TM 9-7218

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

TWIN 40-MM FULL TRACKED SELF-PROPELLED GUN M42 (T141)

DEPARTMENT OF THE ARMY • *MAY 1957*

AGO 10143B—May

TECHNICAL MANUAL
No. 9-7218

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *21 May 1957*

TWIN 40-MM FULL TRACKED SELF-PROPELLED GUN M42 (T141)

* This manual supersedes TM 9-761A, 8 May 1952, including C 1, 20 July 1955, and C 2, 30 December 1955.

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1. Scope

a. These instructions are published for the use of the personnel to whom the materiel is issued. They contain information on the operation and organizational maintenance of the materiel as well as descriptions of major units and their functions in relation to other components of the materiel.

b. The appendix contains a list of current references, including supply manuals, technical manuals, and other available publications applicable to the materiel.

c. This manual differs from TM 9–761A, 8 May 1952, as follows: it revises information on operating instructions, maintenance procedures, and controls.

2. Organizational Maintenance Allocation

In general, the prescribed organizational maintenance responsibilities will apply as reflected in the allocation of tools and spare parts in the appropriate columns of the current ORD 7 supply manual pertaining to this vehicle and in accordance with the extent of disassembly prescribed in this manual for the purpose of cleaning, lubricating, or replacing authorized spare parts. In all cases where the nature of repair, modification, or adjustment is beyond the scope or facilities of the using organization, the supporting ordnance maintenance unit should be informed in order that trained personnel with suitable tools and equipment may be provided or other proper instructions issued.

Note. The replacement of certain assemblies, such as power plant, engine, transmission, final drives, and auxiliary generator and engine is normally an ordnance maintenance operation, but may be performed in an emergency by the using organization, provided authority for performing these replacements is obtained from the responsible commander. A replacement assembly, any tools needed for the operation which are not carried by the using organization, any necessary special instructions regarding associated accessories, etc, may be obtained from the supporting ordnance maintenance unit.

3. Forms, Records, and Reports

a. General. Responsibility for the proper execution of forms, records, and reports rests upon the officers of all units maintaining

this equipment. However, the value of accurate records must be fully appreciated by all persons responsible for their compilation, maintenance, and use. Records, reports, and authorized forms are normally utilized to indicate the type, quantity, and condition of materiel to be inspected, to be repaired, or to be used in repair. Properly executed forms convey authorization and serve as records for repair or replacement of materiel in the hands of troops and for delivery of materiel requiring further repair to ordnance shops in arsenals, depots, etc. The forms, records, and reports establish the work required, the progress of the work within the shops, and the status of the materiel upon completion of its repair.

b. Authorized Forms. The forms generally applicable to units operating and maintaining these vehicles are listed in the appendix. For a complete listing of all forms, refer to current DA Pam 310–2. For instructions on use of these forms, refer to FM 9–10.

c. Weapon Record Book. The 40-mm dual automatic gun M2A1 is furnished with a weapon record book. Procedures and precautions to be observed by responsible personnel in the recording of pertinent data in the weapon record book (DA Forms 9–13 and 9–13–1, formerly Artillery Gun Book, 00 Form 5825) and instructions relative to its disposition are described in (1) through (10) below.

(1) *Purpose.* The weapon record book is used to keep an accurate record of the weapon.

(2) *Scope of weapon record books.*

(*a*) They serve as the record of use and maintenance of the materiel.

(*b*) They inform unit commanders of the condition and serviceability of weapons under the commander's jurisdiction.

(*c*) They serve as a source of technical data to the Ordnance Corps for the improvement of materiel and furnish valuable performance data for the development of new equipment.

(3) *Arrangement.* The weapon record book is divided into two parts.

(*a*) *Part I—major item complete record.* Part I (DA Form 9–13, replaces 00 Form 5825 which may be used) of the weapon record book is to remain with the carriage or mount at all times during its serviceable life. It contains:

Instructions for making entries, adding to filled books, replacement of lost books, and disposal of books.

A summary sheet—weapon component performance, identifying weapon components, dates of their in-

stallation and removal, and total rounds fired to these dates.

Record of assignments to battery and unit.

Weapon data record—noting results of inspections, repairs, alterations, replacements, and condition of principal components.

(*b*) *Part II—cannon data.* Part II (DA Form 9–13–1) of the weapon record book is to remain with the gun tube, liner, or cannon at all times during its serviceable life. It contains:

Identification of weapon components.

Battery commander's record of rounds fired.

Bore inspection record—chronological star gage and pullover gage readings.

Bore inspection record—chronological estimations of remaining accuracy life (per TB 9–1860–2) and remarks on bore and chamber condition.

(4) *Instructions for use.* The weapon record book contains instructions for making entries and for adding a new part I or II when the original has been filled. It is imperative that the entries be kept complete and up to date. It is also imperative that carbon paper be inserted between the pairs of pages when making entries in part II. Perforated copies of pages will not be removed. When the gun tube, liner, or cannon (breech ring and tube) is condemned, part II will be removed from the book and forwarded to Office, Chief of Ordnance, Department of the Army, Washington 25, D. C., ATTN: ORDFM-Weapons.

(5) *Additional prescribed entries.* To facilitate proper maintenance of the weapon and to avoid unnecessary duplication of repairs and maintenance, a record of completed work (MWO, TB's, etc.) will be entered in the book. This entry, in addition to indicating the modifications completed, will also bear the signature of personnel responsible for the completion of the modifications.

(6) *Security during shipment or transfer.* The procedures in (*a*) through (*c*) below are prescribed to insure that the book will always accompany the complete materiel whenever it is shipped or transferred from one organization to another.

(*a*) During transfer or shipment, the book will be kept in a waterproof envelope securely fastened to the materiel with waterproof tape in its designated location.

(*b*) Under one of the wrappings of tape, one end of a small tab will be inserted reading "Weapon Record Book Here."

(*c*) Ordnance direct and heavy support units and depots will insist that the book accompany each weapon when it enters their shop for repair or maintenance.

(7) *Replacement cannon or tubes.* If part II is missing on receipt of replacement cannon or tube, it should be immediately requisitioned directly from Headquarters, Ordnance Weapons Command, Rock Island, Illinois, ATTN: ORDOW-FQ, as described in (9) below. The serial number of the mount or carriage must be included. The serial number of the breech ring or the tube is neither wanted nor required.

(8) *Forms for proofed weapons.* If the weapon requires proofing after repair and this is to be accomplished by another facility, the proofing facility will requisition the required forms.

(9) *Procedure when weapon record book is lost or separated from the weapon.* If the book is lost, it will be replaced immediately and all available data will be entered in the new book. Pending receipt of new book, a temporary record should be prepared and maintained. Number of rounds fired will be estimated by comparison of the pullover gage measurement with the appropriate curve shown in TB 9–1860–2. The Weapon Record Book, Part I (DA Form 9–13, Stock No. J003–8407300, formerly 00 Form 5825) and/or Part II (DA Form 9–13–1, Stock No. J003–8407301) (part I plus part II, Stock No. J003–8408957) will be requisitioned when required from Headquarters Ordnance Weapon Command, Rock Island, Illinois, ATTN: ORDOW-FQ. A complete justification and explanation, including serial number of the weapon for which the book is required, will be included on each requisition submitted. A record book that has become separated from a weapon to which it pertains will be forwarded to Office, Chief of Ordnance, Department of the Army, Washington 25, D. C., ATTN: ORDFM-Weapons. All perforated pages that contain notes and are separated from the record book will also be forwarded to this address.

(10) *Disposal of weapon record book for condemned weapon (complete combination of major item).* When a weapon has become obsolete or is condemned, destroyed, turned in for salvage, or otherwise lost from service, a notation of this fact will be entered in part II and signed and dated by the personnel who condemned the weapon. The weapon record

book (part I and part II) will then be sent through channels to Office, Chief of Ordnance, Department of the Army, Washington 25, D. C., ATTN: ORDFM-Weapons.

(11) *Prior to entering combat.* Record of assignment data must be removed and destroyed prior to entering combat.

d. Field Report of Accidents. The reports necessary to comply with the requirements of the Army safety program are prescribed in detail in SR 385–10–40 series of special regulations. These reports are required whenever accidents involving injury to personnel or damage to materiel occur. Whenever an accident or malfunction involving the use of ammunition occurs, firing of the lot which malfunctions will be immediately discontinued. In addition to any applicable reports required above, details of the accident or malfunction will be reported as prescribed in SR 385–310–1.

e. Report of Unsatisfactory Equipment or Materials. Any suggestions for improvement in design and maintenance of equipment, safety and efficiency of operation, or pertaining to the application of prescribed petroleum fuels, lubricants, and/or preserving materials, will be reported through technical channels, as prescribed in AR 700–38, to the Chief of Ordnance, Washington 25, D. C., ATTN: ORDFM. Such suggestions are encouraged in order that other organizations may benefit.

Note. Do not report all failures that occur. Report only REPEATED or RECURRENT failures or malfunctions which indicate unsatisfactory design or material. However, reports will always be made in the event that exceptionally costly equipment is involved. See also AR 700–38 and the printed instructions on DA Form 468.

Section II. DESCRIPTION AND DATA

4. Description

a. General. The twin 40-mm full tracked self-propelled gun M42 (T141) (figs. 1–4) is a full-track-laying, armored, antiaircraft vehicle capable of operating in temperatures ranging from —65° to +120° F. Major armament is a 40-mm automatic dual gun M2A1 mounted in 40-mm twin gun mount M4E1. Additional fire power is provided by an air-cooled cal. .30 machine gun M1919A4 (flex) which is mounted on either of two pintle stands on the gun mount. This vehicle was designed for deployment with armored divisions as a means of antiaircraft protection, but because of its rapid rate of fire, it has proved a valuable infantry support weapon against ground targets. The interior of the vehicle is divided into three distinct areas; the driving compartment at the front, the stowage compartment in the center, and the engine compartment in the rear. The driving

compartment houses the driving controls and instruments and has seats for the driver and the commander-radio operator. The stowage compartment serves as a base for the gun mount and provides stowage space for 12 boxes of 40-mm ammunition. The engine compartment houses the main engine, auxiliary generator and engine, transmission, and fuel tanks. A 4-man gun crew consisting of a gunner, sightsetter, and two loaders, rides in the gun mount.

b. Power Plant.

(1) *Engine.* The vehicle is powered by a supercharged AOS895–3 Continental engine which develops 500 hp at 2,800 rpm. The engine is a horizontally-opposed 6-cylinder, air-cooled engine with overhead valves and a single overhead camshaft for each bank of three cylinders. Total cylinder displacement is 895.9 cubic inches. Fuel intake is controlled by two synchronized downdraft, double-venturi carburetors. The ignition system consists of two magnetos which fire two spark plugs in each cylinder.

(2) *Transmission.* An Allison CD500–3 cross-drive transmission is connected with, and bolted to, the flywheel end of the engine. This transmission incorporates a hydraulically operated clutch-type steering system, mechanically operated multiple wet disk brakes, and a hydraulic torque converter driving selective gear trains to provide high, low, and reverse driving ranges. The steering system is controlled by the steering crossbar in the driving compartment which controls hydraulically operated steering clutches. The brakes are operated by a brake pedal in the driving compartment. Output from the transmission is delivered by two short shafts through the universal joints to the final drives.

c. Suspension.

(1) Ten independently sprung dual road wheels support the weight of the vehicle on the tracks. Each road wheel consists of two steel disks with vulcanized solid rubber tires. Five dual road wheels are located on each side of the vehicle and attached to the hull by forged steel road wheel supporting arms. Each road wheel supporting arm is independently sprung by a torsion bar which extends through the hull immediately above the floor to an anchor on the opposite side of the vehicle.

(2) Ten volute-type springs are attached to the outer sides of the hull to act as bumper stops against the road wheel supporting arms. These springs prevent excess deflection of

Figure 1. Twin 40-mm full tracked self-propelled gun M42 (T141) with guns in firing position—left front view.

Figure 2. Twin 40-mm full tracked self-propelled gun M42 (T141) with guns in firing position—right rear view.

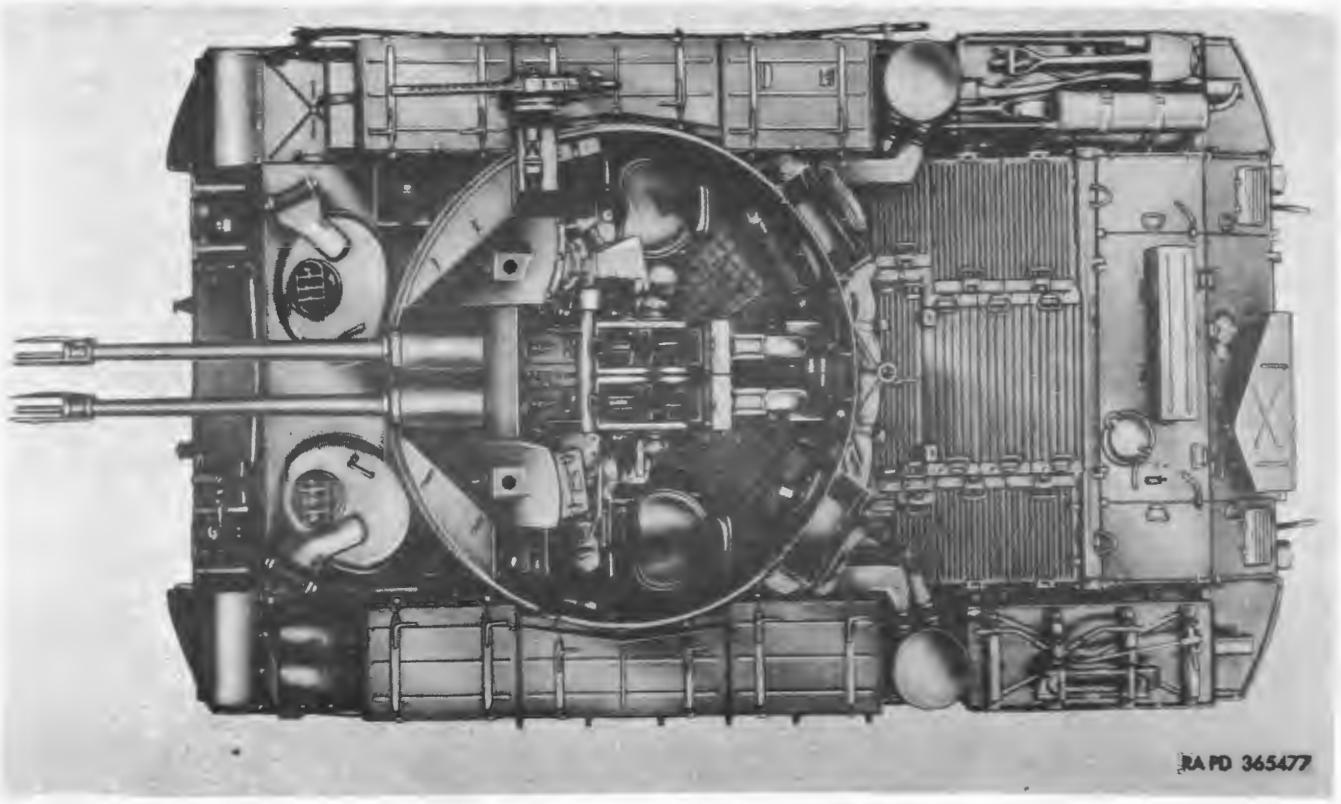


Figure 3. Twin 40-mm full tracked self-propelled gun M42 (T141) with guns in firing position—top view.

Figure 4. Twin 40-mm full tracked self-propelled gun M42 (T141) with guns in traveling position—right front view.

the road wheel supporting arms and retard the possibility of setting or breaking the torsion bars on rough terrain.

(3) Shock absorbers are connected to all road wheel supporting arms with the exception of the center and intermediate pairs. The lower ends of the direct-action-type shock absorbers are attached to the road wheel supporting arms and the upper ends are fastened to the hull side plate.

(4) Compensating wheels are located at the left and right front of the vehicle to maintain proper truck tension. Each compensating wheel is attached to the adjacent front road wheel by a swinging arm and link. Any decrease in track tension caused by deflection of the front road wheel is compensated immediately by the arm moving the compensating wheel forward, thereby maintaining proper tension.

d. Hull. The hull is divided into three compartments: a driving compartment in the front, a stowage compartment in the center, and an engine compartment in the rear. Driving controls and seats for the driver and commander-radio operator are located in the driving compartment. Three doors provide access to the driving compartment. A large door is located in the hull front plate and hatch doors are located above the driver's and commander's seats. The stowage compartment is comprised of two tunnels which extend along the sides of the vehicle from the rear of the driving compartment to the engine compartment. This compartment provides ammunition stowage and access to the engine compartment from the vehicle interior. The engine, transmission, fuel tanks, and auxiliary generator and engine are housed in the engine compartment. This compartment is separated from the forward sections of the hull by a bulkhead which extends across the vehicle. This bulkhead adds rigidity to the hull and serves as a firewall for the engine compartment. One removable door is located in the center of the bulkhead. Removable engine compartment grilles are mounted over the engine cooling fan and hinged doors and grilles permit access to other portions of the engine compartment from the outside of the vehicle.

e. 40-mm Twin Gun Mount M4E1 (fig. 1). The welded armor plate gun mount is an open-topped cylinder supported midway through the vehicle on a ball bearing race ring. The gun mount can be traversed 360° in either direction by power or manual operation. A 40-mm automatic dual gun M2A1 and cal. .30 machine gun M1919A4 (flex) are mounted on the gun mount. The 40-mm gun can be elevated to +85 degrees and depressed to —3 degrees by power operation. Under normal operation, 87° elevation is attainable and the gun can be depressed to —5°. Power traverse and elevation is controlled by the local control system M16A1E1. Supereleva-

tion and lead adjustments for the gun are made by operating computing sight M38 (T154). Crew positions for the gunner, sightsetter, and two loaders are in the gun mount.

f. Armament (fig. 1). The armament in each M42 vehicle consists of a 40-mm automatic dual gun M2A1 and a cal. .30 machine gun M1919A4 (flex). Both guns are mounted on gun mount M4E1.

(1) *40-mm automatic dual gun M2A1.* The 40-mm automatic dual gun is the major armament furnished on M42 vehicles. The gun is a high-velocity, flat-trajectory, automatic-loading antiaircraft weapon capable of firing 240 rpm.

(2) *Cal. .30 machine gun M1919A4* (flex). This gun is a flexibly-mounted, air-cooled weapon used to provide additional fire support.

g. Sighting and fire control instruments. The sighting and fire control instruments on the self-propelled twin 40-mm gun M42 (T141) are used for both direct and indirect fire.

(1) *Direct fire control instruments.* The direct fire control instruments consist of computing sight M38 (T154) with reflex sight M24C, and local control systems M16A1E1 composed of two oil gears M6A1E1, wiring set M10A1E1, and drive controller M12E2.

(2) *Indirect fire control instruments.* The indirect fire control instruments consist of azimuth indicator M27 with instrument light —7983714 and gunner's quadrant M1 or M1A1 with carrying case M18, M56, or M82.

(3) *Miscellaneous instruments.* The periscope M13 or M13B1 and periscope M19 are miscellaneous instruments used with the twin 40-mm full tracked self-propelled gun M42 (T141).

5. Name, Caution, and Instruction Plates

a. Vehicle Nameplate (fig. 10). This nameplate, located on the hull wall to the left of the driver's seat, furnishes vehicle nomenclature, model number, serial number, manufacturer, maximum driving speeds allowable in transmission ranges, vehicle dimensions, lowest operable height, shipping cubic footage required, fighting weight, engine governed speed, and date of manufacture. Pertinent operator's maintenance and supply manuals are also listed.

b. Army Vehicle Registration Number (figs. 1 and 4). This number is stenciled on both the left and right side stowage boxes and on the hull front and rear plates.

c. Engine Nameplate (fig. 99). This nameplate, mounted on top of the accessory case at the front of the engine, furnishes part number, model number, serial number, manufacturer, rated revolutions

per minute, compression ratio, oil pressure, spark advance, valve timing, and valve clearance cold.

d. Transmission Nameplate (fig. 178). This nameplate, located on top of the transmission to the left of the oil filler, furnishes model number, serial number, manufacturer, type and grade of oil to be used, and refilling instructions.

e. Generator Nameplate (fig. 147). This nameplate, mounted on the generator, furnishes part number, manufacturer, manufacturer's model number, type, speed range in revolutions per minute, and rated amperage and voltage.

f. Starter Nameplate (fig. 140). This nameplate, mounted on the starter, furnishes manufacturer's name, model number, ordnance part number, voltage rating, and clutch rating in pound-feet.

g. Carburetor Nameplates (fig. 123). These nameplates, mounted on the carburetors, furnish manufacturer's name, model number, ordnance part number, serial number, float level, and fuel pressure.

h. Oil Cooler Nameplates (fig. 134). These nameplates furnish the manufacturer's name, model number, ordnance part number, and serial number.

i. Portable Fire Extinguisher Cylinder Nameplate (fig. 63). This nameplate furnishes empty and fully charged cylinder weights, weight of charge, recommended inspection frequency, operating instructions and cautions, manufacturer, and serial number. The ordnance part number is stamped on the cylinder body.

j. Fixed Fire Extinguisher Instruction Plate (fig. 62). This plate, fastened on the left side of the driving compartment above and to the rear of the driver's position, describes the procedure for setting the fixed fire extinguisher after use.

k. Auxiliary Generator and Engine Nameplate (fig. 159). This nameplate, mounted on the shroud panel of the auxiliary generator and engine, furnishes manufacturer's name, model number, serial number, ordnance part number, and ratings.

l. Range Selector Control Box Instruction Plate (fig. 10). This plate, attached to the top of the range selector control box, names the various driving ranges and gives operating instructions and cautions.

m. Personnel Heater Nameplate (fig. 62). This nameplate, mounted on the left side of the driving compartment above and to the rear of the driver's position, furnishes instructions on starting, setting temperature, and the failure to start procedure for the personnel heater.

n. Tube Serial Number (C, fig. 45). The 40-mm gun tube serial number is stamped on the top surface of the tube immediately forward of the tube guide sleeve.

o. Gun M2A1 Nameplate (fig. 301). This nameplate, attached to the left side of the breech casing above the side cover, furnishes part nomenclature, model number, and serial number.

p. Gun Mount M4E1 Nameplate (fig. 41). This nameplate, attached to the right side of the top carriage of the gun mount behind the traversing mechanism, furnishes part nomenclature, manufacturer's name, model number, serial number, and date gun was proofed.

q. Drive Controller M12E2 Nameplate (fig. 28). This nameplate, attached to the turret of the drive controller, furnishes part nomenclature, model number, and serial number.

r. Computing Sight M38 (T154) Nameplate (F, fig. 47). This nameplate, attached to the left mounting arm of the computing sight, furnishes part nomenclature, model number, and serial number.

s. Azimuth Indicator M27 Nameplate. This nameplate, mounted on the housing of the azimuth indicator M27 (fig. 41), cannot be seen when the azimuth indicator is in its installed position. Part nomenclature, model number, and serial number are included on this plate.

t. Oil Gear M6A1E1 Nameplate (fig. 24). This nameplate, attached to the output coupling end of the oil gear case, furnishes part nomenclature, model number, and serial number.

u. Reflex Sight M24C Nameplate (U, fig. 47). This nameplate, attached to the top of the reflex sight support arm, furnishes part nomenclature, model number, and serial number.

v. Periscope M19 Nameplate (fig. 19). This nameplate, attached to the front of the periscope, furnishes part nomenclature, model number, and serial number.

w. Modification Plate (fig. 30). This plate, welded on the hull rear plate 10 inches below the right lifting eye, furnishes numbers of completed modifications, ordnance serial number of the vehicle, and manufacturer's serial number.

6. Tabulated Data

a. General Data.

Armament	one 40-mm automatic dual gun M2A1 and one cal. .30 machine gun M1919A4 (flex)
Crew	6
Engine	Continental AOS895-3, 6-cylinder, air-cooled
Transmission	Allison CD500-3, cross-drive hydraulic torque
Weight	49,500 lb

b. Vehicle.

Dimensions:

Length	20 ft 9⅛ in.
Width	10 ft 6⅛ in.

Height	9 ft 4⅝ in.
Ground clearance	1 ft 5½ in.
Ground pressure	9.3 psi
Electrical system	24 volt
Number of batteries	4
Capacities:	
Crankcase (refill)	44 qt
Final drives (each)	2.9 qt
Fuel tanks (2)	140 gal
Transmission (refill)	44 qt

c. Armament.

40-mm automatic dual gun M2A1:	
Weight of gun without mount or accessories	2,000 lb
Weight of barrel assembly (each)	206 lb
Overall length of gun (complete)	12 ft
Length of barrel with flash suppressor	8 ft 6 in.
Length of bore	88.15 in.
Length of rifling	75.85 in.
Estimated accuracy life of barrels	12,000 rds
Maximum rate of fire per minute (both guns)	240 rds
Maximum number of rounds which may be fired consecutively at maximum rate before cooling (both guns)	120 rds
Muzzle velocity (shell HE–T, Mk2)	2,870 fps
Type of operation	recoil
Type of breechblock	vertical sliding
Type of firing mechanism	percussion
Capacity of automatic loaders (2 clips)	8 rds
Type of recoil mechanism	recuperator spring and oil
Type of counterrecoil mechanism	recuperator spring and oil
Maximum allowable recoil	8.3 in.
Minimum allowable recoil	7.4 in.
Metal-to-metal recoil	8.8 in.
Desirable recoil	7.83 in.
Elevation at which maximum recoil occurs	85 deg
Number of recoil cylinder	2
Weight of recoil cylinder (each)	24.04 lb
Capacity of recoil cylinder (each)	1.32 pt

Ammunition refer to paragraphs 306 through 315 for complete data.

40-MM twin gun mount M4E1:	
Weight complete with gun (approx)	6,900 lb
Diameter	7 ft 1 in.
Gun elevation limits:	
Power operation	85 deg
Manual operation	87 deg
Gun depression limits:	
Power operation	—3 deg
Manual operation	—5 deg
Speed of power elevation	25 deg/sec
Amount of elevation per turn of crank	4 deg
Type of equilibrator	spring
Traversing range	360 deg
Speed of power traversing	40 deg/sec
Amount of traverse per turn of crank	10.3 deg

d. Sighting and Fire Control Instruments.

Azimuth indicator M27:
- Dial graduations (100-mil) ..... 0 to 3,200 mils right and left, numbered every 200 mils
- Dial graduations (1-mil) ..... 0 to 100 mils, numbered every 5 mils
- Gunner's aid dial (1-mil) ..... 0 to 50 mils right and left numbered every 5 mils

Computing sight M38 (T154):
- Speed settings ..... 0 to 700 mph in 20 mph increments
- Target course azimuth angle ..... 0 to 6,400 mils
- Maximum dive angle ..... 85 deg
- Maximum climb angle ..... 60 deg
- Elevation limits ..... −5 to +87 deg
- Maximum lead deflection (vertical or lateral) ..... approx 400 mils
- Superelevation at 0-mil gun elevation ..... 3 mils
- Superelevation at 1,600-mils gun elevation ..... 0 mils

Local control system M16A1E1:
- Capabilities:
  - Maximum speed in azimuth ..... 40 deg per sec
  - Maximum speed in elevation ..... 25 deg per sec
- Drive controller M12E2:
  - Rate motor:
    - Volts ..... 115-ac, 60 cycle

Oil gear M6A1E1:
- Electric motor:
  - Volts 24-dc
  - Horsepower 1½
  - Speed ..... 4,300 rpm
  - Torque:
    - Output coupling rated torque at 500 rpm ..... 94 lb-in.
    - Output coupling minimum stall torque ..... 40 lb-ft
  - Hydraulic elevation limit ..... −3 to +85 deg
- Wiring set M10A1E1:
  - Inverter box:
    - Generator ..... 115 volts ac, 1-phase, 60 cycle
    - Motor ..... 24 volts dc
- Gunner's quadrant M1 or M1A1:
  - Scale graduations:
    - Coarse scale ..... 0 to 800 mils, 800 to 1,600 mils, graduated in 10-mil increments, numbered every 50 mils
    - Micrometer scale ..... 0 to 10 mils, graduated in 0.2-mil increments
- Periscope M13 or M13B1:
  - Magnification IX
  - Field of view ..... 25 deg vert, 90 deg hor
- Periscope M19:
  - Magnification IX
  - Field of view ..... 26.8 deg hor, can be pivoted 15 deg in elevation
  - Focal point ..... 18 to 20 yds
  - Operating voltage ..... 16,000 volts

e. Performance.

	Low	*High*	*Reverse*
Allowable speed	11.5	45	11 5 mph
Cruising range			100, miles
Cruising speed			25 mph
Fording depth (max)			40 in.
Fuel consumption			0.7 mpg
Grade ascending ability (max)			60 percent
Recommended towed load (max)			5,000 lb
Traverse of gun mount			(6,400 mils) 360 deg
Maximum time required to traverse 360 deg by power			9 sec
Turning radius ("LOW" range) (min)			18 ft
Turning radius ("HIGH" range) (min)			55 ft
Vertical obstacle vehicle will climb (max)			2 ft 4 in.
Width of ditch vehicle will cross (max)			6 ft

f. Detailed Data References. Additional detailed tabular data pertaining to individual components and systems are contained in the following paragraphs:

	Paragraphs
Batteries and generating system	171
Engine	131*c*
Fuel, air intake, and exhaust systems	149*d*
Ignition system	144*b*
Transmission	208*b*

CHAPTER 2
OPERATING INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF MATERIEL

7. Purpose

a. When a new or reconditioned vehicle is first received by the using organization, it is necessary for the organizational mechanics to determine whether the vehicle has been properly prepared for service by the supplying organization and is in condition to perform any mission to which it may be assigned when placed in service. For this purpose, inspect all assemblies, subassemblies, and accessories to be sure they are properly assembled, secure, clean, and correctly adjusted and/or lubricated. Check all tools and equipment (pars. 88 and 89) to be sure every item is present, in good condition, clean and properly mounted or stowed.

b. In addition, perform a "run-in" of at least 50 miles on all new or reconditioned vehicles and a sufficient number of miles on used vehicles to completely check their operation according to procedures in paragraph 9 and TM 9–2810.

c. Clean armament parts coated with rust-preventive compound.

(1) These parts when received from storage coated with rust-preventive compound should be thoroughly cleaned with waste, wiping cloths, or a brush saturated with dry-cleaning solvent or mineral spirits paint thinner or one part of grease-cleaning compound to four parts dry-cleaning solvent or mineral spirits paint thinner. After complete removal of the compound, lubricate as specified in lubrication order LO 9–7218 (par. 90).

(2) Component parts of each weapon should be cleaned separately where practicable. Although like parts are interchangeable, the parts originally assembled work best together.

d. Whenever practicable, the vehicle crew will assist in the performance of these services.

8. Preliminary Service

Perform the D (quarterly or 750-mile) preventive-maintenance service (par. 107) using DA Form 462 with the following variations:

a. General. Line out the other services on the work sheet (DA Form 462) and write in "New (or Rebuilt) Vehicle Reception."

b. Item 19. Perform this item before starting the road test. If a processing tag on the vehicle states that the engine contains preservative oil that is suitable for 500 miles of operation, and of the correct seasonal viscosity, check the level but do not change the oil; otherwise, change oil. Lubricate all points, regardless of interval. Check the levels of the lubricant in all units (par. 90). If the lubricant is known to be of the correct seasonal grade, do not change it; otherwise, change it.

c. Items 12 and 27. Inspect breaker points; dressing should not be necessary.

d. Armament. Perform preliminary services described in paragraph 279.

9. Run-In Test

a. Run-In Test. Refer to paragraphs 42 through 46 for operating instructions. Continue the road test (items 1–9) on DA Form 462 for at least 50 miles, unless the vehicle has been driven to the using organization. In the latter case, make the road test only long enough to make the usual observations. Continuously observe instrument panel and warning signal lights. Stop at least every 10 miles and make external observations around the vehicle; look particularly for an overheated final drive, idler, road wheel, or support-roller hub and leaks from their lubricant seals. Upon completion of the road test, operate the traversing and gun elevating mechanisms to check for proper operation (pars. 55–62).

b. After Run-In Test. Upon completion of the run-in test, change the engine and transmission oil and place the vehicle in normal service. It will be due for its first regular preventive-maintenance service after 1 month or 250 additional miles.

10. Correction of Deficiencies

a. Ordinary deficiencies disclosed during the preliminary inspection and servicing or during the break-in period will be corrected by the using organization or a higher maintenance echelon.

b. Serious deficiencies, which appear to involve unsatisfactory design or material, will be reported on DA Form 468, Unsatisfactory Equipment Report. The commander of the using organization will submit the completed form (in accordance with AR 700–38) to the Chief of Ordnance, Washington 25, D. C., ATTN: ORDFM, or to the Chief of appropriate technical service for other than ordnance equipment.

Section II. VEHICLE CONTROLS AND INSTRUMENTS

11. General

This section describes, locates, illustrates, and furnishes the crew with sufficient information pertaining to the various controls and instruments provided for proper operation of the vehicle.

12. Front Door Controls

a. General. The front door is located in the front upper plate of the hull to provide a large opening into the driving compartment for the stowage and removal of ammunition from the stowage compartment. The door is equipped with two interior locking handles (figs. 5 and 6), an outside handle, and a spring which counterbalances the door for easier operation. A front door hold-open latch (fig. 7) is positioned above the left headlight group to retain the door in an open position. When closed, the door is made watertight by a rubber gasket which is compressed by the cam action of the two interior locking handles.

b. Early Vehicles (fig. 5). The front door has provisions for mounting cal. .30 carbine M2, cal. .45 submachine gun M13A1, and the cal. .30 ammunition stowage box.

Note. Some doors on early vehicles provided space for a second carbon instead of the submachine gun.

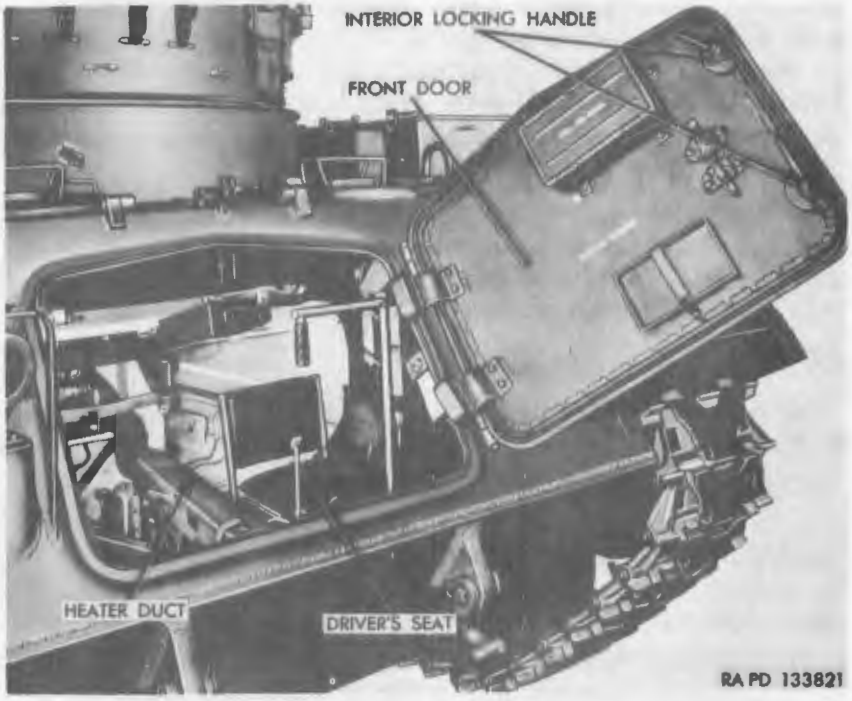


Figure 5. Front door in open position—early vehicles.

Figure 6. Front door in open position—late vehicles.

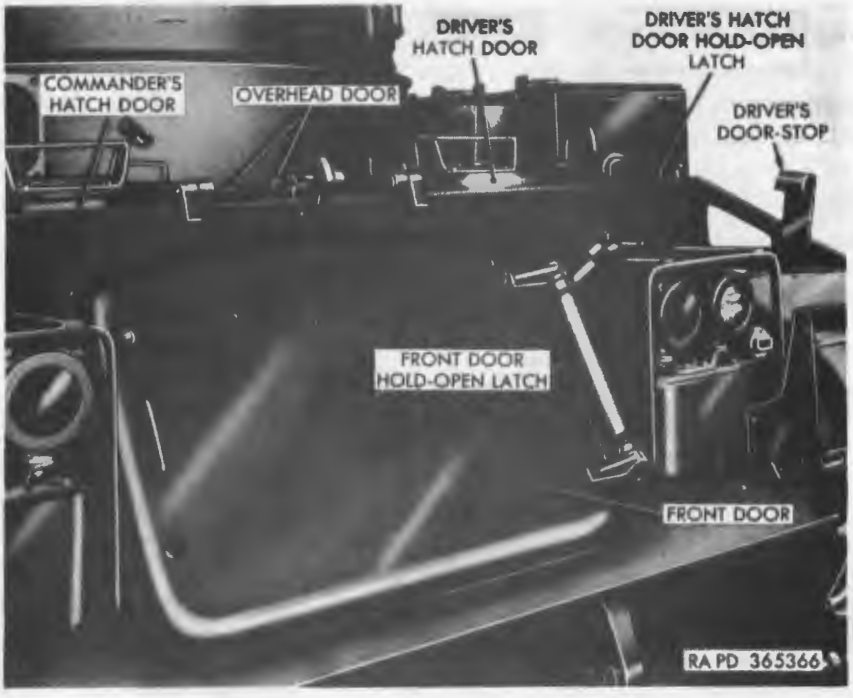


Figure 7. Front door in closed position.

c. Late Vehicles (fig. 6). The front door has provisions to mount the periscope M19 stowage box, flashlight retaining bracket, and the cal. .30 ammunition stowage box.

13. Commander's and Driver's Hatch Door Controls (fig. 7)

The commander's and driver's hatch doors are located at the front right and left of the vehicle respectively. In principle, the two doors are identical; the major difference is that they open outward in opposite directions and the driver's hatch door has a padlock lug for locking the hatch from the outside. Each door is equipped with an inside locking lever, a spring which acts against the door's weight for easier operation, and a hold-open latch to prevent the doors from swinging closed. The doors are sealed, when closed, by rubber gaskets which are compressed by the cam action of the locking levers.

Note. Front and rear overhead doors to the driving compartment are provided on vehicles with Ordnance serial Nos. 1 through 1137, 1205 through 1354, and 1555 through 1626. On all other M42 vehicles, overhead doors are not provided and a flat steel plate has been welded in this location.

14. Driving Compartment Overhead Door Controls—Early Vehicles (fig. 8)

Front and rear overhead doors to the driving compartment facilitate the passing of 40-mm ammunition from the stowage compartment to the gun mount. These doors open upward and are retained in their open positions by hold-open latches. The doors are supported by a center bar which is pivot mounted at its front end so it can be swung out of the way when the doors are opened. Each door is equipped with cam action locking handles that secure the doors to the center support bar.

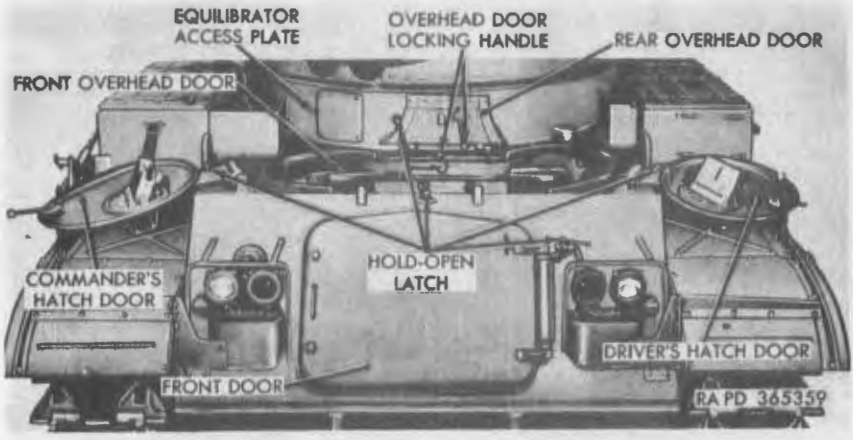


Figure 8. Driving compartment overhead doors in open position—early vehicles.

15. Commander's Seat Controls

(fig. 9)

The commander's seat is mounted in the right side of the driving compartment beneath the commander's hatch door. Height of the seat can be adjusted to individual preference by means of the vertical adjustment handle. To raise or lower the seat, lift the vertical adjustment handle and raise or lower body weight until position desired is reached. The seat will lock in place when the vertical adjustment handle is pushed downward.

Caution: Do not attempt to adjust seat height unless sitting in seat as body weight is required to control action.

The commander's seat mounting post is quickly detachable at the top and pivot-mounted at the bottom so that it may be swung down for

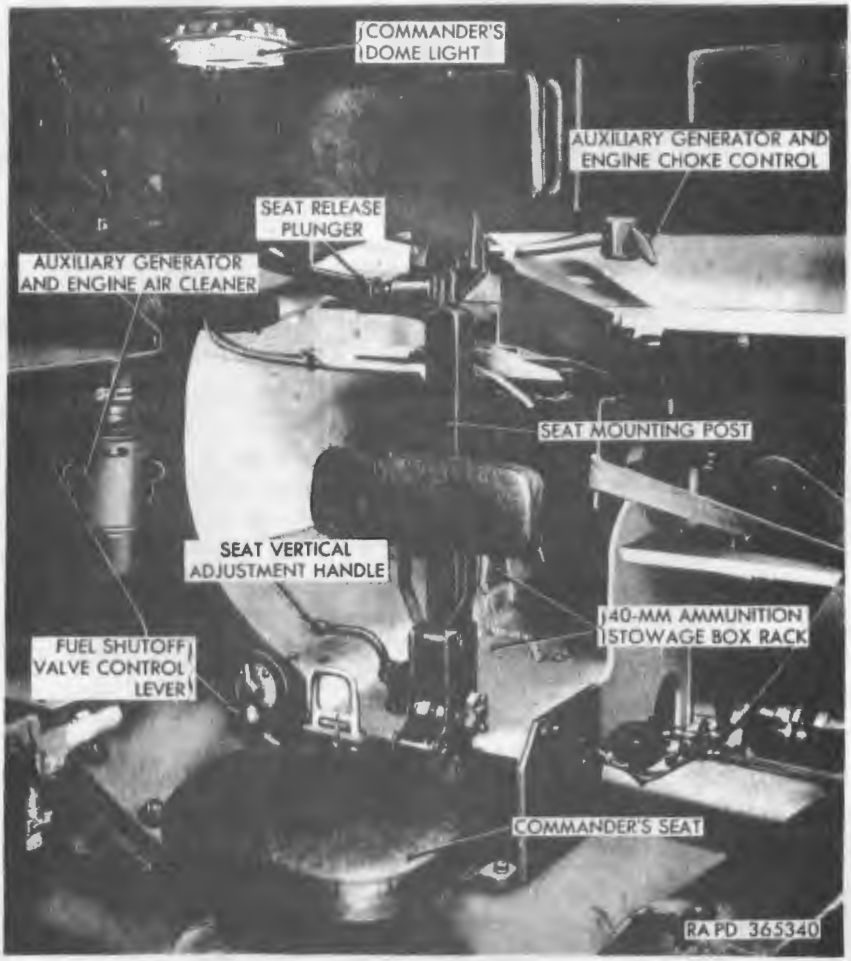


Figure 9. Commander's seat and controls.

access to the stowage compartment area. To detach the seat mounting post, pull out the release plunger at the top right and lower the post.

16. Driver's Seat Controls

(fig. 10)

The driver's seat is mounted in the left side of the driving compartment on a vertical column. The seat is equipped with a removable backrest and is adjustable vertically and horizontally. This seat can be released to hang parallel with the hull side wall to facilitate ammunition handling. To adjust the seat height, pull upward on the vertical adjustment handle and raise or lower body weight until desired position is reached.

Caution: Do not attempt to adjust seat height unless sitting in seat as body weight is required to control action.

The seat will lock in position when the vertical adjustment handle is released. To move the seat horizontally, pull upward on the horizontal control handle, shift the seat forward or backward, and release the handle to lock the seat in place. Pull the trip release to drop the seat parallel with the hull side wall. The trip release is painted red to avoid accidental usage.

17. Fuel Shutoff Valve Control Lever

(fig. 9)

The fuel shutoff valve control lever is mounted behind the commander's seat in the driving compartment. This 5-position lever controls the fuel shutoff valve in the engine compartment by mechanical linkage. Lever positions are: ALL OFF, tanks will not crossfeed and no fuel will flow; OFF, fuel will not flow but tanks will crossfeed; RIGHT ON, tanks will not crossfeed but fuel will flow from the right tank; LEFT ON, tanks will not crossfeed but fuel will flow from the left tank; and BOTH ON, tanks will crossfeed and fuel will flow from both fuel tanks. The BOTH ON position is used for normal operation.

18. Primer Pump

a. The primer pump is a manually operated pump which forces fuel into the intake valve port of the cylinder assembly to facilitate starting. The accelerator pedal cannot be used for priming since the throttle pump discharges fuel ahead of the supercharger which, during cranking with the starter, does not turn at enough speed to introduce the fuel mixture into the cylinders. Vehicles with Ordnance serial Nos. 1 through 1662 have the primer pump mounted in a vertical position to the left rear of the driver's seat (fig. 10). Vehicles

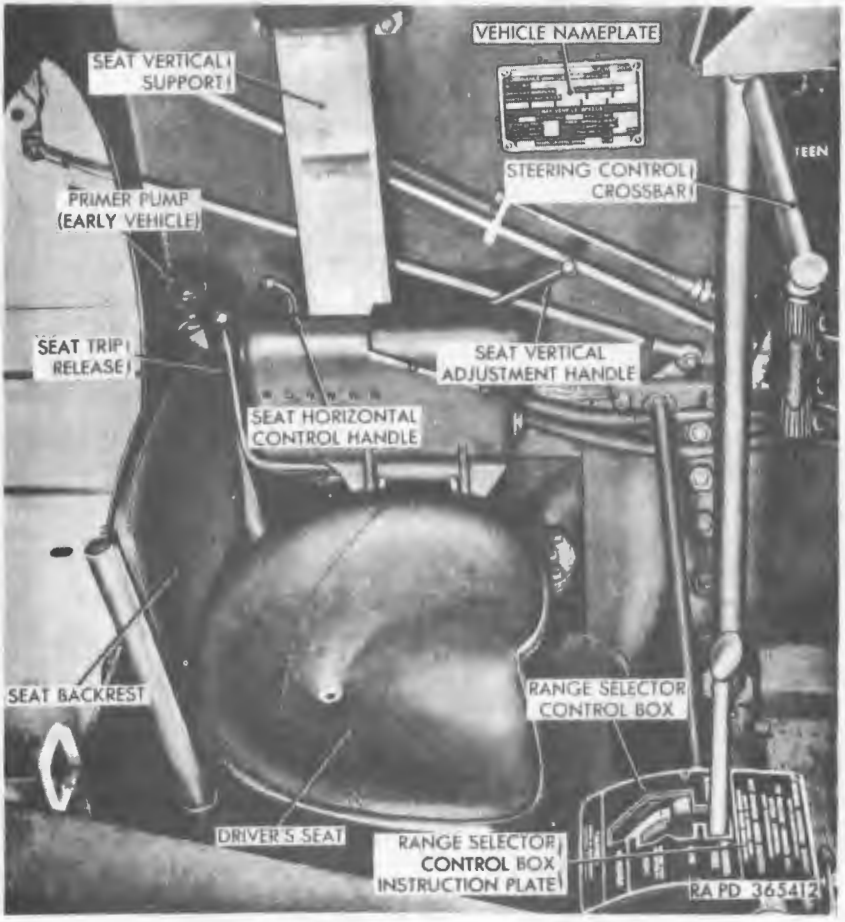


Figure 10. Driver's seat and controls.

with Ordnance serial Nos. 1663 and up have the primer pump mounted in a more accessible position alongside the range selector control box (fig. 11).

b. At temperatures of freezing and below, it is necessary to do some priming; the primer pump should be operated only while the engine is being cranked. The number of strokes necessary to prime at various temperatures is given in table I. Under no circumstances should the number of priming strokes for a given temperature be exceeded. If the exact ambient temperature is unknown, estimate the temperature conservatively so that the least number of priming strokes will be used. Excessive priming may cause hydrostatic lock and result in serious damage to the engine.

Note. When using table I, allowances for humidity, altitude, and condition of engine should be considered.

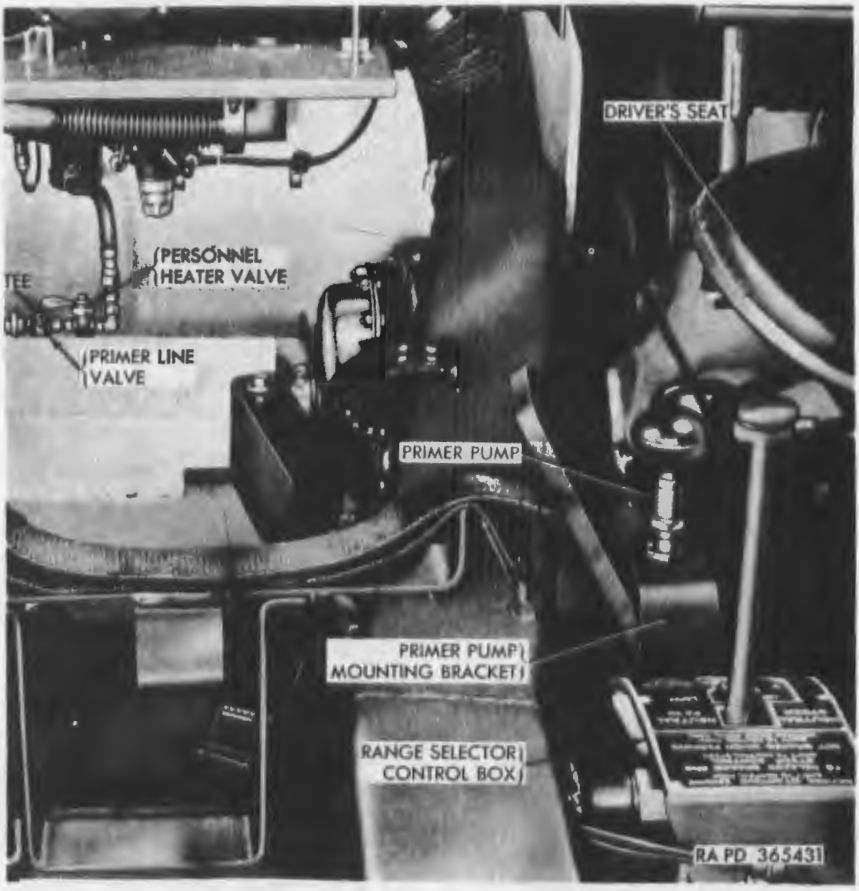


Figure 11. Primer pump location—late vehicles.

Table I. Priming Strokes Required with Starting Attempts in Subfreezing Temperatures

Ambient temperature	Priming strokes required
Above 32°F.	None
32° to 20°F.	1 to 3
19° to 10°F.	3 to 5
9° to 0°F.	5 to 6
—1° to —5°F.	7 to 10
—6° to —10°F.	8 to 10
—11° to —15°F.	9 to 13
—16° to —25°F.	10 to 14

c. As soon as the engine begins running, prime as required to maintain a smooth engine warmup speed of 1,500 rpm. Priming should be stopped when the engine will run smoothly by itself.

Note. At high priming rates, it takes longer for the primer pump to fill than discharge, therefore allow more time on the "out" (filling) stroke of the pump than on the "in" (discharge) stroke.

19. Accelerator
(fig. 12)

The accelerator, mounted to the right front of the driver's seat, is connected by mechanical linkage to both engine carburetors. The hand throttle is also connected to this linkage. A stepdown and a heel rest in the pedal surface are incorporated to accomodate various driver's seating positions.

Figure 12. Driving controls, levers, and pedals.

20. Hand Throttle

(fig. 12)

The hand throttle is mounted in a bracket immediately to the left of the steering control crossbar and provides for both coarse and fine throttle adjustments. Coarse adjustments are made by depressing the lock button and pulling the throttle outward to increase engine speed or pushing it inward to decrease engine speed. Fine throttle adjustments are made by turning the knob counterclockwise to increase engine speed or clockwise to decrease engine speed. Depress the lock button and the throttle will return to its idle position. When the throttle is returned to the idle position, turn the knob clockwise until tight to prevent it from creeping outward during driving operation.

21. Range Selector Control Lever

(fig. 12)

The range selector control lever is located to the right of the driver's seat and controls the five transmission driving ranges NEUTRAL PARK, NEUTRAL STEER, LOW, HIGH, and REVERSE.

22. Steering Control Crossbar

(fig. 10)

The steering control crossbar, located directly in front of the driver's seat, provides directional control of the vehicle. Mechanical linkage connects the steering control crossbar to the steering control valve on the transmission which operates the steering clutches. Refer to paragraph 44 for steering instructions.

23. Brake Pedal

(fig. 12)

The brake pedal is located in front of the driver on the hull floor. To apply the brakes, push the pedal forward with the foot. The pedal will return to the released position when pressure is removed from the pedal. The brakes may be locked for parking by moving the range selector control lever to the NEUTRAL PARK position before the brake pedal is applied. The parking brake is released by applying pressure to the brake pedal, moving the range selector control lever out of NEUTRAL PARK position, and releasing the brake pedal.

Caution: Do not shift out of NEUTRAL PARK without applying pressure to the pedal or injury may occur when pedal is released.

24. Hull Drain Valve Controls

a. Four drain valves are provided in the hull floor to drain the vehicle of any accumulated water, oil, or fuel. One valve is located

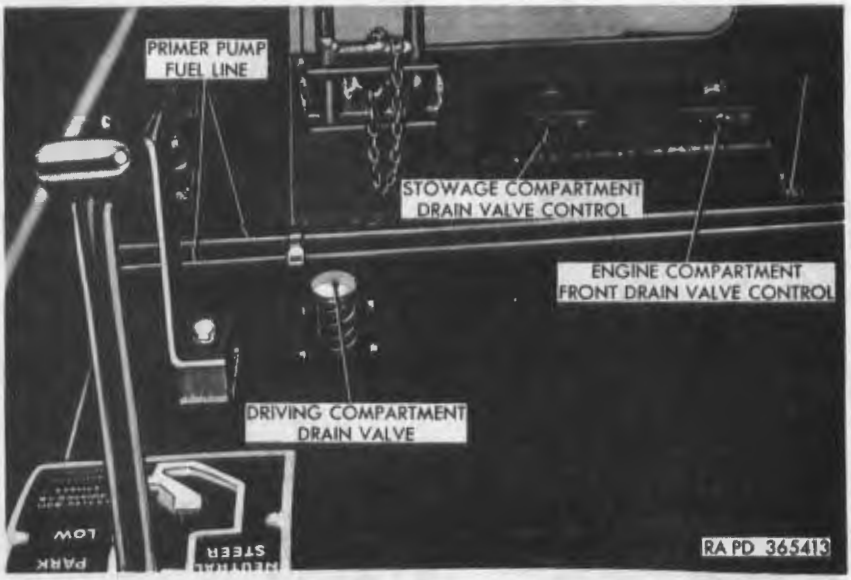


Figure 13. Driving, stowage, and engine compartment front drain valve controls.

in the driving compartment, one in the stowage compartment, and two in the engine compartment. The three valves in the stowage and engine compartments are operated by mechanical linkage. The valve in the driving compartment is operated by direct foot or hand pressure.

b. The driving compartment drain valve (fig. 13) is in the hull floor to the right of the driver's seat. This valve is opened by depressing and is spring-loaded to return to the closed position. However, the valve can be retained in the open position by depressing and turning one-quarter turn either left or right.

c. Controls for the stowage compartment drain valve and the engine compartment front drain valve are located to the right rear of the driver's seat. To open either valve, pull outward on the control (fig. 13) and hold in this position until draining is complete. The valve will close by spring tension when the control is released.

d. The engine compartment rear drain valve is operated by a control lever (fig. 14) mounted on the hull rear plate. To open drain valve, open the transmission access door and rotate the control lever upward. The valve will remain in the open position until the control lever is moved back to its horizontal position.

25. Instrument Panel
(fig. 15)

The instrument panel is located directly in front of the driver's

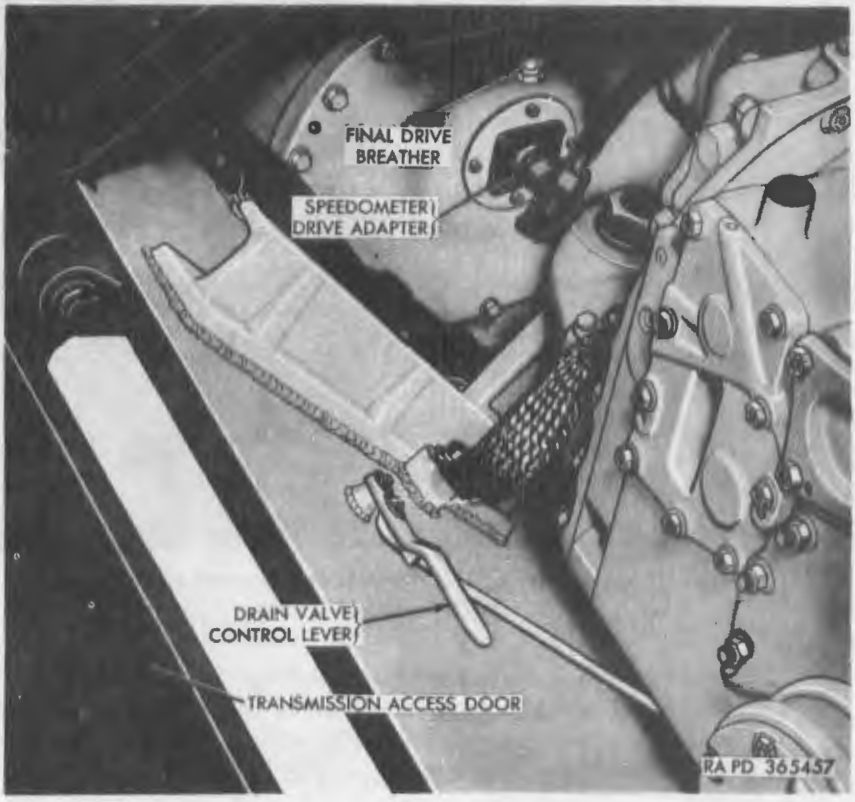


Figure 14. Engine compartment rear drain valve control lever.

steering controls. It contains the light switch assembly (A), warning light panel (B), starter, magneto, booster, and degasser (fuel cutoff) switch assembly (C), engine oil pressure gage (D), master relay switch (E), master relay switch indicator light (F), right and left fuel tank gages (G and K), high beam indicator light (H), and blackout receiver switch (J), a blackout selector switch (L), which is bracket mounted to the lower left corner of the instrument panel.

26. Master Relay Switch

(fig. 15)

The master relay switch (E) is located in the instrument panel in front of the driver. This switch electrically operates the master relay, which connects the batteries to the vehicle electrical system. The master relay switch indicator light (F), mounted to the left of the switch, lights when the batteries are connected to the vehicle electrical system.

Caution: Do not turn master relay switch off if radio is on.

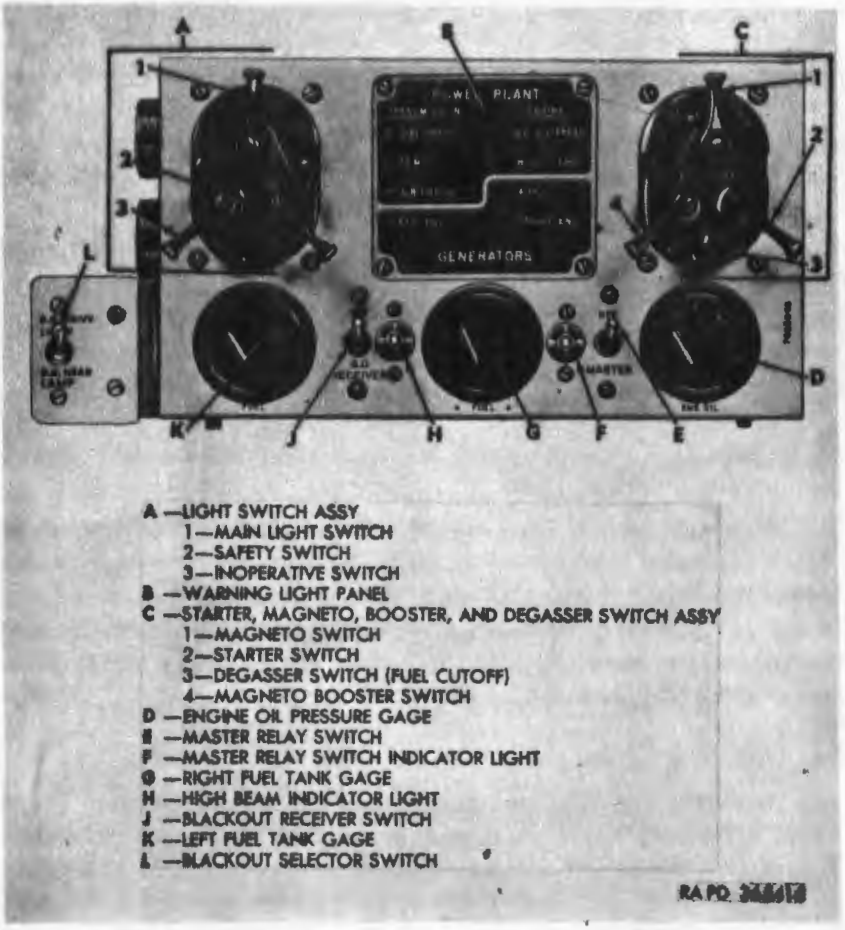


Figure 15. Instrument panel.

27. Starter, Magneto, Booster, and Degasser Switch Assembly (fig. 15)

a. General. The starter, magneto, booster, and degasser switch assembly (C) is located in the upper right corner of the instrument panel and consists of a starter switch, magneto switch, magneto booster switch, and a degasser switch.

b. Starter Switch (C–2). The starter switch is located in the lower right corner of the starter, magneto, booster, and degasser switch assembly. Switch positions are selected by a spring-loaded switch lever that returns to the off position when released.

c. Magneto Switch (C–1). The magneto switch is at the top of the starter, magneto, booster, and degasser switch assembly. It is a 4-position switch which controls the two engine magnetos by making

or breaking the magneto ground connections. When the magneto switch is in the OFF position, both magnetos are grounded and inoperative; in the BOTH position, both magnetos are operative; in the F or A positions, the flywheel or accessory magnetos, respectively, operate singly. The BOTH position is used for normal operation; whereas the F and A positions are only used for testing the operation of each magneto (par. 43*f*(2)).

d. Magneto Booster Switch (C–4). The magneto booster switch is located in the lower left corner of the starter, magneto, booster, and degasser switch assembly. It is used to energize the booster coil during engine cranking. Switch positions are selected by use of a spring-loaded lever that returns to the off position when released.

Caution: Do not operate the magneto booster switch for more than 30 seconds at a time as it will burn out the booster coil. Allow 5 minutes for the booster coil to cool between starting attempts.

e. Degasser Switch (fuel cutoff) (C–3). The degasser switch is on the bottom of the starter, magneto, booster, and degasser switch assembly. This is a plunger-type switch used to stop the flow of fuel in the idle circuit of the carburetors by electrically operating the carburetor degassers. To stop the engine, return to idle speed, press the switch and hold until the engine stops.

28. Light Switch Assembly

a. General. The light switch assembly (A, fig. 15), located in the upper left corner of the instrument panel, controls the driving lights. This switch consists of a main light switch (A–1, fig. 15), a safety switch (A–2, fig. 15), and an inoperative switch (A–3, fig. 15) that is not used on this vehicle. Early and late type vehicles have the same light switch assembly with the exception noted in *b* below.

b. Main Light Switch. The main light switch (A–1, fig. 15) is located at the top of the light switch assembly. The switch has five positions BO DRIVE (blackout headlights), BO MARKER (blackout marker), OFF, STOP LIGHT, and SER DRIVE (service headlights). The switch marked HEAD is inoperative on this vehicle. The main light switch lever can be moved only to the BO MARKER position without releasing the safety switch (*c* below). On early vehicles, the blackout headlights operate when the main light switch is placed in the BO DRIVE position (fig. 16). On late vehicles, a blackout driving light and blackout selector switch were added to be used in conjunction with the periscope M19. The switch is mounted on the instrument panel left mounting bracket and selects either the BO DRIVE LAMP or BO HEAD LAMP when the main light switch is in the BO DRIVE position (fig. 17).

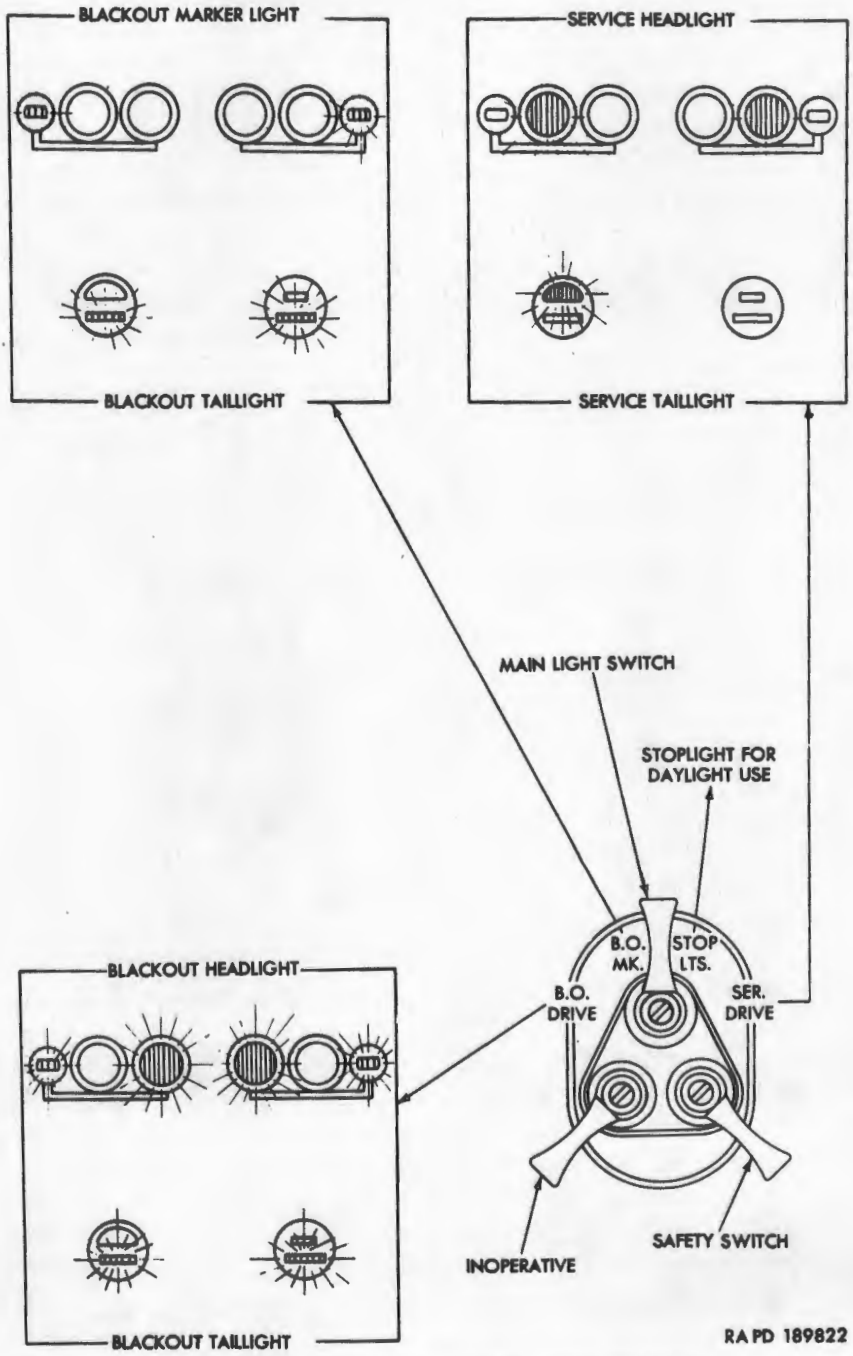


Figure 16. Driving lights chart—early vehicles.

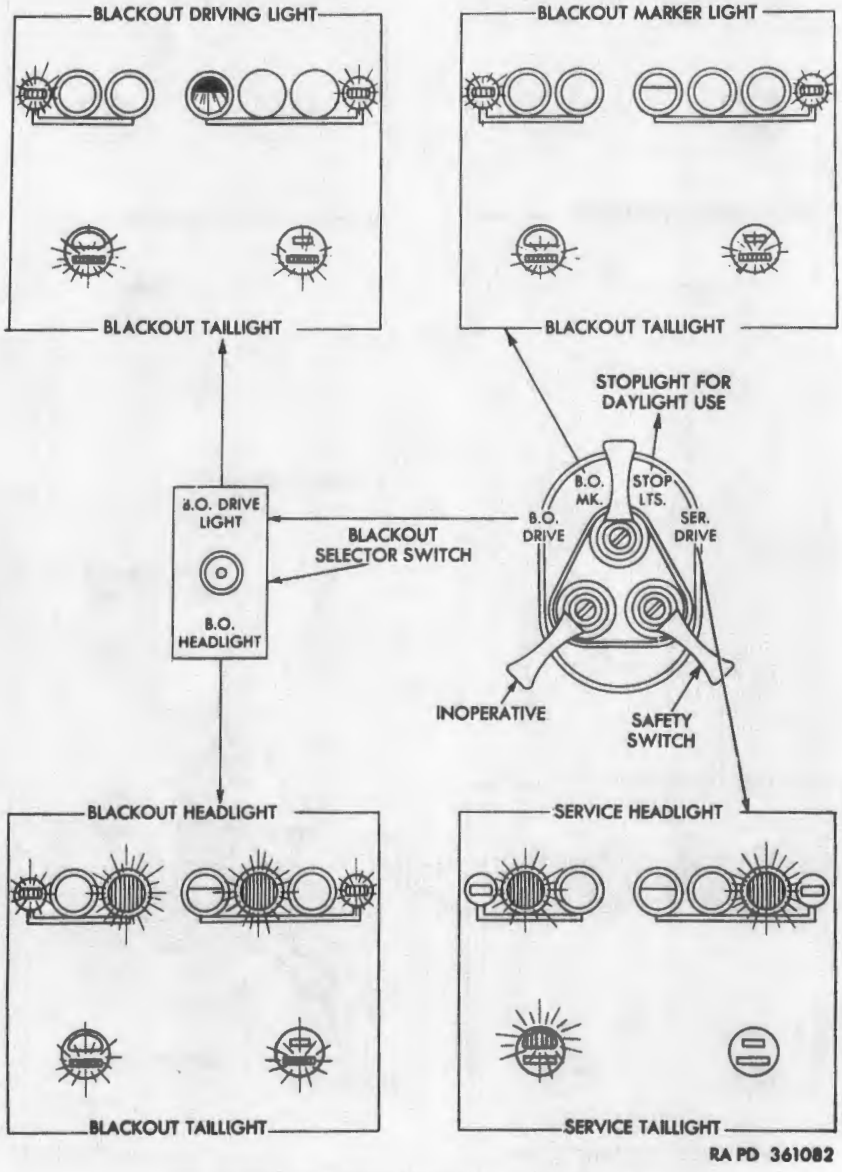


Figure 17. Driving lights chart—late vehicles.

c. Safety Switch (A–2, fig. 15). The safety switch is located in the lower right corner of the light switch assembly and prevents the main light switch from being operated accidentally during blackout condition.

29. Headlight Dimmer Switch

The headlight dimmer switch (fig. 12) is located on the hull floor to the left front of the driver's seat. It is a foot-operated, rotary switch which controls the upper and lower beams of the service headlights and blackout headlights. A high beam indicator light (H, fig. 15), located on the instrument panel, shows the position of the dimmer switch.

30. Hull Dome Light Switches

The three hull dome lights are identical units installed on the hull ceiling, two in the driving compartment and one in the rear of the ammunition stowage compartment (fig. 61). The driver's dome light

Figure 18. Speedometer, tachometer, and auxiliary generator and engine control box.

(fig. 18) is over the speedometer tachometer bracket and the commander's dome light (fig. 9) is in the right rear corner of the driving compartment. Each light is equipped with two lamps and separate red and white lenses. The dome lights are individually controlled by integral switches equipped with a safety latch to prevent accidental use of the white light. To turn red light on, move switch lever toward red lens. To turn white light on, push in plunger on end of switch lever, then move lever toward white lens. Turn off either red or white light by returning lever to center position.

31. Blackout Receiver Switch

The blackout receiver switch (J, fig. 15) is located on the lower left face of the instrument panel. It operates the high-voltage supply unit for the periscope M19 which is used in conjunction with the blackout headlights.

32. Horn Switch

The horn switch (fig. 18) is mounted on the steering control crossbar near the left steering control hand grip. On early vehicles, the horn switch is mounted near the right steering control hand grip. This push-button-type switch sounds the horn, which is mounted behind the right front driving lights.

33. Circuit Breakers

The three circuit breakers in the instrument panel are of the thermal-type, which reset automatically and protect their respective circuits. One circuit breaker is for the dome lights and blackout receiver, one for the horn and lighting system, and one for the gages, degasser, starting, booster, and warning light circuits.

34. Fuel Gages

a. General. Two fuel gages are mounted in the instrument panel. On early vehicles, the left fuel tank gage (K, fig. 15) is inoperative and the right fuel tank gage (G, fig. 15) indicates the approximate level of fuel in both fuel tanks when the fuel shutoff valve control lever is in the BOTH ON position. Both fuel gages are operative in late vehicles, the left gage indicates the fuel level in the left tank and the right gage indicates the fuel level in the right tank.

b. Fuel Quantities. Due to the irregular shape of the fuel tanks, the divisions on the fuel gage are not accurate indications of the amount of fuel. The data in table II indicates the amount of fuel remaining at the various gage indications.

Table II. Fuel Gage Correction

Fuel gage indication	Approximate gallons of fuel remaining	
	One gage operative	Both gages operative (each gage)
E	40	20
¼	85	42
½	113	56
¾	133	66
F	140	70

35. Main Engine Warning Lights

a. The engine high-oil-temperature warning light is located in the warning light panel (B, fig. 15) and is marked HI OIL TEMP. The lamp is energized by the engine high-oil-temperature warning light switch and lights when the engine oil temperature is above 245° ± 5° F.

b. The engine low-oil-pressure warning light is located in the warning light panel (B, fig. 15) and is marked LO OIL PRESS. The lamp is energized by the engine low-oil-pressure warning light switch and lights when the engine oil pressure is less than 30 ± 2 psi on engines through serial No. 7199. On engines with serial No. 7200 and up, the lamp is energized when the pressure is less than 17 ± 2 psi.

c. The main engine generator warning light is located in the warning light panel (B, fig. 15) and is marked LEFT ENG and will light when the main engine generator is not charging properly.

Note. The warning lights marked RIGHT ENG, LO AIR PRESS, and AUX are inoperative in this vehicle.

36. Transmission Warning Lights

a. The transmission high-oil-temperature warning light is located in the warning light panel (B, fig. 15) and is marked HI TEMP. The lamp is energized by the transmission high-oil-temperature warning light switch and lights when the transmission oil temperature reaches 280° ± 5° F.

b. The transmission low-oil-pressure warning light is located in the warning light panel (B, fig. 15) and is marked LO LUBE PRESS. The lamp is energized by the transmission low-oil-pressure warning light switch and lights when the transmission oil pressure is less than 11 psi.

37. Main Engine Oil Pressure Gage

The main engine oil pressure gage (D, fig. 15), located in the lower right corner of the instrument panel, indicates the ap-

proximate pressure in the engine lubrication system. The dial is calibrated to read from 0 to 120 psi. Normal engine oil pressure with OE 50 grade oil is from 60 to 70 psi at an engine speed of 1,600 rpm.

Note. Due to tilt of the instrument panel in this vehicle, the gage may indicate up to 20 psi more than true oil pressure.

38. Tachometer
(fig. 18)

a. The tachometer is mounted in a bracket with the speedometer in the upper left front corner of the driving compartment below the driver's dome light. It indicates engine crankshaft speed in hundreds of revolutions per minute, with the dial calibrated to read 0 to 40 (0 to 4,000 rpm). For example: if the engine is operating at 2,800 rpm, the pointer will indicate 28 on the dial.

b. An hourmeter is provided as part of the tachometer and registers total engine operating time in hours and tenths of an hour on a basis of 2,053 rpm. If the engine is operated at a slower speed, it will require more than one hour of actual time to make the hourmeter record one additional hour. Conversely, the hourmeter will register more than the actual time if the engine is continuously operated faster than 2,053 rpm.

39. Speedometer

The speedometer (fig. 18) is mounted in a bracket with the tachometer in the upper left front corner of the driving compartment below the driver's dome light. This instrument is connected by a flexible shaft to a speedometer drive adapter (fig. 14) on the left final drive housing and is calibrated to indicate vehicle speed within a range from 0 to 60 mph. It is equipped with an odometer (fig. 18) which registers total cumulative vehicle mileage.

40. Periscope M19

a. General. Periscope M19 (fig. 19) is a binocular-type infrared viewing device used when driving the vehicle under blackout conditions. Infrared rays are projected forward from the blackout headlights to illuminate the field of view and the periscope M19 converts the infrared image to a visible image which is viewed through conventional eyepieces. The periscope is supported by its trunnions in a holder mounted in the driver's hatch cover. The head assembly projects through the cover and the body assembly is contained within the vehicle.

b. Controls.

(1) *Elevation setting lever* (fig. 20). Vertical line-of-sight adjustment is made by manually rotating the periscope

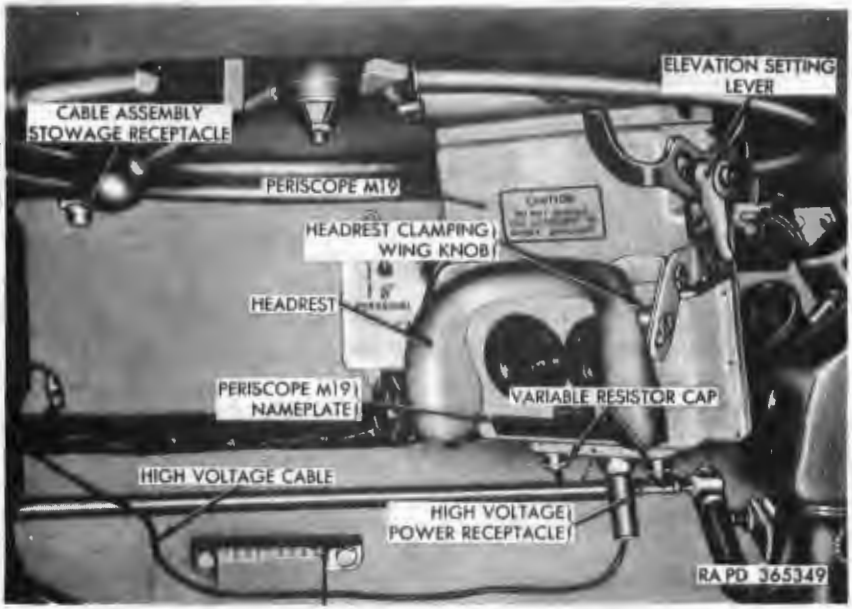


Figure 19. Periscope M19—installed view.

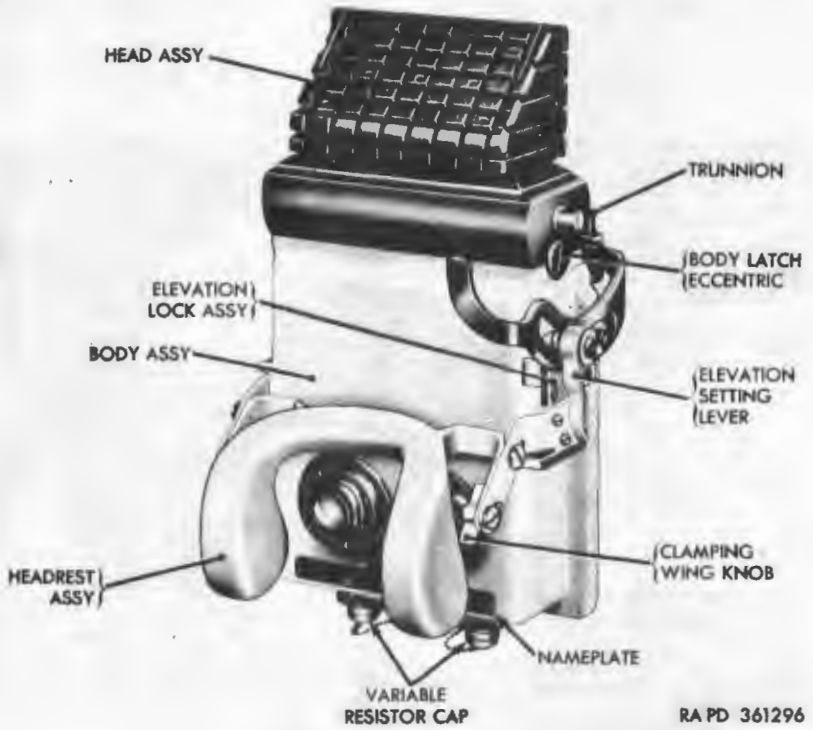


Figure 20. Periscope M19.

M19 on its trunnions. The elevation setting lever maintains the desired adjustment.

(2) *Headrest clamping wing knobs* (fig. 20). An adjustable headrest provides support for the operator and adjustment of the distance from the operator's eyes to the eyepieces. Two clamping wing knobs secure this adjustment.

(3) *Focus.* Left and right focus controls, as indicated on the nameplate, are located on the bottom of the periscope M19 body assembly. These controls provide an external adjustment for the electrostatic focus and are protected by variable resistor caps (fig. 20) which screw onto the control receptacles.

(4) *Switch.* The blackout receiver switch (J, fig. 15) on the instrument panel connects the high voltage power supply unit to the vehicle batteries.

(5) *Power supply unit.* The high-voltage power supply unit is located on the rear of the bulkhead behind the driver and supplies the power through a high voltage cable to operate the periscope M19.

Caution: Because of the high voltage, do not operate the power supply unit unless it is connected to the periscope M19.

c. Stowage. When not in use, the periscope M19 is stowed in

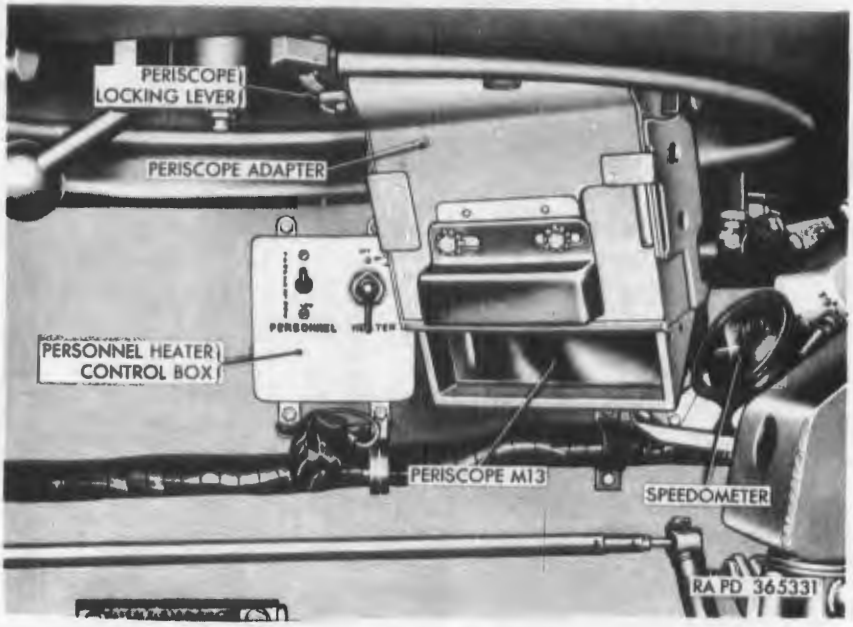


Figure 21. Periscope M13—installed view.

the stowage box located on the center inside surface of the front door (fig. 6).

41. Periscope M13 or M13B1

The periscope M13 (fig. 21) or M13B1 is used by the driver and commander while operating under combat conditions during daylight hours. The periscope M13 or M13B1 is retained in the driver's or commander's hatch cover by an adapter. The driver's periscope is stowed in the periscope stowage box mounted on the hull roof directly behind the driver. The commander's periscope is stowed in the stowage box mounted on the front slope plate directly in front of the commander's position. The driver's periscope adapter is stowed in the periscope M19 stowage box when the periscope M19 is installed in the driver's hatch cover.

Section III. OPERATION OF VEHICLE UNDER USUAL CONDITIONS

42. General

This section contains instructions for the mechanical steps necessary to operate the twin 40-mm full tracked self-propelled gun M42 (T141) under conditions of moderate temperatures and humidity. For operation under unusual conditions, refer to paragraphs 76 through 81.

43. Starting the Main Engine

a. General.

(1) Before a new or reconditioned vehicle is placed in service, be sure that the services outlined in paragraphs 7 through 10 have been performed.

(2) Before attempting to start the vehicle engine, the driver must be familiar with the purpose and location of the various instruments and controls as outlined in paragraphs 11 through 41.

Caution: If a warning tag is attached in driver's compartment, correct deficiency indicated on tag before starting engine.

(3) Perform the before-operation services in table V before attempting to start engine.

b. Starting the Engine with Full Battery Charge.

Caution: Be sure radio switches are off before starting the engine. After engine is started, radio may be turned on.

(1) Move the steering control crossbar (par. 22) to its neutral position, and the range selector control lever (par. 21) to NEUTRAL PARK position.

Note. The steering control must be in neutral position and the range selector control lever in NEUTRAL PARK position before the engine can be started.

(2) Set parking brake (par. 23).

(3) Turn on master relay switch (par. 26). Apply starter switch (par. 27*b*), but do not activate magneto or booster switches. This should crank engine. If engine will not crank, hydrostatic lock or a mechanical seizure of engine parts is indicated. If the engine is hydrostatically locked, correct (par. 110*b*). If there is indication of mechanical seizure of engine parts, do not attempt to start engine; notify ordnance maintenance personnel.

(4) Turn fuel shutoff valve control lever to the BOTH ON position (par. 17).

(5) Pull out hand throttle (par. 20) approximately one inch.

(6) Turn the magneto switch to the BOTH position (par. 27*c*).

(7) Check quantity of fuel in fuel tanks (par. 34).

Note. Fuel gages are energized through the magneto switch.

(8) Turn the main engine starter switch (par. 27*b*) and the booster switch on (par. 27*d*). If the atmospheric temperature is below 32° F., prime the engine (par. 18) while attempting to start.

Caution: Do not deviate from priming procedure in paragraph 18 or engine may flood. Also, do not hold the starter and booster switch on longer than 30 seconds at a time as this would seriously damage the starter and booster coil and reduce the battery charge.

If the engine does not start within 30 seconds, discontinue starting attempt for 5 minutes to allow starter and booster coil to cool.

(9) Release starter and booster switches as soon as engine starts. If ambient temperature is below freezing, use primer pump as required to maintain smooth operation of engine during warmup period. Accelerate several times until engine operates with relative smoothness and check that the low-oil-pressure warning light goes out within 10 seconds after engine has started. If warning light remains illuminated, stop engine and investigate cause. Idle engine at 1,500 rpm for 3 to 8 minutes to insure complete warmup.

Caution: Do not allow engine to idle at less than 650 rpm at any time.

c. Starting the Engine with Reduced Battery Charge. If battery charge is reduced due to low ambient temperature or because

of inactivity, start the auxiliary generator and engine (par. 70) and allow 5 minutes or more for batteries to be replenished before attempting to start engine (*b* above). The auxiliary generator and engine should be left running until after the main engine has been started.

d. Starting the Engine with Dead Batteries. The three methods used to start a vehicle in which the batteries have become completely discharged are described in (1) through (3) below.

(1) Start the auxiliary generator and engine with hand starter (par. 70*c*).

(2) Connect an external power source (*e.g., another vehicle*) to the auxiliary power receptacle (*e* below) by means of extension cable—17–C–568.

(3) Towing the vehicle (par. 47*c*).

e. Starting Engine from an Outside Power Source.

(1) Connect extension cable—17–C–568 to the auxiliary power receptacle (fig. 143) in each vehicle.

Caution: The master relay switch in both vehicles must be in the OFF position while connecting the extension cable.

(2) Start the engine in the vehicle which is to supply the auxiliary power and adjust the engine idling speed to 1,400 rpm.

(3) Start the engine in the vehicle with the dead batteries, with the master relay switch turned on.

(4) When the engine in the started vehicle is running smoothly, turn off the master relay switch in both vehicles and disconnect the extension cable from both vehicles. After the disconnection is made, turn on master relay switches of both vehicles.

f. Checking Engine Operation. The following checks must be performed after completion of the procedures in *b* above or prior to driving the vehicle.

(1) Check engine oil pressure gage (D, fig. 15) after idling engine to 650 rpm. Engine oil pressure may drop as low as 20 psi when using engine lubricating oil OE–10 causing the engine low-oil-pressure warning light on the warning panel (B, fig. 15) to flicker on and off. However, warning light should remain out when engine speed is advanced to 750 rpm or higher.

(2) Test magnetos with transmission in NEUTRAL PARK position at end of engine warmup period (*b* (9) above). Adjust hand throttle until engine is running smoothly

at 1,800 rpm. While maintaining this speed, move the magneto switch (C–1, fig. 15) to the F position and then to the A position, comparing the tachometer reading at each of these positions to the indication (1,800 rpm) at the BOTH position. Refer to paragraph 112 if a tachometer indication of less than 1,650 rpm occurs when the switch is moved to either the F or A position.

Caution: Do not run the engine for more than one minute with the magneto switch in either the F or A position as spark plugs may become fouled.

After the magneto test is completed, move the magneto switch to the BOTH position and accelerate the engine several times to clear system.

(3) Check that all warning lights on the instrument panel remain out. If any warning lights remain illuminated, stop the engine and investigate the cause.

44. Placing the Vehicle in Motion

a. General. When tactical situation permits, engage traversing lock and elevating travel lock (par. 62). If the vehicle is to be maneuvered in close quarters, station a guide in front of and/or behind the vehicle to assist the driver until the vehicle is in open terrain. If the guide is at rear of the vehicle, station a man to relay the signals to the driver. At all times while operating the vehicle, observe gages and instruments on the instrument panel (fig. 15).

b. Driving the Vehicle Forward.

(1) Start the engine (par. 43). Perform all during operation services (table V).

(2) Shift the range selector control lever (fig. 12) either to the HIGH or LOW range while the engine is at idle speed. For driving on normal level terrain, place the range selector control lever in HIGH range. If driving is to be upgrade or downgrade or on muddy terrain, place the lever in LOW range. Refer to paragraph 45 for information concerning ascending or descending steep grades.

(3) Depress the accelerator (fig. 12) to move the vehicle forward. Maximum operating speeds are 45 mph in HIGH range and 11 mph in LOW range.

(4) The range selector control lever may be shifted from LOW to HIGH range or from HIGH to LOW range while the vehicle is in motion. To shift from LOW to HIGH range, release accelerator pressure, move range selector

control lever (fig. 12) into the HIGH range, and depress accelerator. When shifting from HIGH into LOW range, reduce vehicle speed to 8 to 10 mph, accelerate engine to full throttle, then shift the range selector control lever to LOW range.

Caution: Do not attempt to shift from HIGH to LOW range without advancing engine speed to full throttle, as vehicle speed would reduce sharply due to increased transmission braking action in LOW range.

(5) Steering the vehicle while moving forward is conventional; pulling the left steering control hand grip (fig. 12) turns the vehicle left, and pulling the right hand grip turns the vehicle right. Gradual or sharp turns are governed by the amount the steering control crossbar is moved. The minimum turning radius in LOW range is 18 feet (fig. 22), in HIGH range, 55 feet.

(6) Greater care in driving must be observed at all times when operating on hard surface or pavement. Normally, the vehicle may be driven safely at recommended speed, providing the driver has the proper skill and experience in operating this type of vehicle.

Warning: Careless handling can result in loss of steering control and subsequent injury to personnel, damage to property, and damage to vehicle.

c. Driving the Vehicle in Reverse.

(1) Two special conditions must be considered when backing up a vehicle. These are: limited driver visibility and opposite steering when the range selector control lever (fig. 12) is in REVERSE range.

(2) Start the engine (par. 43). Perform all during operation services (table V).

(3) With the engine at idle speed (650 rpm), shift the range selector control lever to REVERSE range.

(4) Station a guide in front of the vehicle to direct the driver while backing the vehicle. If tactical situation prevents the use of a guide, back the vehicle with caution to prevent a collision and have a man in the gun mount relay instructions through the interphone system.

(5) Back the vehicle slowly, while observing the directions of the guide. To turn the rear of the vehicle to the right, pull the left steering control hand grip (fig. 12); to turn left, pull the right hand grip.

(6) To shift the range selector control lever (fig. 12) into or out of REVERSE range, bring the vehicle to a dead stop,

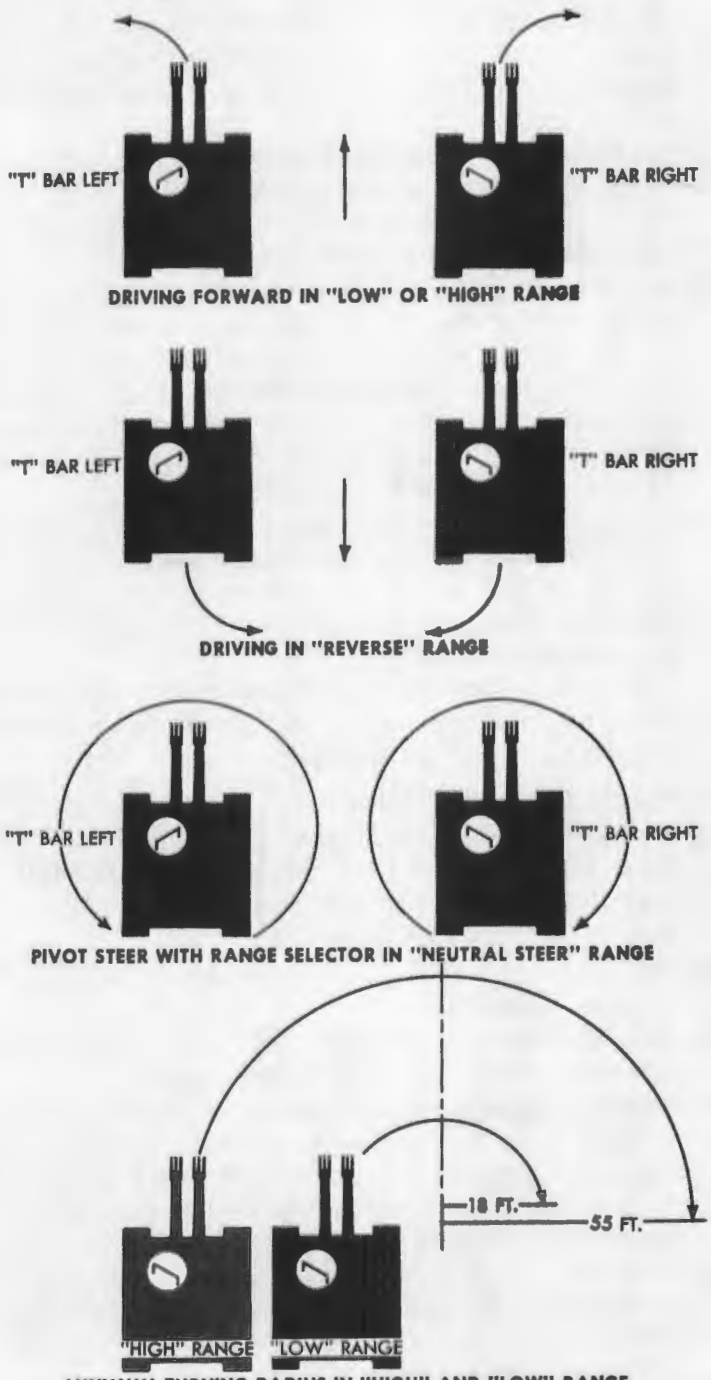


Figure 22. Steering chart.

allow engine speed to return to idle (650 rpm), and move the range selector control lever to the desired range.

d. Pivoting the Vehicle in Place. In this maneuver, the tracks are being turned in opposite directions and the vehicle will pivot in place. To pivot steer, hold range selector control lever (fig. 12) in NEUTRAL STEER position, pull steering control crossbar to full steer position in desired direction and maintain full steer force. Increase engine speed and control vehicle motion with accelerator pedal.

Caution: To maintain complete control of the vehicle, do not deviate from this procedure.

45. Ascending or Descending Steep Grades, Ditches, and Obstructions

a. Ascending Steep Grades. Steep upgrades are usually negotiated in LOW range. The only exception to this would be if the upgrade were relatively short, and the vehicle speed great enough to carry it over the peak. If a long climb is encountered while driving, the usual procedure is to continue driving in HIGH range until initial speed has been decreased by the incline to approximately 11 mph, then to downshift into LOW range as described in paragraph 44*b*. During a long climb, be especially watchful of all high temperature warning lights on the warning light panel (B, fig. 15). Should any warning light come on, stop the vehicle, set the parking brake (par. 23), and allow the engine to idle at 1,000 to 1,500 rpm until all high temperature warning lights go out. When temperature returns to normal, the climb may be resumed.

Caution: Do not attempt to ascend grades greater than 60 percent or 30° as this would cause oil circulation failure in the engine.

b. Descending Steep Grades. To drive down short, steep grades, shift the range selector control lever (fig. 12) into LOW range for better speed control. LOW range will usually brake the vehicle sufficiently so that application of the brakes is not necessary. If, however, the vehicle is not slowed adequately, use intermittent application of the brakes to further decrease speed. When approaching long steep downgrades, start the descent as described above. If the grade is severe and it is found necessary to "ride" the brakes for long periods, stop the vehicle frequently and shift the range selector control lever (fig. 12) into NEUTRAL PARK position and idle the engine at 1,000 to 1,500 rpm to allow the transmission to cool.

Warning: Do not coast down grades in NEUTRAL PARK position as this can result in loss of control as steering will lock when

the steering control crossbar is centered and the brakes will lock when applied. The loss of control could result in a fatal accident. Keep close watch of the transmission high temperature warning light during this maneuver as the transmission will tend to overheat quickly. During long descents in LOW range, it will be normal for the transmission high temperature warning light to be illuminated occasionally because of the increased friction and resultant heat. Each time the warning light goes on, stop the vehicle, set the parking brake (par. 23), and idle engine at 1,000 to 1,500 rpm to allow the transmission to cool before continuing further. When the bottom of the grade is reached, shift range selector control lever (fig. 12) to the desired forward range, and proceed.

c. Ditches and Obstructions. When crossing a ditch, shell hole, or trench, release accelerate pedal gradually, slow to a point where a shift to LOW range is possible, shift and enter the depression slowly, then bring engine up to full power as vehicle starts to climb. When going over an obstruction, release accelerator pedal and allow the vehicle to settle down over the obstruction before applying full power. In going over a high obstruction, it may be necessary to use full power at the start, but, upon reaching the crest of the obstruction, release accelerator until vehicle is fully over the top of the obstacle. Use LOW range to travel over a series of obstructions.

Caution: Use care not to damage the guns or fenders when climbing into or out of ditches or shell holes, or when approaching or pulling away from obstructions,

46. Stopping the Vehicle and Stopping the Engine

a. Stopping the Vehicle. To stop the vehicle, release foot pressure on accelerator pedal and depress the brake pedal.

Caution: Do not move range selector control lever to NEUTRAL PARK position until vehicle is brought to a complete stop. Some steering may be necessary to control direction of vehicle during braking and stopping operation.

When vehicle is stopped, set the parking brake (par. 23) and perform the at-the-halt services (table V). If it is necessary to leave the engine idling during an extended halt, accelerate the engine to 1,000 to 1,100 rpm for 5 to 10 seconds at least once every 15 minutes. This is necessary to reduce the possibility of spark plugs becoming fouled and to increase the generator output. Under no circumstances should the vehicle be left unattended while the engine is running.

b. Stopping the Engine. After stopping the vehicle, set the hand throttle to operate the engine at 1,000 to 1,100 rpm and allow

the engine to run at this speed for 2 to 5 minutes to assure gradual and uniform cooling of valves and other engine parts. When the cooling period is over, reduce the engine speed to idle (650 rpm) and depress the degasser switch (fuel cutoff) (C–3, fig. 15) until the engine stops. Turn the engine magneto switch to the OFF position. If the vehicle is to be stopped for any length of time and no accessories, lights, or radios are to be used during the halt, turn the master relay switch (E, fig. 15) to the OFF position. Perform the after operation services (table V).

47. Towing the Vehicle

a. General. The vehicle is equipped with four towing hooks, a towing pintle, and a tow cable. Two towing hooks are mounted on the front of the vehicle and two are mounted on the rear. The towing pintle is not to be used for towing heavy loads; its purpose is for small trailers or field pieces. A tow cable is furnished with each vehicle and is secured to the 40-mm ammunition stowage boxes on the right side of the vehicle. Its use is for towing disabled vehicles and other similar functions, but it is not recommended as a means of starting a vehicle unless the alternate starting methods fail (*c* below).

b. Towing a Disabled Vehicle. A driver must be in control of a disabled vehicle at all times during towing operations. Hold the range selector control lever in NEUTRAL STEER position during the entire towing operation. If the range selector control lever is in NEUTRAL PARK position, the parking brake will be set automatically whenever the service brakes are applied. Should the vehicle become disabled because of a final drive or track failure, remove the universal joints (par. 218) to prevent possible damage to the steering system or fuel tanks.

Warning: When universal joints are disconnected, all vehicle driving controls including the brakes are inoperative, therefore, do not exceed 5 mph.

If the pulling vehicle is an M42, traverse and lock the 40-mm gun in a forward position to prevent the gun from colliding with the towed vehicle or causing injury to the driver. Keep the vehicles in line as much as possible, especially when entering and crossing wet or muddy terrain. If the service brakes of the disabled vehicle are operative, maximum speed should never exceed 12 mph during a towing operation.

Caution: The towing cable must not be connected by any means other than the cable eyes, as doubling the cable causes short bends which break the wire strands, leaving the cable weak and dangerous to handle.

c. Pulling a Vehicle to Start Engine. Pulling to start the engine is the least recommended method of emergency starting because

the towed vehicle could easily collide with the pulling vehicle and result in a serious accident unless a rigid type tow bar is available. Furthermore, should the battery charge be insufficient to start the engine, two other alternate methods of starting the main engine are described: starting the auxiliary generator and engine with hand starter (par. 70*c*) or connecting a power source to the auxiliary power receptacle (par. 43*e*). These provisions make towing to start the vehicle highly impractical because of the possible danger involved. However, should these alternate methods fail, connect the tow cable to the front towing hooks of the vehicle and to the rear towing hooks of pulling vehicle in a crisscross pattern. Turn on the master relay switch (par. 26) and the magneto switch to the magneto switch to the BOTH position. If the ambient temperature is below 32° F., prime the engine as indicated in paragraph 18. When the vehicle reaches a speed of 5 mph, shift the range selector control lever into LOW range and hold the magneto booster switch (C–4, fig. 15) on.

Caution: Do not operate the booster switch longer than 30 seconds at a time as the booster coil may burn out. Allow 5 minutes for the booster coil to cool before the next starting attempt. Release the booster switch when the engine is running smoothly. In subfreezing temperatures, use the primer pump (par. 18) as required to maintain smooth engine operation during the 3 to 8 minutes warmup period.

48. Periscope M13 or M13B1

a. General. The periscope M13 or M13B1 is mounted in the periscope adapter (fig. 21) by inserting the periscope in the adapter and tightening the locking knob on the rear of the periscope.

b. Operation. To operate the periscope M13 or M13B1, grasp the sides and elevate or depress the periscope and adapter until the desired view is obtained.

c. Removal and Stowage. Periscope M13 or M13B1 should be stowed when not in use. To remove the periscope, loosen the locking knob and slide the periscope from the adapter. Stow the periscope in the periscope box (fig. 59) behind the driver. The periscope adapter remains in the driver's hatch cover holder unless the periscope M19 is to be used. To remove the periscope adapter, depress the two locking levers on the driver's hatch cover and remove adapter. Stow adapter in periscope M19 stowage box.

49. Periscope M19

a. Installation. Remove and stow periscope M13 and adapter (par. 48*c*). To install the periscope M19, depress the periscope

locking levers (fig. 21) and insert the periscope in the holder with the trunnions in the periscope holder bearings. Release the locking levers. Connect the high voltage cable to the periscope high voltage power receptacle (fig. 19) and tighten securely.

b. Operation. Turn on the blackout receiver switch (J, fig. 15) on the instrument panel and blackout selector switch (L, fig. 15) to the BO DRIVE LAMP position. Adjust the vertical line-of-sight by manually rotating the periscope on its trunnions. Lock periscope in desired position with elevation setting lever (fig. 19). Adjust the headrest for proper eye distance by loosening two headrest clamping wing knobs (fig. 19). Adjust headrest to the desired position. After positioning headrest, tighten clamping wing knobs. After one minute warmup period, observe through the eyepieces of the periscope for an image to appear. If image is not clear notify ordnance maintenance personnel to adjust variable resistors for electrostatic focus.

c. Removal and Stowage.

Caution: Make certain that blackout receiver switch (J, fig. 15) and blackout selector switch are off.

Disconnect the high voltage cable (fig. 19) from the high voltage power receptacle. Remove the periscope M19 from holder by depressing the locking levers (fig. 21) and sliding periscope out of the holder. Place periscope in stowage box located on the inside surface of the front door (fig. 6).

Section IV. ARMAMENT AND SIGHTING AND FIRE CONTROL MATERIEL, CONTROLS, AND INSTRUMENTS

50. General

This section describes, locates, illustrates, and furnishes the crew with sufficient information to understand the basic functions of the various controls and instruments which operate the armament and sighting and fire control materiel.

51. Computing Sight M38 (T154)

a. General (fig. 23). The computing sight M38 (T154) is an on-carriage sighting device designed to provide an effective means of controlling fire of the 40-mm automatic dual gun M2A1 against either a vehicular or a rapidly moving aerial target. It is mounted across the top of the breech casings.

b. Computer (fig. 24). The computer is located on the right end of the computing sight and contains the speed knobs, computer bail, and computer positioning handwheel.

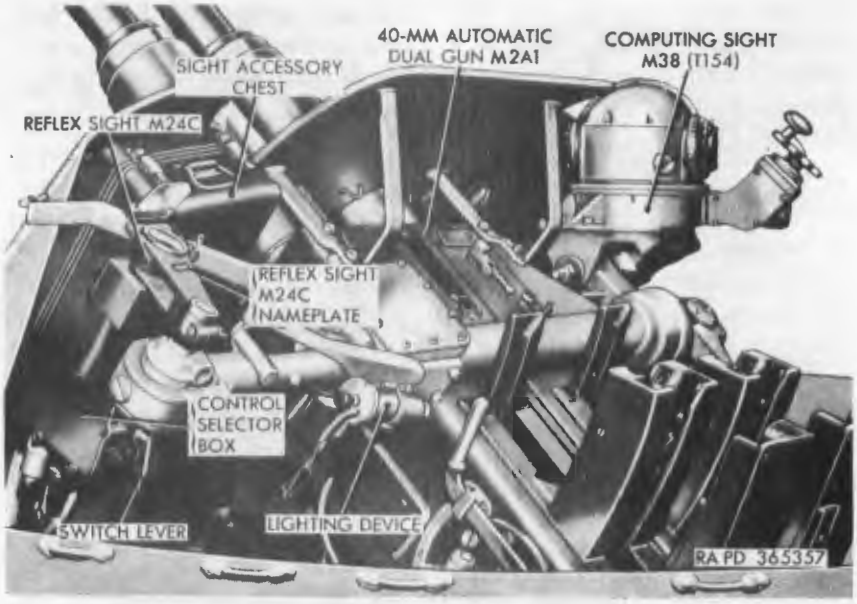


Figure 23. Computing sight M38 (T154)—installed view.

(1) *Speed knobs.* The speed knobs are located on each side of the computer and graduated from 0 to 700 mph in 20-mph increments. The speed knobs rotate together so that either one or both may be used to set the estimated speed of the target into the computer.

(2) *Computer bail.* The computer bail, mounted across the top of the computer, supports the flight direction indicator and is manually pivoted to correspond to the angle of dive or climb of the target.

(3) *Computer positioning handwheel.* The computer positioning handwheel, mounted on the rear of the computer, rotates the computer in azimuth to place the flight direction indicator in the direction of target flight and parallel with the target course.

c. Reflex Sight M24C. The reflex sight M24C (fig. 23) is a sighting instrument designed to superimpose a reticle pattern (fig. 25) in the gunner's line of sight and is stowed in the sight accessory chest (fig. 23). It is provided with a dovetail slot at its forward end to receive the lamp bracket of the lighting device (fig. 23) or reflex sight light (fig. 32), which provide a source of variable illumination for the sight.

52. Local Control System M16A1E1

a. General. The 40-mm twin gun mount M4E1 and 40-mm automatic dual gun M2A1 (fig. 27) are electrohydraulically operated in

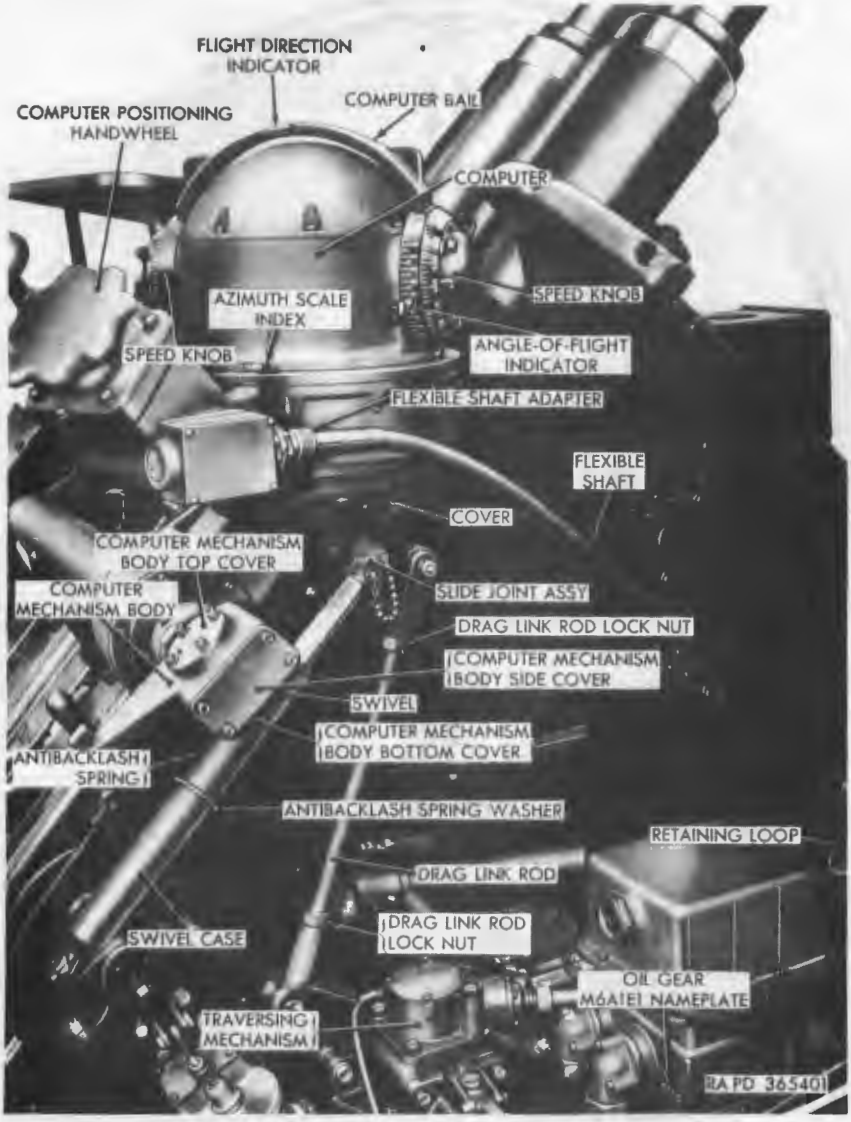


Figure 24. Computer controls.

azimuth and elevation during power operation by the local control system M16A1E1 (fig. 26). The local control system is composed of a drive controller M12E2, two oil gears M6A1E1, and a wiring set M10A1E1.

b. Difference Between Models.

(1) *Remote control provisions.* Production vehicles with Ordnance serial No. 1878 and up have been modified to eliminate the control selector box (fig. 23) and the remote

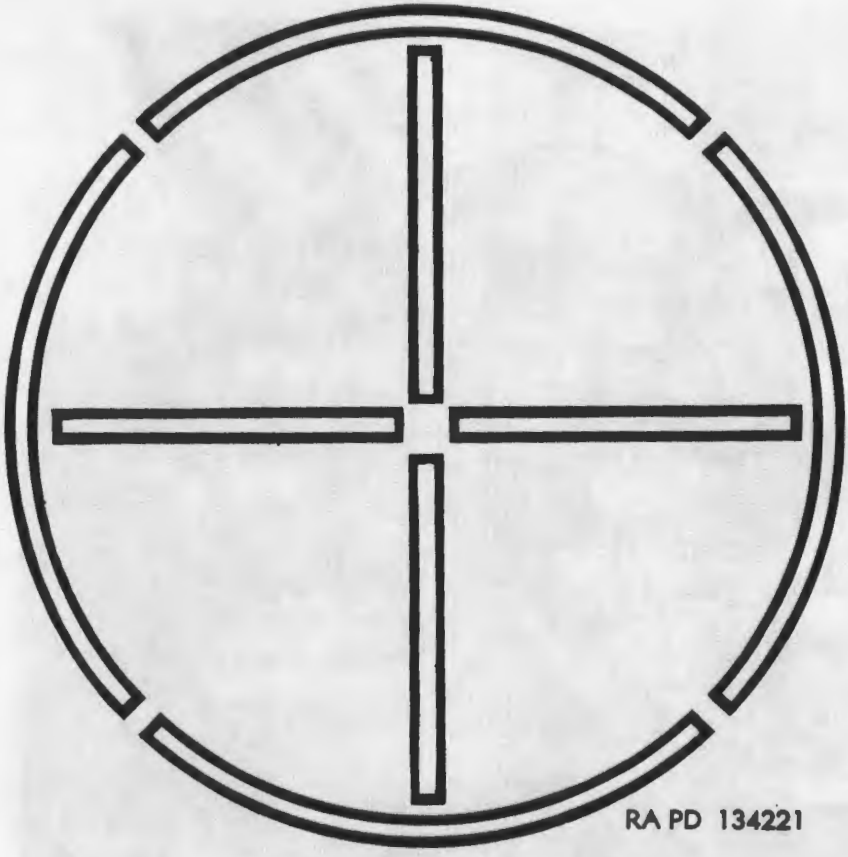


Figure 25. Reticle pattern.

control provisions incorporated in the oil gears. All components of the local control system for all vehicles, however, remain interchangeable.

(2) *Lighting device and reflex sight light.* The lighting device (fig. 23) installed on vehicles with Ordnance serial Nos. 1 through 1662 include a resistor, rheostat, and rheostat control knob in the case of the lighting device. Vehicles with Ordnance serial No. 1663 and up are equipped with a reflex sight light (fig. 32), and the resistor, rheostat, and rheostat control knob are installed in the elevation switch.

c. *Drive Controller M12E2.*

(1) *General.* The drive controller M12E2 (fig. 27), mounted on the shield in front of the gunner's seat, is carried in the stowed position when not in use and is raised to the operating position (fig. 28) during power operation of the gun and mount. Manual signals caused by manipula-

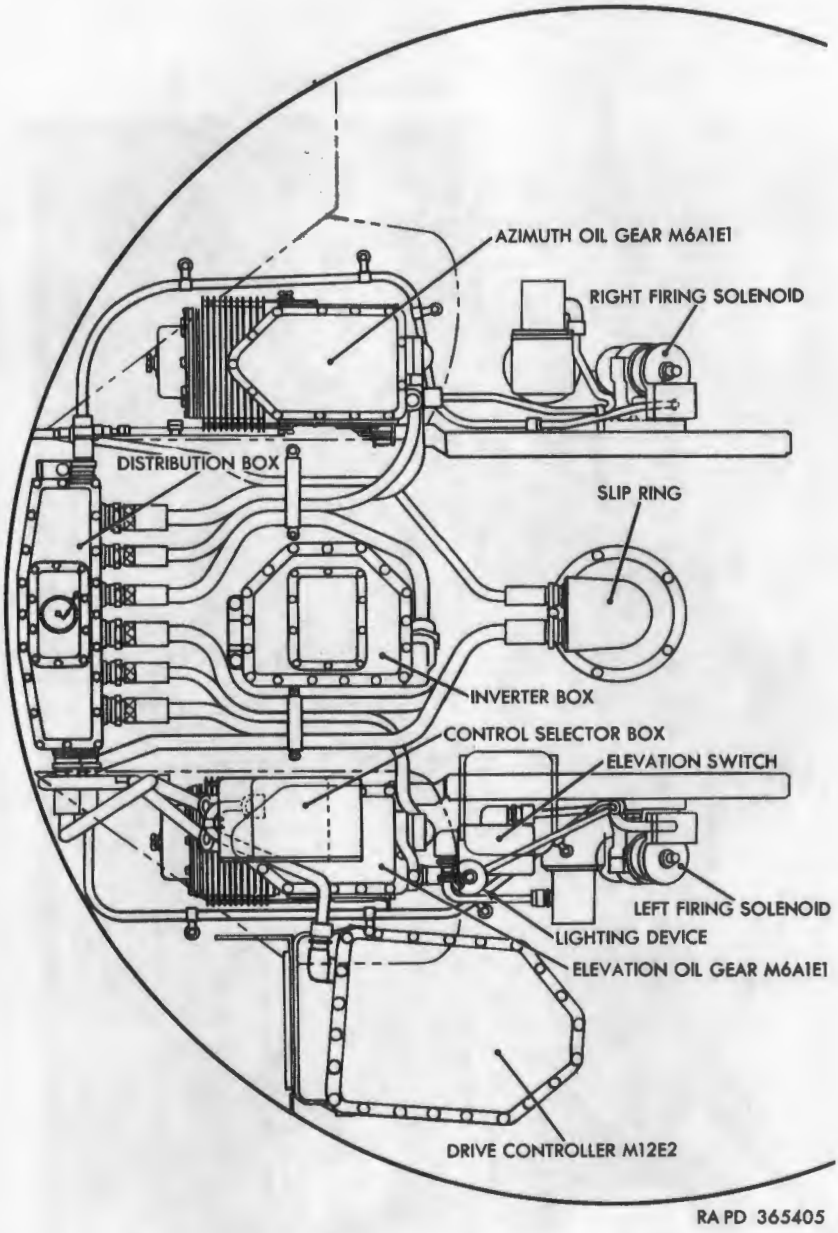


Figure 26. Local control system M16A1E1—schematic.

tion of the hand grips (fig. 28) of drive controller by the gunner are transformed into corresponding electrical signals which are transmitted to the elevation and azimuth oil gears M6A1E1 (fig. 26). These electrical signals control the operation of the oil gears which hydraulically power the gun and mount in azimuth and elevation.

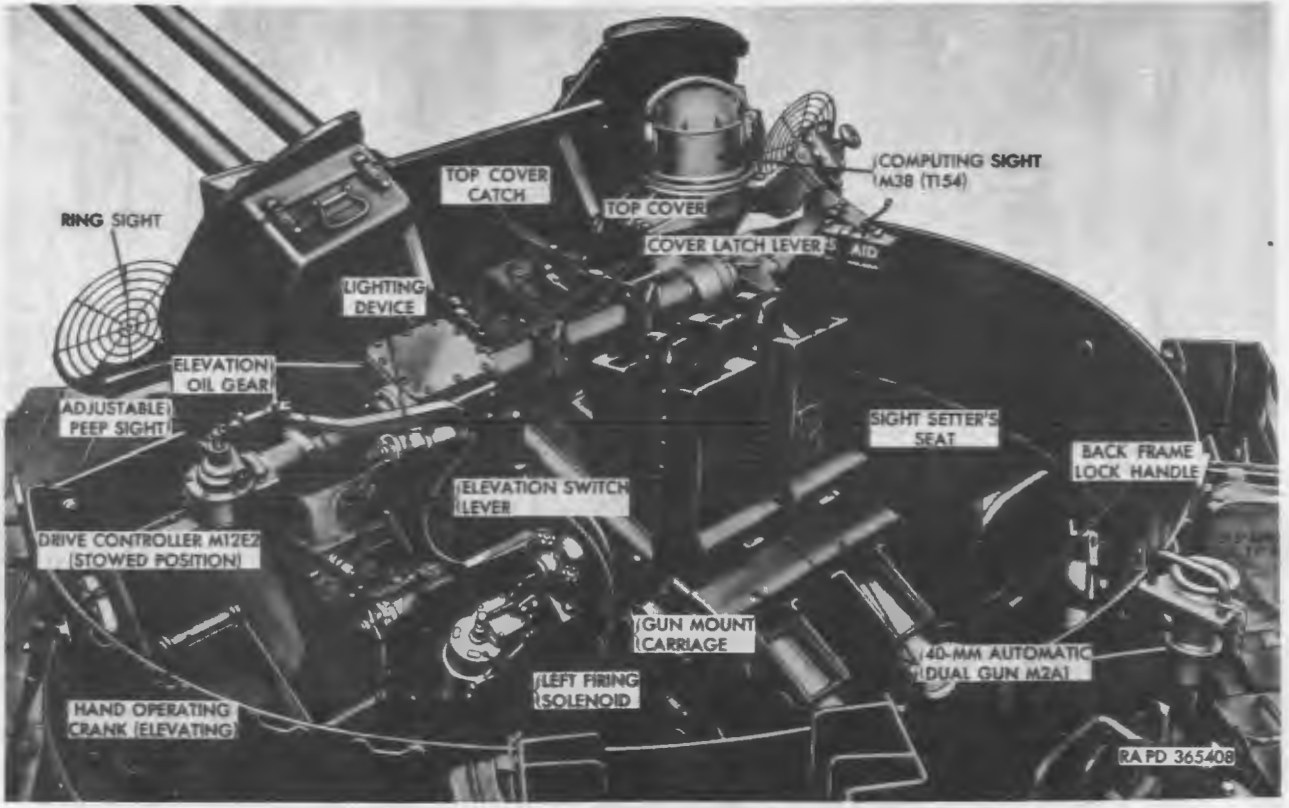


Figure 27. Armament and sighting and fire control materiel installed on 40-mm twin gun mount M4E1.

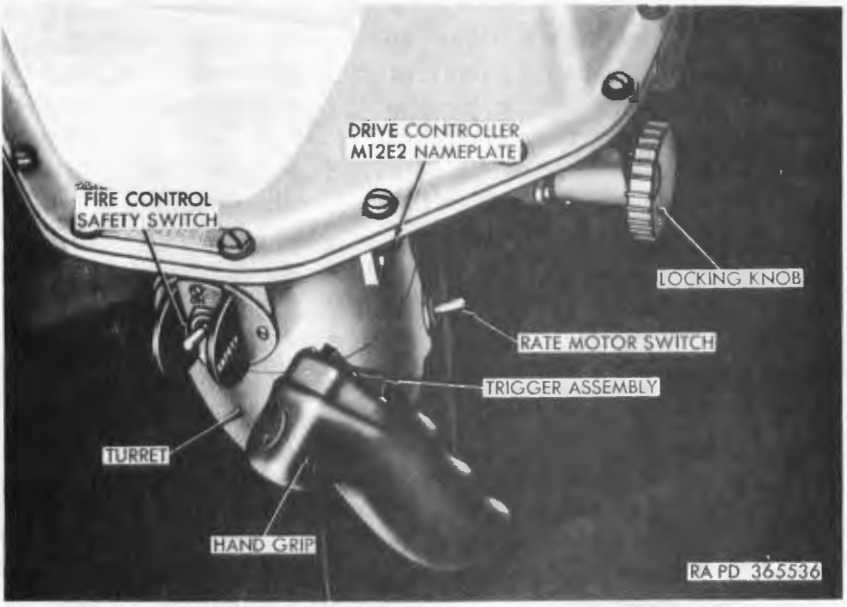


Figure 28. Drive controller M12E2 in operating position.

(2) *Positioning of drive controller* (fig. 28). To raise drive controller into the operating position, turn locking knob counterclockwise 180° to retract plunger and raise drive controller to operating position. Release knob to permit spring-loaded plunger to seat in hole of mount support slide. Make sure that plunger locks drive controller securely in place by attempting to lower drive controller without turning knob. To lower drive controller, rotate locking knob counterclockwise 180° to retract plunger, lower drive controller and release knob. Make sure drive controller is locked in the stowed position by attempting to raise drive controller without turning knob.

(3) *Turret* (fig. 28). The turret, attached to the base of the drive controller contains a fire control safety switch, rate motor switch, and two hand grips on which are installed the trigger assemblies.

(*a*) *Hand grips.* The gun mount is traversed by grasping the hand grips and rotating the drive controller turret. Clockwise rotation of the turret, rotates the gun mount to the right; counterclockwise rotation of the turret, rotates the gun mount to the left. Movement of the hand grips in a vertical motion, elevates or depresses the dual gun. To elevate the gun, the bottom of the hand grips is moved toward the muzzle end of the gun;

to depress the gun, the bottom of the hand grips is moved toward the breech end of the gun. A combination of both horizontal and vertical hand grip movement is necessary to track a target. A trigger assembly is incorporated in each hand grip and either or both can be used to electrically fire the dual gun.

(*b*) *Rate motor switch.* The rate motor switch, mounted on the rear of the turret, controls the operation of the drive controller rate motor. To place the drive controller in operation, the rate motor switch is moved upward to be turned on.

(*c*) *Fire control safety switch.* The fire control safety switch, mounted on the front of the turret, is wired in series with the two trigger assemblies to prevent accidental firing of the dual gun. The dual gun is fired electrically by moving the safety switch upward to the ON position and depressing either or both of the trigger assemblies.

d. Oil Gears M6A1E1. There are two identical oil gear units in the local control system: one to furnish hydraulic power for gun mount movement in azimuth, and one to furnish hydraulic power for gun movement in elevation and depression. Electric power from the vehicle drives an electric motor mounted on the top rear of each oil gear which drives a variable displacement oil pump that is coupled directly to a fixed displacement oil motor. Speed and direction of rotation of the variable displacement oil pump is controlled electrically by signals originating in the drive controller and determine the speed and direction of rotation of the oil gear output shaft.

(1) The azimuth oil gear (fig. 29) is mounted on the gun mount platform in front of and to the left of the sight setter's seat. This oil gear provides power to rotate the gun mount through 360° in either direction at variable speeds.

(2) The elevation oil gear (fig. 27) is mounted on the gun mount platform in front of and to the right of the gunner's seat. This oil gear provides power to operate the dual gun from —3° depression to +85° elevation at variable speeds.

e. Wiring Set M10A1E1. The function of wiring set M10A1E1 is to receive, regulate, and distribute electrical power to operate and control the components of local control system M16A1E1. The wiring set consists of the slip ring, inverter box, distribution box,

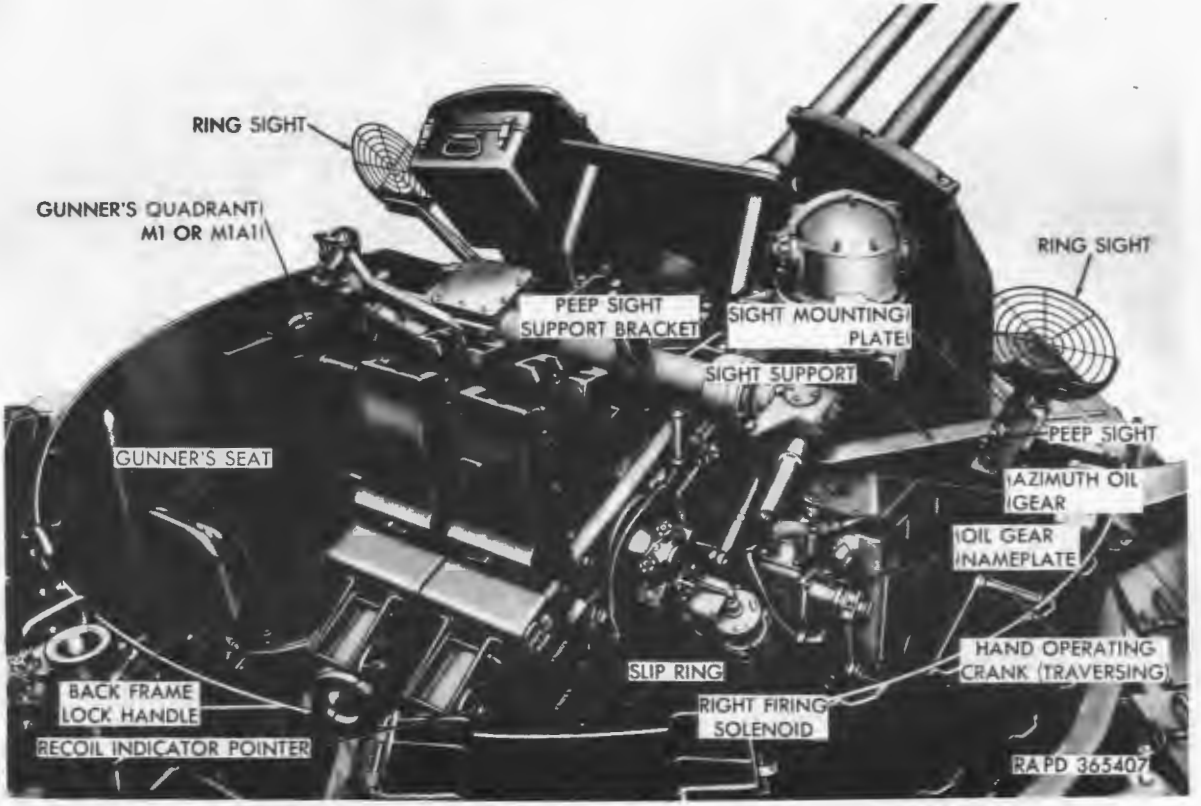


Figure 29. Armament and controls and sighting and fire control materiel installed on right side of gun mount.

elevation switch, control selector box, lighting device or reflex sight light, left and right firing solenoids, and cables.

(1) *Slip ring.* The slip ring (figs. 26 and 29) provides a means of transferring electrical current between the vehicle hull and the revolving gun mount M4E1. The revolving section of the slip ring is secured to the gun mount platform under the 40-mm automatic dual gun F2A1. The stationary section is secured to the vehicle hull. The slip ring normally carries communications antennae circuits, 24-volt power circuits, and 115-volt alternating current data circuits handled by the slip ring, originate at a remote control director which is coupled through a remote control receptacle cover (fig. 30) provided at the right rear of the vehicle.

(2) *Inverter box* (fig. 31). The inverter box receives the 24-volt direct current power supply from the slip ring and distribution box and converts it to 115-volt alternating current. This alternating current is necessary to operate the rate motor in the drive controller and for the signals which control the operation of the oil gears. The inverter box is secured to the front of the gun mount platform beneath the dual gun M2A1 and between the equilibrators.

(3) *Distribution box* (fig. 31). The distribution box, secured

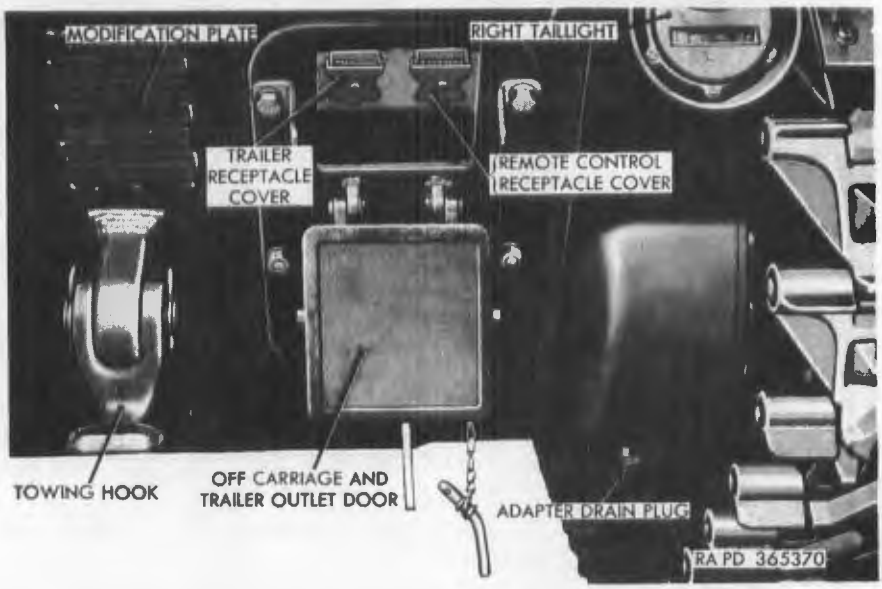


Figure 30. Remote control and trailer receptacle location.

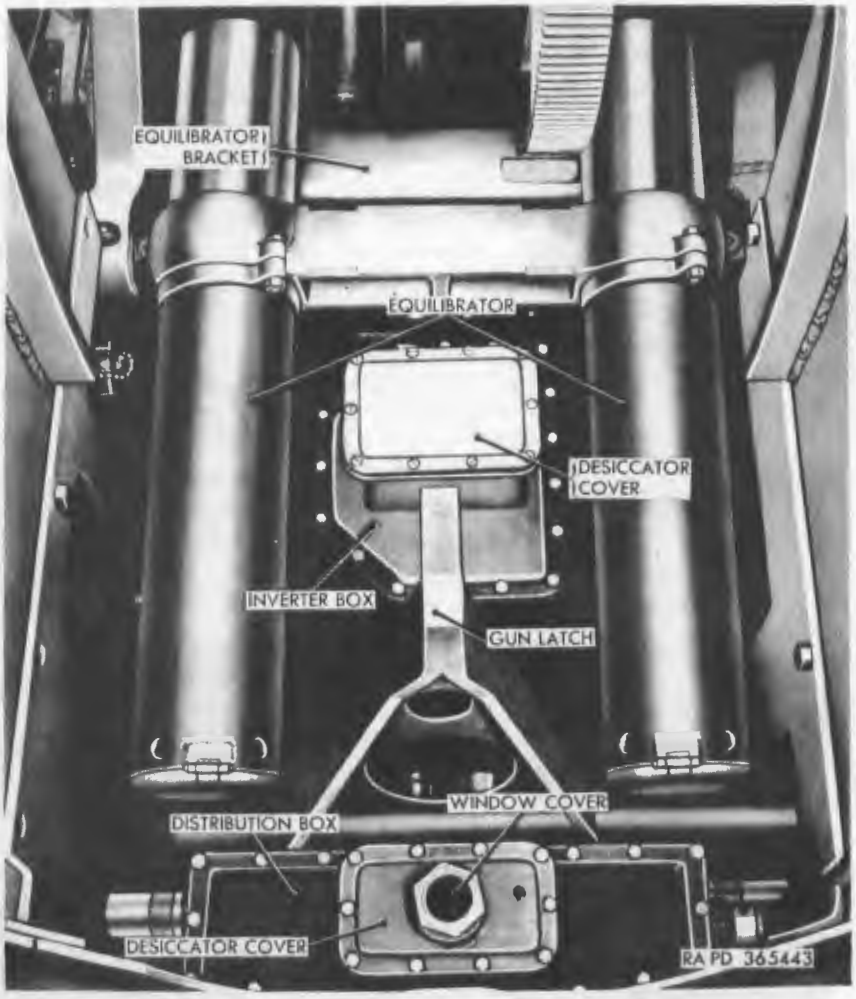


Figure 31. Inverter box and distribution box installed.

to the front of the gun mount platform beneath the dual gun M2A1, serves as the electrical nerve center for the local control system M16A1E1. All major gun mount circuits, both 24-volt direct current and 115-volt alternating current, pass through the distribution box and are distributed to the various components of the local control system. The distribution box also contains two relays: one closes the firing circuits, the other closes the 24-volt direct current power circuit to the inverter box as soon as both oil gears have started.

(4) *Elevation switch* (fig. 32). The elevation switch is secured to the side of the gun mount carriage to the rear of

the elevation oil gear. Electrically, it serves as a master switch for the local control system. Movement of the elevation switch lever rearward to the on position completes the power circuit and starts, in sequence, the elevation oil gear, azimuth oil gear, and the inverter box. Through interconnecting mechanical linkage attached to the elevation switch lever, the slewing clutches in both oil gears are engaged just prior to the completion of the power circuits. Movement of the switch lever forward to the off position disconnects the gun mount from power operation and permits manual control.

Note. Elevation switches installed on vehicles with Ordnance serial No. 1663 and up contain the resistor, rheostat, and rheostat control knob which control the illumination of the reflex sight light.

(5) *Control selector box.* The control selector box (fig. 23) installed on vehicles with Ordnance serial Nos. 1 through 1877, mounted on the shield in front of the gunner's seat, contains a 2-position rotary switch which provides a means of selecting either LOCAL or REMOTE control

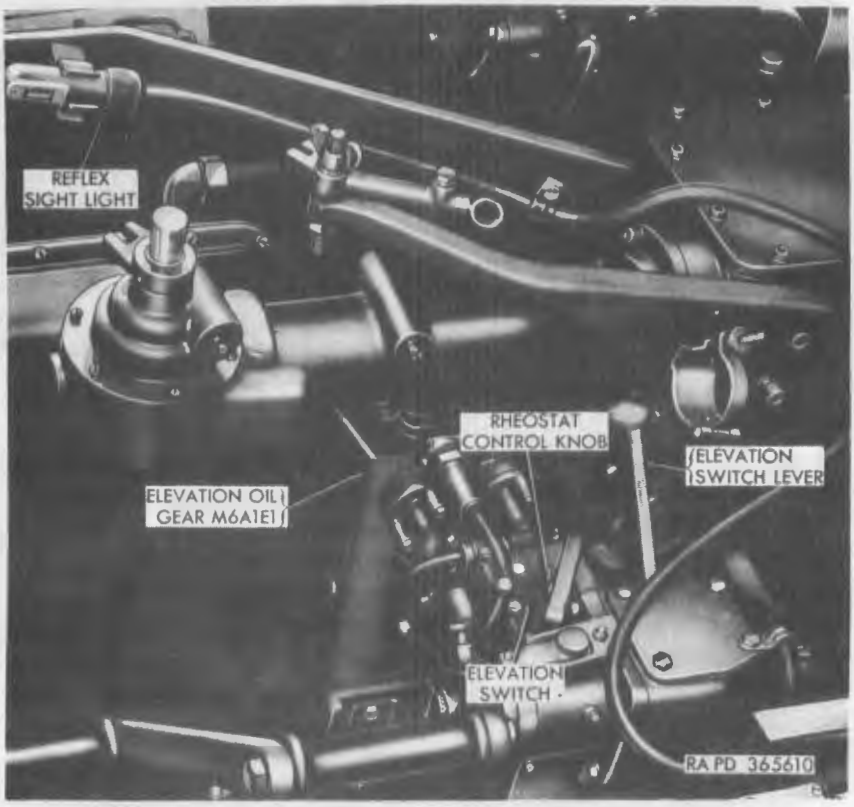


Figure 32. Elevation switch and reflex sight light.

sources. With the switch lever (fig. 23) in the LOCAL position, electrical control signals originating in the drive controller M12E2 are delivered to the oil gears. In the REMOTE position, electrical control signals originating in a remote control director plugged into the remote control receptacle located beneath the remote control receptacle cover (fig. 30) at the rear of the vehicle will control the operation of the oil gears. Under normal operating conditions, the switch lever must be in the LOCAL position.

(6) *Lighting device or reflex sight light.*

(*a*) *General.* The lighting device (fig. 23) or reflex sight light (fig. 32) provide a source of variable illumination for the reticle of the reflex sight M24C (fig. 23) and operate on 24-volt direct current power received through the elevation switch.

(*b*) *Lighting device* (fig. 23). The lighting device, mounted on the peep sight bracket attached to the left side of the computing sight M38 (T154), consists of a light bracket and a case which contains the resistor, rheostat, and rheostat control knob. The light bracket is designed to fit in the dovetail slot provided on the reflex sight. The resistor reduces the 24-volt direct current power to 3 volts, and variable voltage from 0 to 3 volts is controlled by the rheostat knob to provide the desired light intensity at the light bracket.

(*c*) *Reflex sight light* (fig. 32). The reflex sight light, mounted on the left ring sight mounting bracket, is designed to fit in the dovetail slot provided on the reflex sight. The controlling elements for this light are installed in the top of the elevation switch and the principle of operation is identical to that of the lighting device (*b* above).

(7) *Firing solenoids* (figs. 27 and 29). Two firing solenoids, one secured to each side of the gun mount carriage, are provided to electrically operate the firing plungers of 40-mm automatic dual gun M2A1. The firing solenoids are actuated simultaneously by either trigger assembly in the hand grips of the drive controller through a relay in the distribution box.

(8) *Cables.* Heavily insulated cables interconnect the components of the local control system M16A1E1. All cables are equipped with waterproof electrical connectors to prevent the entrance of moisture.

53. 40-MM Automatic Dual Gun M2A1

a. Hand Operating Levers (fig. 33). A hand operating lever is provided on each side of the dual gun. The lever on the left side operates the left gun and the lever on the right side operates the right gun. The function of each lever is to prepare its gun for firing. Movement of the lever to the rear opens the breech, cocks the firing assembly and rammer shoe, and releases the ammunition feed rollers. The hand operating lever is also used to recock the gun and remove the complete round in case of a misfire. A rear catch bracket marked SAFE is provided to hold the hand operating lever in the rear position when desired.

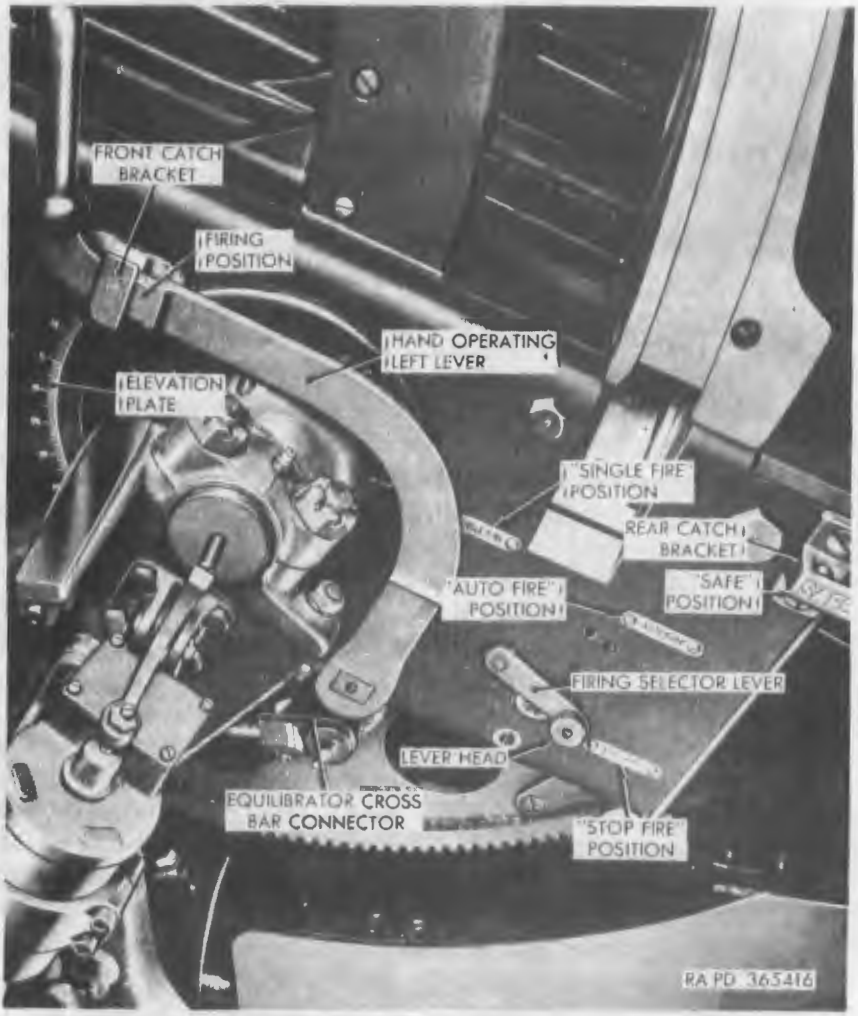


Figure 33. Hand operating lever in firing position (left).

b. Firing Selector Levers (fig. 33). A firing selector lever is provided on each side of the dual gun. Each lever has three positions and the setting is altered for the desired operation. STOP FIRE, SINGLE FIRE, or AUTO FIRE, will prevent firing, allow single fire, or allow automatic fire respectively. The firing selector lever is locked in position by a spring-loaded plunger and unlocked by pulling out on the lever head. When the firing selector lever has been moved to a desired setting, the spring-loaded plunger must be fully engaged.

c. Feed Control Thumb Levers (fig. 34). A feed control thumb lever is located on the rear of each automatic loader. The function of this lever is to stop automatic fire while one cartridge remains on the loader tray and one cartridge remains in the loader. This

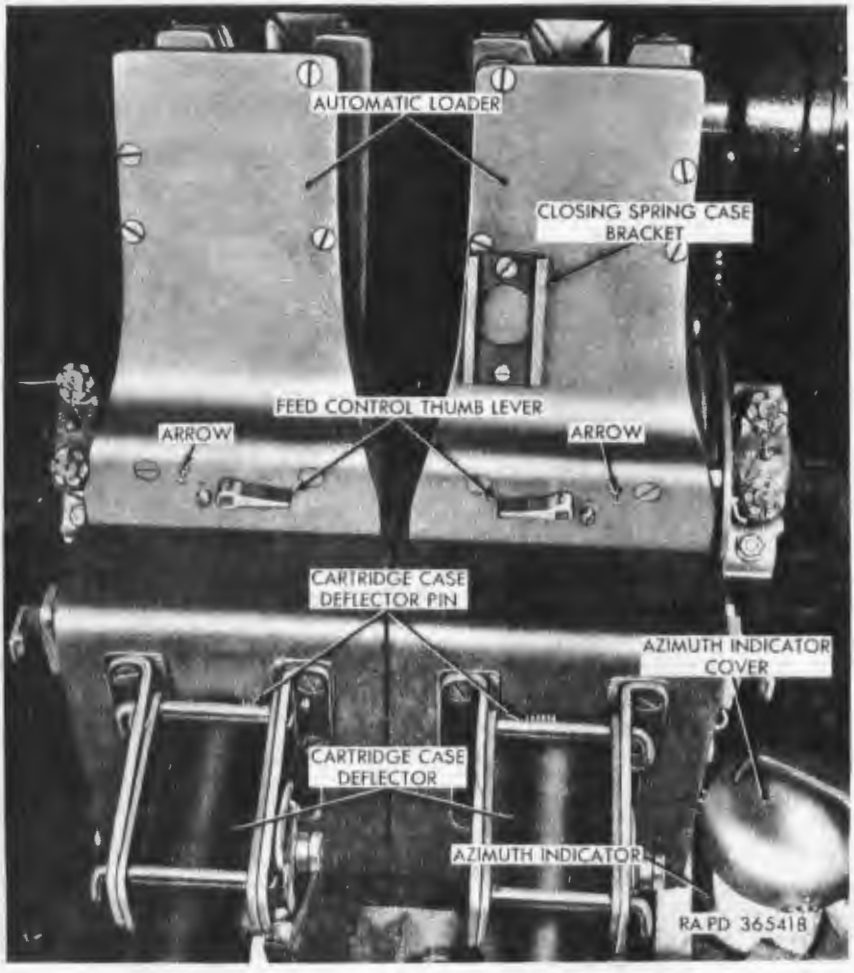


Figure 34. Feed control thumb levers.

control permits resumption of automatic fire by merely inserting a clip of cartridges in the top of the loader. When the lever is rotated in the direction of the arrow on the rear of the automatic loader, this feature becomes operative; when the lever is rotated in the opposite direction, the gun may be fired until the loader is completely empty.

d. Extractor Releasing Levers (fig. 52). An extractor releasing lever is provided on the underside of each gun. Pulling out on the lever releases the extractors so the breechblock will close without a cartridge being chambered.

e. Recoil Indicator Pointers (fig. 35). A recoil indicator pointer, located on the outer side of each cartridge case deflector bracket, indicates length of recoil. The recoil indicator pointer is operated by a movement of the automatic loader tray in recoil (par. 280*d* (3)).

f. Top and Bottom Covers. A top cover (fig. 27), located on top of the breech casing in front of the automatic loader, provides a

Figure 35. Recoil indicator pointer.

means for releasing the breech ring barrel catch which locks the barrel assembly to the breech ring. The top cover also actuates the breech casing when the top cover is open. This prevents the breech ring from slipping to the rear when the barrel assembly is removed. A bottom cover (fig. 52), located on the bottom of the breech casing below the breechblock, permits removal of the breechblock with breech ring inner cranks, breech closing spring assembly, and extracting without further disassembly of the gun.

g. Cover Latch Levers (fig. 27). A cover latch lever is located on each of the top and bottom covers of the breech casing body. The lever retains the cover in locked position with a spring-loaded plunger. Two holes in each cover retain the lever in either a locked or unlocked position. Lift cover latch lever head to release the plunger from its locked position, then rotate the lever to unlock the cover. Release the head to secure the lever in an unlocked position.

h. Top Cover Catch (fig. 27). A top cover catch is located on the forward edge of the top cover. The catch retains the top cover in an upright position when opened. Press the catch to release and close the cover.

54. 40-MM Twin Gun Mount M4E1

a. Hand Operating Cranks (Traversing and Elevating).

(1) *General.* The hand operating crank (traversing) (fig. 36) is used on the traversing mechanism to manually traverse the gun mount. Clockwise rotation of the crank traverses the gun mount to the left; counterclockwise rotation traverses the gun to the right. The hand operating crank (elevating) (fig. 37) is used on the elevating mechanism to manually elevate or depress the dual gun. Clockwise rotation of the crank elevates the dual gun; counterclockwise rotation, depresses the dual gun.

(2) *Installation* (fig. 37). Position hand operating crank on crank adapter, lift up on knob, slide crank on adapter, and release knob. Carefully engage hand operating crank and adapter on splined gear of elevating or traversing mechanism.

(3) *Removal* (fig. 37). Pull hand operating crank and adapter out to disengage adapter from splined gear of elevating or traversing mechanism. Position lever detents in depressions on crank adapter to prevent adapter from engaging splined gear during power operation. Lift up on knob and slide hand operating crank from crank adapter.

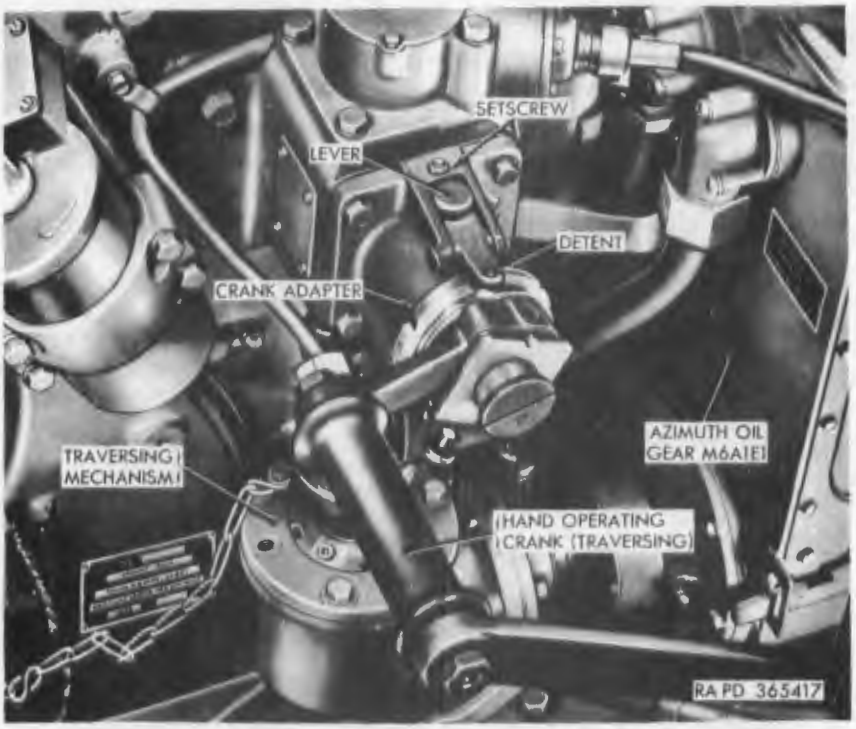


Figure 36. Hand operating crank (traversing).

Caution: Hand operating cranks must be removed from crank adapters during power operation to prevent possible injury to personnel.

b. Firing Mechanism Pedal (fig. 38). The firing mechanism pedal, located forward of the gunner's seat, is used to manually fire the dual gun. Depressing the pedal will fire the dual gun through mechanical linkage.

c. Elevating Travel Lock. The elevating travel lock, located to the right of the gunner's seat, secures the dual gun M2A1 at 0° elevation for traveling or during storage. To release the elevating travel lock, squeeze the releasing lever and move the elevating lock handle (fig. 38) forward to the unlocked position. Be sure that releasing lever plunger mechanism is seated in hole of elevating lock handle bracket. To lock dual gun in traveling position, manually depress gun to 0° elevation, squeeze releasing lever and move elevating lock handle rearward to the locked position. If releasing lever plunger mechanism does not seat in hole of travel lock bracket, rotate hand operating crank (elevating) slightly in both directions until plunger seats.

d. Traversing Lock (fig. 39). The traversing lock, located to the right of the gunner's seat, secures the gun mount in either of

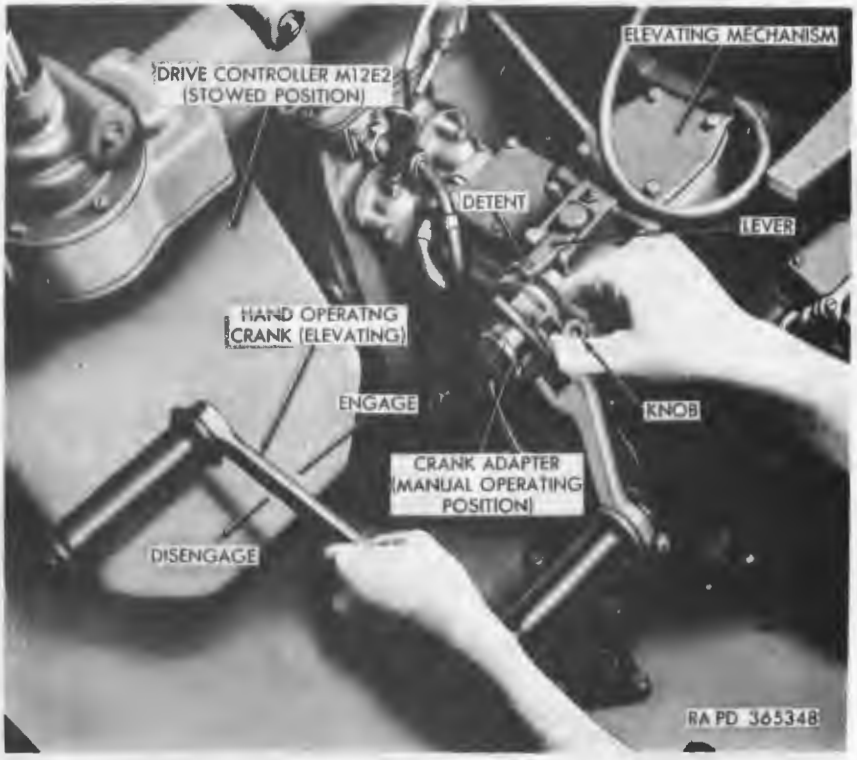


Figure 37. Installing or removing hand operating crank.

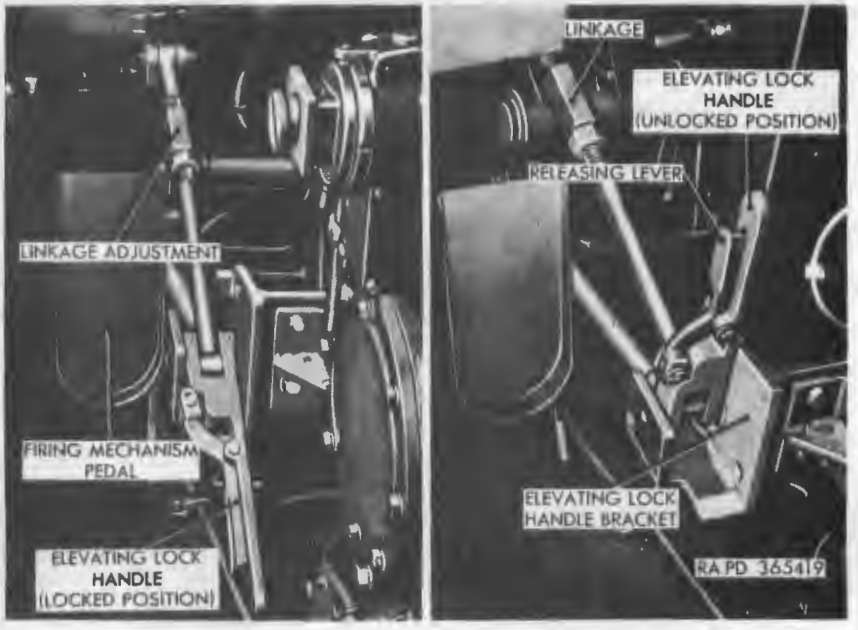


Figure 38. Firing mechanism pedal and elevating travel lock controls.

two positions: with dual gun straight forward, or directly to the rear. To release traversing lock, squeeze releasing lever and move traversing lock lever forward to the unlocked position until releasing lever plunger mechanism seats in hole of traversing lock support. To lock gun mount in traveling position, squeeze releasing lever and move traversing lock lever rearward to the locked position. If releasing lever plunger mechanism does not seat in hole of traversing lock support, rotate hand operating crank (traversing) slightly in both directions until plunger seats.

Caution: Do not attempt to engage traversing lock unless dual gun is in its proper position for locking, to prevent shearing of the plunger which engages gun mount base ring.

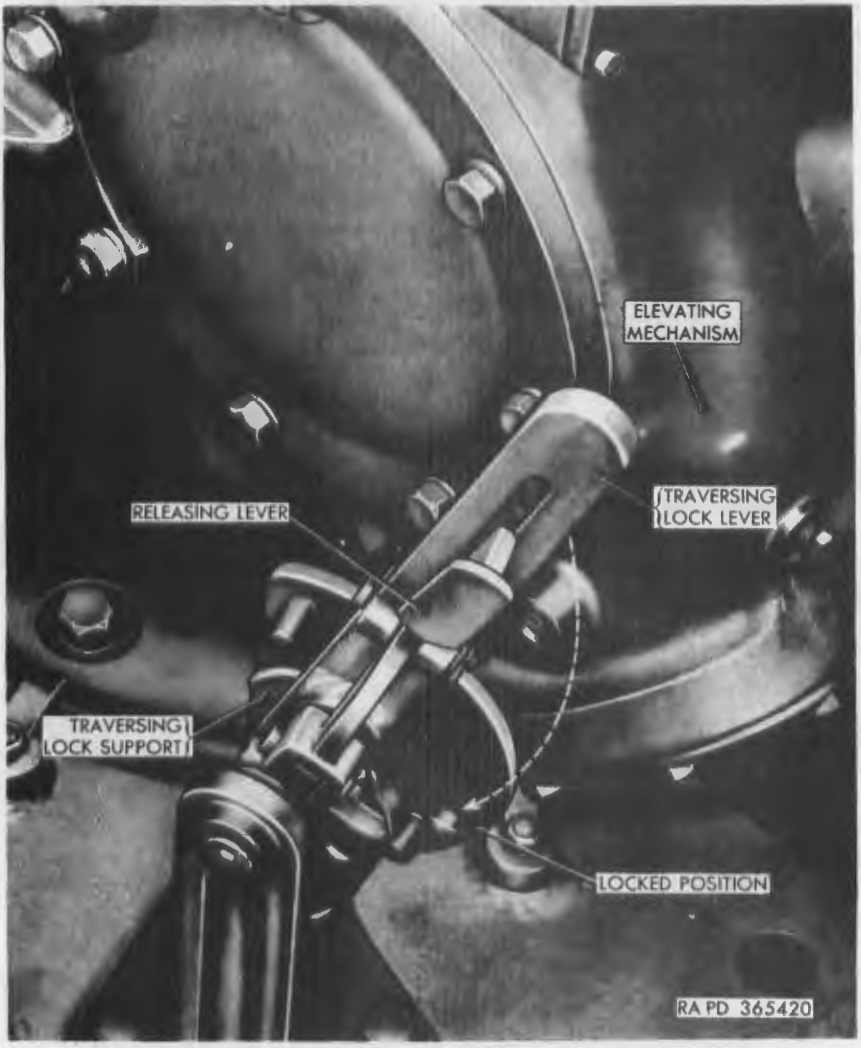


Figure 39. Traversing lock.

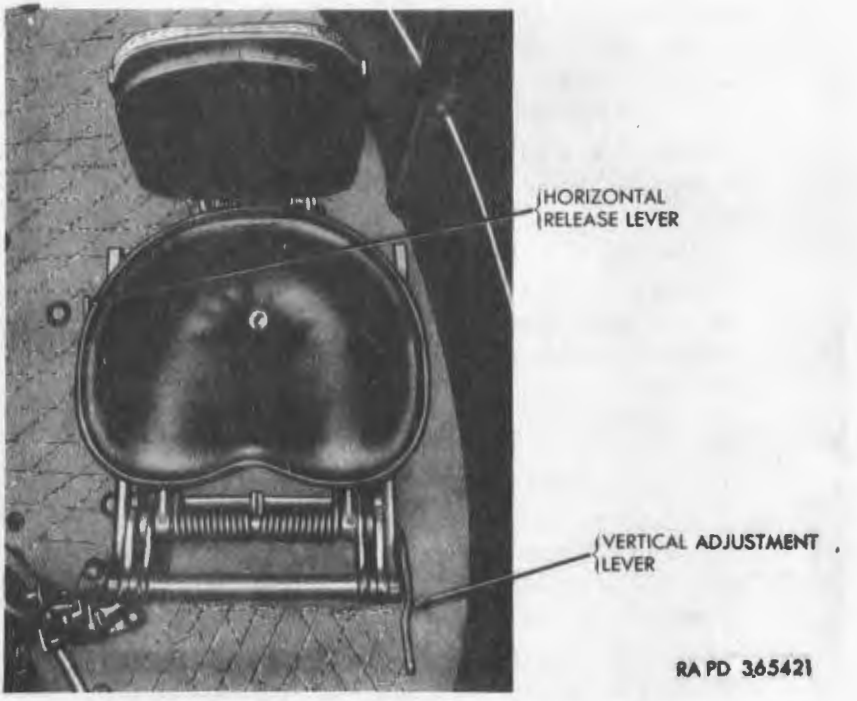


Figure 40. Gunner's seat controls.

e. Gunner's and Sight Setter's Seat Controls (fig. 40). The gunner's and sight setter's seats are identical in construction and are controlled in the same manner. The backrests are spring loaded and both seats are adjustable horizontally and vertically to allow for physical size differences of the crew.

(1) *Vertical adjustment lever.* To raise or lower the seat, lift the vertical adjustment lever at left-front corner of seat, and raise or lower body weight until position desired is reached. The seat will lock in place when the lever is released.

Caution: Do not attempt to adjust seat height unless seat is occupied as body weight is required to control action.

(2) *Horizontal release lever.* To adjust seat horizontally, press in on horizontal release lever, hold lever in this position and move seat forward or rearward as desired, then release lever.

(3) *Seat back frame lock handle* (figs. 27 and 29). Pulling upward on the handle permits the seat back frame and cushion to be folded down onto the seat. When folded up and back, the handle automatically latches the seat back frame and cushion in the upright position.

f. Azimuth Indicator M27 (fig. 41). The azimuth indicator M27, mounted on the gun mount platform to the left of the sight setter's seat, is geared to the main turret traversing ring gear. This indicator is provided with three graduated scales, three moving pointers, and a resetter knob. It is used to calculate azimuth angles in mils, with respect to the longitudinal axis of the vehicle, during gun mount traversing.

(1) *Scales* (fig. 42). The 100-mil scale is marked in increments of 200 mils. The 1-mil scale is marked in increments of 5 mils. These scales are stationary with the instrument and the zero markings are in relation to the centerline of the 40-mm dual gun. The gunner's aid dial (outer scale) is graduated in 1-mil increments and marked every 5 mils from 0 to 50 right and left, and is varied manually to provide an index to facilitate azimuth corrections.

(2) *Pointers* (fig. 42). The bottom pointer is not adjustable and is set in relation to the longitudinal axis of the vehicle at the time of installation of the azimuth indicator M27. This pointer is geared to turn in the same direction as traverse and will indicate on the 100-mil scale the number of mils the gun mount has traversed from the axis of the vehicle.

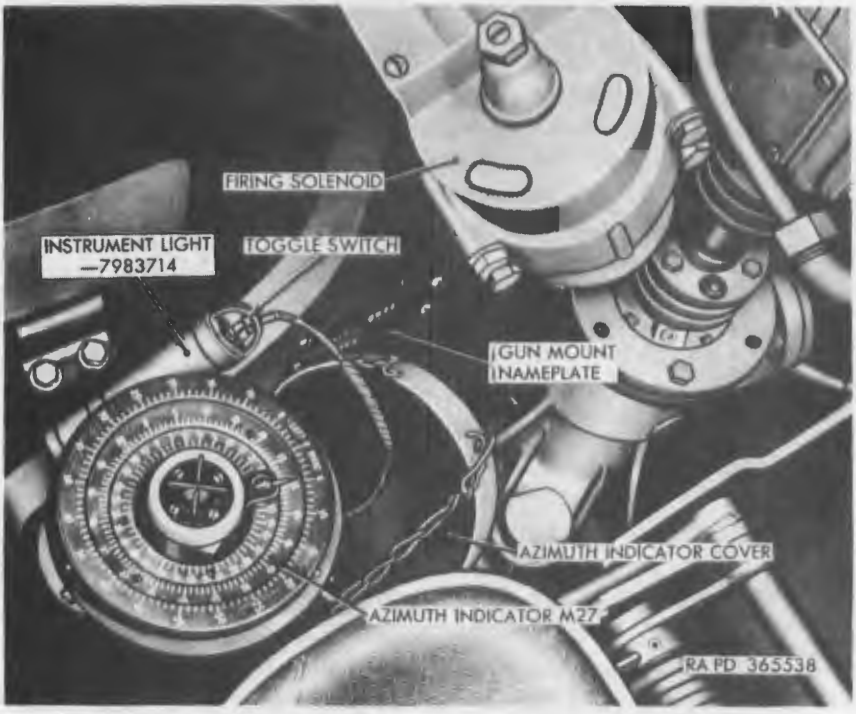


Figure 41. Azimuth indicator M27 and instrument light—7983714.

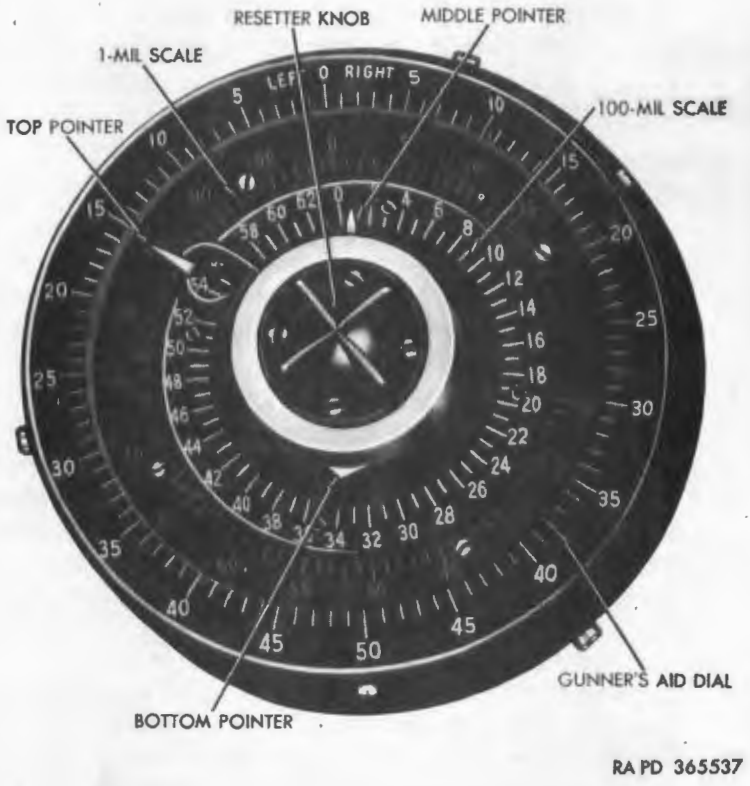


Figure 42. Azimuth indicator M27 dial.

The middle pointer rotates in conjunction with the top pointer. The sum of the readings on the 100-mil scale and the 1-mil scale will give a fine reading of the gun traverse from a given reference point. The middle and top pointers are adjustable and may be set to indicate any desired azimuth by use of the resetter knob.

(3) *Resetter knob* (fig. 42). The resetter knob, located on top of the azimuth indicator M27, turns the top pointer. Pushing down and turning the knob will turn both the middle and top pointers. The top and middle pointers may be placed at zero regardless of gun mount position.

(4) *Illumination.* The dial of the azimuth indicator M27 is indirectly illuminated by two lamps in the housing which are lighted by operation of the instrument light 7983714 (fig. 41).

g. Instrument Light 7983714 (fig. 41). The instrument light —7983714 is bracket mounted to the gun mount carriage alongside

the azimuth indicator M27. The light consists of a tube which houses two 1½-volt batteries, a toggle switch, and a lead wire with plug. A receptacle is provided on the housing of the azimuth indicator to receive the plug of the lead wire. Turning the toggle switch on lights the lamps in the azimuth indicator.

h. Gunner's Quadrant M1 or M1A1.

(1) *General.* The gunner's quadrant M1 or M1A1 (fig. 29) is stowed in carrying case M18, M56 or M182 carried in a tray on the gun mount outer shield to the left of the gunner's seat. The gunner's quadrant is used for leveling the dual gun M2A1, for laying the dual gun in elevation, or for measuring its angle of elevation.

(2) *Gunner's quadrant M1* (fig. 43). The gunner's quadrant M1 consists of a level holder with an (index) plate, an elevation scale, micrometer, and a level vial. The elevation angle is read as the sum of the elevation scale and micrometer readings when the level bubble on the level holder is centered. A plunger in the level holder, when pressed into the holder, permits rapid setting of coarse steps, and the micrometer permits fine adjustments. Two elevation scales, one on each side of the quadrant, are graduated in 10-mil increments and numbered every 50 mils. One scale reads from 0 to 800 mils, and the other from 800 to 1,600 mils. The micrometer has two scales which are graduated in 0.2-mil increments from 0 to 10 and numbered every mil.

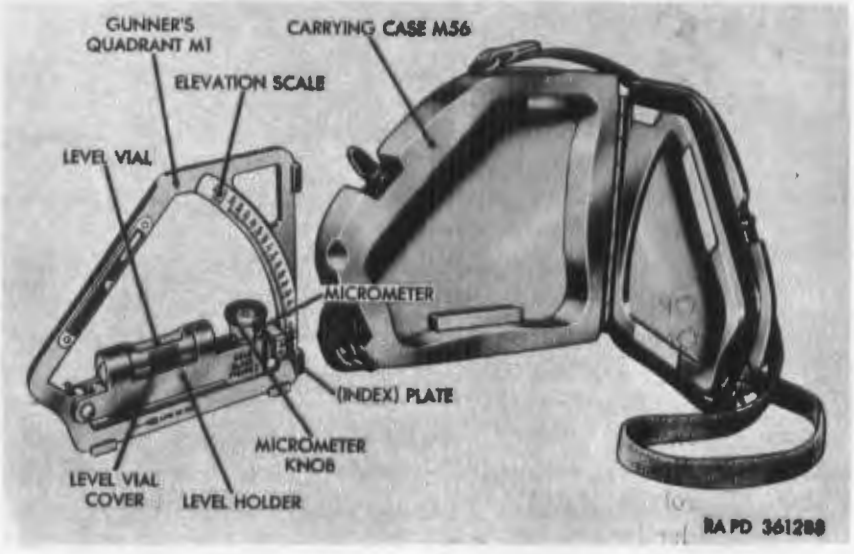


Figure 43. Gunner's quadrant M1.

Red or black figures on the scales are read according to the engraved instructions below the micrometer. Arrows marked LINE OF FIRE indicate the correct reference surface for the scale in use as well as the direction for positioning the quadrant on the gun.

(3) *Gunner's quadrant M1A1* (fig. 44). The gunner's quadrant M1A1 is essentially the same as the gunner's quadrant M1 ((2) above) with the exception of the micrometer and the addition of the micrometer mask. The micrometer on gunner's quadrant M1A1 has the figures in black covered with a mask to eliminate errors in reading the micrometer.

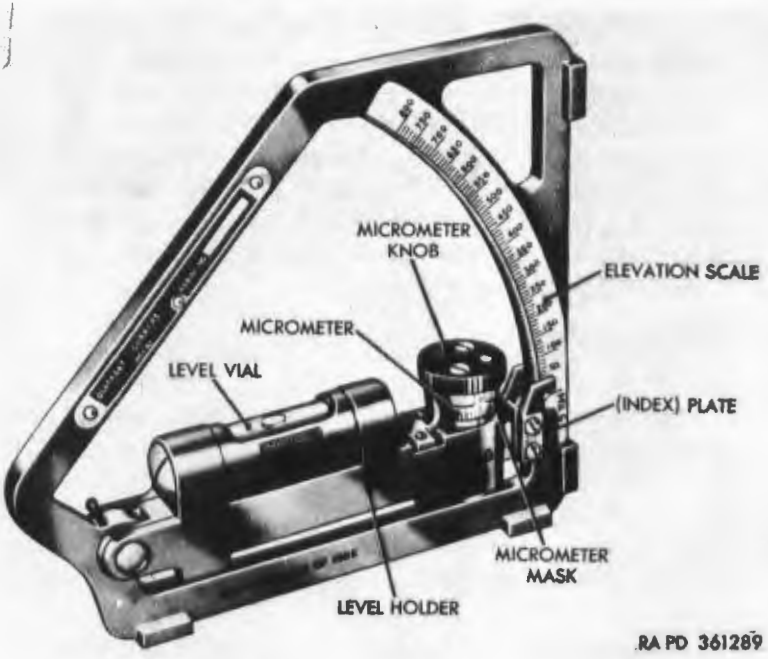


Figure 44. Gunner's quadrant M1A1.

Section V. OPERATION OF GUN MOUNT AND SIGHTING AND FIRE CONTROL MATERIEL UNDER USUAL CONDITIONS

55. General

This section contains instructions for the mechanical steps necessary to operate the 40-mm twin gun mount M4E1 and the sighting and fire control materiel of the twin 40-mm full tracked self-propelled gun M42 under conditions of moderate temperatures and humidity. For operations under unusual conditions, refer to paragraphs 76 through 81.

56. Preparation for Operation

a. Emplacement. The twin 40-mm full tracked self-propelled gun M42 (fig. 1) should be emplaced on as level terrain as is available prior to operating the 40-mm twin gun mount M4E1. This procedure should be followed whenever the tactical situation permits to prevent damage to oil gear clutch gearing, and to eliminate the need for compensating for angle of cant throughout sighting operations. Emplacement on sloping terrain will make it necessary to use other than normal compensation in order to make the projectile pass through a given point.

b. Preliminary Operations.

(1) *General.* Check to see that the equipment secured to the outside of the gun mount will clear the vehicle in traverse. Make sure that driver's and commander's hatch doors, engine compartment grille doors, and air outlet grilles are closed to prevent damage by contact with the gun barrels when the mount is being traversed with the dual gun in a depressed position. Check to see that there is sufficient clear area around the vehicle so that the dual gun will traverse 360° without obstruction.

(2) *Remove covers.*

Note. **The key letters shown below in parentheses refer to figure 45.**

Unfasten snaps, open slide fasteners, and remove flash suppressor covers (A). Unfasten snaps and ties and remove automatic loader cover (Q). Open slide fasteners on cal. .30 machine gun cover (F) and remove cover. Unfasten snap and remove computer cover (G) by pulling out on elastic band at bottom of cover and carefully lifting cover from computer.

Caution: Be sure that computer cover (G) is removed before gun mount is traversed either manually or by power. Traversing the gun mount with cover installed will result in serious damage to computer.

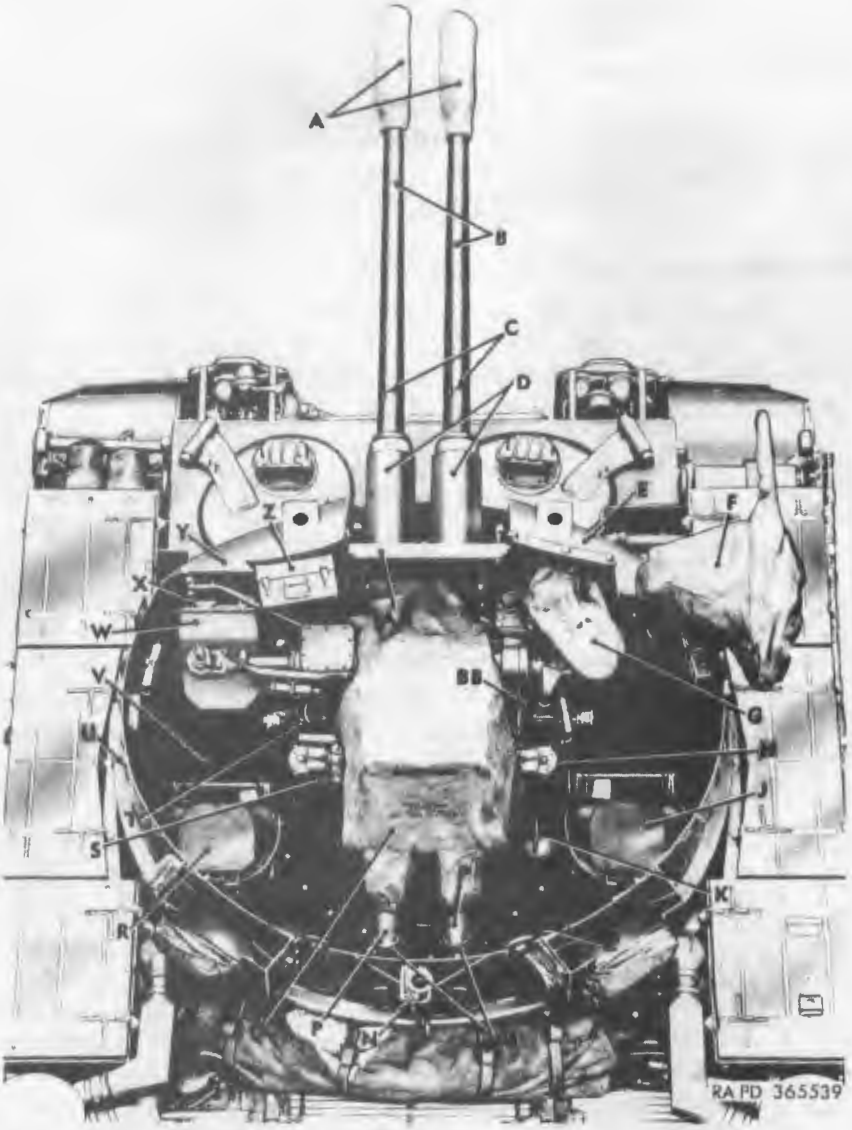
(3) *Service oil gears.* Refer to paragraph 271*c*.

(4) *Adjust seats.* Refer to paragraph 54*e*.

(5) *Install hand operating cranks.* Refer to paragraph 54*a*(2).

(6) *Release gun and gun mount locks.* Refer to paragraphs 54*c* and 54*d*.

(7) *Check gun and gun mount operation.* Manually operate the gun mount one complete revolution in azimuth and the guns throughout their complete range of elevation (par. 61*b*(2)). This insures that the elevating and traversing mechanisms



A—Flash suppressor covers 7772032
B—40-mm automatic dual gun M2A1
C—Tube serial number
D—Breech casing body
E—Gunner's shield, right
F—Cal..30 machine gun cover 7984387
G—Computer cover
H—Firing solenoid
J—Sight setter's seat
K—Azimuth indicator cover
L—Access door
M—Spent cartridge chute
N—Cal..30 machine gun pintle mount
P—Carthridge case deflector
Q—Automatic loader cover 7308217
R—Gunner's seat
S—Trunnion bearing
T—Elevating mechanism
U—Outer shield
V—Gun mount platform
W—Drive controller M12E2
X—Silica gel container
Y—Gunner's shield, left
Z—Sight accessory chest
AA—Gun shield
BB—Traversing mechanism

Figure 45. Top view of gun mount M4E1 with covers installed.

are operating properly. See paragraph 125 for correction of malfunctions.

(8) *Remove hand operating cranks.* Remove hand operating cranks (par. 54*a*(3)) only if gun and gun mount are to be operated under power (par. 57). If the vehicle was emplaced on sloping terrain, traverse the gun mount to the low side before removing the hand operating cranks.

57. Preparation for Power Operation

a. General. The instructions given below are for power operation of the 40-mm twin gun mount M4E1 and the sighting and fire control materiel of the twin 40-mm full tracked self-propelled gun M42 using local control system M16A1E1.

b. Procedure.

(1) Perform the preliminary operations outlined in paragraph 56.

(2) Place drive controller M12E2 (fig. 28) in the operating position by turning locking knob 180° to retract plunger, and raise drive controller to operating position. Release knob to permit spring-loaded plunger to seat in hole of mount support slide. Make sure that plunger locks drive controller securely in place by attempting to lower drive controller without turning knob.

(3) Remove reflex sight M24C and one of the flat glass reflectors from sight accessory chest (fig. 46). Insert reflector in slotted opening in reflector bracket on top of reflex sight and push in until reflector is held securely by retaining springs of bracket. Close sight accessory chest and secure with two hinged clamps.

Note. Two types of reflectors are provided; the clear reflector is used during unfavorable lighting conditions; the dark reflector is used during bright sunlight operation.

Install reflex sight M24C (A, fig. 47) on support shaft extending vertically from left end of computing sight M38 (T154). Be sure that stud on bottom of reflex sight is engaged by the slot in the adapter secured to support shaft, then tighten clamping bolt at rear of sight. Insert lamp bracket of lighting device (fig. 23) or reflex sight light (fig. 32) into dovetail slot at front of reflex sight. Turn knob of lighting device clockwise to the ON position. Sight through reflector of reflex sight and turn rheostat knob until the reticle pattern (fig. 25) is clearly defined on the flat glass reflector. Position the reticle approximately in

the center of the reflector by adjusting the reflex eccentric screw (fig. 273).

Note. Rheostat control knob (fig. 32), installed on elevation switch of late vehicles (par. 52*b*(2)), controls illumination of reflex sight light in an identical manner as the knob on the lighting device.

(4) Turn switch lever of control selector box (fig. 23) to the LOCAL position (par. 52*e*(5)).

Note. This switch lever should never be turned from the LOCAL position, except when it is desired to operate the gun mount by a remote control director. The control selector box is not installed in late vehicles.

(5) Turn master relay switch on (par. 26).

(6) Start the auxiliary generator and engine (par. 70) if main engine is not operating.

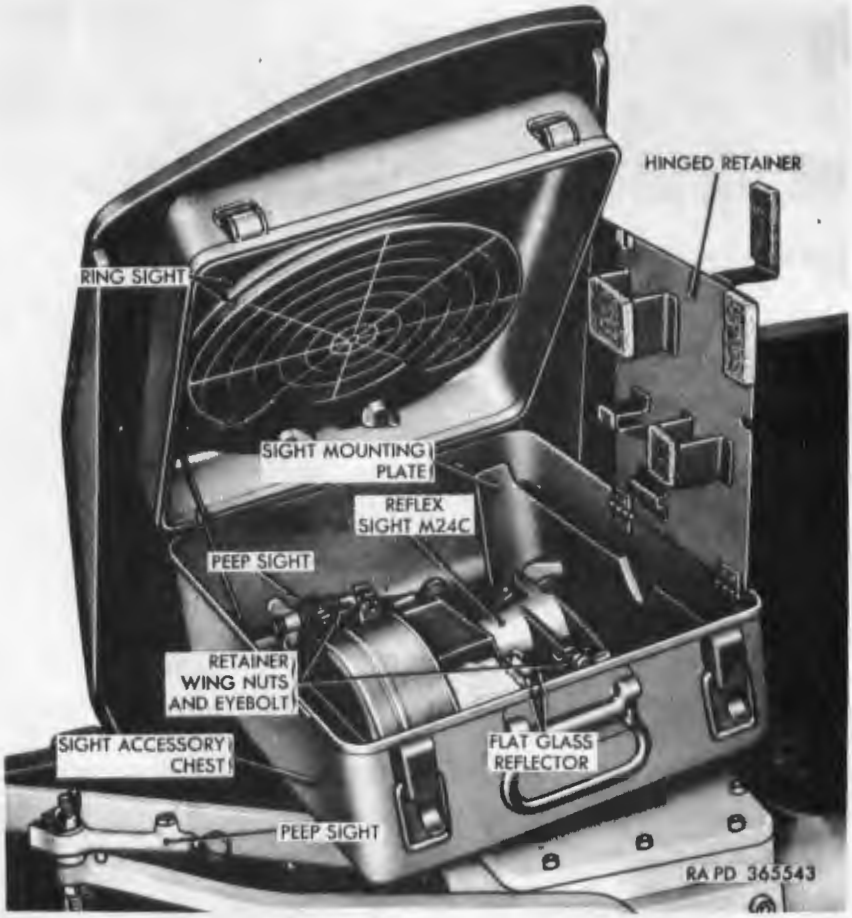


Figure 46. Sight accessory chest stowage arrangement.

Figure 47. Gunner's sighting and fire control materiel for power operation.

(7) Place the lever of the elevation switch in the on position (par. 52*e*(4)).

(8) Turn drive controller rate motor switch on (par. 52*c*(3)(*b*)).

58. Synchronization and Boresighting

a. General. Synchronization is the process of adjusting the computing sight M38 so the computer leveling pads are always parallel

to the gun mount carriage leveling pads at any elevation of the dual gun M2A1. Boresighting is the process of alining the lines of sight of the sighting instruments with a line of sight through the axis of the gun bores upon a common aiming point no less than 1,000 yards distant. The purpose of synchronization and boresighting is to insure accuracy of fire. The dual gun M2A1 should be boresighted whenever operational circumstances might alter the sight adjustment such as a prolonged march, rough terrain, acute variations in temperature, or accidental abuse by crew members.

b. Synchronization.

(1) Place vehicle on as level terrain as possible.

(2) Set dual gun at zero degrees in elevation.

(3) Place gunner's quadrant M1 (fig. 43) or M1A1 (fig. 44) on gun mount carriage leveling pads (fig. 48) parallel to the dual gun with the line of fire arrow pointing toward the gun muzzle.

(4) Adjust the gunner's quadrant M1 or M1A1 until the bubble in the level vial is centered. Observe the quadrant reading for future use.

(5) Place gunner's quadrant on breech casing leveling pads. Manually elevate or depress the dual gun until quadrant reading is the same as reading obtained in (4) above.

(6) Place gunner's quadrant on computer body leveling pads (fig. 48) and check level of computer body. This quadrant reading must be within ± 2 mils of quadrant reading obtained in (5) above. If reading is not within the prescribed limits, drag link rod (fig. 24) must be adjusted.

(7) Loosen the two drag link rod locknuts (fig. 24).

Note. Uppermost locknut has a left-hand thread.

Hold gunner's quadrant on computer body leveling pads (fig. 48) and turn drag link rod until the quadrant setting is the same as the setting obtained in (4) and (5) above.

(8) Tighten the two drag link rod locknuts (fig. 24), using care to maintain setting obtained in (7) above.

(9) The gunner's quadrant should read level within ± 2 mils when placed on the gun mount carriage leveling pads (fig. 48), breech casing leveling pads, and the computer body leveling pads; if not, repeat (1) through (8) above.

(10) Manually elevate dual gun to 45° and check level of computer body. This reading must be level within ± 2 mils.

(11) Fully elevate dual gun and check level of computer body. From 45° to full elevation, this reading must be level within ± 4 mils.

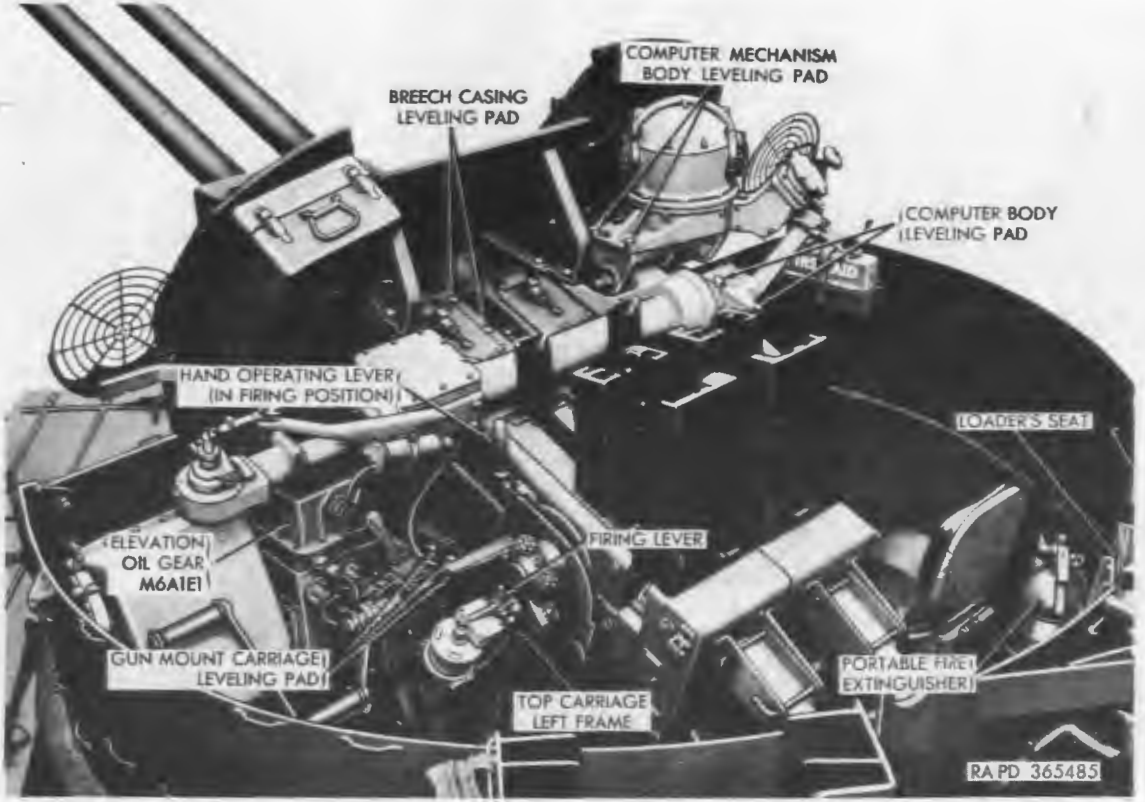


Figure 48. Location of gun mount leveling pads.

(12) If the readings obtained in (10) and (11) above are not within the specified limits, place the dual gun at the position where the gunner's quadrant shows the greatest deflection and adjust the drag link rod as outlined in (7) and (8) above.

c. Preparation for Boresighting.

Note. Boresighting cannot be performed correctly until the dual gun has been synchronized (*b* above).

(1) Set speed knobs (fig. 24) to BS boresight mark (20 mph) and set the computer bail at 50° dive.

Note. Some vehicles are equipped with early-type computing sights M38 (T154). The early-type computing sight M38 (T154) has the BS mark at the 16-mph detent on the speed knob, whereas, the late-type computing sight has the BS mark at 20-mph detent of the speed knob. On early-type computing sights, the computer bail must be set at full dive.

(2) Turn computer positioning handwheel (fig. 24) to set the computer housing at + 1,600-mils angle-of-approach on the azimuth scale index.

(3) Place gunner's quadrant M1 (fig. 43) or M1A1 (fig. 44) on computer body leveling pads (fig. 48). If reading is not level within ± 1 mil, the vertical slide joint stem must be adjusted ((4) and (5) below).

(4) Loosen No. 8 x ½ roundhead screw (fig. 49) which clamps computer cover to the base of computer mechanism body and drop cover to expose end of vertical slide and slide joint stem. Loosen ¼ x ¾ cap screw in vertical slide and screw slide joint stem in or out until computer mechanism body is level within ± 1 mil.

(5) Tighten the ¼ x ¾ cap screw (fig. 49) in vertical slide. Position computer cover on computer body and secure by tightening the No. 8 x ½ roundhead screw.

(6) Set speed knobs (fig. 24) at zero mph and set computer bail at 0°. These settings will tilt the computer mechanism body forward 9 mils ± 1 mil, *less* than level. This operation sets in the proper superelevation.

(7) Set speed knobs (fig. 24) to BS mark (20 mph) and computer bail to 50° dive.

(8) With gunner's quadrant on the computer mechanism body leveling pads, check for level reading. If reading is not level within 1 mil, repeat (4) through (7) above.

Note. If level reading cannot be obtained, notify ordnance maintenance personnel.

d. Boresighting Procedure. Breech boresight M17—7692047 (fig. 73) and muzzle boresight 5276694 (fig. 73) are provided in carrying

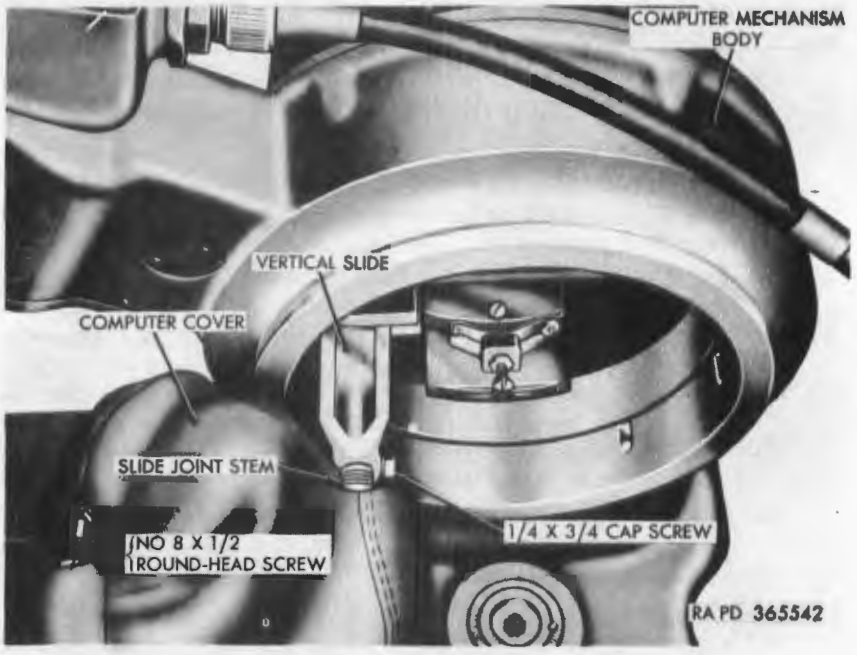


Figure 49. Computer with computer cover removed.

case M61—7692946 (fig. 73). The boresights are designed to fit into the breech chamber and muzzle of the gun. The breech boresight contains a mirror set at an angle of 45° which reflects the bore line of sight vertically through the top cover opening. The muzzle boresight consists of a tube with two wires across the end which are set at right angles to each other and intersect at the center. A chain attached to the muzzle boresight allows a red disk to hang in view as a warning that an obstruction is in the bore.

(1) Pull the hand operating lever (fig. 50) of the left gun back as far as possible and fasten in this position while another man performs the operations outlined in (2) and (3) below.

(2) Open top cover of left gun (par. 279*b* (4)).

(3) Insert breech boresight M17 into chamber of left gun. Position boresight so the peep hole is up and press into place. Carefully move hand operating lever to SAFE position (fig. 50).

Caution: Exercise extreme care when installing breech boresight to prevent injury by accidentally tripping the extractors.

(4) Install muzzle boresight in muzzle of left gun with the crossed wires horizontal and vertical and the red disk hanging in view.

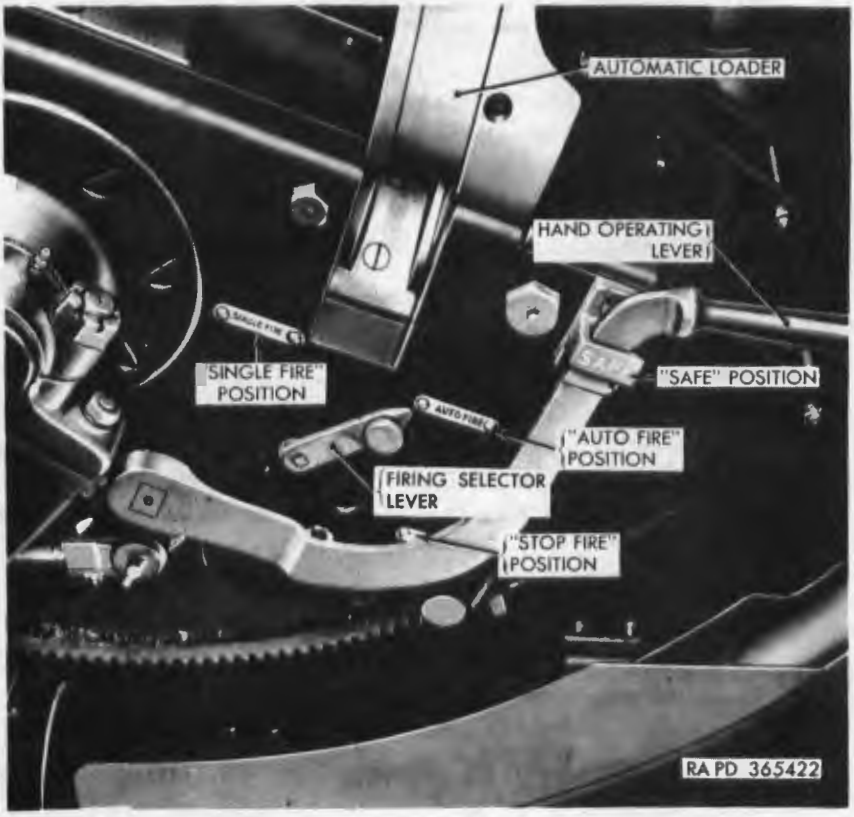


Figure 50. Hand operating lever—safe position.

(5) Set speed knobs (fig. 24) to BS mark (20 mph) and computer bail (fig. 24) to 50° dive. Set azimuth scale to + 1,600 mils (*c*(2) above).

(6) Sighting through the boresights, move the dual gun until it is carefully aimed at a well defined object not less than 1,000 yards distant.

(7) Install reflex sight M24C (A, fig. 47) (par. 57*b*(3)).

(8) Adjust reflex sight M24C (A, fig. 47) so that its reticle pattern is accurately centered on the same distant aiming point by performing operations indicated in (*a*) and (*b*) below.

(*a*) Adjust in azimuth by rotating the azimuth adjusting worm (R, fig. 47).

(*b*) Adjust in elevation by loosening the socket-head cap screw and then rotating the elevation adjusting worm (D, fig. 47). When adjustment is complete, tighten $\frac{3}{8}$ x $1\frac{1}{2}$ socket-head cap screw (Q, fig. 47).

(9) Remove muzzle boresight and stow in carrying case. To remove breech boresight, pull hand operating lever out of SAFE position (fig. 50) and back as far as it will move. Fasten lever back, reach into breech, and withdraw breech boresight. Move hand operating lever to firing position (fig. 48) after breech has been completely cleared.

(10) Close top cover of left gun (par. 279*d*(1)).

(11) Remove and stow reflex sight M24C in sight accessory chest (par. 62*c*(2)).

59. Direct Fire Operation

a. General. Direct fire operation is defined as firing directly on visible targets. It is accomplished while the gun mount is under either power or manual operation. Sighting is accomplished using the computing sight M38 (T154) (fig. 23) and reflex sight M24C during power operation; ring and peep sights are used during manual operation.

b. Power Operation.

(1) *Preparation.*

(*a*) Perform all of the preparatory operations described in paragraph 56.

(*b*) Install reflex sight M24C (A, fig. 47) (par. 57*b*(3)).

(*c*) Make sure that switch lever of control selector box (fig. 23) is in the LOCAL position.

Note. This switch lever should never be turned from the LOCAL position, except when it is desired to operate the gun mount by a remote control director.

(*d*) Raise drive controller M12E2 into operating position (par. 52*c*(2)).

(*e*) Turn master relay switch on (par. 26). If main engine is not running, start auxiliary generator and engine (par. 70) to prevent excessive drain on batteries.

(*f*) Turn on elevation switch by pulling elevation switch lever (H, fig. 47) back toward breech end of gun.

(*g*) Turn on rate motor switch (fig. 28) for drive controller rate motor.

(2) *Operation.*

(*a*) The gunner and sight setter must work together as a highly coordinated team to successfully operate the sighting and fire control materiel on the 40-mm twin gun mount M4E1. The gunner's function is to operate or control the movement of the gun mount in azimuth and the dual gun in elevation with the drive controller M12E2 under power operation. The sight setter's duties are to

estimate target course, speed, and angle of dive or climb, and then to set these estimated values into the computing sight M38 (T154). After these initial settings have been made, the sight setter will watch the trajectory of the tracers, make the necessary corrections in his original estimates to bring the line of fire on target, and incorporate these corrections on the control settings of the computing sight.

Note. It is very important to remember that the computing sight adds all of the horizontal and vertical lead necessary to bring fire on target. The gunner should not attempt to lead the target, he should keep it centered in the reticle pattern of the reflex sight M24C.

(*b*) Set the direction of travel of the target into the computing sight by turning the computer positioning handwheel (fig. 24) which rotates the computer in azimuth until the flight direction indicator on the computer bail points in the direction of target flight and is parallel with target course. The flexible shaft (fig. 24) which connect the computing sight to the traversing mechanism drives the computer at an equal speed and in the opposite direction to that in which the gun mount is being traversed. This causes the computer to remain motionless with respect to the target even though the gun mount is being traversed to bring the gun on target. The resulting action makes it unnecessary for the sight setter to operate the positioning handwheel once the flight direction indicator has been accurately alined with the target course.

(*c*) Estimate angle of target dive or climb and set this value into the computer by moving computer bail (fig. 24) until flight direction indicator duplicates the angle of target course. Computing sights with serial Nos. through 687 are provided with two inclination knobs on the computer, either of which may be turned to provide a fine adjustment of the computer bail. Inclination knobs have been eliminated on computing sights with serial No. 688 and up and also on some early models in accordance with field modification pertaining to computing sight M38 (T154).

(*d*) Estimate the speed of the target and set this estimated value into the computer by rotating the speed knob (fig. 24) until the estimated speed value is alined with the angle of flight scale index. The speed knobs are graduated from 0 to 700 mph in 20-mph increments to provide

accurate speed settings. The speed knobs rotate together so either one or both may be used to set the estimated speed. Note that in figure 24, the computer is set at —2,400 mils in azimuth ((*b*) above), 5° dive ((*c*) above), and 460 mph speed.

(*e*) Traverse and/or elevate the gun and gun mount until the target can be seen within the reticle pattern of the reflex sight.

Note. The open sight bracket (B, fig. 47) may be swung upward by the gunner and used as an aid to approximate alinement of the reflex sight line-of-sight on the target.

To track the target in azimuth, grasp the hand grips (L, fig. 47) and rotate the turret of the drive controller. To traverse the gun mount to the right, rotate the drive controller turret clockwise; to traverse the gun mount to the left, rotate the turret counterclockwise.

Warning: Be sure all personnel are aware of the operator's intentions before traversing.

Movement of the hand grips in a vertical motion elevates or depresses the gun. To elevate the gun, move the bottom of the grips toward muzzle end of gun; to depress the gun, move the bottom of the grips toward breech end of gun. A combination of both horizontal and vertical movements of the grips is necessary to track the target. A small movement of the hand grips at high tracking speed produces a greater change in speed than an equal movement of the grips would produce at low speed. This provides greater sensitivity of movement when tracking a fast moving target. Releasing the hand grips will cause the turret of the drive controller to return to its neutral position and the gun and gun mount to come smoothly and quickly to a rest position.

(*f*) After the line of sight through the reflex sight M24C has been brought onto the target, firing may be started (par. 65). Observe tracer stream and make any necessary corrections to the estimated values set into the computer in (*b*) through (*d*) above until the line of fire falls on target. If tracer stream passes in front of target, decrease estimated target speed; increase estimated target speed if tracer stream passes behind target. Remember that any adjustments made in the settings of the computer controls will result in a deflection of the reflex sight and must therefore be made in a smooth and uniform manner so as to avoid jerking the reticle pattern off target and upsetting the gunner's line of sight.

(3) *After operation procedure.*

(*a*) Turn off rate motor switch (fig. 28) for drive controller rate motor.

(*b*) Turn off elevation switch by moving elevation switch lever (H, fig. 47) forward toward muzzle end of gun.

(*c*) Stop main engine or auxiliary generator and engine (par. 70) and turn master relay switch to the OFF position (par. 26).

(*d*) Place drive controller in stowed position (par. 52*c*(2)).

(*e*) Remove lamp bracket from front of reflex sight M24C (A, fig. 47) and stow in dovetail slot provided on cover of lighting device (fig. 23) or remove reflex sight light (fig. 32) and stow on ring sight bracket. Loosen clamping bolt at rear of reflex sight and remove sight from support shaft of computing sight. Pull flat glass reflector from bracket on top of reflex sight.

(*f*) Open sight accessory chest (fig. 46). Release and open hinged retainer and stow reflex sight and flat glass reflector in chest. Close and secure retainer and chest.

60. Indirect Fire Operation

a. General. Indirect fire operation is defined as sighting and firing upon a ground target which, because of its location, is not within view of the personnel operating the 40-mm automatic dual gun M2A1 and 40-mm twin gun mount M4E1. It is generally accomplished with the aid of a fixed aiming point, that is, within sight of the personnel operating the gun and gun mount and a ground or aerial observer positioned to view the target area.

b. Preparation.

(1) Perform all of the preparatory operations described in paragraph 56.

(2) Remove reflex sight M24C from sight accessory chest and install on computing sight (par. 57*b*(3)).

(3) Install hand operating cranks (elevating and traversing) (par. 54*a*(2)).

(4) Remove cover from azimuth indicator M27 (fig. 41) and, for night operations, turn on toggle switch of instrument light 7983714.

(5) Set speed knobs (fig. 24) on computer to zero mph, computer bail to 0° climb and dive, and rotate computer positioning handwheel until the computer is set at + 1,600 mils on the azimuth scale index.

(6) Turn off rate motor switch (fig. 28) for drive controller rate motor.

(7) Turn off elevation switch by moving elevation switch lever (H, fig. 47) forward toward muzzle end of gun.

c. Operation.

(1) Manually elevate and traverse the gun and gun mount until the reticle pattern of the reflex sight is accurately centered on the fixed aiming point.

(2) Turn the resetter knob (fig. 42) of the azimuth indicator until top pointer coincides with middle pointer; then press down on knob and turn. Both pointers will now turn together. Turn the pointer until they read 0 mils on both the 1-mil (middle) and 100-mil (inner) scales and release the knob.

(3) Traverse gun mount until the sum of the readings opposite middle and top pointers equals the azimuth angle between the fixed aiming point and the target area. For example: if the required azimuth angle is 534 mils right, the middle pointer (fig. 42) should read halfway between the 500 and 600 mil graduations on the 100-mil scale and the top pointer should read 34 mils on the right side of the 1-mil scale.

(4) To make deflection corrections, rotate the gunner's aid dial (fig. 42) by hand until the zero graduation is opposite the top pointer. Traverse the gun mount until the top pointer indicates the desired deflection correction on the gunner's aid dial.

(5) Elevate or depress the dual gun until the desired elevation angle is set on the gunner's quadrant M1 or M1A1, using the leveling pads on the breech casing (fig. 48).

d. After Operation Procedure.

(1) Turn off toggle switch of instrument light 7983714 (fig. 41), and install azimuth indicator cover.

(2) Remove hand operating cranks from elevating and traversing mechanisms (par. 54*a*(3)).

(3) Remove reflex sight M24C from computing sight and stow in sight accessory chest (par. 62*c*(2)).

(4) Secure elevating travel lock (par. 54*c*) and traversing lock (par. 54*d*).

(5) Install computer cover (G, fig. 45) on right end of computing sight and secure with the snaps provided with the cover.

61. Manual Operation

a. General. The gun and mount normally are operated under power. In the event of a power failure or a local control system malfunction, the gun and mount may be operated manually.

b. Direct Fire.

(1) *Preparation.*

(*a*) Perform the preparatory operations described in paragraph 56*a*, *b*(1), (2), (4) and (7).

(*b*) Place the elevation switch lever in the off position (par. 52*e*(4)).

(*c*) Place drive controller in stowed position (par. 52*c*(2)).

(*d*) Release two hinged clamps securing sight support (fig. 29) to inside of gun mount platform below gunner's shield right and remove sight support. Push the slide attached to the base of the support into the peep sight support bracket (fig. 29) secured to the side of the right breech casing body and secure by tightening the two wingnuts supplied on the slide.

(*e*) Open sight accessory chest (fig. 46) by releasing two hinged clamps and swinging cover down. Unscrew two wingnuts within chest, swing eyebolts clear, and open hinged retainer. Remove sight mounting plate, peep sight, and two ring sights from chest. Close and secure retainer and chest.

(*f*) Install sight mounting plate (fig. 29) on right end of sight support and then secure the peep sight and one of the ring sights to the sight mounting plate using the wingnuts supplied with peep sight and plate. Secure remaining ring sight (fig. 27) to ring sight bracket on left end of computing sight and secure with wingnuts supplied on bracket. Loosen wingnut securing adjustable peep sight (fig. 27) on peep sight bracket at left side of computing sight, lift and rotate peep sight 180° so that it is alined with center of left ring sight, and secure by tightening wingnut.

(*g*) Before the ring sights (fig. 27) can be used effectively, they must be boresighted. Install the breech boresight M17 and muzzle boresight into the left gun (par. 58*d*(1)–(4)).

(*h*) Install hand operating cranks (elevating and traversing) (figs. 27 and 29) on hand operating crank adapters of elevating and traversing mechanism (par. 54*a*(2)). The hand operating crank for the elevating mechanism is stowed on the inside of the gun mount platform shield directly behind the gunner's seat; the crank for the traversing mechanism is stowed on the floor of the gun mount platform directly in front of the sight setter's seat.

(*i*) If hand operating crank adapter (fig. 37) is not in the manual operating position, push the adapter in, or both the elevating and traversing mechanisms, until the internal spline is engaged and the detent rides on the small shoulder diameter of the adapter.

(*j*) Unlock elevating travel lock (par. 54*c*) and traversing lock (par. 54*d*).

Caution: If the guns are emplaced on sloping terrain, the gun mount may drift to the low side if not restrained by holding the hand operating crank (traversing).

(*k*) Sighting through the boresights, move the dual gun until it is carefully aimed at a well defined object not less than 1,000 yards distant. Adjust the ring sights by loosening the wingnuts attaching the sights to their mounting studs and center as closely as possible on the same distant point when viewed through the peep sight (fig. 27). Secure the ring sights by tightening the wingnuts. Remove boresights (par. 58*d*(9)). Close top cover of left gun (par. 279*d*(1)(*f*)).

(2) *Operation.*

(*a*) Operate the gun mount in azimuth by turning the hand operating crank (traversing) (fig. 29), installed on the traversing mechanism. Clockwise rotation of the crank traverses gun and gun mount to the left; counterclockwise rotation of the crank traverses gun and gun mount to the right.

(*b*) Operate the gun in elevation by turning the hand operating crank (elevating) (fig. 27) installed on the elevating mechanism. Clockwise rotation of the crank elevates the gun; counterclockwise rotation depresses the gun.

(*c*) A combination of the operations described in (*a*) and (*b*) above is usually necessary to track a moving target. The gunner and sight setter must work together as a highly coordinated team to operate the gun mount smoothly and swiftly so the target can be kept in the field of vision defined by the ring sights.

(*d*) The ring sights (fig. 29) used in manual operation, are composed of seven concentric rings. The space between every 2 rings represents the amount of lead required for each 100 mph of target speed at average range (fig. 51). To effectively lead the target, estimate the target speed and elevate and traverse gun and gun mount until the center of the ring sight is alined with and moving along

the target path and the target is within the space between the rings representing its estimated speed.

Note. The center of the ring sights must always be maintained in a position in front of the moving target.

When the target is moving from left to right, the target should be viewed through the left side of the ring sight (fig. 51); when the target is moving from right to left, the target should be viewed through the right side.

(*e*) Refer to paragraph 65 for instructions on firing the gun.

(3) *After operation procedure.*

(*a*) Remove hand operating cranks from elevating and traversing mechanism (par. 54*a*(3)). Stow hand operating crank removed from elevating mechanism on inside of gun mount platform shield behind gunner's seat. Stow crank removed from traversing mechanism on floor of platform directly in front of sight setter's seat.

(*b*) Remove sight mounting plate, peep sight, and ring sight (fig. 29) from sight support mounted on right breech casing body. Release wingnuts and separate peep sight and ring sight from sight mounting plate. Loosen two wingnuts and remove remaining ring sight (fig. 29) from ring sight bracket on left side of computing sight. Loosen one wingnut securing adjustable peep sight at left side of computing sight, lift and rotate peep sight 180° to its stowed position, and secure by tightening the wingnut.

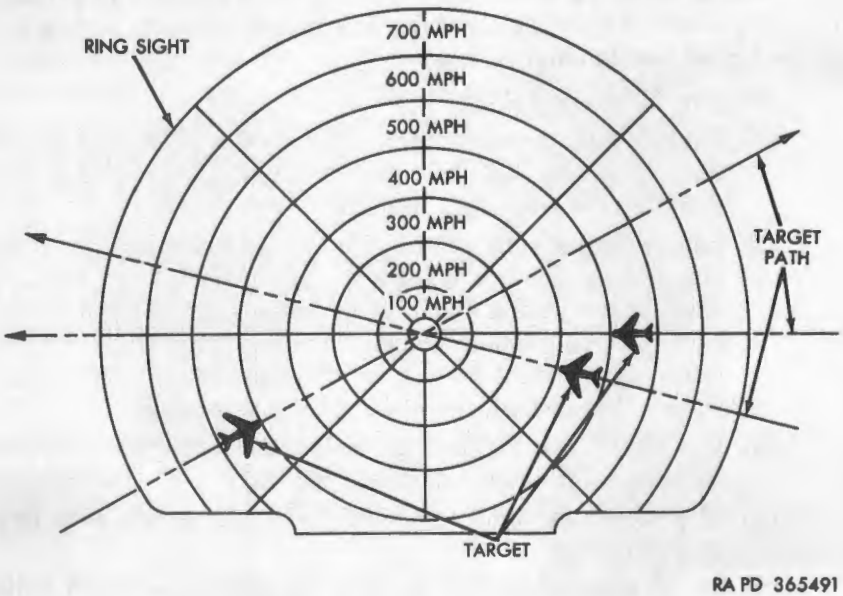


Figure 51. Alining aerial target within ring sights.

c. Indirect Fire with Reflex Sight M24C.

(1) Prepare the gun for hand crank operation (*b* above).

(2) Install reflex sight M24C (par. 57*b*(3)).

(3) Set the speed knobs to zero and the angle of flight scale to zero climb and dive.

(4) Sight through the reflex sight and by traversing and elevating or depressing, aline the line of sight on the aiming point.

(5) Manually operate the gun and gun mount (par. 60*c*).

d. Indirect Fire with Peep Sight and Ring Sight.

(1) Prepare the gun and gun mount for operation by hand crank (*b* above).

(2) Manually elevate and traverse the gun and gun mount until the center apertures of the peep sights and ring sights are centered on a fixed aiming point. Follow indirect fire operations (par. 60*c*(2) through (5)).

62. Preparation for Traveling

a. Secure Traversing Lock. Position gun mount so that dual gun is aimed either straight forward or to the rear of the vehicle. Grasp traversing lock lever (fig. 39) and squeeze to actuate releasing lever. Swing the traversing lock lever back on its bracket to the locked position and release.

b. Secure Elevating Travel Lock. Position dual gun at 0° elevation. Grasp elevating lock handle (fig. 38) and squeeze to actuate releasing lever. Swing the elevating lock handle back on its bracket to the locked position and release.

c. Prepare Computing Sight.

(1) Remove lamp bracket from reflex sight and stow on lighting device (fig. 23) or remove reflex sight light (fig. 32) and stow on ring sight bracket.

(2) Remove reflex sight M24C (fig. 23) by loosening clamping bolt at rear of reflex sight and remove sight from support shaft of computing sight. Stow reflex sight in sight accessory chest on gunner's shield. The speed ring sight and the reflex sight cannot be used at the same time; when either sight is being used, the other should be stowed.

(3) Place speed ring sights and brackets for azimuth speed ring sight in sight accessory chest (fig. 46).

(4) Close cover of sight accessory chest and secure with two hinged clamps.

(5) Install azimuth indicator cover (fig. 41) on azimuth indicator.

(6) Set rate motor switch and fire control safety switch (fig. 28) on the drive controller turret in the off position.

(7) Place the elevation switch lever in the off position (par. 52*e*(4)).

d. Install Protective Covers.

(1) Install flash suppressor covers (A, fig. 45).

(2) Install automatic loader cover (Q, fig. 45) on automatic dual gun.

(3) Install computer cover (G, fig. 45) on computer and secure with snaps provided on cover.

Section VI. OPERATION OF 40-MM AUTOMATIC DUAL GUN M2A1 UNDER USUAL CONDITIONS

63. Preparation for Firing

a. General. The 40-mm automatic dual gun M2A1 should be carefully inspected before firing to insure safe and proper operation. Failure to properly inspect the gun before firing may result in injury to personnel and/or damage to equipment. Perform the before-firing operation outlined in table VI.

b. Preliminary Operations. Refer to paragraph 56.

c. Recoil Cylinder Oil Level Check. Elevate dual gun to 25° (par. 54*a*). Cut locking wire and remove filler plug (fig. 52) from each recoil cylinder. Check to see that oil is up to level of each plug hole. If oil is not up to plug-hole level, fill in accordance with LO 9–7218 (pars. 90 and 280*d*(1)). Install filler plugs and lock in place with locking wire.

64. Loading the Dual Gun M2A1

Note. Perform the following operations on each gun.

a. Preparation for Loading.

(1) Pull hand operating left lever (fig. 33) rearward as far as possible, then move it forward into the rear catch bracket marked SAFE. Move firing selector lever (fig. 33) to the STOP FIRE position.

(2) Check bore and chamber for cleanliness. Wipe bore of barrel clean with a dry cloth.

(3) Make certain both gun breech top covers (fig. 53) are closed and locked. To be properly locked, the plunger of the cover latch lever (fig. 53) must be completely seated into the hole in the top cover. It is important that this plunger be seated since vibration of the weapon during

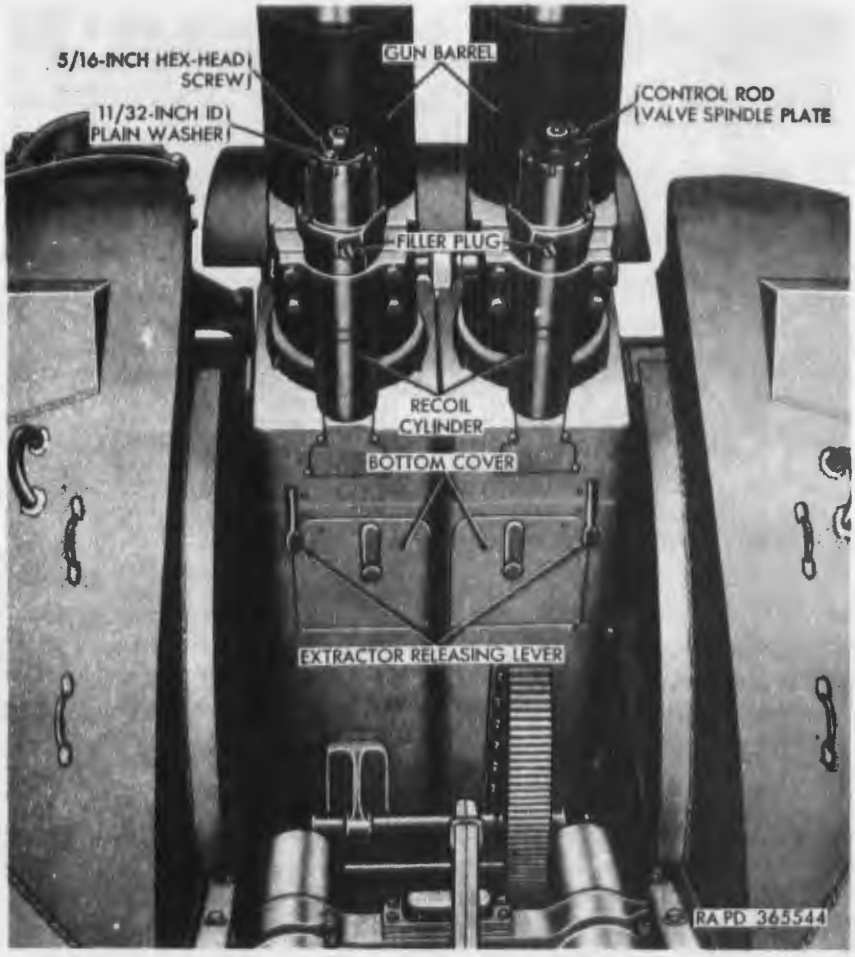


Figure 52. Recoil cylinders—installed view.

firing may cause the lever to work into the unlocked position. To check, attempt to rotate the cover latch lever from its locked position in either direction and try to open cover by pulling up on handle.

Warning: Serious injury to personnel and severe damage to equipment will result if guns are fired with the top covers not closed and securely locked.

b. Loading.

(1) To load charger clip, press pin and hook (fig. 54) outward with finger and insert rim of cartridge into one of the four concave depressions. Release pin to permit hook to clamp cartridge in place. Repeat operation until clip is filled.

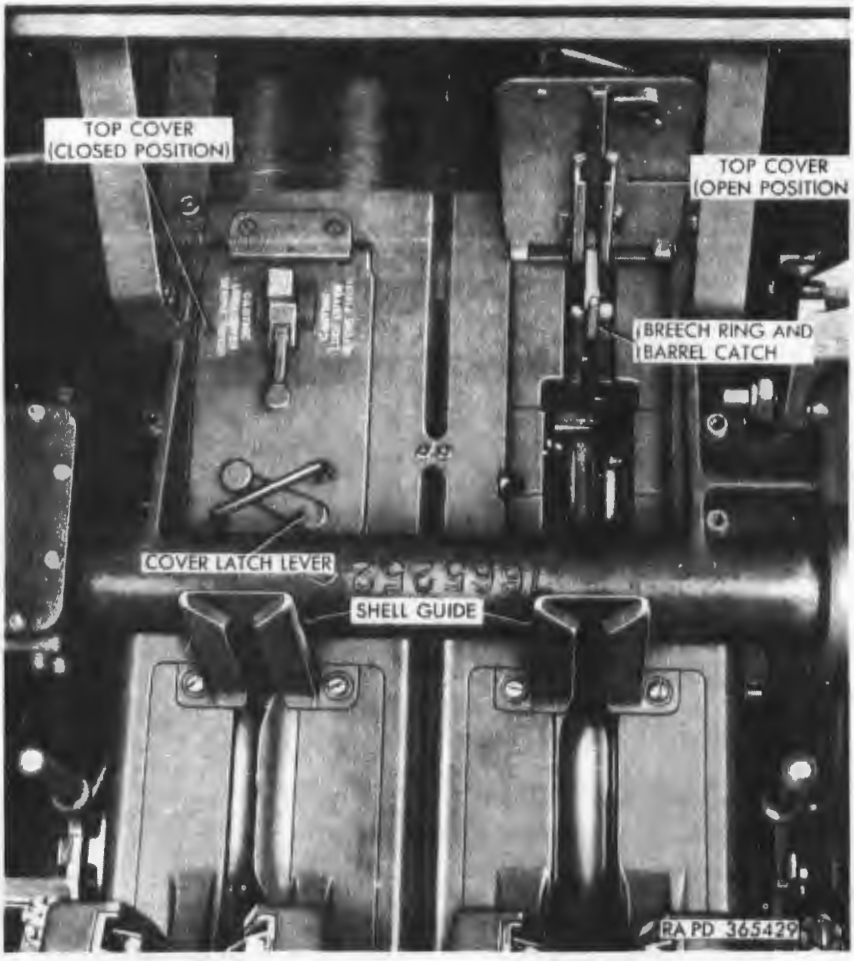


Figure 53. Gun breech top covers in closed and open position.

(2) Push loaded charger clip down into guides on automatic loader (fig. 55) until feed rollers are rotated and one cartridge drops onto loader tray.

(3) Set feed control thumb levers (fig. 34) in direction indicated by arrows (par. 53*c*).

(4) Rotate firing selector lever (fig. 33) to either AUTO FIRE or SINGLE FIRE position as desired. Move the hand operating lever forward to firing position (fig. 33). Gun is now ready for firing.

65. Firing the Dual Gun M2A1

Note. Each of the single guns which make up the dual gun should be used equally during firing. This is done so that wear is distributed equally.

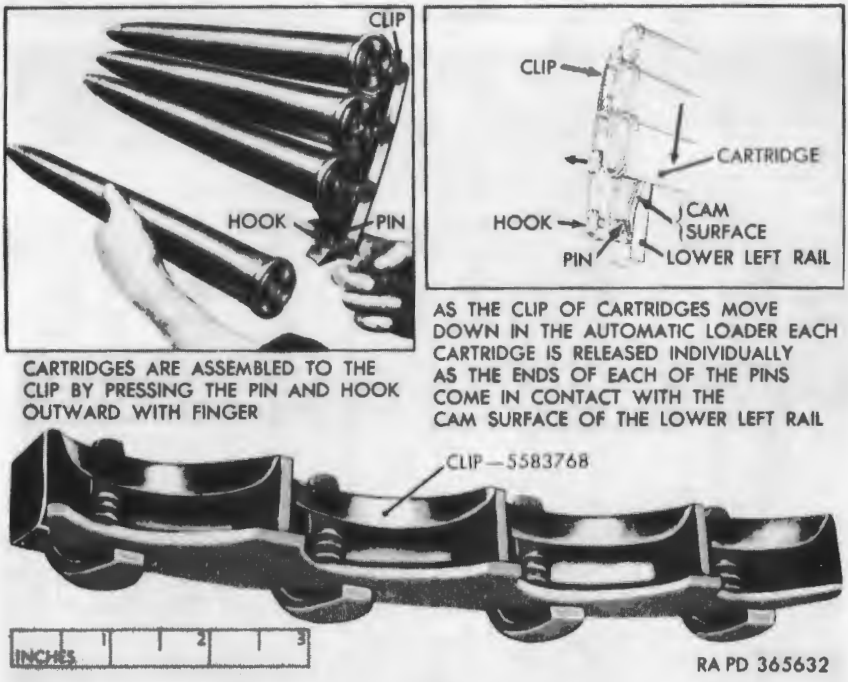


Figure 54. Loading cartridge in charger clip.

Figure 55. Loading clips of cartridges in gun.

a. Electrically. Place the gun mount in power operation (par. 59*b*(1). Turn fire control safety switch (fig. 28) to the ON position. Squeezing one or both of the trigger assemblies (fig. 28) on the drive controller hand grips will fire one or both guns. To cease firing, release pressure on trigger assembly. With the firing selector lever (fig. 33) in the SINGLE FIRE position, trigger assembly must be depressed for each shot. With the firing selector lever in the AUTO FIRE position, the guns will continue to fire so long as the trigger assembly is depressed and ammunition is supplied.

b. Mechanically. To fire depress the firing mechanism pedal (fig. 38). To cease firing, release pressure on pedal.

c. Stoppages. It is important that someone be available to observe the functioning of the dual gun when it is firing. When both guns are being fired, it may not be readily apparent that a stoppage has occurred. Since the time element is important in hangfire, it is imperative that an experienced operator, preferably the loader, observe gun functioning. A stoppage will not always be a failure to fire.

66. Misfire, Hangfire, Cook-Off, and Excessive Pressure

a. General. Although malfunctions, described below, are rarely encountered when authorized and properly maintained ammunition is fired in properly maintained and operated weapons, it is important that all personnel concerned understand the nature of each kind of malfunction as well as the proper preventive and corrective procedures to avoid injury to personnel or damage to materiel.

b. Misfire. A misfire is a complete failure to fire which may be due to a faulty element in the propelling charge explosive train, or to a defect in the firing mechanism. A misfire in itself is not dangerous but since it cannot be immediately distinguished from a delay in the functioning of the firing mechanism, or a hangfire (*c* below), it should be considered as a possible delayed firing until such possibility has been eliminated. Such a delay in the functioning of the firing mechanism, for example, could be caused by foreign matter or improper lubrication. When the partial restraint is overcome or removed, the firing mechanism functions normally. The danger lies in the fact that the delay may vary in its duration.

c. Hangfire. A hangfire is a delay in the functioning of a propelling charge explosive train at the time of firing. The amount of the delay is unpredictable but in most cases will fall within the range of a split second to several minutes. Thus, a hangfire cannot be distinguished immediately from a misfire and therein lies the principal danger—that of assuming that a failure of the weapon to

fire immediately upon actuation of the firing mechanism is a misfire whereas in fact it may prove to be a hangfire.

d. Cook-Off. A cook-off is a functioning of any or all of the explosive components of a round chambered in a very hot weapon due to heat from the weapon. The primer and propelling charge, in that order, are in general more likely to cook-off than the projectile or the fuze. If the primer or the propelling charge should cook-off, the projectile *may* be propelled from the weapon with normal velocity even though the firing mechanism was not touched. Should the bursting charge explosive train cook-off, injury to the weapon and crew may result.

e. Procedure.

(1) The time intervals prescribed herein are based on experience and consideration of safety and are established to minimize the dangers of misfire, hangfire, etc.

Note. This procedure presupposes that the weapon has functioned normally up to the misfire. Refer to troubleshooting for failure to fire because of other mechanical defects.

(2) When a gun fails to fire, immediately recock, without opening the breech, and fire.

Caution: Do not open the top cover.

To recock the gun without opening the breech, lift the hand operating lever (fig. 33) slightly until the inner cocking lever is engaged by the check plunger, then return the hand operating lever to the normal firing position. This operation will permit the breechblock to drop about one-fourth inch and cock the percussion mechanism and then return the breechblock, releasing the firing pin to strike the primer.

Caution: It is imperative that movement of the hand operating lever be limited to that amount required to recock the percussion mechanism. Further movement of the lever lowers the breechblock to a position where the base of the cartridge case is no longer supported by the breechblock face.

The movement of the hand operating lever just necessary to recock the percussion mechanism must be based on experience gained from practice using the drill cartridge. The gun crew should be trained in this procedure before firing.

(3) If the round does not fire upon the second attempt, wait 30 seconds from the last attempt and remove the round as outlined in (*a*) below. If the round cannot be removed within 30 seconds, make no further attempt to remove

round until the weapon is cool. If the gun has been subjected to continuous fire for a considerable length of time before the misfire, the barrel will be hot and there is the possibility of a cook-off. If the barrel is hot, cool immediately by playing water on it or, if water is not immediately available, clear all personnel from the gun until it has cooled. Then remove the round as outlined in (*a*) or (*b*) below.

(*a*) Place the firing selector lever in STOP FIRE position. Elevate gun to 30°. Place a man at rear of breech casing to catch the round as it is being ejected and move the operating handle all the way back past the rear catch bracket.

(*b*) If the round is stuck and cannot be removed as in (*a*) above, proceed as follows:

1. With firing selector lever in STOP FIRE position, latch hand operating lever in rear catch bracket marked SAFE.

2. Place dual gun at 0° elevation.

3. Assemble the cleaning staffs—6110686 and 6110689 M14 (fig. 71) and install the shell ejector—5298763 (fig. 56) into the end of the cleaning staff.

4. Insert the ejector into the muzzle of the gun and push the round back onto the loader tray.

f. Inspect the Base of the Removed Round.

(1) If the indent is normal, the ammunition round is defective and should be removed to a safe distance from the vicinity of firing due to the continued possibility of a hangfire. When the possibility of a hangfire has been eliminated, the round will be disposed of in accordance with AR 385–63. Resume firing.

Figure 56. Removal of round using shell ejector—5298763.

(2) If the indent on the primer is exceptionally light or if their is no indent, either the firing mechanism is defective or the breechblock failed to close entirely. Refer to paragraph 281 for corrective procedures.

Note. Inspection of the primer indent is not always conclusive since the firing pin actually strikes a solid brass plug rather than a primer cup. It is possible for the brass plug to receive a blow of sufficient force to properly initiate the primer ignition train, yet the primer indent will appear weak or be nonexistent.

Consider the first failure to fire as a misfire (*b* above). If the next round fails to fire, inspect the breech and firing mechanism for malfunctions. Check firing pin protrusion. If further failure to fire occurs, treat the ammunition lot as defective and notify ordnance maintenance personnel.

67. Unloading

a. General. Unloading, pertaining to the 40-mm automatic dual gun M2A1, means removing the round on the loader tray and any other rounds left in the automatic loader since a live round left in the chamber is either a misfire or the result of a malfunction.

b. Safety Precautions.

(1) Place firing selector levers (fig. 33) in STOP FIRE position.

(2) Pull hand operating levers (fig. 33) back and engage in the rear catch bracket marked SAFE.

(3) Position feed control thumb levers (fig. 34) opposite to that indicated by arrows.

(4) Remove cartridge case deflector pins (fig. 34) and remove cartridge case deflectors.

c. Clear Loader Tray.

(1) Make sure all safety precautions have been performed (*b* above).

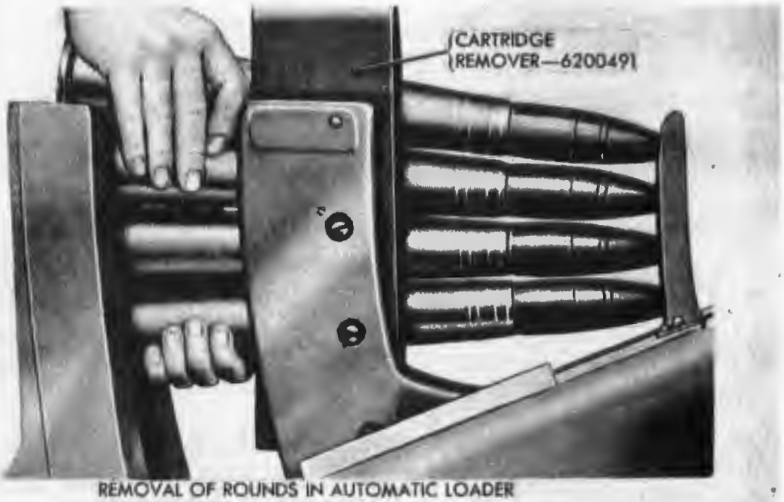
(2) Reach through opening in the breech casing normally covered by cartridge case deflectors, lift live round from the rammer levers, and withdraw the round carefully to the rear and out of the breech casing.

d. Unload Automatic Loader.

(1) Insert cartridge remover 6200491 (fig. 57) into the automatic loader, retracting the feed pawls and stop pawls.

Caution: Exercise care when inserting the cartridge remover to avoid damaging the feed rollers.

(2) Insert the flat end of shell pusher 5595031 (fig. 57) through the opening in rear of the breech casing, between



REMOVAL OF ROUNDS IN AUTOMATIC LOADER
USING CARTRIDGE REMOVER

SHELL PUSHER WITH FLAT END
INSERTED BETWEEN FEED ROLLERS
FORCING ROUNDS UPWARD INTO
CARTRIDGE REMOVER

SHELL PUSHER IN POSITION
FOR REMOVING ROUNDS BY
FORCING THEM THROUGH FEED
ROLLER ONTO LOADING TRAY

RA PD 365427

Figure 57. Unloading automatic loader using cartridge remover—6200491 and shell pusher—5595031.

the feed rollers and force the rounds up into the cartridge remover (fig. 57). Use care with the shell pusher to avoid damage to cartridge cases and feed rollers.

(3) Lift the cartridge remover and rounds out of automatic loader (fig. 57).

(4) An alternate method may be used as follows:

(*a*) Perform safety precautions (*b* above).

(*b*) Clear loader tray (*c* above).

(*c*) Force the cartridge between the feed rollers on the loader tray one at a time, using shell pusher 5595031 (fig. 57) and remove as in *c* above.

(*d*) It will be necessary to actuate the hand operating lever before each cartridge is forced between the feed rollers. Move the hand operating lever from SAFE position forward to the front catch bracket and immediately back to SAFE position. This action will release the feed roller catch heads.

e. Uncock the Gun. When the automatic loader and loader tray of both guns are completely empty, release tension on the operating springs as follows:

(1) Position the feed control thumb lever (fig. 34) opposite to the arrows.

(2) Push the extractor release levers forward and, at the same time, release the hand operating lever (fig. 33) from the rear catch bracket and allow the lever to rotate slowly to its forward position. As the lever is rotated forward, the breechblock will close.

(3) Move the firing selector levers (fig. 33) to AUTO FIRE position.

(4) Depress the firing mechanism pedal to release the rammer shoes. A distinct click will be heard when the rammer shoes are released.

(5) Move the firing selector levers (fig. 33) to STOP FIRE position.

(6) Position cartridge case deflectors (fig. 34) and secure with cartridge case deflector pins.

68. Stuck Cartridge Case

If a cartridge case sticks and cannot be removed by operation of the hand operating lever (par. 66*e*), proceed as follows:

a. Latch the hand operating lever (fig. 33) in the rear catch bracket marked SAFE. Open the gun breech top cover (fig. 53). Insert the hand cartridge extractor—5228060 (fig. 58) through

Figure 58. Removal of case, using hand cartridge extractor—5228060.

the top cover opening into the aperture in the breech end of the barrel tube. Engage the rim of the cartridge case and carefully pry case out of the chamber.

b. If the procedure outlined in *a* above fails to extract the case, it may be removed by following the procedure given in paragraph 66*e*, with the exception, however, that the ejector 5298763 would probably not be needed to remove an empty cartridge case.

Section VII. OPERATION OF MATERIAL FURNISHED WITH MAJOR ITEM

69. General

This section describes, locates, and furnishes the crew with pertinent information pertaining to the various controls and instruments provided for the proper operation of the auxiliary generator and engine, personnel heater, fire extinguishers, auxiliary

power outlet receptacle, and accessory outlet receptacle. Bilge pumps and controls were furnished in vehicles with Ordnance serial Nos. 1 through 661, 1205 through 1354, and 1555 through 1626.

70. Auxiliary Generator and Engine

a. Description. The auxiliary generator and engine (fig. 161) is an integral unit mounted in the right front corner of the engine compartment. This is a multipurpose accessory used to recharge the batteries, to provide a source of electrical power when the main engine is not running, to provide a source of electrical power to supplement the main engine generator, and to furnish heat to the engine compartment during cold weather operation. Controls for the unit are the auxiliary generator and engine control box (fig. 18), a manual starter handle (fig. 161), and a choke control (fig. 59).

(1) *Auxiliary generator and engine control box* (fig. 18). This box is mounted on the hull front wall directly in front of the driver. A 3-position (OFF, RUN, and START), heat exchanger heater switch, and two warning lights (LOW OIL PRESSURE and GEN. NOT CHARGING) are mounted on the control box.

(2) *Auxiliary generator and engine choke control handle* (fig. 59). This control handle is mounted on the driving compartment rear wall to the left of the commander's backrest. It is connected by flexible cable to the auxiliary generator and engine carburetor and its mounting bracket is angled to face the driver.

(3) *Auxiliary generator and engine manual starter* (fig. 161). This mechanism is an automatic rewind pull-cable-type starter providing an alternate means of starting the auxiliary generator and engine when the battery charge is low. The manual starter handle is mounted on the auxiliary generator and engine unit and is located under the right front grille door of the engine compartment.

(4) *Preheating intake elbow.* There are two electrically controlled heating elements located in the carburetor intake elbow. The elements are energized when the ignition and starter switch is in the START or RUN position and the ambient temperature is below 40° F.

(5) *Heat exchanger and 6-kw heater.* The heat exchanger furnishes, when necessary, heat for main engine compartment. A built-in 6-kw electric heater provides for additional heat when required and is controlled by the heater switch in the control box.

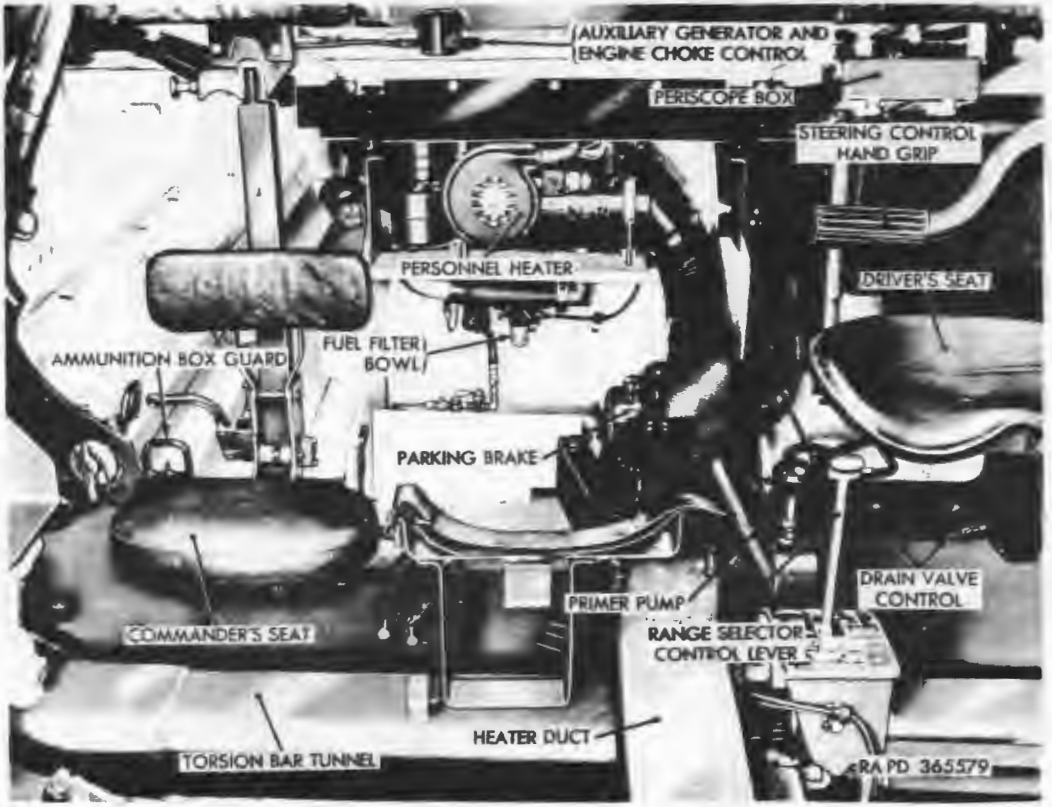


Figure 59. Driving compartment accessories.

(6) *Hydrostatic lock.* Oil or liquid fuel entering the combustion chamber when the engine is not running, or water entering the chamber during accidental immersion of exhaust tube outlet, will cause a hydrostatic lock. Before an attempt is made to start the engine, crank engine with the manual starter two complete engine cycles. If the engine cannot be turned in the above manner it indicates hydrostatic lock or engine seizure. Remove spark plug and try cranking engine with manual starter. If engine turns, continue cranking until all liquid has been removed. If engine cannot be hand cranked with spark plug removed, there is a seizure of engine or generator parts. Notify ordnance maintenance personnel.

b. Starting with Electric Starter. Check for hydrostatic lock (*a*(6) above). Turn the fuel shutoff valve control lever (fig. 9) to BOTH ON position and the master relay switch (E, fig. 15) to the on position. Move auxiliary generator and engine ignition and starting switch to START position and hold it until engine starts.

Caution: Do not hold switch in START position longer than 30 seconds at a time.

When engine starts, release switch handle and it will return to RUN position. If warning lights in control box do not go out within 10 seconds after the engine starts, stop auxiliary generator and engine and investigate. In starting the auxiliary generator and engine at temperatures below 25° F., place the switch at RUN position but do not attempt to start for approximately 5 minutes. This will allow the intake elbow heaters to preheat the elbow, aiding fuel vaporization. The thermostatically controlled intake elbow heaters will operate whenever the ambient temperature is below 40° F., and the ignition and starting switch is in the RUN or START position.

Caution: The 6-kw heater is not to be used to preheat the intake elbow.

Pull out auxiliary generator and engine choke control (fig. 59) as required to provide smooth operation until engine has warmed up.

Caution: The master relay switch must be on at all times when auxiliary generator and engine is in operation, or no current will reach the battery and damage to the generator regulator control box may result.

Be sure the radio is off before starting the auxiliary generator and engine.

c. Starting with Hand Starter. Check for hydrostatic lock (*a* (6) above). Turn the fuel shutoff valve control lever (fig. 9) to the BOTH ON position and turn on the master relay switch. If

temperature is low and the engine is cold, pull out the auxiliary generator and engine choke control (fig. 59) to full choke position. If temperature is below 25° F., place the ignition and starting switch in RUN position for approximately 5 minutes. This allows the intake elbow heaters to preheat the elbow which aids fuel vaporization. The heaters are operated by thermostatic control whenever the ambient temperature is below 40° F., and the switch is in the RUN or START position. Before attempting to manually start the auxiliary generator and engine at temperatures below 0° F., reduce engine friction by diluting the crankcase oil with 1½ pints of gasoline. An equivalent amount of oil must be drained from the crankcase prior to adding the gasoline. Check the oil level gage after adding gasoline and if it indicates a level above full mark drain to the mark.

Caution: Filling above full mark will cause spark plug fouling. Crank engine to compression stroke with a series of short steady pulls on the auxiliary generator and engine manual starter handle (fig. 161). Release handle, allowing cable to completely rewind, then pull the manual starter handle with a long steady pull through the complete cable length. Repeat the long steady pulls until engine starts, but be certain that the starting cable is allowed to rewind completely before each pull. Adjust the choke control for smooth operation during warmup period. Return choke control to the normal inoperative position after 3 to 5 minutes of operation. Operate engine for at least 1 hour to insure boiling off the gasoline diluted in the oil before additional gasoline is added for the next cold start. Failure to do this will result in overdilution of the crankcase oil which will shorten engine life.

d. Use As a Heater. A heat exchanger with a built in 6-kw electric heater and a heat exchanger duct (fig. 158) are integral with the auxiliary generator and engine to provide cold weather heating facilities for the main engine compartment.

(1) Air is drawn in through the rear shroud panel (fig. 159) and circulated over the generator and engine, through the heat exchanger, and over the main engine. If no heat is required over the main engine, move the duct damper lever (fig. 158) to the off position and tighten locking screw.

(2) Additional heat for the main engine compartment can be obtained by moving the duct damper lever to the on position and the HEATER switch in the auxiliary generator and engine control box (fig. 18) to the ON position. This activates a 6-kw heater in the heat exchanger.

Caution: Do not place HEATER switch in the auxil-

iary generator and engine control box in the ON position unless the 6-kw electric heater is to be used.

With the heater in operation, temperature of the circulating air ranges up to 500° F.; it can supply 80,000 Btu per hour. Heat output from the combination of heat exchanger and the auxiliary generator and engine varies according to the electrical load being applied to the auxiliary generator and engine; the greater the load condition, the greater the heat generated.

e. Stopping. To stop auxiliary generator and engine, move control switch on auxiliary generator and engine control box (fig. 18) to the OFF position.

71. Personnel Heater

a. Description. The gasoline-burning personnel heater (fig. 59) is located to the immediate rear of the driving compartment and positioned centrally between the two ammunition stowage compartments. The heater control switch, marked OFF - ON - PRIME and the temperature control switch, marked HI - LOW are mounted on the personnel heater control box (fig. 60) which is mounted on the hull left wall in the driving compartment. Heat

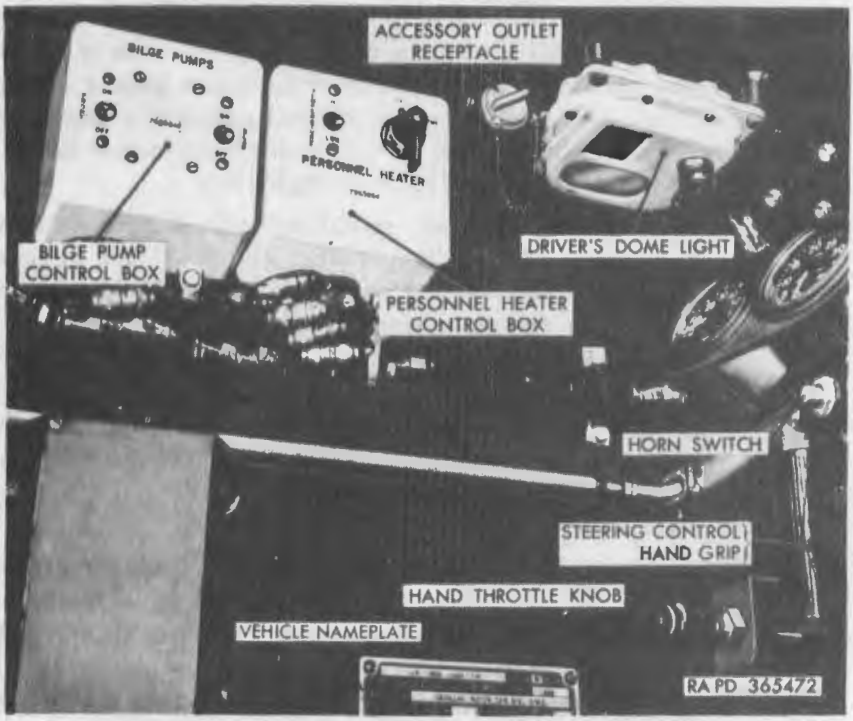


Figure 60. Personnel heater and bilge pump control boxes.

is distributed in the driving compartment by a heater duct. The personnel heater has a rated output capacity of 20,000 Btu per hour at ¼ gallon of gasoline consumption per hour. At the LOW position, heat output is reduced to 10,000 Btu per hour and gasoline consumption is reduced to ⅛ gallon per hour.

b. Operation.

(1) Turn the fuel shutoff valve control lever (fig. 9) to the BOTH ON position. Move the master relay switch to the on position. At the personnel heater control box (fig. 60), set the temperature control switch to HI position and turn heater control switch to ON position. Warm air should be felt at the heater outlets in 1 to 3 minutes. Heat output during operation is controlled by the temperature control switch.

(2) The heater is equipped with a safety device that automatically shuts off the fuel supply should the heater fail to ignite. If warm air is not felt at the outlets within 3 minutes, hold the spring-loaded heater control switch on PRIME position for 30 seconds, then return to the ON position. If heater does not start on the third attempt, service is required and no further attempts should be made until the cause of failure has been corrected.

Note. The personnel heater electrical system contains two automatic-resetting circuit breakers which function in the event of a short circuit or overload. Wait 30 seconds for the circuit breakers to reset if a temporary short or overload occurs.

(3) When heat is no longer desired, turn the heater control switch to the OFF position. Burning in the heater will stop in a few seconds, but the blowers will continue to operate for 2 or 3 minutes. When the heater cools sufficiently, the blowers will stop automatically. If the heater control switch is turned to the ON position during the cooling period, the heater will not start until the cooling period is over. The heater blower will continue to operate to cool the heater. even though master relay switch is in the OFF position, as the blower is fed by a circuit-breaker-protected lead directly from the batteries and not from main feed harness through the master relay.

72. Fire Extinguishers

a. General. A fixed fire extinguisher system and a portable fire extinguisher are furnished with each vehicle to provide protection in the event of fire.

b. Fixed Fire Extinguisher System. Two 10-pound capacity carbon dioxide cylinder extinguishers are mounted in the 40-mm

ammunition stowage compartment to the left and right of the generator regulator control box (fig. 61). Discharge nozzles from these extinguishers are directed into the engine compartment. Two manually operated fire extinguisher handles (fig. 62) are provided; one is located behind the driver's seat in the driving compartment and the second is mounted on the outside of the vehicle immediately behind the driver's hatch. Pulling either of these handles causes both fixed fire extinguishers to discharge simultaneously.

c. Portable Fire Extinguisher. A 5-pound capacity carbon dioxide portable fire extinguisher (fig. 63) is mounted on the wall inside of the gun mount. To operate, remove the extinguisher from its bracket and convey it to the fire location. Swing discharge nozzle upward to a position 90° from the cylinder. Remove the safety pin and direct the discharge nozzle at the base of the flame. Control discharge with the trigger. Advance slowly as fire is extinguished being sure all flame is out in an area before moving discharge. When flames are out, continue to coat all hot material with carbon dioxide snow to prevent rekindling of fire. Completely discharge the cylinder for each fire and obtain replacement from higher echelon.

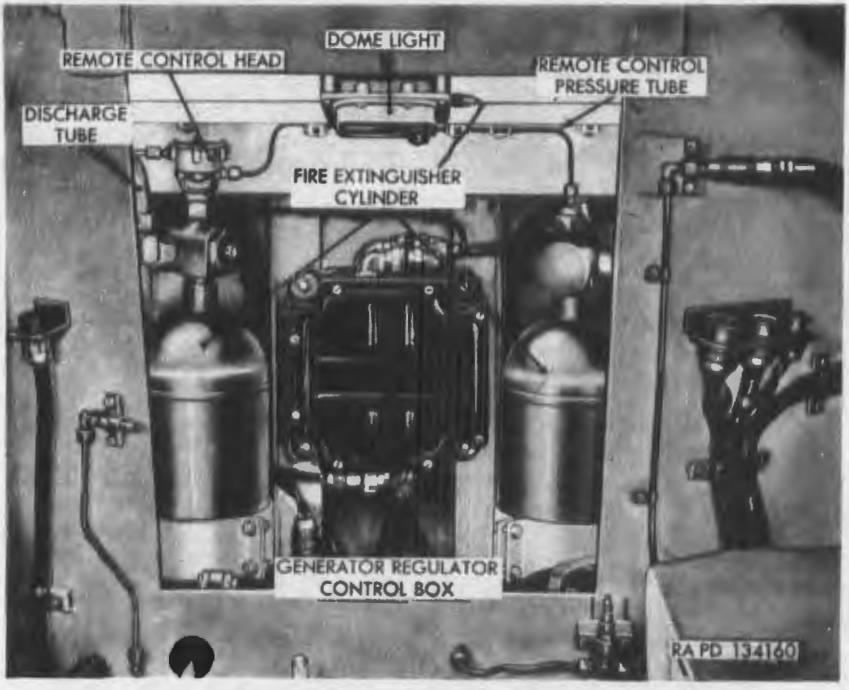


Figure 61. Fixed fire extinguishers.

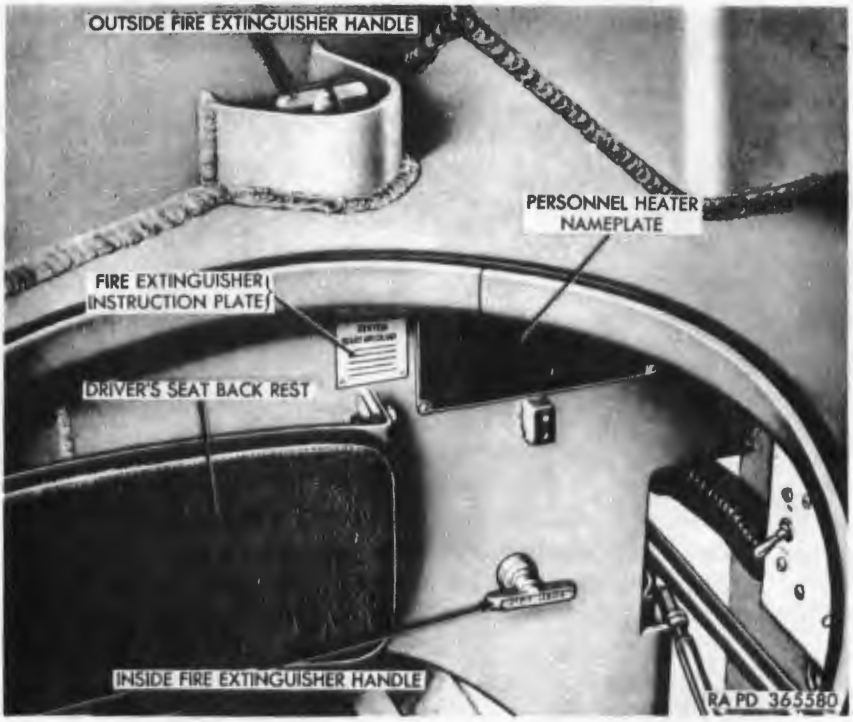


Figure 62. Fixed fire extinguisher controls.

d. Operation. Carbon dioxide when released from fire extinguisher is heavier than air and will fill an inclosed engine compartment from the bottom up. As the level of carbon dioxide rises, air is pushed out. In case of fire in engine compartment the fire extinguisher system should not be released until after the vehicle engine has been stopped because the engine cooling fan would expell the carbon dioxide before it could quench the flames.

Note. Driver should guard against the natural impulse to release the fire extinguisher system before engine has been shut down.

(1) Procedure if fire occurs when vehicle is in combat status.

(*a*) Increase the engine to full speed to reduce engine compartment temperature and move vehicle out of line of fire if situation permits.

(*b*) Stop engine, or if engine has failed release the fixed fire extinguisher system when cooling fan has completely stopped.

(*c*) The portable extinguisher may be used to assist in fire quenching or used in case of recurrence of fire.

(2) Procedure if fire occurs when vehicle is in nontactical situation.

(*a*) Stop engine and evacuate vehicle.

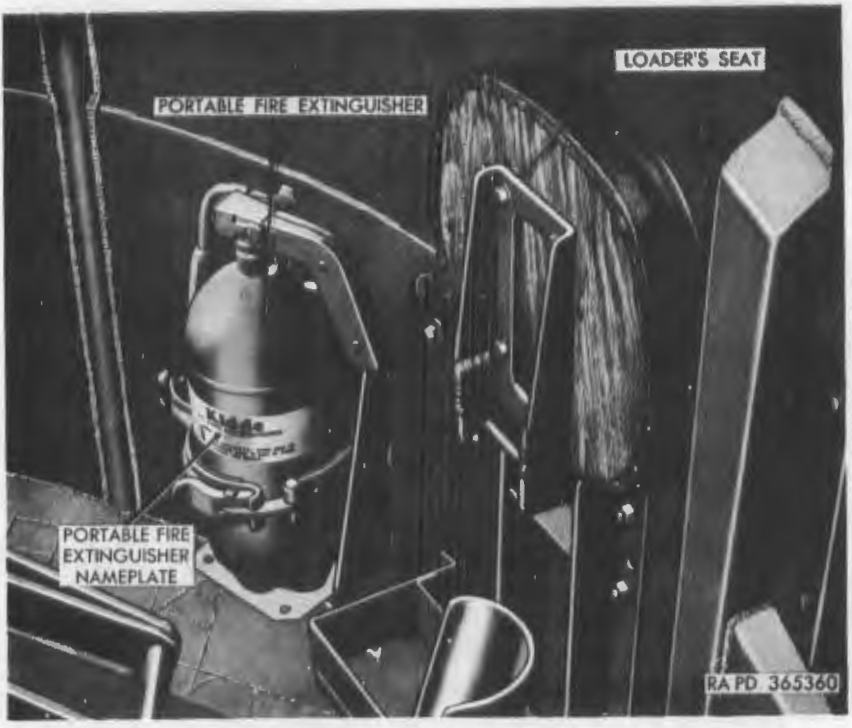


Figure 63. Portable fire extinguisher.

(*b*) As soon as engine cooling fan has stopped, release fixed fire extinguisher system.

(*c*) Obtain portable fire extinguishers from other vehicles if available.

(*d*) Extinguish recurring fires with any available portable extinguisher.

Warning: Do not attempt to start engine after an engine fire until the power pack has been inspected.

Note. Sand or dirt if available is useful in quenching a fire.

73. Bilge Pumps

a. Description. Two bilge pumps (fig. 64), one in the driving compartment and one in the engine compartment are provided to hold water level to a minimum should water enter the hull during fording operations. These two pumps, with their screened intakes installed one-half inch above the hull floor, have a capacity of 50 gpm each.

Note. See paragraph 69 for serial numbers of vehicles having bilge pumps.

In vehicles without bilge pumps, the control box (fig. 60) has been eliminated. The torsion bar tunnels (fig. 59) have slotted areas at the floor line to allow any water to drain to the lowest point in the

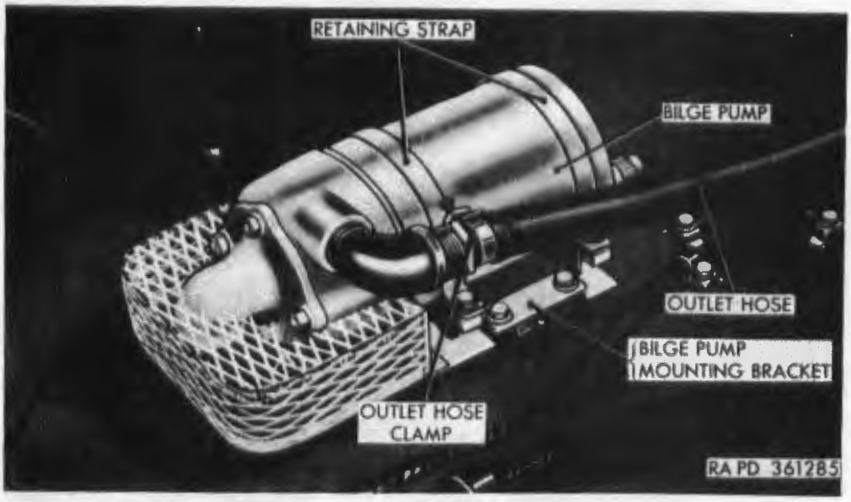


Figure 64. Engine compartment bilge pump.

hull interior. Any water remaining below the bilge pump pick-up level after fording operations can be released through the three drain valves in the hull floor.

b. Operation. Turn the master relay switch on. Turn one or both switches in the bilge pump control box (fig. 60) to the ON position. The switch marked FRONT controls the bilge pump in the driving compartment and the switch marked REAR controls the one in the engine compartment. During fording operations, turn bilge pumps on before entering water.

74. Auxiliary Power Outlet Receptacle

The auxiliary power outlet receptacle (fig. 65) is mounted in a bracket attached, to the left, inside of the hull rear plate. This receptacle is protected by a metal cap to keep out dirt and to prevent short circuits when not in use. Being wired in parallel with the vehicle electrical system, this receptacle is used to receive electrical current from an outside source when the batteries are are unable to furnish desired current. This receptacle may also be used as an outlet to furnish current to other equipment or vehicles using a 24-volt system. For either purpose, supplying or receiving electrical current to or form another vehicle, the auxiliary power outlet receptacles are to be connected with extension cable 17–C–568. The procedure for making connections is described in paragraph 43.

75. Accessory Outlet Receptacle

The accessory outlet receptacle (fig. 60) is located between the personnel heater control box and the driver's dome light. This

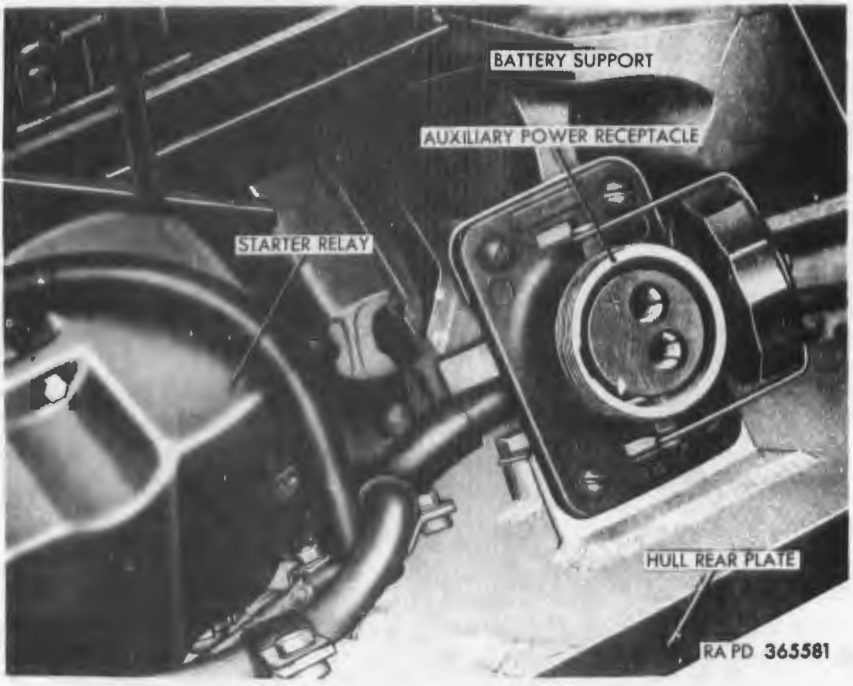


Figure 65. Auxiliary power outlet receptacle.

receptacle provides a 24-volt accommodation for a plug-in extension such as a map reading lamp, etc.

Section VIII. OPERATION UNDER UNUSUAL CONDITIONS

76. General Conditions

a. In addition to the operating procedures described for usual conditions (pars. 42–49, 55–57, and 63–68), special instructions of a technical nature for operating and servicing this vehicle under unusual conditions are contained or referred to herein. In addition to the normal preventive maintenance service, special care in cleaning and lubrication must be observed where extremes of temperature, humidity, and terrain conditions are present or anticipated. Proper cleaning, lubrication, and storage and handling of fuels and lubricants not only insure proper operation and functioning, but also guard against excessive wear of the working parts and deterioration of the materiel.

b. TM 21–301 contains very important instructions on driver selection, training, and supervision, and TM 21–306 prescribes special driving instructions for operating full-track and tank-like vehicles under unusual conditions.

Caution: It is imperative that the approved practices and precautions be followed. A detailed study of these TM's are essential for use of this materiel under unusual conditions.

c. Refer to paragraphs 92 through 95 for lubrication under unusual conditions, to paragraphs 99 and 100 for preventive maintenance checks, and to paragraphs 299 through 305 for maintenance procedures.

d. When chronic failure of materiel results from subjection to extreme conditions, report of the conditions should be made on DA Form 468 (par. 3*e*).

77. Extreme-Cold Weather Conditions

a. General Problems.

(1) Extensive preparation of materiel scheduled for operation in extreme cold weather is necessary. Generally, extreme cold will cause lubricants to thicken or congeal, freeze batteries or prevent them from furnishing sufficient current for cold-weather starting, crack insulation and cause electrical short circuits, prevent fuel from vaporizing and properly combining with air to form a combustible mixture for starting, and will cause the various construction materials to become hard, brittle, and easily damaged or broken.

(2) The vehicle should be prepared and protected for temperatures below 32° F. in accordance with instructions given in TM 9–2855 and TM 9–2858 on draining and cleaning the system and the selection, application and checking of antifreeze compounds to suit the anticipated conditions.

(3) TM 9–2855 also describes the method of correcting specific gravity readings for batteries exposed to extreme cold.

(4) Armament scheduled for extreme-cold operation must be checked for proper lubrication. Sighting and fire-control instruments should not be transferred suddenly from cold to warm temperature or vice versa. Condensation induced by this action may cause clouding of optics and rusting of internal parts. Strains may be set up in parts.

(5) For description of operations in extreme cold, refer to FM 31–70, FM 31–71, and TM 9–2855.

Caution: It is imperative that the approved practices and precautions be followed.

Note. TM 9–2855 contains general information which is specifically applicable to the vehicle as well as to all other vehicles.

It must be considered an essential part of this manual, not merely an explanatory supplement to it.

b. Winterization Equipment. Special equipment is provided for the vehicle when protection against extreme-cold weather (0° to —65° F.) is required. This equipment is issued as specific kits. Each kit contains data that provides information on description, installation instructions, and method of use. TM 9–2855 and SB 9–16 contains general information on winterization equipment and processing.

c. Fuels and Lubricants (Storage, Handling, and Use).

(1) The operation of equipment at arctic temperatures will depend to a great extent upon the condition of the fuels and lubricants used in the equipment. Immediate effects of careless storage and handling or improper use of these materials are not always apparent, but any deviation from proper procedures may cause trouble at the least expected time.

(2) In arctic operations, contamination with moisture is the source of many difficulties. Moisture can be the result of snow getting into the product, condensation due to "breathing" of a partially filled container, or moisture condensed from warm air in a partially filled container when a product is brought outdoors from room temperatures. Other impurities will also contaminate fuels and lubricants so that their usefulness is impaired.

(3) Refer to TM 9–2855 for detailed instructions on storage, handling, and use.

78. Extreme-Cold Weather Operation

a. General.

(1) The driver or operators must always be on the alert for indications of the effect of cold weather on the vehicle.

(2) The driver or operators must be very cautions when placing the vehicle in motion after a shutdown. Congealed lubricants may cause failure of parts. Tracks frozen to the ground must be considered. Preheat the engine compartment by operating the auxiliary generator and space heater, then start the engine. After warming up the engine thoroughly, place shifting control lever in LOW position and drive vehicle slowly about 100 yards, being careful not to stall the engine. This should heat lubricant in gears and tracks to a point where normal operation can be expected.

(3) Constantly note instrument readings.

Note. If vehicle is equipped with a power plant heater kit, the engine thermostat provided in the kit begins to open at 180° F. If temperature gage readings consistently exceed 200° F., open flaps of grille covers or remove covers.

(4) Refer to TM 21–306 for special instructions on driving hazards in snow, ice, and unusual terrain encountered under extreme-cold conditions.

b. At Halt or Parking.

(1) When halted for short shutdown periods, park the vehicle in a sheltered spot out of the wind. If no shelter is available, park so that the vehicle does not face into the wind. For long shutdown periods, if high dry ground is not available, prepare a footing of planks or brush. Chock in place if necessary.

(2) When preparing a vehicle for shutdown period, place control levers in the neutral position to prevent them from possible freezing in an engaged position. Freezing may occur when water is present due to condensation.

(3) Clean all parts of the vehicle of snow, ice, and mud as soon as possible after operation. Refer to table V for detailed after-operation procedure. If the winter front and side covers are not installed, be sure to protect all parts of the engine and engine accessories against entrance of loose, drifting snow during the halt. Snow flurries penetrating the engine compartment may enter the crankcase filler vent, etc. Cover and shield the vehicle but keep the ends of the canvas paulins off the ground to prevent them from freezing to the ground.

(4) If no power plant heater is present, the batteries should be removed and stored in a warm place. However, it is unnecessary to drain engine oil (subzero) as it will remain fluid even though unheated.

(5) Refuel immediately in order to reduce condensation in the fuel tanks. Prior to refueling, open fuel tank drains and drain off any accumulated water.

(6) When the vehicle is equipped with a power plant heater as provided by the arctic winterization kit, immediately after engine "shut-down," start the power plant heater and check to be sure that it is operating effectively. This heater should avoid the necessity of removing the battery to warm storage, and is designed to operate unattended during overnight stops. Instructions for operation of winterization equipment will be found in pamphlet packed with kit.

c. Armament. Weapons should be covered when not in use. Breech and firing mechanisms must be extremely clean and lightly lubricated. Keep checking recoil mechanisms, equilibrators, arcs, and handwheels for sluggishness. When cleaning, do not dilute rifle-bore cleaner or add an antifreeze. Store cleaning solutions in a warm place, if practical. Shake rifle-bore cleaner well before using. The crew must be very cautions when placing the gun and gun mount in operation after a halt or period of inactivity. Congealed lubricants may cause slow operation or failure of parts. Keep all covers secure to prevent ice and snow from collecting on the working parts, particularly the teeth of the elevating gear sector, pinion, and traversing ring gear. Exercise the elevating, traversing, loading, and firing controls at intervals as required to aid in keeping the controls from freezing in place and to reduce the effort required to operate them.

d. Sighting and Fire Control Equipment. Avoid breathing on optics and causing condensation which might freeze. Cover or stow sighting and fire control equipment when not in use, to prevent accumulation of snow or ice.

79. Extreme-Hot Weather Operations

a. General. Continuous operation of the vehicle at high speeds or long hard pulls in low gear ratios on steep grades or in soft terrain may cause the engine to overheat. Avoid the continuous use of low gear ratios whenever possible. Continually observe engine temperature and halt the vehicle for a cooling-off period whenever necessary and the tactical situation permits. Make frequent inspections and servicing of cooling unit, oil filter, and air cleaner. If the engine oil temperature or transmission high oil temperature warning signal lights come on, stop the vehicle and look for dust, insects, or any obstruction in cooler cores and remove.

b. At Halt or Parking.

(1) Do not park vehicle in the sun for long periods of time. When practical, park vehicle under cover to protect it from sun, sand, and dust.

(2) Cover inactive vehicle with paulins if no other suitable shelter is available. Where entire vehicle cannot be covered, protect periscopes, etc., against etching by sand, and protect engine compartment against entry of sand.

(3) Vehicles inactive for long periods in hot humid weather are subjected to rapid rusting and accumulation of fungi growth. Make frequent inspections and clean and lubricate to prevent excessive deterioration.

c. Sighting and Fire Control Materiel. This materiel should be shielded as much as possible from the direct rays of the sun.

(1) On-carriage electrical components of fire control equipment and associated off-carriage cable systems are tropicalized (moisture and fungus proofed). Where the varnish, wax coating, or insulating medium is broken, notify ordnance maintenance personnel.

(2) In hot, damp climates, corrosive action will occur and will be accelerated in areas of high humidity and during rainy season. Evidence will appear in the form of rust and paint blisters on metal surfaces and mildew or fungi mold on covers and unpainted surfaces.

(3) Protect all exposed exterior painted surfaces and unfinished exposed metal surfaces by applying a film of engine lubricating oil (OE–10). Cables and terminals, not tropicalized, will be protected by using ignition-insulation compound.

(4) Remove any corrosion from exterior unpainted surfaces with abrasive cloth and apply a protective film of oil or suitable rust preventive.

80. Operation on Unusual Terrain

a. Mud. Select transmission low range to move vehicle steadily without digging in. If the vehicle becomes mired, arrange to be towed out of the mud instead of digging in. When a drop to below freezing temperature is anticipated, make sure that the vehicle is parked on solid ground or footing to prevent the tracks from being frozen in the mud, and that accumulation of mud has been removed from track and wheel contacting surfaces.

b. Snow. It may be possible for the vehicle to ride heavily crusted snow with occasional breakthrough. To climb back onto the crust, reduce engine speed and shift into transmission low range to achieve very low track speed for forward movement without slippage. Avoid grades. Where grades must be taken, drive as nearly straight up and down as possible to equalize track load. Avoid sharp turns. For soft or fine snow, select the transmission low range shift position which will give good traction.

c. Ice. Skidding is the general hazard encountered on ice. Select the proper transmission range to move the vehicle steadily, without imposing undue strain on engine. When skidding occurs, decelerate the engine and proceed with caution.

d. Sand. The main objective when driving in sand is to avoid spinning the tracks. Reduce speed and use low-range drive to

move the vehicle steadily. Do not allow the engine to labor. Keep sighting and fire control instruments in cases or covered when not in use. When in use, remove sand and dust frequently particularly from periscopes, cover joints, pivot connections, and sliding surfaces. After operation clean all painted surfaces damaged by sand; if repainting is necessary, notify ordnance maintenance personnel.

81. Fording Operation

a. General. In fording, the vehicle may be subjected to water varying in depth from only a few inches to depths sufficient to completely submerge the vehicle. Factors to be considered are spray-splashing precautions, normal fording capabilities, deep-water fording using fording kits, and accidental complete submersion. Optical instruments should not be submerged, except those periscopes used for driving.

b. Normal Fording. Fording of bodies of water up to maximum vehicle fording depth of 40 inches is based on the standard vehicle with waterproofing protection provided for critical units when manufactured, but without deep-water fording kit. Observe the following precautions:

(1) Make sure that battery cell vent caps are snug.

(2) Do not exceed the known fording limits of the vehicle.

(3) The engine must be operated at maximum efficiency before attempting to ford. Start bilge pumps.

(4) Shift transmission into lowest speed positions. Speed up engine to overcome possibility of a "stall" when the cold water chills the engine. Enter the water slowly. Should the engine stall while submerged, it may be started in the usual manner.

(5) All normal fording should be at speeds of 3 to 4 mph to avoid forming a "bow wave." Check bilge pump operation.

(6) If accidental complete submersion occurs, the vehicle will be salvaged, temporary preservation applied as outlined in paragraph 304, and then sent to the ordnance maintenance unit as soon as possible for necessary permanent maintenance.

c. Deep-Water Fording. Refer to TM 9–2853 for general information, description, and methods of use of deep-water fording kits, and for general procedures for the operation of vehicles so equipped.

d. After-Fording Operation. Open all drain valves in hull (par. 24). Also, at the earliest opportunity, check the engine oil level

and check for presence of water in the crankcase. Heat generated by driving will evaporate or force out most water which has entered at various points. Also, any *small* amount of water which has entered the crankcase either through leakage or due to condensation will usually be dissipated by the ventilating system. Refer to paragraph 304 for maintenance operations after fording. Optical instruments that have become wet should be quickly wiped dry and examined for indication of leakage into the instrument. Such instruments should be turned in for reconditioning at the first opportunity. Shut off bilge pumps. Gun and/or mount mechanisms that have been submerged should be immediately dried and the lubricants renewed. For items not within the scope of the battery or artillery mechanic, notify ordnance maintenance personnel.

82. General Lubrication Instructions for Unusual Conditions

For information pertaining to lubrication instructions for unusual conditions, refer to paragraph 92.

83. Lubrication for Continued Operation Below 0° F.

For information pertaining to lubrication for continued operation below 0° F., refer to paragraph 93.

84. Lubrication after Fording Operations

For information pertaining to lubrication after fording operations, refer to paragraph 94.

85. Lubrication after Operation Under Dust and Sandy Conditions

For information pertaining to lubrication after operation under dusty and sandy conditions, refer to paragraph 95.

CHAPTER 3
ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. PARTS, SPECIAL TOOLS, AND EQUIPMENT FOR OPERATION AND ORGANIZATIONAL MAINTENANCE

86. General

Tools, equipment, and spare parts are issued to the using organization for operating and maintaining the materiel. Tools and equipment should not be used for purposes other than prescribed and, when not in use, should be properly stored in the chest and/or roll provided for them.

87. Parts

Spare parts are supplied to the using organization for replacement of those parts most likely to become worn, broken, or otherwise unserviceable, providing replacement of these parts is within the scope of organizational maintenance functions. Spare parts, tools, and equipment supplied for the twin 40-mm full-tracked self-propelled gun M42 (T141) are listed in Department of the Army Supply Manual ORD 7 SNL G–253, which is the authority for requisitioning replacement.

88. Common Tools and Equipment

Standard and commonly used tools and equipment having general application to this materiel are authorized for issue to 1st echelon by ORD 7 manual. Common tools and equipment are listed in pertinent supply manuals and are authorized for issue by TA and TOE.

89. Special Tools and Equipment

Certain tools and equipment specially designed for organizational maintenance, repair, and general use with the materiel are listed in table III for information only. This list is not to be used for requisitioning replacements.

Table III. Special Tools and Equipment for Operation and Organizational Maintenance

Item	Identifying No.	References		Use
		Fig.	Par.	
For twin 40-mm full tracked self-propelled gun M42 (T141).				
ADAPTER, puller	5120–708–2997 (7082997)	68	224	For road wheel supporting arm replacement (used w/PULLER—5120–557–3615).
ADAPTER, puller	5120–322–5953 (7083703)	68 218	223	For removing torsion bar (used w/PULLER—5120–557–3615).
ADAPTER, puller	5120–322–5954 (8375338)	68 225	225	For removing and installing compensating wheel link pin (used w/PULLER—5120–557–3615).
FIXTURE, track connecting	5120–708–3799 (7083799)	67 203 206	220	For connecting track.
GAGE, oil pressure	6620–795–0330 (7950330)	67 184	211	For testing transmission oil pressures.
GAGE, valve tappet adjustment	5120–708–3769 (7083769)	66 112	143	For checking valve tappet and roller clearance.
HANDLE, remover and replacer	41–H–1396–507 (7083883)	66 221 222 223	224 229	For removing and replacing inner and outer bearing cups on roller hub and road wheel hub (used w/REMOVER and REPLACER—41–R–2374–620, 41–R–2374–630, and 41–R–2374–652.
HANDLE, remover	5120–473–7121 (7082881)	66	224 225	For removing and replacing oil seals and bearings in road wheel arms and compensating wheel link (used w/REMOVER and REPLACER—41–R–2373–455 and REPLACER—41–R–2393–650).

Table III—Continued

Item	Identifying No.	References		Use
		Fig.	Par.	
For twin 40-mm full tracked self-propelled gun M42 (T141)—continued				
KIT, electrical cables and fuel line extension	4910–383–3653 (8390253)	70 99	129	For testing power plant when removed from vehicle.
LIFTER, road wheel arm	41–L–1390–205 (7950619)	68 212	222	For raising road wheels.
PIN, drift	5120–708–3639 (7083639)	66 204	220	For removing track pins.
PULLER, screw type	5120–795–0052 (7950052)	66 210	221	For removing shock absorbers.
PULLER, slide hammer	5120–557–3615 (5573615)	66 218 225	223 224 225	For removing suspension components (used w/ADAPTER—5120–708–2997, 5120–322–5953, 5120–322–5954).
REMOVER and REPLACER bearing	41–R–2373–455 (7082994)	66	224	For removing and replacing road wheel arm bearing and compensating wheel link bearing (used w/HANDLE—5120–473–7121).
REMOVER and REPLACER, inner and outer bearing cups	41–R–2374–620 (7082860)	66	229	For removing and replacing inner and outer bearing cups in track support roller hub (use w/HANDLE—41–H–1396–507).
REMOVER and REPLACER, inner bearing cup	41–R–2374–630 (7082863)	66 221 222	224	For removing and replacing inner bearing cups of compensating wheel hub and road wheel hub (used w/HANDLE—41–H–1396–507).
REMOVER and REPLACER, outer bearing cup	41–R–2374–652 (7082866)	66 223	224	For removing and replacing outer bearing cups in compensating wheel hub and road

				wheel hub (used w/HANDLE—41–H–1396–507).
REPLACER, bearing	41–R–2382–803 (7950646)	68 211	221	For replacing shock absorber bearing.
REPLACER, oil seal	41–R–2393–650 (7083650)	66	224	For replacing road wheel arm support oil seal (used w/HANDLE—5120–708–3639).
REPLACER, oil seal	5120–795–0227 (7950227)	70 224	224	For replacing compensating and road wheel hub oil seals.
*SLING, lifting	41–S–3830–30 (7076000)	67	217	For lifting final drive sprockets and hub.
SLING, lifting	3940–708–3651 (7083651)	--	217	For lifting final drive assembly (used w/-SLING—41–S–3830–30).
SLING, lifting	3940–708–3721 (7083721)	69 92	126	For removing and replacing power plant.
SLING, lifting	3940–473–7556 (7081593)	69 94	127	For removing and replacing transmission.
STAND, transport	4910–836–6519 (8366519)	70 93	126	For transporting power plant when removed from vehicle.
WRENCH, ignition harness nut	5120–795–0895 (7950895)	67 120	148	For removing and replacing ignition harness nut.
WRENCH, spark plug	5120–098–6723 (8708639)	67	148	For removing and replacing main engine spark plugs.
WRENCH, socket	5120–317–8096 (7083649)	70 219	224	For removing and replacing road wheel arm spindle nut.
WRENCH, torsion bar retaining nut	41–W–3638–50 (7083642)	68 217	223	For removing and replacing torsion bar retaining nut.
WRENCH, open end	5120–708–3738 (7083738)	68 137	164	For removing or installing inlet and outlet flexible oil lines at oil cooler connectors.
WRENCH, tubular	5120–473–7791 (7082003)	67 107	135 136	For removing and replacing oil control housing and oil cooler valves.

* This tool is a 2d echelon emergency allocated tool to be obtained from ordnance maintenance personnel in accordance with paragraph 2.

Table III—Continued

Item	Identifying No.	References		Use
		Fig.	Par.	
***For twin 40-mm full tracked self-propelled gun M42 (T141)*—continued**				
WRENCH, engine turning	5120–310–4673 (8708806)	68 111	143 145	For turning engine from power-take-off shaft.
WRENCH, crowfoot	8390093	70 208	220	For adjusting track tension.
*WRENCH, engine right rear hotspot outlet housing assembly mounting nut	41–W–2999–145	—	140	For removing and installing engine right rear hotspot outlet housing.
WRENCH, engine high oil temperature warning light switch	5120–708–3852 (7083852)	70	252	To remove or install engine oil high temperature switch.
WRENCH, engine starter mounting nuts or fuel filter bracket mounting nuts	8708189	—	167	To remove or install engine starter mounting nuts or fuel filter bracket mounting nuts.
For 40-mm dual automatic gun M2A1				
BRUSH, bore (M29) complete	6240944	73	279	For cleaning tube bore.
CARRIER, gun barrel	7231517	71 285	279	For supporting rear end of barrel when removing barrel from breech.
CHEST, gun tools and spare parts	7716919	75	86	For stowage of gun tools and spare parts.
CLIP, charger M3	5583768	54 73	64	For holding 4 rounds and facilitate loading gun.
COMPRESSOR, automatic loader feed rod spring	5228063	332	282	For disassembling and assembling feed rod assembly.
*COMPRESSOR, equilibrator spring, ratchet type	7219885	72 362	290	For removing or installing springs in equilibrator.
COVER, breech	7231905	—	—	To cover breech when not in use (early issue).

COVER, breech spare barrel	7038008	74	237	For covering breech end of spare barrels.
COVER, flash suppressor	7772032	45 74	56 62	For covering flash suppressors when not in use.
COVER, gun book M539	7228906	74	328	For stowage of gun book M539.
COVER, loader, M540	7228690	--	--	Cover loader (early issue).
COVER, loader and breech	7308217	45 74	56	For covering loader and breech when not in use (Replaces COVER—7231905 and COVER—7228690).
EJECTOR, shell	5298763	56 73	66 68	For removing unfired round from chamber.
EXTRACTOR, hand	5228060	58 73 303	68 281	For removing cartridge case from chamber.
EXTRACTOR, spindle and safety plunger	5228093	73 341	283	For removing or installing extractor spindle.
GAGE, firing pin protrusion	5276650	73 309	281	For measuring firing pin protrusion.
KEY, side cover	5228061	72 301 325	281 282	For opening and closing side covers.
LIFTER, automatic loader, front	6200472	71 326	282	For removing and carrying automatic loader.
LIFTER, automatic loader, rear	6200471	71 326	282	For removing and carrying automatic loader.
PUSHER, shell	5595031	57 73	67	For forcing cartridge into remover when unloading automatic loader.
REMOVER, cartridge	6200491	57 73	67	For removing cartridge from automatic loader.
ROLL, spare parts	7211476	74	86	For stowage of spare parts.

* This tool is a 2d echelon emergency allocated tool to be obtained from ordnance maintenance personnel in accordance with paragraph 2.

Table III—Continued

Item	Identifying No.	References		Use
		Fig.	Par.	
For 40-mm dual automatic gun M2A1—continued				
SIGHT, bore complete, composed of	41–S–3642–107			
1 CASE, M61	7692946	73	58	
1 SIGHT M17	7692047	73	58	For boresighting.
1 SIGHT	5276694	73	58	For boresighting.
STAFF, cleaning barrel	6111686	56	66	
		71	279	
STAFF, cleaning	6160689	—	—	Used w/EJECTOR—5298763 or BRUSH—6240944.
		—	—	
WRENCH, equilibrator bushing nut	6198554	72	290	For adjusting compression of the equilibrator springs and for removing and replacing the equilibrator bushing nut.
		361		
WRENCH, key plug	5228074	72	281	For removing or installing cover from closing spring.
		305		
WRENCH, loader tray and firing pin spring cover	5228057	72	281	For removing or installing cover from firing pin spring and loader tray connecting bolt and tray to breech ring bolt spring seat.
		306	282	
		325	283	
		344		
WRENCH, flash hider	7228692	71	279	For removing or installing barrel assembly.
or				
WRENCH, flash suppressor	7305580	71	279	For removing or installing barrel assembly.
		285		
WRENCH, recuperator spring collar	6200473	72	279	For tightening recuperator spring collar.
WRENCH, recoil cylinder and control rod	6200462	72	280	For removing or installing recoil cylinder from bracket.
		289		

WRENCH, safety plunger	7228697	72 286	279	For retracting breech ring safety plunger when barrel assembly is removed from breech ring.
WRENCH, safety plunger spring seat	5228054	72 347	283	For removing or installing safety plunger spring seat.
WRENCH, tubular	7212467	72 361	290	For removing or loosening equilibrator rod jamnut so that bushing nut can be removed when assembling the spring compressor on the equilibrator rod or when adjusting the bushing nut.
For mount, gun, twin 40-mm, AA, M4E1				
BOX, ammunition, 40-mm, M14	7219890	--	--	For storage of 40-mm ammunition.
COVER, mount	7773371	75	--	For covering mount and protecting from weather when not in use.
EXTENSION	4930-387-9570 (7007459)	--	--	For lubricating gun.
HOOK, retrieving, 40-mm, ammo box	7983908	75	--	For pulling ammo boxes within reaching distance in storage compartment.
ROLL, tool	7211475	75	--	For storage of gun mount tools.
GUN, lubricating	4930-223-3391 (5644803)	--	--	Hand operated.
OILER	4939-473-6352 (6169931)	--	--	Hand operated.
For cradle, pintle, and ammunition box holder, assembly				
COVER, cal..30 machine gun, assembly	7984387	45 75	56 298	For covering cal..30 machine gun when not in use.
BAG, assembly empty cartridge	7773448	75 363	292	For collecting cal..30 spent cartridge cases.

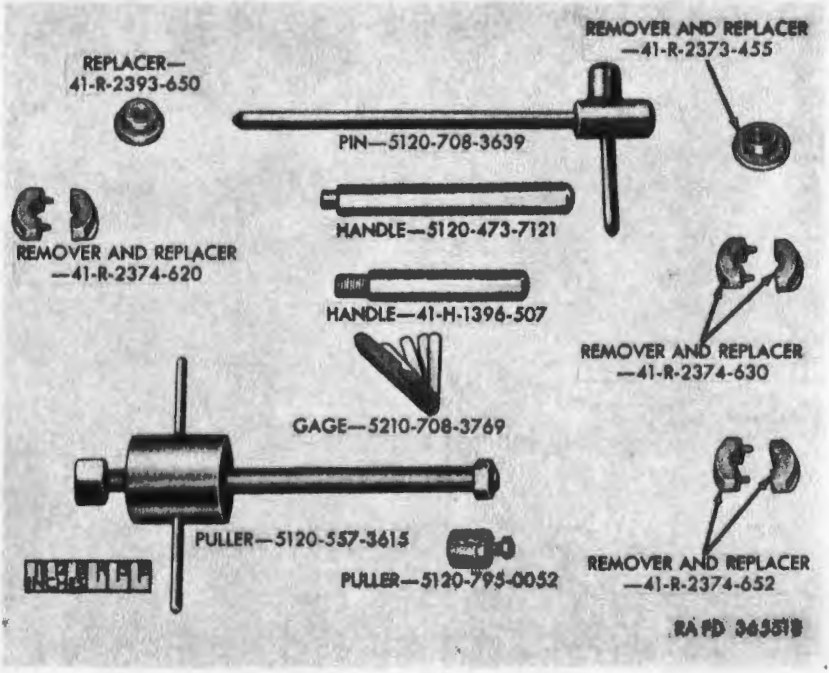


Figure 66. Special tools and equipment.

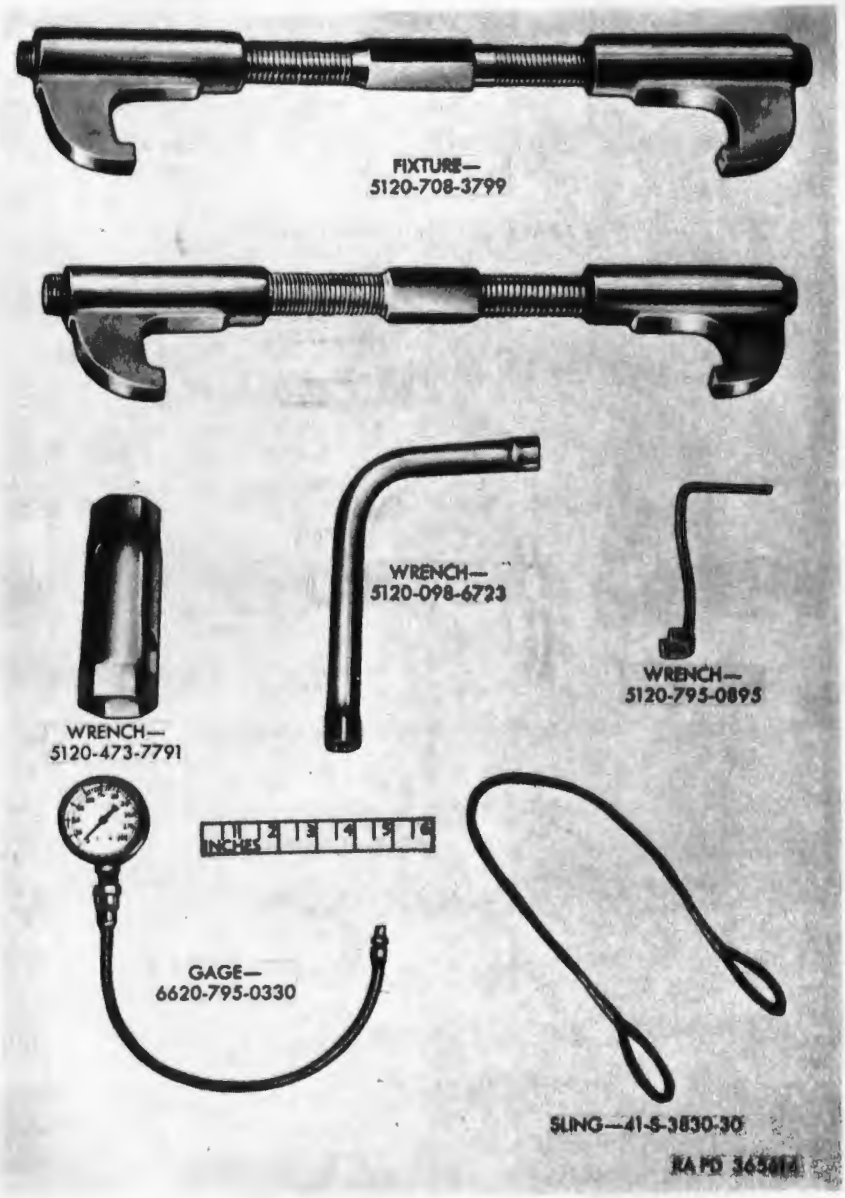


Figure 67. Special tools and equipment.

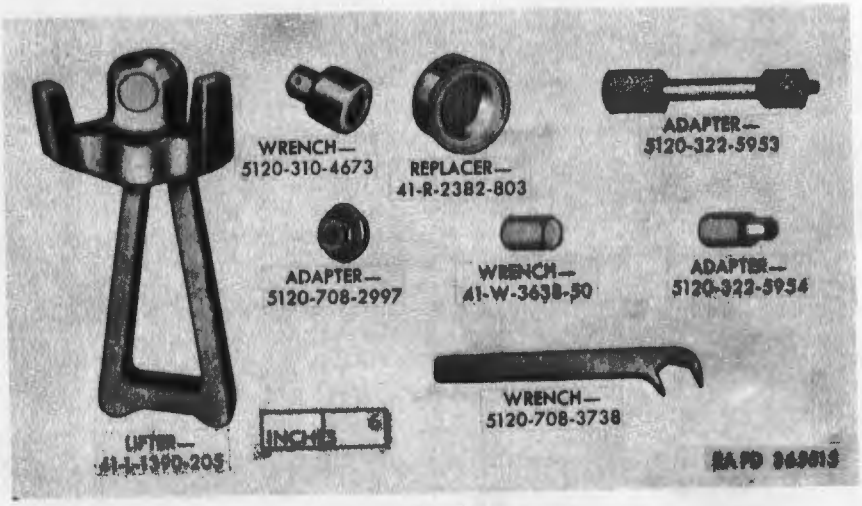


Figure 68. Special tools and equipment.

Figure 69. Special tools and equipment.

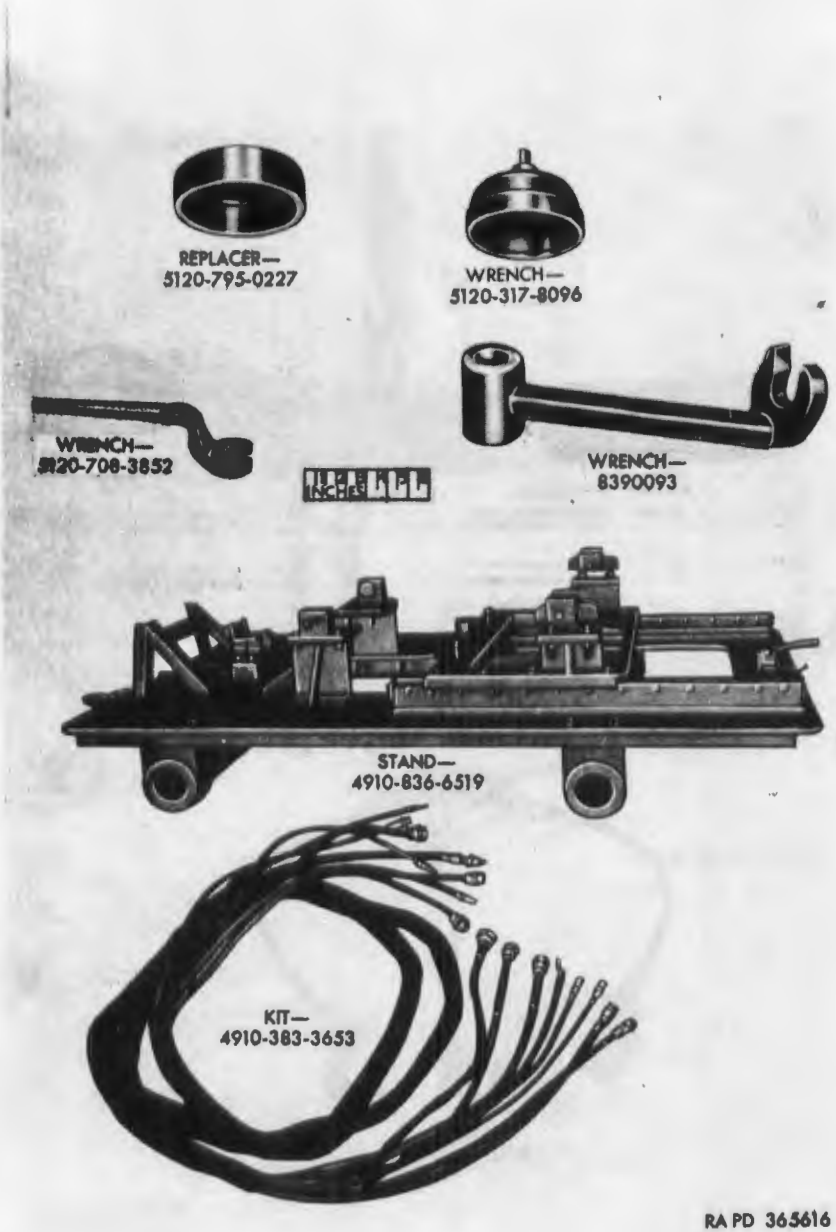


Figure 70. Special tools and equipment.

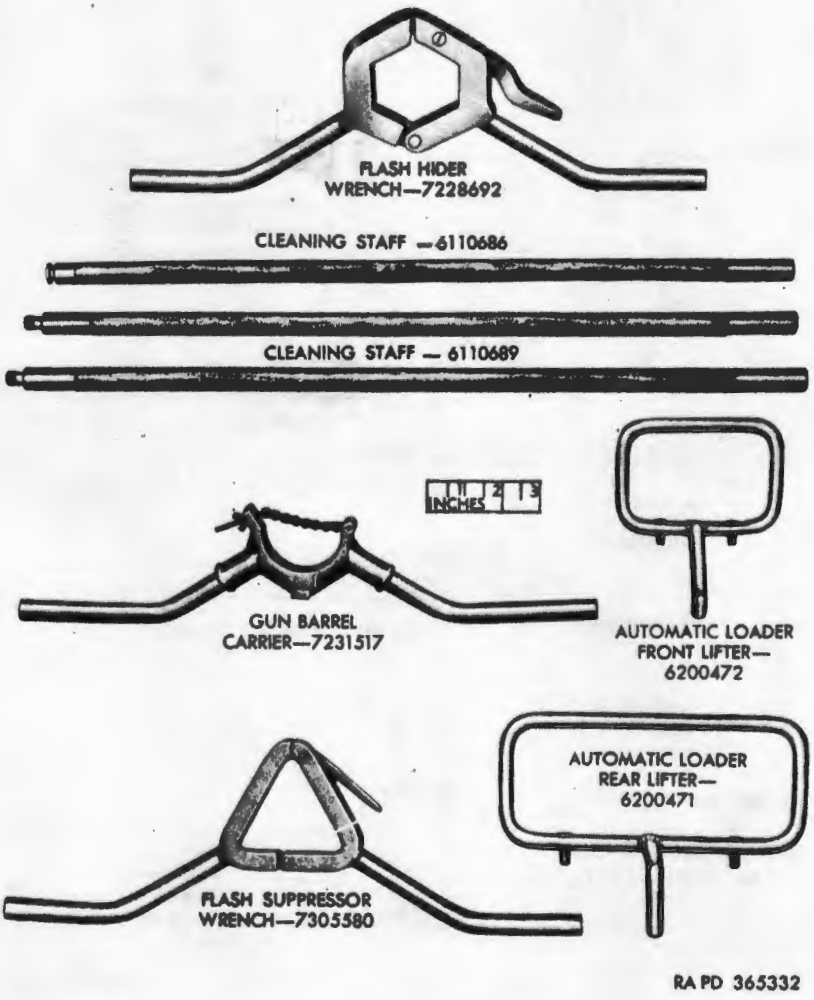


Figure 71. Special tools and equipment.

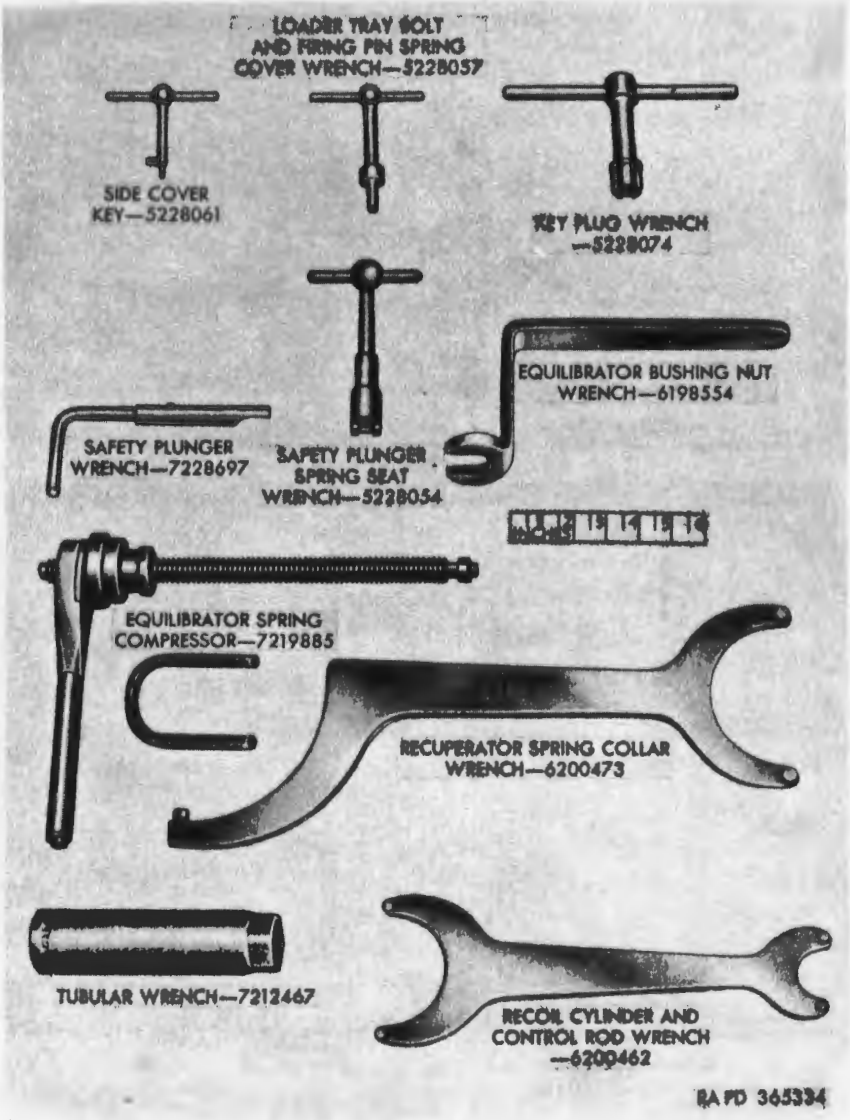


Figure 72. Special tools and equipment.

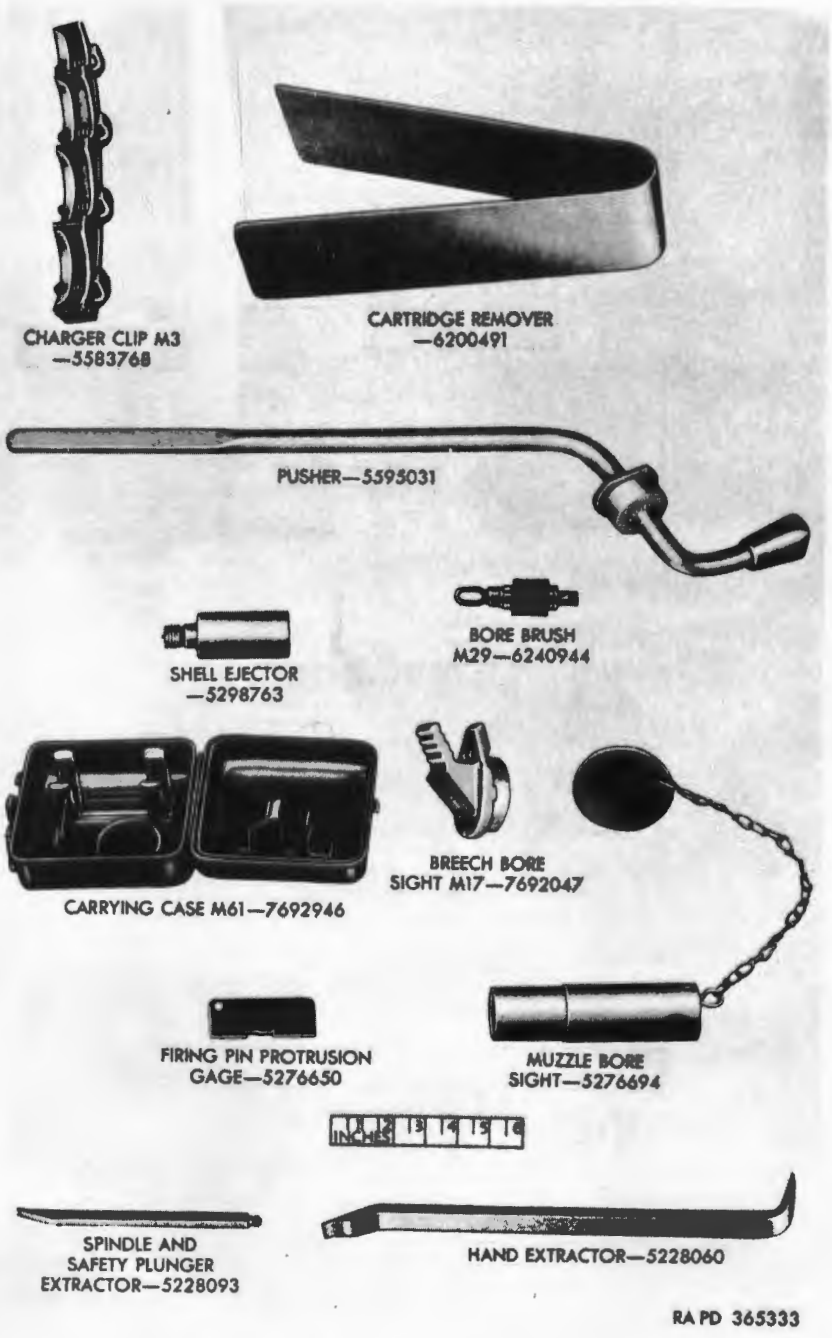


Figure 73. Special tools and equipment.

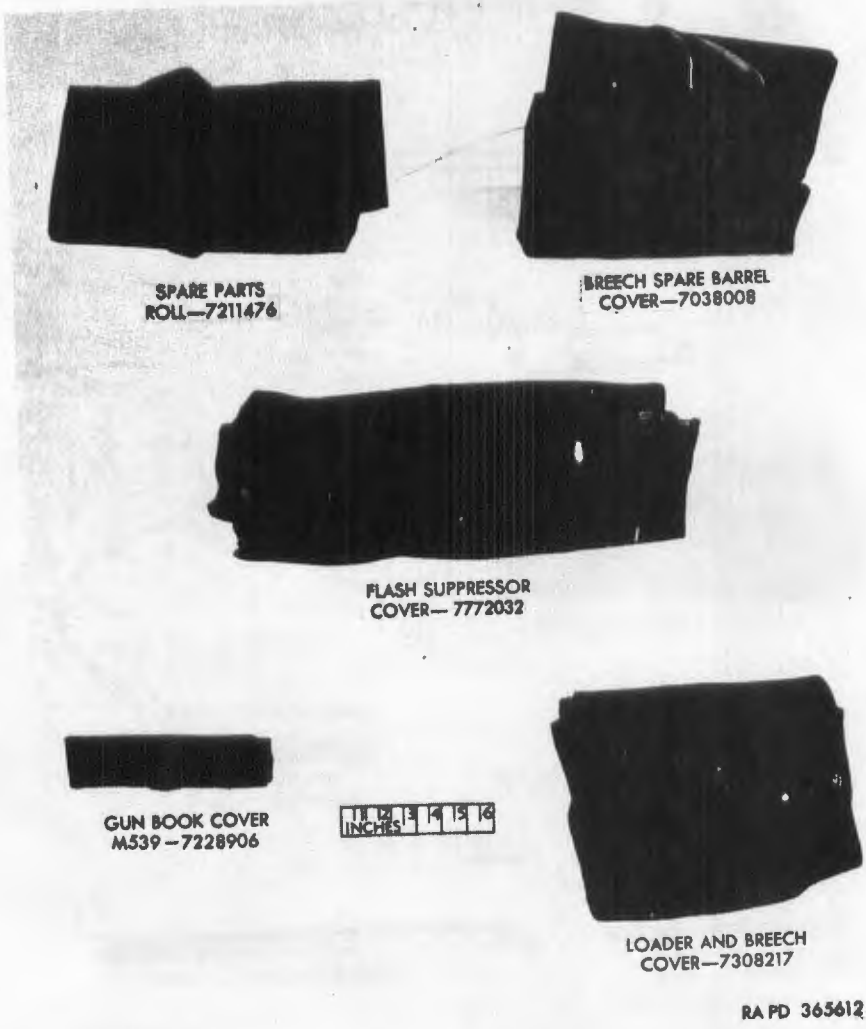


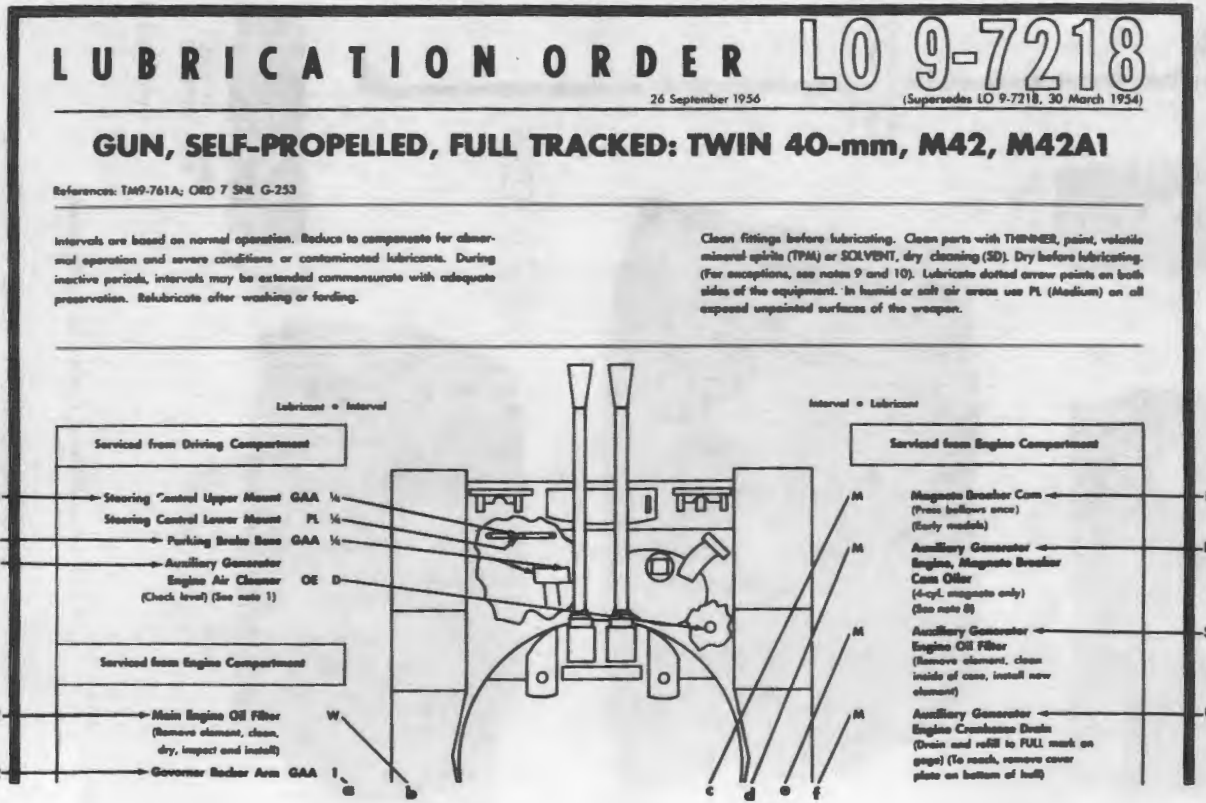
Figure 74. Special tools and equipment.

Figure 75. Special tools and equipment.

Section II. LUBRICATION AND PAINTING

90. Lubrication Order

LO 9–7218 (figs. 76, 77, and 78) prescribes cleaning and lubricating procedures as to locations, intervals, and proper materials for this vehicle. This order is issued with each vehicle and is to



LUBRICATION ORDER LO 9-7218

26 September 1956 (Supersedes LO 9-7218, 30 March 1954)

GUN, SELF-PROPELLED, FULL TRACKED: TWIN 40-mm, M42, M42A1

References: TM9-761A; ORD 7 SNL G-253

Intervals are based on normal operation. Reduce to compensate for abnormal operation and severe conditions or contaminated lubricants. During inactive periods, intervals may be extended commensurate with adequate preservation. Relubricate after washing or fording.

Clean fittings before lubricating. Clean parts with THINNER, paint, volatile mineral spirits (TPM) or SOLVENT, dry cleaning (SD). Dry before lubricating. (For exceptions, see notes 9 and 10). Lubricate dotted arrow points on both sides of the equipment. In humid or salt air areas use Pl (Medium) on all exposed unpainted surfaces of the weapon.

Lubricant • Interval

Serviced from Driving Compartment

P, Fig 80 → Steering Control Upper Mount GAA ¼

Steering Control Lower Mount Pl ½

Q, Fig 80 → Parking Brake Base GAA ¼

T, Fig 81 → Auxiliary Generator Engine Air Cleaner OE D (Check level) (See note 1)

Serviced from Engine Compartment

AA, Fig 82 → Main Engine Oil Filter W (Remove element, clean, dry, impact and install)

BB, Fig 82 → Governor Rocker Arm GAA 1

Interval • Lubricant

Serviced from Engine Compartment

M Magneto Breaker Cam → FF, Fig 82 (Press bellows once) (Early models)

M Auxiliary Generator Engine, Magneto Breaker Cam Oiler → HH, Fig 82 (4-cyl. magneto only) (See note 8)

M Auxiliary Generator Engine Oil Filter → S, Fig 81 (Remove element, clean inside of case, install new element)

M Auxiliary Generator Engine Crankcase Drain → U and V, Fig 81 (Drain and refill to FULL mark on gage) (To reach, remove cover plate on bottom of hull)

a b c d e f

Figure 78. Lubrication order—twin 40-mm full tracked self-propelled gun M42 (T141).

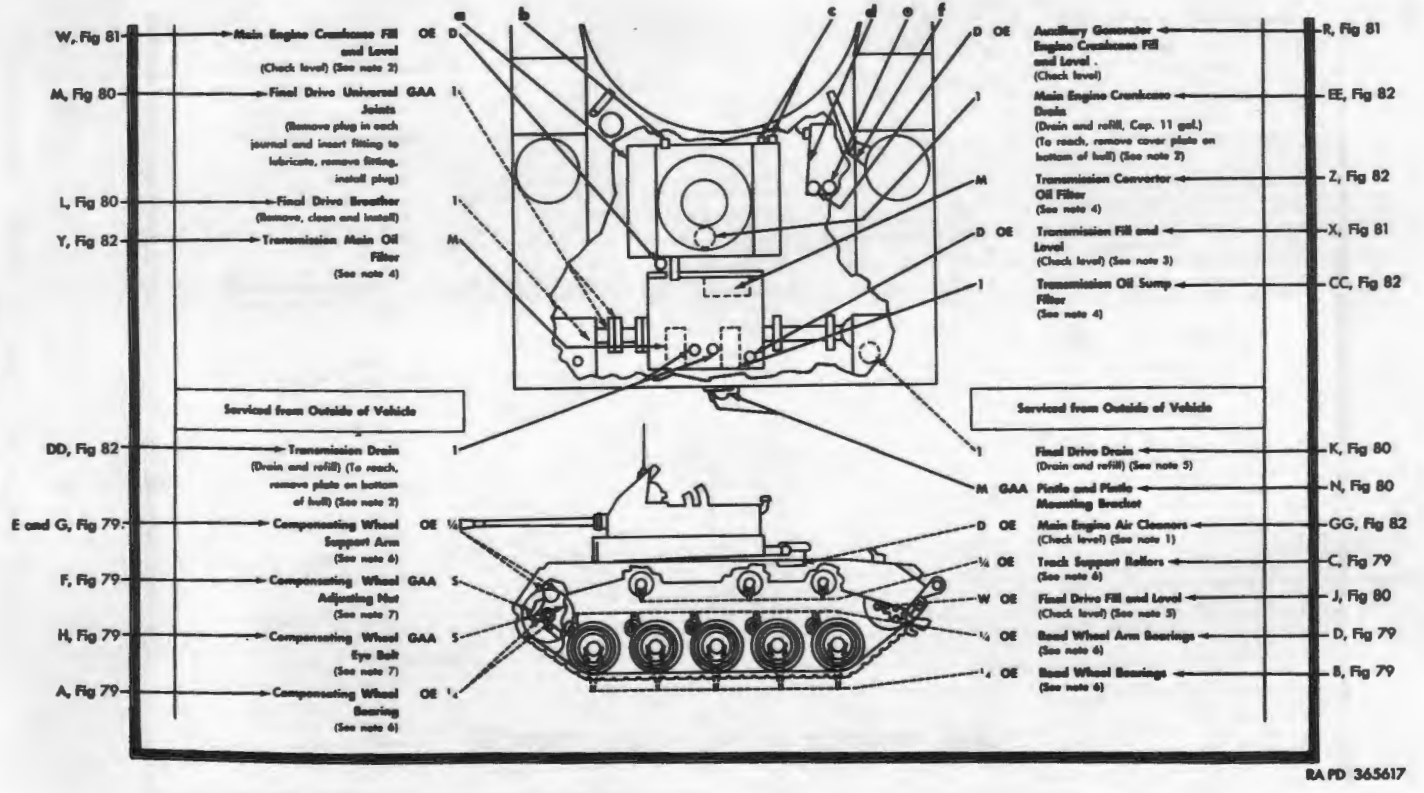


Figure 79—Continued.

Figure 77. Lubrication order—twin 40-mm full tracked self-propelled gun M42 (T141).

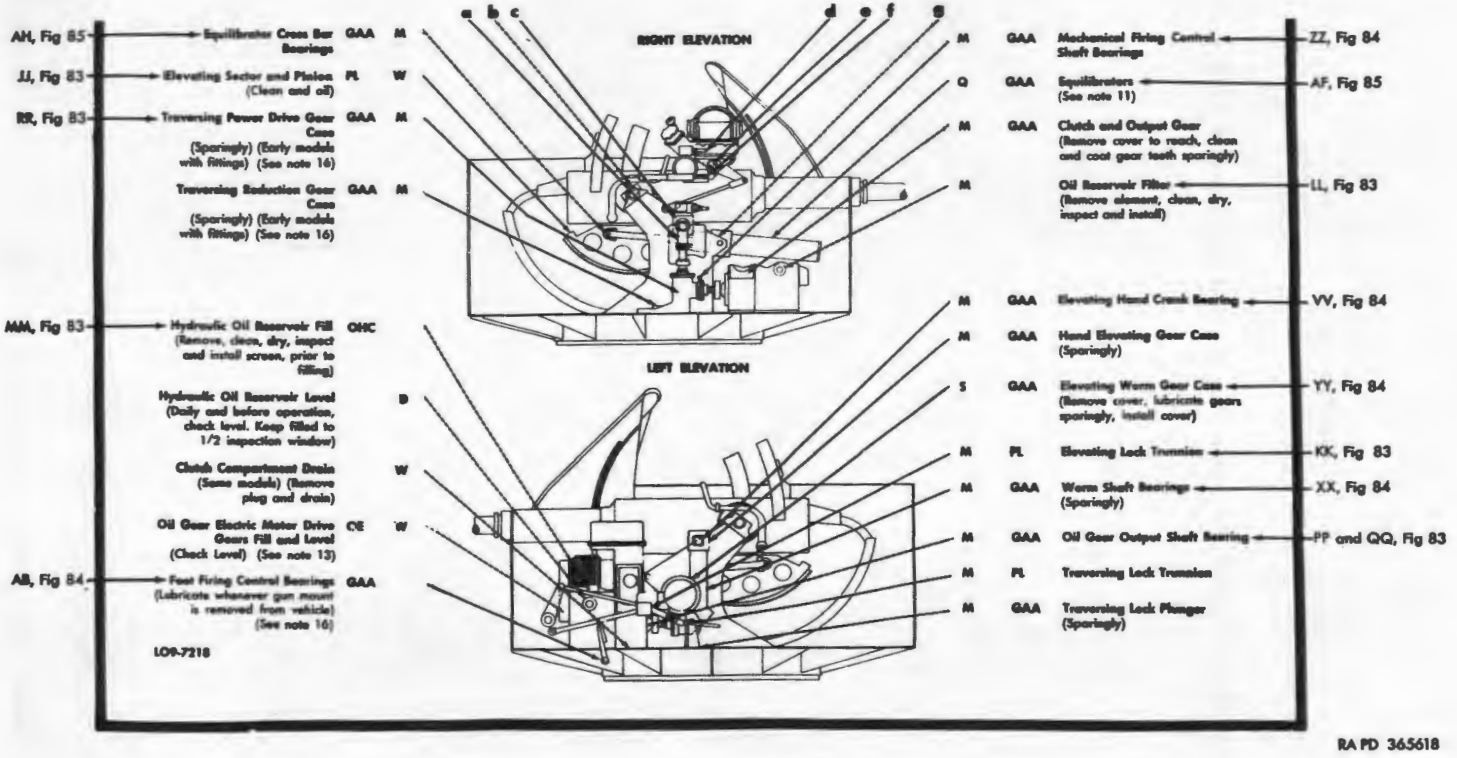


Figure 77—Continued.

- KEY -

LUBRICANTS	EXPECTED TEMPERATURES		
	above +32°F	+40°F to −10°F	0°F to −65°F
OE—Oil, lubr, engine Main engine crankcase Final drives	OE 50	OE 30	OES
Transmission Auxiliary engine crankcase Suspension	OE 10	OE 10	OES
Auxiliary engine and Main engine air cleaners	OE 30	OE 10	OES
GAA—GREASE, lubr, automotive and artillery	GAA	GAA	GAA
PL—OIL - lubr, preservative	PL (Medium)	PL (Special)	PL (Special)
GL—GREASE, aircraft and instrument	GL	GL	GL
*OHA—OIL, hydraulic, petroleum base	OHA	OHA	OHA
OHC—OIL, preservative, hydraulic equipment	OHC	OHC	OHC
*OHC or OHA can be used in recoil mechanism. The two oils can be mixed.			

FOR ARCTIC OPERATION refer to TM 9-2855

LUBRICANTS	INTERVALS
OES—OIL, lubr, engine sub-zero	D—Daily
CR—CLEANER, rifle bore	W—Weekly
	M—Monthly
	Q—Quarterly
	S—Semiannually
	¼—250 miles
	1—1,000 Miles

- NOTES -

1. **AIR CLEANERS AND BREATHERS** — (Oil bath-type). Daily, replenish to bead level with OE. Every 250 miles, clean oil reservoir and refill with OE as above. Disassemble, clean all parts, refill with OE as above whenever crankcase oil is changed. For desert or extremely dusty operation, disassemble, clean all parts and refill once every operating day or more frequently if required.

2. **MAIN ENGINE CRANKCASE** — Drain every 1,000 miles or semiannually. Drain only when hot after operation. To drain, remove oil sump plug. Clean and install plug, install safety wire. Refill crankcase to FULL mark on gage. Idle engine 2 or 3 minutes to fill oil passages. Stop engine. Wait 2 minutes and recheck oil level. At time of power plant removal, clean and coat threads on engine and transmission mounts with GAA.

5. **FINAL DRIVES** — Check level weekly, before operation. Drain every 1,000 miles or semiannually. Drain only when hot after operation. Drain, clean and install plugs. Refill with OE to bottom of filler holes with vehicle on level ground.

6. **SUSPENSION** — (Compensating wheel, road wheel, track support bearings)—Every 250 miles or monthly check oil level by removing level plug. To check level or to fill, rotate until plugs in hub are in horizontal position. Remove either plug to check or fill to level of plug hole. When filling allow sufficient time for lubricant to penetrate all cavities, recheck level, clean and install plug.

12. **RECOIL CYLINDER** — Elevate gun to 25 . Remove filler plug and check oil level. If oil is not up to level of plug hole remove control rod valve adjustment screw, washers and plate on head of cylinder. Loosen squared end of control rod. Fill cylinder and install plug. Elevate and depress gun a few times stopping at 25 elevation. Recheck oil level. If full, reset control rod by turning until tight, then loosen one-third turn. Install adjustment plate, washers and screw. Install filler plug.

13. **OIL GEAR ELECTRIC MOTOR DRIVE GEARS** — Semiannually, remove cover and drain. Clean inside of cover and gear teeth. Install cover and refill to level of plug hole.

Figure 78. Lubrication order—twin 40-mm full tracked self-propelled gun M42 (T141).

3. **TRANSMISSION** — Check transmission oil level daily. Before starting engine, check bayonet gage for indication of oil level which should be up to or above the mark MINIMUM LEVEL BEFORE RUNNING. If not, add oil to bring level up to or above the mark MINIMUM LEVEL BEFORE RUNNING, before starting engine. Set selector lever in neutral range with parking brakes on and start engine. Idle engine 2 or 3 minutes to allow oil to fill torque converter and oil coolers. Check bayonet gage for oil level which should be at mark MINIMUM OPERATING LEVEL IDLE ENGINE 1,000 RPM. If oil level is at mark PERMISSIBLE MAXIMUM EXPANSION, drain transmission until bayonet gage shows oil level to be at mark DO NOT FILL ABOVE THIS LINE. Drain transmission only when hot after operation. Drain every 1,000 miles or semiannually. To drain transmission, remove access plates on bottom of hull and remove drain plugs from transmission housing. After draining, clean and install plugs. Refill transmission to mark MINIMUM LEVEL BEFORE RUNNING and follow check procedures as outlined above.

4. **TRANSMISSION OIL FILTERS** — At required intervals or wherever transmission is drained, remove element, clean, dry, inspect and install element. To reach transmission converter oil filter, raise transmission front access door. To reach transmission main oil filter raise trans-

LO 9-7218

7. **COMPENSATING WHEEL ADJUSTING NUT AND EYE BOLT** — Semiannually, or whenever track is broken, remove nut from eye bolt. Clean and pack threads. Install nut.

8. **AUXILIARY GENERATOR ENGINE MAGNETO BREAKER CAM OILER** — Whenever auxiliary generator engine is removed for other maintenance, remove upper side panel and press bellows of magneto breaker cam oiler while rotating generator several times by hand. CAUTION: Remove spark plug to keep engine from starting.

9. **GUN BORES**—Immediately after firing and on 2 consecutive days thereafter, thoroughly clean with CR, making sure that all surfaces, including the rifling, are well coated. Do not wipe dry. On the third day after firing, clean with CR, wipe dry and lightly coat with PL (Special). Weekly, thereafter, when gun is not being fired, clean with CR, wipe dry and recoil with PL (Special). Wipe clean before firing.

10. **BREECH, FIRING, AND AUTOMATIC LOADER MECHANISMS** — Weekly or before and after firing, clean with CR, dry, oil with PL. Also clean breechblock pockets, outer cocking lever and inner crankcams, wipe dry and oil with PL.

11. **EQUILIBRATORS** — Quarterly, remove end piece and spring, clean, dry, and coat spring and inside of case. Install spring and end piece.

14. **OIL CAN POINTS** — Weekly, lubricate firing mechanism linkage, gun junction cover hinge and latch, elevating and traversing lock linkage, hinges, latches, control rod clevises and pins, control levers, brake linkage, throttle control linkage, and pintle stowage bracket with PL (Med) above +32° F., PL (Special) below +32° F.

15. **DO NOT LUBRICATE** — Oil gear, electric motors, internal parts of computing sight, personnel heater motor and bilge pump motor.

16. **LUBRICATED AT TIME OF DISASSEMBLY BY ORDNANCE PERSONNEL** — Generator bearings, starter bearings, shock absorbers, speedometer and tachometer flexible shafts main engine magnetos (late models) auxiliary generator engine (single cylinder magnetos) foot firing control bearings, traversing mechanism (late model) pinion shaft, power drive and reduction gears, azimuth indicator, and azimuth indicator anti-blacklash gears.

Copy of this lubrication order will remain with the equipment at all times; instructions contained herein are mandatory and supersede all conflicting lubrication instructions dated prior to the date of this lubrication order.

By Order of Wilber M. Brucker, Secretary of the Army:

MAXWELL D. TAYLOR,
General, United States Army,
Chief of Staff

OFFICIAL:

JOHN A. KLEIN,
Major General, United States Army,
The Adjutant General

GPO 914977

RA PD 365619

Figure 78—Continued.

be carried with it at all times. If the vehicle is received without a copy, the using organization shall immediately requisition one. See SR 310–20–4 for lubrication order of current date. Lubrication which is to be performed by ordnance maintenance personnel is listed on the lubrication order in the NOTES.

91. General Lubrication Instructions

a. General. Any special lubricating instructions required for specific mechanism or parts are contained in the pertinent section.

b. Usual Conditions. Service intervals specified on the lubrication order are for normal operation and where moderate temperature, humidity, and atmospheric conditions prevail.

c. Lubrication Equipment. Each vehicle is supplied with lubrication equipment adequate for its maintenance. Clean this equipment both before and after use. Operate the lubricating guns carefully and in such a manner as to insure proper distribution of the lubricant.

d. Points of Application.

(1) Lubrication fittings, grease cups, oilers, and oilholes are shown in figures 79 through 85 and are referenced to the lubrication order. Wipe these devices and the surrounding surfaces clean before and after lubricant is applied.

(2) A ¾-inch red circle should be painted around each lubricating fitting and oilhole.

e. Reports and Records.

(1) Report unsatisfactory performance of prescribed petroleum fuels, lubricants, or preserving materials, using DA Form 468 (Unsatisfactory Equipment Report).

(2) Maintain a record of lubrication of the vehicle on DA Form 462 (Preventive Maintenance Service and Inspection for Full-Track Vehicles).

(3) Maintain a record of changes in grade of lubricant and recoil oil for the weapon in the Weapon Record Book (DA Forms 9–13 and 9–13–1).

92. General Lubrication Instructions Under Unusual Conditions

a. Service Intervals. Reduce service intervals specified on the lubrication order, i.e., lubricate more frequently, to compensate for abnormal or extreme conditions, such as high or low temperatures, prolonged periods of high-speed operation, continued operation in sand or dust, immersion in water, or exposure to moisture. Any one of these operations or conditions may cause contamina-

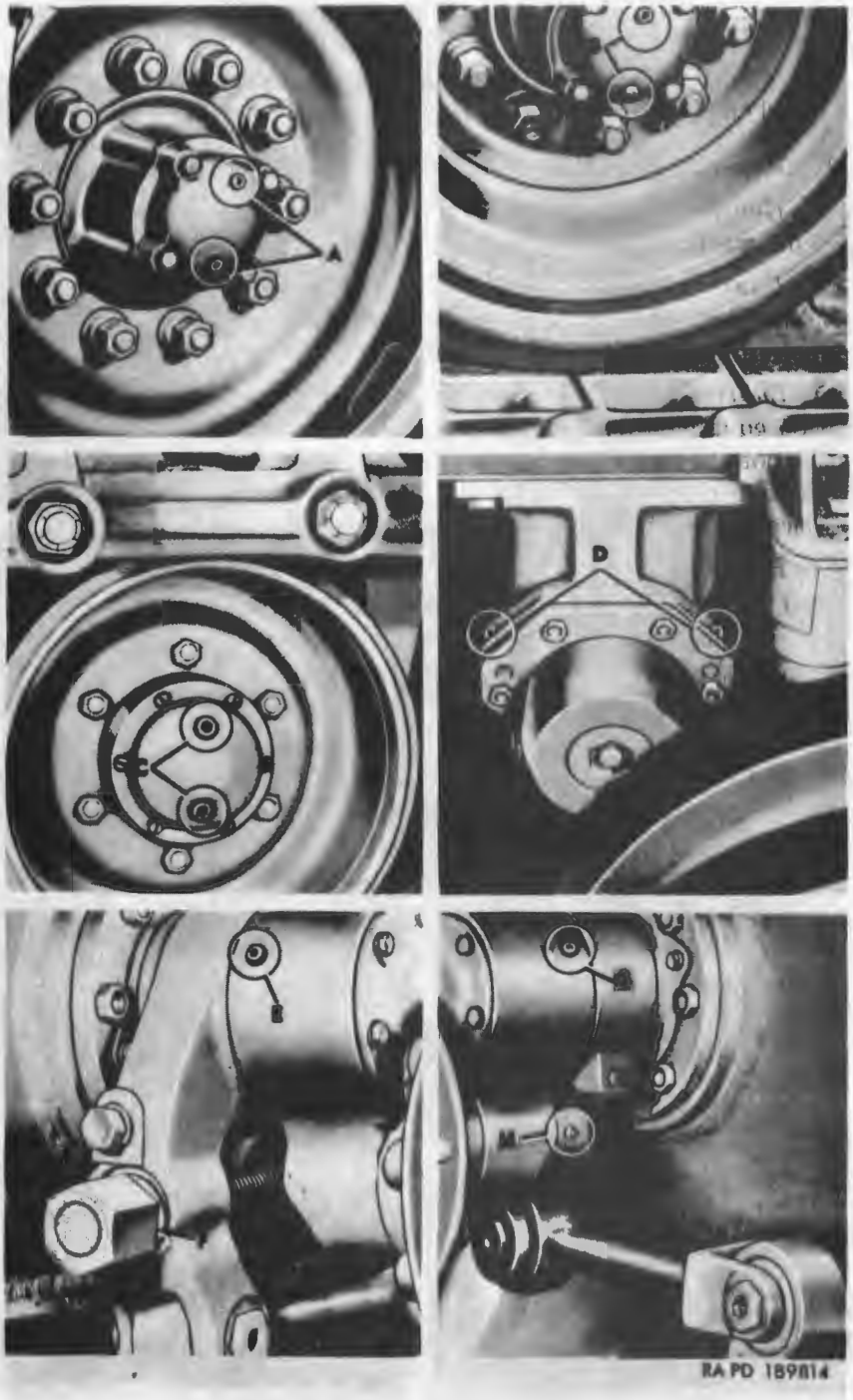


Figure 79. Localized lubrication points (A–H).

Figure 80. Localized lubrication points (J–Q).

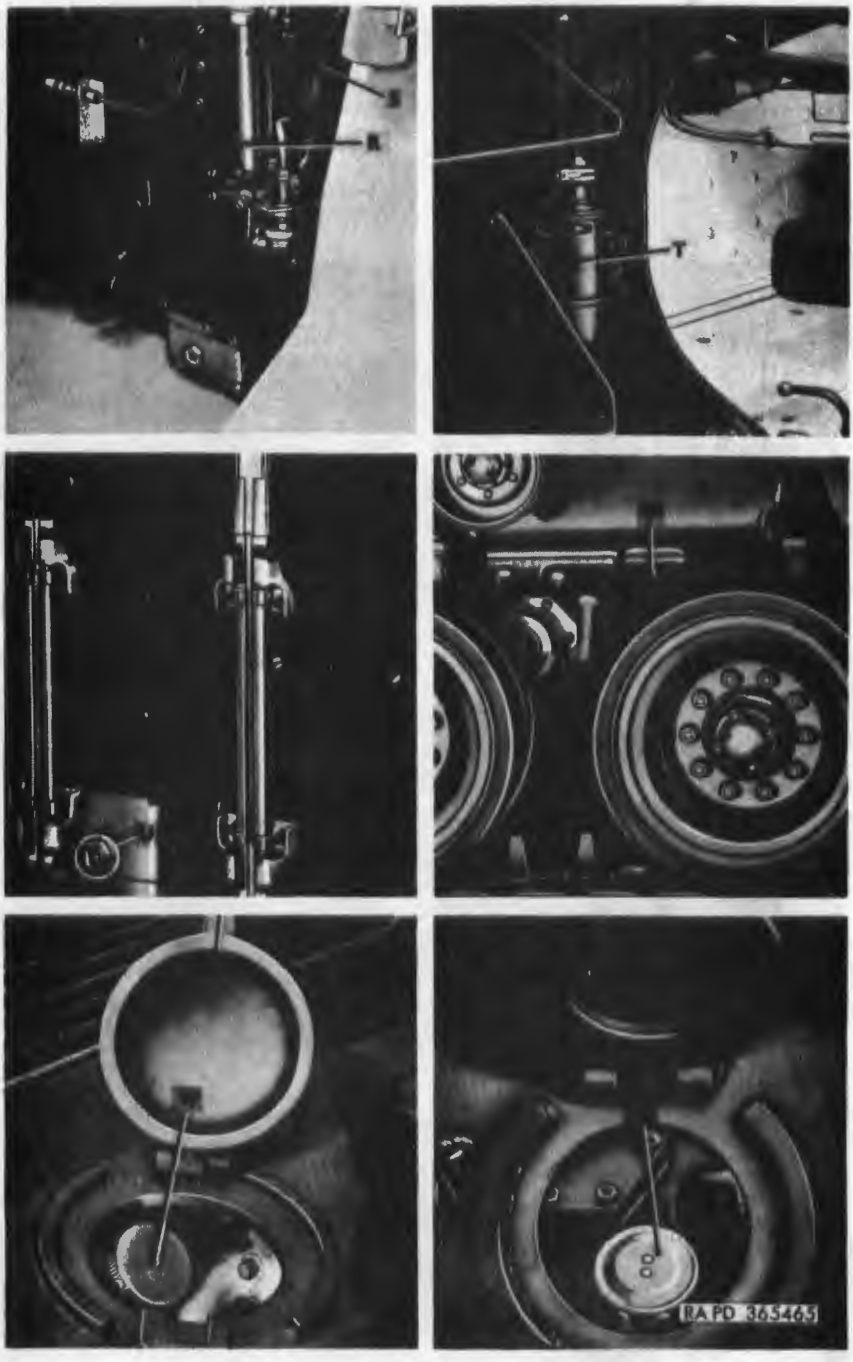


Figure 81. Localized lubrication points (R–X).

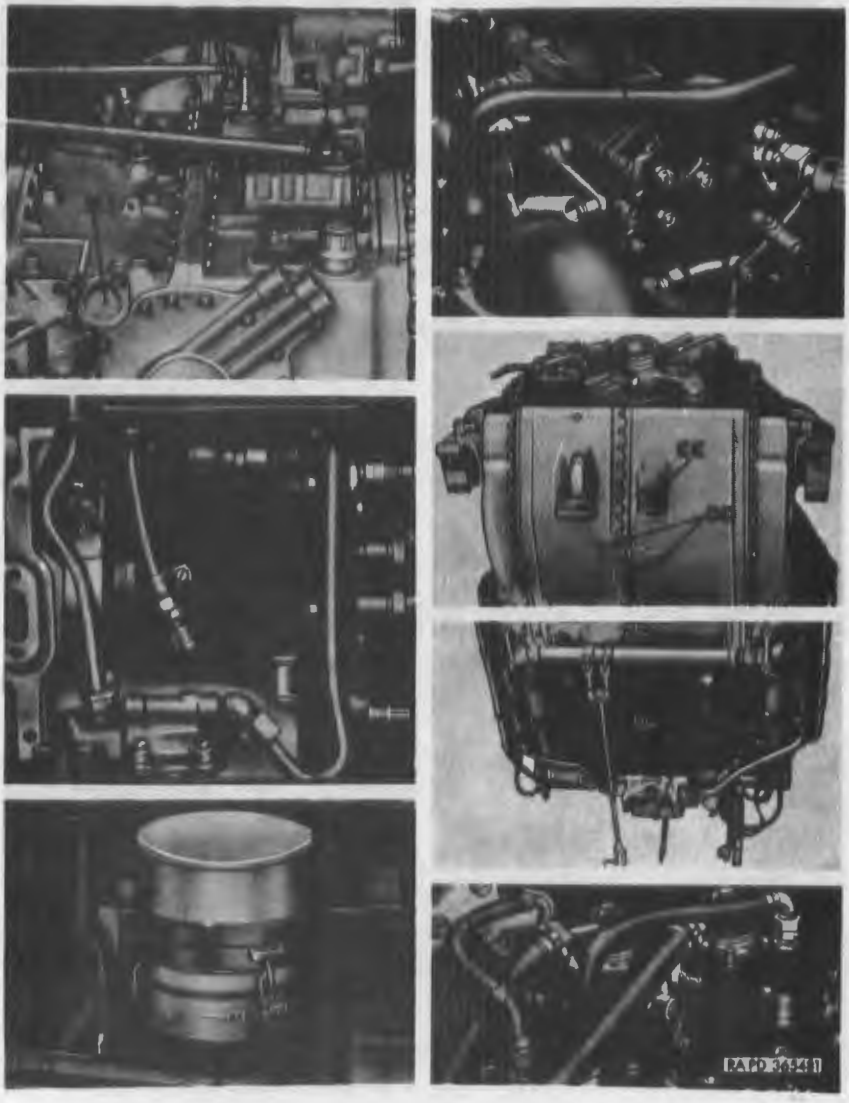


Figure 82. Localized lubrication points (Y–HH).

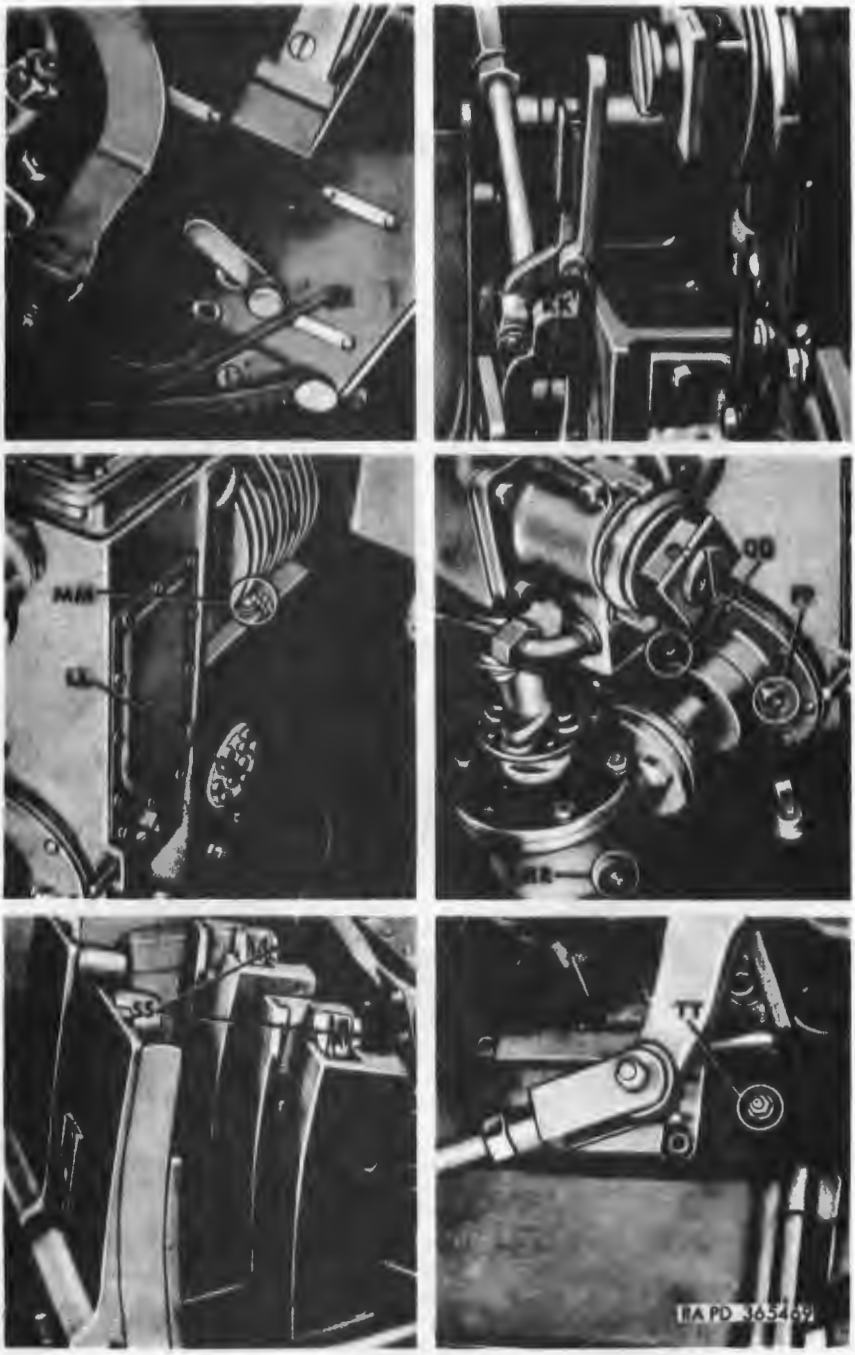


Figure 83. Localized lubrication points (JJ–TT).

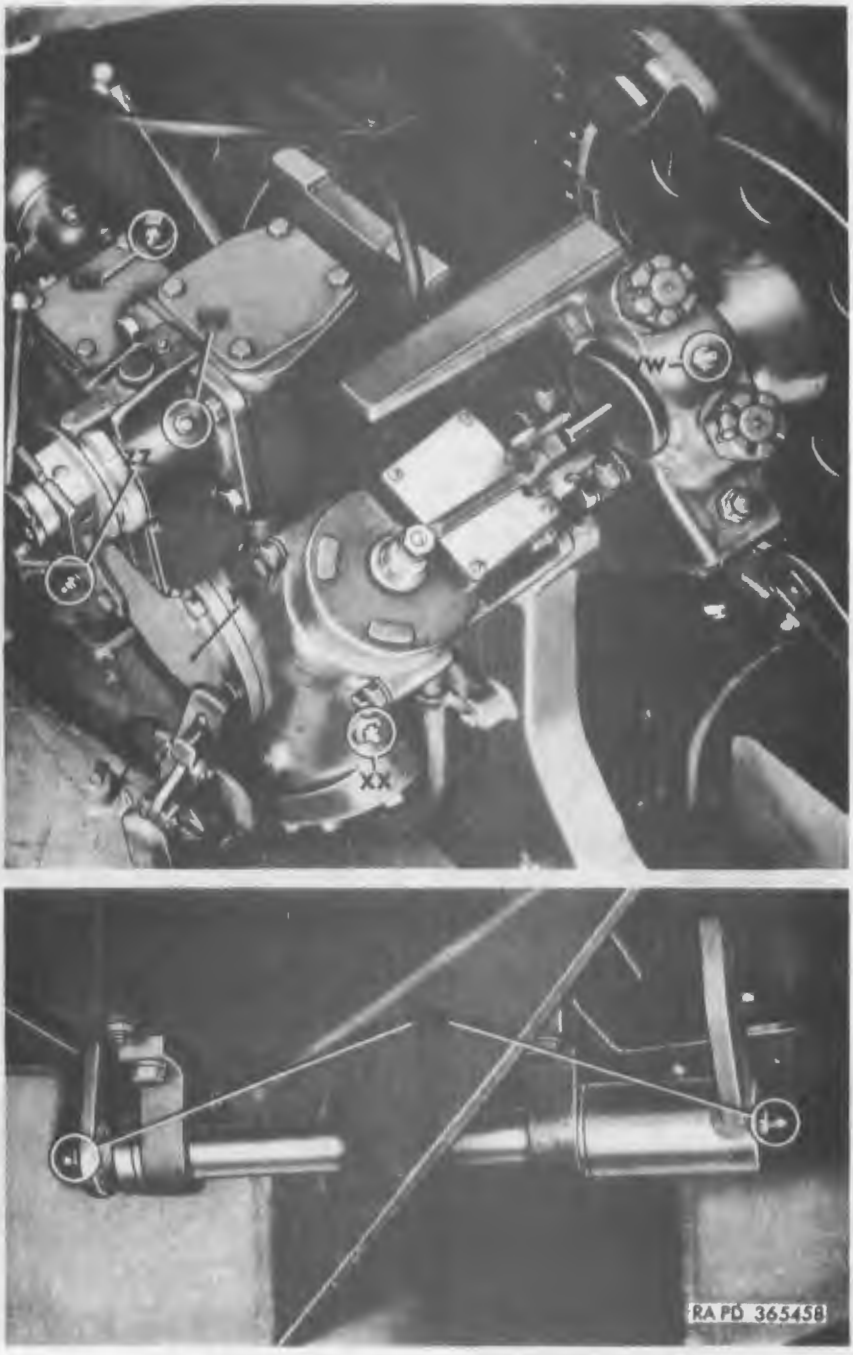


Figure 84. Localized lubrication points (UU–AB).

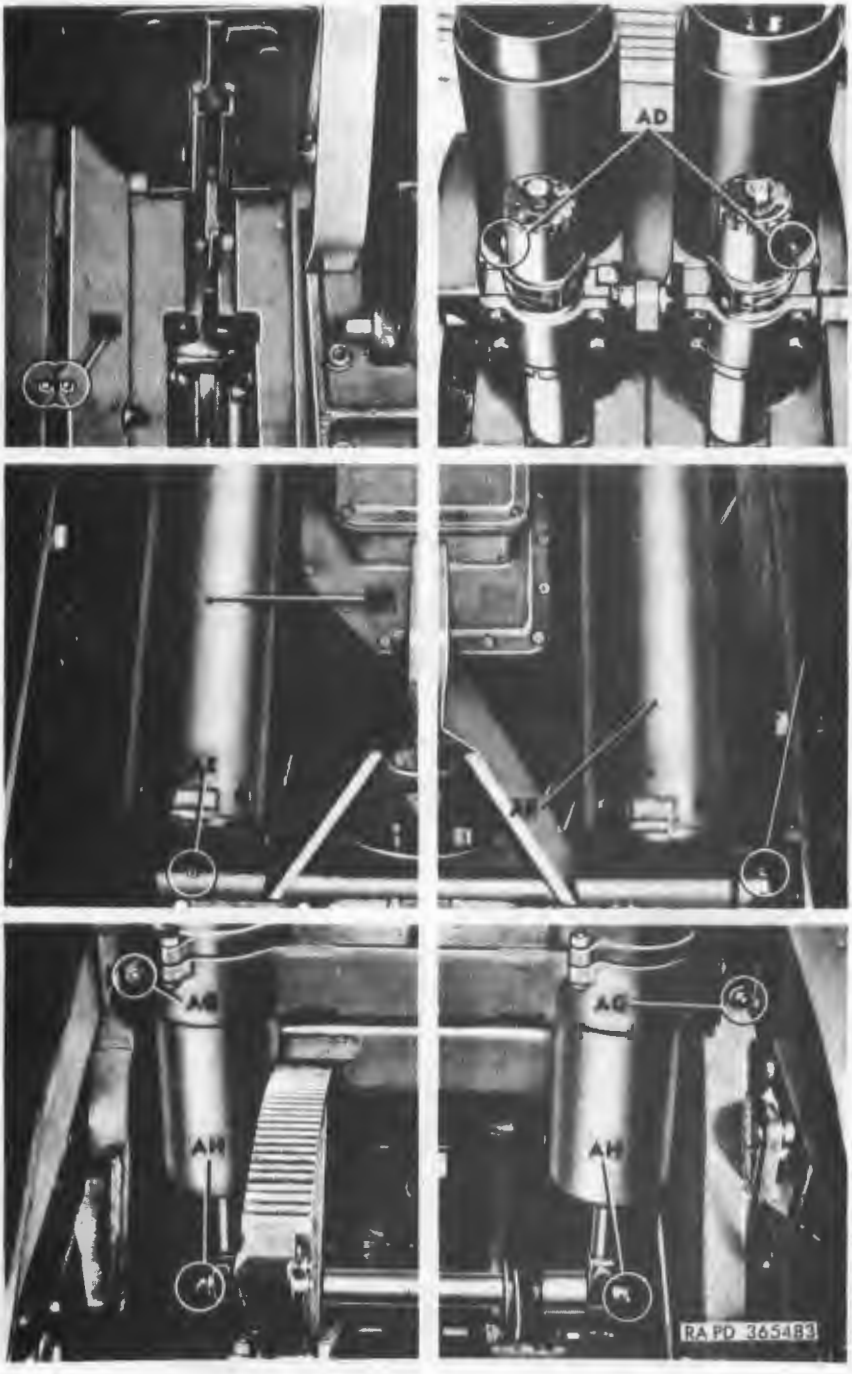


Figure 85. Localized lubrication points (AC–AH).

tion and quickly destroy the protective qualities of the lubricants. Intervals may be extended during inactive periods commensurate with adequate preservation.

b. Changing Grade of Lubricants. Lubricants are prescribed in the "Key" of the lubrication order in accordance with three temperature ranges; above +32° F., +40° to —10° F., and from 0° to —65° F. Change the grade of lubricants whenever weather forecast data indicates that air temperatures will be consistently in the next higher or lower temperature range or when sluggish starting caused by lubricant thickening occurs. No change in grade will be made when a temporary rise in temperature is encountered.

c. Maintaing Proper Lubricant Levels. Lubricant levels must be observed closely and necessary steps taken to replenish in order to maintain proper levels at all times.

93. Lubrication for Continued Operation Below 0° F.

Refer to TM 9–2855 for instructions on necessary special preliminary lubrication of the vehicle.

94. Lubrication after Fording Operations

a. After any fording operation in water 12 inches or over, lubricate all suspension points to cleanse bearings of water or grit as well as any other points required in accordance with paragraph 304 for maintenance operations after fording.

b. If the vehicle has been in deep water for a considerable length of time or was submerged beyond its fording capabilities precautions must be taken as soon as practicable to avoid damage to the engine and other vehicle components as follows:

(1) Perform a complete lubrication service (par. 90).

(2) Inspect engine crankcase oil. If water or sludge is found, drain the oil and flush the engine with preservative engine oil PE–30. Before putting in new oil, remove, clean, and install the engine oil filter (par. 134).

Note. If preservative engine oil is not available, engine lubricating oil OE–30 may be used.

(3) Operation in bodies of salt water enhances the rapid growth of rust and corrosion, especially on unpainted surfaces. It is most important to remove all traces of salt water and salt deposits from every part of the vehicle. For assemblies which have to be disassembled, dried, and relubricated, perform these operations as soon as the situation permits. Regardless of the temporary measures taken,

the vehicle must be delivered as soon as practicable to the ordnance maintenance unit.

95. Lubrication after Operation Under Dusty and Sandy Conditions

After operation under dusty or sandy conditions, clean and inspect all points of lubrication for fouled lubricants and relubricate as necessary.

Note. A lubricant which is fouled by dust and sand makes an abrasive mixture that causes rapid wear of parts.

96. Painting

Instructions for the preparation of the materiel for painting, methods of painting, and materials to be used are contained in TM 9–2851. Instructions for camouflage painting are contained in FM 5–20B. Materials for painting are listed in ORD 7 SNL G–253.

Section III. PREVENTIVE-MAINTENANCE SERVICE

97. General

The purpose of preventive-maintenance services is to detect first signs of electrical and mechanical failures of assemblies in the vehicle, and to insure that appropriate corrective action is taken before expensive and time-consuming repairs or replacements are required. The system of preventive-maintenance services is based on frequent inspections and services accomplished by operators, company battalion, or regimental maintenance personnel, under active supervision by all commanders and leaders.

98. Responsibility

AR 750–5 charges operators and crew chiefs with personal responsibility for assigned vehicles. Squad, section, and platoon leaders are charged with supervisory responsibility for vehicles pertaining to their commands. Unit and organization commanders are required to insure that vehicles issued or assigned to their commands are properly maintained in a serviceable condition, and that they are properly cared for and used.

99. Intervals

The mileage that a vehicle travels is the principal criterion for the frequency of preventive-maintenance services. Operation under adverse conditions, such as extreme temperatures, dust, or mud, may require preventive-maintenance services to be performed more frequently. Reduce intervals between preventive-maintenance

services when environmental conditions indicate the need. Do not extend intervals between preventive-maintenance services, except when authorized to do so.

100. Outline

The system of preventive-maintenance services for tactically-used vehicles is outlined in table IV. A and B services, as outlined, are designated as first echelon services. C and D services are designated as second echelon services.

Table IV. Outline of Preventive-Maintenance Services for Tactically Used Track Vehicles

Services	Interval	Accomplished by
Daily A	Each day operated	Operator or crew
Weekly B	Every week	Crew, supervised by squad, section, and platoon leaders, and assisted by company or battery mechanics.
Mileage-monthly C	Monthly or 250 miles, whichever occurs first	Company or battery maintenance personnel.
Quarterly-mileage D	Quarterly or 750 miles, whichever occurs first	Battalion maintenance personnel.

Note. Vehicle armament and on-vehicle mounted equipment will be given preventive-maintenance services concurrently with the vehicle.

101. General Procedures for All Services and Inspections

a. The following general procedures apply to both first-and second-echelon preventive-maintenance services and to all inspections, and are just as important as the specific procedures.

b. Inspections to see if items are in good condition, correctly assembled or stored, secure, not excessively worn, not leaking, and adequately lubricated apply to most items in the preventive-maintenance and inspection procedures. Any or all of these checks that are pertinent to any item (including supporting, attaching, or connecting members) will be performed automatically, as general procedures, in addition to any specific procedures given.

(1) Inspection for good condition is usually an external visual inspection to determine whether the unit is damaged beyond safe or serviceable limits. Good condition is explained further as meaning: not bent or twisted, not chafed or burned, not broken or cracked, not bare or frayed, not dented or collapsed, not torn or cut, not deteriorated.

(2) Inspection of a unit to see that it is correctly assembled or stowed is usually a visual inspection to see if the unit is in its normal position in the vehicle and if all its parts are present and in their correct relative positions.

(3) Inspection of a unit to determine if it is secure is usually an external visual examination or a check by hand, wrench, pry-bar, or screwdriver inspection for looseness. Such an inspection must include any brackets, lockwashers, locknuts, locking wires, and cotter pins as well as any connecting tubes, hose or wires.

(4) By "excessively worn" is meant worn beyond serviceable limits to a point or likely to result in failure if the unit is not replaced before the next scheduled inspection. Excessive wear of mating parts or linkage connection is usually evidenced by too much play (lash or lost motion). It includes illegibility as applied to markings, data and caution plates, and printed matter.

c. Where the instructions, "tighten" appears in the procedures, it means tighten with a wrench, even if the item appears to be secure.

d. Such expressions as "adjust if necessary" or "replace if necessary" are not used in the specific procedures. *It is understood that whenever inspection reveals the need of adjustment, repairs, or replacements, the necessary action will be taken.*

e. Any special cleaning instructions required for specific mechanism or parts are contained in the pertinent section. General cleaning instructions are as follows:

(1) Use dry-cleaning solvent or mineral spirits paint thinner to clean or wash grease or oil from all parts of the vehicle.

(2) A solution of one part grease-cleaning compound to four parts of dry-cleaning solvent or mineral spirits paint thinner may be used for dissolving grease and oil from engine, chassis, and other parts. After cleaning, use cold water to rinse off any solution which remains.

(3) After the parts are cleaned, rinse and dry them thoroughly. Apply a light grade of oil to all polished metal surfaces (other than optical instruments) to prevent rusting.

(4) When authorized to install new parts, remove any preservative materials, such as rust-preventive compound, protective grease, etc; prepare parts as required (oil seals, etc); and for those parts requiring lubrication, ap-

ply lubricant prescribed in the lubrication order LO 9–7218 (par. 90).

f. General Precautions in Cleaning are as Follows:

(1) Dry-cleaning solvent or mineral spirits paint-thinner is flammable and should not be used near an open flame. Fire extinguishers should be provided when these materials are used. Use only in well-ventilated places.

(2) These cleaners evaporate quickly and have a drying effect on the skin. If used without gloves, that may cause cracks in the skin and, in the case of some individuals, a mild irritation or inflammation.

(3) Avoid getting petroleum products, such as dry-cleaning solvent, mineral spirits paint thinner, engine fuels, or lubricants on rubber parts as they will deteriorate the rubber.

(4) The use of diesel fuel oil, gasoline, or benzene (benzol) for cleaning is prohibited.

g. Nameplates, caution plates, and instruction plates made of steel, rust rapidly. When plates are found in a rusty condition, they should be thoroughly cleaned and heavily coated with an application of clear lacquer.

102. Daily A Preventive-Maintenance Services

Each vehicle will be inspected each day that it is operated. This service is divided into four parts, as indicated in *a* through *d* below.

a. Before-Operation Service. This is a brief service to ascertain that the vehicle is ready for operation; it is mainly a check to see if conditions affecting the vehicle's readiness have changed since the last after-operation service.

b. During-Operation Service. This service consists of detecting unsatisfactory performances. While driving, the driver or crew should be alert for any unusual noises or odors, abnormal instrument readings, steering irregularities, or any other indications of malfunction of any part of the vehicle. Every time he applies the brakes, shifts gears, or turns the vehicle, the driver should instinctively consider it a test and note any unusual or unsatisfactory performance.

c. At-the-Halt Service. This service consists of investigating any deficiencies noted during operation and repeating part of the before-operation service.

d. After-Operation Service. This is the basic daily service for tactical vehicles. It consists of correcting, so far as possible, any operating deficiencies. Thus the vehicle is prepared to operate, upon a moments notice.

103. Weekly B Preventive-Maintenance Services

a. These services supplement the daily A preventive-maintenance services and are applied as indicated in table V and *b* below. They provide for cleaning the vehicle more thoroughly and for servicing certain items that do not require daily attention.

b. The weekly B service is applied to track vehicles once a week by the crew under supervision of the squad, section, and platoon leaders. When necessary, crew will be assisted by company or battery mechanics.

104. Specific Procedures for First-Echelon

Table V gives the specific procedures to be performed on the vehicles by the driver or crew in each of the daily and weekly services. An X in a column means that the procedure opposite it should be performed at the interval designated by the column it appears in.

Table V. Daily A and Weekly B Preventive-Maintenance Services—Vehicle (for Services Pertaining to Armament, Refer to Table VI).

Intervals					Procedure
Daily A					
Before-Operation	During-Operation	At-the-halt	After-Operation	Weekly B Service	
					Caution: Place all tags describing condition of vehicle in the driver's compartment in a conspicious location so that they will not be overlooked.
X	-----	X	X	X	*Fuel and oil.* Check fuel and oil levels (pars. 34 and 133*b*). Look for leaks in engine compartment. Check spare containers for contents.
X	-----	-----	-----	X	*Tracks.* Inspect tracks visually.
			X	X	Inspect tracks for correct tension (par. 220*f*).
X	-----	X	X	X	*Leaks, general.* Look under vehicle and in engine compartment for indications of fuel, engine-oil, or grease leaks.
X	-----	-----	-----	-----	*Vehicle equipment.* Visually inspect fire extinguishers and vehicle publications, including necessary forms.
				X	See that fire extinguishers are charged.
X	-----	-----	X	X	Operate lights (par. 28*b*) and horn (par. 32) (if tactical situation permits). Visually inspect vision devices, hull, armor, towing connections, traveling lock, hatches, doors, paulins, tools, etc.

Table V—Continued

Intervals					Procedure
Daily A					
Before-Operation	During-Operation	At-the-halt	After-Operation	Weekly B Service	
				X	Check for any tampering or damage that may have occurred since last inspection.
X	X	------	------	------	*Instruments.* Observe for normal readings during warm-up (par. 43*f*) and during operation of vehicle.
	X	------	------	------	***Caution:*** If any warning signal light comes on, stop engine immediately and investigate cause.
	X	------	------	------	*General operation.* Be alert for any unusual noises or improper operation of steering, brakes, or range selector control operation.
		X	X	X	*Operating faults.* Investigate and correct or report any faults noted during operation.
		X	X	X	*Suspension.* Look at bumper stop springs, road wheel support arms, shock absorbers, road wheels and track support rollers to see if they have been damaged. Check all suspension components for oil leakage at seals.
			X	------	*Fuel filters.* Check all fuel filters for leaks.
			X	X	Open engine fuel filter drain and drain water and sediment. Remove sediment bowls on primer and personnel filters and remove water and sediment.
			X	X	*Lubricate.* Lubricate items specified on lubrication order LO 9–7218 (par. 90).
			X	X	*Clean.* Clean glass, vision devices, and inside of vehicle. Wipe off exterior of vehicle.
				X	Wash vehicle, clean power plant and engine compartment.
				X	*Batteries.* Clean, check water level, inspect terminals for corrosion, tightness, and coating of grease.
				X	*Assemblies.* Inspect assemblies such as carburetor, generator, engine cooling fan, heater, magnetos, starter, fuel and bilge pumps, for looseness of mountings or connections.
				X	*Electrical wiring.* Visually inspect electrical wiring, conduits, and shielding.
				X	*Final drive vents.* Inspect for clogging.

Table VI. Crew Preventive-Maintenance Services—Armament (for Services Pertaining to the Vehicle, Refer To Table V).

Before-firing	During-firing	After-firing	Weekly	Before-traveling	Procedure
					Bore and chamber.
		X	------	X	Remove round of ammunition from chamber, if present.
X	------	------	------	------	Wipe dry.
		X	------	------	Clean thoroughly according to instructions in vehicle technical manual and lubrication order.
			X	------	Examine for powder fouling, corrosion, or other damage.
				X	Cover muzzle.
					Breech mechanism.
X	------	------	X	------	Test operation for proper functioning (par. 281).
			X	------	Examine for corrosion or other damage.
				X	Cover breech.
					Firing controls.
X	------	------	X	------	Test operation for proper functioning (par. 275).
					Elevating and traversing mechanism.
X	------	------	X	------	Test for smooth operation throughout entire range (pars. 287 and 288).
			X	------	Observe hand-operating crank backlash.
					Recoil mechanism.
X	X	X	X	------	Look for excessive oil leakage.
X	------	------	------	------	Test for smooth operation, length of recoil, and complete return to battery without shock.
X	------	------	X	------	Drain and reestablish oil reserve (par. 280*d*).
					Recoil slides.
			X	------	Look for rust or damage.
					Sighting and fire control materiel.
		X	X	------	Wipe clean.
					Caution: Optical glass is easily scratched. Use a camel hair brush to remove dust. To remove grease or oil apply alcohol with lens tissue paper and wipe clean. Breathing on glass before wiping is permissible above freezing temeratures.
		X	------	------	Cover.
				X	Stow.
		X	X	X	*Covers.* Examine for proper installation and condition of canvas (breech, muzzle, instruments, etc).

Table VI—Continued

Before-firing	During-firing	After-firing	Weekly	Before-traveling	Procedure
					General.
		X	------	X	Inspect gun for general condition.
			X	X	Inspect mount for general cleanliness and condition of paint.
				X	Look for loose bolts or parts.
X	------	------	------	X	Secure or release traveling locks and latches, as applicable.

105. General Procedures for Second Echelon

a. Automatically Applied. All of the general procedures given in paragraph 104 will be followed. Organizational mechanics must be so thoroughly trained in these procedures that they apply them automatically at all times in the performance of their duties.

b. First-Echelon Participation. The driver or crew usually accompanies the vehicle and assists the organizational mechanics in the performance of second-echelon periodic services.

c. Unwashed Vehicles. The driver or crew should present the vehicle for a scheduled preventive-maintenance service in a reasonably clean condition; that is, it should be dry and not caked with mud to such an extent as to seriously hamper inspection and services. However, washing of the vehicle should be avoided immediately prior to an inspection, since certain types of defects such as loose parts and oil leaks may not be evident immediately after washing.

d. Services. Second-echelon services are defined by and restricted to the following general procedures unless approval has been given by the supporting ordnance organization.

(1) *Adjust.* Make all necessary adjustments in accordance with instructions contained in the pertinent section of this technical manual, information contained in changes to the subject publication, or technical bulletins.

(2) *Clean.* Clean the unit as outlined in paragraph 101 to remove old lubricant, dirt, and other foreign material.

(3) *Special lubrication.* This applies either to lubrication operations that do not appear on the vehicle lubrication order or to items that do appear but which should be performed in connection with the maintenance operations if parts have to be disassembled for inspection or service.

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

(5) *Tighten.* All tightening operations should be performed with sufficient wrench torque (force on the wrench handle) to tighten the unit according to good mechanical practice. Use a torque indicating wrench where specified. Do not overtighten, as this may strip threads or cause distortion. Tightening will always be understood to include the correct installation of lockwashers, locknuts, locking wire, or cotter pins to secure the tightened nut.

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

f. DA Form 462. The numbers of the specific preventive-maintenance procedures that follow are identical with those outlined on DA Form 462. Certain items on the form that do not apply to this vehicle are not included in the procedures in this manual. In general, the sequence of items on the form is followed, but in some instances there is deviation for conservation of the mechanics time and effort.

106. Mileage - Monthly C Preventive-Maintenance Services

a. Intervals. The mileage - monthly C services are performed by the organizational mechanics at the intervals given in table VII. All preventive-maintenance services are performed at the prescribed intervals, so far as is practicable.

b. Purpose. The C preventive-maintenance services insure the correct adjustment, securing, and assembly of all components of the vehicle. Necessary replacements, cleaning, lubrication, and protection of part and/or assemblies will be accomplished as required, to give reasonable assurance of trouble-free operation until the next preventive-maintenace service is performed.

107. Quarterly - Mileage D Preventive-Maintenance Services

The quarterly - mileage D preventive-maintenance services are comprehensive scheduled services performed by the organizational mechanics at the intervals given in table VII.

108. Specific Procdures for Second Echelon

Specific procedures for performing each item in the mileage - monthly C and the quarterly - mileage D preventive-maintenance services on vehicles are given in table VII. Each page of the table has columns at its left edge for designated intervals of maintenance. Very often it will be found that a particular procedure does not apply to scheduled intervals. In order to determine which procedure to follow, look down the column corresponding to the maintenance procedure and wherever an item number appears, perform the operations indicated opposite the number.

Table VII. C and D Preventive-Maintenance Services

D (Quarterly or 750 miles)	C (Monthly or 250 miles)	Procedure
		INSPECTION AND ROAD TEST
		Note. When the tactical situation does not permit a full road test, perform only those items that require little or no movement of the vehicle. When a road test can be made, it should be approximately 3 miles, but not over 5 miles.
		Before-operation. Oil, fuel, tracks, leaks, general visual inspection of vehicles, and equipment. Perform the before-operation service (table V).
1	1	*Instruments, gages, warning lights—engine oil pressure and temperature, transmission oil pressure and temperature, generator charging, speedometer, tachometer, and fuel.* Immediately after starting the engine, before the generator regulator has reduced the charging rate, notice if the generator warning light goes out. Check the oil pressure on the engine oil pressure gage. Observe all instruments for normal readings (pars. 35–37). Determine if all warning lights are working.
2	2	*Horn and heater.* If the tactical situation permits, sound horn (par. 32) to see if signal is normal. Test the operation of personnel heater (par. 71).
3	3	*Lamps—head, tail, dome, stop, and blackout.* While the vehicle is stopped, if the tactical situation permits, test the operation of all lights, external and internal, and light switches (pars. 28–30). Notice if the headlights appear to be correctly aimed. Note condition of lights and safety reflectors.
4	4	*Engine—idle, acceleration, power, noise, smoke, and governed speed.* In warming up the engine, observe if it starts easily and if the operation of main engine primer pump and hand throttle control is satisfactory. Notice if idling speed is correct (650 rpm). Note any unusual noises or excessive vibration, at idle or higher speeds. When operating the vehicle, notice if it has normal power and ac-

Table VII—Continued

D (Quarterly or 750 miles)	C (Monthly or 250 miles)	Procedure
		celeration in each transmission range, or any tendency to stall. Listen for any unusual noises when the engine is under load. Look for excessive black or blue smoke issuing from the exhaust. Speed up the vehicle on a level stretch and see if the engine will reach, but not exceed, the governed speed of 2,800 rpm under load.
5	5	*Suspension—tracks, wheels, sprockets, shock absorbers, bumper stop springs, torsion bars, and arms.* Inspect these items. In the tracks, look particularly for deteriorated rubber, loose bushings, and worn or loose pins; notice if track tension appears to be satisfactory (par. 220*f*). Inspect road wheels, sprockets, compensating wheels, and support rollers, paying particular attention to lubricant leaks from the bearing seals and rubber tires separated from rims. Visually inspect bumper stop springs, noting if they have taken a permanent set. Pry up on each road wheel to detect broken torsion bars.
6	6	*Brakes—service, parking, braking effect, and steering action.* Inspect these items. Test service brake pedal for proper operation (par. 213). Move steering control crossbar through its entire range and observe if the steering response is satisfactory and the vehicle does not wander when steering control crossbar is centered. Observe for chatter, noise, or any unusual behavior. Accelerate vehicle to a moderate speed and apply service brakes to see if they stop the vehicle straight, smoothly, and effectively. When the vehicle is on an incline, stop vehicle and apply parking brake to observe if it locks securely and holds the vehicle safely.
8	8	*Transmission—range selector control lever action, vibration, noise, and control.* Inspect these items, looking particularly for clogged vents or breathers; including the final drives. Move range selector control lever through all forward and reverse speed ranges of transmission, noticing if it operates smoothly without excessive vibration or unusual noise, and if vehicle response is satisfactory. Note any tendency of the range selector control lever to jump out of position. Examine control lever, shafts, and linkage for freedom of action and correct adjustment.
8	-------	Tighten all assembly and mounting bolts of these units.
9	9	*Unusual noises—universal joints, final drives, road wheels, compensating wheels, shock absorbers, tracks, drive sprockets, support rollers, and engine cooling fan.* Listen, both from inside and from outside the vehicle, for unusual noises emanating from these components, or others, that would indicate lack of lubrication, maladjustment, or damage. Be alert for unusual noises throughout the road test.

Table VII—Continued

D (Quarterly or 750 miles)	C (Monthly or 250 miles)	Procedure
		AFTER ROAD TEST
11	11	*Temperatures—wheel hubs, drive sprocket hubs, shock absorbers, transmission, and final drives.* Immediately after the road test, feel these components cautiously. Feel the transmission also if there is doubt that the warning light is functioning properly. If shock absorbers are operating satisfactorily, they should be warmer than the hull. An overheated road wheel, compensating wheel, drive sprocket, or support roller hub indicates a maladjusted, dry, or damaged bearing. An overheated final drive indicates internal maladjustment, damage, or inadequate lubrication.
12	12	*Auxiliary generator and engine—power, smoke, governed speed, generator output, and wiring.* Inspect auxiliary generator and engine and wiring; pay particular attention to the carburetor, fuel pump, generator, fuel and oil lines, and choke linkage. Operate the auxiliary generator and engine (par. 70), noticing if it has normal power and generally performs satisfactorily. See if excessive black or blue smoke issues from the exhaust. Determine if the generator output is satisfactory by the method described in paragraph 122*k*. If need is indicated by engine sound or low generator output, use a tachometer to see if engine governed speed is within specified limits of 3,100 to 3,250 rpm.
12	12	Service auxiliary generator and engine air cleaner in accordance with lubrication order LO 9–7218. Clean fuel filter element and sediment bowl.
12	-------	Clean spark plug and adjust gap (par. 148). On every second quarterly or 750-mile inspection and service, examine generator brushes and clean commutator. Inspect mounting brackets.
13	13	*Leaks—engine oil, fuel, transmission, final drives, road and compensating wheels, oil seals, and primer fuel lines.* Make general observations inside and outside the vehicle for fuel, lubricant leaks from seals, gaskets, line and hose connections, oil coolers, fuel tanks, or other sources.
14	14	*Hull—paint, fenders, hatches, grille doors, drain plugs and valves, seats, and bilge pumps.* Inspect these items, all other attachments on hull exterior, and optical devices (including spares) in the hull. ***Caution:*** Optical glass is easily scratched. Use only a camel's-hair brush to remove dust. Clean only with lens tissue. Breathing on the glass before wiping is permissible. If the glass is greasy or oily, apply lens soap only, and wipe off with lens tissue. Particularly inspect for any bare spots in the interior or exterior paint, which might permit rust or reflection, and

Table VII—Continued

D (Quarterly or 750 miles)	C (Monthly or 250 miles)	Procedure
		check legibility of markings. Observe if hatch covers and doors lock and seal properly. Look at grille doors for clogging. Examine hull drain valves (par. 246), for proper functioning. Test operation of bilge pumps (par. 73); see if strainers are clean. Test seat adjusting devices to see if they are functioning properly.
15	15	*Gun Mount—locks, seats, and pads.* Inspect these items including attachments and optical devices on gun mount. Test operation of locks. Make observations similar to those made in item 14 on paint, hatches and locks, seats, and optical devices. Notice particularly if crash pads are in serviceable condition. Test operation of azimuth indicator.
16	16	*Gun Mount, paint, armament mounts, seats, sighting and firing controls, elevating and traversing mechanism, and recoil mechanism.* Inspect these items; include breech mechanism and spare parts. With vehicle tilted sidewise about 10°, test the power and manual operation of gun mount through its entire range (pars. 59 and 61). ***Caution:*** Be sure that gun has clearance to traverse. With gun pointed forward or rearward, test the operation of manual and power elevating mechanisms through their entire range (pars. 59 and 61). Test the operation of manual and electric firing controls (par. 291), noticing particularly if safety devices are functioning. When cleaning optical glass, observe the following: ***Caution:*** Optical glass is easily scratched. Use a camel's hair brush to remove dust. To remove grease or oil, apply alcohol with lens tissue paper and wipe clean. Breathing on glass before wiping is permissible above freezing temperatures.
16	-------	Tighten all gun mount assembly and mounting bolts.
17	17	*Stowage boxes—ammunition stowage, and racks.* Inspect these items, observing particularly if ammunition is securely and safely stowed. If ammunition stowage racks and stowage boxes are empty, observe if they are ready for use.
18	18	*Towing shackles, lifting eyes, pintle, and towing cables.* Inspect these items. Observe if pintle jaw locks satisfactorily.
19	19	*Lubrication—lubricate vehicle in accordance with lubrication order LO 9–7218 (par. 90).* Inspect vehicle and armament for proper lubrication.
		Lubricate vehicle and armament in accordance with lubrication order LO 9–7218 (par. 90), except those items that are to be disassembled later and lubricated before reassembly.

Table VII—Continued

D (Quarterly or 750 miles)	C (Monthly or 250 miles)	Procedure
20	20	*Oil consumption.* Check whether or not the engine has been consuming an excessive amount of oil. Maximum allowable oil consumption for an engine operating cross-country is approximately one gallon in 10 miles.
		MAINTENANCE OPERATION
21	21	*Batteries—specific gravity.* Make a hydrometer test of the electrolyte in each cell (par. 172) and record specific gravity in space provided on DA Form 462.
22	22	*Batteries—voltage.* Perform a high-rate discharge test according to instructions accompanying the test instrument. Record voltage of each cell in space provided on DA Form 462.
22	.....	After battery tests, clean top of batteries, coat terminals lightly with grease, and repaint carrier, if corroded. See if battery requires water. *Note.* If distilled or approved water is not available, clean water, preferably rain water, may be used.
23	.....	*Engine compression.* Test compression in each cylinder, with one spark plug out of each cylinder and engine warm, engine oil at temperature of 60° to 100° F., and battery fully charged. Insert the compression gage in a spark plug hole, and with the throttle wide open, revolve the engine at cranking speed (45 to 55 rpm) until the maximum compression is indicated. Normal compression should be from 75 to 90 psi. Minor variations between cylinders is not ordinarily detectable in performance, however, any cylinder which is more than 10 psi lower than the average of all cylinders should be rechecked. Record readings in space provided on DA Form 462. Repeat this process for each cylinder. Auxiliary generator and engine cylinder compression can be as low as 20 psi without any noticeable difference in performance.
24	.....	*Fuel filter, bilge pump strainers, oil filters, and air cleaners.* Clean and service these items in accordance with instructions in vehicle technical manual and lubrication order. If fuel filter shows signs of contaminated fuel, drain water and sediment from fuel tanks (par. 150), using suitable containers to catch the drainings.
27	.....	*Spark plugs, booster coil and filter, wiring, timing, and magnetos.* Remove and inspect spark plugs (par. 148). Inspect magneto cover, cams, and breaker points. Test booster coil, and capacitor with ohmmeter or with high-tension ignition-circuit test according to instructions accompanying test instrument. Test magneto timing and synchronization (par. 145). Test generator regulator with low-voltage circuit tester following instructions accompanying test instrument.

Table VII—Continued

D (Quarterly or 750 miles)	C (Monthly or 250 miles)	Procedure
27	-------	Clean spark plugs and adjust gap (0.017 to 0.020 inch). Examine generator brushes and clean commutator.
28	-------	*Valve mechanism—clearance and rocker cover gaskets.* Inspect valve mechanism, looking particularly for weak or broken valve springs. Check valve tappet and roller clearance (par. 143). Inspect rocker covers and gaskets.
28	-------	Adjust valve clearance to specification (par. 143). Clean mating surfaces thoroughly with dry-cleaning solvent or mineral spirits paint thinner when replacing valve rocker covers.
29	-------	*Carburetor, fuel pumps, and carburetor control linkages.* Inspect these items, noticing particularly if carburetor shafts and linkage operate freely and are not excessively worn. Observe if the throttle valve opens fully when the accelerator is fully depressed. Note particularly if the throttles are synchronized. Make an engine vacuum test and adjust idler mixture.
		Test fuel pump pressure (par. 153).
30	-------	*Exhaust pipes and mufflers.* Inspect for excessive or unusual noises and for exhaust leaks.
30	-------	Tighten mountings.
31	-------	*Manifolds.* Inspect these items looking particularly for signs of leakage at the manifold gaskets.
32	-------	*Brakes—adjustments and linkage.* Inspect these items; particularly, observe cross shafts and linkage.
32	-------	Adjust service brakes and linkage (par. 213), if need was indicated in the road test. Tighten assembly and mounting bolts.
33	-------	*Engine fan, shroud, and cylinder air deflectors and baffles.* Inspect these items particularly for interference and looseness.
34	-------	*Track tension.* Test track tension, by the method given in paragraph 220*f*, to see if it is within specified limits.
34	-------	Adjust track tension (par. 220*f*), if it is not within permissible limits. Using a torque-indicating wrench, tighten all track pin nuts to 160 to 180 pound-feet. Tighten all assembly and mounting bolts of the suspension components. Whenever the track has been removed for replacement or repair, examine road wheels, drive sprockets, compensating wheels, and support rollers for end play and bearing looseness or damage. Spin each wheel and listen for a damaged bearing. Pull outward and push inward on the wheel to determine if end play is excessive. Test for bearing looseness with a pry bar. Test for end play and bearing looseness or damage should be performed at least every

Table VII—Continued

D (Quarterly or 750 miles)	C (Monthly or 250 miles)	Procedure
		third D service. If the tracks have not been removed within that time, these tests can be performed without removing the tracks by the use of road-wheel lifter, jacks, blocks, and other means described in paragraph 219 through 231.
35	-------	*Electrical controls, wiring, suppressors.* Inspect all exposed electrical controls, terminal boxes and connecting wiring, cables, and conduits. Inspect all visible radio-noise-suppression bond straps, suppressors, shields and radio mountings, radio controls, headsets, microphones, antenna masts, and insulators.
35	-------	Clean these items with a dry soft cloth. If objectionable radio interference noise from the vehicle has been reported, make tests (par. 123) to determine the source. Clean contacting surfaces, tighten bonds, internal and external-teeth lockwashers, and mountings of units bonded together. Replace noise-suppression units as required. If these procedures do not eliminate the trouble, the radio operator will report the condition to the designated authority.
36	-------	*Oil coolers (engine and transmission).* Examine the oil coolers (fig. 134), including their cores and connecting lines, to see that they are in good condition, secure and do not leak. Also check to see that screen and core air passages are not clogged with dirt or foreign material. Tighten all mounting bolts, nuts, and hose connections securely. Check that oil lines are securely fastened and grommets in shroud are properly positioned.

Table VIII. Preventive-Maintenance Services by Artillery Mechanic

Intervals			Procedure
Weekly	Bimonthly (60 days)	Semi-annually (6 months)	
			USUAL CONDITIONS
X	-------	-------	*Gun tube assembly.* Check for unusual wear, erosion, and damage in bore (par. 279).
X	-------	-------	Check for evidence of decoppering and use of unauthorized cleaning materials or methods.
X	-------	-------	Check external surface of gun tube for corrosion and damage.
X	-------	-------	*Breech ring and components.* Check all surfaces of breech ring for wear, burs, or mutilation.
X	-------	-------	*Breechblock and components.* Check breechblock parts for wear, burs, and mutilation. Check springs for cracks and for set by comparing

Table VIII—Continued

Intervals			Procedure
Weekly	Bimonthly (60 days)	Semi-annually (6 months)	
			free length with spare spring. Check protrusion of firing pin (par. 281).
X			*Firing mechanism.* Check both electrical and manual firing mechanism for proper functioning (par. 289).
X			Check extractors for wear or damage.
X			*Recoil mechanism.* Check for leaks. Check oil level (par. 280*d*).
X			*Equilibrators.* Check for proper functioning and adjust if necessary (par. 290).
X			*Elevating and traversing mechanisms.* Check for proper operation (pars. 287 and 288).
X			*Local control system.* Check for proper operation (par. 59).
X			*Desiccators.* Check color of desiccant and replace if necessary (par. 274).
X			*Computing sight.* Check for proper synchronization (par. 58). If necessary, adjust (par. 276).
			Lubricate. See that computing sight, oil gears, gun, and gun mount have been lubricated as prescribed in lubrication order LO 9–7218 (par. 90).
X	X	X	*Tools, equipment, and spare parts.* See that all tools, equipment, and spare parts for the gun, gun mount, and sighting and fire control materiel are serviceable, clean, and properly stowed.
X	X	X	*Publications.* See that all manuals and lubrication orders are present, legible, and properly stowed.
		X	*Remote control equipment.* See that oil gears, cables, boxes, and switches are properly assembled and not damaged.
	X	X	*Modifications.* Check weapon record book to determine whether all modification work orders have been completed. A list of current modification work orders is contained in DA Pam 310–4. Enter any modifications or major unit replacements made during this service in the weapon record book.
			UNUSUAL CONDITIONS
			Maintenance operations, as prescribed under usual conditions, will apply under unusual

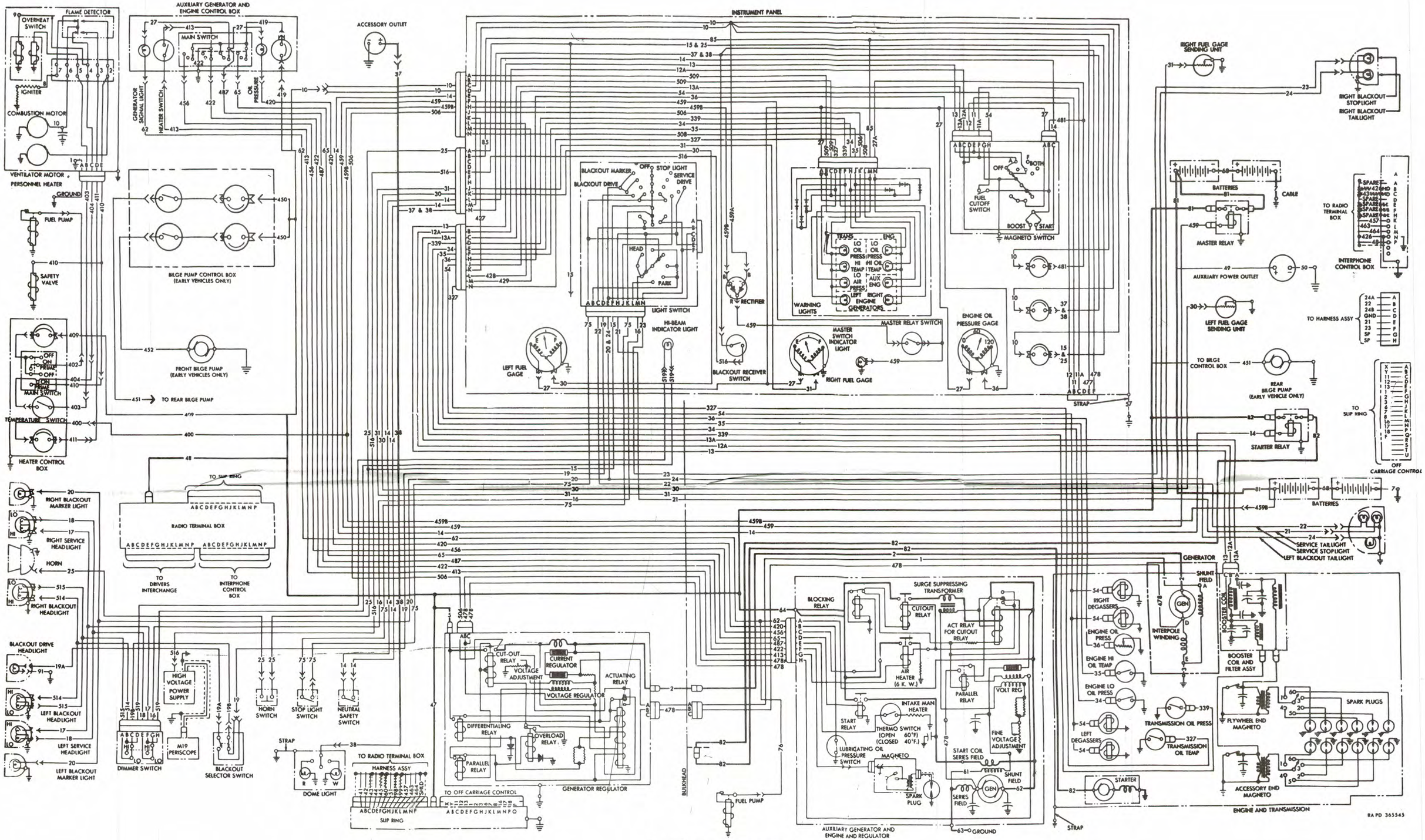


Figure 86. Hull schematic wiring diagram.

Table VIII—Continued

Intervals			Procedure
Weekly	Bimonthly (60 days)	Semi-annually (6 months)	
			conditions except for extreme-cold weather. Intervals are necessarily shortened in extreme cold weather. Materiel subjected to salt-water immersion or complete submersion should be evacuated to ordnance maintenance unit as soon as possible after exposure.

Section IV. TROUBLESHOOTING

109. Scope

a. This section contains troubleshooting information and tests for locating and correcting some of the troubles which may develop in the vehicle or weapon. Troubleshooting is a systematic isolation of defective components by means of an analysis of trouble symptoms, testing to determine the defective component, and applying the remedies. Each symptom of trouble or malfunction, given for an individual unit or system is followed by a list of probable causes of the trouble and corrective actions necessary to remedy the malfunction.

b. This technical manual cannot cover all possible troubles and deficiencies that may occur under the many conditions of operation. If a specific trouble, test, and remedy therefor are not covered herein, proceed to isolate the system in which the trouble occurs and then locate the defective component. Use all the senses to observe and to locate troubles. Do not neglect use of any test instruments such as a voltmeter, ammeter, test lamp, hydrometer, and pressure and vacuum gages (pars. 88 and 89) that are available. Standard automotive theories and principles of operation apply in troubleshooting the vehicle. Standard armament procedures apply in troubleshooting the weapon. Question vehicle crew to obtain maximum number of observed symptoms. The greater the number of trouble symptoms that can be evaluated, the easier will be the isolation of defect. Refer to figure 86 for information on locating and tracing electrical circuits in the hull.

110. Main Engine

a. General.

(1) Ignition, starting, fuel, lubrication, and oil-cooling systems are all regarded as part of the engine, but are treated sepa-

rately to simplify procedures. Trouble in any one of these systems will be reflected in engine performance.

(2) When troubleshooting the engine or one of the systems mentioned in (1) above, open or remove some of the engine compartment access doors, grilles, hinged grille doors (fig. 236), or stowage compartment bulkhead doors for access to components of the engine or various systems. The units on the accessory end of the engine, such as magnetos, fuel pump, and carburetors, may be reached by raising the six cast armor grille doors hinged to the hull sides.

b. Engine Will Not Turn When Starter Switch is Held In A Start Position.

(1) *Hydrostatic lock.* During periods of engine idleness, liquid fuel or engine oil may be accumulated in cylinders and form a hydrostatic lock. A hydrostatic lock may also occur if water enters cylinders through exhaust ports during fording operations. If a hydrostatic lock is suspected, remove one spark plug (par. 148) from each cylinder of the engine. Remove the power-take-off drive cover from the front of the engine (par. 143). Using engine turning wrench 5120–310–4673 (fig. 111), turn the engine over by hand at least two revolutions. If fluid drains from any spark plug hole, turn the engine until the liquid no longer drains. Remove the plugs from the bottom of the intake manifolds and drain the accumulation of liquid. Replace the manifold plugs, the spark plugs (par. 148), and the power-take-off drive cover (par. 145). Turn the master relay switch on (par. 26) and apply the starter switch by short contact periods, to bring approximately one cylinder on full compression each time the switch is pressed, until the engine has made at least two complete revolutions. Do not activate the booster or magneto switch during this operation. If the engine completes the two revolutions, attempt to start the engine.

(2) *Mechanical seizure of engine parts.* If engine will not turn over using procedure (1) above, a mechanical seizure of engine or transmission parts is indicated. Notify ordnance maintenance personnel.

(3) *Starter inoperative.* Refer to paragraph 111.

c. Engine Turns but Fails to Start.

(1) *Preliminary instructions.* Make certain magneto switch is at BOTH position, fuel shutoff valve is at BOTH ON position, and there is fuel in the fuel tanks. Then follow the

procedures in (2) through (5) below for whichever conditions are applicable.

(2) *Engine flooded.* If carburetor or cylinders are flooded due to overuse of primer pump or accelerator pedal, turn magneto switch off, hold accelerator pedal down to keep throttle wide open, and crank engine intermittently for several seconds to clear out surplus fuel.

(3) *Engine extremely cold.* If engine is extremely cold, additional use of the primer pump is required. The primer pump should operate with some resistance. If primer pump operates easily, it indicates broken primer lines, defective primer pump, or clogged lines to pump. Primer line restriction will be indicated by more effort required at the pump. To test for clogged lines, disconnect primer pump fuel line at primer fuel filter and operate primer pump, catching discharge in a suitable container.

Caution: Do not permit fuel to squirt into engine compartment.

Observe flow of fuel at disconnect.

(4) *Fuel not reaching carburetor.* Test and correct (par. 113).

(5) *Current not reaching spark plugs.* Test and correct the ignition system (par. 112).

d. Engine Starts but Fails to Keep Running.

(1) *Inadequate fuel flow to carburetor.* Engine may start and run on fuel in carburetor bowls, then stop when fuel in bowls is exhausted. If engine will restart after use of primer pump but will not continue running, check fuel system (par. 113).

(2) *Short circuits in ignition system.* Check magneto breaker points, ignition wires, and connections. Repair or replace as necessary (par. 112).

e. Engine Operation Indicates Inadequate Power.

(1) *Preliminary instructions.* The many different factors that may cause loss of power make it advisable to perform the quarterly preventive maintenance service in table VII before proceeding further. If this service has been performed recently and the trouble was not eliminated, proceed as in (2) through (11) below, omitting consideration of those items known to be satisfactory. Notify ordnance maintenance personnel if the checks listed below do not accomplish desired results.

(2) *Check main engine stall speed.* Check stall speed by starting the engine. Fully depress the foot brake, then move the

range selector control lever to the HIGH range and fully accelerate the engine. The engine should develop 2,000 to 2,400 rpm. Failure to attain this speed indicates trouble in the air cleaner (par. 159), ignition (par. 112), fuel, or exhaust system (par. 113). Check each system. If the speed exceeds 2,400 rpm, transmission trouble is indicated (par. 209).

(3) *Check ignition timing.* Check timing of both magnetos and retime if required (par. 145).

(4) *Check fuel mixture.* If the above inspections and tests do not locate the cause, check carburetor adjustment (par. 154*a*).

(5) *Governor out of adjustment.* Refer to ordnance maintenance personnel.

(6) *Brakes dragging.* Brakes adjusted too tightly will cause sluggish vehicle action. Adjust brakes if required (par. 213).

(7) *Check for cylinders missing at idle speed.* With vehicle stopped, perform magneto drop test (par. 43*f*). If engine runs unevenly on either magneto, check ignition system (par. 112).

(8) *Valves sticking, warped, or burned.* Check compression pressure. Compression pressure at cranking speed should be approximately 75 to 90 psi. If compression falls below 65 psi, notify ordnance maintenance personnel.

(9) *Piston rings or cylinder worn.* Check compression pressure. If pressures vary more than 10 psi from the average compression of all cylinders, or if all cylinders are low, notify ordnance maintenance personnel.

(10) *Broken back fire traps.* Check air cleaner back fire traps which are located on top of each air cleaner beneath the air duct to see that they are not loose, broken, or restricting airflow.

(11) *Exhaust system blocked or leaking.* Check hose, tubes, clamps, and mufflers for leaks or restrictions. Correct or replace (par. 160).

f. Engine Overheats. If the engine overheats, stop the vehicle and check the oil pressure gage. If there is pressure indicated, cool the engine by operating it at 900 to 1,100 rpm for about 10 minutes to allow the heat to be distributed and dissipated, then stop the engine and allow it to further cool before operating the vehicle. Make the checks (1) through (7) below, during the cooling-off period or as soon as practicable. If the oil pressure gage shows no pressure, stop the engine and notify ordnance maintenance personnel.

(1) *Improper grade or level of engine oil.* Check grade and level of oil. Drain and refill with oil of proper grade if required; otherwise, add oil to correct level (par. 133*b*).

(2) *Restricted air passage.* Check to see that grilles on top of engine compartment are not covered by paulin or other equipment, or clogged with foreign matter. Check to see that engine shrouds are correctly installed. Check to see that engine cylinder and cylinder-head cooling fins are clean and that spaces between fins and baffles are not clogged with dirt or other foreign matter which could impede circulation of air.

(3) *Engine cooling fan operating improperly.* Run engine with engine compartment center grilles removed, and observe action of engine cooling fan. Replace engine fan rotor or drive clutch, as required (par. 163).

(4) *Oil cooler clogged.* Inspect oil cooler fins and screen externally for clogging. Check for oil circulation through cooler by removing outlet line and cranking engine, using a suitable container to catch oil. Clean or replace oil cooler, as required (par. 164).

(5) *Brakes dragging.* Check coasting of vehicle for brakes set too tight. Adjust brakes if required (par. 213).

Note. Dragging brakes will cause transmission to overheat before engine does.

(6) *Faulty ignition timing.* Check and reset ignition timing (par. 145).

(7) *Broken back fire traps.* Refer to *e*(10) above.

g. Excessive Oil Consumption.

(1) *Incorrect grade of oil.* Be sure that oil being used is of correct grade for prevailing atmospheric temperature as specified on lubrication order (LO 9–7218) and that oil changes are being made at specified intervals.

(2) *External leaks.* Check engine compartment floor for excessive quantity of oil that would indicate presence and approximate location of leaks. Examine for leaks at accessible points in engine compartment and repair. Report necessary repairs beyond normal scope to ordnance maintenance personnel.

(3) *Worn internal parts.* If external leaks are not present and proper grade of engine oil is being used, internal engine parts are worn or damaged. Notify ordnance maintenance personnel.

111. Starter System

a. Starter Will Not Turn When Starter Switch is Held in ON Position.

(1) *Check batteries and connection.* Perform weekly B preventive maintenance service (table V). If the engine does not turn after performing this service, proceed with (2) below.

(2) *Check master relay switch, master relay circuit breaker, and master relay.* Be certain the master relay switch (E, fig. 15) is in the ON position. Turn on the headlights if tactical situation permits. If headlights come on, there is current to the starter switch. If headlights do not come on, check the master relay switch, master relay circuit breaker, master relay, and interconnecting circuits (fig. 86).

(3) *Check neutral safety switch.* With power at the starter switch, be sure the range selector control lever is in the NEUTRAL PARK position so that neutral safety switch is closed, check circuits to and from switch.

(4) *Check starter switch to starter relay.* Place hand on starter relay (fig. 143); a definite click should be heard or felt when the starter switch (C–2, fig. 15) is turned on. If no click is heard, use a jumper cable from the battery to the solenoid connection of the starter relay (circuit No. 14) and proceed as in (*a*) and (*b*) below.

(*a*) *Relay clicks and engine turns over.* If the relay clicks and engine turns over when jumper cable is connected, the starter switch, neutral safety switch, or cable from the starter switch to the starter relay is at fault. Tighten all connections, replace the starter switch or cable, or replace the neutral safety switch, whichever is required.

(*b*) *Relay does not click.* If the relay does not click when the jumper cable is connected, the relay is at fault. Replace the starter relay (par. 168).

b. Starter Spins but Does not Turn Over the Engine. Replace the starter (par. 167).

112. Ignition System

a. Open engine compartment, remove ignition cable from the rear spark plug of one cylinder, and hold tip of cable one-quarter of an inch from engine. Turn the magneto switch to BOTH position and start engine. If a strong blue-white spark is evident, the left magneto is supplying sufficient voltage.

b. Test the right magneto as in *a* above by removing the cable

from the front spark plug of one cylinder. If a strong blue-white spark is evident, the right magneto is supplying sufficient voltage.

c. To test for faulty spark plug wiring, remove each spark plug cable as in *a* above, with engine idling. If spark is not evident, replace the lead. Notify ordnance maintenance personnel, if defect is not corrected.

d. If an unsatisfactory spark is obtained from all spark plugs at either the accessory end or flywheel end of engine, the magneto serving those plugs is probably at fault. Remove cover from magneto and examine rotor, rotor spring, breaker points, and magneto cover. Replace magneto (par. 146) or ignition wiring harness assembly (par. 148), whichever is required.

e. Inspect and replace any spark plugs (par. 148) if necessary.

f. Inspect wiring harness from ignition switch to magneto for grounding, repair as necessary.

113. Fuel, Air Intake, and Exhaust Systems

a. General. Most fuel, air intake, and exhaust system troubles will affect engine performance. Therefore, the symptoms listed in *b* through *g* below are established during main engine troubleshooting procedures.

b. Fuel Not Reaching Carburetor.

(1) *Check fuel shutoff valve and fuel in tanks.* Be sure fuel shutoff valve is in BOTH ON position (par. 17) and there is fuel in the fuel tanks.

(2) *Check fuel lines from tanks to fuel pump.* Disconnect the flexible line to the fuel pump at the quick-disconnect which will automatically seal when removed. Using a pencil or similar object, push it into the line from the fuel shutoff valve, and press the seal off its seat. With the fuel valve on, fuel should flow by gravity feed.

Warning: Fuel fumes are explosive. Warn personnel of the hazard and keep fire extinguisher in readiness.

(*a*) *Examine for leaking or broken fuel lines.* Replace as required.

(*b*) *If fuel flows from open end of tube at pump.* If fuel flows from the quick-disconnect, check the line from the quick-disconnect to the fuel filter. Check the fuel filter and fuel pump (par. 153). If the line is free and the fuel pump is operating properly, disconnect the line from the fuel pump to the carburetor, at the carburetor. Crank the engine with the starter to determine whether gasoline is

reaching this point; if it is, the carburetor is at fault and should be replaced (par. 154).

Warning: Do not turn ignition on; be cautious of fire hazard.

(*c*) *If restricted fuel or no fuel flows from open end of tube at pump.* If restricted flow or no flow occurs at any of the check points after the quick-disconnect or the fuel pump is found to be defective, clean or replace the part, as required, to produce full flow of fuel.

(*d*) *Check fuel tank shutoff valve.* Remove drain cover under engine and set fuel tank shutoff valve (fig. 122) to ALL OFF position. Reach through bulkhead opening and disconnect fuel line to engine at the quick-disconnect, using a pencil or similar object push the quick-disconnect seal off its seat. Place a container at opening to catch fuel and turn shutoff valve to BOTH ON position. If there is a flow of fuel, either the fuel pump, main engine fuel filter, or the fuel lines from the shutoff valve to the fuel filter or fuel pump are defective or clogged. Replace the fuel lines, fuel filter, or pump, as required.

c. Fuel Mixture Too Lean.

(1) *Adjust carburetor idle mixture adjusting screws* (fig. 124). Refer to paragraph 154*a* for carburetor adjustment.

Note. Idle fuel adjustment will have little effect on engine performance above 650 rpm.

(2) *Check the fuel pump pressure* (par. 153*b*). If the pressure is less than 4½ psi, replace the fuel pump. If the pressure is still below 4½ psi after a new pump is installed, the fuel lines or fuel filters are restricted. Clean or replace as required.

(3) *Check for air leaks.* Check the carburetor and hotspot manifold flange gaskets for air leaks. Tighten mounting screws or replace gaskets, if required. If all gaskets are satisfactory and mounting screws tightened, continued lean fuel mixture indicates the carburetors are at fault. Replace one or both carburetors as required (par. 154).

d. Carburetor Floods.

(1) *Accelerator pedal misuse.* Over manipulation of accelerator pedal when engine is not running is the most common cause of carburetor flooding and will prevent the engine from starting until the excess fuel is removed. Flooding from other causes will cause the engine to run unevenly and to have a tendency to stall when idling. A strong odor of gasoline usually is present and black smoke is emitted from the exhaust.

(2) *Fuel pump pressure high.* Check fuel pump pressure (par. 153*b*). If pressure is greater than the specified limit of 6 psi, replace pump (par. 153*c* and *d*).

(3) *Carburetor float level incorrect.* Check carburetor float level (par. 154*a*). If fuel level is too high, replace carburetor (par. 154*b* and *c*).

e. Engine Slows Down but Does Not Stop When Fuel Cutoff Switch is Pressed. This will indicate that some but not all of the degassers are operating effectively. Using a voltmeter, check degasser circuits. If voltmeter indicates current is reaching degasser, remove and clean or replace degasser (par. 155).

f. Operation of Fuel Cutoff Switch Has No Effect On Engine. This indicates that either the fuel cutoff switch or fuel cutoff switch circuit breaker (automatic reset type) is defective, since it is not likely that all four degassers will become defective at the same time. Check switch and circuit breakers and replace as necessary.

g. Exhaust System Not Working. Check mufflers, tubing, and clamps for restrictions and leaks. Repair or replace as necessary.

114. Oil Cooling System

a. Preliminary Instructions. Trouble in the oil coolers and lines will be reflected in high engine and/or transmission oil temperatures, low oil pressures, or both. These symptoms can also be caused by improper operation of the vehicle, low or diluted oil, defective sending units, and faulty ignition. Do not disregard these possible causes in any investigation. Always check for oil leaks in the engine compartment.

b. Both Engine and Transmission Temperatures High; Oil Pressure Normal. If the engine and transmission oil temperatures are high and the oil pressures in these units are normal, the oil is not being cooled adequately by the oil coolers. Check that the oil cooler cores and fan shrouds are free and not clogged with dirt or other foreign matter. Inspect oil filters and clean (par. 134), if clogged. Replace the oil cooler thermal bypass valve (par. 138). If temperatures remain high, notify ordnance maintenance personnel

c. Engine Temperatures High; Oil Pressure Low. High engine temperature combined with low oil pressure for the same unit indicates that oil cooler lines for the engine may be restricted. Inspect the oil cooler lines and remove the restrictions or replace the lines (par. 165). If the temperature continues high, check the engine cooling fan for proper operation and free flow of air. If the fan is operating satisfactorily, replace the engine oil cooler (par. 164). Replace the oil cooler thermal bypass valve (par. 138).

d. Transmission Temperature High; Oil Pressure Low. High transmission temperature and low transmission oil pressure may be caused by restrictions in the oil cooler core or lines. In addition, the transmission oil filter may be clogged. Check and, if necessary, clean the filters (par. 210). If this does not correct the trouble, proceed with a check of the oil cooler lines. Remove any restrictions in oil lines or replace cooler (par. 164) or oil cooler lines (par. 165). Replace the oil cooler thermal bypass valve (par. 138). Continued high temperature indicates internal transmission failure; notify ordnance maintenance personnel.

115. Battery and Generating System

a. No Current in Battery Circuit.

(1) *Master relay switch open.* Check that the master relay switch is on or replace master relay switch is defective (par. 174).

(2) *Loose cable connections.* Inspect battery cables, connections at battery, and master relay. Clean and tighten as necessary.

(3) *Discharged batteries.* Remove the batteries and recharge them if the tactical situation permits and replacement batteries are available, or start auxiliary generator and engine using manual starter (par. 70*a*(3)). Charge the batteries and test with hydrometer (par. 172).

(4) *Discharged batteries, one or more cells dead.* If one or more cells are dead (par. 172), replace battery containing defective cells.

b. Batteries Do Not Stay Charged.

(1) *Excessive use of electrical equipment with engines stopped.* Electrical loads, such as oil gear motors or radio, should not be used for prolonged periods without the main or auxiliary generator in operation.

(2) *Generator charging rate inadequate.* Notify ordnance maintenance personnel.

(3) *Batteries not capable of holding a charge.* Test each battery cell with hydrometer and high discharge test equipment, if available. Replace substandard 12-volt battery units. Check by visual inspection for proper connection so that the batteries are not connected with reverse polarity.

c. Batteries at Incorrect State of Charge.

(1) *Excessive charging of batteries.* If frequent addition of water to the battery is necessary, generator charging rate is too high or there is a cracked battery case. Use a voltmeter to determine whether voltage is properly regulated.

Adjust if the control box has an external adjustment, if not, notify ordnance maintenance personnel.

(2) *Undercharged batteries.* Unless caused by abnormal use, notify ordnance maintenance personnel.

d. Generator Does Not Charge. This will be indicated for main engine generator by a warning signal light in warning light panel of instrument panel or for auxiliary generator and engine by a warning signal light on the control box.

(1) *Defective generator.* Connect a jumper lead from B (+) terminal to A (field) terminal; this bypasses the carbon pile voltage control. Bring main engine up to approximately 1,500 rpm.

Caution: Do not operate main engine at this speed more than 2 seconds, to prevent overheating of battery electrolyte.

Failure of the generator to charge indicates a defective generator or an opening in the charging circuit.

(2) *Open wire or connection in charging circuit.* Connect a voltmeter (0 to 50 volts) from generator B (+) terminal to ground, and the jumper wire connected as in (1) above. Increase engine speed; if generator terminal voltage rises above 35 volts (with field jumper connected) it indicates an open or high resistance connection in circuit. To isolate the trouble, move (+) voltmeter lead back through circuit until battery voltage is indicated. The open or high resistance is between that point and the immediately preceding point of test. Repair or replace, as necessary.

(3) *Defective generator regulator control box.* If the generator charges with jumper wire connected but will not charge when disconnected, it indicates a defective generator regulator control box. Notify ordnance maintenance personnel or replace generator regulator control box (par. 176).

116. Engine Lubricating System

a. Low Oil Pressure. Low oil pressure will be indicated on the engine oil pressure gage (D, fig. 15) and by the engine low oil pressure warning light. Noisy engine operation frequently results from low oil pressure.

Caution: Do not operate engine if the oil pressure is low, as serious damage will result.

(1) *Improper lubricating oil.* Dilution of engine oil by overpriming or as a result of infrequent oil change will cause low pressure. It also can be brought about by using a lighter viscosity oil than specified on LO 9–7218 for prevailing

atmospheric temperatures. Oil that is too heavy to flow in cold weather will also cause the oil pressure to be low when the engine is started. Inspect engine oil while engine is cold and again when hot. Drain and refill (par. 133*c* and *d*), if necessary.

(2) *Defective engine oil pressure gage unit or engine low oil pressure warning light switch.* Do not operate engine if either the gage or warning lights, or both, indicate low oil pressure. To check engine low oil pressure warning light switch, turn master relay switch on and magneto switch to the BOTH position. Without the engine running, the engine low oil pressure warning light should be on. Check warning light. If warning light is satisfactory, replace warning light switch (par. 252*d*). Start engine and check oil pressure gage. If engine oil pressure shows an incorrect reading after making necessary corrections ((1) above and (3) or (4) below), replace the oil pressure gage sending unit (par. 250*d*). If low oil pressure reading is still indicated, replace gage (par. 250*b*).

(3) *Defective oil pump.* If oil pump is believed to be defective, it can be checked only by removing and replacing it with a good one. Notify ordnance maintenance personnel.

(4) *Worn or burned out connecting rod bearings.* Defective bearings usually can be determined by an excessive knocking or rattling noise in the engine. If this condition is recognized, immediately stop engine and notify ordnance maintenance personnel.

(5) *Foreign material on oil pressure control valve seat.* Remove oil pressure control valve (fig. 107) to determine if foreign material on seat of valve is causing improper operation. Clean or replace the oil pressure control valve as necessary (par. 135).

b. Excessive Oil Pressure.

(1) *Incorrect grade of engine oil.* Excessive oil pressure may result from the use of improper oil for prevailing atmospheric temperatures. Drain and refill with grade specified on lubrication order LO 9–7218 (par. 90).

(2) *Improperly adjusted or defective oil pressure control valve.* Replace oil pressure control valve (par. 135).

(3) *Defective engine oil pressure gage.* Replace engine oil pressure gage (par. 250*b*) if engine oil grade is correct, oil pressure control valve is operating satisfactorily, oil pressure gage sending unit is serviceable, and excessive oil pressure reading continues to be indicated on gage.

c. Excessive Oil Consumption.

(1) *Oil leaks.* Examine all parts of engine compartment floor for evidence of oil leaks. If possible, correct the cause of any leaks discovered or notify ordnance maintenance personnel.

(2) *Worn or scored pistons and cylinders.* Excessive oil consumption will result if pistons, rings, or cylinders are worn. This condition is indicated by a smoky exhaust, loss of power, and fouled spark plugs; perform a compression test for each cylinder (table VII). If compression pressure is low or uneven between cylinders, notify ordnance maintenance personnel.

(3) *Incorrect grade of engine oil.* Oil which has too low a viscosity will be consumed rapidly. Drain and refill with grade specified on lubrication order LO 9–7218 for prevailing atmospheric temperatures.

d. No Oil Pressure.

Caution: Stop engine immediately if no oil pressure is indicated within 10 seconds after starting engine.

(1) *Low oil pressure.* Check oil level (par. 133*b*). If level is incorrect, fill with proper grade of engine oil as specified on lubrication order LO 9–7218.

(2) *Clogged oil tubes or defective oil pump.* If the engine has been checked and oil has been found to be adequate and of the correct viscosity, the trouble lies in a defective pump or clogged lines. Notify ordnance maintenance personnel.

(3) *Defective engine oil pressure gage sending unit or engine low oil pressure warning light sending switch.* Refer to *a*(2) above.

e. High Oil Temperature. If the engine oil temperature, as indicated by the engine high-oil-temperature warning light, is excessive follow the procedure outlined in paragraph 114*b*.

117. Horn and Lighting System

a. Horn Fails to Operate.

(1) *Defective horn switch.* Test switch with jumper wire; if horn operates, replace horn switch (par. 178*b*).

(2) *Open circuit to horn.* Check back through horn circuit No. 25 with test lamp or voltmeter. Locate and correct "open circuit" condition.

(3) *Defective circuit breaker.* Check both sides of circuit breaker with test lamp or voltmeter. If defective, replace (par. 254).

(4) *Defective horn.* If circuit checks satisfactorily, horn is defective. Replace horn (par. 178).

b. No Lights Operate.

(1) *Master relay switch open.* Turn master relay switch on.

(2) *Circuit breaker open.* If circuit breaker will not reset after 30 seconds, replace (par. 254).

(3) *No current in feed circuit.* Use test lamp or voltmeter to check power circuit Nos. 10, 15, and 25 to light switch (E, fig. 247). If there is no voltage to these points, check back through feed circuits until "short" or "open" circuit is located. Repair or replace switch, wire, or harness as required.

(4) *Defective light switch.* If power feed to light switch is satisfactory, use a jumper lead and interconnect the "hot" and "cold" sides of light switch. If lamp lights, it indicates an inoperative light switch. Replace switch (par. 251*a*).

(5) *Defective headlight dimmer switch.* Test switch with jumper wire, after turning master relay and light switch on. If light operates, replace switch (par. 184).

c. All Lights Burn Dimly.

(1) *Battery voltage low.* If the lights are dim, with the engine stopped check battery condition with hydrometer (par. 172) and voltmeter. Recharge or replace as required.

(2) *High resistance in feed circuit.* Check with voltmeter back through feed circuit. If any point in the circuit indicates less than 24 volts, look for a defective connection, circuit breaker, switch, or cable. Replace defective parts or clean and tighten connections, as required.

(3) *High resistance in main light switch.* If circuits check satisfactorily and all connections are tight, replace switch (par. 251).

(4) *High resistance in battery ground circuit.* Clean and tighten battery ground cables.

d. One Or More Lamps Do Not Light.

(1) *Dirt on lamp contact.* Clean contact.

(2) *Burned out lamp.* Replace lamp.

(3) *Open circuit to lamp.* If replacement lamp does not correct the condition, check back through circuit to light switch with test lamp or jumper. Correct "open" circuit condition as required.

(4) *High resistance in lamp ground.* Clean and tighten ground cable connection.

e. Incorrect Headlights Adjustment. Aline headlights (par. 179*c*).

118. Electrical Instruments and Equipment

a. General. If instruments are inoperative or indicate faulty readings, troubleshoot respective vehicle components (engine, transmission, auxiliary generator and engine, etc) to determine whether faulty readings are the result of component faults, or of inoperative or defective instruments. If vehicle components are found to be satisfactory, check instrument wiring before replacing instrument or gage. Refer to figure 86 for electrical circuits. If no fault is discovered in the component or wiring, replace the instrument or gage.

b. Warning Light On All the Time.

(1) *Defective warning light switch on engine or transmission.* Replace warning light switch (par. 252*d*).

(2) *Defective warning light panel.* Replace panel (par. 252*a*).

c. Warning Light Not Operating.

(1) *Burned out lamp.* If only one warning light fails to light, the fault is probably in the lamp on the instrument panel. Replace lamp (par. 252*c*).

(2) *Defective warning light switch.* If only one warning light fails to light and the lamp is not at fault, disconnect wire to affected switch on engine or transmission and ground it. If lamp lights, replace warning light switch (par. 252*d*).

(3) *Open circuit.* If lamp fails to light, use test lamp to check through affected circuit. If voltage reaches, but does not pass through the circuit breaker, switch, or cable, replace the faulty component.

119. Transmission and Final Drives

a. Preliminary Instructions.

(1) *Inspect for oil leaks.* Visually inspect all gaskets, joints, transmission valve bodies, and plugs for signs of oil leakage. Tighten all mounting bolts when oil leakage is noticed. If leakage continues, notify ordnance maintenance personnel.

(2) *Check oil levels and operate vehicle.* Check oil levels in transmission (par. 209*b*) and final drives (par. 217). Operate vehicle in all speed ranges and observe any unusual conditions, such as loss of power or overheating, which may occur at various speed ranges and steering positions.

b. Brakes Will Not Stop Vehicle Effectively. Check brake linkage and adjust as necessary to eliminate all looseness and play (par. 213*b*). Replace brake linkage connecting parts, if necessary. Adjust

brakes (par. 213*c*). If this does not remedy trouble, notify ordnance maintenance personnel.

c. Vehicle Will Not Steer. Check steering control linkage to make certain it is operative. If steering control lever on transmission operates (par. 212) but the transmission does not respond properly, notify ordnance maintenance personnel.

d. Transmission Does Not Properly Respond to Movements of Range Selector Control Lever. Check range selector control linkage to make certain it is correctly adjusted. If the trouble is in the transmission, notify ordnance maintenance personnel.

120. Tracks and Suspension

a. Vehicle Leads to One Side.

(1) *Unequal track tension.* Unequal track tension or brake adjustment will cause the vehicle to lead to the side having the tighter track tension or brake adjustment. Adjust both tracks (par. 220*f*) and check brake adjustment (par. 213*c*). Failure of steering clutch pack will also be noticeable in a drag to one side. Notify ordnance maintenance personnel.

(2) *Worn or distorted sprockets or tracks.* Worn or distorted sprockets or track parts will cause vehicle to lead to one side. Check track sprockets with a wear gage if available (par. 216*b*), and replace worn parts as required (pars. 216 and 220).

(3) *Crowned road.* A crowned road will cause the vehicle to pull to the low side of the road. Do not mistake this for the causes in (1) and (2) above as it is a normal tendency.

b. Thrown Track.

(1) *Improper driving.* If track is thrown as a result of improper handling of vehicle, further instructions and review of driving methods are required.

(2) *Excessively loose or worn track.* Adjust track tension (par. 220*f*), or replace track (par. 220).

(3) *Compensating wheel ineffective.* If track tension cannot be adjusted (par. 220*f*), check for excessively loose, worn, or broken parts in the connecting link assembly. Tighten or replace parts as necessary (par. 226).

c. Vehicle Sags to One Side. If vehicle sags to one side, a torsion bar is broken on the low side of the vehicle. Attempt to lift each road wheel with a crowbar. If any wheel can be lifted in this manner, the wheel's torsion bar is broken. Replace as required (par. 223*b* and *e*).

d. Excessively Hard Riding. If shock absorbers lose too much oil,

hard riding will result. Test the shock absorbers by the temperature method (par. 221). Replace shock absorbers if defective (par. 221).

121. Driver's Controls

a. Steering Controls.

(1) *Vehicle will not steer.* Check steering control crossbar and linkage (par. 212) to make sure it is operative. Movement of the steering control crossbar must be reflected in movement of the transmission steering lever. Replace defective linkage as necessary (par. 212). Check all control rods at bellcranks for looseness and tighten for proper adjustment if necessary. If this does not correct trouble, check transmission oil pressure (par. 211).

(2) *Vehicle will steer in only one direction.* Check steering control crossbar and linkage (par. 212). Check all control rods and adjust, tighten, or replace, as necessary (par. 212). Check brakes (par. 213) for unequal adjustment. If this does not correct the trouble, check transmission oil pressure (par. 211).

b. Range Selector Controls.

(1) *Range selector control lever will not shift out of neutral or reverse.* Check adjustment of control rods connected to range selector control lever. Adjust, replace, or repair control rods (par. 212) as necessary.

(2) *Range selector control lever has play, or binds in operation.* If operation of range selector control lever indicates looseness, adjust range selector control lever and linkage (par. 212). Check particularly for loose control rods. Replace any worn linkage, connections, or parts as necessary. If binding is felt, inspect control linkage on top of transmission for bent rods. Straighten or replace linkage as necessary. Adjust linkage (par. 212).

c. Brake Controls.

(1) *Pressing brake pedal does not effectively stop vehicle.* Check brake pedal and linkage and adjust as necessary to eliminate all looseness and free play. Adjust brakes in transmission (par. 213). If this does not remedy trouble, notify ordnance maintenance personnel.

(2) *Brakes dragging at one or both sides of transmission.* Check brake adjustment at transmission (par. 213) and adjust if necessary. Adjust brake linkage and replace any worn connections, linkage, or control rods (par. 213).

d. Throttle Controls.

(1) *Throttle control handle does not maintain constant engine*

speed. Check throttle control linkage (par. 158). Check carburetor control linkage (par. 154). Make any necessary adjustments or replace any worn levers, rods, or linkage.

(2) *Engine does not respond properly to accelerator pedal or throttle control handle.* If the engine does not respond properly to operation of the accelerator pedal or throttle handle, check throttle and carburetor control linkage and adjust or replace as necessary (par. 154).

e. Main Engine Primer Pump Operates Too Easily. The main engine primer pump should operate with slight resistance. If the pump operates too easily, it indicates a defective primer pump, broken fuel lines or loose fuel line connections. Replace primer pump if defective (par. 151), or repair fuel line (par. 157).

122. Auxiliary Generator and Engine

Note. Check for hydrostatic lock (par. 70*a*(6)) before attempting to start auxiliary generator and engine.

a. No Response at START Position of Operating Switch.

(1) Be sure master relay switch is on.

(2) Disconnect multiple cable connector plug at auxiliary generator and engine. Connect a voltmeter between D of female end of connector and negative ground on auxiliary generator. Voltmeter should indicate battery voltage when operating switch is on START position. If no voltage is indicated, trouble is in auxiliary generator and engine. Be sure that positive cable is not grounded and that insulation is not worn or damaged.

(3) Connect a voltmeter between terminal No. 64 and negative-ground terminal on rear shroud panel. The voltmeter should indicate battery voltage (24 volts). If no voltage is indicated, check batteries, battery connections, and harness.

(4) If the defect is not located in (1) through (3) above, remove auxiliary generator and engine from the vehicle (par. 188), and perform the following steps:

(*a*) Remove upper left side panel and inspect for loose, broken, or defective wiring between positive battery terminal, starter relay, and series field terminal of generator. Tighten connections or replace wiring as necessary.

(*b*) Connect a 24-volt direct current supply to positive and negative terminals of auxiliary generator and engine. Connect a voltmeter between series field terminal on generator and ground. Connect a test switch from cable No.

65 (fig. 86) to positive terminal on starter relay. When test switch is closed, voltmeter should indicate battery voltage. If no voltage is indicated, replace auxiliary generator and engine (par. 188).

(5) If auxiliary generator and engine will not start after above tests, generator series field is probably defective, notify ordnance maintenance personnel.

b. Engine Turns But Does Not Start.

(1) Check that fuel shutoff valve control lever as at the BOTH ON position (par. 17).

(2) Check fuel lines for proper installation.

(3) Check fuel tanks and fill, if necessary (par. 150).

(4) Look for air leak in fuel lines. A fuel line connector as much as one-quarter turn loose may admit air into fuel lines. Check and tighten all connections.

(5) Check for obstruction in fuel line. Clean the fuel lines.

(6) Tap the carburetor body lightly with a wooden block to free needle valve if stuck due to gum deposits or sediment. This procedure may afford a temporary remedy; therefore, notify ordnance maintenance personnel if tactical situation permits.

c. Engine Hard to Start.

(1) *Water in fuel.* Drain, clean, and refill entire fuel system.

(2) *Dirty, corroded, or maladjusted magneto breaker points.* Notify ordnance maintenance personnel.

Note. The auxiliary engine magneto is serviced in a similar manner to the main engine magneto (par. 146).

(3) *Loose or defective ignition wiring.* Check wiring for breaks or loose connections.

(4) *Incorrect timing.*. Notify ordnance maintenance personnel.

(5) *Cracked spark plugs.* Replace spark plugs (par. 194).

(6) *Fouled or incorrectly set spark plug gap.* Replace, clean, or reset gap (pars. 148 and 194).

(7) *Poor compression.* If the spark plug is loose, tighten to 20 to 25 pound-feet torque. Perform compression test (table VII). If poor compression is due to warped valves, or worn, broken, or sticky rings, notify ordnance maintenance personnel.

d. Erratic and Uneven Operation.

(1) *Air leak in fuel lines.* A fuel line connector as much as one-quarter turn loose can admit air into the fuel line. Check and tighten all connections.

(2) *Loose ignition terminals.* Tighten all connections.

(3) *Fouled or incorrectly set spark plug gap.* Clean, reset or replace plugs. Refer to *c*(6) above.

(4) *Cracked spark plugs.* Refer to *c*(5) above.

(5) *Intermittent short in positive battery cable.* Replace cable.

(6) *Dirty or corroded magneto breaker points.* Refer to *c*(2) above.

(7) *Carburetor linkage.* Inspect and adjust or replace, as necessary.

(8) *Valves warped, broken, or sticking.* Notify ordnance maintenance personnel.

e. Engine Overheating.

(1) *Air flow obstructed or leaking.* Inspect all passages around engine for dirt or foreign material. The panels should be snug and tight. All grommets around fuel lines and electrical wiring should be in good condition to prevent leakage of cooling air. Inspect carburetor intake for leaks or restricted exhaust system.

(2) *Late ignition.* Notify ordnance maintenance personnel.

(3) *Oil level low.* Check and fill to proper level (par. 187).

f. Engine Lacks Power.

(1) *Carburetor air supply restricted.* Inspect air cleaners, silencer, and hose. Remove dirt or other foreign material obstructing flow of air.

(2) *Improper air and gasoline mixture.* If due to defective carburetor, notify ordnance maintenance personnel.

(3) *Exhaust outlet restricted.* Inspect exhaust system and remove dirt and foreign material. Repair or replace as necessary (par. 190).

(4) *Governor malfunction.* Notify ordnance maintenance personnel.

(5) *Valves warped, broken, or sticking.* Refer to *d*(8) above.

(6) *Piston rings worn, stuck, or broken.* Notify ordnance maintenance personnel.

g. Engine Noisy. Notify ordnance maintenance personnel.

h. Engine Does Not React to Load Changes. Notify ordnance maintenance personnel.

i. Black Smoke at Exhaust Outlet.

(1) *Carburetor choke partially closed.* Check choke control lever assembly. Inspect choke control cables and adjust or replace as necessary (par. 197).

(2) *Carburetor incorrectly adjusted.* Notify ordnance maintenance personnel.

j. Blue Smoke At Exhaust Outlet. Notify ordnance maintenance personnel.

k. Generator Will Not Produce Current.

(1) Start auxiliary generator and engine (par. 70*b* and *c*). Turn master relay switch to OFF position.

Caution: Be sure all communication equipment is off. Place heater switch in ON position. Normal operation is indicated if the auxiliary generator and engine labors momentarily and then resumes normal speed but has a deeper exhaust sound.

(2) If not operating properly, remove the auxiliary generator and engine from the vehicle (par. 188). Remove upper left side panel and check for broken or loose wiring on regulator and generator.

(3) If the signal light operated during tests made in (1) and (2) above and there was no loose or broken wiring, remove cable from terminal F of regulator. Connect a voltmeter from terminal F of regulator to negative of battery.

Caution: Do not connect battery negative to generator ground terminal.

Connect battery positive to A terminal No. 62 of regulator. The voltmeter should read battery voltage, indicating that the carbon pile regulator circuit is closed and the regulator is satisfactory. If voltmeter does not indicate battery voltage, the voltage regulator must be replaced; notify ordnance maintenance personnel.

(4) Check shunt field for open circuit by disconnecting cable No. 61 from F terminal of generator. Connect battery ground to negative terminal of generator. A voltmeter connected from F generator terminal to battery positive should indicate battery voltage. If battery voltage is not indicated, replace the auxiliary generator and engine (par. 188) or notify ordnance maintenance personnel.

l. Defective Oil Pressure Signal Light Circuit.

(1) Check signal lamp and replace if necessary. Unscrew warning light lens housing and remove lens, housing, and gasket. Press in and rotate lamp one-quarter turn counterclockwise and remove. Press replacement lamp in socket and rotate one-quarter turn clockwise. Screw on lens, housing, and gasket as an assembly.

(2) Disconnect the multiple-cable electrical connector and place the end of a test lead in socket B of connector and the other

end to ground. If signal light does not operate when the operating switch is at RUN position, isolate the open circuit and repair or replace as necessary.

(3) Check cable B from connector to low oil pressure warning light switch (fig. 158) for open circuit. Replace switch if necessary (par. 193).

(4) Closely check the single cable electrical connections. A short circuit may be caused by defective grommets and insulators or carelessness while handling.

m. Inoperative 6-Kilowatt Electric Heater.

(1) Heater switch on the auxiliary generator and engine control box must be in ON position.

(2) Disconnect multiple-cable electrical connector at auxiliary generator and engine and connect at voltmeter from G (circuit) on harness to battery positive circuit No. 64 (fig. 86). Meter should indicate battery voltage when heater switch is in ON position.

(3) If the defect is not located in (1) or (2) above, remove the auxiliary generator and engine (par. 188).

(4) Remove upper left panel (par. 196*a*(3)) and inspect for loose connections or broken wiring to electric heater and heater relay. Tighten connections or replace wiring as necessary.

(5) Disconnect cable No. 413 to battery positive. Connect battery negative to pin G of connector receptacle. Meter will indicate battery voltage if electric heater relay coil is good. If no voltage is indicated electric heater relay must be replaced; notify ordnance maintenance personnel.

(6) Connect battery negative and positive to the respective terminals on generator. With cable No. 413 removed from E terminal of regulator, connect a test cable and switch in series with cable No. 413 and battery positive. Connect test cable to pin G in stationary receptacle of multiple-cable connector and battery negative. Connect a voltmeter across the battery. Close the test switch while the auxiliary generator engine is operating. If the heater element draws current, the battery-voltage may be reduced. If there is no voltage drop when the test switch is closed, the electric heater element is defective and must be replaced; notify ordnance maintenance personnel. Normal operation is indicated if the auxiliary generator and engine labors momentarily and then resumes normal speed but has a deeper exhaust sound.

123. Radio Interference Suppression System

a. Preliminary Instructions.

(1) When radio interference, resulting from the operation of the vehicle, is reported or experienced, move vehicle to a location free from high-tension lines, other operating vehicles, machinery, and electronic equipment which would be a source of radio interference.

(2) With engine not running, turn on master relay switch and radio receiver and check local noise level. Carefully note type and volume of noise present under these conditions. This preliminary check of local interferences is necessary so that new interference noises can be detected readily when engine or vehicle equipment is operated. When noise level is too high, with all vehicle equipment inoperative, due to atmospheric conditions or other outside sources, delay further checking if tactical situation permits, until such time as more favorable conditions prevail or a better test area can be located.

(3) Disconnect radio terminal box capacitor from radio terminal box as in (*a*) through (*c*) below.

(*a*) Remove three plugs from set AM–65/GRC (fig. 368) and remove sets AM–65/GRC and RT–70 from radio mounting rack.

(*b*) Remove six screws and lockwashers securing radio terminal box cover to housing and remove cover. Remove screw, grounding capacitor to housing and place capacitor on wires to render capacitor inactive.

(*c*) If radio interference increases as it should, leave the capacitor disconnected for the remainder of the tests. If radio interference does not increase immediately, replace capacitor. Install sets in original position and attach three plugs to set AM–65/GRC. Proceed with tests as outlined below.

b. Vehicle Stopped, Engine Running.

(1) *Buzzing sound that increases when engine is accelerated.* This interference is usually caused by a faulty ignition system.

(*a*) *Loose or damaged cables or harnesses.* Inspect ignition system manifold, cables, and harnesses to see that all connections are tight and cables and harnesses are not broken, deteriorated, crushed, or frayed. Replace any defective harnesses or cables.

(*b*) *Loose mountings or ground straps.* Tighten all harness mountings and engine ground straps. Check that all

mounting nuts and bolts have lockwashers (preferably of the internal-teeth type) to insure a positive grounding bond.

(c) *Defective booster and filter coil or capacitor.* Turn magneto switch to F position and note noise level. Turn magneto switch to A position, if noise level increases, booster coil with filter is defective and must be replaced (par. 147).

Note. If the above remedies do not correct the trouble, notify ordnance maintenance personnel.

(2) *Clicking sound noticed only when engine is operating faster than idling speed (650 rpm).* This condition is caused by a faulty generator control box.

(a) *Loose mountings or ground strap.* Tighten mountings to prevent loosening caused by excessive vibration. Inspect and tighten ground strap connections. If connections are dirty or corroded, remove, clean, and install. Check that lockwashers are provided to insure a positive grounding bond.

(b) *Defective generator regulator box.* If clicking interference noise continues after mountings have been tightened and ground strap cleaned and properly installed, replace the generator regulator control box (par. 176).

(3) *Whining noise that varies in pitch with engine speed.* If interference is a whining noise that varies in pitch with engine speed and continues, but at a lowering pitch, for a few seconds after ignition is turned off, it may be attributed to the generating system.

(a) *Loose mountings, connections, or ground strap.* Tighten generator mountings and connections. Inspect and tighten ground strap connections. Check that lockwashers are provided on all mountings and connections to insure a positive grounding bond. If connections are dirty or corroded, remove, clean, and install.

(b) *Defective generator or generator capacitor.* If whining interference noise continues when engine is operated after mountings, connections, and ground straps have been tightened, replace generator (par. 175), or notify ordnance maintenance personnel.

(c) *Vehicle stopped, engine running, and local control system in operation.* If radio interference noise is heard only when gun mount is in power operation and is known to be caused by a faulty local control system electrical component, proceed as in (1) and (2) below.

(1) *Faulty cables, wiring, harnesses, or bonding.* Tighten all electrical connections, cable connectors, and ground straps in local control system. Check that all switch boxes, control boxes, electric motors, cables, and harnesses are securely mounted and provided with lockwashers to insure a positive grounding bond.

(2) *Faulty electric motor, control box, switch box, slip ring, or other electrical components.* If the defect in the gun mount is not found and corrected by checking and correcting any installation defects, an internal malfunction of one of the local control system components is causing the radio interference. Notify ordnance maintenance personnel.

c. Vehicle Stopped, Engine Running and Vehicle Auxiliary and Accessory Equipment In Operation.

(1) *General.* Radio interference noise may be caused by loose or damaged harnesses or components of the lighting system, instruments, and their sending units such as fuel tank gages, oil pressure gage and warning lights, generator warning lights, warning light switches, etc. Instruments, gages, and switches on the instrument panel and control boxes may become loose in their mountings. Battery terminals and ground cables may become loose, corroded, or damaged.

(2) *Location and remedy.* To insolate the system or circuit which may be causing the malfunction, operate each circuit and its components individually with all other circuits inoperative. When the defective circuit or system has been isolated, proceed to check the wiring, harnesses, mounting, and individual components until the malfunction has been located. If the remedy is beyond the scope of the using organization, notify ordnance maintenance personnel.

(3) *Bilge pumps.* On vehicles which have factory installed bilge pumps, operate the bilge pump to determine if it is causing the radio interference. If the bilge pump is causing radio interference and circuit components are not at fault, replace the integral capacitor. If the interference continues, replace the bilge pump (par. 73).

d. Vehicle in Motion.

(1) *Transmission ground strap loose or damaged.* Check transmission ground strap secured to hull rear plate that it is not damaged or broken, and is properly secured to hull plate with lockwasher and bolt to form a positive

grounding bond. Replace ground strap if broken or damaged.

(2) *Track and suspension grounding springs.* If the radio interference noise is present only when the vehicle is in motion, the track and suspension grounding springs or track static wires are broken or damaged. Check for broken track static wires in track bushings by using an ohmmeter and check continuity between each track shoe assembly and connecting pin, if continuity is broken, replace defective track shoe assembly (par. 220). Static grounding springs are installed in each road wheel, compensating wheel, and track support roller hub assembly, to eliminate radio interference caused by static charges being built up in the suspension components. To check for defective, broken, or damaged static grounding springs, use ohmmeter and make continuity check between the hull and each road wheel, compensating wheel, and track support roller hub assembly. If continuity is broken between the hull and any of the suspension components, remove hub cap from defective unit and replace static grounding spring. If spring is not broken or damaged, clean the contact points thoroughly with a rag soaked with dry-cleaning solvent or mineral spirits paint thinner and install in original position.

e. Auxiliary Generator and Engine. If radio interference noise is evident when the auxiliary generator and engine is operating, the trouble is usually caused by a defective radio interference filter, notify ordnance maintenance personnel.

f. Defective Radio Components. If the above procedures do not locate and remedy the cause of radio interference noises, the malfunction is due to defective radio components. Notify ordnance maintenance personnel.

g. Install Radio Terminal Box Capacitor.

(1) Position radio terminal box capacitor on mounting pad in housing and secure with screw. Install radio terminal box cover on housing and secure with six screws and lockwashers.

(2) Install sets AM–65/GRC and RT–70 on radio mounting rack (par. 319).

124. Gun Mount

a. General. Before attempting to troubleshoot the gun mount power operation system, check the manual operation system to

determine if the malfunction is due to a defective mechanical component. Check that elevating lock handle (fig. 38) of elevating travel lock and traversing lock (fig. 39) are released. Install hand operating cranks (par. 54) and operate gun through its full limits of elevation and depression and gun mount through a full 360° in both directions. Observe operation of gun and gun mount; if any malfunction is noted, proceed as outlined in *b* below.

b. Manual Operation System.

(1) *Excessive effort required to elevate or depress gun.*

(*a*) Adjust equilibrators (par. 290) and lubricate as specified on lubrication order LO 9–7218.

(*b*) Weak or broken equilibrator springs will be noticeable during adjustment. Notify ordnance maintenance personnel for replacement.

(*c*) Worn or damaged pinion gearing will cause binding. Notify ordnance maintenance personnel.

(*d*) Clean elevating sector, file any burs from teeth, and polish with crocus cloth. Lubricate in accordnance with lubrication order LO 9–7218.

(2) *Irregular movement of gun during elevation or depression.*

(*a*) Check equilibrator crossbar; if loose or damaged, notify ordnance maintenance personnel.

(*b*) Adjust equilibrators (par. 290). Lubricate as specified on lubrication order LO 9–7218.

(*c*) Check elevating mechanism for backlash (par. 287*c*); if excessive, notify ordnance maintenance personnel.

(*d*) Clean elevating sector, file any burs from teeth, and polish with crocus cloth. Lubricate in accordance with lubrication order LO 9–7218.

(3) *Elevating travel lock does not lock or release.*

(*a*) Tighten mounting bolts and inspect brackets. If brackets are cracked or broken, notify ordnance maintenance presonnel.

(*b*) Lubricate elevating travel lock bearings in accordance with lubrication order LO 9–7218.

(*c*) Inspect linkage and if linkage is bent, broken, or needs adjusting, notify ordnance maintenance personnel.

(4) *Excessive effort required to traverse gun mount.* Make sure computer cover has been removed before traversing. Lubricate traversing mechanism in accordance with lubrication order LO 9–7218. Check appearance of traversing mechanism and if there is evidence of damage, notify ordnance maintenance personnel.

(5) *Irregular movement of gun mount during traverse.*

(*a*) Check traversing mechanism for backlash (par. 288*c*); if excessive, notify ordnance maintenance personnel.

(*b*) Lubricate traversing mechanism as specified in lubrication order LO 9–7218.

(6) *Traversing lock fails to lock or release gun mount.*

(*a*) Lubricate traversing lock plunger as specified in lubrication order LO 9–7218.

(*b*) Remove burs or rough spots between mating parts and adjust plunger (par. 291).

(*c*) Tighten mounting bolts.

(7) *Excessive effort required to operate firing mechanism pedal.*

(*a*) Lubricate linkage in accordance with lubrication order LO 9–7218 and check all linkage joints to be sure they are not binding.

(*b*) Check linkage for bends or damage and notify ordnance maintenance personnel if repairs are needed.

(*c*) Check firing plunger and firing mechanism actuating lever for foreign matter and binding. If trouble continues, notify ordnance maintenance personnel.

(8) *Gun does not fire mechanically.*

(*a*) Adjust firing linkage (par. 274*d*(3) and par. 289*b*) and check for bent or broken rod, clevis, or clevis pin. If parts are broken or damaged, notify ordnance maintenance personnel.

(*b*) Inspect firing solenoid (par. 271*d*(2)). Replace if necessary (par. 274*d*).

c. Power Operation System.

(1) *Oil gear electric motor will not operate.* This condition is due to either an open circuit in the 24-volt direct current power circuit or to a defective electric motor. In either case, notify ordnance maintenance personnel.

(2) *Gun mount does not traverse.*

(*a*) Check to see that master relay switch (E, fig. 15), drive controller rate motor switch (fig. 28), and elevation switch lever (fig. 27) are in their positions.

(*b*) Check to see that switch lever (fig. 23) of control selector box is in the LOCAL position.

(*c*) Check to see that bore sighting clutch lever on azimuth oil gear is in the DOWN position.

(*d*) Check to see that traversing lock is released (par. 54*d*).

(*e*) Micro switch in traversing mechanism defective. Replace microswitch (par. 287).

(*f*) Crank adapter (fig. 36) for hand operating crank not disengaged. Disengage adapter and inspect spline for burs or damaged teeth. Notify ordnance maintenance personnel if repair is required.

(*g*) Check adjustment of slewing clutch linkage. Adjust as required (par. 272*b*).

(*h*) If the gun mount fails to traverse after the above checks and adjustments have been made, the trouble is due to a malfunction of the electrical systems, damage to internal parts of the oil gear or drive controller, or a defective inverter box. Notify ordnance maintenance personnel.

(3) *Gun or gun mount travel reverse to drive controller requested travel.* Wiring in drive controller reversed, notify ordnance maintenance personnel.

(4) *Gun or gun mount travel erratic or sluggish.*

(*a*) Check oil level in oil gear reservoir. Refill to proper level in accordance with lubrication order LO 9–7218.

(*b*) Clean replenishing oil filter (par. 273*c*).

(*c*) If condition cannot be corrected, notify ordnance maintenance personnel.

(5) *Gun or gun mount speed slow in one direction.* This condition is due to the oil gear hydraulic limit system being set incorrectly; notify ordnance maintenance personnel.

(6) *Gun mount operated at only one speed and is inconsistent.* This condition is due to a faulty inverter box (fig. 31); notify ordnance maintenance personnel.

(7) *Oil gear motor runs after elevation switch lever is in the OFF position.* Oil gear starter relay is defective, notify ordnance maintenance personnel.

(8) *Gun will not elevate or depress.*

(*a*) Check to see that elevating travel lock is released (par. 54*c*).

(*b*) Check gun elevation system using the same procedure outlined in (2) above except that elevation system components will be checked.

(9) *Gun does not elevate from —3 to +85 degrees.* This condition is caused by the drive controller being out of synchronization with the elevation oil gear. Adjust elevation oil gear (par. 272*c*).

(10) *Gun will not fire electrically.*

(*a*) Check to see that gun mount is in power operation and drive controller fire control safety switch (fig. 28) is in the ON position.

(*b*) Check that control selector box switch lever is in LOCAL position.

(*c*) Unscrew protective receptacle cap from receptacle on distribution box (fig. 272) and check to see that jumper is installed and connects A and B contacts of receptacle.

(*d*) Replace firing solenoid (par. 274*d*) if inspection (par. 271*d*(2)) shows unit to be defective.

(*e*) If both firing solenoids are inoperative, the malfunction is usually due to a break in continuity of the firing circuit. Notify ordnance maintenance personnel.

(11) *Firing solenoids operate as soon as gun mount is placed in power operation.* This condition is due to the firing solenoid cable assembly wires being reversed. Install wires correctly (par. 274*d*).

(12) *Reflex signal light inoperative.*

(*a*) Continual fluctuation of lamp intensity when gun mount is placed in power operation denotes that there is an electrical malfunction in the local control system power circuit. Immediately place elevation switch lever in the off position and notify ordnance maintenance personnel.

(*b*) Notify ordnance maintenance personnel if the reflex signal light (fig. 268) is inoperative.

125. Armament

This section contains troubleshooting information for locating and correcting some of the malfunctions which may develop in the operation of the gun. A malfunction is a faulty action of some component part of the gun or ammunition that may result in failure to fire, stoppage, or damage to equipment and/or personnel.

a. Gun Fails to Fire.

(1) Refer to paragraph 66 for information on handling equipment with trouble due to misfire, hangfire, and cook-off. Refer to paragraph 124 for corrosion of mechanical difficulties in the gun mount.

(2) Malfunctions occur wherein the breechblock is nearly closed but the firing pin is not released. Trouble of this type is caused by improper cleaning and lubrication of the breech mechanism, grit or burs in the breech

mechanism, or a deformed cartridge case. Normally such malfunctions can be corrected by removing the round, disassembling, cleaning, removing burs, and properly lubricating the breech mechanism.

Warning: Before removing the round take precautions required in paragraph 66.

(3) When the malfunction is due to foreign matter in the chamber or a deformed cartridge case, very often the round cannot be removed by the action of the hand operating lever. The cartridge case being jammed in the chamber prevents the extractors from functioning. The blocked extractors prevent the breechblock from moving downward. Particular care must be taken to insure that the breechblock will not accidentally close and fire the round while the malfunction is being corrected.

Warning: Failure to take necessary precautions may result in injury to personnel and damage to materiel. Take the following corrective action AFTER THE GUN HAS COOLED.

(*a*) Place the firing selector lever at the STOP FIRE position, elevate the gun 30° and point it toward a safe field of fire.

(*b*) Pull the hand operating lever as far back as it will go and maintain a steady pull on the lever, tending to pull the breechblock down into open position.

(*c*) While tension is being maintained on the hand operating lever, open the top cover (fig. 53). Using a wood block and a hammer, drive the breechblock down to the open position.

(*d*) Catch the extracted round as it slides out of the chamber. If the round does not slide freely out of the chamber, remove it with cartridge extractor 5228060 (fig. 58).

(*e*) If the malfunction cannot be corrected by above procedures, notify ordnance maintenance personnel.

b. Gun Fails To Reload. Failure to reload may be attributed to operational oversight by the crew or to actual malfunction of equipment.

(1) Insufficient ammunition will prevent the gun from reloading. When ammunition has run completely out, reload gun (par. 64) and resume firing. Set feed control thumb lever for desired action.

(2) Setting of the feed control thumb lever will permit the gun to run completely out of ammunition or stop reloading when only two cartridges remain (par. 64).

(*a*) With the feed control thumb lever set in direction of arrow (fig. 34), look through rear cover for a live round on the loader tray and check the automatic loader for one round remaining there. If the breechblock is open, insert a loaded clip and resume firing. If breechblock is closed, see (3) below.

(*b*) With the feed control thumb lever set opposite from the arrow, look through the rear cover for a live round on the loader tray. If there is no round on the loader tray and ammunition in the loader, failure to load may have been caused by jammed feed pawls. Unload the automatic loader, release the pawls and load properly. If there is a live round on the loader tray and the breech is closed, see (3) below.

(3) When the gun has fired and the breech remains closed, the live round on the loader tray will be rammed against the closed breech by the rammer shoe. Carefully remove this round and segregate it for inspection by the technical service officer. Inspect the side cover latch for damage or foreign material which made it release during fire. Remove breechblock and inspect for possible damage.

(4) When a round has been rammed into the chamber and the breechblock remains open, the closing spring is broken. Replace closing spring (par. 281*c*).

(5) When stoppage is caused by a cartridge case sticking in gun, the cause is usually a deformed cartridge case, foreign matter, or burs in the mechanism.

(*a*) Pull the hand operating lever as far back as it will go and lock it in the SAFE bracket. Open the top cover (par. 68). Using hand cartridge extractor 5228060 (fig. 58), carefully pry the jammed case out of the chamber.

(*b*) If the cartridge case cannot be removed by using the hand extractor, it may be removed using shell ejector 5298763 (par. 68).

(*c*) When gun has been cleared, thoroughly clean and lubricate entire breech mechanism and chamber.

c. Recoil Is Too Violent.

(1) Insufficient oil in recoil cylinder. Fill recoil cylinder (par. 280*d*).

(2) Weak or broken recuperator spring. Change barrel assemblies (par. 279*d*). If the condition is corrected, return faulty barrel assembly to ordnance maintenance personnel.

(3) Check gun barrel collar and setscrew to be sure they are

tight and set. If trouble continues, notify ordnance maintenance personnel.

d. Counterrecoil Is Too Violent.

(1) Insufficient oil in recoil cylinder. Fill recoil cylinder (par. 280).

(2) Incorrect setting of recoil cylinder control rod. Adjust setting of control rod valve spindle (par. 280*d*(1).

e. Gun Fails To Return to battery Position.

(1) Incorrect setting of recoil cylinder control rod. Adjust setting of control rod valve spindle (par. 280*d*(1)).

(2) Weak or broken recuperator spring. Replace barrel assembly and return defective barrel assembly to ordnance maintenance personnel. If trouble continues, notify ordnance maintenance personnel.

f. Gun Fails To SINGLE FIRE. When the gun will fire with the firing selector lever set at AUTO FIRE and will not fire when set at SINGLE FIRE, notify ordnance maintenance personnel.

Section V. POWER PLANT REMOVAL AND INSTALLATION

126. Power Plant Removal

a. General. The power plant consists of the main engine with accessories and the cross drive transmission (figs. 87, 88, and 89). The power plant is removed and installed as a unit; coordinate with ordnance maintenance unit (par. 2).

b. Preliminary Instructions.

(1) Turn master relay switch (E, fig. 15) to the OFF position.

(2) Turn fuel shutoff valve control lever (fig. 9) to the ALL OFF position.

(3) Manually traverse gun mount (par. 61) until 40-mm twin gun is clear of engine compartment.

(4) Open engine compartment grille doors, battery access doors, and transmission rear access door (fig. 236).

Note. Front engine compartment grille door can be held in the open position with the chains provided (fig. 92).

(5) Remove transmission front access door, engine compartment grilles, supporting beam, and grille supports as an assembled unit (par. 234).

(6) Remove bulkhead door (par. 243).

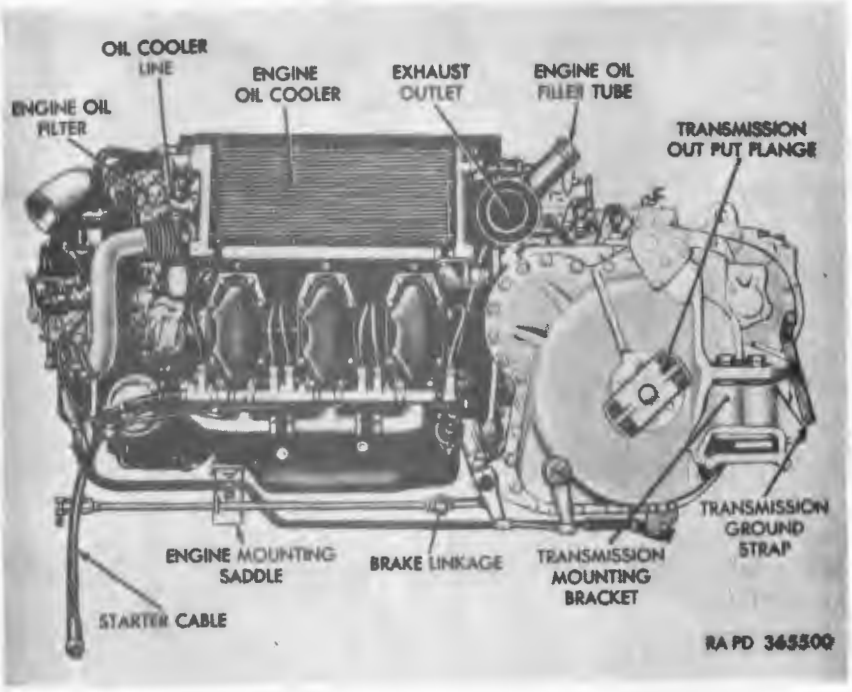


Figure 87. Power plant—right side view.

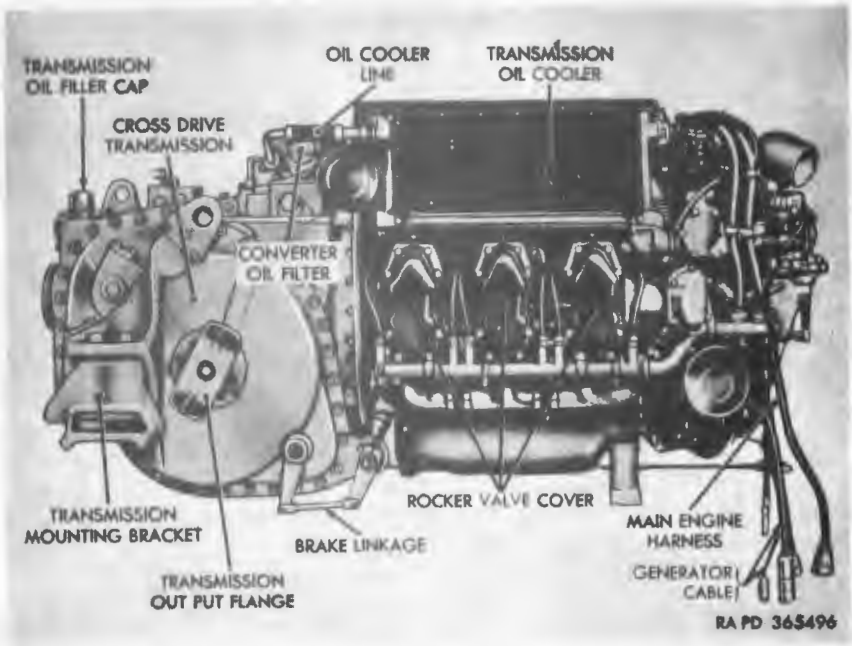


Figure 88. Power plant—left side view.

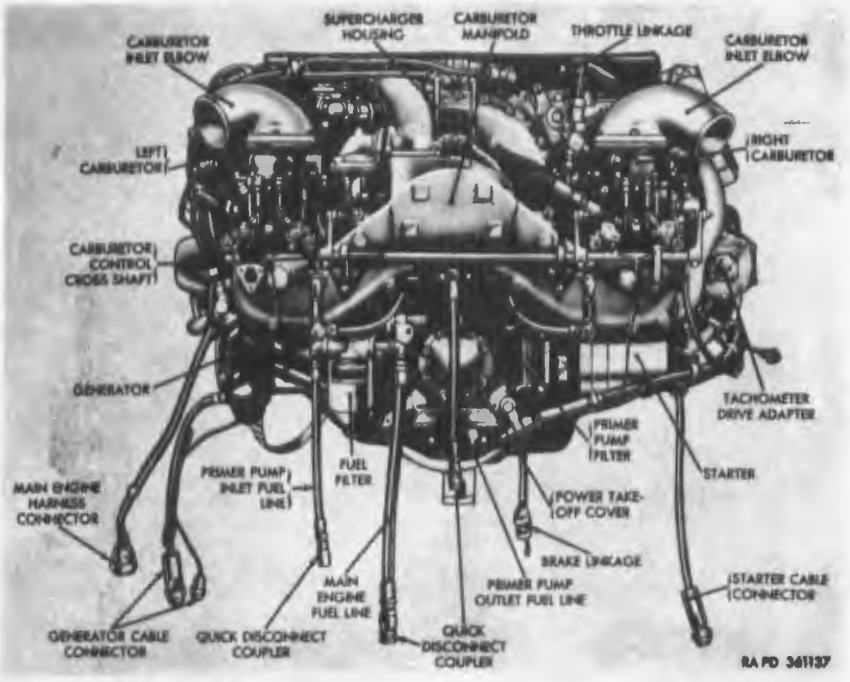


Figure 89. Power plant—engine accessory end view.

c. Disconnect Points Illustrations. All disconnections made from above and within the engine compartment are illustrated in figures 90 and 91.

d. Procedure.

(1) Remove batteries (par. 172*b*) and fold battery support (J, fig. 90) against the wall.

(2) Release quick-disconnect coupler of main engine fuel line (fig. 89) from fuel shutoff valve (E, fig. 91).

(3) Release quick-disconnect coupler of primer pump inlet fuel line (fig. 89) from sitting (D, fig. 91) on bulkhead.

(4) Release quick-disconnect coupler of primer pump outlet outlet fuel line (fig. 89) from fitting (H, fig. 91) on bulkhead.

(5) Remove cotter pin and clevis pin securing brake linkage (fig. 87) to control rod (G, fig. 91) and disconnect linkage from rod.

(6) Remove two generator cable connectors (fig. 89) and main engine harness connector from receptacles on electrical receptacle bracket (C, fig. 91) on bulkhead.

(7) Remove starter cable connector (fig. 89) from receptacle on starter cable receptacle bracket (J, fig. 91) on bulkhead.

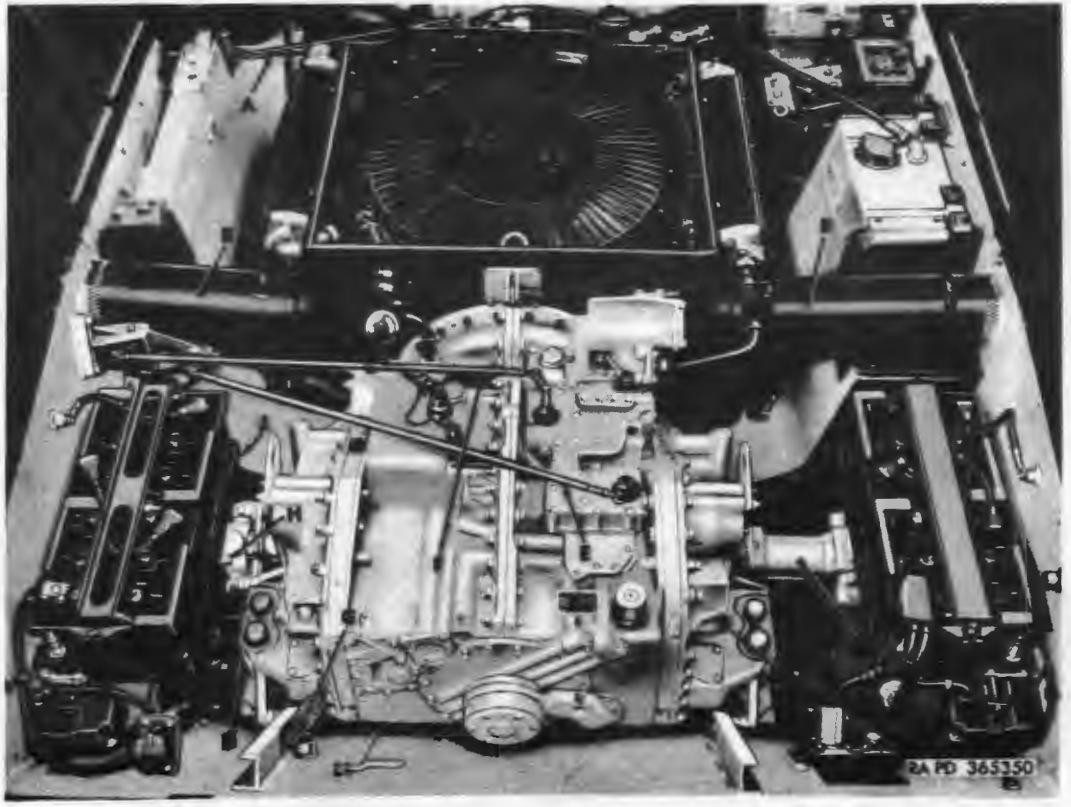


Figure 90. Overall view of power plant disconnect points.

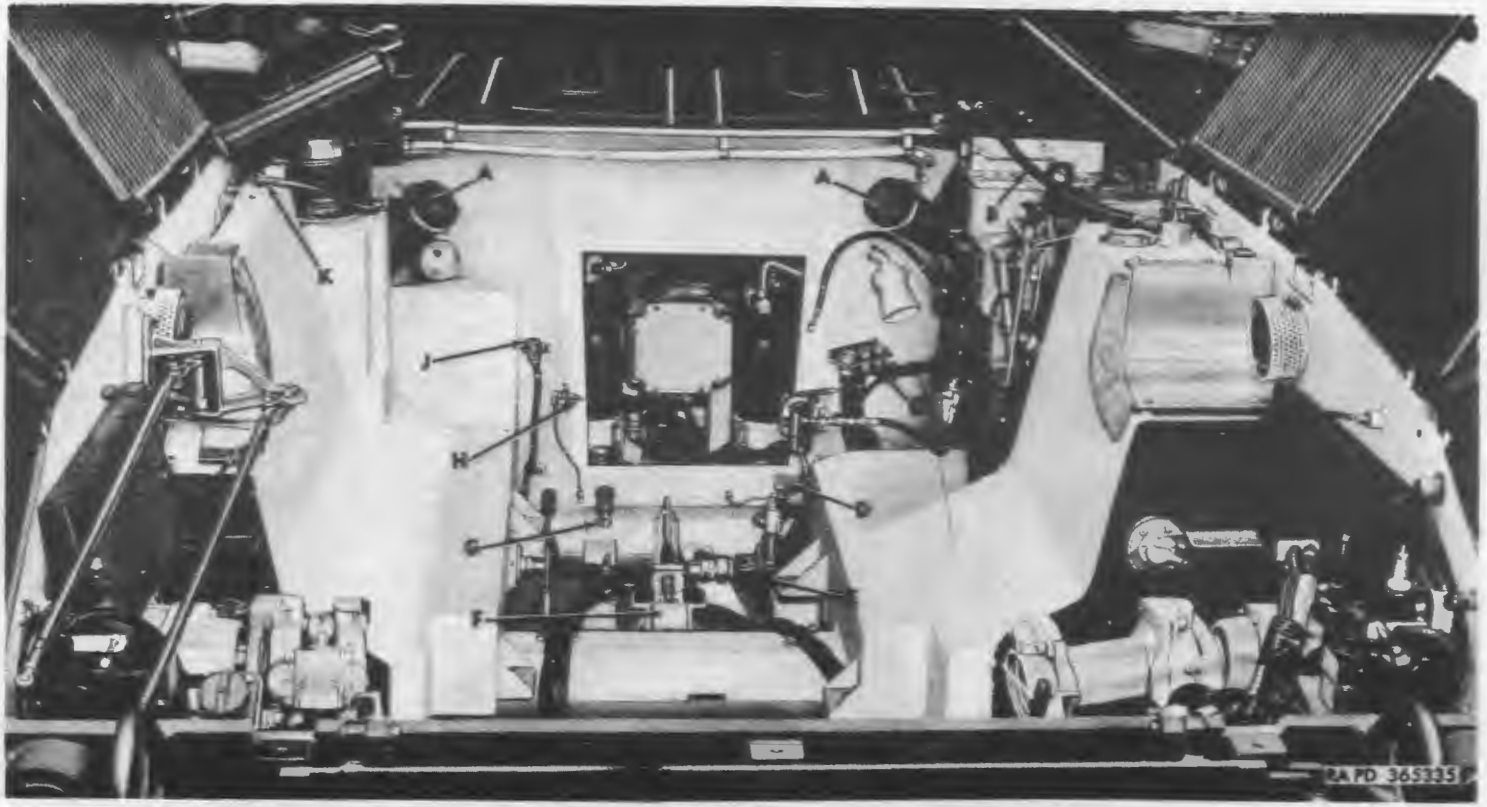


Figure 91. Engine compartment power plant disconnect points.

(8) Release engine mounting saddle (fig. 87) from engine mounting base (F, fig. 91) by turning base actuating bar counterclockwise as far as possible.

(9) Remove hex-head bolt and self-locking nut and disconnect throttle linkage (A, fig. 90) from rear bellcrank at hull.

(10) Loosen hose clamps securing air cleaner hose (A, fig. 91) to carburetor inlet elbows (fig. 89).

(11) Disconnect tachometer cable 90° adapter (K, fig. 91) from tachometer drive adapter (fig. 89) on right camshaft housing.

(12) Disconnect right fuel tank flexible vent line (B, fig. 91) from fuel tank vent line on the bulkhead.

(13) Separate right and left universal joints (C and H, fig. 90) from transmission output flanges (par. 218).

(14) Remove cooling air ducts (B, fig. 90) and exhaust stacks connecting engine exhaust manifolds to muffler connectors (par. 161*a*).

(15) Cut locking wire and remove hex-head bolt and lockwasher and disconnect steering control rod (E, fig. 90) from transmission rear lever. Swing control rod clear of power plant.

(16) Cut locking wire and remove hex-head bolt and lockwasher and disconnect range selector rear control rod (F, fig. 90) from transmission lever. Swing control rod clear of power plant.

(17) Remove hex-head bolt and lockwasher securing transmission ground strap (G, fig. 90) to hull rear plate.

(18) Loosen screws on transmission mounting clamps (D, fig. 90) sufficiently to release transmission mounting brackets (figs. 87 and 88) from mounting clamps.

e. Removal.

(1) Check to be sure that all disconnects have been accomplished (*d* above). Install engine and transmission lifting sling 3940–708–3721 (fig. 92) so that power plant will be level during lifting operation. During the first stage of removal, the front or accessory end of the engine must be kept slightly lower than the transmission to allow proper clearance at the base of the gun mount. This can be accomplished by having a man apply his weight, as necessary, on the accessory end of the engine. When engine is clear, carefully lift power plant from vehicle.

Caution: This unit weighs approximately 4,000 pounds and cast aluminum is fragile. Exercise care during

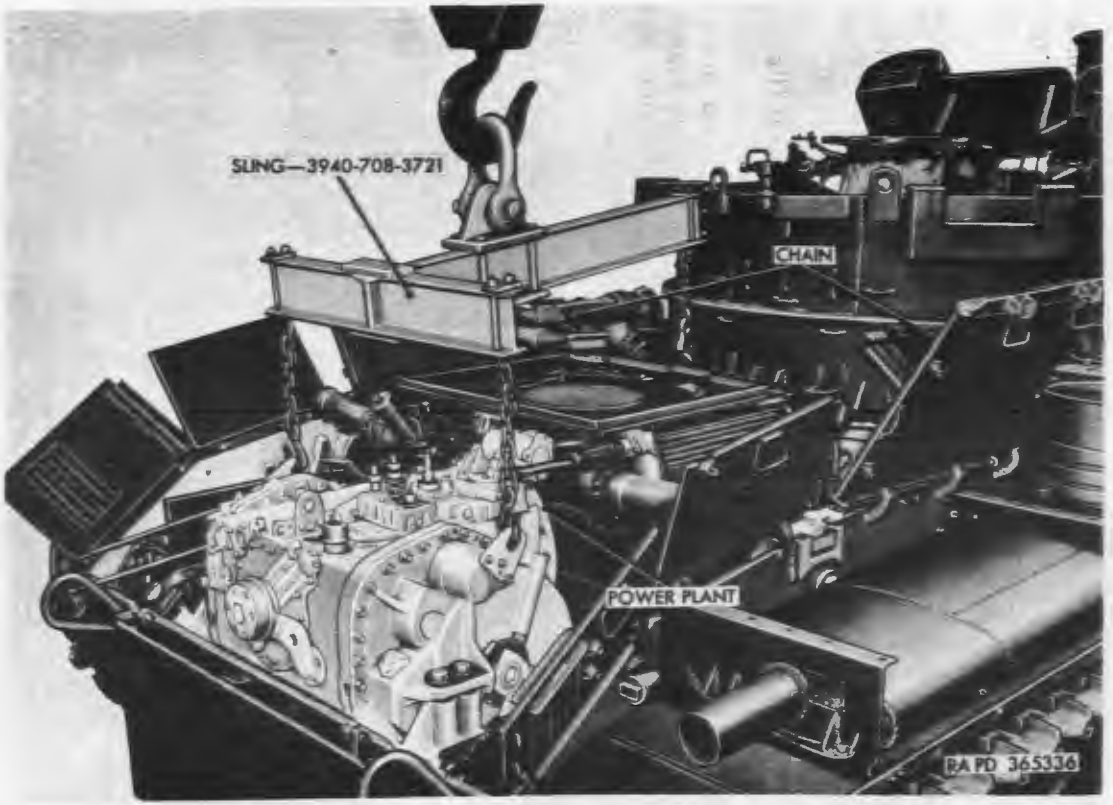


Figure 92. Power plant with lifting sling 3940–708–3721 installed.

removal to prevent damage to oil coolers, wiring harness, and other parts of power plant. Cover engine exhaust outlets and carburetor inlets to prevent entrance of foreign matter.

(2) Place power plant in transport stand 4910–836–6519 (fig. 93) if available. If transport stand is not available, place blocks beneath left and right sides of transmission and engine mounting saddle being careful not to let engine rest on oil pan, drain line, or brake linkage. Remove lifting sling from power plant.

127. Power Plant Disassembly

a. Coordinate with ordnance maintennace unit. Refer to paragraph 2.

b. Procedures.

(1) Install transmission lifting sling 3940–473–7556 (fig. 94) on lifting brackets of transmission.

(2) Disconnect electrical cables from transmission low oil pressure warning light switch and transmission high oil temperature warning light switch on transmission (par. 252).

(3) Disconnect brake linkage (fig. 87) from cross shaft control rod by removing cotter pins and clevis pins.

(4) Loosen hose clamp and remove transmission vent hose from transmission breather (fig. 95).

(5) Disconnect transmission oil cooler inlet and outlet oil lines (par. 165) from connectors at converter oil filter housing (fig. 95).

(6) Remove 24 hex nuts and flat washers from studs on attaching flanges of engine and transmission (fig. 96).

(7) Gradually work transmission away from engine until units are separated and convey transmission to suitable bench or stand. Remove lifting sling from transmission.

Note. A 2 x 4 board may be used to gently pry the transmission from the engine. Apply pressure to the engine crankcase, taking care not to damage studs, harnesses, or other parts of engine.

(8) Gently tap around circumference of transmission input shaft (fig. 95) with soft hammer while pulling shaft from engine and remove shaft. Remove crankcase to transmission O-ring packing (fig. 98) and discard.

128. Power Plant Assembly

a. Aline splines of transmission input shaft (fig. 97) with splines in engine and insert shaft into engine. Tap outer end of shaft with soft hammer until fully seated in engine.

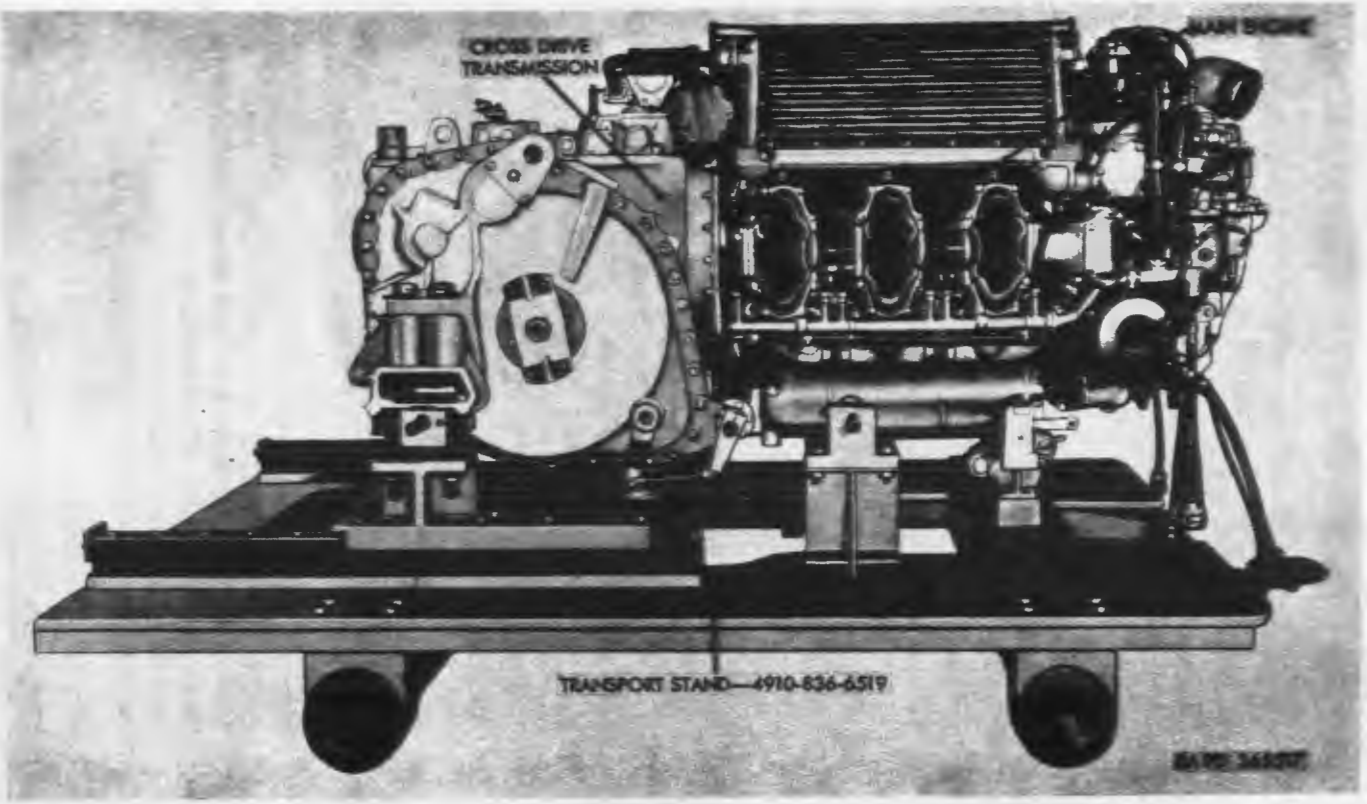


Figure 93. Power plant installed on transport stand 4910–836–6519.

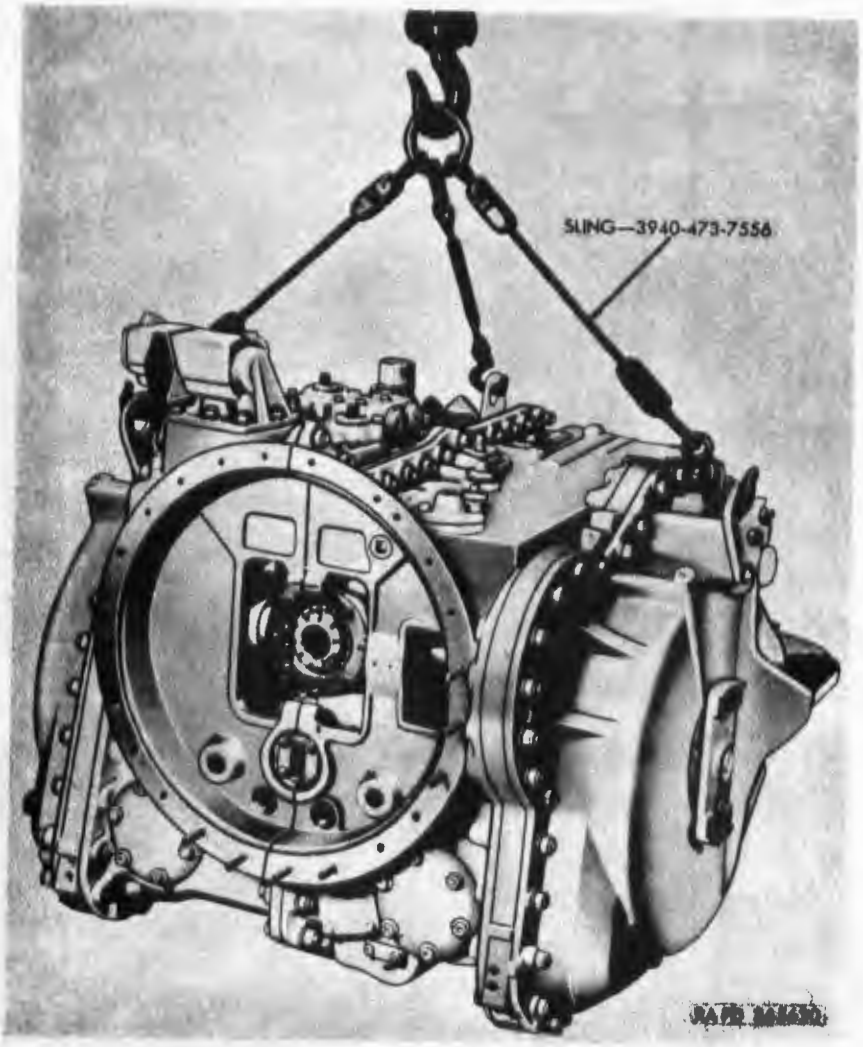


Figure 94. Transmission with lifting sling 3940–473–7556 installed.

b. Wet new crankcase to transmission O-ring packing in soapy water and install on engine flange (fig. 98).

c. Install lifting sling—3940–473–7556 (fig. 94) on transmission. Move transmission into position and aline splines on input shaft with splines in transmission. Aline studs and holes in transmission and engine flanges and join engine and transmission.

Note. If transmission input shaft splines are not alined with splines in transmission, bevel gear on transmission can be turned by hand until splines are alined.

d. Install twenty-four $\frac{7}{16}$-inch self-locking hex nuts and 0.450-inch flat washers on flange studs. Tighten nuts gradually in a

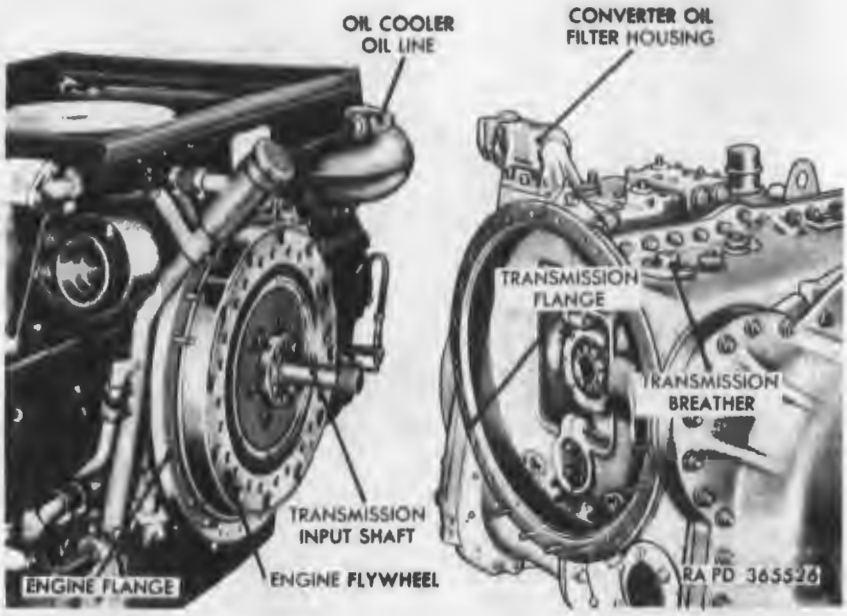


Figure 95. Engine and transmission separated.

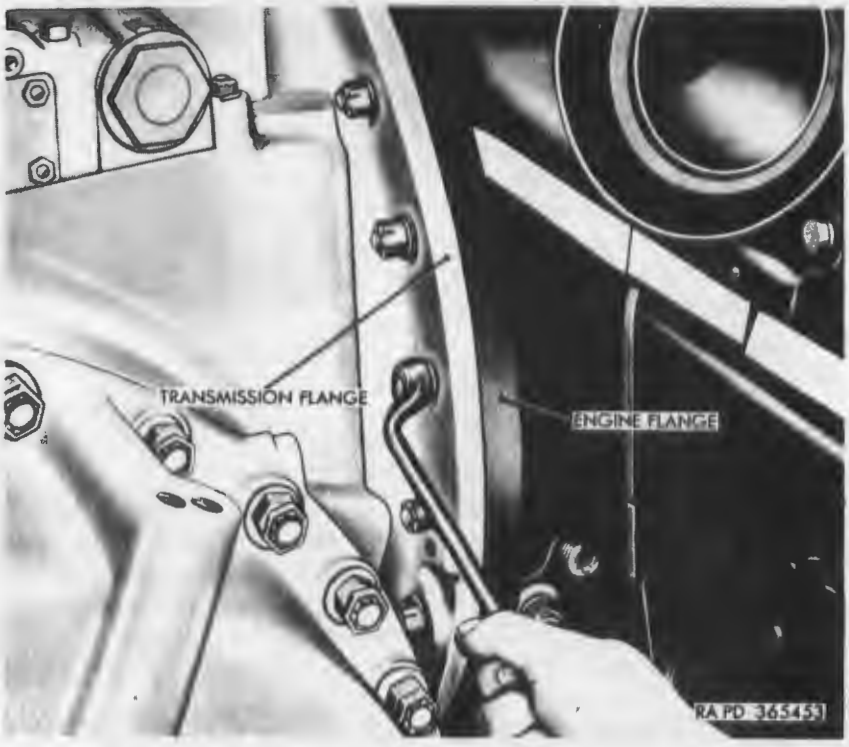


Figure 96. Removing hex nuts from attaching flanges.

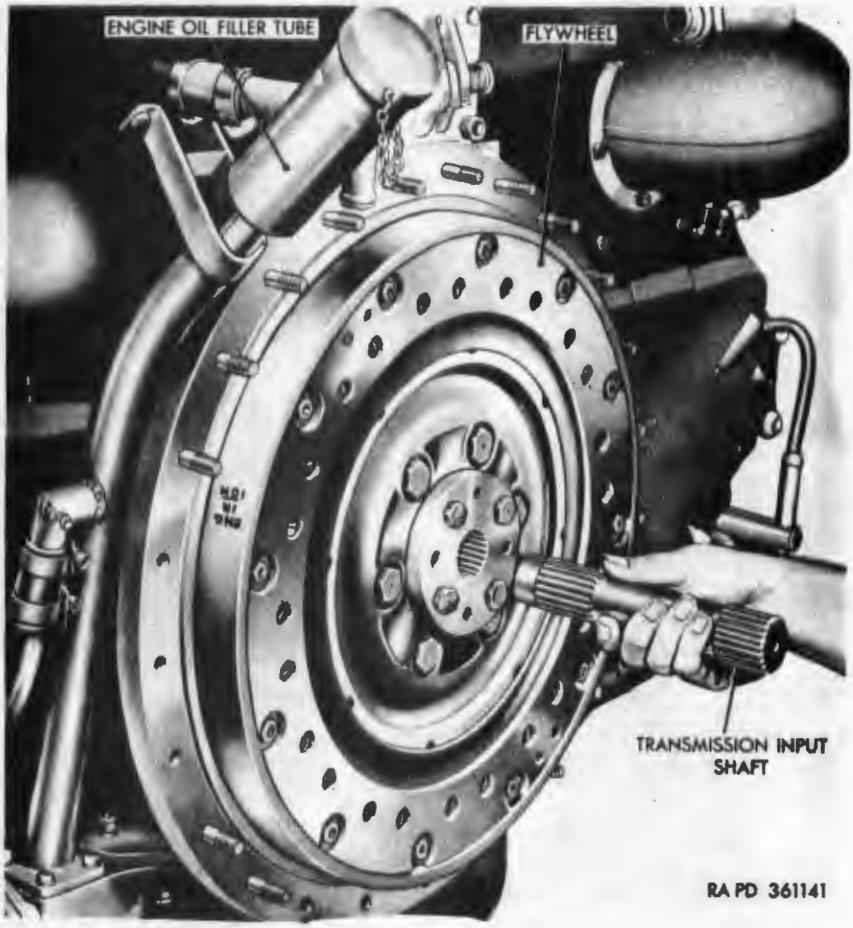


Figure 97. Installing transmission input shaft in engine.

clockwise sequence until all nuts are tightened to 55 to 60 pound-feet torque. Remove lifting sling from transmission.

e. Connect transmission oil cooler inlet and outlet oil lines (par. 165) to connectors on converter oil filter housing (fig. 95).

f. Position transmission vent hose on transmission breather (fig. 95) and tighten hose clamp securely.

g. Connect electrical cables to transmission low oil pressure warning light switch and transmission high oil temperature warning light switch (par. 252*d*).

h. Position brake linkage (fig. 87) on cross shaft control rod and secure with two $\frac{7}{16}$ x $1\frac{1}{16}$ clevis pins and $\frac{3}{32}$ x $\frac{3}{4}$ cotter pins.

129. Power Plant Operational Test Before Installation

a. General. Test of the power plant before installation may be accomplished by the use of the electrical cable and fuel line exten-

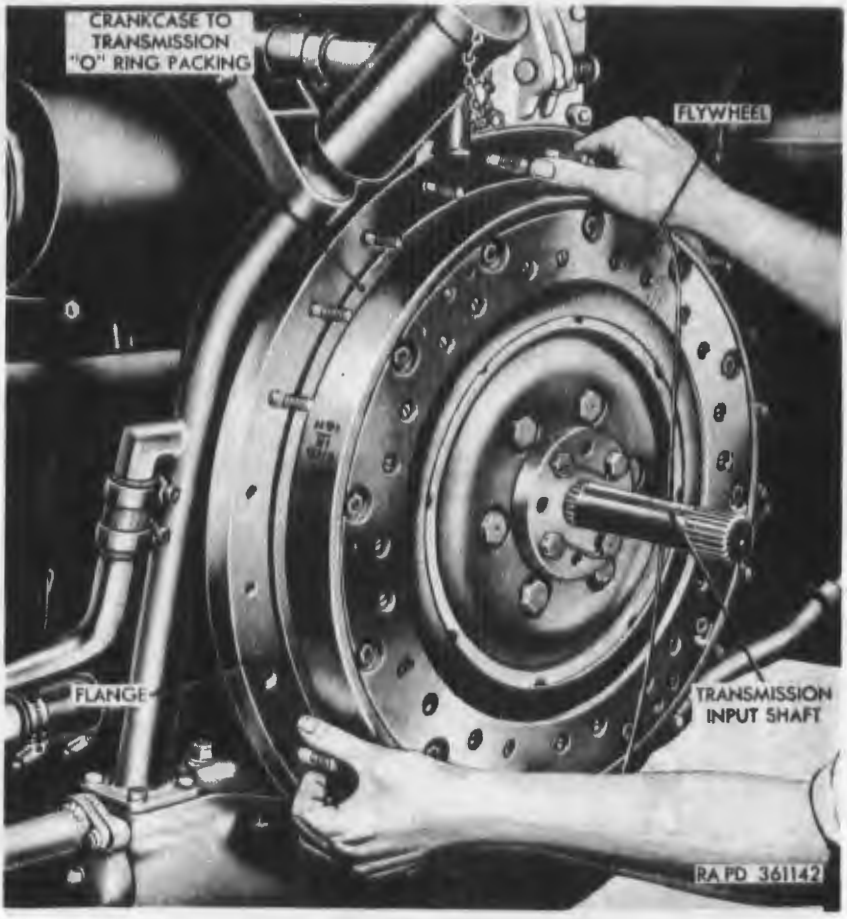


Figure 98. Installing crankcase to transmission O-ring packing.

sion kit 4910–383–3653 (fig. 99). This kit provides an extension of fuel lines and electrical cables between the engine and the disconnect points (fig. 91) within the engine compartment and a means of operating the engine with the vehicle controls.

b. Installation of Kit to Engine (fig. 89).

(1) Install fuel line with ½-inch fitting to quick-disconnect coupler of main engine fuel line.

(2) Install one fuel line with ¼-inch fitting to quick-disconnect coupler of primer pump inlet fuel line. Install remaining fuel line with ¼-inch fitting to quick-disconnect coupler of primer pump outlet fuel line.

(3) Connect cable with three-pin plug of kit to mating generator cable connector of engine.

(4) Connect cable with single-pin plug of kit to mating generator cable connector of engine.

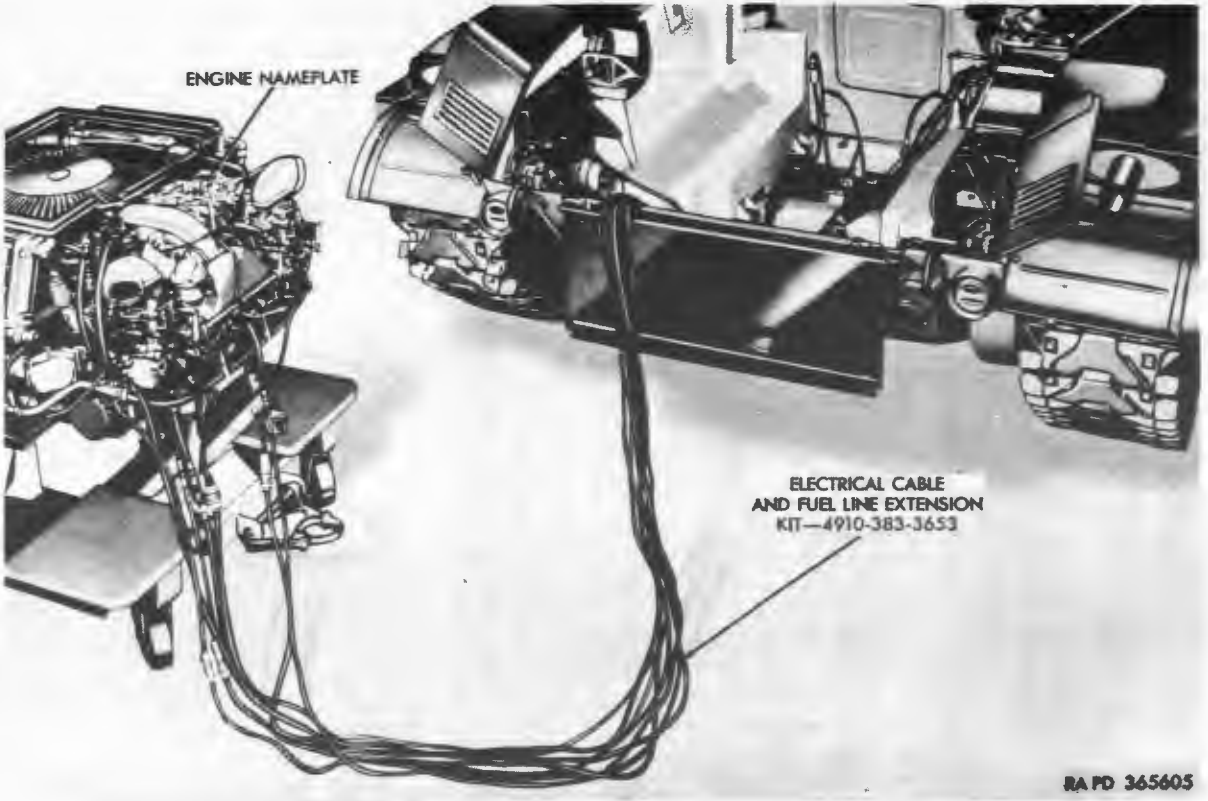


Figure 99. Extension kit 4910–383–3653–installed.

(5) Connect cable with 12-pin plug of kit to main engine harness connector of engine.

(6) Start cable with single-socket plug of kit to starter cable connector of engine.

(7) Attach ground cable terminal of kit to stud on engine carburetor manifold below left carburetor. Secure cable terminal on stud with ¼-inch hex nut and ¼-inch lockwasher.

(8) Remove protective coverings from carburetor inlet elbows and exhaust outlets. Install wire screening over openings to prevent entrance of foreign material.

c. Installation of Kit to Vehicle (fig. 91).

(1) Connect ½-inch main fuel line quick-disconnect coupler of kit to fuel shutoff valve (E).

(2) Connect ¼-inch primer pump inlet fuel line quick-disconnect coupler of kit to fitting (D) on bulkhead.

(3) Connect ¼-inch primer pump outlet fuel line quick-disconnect coupler of kit to fitting (H) on bulkhead.

(4) Connect two generator cable connectors and main engine harness connector of kit to mating receptacles on electrical receptacle bracket (C, fig. 91) on bulkhead.

(5) Connect starter cable connector of kit to receptacle on starter cable receptacle bracket (J) on bulkhead.

(6) Install right set of batteries in vehicle (par. 172*c*).

(7) Attach terminal of ground cable of kit to battery ground for the left set of batteries not installed in vehicle.

d. Operation. Start main engine (par. 43). Perform adjustments to carburetor and throttle linkage (par 158) and check magneto timing and synchronization (par. 145). Stop main engine (par. 46) after all adjustments have been completed and engine is performing satisfactorily.

e. Removal of Kit From Engine and Vehicle.

(1) Remove right set of batteries from vehicle (par. 172*b*).

(2) Disconnect all electrical cable and fuel line connections of kit from vehicle and remove kit components from vehicle.

(3) Disconnect all electrical cable and fuel line connections of kit from engine.

(4) Remove wire screening from carburetor intake elbows and exhaust outlets. If power plant is not to be installed immediately, install protective coverings over these openings to prevent entrance of foreign material.

130. Power Plant Installation

a. General. Coordinate with ordnance maintenance unit (par. 2). Prior to installation, check to be sure that all fuel lines, electrical cables, and parts are installed on the power plant (figs. 87, 88, and 89). If maintenance work was done on the engine or transmission, be sure that all adjustments affected are properly made. If any components of the power plant were removed or new ones installed, check all connections and related parts to be sure that the installations were accomplished satisfactorily.

b. Preliminary Instructions.

(1) Check the engine compartment (fig. 91) to make certain that it is clear and ready to receive the power plant and that all electrical cables and fuel lines are properly positioned.

(2) Check to see that the transmission mounting clamps (D, fig. 90) and engine mounting base (F, fig. 91) are fully opened.

(3) Apply a light film of grease to engine mounting saddle (fig. 87) and transmission mounting brackets (figs. 87 and 88).

(4) Remove protective coverings from carburetor inlet elbows and exhaust outlets of engine if necessary.

c. Procedure.

(1) Install engine and transmission lifting sling 3940–708–3721 (fig. 92) on power plant.

(2) Raise power plant from transport stand 4910–836–6519 (fig. 93) or blocks and move into position over engine compartment.

(3) Carefully lower power plant into vehicle keeping engine accessory case end slightly lower than the transmission during the first stage of installation to allow clearance for the accessory case under the hull plate extending over the forward section of the engine compartment. This will also permit the guide pins of the transmission to enter the guide rails (fig. 100) on the hull rear plate. Guide carburetor inlet elbows into air cleaner hose (A, fig. 91). Check that power plant is seated properly in mounting clamps and base.

(4) Tighten screw at each transmission mounting clamp (D, fig. 90) to 200 to 250 pound-feet torque.

(5) Position transmission ground strap (G, fig. 90) on hull rear plate mounting pad and secure with ½ x 1⅛ hexhead bolt and ½-inch lockwasher.

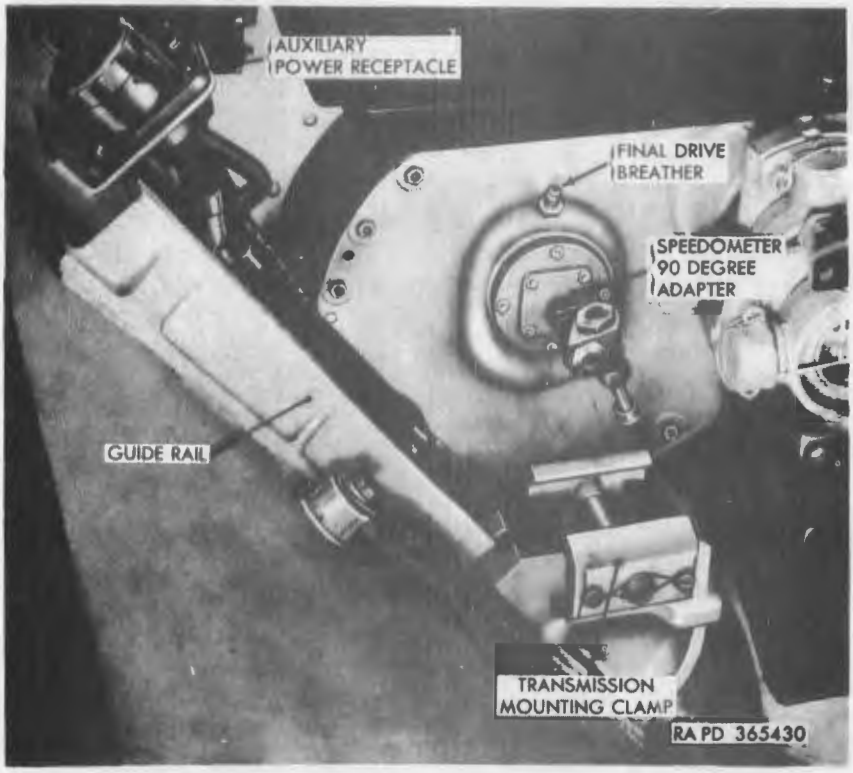


Figure 100. Transmission mounting clamp and guide rail.

(6) Connect range selector rear control rod (F, fig. 90) to transmission lever and secure with ¼ x 1 hex-head bolt, ¼-inch lockwasher, and locking wire. Adjust linkage as outlined in paragraph 212*c*.

(7) Connect steering control rod (E, fig. 90) to transmission rear lever and secure with ¼ x 1 hex-head bolt, ¼-inch lockwasher and locking wire. Adjust linkage as outlined in paragraph 212*b*.

(8) Install exhaust stacks connecting muffler connectors to engine exhaust manifold (par. 161). Install cooling air ducts (B, fig. 90).

(9) Connect right and left universal joints (C and H, fig. 90) to transmission output flanges (par. 218).

(10) Connect right fuel tank vent line (B, fig. 91) to fuel tank vent line.

(11) Connect tachometer cable 90° adapter (K, fig. 91) to tachometer drive adapter (fig. 89) at right camshaft housing of engine.

(12) Position air cleaner hose (A, fig. 91) on carburetor inlet elbows (fig. 89) and tighten hose clamps securely.

(13) Connect throttle linkage (A, fig. 90) to rear bellcrank at hull and secure with 5/16 x 1½ hex-head bolt and 5/16-inch self-locking nut. Adjust throttle linkage (par. 158).

(14) Lower battery supports (J, fig. 90) and install batteries (par. 172).

(15) Secure engine mounting saddle (fig. 87) by turning actuating bar of engine mounting base (F, fig. 91) in a clockwise direction. Tighten to 125 to 150 pound-feet torque.

(16) Install starter cable connector (fig. 89) to receptacle on starter cable receptacle bracket (J, fig. 91) on bulkhead.

(17) Install two generator cable connectors (fig. 89) and main engine harness connector (fig. 89) to receptacle on electrical receptacle bracket (C, fig. 91) on bulkhead.

(18) Position brake linkage (fig. 87) on control rod (G, fig. 91) and secure with 5/8 x 1 15/32 clevis pin and 1/8 x 1 cotter pin.

(19) Connect quick-disconnect coupler of primer pump outlet fuel line (fig. 89) to fitting (H, fig. 91) on bulkhead.

(20) Connect quick-disconnect coupler of primer pump inlet fuel line (fig. 89) to fitting (D, fig. 91) on bulkhead.

(21) Connect quick-disconnect coupler of main engine fuel line (fig. 89) to fuel shutoff valve (E, fig. 91).

(22) Install bulkhead door (par. 243).

(23) Install transmission front access door, engine compartment grilles, supporting beam, and grille supports as an assembled unit (par. 234*b*).

(24) Close engine compartment grille doors, battery access doors, and transmission rear access door (fig. 234).

d. Record of Replacement. Record the replacement on DA Form 478 (Organizational Equipment File).

Section VI. ENGINE

131. Description and Data

a. Description. The twin 40-mm full tracked self-propelled gun M42 (T141) is powered by a 6-cylinder, horizontally-opposed, air cooled, supercharged gasoline engine (fig. 93) with overhead valves and a separate camshaft for each bank of three cylinders. The camshafts actuate the valves by valve assemblies located in each cylinder head. Cooling is provided by a mechanically driven

fan mounted on top of the engine. Deflectors are mounted on the cylinders to direct the air flow. Two conventional down-draft carburetors are mounted on the two inlets of the carburetor manifold and the single outlet of the carburetor manifold is attached to the supercharger housing. Thus, air is drawn through the carburetors, the resulting carbureted mixture is heated as it passes through the manifold into the supercharger housing and into the intake manifolds. Dual ignition is provided by two magnetos, each igniting one spark plug in each of the six cylinders. A generator and starter are mounted on opposite sides of the engine. The engine is lubricated by a forced feed system which consists of a combination scavenger and pressure pump, and a separate accessory case scavenger oil pump. The engine with accessories, and the cross drive transmission are considered the power plant and must be removed (par. 126) or installed (par. 130) as a unit.

b. Engine Nomenclature. The front of the engine is referred to as the accessory end (fig. 101). The rear of the engine is referred to as the flywheel end. The terms "left" and "right," as used in reference to the engine, are as viewed from the accessory end of the engine (fig. 101). Cylinders are numbered from the accessory end, 1–3–5 on the right side of the engine and 2–4–6 on the left side of the engine. The crankshaft rotates clockwise and the camshafts counterclockwise when viewed from the front or accessory end of the engine. The cooling fan rotates clockwise when viewed from above the engine.

c. Tabulated Data.

Make	Continental or Lycoming
Type	6-cylinder, opposed, air-cooled, supercharged
Model	AOS895-3
Overall length	47.43 in
Width	51.56 in
Height	34.81 in
Dry weight	1,399 lb
Gross horsepower	500 at 2,800 rpm
Gross torque	965 lb-ft at 2,400 rpm
Bore	5.75 in
Stroke	5.75 in
Piston displacement	895.9 cu in
Compression ratio	5.5 : 1
Maximum governed speed (no load)	2,950 rpm
Maximum governed speed (full load)	2,800 to 2,840 rpm
Idling speed	650 rpm
Warmup speed	1,000 to 1,100 rpm
Cylinder arrangement	individual cylinders in opposed position
Cylinder cooling	air
Drive from crankshaft	direct

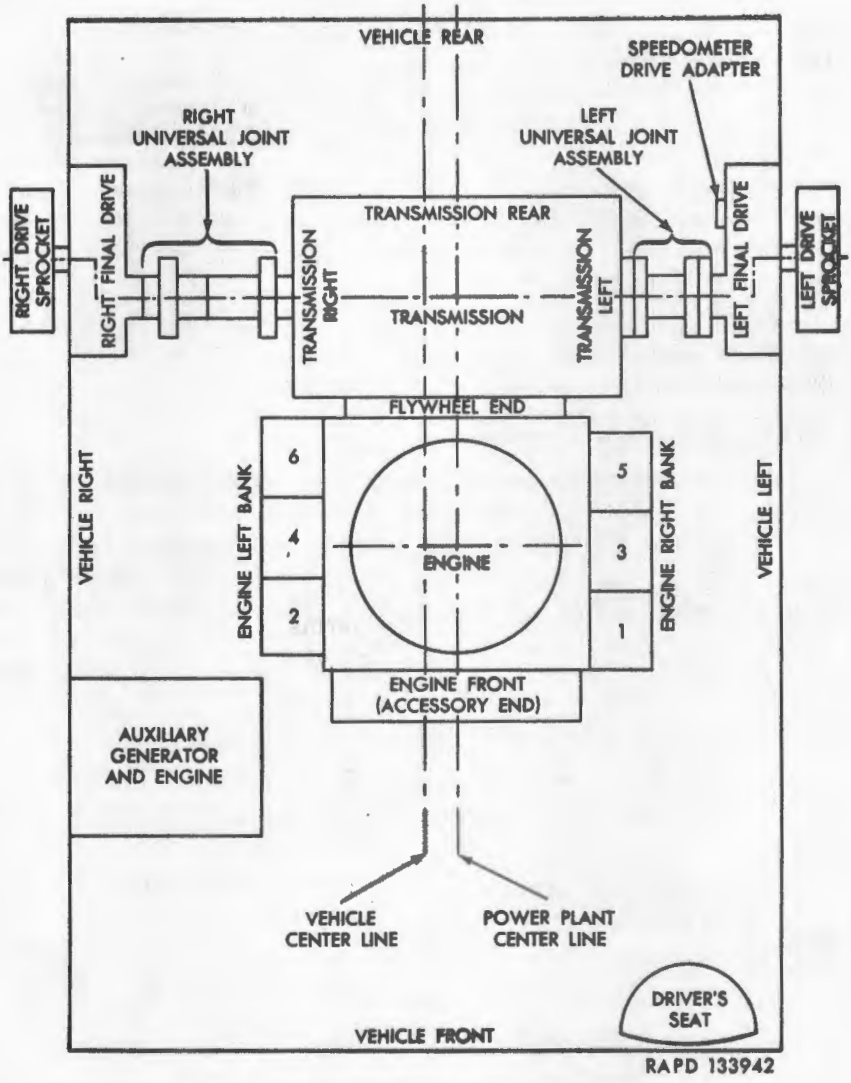


Figure 101. Power plant position in vehicle.

Camshaft rotation	**counterclockwise**
Crankshaft rotation	clockwise
Cooling fan rotation	clockwise
Induction system	**supercharged**
Valve timing setting	**intake closed 50° after bottom center with 0.100-in. clearance**
Valve clearance (cold engine):	
Intake	**0.007 in at rocker tappets**
Exhaust	**0.014 in under rocker roller**
Ignition timing	**automatic advance set 10° BTC**

Firing order	1–6–3–2–5–4
Accessory drive ratios:	
Cooling fan	1:57 crankshaft speed
Tachometer drive	0.50 crankshaft speed
Generator	2.60 crankshaft speed
Magnetoes	0.50 crankshaft speed
Power-take-off	1.00 crankshaft speed
Governor	1.10 crankshaft speed
Starter	0.91 crankshaft speed
Fuel pump	0.81 crankshaft speed
Spark plug gap:	
Double ground contacts	0.011 to 0.014 in
Single ground contact	0.017 to 0.020 in
Oil capacity	11 gal

132. Maintenance Operations

Listed below are the services performed on and around the main engine, subdivided in accordance with the conditions to be met and preliminary operations that must be accomplished before the service operations can proceed: that is, with engine installed in vehicle-center grilles, grille supports, and supporting beam installed-grille doors and access doors open; with engine installed in vehicle-center grilles, grille supports, supporting beam, and transmission front access door removed-grille doors and access doors open; and with power plant removed from vehicle.

a. Engine Installed in Vehicle-Center Grilles, Grille Supports, and Supporting Beam Installed-Grille Doors and Access Doors Open.

(1) Engine lubrication system, service (par. 133).
(2) Engine oil filter, service (par. 134).
(3) Batteries, service or replace (par. 172).
(4) Fuel filter, replace (par. 151).
(5) Fuel pump, test or replace (par. 153).
(6) Carburetor, adjust (par. 154).
(7) Air cleaners, service or replace (par. 159).
(8) Mufflers, replace (par. 160).
(9) Transmission lubrication system, service (par. 209).
(10) Booster coil with filter, replace (par. 147).
(11) Service brakes, adjust linkage (par. 213).
(12) Speedometer drive adapter, replace (par. 265).
(13) Transmission high oil temperature warning signal light switch, replace (par. 252).
(14) Transmission low oil temperature warning signal light switch, replace (par. 252).
(15) Tachometer drive adapter, replace (par. 265).

b. Engine Installed in Vehicle-Center Grilles, Grille Supports, Supporting Beam, and Transmission Front Access Door Removed —Grille Doors and Access Doors Open.

(1) Fan, replace (par. 163).
(2) Carburetor, replace (par. 154).
(3) Engine oil filter bypass valve, replace (par. 136).
(4) Engine oil pressure control valve, replace (par. 135).
(5) Engine oil cooler bypass valve, replace (par. 137).
(6) Engine oil pressure gage sending unit, replace (par. 250).
(7) Engine low oil pressure warning light switch, replace (par. 252).
(8) Engine high oil temperature warning light switch, replace (par. 252).

c. Power Plant Removed From Vehicle.

(1) Fuel shutoff valve, replace (par. 152).
(2) Engine (complete), replace (par. 127).
(3) Starter, replace (par. 167).
(4) Generator, replace (par. 175).
(5) Fuel tanks, replace (par. 150).
(6) Transmission, replace (par. 214).
(7) Spark plugs, replace (par. 148).
(8) Ignition harness, replace (par. 148).
(9) Oil coolers, replace (par. 164).
(10) Ignition timing (par. 145).
(11) Magnetos, adjust or replace (par. 146).

133. Engine Lubrication System

a. Description.

(1) The engine lubricating system is of the forced feed type utilizing two positive displacement pumps, one being a combination scavenger and pressure pump, the other a scavenger pump. The combination pump projects into the main oil sump and is mounted in the crankcase on the lower web of the No. 2 main bearing. The oil pan is divided into two parts, the accessory case sump and the main oil sump. The main oil sump is in turn divided into compartments by baffles. The scavenger pump, upper part of the combination pump, transfers oil from the flywheel end of the main oil sump to the pressure pump reservoir which is the central part of the main oil pump formed by the oil pan partitions and the baffle

plate assembly. The separate scavenger oil pump is located on the lower side of the accessory case and transfers oil from the accessory case oil sump to the pressure pump reservoir. The two scavenger pumps are constantly transferring oil from both ends of the engine to the main oil sump, assuring an adequate supply of the oil at all times to the pressure pump. The pressure pump then forces the oil to the entire system through the oil control housing (fig. 102) at the top of the accessory case.

(2) Oil flow in the system is controlled by five valves. Three of these, the oil pressure control valve, the oil filter bypass valve, and the oil cooler bypass valve, are located in the oil control housing (fig. 102). The remaining two valves are thermal bypass valves (fig. 108) one of which is located in each oil cooler.

(3) The oil cooler thermal bypass valves (fig. 108) permit oil to bypass the oil coolers. On engines through engine serial No. 4470, both valves are of brass and set to close at temperatures above 185° F. Engines with serial No. 4471 and up are equipped with a cadmium plated valve on

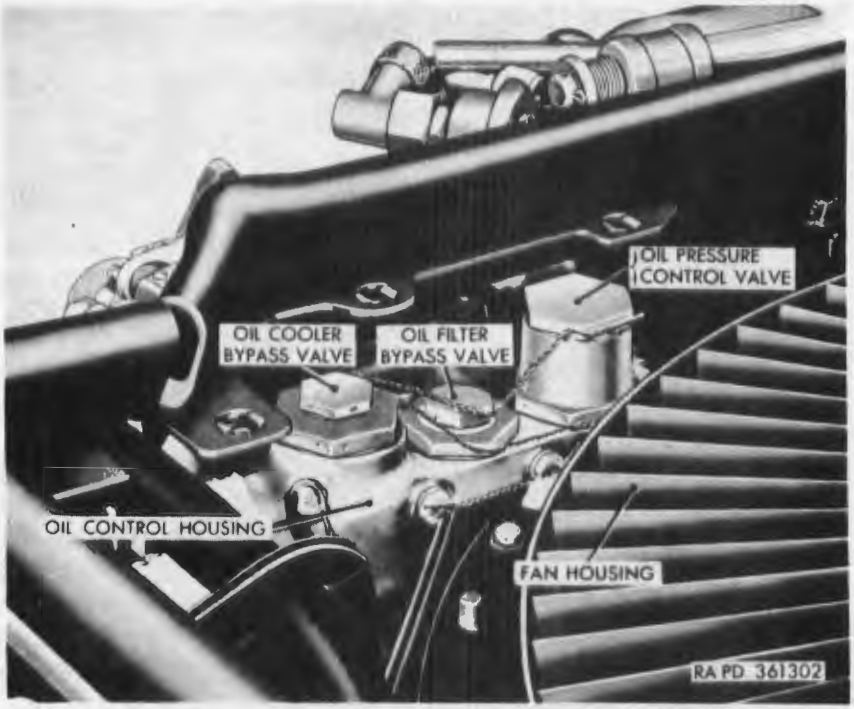


Figure 102. Oil control housing and valves.

the engine oil cooler which is set to close at temperatures above 148° F. When the oil temperatures reach these points, the valve closes and the oil circulates through the cooler. If the engine oil cooler should become clogged, pressure will build up to a differential of 45 psi and the oil cooler bypass valve (fig. 102) in the control housing will open, bypassing the cooler and preventing damage to the cooler. Under this condition the engine oil cooling is seriously reduced. When the engine oil temperature reaches 245 —5° F. (200° F. on some early models), the warning light marked HI OIL TEMP on the warning light panel (B, fig. 15) of the instrument panel is energized by its warning light switch (fig. 248) on the engine. The engine should be stopped immediately when this light is energized.

(4) Oil normally flows around the oil filter bypass valve (fig. 102) and through the oil filter. If the filter should become clogged, the oil filter bypass valve will open and supply oil directly to the engine.

(5) The oil pressure control valve (fig. 102) maintains the desired oil pressure in the oil coolers and in the engine oil passages. Excess oil is bypassed to the accessory case sump.

(6) Drilled passages in the accessory case lead from the oil control housing (fig. 102) to all the bushings in the case and to main oil galleries on each side of the crankcase. Drilled passages extend through the crankcase webs from the main galleries to the main bearings. Drilled holes in the crankshaft direct the flow of oil under pressure from the main bearing journals to the crankpins to provide full-pressure lubrication to the connecting rod bearings. Oil thrown off from the connecting rods lubricates the cylinder bores, piston pins, and rings.

(7) Oil for lubrication of both camshafts is forced through drilled passages in the accessory case and the drive quills. Connecting passages transfer the oil supply to the hollow camshaft and to the camshaft bearings. Drilled holes in the camshaft journals carry oil to the rocker shafts, rocker arm bearings and rollers. Throwoff oil from the camshafts and rocker rollers lubricates the intake valve stems. A drilled oil passage in the cylinder half of the camshaft bearing lubricates the exhaust valve stems.

(8) Surplus oil from the rocker boxes and the camshaft housing is returned to the system through an oil drain manifold attached to the cylinder heads on each side of the

engine. One end of each manifold leads to the bottom of the accessory case, and the other leads into the oil pan. By this system oil is always drained from the cylinder heads regardless of the tilt of the engine.

b. Oil Level Check. To check engine oil level, run the engine for 10 minutes, then stop engine. Allow at least five minutes for oil to drain back into the crankcase. Open engine oil filler access cover and remove oil filler cap (fig. 103). Pull out bayonet-type oil filler gage, wipe with a clean cloth and insert fully in the engine oil filler tube until seated. Remove gage and observe oil level. Repeat operation after adding oil to make sure oil level is at "FULL" mark. Install oil level gage, oil filler cap, and close oil filler access cover.

Caution: Be sure filler cap is securely fastened to prevent dust or dirt being drawn into lubrication system and causing damage to engine.

c. Drain Lubrication System.

(1) Start and operate engine (par. 43) to attain normal operating temperature. Stop engine (par. 46) and remove engine drain hole cover (par. 246) from bottom of hull beneath engine compartment. Cut locking wire and remove crankcase drain plug (fig. 104).

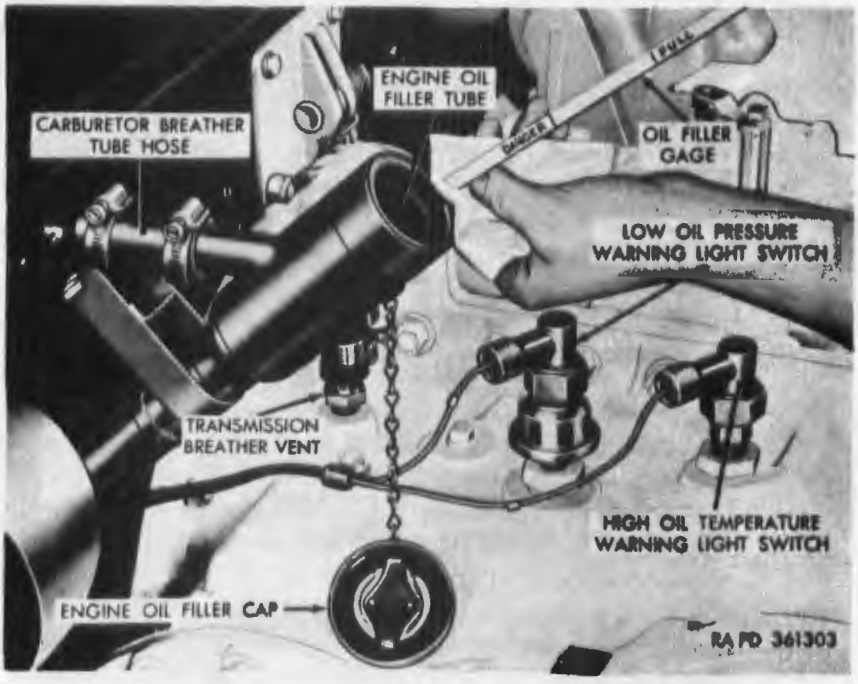


Figure 103. Engine oil level gage.

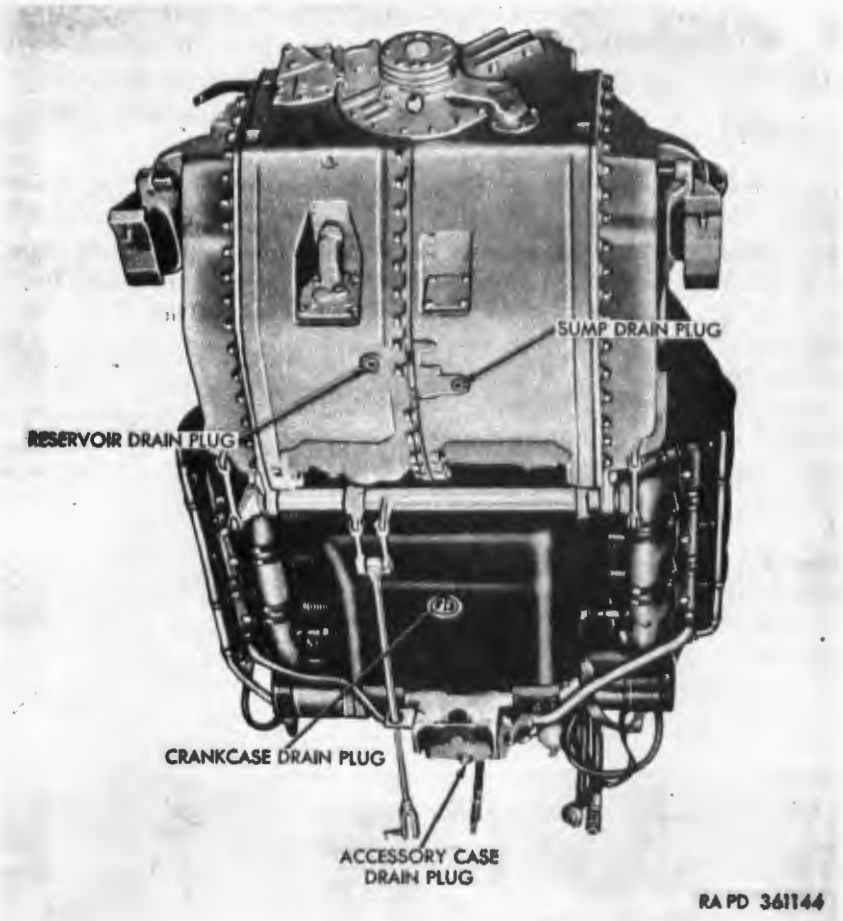


Figure 104. Power plant—bottom view.

(2) Remove bulkhead door (par. 243), cut locking wire and remove accessory case drain plug (fig. 104). Allow oil to drain completely while still warm.

(3) Examine both magnetic drain plugs for metallic particles. If any particles are found, report at once to ordnance maintenance personnel.

(4) Clean both drain plugs in dry-cleaning solvent or mineral spirits paint thinner. Install drain plugs and tighten securely. Lock plugs in place with locking wire.

(5) Install engine drain hole cover (par. 246) and bulkhead door (par. 243).

d. Fill Crankcase. The engine crankcase capacity is 11 gallons. Remove engine oil filler cap (fig. 103) and oil filler gage. Pour oil,

as specified on lubrication order LO 9–7218 (par. 90) into the engine oil filler tube. Check to be sure there are no points of leakage. Check oil level (*b* above) and tighten filler cap securely.

134. Engine Oil Filter

a. Removal (fig. 105). Open engine compartment grille doors above engine oil cooler, cut locking wire and unscrew magnetic drain plug in bottom of filter chamber and drain oil. Install magnetic plug after oil has drained. Remove the six jamnuts, hex nuts, and flat washers securing filter and pull filter assembly straight out using the handle provided. Be careful to keep filter centered with hole in accessory case. Remove filter gasket and discard.

Note. It is important that a thorough check be made of any sediment on the oil filter, in bottom of filter chamber or in the magnetic drain plug to determine the presence of any noticeable metallic particles; if found, report to ordnance maintenance personnel. This operation must be carried out before the filter is washed or cleaned.

b. Cleaning. Wash filter in dry-cleaning solvent or mineral spirits paint thinner, making certain to remove all foreign matter adhering to element. Immerse element in dry-cleaning solvent or mineral spirits paint thinner, and dry with low pressure compressed air.

Note. Do not disassemble filter when cleaning only is required.

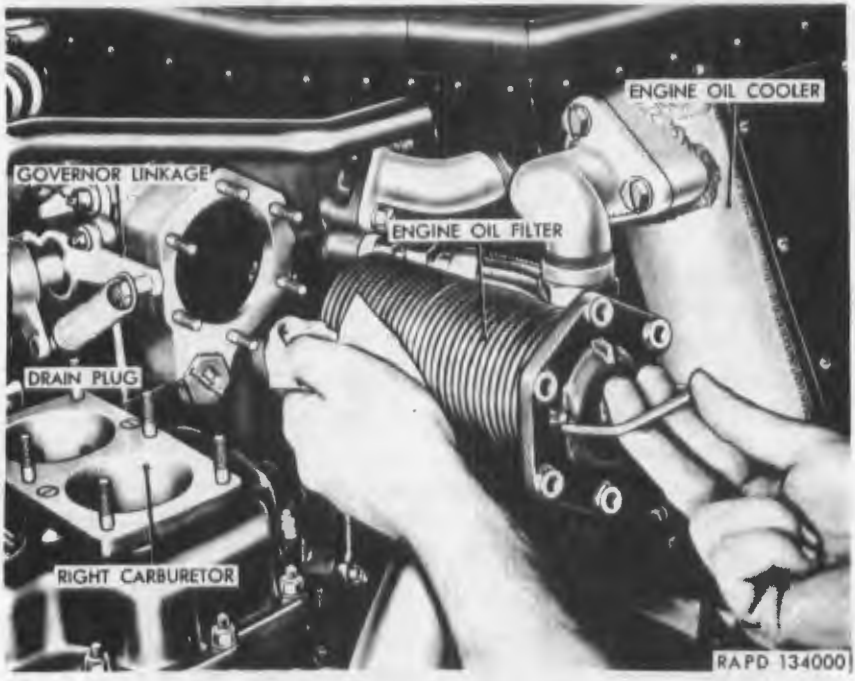


Figure 105. Removing engine oil filter.

c. Disassembly (fig. 106).

(1) Remove hex-head bolt and gasket securing filter head to filter element tube and remove head.

(2) Remove filter element nut holding filter disks and spacers in position on tube and slide off disks and spacers. Discard filter disks.

(3) Wash spacers and tube thoroughly in dry-cleaning solvent or mineral spirits paint thinner and dry with low-pressure compressed air.

d. Assembly (fig. 106).

(1) Install new filter disks and spacers alternately on tube and secure in place with filter element nut.

(2) Install filter head on filter element tube and secure with $\frac{3}{8} \times \frac{59}{64}$ hex-head bolt and gasket.

e. Installation (fig. 106). Insert filter with new gasket into accessory case, using same precautions outlined for removal. The filter has a pilot that supports the inner end of the element. The

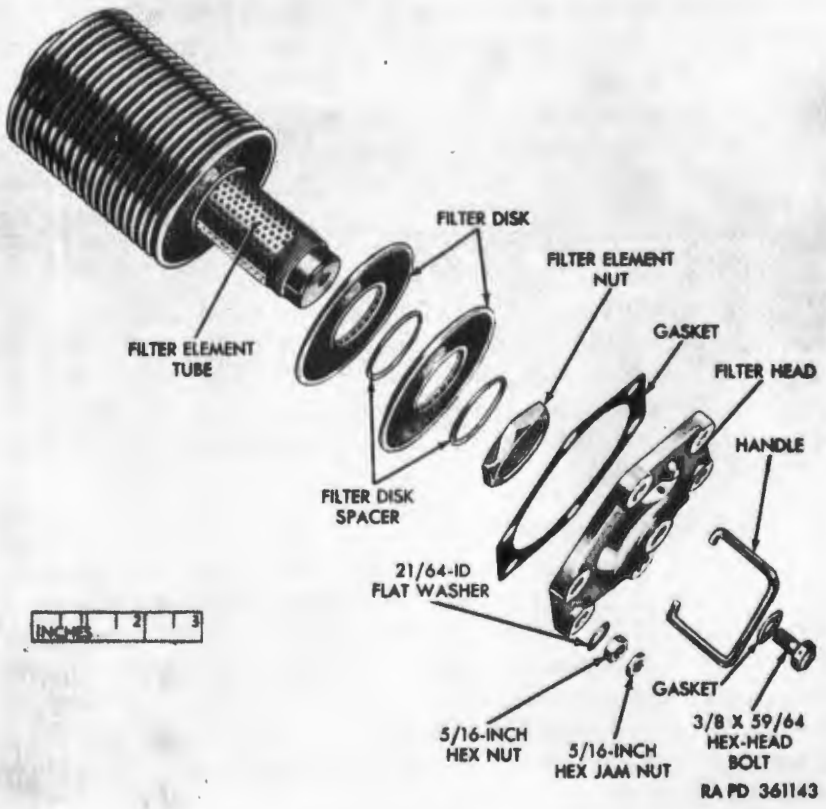


Figure 106. Engine oil filter—exploded view.

pilot seats in a mating hole in the accessory case. When installing filter, do not attempt to force into place. If bind is noted, withdraw and inspect pilot for evidence of misalinement. A properly alined filter will seat without forcing. When filter has been seated, install six $^{21}/_{64}$-inch flat washers and $^{5}/_{16}$-inch hex nuts on retaining studs. Lock the hex nuts with six $^{5}/_{16}$-inch jamnuts and install locking wire on drain plug and bolt of filter element. Close engine compartment grille doors.

Caution: Do not tighten nuts until filter is firmly seated in housing and filter head is against mounting face. Improper seating will strain the filter head to the cracking point.

135. Oil Pressure Control Valve

a. General. Correct engine oil pressure is 70 to 80 psi using OE 50 engine oil; it may be as low as 40 psi when (OE 10) engine oil is used. If oil pressure is below these minimum operating range limits at 2,800 rpm, the oil pressure control valve should be replaced as a unit and returned to higher echelon for adjustment or repair. Report to ordnance maintenance personnel if replacement of the control valve does not correct low oil pressure.

b. Removal. Remove engine compartment center grilles (par. 234) over engine fan assembly. The oil pressure control valve (fig. 102) is mounted on the oil control housing in the right front corner of the fan shroud. Remove six hex-head bolts with integral lockwashers securing oil control housing cover to engine fan shroud and remove cover. Cut locking wire and remove valve as an assembly using wrench 5120–473–7791 (fig. 107). Remove and discard gasket.

c. Installation. Install oil pressure control valve with new gasket in opening in oil control housing. Tighten valve with wrench 5120–473–7791 (fig. 107) and secure with locking wire. Install oil control housing cover and secure with six $^{5}/_{16}$ x $^{5}/_{16}$ hex-head bolts with integral lockwashers. Install engine compartment center grilles (par. 234).

136. Oil Filter Bypass Valve

a. Removal. Remove engine compartment center grilles ,par. 234) over engine fan assembly. The oil filter bypass valve (fig. 102) is mounted on the oil control housing in the right front corner of the fan shroud. Remove six hex-head bolts with integral lockwashers securing oil control housing cover to engine fan shroud and remove cover. Cut locking wire and remove valve as an assembly, using wrench 5120–473–7791 (fig. 107). Remove and discard gasket.

b. Installation. Install oil filter bypass valve (fig. 102) in open-

Figure 107. Removing oil pressure control valve.

ing in oil control housing using new gasket. Tighten valve with wrench 5120–473–7791 (fig. 107) and secure with locking wire. Install oil control housing cover and secure with six $\frac{5}{16}$ x $\frac{9}{16}$ hex-head bolts with integral lockwashers. Install engine compartment center grilles (par. 234).

137. Oil Cooler Bypass Valve

a. Removal. Remove engine compartment center grilles (par. 234) over engine fan assembly. The oil cooler bypass valve (fig. 102) is mounted on the oil control housing in the right front corner of the fan shroud. Remove six hex-head bolts with integral lockwashers securing oil control housing cover to engine fan shroud and remove cover. Cut locking wire and remove valve as an assembly, using wrench 5120–473–7791 (fig. 107). Remove and discard gasket.

b. Installation. Install oil cooler bypass valve (fig. 102) in opening in oil control housing using new gasket. Tighten valve with wrench 5120–473–7791 (fig. 107) and secure with locking wire. Install oil control housing cover and secure with six $\frac{5}{16}$ x $\frac{9}{16}$ hex-head bolts with integral lockwashers. Install engine compartment center grilles (par. 234).

138. Oil Cooler Thermal Bypass Valve

a. General. Servicing or replacement of the oil cooler thermal

bypass valve (fig. 108) on either the transmission or engine oil cooler is the same.

Note. Check temperature marking on new valve to be sure that it is identical to one being replaced (par. 133*a*(3)).

b. Removal. Open grille doors over oil cooler. Cut locking wire and remove valve from housing (fig. 108) using wrench 5120–473–7791 (fig. 107). Remove and discard gasket.

c. Installation. Insert thermal bypass valve with new gasket into valve housing (fig. 108) and tighten with wrench 5120–473–7791 (fig. 107). Secure with locking wire inserted through valve cap and housing. Close grille doors.

139. Intake Manifold

a. General. The removal and installation procedures for the right and left intake manifold (fig. 109) are identical.

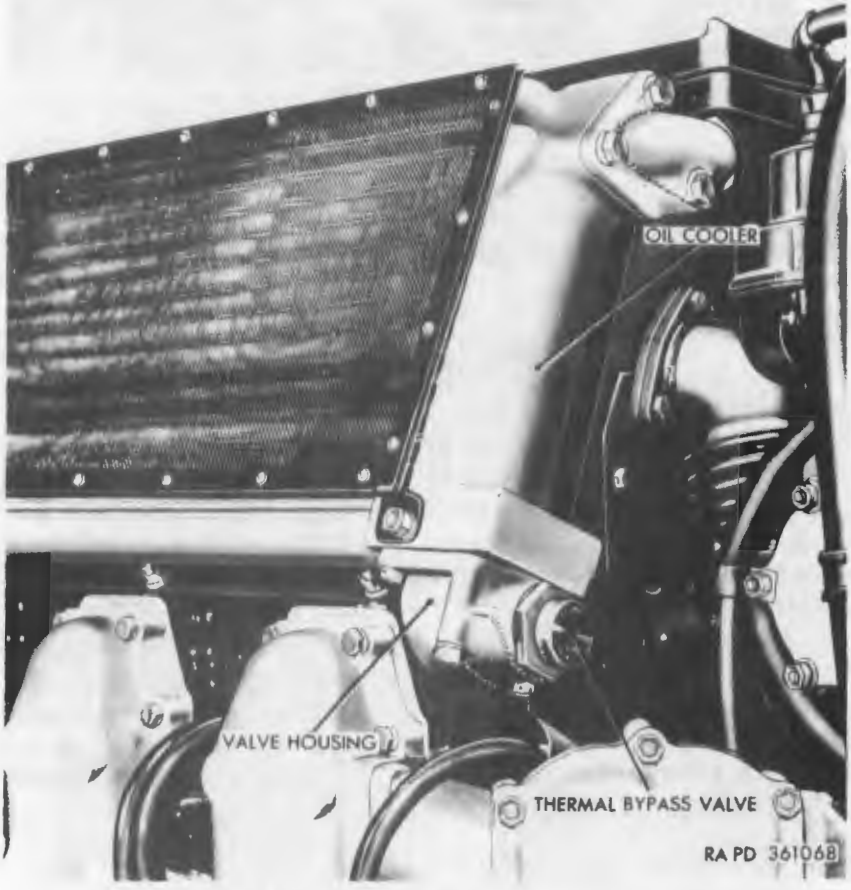


Figure 108. Oil cooler thermal bypass valve.

b. Removal. Remove power plant from vehicle (par. 126). Disconnect primer line from each cylinder by loosening hex nut securing it to cylinder.

Note. Engines with serial Nos. 728 through 5446 do not have a primer line between No. 4 and No. 6 cylinders.

Disconnect air and fuel lines (J and K, fig. 110) from aspirator assembly (L, fig. 110). Remove aspirator assembly from manifold. Remove flange nuts, bolts, and washers securing manifold to cylinder assemblies, supercharger and balance tube connector (D, fig. 110). Remove manifold and gaskets and discard gaskets.

c. Disassembly. Loosen clamp screws and remove all clamps and hoses between manifold sections. Remove the clamps and hose between manifold section (B, fig. 110) and manifold connector (A, fig. 110).

d. Cleaning and Inspection. Clean all parts in dry-cleaning solvent or mineral spirits paint thinner, using a round bristle brush on the inside of the manifold. Wipe and dry with compressed air. Check the machined surface of the manifold which mates with the mounting pad on the cylinders to see that it is flat and without warpage, nicks, or burs. Dress nicks or warped surfaces on a surface plate, or replace manifold. Check all castings for cracks and flaws, replacing unserviceable parts.

e. Assembly. Assemble manifold sections (B, fig. 110) and man-

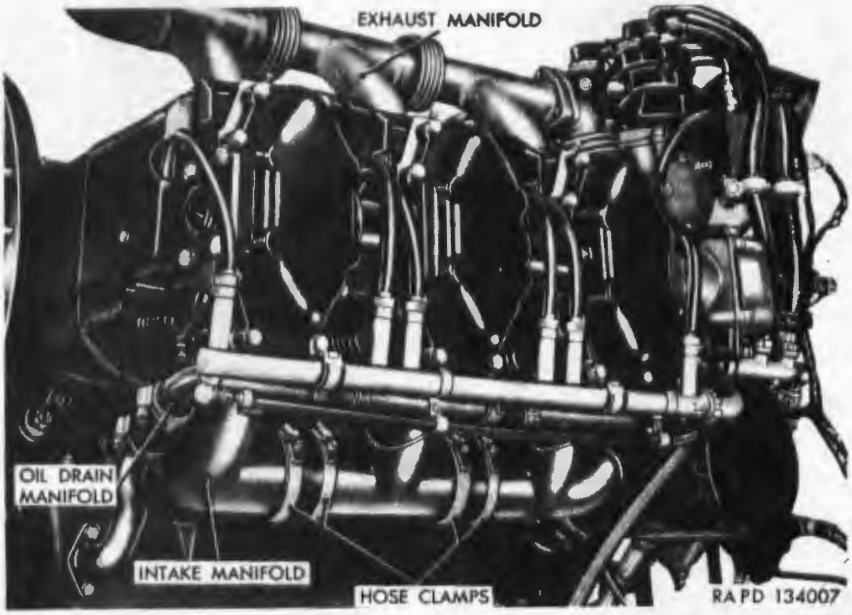


Figure 109. Intake and exhaust manifolds.

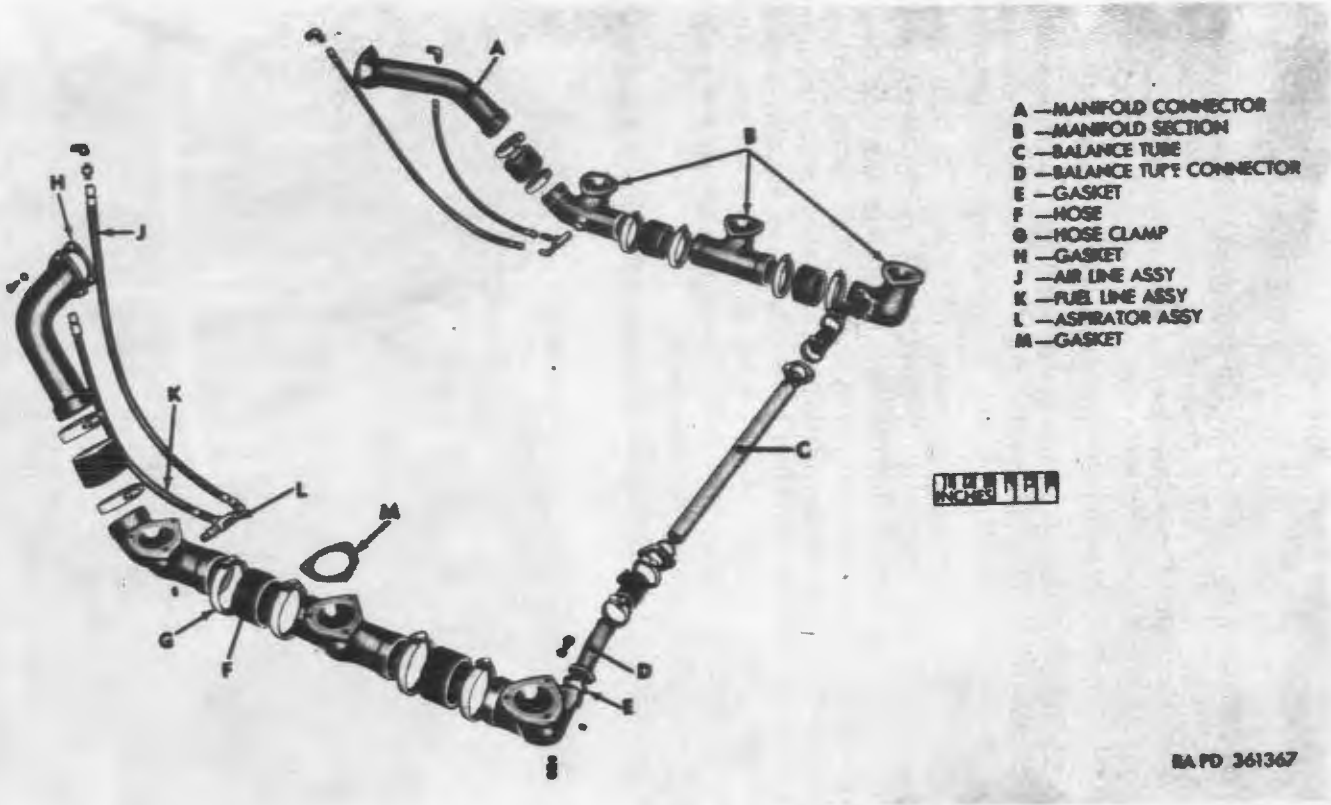


Figure 110. Intake manifold—exploded view.

ifold connector (A, fig. 110) using three 3-inch ID x 2¼ long hose and six 3½ inch clamps.

f. Installation. Install new gaskets and manifold on cylinder assemblies with nine 5/16-inch hex nuts, 5/16-inch jamnuts and 2 1/64-inch ID washers. Install new gasket between supercharger and manifold connector and secure with three 5/16 x 2 7/32 hex-head bolts and 5/16-inch lockwashers. Install new gasket between balance tube connector (D, fig. 110) and manifold section and secure with two 5/16 x 2 7/32 hex-head bolts and 5/16-inch lockwashers. Install aspirator assembly (L, fig. 110) into manifold section. Connect air and fuel line assemblies (J and K, fig. 110) to aspirator assembly. Connect a primer line to each cylinder by tightening hex nut attached to primer line.

Note. Engines with serial Nos. 728 through 5446 do not have a primer line between No. 4 and No. 6 cylinders.

Install power plant in vehicle (par. 130).

140. Exhaust Manifold
(fig. 109)

a. General. The removal and installation procedures for the right and left exhaust manifold are identical.

Note. Use wrench 41-W-2999-145, if available, to remove and install right rear mounting nut of engine hotspot outlet housing assembly.

b. Removal. Remove power plant (par. 126). Remove cooling fan and clutch (par. 163). Remove engine shroud and oil coolers as an assembly (par. 164). Remove locking wire and three bolts that secure hotspot manifold to each exhaust manifold, and remove two gaskets and baffle. Discard gaskets. Remove 12 locknuts and plain washers that secure each exhaust manifold to the engine cylinder and remove manifolds.

c. Cleaning and Inspection. Clean all parts in dry-cleaning solvent or mineral spirits paint thinner, using a round bristle brush on the inside of the manifold. Wipe and dry with compressed air. Inspect all contacting surfaces for burs, nicks, and flaws. Inspect for leaks and burned-out spots. Manifolds showing signs of leaks or burned-out areas must be replaced.

d. Installation. Install six new exhaust manifold gaskets on cylinders and position manifolds on cylinder mounting studs. Install two new gaskets with the baffle between exhaust manifold and hotspot manifold and secure with three 5/16 x 2 7/32 hex-head bolts. Tighten bolts to 25 to 30 pound-feet torque and install locking wire. Secure exhaust manifolds to engine cylinders with twelve 3/8-inch locknuts and 2 5/64-inch ID plain washers. Install engine shroud and oil coolers (par. 164). Install cooling fan and clutch (par. 163). Install power plant (par. 130).

141. Engine Oil Cooler and Lines

For removal and installation procedure of the engine oil cooler and oil lines refer to paragraphs 164 and 165.

142. Engine Mounting Saddle Cushion

a. Removal. Remove power plant (par. 126). Remove two hex-head bolts and bushing-type spacers securing engine mounting saddle (fig. 87) to bottom of accessory case and remove saddle. Remove two-hex-head bolts securing saddle shock cushion to saddle and remove cushion.

b. Installation. Position shock cushion on saddle and secure with two 5/8 x 1 self-locking hex-head bolts. Position engine mounting saddle (fig. 87) on accessory case and secure with two bushing-type spacers and 5/8 x 2¼ self-locking hex-head bolts. Install power plant (par. 130).

143. Valve Clearance Adjustment

a. Remove Power Plant. Refer to paragraph 126.

b. Remove Valve Rocker Covers. Remove ignition harness (par. 148). Remove eight hex-head bolts, lockwashers, and flat washers from each valve rocker valve cover (fig. 88). Remove two outside hex-head bolts and tab washers that secure each valve rocker cover to the camshaft drive housing at No. 1 and No. 2 cylinders (fig. 101). Remove two outside hex-head bolts and tab washers which secure the valve rocker covers of No. 5 and No. 6 cylinders (fig. 101) to each rocker box cover plate. Pull valve rocker covers straight off cylinders.

Caution: Do not attempt to pry cover loose. Use a soft hammer and tap lightly around outside of cover, being careful not to strike at or near the flanges.

c. Install Engine Turning Wrench. Remove locking wire, eight hex-head bolts, and flat washers securing power takeoff cover (fig. 89) to accessory case and remove cover. Install engine turning wrench 5120–810–4673 (fig. 111) on power-take-off drive shaft.

Note. To adjust valves of each cylinder to proper clearance, move engine turning wrench in a counterclockwise direction until piston for that cylinder is near top dead center on compression stroke.

d. Check and adjust valve clearance.

Note. Valve clearance adjustments must be made with engine cold.

Adjust intake valves to 0.007-inch clearance and exhaust valves to 0.014-inch clearance. Insert thickness gage 5210–708–3769 (fig. 112) between valve stem end and adjusting screw pad for intake valve clearance. Insert thickness gage between cam and valve

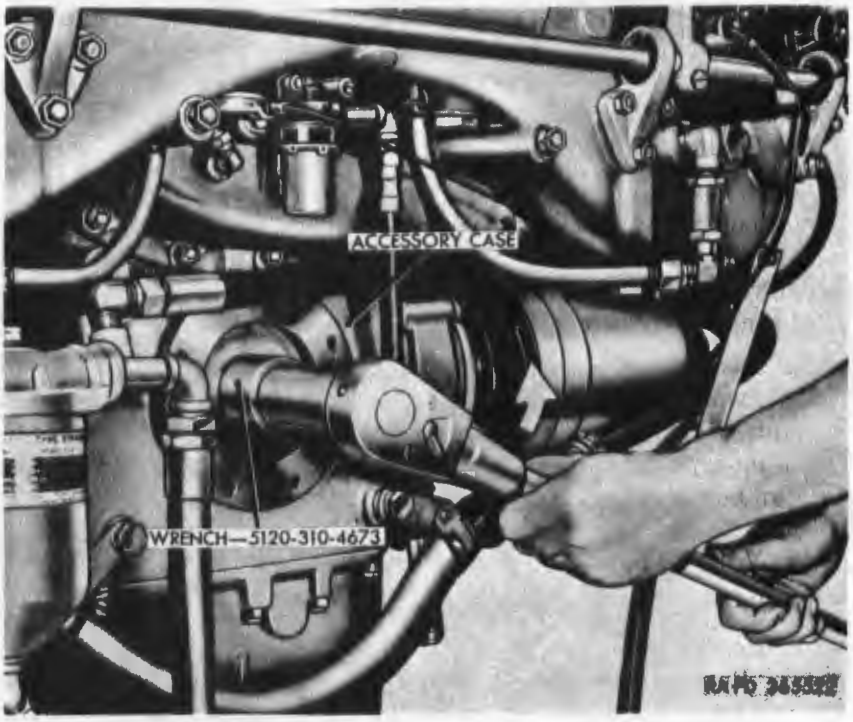


Figure 111. Engine turning wrench installed.

rocker roller for exhaust valve clearance. If adjustment is required, lossen adjusting screw locknut (fig. 112) and turn adjusting screw until a slight drag is evident when the adjusting screw pad is rotated, hold screw in position, and tighten locknut. Recheck clearance.

e. Install Valve Rocker Covers. Clean mating surfaces with dry-cleaning solvent or mineral spirits paint thinner. Position rocker valve covers (fig. 88) on cylinder heads and secure each cover with eight $\frac{5}{16}$ x $1\frac{5}{16}$ hex-head bolts, $\frac{5}{16}$-inch lockwashers, and $\frac{21}{64}$-inch flat washers. Install ignition harness (par. 148). Install two $\frac{7}{16}$ x 1 hex-head bolts and 0.46-inch tab washers which secure each rocker box cover plate to the valve rocker covers of No. 5 and No. 6 cylinders (fig. 101). Install two $\frac{7}{16}$ x 1 hex-head bolts and 0.46-inch tab washers which secure each camshaft drive housing to the valve rocker covers of No. 1 and No. 2 cylinders (fig. 101).

f. Remove Engine Turning Wrench. Remove engine turning wrench from power takeoff drive shaft. Position power takeoff cover and gasket on accessory case and secure cover to case with

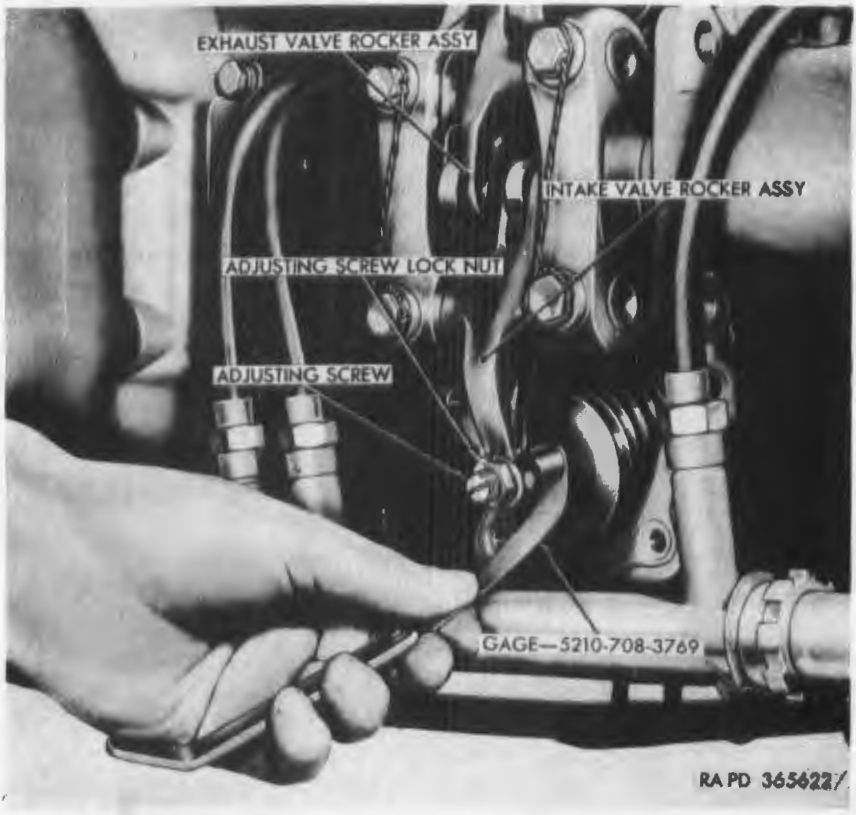


Figure 112. Checking intake valve clearance with thickness gage 5210–708–3769.

eight $\frac{5}{16}$ x $1\frac{3}{32}$ hex-head bolts, and $2\frac{1}{64}$-inch flat washers and locking wire.

g. Install Power Plant. Refer to paragraph 130.

Section VII. IGNITION SYSTEM

144. Description and Data

a. Description.

(1) *General.* The dual ignition system consists of 2 magnetos; a booster coil with filter; 12 spark plugs (2 for each of the 6 cylinders); low voltage booster and ground cables; high tension ignition harness assembly; magneto and ignition harness; ventilating system; and a combination starter, booster, magneto, and degasser switch.

(2) *Magnetos.* The magnetos (fig. 113) are 6-cylinder, waterproof and electromagnetic-radiation proof assem-

bles. The magnetos are mounted on the upper left section of the engine accessory case and are driven clockwise at one-half crankshaft speed. Each magneto fires a spark plug in each of the six engine cylinders. The left magneto fires the rear plug, toward the flywheel end of the engine, in each cylinder. The right magneto fires the front plug, toward the accessory end of the engine, in each cylinder.

(3) *Booster coil with filter.* The booster coil with filter (fig. 113) is bracket mounted on the magneto drive housing and contains a booster coil and two filter coils with capacitors. The booster coil facilitates starting the engine while the filter coils with capacitors bypass radio interference generated in the ignition system. The booster coil is connected in series with the right magneto primary winding (fig. 114) and is fed from the 24-volt battery circuit when the booster switch is turned on.

(4) *Spark plugs.* Two types of 14-mm shielded spark plugs, with externally threaded shells for cable connection, are used. The early plug is an aircraft type with 1,000-ohm internal resistance and double ground electrodes. The late plug is an automotive-type with 10,000-ohm internal resistance and single ground electrode. The spark plugs are fully interchangeable.

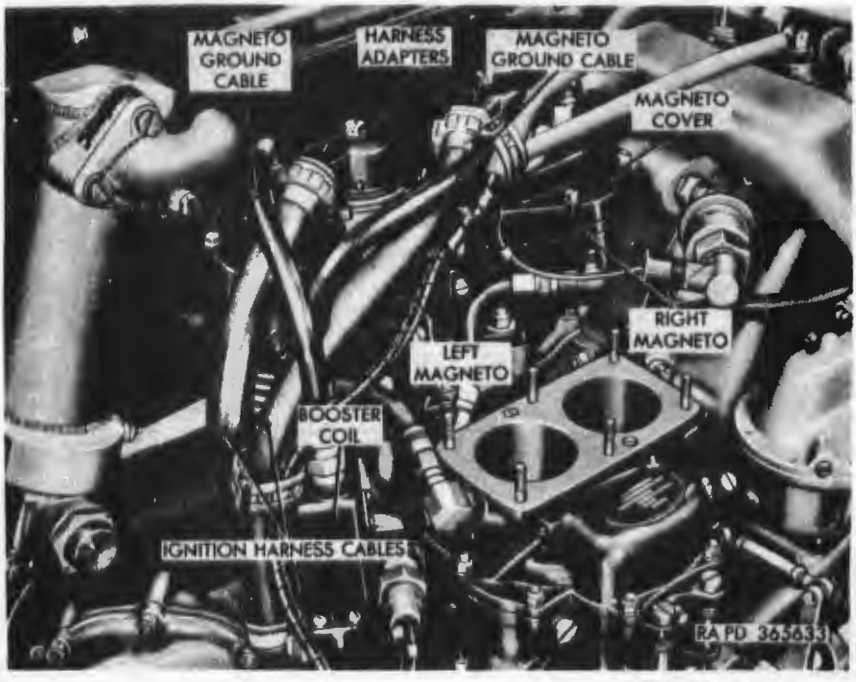


Figure 113. Magneto and booster coil with filter mountings.

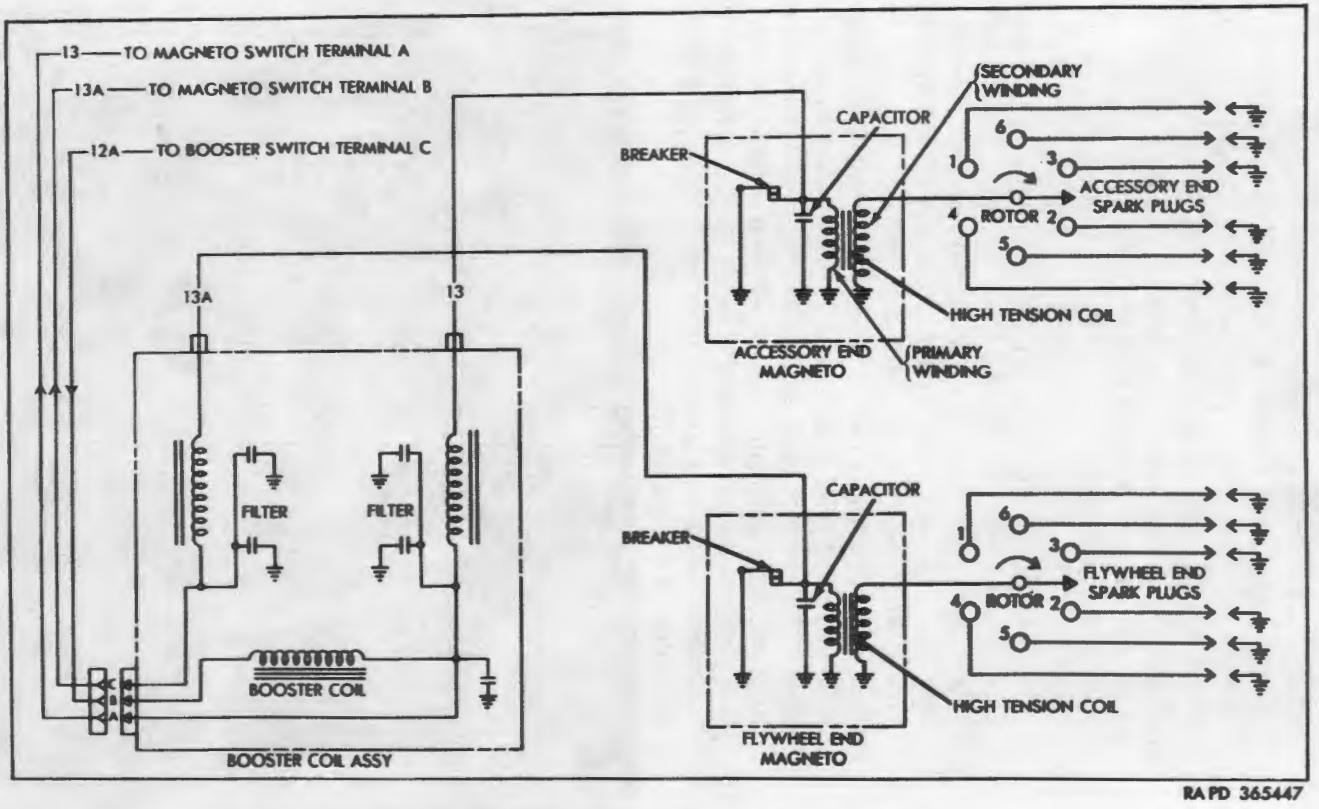


Figure 114. Wiring diagram—dual ignition system.

(5) *Ignition harness assembly* (fig. 115). The ignition harness assembly is waterproof and consists of 2 metal shields or manifolds; 4 flexible rubber-covered shielded conduits; 1 rigid metal conduit; 12 rubber-covered shielded spark plug cables; 12 rubber-insulated high tension cables; and two harness adapters. The manifolds and conduits are assembled with couplings and house the 12 high tension ignition harness cables from the magnetos to the manifold outlets. The spark plug cables connect the high tension cables in the ignition harness manifold to the spark plugs. The manifold sections of the ignition harness assembly are mounted with cushioned clamps on the front and rear rocker arm covers on both banks of the engine. The connecting conduits which extend across the front of the engine are secured with brackets to the crankcase.

(6) *Ground cables.* The cables which connect the booster coil with filter to the magnetos provide a ground circuit to render the magnetos inoperative when the switch (C–1, fig. 15) is in the OFF position. The booster current is supplied through this circuit to the right magneto only when the magneto switch is in either the A or BOTH position and booster switch is on.

(7) *Magneto and ignition harness ventilating system.* (fig.

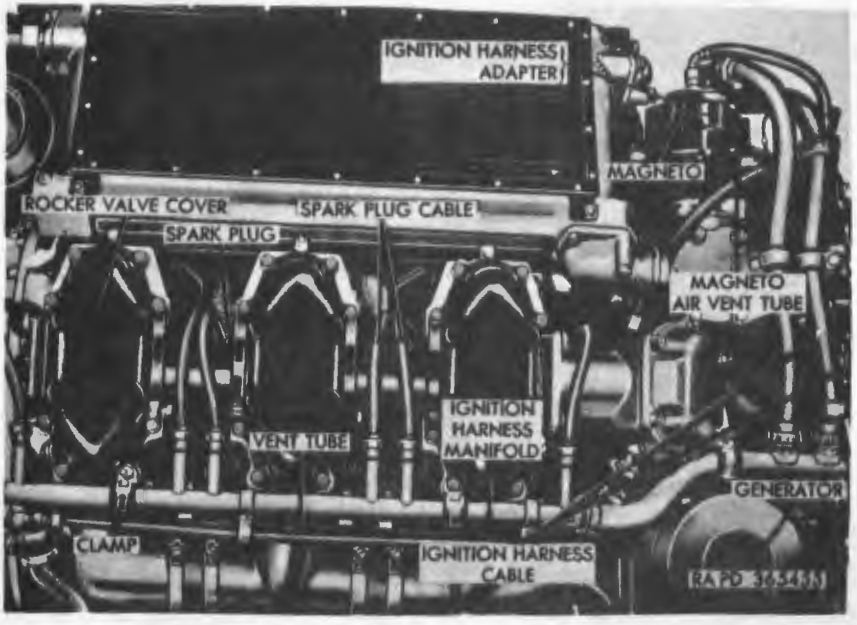


Figure 115. Ignition harness and ventilating system.

115) The magnetos and ignition harness assembly are waterproof but are subject to moisture condensation within the housings and conduits. To dissipate this condensation, a system of vent lines is provided to connect the housings and conduits to the carburetor intake elbows. By utilizing the vacuum in the supercharger intake manifold, fresh air is drawn from the air-inlet side of the carburetor, through the magnetos and the inside of the ignition harness, into the supercharger.

(8) *Starter, booster, magneto, and degasser switch.* This combination switch consists of the magneto, booster, degasser (fuel cutoff), and starter switches. For operation of these switches refer to paragraph 27. Refer to paragraph 251 for removal and installation instructions.

b. Tabulated Data.

Magneto (2):	
Manufacturer	Bendix-Scintilla
Model	S6LN32
Manufacturer (optional)	American Bosch
Model	3D1975
Booster coil with filter:	
Manufacturer	Bendix-Scintilla
Spark plugs (12):	
Manufacturer	Champion
Model	TAC–4
Resistor, internal	10,000 ohms
Manufacturer (optional)	Champion
Model	TAC–2
Resistor, internal	1,000 ohms
Manufacturer (optional)	A.C.
Model	AC–WR42L
Resistor, internal	1,000 ohms
Manufacturer (optional)	B. G. Corporation
Model	RB8978
Resistor, internal	1,000 ohms
Manufacturer (optional)	Auto lite
Model	AER–28
Resistor, internal	1,000 ohms
Type	14-mm shielded
Point gap:	
Double ground contacts	0.011 to 0.014 inches
Single ground contacts	0.017 to 0.020 inches

145. Ignition Timing

a. General. For correct ignition timing, the breaker points of both magnetos must open simultaneously just as the flywheel ignition timing mark alines with the engine timing pointer, when No. 1 cylinder piston is on its compression stroke. Magneto breaker points ordinarily require no adjustment when timing ignition,

provided that proper adjustment (*b* below) was made prior to installation of magneto on the engine. The main engine may be equipped with either Bendix-Scintilla or American Bosch magnetos; however, timing procedure is identical except for minor differences as indicated in *b* below.

Caution: Exercise special care when handling the magnetos to see that no metallic particles are attracted to the magnet. These metallic particles can be very damaging to internal parts when magnetos are operating. Be certain no dust, dirt, or other foreign substances enter the magnetos.

b. Ignition Timing Procedure Using Magneto Timing Light 41–L–1439.

(1) Remove power plant (par. 126).

(2) Cut locking wire, remove eight hex-head bolts and plain washers, and remove power-take-off drive cover (fig. 89).

(3) Remove two hex nuts and plain washers and remove cover from engine timing inspection hole so that timing marks on flywheel (fig. 116) can be seen.

(4) Remove one spark plug (par. 148) from No. 1 cylinder and install in its place compression gage 41–G–124.

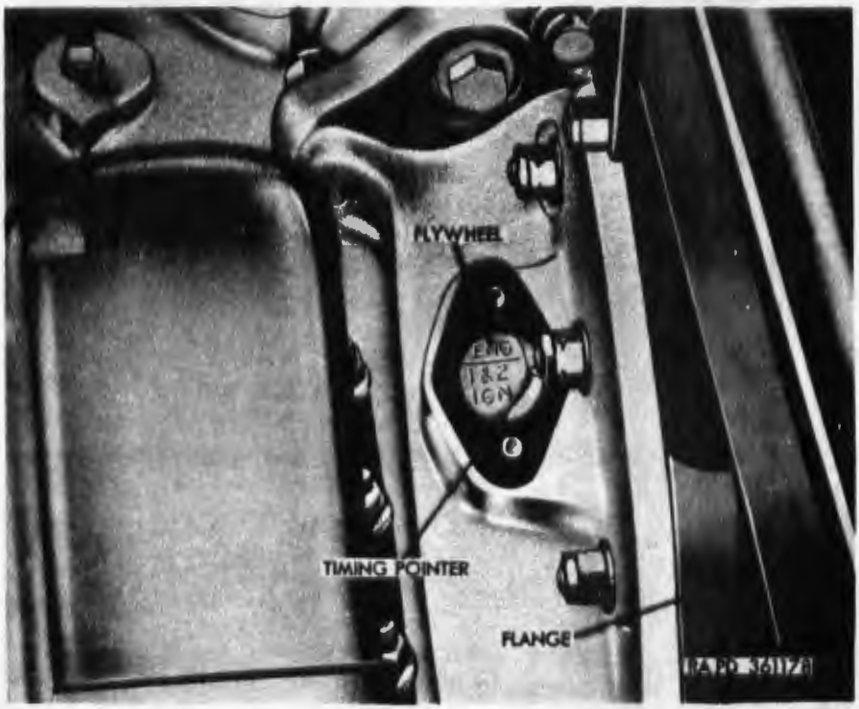


Figure 116. Engine flywheel ignition timing mark.

(5) Using wrench 5120–310–4673 (fig. 111), rotate power-take-off drive shaft counterclockwise.

Note. Crankshaft rotates clockwise as viewed from the accessory end when power-take-off drive shaft is rotated counterclockwise.

Rotate the drive shaft until a pressure reading appears on the compression gage, then continue rotation slowly until flywheel ignition timing mark OPP ENG, 1 & 2 IGN is alined with the timing pointer.

Note. Timing marks must be alined when No. 1 cylinder piston is on its compression stroke, as it is possible to have engine 180° out of time since the camshaft turns at one-half crankshaft speed.

(6) Loosen the lockwasher screws securing each of the two magneto covers and move covers, with cables attached, to one side. Remove and discard cover gaskets.

Note. Cover is attached with five screws on Bendix-Scintilla magnetos, with four screws on American Bosch magnetos.

(7) Connect the two red leads of timing light 41–L–1439 (fig. 117) to the two magneto breaker terminals (Bendix-Scintilla, fig. 118), or to the two magneto contact studs

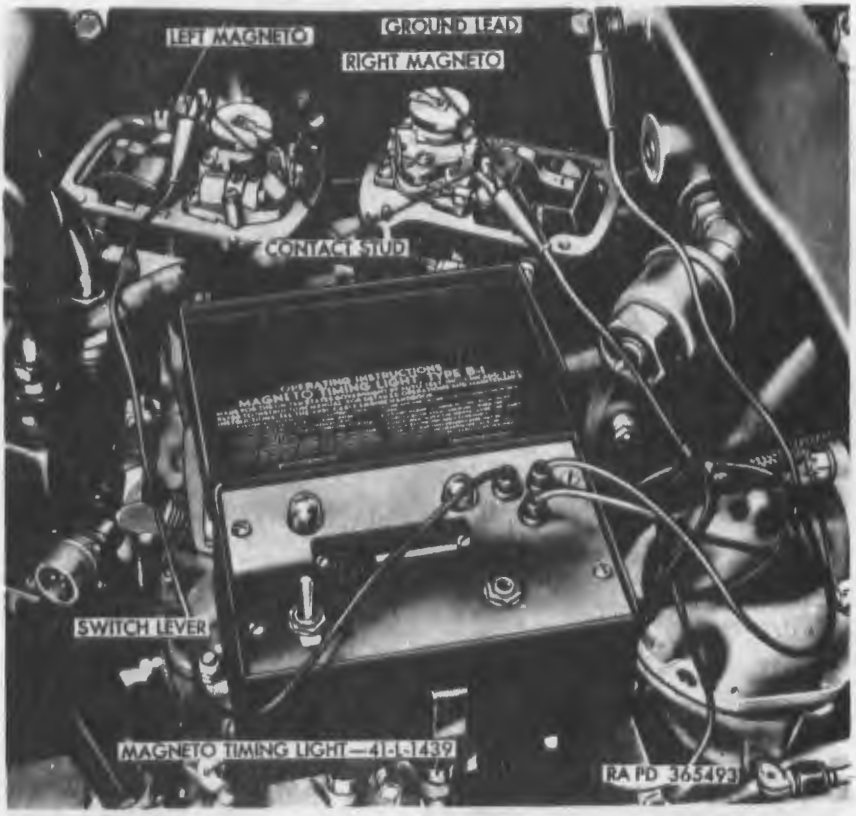


Figure 117. Synchronizing magnetos on engine with magneto timing light 41–L–1439.

American Bosch, fig. 119). Connect the black lead to an adjacent ground. Move timing light switch lever to the ON position.

Note. If setting ignition timing, continue with (8) below. If checking ignition timing, proceed to (9) below.

(8) With flywheel timing mark and timing pointer alined, the breaker points of both magnetos should just start to open. Loosen two hex jam nuts and hex nuts securing each magneto to the engine accessory case just enough to allow the magneto housings to be rotated for adjustment. Rotate both housings clockwise until the timing light indicator lamps go out. Then slowly rotate each housing counterclockwise until the instant its indicator lamp comes on.

Note. Indicator lamp comes on the instant that breaker points open.

Tighten magneto mounting nuts carefully, maintaining correct housing adjustment so indicator lamps are just on after nuts are tightened.

(9) To check timing and synchronization, rotate the power-take-off drive shaft one-quarter turn clockwise, then slowly rotate counterclockwise until the indicator lamps

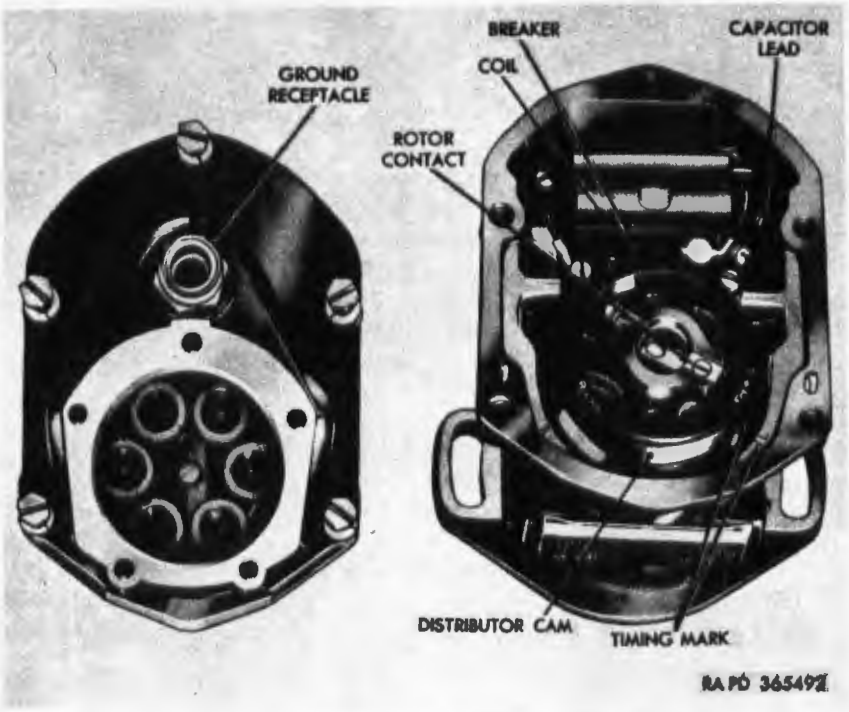


Figure 118. Bendix-scintilla magneto—cover removed.

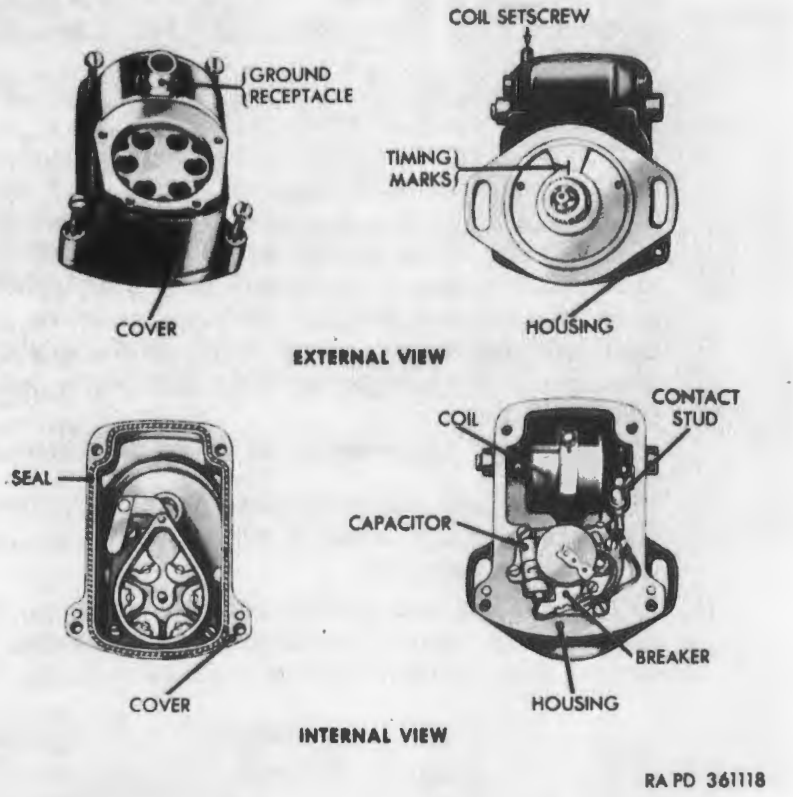


Figure 119. American Bosch magneto—separated.

come on. Both lamps should come on simultaneously at the time that flywheel timing mark OPP ENG, 1 & 2 IGN alines with the timing pointer.

Note. It is permissible for flywheel mark to be up to one-quarter inch off alinement, but indicator lamps must come on simultaneously.

If they do not, adjust either or both of the magnetos ((8) above) as required to obtain correct timing and synchronization.

Note. With engine timing marks alined and the magnetos synchronized, magneto timing marks should also be in alinement. If they are not, it means that breaker point adjustment is incorrect, and magneto(s) must be removed, adjusted (par. 146*b*), and again synchronized after installation.

(10) Disconnect timing light leads and remove timing light.

(11) Install new magneto cover gaskets, install magneto covers, and secure by tightening the ¼ x 1½ lockwasher screws.

(12) Remove compression gage and install spark plug (par. 148) in No. 1 cylinder.

(13) Install engine timing inspection hole cover and secure with two $\frac{5}{16}$-inch hex nuts and plain washers.

(14) Install power-takeoff drive cover, with new cover gasket, and secure with eight $\frac{5}{16}$ x $1\frac{15}{64}$ hex-head bolts, plain washers, and 0.041-inch diameter locking wire.

(15) Install power plant (par. 130).

c. Ignition Timing Procedure Using Feeler Gages. The following is an emergency procedure to be used only when a timing light is not available.

(1) Perform procedures in *b* (1) through (6) above.

(2) When flywheel timing mark OPP ENG, 1 & 2 IGN is alined with timing pointer, the breaker point gap of each magneto should be 0.0015-inch.

Note. A slight drag should be present when a 0.0015-inch feeler gage is moved between the points.

If gap is not correct, loosen the magneto mounting nuts and rotate magneto housings, as required, until the gage can be moved between the points with a slight drag. Tighten mounting nuts.

(3) Place a 0.0015-inch feeler gage between the breaker points of each magneto. Rotate power-take-off drive shaft one-quarter turn clockwise. While pulling on both feeler gages, have the drive shaft rotated slowly counterclockwise. For correct timing and synchronization, both gages should break free simultaneously at the time that flywheel timing mark alines with the pointer.

Note. It is permissible for flywheel mark to be up to one-quarter inch off alinement, but gages must break free simultaneously.

If gages do not break free simultaneously, or flywheel mark is misalined more than one-quarter inch, loosen magneto mounting nuts and adjust either or both magneto housings as required to obtained correct timing and synchronization. Tighten mounting nuts.

(4) Perform procedures in *b* (11) through (15) above.

146. Magnetos

a. Removal.

(1) Remove power plant (par. 126).

(2) Disconnect booster and ground cable (fig. 113) from magneto cover by unscrewing cable connector nut, and withdraw cable from receptacle.

(3) Remove five fillister-head screws and lockwashers which retain ignition harness adapter (fig. 113) to top of magneto and lift adapter free.

(4) Disconnect vent line connecting the two magnetos. Disconnect magneto-to-carburetor vent line (left magneto only).

(5) Remove two hex jamnuts, hex nuts, and flat washers holding magneto to engine accessory case and remove magneto.

b. Adjustment.

(1) Loosen the five (Bendix-Scintilla) or four (American Bosch) lockwasher screws which secure magneto cover to magneto housing and remove cover. Remove and discard cover gasket.

(2) Connect one of the red leads of timing light 41–L–1439 (fig. 117) to magneto breaker terminal (Bendix-Scintilla, fig. 118) or contact stud (American Bosch, fig. 119). Connect black lead to magneto housing. Turn on timing light switch lever.

(3) On Bendix-Scintilla (fig. 118), rotate distributor cam clockwise until timing mark on magneto alines with timing mark "L" on pad of magneto housing. On American-Bosch (fig. 119), rotate magneto drive coupling counterclockwise, as viewed from the bottom of the magneto, until timing marks aline. If breaker point adjustment is correct, timing light indicator lamp will come on at the instant that timing marks aline.

Note. Breaker points should just start to open when magneto timing marks aline; the indicator lamp comes on at the instant that breaker points open.

(4) If breaker point adjustment is not correct, loosen the two breaker assembly mounting screws. Make certain timing marks are alined, then shift the adjustable arm of the breaker assembly until the indicator lamp just comes on. Tighten the two breaker assembly mounting screws with care, so that the indicator lamp stays just on. Check as in (3) above.

Note. When this adjustment is properly made, no further breaker point adjustment is required after magneto has been installed on the engine.

(5) Disconnect leads of timing light and remove timing light.

Note. When a timing light is not available, a 0.0015-inch feeler gage can be used to check the breaker point gap. With magneto timing marks in alinement, place the feeler gage between the breaker points. If points are correctly adjusted, there will be a slight drag present when the gage is moved between the points. If adjustment is not correct, loosen the two breaker assembly mounting screws. Make certain timing marks are alined, then shift the adjustable arm of the breaker assembly, as required, until the gage can be moved between the points with a slight drag. Tighten mount-

ing screws. The use of a feeler gage does not give a precision check.

c. Installation.

(1) Adjust breaker points (*b* above).

(2) Perform procedures in paragraph 145*b*(3) through (5).

(3) With magneto timing marks alined, position magneto (with cover removed) on engine accessory case so that mounting studs are centered in magneto adjusting slots. Secure the magneto with two 5/16-inch hex nuts, hex jamnuts, and flat washers fingertight so as to permit magneto to be rotated for adjustment.

(4) Time and synchronize magnetos (par. 145*b*(7) through (10)).

(5) Perform procedures in paragraph 145*b*(11) through (14).

(6) Install vent line connecting the two magnetos. Install magneto-to-carburetor vent line to left magneto.

Note. Transfer elbow or tee from old magneto, when replacing magneto.

(7) Position ignition harness adapter (fig. 113) onto magneto cover and secure with five No. 10 x 5/8 fillister-head screws and lockwashers.

(8) Place booster and ground cable (fig. 113) in receptacle on magneto cover and secure by tightening cable connector nut.

(9) Install power plant (par. 130).

147. Booster Coil With Filter

a. Removal. Check that master relay switch (E, fig. 15) is in OFF position. Tag the switch to avoid usage during repair operation. Open front grille doors on right side of vehicle. Remove two front air outlet grilles over engine compartment (par. 234). Disconnect three cables from receptacles on booster coil with filter (fig. 113) and remove four roundhead screws and lockwashers which secure the booster coil with filter to the mounting bracket. Remove the assembly.

b. Installation. Position the booster coil with filter on its mounting bracket and secure with four No. 10 x 3/16 roundhead screws and No. 10 lockwashers. Connect right magneto ground cable to the receptacle marked BOOSTER BOT MAG and the left magneto ground cable to the receptacle marked TOP MAG on top of the booster coil. Position the harness plug into receptacle, on front of booster with filter, and secure with coupling nut. Remove tag from master relay switch.

c. Test. Start engine (par. 43). The engine should start with magneto switch (C–1, fig. 15) on the BOTH position. Stop the engine (par. 46). Close grille doors and install front air outlet grilles over engine compartment.

148. Spark Plugs and Ignition Harness Assembly

a. General. Consideration of inspection, cleaning, adjustment, and replacement of the spark plugs should be given whenever the power plant is removed from the vehicle for other maintenance.

b. Spark plug removal and Installation.

(1) *Removal.* Remove power plant (par. 126). Disconnect spark plug cable from spark plug using wrench 5120–795–0895 (fig. 120) and remove cable. Tape terminal end of cable to prevent damage to spring. Install wrench 5120–098–6723 on spark plug and remove spark plug and spark plug gasket.

Caution: Turn spark plug wrench in a clockwise direction to break gasket seal and to avoid shearing pins which secure spark plug insert in the cylinder, and then counterclockwise for removal.

(2) *Inspection.* Clean spark plug thoroughly and check for proper gap between electrodes. Inspect porcelain for cracks and burned condition. Replace spark plugs if badly burned or damaged. Set aircraft-type, (double-grounded contacts) spark plug gap to 0.011 to 0.014-inches using a round wire spark plug gage. Set automotive-type (single-grounded contacts) spark plug gap to 0.017 to 0.020-inches using a round wire spark plug gage.

(3) *Installation.* Make sure that spark plug hole in cylinder is clean and free from burs. Place gasket on spark plug with a small amount of grease to hold it in position. Insert plug into cylinder head and start by hand to avoid cross-threading. Install wrench 5120–098–6723 on spark plug and tighten to 15 to 18 foot-pounds. Remove tape from terminal end of spark plug cable. Insert cable into plug and tighten connector nut using wrench 5120–795–0895. Install power plant (par. 130).

c. Ignition Harness Assembly.

(1) *Removal.* Remove power plant (par. 126). Use crowfoot wrench 5120–795–0895 (fig. 120), and disconnect spark plug cables from spark plugs. Remove ignition harness adapters from magnetos (par. 146*a*). Remove two clamps on front of engine crankcase which secure ignition har-

Figure 120. Removing or installing spark plug cable.

ness conduit to the engine. Disconnect magneto vent lines from fittings at rear of both ignition harness manifolds and remove the elbows from the manifolds. Remove clamps which secure vent hose to ignition harness. Remove two rocker arm cover bolts, on both banks of the engine, which secure the ignition harness to the engine. Remove the ignition harness from the engine.

(2) *Installation.* Position ignition harness on engine and secure manifold sections to rocker arm cover bolts with cushioned clamps. Secure conduit to front of crankcase. Install vent tube elbows in rear end of both ignition har-

ness manifolds, secure vent lines to ignition harness assembly with clamps and connect tubes to elbows at rear ends of ignition manifolds. Use crowfoot wrench 5120–795–0895 (fig. 120) and connect spark plug cables to spark plugs. Install ignition harness adapters (fig. 115) with gaskets on top of magnetos. Test engine out of vehicle (par. 129). Install power plant (par. 130).

Section VIII. FUEL, AIR-INTAKE, AND EXHAUST SYSTEMS

149. Description and Data

a. Fuel System. The fuel system is composed of two fuel tanks; one fuel shutoff valve, which also serves as a fuel tank selector; one fuel pump; one main engine fuel filter; two main engine carburetors; four degassers (two on each carburetor); a governor; a primer pump; primer pump filter; and the necessary connecting fuel and vent lines.

(1) *Fuel Tanks.* The two welded fuel tanks (figs. 125 and 126), one on each side of the engine compartment, are formed to project beneath the engine cylinders. Their combined capacity is approximately 140 gallons. Under usual conditions, fuel is used from both tanks at the same time. Both tanks are normally filled from the top deck of the vehicle through a filler neck located to the left front of the engine compartment grilles. The right tank receives its fuel from the left tank through a flexible fuel line and the shutoff valve. The left fuel tank filler cap (fig. 121) is protected by a cast armor access cover. The right fuel tank filler cap (fig. 126) is under the engine compartment grille doors and is for emergency use only. Each filler neck has a wire-mesh fuel strainer which is removable for cleaning. Wire-mesh fuel strainers are also located at each fuel tank outlet. Vent lines lead from the top of each tank to the left fuel tank filler. A connection is provided to vent into the hull stowage compartment during deep water fording operations. A swinging-arm type electric fuel gage sending unit (fig. 126) is mounted near the center on the rear side of the right fuel tank on early vehicles and on both fuel tanks on late vehicles.

(2) *Fuel filter.* The disk-type fuel filter for the main engine fuel pump is mounted on the engine accessory case below the right carburetor (fig. 89).

(3) *Fuel shutoff valve.* The fuel shutoff valve (fig. 122) is

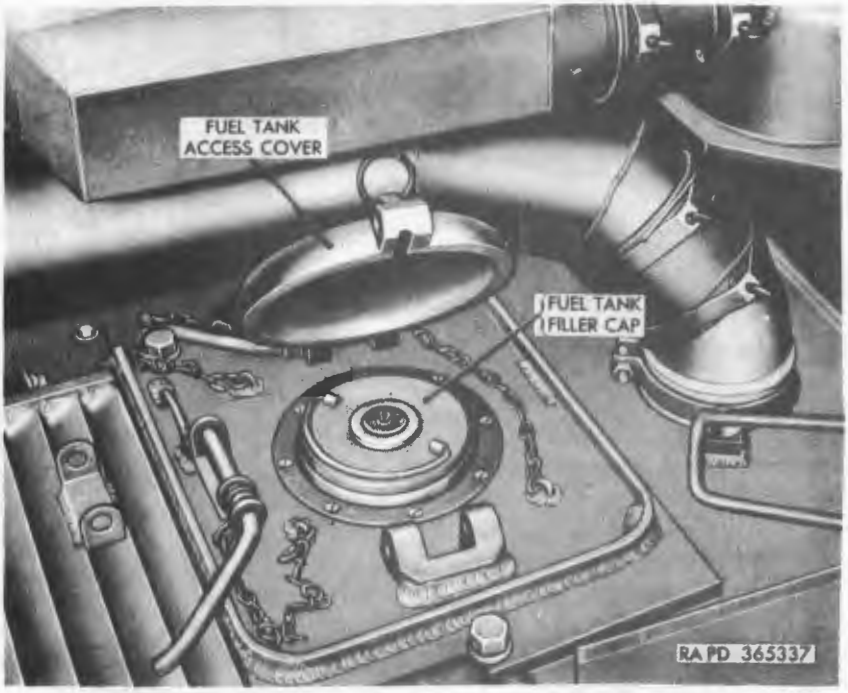


Figure 121. Fuel filler above left fuel tank.

mounted on the right fuel tank, near the floor of the engine compartment. This valve is connected through linkage to a control lever located in the lower right corner of the driving compartment. The fuel shutoff valve control lever (fig. 9) has five positions.

(*a*) ALL OFF position, tanks will not cross-feed and no fuel will flow.

(*b*) OFF position, fuel will not flow, but tanks will cross-feed.

(*c*) RIGHT ON position, tanks will not crossfeed, but fuel will flow from right tank.

(*d*) LEFT ON position, tanks will not crossfeed, but fuel will flow from left tank.

(*e*) BOTH ON position, tanks will crossfeed and fuel will flow from both tanks.

Note. Use of fuel from one tank is desirable only in case of malfunction of the other tank.

(4) *Fuel pump.* The mechanical type fuel pump (fig. 123) is actuated by an engine-driven eccentric cam and is mounted on the accessory end of the engine behind the right carburetor.

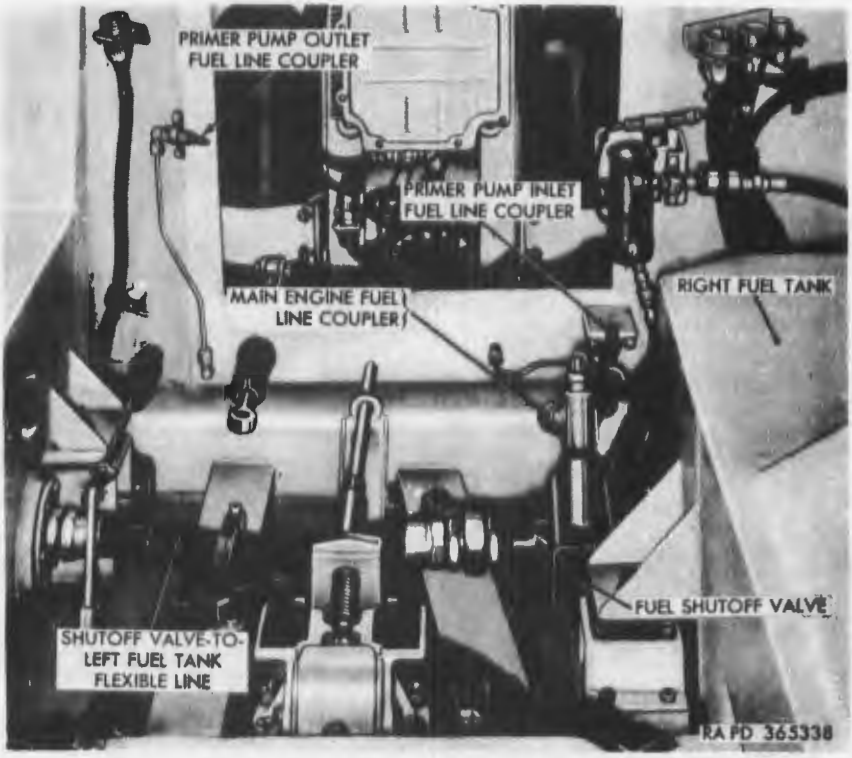


Figure 122. Fuel shutoff valve.

(5) *Carburetors.* Two carburetors (fig. 89) are mounted on the accessory end of the engine, one one each side. Each carburetor (fig. 124) is a double-venturi, down-draft unit. The two floats in each carburetor are connected by one lever, which operates one needle valve and seat. Each venturi has a separate main metering and idle system. An accelerating pump provides an extra quantity of fuel momentarily to produce smooth and rapid acceleration.

(6) *Degassers.* Two degassers (fig. 124) are mounted on the main body of each carburetor which automatically cuts off the fuel supply to the idle circuit of the carburetor to the idle system when high manifold vacuum is present during deceleration periods. In addition, an electric solenoid, controlled by the degasser switch (fuel cutoff) (C–3, fig. 15) located on the instrument panel provides positive shutoff of the fuel supply to insure stopping of the engine before the ignition system is turned off. The engine must be operating at or near the normal idle of 650 rpm for the degassers to be effective.

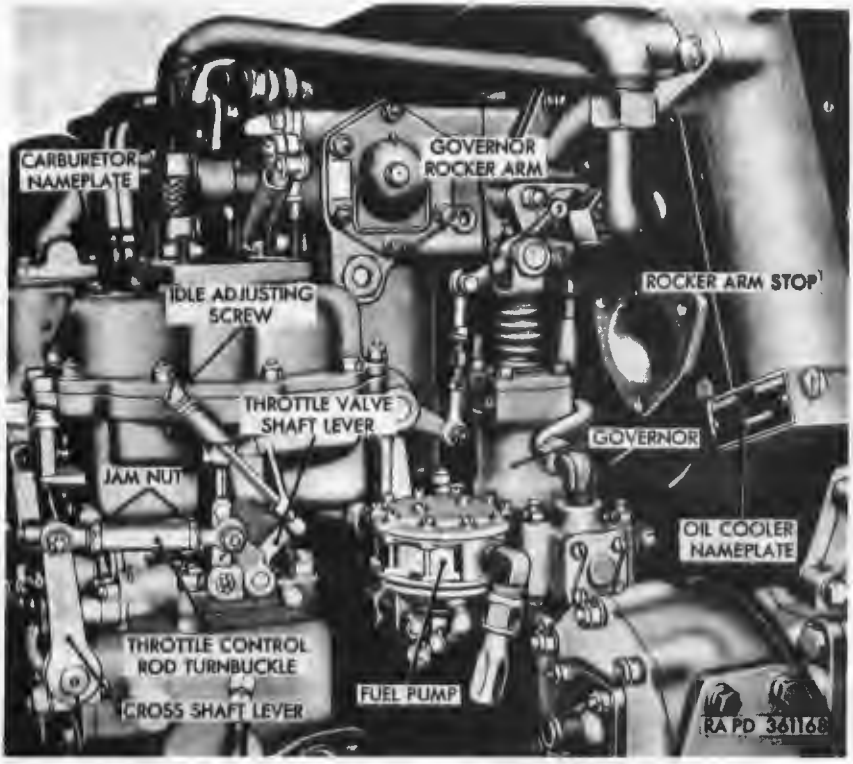


Figure 123. Carburetor, fuel pump, and governor.

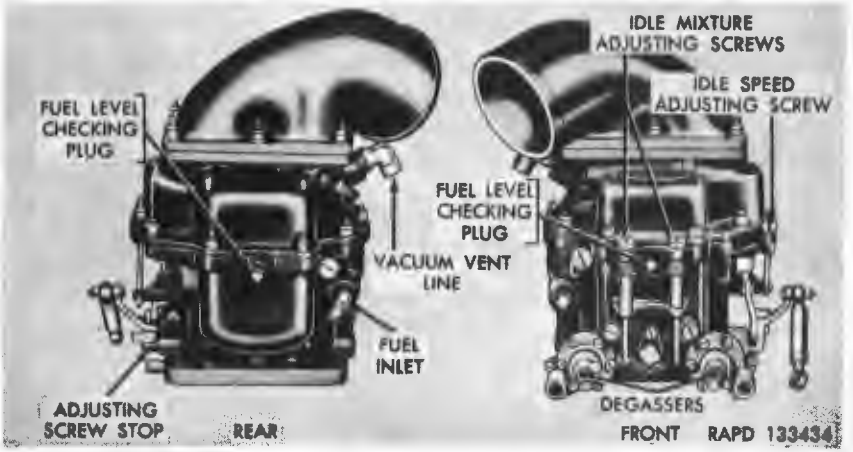


Figure 124./Carburetor, front and rear views.

(7) *Governor.* The mechanical-hydraulic type governer (fig. 123) is mounted on the accessory case directly behind the right carburetor. The governor consists of a fly-ball and race-type mechanical governor which actuates a pilot valve, which in turn controls an oil pressure system. The oil pressure is supplied from the main oil gallery of the engine, and produces the amplified energy required to actuate the governor-to-carburetor control linkage. The pilot valve moves back and forth over oil passage orifices, as governed by the fly-ball system, thereby allowing oil pressures to be increased or decreased in the hydraulic system, controlling the maximum engine rpm between 2,800 rpm (full load speed) and 2,950 rpm (no-load) speed.

Warning: Adjustment or repairs to the governor must be made by authorized personnel only. Any attempt to service the governor by operating personnel may result in serious damage to the engine or injury to personnel.

(8) *Primer pump.* The primer pump (fig. 11) is a manually operated cylinder-and-piston-type pump mounted in the driving compartment to the left rear of the driver's seat. It has fuel line connections to draw fuel from the outlet side of the main engine fuel filter to its own fuel filter, and into the intake ports of each cylinder head. It is used to facilitate cold-weather starting and warmup operations.

b. Air-Intake System. The air-intake system includes two air cleaners (fig. 132), hose, and ducts that connect the air cleaners to the carburetors. Each air cleaner supplies air for one carburetor. The cleaners are mounted on each fender in front of the mufflers.

c. Exhaust System. The exhaust system is composed of two stainless steel mufflers (fig. 133) mounted on each rear fender, and the connecting exhaust stacks from the exhaust manifolds. Each exhaust stack passes through the engine compartment hull wall and connects to a side inlet of the muffler. From engine shroud to hull wall, the exhaust stacks pass through larger steel ducts which form cooling air jackets. These jackets reduce heat transfer and maintain a lower engine area temperature than would otherwise be present.

d. Data.

Carburetor:
Make ..... Bendix Stromberg
Model ..... NA Y5G3
Fuel Pump:
Make ..... AC
Model TL2

Governor:
Make ..... Novi
Model ..... Hydraulic
Air Cleaner:
Make ..... Donaldson
Model A1434

150. Fuel Tanks

a. Filling.

Caution: Keep nozzle of filling container or hose clean and in contact with filler neck. Do not overfill the tanks. A portable fire extinguisher must be held in readiness in case of fire.
Remove locking handle and lift fuel tank access cover (fig. 121) at left front of engine compartment grilles and, wipe off dirt around filler opening, remove left fuel tank filler cap. Both fuel tanks may be filled through the same filler neck if the fuel shutoff valve control lever (fig. 9) is in either BOTH ON or OFF position. Fill tanks to 6½-inches from top of filler neck. Install filler cap. Close access cover and install locking handle.

b. Draining. Set fuel shutoff valve control lever (fig. 9) to BOTH ON position. From below the vehicle, remove the fuel tank drain covers (par. 246). Provide suitable clean containers with a total capacity of 140 gallons. Remove the filler cap and screen from the right fuel tank. Turn the fuel shutoff valve to the BOTH ON position. Use the OVM pump to pump out the tanks as much as possible. Using a suitable containers to catch the remaining gasoline, remove the drain plugs from the bottom of the tank and complete the draining.

Caution: Have a portable fire extinguisher in readiness in case of fire.
To drain fuel tanks on vehicles through Ordnance serial No. 1159, it will be necessary to remove the drain plug from the fuel tank. Vehicles with Ordnance serial No. 1160 and up are provided with a drain plug assembly. To drain fuel tanks on these vehicles, loosen inner drain plug until fuel begins to flow from tanks; control flow of fuel by loosening or tightening drain plug. After tanks have been completely drained, install drain plug on early vehicles or tighten drain plug on late vehicles. Install drain covers (par. 246).

c. Removal. Coordinate with ordnance maintenance personnel (par. 2).

(1) *Remove power plant.* Refer to paragraph 126.
(2) *Drain fuel tanks.* Refer to *b* above.
(3) *Remove left fuel tank* (fig. 125).
(*a*) Disconnect vent lines from fuel tank filler neck and cross vent line.

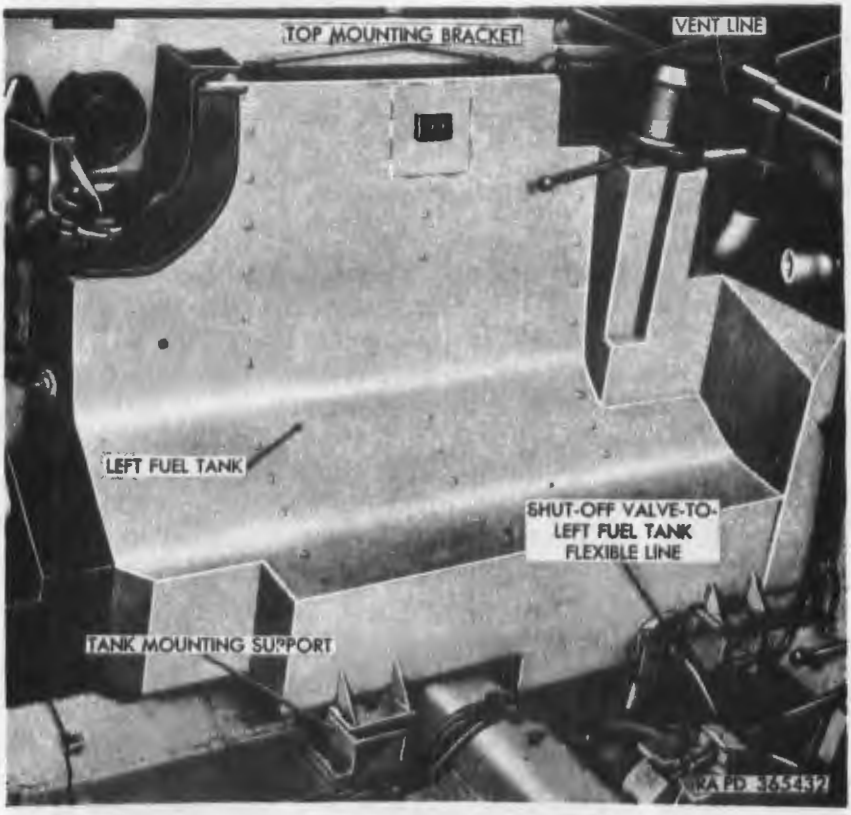


Figure 125. Left fuel tank disconnect points.

(*b*) On earlier vehicles, which have the fire extinguisher discharge nozzle mounted on the fuel tank, refer to paragraph 207 for removal of line and nozzle.

(*c*) Raise the fuel tank access cover and remove the fuel tank filler cap (fig. 121). Remove eight fillister-head screws in the filler neck grommet. Work the grommet up and remove through the hull opening. Remove six hex-head bolts with integral lockwashers which attach the filler neck to the fuel tank and remove the filler neck with filler neck flange, filter, upper gasket, and spacers. Remove lower gasket. Cover fuel tank opening.

(*d*) Remove shutoff valve-to-left fuel tank flexible line and wire screen strainer.

(*e*) Disconnect fuel level gage sending unit on late vehicles (par. 250).

(*f*) Remove two hex-head bolts, hex nuts, and lockwashers

from top mounting brackets and two hex nuts, cotter pins, and flat washers from tank mounting supports.

(*g*) Pry fuel tank to the rear and toward center line of vehicle until clear and lift out with a hoist.

Caution: Check to be certain all cables, lines, and clips are removed before moving fuel tank.

(4) *Remove right fuel tank* (fig. 126).

(*a*) Remove auxiliary generator and engine (par. 188).

(*b*) On early vehicles, which have the fire extinguisher discharge nozzle mounted on the fuel tank, refer to paragraph 207 for removal of line and nozzle.

(*c*) Disconnect fuel level gage sending unit (par. 250).

(*d*) Disconnect auxiliary generator and engine fuel line from fuel shutoff valve.

(*e*) Disconnect shutoff valve-to-left fuel tank flexible line at shutoff valve.

(*f*) Disconnect fuel shutoff valve control linkage. Scribe

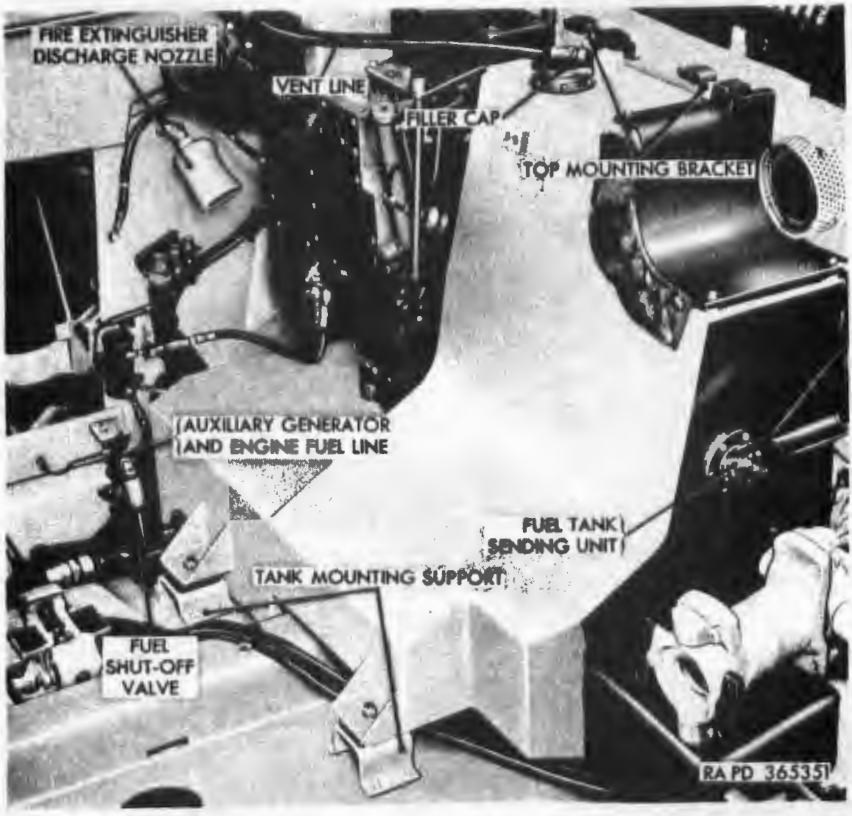


Figure 126. Right fuel tank disconnect points.

marks on linkage and shaft valve to insure proper positioning during installation.

(*g*) Remove two hex-head bolts, hex nuts, and lockwashers from each top mounting bracket and two self-locking nuts and flat washers from tank mounting supports.

(*h*) Pry fuel tank to the rear and toward center line of vehicle until clear and lift out with a hoist.

Caution: Check to be certain all cables, lines, and clips are removed before moving fuel tank.

d. Installation.

(1) *General.* If fuel tanks are to be replaced, be certain to remove any brackets, plates, etc, attached to the replaced fuel tank and install them on the new fuel tank.

(2) *Install left fuel tank* (fig. 125).

(*a*) Position the left fuel tank in vehicle and install two 7/16 x 3 hex-head bolts, 7/16-inch hex nuts, and 7/16-inch lockwashers in each top mounting bracket and two 1/2-inch hex nuts, 17/32-inch flat washers, and 3/32 x 1 cotter pins on studs of tank mounting supports.

(*b*) Raise fuel tank filling access cover. Position filler neck with filler neck flange, filter, upper gaskets, spacers, and lower gasket on fuel tank and secure with six 1/4 x 5/8 hex-head bolts with integral lockwashers. Install the grommet assembly on the filler neck. Adjust the inner and outer grommet assembly on the filler neck so that they fill and seal the opening between the filler plate and the filler neck. Install the eight No. 10 x 1 1/8 fillister-head screws in the filler neck grommet. Install filler cap.

(*c*) Connect fuel tank vent lines to filler neck and cross vent line.

(*d*) Install fire extinguisher discharge line and nozzle, as required, on early vehicles (par. 207).

(*e*) Install wire screen fuel strainer and shutoff valve-to-left fuel tank flexible line.

(*f*) Connect fuel level gage sending unit on late vehicles (par. 250).

(*g*) Install power plant (par. 130).

(3) *Install right fuel tank* (fig. 126).

(*a*) Position right fuel tank in vehicle and install two 7/16 x 3 hex-head bolts, 7/16-inch hex nuts, and 7/16-inch lockwashers in each top mounting bracket and two 1/2-inch

self-locking nuts and $^{17}/_{32}$ flat washer on studs of tank mounting supports.

(*b*) Install fire extinguisher discharge line and nozzle, as required, on early vehicles (par. 207).

(*c*) Connect fuel shutoff valve control linkage. Aline scribe marks made at time of removal.

(*d*) Connect shutoff valve-to-left fuel tank flexible line to fuel shutoff valve.

(*e*) Connect auxiliary generator and engine fuel line to fuel shutoff valve.

(*f*) Connect fuel level gage sending unit (par. 250).

(*g*) Install auxiliary generator and engine (par. 188).

(*h*) Install power plant (par. 130).

151. Engine Fuel Filter and Primer Fuel Filter

a. Engine Fuel Filter.

(1) *Draining.* Remove transmission drain access plate (par. 246) open remote drain valve with $^{7}/_{8}$-inch wrench and allow water and sediment accumulation to drain out. Refer to preventive maintenance (table V, par. 104) for specific intervals.

(2) *Removal.* Turn fuel shutoff valve control lever (fig. 9) to the ALL OFF position. Remove bulkhead door (par. 243). Drain filter ((1) above). Disconnect primer inlet fuel line, main fuel line, and filter-to-fuel pump line from engine fuel filter (fig. 89). Disconnect drain hose from bottom of engine fuel filter. Cut locking wire, and remove two hex-head bolts and flat washers securing filter to bracket and remove filter.

Note. Using wrench C8708189, if available, remove two jamnuts, hex nuts, and washer securing the fuel filter mounting bracket to the engine accessory case. Remove bracket.

(3) *Disassembly.* Remove hex-head bolt and gasket (fig. 127) from cover and remove filter bowl with filter element cover gasket. Remove filter element gasket from cover and discard. Pull out filter element and spring from bowl.

(4) *Cleaning and Inspection.* Filter element (fig. 127) may be removed from filter for cleaning or replacement without removing fuel filter from engine by using procedure outlined in *a* (3) above. Wash filter element in dry-cleaning solvent or mineral spirits paint thinner.

Caution: Do not use a brush to clean filter element. Replace filter cover and/or filter element gasket if either is cut, deteriorated, or otherwise damaged.

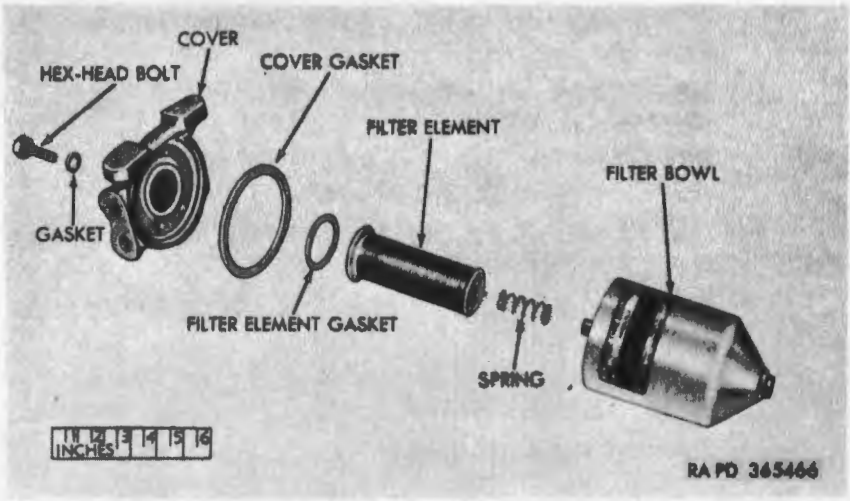


Figure 127. Engine fuel filter—exploded view.

(5) *Assembly.* Coat new filter cover gasket and filter element gasket (fig. 127) with liquid gasket cement and install in cover. Carefully insert spring and element into filter bowl making sure not to damage disks. Position filter bowl with element to filter cover and secure with gasket and hex-head bolt.

(6) *Installation.*

Note. Position fuel filter mounting bracket on engine accessory case studs and secure with two $\frac{13}{32}$ ID washers, $\frac{3}{8}$ hex nuts, and $\frac{3}{8}$ jamnuts, using wrench C8708189, if available.

Position engine fuel filter (fig. 89) on bracket and secure with two $\frac{3}{8}$ x $1\frac{5}{64}$ hex-head bolts, $\frac{25}{64}$ ID flat washers, and locking wire. Coat fuel line connections lightly with liquid gasket cement and connect primer pump fuel line (fig. 89), filter-to-fuel pump fuel line, main fuel line to filter, and drain hose. Turn fuel shutoff valve control lever (fig. 9) to BOTH ON position and inspect all connections for leaks. Install bulkhead door (par. 243).

b. Primer Pump Fuel Filter.

(1) *General.* The primer pump fuel filter (fig. 89) is reached by removing the engine compartment bulkhead door (par. 243) at the rear of the ammunition stowage compartment. As two types of filters are used, the servicing procedures for each type will be designated herein as for "early" engines (before engine serial number 5400) or "late" engines (engine serial number 5400 and up).

(2) *Removal.*

(*a*) *Early engines.* Disconnect primer pump filter fuel line

from each side of filter mounting bracket leading to each bank of cylinders. Disconnect primer pump outlet line at filter. Remove two hex-head bolts and lockwashers and remove primer pump fuel filter with mounting bracket from housing.

(*b*) *Late engines.* Disconnect primer pump filter fuel lines from left or outlet side of filter leading to each bank of cylinders. Disconnect primer pump outlet fuel line from right or inlet side of filter. Remove two hex-head bolts and lockwashers securing filter to mounting bracket and remove filter.

(3) *Disassembly.*

(*a*) *Early engines.* Unscrew primer pump filter from mounting bracket. Loosen knurled nut at bottom of filter bowl, move bail aside, and remove filter bowl with strainer. Remove strainer from bowl and discard cover gasket.

(*b*) *Late engines.* Cut locking wire and unscrew filter bowl from cover. Remove strainer and spring from bowl and discard cover gasket.

(4) *Cleaning and inspection.* The primer pump fuel filter must be cleaned and drained frequently to prevent clogging of primer lines with dirt and to prevent ice formation during cold weather operation. For cleaning purposes it is only necessary to remove the filter bowl as described in (3) above. Clean strainer thoroughly with dry-cleaning solvent or mineral spirits paint thinner. Carefully dry strainer with low pressure compressed air to prevent damage to strainer.

(5) *Assembly.*

(*a*) *Early engines.* Insert strainer into filter bowl. Install new gasket in filter cover. Position filter bowl with strainer in filter cover and move bail under bowl. Turn knurled nut on bail until bowl is tight against cover. Install filter on mounting bracket.

(*b*) *Late engines.* Insert spring and strainer into filter bowl. Install new gasket in filter cover. Install bowl with strainer on cover and tighten securely. Install locking wire.

(6) *Installation.*

(*a*) *Early engines.* Position mounting bracket on supercharger housing and secure with two $\frac{5}{16}$ x $\frac{27}{32}$ hex-head bolts and $\frac{5}{16}$-inch lockwashers. Connect primer pump fuel filter lines from each bank of cylinders to ports on each side of filter mounting bracket. Connect

primer pump outlet line to filter. Install bulkhead door (par. 243).

(*b*) *Late engines.* Position primer pump fuel filter on mounting bracket and secure with two 5/16 x 2 7/32 hex-head bolts and 5/16-inch lockwashers. Connect primer pump fuel filter lines from each bank of cylinders to left or outlet side of filter and connect primer pump outlet line to inlet or right side of filter. Install bulkhead door (par. 243).

152. Fuel Shutoff Valve

a. Removal.

(1) Drain fuel tanks (par. 150*b*).

(2) Remove power plant (par. 126).

(3) Disconnect linkage to control rod, shutoff valve-to-left fuel tank flexible line, and auxiliary generator and engine fuel line from fuel shutoff valve (fig. 122).

Note. Scribe marks on linkage and shaft of shutoff valve to insure proper positioning of linkage during installation.

(4) Remove six hex-head bolts with integral lockwashers securing valve to the right fuel tank and remove valve and gasket. Discard gasket.

(5) Remove wire screen strainer from fuel tank opening.

b. Cleaning and Inspection. Clean wire screen strainer and fuel shutoff valve with dry-cleaning solvent or mineral spirits paint thinner. Dry thoroughly with low pressure compressed air. Inspect valve body and strainer for cracks or breaks.

c. Installation.

(1) Insert wire screen strainer into opening of fuel tank.

(2) Position fuel shutoff valve (fig. 122) and new gasket on fuel tank and secure with six 1/4 x 5/8 hex-head bolts with integral lockwashers.

(3) Connect fuel lines to auxiliary generator and engine and shutoff valve-to-left fuel tank flexible line to fuel shutoff valve. Connect control rod linkage to valve, alining scribe marks made on linkage and valve shaft during removal.

(4) Install power plant (par. 130).

(5) Partially fill fuel tank, and test for leaks and proper valve operation. Complete fuel tank filling operations.

153. Fuel Pump

a. Testing Fuel Pump Vacuum.

(1) Start and run engine for 3 to 5 minutes (par. 43) to be sure that carburetor float bowls are full.

(2) Stop engine and turn fuel shutoff valve control lever to ALL OFF position.

(3) Open the engine compartment grille doors on the left side (fig. 236).

(4) Disconnect fuel filter-to-fuel pump flexible line from fuel pump (fig. 123).

(5) Plug fuel filter-to-fuel pump flexible line.

(6) Connect combination vacuum and pressure gage to inlet side of fuel pump, making all connections secure and leakproof.

(7) Start the engine and idle at 700 rpm on the fuel remaining in the carburetors. Less than one minute's operation of the engine should be sufficient for this test.

(8) Observe gage and stop the engine when maximum reading is indicated. Under normal operating conditions, the fuel pump will produce a minimum vacuum of 10 inches mercury. If gage reading is less than this value, indicator fluctuates, or returns very rapidly to zero when the engine is stopped, replace the fuel pump.

Note. This reading will apply only at sea level. Minimum reading will drop approximately 1-inch for each 1,000 feet of altitude.

(9) Disconnect gage from fuel pump. Remove plug from fuel filter-to-fuel pump flexible line and connect to fuel pump.

(10) Close engine compartment grille doors (fig. 236).

b. Testing Fuel Pump Pressure.

(1) Open engine compartment grille doors (fig. 236) on left side.

(2) Connect a combination vacuum and pressure gage in the fuel line between the fuel pump outlet and the carburetors, making all connections secure and leakproof.

(3) Start the engine and idle at 700 rpm.

(4) Observe gage and stop the engine when maximum reading is indicated. Correct pressure is between 4½ and 6 psi. If the pressure is too low, replace the fuel pump. If the pressure is above 6 psi, the 10 screws which secure cover plate to body assembly should be loosened to free the pulsator diaphragm. Remove bulkhead door (par. 243). Hand turn the engine for 10 revolutions with engine turning wrench (fig. 111) and tighten cover plate attaching screws. This procedure would stretch the pulsator diaphragm and decrease its output. Install bulkhead door (par. 243).

(5) Remove gage and connect fuel line.

(6) Close engine compartment grille doors (fig. 236).

c. Fuel Pump Removal.

(1) Turn fuel shutoff valve control lever to the ALL OFF position.

(2) Open the engine compartment grille doors (fig. 236) on the left side.

(3) Disconnect fuel pump inlet and outlet lines and remove elbows from pump. Remove two jam nuts, hex nuts, and flat washers which secure the fuel pump, and lift off pump and discard gaskets.

d. Fuel Pump Installation.

(1) Coat all fuel line fittings and connections lightly with liquid-type gasket cement before installation. Install the inlet and outlet elbows on fuel pump.

(2) Using new gaskets, position fuel pump on studs and secure with two $^{25}/_{64}$-inch flat washers, $^{3}/_{8}$-inch hex nuts, and $^{3}/_{8}$-inch jamnuts. Connect fuel pump inlet and outlet lines.

Note. Be sure all connections are tight.

(3) Turn fuel shutoff valve control lever to the BOTH ON position, start engine, and check fuel pump for leakage. Close engine compartment grille doors (fig. 236).

154. Carburetors

a. Adjustment.

(1) *Carburetor Fuel Level Check.* Open engine compartment grille doors (fig. 236). With vehicle on level ground, start engine (par. 43) and run at idling speed for 3 to 5 minutes. Stop engine (par. 46). Remove locking wire from fuel level checking plug (fig. 124) in carburetor, and remove plug. If fuel is not visible at the bottom of the threads, the fuel level is too low. If fuel flows freely from hole, the fuel level is too high. Install and tighten plug, and secure with locking wire. If fuel level is incorrect, replace the carburetor (*b* and *c* below). Repeat test on the other carburetor.

(2) *Engine idle speed.* Start and run the engine for at least 10 minutes until it is warmed up to the normal operating temperature (par. 43). Return the throttle linkage to the fully closed position and observe the tachometer reading, which must be 650 rpm. If the speed varies more than 50 rpm, adjust the speed by means of the idle speed ad-

justing screws (fig. 124) on each carburetor. Turn adjusting screws on both carburetors until the engine idles at the recommended idling speed. To increase idle speed, turn the screws clockwise. To decrease the speed, turn the screws counterclockwise. If the engine does not idle smoothly at 650 rpm, and the float level has been tested and found correct ((1) above) stop the engine and adjust the carburetor idle mixture ((3) below). Then start the engine and readjust the idle speed adjusting screws. As soon as adjustment is completed, stop the engine.

(3) *Carburetor idle mixture.* Adjust the carburetor idle mixture with the engine stopped. Very carefully turn each of the idle mixture adjusting screws (fig. 124) on both carburetors clockwise until they seat lightly.

Caution: Do not turn the screws down tight.

Back off each screw one-quarter turn. Start and run the engine for at least 10 minutes until it is warmed up to the normal operating temperature. Return the throttle linkage to the closed position. If the engine does not idle smoothly, vary the adjustment by turning the screws slightly in the direction which improves idling. Readjust the idle speed adjusting screws ((2) above). Stop the engine.

(4) *Throttle linkage adjustment.* To insure uniform main engine idling speed and fuel-air mixture, the throttle valve plates of both carburetors must be in exact synchronization at idle and low throttle position. Carburetor throttle valve shaft levers, governor rocker arm, and vehicle control lever must contact their respective stops simultaneously at the idle position (par. 158). If any mismatch in throttle valve position is necessary, it should occur at wide open throttle, not at idle.

b. Removal. The procedure for removing either carburetor is the same.

(1) Open engine compartment grille doors and remove front air outlet grilles (pars. 234).

(2) Loosen air cleaner hose clamp from carburetor inlet elbow. Remove five self-locking nuts and flat washers which secure inlet elbow to carburetor and raise elbow off studs and slip elbow out of hose. Strip off gasket.

(3) Disconnect carburetor fuel at carburetor fuel inlet (fig. 124). Disconnect throttle control linkage at carburetor. Unscrew connectors and remove electrical cables from both

degassers (fig. 124). Disconnect at carburetor, vent lines from the ignition harness, magnetos, aspirators, and crankcase breather line. Remove four hex jamnuts, hex nuts, and flat washers and remove carburetors. Remove spacer and strip off gaskets from both sides of spacer. Discard gaskets.

c. Installation. The procedure for installing either carburetor is the same.

(1) Place two new gaskets on studs, separated by the spacer. Position carburetor on studs and secure with four $^{25}/_{64}$-inch flat washers, $^{3}/_{8}$-inch hex nuts, and $^{3}/_{8}$-inch hex jamnuts. Connect electrical cable connectors to degassers. Connect throttle control linkage. Connect vent lines from the ignition harness, magnetos, aspirators, and crankcase breather line. Connect carburetor inlet fuel line.

Caution: Be sure the carburetor inlet fuel lines and the aspirator lines are not cross-connected during installation.

(2) Position inlet elbow loosely in air cleaner hose and using a new gasket, position the inlet elbow on carburetor. Secure with five $^{5}/_{16}$-inch self-locking nuts and $^{9}/_{32}$-inch flat washers.

(3) Position air cleaner hose on carburetor inlet elbow and tighten hose clamp securely.

(4) Start engine (par. 43) and adjust carburetor (*a* above). Inspect fuel line connections and gasket for leaks. Stop engine (par. 46).

(5) Install front air outlet grilles (par. 234) and close engine compartment grille doors.

155. Degassers

a. Removal. The procedure for removing any one of the four degassers is the same.

(1) Remove carburetor (par. 154*b*).

(2) Disconnect electrical cable from the degasser (fig. 124) by unscrewing cable connector.

(3) Remove locking wire from three fillister-head screws which extend into the carburetor body and remove the screws.

Note. Using a close-quarter screwdriver, remove three screws which extend into the carburetor body having larger heads than the other screws in the degasser body.

(4) Remove degasser and gasket. Discard gasket.

b. Installation. The procedure for installing any one of the four degassers is the same.

(1) Using a new gasket, position degasser (fig. 124) on carburetor body and secure with three No. 10 x 1⅞ fillister-head screws. Tighten screws uniformly and secure with locking wire.

(2) Connect electrical cable connector to degasser.

(3) Install carburetor (par. 154c).

156. Primer Pump

a. Removal. Turn inlet priming lines shutoff valve below the personnel heater in the driver's compartment in a clockwise direction until fully closed. Disconnect the primer outlet and inlet tubes from the primer pump body (fig. 128) connectors. Remove cotter pin from priming pump mounting bracket. Loosen pump barrel upper locknut and slide pump off mounting bracket.

b. Disassembly. Remove diaphragm cap (fig. 128) from pump body and lift out spring, guide, diaphragm, gasket, and screen. Unscrew knob from plunger and remove packing retaining nut from packing gland. Remove and discard packing rings and gasket from gland.

c. Cleaning and Inspection. Clean all parts in dry-cleaning solvent or mineral spirits paint thinner. Inspect diaphragm and screen for cracks or breaks. Replace any defective parts.

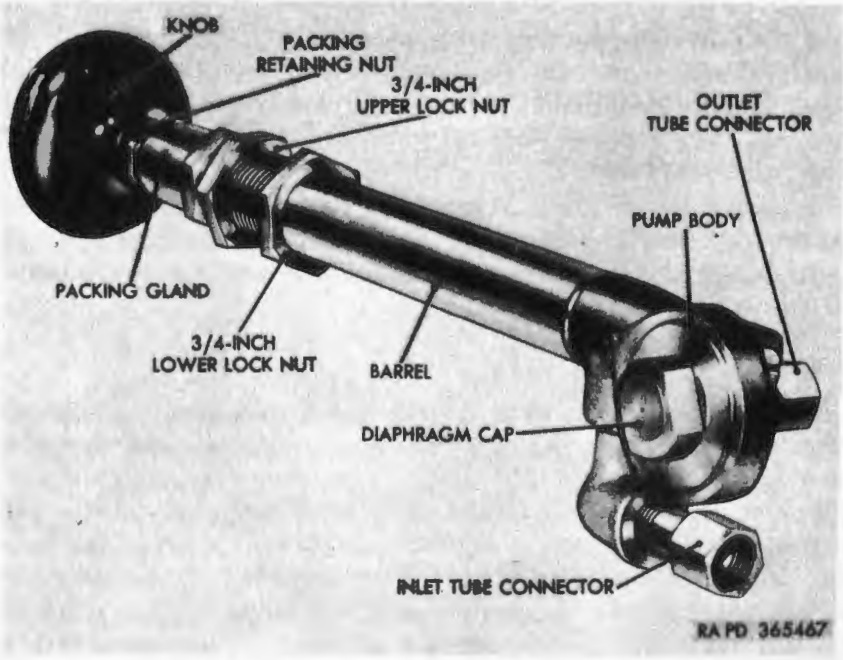


Figure 128. Primer Pump.

d. Assembly. Install in order, screen, gasket, diaphragm, spring guide, spring, and diaphragm cap in pump body (fig. 128). Insert new packing rings and gasket in packing gland and secure with packing retaining nut. Install knob on plunger.

Note. Moisten packing rings sparingly with oil to prevent cutting or tearing and to insure a tighter seal.

e. Installation. Position primer pump onto mounting bracket and tighten ¾-inch upper locknut (fig. 128). Install 5/16 x 2½ cotter pin in mounting bracket. Connect primer inlet and outlet tubes to primer body connectors. Turn inlet priming line shutoff valve in a counterclockwise direction until fully open. Test pump action and inspect connections for leaks.

157. Fuel Lines

a. Fuel lines are provided to supply fuel from either or both fuel tanks to the two carburetors on the main engine, the carburetor on the auxiliary generator and engine, the primer pump, and the personnel heater. A fuel shutoff valve (fig. 122) is provided for selection of the fuel tank to be used. Fuel is normally used from both tanks at the same time. The personnel heater fuel line and primer pump inlet line are joined with a tee connection and fed from one outlet of the main engine fuel filter. The primer pump outlet line is connected to the priming system of the main engine through the primer pump filter.

b. When replacing any lines or connections, lightly coat all threaded elbow and tee connections with liquid type gasket cement before installation, being careful not to use an excess amount. Check to see that all lines are securely mounted with clips where provided.

Caution: Be certain all connections are tight. Test for possible leakage by turning fuel shutoff valve control lever to the BOTH ON position and checking all fuel line connections and components before placing vehicle into operation.

158. Throttle Control Linkage

a. Description. The hand throttle and the accelerator pedal are connected by linkage (fig. 129) to the main engine carburetor control cross shaft levers (fig. 123). A governor is connected into this linkage by a spring-loaded, compound lever that controls the maximum engine speed. Adjustment of the throttle control linkage (*b* below) is accomplished by inserting a ⅛-inch diameter pin in the indexing holes of each bellcrank and lengthening or shortening the individual control rods as necessary. Adjustment must be made with throttle controls in the "idle" position.

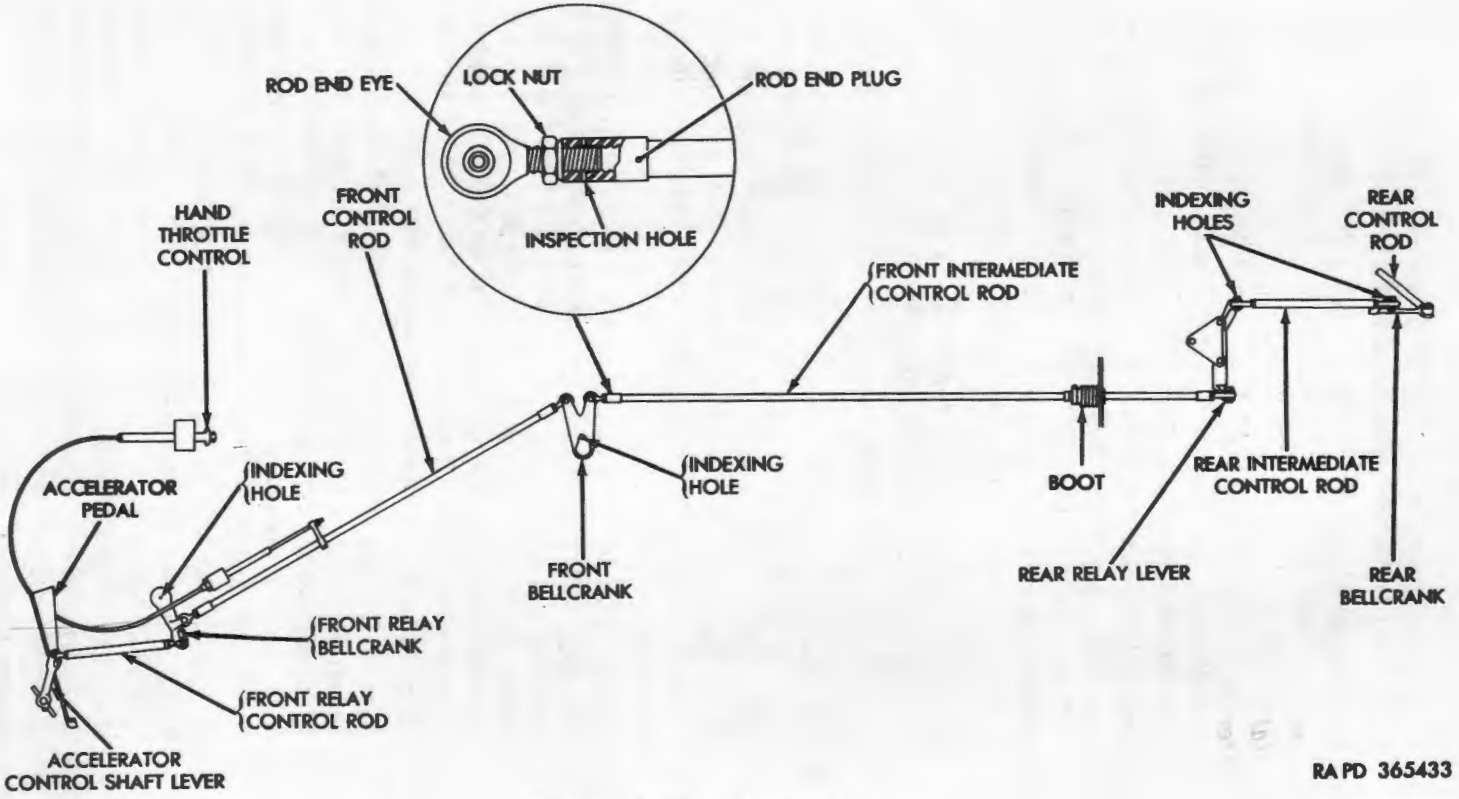


Figure 129. Throttle control linkage.

b. Throttle Linkage Adjustment.

(1) Open engine compartment grille doors (fig. 236) and remove front air outlet grilles (par. 234).

(2) Remove locking wire, hex-head bolt, and lockwasher securing front relay control rod (fig. 129) to front relay bellcrank.

(3) Position front relay bellcrank (fig. 129) so that a ⅛-inch diameter pin can be inserted through indexing holes in bellcrank and insert pin through holes.

(4) Loosen locknut on rod end eye of front relay control rod (fig. 129) and adjust rod end eye so a ¼ x 1 hex-head bolt fits freely between bellcrank and control rod end eye. Secure rod end eye in position by tightening locknut.

Note. At all times, rod end eye should be screwed up to or past inspection hole in rod end plug (fig. 129).

Secure control rod to bellcrank with ¼ x 1 hex-head bolt, ¼-inch lockwasher, and locking wire.

Note. Check that control rod can be rotated and does not bind when accelerator pedal is fully depressed.

(5) Remove locking wire, two hex-head bolts, and lockwashers securing front control rod (fig. 129) and front intermediate control rod to front bellcrank. Position bellcrank so that ⅛-inch diameter pin can be inserted through indexing holes provided in bellcrank and insert pin through holes.

(6) Loosen locknuts on rod end eyes of front relay control rod (fig. 129) and intermediate control rod. Adjust control rod end eyes so ¼ x 1 hex-inch bolts fit freely between front bellcrank and control rod end eyes. Secure rod end eyes in position by tightening locknuts. Secure control rods to front bellcrank with two ¼ x 1 hex-head bolts, ¼-inch lockwashers and locking wire.

(7) Remove locking wire, two hex-head bolts and lockwashers securing rear control rod (fig. 129) and rear intermediate control rod to rear bellcrank. Position bellcrank so that ⅛-inch diameter pin can be inserted in indexing holes provided in bellcrank and insert pin through holes.

(8) Loosen locknuts on rod end eyes of rear control rod (fig. 129) and rear intermediate control rod. Adjust control rod end eyes so ¼ x 1 hex-head bolts fit freely between rear bellcrank and control rod end eyes. Secure rod end eyes in position by tightening locknuts. Secure control rods to front bellcrank with two ¼ x 1 hex-head bolts, ¼-inch lockwashers and locking wire.

(9) Remove 1/8-inch diameter pins from indexing holes in front relay, front, and rear bellcranks.

(10) Remove cotter pin, hex nut, flat washers and hex-head bolt that secure each throttle control rod to the carburetor control cross shaft lever (fig. 123).

(11) Turn both idle adjusting screws (fig. 123) counterclockwise several turns.

(12) Loosen jamnuts (fig. 123) and adjust throttle control rod so that carburetor lever strikes full throttle lever stop simultaneously with the governor rocker arm. Do not tighten jamnuts at this time.

(13) Hold throttle valve plate closed on one carburetor and turn idle adjusting screw (fig. 123) on carburetor until it contacts the adjustment face on the throttle valve shaft lever.

(14) Follow procedure outlined in (13) above for the other carburetor.

(15) Position throttle control rods on carburetor control throttle valve shaft levers (fig. 123) and secure each with No. 10 x 1 5/32 hex-head bolt, two 13/64-inch flat washers, No. 10 hex nut, and 1/16 x 3/4 cotter pin.

(16) Depress accelerator pedal to full throttle position.

(17) Check that the governor rocker arm (fig. 123) and throttle valve shaft lever on each carburetor strike their full throttle stops simultaneously. If the pedal when fully depressed does not give full throttle, shorten front relay control rod ((6) above); if full throttle is attained before the pedal is fully depressed, lenghten front relay control rod. Tighten jamnuts (fig. 123) on throttle control rod turn buckle.

(18) Return linkage to the IDLE position.

(19) Screw the idle adjusting screw (fig. 123) on each carburetor clockwise until they just touch the throttle valve shaft lever.

(20) Start engine (par. 43) and adjust idle speed and mixture in normal manner (par. 154). Stop engine (par. 46) after adjustment is complete.

(21) When adjustment has been completed, be sure that both idle adjusting screws (fig. 123) are in contact with the carburetor throttle valve shaft lever, so that they will function as idle stops. This will prevent possible twisting of the carburetor throttle lever shafts.

(22) Close engine compartment grille doors (fig. 236) and install front air outlet grilles (par. 234).

159. Air Cleaners

a. Servicing. The procedure for servicing either air cleaner is the same.

(1) *Remove air cleaner oil cup and filter element.* Release oil cup bail (fig. 130) and remove oil cup by rotating one-eighth turn clockwise and disengaging cup from oil cup guide of air cleaner and remove oil cup (fig. 131). Loosen three wing nuts that secure filter element and remove filter element by rotating one-eighth turn clockwise to disengage wing nuts from element.

(2) *Clean and inspect.* Discard old oil. Scrape accumulated dirt from oil cup and clean oil cup and filter element thoroughly with dry-cleaning solvent or mineral spirits paint thinner. Inspect parts for cracks or breaks.

(3) *Install air cleaner oil cup and filter element.* Position filter element in air cleaner and rotate slightly to engage the three wingnuts. Tighten wingnuts. Fill oil cup as specified on the lubrication order LO 9–7218 (par. 90) to the oil level mark on the cup. Install oil cup on air cleaner and rotate until engaged in oil cup guides of air cleaner (fig. 130). Position oil cup bail beneath oil cup and secure to oil cup bail hook.

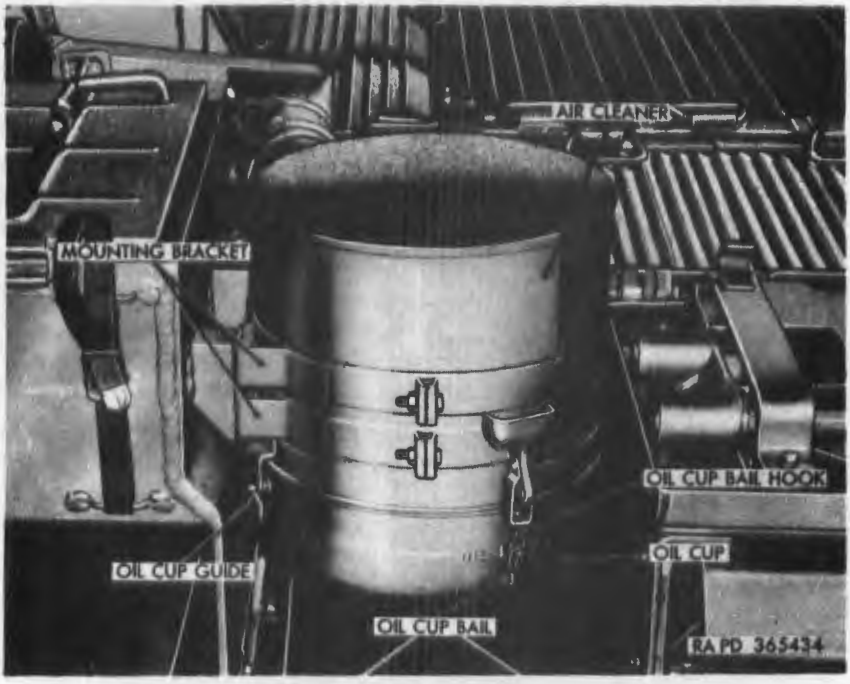


Figure 130. Left air cleaner—installed.

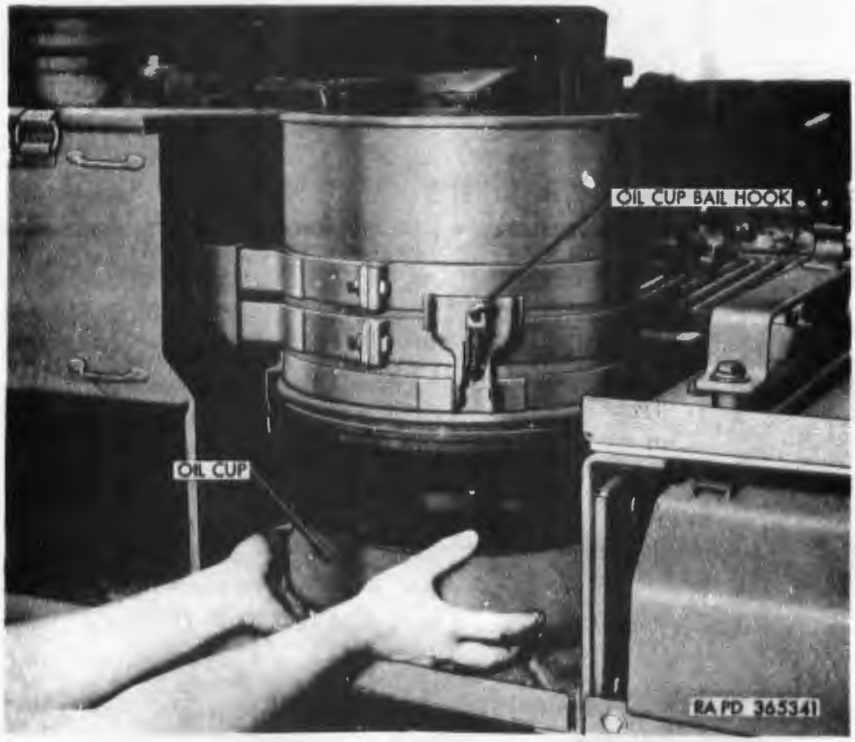


Figure 131. Removing air cleaner oil cup.

b. Air Cleaner Air Inlet and Air Outlet Ducts (fig. 132). The air cleaner, air inlet, and air outlet ducts direct air for the main engine carburetors, from the air duct valve housing, to the air cleaner; and from the air cleaner to the carburetor elbow. Air can be drawn from either the stowage compartment or outside the vehicle. The source of air is controlled by the air duct valve within the air duct valve housing. For cold weather operation, loosen the hex-head bolt securing the air duct valve housing and rotate the air duct valve so that air is drawn from outside the vehicle. For normal operation, air is drawn from the stowage compartment. During cold weather operation, air must be drawn from outside the vehicle since the main engine draws so large a volume of air the pressure in the driving compartment may drop, causing the personnel heater to operate inefficiently.

c. Removal of Air Cleaners. Procedure for removing either air cleaner is the same.

(1) Remove oil cup and filter element (*a*(1) above).

(2) Loosen hose clamps (fig. 132) and on the inlet and outlet hose and remove hose from air cleaner inlet and outlet tubes.

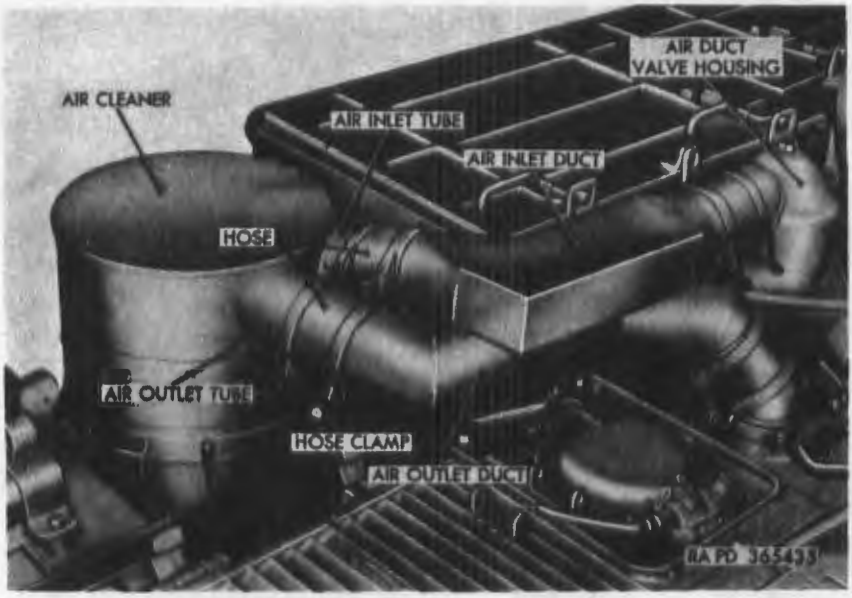


Figure 132. Air intake system—left side.

(3) Remove two squarehead bolts and nuts from mounting brackets (fig. 130), spread brackets and remove air cleaner.

d. Installation of Air Cleaners. Procedure for installing either air cleaner is the same.

(1) Spread both mounting brackets and then lower air cleaner with oil cup removed, into position so that small ridge of air cleaner (fig. 130) is even with top edge of upper mounting bracket. Air inlet and outlet tubes (fig. 132) on air cleaner should be turned toward power plant. Secure with two $\frac{5}{16}$ x $1\frac{1}{2}$ squarehead bolts and $\frac{5}{16}$-inch hex nuts.

(2) Position hose (fig. 132) on air cleaner inlet and outlet tubes and tighten hose clamps securely.

Note Position hose clamps so that clamp screws are below the horizontal centerline of the hose to prevent damage to clamps when closing the hinged grille doors.

(3) Install filter element and oil cup (par. *a*(3) above).

160. Exhaust Mufflers

a. General. The procedure for removing either left or right muffler is the same with the exception that a tool rack is mounted over the right muffler and a track shoe rack is mounted on the left muffler (*c* below).

b. Removal (fig. 133).

(1) Remove four hex nuts, lockwasher, and cap screws securing the tool rack mounted on the right muffler or the track shoe rack mounted on the left muffler.

(2) Remove four hex-head bolts, lockwashers, flat washers, and hex nuts that secure the muffler shield on the outer edge and remove two self-locking hex nuts, flat washers, and spacers on inner edge, and remove muffler shield.

(3) Cut locking wire and remove four hex-head bolts and flat washers securing muffler to mounting brackets and lift muffler off by sliding it outward and upward to disengage muffler inlet from muffler connector.

c. Installation (fig. 133).

(1) Slide muffler into position engaging the muffler inlet with the muffler connector. Secure muffler to fender with four ½ x 1 hex-head bolts, 9/16-inch flat washers, and locking wire.

(2) Position muffler shield over muffler and secure with two ⅜ x ¾ hex-head bolts, ⅜-inch lockwashers, 13/32-inch flat washers, and ⅜-inch hex nuts on the outer edge and two ⅜-inch self-locking hex nuts, 13/32-inch flat washers, and muffler shield bracket spacers on the inner edge.

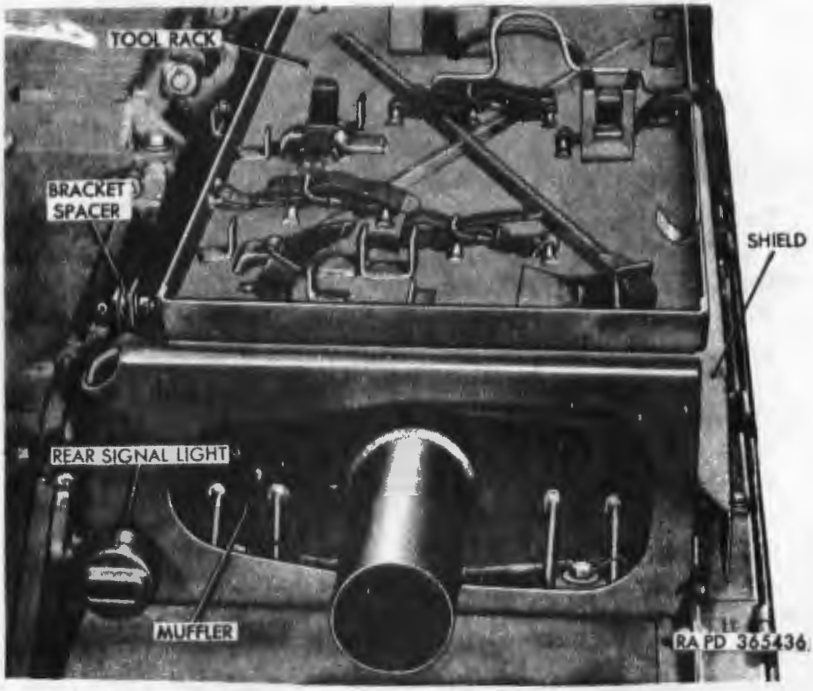


Figure 133. Right exhaust muffler—installed.

(3) Install the tool rack over the right muffler or the track shoe rack over the left muffler and secure with four ½ x 1¼ cap screws, ½-inch lockwashers, and ½-inch hex nuts.

161. Exhaust Stacks

a. Removal. The removal of either exhaust stack, which connect the exhaust mufflers to the engine exhaust manifolds, is identical.

(1) Remove engine compartment center grilles (par. 234) and open grille doors (fig. 236).

(2) Release latches securing cooling ducts (B, fig. 90) around exhaust stacks and remove duct.

(3) Loosen clamps securing exhaust stack to engine exhaust manifold and exhaust muffler connector extending through hull wall to muffler. Remove stack and clamps.

b. Installation. The installation of either exhaust stack is identical.

(1) Position slip clamps on exhaust stack. Secure stack to engine exhaust manifold and exhaust muffler connector, tightening clamps securely.

(2) Place cooling duct around stack and secure latches.

(3) Install engine compartment center grilles (par. 234) and close grille doors (fig. 236).

Section IX. COOLING SYSTEM

162. Description

The entire cooling system is integral with the engine and consists of an engine oil cooler (fig. 134), transmission oil cooler, cooling fan and clutch, fan shroud, and deflectors. Air for cooling the engine, engine oil, and transmission oil is drawn in through the grille doors (fig. 236) of the engine compartment and directed under the engine. The air is then drawn through the cylinder cooling fins, deflectors, and oil coolers by the fan rotor which forces the used air out through the fan vane outlet housing and air outlet grilles of the engine compartment. The cooling effect is increased by shrouding to the top of the cylinder cooling fins. Air ducts (fig. 134) around the exhaust stacks permit air to be drawn in from outside the hull to pass over and cool the exhaust stacks. This air is forced out along with that from the cylinder and oil coolers by the fan rotor. Normal operating temperature of the engine oil and transmission oil is maintained through the use of a thermal bypass valve (par. 133) located in each of the oil coolers.

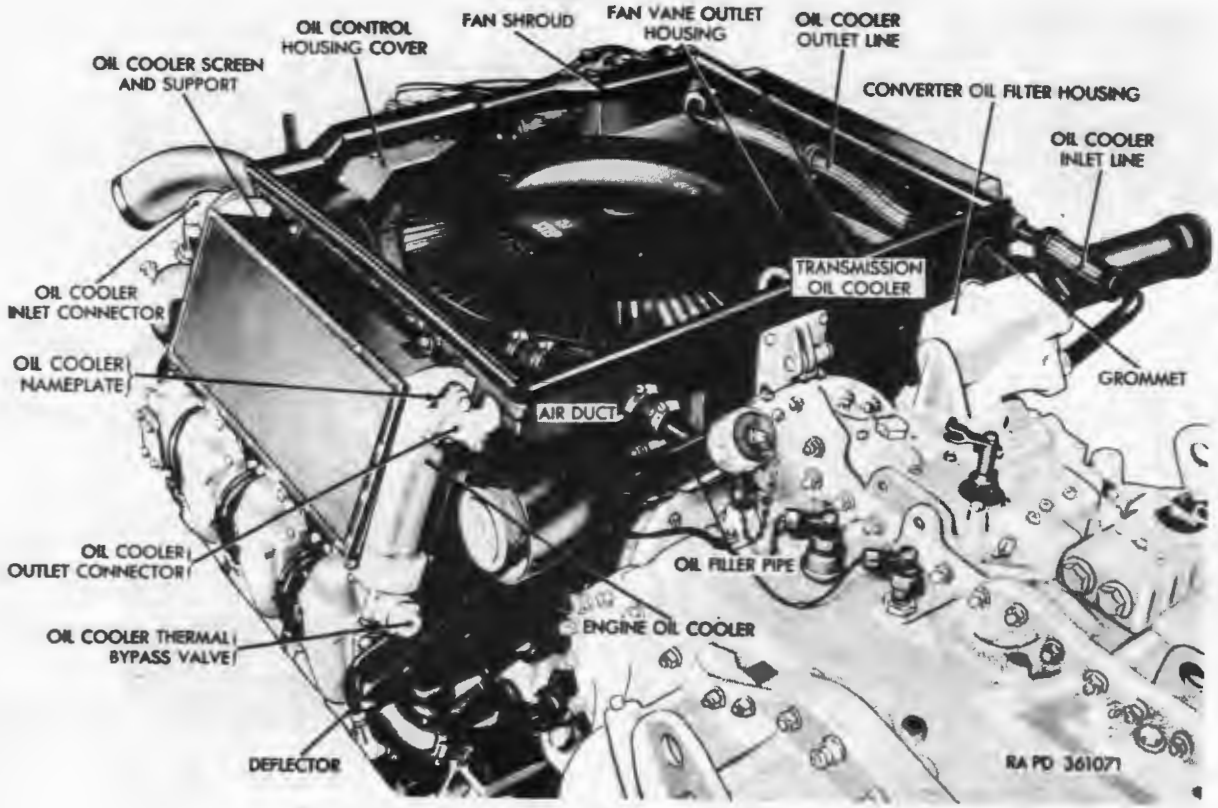


Figure 134. Oil coolers and fan shroud—installed view.

When the oil temperature is low, the oil does not circulate through the oil coolers.

163. Engine Fan Rotor and Drive Clutch

a. General. The fan motor is a 12-blade unit mounted horizontally above the engine and driven by bevel gears through a drive clutch (fig. 135) incorporated in the hub. The main purpose of the fan drive clutch is to provide a safety slipping action in the fan drive system which will absorb any sudden increase in load such as may be encountered during a deep water fording operation.

b. Removal. Remove air outlet grilles and grille supports over engine compartment (par. 234). Remove six hex-head bolts with integral lockwashers and remove oil control housing cover (fig. 134). Remove 14 self-locking hex nuts that secure fan vane outlet housing to engine shroud and remove outlet housing. Remove three roundhead screws with integral lockwashers that secure drive shaft cover to fan and remove cover. Remove cotter pin from slotted nut and remove nut from fan drive shaft with a 1¼-inch socket or box wrench (fig. 136). Remove fan rotor and clutch assembly.

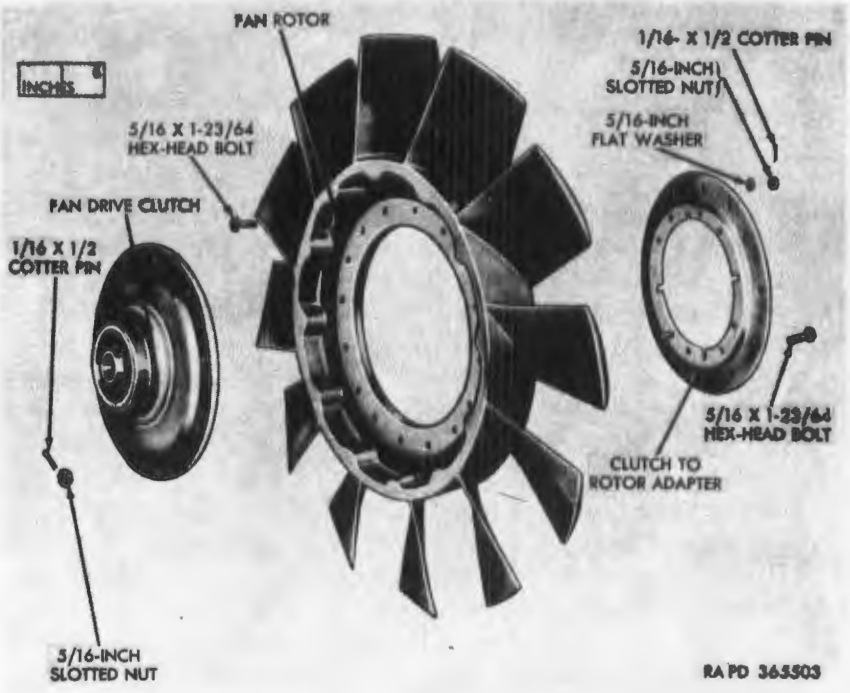


Figure 135. Fan rotor and drive clutch—exploded view.

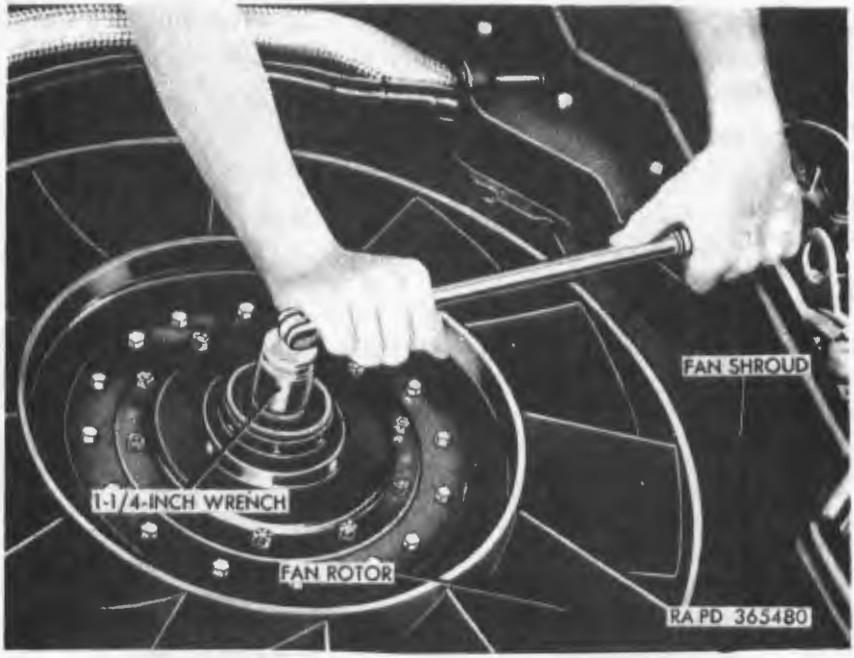


Figure 136. Removing fan rotor.

c. Disassembly (fig. 135). Remove 16 cotters pins, slotted nuts, hex-head bolts, and 32 flat washers securing fan drive clutch and clutch to rotor adapter to fan rotor and separate clutch and adapter from rotor. Remove 10 cotter pins, slotted nuts, and hex-head bolts securing fan drive clutch to adapter and separate clutch from adapter.

d. Assembly (fig. 135). Install clutch to rotor adapter on fan drive clutch, alining adapter dowel in clutch housing dowel hole. Secure clutch to adapter with ten $\frac{5}{16}$ x $1\frac{51}{64}$ hex-head bolts, $\frac{5}{16}$-inch slotted nuts, and $\frac{1}{16}$ x $\frac{1}{2}$ cotter pins. Position assembly clutch and adapter on fan rotor and secure with sixteen $\frac{5}{16}$ x $1\frac{23}{64}$ hex-head bolts, $\frac{5}{16}$-inch slotted nuts, $\frac{1}{16}$ x $\frac{1}{2}$ cotter pins, and thirty-two $2\frac{1}{64}$-inch flat washers.

Note. To maintain proper balance of fan rotor and clutch, be sure to use the correct number and type of bolts, nuts, and washers.

e. Installation. Position assembled fan rotor, clutch, and adapter on splined drive shaft, and install $\frac{3}{4}$-inch slotted nut and cotter pin. Tighten nut with a $1\frac{1}{4}$-inch socket or box wrench (fig. 136). Position drive shaft cover on fan rotor and secure with three $\frac{1}{4}$ x $\frac{9}{16}$ roundhead screws with integral lockwashers. Position fan vane outlet housing (fig. 134) on fan shroud and secure with fourteen $\frac{5}{16}$-inch self-locking nuts. Install oil control housing cover

and secure with six 5/16 x 5/16 hex-head bolts with integral lockwashers. Install air outlet grilles and grille supports over engine compartment (par. 234).

164. Engine and Transmission Oil Coolers

a. General (fig. 134). The transmission oil cooler is mounted over cylinders 1–3–5 and cools the oil for the transmission; the engine oil cooler is mounted over cylinders 2–4–6 and cools the oil for the engine. The flow of oil through the coolers is controlled by an oil cooler thermal bypass valve located at the bottom end of each oil cooler, as well as the oil cooler bypass valve in the oil control housing. Removal and installation of both oil coolers is accomplished in essentially the same manner.

b. Removal.

(1) Remove power plant (par. 126).

(2) Disconnect oil cooler inlet and outlet lines (fig. 134) at oil cooler inlet and outlet connectors, using wrench 5120–708–3738 (fig. 137).

(3) Remove locking wire, six hex-head bolts, and lockwashers that secure oil cooler inlet and outlet connectors (fig. 134) to oil cooler. Remove connectors and gaskets and discard gaskets.

Figure 137. Removing oil cooler lines.

(4) Remove oil cooler screen and support (fig. 134) by cutting locking wire and removing two jamnuts and hex nuts at bottom of support and removing two hex-head bolts with integral lockwashers at top of support. Remove oil cooler screen and support from oil cooler.

(5) Cut locking wire and remove two hex-head bolts and flat washers from lower portion of oil cooler. Remove three jamnuts and hex nuts securing upper portion of oil cooler to fan shroud. Remove oil cooler and drain oil into waste oil receptacle.

Caution: Extreme care should be exercised during removal to prevent damage to the core and cooling fins of the cooler.

c. Cleaning and Inspection. Remove oil cooler thermal bypass valve (par. 138). Clean oil coolers internally by flushing with dry-cleaning solvent or mineral spirits paint thinner. Remove dirt and foreign matter from external surfaces with a stiff brush and low pressure air hose. Make a visual inspection of oil cooler for dents or cracks. Seal openings of oil coolers and apply internal air pressure with a tire pump and adapter (not to exceed 60 psi), immerse in clear water and examine cooler for leaks. If leaks are found, oil cooler must be replaced. Install thermal bypass valve (par. 138) after cleaning oil coolers.

d. Installation.

(1) Position oil cooler (fig. 134) on engine and fan shroud. Secure lower portion of cooler to engine with two 3/8 x 3 53/64 hex-head bolts and 25/64-inch flat washers. Secure cooler to fan shroud by installing three 3/8-inch hex nuts and 3/8-inch jamnuts on oil cooler studs extending through fan shroud.

(2) Position oil cooler screen and support (fig. 134) on oil cooler and fan shroud. Secure support to cooler with two 5/16-inch hex nuts, 5/16-inch jamnuts, and locking wire. Secure support to fan shroud with two 5/16 x 5/16 hex-head bolts with integral lockwashers.

(3) Position oil cooler outlet connector (fig. 134) and new gasket on outlet of oil cooler and secure with one 3/8 x 1 61/64 hex-head bolt at inside and two 5/8 x 1 5/64 hex-head bolts at top and outside of connector flange. Secure bolts in place with locking wire.

(4) Position oil cooler inlet connector (fig. 134) on inlet of oil cooler and secure with three 3/8 x 1 5/64 hex-head bolts. Secure bolts in place with locking wire.

(5) Connect oil cooler inlet and outlet lines (fig. 134) to oil cooler connectors using wrench 5120–708–3738 (fig. 137).

(6) Record the replacement on DA Form 478.

165. Engine and Transmission Oil Cooler Lines

a. General. The removal of the engine oil cooler or transmission oil cooler lines (fig. 134) is identical with the exception that the engine oil cooler lines are attached to the inlet and outlet connectors of the engine oil control housing whereas the transmission oil cooler lines are attached to the inlet and outlet connectors on the converter oil filter housing of the transmission.

b. Removal.

(1) Remove engine compartment grilles and grille supports (par. 234).

(2) Disconnect oil cooler lines from inlet and outlet connectors of oil cooler using wrench 5120–708–3738 (fig. 137).

(3) Disconnect opposite ends of oil lines from inlet and outlet connectors at engine oil control housing or transmission converter oil filter housing and remove oil cooler inlet line.

(4) Remove hex-head bolt with integral lockwasher and closed clip securing oil cooler outlet line to fan shroud and remove outlet line.

c. Cleaning and Inspection. Clean oil cooler lines with dry-cleaning solvent or mineral spirits paint thinner. Make a visual inspection for dents and cracks. Straighten any dents that interfere with oil flow. Repair or replace any parts with cracks that might develop into an oil leak.

d. Installation.

(1) Position oil cooler outlet line on fan shroud and secure with $\frac{5}{16}$ x 1 hex-head bolt with integral lock washer and closed clip to fan shroud.

Note. Check installation of oil cooler outlet line to be sure that grommet (fig. 134) protects oil line from being cut by fan shroud.

(2) Connect oil cooler inlet line to lower or outlet connector and oil cooler outlet line to upper or inlet connector of engine oil control housing or transmission converter oil filter housing using wrench 5120–708–3738 (fig. 137).

(3) Connect oil lines to oil cooler inlet and outlet connectors.

(4) Install engine compartment grilles and grille supports (par. 234).

Section X. STARTING SYSTEM

166. Description and Data

a. Starting System Wiring (fig. 138). The starting system wiring consists of a control circuit carrying very little current and a starter circuit conducting heavy current from the batteries to the starter. The control circuit is routed from the batteries, through the master relay to a circuit breaker in the instrument panel to the main engine starter switch; from the starter switch through the neutral safety switch on the range selector control box, through the starter relay on the left battery box bracket, to ground. The main engine starter switch current is routed from the batteries, through the master relay, through the starter relay, to the starter motor, and then to ground.

b. Starter. A 24-volt, waterproof starter (fig. 139) is mounted on the lower right side of the accessory end of the engine. The engine may be equipped with an Eclipse-Pioneer starter or a Jack and Heintz starter. These starters are essentially the same, differing only in the method of mounting. Each starter consists of a motor section and a gear section. The motor section comprises a commutator, field coil, and an armature and pinion assembly. The starter motor is a series-parallel wound, 4-pole unit, with 4 brushes. Included in the gear section are the reduction gears, clutch, screw shaft, and starter jaw. The gear section is bolted to the drive end of the motor. The terminal stud extends into the commutator end head and is accessible through a watertight access hole cover located on the rear of the starter. An oil seal in the gear section prevents engine oil from entering the starter.

c. Starter Relay. The starter relay (fig. 143) is bracket mounted with the rear support bracket of the left battery set to the hull wall. This relay contains heavy duty contacts which are spring-loaded to a normal-open position and serve to connect the electrical power supply to the starter. The relay circuit (fig. 138) is completed when the starter switch (C–2, fig. 15) on the instrument panel is turned to the start position.

Note. The range selector control lever must be in the NEUTRAL PARK position for the starter relay to be energized.

d. Neutral Safety Switch. The neutral safety switch is spring-loaded in a normal-open position and is mounted in the range selector control box (fig. 11). Its purpose is to prevent starting the vehicle unless the range selector control lever is in the NEUTRAL PARK position.

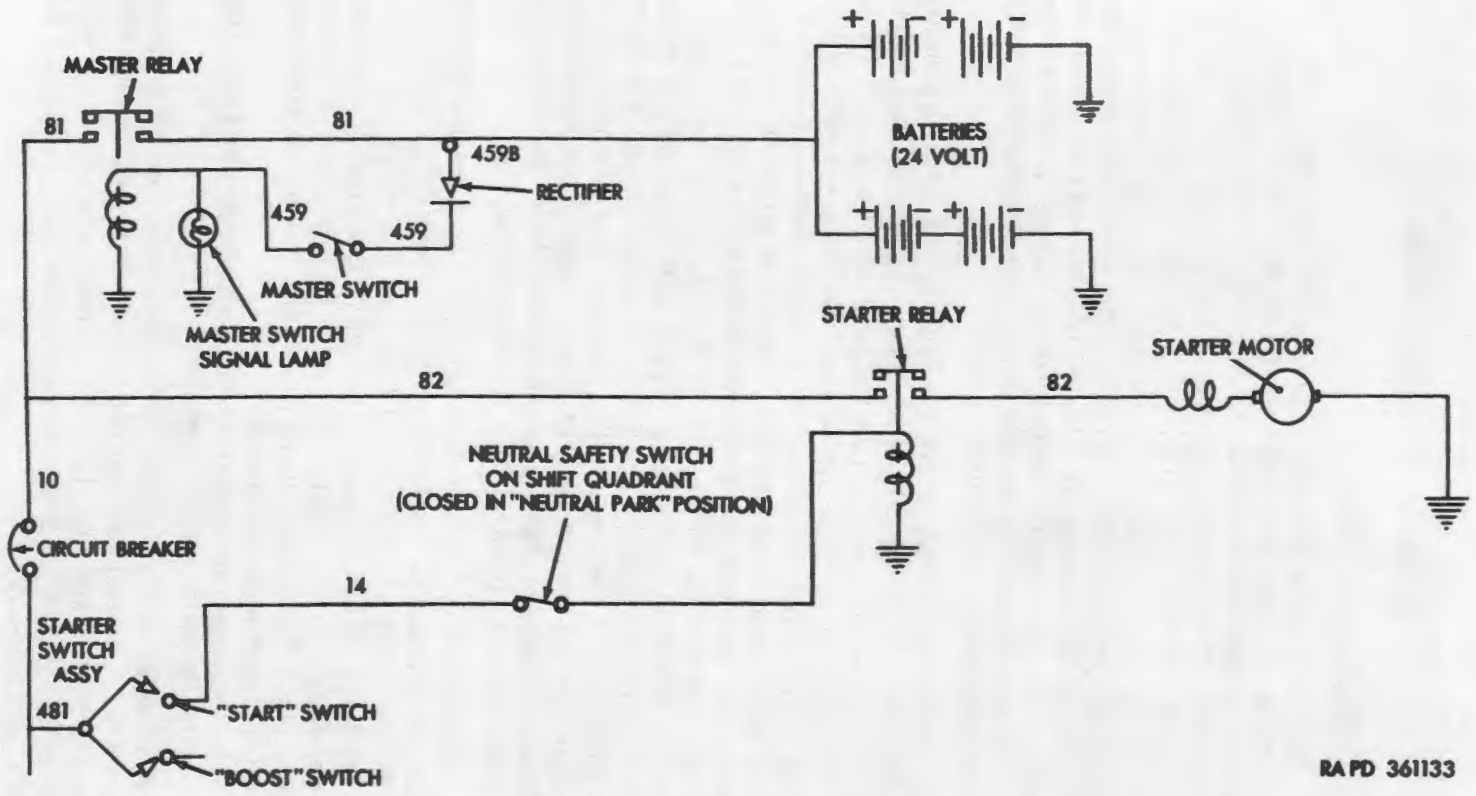


Figure 138. Starter circuit schematic wiring diagram.

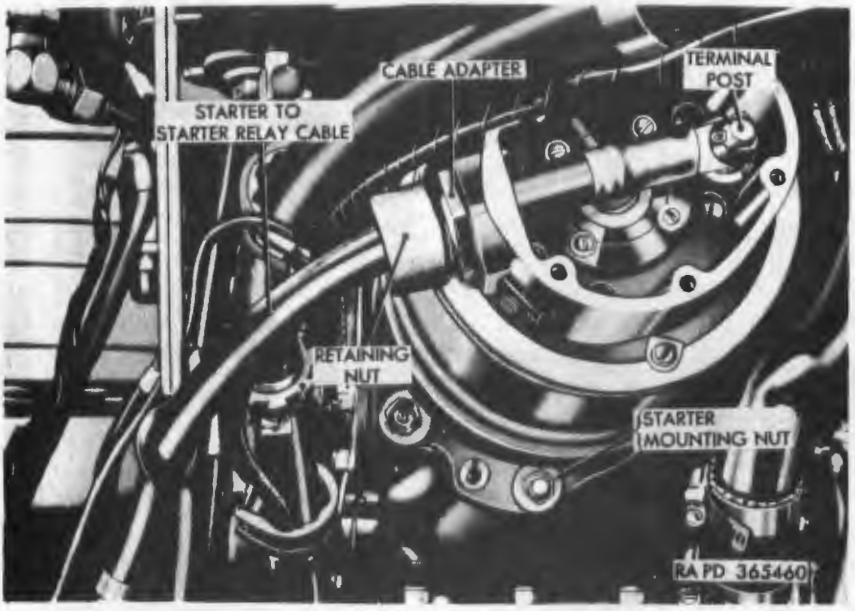


Figure 139. Jack and Heintz starter with cover removed—mounted on engine.

e. Data.

Starter:

Manufacturer		Jack and Heintz or Eclipse-Pioneer
Ordnance part numbers:		
Early engines:	Jack and Heintz (quick-disconnect).	7538988
	or	
	Eclipse-Pioneer (adapter and retaining ring).	7346519
Late engines:	Jack and Heintz (stud mounted)	8365476
	or	
	Eclipse-Pioneer (stud mounted)	7705699
Manufacturer's model number:		
Early engines:	Jack and Heintz (quick-disconnect).	D30
	or	
	Eclipse-Pioneer (adapter and retaining ring).	36E16–1A
Late engines:	Jack and Heintz (stud mounted)	D42
	or	
	Eclipse-Pioneer (stud mounted)	1416–29G

Starter relay:

Manufacturer	Cutler Hammer
Ordnance part number	7983413

Neutral safety switch:

Manufacturer	Soreng Mfg Co
Ordnance part number	7419666

167. Starter

a. General. This paragraph provides information for the removal, installation, and interchangeability of main engine starters used on this vehicle. Early engines with serial Nos. through 2789 were equipped with a Jack and Heintz starter with quick-disconnect type mounting. This starter is interchangeable with the Eclipse-Pioneer starter having the adapter and retaining ring mounting. Late engines with serial No. 2790 and up are equipped with the stud-mounted type Jack and Heintz starter and this starter is interchangeable with the Eclipse-Pioneer having the adapter and stud mounting.

Note. Wrench C8708189, if available, should be used to remove and install starter mounting nuts.

b. Removal of Stud-Mounted Starter (fig. 139).

(1) Remove power plant (par. 126).

(2) Remove six fillister-head screws and lockwashers securing motor end cover and gasket to starter and remove cover and gasket.

(3) Loosen retaining nut and remove cable adapter from starter housing.

(4) Remove starter to starter relay cable from terminal post by removing cotter pin, castellated nut, lockwasher and two flat washers.

(5) Remove six jamnuts, hex nuts, and flat washers securing starter to engine and remove starter and gasket being careful not to damage starter pinion shaft. Discard the gasket.

c. Installation of Stud-Mounted Starter (fig. 139).

(1) Position new gasket on starter mounting studs and insert starter into engine being careful not to damage starter pinion shaft.

(2) Secure starter to engine with six $^{25}/_{64}$-inch flat washers, $^{3}/_{8}$-inch hex nuts, and $^{3}/_{8}$-inch jamnuts.

(3) Insert cable through starter housing hole and position on terminal post. Secure cable terminal with $^{3}/_{8}$-inch flat washer on each side of cable terminal, $^{3}/_{8}$-inch lock washer, $^{3}/_{8}$-inch castillated nut, and $^{1}/_{16}$ x $^{5}/_{8}$ cotter pin.

(4) Install cable adapter in housing and tighten retaining nut.

(5) Install motor end cover and gasket on starter and secure with six No. 10 x $^{11}/_{16}$ fillister-head screws and No. 10 lockwashers.

(6) Install power plant (par. 130).

d. Removal of Jack and Heintz Quick-Disconnect Starter (fig. 140). Perform operations detailed in *b* (1) through (4) above. Remove two safety nuts and flat washers securing locking plate on mounting gear pinion and remove plate. Turn hex nut on mounting gear pinion counterclockwise to unscrew starter from adapter and six mounting studs and remove starter from engine.

e. Installation of Jack and Heintz Quick-Disconnect Starter (fig. 140). Position starter on six mounting studs. Turn hex nut on mounting gear pinion clockwise to screw starter into adapter and tighten to 25 pound-inches; do not exceed 30 pound inches. Install locking plate on mounting gear pinion and secure with two $^{17}/_{64}$-inch flat washers and ¼-inch safety nuts. Complete installation of starter using procedure detailed in *c*(3) through (6) above.

f. Removal of Eclipse-Pioneer Retaining Ring Mounted Starter (fig. 141).

(1) Remove power plant (par. 126).

(2) Cut locking wire and remove four fillister-head screws and flat washers securing covering plate and gasket to starter and remove cover and gasket.

(3) Loosen retaining nut and unscrew cable adapter from starter housing.

(4) Remove cotter pin, castellated nut, lockwasher, and two

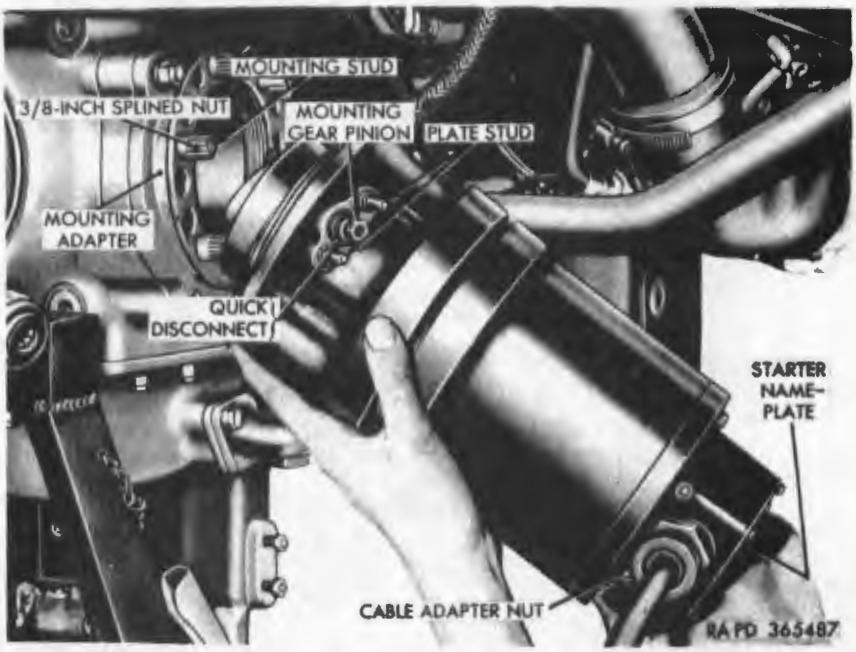


Figure 140. Removing Jack and Heintz quick-disconnect starter.

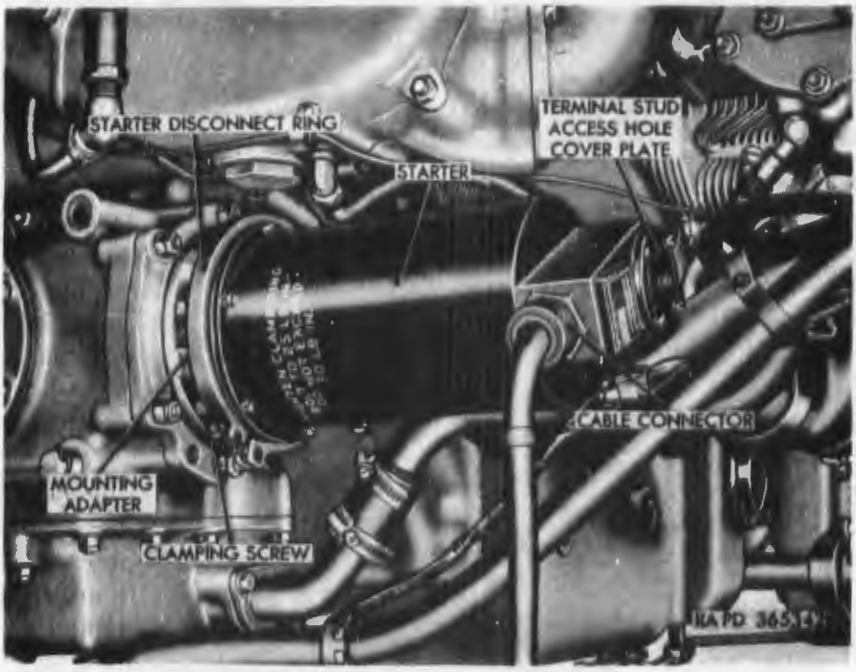


Figure 141. Eclipse-Pioneer starter installed.

flat washers securing starter to starter relay cable to terminal post and remove cable from starter.

(5) Cut locking wire and loosen clamping screw on starter retaining ring. Remove starter and retaining ring from mounting adapter being careful not to damage starter pinion shaft. Remove retaining ring from starter.

g. Installation of Eclipse-Pioneer Retaining Ring Mounted Starter (fig. 141).

(1) Place starter retaining ring on flange of starter and insert starter into mounting adapter.

(2) Position retaining ring on flanges of starter and adapter and secure starter by tightening clamping screw to 25-pound-inches; do not exceed 30 pound-inches. Lock screw in place with locking wire.

(3) Insert starter to starter relay cable through starter housing hole and position on terminal post. Secure cable terminal with $\frac{3}{8}$-inch flat washer on each side of cable terminal, $\frac{3}{8}$-inch lockwasher, $\frac{3}{8}$-inch castellated nut, and $\frac{1}{16} \times \frac{5}{8}$ cotter pin.

(4) Install cable adapter in housing and tighten retaining nut.

(5) Position covering plate and gasket on starter and secure with four No. 8 x 3/8 fillister-head screws and 11/64-inch flat washers, and locking wire.

(6) Install power plant (par. 130).

h. Replacement of Jack and Heintz Quick-Disconnect Starter With Eclipse-Pioneer Retaining Ring Mounting Starter.

(1) Perform operations detailed in *b* (1) through (4) above. Remove two safety nuts and flat washers securing locking plate on mounting gear pinion and remove plate. Turn hex nut on mounting gear pinion counterclockwise to unscrew starter from adapter and six mounting studs and remove starter from engine.

(2) Remove six splined nuts (fig. 140) from starter mounting studs.

(3) Remove mounting plate and gasket and mounting ring and gasket from adapter on engine.

(4) Install Eclipse-Pioneer starter mounting adapter and gasket on starter mounting studs and secure with six 3/8-inch flat washers, 3/8-inch hex nuts, and 3/8-inch jamnuts.

(5) Complete installation using procedure outlined in *g* above.

i. Replacement of Eclipse-Pioneer Retaining Ring Mounted Starter With Jack and Heintz Quick-Disconnect Starter.

(1) Perform operations detailed in *f* above.

(2) Remove six jamnuts, hex nuts, and flat washers which secure the Eclipse-Pioneer mounting adapter (fig. 141) to the gear adapter on the engine and remove the adapter.

(3) Install mounting ring gasket, mounting ring, mounting plate gasket, and mounting plate on the starter mounting studs in order mentioned.

(4) Secure these parts with six special 3/8-inch splined nuts and tighten to 20 to 40 pound-inches.

(5) Position starter on six mounting studs. Turn nut on mounting gear pinion clockwise to screw starter into adapter and tighten to 25 pound-inches. Install locking plate on mounting gear pinion and secure with two 17/64-inch flat washers and 1/4-inch safety nuts. Complete installation of starter using procedure detailed in *c*(3) through (6) above.

168. Starter Relay

a. Removal. Make sure that master relay switch is in the OFF position. Open battery access doors (fig. 236) on both sides of vehicle and disconnect ground cables from both battery sets.

Caution: Both ground cables must be disconnected. Remove two hex-head bolts, hex nuts, and lockwashers securing the starter relay (fig. 143) to the relay bracket. Pull relay up to make lower cables accessible and remove two cables from receptacles on lower-half of relay box. Loosen coupling nut and unscrew cable adapter securing starter relay to starter cable connector cable to upper-half of relay box. Remove four fillister-head screws and lockwashers which secure the two halves of the starter relay box (fig. 146) together and separate the box. Disconnect the cable from the relay terminal post inside the box and remove the cable. Remove starter relay from vehicle.

b. Installation. If starter relay is being replaced, remove the four fillister-head screws and lockwashers which secure the two halves of the new starter relay box (fig. 146) together and separate the box. Position the starter relay in the vehicle and insert the starter relay to starter cable connector cable through hole in upper half of box and connect cable to the relay terminal post. Make sure that O-ring packing is in position in the recess provided in the lower-half and secure halves together with four 1/4 x 5/8 fillister-head screws and 1/4-inch lockwashers. Tighten to 3 to 4 pound-feet. Slide cable adapter into position and tighten into box. Check that seal is seated in coupling nut and tighten nut securely. Connect two cables to receptacles at the bottom of the relay and tighten the coupling nuts securely. Secure the starter relay (fig. 143) on relay mounting bracket with two 5/16 x 3 1/4 hex-head bolts, 5/16-inch internal-teeth lockwashers, and 5/16-inch hex nuts. Tighten to 12 to 14 pound-feet. Connect ground cables to both battery sets and close battery access doors (fig. 236).

169. Neutral Safety Switch

a. Removal. Make sure that master relay switch (E, fig. 15) is in the OFF position and place warning tag on switch lever to prevent use during removal and installation operations. Move range selector control lever into REVERSE range (par. 21). Remove hex-head bolt and cable clamp from forward end of range selector control housing. Remove cable clamp which holds neutral safety switch cables with wiring harness on hull floor. Disconnect two switch cable connectors from wiring harness. Remove jamnut (fig. 142) from inner end of switch and unscrew switch from range selector control housing.

b. Installation. Place range selector control lever in NEUTRAL PARK position (par. 21). Install neutral safety switch (fig. 142) into range selector control housing. Install 3/4-inch jamnut on inner end of switch but do not tighten. Turn switch clockwise

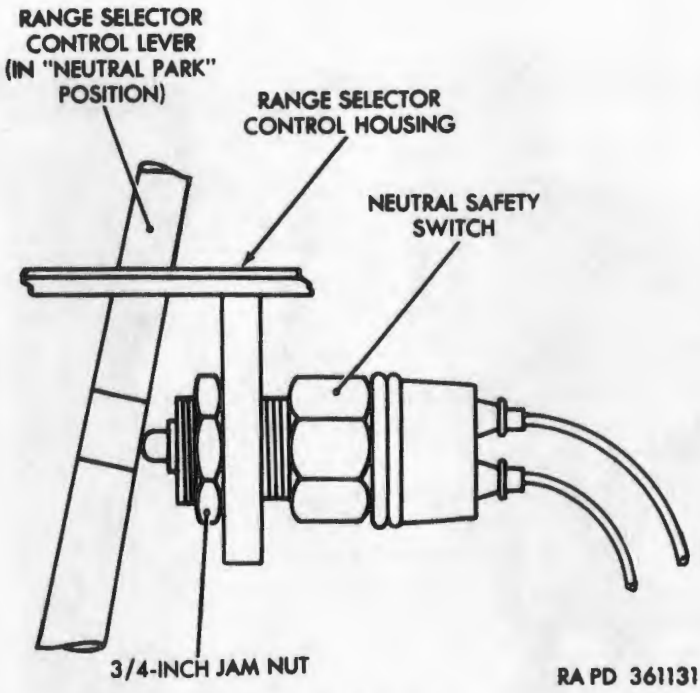


Figure 142. Neutral safety switch adjustment.

until end of switch touches range selector control lever. Connect switch cable connectors to wiring harness. Turn master relay switch (E, fig. 15) on. Hold starter switch (C–2, fig. 15) in the start position and screw neutral safety switch into housing until the main engine starts to crank. Release starter switch. Turn master relay switch to the OFF position. Turn neutral safety switch one-half turn clockwise and secure by tightening jamnut. Disconnect switch cables and straighten cables. Connect switch cable connectors to wiring harness and install cable clamps where provided.

Section XI. BATTERIES AND GENERATING SYSTEM

170. Description

a. General. The 24-volt battery and generating system used in the vehicle consists of four batteries, a main engine generator, an auxiliary generator, an output-regulating system for each generator, a master relay, and the necessary interconnecting wiring and switches. Information pertaining to the auxiliary generator and engine is contained in paragraphs 186 through 200.

b. Batteries. The four 12-volt, 23 plate, 100 ampere-hour bat-

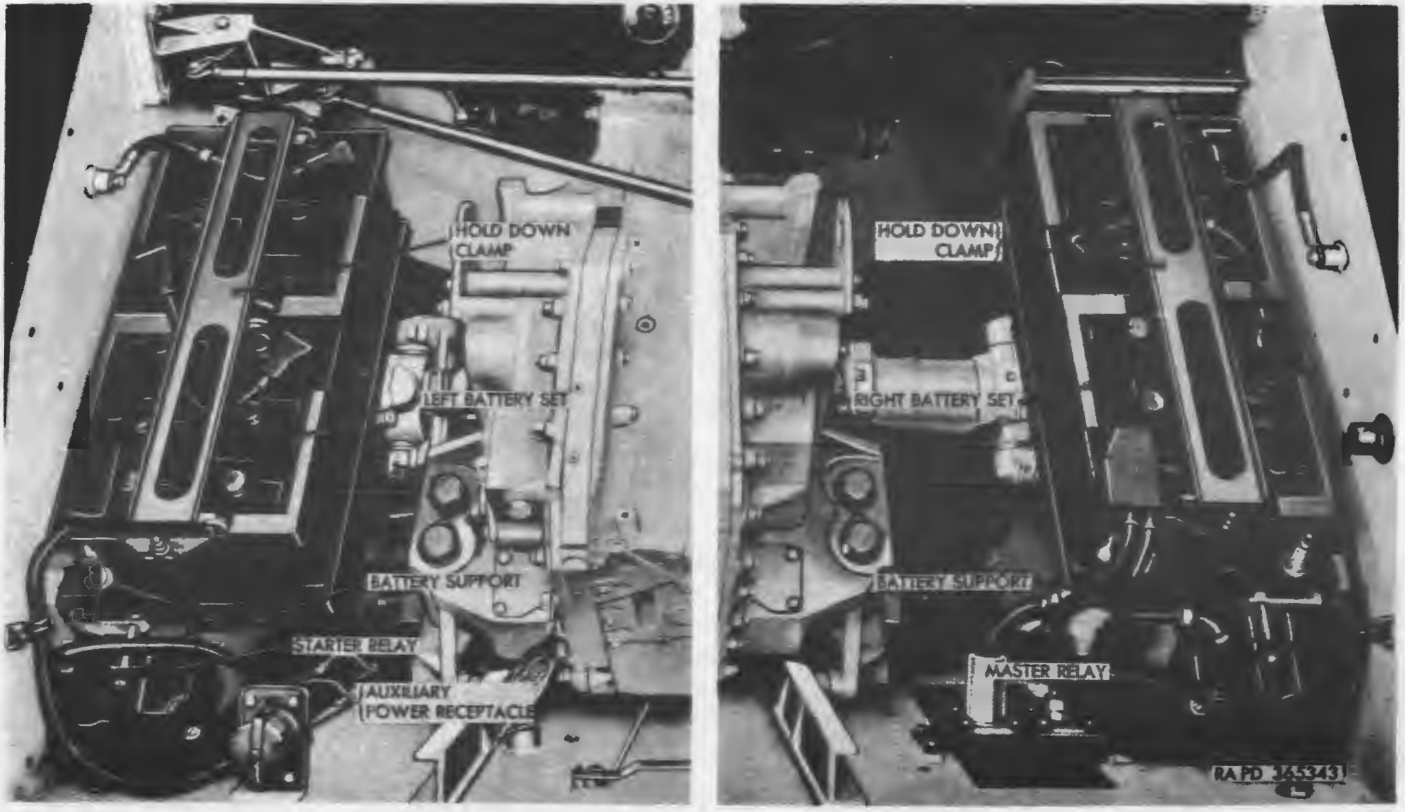


Figure 143. Left and right batteries installed.

teries are mounted in sets of two on battery supports (fig. 143). One set is located on each side of the engine compartment above the final drive assemblies. The two batteries in each set are connected in series with the negative terminal post of each set grounded to the hull side plate. The two sets of batteries are connected in parallel and the positive terminal post of the right set is connected to the master relay.

c. Master Relay. The master relay connects the current supply from the batteries to all electrical circuits of the vehicle, except the master relay actuating circuit No. 459B. This relay is bracket-mounted in the engine compartment to the rear of the right battery set (fig. 143) and is actuated by the master relay switch (E, fig. 15) on the instrument panel through circuit No. 459B from the positive post of the right battery set.

d. Generator. The main generator is a 4-brush, shunt-field-regulated-type with equalizing circuit and power cables terminating at a terminal block located on the fan end of the generator. The generator is gear driven and mounted on lower right side of the accessory end of the engine (fig 147). The output of the generator is 150 amperes at 27.5 volts and is controlled by the regulating system in the generator regulator box (*e* below) at engine speeds above 1,800 rpm.

e. Generator Regulator Box (fig. 144). The generator regulator box is mounted on mounting brackets between the two fixed fire extinguishers forward of the engine compartment bulkhead door. The regulator box contains the electrical components to regulate the output of the engine generator (*d* above).

f. Warning Lights. The warning light marked LEFT ENG on the warning light panel will light when the generator is not charging. The warning light marked RIGHT ENG is not used.

171. Tabulated Data

Battery:	
Make	Delco
Type	6 TN
Volts	12
Plates	23
Rating	100 amperes-hour
Ordnance part number	572554
Number used per vehicle	4
Generator:	
Make	Eclipse-Pioneer
Rating	150 amperes at 27.5 volts.
Ordnance part number	7727461

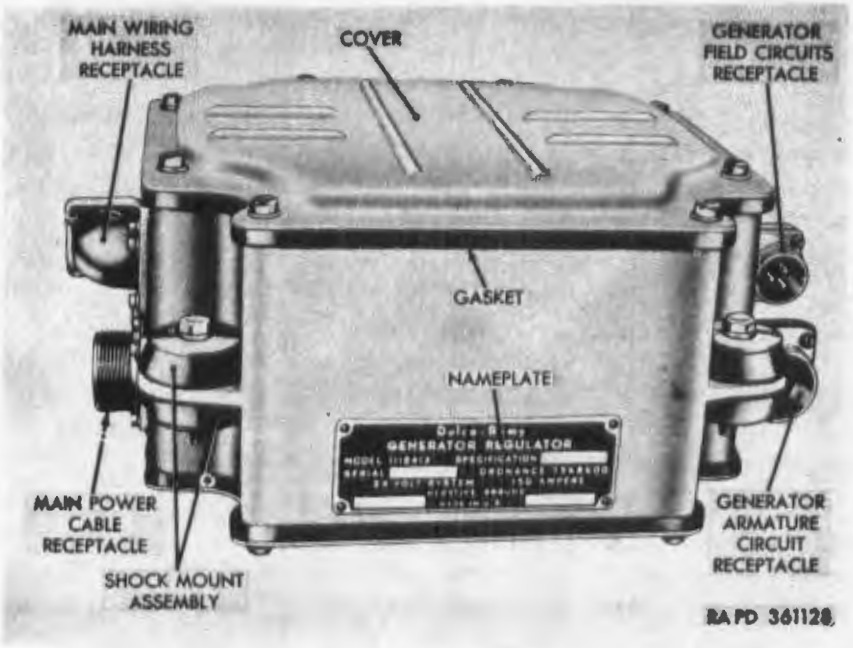


Figure 144. Delco-Remy generator regulator box.

Generator regulator box and electrical components:

Make	Optional
Eclipse-Pioneer:	
Ordnance part number	7528304
Delco-Remy:	
Ordnance part number	7968600

172. Batteries

a. Service.

(1) *Specific gravity tests.* A specific gravity reading of the electrolyte (battery fluid) indicates the state of charge in each battery cell. Use a hydrometer and thermometer. Correct the hydrometer reading for temperature as indicated on the specific gravity temperature correction chart (fig. 145). To determine the state of charge of a battery, hydrometer reading must be corrected to a temperature of 80° F. The correction for temperature is 4 points (0.004) of gravity for each 10° F. change of temperature above or below 80° F. Example: If specific gravity reading is 1.280 at 0° F., subtract 0.032 as shown in figure 145. Corrected reading will be 1.280 minus 0.032 which is 1.248 in the case of this example. A corrected specific gravity reading of 1.285 in each cell indicates a fully charged battery. A specific gravity reading of 1.225 or

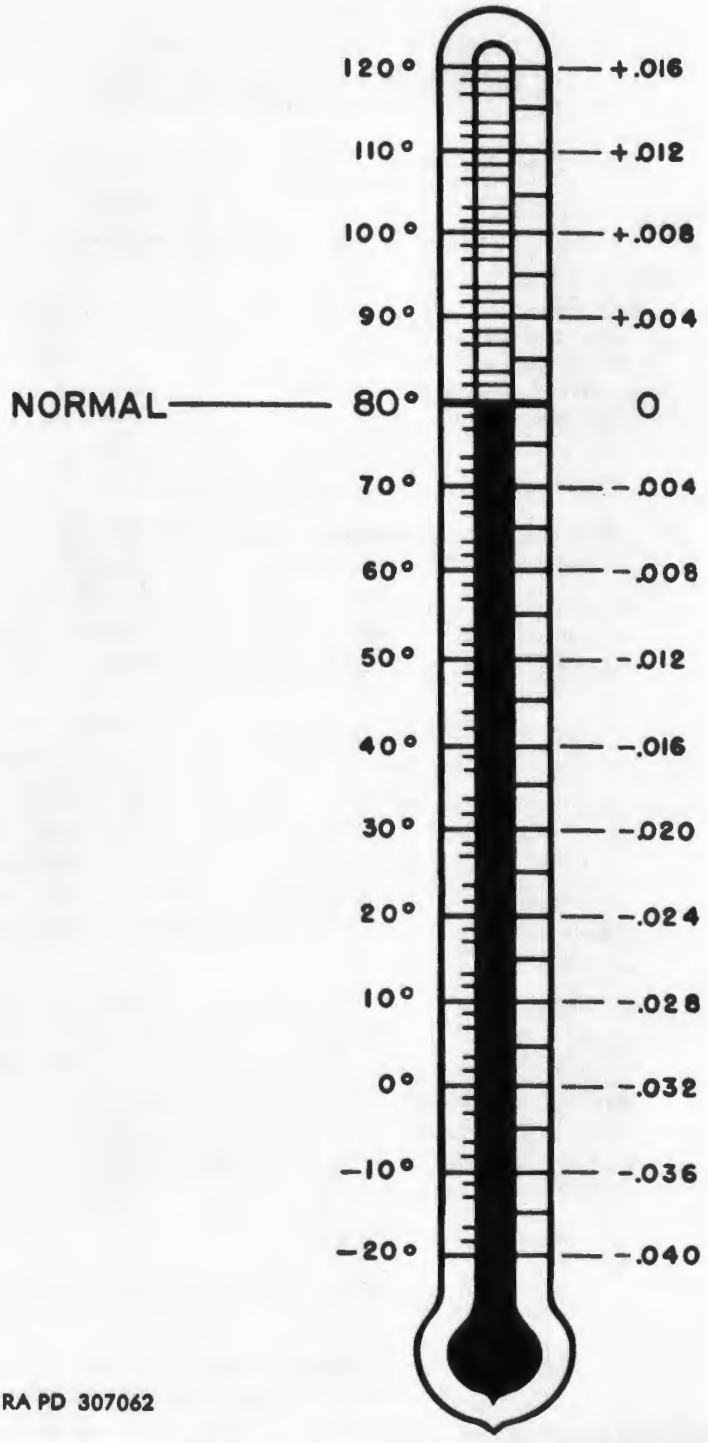


Figure 145. Specific gravity temperature correction chart.

less in each cell indicates that the battery must be recharged or replaced. Table IX lists the freezing temperatures for batteries of various specific gravities.

Caution: Keep batteries fully-charged.

Table IX. Battery Freezing Temperature

	Specific Gravity (Corrected)	Freezing Temperature
Battery fully charged	1.285	—92° F.
Battery one-third discharged	1.255	—72° F.
Battery one-half discharged	1.220	—31° F.
Battery three-quarters discharged	1.185	—8° F.
Battery normally discharged	1.150	+5° F.
Battery completely discharged	1.100	+18° F.

(2) *Adding water.* The water in the electrolyte solution will evaporate due to high temperatures or excessive charging rates. Inspect the electrolyte level and add water at intervals required by service and climatic conditions. Keep the water level up to split ring as indicated on the battery filler plugs.

Caution: Keep batteries clean and do not overfill.

(3) *Placing dry-charged batteries into service.* Remove or destroy any sealing device which may have been used to close or restrict the vent opening. Fill cells to indicated level with 1.280, at 80° F., electrolyte. Battery and electrolyte must be at a temperature above 60° F., but preferably not above 100° F. Test battery as instructed in *a*(1) above.

(4) *Cleaning battery terminals.* To clean battery parts and terminals with batteries in the vehicle, wipe them clean with a cloth saturated with an alkaline solution such as ammonia or bicarbonate of soda and water. With the batteries removed from the vehicle, pour warm water slowly over the terminals to loosen copper sulphate deposits, then brush or flush clean. A heavy coating of general purpose grease on the terminals will retard corrosion.

Caution: Do not allow cleaning solution or dirt to enter cells.

b. Removal (fig. 143). Turn off master relay switch on the instrument panel. Open battery access doors and disconnect the negative ground cable from front battery posts of both battery sets.

Caution: Ground cables must be disconnected first from both battery sets during removal of either set of batteries and connected last during installation.

Disconnect the positive (+) cable from rear battery post and position on battery cable stowage bracket. Unscrew two hex nuts on each battery holddown clamp to permit anchor eyebolt to slide from the holddown clamp. Remove the holddown clamp. Disconnect both ends of the battery jumper cable and remove the cable. Lift batteries, one at a time, out of the vehicle. To remove battery ground cable, remove hex-head bolt with integral lockwasher which secures each cable to hull side plate.

c. Installation (fig. 143). If the battery supports were folded up against the hull walls, fold them down to using position. Position the batteries in the battery supports with positive (+) posts of each battery toward the rear of the vehicle. Connect jumper cable between the two batteries of each set. Position the holddown clamps over the batteries of each set and secure with anchor eyebolts. Connect the battery terminals with single cable to the positive (+) post of the left battery set. Connect the terminal with double cables to the positive (+) terminal post of the right battery set. Connect the ground cables to the negative (—) post of the forward batteries and secure each cable to hull side plate with $\frac{3}{8}$ x $\frac{5}{8}$ hex-head bolt with integral lockwasher. Position the rubber terminal insulators over the battery posts and terminals.

d. Test. Start the main engine (par. 43). Observe the cranking speed of the starter. If generator is charging when engine is running, the warning light should go out. Recheck battery terminals to make sure they are tight. Close battery access doors.

173. Battery Supports With Brackets

(fig. 143)

a. Removal. Remove batteries (par. 172*b*). Remove the upper hex-head bolts and lockwashers which secure the battery cable stowage bracket assembly and the battery support rear bracket to the hull. Remove the stowage bracket. Remove the remaining two hex-head bolts with lockwashers which secure the starter relay on the left side of the vehicle, or the master relay on the right side, to the battery support rear bracket. Remove three hex-head bolts and lockwashers which secure the forward battery support bracket to the hull and slide the support with brackets forward to clear the relay bracket. Remove the battery support with brackets from the vehicle.

b. Installation. Position the battery support and brackets on the hull side plate above the final drive assembly. Slide the rear battery

support bracket between the relay bracket and the hull. Start three ½ x 1⅛ hex-head bolts with ½-inch lockwashers through the forward bracket to locate it. Install two ½ x 1⅛ hex-head bolts with ½-inch lockwashers through the lower holes in the relay and battery support brackets. Install two ½ x 1½ hex-head bolts with ½-inch lockwashers through the battery cable stowage bracket and upper hole of battery support bracket. Tighten the six hex-head bolts. Install batteries (par. 172*c*).

Note. Battery supports fold up against the hull to afford access to other equipment in the engine compartment.

174. Master Relay

a. Removal (fig. 143). Open rear access doors on both sides of the vehicle. Remove tape from cables between right battery set and master relay. Disconnect cable connector in circuit No. 459B from right battery to render master relay switch inoperative. Disconnect ground cables from both battery sets.

Caution: Both ground cables must be disconnected. Remove positive terminal insulator and disconnect the battery-to-master relay cable from the battery terminal. Remove two hex-head bolts, nuts, and lockwashers which secure the master relay to the relay bracket. Pull the relay up to make lower cables accessible. Loosen waterproof knurled locknuts. Unscrew two cable connector nuts from bottom of relay and disconnect the cables. Remove the master relay with battery-to-relay cable from the vehicles.

b. Disassembly (fig. 146). Loosen the waterproof knurled locknut and unscrew the cable adapter bushing from the upper half of the relay box. Remove the four fillister-head screws and lockwashers which secure the two halves of the master relay box together and separate the box. Disconnect the battery-to-relay cable from the relay terminal inside the box and remove the cable.

c. Assembly (fig. 146). If new relay is to be installed on the vehicle, remove the four fillister-head screws and lockwashers which secure the two halves of the master relay box together and separate the box. Install the battery cable through hole in upper half and connect the cable to the relay terminal inside the lower half. Make sure that rubber gasket is in position in the groove of the flange of the lower half. Place the two halves together and secure with four ¼ x ⅝ fillister-head screws and ¼-inch lockwashers. Tighten to 3 to 4 pound-feet torque. Slide the cable adapter into position and tighten into the box. Make sure that the seal is in position in the waterproof locknut and tighten the nut. Cover the locknut and adapter with tape.

d. Installation (fig. 143). Position the master relay with battery-to-relay cable in the vehicle, connect the two cables to the

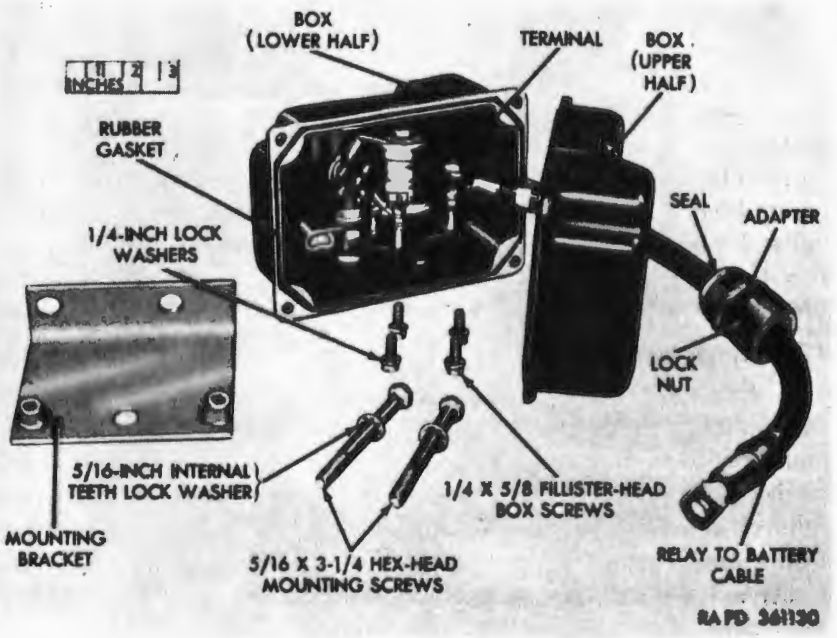


Figure 146. Master or starter relay box—separated.

bottom of the relay and tighten the waterproof locknuts. Secure the master relay on relay mounting bracket with two $\frac{5}{16}$ x $3\frac{1}{4}$ hex-head bolts and $\frac{5}{16}$-inch internal teeth lockwashers. Tighten to 12 to 14 pound-feet torque. Place the battery-to-relay cable through the battery terminal insulator, connect the battery-to-relay cable to the positive battery terminal, and posiion the insulator over the battery and cable terminals. Connect the cable connector on circuit No. 459B to right battery. Tape the cables together between the relay and the battery to protect them from damage. Connect ground cable to both battery sets.

e. Test. Turn master relay switch on. Make sure that the range selector lever is in the NEUTRAL PARK position. Depress the starter switch momentarily to see if starter operates. Release the starter switch. Turn master relay switch to the OFF position. Close rear access door.

175. Generator
(fig. 147)

a. Removal. Remove power plant (par. 126). Remove fuel filter and bracket (par. 151). Disconnect the cables and ground strap from the generator terminal block. Remove the six hex-jamnuts, hex nuts, and flat washers which secure the generator to the adapter on the engine and remove the generator.

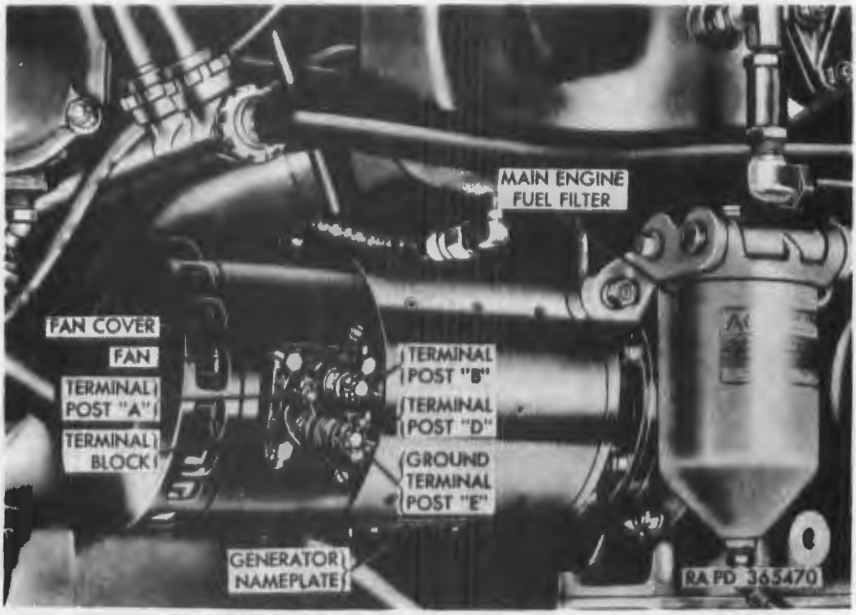


Figure 147. Generator installed on engine.

b. Installation. Make sure the gasket is in position on the generator mounting studs. If the gasket is damaged, replace it. Position generator on adapter mounting studs and secure with six $^{25}/_{64}$-inch flat washers, $^{3}/_{8}$-inch hex nuts, and $^{3}/_{8}$-inch hex-jamnuts. Connect the large insulated cable to terminal post marked B, ground strap to E, cable tagged 478 to D and cable tagged 1 to A on the terminal block. Install the power plant (par. 130).

176. Generator Regulator Control Box
(figs. 144 and 148)

a. Removal. Coordinate with ordnance maintenance personnel (par. 2).

Note. Access to regulator control box is through the ammunition stowage compartment unless the power plant is removed for other reasons.

Make sure that the master relay switch is in the OFF position and tag the switch to prevent usage during removal and installation operations. Remove 40-mm ammunition boxes from left ammunition stowage compartment. Loosen coupling nuts securing four cable plugs to regulator control box receptacles and remove cables. Remove four hex-head bolts and lockwashers which secure the regulator control box and shock mounts to mounting brackets and remove control box.

Note. Regulator control box ground terminal is secured beneath upper left hex-head bolt.

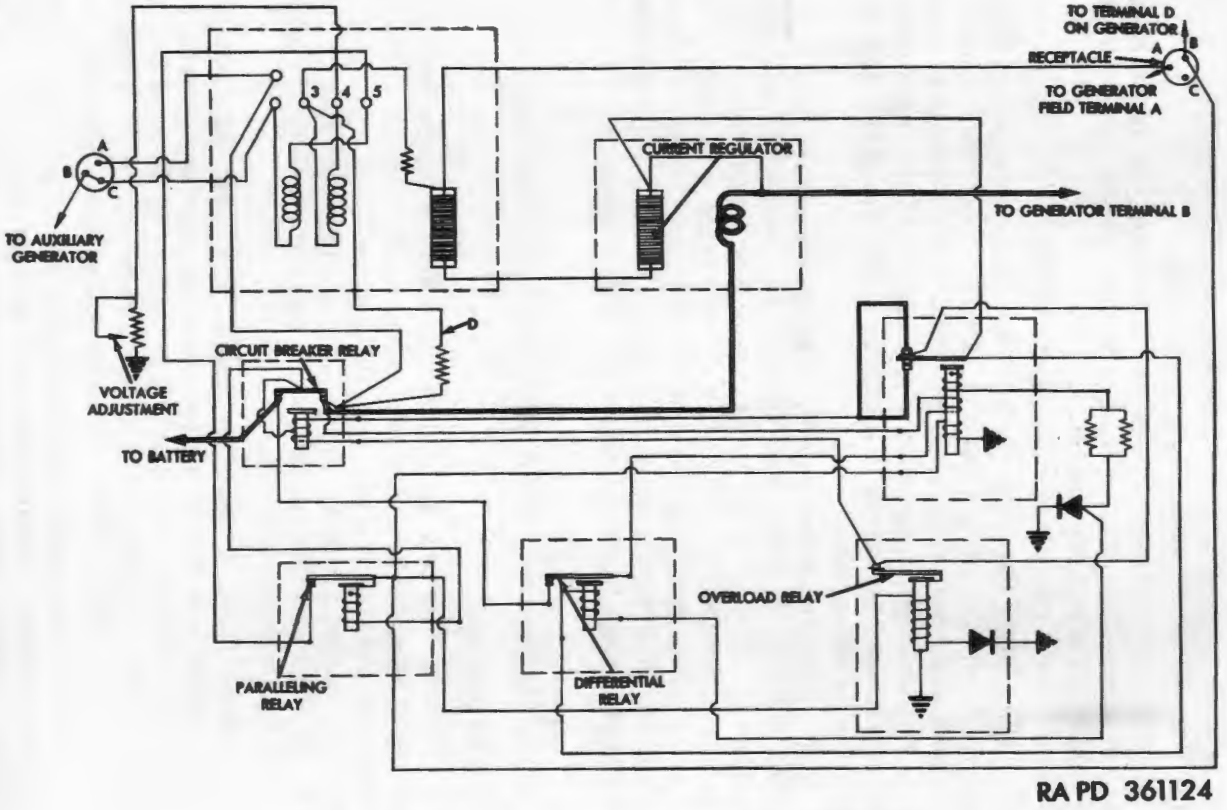


Figure 148. Delco-Remy regulator circuit—schematic view.

b. Installation. Position generator regulator control box and shock mounts on mounting brackets and secure with four ¼ x 1¾ hex-head bolts and ¼-inch lockwashers.

Note. Secure ground cable terminal beneath upper left hex-head bolt.

Aline cable plugs with corresponding receptacles; push plugs into position and secure with cable coupling nuts.

Caution: Do not force plugs into receptacles. If key and keyway are properly alined, no damage to contacts will occur. Be sure ground cable is securely connected.

Test generator regulator control box (*c* below).

c. Test. Start the main engine (par. 43). Turn on headlights and radio equipment to create an electrical load. Run engine at approximately 650 rpm for a minimum of 45 minutes to attain normal operating temperature of the regulator. During warmup, connect low-voltage tester to accessory outlet receptacle (fig. 60) in driving compartment.

Note. Calibrate instrument according to accompanying instructions.

After warmup is completed, turn off the headlights and radio equipment. Observe if 27.5 volt, plus 0.5 volt or minus 0.5 volt, reading is obtained on tester. If reading is more or less than 27 to 28 volts, notify ordnance maintenance personnel for necessary adjustment. Stop main engine (par. 46*b*). Install 40-mm ammunition boxes in left ammunition stowage compartment.

Section XII. HORN AND LIGHTING SYSTEM

177. Description

a. General. The horn and lighting system consists of a horn, two service headlights, two blackout headlights, two blackout marker lights, one blackout driving light, three dome lights, and two taillight assemblies. Current for the horn and lighting system is fed from the batteries through the master relay, the instrument panel, circuit breakers, and switches.

b. Horn and Horn Operating Switch. The horn (fig. 149) is a vibrator type with an internal ground connection and is mounted on the hull front plate between and to the rear of the right service and blackout headlights. The horn is actuated by a push button-type switch located on the steering control crossbar (fig. 10).

c. Service Headlights (figs. 149 and 150). The service headlights are bracket mounted under a guard on the left and right front of the hull. These lights are actuated from the main light switch (A–1, fig. 15) which is located on the instrument panel and are used whenever the tactical situation permits bright lighting. The service headlights contain a replaceable sealed lamp-unit.

Figure 149. Horn and right headlight group.

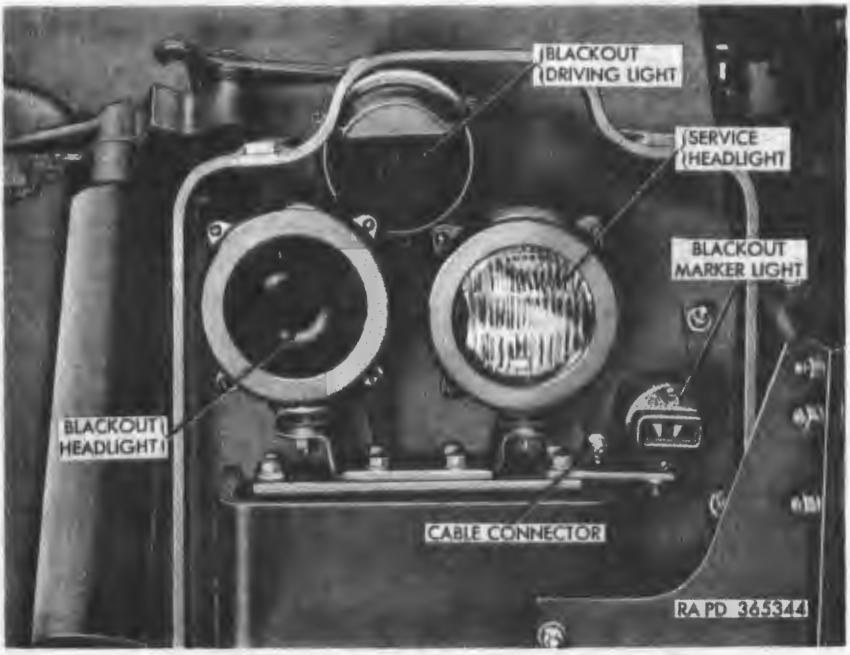


Figure 150. Left headlight group.

d. Blackout Headlights (figs. 149 and 150). Each blackout headlight is mounted beside a service headlight and toward the center of the vehicle. These lights are used for total blackout operations with the periscope M19. Refer to paragraph 40 for description and operation of this equipment.

e. Blackout Driving Light (fig. 150). The blackout driving light

is mounted to the rear and between the left blackout and service headlights. This light is used during partial blackout operations.

f. Blackout Marker Lights (figs. 149 and 150). The blackout marker lights are mounted on the left and right front of the hull next to the service headlights. These lights are identical and are used during partial blackout operations to indicate location to nearby vehicles.

g. Taillights (fig. 151). The taillights are mounted in circular guards welded on the hull rear plate. The left taillight contains the service tail lamp and service stop lamp in the upper section and the blackout tail lamp in the lower section. The right taillight contains the blackout stop lamp in the upper section and the blackout tail lamp in the lower section.

h. Dome lights. Each of the three dome lights (figs. 9, 18, and 61) two in the driving compartment and one at the rear of the stowage compartment has a partition dividing it into two sections. One section has a red lens; the other a white lens. Each section has a separate lamp. The red lens section is used during blackout operations, the white lens section during normal operations. The lamps are actuated by a lever-type switch which is an integral part of the light. Each switch is equipped with a safety plunger which prevents accidental illumination of the white lens section.

i. Rear Signal Light. The rear signal light is installed on early vehicles only. This light is not operative and is not connected into the hull electrical system.

j. Service Headlight Dimmer Switch (fig. 12). The service head-

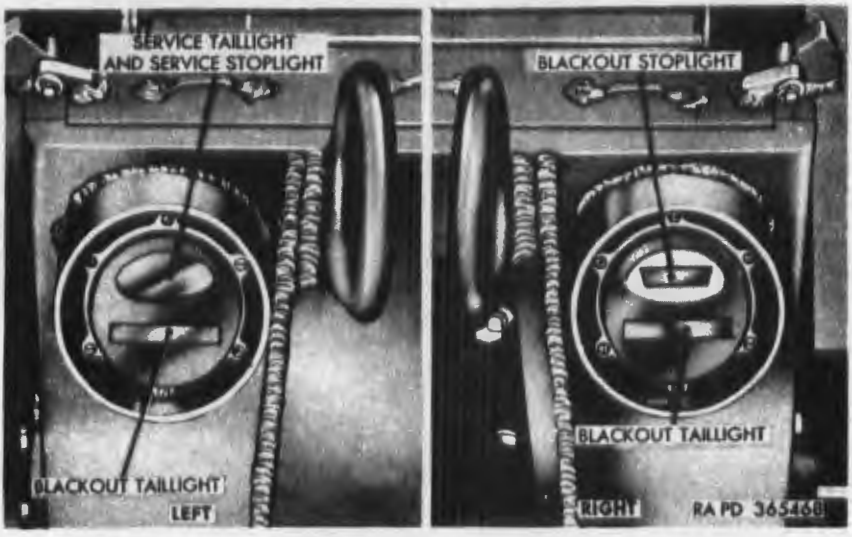


Figure 151. Left and right taillights.

light dimmer switch is foot operated and is located on the hull floor to the left of the driver. This switch is installed on late vehicles only and permits selection of either the high or low beam of the service headlights. When high beam is in use, the HI-BEAM indicator light on the instrument panel will operate.

k. Stoplight Switch. The stoplight switch (fig. 157 is mounted on the hull floor adjacent to the brake pedal cross shaft lever. This switch is actuated whenever the brake pedal is depressed and is energized when the master relay switch is on, and the main light switch (A–1, fig. 15) on the instrument panel is turned to any of the following positions: SER DRIVE, STOP LIGHT, BO MARKER, or BO DRIVE.

178. Horn and Horn Operating Switch

a. Horn (fig. 149).

(1) *Removal.* Disconnect cable connector from receptacle on rear of horn. Remove two hex-head bolts with integral lockwashers and bracket support which secure horn to the mounting bracket and remove horn.

(2) *Installation.* Position horn and bracket support on horn mounting bracket; secure with two 1/4 x 3/4 hex-head bolts with integral lockwashers and be sure that a good ground contact is made. Connect cable connector to receptacle on rear of horn.

b. Horn Operating Switch.

(1) *Removal.* Check that master relay switch (E, fig. 15) is in the OFF position. Disconnect two horn switch cable connectors from wiring harness. Remove hex nut and internal-teeth lockwasher securing horn switch (fig. 18) to mounting bracket on steering control crossbar and remove switch.

(2) *Installation.* Position horn switch (fig. 18) in mounting bracket on steering control crossbar and secure with 5/8-inch internal-teeth lockwasher and 5/8-inch hex nut. Connect two horn switch cable connectors to wiring harness. Turn master relay switch (E, fig. 15) on and depress the switch button to determine if horn operates. Turn master relay switch to the OFF position.

179. Service and Blackout Headlights

Note. Replacement of the service or blackout headlights or their sealed lamp-units is identical.

a. Replacement of Sealed Lamp-Unit.

(1) *Removal.* Check that master relay switch (E, fig. 15) is in the OFF position. Loosen four roundhead screws with

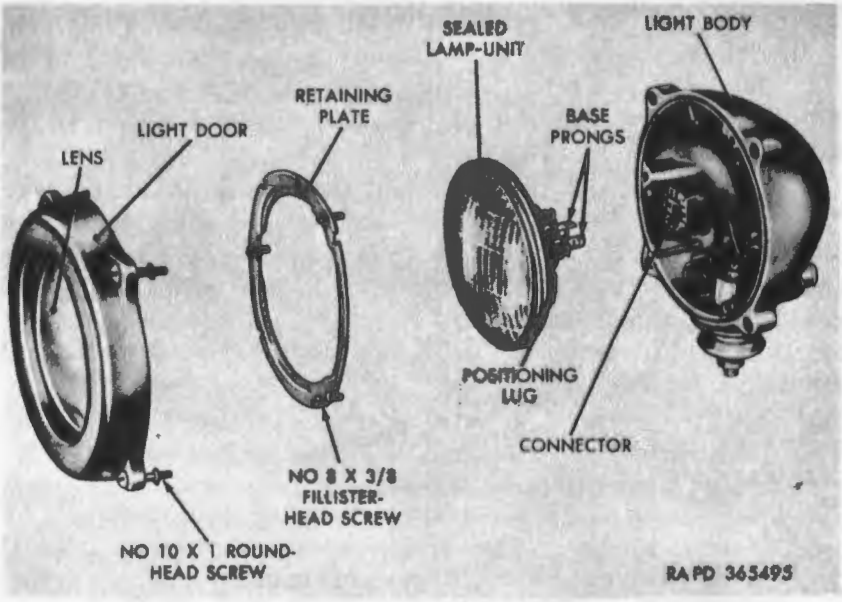


Figure 152. Service or blackout headlight—partially disassembled.

retaining rings which secure the headlight door on the light body and remove door (fig. 152). Unscrew three fillister-head screws with retaining rings securing retaining plate on light body and remove plate. Lift out sealed lamp-unit and remove connector from base prongs. Remove lamp-unit.

(2) *Installation.* Install connector on sealed lamp-unit base prongs and aline positioning lug (fig. 152) in light body. Position retaining plate over lamp-unit and secure plate to body with three No. 8 x 3/8 fillister-head screws with retaining rings. Position headlight door on light body and secure with four No. 10 x 1 roundhead screws with retaining rings.

(3) *Test.* Turn master relay switch on and main light switch (A–1, fig. 15) on instrument panel to the SER DRIVE position and observe if lamp-unit lights. Depress headlight dimmer switch (fig. 12) and check both high and low beam. Turn master relay switch and main light switch to their off positions.

b. Replacement of Service or Blackout Headlight.

(1) *Removal.* Check that master relay switch (E, fig. 15) is in the OFF position. Disconnect two cable connectors from receptacles on rear of service or blackout headlight (fig. 149 or 150). Remove hex nut, lockwasher, and bear-

ing washer securing light to mounting bracket and remove light.

(2) *Installation.* Position service or blackout headlight (fig. 149 or 150) on mounting bracket and secure with bearing washer, 7/16-inch lockwasher and 7/16-inch hex nut but do not tighten until headlight beams are alined (*c* below). Connect two cable connectors to receptacles on rear of headlight.

c. Service Headlight Beam Alinement. Place vehicle, with full fuel tanks, no ammunition or personnel, exactly eight feet from and facing a perpendicular surface such as a wall. Draw a horizontal line on the perpendicular surface 52 inches from ground level. Turn master relay switch on and the main light switch (A–1, fig. 15) on the instrument panel to the SER DRIVE position. Using dimmer switch (fig. 12) select the high beam of the headlights. Adjust the headlights on their mountings so that the high-intensity area of the light beam is on the horizontal line directly in front of each headlight. Tighten 7/16-inch hex nuts and recheck beam alinement.

Note. Do not attempt to converge beams.

This alinement will provide a 1¾-inch drop for every 8 feet of distance, when dimmer switch is set for low beam.

180. Blackout Driving Light

a. Replacement of Sealed Lamp-Unit.

(1) *Removal.* Check that master relay switch (E, fig. 15) is in the OFF position. Unscrew three fillister-head screws with retaining rings which secure light door (fig. 153) and sealed lamp-unit with cables in light body and lift out door and lamp-unit. Remove cable connectors from retainer clips, separate the connectors, and remove door and lamp-unit from body. Pry out three retaining springs holding lamp-unit in door and remove lamp-unit.

(2) *Installation.* Position sealed lamp-unit with cables (fig. 153) in light door with shield on lamp unit opposite the drain holes in the door and secure with three retaining springs. Connect lamp-unit cable connectors to connectors in light body making sure that circuit number markers on cables correspond (fig. 86). Install cable connectors in retainer clips. Position light door with lamp-unit on light body and secure with three No. 8 x ⅜ fillister-head screws with retaining rings.

(3) *Test.* Turn master relay switch (E, fig. 15) on, main light switch on instrument panel to BO DRIVE position and blackout selector switch to BO DRIVE LAMP posi-

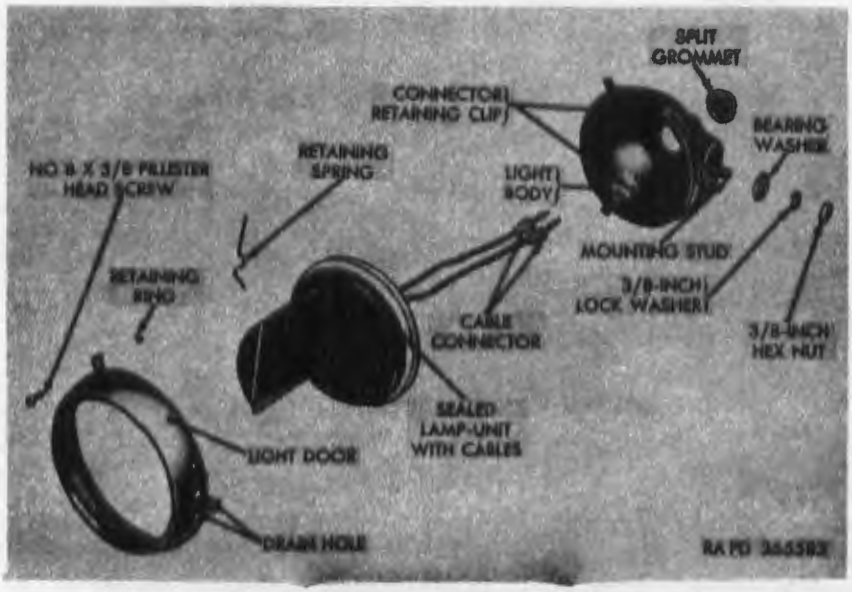


Figure 153. Blackout driving lights—exploded view.

tion and check to see if the lamp-unit operates. Turn blackout selector switch, main light switch, and master relay switch to their off positions.

b. Replacement of Blackout Driving Light (fig. 153).

(1) *Removal.* Remove sealed lamp-unit and light door (*a*(1) above). Press out split grommet with cables and connectors from opening in rear of light body. Remove hex nut, lockwasher, and bearing washer from mounting stud on light body and remove light body from mounting bracket.

(2) *Installation.* If a new blackout driving light is to be installed, remove sealed lamp-unit and light door (*a*(1) above) and remove hex nut, lockwasher, and bearing washer from mounting stud of light body. Position light body on mounting bracket and install bearing washer, 3/8-inch lockwasher, and 3/8-inch hex nut. Aline light body vertically and horizontally with service and blackout headlights before tightening hex nut securely. Insert cables and cable connectors through opening in rear of light body. Install split grommet in opening in light body. Install sealed lamp-unit and light door (*a*(2) above) and test (*a*(3) above).

181. Blackout Marker Lights

a. Replacement of Lamps.

(1) *Removal.* Remove two oval-head screws which secure

blackout marker light (fig. 149) door to light body and remove door. Press in and turn counterclockwise to release lamp from socket and remove lamp.

(2) *Installation.* Insert a 24–28 volt, 3-candlepower, bayonet-base lamp in the blackout marker light socket. Press in and turn clockwise to secure lamp in socket. Turn master relay switch (E, fig. 15) on and main light switch in instrument panel to the BO MARKER position and check if lamp will light. Position light door on light body and secure with two No. 8 x ½ oval-head screws.

b. Replacement of Lights.

(1) *Removal.* Check that master relay switch (E, fig. 15) is in the OFF position. Remove cable connectors (fig. 149) from retaining clip and separate connectors. Remove hex nut and lockwasher securing blackout marker light (fig. 149) to mounting bracket and remove light.

(2) *Installation.* Clean contact surfaces to assure good ground connection and position blackout marker light (fig. 149) on mounting bracket. Secure with 5/16-inch lockwasher and 5/16-inch hex nut. Connect cable connectors and secure connectors in retaining clip.

182. Taillights

a. Replacement of Lamps.

(1) *Removal.* Unscrew six roundhead screws with retaining rings which secure the taillight door on the light body and remove door (fig. 154). Press in on lamp to be re-

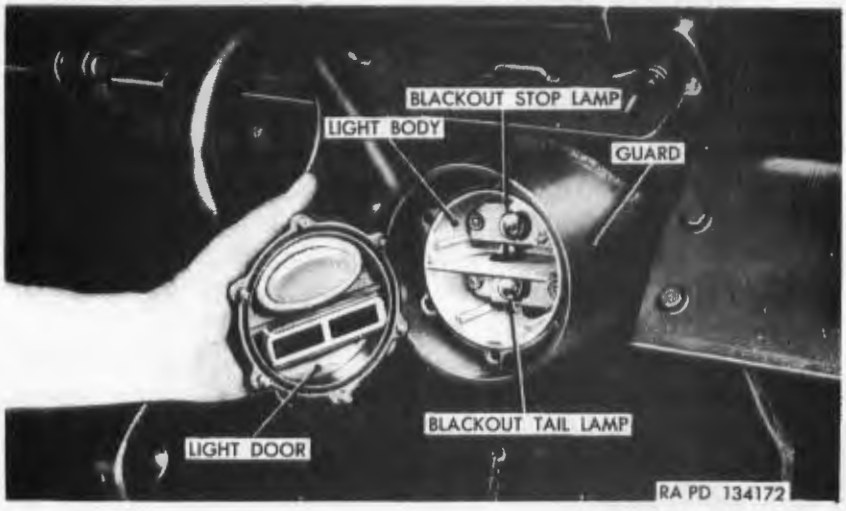


Figure 154. Removing right taillight door.

placed, turn counterclockwise to release lamp from socket and remove lamp.

(2) *Installation.* Install a 24–28 volt, 3-candlepower, bayonet-base lamp in the blackout stop, blackout tail, and service taillight positions; or a 24–28 volt, 32–candlepower, bayonet-base lamp in the service stoplight position (fig. 151). Press in on lamp and turn in a clockwise direction to secure lamp in socket. Perform test ((3) below) then position taillight door on light body and be sure the gasket is in place. Secure with six roundhead screws with retainer rings.

(3) *Test.* Station man at rear of vehicle and turn master relay switch (E, fig. 15) on and light switch in instrument panel to STOP LIGHT position. Depress brake pedal to determine if service stop lamp in left taillight is operative. Release brake pedal, and turn main light switch to BO DRIVE position, depress pedal to determine if blackout stop lamp in right taillight (fig. 151) is operative. Turn main light switch to BO MARKER position; blackout marker lamps in both taillight (fig. 151) should light. Turn main light switch and master relay switch to their off positions.

b. Replacement of Taillights.

Note. Replacement procedure for both taillights is identical.

(1) *Removal.* Open left and right battery access doors (fig. 236). Disconnect single cable connector with circuit number marker 459B, from right battery set to render master relay inoperative. Remove tape covering taillight cable connectors and separate three cable connectors, with circuit number markers 21, 22, and 24, from left taillight or two cable connectors, with circuit number markers 23 and 24 from right taillight. Remove locknut and lockwasher from nipple (fig. 155) extending into hull from taillight. Slide nut and lockwasher off cables by working one cable connector at a time through the nut and lockwasher. Remove two hex-head bolts with integral lockwashers and flat washers securing taillight to mounting bracket inside guard and remove taillight.

(2) *Installation.* Apply coating of gasket cement on threads of nipple (fig. 155). Position taillight in protective guard with cables and nipple inserted through opening in hull. Secure taillight to mounting bracket with two $\frac{3}{8}$ x $\frac{7}{8}$ hex-head bolts with integral lockwashers and $\frac{3}{8}$-inch flat washers. Pass cable connectors through $1\frac{5}{16}$-inch inter-

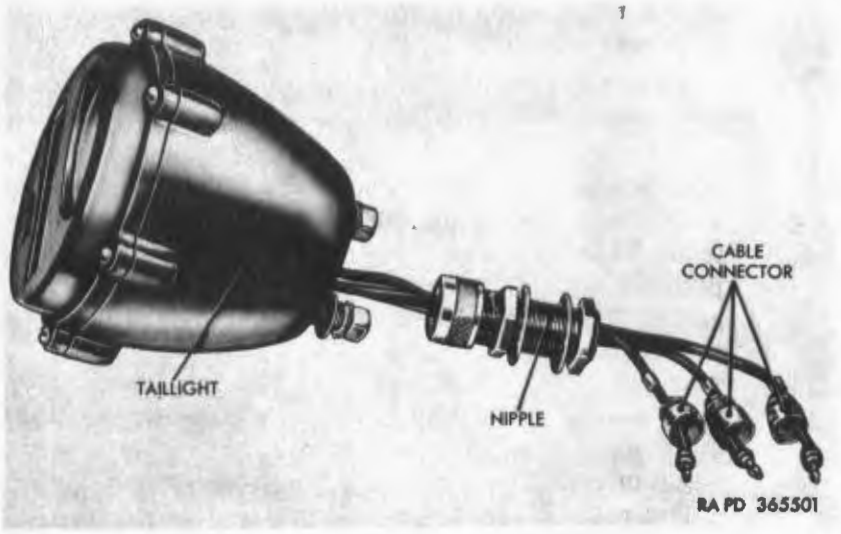


Figure 155. Taillight—removed.

nal-teeth lockwasher and $^{15}/_{16}$-inch locknut. Install lockwasher and nut securely on nipple (fig. 155). Connect three cable connectors with circuit number markers 21, 22, and 24 on left taillight or two cable connectors with circuit number markers 23 and 24 on right taillight to corresponding cable connectors of wiring harness. Make sure that circuit numbers correspond. Connect single cable connector with circuit number marker 459B to right battery set. Perform test (*a*(3) above). Close battery access doors (fig. 236).

183. Dome Lights

a. Replacement of Lamps.

Note. Procedure for replacement of lamps in any of the dome lights is identical.

(1) *Removal* (fig. 156). Unscrew six roundhead screws with retaining rings which secure the dome light door on the light body and swing door with lamps and switch, away from light body. Press in on lamp to be replaced and turn counterclockwise to release. Remove lamp.

(2) *Installation.* Install a 24–28 volt, 6-candlepower, bayonet base lamp in the socket from which the lamp was removed by pressing in on lamp and turning clockwise to secure. Perform test ((3) below) and then install light door (fig. 156) with lamps and switch attached on light body and secure with six No. 10 x 1 roundhead screws with retaining rings.

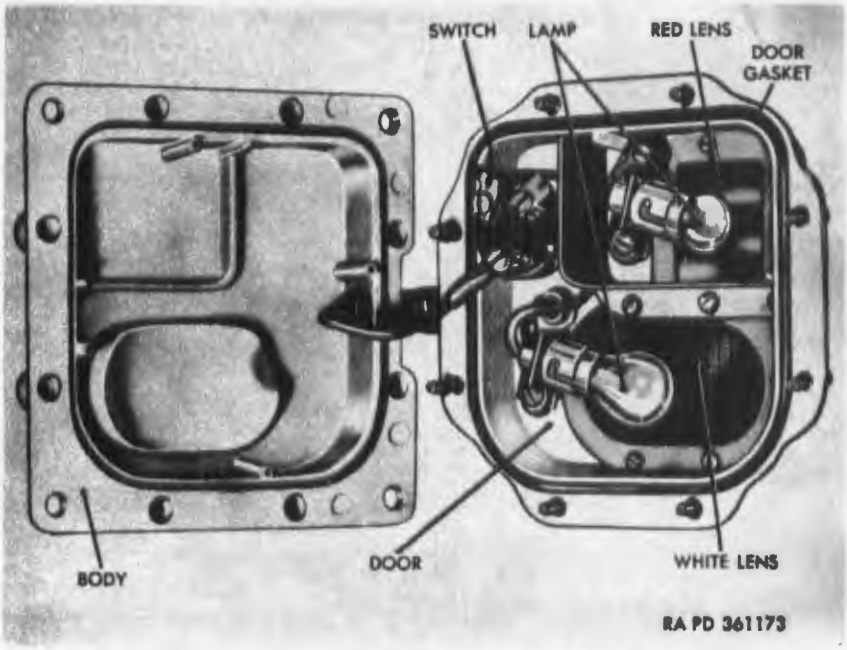


Figure 156. Dome light—partially disassembled.

Note. Make sure that dome light door gasket (fig. 156) is properly seated before securing door on body.

(3) *Test.* Turn master relay switch (E, fig. 15) on and dome light switch to the position corresponding to the lamp which was installed. Touch cover against body to effect a ground connection. The lamp should light.

b. Replacement of Dome Lights.

Note. Procedure for replacement of any of the dome lights is identical.

(1) *Removal.* Check that master relay switch (E, fig. 15) is in the OFF position. Disconnect cable connector from receptacle on dome light to be removed. Remove four hex-head bolts and lockwashers securing dome light to hull and remove light.

(2) *Installation.* Position dome light on hull and secure with four ¼ x 1 hex-head bolts and ¼-inch lockwashers. Connect cable connector to receptacle on dome light.

(3) *Test.* Turn master relay switch on and turn dome light switch to first one position and then the other to see if both lamps light. Turn dome light and master relay switches off.

184. Dimmer Switch

a. Removal. Check that master relay switch (E, fig. 15) is in the OFF position. Unscrew coupling nut securing wiring harness

plug on receptacle on dimmer switch (fig. 12) and remove wiring harness plug. Remove two hex-head bolts with integral lockwashers securing switch to mounting bracket on hull and remove dimmer switch.

b. Installation. Position dimmer switch (fig. 12) on mounting bracket and secure with two ¼ x ½ hex-head bolts with integral lockwashers. Install wiring harness plug on receptacle of dimmer switch and secure with coupling nut.

c. Test. Perform test as outlined in paragraph 179*a*(3).

185. Stoplight Switch

a. Removal. Check that master relay switch (E, fig. 15) is in the OFF position. Disconnect two switch cable connectors. Remove two hex-head bolts with integral lockwashers and two flat washers securing stoplight switch (fig. 157) to mounting bracket on lower front hull plate. Remove stoplight switch with cables.

b. Installation. Position stoplight switch (fig. 157) on mounting bracket and secure with two No. 10 x ½ hex-head bolts with integral lockwashers and two 7/32-inch flat washers. Connect two

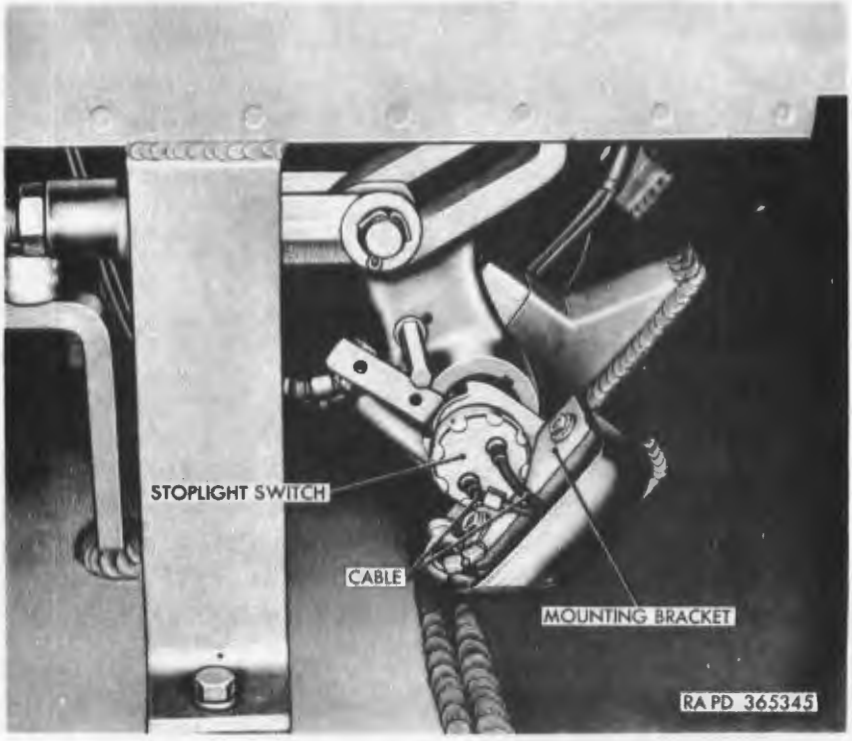


Figure 157. Stoplight switch installed.

switch cable connectors to cables marked 75 on hull electrical harness.

c. Test. Perform test as outlined in paragraph 182*a*(3).

Section XIII. AUXILIARY GENERATOR AND ENGINE

186. Description and Data

a. Description.

(1) *General.* The auxiliary generator and engine (figs. 158 and 159) is installed as an integral unit on mounting rails in the right-front corner of the engine compartment and consists of a single-cylinder, air-cooled, gasoline engine which is connected directly to a 300-ampere, 27.5 volt, direct current generator. The generator is designed to also act as the starting motor for cranking the auxiliary engine. For operating instructions of the auxiliary generator and engine, refer to paragraph 70.

(2) *Starting system.* The auxiliary generator and engine is provided with a remote control electrical starting system

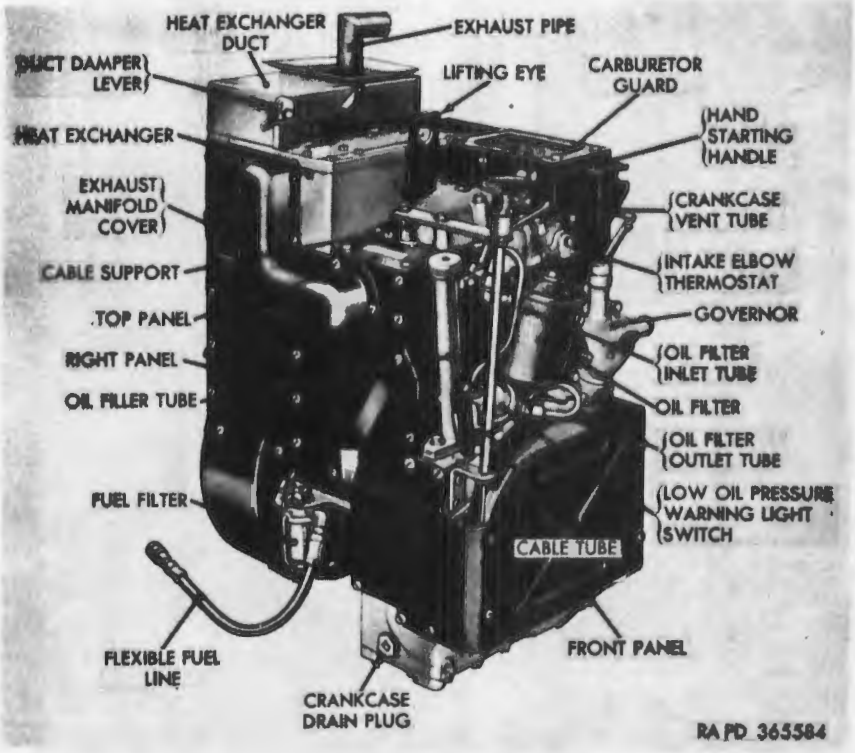


Figure 158. Auxiliary generator and engine—right front view.

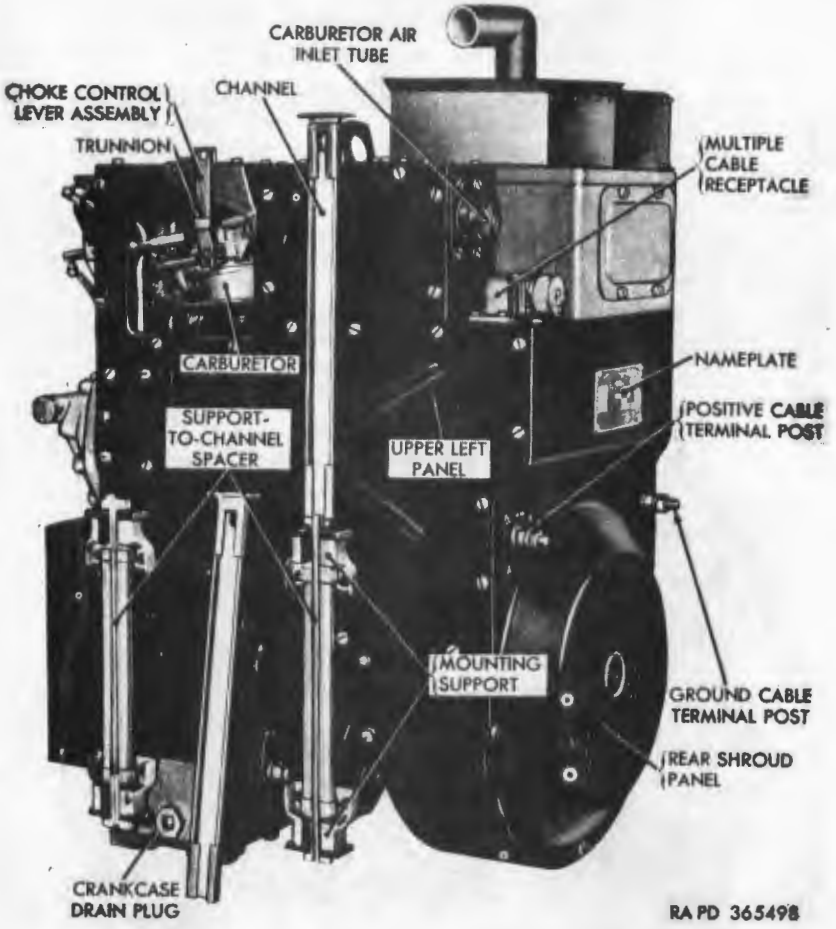


Figure 159. Auxiliary generator and engine—left rear view.

and a manual starting system. The electrical starting system is controlled from an auxiliary generator and engine control box (fig. 18) located in the driving compartment. The pull-type hand starting manual (fig. 158) is provided to facilitate extreme low temperature or emergency starting. For instructions on starting the auxiliary generator and engine, refer to paragraph 70.

(3) *Fuel system.*

(*a*) *General.* A diaphragm-type fuel pump (S, fig. 160) supplies gasoline to a horizontal-barrel, fixed-jet carburetor. A bowl-type fuel filter (figs. 158 and 169) is provided in the fuel system to filter the incoming gas-

oline. An auxiliary generator and engine choke control (fig. 9), located on the rear bulkhead of the driving compartment, manually controls the choke and properly positions the throttle opening for easy starting of the engine under all conditions.

Note. Auxiliary generator and engines with serial No. 7329 and up have been modified by relocating the fuel filter and incorporating an electric fuel pump (fig. 161) in the fuel system. This provides the engine with a pressurized fuel system which minimizes vapor locking conditions encountered during extremely high air temperatures. These units will be referred to herein as "late" engines.

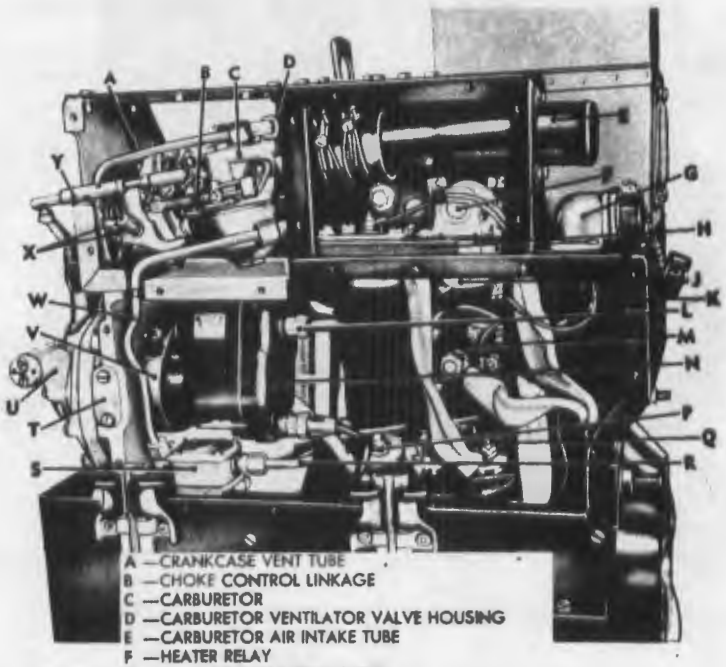


Figure 160. Auxiliary generator and engine—upper left panel removed.

(*b*) *Early engines.* The flexible fuel line (fig. 169) is connected to the main engine primer pump line which is fed from one outlet of the main engine fuel filter (fig. 89). The fuel filter (fig. 169) is secured to a bracket on the top-front panel of the unit and filters the gasoline to the fuel pump which in turn pumps the fuel into the carburetor.

(*c*) *Late engines.* The flexible fuel line (fig. 161) is connected to an electric fuel pump which in turn connects directly to the fuel shutoff valve. Fuel is pumped from the electric fuel pump to a fuel filter that is bracket mounted on the lower right side of the engine; from this point, the fuel system is similar to that of the early engines.

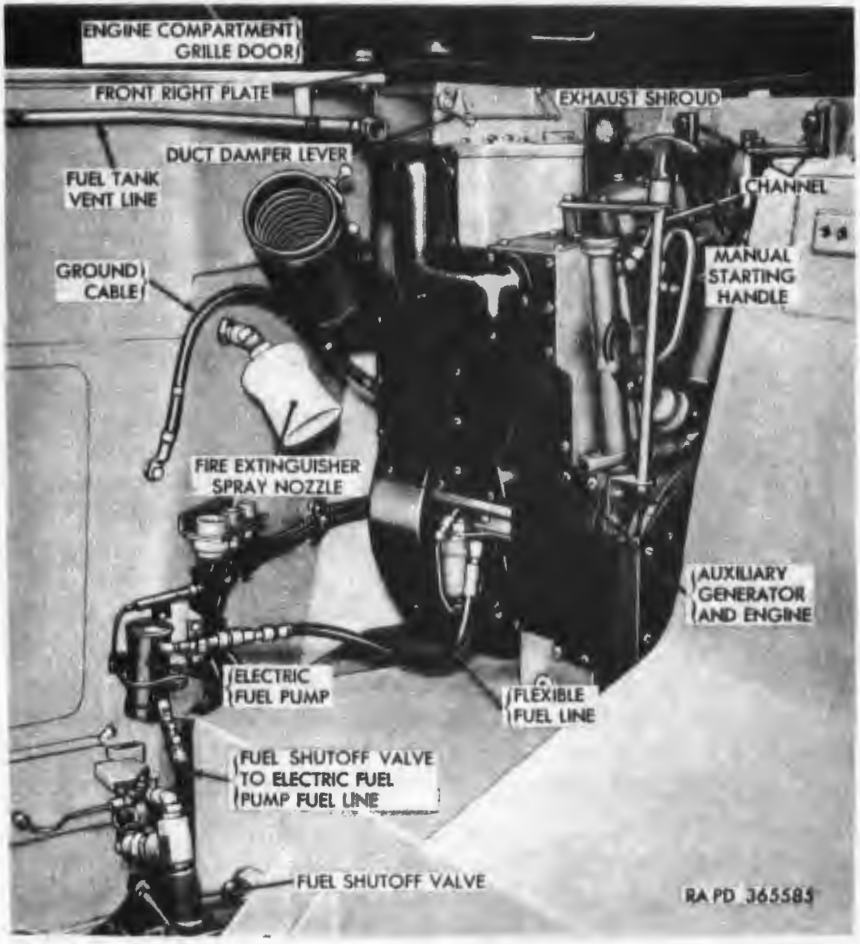


Figure 161. Auxiliary generator and engine—installed view.

(*d*) *Carburetor* (C, fig. 160). The carburetor is connected through linkage to a governor which controls the engine speed by varying the throttle opening to suit the load imposed on the engine. Two thermostatically controlled heating elements are located in the carburetor intake elbow. These heating elements are energized by the thermostat when the temperature is below 40° F. and the control box switch lever is in the START or RUN positions. On engines through serial No. 1576, the carburetor ventilates the engine crankcase and the 4-cylinder magneto. Vapors are drawn from the crankcase and magneto through tubes connecting the oil filler tube and the magneto to the carburetor ventilator valve housing. On engines with serial No. 1577 and up, only the crankcase is vented since the single-cylinder magneto does not require venting.

(4) *Intake and exhaust systems.*

(*a*) *Air intake system.* The air intake system of the auxiliary generator and engine consists of an oil bath-type air cleaner, air intake silencer, connecting hose and tube, and the necessary attaching parts. The air cleaner (fig. 9) is mounted on the hull right wall of the driving compartment. The air intake silencer is mounted in an opening in the engine compartment bulkhead. Air for the intake system is drawn from the driving compartment, through the air cleaner, silencer, and connecting hose and tube into the carburetor air intake tube (E, fig. 160).

(*b*) *Exhaust system.* The exhaust system consists of an oval shaped muffler and a connecting flexible exhaust tube (fig. 162). The muffler is strapped to mounting brackets on the tool stowage rack installed on the right muffler shield. Vehicles with Ordnance serial No. 1 through 400, 490 through 643, and 879 and up are equipped with a large muffler which is mounted along the length of the rack. Vehicles with Ordnance serial No. 401 through 489 and 644 through 878 are equipped with a small muffler which is mounted on the front of the rack directly behind the main engine right air cleaner.

(5) *Cooling system.* Air for cooling the auxiliary generator and engine is provided by an impeller-type fan mounted on the rear of the generator armature shaft. The rear shroud panel (fig. 159) completely encloses the fan pre-

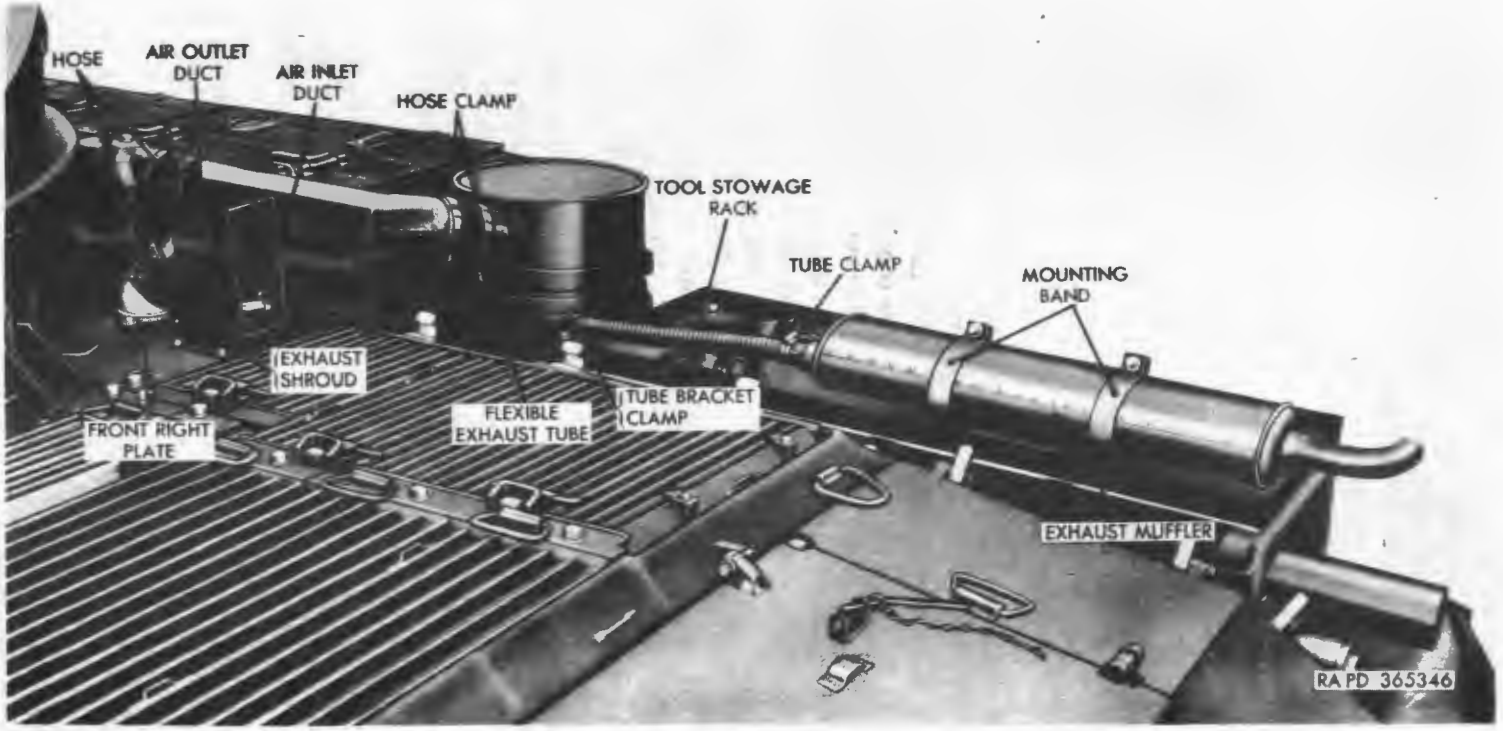


Figure 162. Exhaust muffler—late vehicle.

vents foreign matter from entering into the cooling system. A diffuser, mounted around the fan, spreads the air uniformly over the electrical components and through the generator. A series of shrouds and baffles directs the air flow over the crankcase, cylinder, cylinder head, and through the heat exchanger.

(6) *Electrical system.* The direct-current, shunt-wound starter generator is directly connected to the auxiliary engine crankshaft. The generator delivers approximately 300 amperes at 27.5 volts at the normal full-load governed speed of 3,100 rpm. Series-parallel windings are provided in the generator but are energized only when the generator is used as the starter for the auxiliary engine. Generator voltage output is automatically controlled by a carbon-pile voltage regulator (M, fig. 160). A low oil pressure warning light switch (fig. 158), located beneath the oil filter, energizes the warning light on the auxiliary generator and engine control box (fig. 18) whenever the oil pressure in the crankcase falls below 13 psi. A wiring harness (K, fig. 160) interconnects the electrical components of the auxiliary generator and engine to the multiple cable receptacle.

(7) *Ignition system.* A magneto (N, fig. 160) is coupled to the governor and provides the necessary power for the ignition system. The magneto is equipped with an impulse coupling, which retards the spark for hand starting operation. A shielded spark plug cable connects the spark plug to the magneto. The magneto used on auxiliary generator and engines through serial No. 1576 is of the 4-cylinder type and is ventilated to the carburetor and requires a radio interference filter for radio noise suppression. On engines with serial No. 1577 and up, magnetos are of the 1-cylinder type, not ventilated, and radio noise suppression is integral with the magneto.

Note. Timing and servicing operations on the magneto are to be performed by authorized ordnance maintenance personnel only.

(8) *Governor.* Engine speed is controlled by a flyball-weight and spring-type governor (fig. 158) which is gear driven by the gear train. The governor controls the engine speed by varying the throttle opening to suit the load imposed on the generator. A vernier adjustment is provided on the governor spring for fine adjustment.

Note. Adjustments and maintenance operations on the governor are to be performed by authorized ordnance maintenance personnel only.

(9) *Heat exchanger.* A heat exchanger (fig. 158) is provided for main engine compartment heating and is composed of a series of steel tubes encased in a sheet-metal retainer. Hot exhaust gases from the combustion chamber pass through and heat these tubes. The warm cooling air from the auxiliary engine is heated further by these tubes and is passed into the engine compartment to aid in cold weather starting of the main engine or directly out through the engine compartment grilles during normal temperature operation. A 6-kw electric heater is located inside the heat exchanger to further heat this air when desired. This heater is controlled by the heater switch on the auxiliary generator and engine control box (fig. 18).

(10) *Gear train.* An enclosed gear train is located at the front end of the engine. The crankshaft driving gear is connected to the oil pump, governor, camshaft, and primary counterweight gears, through the use of five idler gears. The crankshaft, magneto, camshaft, and counterweight gears are located in their correct position through the use of mating timing marks on the gears and engine crankcase.

(11) *Lubrication.* The lubrication of the engine is accomplished partially by splash but primarily by the use of a constant displacement gear-type pump. The crankcase contains oil passages which are drilled to provide oil under pressure to the various engine parts requiring pressure lubrication. Hollow push rods conduct oil, under pressure, from the hydraulic valve lifters to the valve rocker arm and shaft assembly. Oil spill from the rocker arm and shaft assembly is returned to the crankcase by way of the cylinder head drain tube (fig. 167). A full-flow, replaceable element-type oil filter (fig. 158) is incorporated in the lubrication system. Refer to lubrication order LO 9–7218 (par. 90) for proper grade of lubricant and intervals for servicing the auxiliary generator and engine.

b. Data.

Engine:

Make	Detroit Diesel Engine Division General Motors Corporation
Model	A–41–1 or A–41–2
Ordnance number	7402328 or 7402950
Type	4-cycle, gasoline
Number of cylinders	one

Compression ratio	6.5:1
Bore and stroke	3¾ x 4
Speed (rated):	
No-load	3,250 rpm
Full-load	3,100 rpm
Lubrication system:	
Pressure pump	gear driven, gear type
Sump	wet
Capacity (refill)	approx 4 qts (full mark on oil level gage)
Generator regulator:	
Make	Delco-Remy Division General Motors Corporation
Ordnance number	7402586 or 8360022
Volts	27.5
Oil filter:	
Make	AC Spark Plug Division General Motors Corporation
Ordnance number	7402654
Type	full-flow, replaceable element
Fuel filter:	
Make	AC Spark Plug Division General Motors Corporation
Ordnance number	7402346 or 7402925
Type	bowl
Carburetor:	
Make	Rochester Products Division General Motors Corporation
Ordnance number	7378898
Type	horizontal-barrel, fixed jet
Magneto:	
Make (4-cylinder)	Scintilla Magneto Division Bendix Aviation Corporation
Ordnance number	7402662
Model	S4/IRN-32
Breaker point gap	0.016 inches
Make (1-cylinder)	Scintilla Magneto Division Bendix Aviation Corporation
Ordnance number	7402754
Model	H1-21
Breaker point gap	0.018 inches
Make (1-cylinder)	Wico Electric Company
Ordnance number	7402753
Model	XHS-1
Breaker point gap	0.018 inches

Governor:
- Make: Novi Products Company
- Model: 53753–B
- Type: flyball mechanical
- Full-load speed: 3,100 rpm
- No-load speed: 3,250 rpm
- Ordnance number: 7402467

Fuel pump:
- Make: AC Spark Plug Division General Motors Corporation
  - Type: diaphragm
  - Ordnance number: 7378810 or 7402926
- Make: Eclipse Machine Division (Bendix Aviation Corp)
  - Type: Electric, Piston
  - Ordnance number: 7354014

Spark plug:
- Make and model: Champion TAC2 or AC 5569413
- Ordnance number: 7525550
- Thread: 14-mm
- Gap: 0.017 to 0.020 inches

Starter:
- Type (hand starter): manual starting through cable pull-type starter on front of crankshaft (late vehicles only)
- Type (electrical): integral with generator

Direct current starter generator:
- Make: Delco Products Division General Motors Corporation
- Model: A–8585
- Ordnance number: 7402334
- Type: type II, shunt-wound, automatic carbon-pile voltage regulator
- Kilowatt output: 9.4
- Volts: 27.5
- Amperes: 300

Weight of unit: 393 lb (dry)

187. Servicing

a. Oil Change. Engine oil should be changed at intervals specified in lubrication order LO 9–7218 (par. 90). To reach crankcase drain plug (fig. 159), remove access cover plate (par. 246) and gasket on right side of hull between third and fourth support rollers. Remove drain plug and gasket and allow oil to drain from auxiliary generator and engine. Inspect magnetic-type drain plug

for metal particles which indicates abnormal wear or damage of internal engine parts. After oil has drained completely, install drain plug using a new gasket. Open grille doors (fig. 236) over auxiliary generator and engine. Remove bayonet-type oil level gage with cap (fig. 163) and pour quantity and grade of oil specified in lubrication order LO 9–7218 (par. 90) into oil filler tube (fig. 158). Check for leaks around drain plug before installing access cover plate (par. 246). Check oil level and install oil level

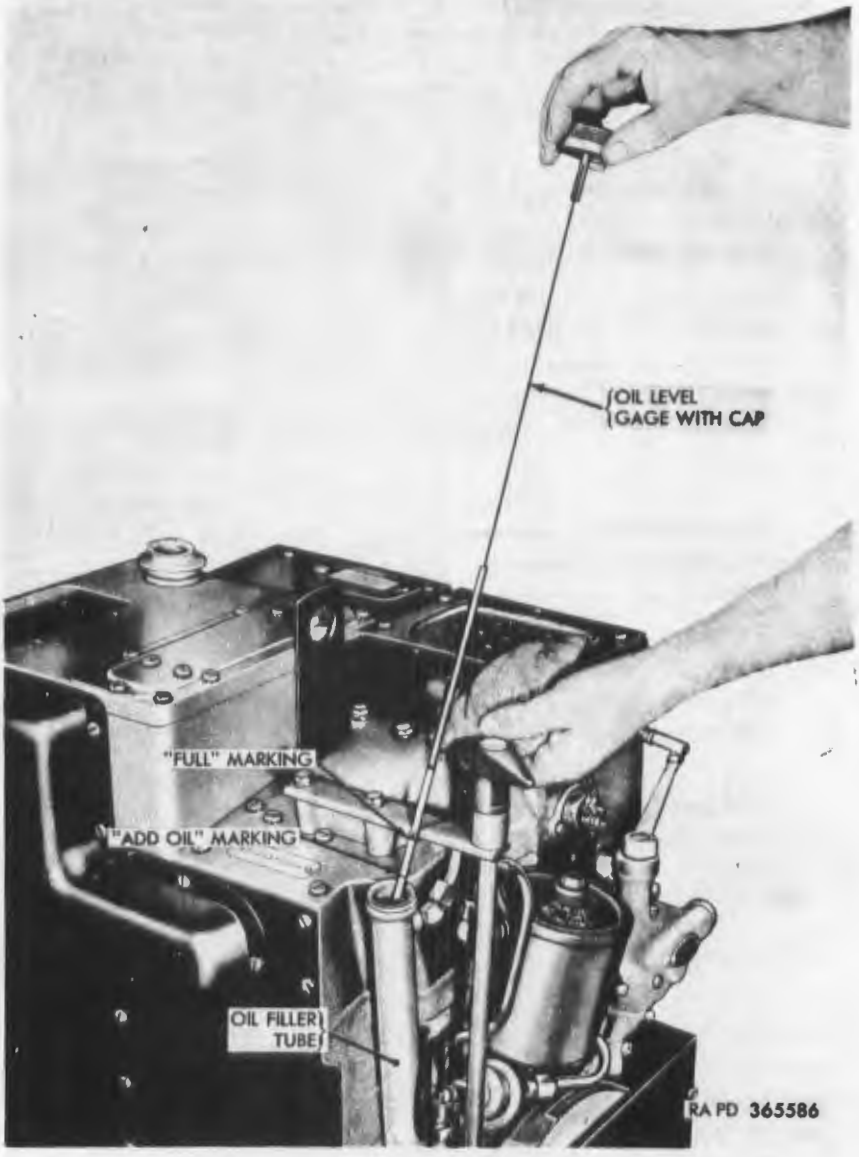


Figure 163. Checking oil level.

gage with cap securely on filler tube. Close engine compartment grille doors.

Caution: Do not fill above FULL mark on oil level gage and do not screw cap on filler tube when checking oil level.

b. Oil Filter Element. The engine oil filter element (fig. 164) should be replaced at time of oil change. Open engine compartment grille doors (fig. 236) over auxiliary generator and engine. Loosen cover screw (fig. 164) and remove filter cover and gasket. Discard gasket. Pull out filter element, spring, and retainer from oil filter shell. Clean spring and retainer and remove all oil and dirt from within shell with cloth soaked in dry-cleaning solvent or mineral spirits paint thinner. Install spring, retainer, and new filter element into shell. Position filter cover and new cover gasket on shell and secure with special cover screw. Start auxiliary generator and engine (par. 70) and check for oil leakage around cover. If leaks are evident, stop engine and check installation of cover; tighten if necessary. Check oil level with oil level gage (fig. 163) and add oil to bring to correct level due to filter requirement. Close engine compartment grille doors.

c. Fuel Filter. Semiannually or when the auxiliary generator and engine is removed for other maintenance, remove the filter element and gasket and clean the fuel filter (fig. 158) thoroughly with dry-cleaning solvent or mineral spirits paint thinner. To gain access to the fuel filter on late engines (par. 186*a*(3)(*a*)), remove the auxiliary generator and engine (par. 188*a*). Loosen nut on bail securing bowl to filter cover, move bail aside, and remove fuel filter bowl and bowl gasket. Lift out element gasket and filter element from bowl and clean bowl with dry-cleaning sol-

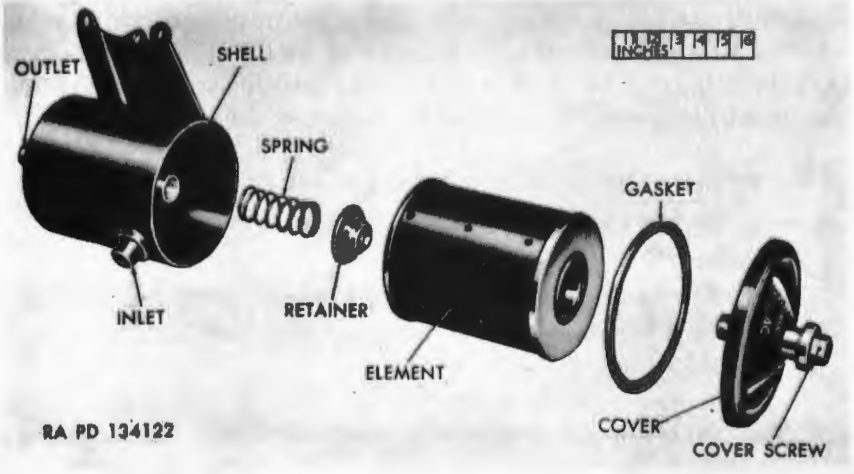


Figure 164. Auxiliary generator and engine oil filter—exploded view.

vent or mineral spirits paint thinner. Replace element gasket if necessary. Position element gasket on filter element and install element and gasket in bowl. Using a new bowl gasket, position bowl on fuel filter cover, place bail in position and tighten nut on bail securely. Improvise a fuel supply for the auxiliary generator and engine. Start auxiliary generator and engine (par. 70) and inspect for evidence of leakage around filter bowl. If any leaks are found, stop engine and check installation of bowl and seating of bowl gasket. The servicing procedure of the fuel filter on early and late engines is identical. If no leaks are found, install auxiliary generator and engine (par. 188*b*).

d. Spark Plug Cleaning and Adjustment. The spark plug (fig. 166) should be cleaned and adjusted at regular intervals or whenever the auxiliary generator and engine is removed from the vehicle. Using a round wire gage, adjust gap 0.017 to 0.020-inch between electrodes. Install a new gasket when plug has been removed for cleaning or adjustment. Replace spark plug if badly burned, or otherwise damaged. Refer to paragraph 194*a* for removal and installation instructions.

e. Air Cleaner. Refer to lubrication order LO 9–7218 (par. 90) for intervals and grade of lubricant to be used when servicing the auxiliary generator and engine air cleaner (fig. 9). Release pressure clamps on each side of air cleaner, remove oil cup, and discard oil. Scrape accumulated dirt from cup and clean with a cloth soaked with dry-cleaning solvent or mineral spirits paint thinner. To inspect or remove air cleaner filters, remove filter retaining spring and pull filters from cleaner body. Soak air filters in dry-cleaning solvent or mineral spirits paint thinner and shake to remove excess thinner. Dip air cleaner filters in clean oil and insert filters into air cleaner body; secure in place with retaining spring. Fill oil cup with oil as prescribed in lubrication order LO 9–7218 (par. 90) to oil level mark. Position cup on air cleaner body and secure with two pressure clamps.

188. Auxiliary Generator and Engine Removal and Installation

Note. Coordinate with ordnance maintenance unit (par. 2).

a. Removal.

(1) Turn master relay switch (E, fig. 15) to the OFF position and fuel shutoff valve control lever (fig. 9) to the ALL OFF position.

(2) Loosen screws on hose clamps (fig. 162) securing air inlet and air outlet duct hose to air cleaner, valve housing, and main engine air intake duct. Remove hose and air inlet and outlet ducts from vehicle.

(3) Loosen tube clamp securing flexible exhaust tube (fig. 162) to exhaust pipe of auxiliary generator and engine and remove tube from pipe.

(4) Remove four hex-head bolts with integral lockwashers and two spacers securing exhaust shroud (fig. 162) to front right plate and remove shroud.

Note. Spacers are installed beneath the open end of the exhaust shroud; save spacers for installation.

(5) Remove three hex-head bolts and lockwashers securing front right plate (fig. 162) to hull and remove plate.

(6) Remove bulkhead door (par. 243*a*) and disconnect quick-disconnect coupler to flexible fuel line (fig. 161) from fitting on bulkhead.

(7) Open engine compartment grille doors (fig. 236).

(8) Disconnect right fuel tank flexible vent line from fuel tank vent line (fig. 161).

(9) Disconnect cable connector from multiple cable receptacle (fig. 159) on auxiliary generator and engine.

(10) Loosen screws on hose clamp securing air intake hose from silencer to carburetor air inlet tube (fig. 159) and remove hose from tube.

(11) Loosen screw securing choke control cable wire to trunnion on choke control lever assembly (fig. 159) and remove wire from lever assembly. Remove panhead screw and lockwasher securing choke control cable support to guard and remove support.

(12) Remove two hex-head bolts and lockwashers securing channels (fig. 161) to mounting rails and lift out channels.

(13) Attach hoist to lifting eye (fig. 158) and carefully raise auxiliary generator and engine until ground and positive cable terminal posts are accessible. Remove nut and lockwasher securing each cable to its terminal post and remove cables.

Caution: Tape terminal of positive cable.

(14) Remove auxiliary generator and engine from vehicle.

Caution: Avoid lateral movement of unit during lifting operation to prevent damage to mounting supports (fig. 159).

b. Installation.

(1) Check to be sure master relay switch is in the OFF position. Attach hoist to auxiliary generator and engine. Aline mounting supports (fig. 159) on unit with mount-

ing rails on hull. Lower unit carefully into vehicle to approximately halfway point. Remove tape from terminal of positive cable and secure positive and negative cable terminals to terminal posts (fig. 159) on auxiliary generator and engine. Lower unit into position and remove hoist.

(2) Position choke control cable support with cable on carburetor guard and secure with ¼ x ½ panhead screw and integral lockwasher. Insert wire of choke control cable through trunnion of choke control lever assembly (fig. 159) and secure by tightening No. 8 x 5/16 locking screw.

Note. A dimension of 7-inches plus or minus ⅛-inch must be maintained between the cable support and the end of the cable housing to insure maximum choking action.

(3) Position air intake hose from silencer on carburetor air inlet tube (fig. 159) and secure by tightening screw on hose clamp.

(4) Connect cable connector to multiple cable receptacle (fig. 159).

(5) Slide channels (fig. 159) on mounting rails and secure channels to rails with two ½ x ¾ hex-head bolts and ½-inch lockwashers.

(6) Connect right fuel flexible tank vent line to fuel tank vent line (fig. 161).

(7) Close engine compartment grille doors.

(8) Connect quick-disconnect coupler of flexible fuel line (fig. 161) to fitting on bulkhead and install bulkhead door (par. 243*b*).

Note. Before continuing with installation procedure, test operation of auxiliary generator and engine (par. 70).

(9) Position front right plate (fig. 162) on hull and secure with three ⅝ x 1½ hex-head bolts and ⅝-inch lockwashers.

(10) Position exhaust shroud (fig. 162) on front right plate with one spacer between shroud and plate at each bolt hole nearest shroud opening. Secure shroud to plate with two ⅜ x ⅞ hex-head bolts with integral lockwashers at shroud opening and two ⅜ x ⅝ hex-head bolts with integral lockwashers at rear of shroud.

(11) Install flexible exhaust tube (fig. 162) on exhaust pipe of auxiliary generator and engine and tighten tube clamp securely.

(12) Install air inlet duct and hose (fig. 162) on inlet of air cleaner and valve housing and tighten screws on hose clamps securely.

(13) Install air outlet duct and hose (fig. 162) to outlet of air cleaner and main engine air intake duct and tighten screws on hose clamps securely.

189. Air Cleaner and Air Intake Silencer

a. Air Cleaner.

(1) *Removal.* Loosen clamp screw securing hose to outlet of air cleaner (fig. 9) and remove hose from cleaner. Remove two hex-head bolts, lockwashers, and flat washers securing air cleaner mounting bracket to hull wall and remove air cleaner.

(2) *Installation.* Position auxiliary generator and engine air cleaner (fig. 9) mounting bracket on right hull wall in driver's compartment and secure with two 3/8 x 5/8 hex-head bolts, 3/8-inch lockwashers, and 3/8-inch flat washers. Attach hose to outlet of air cleaner, position clamp, and tighten clamp screw securely.

b. Air Intake Silencer.

(1) *Removal.* Remove auxiliary generator and engine (par. 188*a*). Working from right ammunition stowage compartment, loosen hose clamp screw securing hose to inlet end of intake silencer and remove hose. From engine compartment side of bulkhead, loosen hose clamp screw securing carburetor inlet tube hose to outlet of silencer, and remove hose. Pull silencer out the engine compartment side of bulkhead being careful not to damage grommet. Remove silencer and grommet.

(2) *Installation.* Position grommet around silencer and insert silencer into opening in bulkhead from engine compartment side. Working from right ammunition stowage compartment, install hose on inlet of silencer and secure by tightening hose clamp screw securely. From engine compartment side, seat grommet in opening in bulkhead and around silencer. Install carburetor inlet tube hose to outlet of silencer and tighten hose clamp screw securely. Install auxiliary generator and engine (par. 188*b*).

190. Exhaust System

(fig. 162)

a. General. The muffler for the auxiliary generator and engine may have been installed on either the front or the side of the tool stowage rack mounted on the right muffler shield. The removal and installation procedure for either type is essentially the same.

b. Removal. Loosen tube clamp screw securing flexible exhaust tube to exhaust pipe of auxiliary generator and engine. Loosen

screw on tube clamp securing flexible exhaust tube to inlet of exhaust muffler. Remove two hex-head bolts, flat washers, and hex nuts securing tube bracket clamp and tube to tool stowage rack and remove bracket clamp and tube. Remove two hex-head bolts, flat washers, and hex nuts from mounting bands on exhaust muffler. Spread bands and slide muffler out of bands.

c. Installation. Slide muffler into bands and position muffler so that outlet end is projecting away from vehicle. Secure muffler with two 3/8 x 2 1/4 hex-head bolts, 3/8-inch flat washers, and 3/8-inch hex nuts in mounting bands and tighten securely. Install flexible exhaust tube with tube clamps on exhaust pipe of auxiliary generator and engine and inlet end of muffler and tighten hose clamp screws securely. Position tube bracket clamp over tube and on tool stowage rack and secure with two 3/8 x 1 hex-head bolts, 3/8-inch flat washers, and 3/8-inch hex nuts.

191. Fuel Filter

a. Early Engines.

(1) *Removal.* Open engine compartment grille doors (fig. 236) over auxiliary generator and engine. Disconnect from elbows on fuel filter, union to fuel filter fuel line (fig. 169), and fuel filter to fuel pump fuel line (fig. 165). Loosen two

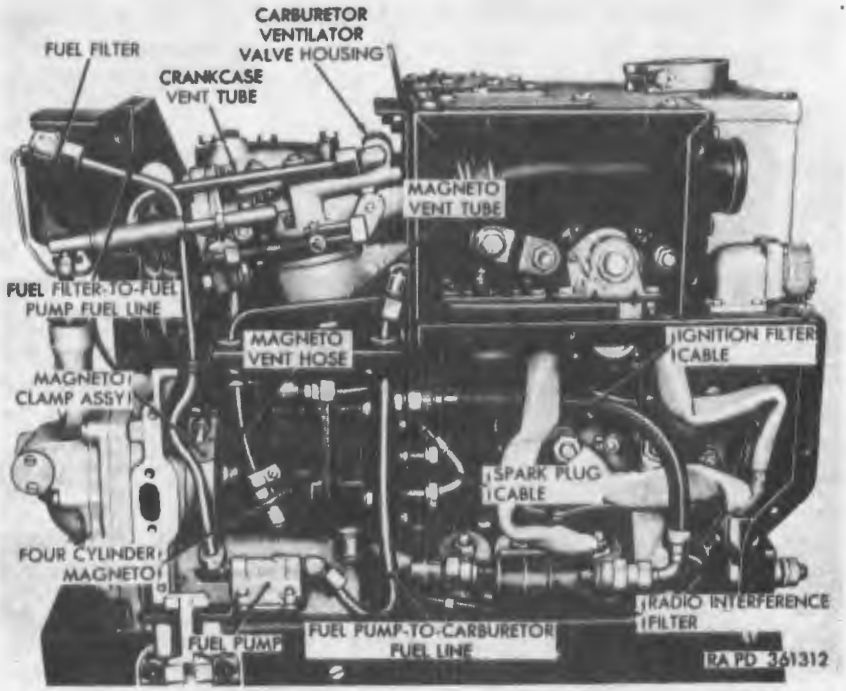


Figure 165. Fuel and ventilating lines—early engines.

outer hex nuts and lockwashers, and two inner hex nuts and lockwashers securing fuel filter to mounting bracket and remove fuel filter. Remove elbows, hex nuts, and lockwashers from filter.

(2) *Installation.* Install 9/16-inch internal-teeth lockwasher and 9/16-inch hex nut on each fuel line fitting of fuel filter (fig. 165). Install 9/16-inch internal-teeth lockwasher and 9/16-inch hex nut on each elbow and install elbows on fuel filter. Position fuel filter on mounting bracket so that bracket is between inner and outer hex nuts and lockwashers. Tighten hex nuts to hold filter in place. Connect union to fuel filter fuel line (fig. 169) and fuel filter to fuel pump line (fig. 165) to fuel filter elbows. Operate auxiliary generator and engine (par. 70) and check fuel lines, connections, and filter for leaks. Stop engine after test and close grille doors.

b. Late Engines.

(1) *Removal.* Remove auxiliary generator and engine (par. 188*a*). Disconnect flexible fuel line and fuel filter to fuel pump fuel line from fittings on fuel filter. Remove hex nut and lockwasher securing fuel filter to mounting bracket and remove fuel filter from bracket.

(2) *Installation.* Position fuel filter on mounting bracket and secure with 5/8-inch hex nut and 5/8-inch internal-teeth lockwasher. Connect fuel filter to fuel pump fuel line to outlet port of filter and flexible fuel line to inlet port of filter. Install auxiliary generator and engine (par. 188*b*). Operate auxiliary generator and engine (par. 70) and check fuel lines, connections, and fuel filter for leaks.

192. Crankcase and Magneto Ventilating Lines

a. General. The crankcase ventilating system consists of a crankcase vent tube (fig. 158) connected to the carburetor ventilator valve housing (fig. 165) and the upper portion of the oil filler tube. The magneto ventilating system consists of two magneto vent tubes and hose (fig. 165) which are joined together to form an inlet and outlet from the magneto to the carburetor.

Note. The magneto ventilating lines are only used on those auxiliary generator and engines which are equipped with a 4-cylinder magneto.

When a Scintilla or Wico single-cylinder replacement magneto is serviced, plug the vent holes in the oil filler tube and the carburetor with 1/8-inch pipe plugs.

b. Crankcase Vent Tube.

(1) *Removal.* Open engine compartment grille doors (fig. 236) over auxiliary generator and engine. Loosen locking screw

and remove choke control cable wire from trunnion of choke control lever assembly (fig. 159). Remove two panhead screws with integral lockwashers and lift off choke control lever assembly. Remove four panhead screws with integral lockwashers and remove carburetor guard (fig. 158). Unscrew crankcase vent tube connector nuts from carburetor and oil filler tube and remove crankcase vent tube (figs. 158 and 165).

(2) *Installation.* Position crankcase vent tube (figs. 158 and 165) to connection on the oil filler tube and carburetor and tighten connector nuts securely. Install carburetor guard (fig. 158) and secure with four 1/4 x 1/2 panhead screws with integral lockwashers. Position choke control lever assembly (fig. 159) on guard and secure with two 1/4 x 1/2 panhead screws with integral lockwashers. Thread choke control cable wire through trunnion and tighten No. 8 x 5/16 locking screw. Close engine compartment grille doors (fig. 236).

c. Magneto Vent Tubes and Hose.

(1) *Removal.* Remove auxiliary generator and engine (par. 188*a*). Loosen locking screw and remove choke control cable wire from trunnion of choke control lever assembly (fig. 159). Remove two panhead screws with integral lockwashers and lift off choke control lever assembly. Remove four panhead screws with integral lockwashers and remove carburetor guard (fig. 158). Remove 18 panhead screws with integral lockwashers and lift off upper left panel (fig. 159). To remove the magneto vent hose (fig. 165), loosen hose clamps and pull hose away from vent tubes and magneto elbows. To remove magneto vent tubes (fig. 165), unscrew the connector nuts at the carburetor, remove the rubber grommets, and remove the magneto vent tubes.

(2) *Installation.* Position magneto vent tubes (fig. 165) and tighten vent tube connector nuts at carburetor. Place rubber grommet around vent tube and press in place. Install magneto vent hose (fig. 165) with hose clamps, onto magneto elbows and vent tube ends. Tighten hose clamps to secure magneto vent hose. Install upper left panel (fig. 159) using eighteen 1/4 x 1/2 panhead screws with integral lockwashers. Install carburetor guard (fig. 158) using four 1/4 x 1/2 panhead screws with integral lockwashers. Position choke control lever assembly (fig. 159) on guard and secure with two 1/4 x 1/2 panhead screws with integral

lockwashers. Thread choke control cable wire through trunnion and tighten No. 8 x 5/16 locking screw. Install auxiliary generator and engine (par. 188*b*).

193. Low Oil Pressure Warning Light Switch

a. Removal. Disconnect electrical cable connector from receptacle on low oil pressure warning light switch (fig. 158). Unscrew warning light switch from connector at bottom of oil filter.

b. Installation. Screw low oil pressure warning light switch (fig. 158) on connector at bottom of oil filter and turn until tight. Connect electrical cable connector to receptacle on switch.

194. Spark Plug and Spark Plug Cable

a. Spark Plug.

(1) *Removal.* Open engine compartment grille doors (fig. 236) over auxiliary generator and engine. Remove choke control lever assembly (fig. 159) by removing two panhead screws with integral lockwashers and disconnecting choke control cable wire from trunnion. Remove four panhead screws with integral lockwashers and lift off carburetor guard (fig. 158). Remove spark plug cover by turning the quick-release thumbscrew one-quarter turn clockwise or counterclockwise. Loosen spark plug cable connector nut (fig. 166) and remove spark plug cable from spark plug. Place deep-socket wrench on spark plug (fig. 166) and turn counterclockwise until plug can be lifted from the engine cylinder head. Discard spark plug gasket. For servicing of spark plug, refer to paragraph 187*d*.

(2) *Installation.* Insert spark plug (fig. 166) and new gasket into engine cylinder head and turn by hand until snug. Using a deep-socket wrench, turn spark plug clockwise until tight. Position spark plug cable on spark plug and tighten cable connector nut (fig. 166). Position spark plug cover and turn quick-release thumbscrew one-quarter turn clockwise or counterclockwise to secure. Install carburetor guard (fig. 158) and secure with four 1/4 x 1/2 panhead screws with integral lockwashers. Position choke control lever assembly (fig. 159) on carburetor guard and secure with two 1/4 x 1/2 panhead screws with integral lockwashers. Insert choke control cable wire into trunnion on choke control lever assembly and secure by tightening No. 8 x 5/16 locking screw. Close engine compartment grille doors (fig. 236).

b. Spark Plug Cable.

(1) *Removal.* Remove auxiliary generator and engine (par.

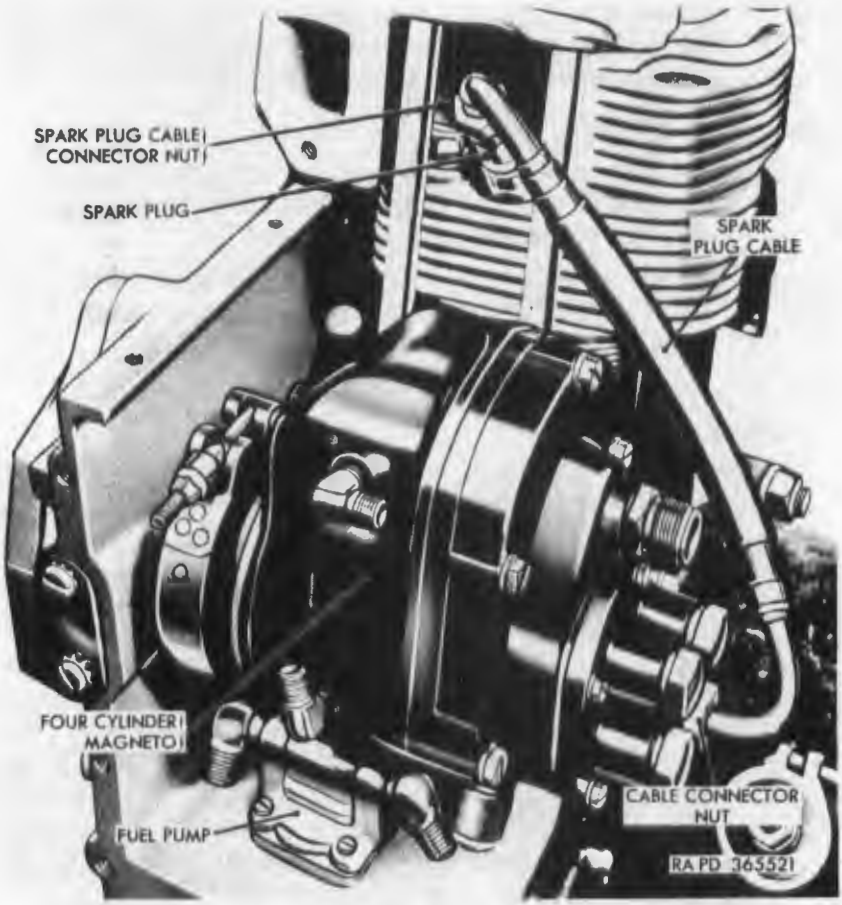


Figure 166. Four cylinder magneto, spark plug, and spark plug cable.

188*a*). Remove choke control lever assembly (fig. 159) by removing two panhead screws with integral lockwashers and disconnecting choke control cable wire from trunnion. Remove four panhead screws with integral lockwashers and remove carburetor guard (fig. 158). Remove 18 panhead screws with integral lockwashers and remove upper left panel (fig. 159). Remove spark plug cover by turning the quick-release thumbscrew one-quarter turn clockwise or counterclockwise. Remove spark plug cable from spark (fig. 166) by removing cable connector nut. Remove cable connector nut securing spark plug cable (fig. 166) to magneto receptacle and remove cable from engine.

(2) *Installation.* Position spark plug cable (fig. 166) on spark plug and tighten cable connector nut. Insert other end of cable into magneto cable receptacle and tighten cable con-

nector nut. Position spark plug cover and turn quick-release thumbscrew one-quarter turn clockwise or counterclockwise to secure. Install carburetor guard (fig. 158) and secure with four ¼ x ½ panhead screws with integral lockwashers. Position upper left panel (fig. 159) on engine and secure with eighteen ¼ x ½ panhead screws with integral lockwashers. Install choke control lever assembly (fig. 159) on guard and secure with two ¼ x ½ panhead screws with integral lockwashers. Insert choke control cable wire into trunnion of choke control lever assembly and secure by tightening No. 8 x 5/16 locking screw. Install auxiliary generator and engine (par. 188*b*).

195. External Oil Lines and Connections

a. General. The external oil lines for the auxiliary generator and engine consist of oil filter inlet and outlet tubes (fig. 158) which are connected to the oil filter and crankcase and a cylinder head drain tube (fig. 167) which is connected to the cylinder head and the crankcase.

b. Oil Filter Inlet and Outlet Tubes (fig. 158).

(1) *Removal.* Remove auxiliary generator and engine (par. 188*a*). Unscrew connector nuts securing oil filter inlet tube on elbow at top of oil filter and from fitting in crankcase. Remove inlet tube. Unscrew connector nuts securing oil filter outlet tube to tee at bottom of oil filter and fitting in crankcase and remove outlet tube.

(2) *Installation.* Position oil filter outlet tube on tee at filter and on fitting on crankcase and tighten connector nuts to secure tube. Position oil filter inlet tube on elbow at top of filter and on fitting in crankcase. Tighten connector nuts to secure tube. Install auxiliary generator and engine (par. 188*b*).

c. Cylinder Head Drain Tube.

(1) *Removal.* Remove auxiliary generator and engine (par. 188*a*). Remove nine panhead screws with integral lockwashers and remove exhaust manifold cover (fig. 158). Remove two hex-head bolts and lockwashers securing cable support (fig. 158) to rocker arm cover and swing support to one side. Remove five panhead screws with integral lockwashers and lift off top panel (fig. 158). Remove 22 panhead screws with integral lockwashers securing right panel (fig. 158) to baffles and two panhead screws at front panel. Remove safety nut from manifold clamp (fig. 167) and slide clamp on tube of heat exchanger. Compress bel-

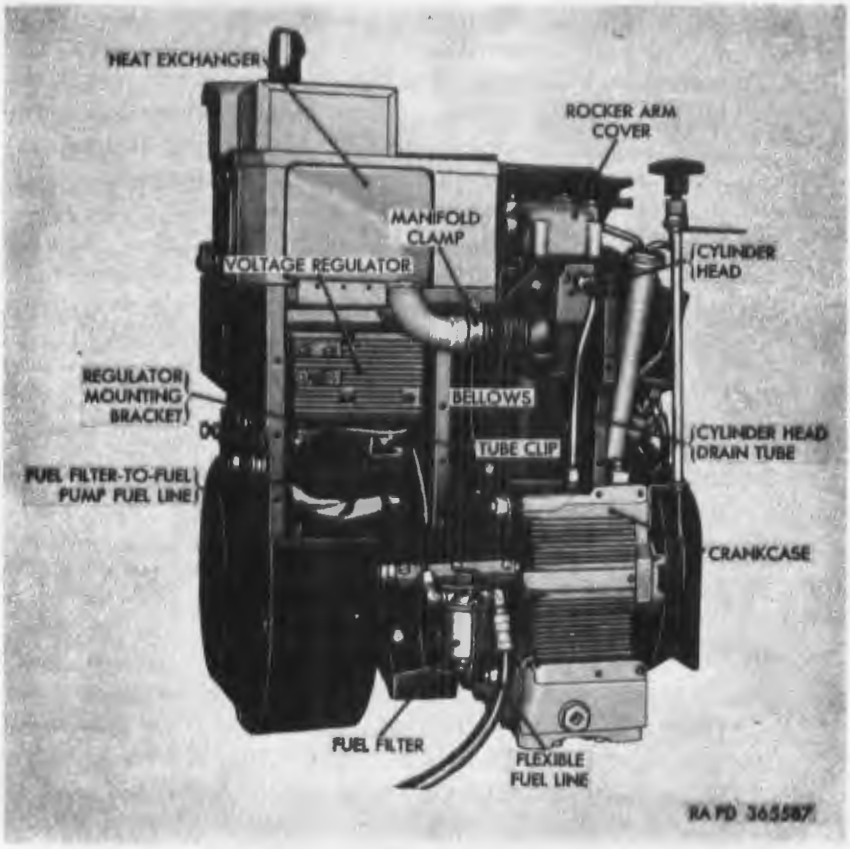


Figure 167. Auxiliary generator and engine—right panel removed.

lows with screwdriver and rotate right panel until narrowest portion of panel can pass between heat exchanger tube and bellows and remove right panel. Unscrew connector nuts securing cylinder head drain tube (fig. 167) to fittings on cylinder head and crankcase and remove tube.

(2) *Installation.* Position cylinder head drain tube (fig. 167) on cylinder head and crankcase fittings and tighten connector nuts at both ends securely. Compress bellows and insert narrowest portion of right panel (fig. 158) between bellows and tube of heat exchanger (fig. 167). Position right panel on baffles and secure with four 5/16 x 1/2 panhead screws with integral lockwashers installed at crankcase, eighteen 1/4 x 1/2 panhead screws with integral lockwashers installed at baffles, and two 1/4 x 1/2 panhead screws with integral lockwashers at front panel. Slide manifold clamp (fig. 167) over heat exchanger tube and bellows, install safety nut on clamp screw, and tighten

clamp securely. Position top panel (fig. 158) over cylinder head and secure with five ¼ x ½ panhead screws with integral lockwashers. Install exhaust manifold cover (fig. 158) and secure with nine ¼ x ½ panhead screws with integral lockwashers. Position cable support (fig. 158) on rocker arm cover and secure with two 5/16 x 2¾ hex-head bolts and 5/16-inch lockwashers. Install auxiliary generator and engine (par. 188*b*).

196. Wiring Harness

a. Removal.

(1) Remove auxiliary generator and engine (par. 188*a*).

(2) Remove two panhead screws with integral lockwashers and remove choke control lever assembly (fig. 159).

(3) Remove upper left panel (fig. 159) by removing 18 panhead screws with integral lockwashers.

(4) Disconnect cable No. 422 (fig. 168) from magneto terminal on 1-cylinder magneto (N, fig. 160) by unscrewing connector nut and pulling plug from receptacle. On those units equipped with 4-cylinder magnetos, disconnect cable No. 422 from radio interference filter (fig. 165) by unscrewing connector nut and pulling plug from filter receptacle.

(5) Disconnect cable No. 420B (fig. 168) from low oil pressure warning light switch (fig. 158) by separating cable connector from receptacle on switch.

(6) Disconnect cable No. 487 (fig. 168) from lower terminal of intake elbow thermostat (fig. 158) by removing hex nut and lockwasher.

(7) Disconnect cable No. 61 (fig. 168) from terminal F on voltage regulator (M, fig. 160) and from generator terminal F by removing two hex nuts and lockwashers.

(8) Disconnect cable No. 62 (fig. 168) from generator terminal A by removing hex nut and lockwasher.

(9) Disconnect cable No. 414 (fig. 168) from rheostat and from terminal R on voltage regulator (M, fig. 160) by removing two hex nuts and lockwashers.

(10) Disconnect cable No. 456C (fig. 168) from terminal SW on voltage regulator by removing hex nut and lockwasher.

(11) Disconnect cable 478H (fig. 168) from terminal P on voltage regulator (M, fig. 160) by removing hex nut and lockwasher.

(12) Disconnect cable No. 413G (fig. 168) from upper left ter-

minal of heater relay (F, fig. 160) by removing hex nut, lockwasher, and flat washer.

(13) Disconnect cable No. 413 (fig. 168) from upper right terminal of heater relay and from terminal E on voltage regulator (M, fig. 160) by removing two hex nuts and lockwashers.

(14) Disconnect cable No. 65D (fig. 168) from starter relay terminal by removing hex nut and lockwasher.

(15) Remove four fillister-head screws, hex nuts and lockwashers that secure the multiple cable receptacle.

(16) To gain access to electrical cables leading to the low oil pressure warning light switch and the intake elbow thermostat, remove the oil filter (fig. 158). Disconnect the inlet and outlet tubes and remove two hex-head bolts, one slotted-head screw, and three lockwashers securing the oil filter to the governor body. Press out grommet and pass cables through opening in panel. Remove grommet from cables.

(17) Pull multiple cable receptacle (G, fig. 160), with cables attached, away from the auxiliary generator and engine being careful not to damage cables as harness is withdrawn from top panel.

b. Inspection. Examine harness for cracked, frayed, burned or deteriorated insulation; loose terminals, or missing circuit markers. Inspect receptacles for corrosion and bent, or damaged cable contacts.

c. Installation. For proper installation of the auxiliary generator and engine wiring harness (K, fig. 160), refer to wiring diagram (fig. 168).

(1) Insert harness cables through opening in top panel being careful not to damage cables. Position multiple cable receptacle on panel and secure with four No. 10 x ½ fillister-head screws, No. 10 lockwashers, and No. 10 hex nuts.

(2) Insert low oil pressure warning light switch cable No. 420B (fig. 168) and intake elbow thermostat cable No. 487 through opening in panel. Install grommet around cables and press grommet into position to protect cables from friction against the panel.

(3) Position oil filter (fig. 158) on governor body and secure with two ¼ x 2 hex-head bolts, one ¼ x 1 slotted-head screw, and three ¼-inch lockwashers. Connect oil filter outlet tube to connector at bottom of oil filter. Connect oil filter inlet tube to elbow at top of oil filter.

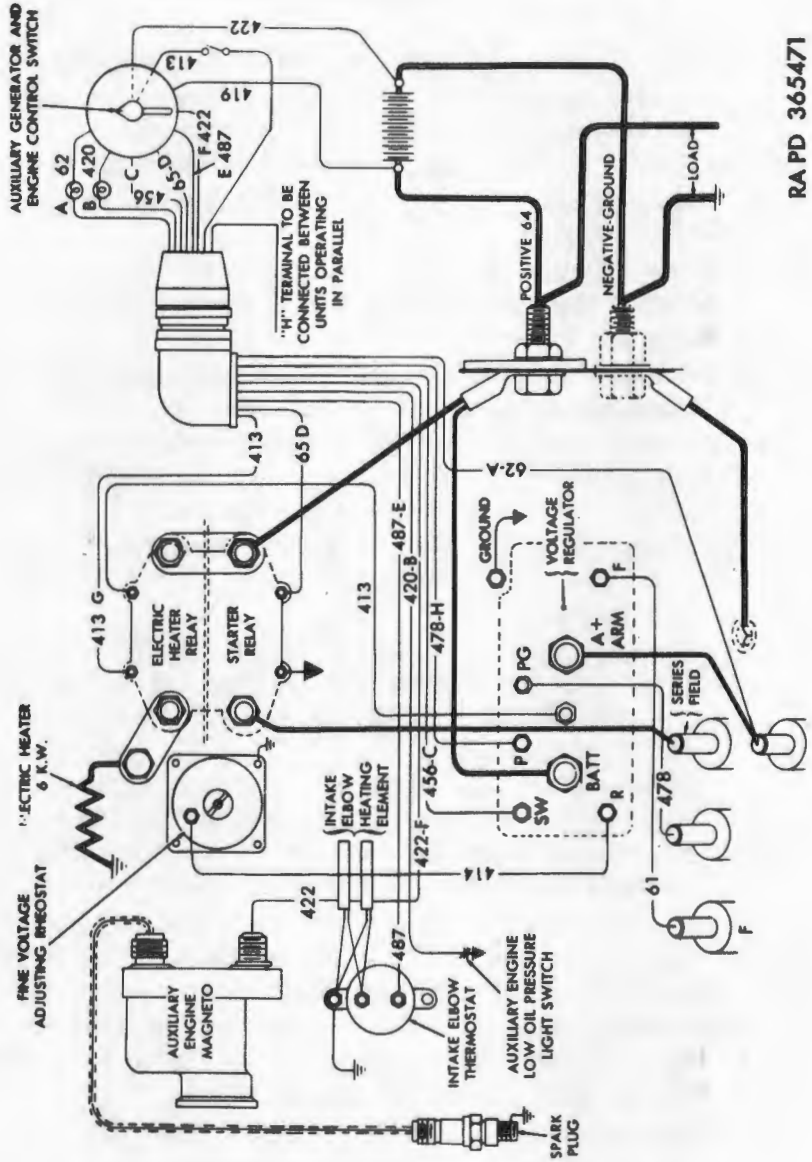


Figure 168. Auxiliary generator and engine wiring diagram.

(4) Connect cable No. 65D (fig. 168) to starter relay terminal and secure with hex nut and lockwasher.

(5) Connect cable No. 413 (fig. 168) to upper right terminal of heater relay (F, fig. 160) and to terminal E on voltage regulator and secure with two hex nuts and lockwashers.

(6) Connect cable No. 413G (fig. 168) to upper left terminal of heater relay (F, fig. 160) and secure with hex nut, lockwasher and flat washer.

(7) Connect cable No. 478H (fig. 168) to terminal P on voltage regulator (M, fig. 160) and secure with hex nut and lockwasher.

(8) Connect cable No. 456C (fig. 168) to terminal SW on voltage regulator (M, fig. 160) and secure with hex nut and lockwasher.

(9) Connect cable No. 414 to rheostat and to terminal R on voltage regulator (M, fig. 160) and secure with two hex nuts and lockwashers.

(10) Connect cable No. 62 (fig. 168) to generator terminal A and secure with hex nut and lockwasher.

(11) Connect cable No. 61 (fig. 168) to terminal F on voltage regulator (M, fig. 160) and to generator terminal F and secure with two hex nuts and lockwashers.

(12) Connect cable No. 487 (fig. 168) to lower terminal of intake elbow thermostat (fig. 158) and secure with hex nut and lockwasher.

(13) Connect connector of cable No. 420B (fig. 168) to receptacle on low oil pressure warning light switch (fig. 158).

(14) Connect cable No. 422 (fig. 168) to 1-cylinder magneto (N, fig. 160) by inserting connector plug into receptacle and tightening cable connector nut. On those units equipped with 4-cylinder magnetos, connect cable No. 422 to radio interference filter (fig. 165) by inserting connector plug into receptacle and tightening cable connector nut.

(15) Position upper left panel (fig. 159) on auxiliary generator and engine and secure with eighteen ¼ x ½ panhead screws with integral lockwashers.

(16) Position choke control lever assembly (fig. 159) on carburetor guard and secure with two ¼ x ½ panhead screws with integral lockwashers.

(17) Install auxiliary generator and engine (par. 188*b*).

197. Choke Control Assembly

a. Removal. Open engine compartment grille doors (fig. 236) over auxiliary generator and engine. Loosen locking screw securing choke control cable wire to choke control lever assembly (fig. 159) and pull wire from trunnion. Remove fillister-head screw, lockwasher, flat washer, hex nut, and mounting clip securing cable assembly to cable support and remove clip from cable assembly. Working in right ammunition stowage compartment, pull cable from cable guide grommet located in bulkhead. Remove hex-head bolt and lockwasher securing cable and cable clip to intake tube sup-

port and remove clip from cable. Remove hex-head bolt, lockwasher, and cable clip securing cable to bulkhead at rear of driving compartment and remove clip from cable. Loosen hex nut securing choke control (fig. 9) handle to mounting bracket on bulkhead at rear of driving compartment, slide nut and lockwasher off end of cable, and pull choke control cable assembly out through opening in mounting bracket.

b. Installation. Insert end of choke control cable assembly into opening in mounting bracket. Slide ½-inch lockwasher and ½-inch hex nut on cable and seat choke control (fig. 9) handle in mounting bracket, secure handle by tightening ½-inch hex nut. Install cable clip on cable and secure cable and clip to rear of driving compartment bulkhead with ¼ x ½ hex-head and ¼-inch lockwasher. Position cable around air intake tube. Install cable clip on cable and secure cable clip and air intake tube support to hull wall with ¼ x ½ hex-head bolt and ¼-inch lockwasher. Install cable guide grommet around cable and insert cable through opening in bulkhead; position grommet in opening. Insert cable wire through trunnion on choke control lever assembly (fig. 159), bend end of wire and tighten No. 8 x 5/16 locking screw. Install mounting clip on cable and secure clip to support with ¼ x ½ fillister-head screw, ¼-inch flat washer, ¼-inch lockwasher, and ¼-inch hex nut. To insure maximum choking action, check that a dimension of 7 inches plus or minus ⅛-inch is maintained between the cable support and end of cable housing when the choke control (fig. 9) handle is against its mounting bracket. Close engine compartment grille doors (fig. 236).

198. Fuel Lines and Connections

a. General.

(1) *Early engines.* The auxiliary generator and engine fuel lines on engines installed in vehicles through Ordnance serial No. 866 consists of a flexible fuel line (fig. 169), union to fuel filter fuel line (fig. 169), fuel filter-to-fuel pump fuel line (fig. 165), and fuel pump to carburetor fuel line (fig. 165). Fuel for the early engines is drawn from the main engine fuel filter.

(2) *Late engines.* The auxiliary generator and engine fuel lines on engines installed in vehicles with Ordnance serial No. 867 and up, consists of a fuel shutoff valve to electric fuel pump fuel line (fig. 161), flexible fuel line (fig. 161), fuel filter to fuel pump fuel line (fig. 167), and the fuel pump-to-carburetor fuel line (W, fig. 160). Fuel is drawn directly from the fuel shutoff valve by the electric fuel pump (fig. 161) and then pumped into the auxiliary generator and engine fuel system.

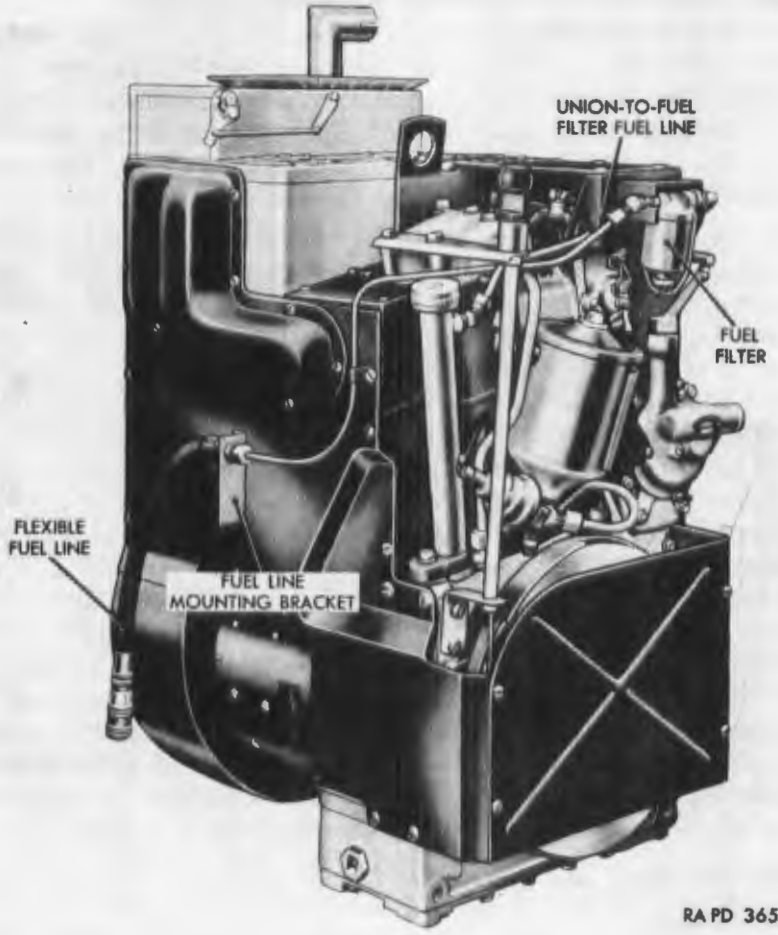


Figure 169. Fuel lines—early engines.

b. Fuel Lines—Early Engines.

(1) *Removal.* Remove auxiliary generator and engine (par. 188*a*). Unscrew connector nut securing flexible fuel line (fig. 169) to union and remove fuel line. Unscrew connector nuts at fuel filter and union, remove two panhead screws with integral lockwashers securing tube clips to panels, and remove union-to-fuel filter fuel line (fig. 169). Remove two panhead screws with integral lockwashers securing choke control lever assembly (fig. 159) to carburetor guard and remove lever assembly. Remove 18 panhead screws with integral lockwashers and remove upper left panel (fig. 159). Unscrew connector nuts securing fuel filter-to-fuel pump fuel line (fig. 165) at filter and fuel

pump, and remove fuel line. Unscrew connector nuts securing fuel pump-to-carburetor fuel line (fig. 165) at outlet of fuel pump and inlet of carburetor and remove fuel line.

(2) *Installation.* Before installing any fuel lines, coat threaded ends lightly with gasket cement to prevent possible leakage. Position fuel pump to carburetor fuel line (fig. 165) and secure by tightening connector nuts at each end of fuel line. Position fuel filter to fuel pump fuel line (fig. 165) and secure by tightening connector nuts at each end of fuel line. Attach union to fuel filter fuel line (fig. 169) to inlet of fuel filter and union at side of auxiliary generator and engine; and secure with connector nuts at both ends. Install two tube clips on fuel line and secure to panels with two ¼ x ½ panhead screws with integral lockwashers. Attach flexible fuel line (fig. 169) to opposite end of union and secure with connector nut. Position upper left panel (fig. 159) on unit and secure eighteen ¼ x ½ panhead screws with integral lockwashers. Position choke control lever assembly (fig. 159) and secure with two panhead screws with integral lockwashers. Install auxiliary generator and engine (par. 188*b*).

c. Fuel Lines—Late Engines.

(1) *Removal.* Turn fuel shutoff valve control lever (fig. 9) to the ALL OFF position. Remove fuel shutoff valve to electric fuel pump fuel line (fig. 161) by removing bulkhead door (par. 243*a*) and loosening connector nuts securing fuel line to shutoff valve and fuel pump. To remove the remaining fuel lines remove the auxiliary generator and engine (par. 188*a*). Unscrew connector nut at fuel filter and remove flexible fuel line (fig. 158). Remove nine panhead screws with integral lockwashers and remove exhaust manifold cover (fig. 158). Remove two hex-head bolts and lockwashers securing cable support (fig. 158) to rocker arm cover and swing support to one side. Remove five panhead screws with integral lockwashers and lift off top panel (fig. 158). Remove 22 panhead screws with integral lockwashers securing right panel (fig. 158) to baffles and 2 panhead screws securing right panel to front panel. Remove safety nut from manifold clamp (fig. 167) and slide clamp on tube of heat exchanger. Compress bellows with screwdriver and rotate right panel until narrowest portion of panel can pass between heat exchanger tube and bellows and remove right panel. Remove two panhead screws with integral lockwashers securing choke control lever assembly

(fig. 159) to carburetor guard and remove lever assembly. Remove 18 panhead screws with integral lockwashers securing upper left panel (fig. 159) and remove panel. Unscrew connector nuts at both ends of fuel filter to fuel pump fuel line (R, fig. 160 and fig. 167). Remove hex-head bolt and lockwashers securing tube and tube clip to voltage regulator bracket. Press out grommet from opening in panel and remove fuel line. Remove fuel pump to carburetor fuel line (W, fig. 160) by unscrewing connector nuts at both ends.

(2) *Installation.* Before installing any fuel line, coat threaded fittings with gasket cement to prevent possible leakage. Position fuel pump to carburetor fuel line (W, fig. 160) and tighten connector nuts at each end. Be sure that grommet is properly positioned around tube and in panel. Insert fuel filter end of fuel filter-to-fuel pump fuel line (R, fig. 160 and fig. 167) through opening in panel and seat grommet in panel. Position line and tighten connector nuts at both ends. Place tube clip beneath voltage regulator mounting bracket (fig. 167) and secure bracket and clip with 5/16 x 5/16 hex-head bolt and 5/16-inch lockwasher. Position upper left panel (fig. 159) and secure with eighteen 1/4 x 1/2 panhead screws with integral lockwashers. Position choke control lever assembly (fig. 159) on carburetor guard and secure with two 1/4 x 1/2 panhead screws with integral lockwashers. Compress bellows (fig. 167) and insert narrowest portion of right panel (fig. 158) between bellows and tube of heat exchanger. Position right panel on baffles and secure with four 5/16 x 1/2 panhead screws with integral lockwashers installed at crankcase, eighteen 1/4 x 1/2 panhead screws with integral lockwashers installed at baffles, and two 1/4 x 1/2 panhead screws with integral lockwashers installed at front panel. Slide manifold clamp (fig. 167) over heat exchanger tube and bellows, install safety nut on clamp screw, and tighten clamp securely. Position top panel (fig. 158) over cylinder head and secure with five 1/4 x 1/2 panhead screws with integral lockwashers. Install exhaust manifold cover (fig. 158) and secure with nine 1/4 x 1/2 panhead screws with integral lockwashers. Position cable support (fig. 158) on rocker arm cover and secure with two 5/16 x 2 3/4 hex-head bolts and 5/16-inch lockwashers. Install auxiliary generator and engine (par. 188*b*). Position fuel shutoff valve to electric fuel pump fuel line (fig. 161) and secure by tightening connector nuts. Install bulkhead door (par. 243*b*).

199. Manual Starting Cable, Handle, and Pulley

a. Removal. Remove auxiliary generator and engine (par. 188*a*). Remove four panhead screws with integral lockwashers that secure front panel (fig. 158) and remove front panel. Pull upward on manual starting handle (fig. 158) and hold manual starting cable. Pry cable retainer from top of handle and drive out spring pin. Remove retainer and handle from cable. Pull starting cable from bottom of cable tube (fig. 158). Remove two hex-head bolts and lockwashers securing cable support (fig. 158) to rocker arm cover and two hex-head bolts and lockwashers securing cable tube bracket to crankcase. Remove cable tube and cable support from auxiliary generator and engine and slide support off cable tube. Install a $\frac{5}{16}$–18 bolt, 6 or 7 inches long, in the $\frac{5}{16}$-inch tapped hole (fig. 170) in starting pulley. Using bolt as handle, rotate pulley clockwise approximately three-fourths inch, and turn pulley latch knob at rear of cable guard (fig. 171) counterclockwise as far as possible. Permit pulley to rotate counterclockwise until pin on pulley is stopped by starting pulley latch (fig. 171). Repeat this procedure until tension of spring in starting pulley is relieved. Remove four hex-head bolts and lockwashers that secure starting pulley and spring inspection hole cover (fig. 170) to the starting pulley hub (fig. 171). Remove cover and lift pulley with spring enclosed, from hub. Drive the spring pin (fig. 170) from starting pulley and the end of starting cable, and remove cable from pulley.

b. Cleaning and Inspection. Clean manual starting cable, starting pulley, cable tube, cable support and spring inspection hole cover in dry-cleaning solvent or mineral spirits paint thinner. Dry with compressed air. Inspect cable for cracks, kinks, and fraying. Replace cracked, kinked, or frayed cable. Inspect pulley and inclosed spring for cracks or damage, replace pulley if either is damaged. Inspect cable tube and cable support for cracks or kinks in tube. Replace tube if it is bent or cracked. Straighten bent cable support, if possible, or replace bent or cracked cable support which is beyond repair.

c. Installation. Insert one end of manual starting cable in groove of starting pulley (fig. 170) and aline hole in cable end with the $\frac{1}{8}$-inch reamed hole in pulley. Secure cable to pulley by driving a $\frac{1}{8}$ x $\frac{1}{2}$ spring pin (fig. 170) into holes in pulley and cable. Wind cable clockwise around pulley. Position starting pulley (fig. 170) with inclosed spring, to the cable guard (fig. 171), so that hook on inner end of spring enters the notch in flange of guard. Position spring inspection hole cover (fig. 170) on pulley and secure pulley and cover to starting pulley hub (fig. 171) with four $\frac{1}{4}$ x $\frac{5}{8}$ hex-head bolts and $\frac{1}{4}$-inch lockwashers. Install a $\frac{5}{16}$–18 bolt 6 or 7 inches

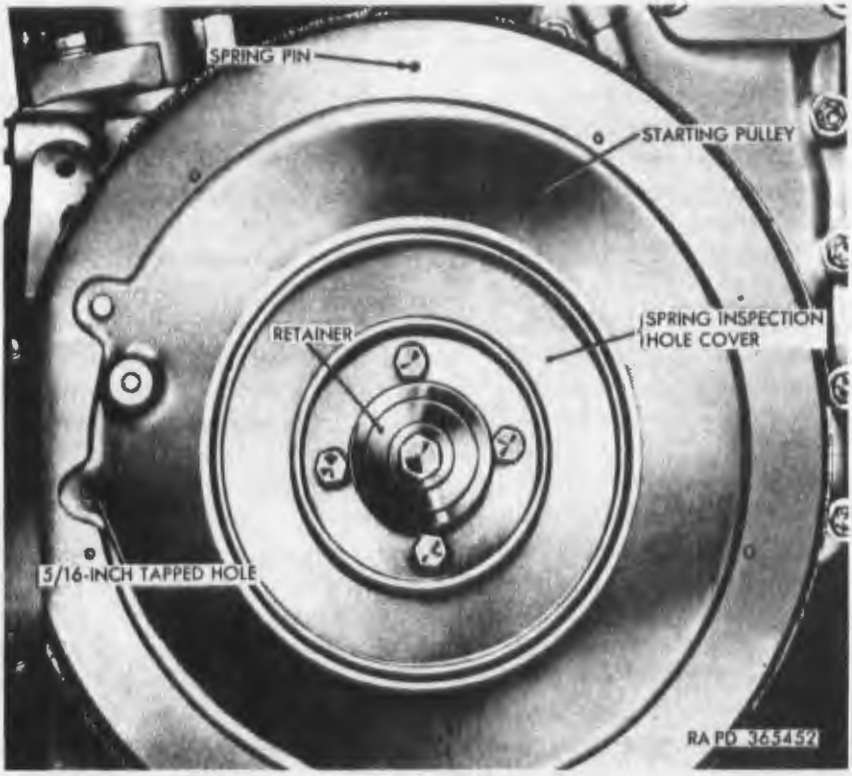


Figure 170. Starting pulley—installed.

long, in the 5/16-inch tapped hole in starting pulley (fig. 170). Remove spark plug (par. 194*a*(1)) to prevent engine from starting when pulley is rotated. Using bolt as handle, rotate pulley clockwise until pin on pulley is stopped by the starting pulley latch (fig. 171). Turn pulley latch knob on rear of cable guard (fig. 171) clockwise as far as possible to allow pin to pass latch. Repeat this procedure until spring tension prevents further rotation of pulley. Turn latch knob clockwise and allow pulley to slowly rotate counterclockwise until pin on pulley strikes latch, pulley spring will now be adjusted to its proper tension. Install spark plug (par. 194*a*(2)). Slide cable support on cable tube. Position cable tube and support on auxiliary generator and engine and secure cable tube bracket to crankcase with two 1/4 x 9/16 hex-head bolts and 1/4-inch lockwashers. Secure cable support to rocker arm cover with two 5/16 x 2 3/4 hex-head bolts and 5/16-inch lockwashers. Insert free end of manual starting cable through bottom of cable tube. Pull end of cable out of tube, hold cable, and slide manual starting handle and handle retainer onto cable. Drive a 1/8 x 1/2 spring pin into holes in retainer and cable end to secure retainer to cable. Slide manual starting handle up on

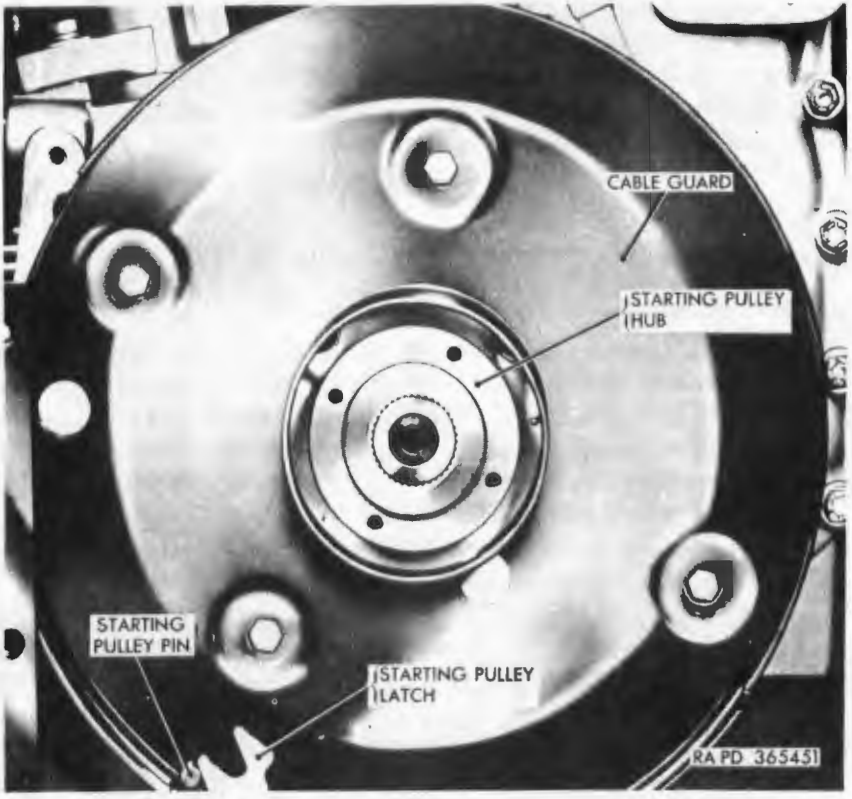


Figure 171. Starting pulley hub and cable guard.

cable and press retainer into end of handle. Position front panel (fig. 158) on auxiliary generator and engine and secure with four ¼ x ½ panhead screws with integral lockwashers. Install auxiliary generator and engine (par. 188*b*).

200. Mounting Supports and Spacers

a. Removal. Remove auxiliary generator and engine (par. 188*a*). To remove lower mounting supports, remove two socket-head cap screws and lockwashers securing mounting support (fig. 159) to auxiliary generator and engine and remove support, support spacer, and support to channel spacer. To remove upper mounting supports, remove two socket-head cap screws and lockwashers securing mounting support to auxiliary generator and engine and remove mounting support and support to channel spacer.

b. Installation. To install lower mounting supports, insert two 5/16 x 7/8 socket-head cap screws and 5/16-inch lockwashers through holes in mounting support. Install mounting support spacer on screws and position mounting support (fig. 159), spacer, and sup-

port to channel spacer on auxiliary generator and engine. Tighten socket-head cap screws securely. To install upper mounting supports, position support-to-channel spacer (fig. 159) and mounting support on auxiliary generator and engine and secure with two 5/16 x 7/8 socket-head cap screws and 5/16-inch lockwashers. Install auxiliary generator and engine (par. 188*b*).

Section XIV. FIRE EXTINGUISHER SYSTEM

201. Description

a. Fixed System. This vehicle is equipped with a carbon dioxide (CO_2) fixed fire extinguisher system (fig. 172) for smothering fires in the engine compartment. The system consists of two 10-pound capacity cylinders equipped with discharge valves, a remote control system, two spray nozzles, and the interconnecting tubing. Both cylinders are discharged simultaneously by pulling either of the pull cable handles marked FIRE-PULL. Refer to paragraph 72 for fixed fire extinguisher system operating instructions.

(1) *Cylinders.* The two 10-pound capacity fixed fire extinguisher cylinders are equipped with discharge valves, which contain a safety valve to release the charge should the safe pressure limits of the cylinder be approached due to expansion of the gas. These cylinders are mounted in the 40-mm ammunition stowage compartment to the left and right of the generator regulator control box (fig. 61).

(2) *Remote control system* (fig. 172). The remote control system consists of a remote control on the left cylinder, a pressure control head on the right cylinder, an outside pull cable handle, an inside pull cable handle, and the necessary interconnecting pull cables and protective conduits. The fixed fire extinguisher cylinders are discharged simultaneously by operating either of the pull cable handles with a quick, hard pull. The remote control is sealed with a wire through the pulley shaft and one cover screw when set.

(3) *Spray nozzles and tubing.* The two spray nozzles are mounted on the left and right fuel tanks in vehicles with Ordnance serial Nos. 1 through 895, 1205 through 1354, and 1555 through 1626. The two spray nozzles are mounted on the engine compartment side of the bulkhead in vehicles with Ordnance serial Nos. 896 through 1204, 1355 through 1554, and 1627 and up. The spray nozzles are connected to the fixed fire extinguisher cylinders by tubing.

b. Portable Fire Extinguisher (fig. 63). The vehicle is equipped with one portable fire extinguisher which is mounted on the gun mount wall to the right of the loader's seat. This fire extinguisher consists of a 5-pound capacity carbon dioxide (CO_2) cylinder equipped with a trigger action discharge valve and a spray nozzle horn. Operating instructions for the portable fire extinguisher are outlined in paragraph 72.

202. Inspection

Note. The key letters noted in parentheses are in figure 172, except where otherwise indicated.

a. General. This paragraph contains information pertaining to periodic inspection services to be performed at intervals indicated in preventive maintenance instructions (table V, par. 104).

b. Fixed Cylinders. Remove the fixed fire extinguisher cylinders (par. 203*a*). Weigh each cylinder on an accurate scale and compare with fully-charged weight that is stamped on the discharge valve. If the actual weight is 6 ounces less than fully-charged weight, replace the cylinder.

c. Remote Control Pull Cable Handles, Cables, and Conduits. Inspect the remote control inside and outside pull cable handles (A) and make sure they are not damaged or obstructed and are properly seated in their mounting sockets (B). Check the remote control cable conduits (F, G, and AA) and housing (H). Check that they are free from kinks, twists or any damage, securely fastened in proper position, and that all conduit connectors (C) are tight. Examine the remote control assembly (BB) on the left cylinder to see if the locational arrows on the cover and shaft (fig. 173) are alined and seal wire is not broken. When arrows are not alined or seal wire is broken, remove cylinders (par. 203) and weigh (*b* above). When slack exists in the pull cables as evidenced by the pull handles not properly seating in their sockets, remove remote control from left cylinder (par. 204) and check installation of cable on pulley. Check remote control for foreign material that might enter through conduit opening. Inspect the seals on safety valve (M); if damaged or missing, the cylinders may have been discharged by expansion of gas. Replace cylinders (par. 203).

d. Tubes and Nozzles. Inspect the tubes (N and Y) from cylinder discharge valves to bulkhead and the unions (P) in the bulkhead to make sure they are tight. Open engine compartment grille doors and inspect tubes from bulkhead unions to spray nozzles on vehicles with Ordnance serial Nos. through 895, 1205 through 1354, and 1555 through 1626. Inspect the spray nozzles (V) to be sure they are clean, not clogged, damaged, or loose.

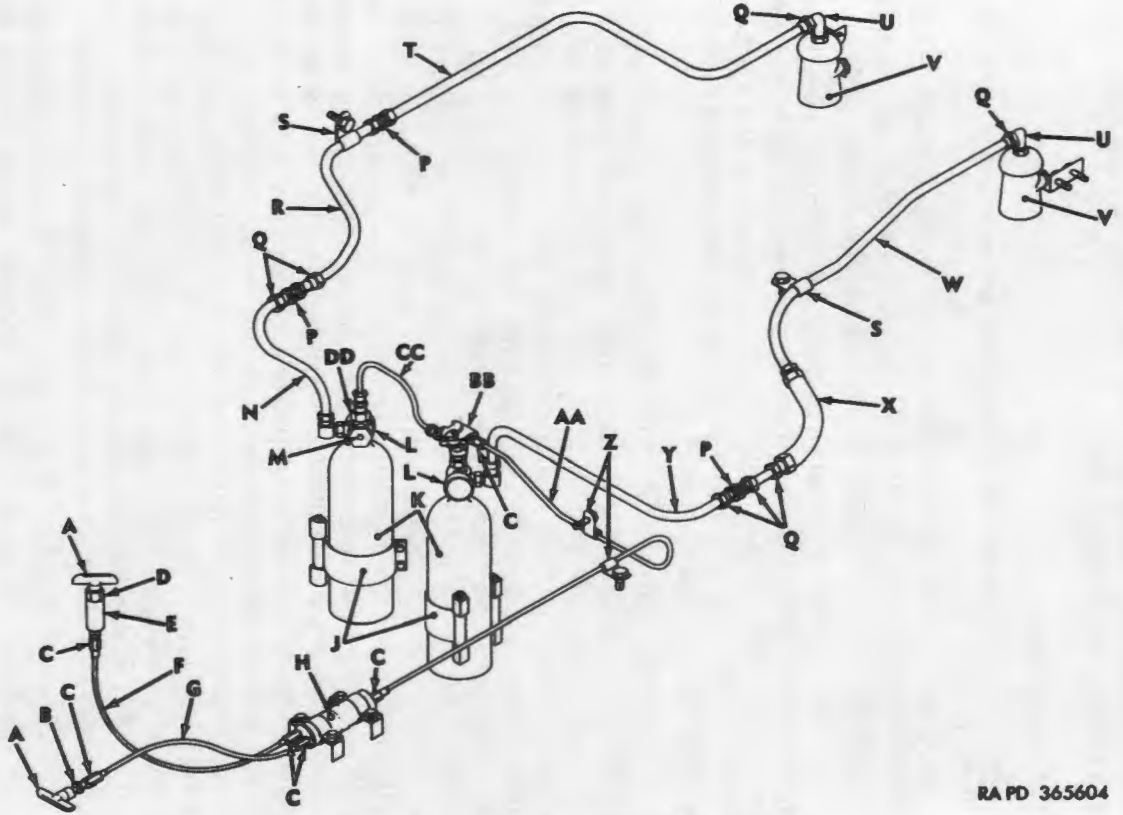


Figure 172. Fixed fire extinguisher system.

A—Inside and outside pull cable handles
B—Mounting socket
C—Connector
D—Pull cable packing nut
E—Guide (part of hull)
F—Outside pull cable flexible conduit
G—Inside pull cable flexible conduit
H—Cable inlet and outlet housing
J—Cylinder mounting strap
K—Cylinders
L—Discharge valve
M—Safety valve
N—Right cylinder front discharge tube
P—Tube union
Q—Tube coupling nut
R—Right front discharge tube
S—Discharge tube clip
T—Right nozzle end discharge tube
U—Elbow
V—Spray nozzle
W—Left nozzle end discharge tube
X—Flexible discharge line
Y—Left cylinder front discharge tube
Z—Pull cable conduit clamp
AA—Inlet pull cable flexible conduit
BB—Remote control assembly
CC—Remote control pressure tube
DD—Pressure control head

Figure 172—Continued.

e. Portable Fire Extinguisher (fig. 63). Weigh the portable fire extinguisher. If actual weight is not 4½-pounds or more above the empty weight stamped on the stationary portion of the swivel head, replace the extinguisher with one that is fully charged. Clean spray nozzle horn and be sure that swivel works freely. Check that locking wire is in position on trigger.

203. Fixed Fire Extinguisher Cylinders

Note. The key letters noted in parentheses are in figure 172, except where otherwise indicated.

a. Removal.

(1) Remove 40-mm ammunition boxes from left or right stowage compartment as desired to gain access to the fixed fire extinguisher cylinders.

(2) Unscrew the coupling nut which secures the remote control assembly (BB) to the left cylinder discharge valve (L).

Caution: If cylinders are charged, handle with care to avoid accidental discharge.

Lift the remote control free of the discharge valve.

(3) Unscrew the coupling nut which secures the pressure control head (DD) to the right discharge valve (L) and lift the pressure head off the valve.

(4) Disconnect the two cylinder front discharge tubes (Y and N) from the left and right cylinders.

(5) Remove the two hex-head bolts which secure each cylinder in the mounting straps (J).

(6) Remove the fixed fire extinguisher cylinders through the stowage compartment.

Caution: Charged cylinders must be handled with care. They must not be dropped, struck, or subjected to temperatures above 140° F.

b. Installation.

(1) Position fully charged cylinders (K) in the mounting straps (J), and secure with four 3/8 x 1¼ hex-head bolts. Aline and connect the left and right cylinder front discharge tubes (Y and N), making sure that discharge tubes are tight at tube unions (P).

(2) Check and reset the remote control (par. 204*b*(4)).

Caution: Be careful of accidental discharge of cylinders when connecting remote control.

Position the remote control assembly (BB) on the left discharge valve (L) and secure with coupling nut, then position the pressure control head (DD) on the right discharge valve and secure with coupling nut.

(3) Stow the 40-mm ammunition boxes in left or right ammunition stowage compartments.

204. Fixed Fire Extinguisher Remote Control Assembly

Note. Coordinate with ordnance maintenance personnel (par. 2). The key letters noted in parentheses are in figure 172, except where otherwise indicated.

a. Removal.

(1) Remove the 40-mm ammunition boxes from the left or right stowage compartment to gain access to the fixed fire extinguisher.

(2) Disconnect the remote control pressure tube (CC) from the remote control assembly (BB).

(3) Unscrew the coupling nut which secures the remote control assembly (BB) to the left discharge valve (L) and lift the control free of the valve.

Caution: Be careful. Do not accidentally discharge the cylinder.

(4) Remove sealing wire from pulley shaft and cover screw, remove three fillister-head screws and lockwashers, and remove the cover.

(5) Loosen the two setscrews, which secure the pull cable in the stem return pulley (fig. 173), disconnect conduit connector (C) from control body, and pull the cable out of the control. Remove the remote control.

b. Installation.

(1) Remove the cover from new remote control and lift the

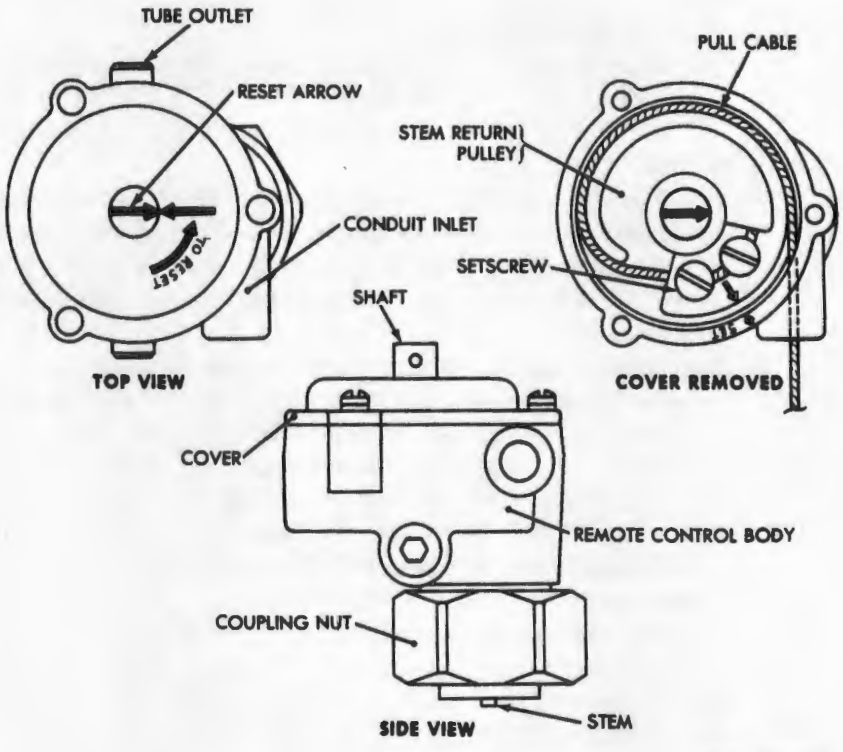


Figure 173. Fixed fire extinguisher remote control.

stem return pulley out of the body. Loosen the two setscrews (fig. 173) provided to secure the cable in the pulley.

(2) Install conduit and pressure tube attaching nipples into upper inlet and opposite lower outlet. Obtain these nipples from control that was removed.

Note. When installing same remote control which was removed in *a* above, check that it is free from rust inside the body.

(3) Insert cable through upper nipple and secure conduit (AA) with connector (C). Make sure that the remote control pull cable handles (A) are seated and secured in their sockets (B). Pull the cable into the remote control body (fig. 173) as far as possible and wrap cable counterclockwise around the pulley. Insert end of cable under setscrews but do not tighten.

(4) Position pulley in remote control body (fig. 173) so that the arrow on the pulley is alined with the arrow on the body.

Note. In this position, the discharge stem will locate in a detent on the lower side of the pulley.

Adjust the cable around the pulley so there is no slack and tighten the two setscrews. If cable is too long, cut off the excess so it will not interfere with rotation of pulley.

(5) Position the remote control cover on the body so that locational arrows on shaft and cover are alined with shaft in the position described in (4) above. Secure cover with three No. 8 x ½ drilled fillister-head screws and No. 8 lockwashers.

(6) Pull outside pull cable handle out as far as possible and observe if the stem (fig. 173) moves out of the control body freely. Insert pin through hole in pulley shaft and rotate counterclockwise to aline the arrows and reset the control. Make sure the pull cable handle returns to its seat. Repeat this test using the inside pull cable handle. Install seal wire through hole in pulley shaft and one cover screw.

(7) Position the remote control assembly (BB) on the left cylinder discharge valve (L) and secure with coupling nut. Connect the remote control pressure tube (CC) to the control assembly (BB). Check that all connections are tight and conduit is properly positioned.

(8) Stow 40-mm ammunition boxes in left or right ammunition stowage compartment.

205. Inside and Outside Remote Control Pull Cable Handles

Note. Coordinate with ordnance maintenance personnel (par. 2). Inside and outside remote control pull cable handles are identical and removal and installation procedures are similar.

a. Removal. Remove 40-mm ammunition boxes from left stowage compartment. Disconnect remote control assembly from left fire extinguisher cylinder (par. 203*a*(2)). Pull the handle (figs. 174 and 175) out of its packing nut socket assembly as far as possible. Hold the cable fastener assembly and unscrew the handle from the fastener assembly. Push the insert out of the fastener to free the cable and remove cable from fastener.

b. Installation. Thread the remote control pull cable through one groove in the hexagonal end of the fastener insert, and loop the cable back through the other groove until the end of the cable is flush with the end of the insert. Using pliers, press the insert into the fastener to secure the cable.

Note. The pull cable should extend out of the socket assembly or packing nut five inches to allow 1¼ inch for attaching to fastener assembly and retain 3¾-inch total cable travel.

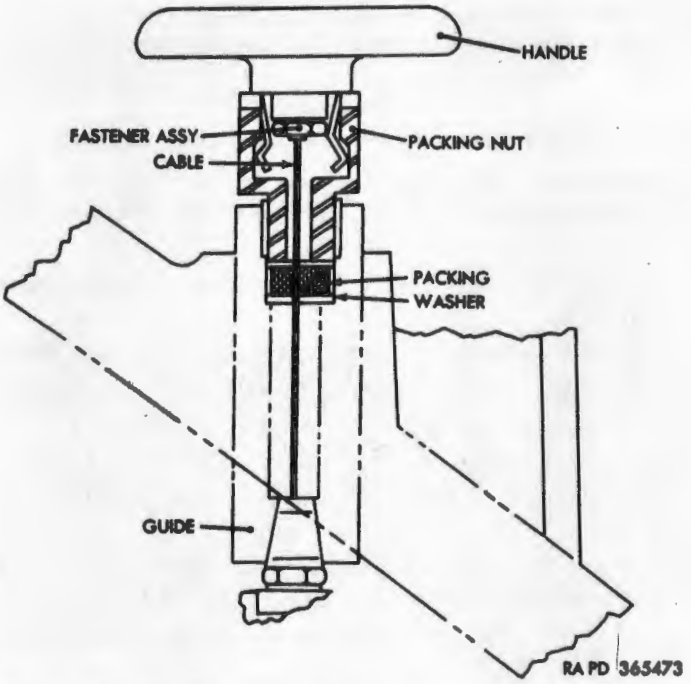


Figure 174. Outside remote control pull cable handle installation—sectional view.

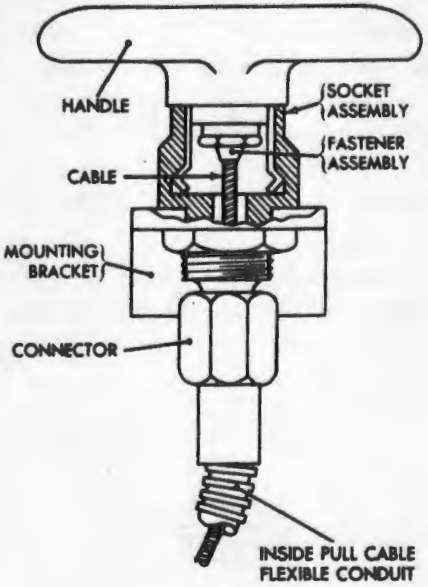


Figure 175. Inside remote control pull cable handle installation—sectional view.

Reset and connect remote control (par. 204*b*(4)–(7)). Stow 40-mm ammunition boxes in left or right ammunition stowage compartment.

206. Remote Control Pull Cables, Conduits, and Housing

Note. Coordinate with ordnance maintenance personnel (par. 2). The key letters noted in parentheses are in figure 172, except where otherwise indicated.

a. Removal.

(1) Remove fixed fire extinguisher remote control assembly (par. 204*a*).

(2) Remove remote control pull cable handles (par. 205*a*).

(3) Remove the two hex-head bolts with integral lockwashers which secure the pull cable conduit clamps (Z).

(4) Disconnect the inside and outside pull cable flexible conduits (G and F) from the socket assembly (B) and packing nut (D) and pull the cables out.

(5) Remove the four hex-head bolts with integral lockwashers which secure the cable inlet and outlet housing (H) to the hull and remove the housing and conduits from the vehicle.

b. Disassembly. Unscrew the three connectors (fig. 176) which secure the flexible cable conduits to the inlet and outlet housings and slide conduits off cables. Unscrew the inlet housing out of the outlet housing and remove the cable assembly from the housing.

c. Assembly. Assemble the remote control cable assembly into the housings with the long cable through the inlet housing (fig. 176) end. Screw the outlet housing on the inlet housing. Assemble the flexible conduits over the control cables according to lengths and secure with connectors to the inlet and outlet housings.

d. Installation.

(1) Position the cable inlet and outlet housings (H) in the mounting clamp with the dual end of outlet housing to-

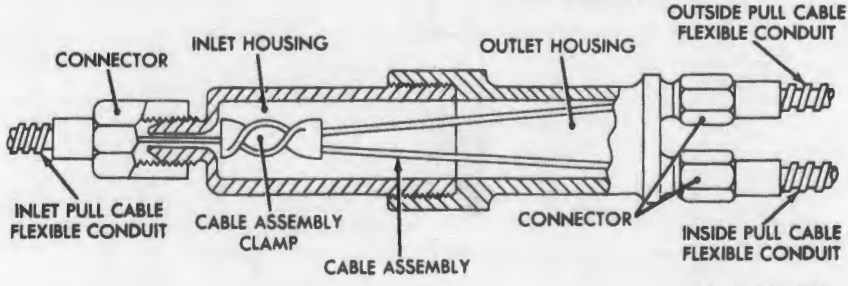


Figure 176. Cable inlet and outlet housings—sectional view.

ward the front of the vehicle and the longest of the two cables toward the left of the vehicle. Secure housing in clamps with two clamp covers and four 5/16 x 3/4 hex-head bolts with integral lockwashers.

(2) Insert the outside and inside remote control cables through their socket assembly or packing nut (figs. 174 and 175) and secure the conduits with connectors (C). Tighten packing nut (fig. 174) after cable is inserted to insure a watertight seal.

(3) Install inside and outside pull cable handles (par. 205*b*).

(4) Route the inlet pull cable conduit (AA) along hull and bulkhead and secure with two conduit clamps (Z) and two 1/4 x 3/8 hex-head bolts with integral lockwashers.

(5) Install fixed fire extinguisher remote control assembly (par. 204*b*).

207. Tubes and Nozzles

Note. The key letters noted in parentheses are in figure 172, except where otherwise indicated.

a. General. The location of the fixed fire extinguisher spray nozzles and the serial number break points are described in paragraph 201*a*(3). If replacement discharge tubes are not available for early vehicles, the installation can be changed so that the nozzles are mounted on the bulkhead as in later vehicles.

b. Discharge Tubes.

(1) *Removal.* Disconnect both ends of tube to be removed using a wrench that provides a snug fit. Use a wrench to hold elbow of fitting from which tube coupling nut (Q) is being removed. Remove hex-head bolts and discharge tube clips (S) where provided. Do not bend, crimp, or dent tubes during removal or installation. Protect tubes from possible damage after removal.

(2) *Installation.* Preassembled steel tubes, with fittings in place, will be used to make replacements. Take care not to bend, crimp, or dent tubes as they are worked into position. Hand tighten tube coupling nuts (Q). Install right side discharge tube clip (S) and secure with 3/8 x 3/4 hex-head bolt with integral lockwasher. Install left side discharge tube clip (S) and secure with 1/4 x 3/8 hex-head bolt with integral lockwasher. Tighten tube coupling nuts with a snug fitting wrench and use a second wrench to hold elbow, union, or fitting from turning.

c. Spray Nozzles.

(1) *Removal of fuel tank mounting type.* Remove two hex-

head bolts with integral lockwashers and flat washers securing spray nozzle (V) to mounting bracket on fuel tank. Unscrew spray nozzle (V) from elbow (U) and remove nozzle.

(2) *Removal of bulkhead mounting type.* Unscrew spray nozzle (fig. 161) from elbow on bulkhead union and remove spray nozzle.

(3) *Installation of fuel tank mounting type.* Install spray nozzle (V) on elbow (U) and tighten until holes in spray nozzle are alined with holes in mounting bracket. Secure spray nozzle to bracket with two 3/8 x 3/4 hex-head bolts, integral lockwasher, and 13/32-inch flat washers.

(4) *Installation of bulkhead mounting type.* Install spray nozzle (fig. 161) on elbow of bulkhead union and tighten securely. The spray nozzle installed on right side of bulkhead should be directed toward the auxiliary generator and engine. The spray nozzle installed on left side of bulkhead should be directed toward the power plant.

Section XV. TRANSMISSION

208. Description and Data

a. Description.

(1) The CD 500–3 Allison cross drive transmission (fig. 94), combines the functions of a clutch, differential, steering, and braking mechanism. It transmits power from the engine to the final drives and final drive sprockets. The transmission is controlled by a steering control crossbar, range selector control lever, and a brake pedal.

(2) Power is transmitted from the engine to the cross drive transmission by a transmission input shaft (fig. 97) which engages a splined bevel gear set in the transmission. A spur gear train drives the torque converter, which is on the transverse axis of the transmission. The power output of the torque converter is transmitted through planetary gear sets to the output flanges, and then through the universal joints and final drives to the tracks. Power for hydraulic steering is taken from the torque converter output by bevel gearing to the steering drive shaft.

(3) The steering control crossbar and linkage (fig. 186) operates the steering lever (fig. 177) on the steering control valve assembly. The control valve directs the oil pressure to the selected steer clutch (left or right), in any drive

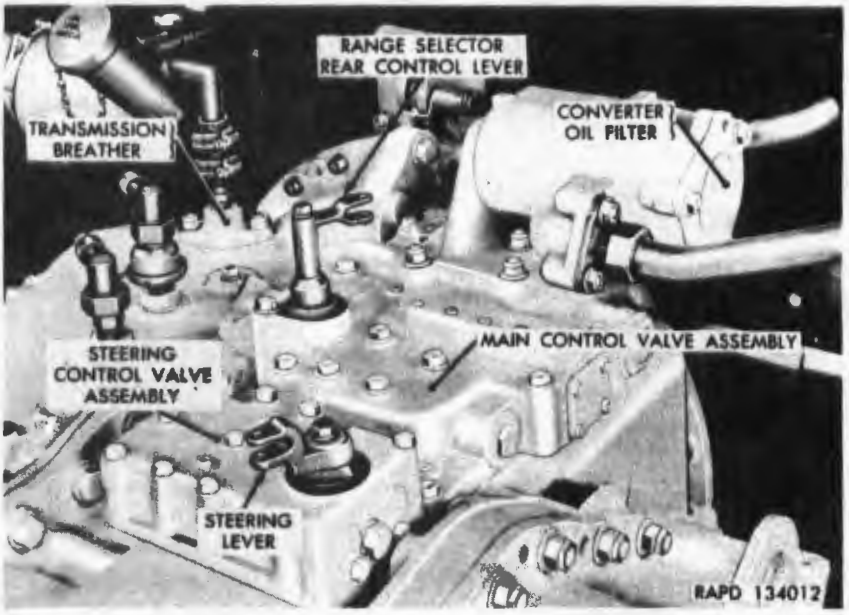


Figure 177. Transmission control valve assemblies and levers.

range (LOW, HIGH, or REVERSE), or holds the vehicle to a straight course.

(4) The range selector control lever and linkage (fig. 187), operates the range selector rear control lever (fig. 177) on the main control valve assembly. This control valve directs the oil pressure to the selected drive clutch (LOW, HIGH, or REVERSE), or holds the selected NEUTRAL position (park or steer).

(5) Two multiple disk-type brakes are mechanically applied simultaneously through the brake control linkage (fig. 188) when the brake pedal is depressed.

(6) A transmission oil low pressure warning light on the instrument panel is energized by the oil low pressure warning light switch on the transmission whenever the pressure in the oil system drops below 11 psi. Normal lubricant pressure is 40 psi.

Note. The warning light may indicate low pressure at low engine speeds but should go out at normal operating speeds (1,200 rpm and above).

(7) A transmission oil high temperature warning light on the instrument panel is energized by the oil high temperature warning light switch (fig. 249) on the transmission whenever the oil temperature reaches 285° F. Normal operating temperature under the load is 225° F.

b. Tabulated Data.

Make	Allison, CD 500–3
Type	cross drive
Weight	1,945 lb
Overall length	84.156 in.
Overall height	33.50 in.
Overall width	44.75 in.
Drive ranges	LOW, HIGH, and REVERSE.
Steering clutches engaged by	oil pressure
Steering clutches released by	spring pressure
Driving range clutches engaged by	oil pressure
Driving range clutches released by	spring pressure
Suspension	3 point (engine and two mounting brackets)
Shifting and steering control:	
External	mechanical
Internal	hydraulic
Service brakes:	
Quantity	2
Type	multiple wet disk
Application	mechanical
Cooled by	oil
Parking brake	mechanical lock for service brakes.
Oil pumps:	
Quantity	7
Type	five positive displacement gear, one gerotor, and one paddle wheel.
Driven by	three input and two output; one output by steer drive shaft, and one output by left steer cross shaft.
Oil system:	
Capacity	16 gal
To refill	11 gal
Oil system pressures:	
Drive range clutches	150 psi
Steering clutches	150 psi
Torque converter and coolers	80 psi
Lubrication	40 psi
Oil filters:	
Quantity	3
Type	Air Maze
Oil cooled by	air cooled radiator
Transmission ratios:	
Overall transmission reduction	low stall 15.3:1
Overall transmission reduction	high stall 4:1
Overall transmission reduction	high lockup 1:1

209. Transmission Oil System

a. Description.

(1) A single oil supply supplies all cooling, lubrication, and hydraulic requirements for the cross drive transmission. It serves as the applying force for control clutches and brakes, as a power transmitting medium in the torque converter, as a lubricant, and as a coolant for the entire transmission.

(2) The oil supply is carried in the transmission reservoir. Oil is supplied to the reservoir through the oil filler tube (fig. 178) after removal of the transmission oil filler cap. Oil flow and pressure is provided to the various transmission components by seven oil pumps; five are ordinary gear-type pumps, one is an internal-external gerotor type, and one is a special paddle-wheel type. Scavenger pumps pick up oil from the sump through the sump filter and pump it to the reservoir thus keeping the sump evacuated. The input-pressure pump picks up oil from the reservoir and pumps it to the main filter. As the flow leaves the main filter, it branches to the main control valve assembly, steering control valve assembly, converter lockup clutch governor, relay valve, brake oil pressure regulating valve and main pressure regulator valve. The main pressure regulator valve maintains 150 psi pressure in the oil system by passing oil into the converter system. If the main pressure regulator valve becomes inoperative, the oil system is provided with a safety valve which opens at 230 psi and relieves the oil pressure by returning the excess oil to the sump. Regulating valves are also used to regulate the pressures at the various hydraulically operated components. A main oil filter (fig. 179), sump oil filter (fig. 180), and a converter oil filter (fig. 181), provide oil filtration in the oil system. The oil is cooled by an oil cooler (fig. 38) which is installed on the main engine and is connected to the converter oil filter housing.

(3) It is very important that oil level be checked (*b* below) before operation with engine idling at 1,000 rpm. A lack of oil will prevent proper transmission operation and an excess of oil will cause the transmission to become overheated and sluggish.

b. Checking Oil Level.

(1) *General.* The oil level is checked with an oil level gage

(fig. 178) which is located in the oil filler tube and is part of the filler cap. To check oil level, remove locking handle and open transmission oil filler cover (fig. 236) located on the transmission rear access door. Loosen oil filler cap and withdraw oil level gage, wipe dry with a clean cloth, insert gage until seated and withdraw, noting level of oil on gage.

Note. The oil level gage may be one of two types, the late type is as illustrated in figure 178, the early type has only ADD and FULL markings. The ADD mark on early gages corresponds to the MIN OPERATING LEVEL IDLE ENGINE 1,000 RPM marking on late gages and the FULL mark corresponds to the DO NOT FILL ABOVE THIS LINE on late gages.

(2) *Before operation check.* Check oil level before starting main engine. The oil level gage (fig. 178) should indicate oil above the mark MIN LEVEL BEFORE RUNNING TRANSMISSION stamped on the gage. On early gages, be sure that an oil depth of at least 2-inches in the

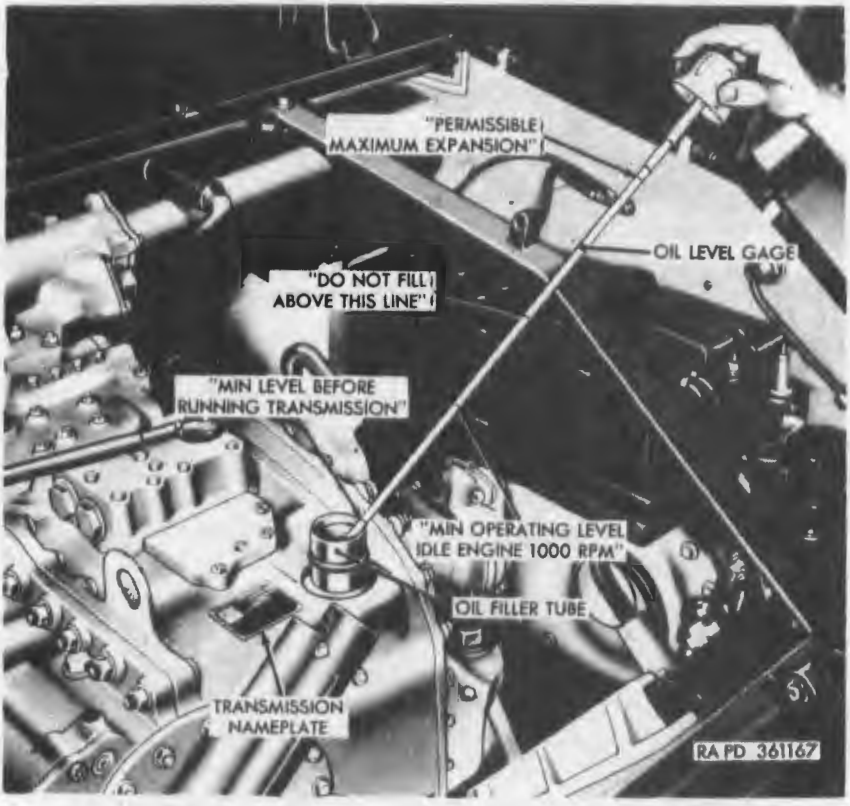


Figure 178. Transmission oil level gage.

reservoir is indicated on the gage. If the level is too low, add oil (*c*(2) below).

(3) *Idling speed check.* Operate the main engine 10 minutes to warm the transmission to normal operating temperature. Maintain an engine idling speed of 1,000 rpm with the range selector lever in the NEUTRAL position and check oil level. Indicated level should be between the MIN OPERATING LEVEL IDLE ENGINE 1,000 RPM and DO NOT FILL ABOVE THIS LINE. On early type gage, oil should be between ADD and FULL markings. Drain or add oil as necessary to bring oil within the specified range.

Caution: When operating the vehicle over rugged terrain or at high speeds, be alert for a signal at the high oil temperature warning light which indicates that the oil is reaching the PERMISSIBLE MAXIMUM EXPANSION mark on the oil level gage (fig. 178). As soon as the warning light signals excessive heat, place range selector control lever in NEUTRAL PARK position and operate engine at 1,600 rpm. If the oil system is clear and the oil cooler is functioning properly, the lubricant temperature will return to normal within 2 or 3 minutes. If not, check oil level, drain excess oil, and perform idling speed check.

c. Replacing Transmission Oil.

(1) *Drain transmission oil.* Remove the transmission oil drain hole cover from beneath the vehicle (par. 246), and remove the reservoir and sump oil drain plugs (fig. 104) from the bottom of the transmission.

(2) *Fill transmission with oil.* Install drain plugs in transmission. Install transmission oil drain hole cover on hull bottom (par. 246*d*). Remove locking handle and open cover on transmission rear access door (fig. 236). Remove locking handle and open cover on transmission rear access door (fig. 236). Remove transmission oil level gage (fig. 178) and pour 11 gallons of oil, as specified on lubrication order LO 9–7218 (par. 90), into the transmission through the filler tube. Start engine and operate for 3 or 4 minutes to fill torque converter and oil cooler. With engine idling at 1,000 rpm, add sufficient oil through filler tube to bring oil to its proper level.

Caution: Do not add oil with engine stopped, gage will give false reading and the transmission will be flooded with oil.

Insert transmission oil level gage. Close transmission oil filler cover and install locking handle.

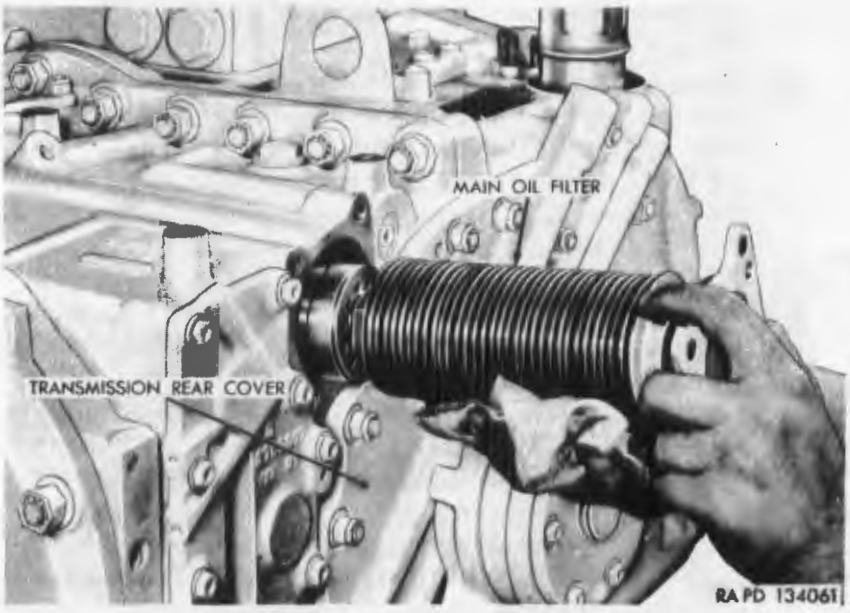


Figure 179. Removing or installing main oil filter.

210. Oil Filters

a. Main Oil Filter.

(1) *Removal.* Open transmission rear access door (fig. 236). Remove three self-locking hex-head bolts and flat washers from filter body and pull filter (fig. 179) out of transmission housing. Remove and discard gasket.

Note. Two of the bolts may be used as pullers in the tapped holes provided for this purpose in the oil filter.

(2) *Cleaning.* Wash filter thoroughly in dry-cleaning solvent or mineral spirits paint thinner. Thoroughly drain and blot dry with clean cloth. Do not disassemble filter when only cleaning is required.

Caution: Do not clean or dry with compressed air. Use extreme care to prevent dirt from entering the transmission oil system.

(3) *Installation.* Insert main oil filter (fig. 179) in transmission housing, using a new gasket. Secure filter in transmission with three $\frac{3}{8}$ x $\frac{7}{8}$ self-locking hex-head bolts and $\frac{13}{32}$-inch flat washers. Close transmission rear access door.

b. Sump Oil Filter.

(1) *Removal.* Remove power plant from vehicle (par. 126). Drain oil from transmission (par. 209*c*). Remove four

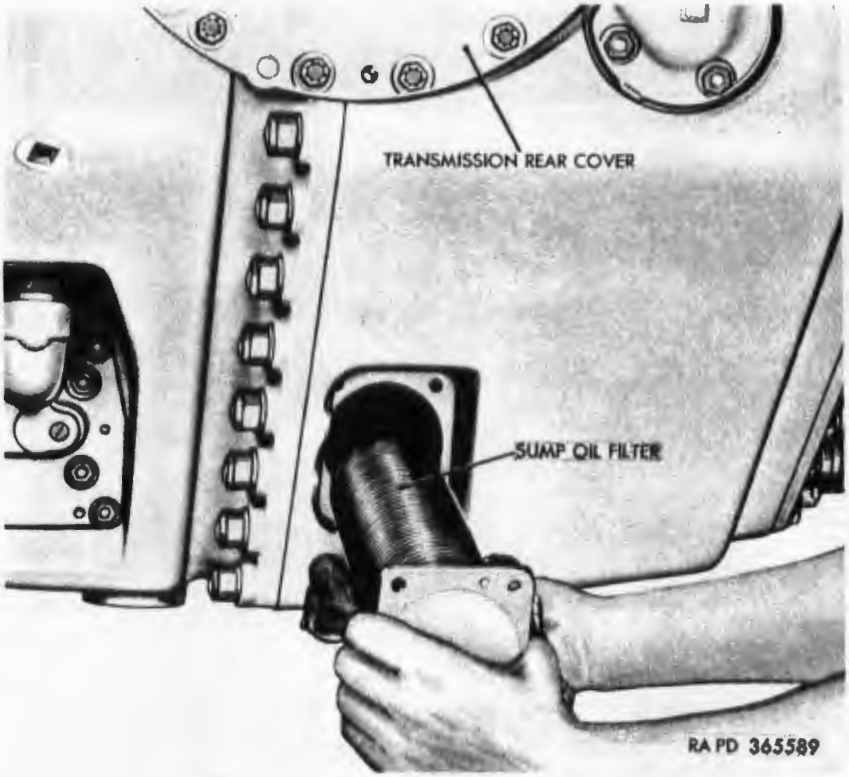


Figure 180. Removing or installing sump oil filter.

self-locking hex-head bolts and flat washers from filter body and pull sump oil filter (fig. 180) out of transmission housing. Remove and discard gasket.

Note. Two of the bolts may be used as pullers in the tapped holes provided for this purpose in the oil filter.

(2) *Cleaning.* Refer to *a* (2) above.

(3) *Installation.* Insert sump oil filter (fig. 180) into transmission housing, using a new gasket. Secure filter in transmission with four $\frac{5}{16}$ x 1 self-locking hex-head bolts and $\frac{11}{32}$-inch flat washers. Install power plant in vehicle (par. 130).

c. Converter Oil Filter.

(1) *Removal.* Open transmission front access door (fig. 236). Remove three self-locking hex-head bolts and flat washers from filter body and pull filter out of converter oil filter housing (fig. 181). Remove and discard gasket.

Note. Two of the bolts may be used as pullers in the tapped holes provided for this purpose in the oil filter.

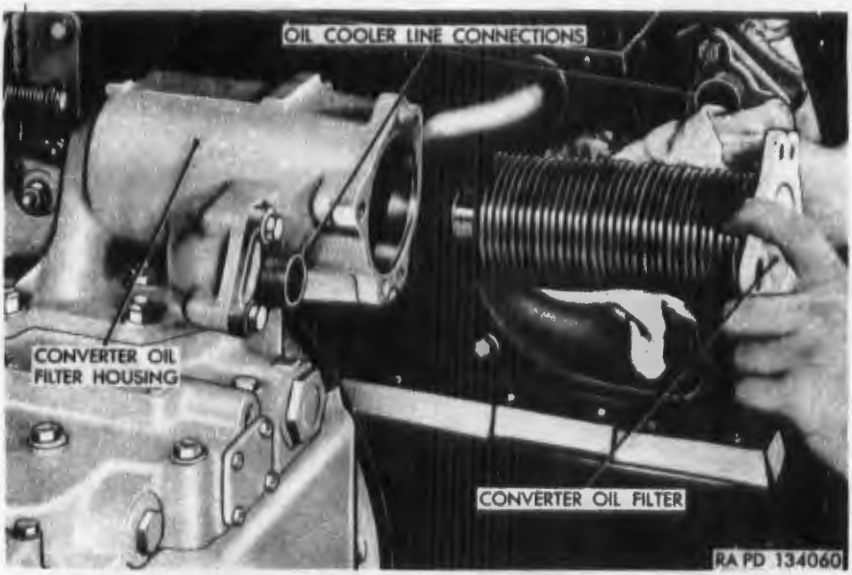


Figure 181. Removing or installing converter oil filter.

(2) *Cleaning.* Refer to *a* (2) above.

(3) *Installation.* Insert converter oil filter into converter oil filter housing (fig. 181), using a new gasket. Secure filter in housing with three $\frac{3}{8}$ x 1 self-locking hex-head bolts and $\frac{13}{32}$-inch flat washers. Close transmission front access door.

d. Disassembly of Transmission Oil Filters.

(1) *Converter and sump oil filters.*

Note. The converter and sump oil filters are of similar construction and disassembly is identical. Filters should be disassembled only if replacement of the pack disks is necessary.

Remove tube nut (fig. 182) holding pack disks and spacers on tube assembly and slide off disks and spacers. Discard any damaged pack disks. Wash spacers, disks, and tube assembly thoroughly in dry-cleaning solvent or mineral spirits paint thinner.

(2) *Main oil filter.* Remove internal retaining snap ring (fig. 183) securing plate, springs, and valve in retainer. Remove plate, springs, and valve and unscrew retainer from tube assembly. Inspect springs for cracks, fatigue, or weakened condition. Replace if necessary. Unscrew tube nut holding pack disks and spacers in position on tube and slide off disks and spacers. Discard any damaged pack disks. Wash all parts thoroughly in dry-cleaning solvent or mineral spirits paint thinner.

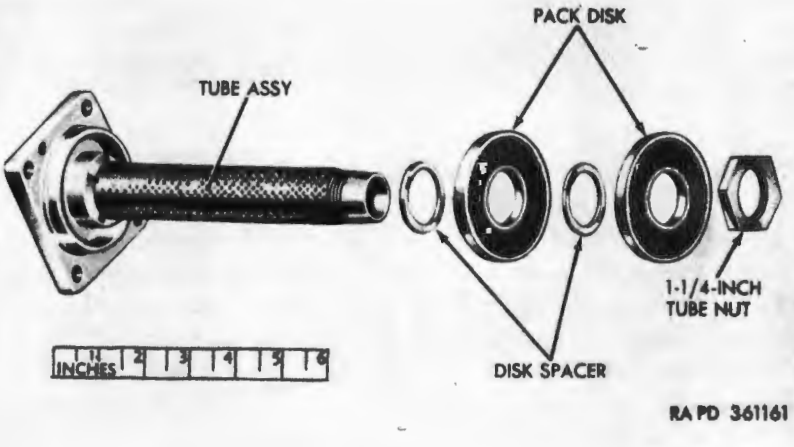


Figure 182. Sump oil filter—exploded view.

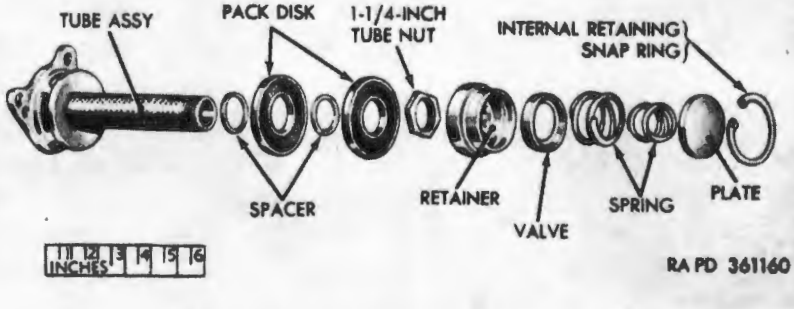


Figure 183. Main oil filter—exploded view.

e. Assembly of Transmission Oil Filters.

(1) *Converter and sump oil filters.* Install pack disks (fig. 182) and spacers alternately on tube assembly and secure with 1¼-inch tube nut.

(2) *Main oil filter.* Install pack disks (fig. 183) and spacers alternately on tube assembly and secure with 1¼ inch tube nut. Install retainer on tube assembly. Insert valve, springs, and plate in retainer and secure with internal retaining snap ring.

211. Transmission Oil Pressure and Temperature Tests

a. General. Abnormal oil temperature and pressure conditions that might lead to internal malfunction are revealed by gage readings taken at specific check points on the transmission. At each pressure check point, a removable pipe plug provides access to the

opening in which a gage (fig. 184) is inserted. The temperature gage reading is made by removing the transmission high oil temperature switch (fig. 249) and inserting the gage into the opening provided.

b. Oil Pressure Tests.

Caution: Setting range selector control lever in position indicated in tests and with engine speed at 1,200 rpm will cause vehicle to move. Perform tests in a clear space and person reading gage must exercise care to avoid personal injury. Stop engine each time before removing or installing pipe plugs and attaching gage adapter. Install plug as soon as gage adapter is removed. Remove only the one pipe plug necessary to perform the desired test.

Transmission oil pressure is tested with the transmission oil pressure gage—6620–795–0330 (fig. 184). No external adjustments can be made to correct improper oil pressures. The gage adapter can be inserted into the various oil circuits by removing pipe plugs located on the main control valve assembly and steering control valve assembly (fig. 185). The tests listed in table X below are to be performed with the engine operating at 1,200 rpm and with

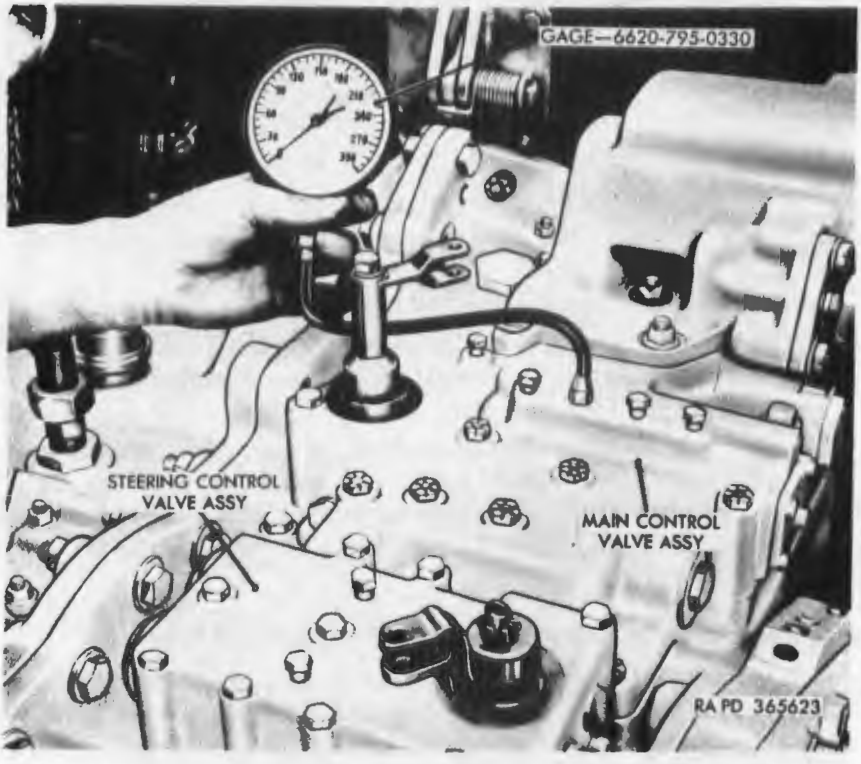


Figure 184. Checking transmission oil pressure with gage 6620–795–0330.

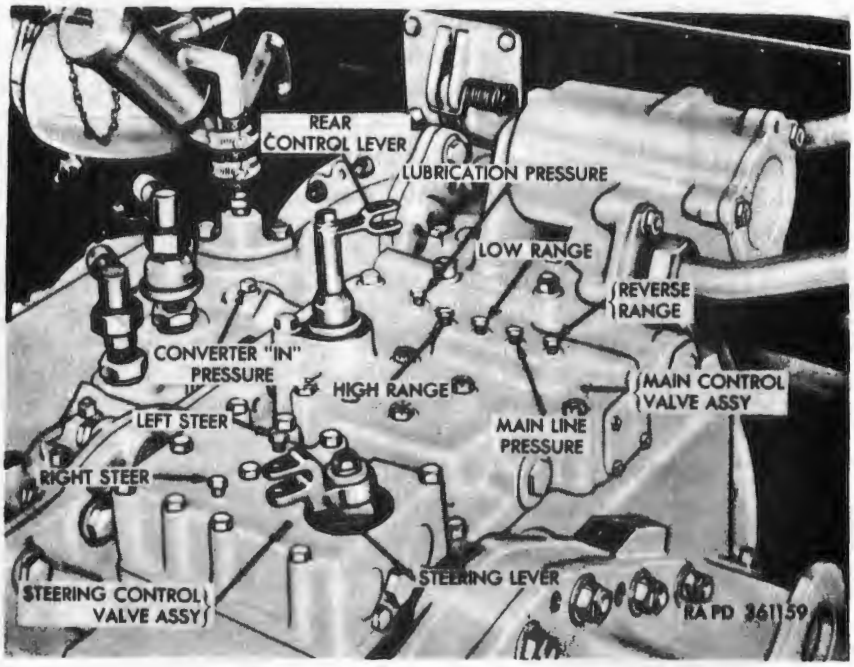


Figure 185. Transmission oil pressure check points.

the range selector control lever and steering control crossbar in the positions indicated.

Note. If oil pressuge gage reading is below the specified limit in any test, notify ordnance maintenance personnel.

Table X. Transmission Oil Pressure Tests

Test	Oil circuit	Shifting position	Steering position	Normal range (psi)	Allowable (psi)
1	Right steering clutch	NEUTRAL	Full right	135 to 150	130 min
2	Left steering clutch	NEUTRAL	Full left	135 to 150	130 min
3	Converter pressure OUT (not regulated—no test required).				
4	Converter pressure "IN"	NEUTRAL	Neutral	80	72 min
5	Lubricating oil	NEUTRAL	Neutral	40	25 min
6	Main line pressure	NEUTRAL	Neutral	135 to 150	135 min
7	Reverse range	REVERSE	Neutral	135 to 150	135 min
8	Low range	LOW	Neutral	135 to 150	135 min
9	High range	HIGH	Neutral	135 to 150	135 min

212. Transmission Control Linkage

a. Description. The steering and range selector controls on the CD 500–3 cross drive transmission incorporate both a mechanical and a hydraulic system for their operation.

(1) The steering hydraulic mechanism is controlled by a steering control crossbar (fig. 10), through the steering control linkage (fig. 186) to the steering control valve assembly (fig. 177) on the transmission housing.

(2) The range selector control lever (fig. 12) is connected through the range selection control linkage (fig. 187) to the main control valve assembly (fig. 177) on the transmission housing and controls the hydraulic driving mechanism.

b. Steering Control Linkage Adjustment.

(1) Working in driving compartment, remove locking wire, hex-head bolt, and lockwasher securing front steering control rod (fig. 186) to left end of steering control crossbar. Disengage control rod from crossbar.

(2) Place range selector control lever in NEUTRAL PARK position.

(3) Loosen four hex-head bolts, two on bottom and two on top, that secure plate and centering spring (fig. 186) to steering control support bracket.

(4) Move steering control crossbar (fig. 186) so that spring-loaded locking pin enters hole at bottom of steering control column. The steering control crossbar will now be locked in neutral position.

(5) If steering control crossbar is not centered when locked in neutral position, turn centering spring (fig. 186) and plate to the left and right on supporting bracket until centering spring returns steering control crossbar to neutral position and locking pin automatically enters steering column with steering control crossbar in centered position. Secure plate and centering spring by tightening the four ¼ x ¾ hex-head bolts previously loosened.

Note. To release locking pin from steering control column, move range selector control lever out of NEUTRAL PARK position.

(6) Open transmission front and rear access doors and left battery access doors (fig. 236). Position bellcrank (fig. 186) so that a ⅛-inch pin can be inserted through indexing holes provided in bellcrank and insert pin through holes. This will lock bellcrank in correct (neutral) position for front and rear steering control rod adjustment.

(7) Loosen locknut on forward end of front steering control rod (fig. 186) and adjust steering rod eye so a ¼ x 1 hex-head bolt fits freely between steering control crossbar and steering rod eye. Secure steering rod eye by tighten-

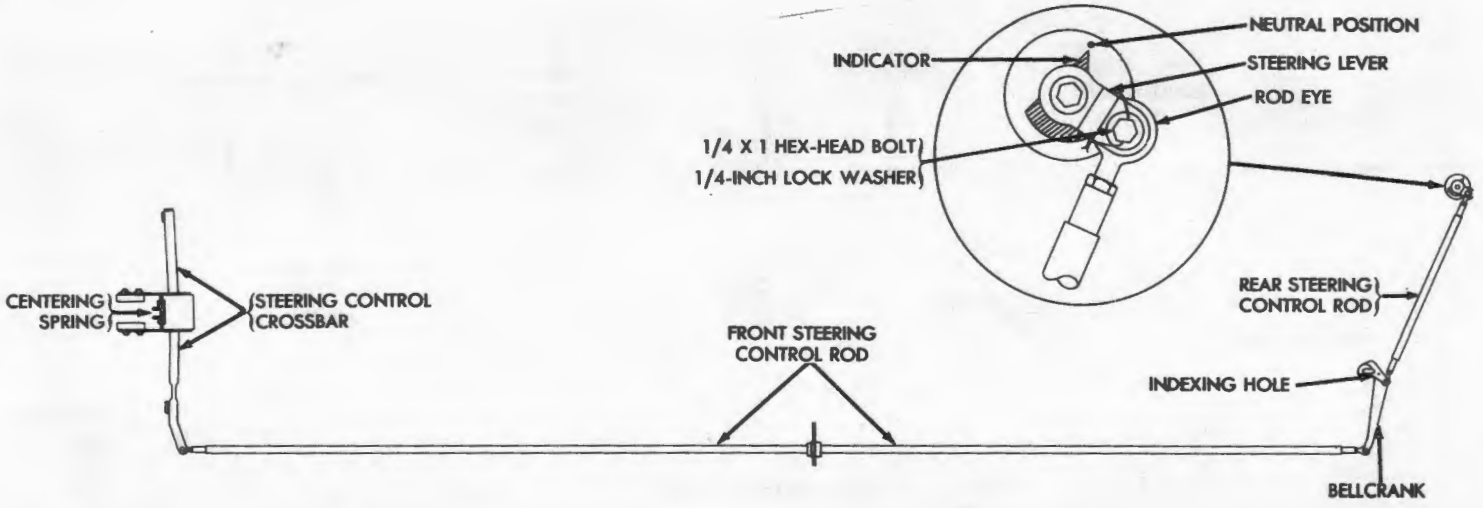


Figure 186. Steering control linkage.

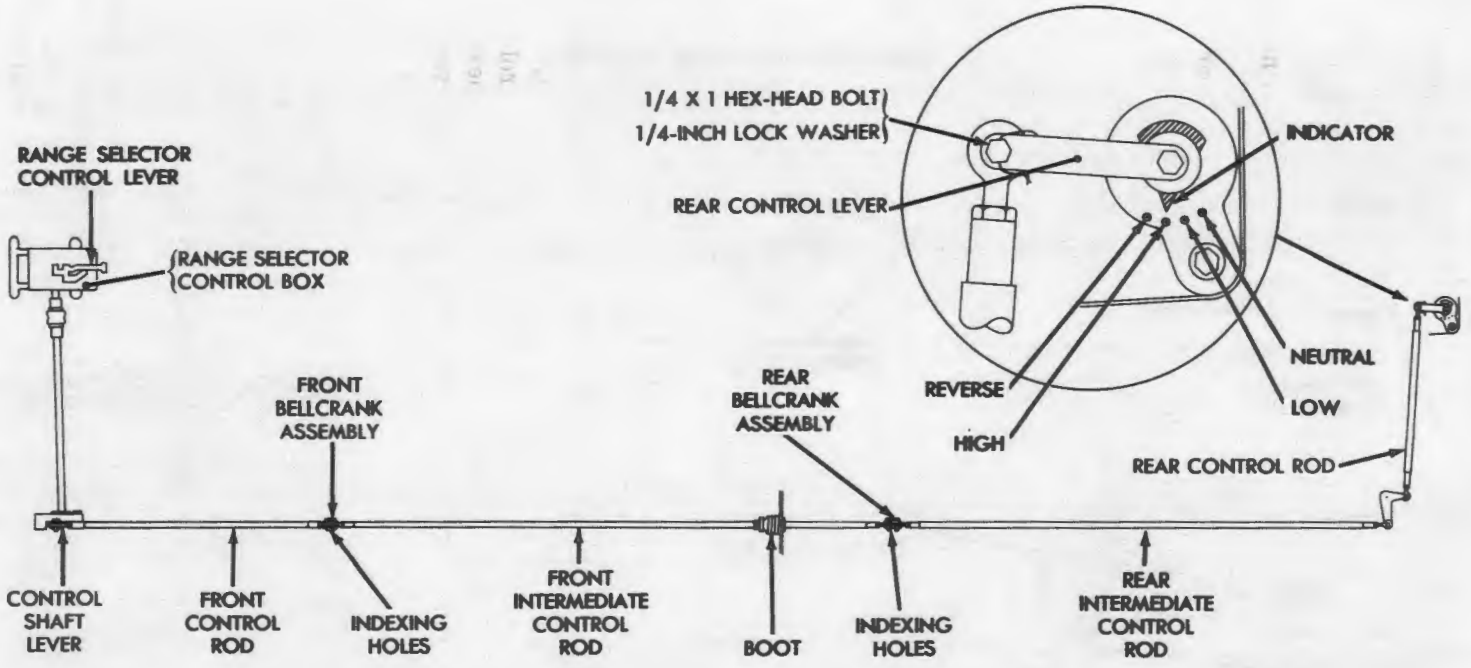


Figure 187. Range selection control linkage.

ing locknut. Secure front steering control rod to crossbar with ¼ x 1 hex-head bolt, ¼-inch lockwasher, and locking wire.

(8) Remove locking wire, hex-head bolt, and lockwasher securing rear steering control rod (fig. 186) to steering lever on steering control valve.

(9) Position steering lever so that indicator is in neutral position (fig. 186).

(10) Loosen locknut on transmission end of rear steering control rod (fig. 186) and adjust steering rod eye so that a ¼ x 1 hex-head bolt fits freely between steering rod eye and steering lever. Secure steering rod eye by tightening locknut. Secure rear steering control rod to steering lever with ¼ x 1 hex-head bolt, ¼-inch lockwasher, and locking wire.

(11) Remove ⅛-inch pin from indexing holes (fig. 186) in bellcrank.

(12) Close transmission front and rear access doors and left battery access doors (fig. 236).

c. Range Selection Control Linkage Adjustment.

(1) Remove driver's seat back rest (par. 247).

(2) Place range selector control lever (fig. 12) in HIGH position.

(3) Remove locking wire, hex-head bolt, and lockwasher securing control shaft lever (fig. 187) to front control rod.

(4) Position front bellcrank assembly (fig. 187) so that a ⅛-inch pin can be inserted through indexing holes provided in bellcrank assembly, and insert pin through holes. This will lock bellcrank for control rod adjustment.

(5) Loosen locknut on forward end of front control rod (fig. 187) and adjust rod eye so that a ¼ x 1 hex-head bolt fits freely between rod eye and control shaft lever. Secure rod eye by tightening locknut. Secure rod to lever with ¼ x 1 hex-head bolt, ¼-inch lockwasher, and locking wire.

(6) Open engine compartment left grille doors (fig. 236). Remove locking wire and two hex-head bolts and lockwashers securing front intermediate control rod (fig. 187) to rear bellcrank assembly.

(7) Position rear bellcrank assembly (fig. 187) so that a ⅛-inch pin can be inserted through indexing holes provided in bellcrank assembly, and insert pin through holes. This will lock bellcrank for rod adjustment.

(8) Inspect indicator (fig. 187) on range selector rear control lever to make sure that it is at the HIGH position.

(9) Loosen locknuts on ends of front intermediate control rod (fig. 187) and rear intermediate control rod at rear bellcrank. Adjust rod eyes so that ¼ x 1 hex-head bolts fit freely between rod eyes and rear bellcrank assembly. Secure rod eyes by tightening locknuts. Secure control rods to bellcrank assembly with two ¼ x 1 hex-head bolts, ¼-inch lockwashers, and locking wire.

(10) Open transmission front and rear access doors and left battery access doors (fig. 236).

(11) Remove locking wire, hex-head bolt, and lockwasher securing rear control rod (fig. 187) to rear control lever.

(12) Inspect indicator (fig. 187) on rear control lever to see that it has remained at the HIGH position.

(13) Loosen locknut and adjust rear control rod eye so that a ¼ x 1 hex-head bolt fits freely between rod eye and rear control lever (fig. 187). Secure rod eye by tightening locknut. Secure rod lever with ¼ x 1 hex-head bolt, ¼-inch lockwasher, and locking wire.

(14) Remove ⅛-inch pins from the indexing holes (fig. 187) in front and rear bellcrank assemblies.

(15) Test range selector positions by comparing positions of range selector control lever (fig. 187) in control box with position of rear control lever indicator on transmission.

(16) Close engine compartment left grille doors, transmission front and rear access doors, and left battery access doors (fig. 236).

(17) Install driver's seat back rest (par. 247).

213. Brakes and Linkage

a. General. Brake linkage should be inspected and adjusted, if necessary, before adjusting the brake mechanism in the transmission assembly. Check parking brake operation to be sure that the brakes are released when the range selector control lever (fig. 12) is moved out of the NEUTRAL PARK position. Correct linkage and lever relationships must be maintained to insure proper brake operation.

b. Brake Control Linkage Adjustment.

Note. Vehicle must be on level ground during brake adjustment.

(1) Remove driver's seat back rest, and lower seat as far as possible (par. 247).

(2) Remove personnel heater duct from driving compartment (par. 262*d*).

(3) Remove cotter pin and clevis pin securing front control rod (fig. 188) to parking brake assembly.

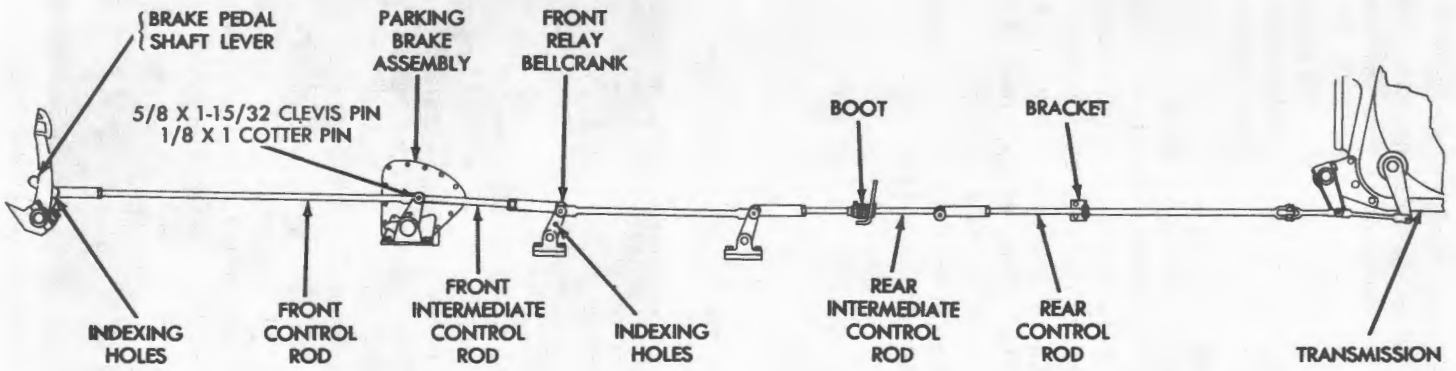


Figure 188. Brake control linkage.

(4) Position brake pedal shaft lever (fig. 188) so that a 1/8-inch pin can be inserted through indexing holes provided in lever and supporting bracket and insert pin through holes. This will lock lever in correct position for front control rod adjustment.

(5) Remove cotter pin and clevis pin (fig. 188) securing front intermediate control rod to parking brake assembly.

(6) Position front relay bellcrank (fig. 188) so that a 1/8-inch pin can be inserted through indexing holes provided in bellcrank assembly. This will lock bellcrank in position for front intermediate control rod adjustment.

(7) Loosen locknuts on front end of front control rod (fig. 188) and rear end of front intermediate control rod at front relay bellcrank. Adjust rod eyes so that a 5/8 x 1 15/32 clevis pin will fit freely between rod eyes and bellcrank of parking brake assembly. Secure rod eyes in position by tightening locknuts. Secure control rods to bellcrank with two 5/8 x 1 15/32 clevis pins and 1/8 x 1 cotter pins.

(8) Remove bulkhead door (par. 243*a*).

(9) Open transmission access doors (fig. 236).

(10) Remove six self-locking hex-head bolts that secure brake adjustment covers (fig. 189) on rear of transmission, and remove covers.

(11) Two men are required to perform the final brake adjust-

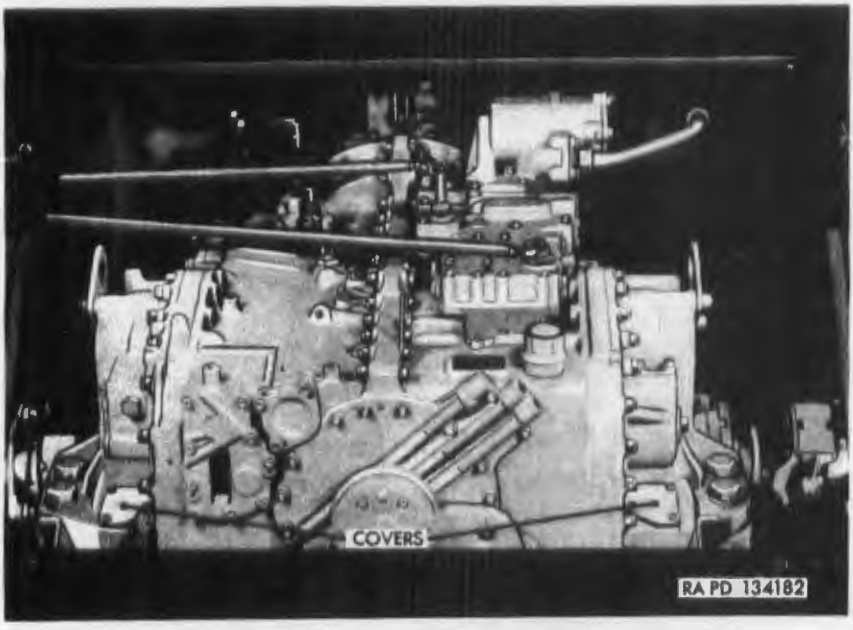


Figure 189. Brake adjustment cover location.

ment procedure. Station a man to watch the brake adjustment indicator (fig. 190) in the transmission. Remove cotter pin and clevis pin from rear intermediate control rod (fig. 188) and rear control rod. Loosen locknut on control rod and adjust control rod yoke until brake adjustment indicator is alined with R (release) line on brake, apply cam movable ring (fig. 190).

(12) When correct linkage adjustment has been made, secure control rod yoke by tightening locknut and installing $\frac{5}{8}$ x $1\frac{15}{32}$ clevis pin and $\frac{1}{8}$ x 1 cotter pin between rear intermediate control rod (fig. 188) and rear control rod. Install brake adjustment covers and secure with six $\frac{5}{16}$ x $\frac{7}{8}$ self-locking hex-head bolts.

(13) Install bulkhead door (par. 243*b*).

(14) Remove $\frac{1}{8}$-inch diameter pins from indexing holes in

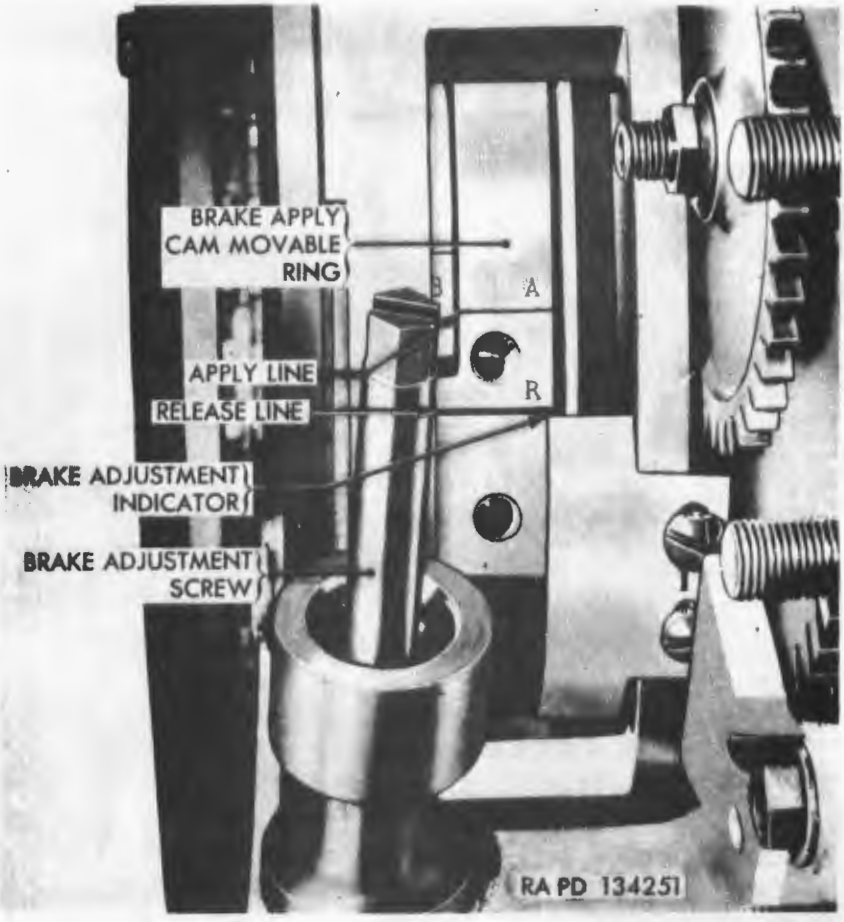


Figure 190. Brake adjustment components.

parking brake assembly (fig. 188) and front relay bellcrank.

(15) Adjust brakes (*c* below).

c. Brake Adjustment.

(1) Station a man in the driving compartment to apply and release the brake pedal when signaled to do so.

(2) Remove six self-locking hex-head bolts and remove brake adjustment covers (fig. 189) at rear of transmission.

(3) Two lines are visible; one is marked A (apply) the other is marked R (release) (fig. 190). When the brake pedal is released, the brake adjustment indicator should aline with the R line (*b* above). When the brakes are applied, the indicator should aline with the A line.

(4) To adjust brakes, apply the brake pedal and turn brake adjusting screw (fig. 191) clockwise to apply and counterclockwise to release until A (apply) line on brake apply cam movable ring (fig. 190) alines with brake adjustment indicator.

Caution: Always complete the adjustment while turn-

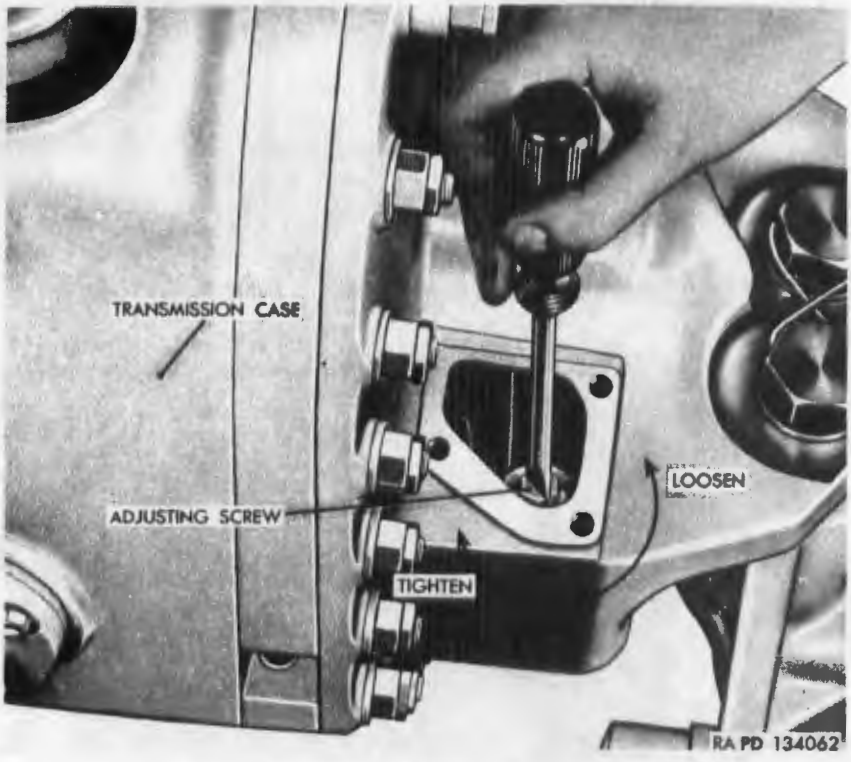


Figure 191. Adjusting brakes.

ing the adjustment screw clockwise. This will remove backlash from the brake adjusting mechanism.

(5) When adjustment is complete, be sure slot of brake adjustment screw (fig. 190) is in the proper position to receive the angle plate mounted on the inside of the brake adjustment cover. The angle plate holds the screw in its set position to prevent vibration from jarring the brakes out of adjustment. This correct slot position is crosswise of the vehicle for each brake.

(6) Position brake adjustment covers (fig. 189) on transmission and secure covers with six 5/16 x 7/8 self-locking hex-head bolts.

(7) Install personnel heater duct in driving compartment (par. 262*d*).

(8) Close transmission access doors (fig. 236).

Note. The final brake adjustment must be made when the power plant is installed in the vehicle to insure proper action in connection with the brake linkage.

214. Transmission Replacement

a. General. Coordinate with ordnance maintenance unit (par. 2).

b. Removal. Remove power plant (par. 126). Disassemble power plant (par. 127).

c. Installation. Assemble power plant (par. 128). Install power plant (par. 130).

d. Record of Replacement. Record the replacement on DA Form 478.

Section XVI. FINAL DRIVES AND UNIVERSAL JOINTS

215. Description

a. Final Drives. The final drive assemblies transmit power from the transmission to the inner and outer drive sprockets (fig. 192). A final drive assembly is mounted on each side of the vehicle near the rear. The connection between the transmission and final drive assemblies is made by left and right universal joint assemblies (fig. 195). Each final drive assembly has a spur gear speed reduction combination consisting of a 12 tooth pinion gear, a 25 tooth idler gear, and a 51 tooth final drive gear. This gearing results in a final output speed reduction of 4.25:1. The final drive gear assemblies are encased in a final drive housing (fig. 193) made of cast armor with a cast steel cover. The assembly is se-

cured by 24 hex-head bolts on early vehicles or by 21 hex-head bolts on late vehicles to a final drive adapter (fig. 194) that is welded to and forms a part of the hull. The outer end of the final drive output shaft (fig. 192) is flanged and has 10 equally spaced studs for mounting the drive sprocket hub and drive sprockets.

b. Hub and Drive Sprockets. A cast steel drive sprocket hub (fig. 192) is secured to each final drive output shaft by 10 nuts. A drive sprocket is bolted to each flanged end of the drive sprocket hub with 12 self-locking bolts.

c. Universal Joint Assemblies (fig. 195). A universal joint assembly connects each final drive assembly to the output flange on either side of the cross-drive transmission. An adapter is required in the right universal joint assembly due to the offset installation of the power plant. Each universal joint assembly is connected by a splined final drive connecting flange to the final drive assembly.

d. Speedometer Drive Adapter. A mechanical speedometer drive adapter (fig. 14) is mounted on the cover of the left final drive. Refer to paragraph 265 for maintenance of this unit.

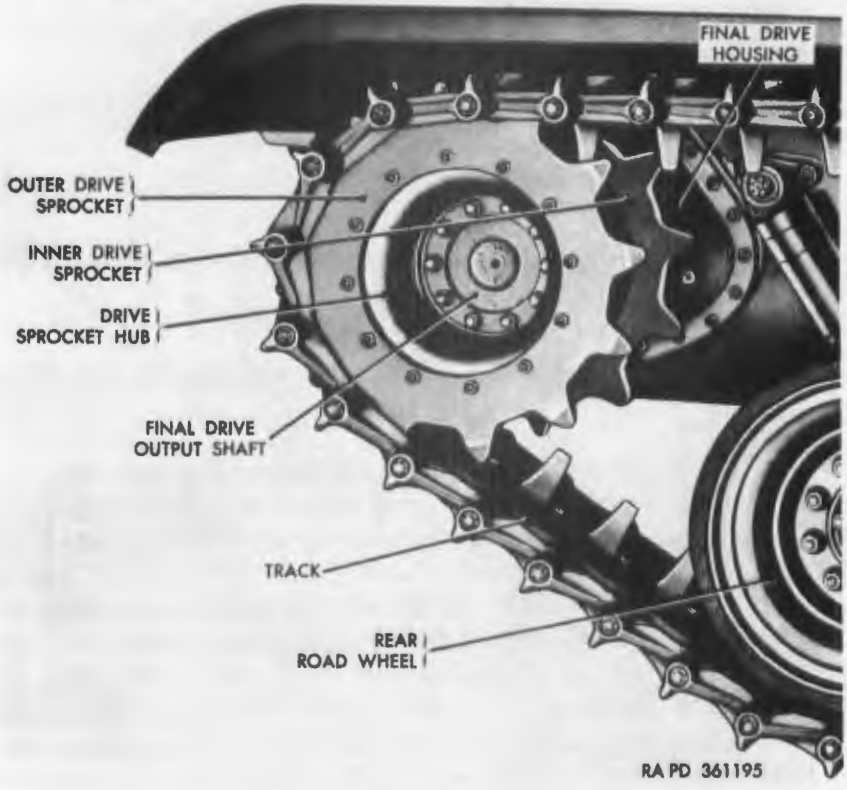


Figure 192. Final drive with drive sprockets, hub, and track.

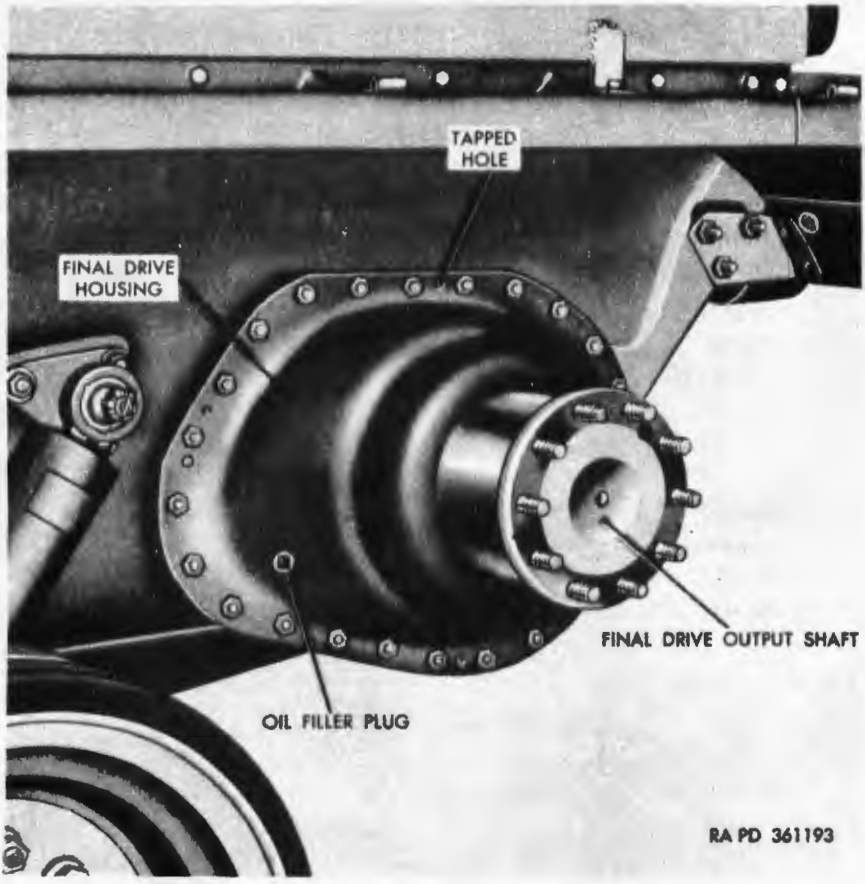


Figure 193. Final drive assembly installed.

216. Hub and Drive Sprockets

a. Removal. Disconnect track (par. 220*b*) and remove from drive sprockets. To remove the outer drive sprocket (fig. 196), remove the 12 self-locking bolts that secure it to the drive sprocket hub and lift off sprocket. To remove the drive sprocket hub and inner drive sprocket (fig. 197), remove 10 nuts that secure the hub to the final drive output shaft, and lift hub and sprocket from shaft. To remove inner drive sprocket, remove the 12 self-locking bolts that secure it to the hub and lift off sprocket.

Note. Two men are required to remove the hub and inner drive sprocket.

b. Inspection.

(1) When teeth on drive sprockets become worn, the inner drive sprocket can be exchanged with the outer drive sprocket or the complete hub and drive sprockets can be changed from one side of the vehicle to the other. This

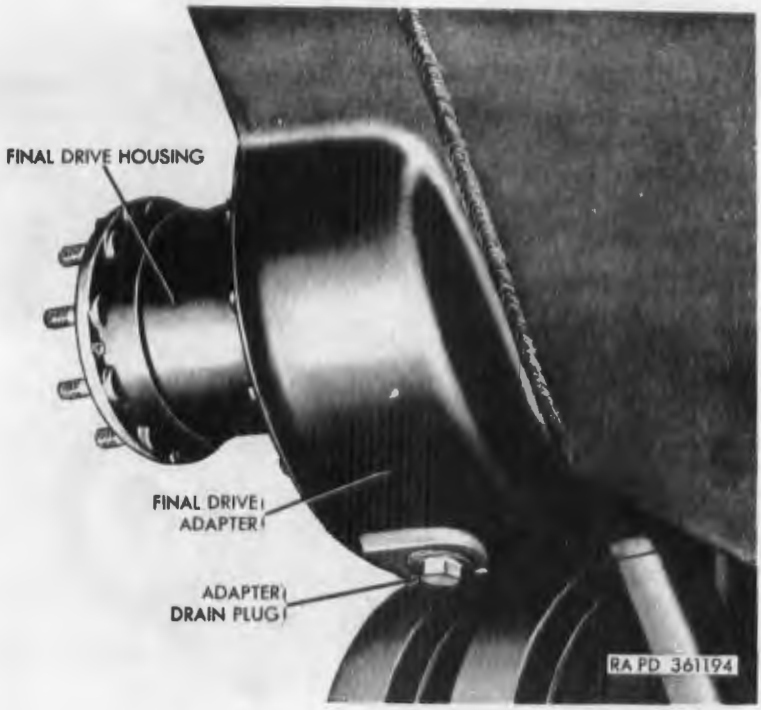


Figure 194. Final drive adapter.

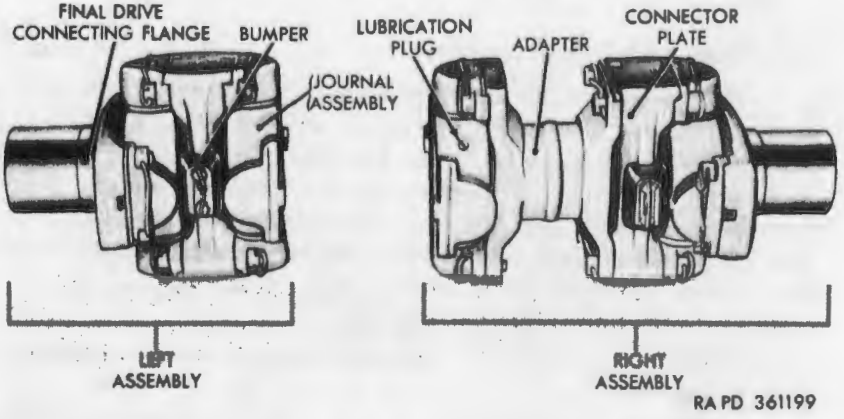


Figure 195. Left and right universal joint assemblies.

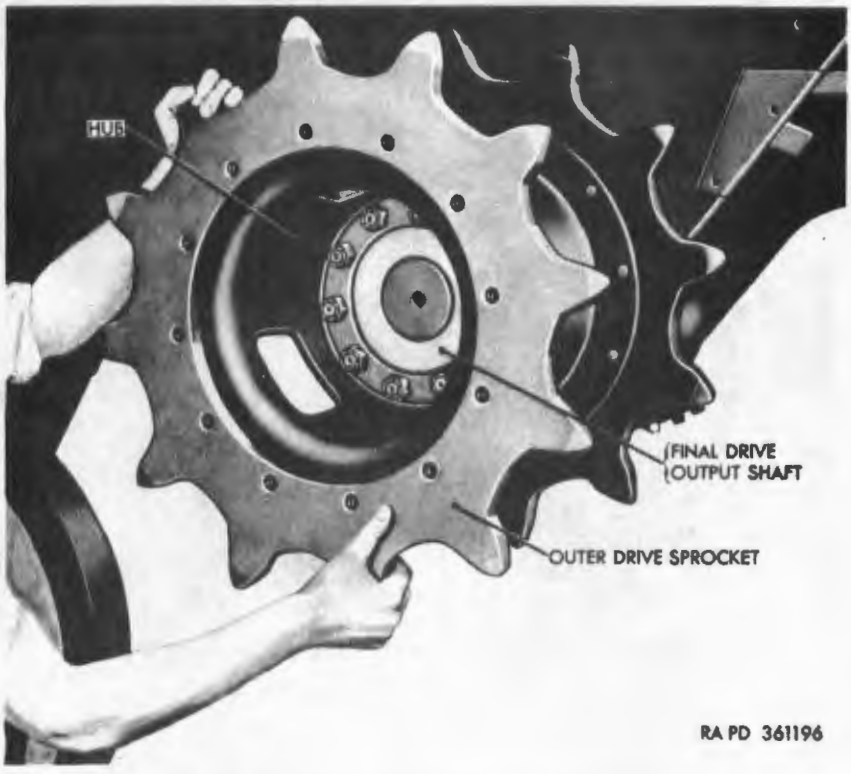


Figure 196. Removing or installing outer drive sprocket.

will present a new driving tooth surface to the track and provide a longer sprocket life.

(2) To properly inspect drive sprockets for excessive wear, a wear gage can be improvised from a suitable piece of ⅛-inch flat steel stock. Using a new sprocket as a pattern, place flat steel stock over opening between two of the drive sprocket teeth, carefully scribe inside contour of sprocket teeth on steel stock, and cut out wear gage. Cut a piece 4-inches in length from ⅜-inch drill rod for checking purposes in (3) below.

(3) Place wear gage between sprocket teeth of drive sprocket to be inspected. If wear on lower contour of drive side of one tooth exceeds wear at same point on trailing side of other tooth by one-eighth inch, exchange inner and outer drive sprockets. If ⅜-inch drill rod can be inserted between wear gage and sprocket at any point, sprocket must be replaced.

Note. Sprockets must be replaced in pairs or complete sets.

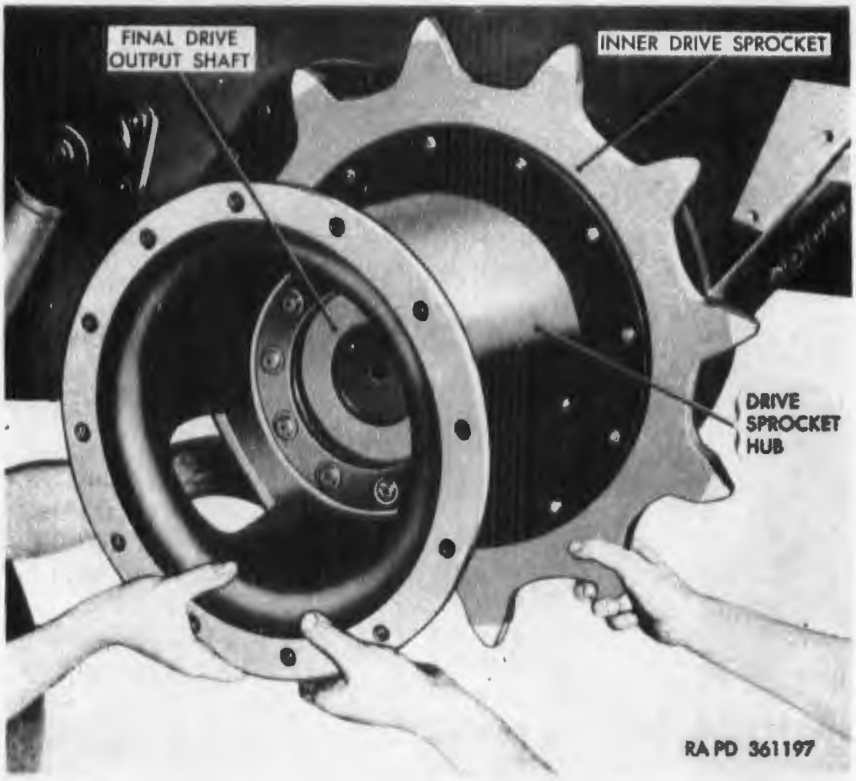


Figure 197. Removing or installing hub and inner drive sprocket.

c. Installation. Position inner drive sprocket (fig. 197) on drive sprocket hub and secure with twelve 5/8 x 1 3/4 self-locking hex-head bolts. Tighten bolts to 140 to 150 pound-feet torque. Install hub and inner drive sprocket on drive shaft mounting studs and secure with ten 3/4-inch safety nuts, tightened to 280 to 300 pound-feet torque. Position outer drive sprocket on hub and secure with twelve 5/8 x 1 3/4 self-locking hex-head bolts. Tighten bolts to 140 to 150 pound-feet torque. Connect track (par. 220*e*(6)).

217. Final Drives

a. Service. The oil filler plug (fig. 193) and the oil drain plug are located in the housing of the final drive assembly and are accessible from outside the vehicle. The drain plug is reached by first removing the adapter drain plug (fig. 194) in the bottom of the final drive adapter. Fill with lubricant as specified on lubrication order LO 9–7218 (par. 90) to the bottom of the oil filler plug hole with the vehicle on level ground. Unscrew final drive breather mounted on the side of each final drive cover at service interval specified on lubrication order LO 9–7218 (par. 90) and clean thor-

oughly with dry-cleaning solvent or mineral spirits paint thinner and install in housing.

b. Removal. Coordinate with Ordnance maintenance unit (par. 2).

(1) *Drain lubricant.* Remove adapter drain plug (fig. 194), final drive drain plug, and oil filler plug (fig. 193) and drain lubricant into a container with at least 1-gallon capacity.

(2) *Remove track.* Refer to paragraph 220*b*.

(3) *Remove hub and drive sprockets.* Refer to paragraph 216*a*.

(4) *Remove batteries.* Remove batteries (par. 172*b*) and fold up battery support against hull.

(5) *Remove speedometer drive adapter.* Remove four self-locking hex-head bolts securing drive adapter (fig. 14) and remove adapter and cable from cover of left final drive. Cover opening in final drive cover to prevent entrance of dirt or other foreign matter.

(6) *Remove final drive assembly.* The final drive assembly (fig. 198) may be removed by using an improvised lifting sling (fig. 198) or final drive assembly lifting sling 3940–708–3651 with final drive sprocket and hub lifting sling 41–S–3830–30 (fig. 67). Attach final drive assembly lifting sling to final drive shaft studs and support weight of assembly with suitable lifting device. Remove 24 or 21 hex-head bolts (par. 215*a*) that secure the final drive housing to the final drive adapter. Force housing from adapter with four of the securing bolts used as puller bolts in the tapped holes (fig. 193) provided for this purpose. Carefully lift out final drive assembly from vehicle and remove sling.

Note. Final drive connecting flange (fig. 195) will slip out of final drive cover and off splined pinion gear during removal of final drive assembly.

c. Installation. Coordinate with Ordnance maintenance unit (par. 2).

(1) *Install final drive assembly.* Install adapter drain plug (fig. 194), final drive plug, and oil filler plug (fig. 193). Install improvised lifting sling (fig. 198) or final drive assembly lifting sling 3940–708–3651 with final drive sprocket and hub lifting sling 41–S–3830–30 (fig. 67) on studs of final drive shaft. Clean mating surfaces with wire brush and coat machined surface of housing flange with sealing compound. Hoist and position final

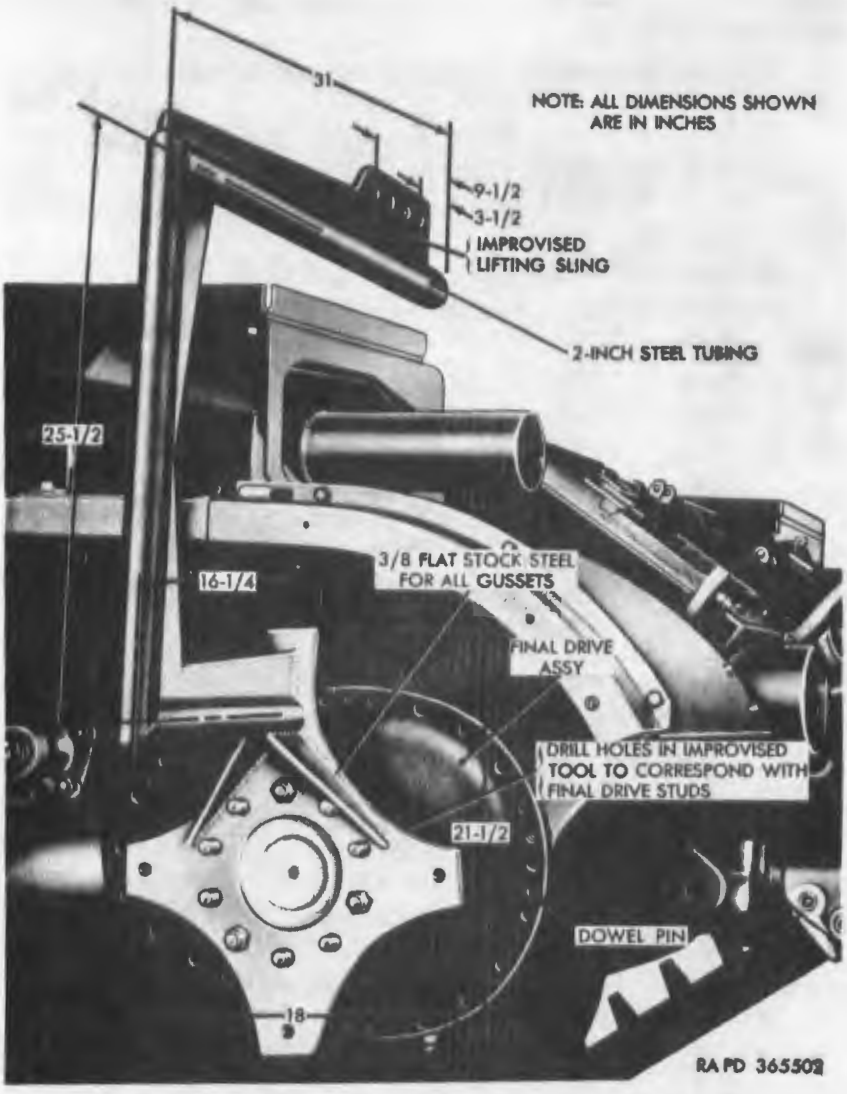


Figure 198. Removing or installing final drive assembly with improvised lifting sling.

drive assembly on adapter being careful to aline splined final drive connecting flange (fig. 195) on splined pinion gear in final drive cover and also aline dowel holes in housing with two ½ x 1½ dowel pins (fig. 198) in adapter.

Note. Be sure seal element is seated properly on universal joint flange.

Secure final drive assembly to adapter with twenty-four

or twenty-one (par. 215*a*) 5/8 x 1 3/4 self-locking hex-head bolts tightened to 135 pound-feet torque.

Note. Be sure hub of flange is clean and free of nicks or burs. Remove any nicks or burs with oil stone or crocus cloth soaked in mineral spirits paint thinner to prevent damage to oil seal.

(2) *Install speedometer drive adapter.* Position speedometer drive adapter (fig. 14) and cable on left final drive cover and secure with four 1/4 x 3/4 self-locking hex-head bolts.

Note. Speedometer gear is retained in the cover by a snap ring on the outer bearing race. Be sure snap ring is properly seated in bearing race.

(3) *Install batteries.* Lower battery support into position and install batteries (par. 172*c*).

(4) *Install hub and drive sprockets.* Refer to paragraph 216*c*.

(5) *Install and adjust track.* Refer to paragraphs 220*e* and 220*f*.

(6) *Lubricate.* Lubricate final drive assembly as specified on lubrication order LO 9–7218 (par. 90).

(7) *Record of Replacement.* Record the replacement on DA Form 478.

218. Universal Joint Assemblies

a. General. Removal and installation procedure are identical for the left and right universal joints even though an adapter is used in the right universal joint assembly.

b. Removal.

(1) *Remove batteries.* Remove batteries (par. 172*b*) from either side as required and fold up battery support against hull.

(2) *Remove universal joint assembly.* Secure a rope sling to the universal joint assembly to be removed. Remove locking wire and four socket-head screws which secure the journal assembly to the final drive connecting flange (fig. 195). Push connecting flange into final drive. Remove four hex-head bolts (late vehicles) or four socket-head screws (early vehicles) securing universal joint assembly to transmission output flange.

Note. Late vehicles use hex-head bolts in place of socket-head screws to secure the universal joint assembly to the transmission output flange.

Remove universal joint assembly from vehicle and remove sling.

c. Installation.

(1) *Install universal joint assembly.* Install a rope sling on universal joint assembly and lower into position between

transmission and final drive assembly. Secure assembly to transmission output flange with four ½ x 1¼ socket-head screws (early vehicles) or four ½ x 2 23/32 hex-head bolts (late vehicles) and locking wire. Position final drive connecting flange (fig. 195) on universal joint assembly and secure with four ½ x 1 5/16 socket-head cap screws and locking wire. Remove rope sling from assembly.

(2) *Install batteries.* Lower battery support into position and install batteries (par. 172*c*).

Section XII. TRACKS AND SUSPENSION

219. Track and Suspension System

a. Description.

(1) Two individually driven track assemblies (fig. 199) provide the traction to move the vehicle. Each track assembly is composed of 75 track shoe assemblies (fig. 200). Track shoe road pads (fig. 200) are provided for attachment to the shoes for increased traction on icy or slippery roads, training maneuvers, or operation on hard surfaced roads. An inner and outer drive sprocket (fig. 199), on each side at rear of the hull, transmit power from the final drive assemblies to the track assemblies.

(2) The vehicle is supported on each side by rubber tired road wheels (fig. 199) which roll on the track assembly. The road wheels are bolted in pairs to a road wheel hub assembly mounted on each road wheel supporting arm with shaft and spindle assembly. Road wheel supporting arms (fig. 201) are splined to torsion bars mounted in the road wheel arm supports. These arm supports are bolted to the bottom of the hull sides.

(3) The torsion bars (F, fig. 216) are made of spring steel, and splined at each end and extend crosswise from the road wheel supporting arms (fig. 201) to the torsion bar anchors in the opposite side road wheel arm supports. The torsion bars support the weight of the vehicle, and through torsional resistance or "twisting" action, permit up and down movement of the road wheels.

(4) Bumper stop springs (fig. 199), installed on supports mounted to the hull, are provided for each road wheel supporting arm to prevent shock absorbers from bottoming and prevent torsion bars from being overstressed.

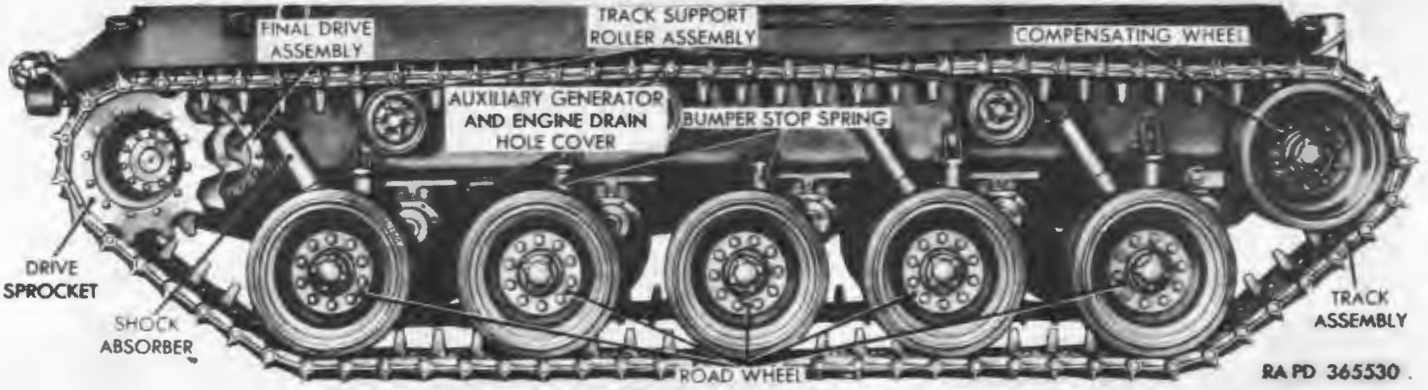


Figure 199. Track and suspension—right side view.

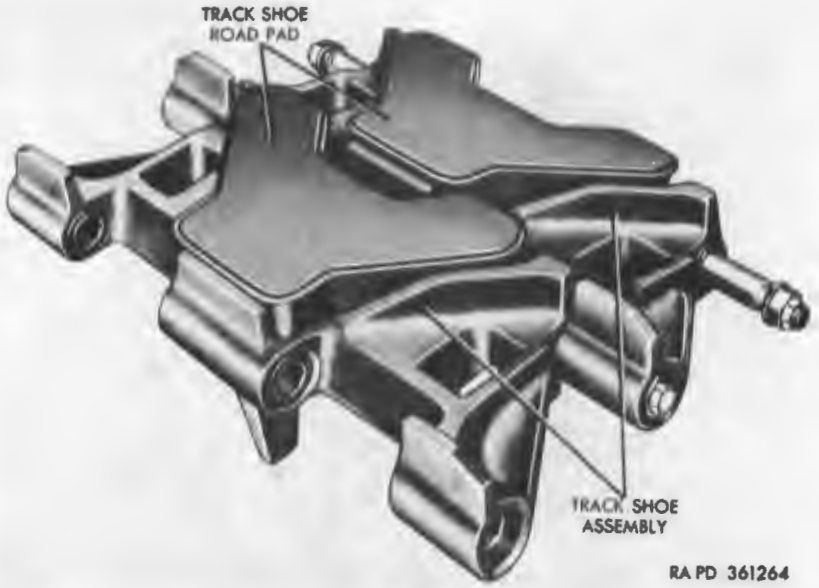


Figure 200. Track shoe assembly with track shoe road pad—assembled view.

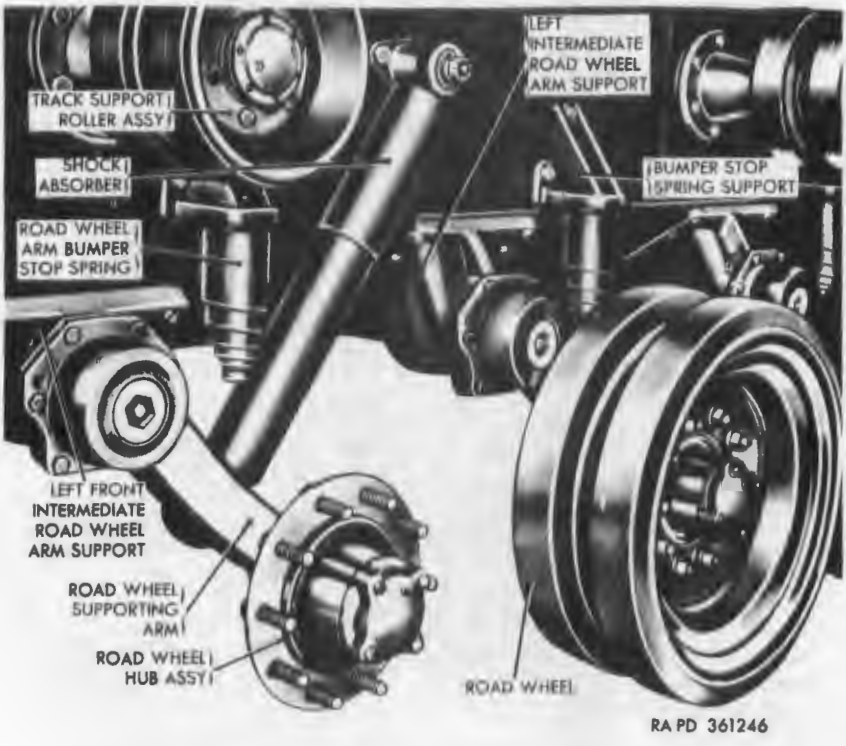


Figure 201. Intermediate road wheel suspension.

(5) Six hydraulic shock absorbers (fig. 199), three mounted on each side of the vehicle, cushion the supporting arm movements.

(6) A compensating wheel (fig. 199), for each track assembly, is mounted on each side at the front of the hull to provide for adjustment of the track and maintain tension in the track assembly at all times.

(7) Three rubber tired track support roller assemblies (fig. 199) are mounted on each side of the hull to support the upper length of each track assembly as it moves between the drive sprocket and the compensating wheel.

b. Data.

Track shoe assembly:
- Number, each track assembly 75
- Width ..... 21 in.
- Type T91E3
- Ordnance part number 7952167

Track assembly:
- Pitch ..... 6 in.
- Ground contact ..... 127 in. approx
- Ordnance part number 7333071

Compensating wheel:
- Number, each side 1
- Type ..... dual, demountable
- Ordnance part number 6576488

Road wheel:
- Number, each side 5
- Type ..... dual, demountable
- Bearings, each wheel ..... 2, tapered roller
- Ordnance part number 6576489

Road wheel supporting arm:
- Number, each side 5
- Bearings, each arm ..... 2, needle roller
- Springing ..... torsion bar
- Ordnance part number, left 7419937
- Ordnance part number, right 7419938

Torsion bar:
- Number, each side 5
- Type ..... solid steel
- Ordnance part number 7528974
  7528976
  7528981
  7528983

Shock absorber:
- Number, each side 3
- Type ..... hydraulic
- Ordnance part number 7404209

Bumper stop spring:
- Number, each side 5

Type ..... volute spring
Ordnance part number 7984870
Track support roller assembly:
Number, each side 3
Type ..... dual, demountable
Bearings, each wheel ..... 2 tapered roller
Ordnance part number 7419907

220. Track Assemblies

a. Description. Each track assembly is composed of 75 track shoe assemblies (fig. 202) connected by track pins carried in rubber-mounted track shoe link bushings. An integral center guide serves to keep the track assembly on the vehicle. Space is provided between the road wheels, track support roller assemblies, and compensating wheels to accommodate the center guide as the track assembly moves over them. Track shoe assemblies are interchangeable for either the right or left track assembly.

b. Removal.

(1) *Disconnecting track assembly.* Install two track connecting fixtures 5120–708–3799 (fig. 203), one on each side of the track assembly between the compensating wheel and the front road wheel and tighten sufficiently to take track tension off track pin. Remove the self-locking hexnut and washer (fig. 202) from one end of track pin. Using

Figure 202. Track shoe assembly—exploded view.

pin 5120–708–3639 (fig. 204), drive track pin from shoe assemblies.

Caution: Be careful when using pin 5120–708–3639 to avoid damage to threads on end of track pin. Loosen and remove track fixtures (fig. 203).

(2) *Removing track assembly.* Remove fender skirts if provided with vehicle (par. 235). Block the road wheels to prevent the vehicle from moving and disconnect track assembly ((1) above). Start the engine (par. 43) and place the range selector control lever in REVERSE range (par. 44). Accelerate engine very slowly. As the drive sprockets rotate in reverse, the sprocket teeth will pull the disconnected track assembly over the track support roller assemblies toward the rear of the vehicle. As the track comes off the sprockets, two men with a crowbar are necessary to guide the track assembly away from the vehicle. This prevents the track from piling up and jamming the drive sprockets. When the end of the track assembly drops clear of the drive sprockets, place the range selector control lever in NEUTRAL PARK position and stop the engine (par. 46). Carry the end of the track away from the vehicle until the track assembly lies flat on the ground.

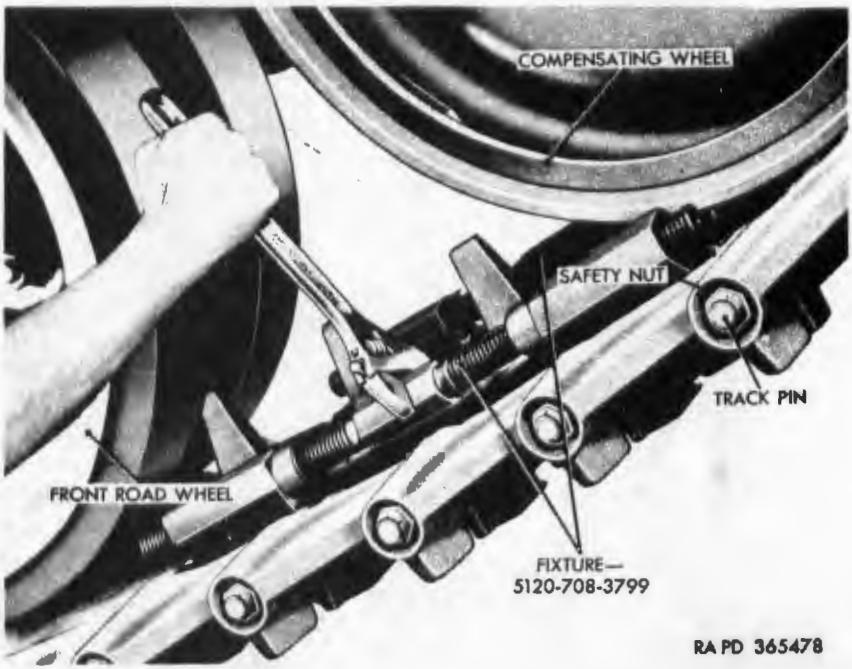


Figure 203. Track connecting fixtures installed.

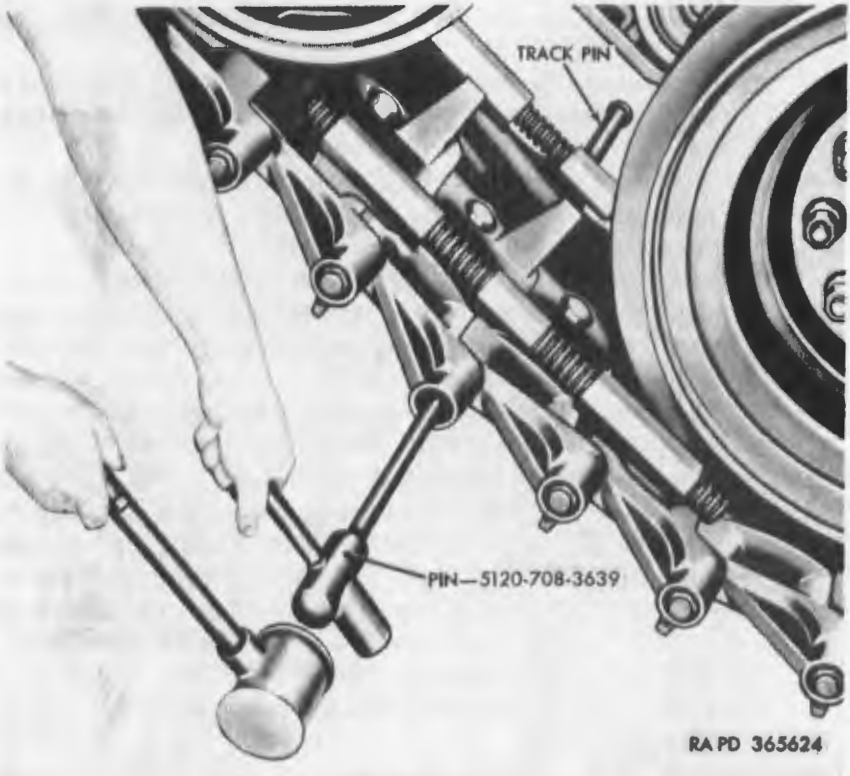


Figure 204. Removing track pin.

c. Disassembly. With track assembly flat on the ground, remove self-locking hex nut and washer from each end of track pins (fig. 202). Use drift pin 5120–708–3639 (fig. 204) to drive track pins from track shoe assemblies, taking extreme care not to damage threads on pin. After track shoe assemblies have been separated, remove self-locking hex nut (fig. 202) securing track shoe road pad to track shoe link and, using a soft hammer, tap road pad free from link.

d. Assembly. Install track shoe road pad (fig. 202) in recess provided in each track shoe link and secure with ¾-inch self-locking hex nut. Position track shoe links on the ground, center guide upward, so that track shoe link bushings of shoe assemblies are in alinement. Using a soft hammer, drive ¾ x 21 5/16 track pin (fig. 202) through track shoe link bushings to connect track shoe links. Install a 49/64-inch ID, 1¼-inch OD washer and ¾-inch self-locking hex nut on each end of track pin. Be sure that small shoulder of washer is facing inward. Tighten self-locking hex nuts to 160 to 200 pound-feet torque.

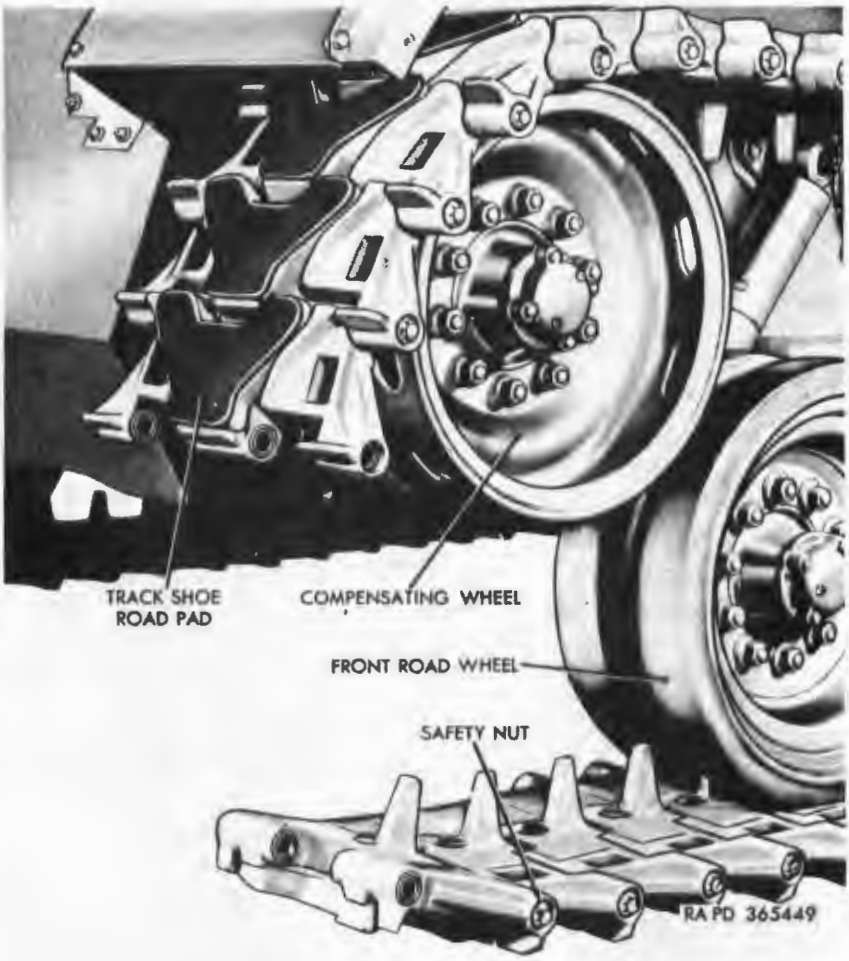


Figure 205. Track assembly disconnected.

e. Installation.

(1) *Installing track assembly.*

Note. These instructions cover track assembly installation when the vehicle is standing on part of the track to be installed and the other part is stretched out flat on the ground behind the vehicle. For installation under other conditions, refer to *e*(2), (3) or (4) below.

Place a crowbar under the seventh or eighth track shoe assembly from the free end of the track and double it back to the drive sprocket. Lift the free end and engage the first track shoe assembly with the drive sprocket teeth. Block the road wheels to prevent the vehicle from moving. Apply foot brake and release parking brake. Release foot brake slowly and rotate the drive sprocket

hub with a crowbar. Lift the free end of the track assembly over the rearmost track support roller assembly (fig. 199). When three or four track shoe assemblies have passed over the rear track support roller assembly, remove the crowbar from the drive sprocket hub and start the engine (par. 43). Place the range selector control lever in LOW range (par. 44) and very slowly apply power to rotate the drive sprockets. As the track assembly moves forward, using a crowbar, guide the free end over the remaining track support roller assemblies and the compensating wheel. When the track shoe assemblies are tight between the drive sprocket teeth and the rear road wheel, apply foot brake, move range selector control lever to NEUTRAL PARK position, and stop engine (par. 46). Connect track assembly (*e*(6) below) and adjust (*f* below). Install fender skirts (par. 235) if provided with vehicle.

(2) *Installing new track assembly with old track assembly on vehicle.* Remove fender skirt (par. 235), if provided, from the side of the vehicle on which track assembly is to be changed. Disconnect old track assembly between the compensating wheel and the front road wheel (*b*(1) above). Place new track assembly in a straight line extending away from the disconnected end of the old track with center guides down.

Note. **Be sure track shoe road pads are positioned in same direction as those in old track assembly.**

Connect new track assembly to the old track assembly so as to feed new track over the top of the compensating wheel. Start the engine (par. 43) and place the range selector control lever in REVERSE range (par. 44). Slowly back the vehicle, drawing the new track assembly up over the compensating wheel, track support roller assemblies, and drive sprockets, and around under the road wheels. Stop vehicle and remove portions of old track when necessary to prevent its piling up. When the front road wheel has passed over the seventh track shoe assembly from the end of the new track, stop the vehicle and engine (par. 46), and move the range selector control lever to the NEUTRAL PARK position (par. 46). Disconnect the old track from the new track (*c* above). Connect the new track assembly between the front road wheel and compensating wheel ((6) below) and adjust (*f* below). Install fender skirts (par. 235) if provided with vehicle.

(3) *Installing new track assembly with old track assembly removed.* Place the new track assembly on the ground ahead of the vehicle directly in line with the front road wheel with the grouser's V pattern pointing toward the rear of the vehicle.

Note. The tracks are installed so that the point of the grouser V pattern touches the ground first when the vehicle is moving forward.

Remove fender skirts (par. 235) if provided with vehicle. Place a metal plate or plank on the track shoe assembly nearest the vehicle for use as a ramp or dig a trench under the first track shoe assembly so the track can drop down into the depression and the road wheels can roll directly onto the track. Place a wood block on the third track shoe assembly from the front end of the new track. Tow or push the vehicle forward onto the track assembly until the front road wheel contacts the wood block. Continue the installation by following procedure outlined in (1) above.

(4) *Installing thrown track assembly.* Replace any damaged track shoe assemblies as described in (5) below. Proceed as outlined in (3) above.

(5) *Installing new track shoe assembly.* Individual track shoe assemblies can be replaced by disassembling the track assembly (*c* above) at each side of the affected parts, and installing new track shoe assemblies in place of those removed. Position vehicle so that defective shoe is between compensating wheel and front road wheel. Disconnect track (*b*(1) above) and remove defective shoe from track. Install new shoe and assemble track assembly (*d* above). Adjust track tension (*f* below). Spare track shoe assemblies are stowed on stowage rack over left muffler.

(6) *Connecting track assembly.* Install two track connecting fixtures 5120–708–3799 (fig. 203) on each end, one on each edge, of track assembly. Tighten track fixtures until track shoe link bushings are alined and track shoe assemblies meet at a 15° angle (fig. 206).

Note. To obtain proper 15° angle, place a 12-inch straightedge on the track shoe assemblies alongside the track fixture. Draw track together until center of the V formed by the track shoe assemblies is three-fourths inch from the straightedge (fig. 206).

Install a $^{49}/_{64}$-inch ID, 1¼-inch OD washer (fig. 202) so that small shoulder of washer is facing inward, and a ¾-inch self-locking hex nut on one end of ¾ x $21^{5}/_{16}$

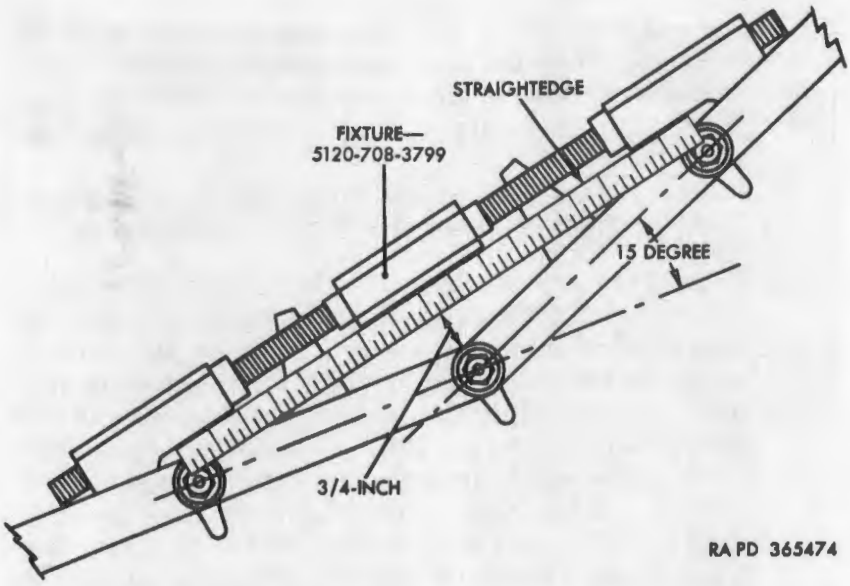


Figure 206. Correct alinement for track pin installation.

track pin. A thin film of grease or oil on pin will facilitate installation. Insert pin through first track shoe link bushing and carefully drive through remaining bushings with soft metal hammer. Install remaining washer and self-locking hex nut on other end of pin. Tighten self-locking hex nuts to 160 to 200 pound-feet torque and remove track fixtures. Adjust track tension (*f* below).

f. Track Assembly Adjustment.

(1) *Checking adjustments.* To check track assembly adjustment, drive vehicle and allow it to coast to a stop on level ground without applying the brakes. Check the track sag with a straightedge placed over the track above the first and second track support roller assemblies (fig. 207). Track assembly should sag below bottom edge of straightedge a distance of 5/8 to 1-inch. If sag is over 1-inch, adjust the track assembly ((2) below).

(2) *Adjusting tension.* Loosen clamping bolt (fig. 208) and rotate eye bolt nut stop away from flat of adjusting nut on compensating wheel adjustable supporting arm. Using wrench 8390093 (fig. 208) and a suitable bar, turn adjusting nut clockwise to tighten track assembly or counterclockwise to loosen track assembly until sag is within limits specified in (1) above. Install nut stop and tighten clamping bolt to prevent adjusting nut from turning.

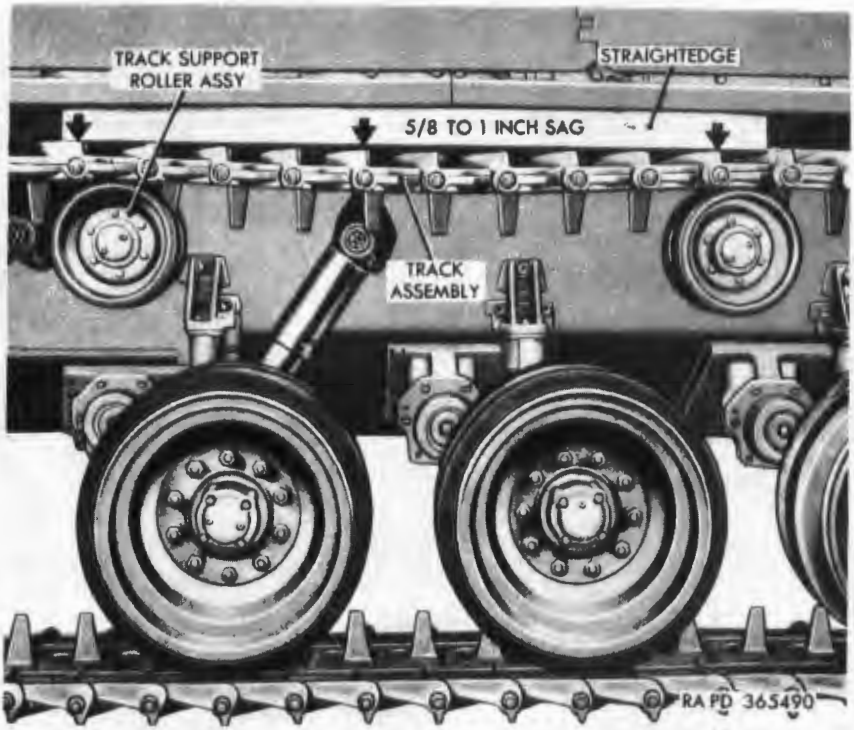


Figure 207. Measuring track tension.

221. Shock Absorbers

Note. **The key letters noted in parentheses are in figure 209 except where otherwise indicated.**

a. Description. Hydraulic shock absorbers (fig. 199) control the movement of the two front and one rear road wheel supporting arms on each side of the vehicle. Shock absorbers are not provided for the left or right intermediate road wheel supporting arms. A self-alining bearing assembly is used at each end of the shock absorber for mounting on the hull and the road wheel supporting arms. Damaged or defective shock absorbers must be replaced as outlined in *c* through *f* below.

b. Inspection of Shock Absorbers.

(1) *Oil leaks.* Slight indications of oil leakage does not warrant shock absorber replacement. One-half ounce of the oil used will completely cover the internal parts and will make no difference in the shock absorber operation. A shock absorber can loose between 6 and 8 ounces of oil before its operation may be affected.

(2) *Temperature test.* The most practical method of testing the shock absorber is by the temperature method. This

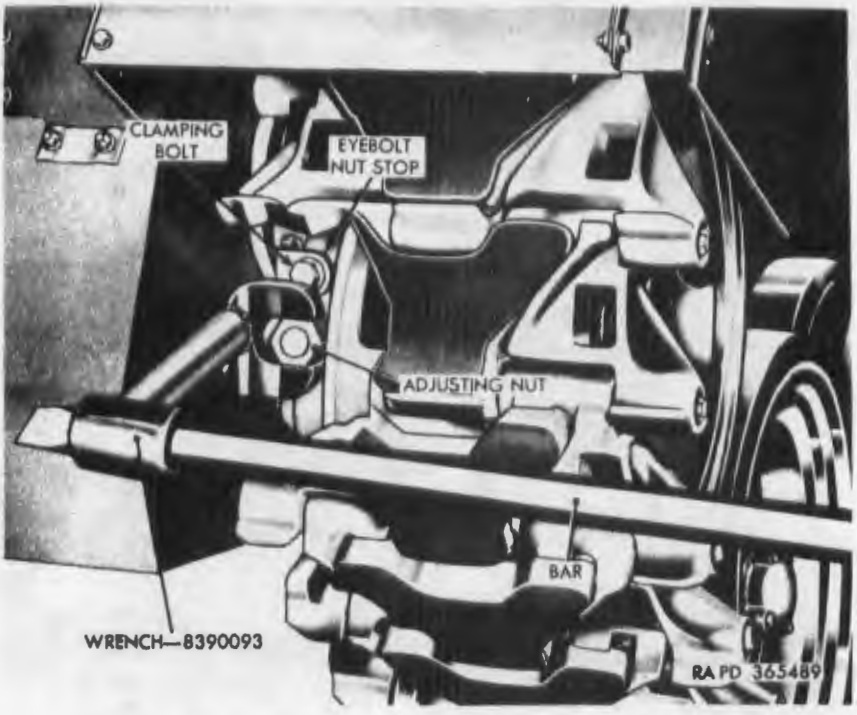


Figure 208. Adjusting track assembly at compensating wheel.

test should be made immediately after a run of not less than 5 miles of high speed operation or 4 miles of cross-country operation. Carefully feel the lower end of the shock absorber and then the hull near the shock absorber and note the difference in temperature. If the hull and shock absorber are the same temperature, the shock absorber is not operating and should be replaced. If the shock absorber is warmer than the hull, it is operating properly. The difference in temperature should be clearly evident, but the lower part of the shock absorber (oil reservoir tube or base) does not need to be extremely hot to indicate a satisfactory unit.

Caution: Due to the high temperatures developed by shock absorbers when in operation, care must be exercised when checking to prevent burns.

(3) *Bearing play.* Grasp ends of shock absorber and shake. If either upper or lower self-alining bearing assembly is loose enough so that play can be seen or felt, remove shock absorber and replace bearing assemblies (*c–f* below).

c. Removal of Shock Absorber with Bearing Assembly. Remove the split cotter pin (A), slotted nut (Y), bearing dust shield (B), and flat washer (C), from the lower end of the shock absorber with bearing assembly (E), and pull shock absorber from pin on road wheel arm using puller 5120–795–0052 (fig. 210). Remove the upper end of the shock absorber with bearing assembly from the shock absorber mounting bracket (D) on the hull as described above.

d. Removal of Shock Absorber Bearing Assembly. Place either end of shock absorber in an arbor press, aline replacer 41–R–2382–803 on self-alining bearing assembly and press bearing assembly out of shock absorber.

e. Installation of Shock Absorber Bearing Assembly. Place either end of shock absorber in an arbor press and aline self-alining bearing assembly in hole provided in shock absorber. Using replacer 41–R–2382–803 (fig. 211), press bearing assembly into shock absorber and stake in three places.

f. Installation of Shock Absorber with Bearing Assembly. Position shock absorber with bearing assembly (E) on the shock absorber mounting bracket (D) on the hull and on the road wheel arm pin. Install one bearing dust shield (B), 1 9/32-inch flat washer (C), and 3/4-inch slotted nut (Y) on shock absorber mounting bracket (D). Tighten nuts to a minimum of 150 pound-feet torque. Install 5/32 x 2 split cotter pin (A) in each nut.

222. Road Wheels

a. Description. Ten dual road wheels, five on each side of the vehicle, are secured to hub assemblies mounted on road wheel supporting arms. Each dual road wheel consists of an outer and inner rubber tired road wheel disk. The road wheel disks are interchangeable and may be mounted on the hub assemblies on either side of the vehicle.

b. Removal. Loosen 10 locknuts (T, fig. 209), but do not remove at this time. Install lifter 41–L–1390–205 (fig. 212) with the lower or claw end facing the front of the vehicle.

Caution: Make sure the upper or swivel end of the lifter is properly seated on the road wheel supporting arm with hub assembly. Drive vehicle forward slowly, being sure the lower or claw end of the lifter engages in the track shoe. Stop the vehicle when the lifter is vertical and the wheel fully raised. Remove locknuts and remove road wheel disks (V, fig. 209).

Note. If lifter 41–L–1390–205 is not available, road wheel can usually be raised by a hydraulic jack (fig. 213) positioned under the lower end of the shock absorber.

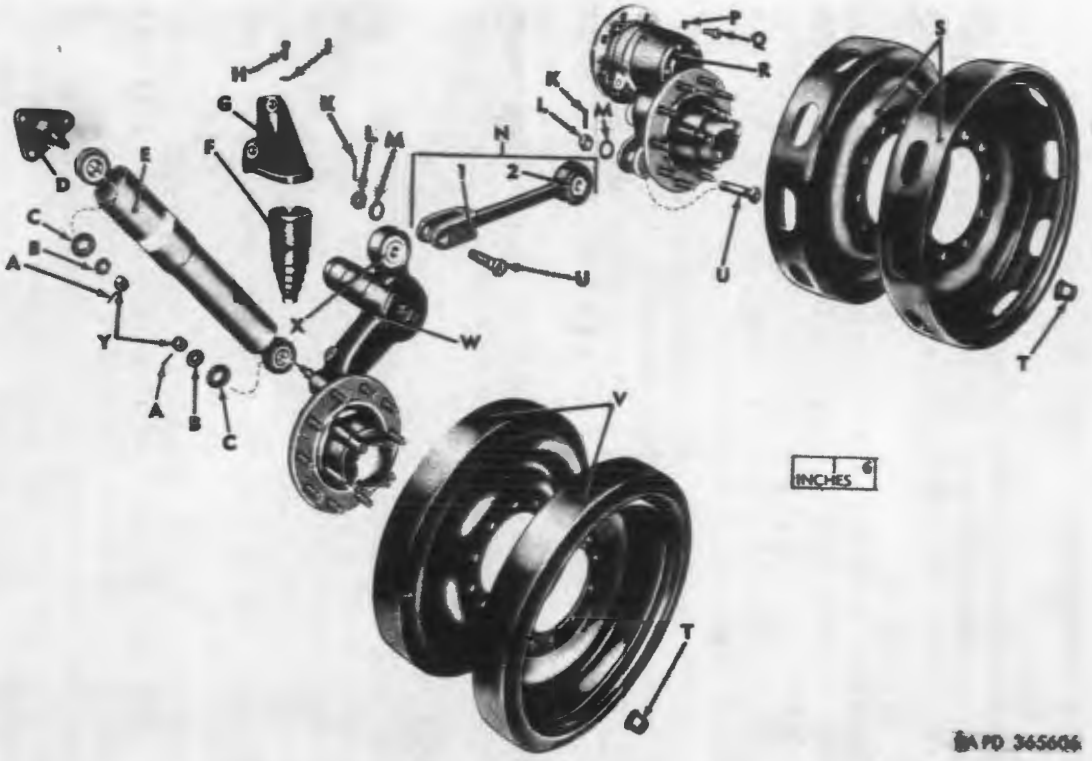


Figure 209. Shock absorber with bearing assembly, bumper stop spring connecting link assembly, compensating wheel supporting arm with hub spindle assembly, and road wheel front supporting arm with hub assembly—exploded view.

A—$\frac{1}{32}$ x 2 cotter pin—137243
B—Bearing dust shield—7404078
C—1$\frac{3}{32}$-inch flat washer—8338102
D—Shock absorber mounting bracket—7404980
E—Shock absorber with bearing assy—7404209
F—Bumper stop spring—7982898
G—Bumper spring support—7528960
H—$\frac{5}{8}$ x 1$\frac{1}{2}$ hex-head bolt—223809
J—$\frac{5}{8}$-inch lockwasher—121574
K—$\frac{1}{8}$ x 1$\frac{3}{4}$ cotter pin—137258
L—1-inch slotted hex nut—125294
M—2-inch OD washer—131019
N—Left connecting link assy—7962364
Right connecting link assy—7962365
1—Left connecting link—7962366
Right connecting link—7962367
2—Self-alining bearing assy—293112
P—$\frac{3}{4}$-inch lockwasher—131046
Q—$\frac{3}{4}$ x 1$\frac{7}{8}$ hex-head bolt—224261
R—Left supporting arm with hub and spindle assy—7419945
Right supporting arm with hub and spindle assy—7419946
S—Compensating wheel disk—8378742
T—$\frac{3}{4}$-inch locknut—A287416
U—1 x 4$\frac{1}{8}$ hex-head bolt—B293112
V—Road wheel disk—D76489
W—Left front supporting arm with hub assy—7419937
Right front supporting arm with hub assy—7419938
X—Self-alining bearing assy—293112
Y—$\frac{3}{4}$-inch slotted nut—175085

Figure 209—Continued.

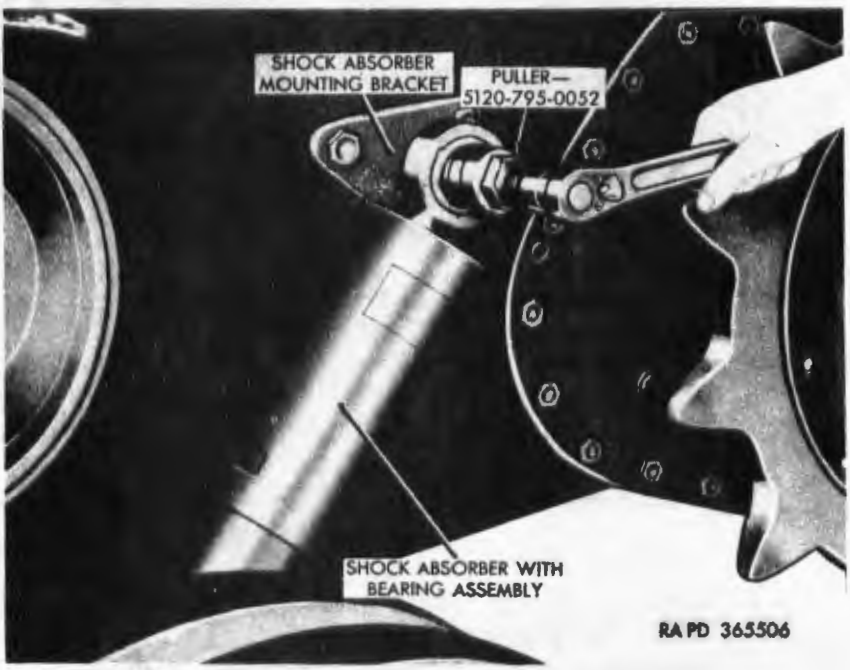


Figure 210. Removing shock absorber.

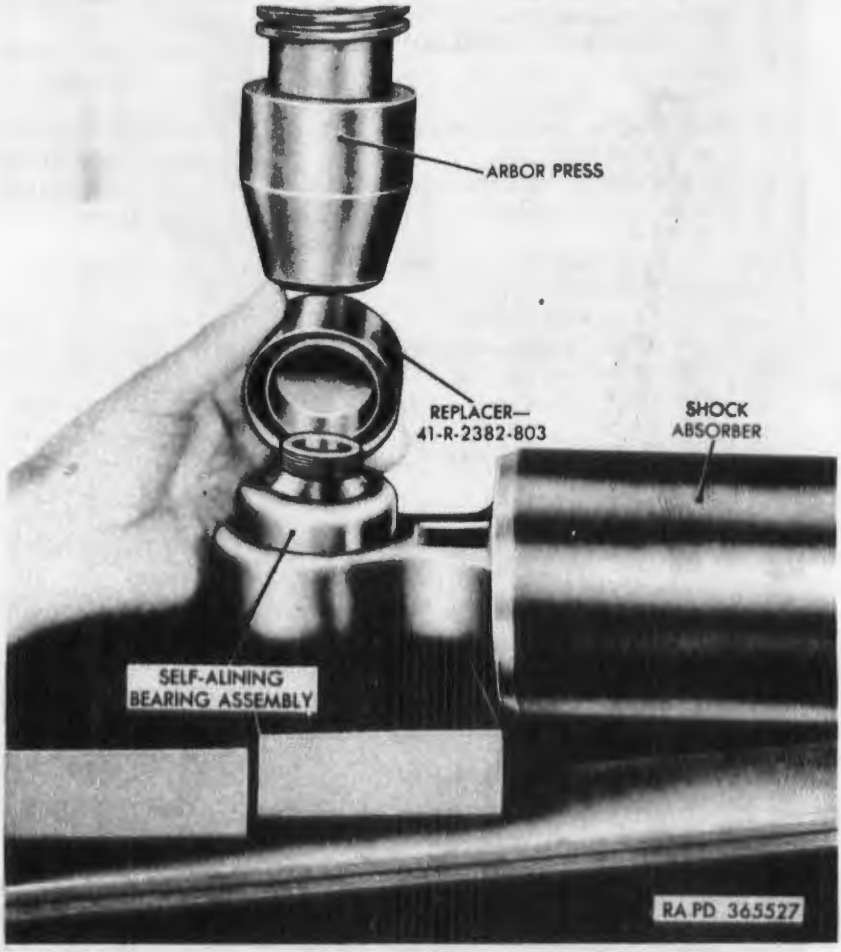


Figure 211. Installing shock absorber self-alining bearing assembly.

Caution: Extreme care should be exercised when using the hydraulic jack to prevent injury to personnel.

c. Cleaning. Clean road wheel disks thoroughly with a stiff-bristle brush and water. If available, steam may be used to remove accumulations of grease and dirt.

d. Inspection and Repair.

(1) *Inspection.* Inspect stud holes in center of road wheel disks for excessive wear. Check tires for gouges, chips, cuts, or separation from rim.

(2) *Repair.* Replace road wheel disks if inspection ((1) above) reveals excessive wear of stud holes. Replace road wheel disks if gouges, chips, cuts, or separation extends completely across the tire in any one place.

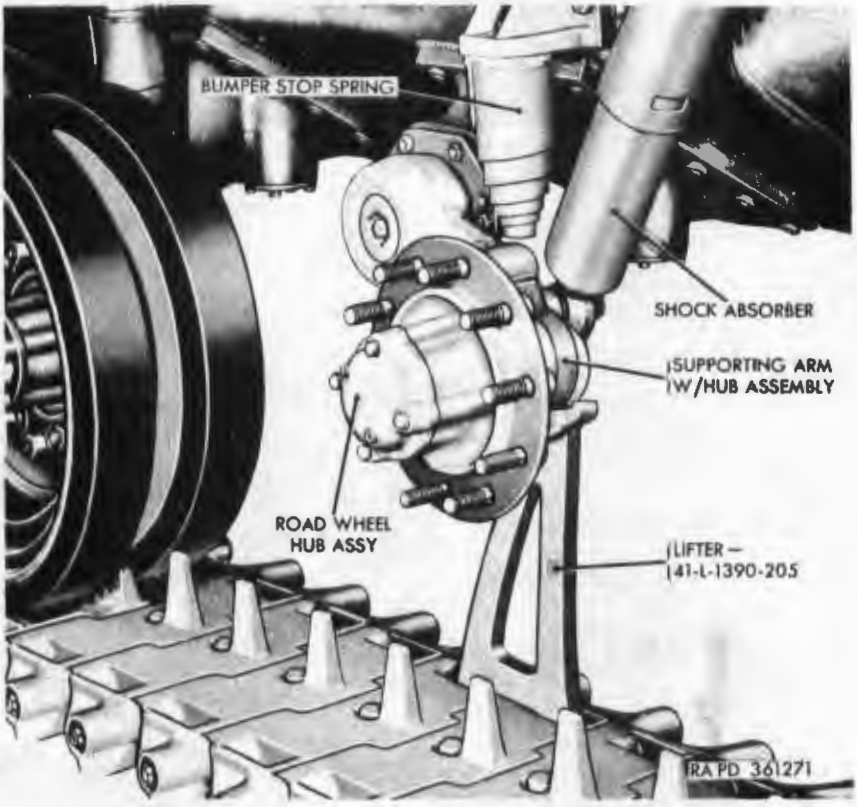


Figure 212. Lifting road wheel with lifter 41–L–1390–205.

e. Installation. With the road wheel hub raised by means of lifter 41–L–1390–205 (fig. 212) or the hydraulic jack (fig. 213), position road wheel disks (V, fig. 209) on hub assembly. Install ten ¾-inch locknuts (T, fig. 209) and remove hydraulic jack. If lifter is used, drive vehicle backward slowly until the road wheel is on the track assembly and lower or claw end of lifter is free of the track shoe. Remove lifter. Tighten locknuts to 250 to 300 pound-feet torque. Adjust track assembly tension (par. 220*f*).

f. Operational Check. After 10 miles of vehicle operation, check all road wheel locknuts for tightness. Tighten as necessary to 250 to 300 pound-feet torque.

223. Torsion Bars and Anchors

Note. The key letters noted in parentheses are in figure 216 except where otherwise indicated.

a. Description. Ten torsion bars run across the bottom of the hull and connect the road wheel supporting arms on each side of the vehicle to the torsion bar anchors in the opposite road wheel

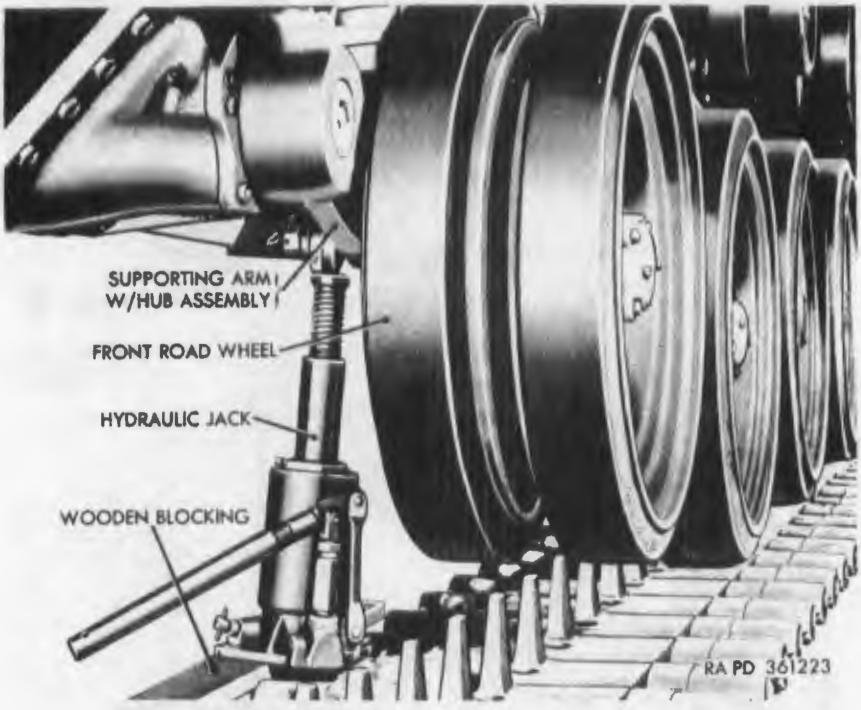


Figure 213. Lifting road wheel with hydraulic jack.

arm supports. The serrations at the outer end of the torsion bar match with serrations when mounting in the upper end of the road wheel supporting arms, and the serrations at the inner end of the torsion bars match with serrations in the torsion bar anchors. One blank tooth at each end of the torsion bar has been cut to match block teeth in the supporting arms and anchors (fig. 214) for correct positioning during installation. Each torsion bar is marked on the supporting arm end with an arrow showing direction of torque rotation, part number, and a daub of paint to permit quick identification for correct installation. Refer to figure 215 for location and markings of torsion bars.

b. Removal.

(1) *Torsion bar.*

(*a*) Release track tension (par. 220*f*).

(*b*) Remove road wheel (par. 222*b*).

(*c*) Run vehicle slowly backwards until road wheel lifter (fig. 212) is free, supporting arm lowers, and torsion bar load tension is relieved.

(*d*) Remove hex-head bolt (A) and lockwasher (B) and remove hex-socket nut (C) and gasket (D) from road wheel arm using wrench 41–W–3638–50 (fig. 217) and

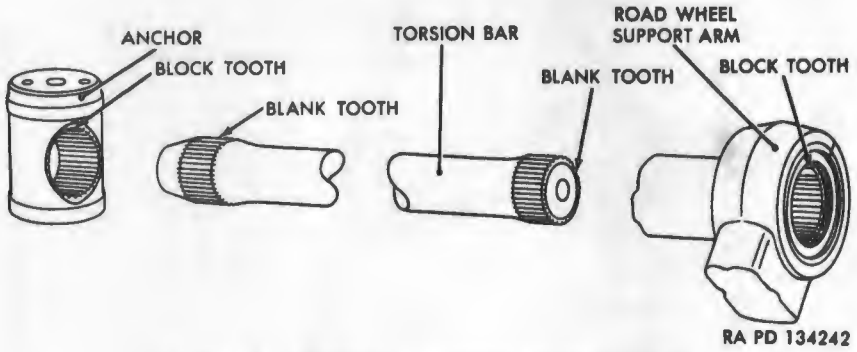


Figure 214. Markings for torsion bar installation.

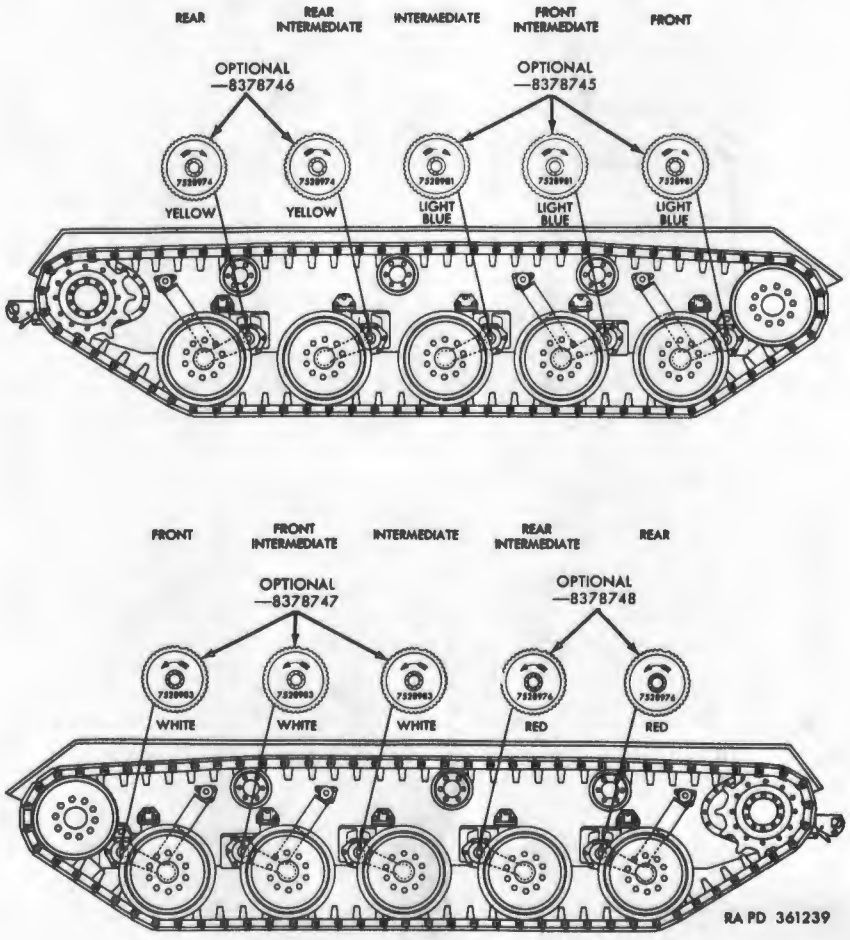


Figure 215. Torsion bar identification diagram.

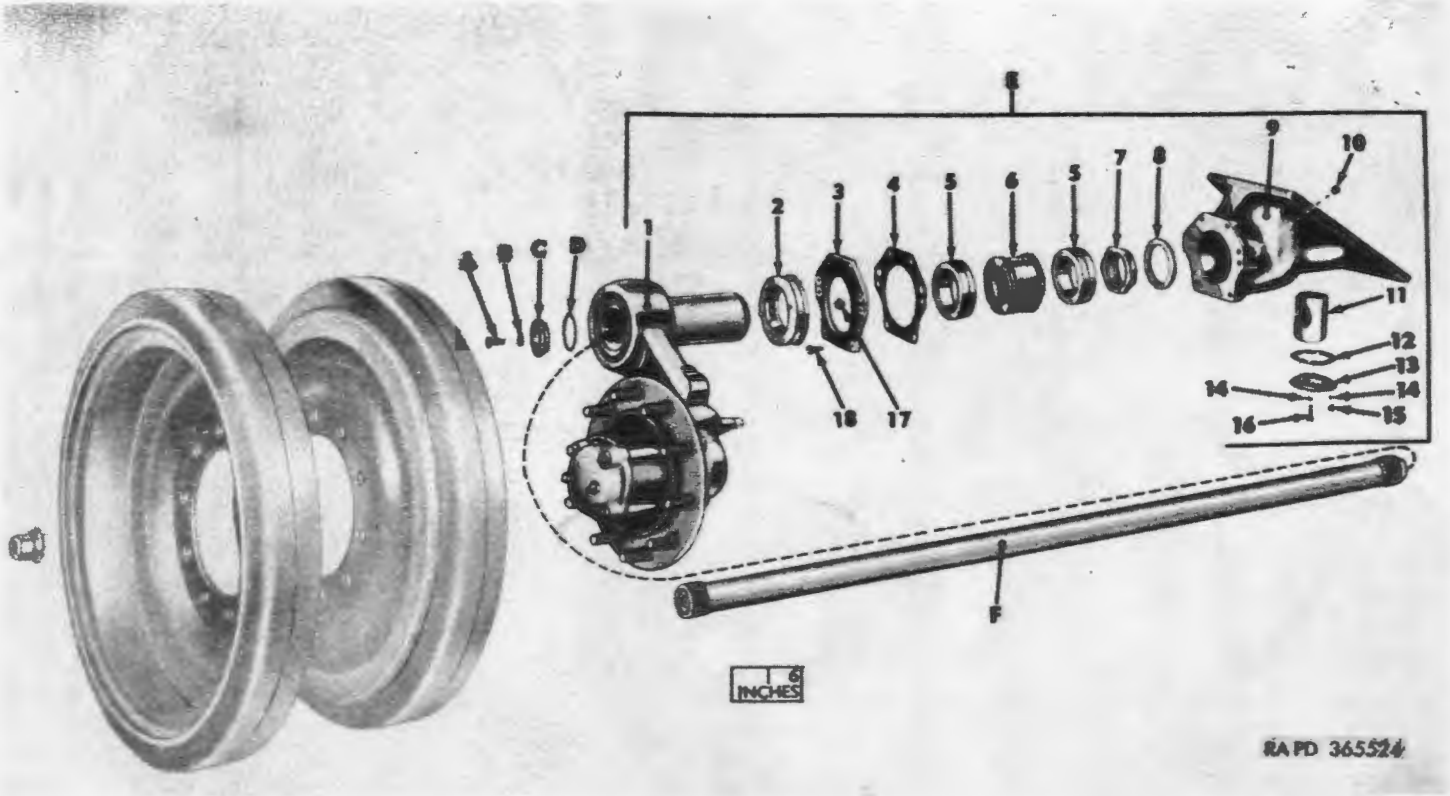


Figure 216. Torsion bar and supporting arm with hub and support assembly—exploded view.

A—½ x 1⅛ hex-head bolt 224051
B—½-inch lockwasher 120384
C—2½-inch hex-socket nut 7724599
D—2⅜-inch ID gasket 7098444
E—Supporting arm with hub and support assy
Left front 7984452
Right front 7984453
Left front intermediate 7984454
Right front intermediate 7984455
Intermediate and rear intermediate 7984456
Rear 7984457
1—Supporting arm with hub assy
Front intermediate and rear 7419936
Left front 7419937
Right front 7419938
Intermediate and rear intermediate 7963641
2—Face-type oil seal 7419933
3—Bearing retainer 7419914
4—Retainer gasket 7419923
5—Needle bearing 712160
6—Bearing spacer 7419915
7—Bearing adjusting nut 7528972
8—Bearing oil seal 500263
9—Arm support
Intermediate, rear intermediate and rear 7419924
Left front and left front intermediate 7419925
Right front and right front intermediate 7419926
10—¼-inch pipe plug —7968697
11—Torsion bar anchor
Right front, right front intermediate, intermediate, rear intermediate and rear—C108208
Left front and left front intermediate 7725837
12—Retainer gasket 7714827
13—Anchor retainer 7715054
14—⅜-inch lockwasher 120382
15—⅜-inch drain plug 445001
16—⅜ x 1¼ hex-head bolt 223673
17—⅝-inch filler plug 445013
18—½ x 1¼ self-locking hex-head bolt 221981
F—Torsion bar
Right rear and right rear intermediate 7528974
Left rear and left rear intermediate 7528976
Right front, right front intermediate, and right intermediate 7528981
Left front, left front intermediate, and left intermediate 7528983

Figure 216. Torsion bar and supporting arm with hub and support assembly—exploded view.

box or socket wrench. Discard gasket if damaged during removal.

(*e*) Pull torsion bar from installed position using puller 5120–557–3615 and adapter 5120–322–5953 (fig. 218).

(2) *Torsion bar anchor.* Remove torsion bar anchor (E–11) by removing four hex-head bolts (E–16) and lockwashers (E–14) from the outer rim of anchor retainer (E–13). Remove two drain plugs (E–15) and lockwashers (E–14) from two tapped blind holes in anchor retainer (E–13). Screw two of the bolts (E–16) into the blind holes and, using bolts as pullers, remove retainer, torsion bar anchor, and retainer gasket (E–12) from arm supports (E–9). Discard gasket. Remove two hex-head bolts (E–16) and lockwashers (E–14) securing torsion

bar anchor to anchor retainer and remove anchor from retainer. Remove the two bolts used as pullers to remove anchor from arm support.

Note. Torsion bar anchors are removed from the outside of the vehicle on all arm supports, with the exception of the left front and left front intermediate arm supports. On these, the anchors are removed from the inside of the vehicle.

c. Cleaning. Clean torsion bars and torsion bar anchors with dry-cleaning solvent or mineral spirits paint thinner.

d. Inspection and Repair.

(1) *Inspection.* Inspect serrations on torsion bar for chipping, cracks, or signs of distortion. Inspect torsion bar for signs of fatigue or failure. Inspect torsion bar anchor for damage to serrations or cracks in anchor.

(2) *Repair.* Replace torsion bars or torsion bar anchors if inspection reveals defects described in (1) above.

e. Installation.

(1) *Torsion bar anchor.* Position torsion bar anchor (E–11) on anchor retainer (E–13) and secure with two 3/8-inch medium lockwashers (E–14) and 3/8 x 1 1/4 hex-head bolts (E–16) in the centermost holes of anchor and retainer. Install anchor, anchor retainer, and new retainer gasket (E–12) into arm support (E–9) and secure with four 3/8-inch lockwashers (E–14) and 3/8 x 1 1/4 hex-head bolts (E–16).

Note. Do not fully tighten anchor retainer bolts until after torsion bar has been installed.

Install two 3/8-inch drain plugs (E–15) and 3/8-inch medium lockwashers (E–14) in tapped blind holes in anchor retainer.

Note. If retainer gasket (E–12) is not available, gasket cement may be used.

(2) *Torsion bar.*

(*a*) Inspect torsion bar part number and arrow markings (fig. 215) checking that the correct torsion bar (F) is installed. Grease serrations at each end, and insert tapered end of bar through upper end of supporting arm with hub and support assembly (E). Position the supporting arm with hub assembly (E–1) to aline the blank tooth on the torsion bar with the block tooth on the supporting arm with hub assembly and torsion bar anchor (E–11) and slide the torsion bar into place. It may be necessary to tap the bar in place with the end of a hammer handle.

Caution: Do not use a heavy hammer or a slide hammer to install torsion bar.

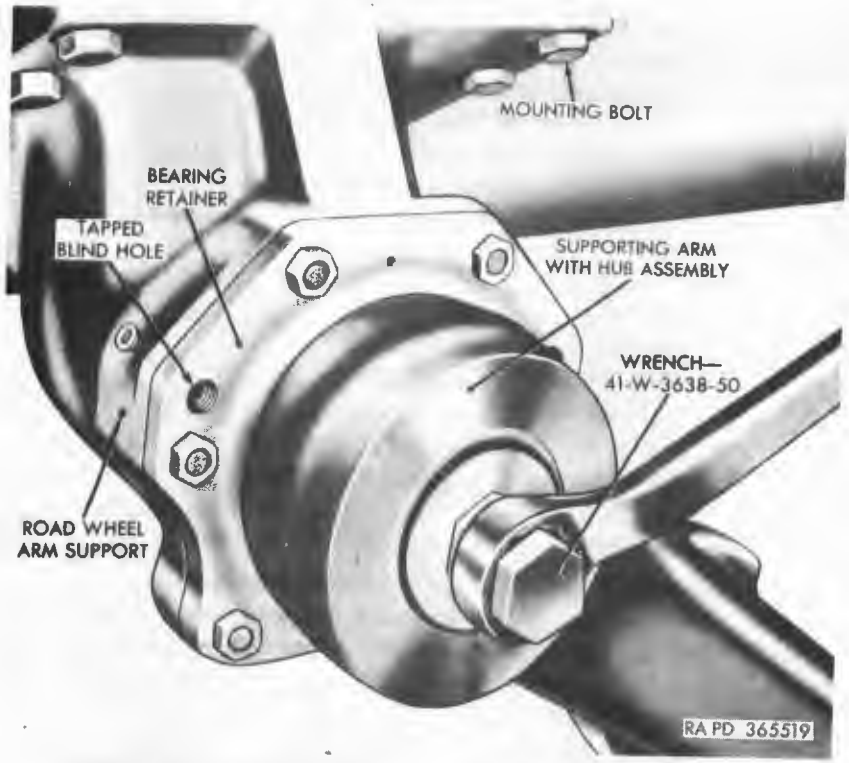


Figure 217. Removing or installing torsion bar hex-socket nut.

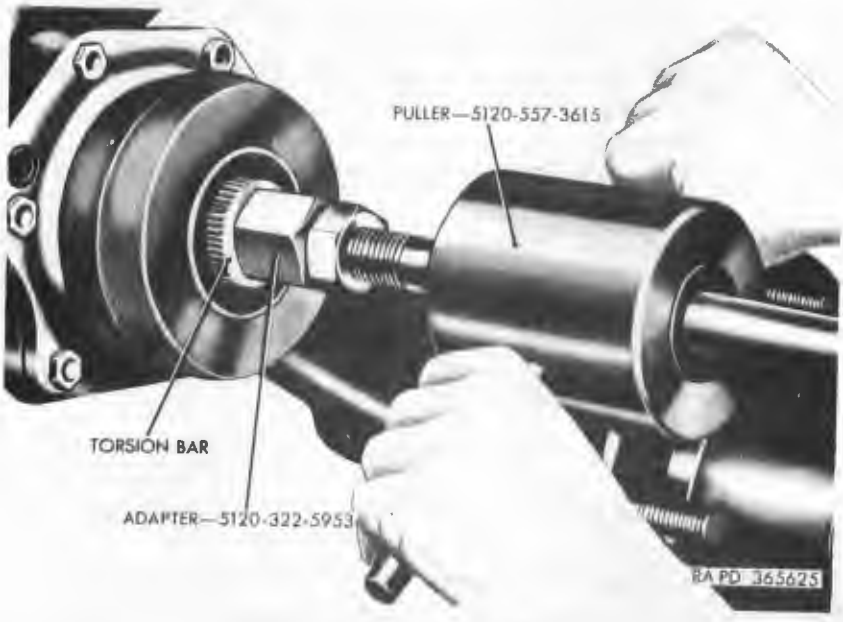


Figure 218. Removing torsion bar.

If the installation requires too much effort, remove the torsion bar and make sure that the blank tooth and the block tooth (fig. 214) are in alinement.

Note. Use a new anchor when installing a new torsion bar.

(*b*) Install 2½-inch hex-socket nut (C) and new 2 17/32-inch ID gasket (D) using wrench 41–W–3638–50 (fig. 217) and box or socket wrench. Tighten hex-socket nut to 50 to 75 pound-feet torque.

(*c*) Insert ½ x 1⅛ hex-head bolt (A) and ½-inch lockwasher (B) through hole in hex-socket nut (C) and tighten to 60 to 75 pound-feet torque.

(*d*) Tighten four hex-head bolts (E–16) in the anchor retainer (E–13).

(*e*) Install road wheels (par. 222*e*).

(*f*) Adjust track tension (par. 220*f*).

224. Road Wheel Supporting Arm with Hub and Support Assembly

a. Description. Ten supporting arms with hub and support assemblies (E, fig. 216), five on each side, provide running gear for the road wheels and serve as a means of transferring road wheel movement to the torsion bars during operation on uneven terrain.

b. Removal.

(1) *Front, front intermediate, and rear supporting arm with hub and support assemblies.*

(*a*) Jack up vehicle and block to remove hull weight from road wheels and supports.

(*b*) Remove shock absorber with bearing assembly (par. 221*c*).

(*c*) Remove road wheel (par. 222*b*).

(*d*) Remove torsion bar and torsion bar anchor (par. 223*b*).

(*e*) On front supporting arm with hub and support assemblies only, remove connecting link assembly (N, fig. 209) following the procedures described in paragraph 225*b*.

(*f*) Remove torsion bar (F, fig. 216) (par. 223*b*) from arm support (E–9, fig. 216) on opposite side of hull and remove supporting arm with hub assembly (E–1, fig. 216). Remove 10 mounting bolts (fig. 217) securing arm support (E–9, fig. 216) to hull and remove arm support.

(2) *Intermediate and rear intermediate supporting arm with hub and support assemblies.* Operations to be performed for the removal of these supporting arm assemblies are

identical with those described in (1) above, except that there is no shock absorber with bearing assembly or connecting link assembly to be removed.

c. Disassembly of Supporting Arm With Hub and Support Assembly.

Note. The key letters noted in parentheses are in figure 216, except where otherwise indicated.

(1) Remove two filler plugs (E–17) and six self-locking hex-head bolts (E–18) from bearing retainer (E–3). Install two of the bolts just removed in the two tapped blind holes (fig. 217) in bearing retainer. Place a suitable container of at least 1-quart capacity under supporting arm with hub assembly (E–1) and arm support (E–9), and alternately tighten bolts installed in retainer to release arm with hub assembly from support. Permit oil to drain into container and remove arm with hub assembly.

Note. Adapter 5120–708–2997, if available, may be installed in threaded opening for hex-socket nut (C) and used with puller 5120–557–3615 to remove supporting arm with hub assembly from arm support.

(2) Remove two pipe plugs (E–10) and bearing oil seal (E–8) from arm support (E–9). Discard oil seal if worn or damaged during removal.

(3) Remove bearing adjusting nut (E–7) from shaft of supporting arm with hub assembly (E–1) using wrench 5120–317–8096 (fig. 219).

Note. This nut is staked in place and may require more than normal effort to remove.

Remove two needle bearings (E–5), bearing spacer (E–6), retainer gasket (E–4), bearing retainer (E–3), and face-type oil seal (E–2).

Note. It may be necessary to use a screwdriver or pry bar to remove oil seal.

Discard gasket and oil seal if worn or damaged during removal.

d. Disassembly of Supporting Arm with Hub Assembly.

Note. The key letters noted in parentheses are in figure 220, except where otherwise indicated.

(1) Place suitable container of at least 1-pint capacity beneath hub cap (D). Remove four hex-head bolts (A), lockwashers (B), hub cap (D), static grounding spring (E), and hub cap gasket (F) from hub assembly (L). Allow oil to drain into container and wipe excess oil from hub assembly. Remove two pipe plugs (C) from hub cap (D). Remove split cotter pin (H), slotted hex nut (G),

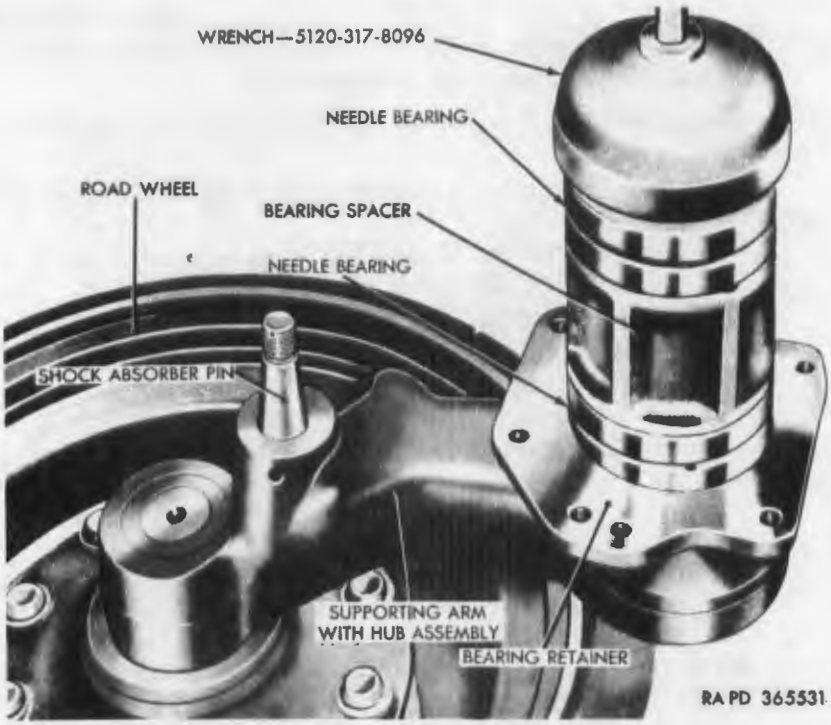


Figure 219. Removal or installation of bearing adjusting nut.

and tang washer (J) from supporting arm with shaft and spindle assembly (Q). Temporarily install hub cap to prevent outer bearing cone (K) from falling out when hub assembly (L) is removed. Pull hub assembly (L) off spindle assembly (Q). Remove hub cap and lift out outer bearing cone (K). Inspect inner bearing oil seal (N) installed in rear of hub assembly for indications of oil leakage. Do not remove oil seal or inner bearing cone (M) unless inspection reveals the oil seal to be unserviceable. To remove oil seal (N) and inner bearing cone (M), drive oil seal from hub and lift out inner bearing cone. Discard oil seal. Inspect inner bearing spacer (P); if scored or otherwise damaged, remove spacer by carefully heating it with a torch until spacer can be removed from spindle assembly. Remove self-alining bearing assembly (X, fig. 209) from front supporting arm with shaft and spindle assembly using remover and replacer 41–R–2373–455 and handle 5120–473–7121.

(2) Inspect inner and outer bearing cups (L–1 and L–4) for pits, scoring, or excessive wear. When required, remove

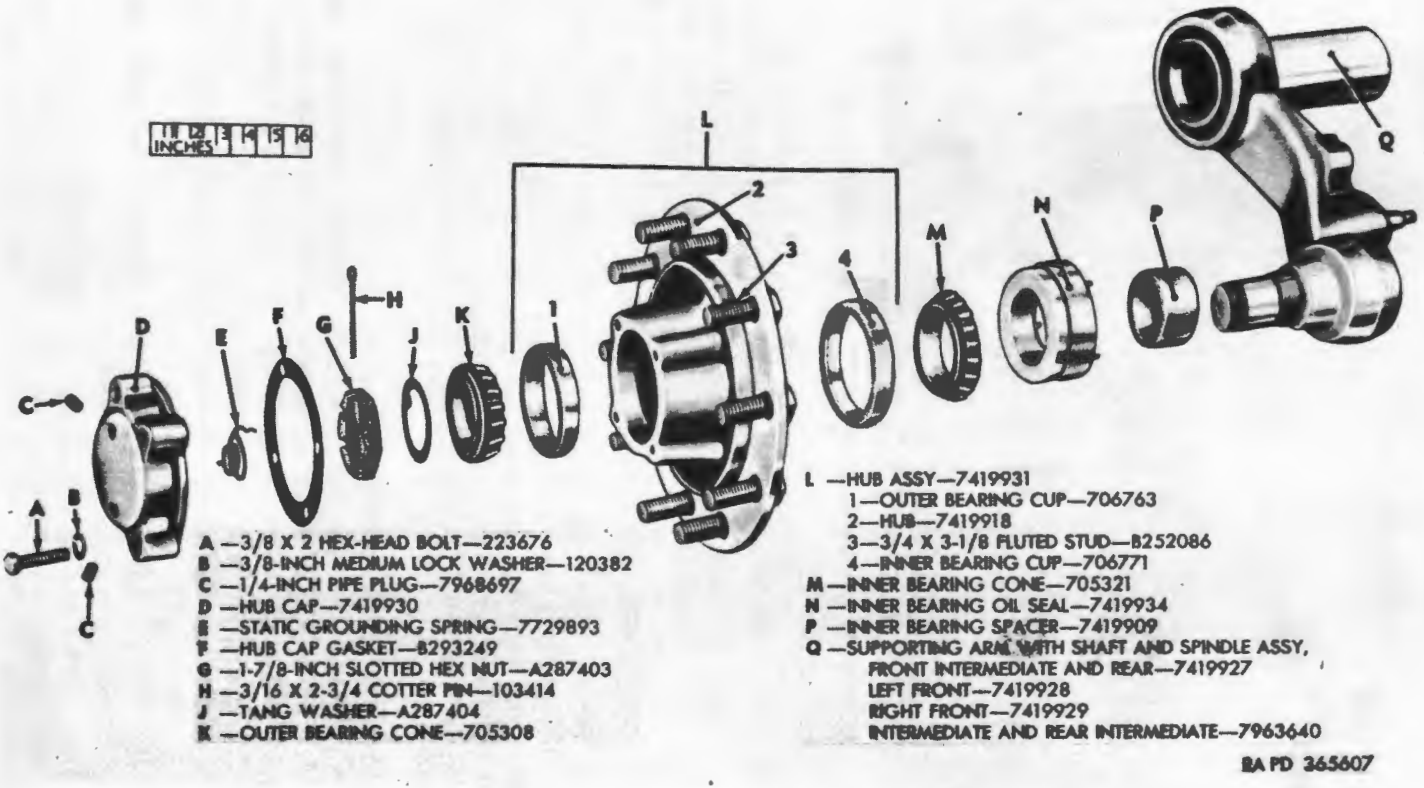


Figure 220. Road wheel supporting arm with hub assembly—exploded view.

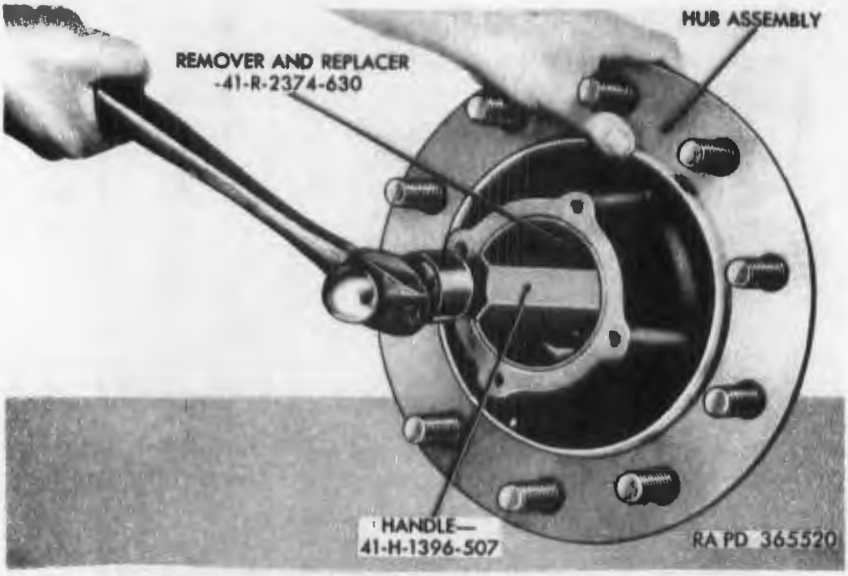


Figure 221. Removing inner bearing cup from hub assembly.

inner bearing cup using remover and replacer 41–R–2374–630 (fig. 221) and outer bearing cup using remover and replacer 41–R–2374–652. Use handle 41–H–1396–507 with both remover and replacers. Remove stripped, bent, or otherwise damaged fluted studs (L–3) by driving studs out of hub with heavy hammer.

e. Cleaning. Clean all parts of supporting arm with hub assemblies thoroughly with dry-cleaning solvent or mineral spirits paint thinner and wipe dry. Remove rust spots or minor scratches from machined surfaces by polishing with crocus cloth wet in dry-cleaning solvent or mineral spirits paint thinner and repeat cleaning operation where required.

f. Inspection and Repair.

(1) *Inspection.* Examine all parts for wear or scoring. Inspect bearing cups, cones, and bearings for cracks, wear, and indications of brinelling. Inspect spindle and shaft for cracks, scoring, and general thread condition. Inspect castings for cracks or other indications of incipient failure.

(2) *Repair.* All damaged bearings, cones, or bearing cups must be replaced with new materiel.

Note. Bearing cone and cup sets should consist of parts made by the same manufacturer. This will eliminate the possibility of an early failure due to a slight difference between a bearing cup of one manufacturer and bearing cones from another.

Thread damage should be repaired by using a thread chaser or used tap whenever possible. Parts having casting cracks, chips, or deep scoring must be replaced.

g. Assembly of Supporting Arm With Hub Assembly.

Note. The key letters noted in parentheses are in figure 220, except where otherwise indicated.

(1) Install outer and inner bearing cups (L–1 and L–4) in hub (L–2) with the narrow lip of each cup facing outward. Use remover and replacer 41–R–2374–630 with handle 41–H–1396–507 for installing inner bearing cup (fig. 222) and remover and replacer 41–R–2374–652 with handle 41–H–1396–507 for installing outer bearing cup (fig. 223). If any of the ¾ x 3⅛ fluted studs (L–3) were removed at disassembly, aline serrations within hub with

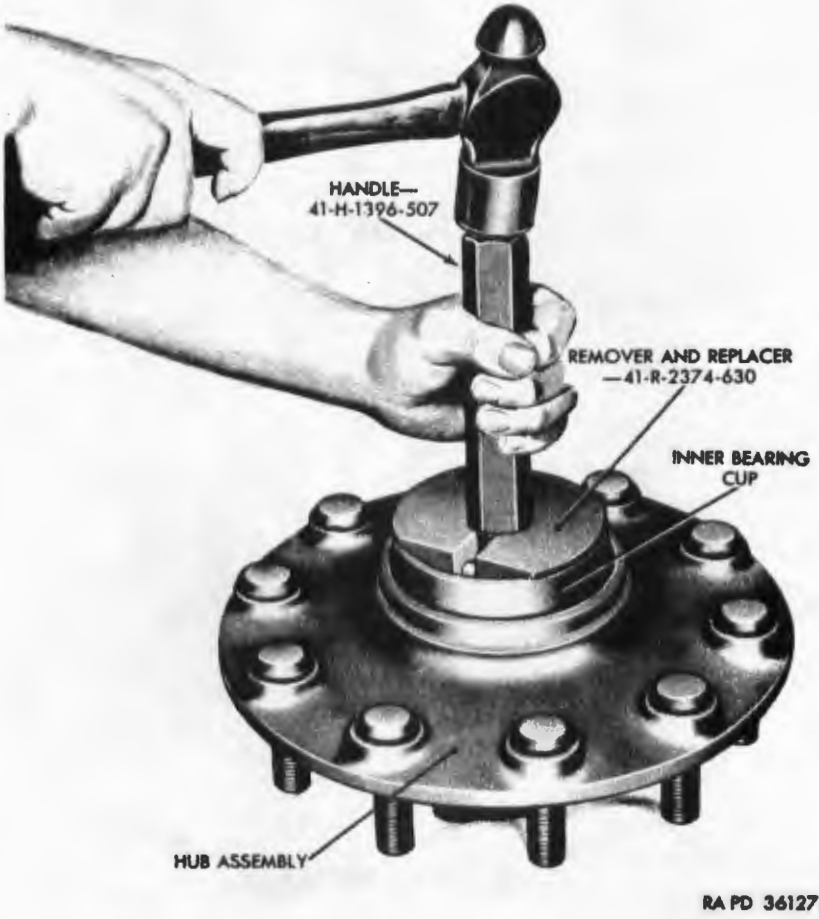


Figure 222. Installing inner bearing cup in hub assembly.

those on new stud and carefully drive stud into hub. Insert inner bearing cone (M) into inner bearing cup (L–4) and press new inner bearing oil seal (N) into hub assembly (L) using replacer 5120–795–0227 (fig. 224).

(2) If inner bearing spacer (P) was removed from supporting arm with shaft and spindle assembly (Q) at disassembly, heat a new spacer in an oil bath and shrink into place on spindle of arm assembly. Carefully slide hub assembly (L) with inner bearing cone (M) and inner bearing oil seal (N) onto spindle and install outer bear-

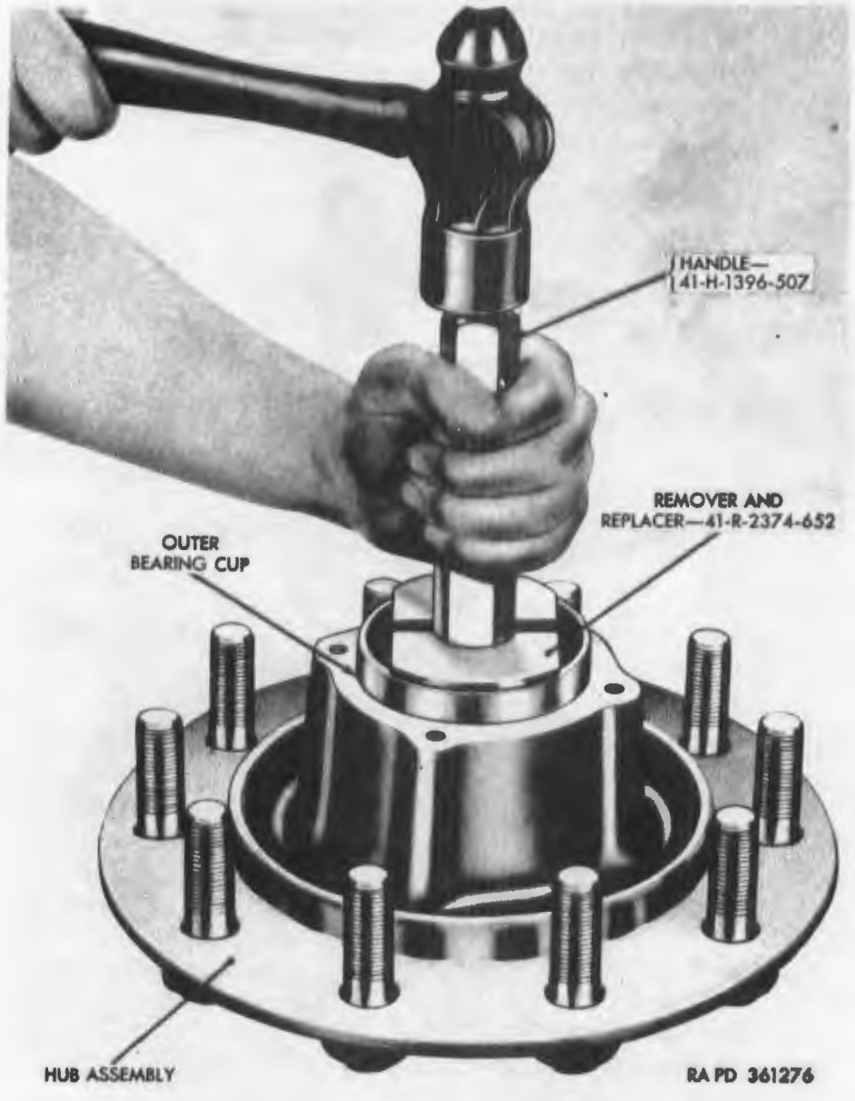


Figure 223. Installing outer bearing cup in hub assembly.

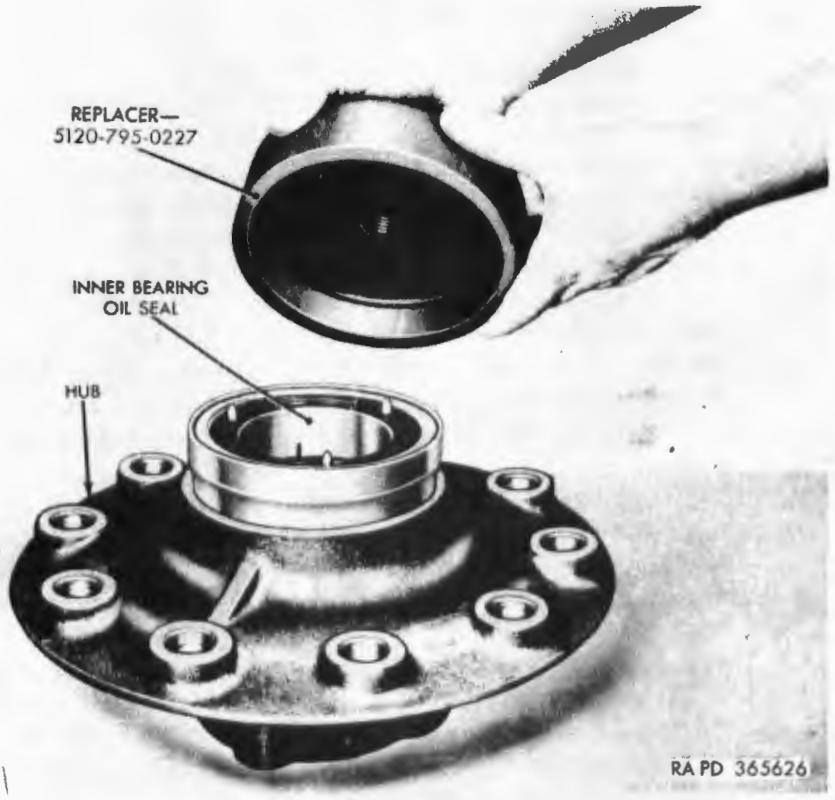


Figure 224. Installing inner bearing oil seal in hub assembly.

ing cone (K), tang washer (J), and 1⅞-inch slotted hex nut (G). Tighten hex nut to 200 pound-feet torque, loosen sufficiently to release all torque, and tighten again to 30 pound-feet torque while rotating hub assembly. Loosen hex nut to first cotter pin hole if required, and secure hex nut with 3/16 x 2¾ split cotter pin (H). Position static grounding spring (E), hub cap gasket (F), and hub cap (D) on hub assembly and secure with four ⅜ x 2 hex-head bolts (A) and ⅜-inch lockwashers (B). Install one ¼-inch pipe plug (C) in hub cap, fill hub assembly with oil as specified on lubrication order LO 9–7218 (par. 90), and install remaining ¼-inch pipe plug in hub cap. Carefully install self-alining bearing assembly (X, fig. 209) into boss on front supporting arm with hub assembly (W, fig. 209) using remover and replacer 41–R–2373–455 and handle 5120–473–7121.

h. Assembly of Supporting Arm With Hub and Support Assembly.

Note. The key letters noted in parentheses are in figure 216, except where otherwise indicated.

(1) Drive bearing oil seal (E–8) into arm support (E–9) using replacer 41–R–2393–650 and handle 5120–473–7121.

(2) Dip leather sealing surface of a new face-type oil seal (E–2) in oil and slide onto shaft of supporting arm with hub assembly (E–1). Install bearing retainer (E–3), retainer gasket (E–4), needle bearing (E–5), bearing spacer (E–6), and remaining needle bearing (E–5) on shaft of arm with hub assembly. Install bearing adjusting nut (E–7) behind outer needle bearing (E–5) and, using wrench 5120–317–8096 (fig. 219), tighten nut to a minimum of 200 pound-feet torque. Stake nut at one place.

(3) Carefully insert shaft of supporting arm with hub assembly (E–1) and attached parts into arm support (E–9). Tap shaft of arm with hub assembly until seated in arm support, being careful not to cut or damage oil seals. Secure bearing retainer (E–3) to arm support with six ½ x 1¼ self-locking hex-head bolts (E–18) tightened to 80 to 90 pound-feet torque. Install two ⅝-inch filler plugs (E–17) in two tapped blind holes (fig. 217) in retainer. Fill arm support of supporting arm with hub and support assembly with oil as specified on lubrication order LO 9–7218 (par. 90) and install two ¼-inch pipe plugs (E–10).

i. Installation.

Note. The key letters noted in parentheses are in figure 216, except where otherwise indicated.

(1) *Front, front intermediate, and rear supporting arm with hub and support assemblies.*

(*a*) Coat mating surfaces of arm support (E–9) and hull with a thin film of gasket cement. Position supporting arm with hub and support assembly on hull, and secure with ten ¾ x 2¾ mounting bolts (fig. 217). Tighten bolts to 300 to 325 pound-feet torque.

(*b*) Install torsion bars (F) and torsion bar anchors (E–11) (par. 223*e*). Attach connecting link assembly (par. 225*g*) to front supporting arm with hub assembly (E–1).

(*c*) Install road wheels (par. 222*e*).

(*d*) Install shock absorber with bearing assemblies (par. 221*f*).

(2) *Intermediate and rear intermediate supporting arm with hub and support assemblies.* Installation of the intermediate and rear intermediate supporting arm with hub and support assemblies (E) are identical with those in (1) above, except that no shock absorber with bearing assemblies are to be installed.

225. Connecting Link Assembly

Note. The key letters noted in parentheses are in figure 209, except where otherwise indicated.

a. Description. The connecting link assemblies (N) transfer vertical movement, which would tend to loosen the track, from the front road wheels to the compensating wheels. As the road wheels swing up to go over an obstacle, the link assembly moves the compensating wheel forward, thus maintaining a constant tension on the track assembly.

b. Removal.

(1) Remove compensating wheel (par. 226*b*).

(2) Remove hub assembly from supporting arm with hub and spindle assembly (R) (par. 227*b*).

(3) Remove one cotter pin (K) slotted hex nut (L), and plain washer (M) from hex-head bolts (U) securing ends of connecting link assembly (N). Thread adapter 5120–322–5954 (fig. 225) into hex-head bolts, attach puller 5120–557–3615 to adapter and pull bolts from link assembly. Remove link assembly.

c. Disassembly. To disassemble connecting link assembly (N) press self-alining bearing assembly (N–2) out of connecting link (N–1) using remover and replacer 41–R–2373–455 and handle 5120–473–7121.

d. Cleaning. Clean connecting link (N–1) and exterior of bearing assembly (N–2) with dry-cleaning solvent or mineral spirits paint thinner.

Caution: Be careful not to wash internal lubricant from bearing assembly.

e. Inspection and Repair.

(1) *Inspection.* Inspect bearing assembly (N–2) for excessive wear, cracks, or other damage which will prevent proper operation. Inspect connecting link (N–1) for cracks, bends, or breaks.

Note. Minor wear or damage to serrations of hex-head bolts (U) or bolt holes will not make the parts unserviceable. Proper tightening of the bolts (*g* below) will compensate for slight wear.

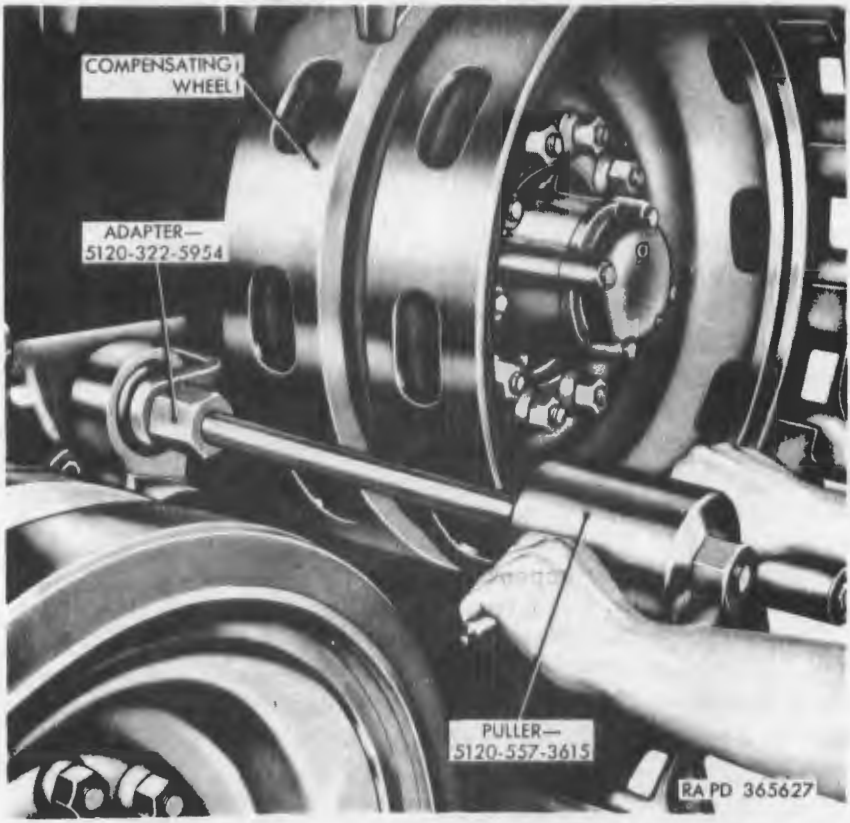


Figure 225. Removing bolt from link of connecting link assembly.

(2) *Repair.* If any of the above defects are found upon inspection, replace the defective part.

f. Assembly. Position self-alining bearing assembly (N–2) on connecting link (N–1) and carefully press into place using remover and replacer 41–R–2373–455 and handle 5120–473–7121.

g. Installation.

(1) Position connecting link assembly (N) between front road wheel supporting arm with hub assembly (W) and compensating wheel supporting arm with hub and spindle assembly (R). Aline serrations and drive two 1 x 4⅛ hex-head bolts (U) into place to secure ends of link assembly. Install one 2-inch plain washer (M) and 1-inch slotted hex nut (L) on each hex-head bolt just installed. Tighten hex nuts (L) to a minimum of 180 pound-feet torque and secure each with one 3/16 x 1¾ split cotter pin (K).

(2) Install hub assembly on compensating wheel supporting arm with hub and spindle assembly (R) (par. 224*g*).

(3) Install compensating wheel (par. 226*e*).

226. Compensating Wheels

Note. The key letters noted in parentheses are in figure 209, except where otherwise indicated.

a. Description. Two compensating wheels (fig. 199), each composed of two compensating wheel disks (S) are mounted at the front of the hull. The compensating wheels provide a means of maintaining track tension. The connecting link assemblies (par. 225*a*) transfer vertical movement, which would tend to loosen the track, from the road wheels to the compensating wheels. There are three types of compensating wheel disks installed on the vehicle by the manufacturers. Early vehicles were assembled with all-metal compensating wheel disks (S). Intermediate vehicles were assembled with road wheel disks (V) having flat-surfaced rubber tires used as compensating wheel disks. Late vehicles were assembled with crown-surfaced rubber-tired compensating wheel disks with tires which taper to a narrower running surface than the intermediate vehicle disks. All three types of compensating wheel disks are interchangeable but they should be replaced in pairs of like disks on each side of the vehicle.

b. Removal.

(1) Loosen but do not remove 10 locknuts (T) securing the compensating wheel to its hub assembly.

(2) Release track tension (par. 220*f*) and disconnect track (par. 220*b*). Using a crowbar, pry track assembly toward the rear of the vehicle until compensating wheels are cleared.

(3) Remove the 10 locknuts (T) loosened in (1) above and lift two compensating wheel disks (S) from hub assembly.

c. Cleaning. Clean compensating wheel disks thoroughly with stiff bristle brush and water. If available, steam may be used to remove accumulations of grease and dirt. Remove adjusting nut and lubricate in accordance with lubrication order LO 9–7218 (par. 90).

d. Inspection and Repair.

(1) *Inspection.* Inspect stud holes in compensating wheel disks for enlarged or elongated stud holes. Check rubber tires for gouges, chips, or separation from disk.

(2) *Repair.* Replace compensating wheel disks if inspection

reveals enlarged or elongated stud holes or if gouges, chips, cuts, or separation extends completely across the tire in any one place.

e. Installation.

(1) Install two compensating wheel disks (S) on each hub assembly and secure each pair of disks with ten ¾-inch locknuts (T). Tighten lock nuts to 250 to 300 pound-feet torque.

(2) Pry track assembly forward over compensating wheels using crowbar. Connect track (par. 220*e*(6)) and adjust track tension (par. 220*f*).

227. Compensating Wheel Hub Assembly

a. Description. Compensating wheel hub assemblies are provided to serve as running gear for the compensating wheels. The hub assemblies are lubricated with oil and are identical with hub assemblies used on road wheel supporting arm with hub assemblies. Maintenance operations and special tools are identical for road and compensating wheel hub assemblies.

b. Removal.

(1) Remove compensating wheel (par. 226*b*).

(2) Remove compensating wheel hub assembly (L, fig. 226) and related parts from compensating wheel supporting arm with hub and spindle assembly (par. 224*d*(1)).

c. Disassembly. Refer to paragraph 224*d* and perform the operations described for the disassembly of road wheel hub assemblies.

d. Cleaning. Clean all parts thoroughly with dry-cleaning solvent or mineral spirits paint thinner and wipe dry. Remove rust spots or minor scratches from machined surfaces by polishing with crocus cloth wet in dry-cleaning solvent or mineral spirits paint thinner and repeat cleaning operations where required.

e. Inspection and repair.

(1) *Inspection.* Examine all parts for scoring. Inspect bearing cups and cones for cracks and indication of brinelling. Inspect forgings for cracks or other indications of potential failure.

(2) *Repair.* All damaged bearing cups or cones must be replaced with new materiel. Parts having cracks, chips, or deep scoring must be replaced if defect affects the operation of the part.

Note. Bearing cone and cup sets should consist of parts from one manufacturer to eliminate the possibility of an early failure due to

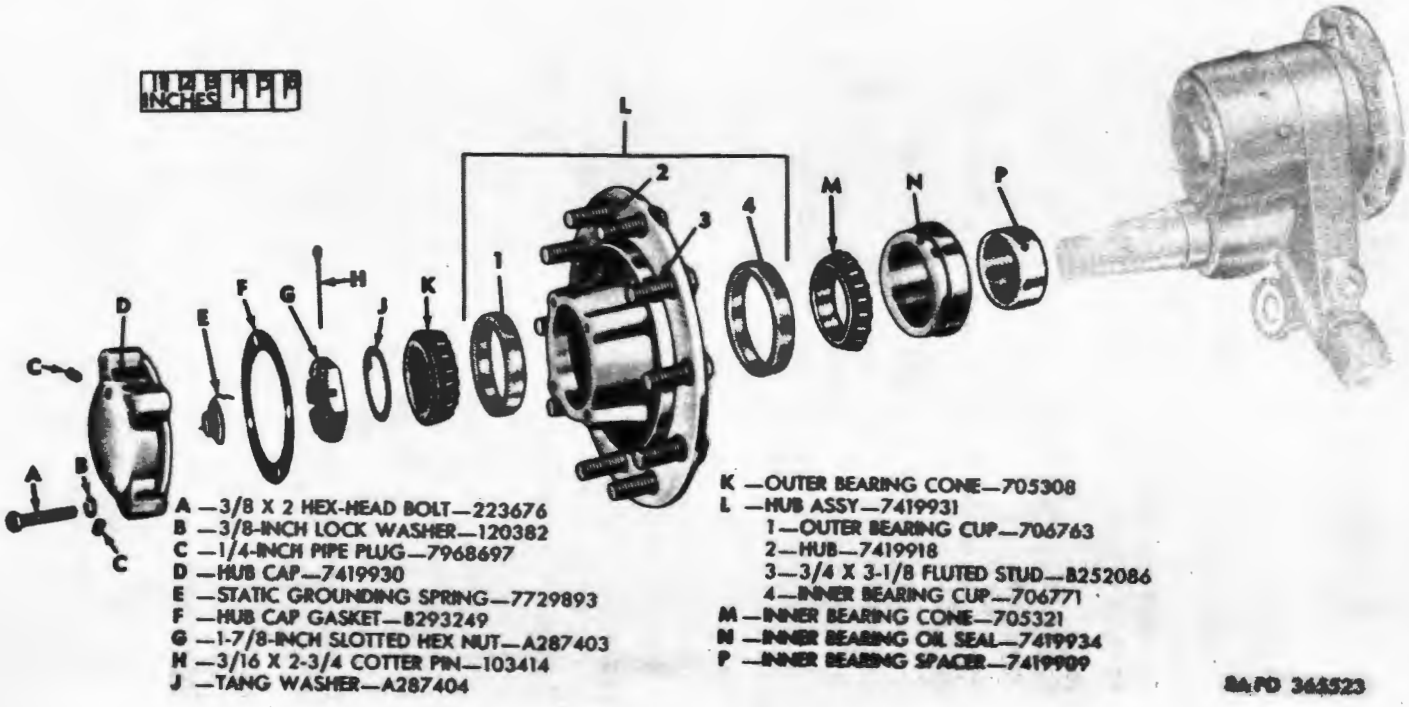


Figure 226. Compensating wheel supporting arm with hub and spindle assembly—exploded view.

any slight differences between bearing cups and cones of different *manufacturers*.

f. Assembly. Refer to paragraph 224*g*(1) and perform the operations described for the assembly of road wheel hub assemblies.

g. Installation.

(1) Install compensating wheel hub assembly (L, fig. 226) and related parts on compensating wheel supporting arm spindle (par. 224*g*(2).

(2) Install compensating wheel (par. 226*e*).

228. Compensating Wheel Supporting Arm With Hub and Spindle Assembly

Note. The key letters noted in parentheses are in figure 227, except where otherwise indicated.

a. Description. Compensating wheel supporting arms with hub and spindle assemblies are provided to furnish adjustable running gear to accommodate the movement of the compensating wheels. Refer to paragraph 226*a* for a description of compensating wheel movement.

b. Removal.

(1) Remove compensating wheel (par. 226*b*).

(2) Remove compensating wheel hub assembly (par. 227*b*).

(3) Disconnect end of connecting link assembly nearest compensating wheel hub assembly (par. 225*b*(3)).

(4) Remove eight hex-head bolts (P) and lockwashers (N) and remove compensating wheel supporting arm with attached parts from hull of vehicle.

c. Disassembly.

(1) Remove six hex-head bolts (Z) and lockwashers (Y) and remove supporting arm cover (A) and supporting arm cover gasket (B) and allow oil to drain from supporting arm (X–2) into suitable container of at least 1-pint capacity.

(2) Remove outer bearing snap ring (C) and press supporting arm spindle (M) out of supporting arm with bearing and spindle assembly (X).

(3) Remove four hex-head bolts (H) and lockwashers (J) and remove inner bearing oil seal dust shield (K) and face-type oil seal (L). Discard oil seal if worn or damaged.

(4) Remove hex-head clamping bolt (S), lockwasher (R),

Figure 227. Compensating wheel supporting arms and supporting arm spindle—exploded view.

and eye bolt nut stop (Q) from adjustable supporting arm (G).

(5) Remove adjusting nut (U) and eye bolt nut seat (V) and slide adjustable supporting arm (G) and adjusting arm eye bolt (W) from supporting arm with bearing and spindle assembly (X). Pull eye bolt from supporting arm and remove lubrication fitting (F) from eye bolt. If expansion plug (T) is loose in adjusting nut (U), remove and discard plug.

(6) Remove outer ball bearing (D) and two pipe plugs (E) from supporting arm with bearing and spindle assembly (X).

(7) Inspect supporting arm with bearing and spindle assembly (X). If hub spindle (X–1) is bent, cracked, or broken, or if supporting arm shows signs of excessive wear, replace supporting arm with bearing and spindle assembly as an assembly. When bushing-type split bearing (X–3) must be replaced, press from supporting arm (X–2) using an arbor press. Do not attempt to remove hub spindle (X–1) from supporting arm.

d. Cleaning. Thoroughly clean compensating wheel supporting arm, supporting arm spindle, and related parts with dry-cleaning solvent or mineral spirits paint thinner. Steam may be used, if available, to remove accumulations of grease and dirt on supporting arms.

e. Inspection and Repair.

(1) *Inspection.* Inspect bearings for evidence of pitting, scoring, or other indications of wear. Inspect spindles for cracks, scoring, and straightness. Inspect threaded parts for stripped or damaged threads.

(2) *Repair.* Replace damaged bearings and attaching parts having damaged threads. Repair large parts having damaged threads with either a used tap of the proper size or a thread chaser. Replace supporting arm with spindle assembly if spindle is cracked, bent, or broken. Repair superficial scoring on otherwise serviceable machined facings by polishing with crocus cloth wet in mineral spirits paint thinner.

f. Assembly.

(1) Install inner bearing oil seal dust shield (K) and secure to supporting arm spindle (M) with four $\frac{3}{8}$ x $2\frac{1}{4}$ hex-head bolts (H) and $\frac{3}{8}$-inch lockwashers (J). Dip leather surfaces of 5.500-inch OD face-type oil seal (L) in oil and slide seal onto supporting arm spindle (M).

(2) If replacement of 4.007-inch OD bushing-type split bearing (X–3) is necessary assemble it into supporting arm with bearing and spindle assembly (X) with an arbor press. Machine to size as specified in repair and rebuild standards (par. 231). Install inner bearing sealing ring (X–4).

(3) Install ⅛-inch lubrication fitting (F) in 1¼-inch adjusting arm eye bolt (W) and coat threads of eye bolt with automotive and artillery grease (GAA). Install eye bolt in adjustable supporting arm (G) and install bolt and arm simultaneously on supporting arm with bearing and spindle assembly (X). If removed, install 1½-inch OD expansion plug (T) in end of adjusting nut (U) and stake plug in place. Coat threads of 1¼-inch adjusting nut (U) with grease (GAA) and install with eye bolt nut seat (V) on eye bolt (W).

(4) Install supporting arm with bearing and spindle assembly (X) with attached adjustable supporting arm (G) on supporting arm spindle (M).

(5) Install 4.3307-inch OD outer ball bearing (D) on supporting arm spindle (M). Secure bearing by installing outer bearing snap ring (C).

(6) Apply a light coating of gasket cement to both sides of a new supporting arm cover gasket (B) and install gasket and supporting arm cover (A). Secure cover and gasket with six ⅜ x 2¼ hex-head bolts (Z) and ⅜-inch lockwashers (Y).

(7) Install eye bolt nut stop (Q), ¾-inch lockwasher (N), and ¾ x 10 hex-head clamping bolt (S) in adjustable supporting arm (G) and tighten securely.

(8) Lubricate all parts in accordance with lubrication order LO 9–7218 (par. 90).

g. Installation.

(1) Position compensating wheel supporting arm with attached parts on hull of vehicle and secure with eight ¾ x 1⅞ hex-head bolts (P) and ¾-inch lockwashers (N). Tighten bolts to 300 to 325 pound-feet torque.

(2) Connect end of connecting link assembly (N, fig. 209) to adjustable supporting arm (par. 225*g*).

(3) Install compensating wheel hub assembly (par. 227*g*).

(4) Install compensating wheel (par. 226*e*).

229. Track Support Roller Assemblies

Note. The key letters noted in parentheses are in figure 228, except where otherwise indicated.

a. Description. Three track support roller assemblies (fig. 199) are used on each side of the vehicle to support the track assembly between the drive sprocket and the compensating wheel. Track support roller assemblies have two different disk and tire combinations. One disk has a flat-shaped tire and the other has a crown-shaped tire. Both types are interchangeable in pairs of the same type.

b. Removal.

(1) Remove or fold up fender skirts if provided on vehicle (par. 235).

(2) Release track tension (par. 220*f*) and disconnect track assembly (par. 220*b*(1)). Using crowbars, pry track toward the rear of the vehicle until the track roller assembly requiring service has been cleared.

(3) Loosen the six hex-head bolts (T) securing the track support roller assembly to the hull of the vehicle. Remove the lower bolts first, then support the roller assembly, remove the upper bolts, and remove the roller assembly from the vehicle.

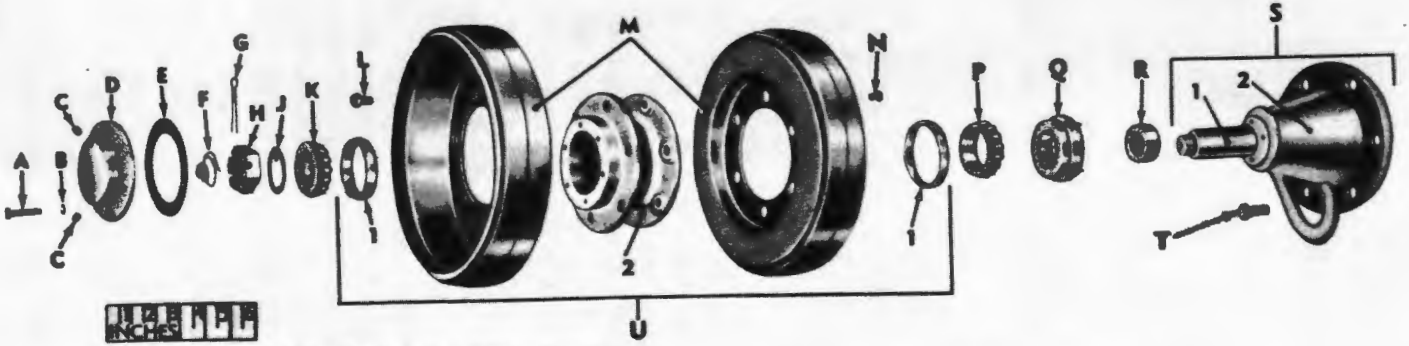
c. Disassembly.

(1) Place suitable container of at least 1-pint capacity beneath hub cap (D). Remove six socket-head cap screws (A), lockwashers (B), hub cap (D), gasket (E), and static grounding spring (F). Drain oil into container and discard oil. Remove two pipe plugs (C) from hub cap.

(2) Remove cotter pin (G), slotted hex nut (H), and tang washer (J), and then pull bearing cone (P) and hub with cup assembly (U) from bracket spindle (S–1) of bracket with spindle assembly (S). Remove bearing cone (K) from outer of hub with cup assembly (U).

(3) Remove six hex-head bolts (L) and six hex-head bolts (N) and remove two disks and tires (M) from hub with cup assembly (U).

(4) Inspect face-type oil seal (Q) in rear of hub with cup assembly (U) for indications of oil leakage. Do not remove oil seal (Q) or bearing cone (P) unless inspection reveals oil seal to be defective. To remove oil seal (Q) and inner bearing cone (P), drive oil seal from hub with



A —NO 10 X 5/8 SOCKET-HEAD CAP SCREW—583894
B —NO 10 LOCK WASHER—131183
C —1/4-INCH PIPE PLUG—7968697
D —HUB CAP—7419901
E —4-INCH OD GASKET—7419073
F —STATIC GROUNDING SPRING—7729892
G —3/16 X 2 COTTER PIN—103411
H —1-3/8-INCH SLOTTED HEX NUT—7764229
J —2-1/4-INCH TANG WASHER—7983089
K —BEARING CONE—705464
L —7/16 X 13/16 HEX-HEAD BOLT A287381
M —DISK AND TIRE
FLAT TYPE—C136637 (SHOWN)
CROWNED TYPE—8674928

N —7/16 X 13/16 HEX-HEAD BOLT—A287381
P —BEARING CONE—705464
Q —3.758-INCH OD FACE-TYPE OIL SEAL—7419935
R —BEARING SPACER—7419900
S —BRACKET WITH SPINDLE ASSY—7419906
1—BRACKET SPINDLE—7983088
2—BRACKET—7419904
T —3/4 X 1-1/2 SELF-LOCKING HEX-HEAD BOLT—214257
U —HUB WITH CUP ASSY—7419905
1—BEARING CUP—706863
2—HUB—7419903

RA PD 365532

Figure 228. Track support roller assembly—exploded view.

cup assembly (U) and lift out bearing cone. Discard oil seal if damaged by removal.

(5) Remove bearing spacer (R) from spindle of bracket with spindle assembly (S). Do not attempt to disassemble bracket with spindle assembly, replace as a unit if unserviceable.

(6) Disassemble hub with cup assembly (U) by removing two bearing cups (U–1) from hub (U–2) using remover and replacer 41–R–2374–620 and handle 41–H–1396–507.

d. Cleaning. Clean disks and tires (M) with stiff-bristle brush and water. All other parts must be thoroughly cleaned with dry-cleaning solvent or mineral spirits paint thinner and wiped dry. If available, steam may be used to remove accumulations of grease and dirt.

e. Inspection and Repair.

(1) *Inspection.* Check disks and tires (M) for gouges, chips, cuts, or disk and tire separation. Examine all machined surfaces for wear or scoring. Inspect bearing cups, cones, and spindle for cracks, scoring, or wear. Inspect all parts for cracks or other indications of failure.

(2) *Repair.* Replace disk and tire (M) if there is extensive evidence of disk and tire separation or damage. Damaged bearing cones, bearing cups, and parts having cracks or deep scoring must be replaced. Replace bearing cups and cones in sets from one manufacturer to eliminate possibility of early failure due to slight differences in bearing cups and cones of different manufacturers.

f. Assembly.

(1) Assemble hub with cup assembly (U) by installing two bearing cups (U–1) in hub (U–2) using remover and replacer 41–R–2374–620 and handle 41–H–1396–507.

(2) Install inner bearing cone (P) in rear of bearing cup (U–1) of hub with cup assembly (U). Coat a new 3.758-inch OD face-type oil seal (Q) with gasket cement and press into rear of hub with cup assembly using a wooden block and an arbor press.

(3) Position one disk and tire (M) on each side of hub with cup assembly (U) and secure rear disk with six $\frac{7}{16}$ x $1\frac{3}{16}$ hex-head bolts (N) and front disk with six $\frac{7}{16}$ x $1\frac{3}{16}$ hex-head bolts (L). Tighten bolts to 55 to 60 pound-feet torque.

(4) Install bearing spacer (R) on bracket spindle (S–1) of bracket with spindle assembly (S) and carefully slide

hub with cup assembly (U) over spindle and bearing spacer, being careful not to damage oil seal (Q). Install outer bearing cone (K), 2¼-inch tang washer (J), and 1⅜-inch slotted hex nut (H). Tighten hex nut to 150 pound-feet torque, back off nut, then tighten nut again to 30-pound-feet torque while rotating hub assembly. If hole in spindle and slot in hex nut are not alined, back off nut until hole and slot are alined and install 5/16 x 2 cotter pin (G).

(5) Install static grounding spring (F), new 4-inch OD gasket (E), and hub cap (D) and secure with six No. 10 x ⅝ socket-head cap screws (A) and No. 10 lockwashers (B).

(6) Fill track support roller assembly with oil as specified in lubrication order LO 9–7218 (par. 90) and install two ¼-inch pipe plugs (C) in hub cap (D).

g. Installation.

(1) Position track support roller assembly on vehicle hull and secure with six ¾ x 1½ self-locking hex-head bolts (T). Tighten bolts to 300 to 325 pound-feet torque.

(2) Pry track assembly forward over track support roller assemblies and compensating wheel, connect track (par. 220*e*(6)), and adjust track tension (par. 220*f*).

(3) Install or fold down fender skirts (par. 235) if provided on vehicle.

230. Bumper Stop Springs

Note. The key letters noted in parentheses are in figure 209, except where otherwise indicated.

a. Description. Bumper stop springs (F) cushion and stop travel of the road wheel supporting arms, prevent shock absorbers from bottoming, and keep torsion bars from being overstressed when vehicle runs over large obstacles.

b. Removal. Remove hex-head bolt (H) and lockwasher (J) and remove bumper stop spring (F) from bumper stop spring support (G).

c. Cleaning. Clean bumper stop spring supports (G) and bumper stop springs (F) with dry-cleaning solvent or mineral spirits paint thinner. Steam may be used, if available, to remove accumulations of grease and dirt.

d. Inspection and repair. Inspect bumper stop springs (F) for cracks, breakage, or other indications of potential failure. Replace if defective.

e. Installation. Position bumper stop spring against bottom of bumper stop spring support (G) and secure with 5/8 x 1½ hex-head bolt (H) and 5/8-inch lockwasher (J). Tighten bolts to 160 to 170 pound-feet torque.

231. Repair and Rebuild Standards

a. General. The repair and rebuild standards included herein give the minimum, maximum, and key clearances of new or rebuilt parts. They also give wear limits which indicate that point to which a part may be worn before replacement, to give maximum service with minimum replacement. Normally, all parts which have not been worn beyond the dimensions shown in the wear limits column, or damaged, will be approved for service. An asterisk in the wear limits column indicates that the parts or part should be replaced when worn beyond the limits given in the "Sizes and Fits of New Parts" column. In the sizes and fits of new parts column a letter L indicates a loose fit (clearance) and a letter T indicates a tight fit (interference).

b. Road Wheel Supporting Arm With Hub and Support Assembly and Related Parts.

Fig. No.	Ref letter	Point of measurement	Sizes and fits of new parts	Wear limits
229	D	Inside diameter of seal	Must not leak	(*)
	E	Length of spacer (faces must be smooth and parallel).	3.811 to 3.813	
	F	Outside diameter of nut	3.750 to 3.755	
	G	Inside diameter of seal	Must not leak	(*)
	J	Inside diameter of support	5.1254 to 5.1274	
	K	Outside diameter of bearing	5.124 to 5.125	
	K–J	Fit in support	0.0034L to 0.0004T	

c. Hub Assembly and Related Parts.

Fig. No.	Ref letter	Point of measurement	Sizes and fits of new parts	Wear limits
230	C	Inner bearing oil seal	Must not leak	(*)

d. Bumper Stop Spring, Connecting Link Assembly and Related Parts.

Fig. No.	Ref letter	Point of measurement	Sizes and fits of new parts	Wear limits
231	D	Hole in clevis of link assembly	1.1245 to 1.1255	1.250
	H	Hole in adjustable supporting arm.	1.1245 to 1.1255	1.250
	G	Shank diameter of bolt	1.1225 to 1.1235	1.062
	J	Shank diameter of bolt	1.1225 to 1.1235	1.062
	J–D	Fit of bolt shank to link assembly.	0.003L to 0.001L	
	G–H	Fit of bolt shank to adjustable supporting arm.	0.003L to 0.001L	

Figure 229. Repair and rebuild standard points of measurement and torque specifications for road wheel supporting arm with hub and support assembly and related parts.

RA PD 365534

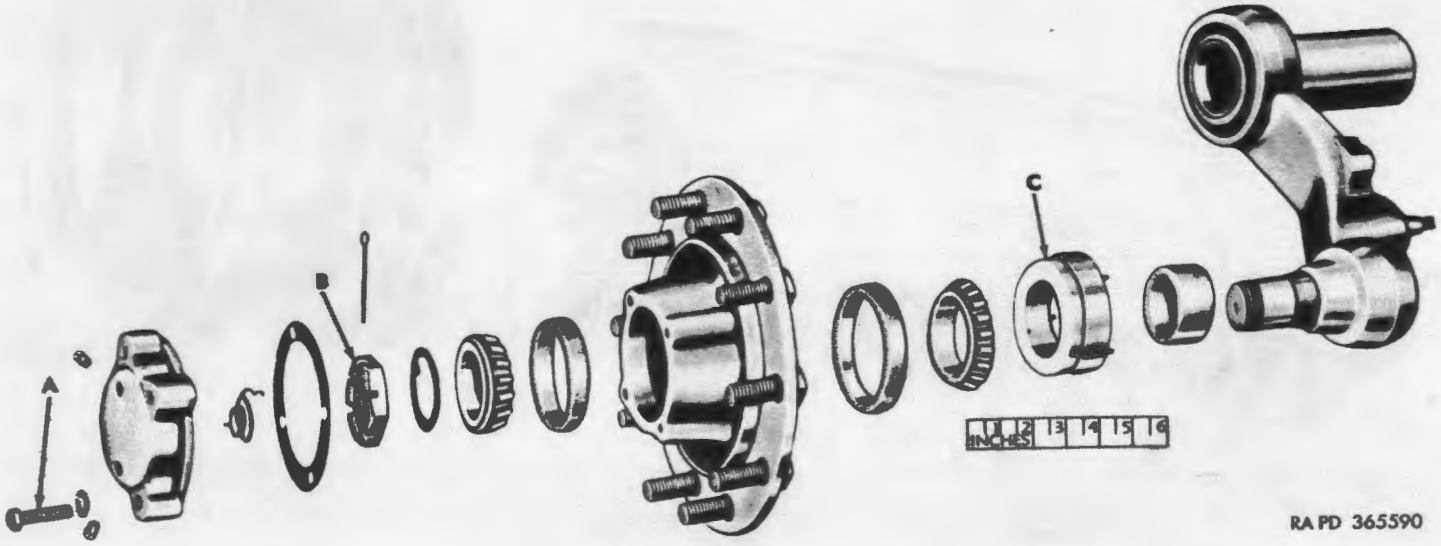


Figure 230. Repair and rebuild standard points of measurement and torque specifications for supporting arm with hub assembly and related parts.

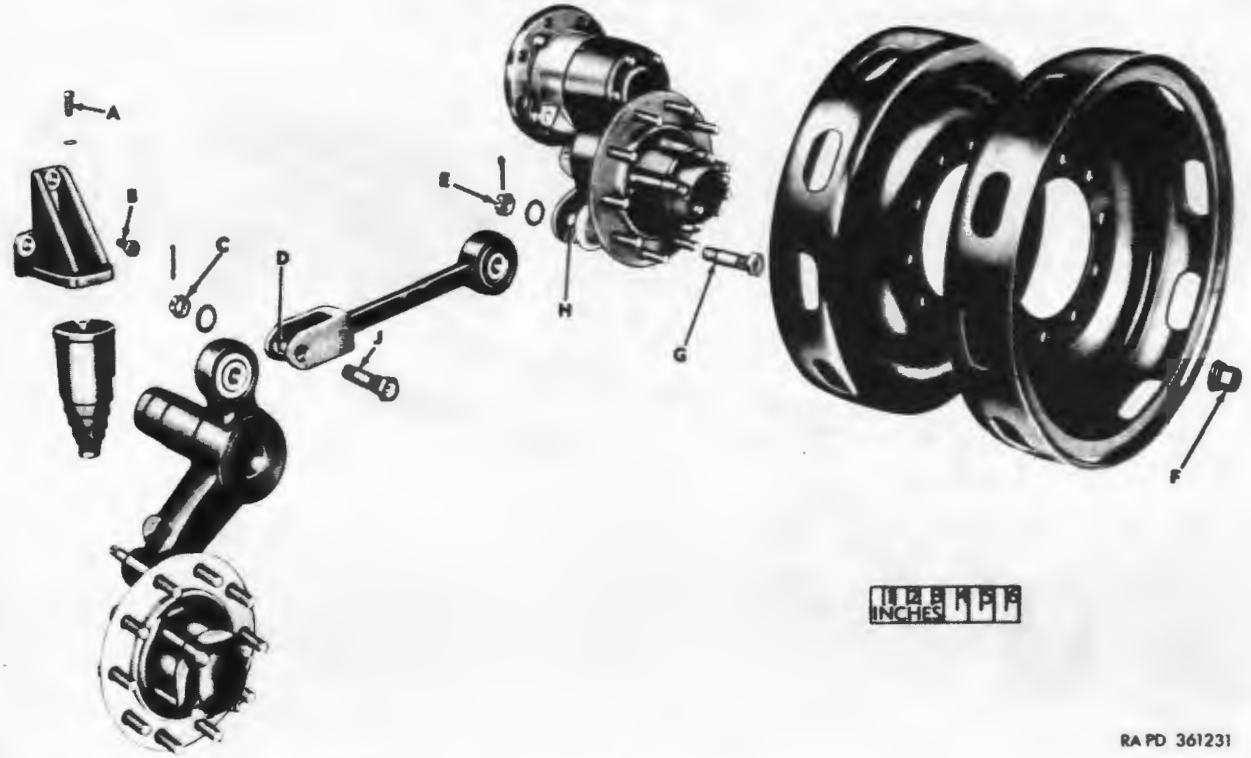


Figure 231. Repair and rebuild standard points of measurement and torque specifications for bumper stop spring, connecting link assembly and related parts.

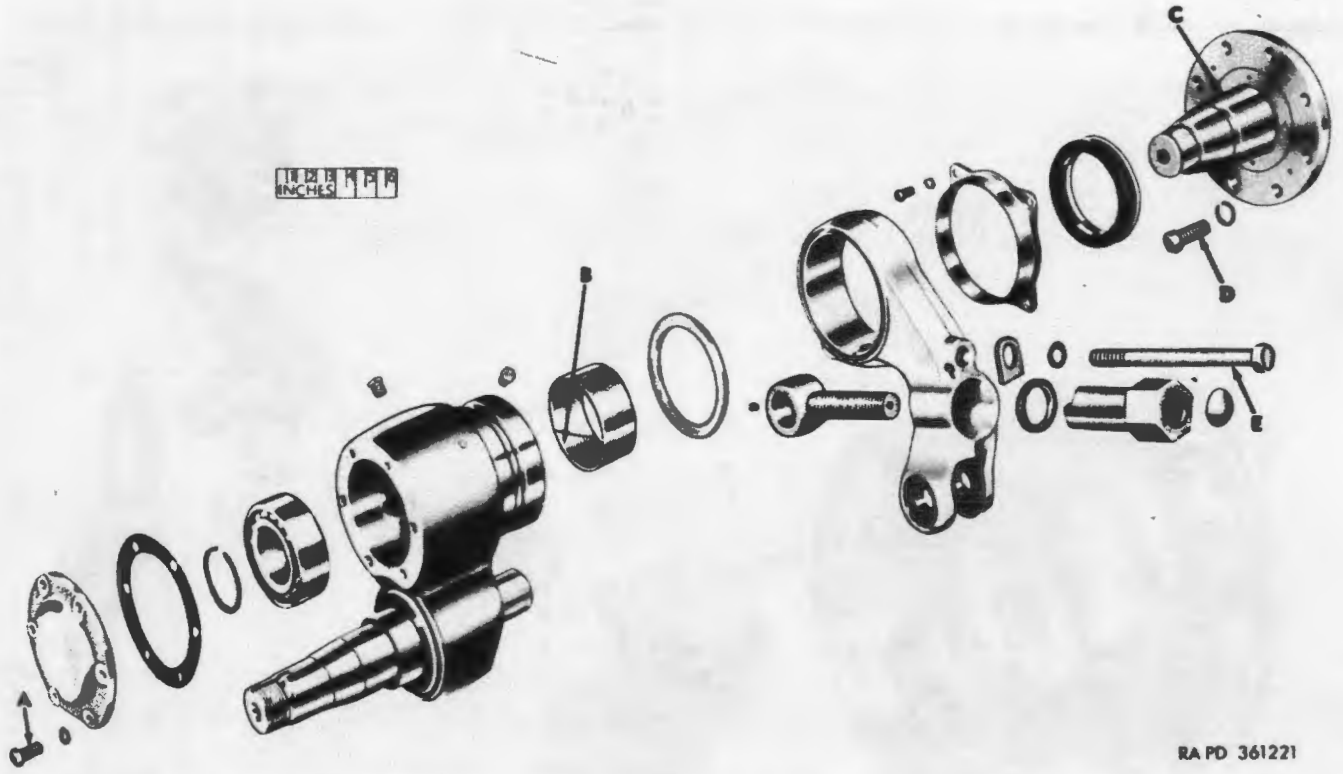


Figure 232. Repair and rebuild standard points of measurement and torque specifications for compensating wheel supporting arms and supporting arm spindle.

e. Compensating Wheel Supporting Arms and Supporting Arm Spindles.

Fig. No.	Ref letter	Point of measurement	Sizes and fits of new parts	Wear limits
232	B	Inside diameter of split bearing (installed).	3.813 to 3.815	
	C	Outside diameter of spindle	3.809 to 3.810	
	B–C	Fit on spindle	0.006L to 0.008L	

f. Track Support Roller Assemblies.

Fig. No.	Ref letter	Point of measurement	Sizes and fits of new parts	Wear limits
233	D	Face-type oil seal	Must not leak	(*)

g. Suspension Torque Wrench Specifications.

Fig No.	Ref letter	Location	Torque (lb-ft)
229	A	Locking nuts, road wheel disk to hub assembly	250 to 300
229	B	Bolt, hex socket nut to torsion bar	60 to 75
229	C	Hex-socket nut	50 to 75
229	F	Bearing adjusting nut	200 min
229	H	Bolt, arm support to hull	300 to 325
229	L	Bolt, bearing retainer to arm support	80 to 90
230	B	Nut, hub attaching	200-release–30
230	A	Bolt, hub cap to hub	35 to 40
231	A	Bolt, bumper support to bumper spring	160 to 170
231	B	Bolt, bumper support to vehicle	300 to 325
231	C	Nut, connecting link assembly	180 min
231	E	Nut, connecting link assembly	180 min
231	F	Nut, compensating wheel to hub assembly	250 to 300
232	A	Bolt, supporting arm cover to supporting arm	35 to 40
232	D	Bolt, supporting arm spindle to hull	300 to 325
232	E	Bolt, clamping	150 to 175
233	A	Bolt, hub cap to hub	4 to 6
233	B	Nut, hub attaching	150-release–30
233	C	Bolt, disk and tire to hub	55 to 60
233	E	Bolt, track support roller assembly to hull	300 to 325

Section XVIII. HULL

232. Description

a. General. The hull is constructed of welded armor steel plates, castings, and forgings. The hull front consists of two plates welded to form ballistically protective angles. The driving comparment top plate extends backward to the gun platform stationary shield. The upper front hull plate contains the front door (fig. 5) which serves as the entrance to the driving compartment and hull ammunition stowage compartments. The driving compartment roof has two hatch doors (fig. 7), one for the driver and one for the commander. On early vehicles, the driving compartment roof between the hatch doors is made in two hinged sections of armor plate which, when open, permit ammunition to be lifted directly out of

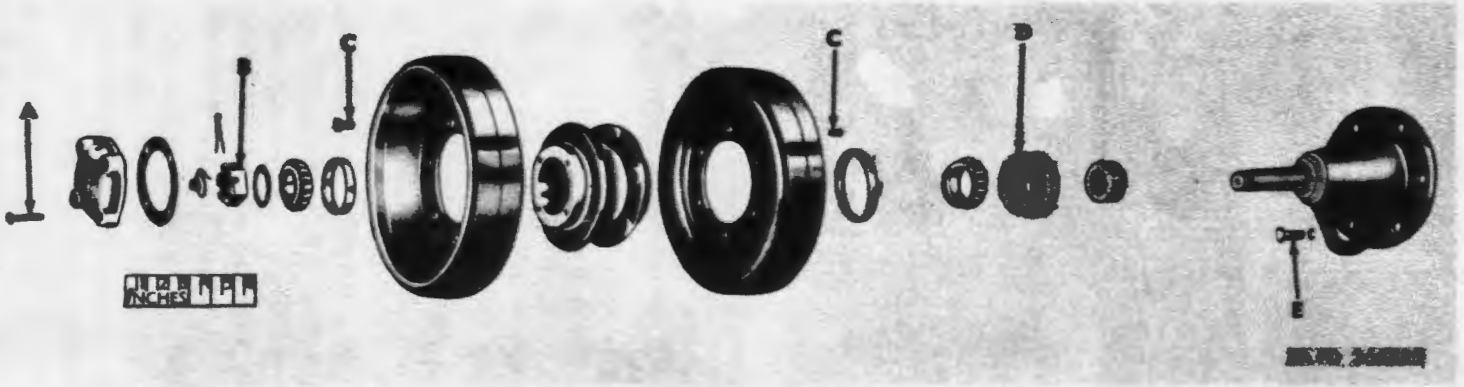


Figure 233. Repair and rebuild standard points of measurement and torque specifications for track support roller assembly.

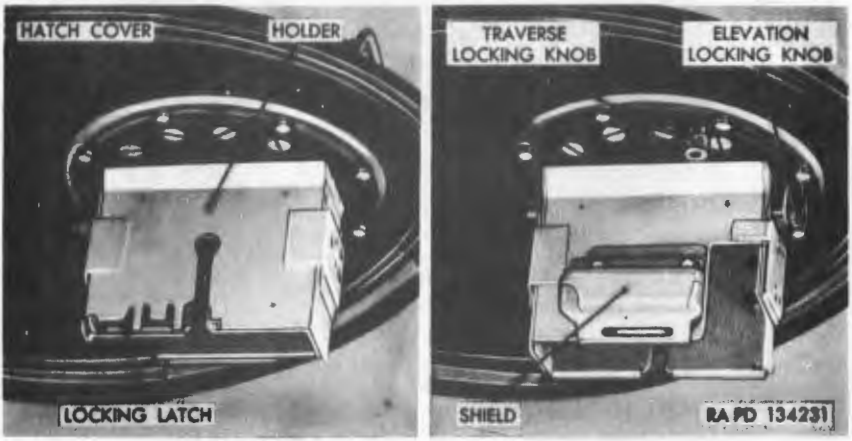


Figure 234. Periscope holder, front and rear view.

the hull. On late vehicles, the roof plate is welded to the hull. A periscope holder (fig. 234) is provided in both the commander's and driver's hatch covers. Each periscope holder can be traversed 360° and elevated or depressed 25°. Traverse and elevation locking knobs (fig. 234) are provided to secure the periscope holder in the desired position. The rear of the hull is a welded unit up to the engine compartment access doors and grilles. The top of the engine compartment is constructed of removable grilles, hinged grille doors, battery access doors, transmission access doors, and supports (fig. 236).

b. Miscellaneous Components. Welded in position between the ammunition stowage compartment and the engine compartment is a fire and water bulkhead. A small door in the center of the bulkhead is used for inspection and maintenance purposes. Four drain valves (fig. 245) are provided in the hull, one in the driver's compartment, one at the rear of the ammunition stowage compartment, and two in the engine compartment.

Note. Early vehicles have only one drain valve in the engine compartment.

These drain valves provide quick drainage of water, oil, or fuel which may collect in the various compartments. Four removable drain hole covers (fig. 246) are attached to the bottom of the hull and provide access to the main engine, transmission, and fuel tank drain plugs. The auxiliary generator and engine drain hole cover (fig. 199) is located directly forward of the right rear arm support. Two towing hooks (fig. 235) on the front and two on the rear of the hull provide a means of attaching towing cables or a tow bar. A towing pintle (fig. 235) is provided for towing a trailer. The towing pintle should never be used for towing a similar or heavier

vehicle. Four lifting eyes are provided to lift the vehicle. Fender supports are bolted to the hull side plates to support fenders, equipment stowage boxes, and mufflers.

Note. Early vehicles were provided with fender skirts.

Mounted above the left fenders are the spare 40-mm gun barrel racks; the corresponding space on the right side of the vehicle is occupied by three stowage boxes. Secured above the side-opening stowage boxes on the right and spare 40-mm gun barrel racks on the left are 40-mm ammunition stowage boxes (fig. 244). A towing cable (fig. 244) is secured on the right side of the vehicle.

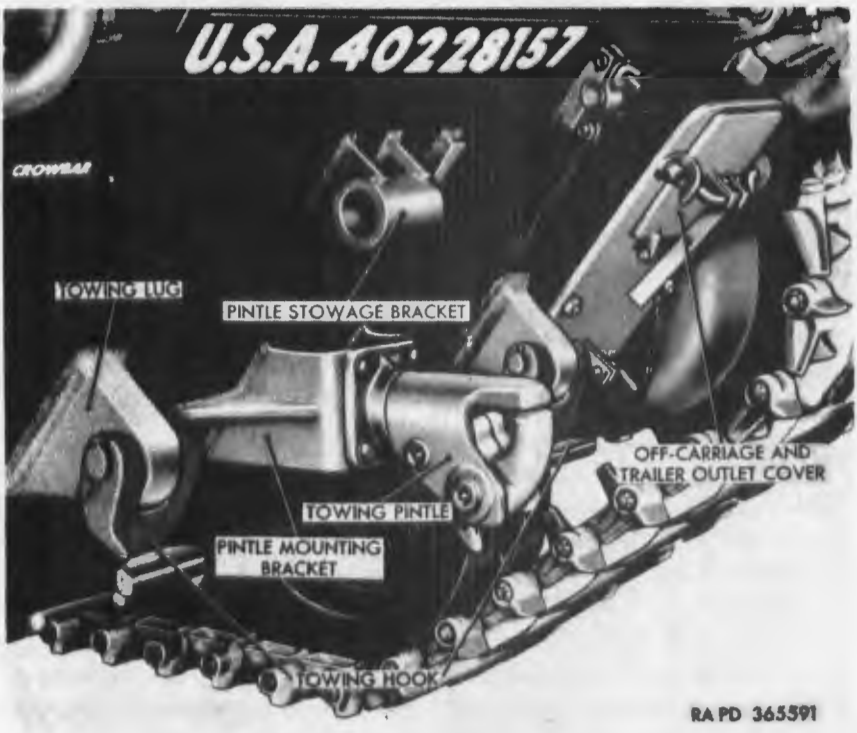


Figure 235. Towing Pintle.

233. Front and Rear Roof Doors

a. General. Front and rear roof doors are installed over the driving compartment on vehicles through Ordnance serial No. 1138. Vehicles with Ordnance serial No. 1139 and up have a welded One piece roof on the driving compartment between the driver's and comander's hatch doors.

b. Removal. Remove two hinge pins, flat washers, and cotter pins from each door and remove doors.

c. Installation. Position front and rear roof doors on the driving compartment roof plate and secure each with two hinge pins, 9/16-inch flat washers, and 1/8 x 7/8 cotter pins.

234. Engine Compartment Grilles and Doors

a. Grilles and Grille Doors (fig. 236).

(1) *Removal.*

(*a*) *Grilles.* Remove two hex-head bolts and lockwashers from each of the five engine compartment grilles and remove grilles by means of attached grips.

(*b*) *Grille Doors.* Remove hinge pin, washer, and cotter pin from outer end of each of the six engine compartment grille doors. Remove doors by means of attached grips.

(2) *Installation.*

(*a*) *Grilles.* Position five engine compartment grilles on the grille door supports and secure each with two 5/8 x 1 1/2 hex-head bolts and 5/8-inch lockwashers.

(*b*) *Grille doors.* Position six engine compartment grille doors, three on each side, on the vehicle. Secure each with a 0.630 x 4 3/16 hinge pin, 1 1/16-inch flat washer, and 1/8 x 1 cotter pin.

b. Access Doors (fig. 236).

(1) *Removal.*

Note. The two transmission access doors and four battery access doors are retained by two lock handles and must be opened in sequence.

(*a*) *Transmission access doors.* Remove two lock handles and two clevis pins, flat washers, and cotter pins from each transmission access door. Secure a rope sling to the attached grips and lift each door off vehicle.

Note. Remove front door first.

(*b*) *Battery access doors.* Remove two hinge pins, washers, and cotter pins from each battery access door, and remove doors from vehicle.

Note. Remove front door first.

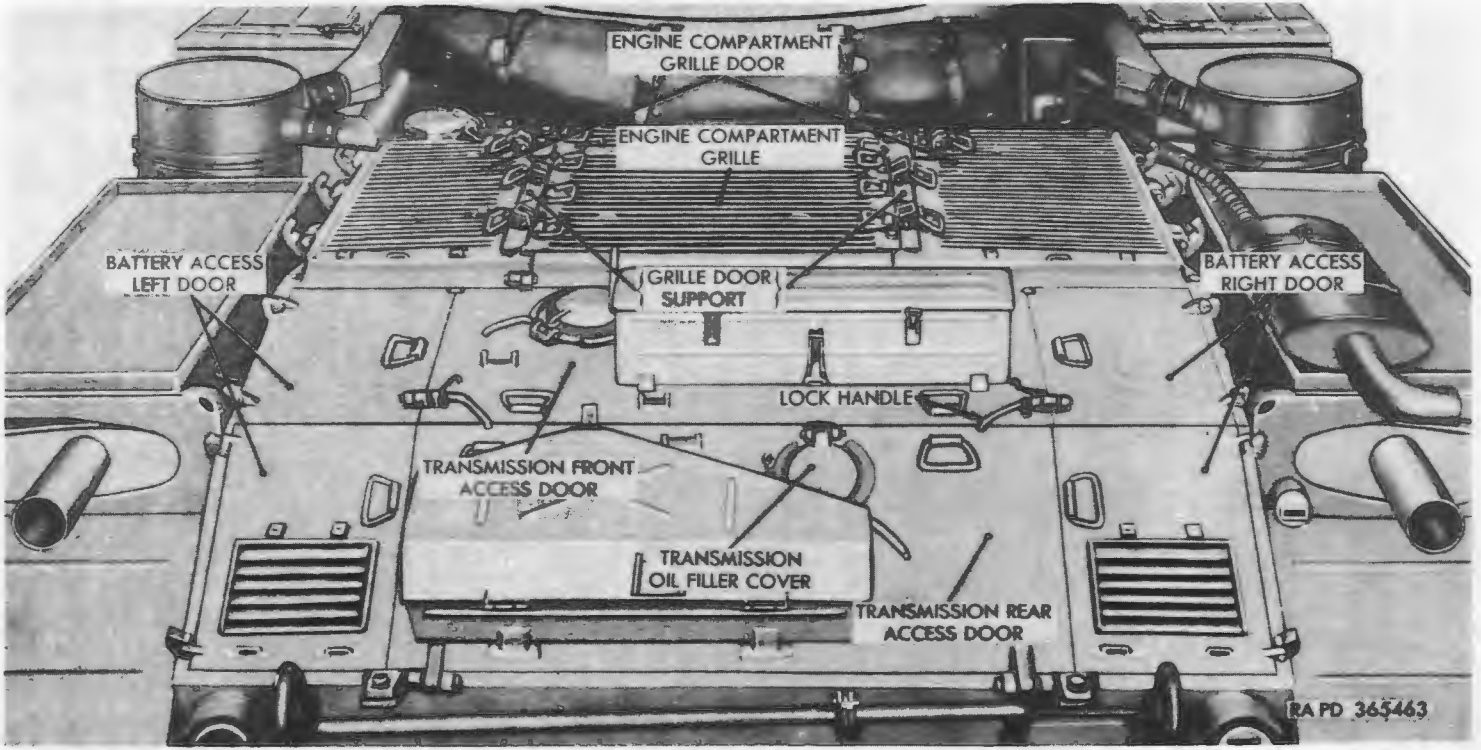


Figure 236. Engine compartment grilles and access doors.

(2) *Installation.*

(*a*) *Battery access doors.* Position battery access rear doors on vehicle; then battery access front doors. Secure each with two 0.375 x 1 25/32 hinge pins, 1 3/32-inch flat washers, and 3/32 x 5/8 cotter pins.

(*b*) *Transmission access doors.* Using a rope sling, position transmission rear access door on the vehicle; then position the transmission front access door. Secure each door with two 0.630 x 2 5/8 clevis pins, 1 7/32-inch flat washers, and 1/8 x 1 cotter pins. Secure all access doors by installing two lock handles on transmission front access door.

c. Supporting Beam, Grille Door Supports, and Access Door Supports.

(1) *General.* The engine compartment grille doors, grilles, and transmission and battery access doors are supported over the engine compartment by the supporting beam, grille doors supports, and access door supports. The supporting beam (fig. 237) crosses laterally over the engine compartment and is mounted on the hull side plates above the exhaust stack supports. The grille doors supports (fig. 236) are secured to the supporting beam assembly and to the top of the engine compartment bulkhead. The access door supports (fig. 237) are secured to the supporting beam and to the hull rear plate. The supporting beam may be removed with the grille door and access door supports attached or each part may be removed separately. Remove supporting beam, supports, grilles, and transmission front access door as an assembled unit whenever power plant is to be removed and if adequate lifting equipment is available.

(2) *Removal and installation of supporting beam with grille door supports, access door supports, grilles, and transmission front access door.*

(*a*) *Removal.* Open six engine compartment grille doors, four battery access doors, and transmission rear access door. Remove six hex-head bolts and lockwashers, two located on the front end of engine compartment grille door supports (fig. 236), two on the supporting beam (fig. 237), and two securing the access door supports (fig. 237) to the rear hull plate. Attach hoist and lift from vehicle as an assembled unit (fig. 238).

(*b*) *Installation.* Position the supporting beam grille door supports, access door supports, grilles, and transmis-

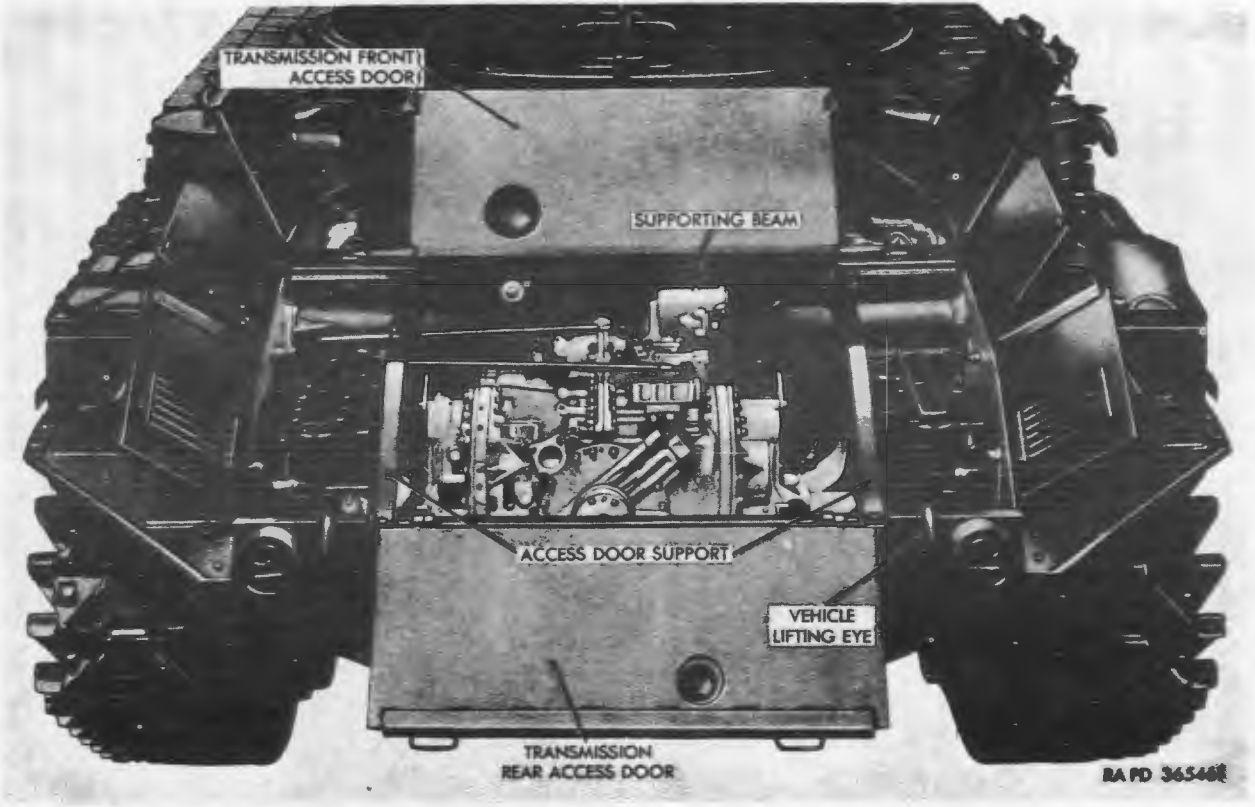


Figure 237. Engine compartment—grille and access doors open.

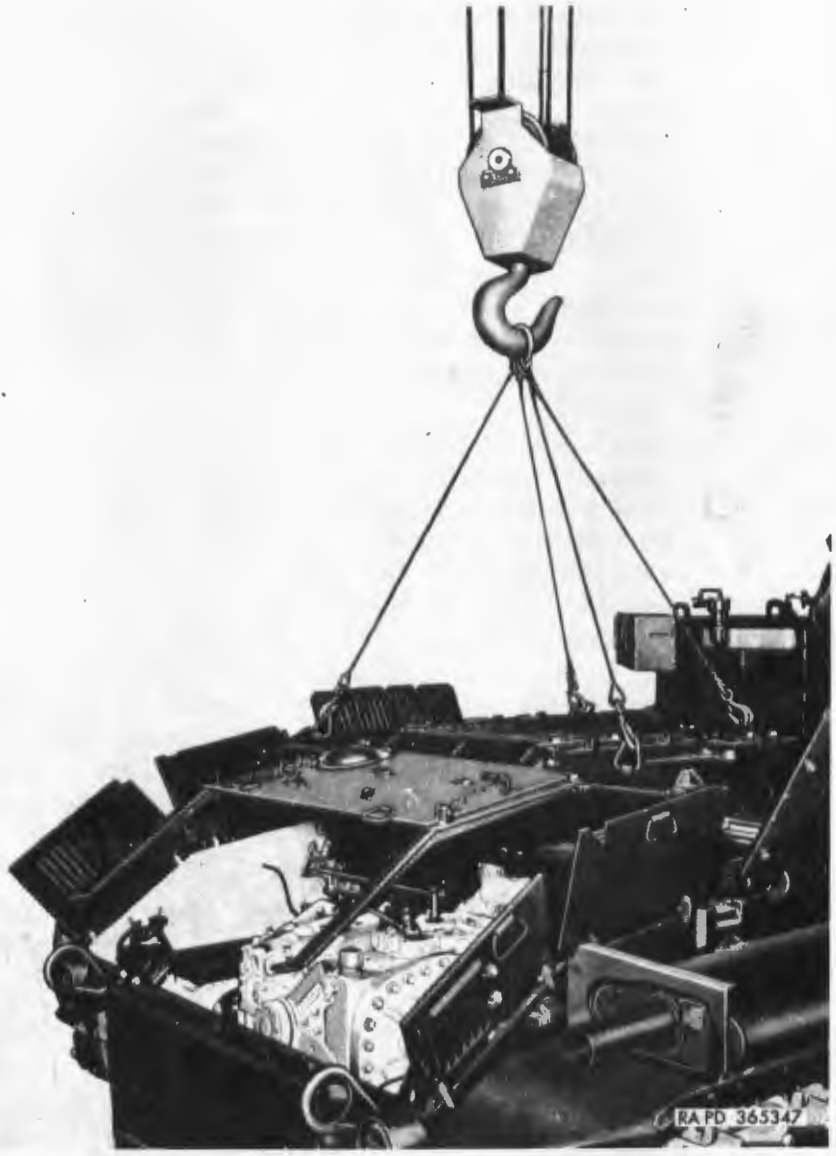


Figure 238. Removal or installation of supporting beam, supports, grilles, and transmission front access door as an assembled unit.

sion front access door (fig. 238) over the engine compartment and secure with six $\frac{5}{8}$ x $1\frac{1}{2}$ hex-head bolts and six $\frac{5}{8}$-inch lockwashers. Close six engine compartment grille doors, four battery access doors, and the transmission rear access door.

(3) *Removal and installation of supporting beam, engine grille door supports, and access door supports.*

(*a*) *Removal.* Open six engine compartment grille doors, four battery access doors and the transmission rear access door (fig. 237). Remove the transmission front access door (*b*(1)(*a*) above). Remove five engine compartment grilles (*a*(1)(*a*) above). Remove four hex-head bolts and lockwashers, one at each end of the two access door supports and lift off access door supports (fig. 237). Remove four hex-head bolts and lockwashers, one at each end of two grille door supports and lift off engine grille door supports (fig. 236). Remove the hex-head bolt and lockwasher at each end of the supporting beam and lift off the supporting beam (fig. 237).

(*b*) *Installation.* Position the supporting beam (fig. 237) across the engine compartment and secure with two 5/8 x 1½ hex-head bolts and 5/8-inch lockwashers. Position the two grille door supports (fig. 236) and secure each with two 5/8 x 1½ hex-head bolts and 5/8-inch lockwashers. Position the two access door supports (fig. 237) and secure each with two 5/8 x 1½ hex-head bolts and 5/8-inch lockwashers. Install five engine compartment grilles (*a*(2)(*a*) above). Install the transmission front access door (*b*(2)(*b*) above). Close six engine compartment grille doors, four battery access doors, and the transmission rear access door (fig. 236).

235. Fender Skirts and Fender Extensions

a. General. Early vehicles were equipped with fender skirts and fender extensions.

b. Removal.

(1) *Fender skirts.* Loosen fender skirt fasteners by turning one-quarter turn counterclockwise. Slide skirt hinge pin out of hinge, and remove fender skirts.

(2) *Fender extensions.* Remove fender skirts ((1) above). Remove 28 safety nuts, plain washers, and hex-head cap screws that secure fender extensions to fenders, and remove extensions.

c. Installation.

(1) *Fender extensions.* Position fender extensions on fenders and secure with twenty-eight 3/8 x 7/8 hex-head cap screws, 13/32-inch flat washers, and 3/8-inch safety nuts.

(2) *Fender skirts.* Position fender skirt on fender extension, and insert skirt hinge pin in fender extension hinge.

Secure fender skirts in position by pressing fasteners into receptacles and turning one-quatrer turn clockwise.

236. Fenders
(fig. 239)

Note. Before removing fenders on early vehicles, remove fender skirts and fender extensions (par. 235).

a. Front Fenders (fig. 239).

(1) *Removal.* Remove 10 self-locking nuts, 11 hex-head cap screws, 17 plain washers, and 1 toothed-periphery dome lockwasher securing the front fender to the front intermediate fender and fender bracket. Remove the front fender.

(2) *Installation.* Position the front fender and secure the rear edge with two 3/8 x 1 1/4 hex-head cap screws, four 7/16-inch plain washers, and two 3/8-inch safety nuts. Place one washer under each screw head and nut. Secure the rear inside corner with one 3/8 x 7/8 hex-head cap screw and 3/8-inch toothed-periphery dome lockwasher. Secure the rear outside corner with 3/8 x 1 1/4 hex head cap screw, 7/16-inch plain washer under the cap screw head, and 3/8-inch safety nut. Secure the outside edge with two 3/8 x 1 hex-head cap screws, 13/32-inch plain washers under the screw heads, and 3/8-inch safety nuts to the front fender finishing reinforcement. Secure the inside edge of the fender bracket with two 3/8 x 1 hex-head cap screws, four 13/32-inch plain washers, and two 3/8-inch nuts. Place one washer under each screw head and nut. Secure the fender to the fender supporting plate with three 3/8 x 1 hex-head cap screws, six 13/32-inch plain washers, and three 3/8-inch safety nuts. Place one washer under each screw head and nut.

b. Front Intermediate Fenders (fig. 239).

(1) *Removal.* Remove front fender (*a*(1) above). Remove six hex-head cap screws, three internal-external-teeth lockwashers, three plain washers, and three safety nuts that secure the front intermediate fender to the vehicle. Lift off fender.

(2) *Installation.* Position the front intermediate fender on the vehicle and secure the rear edge with three 3/8 x 3/4 hex-head cap screws and 3/8-inch internal-external-teeth lockwashers. Secure the outside edge with three 3/8 x 1 1/8 hex-head cap screws, 7/16-inch plain washers, and 3/8-inch safety nuts. Install the front fender (*a*(2) above).

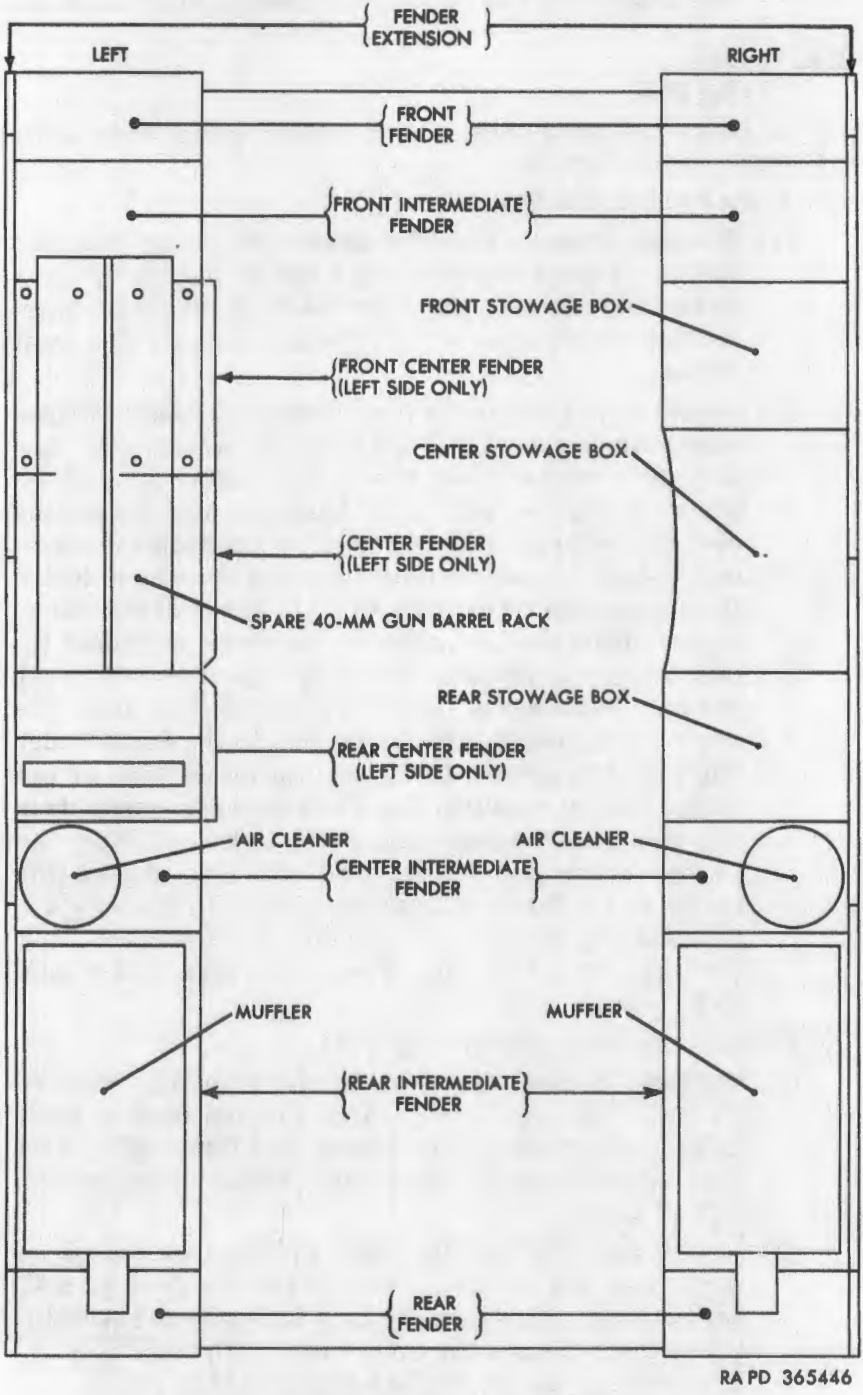


Figure 239. Fender and stowage box diagram.

c. Front Center Fender (Left Side Only). Vehicles through Ordnance serial No. 1013 have the front center fender welded in place. The removal and installation procedure in (1) and (2) below is for vehicles with Ordnance serial No. 1014 and up.

(1) *Removal.* Remove eight hex-head cap screws, safety nuts, and plain washers. Remove front center fender.

(2) *Installation.* Position fender on vehicle and secure the outside edge with two 3/8 x 1 1/8 hex-head cap screws, 7/16-inch plain washers, and 3/8-inch safety nuts. Install six 3/8 x 1 hex-head cap screws, 7/16-inch plain washers, and 3/8-inch safety nuts in the remaining six holes in the fender.

d. Center Fender (Left Side Only). Vehicles through Ordnance serial No. 1013 have the center fender welded in place. The removal and installation procedure in (1) and (2) below is for vehicles with Ordnance serial No. 1014 and up.

(1) *Removal.* Remove eight hex-head cap screws, ten plain washers, and eight safety nuts. Remove center fender.

(2) *Installation.* Position fender on vehicle and secure the outside edge with two 3/8 x 1 1/8 hex-head cap screws, 7/16-inch plain washers, and 3/8-inch safety nuts. Secure the center of the front edge of the fender with two 3/8 x 1 3/8 hex-head cap screws, four 7/16-inch plain washers, and two 3/8-inch safety nuts. Place the washers under each screw head and nut. Install four 3/8 x 1 hex-head cap screws, 7/16-inch plain washers, and 3/8-inch safety nuts in the remaining four holes in the fender.

e. Rear Center Fender (Left Side Only). The removal and installation procedure for the rear center fender is identical to the procedure for the center fender (*d* above).

f. Center Intermediate Fenders. The removal and installation procedure for the center intermediate fenders is identical to the procedure for the front center fender (*c* above).

g. Rear Intermediate Fenders.

(1) *Removal.* Remove rear fender reinforcement (*i* below). Remove tool rack and track shoe rack (par. 238*c*). Remove muffler (par. 160*b*). Remove nine hex-head cap screws, ten plain washers, one toothed-periphery dome lockwasher, and eight safety nuts. Remove rear intermediate fender.

(2) *Installation.* Position the fender on the vehicle and secure the forward inside corner with a 3/8 x 1 1/8 hex-head cap screw, 7/16-inch plain washer, and 3/8-inch safety nut. Secure the center of the forward edge with two 3/8 x 1 3/8

hex head cap screws, four 7/16-inch plain washers, and two 3/8-inch safety nuts. Place the washers under each screw head and nut. Secure each of the remaining three corners with a 3/8 x 1 1/4 hex-head cap screw, 7/16-inch plain washer, and 3/8-inch safety nut. Secure the center of the inside edge with a 3/8 x 3/4 hex-head screw and 3/8-inch toothed-periphery dome lockwasher. Secure the center of the rear edge with two 3/8 x 1 1/2 hex-head cap screws, 7/16-inch plain washers, and 3/8-inch safety nuts. Install muffler (par. 160*c*). Install the rear fender reinforcements (*i* below).

h. Rear Fenders.

(1) *Removal.* Remove the rear fender reinforcement (*i* below). Remove six hex-head cap screws, plain washers, and safety nuts that secure the rear fender to the vehicle. Lift off fender.

(2) *Installation.* Position the rear fender on the vehicle and secure the front inside and outside corners with two 3/8 x 1 1/4 hex-head cap screws, 7/16-inch plain washers, and 3/8-inch safety nuts. Secure the center of the front edge with two 3/8 x 1 1/2 hex-head cap screws, 7/16-inch plain washers, and 3/8-inch safety nuts. Secure the rear inside corner with two 3/8 x 1 hex-head cap screws, 18/32-inch plain washers, and 3/8-inch safety nuts. Install the rear fender reinforcement (*i* below).

i. Rear Fender Reinforcement.

(1) *Removal.* Remove seven-head cap screws, plain washers, and safety nuts securing rear fender reinforcement to the rear fender and rear intermediate fender. Remove rear fender reinforcement.

(2) *Installation.* Position rear fender reinforcement on the rear and rear intermediate fenders. Secure with six 3/8 x 1 hex-head cap screws, one 3/8 x 1 1/4 hex-head cap screw (third from rear), seven 18/32-inch plain washers, and seven 3/8-inch safety nuts.

237. Spare 40-mm Gun Barrels

a. Removal. The two spare 40-mm gun barrels are stowed in stowage racks above the left fenders. Disconnect chain snap and loosen spare barrel clamp (fig. 240) by turning the spare barrel stowage clamp nuts counterclockwise and swinging the saddle clamp off the gun barrel. Loosen retaining strap at the muzzle end of barrel. Loosen spare barrel stowage end clamp nut (fig. 241) and swing forward. Slide barrels forward and out of stowage tray.

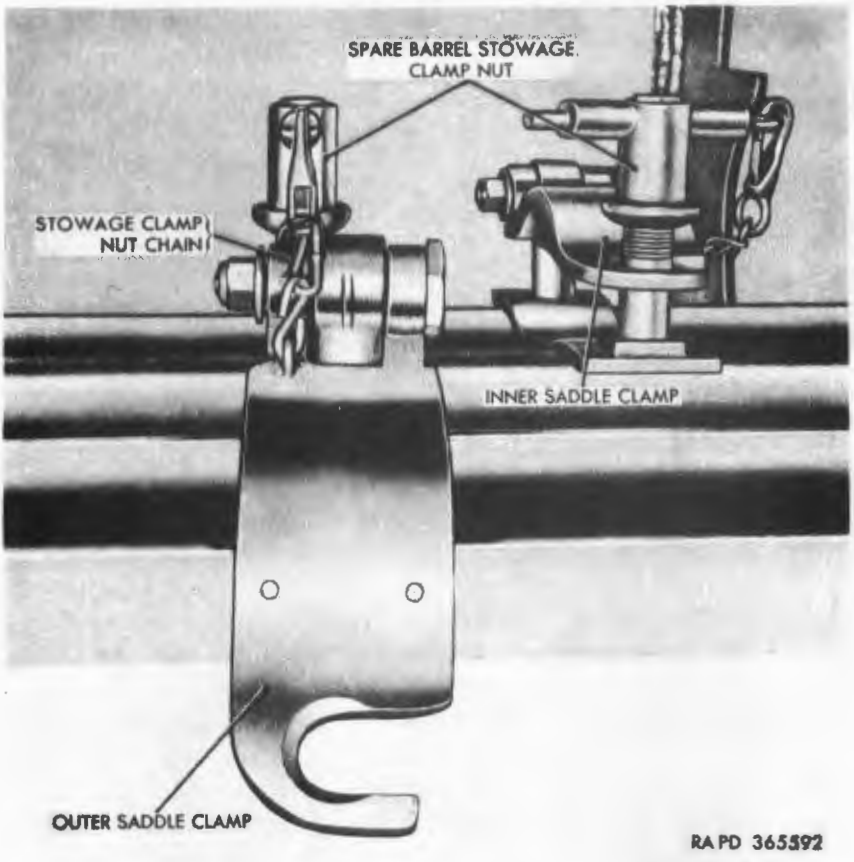


Figure 240. Spare barrel clamps.

b. Installation. Make sure that gun barrel covers 7038008 are secured on barrel. Slide barrel, muzzle end first, onto stowage tray in approximate stowage position with clearance between muzzle end of barrels and rear shield of ammunition stowage box. Place open end of end clamp assembly over anchor bolt (fig. 241). Turn end clamp nut (fig. 241) clockwise until outer disk on end clamp contacts breech end of outer spare barrel. Turn handle on inner disk (fig. 241) of end clamp clockwise until inner disk contacts breech end of inner spare gun barrel. Swing saddle clamps (fig. 240) over spare barrels and tighten the spare barrel stowage clamp nuts. Engage snaps on chains in nearest hole in spare barrel stowage clamp nuts. Tighten spare barrel end clamp nut and inner disk handle (fig. 241) until disks on end clamp are rigid against breech ends of spare barrels. Engage snaps on chains in handle of inner disk and in end clamp nut. Install and tighten spare barrel strap over muzzle end of spare barrels.

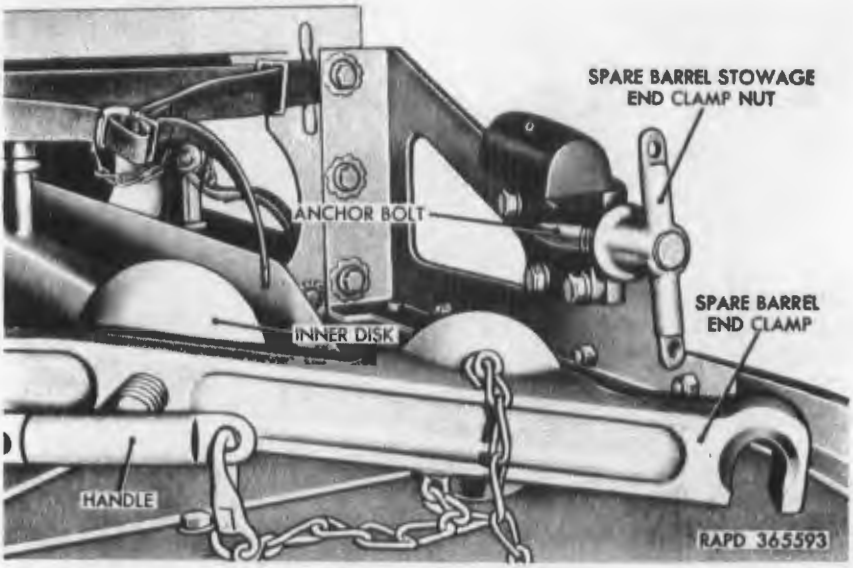


Figure 241. Spare barrel end clamps.

238. Fender Stowage Boxes

a. Front and Rear Stowage Boxes.

(1) *General.* The stowage boxes (fig. 242) are mounted above the right fender. The front stowage box (fig. 243) has stowage fittings for an oil can and spare machine gun barrel. The rear stowage box has provisions for the hand refueling pump. The front and rear stowage boxes are removed or installed in the same manner.

(2) *Removal.* Remove four hex-head cap screws and lockwashers from the upper outside edge. Remove three hex-head cap screws and toothed-periphery dome lockwashers from inside of box. Remove hex-head cap screw, safety nut, and four plain washers securing the box to the center fender stowage box and remove box.

(3) *Installation.* Position stowage box under right ammunition stowage boxes and secure with three 3/8 x 3/4 hex-head cap screws and 3/8-inch toothed-periphery dome lockwashers on the inside. Secure the box to the center stowage box with one 3/8 x 1 3/4 hex-head cap screw, to 3/8-inch plain washers, two 1 3/32-inch plain copper washers, and one 3/8-inch safety nut. Install four 3/8 x 5/8 hex-head cap screw and 3/8-inch internal-external-teeth lockwashers in the upper outside edge of the stowage box.

b. Center Stowage Box.

(1) *Removal.* Remove five hex-head cap screws and lockwashers from the upper outside edge. Remove four hex-

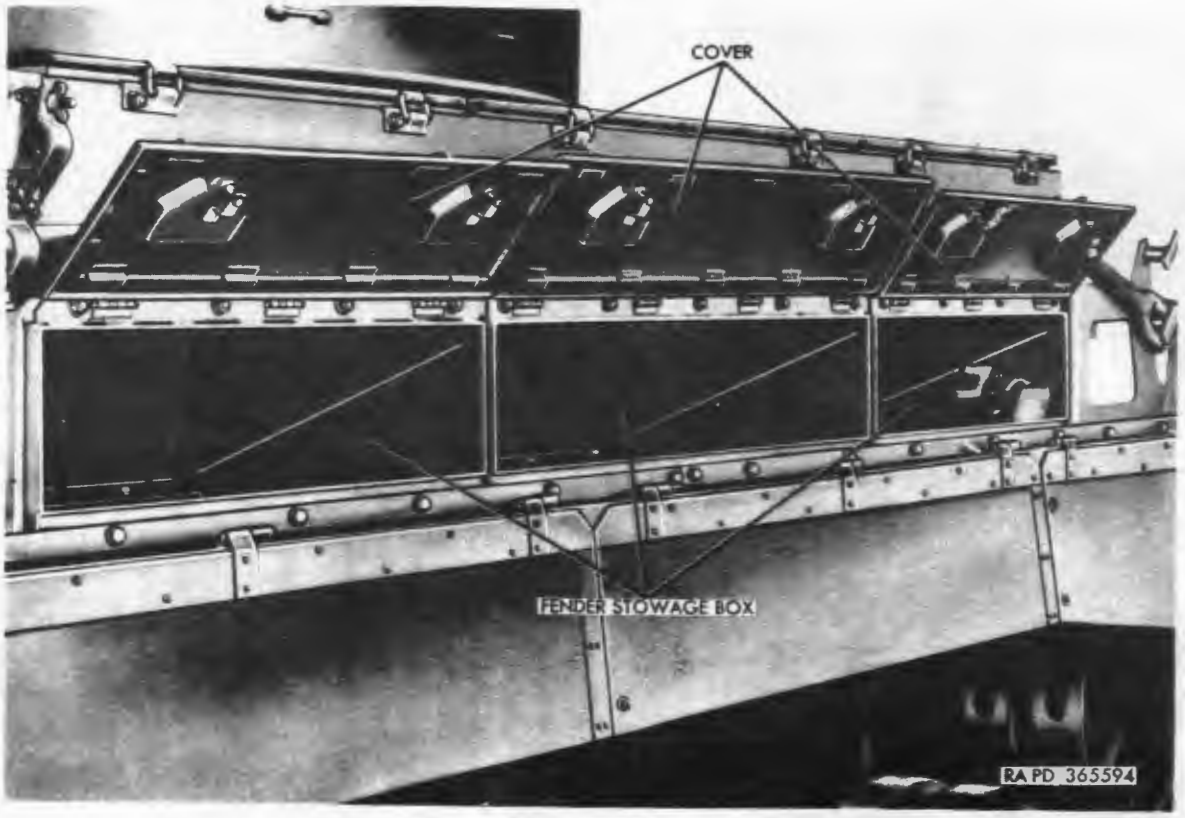


Figure 242. Fender stowage boxes—covers open.

Figure 243. Front stowage box components.

head toothed-periphery dome lockwashers from inside of box. Remove two hex-head cap screws, eight plain washers, and two safety nuts securing the center stowage box to the front and rear stowage boxes. Remove center stowage box.

(2) *Installation.* Position the center stowage box on the vehicle and secure with four 3/8 x 3/8 hex-head bolts and 3/8-inch toothed-periphery dome lockwashers on the inside. Secure the box to the front and rear stowage box with two 3/8 x 1 3/4 hex-head cap screws, four 3/8-inch plain washers, four 13/32-inch plain copper washers, and two 3/8-inch safety nuts. Install five 3/8 x 5/8 hex-head cap screws and 3/8-inch internal-external-teeth lockwashers in the upper outside edge of the stowage box.

c. *Tool Rack and Track Shoe Rack.*

(1) *General.* The procedure is the same for removal of the tool rack (fig. 133) that is mouted over the right muffler and the track shoe rack which is mounted over the left muffler.

(2) *Removal.* Remove four hex nuts, lockwashers, and cap screws securing the tool rack (fig. 133) mounted on the right muffler or the track shoe rack mounted on the left muffler.

(3) *Installation.* Install the tool rack (fig. 133) over the right muffler or the track shoe rack over the left muffler and secure with four ½ x 1¼ cap screws, ½-inch lockwashers, and ½-inch hex nuts.

239. 40-mm Ammunition Stowage Boxes

Note. The two center ammunition stowage boxes (fig. 244) are interchangeable, and the four outer ammunition stowage boxes are interchangeable.

a. Removal. Remove two hex-head cap screws and lockwashers from the outer edge and two hex-head cap screws and lockwashers from the inside edge of the ammunition stowage box to be removed. Remove ammunition stowage box.

b. Installation. Position ammunition stowage box on vehicle and secure with four ⅜ x ¾ hex-head cap screws and ⅜-inch internal-external-teeth lockwashers.

240. Towing Pintle and Towing Hooks (fig. 235)

a. Towing Pintle.

Note. When not in use, the towing pintle is stowed in a bracket provided for this purpose on the hull rear plate.

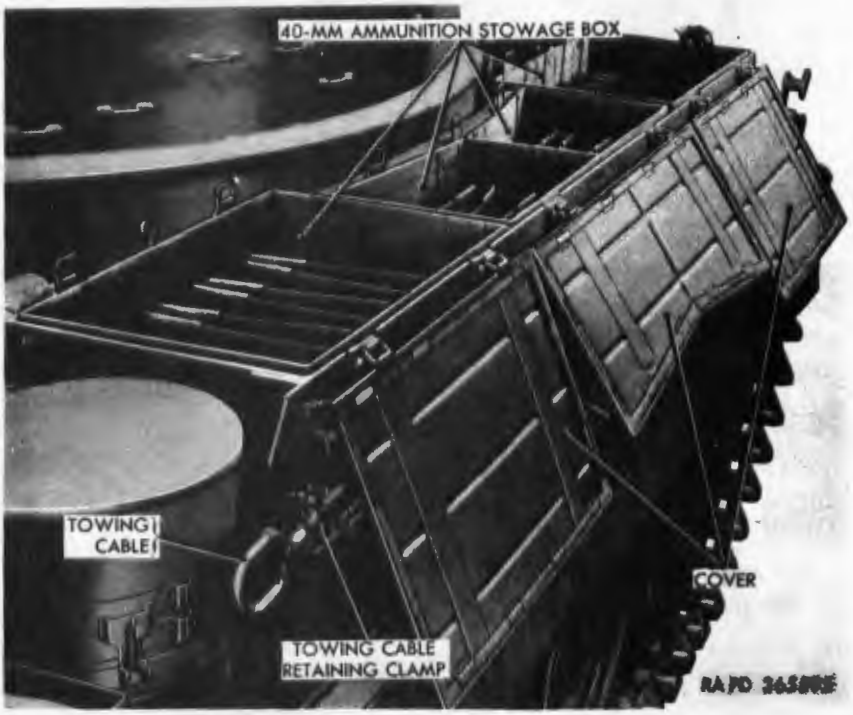


Figure 244. 40-mm ammunition stowage boxes.

(1) *Removal.* Remove cotter pin, hex nut, and flat washer from threaded end of pintle. Remove towing pintle.

(2) *Installation.* Position pintle in stowing or mounting bracket and secure with a 1½-inch hex nut, 1 17/32-inch flat washer, and ¼ x 3 cotter pin.

b. Towing Hooks.

Note. Removal and installation for each of the four towing hooks is identical.

(1) *Removal.* Remove locking clip from one end of the grooved pin. Remove grooved pin from towing hook and remove towing hook from towing lug.

(2) *Installation.* Position towing hook in towing lug. Insert the 5/8 x 1.486 grooved pin through hook and lug. Secure with locking clip.

241. Towing Cable
(fig. 244)

a. Removal. Loosen wingnut on the towing cable retaining clamp and move hinged clamp to open position. Lift cable out of brackets, and remove from forward retaining bracket.

b. Installation. Position towing cable on forward retaining bracket located on right side of vehicle. Lift cable into brackets, and secure cable eye in towing cable retaining clamp with wingnut.

242. Rocket Container Rack
(fig. 256)

a. Removal. Remove two hex nuts, seven hex-head bolts, and lockwashers securing the rocket container rack to the hull roof above the personnel heater. Remove rocket container rack.

b. Installation. Position the rocket container rack above the personnel heater and secure rear edge with five 3/8 x 3/4 hex-head bolts and 3/8-inch lockwashers. Secure the front right and left corners with two 3/8 x 3/4 hex-head bolts, 3/8-inch lockwashers, and 3/8-inch hex nuts.

243. Bulkhead Door

a. Removal. The bulkhead door is accessible from the ammunition stowage compartments. Remove four fasteners securing the bulkhead door to the bulkhead and remove door.

b. Installation. Position the bulkhead door on the bulkhead studs and secure with four internally-threaded fasteners.

244. 40-mm Ammunition Box Racks

a. General. The 40-mm ammunition stowage box racks (fig. 9) are installed along each hull wall in the ammunition stowage com-

partment and are accessible from the driving compartment. An inner and outer stowage box rack is installed in each compartment and the removal or installation procedure for the racks in either compartment is the same.

b. Removal. Remove nine hex-head bolts, lockwashers, and flat washers securing the inner and outer 40-mm ammunition box racks to the hull and remove racks from vehicle.

c. Installation. Position the inner and outer 40-mm ammunition box racks in ammunition stowage compartment with the inside rack overlapping the outside rack. Secure with nine $\frac{3}{8}$ x $1\frac{1}{8}$ hex-head bolts, $\frac{3}{8}$-inch lockwashers, and $1\frac{3}{32}$-inch flat washers.

245. Drain Valves and Controls

(fig. 245)

a. General. Coordinate with ordnance maintenance personnel (par. 2). See paragraph 24 for description and operation of the drain valves.

b. Drain Valves. The removal and installation procedure is the same for the four drain valves with the following exceptions: to remove the rear intermediate and rear drain valves, remove the power plant (par. 126); to remove the center drain valve, remove the left fixed fire extinguisher cylinder (par. 203*a*).

(1) *Removal.* Remove four hex-head bolts securing drain valve to the hull floor plate. Remove drain valve and seal.

(2) *Installation.* Position drain valve and seal and secure with four $\frac{3}{8}$ x $\frac{7}{8}$ self-locking hex-head bolts. Install power plant (par. 130) or install left fixed fire extinguisher cylinder (par. 203*b*) if necessary.

c. Drain Valve Controls.

(1) *Center drain valve control.*

(*a*) *Removal.* Remove the left fixed fire extinguisher cylinder (par. 203*a*). Remove the left inner and outer 40-mm ammunition box racks (par. 244*b*). Loosen clamping bolt on the center drain valve telescopic unit. Pull the center drain valve control handle with cable attached, out of the center drain valve control line. Disconnect the rear end of the center drain valve control line from the telescopic unit. Remove the jam nut from the front end of the telescopic unit and the clevis pin from the actuating lever and remove the telescopic unit. Disconnect the front end of the center drain valve control line by removing hex-head bolt and lock washer securing mounting clip, and remove control

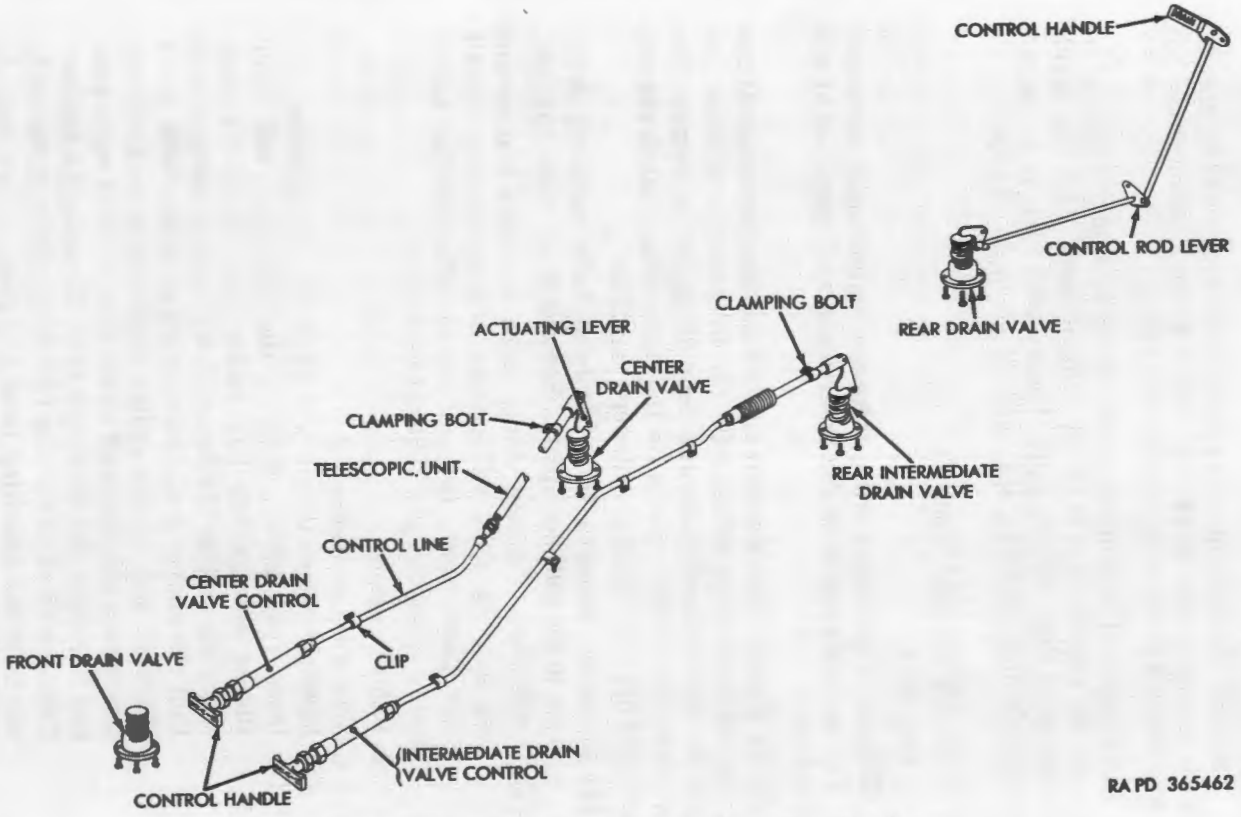


Figure 245. Drain valves and controls—schematic view.

line. Remove jam nut on center drain valve control and remove control.

(*b*) *Installation.* Install center drain valve control and secure with 5/8-inch jam nut. Position the telescopic unit in the mounting bracket and secure with 5/8-inch jam nut. Install a 1/4 x 2 9/32 clevis pin in the rear end of the telescopic unit securing it to the actuating lever. Position the control line between the drain valve control and the telescopic unit and secure by tightening the control line nut at each end. Secure control line clip to the mounting bracket with a 1/4 x 5/8 hex-head bolt and 1/4-inch lockwasher. Push the control valve cable through the drain valve control until the control handle is tight against the drain valve control. Tighten the clamping bolt on the telescopic unit securing the rear end of the unit to the cable. Install left 40-mm ammunition box racks (par. 244*c*). Install left fixed fire extinguisher cylinder (par. 203*b*).

(2) *Intermediate drain valve control.* The removal and installation procedure for the intermediate drain valve control is the same as for the center drain valve control ((1) above) with the exception of the control line being secured with four clips instead of one.

(3) *Rear drain valve control.*

(*a*) *Removal.* Remove power plant (par. 126). Remove the cotter pin and flat washer securing the rear drain valve control handle to the mounting bracket on the hull rear plate. Remove the cotter pin and flat washer securing the control rod lever to its mounting bracket. Remove the cotter pin, flat washer, and clevis pin securing the actuating lever to its mounting bracket and remove the rear drain valve control.

(*b*) *Installation.* Position the rear drain valve control in the engine compartment and secure the actuating lever to the mounting bracket on the hull rear plate with a 1/4 x 4 3/64 clevis pin, 9/32-inch flat washer, and a 1/16 x 5/8 cotter pin. Secure the control rod lever and the control handle to their brackets with a 1/16 x 5/8 cotter pin and 9/32-inch plain washer. Install power plant (par. 130).

246. Drain Hole Covers

a. General. The auxiliary generator and engine, main engine, transmission, and fuel tank drain hole covers on vehicles with

Ordnance serial Nos. 1 through 160 and from 490 through 625 are secured to the hull with mounting studs, plain washers, and lock nuts. On vehicles with Ordnance serial Nos. 161 through 489 and 626 and up, the drain hole covers are secured to the hull with hex-head bolts and lockwashers.

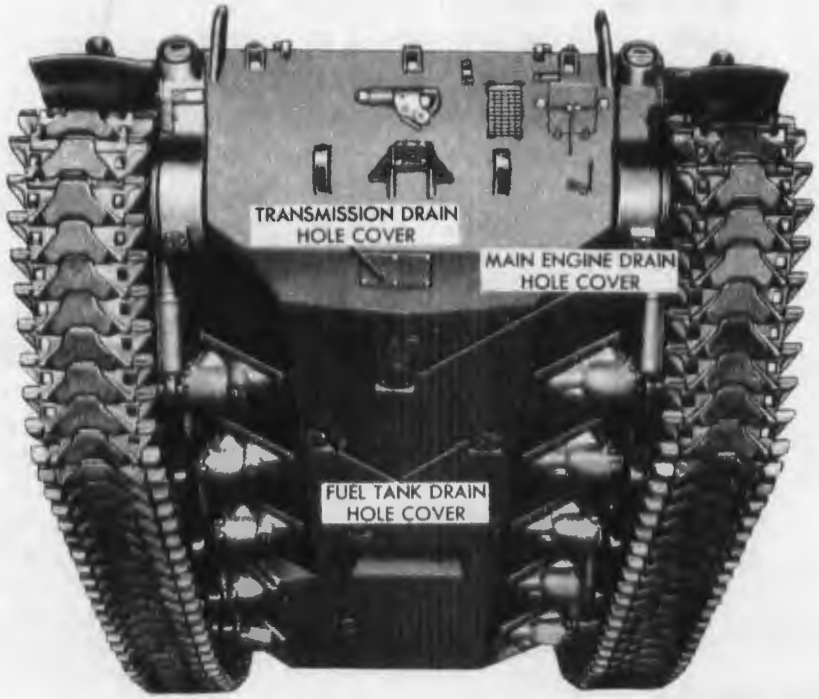
b. Auxiliary Generator and Engine Drain Hole Cover (fig. 199).

(1) *Removal.* Remove three hex locknuts and plain washers on three hex-head bolts and lockwashers securing the drain hole cover to the hull and remove cover.

(2) *Installation.* Position drain hole cover on hull and secure with three ½-inch hex locknuts and ½-inch plain washers or three ½ x 1¼ hex-head bolts and ½-inch lockwashers.

c. Main Engine Drain Hole Cover (fig. 246).

(1) *Removal.* Remove four hex locknuts and plain washers or four hex-head bolts and lockwashers securing drain hole cover to hull and remove cover.



RA PD 365459

Figure 246. Hull—bottom view.

d. Transmission Drain Hole Cover (fig. 246).

(1) *Removal.* Remove six hex locknuts and plain washers or six hex-head bolts and lockwashers securing the drain hole cover to the hull and remove cover.

(2) *Installation.* Position the drain hole cover on the hull and secure with six ½-inch hex locknuts and ½-inch plain washers or six ½ x 1¼ hex-head bolts and ½-inch lockwashers.

e. Fuel Tank Drain Hole Covers (fig. 246). There are two fuel tank drain hole covers and their removal and installation procedures are identical.

(1) *Removal.* Remove four hex locknuts and plain washers or four hex-head bolts and lockwashers securing the drain hole cover to the hull and remove cover.

(2) *Installation.* Position the drain hole cover on the hull and secure with four ½-inch hex locknuts and ½-inch plain washers or four ½ x 1¼ hex-head bolts and ½-inch lockwashers.

247. Driver's Seat and Back Rest (fig. 10)

a. Removal.

(1) *Driver's seat back rest.* Remove the driver's seat back rest by lifting back rest out of seat support.

(2) *Driver's seat.* Remove driver's seat by removing four hex-head cap screws and lockwashers securing driver's seat vertical support to mounting brackets on hull wall.

b. Installation.

(1) *Driver's seat.* Position driver's seat vertical support on mounting brackets and secure top of support with two 7/16 x ¾ hex-head cap screws and 7/16-inch lockwashers. Secure base of support with two ⅜ x ¾ hex-head cap screws and ⅜-inch lockwashers.

(2) *Driver's seat back rest.* Position driver's seat back rest on seat support and force back rest down into support.

Section XIX. INSTRUMENT PANEL AND RELATED EQUIPMENT

248. Description

a. Instrument Panel and Components (fig. 247). The instrument panel is shock mounted on brackets that are welded to the

hull front plate in front of the driver. Located in the front of the panel are the fuel level and oil pressure gages; light switch; starter, magneto, booster, and degasser (fuel cutoff) switch; master relay and blackout receiver switches; warning light panel; and the master relay and HI-BEAM indicator lights. The circuit breakers, rectifiers, and wiring harness are located inside the instrument panel.

b. Sending Units and Switches. The warning light switches and sending units which are mounted on the engine (fig. 248), transmission (fig. 249), and fuel tanks (figs. 125 and 126), actuate their respective warning lights and gages on the instrument panel

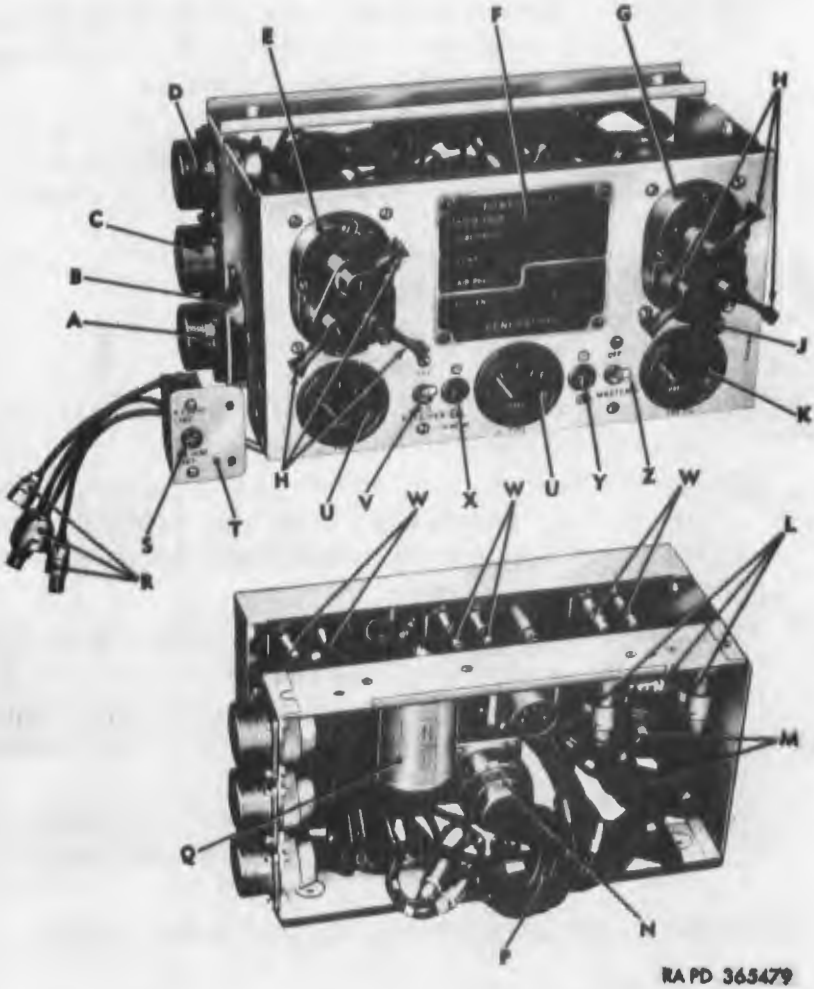


Figure 247. Instrument panel and blackout selector switch—front and rear view.

A—Engine wiring harness receptacle
B—Light switch harness receptacle
C—Headlight and accessory outlet harness receptacle
D—Warning light harness receptacle
E—Light switch
F—Warning light panel
G—Starter, magneto, booster, and degasser (fuel cutoff) switch
H—Switch lever
J—Degasser control (fuel cutoff) switch
K—Oil pressure gage
L—Circuit breaker
M—Starter switch cable coupling nut
N—Warning light box cable coupling nut
P—Instrument panel wiring harness
Q—Rectifier
R—Cable connector
S—Blackout Light Selector Switch
T—Blackout Light Selector Switch panel
U—Fuel level gage
V—Blackout receiver switch
W—Cable connector
X—Hi-beam indicator light
Y—Master relay indicator light
Z—Master relay switch

Figure 247—Continued.

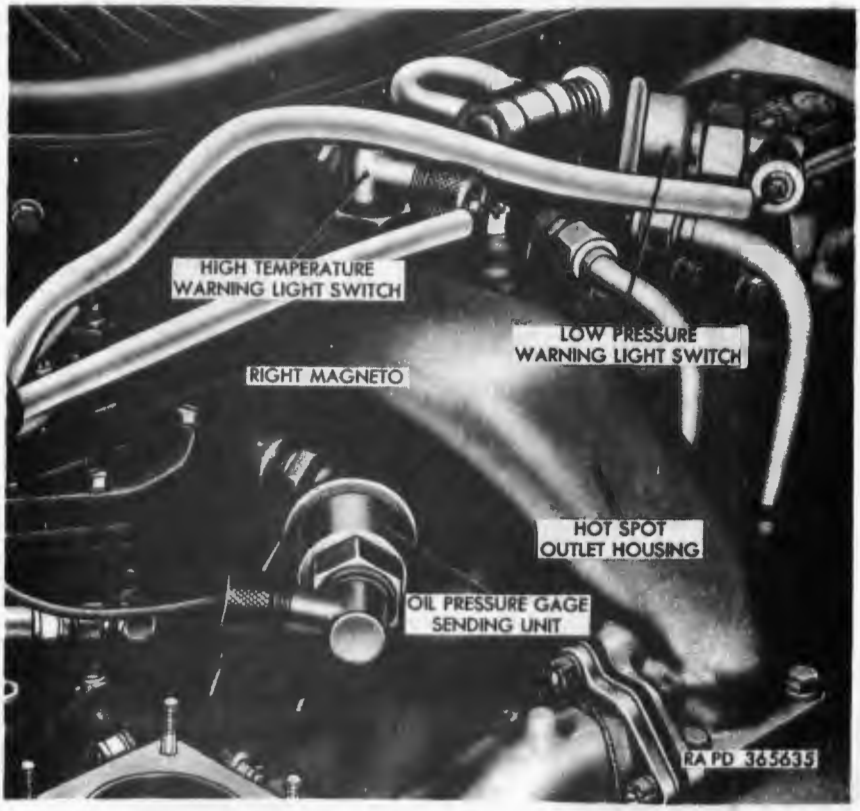


Figure 248. Warning light switches and sending unit—engine.

(fig. 247). The function of these sending units and switches is explained in paragraphs 32 through 35.

249. Instrument Panel and Vibration Insulators

a. Instrument Panel.

(1) *Removal.*

Note. The key letters noted in parentheses are in figure 247.

Make sure that master relay switch is in the OFF position. Disconnect the harness connector coupling nuts from the main light switch harness receptacle (B) and receptacles (A, C, and D) on the left end of the instrument panel. Disconnect two single connectors from HI-BEAM indicator light cables, circuit number 519 (fig. 250) which extend from the bottom of the panel. Remove four hex-head bolts and lockwashers which secure the instrument panel to the vibration insulators in the instrument panel mounting brackets. Remove ground strap from upper right mounting bolt. Remove the panel and be sure to save the snubber and spacer washers which are between the vibration insulator and the instrument panel.

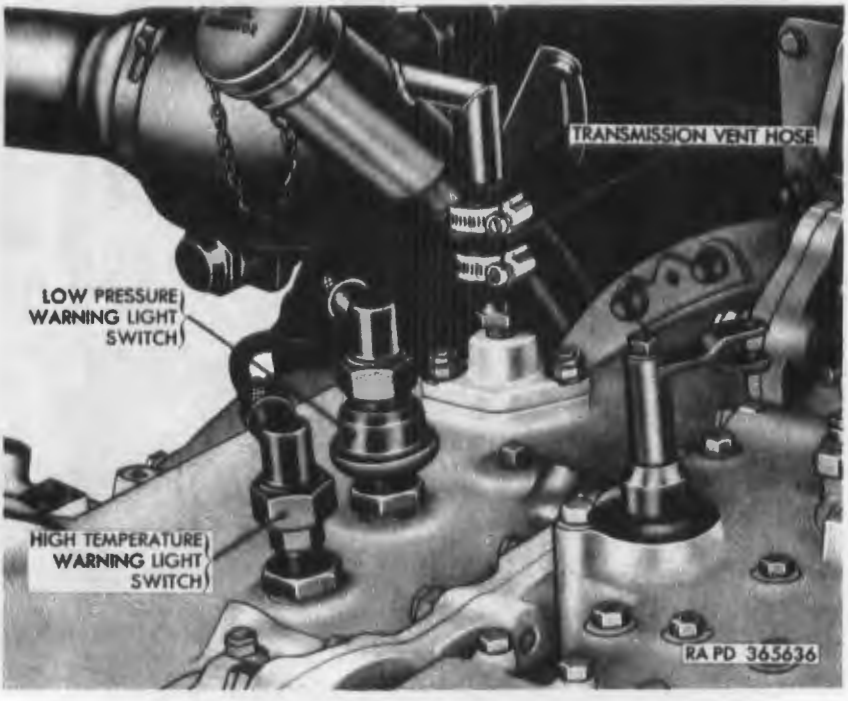


Figure 249. Warning light switches—transmission.

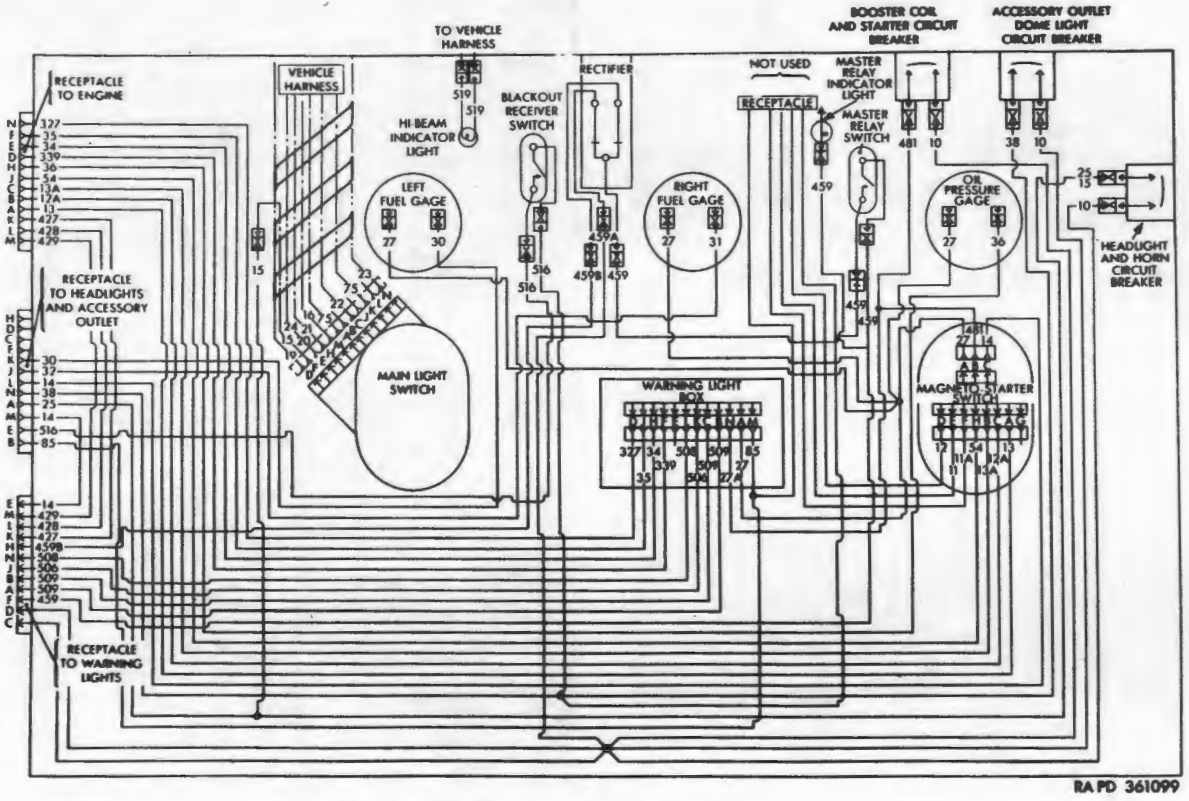


Figure 250. Circuit diagram—instrument panel.

(2) *Installation.* Position the instrument panel in the mounting brackets which are welded on the hull front plate and secure with four ½ x 1⅛ hex-head bolts and ¼-inch lockwashers.

Caution: The snubber and spacer washers must be positioned on the instrument panel mounting bolts with the snubber washer next to the vibration insulator and between the insulator and the panel. Connect ground strap between spacer and panel on upper right mounting bolt and be sure that contact surfaces are clean.

Connect harness connector plugs to instrument panel and light switch receptacles as shown in circuit diagram (fig. 250), and secure with coupling nuts . Connect single cable connectors (circuit numbers 519) to cables of HI-BEAM indicator light (fig. 250).

b. Instrument Panel Vibration Insulators.

(1) *Removal.* Remove instrument panel (*a*(1) above). Remove four roundhead screws, lockwashers, and hex nuts which secure the vibration insulators to the instrument panel mounting brackets and remove the insulators.

(2) *Installation.* Position the instrument panel vibration insulator on the mounting bracket from the inside of the bracket with the long end of the rubber insulator toward the outside of the bracket. Secure each insulator with four No. 8 x ⅜ roundhead screws, lockwashers, and hex nuts.

Note. Install the insulator mounting screws through the insulator and panel bracket with the head of the screw toward the instrument panel.

Install instrument panel (*a*(2) above).

250. Gages and Sending Units

Note. The key letters noted in parentheses are in figure 247.

a. Fuel Level Gage. Removal and installation of the left or right fuel level gage (U) is identical, and require the same operations.

(1) *Removal.* Remove instrument panel (par. 249*a*(1)). Disconnect cable connectors (W) from the fuel level gage (U). Remove two hex nuts, lockwashers and gage mounting clamp which secure the gage in the instrument panel and remove the gage.

(2) *Installation.* Position the fuel level gage (U) in the instrument panel and secure with mounting clamp, two No. 10 hex nuts, No. 10 lockwashers. Connect two cable connectors (W) to the gage which was installed and make

sure that the circuit numbers match (fig. 250). Install instrument panel (par. 249*a*(2)).

b. Oil Pressure Gage.

(1) *Removal.* Remove instrument panel (par. 249*a*(1)). Disconnect two cable connectors (W) from the oil pressure gage (K). Remove two hex nuts, lockwashers and gage mounting clamp which secures the gage in the instrument panel and remove the gage.

(2) *Installation.* Position the oil pressure gage (K) in the instrument panel and secure with mounting clamp, two No. 10 hex nuts, and No. 10 lockwashers. Connect two cable connectors (W) to the gage and be sure that the circuit numbers (fig. 250) match. Install instrument panel (par. 249*a*(2)).

c. Fuel Level Gage Sending Unit—Left or Right Fuel Tank.

(1) *Removal.* Turn fuel shutoff valve control lever (fig. 9) to the ALL OFF position. Remove left or right battery set (par. 172*b*) and fold battery support up against hull wall. Drain left or right fuel tank (par. 150). Disconnect the cable connector from the fuel level gage sending unit. Remove five round-head screws and lockwashers which secure sending unit in fuel tank and disconnect ground cable from right sending unit. Remove sending unit and gasket.

Caution: Avoid open flame near fuel tank opening and cover opening to prevent entrance of dirt or moisture.

(2) *Installation.* Clean gasket surfaces on sending unit and fuel tank. Remove protective covering from opening in fuel tank. Install gasket on sending unit and position sending unit in fuel tank so that float will move vertically as tank is filled. Secure sending unit with five No. 10 round-head screws and No. 10 lockwashers and connect ground cable on right sending unit under head of one of these screws. Connect cable connector (circuit number 30 for left fuel tank or number 31 for right fuel tank) to the sending unit. Install left or right battery set (par. 172 *c*). Turn master relay switch on. The fuel level gage should read "E." Add fuel in quantities to represent one-quarter, one-half, three- quarters, and full (par. 35). Observe if the gage responds as tank is filled.

Note. The fuel gages indicate the fuel level in the tanks rather than accurate gallonage.

Turn the master relay switch to the OFF position.

d. Oil Pressure Gage Sending Unit (fig. 248).

(1) *Removal.* Make sure that the master relay switch is in

the OFF position. Open engine compartment right-front grille doors (fig. 236). Unscrew knurled nut from oil pressure gage sending unit (fig. 248) and disconnect the cable. Clean thoroughly around the reducing bushing and unscrew sending unit from bushing. Remove sending unit and cover the reducing bushing with tape to keep out dirt or water.

(2) *Installation.* Remove the tape and install oil pressure gage sending unit into reducing bushing and tighten securely. Connect cable to sending unit. Make sure that waterproof washer is in place within knurled nut. Start engine (par. 43*b*) and observe the oil pressure gage to see if it registers as described in paragraph 42. Stop the engine (par. 46*b*). Close right-front engine compartment grille doors.

251. Main Lighting and Starting Switches

Note. The key letters noted in parentheses are in figure 247.

a. Main Lighting Switch.

(1) *Removal.* Remove instrument panel (par. 249*a*(1)). Remove the rectifier (par. 254*b*(1)). Disconnect wiring harness coupling nut from light switch harness receptacle (B). Remove three fillister-head screws, lockwashers, and flat washers which secure the three switch levers (H) and remove the levers. Remove four round-head screws which secure light switch (E) in the instrument panel and remove the switch out through the back of the panel.

(2) *Installation.* If replacement is to be made, remove switch levers from new switch and note their position when removed to facilitate installation. Position the light switch in the instrument panel and secure with four No. 10 x 5/8 roundhead screws. Position three switch levers (H) on the switch shafts and secure each lever with one No. 8 x 1/2 fillister-head screw, $1\frac{1}{64}$-inch flat washer, and No. 8 lockwasher. Connect wiring harness to switch receptacle (B) and secure with coupling nut. Install the rectifier (par. 254*b*(2)). Install instrument panel (par. 249*a*(2)).

b. Starter, Magneto, Booster, and Degasser (Fuel Cutoff) Switch. The removal and installation operations required for the replacement of starter, magneto, booster, and degasser switch (G) are identical with those described in paragraph *a* above except that it is not necessary to remove the rectifier. It is necessary how-

ever, to disconnect two starter switch cable coupling nuts (M) and the cable connectors from the three circuit breakers (L) to facilitate removal and installation of the switch.

Note. Four No. 10 internal-teeth lockwashers are used on the mounting screws.

252. Instrument Panel Warning Lights and Switches

a. Warning Light Panel.

(1) *Removal.* Remove the four roundhead screws and internal-teeth lockwashers which secure the warning light panel (F, fig. 247) on the front of the instrument panel. Remove the warning light panel.

(2) *Installation.* Position the warning light panel (F, fig. 247) on the instrument panel and secure with four No. 8 x 5/16 roundhead screws and No. 8 internal-teeth lockwashers.

b. Warning Light Box Face.

(1) *Removal.* Remove warning light panel (*a*(1) above). Remove six roundhead screws which secure the warning light box face and frame on the box. Remove the frame, gasket, and box face from instrument panel.

(2) *Installation.* Position the warning light box face and gasket in the instrument panel. Position the box face frame over the box face and secure with six No. 8 x ½ roundhead screws. Install warning light panel (*a*(2) above).

c. Replacement of Warning Lamps. Remove warning light panel and box face (*a*(1) and *b*(1) above). Push in on lamp to be replaced, turn counterclockwise to release and remove the lamp. Place new lamp in socket, push in and turn clockwise to secure. Install warning light box face and panel (*a*(2) and *b*(2) above).

d. Warning Light Switches. Procedures for removal and installation of engine low oil pressure warning light switch (fig. 248), engine high oil temperature warning light switch (fig. 248), engine oil pressure gage sending unit (fig. 248), transmission low oil pressure warning light switch (fig. 249), and transmission high oil temperature warning light switch (fig. 249), are identical and require the same operations. Wrench 5120–708–3852 (fig. 70) should be used, if available, to remove and install engine high oil temperature warning light switch.

(1) *Removal.* Make sure that the master relay switch is in the OFF position. Open engine and transmission access doors (fig. 236). Disconnect the cable switch and/or sending unit on the engine or the transmission. Clean

thoroughly around the switch and adapter bushing before removing, and unscrew the switch from the adapter bushing in the engine or transmission.

Caution: Cover the hole in the adapter bushing with tape to prevent entrance of water or dirt.

(2) *Installation.* Remove protective tape from adapter bushing. Screw the switch and/or sending unit into their respective adapter bushings on the engine or the transmission. Tighten switch and locate for convenient cable connection. Connect cable to switch. Close engine and transmission access doors (fig. 236).

253. Master Relay Switch, Blackout Receiver Switch, and Indicator Lights

Note. The key letters noted in parentheses are in figure 247.

a. Master Relay Switch or Blackout Receiver Switch.

(1) *Removal.* Remove instrument panel (par. 249*a*(1)). Disconnect two cable connectors from switch to be removed. Remove two roundhead screws and internal-teeth lockwashers which secure either the master relay switch (Z) or the blackout receiver switch (V) in the instrument panel and remove the switch.

(2) *Installation.* Position the master relay switch (Z) or blackout receiver switch (V) in the instrument panel and secure with two No. 8 x 3/8 roundhead screws and No. 8 internal-teeth lockwashers. Connect two cable connectors to the switch and check that circuit numbers (fig. 250) correspond. Install the instrument panel (par. 249*a*(2)).

b. Master Relay and HI-BEAM Indicator Lights.

(1) *Replacement of indicator light lamps.* Make sure that the master relay switch (Z) is in the OFF position. Replacement of the master relay and HI-BEAM indicator lights is identical. Unscrew the cap with gasket which secures the lamp in the light socket and remove the cap with lamp. Remove flanged base lamp from cap. Install flanged base 24–28-volt lamp in cap and screw cap with gasket into light socket.

(2) *Indicator lights.*

(*a*) *Removal.* Remove instrument panel (par. 249*a*(1)). Disconnect one cable connector from master relay indicator light (Y) or two connectors from HI-BEAM indicator light (X). Remove two roundhead screws and

internal-teeth lockwashers which secure the light in the instrument panel and remove light.

(*b*) *Installation.* Position the master relay indicator light (Y) or HI-BEAM indicator light (X) in the instrument panel and secure with two No. 8 x 3/8 roundhead screws and No. 8 internal-teeth lockwashers. Check that circuit numbers (fig. 250) correspond and connect cable connector or connectors to the light. Install instrument panel (par. 249*a*(2)).

254. Circuit Breakers and Rectifier

Note. The key letters noted in parentheses are in figure 247.

a. Circuit Breakers. The three circuit breakers (L) contained in the instrument panel are identical and require the same operations for removal and installation.

(1) *Removal.* Remove instrument panel (par. 249*a*(1)). Disconnect two cable connectors from circuit breaker (L) to be removed. Remove two flathead screws or roundhead screws, hex-nuts, and internal-teeth lockwashers which secure the circuit breaker in the instrument panel. Remove circuit breaker.

(2) *Installation.* Position circuit breaker (L) in the instrument panel and secure with two No. 8 x 3/4 flathead screws or roundhead screws as required, two No. 8 internal-teeth lockwashers and two No. 8 hex nuts. Connect two cable connectors to the circuit breaker according to circuit numbers (fig. 250). Install instrument panel (par. 249*a*(2)).

b. Rectifier.

(1) *Removal.* Remove instrument panel (par. 249*a*(1)). Disconnect five cable connectors which connect the cables from the rectifier (Q) to the wiring harness and other components in the instrument panel. Loosen the two roundhead screws with self-locking nuts and flat washers which secure the rectifier mounting bracket in the instrument panel. Slide the rectifier with cables out of the bracket.

(2) *Installation.* Position the rectifier (Q) with cables, in the mounting bracket and tighten the two No. 8 x 7/8 roundhead screws with 5/16-inch flat washers, and No. 8 self-locking nuts. Connect the five cable connectors to the wiring harness and other components. Make sure that circuit numbers (fig. 250) correspond. Install instrument panel (par. 249*a*(2)).

255. Blackout Light Selector Switch and Panel

Note. The key letters noted in parentheses are in figure 247.

a. Replacement of Selector Switch.

(1) *Removal.* Make sure that the master relay switch is in the OFF position. Disconnect three cable connectors (R) from the vehicle wiring harness. Remove two roundhead screws and lockwashers which secure the blackout light selector switch (S) to the blackout light selector switch panel (T) and remove the switch with cables and connectors.

(2) *Installation.* Position blackout light selector switch (S) with cables and connectors on blackout light selector switch panel (T) and secure with two No. 8 x 3/8 roundhead screws and No. 8 internal-teeth lockwashers. Connect three switch cable connectors (R) to wiring harness.

b. Replacement of Blackout Selector Switch Mounting Panel.

(1) *Removal.* Remove blackout selector switch from mounting panel (*a*(1) above) but do not disconnect the cable connectors. Remove two roundhead screws and lockwashers which secure the blackout light selector switch panel (T) on the instrument panel mounting bracket and remove the panel.

(2) *Installation.* Position the blackout light selector switch panel (T) on the instrument panel mounting bracket and secure with two No. 8 x 3/8 roundhead screws and No. 8 lockwashers. Install the blackout light selector switch in the panel (*a*(2) above).

Section XX. HULL ELECTRICAL SYSTEM AND MISCELLANEOUS COMPONENTS

256. Description

a. Hull Electrical System. The hull electrical system consists of several systems interconnected by means of the main wiring harness. These electrical systems, which are detailed in pertinent paragraphs, include the battery and generating system; starting system; lighting system and horn; ignition system; and gun mount electrical system.

b. Miscellaneous Components. Paragraph 257 through 265 contain information concerning the removal and installation of miscellaneous components which are installed in the hull. These are the bilge pumps; personnel heater; auxiliary generator and engine; the respective control boxes for this equipment; and the speedometer and tachometer.

257. Electrical Circuit Numbers

The circuits of the electrical system are listed by nomenclature and number in table XI. Each electrical cable is marked with a circuit number on a tape or metal tag attached to the junction or terminal end of the cable. Each electrical circuit shown in schematic and wiring diagrams is identified by its number listed in table XI.

Table XI. Electrical Circuit Numbers

No.	Engine and hull circuits
1	Generator field
2	Generator armature
3	Generator ground strap
5	Generator regulator to battery
7	Battery ground cables
10	Instrument panel circuit breakers, rectifier, and personnel heater motor.
12A	Booster switch to booster coil
13	Accessory end magneto ground
13A	Fywheel end magneto ground
14	Starter relay and neutral safety switch
15	Main light switch feed
16	Dimmer switch
17	Dimmer switch to service headlight upper beam
18	Dimmer switch to service headlight lower beam
19	Light switch to blackout selector switch
19A	Blackout selector switch to blackout drive headlight
19B	Blackout selector switch to dimmer switch
20	Light switch to blackout marker lights
21	Light switch to service taillight
22	Light switch to service stoplight
23	Light switch to blackout stoplight
24	Light switch to blackout taillights
24A	Trailer blackout taillight
24B	Trailer blackout taillight
25	Horn switch and horn
27	Gages and auxiliary generator and engine warning lights in instrument panel and control box.
30	Left fuel gage to sending unit
31	Right fuel gage to sending unit
34	Engine low oil pressure warning light
35	Engine high oil temperature warning light
36	Engine oil pressure gage
37	Accessory outlet and blackout receiver switch
38	Dome light in hull
41	Interphone No. 1
42	Interphone No. 2
43	Interphone No. 3
44	Interphone No. 4

Table XI. Electrical Circuit Numbers—Continued

No.	Engine and hull circuits
45	Interphone No. 5
47	Slipring feed
48	24-volt radio feed
49	Auxiliary power outlet
50	Auxiliary power outlet ground
51	Interphone No. 7
54	Fuel cutoff switch to right and left degassers
57	Instrument panel ground strap
60	Interphone No. 6, spare
61	Auxiliary generator field
62	Auxiliary generator armature
63	Auxiliary generator ground
64	Auxiliary generator regulator to battery
65	Auxiliary generator starter relay
68	Battery interconnecting cables
73	Radio terminal box ground
75	Main light switch to stoplight switch
76	Fuel pump
79	Fuel tank ground
81	Batteries to master relay
82	Master relay to starter relay and starter
91	Blackout driving light ground
98	Interphone No. 8
99	Interphone No. 9
327	Transmission high oil temperature warning light and switch
339	Transmission low oil pressure warning light and switch
400	Personnel heater feed to flame detector circuit breaker
402	Personnel heater starting switch and fuel pump
403	Personnel heater temperature switch to overheat switch
404	Personnel heater starting switch to flame detector
409	Personnel heater feed to circuit breaker and starter switch
410	Personnel heater safety valve and ventilator motor
411	Personnel heater circuit breaker to flame detector
413	Auxiliary generator and engine air heater switch
419	Auxiliary generator and engine control box feed
420	Auxiliary generator and engine oil pressure warning light
422	Auxiliary generator and engine magneto ground
423	Auxiliary interphone signal light
426	Interphone ground
450	Bilge pump circuit breaker feed
451	Rear bilge pump switch to rear bilge pump
452	Front bilge pump switch to front bilge pump
456	Auxiliary generator and engine disconnect
457	Interphone No. 10
459	Rectifier to master relay switch, master relay switch indicator light, and master relay.
459A	Rectifier to circuit No. 10 in instrument panel
459B	Left batteries to rectifier

Table XI. Electrical Circuit Numbers—Continued

No.	Engine and hull circuits
463	Interphone No. 11
464	Interphone No. 12
478	Generator equalizer
481	Circuit breaker to fuel shutoff, booster, and starter switches in instrument panel.
487	Auxiliary generator and engine manifold heater
506	Generator charge warning light
514	Dimmer switch to blackout headlight upper beams
515	Dimmer switch to blackout headlight lower beams
516	Infrared red high-voltage power supply feed
519	High beam indicator

258. Wiring Harnesses and Cables

Note. The key letters noted in parentheses are in figure 251.

a. Description. The wiring harnesses and cables interconnect the various electrical systems and equipment in the hull. The harnesses and cables are insulated with oil-and-water-resistant synthetic rubber and equipped with single connectors, multiple-plug and socket-type connectors, and terminals. Groups of cables are positioned in cable clips and secured with cable clip covers. Single cables are secured with closed-cushioned cable clamps. The cable clip covers and closed clips are attached with hex-head bolts with integral lockwashers. The removal and installation operations for all wiring harnesses and cables are essentially the same and similar to the procedure for the main wiring harnesses described in *b* and *c* below.

b. Removal of Main Wiring Harness. Coordinate with ordnance maintenance personnel (par. 2). Remove power plant (par. 126). Remove auxiliary generator and engine (H) (par. 188). Remove left ammunition box rack (par. 244). Remove hex-head tapping screw (D) from all closed-cushioned cable clips (CC) and remove clips from harness. Loosen two hex-head bolts with integral lockwasher (W) which secure the cable clip cover (S), remove one bolt from each cover and turn the covers so that harness can be lifted from cable clips. Disconnect bayonet-type, and plug and socket-type cable connectors from all equipment and receptacles to which the main wiring harness is connected. Remove two hex nuts (X) and external-teeth lockwashers securing electrical receptacle bracket (G) and two hex nuts (X) and external-teeth lockwashers securing starter cable receptacle bracket (Y) to bulkhead.

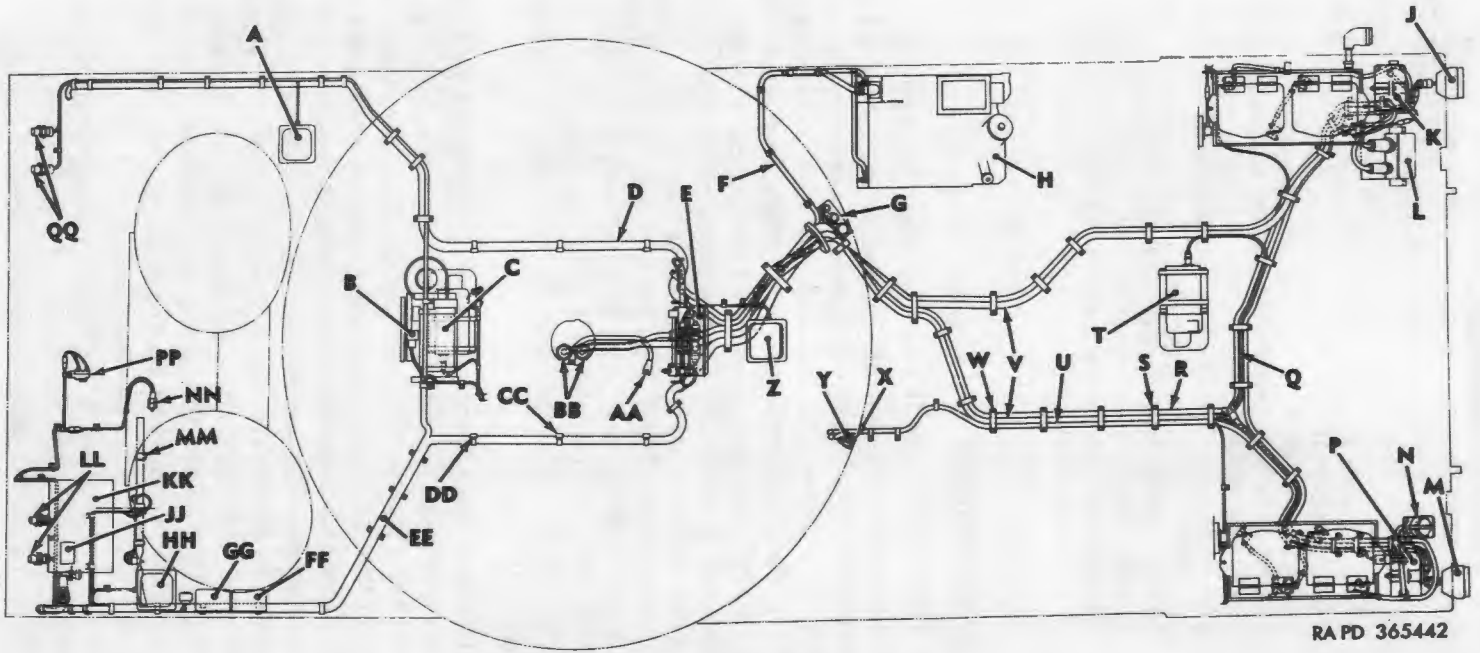


Figure 251. Hull wiring harness and cables.

A—Commander's dome light
B—Front bilge pump
C—Personnel heater
D—Slip ring-to-radio terminal box harness
E—Generator control box
F—Auxiliary generator and engine power cable
G—Electric receptacle bracket
H—Auxiliary generator and engine
J—Taillight
K—Master relay
L—Off-carriage outlet
M—Taillight
N—Auxiliary power receptacle
P—Starter relay
Q—Master relay to starter relay cable
R—24-volt power cable
S—Cable clip cover
T—Rear bilge pump
U—Starter cable
V—Main wiring harness
W—Hex-head bolt with integral lockwasher
X—Hex nut
Y—Starter cable receptacle bracket
Z—Dome light
AA—Ground cable
BB—Slipring receptacle
CC—Closed cushioned clip
DD—Hex-head tapping screw
EE—Main wiring harness
FF—Bilge pump control box
GG—Personnel heater control box
HH—Driver's dome light
JJ—Auxiliary generator and engine control box
KK—Instrument panel
LL—To L H headlight
MM—Horn switch
NN—Neutral safety control switch
PP—Stoplight switch
QQ—To R H headlights

Figure 251—Continued.

Remove brackets from bulkhead and remove main wiring harness (V) from vehicle.

Note. The slipring to radio-terminal-box harness (D) may be removed after removing the stowage from the right ammunition stowage compartment.

c. Installation of Main Wiring Harness. Coordinate with ordnance maintenance personnel (par. 2). Route the main wiring harness (V) through the vehicle from instrument panel (KK) to taillights (L and M) and aline the connectors with the respective equipment to avoid tension on any of the cables when harness is secured. Position electrical cable receptacle bracket (G) on bulkhead and secure with two $\frac{5}{16}$-inch hex nuts (X) and $\frac{5}{16}$-inch external-teeth lockwashers. Position starter cable receptacle bracket (Y) on bulkhead and secure with two $\frac{5}{16}$-inch hex nuts (X) and $\frac{5}{16}$-inch external-teeth lockwashers. Position harness in cable clips, place cable clip covers (S) over harness and cables and install $\frac{1}{4}$ x $\frac{1}{2}$ hex-head bolt with integral lockwasher (W) as required but do not tighten. Install closed-cushioned clip (CC) on harness as required and attach to cable clip mounting brackets with No. 14 x $\frac{5}{8}$ hex-head tapping screw (DD) and No. 14 A-U-type speed nuts do not tighten. Connect all cable connectors to the various equipment. Make sure the circuit numbers correspond and that the key and groove in the plug and socket type connectors are alined. Do not force these connectors. Shift harness and cables

as necessary to avoid interference with or damage by other equipment. Tighten all cable clamp and clip cover attaching bolts. Install power plant (par. 130), auxiliary generator and engine (H) (par. 188), and left ammunition box rack (par. 244). Turn master relay switch on and operate all lights, horn, and auxiliary equipment to assure that all function properly. Turn master relay switch to the OFF position.

259. Auxiliary Generator and Engine Control Box (fig. 252)

The auxiliary generator and engine control box is mounted in the driving compartment on the hull front plate above the instrument panel. This control box contains an ignition switch, a circuit breaker, a single pole toggle switch which actuates the space heater, and two warning lights, LOW OIL PRESSURE and GEN NOT CHARGING. Operation of the control box is described in paragraph 70.

a. Removal.

Caution: Check that master relay switch is in the OFF position. Disconnect eight cable connectors from the auxiliary generator and engine control box. Remove four hex-head bolts and lockwashers which secure the control box to the hull front plate and remove the control box.

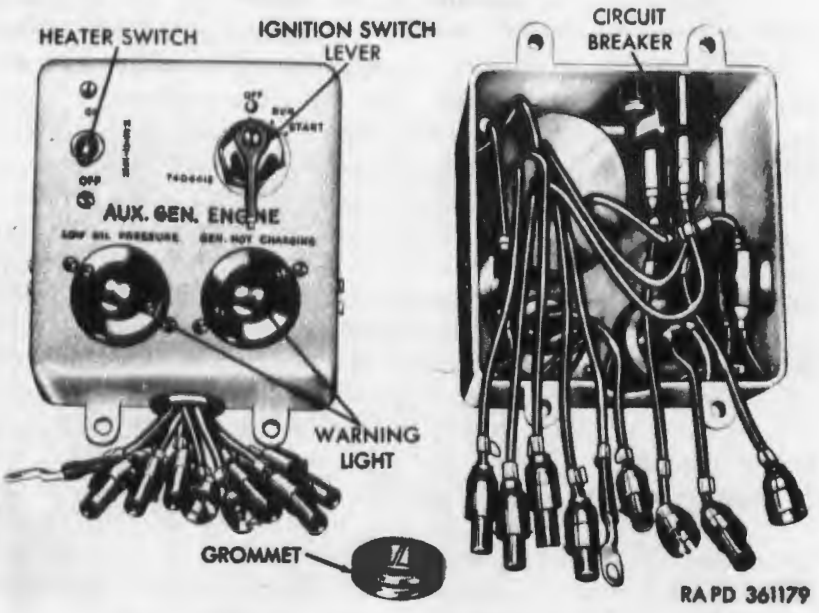


Figure 252. Auxiliary generator and engine control box.

b. Installation.

Caution: Make sure the cable grommet is properly positioned on the lower flange of the control box to protect the cables. Position auxiliary generator and engine control box on the hull front plate and secure with four ¼ x ⅞ hex-head bolts and ¼-inch lockwashers.

Note. Attach terminal of ground cable with circuit number 422, under head of the lower-left mounting bolt. Be sure contact surfaces are clean.

Connect the eight cable connectors from control box to the main wiring harness and check that circuit numbers correspond.

c. Test. Start auxiliary generator and engine (par. 70*b*) and operate for five minutes. Stop auxiliary generator and engine (par. 70*d*).

d. Ignition Switch.

(1) *Removal.* Remove auxiliary generator and engine control box (*a* above). Disconnect four cable connectors which connect switch cables to other components in control box. Remove the fillister-head screw and lockwasher holding switch lever on switch shaft and remove the lever. Remove switch mounting nut and washer and remove switch from rear of the box.

(2) *Installation.* Position ignition switch in control box and secure with mounting nut and washer which are part of switch assembly. Install switch lever on switch shaft and secure with one No. 8 x ⅜ fillister-head screw and No. 8 lockwasher. Connect four cable connectors to switch cables, making sure that circuit numbers match and secure connectors in retainer clips. Install auxiliary generator and engine control box (*b* above).

e. Heater Switch.

(1) *Removal.* Remove auxiliary generator and engine control box (*a* above). Disconnect one cable connector from switch cable. Remove two panhead screws and lockwashers which secure the switch in the control box and remove the heater switch with attached cables and connectors.

(2) *Installation.* Position the heater switch with attached cables and connectors in the auxiliary generator and engine control box and secure with two No. 8 x ⅜ panhead screws and No. 8 lockwashers. Connect cable, circuit No. 413, to corresponding circuit number (short cable) on

switch. Install auxiliary generator and engine control box (*b* above).

f. Circuit Breaker.

(1) *Removal.* Remove auxiliary generator and engine control box (*a* above). Disconnect two cable connectors with circuit No. 419 from circuit breaker. Remove two panhead screws, nuts, and lockwashers which secure the circuit breaker in the control box and remove the circuit breaker.

(2) *Installation.* Position the circuit breaker in the auxiliary generator and engine control box and secure with two No. 8 x 7/8 panhead screws, No. 8 lockwashers (under head of screws) and No. 8 hex nuts. Connect two cable connectors, circuit No. 419, to circuit breaker. Install auxiliary generator and engine control box (*b* above).

(3) *Test.* To test the circuit breakers in the auxiliary generator and engine control box. Start the auxiliary generator and engine (par. 70).

g. Warning Lights. The removal and installation operations and the procedure for replacement of lamps are identical for both warning lights in the auxiliary generator and engine control box.

(1) *Replacement of warning light lamps.* Loosen the two captive screws which secure the warning light door in position and remove the door. Press in and turn the lamp counterclockwise to loosen and remove the lamp. Place new lamp in socket, press in and turn clockwise to secure. Position door on control box and secure with two captive No. 6 x 9/16 fillister-head screws.

(2) *Removal of Warning Lights.* Remove the auxiliary generator and engine control box (*a* above). Disconnect cable connector from the warning light to be removed. Remove two panhead screws and lockwashers which secure the warning light in the control box and remove the light with attached cables and connectors.

(3) *Installation of warning lights.* Position the warning light with cables and connectors in the auxiliary generator and engine control box and secure with two No. 6 x 3/8 panhead screws and No. 8 lockwashers. Connect one cable connector to the corresponding circuit number on the warning light. Install auxiliary generator and engine control box (*b* above).

(4) *Test of warning lights and lamps.* Start the auxiliary generator and engine (par. 70) and observe lights for proper operation.

260. Personnel Heater Control Box

The description and operation of the personnel heater control box is explained in paragraph 71.

a. Removal. Disconnect seven cable connectors from the main wiring harness to the personnel heater control box (fig. 253).

Caution: Disconnect heater feed cable circuit marker No. 400, first.

Remove four hex-head bolts and lockwashers which secure the control box to the hull and remove the box.

b. Installation. Make sure that the cable grommet (fig. 253) is in position to protect the cables. Position control box (fig. 253) on hull left wall and secure with four ¼ x ⅞ hex-head bolts and ¼-inch lockwashers. Connect seven cable connectors (fig. 253) to the main wiring harness and make sure the circuit numbers match.

Caution: Connect cable connector with circuit marker No. 400 last.

c. Heater Switch (fig. 253).

(1) *Removal.* Remove personnel heater control box (*a* above). Disconnect one cable connector, circuit No. 404, from temperature control switch inside the control box.

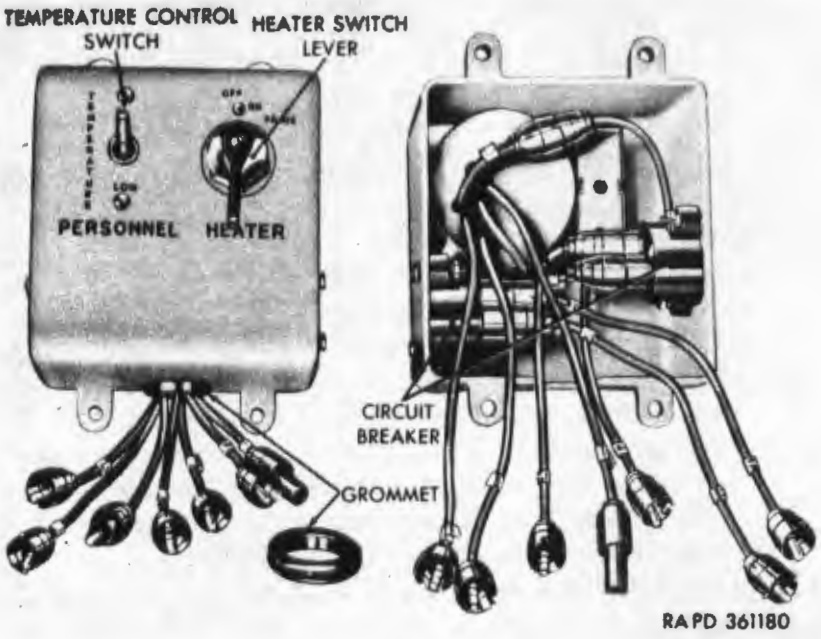


Figure 253. Personnel heater control box, front and rear view.

Remove the fillister-head screw which secures the switch lever to the switch shaft. Remove the switch mounting nut and washer and remove the heater switch from the control box.

(2) *Installation.* Position the heater switch in the personnel heater control box and secure with mounting washer and nut. Position the switch lever with washer on the switch shaft and secure with one No. 8 x 3/8 fillister-head screw. Connect cable connector, circuit No. 404, to corresponding circuit on temperature control switch. Install personnel heater control box (*b* above).

d. Temperature Control Switch (fig. 253).

(1) *Removal.* Remove personnel heater control box (*a* above). Disconnect two cable connectors from the temperature control circuit breaker to provide access to the switch. Disconnect one cable connector, circuit No. 404, from the switch. Remove two panhead screws and lockwashers which secure the temperature control switch in the control box and remove the switch with attached cables and connectors.

(2) *Installation.* Position the temperature control switch with cables and connectors in the personnel heater control box and secure with two No. 8 x 3/8 panhead screws and No. 8 lockwashers. Connect cable, circuit No. 404, from heater switch to corresponding temperature control switch cable. Connect two cable connectors, circuit Nos. 400 and 411, to the temperature control circuit breaker. Install personel heater control box (*b* above).

e. Circuit Breaker (fig. 253). The circuit breakers for the personnel heater and temperature control circuits require identical operations for removal and installation.

(1) *Removal.* Remove the personel heater control box (*a* above). Disconnect two cable connectors from the circuit breaker to be removed. Remove two panhead screws, hex nuts and lockwashers which secure the circuit breaker in the control box and remove the circuit breaker.

(2) *Installation.* Position the circuit breaker in the personnel heater control box and secure with two No. 8 x 7/8 panhead screws, No. 8 lockwashers, and No. 8 hex-nuts. Install personnel heater control box (*b* above).

f. Test. To test any of the components of the personnel heater control box, operate the personnel heater (par. 71) and observe for proper operation.

261. Bilge Pump Control Box
(fig. 254)

The bilge pump control box is installed in vehicles from Ordnance serial Nos. 490 through 650. This box contains two switches and two circuit breakers for the operation and control of the front and rear bilge pumps. The bilge pump control box is mounted to the left of the driver on the hull wall.

a. Removal.

Caution: Check to see that the master relay switch is in the OFF position.

Disconnect four bilge pump cable connectors from the main wiring harness. Remove four hex-head bolts and lockwashers which secure the control box to the hull wall and remove the bilge pump control box.

b. Installation. Position the bilge pump control box on the hull wall and secure with four ¼ x ⅞ hex-head bolts and ¼-inch lockwashers. Connect four bilge pump cable connectors to the main wiring harness.

Caution: Make sure that cable grommet is in position to protect the cables.

c. Switches. The front and rear bilge pump switches are identical and require the same operations for removal and installation.

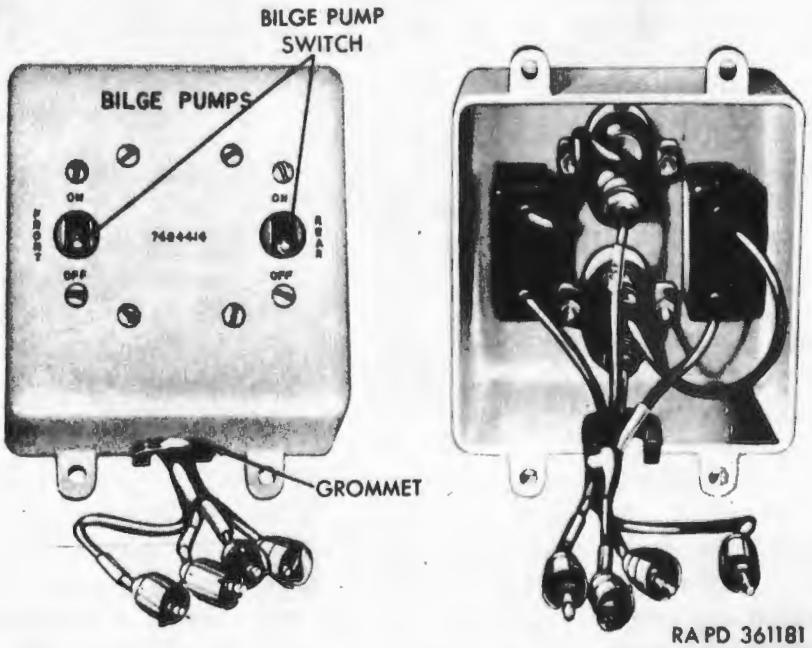


Figure 254. Bilge pump control box—front and rear view.

(1) *Removal.* Remove the bilge pump (*a* above). Disconnect two cable connectors from the bilge pump switch to be removed. Remove two panhead screws and lockwashers which secure switch in control box and lift out switch from rear of box.

(2) *Installation.* Position the bilge pump switch in the control box and secure with two No. 8 x 3/8 panhead screws and No. 8 lockwashers. Connect two cable connectors to the switch. Install bilge pump control box (*b* above).

d. Circuit Breakers. The two circuit breakers contained in the bilge pump control box are identical and require the same operations for removal and installation.

(1) *Removal.* Remove the bilge pump control box (*a* above). Disconnect two cable connectors from the circuit breaker to be removed. Remove two panhead screws, lockwashers, and hex nuts which secure the circuit breaker in the control box and remove circuit breaker from rear of box.

(2) *Installation.* Position the circuit breaker in the bilge pump control box and secure with two No. 8 x 7/8 panhead screws, lockwashers, and hex nuts. Connect two cable connectors to the circuit breaker. Install bilge pump control box (*b* above).

e. Test. To test any of the components of the bilge pump control box, operate the bilge pumps (par. 73) and observe for proper operation.

262. Personnel Heater

a. Description. The description and operating instructions for the personnel heater are given in paragraph 71.

b. Service. The personnel heater fuel filter (fig. 255) must be cleaned and drained frequently to prevent ice formation during cold weather operation. The fuel filter (fig. 256) is mounted next to the personnel heater fuel pump below the personnel heater mounting bracket at the rear of the driving compartment. To service, unscrew bowl and remove gasket, spring, filter element, and washer from head (fig. 255). Wash parts with dry-cleaning solvent or mineral spirits paint thinner and allow to dry. Do not use cloth to dry these parts as fine pieces of lint will clog the personnel heater fuel system. Place gasket on flange at threaded end of bowl. Place spring, filter element, and washer in the bowl. Position bowl against head and engage the threads by hand. Tighten bowl to 40 to 50 pound-inches torque with a wrench applied to hexagonal lower end.

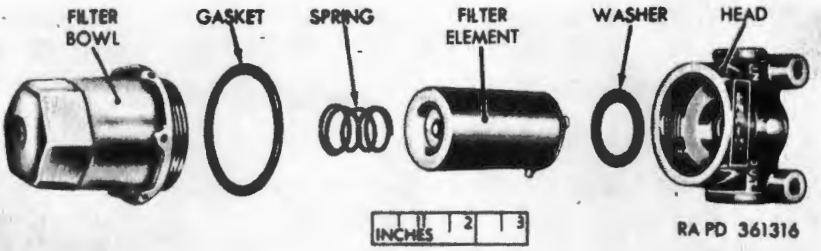


Figure 255. Personal heater fuel filter—exploded view.

c. Heater (fig. 256).

(1) *Removal.* Disconnect wiring harness connector from personnel heater. Disconnect fuel line from top of heater. Loosen heater hose clamp and remove hose. Remove two hexhead bolts which secure heater mounting clamp on the right end of the personnel heater and remove clamp. Remove one hex-head bolt from front end of mounting strap on left end of heater and bend strap back and away from the heater. Lift and disengage heater from exhaust tube which is secured to the heater support plate. Do not lose or damage the O-ring packing and washer. Remove the personnel heater.

(2) *Installation.* Place the O-ring packing over the exhaust outlet of the heater. Place the washer in the flared end of the exhaust tube elbow on the heater support plate. Position the heater in the mounting brackets on the support plate and enter the exhaust outlet into the exhaust tube elbow. Make sure the O-ring packing and washer are in place. Install the heater mounting clamp and secure with two $\frac{5}{16}$ x $6\frac{1}{2}$ hex-head bolts on the right end of heater and tighten. Bend mounting strap into position over left end of heater and secure with one $\frac{5}{16}$ x 4 hex-head bolt. Connect fuel line to top of heater. Connect wiring harness connector to personnel heater and tighten coupling nut. Install hose on heater and tighten hose clamp.

d. Heater duct. (fig. 256)

(1) *Removal.* Remove eight hex-head bolts and lockwashers which secure the heater duct to the hull. Loosen hose clamp securing hose to duct and slide duct forward out of the vehicle.

(2) *Installation.* Position heater duct in hull with rear end entered into heater hose. Secure heater duct to hull floor with five $\frac{3}{8}$ x 1 hex-head bolts and $\frac{3}{8}$-inch lockwashers.

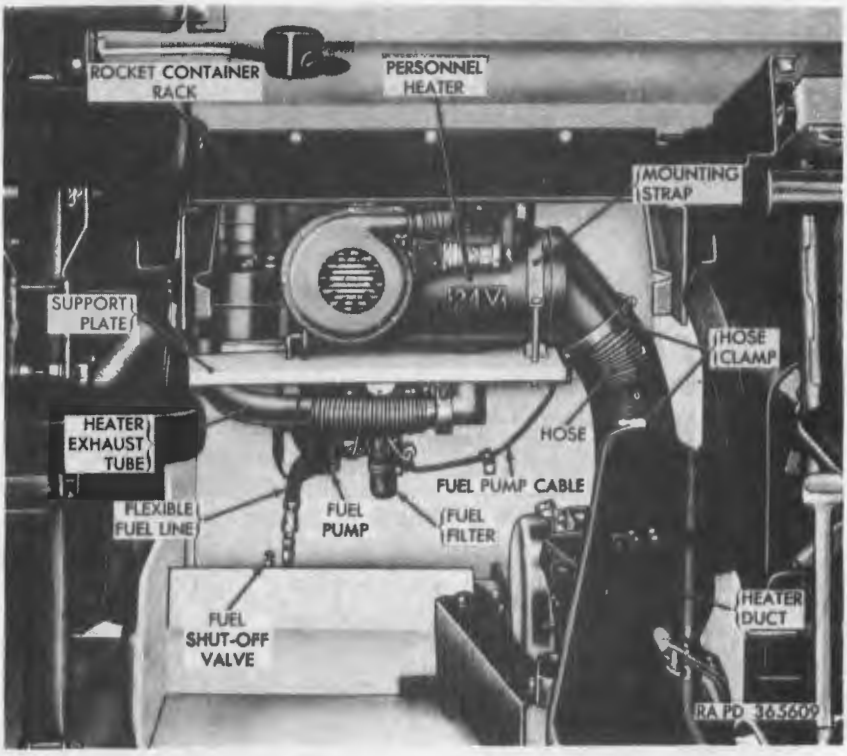


Figure 256. Personal heater—installed.

Secure forward end of duct to hull front plate with two 3/8 x 5/8 hex-head bolts and 5/8-inch lockwashers. Secure heater duct right rear support to hull reinforcement plate with a 3/8 x 1 1/4 hex-head bolt and 3/8-inch lockwasher. Tighten heater hose clamp.

e. Test. To test any personnel heater components, operate personnel heater (par. 71) and observe for proper operation.

263. Personnel Heater Accessories and Fuel Lines (fig. 256)

This paragraph contains information for the removal and installation of the personnel heater electric fuel pump, electric safety valve, fuel filter and fuel lines which are bracket mounted in a group, on the lower side of the heater support plate. Removal and installation of components may be performed after removal of the accessory group with mounting bracket.

a. Removal.

Caution: Close personnel heater fuel shutoff valve and make sure the master relay switch is in the OFF position.

Disconnect flexible fuel line from shutoff valve and heater. Disconnect fuel pump cable connector from fuel pump and cable terminal from safety valve terminal block. Remove two hex-head bolts with integral lockwashers which secure accessory mounting bracket to hull and remove the accessories and fuel lines with bracket.

b. Installation. Route flexible fuel line from safety valve up through hole in heater support plate. Position bracket with accessories and fuel lines on hull under personnel heater support plate and secure with two 1/4 x 5/8 hex-head bolts with integral lockwashers. Connect flexible fuel lines to heater and fuel shutoff valve. Connect fuel pump cable to fuel pump. Connect terminal on fuel pump cable with circuit marker No. 410 to terminal block on safety valve. Open fuel shutoff valve.

c. Test. To test a personnel heater accessory or fuel line, operate personnel heater (par. 71) and observe for proper operation and fuel leakage.

264. Bilge Pumps

a. Service. Keep bilge pump strainers free from foreign matter which may clog the pump intake. Service the rear bilge pump whenever the power plant is removed.

b. Front Bilge Pump.

(1) *Removal.* Coordinate with ordnance maintenance unit (par. 2).

Caution: Make sure the master relay switch is in the OFF position.

Loosen hose clamp on the bilge pump hose and slide hose off pump outlet fitting. Disconnect the electrical cable connector from the pump receptacle. Remove two hex-head bolts and flat washers from front end of bilge pump retainer straps and bend straps back to clear bilge pump. Lift pump up and forward to remove from vehicle.

(2) *Test before installation.* The bilge pump is not self priming and must be immersed in water to operate. Connect a 24-volt waterproof test lead to the receptacle and place bilge pump in a bucket of water to test pumping operation.

(3) *Installation.* Coordinate with ordnance maintenance unit (par. 2). Position the bilge pump in mounting bracket, bend retaining straps forward over the pump and secure with two 5/16 x 3/4 hex-head bolts with integral lockwashers and two 5/16-inch flat washers. Connect electrical

cable connector to receptacle on bilge pump. Position the bilge pump hose on pump outlet fitting and tighten clamp.

(4) *Test after installation.* Operate bilge pump (par. 73) and listen to be sure bilge pump is operating.

c. Rear Bilge Pump (fig. 64).

(1) *Removal.* Coordinate with ordnance maintenance unit (par. 2). Remove power plant (par. 126). Remove rear bilge pump in the same manner as described in *b* (1) above.

(2) *Test before installation.* Refer to *b* (2) above.

(3) *Installation.* Coordinate with ordnance maintenance unit (par. 2). Install rear bilge pump as described in *b* (3) above. Install power plant (par. 130).

(4) *Test after installation.* Refer to *b* (4) above.

d. Bilge Pump Mounting Bracket With Strainer.

(1) *Removal.* Coordinate with ordnance maintenance unit (par. 2). Remove front bilge pump (*b* (1) above) or rear bilge pump (*c* (1) above). Remove four hex-head bolts with integral lockwashers and flatwashers which secure the bilge pump mounting bracket with strainer to the hull floor and remove the bracket with strainer.

(2) *Installation.* Coordinate with ordnance maintenance unit (par. 2). Position front or rear bilge pump mounting bracket with strainer on hull floor and secure with four 5/16 x 5/8 hex-head bolts with integral lockwashers and 5/16-inch flat washers. Install front bilge pump (*b* (2) above) or rear bilge pump (*c* (2) above).

(3) *Test.* Refer to *b* (4) above.

265. Speedometer and Tachometer

Note. The key letters noted in parentheses are in figure 258.

a. General. The procedures for the removal and installation of the speedometer and tachometer indicators are identical. Vehicles with Ordnance serial Nos. 490 through 582 do not have the shock-type mounting bracket.

b. Speedometer and Tachometer Indicators.

(1) *Removal.* Disconnect the flexible drive shaft from the speedometer or tachometer indicator (fig. 257). Remove the two hex nuts, flat washers, and lockwashers which secure the speedometer or tachometer indicator in the mounting bracket and remove indicator from bracket.

(2) *Installation.* Position the speedometer or tachometer indicator in the mounting brackets (fig. 257) and secure

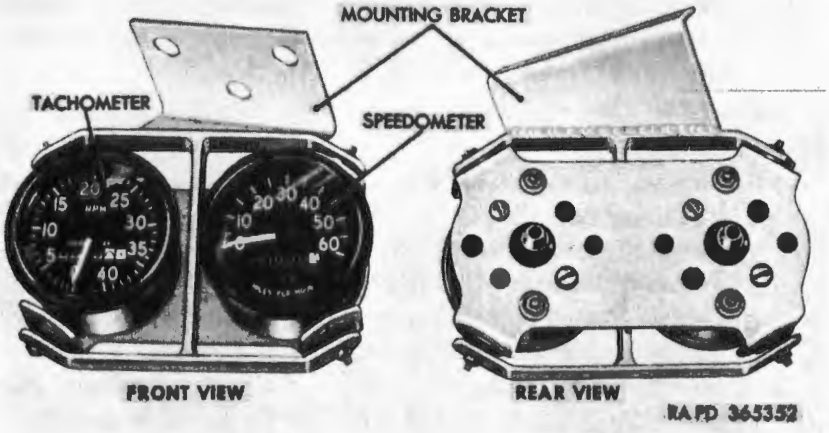


Figure 257. Speedometer and tachometer with mounting bracket—front and rear view.

with two ¼-inch flat washers, No. 10 lockwashers, and No. 10 hex nuts. Connect flexible drive shaft to speedometer or tachometer indicator and tighten to 80 to 90 pound-inches torque. The upper flexible drive shaft, as viewed from their positions in the mounting clips, connects to the tachometer indicator.

Caution: Make sure that both ends of the core are seated in the flexible drive casing by stretching or twisting the shaft when making connections. The ends of the core must aline with the mating adapters to avoid damage and the rubber washers must be in the coupling nuts to effect a seal.

(3) *Test.* Start engine (par. 43), and operate vehicle to see if speedometer and tachometer indicators function properly.

c. Mounting Bracket.

(1) *Removal.* Disconnect the flexible drive shafts from the speedometer and tachometer indicators (fig. 257). Remove three hex-head bolts and lockwashers which secure the bracket to the hull and remove the bracket with indicators attached. Remove the speedometer and tachometer indicators from the mounting bracket as described in *b* (1) above.

(2) *Installation.* Install speedometer and tachometer indicators (fig. 257) in the mounting bracket as described in *b* (2) above. Position mounting bracket with indicators

on the hull front plate and secure with three 5/16 x 5/16 hex head bolts and 5/16-inch lockwashers. Connect the flexible drive shafts to the speedometer and tachometer indicators. Refer to CAUTION (*b*(2) above).

d. Flexible Shafts, Speedometer and Tachometer Indicators to Bulkhead Coupling.

(1) *Removal.* Remove left 40-mm ammunition box rack (par. 244). Disconnect the flexible shaft (R) from speedometer or tachometer indicators and couplings (Q) in bulkhead. Remove four hex-head bolts, lockwashers, and mounting clips which secure the shafts to the hull and remove the speedometer or tachometer shaft.

(2) *Installation.* Route the speedometer or tachometer flexible shaft (R) through the left ammunition stowage compartment from the speedometer or tachometer indicators to the couplings (Q) in the bulkhead with the smaller coupling nut toward the front of the vehicle. Refer to CAUTION (*b*(2) above) and connect the shaft to the coupling in the bulkhead. Secure shafts in position on hull with four mounting clips, 1/4 x 1/2 hex-head bolts and 1/4-inch lockwashers. Connect the flexible shaft to the speedometer or tachometer indicators. Install the left 40-mm ammunition box rack (par. 244).

e. Flexible Shafts, Bulkhead Couplings to Drive Adapters. The removal and installation of the flexible shafts (K and S) requires the removal of power plant or the left rear-intermediate road wheel with arm support. Removal of the road wheel with arm support is the simpler method unless the power plant has been removed for other reasons.

(1) *Removal.* Remove power plant (par. 126) or left rear-intermediate road wheel with arm support (par. 224) as desired. If latter method is used, remove left battery set (par. 172) and fold battery support up against hull side plate.

Caution: Be sure to disconnect ground straps first from both battery sets before removing left batteries. Disconnect the speedometer flexible shaft (S) from the 90-degree drive adapter (A) on left final drive or the tachometer flexible shaft (K) from 90° drive adapter on engine. Remove hex-head bolt (H) with integral lockwasher and cushioned closed cable clip (J) which secures the speedometer flexible shaft to the hull floor under the rear end of the left fuel tank or the tachometer flexible shaft to the inboard upper corner of the left fuel tank.

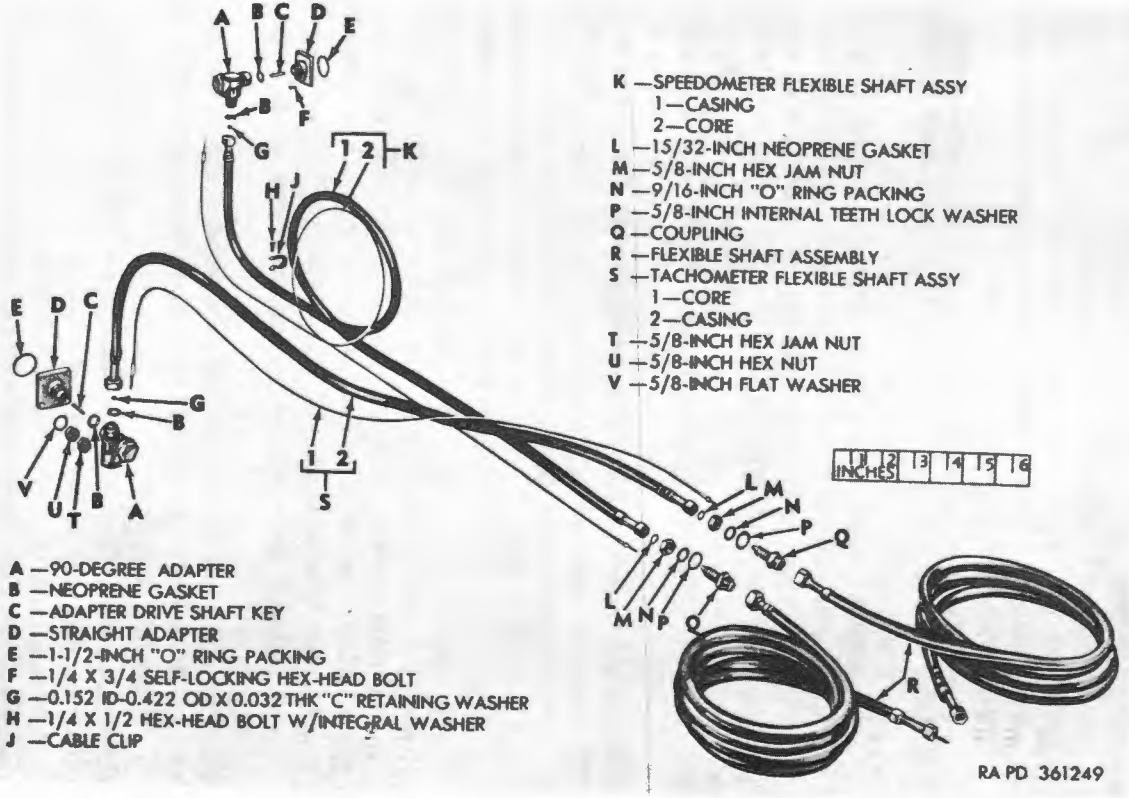


Figure 258. Speedometer and tachometer shafts and adapters—partial exploded view.

Work through hole in hull where road wheel arm support was removed and disconnect the speedometer or tachometer flexible shaft from coupling (Q) in bulkhead. Remove flexible shaft (S or K).

(2) *Installation.* Route the speedometer flexible shaft (S) from the 90° drive adapter (A) on the left final drive, under the left fuel tank to the coupling (Q) in the bulkhead or the tachometer flexible shaft (K), from 90° drive adapter (A) on engine, around forward end of left fuel tank to coupling (Q) in bulkhead.

Note. The larger coupling nut connects to the 90° drive adapter.

Refer to CAUTION (*b*(2) above) and connect flexible shaft to coupling (Q) and 90° drive adapter. Secure the speedometer shaft to hull floor under left fuel tank or tachometer shaft to inboard upper corner of left fuel tank with one closed cushioned cable clip (J) and ¼ x ½ hex-head bolt with integral lockwasher (H). Install power plant (par. 130), or left rear-intermediate road wheel with arm support (par. 224) and left battery set (par. 173).

f. Flexible shaft cores, bulkhead couplings to 90° drive adapters.

(1) *Removal.* Remove left rear-intermediate road wheel and arm support (par. 224). Disconnect flexible shaft (K or S) from couplings (Q) in the bulkhead. Pull ends of flexible shafts out through hole in hull. Open engine compartment doors and grilles on left side and disconnect flexible shafts (K or S) from 90° drive adapters (A). Use pliers and pull tanged end of cores (K–2 or S–1) out of casings (K–1 or S–2) sufficiently to allow removal of C retaining washers (G) from cores.

Caution: Do not lose or damage the C retaining washers.

Pull cores (K–2 or S–1) out of bulkhead end of casings (K–1 or S–2). If core is broken, remove sections from both ends of casing.

(2) *Installation.* Keep flexible shaft cores (K–2 or S–1) free from dirt and apply coating of aircraft and instrument grease. Insert the cores into the flexible shaft casings (K–1 or S–2) from bulkhead end until the shoulders on the square end of the cores seat in the casings. Pull cores out of adapter end of casings and install C retaining washers (G). Refer to CAUTION (*b*(2) above) and connect flexible shaft to couplings (Q) and 90° drive adapters (A). Install left rear-intermediate road wheel

with arm support (par. 224). Close engine compartment doors and grilles.

a. Flexible Shaft Cores, Speedometer and Tachometer Indicators to Bulkhead Couplings.

(1) *Removal.* Remove left 40-mm ammunition box rack (par. 244). Disconnect the flexible shafts (R) from speedometer or tachometer indicator. Disconnect flexible shafts (R) from the couplings (Q) in the bulkhead. Use pliers to pull core out of bulkhead end of casing far enough to remove C retaining washer. Pull cores out through indicator end of casings. If core is broken, pull sections from both ends of casing.

(2) *Installation.* Keep cores free from dirt and apply coating of aircraft and instrument grease. Insert cores into casings from the indicator ends. Pull cores out of bulkhead end of casings far enough to install C retaining washer. Refer to CAUTION (*b*(2) above) and connect flexible shafts (R) to couplings (Q) in bulkhead and to speedometer or tachometer. Install left 40-mm ammunition box rack (par. 244).

h. Flexible Shaft 90° Drive Adapters.

(1) *Removal.* Open engine compartment access doors on left side of vehicle. Disconnect flexible shaft from 90° drive adapter (A) on final drive or engine. Unscrew coupling nut on 90° drive adapter (A) from straight drive adapter (D) and remove the 90° drive adapter.

Caution: Do not damage or lose the O-ring packing (E) and key (C).

(2) *Installation.* Install key (C) in the straight drive adapter (D) on final drive or engine. Position gasket (B) in coupling nut and aline 90° drive adapter (A) with key. Refer to CAUTION (*b*(2) above) and tighten coupling nut. Connect flexible shaft to drive adapter. Close engine compartment access doors.

i. Flexible Shaft Straight Drive Adapters.

(1) *Removal.* Open engine compartment access doors on left side of vehicle. Disconnect 90° drive adapter (A) from straight drive adapter (D) on left final drive or engine.

Caution: Do not damage or lose the key (C) and gasket (B).

Lay the flexible shaft with drive adapter to one side. Remove four hex-head bolts (F) which secure the straight drive adapter (D) to the final drive or the engine. Remove the adapter and O-ring packing (E).

(2) *Installation.* Position straight drive adapter (D) on final drive or engine so that O-ring packing (E) is seated in groove in adapter and secure with four ¼ x ¾ self-locking hex-head bolts (F). Insert key (C) in straight drive adapter (D). Refer to CAUTION (*b*(2) above) and connect drive adapter (A) to straight drive adapter (D) on final drive or engine.

j. Flexible Shaft Couplings in Bulkhead.

(1) *Removal.* Remove left rear-intermediate road wheel with arm support (par. 224). Remove left 40-mm ammunition box rack (par. 244). Assistance will be required to hold the coupling (Q) from the stowage compartment side of bulkhead from turning. Disconnect flexible shafts (K and R) or (S and R) from the coupling (Q). Remove hex jam nut (M) which secures the coupling (Q) in the bulkhead. Remove the O-ring packing (N). Remove coupling and internal-teeth lockwasher (P).

(2) *Installation.* Place ⅝-inch internal-teeth lockwasher (P) on long threaded end of coupling (Q). Insert coupling in bulkhead from stowage compartment side. Install O-ring packing (N) on coupling and be sure it seats in recess provided in bulkhead. Install ⅝-inch hex jam nut (M) on coupling and tighten. Refer to CAUTION (*b*(2) above) and connect flexible shafts to coupling. Install left rear-intermediate road wheel (par. 224). Install left 40-mm ammunition box rack (par. 244).

k. Test. To test speedometer or tachometer components or associated parts and assemblies, start engine (par. 43) and operate vehicle to see if tachometer and speedometer indicators function properly.

Section XXI. RADIO INTERFERENCE SUPPRESSION

266. Purpose

a. Radio interference suppression is the elimination or minimizing of electrical disturbances which interfere with radio reception or disclose the vehicle location to sensitive electrical detectors. It is important that vehicles with, as well as vehicles without, radios be properly suppressed to prevent interferences with radio reception in neighboring vehicles and to avoid detection.

b. Suppression in this vehicle is accomplished by use of braided bond, ground cables, toothed washers, resistor suppressors, and bypass capacitors in circuits and components where required.

Shielding is used on some primary and all secondary high voltage circuits in the engine electrical system.

267. Main Engine Suppression Equipment

a. Ignition System.

(1) *High tension cables.* On early vehicles, a metallic tube shields the high tension harness assemblies and the cable to each spark plug is individually shielded by rubber covered metallic loom terminating in appropriate fittings. On late vehicles, the conduit is bonded to the engine in six places by flexible braided straps.

(2) *Spark plugs.* Spark plugs on early vehicles, in addition to being shielded integrally, have an internal 1,000-ohm resistor that aids suppression. On late vehicles, a spark plug with an internal 10,000-ohm resistor is used.

(3) *Magnetos.* Metal caps and aluminum-clad gaskets effectively shield each magneto.

(4) *Filters.* A radio filter for each magneto is included in the booster coil unit. Each filter eliminates the radio interference from its respective magneto circuit.

b. Generator.

(1) The B terminal (fig. 147) on the generator used in early vehicles is bypassed to ground by means of 0.1 mfd, 100-volt capacitors in the radio terminal box. The E terminal is bonded to the engine with a tinned copper-braid ground strap.

(2) The generators used on late vehicles are suppressed as follows:

(*a*) The B terminal is bypassed to the generator capacitor box with a 1.75 mfd, 200 ampere, 50-volt dc. feed-through-type capacitor.

(*b*) The A and D terminals are each bypassed to the generator capacitor box with a 0.25 mfd, 20 ampere, 100-volt dc, feed-through-type capacitor.

(*c*) The E terminal is bonded to the engine with a tinned copper-braid ground strap.

268. Auxiliary Generator and Engine

a. Engine.

(1) *High tension cable.* The high tension cable from the magneto to the spark plug is enclosed in a woven metal hose shielding grounded at each end with appropriate threaded fittings.

(2) *Magneto.* An integrally shielded and suppressed magneto is utilized with a feed-through-type capacitor incorporated in the stop lead at the magneto.

(3) *Spark plug.* The spark plug is integrally shielded and suppressed.

b. Generator. All four generator leads are bypassed to the generator case with a 0.25 mfd, 20 ampere, 100-volt dc, feed-through-type capacitor.

269. Miscellaneous Electrical Components

a. Personnel Heater.

(1) *Combustion blower motor.* A 0.25 mfd, 20 ampere, 100-volt dc, feed-through-type capacitor is inserted in the power input lead to the motor at the bell housing.

(2) *Ventilating blower motor.* A 0.25 mfd, 20 ampere, 100-volt dc, feed-through-type capacitor is inserted in the power output lead to the motor at the bell housing.

b. Azimuth and Elevation Oil Gear Electric Motors. A 1.5 mfd, 60 ampere, 100-volt dc, feed-through-type capacitor is inserted in the power input lead to each motor at the motor housing.

c. Inverter. A 0.25 mfd, 20 ampere, 200-volt dc, feed-through-type capacitor is inserted in each of the three leads to the inverter at the housing.

d. Power Supply (Periscope M19).

(1) A 1.0 mfd, 35 ampere, 50-volt dc, feed-through-type capacitor is inserted in the power output lead and located in the power supply cover.

(2) The power output lead from the power supply to the periscope M19 is enclosed in shielding which is grounded at each end with appropriate threaded fittings.

e. Static Grounding Springs. Static grounding springs are located in the hub caps of the road wheels, track support rollers, and compensating wheels.

f. Electric Fuel Pumps. Personnel heater and auxiliary generator and engine electric fuel pumps have a shielded lead and a feed-through-type capacitor integral with the connector.

Section XXII. LOCAL CONTROL SYSTEM M16A1E1

270. General

Due to the complexity of the local control system M16A1E1 components that is, drive controller M12E2, oil gears M6A1E1, and

wiring set M10A1E1, maintenance beyond the scope of the using personnel must not be attempted. However, certain adjustments, maintenance, and replacement of authorized organizational spare parts as outlined in paragraphs 271 through 274 are necessary for the proper operation of the local control system. Instructions to perform these functions are contained herein. In those cases where the malfunction of the local control system cannot be corrected by adjustment or replacement of authorized spare parts, notify ordnance maintenance personnel. Refer to paragraph 52 for description of the local control system M16A1E1.

271. Inspection

a. General.

(1) *Cleanliness.* Inspect the components of the local control system M16A1E1 to make sure they have been thoroughly cleaned of corrosion-preventive compound, and there are no accumulations of grease, oil, dirt, or other foreign matter which may interfere with proper functioning.

(2) *Completeness.* Inspect for missing screws, bolts, nuts, cotter pins, and washers. Check to see that there are no loose brackets or cable clamps and that all cable assemblies are tightly secured to the receptacle assemblies of the various components.

(3) *Appearance.* Inspect components for paint which has deteriorated or chipped off. Check for evidence of dents, nicks, or scores which may effect the operation of the local control system or expose the bare metal surfaces and lead to corrosion. Notify ordnance maintenance personnel if refinishing is required.

b. Drive Controller M12E2.

(1) Check the locking knob (fig. 28) beneath the drive controller M12E2 to make sure that it seats properly and holds the drive controller in both the stowed and operating positions.

(2) Check to see that each hand grip (fig. 28) is not loose on the turret, move laterally and vertically in all positions without binding, and does not contact drive controller mount in the extreme positions.

(3) Inspect silica gel containers (fig. 269) in rear and side of drive controller base for proper blue color. If color of desiccant is pink, silica gel containers must be replaced (par. 274*c*(1)).

(4) Place gun mount in power operation (par. 59*b*(1)). Turn fire control safety switch (fig. 28) to the ON position and depress trigger assembly in each hand grip singly, or both and simultaneously while observing action of firing solenoids (fig. 263). Action of firing solenoids should be immediate and positive.

Warning: Be sure dual gun M2A1 is cleared of ammunition before operating drive controller trigger assemblies. Refer to *d*(2) below for mechanical check of firing solenoids.

c. Oil Gears M6A1E1.

(1) Inspect the elevation and azimuth oil gears M6A1E1 (figs. 27 and 29) for indications of oil leakage around all covers and at the output coupling (fig. 259).

(2) Check that level of hydraulic oil, in oil gear reservoir, covers half of inspection window. If oil is not up to proper level, fill as prescribed in lubrication order LO 9–7218 (par. 90).

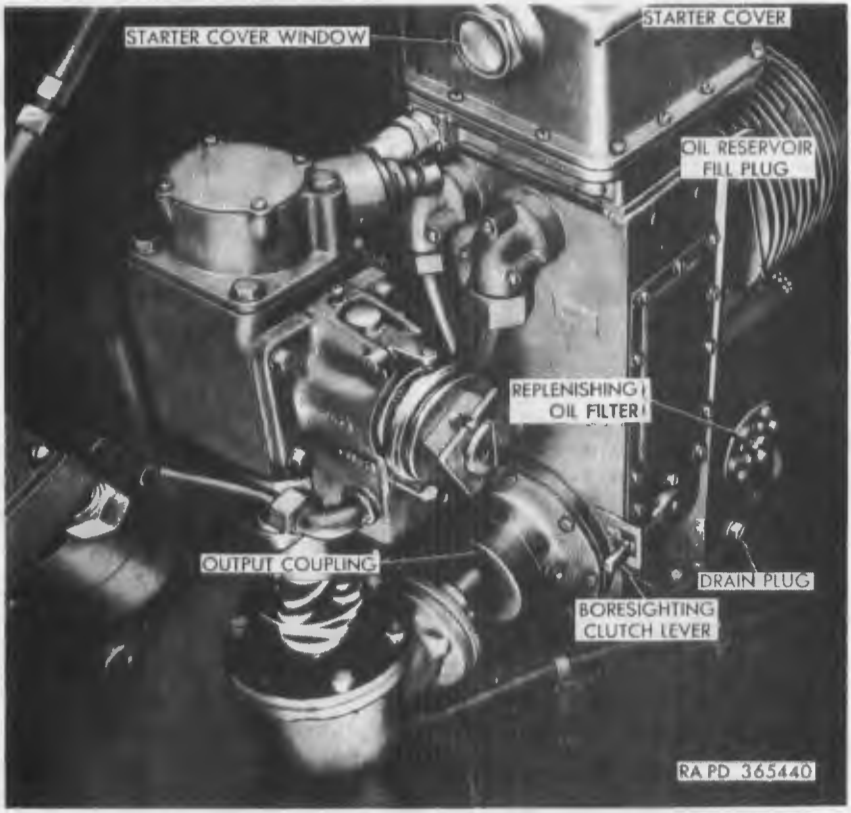


Figure 259. Azimuth oil gear M6A1E1—installed view.

(3) Unscrew the two oil reservoir fill plugs (fig. 259), one on each side, at top of oil gear reservoir and lift out filters. Inspect filters for cleanliness and clean thoroughly using dry-cleaning solvent or mineral spirits paint thinner.

Note. Clean area around fill plugs before removing. Under no circumstances are filters to be removed during filling operation.

(4) Remove replenishing oil filter, inspect for cleanliness, disassemble, and clean as required (par. 273*c*).

(5) Check to make sure that slewing clutch linkage (fig. 260) is properly adjusted (par. 272*b*). Slewing clutch levers on both oil gears should touch the rear of the

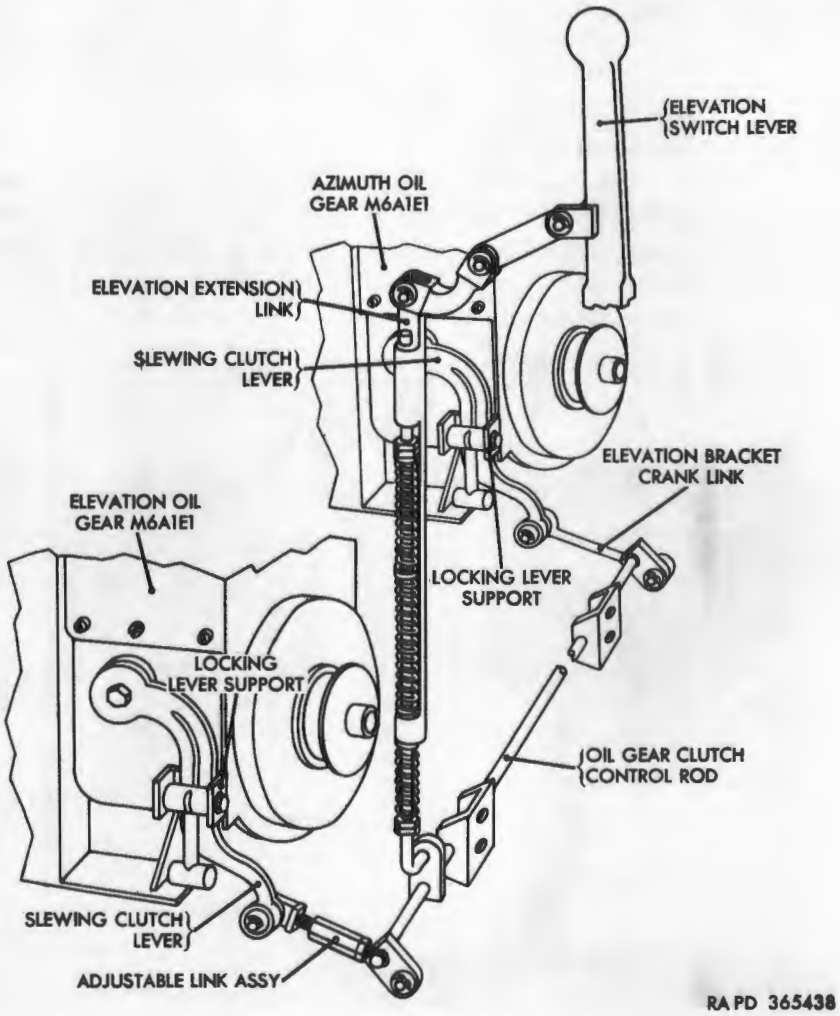


Figure 260. Slewing clutch linkage.

locking lever supports when the elevation switch lever is in the ON position.

Caution: Do not attempt to power operate the gun mount if any maladjustment of slewing clutch linkage is evident.

(6) Unscrew cam access cover (fig. 261) on elevation oil gear and check setting of hydraulic limit stop adjustment components. Cam pin should be opposite the —3° reading on the receiver adapter cover. If maladjustment is evident, correct setting (par. 272*c*).

Note. The adjustment components are set inoperative in the azimuth oil gear and need not be inspected unless the gun mount cannot be traversed through a full 360° during power operation.

(7) Inspect desiccator in each oil gear for proper blue color by viewing desiccator through starter cover window (fig. 259). If color of dessicant is pink, desiccator must be replaced (par. 274*c*(2)).

d. Wiring Set M10A1E1.

(1) *General.* Inspection of the wiring set components (fig. 262), slipring, inverter box, distribution box, firing solenoids, control selector box, elevation switch, and lighting device or reflex sight light will be limited primarily to a visual inspection (*a* above).

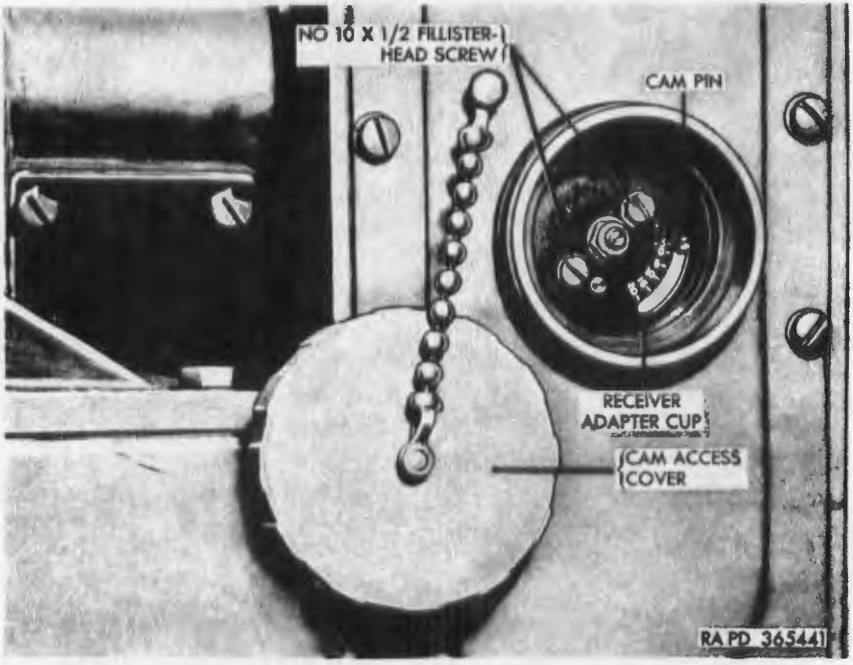


Figure 261. Elevation oil gear hydraulic limit stop adjustment components.

Note. The control selector box is not installed on late vehicles.

Special attention however, should be given the cables which interconnect these components, the oil gears, and the drive controller. Inspect cable insulation for cuts, cracks, or deterioration. Lubricants should not be permitted to come in direct contact with the cables since oil or grease will cause rapid deterioration of the cable insulation. Maintenance operations on the wiring set components, with the exception of those items for which instructions are contained in paragraph 273, must not be attempted by using personnel.

(2) *Firing solenoids* (fig. 263). Inspect action of each firing solenoid by pulling up on firing mechanism lever to free plunger shaft. Move shaft up and down and rotate. Check for any binding of shaft. Using a thickness gage, check clearance between each firing mechanism lever and the firing plunger in the gun trunnion. Clearance can be

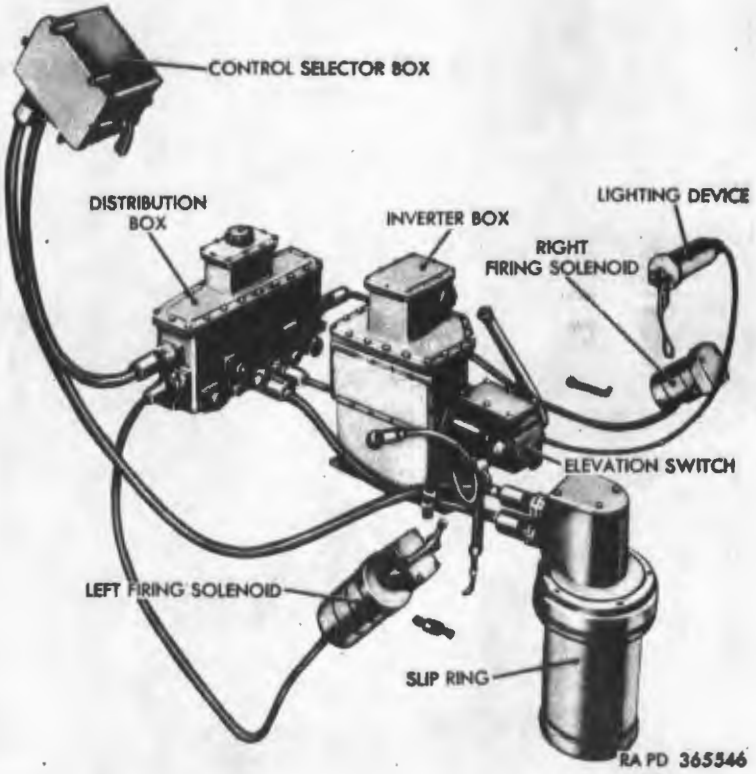


Figure 262. Parts of wiring set M10A1E1.

between 0.030 and 0.064-inch, but clearance of both must be identical in order for both guns to fire simultaneously.

Note. Refer to *b*(4) above for electrical check of firing solenoids. If firing solenoid is not operating properly, it must be replaced (par. 274*d*).

(3) *Desiccators.* Inspect desiccators installed in inverter box (fig. 31) and distribution box for proper blue color by viewing desiccators through cover windows. If color of desiccant is pink, desiccator must be replaced (par. 274*c*(3) and (4)).

e. Lubrication. Inspect all movable parts and components of the local control system that they have been properly lubricated in ac-

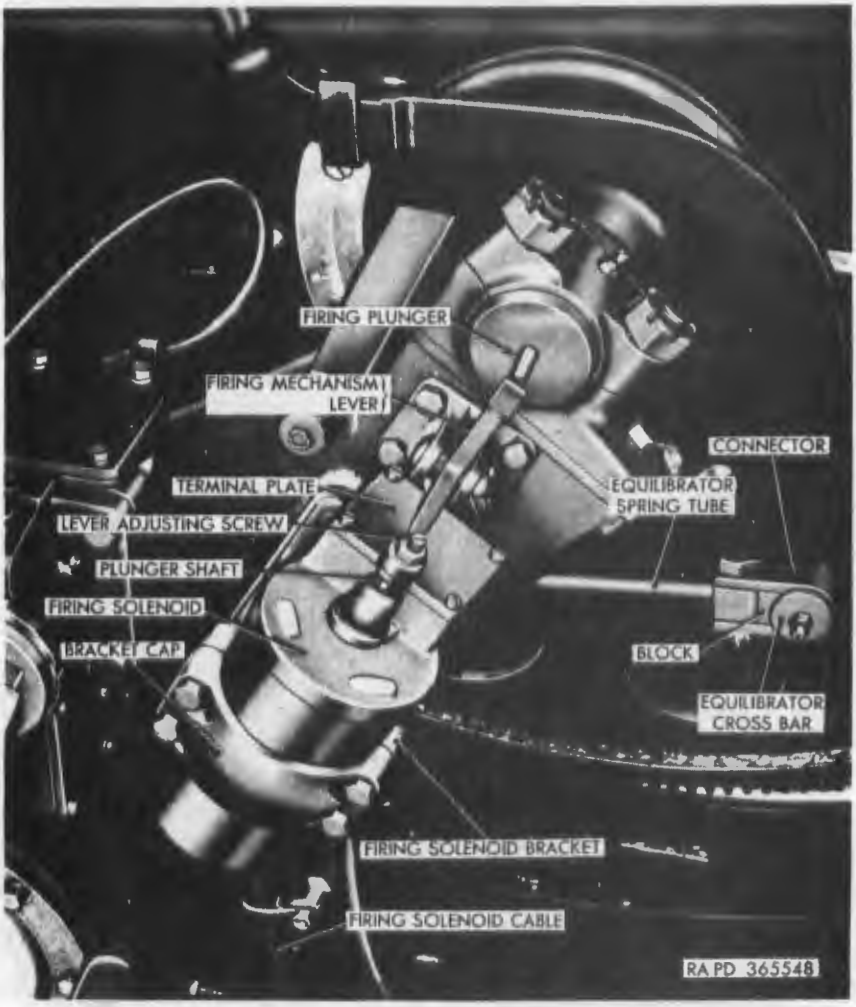


Figure 263. Left firing solenoid and equilibrator spring tube—installed view.

cordance with instructions contained in lubrication order LO 9–7218 (par. 90).

272. Adjustments

a. General. The instructions for adjusting components of the local control system contained in this paragraph are provided only for the use of organizational maintenance personnel. Under no circumstances are using personnel to perform these operations.

b. Slewing Clutch Linkage (fig. 260).

(1) *General.* It is imperative that the slewing clutch linkage interconnecting the oil gears M6A1E1 be properly adjusted. A maladjustment will cause the slewing clutch gearing to become damaged and extensive repairs will have to be made to the oil gears.

(2) *Procedure.*

(*a*) With master relay switch in the OFF position, move elevation switch lever rearward to the ON position.

(*b*) Check slewing clutch lever on azimuth oil gear. Lever should be tight against locking lever support. If not, loosen locknut and turn coupling of adjustable link until azimuth oil gear slewing clutch lever strikes rear of locking lever support.

(*c*) Check to see that elevation oil gear slewing clutch lever is also striking rear of its locking lever support. If not, turn coupling of adjustable link until it does, and tighten locknut on adjustable link to secure linkage in position.

(*d*) If the azimuth oil gear slewing clutch lever cannot be set in its proper position by the adjustable link, a further adjustment of the slewing clutch linkage is available on the elevation extension link which connects the elevation switch lever to the oil gear clutch control rod.

(*e*) Loosen hex locknuts at both top and bottom of elevation extension link. Turn jam nut at bottom of link counterclockwise and jam nut at top clockwise until bellcranks on control rod move slewing clutch levers to a position within the adjusting limits of the adjustable link. Tighten both locknuts and make the final adjustment of the slewing clutch levers ((*a*) through (*c*) above).

c. Elevation Oil Gear M6A1E1.

(1) *General.* Hydraulic limit stops of the elevation oil gear M6A1E1 (fig. 27) should permit operation of the dual

gun M2A1 through a range of —3° depression to +85° elevation. A deviation of ±1° is permissible. If the dual gun M2A1 cannot be operated throughout its full limit of travel, proceed as outlined below.

(2) *Procedure.*

(*a*) Unscrew cam access cover (fig. 261) on elevation oil gear and check that cam pin is opposite the —3° marking. If necessary to reset cam pin, loosen the two fillister-head screws on the receiver adapter cup and move the cam pin until it is opposite the —3° mark. Tighten the two No. 10 x ½ fillister-head screws.

(*b*) Be sure that elevation switch lever (fig. 260) is forward or in the off position and disengage the boresighting clutch by moving the boresighting clutch lever (fig. 259) to the up position.

(*c*) Manually depress the dual gun M2A1 to —3 degrees as indicated on the elevation plate (fig. 33).

(*d*) Place gun mount in power operation (par. 59) and hold drive controller hand grip (fig. 28) in a fully depressed position so that the elevation oil gear will reach its hydraulic limit. While holding the hand grips in the depressed position, move the elevation switch lever (fig. 260) forward to the off position, and engage the boresighting clutch by moving the boresighting clutch lever (fig. 259) to the down position.

Caution: Do not engage boresighting clutch or release hand grips until elevation oil gear has completely stopped.

(*e*) Place gun mount in power operation (par. 59) and check that dual gun can be operated from —3° depression to +85° elevation. If trouble is not corrected, notify ordnance maintenance personnel.

(*f*) Install cam access cover.

273. Maintenance

a. Lubrication. Perform only those lubrication operations specified on lubrication order LO 9–7218 (par. 90). Lubrication of internal parts of local control system components is an ordnance maintenance function.

b. Draining and Refilling of Oil Gear M6A1E1.

(1) Place gun mount in power operation (par. 59). After 10 minutes of operation. Turn off elevation switch by moving elevation switch lever forward toward muzzle end of gun.

(2) Immediately remove drain plug (fig. 259) and gasket and oil reservoir fill plug.

Note. Oil reservoir drain plugs are located below the nameplate, and on each side of the oil reservoir. A gear compartment drain plug is located at the bottom of the gear compartment cover. Only one drain plug has to be removed.

(3) Allow the oil to drain from the oil gear and check oil for water, sludge, metallic particles, or evidence of corrosion. Should any evidence of metallic particles or corrosion exist, notify ordnance maintenance personnel.

(4) Install the drain plug or plugs and gasket.

(5) Pour oil as specified on lubrication order LO 9–7218 (par. 90) through the filler opening slowly. The filling will take approximately 12 minutes. Oil drained from any unit should not be reused.

Note. Do not under any circumstances remove the filter from the filler opening while filling.

(6) Install the oil reservoir fill plug (fig. 259) and tighten.

c. *Cleaning of Replenishing Oil Filter.*

(1) Remove the inner circle six hex-head bolts and internal-teeth lockwashers securing the replenishing oil filter (fig.

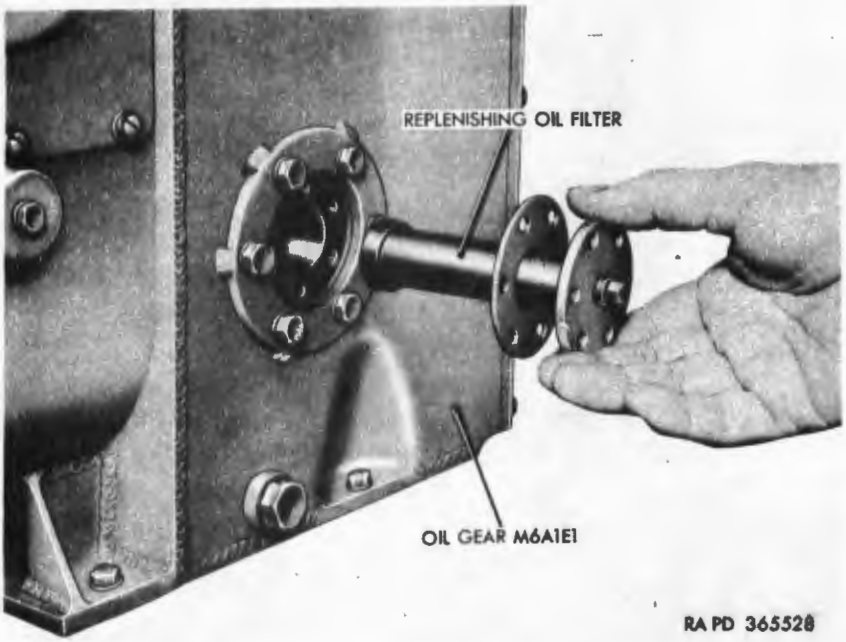


Figure 264. Removal or installation of replenishing oil filter.

259) and filter gasket to the filter housing. Pull out replenishing oil filter (fig. 264) and remove gasket.

(2) Examine filter for evidence of water, sludge, metallic particles, or corrosion. Foreign matter in the filter should, if possible, be identified as to source. The presence of any metallic particles is an indication of excessive wear of the oil gear hydraulic components. Report such findings to ordnance maintenance personnel.

Note. When a new oil gear, or a newly-rebuilt oil gear is first operated, the filter may clog up during the first few minutes of operation. The symptom of a congested filter is absence of vibration at the output coupling (fig. 259) or sluggish operation of the gun or gun mount during rapid acceleration. After a few cleanings of the filter, the difficulty should disappear and the oil gear will operate satisfactorily.

(3) Disassemble the replenishing oil filter for cleaning. Remove the pipe plug (fig. 265) from the oil filter head. Remove the fillister-head screw and internal-teeth lockwasher securing filter parts together. Separate filter retainer, oil filter, and filter head.

(4) Clean all parts of filter thoroughly with dry-cleaning solvent or mineral spirits paint thinner and allow to dry before assembling.

(5) Position oil filter (fig. 265) and filter retainer on oil filter head. Install the No. 10 internal-teeth lockwasher on the No. 10 x 3¼ fillister-head screw. Insert screw through retainer and filter and secure to oil filter head. Install ⅛-inch pipe plug in oil filter head.

(6) Slip filter head gasket over oil filter and position on filter head. Install replenishing oil filter (fig. 264) into filter

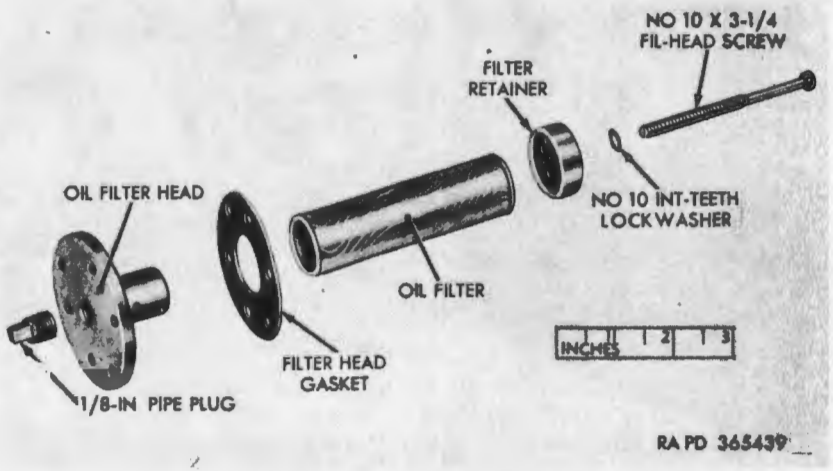


Figure 265. Parts of replenishing oil filter.

housing in oil gear reservoir. Aline bolt holes and secure with six ¼ x ⅝ hex-head bolts and ¼-inch internal-teeth lockwashers.

274. Replacement of Authorized Spare Parts for Local Control System M16AE1

a. General. Replacement of authorized spare parts by the using personnel is limited to replacement of lamps in the control selector box, lighting device, and reflex sight light. Replacement of the silica gel containers, desiccators, and firing solenoids is a function of organizational maintenance personnel (par. 2).

b. Replacement of Lamps.

(1) *Control selector box* (fig. 266).

Note. The control selector box is not installed in late vehicles.

To replace the neon lamp which is installed in each of the signal lights of the control selector box, unscrew the signal light cap and remove the gap gasket. Depress the neon lamp, rotate one-quarter turn counterclockwise, and lift out lamp. Position new lamp in light socket, depress, and rotate one-quarter turn clockwise to secure. Install signal light cap and gasket.

(2) *Lighting device or reflex signal light.* The replacement of the lamps in the lighting device (fig. 267) or reflex signal

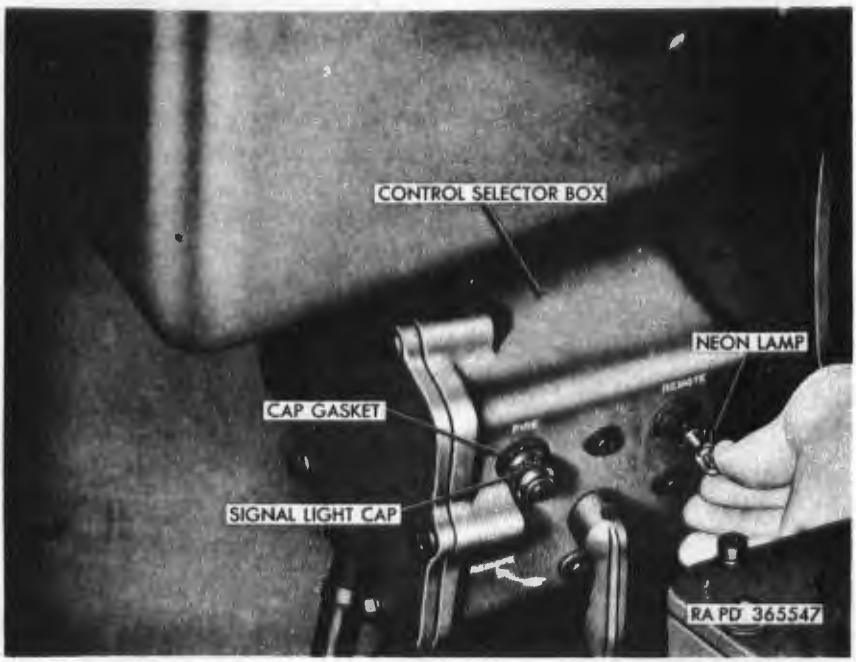


Figure 266. Replacing neon lamp in control selector box.

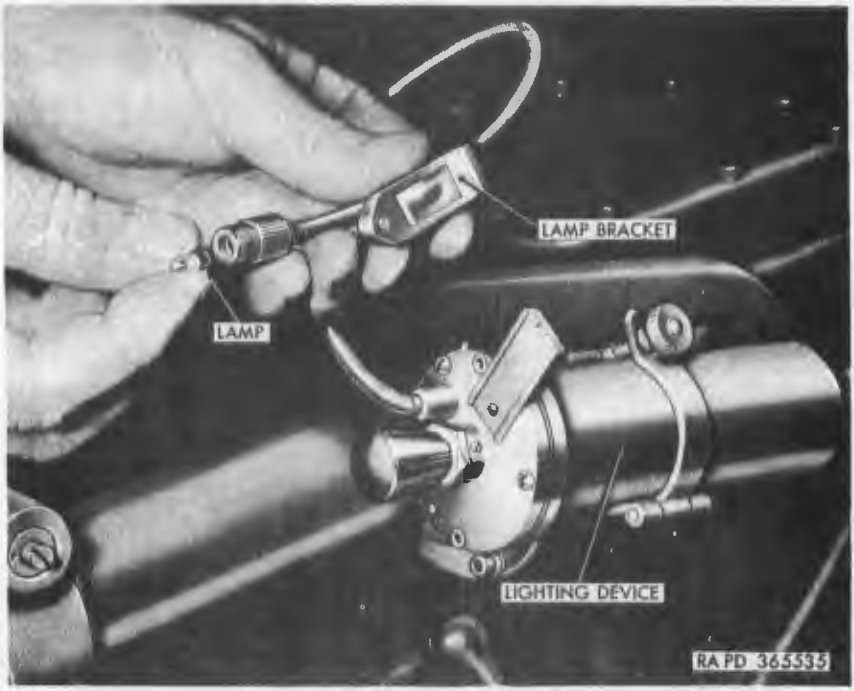


Figure 267. Replacing lamp in lighting device.

Figure 268. Replacing lamp in reflex signal light.

light (fig. 268) is accomplished in the same manner. Unscrew the lamp bracket from the lead cable and remove bracket. Unscrew lamp from lead cable. Install new lamp on lead cable. Install lamp bracket on lead cable.

c. *Replacement of Silica Gel Containers and Desiccators.*

(1) *Drive controller M12E2* (fig. 269). To replace either silica gel container in the drive controller, unscrew the container from the drive controller base. Remove the container gasket from the container. Install container gasket on new silica gel container and install container in drive controller base. Tighten.

(2) *Oil Gear M6A1E1* (fig. 270). To replace the desiccator in either oil gear, remove 13 fillister-head screws and lockwashers securing the starter cover, and remove cover. Remove four fillister-head screws and lockwashers securing desiccator retaining plate and desiccator within starter cover. Remove plate and lift out desiccator. Place new desiccator within starter cover. Position desiccator retaining plate and secure with four No. 5 x 3/8 fillister-

Figure 269. Replacing silica gel container in drive controller M12E2.

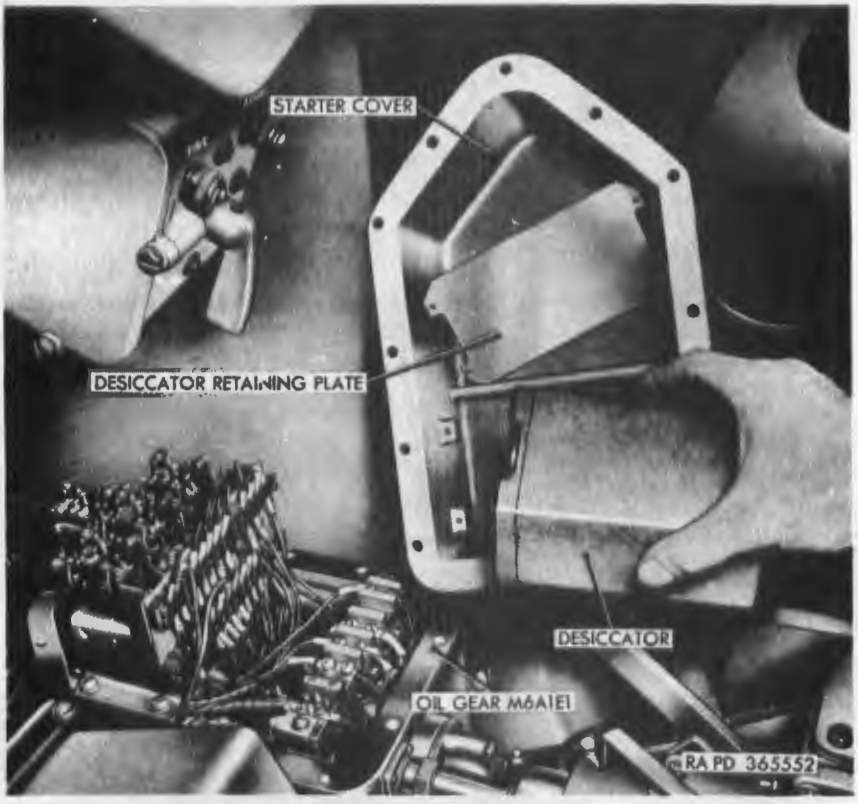


Figure 270. Replacing desiccator in oil gear M6A1E1

head screws and No. 5 lockwashers. Position starter cover on oil gear case and secure with six ¼ x 2¼ fillister-head screws, seven ¼ x ¾ fillister-head screws, and thirteen ¼-inch lockwashers.

(3) *Inverter box* (fig. 271). To replace the desiccator in the inverter box, remove 10 fillister-head screws and internal-teeth lockwashers securing desiccator cover to inverter box. Remove cover and lift out desiccator. Place new desiccator within inverter box. Position desiccator cover on inverter box and secure with ten ¼ x ¾ fillister-head screws and ¼-inch internal teeth lockwashers.

(4) *Distribution box* (fig. 272). To replace the desiccator in the distribution box, remove 10 cap screws and internal-teeth lockwashers securing desiccator cover to distribution box and remove cover. Lift out desiccator. Place new desiccator within distribution box. Position desiccator cover on distribution box and secure with ten ¼ x ¾ cap screws and ¼-inch internal-teeth lockwashers.

Figuree 271. Replacing desiccator in inverter box.

d. Replacement of Firing Solenoid (fig. 263). The replacement of either the left or right firing solenoid is identical.

(1) *Removal*

(*a*) Remove four fillister-head screws and lockwashers securing terminal plate and gasket to firing solenoid body and remove plate and gasket.

(*b*) Remove two fillister-head screws and internal-teeth lockwashers securing wire terminals of firing solenoid cable to terminal block. Unscrew knurled follower from coupling and pull out cable with attached follower, cupped washer, and molded bushing. Unscrew coupling from firing solenoid body.

(*c*) Remove four hex-head cap screws and lockwashers securing bracket cap to firing solenoid bracket and re-

Figure 272. Replacing desiccator in distribution box.

move bracket cap. Lift firing mechanism lever and remove firing solenoid.

(2) *Installation.*

(*a*) Remove terminal plate and gasket ((1) (*a*) above) from new firing solenoid. Install coupling previously removed from inoperative firing solenoid in new firing solenoid.

(*b*) Lift firing mechanism lever and position firing solenoid in firing solenoid bracket. Install bracket cap and secure with four ⅜ x 1½ hex-head cap screws and ⅜-inch lockwashers.

(*c*) Insert firing solenoid cable through coupling. Connect neutral and white wire terminals marked "F" to terminal post marked "F" and black wire terminal marked "G" to terminal post marked "G" of terminal block, using the No. 6 x ¼ fillister-head screws and No. 6 internal-teeth lockwashers provided with terminal block.

(*d*) Position molded bushing into coupling, assuring a watertight fit. Seat cupped washer in follower and tighten follower on coupling.

(*e*) Position terminal plate and gasket on firing solenoid body and secure with four No. 10 x 3/8 fillister-head screws and No. 10 lockwashers.

(3) *Adjustment.* Using a thickness gage, check clearance between firing mechanism lever and the firing plunger in the gun trunnion. Clearance can be between 0.030 and 0.064-inch, but clearance between both firing mechanism levers and firing plungers must be identical in order for both guns to fire simultaneously. To adjust clearance, loosen locknut securing lever adjusting screw on firing mechanism lever and turn adjusting screw in or out until proper clearance is obtained. Tighten locknut.

(4) *Test.* Test operation of firing solenoid (par. 271*b*(4)).

Note. If firing solenoid operates as soon as gun mount is placed in power operation, firing solenoid cable wires were reversed during installation. Check terminal connections ((2)(c) above).

Section XXIII. SIGHTING AND FIRE-CONTROL INSTRUMENTS

275. General

a. Care in Handling Sighting and Fire-Control Equipment.

(1) Sighting and fire-control instruments are, in general, rugged and suited for the designed purpose. They will not, however, stand rough handling or abuse. Inaccuracy or malfunctioning will result from mistreatment.

(2) Unnecessary turning of screws or other parts not required in the use of the instruments is forbidden.

(3) Stops are provided on instruments to limit the travel of the moving parts. Do not attempt to force the rotation of any knob beyond the stop limit.

(4) Keep the instruments as dry as possible. If an instrument is wet, dry it carefully before placing it in its carrying case.

(5) When not in use, instruments must be kept in the carrying cases provided or covered and protected from dust and moisture.

(6) Any instruments which indicate incorrectly or fail to function properly after the authorized tests and adjustments have been made, are to be turned in for repair by ordnance maintenance personnel. The authorized tests and adjustments are those for which tools and parts

(pars. 86 through 89) have been provided. Adjustments other than those expressly authorized are not the responsibility of the using arm personnel.

(7) Complete painting of the sighting and fire-control equipment by the using personnel is not permitted. Scratched, chipped, or worn surfaces exposing bare metal should be touched up to prevent rust or corrosion.

(8) Do not point an optical instrument directly at the sun unless a filter is used, as the heat of the focused rays may damage optical elements.

b. Optical Parts.

(1) To obtain satisfactory vision, it is necessary that the exposed surfaces of the lenses and other parts are kept clean and dry. Corrosion and etching of the surface of the glass, which interfere with vision, can be prevented or greatly retarded by keeping the glass clean and dry.

(2) ***Caution:*** Under no circumstances should polishing liquids, pastes, or abrasives be used for polishing lenses and windows.

(3) For wiping optical parts, use only lens tissue paper especially intended for cleaning optical glass. Use of cleaning cloths is not permitted. To remove dust, brush the glass lightly with a clean artist's camel's hair brush. Rap the brush against a hard body to dislodge the small particles of dust that cling to the hairs. Repeat this operation until all dust is removed.

(4) Exercise particular care to keep optical parts free from oil and grease. Do not touch the lenses or windows with the bare fingers. To remove oil or grease from optical surfaces, apply alcohol with a tuft of lens tissue paper, and wipe gently, in a circular motion with clean lens tissue paper. If alcohol is not available and the temperature is above freezing, breathe heavily upon glass and wipe off with clean lens tissue paper. Repeat this operation until clean.

(5) In cold weather, optical surfaces should be cleaned with lens tissue paper moistened with alcohol. If alcohol is not available, use dry lens tissue paper. Wipe gently in a circular motion to avoid scratching or removing the coated surface. Alcohol should never be applied directly to the lens surfaces, as any excess may injure the sealing compound. Do not breathe on the optics.

(6) Because of condensation, moisture may collect on the optical parts of the instrument when the temperature of the parts is lower than that of the surrounding air. This moisture, if not excessive, can be removed by placing the instruments in a warm place. Heat from strongly concentrated sources should not be applied directly, as it may cause unequal expansion of parts, thereby resulting in damage to optical parts and inaccuracies of function.

c. Batteries.

(1) Dry cell-type batteries are used in the instrument light 7983714 (fig. 41) for the azimuth indicator M27. These batteries should habitually be removed whenever the light is not in use. Chemical reaction set up in an exhausted battery will damage the battery tube.

(2) To replace batteries, remove cap from instrument light tube. The cap is secured by a bayonet-type lock. When replacing the batteries, be sure they go back into the tube in the same position as when removed and that the cap is properly installed to insure a tight contact between the battery terminals.

d. Lubrication.

(1) Lubricants (par. 91) for sighting and fire control instruments function also as a rust-preventive. It is important that they be applied carefully and effectively. Extreme care should be taken not to apply lubricants excessively. Excessive lubrication of certain parts may be as damaging as the absence of any lubricant. Wipe off excess lubrican to prevent the accumulation of dust and dirt.

(2) Only ordnance maintenance personnel will disassemble to clean and lubricate the internal mechanisms of the instruments.

276. Inspection of Sighting and Fire-Control Instruments

a. General.

(1) Inspection of the sighting and fire-control instruments by the using arm should cover functionability, damage, and appearance.

(2) Replacement of parts, other than those listed in ORD 7 SNL G–253, must be accomplished by ordnance maintenance personnel.

b. Computing Sight M38.

(1) The appearance of the computing sight M38 (T154) will indicate its general condition and will reflect the type of

treatment it has received. Bent or broken parts indicate abuse and need of repairs or adjustment.

(2) Examine computing sight for missing nuts, bolts, pins, screws, rivets, and parts.

(3) Examine computer leveling pads (fig. 48) for nicks, burs, or damage that would render them unserviceable.

(4) Examine computer cover (fig. 49) on the bottom of the computer. The cover must be free from cracks, tears, and broken stitching and it must be flexible.

(5) Check movement of computer bail (fig. 24), speed knobs, and computer positioning handwheel for free action throughout their limits of travel. Detent action on speed knobs and positioning handwheel must be positive. The position of the bail must remain undisturbed when speed knobs are rotated.

(6) Examine condition of exposed machined surfaces for corrosion.

(7) Check the painted surfaces for worn spots, scratches exposing bare metal, or chipped or loose paint.

(8) Check that all graduations, lettering, numbers, and indices are clear and distinct.

c. Reflex Sight M24C.

(1) Examine the main body assembly of the reflex sight M24C (A, fig. 47). The mounting hole and positioning stud must be clean and free from nicks or burs which would prevent proper mounting.

(2) Check that mounting surfaces of lamp bracket are free of burs and paint.

(3) Check desiccator for proper blue color. Replace desiccator (par. 277*b*) when the color indicates saturation (pink).

(4) Examine reflector bracket and make sure the reflector fits securely. The bracket should be free of foreign matter.

d. Ring Sight and Peep Sight (fig. 27).

(1) Inspect the ring sights for rust or corrosion and burs which might prevent proper mounting.

(2) Inspect peep sight for rust or corrosion, thread damage, and burs which might prevent proper mounting.

e. Gunner's Quadrant M1 and M1A1 (figs. 43 and 44).

(1) Examine the shoes of the gunner's quadrant M1 or M1A1 for nicks or burs which might cause inaccurate readings.

(2) Check the micrometer knob for smoothness of operation. It should revolve without binding or looseness.

(3) Examine level vial for broken glass or leakage.

(4) Check carrying case for broken straps or fasteners.

f. Azimuth Indicator M27 and Instrument Light 7983714.

(1) Remove the azimuth indicator cover and examine resetter knob (fig. 42) and dial window for visible damage.

(2) With the resetter knob in its normal (up) position, turn the knob and observe if the top pointer turns in either direction, without movement of the other two pointers.

(3) Press down and and turn the resetter knob and observe if the top and middle pointers turn in unison.

(4) Traverse the gun mount manually and observe that all three pointers turn, with the top pointer making one complete revolution while the bottom and middle pointers move one graduation.

(5) Turn the gunner's aid dial (fig. 42) to see that it is free to turn and when released it is held in the turned position.

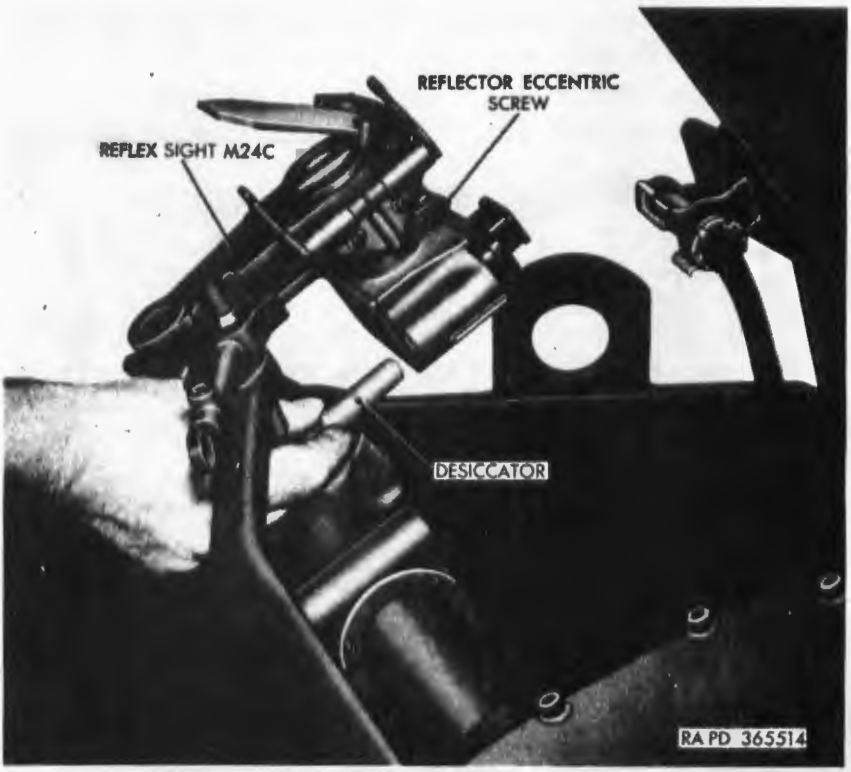


Figure 273. Replacing desiccator in reflex sight M24C.

(6) Install two dry-cell batteries in the instrument light 7983714 (fig. 41) and connect the cable to the azimuth indicator socket. Snap the toggle switch to the on position; both lamps in the azimuth indicator should light. If lamps are defective and replacement is required, refer to paragraph 277*e*.

277. Replacement of Authorized Spare Parts for Sighting and Fire-Control Equipment

a. General. Replacement of authorized spare parts by the using personnel is limited to replacement of the periscope M19 head assembly and lamp in the azimuth indicator M27. Replacement of desiccators and flexible shaft is a function of organizational maintenance personnel (par. 2).

b. Replacement of Desiccator in Reflex Sight M24C (fig. 273).

(1) Remove fillister-head plug, brass washer, gasket, pad, and desiccator. Pink color of desiccator indicates a need for replacement.

(2) Insert desiccator, pad, gasket, brass washer, and secure with $\frac{5}{8}$ x $\frac{9}{32}$ fillister-head plug.

c. Replacement of Flexible Shaft (fig. 24).

(1) Unscrew flexible shaft coupling from flexible shaft

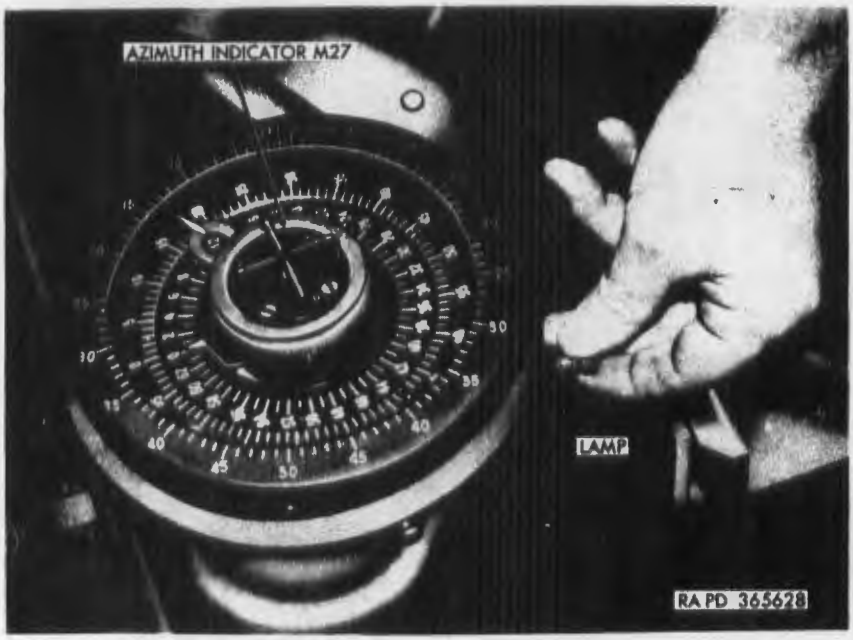


Figure 274. Replacing lamp in azimuth indicator M27.

adapter on the computing sight and also from the adapter on the traversing mechanism and remove flexible shaft.

(2) Aline splines of new flexible shaft with adapter on computing sight and secure to adapter with coupling nut. Insert free end of shaft through retaining loop, welded to the inside of gunner's shield, and secure to adapter in traversing mechanism.

d. Replacement of Periscope M19 Head Assembly (fig. 20).

(1) Turn the two body latch eccentrics on the periscope M19 counterclockwise until the head assembly is released and remove the head assembly from periscope.

(2) Remove spare head assembly from stowage box in front door (fig. 6). Position the head assembly into the top of the periscope M19 and turn the two body latch eccentrics clockwise to secure the head assembly to the periscope.

e. Replacement of Lamps in Azimuth Indicator M27 (fig. 274).

(1) Unscrew the base and lamp from azimuth indicator M27.

(2) Insert new lamps and install into azimuth indicator M27.

Section XXIV. 40-MM AUTOMATIC DUAL GUN M2A1

278. Cyclic Functioning of Gun (Automatic Fire)

a. General.

(1) The cyclic functioning of each gun in automatic, from the firing of one round to the next, is described in the following paragraphs. The function of each mechanism such as breechblock, automatic loader and rammer, recoil cylinder, etc., is given in the pertinent sections which follow.

Note. The cyclic action for both guns is the same upon actuation of components necessary for firing. Herein, the left gun will be used for purposes of illustration and description.

(2) The motions of the various parts occur in a definite, timed, and interrupted manner. To bring out this relationship and to illustrate their related functions at specific points during the firing cycle, figures 276 through 281 show the actions and positions of parts at six stages during the firing cycle.

(3) To obtain automatic fire, certain conditions must be met. The feed control thumb lever (fig. 34) must be in the direction of the arrow, one round must be on the loader tray, and two or more rounds of ammunition must be in the automatic loader. The firing selector lever (fig. 33)

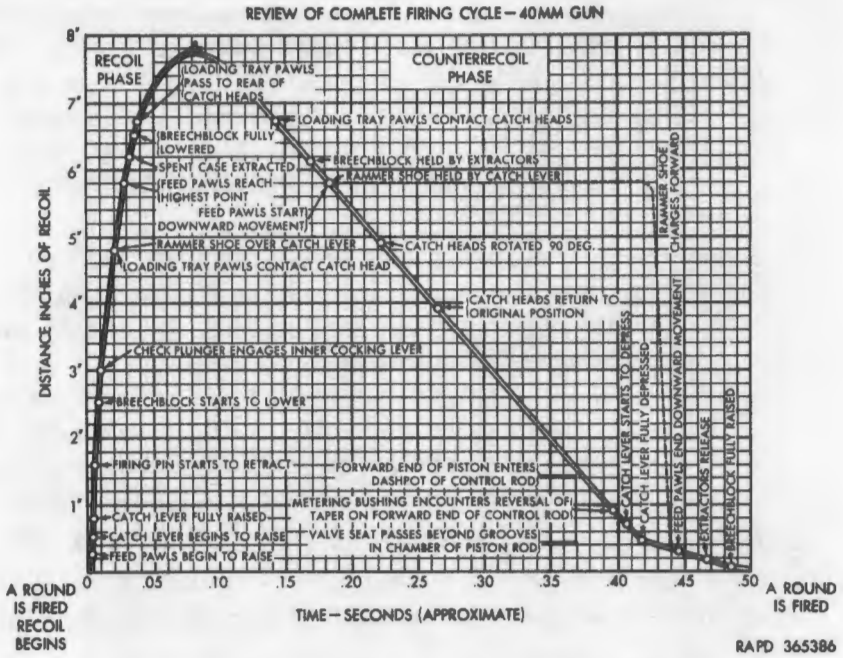


Figure 275. Review of complete firing cycle 40-MM gun.

must be in AUTO FIRE position. Firing triggers or firing mechanism pedal must be depressed.

(4) Part of the firing cycle occurs during recoil. The balance occurs during and at the end of counterrecoil. Figure 275 indicates the approximate time for the action of the various parts during the cycle.

b. First Stage—During Recoil.

(1) Figure 276 shows the position of the parts just after the primer of the cartridge case has been struck by the firing pin. Immediately after firing, the barrel, breech ring, and loader tray begin to recoil and the projection on the bottom of the loader tray relieves its pressure from the rammer releasing lever, permitting the tray rammer catch lever to rise. During the first few inches of the recoil, the breech ring outer crank rotates enough to cause the firing pin to be withdrawn into the breechblock.

(2) As recoil continues, the breech ring outer crank continues to be rotated by the cam surfaces of the side cover. The breech ring inner cranks begin to lower the breechblock. In doing so, they actuate the breechblock outer cocking lever which cocks the firing pin for the next cycle. The

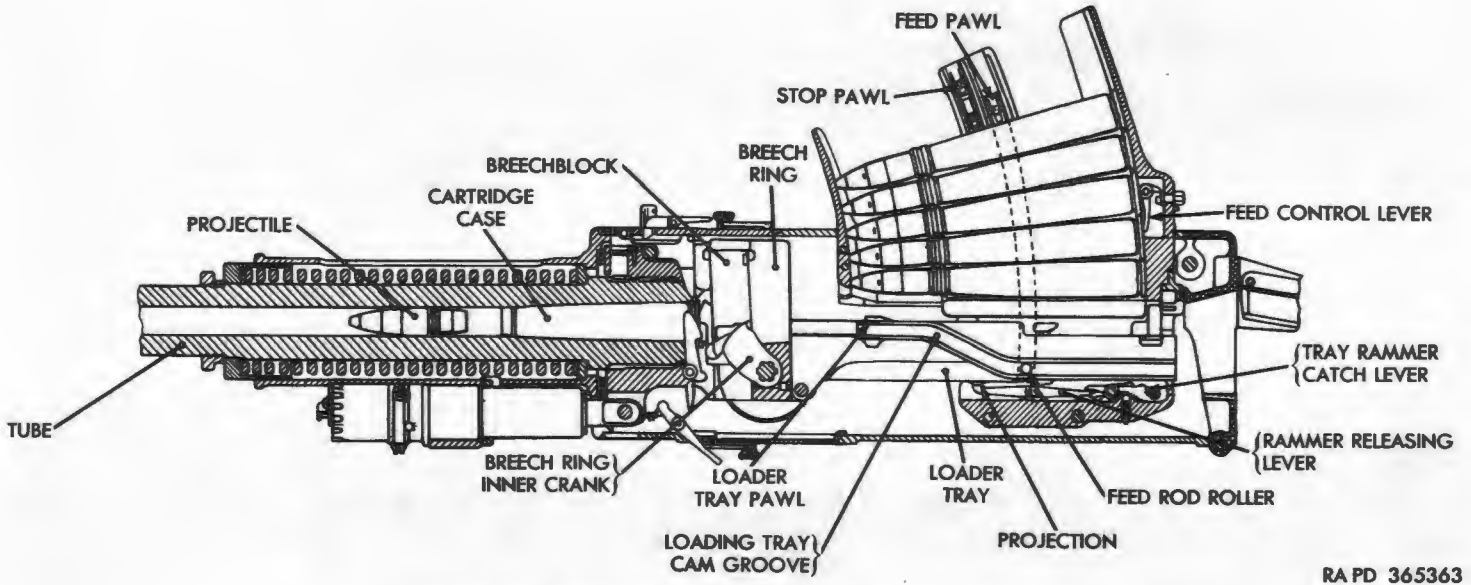


Figure 276. Automatic firing cycle—first stage—gun firing.

breechblock inner cocking lever plunger engages the breechblock inner cocking lever.

(3) As the loader tray moves to the rear, the cam grooves move past the feed rod rollers on the ends of the feed rods and the rollers enter the inclined portion of the grooves, raising the feed rods. The feed rods carry the feed pawls upward and over the next cartridge in the loader. The cartridges are prevented from being raised by the stop pawls. The loader tray pawls on the front of the loader tray are depressed by and pass under the lugs which extend sidewise from the feed roller catch heads.

c. Second Stage—During Recoil.

(1) Figure 277 shows the position of the parts when the breechblock has been lowered part of the way in its slides in the breech ring. The feed rods, holders, and pawls are nearing their extreme upward position. The rammer shoe is over the tray rammer catch lever. The loader tray is free of obstructions to permit the ejection of the empty case because the rammer levers were forced to the sides of the tray by their cam grooves at the same time they released the cartridge in ramming it.

(2) As the breechblock descends, the projections at the sides of the front face of the breechblock strike the toes of the extractors. The extractors are rotated toward the rear and their lips catch the rim of the cartridge case and eject it. The empty case is thrown with considerable force out of the chamber, along the loader tray, through the rear cover opening, against the cartridge case deflector, and into the cartridge case chute. The case slides down the chute, under the gun, and out under the vehicle.

d. Third Stage—During Recoil. Figure 278 shows the position of the parts at the end of recoil. The empty cartridge case has been extracted. The breechblock is in its lowered position. The feed rod rollers are in the upper horizontal portion of the loader tray cam grooves and the feed rods are fully raised. Recoil has been stopped by the action of the recuperator spring and the recoil cylinder. The hook-shaped heads of the extractors are over the notched tops of the projections on the front face of the breechblock. The rammer shoe is to the rear of the tray rammer catch lever, and the loader tray pawls are to the rear of the feed roller catch heads.

e. Fourth Stage—During Counterrecoil.

(1) Figure 279 shows the position of the parts as the cartridge drops onto the loader tray and is engaged by the

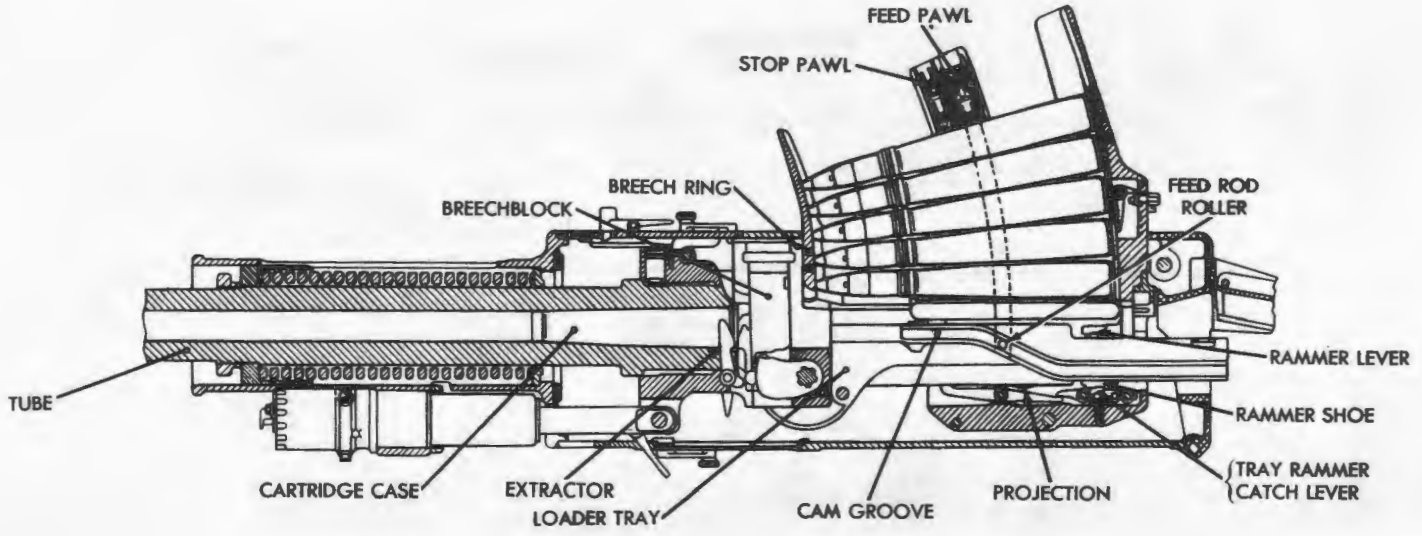


Figure 277. Automatic firing cycle—second stage—breechblock being lowered.

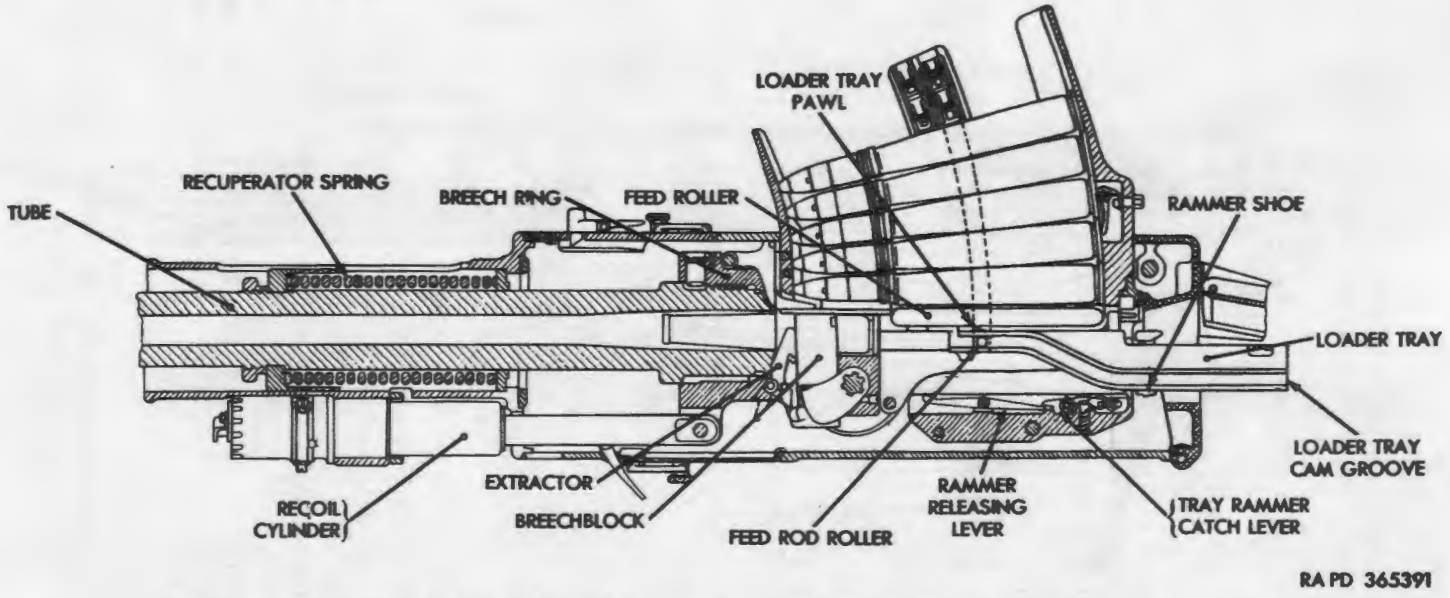


Figure 278. Automatic firing cycle—third stage—breechblock lowered and cartridge case extracted.

rammer levers. The tube, breech ring, and loader tray start to move toward battery position. The breechblock moves slightly upward under the action of the closing spring until it is brought to a stop and held by the extractor heads engaging the notches in the tops of the breechblock projections. The rammer shoe is engaged by the tray rammer catch lever, holding the shoe and compressing the rammer spring as the tube, breech ring, and loader tray move toward battery position. The feed control rammer catch lever is held out of engagement because there are sufficient cartridges in the loader to hold the feed control lever in its rearward position. The trigger rammer catch lever is held out of engagment because the firing trigger is depressed and the firing selector lever is set for automatic fire.

(2) As the loader tray moves forward, the loader tray pawls on the front end of the tray engage the lugs on the feed roller catch heads, rotating the catch heads and releasing the feed rollers for one-quarter turn. At the same time the feed rod rollers enter the declined portion of the loader tray cam grooves, forcing the feed rods and feed pawls downward. The feed pawls engage the cartridges, forcing them downward.

(3) The lowest cartridge rotates the feed rollers, passes through and drops on the loader tray into the rammer levers. The pawls on the feed roller catch heads engage the feed rollers, preventing them from revolving more than one-quarter turn, thus preventing more than one cartridge from passing through. The cam slots in the top of the loader tray force the heads of the rammer levers inward to grip the rim of the cartridge.

f. Fifth Stage—During Counterrecoil.

(1) Figure 280 shows the position of the parts as the cartridge enters the chamber. When the feed rollers have completed a quarter turn, they are relocked by the catch heads which are returned to their normal positions by their torsion springs. As the gun nears the end of counterrecoil, the beveled projection on the bottom of the loader tray trips the rammer releasing lever freeing the rammer shoe from the restraint of the tray rammer catch lever.

(2) The rammer shoe is pulled forward by the rammer spring, and the rammer levers carry the cartridge forward with the shoe. As the rammer shoe nears the end

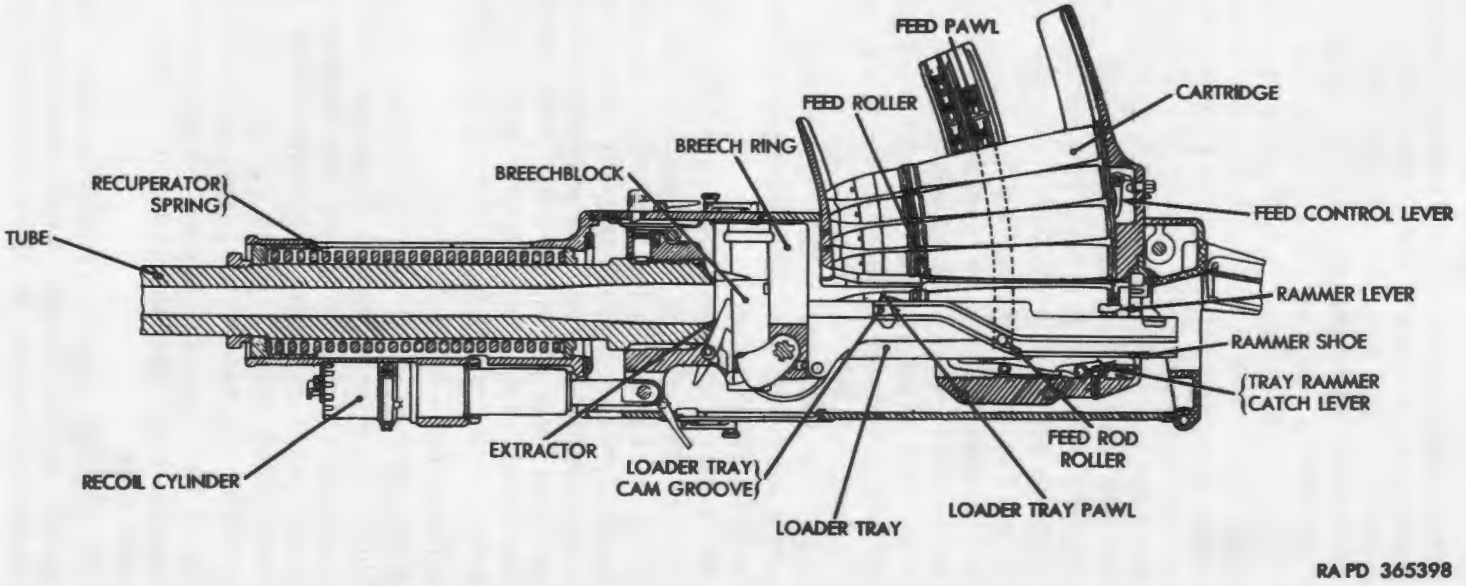


Figure 279. Automatic firing cycle—fourth stage—cartridge on loader tray.

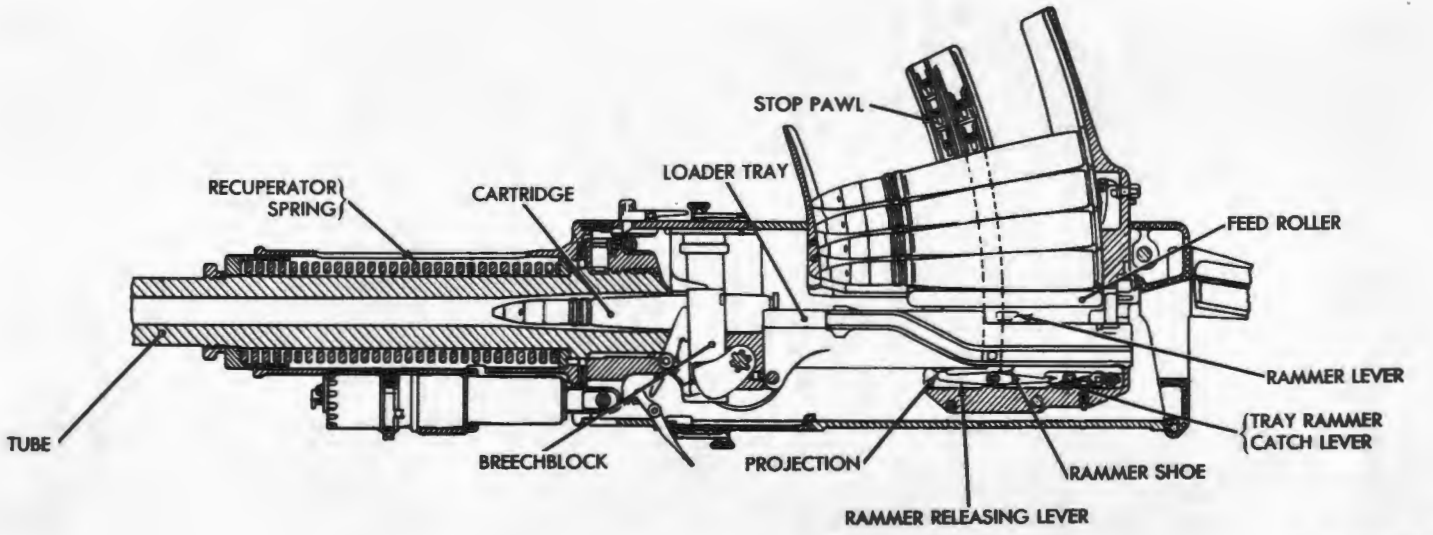


Figure 280. Automatic firing cycle—fifth stage—cartridge being rammed.

of its travel, the cam slots in the top of the loader tray force the rammer levers outward, releasing the cartridge. The cartridge is thrown forward through the U-shaped channel in the top of the breechblock and into the chamber of the gun.

g. Sixth Stage—During Counterrecoil.

(1) Figure 281 shows the position of the parts the instant before the cartridge is fired. After the rim of the cartridge passes through the U-shaped channel at the top of the breechblock, it engages the extractors, pulling them forward and releasing the breechblock. The closing spring forces the breechblock upward. The beveled front surface of the breechblock engages the rear of the cartridge, forcing it completely into the chamber.

(2) As the breechblock reaches its uppermost position, the projection on the breech ring inner crank contacts the beveled end of the inner cocking lever plunger, moving the plunger to the left, releasing the inner cocking lever, and permitting the firing pin to be thrust forward by the firing pin spring. The cartridge is fired and the cycle starts again.

279. Barrel Assembly

a. Description and Functioning (fig. 282).

(1) The barrel assembly consists principally of the tube, recuperator spring, flash suppressor, and the necessary mounting devices.

(2) The flash suppressor, which is fastened to the muzzle end of the tube, minimizes operator's temporary blindness from fire flash by diffusing the flash and, also, reduces the hazard of being accurately observed by enemy aircraft during night operations. The flash suppressor consists of three equally spaced suppressor bars welded to two mounting rings.

Note. The flash suppressors are being modified as illustrated on figure 283.

(3) The tubes have a register mark at bottom center line at the rear of the flash suppressor to facilitate alinement of the barrel assembly during removal and installation operations.

(4) The recuperator spring is installed near the breech end of the tube and, in conjunction with the recoil cylinder, absorbs a portion of the rearward thrust caused by firing the gun. The spring is compressed during recoil and

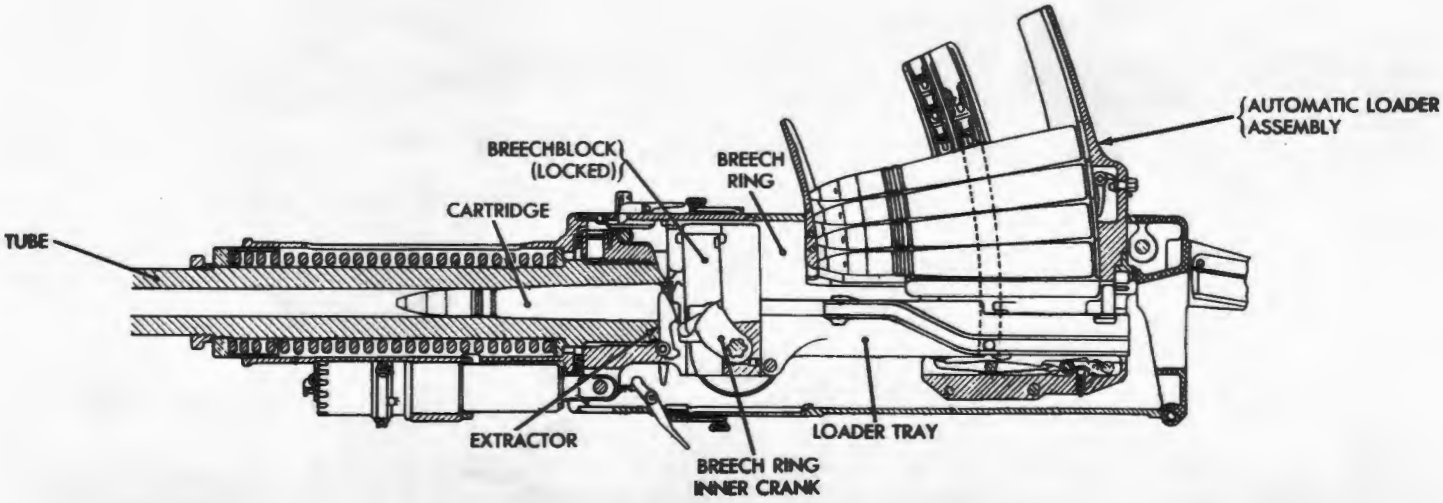


Figure 281. Automatic firing cycle—sixth stage—cycle completed and gun in act of firing.

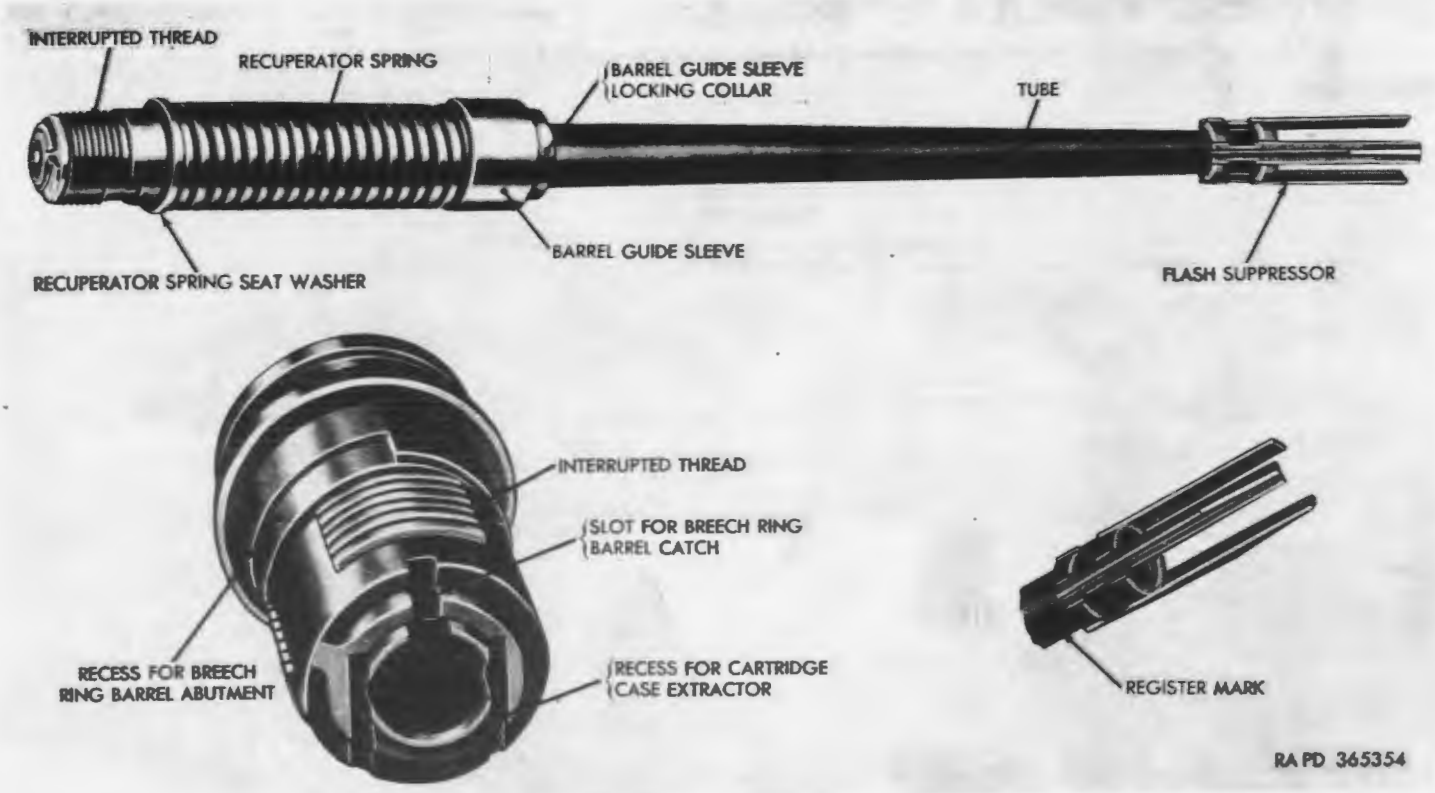


Figure 282. Barrel assembly.

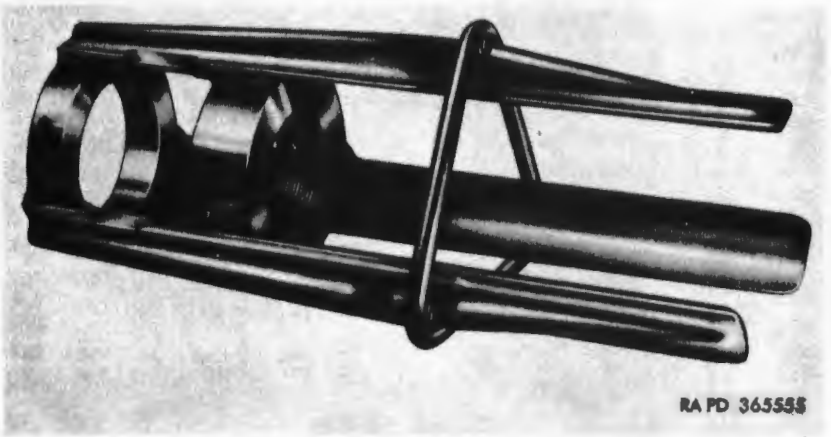


Figure 283. Modified flash suppressor.

energy stored in the spring is expended during counterrecoil to force the gun back into battery position.

(5) The recuperator spring is held in compression against the recuperator spring seat washer and a surface inside the breech casing by a barrel guide sleeve and a barrel guide sleeve locking collar. The sleeve centers the barrel assembly in the breech casing and provides a bearing surface for movement during recoil and counterrecoil. The recuperator spring seat washer is positioned on the tube by a shoulder, forward of the interrupted threads.

(6) Interrupted threads at the breech end of the tube are screwed into mating threads in the front end of the breech ring. A vertical slot, cut in the breech face of the tube, is provided for the breech ring and barrel catch. The breech ring and barrel catch insures correct assembly and provides a means for locking the barrel assembly in the breech ring. Vertical recesses on the breech face of the tube at each side of the chamber provide clearance for operation of the cartridge case extractors.

b. Removal of Barrel Assembly. The barrel assembly may be removed separately or as a part of a sequence of operations including removal of automatic loader and breech ring. The procedure in this paragraph pertains to removal of barrel assembly without the removal of other components.

(1) Engage elevating travel lock (par. 54*c*).

Caution: Be sure elevating travel lock (fig. 38) is fully engaged as serious injury can result after tubes are removed. If lock is not secured, the pressure of the equi-

librator springs is sufficient to cause breech casing movement.

(2) Open breech by moving hand operating lever to rear and engaging it in rear catch bracket (fig. 33).

Caution: Do not attempt to remove barrel assembly unless breech is open or breechblock has been removed from breech ring. To do so will damage extractors and produce burs in extractor grooves in breech end of tube.

(3) Remove breechblock lock bolt from bracket and insert into hole in breech casing (fig. 284) and breech ring, then turn bolt to a vertical position.

(4) Open top cover on breech casing by lifting cover latch lever head, rotating cover latch lever, and lifting top cover (fig. 53). Cover will lock automatically in open position. Opening cover will lift and release breech ring and barrel catch.

(5) Install flash suppressor wrench 7305580 (fig. 285) at muzzle end of barrel. Be sure handles of wrench are almost horizontal and at the bottom.

Note. On early vehicles equipped with flash hiders, use flash hider wrench 7228692 (fig. 71) at muzzle end of barrel.

(6) Place gun barrel carrier 7231517 (fig. 285) under barrel and secure by placing carrier chain over barrel and tightening with wingnut. Place one man on each handle of gun barrel carrier and a third man on the flash suppressor wrench. The two men handling the gun barrel carrier support the greater portion of the weight of the

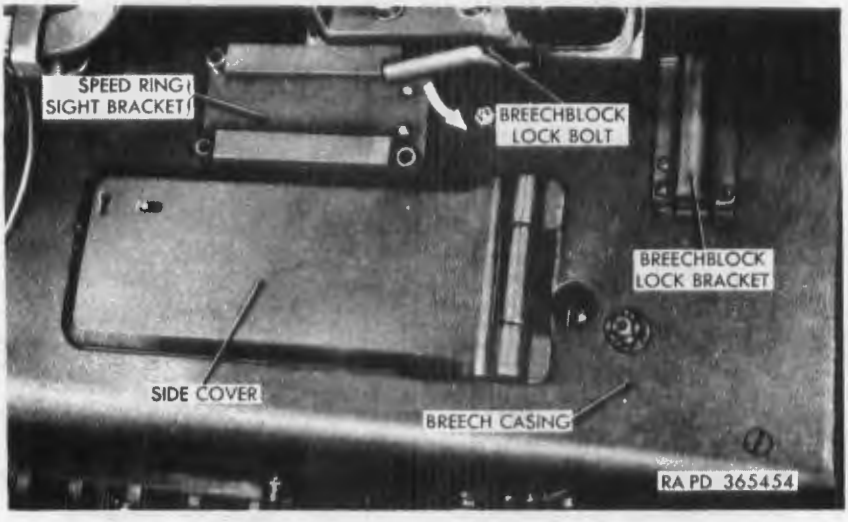


Figure 284. Breechblock lock bolt.

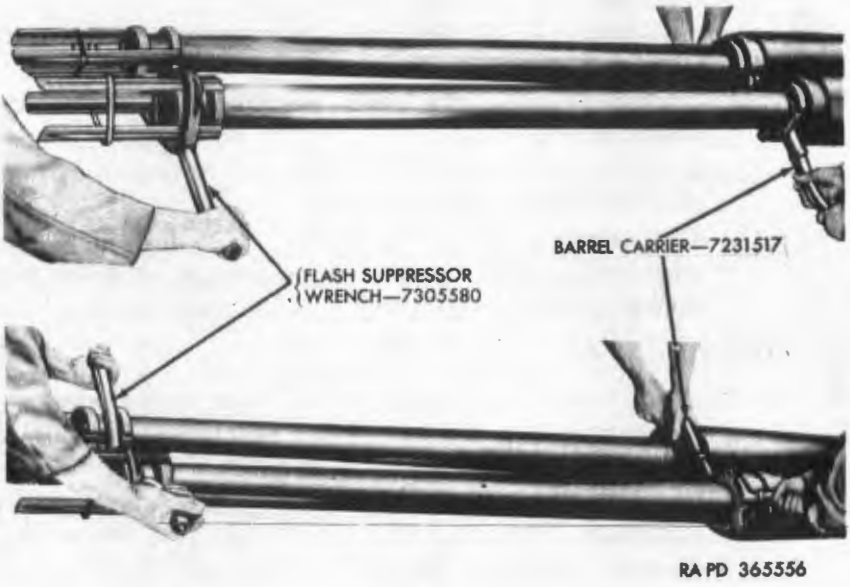


Figure 285. Removing or installing barrel assembly—special tools in position.

barrel assembly and must exercise care to prevent damaging the interrupted threads on breech end of barrel assembly.

(7) Rotate barrel one-half turn counterclockwise. This will place flash suppressor wrench and barrel carrier handles in a horizontal position above the barrel. The interrupted threads now will be unlocked and barrel assembly ready for removal.

(8) Remove the barrel assembly straight forward from breech casing exercising caution that the interrupted threads on tube do not come in contact with breech casing as the barrel guide sleeve slides from casing.

(9) If gun is to remain inactive for any length of time with tube removed, relieve tension from springs by uncocking the gun in the following manner:

(*a*) Release hand operating lever from the rear catch bracket and hold in this position. Remove the breechblock lock bolt.

(*b*) Insert safety plunger wrench 7228697 (fig. 286) in opening on top of breech ring, and turn in either direction until breech ring safety plunger is retracted. At

the same time the safety plunger is retracted, push the extractor releasing lever (fig. 287) forward. As the extractors are released, allow the hand operating lever to rotate to the front catch bracket. The breechblock will close as the hand operating lever is rotated forward.

(*c*) Rotate feed control thumb lever (fig. 34) in direction opposite to the arrow.

(*d*) Actuate the firing mechanism by depressing the firing mechanism pedal (fig. 38). A pronounced click will be heard, indicating that the rammer has been released.

c. Maintenance.

(1) *General.* Since the accuracy life of a tube is decreased by a fast rate of fire, the gun should be allowed to cool as often as is practicable. Barrel assemblies should be changed during periods of prolonged firing to prevent overheating. Organizational maintenance is limited to operations covered herein; for all others, notify ordnance maintenance personnel.

Figure 286. Retracting safty plunger.

Figur 287. Extractor releasing lever.

(2) *Inspection of barrel assemblies.* Inspection of barrel assemblies includes the spares.

(*a*) Observe condition of the bore for wear on lands or deposits in grooves; raised, flattened, chipped or stripped lands; pitting or pastilles (indentations in bore which resemble gas pockets in a casting); and examine for evidence of powder fouling and rust. Do not confuse coppering of bore with powder fouling. The removal of copper fouling is prohibited. A clean bore is not necessarily a shiny bore as it frequently may have a dull gray appearance. A shiny polished bore may indicate that abrasives have been used in cleaning operations and the use of abrasives is prohibited. If lands

or grooves are deformed or pitted or if there is an indication of cracking (outside or inside of tube), notify ordnance maintenance personnel.

(*b*) The determination of serviceability of tubes is a function of ordnance maintenance personnel.

(*c*) Observe interrupted threads and recesses in breech face for scoring or other mutilation. Examine barrel sleeve for burs, wear, or mutilations. Remove such scores, burs, or other raised metallic areas as may be removed by using crocus cloth. For heavy scoring, burs, or other raised areas, notify ordnance maintenance personnel.

(*d*) See that barrel guide sleeve and guide sleeve locking collar are properly tightened. Tighten, if necessary, using recuperator spring collar wrench 6200473 (fig. 72). The barrel guide sleeve locking collar setscrew and friction disk must be tightly screwed into place.

(*e*) Examine flash suppressors for cracks or corrosion.

(*f*) Examine recuperator spring. If broken or kinked against surface of tube, notify ordnance maintenance personnel.

(3) *Clean and lubricate.* Wear and corrosion of tube do not result entirely from the number of rounds fired but also depend on care given in cleaning, lubricating, and cooling. Perform cleaning procedures from the breech end after the barrel assembly is removed. Tubes may be cleaned while mounted in place when breechblock and extractors are removed. The latter method of cleaning must be done from muzzle end and can be done best when tube is slightly warm after firing.

(*a*) *Before firing.* Install bore brush (M29) 6240944 (fig. 73) on end of cleaning staff 6110686 and 6110689 (fig. 71). Insert a clean wiping cloth through the eye on the bore brush to make a reasonably tight fit in the bore and insert it into bore. Wipe bore thoroughly with a push-pull action from one end of bore to the other until surfaces are dry and clean. Add staff sections as required, to reach full length of tube. Clean all tubes.

(*b*) *After firing.* In tubes that have been fired, delay cleaning of bores until tube is cool enough to be touched by the bare hand without discomfort so as to avoid loss of certain volatile cleaning agents in rifle-bore cleaner. Apply rifle-bore cleaner to a wiping cloth in-

serted through the eye on the bore brush and insert bore brush into bore. Scrub all surfaces with a push-pull action from one end of bore to the other. Use bore brush to remove any powder fouling not removed by wiping cloth. Lengthen staff, as required, by adding additional sections. After firing and on three consecutive days thereafter, thoroughly clean bore with rifle-bore cleaner and *do not wipe dry*. After a fourth cleaning, dry thoroughly. Insert a wiping cloth through the eye on the bore brush and saturate cloth with preservative lubricating oil and oil entire surface of bore, being careful to work oil into grooves of the rifling.

Note. When firing is anticipated, the bore need not be wiped dry and oiled on the fourth day after firing. Simply clean with rifle-bore cleaner and do not dry. Rifle-bore cleaner does not inhibit rust and daily cleaning of mounted and spare tube is necessary whenever rifle-bore cleaner is left in the bore. The use of preservative lubricating oil avoids the need for daily cleaning.

(*c*) *Weekly (LO 9–7218, par. 90)*. Clean with rifle-bore cleaner, wipe dry, and oil with preservative lubricating oil.

d. Installation.

(1) With rammer cocked, breechblock in down position and breechblock lock bolt inserted:

(*a*) Make certain that elevating travel lock is engaged. The top cover on breech casing must be open and hand operating lever engaged in the rear catch bracket (fig. 33).

(*b*) Install flash suppressor wrench 7305580 (fig. 285) with hinged portion of wrench over tube.

Note. On early vehicles equipped with flash hiders, use flash hider wrench 7228692 (fig. 71).

(*c*) Place barrel carrier 7231517 (fig. 285) over tube and secure by placing carrier chain under tube and tighten with wingnut.

(*d*) Lift barrel assembly and insert breech end in front opening of breech casing, carefully sliding it into the casing to prevent damage to threads.

Caution: Register mark (fig. 282) must be at top center when barrel assembly is being inserted into breech casing.

(*e*) Rotate tube one-half turn clockwise by means of flash suppressor wrench (fig. 285).

(*f*) Release top cover catch. Close top cover (fig. 53) and

lock with cover latch lever, thus locking barrel assembly in breech ring with breech ring and barrel catch.

(*g*) Remove wrench and carrier.

(*h*) Remove breechblock lock bolt. Push the extractor releasing lever forward, at the same time allowing the hand operating lever to rotate forward. Actuate the firing mechanism pedal and release the rammer.

(2) With rammer released and breechblock in the up position:

(*a*) Pull hand operating lever to the rear and engage in rear catch bracket. Install the breechblock lock bolt.

(*b*) Repeat all operations in *d*(1)(*b*) through (*h*) above.

280. Recoil Mechanism

a. Description. The recoil mechanism of each gun consists of a recuperator spring (fig. 282) held in compression around the breech end of the tube, and a recoil cylinder (fig. 287) mounted under the tubular front end of the breech casing.

Note. The recuperator spring is a component of the barrel assembly.

The piston rod (fig. 288) of the recoil cylinder is connected to the breech ring. When the gun is fired, the tube, piston rod, breech ring, and loader tray move to the rear in recoil.

b. Functioning.

Note. The key letters noted in parentheses are in figure 288.

(1) When a round is fired, pressure of the propellant gases in the tubes forces the recoiling parts of gun to the rear for a distance of 7.4 to 8.3 inches. As the gun recoils, the piston rod (fig. 288) is drawn to the rear by recoiling parts of the gun. Oil in the rear of the cylinder is forced through eight inclined openings (C) in the piston, through the metering bushings and into the space in front of the metering bushing.

(2) The control rod, over which the metering bushing travels, is tapered with a larger diameter at front and rear. The effective flow space (B) between the control rod and the metering bushing gradually diminishes because of the increasing diameter of the control rod. This offers a greater resistance to the oil as it moves from the rear to the front of the piston.

(3) During recoil, a quantity of oil flows to the rear between the control rod and the piston rod into the rear end of the hollow piston rod. This oil is used to control counterrecoil. Part of this oil flows through four holes (G) in the control rod valve seat, forces the control rod valve

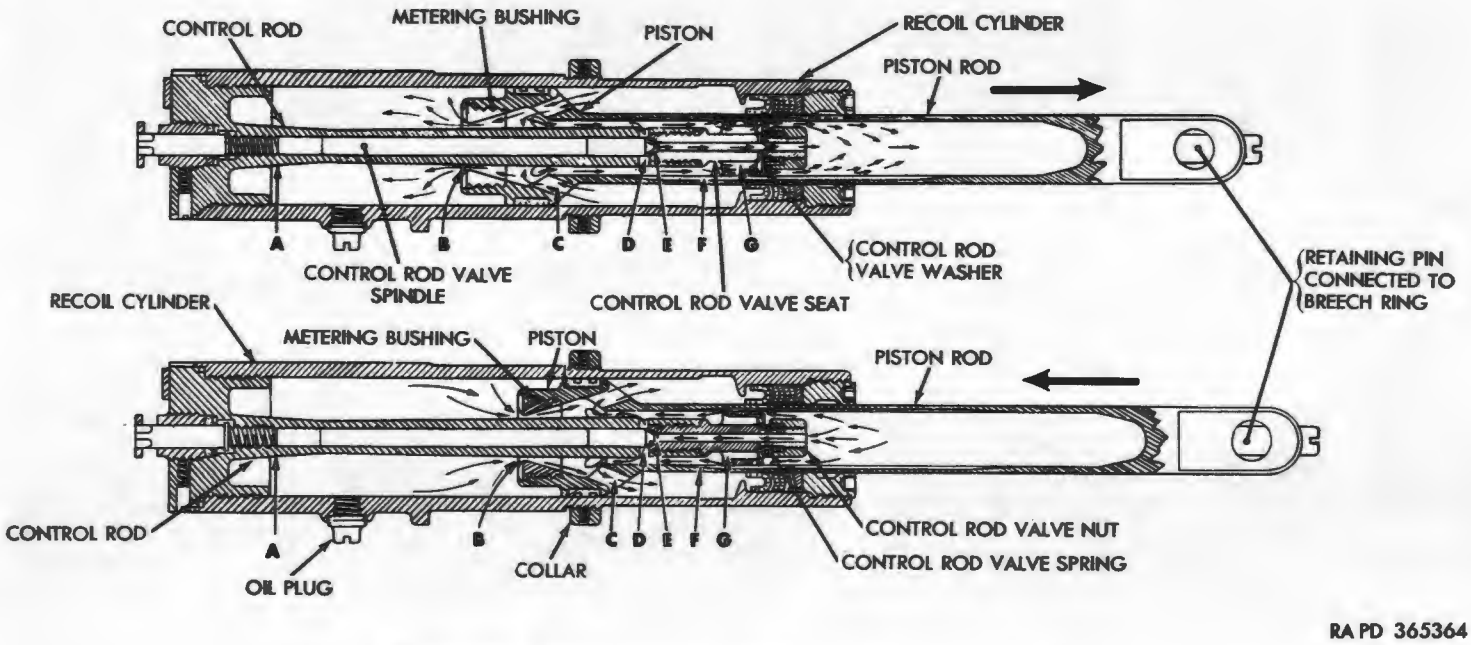


Figure 288. Recoil cylinder—action in recoil and counterrecoil.

washer against its spring, and continues into the rear end of the hollow piston rod. More oil flows around the control rod valve seat through two tapered grooves (F) in the walls of the piston rod. A small amount of oil flows through four radial holes (D) in the control rod, past the end of the control rod valve spindle, and through the bore (E) of the control rod valve seat.

(4) The action of the oil in the recoil cylinder, together with the compression of the recuperator spring, absorbs the energy of recoil, thereby, slowing down and controlling rearward movement of the gun.

(5) When recoil ceases, the recuperator spring reasserts itself and forces the barrel assembly, breech ring, and loader tray forward, carrying with them the recoil cylinder piston rod and piston. During this forward movement, oil in front of the piston returns to the rear, flowing between the control rod and the metering bushing and back through the eight inclined holes (C) in the piston.

(6) This flow of oil is too rapid to ease the gun back into battery position without shock. Full control of counterrecoil is brought about by restricted release of oil in the rear end of the hollow piston rod.

(7) As this oil attempts to escape to the front of the recoil cylinder at the start of counterrecoil, the control rod valve spring forces the control rod valve washer forward, closing the holes (G) in the valve seat and preventing oil back of the valve seat from returning by this path.

(8) The greater part of the oil escapes by flowing through tapered groove (F) in the inside walls of the piston rod. A controlled amount of oil, however, escapes past the pointed end of the control rod valve spindle. Adjustment of this spindle controls the amount of oil which can flow through the bore (E) in the valve seat to the four radial holes (D) in the control rod. This adjustment regulates the speed of counterrecoil.

(9) As the gun nears the end of counterrecoil, the two tapered grooves (F) gradually reduce the flow space around the valve seat. Finally the flow of oil is restricted to that passing the pointed end of the control rod valve spindle which must be precisely adjusted for correct counterrecoil action. The reverse taper (A) at front end of control rod reduces the flow space between the control

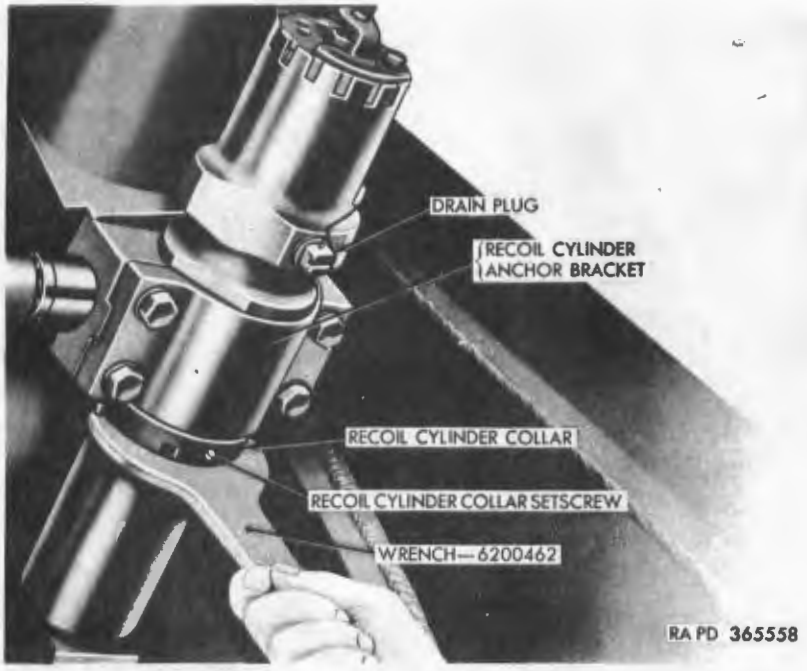


Figure 289. Backing off recoil cylinder collar.

rod and the metering bushing at this point. Final buffing is accomplished by dashpot action as the piston enters the seat in the forward end of the recoil cylinder.

c. Removal.

(1) Manually elevate gun (par. 61*b*(2)) to approximately 85°

(2) Loosen recoil cylinder collar setscrew (fig. 289).

(3) Back off recoil cylinder collar from recoil cylinder anchor bracket, using recoil cylinder wrench 6200462 (fig. 289). Pry breech casing dust cover forward and remove from breech casing.

(4) Remove four hex-head bolts and internal-teeth lockwashers and remove recoil cylinder anchor bracket (fig. 289) while holding up recoil cylinder to prevent it from falling. Lower recoil cylinder until it is approximately at right angles to gun, thereby disengaging recoil cylinder piston rod retaining pin from lugs of breech ring and remove recoil cylinder (fig. 290).

d. Maintenance.

(1) *Filling and adjustments.* Remove the hex-head cap screw, washers, and control rod valve spindle plates (fig. 52).

Figure 290. Removing or installing recoil cylinder.

Open control rod valve by turning squared end of control rod valve spindle (fig. 291). Using a recoil cylinder filling funnel (fig. 291), pour in petroleum base hydraulic oil OHA or OHC until it overflows. Remove funnel and install filler plug. Elevate and depress gun slowly twice and stop at 25°. Remove filler plug again, and using funnel, pour in oil until full. Remove funnel and install filler plug. Turn squared end of control rod valve spindle (fig. 291) to close control rod valve fully, then back-off one-third turn. Lock spindle by installing control rod valve spindle plate and securing with $\frac{5}{16}$ x $\frac{5}{8}$ cap screw, $\frac{11}{32}$ ID, $\frac{11}{16}$ OD, 0.065 flat washer, and $\frac{5}{16}$-inch lockwasher. A slight adjustment ((3) below) may be nec-

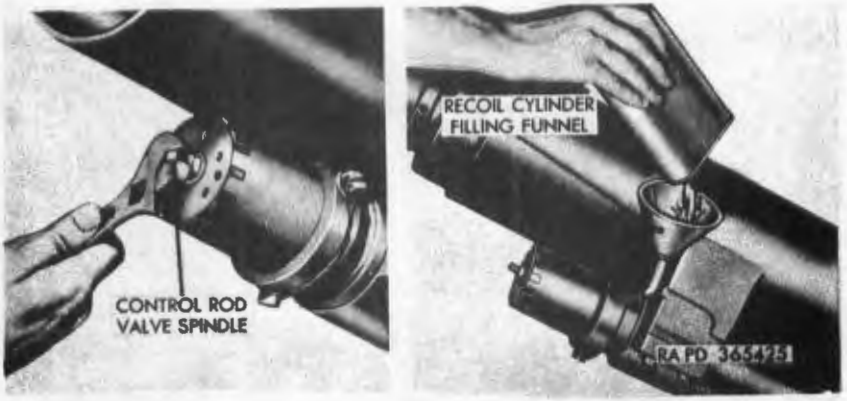


Figure 291. Filling and adjusting recoil cylinder.

essary after the gun has been fired. Check cylinder for leakage.

(2) *Recoil cylinder exercising.*

(*a*) The recoil cylinder piston rod (fig. 290) will corrode and stick at the rear packing gland unless it is exercised frequently. Such sticking may result in severe damage to the weapon when gun is fired. The recoil cylinder piston rod must be exercised periodically (monthly) when the gun has not been fired to insure proper operating condition.

(*b*) Detach recoil cylinder from anchor bracket (*c* above). With piston rod retaining pin held in lugs on front of breech ring, pull piston rod out of recoil cylinder to its limit and return to original position. Repeat this operation several times.

(*c*) If piston rod is corroded, it may be difficult to break free, in which case install recoil cylinder in reversed position (piston rod pointing toward muzzle of gun). This will provide a means of holding the cylinder without danger of crushing it. Tap or apply pressure to retaining pin to turn rod on its axis to break it free.

(*d*) After piston rod has been freed, polish corroded area with crocus cloth and oil lightly. Check piston rod at point where it enters the cylinder. Remove any build-up of foreign matter. Install cylinder in proper position.

Note. If organizational maintenance personnel cannot free piston rod by above methods, notify ordnance maintenance personnel.

(3) *Measuring and adjusting length of recoil.* The recoil should be smooth and the length of recoil should be be-

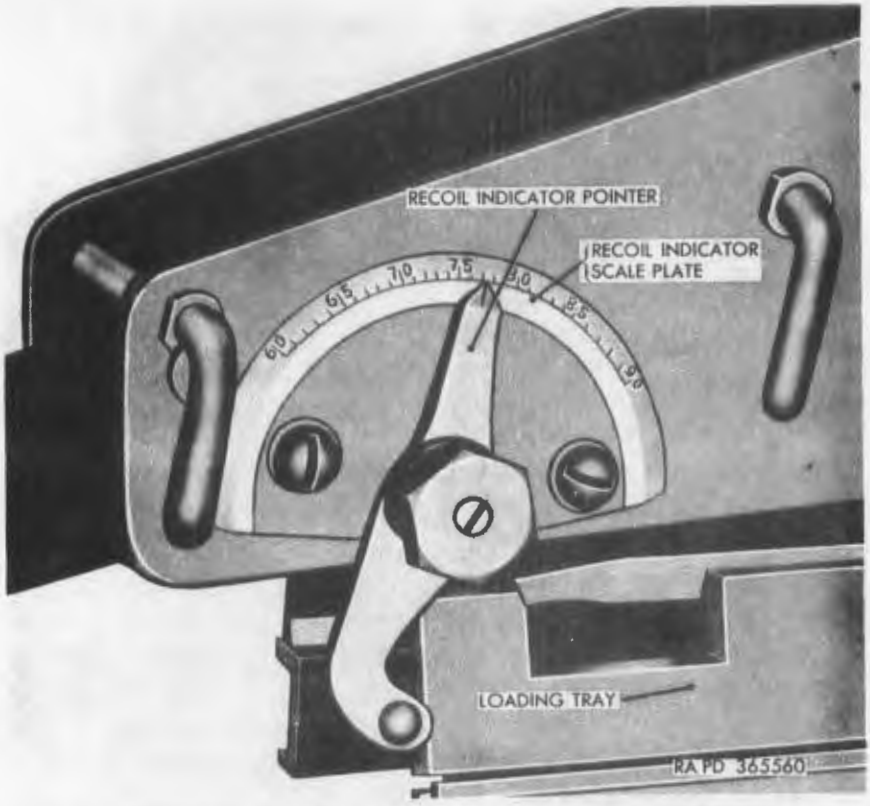


Figure 292. Loader tray striking recoil indicator pointer.

tween 7.4 and 8.3 inches. The most desirable length is 7.83 inches. The length of recoil is measured by means of the recoil indicator pointer (fig. 292) while the gun is being fired. Proceed as follows:

(*a*) Press lower arm of recoil indicator pointer (fig. 292) forward, causing the pointer to register 60 (6 in.) on the recoil indicator scale plate.

(*b*) When the gun is fired, the rear end of the loader tray will strike the lower arm of the indicator pointer.

(*c*) The pointer will indicate the extent of rearward movement of the loader tray. Read the measurement on the scale plate, which is calibrated in tenths of inches from six to nine inches.

(*d*) The extreme length of recoil is fixed by the dimension between the recoil cylinder piston and the rear end of the cylinder which forms a seat for the packing. Maximum recoil (metal to metal) is approximately 8.8 inches.

Caution: This maximum must not be reached, as a recoil of such length will result in damage to the mechanism.

(*e*) If length of recoil does not come within limits, check fluid level in recoil cylinder and fill to proper level if necessary (par. 63*c*). If recoil is unsatisfactory with a properly filled recoil cylinder, the cause may be a weak or broken recuperator spring; change barrel assemblies (par. 279).

(*f*) If length of recoil is corrected by changing barrel assemblies, this indicates that the recuperator spring on the original barrel assembly is unsatisfactory. Notify ordnance maintenance personnel.

(*g*) If changing barrel or barrel assemblies does not correct length of recoil, notify ordnance maintenance personnel.

(4) *Draining recoil cylinder.*

(*a*) Drain recoil oil by loosening recoil cylinder control rod and removing the filler plug (par. 63*c*). Remove drain plug (fig. 289) after placing a clean dry pail, or other adequate container in position.

(*b*) Fill recoil cylinder *d*(1) above.

(5) *Care of recoil oil.*

(*a*) Care must be taken not to use any liquid other than that prescribed. Water and other foreign matter must not be introduced into recoil cylinder.

(*b*) Recoil oils must not be put into any container not marked with the name of the oil, left in open containers, be subjected to excessive heat, nor mixed with any type of oil other than those prescribed.

(*c*) Recoil oil must be filtered through the wire strainer of the filling funnel. Every precaution must be taken to prevent the introduction of water or grit into the cylinder either in the mixture or through failure to clean thoroughly the connections and servicing equipment.

(*d*) Exposure of these liquids in an open container may result in the accumulation of moisture. Condensation in a container partly filled with recoil oil, the mixture of such oils, or pouring of these liquids from one container to another which has moisture on its inner walls, results in moisture being carried into recoil cylinder.

(*e*) If there is a possibility that the recoil oils or a blend of such oils may contain water, the suspected liquid should be turned over to ordnance maintenance personnel for test and replacement.

(6) *Controlling rate of fire.*

(*a*) The squared head of the control rod valve spindle, which protrudes from the front end of the recoil cylinder, provides a means for adjusting the speed of counterrecoil. The setting of this spindle is normally one-third of a turn open (*d*(1) above). The valve should be closed slightly if the rate of fire is too great, or opened slightly if the rate is too slow.

(*b*) When the correct setting is determined, mark the position of the valve spindle for future reference.

(*c*) The gun can counterrecoil more easily at lower elevation. Watch for excessive counterrecoil when the gun is fired at low elevation. Report irregularities to ordnance maintenance personnel.

(7) *Replacement of parts.*

(*a*) Replace filling and/or drain plugs and washers if excessive oil leakage occurs.

(*b*) Replace the recoil cylinder piston rod retaining pin screw when it becomes unserviceable.

e. Installation.

(1) Engage the recoil cylinder piston rod retaining pin in lugs on lower front of breech ring while holding recoil cylinder at right angles to bottom of breech ring and with flat surface on recoil cylinder (fig. 290) flange upward.

(2) Raise recoil cylinder and secure in place with recoil cylinder anchor bracket (fig. 289) by installing four ½ x 1¾ hex-head bolts and ½-inch internal-teeth lockwashers.

Caution: Arrow on each bracket must aline with that on breech casing, or number on casting must match number on breech casing.

(3) Install breech casing dust cover.

(4) Install recoil cylinder collar (fig. 289) until it bears against side of bracket, using wrench 6200462.

(5) Lock collar with ¼ x ¼ recoil cylinder collar setscrew (fig. 289) after placing the $1\frac{1}{64}$ OD x $\frac{3}{32}$ copper disk between the setscrew and thread on recoil cylinder.

281. Breechblock Assembly, Inner and Outer Cranks, and Closing Spring

a. Description.

(1) *Breechblock assembly.* The breechblock assembly is composed of a breechblock and percussion mechanism. The percussion mechanism is made up of the breechblock inner and outer cocking levers, inner cooking lever plunger and spring, and the firing pin, spring, and cover. Figures 293 and 294 illustrate a breechblock assembly

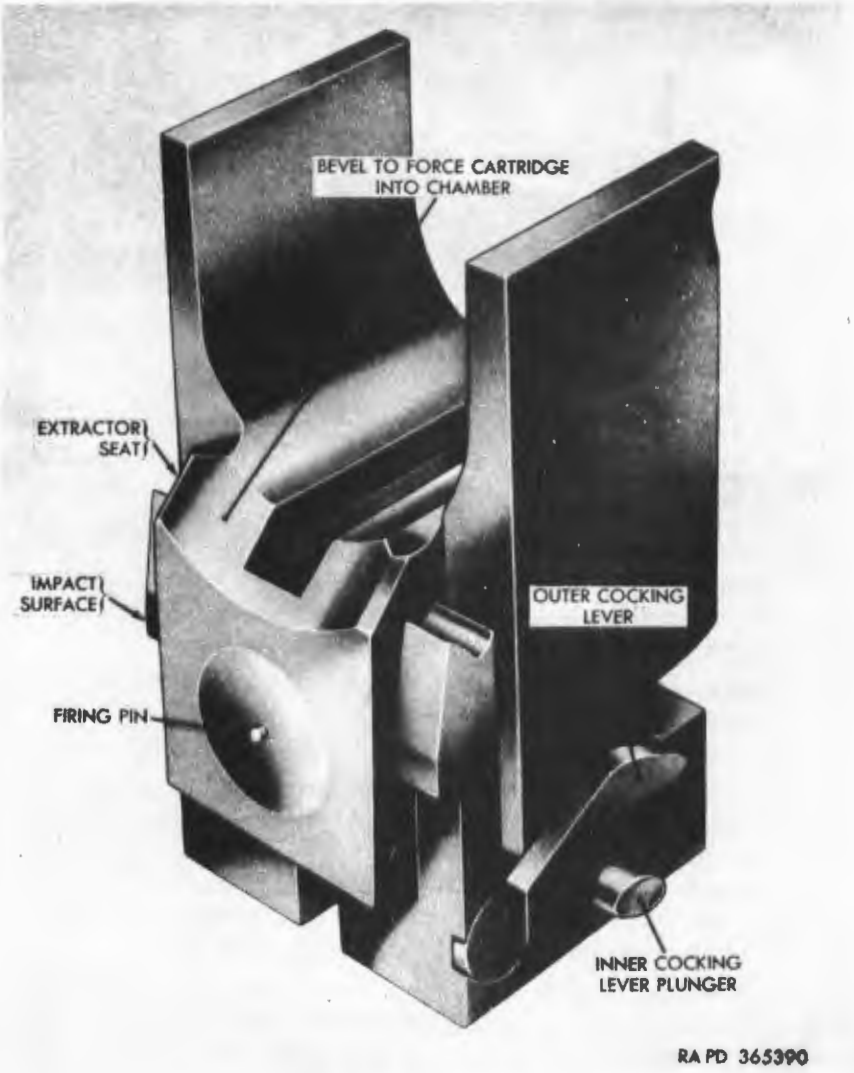


Figure 293. Breechblock assembly—front view.

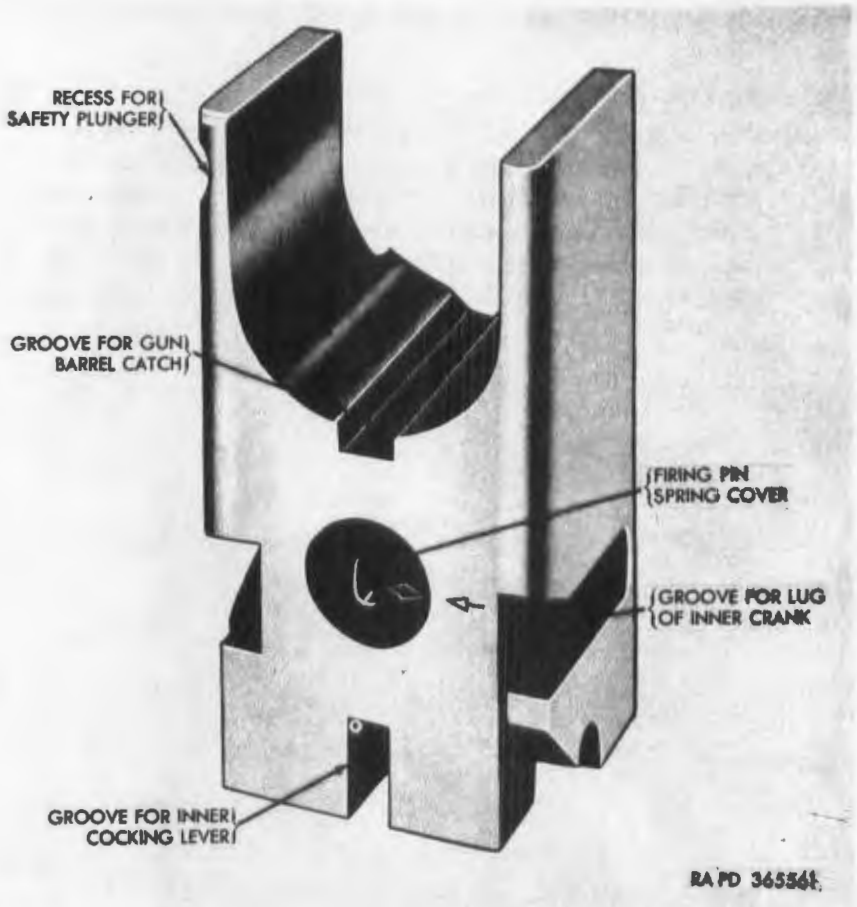


Figure 294. Breechblock assembly—rear view.

and show details concerning the various grooved, recessed, and beveled surfaces.

(2) *Breech ring inner and outer cranks and closing spring.* The breech ring inner cranks (fig. 295) raise and lower the breechblock assembly, operate the outer cocking lever, and actuate the inner cocking lever plunger. The breech ring inner cranks are splined to the breech ring crank shaft and are rotated by the breech ring outer crank (fig. 296) or the breech closing spring.

b. Functioning. The breechblock is held in the raised or closed position against the breechblock stops of the breech ring by the tension of the breech closing spring (fig. 296). The breech may be opened and closed by hand or opened automatically by the action of recoil and closed by the ramming of a cartridge.

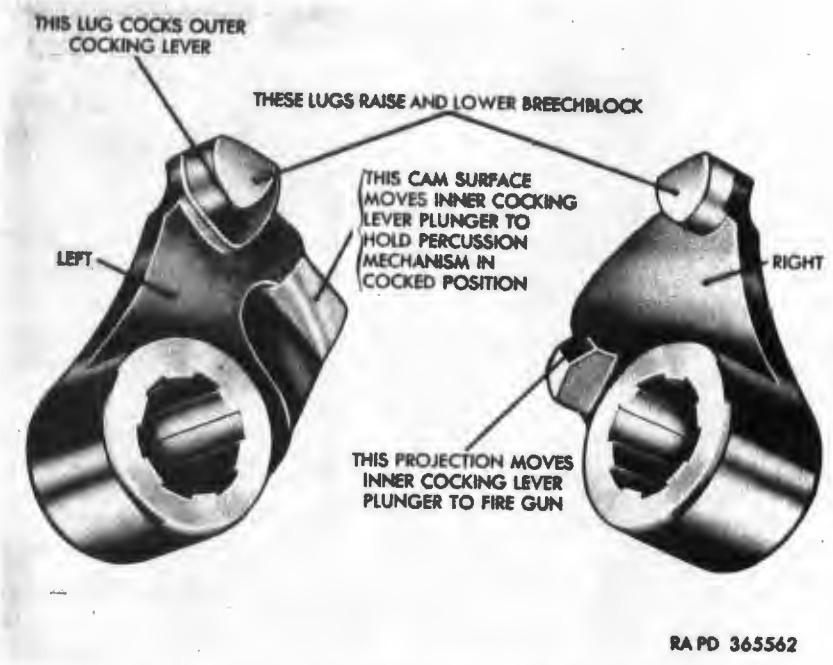


Figure 295. Left and right breech ring inner cranks.

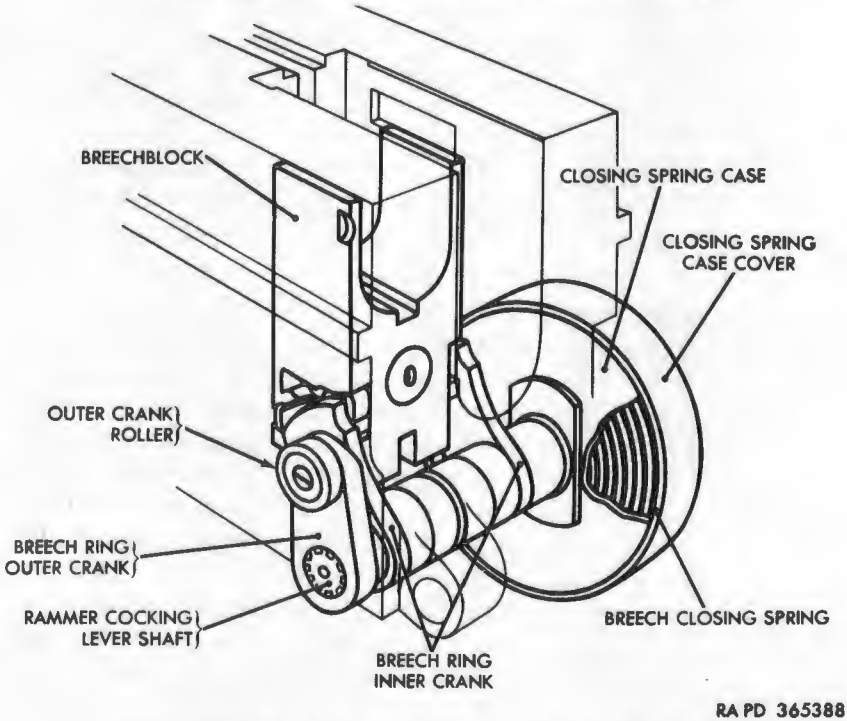


Figure 296. Breechblock raised by breech closing spring.

(1) *Manual operation.* The breechblock may be opened manually by operation of the hand operating left lever (fig. 33). By pulling the lever upward and to the rear, a mechanical linkage rotates the breech ring outer crank (fig. 296) which lowers the breechblock. As the breechblock lowers, the breech closing spring (fig. 296) is placed under tension (torsion spring). As the breechblock descends, impact surfaces on front of breechblock (fig. 293) strike the toes of the extractors (fig. 278), rotating them to the rear. The extractors lock the breechblock in the lowered position as shown in figure 279. The breechblock may be raised (closed) manually by pressing the extractor releasing lever (fig. 52) forward.

Note. If difficulty is exprienced in releasing the extractors, tension may be relieved by pulling the hand operating lever rearward (par. 67*e*(2)).

This moves the extractors forward and releases the breechblock. Tension of the closing spring will then rotate the breech ring crank shaft, raising the breechblock to its closed position.

(2) *Automatic operation.* When the weapon recoils on firing, the outer crank roller runs along the cam formed on the inner surface of the side cover (fig. 297). The cam rotates the breech ring outer crank (fig. 297) and the action is the same as for lowering the breechblock by hand ((1) above). The cartridge moving forward by action of the rammer (par. 278*g*) engages the extractors and rotates them forward, thus releasing the breechblock. The breech closing spring asserts itself and the action is the same as for closing the breech by hand ((1) above).

(3) *To cock percussion mechanism assembly.*

(*a*) When the hand operating left lever (fig. 33) is pulled to the rear or the gun recoils, the breech ring outer crank (fig. 297) is rotated which in turn rotates the breech ring inner crank (fig. 296) and lowers the breechblock. A lug on the left inner crank engages the breechblock outer cocking lever, which rotates and turns the brechblock inner cocking lever (fig. 298). The rounded end of the inner cocking lever bears against the shoulder of the firing pin (fig. 298), forcing it to the rear and compressing the firing pin spring. The beveled projection on the right inner crank is moved from contact with the end of the inner cocking lever plunger (fig. 298) and the lever plunger is forced to the right by the plunger spring.

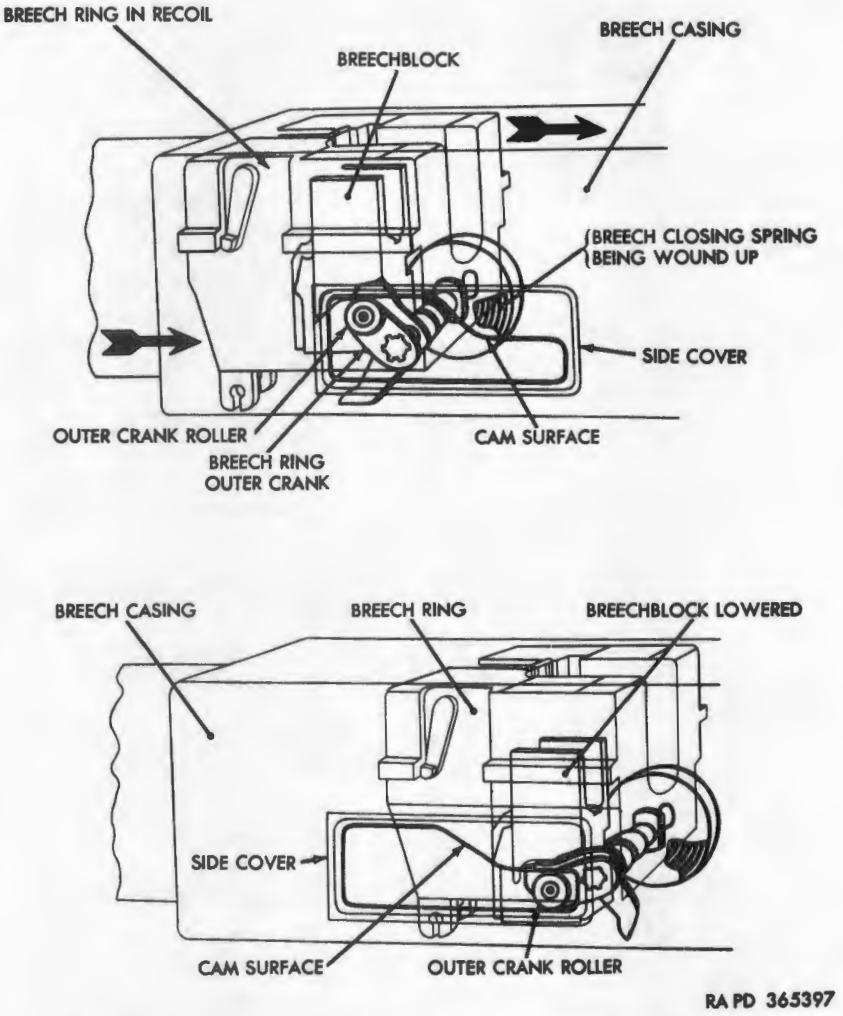


Figure 297. Cam action of breech ring outer crank and side cover.

(*b*) When the inner cocking lever (fig. 298) has been rotated downward through the recess in the inner cocking lever plunger until its notched end is clear of the recess, the lever plunger is released and is forced to the right by action of the plunger spring. This movement of the lever plunger is made positive by the cam surface on the breech ring left inner crank (fig. 295) which engages the left end of the lever plunger and forces and holds the plunger to the right. The lever plunger engages the cock notch in the end of the inner

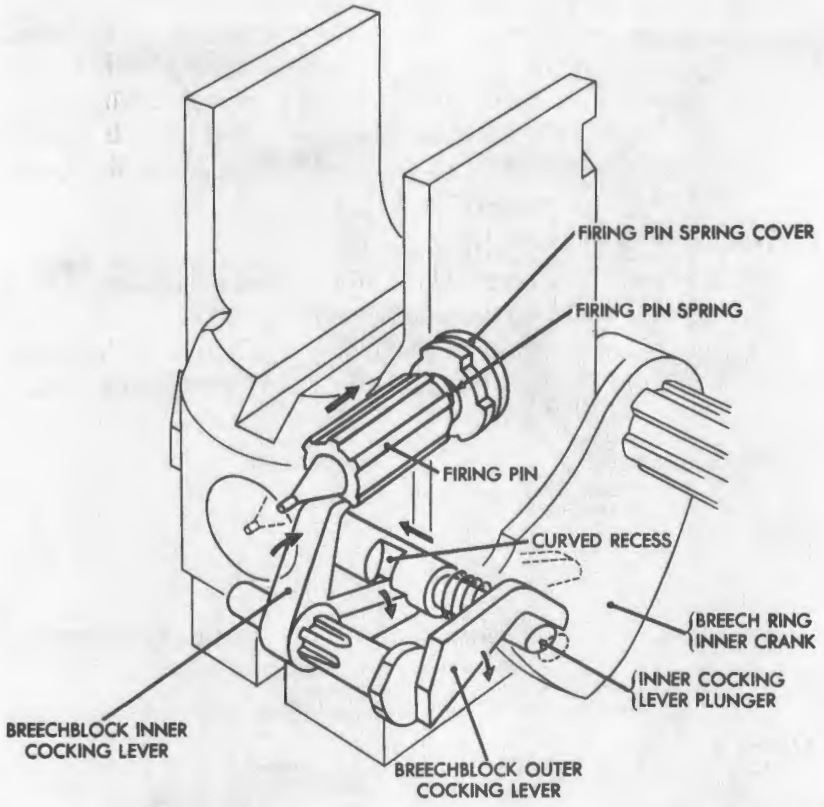


Figure 298. Firing pin in cocked position.

cocking lever, retaining the lever and firing pin in a cocked position (fig. 298).

(4) *To fire percussion mechanism assembly.*

(*a*) When a cartridge is rammed into the breech releasing the extractors and causing the breech ring inner cranks to rotate under the action of the closing spring, the inner cranks raise the breechblock. The left end of the inner cocking lever plunger is released from the cam surface of the left inner crank as this crank rotates.

(*b*) After the breechblock comes to closed position, the beveled projection on the breech ring right inner crank (fig. 299) engages the cam surface head at right end of inner cocking lever plunger (fig. 299) and forces the plunger to the left. This compresses the plunger spring and releases the inner cocking lever which was held by the plunger. The inner cocking lever (fig. 300)

is now free to rotate under the action of the compressed firing pin spring, and its notched end swings upward into the recess in the inner cocking lever plunger. The released firing pin (fig. 300) is carried forward by action of the compressed firing pin spring and fires the cartridge.

c. Removal and Disassembly.

(1) *Removal.* The breechblock and closing spring assemblies may be removed without removing other parts of the gun. The procedures given are applicable to both left and right guns of the dual gun M2A1 except as noted.

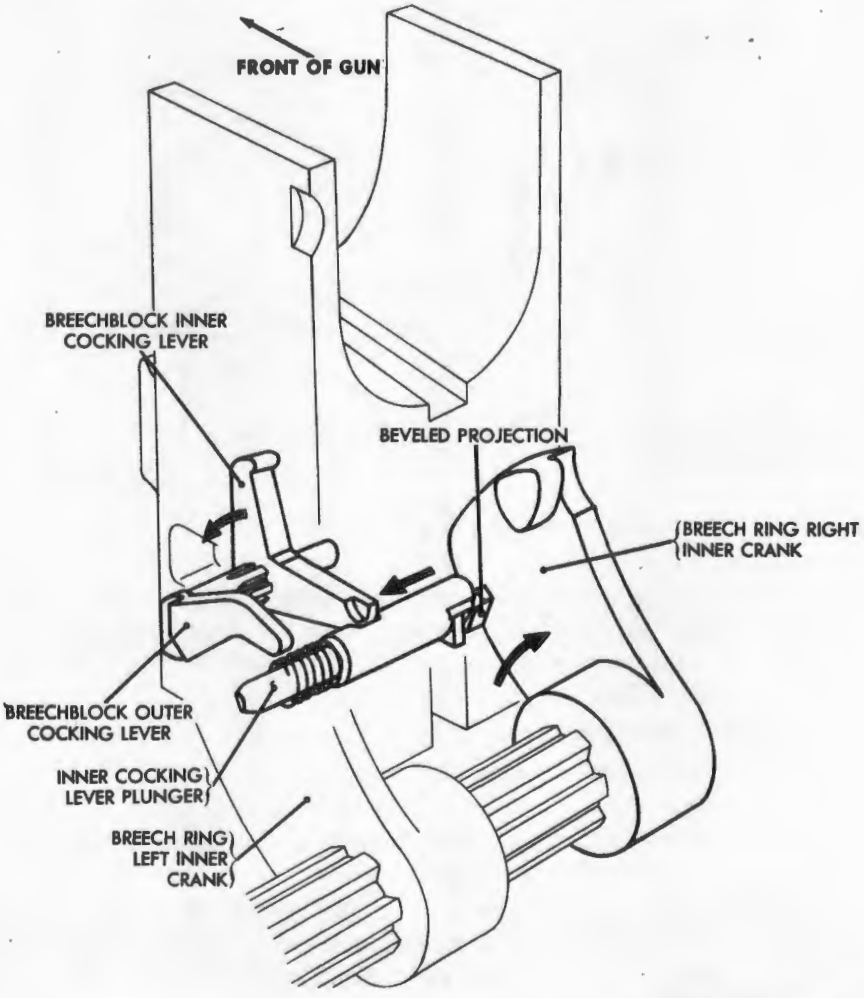


Figure 299. Inner cocking lever plunger—released by right inner crank.

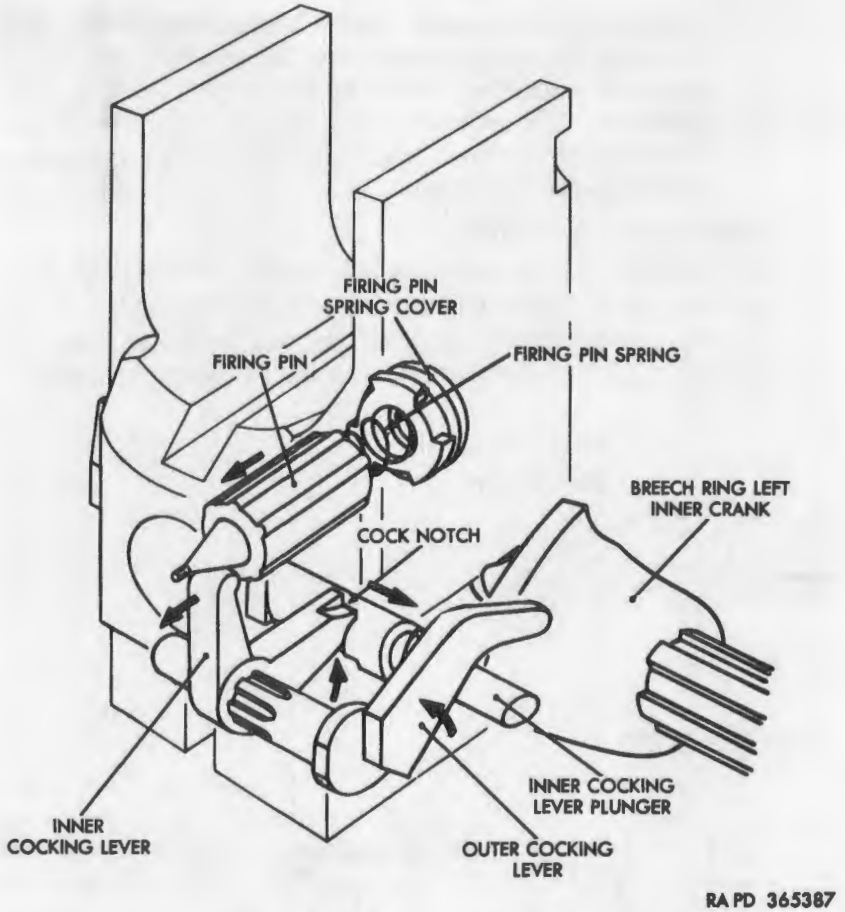


Figure 300. Firing pin—fired position.

(*a*) On right gun only, remove hex nut and lockwasher and tap out pin that connects elevating drag link rod and computing sight support at upper end of drag link rod (fig. 24).

(*b*) Close breech (par. 67*e*).

(*c*) Elevate gun to approximately 80°.

(*d*) Open side cover (fig. 301) by inserting side cover key 5228061, pressing key inward, and rotating clockwise. Secure cover in the open position.

(*e*) Release bottom cover (fig. 302) by rotating cover latch lever clockwise, and remove cover by disengaging rear flange of cover from breech casing.

(*f*) Using rectangular end of hand cartridge extractor 5228060 (fig. 303), pry breech ring outer crank out

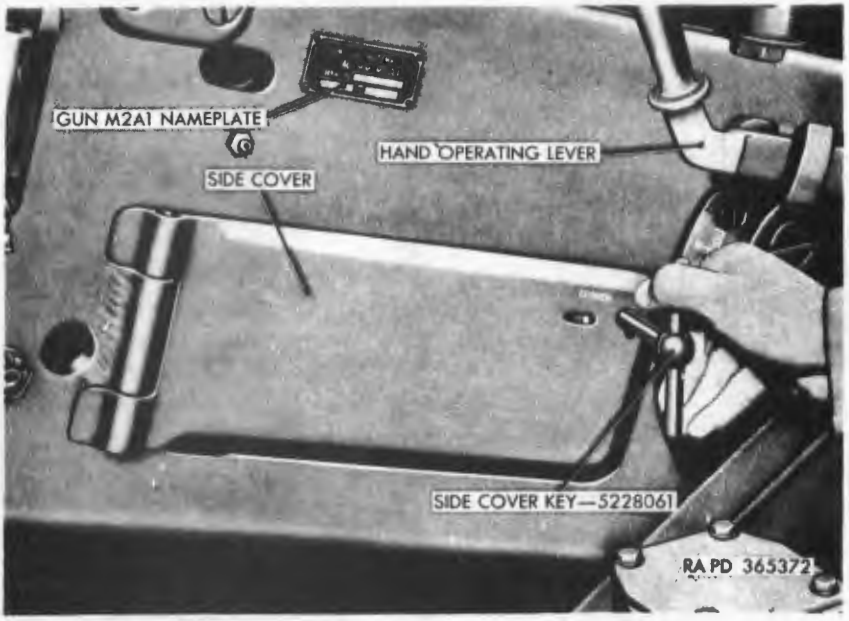


Figure 301. Opening or locking side cover.

about two inches while another crew member withdraws breech closing spring case assembly.

(*g*) Pull breech ring outer crank, with breech ring crank shaft, completely out while another crew member supports and guides breechblock assembly (fig. 304) with attached inner cranks, out of breech ring and through bottom of breech casing.

(*h*) Install bottom cover, if breechblock assembly is to be removed for a long period of time, to prevent dust or other foreign matter from getting into the internal mechanism.

(2) *Disassembly of closing spring case assembly.*

(*a*) Place assembled breech closing spring case assembly (fig. 305) on the breech closing spring bracket located on the rear of the right automatic loader.

(*b*) Insert key plug wrench 5228074 (fig. 305) into hole in center of case and engage protruding end of closing spring with the wrench.

(*c*) Force closing spring case cover inward to disengage bayonet connection on inside of the cover rim. Permit cover to rotate (counterclockwise for left-hand assembly and clockwise for right-hand assembly) under action of the spring, using care to prevent the tension

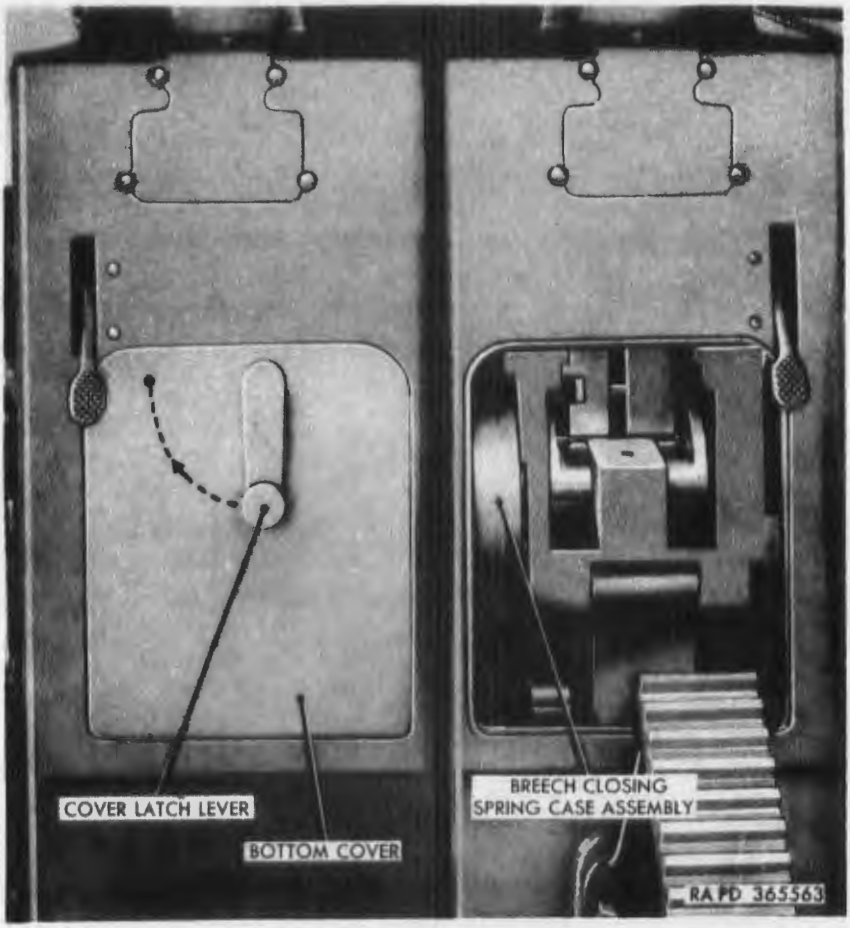


Figure 302. Bottom cover.

from being released too violently. Remove cover, wrench, and closing spring.

(3) *Disassembly of breechblock assembly.*

(*a*) Using firing pin spring cover wrench 5228057 (fig. 306), remove breechblock firing pin spring cover by pressing wrench inward and turning to 90° in either direction.

(*b*) Lift out firing pin spring and firing pin (fig. 306) from breechblock.

(*c*) Press inner cocking lever plunger inward and withdraw outer cocking lever (fig. 307).

(*d*) Press inner cocking lever plunger, turning breechblock so that front face is down, and shake to dislodge inner cocking lever (fig. 307).

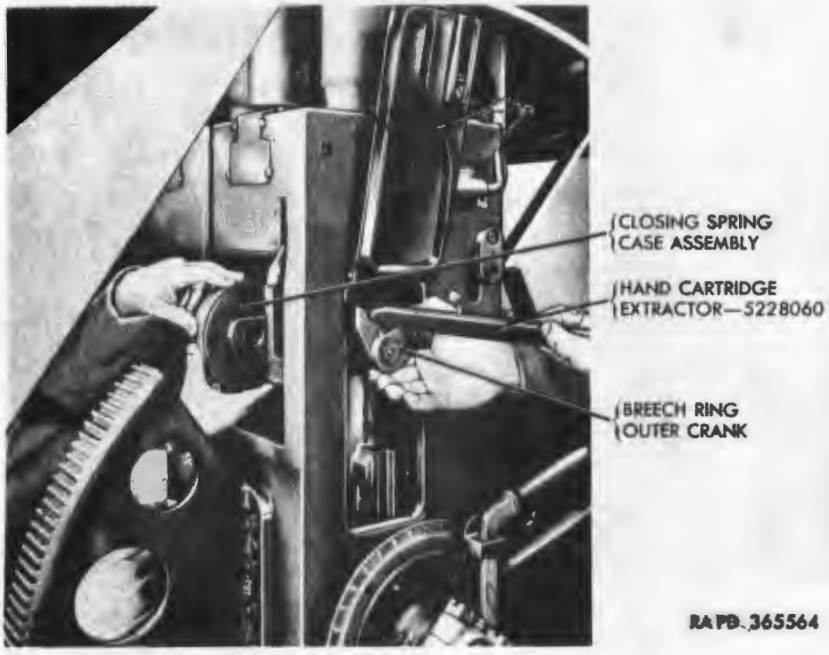


Figure 303. Removing breech closing spring case assembly.

Figure 304. Removing breechblock assembly and inner cranks.

Figure 305. Disassembling closing spring case assembly.

(*e*) Withdraw inner cocking lever plunger and plunger spring (fig. 308).

d. Maintenance.

(1) The breechblock assembly, inner and outer cranks, and closing spring case assembly should be cleaned with rifle-bore cleaner. Lubricate as specified in lubrication order LO 9–7218 (par. 90).

(2) If the breechblock assembly does not function smoothly, or if greater than normal effort is required when operated by the hand operating lever, the breechblock assembly should be disassembled (*c*(3) above) and the cause determined and corrected. Carefully examine all exterior surfaces of breechblock (fig. 308) for burs, scores, or rough spots. Pay particular attention to impact surfaces (fig. 293) which cam the extractors. Also check for burs on extractor seats. If necessary polish with crocus cloth.

(3) Examine firing pin spring (fig. 308) and inner cocking lever plunger spring for cracks, breaks, or set condition. Replace spring if cracked, broken, or set.

(4) Examine breech ring outer crank (fig. 303), and outer and inner cocking levers (fig. 308) for burs, scores, damage to splines, and for fit in breechblock. If necessary, polish with crocus cloth. When polishing inner cocking

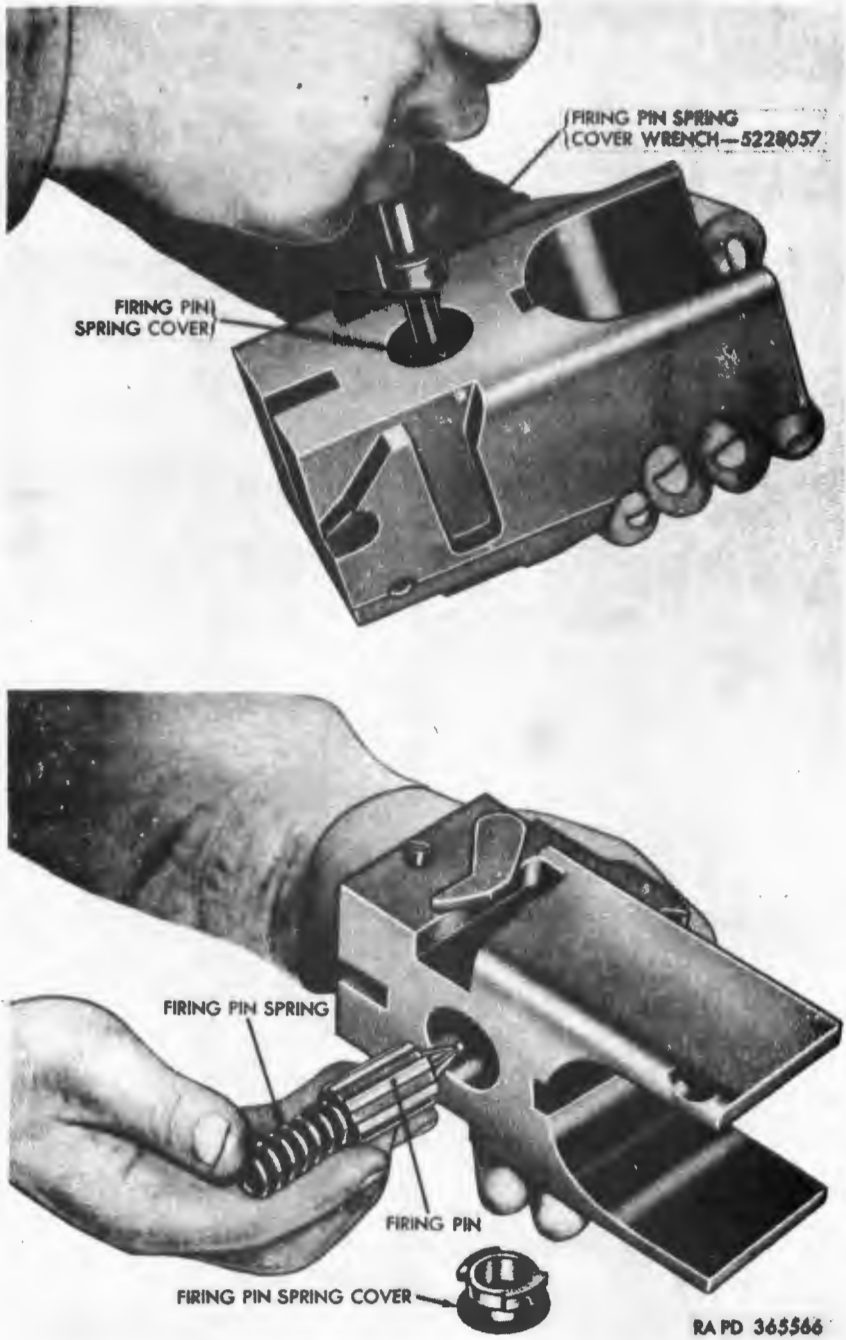


Figure 306. Removing breechblock firing pin spring cover and firing pin.

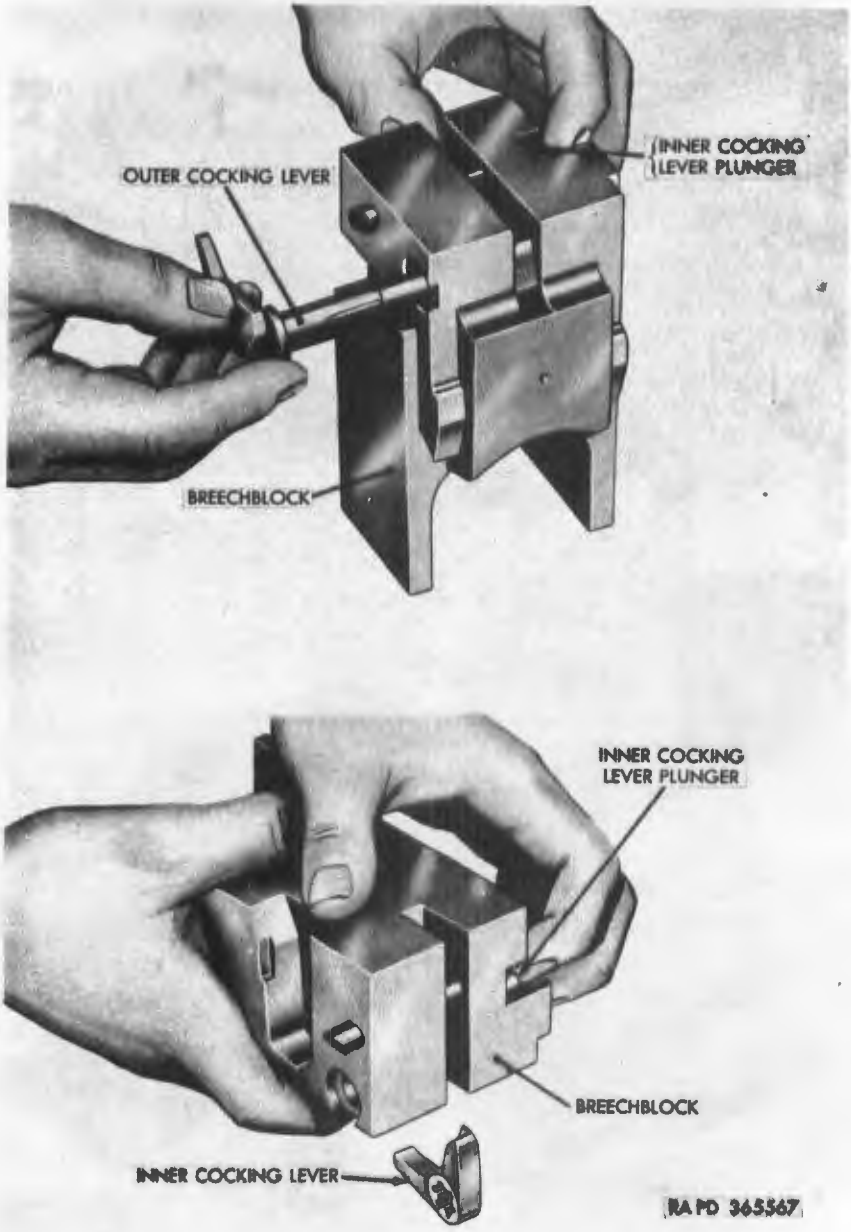


Figure 307. Withdrawing outer and inner cocking levers.

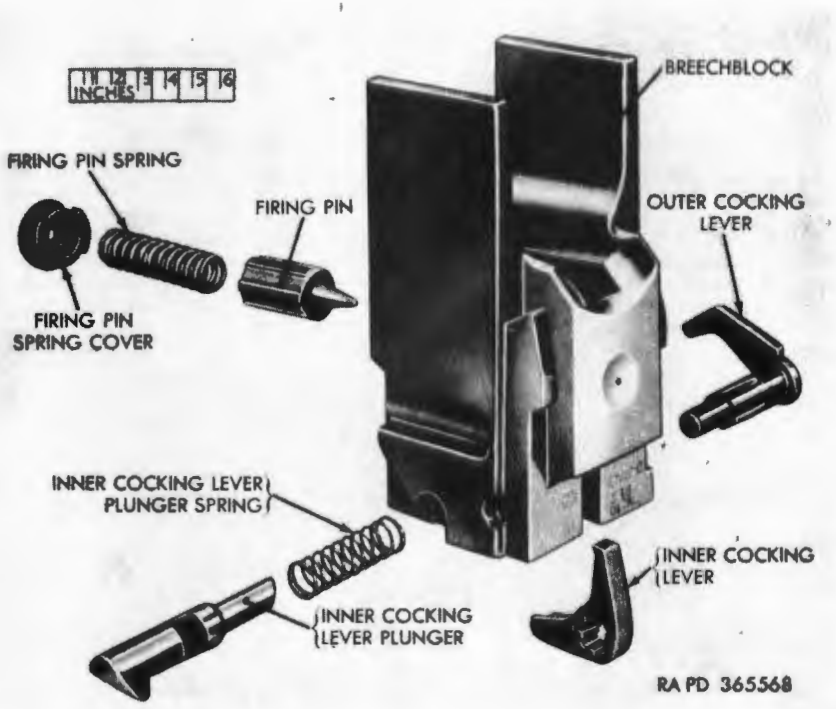


Figure 308. Breechblock assembly—Exploded view.

lever, do not remove more metal than is absolutely necessary. If splines bind or if parts show signs of wear or cracking, replace.

(5) Examine breechblock inner cocking lever plunger (fig. 308) carefully for burs and scores, particularly on cam surfaces. If necessary, polish with crocus cloth but do not remove more metal than is absolutely necessary. Replace plunger if cam surfaces are worn, or if part is cracked, broken, or deformed.

(6) Examine firing pin (fig. 308) for pitting, deformation, broken point, or cracks; if any of these conditions exist replace pin. Measure protrusion of firing pin with firing pin protrusion gage 5276650 (fig. 309). If protrusion is less than the minimum allowable (0.099 inch) or more than the maximum allowable (0.114 inch), replace firing pin.

(7) Check rotation of firing pin spring cover (fig. 308) in breechblock. If binding is noted, remove any burs or scores from locking lugs with crocus cloth. Replace spring cover if lugs are damaged or worn.

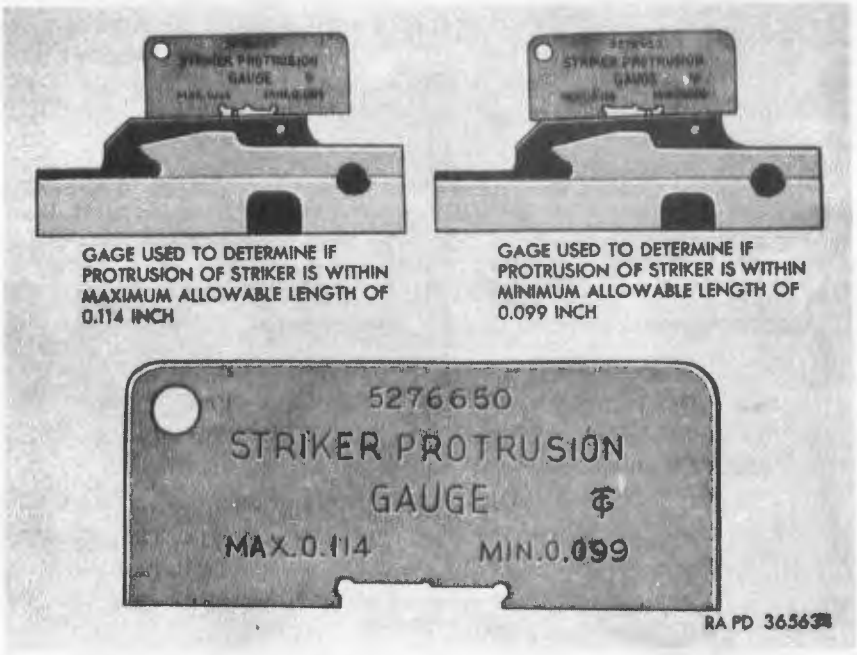


Figure 309. Firing pin protrusion gage 5276650.

(8) Examine breech closing spring case assembly for condition. Replace spring (fig. 310) if cracked, broken, or deformed. Remove any burs and scores from spring anchor, splines, and bayonet connections on case and cover with crocus cloth. Replace case assembly, if cover is damaged beyond repair. Replace case if spring anchor or case is cracked or broken.

e. Assembly and Installation.

(1) *Assembly of breechblock assembly.*

(*a*) Insert inner cocking lever plunger spring (fig. 308) and plunger into bore in breechblock.

(*b*) While holding inner cocking lever plunger in, insert inner cocking lever (fig. 308) by fitting slotted end of lever into slot in plunger.

(*c*) Press lever plunger in and insert outer cocking lever (fig. 308) by fitting splined section of outer cocking lever shaft into the splines in hub of inner cocking lever.

(*d*) Place firing pin spring (fig. 308) in cupped end of firing pin and insert firing pin in bore in breechblock.

(*e*) Press firing pin spring cover (fig. 308) into bore of

breechblock using firing pin spring cover wrench 5228057 (fig. 306) and turn cover 90° to match outer point of diamond on cover with arrow on rear face of breechblock.

(2) *Assembly of closing spring case assembly.* Before proceeding to assemble the parts, select the correct spring, cover, and case for the left and right-hand assemblies as follows:

(*a*) The left-hand case (fig. 310) spring anchor tapers down to the right. The right-hand case spring anchor tapers down to the left.

(*b*) The left-hand spring (fig. 310) points counterclockwise when the bulging side of the spring points up. The right-hand spring (fig. 310) points clockwise when the bulging side of spring points up.

(*c*) The left-hand cover (fig. 310) spring anchor slot is even with the clockwise edge of the land on the rim of the cover. The right-hand cover spring anchor slot is even with the counterclockwise edge of the land on the rim of the cover.

(*d*) Mount closing spring case on closing spring case bracket (fig. 34).

(*e*) Position closing spring in case.

(*f*) Position cover over case and spring.

(*g*) Insert key plug wrench 5228074 (fig. 305) into hole in center of the case. Turn wrench (clockwise for left-hand assembly and counterclockwise for right-hand assembly) to wind closing spring and to lock bayonet connection (fig. 310) of case and cover. There will be an audible click as case locks in position.

(*h*) Remove closing spring case assembly from bracket.

(3) *Installation.*

(*a*) Elevate gun to approximately 80°.

(*b*) Remove bottom cover (*c* (1) (*e*) above).

(*c*) Insert breechblock with firing pin in fired position, into breech ring, so that base of breechblock is flush with base of breech ring.

(*d*) Grasp inner cranks at splined holes so that curves of cranks are toward the top of the gun and cams are to the inside.

(*e*) Install cranks (fig. 311) so that they lie to rear of the opening in the breech ring, rotate leading edge up as they are installed.

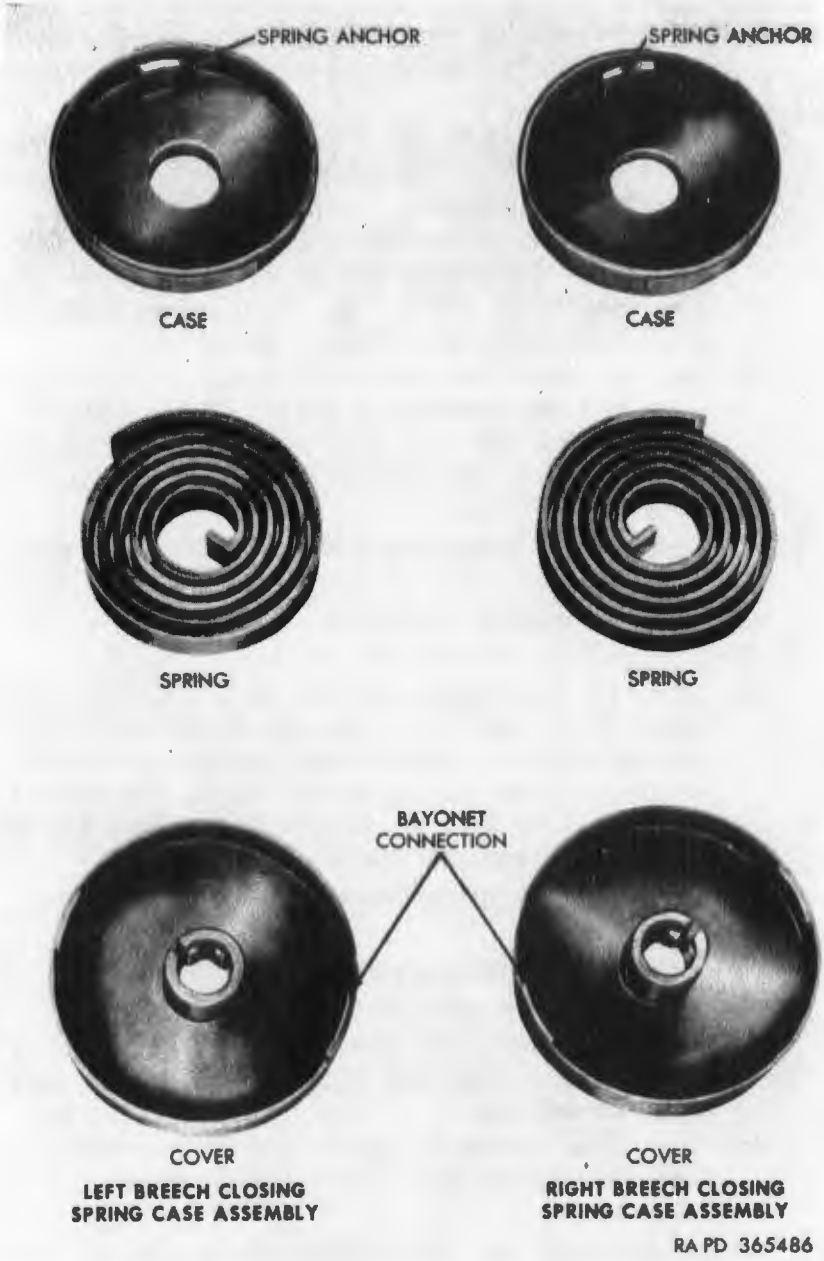


Figure 310. Parts for left and right-hand closing spring case assemblies.

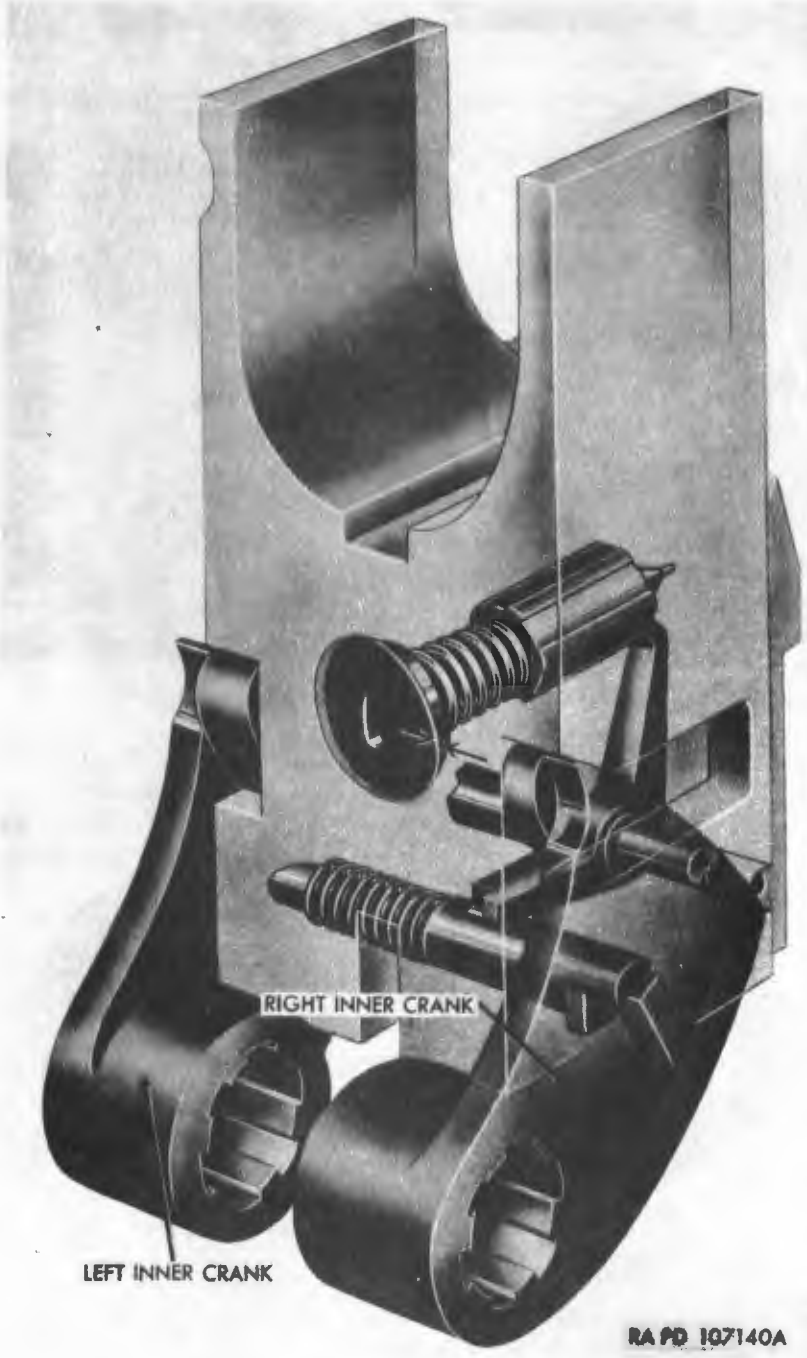


Figure 311. Inner cranks (installed position).

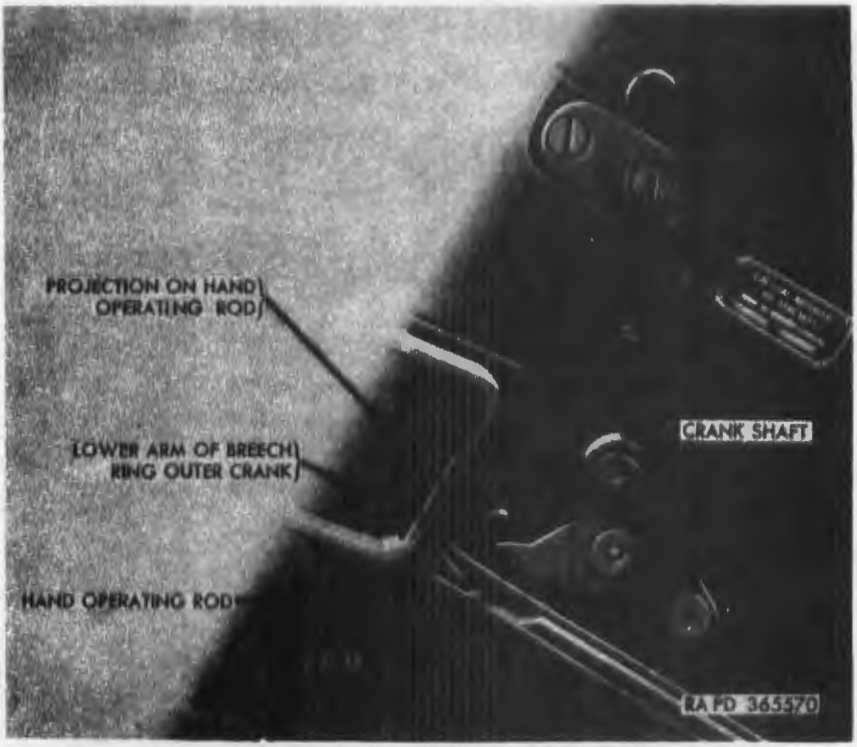


Figure 312. Outer crank with crank shaft (installed).

(*f*) Install breech ring outer crank with crank shaft (fig. 312) far enough to hold inner cranks and breechblock in place. Install outer crank and crank shaft so that lower arm of outer crank mates with projection on hand operating rod.

(*g*) Position closing spring case assembly so that lug on cover slides in slot in side of breech ring and secure by forcing in outer crank shaft.

(*h*) Install bottom cover.

(*i*) Close and lock side cover (fig. 301), making sure that cover is locked.

(*j*) On right-hand gun only, install pin connecting computing sight support to elevating drag link rod (fig. 24) by inserting pin through yoke on upper end of rod and foot of computing sight support. Install 3/8-inch lockwasher and 3/8-inch hex nut on pin.

282. Automatic Loader Assembly

a. Description (figs. 313 and 314).

(1) The automatic loader is both a cartridge magazine and a

loading device. Cartridges, in clips of four, are inserted in the top of the loader. They are fed singly to the loader tray, the clips are removed automatically during the process. A cartridge is rammed into the chamber of the gun, tripping the extractors, which permits the breechblock to be raised. With the closing of the breechblock the gun fires automatically if firing mechanism is depressed or firing solenoid is actuated.

(2) The gun may be loaded manually or automatically. After the mechanism has been prepared for automatic loading, the feed mechanism of the loader feeds the loader tray with a continuous supply of cartridges. Provisions are made to insure, that only one cartridge is fed onto the loader tray at a time, that automatic loading and firing can be stopped when only one cartridge remains in the feed guides and a cartridge on the loader tray (to eliminate the necessity of manual loading), that the rammer cannot be

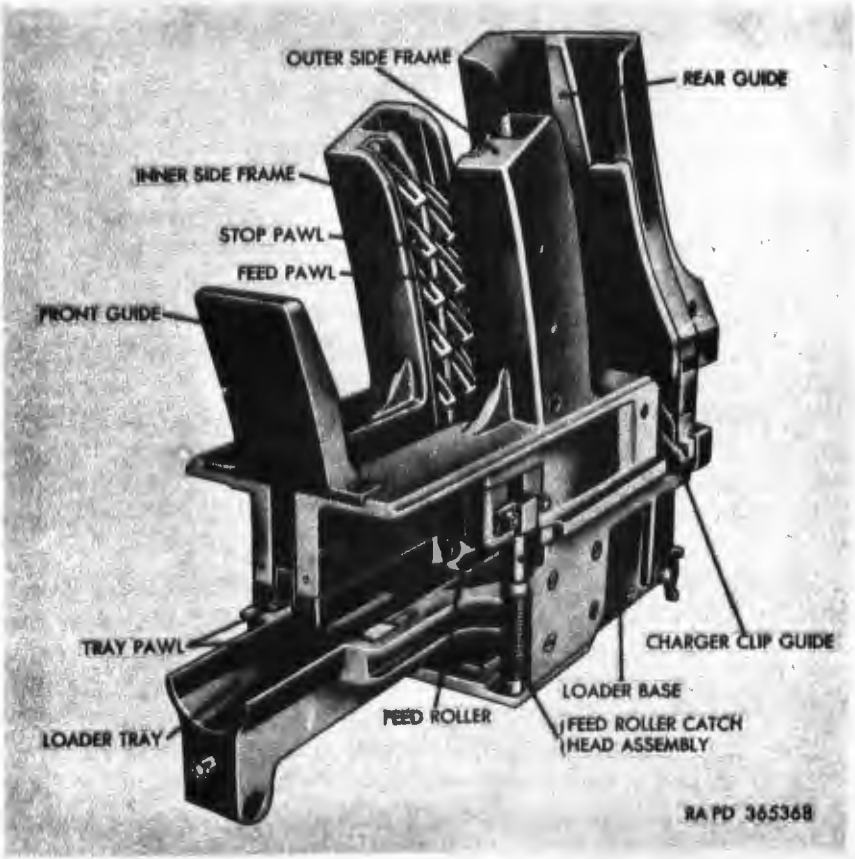


Figure 313. Left automatic loader assembly—front view.

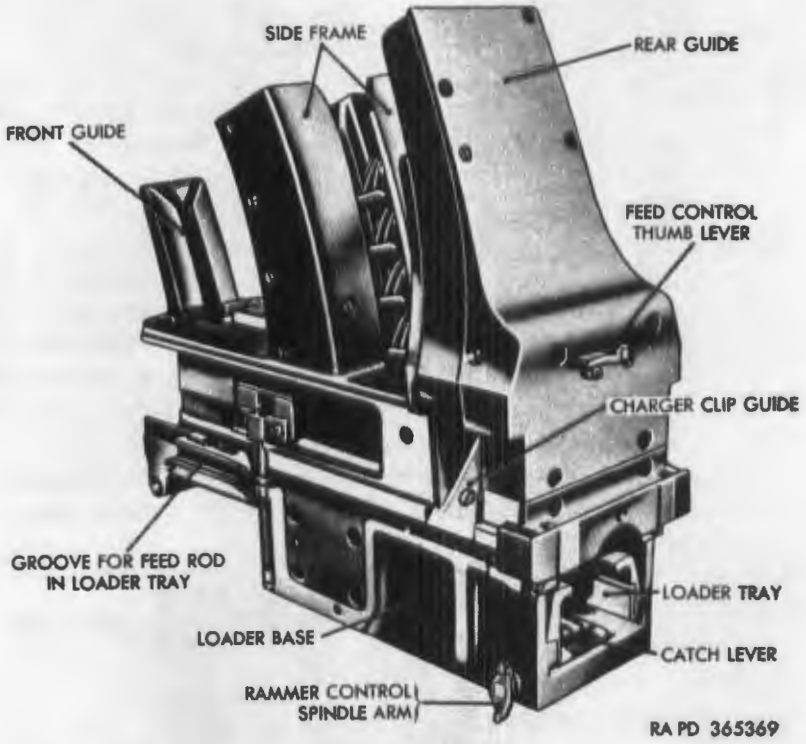


Figure 314. Left automatic loader assembly—rear view.

released until the gun reaches the end of counterrecoil, and that the rammer can be latched out of action to prevent accidental discharge of the weapon.

(3) The front and rear guides and the upper part of the feed mechanism protrude from the top of the breech casing and are covered by the automatic loader cover when the gun is not in action. All other parts of the loader are contained within the breech casing.

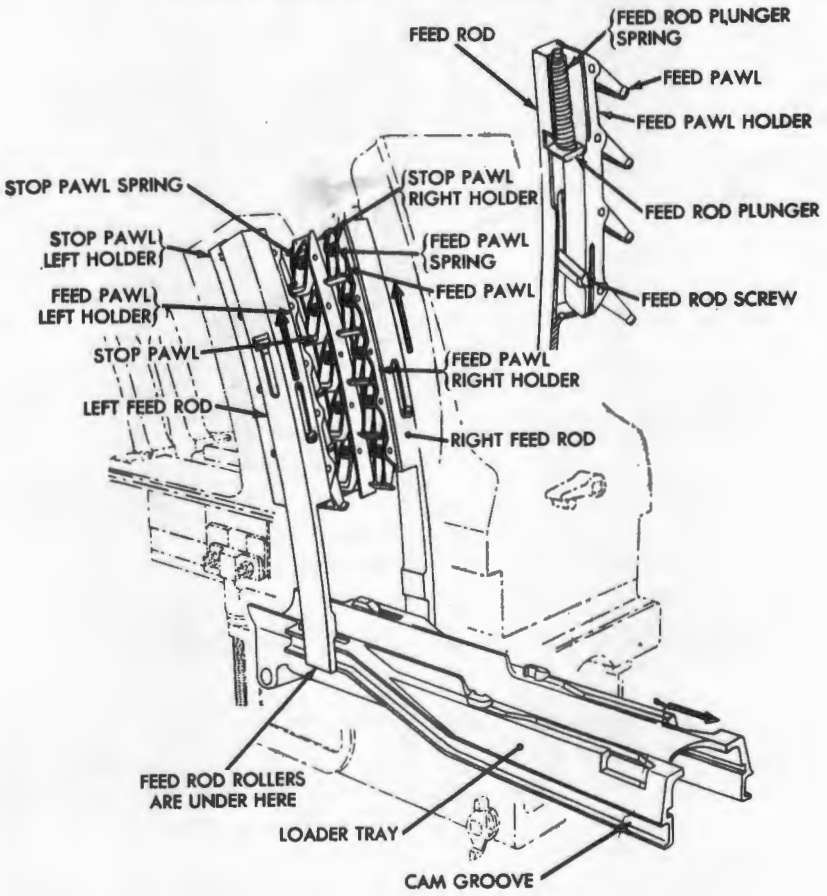
(4) All parts of the loader, with the exception of the loader tray and the rammer, remain in a fixed position in the breech casing. The loader tray is bolted to the rear of the breech ring and recoils and counterrecoils with it. Motion of the loader tray is the main source of energy for operating the feed mechanism. The rammer moves independently of the loader tray to ram the cartridges.

(5) The principal mechanisms of the automatic loader are the feed mechanism, loader tray, cartridge rammer assembly, and the automatic loader control mechanism.

b. Functioning of Feed Mechanism Assembly (figs. 315 and 316). The feed mechanism assembly comprises those parts of the automatic loader which feed the loader tray. The assembly consists of the front and rear guides, side frames, feed rods and rollers, feed and stop pawls and holders, feed rollers, catches and plungers, and the ammunition charger clip release arrangement.

(1) *Feed and stop pawls* (figs. 315 and 316).

(*a*) The feed and stop pawls and holders are housed in the side frames. The feed pawls are operated by feed rods which are raised and lowered by the feed rod rollers moving in the cam grooves in the sides of the loader tray as the loader tray moves in recoil and counterrecoil. The



RA PD 365392

Figure 315. Feed mechanism assembly—raised position.

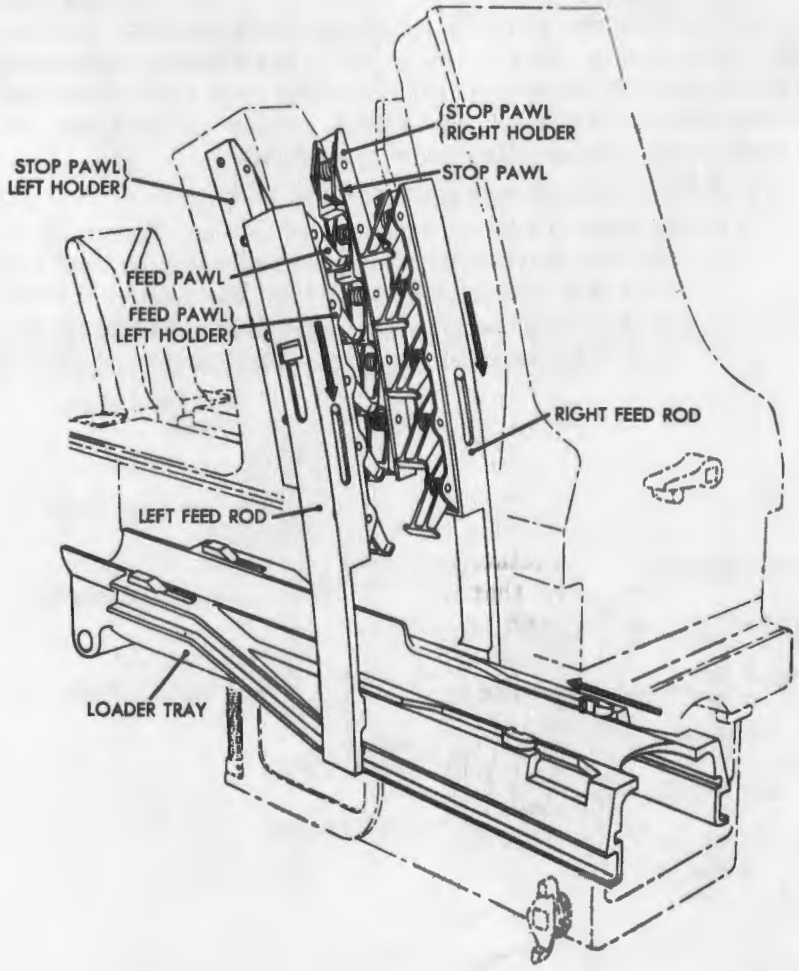


Figure 316. Feed mechanism assembly—lowered position.

feed pawls move all cartridges in the loader downward each time a round is fired. The stop pawls, which are retained in stationary holders, prevent the cartridges from moving upward during vertical movement of the feed pawls.

(*b*) During recoil, the feed rod rollers moving in the cam grooves in the sides of the loader tray raise the feed rods. The feed rods carry the feed pawl holders and feed pawls upward. The feed pawls ride against the sides of the cartridges in the loader on the upward movement. The stop pawls are forced outwardly from their

holders by their springs and prevent the cartridges from being raised as the feed pawls move upward.

(*c*) The feed rods draw the feed pawls downward during counterrecoil. The feed pawls, forced outward from their holders by their springs, engage the cartridges and force them downward. The stop pawls are forced into their holders by the cartridges, permitting a cartridge to be fed onto the loader tray.

(*d*) A spring and plunger are provided at the top of each feed rod to protect the mechanism in case of a jammed cartridge. Should a cartridge jam during the downward movement, the compression of this spring permits each feed pawl holder to remain in the raised position.

(2) *Feed rollers* (figs. 317 and 318).

(*a*) The feed rollers are metal prisms with four concave sides. They are located in the loader under the feed and stop pawl assemblies and over the loader tray and are mounted to rotate in opposite directions. Their purpose is to insure that only one cartridge is fed onto the loader tray at a time.

(*b*) The feed rollers are revolved by the cartridge as it is forced downward onto the loader tray. Their movement

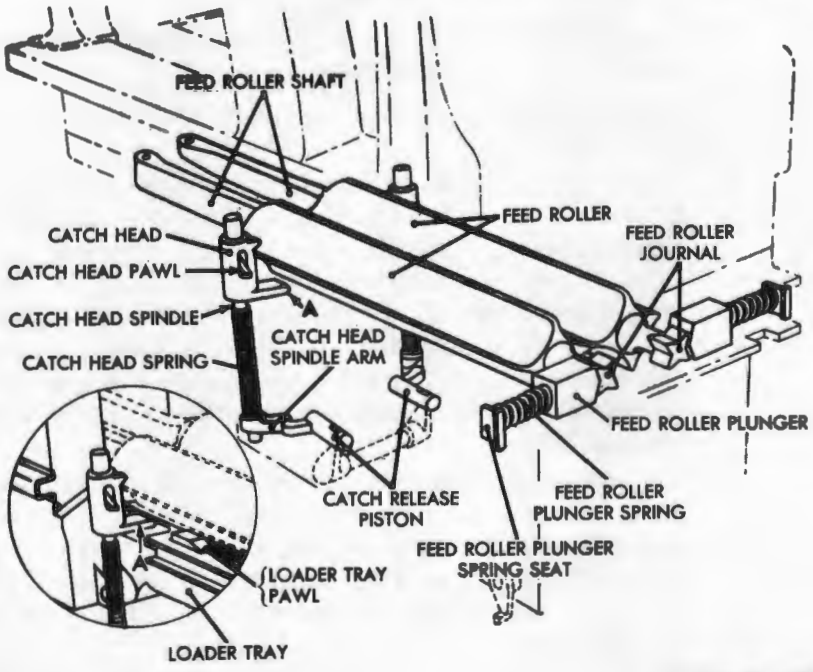


Figure 317. Feed rollers—engaged.

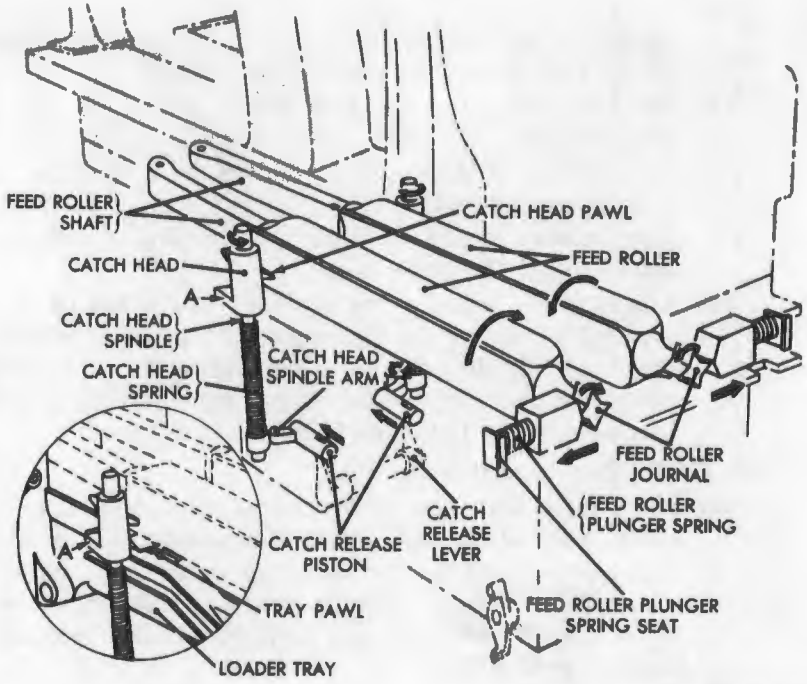


Figure 318. Feed rollers—released.

is controlled by the feed roller catch mechanism and the feed roller plunger mechanism.

(3) *Feed roller catch and feed roller plunger mechanisms* (figs. 317 and 318).

(*a*) The feed roller catch mechanism consists of catch heads fitted with spring-loaded catch head pawls, catch head spindles, springs, spindle arms, and catch release pistons. A catch mechanism is located near the front end of each feed roller. Its functions are to hold and release the feed roller and to limit its rotation to exactly one-quarter revolution. The catch mechanisms are actuated by the tray pawl in automatic operation (inserts, figs. 317 and 318).

(*b*) The feed roller plunger mechanism consists of feed roller plungers, springs, and spring seats. They are located under and at the rear of the loader over the loader tray. Each plunger acts on a 4-pointed feed roller journal on the rear of a feed roller to aline the roller after each one-quarter turn.

(*c*) The feed rollers normally are locked in position by the catch heads. During counterrecoil, when the cartridges

are being moved downward by the feed mechanisms, the loader tray pawls engage and rotate the catch heads. This action releases the feed rollers and permits them to be revolved by the cartridge as it is forced downward. When the cartridge has passed through the feed rollers and the rollers have revolved one-quarter turn, the catch heads are returned to their normal position by the catch head springs, locking the rollers in place.

(*d*) The catch heads are also rotated in another manner. When the hand operating lever (fig. 33) is pulled to the rear, it actuates the hand operating device which rotates the feed roller catch release levers (fig. 318) to a forward position. These move the catch release pistons against the catch head spinde arms, rotating the catch heads and releasing the feed rollers for one-quarter turn.

(4) *Charger clip release arrangement.*

(*a*) The cartridges are released from the charger clips (fig. 319) as they move downward in the automatic loader. As the cartridge and clip move downward, the charger clip pins are forced to the rear by the cam surface of the lower rail in the loader rear guide. This action releases the cartridges from their hooks and from the clip. When fully released, the clip is deflected by the rear rail and is ejected through the ammunition charger clip guide on the left gun and right side of the right gun.

(*b*) The action on the charger clip pins is shown in figure 319. Pin A has not engaged the lower rail; pin B has engaged the lower rail and is being forced rearward; pins C and D have been forced fully to the rear and have released their cartridges. Action of the hooks is shown in the insert in figure 319. Hooks E and F hold their cartridges; hook G has been forced to the rear releasing its cartridge; the cartridge has been removed from hook H.

c. Functioning of Loader Tray (figs. 320 and 321).

(1) The functions of the loader tray are: to support the cartridge until it is rammed into the gun chamber by the rammer, to rotate the feed roller catch heads, to actuate the feed rods, to operate the rammer levers, and to support and actuate the cartridge rammer assembly. These operations are performed by various surfaces and assemblies either incorporated into the shape of the tray or attached to it.

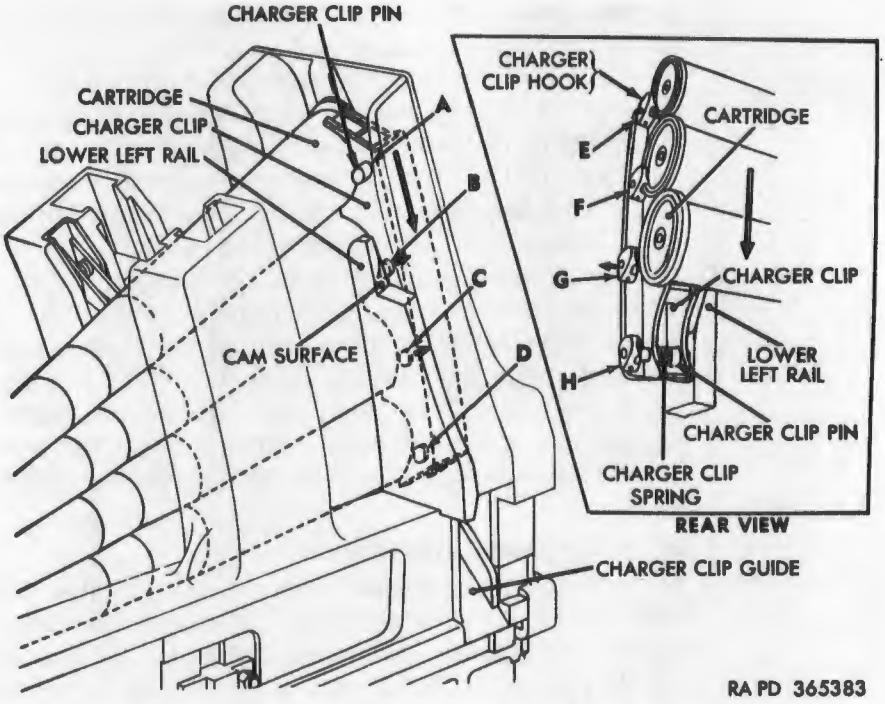


Figure 319. Charger clip—released from cartridges.

(2) The loader tray is trough-shaped to receive the cartridge. The front of the loader tray is bolted to the breech ring and recoils and counterrecoils with it. The tray pawls, which rotate the catch heads, are located near the front. The cam grooves, in which the feed rod rollers move, are located along sides of the tray. These grooves cause the rollers to raise the feed rods during recoil and to force them down during counterrecoil. This movement actuates the feed mechanism and feeds a fresh cartridge onto the loader tray.

(3) The housing for the rammer rod and spring is cast integral with the under side of the loader tray toward the front. Cam slots are provided along both sides in the top of the tray for the rammer levers. A beveled projection on the bottom of the rammer rod and spring housing (A, fig. 320) trips the rammer lever as the loader tray nears the end of counterrecoil.

d. Functioning of Cartridge Rammer Assembly.

(1) The function of the cartridge rammer assembly is to store up energy by the compression of the rammer spring (fig. 320) during counterrecoil of the loader tray and, by means

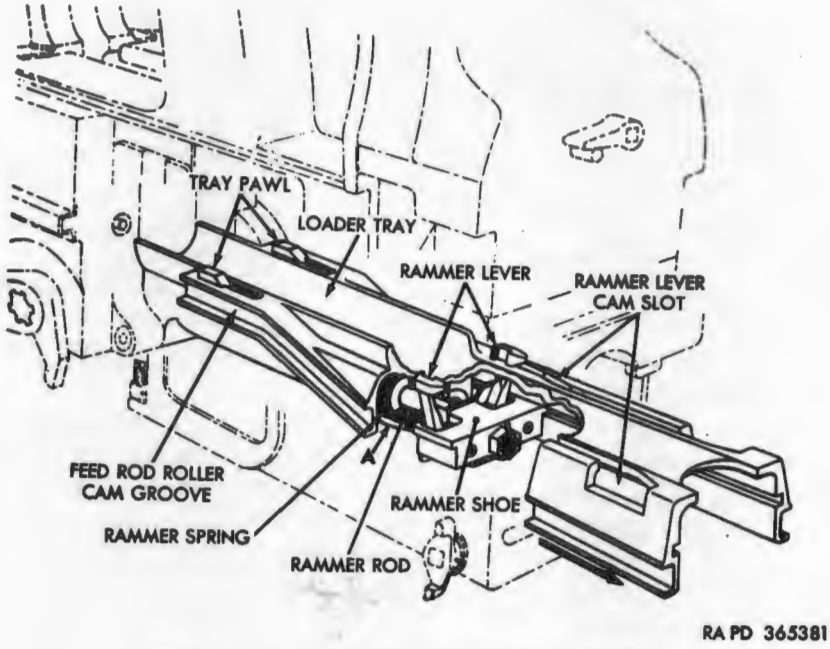


Figure 320. Loader tray—rammer shoe held.

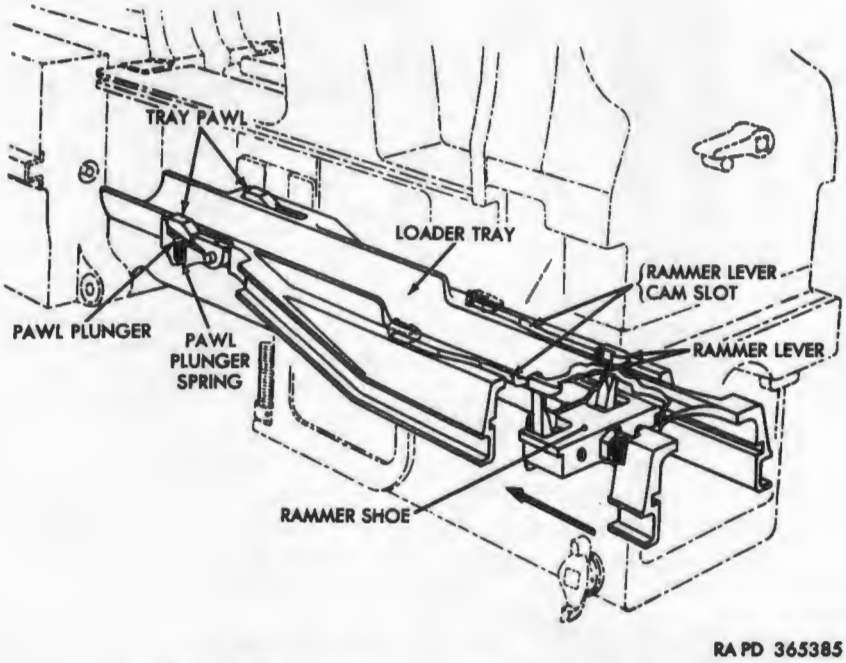


Figure 321. Loader tray—rammer shoe released.

of the rammer levers, to grip the rim of the cartridge; then, when the rammer shoe is released, to carry the cartridge forward, release it, and send it forward by momentum into the gun chamber.

(2) The rammer rod (fig. 320), head, spring, and seat are contained within the housing in the under side of the loader tray. The rammer shoe is attached to the rear end of the rammer rod. The rammer levers are pivoted in the sides of the shoe. Spring loaded plungers force the heads of the rammer levers inward. A leather rammer buffer pad, mounted in the front end of the housing, absorbs the shock as the rammer is driven forward by the rammer spring when the rammer shoe is released.

(3) The rammer can be operated manually or automatically. The rammer must be operated manually to prepare for firing of the initial round if the loader has been permitted to become empty. To prevent the ammunition in the loader from running out, the feed control thumb lever (fig. 34) is normally placed in the direction of the arrow during firing. This will stop automatic firing when one cartridge remains in the feed guides and one cartridge is on the loader tray.

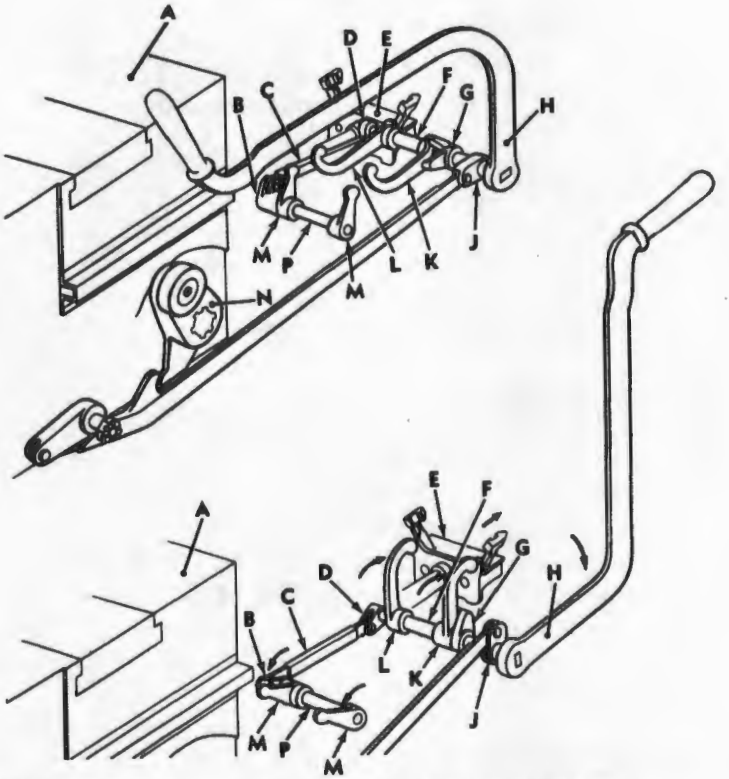
(4) Manual operation is as follows:

Caution: Before initial loading, the firing selector lever (fig. 33) must be placed in the STOP FIRE position.

(*a*) When the hand operating lever (H, fig. 322) is pulled to the extreme rear position it causes the rammer cocking levers (K and L, fig. 322) to force the rammer shoe (E, fig. 322) to the rear, compressing the rammer spring (fig. 320). With the hand operating lever held in the rear position permitting the catch release pistons (fig. 318) to rotate the feed roller catch heads, a clip of cartridges is placed in the automatic loader and pushed down until the feed rollers rotate one-quarter turn and a cartridge moves onto the loader tray. The rim of the cartridge is engaged in the grooves of the upper arm flanges of the rammer levers (fig. 320).

Note. The rammer shoe is carried farther to the rear during manual operation than during automatic operation.

(*b*) When the hand operating lever (H, fig. 322) is returned to its horizontal position, the rammer cocking levers (K and L, fig. 322) will return to their normal positions and the rammer shoe (E, fig. 322) will move forward a short distance until it engages the trigger rammer catch lever (N, fig. 323). The rammer catch tray lever is depressed by the rammer releasing lever as a result of the



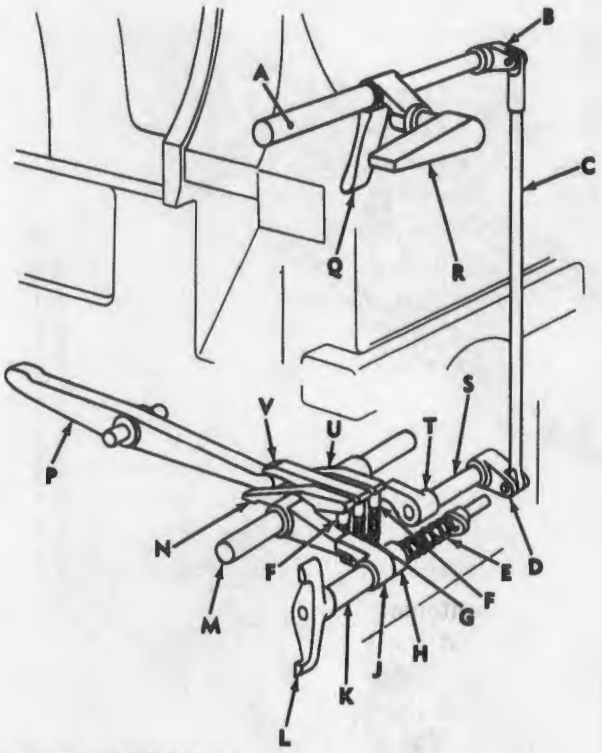
A —BREECH RING
B —FEED ROLLER CATCH RELEASE LEVER ARM
C —FEED ROLLER CATCH RELEASE LINK
D —RAMMER COCKING LEVER SHAFT ARM
E —RAMMER SHOE
F —RAMMER COCKING LEVER SHAFT
G —HAND OPERATING LEVER SHAFT ARM
H —HAND OPERATING LEVER
J —HAND OPERATING LEVER SHAFT
K —LEFT OUTER RAMMER COCKING LEVER
L —LEFT INNER RAMMER COCKING LEVER
M —FEED ROLLER CATCH RELEASE LEVER
N —BREECH RING OUTER CRANK
P —FEED ROLLER CATCH RELEASE SPINDLE

RA PD 365396

Figure 322. Hand operating mechanism.

projection on the under side of loader tray depressing the toe of the rammer releasing lever (P, fig. 323).

(*c*) All three rammer catch levers (N, V, and U, fig. 323) are depressed and the rammer shoe released when the firing selector lever (fig. 33) is moved to a fire position, there are more than two rounds in the automatic loader and the firing mechanism pedal (fig. 38) or the firing solenoids (fig. 27) are actuated. The rammer shoe (E, fig. 322) is carried forward by the action of the compressed rammer spring (fig. 320). When the rammer shoe moves forward, the rammer levers (fig. 320) carry the cartridge with it. As the rammer shoe nears its forward position, the rammer levers are forced outward by



A —FEED CONTROL LEVER SPINDLE
B —FEED CONTROL LEVER SPINDLE ARM
C —LOWER FEED CONTROL ROD
D —OUTER RAMMER CONTROL INTERMEDIATE SPINDLE ARM
E —RAMMER CONTROL FREE TAPPET SPRING
F —TRIGGER AND FEED CONTROL RAMMER CATCH LEVER PLUNGER AND SPRING
G —TRAY RAMMER CATCH LEVER PLUNGER AND SPRING
H —RAMMER CONTROL FREE TAPPET
J —RAMMER CONTROL FIXED TAPPET
K —RAMMER CONTROL SPINDLE
L —RAMMER CONTROL SPINDLE TRIGGER ARM
M —RAMMER CATCH LEVER AXIS PIN
N —TRIGGER RAMMER CATCH LEVER
P —RAMMER RELEASING LEVER
Q —FEED CONTROL LEVER
R —FEED CONTROL THUMB LEVER
S —RAMMER CONTROL INTERMEDIATE SPINDLE
T —INNER RAMMER CONTROL INTERMEDIATE SPINDLE ARM
U —FEED CONTROL RAMMER CATCH LEVER
V —TRAY RAMMER CATCH LEVER

RA PD 365389

Figure 323. Check, catch, and release mechanisms—all levers depressed.

the cam slots in the loader tray, releasing the cartridge which is thrown into the gun chamber by the momentum of the ramming action.

Note. At the end of this sequence the gun will fire.

(5) Automatic operation is as follows:

(*a*) During recoil, the rammer shoe assembly is carried to

the rear with the loader tray. As the loader tray starts forward in counterrecoil, the lower portion of the rammer shoe is engaged by the rammer catch tray lever. This lever retains the rammer shoe in its rearward position while the loader tray continues to return to battery position with the gun and breech ring, causing the rammer spring to become compressed.

(*b*) As the loader tray nears the end of counterrecoil, the beveled projection on the underside of the loader tray trips the rammer releasing lever (P, fig. 323), freeing the rammer shoe from the restraint of the rammer catch tray lever.

(*c*) If all of the rammer catch levers (N, V, and U, fig. 323) are depressed, the rammer shoe is carried forward by action of the compressed rammer spring (fig. 320) to ram the cartridge.

e. Functioning of Automatic Loader Control Mechanism.

(1) *General.* The automatic loader control mechanism consists of those parts of the automatic loader which cock, hold, and release the rammer shoe (E, fig. 322) and which actuate the catch heads (fig. 318) that hold and release the feed rollers. The feed roller control parts are described in *b*(2) above.

(2) *Rammer control mechanism.* The rammer control parts consist of the rammer cocking lever shaft assembly which is actuated by the hand operating lever to compress the rammer spring manually; the catch and release mechanism which holds the rammer shoe while the spring is compressed automatically and insures that the rammer shoe will not be released until the gun has reached the end of counterrecoil; the feed control check and release mechanism which can be set to stop automatic firing when only one cartridge remains in the feed guides; and the firing mechanism check and release mechanism which is controlled by the firing selector lever.

(3) *Rammer cocking lever shaft assembly.*

Note. The key letters noted in parentheses are in figure 322, except where otherwise indicated.

(*a*) This mechanism is housed in the base of the automatic loader. It is operated manually by the hand operating lever (H) to force the rammer shoe (E) to the rear and compress the rammer spring (fig. 320), at the same time pressing the catch release pistons (fig. 318) forward to contact the catch head spindle arms and rotate

the feed roller catch heads. This frees the feed roller for a one-quarter turn resulting from pressure applied on the cartridges in the magazine.

(*b*) The functioning of the mechanism is shown in detail in figure 322. When hand operating lever (H) is pulled to the rear, the hand operating lever shaft arm (G) engages the left outer rammer cocking lever (K). The rammer cocking lever shaft (F) and the left outer and inner rammer cocking levers (K and L) are rotated backward, carrying the rammer shoe (E) to the rear.

(*c*) The rammer cocking lever shaft (F) also rotates the rammer cocking lever shaft arm (D), transmitting motion through the feed roller catch release link (C) and feed roller catch release lever arm (B) to feed roller catch release levers (M). These move the catch release pistons (fig. 318) forward to contact the catch head spindle arms and rotate the catch heads.

(4) *Automatic catch and release mechanism.*

Note. The key letters noted in parentheses are in figure 323.

(*a*) The tray rammer catch lever (V) of the automatic catch and release mechanism is the center lever of the three mounted in the rear of the automatic loader base. The tray rammer catch lever plunger and spring (G) forces the rear end of the catch lever upward to engage the rammer shoe.

(*b*) The tray rammer catch lever (V) is the only one which holds the rammer shoe until the rammer spring is compressed. The lever is not released until the gun is near the end of counterrecoil.

(*c*) The tray rammer catch lever (V) is released by the beveled projection on the bottom of the loader tray engaging the front end of the rammer releasing lever (P) when the loader tray is near the end of the counterrecoil. Then, the rammer releasing lever pivots on its axis pin and its rear end lifts the front end of the tray rammer catch lever (V). The rear end of the rammer catch tray lever being forced downward against its spring-loaded plunger, releases the rammer shoe. The rammer shoe is driven forward by the rammer spring unless the shoe is held by the trigger or feed control tray rammer catch lever.

(5) *Feed control check and release mechanism.*

(*a*) The function of the feed control check and release mechanism is to stop automatic firing when only one car-

tridge remains in the feed guides and one cartridge is on the loader tray. This eliminates the necessity of reloading by hand which must be done if the supply of ammunition in the loader runs out. The mechanism operates when the feed control thumb lever is pointed in the direction of the arrow (fig. 34). The mechanism may be made inoperative to eliminate the reserve feature by pointing the feed control thumb lever in the direction opposite to the arrow.

(*b*) The feed control rammer catch lever (U, fig. 323) of the feed control mechanism is the right lever of the three mounted on the rammer catch lever axis pin. Its rear end is raised by a spring-loaded rammer catch lever plunger to engage the shoulder of the rammer shoe unless the lever is held in the depressed position. The lever has an integral arm which is contacted by the inner rammer control intermediate spindle arm (T, fig. 323).

(*c*) The feed control check and release mechanism is actuated by the feed control lever (Q, fig. 323) at the rear and inside and by the feed control thumb lever at the rear and on the outside of the rear guide of the loader. Both levers act upon the inner rammer control intermediate spindle arm through the feed control lever spindle, arm, lower feed control rod, outer rammer control intermediate spindle arm, and rammer control intermediate spindle to depress the rear end of the feed control rammer catch lever.

(*d*) The feed control check and release mechanism is controlled also by the feed control thumb lever. When this lever is in the direction of the arrow, the mechanism is actuated by the cartridges. It is placed in this position for single and automatic fire. When more than one cartridge is in the feed guides of the loader, the feed control lever (Q, fig. 323) is held to the rear of the loader by the base of the second cartridge above the feed rollers. In this case, the inner rammer control intermediate spindle arm holds the feed control rammer catch lever down where it has no effect on the holding of the rammer shoe.

(*e*) When only one round is left above the feed rollers, the feed control lever (Q, fig. 323) is free to lift and no longer has a restraining influence on the inner rammer control intermediate spindle arm. The rear end of the feed control rammer catch lever is raised by its spring-

loaded plunger and holds the rammer shoe in its rearward position until the lever is depressed. When more cartridges are inserted in the loader, the releasing mechanism comes into operation again and automatic firing may be resumed.

(*f*) When the feed control thumb lever is in the direction opposite to the arrow, the eccentric on the shaft of the thumb lever engages and operates the short arm of the feed control lever and, through the linkage, causes the rear end of the feed control rammer catch lever to be depressed and the reverse feature is eliminated. This action is utilized also in releasing the rammer shoe when the weapon is unloaded.

(6) *Firing mechanism check and release mechanism.*

Note. The key letters noted in parentheses are in figure 823.

(*a*) This mechanism is controlled by the firing selector lever. In single fire operation, it is intended to be the last link in the holding of the rammer shoe prior to its release and the firing of the gun. It is released when the firing selector lever is set either for single fire or automatic fire, the firing pedal is depressed, or the firing solenoids actuated.

(*b*) The trigger rammer catch lever (N) of the firing mechanism is the left lever of three mounted on the rammer catch lever axis pin (M). Its rear end is raised by a trigger and feed control rammer catch lever plunger and spring (F) to engage the rammer shoe unless the lever is held in the depressed position. This lever has an integral arm which is contacted by a rammer control fixed tappet (J) keyed to the rammer control spindle (K).

(*c*) When the firing selector lever is set and the firing pedal is depressed, the firing lever pawl of the breech casing firing mechanism engages and rotates the firing trigger and the rammer control spindle trigger (L). This arm rotates the rammer control spindle (K) and rammer control fixed tappet (J). The tappet depresses the trigger rammer catch lever (N) and releases the rammer shoe, if this lever is the only one engaging the rammer shoe.

(*d*) When the firing lever pawl disengages the firing trigger, the trigger rammer catch lever (N) is raised to its normal position by action of its spring-loaded plunger. The rammer control free tappet (H) is held against the rammer control fixed tappet (J) by the rammer control free tappet spring (E), and snubs the free tappet's action.

f. Removal. The removal procedure is the same for both the left and right automatic loaders.

(1) Unload the gun and automatic loader and uncock the gun (par. 67). An audible click will be heard indicating release of the rammer shoe.

(2) Remove cartridge case deflector pin (fig. 324) and press down lower end of cartridge case deflector. Insert pin in cartridge case deflector bracket to prevent loss.

(3) Remove hex-head cap screw (fig. 324).

(4) Remove screw (fig. 324) securing rear cover.

(5) Lower rear cover, being careful not to let it fall back violently as screw is removed.

(6) Open side cover (fig. 301) by inserting side cover key 5228061, pressing key inward, and rotating clockwise. Tie cover in open position.

(7) Place gun at approximately 0° elevation.

(8) Using wrench 5228057, press loader tray connecting bolt (fig. 325) inward, turn 90° in either direction and remove bolt.

(9) Turn feed control thumb lever in direction of arrow. This is necessary to raise the feed control rammer catch lever plunger and protect it from damage.

(10) Slide loader tray back to rear edge of breech casing to raise

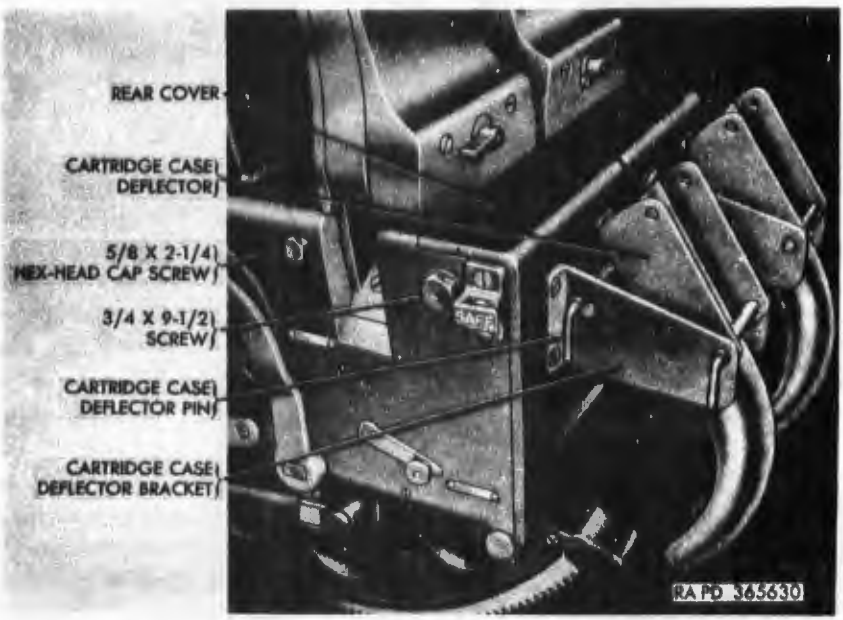


Figure 324. Parts to be removed before removing automatic loader.

Figure 325. Removing loader tray connecting bolt.

rammer catch tray lever plunger and protect it from damage when automatic loader assembly is removed.

(11) Slide the entire automatic loader assembly approximately five inches to the rear to permit attachment of loader front lifter 6200472 and loader rear lifter 6200471 and attach the lifters (fig. 326).

(12) With a man grasping each of the loader lifters, slide it backward on its rails out of the breech casing through the opening made by lowering the rear cover. Lift the automatic loader carefully to clean any obstruction.

g. Maintenance. Maintenance consists of cleaning, lubrication, inspection, and replacement of worn or broken parts.

(1) Clean the automatic loader with rifle-bore cleaner, making sure that all foreign matter is removed from all surfaces, particularly from recesses. Wipe dry and then oil as prescribed in lubrication order LO 9–7218 (par. 90).

(2) Rotate feed control thumb lever in direction of arrow. Pull hand operating lever all the way back and then return it to the front catch bracket. The rammer shoe should now be held back, if not, notify ordnance maintenance personnel. Rotate feed control thumb lever in the direction opposite to that of the arrow. Note whether the rammer shoe is held back, if not, notify ordnance maintenance personnel. Actuate the firing mechanism. Rammer shoe should be re-

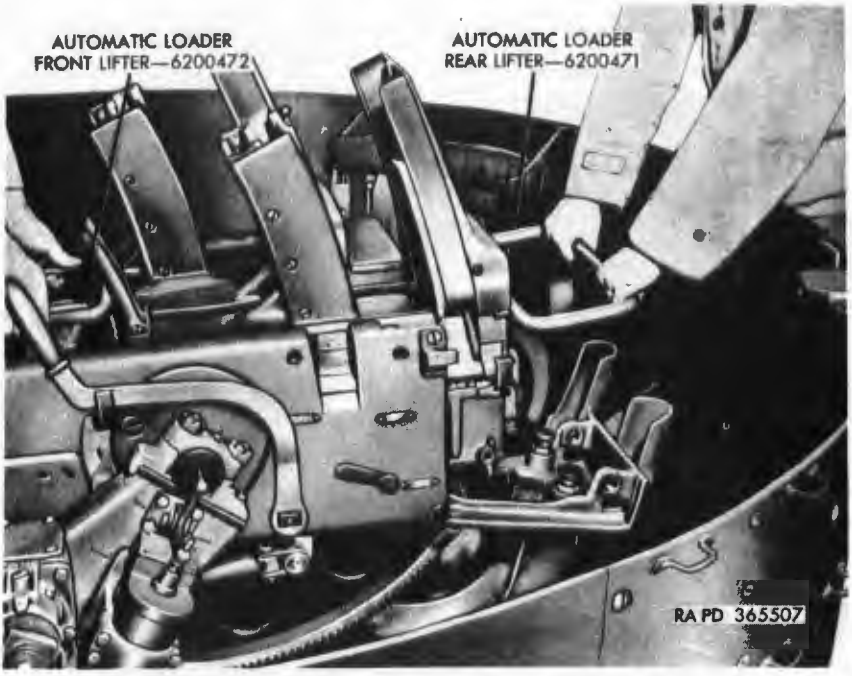


Figure 326. Removing or installing automatic loader.

leased, if not, notify ordnance maintenance personnel. Rotate feed control thumb lever in direction of arrow. Depress firing mechanism pedal and pull hand operating lever all the way back, then return it to the front catch bracket. If the rammer shoe is not held back, notify ordnance maintenance personnel.

(3) Insert a clip of dummy ammunition in automatic loader and check for proper operation. If the mechanism does not operate smoothly or requires greater effort than normal, it should be disassembled and the cause determined as described in the following paragraphs.

(4) Pull the loader tray forward out of loader and examine the tray for normal condition. If any part of the tray is damaged or broken, notify ordnance maintenance personnel. To install the loader tray, slide it into position, being careful not to push the tray in far enough that the rammer shoe will pass over the catch levers.

(5) Check feed rod rollers (fig. 327) for freedom of rotation and examine for cracks. If feed rod rollers bind or are cracked or broken, they must be replaced. To replace the rollers it is necessary to remove the loader tray first, the rollers can then be removed and replaced.

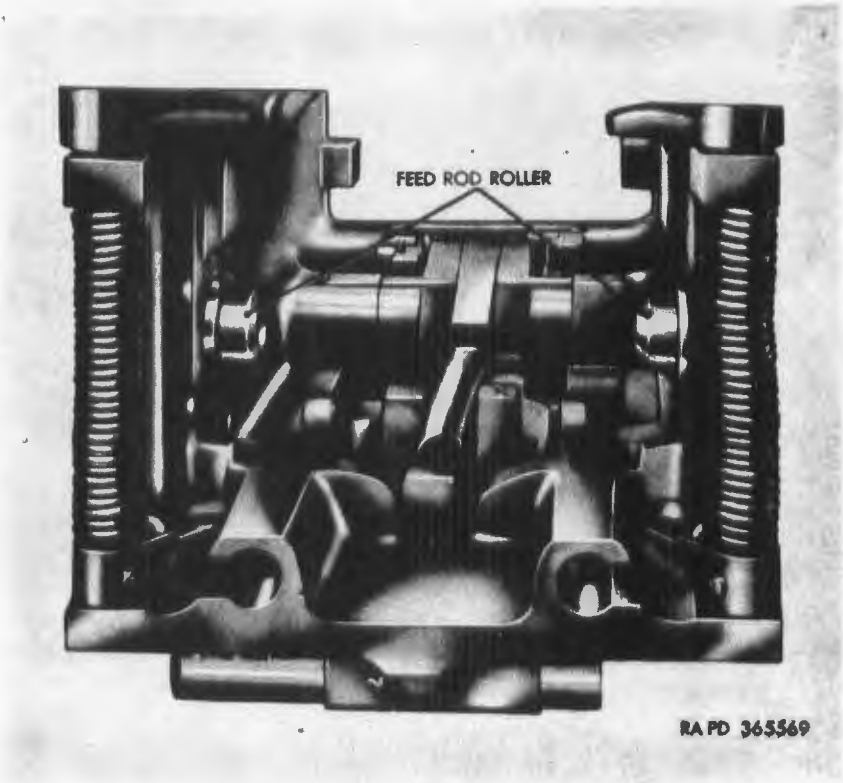


Figure 327. Feed rod rollers—installed.

(6) Observe whether any of the stop and feed pawls or springs are broken. To replace a broken pawl or weak or broken spring, proceed as outlined in (*a*) through (*h*) below:

(*a*) Remove the loader tray ((4) above).

(*b*) Remove the three fillister-head screws (fig. 328) and flat washers which retain the stop pawl holder, tap out the dowel pin, and withdraw the stop pawl holder assembly.

(*c*) Drive out pin and remove roller, spring, and pawl from the holder (fig. 329). Replace damaged parts.

(*d*) Position spring (fig. 329) between arms of pawl so that tang of spring engages small hole in arm of pawl.

(*e*) Insert roller (fig. 329) through holes in arms of pawl and through the spring.

(*f*) Rotate spring (fig. 329) so that free end of spring is on underside and points toward closed end of pawl. Lower the unit into pawl holders. Arms of pawl should point toward the hole for the loader frame dowel pin (fig.

Figure 328. Removal of stop pawl holder attaching screws.

329) and the curved surfaces of the pawls should rest on the bottom of the holder. The spring should be operative; free end of spring should be against bottom of holder and point away from hole for dowel pin.

(*g*) Aline holes of holder and roller and drive in the 0.274 x 1.020 straight pin (fig. 329).

(*h*) Position the stop pawl holder assembly in automatic loader frame and secure with $\frac{5}{16}$ x $1\frac{3}{8}$ dowel pin (fig. 328), three $\frac{5}{16}$ x $1\frac{1}{8}$ fillister-head screws, and three $\frac{11}{32}$ ID-inch flat washers.

(7) Check operation of feed pawl holder assembly and feed rod spring. Observe whether any of the feed pawls are broken and whether any feed pawl springs are weak or broken. To replace a stop and feed pawl or spring, proceed as in (*a*) through (*h*) below.

(*a*) Unscrew and remove the flat-head screw (fig. 328) which retains the feed rod assembly.

(*b*) Rotate the catch head (fig. 330) until it clears the feed roller and, while holding the catch head in this position, lift the feed rod assembly up past the feed roller and remove it from loader.

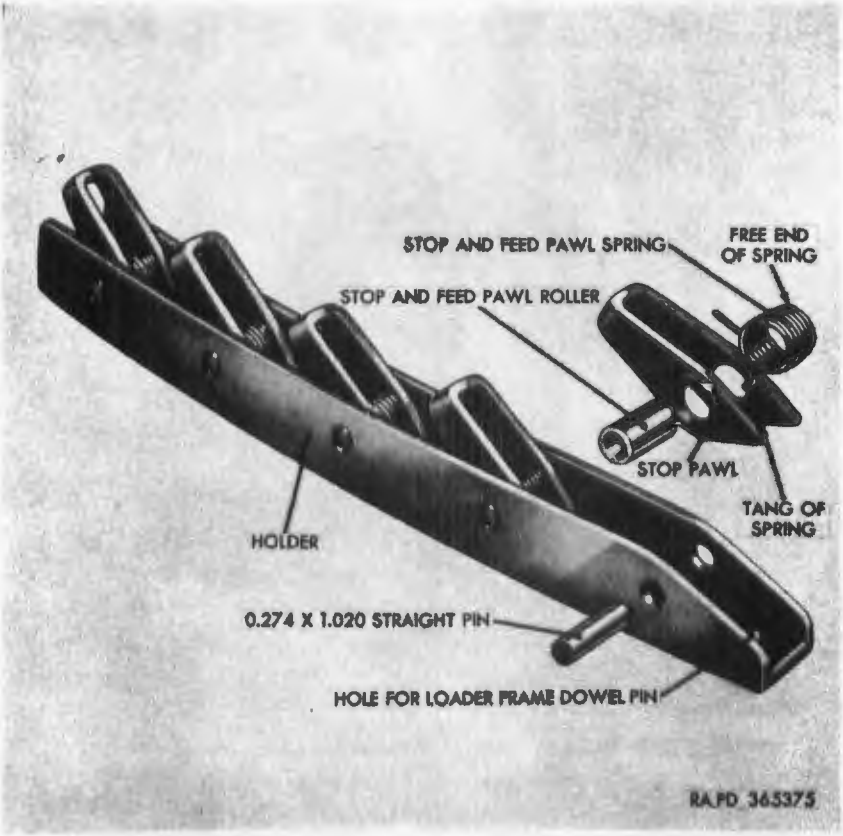


Figure 329. Stop pawl holder assembly—partially exploded.

(*c*) Drive out straight pin (fig. 331) and remove the stop and feed pawl roller, spring, and pawl from the holder. Replace damaged parts.

(*d*) Position stop and feed pawl spring (fig. 331) between arms of the feed pawl so that the tang of the spring engages the small hole in the arm of the pawl.

(*e*) Insert stop and feed pawl roller through holes of the arms and through the spring.

(*f*) Rotate stop and feed pawl spring so that free end of spring is on underside and points toward closed end of pawl. Position the unit in the feed pawl holder. Arms of pawl should point away from shaft for feed rod roller (fig. 331). Curved surfaces of the arms should rest on bottom of holder. The spring should be operative; free end of spring should press against bottom of holder and point toward shaft for feed rod roller.

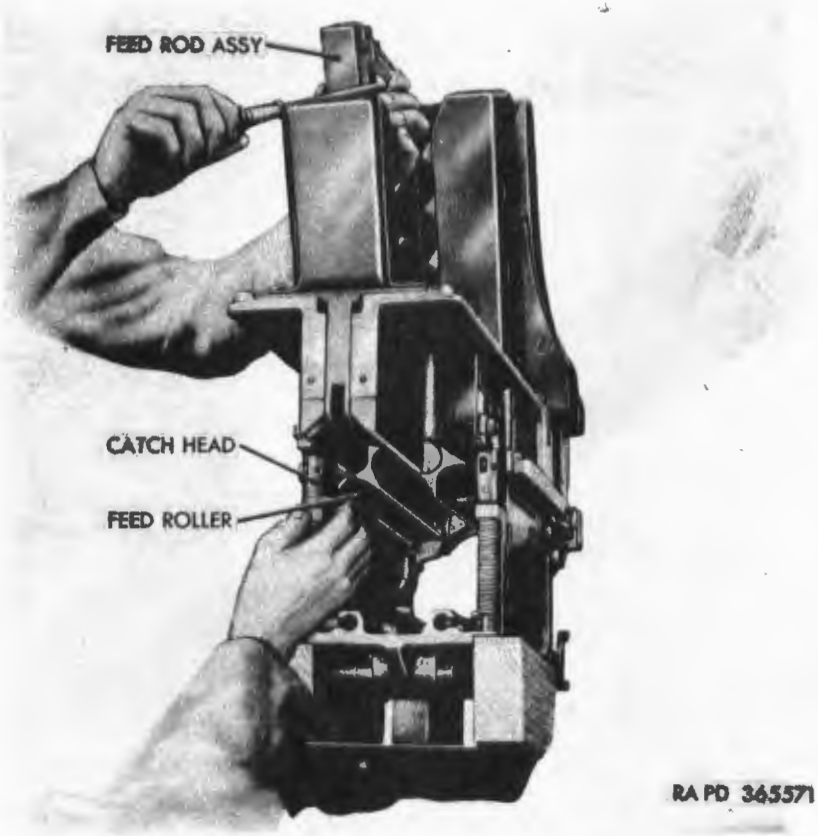


Figure 330. Removing feed rod assembly.

(*g*) Aline holes of holder and roller and drive in the 0.274 x 1.020 straight pin (fig. 331).

(*h*) Position feed rod assembly in automatic loader frame and secure with 5/16 x 3 7/16 flat-head screw (fig 328).

(8) To replace a feed pawl holder assembly, proceed as outlined in (*a*) through (*f*) below.

(*a*) With feed rod assembly removed from loader frame, compress feed rod plunger spring using automatic loader feed rod spring compressor 5228063 (fig. 332).

(*b*) Lift out feed pawl holder assembly (fig. 332).

(*c*) Release pressure on feed rod plunger spring and remove compressor, feed rod plunger spring, and feed rod plunger.

(*d*) To assemble the feed rod assembly, position feed rod spring and feed rod plunger. Install compressor 5228063 and compress the feed rod plunger spring (fig. 332).

(*e*) Insert feed pawl holder assembly.

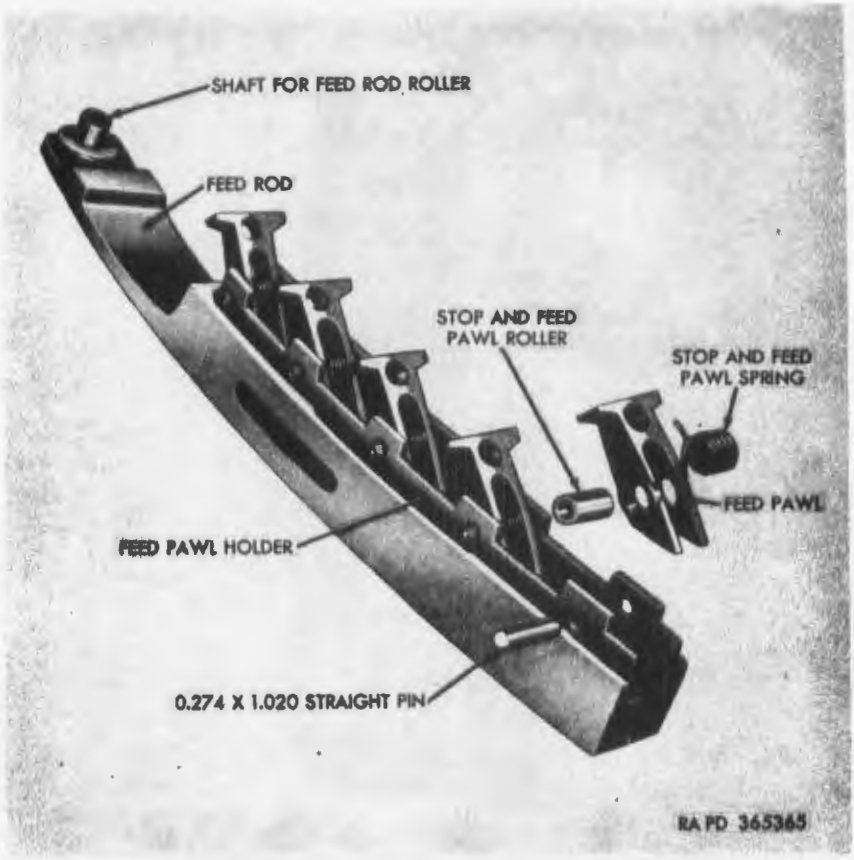


Figure 331. Right feed rod assembly—partially exploded.

(*f*) Relieve pressure on feed rod plunger spring and remove spring compressor.

(9) Check each feed roller plunger (fig. 333) in the loader crosspiece for freedom of action. If plungers bind or have weak action, replace the feed roller plunger springs.

(*a*) Remove the flat-head screw securing the crosspiece cover to the crosspiece and remove cover.

(*b*) Compress feed roller plunger springs (fig. 333) and remove plungers, springs, and seats.

(*c*) Install new springs in crosspiece.

(*d*) Position crosspiece cover on crosspiece and secure with a ¼ x ⅞ flat-head screw (fig. 333). Recheck action of plungers.

(10) Replace No. 00 x 1 tapered pin in the tray pawls and No. 1 x 1¼ tapered pin in the rammer cocking levers if pins are unserviceable.

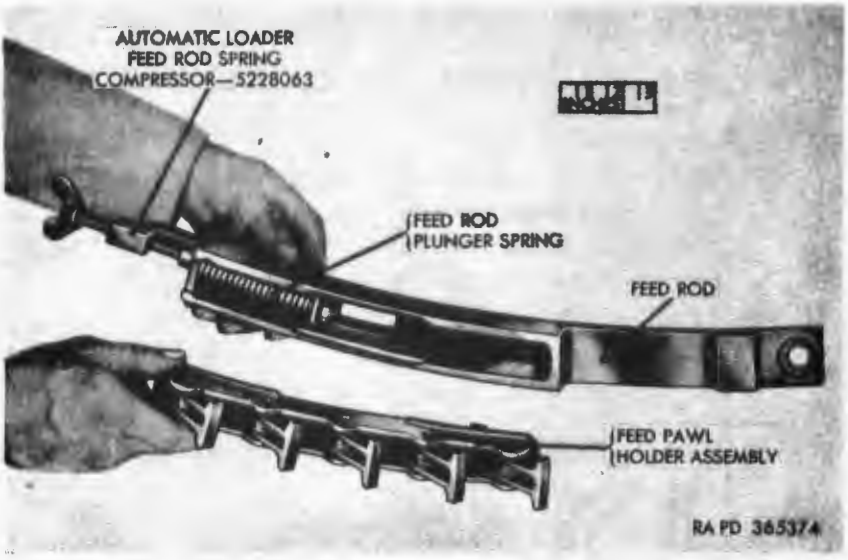


Figure 332. Removing feed pawl holder assembly.

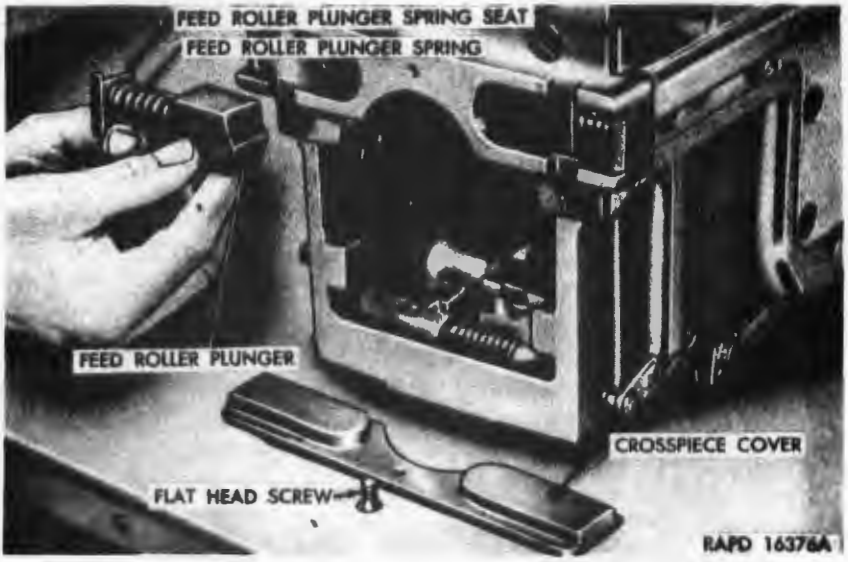


Figure 333. Replacing feed roller plunger springs.

h. Installation.

(1) With loader tray installed in loader, attach rear loader front and rear lifters (fig. 326) on the automatic loader.

(2) Lift automatic loader and carefully place front ends of guides in guideways of breech casing.

(3) Slide automatic loader forward until it is supported by the guideways.

(4) Remove lifters and slide automatic loader forward until loader tray connecting bolt (fig. 325) can be inserted and locked with its bayonet connection using wrench 5228057. Close and lock side cover, using side cover key 5228061 (fig. 301).

(5) Raise rear cover (fig. 324) and insert the ¾ x 9½ screw until only about one-inch of the screw is exposed (this must be done carefully to avoid stripping the threads). Engage threads and complete installation of screw.

(6) Install ⅝ x 2¼ hex-head cap screw (fig. 324).

(7) Raise lower end of cartridge case deflector and secure in position with cartridge case deflector pin (fig. 324).

283. Breech Ring, Extractors, Breech Ring and Barrel Catch, and Safety Plunger

a. Description.

(1) *Breech ring.* The breech ring is threaded internally at the front to receive the barrel assembly. It has a recessed area from top to bottom in which the breechblock slides. Stops mounted in the top surface of the breech ring limit the upward travel of the breechblock when closing. Figures 334 and 335 illustrate the right and left breech rings, with the extractors, barrel catch, and safety plungers installed.

(2) *Cartridge case extractor group.* The cartridge case extractor (fig. 336) group consists of two extractors with bushing, extractor spindle, and extractor arm. An extractor releasing lever is provided to manually release the extractors. The extractors serve two purposes. They hold the breechblock in the open position until released by the extractor releasing lever (manual operation) or by the ramming of a round into the breech (automatic operation). They extract and eject empty cartridge cases from the firing chamber of the gun.

(3) *Breech ring and barrel catch.* The breech ring and barrel catch (fig. 334), when locked, prevents the barrel assembly from rotating to a position where it could be removed from the breech ring. It is installed in the upper part of the breech ring and is operated by opening the top cover (par. 279*b*(4)).

(4) *Breech ring safety plunger.* The safety plunger (fig. 335) is a safety device that locks the breechblock in the open position when the barrel assembly is improperly installed.

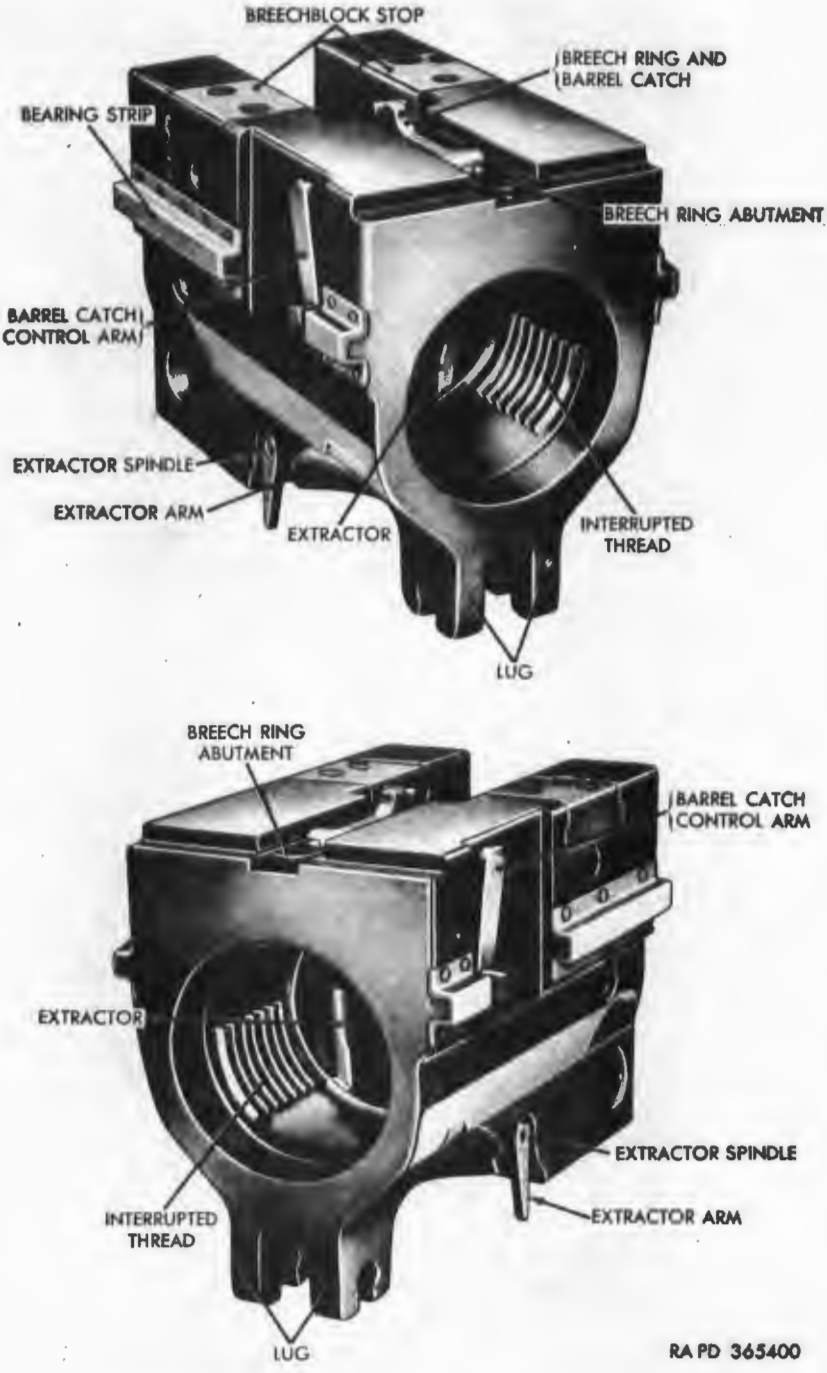


Figure 334. Right and left hand breech ring—front view.

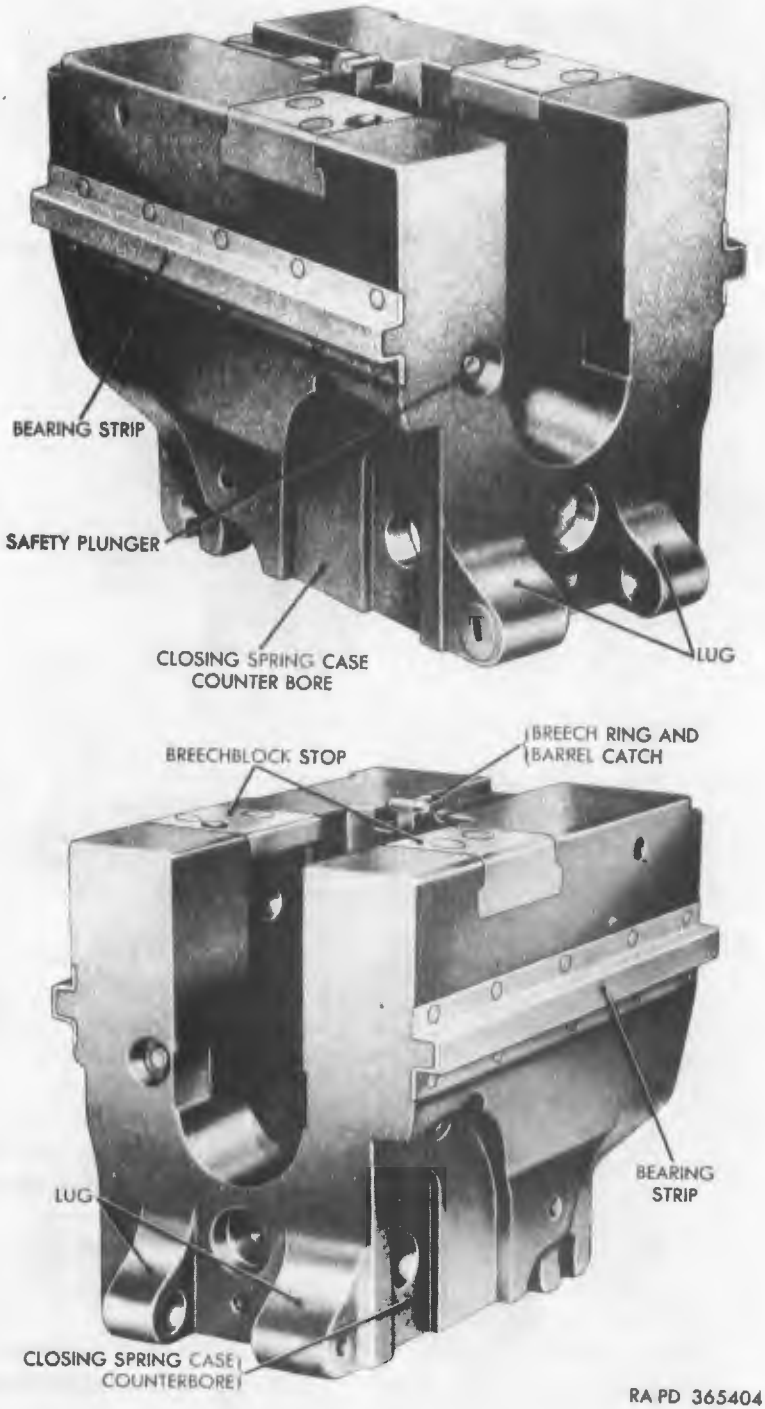


Figure 335. Right and left hand breech ring—rear view.

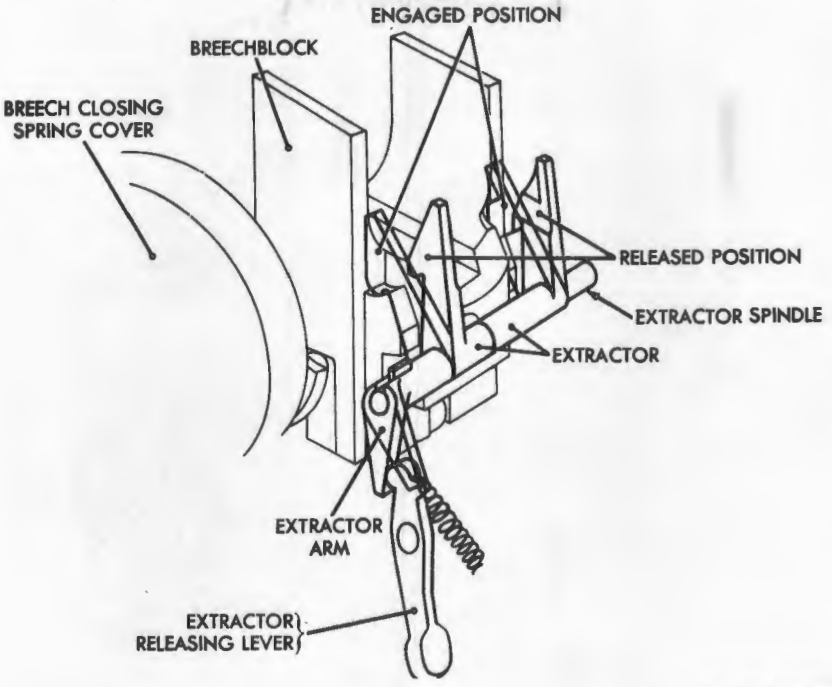


Figure 336. Functioning of cartridge case extractor assembly.

It is installed in the left side of the breech ring together with the safety plunger spring seat, spring, and internal retaining snap ring.

b. Functioning.

(1) *Extractors.*

(*a*) When the breechblock is lowered to open the breech, the extractors (fig. 336) are tipped backward until their hooked ends are engaged in seats on the front of the breechblock. In their engaged position (fig. 336), they hold the breechblock in the open position. The breechblock is released manually by rotating the extractor releasing lever downward and forward. The breechblock is released automatically when a cartridge case is rammed into the chamber of the gun, the rim of the case rotating the extractors from their seats on the breechblock as the rim of the cartridge case forces the extractors (fig. 337) forward.

(*b*) The extractors remove the cartridge case from the chamber by reversing the procedure in (*a*) above. As the extractors are rotated to the rear to engage the breechblock and hold it in open position, their upper

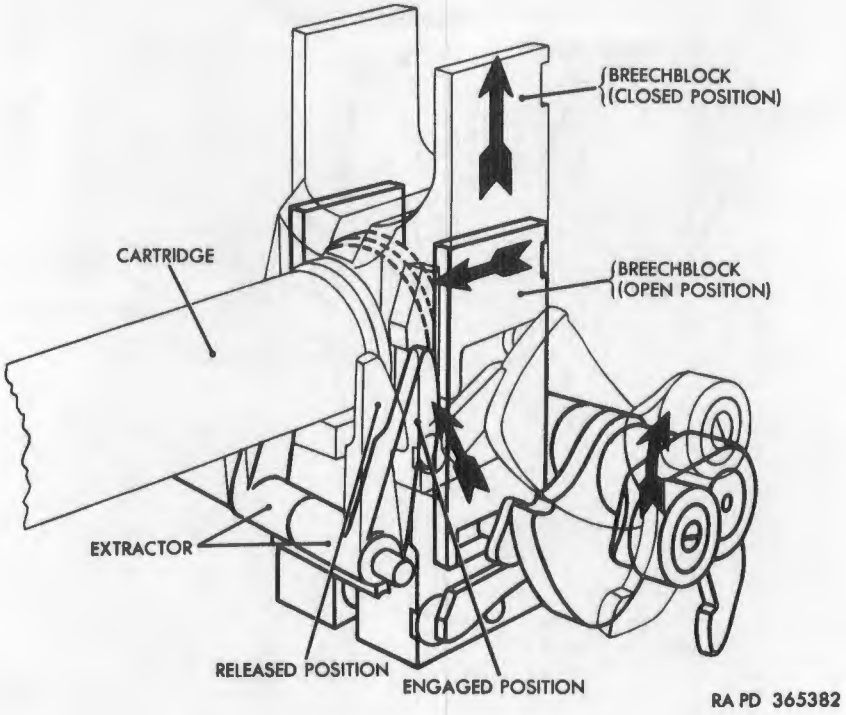


Figure 337. Extractors—released by cartridge.

lips press against the rim of the cartridge case with such force as to extract the case from the gun chamber and eject it through the breech casing and into the cartridge chute.

(2) *Breech ring and barrel catch.* The breech ring and barrel catch (fig. 338) locks the barrel assembly to the breech ring by engaging a slot in the breech end of the tube. The pointed rear end of the catch guides the cartridge into the chamber. The catch is disengaged by opening the top cover. Two lugs (A, fig. 338) ride in grooves in the top cover and lift the catch when the cover is opened. As the catch is raised, the control arm (fig. 338) is rotated to a position where its toe engages the breech ring stop. This locks the breech ring in the casing and prevents it from slipping to the rear when the barrel assembly is removed.

(3) *Breech ring safety plunger* (fig. 339). The safety plunger extends through a bore in the breech ring to contact the breech face of the gun tube. It is fitted with a tubular seat that fits a depression in the lowered breechblock when the barrel assembly is out of its proper position and the com-

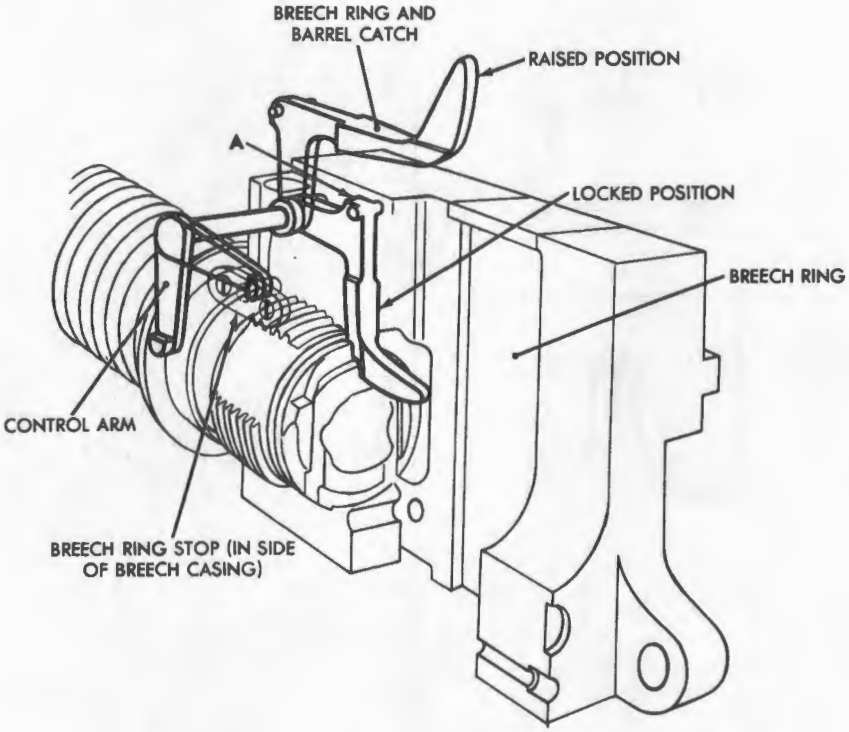


Figure 338. Breech ring and barrel catch.

pression spring of the safety plunger drives the plunger forward. This action locks the breechblock in the down position, thus putting the breech mechanism out of action. The plunger is pressed to the rear and held out of the depression in the breechblock when the barrel assembly is properly assembled in the breech ring.

c. Removal.

(1) Before proceeding to remove a breech ring assembly, remove the barrel assembly (par. 279*b*), recoil cylinder (par. 280*c*), breechblock and closing spring case assembly (par. 281*c*), and automatic loader (par. 282*f*).

(2) Close top cover to release breech ring and barrel catch (fig. 338). Remove breechblock locking bolt (fig. 284) from its hole in breech casing and breech ring and place in its bracket.

(3) Slide breech ring assembly to the rear along its guideways and lift it out of the breech casing (fig. 340). Use care

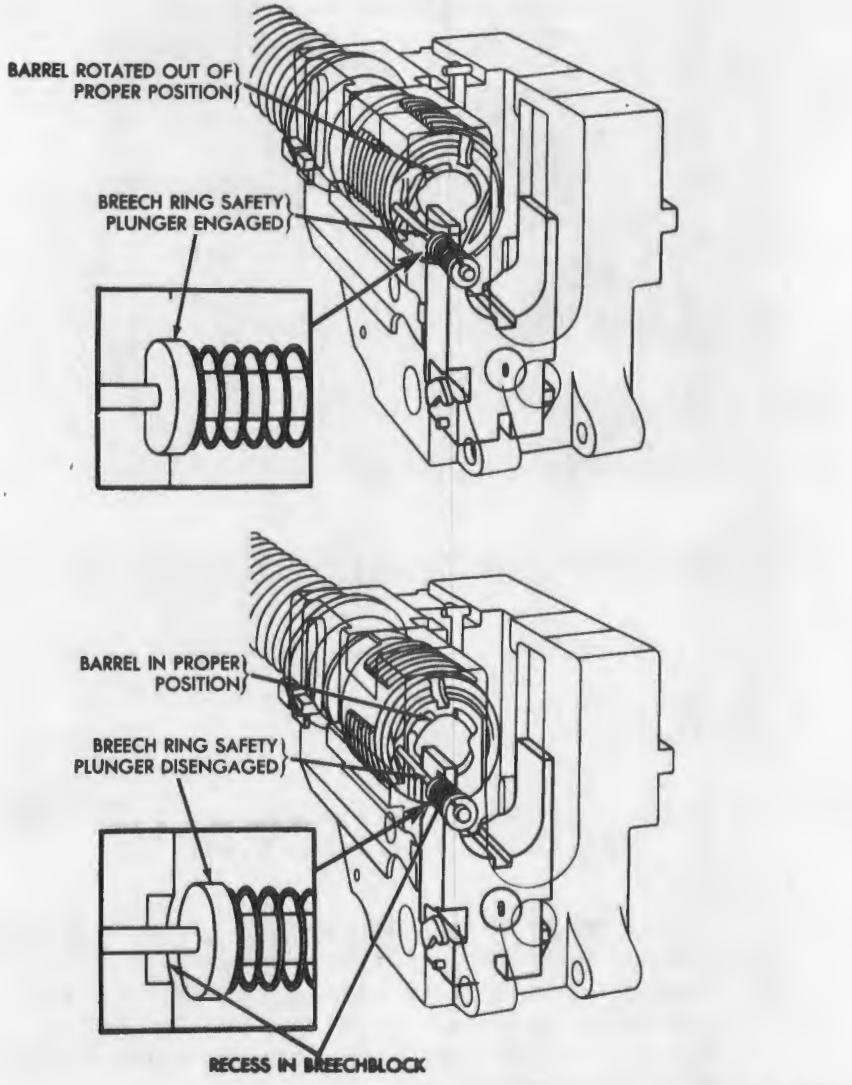


Figure 339. Functioning of breech ring safety plunger.

to avoid dropping breech ring as it comes to the end of the guideways.

d. Disassembly.

(1) Screw spindle extractor 5228093 (fig. 341) into threaded hole in end of extractor spindle.

(2) Holding extractors upright and extractor arm down, withdraw extractor spindle (fig. 341).

Note. To remove extractors without removing breech ring, refer *e*(4) below.

Figure 340. Removing or installing breech ring.

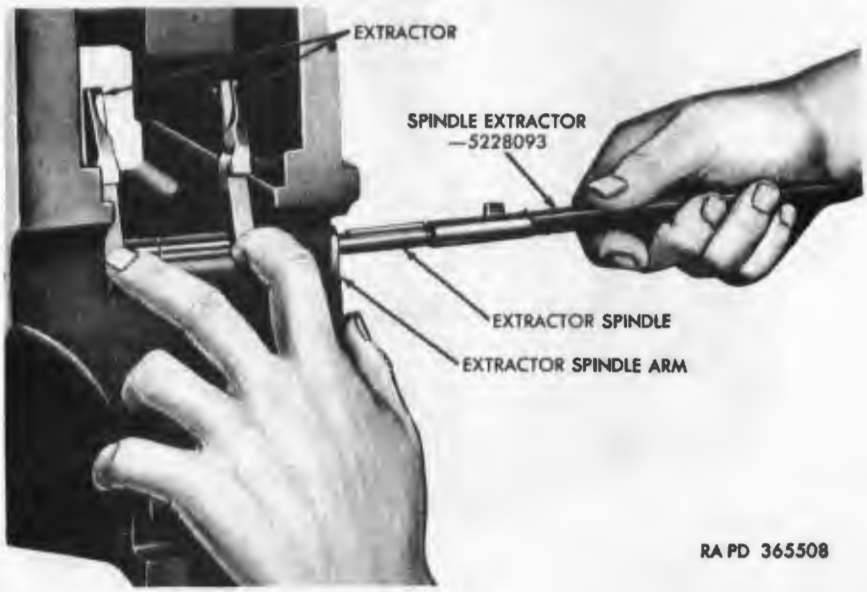


Figure 341. Removing or installing extractor spindle.

(3) Remove extractor arm and extractors from breech ring. The extractor arm has an integral key which necessitates rotating the arm so that the lug may pass through the keyway cut in the breech ring.

(4) Raise breech ring and barrel catch (fig. 342) until its shank is at right angles to the top surfaces of breech ring.

(5) Withdraw barrel catch control arm (fig. 342). In doing this, key on shaft of arm must be mated with keyway in breech ring.

(6) Remove catch.

(7) Unscrew and withdraw breech ring crankshaft collar screw (fig. 343).

(8) Slide breech ring crankshaft collar out of breech ring.

(9) Remove headless setscrew (fig. 344) from edge of breech ring bolt spring seat.

(10) Unscrew seat, using wrench 5228057 (fig. 344).

(11) Remove breech ring bolt spring and sleeve (fig. 344).

(12) Remove flat-head screw that holds breech ring abutment (fig. 345) in place in top front of breech ring and remove abutment.

(13) The parts of the disassembled left breech ring are shown in figure 346. The parts of the breech ring are similar.

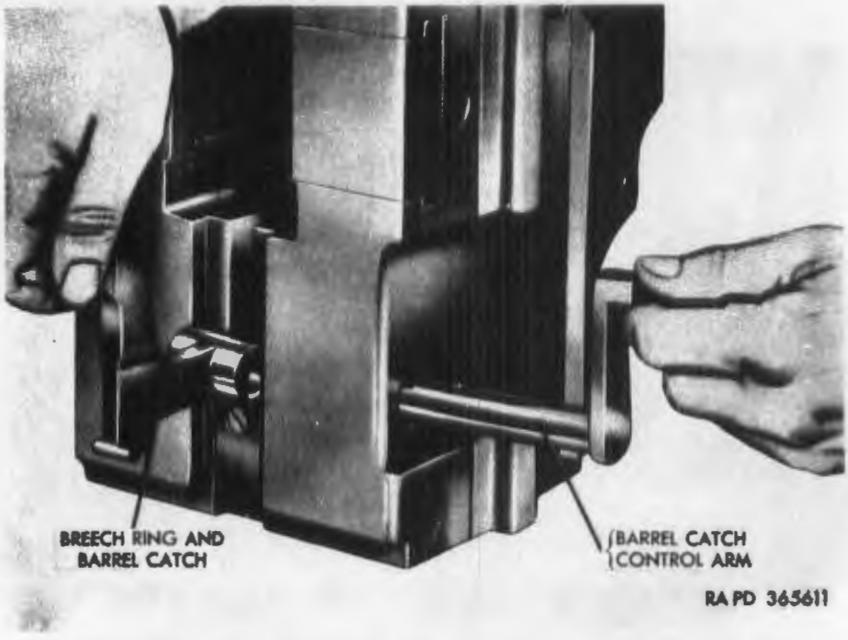


Figure 342. Removing or installing breech ring and barrel catch.

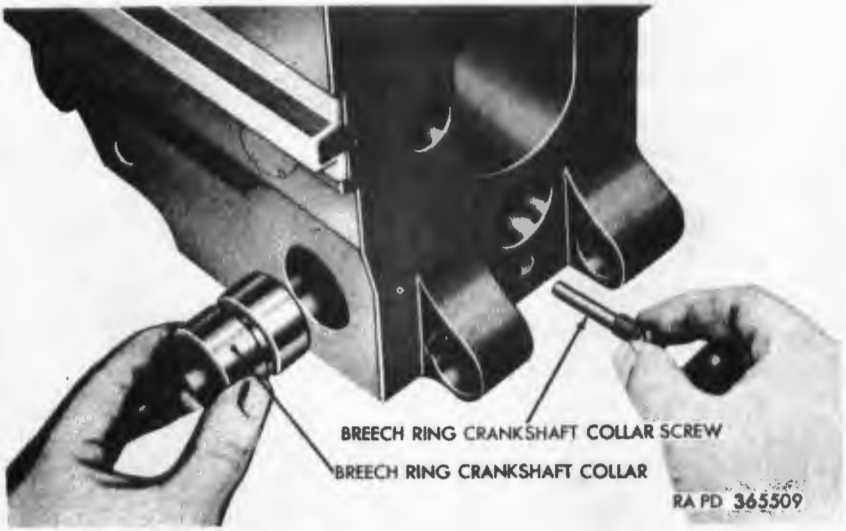


Figure 343. Removing or installing breech ring crankshaft collar and screw.

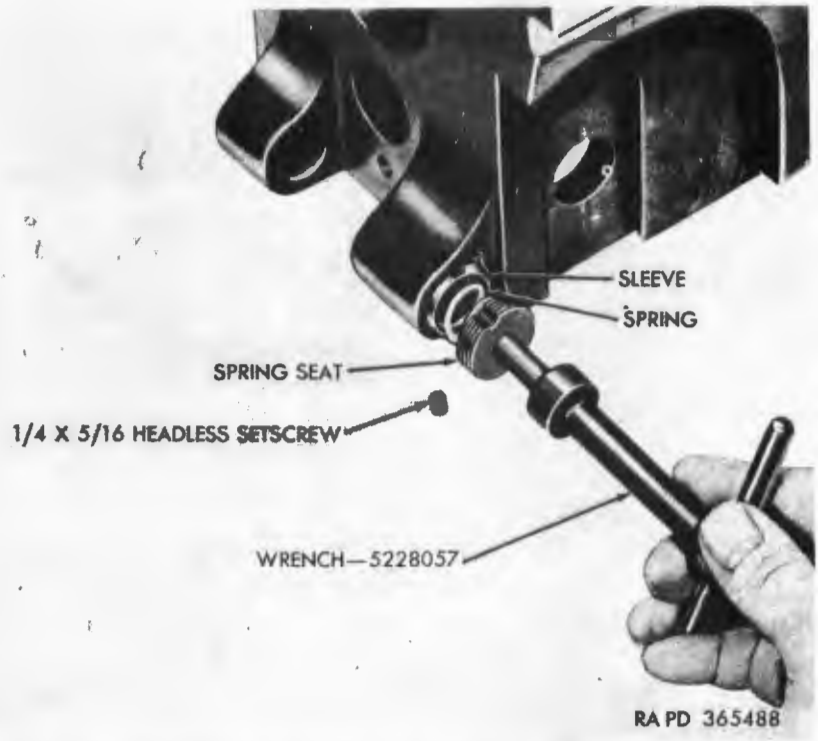


Figure 344. Removing or installing tray to breech ring bolt spring and seat.

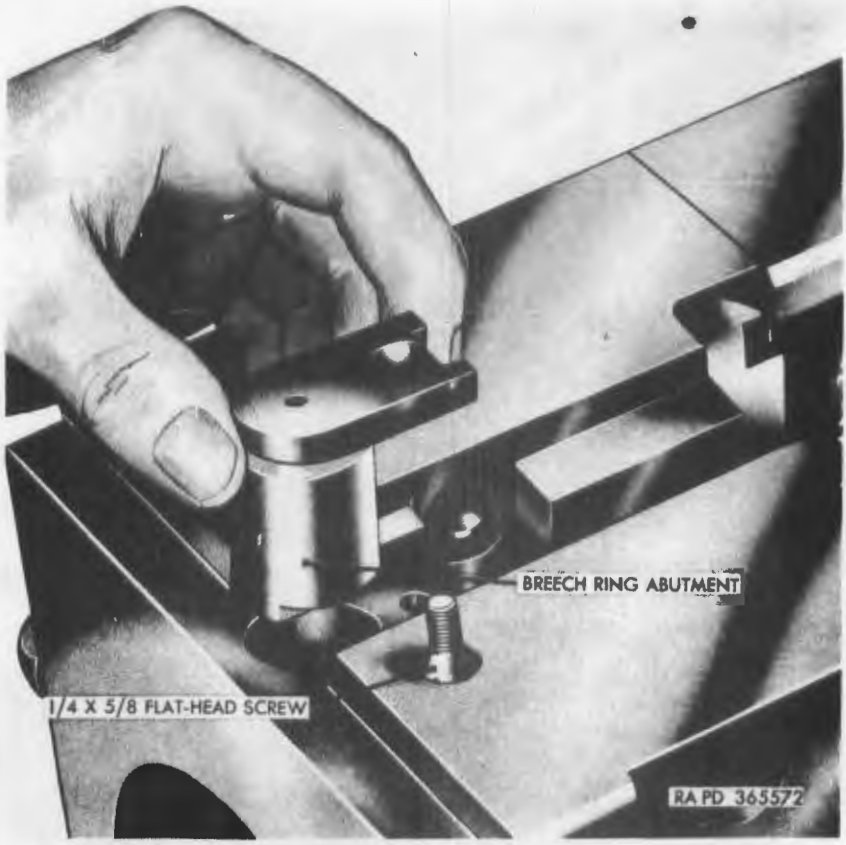


Figure 345. Removing or installing breech ring abutment.

(14) Remove internal retaining snap ring (A, fig. 346), insert wrench 5228054 (fig. 347), and unscrew safety plunger spring seat (B, fig. 346). Remove safety plunger spring (C, fig. 346) and safety plunger (D, fig. 346).

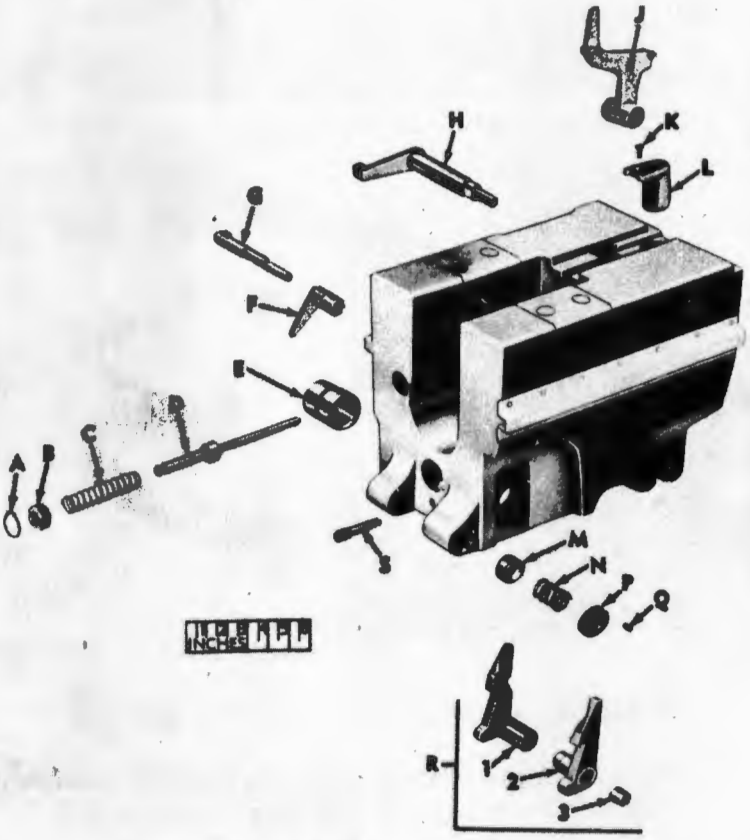
e. Maintenance.

(1) Examine breech ring for general condition, missing or broken parts, and check all contact surfaces for burs, scores, or other damage.

(2) Clean all parts with rifle bore cleaner, wipe dry, and oil as prescribed in lubrication order LO 9–7218 (par. 90).

(3) Remove such burs, scores, or other raised metallic areas as may be removed by using crocus cloth. For heavy burs, scores, or other damage notify ordnance maintenance personnel.

(4) If extractor assembly (R, fig. 346) is cracked, broken, or worn; replace as an assembly. The extractor assembly



A—INTERNAL RETAINING SNAP RING
B —SAFETY PLUNGER SPRING SEAT
C —SAFETY PLUNGER SPRING
D —SAFETY PLUNGER
E —BREECH RING CRANK SHAFT COLLAR
F —EXTRACTOR ARM
G —EXTRACTOR SPINDLE
H —BREECH RING AND BARREL CATCH CONTROL ARM
J —BREECH RING AND BARREL CATCH
K —1/4 X 5/8 FLAT-HEAD SCREW
L —BREECH RING ABUTMENT
M —TRAY TO BREECH RING BOLT SLEEVE
N —TRAY TO BREECH RING BOLT SPRING
P —TRAY TO BREECH RING BOLT SPRING SEAT
Q —1/4 X 5/16 HEADLESS SETSCREW
R —EXTRACTOR ASSEMBLY
1—EXTRACTOR
2—EXTRACTOR
3—BUSHING
S —BREECH RING CRANK SHAFT COLLAR SCREW

RA PD 365573

Figure 346. Left breech ring—exploded view.

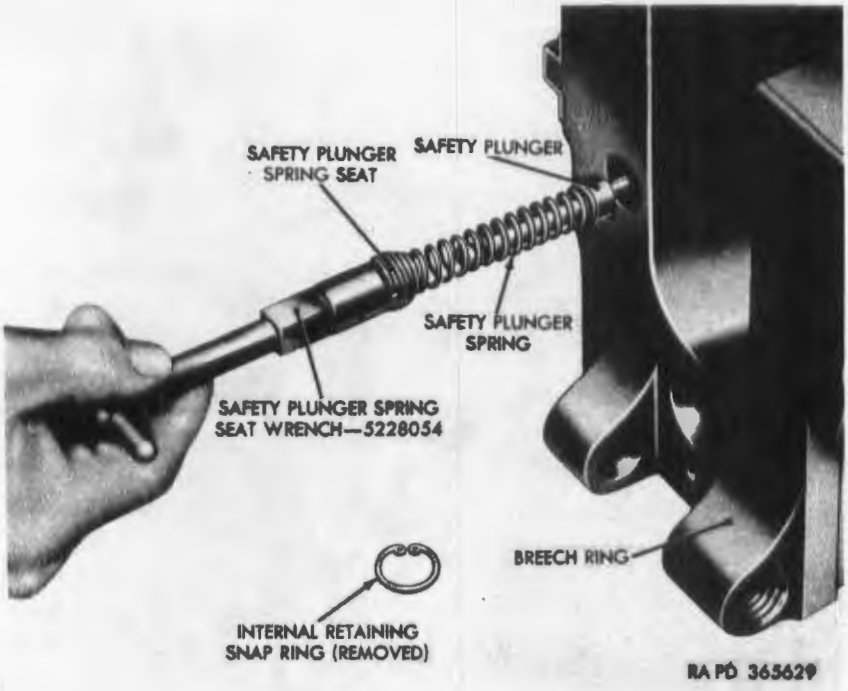


Figure 347. Removing or installing breech ring abutment.

may be replaced without removing breech ring from breech casing. Proceed as in (*a*) through (*h*) below:

(*a*) Remove the breechblock (par. 281).

(*b*) Install spindle extractor 5228093 (fig. 341) through hole in side of casing, and into threaded holes in end of extractor spindle.

(*c*) Reach through bottom opening in breech casing and support extractors to keep them from falling out of weapon after they have been released.

(*d*) Withdraw extractor spindle and remove extractors.

(*e*) To install extractors, screw spindle extractor 5228093 into threaded end of extractor spindle.

(*f*) Assemble the two extractors together and hold them in position in breech ring.

(*g*) Insert extractor spindle through the larger hole in right side of breech casing and on through breech ring and extractors, mating the key and keyway.

(*h*) Remove tool from extractor spindle.

(5) Check functioning of tray to breech ring bolt spring (N, fig. 346). Replace if deformed, cracked, or broken.

(6) Examine safety plunger spring (C, fig. 346). Replace if deformed, cracked, or broken.

f. Assembly.

Note. The key letters noted in parentheses are in figure 346, except where otherwise indicated.

(1) Install breech ring abutment (L) in breech ring and secure with 1/4 x 5/8 flat-head screw (K).

(2) Install tray to breech ring bolt sleeve (M) (closed end first) into its seat in lug; install spring (N) and seat (P). Tighten seat using wrench 5228057 (fig. 344). Secure seat by installing 1/4 x 5/16 headless setscrew (Q).

(3) Slide breech ring crank shaft collar (E), into shaft hole in breech ring until groove on collar alines with hole for breech ring crank shaft collar screw (S). Install screw (3/8 x 1 31/32) (S), making sure that it engages groove in collar.

(4) Aline key and keyway and place breech ring and barrel catch (J) in recess in top of breech ring, holding barrel catch at right angles to top surface of breech ring. Insert shaft of breech ring and barrel catch control arm (H) into breech ring and through barrel catch (fig. 342).

(5) Attach spindle extractor 5228093 (fig. 341) to threaded end of extractor spindle.

Note. The left extractor spindle 7165193 and right extractor spindle 6197106 are similar and it is possible to install them in a reversed position. Use special care, checking by part number if possible, to insure the correct spindle is installed in the correct breech ring.

(6) Position assembled extractor assembly (R) and extractor arm (fig. 341) in breech ring and install extractor spindle. Observe positions of keys and keyways.

(7) Remove spindle extractor from spindle.

(8) Install safety plunger (D) and safety plunger spring (C) into recess of breech ring. Secure with safety plunger spring seat (B) using wrench 5228054 and internal retaining snap ring (1 5/16-inch OD) (A).

g. Installation.

(1) Before installing breech ring, determine the correct ring for left or right gun of the dual gun.

(2) Place breech ring assembly in guideways at open rear end of breech casing (fig. 340).

(3) With top cover closed, slide breech ring forward as far as possible, fitting lugs on sides of breech ring and barrel catch (J, fig. 346) into slot on underside of top cover.

(4) Open top cover. If remainder of installation (5) below is not performed immediately insert breechblock lock bolt (fig. 284) through hole in breech casing and breech ring to keep breech ring from sliding backward in casing.

(5) Install automatic loader (par. 282*h*), breechblock and closing spring assembly (par 281*e*), recoil clyinder (par. 280*e*) and barrel assembly (par. 279*d*).

284. Breech Casing

a. Description and Functioning.

(1) The breech casing is the housing or supporting unit for the various subassemblies of the gun. The casing itself is supported in the top carriage of the gun mount by trunnions at the sides of the assembled casings.

(2) The recoiling parts of the gun slide in recoil and counterrecoil in the breech casing. The recuperator spring on the breech end of the barrel assembly is compressed in the tubular front portion of the casing. The breech ring is guided in its backward and forward movement in the casing by channels on the inner sides of the casing. Four hinged or detachable covers provide access to the interior of the casing.

(3) The top cover (fig. 286), which is hinged to the upper surface of the casing near the front, provides a means of releasing the breech ring and barrel catch which locks the barrel assembly to the breech ring and also actuates the barrel catch control arm (par. 283).

(4) The rear cover (fig. 324) acts as an abutment for the automatic loader. This cover carries the cartridge case deflector and bracket. The recoil indicator (fig. 292) is mounted on this bracket. The rear cover is hinged at the bottom and permits removal of the units within the casing. This cover has an opening through which the rear end of the loader tray moves in recoil and counterrecoil and through which the empty cartridge cases are ejected against the cartridge case deflector and down into the cartridge case chute.

(5) The bottom cover (fig. 302) is not hinged but is retained by a flange at its rear end. This cover permits removal of breechblock with breech ring inner cranks, breech closing spring assembly, and extractors without further disassembly of the gun.

(6) The side cover (fig. 348) has a cam surface on the inside which operates the breech ring outer crank assembly to

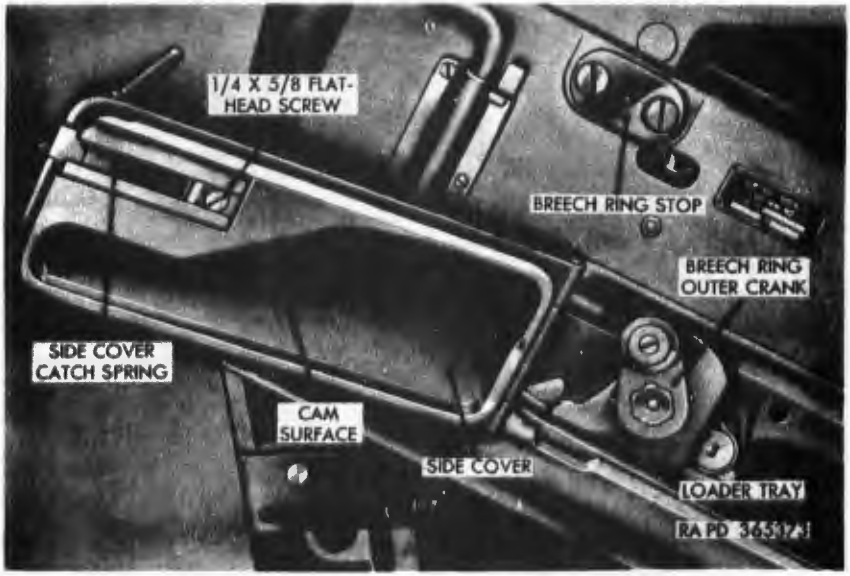


Figure 348. Side cover—open position.

lower the breechblock automatically during recoil. This cover also permits removal of the breech ring outer crank assembly and the loader tray attaching bolt.

(7) The firing selector lever (fig. 349) prevents the gun from being fired, allows single rounds to be fired, or permits automatic firing. The firing plunger, which protrudes through the trunnion, is the means of contact between the firing solenoid or foot firing pedal, and the parts of the firing mechanism housed within the breech casing.

(8) The opening at the rear of the top of the breech casing serves to accommodate the automatic loader. Cartridge clips are ejected from the automatic loader and breech casing through a charger clip guide (fig. 319) on the side of the casing toward the rear.

(9) The hand operating lever (fig. 301) on the side of the breech casing opens the breech and prepares the gun to receive the first round. When the hand operating lever is pulled to the rear, the hand operating lever shaft is rotated. This shaft pulls the front end of the hand operating rod downward and to the rear, the motion being limited by the hand operating rod crank. A projection on the hand operating rod engages the lower arm of the breech ring outer crank and rotates the crank, opening the breech. The breechblock is held in open position by action of the extractors. When the breechblock is lowered to open the

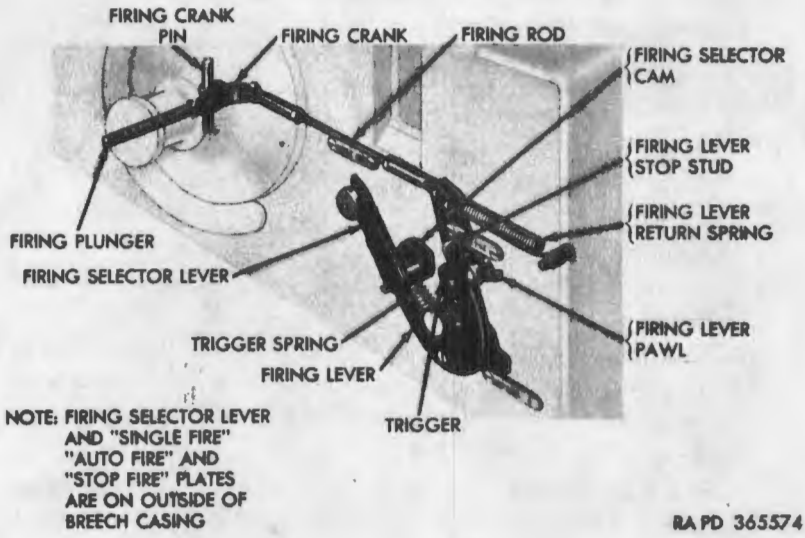


Figure 349. Breech casing firing mechanism.

breech the extractors are tipped to the rear until their hooked ends are engaged in seats on the front of the breechblock (fig. 336). In their engaged position, they hold the breechblock in open position. The breechblock (fig. 336) is released manually by rotating the extractor releasing lever forward. If the gun is not to be fired immediately, the hand operating lever is placed in the rear latch bracket marked SAFE. The projection on the hand operating rod will hold the lower arm of the breech ring outer crank in place, preventing the breechblock from being raised. At the same time, the rear end of the rod prevents the operation of the breech casing firing assembly. When the hand operating lever is returned to its forward position, the projection on the lever will no longer engage the lower arm of the breech ring outer crank. This will permit the breechblock to be raised and the gun fired.

b. Maintenance.

(1) Maintenance of the breech casing consists chiefly of cleaning, lubricating and replacement of worn or broken parts. In order to perform these operations, it is necessary to remove the following:

(*a*) Barrel assembly (par. 279*b*).

(*b*) Recoil cylinder (par. 280*c*).

(*c*) Breech closing spring case assembly (par. 281*c*).

(*d*) Breechblock (par. 281*c*).

(*e*) Automatic loader (par. 282*f*).

(*f*) Breech ring (par. 283*c*).

(2) Clean all interior surfaces with rifle-bore cleaner, making certain that all traces of dirt, rust, grit, or other foreign matter have been removed. Wipe dry and oil as prescribed by lubrication order LO 9–7218 (par. 90).

(3) Examine casing for general condition, broken, loose, or missing parts.

(4) Examine sliding and operating surfaces in the casing for burs or other raised metallic surfaces. Remove such burs as may be removed with crocus cloth, otherwise refer to ordnance maintenance personnel.

(5) Check functioning of side cover catch spring (fig. 348). If deformed, cracked, or broken, remove flat-head screw and replace spring. Install ¼ x ⅝ flat-head screw to retain spring.

(6) Check functioning of top cover catch spring by operating the top cover catch. If spring is deformed, cracked, or broken, remove four flat-head screws which secure bracket to top cover and replace spring. Install four No. 10 x ½ flat-head screws.

(7) Replace the ¼ x 9/16 flat-head screws in the firing lever (fig. 353), if necessary.

(8) Check functioning of cover latch lever springs in top and bottom covers by actuating the lever head plungers. If springs are deformed, cracked, or broken, notify ordnance maintenance personnel.

(9) Examine mating surfaces of rear cover and breech casing also screw holes for burs. Remove all burs. Examine ¾ x 9½ screw (fig. 324) for burs or damage to thread. Remove burs from smooth surface of screw. If threads are damaged, replace the ¾ x 9½ screws, if available, otherwise notify ordnance maintenance personnel.

285. Breech Casing Firing Mechanism

a. Description and Functioning.

(1) The breech casing firing mechanism (fig. 349) consists of parts of the firing mechanism which are mounted on the left wall and floor of the left casing and the right wall and floor of right casing. It includes the firing selector lever and its assembly. The breech casing firing mechanism converts the movement of the firing plunger in the

gun trunnion into action which releases the rammer and fires the gun. The firing plunger is actuated by depressing the firing mechanism pedal or by actuating the firing solenoids.

(2) The firing lever (fig. 349) is pivoted on a bracket attached to the floor of the breech casing. Its longer upper arm is pulled forward by the firing rod and crank when the firing plunger is pressed inwardly by the action of depressing the firing mechanism pedal or actuating the firing solenoids. It is returned to its normal position by the firing lever return spring.

(3) The firing lever pawl (fig. 349) is pivoted between lugs on the rear of the longer arm of the firing lever. The trigger is located in the "U" of the firing lever and mounted on a pin in the wall of the breech casing. When the firing lever is pulled forward, the firing lever pawl contacts the trigger which rotates on its axis pin. The trigger rotates the rammer control spindle arm of the automatic loader to release the rammer shoe and fire the gun. When rotation has stopped, the trigger is returned to normal position against its stop on the firing lever by the trigger spring.

(4) The firing lever pawl (fig. 349) is tripped by the firing lever stop stud to release the trigger and produce single action. Rotation of the trigger is controlled by the position of the firing selector cam.

(5) The firing selector lever (fig. 350) is mounted toward the rear on the outer side of the breech casing. Its head or handle has a spring-loaded plunger which permits it to be locked in any one of the three positions. Movement of the lever rotates the firing selector cam, the surfaces of which control the action of the trigger. In the STOP FIRE position of the firing selector lever, the gun is prevented from being fired, the AUTO FIRE position permits automatic firing, and the SINGLE FIRE position permits single rounds to be fired.

(6) With the firing selector lever in the STOP FIRE position (fig. 350) the firing selector cam is turned so that its contoured surface restricts rotation of the trigger to such an extent that the trigger cannot move sufficiently to rotate the rammer control spindle arm and release the rammer.

(7) With the firing selector lever in the SINGLE FIRE (fig. 350) or foremost position, the selector cam is rotated

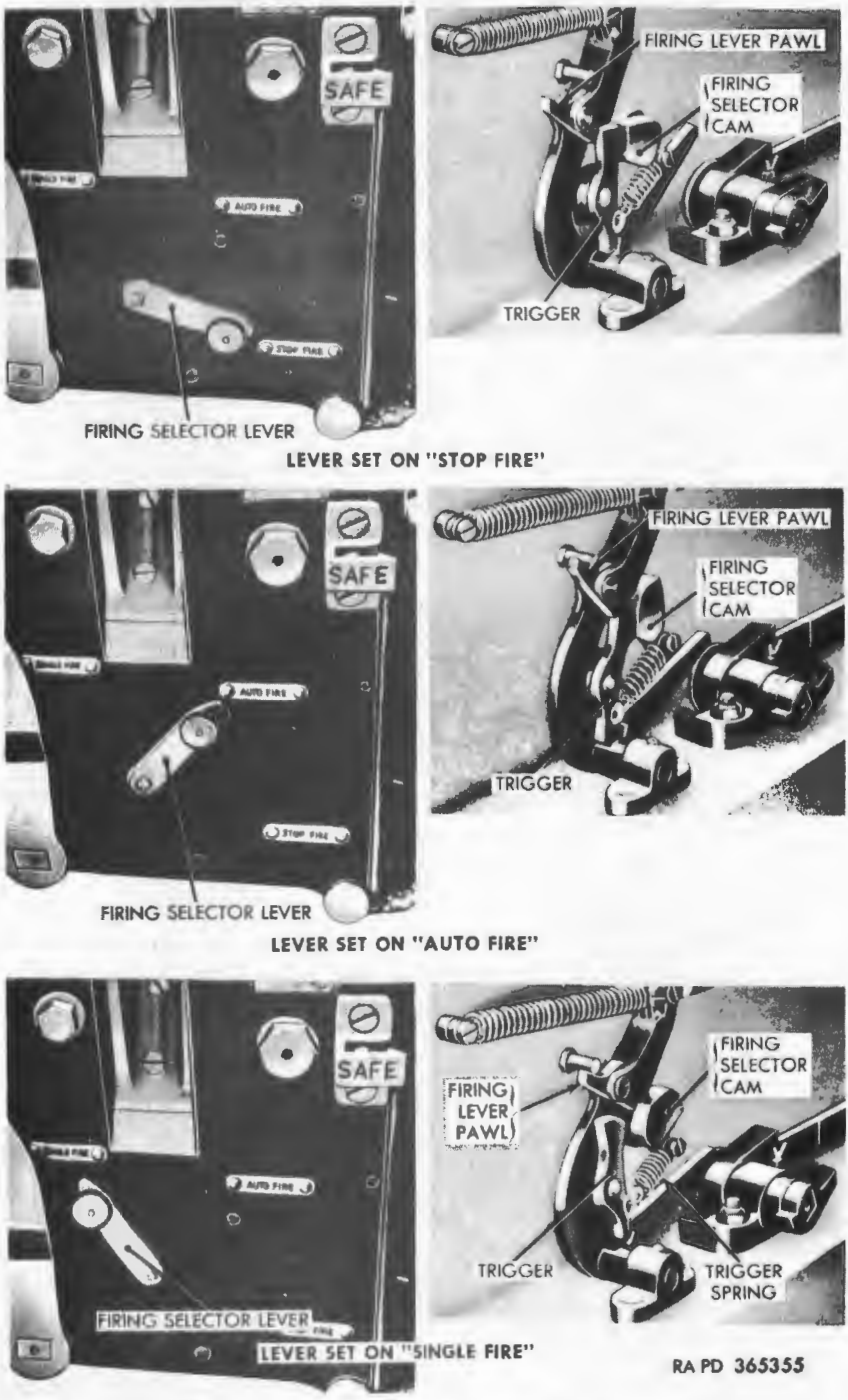


Figure 350. Three positions of firing selector lever.

until it is completely out of contact with the trigger (fig. 351). When the firing lever (fig. 352) is pulled forward by the firing rod, the firing lever pawl rotates the trigger to fire one round. This is done by rotating the rammer control spindle arm which releases the trigger rammer catch lever from the rammer shoe. Then the firing lever pawl is tripped upon contact with the firing lever stop stud and the trigger is released and snapped back to its original position by the trigger spring (fig. 353).

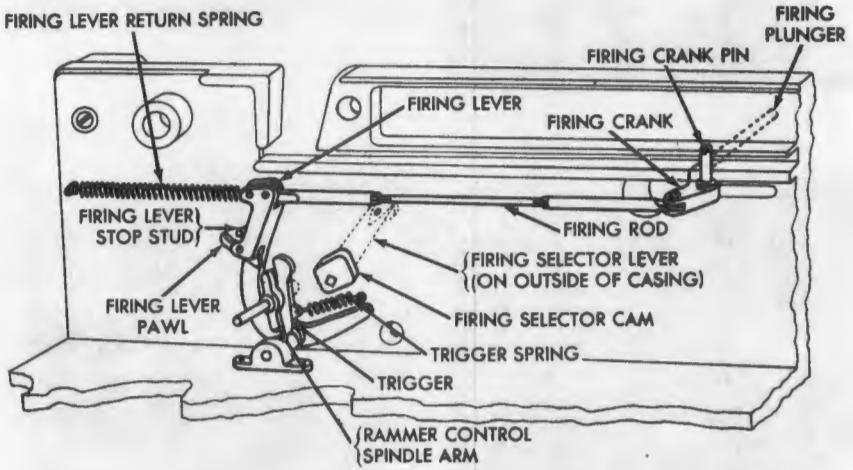


Figure 351. Firing assembly prior to firing—single fire.

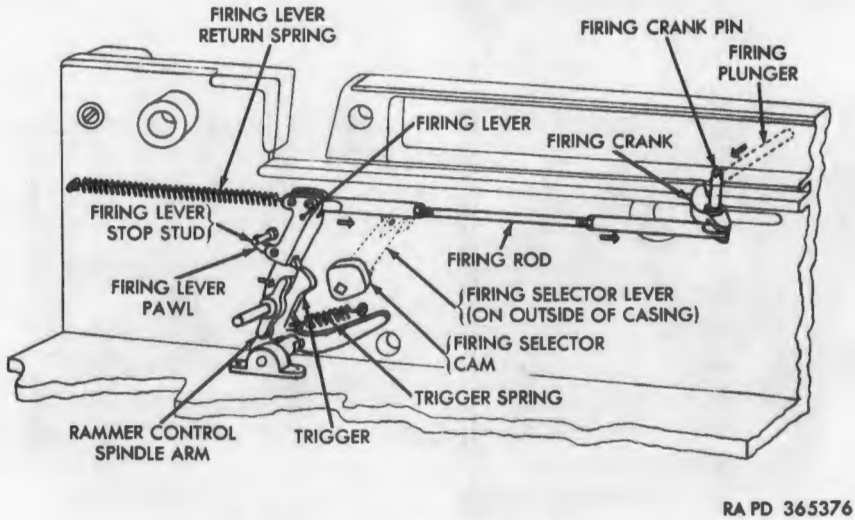


Figure 352. Firing assembly during firing—single fire.

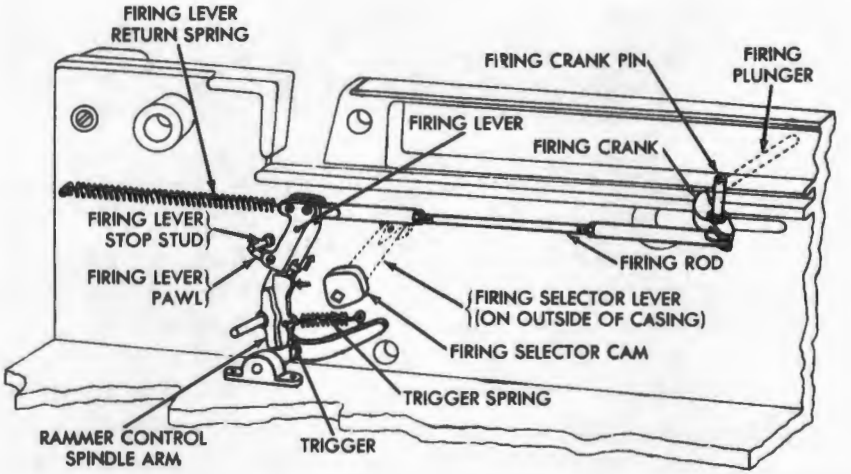


Figure 353. Firing assembly after firing—single fire.

(8) With the firing selector lever in the AUTO FIRE position (fig. 350), the cam is rotated sufficiently to prevent the trigger from being released by the firing lever stop stud. It does, however, permit the trigger to rotate far enough to rotate and hold the rammer control spindle arm and depress the trigger rammer catch lever. Uninterrupted firing will continue until the firing pedal or the trigger assemblies on the drive controller hand grips are released or the supply of ammunition in the automatic loader is inadequate.

b. Maintenance.

(1) Maintenance of the breech casing firing assembly consists of cleaning, oiling, inspection, adjustment, and replacement trigger firing. If other maintenance is required, notify ordnance maintenance personnel.

(2) Check the assembly for general condition, loose, missing, or broken parts.

(3) Examine all parts of the assembly for burs, scores, or other damage.

(4) Remove all burs, or other raised metallic areas with crocus cloth. Confine operation to affected area and do not remove more metal than is absolutely necessary. If any parts are excessively worn, notify ordnance maintenance personnel.

(5) Test tension of firing lever return spring and trigger spring. If trigger spring (fig. 350) is deformed, cracked,

or broken, replace. Replace the No. 000 x 1 tapered pin in the firing selector lever assembly, if unserviceable. If other maintenance is required, notify ordnance maintenance personnel.

(6) Test functioning of trigger with firing selector lever in STOP FIRE, AUTO FIRE, and SINGLE FIRE positions (fig. 350). If the gun fires when the lever is at STOP FIRE position, notify ordnance maintenance personnel. If the gun single fires when the lever is at AUTO FIRE position, notify ordnance maintenance personnel. If the gun will not single fire when the lever is at SINGLE FIRE position, notify ordnance maintenance personnel.

(7) Rotate firing plunger (fig. 349) and note any binding or other restricted action. The plunger should rotate freely and protrude $1\frac{5}{32}$-inches.

(8) Measure the play (clearance) between the firing crank and firing plunger (fig. 353). The correct clearance should be one-thirty-second of an inch.

Section XXV. GUN MOUNT M4E1

286. General

This section contains specific maintenance instructions for the components of thegun mount M4E1. These components are as follows: elevating mechanism, traversing mechanism, firing mechanism (mechanical), equilibrators, top carriage, gun mount platform, and gunner's shields. Description, function and, where necessary, adjustment of these components is also included.

287. Elevating Mechanism

a. Description. The elevating mechanism (fig. 354) consists of hand power operated gear groups. The hand operated gears are operated by a double hand operating crank. Rotation of the shaft is transmitted through gearing to the elevating mechanism worm wheel pinion which meshes with the elevating sector (fig. 354) attached to the underside of the left breech casing. The pinion is inclosed in the tubular brace between the top carriage frames. The evelating sector is provided with a stop on the rear of the sector to limit the movement of the gun in elevation. A rubber stop, mounted on the top of the equilibrator mounting bracket, serves as a stop and cushion when the dual gun M2A1 is locked at zero elevation. The elevating mechanism drive components are coupled to the elevation oil gear M6A1E1 permitting the dual gun M2A1 to be elevated by power.

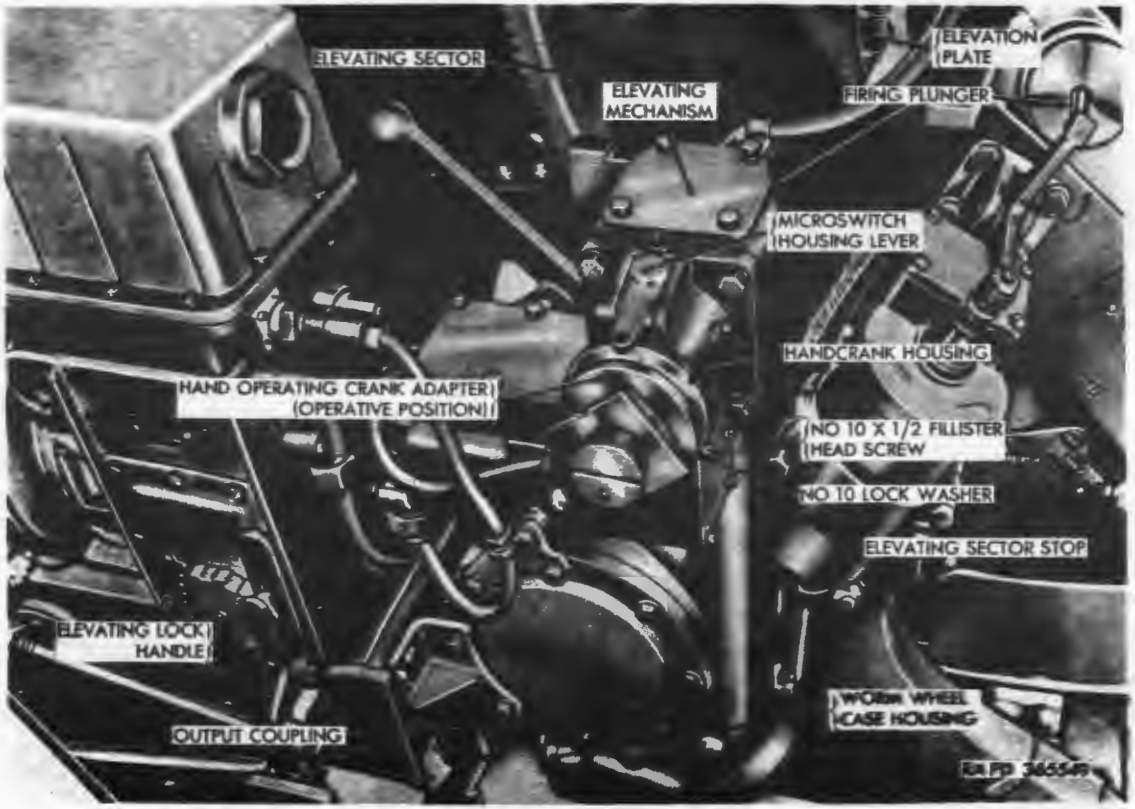


Figure 354. Elevating mechanism—installed view.

(1) The hand elevating gears are provided with a microswitch (fig. 355), the function of which is to disconnect all power to the oil gears while the weapon is under manual operation. When the hand operating crank adapter (fig. 354) is pushed into the operative position, the crank adapter forces the housing pawl (fig. 355) to ride over the switch operating roller and pivot the actuating arm against the housing spring. As the front of the actuating arm is forced downward, it carries the spring-operated actuating arm plunger. The arm plunger bears against the contact arm (fig. 355) which depresses the actuating point of the switch to shut off all power to the oil gears. When the hand operating crank adapter (fig. 354) is in the nonoperative position, the groove in the housing pawl (fig. 355) is over the switch operating roller allowing the housing spring to pivot the front end of the actuating arm upward. As the end of the actuating arm swings up, it carries the actuating arm plunger, releasing pressure of the contact arm on the switch actuating point. This causes the microswitch to close the circuit and make power available to the oil gears.

(2) The microswitch housing lever (fig. 354) is provided to prevent the handcrank adapter from rotating when the oil gear is in operation.

b. Function.

(1) The elevating mechanism, when actuated by power furnished by the elevation oil gear, provides vertical movement of the dual guns from —3° to +85° at a maximum rate of 25° per second.

(2) The elevating mechanism, when disconnected from power operation and actuated by manual rotation of the hand operating crank, provides vertical movement of the dual gun from —5° to +87°.

c. Inspection.

(1) Elevate and depress the dual gun manually throughout the full range of travel. The same effort should be required to elevate as to depress. Refer to paragraph 290*g* if adjustment is required.

(2) Check for backlash in accordance with instructions contained in (*a*) through (*h*) below.

(*a*) Install the hand operating crank (elevating) on the handcrank adapter (par. 54*a*).

(*b*) Twist a piece of wire around the splines between the output coupling and worm wheel case housing (fig.

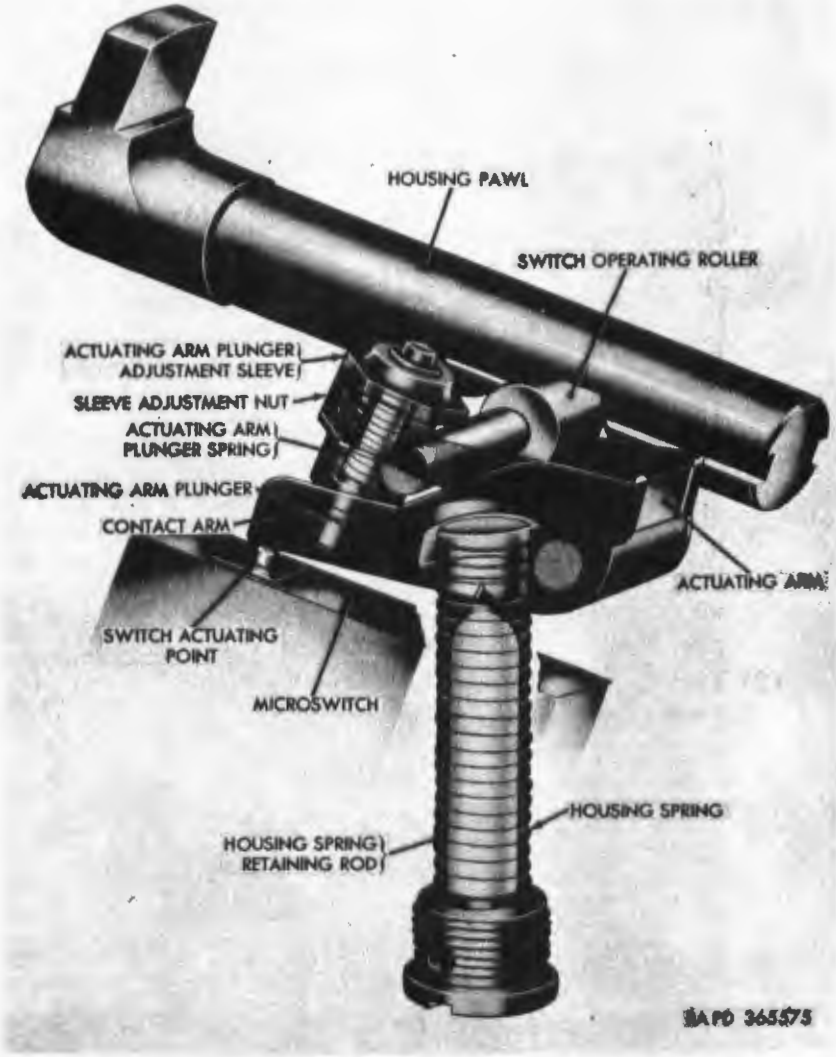


Figure 355. Functioning of microswitch actuating parts.

354). Twist the wire friction tight and extend one end to act as a pointer on the edge of the housing.

(*c*) *Install boresights.* Elevate the gun and site on some distant object.

Note. Do not go past the object.

(*d*) Carefully mark the worm wheel case housing at the pointer ((*b*) above).

(*e*) Elevate the gun approximately one-half revolution past the distant object.

(*f*) Depress the gun until the boresights intersect the distant object.

Note. Do not go past the object.

(*g*) The pointer ((*b*) above) should be within $\frac{3}{16}$-inch of the worm wheel case housing mark ((*d*) above). When greater tolerance is indicated notify ordnance maintenance personnel.

(*h*) Remove wire pointer from around splines. Remove hand operating crank.

(3) Inspect elevating sector (fig. 354) and pinion for dirt, rust, wear, burs, and protective lubrication. Remove all burs and any foreign matter from teeth. Wipe with an oiled cloth after cleaning.

(4) Remove the five fillister-head screws (fig. 354) and lockwashers that secure the cover to the microswitch mechanism housing and remove the cover and gasket.

Note. The procedure is the same for the microswitch on either the elevating or traversing mechanisms.

(5) Push the hand operating crank adapter (fig. 354) into the operative position. The switch actuating arm (fig. 355) should depress the actuating point of the microswitch. If the switch actuating point has not been depressed, loosen the adjustment sleeve nut (fig. 356) and adjust the plunger adjustment sleeve until the microswitch is actuated, and tighten the nut. Adjustment is correct if the microswitch is actuated when the external and internal gears are one-fourth of an inch apart. Adjust the plunger adjustment sleeve if distance between external and internal gears is correct. Position gasket and cover and secure with five No. 10 x ½ fillister-head screws and No. 10 lockwashers.

(6) Perform an inspection test on microswitch by leaving the hand operating crank adapter on the traversing mechanism set for power operation (disengaged) and the handcrank adapter on the elevation side set for handcrank operation (engaged).

Caution: Do not install hand operating crank during this operation.

Attempt to elevate the dual gun by power operation. If the dual gun elevates under power, replace microswitch ((*a*) through (*e*) below).

(*a*) Remove cover and gasket ((4) above).

(*b*) Remove the two fillister-head screws (fig. 356) and lockwashers that secure the switch to the housing and withdraw the microswitch from the housing.

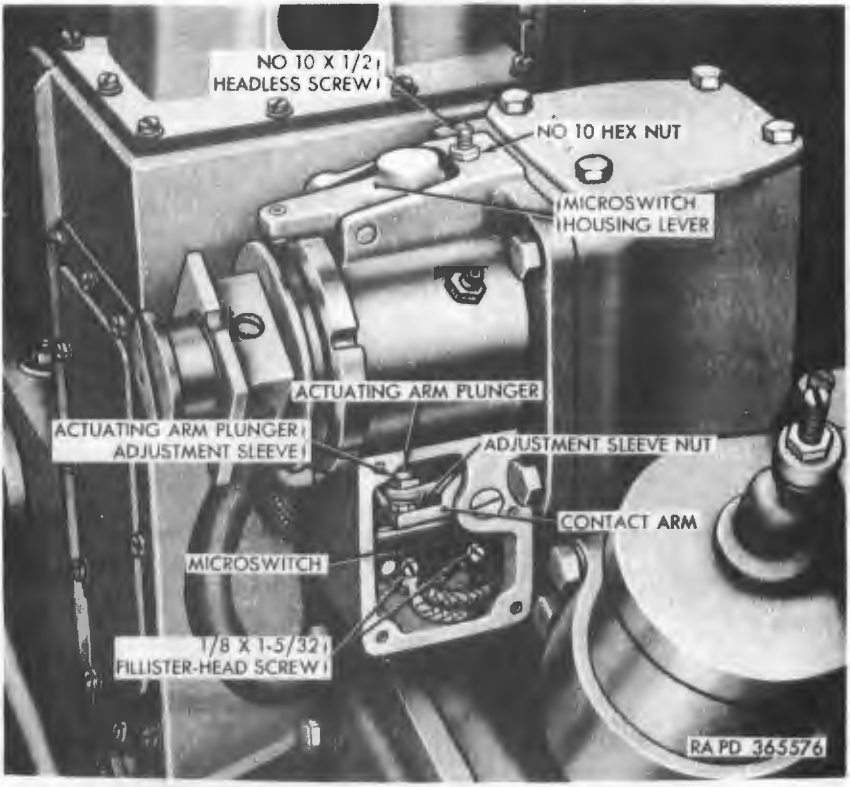


Figure 356. Adjustment of actuating arm plunger—elevation side.

(*c*) Disconnect the microswitch from the elevation switch to elevating mechanism cable leads (fig. 357) and install cable leads on new switch.

(*d*) Secure the microswitch to the microswitch housing with two $\frac{1}{8}$ x $1\frac{5}{32}$ fillister-head screws (fig. 356) and No. 6 internal-teeth lockwashers. The contacting point on the switch must be on top and in line with the actuating arm plunger.

(*e*) Place the gasket and cover in position and secure with five No. 10 x $\frac{1}{2}$ fillister-head screws and No. 10 lockwashers (fig. 354).

(7) Check the effort required to move the hand operating crank adapter (fig. 354) into operative and nonoperative positions; effort should be moderate. To engage or disengage properly, splines must be clean and free from burs, nicks, foreign material, or congealed lubricants. Check that microswitch housing lever (fig. 356) holds handcrank adapter in the disengaged position during power operation. If necessary, adjust by loosening the No. 10 hex nut (fig. 356), loosening the No. 10 x $\frac{1}{2}$ head-

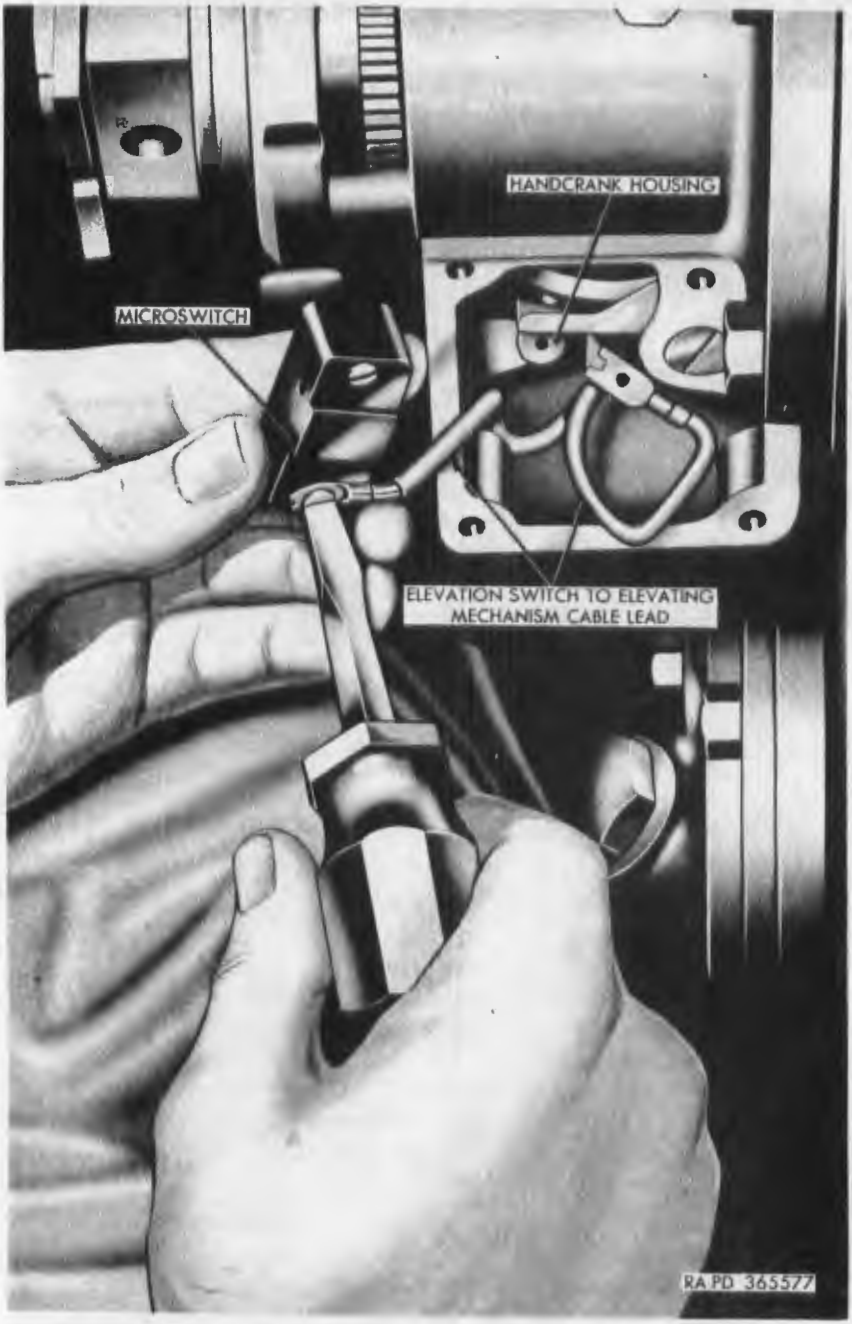


Figure 357. Replacing microswitch—elevation side.

less screw as required to increase tension, and tightening the hex nut.

288. Traversing Mechanism

a. Description. The traversing mechanism (fig. 358) consists of upper, intermediate and lower case assemblies which permit the mount to be traversed either by hand or power. Power for traversing is furnished by the azimuth oil gear M6A1E1 which is coupled through the intermediate case gears to the traversing mechanism pinion. The traversing mechanism pinion meshes with the traversing ring gear mounted in the bearing assembly for the carriage. The gun mount is rotated in azimuth by the traversing mechanism pinion being rolled around the circumference of the stationary ring gear.

(1) The hand traversing gears (fig. 358) are mounted on the outside of the carriage right frame. They are operated manually by a double hand operating crank. Rotation of this crank is transmitted through the upper case gears, through the flexible coupling assembly, and through the

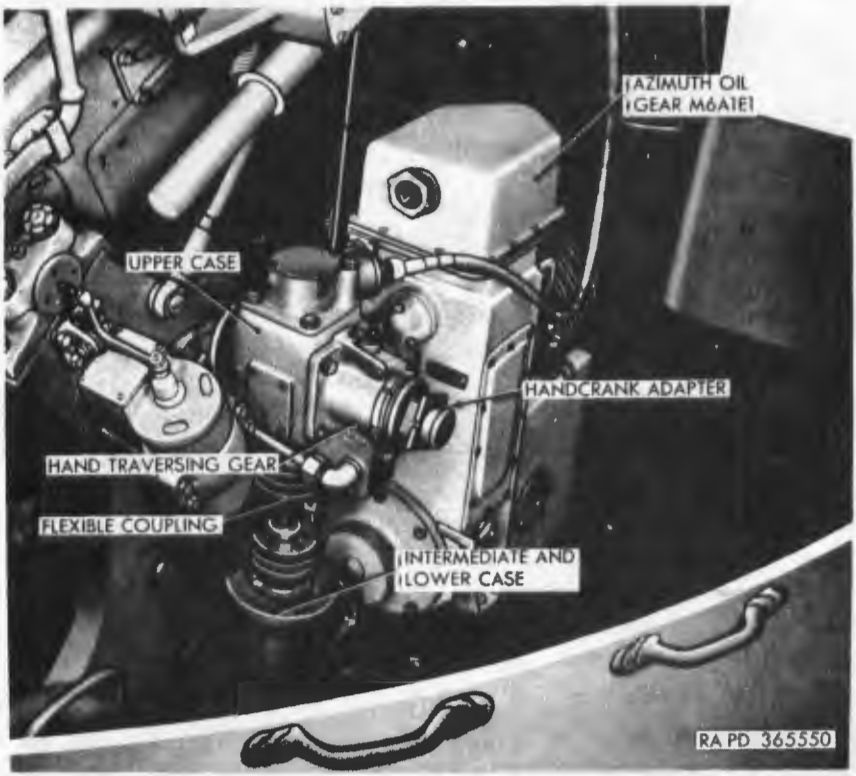


Figure 358. Traversing mechanism.

intermediate and lower case gears to the traversing mechanism pinion.

(2) The hand traversing gears (fig. 358) are contained in the handcrank housing which also contains a microswitch, actuating assembly, and housing lever identical to those in the handcrank housing of the elevating mechanism (fig. 354).

(3) The gun mount may be locked with the gun barrels straight ahead at 0 or directly to the rear at 3,200 mils azimuth by the traversing lock (par. 54*d*).

b. Function.

(1) The traversing mechanism, actuated by power from the azimuth oil gear M6A1E1, provides lateral movement of the gun mount for 360° in either direction at a maximum speed of 40° per second.

(2) The traversing mechanism, disconnected from power operation and actuated by manual rotation of the hand operating crank, provides movement of the gun mount for 360° in either direction.

c. Inspection. Traverse the gun mount manually 360° in each direction and check smoothness of operation. Lubricate as specified on lubrication order LO 9–7218 (par. 90). Perform a field expedient check on backlash by holding the output coupling or shaft, between the oil gear and traversing mechanism intermediate case, in a vise-grip or strap wrench while a second member of the crew grasps one of the gun barrels and by applying hand pressure rocks it back and forth in traverse. Remove the azimuth indicator cover (fig. 41) and observe the movement of the 1-mil pointer. A movement of more than 3-mils indicates excessive backlash, notify ordnance maintenance personnel.

289. Firing Mechanism

a. Description. The firing mechanism (fig. 359) consists of mechanical linkage so arranged as to permit firing the dual gun M2A1 mechanically. The firing mechanism is actuated by applying pressure to the firing mechanism pedal. Pressure on the pedal is transmitted through linkage to the actuating rods which are attached to the firing mechanism levers that contact the firing plungers. When pressure is released, the pedal is returned to its original position.

b. Adjustment. The firing mechanism (fig. 359) must be adjusted so that when the firing mechanism pedal is released, the exposed portion of the firing plunger (fig. 354) measures approxi-

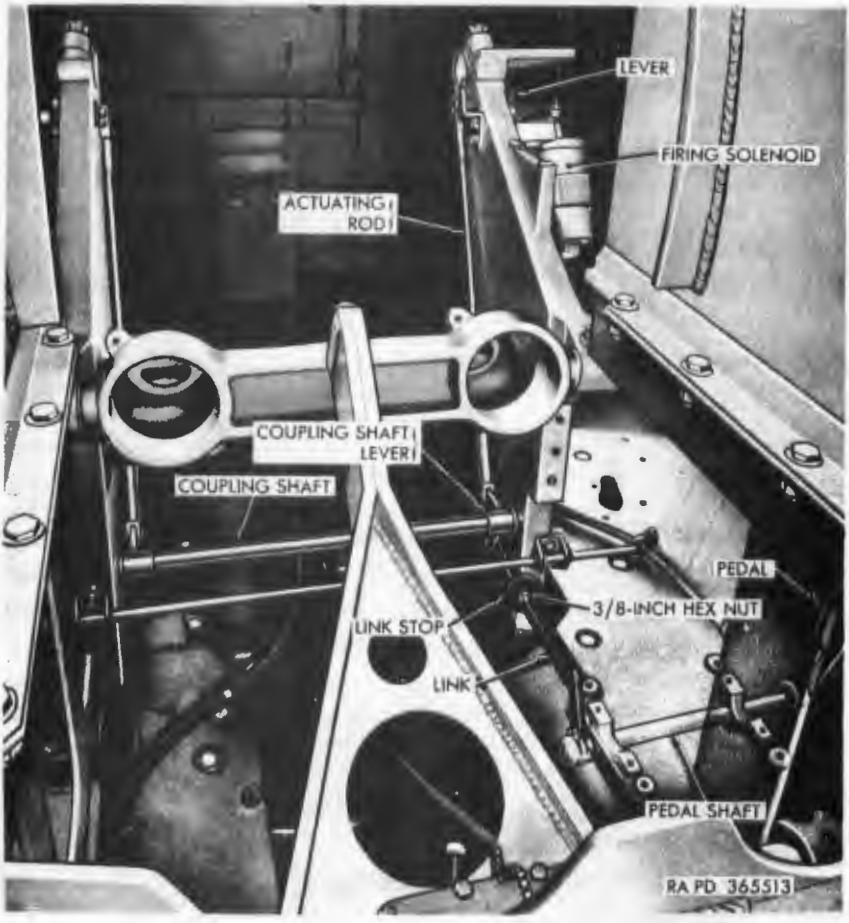


Figure 359. Firing mechanism.

mately $1\frac{5}{32}$ inches, and the plunger rotates freely in the gun trunnion. To adjust the firing mechanism, loosen the $\frac{3}{8}$-inch hex nut (fig. 359) on firing mechanism link. Adjust link stop (fig. 359), as necessary, and tighten hex nut.

290. Equilibrators

a. Description. Two spring-type equilibrators (figs. 360 and 31) are installed under the dual gun M2A1 and between the top carriage frames. They operate as a unit and are provided to neutralize the unbalanced weight of the weapon and reduce the effort required to elevate the gun. Each equilibrator consists of a tubular case containing a set of three springs (fig. 360) held in compression on an equilibrator spring tube. The two cases are held in the equilibrator trunnion bracket which is supported in

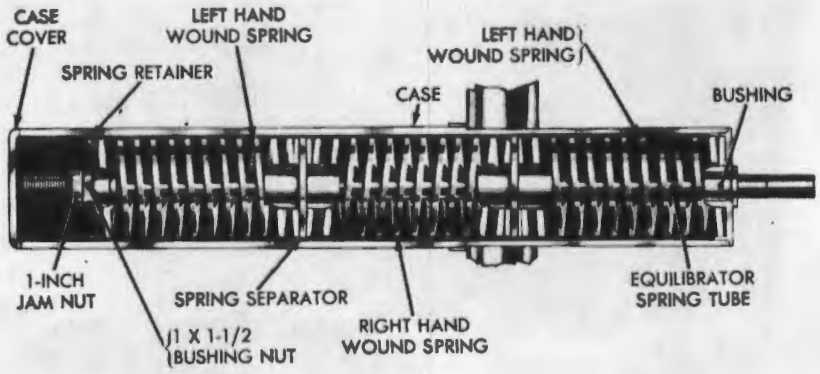


Figure 360. Equilibrator case and components—cross-sectional view.

trunnions in the front edges of the top carriage frames. The two equilibrator spring tubes are pivoted on the equilibrator crossbar (fig. 263) which projects from each side of the elevating sector. As the gun is depressed, the rear end of the breech casing rises, pulling the spring tube and compressing the equilibrator springs. This counterbalances the muzzle-heavy weight of the weapon and eliminates the need for braking their descent. The energy stored in the compressed springs is released as the gun is elevated, the expanding springs exert a pull on the elevating sector and assist in elevating the gun.

b. Removal. Coordinate with ordnance maintenance unit (par. 2).

(1) Remove equilibrator access plate (fig. 8).

Note. On early vehicles, this plate is secured by four nuts and washers on studs. On late vehicles, this plate is secured by four hex-head bolts and lockwashers.

(2) Insert U-shaped guards (fig. 361) in opening provided in the ends of equilibrator assemblies. Manually elevate dual gun M2A1 to maximum limit and relieve tension on equilibrator springs by adjusting until springs seat against U-shaped guards. Tie the hand operating crank (elevating) to gun mount to prevent dual gun M2A1 from falling when equilibrators are removed.

(3) Remove cotter pins and castle nuts from hex-head bolts and remove bolts, connectors, and blocks from equilibrator crossbar (fig. 263).

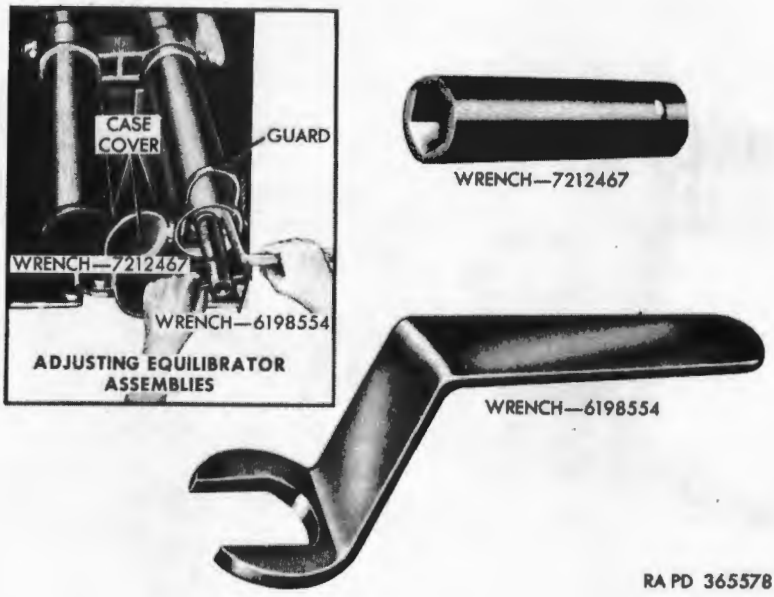


Figure 361. Adjusting equilibrators.

(4) Remove hex nuts, washers, and screws which attach the equilibrators to the equilibrator bracket (fig. 31). Remove equilibrators through openings provided in the front of the outer shield.

c. Disassembly. Coordinate with ordnance maintenance unit (par. 2).

Warning: Before any attempt is made to disassemble equilibrators, organizational maintenance personnel must read entire section as serious injury may result if proper precautions are not used.

(1) Place equilibrator on bench and secure equilibrator spring tube end to prevent rotation when removing springs.

(2) Open cover and remove jamnut using wrench 7212467 (fig. 361) and equilibrator tube bushing nut using wrench 6198554 (fig. 361).

(3) Screw shaft of equilibrator spring compressor 7219885 (fig. 362) on end of equilibrator spring tube (fig. 360). When pin clip hole in end of shaft alines with holes in equilibrator spring tube, install pin clip to lock compressor shaft to equilibrator tube.

Warning: The shaft of the spring compressor must be locked to the equilibrator tube by means of the pin clip to prevent unscrewing of the compressor shaft from the

Figure 362. Removing equilibrator springs.

equilibrator tube when attempting to relieve the compression of the springs. If the shaft should unscrew, the equilibrator springs will be released suddenly and may seriously injure personnel.

(4) Turn handle of compressor clockwise sufficiently to force spring retainer (fig. 360) away from U-shaped guard (fig. 361) so that guard can be removed. Withdraw guard from holes in case.

(5) Turn handle of compressor counterclockwise relieving spring compression (fig. 362). When compression has been entirely relieved, remove compressor from spring tube.

(6) Remove springs, tube, and separators (fig. 360) from equilibrator case.

d. Maintenance.

(1) Clean all parts with dry-cleaning solvent or mineral spirits paint thinner. Inspect springs, tube threads, bushing, connectors, blocks, bolts, and jamnut for cracks, breaks, or wear. If replacement is required, notify ordnance maintenance personnel.

(2) Lubricate springs, separators, retainers, tube, bushing, and interior of cases in accordance with lubrication order LO 9–7218 (par. 90).

e. Assembly.

(1) Place spring tube through bushing (fig. 360) in closed end of equilibrator case so that threaded end of tube is at cover end of case.

(2) Place the following parts on the tube, through the cover end of case, as follows: Left hand wound spring, and spring separator, right hand wound spring, and spring separator, left hand wound spring, and spring retainer. Install compressor 7219885 (fig. 362) on shaft of compressor (*c*(3) above) and compress springs to the point where U-shaped guard (fig. 361) can be inserted through holes in case. Install guard and remove compressor.

(3) Using wrench 6198554 (fig. 361) install 1 x 1½ bushing nut and install 1-inch hex jamnut using wrench 7212467 (fig. 361). Remove U-shaped compressor guard.

Note. Tighten bushings the same number of turns on each tube. Final adjustment must be made after installation of equilibrators on dual gun M2A1.

f. Installation.

(1) Slide equilibrators through access hole after removing equilibrator access plate (fig. 8), through openings at front of openings at front of outer shield and into position in equilibrator bracket (fig. 31).

(2) Install two ⅜ x 2 hex-head cap screws, ⅜-inch lockwashers and ⅜-inch hex nuts to retain each equilibrator in bracket.

(3) Position equilibrator crossbar connectors on equilibrator crossbar (fig. 263) and aline crossbar with equilibrator tubes. Position blocks on crossbar and in connectors.

(4) Install two ⅜ x 4 7/16 hex-head bolts through connectors and secure with two ⅜-inch castle nuts and 3/32 x 1 cotter pins.

(5) Free hand operating crank (elevating) and lower guns.

g. Adjustment (fig. 361). The equilibrators must be adjusted to satisfy two requirements. They must be adjusted to the same load so that the work done by each equilibrator matches its mate, and the equilibrators working together must be adjusted so that the effort required to elevate or depress the dual gun M2A1 is equal.

(1) Open both equilibrator case covers. Remove equilibrator tube jamnuts using wrench 7212467.

(2) If effort to depress dual gun M2A1 is greater than that required to elevate, loosen bushing nuts using wrench 6198554; if effort to elevate is greater, tighten the bushing nuts. In tightening or loosening the nuts, be sure to adjust

both equilibrators exactly alike, observing the number of complete revolutions of the wrench in either direction on each equilibrator. If the bushing nuts require excessive effort to turn, insert the U-shaped guards as in paragraph *h* above.

(3) In making adjustments in (2) above, note carefully the effort required to move each bushing nut. When there is a marked difference, it is an indication of a weak or broken equilibrator spring; proceed as in paragraphs *c* through *f* above.

(4) When adjustment is complete, lock bushing nuts in place by installing a 1-inch jamnut on each tube. Close case covers and remove U-shaped guard.

(5) Install equilibrator access plate.

291. Top Carriage, Gun Mount Platform and Gunner's Shields

a. General.

Note. **The key letters noted in parentheses are in figure 45, except where otherwise indicated.**

The top carriage supports the dual gun (B), equilibrator, gun mount platform (V), gunner's shields (E and Y), and elevating mechanism (T), traversing mechanism (BB), and firing mechanism. It rotates in azimuth on the top carriage bearing and motion is furnished and controlled by the traversing mechanism (BB) which is mounted on the right frame of the top carriage. The elevating mechanism (T) is mounted on and through the left frame. The gun mount platform (V) and outer shield is a welded structure. The platform supports both oil gears M6A1E1, inverter box, distribution box, traversing and elevating travel locks, and the gunner's and sight setter's seats (R and J). The outer shield surrounds the entire mount and supports the loaders' seats, portable fire extinguisher, drive controller M12E2, cal..30 machine gun pintle mount (N), and various stowage boxes; it also partially supports the left and right gunner's shields (E and Y). The cartridge case chute support is attached to both the platform (V) and the outer shield. Two openings, at the front of the outer shield, are provided for removal and installation of equilibrators.

b. Maintenance.

(1) Inspect all shields for loose or missing bolts, washers, and nuts. Tighten or replace, as necessary. Observe that all stowage boxes or containers are securely welded to outer shield. Repair any cracked or broken weldments if welding equipment is available; otherwise, notify ordnance maintenance personnel.

(2) Examine surfaces of shields and the gun mount platforms

for worn or exposed areas. Repaint or touch up as necessary. Refer to TM 9–2851.

(3) See that all lubrication fittings are intact, clean, and that a red-painted circle around each fitting is clearly visible.

(4) Inspect for loose, missing, or damaged bolts, nuts, and cotter pins on the hinges, latches, and covers of the stowage boxes. Replace as necessary.

(5) Adjust the traversing lock for full engagement and disengagement of the plunger by backing off the adjusting nut and turning the connecting rod to either lengthen or shorten the travel of the plunger as required. Lock in position by tightening adjusting nut.

Section XXVI. CRADLE, PINTLE, AND AMMUNITION BOX HOLDER ASSEMBLY (E10014) FOR CAL..30 MACHINE GUN

292. General
(fig. 363)

The twin 40-mm full tracked self-propelled, gun M42 (T141) is provided with a flexible cal..30 machine gun M1919A4. Pintle sockets are provided at the front right side and at the rear of the gun mount platform. The machine gun is supported by the cradle, and the cradle is supported by the pintle. The cradle, pintle, and ammunition box comprise an assembly (E10014) which serves as the machine gun mount. Each pintle socket is provided with a locking bail which prevents the machine gun and cradle from moving in azimuth. The cradle locking pin prevents the machine gun from moving in elevation. An empty cartridge bag assembly 7773448 is provided for collecting the spent cartridge cases. For information regarding the cal..30 machine gun, refer to FM 23–55. For parts and equipment of the cradle, pintle, and ammunition box holder assembly (E10014), refer to ORD 7 SNL G–253.

293. Removal of Flexible Cal..30 Machine Gun M1919A4
(fig. 363)

a. Check to see that machine gun is not loaded.

b. Check to see that cradle locking pin is installed.

c. Remove front and rear mounting pins and lift machine gun from cradle.

294. Removal of Machine Gun Cradle, Pintle, and Ammunition Box Holder Assembly (E10014)

a. Remove machine gun (fig. 363).

b. Unscrew pintle locking handle (fig. 363).

c. Lift cradle (fig. 363), pintle, and ammunition box holder assembly (E10014) out of pintle socket.

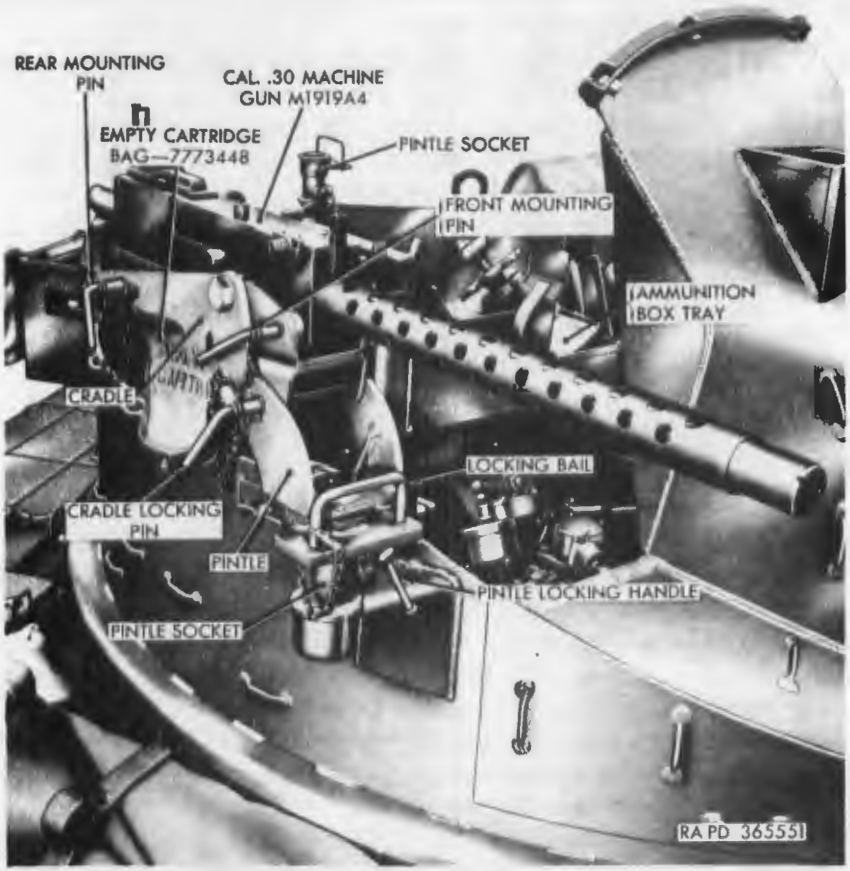


Figure 363. Cradle, pintle, ammunition box holder assembly (E10014), and cal..30 machine gun mounted on gun mount platform.

Note. The ammunition box tray may be removed by loosening the locking cam (right side, forward of ammunition box tray) and lifting the tray straight up.

295. Maintenance

a. Clean and lubricate in accordance with lubrication order LO 9–7218 (par. 90).

b. For repair or replacement of damaged, worn, or missing parts, notified ordnance maintenance personnel.

c. Keep machine gun (fig. 363), cradle, and pintle properly covered when not in use.

296. Installation of Machine Gun Cradle, Pintle, and Ammunition Box Holder Assembly (E10014)

a. Install cradle pintle, and ammunition box holder assembly (E10014) in pintle socket (fig. 363).

b. Tighten pintle locking handle (fig. 363) to secure assembly.

297. Installation of Flexible Cal..30 Machine Gun M1919A4 (fig. 363)

a. Install machine gun in cradle with barrel toward open end of cradle.

b. Aline mounting pin holes and install front and rear mounting pins.

298. Functional Check (fig. 363)

a. Remove cal..30 machine gun cover (F, fig. 45) after checking for damage and proper fit.

b. Remove locking bail and cradle locking pin.

c. Elevate, depress, and traverse machine gun and check freedom of movement. There should be no binding or stiffness throughout these movements.

d. Install the locking bail and check that it prevents traverse of the gun.

e. Install cradle locking pin and check that it prevents elevation of the gun.

f. Install cal..30 machine gun cover (F, fig. 45).

Section XXVII. MAINTENANCE UNDER UNUSUAL CONDITIONS

299. Extreme-Cold Weather Maintenance Problems

a. The importance of maintenance must be impressed on all concerned, with special emphasis on organizational (preventive) maintenance. Maintenance of mechanical equipment in extreme cold is exceptionally difficult in the field. Even shop maintenance cannot be completed with normal speed, because the equipment must be allowed to thaw out and warm up before the mechanic can make satisfactory repairs. In the field, maintenance must be undertaken under the most difficult of conditions. Bare hands stick to cold metal. Fuel in contact with the hands results in super-cooling due to evaporation, and the hands can be painfully frozen in a matter of minutes. Engine oils, except subzero grade, are unpourable at temperatures below —40°F. Ordinary greases become as solid as cold butter.

b. These difficulties increase the time required to perform maintenance. At temperatures below—40°F., maintenance requires up to five times the normal amount of time. The time required to warm up a vehicle so that it is operable at temperatures as low as —50°F. may approach two hours. Vehicles in poor mechanical condition probably will not start at all, or only after many hours of laborious maintenance and heating. Complete winterization, diligent main-

tenance, and well trained crews are the key to efficient Arctic-winter operations.

c. Refer to TM 9–2855 and TB ORD 193 for general information on extreme-cold weather maintenance procedures.

Caution: It is imperative that the approved maintenance procedures be followed. TM 9–2855 contains general information which is specificially applicable to this vehicle as well as all other vehicles. It must be considered an essential part of this manual, not merely an explanatory supplement to it.

300. Extreme-Cold Weather Maintenance—Vehicle

Carefully drain hull of all accumulated water during cold weather. Do not attempt to start bilge pumps when they are frozen. Thaw them out first—otherwise serious damage to the pumps may result.

301. Extreme-Cold Weather Maintenance—Armament

a. Keep gun bore and automatic loader covered when not in use, in order to prevent the entrance of snow.

b. Clean gun bore while the weapon is still hot, if possible. When cleaning, shake rifle-bore cleaner before using and do not dilute or add any antifreeze. Lubricate the weapon lightly when thoroughly cleaned.

c. The recoil mechanism may stick unless it has been exercised frequently. Intervals of exercise will be governed by the existing temperature. Refer to paragraph 280*d*(2) for methods of exercising.

Note. **Severe damage to the weapon may result if the recoil mechanism is frozen.**

d. Prevention of condensation in cold weather.

(1) When guns or parts are brought indoors after having been outside at low temperatures, vapor in the warm air will condense on the cold parts. If it is not dried off, this condensed moisture may cause rust and corrosion. In some cases drying without disassembly is impossible. If the materiel is operated indoors while this moisture is present, the moisture will form an emulsion with the grease used for lubrication. Such a condition will necessitate removing all the grease and relubricating. If the materiel is taken outside with this moisture present, the parts will become covered with frost and may not function.

(2) Do not bring any materiel indoors unless it is absolutely necessary. It is best to leave it outdoors, but covered to protect it from snow. Snowtight lockers, which stay at outdoor temperatures, are recommended for keeping binoculars, telescopes, and other equipment.

(3) If it is necessary to bring instruments or other equipment from low temperatures to room temperatures, "anticondensation" containers should be used. These containers can be specially made boxes, water cans, barracks bags, or any other fairly airtight containers with heat conducting walls. Keep them outside so that they will remain at prevailing temperatures until it is desired to bring the instrument indoors. Then put the instrument in the container, close the top, bring it indoors and let it come to room temperature, after which the container can be opened and the instrument removed without condensation forming.

(4) It is possible for condensation to form on the inside of sealed optical instruments when they are taken outdoors in low temperatures after having been assembled at room temperature. To avoid this, the instrument should be finally sealed in a room that is kept at outdoors temperatures.

302. Extreme-Cold Weather Maintenance—Sighting and Fire Control Equipment

a. When it is planned to use a piece of sighting or fire control equipment, it should be prepared to operate at the lowest prevailing temperature expected, so that if shelter is not available, the equipment will not be rendered useless.

b. Sighting and fire control equipment should not be exposed to sudden changes in temperature because of the dangers of condensation, and the effects of sudden lowering of temperatures on the accuracy of the equipment. If a piece of equipment is going to be used outside at a low temperature, it should stay outside and not be stored at room temperature and brought outside when it is to be operated.

c. All electrical cables should be removed periodically from beneath snow which continues to accumulate. This eliminates the necessity of locating and digging out cables when preparing to shift the materiel.

303. Extreme-Hot Weather Maintenance

a. Batteries.

(1) *Electrolyte level.* In torrid zones, check level of electrolyte in cells daily and replenish, if necessary, with pure distilled water. If this is not available, rain or drinking water may be used. However, continuous use of water with high mineral content will eventually cause damage to batteries and should be avoided.

(2) *Specific gravity.* Batteries operating in torrid climates should have a weaker electrolyte than for temperate climates. Instead of 1.280 specific gravity (TM 9–2857). This is the correct reading for a fully-charged battery in tropical climates. This procedure will prolong the life of the negative plates and separators. Batteries should be recharged at about 1.160 specific gravity.

(3) *Self-discharge.* A battery will self-discharge at a greater rate if left standing for long periods at high temperatures. This must be considered when operating in torrid zones. If necessary to park for several days, remove batteries and store in a cool place.

Note. Do not store acid-type storage batteries near stacks of tires, as the acid fumes have a harmful effect on rubber.

b. Hull and Gun Mount.

(1) In hot, damp climates, corrosive action will occur on all parts of the vehicle and will be accelerated during the rainy season. Evidences will appear in the form of rust and paint blisters on metal surfaces and mildew, mold, or fungus growth on fabrics, leather, and glass.

(2) Protect all exposed exterior painted surfaces from corrosion by touchup painting and keep a film of preservative lubricating oil (medium) on unfinished exposed metal surfaces. Cables and terminals should be protected by ignition-insulation compound.

(3) Make frequent inspections of idle, inactive vehicles. Remove corrosion from exterior metal surfaces with abrasive paper or cloth and apply a protective coating of paint, oil, or suitable rust preventive.

c. Armament. In hot, humid areas, inspect parts frequently for moisture or corrosion. Thoroughly dry all exposed unpainted surfaces such as bore, breech and firing mechanisms and oil as prescribed on the lubrication order LO 9–7218 (par. 90). In dry, dusty or sandly areas, during operation or traveling, leave exposed surfaces such as the recoil slides dry rather than oiled, since contamination of the lubricant with sand makes an abrasive paste far more damaging the surfaces than does dry operation. At other times, keep such surfaces lubricated to prevent rusting.

d. Sighting and Fire Control. In hot, humid areas, inspect parts frequently for moisture, corrosion, or fungus growth. In dry, dusty or sandy areas, keep optics protected from etching by sand.

304. Maintenance After Fording

a. General. Although the vehicle unit housings are sealed to prevent the free flow of water into the housings, it must be realized

that, due to the necessary design of these assemblies, some water may enter, especially during submersion. The following services should be accomplished on all vehicles which have been exposed to some depth of water or completely submerged, especially in salt water. Precautions should be taken as soon as practicable to halt deterioration and avoid damage before the vehicle is driven extensively in regular service.

b. Hull and Gun Mount. Drain and clean out hull. Clean all exposed surfaces and touch up paint where necessary. Coat unpainted metal parts with preservative lubricating oil.

c. Engine, Transmission, and Final Drives. Check the lubricant in the engine, transmission, and final drives. Should there be evidence that water has entered, drain, flush, and refill with the correct lubricant. Remove and clean engine and transmission oil filters.

d. Suspension. Clean and lubricate all parts as specified on the lubrication order LO 9–7218 (par. 90). Remove road wheels, idlers, and support rollers, and clean and repack bearings. Make sure that lubricant is generously forced into each fitting to force out any water present.

e. Batteries. Check the batteries for quantity and specific gravity of electrolyte to be sure no water has entered through the vent plugs. This is of special importance should the vehicle have been submerged in salt water.

f. Electrical Connections. Check all electrical connections for corrosion, particularly the bayonet-type connectors.

g. Fuel System. Drain fuel tanks of any accumulated water, clean fuel filter and lines as necessary. If water is found in the air cleaner, clean and refill with oil.

h. Condensation. Although most units are sealed, the sudden cooling of the warm interior air upon submersion may cause condensation of moisture within the cases or instruments. A period of exposure to warm air after fording should eliminate this condition. Cases which can be opened may be uncovered and dried.

i. Aluminum or Magnesium Parts. If vehicle remains in salt water for any appreciable length of time, aluminum or magnesium parts which were exposed to the water will probably be unfit for further use and must be replaced.

j. Armament. Armament subjected to submersion should be disassembled, dried and lubricated.

k. Sighting and Fire Control Instruments. If moisture has entered optical instruments turn in to ordnance maintenance for repair at earliest opportunity.

l. Deep-Water Fording. Refer to TM 9–2853 and pertinent technical bulletins in the TB 9–2853 series for deep-water fording kit information.

305. Maintenance After Operation on Unusual Terrain

a. Mud. Thorough cleaning and lubrication of all parts affected must be accomplished as soon as possible after operation in mud, particularly when a sea of liquid mud has been traversed. Clean all suspension components and lubricate as specified on the lubrication order LO 9–7218 (par. 90).

b. Sand or Dust. Clean engine and engine compartment. Touch up all painted surfaces damaged by sandblasting. Lubricate completely to force out lubricants contaminated by sand or dust. Air cleaners, fuel and oil filters must be cleaned at least daily. When halted, the engine grilles and other exposed vents should be covered with cloth to prevent entrance of sand or dust.

CHAPTER 4
MATERIEL USED IN CONJUNCTION WITH MAJOR ITEM

Section I. AMMUNITION

306. General

Ammunition for the 40-mm dual automatic gun M2A1 is issued in the form of complete round of fixed ammunition. The term "fixed", used in conjunction with ammunition, signifies that the propelling charge is fixed (not adjustable) and the round is loaded into the weapon as a unit. A complete round (cartridge) consists of all components necessary to fire the weapon once, that is, projectile, cartridge case, propellant, primer, and fuze (if applicable). The primer and propellant are assembled in the cartridge case; the fuze (if applicable) is assembled in the projectile; and the cartridge case is crimped rigidly to the projectile.

307. Firing Tables

a. Firing data for rounds for this gun are published in FT 40AA–A–3.

b. Supplemental and additional firing tables, and trajectory charts, as they become available, will be listed in the index of firing tables maintained in SR 310–20–3.

308. Classification

The ammunition authorized for use in this gun is classified as high-explosive-incendiary with shell-destroying tracer (HEI–T, SD), high-explosive with shell-destroying tracer (HE–T, SD), armor-piercing with tracer (AP–T), target-practice with tracer (TP–T), or drill depending on the type of projectile.

a. The high-explosive-incendiary projectile with shell-destroying tracer (Navy) is a relatively thin-walled projectile containing both a high-explosive bursting charge and an incendiary mixture. The base is fitted with a direct ignition tracer that will detonate the bursting charge of the shell before reaching maximum flight range unless prior detonation has been caused by functioning of the fuze. The nose of the projectile is fitted with a supersensitive point detonating fuze.

b. The high-explosive projectile with shell-destroying tracer is identical with the projectile described in *a* above, except that it

does not contain an incendiary mixture—only the high-explosive bursting charge.

c. The armor-piercing with tracer projectile is a solid projectile fitted with a lightweight windshield over the nose, and a tracer element in the base to provide for observing the path of the projectile in flight.

d. The target-practice with tracer projectile is inert except for the tracer in the base. The target-practice round contains a service propelling charge and primer and simulates the service rounds in size, shape, and weight.

e. The drill round is completely inert and is intended for practice in service of the piece and handling.

309. Identification

a. General. Ammunition and ammunition components are completely identified by the painting and marking (including and ammunition lot number) on the ammunition items and on all original packing containers. The components of various types of rounds may be identified by the marking thereon and by the color scheme (when employed). Refer to figures 364 through 367.

b. Model. To identify a particular design, a model designation is assigned at the time the item is classified as an adopted type. This model designation becomes an essential part of the standard nomenclature and is included in the marking on the item. The present system of model designation within the Department of the Army, consists of the letter M followed by an Arabic numeral, for example, M81; the Navy Department system of model designation, however, consists of the letters Mk (mark) followed by a Roman numeral (on older model items) or an Arabic numeral (on later model items), for example Mk 11 or Mk 2.

Note. Do not confuse the Roman numeral II with Arabic numeral 11 in table I.

Modifications on Army items are indicated by adding the letter A and appropriate Arabic numeral; thus, M81A1 indicates the first modification of an item for which the original designation was M81. Modification of Navy items are indicated by adding the letters Mod (modification) and appropriate Arabic numeral; thus, Mk 2 Mod 3 indicates the third modification of an item originally designated Mk 2. Similarly, the army system applied to development items involves the use of a T designation to indicate the basic design and an E to indicate modifications thereof; thus, T122E1 would indicate the first modification of a development item originally designated T122. The Navy system of model designation for development items utilizes the letter X to indicate a development

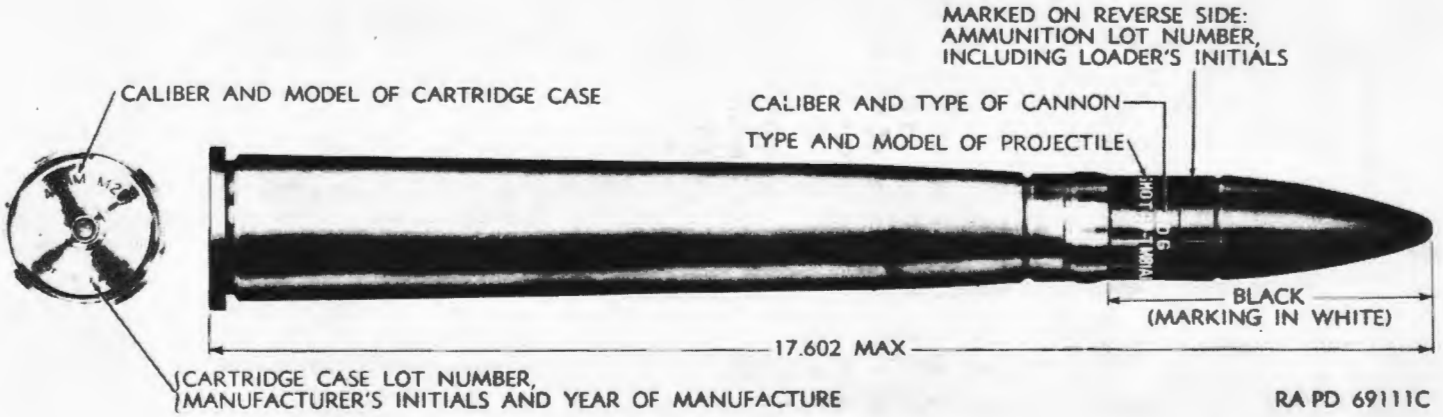


Figure 364. Cartridge, AP–T, M81A1, for 40-mm guns.

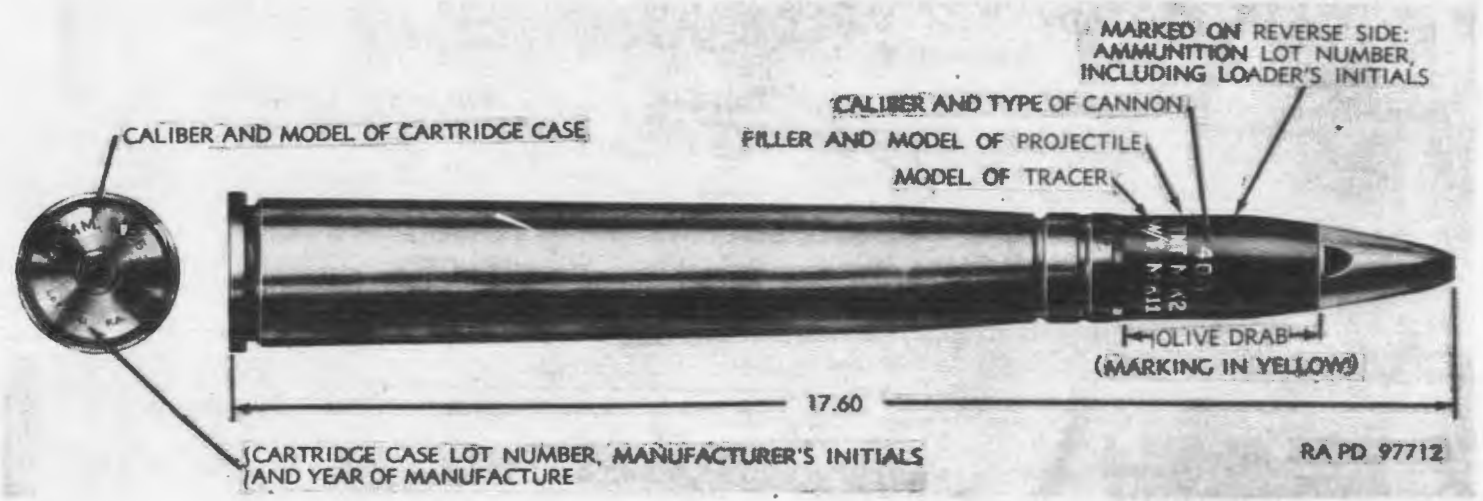


Figure 365. Cartridge, HE–T, SD MK11, MK 2, MV 2,870 w/fuze, PD, MK 27, for 40-mm guns.

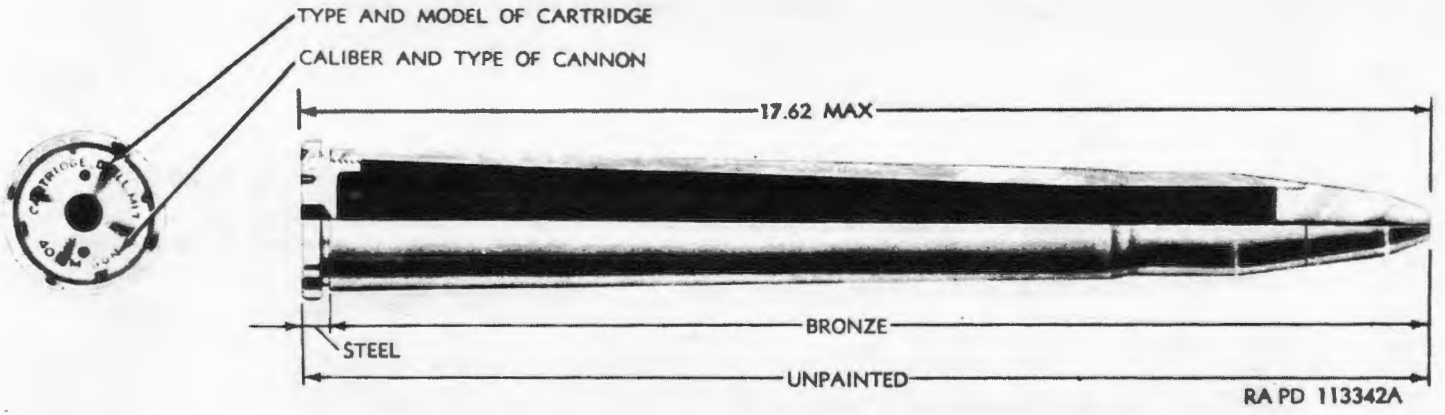


Figure 366. Cartridge, drill, M17, for 40-mm guns.

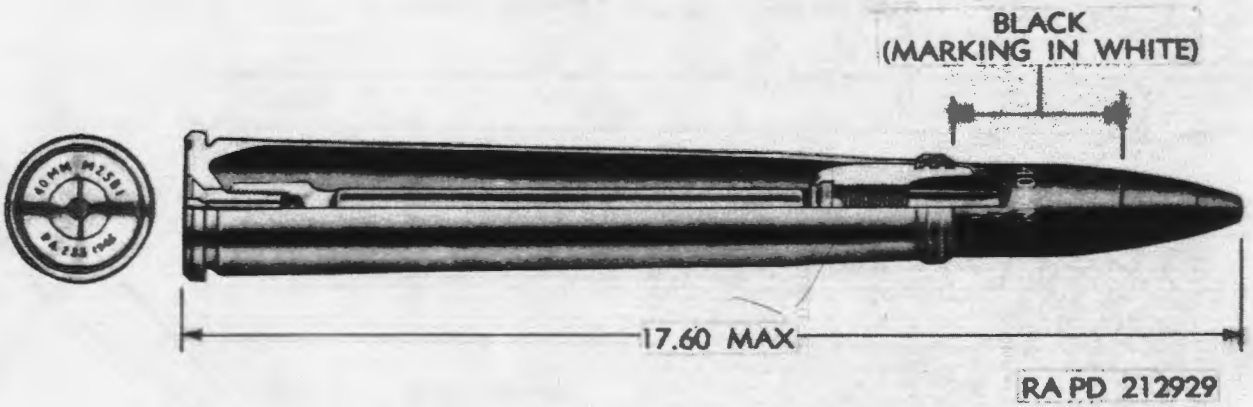


Figure 367. Cartridge, drill, M25, w/fuze, dummy, M69, for 40-mm guns.

type item and the letter A to indicate a modification of a development item originally designated X101. The letters B and C as well as others in the alphabet may be used to designate development items that have not had final proofing.

c. Ammunition Lot Number. When ammunition is manufactured, an ammunition lot number, which becomes an essential part of the marking, is assigned in accordance with pertinent specifications. This lot number, which usually consists of the loader's initials or symbol and the number of the lot, is stamped or marked on every loaded complete round and on all packing containers. It is required for all purposes of record, including reports on condition, functioning, or accidents in which the ammunition may be involved. To provide for the most uniform functioning, all of the components used in the assembly or any one lot are manufactured under as nearly identical conditions as practicable; all of the rounds of any lot of fixed ammunition consist of projectiles of one lot number, fuzes of one lot number, primers of one lot number, and propellant of one lot number.

d. Painting. Ammunition is painted primarily to prevent rust and to provide, by the color, a means of identification as to type, due consideration being given to the requirements for camouflage. The color scheme is as follows (figs. 364 and 365):

Armor-piercing with tracer	Black, marking in white
High-explosive with tracer	Olive drab, marking in yellow
Target-practice with tracer	Blue, marking in white
Drill (dummy)	Unpainted when made of bronze; otherwise black, marking in white

e. Marking. The components of each round of ammunition described herein are marked as follows:

(1) *On projectile (stenciled).*
- (*a*) Type of shell.
- (*b*) Caliber and model designation.
- (*c*) Loader's initials.
- (*d*) Ammunition lot number.

(2) *On projectile (stamped in rotating band).*
- (*a*) Projectile lot number.
- (*b*) Year of manufacture.
- (*c*) Manufacturer's initials or symbol.
- (*d*) Caliber and model designation.

(3) *On head of cartridge case (stamped in metal).*
- (*a*) Caliber and model designation of case.
- (*b*) Manufacturer's initials or symbol.
- (*c*) Lot number of cartridge case.
- (*d*) Year of manufacture, in full.

(4) *On fuze (stamped in metal).*

(*a*) Model and fuze designation.

(*b*) Manufacturer's initial or symbol.

(*c*) Loader's lot number.

(*d*) Month and year of loading.

310. Care, Handling, and Preservation

Caution: Explosive ammunition must be handled with care at all times. The explosive elements in primers and fuzes are particularly sensitive to undue shock and high temperature. Explosive ammunition and components should not be dropped, thrown, tumbled, or dragged.

a. Ammunition is packed to withstand conditions ordinarily encountered in the field. Care must be taken to keep packing boxes from becoming broken or damaged. All broken packings must be repaired immediately and careful attention given to the transfer of all original markings to the new parts.

b. When it is necessary to leave ammunition in the open, raise it on dunnage at least 6 inches from the ground and cover it with a double thickness of paulin, leaving enough space for the circulation of air. Where practicable, dunnage strips should be placed under each layer of ammunition boxes. Suitable trenches should be dug to prevent water from running under the pile.

c. Since ammunition and explosives are adversely affected by moisture and high temperature, due consideration should be given to the following:

(1) Do not open containers until the ammunition is to be used. Ammunition removed from airtight containers, particularly in damp climates, is apt to corrode, thereby rendering the ammunition unserviceable.

(2) Protect ammunition from high temperature and direct rays of the sun. More uniform firing is obtained if the rounds are at the same temperature. The combination of high temperature and a humid atmosphere is particularly detrimental to the stability of the propellant and of the tracer mixture in tracer ammunition.

d. Do not attempt to disassemble the complete round or any of its components.

e. The use of grease or oil on cartridge is prohibited.

f. Ammunition should be protected from sand, mud, moisture, frost, snow, ice, grease, or other foreign matter. If it gets wet or dirty, it should be wiped off at once. If verdigris or light corrosion forms on the cartridges, it should be wiped off with a clean

dry cloth. However, cartridges should not be polished to make them look better or brighter.

g. Brass cartridge cases are easily dented and should be protected from hard knocks and blows. Dented cartridge cases may result in incomplete obduration, jamming in the chamber, and difficulty in extraction.

h. Ammunition when stored should be segregated by type and ammunition lot number (refer to TM 9–1900).

i. When only a part of a box of ammunition is used, the ammunition remaining in the box should be protected against unauthorized handling and use by firmly fastening the box cover in place.

j. Do not handle duds. Because their fuzes may be armed, duds are extremely dangerous. They will not be moved or touched but will be destroyed in place in accordance with TM 9–1900.

311. Authorized Rounds

a. Ammunition authorized for use in the 40-mm dual automatic gun M2A1 is listed in table I. Standard nomenclature, which is used in the listing, completely identifies the ammunition except for ammunition lot number.

b. All rounds are painted and clearly marked for easy identification (figs. 364–367). The ammunition lot number is included in the marking.

Table XII. Authorized Rounds for 40-mm Dual Automatic Gun M2A1

Standard nomenclature	Complete round		Projectile weight as fired (lb)	Action of fuze
	Weight (lb)	Length (in.)		
SERVICE AMMUNITION				
CARTRIDGE, AP–T, M81, for 40-mm guns.	4.535	17.62	1.96	None
CARTRIDGE, AP–T, M81A1, for 40-mm guns.	4.58	17.602	1.96	None
CARTRIDGE, AP–T, M81A1, steel case, for 40-mm guns.[1]	4.39	17.602	1.96	None
CARTRIDGE, HEI–T, SD Mk 11, Mk 2, MV 2,890, w/fuze, PD, Mk 27, for 40-mm guns.				SQ
CARTRIDGE, HEI–T, SD Mk 11, Mk 2, steel case, MV 2,890, w/ fuze, PD, Mk 27, for 40-mm guns.				SQ

See abbreviations and footnotes at end of table.

Table XII—Continued

Standard nomenclature	Complete round		Projectile weight as fired (lb)	Action of fuze
	Weight (lb)	Length (in.)		
SERVICE AMMUNITION—Continued				
CARTRIDGE, HE–T, SD Mk 11, Mk 2, MV 2,870, w/fuze, PD, Mk 27, for 40-mm guns.	4.75	17.60	1.99	SQ
CARTRIDGE, HE–T, SD Mk 11, Mk 2, steel case, MV 2,870, w/fuze, PD, Mk 27, for 40-mm guns.[1]	4.49	17.60	1.99	SQ
CARTRIDGE, HE–T, SD M3A1, Mk 2, MV 2,700, w/fuze, PD, Mk 27, for 40-mm guns.	4.74	17.61	2.02	SQ
TARGET PRACTICE AMMUNITION				
CARTRIDGE, TP–T, M91, w/fuze, dummy, M69, for 40-mm guns.[2]	4.72	17.602	1.96	None
CARTRIDGE, TP–T, Mk 2, w/fuze, dummy, M69, for 40-mm guns.[2]	4.677	17.602	1.988	None
DRILL AMMUNITION				
CARTRIDGE, drill, M17, for 40-mm guns.	4.75	17.62	--------	--------
CARTRIDGE, drill, M25, w/fuze, dummy, M69, for 40-mm guns.	4.75	17.60	--------	--------

AP–T	—armor-piercing wtih tracer	mm	—millimeter(s)
HEI–T	—high-explosive-incendiary with tracer	MV	—muzzle velocity
HE–T	—high-explosive with tracer	PD	—point detonating
in	—inch(es)	SD	—shell-destroying
lb	—pound(s)	SQ	—superquick
Mk	—mark	TP–T	—target practice with tracer
M	—model	w/	—with

[1] Steel-case rounds of 40-mm ammunition are an alternative for brasscase rounds.

[2] Rounds may be assembled with alternative fuses (inert); Fuse, PD, (inert), Mk 27 (Navy); Fuse, Dummy, PD, M69B1.

312. Preparation for Firing

After removal from packing materials, charger clips loaded with cartridges are ready for insertion into the automatic feed mechanism of the gun. Cartridges packed in fiber containers, when removed therefrom, need only be loaded into the charger clips. Cartridges prepared for firing but not fired will be returned to

their original condition. The packing containers should be appropriately marked to indicate the nomenclature of the cartridges, the quantity of cartridges therein, and the appropriate ammunition lot number. Such rounds will be used first in subsequent firings in order that stocks of opened packings may be kept at a minimum.

313. Fuzes

a. General. A fuze is a device used with a projectile to explode it at the time and under the circumstances required. The fuzes used with ammunition for this gun are assembled to the rounds as issued.

Caution: Fuzes will not be disassembled. Any attempt to disassemble fuzes in the field is dangerous and is prohibited except under specific directions from the Chief of Ordnance.

b. Classification. Fuzes are classified according to their manner of functioning as TIME and IMPACT, TIME, or IMPACT. Impact fuzes function upon striking a resistant object. They are classified, according to the time of functioning after impact, as *superquick, nondelay,* or *delay.* An impact fuze, which is intended to function on impact with a very light material target, such as an airplane wing is called *supersensitive.*

c. Boresafety. In certain types of fuzes, the mechanisms are so arranged that the fuzes are said to be boresafe (detonator-safe). A boresafe (detonator-safe) fuze is one in which the explosive train is so interrupted that, while the projectile is still in the bore of the weapon, premature action of the bursting charge is prevented should any of the more sensitive elements (primer or detonator) function. The Mk 27 PD, fuze (Navy) is considered boresafe.

d. Mk 27, PD, Fuze (Navy).

(1) *Description.* This fuze is a single-action impact type designed to function with superquick action on impact with light targets (aircraft). The fuze mechanism incorporates a disk-shaped rotor-type interrupter and two centrifugally actuated plunger pins. The plunger pins are under spring tension and provide boresafety by locking the rotor (detonator holder) in the unarmed position. The firing pin is also supported by two spring-held plunger pins thus preventing it from coming in contact with the rotor.

(2) *Setting.* This fuze requires no setting or other preparation for firing.

314. Precautions in Firing

The following precautions should be closely observed to prevent injury to personnel or damage to materiel.

a. Before loading into the weapon, the ammunition and charger clips should be free of sand, mud, moisture, frost, snow, ice, grease, or other foreign matter.

b. Appropriate precautions should be observed when firing in wooded or other areas containing objects in the line of fire. In such firing, premature functioning may result should the projectile strike a branch, overhead wires, or other resistant object.

c. Cartridges which are seriously corroded should not be fired.

d. Cartridges which have badly dented cartridge cases, or those having loose projectiles, should not be used.

e. Ammunition should not be fired unless it has been identified by ammunition lot number.

f. Exercise care when loading to avoid striking the fuze or primer.

g. Misfires will be handled as indicated in SR 385–310–1.

315. Packing and Marking

a. General.

(1) Service, target-practice, and drill ammunition for the 40-mm dual automatic gun M2A1 are packed as indicated in (*a*) and (*b*) below. The data given are considered suitable for estimating weight and volume requirements.

(2) Complete data are published in Department of the Army Supply Manuals ORD 3 SNL's P–5 and P–8.

(*a*) *Cartridges packed in individual fiber containers.*

	Weight (lb)	*Volume (cu ft)*
6 rounds (1 fiber container) in wooden packing box:		
AP–T, M81; AP–T, M81A1; HE–T SD M3A1; HE–T, SD Mk 11	52.0	1.00
Overall dimensions of 6-round packing box (in.): 21¾ x 7⅝ x 10⅞		
8 rounds (1 fiber container) in wooden packing box:		
HE–T, SD Mk 11	59.0	1.27
Overall dimensions of 8-round packing box (in.): 21¾ x 13½ x 7¼		
12 rounds (1 fiber container) in wooden packing box:		
AP–T, M81; AP–T, M81A1; HE–T SD Mk 11; Drill, M17; Drill M25	89.0	1.71

	Weight (lb)	Volume (cu ft)
Overall dimensions of 12-round packing box (in.): 21⅝ x 12⅝ x 10⅞		
24 rounds (1 fiber container) in wooden packing box: AP–T, M81; AP–T, M81A1; HE–T SD Mk 11; Drill, M17	160.0	3.06
Overall dimensions of 24-round packing box (in.): 22 x 18⅛ x 13⅝		

(*b*) *Cartridges packed in charger clips.*

16 rounds (4 charger clip M1) in metal packing box: AP–T, M81; AP–T, M81A1; HEI–T, SD Mk 11; HE–T, SD Mk 11; TP–T, M91	115.0	1.70
Overall dimensions of 16-round packing box (in.): 22 x 11¾ x 11¾		
24 rounds (4 charger clip M1) in metal packing box: AP–T, M81A1	151.0	2.30
Overall dimensions of 24-round packing box (in.): 20⅝ x 17¾ x 11		

b. Marking.

(1) The information in (*a*) through (*k*) below is marked on wooden packing boxes and on metal packing boxes of 40-mm ammunition:

(*a*) Interstate Commerce Commission (ICC) shipping designation.
(*b*) Ammunition Identification Code (AIC) symbol.
(*c*) Ammunition lot number.
(*d*) Gross weight of packing box and contents.
(*e*) Cubical displacement of packing box.
(*f*) Brusting charge in projectile (if applicable).
(*g*) Date loaded.
(*h*) Descriptive nomenclature of packed item.
(*i*) Caliber and weapon designation.
(*j*) Ordnance insignia.
(*k*) Name and address of box manufacturer and date manufactured.

(2) Yellow adhesive tape is used to seal fiber containers containing HEI or HE ammunition; blue, for practice ammunition; and black, for AP ammunition.

(3) Packing boxes of practice ammunition are encircled girthwise with a 3-inch solid blue band, centrally located; outside faces of end cleats are painted blue.

Section II. COMMUNICATION SYSTEM

316. General

This section contains information for guidance of personnel responsible for operation of the communication system. It contains only the information necessary to properly identify, connect, and protect this equipment while being used or transported with the vehicle. Detailed instructions for the components of the system are contained in separate technical manuals (TM 11–286, TM 11–289, TM 11–295, TM 11–2643, and TM 11–5038).

317. Description

a. General. The communication system consists of radio set AN/VRC 8, 9, or 10, radio receiving set AN/GRR–5, intercommunication set AN/UIC–1, and interphone controls C–980/U and C–981/U. This equipment is shock mounted on mountings MT–299/GR, MT–300/GR, and MT–768/URR which are secured to support shelves on the hull right side wall in the driving compartment (fig. 368). The principal components of the communication system are listed in table XIII.

Table XIII. Components of Radio Sets AN/VRC 8, 9, and 10, Radio Receiver AN/GRR–5, and Intercommunication Set AN/UIC–1

	AN/ VRC–8	AN/ VRC–9	AN/ VRC–10	AN/ GRR–5	AN/ UIC–1
RECEIVER-TRANSMITTER RT–66/ GRC (A Set).	X				
RECEIVER-TRANSMITTER RT–67/ GRC (A Set).		X			
RECEIVER-TRANSMITTER RT–68/ GRC (A Set).			X		
AM-AMPLIFIER AM–65/GRC (Interphone Amplifier).					X
POWER SUPPLY PP–112/GR	X	X	X		
POWER SUPPLY PP–308/URR				X	
MOUNTING MT–299/GR	X	X	X		
MOUNTING MT–300/GR					X
MOUNTING MT–768/URR				X	
INTERPHONE CONTROL C–980/U	X	X	X		
INTERPHONE CONTROL C–981/U	X	X	X		
CONTROL BOX C–375/VRC	X	X	X		X
LOCAL CONTROL C–434/GRC	X	X	X		
RADIO RECEIVER R–174/URR				X	
ELECTRICAL EQUIPMENT CABINET CY–615/URR.				X	

Figure 368. Communication system components—driving compartment.

b. Radio Sets (fig. 368). The basic radio set AN/VRC–8, 9, or 10 (TM 11–286) consists of receiver-transmitter RT–66/GRC, RT–67/GRC, or RT–68/GRC respectively, power supply PP–112/GR, and mounting MT–299/GR.

(1) *Receiver-transmitter* (fig. 368). The receiver-transmitters RT–66/GRC, RT–67/GRC, or RT–68/GRC (TM 11–289) are compact, light-weight radio sets for reception and transmission of fm (frequency-modulated) signals. These receiver-transmitters are identical in appearance and function, and differ only in their operating frequency ranges. They provide intervehicles radio communication.

(2) *Power supply PP–112/GR* (fig. 368). The power supply PP–112/GR is a vibrator type and receives power from the vehicle 24-volt electrical system.

(3) *Mounting MT–299/GR* (fig. 369). The mounting MT–299/GR (TM 11–268) is shock mounted on the communication equipment support shelves and serves as a support for the receiver-transmitter, RT–66/GRC, RT–67/GRC, or RT–68/GRC, power supply PP–112/GR, and also as a junction box for interconnecting this equipment. Locking levers are provided on the front edge of the mounting to secure the transmitter-receiver and power supply.

c. Radio Receiving Set AN/GRR–5 (fig. 368). The radio receiving set AN/GRR–5 (TM 11–295) consists of radio receiver R–174/URR, power supply PP–308/URR, and electrical equipment cabinet. The equipment is secured on mounting MT–768/URR and can be used as a conventional radio system or in conjunction with communication set AN/UIC–1 (*d* below) for a particular system.

(1) *Radio receiver R–174/URR* (fig. 368). This 8-tube superheterodyne receiver is used for the reception of am (amplitude-modulated) or cw (continuous wave) signals with a frequency range of 1.5—18 mc (megacycles). The receiver is powered by power supply PP–308/URR (TM 11–295) and is secured in electrical equipment cabinet CY–615/URR by four latches located on the sides of the case.

(2) *Power supply PP–308/URR* (fig. 368). This power supply is operated to supply dc (direct-current) voltages for radio-receiver R–174/URR and is secured in the electrical equipment cabinet CY–615/URR by four latches along the sides of the case.

(3) *Electronic equipment cabinet CY–651/URR* (fig. 368).

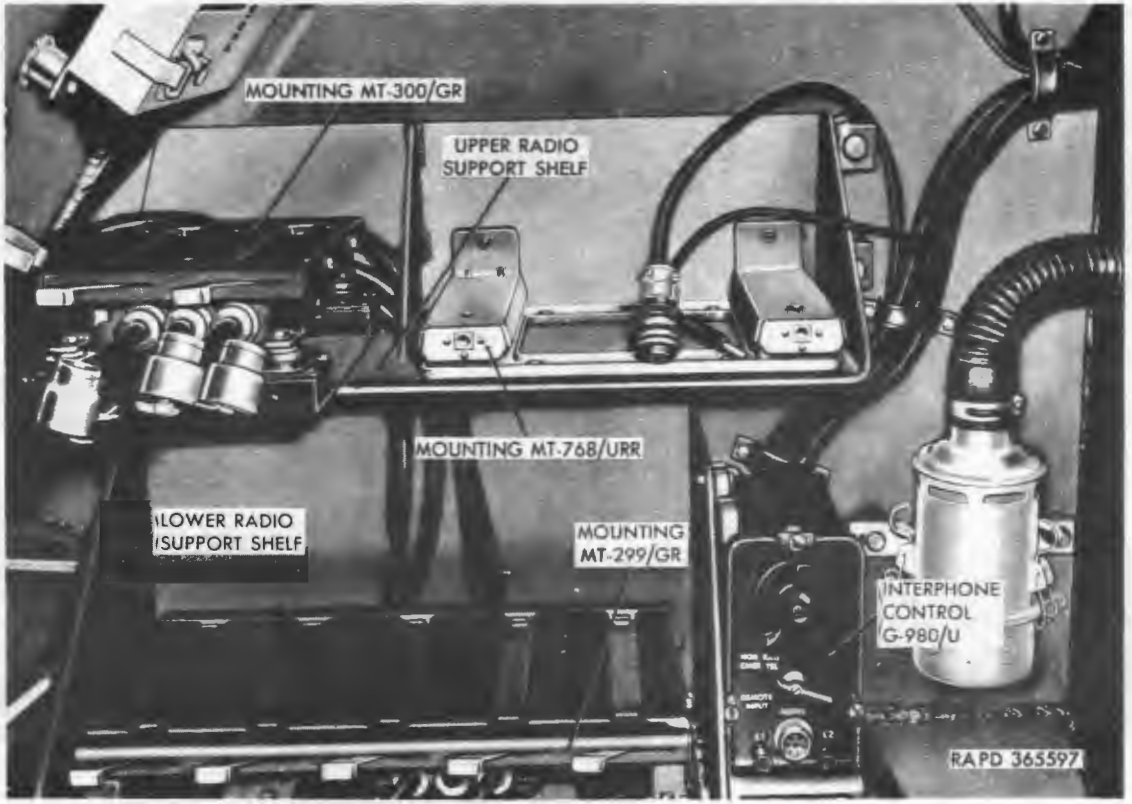


Figure 369. Mountings MT–299/GR, MT–300/GR, MT–768/URR and radio support shelves.

This cabinet consists of two sections, one above the other, to provide housing for radio receiver R–174/URR and power supply PP–308/URR. Each section of the cabinet is equipped with two channels secured across their depth to provide support for the receiver and power supply. The cabinet is equipped with electrical receptacles and interconnecting cables to connect the radio receiver and power supply. Two channels across the bottom width of the cabinet engage with the supports on mounting MT–768/URR and are secured with two knurled mounting screws.

(4) *Mounting MT–768/URR* (fig. 369). This mounting provides a support for the radio receiving set AN/GRR–5 and is located on the upper radio support shelf. Two supports are provided across the width of this mounting, to secure the electrical equipment cabinet CY–615/URR of the radio receiving set AN/GRR–5.

d. Intercommunication Set AN/UIC–1. The intercommunication set AN/UIC–1 (TM 11–2643) is a combination of AF am-

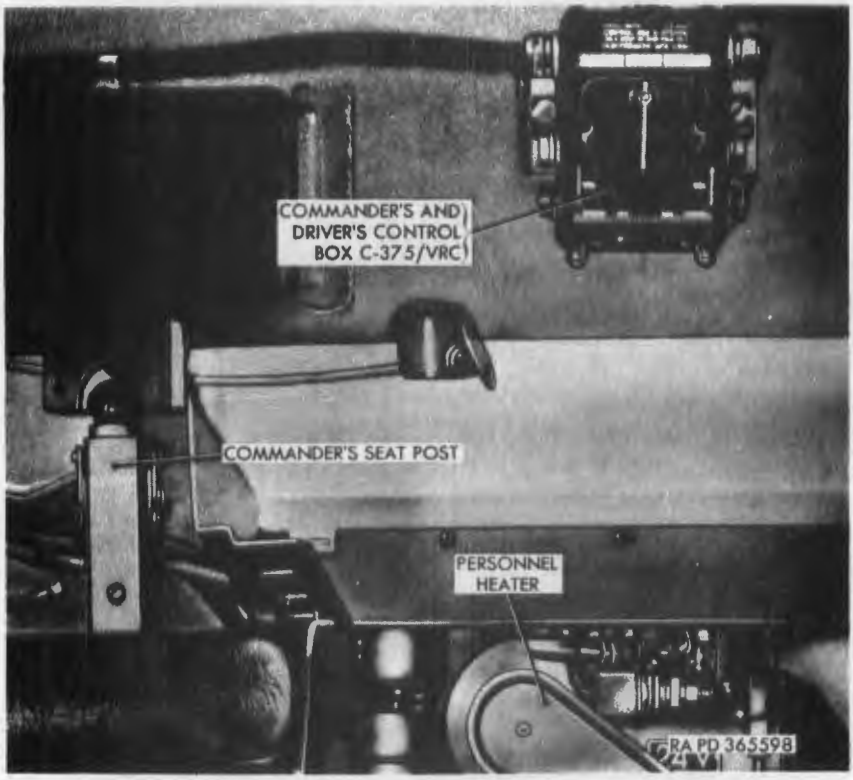


Figure 370. Commander's and driver's control box C–375/VRC.

plifier AM–65/GRC (fig. 368), mounting MT–300/GR (fig. 369), and 3 control boxes C–375/VRC (figs. 370, 371, and 372) to provide remote control and 3-way switching for plug-in audio accessories.

(1) *AF amplifier AM–65/GRC* (fig. 368). The AF amplifier AM–65/GRC is a 7-tube 3-channel AF (audio-frequency) amplifier and electronic mixer. It provides interphone operation and radio monitoring with the use of receiver-transmitter RT–66/GRC, RT–67/GRC, or RT–68/GRC and radio receiver R–174/URR in conjunction with the control box C–375/VRC. This amplifier is supported in mounting MT–300/GR which is secured to the upper radio support shelf in the driving compartment.

(2) *Mounting MT–300/GR* (fig. 369). This mounting provides a shockproof support for AF amplifier AM–65/GRC and is provided with locking levers which secure the amplifier in the mounting channels. A junction box

Figure 371. Right gunner's and loader's control box C–375/VRC.

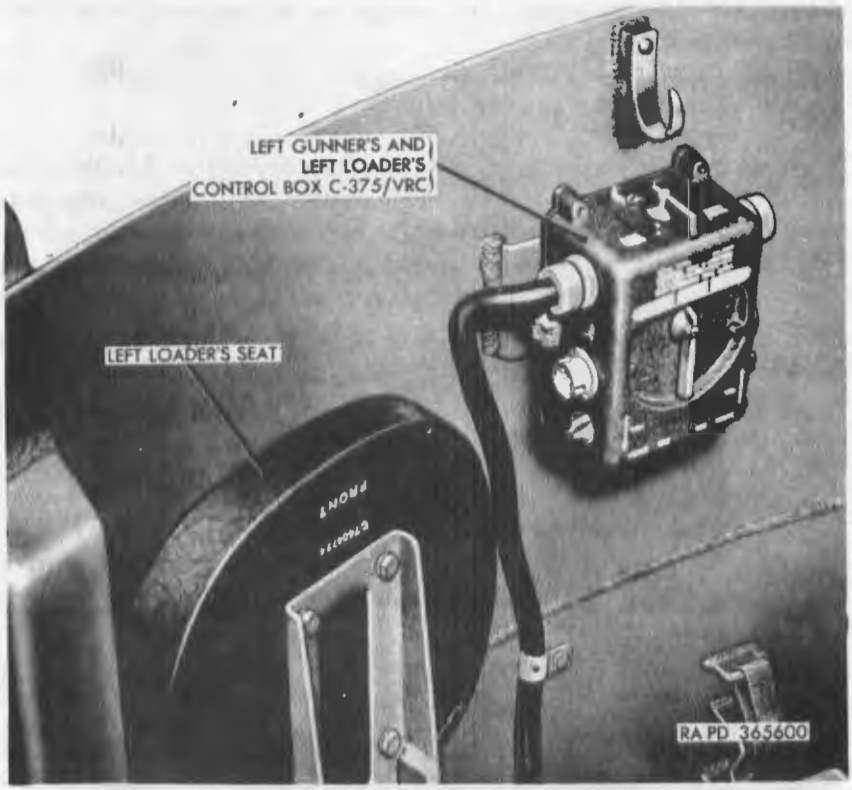


Figure 372. Left gunner's and loader's control box C–375/VRC.

providing eight cable outlets is attached to the bottom of the mounting. This junction box with interconnecting cables provides facilities for connecting the units of the intercommunication set AN/UIC–1.

e. Control Box C–375/VRC. Three control boxes C–375/VRC are used for control of the A set or the interphone amplifier. These boxes are equipped with a main control switch to select the desired radio and interphone facilities. A spring loaded radio-transmitter switch is located on top of the box.

(1) One control box (fig. 370) is mounted on a bracket secured to the gun mount ring shield in the driving compartment for use by the commander and driver.

(2) One control box (fig. 371) is mounted on a bracket secured to the right side of the gun protective shield for use by the right gunner and loader.

(3) One control box (fig. 372) is mounted on a bracket secured to the left side of the gun mount protective shield for use by the left gunner and loader.

f. Interphone Controls C–980/U and C–981/U. The interphone

controls are used to provide telephone communication between local control stations.

(1) Interphone control C–980/U (figs. 368 and 369) is located on the lower radio support shelf.

(2) Interphone control C–981/U (fig. 373) is located in the right rear corner of the engine compartment with access through a waterproof off carriage and trailer outlet door (fig. 374) at the rear of the vehicle.

g. Cable WM–46/U. This cable is used to interconnect the junction boxes on mounting MT–299/GR and MT–300/GR, the vehicle's radio terminal boxes, and interphone controls C–980/U and C–981/U.

h. Local Control C–434/GRC. The local control C–434/GRC is a component of control group AN/GRA–6 and is used to provide interphone communications in conjunction with other components of the intercommunications system (TM 11–5038).

i. Antenna (fig. 375). Two antennae are used with radio sets AN/VRC–8, 9, or 10. One antenna is mounted on each right and left gunner's shield. These antennae differ in length dependent on usage with different radio sets.

Note. When both radios are installed in the vehicle, one antenna is required to be longer than the other. If the antenna leads are not consistant in

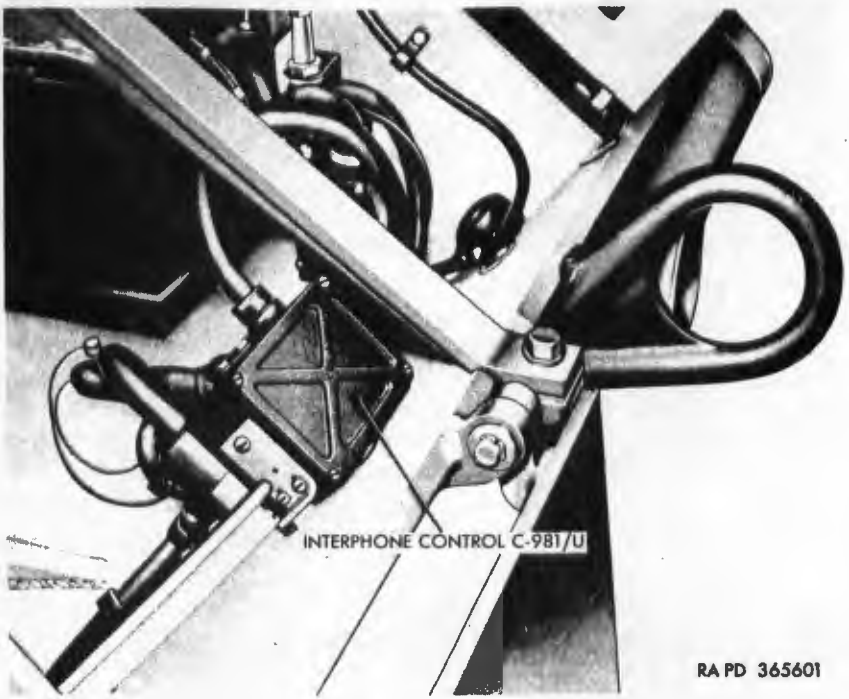


Figure 373. Interphone control C–981/U—engine compartment view.

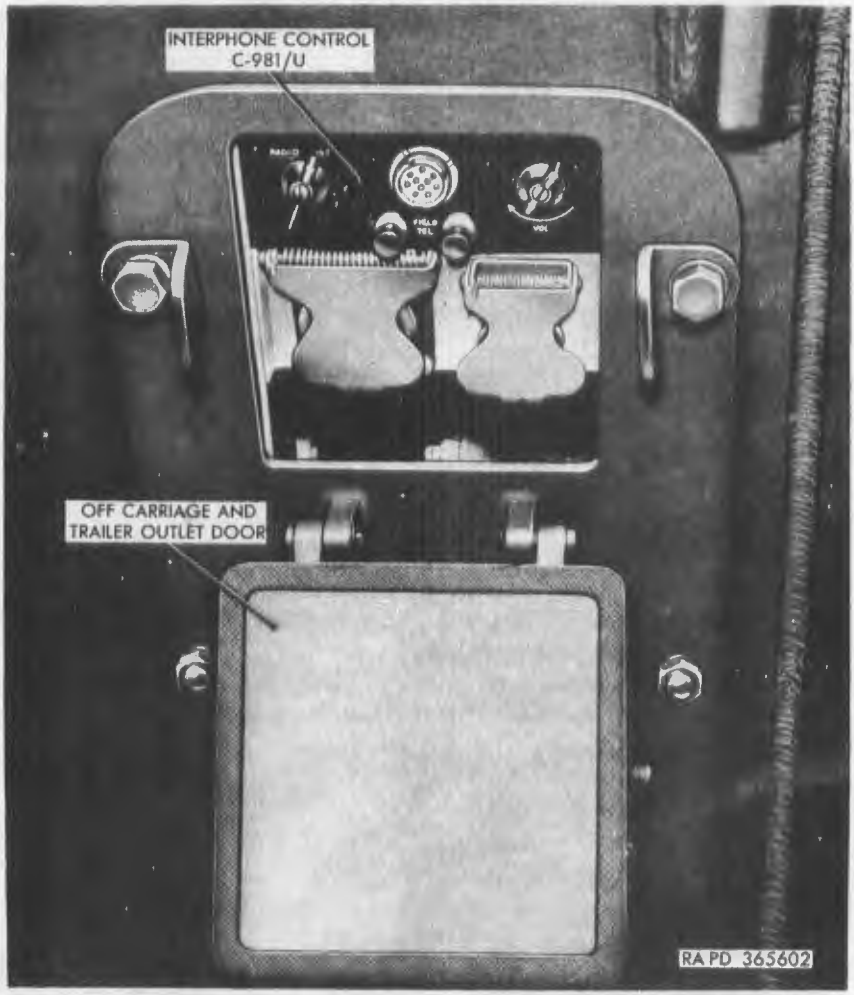


Figure 374. Interphone control C–981/U—access door open.

any two vehicles, the long antenna will appear on one side of one vehicle while the same length antenna will appear on the opposite side of the second vehicle. If a field fix is necessary, the antenna leads may be reversed at the top of the slip ring box and a consistant pattern obtained with other vehicles.

(1) For each antenna in installation of radio sets AN/VRC–8 and 9, one antenna mast section (MS–116–A, MS–117–A, and MS–118–A) is used with mast base AB–15/GR.

(2) For each antenna in installation of radio set AN/VRC–10, one antenna mast section (MS–117–A, AB–24/GR) is used with mast base AB–15/GR.

318. Removal

a. Radio Set AN/VRC–8, 9, or 10 and Intercommunication Set

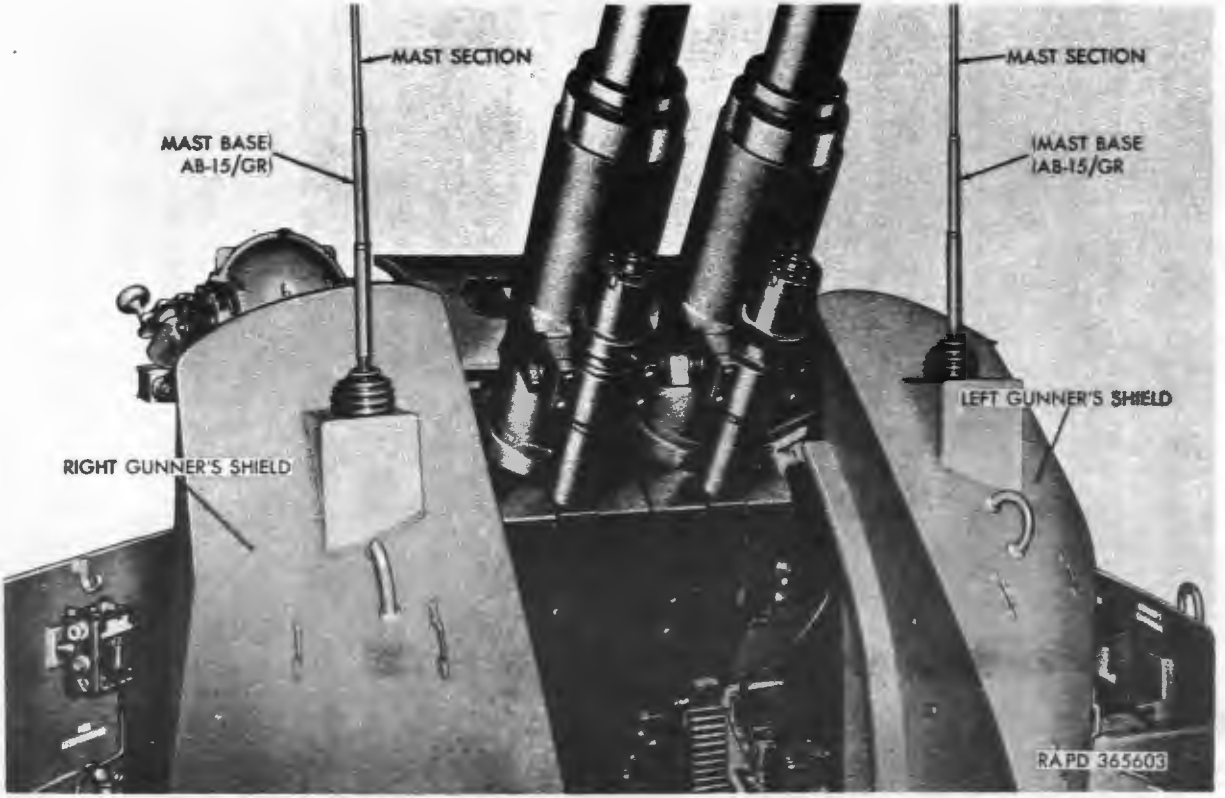


Figure 375. Antennae installed on gunner's shields.

AN/UIC–1. Check that master relay switch is in the OFF position. To remove the principal components located on top of mountings MT–299/GR and MT–300/GR (fig. 369), disconnect the antenna lead-in cables at the radio set. Disconnect the cables leading to the terminal boxes under the mountings by removing the connector plugs from receptacles on the front panels of the components. Release the locking devices on the front top of the mountings and remove the components. To remove the mountings from the vehicle, disconnect all cable plugs that interconnect the mountings with the other components. Remove cable clamps securing the cables to the vehicle. Remove the screws at the top edges of the mountings and then remove the top plate making accessible the screws which secure the shock mount adapter plates to the vehicle. Remove these screws, coil the cables attached to the mountings, and withdraw equipment from the vehicle. To remove control boxes C–375/VRC, disconnect the pin-and-socket connectors on the cables joining with the other components in the vehicle. Remove cable clamps, two cap screws, and spacers that secure each control box (fig. 370) to their mounting brackets. Remove the control boxes with cables attached.

b. Radio Receiving Set AN/GRR–5. To remove the principal components located on mounting MT–768/URR (fig. 369), disconnect the antenna lead-in cable, the power cable, and the audio cable from the front panel of the radio set. Unscrew the two knurled knobs at the lower front edge of the radio set and remove the case from the mounting. Remove the screws securing the mounting to the vehicle and take out the mounting.

c. Interphone Controls C–980/U and C–981/U. To remove interphone control C–980/U (fig. 369), disconnect the two cables leading to the other components by unscrewing the plug-locking screws and removing the connectors from the front panel receptacles. Disconnect the two telephone wire leads from the binding posts on the same panel. Remove the cap screws that secure the interphone control C–980/U to the mounting bracket and remove the control from the vehicle. To remove interphone control C–981/U (fig. 373), remove the two cap screws securing the control to the hull rear plate. Remove the cover of the unit and disconnect the eight cable terminals from the terminal strip. A diagram should be made of the hookup before it is disconnected so that it can be installed correctly.

319. Installation

For installation, refer to Signal Corps Installation Instructions, Signal Corps Stock No. 6D12909–VII7.

Section III. SUBCALIBER GUN

320. General

Subcaliber equipment is used for training purposes only and is not to be taken into the theater of operations. It consists of cal..50 subcaliber mount M19 (figs. 376 and 377) and a fixed heavy barrel, cal..50 Browning machine gun M2 (fig. 378). Subcaliber equipment provides practice in laying and firing the 40-mm automatic dual gun materiel. While the actual handling, loading, and range are different, the results obtained in elevating, traversing, sighting, and similar operations are adequate for instructional purposes. Refer to FM 23–65 for further information on the machine gun. Refer to paragraphs 55 through 62 for sighting and fire control instruments and boresighting instructions and to FM 23–65 for ammunition used with this subcaliber gun. Refer to ORD 7 SNL A–77 for replacement parts for mount M19 (par. 326).

321. Description

The cal..50 Browning machine gun M2, heavy barrel, fixed, is mounted on the subcaliber mount M19 (fig. 378). The cal..50 subcaliber mount M19, in turn, is installed in the left-hand breech casing of the 40-mm automatic dual gun M2A1 in place of the left automatic loader assembly. The ammunition box (fig. 378), located on the left side of the mount, holds 40 rounds of linked ammunition for the machine gun. Actuating the firing linkage of the 40-mm gun operates the firing linkage of the subcaliber mount to fire the cal..50 machine gun single shot. The empty cartridge cases fall into the clip collecting bag while the links are ejected through the ammunition chute (fig. 376) into the bag. A boresight hole (fig. 376) in the mount coincides with the line of the bore of the 40-mm gun.

322. Installation

a. Removal of Automatic Loader Assembly. Refer to paragraph 282*f*.

Note. Boresight 40-mm dual gun (par. 58*d*) before removing automatic loader assembly.

b. Installing Cal..50 Subcaliber Mount M19. Place the front guides of the mount in the automatic loader guideways of the breech casing (fig. 379) and slide the mount forward until the mount retaining bolt hole coincides with the hole for the automatic loader retaining screw. Install the mount retaining self-locking bolt (fig. 380).

Note. Be sure the firing rod latch lever and latch (fig. 384) are positioned correctly before securing mount in place.

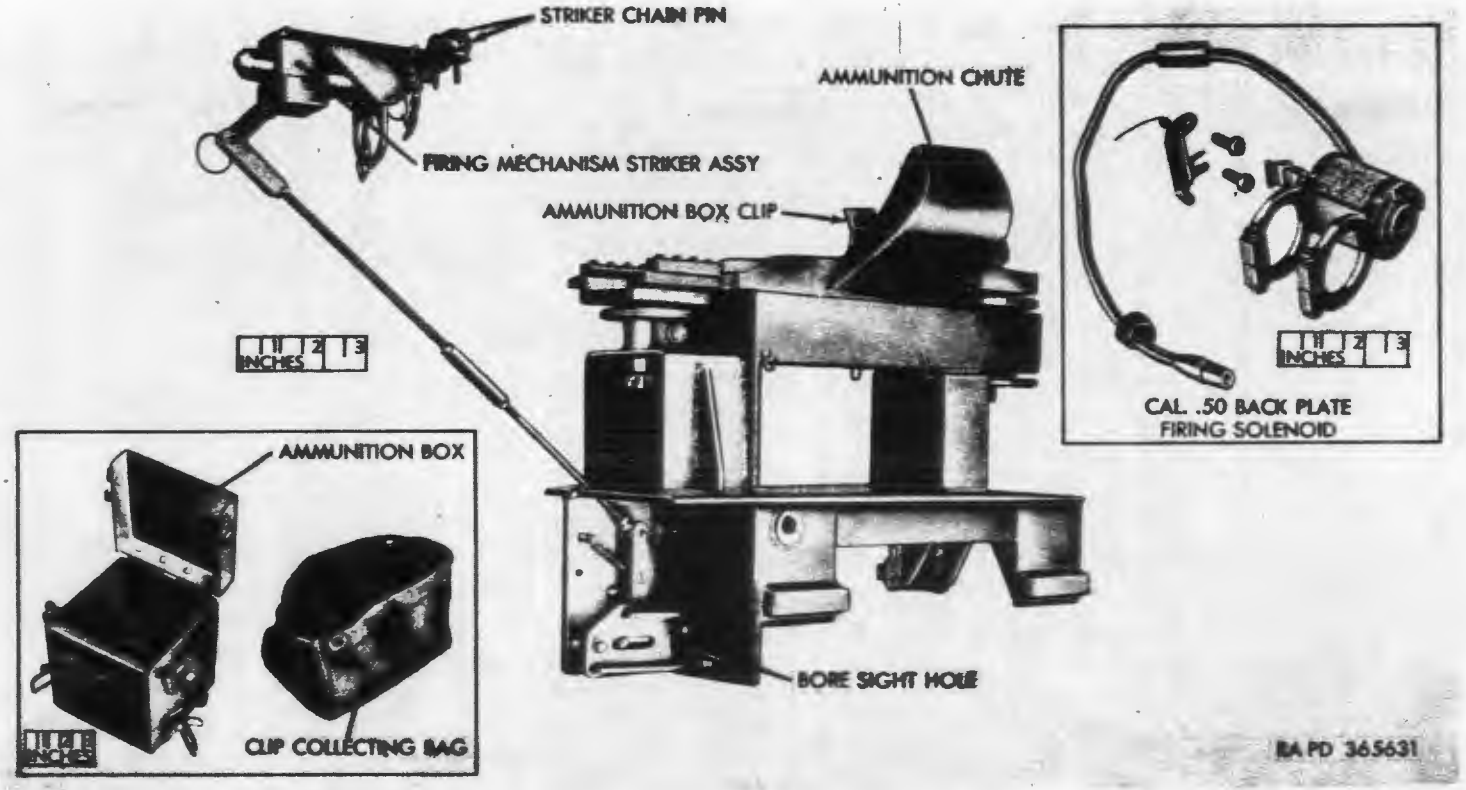


Figure 876. Cal..50 subcaliber mount M19, with firing solenoid—left rear view.

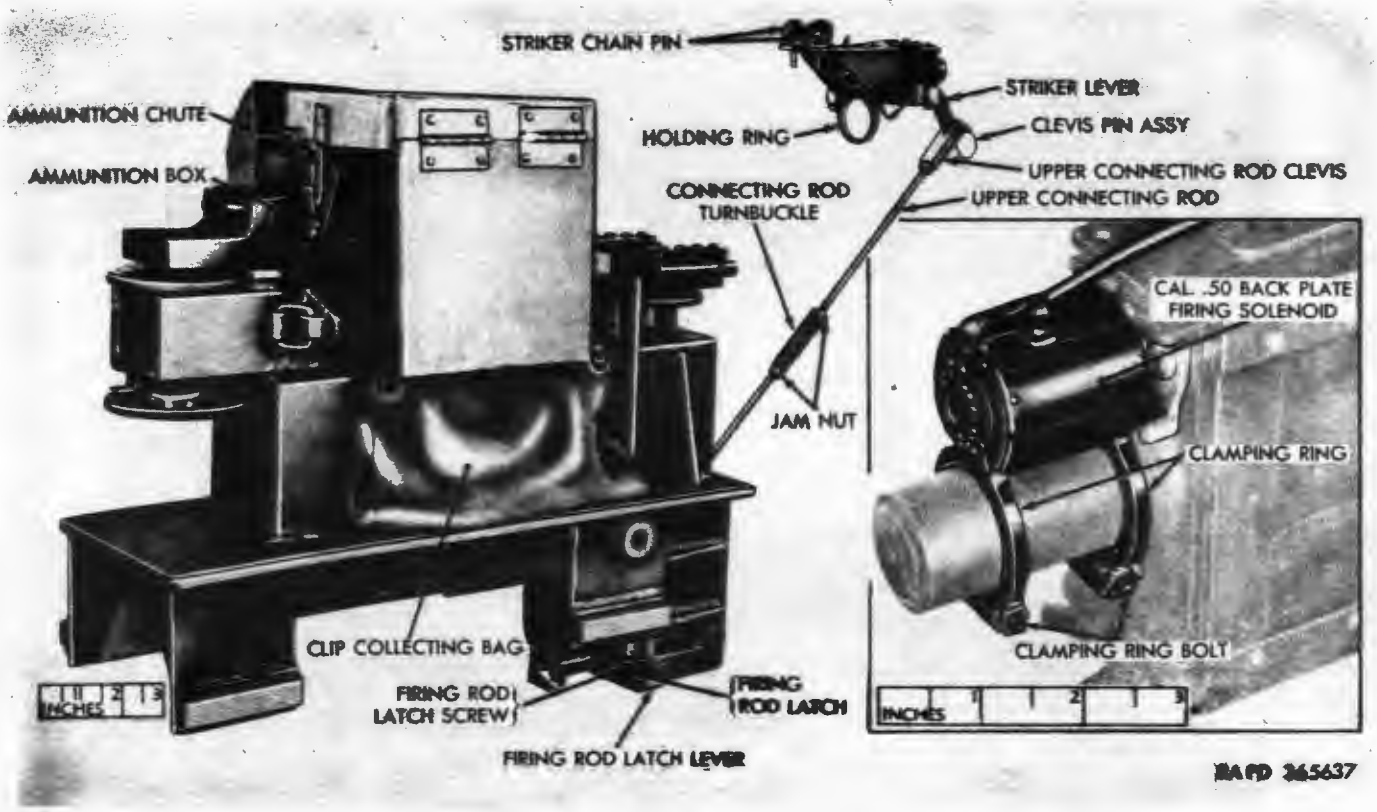


Figure 377. Cal..50 subcaliber mount M19—right front view.

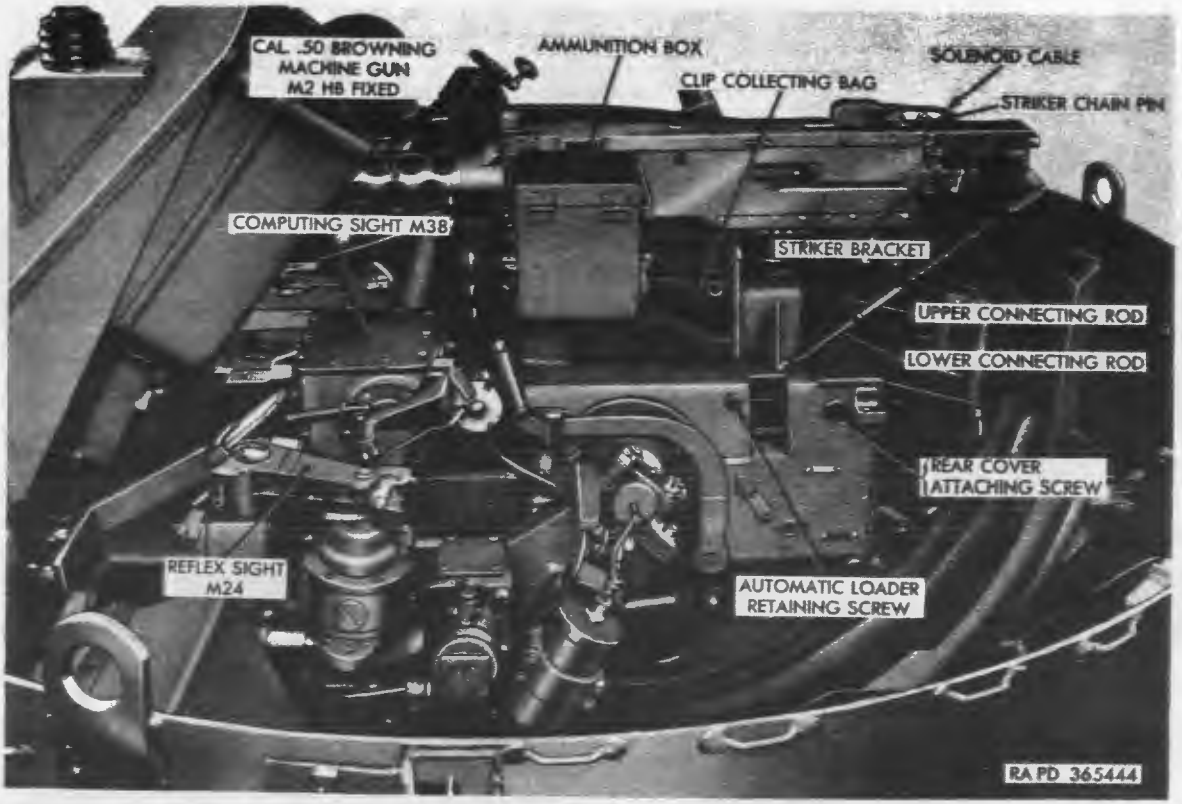


Figure 378. Subcaliber mount M19 with cal..50 M2 heavy barrel machine gun installed.

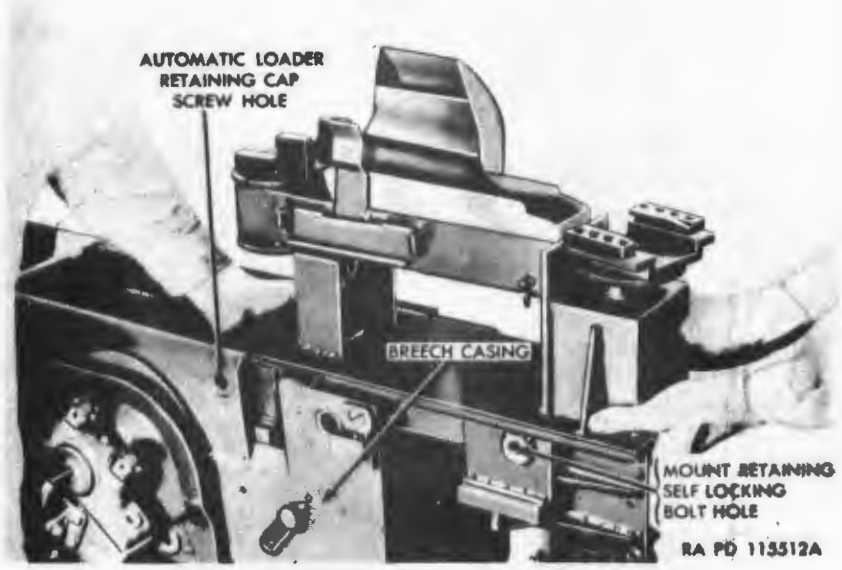


Figure 379. Installing the subcaliber mount in the breech casing.

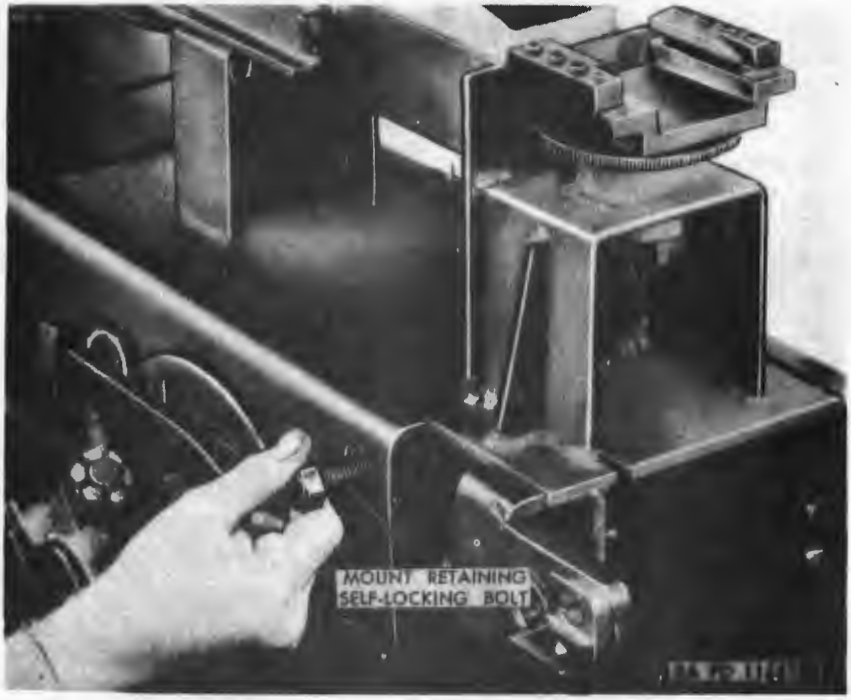


Figure 380. Securing the subcaliber mount to the breech casing.

c. Installing cal..50 M2 Heavy Barrel Machine Gun.

Caution: Before handling and installing cal..50 machine gun, make sure it is not loaded.

Lift the gun by holding it at the rear by the receiver and at the front by the barrel support (fig. 381).

Caution: Do not hold by the gun barrel.

Hold the gun over the vertical adjustment yoke and horizontal adjustment block and lower the rear of the gun until the rear gun securing pin, on the underside of receiver, rests on the horizontal adjustment block (fig. 381). Ease the gun backward until the securing pin drops to the level of the horizontal slot in the block and engage the pin in the slot by moving the gun forward. Simultaneously, lower the front of the gun until the hole in forward end of the receiver is in line with the holes in the vertical adjustment yoke (fig. 382). Press the gun securing pin latch and insert the gun securing pin (fig. 382) in the yoke, using a twisting motion, until the latch enters the slot under the knurled head of the pin when released.

d. Installing Firing Solenoid.

Caution: Before mounting and adjusting firing solenoid, make sure machine gun is not loaded.

Remove the backplate of the machine gun and the pin holding the backplate filler piece in the window of the backplate and remove the piece; install the backplate on the machine gun (FM 23–65). Mount the solenoid locking clamp on the backplate of the gun with two locking clamp screws so that the clamp spring bears on the backplate buffer tube (fig. 383). Loosen the bolts on the solenoid clamping rings and slide the rings over the backplate buffer tube. Depress the locking clamp with the right thumb, raise the trigger bar lifter with the left index finger, and slide

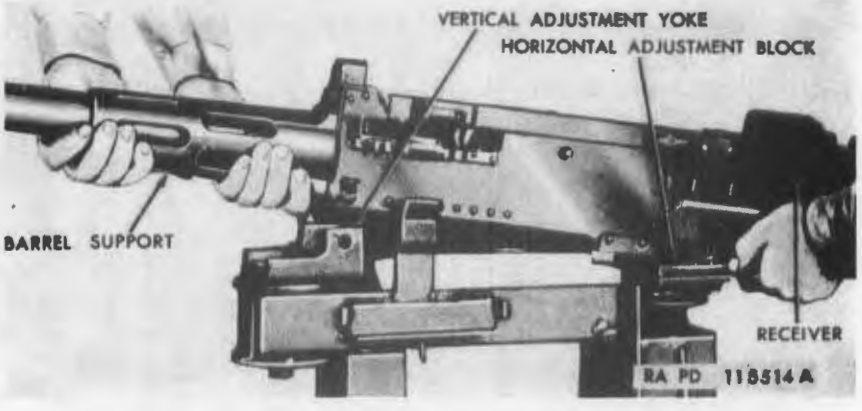


Figure 381. Installing cal..50 machine gun on the subcaliber mount.

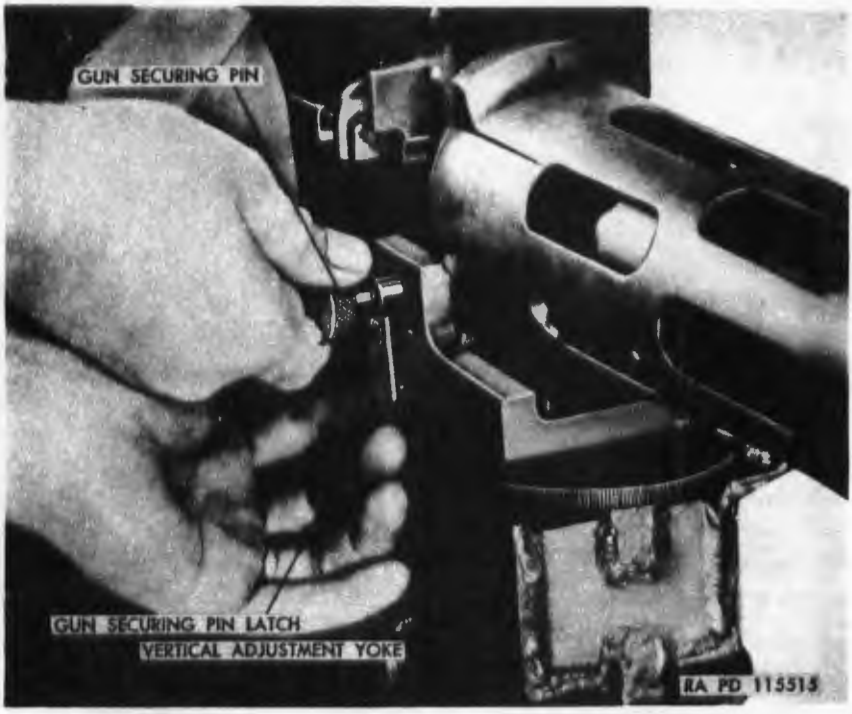


Figure 382. Inserting gun securing pin in vertical adjustment yoke.

the solenoid forward until the locking clamp enters the slot in the solenoid case (immediately behind the trigger bar lifter) when released. Aline the solenoid case approximately with the center of the backplate window and tighten the clamping ring bolts (fig. 377).

e. Installing Firing Mechanism Striker Assembly. Slide the holding ring (fig. 377) of the striker bracket over the backplate buffer tube of the machine gun so that the bracket straddles the solenoid cable (fig. 378). Insert the bracket between the two flanges on the backplate of the gun so that the holes in the bracket are in line with the holes in the flanges and insert the two striker chain pins (fig. 378).

f. Installing Firing Linkage. Rotate the firing rod latch lever (fig. 377) until the firing rod of the 40-mm dual gun engages in the lever slot, then slide the firing rod latch over the slot and firing rod, and tighten the firing rod latch screw (fig. 377). Hook the projecting pins from the lower connecting rod (fig. 384) into the slots in the firing operating lever, tighten the adjusting nut enough to prevent the connecting rod from becoming disengaged or from having too much play, and tighten the locking nut against the adjusting nut to prevent turning. Raise the lower connecting

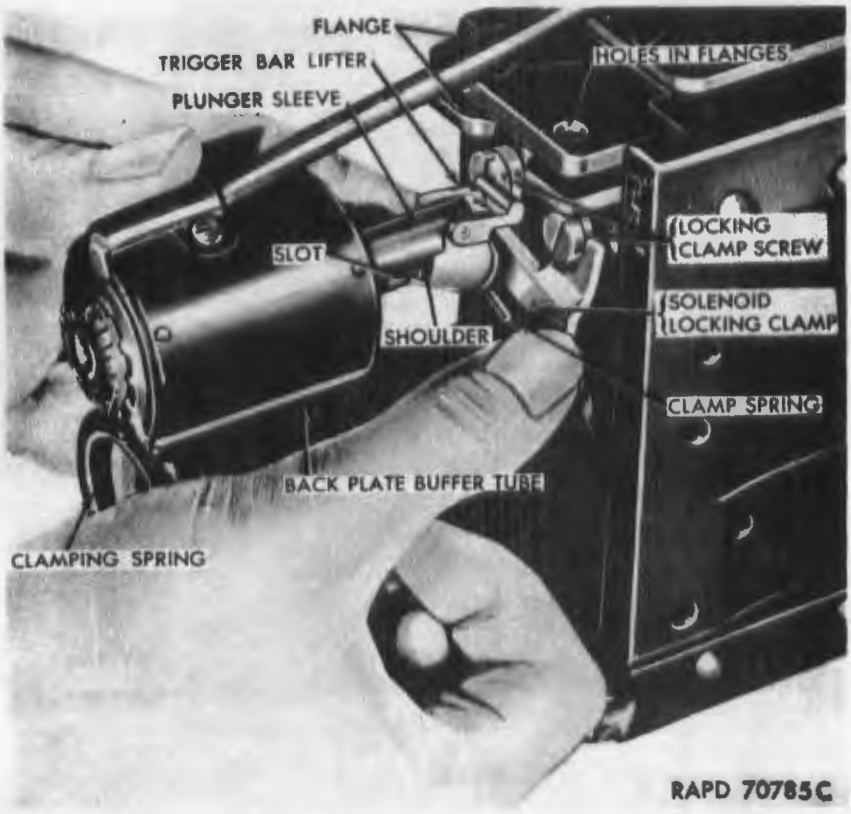


Figure 383. Installing firing solenoid.

rod through the slot in the subcaliber mount (fig. 384) until the striker lever (fig. 377) enters the connecting rod clevis. Aline the holes in the clevis with the hole in the lever and insert the clevis pin assembly (fig. 377). If the connecting rod is too long or too short, loosen the jamnuts at each end of the turnbuckle (fig. 377), rotate the turnbuckle until the proper length is obtained and tighten the jamnuts.

g. Closing Covers of 40-mm Dual Gun. Close and lock side cover. Raise the cover and secure. Swing cartridge case deflector into place and secure with cartridge case deflector pin (par. 282*h*).

h. Boresighting and Adjustment.

(1) Remove backplate, driving rod and springs, and bolt assembly (FM 23–65).

(2) Open the breech of the 40-mm gun and utilizing the muzzle boresight in the 40-mm gun and subcaliber mount M19 boresight hole (fig. 376) aline the 40-mm gun barrel

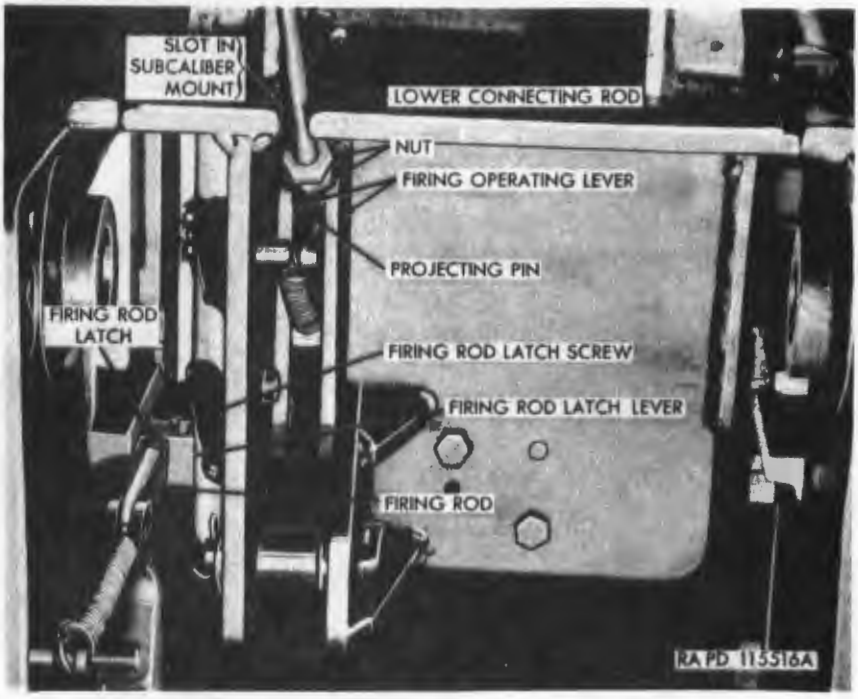


Figure 384. Connecting firing linkage of subcaliber mount to 40-mm dual gun M2A1.

with the well defined target used in boresighting (par. 58*d*(6)).

(3) Sighting through the bore of the cal..50 machine gun barrel aline the gun with the same aiming point used in boresighting.

(*a*) To adjust the subcaliber gun in elevation remove the cotter pins which lock the upper and lower vertical adjustment handwheels (fig. 385) to the mount clips. Loosen the lower vertical adjustment handwheel (A, fig. 385) several turns and adjust the upper vertical adjustment handwheel (B, fig. 385) until the correct elevation is obtained. Tighten the lower handwheel and install the cotter pins through the handwheels and mount clips (fig. 385).

(*b*) To adjust the subcaliber gun in azimuth (fig. 386), remove the cotter pin which locks the horizontal adjustment handwheel to the mount clip, adjust the handwheel until the correct azimuth is obtained, and install the cotter pin.

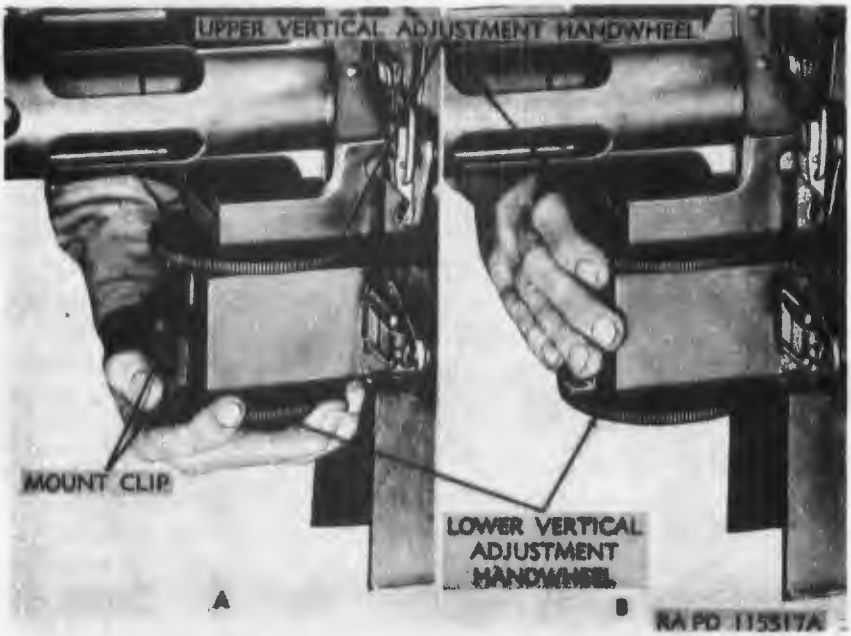


Figure 385. Adjusting subcaliber gun in elevation.

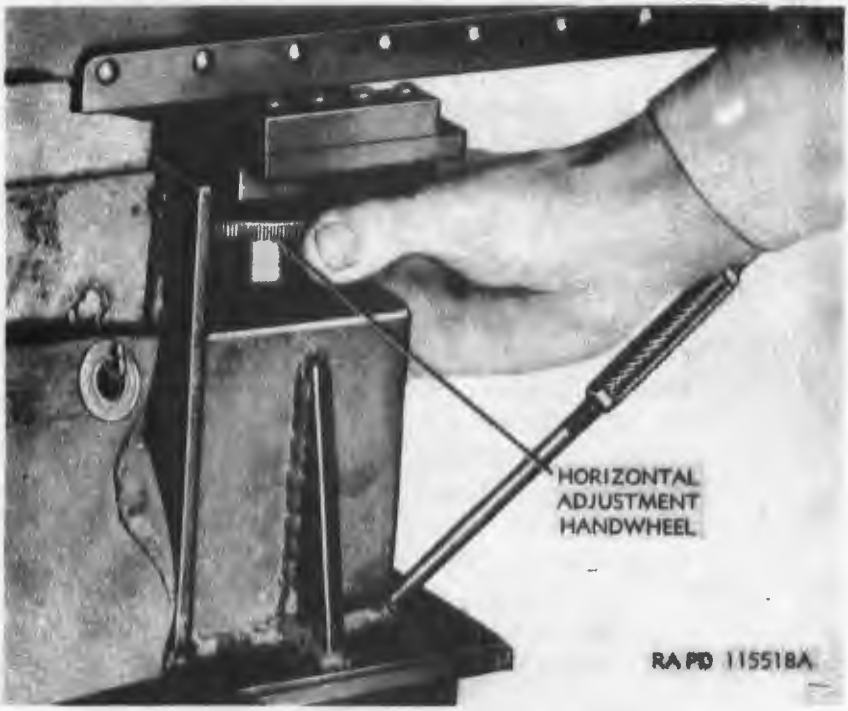


Figure 386. Adjusting subcaliber gun in azimuth.

(4) Before attempting to adjust the firing solenoid, the cal..50 machine gun must be adjusted for head space and proper timing (FM 23–65).

(*a*) To adjust the solenoid, rotate the adjusting cap (fig. 387) clockwise, toward minimum, as far as it will go, then rotate counterclockwise, toward maximum, one and one-half turns. Charge the machine gun and actuate the firing linkage of the 40-mm dual gun. If the firing pin is not released, rotate the adjusting cap an additional notch counterclockwise. Repeat charging the gun, actuating firing linkage, and rotating the adjusting cap toward maximum, a notch at a time, to the first setting at which the solenoid will release the firing pin.

(*b*) Using one of the adjusting cap pins (fig. 387) as an index, note its clock-hour setting. Repeat charging the gun, actuating firing linkage, and rotating the adjusting cap counterclockwise toward maximum, a notch at a time, until the last clock-hour setting at which the solenoid will release the firing pin is noted, then rotate the adjusting cap clockwise toward minimum, one-half the number of settings at which the firing pin is released. (Example: If the first setting at which the

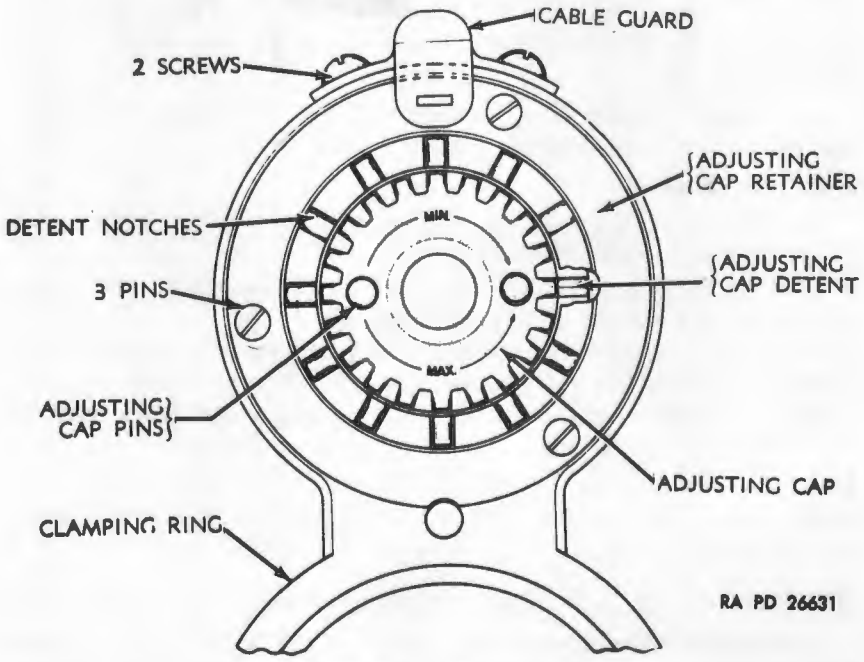


Figure 387. Solenoid adjusting cap.

firing pin is released is 3 o'clock and the last setting 9 o'clock, a total of six settings, move the cap toward the minimum three notches, namely 12 o'clock.)

Note. During this adjustment, it is necessary to retract the retracting slide handle of the machine gun before each attempt to release the firing pin.

(*c*) Check the final adjustment by charging the gun and inserting a 0.020-inch gage between the trunnion block and barrel extension and actuating the firing linkage once. The firing pin must be released. Insert a 0.116-inch gage between the block and extension and actuate the firing linkage once. The firing pin must not be released.

323. Operation

a. Loading. Release the two upper latches on the ammunition box and lift open cover. Fold in 40 rounds of cal..50 linked ammunition, starting with the single-loop end of the belt, so that the projectile is pointing toward the muzzle of the gun. With the machine gun cover closed, feed the double-loop end of the belt through the feed opening of the gun until the first cartridge is beyond the belt holding pawl. Fully retract the bolt and allow to go forward freely twice. Close the ammunition box cover and fasten the latches.

b. Sighting. Crew training with the subcaliber gun can be accomplished up to approximately 800 yards by use of the reflex sight M24C (fig. 378).

c. Firing. Actuate firing linkage of the 40-mm dual gun M2A1. Automatic fire is not possible with this equipment.

d. Unloading.

Caution: Before unloading, remove the clevis pin assembly (fig. 377) from the connecting rod clevis and striker lever, the two striker chain pins (holding the striker to the machine gun), and the striker to place the gun in safe position.

Lift the gun cover, raise the extractor, and remove the ammunition belt. Lower the extractor, retract the bolt sufficiently to remove the round in the chamber, and make a visual inspection of the freeway T-slot to make sure the gun is unloaded. Release the bolt and close the gun cover. When certain the gun is unloaded, install the striker and depress the firing pedal to relieve compression of the firing pin spring of the gun.

324. Removal of Subcaliber Gun and Mount

a. Removing Ammunition Box and Clip Collecting Bag. Release the two lower latches holding the box to the mount and remove

the ammunition box (fig. 378) from the clip. Unhook the clip collecting bag (fig. 378) from the four hooks on the mount and remove the bag.

b. Opening Covers of 40-mm Dual Gun. Unlock and open side cover (par. 282*f*). Remove the cartridge case deflector pin and lower the deflector (par. 282*f*). Remove the rear cover attaching screw and lower the rear cover.

c. Removing Firing Linkage. Remove the clevis pin assembly to separate the firing linkage from the striker lever (fig. 377). Loosen the two nuts holding the lower connecting rod (fig. 384) to the firing operating lever and remove the rod. Loosen the firing rod latch screw (fig. 384) and slide the firing rod latch so that the latch lever disengages from the 40-mm gun firing rod.

d. Removing Firing Mechanism Striker Assembly. Remove the two striker chain pins (fig. 378) holding the striker bracket to the gun and remove the bracket and striker assembly.

e. Removing the Firing Solenoid. Loosen the bolts on the solenoid clamping rings (fig. 377), depress the solenoid locking clamp, and slide the solenoid from the backplate buffer tube (fig. 383). If necessary, remove the two locking clamp screws from the backplate to remove the solenoid locking clamp (fig. 383); then remove the backplate from the gun, and install the backplate filler piece, pin, and backplate (FM 23–65).

f. Removing the Machine Gun. Press the gun securing pin latch (fig. 382), and remove the securing pin from the vertical adjustment yoke, using a twisting motion. Hold the gun at the rear by the receiver and at the front by the barrel support.

Caution: Do not hold by the barrel.
Lift the front of the gun until clear of the yoke, then slide the gun backward until the gun securing pin disengages from the horizontal adjustment block, and remove gun.

g. Removing the Subcaliber Mount. Remove the mount retaining screw (fig. 386) and slide the mount from the breech casing.

h. Installing Automatic Loader Assembly. Follow the instructions in paragraph 282*h*.

325. Malfunctions and Corrections

a. Gun Fails to Fire When Firing Linkage of 40-mm Dual Gun Is Actuated. Solenoid may not be properly seated on the buffer tube of the machine gun. Loosen the clamping ring bolts (fig. 377), depress the solenoid locking clamp, and slide the solenoid forward until the locking clamp enters the slot in the solenoid plunger sleeve when released. Aline the solenoid case in the center

of the backplate window of the gun and tighten the bolts in the clamping rings. If this does not correct the malfunction, check firing linkage of 40-mm dual gun for loose or damaged parts.

b. Links Jam in the Link Stripper or at the Mouth of the Ammunition Chute. Lift gun cover, remove jammed links, close cover, charge gun, and resume firing.

c. Firing Pin Fails to Release. Adjust solenoid as instructed in paragraph 322*g*.

326. Ammunition

Refer to FM 23–65 for ammunition used for the subcaliber gun.

327. Organizational Spare Parts, Tools, and Equipment

Organizational spare parts, tools, and equipment supplied for the fixed, heavy barrel, cal..50 Browning machine gun M2 are listed in Department of the Army Supply Manual ORD 7 SNL A–39. Organizational spare parts, tools, and equipment supplied for cal..50 subcaliber mount M19 are listed in ORD 7 SNL A–77. Packing box 7212402 (fig. 388) has been specially designed for storing the cal..50 subcaliber mount M19 when not in use.

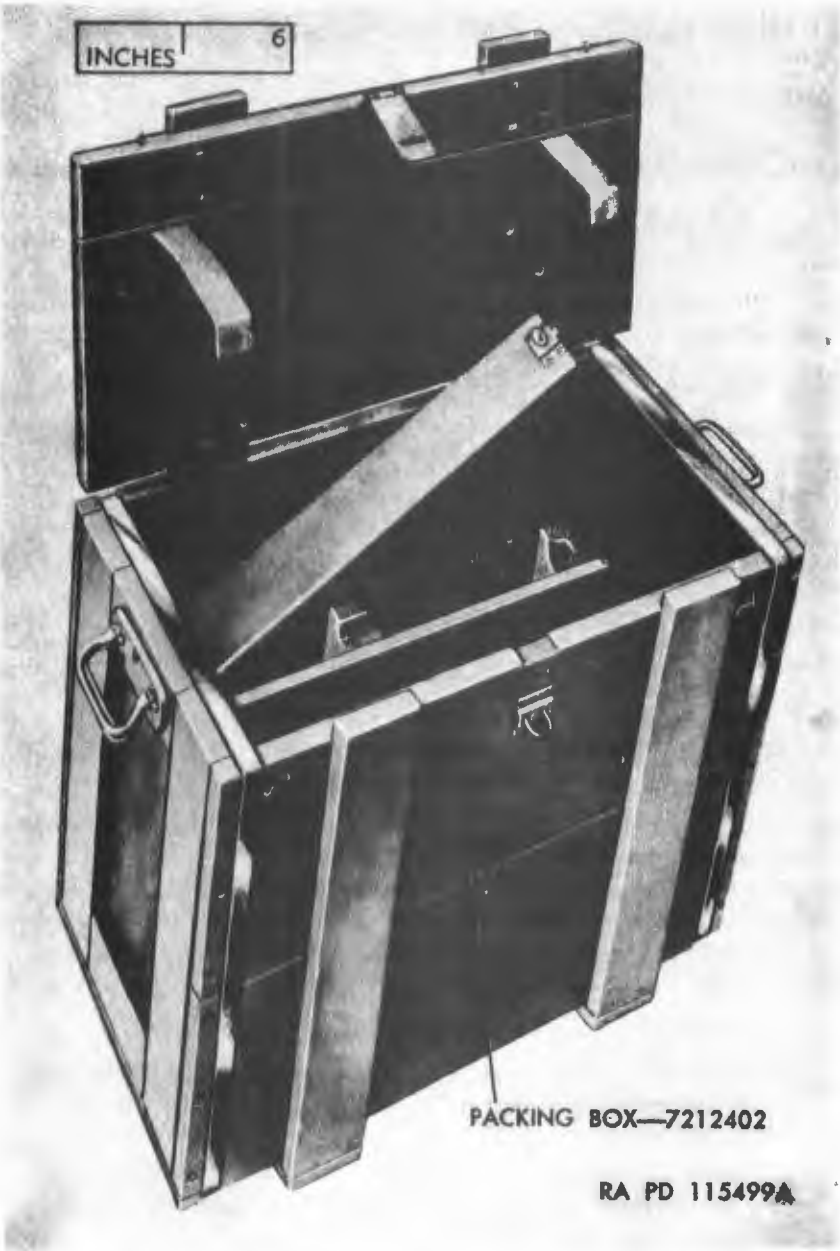


Figure 388. Specially designed packing box for cal..50 subcaliber mount M19.

CHAPTER 5
SHIPMENT AND LIMITED STORAGE AND DESTRUCTION OF MATERIEL TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

328. Domestic Shipping Instructions

a. Preparation For Shipment In Zone of Interior. When shipping the twin 40-mm full tracked self-propelled gun M42 (T141) interstate or within the zone of interior, the officer in charge of preparing the shipment *will be responsible* for furnishing the vehicles to the carrier for transport in a serviceable condition, properly cleaned, preserved, painted, and lubricated as prescribed in SB 9–4.

Note. For instructions on loading and blocking these vehicles on flatcars, refer to paragraphs 330 and 331. On-vehicle materiel (OVM) will be prepared, packed, and stowed as prescribed in paragraph 330*b*.

b. Removal of Preservatives Before Shipment. Personnel withdrawing vehicles from limited storage for domestic shipment *must not remove preservatives* other than to insure that vehicles are complete and serviceable. If it has been determined that preservatives have been removed, they must be restored prior to domestic shipment. Removal of preservatives is the responsibility of depots, ports, and field installations (posts, camps, and stations) receiving the shipments.

c. Preparation for Shipment To Ports (see AR 747–30).

(1) *Inspection.* All used vehicles destined for oversea use will be inspected, prior to shipment, in accordance with TB ORD 385.

(2) *Processing for shipment to ports.* All vehicles destined to ports of embarkation for oversea shipment will be further processed in accordance with SB 9–4.

Note. Ports of embarkation will perform any necessary supplementary or previously omitted processing upon receipt of vehicles, in accordance with AR 747–30.

(3) *Marking of arctic-lubricated materiel.* It will be the responsibility of the officer in charge of the installation performing arctic lubrication to insure that the equipment is marked as prescribed in AR 746–2300–1. It will

be the responsibility of the officer in charge of the installation shipping arctic-lubricated equipment to insure that each item is so marked. Unit commanders of using organizations will insure that such markings are not obliterated while the equipment is arctic-lubricated. When the equipment is deprocessed of this special lubrication, such marking will be immediately and thoroughly obliterated.

d. Army Shipping Documents. Prepare all Army shipping documents accompanying freight in accordance with TM 38–705.

e. Deep-Water Fording. If deep-water fording is anticipated during shipment, prepare vehicles in accordance with TM 9–2853.

f. Weapon Record Book. During transfer or shipment, locate the weapon record book in the gun book cover and secure to the top of the breech mechanism with nonhygroscopic adhesive tape. Under one of the wrappings of tape, insert one end of a tab reading WEAPON RECORD BOOK HERE.

329. Limited-Storage Instructions

a. General.

(1) The vehicles received for storage and already processed for domestic shipment, as indicated on DA Form 9–3, must be reprocessed, unless inspection, performed on receipt, reveals corrosion, deterioration, etc.

(2) Process vehicles upon receipt directly from manufacturing facilities or if processing data recorded on the tag indicates that the preservatives have been rendered ineffective by operation or freight shipping damage.

(3) Vehicles to be prepared for limited storage must be given a limited technical inspection and be processed as prescribed in SB 9–4. Results and classification will be entered on DA Form 461–5.

b. Receiving Inspections.

(1) Report of vehicles received for storage in a damaged condition or improperly prepared for shipment will be made on DD Form 6, in accordance with AR 700–58. Report of vehicles received in an unsatisfactory condition (chronic failure or malfunction) will be made on DA Form 468, (Unsatisfactory Equipment Report) in accordance with AR 700–38.

(2) When vehicles are inactivated, they will be processed in accordance with type I as prescribed in SB 9–4. Standby storage will normally be handled by ordnance maintenance personnel only.

(3) Immediately upon receipt of vehicles for storage, they must be inspected and serviced as prescribed in paragraph 7. Perform a systematic inspection and replace or repair all missing or broken parts. If repairs are beyond the scope of the unit and vehicles will be inactivated for an appreciable length of time, place them in limited-storage and attach tags specifying repairs needed. Reports of these conditions will be submitted by the unit commander for action by an ordnance maintenance unit.

c. Inspection During Storage. Perform a visual inspection periodically to determine general condition. If corrosion is found on any part, remove it and clean, paint, and treat with the prescribed preservatives.

Note. Touchup painting will be in accordance with TM 9–2851.

d. Removal From Limited Storage.

(1) If vehicles are not shipped or issued upon expiration of the limited-storage period, they will be further treated for stand-by storage by ordnance maintenance personnel.

(2) If vehicles to be shipped will reach their destination within the limited-storage period, they need not be reprocessed upon removal from storage, unless inspection reveals it to be necessary according to anticipated in-transit weather conditions.

Note. All vehicles being reissued through the depot supply system to troops within the continental limits of the United States must meet the requirements of TB ORD 385. This is NOT required for so-called reissues, exchanges, or redistribution among troop units, where the depot supply system is not involved.

(3) Deprocess vehicles when it has been ascertained that they are to be placed into immediate service. Remove all rust-preventive compounds and thoroughly lubricate as prescribed in paragraph 7. Inspect and service vehicles as prescribed in paragraph 8.

(4) Repair and/or replace all items tagged in accordance with *b* (3) above.

e. Storage Site. Whenever possible, the preferred type of storage for vehicles is under cover in open sheds or warehouses. When it is found necessary to store vehicles outdoors, the storage site must be selected in accordance with AR 700–105 and vehicles protected against the elements as prescribed in TB ORD 379.

330. Loading the Self-Propelled Twin 40-mm Gun M42 on Railroad Flatcars

a. Preparation.

(1) When the vehicles are to be shipped by rail, every precaution must be taken to see that they are properly loaded

and securely fastened and blocked to the floor of the flatcar. All on-vehicle materiel (OVM) will be thoroughly cleaned, preserved, packed (boxed or crated), and securely stowed in or on the vehicle or on flatcar for transit.

(2) Load vehicle on the flatcar in such a manner as to prevent the flatcar from carrying an unbalanced load. Apply the parking brakes and place the transmission in neutral position, after the vehicle has been finally spotted on the flatcar.

b. On-Vehicle Materiel (OVM) Requirements.

(1) *General.* Preserve and package all OVM materiel individually, except items used as sets or in quantities greater than one.

(2) *Armament and fire control items.* Preservation and packaging of armament and fire control items will be in accordance with applicable technical manuals covering the materiel.

(3) *Communications equipment.* Preservation and packaging of communications and allied equipment will be in accordance with applicable signal corps manuals covering the materiel.

(4) *Battery and electrolyte.*

(*a*) If the materiel is to be shipped within the continental limits of the United States, except directly to ports of embarkation, disconnect the battery cables from battery, clean, if necessary, ((*b*) below) coat terminals and battery posts with artillery and automotive grease (GAA), and wrap with nonhygroscopic adhesive tape. Secure terminals *away* from battery.

(*b*) If materiel is to be shipped directly to ports of embarkation, *except* when it is to be combat-loaded, disconnect battery cables and remove batteries. Plug vents and clean outside of batteries with a solution containing one-half pound of commercial grade baking soda (sodium bicarbonate) to one gallon of water. Rinse with *cool* water and remove vent plugs. Scrape or wire-brush and clean cable terminals and battery box (holder) with this cleaning solution, rinse with *cool* water, coat terminals and battery posts with automotive and artillery grease (GAA), and wrap with nonhygroscopic adhesive tape. Paint battery boxes, if required, with black acid-resisting paint. Battery and electrolyte will be packed in accordance with TM 9–

2857 and TM 9–1005 and shipped in vehicle separate from other OVM.

(5) *Publications.* Package technical manuals in type I, grade A, class b bags and heat seal opening (method IC–2) (TM 9–1005). Pack in the OVM container. Where publications are provided by separate technical services, such material will be packaged similarly and packed in the same exterior OVM container with the items to which they are applicable.

(6) *Unit packages.* Unit packages that are not water-resistant and are impracticable to intermediate package will be overwrapped in flexible waterproof barrier-material (method IC–2) (TM 9–1005) and sealed with waterproof water-resistant adhesive.

(7) *Intermediate packages.* Unit packages of related items (except pioneer tools) will be grouped together whenever possible and intermediate packaged in fiberboard cartons. Container closure will be made by sealing all seams with water-resistant gummed paper tape. When the gross weight exceeds 20 pounds, the container will be sealed with water-resistant adhesive (for sealing fiberboard boxes), in addition to being sealed with tape (TM 9–1005).

(8) *Exterior containers.*

(*a*) Keep the number of exterior containers to a minimum. The size will be governed by the cubic displacement of the packaged OVM. Dimensions will be such that when assembled in sets, as required, and stowed on vehicles, the overall cubage of the vehicle will not be increased and lifting devices will not be obstructed.

(*b*) Place pioneer tools and heavy materiel or equipment in the bottom of exterior containers and block and brace as necessary so that they will not damge other contents. Pack fragile materiel, and canvas items above other OVM items at the top of the container; in addition, pack canvas covers for OVM items in the same exterior container with the item for which it is intended.

(*c*) Pack unit and intermediate packages in style 2 unlined, snug fitting, nailed wood boxes, for a type III load (TM 9–1005), modified as prescribed in *1* through *5* below.

1. Exterior containers over 200 pounds gross weight will have nominal 2 x 4 cleats. Also, beveled end skids of nominal 2 x 4 lumber, will be placed flat, parallel to the ends of the containers, and spaced approximately 6

inches from each end, with span between skids not to exceed 36 inches.

2. The fastening of the skids to the bottom will be accomplished by the use of nails driven through the floor into the skid member. Nails will be of sufficient length and size to achieve maximum holding power.

3. Additional battens, when required, will be fastened to the inside faces of the top and side panels, and to the inside face of the bottom panel when skids are not required.

4. Construct the container top of matched lumber and nail to the side and end panels. The container will be weatherproofed, strapped, and marked in accordance with TM 9–1005.

Note. Weatherproofing top of containers will not be necessary if containers are to be stowed within the vehicle.

5. Cover exterior surfaces of all OVM exterior containers (except tops) with one coat of quick-drying lusterless enamel.

Note. OVM containers stowed within the vehicle will not require painting.

(9) *Stowage.*

(*a*) Mount all OVM containers on raised platforms (saddles) installed over the engine compartment and secure with metal strapping. Do not exceed the external dimensions or contour of the vehicle. Locate OVM containers so as to prevent damage by lifting devices and obstruction to lifting eyes.

Note. OVM containers must receive maximum protection against corrosion, deterioration, and mechanical damage during shipment and prolonged periods of storage.

(*b*) OVM containers constructed without skids that are to be stowed in exposed locations in contact with platforms, floors, or other boxes, will be placed on nominal 1 x 4 wood cleats to minimize surface contact. Secure cleats in a manner that will prevent shifting or damage to contacted surfaces.

c. Method Of Loading On Flatcars. For methods of loading on flatcars and general loading rules pertaining to rail shipment of ordnance vehicles, refer to TB 9–OSSC–G.

Warning: The height and width of vehicles, when prepared for rail transportation, must not exceed the limitations indicated by the loading table in AR 700–105 (Section II). Whenever possible, local transportation officers will be consulted about the limitations of the particular railroad lines to be used for the movement in order to prevent delays, dangerous conditions, or damage to equipment.

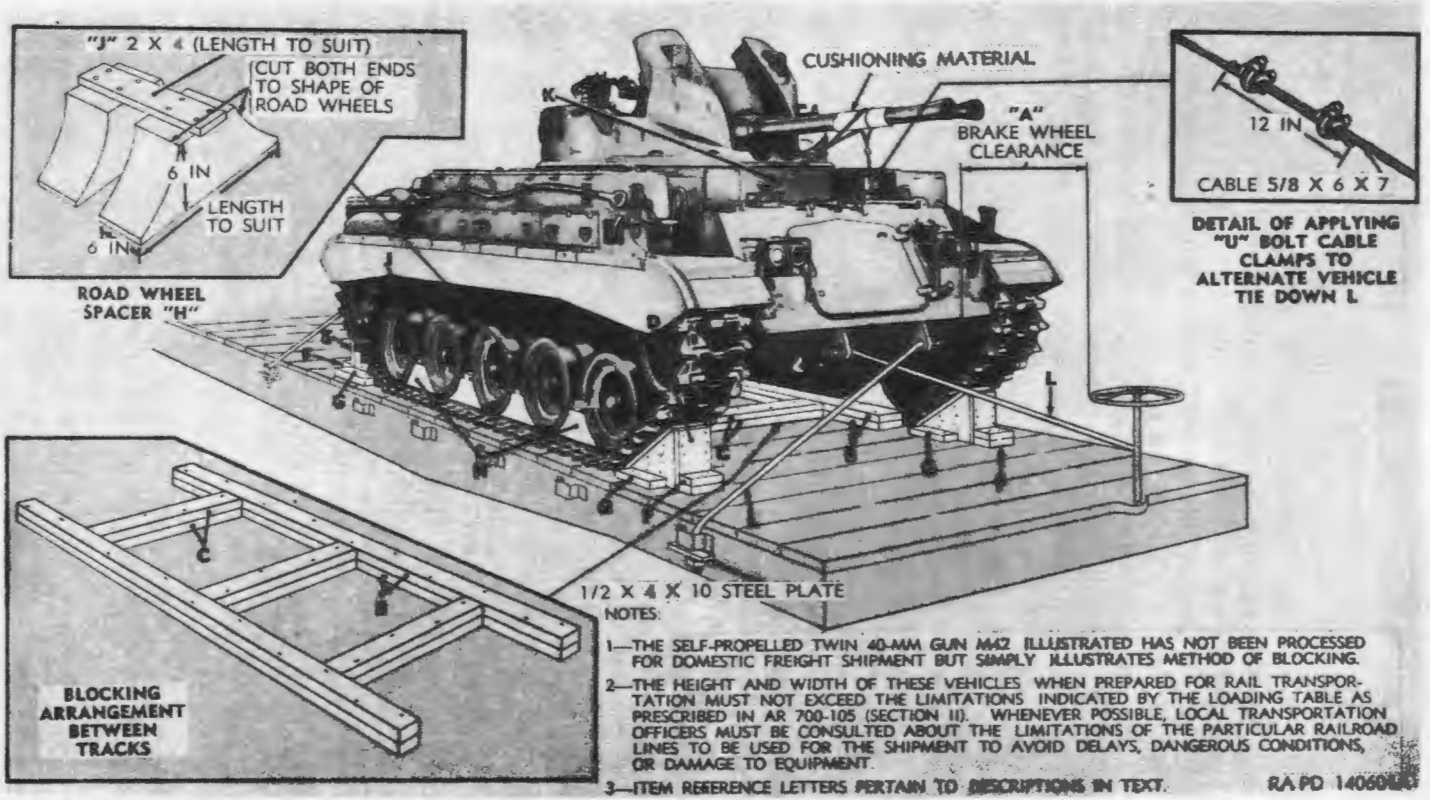


Figure 389. Method of blocking the twin 40-mm full tracked self-propelled gun M42 (T141) on railroad flatcars.

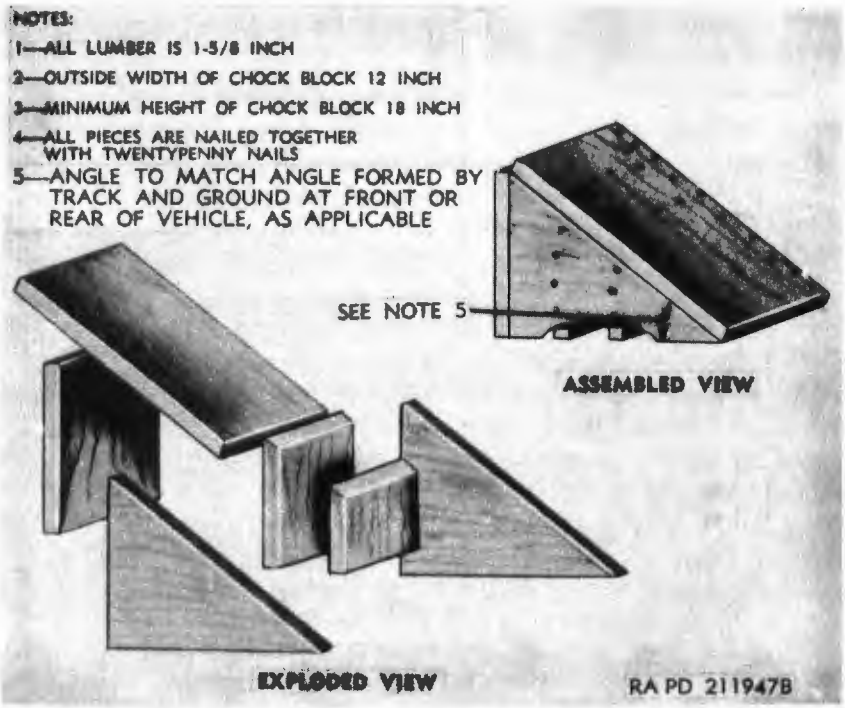


Figure 390. Details for fabricating chock blocks.

331. Blocking the Twin 40-mm Self-Propelled Full Tracked Gun M42 (T141) on Railroad Flatcars

a. General. All blocking instructions specified herein are minimum and are in accordance with "Pamphlet No. MD–7, Rules Governing the Loading of Department of Defense Materiel on Open Top Cars" of the Association of American Railroads. Additional blocking may be added, as required, at the discretion of the officer in charge. Double-headed nails may be used, if available, except in lower piece of two-piece cleats. All items reference letters given in *b* through *k* below refer to details in location shown in figure 389.

Note. Any other loading instructions, regardless of source, which appear to be in conflict with this publication or existing loading rules of the carriers, must be submitted for approval of Chief of Ordnance, Washington 25, D. C.

b. Brake Wheel Clearance A. Load vehicles on flatcars with a minimum clearance of at least 4 inches below and 6 inches above, behind, and to each side of brake wheel. Any increase of clearance must be consistent with proper location of load.

c. Track Inside Cleats B (2 x 4 in. Length To Suit, Four Required). Locate a cleat B along the inside of the left and right tracks and nail to car floor with thirtypenny nails, staggered approximately every 12 inches. Locate a second cleat B on top of

each lower cleat and nail to the lower cleats with thirtypenny nails, staggered approximately 12 inches.

d. Track Inside Spacers C (2 x 4 in., Length To Suit, Six Required). Locate three spacers C equidistant along cleats B crosswise of car floor, with ends against the side of lower cleats B. Nail to car floor with thirtypenny nails, staggered approximately every 12 inches. Locate upper spacers on top of lower spacers and nail to lower spacers with thirtypenny nails, staggered every 12 inches.

e. Chock Blocks D (Pattern 31) and E (Pattern 30) (Two Of Each Required). Construct two chock blocks D and two chock blocks E as shown in figure 390. Locate one chock block D against the front of each track and one chock block E against the rear of each track. Toenail the chock blocks to floor with fortypenny nails.

Note. If there is clearance between chock blocks and tracks insert and nail a wedge to take up space.

f. End Cleats F (2 x 4 x 12 in., Eight Required). Locate one cleat F against the end of each chock block and secure to floor with thirtypenny nails. Locate upper cleats on top of the lower cleats and secure with thirtypenny nails.

g. Side Cleats G (2 x 4 x 20 in., Eight Required). Locate one cleat G against the inside and outside of each of the D and E chock blocks and secure to floor with twentypenny nails.

h. Road Wheel Spacers H (16 Required) and Spacer Cleats J (2 x 4 in., Length to Suit, Eight Required). Cut road wheel spacers H to conform with radius of road wheels. Locate spacers on tracks between wheels as shown in figure 389. Locate wedges under blocks to assure a snug fit, if necessary. Nail a 2 x 4, length to suit, cleat J across top of blocks to prevent them from sliding out of position.

i. Gun Barrel Tie Down K (⅝-inch Steel Cable Doubled). Place cloth or felt padding around gun barrels at a suitable location between breech and muzzle. Pass cable around both gun barrels and down through a lifting bracket on the hull of vehicle. Overlap the ends of the cable at least 12 inches and secure with U-bolt cable clamps. Twist-tighten to remove slack. Repeat operation to secure the gun barrels to the other side of the hull.

j. Tie Rod L (1¼Diam Rods, Length To Suit, Bend At Assembly, Four Required). Remove towing pintles from towing brackets and stow on vehicle clearly marked for identification. Insert one end of rod through towing bracket of vehicle and secure with spacers and locknuts. Insert other end of tie rod through a stake pocket forward of vehicle on the *opposite* side of the car. Secure the rod to stake pocket and ½ x 4 x 10 steel plate with washers and locknuts. Nick the threaded portion of the tie rods behind the nuts to prevent them from turning loose.

Note. If the 1¼-inch steel rods are not available, use ⅝-inch steel cable, doubled. In applying the ⅝-inch cable, cut four required lengths, pass one end of each cable through each towing bracket of the vehicle and the other end through stake pockets on opposite sides of the vehicle. Overlap the ends of the cable at a point at least 12 inches above the stake pocket and secure with U-bolt cable clamps.

332. Marking

a. Identification marking will be stamped on metal tags after which tags will be dipped in ordnance yellow paint, and securely attached with soft wire to the front and rear light bracket or light guard of each vehicle. Marking will consist of nomenclature, stock number, gross weight, cubage, shipping dimensions, name of contractor, and contract number.

b. Processing directive (identifying number), symbol of installation performing processing, and date processed, will be stenciled with gasoline-soluble, white or yellow paint on the front and rear of each vehicle, adjacent to light brackets or guards.

c. The complete coded oversea address (where applicable) will be stenciled adjacent to headlight in front and taillight in rear, with gasoline-soluble paint (white or yellow on OD surfaces). The stenciling will be in letters not more than 1½ inches nor less than ¾ inches high. An equilateral triangle (ordnance yellow) not more than 3 inches nor less than 1½ inches high will be stenciled on each vehicle adjacent to the oversea address.

Section II. DESTRUCTION OF MATERIEL TO PREVENT ENEMY USE

333. General

a. Destruction of the twin 40-mm full tracked self-propelled gun, M42 (T141). When subject to capture or abandonment in the combat zone, will be undertaken by the using arm only when, in the judgment of the unit commander concerned, such action is necessary in accordance with orders of, or policy established by, the army commander.

b. The information which follows is for guidance only. Certain of the procedures outlined require the use of explosives and incendiary grenades which normally may not be authorized items for the vehicle. The issue of these and related materials, and the conditions under which destruction will be effected, are command decisions in each case, according to the tactical situation. Of the several means of destruction, those most generally applicable are:

Mechanical____Requires axe, pick mattock, sledge, crowbar, or similar implement.
Burning_____Requires gasoline, oil, incendiary grenades, or other flammables.
Demolition____Requires suitable explosives or ammunition.
Gunfire_____Includes artillery, machine guns, rifles using rifle grenades, and launchers using antitank rockets. Under some circumstances, hand grenades may be used.

In general, destruction of essential parts, followed by burning will usually be sufficient to render the materiel useless. However, selection of the particular method of destruction requires imagination and resourcefulness in the utilization of the facilities at hand under the existing conditions. Time is usually critical.

c. If destruction to prevent enemy use is resorted to, the vehicle, armament, and equipment must be so badly damaged that they cannot be restored to a usable condition in the combat zone either by repair or cannibalization. Adequate destruction requires that all parts essential to the operation of the vehicle, armament, and equipment, including essential spare parts, be destroyed or damaged beyond repair. However, when lack of time and personnel prevents destruction of all parts, priority is given to the destruction of those parts most difficult to replace. Equally important, the same essential parts must be destroyed on all like materiel so that the enemy cannot construct one complete unit from several damaged ones.

d. If destruction is directed, due consideration should be given to:

(1) Selection of a point of destruction that will cause greatest obstruction to enemy movement and also prevent hazard to friendly troops from fragments or ricocheting projectiles which may occur incidental to the destruction.
(2) Observance of appropriate safety precautions.

334. Destruction of Sighting and Fire Control Instruments and Equipment

All items of sighting and fire control instruments and equipment, especially such items as binoculars, gunner's quadrants, computing sights, and periscope, are costly, difficult to replace, yet relatively light; hence, they should be conserved and evacuated whenever practicable. If evacuation is impracticable, the instruments and equipment will be destroyed completely. All optical elements and mountings, the computer, and the control system will be smashed; firing tables, trajectory charts, and flammable items will be burned.

335. Destruction of Armament

a. General. Ordinarily, the armament should be destroyed in conjuction with the destruction of the vehicle (par. 337); however, if limitation of time, personnel, and materials preclude simultaneous destruction of the vehicle, armament, and equipment, priority will be given to destruction of the armament.

b. 40-MM Automatic Dual Gun M2A1 and 40-MM Twin Gun Mount M4E1.

(1) *Method No. 1—by demolition.*

(*a*) *With demolition material.*

1. Using an axe, pick mattock, sledge, or other heavy implement, destroy the two spare barrels by smashing the flash hiders, deforming the interrupted threads, cartridge case extractor recesses, breech slots, and breech recesses.

2. Planning for simultaneous detonation, prepare and place the charges of EXPLOSIVE, TNT (using 1-lb blocks or equivalent together with the necessary detonation cord to make up each charge) as indicated below:

Charge	*Location of Charge*
2-lb (2 reqd)	With the breechblocks in the open position and the top covers raised, place a charge on each breechblock adjacent to the chamber. Before closing the top covers, insert an object, such as a hammer handle, in the upper opening of breech casing to prevent damage to the detonating cord due to full closing of the top covers.
2-lb	Place the charge on the equilibrator trunnion bracket.
1-lb	Place the charge on the elevating gear mechanism.

3. Connect these charges for simultaneous detonation with detonating cord. For methods of detonating these charges, refer to paragraph 337*c*(7) through (9). The danger zone is approximately 250 yards. Elapsed time: about 8 minutes.

(*b*) *With HE ammunition.*

1. Using an axe, pick mattock, sledge, or other heavy implement, destroy the two spare barrels by smashing the flash hiders, deforming the interrupted threads, cartridge case extractor recesses, breech slots, and breech recesses.

2. With the gun at zero-degree elevation, open the drain plugs on the recoil mechanism and allow recoil fluid to drain. It is not necessary to wait for the recoil fluid to

drain completely before proceeding with the next step.

3. Plug each bore for approximately two-thirds of its length, using ramrods wrapped with cloth or waste to make them fit snugly in the bores. Mud, stones, clay, or other suitable materials may be used in lieu of the ramrod.

4. As an alternative to 3 above, jam a fuzed HE round into the muzzle end of each bore and load each gun with a fuzed HE round. An armor-piercing round, if used in lieu of the HE round, will not be as satisfactory.

5. Fire the guns from cover using a lanyard 100 feet long. The danger area is approximately 200 yards. Elapsed time: about 5 minutes.

(2) *Method No. 2—by burning (incendiary grenades).*

(*a*) Using an axe, pick mattock, sledge, or other heavy implement, destroy the two spare barrels by smashing the flash hiders, deforming the interrupted threads, cartridge case extractor recesses, breech slots, and breech recesses.

(*b*) With the gun at 0° elevation, raise the top covers of the breech casings and place two unfuzed incendiary grenades over each breechblock. Ignite the two grenades by means of a third one fitted with safety fuse approximately 2 feet in length (safety fuse burns at the rate of 1 ft in approx 40 sec; test before using). The metal from the grenades will fuse the breechblocks to the breech rings. Elapsed time: about 3 minutes.

(*c*) Place two incendiary grenades on top of the elevating mechanism gear box. Ignite the two grenades by means of a third one fitted with a sufficient length of safety fuse.

(*d*) Ignite the fused grenades. Safety fuse may be ignited by a fuse lighter or a match. Take cover immediately. Elapsed time: about 3 minutes.

336. Destruction of Communications Equipment

Radios and intercommunication equipment will be damaged mechanically in conjunction with the destruction of the self-propelled gun (par. 335*b*); circuit and wiring diagrams, performance data, and pertaining technical publications will be burned.

337. Destruction of the Vehicle

a. General. Although varying degrees of damage to the armament and equipment of the self-propelled gun may be expected incidental to the destruction of the vehicle by any one of the methods

outlined below, complete destruction of the self-propelled gun (vehicle, armament, and equipment) requires that applicable parts of the procedure for destruction of the armament and equipment (pars. 334–336) be coordinated with the method employed for destruction of the vehicle.

b. Method No. 1—By Burning.

(1) Remove and empty portable fire extinguishers and discharge the fixed fire extinguisher system.

(2) Smash all vital elements such as magnetos, carburetors, air cleaners, generators, spark plugs, lights, switches, instruments, and controls.

(3) Destroy the communications equipment by shearing off all panel knobs, dials, and switches.

(4) Break sockets, smash tubes, coils, phones, and batteries.

(5) If time permits and a sufficiently heavy implement is available, smash the engine cylinder blocks and heads, transmissions and final drives.

(6) If time permits, drain or puncture the fuel tanks, collecting gasoline for use as outlined in (8) below.

(7) Explosive ammunition should be removed from packing or other protective material. Place ammunition in and about the self-propelled gun so that the greatest damage will result from its detonation.

(8) With all doors and hatches open to admit air for combustion, pour gasoline and oil in and over the entire vehicle; ignite by means of an incendiary grenade fired from a safe distance, a burst from a flame thrower, a combustible train of suitable length, or other appropriate means. Take cover immediately.

Caution: Cover must be taken without delay since an early explosion of the explosive ammunition may be caused by the fire. Due consideration should be given to the highly flammable nature of gasoline and its vapor. Carelessness may result in painful burns.
Elapsed time: about 6 minutes.

c. Method No. 2—By Demolition.

(1) Remove and empty portable fire extinguishers and discharge the fixed fire extinguisher system.

(2) Smash all vital elements as outlined in *b* above.

(3) If time permits, drain the fuel tanks or puncture them as near the bottom as possible.

(4) For the guns and mount, prepare, place, and set the charges as outlined in paragraph 335*b* (1) (*a*).

(5) For the engine compartment, cross drive transmission, and tracks, prepare six 2-pound charges of EXPLOSIVE, TNT (two 1-lb blocks or equivalent per charge together with the necessary detonating cord). Place the charges as follows:

(*a*) Set the *first* charge on the cross drive transmission.

(*b*) Set the *second*, *third*, and *fourth* charges on the engine; one on the *left* side, one *beneath* the engine; and one on the *right* side.

(*c*) Set the *fifth* and *sixth* charges on the *left* and *right* track driving sprockets.

(6) Connect these six charges for simultaneous detonation with detonating cord.

(7) Provide for dual priming to minimize the possibility of a misfire. For priming, either a nonelectric blasting cap crimped to at least 5 feet of safety fuse (safety fuse burns at the rate of 1 ft in approx. 40 sec; test before using) or an electric blasting cap and firing wire may be used. If a nonelectric blastic cap and safety fuse are used, the fuse should be sufficiently long and so positioned that it may be ignited from the outside of the vehicle since gasoline which is draining from the fuel tanks may be exploded prematurely by the burning fuse. Safety fuse, which contains black powder, and nonelectric blasting caps must be protected from moisture at all times. The safety fuse may be ignited by a fuse lighter or a match; the electric blasting cap requires a blasting machine or equivalent source of electricity.

(8) Connect all charges, the charges for the guns and mount and the charges for the engine compartment and tracks, for simultaneous detonation with detonating cord. Detonate these charges as indicated in (9) below.

Caution: Keep the blasting caps, detonating cord, and safety fuse separated from the charges until required for use.

Note. For the successful execution of methods of destruction involving the use of demolition materials, all personnel concerned will be thoroughly familiar with the provisions of FM 5–25. Training and careful planning are essential.

(9) Detonate the charges. If primed with nonelectric blasting cap and safety fuse, ignite and take cover. If primed with electric blasting cap, take cover before firing. The danger zone is approximately 250 yards. Elapsed time: About 15 minutes.

d. Method No. 3—By Gunfire.

(1) Remove and empty portable fire extinguishers and discharge the fixed fire extinguisher system.

(2) Smash all vital elements as outlined in *b*(2) through (5) above.

(3) Puncture the fuel tanks and cut the fuel lines.

(4) Destroy the self-propelled gun by gunfire using adjacent self-propelled guns, artillery, machine guns, rifles using rifle grenades, or launchers using antitank rockets. Fire on the self-propelled gun aiming at the track driving sprockets, road and compensating wheels, engine compartment, and guns and mount. Although one well-placed direct hit may render the self-propelled gun temporarily useless, several hits are usually required for complete destruction unless an intense fire is started, in which case the self-propelled gun may be considered destroyed.

Caution: Firing artillery at ranges of 500 yards or less should be from cover. Firing rifle grenades of antitank rockets should be from cover.

Elapsed time: about 6 minutes.

(5) Unless evacuated, destroy the last remaining self-propelled gun or its weapons by the best means available.

APPENDIX
REFERENCES

1. Publication Indexes

Consult DA Pamphlets in the 310-series frequently for latest changes or revisions of references given in this appendix and for new publications relating to materiel covered in this manual.

2. Supply Manuals

a. Ammunition.

Ammunition, Fixed and Semifixed, Including Subcaliber, for Pack, Light and Medium Field, Aircraft, Tank, and Antitank Artillery, Including Complete Round Data.	SM 9–5–1305 SM 9–5–1310 SM 9–5–1315
Grenades, Hand and Rifle, and Related Components.	SM 9–5–1330
Land Mines and Components; Demolition Explosives and Related Items; and Ammunition for Simulated Artillery, Booby Trap, Hand Grenade; and Land Mine Fire.	SM 9–5–1345 SM 9–5–1370 SM 9–5–1375
Service Fuzes and Primers for Pack, Light and Medium Field, Aircraft, Tank, and Antitank Artillery.	SM 9–5–1390
Ammunition for Antiaircraft Artillery	SM 9–5–1310, SM 9–5–1315
Ammunition, Instruction Material for Pack, Light and Medium Field, Aircraft, Tank and Antitank Artillery.	SM 9–5–1305, SM 9–5–1310, SM 9–5–1315, SM 9–5–1320, SM 9–5–1390
Ammunition, Obsolete and Nonstandard, for Group R.	ORD 11 SNL R–8
Ammunition, Small-Arms, Obsolete and Nonstandard.	ORD 11 SNL T–6

b. Armament.

Gun, Machine, Cal..30, Browning, AN–M2, Aircraft, Fixed, Flexible, and Flexible with Fixed Back Plate.	ORD (*) SNL A–28

* See DA Pam 310–29 for Index of Supply Manuals—Ordnance Corps for published types of manuals of the Ordnance Section of the Department of the Army Supply Manuals.

Gun, Dual, Automatic 40-mm, M2A1 and Mount, Gun, Twin, 40-mm M4E1.	ORD (*)	SNL A–50
Gun, Machine, Cal..30, Browning, M1919A4, Fixed and Flexible; M1919A5, Fixed, and M1919A6; and Ground Mounts.	ORD (*)	SNL A–6
c. Auxiliary Materiel.		
Receiver Transmitters RT–66/GRC, RT–67/GRC and RT–68/GRC.		TM 11–289
Radio Sets AN/GRC–3; 4; 5; 6; 7; and 8		TM 11–284
Suppression of Radio Noises		TM 11–483
Auxiliary Interphone Equipment AN/VIA–1		TM 11–704
d. Destruction to Prevent enemy use.		
Land Mines and Components; Demolition Explosives and Related Items; and Ammunition for Simulated Artillery, Booby Trap, Hand Grenade, and Land Mine Fire.		SM 9–5–1370 SM 9–5–1375
e. Maintenance and Repair.		
Cleaners, Preservatives, Lubricants, Recoil Fluids, Special Oils, and Related Maintenance Materials.	ORD 3	SNL K–1
Common Handtools	ORD 3	SNL J–17
Items of Soldering, Metallizing, Brazing, and Welding Materials; Gases and Related Items.	ORD 3	SNL K–2
Lubricating Fittings, Oil Filters, and Oil Filter Elements.	ORD 5	SNL H–16
Tool Set, General Mechanic's (41–T–3534–30).	ORD 6	SNL J–10 Sec 4
Tool Set, Organizational Maintenance (2d echelon), No. 1, Common (5180–754–0654).	ORD 6	SNL J–7, Sec 1
Tool Set, Organizational Maintenance (2d echelon), Set No. 1, Supplemental (41–T–3538–865).	ORD 6	SNL J–7, Sec 2
Tool Set, Organizational Maintenance (2d echelon), No. 2, Common (41–T–3538–855).	ORD 6	SNL J–7, Sec 3
Tool Set, Organizational Maintenance (2d echelon), No. 2, Supplemental.	ORD 6	SNL J–7, Sec 4
f. Sighting and Fire Control Equipment.		
Periscope, M6	ORD (*)	SNL F–235, Vol 2
Periscope, M13, M13B1, M17	ORD (*)	SNL F–235, Vol 5

* See DA Pam 310–29 for Index of Supply Manuals—Ordnance Corps for published types of manuals of the Ordnance Section of the Department of the Army Supply Manuals.

Periscope, M19 ORD (*) SNL F–235, Vol 17
Quadrant, Elevation, M9 ORD (*) SNL F–281
Quadrant, Gunner's M1, M1A1 ORD (*) SNL F–140
Setter, Fuze, M27 ORD (*) SNL F–357
Telescope, M97 (T156) ORD (*) F–235, Vol 16

g. Subcaliber Equipment.

Gun, Machine, Cal..50, Browning, M2, Heavy Barrel, Fixed and Flexible; Mount, Machine Gun, Cal..50, AA, M63 and Mount, Tripod, Machine Gun, Cal..50, M3. ORD (*) SNL A–39

h. Vehicle.

Gun, Twin, 40-mm, Self-propelled, M42 (T141). ORD (*) SNL G–253

3. Forms

Standard Form 91, Operator's Report of Motor-Vehicle Accident (Card).
Standard Form 94, Statement of Witness
DA Form 9–1, Materiel Inspection Tag
DA Form 9–3, Processing record of Stowage and Shipment (Tag)
DA Form 9–4, Vehicular for Stowage and Servicing Record (Card)
DA Form 9–13 and 9–13–1, Weapon Record Book (Formerly 00 Form 5825, Artillery Gun Book).
DA Form 9–69, Spot Check Inspection Report for all Full-Track and Tank-Like Wheeled Vehicles.
DA Form 9–75, Daily Dispatching Record of Motor Vehicles
DA Form 348, Driver Qualification Record
DA Form 460, Preventive Maintenance Roster
DA Form 462, Preventive Maintenance Service and Inspection for Full-Track Vehicles.
DA Form 468, Unsatisfactory Equipment Report
DA Form 478, Organizational Equipment File
DA Form 811 and 811–1, Work Request and Job Order and Receipt (Set).
DD Form 6, Report of Damaged or Improper Shipment
DD Form 313, U. S. Government Operator's Permit
DD Form 317, Preventive Maintenance Service Due (Sticker)
DD Form 518, Accident Identification Card

4. Other Publications

a. Ammunition.

Ammunition, General TM 9–1900
Ammunition Inspection Guide TM 9–1904

* See DA Pam 310–29 for Index of Supply Manuals—Ordnance Corps for published types of manuals of the Ordnance Section of the Department of the Army Supply Manuals.

Artillery Ammunition	TM 9–1901
Ballistic Data (U) (Classified)	TM 9–1907
Identification of Inert Ammunition and Ammunition Components.	AR 385–65
Qualification in Arms and Ammunition Training Allowances.	AR 755–10
Report of Malfunction and Accidents Involving Ammunition and Explosives (During Training and Combat).	SR 700–45–6
Safety: Regulations for Firing Ammunition for Training, Target Practice, and Combat.	AR 385–63
Small Arms Ammunition	TM 9–1990
Supply Control: Distribution of Ammunition for Training.	AR–710–1300–1
Training Ammunition	T/A 23–100
b. Armament.	
40-mm Dual Automatic Gun M2 and Twin 40-mm Gun Mount M4.	TM 9–251
40-mm Automatic Gun M1, 40-mm Antiaircraft Gun, and 40-mm Gun Mount M3.	TM 9–252
Browning Machine Guns, Cal..30, M1917A1, M1919A4, and M1919A6.	FM–23–55
Fundamentals of Artillery Weapons	TM 9–2305
Self-Propelled Twin 40-mm Gun	FM 44–61
c. Camouflage.	
Camouflage, Basic Principles	FM 5–20
Camouflage of Vehicles	FM 5–20B
d. Communications.	
Receiver-Transmitter RT–66/GRC–67 and 68	TM 11–289
Auxiliary Interphone Equipment AN/VIC–1	TM 11–704
e. Decontamination.	
Decontamination	TM 3–220
Defense Against Chemical Attack	FM 21–40
f. Destruction To Prevent Enemy Use.	
Explosives and Demolitions	FM 5–25
g. General.	
Basic Arctic Manual	FM 31–70
Cooling Systems: Vehicle and Powered Ground Equipment.	TM 9–2858
Driver Selection, Training, and Supervision, Half-Track and Full-Track Vehicles.	TM 21–301
Fording Kits for Combat and Transport Vehicles	MIL–F–3201
Instruction Guide: Operation and Maintenance of Ordnance Materiel in Extreme Cold (0° to —65° F.).	TM 9–2855

Lubrication Order	LO 9–7218
Manual for the Full Track Vehicle Driver	TM 21–306
Mountain Operations	FM 70-10
Operations in the Arctic	FM 31–71
Ordnance Maintenance and General Supply in the Field	FM 9–10
Precautions in Handling Gasoline	AR 850–20
Preparation of Ordnance Materiel for Deep-Water Fording (if applicable).	TM 9–2853
Principles of Automotive Vehicles	TM 9–8000
Safety: Prevention of Motor Vehicle Accidents	AR 385–55
Safety: Reports of Accident Experience	SR 385–10–40
Spark Plugs	TB ORD 313 (TM 9–8638)
Storage Batteries, Lead-Acid Type	TM 9–2857
Supplies and Equipment: Motor Vehicles	700–2300–1
Supplies and Equipment: Unsatisfactory Equipment Report.	AR 700–38

h. Maintenance and Repair.

Abrasives, Cleaning, Preserving, Sealing, Adhesive, and Related Materials Issued for Ordnance Materiel.	TM 9–850
Automotive Vehicles with 24-Volt Electrical Systems; Operating Precautions and Maintenance and Stowage of New Type 12-Volt Lead-Acid Storage Batteries 2HN and 6TN.	TB ORD 463
Fire Control Materiel: Lubrication	TB 9–2835–1
General Supply: Winterization Equipment for Automotive Materiel.	SB 9–16
Instruction Guide: Care and Maintenance of Ball and Roller Bearings.	TM 37–265
Instruction Guide: Welding Theory and Application	TM 9–2852
Lead-Acid Type Storage Batteries; Restoration of Sulfated Batteries to Serviceable Condition.	TB 9–2857–1
Lubrication	TM 9–2835
Maintenance and Care of Hand Tools	TM 9–867
Maintenance of Supplies and Equipment: Maintenance Responsibilities and Shop Operation.	AR 750–5
Painting Instructions for Field Use	TM 9–2851
Tactical Motor Vehicle Inspections and Preventive Maintenance Services.	TM 9–2810
Track-Laying Vehicles; Instructions Governing Application, Interchangeability, Inspection, Classification, Maintenance and Disposition of Tracks, Track Suspension Wheels.	TB ORD 562

i. Shipment and Limited Storage.

Catalog of Approved Packaging Instructions for Major Items and Spare Parts for Ordnance General Supplies.	PS 1000[1]
Instruction Guide: Ordnance Preservation, Packaging, Packing, Storage, and Shipping.	TM 9–1005
Marking and Packing of Supplies and Equipment: Marking of Arctic-Lubricated Materiel and Equipment.	SR 746–30–10
Marking and Packing of Supplies and Equipment: Marking of Oversea Supply.	SR 746–30–5
Marking and Packing of Supplies and Equipment: Shipment Digit Marking.	SR 746–30–6
Military Standard—Marking of Shipments	MIL STD 129[2]
Ordnance Storage and Shipment Chart Group G: Major Items and Major Combinations of Group G.	TB 9–OSSC–G
Packaging and Shipping of Materiel: Army Shipping Document.	TM 38–705
Packaging and Shipping of Materiel: Preservation, Packaging, and Packing of Military Supplies and Equipment.	TM 38–230
Preparation of Supplies and Equipment for Shipment: Processing of Unboxed and Uncrated Equipment for Oversea Shipment.	AR 747–30
Processing of Motor Vehicles and Related Unboxed Materiel for Shipment and Storage.	SB 9–4
Protection of Ordnance General Supplies in Open Storage.	TB ORD 379
Shipment of Supplies and Equipment: Report of Damaged or Improper Shipment.	AR 700–58
Standards for Oversea Shipment and Domestic Issue of Ordnance Materiel Other than Ammunition and Army Aircraft.	TB ORD 385
Packaging of Small Arms Materiel with Vehicle Corrosion Inhibitor (VCI).	TB ORD 623

j. Sighting and Fire Control Equipment.

Auxiliary Sighting and Fire Control Equipment	TM 9–575
Graphical Firing Table, M39, M40, M41, M42, M43, M44, M45, M46, M47, M48, M49, M50, and M51.	TM 9–525
Instruction Guide: Elementary Optics and Applications to Fire Control Instruments.	TM 9–2601
12-inch Graphical Firing Tables	TM 9–524

[1] Copies may be obtained from Raritan Arsenal, Pub Div, Metuchen, N. J.
[2] Copies may be obtained from Aberdeen Proving Ground, Aberdeen, Md.

INDEX

[AG 472 (7 May 57)]

By Order of *Wilber M. Brucker*, Secretary of the Army:

MAXWELL D. TAYLOR,
General, United States Army,
Chief of Staff.

Official:

HERBERT M. JONES,
Major General, United States Army,
The Adjutant General.

Distribution:

Active Army:

CNGB
ASA
Tec Svc, DA
Ord Bd
Hq CONARC
CONARC Bd
USA Air Def Comd
OS Maj Comd
OS Base Comd
Log Comd
MDW
Armies
Corps
Div
Ord Gp
Ord Bn
Ord Co
Ft & Cp
Gen & Br Svc Sch
PMST Sr Div Ord Units
Ord Ammo Comd
Ord Tk Autmv Comd
Gen Depots
Ord Sec, Gen Depots
Ord Depots
POE (OS)
Trans Terminal Comd
Army Terminals
OS Sup Agencies
Ord PG
Ord Arsenals
Mil Dist
Ord Proc Dist
MAAG
Mil Msn
JBUSMC
JUSMAG (Greece)
Fld Comd, AFSWP
44–75, AAA Bn, AW, Self-propelled
44–77, AAA Btry, AW, Self-propelled
44–275, Abn AAA Bn, AW
44–277, Abn AAA Btry, AW

NG: State AG; units—same as Active Army.

USAR: None.

For explanation of abbreviations used, see SR 320–50–1.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983-381-647/1120