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DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 1 February 1988

Operator's, Organizational, Direct Support and
General Support Maintenance Manual

PUMPING ASSEMBLY, DIESEL ENGINE DRIVEN,
WHEEL MTD, 350 GPM, 275 FT.
HEAD, MODEL 13220E1070 (97403) (FUEL USE ONLY)
NSN 4320-01-092-3551

PUMPING ASSEMBLY, DIESEL ENGINE DRIVEN,
WHEEL MTD, 350 GPM, 275 FT.
HEAD, WITH REGULATOR, MODEL 13226E2289 (97403) (FUEL USE ONLY)
NSN 4320-01-141-5154

PUMPING ASSEMBLY, DIESEL ENGINE DRIVEN,
WHEEL MTD, 350 GPM, 275 FT.
HEAD, MODEL 13225E9200 (97403) (WATER USE ONLY)
NSN 4320-01-158-2954

PUMPING ASSEMBLY, DIESEL ENGINE DRIVEN,
WHEEL MTD, 350 GPM, 275 FT.
HEAD, MODEL LLP-TM (36024) (FUEL USE ONLY)
NSN 4320-01-215-7671

PUMPING ASSEMBLY, DIESEL ENGINE DRIVEN,
WHEEL MTD, 350 GPM, 275 FT.
HEAD, MODEL LC 350 GPM (36024) (FUEL USE ONLY)
NSN 4320-01-259-5965

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By Order of the Secretary of the Army:

CARL E. VUON
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:

To be distributed in accordance with DA Form 12-25A, Operator, Unit, Di
port and General Support Maintenance requirements for Pumping Assembly, I
Driven, Wheel Mounted, 350 GPM, 275 FT Head (FUEL: 13220E1070, 13226E228
13225E9200).

TM 5-4320-226-14

WARNING

DEATH

or severe injury to personnel may result if personnel fail to observe precautions.

To prevent pumping assembly from rolling or sliding securely chock both wheels.

Pumping Assembly must be grounded prior to operation, when pumping flammable liquids.

Ear protectors must be worn when within 50 ft (15.2 m) of operating unit.

Do not operate pumping assembly in an enclosed area unless exhaust gases are piped to outside and adequate ventilation is provided.

To prevent serious burns, take necessary precautions when filling battery with electrolyte. Do not allow electrolyte to come in contact with skin or eyes. Use rubber gloves and protective clothing.

Do not puncture or mishandle quick start kit container. Container contains ether-based mixture that is extremely combustible.

Do not smoke or use an open flame in the vicinity when filling fuel tank.

Use care during testing of injection pump. Fuel is under high pressure and spray may cut through skin.

Potential health hazards result from inhalation of petroleum solvent vapors and from contact of solvent with skin. Use rubber gloves and hand cream for protection, and work with adequate ventilation.

Do not use a fuel transfer pump to transfer water.

Do not use a water transfer pump to transfer fuel.

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TECHNICAL MANUAL

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 15 AUGUST 1984

TM 5-4320-226-14

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and General Support Maintenance Manual

PUMPING ASSEMBLY, DIESEL ENGINE
DRIVEN, WHEEL MTD, 350 GPM, 275 FT.
HEAD, MODEL 13220E1070 (97403) (FUEL USE ONLY),
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PUMPING ASSEMBLY, DIESEL ENGINE
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(FUEL USE ONLY), NSN 4320-01-141-5154

PUMPING ASSEMBLY, DIESEL ENGINE
DRIVEN, WHEEL MTD, 350 GPM, 275 FT.
HEAD, MODEL 13225E9200 (97403) (WATER USE ONLY)
NSN 4320-01-158-2954

PUMPING ASSEMBLY, DIESEL ENGINE
DRIVEN, WHEEL MTD, 350 GPM, 275 FT.
HEAD, MODEL LPP-TM (36024) (FUEL USE ONLY)
NSN 4320-01-215-7671

PUMPING ASSEMBLY, DIESEL ENGINE
DRIVEN, WHEEL MTD, 350 GPM, 275 FT.
HEAD, MODEL LC 350 GPM (36024) (FUEL USE ONLY)
NSN 4320-01-259-5965

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes Publications and Blank Forms) or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Troop Support Command, ATTN: AMSTR-MCTS, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. A reply will be furnished to you.

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CARL E. VUONO
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:

To be distributed in accordance with DA Form 12-25A, Operator, Unit, Direct Support and General Support Maintenance requirements for Pumping Assembly, Diesel Driven, Wheel Mounted, 350 GPM, 275 FT Head (FUEL: 13226E2289; WATER: 13225E 2289; WATER: 13225E9200)

TECHNICAL MANUAL
 No. 5-4320-226-14

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CHAPTER 1

INTRODUCTION

Section I. GENERAL INFORMATION

1. SCOPE.

a. This manual contains operational and maintenance instructions for the operator, organization, direct and general support maintenance.

b. The purpose of these pumping assemblies is to transfer gasoline, jet fuels, light liquid petroleum fuels and water, however, three models have been designated for fuel transfer only and one model designated for water transfer only.

2. MAINTENANCE FORM AND RECORDS. Department of the Army forms and procedures used for equipment maintenance will be those prescribed in DA Pam 738-750, The Army Maintenance Management System (TAMMS).

3. EQUIPMENT IMPROVEMENT REPORTS (EIRs).

If your pumping assembly needs improvement send an EIR to: Commander, US Army Troop Support Command, ATTN: AMSTR-QX, 4300 Goodfellow Boulevard, St. Louis, Missouri 63120-1798.

4. QUALITY DEFICIENCY REPORTS (QDRs).

If you don't like the design or performance of your pumping assembly put it on a SF 368 (Quality Deficiency Report). Mail it to: Commander, US Army Troop Support Command, ATTN: AMSTR-QX, 4300 Goodfellow Boulevard, St. Louis, Missouri 63120-1798.

5. DESTRUCTION OF ARMY MATERIEL TO PREVENT ENEMY USE.

a. General. Time and number of personnel will dictate the priority and method demolition.

b. Demolition with Explosives. Place 1/2 pound charges on the following:

- (1) Each axle.
- (2) Control Panel.
- (3) Fuel Tank.
- (4) Engine Block.
- (5) Pump Case.
- (6) Suction and Discharge Valves.
- (7) Injection Pump.
- (8) Cooling Fan.
- (9) Alternator.

c. Mechanical Demolition. Use an axe, pick, mattock, sledge, or any other heavy implement to damage all vital parts.

- (1) Punch holes in fuel tank and tires.
- (2) Cut drive belts, hoses and wires.
- (3) Smash control panel, injection pump, pump case, manifolds and engine block.

d. Demolition by Misuse. Add sand to oil and drop nuts and bolts into pump case. Operate pumping assembly until it fails.

e. Demolition by Burning. Pack rags, clothing, or canvas under or around the engine and pump. Saturate this packing with gasoline, oil, or diesel fuel and ignite.

1-6. PREPARATION FOR STORAGE OR SHIPMENT. Contact organizational maintenance for preparation of the pumping assembly for storage or shipment.

a. Placement of equipment in administrative storage should be for short periods of time when a shortage of maintenance effort exists. Items should be in mission readiness within 24 hours or within the time factors as determined by the directing authority. During the storage period appropriate maintenance records will be kept.

b. Before placing equipment in administrative storage, current maintenance services and equipment serviceable criteria (ESC) evaluations should be completed, shortcomings and deficiencies should be corrected, and all modification work orders (MWO's) should be applied.

c. Storage site selection. Inside storage is preferred for items selected for administrative storage. If inside storage is not available, trucks, vans, conex containers and other containers may be used.

1-7. REFERENCE INFORMATION. Abbreviations used in this manual are as follows:

m	meter	dc	direct circuit
mm	millimeters	psi	per square inch
cm	centimeters	psig	pounds per square inch gauge
TDC	top dead center	"Hg"	inches of mercury
BDC	bottom dead center	Kg	kilograms
Nm	newton meters	hp	horsepower
RPM	revolutions per minute	mph	miles per hour
amp	ampere	VDC	volts direct current

Section II. EQUIPMENT DESCRIPTION

. EQUIPMENT PURPOSE, CAPABILITIES, AND FEATURES. The 350 GPM Pumping Assembly is designed specifically to transfer gasoline, jet fuels, light liquid petroleum fuels and water. The unit can be field transported by means of a towing vehicle. It consists of an air cooled, three cylinder diesel engine and a self-priming centrifugal pump mounted on a two wheel frame assembly. The pumping assembly incorporates its own control panel suction and discharge valves. These components are also mounted on the frame assembly. An internal fuel tank supplies fuel to the diesel engine, thereby making the unit a complete self supporting pumping assembly.

. LOCATION AND DESCRIPTION OF MAJOR COMPONENTS. Figure 1-2 shows the location of the 350 GPM Pumping Assembly major components. A description of these components are as follows:

DISCHARGE VALVE (1). Gate valve, manually operated, provides positive means of pump flow shutoff. When opened, allows liquids to be discharged through centrifugal pump.

SUCTION VALVE (2). Gate valve, manually operated, provides positive means of pump flow shutoff. When opened, allows liquids to be brought up through the centrifugal pump.

CENTRIFUGAL PUMP (3). Pumps liquids through the suction valve and out through the discharge valve.

CONTROL PANEL (4). Contains the EMERGENCY STOP switch (Model LC 350GPM (36024), start/stop switch (Models 13220E1070, 13226E2289, and 13225E9200 (97403), start switch, oil pressure bypass switch, oil pressure gauge, tachometer/hourmeter, ammeter gauge, suction and discharge pressure gauges.

ENGINE ASSEMBLY (5). An air cooled, three cylinder diesel engine that drives the centrifugal pump.

AIR CLEANER (6). Filters ambient air prior to entering the diesel engine.

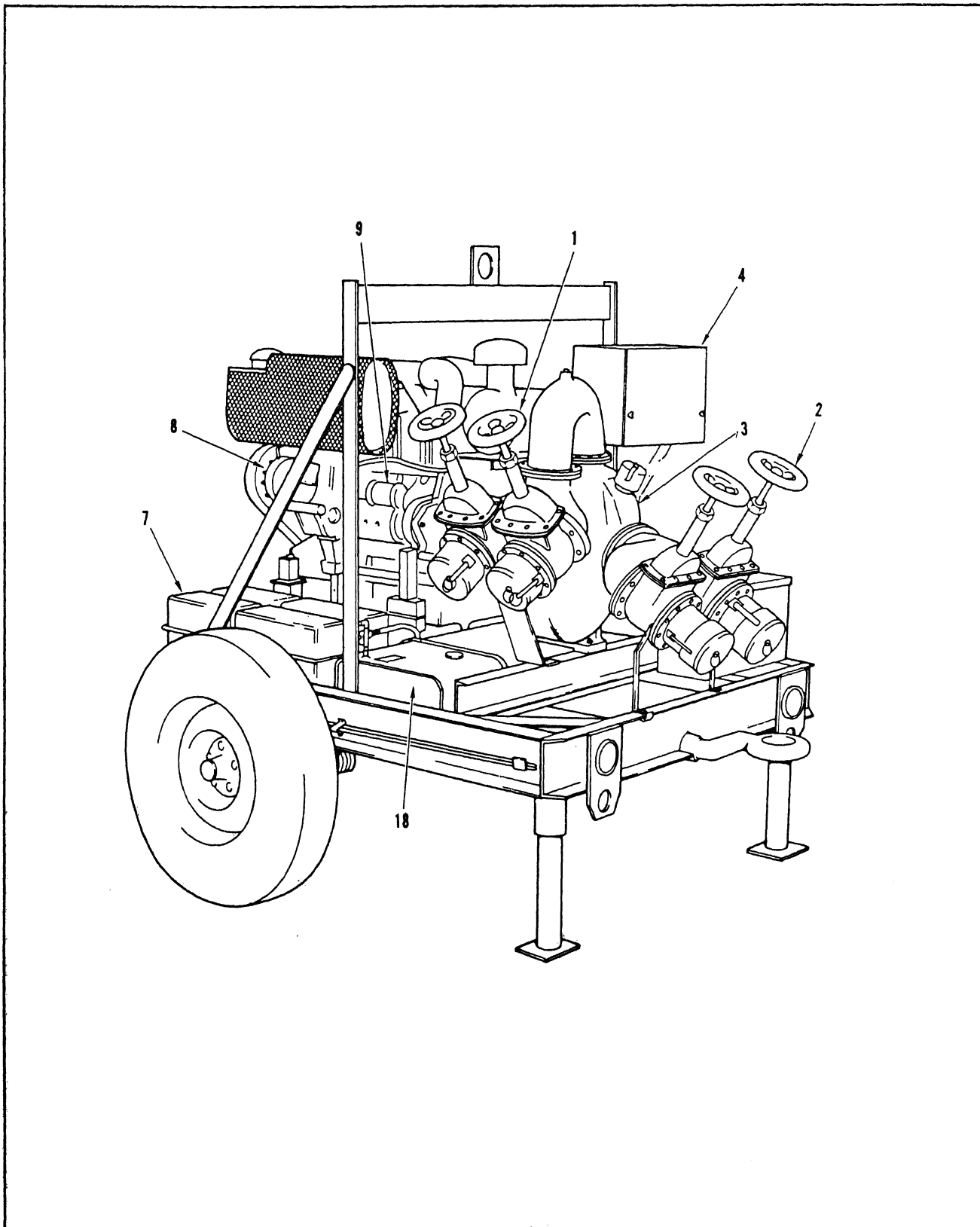


Figure 1-2. Major Components (Sheet 1 of 3)

BATTERIES (7). Two twelve volt, 100 ampere hour, lead-acid batteries used to supply 12 VDC for engine cranking.

ALTERNATOR (8). Belt driven; allows batteries to maintain charge. Provides 12 VDC to all pump assembly electrical circuits after engine start.

STARTER ASSEMBLY (9). Turns flywheel to crank engine during startup. Operates on 12 VDC obtained from the batteries.

* FUEL SHUTDOWN SOLENOID (10). A two position 12 VDC rack type solenoid. Attached to fuel injection pump cutoff lever. Shuts off fuel supply to engine when either a low oil pressure condition exists, or a drive belt breaks.

* SPEED REGULATING THROTTLE CONTROL (11). Operates engine speed.

FUEL FEED PUMP (12). Pumps fuel from internal fuel tank to injection pump. A diaphragm type pump actuated by cam in fuel injection pump. Cleanable inlet screen. Provides positive head of pressure to injection pump.

FUEL INJECTION PUMP (13). Meters high pressure fuel to injector nozzles. A high pressure fuel delivery pump driven by gear in engine timing cover. Main shaft in cover has cams which operate plunger pumping fuel to injection nozzle.

FUEL FILTER (14). A throwaway element which filters fuel from internal fuel tank prior to entering fuel pump.

OIL FILTER (15). A throwaway element which filters oil from oil sump prior to entering engine.

LOW OIL PRESSURE SWITCH (16). Relays a signal to fuel shutdown switch upon a drop in oil pressure. Set to automatically shutdown engine when oil pressure drops below 4 psi (0.28 Kg/cm²).

STARTING AID HANDPUMP (17). Supplies ether to engine air intake for starting in cold weather.

FUEL TANK (18). Contains fuel supply for operation of diesel engine. Retained by hold down straps to frame assembly. Has 19 gallon (72 liters) capacity, and incorporates a fuel level gauge, fuel selector valves, filler cap, drain plug, and overflow return fitting.

FILTER/SEPARATOR (19). Attached to frame assembly. A throwaway element removes nearly 100 percent of water and solid contaminants down to one micron in size.

FRAME ASSEMBLY (20). Provides mounting of engine assembly, pump, and components. Contains axle assembly, wheels and tires, and towbar to enable pumping assembly to be field transported.

* Used on models 13220E1070 (97403), 13225E9200 (97403), and LC 350GPM (36024).

****PRESSURE CONTROLLER (21).** Senses suction and discharge pump pressure and provides manual and automatic modes of operation. In the automatic mode of operation, provides pump discharge pressure and engine speed regulation.

****CONTROL BOX (22).** Receives signals from the pressure controller and senses engine speed through a magnetic pick-up and signals the actuator.

****ACTUATOR (23).** Increases or decreases engine speed through the engine fuel injection pump.

1-10. DIFFERENCE IN MODELS.

a. Model 13220E1070 (97403). This model is used to transfer fuel only and does not have a regulator. It is manually controlled.

b. Model 13226E2289 (97403). This model is used to transfer fuel only and has a regulator that provides manual and automatic modes of operation.

c. Model 13225E9200 (97403). This model is used to transfer water only and does not have a regulator. It is manually controlled and does not have grounding devices.

d. Model LC 350GPM (36024). This model is used to transfer fuel only and does not have a regulator. It is manually controlled.

****Installed on Model 13226E2289 (97403).**

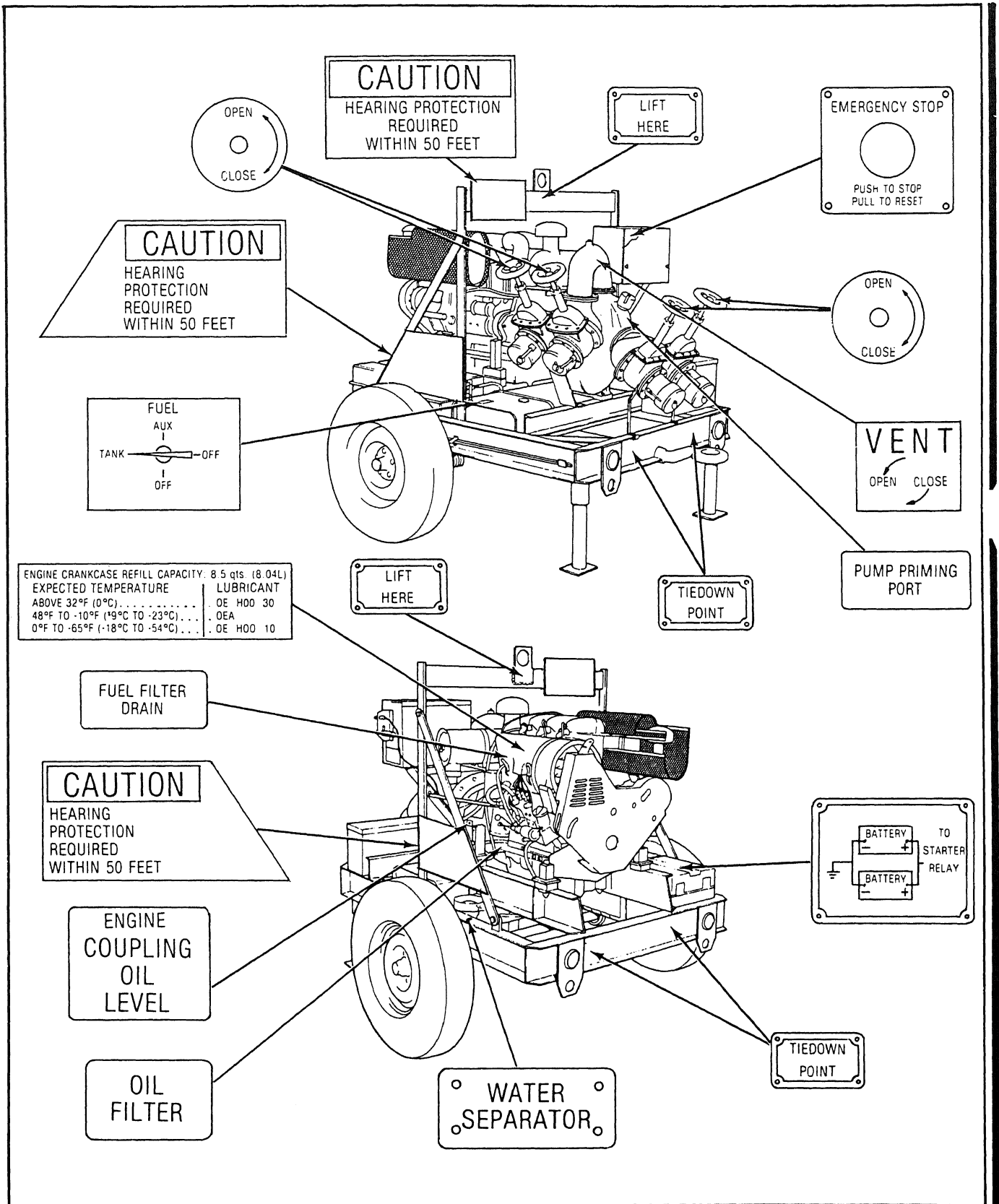


Figure 1-2.1. 350 GPM Pumping Assembly Information
Plate Locations, Model LC 350GPM (36024).

Section III

TECHNICAL PRINCIPLES OF OPERATION

1-12. FUEL SYSTEM (Figure 1-3)

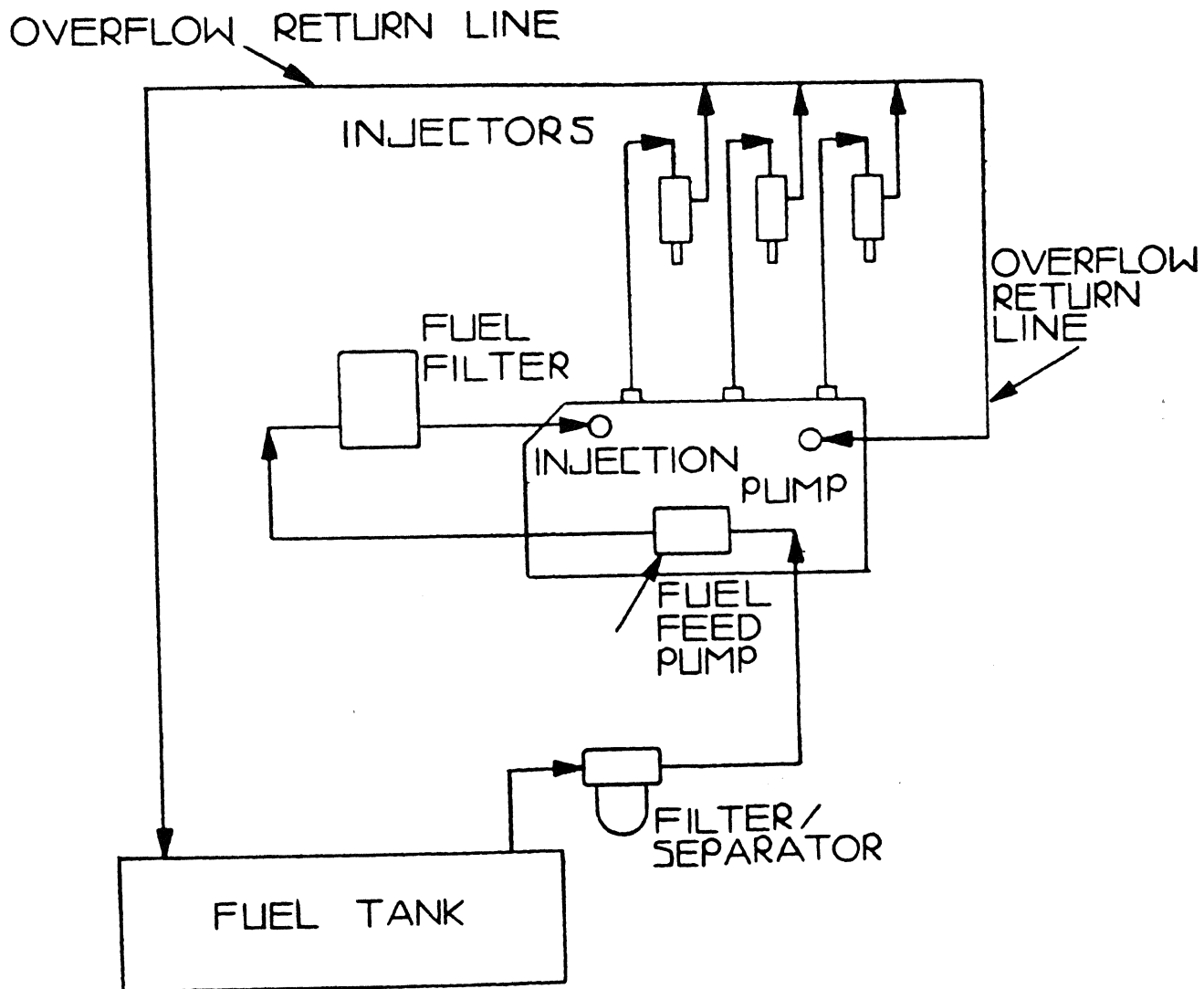


Figure 1-3. Fuel System Functional Diagram.

Fuel Tank - Retained by holddown straps to trailer frame. Has 19 gallon (17.9 liters) capacity. Has fuel level gauge, fuel source selector valve, filler cap, drain plug, and overflow return fitting.

Filter/Separator - Attached to trailer frame. A throwaway element removes nearly 100% of water and solid contaminants down to one micron in size.

Fuel Feed Pump - A diaphragm type pump actuated by cam in fuel injection pump. Cleanable inlet screen. Provides positive head of pressure to injection pump.

Fuel Injector Pump - A high pressure fuel delivery pump driven by gear in engine timing cover. Main shaft in pump has cams which operate plungers pumping fuel to injector nozzles. Mechanically controlled Models 13220E1070 (97403), 13225E9200 (97403), and LC 350GPM (36024) or electronically controlled Model 13226E2289 (97403).

Fuel Filter - A throw-away element removing contaminants from fuel on way to injection pump.

Injector Nozzles - Single inlet, four outlet, high pressure injectors. Spray fuel directly into cylinders.

Overflow lines - Carry excess fuel not needed for combustion to fuel tank and injection pump.

Handpump - Pressurizes reservoir forcing starting fluid (Ether) through system.

Reservoir - Has liquid level sight line--MAXI--to insure full servicing.

Nozzle - Screwed into engine air intake manifold. Directs fluid spray towards upstream end of manifold.

1-15. ELECTRICAL SYSTEM, Models 13220E1070, 13225E9200 (97403), (Figure 1-6) and LC 350GPM (36024) (Figure 1-6.1).

Batteries - Two 12 volt, 100 ampere hour, lead acid batteries.

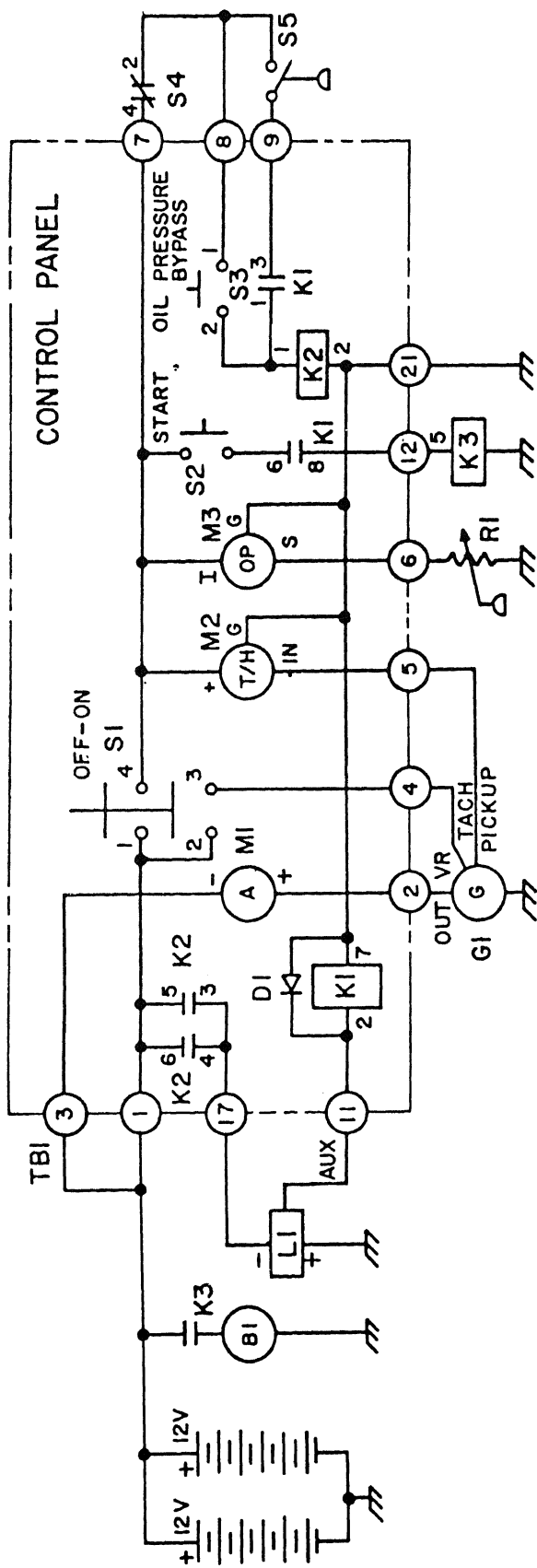
Supply power to all pumping assembly electrical circuits.

Emergency Stop Switch (S1) - Two position PUSH-PULL switch. PULL position provides normal operation. PUSH position cuts off power and shuts down assembly. Provides rapid engine shutdown. in event of emergency.

K2 Relay - A normally open relay, actuated by the bypass switch during start. Held closed when oil pressure reaches 4 to 7 psi and K1 relay is closed. K2 provides power to actuate fuel shutdown solenoid.

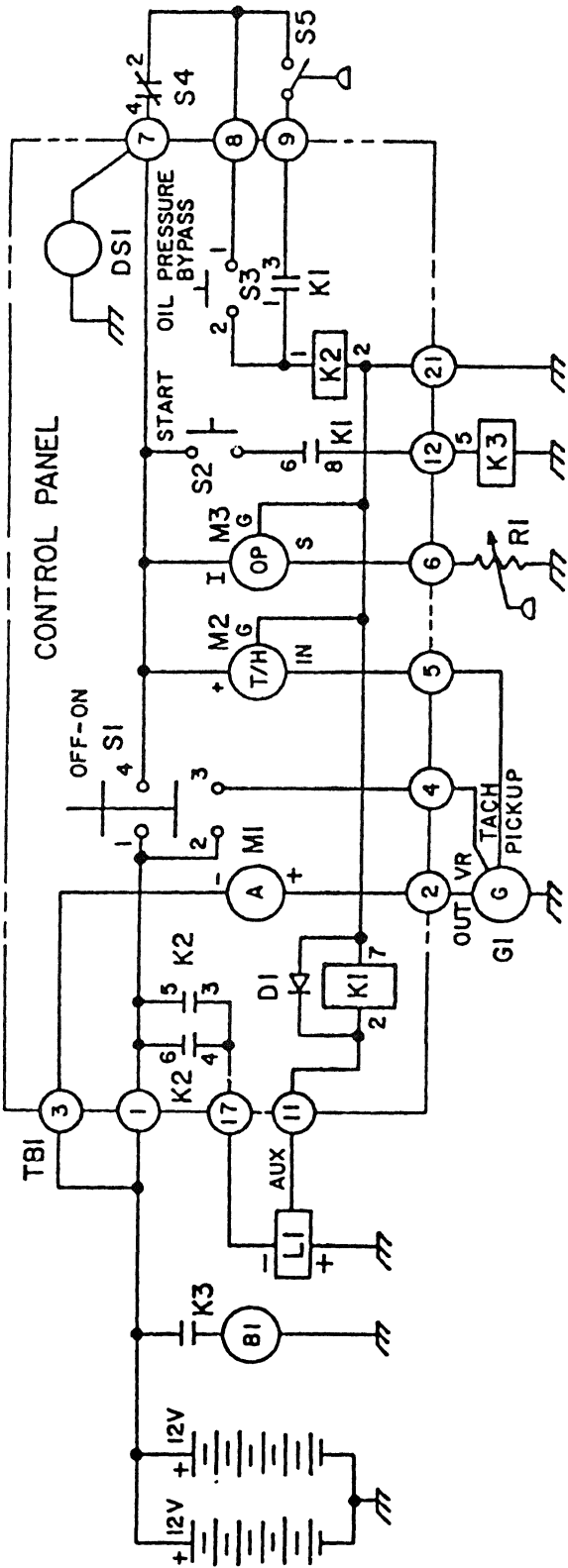
Fuel-Shut-down Solenoid - A two position 12 VDC rack type solenoid. Attached to governor cutoff lever, it provides positive fuel cutoff to shut-down engine. When fully retracted (fuel open), auxiliary tap (A) actuates K1 relay.

Panel Light (DS1) - A light circuit is energized when the Emergency Stop switch is pulled out. Provides illumination of control panel until switch is pushed in.



REF DES	PART NO.	DESCRIPTION
B1		MOTOR, STARTER
B1, 2		BATTERY
G1		ALTERNATOR
K1		RELAY, GP
K2		RELAY, POWER
K3		RELAY, STARTER
L1		SOLENOID, FUEL SHUTOFF
M1		AMMETER
M2		TACHOMETER/HOURMETER
M3		GAGE, OIL PRESSURE
R1		SENDING UNIT, OIL PRESSURE
S1		SWITCH, PUSH-PULL
S2, 3		SWITCH, PUSHBUTTON
S4		SWITCH, V-BELT
S5		SWITCH, LOW OIL PRESSURE
TBI		TERMINAL BOARD, 38TB-21
DI		DIODE, SILICONE RECTIFIER

Figure 1-6. Electrical Schematic, Models 13220E1070 (97403) and 13225E9200 (97403)



LIST OF COMPONENTS		
REF DES	PART NO.	DESCRIPTION
B1	P/O 13220E1067	MOTOR, STARTER
B1, 2	MS 35000-3	BATTERY
G1	P/O 13220E1067	ALTERNATOR
K1	13225E9080	RELAY, GP
K2	13225E9082	RELAY, POWER
K3	P/O 13220E1067	RELAY, STARTER
L1	P/O 13220E1067	SOLENOID, FUEL SHUTOFF
M1	13225E9069	AMMETER
M2	13225E9079	TACHOMETER/HOURMETER
M3	13225E9070	GAGE, OIL PRESSURE
R1	13225E9068	SENDING UNIT, OIL PRESSURE
S1	13225E9076	SWITCH, PUSH-PULL
S2, 3	13225E9067	SWITCH, PUSHBUTTON
S4	P/O 13220E1067	SWITCH, V-BELT
S5	P/O 13220E1067	SWITCH, LOW OIL PRESSURE
TBI	MIL-T-5516H/2	TERMINAL BOARD, 38TB-21
D1	1H5552	DIODE, SILICONE RECTIFIER
DS1	13227E9209	PANEL LIGHT

Figure 1-6.1. Electrical Schematic, Model LC 350GPM (36024).

ay - A normally open relay, actuated by auxiliary tap (A) of fuel shutoff solenoid. One contact of relay when closed, provides path for current flow from start switch to starter solenoid. Second contact of relay provides current flow through V-belt contact switch and low oil pressure switch to K2 relay coil.

Low Oil Pressure By-Pass Switch (S3) - A spring loaded off pushbutton switch. Operates only during engine start. When depressed, switch bypasses low oil pressure switch. K2 relay then energizes to allow fuel shut-down solenoid to retract (fuel open) and K1 relay coil to energize.

Start Switch (S2) - Spring loaded. When depressed (simultaneously with low oil pressure bypass switch), directs current through K1 relay contact to starter solenoid coil K3.

Starter Solenoid - A normally open 12vdc coil. When energized, engages starter drive with engine flywheel and allows battery power to rotate starter motor. Solenoid deenergized when start button released. Starter then disengages from engine.

Temperature-Contact Switch (S4) - A normally closed switch. Provides current path in series with low oil pressure switch and K1 relay contact keeping K2 relay coil energized. If cooling blower V-belt breaks, switch will deenergizing K2 relay coil. When K2 opens, fuel shut-down solenoid retracts (fuel closed) and engine shuts down.

Oil Pressure Switch - A normally open switch. Closes when oil pressure reaches 4 to 7 psi while starting. As long as oil pressure remains above close point, switch provides current path in series with V-belt contact switch and K1 relay contact keeping K2 relay coil energized. If oil pressure drops below 4-7 psi, pressure switch opens deenergizing K2 relay coil. When K2 opens, fuel shut-down solenoid retracts (fuel closed) and engine shuts down.

1-6. ELECTRICAL SYSTEM, Model 13226E2289 (97403). (Figure 1-7).

Batteries - Two 12 volt, 100 ampere hour, lead acid batteries. Supply power to all pumping assembly electrical circuits.

Emergency Stop Switch (S1) - Two position PUSH-PULL switch. PULL position provides normal operation. PUSH position cuts off power and shuts down assembly. Provides rapid engine shut-down in event of emergency.

K2 Relay - A normally open relay, actuated by the Bypass switch during start. Held closed when oil pressure reaches 4 to 7 psi and K1 relay is closed.

Run Switch - Two position ON-OFF toggle switch. It is in series with Emergency Stop Switch (S1) and provides power to alternator voltage regulator.

K1 Relay - A normally open relay, actuated by pressure control. One contact of relay when closed, provides path for current flow from start switch to starter solenoid. Second contact of relay provides current flow through V-belt contact switch and low oil pressure switch to K2 relay coil.

Oil Pressure Bypass Switch (S3) - A spring loaded off pushbutton switch. Used only during engine start. When depressed, switch by passes low oil pressure switch. K2 relay then energizes to allow K1 relay coil to energize.

Start Switch (S2) - Spring loaded. When depressed (simultaneously with oil pressure Bypass switch), directs current through K1 relay contact to starter solenoid coil K3.

Starter Solenoid - A normally open 12vdc coil. When energized, engages starter drive with engine flywheel and allows battery power to rotate starter motor. Solenoid deenergized when start button released. Starter then disengages from engine.

V-Belt Contact Switch (S4) - A normally closed switch. Provides current path in series with low oil pressure switch and K1 relay contact keeping K2 relay coil energized. If cooling blower V-belt breaks, switch will open deenergizing K2 relay coil. When K2 opens, pressure control shuts engine down.

Low Oil Pressure Switch - A normally open switch. Closes when oil pressure reaches 4 to 7 psi while starting. As long as oil pressure remains above close point, switch provides current path in series with V-belt contact switch and K1 relay contact keeping K2 relay coil energized. If oil pressure drops below 4-7 psi, pressure switch opens deenergizing K2 relay coil. When K2 opens, pressure control shuts engine down.

CHAPTER 2
OPERATING INSTRUCTIONS

Section I. DESCRIPTION AND USE OF OPERATOR'S CONTROLS AND INDICATORS

2-1. OPERATOR'S CONTROLS.

a. Control Panel. The control panel is located on the forward right side of the pumping assembly. It contains the following controls. See figure 2-1.

- (1) Start/Stop. This switch is a push-pull type switch and is marked EMERGENCY STOP, PULL TO RESET and PUSH TO STOP for Model LC 350GPM (36024) and PULL TO START, PUSH TO STOP for Models 133220E1070 (97403), 13226E2289 (97403), and 13225E9200 (97403). The switch is pulled out during engine start cycle and remains pulled out while engine is operating. It is pushed in to shut down engine.
- (2) Start Switch. This switch is a pushbutton type switch and is marked PUSH TO START for Model LC 350GPM (36024) and START for Models 13220E1070 (97403), 13226E2289 (97403), and 13225E9200 (97403). The switch is pushed in and held during engine start to activate K3 start relay. The switch is released upon ignition.
- (3) Oil Pressure Bypass Switch. This switch is a pushbutton type switch and is marked PUSH FOR OIL PRESSURE BYPASS for Model LC 350GPM (36024) and OIL PRESSURE BYPASS for Models 13220E1070 (97403), 13226E2289 (97403), and 13225E9200 (97403). The switch must be pushed in simultaneously with start switch during engine start. The oil pressure bypass switch is released upon ignition and oil pressure buildup.
- (4) Oil Pressure Gauge. Indicates engine oil pressure by pounds per square inch (PSI). This gauge is graduated in 10 pound increments from 0 to 80 PSI.
- (5) Tachometer/Hourmeter. Indicates engine speed in revolutions per minute (RPM). This gauge is graduated in 100 RPM increments from 0 to 3000 RPM. The center portion of the gauge indicates the total number of hours the engine has been operated.
- (6) Ammeter Gauge. Indicates alternator amperage output. This gauge is graduated in 30 amp increments from 0 to +60 AMPS and from 0 to -60 AMPS.
- (7) Suction Gauge. This gauge is marked SUCTION and indicates pump suction pressure and vacuum per square inch (PSI). This gauge is graduated in one unit increments from 0 to 30 psi for both vacuum and pressure with numerals at five unit intervals on the pressure side and at ten unit intervals on the vacuum side.

(8) Discharge Gauge. This gauge is marked DISCHARGE and indicates pump discharge pressure in pounds per square inch (PSI). This gauge is graduated in 5 pound increments from 0 to 160 psi with numerals at 20 psi intervals.

** (9) Engine Throttle. Provides manual speed selection. Turning throttle control counterclockwise increases engine speed. Clockwise rotation decreases engine speed.

(10) Handpump. Used to pressurize the cold start reservoir. If the outside air temperature is below +40°F (+5°C) the cold start system may be used to assist in starting engine.

* (11) Manual Speed Control. This control provides for manual control of engine speed from IDLE (low speed) to HIGH (full speed) when Mode Selector (12) is in manual position.

† (12) Mode Selector. This control provides for the following modes of operation:

START - Connects regulating system to pumping assembly starting circuit.

MANUAL - Established control over engine speed by use of Manual Speed Control.

AUTO - Provides automatic pump discharge pressure and engine speed regulation.

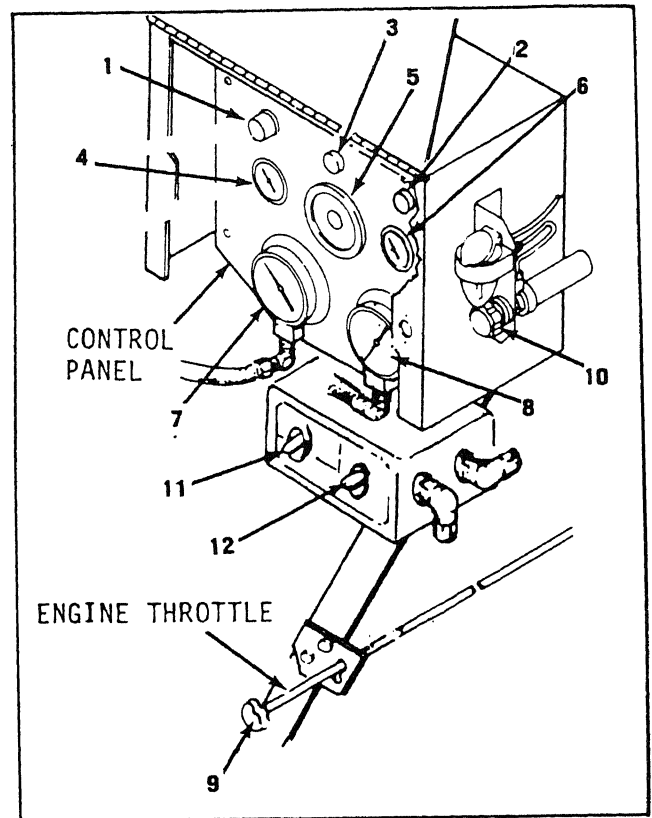


Figure 2-1. Control Panel

* Used on Model 13226E2289 (97403).

**Used on Models 13220E1070 (97403), 13225E9200 (97403), and LC 350GPM. (36024).

Table 2-1. Operator/Crew Preventive Maintenance Checks and Services-Continued

Item No	Interval					Item to be inspected	Procedures Check for and have repaired or adjusted	Equipment is not ready/available if:
	B	D	A	W	M			
5-continued							hours of operation. Check warning device for correct function after at least every 100 hours of operation.	
6	•	•	•			Fuel Lines	Visually inspect unit for fuel leaks.	Leaks are present.
7	•	•	•			Oil lines	Visually inspect unit for oil leaks.	Leaks are present.
8	•		•			Fuel Tank	Check fuel tank fitting, lines, drain plug and all tank surfaces for leaks or any other damage. Check tank retaining straps for security. Check fuel level gauge for damage. Check for clogged strainer, clean as required.	Leaks are present.
9	•					Air Cleaner	Check service indicator for red signal indicating that elements require replacement. If signal shows, replace elements in accordance with paragraph 3-4.	
10	•		•			Alternator	Check that alternator and all electrical connections are secure and no broken wires are present.	
11	•	•				Controls and instruments	Inspect for damage, secure mounting and proper operation of controls and instruments.	

Table 2-1. Operator/Crew Preventive Maintenance Checks and Services-Continued

Item No	Interval					Item to be inspected	Procedures Check for and have repaired or adjusted	Equipment is not ready/available if:
	B	D	A	W	M			
* 12	•		•			Throttle control	Inspect for worn or loose control mechanism.	Throttle control inoperative.
13	•		•			Wiring Harness	Inspect for frayed or worn spots in wiring harness.	If wiring excessively frayed, worn or deteriorated.
14	•		•			Tires	Check for proper inflation; be sure tires are not excessively worn. Check that both tires are worn evenly.	
15	•		•			Wheel	Check for damaged wheels. Check that lug nuts on wheels are securely tightened. Check that bearing caps are properly seated and tight.	
16	•		•			Axle	Visually inspect for broken welds, torsion spring, bent or otherwise damaged axle.	
17	•		•			Frame Assembly	Inspect for broken welds, reflectors, damaged landing leg assemblies and damaged towbar.	

*Used on models 13220E1070, 13225E9200 (97403), and LC 350GPM (36024)

2-6. STARTING AND SHUTDOWN PROCEDURES, Models 13220E1070, 13225E9200 (97403), and LC 350GPM (36024).

WARNING

Ear protection must be worn when within 50 feet (15.2 m) of operating unit.

CAUTION

Never operate pump unless pump housing is filled with liquid. The pump will not pump when dry. Extended operation of a dry pump will destroy the seal assembly.

a. Starting

- (1) Open vent valve (1, figure 2-6) and insure that all suction valves (2), and discharge valves (3) are closed.
- (2) Check pump fluid level by carefully opening camlock levers on priming port cap (4) and raising port cap slightly to see if liquid is discharged from priming port. If liquid is discharged, quickly install priming port cap and place camlock levers in locked position. If fluid is not discharged, remove port cap and add clean liquid of the type to be pumped, until the liquid level reaches the top of the priming port.

WARNING

Failure to replace priming port cap and lock securely will result in a two inch (5.08 cm) stream of liquid at high pressure, creating a severe fire hazard if the fluid is flammable.

- (3) Install priming port cap (4) and place camlock levers in locked position.
- (4) Push and raise throttle control (5) from detent latch, releasing it to the idle position.

NOTE

If outside temperature is below +10°F (-12°C) refer to paragraph 2-8 for operation of cold start system.

Refer to table 2-2 for performance data.

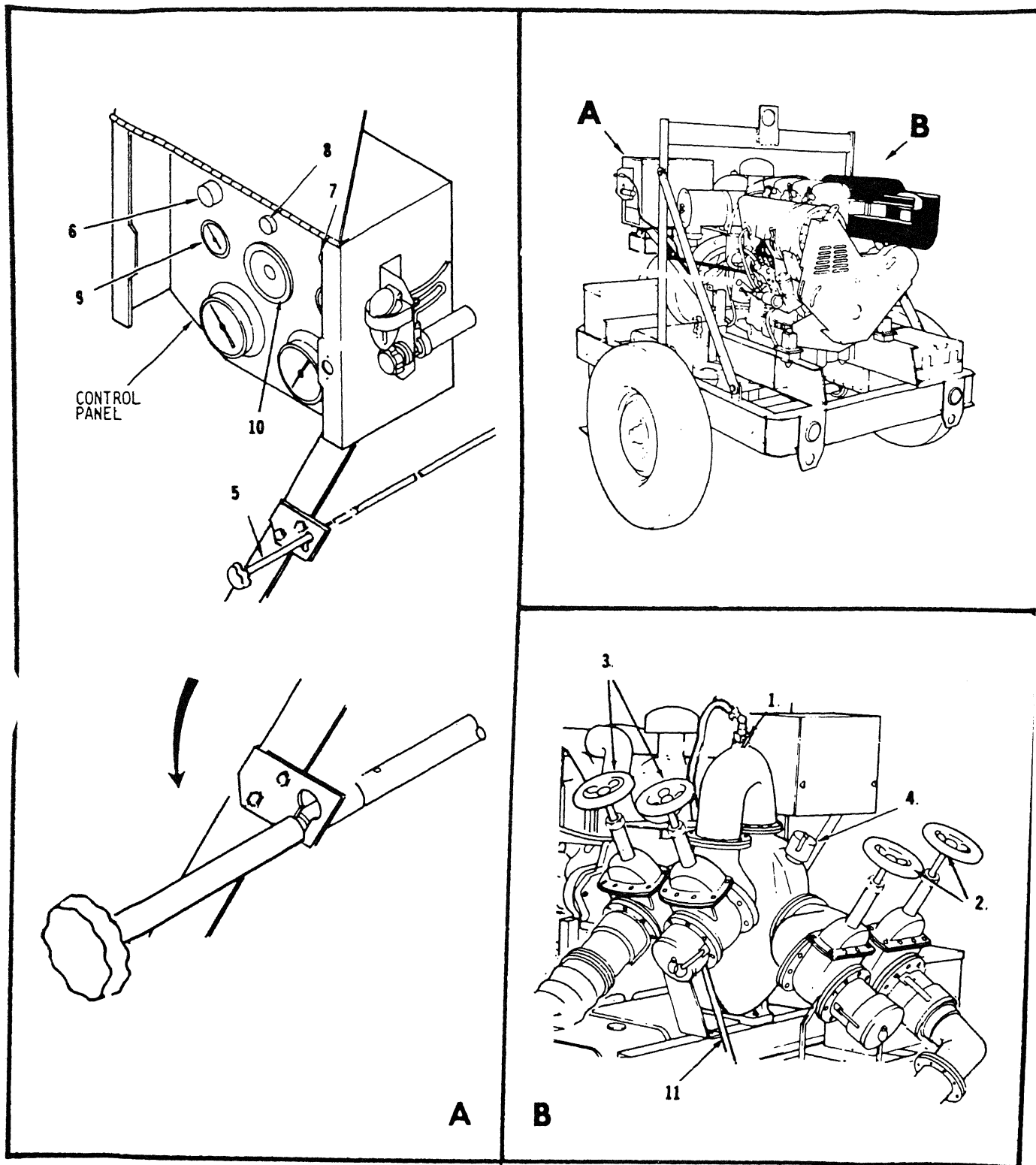


Figure 2-6. Starting and Shutdown Controls for Models 13220E1070, 13225E9200 (97403), and LC 350GPM (36024).

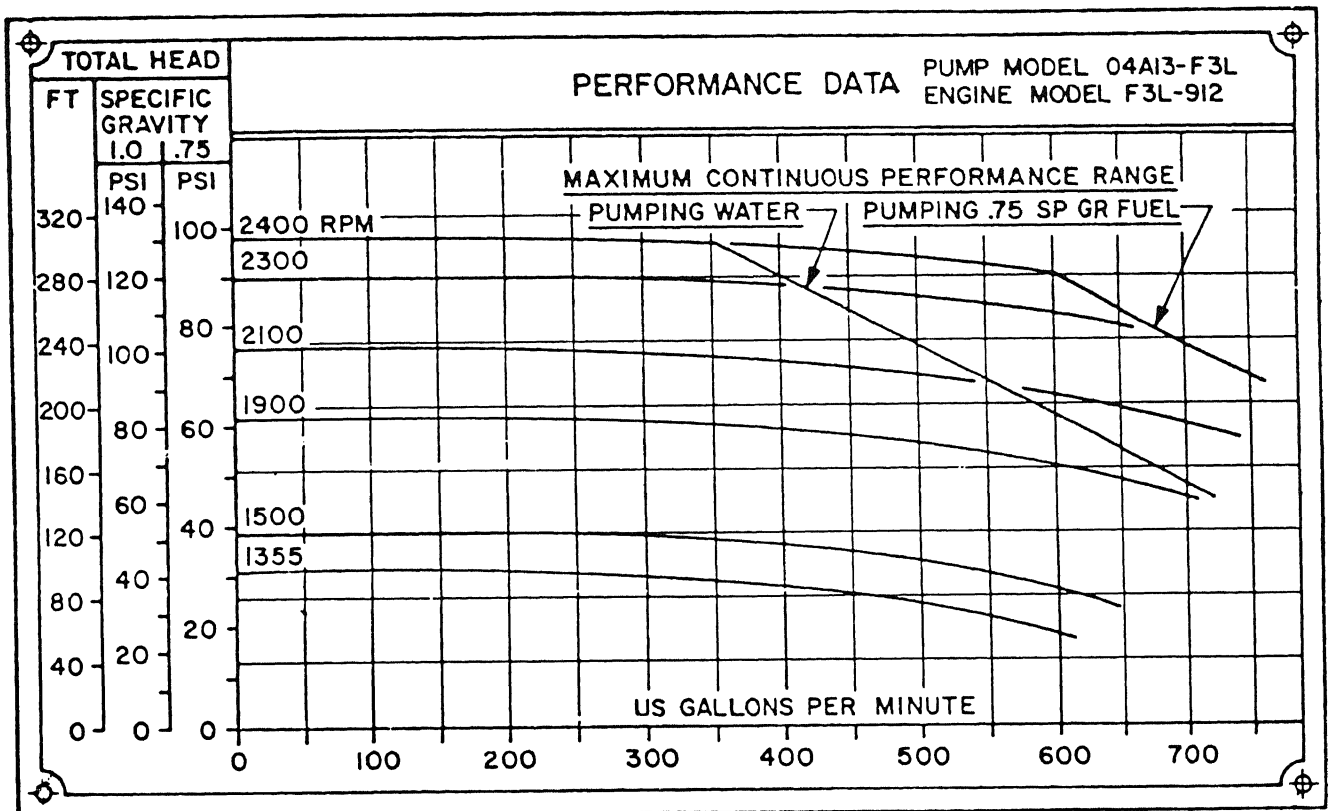


Table 2-2. Performance Data

- (5) Pull out EMERGENCY STOP switch (6).

CAUTION

Do not operate starter motor for more than 10 seconds, damage to starter can result.

- (6) Push in start switch (7) and oil pressure bypass switch (8) simultaneously.
- (7) Upon engine start, release start switch (7).

NOTE

The engine will shutdown when oil pressure bypass switch is released if oil pressure is not 8 psi or above.

- (8) Release oil pressure bypass switch (8) when 8 psi is exceeded on gauge (9).
- (9) Allow engine to idle approximately two minutes, then smoothly push throttle control (5) into detent.
- (10) Turn throttle control counterclockwise to increase or clockwise to decrease engine speed to approximately 2400 revolutions per minute (RPM) as indicated on gauge (10).
- (11) Open suction valve (2) that is connected to suction line.
- (12) Slowly open discharge valve (3) that is connected to discharge line.
- (13) Observe the end of vent line (11) for liquid flowing from it. Once liquid begins to flow from line, close vent valve (1).

CAUTION

As pump begins to pump, reduce engine speed and reduce discharge valve opening to prevent hydraulic shock to system when line is filled too fast, causing hose rupture and fitting failure.

NOTE

When pump picks up prime, a change in engine RPM will be noted.

Depending on pumping conditions, pump may not take suction immediately. It may be necessary to fill suction line with liquid before the pump takes suction. If after a reasonable time pump fails to take suction, shutdown engine and check suction line for leaks, then repeat steps (1) thru (13).

- (14) Readjust pump speed to desired level.
- (15) Check all control panel gauges for indications of malfunctions. If a malfunction is indicated, shutdown pump immediately.
- (16) Perform during operation PMCS (table 2-1).

CAUTION

Ensure discharge valve is open. Pump can overheat if discharge valve is closed for long periods of time. A vapor-locked condition may result. If this occurs, shutdown engine and allow pump to cool before filling housing with liquid.

b. Shutdown

CAUTION

Do not shut engine down suddenly from full speed unless an emergency exists. Allow engine to stabilize at idle before shutdown.

- (1) Push and raise throttle control (5, figure 2-6) from detent to set engine speed to idle.
- (2) After approximately two minutes, close discharge valve (3) and suction valve (2).
- (3) Push in EMERGENCY STOP switch (6).
- (4) Perform after operation PMCS (Table 2-1).

STARTING AND SHUTDOWN PROCEDURES, Model 13226E2289 (97403).

WARNING

Ear protection must be worn when within 25 feet (7.6m) of operating unit.

CAUTION

Never operate pump unless pump housing is filled with liquid. The pump will not pump when dry. Extended operation of a dry pump will destroy the seal assembly.

a. Starting

- 1) Open vent valve (1, figure 2-7) and insure all suction valves (2) and discharge valves (3) are closed.
- 2) Check pump fluid level by carefully opening camlock levers on priming port cap (4) and raising port cap slightly to see if liquid is discharged from priming port. If liquid is discharged from priming port, quickly install port cap and place camlock levers in locked position. If fluid is not discharged, remove port cap, add clean liquid of the type to be pumped, until the liquid level reaches the top of the priming port.

WARNING

Failure to replace priming port cap and lock securely will result in a two inch (5.08 cm) stream of liquid at high pressure, creating a severe fire hazard if the liquid is flammable.

- (3) Install priming port cap (4) and place camlock levers in locked position.

CHAPTER 3

OPERATOR'S MAINTENANCE INSTRUCTIONS

Section I. LUBRICATION INSTRUCTIONS

3-1. GENERAL LUBRICATION INFORMATION. Refer to LO 5-4320-226-12.

3-2. DETAILED LUBRICATION INFORMATION. Keep all lubricants in closed containers and store in a clean dry area away from excessive heat. Do not allow dust, dirt, or other foreign matter to mix with the lubricants. Keep the lubrication equipment clean and ready for use. Before lubricating the equipment wipe all lubrication points to remove dirt and grease. After lubricating, clean all lubrication points of any spilled or excessively applied lubricant to prevent accumulation of dirt and foreign matter. Keep all external surfaces and parts not requiring lubrication free of lubricants. Inspect all oil lines, fitting and filters for leaks immediately after lubrication and during operation.

CAUTION

Use only the type lubricants specified on current lubrication order and do not over lubricate. Over lubrication may cause equipment failure or damage to working parts.

Section II. TROUBLESHOOTING PROCEDURES

3-3. TROUBLESHOOTING TABLE. The Troubleshooting Table 3-1 contains information useful in diagnosing and correcting unsatisfactory operation or malfunction of the pumping assembly.

a. Table 3-1 lists common malfunctions which may be encountered during operation or maintenance of the pumping assembly or its components. Perform the tests/inspections and corrective actions in the order listed.

All data on pages 3-2 and 3-3 including figure 3-1 deleted.

Table 3-1. Troubleshooting

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
AIR CLEANER		
1. EXHAUST SMOKE EXCESSIVELY BLACK.		
	Step 1. Visually inspect for dirty cartridge.	
		a. Clean cartridge .
		b. Replace cartridge and safety cartridge. Notify organizational maintenance.
2. AIR CLEANER IS LOOSE.		
	Step 1. Inspect for loose or broken clamps. Notify organizational maintenance.	
	Step 2. Inspect for loose mounting plate. Notify organizational maintenance.	
EXHAUST SYSTEM		
1. EXHAUST HEAT SHIELD LOOSE.		
	Step 1. Inspect for loose or damaged fasteners. Notify organizational maintenance.	
2. EXHAUST HEAT SHIELD DAMAGED.		
	Step 1. Inspect for bent or broken heat shield. Notify organizational maintenance.	
3. SPARK ARRESTOR.		
	Step 1. Inspect for clogged or damaged arrestor. Notify organizational maintenance.	
4. EXHAUST PIPE LOOSE OR LEAKS.		
	Step 1. Check for loose connections allowing exhaust pipe to move. Notify organizational maintenance.	
	Step 2. Check for burned out exhaust pipe. Notify organizational maintenance.	

Section III. MAINTENANCE PROCEDURES

3-4. AIR CLEANER (figure 3-2). Dust in combustion air can cause premature wear of engine. Maintenance of air cleaner is therefore essential to ensure long life. The air cleaner must be replaced when indicator (1) keeps displaying red warning signal when engine is shut down. Another indication that cartridge needs replacing is a smoking exhaust and decreasing engine output. Report any of these conditions to organizational maintenance for replacement of air cleaner elements.

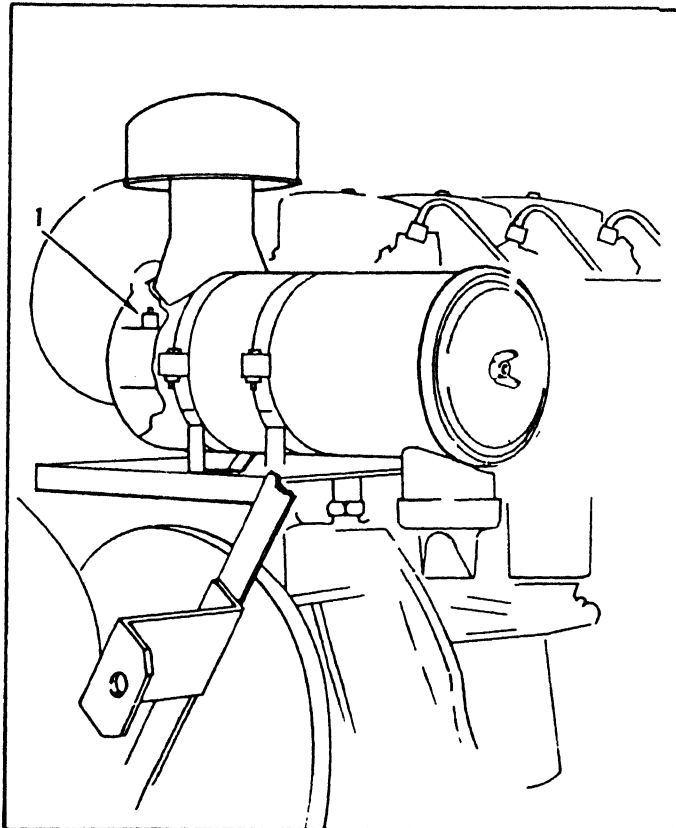


Figure 3-2. Inspecting Air Cleaner

3-5. BATTERIES AND CABLES (figure 3-3).

CAUTION

To prevent short circuits, never rest tools on battery.

a. Servicing. Prior to operating the unit, check electrolyte level in each cell as follows:

- (1) Remove caps (1).
- (2) Visually check the electrolyte level of all cells.
- (3) Electrolyte level must cover lead plates (2) and be to a level at the lower portion of the fill hole.

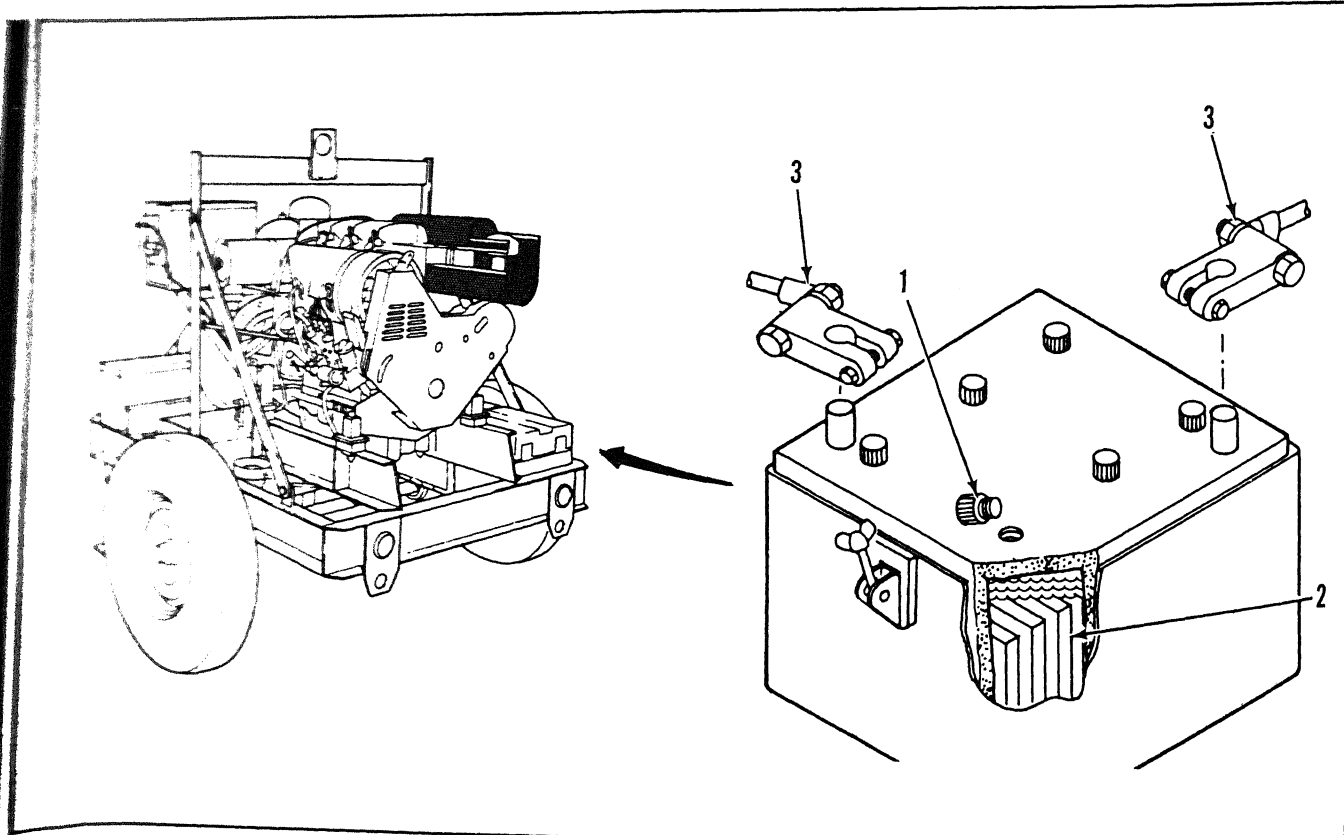


Figure 3-3. Servicing Batteries and Cables

WARNING

To prevent serious burns, take necessary precautions when filling battery with electrolyte. Do not allow electrolyte to come in contact with skin or eyes. Use rubber gloves and protective clothing.

- (4) If electrolyte level is low, add water only.
- (5) Replace caps (1).

CAUTION

Remove negative (-) battery cable first to prevent possible electrical arc.

- (6) Remove battery cables (3), clean terminals and posts with standard battery cable and post cleaning brush.
- (7) Install battery cables (3), tighten terminals and coat with clean grease.

3-6. FUEL TANK

a. Servicing. Ensure that fuel tank does not run dry, otherwise fuel filter and injection lines will require bleeding of air from fuel system.

WARNING

Do not smoke or use an open flame in the vicinity when filling fuel tank.

NOTE

Observe strict cleanliness during replenishing of fuel tank. At low ambient temperatures, use wintergrade fuel only.

- (1) Check fuel level. If low replenish promptly. Fill tank to (F) mark on quantity indicator.
- (2) Remove tank filler cap and inspect gasket for damage.
- (3) Ensure that vent valve is open.
- (4) Check filler neck for debris.
- (5) Install filler cap.

3-7. FUEL FILTER/SEPARATOR SERVICING (figure 3-4).

CAUTION

The fuel filter/separator must be drained after operation if the ambient temperature is expected to fall below 32°F (0°C).

- a. Place bucket under fuel filter separator.
- b. Open petcock (1) on Model 13226E2289 (97403) or remove plug (2) on Models 13220E1070 (97403), 13225E9200 (97403), and LC 350GPM (36024) to drain fuel filter/separator.
- c. Close petcock (1) on Model 13226E2289 (97403) or install plug (2) on Models 13220E1070 (97403), 13225E9200 (97403), and LC 350GPM (36024).

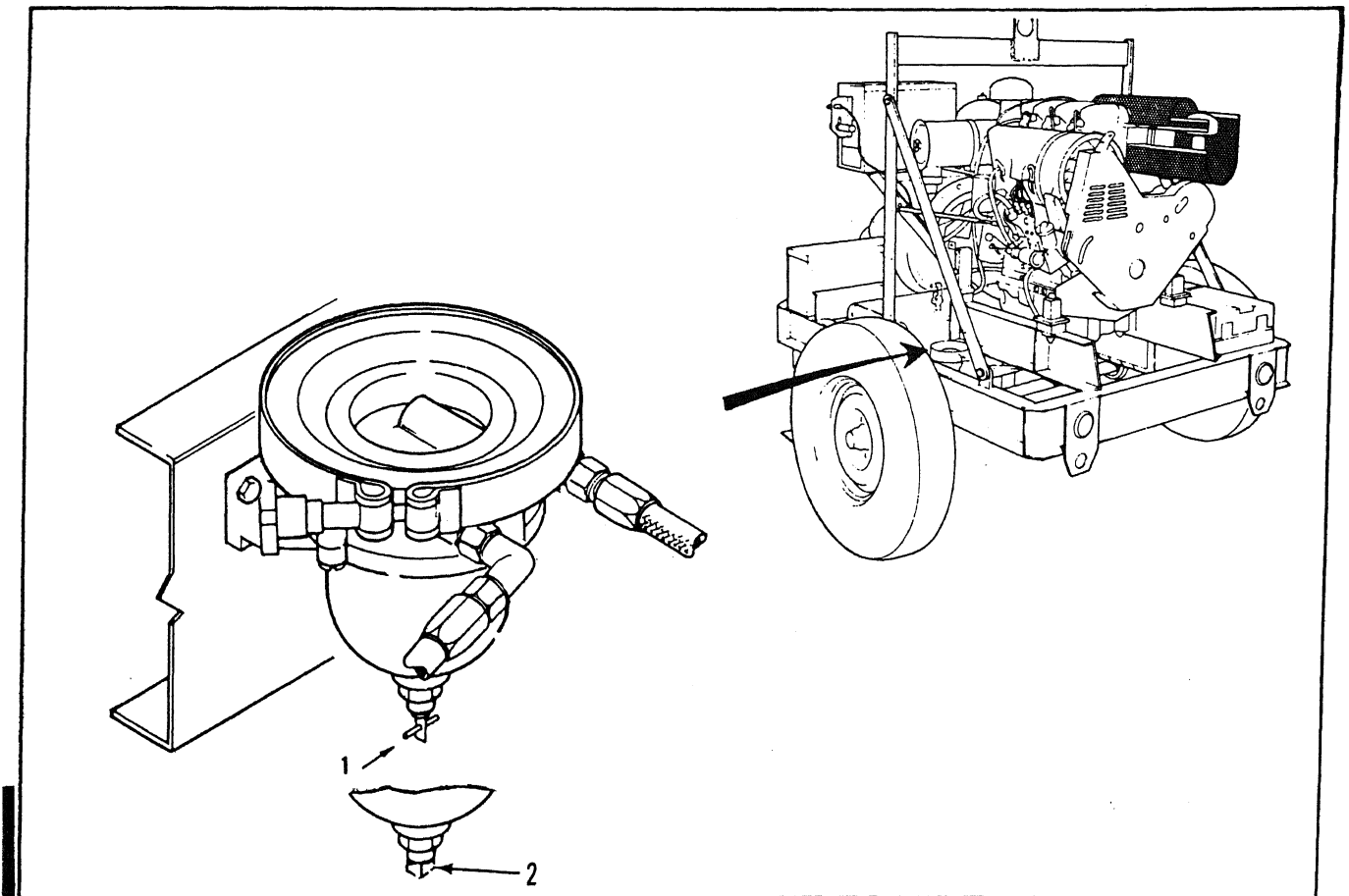


Figure 3-4. Fuel Filter/Separator Servicing

Table 4-2. Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
ELECTRICAL SYSTEM-continued		
2. ENGINE FAILS TO CRANK-continued.	Step 2. Check terminals for corrosion.	Clean terminals, tighten and coat with grease (refer to paragraph 3-5).
	Step 3. Check battery charge using hydrometer.	<p>a. If battery condition is low (minimum of 1.250 specific gravity), recharge battery.</p> <p>b. Replace battery (refer to paragraph 4-15).</p>
3. BATTERY WILL NOT MAINTAIN CHARGE.	Step 1. Check for broken or frayed wires between alternator and voltage regulator.	Replace wires.
	Step 2. Check alternator output.	Replace alternator (refer to paragraph 4-20).
	Step 3. Check for loose or corroded connections at battery.	Clean and tighten connections (refer to paragraph 3-5).
	Step 4. Check V-belt tension.	Tighten V-belt (refer to paragraph 4-18).
4. STARTER FAILS TO CRANK.	Step 1. Check for loose or corroded terminals on battery.	Clean and tighten terminals (refer to paragraph 3-5).
	Step 2. Check for broken or frayed cables.	Replace cables (refer to paragraph 4-16).

Table 4-2. Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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ELECTRICAL SYSTEM-continued

4. STARTER FAILS TO CRANK-continued.

Step 3. Inspect electrolyte in batteries.

If fluid is low, refill with water (refer to paragraph 3-5).

Step 4. Check battery charge using hydrometer.

a. If battery condition is low (minimum of 1.250 specific gravity), recharge battery.

b. Replace battery (refer to paragraph 4-16).

Step 5. Check for loose connections at starter solenoid.

Tighten connections.

Step 6. Inspect for proper starter operation.

Replace starter (refer to paragraph 4-21).

5. V-BELT CONTACT SWITCH NOT FUNCTIONING.

Step 1. Check for loose, broken or frayed wiring.

a. Tighten any loose connections.

b. Replace any damaged wiring.

Step 2. Test switch for proper operation.

Replace switch (refer to paragraph 4-22).

6. NO ELECTRICAL POWER.

Step 1. Visually inspect wiring harness for corroded or dirty connections, broken, frayed, or damaged wires.

a. Clean all corroded or dirty connections and tighten securely.

b. Replace any damaged wires (refer to paragraph 4-23).

c. Replace harness assembly (refer to paragraph 4-23).

Table 4-2. Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
FUEL SYSTEM		
1. THROTTLE STICKS. Models 13220E1070 (97403), 13225E9200 (97403), and LC 350GPM (36024).	Step 1. Check for bent, broken, or damaged control arm.	Replace throttle control (refer to paragraph 4-24).
	Step 2. Check for frozen fuel control lever at injection pump.	a. Free fuel control lever. b. Notify direct support maintenances.
2. ENGINE FAILS TO START.	Step 1. Check fuel supply in fuel tank.	a. Fill with fuel if empty or low (refer to paragraph 3-6). b. If tank was empty, bleed fuel system (refer to paragraph 4-26).
	Step 2. Check for loose, broken, frayed or damaged wires between fuel shut-down solenoid, low oil pressure switch and V-belt switch.	Replace or repair wires as required.
	Step 3. Check for closed shut-off valve.	Open shut-off valve. and bleed fuel system, if necessary.
	Step 4. Inspect for broken fuel lines or hoses and loose fittings.	a. Replace broken fuel lines or hoses (refer to paragraph 4-26). b. Tighten all fuel line connections.
	Step 5. Inspect for blocked or damaged fuel filter.	a. Replace filter and bleed fuel system (refer to paragraph 4-28). b. If in winter replace filter, bleed fuel system and use winter-grade fuel.

Table 4-2. Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
FUEL SYSTEM-continued		
2. ENGINE FAILS TO START-continued.	Step 6. Check for blocked strainer in fuel feed pump; verify pump operates properly.	a. Wash strainer (refer to paragraph 4-29). b. Replace fuel feed pump; bleed fuel system (refer to paragraph 4-29).
	Step 7. Inspect for leaks at fuel tank. Notify direct support maintenance.	
	Step 8. Check for air in fuel lines. Locate point of air entrance; tighten if loose connection and bleed fuel system.	
	Step 9. If operating during winter, check for fuel clouding. Replace filter, bleed fuel system and use winter-grade fuel (refer to paragraph 4-28).	
	Step 10. Check injection pump for proper operation. Notify direct support maintenance.	
3. COLD START SYSTEM FAILS TO ASSIST CRANKING OF ENGINE DURING COLD START.	Step 1. Check reservoir for ether supply. Fill reservoir.	
	Step 2. Inspect pumping action of pump. Replace pump (refer to paragraph 4-30).	
ENGINE ASSEMBLY		
1. ENGINE FAILS TO START.	Step 1. Inspect fuel supply in tank. Fill tank with proper fuel and bleed fuel system (refer to paragraph 3-6).	

e. Installation (figure 4-4)

- (1) Slide hose onto air cleaner assembly (5).
- (2) Position clamps (4) around air cleaner and install screws (3) and nuts (2).
- (3) Tighten clamp (1) to secure hose.

4-11. EXHUAUST HEAT SHIELD (figure 4-5).

a. Removal.

- (1) Loosen nut (1) and clamp (2). Slide clamp onto exhaust pipe and remove spark arrestor (3).
- (2) Remove nuts (4), washers (5), bolts (6) and spacer (7).
- (3) Slide heat shield (8) off muffler and exhaust pipe.

b. Installation.

- (1) Position heat shield (8) over muffler and exhaust pipe such that cutout in heat shield is over exhaust pipe.
- (2) Secure heat shield with spacer (7), bolts (6), washers (5) and nuts (4).
- (3) Place spark arrestor (3) on exhaust pipe, position clamp (2) and tighten nuts (1).

4-12. SPARK ARRESTOR (figure 4-5).

a. Removal.

- (1) Loosen nuts (1) and clamp (2). Slide clamp onto exhaust pipe and remove spark arrestor (3).

b. Disassembly (figure 4-6).

- (1) Remove nut (1), washer (2) and cap (3).
- (2) Remove baffles (4) from base (5).

c. Cleaning.

WARNING

Potential health hazards result from inhalation of petroleum solvent vapors and from contact of solvent with skin. Use rubber gloves and hand cream for protection, and work with adequate ventilation.

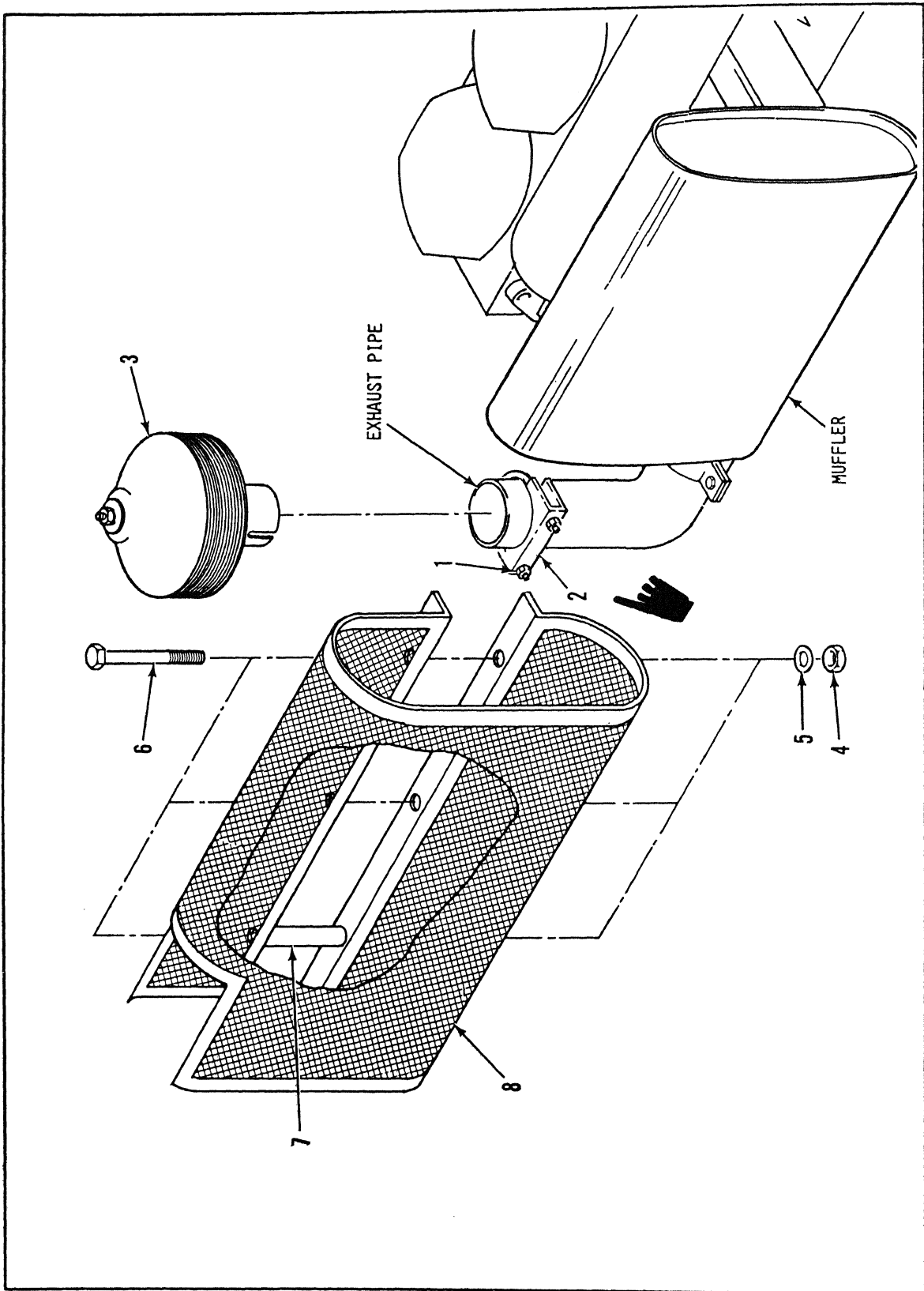


Figure 4-5. Exhaust Heat Shield and Spark Arrestor, Removal/Installation

CAUTION

Petroleum solvents are highly flammable. Keep solvent container lids closed when not in use, and avoid all possible risks of igniting solvent vapors, keep away from open flame and excessive heat. Flash point of solvent is 100 to 138 degrees F (38 to 59 degrees C.)

- (1) Clean all parts of spark arrestor with wire brush and solvent, Federal Specification P-D-680, Type II.

d. Inspection.

- (1) Inspect baffles for cracks, holes or other damage.
- (2) Check base for cracks and holes. Check mounting stud to make sure it is secure.
- (3) Replace any damaged or burned parts.

e. Assembly (figure 4-6).

- (1) Align indentations of baffles (4) and position to base (5) as indicated in figure 4-6.
- (2) Position cap (3) and install washer (2) and nut (1).

f. Installation (figure 4-5).

- (1) Place spark arrestor (3) on exhaust pipe.
- (2) Position clamp (2) and tighten nuts (1)

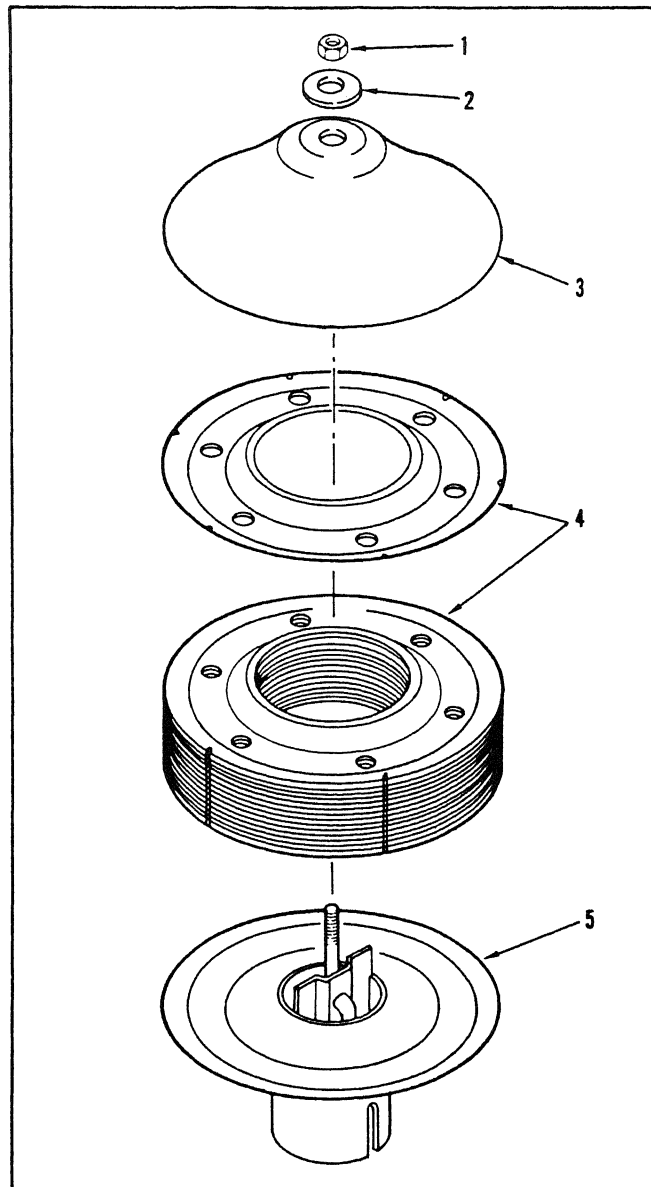


Figure 4-6. Spark Arrestor, Assembly/Disassembly

4-13. EXHAUST PIPE (figure 4-7).

a. Removal.

- (1) Loosen nuts (1) and clamp (2). Remove spark arrestor (3) and nuts and clamp.
- (2) Loosen nut (4), washer (5), bolt (6) and clamp (7).
- (3) Pull exhaust pipe (8) out of muffler.

b. Installation.

- (1) Slide exhaust pipe (8) into muffler and position with open end up.
- (2) Position clamp (7) and tighten bolt (6), washer (5) and nut (4).
- (3) Place clamp and nuts over exhaust pipe.
- (4) Place spark arrestor (3) on exhaust, position and tighten clamp (2) and nuts (1).

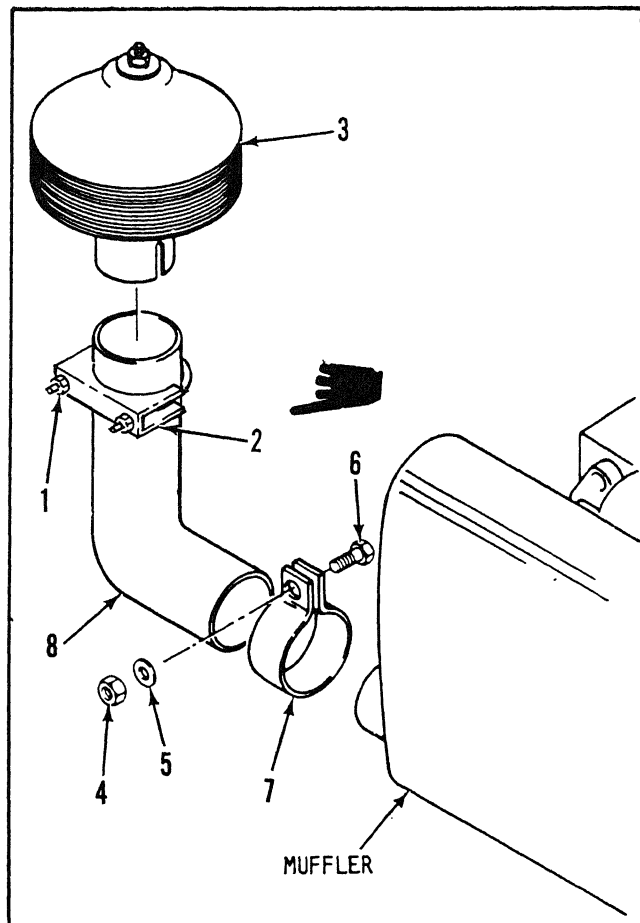


Figure 4-7. Exhaust Pipe, Removal/Installation

4-14. MUFFLER (figure 4-8).

a. Removal.

- (1) Refer to paragraphs 4-11 and 4-12 to remove heat shield and spark arrestor.
- (2) Loosen nut (1), washer (2), bolt (3) and clamp (4).
- (3) Pull exhaust pipe (5) out of muffler and remove nut, bolt and clamp.
- (4) Remove nuts (6) and (7) and washers (8).
- (5) Carefully remove muffler (9) from studs.
- (6) Remove gaskets (10).

b. Inspection.

- (1) Inspect muffler for holes or cracks.
- (2) Check to ensure internal components are not burned out.

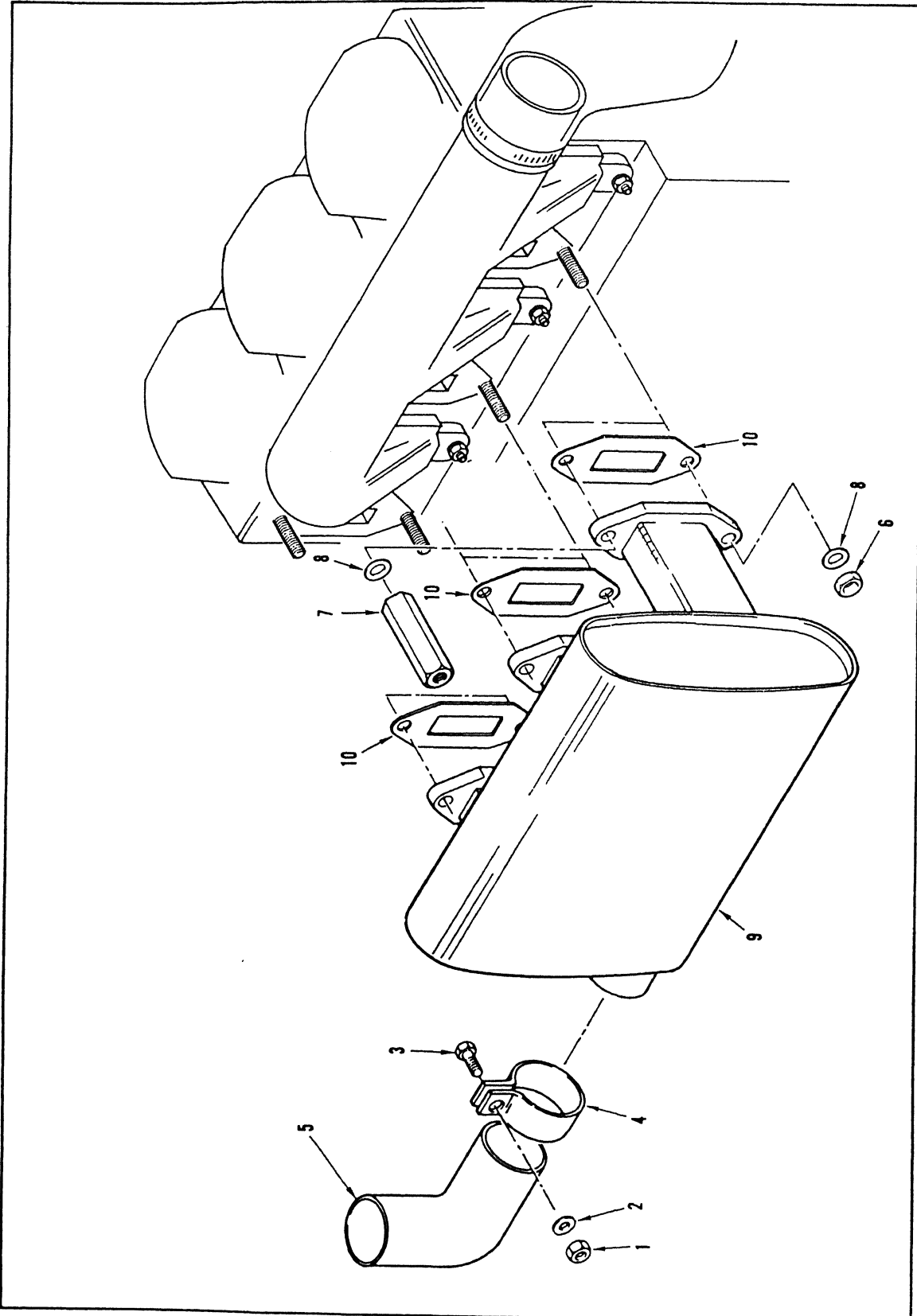


Figure 4-8. Muffler, Removal/Installation

c. Installation.

- (1) Position gaskets (10) over studs.
- (2) Carefully position muffler (9) over studs, with open end facing aft.
- (3) Install washers (8) and nuts (6) and (7). Do not fully tighten at this time.
- (4) Slide exhaust pipe (5) into muffler and position with open end up.
- (5) Slide clamp (4) over exhaust pipe to mating edge of muffler.
- (6) Tighten nut (1), washer (2) and bolt (3) to secure clamp. Tighten securely, but do not overtighten.
- (7) Securely tighten nuts (6) and (7).
- (8) Refer to paragraphs 4-11 and 4-12 to install heat shield and spark arrestor.

4-15. BATTERY BOX AND COVER (figure 4-9).

a. Removal.

- (1) Loosen wing nuts (1) and pull eye bolts (2) down so that they clear top of bar (3).
- (2) Remove bar (3) and covers (4).

NOTE

If required, remove information plate by drilling out four drive screws.

CAUTION

Remove negative (-) battery cable first to prevent possible electrical arc.

- (3) Loosen battery terminals (5), and remove from batteries. Place cables and jumpers out of the way.
- (4) Remove batteries (6) from boxes.
- (5) Remove nuts (7) washers (8) and (9) and screw (10).
- (6) Remove box (11).

b. Installation.

- (1) Position box (11) to frame.
- (2) Install screw (10), washers (9) and (8) and nuts (7).
- (3) Position batteries (6) in box.
- (4) Place battery terminals (5) on battery and tighten terminals. Coat terminals with grease.

NOTE

If required, place information plate on battery box cover and install four drive screws.

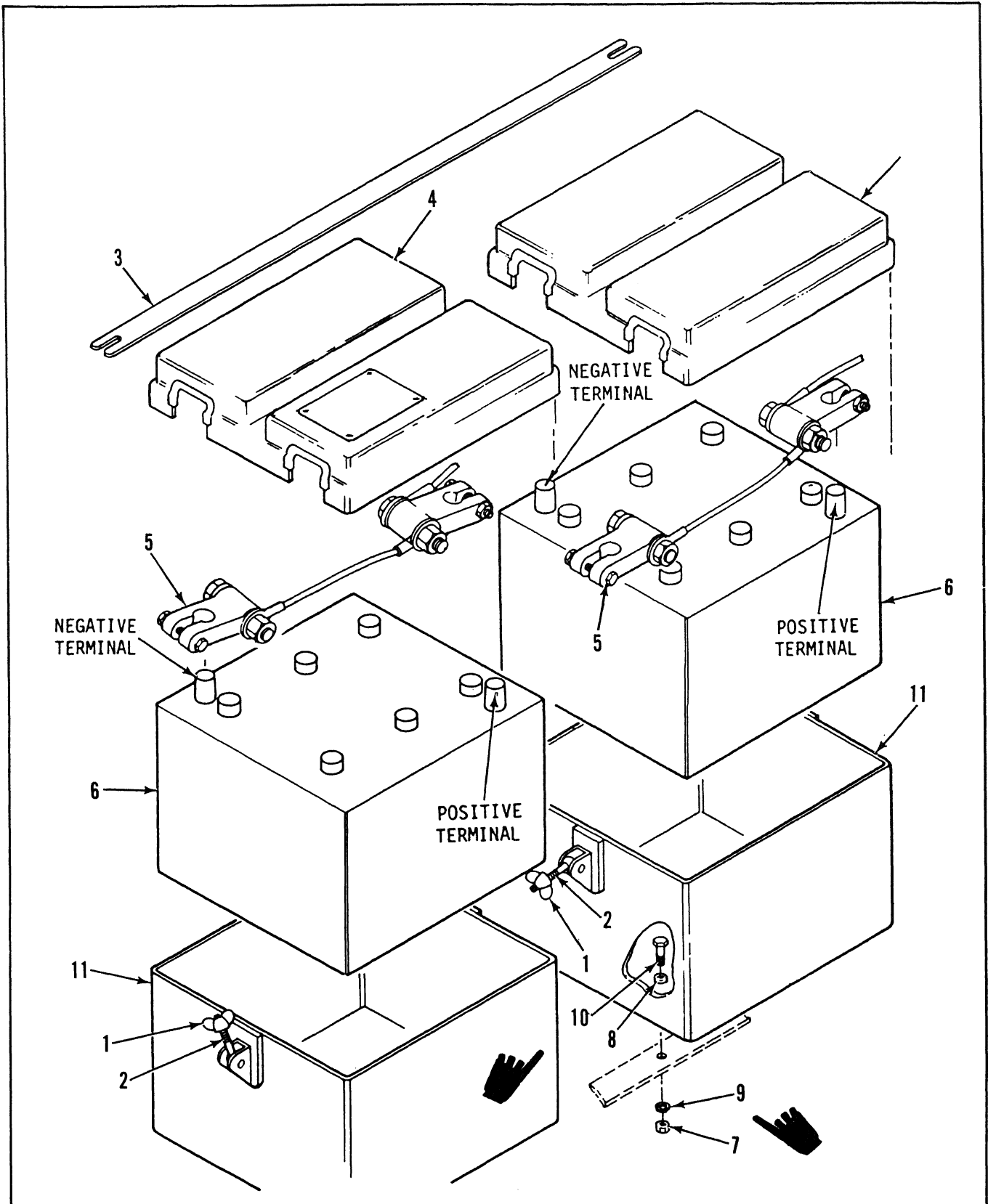


Figure 4-9. Battery Box and Cover, Removal/Installation

- (5) Position covers (4) and bar (3) on box.
- (6) Raise eye bolts (2) up and into slots of bar.
- (7) Tighten wing nuts (1).

4-16. BATTERIES AND CABLES (figure 4-10).

NOTE

Tag all wires and cables
before removing.

a. Removal.

- (1) Refer to paragraph 4-15 and remove cover and batteries.
- (2) Remove nut (1), two small electrical leads (2) and cable (3) from star solenoid connection. Remove bolt (4), washer (5), lead wire (6) and cable (7) from starter mounting connection. Remove jumpers (8 and

b. Cleaning. Clean all cables and jumpers to remove any corrosion buildup. Use standard battery terminal cleaning brush to clean terminals.

c. Testing. Check jumpers and cables for continuity. If continuity is not indicated, replace.

d. Inspection.

- (1) Inspect cables and jumpers for any broken or frayed wires.
- (2) Inspect terminals for any damaged nuts or bolts.

e. Installation.

- (1) Place batteries in battery box.

CAUTION

System is 12-volt. Batteries must be
connected in parallel to prevent supplying
24-volts to system.

- (2) Position jumpers (8 and 9) and cable (3) on batteries as indicated in figure 4-10.
- (3) Position positive (+) connection to starter solenoid and install nut (1) small leads (2), and cable (3).
- (4) Position ground (-) connection at starter mounting hole and install washer (5), bolt (4), lead wire (6), and cable (7).
- (5) Position cable (7) on battery as indicated in figure 4-10.

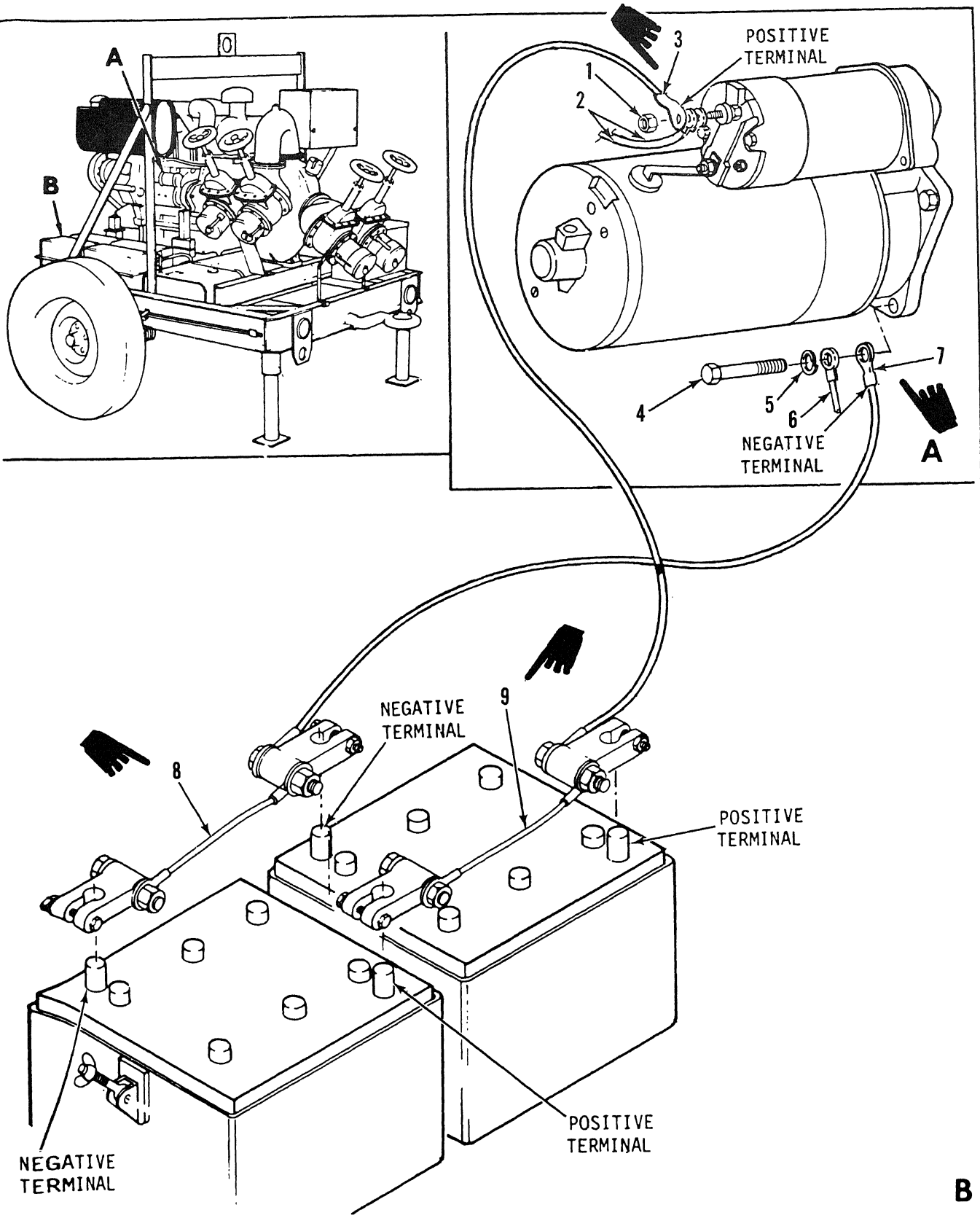


Figure 4-10. Batteries and Cables, Removal/Installation.

4-17. V-BELT GUARD (figure 4-11).

a. Removal.

- (1) Remove bolt (1), washer (2) and spacer (3).
- (2) Remove bolt (4), washer (5) and spacer (6).
- (3) Remove bolts (7), lockwashers (8) and washers (9).
- (4) Remove nut (10), washer (11), spacer (12), retainer (13), washer (14) and bolt (14A). Remove bolt (16) and washer (17).
- (5) Remove V-belt guard (15).
- (6) Remove bolts (18) locknuts (19), and engine pulley guard (20).

b. Installation.

- (1) Assemble engine pulley guard (20) , bolts (18), and locknuts (19) onto V-belt guard (15). Position V-belt guard (15) in place on engine.
- (2) Install bolt (14A), washer (14), retainer (13), spacer (12), washer (11) and nut (10), bolt (16) and washer (17).
- (3) Install washer (9), lockwasher (8) and bolt (7).
- (4) Install spacer (6), washers (5) and bolt (4).
- (5) Install spacer (3), washer (2) and bolt (1).

4-18. V-BELT, ALTERNATOR

a. Removal (figure 4-12)

- (1) Remove V-belt guard (paragraph 4-17).
- (2) Loosen bolts (1) and (2).
- (3) Push alternator (3) towards engine and remove V-belt (4).

b. Installation (figure 4-12)

- (1) Position alternator V-belt (4) on alternator and crankshaft pulley.
- (2) Move alternator away from engine and tighten bolts (1) and (2).

c. Adjustment

- (1) Measure belt deflection as shown in figure 4-12.
- (2) Loosen bolts (1) and (2), figure 4-12, and reposition alternator to obtain desired belt deflection.
- (3) Install V-belt guard (paragraph 4-17).

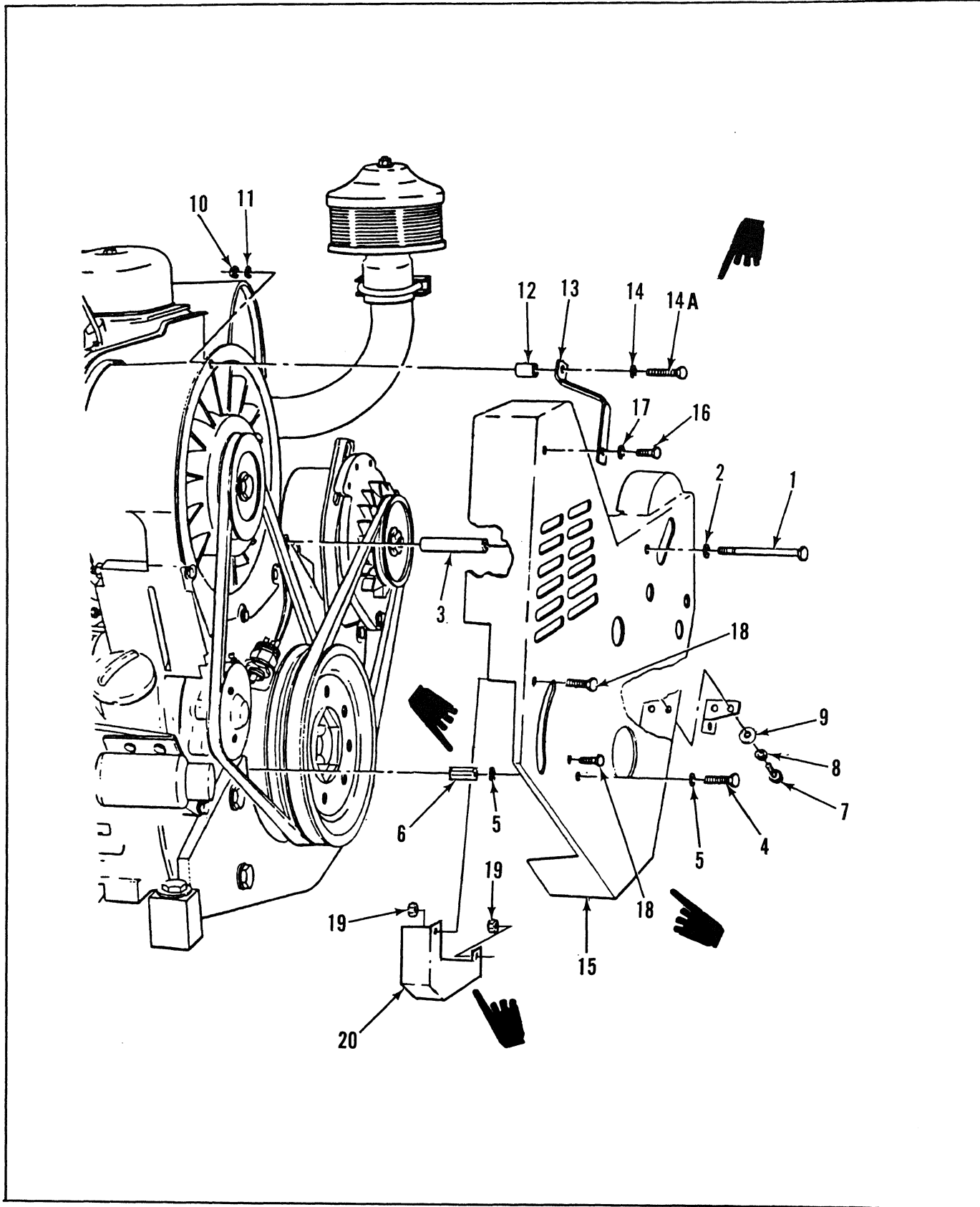


Figure 4-11. V-Belt Guard Removal and Installation.

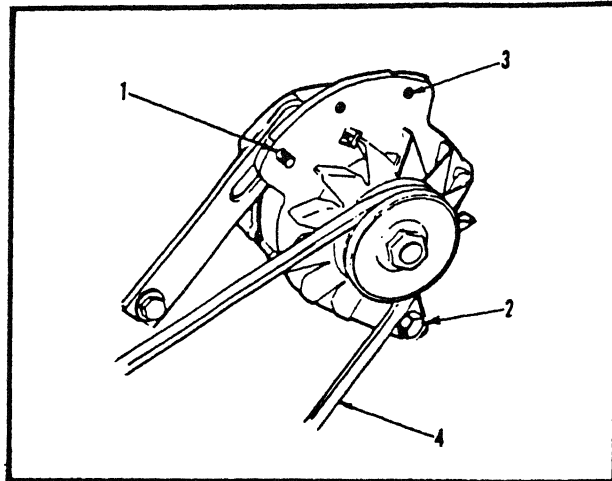


Figure 4-12. Alternator V-Belt, Removal/Installation.

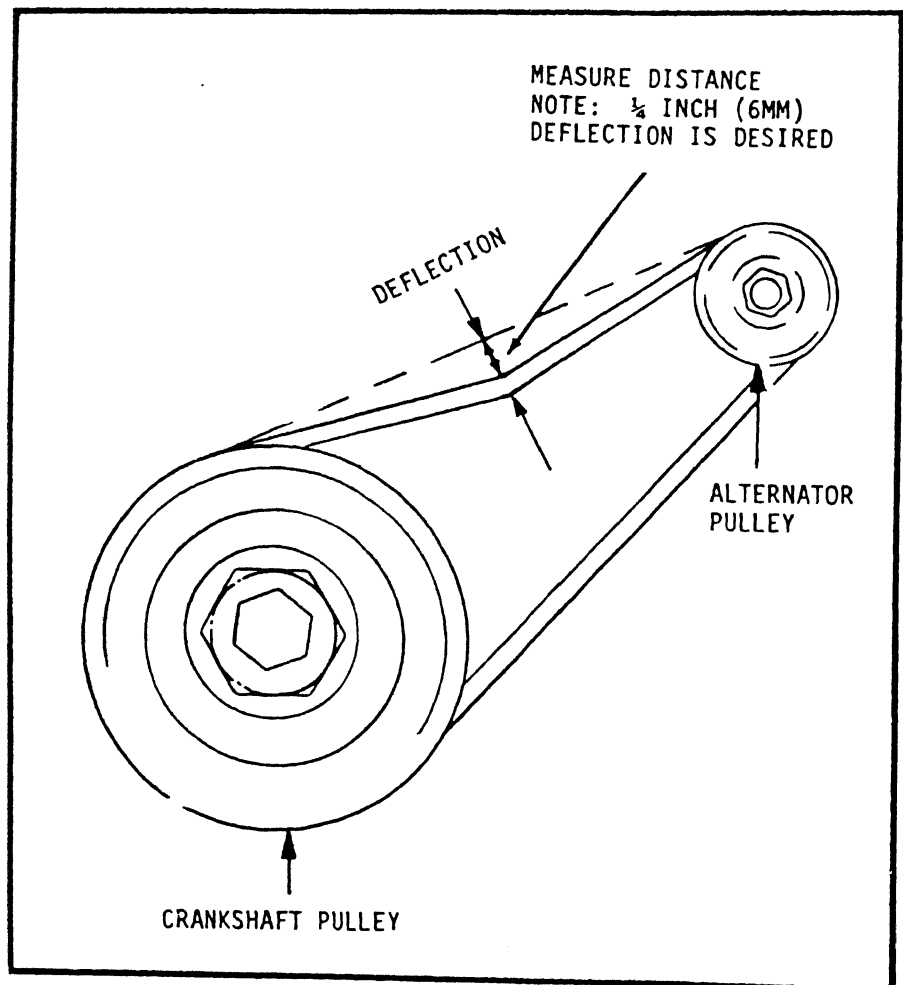


Figure 4-13. Alternator V-Belt Deflection

4-19. V-BELT, COOLING BLOWER (figure 4-14)

a. Removal.

- (1) Remove alternator V-belt (paragraph 4-18).
- (2) Apply pressure to idler pulley (1) and slip V-belt (2) off of pulley and remove it.

b. Installation.

- (1) Apply pressure to idler pulley (1) and slip V-belt (2) on idler pulley (1), and blower and crankshaft pulleys.
- (2) Install alternator V-belt (paragraph 4-18).

4-20. ALTERNATOR (WITH ISOLATION DIODE) (figure 4-15, Views A and B)

a. Removal.

- (1) Remove alternator V-belt (paragraph 4-18).
- (2) Disconnect alternator quick disconnect (1).
- (3) Remove nuts (2); tag and remove wire (3).
- (4) Remove nut (4), lockwasher (5); tag and remove wire (6).
- (5) Remove bolt (7), lockwasher (8), bolt (9), lockwasher (10) and alternator (11).

b. Installation.

- (1) Position alternator (11) in place on engine.
- (2) Install, but do not fully tighten, lockwasher (10), bolt (9), lockwasher (8) and bolt (7).
- (3) Install wire (6), lockwasher (5) and nut (4).
- (4) Install wire (3) and nut (2).
- (5) Connect alternator quick disconnect (1).
- (6) Install alternator V-belt (paragraph 4-18).

4-20.1 ALTERNATOR (WITH FIELD DIODE) (figure 4-15, Views B and C)

a. Removal.

- (1) Remove the alternator V-belt (paragraph 4-18).
- (2) Disconnect alternator quick disconnect (1).
- (3) Remove nuts (2 and 4) and lockwashers (5) then tag and remove wires (3 and 6).

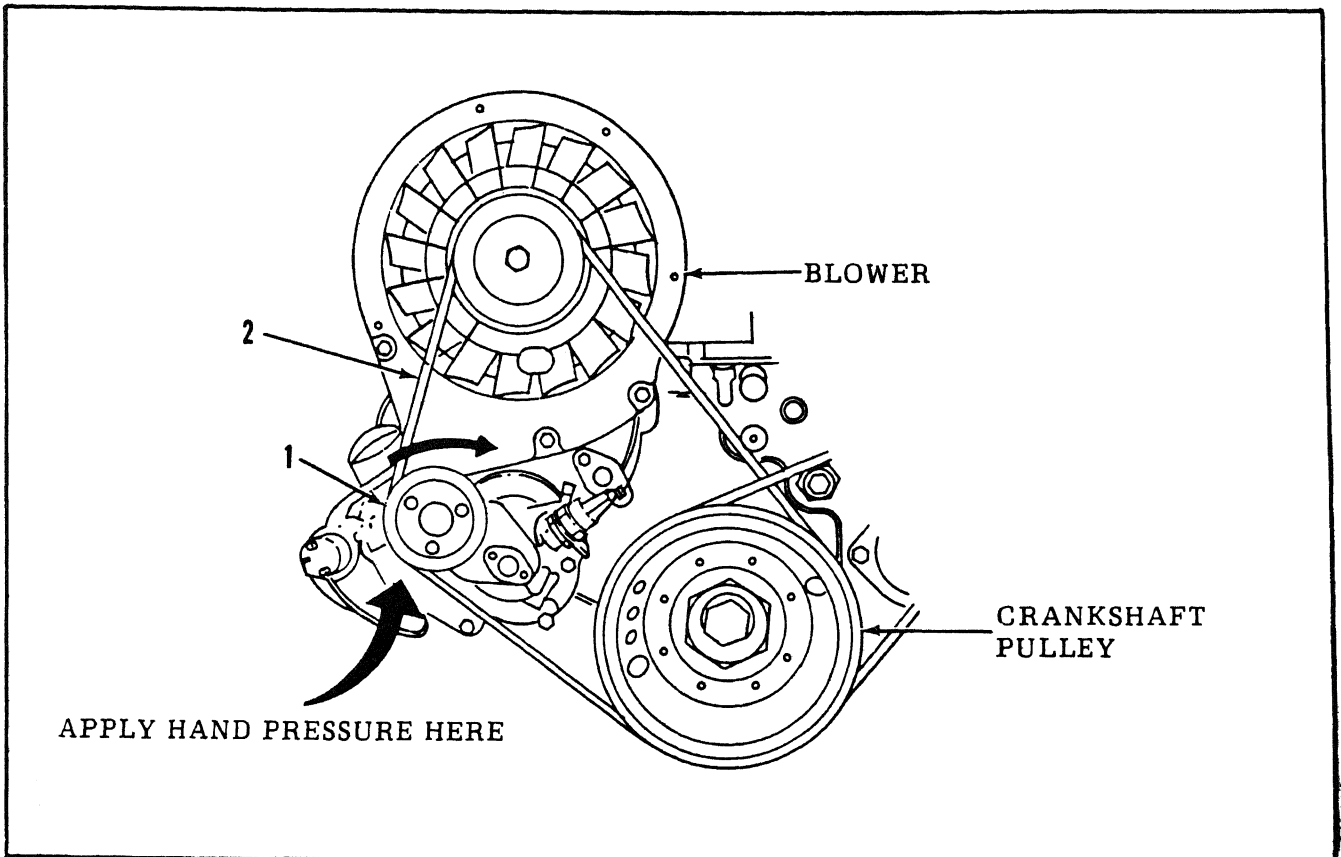


Figure 4-14. Cooling Blower Drive V-Belt Replacement

(4) Remove bolt (7), lockwasher (8), bolt (9), lockwasher (10) and alternator (11).

b. Installation

(1) Position alternator (11) in place on engine.

(2) Install, but do not fully tighten, lockwasher (10), bolt (9), lockwasher (8) and bolt (7).

(3) Install wires (3 and 6), lockwashers (5) and nuts (2 and 4).

(4) Connect alternator quick disconnect (1).

(5) Install alternator V-belt (paragraph 4-18).

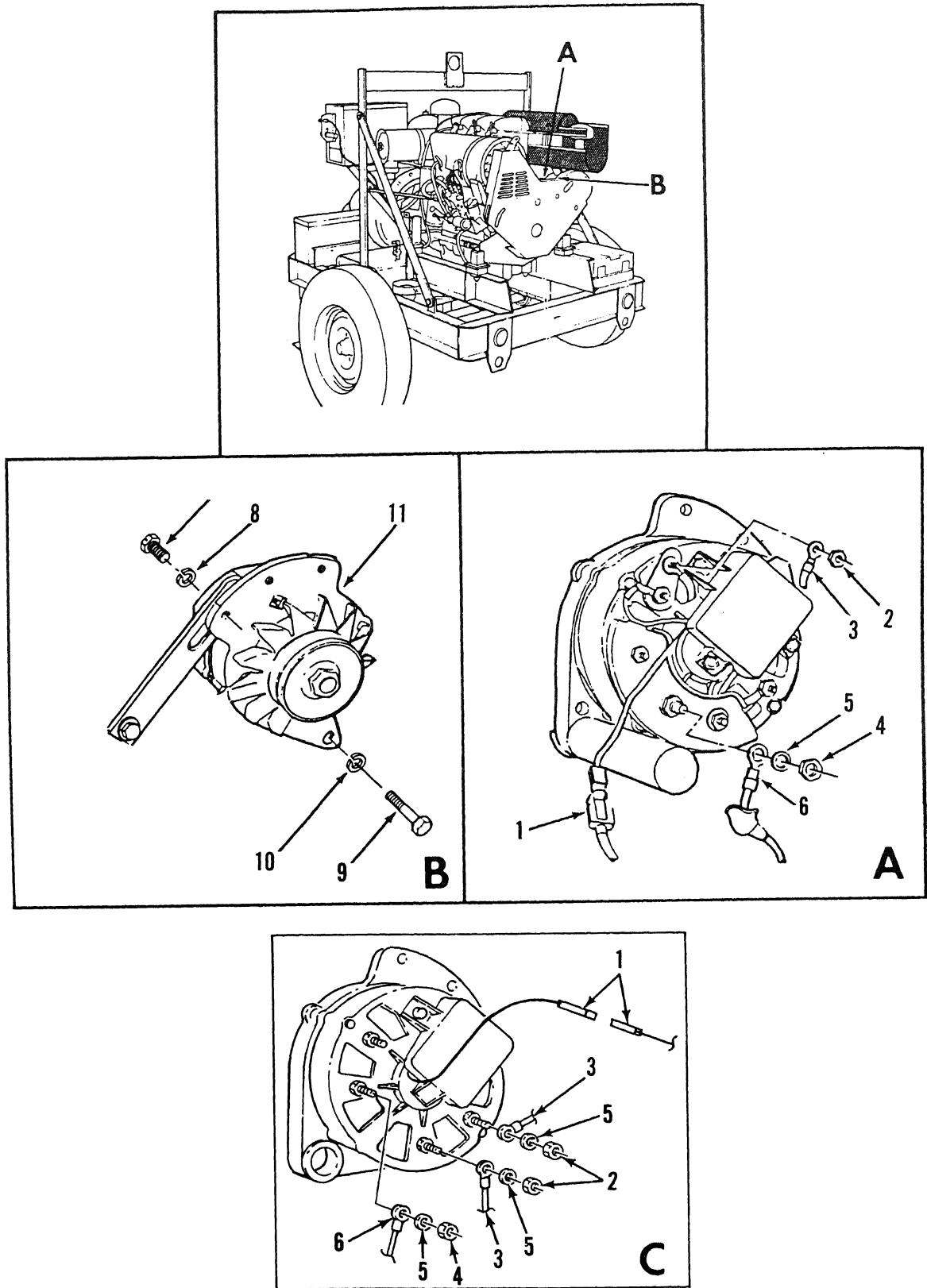


Figure 4-15. Alternator Assembly, Removal/Installation

4-21. STARTER ASSEMBLY (figure 4-16).

a. Removal.

CAUTION

Remove negative (-) battery cable to prevent possible electrical arc.

- (1) Refer to paragraph 4-15 and remove negative (-) battery cable.
- (2) Remove nut (1) and disconnect wire (2).
- (3) Remove nut (3), washer (4), positive battery cable (5) and wires (6).
- (4) Remove bolts (7), lockwashers (8) and negative battery cable (9); carefully separate starter (10) from engine.

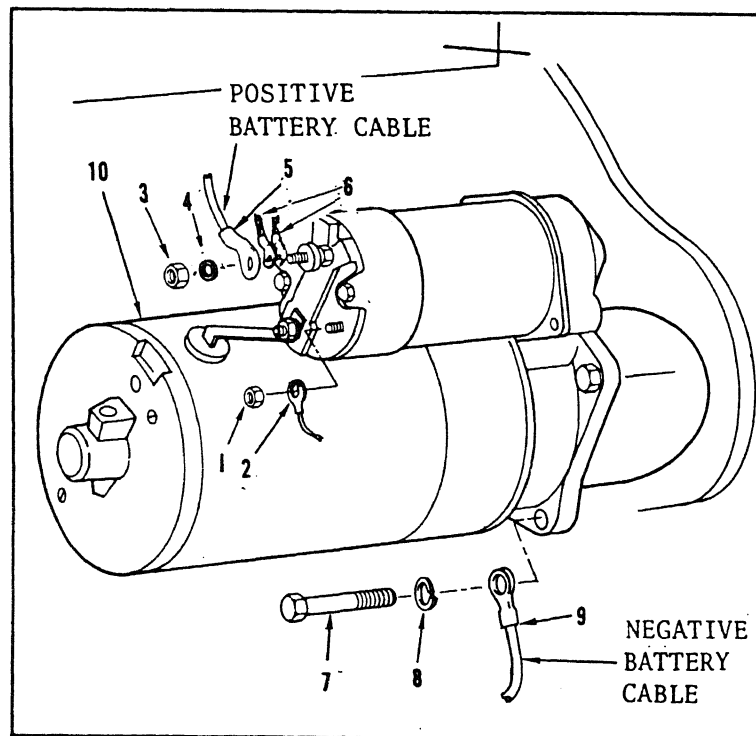


Figure 4-16. Starter Assembly, Removal/Installation

- (6) Disconnect harness assembly from terminal board (5), oil sending unit (6), low oil pressure switch (7) fuel shut-down solenoid (8) on Models 13220E1070 and 13225E9200 (97403) or phenolic strip (9) on Model 13226E2289 (97403), V-belt contact switch (10) starter solenoid (11) and alternator (12).
- (7) Remove harness assembly (13).

b. Inspection.

- (1) Inspect harness for cracks, cuts, abrasions and loose ends. Replace if damaged.
- (2) Check individual wires for loose solder connections at connectors. Repair solder connections and replace connectors if damaged.

c. Testing. Using wiring diagram, figure 4-19, check individual wires for continuity. If continuity is not indicated, check solder connections, replace all damaged wires and connectors.

d. Repair. When repairing solder joints, wire connections must be made mechanically sound before they are soldered; solder alone does not provide sufficient strength to prevent breakage. Surfaces of connections to be soldered must be clean and bright. Solder shall be a lead-tin solder conforming to Specification QQ-S-571. Wires should always be heated to the point at which the solder will melt completely and flow into all parts of the joint. Excessive buildup on solder globs on the joint should be avoided or removed.

e. Installation.

- (1) Position harness assembly (13) to engine and connect to alternator (12), starter solenoid (11), V-belt contact switch (10), phenolic strip (9) on Model 13226E2289 (97403) or fuel shut down solenoid on Models 13220E1070 and 13225E9200 (97403) and LC 350GPM (36024), low oil pressure switch (7), oil sending unit (6) and terminal board (5) as indicated on wiring harness diagram, figure 4-19.
- (2) Carefully position control panel cover (4), figure 4-18, over control panel.
- (3) Position cold weather start kit (3) to control panel cover and install washers (2) and screws (1).

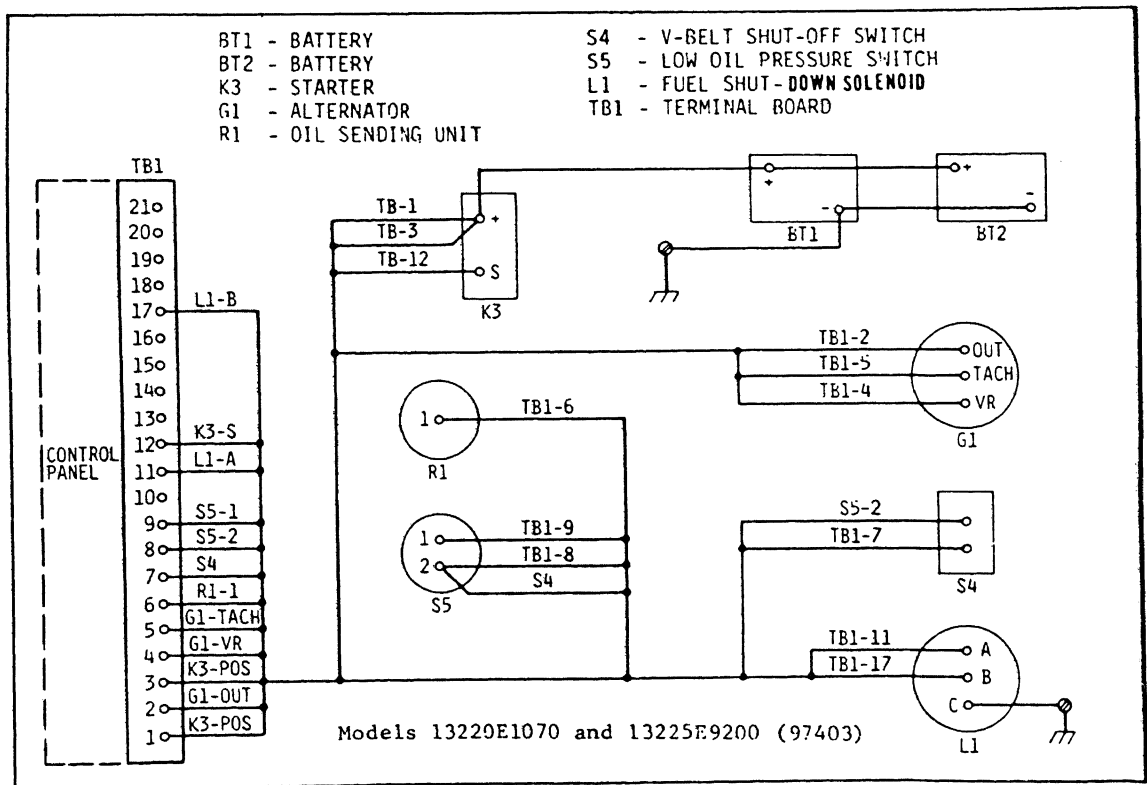
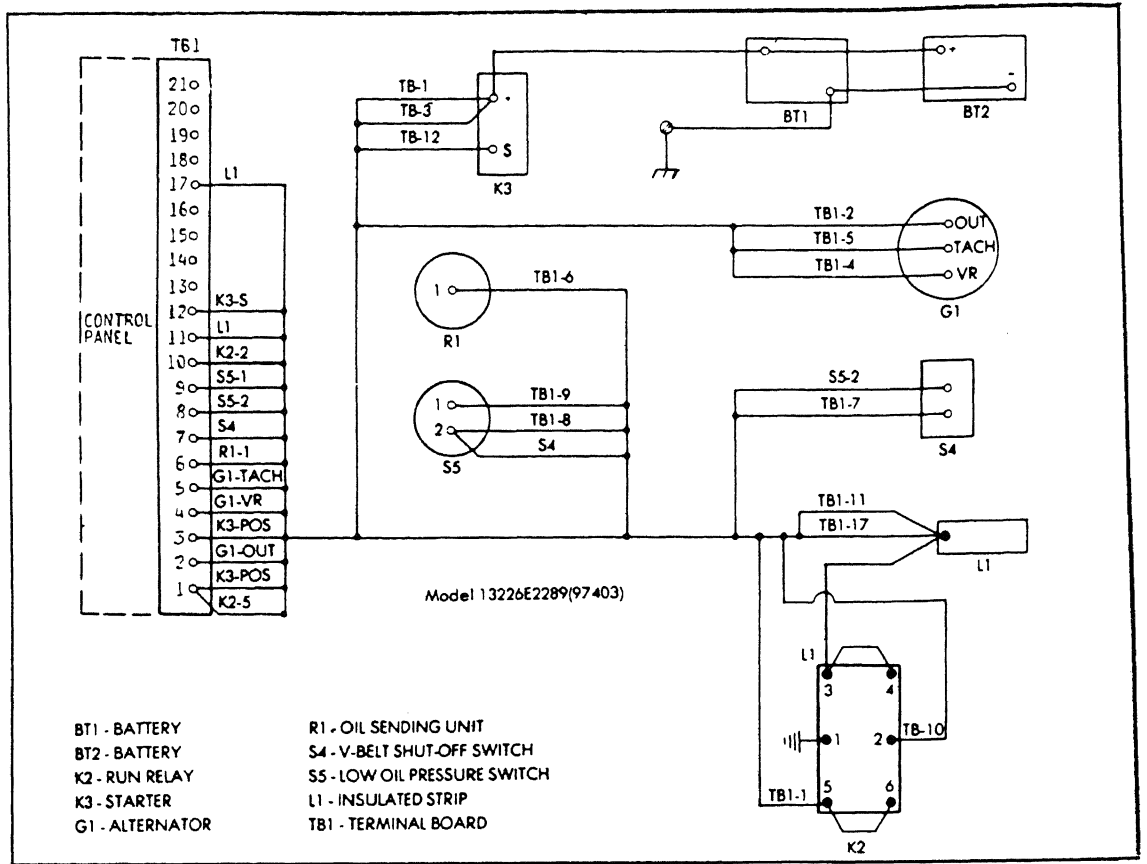


Figure 4-19. Wiring Harness Diagrams

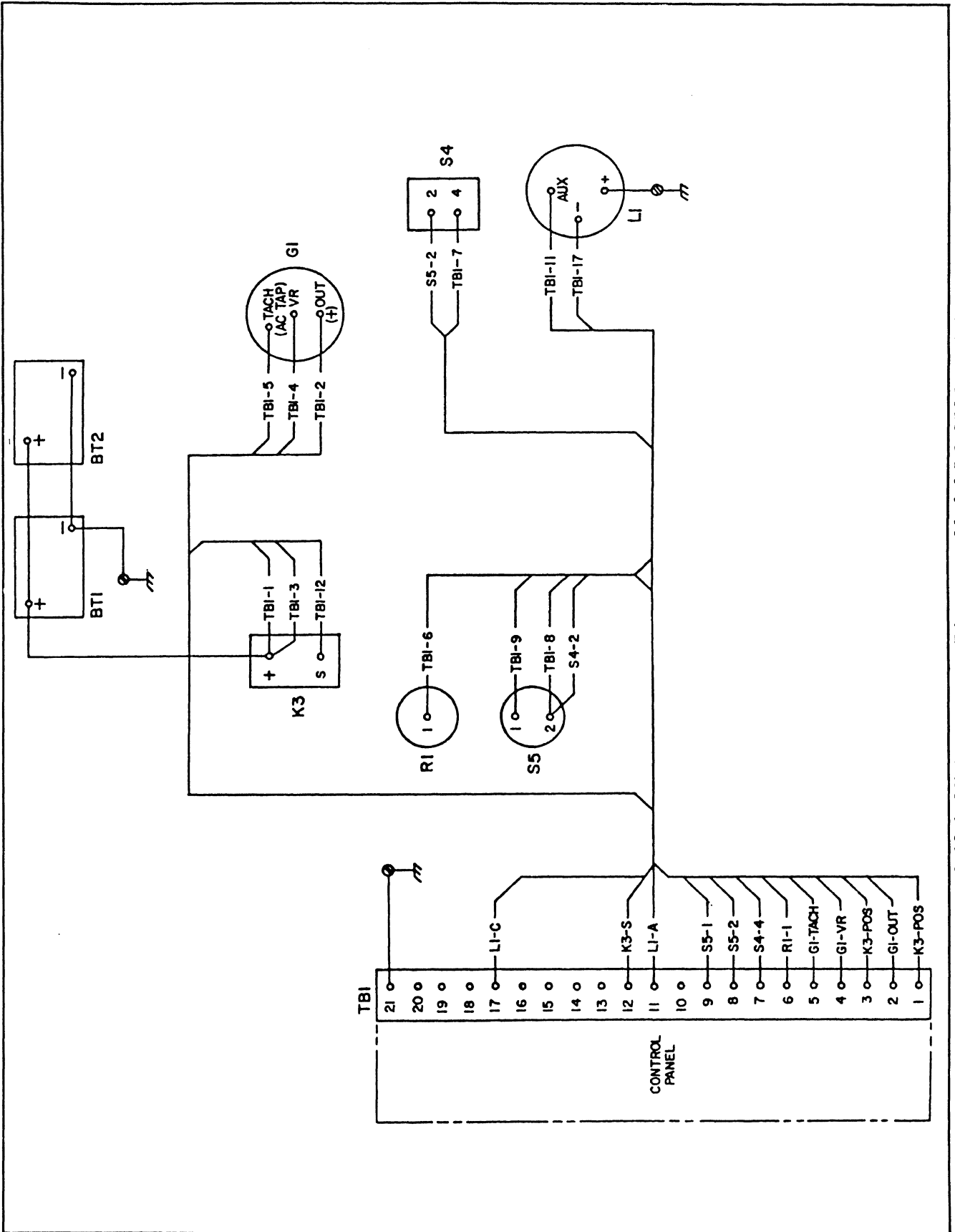


Figure 4-19.1 Wiring Harness Diagrams. Model LC 350GPM (36024)

4-24. THROTTLE CONTROL ROD (figure 4-20). Used on Models 13220E1070 (97403), 13225E9200 (97403), and LC 350GPM (36024).

a. Removal and Disassembly.

- (1) Remove set screw (1), cotter pin (2), rivet (3) and spacer (4).
- (2) Squeeze ends of clamp (5) and remove bellows (6).
- (3) Loosen lock nut (7) and remove coupling nut (8) retaining spring (9), lock nut (7) and clamp (5).
- (4) Remove threaded rod (10), knob (11), threaded rod (12), set screw (13), rod (14) and throttle extension rod (15).

b. Inspection and Repair.

- (1) Inspect all parts for obvious damage.
- (2) Replace defective parts.

NOTE

Units without bellows may have an extension rod that is longer and coupling nut shorter than those units with bellows. If replacement of either of these parts is required, they must be replaced as a set in order to obtain the required length.

c. Reassembly and Installation.

- (1) Position throttle rod (14) in extension rod (15) and secure in place with set screw (13).
- (2) Install threaded rod (12), knob (11) and threaded rod (10).
- (3) Position clamp (5), spring (9) on coupling nut (8).
- (4) Install lock nut (7) and coupling nut (8).
- (5) Install bellows (6).
- (6) Install spacer (4) and rivet (3) through coupling nut and control arm.
- (7) Install cotter pin (2) in rivet (3).
- (8) Install set screw (1).

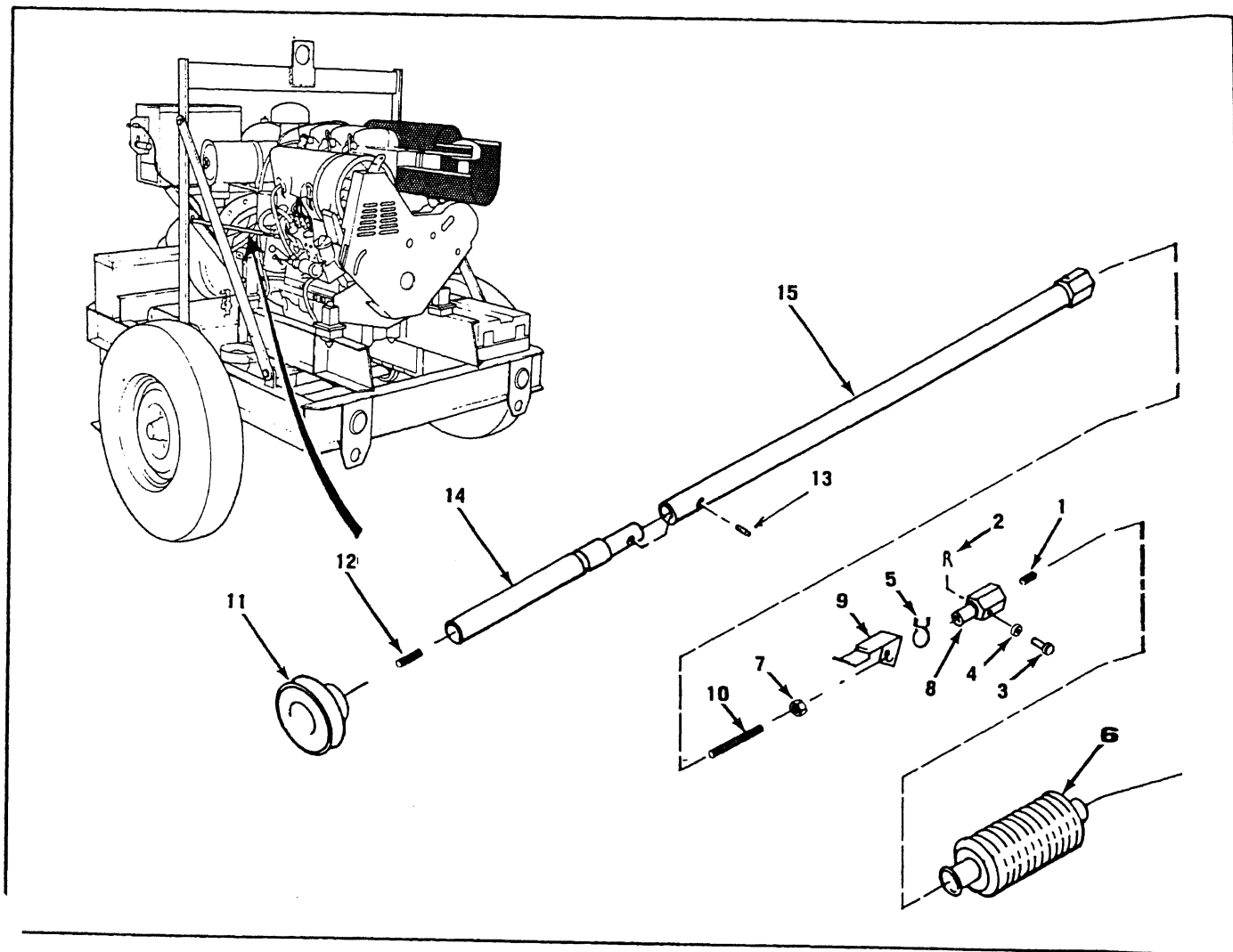


Figure 4-20. Throttle Control, Removal/Installation

4-25. SHUTDOWN SOLENOID, USED ON MODELS 13220E1070, 13225E9200 (97403) and LC 350GPM (36024)

a. Testing (Shutdown Solenoid Installed)

- (1) Pull out EMERGENCY STOP switch (1, figure 2-1).
- (2) Connect a 12 volt test lamp to shutdown solenoid auxiliary terminal (figure 4-21) and ground terminal.

CAUTION

Release oil pressure bypass switch within 30 seconds, if voltage is not indicated (by illumination of light bulb) at the auxiliary terminal.

- (3) Depress oil pressure bypass switch and monitor the solenoid rod retracting and the test lamp illuminating.

NOTE

If the solenoid rod does not retract or test lamp does not illuminate, replace shutdown solenoid.

b. Removal (figure 4-22)

- (1) Disconnect wires (1, 2, and 3).
- (2) Remove nuts (4), lockwashers (5), flatwashers (6), and bolts (7).
- (3) Remove nut (8) and lockwasher (9).
- (4) Remove shutdown solenoid assembly (10) with linkage.

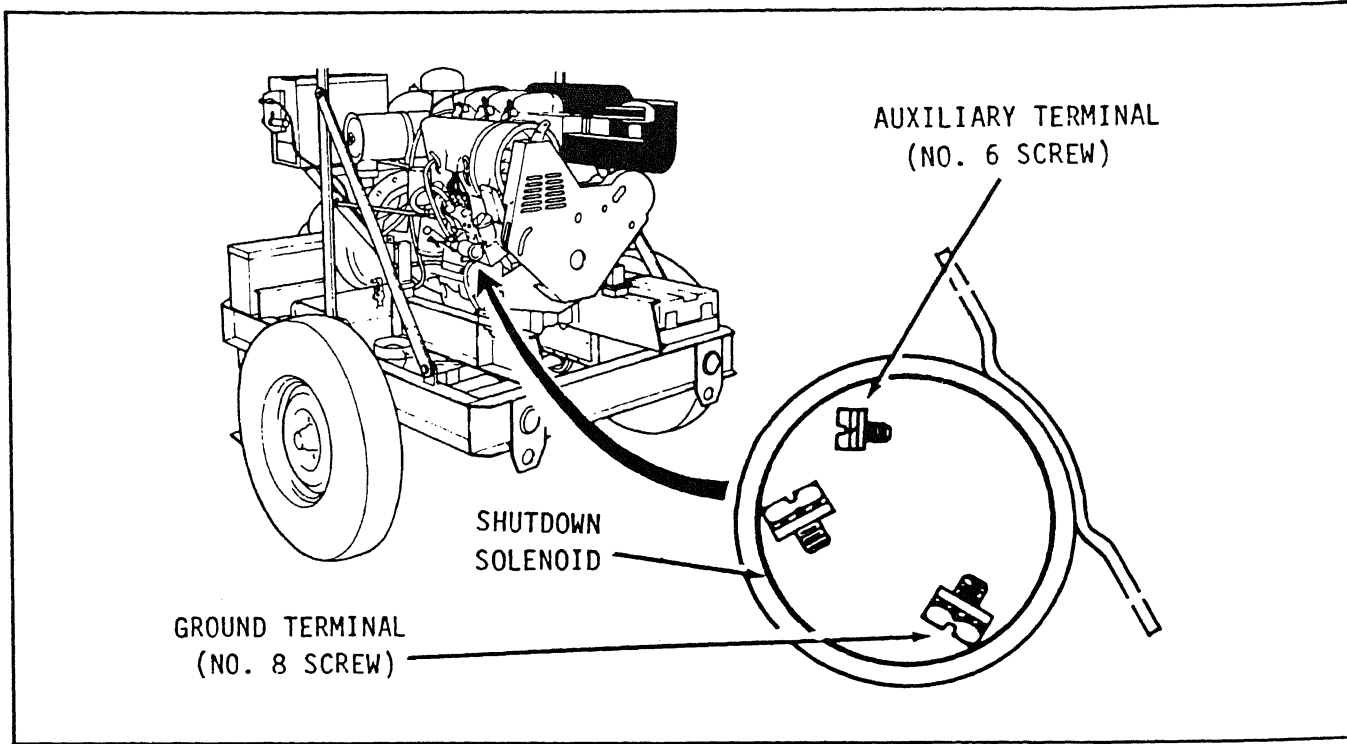


Figure 4-21. Shutdown Solenoid Test Terminals.

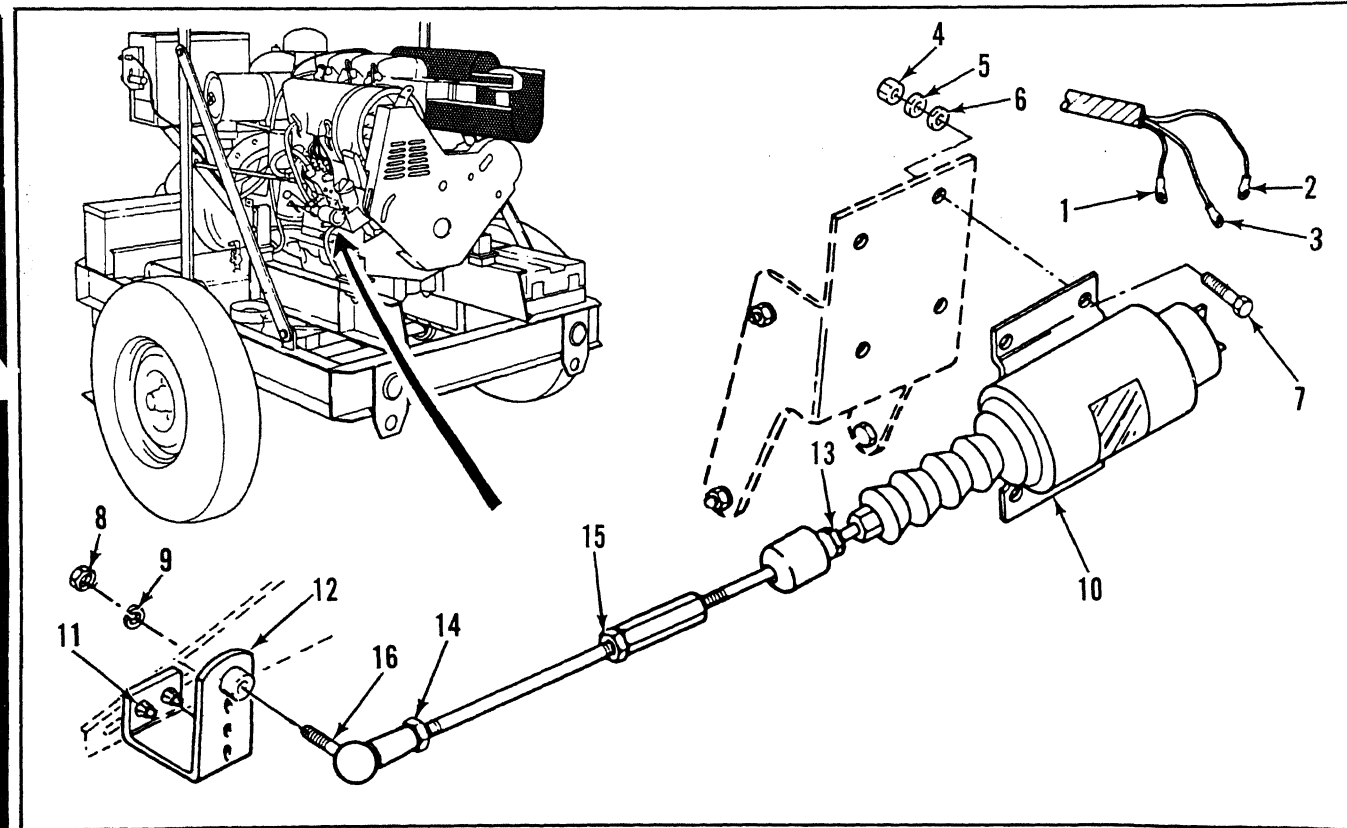


Figure 4-22. Shutdown Solenoid, Removal/Installation.

c. Cleaning.**WARNING**

Potential health hazards result from inhalation of petroleum solvent vapors and from contact of solvent with skin. Use rubber gloves and hand cream for protection, and work with adequate ventilation.

CAUTION

Petroleum solvents are highly flammable. Keep solvent container lids closed when not in use, and avoid all possible risks of igniting solvent vapors, keep away from open flame and excessive heat. Flash point of solvent is 100 to 138 degrees F (38 to 59 degrees C).

- (1) Clean all metal surfaces with clean cloth moistened with solvent Federal Specification P-D-680, Type II.
- (2) Wipe rubber boot around solenoid rod with clean cloth.
- (3) Dry thoroughly.

d. Inspection.

- (1) Inspect electrical terminals for cracks, corrosion and looseness.
- (2) Inspect solenoid housing and linkage for cracks or any other damage.

e. Repair. Replace defective parts.f. Installation and Adjustment.

- (1) Position complete shutdown solenoid assembly (10) between mounting brackets.
- (2) Install bolts (7), flatwashers (6), lockwashers (5), and nuts (4).
- (3) Loosen two nuts (11) that attach lever (12).
- (4) Slide lever (12) towards dip stick and tighten two nuts (11).
- (5) Loosen jam nuts (13, 14, and 15).

CAUTION

Ensure that positive (+) terminal is connected to ground.

- (6) Connect wires (3, 2, and 1).
- (7) Pull EMERGENCY STOP switch to RESET position.
- (8) Pull shutdown lever towards dipstick until stop is reached, and adjust rod end length until stud (16) aligns with top hole in lever (12).

CAUTION

Ensure that plunger of solenoid bottoms completely before attaching governor lever. Failure to bottom causes internal "PULL" circuit to main engaged, building excessive heat.

(9) Insert stud (16) through top hole in lever (12).

(10) Install lockwasher (9) and nut (8).

(11) Tighten jam nuts (13, 14 and 15).

(12) Push in EMERGENCY STOP switch.

4-26. FUEL LINES, HOSES AND FITTINGS (figure 4-23)

NOTE

Upon removal of any fuel line, hose or fittings, plug all open ports and place caps over all fuel lines and hoses to prevent contamination of fuel system.

a. Removal.

(1) Disconnect fuel supply line (1) at fuel tank source selector valve discharge fitting (2) and at filter/separator inlet fitting (3). Remove line (1) and fuel selector valve (2).

(2) Disconnect fuel line (4) at filter/separator discharge fitting and remove banjo bolt (5), and washers (6), at fuel feed pump. Remove li

(3) Disconnect fuel line (7) at fitting on fuel selector valve (8) and at engine injection nozzle overflow manifold. Remove line (7) and fuel selector valve (8).

(4) Disconnect fuel hose (9) by removing banjo bolts (10) and washers (11). Remove hose (9).

(5) Disconnect fuel hose (12) by removing banjo bolts (13) washers (14). Remove hose (12).

(6) Release clips (15) and raise cover (16).

(7) Remove nut (17), washer (18), bolt (19) and clamp (20).

(8) Remove fuel injection lines (21, 22, and 23) with grommets (24).

NOTE

Remove overflow valve by holding the larger hexagon fitting with a wrench.

- (9) Remove overflow valve (25), and washer (26).
- (10) Remove banjo bolt (27), washers (28) and overflow line (29).
- (11) Remove banjo bolts (30), washers (31) and backleakage line (32).

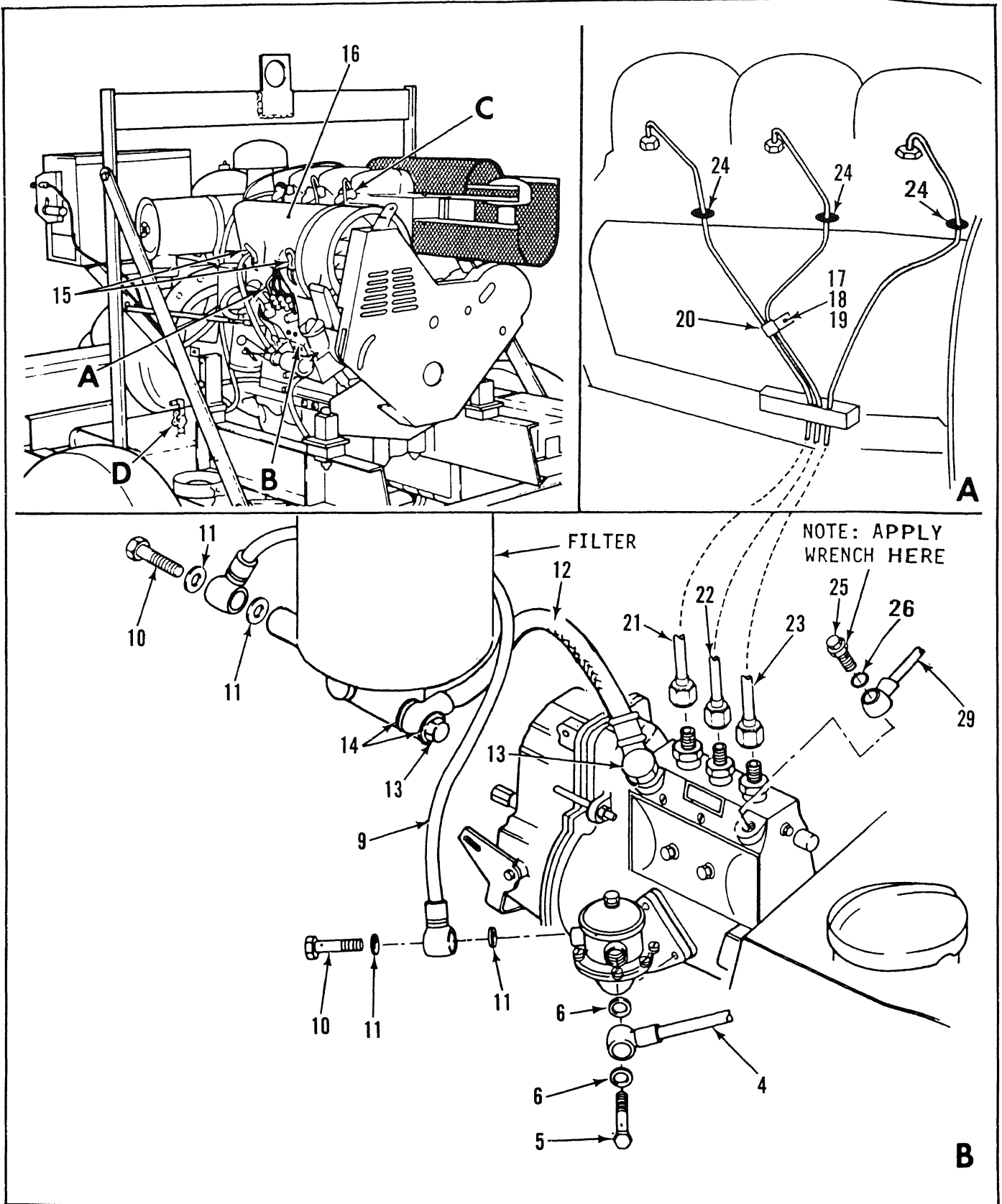


Figure 4-23. Fuel Lines, Hoses and Fittings, Removal/Installation (Sheet 1 of 2).

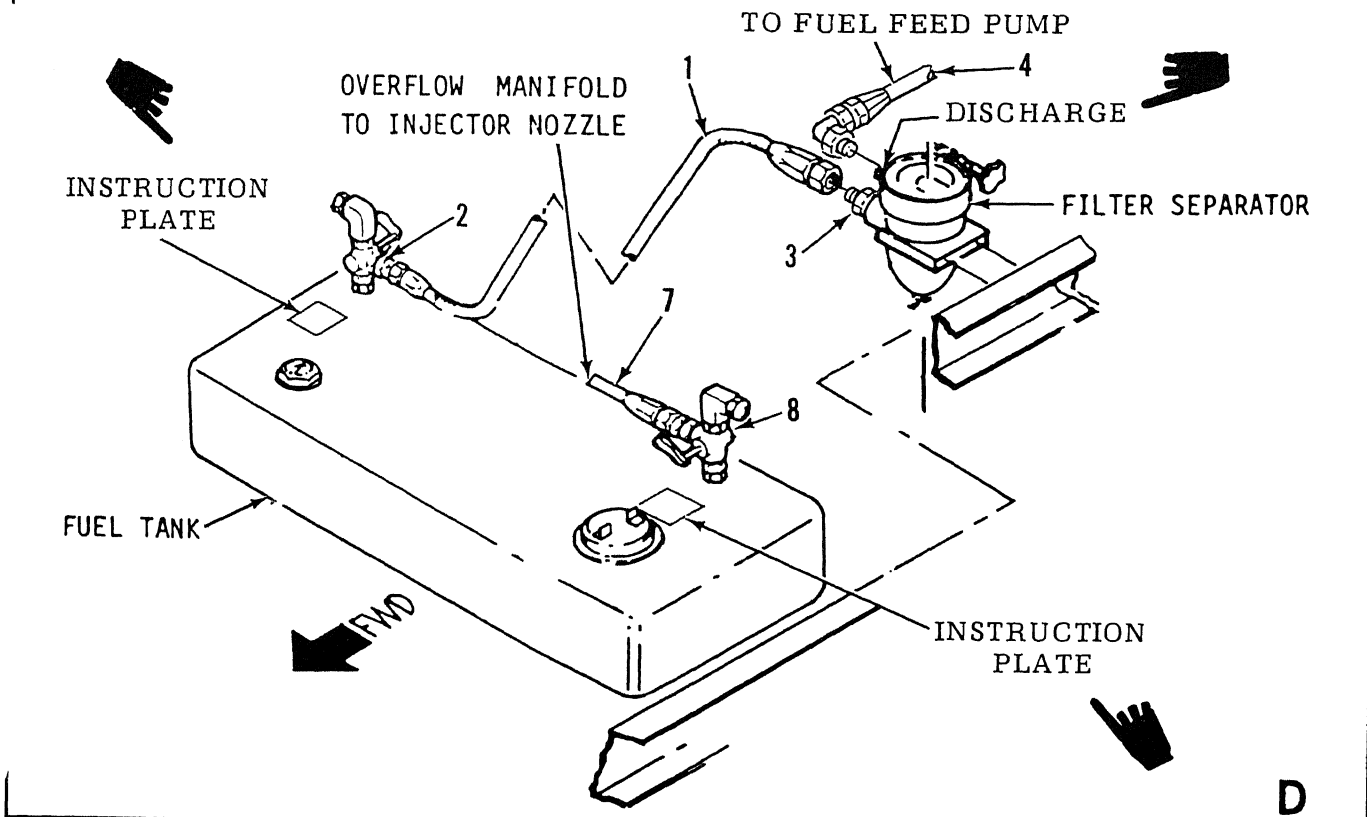
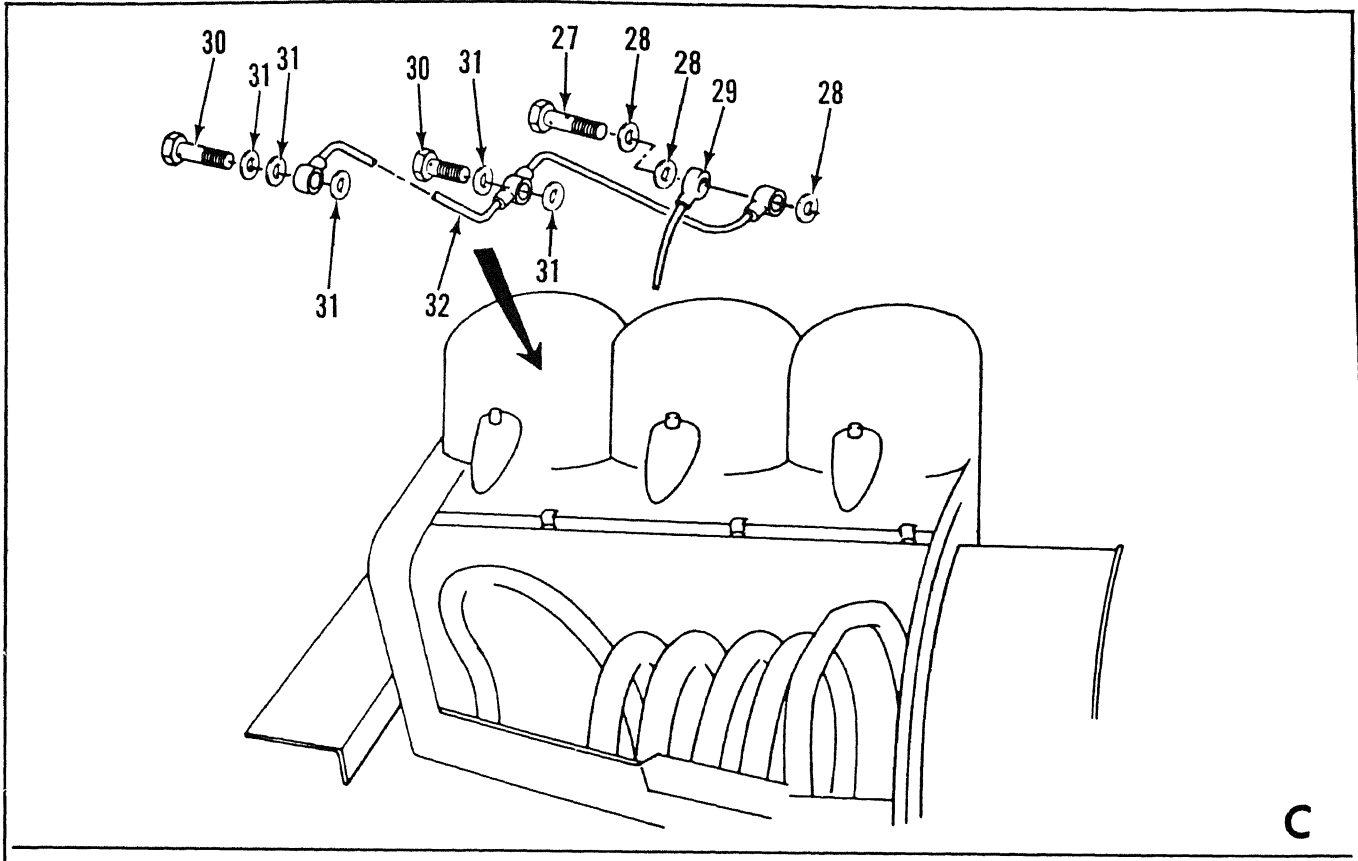


Figure 4-23. Fuel Lines, Hoses and Fittings, Removal/Installation (Sheet 2 of 2).

b. Cleaning and Inspection.

WARNING

Potential health hazards result from inhalation of petroleum solvent vapors and from contact of solvent with skin. Use rubber gloves and hand cream for protection, and work with adequate ventilation.

CAUTION

Petroleum solvents are highly flammable. Keep solvent container lids closed when not in use, and avoid all possible risks of igniting solvent vapors, keep away from open flame and excessive heat. Flash point of solvent is 100 to 138 degrees F (38 to 59 degrees C).

- (1) Clean all fittings and lines (exterior) with clean cloth moistened with solvent, Federal Specification P-D-680, Type II.
- (2) Induce 25 to 30 psi (1.7-2.1 kg/cm²) of dry air into lines to clear of any foreign matter.
- (3) Inspect lines for cracks, chafing, and defective connectors. Replace if defective.
- (4) Inspect fittings for cracks and thread distortions. Replace if defective.

c. Installation.

NOTE

Prior to installation of fuel lines, hoses or fittings, remove plugs and caps installed to prevent contamination.

- (1) Position backleakage line (32) and install washers (31) and banjo bolts (30). Do not fully tighten at this time.
- (2) Position overflow line (29), install washers (28) and banjo bolt (27). Do not fully tighten at this time.
- (3) Install washer (26) and overflow valve (25).
- (4) Tighten banjo bolts (30) and (27).
- (5) Install grommets (24), and fuel injection lines (23), (22) and (21).

- (6) Install clamp (20), bolt (19), washer (18 and nut (17).
- (7) Close cover (16) and fasten clips (15).
- (8) Install banjo bolts (13), washers (14) and hose (12).
- (9) Install banjo bolts (10), washers (11) and hose (9).
- (10) Connect fuel line (7) at fuel selector valve (8) and at engine nozzle overflow manifold.
- (11) Connect fuel line (4) at fuel feed pump by installing banjo bolt (5) and washers (6). Connect line (4) to filter/separator at discharge fitting.
- (12) Connect fuel line (1) at filter/separator inlet fitting (3) and at fuel tank source selector valve (2).

NOTE

Information plates must be installed with arrow pointing toward the center of the fuel tank.

NOTE

If information plate replacement is required, MMM-A-134 epoxy should be applied over old plate on the fuel tank. The new plate must be installed on top of the old plate.

d. Bleeding Fuel System (figure 4-24).

- (1) Loosen overflow valve (1), by turning the larger hexagon fitting (19mm) two or three turns.
- (2) Operate fuel feed pump lever (2) by pressing down until fuel, free of air bubbles emerges at the loosened overflow valve (1).

NOTE

The fuel feed pump will only work if camshaft of injector pump is in such position that diaphragm of fuel pump is not lifted. When operating priming lever, commencement of lifting movement of diaphragm must occur in first quarter of its total travel. If not, turn engine over a little by hand.

- (3) Tighten overflow valve (1).
- (4) Start engine and check for leaks.

e. Bleeding Injection Lines (figure 4-24).

- (1) Loosen fittings (3) approximately two turns at injection nozzle end of injection lines (4).
- (2) Set throttle to wide open position.

CAUTION

Crank engine no longer than ten-seconds cycles, with one and one-half minutes between first two cycles. After this wait five minutes between cycles.

- (3) Crank engine until fuel leakage at injection line fittings are free of air bubbles.
- (4) Tighten all injection line fittings.
- (5) Start engine and check for leaks.

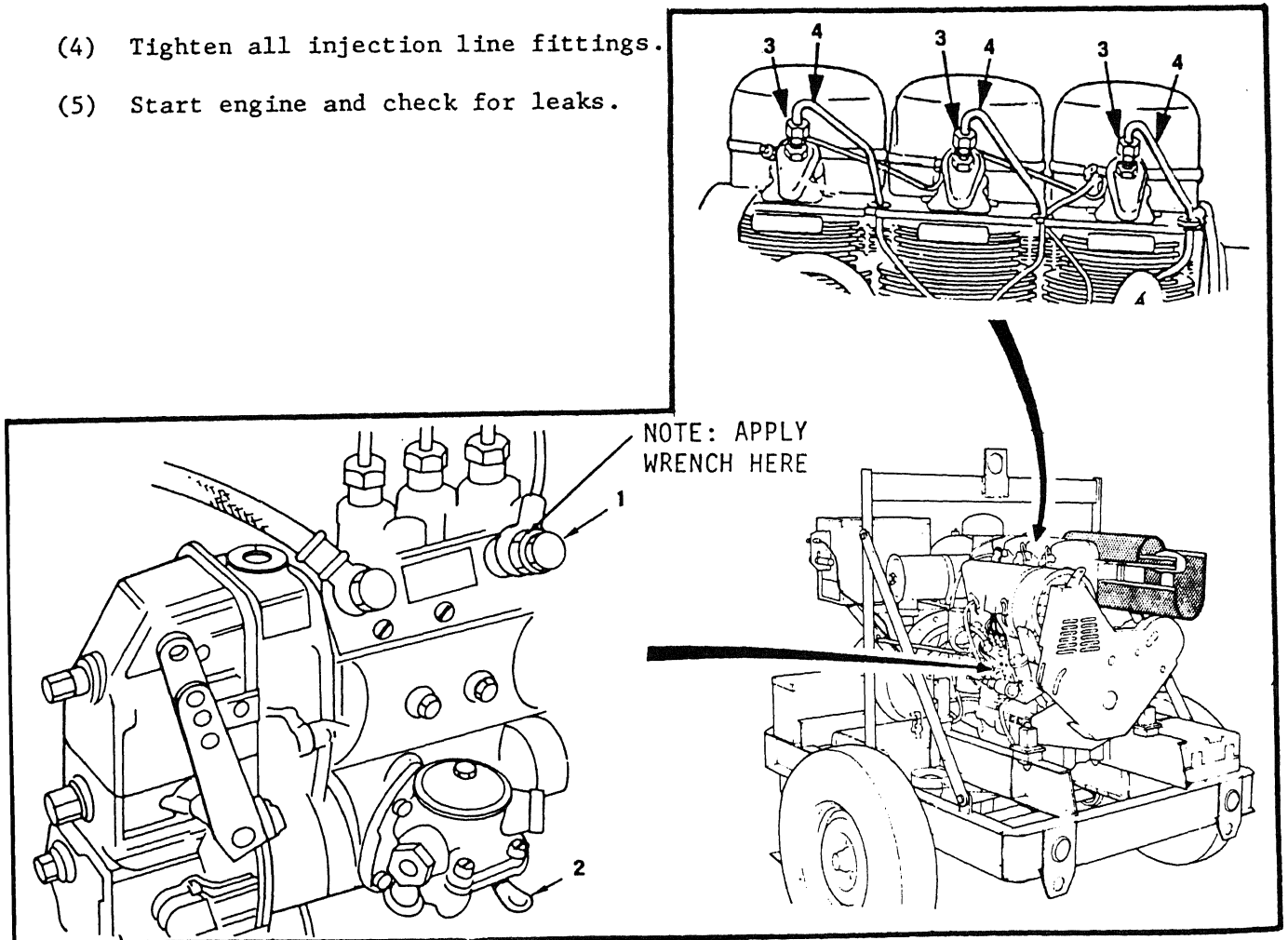


Figure 4-24. Bleeding Fuel System

4-27. FUEL FILTER/SEPARATOR.

a. Removal (figure 4-25).

- (1) Place bucket under filter bowl (1) and drain fuel from filter. (Refer to paragraph 3-7.)
- (2) Disconnect fuel inlet (2) and outlet lines (3) from filter housing.
- (3) Remove nuts (4), washers (5) and bolts (6); remove housing (7).

b. Disassembly (figure 4-26).

- (1) Remove retaining clamp (1) and remove lid and element (element attached to lid).
- (2) Pull element (2) from lid (3) and discard element.
- (3) Remove upper lid gasket (4) and lower lid gasket (5) and discard.

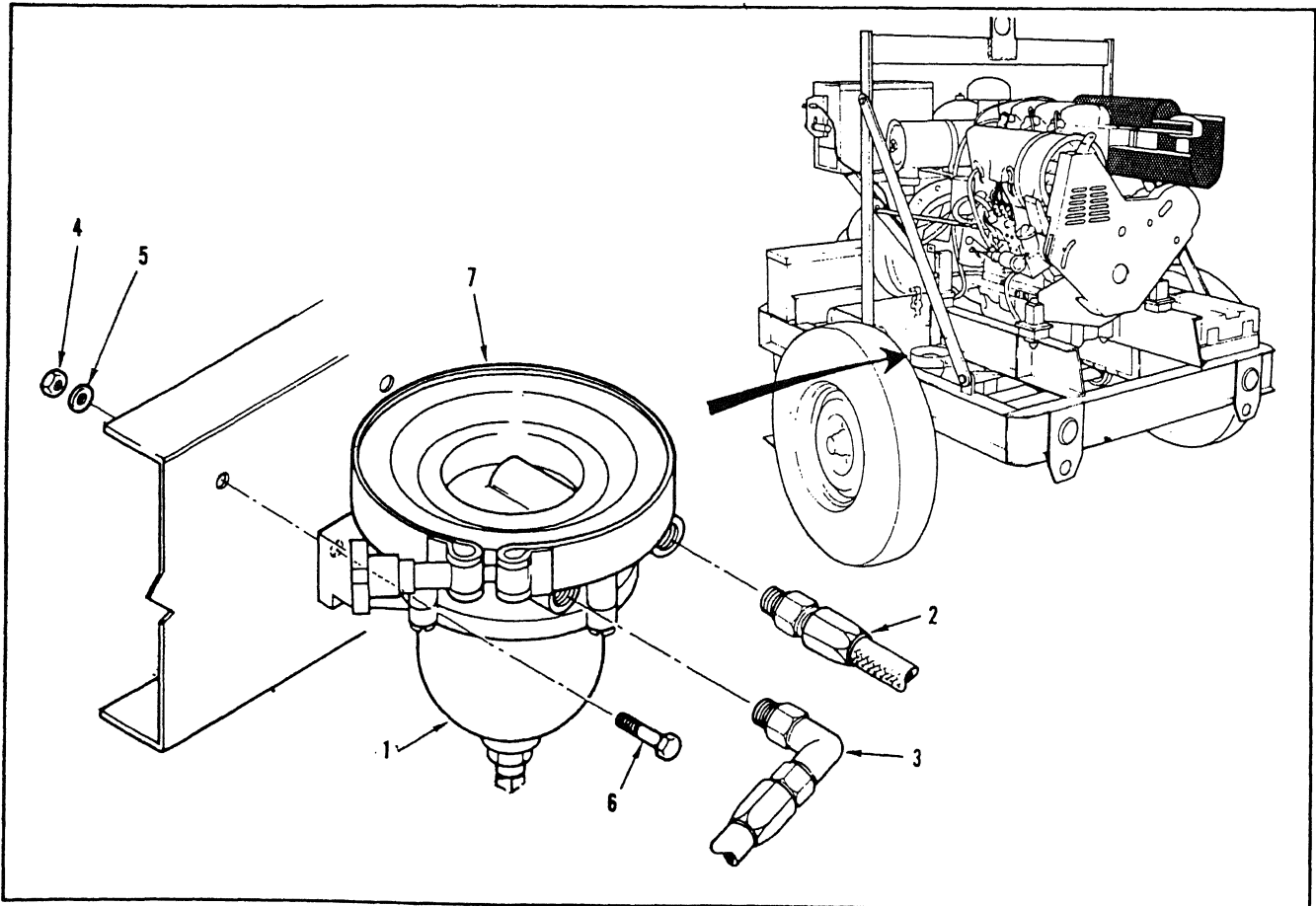


Figure 4-25. Fuel Filter/Separator, Removal/Installation

4-28. FUEL FILTER (figure 4-27).

a. Servicing. Servicing of fuel filter consists of removing and replacing the expendable cartridge.

b. Removal.

CAUTION

Fuel will run out when expendable cartridge is loosened. Use shop towel and clean up all fuel.

- (1) Carefully unscrew expendable cartridge (1); discard cartridge.
- (2) Using a clean shop towel, carefully clean seat (2).

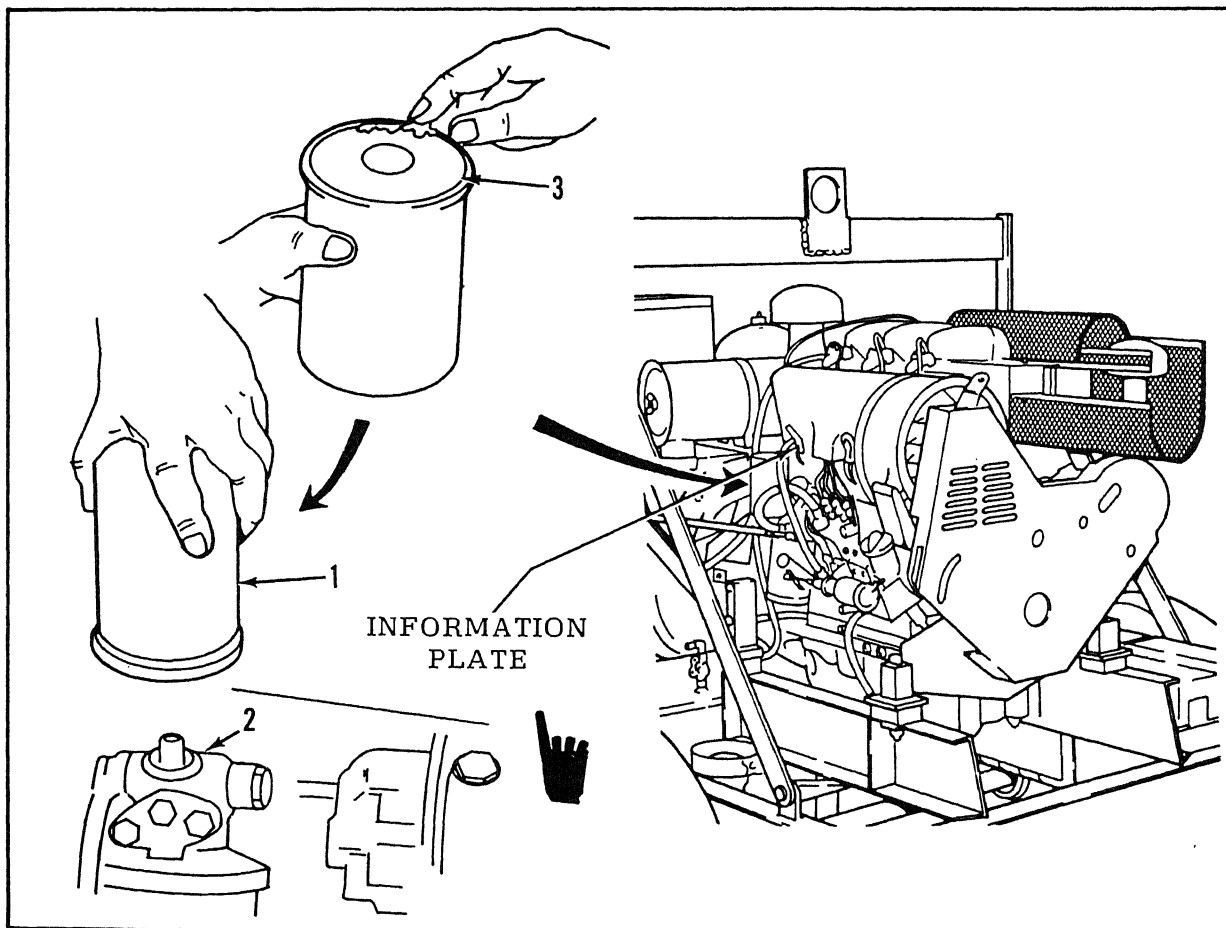


Figure 4-27. Fuel Filter, Removal/Installation

c. Installation.

WARNING

Potential health hazards result from inhalation of petroleum solvent vapors and from contact of solvent with skin. Use rubber gloves and hand cream for protection, and work with adequate ventilation.

CAUTION

Petroleum solvents are highly flammable. Keep solvent container lids closed when not in use, and avoid all possible risks of igniting solvent vapors, keep away from open flame and excessive heat. Flash point of solvent is 100 to 138 degrees F (38 to 59 degrees C).

NOTE

If information plate replacement is required, TT-T-548 should be applied over the old plate on the cowling. The new plate must be installed on top of the old plate.

- (1) Slightly oil rubber seal (3); then, screw new cartridge (1) in place until seal is squarely seated.
- (2) Turn cartridge (1) a final half turn.
- (3) Bleed fuel system (refer to paragraph 4-26).
- (4) Start engine and check for leaks.

4-29. FUEL FEED PUMP

- a. Servicing (figure 4-28). The strainer located within the fuel feed pump requires cleaning after every 100 hours of operation.
 - (1) Removal. To clean strainer it must be removed from fuel pump as follows:
 - (a) Remove screw (1), washer (2), cover (3) and gasket (4).
 - (b) Remove strainer (5) from pump (6).
 - (c) Using clean fuel, thoroughly clean strainer (5).
 - (2) Installation. Install cleaned strainer as follows:
 - (a) Position strainer (5) to fuel pump (6).

- (b) Put gasket (4) into place and install cover (3).
- (c) Install washer (2), screw (1) and ensure tightness.

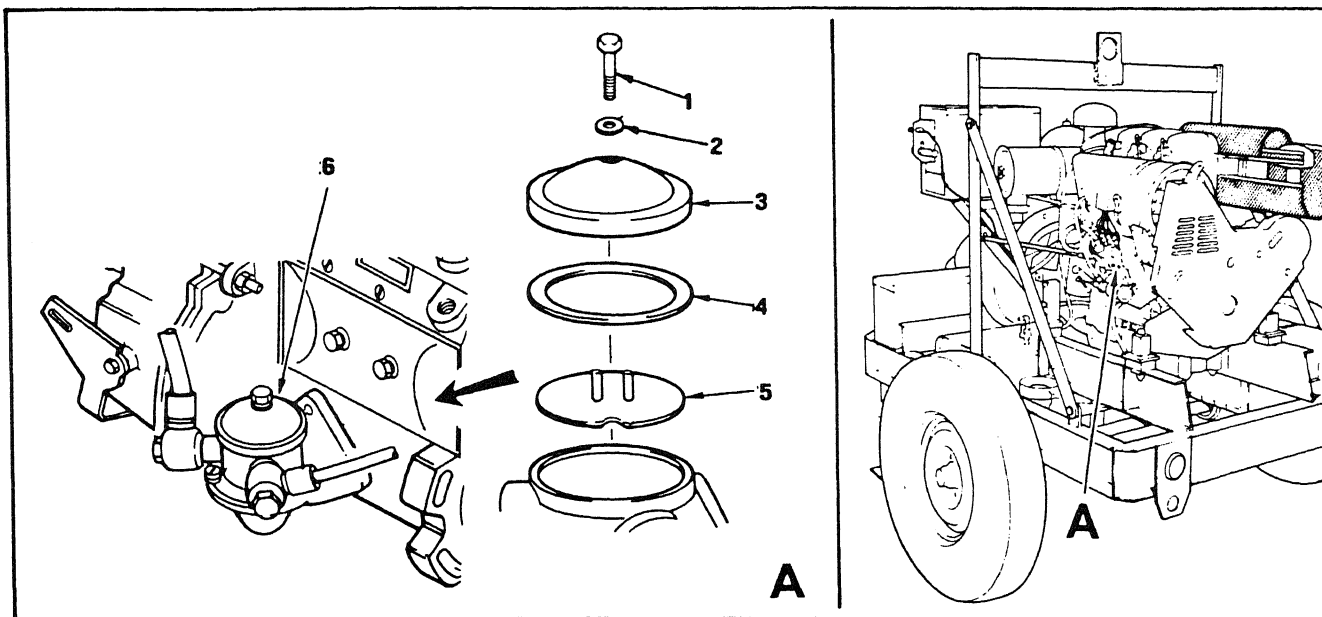


Figure 4-28. Servicing Fuel Feed Pump

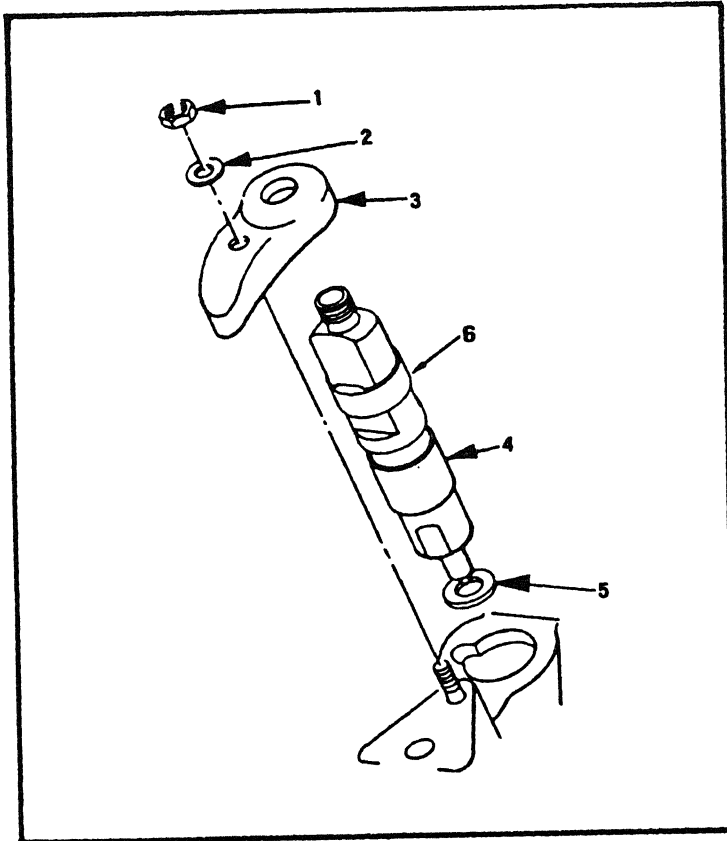


Figure 4-37. Fuel Injection Nozzle Removal and Installation.

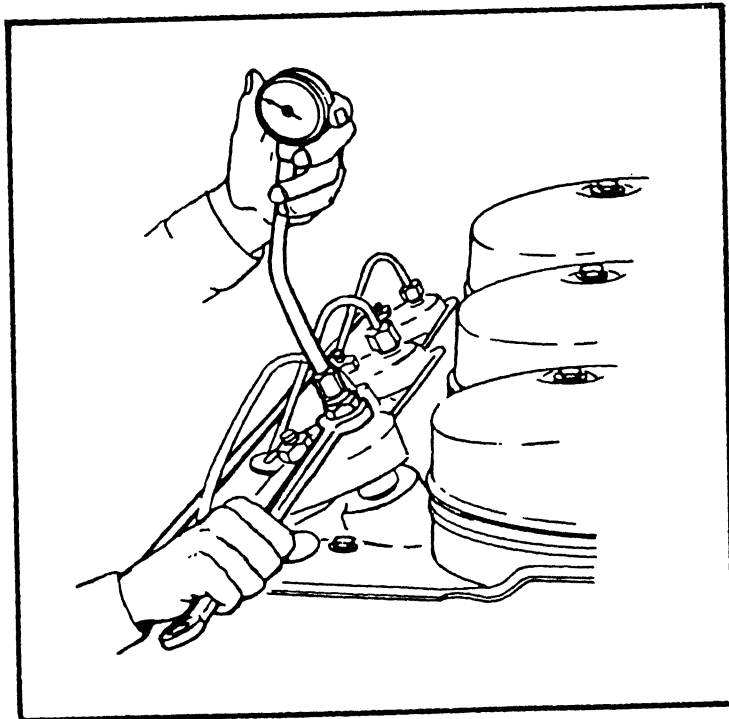


Figure 4-38. Compression Gauge Installation.

NOTE

On Models 13220E1070, 13225E9200 (97403), and LC 350GPM (36024), the fuel shutdown solenoid rod end must be disconnected from the injection pump fuel shutdown lever to prevent discharge of fuel. Identify the hole, when removing rod end for reassembly. On Model 13226E2289 (97403) the actuating rod must be disconnected from the actuator lever to prevent discharge of fuel.

- g. On Models 13220E1070, 13225E9200 (97403), and LC 350GPM (36024), disconnect fuel shutdown solenoid rod (1, Figure 4-39) from injection pump fuel shutdown lever (2), by removing nut (3) and washer (4). Pull rod end (5) away from lever (6). Press down on shutdown lever (2) and wire it in this position, which is the full shutdown position.

CAUTION

Insure that rod end is clear of any obstructions to prevent damage upon solenoid actuation.

- h. On Model 13226E2289 (97403), disconnect actuating rod (1), Figure 4-40) from actuator lever (2) by removing nut (3), lockwasher (4) bolt (5) and washer (6). Pull rod end (7) away from lever (2). Press down on shutdown lever (8) and wire it in this position which is the full shutdown position.
- * i. Place RUN switch ON.
- ** Pull out EMERGENCY STOP SWITCH.
- j. Depress oil pressure bypass switch and the start switch simultaneously and hold for approximately three seconds.
- k. Take compression reading and record.
- *l. Release start switch, oil pressure bypass switch and place RUN switch OFF.
- ** Release start switch, oil bypass switch and push in EMERGENCY STOP switch.
- l m. Remove compression gauge and adapter with injection nozzle washer.
- n. Discard injection nozzle washer.
- * On Models 13220E1070, 13225E9200, and 13226E2289 (97403)
- ** On Model LC 350GPM (36024)

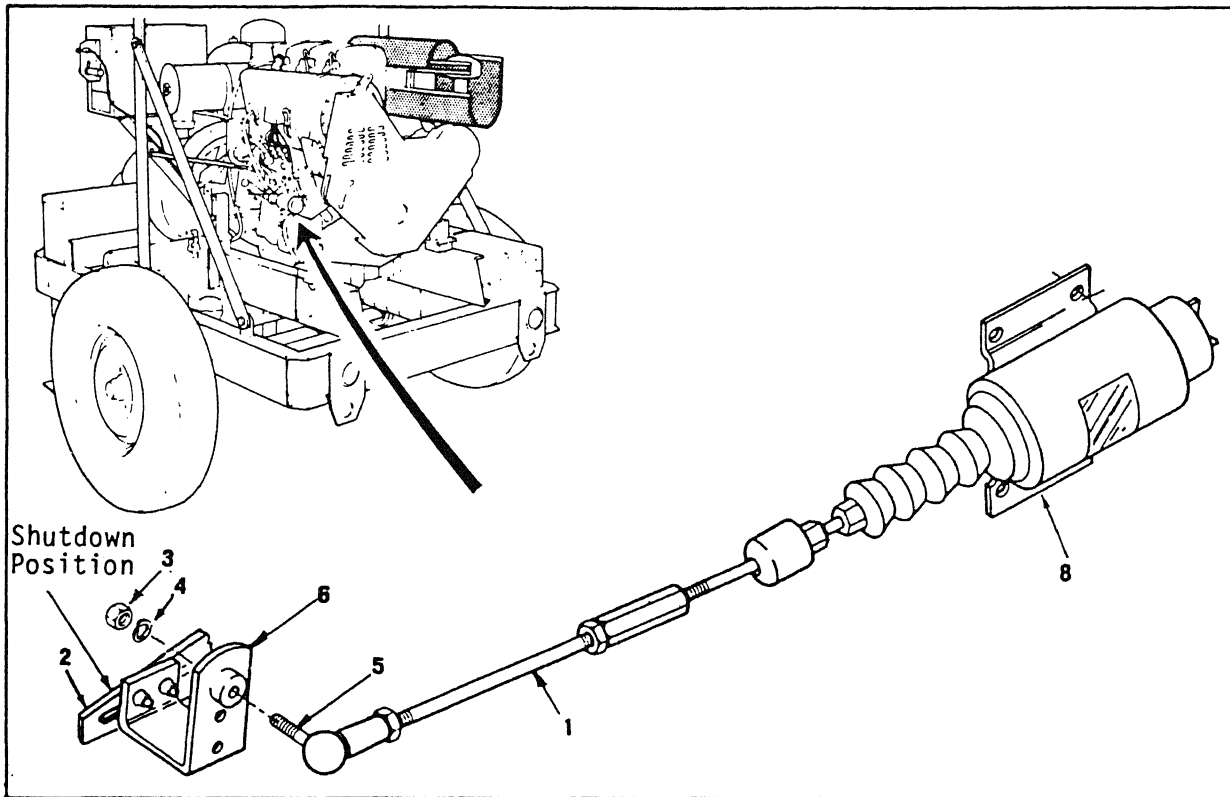


Figure 4-39. Shutdown Solenoid Rod, Disconnecting/Reconnecting

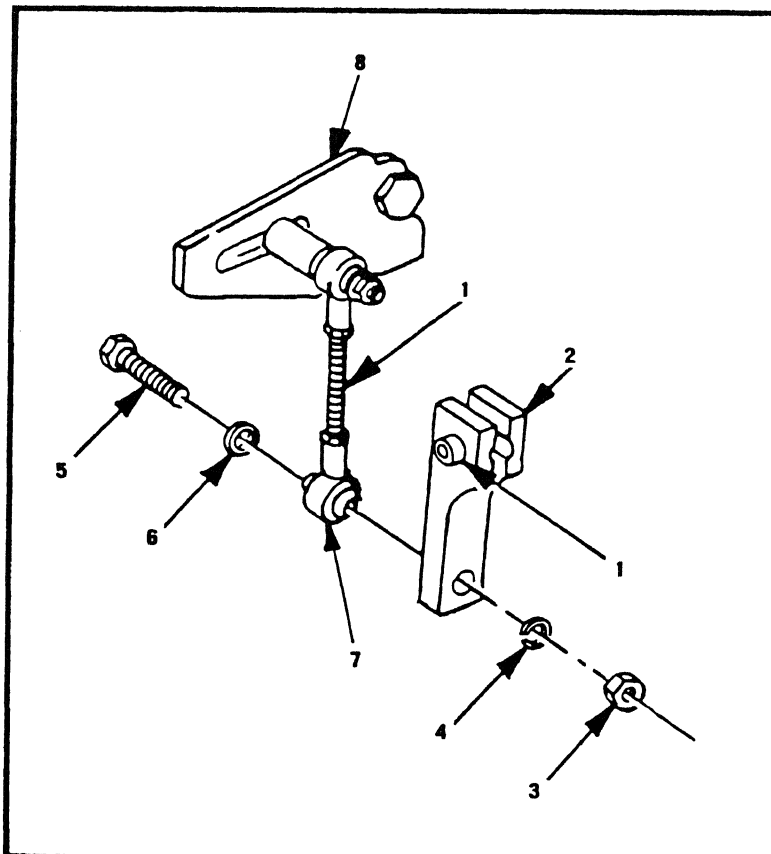


Figure 4-40. Actuator Lever to Actuating Rod Removal and Installation.

- o. Perform compression Check on remaining cylinders as outlined in steps (c) through (m) above.
- p. Compare compression readings for all cylinders. Pressure reading differential must not exceed 58 psi (4 bars) within the allowable 284 psi (20 bars) and 397 psi (28 bars) compression range.
- q. Install new injection nozzle washer (5, Figure 4-37) (metal surface down) injection nozzle (4), bushing (6), and yoke (3), and secure with washer (2) and nut (1).
- r. Refer to paragraph 4-26 and install fuel injection and overflow lines.
- s. Remove wire securing injection pump fuel shutdown lever and discard.

NOTE

Insure that rod end is installed
in the same hole of lever before
removal.

- t. On Models 13220E1070, 13225E9200, and LC 350GPM install fuel shutdown solenoid rod end (5, figure 4-39) to injection pump fuel shutdown lever (6). Secure with nut (3) and washer (4).
- u. On Model 13226E2289, install rod end (7, Figure 4-40) to actuator lever (2). Secure with bolt (5) washer (6), lockwasher (4) and nut (3).

4-39. PUMP VALVES, MANIFOLDS AND FITTINGS (figure 4-42).

a. Removal of Coupling Half.

- (1) Remove nuts (1), washers (2), screws (3), coupling half (4) and gasket (5).

b. Installation of Coupling Half.

NOTE

The longest of the screws must be located at hole that connects coupling half to support bracket.

- (1) Position gasket (5) and coupling half (4) to valve; install screws (3), washers (2) and nuts (1).

c. Removal of Gate Valve.

- (1) Refer to step a, this paragraph, and remove coupling half.

NOTE

Gate valve may be removed with coupling half installed.

- (2) Remove nuts (6), washers (7), gate valve (8) and gasket (9).

d. Installation of Gate Valve.

- (1) Align gasket (9) and gate valve (8) over studs of manifold.
- (2) Install washers (7) and nuts (6).
- (3) Refer to step b, this paragraph, and install coupling half.

e. Repair of Gate Valve (Stem Packing Replacement)

- (1) Remove nut (10), information plate (10A), and handwheel (11).
- (2) Remove packing nut (12) and spring (13).
- (3) Remove packing gland (14) and packing (15).
- (4) Slide new packing (15) onto stem until packing is seated.
- (5) Slide packing gland (14) onto stem.
- (6) Position spring (13) over gland and install packing nut (12).
- (7) Place handwheel (11), and information plate (10A) on stem and secure with nut (10).

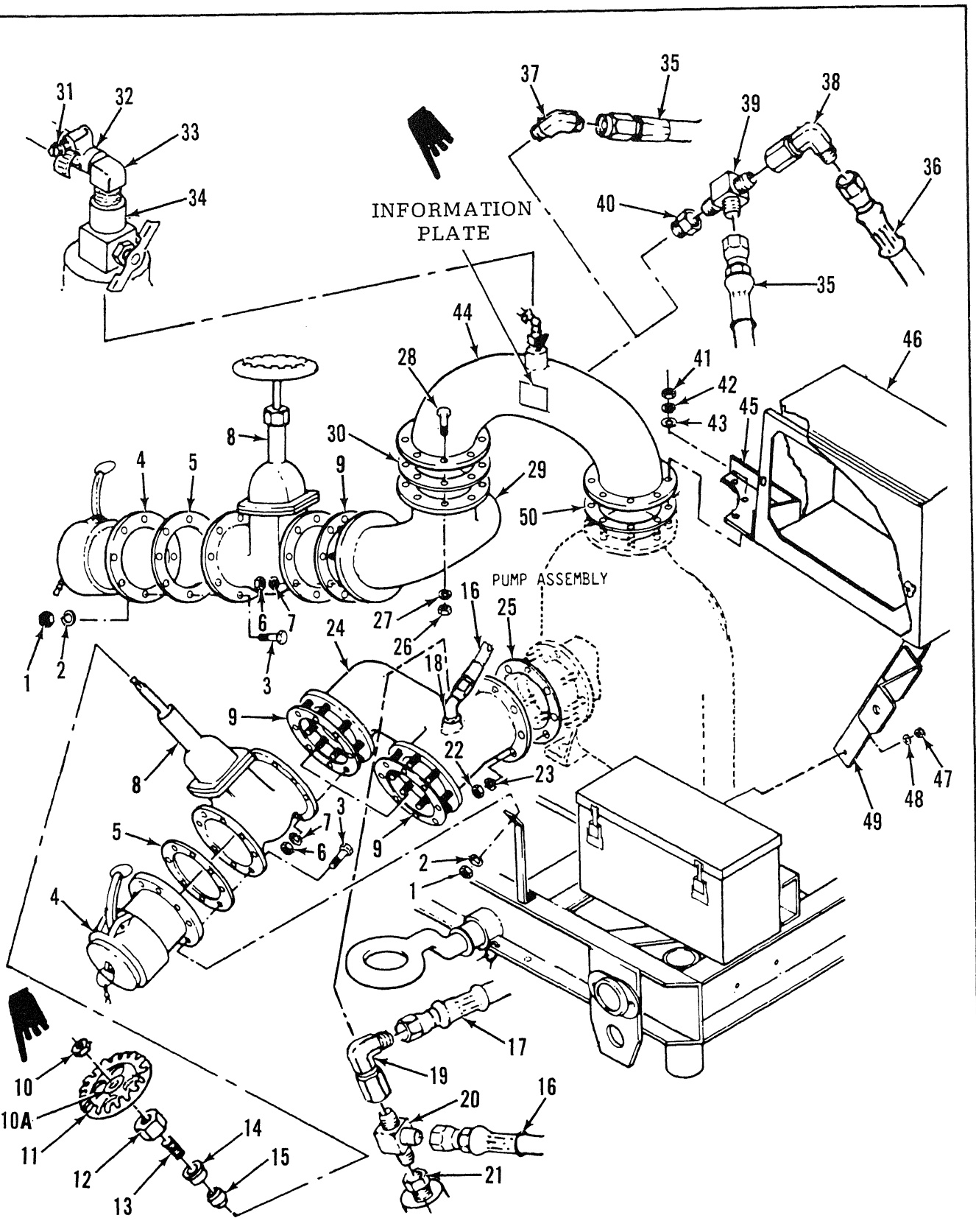


Figure 4-42. Pump Valves, Manifolds and Fittings, Removal/Installation.

f. Removal of Suction Manifold.

- (1) Refer to steps a and c, this paragraph, and remove coupling half and gate valve.

NOTE

Suction manifold may be removed with coupling half installed.

- (2) Disconnect hose (16) and (17) on Model 13226E2289 (97403).
- (3) Remove elbow (18) on Models 13220E1070, 13225E9200 (97403) and LC 350GPM (36024); or elbow (19), tee (20) and bushing (21) on Model 13226E2289 (97403).
- (4) Remove nuts (22), lockwashers (23), suction manifold (24) and gasket (25).

g. Installation of Suction Manifold.

- (1) Align gasket (25) and suction manifold (24) over studs of centrifugal pump.
- (2) Install lockwashers (23) and nuts (22).
- (3) On Model 13226E2289 (97403) install bushing (21), tee (20) and elbow (19); or on Models 13225E9200, 13220E1070 (97403) and LC 350GPM (36024) install elbow (18).
- (4) Connect hose (16) and (17) on Model 13226E2289 (97403).
- (5) Refer to steps b and d, this paragraph, and install gate valve and coupling half.

h. Removal of Discharge Manifold.

- (1) Refer to steps a and c, this paragraph, and remove coupling half and gate valve.

NOTE

Discharge manifold may be removed with coupling half and gate valve installed.

- (2) Remove nuts (26), lockwashers (27), screws (28), discharge manifold (29) and gasket (30).

i. Installation of Discharge Manifold.

- (1) Position gasket (30) on discharge manifold (29).
- (2) Install screws (28), lockwashers (27), and nuts (26).
- (3) Refer to steps b and d, this paragraph, and install gate valve and coupling half.

j. Removal of Discharge Connection.

- (1) Refer to steps a, c, and h, this paragraph, and remove coupling half, gate valve and discharge manifold.

NOTE

Discharge connection may be removed with coupling half, gate valve, and discharge manifold installed. However, the weight of these items must be supported.

- (2) Loosen clamp (31) and disconnect hose (32).
- (3) Remove elbow (33) and vent valve (34).
- (4) Disconnect hose (35) and (36) on Model 13226E2289 (97403).
- (5) Remove elbow (37) on Models 13220E1070, 13225E9200 (97403), and LC 350GPM (36024) or elbow (38), tee (39), and bushing (40) on Model 13226E2289 (97403).
- (6) Support discharge connection (44), before disconnecting it from pump and control panel brackets.
- (7) Remove nuts (41), lockwashers (42) and flat washers (43) from connection (44) and upper control panel bracket (45).
- (8) Support control panel (46) and loosen nut (47).
- (9) Move control panel (46) from connection (44), and secure control panel, making certain that stress is not placed on any of its parts.
- (10) Remove connection (44) and gasket (50).

k. Installation of Discharge Connection.

- (1) Align gasket (50), discharge connection (44) and upper control panel bracket (45) over studs of pump.
- (2) Install lower support bracket (49) with lockwasher (48) and nut (47).
- (3) Install flat washers (43), lockwashers (42), and nuts (41).
- (4) Install elbow (37) on Models 13220E1070, 13225E9200 (97403) and LC 350GPM (36024) or bushing (40), tee (39), and elbow (38) on Model 13226E2289 (97403).
- (5) Connect hose (35) and (36) on Model 13226E2289 (97403).
- (6) Install vent valve (34) and elbow (33).
- (7) Connect hose (32) and tighten clamp (31).
- (8) Refer to steps b., d., and i., this paragraph, and install discharge manifold, gate valve, and coupling half.

WARNING

Potential health hazards result from inhalation of petroleum solvent vapors and from contact of solvent with skin. Use rubber gloves and hand cream for protection, and work with adequate ventilation.

CAUTION

Petroleum solvents are highly flammable. Keep solvent container lids closed when not in use, and avoid all possible risks of igniting solvent vapors, keep away from open flame and excessive heat. Flash point of solvent is 100 to 138 degrees F (38 to 59 degrees C).

NOTE

If information plate replacement is required, TT-T-548 should be applied over the old plate on the discharge connection. The new plate must be installed on top of the old plate.

4-40. CONTROL PANEL ASSEMBLY.

CAUTION

Disconnect negative cables from batteries.

a. Removal (figure 4-43).

- (1) Remove screws (1), washers (2) and cold weather start kit (3). Temporarily place cold weather start kit in a place where it will not be damaged.
- (2) Carefully remove control panel cover (4).
- (3) Disconnect hoses (5) and (6).
- (4) Tag and disconnect all wires from terminal board.
- (5) Remove nuts (7), screws (8), spacers (9), and control panel assembly (10).

b. Disassembly (figure 4-44).

- (1) Tag and disconnect wires attached to EMERGENCY STOP switch (3).
- (2) Rotate red knob (1) counterclockwise and remove.
- (3) Holding back of EMERGENCY STOP switch (3) firm, remove nut (2), switch, and ring (4).

NOTE

If required, remove information plate by drilling out four rivets.

- (4) Tag and disconnect wires attached to oil pressure bypass switch (7).
- (5) Rotate rubber knob (5) counterclockwise and remove.
- (6) Holding back of oil pressure bypass switch (7) firm, remove nut (6) and switch.
- (7) Tag and disconnect wires attached to start switch (10).
- (8) Rotate rubber knob (8) counterclockwise and remove.
- (9) Holding back of start switch (10) firm, remove nut (9) and switch.
- *(10) Tag and disconnect wires attached to run relay (K2).
- *(11) Remove nuts (11), lockwashers (11A), screws (12), and relay (13).

*Models 13220E1070, 13225E9200 (97403), and LC 350GPM (36024). Refer to para 4-41 for location of run relay on Model 13226E2289.

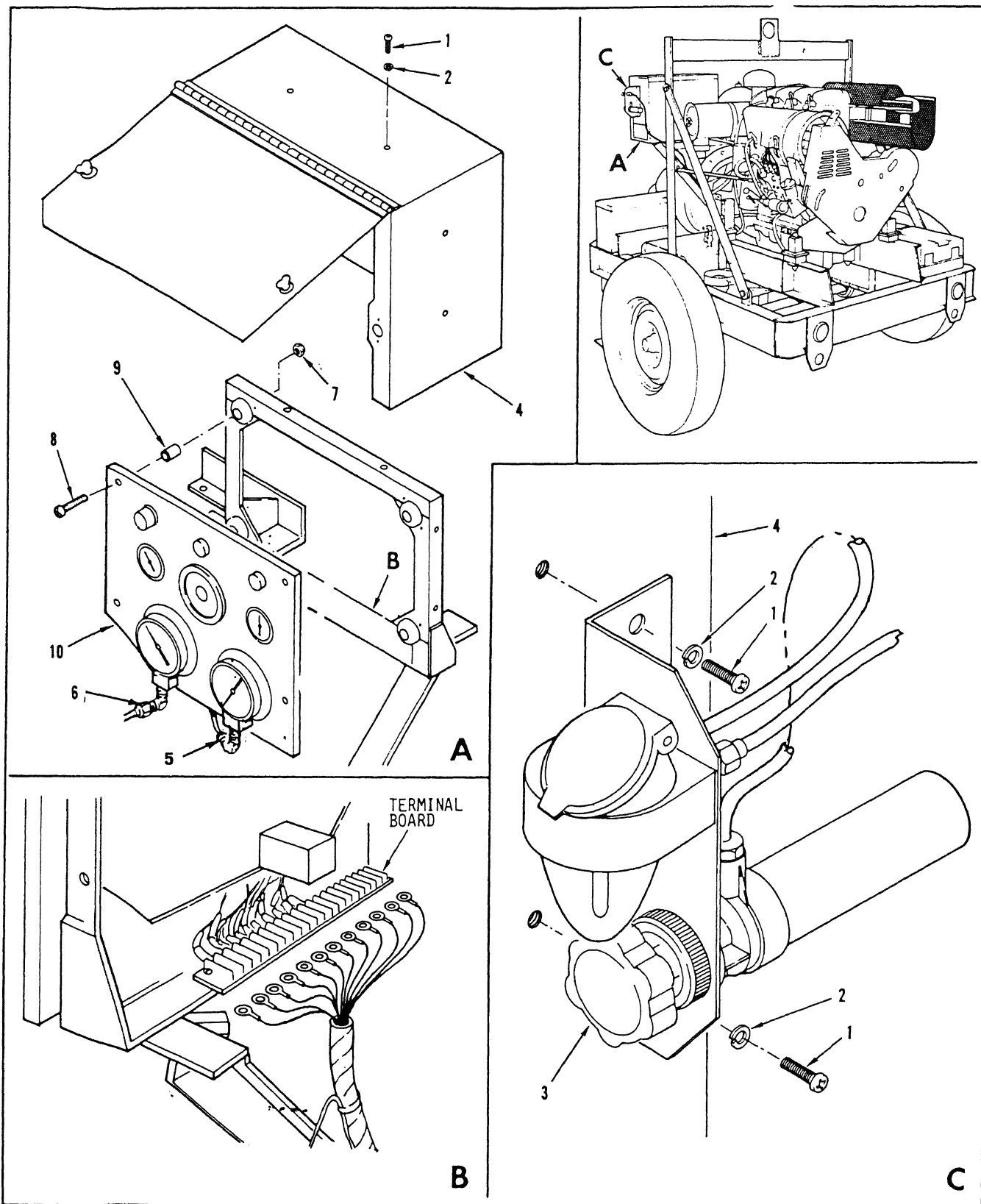


Figure 4-43. Control Panel Assembly, Removal/Installation

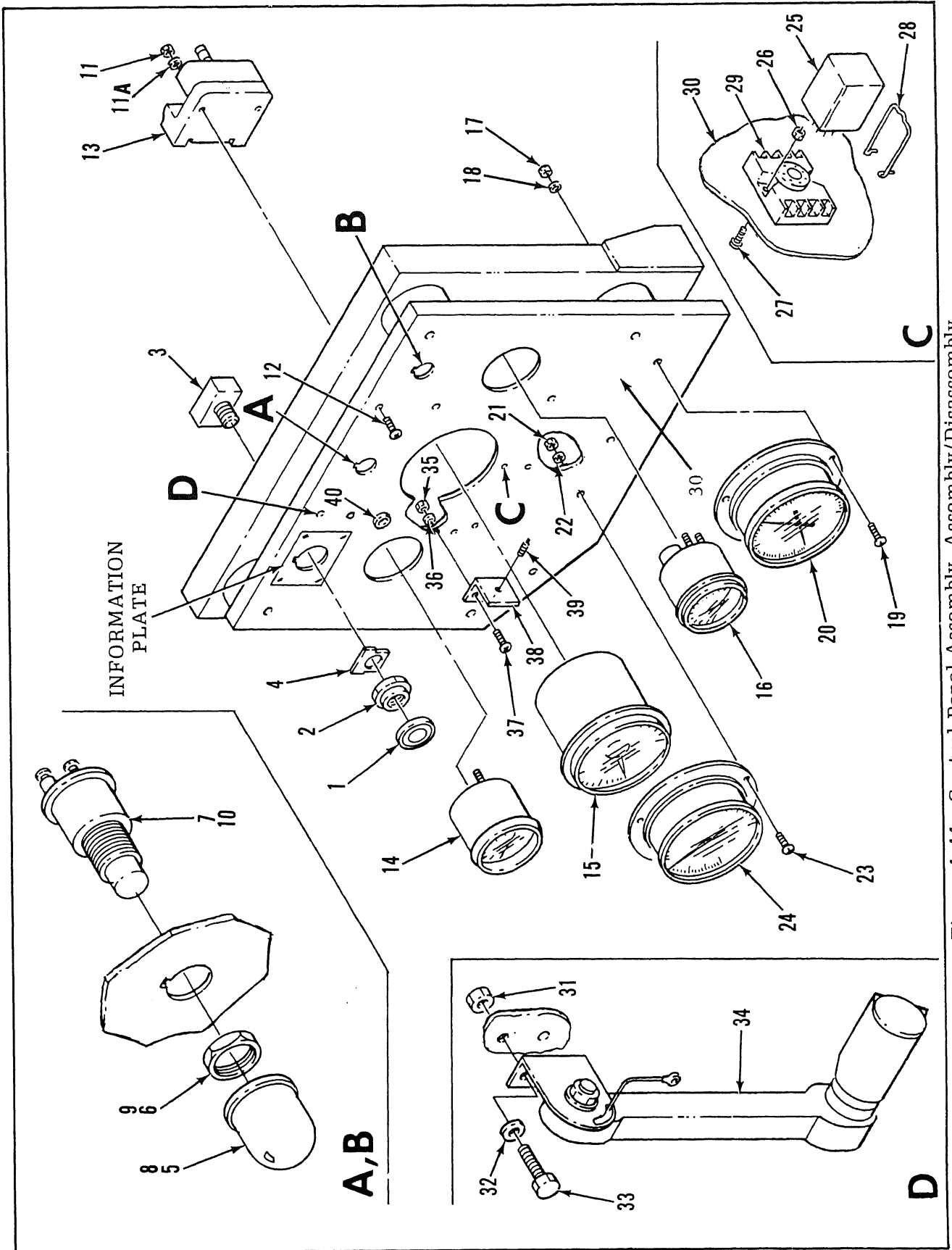


Figure 4-44. Control Panel Assembly, Assembly/Disassembly

- (12) Tag and disconnect wires attached to oil pressure gauge (14) and remove retaining bracket.
- (13) Remove oil pressure gauge (14).
- (14) Tag and disconnect wires from tachometer/hourmeter (15) and remove retaining bracket.
- (15) Remove tachometer/hourmeter (15).
- (16) Tag and disconnect wires from ammeter (16) and remove retaining bracket.
- (17) Remove ammeter (16).
- (18) Remove nuts (17), washers (18), screws (19) and suction gauge (20).
- (19) Remove nuts (17), washers (22), screws (23) and discharge gauge (24).
- (20) Slide lockwire (28) from relay (25) and pull relay out of K1 relay socket (29).
- (21) Tag and disconnect wires from K1 relay socket (29).
- (22) Remove nuts (26), screws (27), lock wire (28) and K1 relay socket (29) from control panel (30).
- (23) On Model LC 350GPM (36024), (figure 4-44), tag and disconnect wire attached to panel light.
- (24) Remove nuts (31), washers (32), screws (33), and panel light (34).
- (25) Remove nuts (35), washers (36), screws (37), and bracket (38).
- (26) Remove spring plunger (39) from bracket (38).
- (27) Inspect grommet (40) for signs of wear or cracks and remove and replace.

c. Repair. Repair of the control panel assembly consists of removing and replacing electrical components and gauges. When repairing solder joints, wire connections must be made mechanically sound before they are soldered; solder alone does not provide sufficient strength to prevent breakage. Surfaces of connections to be soldered must be clean and bright. Solder should be a lead-tin solder conforming to Specification QQ-S-571. Wires should always be heated to the point at which the solder will melt completely and flow into all parts of the joint. Excessive buildup of solder globs on the joint should be avoided or removed. Figure 4-45 contains a wiring diagram of the control panel assembly for Models 13220E1070 and 13225E9200 (97403). Figure 4-46 contains a wiring diagram of the control panel for Model 13226E2289 (97403).

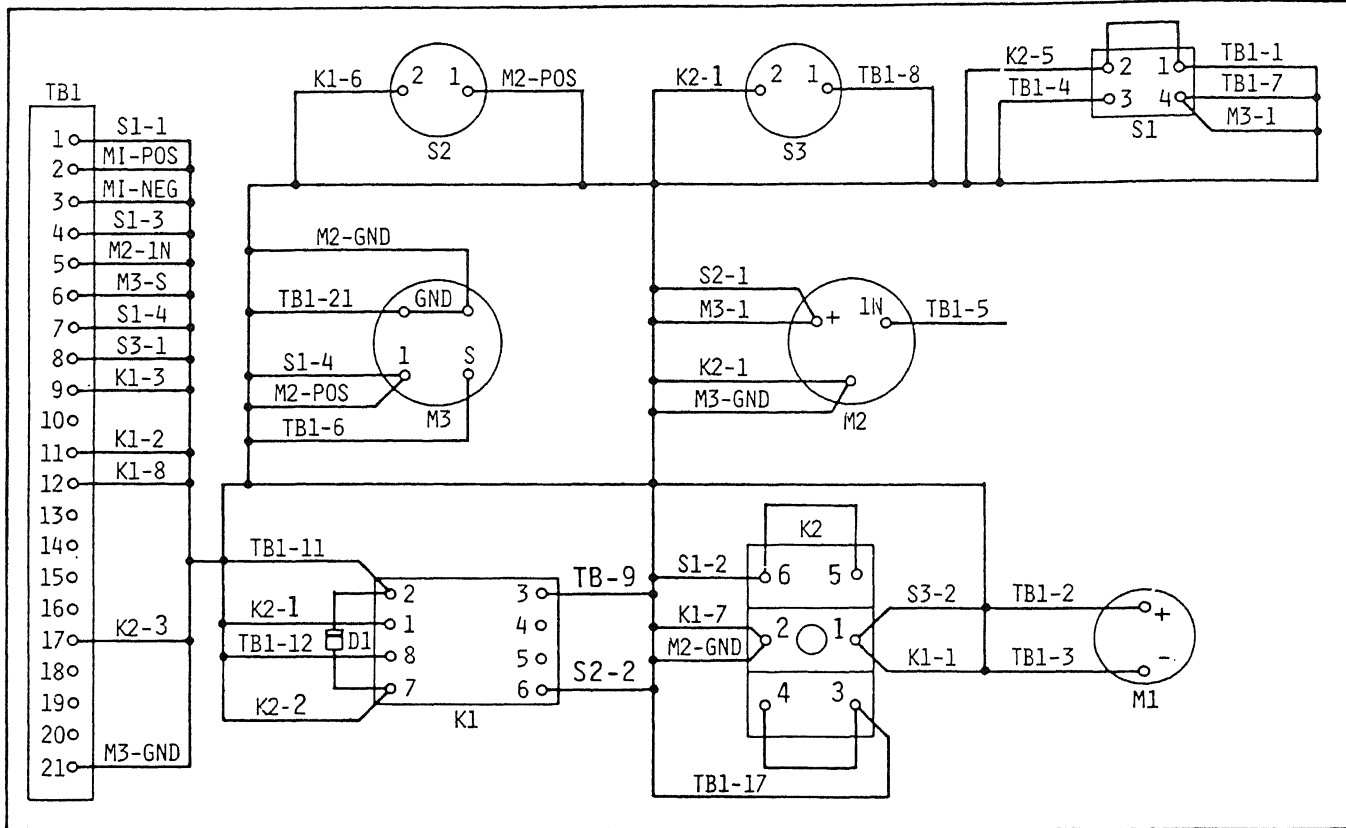


Figure 4-45. Control Panel Assembly Wiring Diagram (Models 13220E1070 and 13225E920)

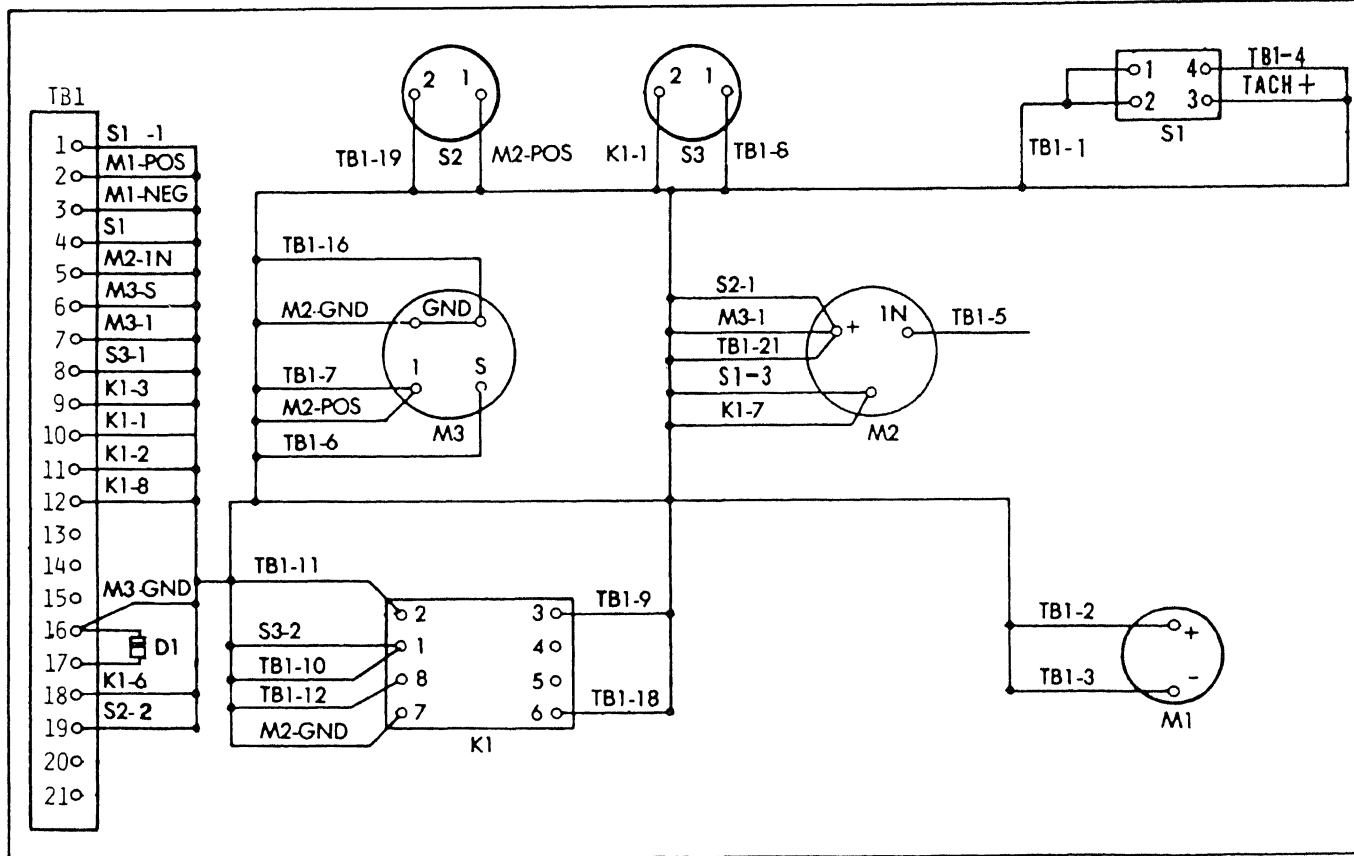


Figure 4-46. Control Panel Assembly Wiring Diagram (Model 13226E2289)

d. Assembly (figure 4-44).

- (1) On Model LC 350GPM (36024) (figure 4-44), screw spring plunger (39) into bracket (38) and install bracket on control panel (30) with screws (37), washers (36), and nuts (35).
- (2) Position panel light (34) on control panel (30) and secure with screws (33), washers (32), and nuts (31).
- (3) Position K1 relay socket (29) to control panel (30) and connect wires. Install lock wire (28), screws (27) and nuts (26).
- (4) Align and plug relay (25) into K1 relay socket (29) and secure in place with lockwire (28).
- (5) Position discharge gauge (24) and secure to panel with screws (23), washers (22) and nuts (21).
- (6) Position suction gauge (20) and secure to control panel (30) with screws (19), washers (18) and nuts (17).
- (7) Position ammeter (16) in control panel (30) and secure with retaining bracket.
- (8) Position tachometer/hourmeter (15) in control panel (30) and secure with retaining bracket.
- (9) Position oil pressure gauge (14) in control panel (30) and secure with retaining bracket.
- (10) On Models 13220E1070 and 13225E9200 (97403), position relay (13) in panel and secure with screws (12), lockwashers (11A), and nuts (11).
- (11) Align keyway of start switch (10) with slot in control panel (30) and install switch; secure to control panel with nut (9).
- (12) Thread rubber knob (8) into switch (10).
- (13) Align keyway of oil pressure bypass switch (7) with slot in control panel (30) and install switch; secure to control panel with nut (6).
- (14) Thread rubber knob (5) onto oil pressure bypass switch (7).

NOTE

If required, place information plate on control panel and install four rivets.

- (15) Position ring (4) on EMERGENCY STOP Switch (3), align keyway with slot in control panel (30) and install switch. Secure switch to control panel with nut (2).

- (16) Install red knob (1) on EMERGENCY STOP switch (3).
- (17) Refer to wiring diagram, figure 4-45 and connect all control panel assembly wiring for Models 13220E1070 and 13225E9200 (97403). Refer to wiring diagram, figure 4-46, and connect all control panel assembly wiring for model 13226E2289 (97403).
- (18) Refer to wiring diagram, figure 4-46, and connect all control panel assembly wiring for Model LC 350GPM (36024).

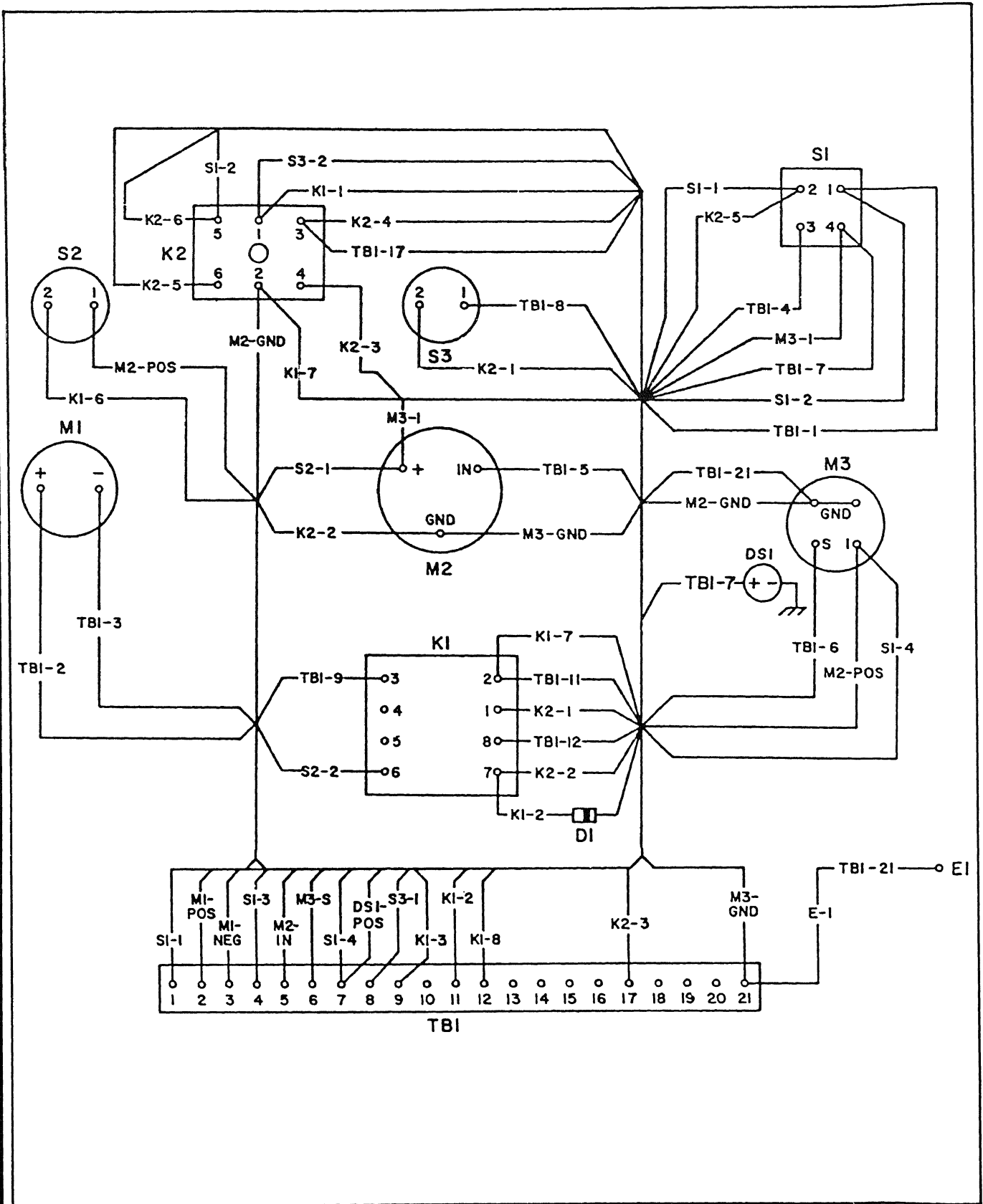


Figure 4-46.1. Control Panel Assembly Wiring Diagram (Model LC 350GPM)

e. Installation (figure 4-43).

- (1) Position control panel assembly (10) to bracket and install spacers (9), screws (8) and nuts (7).
- (2) Connect all wires to terminal board (TB1).
- (3) Connect hoses (5) and (6) to gauges.
- (4) Carefully position control panel cover (4).
- (5) Position cold weather start kit (3) to control panel. Install washers (2) and screws (1).

4-41. RUN RELAY (K2), Used on Model 13226E2289 (97403). (figure 4-47)

CAUTION

Disconnect negative cables from batteries.

a. Removal.

- (1) Remove screws (1), lockwashers (2), cover (3) and gasket (4).
- (2) Tag and disconnect leads (5), jumper wires (6) and ground strap (7).
- (3) Remove nuts (8), lockwashers (9), screws (10) washers (11), and relay (12).
- (4) Remove screws (13), lockwashers (14) and box (15).
- (5) Remove nuts (16), lockwashers (17), screws (18), ground strap (19) and mounts (20).

b. Cleaning and Inspection.

- (1) Clean relay with soft clean lint free cloth.
- (2) Inspect relay contacts for evidence of arcing (burns). Replace relay if contacts are burnt.
- (3) Check action of contacts return springs. Replace relay if contacts stick.
- (4) Inspect wires and terminals for cracked or loose ends. Replace defective wires and terminals.

c. Installation.

- (1) Install mounts (20), ground strap (19), screws (18), lockwashers (17) and nuts (16).
- (2) Install box (15), washers (14) and screws (13).
- (3) Install relay (12), washers (11) and screws (10), lockwashers (9) and nuts (8).
- (4) Install ground strap (7), jumper wires (6) and leads (5).
- (5) Install gasket (4), cover (3), lockwashers (2) and screws (1).

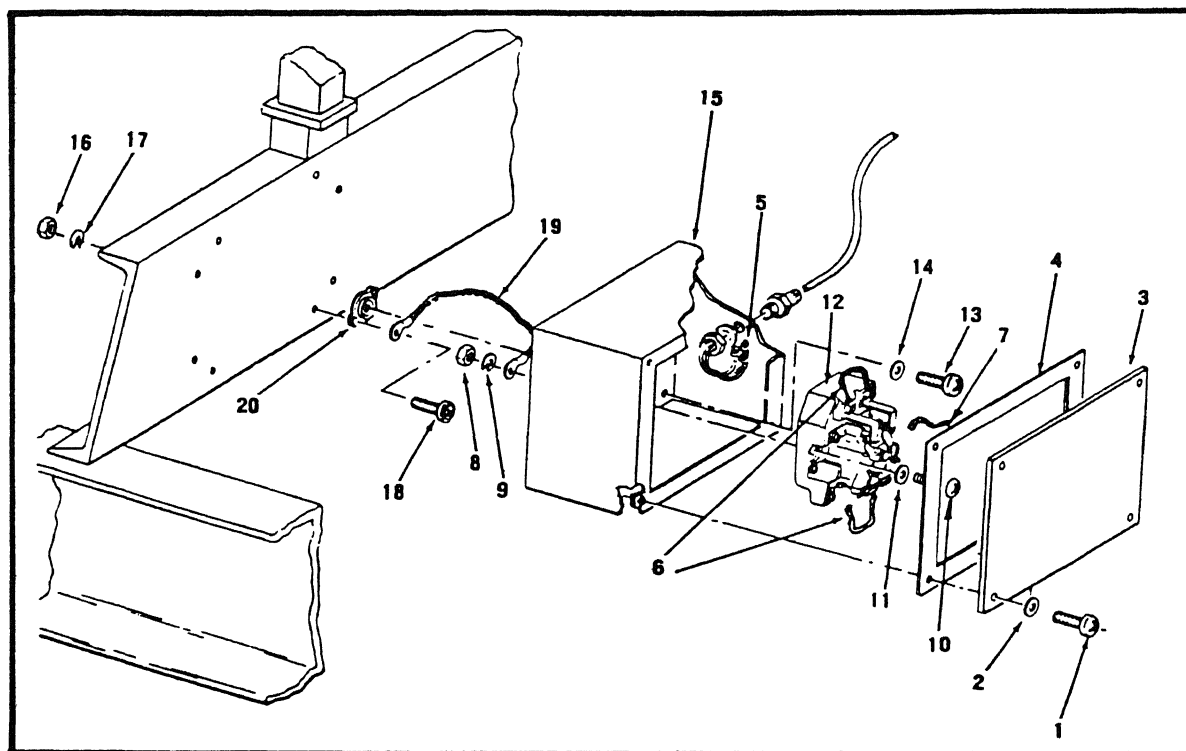


Figure 4-47. Run Relay (K2), Removal/Installation

c. Shutdown**CAUTION**

Do not shut engine down suddenly from full speed unless an emergency exists. Allow engine to stabilize at idle before shutdown.

- (1) Place pressure controller mode selector switch (6, figure 2-7) to "MANUAL".
- (2) Place pressure controller manual speed control (5) to "IDLE" position.
- (3) After approximately two minutes close discharge valve (3) and suction valve (2).
- (4) Push in start/stop switch (7).

d. After Operation

- (1) Install control box cover (3, figure 4-54) washers (2) and screws (3).
- (2) Perform after operation PMCS (Table 2-1).

4-48. PRESSURE CONTROL SYSTEM TEST, Model 13226E2289 (97403)

- a. Requirements. To test the regulator system the following items are required.

(1) 350 GPH pumping assembly (pressure supply).

NOTE

The regulated pump, Model 13226E2289 (97403), in the manual mode can be used as an unregulated pump. In the automatic mode, 20 psig must be supplied to the suction manifold to allow regulator to advance to full power.

(2) Liquid source that pumps use.

(3) One suction hose and two discharge hoses.

(4) Storage tank.

- b. Test Set-Up.

(1) Locate clean level site with surface firm enough to support pumping assemblies.

(2) Position source pressure pumping assembly (pump no. 1), figure 4-56 in such a manner that connections where liquid is to be pumped from will connect with fitting on suction valve.

(3) Position regulated pumping assembly (pump no. 2) in such a manner that suction valve connection will connect with discharge hose from no. 1 pumping assembly.

(4) On both pumping assemblies, remove pins (1) and (2) and extend trailer support legs (3). Reinstall pins (1) and (2).

WARNING

Chocks must be placed under both wheels on each pumping assembly to prevent pumps from rolling.

(5) On both pumps, place chocks (4) under wheels (5).

4-49. IDLER PULLEY ASSEMBLY

a. Removal.

- (1) Remove cooling blower V-belt. (para 4-19)

CAUTION

Remove negative cables
from batteries.

- (2) Tag and disconnect V-belt contact switch wires (1, fig. 4-57).
- (3) Loosen spacer (2).
- (4) Hold pulley (4) as shown and loosen bolt (5) until the contact switch bracket (6) can be moved to disengage idler lever (7) release pulley.
- (5) Remove bolt (8), washer (9), spacer (2), washer (3), nut (10), washer (11) and idler pulley assembly (12).

b. Disassembly.

- (1) Remove and replace o-ring seal (13, fig. 4-57).
- (2) Remove nut (14), washer (15) and washer (16).
- (3) Remove screws (17), cover (18) and gasket (19).
- (4) Remove bolt (20), bushing (21), bearing (22) and ring (23) from pulley (4).

c. Inspection. Inspect all parts for obvious defects.

d. Repair. Replace defective parts.

e. Reassembly.

- (1) Reassemble ring (23, fig. 4-57), bearing (22), bushing (21) and bolt (20) in pulley (4).
- (2) Install gasket (19), cover (18) and screws (17).
- (3) Install washer (16), washer (15), nut (14), and o-ring seal (13).

f. Installation.

- (1) Position idler pulley assembly (12, fig. 4-57) in place on engine and install washer (11) nut (10), washer (9), bolt(8), washer (3) and spacer (2). Do not fully tighten spacer (2).

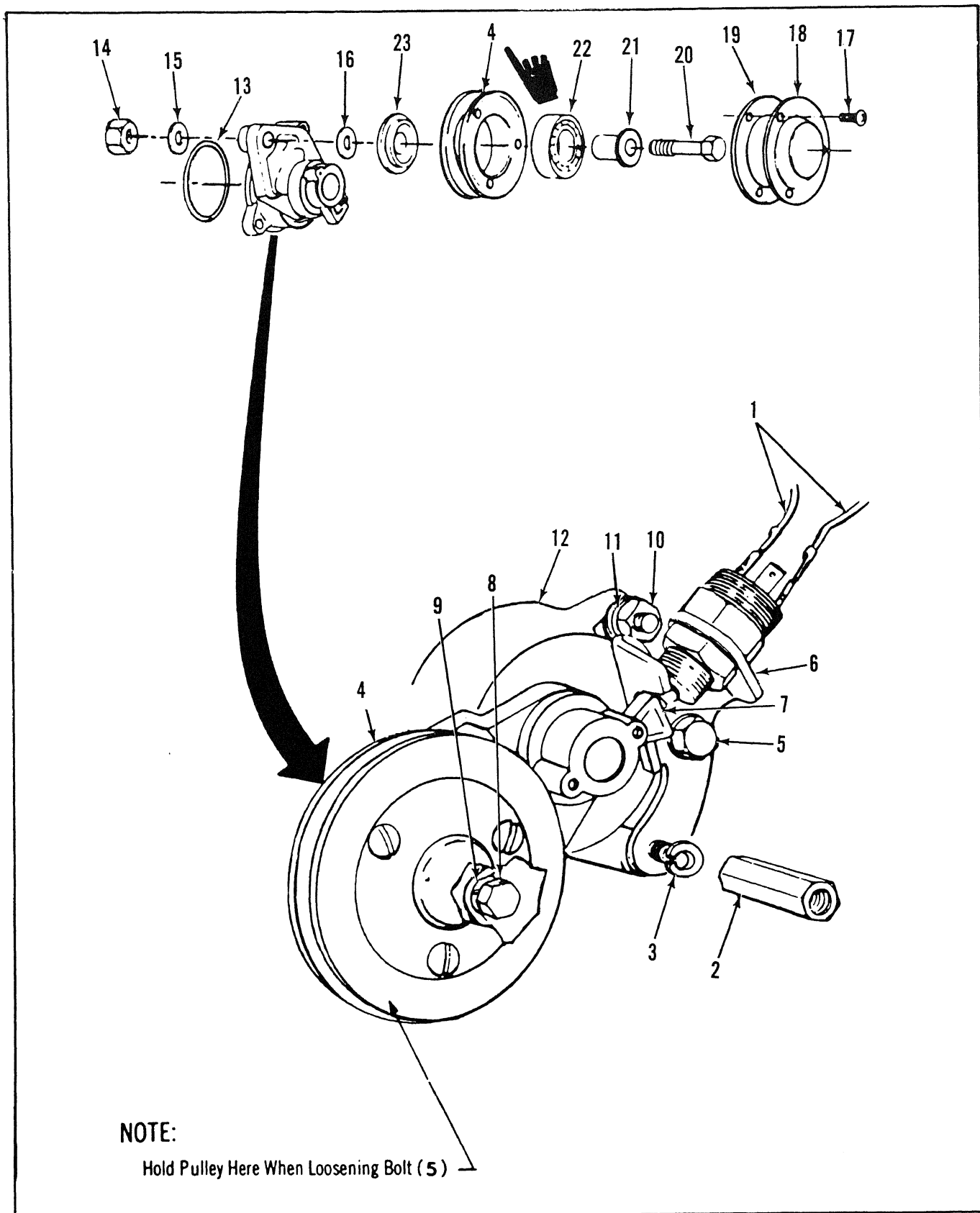


Figure 4-57. Idler Pulley Assembly, Removal/Installation.

e. Removal of Wheel Bearings
(figure 4-60).

- (1) With axle assembly adequately supported, remove tires and wheels as indicated in this paragraph, step a.
- (2) Remove dust cap (1).
- (3) Remove cotter pins (2); then remove nuts (3), and washers (4).
- (4) Remove outer cones (5)
- (5) Remove hub (7); then remove seal (8), inner cones (9) inner cups (10) and outer cups (6).

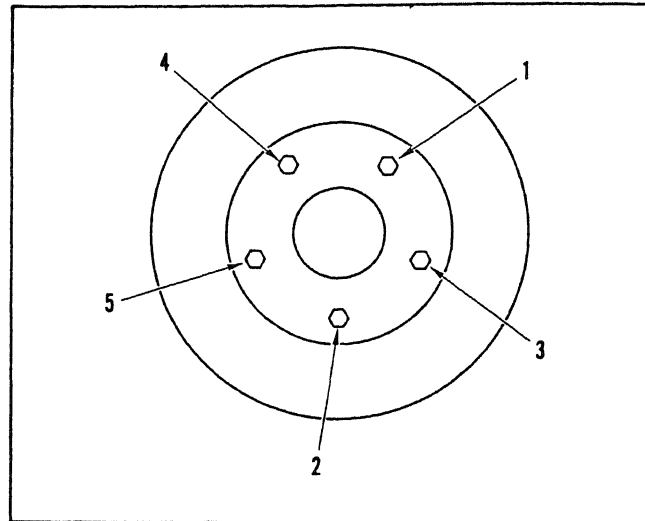


Figure 4-59. Lug Nut Tightening Sequence

f. Installation of Wheel Bearings (figure 4-60).

- (1) Apply grease, MIL-G-10924 to bearing cone and install inner cups (10) and inner cones (9) and seal (8) in hub (7).

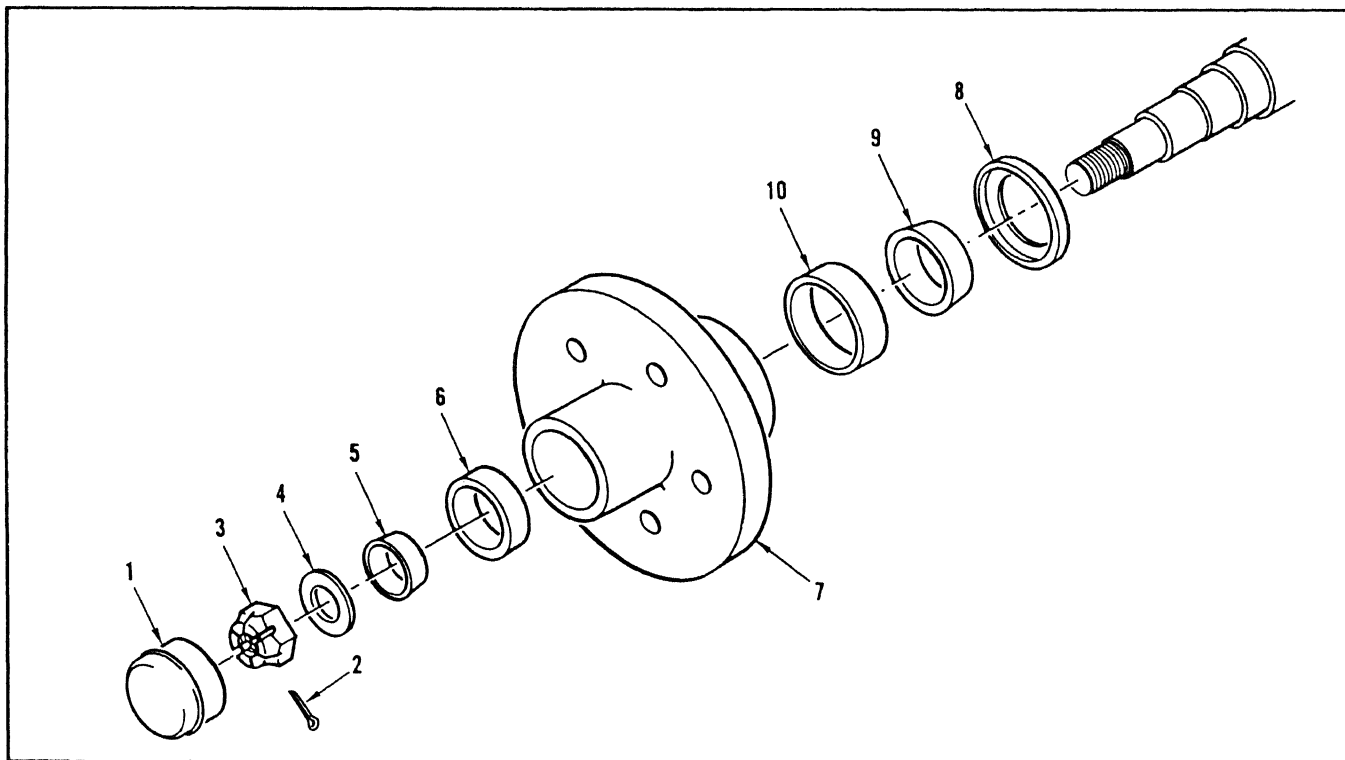


Figure 4-60. Wheel Bearings, Removal/Installation

- (2) Apply grease, MIL-G-1094 to bearing cones (5) and install outer cups (6) and outer cones (5).
- (3) Install washers (4), nuts (3) and cotter pins (2).
- (4) Install dust cap (1).
- (5) Install tires and wheels as indicated in this paragraph, step d.

4-51. COOLING COIL

a. Removal.

- (1) Unlatch, open and remove upper air cowling.
- (2) Remove fuel injection feed lines and overflow return line to injection pump. (para 4-26)
- (3) Loosen two cooler coil connectors (1, figure 4-61).
- (4) Remove two nuts (2) and washers (3) securing coil clips to cowling.
- (5) Lift cooler (4) out of engine.
- (6) Remove connectors (1) and ferrules (5).
- (7) Remove two nuts (6) securing top (7) and bottom halves (8) of clips together.
- (8) Remove two bolts (9) and separate clips.
- (9) Remove four rubber sleeves (10) from around coils.

b. Cleaning and Inspection.

- (1) Blow clean compressed air through coils to remove any obstructions.
- (2) Blow clean compressed air across all coil surfaces.
- (3) Inspect cooler connectors for thread damage and deep scratches across the ferrule mating surfaces. Replace if defective.
- (4) Inspect ferrules for deep scratches across mating surfaces. Replace if defective.
- (5) Inspect coils for dents or evidence of leakage. Replace if defective.

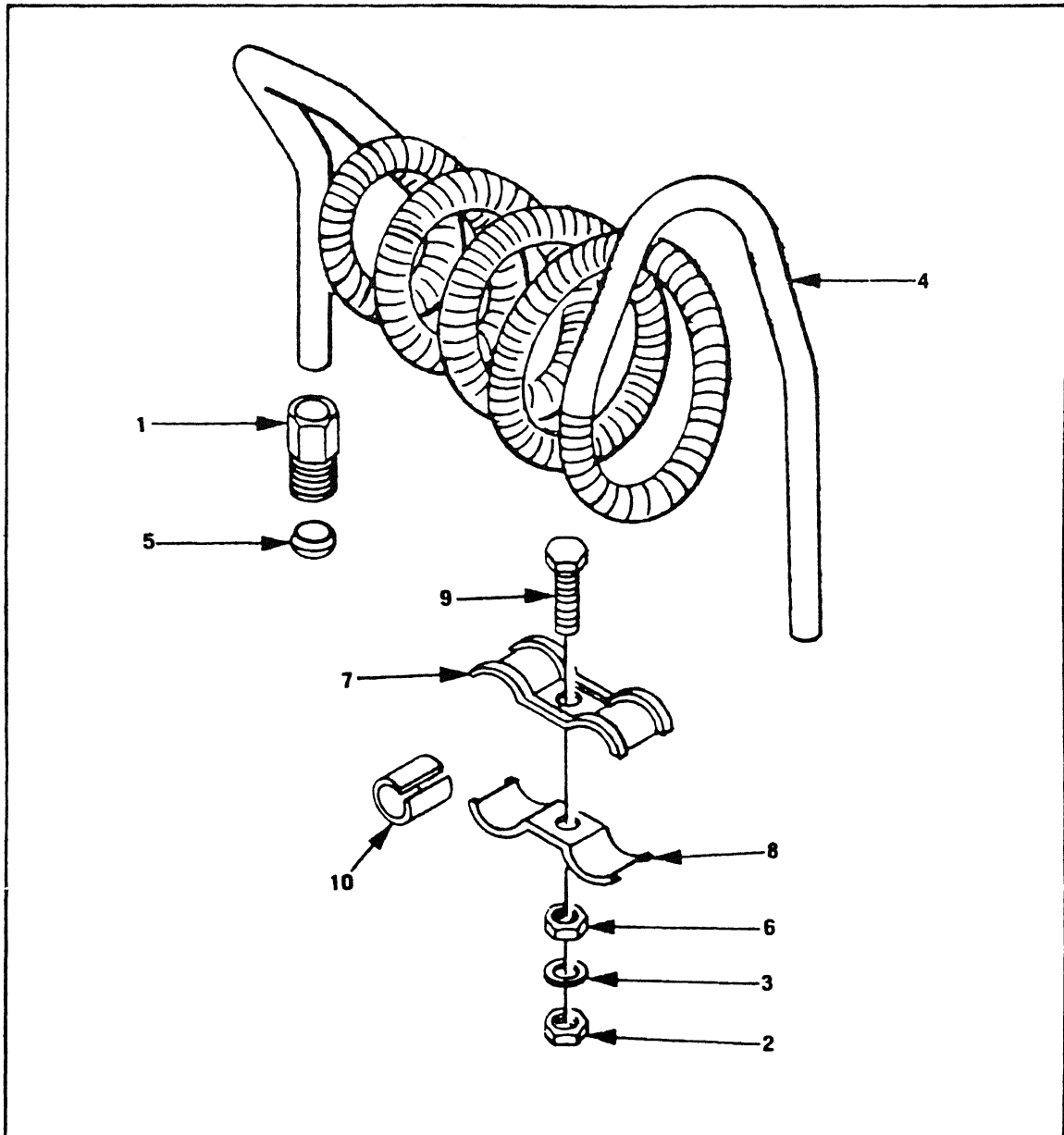


Figure 4-61. Oil Cooler

c. Installation.

- (1) Place rubber sleeves (10, figure 4-61) around bottom of coils.
- (2) Position top (7) and bottom halves (8) of clips over rubber sleeves and secure with bolts (9) and nuts (6). Do not tighten nuts at this time.
- (3) Slide connectors (1) and ferrules (5) onto tubing, and place cooler (4) in engine, aligning coil connectors at their attach points.
- (4) Slide clips and rubber sleeves around to align clip bolts with holes in cowling.
- (5) Remove cooler from engine and tighten clip attach nuts (6).
- (6) Reinstall cooler and tighten coil connectors (1).
- (7) Install washers (3) and nuts (2) securing clips to cowling.
- (8) Install fuel injection lines and overflow return line to injection pump . (para 4-26)
- (9) Bleed fuel injection lines. (para 4-26e).
- (10) Operate engine (para 2-6 or 2-7) and check for leaks.
- (11) Install, close and latch upper air cowling.

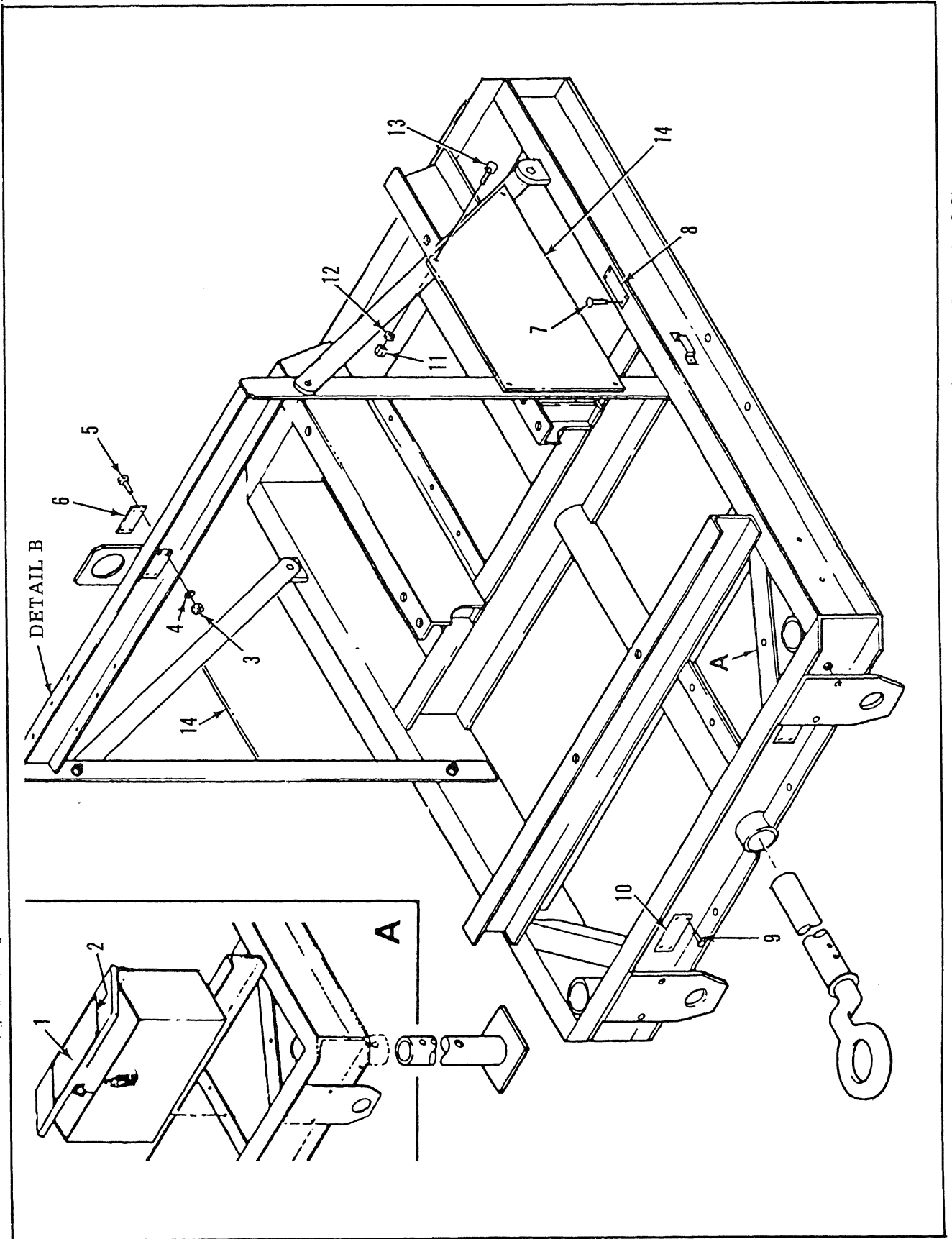
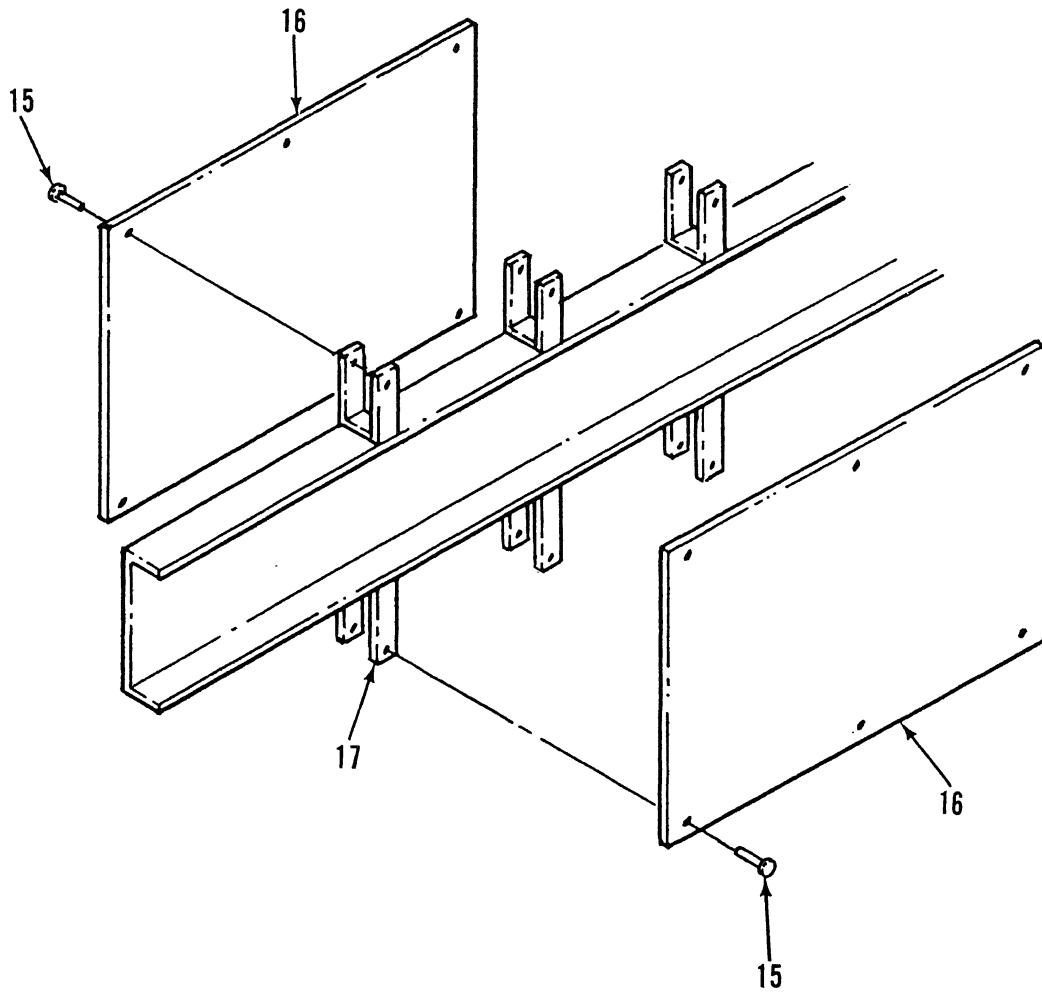


Figure 4-62. Frame Mounted Information Plates, Removal/Installation (Sheet 1 of 2)



DETAIL B

Figure 4-62. Frame Mounted Information Plates, Removal/Installation (Sheet 2 of 2)

4-53. CRATING

- a. Carefully place wooden crate over pumping assembly and set on frame.
- b. Wrap and secure steel bands around crate and frame.
- c. Use a minimum of two bands lengthwise and two across the width.

4-54. ADMINISTRATIVE STORAGE

- a. Store equipment so as to provide maximum protection from the elements and to provide access for inspection, maintenance and servicing. Anticipate removal or deployment problems, and take suitable precautions.
- b. Take into account environmental conditions, such as extreme cold or heat, high humidity, blowing snow, earthquakes, or combinations thereof, and take adequate precautions.
- c. Placement of equipment in administrative storage should be for short periods of time when a shortage of maintenance effort exists. Items should be in mission readiness within 24 hours or within the time factors as determined by the directing authority. During the storage period appropriate maintenance records will be kept.
- d. Before placing equipment in administrative storage, current maintenance services and equipment serviceable criteria (ESC) evaluations should be completed. Shortcomings and deficiencies should be corrected, and all modification work orders (MWO's) should be applied.
- e. Establish a fire plan, and provide for adequate precautions.

4-55. FRAME MOUNTED INFORMATION PLATES (Figure 4-62)

- a. Removal and installation of Performance Data Information Plate.
 - (1) Drill out four rivets (1) and remove information plate (2).
 - (2) Place information plate (2) into position and install rivets (1).
- b. Removal and Installation of Lift Here Information Plates.
 - (1) Remove four nuts (3), washers (4), screws (5), and remove two information plates (6).
 - (2) Place information plates (6) into position and install screws (5), washers (4) and nuts (3).
- c. Removal and Installation of Water Separator Information Plate.
 - (1) Drill out four drive screws (7) and remove information plate (8).
 - (2) Place information plate (8) into position and install drive screws (7).

NOTE

There are two tie down plates in the front and two in the rear of the frame.

d. Removal and Installation of Tie Down Information Plates.

- (1) Drill out four rivets (9) in each plate and remove four information plates (10).
- (2) Place information plate (10) into position and install four rivets (9).

e. Removal and Installation of Caution Information Plates.

- (1) Remove four nuts (11), washers (12) and screws (13) in each plate and remove two information plates (14).
- (2) Place information plate (14) into position with printed side facing out, and install screws (13), washers (12) and nuts (11).

f. Removal and Installation of Caution Information Plates.

- (1) Drill out six rivets (15) and remove two information plates (16).
- (2) Place information plates (16) on brackets (17) and install six rivets (15).

Table 5-1. Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
FUEL SYSTEM-continued		
2. ENGINE FAILS TO START-continued		
	Step 3. Inspect for leaks at fuel tank.	Repair as required (refer to paragraph 5-8).
	Step 4. Test injection pump. (refer to paragraph 5-9).	Replace injection pump. (refer to paragraph 5-9).
ENGINE ASSEMBLY-continued		
3. ENGINE PERFORMANCE IS POOR		
	Step 1. Check for broken valve spring.	Replace engine. (refer to paragraph 5-13).
4. EXHAUST SMOKES EXCESSIVELY.		
	Step 1. Check for inefficient compression due to sticking or broken compression rings or incorrect valve clearance.	Replace engine. (refer to paragraph 5-13).
5. LOW ENGINE PRESSURE		
	Step 1. Check for excessive play on main bearing.	a. Replace engine (refer to paragraph 5-13).
6. AMMETER READING TOO LOW.		
	Step 1. Check for defective alternator, causing insufficient charging of the batteries.	a. Repair alternator (refer to paragraph 5-6).
LUBRICATION SYSTEM		
1. LOW ENGINE OIL PRESSURE.		
	Step 1. Check for excessive play on main bearing.	Replace engine (refer to paragraph 5-13).

Table 5-1. Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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LUBRICATION SYSTEM-continued

2. ENGINE OIL EXCESSIVELY HOT.

Step 1. Check condition and operation of cooling fan.

- a. Repair cooling fan (refer to paragraph 5-12).
- b. Replace cooling fan (refer to paragraph 5-12).

PUMP ASSEMBLY

1. PUMP FAILS TO PRIME.

Step 1. Check for foreign matter in discharge valves.

Remove foreign matter.

Step 2. Inspect for faulty seal or pump gasket.

Replace seal (refer to paragraph 5-15).

2. PUMP STOPS OR FAILS TO DELIVER RATED FLOW OR PRESSURE

Step 1. Inspect for faulty seal or pump gasket.

Replace seal (refer to paragraph 5-15).

Step 2. Check for clogged impeller.

Free impeller (refer to paragraph 5-15).

Step 3. Inspect for broken impeller or wear plate.

Replace impeller or wear plate (refer to paragraph 5-15).

Step 4. Check that pump is not driven too slow.

Check engine speed.

3. BEARINGS RUN TOO HOT

Step 1. Check for proper bearing lubrication.

Replace bearing (refer to paragraph 5-15).

Table 5-1. Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
PUMP ASSEMBLY-continued		
3. BEARINGS RUN TOO HOT-continued		
	Step 2. Check for bent impeller shaft.	Replace impeller shaft (refer to paragraph 5-15).
	Step 3. Inspect for worn bearings.	Replace bearings (refer to paragraph 5-15).
	Step 4. Check for binding, broken, or loose rotating parts.	Replace parts as required (refer to paragraph 5-15).
4. PUMP NOISY		
	Step 1. Check for cavitation.	Replace parts causing cavitation (refer to paragraph 5-15).
	Step 2. Check for worn bearings.	Replace bearings (refer to paragraph 5-15).
5. PUMP DOES NOT OPERATE		
	Step 1. Check to see if pump rotation is free.	Free pump.
CONTROL PANEL ASSEMBLY		
1. GP RELAY NOT FUNCTIONING.		
	Step 1. Inspect for loose, broken, frayed or damaged wires.	Replace wiring.
	Step 2. Inspect for burned relay.	Replace relay.

Table 5-1. Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
CONTROL PANEL ASSEMBLY-continued		
2. POWER RELAY NOT FUNCTIONING.		
	Step 1. Inspect for loose, broken, frayed or damaged wires.	Replace wiring.
	Step 2. Inspect for burned relay.	Replace relay.
FRAME ASSEMBLY		
1. UNIT DOES NOT TRACK STRAIGHT.		
	Step 1. Inspect for damaged towbar.	Replace towbar.
	Step 2. Inspect for bent, broken or damaged frame.	
		a. Repair as required (refer to paragraph 5-23).
		b. Replace frame assembly (refer to paragraph 5-23).
	Step 3. Inspect for bent, broken, or damaged axle.	Notify general support maintenance.

5-6. ALTERNATOR ASSEMBLY.*a. Testing.**

- (1) A thorough visual inspection is required prior to electrical testing, to eliminate associated conditions that may be interpreted as a defective alternator or voltage regulator.
- (2) Check all electrical leads and connections, repair or replace components as required.
- (3) Check alternator drive belt and pulley. Several operating conditions will accelerate belt and pulley wear. Tighten belt to avoid slippage.
- (4) Battery used in electrical testing must be of correct voltage and must be in good condition and fully charged. If a slave or jumper battery is used in testing, it must meet all requirements and must be securely connected to avoid accidental loss of connection. Observe correct polarity.

CAUTION

If battery must be charged, as a precautionary measure, disconnect ground battery terminal while charging. Connecting charger in reverse will destroy rectifier diodes in alternator.

- (5) Prior to testing, connect test ammeter in series with positive output terminal of alternator and original output lead. Switch meter range to the 0 to 60 ampere scale and dress connecting leads to avoid damage from hot manifolds or engine V-belt. Meter polarity is reversed during some tests, note this information in each procedure.
- (6) Alternator and regulator tests require electrical test equipment to measure voltage, current and resistance. Table 5-3.1 contains a list of this equipment.
- (7) The following tests are made with alternator installed on test stand. Figure 5-28.1 shows terminal arrangement at rear of alternator for terminal identification.

*For models 13220E1070 (97403), 13226E2289 (97403), and 13225E9200 (97403).

Table 5-2. Alternator Test Equipment Required

Equipment	Range
1. Voltmeter	0 to 20 Volt
2. Ammeter	0 to 5 Amperes, for field current tests 0 to 60 Amperes, for alternator output tests
3. Field rheostat, wirewound with alligator clips or connecting leads	0 to 50 Ohms, 100 watt rating
4. Series resistance	1/4 ohm
5. Carbon pile	
6. Volt-Ohm-Millimeter	
7. Test lamp	12 volt D.C.
8. Diode Tester	

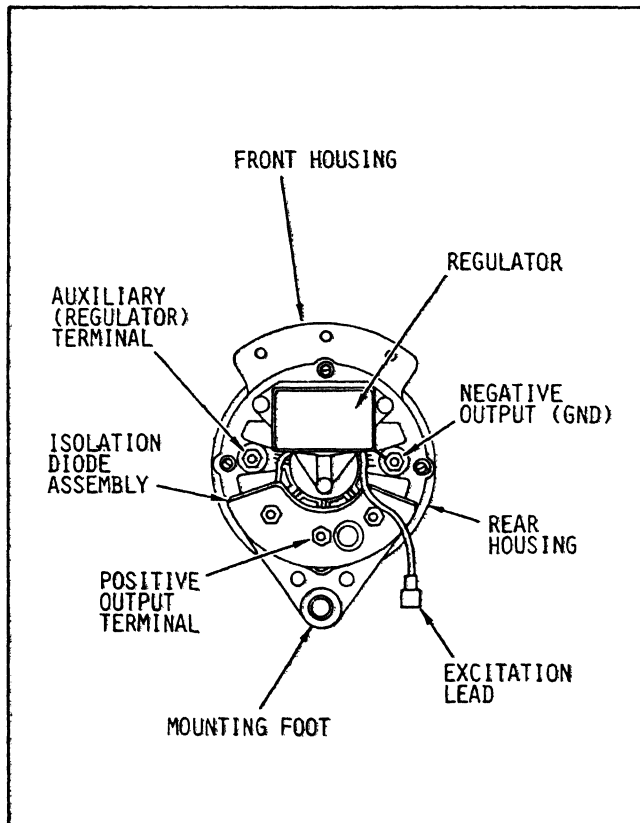


Figure 5-1. Alternator Terminal Identification

- (8) Using a driver that contacts inner bearing race only, press rear bearing (27) over shaft to shoulder.
 - (9) Place spacer (25) over shaft; install Woodruff key (24).
 - (10) Place fan (23) and pulley (22) over shaft; install lockwasher (21) and nut (20).
 - (11) Clamp pulley in vise, using old oversize belt to protect pulley from vise jaws, tighten nut to 35 to 50 ft. pounds (4.83 to 6.9 m.kg).
 - (12) Place insulating sleeves (16) and washers (15) over rectifying diode studs.
 - (13) Insert heat sink studs (17) through openings in rear housing.
 - (14) Place insulating washers (15) over studs; install nuts (14) and secure.
 - (15) Ensure that rear bearing retainer is installed in rear housing recess.
 - (16) Determine position of rear housing (19) with reference to mounting foot, place rear housing-stator assembly over rotor assembly and hand-press housing together.
 - (17) Install through bolts (13) and square nuts (12), tighten evenly.
 - (18) Spin rotor by hand to test freedom of bearings and rotor.
 - (19) Place brush assembly (11) in cavity, add dust shield (10) and cover (9); secure with screw (8).
 - (20) Refer to step i, and test alternator, less regulator.
 - (21) Connect regulator brush connecting lead (7).
 - (22) Secure regulator (6) to rear housing with screws (5).
 - (23) Connect regulator connector lead (4).
 - (24) Install flat fiber washer (3) on isolation diode stud.
 - (25) Position isolation diode assembly (2) on studs, installing a flat fiber washer and short nylon sleeve over lower negative output stud, as shown in figure 5-15.
 - (26) Install nuts (1), figure 5-14, to secure insulation diode on terminal studs.
- i. Alternator operating test (less regulator).
- (1) Mount alternator in test fixture capable of providing 3000 to 4000 alternator RPM.

- (2) Set drive motor rotation to direction dictated by alternator fan for proper cooling.
- (3) Connect circuit leads as indicated in figure 5-28. Ammeter shown is panel ammeter of test fixture, a separate ammeter will serve the same purpose.
- (4) Switch ammeter to show possible discharge during hook-up, reverse meter for output test.
- (5) Set field rheostat to maximum resistance before connecting to system.
- (6) Turn drive motor on, adjust to obtain 3000 to 4000 alternator shaft RPM.
- (7) Reduce resistance of field rheostat, alternator should begin to charge.
- (8) Continue to reduce rheostat resistance until alternator reaches rated output.

CAUTION

Do not operate alternator for more than a few minutes in this manner, due to lack of voltage control. If alternator delivered rated current output, terminate test.

j. Installation. Refer to paragraph 4-20, step b, for procedure covering alternator installation.

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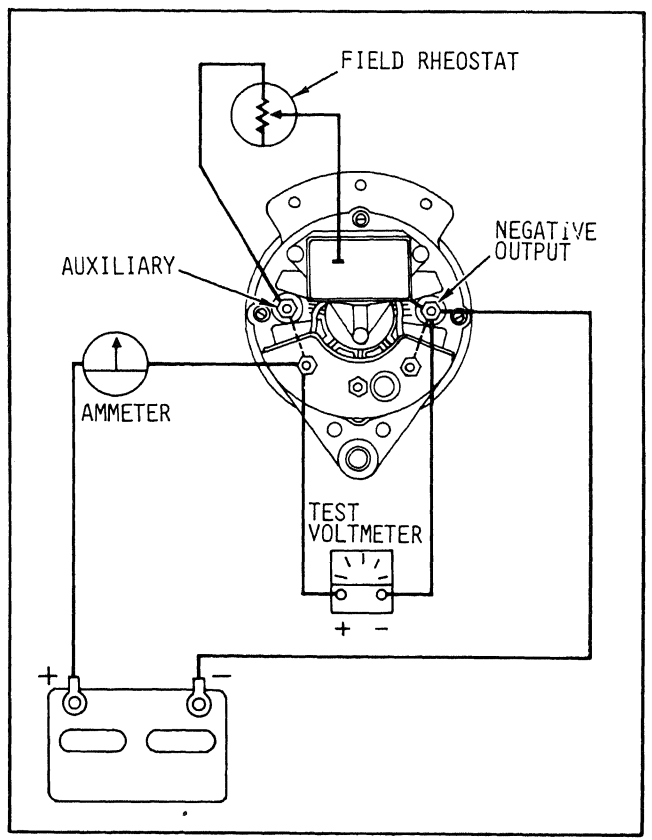


Figure 5-28. Alternator Operating Test Setup

5-6.1 ALTERNATOR ASSEMBLY WITH FIELD DIODE

a. Testing.

- (1) A thorough visual inspection is required prior to electrical testing, to eliminate associated conditions that may be interpreted as a defective alternator or voltage regulator.
- (2) Check all electrical leads and connections, repair or replace components as required.
- (3) Check alternator drive belt and pulley. Several operating conditions will accelerate belt and pulley wear. Tighten belt to avoid slippage.
- (4) Battery used in electrical testing must be of correct voltage and must be in good condition and fully charged. If a slave or jumper battery is used in testing, it must meet all requirements and must be securely connected to avoid accidental loss of connection. Observe correct polarity.

CAUTION

If battery must be charged, as a precautionary measure, disconnect ground battery terminal while charging. Connecting charger in reverse will destroy rectifier diodes in alternator.

- (5) Prior to testing, connect test ammeter in series with positive output terminal of alternator and original output lead. Switch meter range to the 0 to 60 ampere scale and dress connecting leads to avoid damage from hot manifolds or engine V-belt. Meter polarity is reversed during some tests, note this information in each procedure.
- (6) Alternator and regulator tests require electrical test equipment to measure voltage, current and resistance. Table 5-3.1 contains a list of this equipment.
- (7) The following tests are made with alternator installed on test stand. Figure 5-28.1 shows terminal arrangement at rear of alternator for terminal identification.

Table 5-3.1 Alternator Test Equipment Required

Equipment	Range
1. Voltmeter	0 to 20 Volt
2. Ammeter	0 to 60 Amperes, for alternator output tests
3. Multimeter	
4. Field Rheostat, wire wound with alligator clips	0 to 50 ohms, 100 watt rating

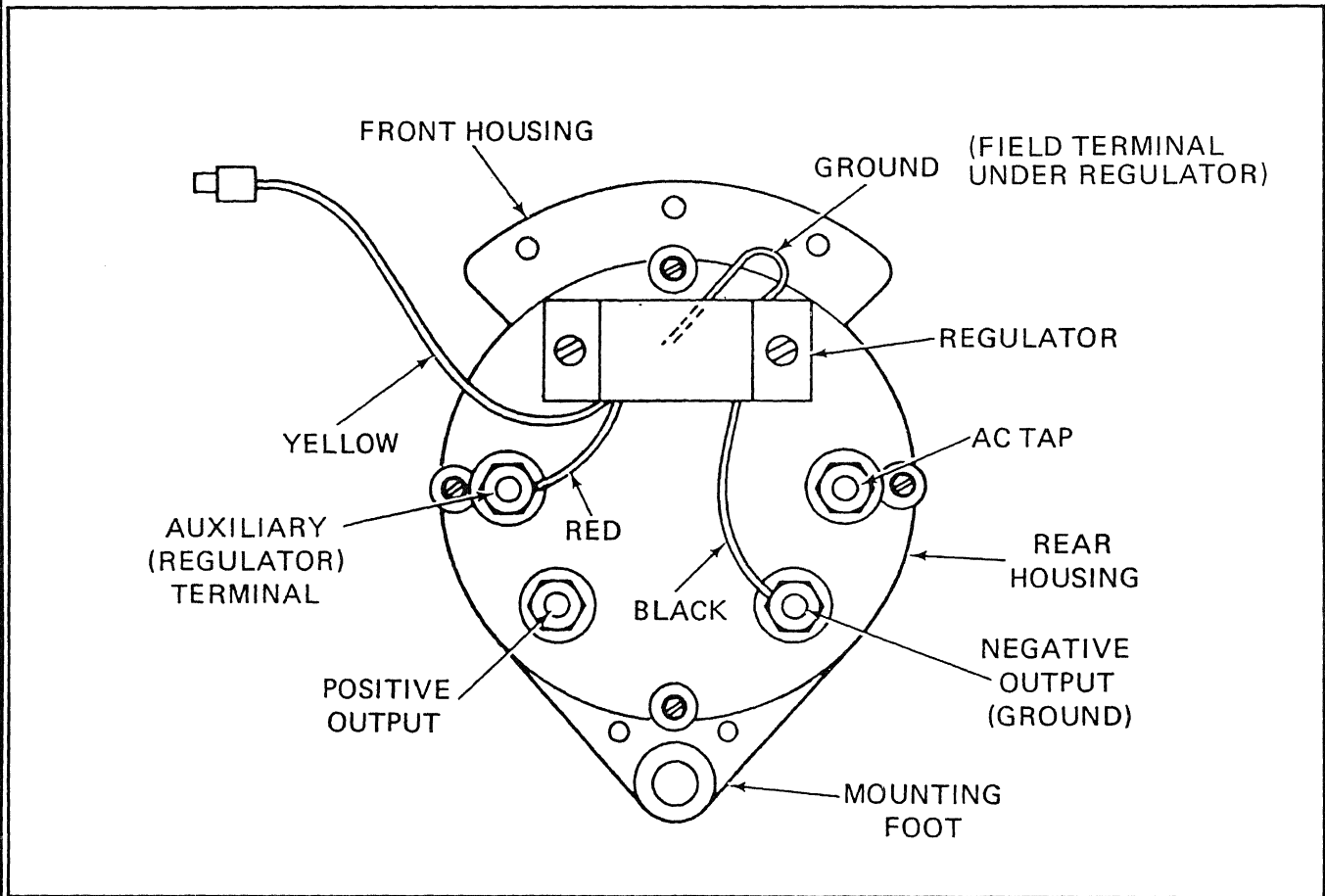


Figure 5-28.1 Alternator Terminal Identification

CAUTION

DO NOT, under any circumstances, short field terminal of alternator to ground, as permanent damage to regulator may occur.

DO NOT, disconnect voltage regulator while alternator is operating, because the large voltage transient that occurs when disconnection takes place may damage regulator.

DO NOT, disconnect alternator output lead from alternator while alternator is operating, as damping effect of battery will be lost. The voltage will rise to an extreme value and permanent damage to regulator may occur.

DO NOT, remove alternator from engine without first disconnecting ground battery cable.

(a) Test No. 1 - Field Diode Test (open)

CONDITIONS: Alternator mounted on test stand, shaft not rotating.

- (1) Measure battery voltage between A and Ground. Meter should read 12-14 volts.
- (2) Measure battery voltage between B and Ground. Meter should read 1.5 to 3 volts.
- (3) Rotate alternator shaft 3000 to 4000 RPM, clockwise, as viewed facing the fan.
- (4) Measure voltage between A and Ground. Meter should read between 12 to 15 volts.
- (5) Measure voltage between B and Ground. Meter should read between 12 to 15 volts.
- (6) The readings taken in steps 4 and 5 should be approximately equal.
- (7) If B to Ground reading remains low, field diode is open.

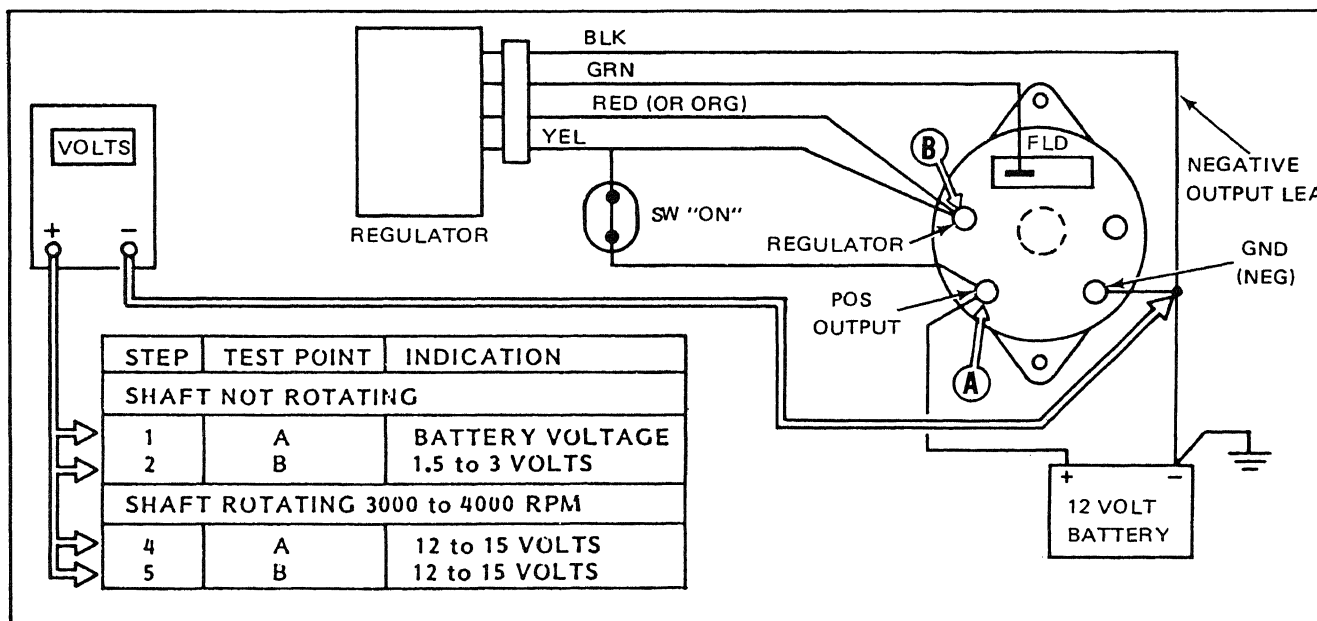


Figure 5-28.2. Field Diode Test (Open)

(b) Test No. 2 - Regulator Test (open)

CONDITIONS: Alternator mounted in test stand, shaft rotating at 3000 RMP, jumper wire installed between B and field terminal.

- (1) Measure voltage at terminal A. Meter should read approximately 14 volts.
- (2) Increase RPM to 4000. (clockwise as viewed facing the fan).
- (3) Measure voltage at terminal A. Voltage should increase to 15 to 16 volts.
- (4) This indicates the alternator is good, the regulator is open. Replace regulator.

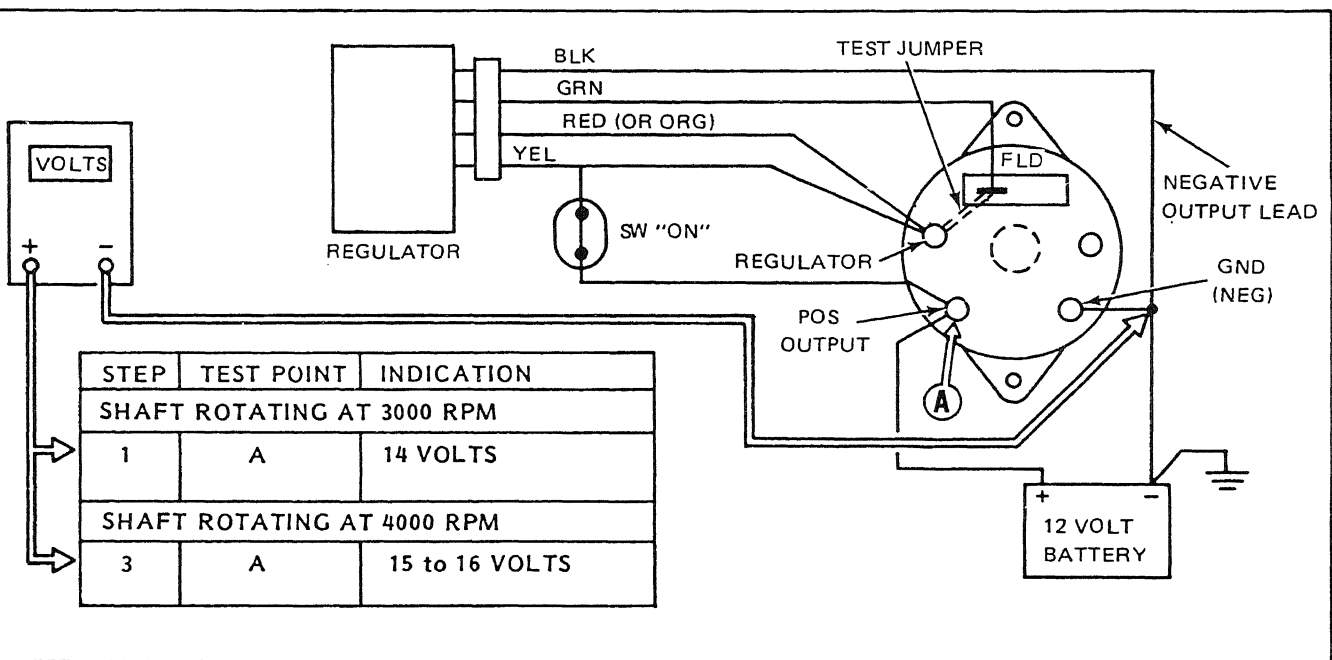


Figure 5-28.3 Regulator Test (Open)

(c) Test No. 3 - Regulator Test (shorted)

CONDITIONS: Alternator mounted on test stand, shaft rotating at 3000 (clockwise as viewed facing the fan)

- (1) Measure voltage at terminal A. The meter should indicate approximately 14 volts.
- (2) Increase RPM to 4000. If voltage at A increases beyond 15 volts, regulator is shorted. Replace regulator.

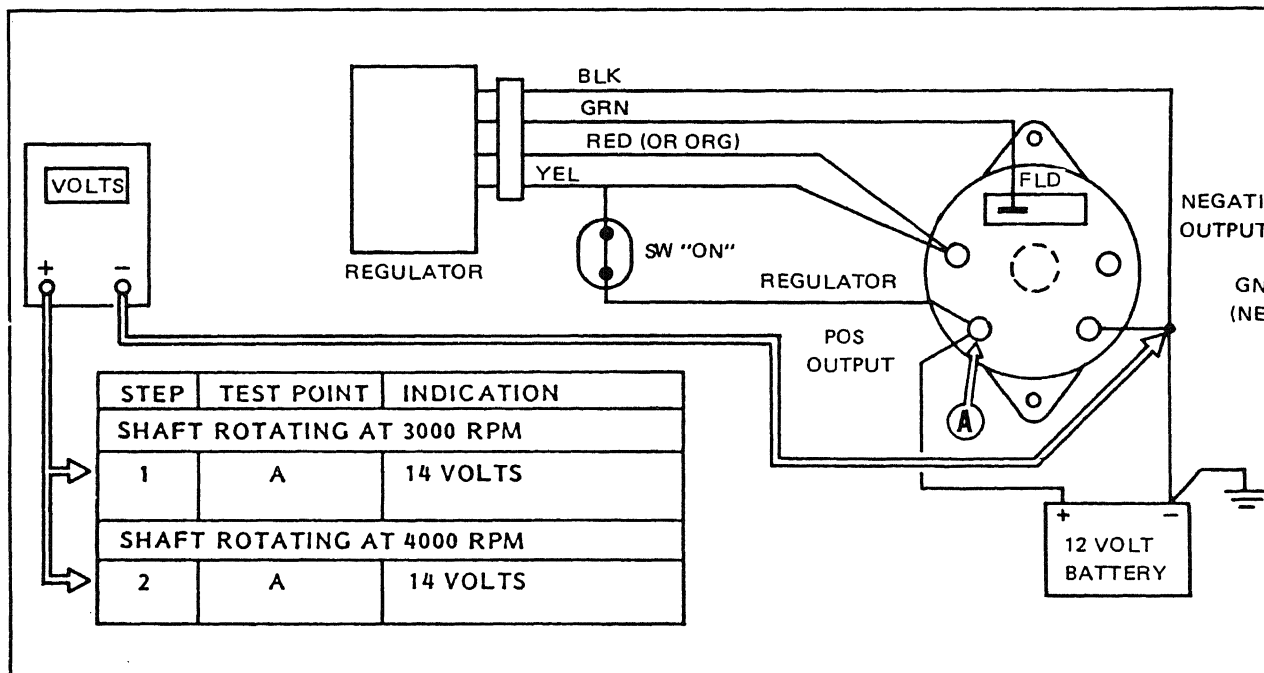


Figure 5-28.4 Regulator Test (Shorted)

(d) Test No. 4 - Alternator Output Test

CONDITIONS: Alternator mounted in test stand, shaft rotating at 4000 RPM.
(clockwise as viewed facing the fan)

- (1) Spin alternator shaft at 4000 RPM.
- (2) Check voltage at terminal A. Voltage reading should be between 13.8 and 14.8 volts.
- (3) If voltage reading is not within this range, the alternator should be disassembled for further inspection and tests.

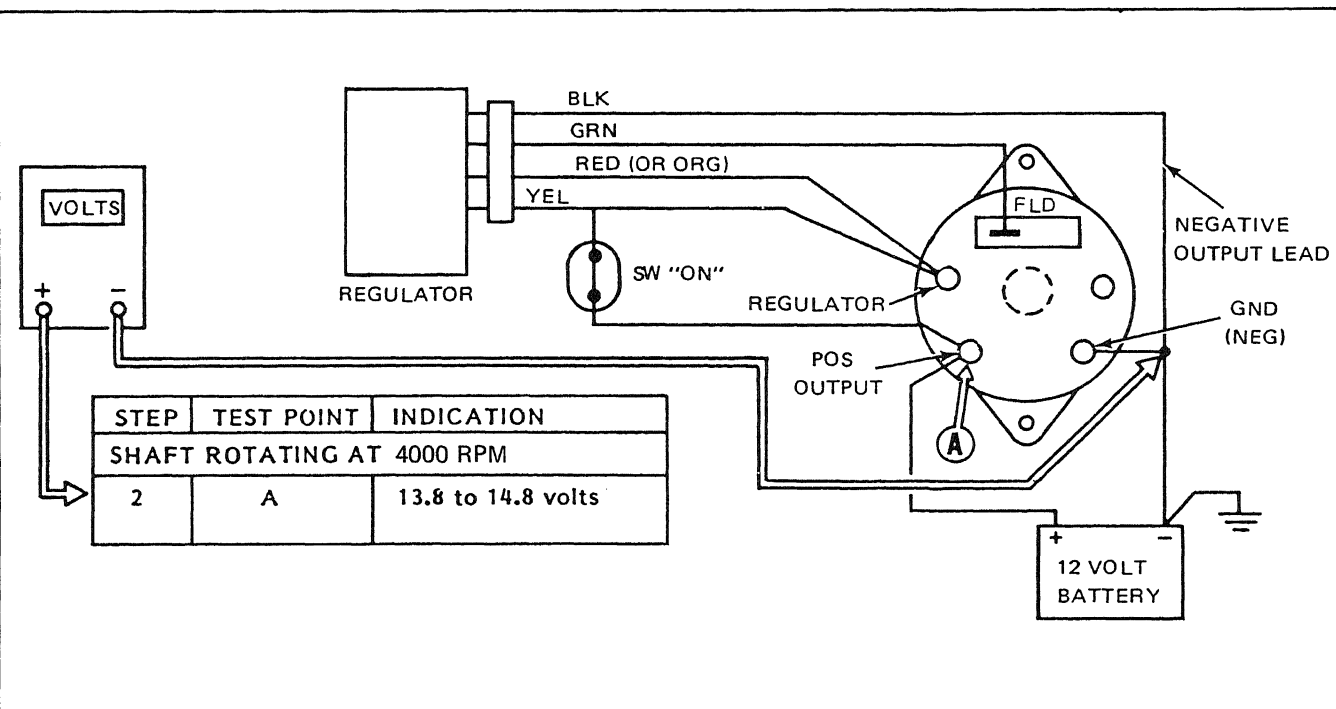


Figure 5-28.5 Alternator Output Test

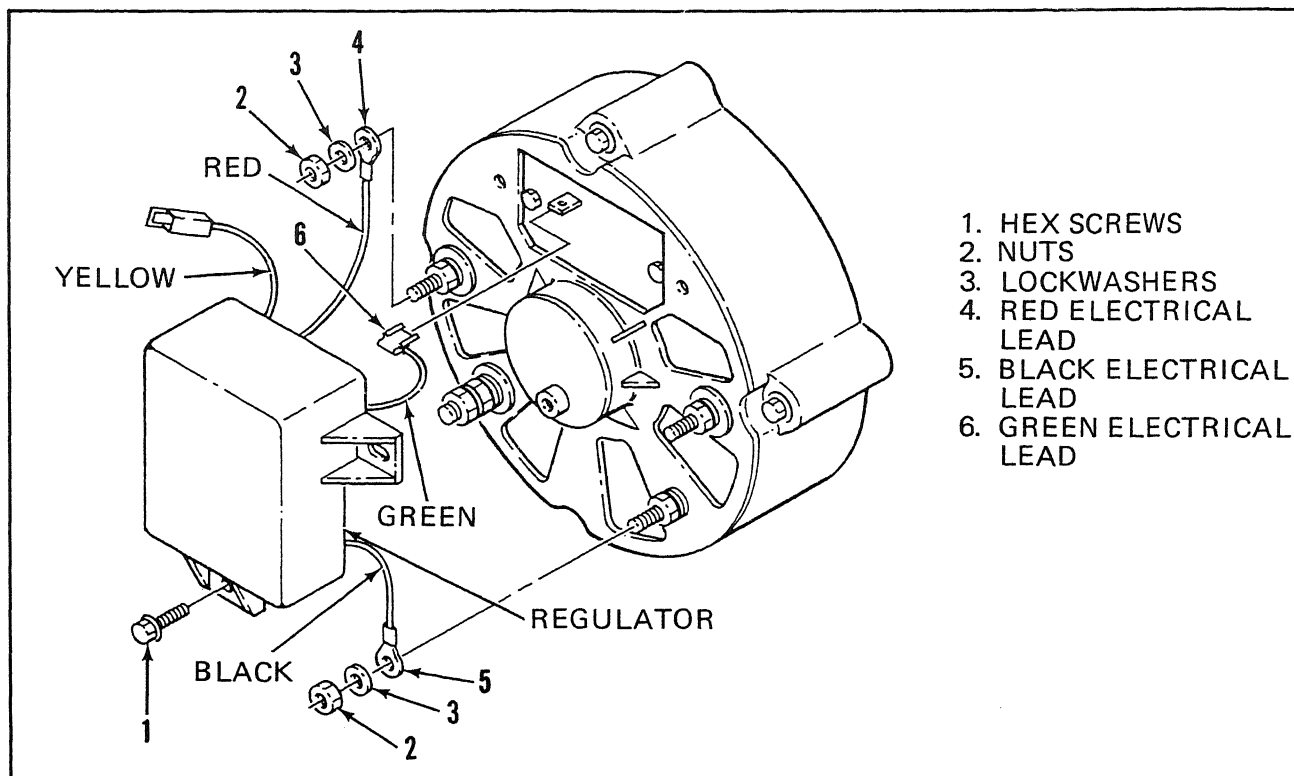


Figure 5-28.6 Regulator Removal

b. Removal. Refer to paragraph 4-20 for procedures covering alternator removal.

c. Disassembly.

- (1) Remove the hex screws (1, Figure 5-28.6) then pull back regulator and disconnect the green electrical lead (6) from the brush assembly.
- (2) Remove the nuts (2), and lockwashers (3) to release the red electrical lead (4) and black electrical lead (5).
- (3) Refer to Figure 5-28.7 and remove the two hex screws (1), cover (2) and brush assembly (3).
- (4) Mark the front and rear housings for indexing purposes. Remove the four through bolts (4).

CAUTION

Do not insert screwdriver blades more than 1/16 inch. Damage to windings will result.

- (5) Carefully insert two small bladed screwdrivers in the stator slots between the stator and front housing (see Figure 5-28.8).

- 1. HEX SCREWS
- 2. COVER
- 3. BRUSH ASSEMBLY
- 4. THROUGH-BOLT

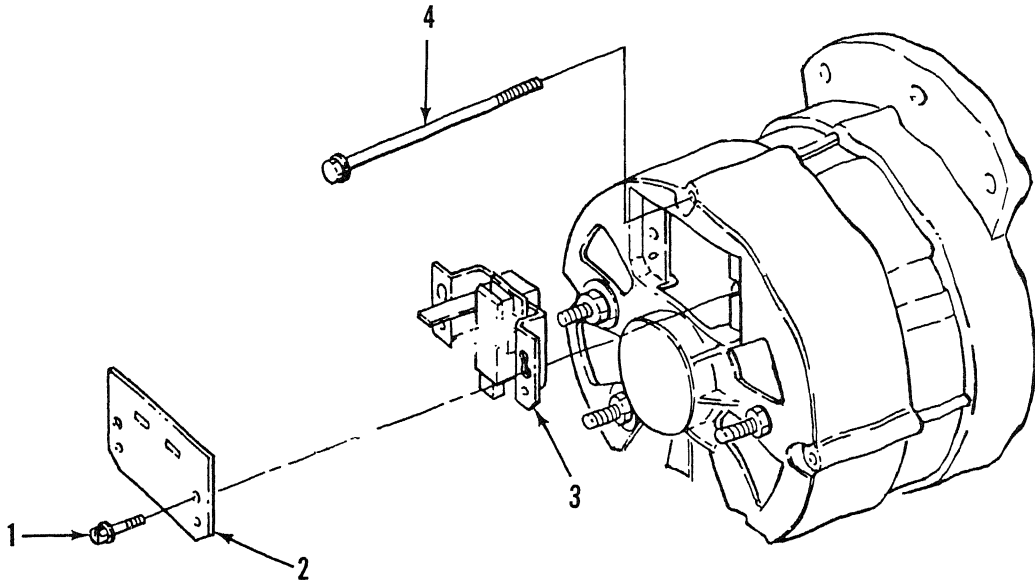


Figure 5-28.7. Brush Assembly Removal

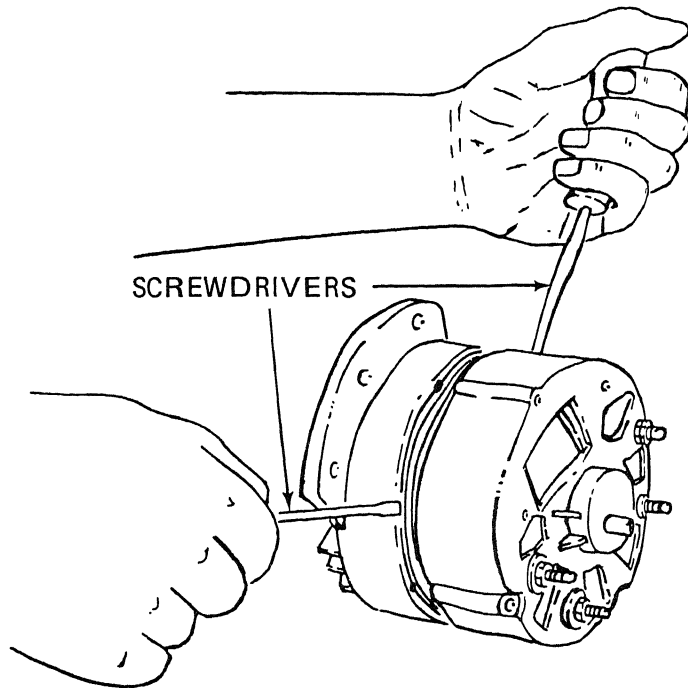


Figure 5-28.8 Front and Rear Housing Separation

- (6) Apply prying pressure at several points around the stator to extract rotor and front housing as an assembly. Do not burr the stator core which would make reassembly difficult.
- (7) Place the open end of the stator on a clean work surface, free of metal chips that could damage the stator windings. Remove all locknuts, lockwashers, flatwashers and insulators from the diode terminal studs, Figure 5-28.9.

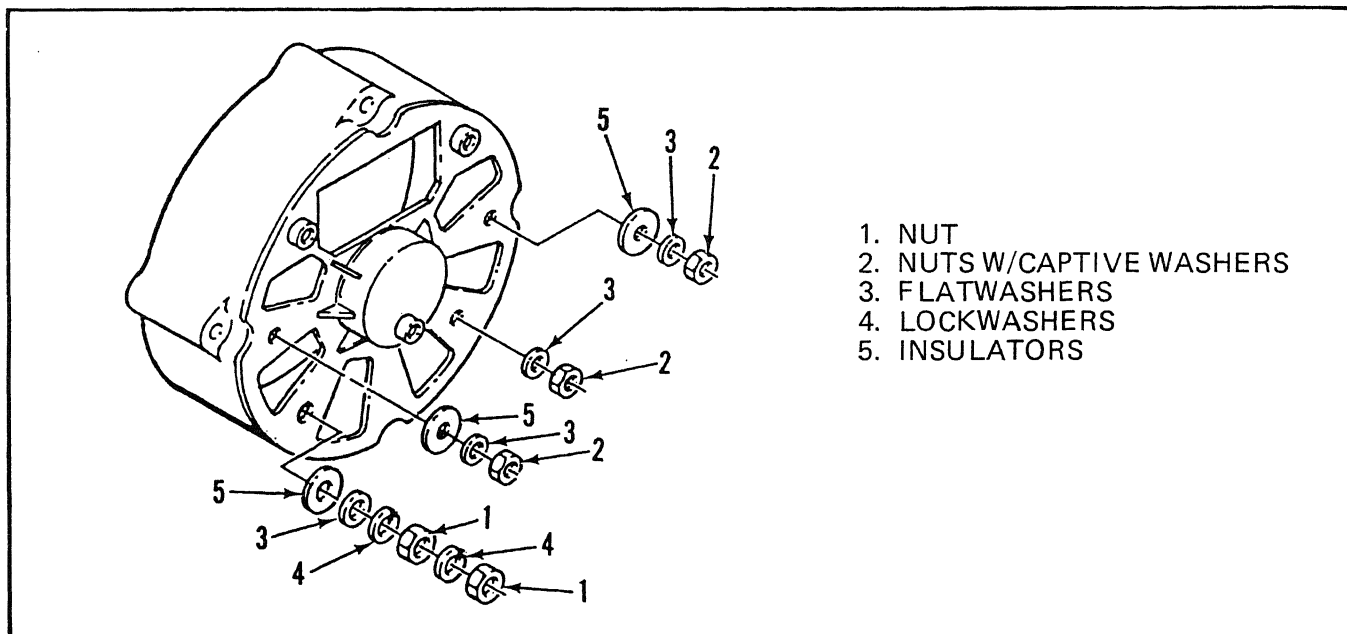


Figure 5-28.9 Stator Removal

- (8) Carefully and evenly tap the rectifier diode terminal studs out of the rear housing, as shown in Figure 5-28.10. Lift rear housing off the studs. Remove any insulating sleeves remaining in terminal stud holes. The stator and diode sets are removed as an assembly.
- (9) Unsolder the stator leads from the rectifier diode terminals, in order to properly test each diode. Make note of the diode to stator connections for reassembly purposes later on.

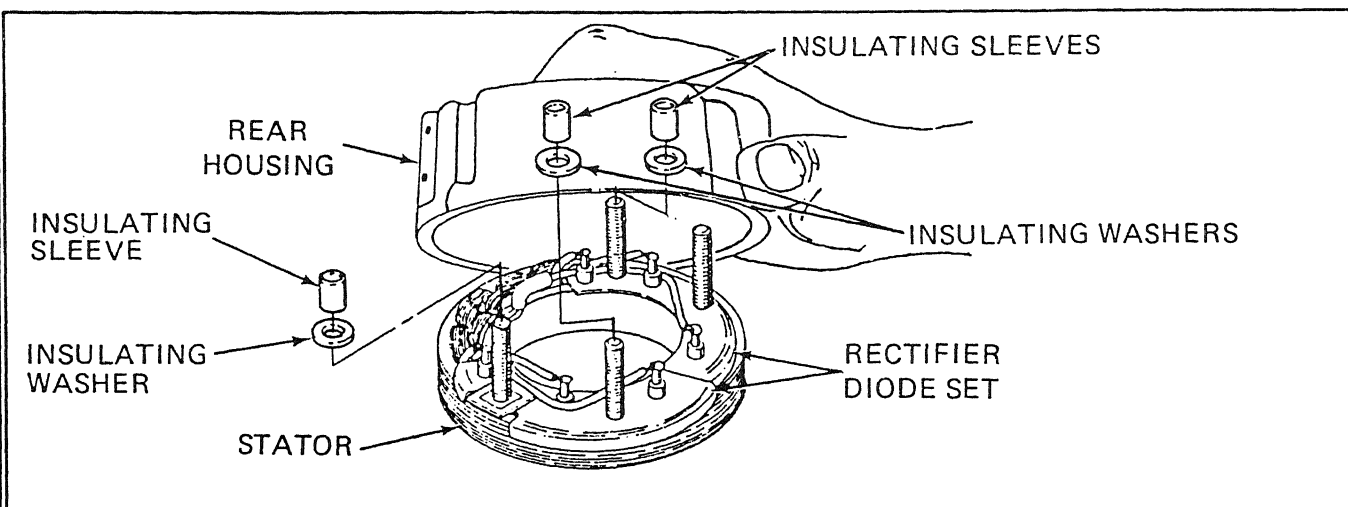


Figure 5-28.10. Rear Housing and Diode Terminal Separation

NOTE

Figure 5-28.11 shows a heat dam in place between the tip of the diode and diode body, in order to protect the diode from damage in removing and replacing the stator leads.

- (10) Allow solder joint to cool for a few seconds before removing heat dam. Avoid bending or twisting diode terminal.

NOTE

Only rosin core (electrical) solder should be used for all alternator service operations.

- (11) Remove the field diode assembly by removing the hex nut and washer securing the field diode assembly to the ungrounded rectifier diode heat sink, Figure 5-28.12. Unsolder the three leads at the rectifier diode terminals to free or test the field diode assembly. Use heat dams to protect the rectifier diodes in all soldering operations.

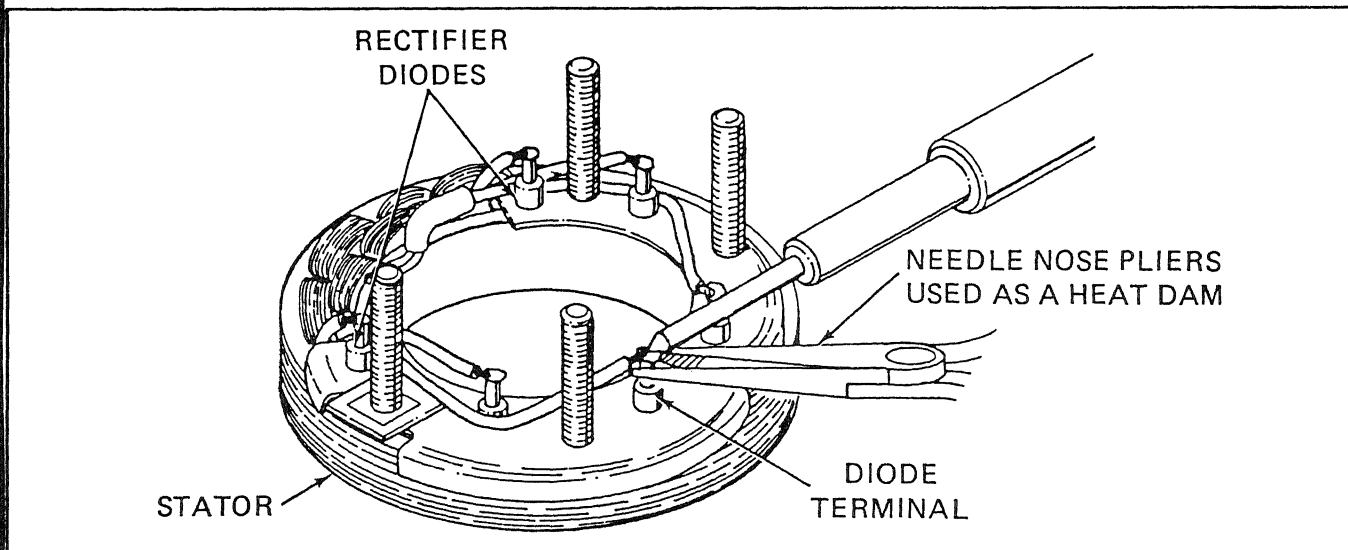


Figure 5-28.11. Unsoldering Rectifier Diode

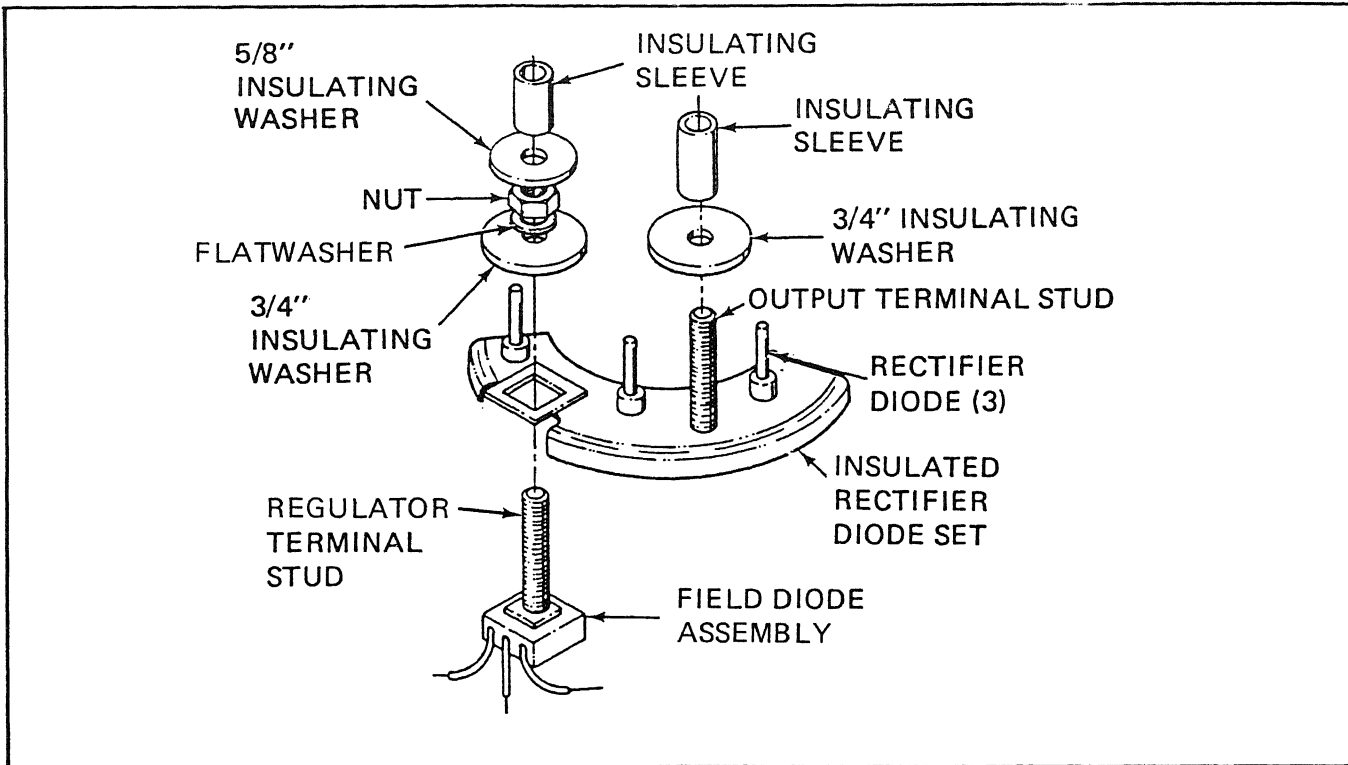


Figure 5-28.12. Field Diode Assembly Detail

- (12) Remove the nut and lockwasher (Figure 5-28.13) to allow removal of the pulley, fan and woodruff key.

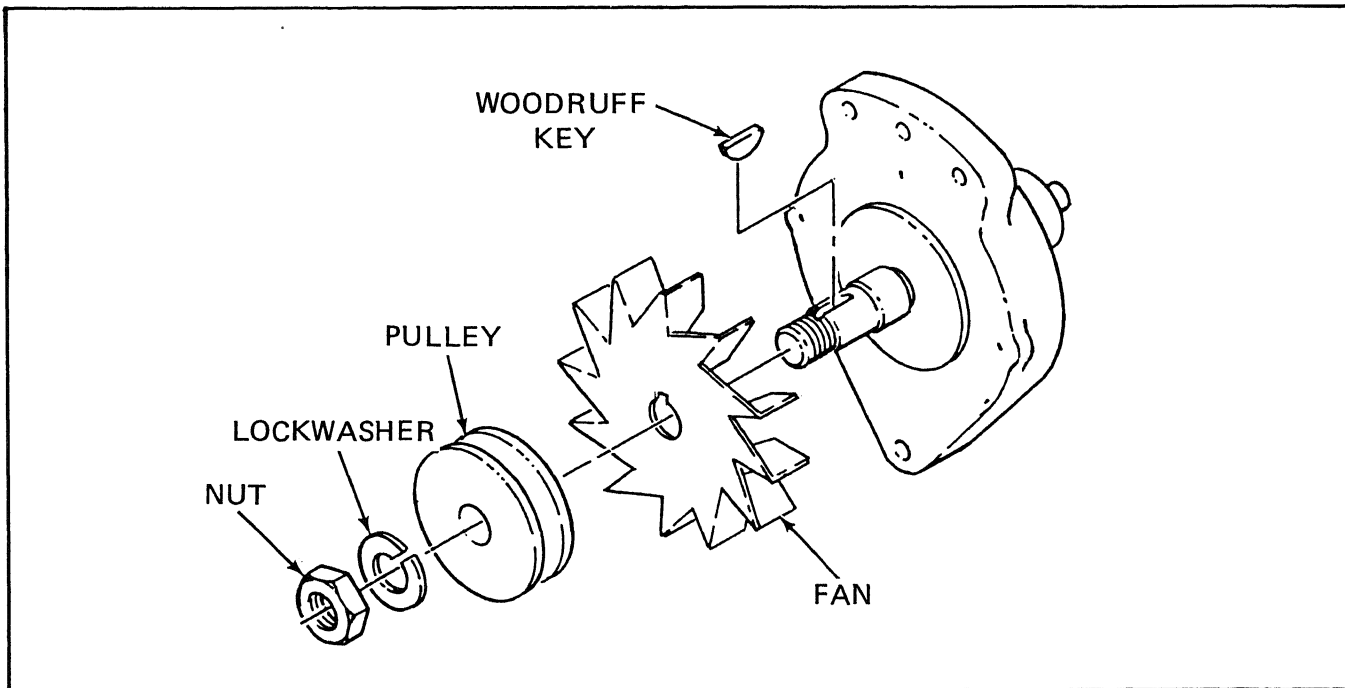


Figure 5-28.13 Fan Removal

- (13) Remove the front bearing retainer (Figure 5-28.14) using needle nose pliers to compress the ears of the retainer.

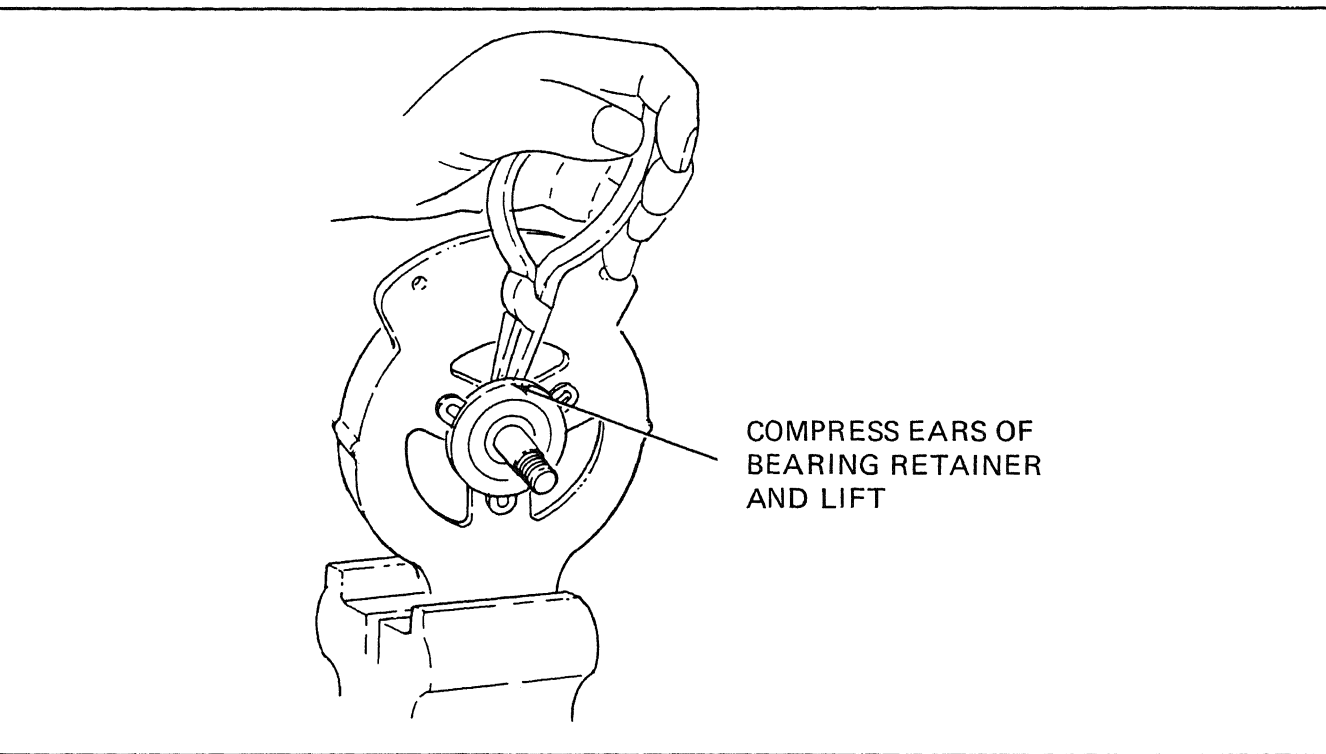


Figure 5-28.14. Front Bearing Retainer Removal

- (14) Separate the front housing from the rotor by holding of the front housing and tapping the assembly on a wood block as shown in Figure 5-28.15.

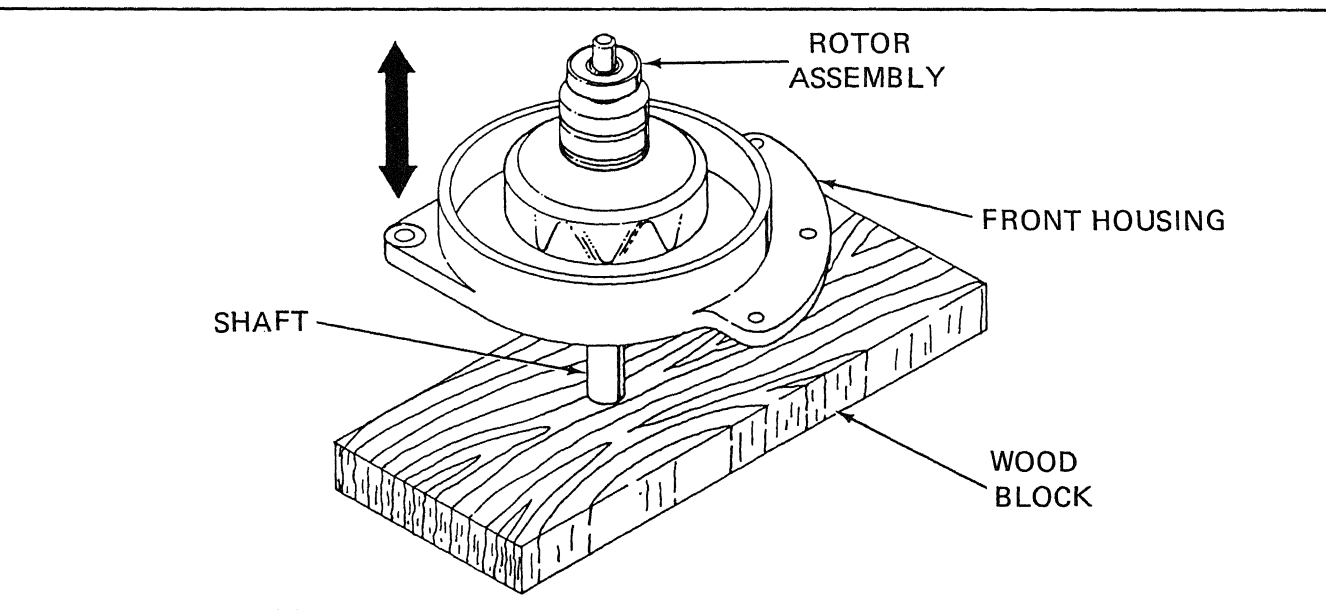


Figure 5-28.15. Housing Removal

- (15) Use a puller to remove the front and rear bearings from the rotor shaft, Figure 5-28.16.

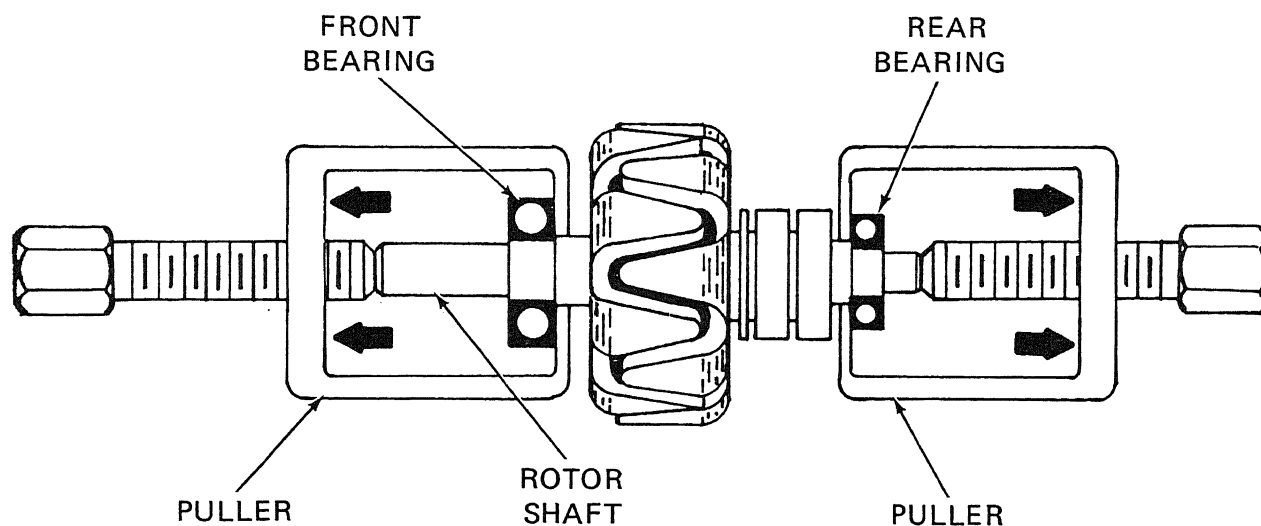


Figure 5-28.16. Bearing Removal

d. Cleaning.

WARNING

Potential health hazards result from inhalation of petroleum solvent vapors and from contact of solvent with skin. Use rubber gloves and hand cream for protection, and work with adequate ventilation.

Petroleum solvents are highly flammable. Keep solvent container lids closed when not in use, and avoid all possible risks of igniting solvent vapors, keep away from open flame and excessive heat. Flash point of solvent is 100 to 138 degrees F (38 to 59 degrees C).

- (1) Clean field diode with mild cleaning solvent, do not immerse in a severe cleaning chemical that may remove special corrosion resistant paint.

WARNING

Compressed air used for cleaning can create airborne particles that may enter the eyes. Pressure will not exceed 30 psig. Eye protection required.

- (2) Clean all assemblies in PD 680, Type II. Blow dry with compressed air.

e. Inspection.

(1) Inspect brush assembly for:

- (a) Excessive wear. Replace if 3/16 or less extends beyond bottom of holder.
- (b) Deposit of foreign material, oil or dirt, that may bind brush movement or result in poor slip ring contact.
- (c) Correct brush spring tension. Correct tension to move brush against spring is 4 to 6 ounces.
- (d) Insulation and continuity. Use 12 volt test lamp or ohmmeter. Refer to Figure 5-28.17 and perform the following:
 - 1. Insulation test, Point A to D, no circuit indicates no short circuit, assembly is correct.
 - 2. Continuity test, Point A to C and D to E, continuous circuit, indicates no open connection, assembly is correct.

NOTE

Resistance should not vary when brush and connecting wire is moved around.

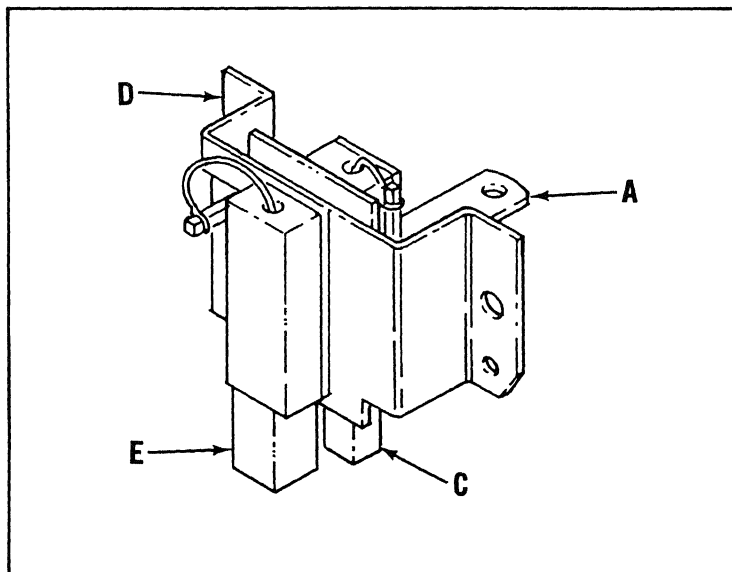


Figure 5-28.17. Alternator Brush Insulation and Continuity Test

- (2) Check rear housing for cracks around drilled openings. Replace housing if cracks are present.
 - (3) Check for scuff marks at rear bearing bore of housing. If rear bearing bore has been scuffed from bearing turning in casting, replace housing.
 - (4) Inspect fan for cracked or broken fins, and note condition of mounting holes. Replace fan if cracked or broken fins are found. If mounting holes are worn from running loose, replace fan to ensure balance, see figure 5-28.18.
 - (5) Inspect pulley for possible faults shown on figure 5-28.19.
 - (6) Inspect spacer for cracks. Replace spacer if cracks are present.
 - (7) Inspect front bearing cavity of front housing for evidence of wear. Note condition of retainer recess, replace housing if worn.
 - (8) Inspect front bearing retainer for distortion, replace if retainer is distorted.
 - (9) Inspect bearings for adequate lubrication.
- f. Repair or replacement. Repair to component parts of alternator is not recommended. If inspection indicates that a part is defective, replace defective part.

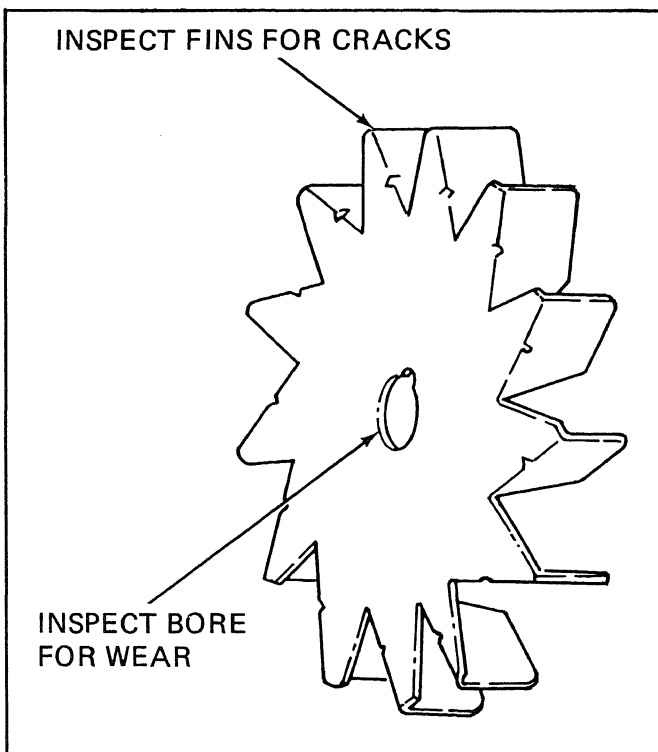


Figure 5-28.18. Alternator Fan Inspection

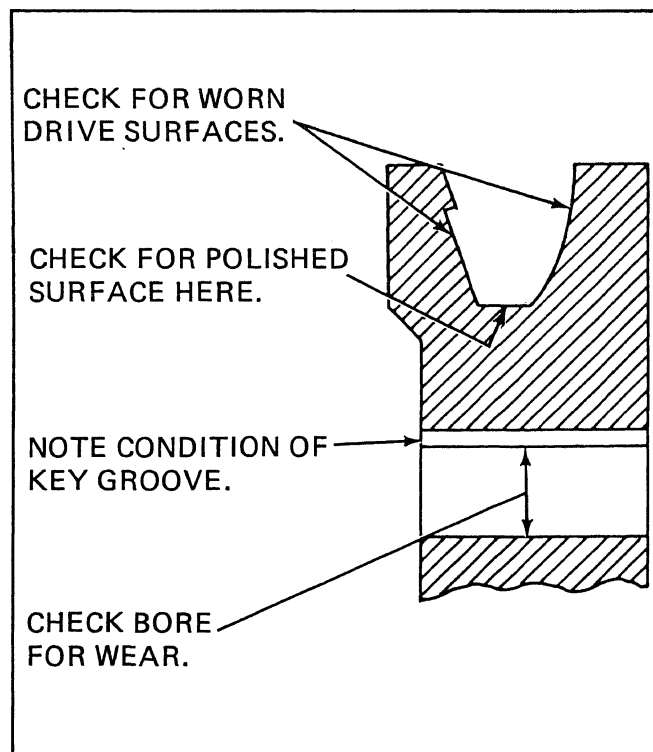


Figure 5-28.19. Pulley Inspection Points

g. Testing.

- (1) Field diode. Using a diode tester or 12 volt DC test lamp, check for continuity from each lead separately to the center metal contact stud.
 - (a) Connect one lead of the tester to the center stud then test each of the three leads individually. Continuity should be observed in one direction (polarity) only, and all diodes should test the same, figure 5-28.20.
 - (b) If any diode is defective, replace the entire field diode.

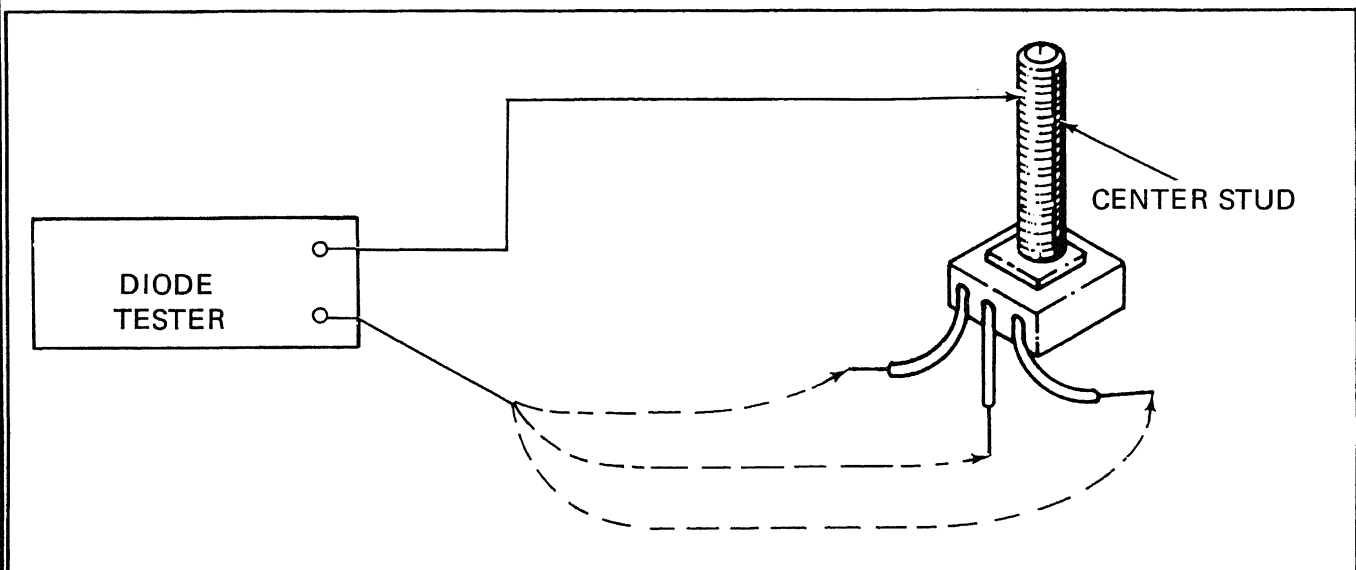


Figure 5-28.20. Testing Field Diode Assembly

NOTE

Remove the 3 leads to the field diode assembly before testing rectifier diodes.

- (2) Rectifier diodes. Test diodes at points shown in Figure 5-28.21.
 - (a) When using a 12VDC test lamp or ohmmeter, the same test points are used. All diodes in the positive heat sink, where the part number is printed in RED, should test as indicated in Figure 5-28.22.
 - (b) Figure 5-28.23 shows testing of the negative rectifier diode assembly, where the part number is printed in Black.

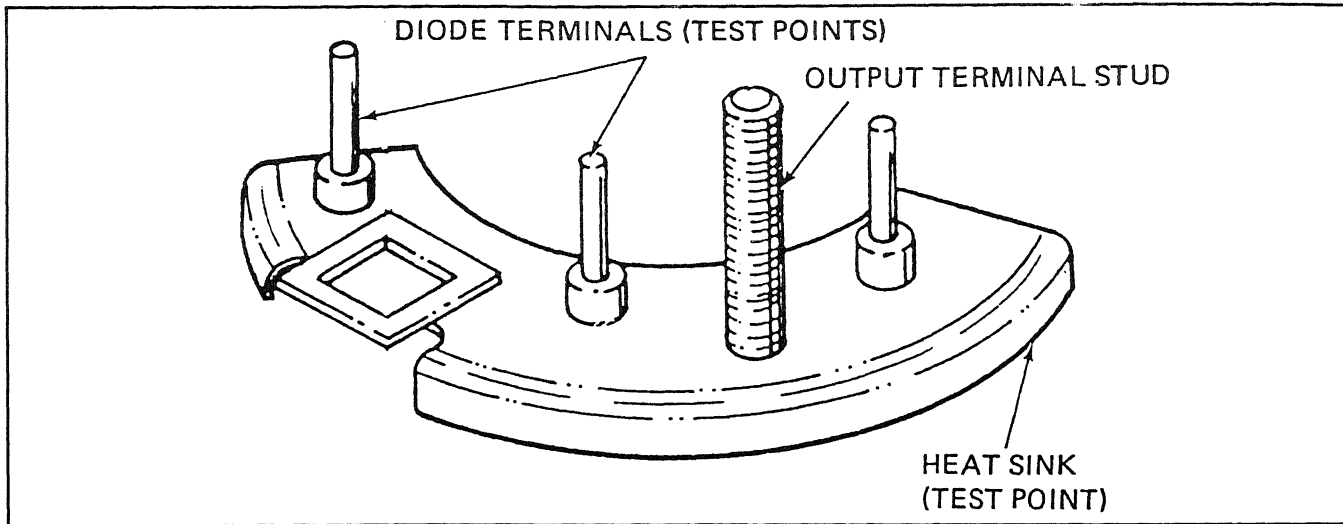


Figure 5-28.21. Rectifier Diode Test Points

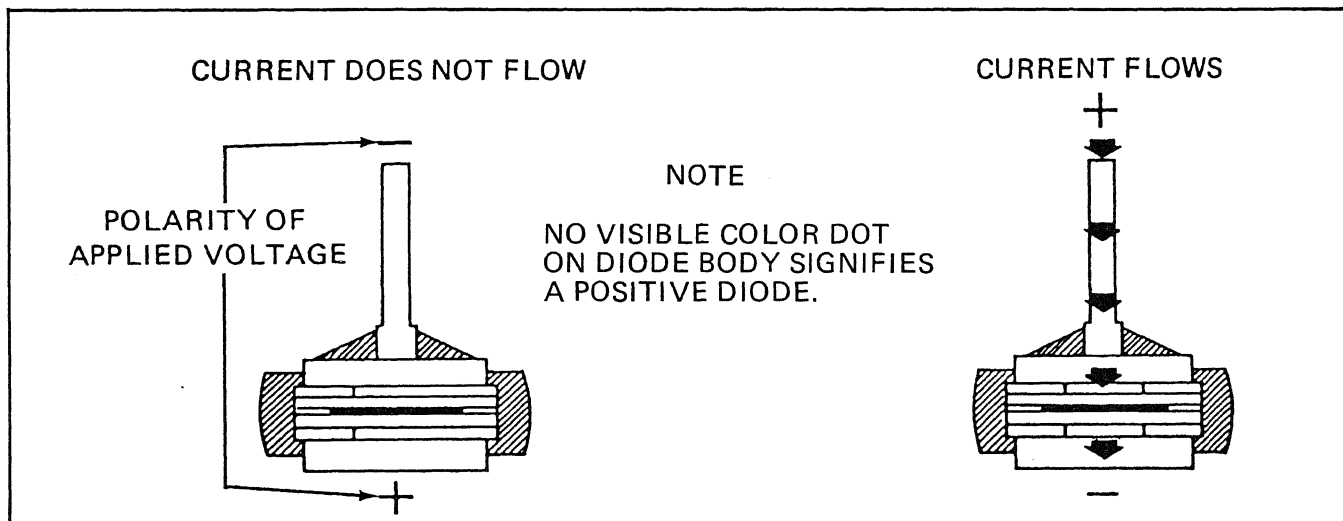


Figure 5-28.22. Positive Diode Tests

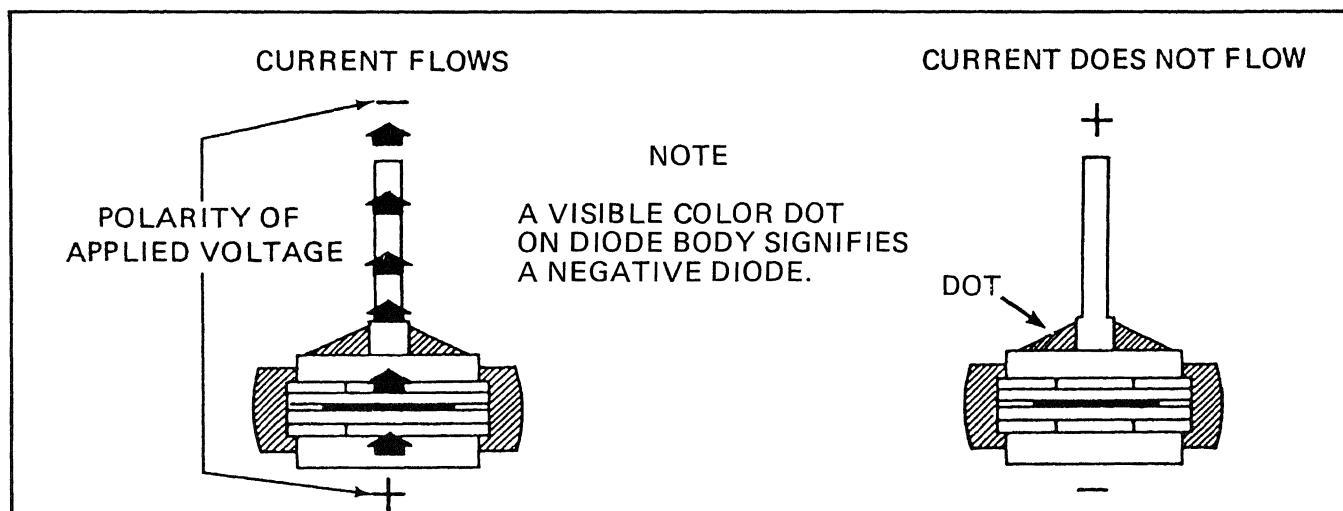


Figure 5-28.23. Negative Diode Tests

- (c) Replace the complete rectifying diode assembly if any diode in the assembly is open or shorted.
 - (d) Solder the field diode leads to the rectifier diode terminals, using rosin core solder only. Use heat dam to protect the diodes from damage.
 - (e) Arrange leads to original position for ease of assembly. Coat solder connections with enamel to avoid corrosive action.
- (3) Stator. Discoloration of enamel on windings is evidence of overheating and may cause shorted condition. Test for shorted condition as follows:
- (a) Unsolder diode connecting leads from stator junctions, as shown in figure 5-28.11, to protect diodes from heat damage. Avoid bending or twisting diode terminal.
 - (b) Separate leads as shown in figure 5-28.24.
 - (c) Test circuits with ohmmeter or test lamps.
 - (d) If ohmmeter is used, approximately 0.1 ohm. resistance will be detected. Lighted test lamps will indicate continuity.
 - (e) If stator is in good condition, reuse. If not, replace stator.

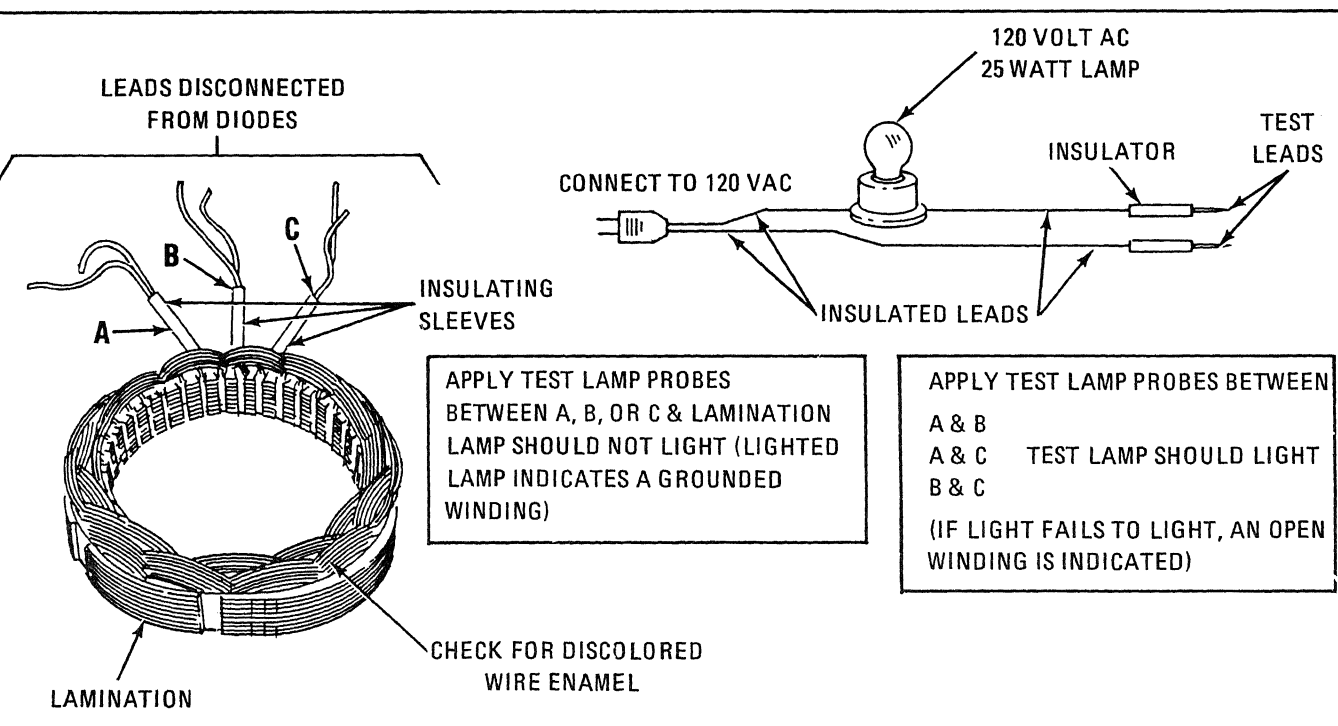


Figure 5-28.24. Stator Test Points

NOTE

Replacement stators have diode leads properly connected and soldered.

- (f) Solder stator leads to diode terminals using rosin core solder only. Use heat dam to protect diodes from damage.
- (4) Rotor. Check rotor assembly, as shown in figure 5-28.25, for the following electrical properties.
 - (a) Current draw or resistance of winding. Current draw in amperes at 70° to 80°F (21° to 26.6°C), and at 20.0 volts should be between 1.65 to 2.25. Resistance of winding in ohms at 70° to 80°F (21° to 26.6°C) should be 4.0 to 5.2.
 - (b) Grounded slip ring, connecting leads or rotor winding. No circuit from either slip ring to shaft, is correct condition.
 - (c) Condition of slip rings. Clean brush contacting surfaces with fine crocus cloth, wipe dust and residue away. If surface cannot be restored by cleaning with fine crocus cloth, replace rotor. Do not attempt to turn slip rings down in a lathe.
 - (d) Rotor shaft and body assembly. Check for worn key slot, worn bearing surfaces, scuff marks on pole fingers, and stripped threads. Replace rotor assembly if any of these faults are noted.

h. Assembly

- (1) Make certain the bearing cavity of the front housing is clean and that all burrs are removed.

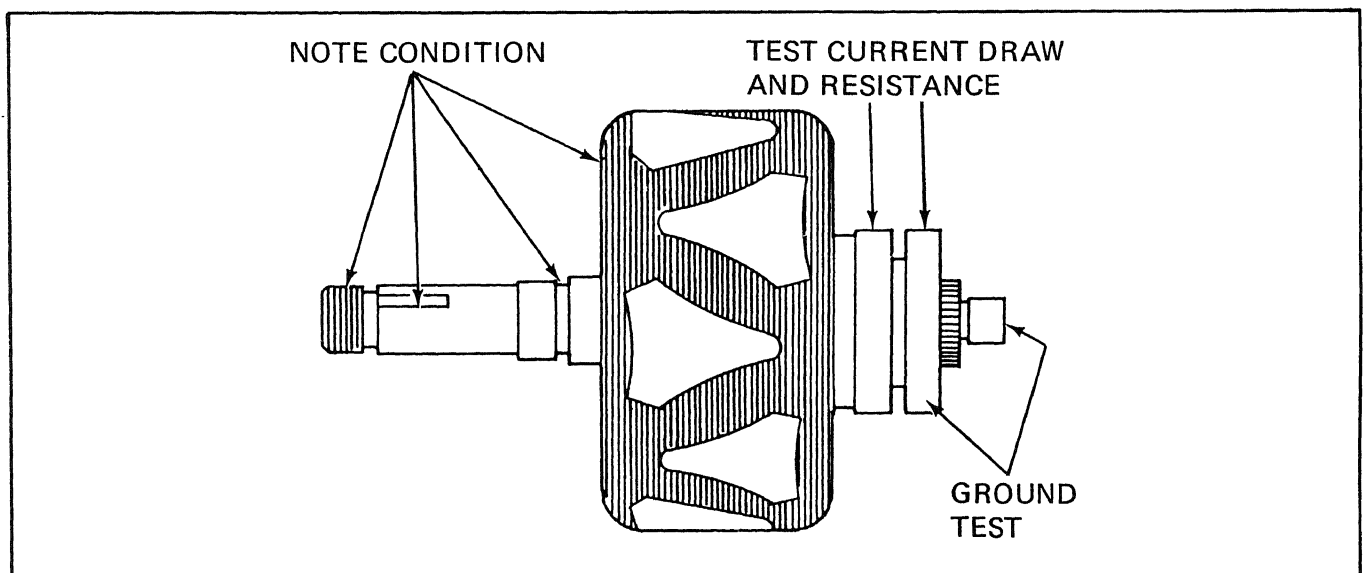


Figure 5-28.25. Alternator Rotor Testing

- (2) Using a driver tool that exerts pressure on the outer race only, press the bearing into the front housing (Figure 5-28.26) then, install the front bearing retainer making sure the retainer ears line up with the opening in the housing.
- (3) Support the pulley end of the rotor on an arbor press. Place the rear bearing over the end of the shaft. Using a driver that contacts only the inner race, press the bearing onto the shaft until it contacts the shoulder (Figure 5-28.27).
- (4) Place the rotor on the bed of an arbor press, using two steel blocks for support, as shown in Figure 5-28.28. Place front housing over shaft. Using driver sleeve that contacts inner bearing race only, press front housing down until inner bearing race contacts shoulder on the shaft.
- (5) Install the fan, woodruff key, pulley, lockwasher and nut, (figure 5-28.13). Tighten to 40 to 50 ft. lbs. torque.
- (6) Spin the rotor by hand to test the freedom of the bearing.
- (7) Place insulating sleeves and washers over the diode studs as shown in figure 5-28.29.
- (8) Carefully insert the rectifier diode terminal studs through the rear housing.
- (9) Install insulating washers, flatwashers, lockwashers and nuts as shown in Figure 5-28.30.

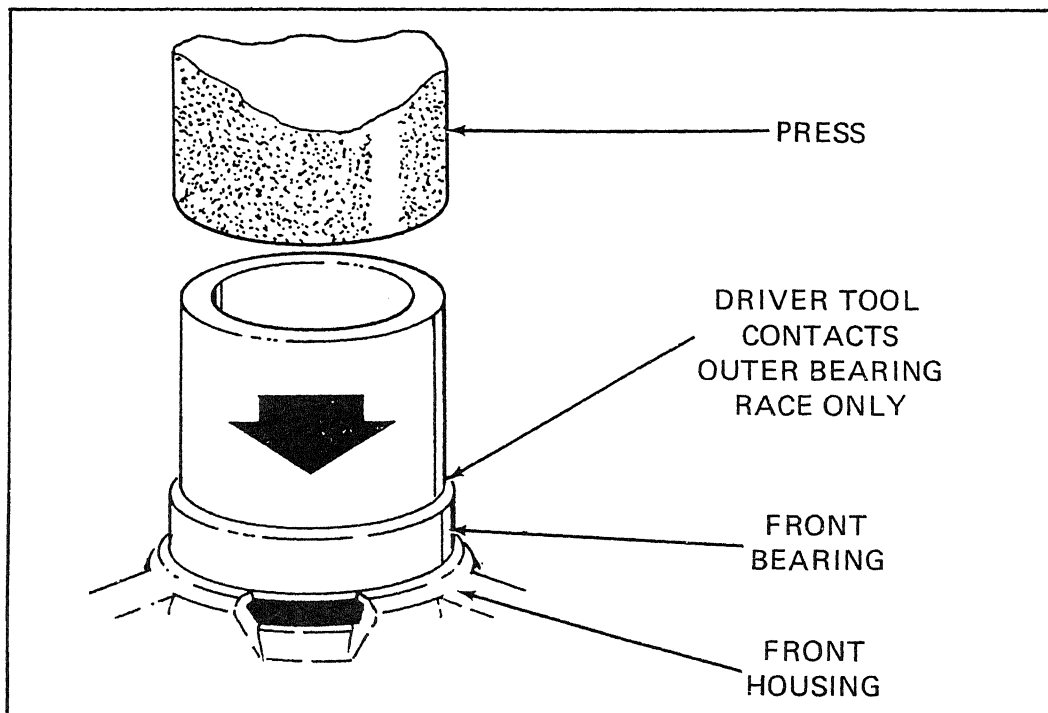


Figure 5-28.26. Installing Front Bearing

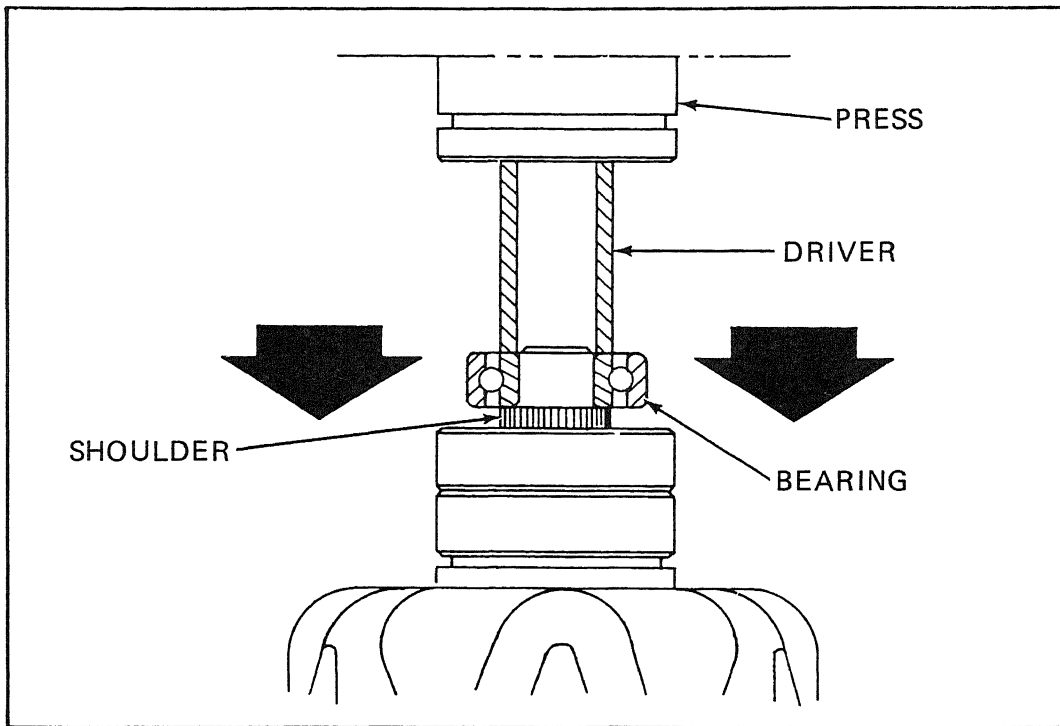


Figure 5-28.27. Installing Rear Bearing

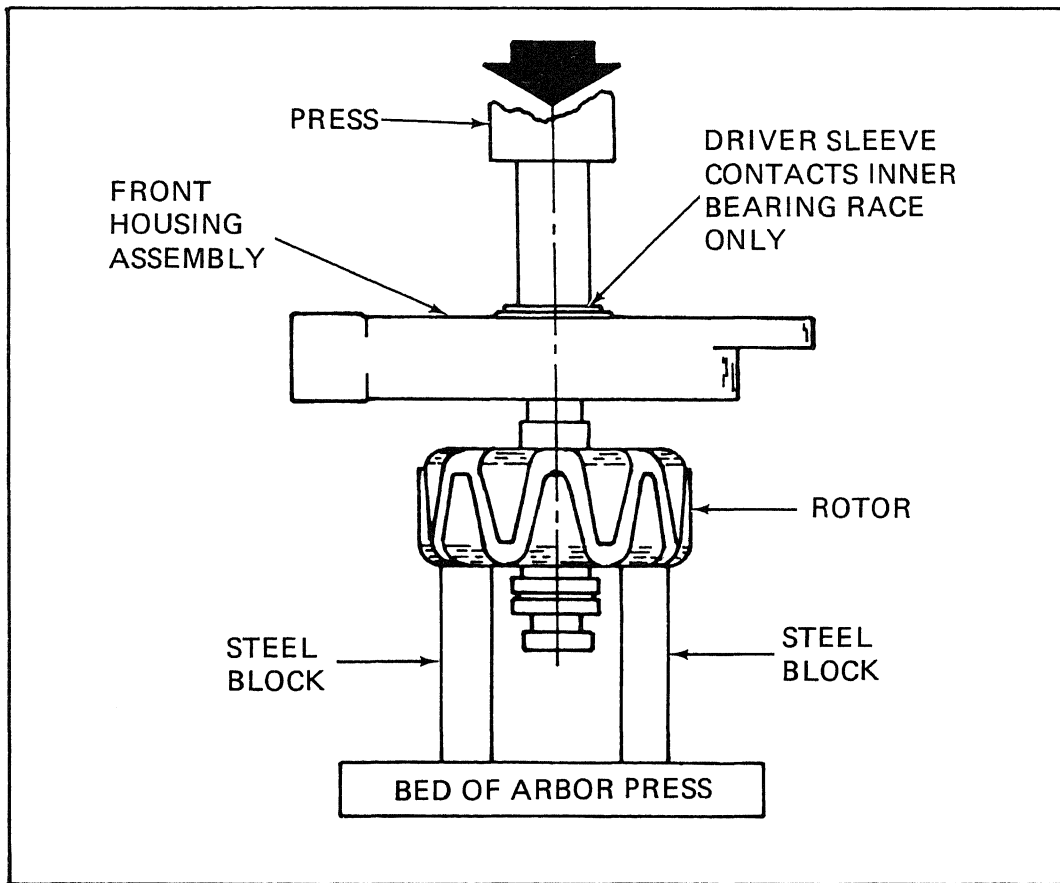


Figure 5-28.28. Assembling Front Housing to Rotor

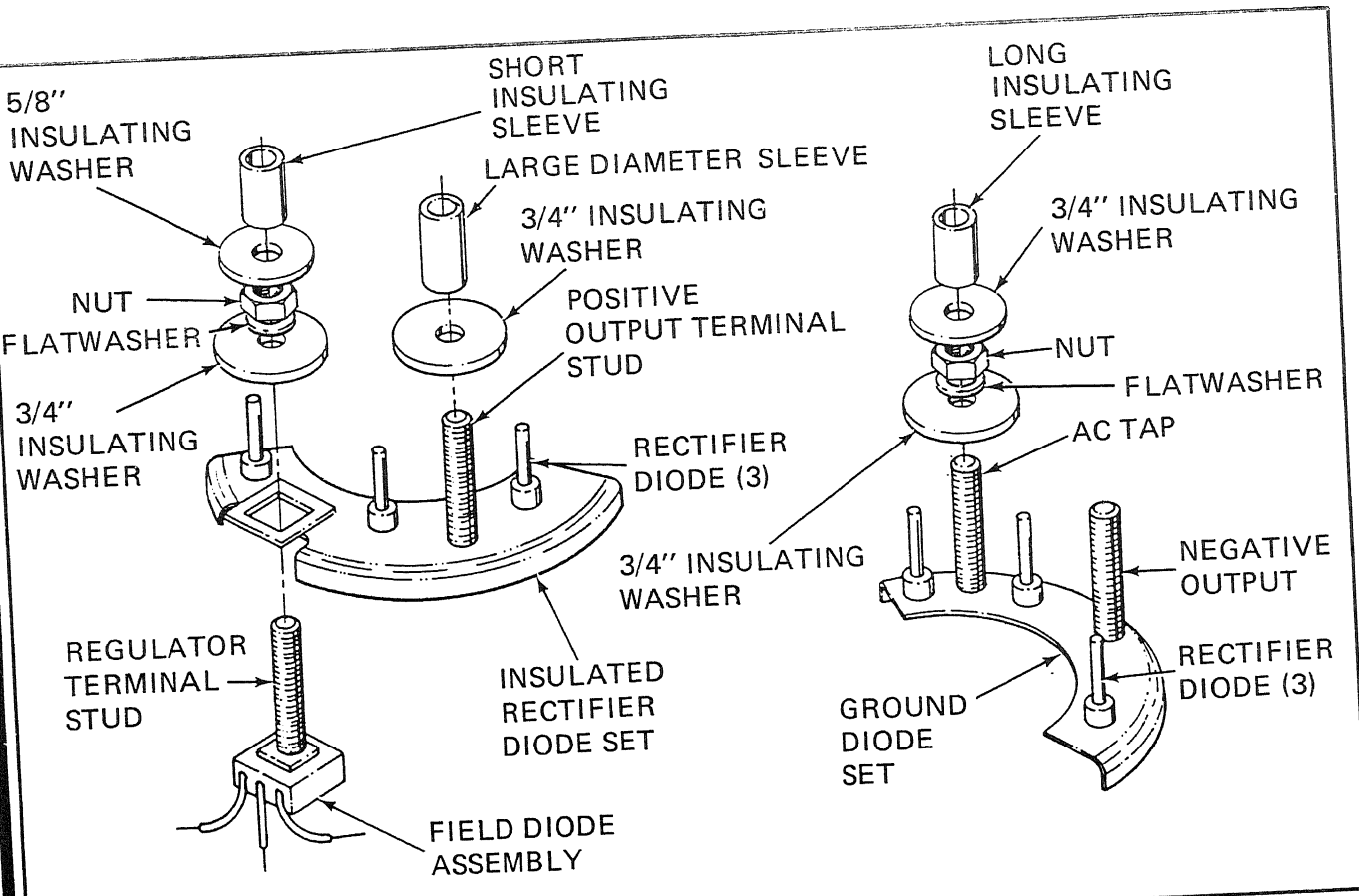


Figure 5-28.29. Placement of Internal Insulators

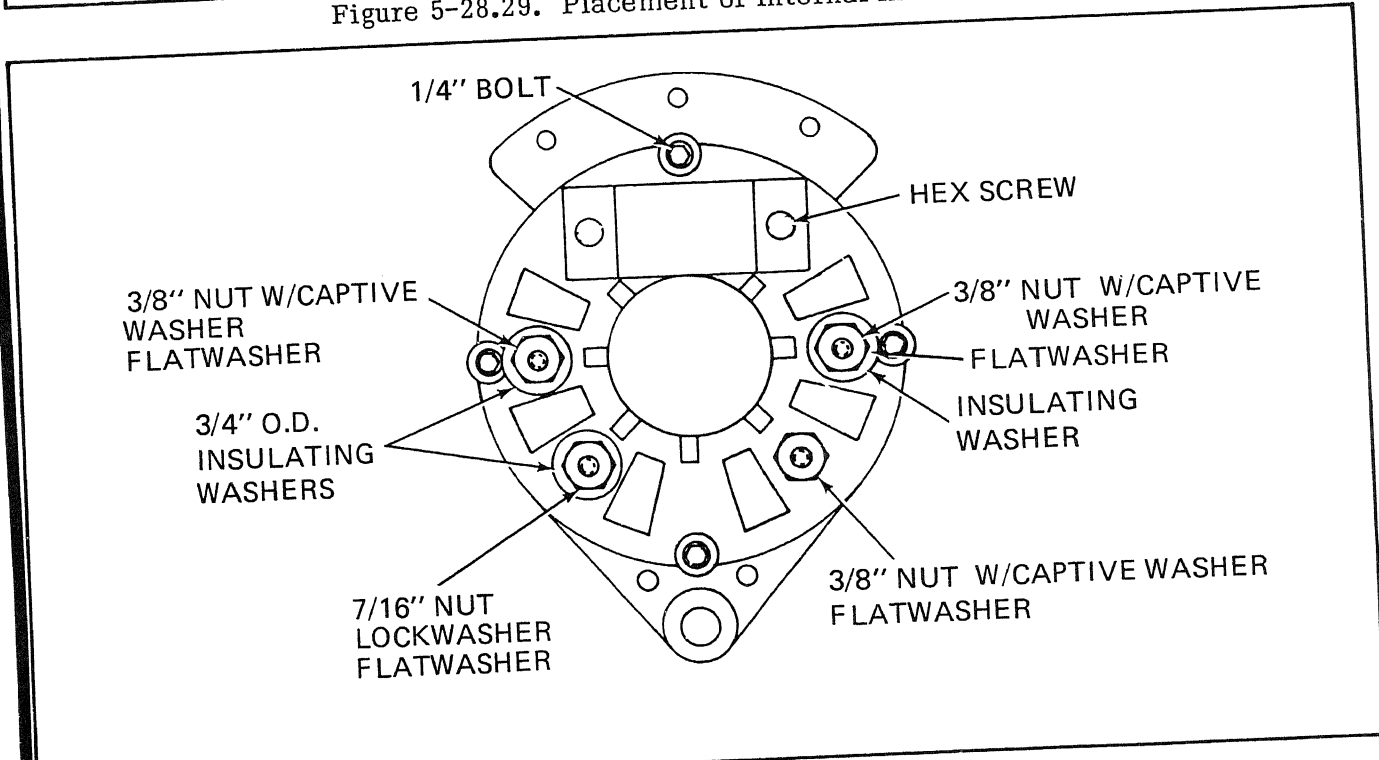


Figure 5-28.30. Placement of External Insulators

CAUTION

Do not use petroleum based oil. Use of oil will cause damage to o-ring.

- (10) Place a new synthetic o-ring bearing retainer in the recess in the rear bearing bore. Lubricate the exposed surface of the ring with a minimum amount of hydraulic brake fluid to ease assembly.
 - (11) Determine correct position of the rear housing with reference to the alternator mounting foot. Make certain that internal wiring is properly positioned to avoid damage by spinning rotor.
 - (12) Align the housing indexing marks. Hand press the housings together.
 - (13) Install the through bolts and tighten evenly to 30 to 35 inch lbs. torque.
 - (14) Spin the rotor by hand to be certain it spins freely.
 - (15) Refer to figure 5-28.7 and install the brush assembly, cover and screws.
 - (16) Refer to step i, and test alternator, less regulator.
 - (17) Attach the regulator leads then secure the regulator to the alternator with three screws (figure 5-28.6).
- i. Alternator operating test (less regulator).
- (1) Mount alternator in test stand capable of providing 3000 to 4000 alternator shaft RPM.
 - (2) Connect circuit leads as indicated in figure 5-28.31.
 - (3) Switch ammeter to show possible discharge during hook-up, reverse meter for output test.
 - (4) Set field rheostat to maximum resistance before connecting to system.

CAUTION

Do not operate alternator for more than a few minutes in this manner, due to lack of voltage control. If alternator delivered rated current output, terminate test.

- (5) Turn drive motor on, adjust to obtain 3000 to 4000 alternator shaft RPM.
- (6) Slowly reduce resistance of field rheostat, alternator should develop a charge.
- (7) Continue to reduce rheostat resistance until alternator reaches rated output in amperes.

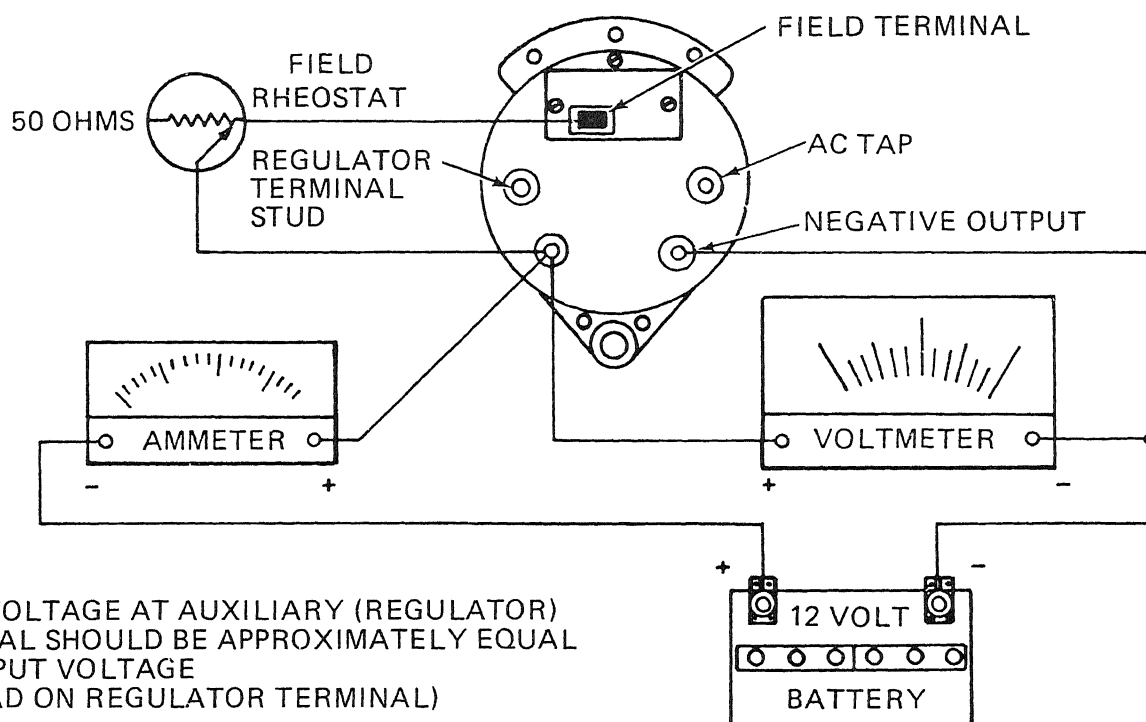


Figure 5-28.31. Alternator Performance Test

- j. Troubleshooting. If alternator performance test fails to produce rated current output (51 AMP), repair is indicated. Disconnect alternator.
- (1) Test No. 1 - Test Diode Sets
 - (a) Disconnect red wire from regulator to regulator terminal.
 - (b) Set multimeter to diode test function then, place positive lead to negative output and negative lead to either regulator or positive terminal. The meter should read 0.5 - 3.0 ohms on both the positive output terminal and on the regulator terminal. Reversing leads will produce infinite readout. If the readings are lower than the above value, then there is probably a short in one of the diodes. Higher readings indicate an open in one or more of the diodes.
 - (2) Test No. 2 - Field Circuit Test
 - (a) Disconnect yellow lead and red lead.
 - (b) Set multimeter to ohmmeter function. Measure between field terminal and alternator frame. The reading should be 3.5 to 7.0 ohms.

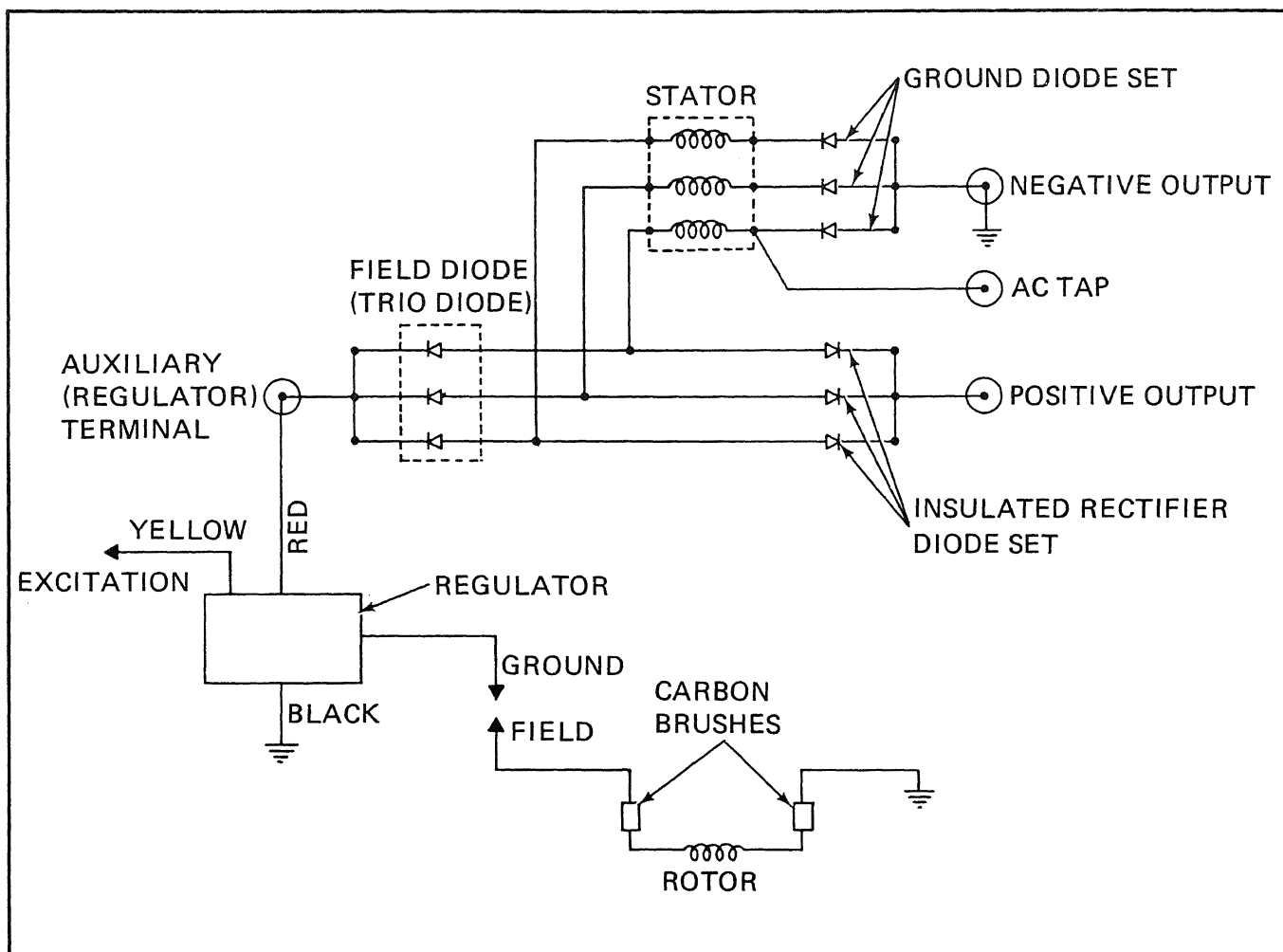


Figure 5-28.32. Alternator Schematic

(3) Test No. 3 - Regulator Test (Short)

If during the "Alternator Operating Test", the output current becomes too excessive, most probably the regulator is shorted. In terms of voltage, this high end voltage reading must not exceed 15 volts for a correctly operating charging system.

(4) Test No. 4 - Regulator Test (Open)

If the regulator does not appear shorted from the above test and test No. 1, and test No. 2 appears normal, then we can suspect the regulator is defective with an open circuit.

- j. Installation. Refer to paragraph 4-20.1, step b, for procedure covering alternator installation.

5-7. STARTER ASSEMBLY.

a. Inspection.

- (1) Inspect all wiring for damage.
- (2) Inspect all connections to starter motor, solenoid, start switch, and battery, including all ground connections. Clean and tighten all connections as required.
- (3) Inspect start switch to determine its condition. With switch closed, use a voltmeter to check the circuit for continuity.
- (4) If battery, wiring and start switch is in satisfactory condition, and engine is to be functioning properly, refer to paragraph 4-21, and remove starter assembly.

b. Testing.

- (1) With starter motor removed from engine, check pinion for freedom of operation by turning it on the screw shaft.
- (2) Check armature for freedom of rotation by prying pinion with a screwdriver. Sticking bearings, a bent armature shaft, or a loose pole shoe screw will cause armature not to turn freely.
- (3) If armature does not turn freely starter motor should be disassembled.
- (4) If armature rotates freely, perform the following no-load test prior to disassembly.
 - (a) Connect a voltmeter from starter motor terminal to starter motor frame (figure 5-29), and use an r.p.m. indicator to measure armature speed.
 - (b) Connect starter motor and an ammeter in series with a fully charged battery and a switch in the open position from solenoid battery terminal to solenoid switch terminal.
 - (c) Close switch and compare the r.p.m., current, and voltage readings with specifications given in Table 5-4.

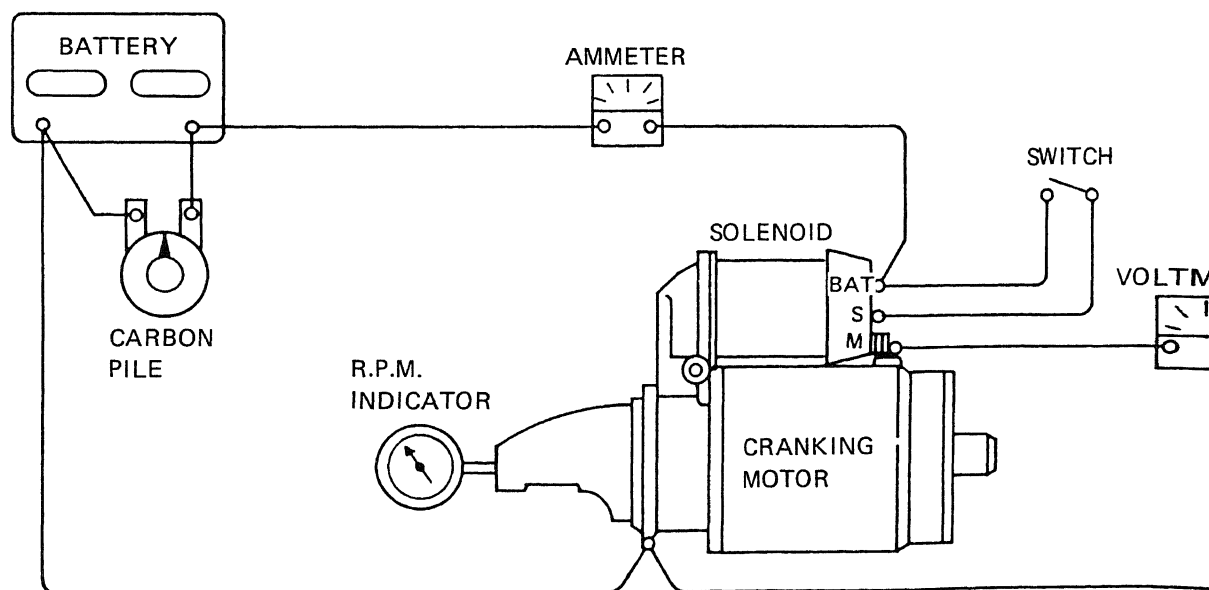


Figure 5-29. Starter No-Load Test Setup

Table 5-4. Starter No-Load Test Specifications

No-Load Test (Includes Solenoid Current)				
Volts	Min Amps	Max Amps	Min RPM	Max RPM
11	120	210	9000	13400

- (d) It is not necessary to obtain the exact voltage specified in Table 5-4, as an accurate interpretation can be made by recognizing that if voltage is slightly higher r.p.m. will be proportionately higher, with current remaining essentially unchanged.
- (e) To obtain exact voltage, connect a carbon pile across battery to reduce voltage to value specified in Table 5-4.
- (f) Make disconnections only with switch open.
- (g) Interpret test results as indicated in Table 5-5.

Table 5-5. Starter No-Load Test Results

Result obtained	Problem
1. Rated current draw and no-load speed.	1. Normal condition of starter motor.
2. Low free speed and high current draw.	1. Too much friction; tight, dirty, or worn bearings, bent armature, shaft or loose pole shoes allowing armature to drag. 2. Shorted armature. 3. Grounded armature or fields.
3. Failure to operate with high current draw.	1. A direct ground in terminal or fields. 2. Frozen bearings.

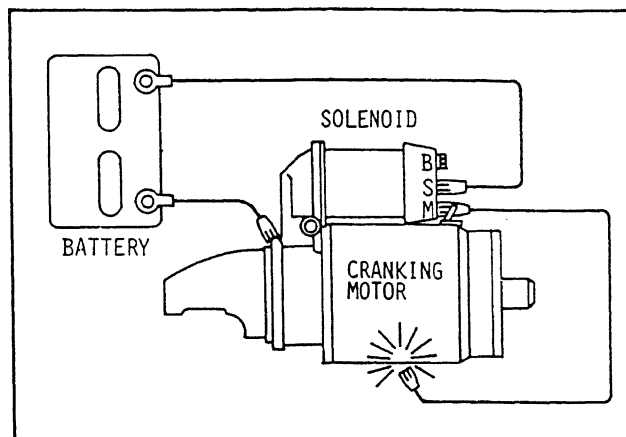


Figure 5-37. Circuit for Checking Starter Pinion Clearance

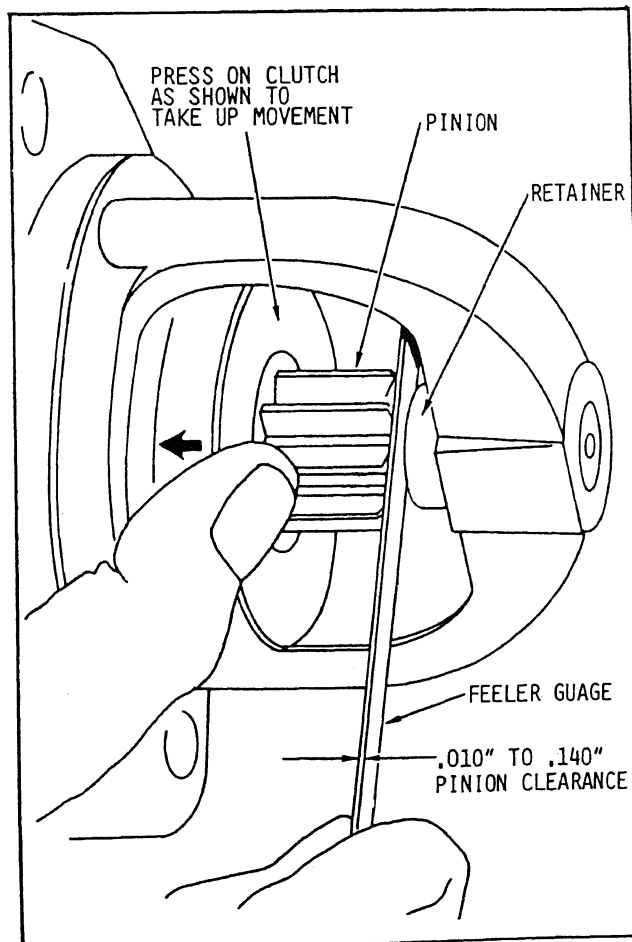


Figure 5-38. Checking Starter Pinion Clearance

5-8. FUEL TANK (figure 5-39).

a. Removal.

- (1) Disconnect hoses (1) and (2) and cap open ends.
- (2) Refer to paragraph 5-23, and remove lift frame assembly.
- (3) Refer to paragraph 5-13 and remove engine and pump mounting bolts.
- (4) Using sling of adequate size, raise engine and pump clear of frame.
- (5) Remove three-way fuel selector valves (3).
- (6) Remove nuts (4), washers (5), (6) and (7), and screws (8).
- (7) Remove straps (9) and (10).
- (8) Carefully remove fuel tank (11) from frame.

b. Disassembly. Remove filler cap (12) and strainer (13).

c. Cleaning.

WARNING

Potential health hazards result from inhalation of petroleum solvent vapors and from contact of solvent with skin. Use rubber gloves and hand cream for protection, and work with adequate ventilation.

CAUTION

Petroleum solvents are highly flammable. Keep solvent container lids closed when not in use, and avoid all possible risks of igniting solvent vapors, keep away from open flame and excessive heat. Flash point of solvent is 100 to 138 degrees F (38 to 59 degrees C).

- (1) Clean exterior of tank with solvent Federal Specification P-D-680, Type II.
- (2) Flush interior of tank with same type solvent.
- (3) Purge tank with continuous flow of clean water.

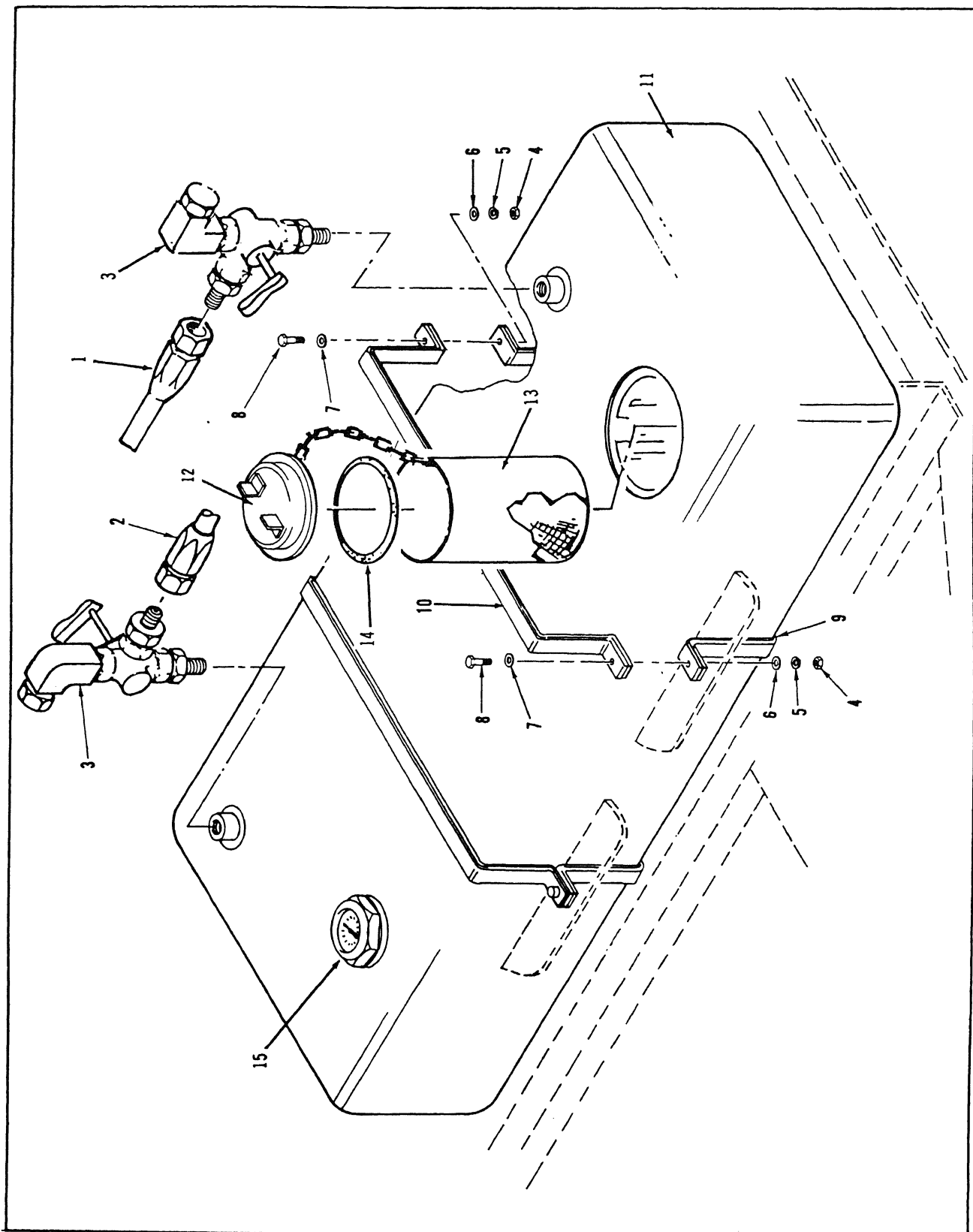


Figure 5-30 Fuel Tank Removal/Installation

d. Inspection.

- (1) Inspect tank for leakage by closing off all ports with the exception of drain port and adapting fitting for air line to that port.
- (2) Pressurize tank with clean air regulated to a 4 to 5 psi (0.28-0.35 kg/cm²) level for 5 minutes. There shall be no signs of leakage or permanent deformation.
- (3) Inspect tank straps for cracks, breaks, and torn or separated rubber.
- (4) Inspect condition of filler cap gasket and fording vent valve.
- (5) Inspect fuel quantity indicator for broken or cracked face glass and glass frame screws for looseness.

e. Repair.

- (1) Weld tank in accordance with Weldment Requirements for Plain Carbon Steel.
- (2) Replace filler cap (12) if fording vent valve contains defects.
- (3) Replace strainer (13) if defective.
- (4) Replace damaged rubber on tank straps using adhesive MMM-A-122 or equivalent. Replace filler cap gasket (14) if defective.
- (5) Replace fuel quantity indicator (15) if defects are found.

f. Assembly.

- (1) Remove plugs from all openings and inspect tank to ensure no foreign material is present in tank.
- (2) Install filler cap (12) and strainer (13).

g. Installation.

- (1) Position fuel tank (11) on frame.
- (2) Install straps (9) and (10) with screws (8) washers, (7), (6), (5) and nuts (4).
- (3) Using sling of adequate size, position engine and pump on frame.
- (4) Install pump and engine mounting bolts.
- (5) Install lift frame assembly. (para 5-23)
- (6) Remove caps from hoses (1) and (2) and connect the hoses to selector valves (3).

5-11. INJECTION PUMP.

- a. Testing. Testing of the injection pump is confined to making sure that delivery valves and pump elements are free from internal leaks causing low output pressure.

WARNING

Fuel is under high pressure during this test.

- (1) Rotate injection input lever (2, figure 5-46) clockwise (towards dipstick), the full run position and secure lever in this position.
- (2) Remove V-belt guard. (para. 4-17)

CAUTION

Do not bend injection lines more than 5° from original shape.

- (3) Loosen the three injection lines (1, figure 5-45).
- (4) Remove overflow valve (by larger hex) from injection pump, and loosely install a plug previous to bleeding air from this port. Upon evacuation of air, tighten plug.

NOTE

The following steps apply to each of the three elements.

- (5) Disconnect injection line from element to be tested.
- (6) Evacuate air from injection pump. (para 4-26d.).
- (7) Connect injection pump tester gauge to the element to be tested.
- (8) Open bleeder connection of tester (2).
- (9) Remove bolts (3) and cover (4).
- (10) Manually rotate crankshaft in normal clockwise rotation until the injection pump element to be tested is at the bottom of it's stroke.

NOTE

The lever bar should apply pressure under head of element adjustment screw. Use care in inserting lever bar in order not to dislodge plunger spring keeper.

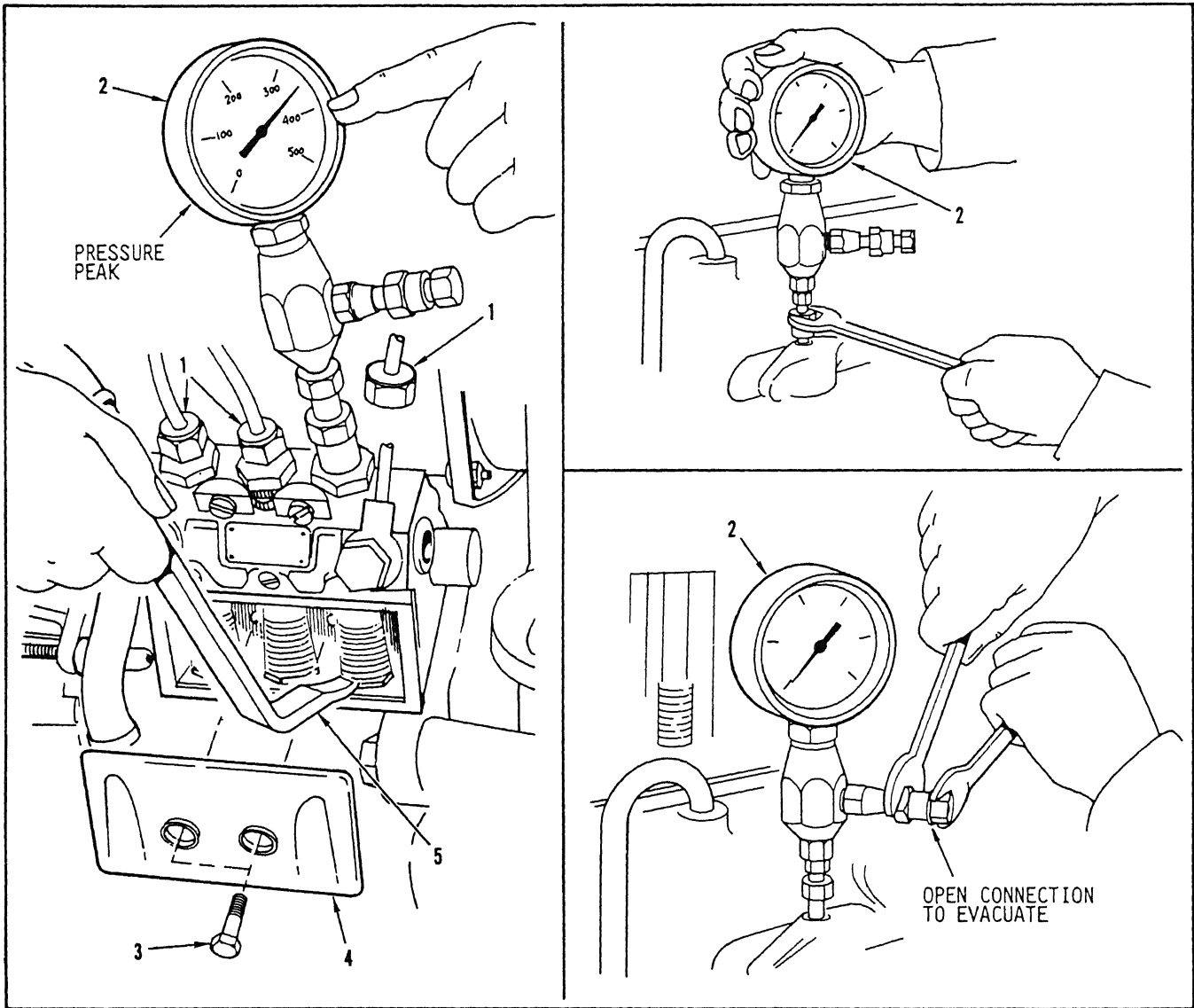


Figure 5-45. Testing Injection Pump

- (11) Insert lever bar (5) under injection pump plunger element adjustment screw head, and activate lever bar to evacuate air from gauge. When escaping fuel is free of bubbles, close bleeder connection on tester.
- (12) Pump lever bar to generate a pressure of 2175 psi (150 bar).

NOTE

Wait a minute and observe pressure gauge. The pressure gauge must not drop more than 145 psi (10 bar). Replace pump if pressure drop is exceeded.

- (13) Pump with lever bar (approximately five strokes) to generate a pressure peak of 5075 psi (350 bar).

NOTE

Replace pump if pressure peak cannot be obtained.

- (14) Repeat the above steps (5) through (13) for the other two elements.

NOTE

Replace defective injection pump as directed in para. b and c. If injection pump is not to be replaced, continue as follows.

- (15) Install injection cover (4) with screws (3).
- (16) Remove test gauge (2), install lines (1), and remove plug from overflow port and install overflow line.
- (17) Bleed injection lines and tighten fittings. (para. 4-26e)
- (18) Install V-belt guard. (para. 4-17)
- (19) Return injection pump lever to shutdown position.

b. Removal.

- (1) Remove idler pulley assembly. (para. 4-49)
- (2) Remove fuel feed pump. (para. 4-29)
- (3) On Models 13220E1070, 13225E9200 (97403), and LC 350GPM (36024), disconnect solenoid rod end bracket (1, figure 5-46) from injection pump input lever (2) by removing two nuts (3), two washers (4) and two bolts (5).
- (4) On Model 1322E2289 (97403), disconnect actuator rod (6) from injection pump input lever (2) by removing nut (7), washer (8), washer (9), spacer (10), bolt (11) and washer (12).
- (5) On Models 13220E1070, 13225E9200 (97403), and LC 350GPM (36024), remove throttle control rod. (para. 4-24)

NOTE

Upon removal of any fuel line, hose or fittings, plug all open ports and place caps over all fuel lines and hoses to prevent contamination of fuel system.

- (6) Remove banjo bolt (13), washers (14) and hose (15).

NOTE

Remove overflow valve bolt by the larger hexagon.

- (7) Remove overflow valve bolt (16), two washers (17) and banjo fitting (18).
- (8) Disconnect fuel injection lines (19), (20) and (21).
- (9) Manually rotate engine clockwise until #1 injection pump element (element closest to governor end of pump) is in upper position and engine is on TDC mark.

CAUTION

Do not drop capscrews or washers into timing cover. A clean shop cloth placed inside case will catch tools/bolts.

- (10) Remove capscrews (22), washers (23) and flat washers (24).
- (11) Remove nuts (25) and washers (26).

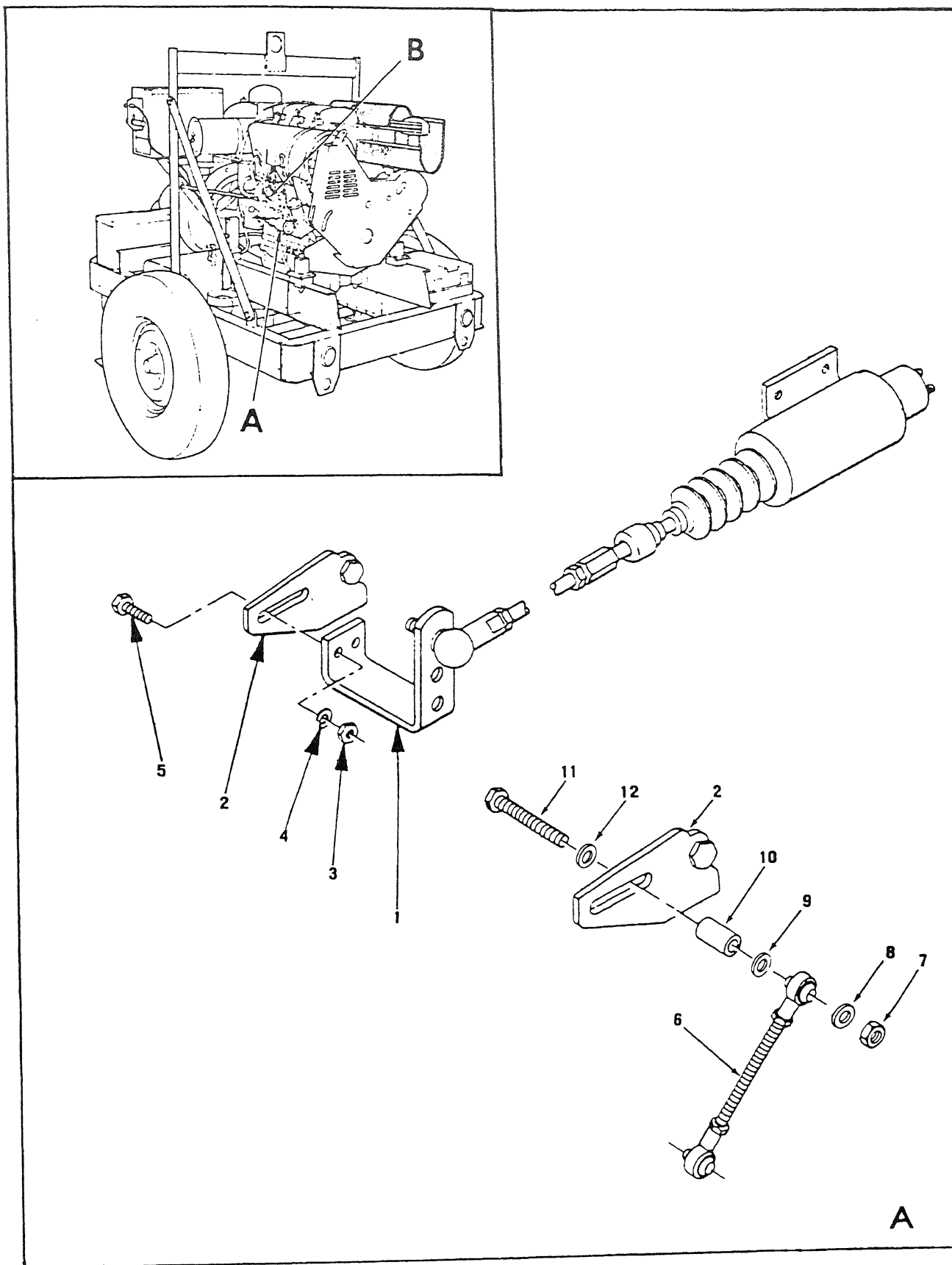
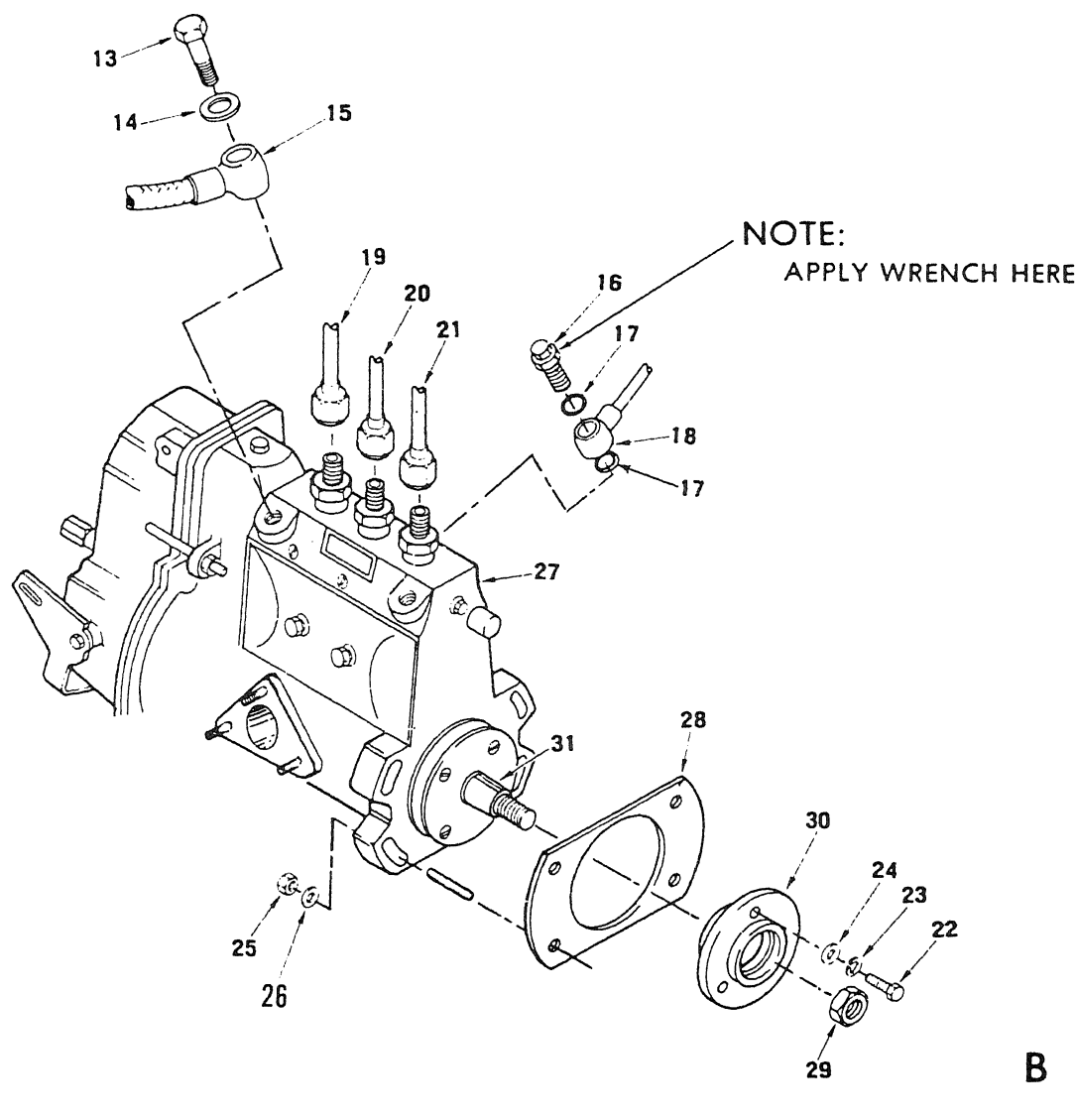


Figure 5-46. Injection Pump, Removal/Installation (Sheet 1 of 2)



B

Figure 5-46. Injection Pump, Removal/Installation (Sheet 2 of 2)

- (18) Remove plug from overflow port and with two new washers, install overflow line.
- (19) On Models 13220E1070, 13225E9200 (97403), and LC 350GPM (36024), position fuel shutdown solenoid rod end bracket (1, figure 5-46) onto injection pump input lever (2) and secure with two bolts (5), two washers (4), and two nuts (3).
- (20) On Model 13226E2289 (97403), connect actuator rod (6) to injection pump input lever (2) by installing bolt (11), washer (12), spacer (10), washer (9), washer (8), and nut (7).
- (21) On Models 13220E1070, 13225E9200 (97403), and LC 350GPM (36024), replace throttle control rod. (Para. 4-24)
- (22) Replace fuel feed pump. (Para. 4-29)

NOTE

Remove shop cloth from timing gear case and pointer from dowel sleeve.

- (23) With a new o-ring seal, install idler pulley. (Para. 4-49)

5-12. INJECTION NOZZLE (figure 5-47)

- a. Testing. Testing of injection nozzle is performed with nozzle removed. (para 4-37c.)

WARNING

Keep hands away from spray. Spray is under high pressure and can cut through skin.

- (1) Connect nozzle to tester.
- (2) With pressure gauge cut in, press tester pump lever several times.
- (3) Read opening pressure and inspect spray pattern.

NOTE

Readings should be 2537-2653 psi (175-183 bar) for used nozzle. Readings should be 2610-2726 psi (180-188 bar) for new nozzle, or new spring in nozzle. The jet pattern must be solid without surrounding mist.

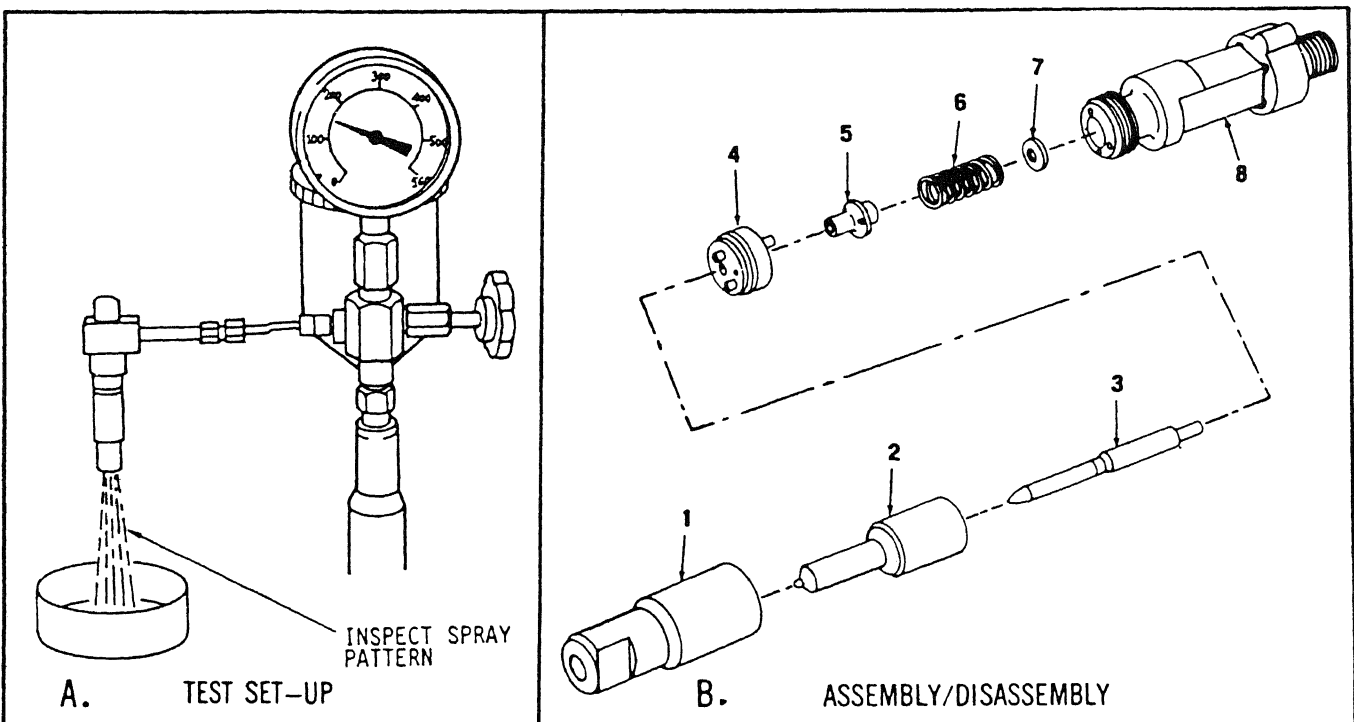


Figure 5-47. Injection Nozzle, Test Set-up/Assembly/Disassembly

- (4) Reduce pressure to 362.5-435 pounds (25-30 bar) below specified opening pressure, check that no fuel dribbles from nozzle.
- (5) Adjust nozzle opening pressure by adding or removing shims (7). as directed in para b.
- (6) Repeat test as required, then remove nozzle from tester.

b. Disassembly.

- (1) Unscrew cap (1) and remove body (2), needle (3) and intermediate piece (4).
- (2) Remove plunger (5), spring (6), shims (7) from holder (8).

c. Cleaning, Inspection and Repair.

- (1) Wash all parts in clean diesel fuel and blow out with compressed air.
- (2) Inspect for obvious defects and replace defective parts or assemblies.

d. Assembly.

- (1) Install shims (7), spring (6) in holder (8) and plunger (5) with shoulder next to spring.

(2) Insert intermediate piece (4) with guide pins into holes in holder. Insert needle (3) in body (2). Align body holes with guide pins on intermediate piece (4) and insert guide pins, then install cap (1).

(3) Test injection nozzle in accordance para a.

e. Installation. Install nozzle (para 4-37 q).

5-13. ENGINE ASSEMBLY

a. Removal.

CAUTION

Remove negative (-) battery cable to prevent possible electrical arc.

- (1) Refer to paragraph 4-15 and remove negative (-) battery cable.
- (2) Remove screws (1, figure 5-48), washers (2) and cold weather start kit (3).
- (3) Place cold weather start kit on top of engine if the engine is to be reinstalled. If engine is to be replaced disconnect cold start line from manifold (1, figure 4-32).
- (4) Carefully remove control panel cover (4, figure 5-48).

NOTE

TAG ALL ELECTRICAL LEADS BEFORE REMOVING.

- (5) Disconnect harness assembly (5) from control panel terminal (6).
- (6) On Model 13226E2289 (97403) also disconnect wires from control panel terminal to pressure controller (figure 4-48).
- (7) Disconnect overflow line from injector nozzle to fuel tank (7, figure 4-23).
- (8) Disconnect throttle control rod on Models 13220E1070 (97403), 13225E9200 (97403) and LC 350GPM (36024) (para 4-24).
- (9) On Model 13226E2289 (97403) remove magnetic pick-up (para 4-44), control box, actuator and mount bracket (para 4-45), actuating rod and actuator lever, (para 4-46).
- (10) On Model 13226E2289 (97403), tag and disconnect run relay leads (5, figure 4-47).

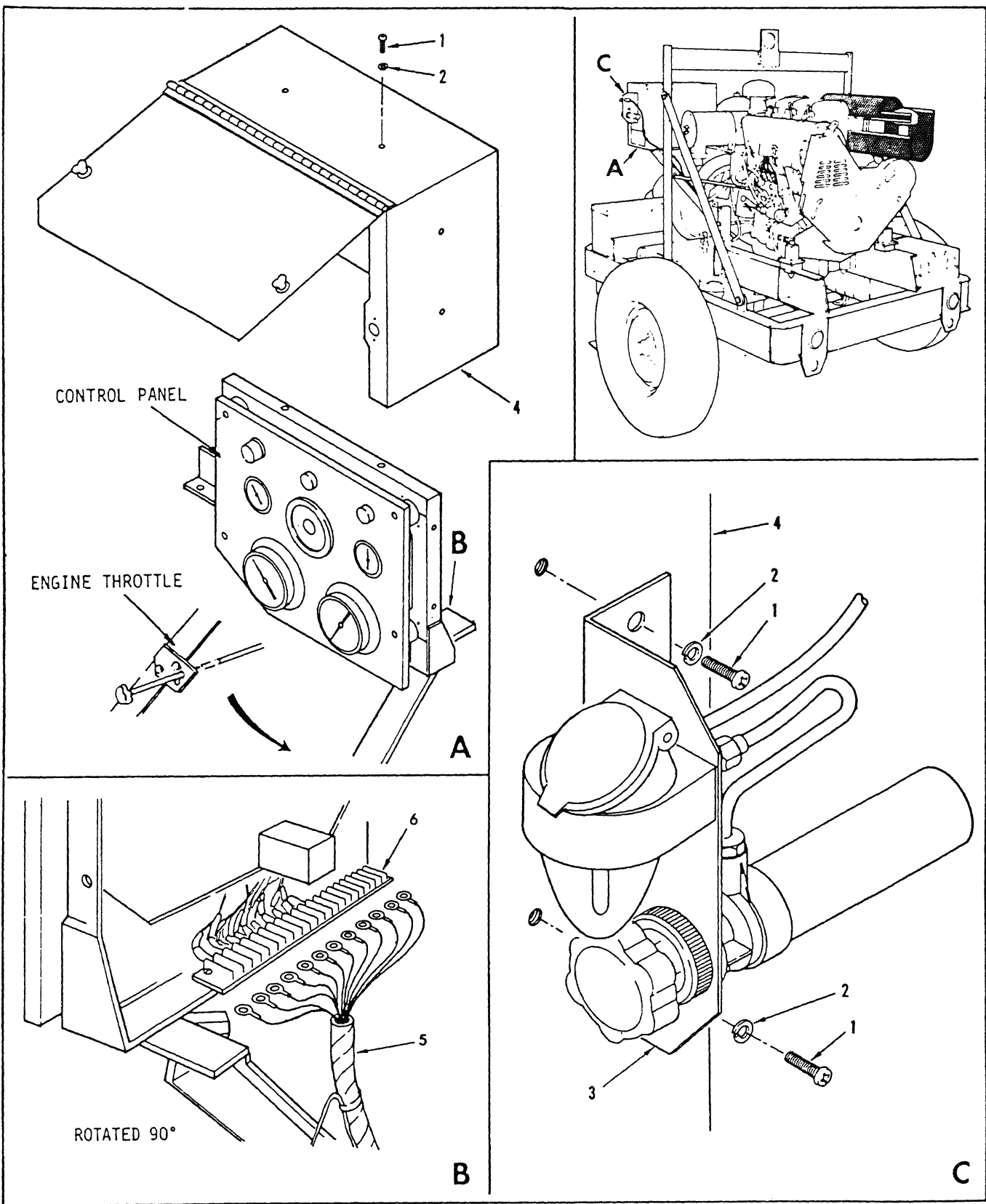


Figure 5-48. Engine Assembly, Removal Installation (Sheet 1 of 2)

- (11) Connect throttle control rod on Models 13220E1070 and 13225E9200 (97403).
- (12) Connect overflow line from injector nozzle to fuel tank (7, figure 4-23).
- (13) On Model 13226D2290 (97403) connect wires from pressure controller to control panel terminal strip (figure 4-48).
- (14) Connect harness assembly (5, figure 5-48) to control panel.
- (15) Install control panel cover (4).
- (16) Install cold weather start kit (3) with screws (1) and washers (2).
- (17) Connect cold start line to manifold (1, figure 4-32) if applicable.

5-14. COOLING FAN.

a. Removal (figure 5-49).

- (1) Remove V-belt guard (para 4-17).
- (2) Loosen V-belt tension and remove V-belt (1).
- (3) Loosen clips (2) and open air cowling (3).
- (4) Remove nut (4), washers (5 and 6), and bolt (7).
- (5) Remove bolts (8) and washers (9); remove cooling fan (10).

b. Inspection. Check cooling fan radial clearance. If extensive radial clearance is present, disassemble and repair.

c. Disassembly (figure 5-50).

- (1) Place cooling fan on clean work bench for disassembly.
- (2) Remove nut (1) and bolt (2).
- (3) Remove V-belt pulley (3), roller (4) and bearing shaft (5).
- (4) Remove circlip (6); then, push bearings (7) and bushing (8) from jacket (9).

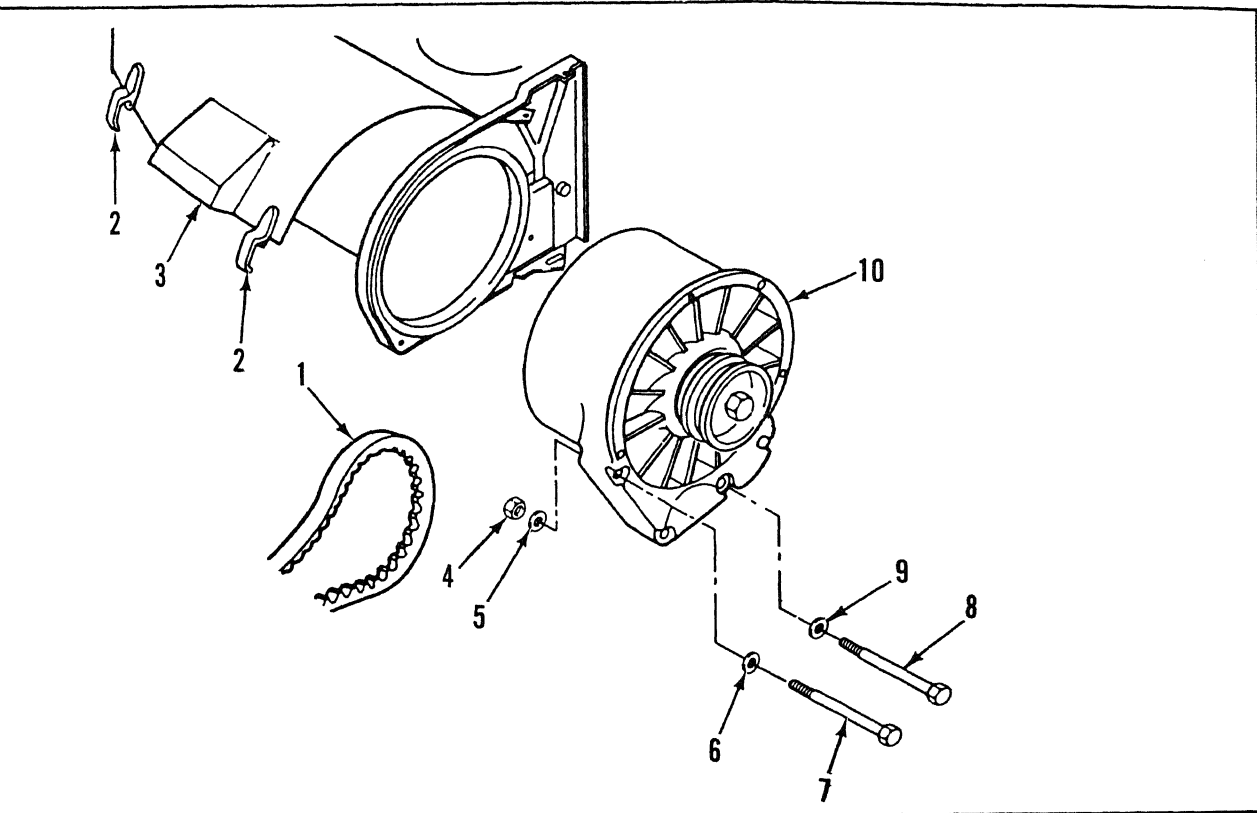


Figure 5-49. Cooling Fan, Removal/Installation.

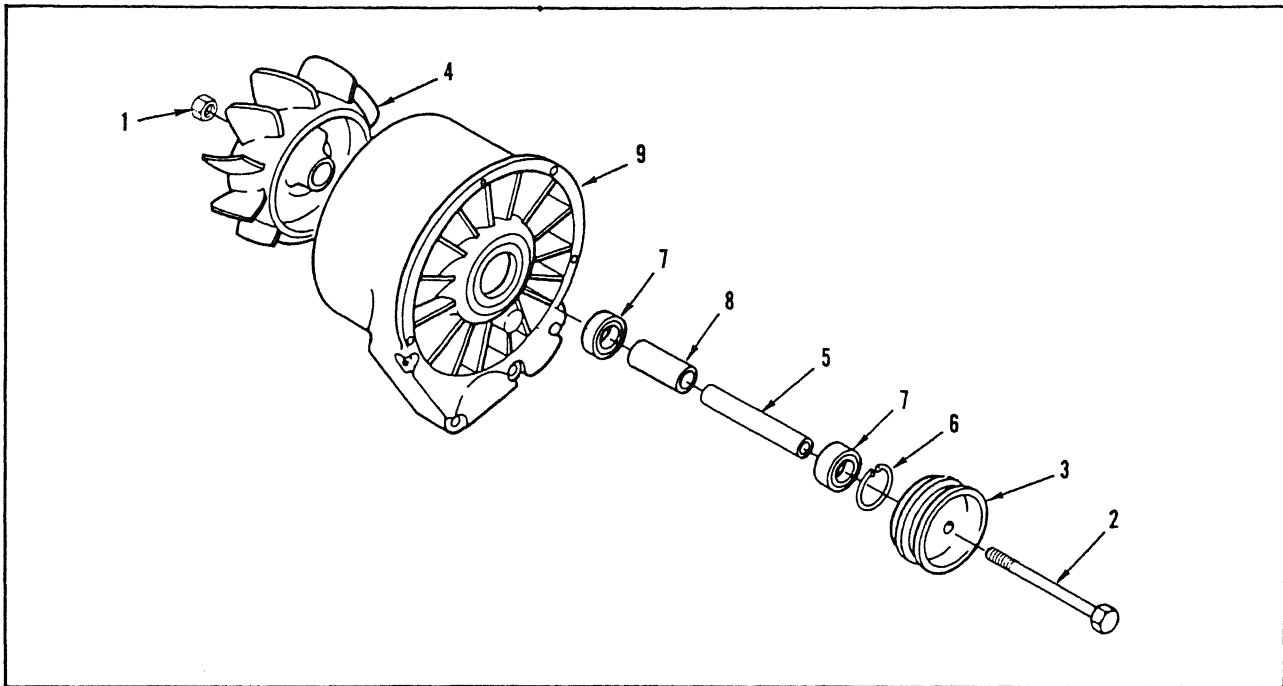


Figure 5-50. Cooling Fan, Assembly/Disassembly

WARNING

Potential health hazards result from inhalation of petroleum solvent vapor and from contact of solvents with skin. Use rubber gloves and hand cream for protection, and work with adequate ventilation.

CAUTION

Petroleum solvents are highly flammable. Keep solvent container lids closed when not in use, and avoid all possible risks of igniting solvent vapors, keep away from open flame and excessive heat. Flash point of solvent is 100 to 138 degrees F (38 to 59 degrees C).

d. Cleaning. Clean all parts in low-toxicity petroleum solvent, Federal Specification P-D-680, Type II.

e. Inspection.

- (1) Inspect roller and jacket for cracks. If cracks are found, replace defective part.
- (2) Check inside of jacket for signs of roller rub, indicating worn bearings. If signs of rub are present, replace defective bearing.

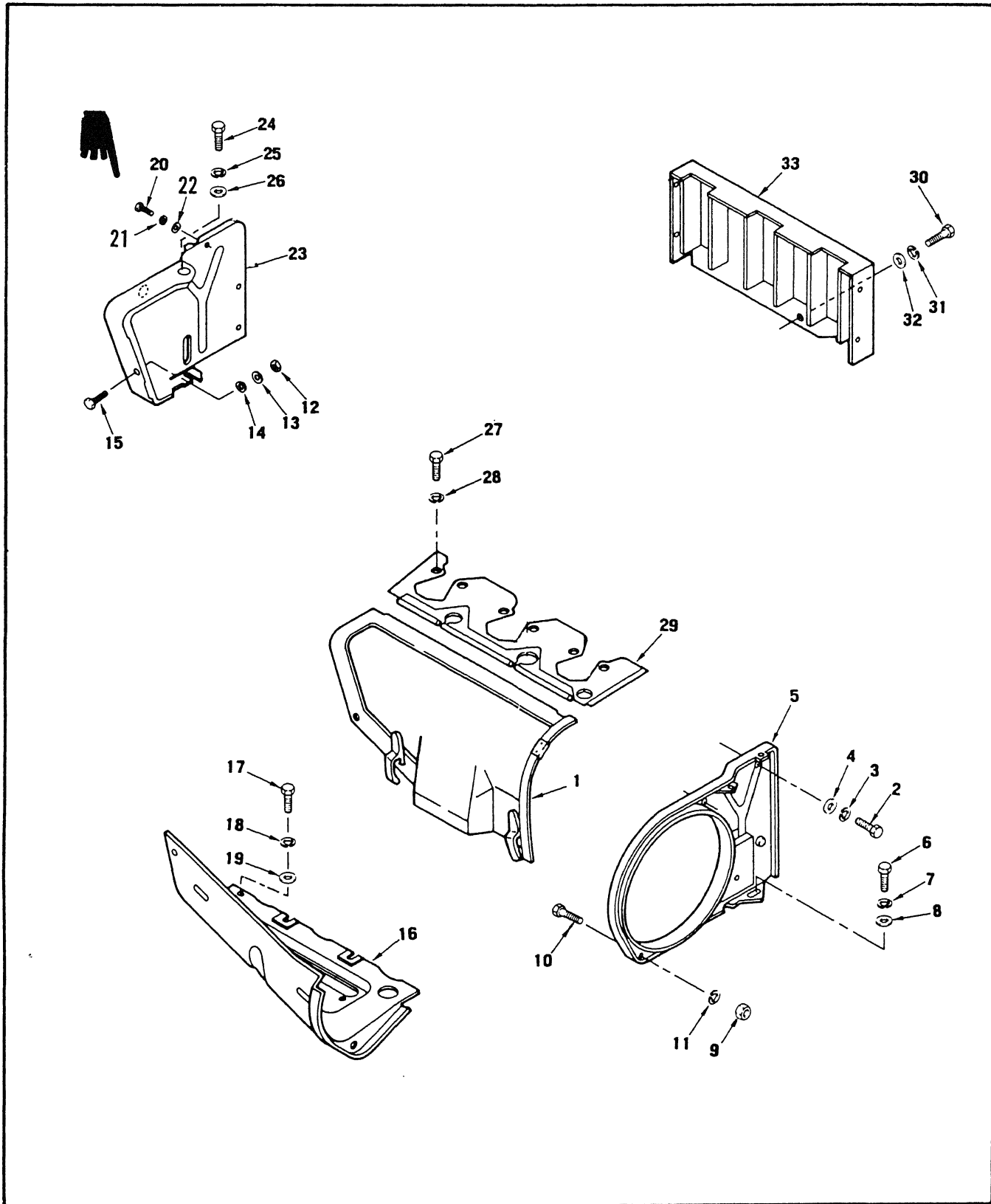
f. Repair. Repair consists of replacing parts found defective during inspection.

g. Assembly (figure 5-50).

- (1) Perform work on clean work bench.
- (2) Use new bearings (7) and fill them with special high melting point bearing grease.
- (3) Install one bearing (7) into jacket (9) with enclosed side to front.
- (4) Insert bearing shaft (5) in bearing and slide bushing (8) on shaft.
- (5) Half-fill space between bushing and jacket wall with special high melting point bearing grease.
- (6) Press remaining bearing (7) into jacket (9) so that face opposite closed side seats against bushing (8).
- (7) Install circlip (6) into groove.
- (8) Install roller (4), with wide flange facing upwards, into jacket (9).
- (9) Mount V-belt pulley (3) on opposite side of roller (4) and insert bolt (2).
- (10) Install nut (1), finger-right.
- (11) Grip nut in a vice and, using angle-of-turn indicator, tighten and lock down bolt in accordance with Appendix F.

h. Installation (figure 5-49).

- (1) Align cooling fan (10) to mounting holes, and install washers (9) and bolts (8).
- (2) Install bolt (7), washers (6 and 5), and nut (4).
- (3) Close air cowling (3) and fasten clips (2).
- (4) Install and properly adjust V-belt (1) (para 4-18).
- (5) Install V-belt guard (para 4-17).



Figurer 5-52. Engine Cowlings,Removal/Installation

- (8) Remove bolt (6), lockwasher (7) and flat washer (8) securing vertical cowling to engine.
 - (9) Remove nut (9), bolt (10) and lockwasher (11) securing vertical cowling to lower cowling.
 - (10) Remove forward vertical cowling (5).
 - (11) Remove nut (12), lockwasher (13), flat washer (14) and bolt (15) attaching lower cowling (16) to rear vertical cowling.
 - (12) Remove bolt (17), lockwasher (18), flat washer (19), and lower cowling (16).
 - (13) Remove three bolts (20), lockwashers (21) and flat washers (22) from rear vertical cowling (23).
 - (14) Remove bolt (24), lockwasher (25), flat washer (26) and rear vertical cowling (23).
 - (15) Remove five bolts (27) with lockwashers (28) and cylinder cowling (29).
 - (16) Remove two bolts (30) with lockwasher (31), flat washers (32) and exhaust cowling (33).
- b. Inspection. Inspect engine cowlings for obvious damage. Replace damaged cowlings.
- c. Installation
- (1) Position exhaust cowl (33) in place on engine and install two bolts (30) with flat washers (32) and lockwashers (31).
 - (2) Place cylinder cowling (29) on engine and secure with five bolts (27) and lockwashers (28).
 - (3) Place rear vertical cowling (23) in place on engine and install bolt (24), lockwasher (25) and flat washer (26).
 - (4) Install three bolts (20), lockwashers (21) and flat washers (22) to rear vertical cowling (23).
 - (5) Position lower cowling (16) in place and install bolt (17), lockwasher (18) and flat washer (19).
 - (6) Install bolt (15), lockwasher (14), flat washer (13), and nut (12) attaching lower cowling (16) to rear vertical cowling.

- (7) Position forward vertical cowling (5) in place and secure with bolt (10), lockwasher (11) and nut (9).
- (8) Install bolt (6), lockwasher (7) and flat washer (8) attaching forward vertical cowling to engine.
- (9) Install three bolts (2), lockwashers (3) and flat washers (4).
- (10) Install engine lifting eyes.
- (11) Install oil cooler. (para 4-51)
- (12) Install cooling fan. (para 5-14)
- (13) Install muffler. (para 4-4)
- (14) Install fuel, overflow and manifold lines. (para 4-26)
- (15) Install upper cowling (1).

5-17. CYLINDER HEAD.

a. Removal.

- (1) Remove injection nozzle. (para 4-37c)
- (2) Remove intake manifold and muffler. (para 5-15).
- (3) Remove engine cowlings. (para 5-16)
- (4) Remove rocker cover bolt (1, figure 5-53) and washers (2) and (3).
- (5) Remove rocker cover (4) and gasket (5).
- (6) Remove three nuts (6), lockwashers (7), flat washers (8) and rocker arm assembly (9).
- (7) Remove two pushrods (10) from cylinder head.
- (8) Remove two cover plugs (11) and gaskets (12).
- (9) Remove four head bolts (1, figure 5-54) and washers (2).
- (10) Slowly lift cylinder head (3) from cylinder while keeping cover tubes steady; then remove the two tube assemblies.
- (11) Remove washer (1, figure 5-55), tube (2), spring (3), cap (4), and washer (5) from each cover tube assembly.
- (12) Remove intermediate ring (4, figure 5-54).

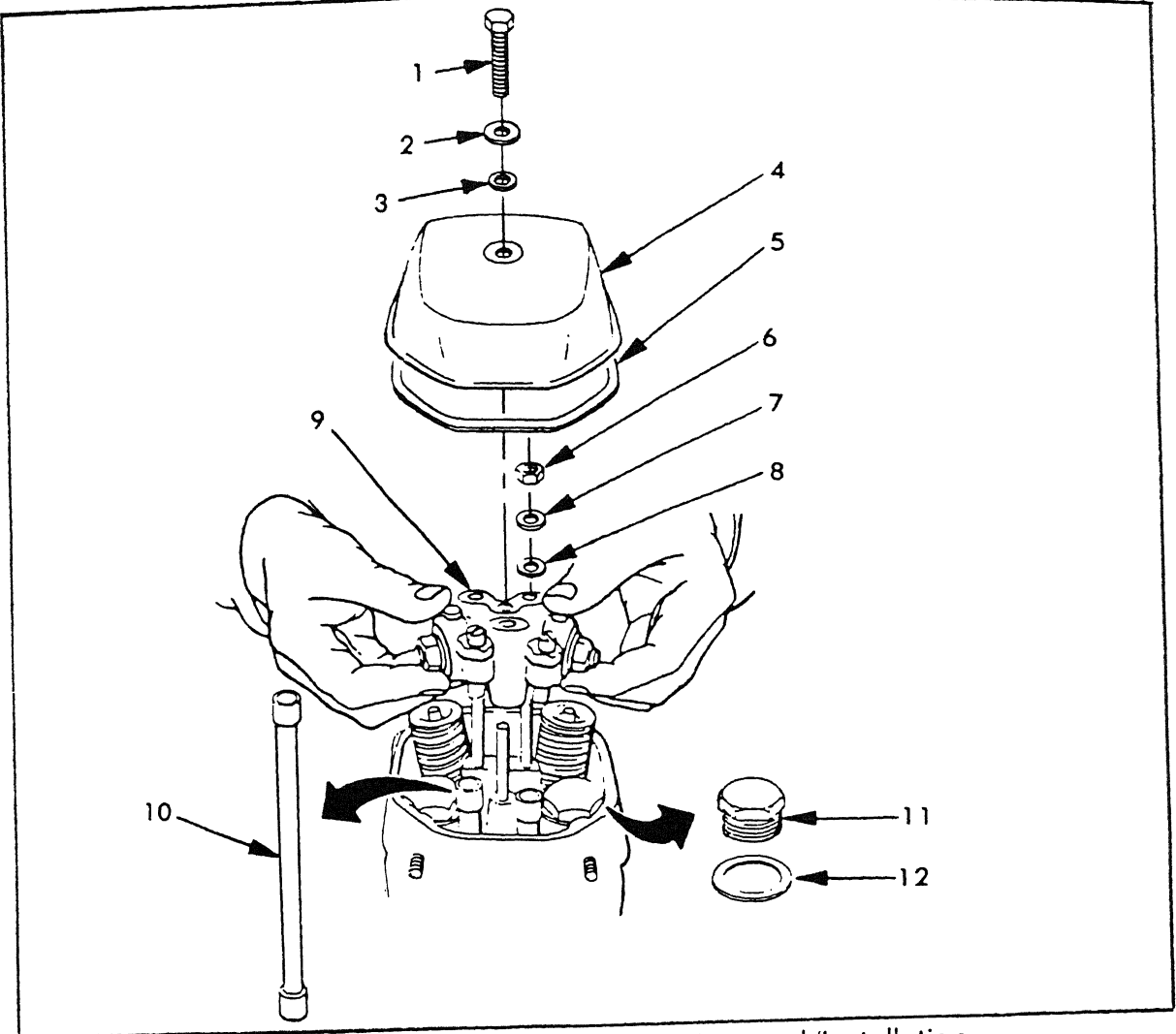


Figure 5-53. Cylinder Head Components, Removal/Installation

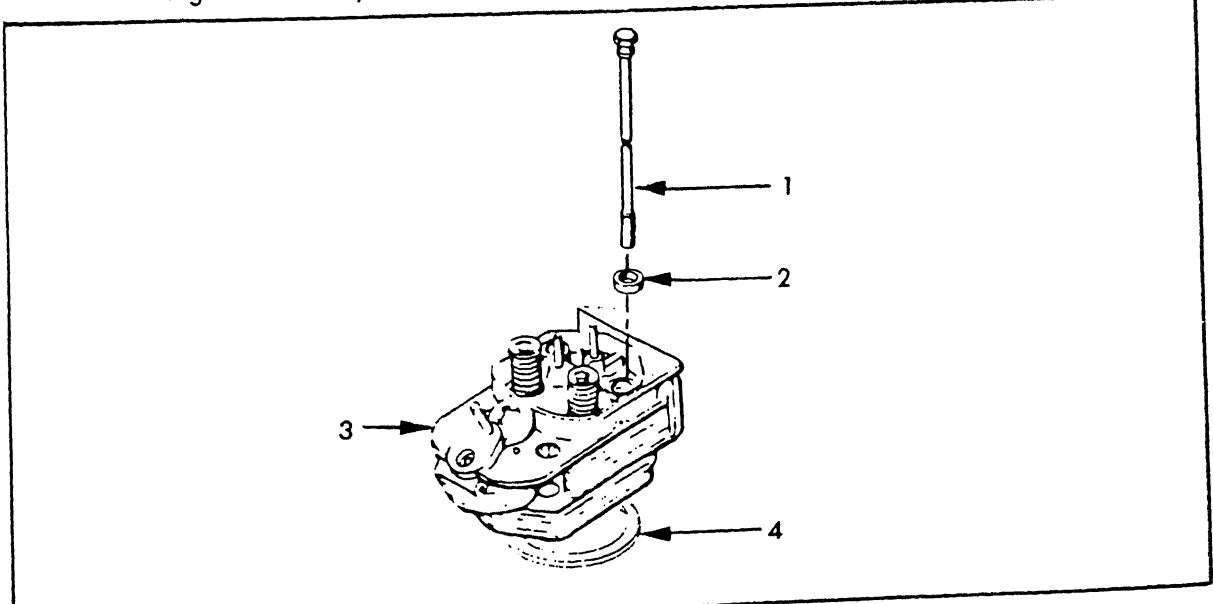


Figure 5-54. Cylinder Head, Removal/Installation

b. Installation.

- (1) Make sure cylinders are aligned.
- (2) Coat a piece of 2mm resin core solder with grease and place it in position on piston crown at right-angles to center line of engine, as shown in figure 5-56, but not on any stenciling on piston.

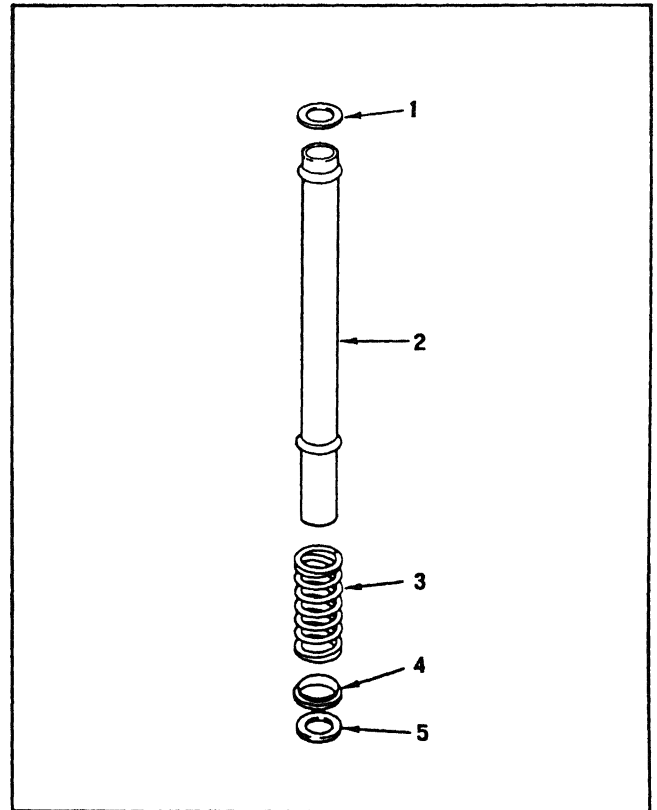


Figure 5-55. Pushrod Cover Tube, Assembly/Disassembly

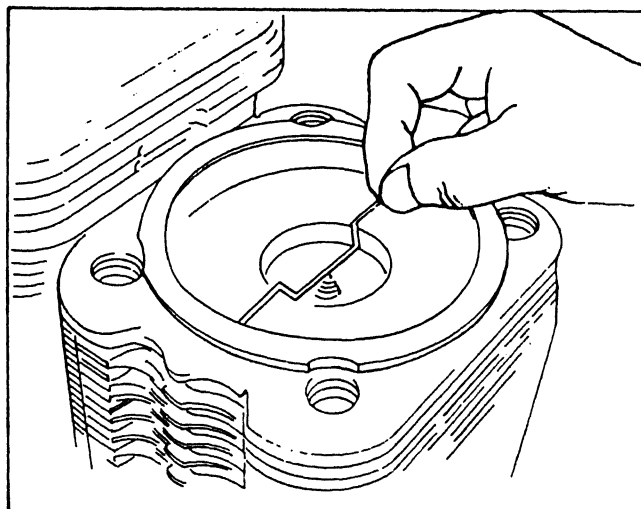


Figure 5-56. Checking Piston To Cylinder Head Clearance

- (3) Measure length of each cylinder head bolt (1, figure 5-54).

NOTE

Bolts must be between 8.440 to 8.480 inches (211 to 212mm). Replace bolts that have stretched beyond these limits.

- (4) With piston positioned a little before top dead center (BTDC), install intermediate ring (4), and place cylinder head (3) on cylinder. Install washers (2) and head bolts (1) but only slightly tighten head bolts.
- (5) Align inlet and exhaust flanges of cylinder heads, using a bar with straight edge as shown in figure 5-57.

NOTE

Use care in order not to disturb alignment of cylinders.

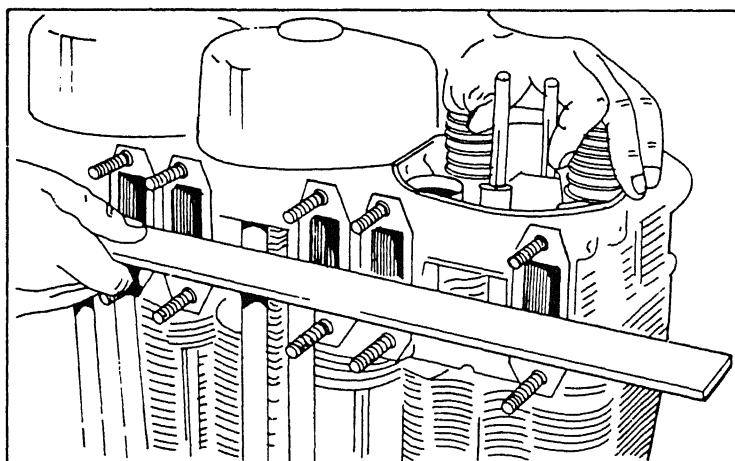


Figure 5-57. Aligning Cylinder Heads

- (6) Using torque wrench and angle-of-turn indicator, tighten head bolts in sequence as shown in figure 5-58 and in accordance with Table F-1 through first stage 45° angle.
- (7) Turn crankshaft through 360° in direction of engine rotation.

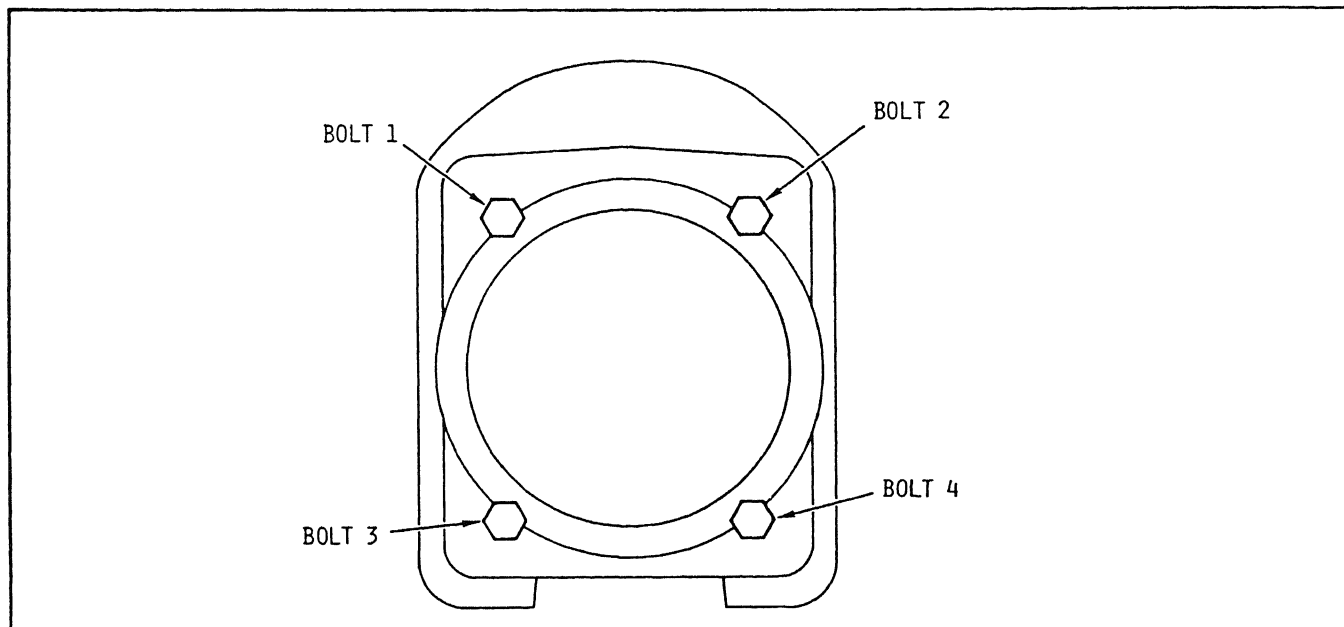


Figure 5-58. Cylinder Head Torquing Sequence

- (8) Remove cylinder head, and measure the thickness of the resin core solder at its smallest point.

NOTE

The average thickness must be between .040 and .048 inch (1.0 and 1.2mm). Shim combinations at base of cylinder adjusts this clearance.

- (9) Install cylinder head, four head bolts and washers.
- (10) Tighten head bolts in sequence as shown in figure 5-58 and in accordance with Table F-1.
- (11) Install the cover plugs (11, figure 5-53) with new gaskets (12) and torque plugs according to Appendix F.
- (12) Using spring tensioning tool, assemble and compress spring (3, figure 5-55) on pushrod cover tube.
- (13) Assemble cap (4) with open side towards spring.
- (14) Install a new washer (5), with wide end face toward end of tube (2).
- (15) Install a new washer (1), with wide end face toward upper shoulder on tube.
- (16) Insert spring end of cover tube in crankcase hole. Position upper end of cover tube with cone in cylinder head.
- (17) Slowly remove spring tensioning tool while guiding upper end of tube into cylinder head.

- (18) Repeat steps (12) through (17) for the other tube assembly.
- (19) Check that upper and lower cover tube washers are properly seated.
- (20) Install push rods (10, figure 5-53) with cup ends up.
- (21) Install rocker arm assembly (9) with flatwashers (8), lockwashers (7) and nuts (6).
- (22) Adjust valve clearance (See para 4-36).

NOTE

Insure that old gasket material is removed from cylinder head and rocker cover.

- (23) Install new rocker cover gasket (5) using gasket sealer.
- (24) Install rocker cover (4) with bolt (1) and washers (2) and (3).
- (25) Install engine cowlings. (para 5-16)
- (26) Install intake manifold and muffler. (para 5-15)
- (27) Install fuel injection nozzle (para 4-37q), feed lines, overflow lines, and manifold lines (para 4-26).
- (28) Bleed fuel system. (para 4-26d.)
- (29) Operate engine and check for leaks and proper operation.

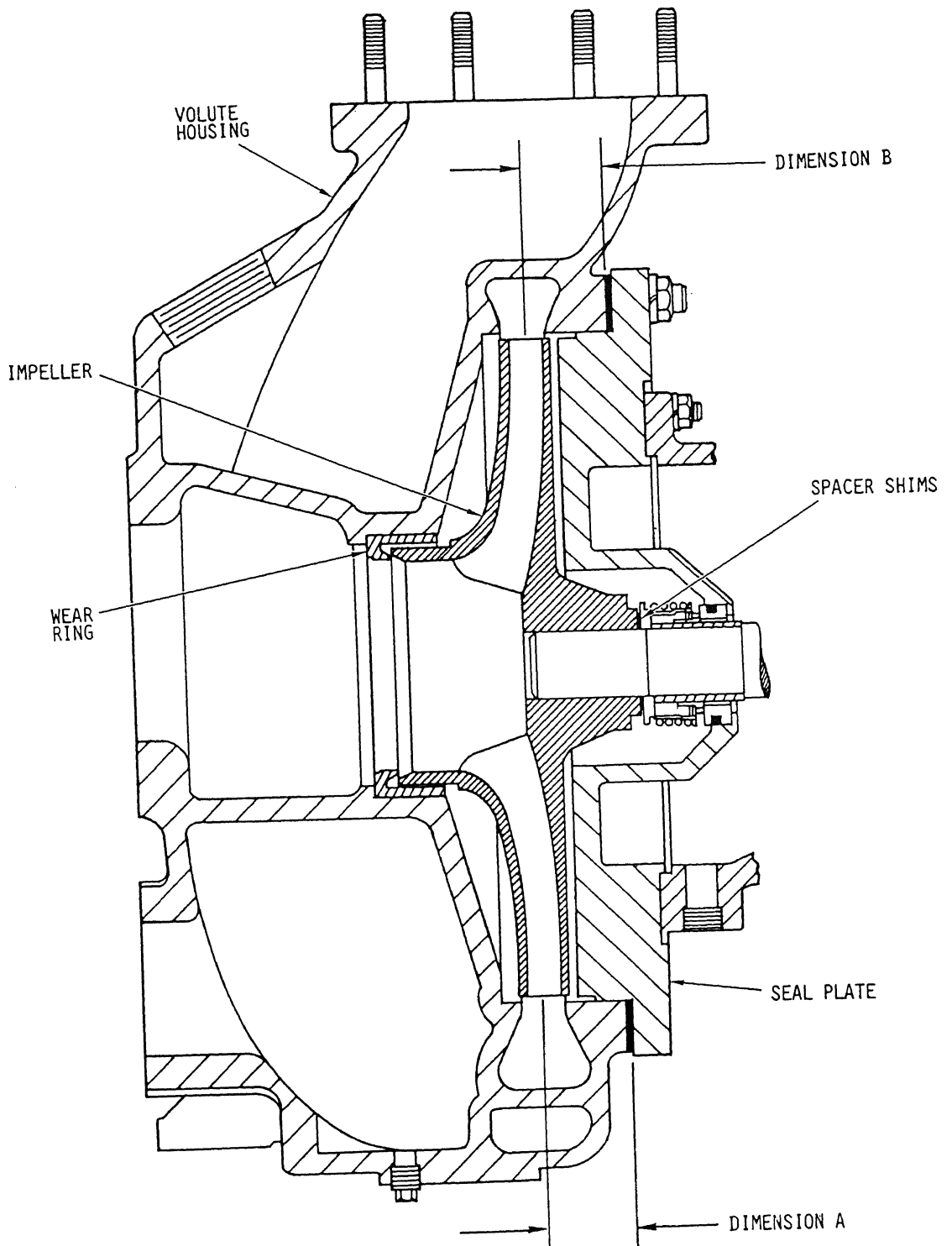


Figure 5-66. Determining Pump Spacer Shim Thickness

5-21. COUPLING FLANGE.

a. Removal.

- (1) Remove pump assembly (para 5-19).
- (2) Remove bolts (1, figure 5-67) and lockwashers (2) from coupling flange (3).

b. Inspection. Inspect for obvious damage and excessive wear. Replace defective coupling flange.

c. Installation.

- (1) Position coupling flange (3, figure 5-67) in place on engine flywheel and secure with bolts (1) and lockwashers (2).
- (2) Install pump assembly (para 5-19).

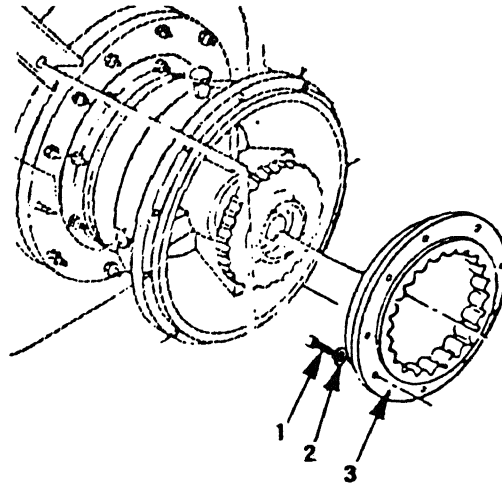


Figure 5-67. Coupling Flange, Removal/Installation

5-22. AXLE ASSEMBLY (figure 5-68).

a. Removal.

- (1) Raise unit clear of ground or floor and adequately support.
- (2) Adequately support axle assembly to prevent it from dropping when attaching hardware is removed.

WARNING

Coil springs under high tension. Never remove bolts securing top bracket to base bracket.

- (3) Refer to paragraph 4-50 and remove wheel and tire.
- (4) Remove nuts (1), washers (2, 3, and 4), beveled washers (6) and screws (5).
- (5) Axle assembly (7) is now free from frame. Carefully remove axle assembly from supports and move free of frame.

b. Disassembly (figure 5-69).

(1) Lift frame.

- (a) Remove information plates (paragraph 4-55 e and f).
- (b) Remove nuts (1), washers (2) and bolts (3).
- (c) Remove nuts (4), washers (5) and bolts (6).
- (d) Remove braces (7).
- (e) Remove nuts (8), washers (9) and bolts (10).
- (f) Remove frame (11).

(2) Tool box.

- (a) Remove two ground cables (12) from tool box.
- (b) Remove nuts (13) washers (14) and (15), and bolts (16).
- (c) Remove tool box (17).

(3) Reflectors.

- (a) Remove nuts (18), washers (19), and bolts (20).
- (b) Remove reflectors (21).

(4) Towbar.

- (a) Remove retaining pin (22).
- (b) Remove anchor pin (23).
- (c) Remove towbar (24).

(5) Support legs.

- (a) Attach hoist to lift frame.
- (b) Place chocks at front and rear of both wheels.
- (c) Carefully tilt entire assembly rearward until enough clearance is attained to remove support legs.
- (d) Remove retaining pins (25).
- (e) While holding support legs, remove anchor pins (26).
- (f) Remove support legs (27).
- (g) Tilt entire pumping assembly forward onto two jackstands positioned directly behind support leg housings.

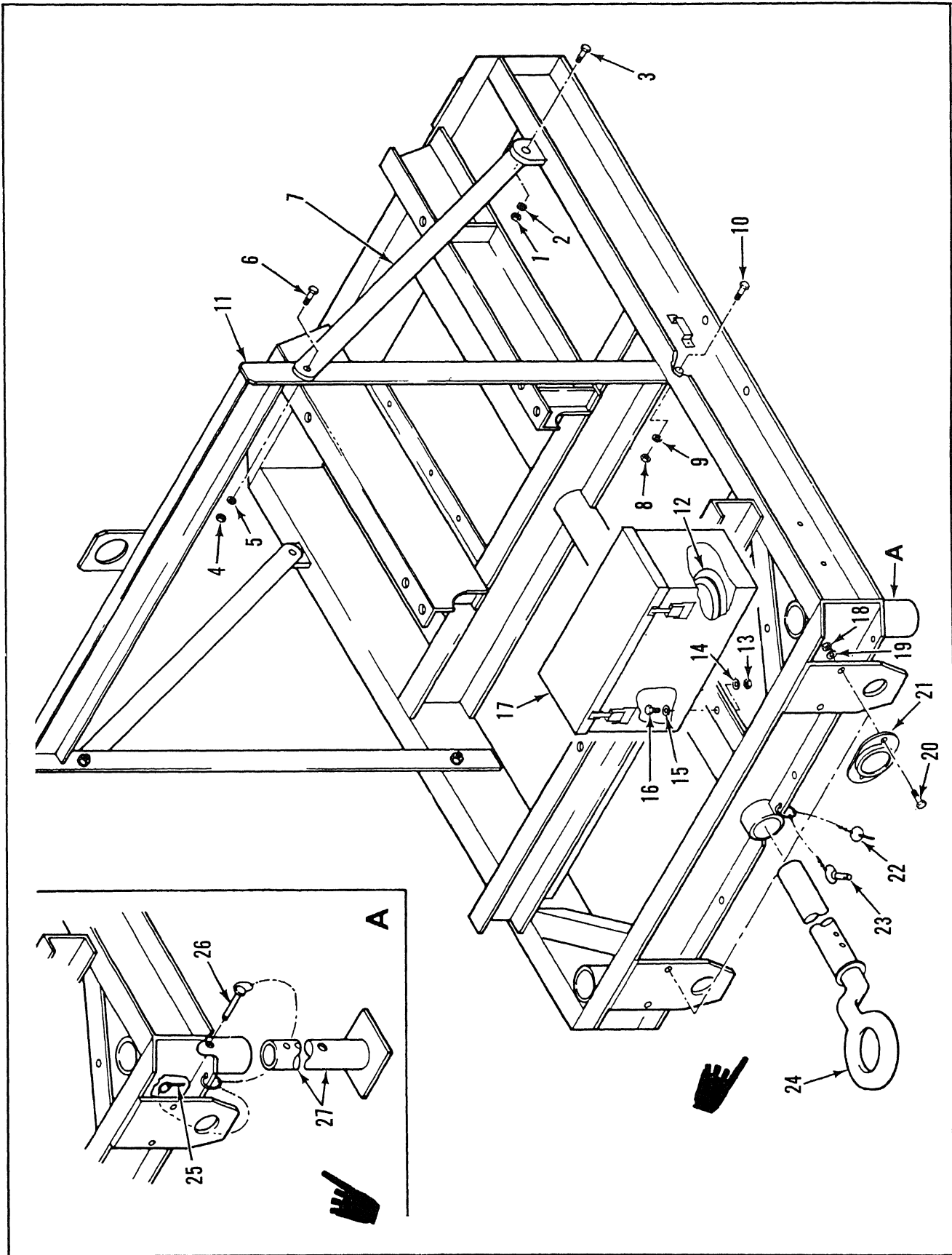


Figure 5-69. Frame Assembly. Assembly/Disassembly.

c. Cleaning.

CAUTION

Petroleum solvents are highly flammable. Keep solvent container lids closed when not in use, and avoid all possible risks of igniting solvent vapors, keep away from open flame and excessive heat. Flash point of solvent is 100 to 138 degrees F (38 to 59 degrees C).

- (1) Clean frame and braces with cloth moistened with solvent, Federal Specification P-D-680, Type II. Dry thoroughly.
- (2) Clean cables and tool box with cloth moistened with solvent, Federal Specification P-D-680, Type II. Dry thoroughly.
- (3) Wipe reflectors clean with soft cloth.
- (4) Clean support legs and towbar with water and detergent.

d. Inspection.

- (1) Inspect all welds for cracks.
- (2) Inspect ground cable clamps for looseness and tension loss.
- (3) Inspect ground cables wires for damage.
- (4) Inspect tool box latch halves for damage.
- (5) Check glass on reflectors for cracks and breaks.
- (6) Inspect support leg pad welds and towbar for cracks.
- (7) Inspect anchor pins and retaining pin chains for breaks.
- (8) Inspect pins for deformation or any other damage.

e. Repair.

- (1) Reweld cracks in lift frame in accordance with Weldment Requirements for Plain Carbon Steel. Class 1, Type 4 instructions apply.
- (2) Replace ground cable clamps if defective.
- (3) Replace ground cable if wires are defective.
- (4) Repair cracks in tool box welds in accordance with Weldment Requirements for Plain Carbon Steel. Class 2, Type 4 instructions apply.
- (5) Replace tool box latch halves if defective by drilling out rivets and attaching with new rivets.
- (6) Replace reflector if defective.

- (7) Reweld cracks in support leg pad and towbar in accordance with Weldment Requirements for Plain Carbon Steel. Class 1, Type 4 instructions apply.
 - (8) Replace anchor pin and retaining pin chains if defective.
 - (9) Replace pins if defective.
 - (10) Straighten all bent, twisted or dented frame members using conventional repair methods.
 - (11) Reweld cracks in frame in accordance with Weldment Requirements for Plain Carbon Steel. Class 1, Type 4 instructions apply.
- f. Assembly (figure 5-69).
- (1) Lift frame.
 - (a) Position lift frame (11) and secure with bolts (10), washers (9) and nuts (8).
 - (b) Attach braces (7) to lift frame with bolts (6), washers (5) and nuts (4).
 - (c) Attach braces to frame with bolts (3), washers (2) and nuts (1).
 - (d) Install information plates (paragraph 4-55 e and f).
 - (2) Tool box.
 - (a) Align tool box mount holes and secure box (17) with bolts (16), washers (15) and (14), and nuts (13).
 - (b) Place ground cables (12) in box and latch lid.
 - (3) Reflectors.
 - (a) Attach reflector (21) with bolts (20) washers (19) and nuts (18).
 - (b) Clean glass with soft cloth.
 - (4) Towbar.
 - (a) Install towbar (24) and align anchor pin holes.
 - (b) Insert anchor pin (23).
 - (c) Install retaining pin (22).
 - (5) Support legs.
 - (a) Attach hoist to lift frame.
 - (b) Place chocks at front and rear of both wheels.

- (c) Carefully tilt entire assembly rearward until enough clearance is attained to install support legs.
- (d) Remove jackstands from behind support leg housings.
- (e) Position support legs (27) and align anchor pin holes.
- (f) While holding support legs (27), insert anchor pins (26).
- (g) Install retaining pins (25).
- (h) Lower assembly until support legs (27) are fully down. Remove hoist from lift frame.
- (i) Remove chocks from front and rear of both wheels.

g. Installation. Install fuel tank (para 5-8) and axle assembly (para 5-22).

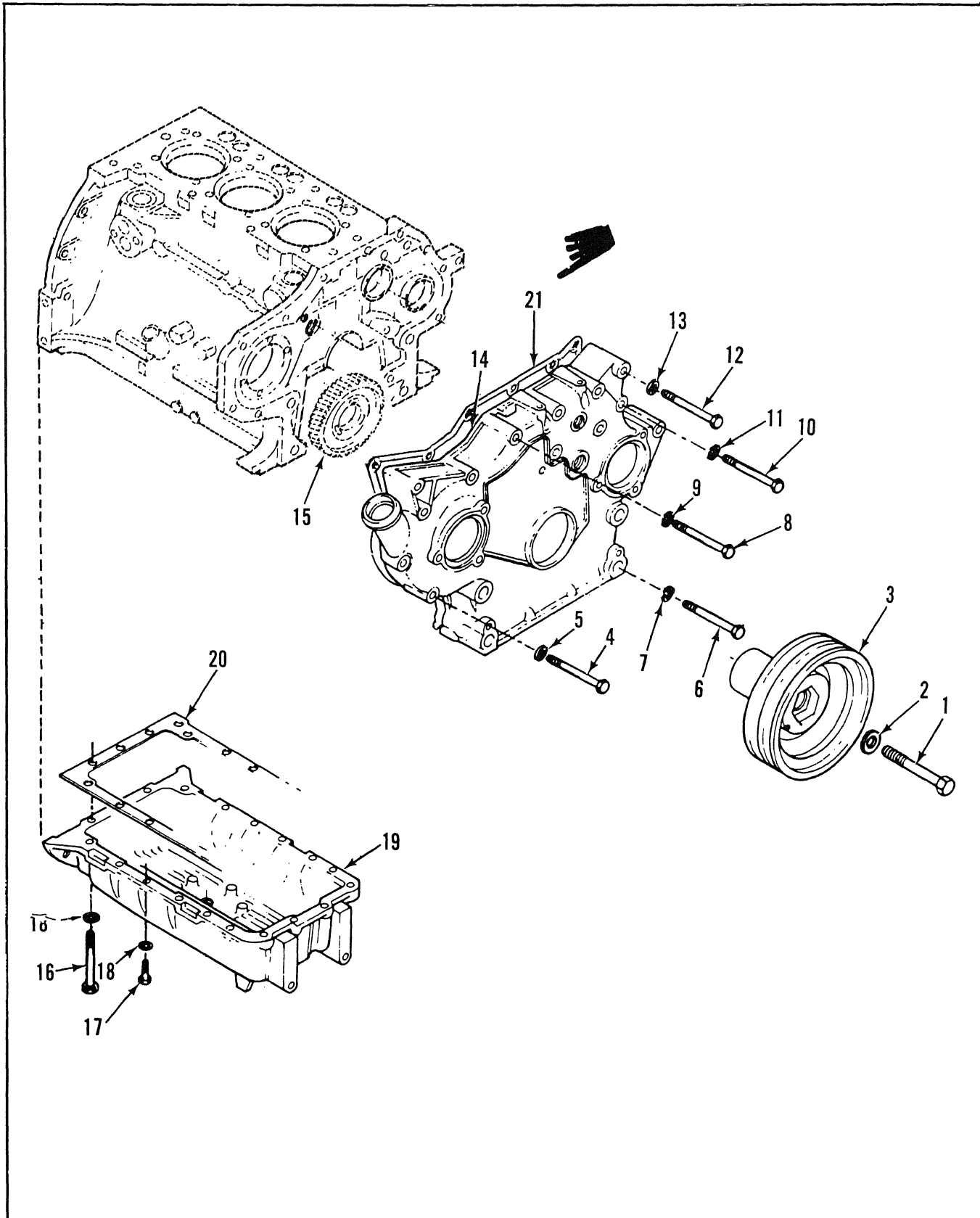


Figure 6-1. V-Belt Pulley, Front Cover and Oil Sump, Removal/ Installation.

- (15) Remove bolts (4), washers (5), bolts (6), washers (7), bolts (8), washers (9), bolts (10), washers (11), bolts (12), washers (13), front cover (14), gear (15) and gasket (21).
- (16) Carefully rotate engine over on injection pump side.
- (17) Remove bolts (16) and (17), washers (18), oil sump (19) and gasket (20).
- (18) Remove breather pipe (1, figure 6-2).
- (19) Remove nut (4), washer (5) and bolt (6).
- (20) Remove pipe nut (7), ferrule (8) and suction pipe (9).
- (21) Remove two bolts (10), lockwashers (11), shield (12) and oil pump (13).
- (22) Remove tube (2) and seal (3).
- (23) Remove capscrew (14) and idler gear (15).
- (24) Remove cylinders (16) and shims (17).

NOTE

Mark connecting rod caps and
corresponding connecting
rods.

- (25) Remove connecting rod bolts (1, figure 6-3) and connecting rod caps (2).
- (26) Remove connecting rods and pistons (18, figure 6-2).
- (27) Carefully remove camshaft (1, figure 6-4), washer (2) and valve tappets (3).
- (28) Remove bolts (4) and flywheel (5), if ring gear (6) needs to be replaced, cut through it with a hard chisel and remove it.

NOTE

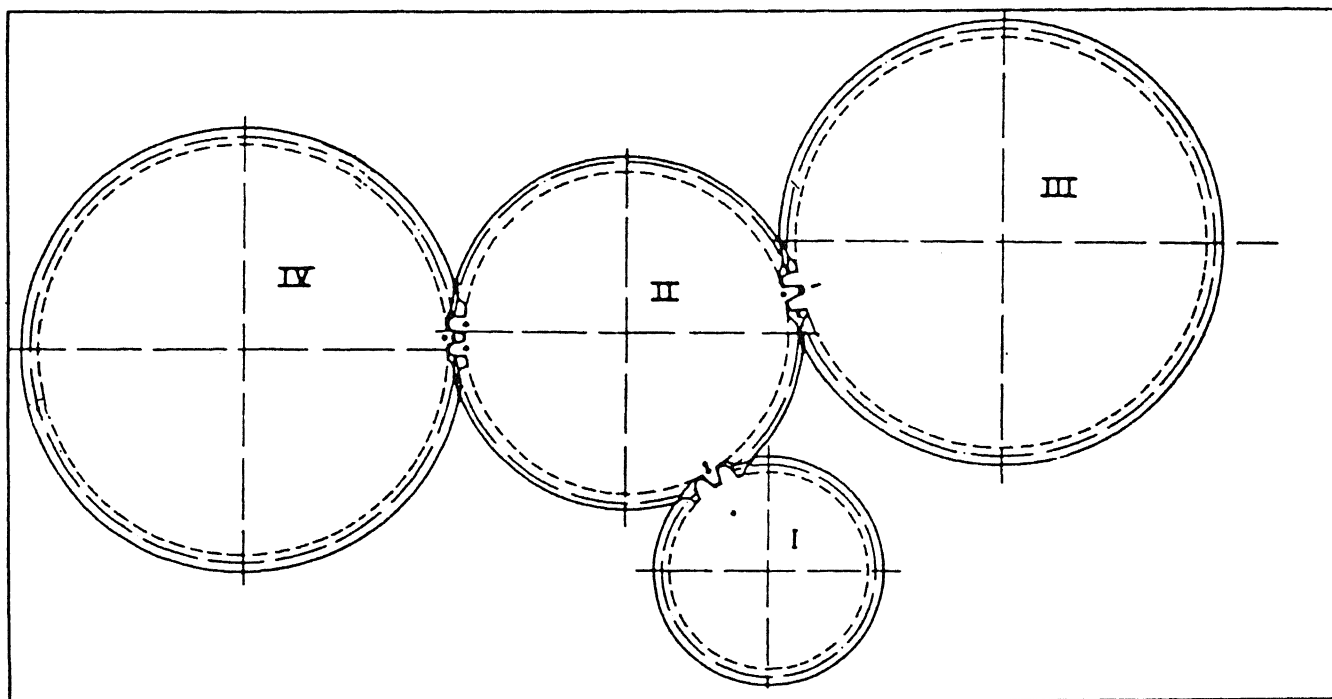
Identify main bearing caps,
mark for location.

- (29) Remove bolts (7), washers (8) and bearing caps (9) and (10).

NOTE

Mark bearing halves on back
corresponding with crank-
shaft and bearing caps.

- (30) Remove crankshaft (11) and bearing halves (12).



- I — Crankshaft gear
- II — Idler gear
- III — Camshaft gear
- IV — Injection pump gear

Figure 6-15. Timing Gears Layout With Match Marks

- (23) Install oil sump (19, figure 6-1) and gasket (20) with bolts (16), (17) and washers (18).
- (24) Place gear (15) and gasket (21) inside of front cover (14) and install front cover with washers (13), bolts (12), washers (11), bolts (10), washers (9), bolts (8), washers (7), bolts (6), washers (5) and bolts (4). Position gear (15) with match mark as shown in figure 6-15.

NOTE

Bolt securing V-belt pulley has left hand threads.

- (25) Install V-belt pulley (3, figure 6-2) with washer (2) and bolt (1). Torque in accordance with Table F-1.
 - (26) Refer to paragraph 5-17, and install cylinder head.
 - (27) Refer to paragraph 5-16, and install engine cowlings.
 - (28) Refer to paragraph 5-11, and install injection pump.
 - (29) Refer to paragraph 5-9, and install idler pulley assembly.
 - (30) Refer to paragraph 5-14, and install cooling fan.
 - (31) Refer to paragraph 4-26, and install fuel lines, hoses and fittings.
 - (32) Refer to paragraph 4-25, and install shutdown solenoid.
 - (33) Refer to paragraph 4-22, and install V-belt contact switch.
 - (34) Refer to paragraph 4-20, and install alternator assembly.
 - (35) Refer to paragraph 4-21, and install starter assembly.
 - (36) Refer to paragraph 4-14, and install muffler.
 - (37) Refer to paragraph 5-15, and install intake manifold.
 - (38) Refer to paragraph 4-10, and install air cleaner.
- j. Installation. Refer to paragraph 5-13 and install engine.

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APPENDIX B

COMPONENTS OF END ITEMS AND BASIC ISSUE ITEMS LISTS

Section I. INTRODUCTION

B-1. SCOPE. This appendix lists components of end item and basic issue items for the Pumping Assembly to help inventory items required for safe and efficient operation.

B-2. GENERAL. The Components of End Item and Basic Issue Items are divided into the following sections:

a. Section II. Note applicable to this unit.

b. Section III. Basic Issue Items. These are the minimum essential items required to place the pumping assembly in operation and to operate it. BII must be with the pumping assembly during operation and whenever it is transferred between property accounts. The illustrations will assist you with hard-to-identify items. This manual is your authority to request/requisition replacement BII, based on TOE/MTDE authorization of the end item.

B-3. EXPLANATION OF COLUMNS. The following provides an explanation of columns found in the tabular listings:

a. Column (1) - Illustration Number (Illus Number). This column indicates the number of the illustration in which the item is shown.

b. Column (2) - National Stock Number. Indicates the national stock number assigned to the item and will be used for requisitioning purposes.

c. Column (3) - Description. Indicates the National Item name and, if required a minimum description to identify and locate the item. The last line for each item indicates the FSCM (in parentheses) followed by the part number.

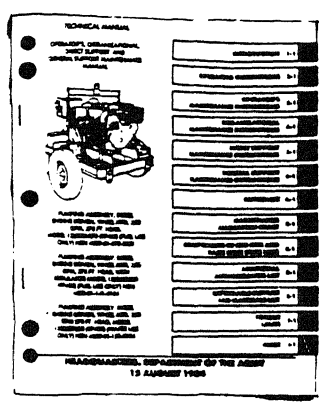
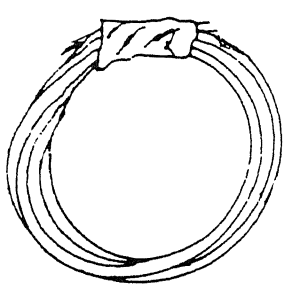
d. Column (4) - Unit of Measure (U/M). Indicates the measure used in performing the actual operational/maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in, pr).

e. Column (5) - Quantity required (Qty rqr). Indicates the quantity of the item authorized to be used with/on the equipment.

Section III. BASIC ISSUE ITEMS



2



3

NSN	Description FSCM & Part No.	Useable On Code	U/M	Qty. Req.
6150-01-197-6335	Cable Grounding (58541) 13220E1127	DCW, DRG	EA.	2
	Rod, Grounding (97403) 13220E1137	DCW, DRG	EA.	2
	Technical Manual TM-5-4320-226-14	DCW, DRG, DRH	EA.	1

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