconnect electrical wiring, melting solder whenever necessary.

(5) Unscrew recoil switch from shielded conduit fitting.

(6) Reinstall recoil switch by reversing the foregoing operations.

(7) Reconnect the wiring and remount the switch.

e. Control box.

(1) Throw the master switch to the "off" position, disconnecting the power supply to the gyro-stabilizer.

(2) Remove top cover from control box and disconnect the three external wires, see Wiring Diagram, Figure 81.

(3) Remove screws holding control box to turret wall and remove control box.

(4) Install control box by reversing the above operations, connecting the wires as shown in the diagram. Remount box and replace cover.

f. Mounting bracket assembly.

(1) Remove the gyro-control unit as described in Paragraph 142a.

(2) Loosen the two piston rod pivot pin set screws.

(3) Slide the piston rod pivot pin out through the piston rod end.

(4) Loosen the flexible shaft clamp screw on the flexible shaft, Figure 78, and remove shaft.

(5) Remove four bolts holding mounting bracket assembly to gun mount. Lift mounting bracket up and toward the breech of the gun to remove.

(6) To reinstall mounting bracket, lift assembly up and over breech of gun.

(7) Lower bracket assembly on gun mount and place in position shown in Figure 75.

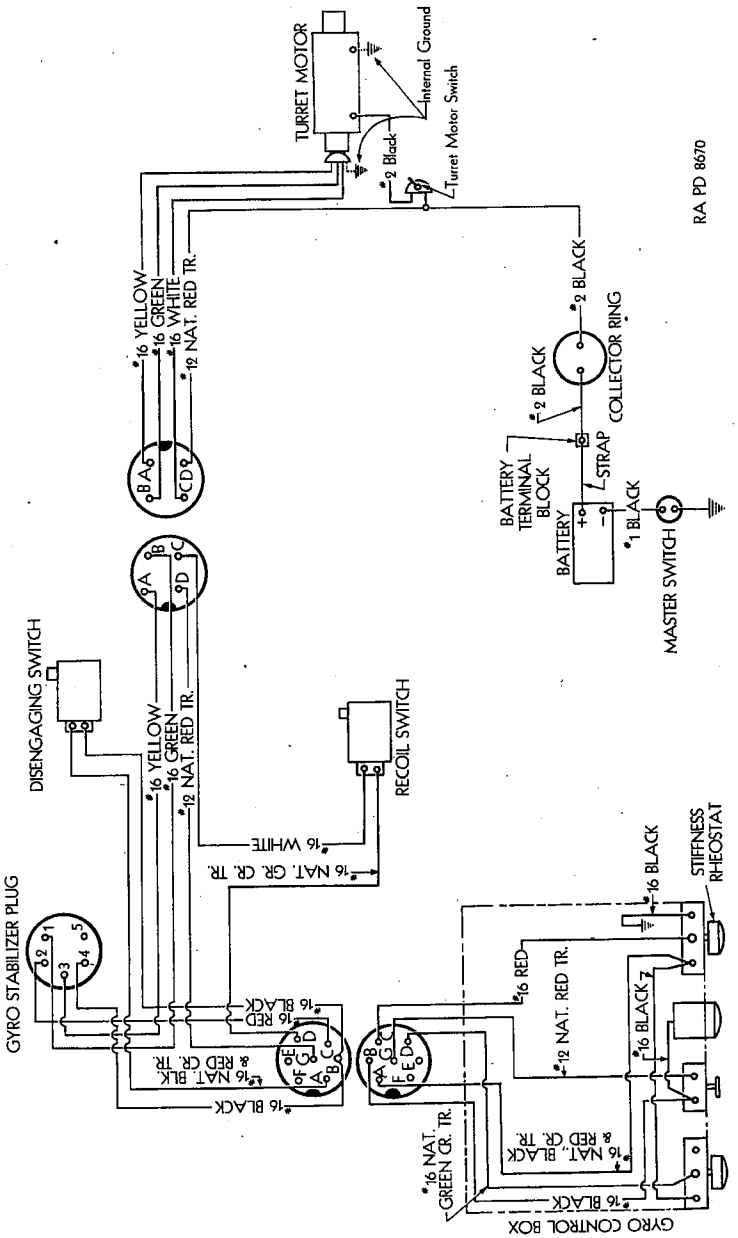

Figure 81—Wiring Diagram, Gyro-Stabilizer

(8) Install and tighten the four mounting bolts to hold the bracket securely to the gun mount.

(9) Slide piston rod pivot pin through piston rod end bending it into place in the mounting bracket assembly.

CAUTION: Flats on pivot pin must face toward set screws.

(10) Tighten the two piston rod pivot pin set screws.

(11) Reinstall the gyro-control unit.

g. Gyro-control mounting shaft.

(1) Throw the master switch to the "off" position, disconnecting power supply to gyro-stabilizer.

(2) Remove the gyro-control unit as described in Paragraph 142 a.

(3) Remove the worm gear housing cover plate (Figure 76).

(4) Remove the worm wheel lock nut and lockwasher.

(5) Remove the worm wheel from the gear housing at shaft end.

(6) Remove the clutch spacer and two clutch springs (Figure 80).

(7) Pull the gyro-control mounting shaft from the bracket assembly.

(8) If necessary, drive the two oil seals from the mounting bracket assembly.

(9) Assembly of a new gyro-control mounting shaft is the reverse of the above operations.

NOTE. After the shaft has been reinstalled, the backlash between the worm and worm wheel must be adjusted as outlined in Paragraph 139 f.

h. Disengaging switch

(1) Throw the motor switch to the "off" position, disconnecting the power supply to the gyro-stabilizer.

(2) Remove the screws holding the switch mounting bracket to the gun mount.

(3) Remove the bolts holding the switch to the switch mounting bracket.

(4) Remove the cover plate from the switch.

(5) Disconnect the electrical wiring.

(6) Unscrew switch from the shielded conduit fitting.

(7) Install new disengaging switch.

(8) Reconnect the wiring and remount the switch.

i. Flexible shaft support bracket.

(1) Loosen the flexible shaft clamp on the flexible shaft bracket.

(2) Remove the flexible shaft.

(3) Remove the two shaft bracket cap screws.

(4) Remove the shaft bracket.

(5) The replacement of the flexible shaft bracket is the reverse of the preceding steps.

j. Replacement of flexible shaft.

(1) Remove the gear case cover plate (Fig. 76).

(2) Loosen the flexible shaft clamp on the worm bracket and remove the flexible shaft (Fig. 78).

(3) Loosen the flexible shaft clamp on the flexible shaft support bracket.

(4) Remove the flexible shaft.

(5) The replacement of the flexible shaft is the reverse of the preceding steps.

CAUTION: Be sure the couplings of each end of the flexible shaft are in mesh before tightening the flexible shaft clamps.

Section XXVI

REFERENCES

143. STANDARD NOMENCLATURE LISTS:

a. Cleaning, preserving, and lubricating materials ..... SNL K-1

b. Tank, light, M5 (in preparation) ..... SNL G-103

c. Armament

Gun, cal. .30, Browning, M1919A4, fixed and flexible bow mounts ..... SNL A-6

Gun, sub-machine, cal. .45, Thompson, M1928A1.. SNL A-32

Gun, 37-mm, M6, and cal. .30, M1919A5, in combination mount M23 ..... SNL A-45

Current Standard Nomenclature Lists are as tabulated here. An up-to-date list of SNL'S is maintained in the "Ordnance Publications for Supply Index" ..... OPSI

144. EXPLANATORY PUBLICATIONS:

a. Cleaning, preserving, and lubricating materials ..... TM 9-850

b. Maintenance and inspection

Echelon system of maintenance..... TM 10-525

Fire prevention, safety precautions, accidents.... TM 10-360

Motor transport inspection..... TM 10-545

Sheet metal work, body, fender and radiator repairs TM 10-450

c. Armament

Gun, cal. .30, Browning, M1919A4..... FM 23-50

Gun, sub-machine, cal. .45, Thompson, M1928A1.. FM 23-40

Gun, 37-mm, M6, and Cal. .30, M1919A5..... FM 23-81

d. Storage and shipment

Loading of mechanized and motorized army equipment on open top railroad equipment—Association of American Railroads Storage of military motor vehicles ..... AR 850-18

e. Miscellaneous

Automotive electricity ..... TM 10-580
Automotive lubrication ..... TM 10-540
Defense against chemical attack ..... FM 21-40
Electrical fundamentals ..... TM 1-455
Fuels and carburetion ..... TM 10-550
Motor transport ..... FM 25-10
Tank units ..... FM 7-10

145. TRAINING FILMS AND FILM STRIPS:

a. Maintenance and inspection

The motor vehicle driver, first echelon maintenance TF 11-558
First echelon of maintenance ..... FS 10-53
Second echelon of maintenance ..... FS 10-54
Inspection of motor vehicles ..... FS 10-58

b. Lubrication ..... FS 10-39

c. Engine

Gasoline motors ..... TF 10-166
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The internal combustion engine ..... FS 10-42

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