TM 9-4940-568-34

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL

FOR

FORWARD REPAIR SYSTEM (FRS)

MODEL M7

NSN 4940-01-463-7940

DISTRIBUTION RESTRICTION
Approved for public release; distribution is unlimited.

HEADQUARTERS, DEPARTMENT OF THE ARMY
MARCH 2002

WARNING

Never exceed 110% of the given crane capacity for the actual radius. Failure to comply may result in damage to equipment and/or injury to personnel.

WARNING

Stay clear of test load when supported by crane. If test load fails, serious injury or death may result.

WARNING

Never disconnect any hydraulic hose or part while FRS is running. Allow several minutes for pressure to relieve itself. With FRS shut down, operate control valves fully in each direction to relieve trapped pressure.

WARNING

Before testing hydraulic system with a flow meter, always open the pressure control valve all the way by turning the knob counter clockwise to DECREASE. Failure to do so may cause hydraulic lines to burst, causing personal injury.

WARNING

When increasing hydraulic system pressure with the pressure control valve, always increase pressure slowly. If pressure is increased too fast, damage to hydraulic system or test set will result.

WARNING

Ensure engine is cool before performing this task or injury to personnel may result.

WARNING

Cylinder head weighs 80 lbs (36 kg). Attach suitable lifting device for removal and properly support cylinder head to prevent injury to personnel.

WARNING

Cylinder head weighs 80 lbs (36 kg). Attach suitable lifting device for installation and properly support cylinder head to prevent injury to personnel.

WARNING

Fuel is very flammable and can explode easily. To avoid serious injury or death, keep fuel away from open fire and keep fire extinguisher within easy reach when working with fuel. Do not work on fuel system when engine is hot. Fuel can be ignited by hot engine.

WARNING

The hydraulic system operates at high pressures. Never disconnect any hydraulic line or fitting without first, crane stowed with no load at zero pressure. Failure to comply may result in serious injury or death to personnel.

WARNING

Personnel hearing can be PERMANENTLY DAMAGED if exposed to constant high noise levels of 85 DBA or greater. Wear approved hearing protection devices when working in high noise level areas. Personnel exposed to high noise levels shall participate in a hearing observation program in accordance with TB MED 501. Hearing loss occurs gradually but becomes permanent over time.

WARNING

Storage rack weighs approximately 300 lbs (136 kg). Attach suitable lifting device to prevent possible injury to personnel.

WARNING

Generator set housing weighs approximately 200 lbs (65 kg). Attach suitable lifting device to prevent possible injury to personnel.

WARNING

Generator set enclosure weighs approximately 2450 lbs (1111 kg). Attach suitable lifting device to prevent possible injury to personnel.

WARNING

Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

WARNING

Starting fluid is toxic and highly flammable. Container is pressurized. NEVER heat container and NEVER discharge starting fluid in confined areas or near open flame. Severe injury to personnel may result.

WARNING

Generator control housing weighs approximately 75 lbs (34 kg). Use an assistant to help remove generator control housing or possible injury to personnel may result.

WARNING

Generator weighs 550 lbs (249 kg). Attach suitable lifting device for removal and properly support generator to prevent possible injury to personnel.

WARNING

Support engine prior to removal of generator to prevent possible injury to personnel.

WARNING

Accidental starting of the generator set while working on it can cause severe personal injury or death. Prevent accidental starting by disconnecting the starting battery cables (negative [–] first).

WARNING

Arcing can ignite the explosive hydrogen gas given off by batteries, causing severe personal injury. Arcing can occur if the negative (–) battery cable is connected and a tool being used to connect or disconnect the positive (+) battery cable accidentally touches the frame or other grounded metal part of the set. To prevent arcing, always remove the negative (–) cable first, and reconnect it last.

WARNING

Touching un-insulated high voltage parts inside the control and power output boxes can result in severe personal injury or death. Measurements and adjustments must be done with care to avoid touching high voltage parts.

WARNING

For your protection, stand on a dry wooden platform or rubber insulating mat, make sure your clothing and shoes are dry, remove jewelry and use tools with insulated handles.

WARNING

Radiator assembly weighs approximately 50 lbs (23 kg). Use an assistant to help remove radiator assembly or possible injury to personnel may result.

WARNING

Engine weighs approximately 680 lbs (308 kg). Attach suitable lifting device to prevent possible injury to personnel.

WARNING

Keep out from under engine when lifting. If engine slips, sideways, or falls, serious injury or death may result.

WARNING

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc). Failure to comply may result in injury or death to personnel.

WARNING

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles, face shield, and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes, and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent. The flashpoint for Type II Drycleaning Solvent is 140 degrees F (60 degrees C) and Type III Drycleaning Solvent is 200 degrees F (93 degrees C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.

WARNING

The flywheel housing weighs approximately 50 lbs (23 kg). Attach suitable lifting device to prevent possible injury to personnel.

WARNING

Wear eye protection when driving the ring gear from flywheel. Serious injury may result from flying metal fragments. Do not use a steel drift pin.

WARNING

Wear protective gloves when installing ring gear. Failure to comply may result in injury to personnel.

WARNING

Keep fingers and tools away from opening in drive end housing while testing. The strong shifting action of the solenoid could cause personal injury as the drive pinion moves into the cranking position and spins. Failure to comply may cause injury to personnel.

WARNING

The crane hydraulic system operates at oil pressures up to 3,500 psi (24,132 kPa). Never disconnect any hydraulic line or fitting without first crane stowed with no load at zero pressure. Failure to comply may result in serious injury or death to personnel.

WARNING

Crane assembly weighs approximately 5,700 lbs (2,586 kg). Attach suitable lifting device to prevent possible injury to personnel.

WARNING

Do not stand under crane. Mechanical failure and operator error can cause injury or death to personnel.

WARNING

Hydraulics may be under pressure and can spurt out when lines are disconnected. Crack all lines slowly and keep your face clear of lines.

WARNING

Be sure to wear safety glasses when servicing hydraulic system.

WARNING

Outrigger beams are heavy and coated with grease. Use extreme care to avoid personal injury.

WARNING

Unsafe welding practices can cause serious injury from fire, explosions, or harmful agents. Allow only authorized personnel to weld or cut metals, and follow safety precautions in TM 9-237. Protective clothing and goggles must be worn; adequate protective equipment used, a suitable fire extinguisher kept nearby; and requirements of TM 9-237 strictly followed.

WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

WARNING

Remove pivot shaft only far enough to release tension link cylinder and support tension link upon removal of pivot shaft. Failure to comply may result in injury to personnel or damage to equipment.

WARNING

Remove pivot shaft only far enough to release mast and support mast upon removal of pivot shaft. Failure to comply may result in injury to personnel or damage to equipment.

WARNING

Lift cylinders must be supported to install pivot shaft. Failure to comply may result in injury to personnel or damage to equipment.

WARNING

Remove pivot shaft only far enough to release tension link cylinder and erection cylinder. Failure to comply may result in injury to personnel or damage to equipment.

WARNING

Remove pivot shaft only far enough to release tension link. Failure to comply may result in injury to personnel or damage to equipment.

WARNING

Use care when removing springs. Springs are under tension and can act as projectiles when released. Failure to comply may result in injury to personnel.

WARNING

The FRS hydraulic system operates at oil pressure up to 3,500 psi (24, 132 kPa). Never disconnect any hydraulic line or fitting without first dropping the pressure to zero. Failure to comply may result in serious injury or death to personnel.

WARNING

Remove pivot shaft far enough to release RH tension link cylinder. Ensure that tension cylinder is properly supported. Failure to comply may result in injury to personnel or damage to equipment.

WARNING

Remove pivot shaft far enough to release mast. Ensure that mast is properly supported. Failure to comply may result in injury to personnel or damage to equipment.

WARNING

Lift cylinders must be supported to remove pivot shafts. Failure to comply may result in injury to personnel or damage to equipment.

WARNING

When loads are applied to boom cable all personnel must move to a safe distance. Failure to comply may result in injury to personnel.

WARNING

Wear appropriate eye protection when working under vehicle due to the possibility of falling debris. Failure to comply may result in injury to personnel.

WARNING

- Remove all jewelry such as rings, dog tags, bracelets, etc. If jewelry or tools contact positive electrical circuits a direct short may result. Damage to equipment, injury or death to personnel may result.
- Do not stand under crane. Mechanical failure and operator error can cause injury or death to personnel.

WARNING

CARC paint contains isocyanate (HDI) which is highly irritating to skin and respiratory system. High concentrations of HDI can produce symptoms of itching and reddening of skin, a burning sensation in throat and nose, and watering of the eyes. In extreme concentrations, HDI can cause cough, shortness of breath, pain during respiration, increased sputum production, and chest tightness. The following precautions must be taken whenever using CARC paint:

Never weld or cut CARC–coated materials.

WARNING

Wire rope can become frayed or contain broken wires. Wear heavy leather palmed work gloves when handling wire rope. Failure to comply may result in injury to personnel.

WARNING

The hydraulic system operates at high pressures. Never disconnect any hydraulic line or fitting without first dropping pressure to zero. Failure to comply may result in serious injury or death to personnel.

WARNING

Crankshaft weighs 80 lbs (36 kg). Attach a suitable lifting device prior to removal to prevent possible injury to personnel.

WARNING

Wear protective gloves when handling hot gear. SERIOUS INJURY may result if skin contacts hot gear.

WARNING

To prevent serious eye damage, wear eye protection during this operation.

WARNING

Use care when removing or installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released and could cause eye injury.

WARNING

Use extreme care when removing or installing spring retaining rings. Spring retaining rings are under tension and can act as projectiles when released suddenly. Ensure proper eye protection is worn to prevent injury to personnel.

WARNING

Oil will spray from cylinder manifold ports when rod is moved in or out. Cover ports with two cloths to prevent oil from spraying. Failure to comply may result in injury to personnel.

WARNING

High pressure steam can blow particles into eyes, can cause severe burns, and creates hazardous noise levels. Eye, skin, and hearing protection is required.

WARNING

Use extreme care to avoid being scalded or burned when heating retaining head. Use heavy rag or gloves to protect hands.

WARNING

Use extreme care to avoid being scalded or burned when heating piston. Use heavy rag or gloves to protect hands.

WARNING

Use extreme care to avoid being scalded or burned when heating jack cylinder barrel. Use heavy rag or gloves to protect hands.

WARNING

Use care when removing retaining rings. Retaining rings are under tension and can act as projectiles when released. Failure to comply may result in injury to personnel.

WARNING

Cover is under pressure. Loosen capscrews equally when removing cover. Failure to comply may result in injury to personnel.

WARNING

CARC paint contains isocyanate (HDI) which is irritating to skin and respiratory system. High concentrations of HDI can produce symptoms of itching and reddening of skin, a burning sensation in throat and nose and watering of the eyes. In extreme concentrations, HDI can cause cough, shortness of breath, pain during respiration, increased sputum production, and chest tightness. The following precautions must be taken whenever using CARC paint:

- ALWAYS use air line respirators when using CARC paint unless air sampling shows exposure to be below standards. Use chemical cartridge respirator if air sampling is below standards.
- DO NOT let skin or eyes come in contact with CARC paint. Always wear protective equipment (gloves, ventilation mask, safety goggles, etc.).
- DO NOT use CARC paint without adequate ventilation.
- NEVER weld or cut CARC-coated materials.
- DO NOT grind or sand painted equipment without high-efficiency air purifying respirators in use.
- BE AWARE of CARC paint exposure symptoms; symptoms can occur a few days after initial exposure. Seek medical help immediately if symptoms are detected.

LIST OF EFFECTIVE PAGES Insert latest changed pages. Destroy superseded pages.

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Orginal ..... 0.....March 15, 2002

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 654 CONSISTING OF THE FOLLOWING:

Page No.	*Change No.	Page No.	*Change No.	Page No.	*Change No.
Title	0	D-8 Blank	0		
Blank	0	E-1 - E-7	0		
a - i	0	E-8 Blank	0		
j Blank	0	F-1 - F-3	0		
A	0	F-4 Blank	0		
B Blank	0	Index-1 - Index-3	0		
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TECHNICAL MANUAL **HEADQUARTERS**
DEPARTMENT OF THE ARMY
No. 9-4940-568-34 Washington, D.C. March 15, 2002

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL FOR FORWARD REPAIR SYSTEM (FRS)

Current as of 15 December 2000

REPORTING OF ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this publication. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Submit your DA Form 2028-2 (Recommended Changes to Equipment Technical Publications), through the Internet, on the Army Electronic Product Support (AEPS) website. The Internet address is http://aeps.ria.army.mil. If you need a password, scroll down and click on "ACCESS REQUEST FORM." The DA Form 2028 is located in the ONLINE FORMS PROCESSING section of the AEPS. Fill out the form and click on SUBMIT. Using this form on the AEPS will enable us to respond quicker to your comments and better manage the DA Form 2028 program. You may also mail, fax or email your letter, DA Form 2028, or DA Form 2028-2, directect to: Commander, U.S. Army Tank-automotive and Armaments Command, ATTN: AMSTA-LC-CIP-WT, Rock Island, IL 61299-7630. The email address is TACOM-TECH-PUBS@ria.army.mil. The fax number is DSN 793-0726 or Commercial (309) 782-0726.

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HOW TO USE THIS MANUAL

This manual is designed to help maintain the Forward Repair System (FRS). Listed below are some special features included in this manual to help locate and use the needed information:

- A front cover table of contents is provided for quick reference to chapters and sections that will be used often.
- WARNING, CAUTION, and NOTE headings, subject headings, and other essential information are printed in bold type making them easier to see.
- The maintenance tasks describe what must be done to the FRS before starting the task (Equipment Condition), and what must be done to return the system to operating condition after the task is finished (Follow-On Maintenance).
- The Appendices are located at the end of the manual. They contain a reference guide to other manuals, the Maintenance Allocation Chart (MAC), a list of expendable supplies and materials, and other material for maintaining the FRS.
- In addition to text, there are exploded-view illustrations showing how to take a component off and put it back on. Cleaning and inspection procedures are also included as required.
- Chapter 1 of this manual describes the FRS and provides equipment description.
- Chapter 2 of this manual covers Troubleshooting Procedures.
- Chapter 3 of this manual covers Direct Support Maintenance Instructions.
- Chapter 4 of this manual covers General Support Maintenance Instructions.

Follow these guidelines when using this manual:

- Read all WARNINGS and CAUTIONS before performing any procedure.
- The equipment conditions found in the maintenance procedures are of a general nature and the mechanic may be able to perform only certain steps within a procedure to accomplish the equipment condition.
- The FRS is used with PLS M1074/M1075 or LHS HEMTT trucks. PLS M1075 truck shown.

CHAPTER 1

INTRODUCTION

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Section I. GENERAL INFORMATION

1-1. SCOPE.

This chapter provides general information, equipment descriptions and principles of operation for the Forward Repair System (FRS).

a. Type of Manual. Direct and General Support maintenance manual, TM 9-4940-568-34.

b. Model Numbers and Equipment Names. Forward Repair System (FRS).

c. Purpose of Equipment. The purpose of FRS is to enable maintenance personnel to repair heavy equipment in the field or at a central location.

Figure 1-1. Forward Repair System

1-2. MAINTENANCE FORMS, RECORDS AND REPORTS.

Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA PAM 738-750, The Army Maintenance Management System (TAMMS) (Maintenance Management UPDATE).

1-3. DESTRUCTION OF ARMY MATERIAL TO PREVENT ENEMY USE.

Command decision, according to tactical situation, will determine when the destruction of the truck will be accomplished. A destruction plan will be prepared by the using organization unless one has been prepared by a higher authority. For general destruction procedures for this truck, refer to TM 750-244-6, Procedures for Destruction of Tank-Automotive Equipment to Prevent Enemy Use (US Army Tank-Automotive Command).

1-4. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR).

If your FRS needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design. Put it on an SF368 (Quality Deficiency Report). Mail it to us at: Commander, U.S. Army Tank-automotive and Armaments Command, ATTN: AMSTA-TR-E-PQDR; Warren, Michigan 48397-5000. We'll send you a reply.

1-5. CORROSION PREVENTION AND CONTROL (CPC).

The FRS has a total service life of ten years which allows for extended periods of operation in a corrosive environment. A corrosive environment includes exposure to high humidity, salt spray, road-deicing chemicals, gravel, and atmospheric contamination. No action beyond normal washing and repair of damaged areas is necessary to control corrosion. To prevent moisture accumulation, drain holes are provided on structural and sheet metal areas where necessary.

1-6. PREPARATION FOR STORAGE AND SHIPMENT.

Refer to TM 9-4940-568-20 for storage or shipment instructions on the FRS.

1-7. WARRANTY INFORMATION.

There is no warranty, as such, for the FRS "box". The government is procuring the hardware from itself (the prime contractor is a government agency). By law, the government cannot make warranty type claims against itself; however, Rock Island Arsenal (RIA) for the FRS guarantees that the deliverables are free from defects or systemic defects in materiel and workmanship. In addition, there are "pass through" warranties on the major FRS components, i.e., the air compressor, generator, welding equipment, and crane. The FRS will conform to the design and manufacturing requirements specifically delineated in the contract and all future modifications. The FRS will conform to the essential performance requirements as defined in the system specification. If, during normal system operations, a defect/failure of FRS "box" component occurs, the using unit will submit, to the RIA Major Item and Product Assurance managers, an SF 2407. RIA will replace the failed/damaged component. If a major component of the FRS (engine, air compressor, generator, welding equipment) fails during normal operations, upon notification of such failure, RIA will exercise the "pass through" warranty with the appropriate component contractor. How to process "pass through" warranty claims is currently being assessed. As stated above, the contractor will provide a hand-off warranty during all fieldings. Under this warranty, the contractor will be liable for the supply of components required to correct all failures from the time of system final acceptance up to and including hand-off to the user. The contractor will supply all repair parts required during deprocessing within seventy-two (72) hours after notification. The deprocessing team, not the contractor field technical representative, will perform all labor necessary to correct hand-off deficiencies.

1-8. LIST OF ABBREVIATIONS/ACRONYMS.

FRS	Forward Repair System
TDC	Top Dead Center
BDC	Bottom Dead Center

SECTION II. EQUIPMENT DESCRIPTION AND DATA

1-9. EQUIPMENT CHARACTERISTICS, CAPABILITIES AND FEATURES.

Refer to TM 9-4940-568-10 for equipment characteristics, capabilities and features.

1-10. LOCATION AND DESCRIPTION OF MAJOR COMPONENTS.

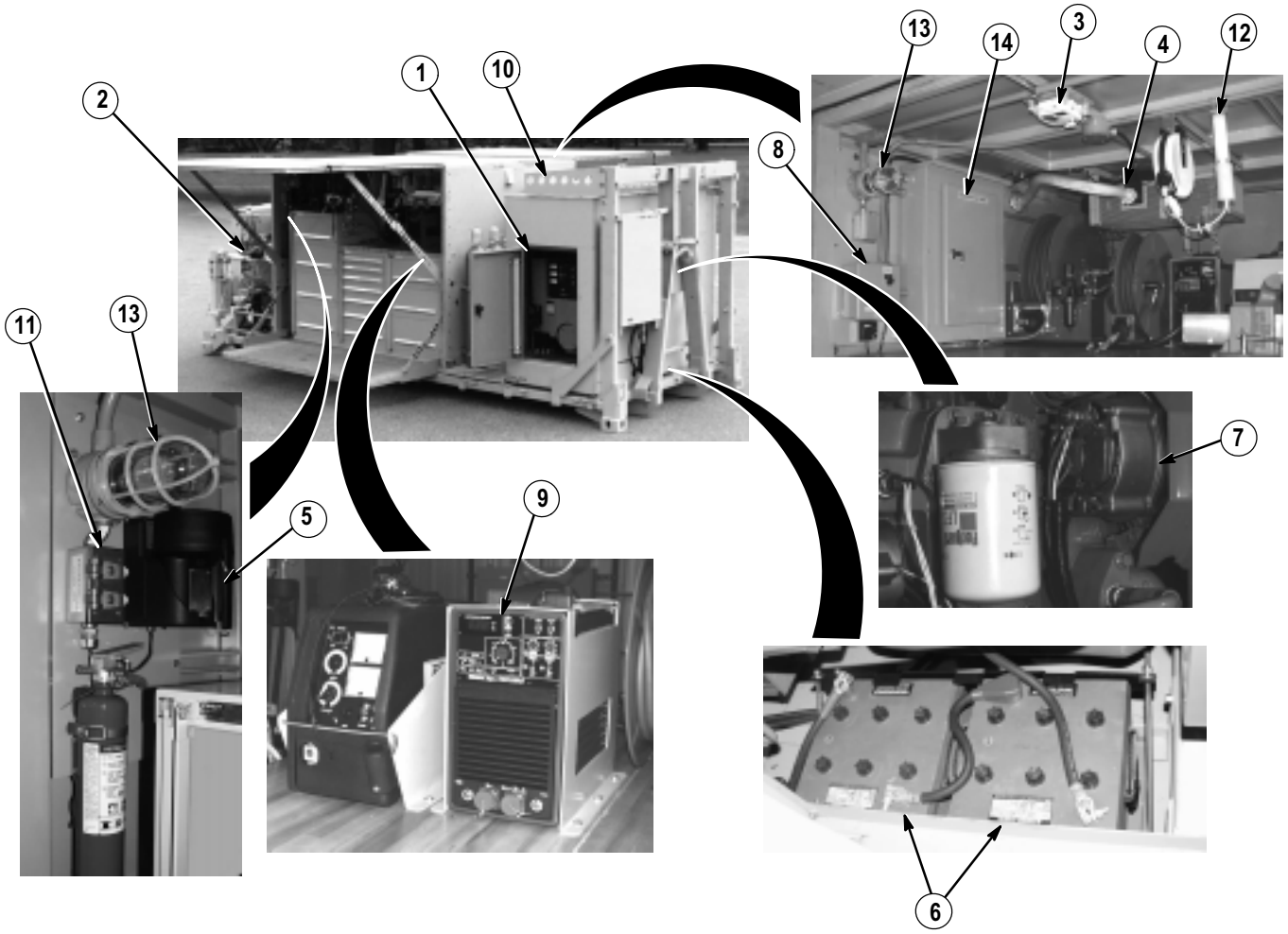
Refer to TM 9-4940-568-10 for location and description of major components.

Section III. PRINCIPLES OF OPERATION

1-11. SYSTEMS INTRODUCTION.

This section provides a basic explanation of major systems on the FRS. Detailed operation information is provided in TM 9-4940-568-20.

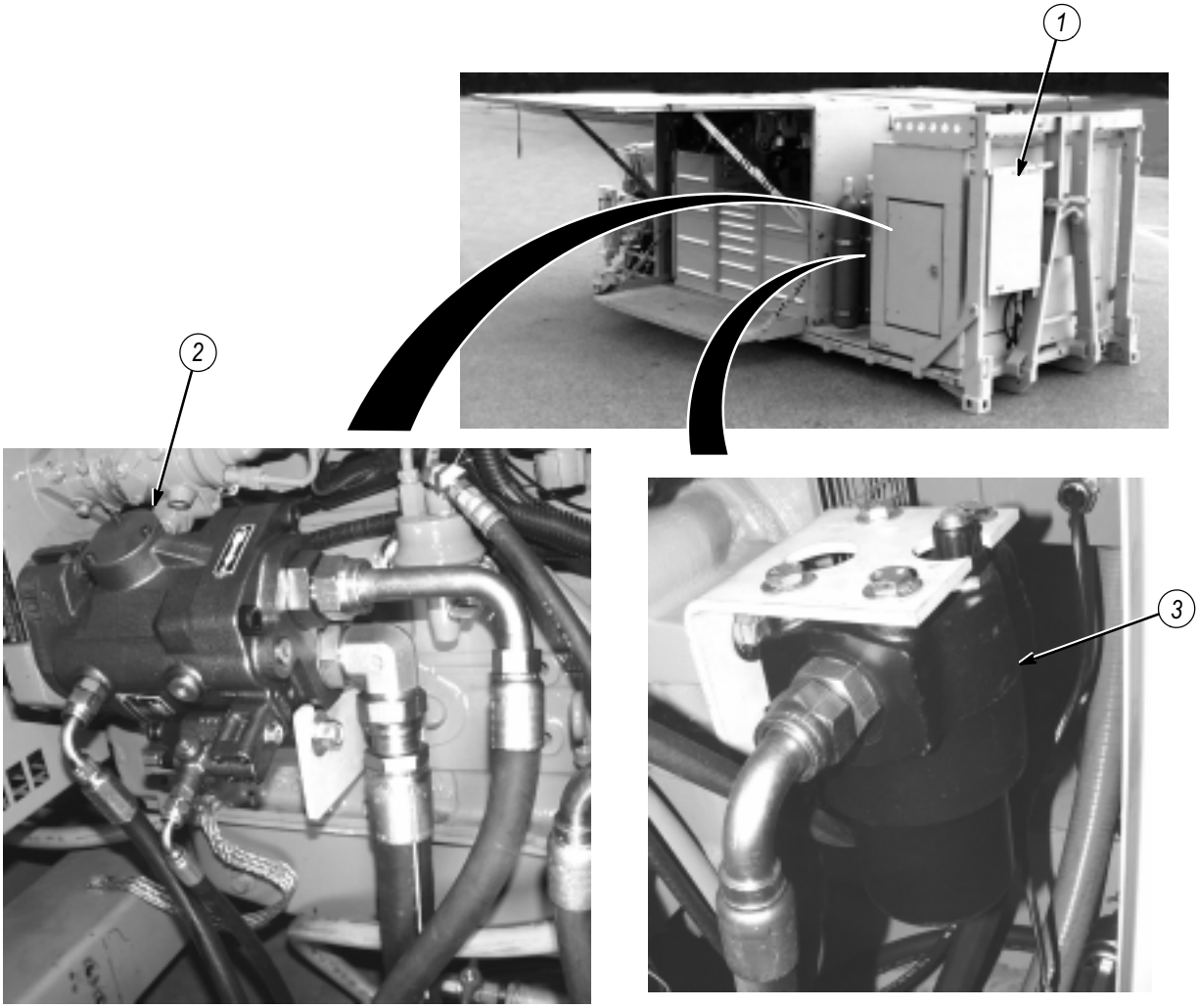
1-12. ELECTRICAL SYSTEM.



The electrical power for the FRS unit is provided by a 35KW Generator Set (1). The electrical system is composed of a 24VDC system and 120/208 AC system. The 24VDC system provides electrical current for the crane (2), domelights (3), heater (4) and portable flashlights (5). Electrical power for the 24VDC system is provided by two 12 volt series connected batteries (6). The alternator (7) on the engine of the generator set maintains battery charging and equipment operation. Manual resetting circuit breakers are used for the different systems. Circuit breakers are located in the 24VDC control panel (8) inside shelter of the FRS.

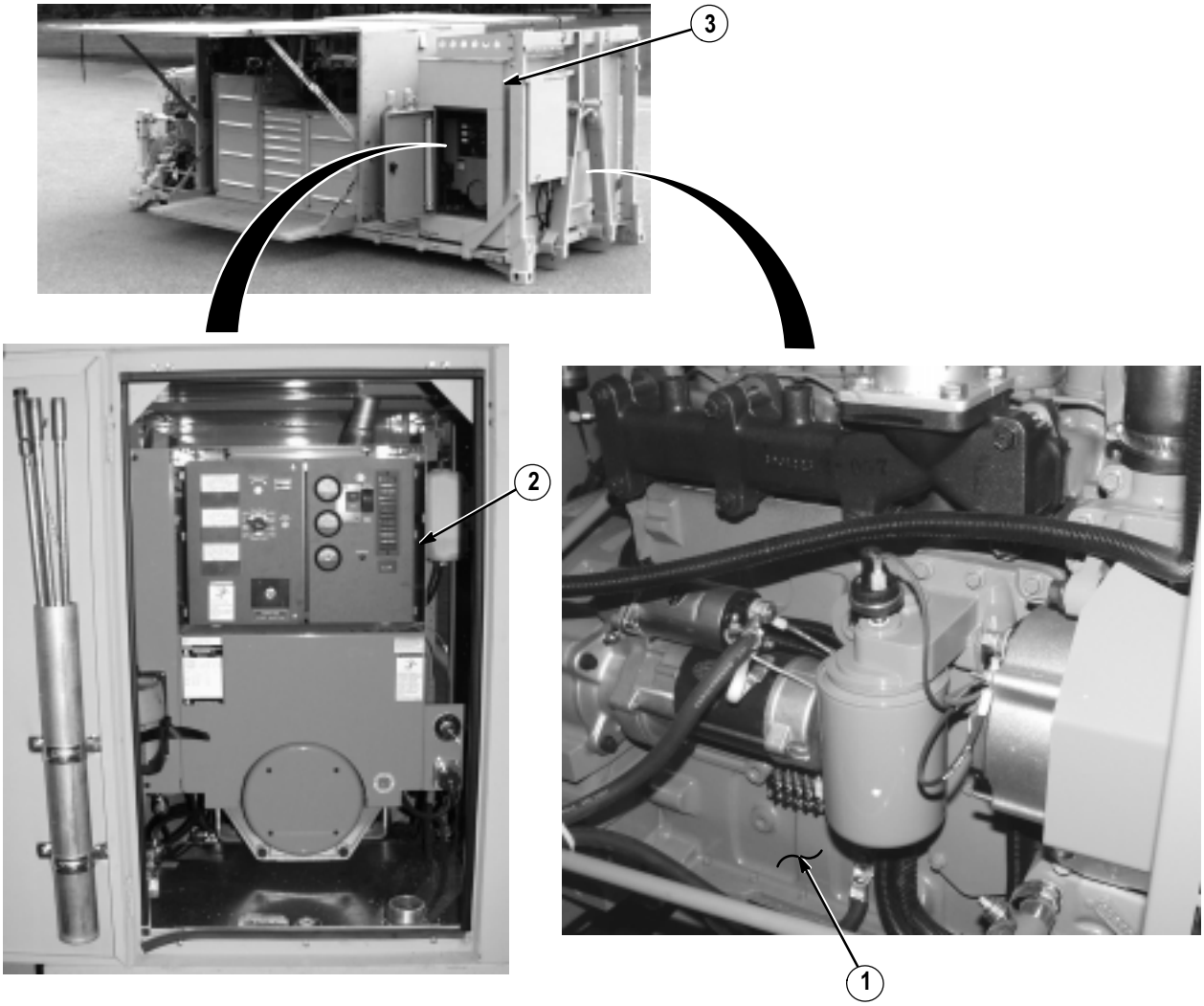
The 120/208 VAC system provides power for the welder (9), air compressor (10), 110 receptacles (11), reel lights (12) and fixed lighting system (13). Electrical power for the 120/208 VAC system is provided by the 35KW generator set which is powered by a 239 cubic inch (3.9L) diesel engine. Circuit breakers for the 120/208 system are located in main panel (14) inside shelter of the FRS.

1-13. HYDRAULIC SYSTEM.



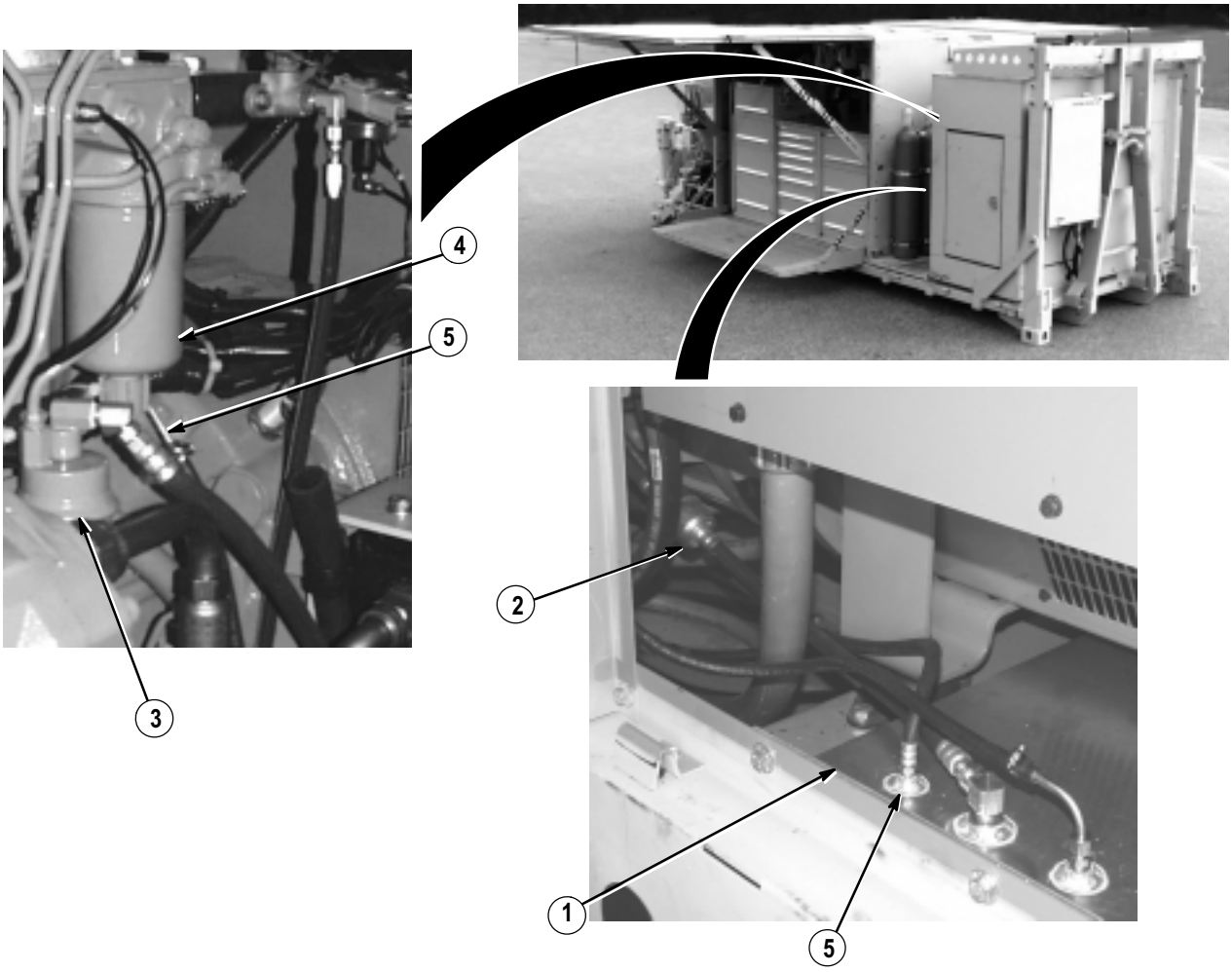
The hydraulic reservoir (1) holds 25 gallons of hydraulic fluid that is used during operation of the crane. Hydraulic fluid is drawn from the hydraulic reservoir to the hydraulic pump (2) through the hydraulic filter (3). The hydraulic pump is mounted on left front side of the engine. It provides hydraulic pressure for the crane hydraulic system.

1-14. GENERATOR ENGINE SET.



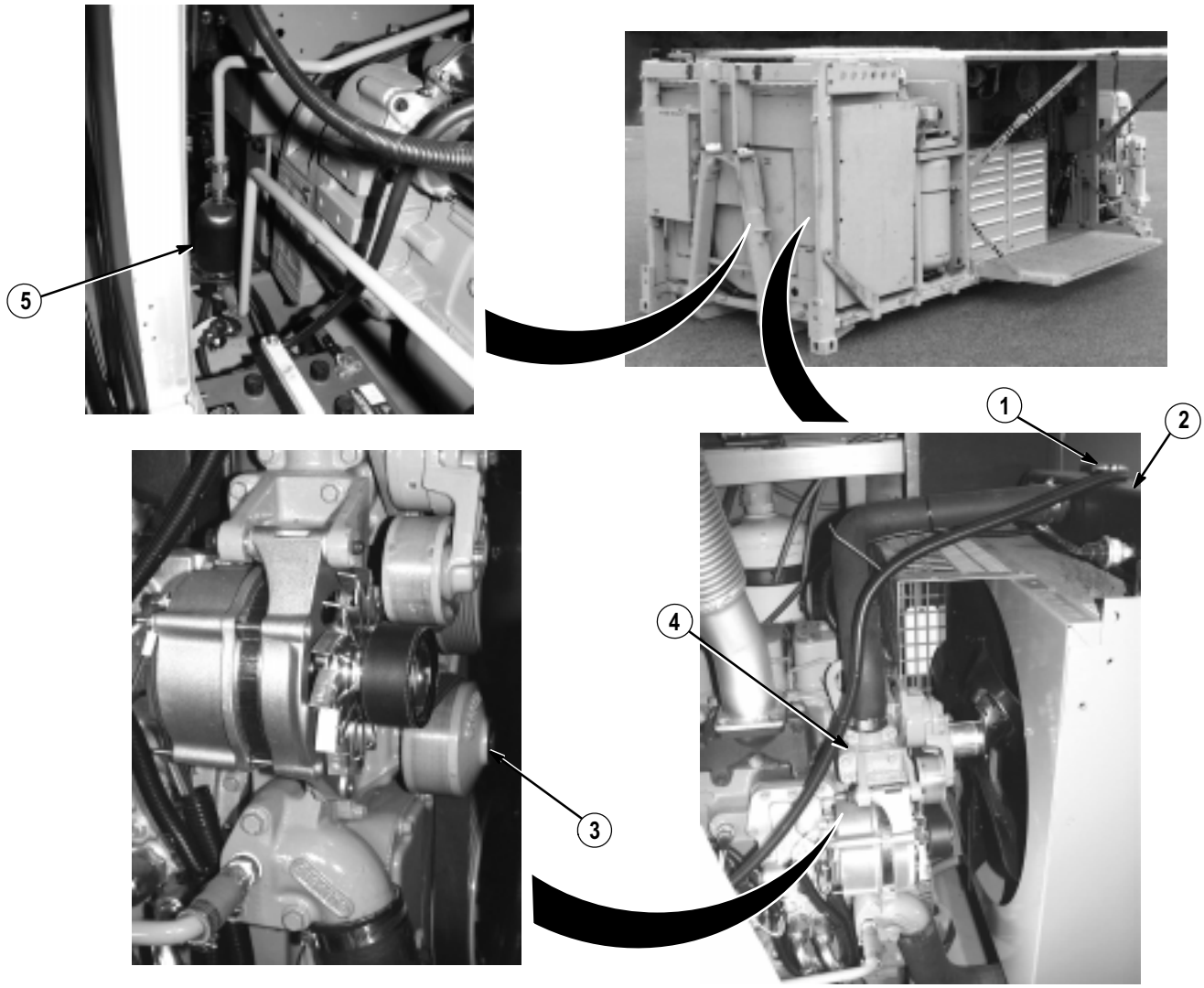
The FRS is equipped with a 4 cylinder, in-line 239 cubic in. (3.9L) diesel powered engine (1), standby generating system, 35KW/44 KVA, continuous standby, 120/208 VAC, 0 three phase (broad range), 60Hz, 1800RPM. The engine controller is unit (2). The engine is mounted in the weather protective housing (3).

1-15. GENERATOR FUEL SYSTEM.



Fuel is pumped from fuel tank (1), passes through a primary fuel filter (2) to a mechanical fuel pump (3). From the fuel pump, fuel is pumped through the secondary fuel filter (4) to the engine. Excess fuel from the engine is returned to the fuel tank through the return line (5). The primary fuel filter removes large solid particles from the fuel. The smaller particles are removed by the secondary fuel filter before they can enter the engine fuel injectors.

1-16. COOLING SYSTEM.



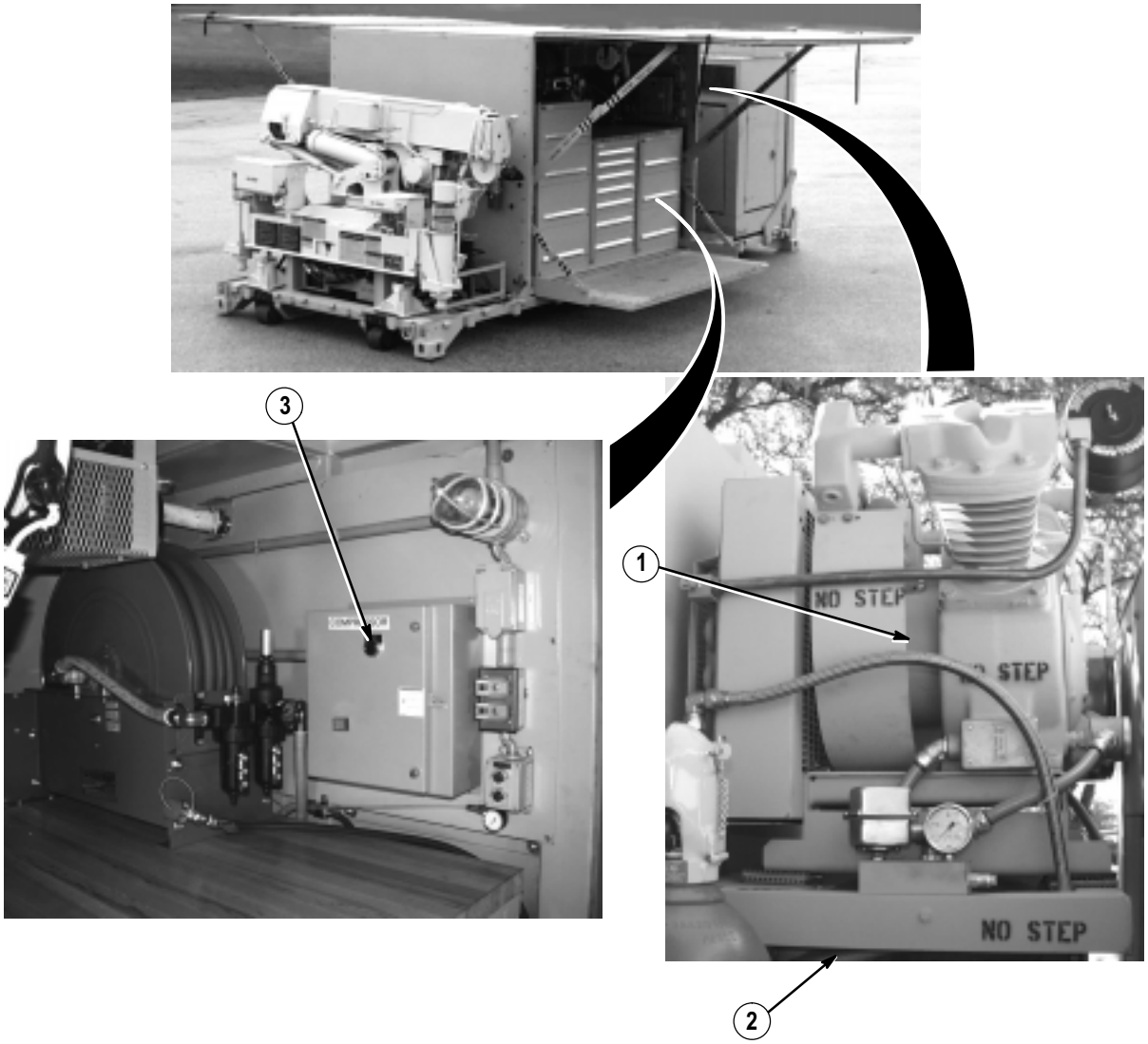
a. Cooling System.

The pressure-type cooling system protects the engine by removing the heat generated during combustion process. Pressure within the cooling system is limited by a pressure release in the radiator filler cap (1). The hot coolant flows from the engine to the radiator tank (2) and through the radiator core where a stream of air removes heat. This stream of air is blown through the core by the fan. The water pump (3) draws coolant from the radiator and pushes it through the engine, repeating the cooling process. Thermostat (4) mounted on the coolant outlet elbow, remains closed until the coolant approaches 180 –185 degrees F (82°C – 85°C), when it opens. When coolant temperature drops below thermostat rating, the thermostat closes.

b. Engine Block Heating System (Cold Operations Below 15 Degrees F (–9° C)).

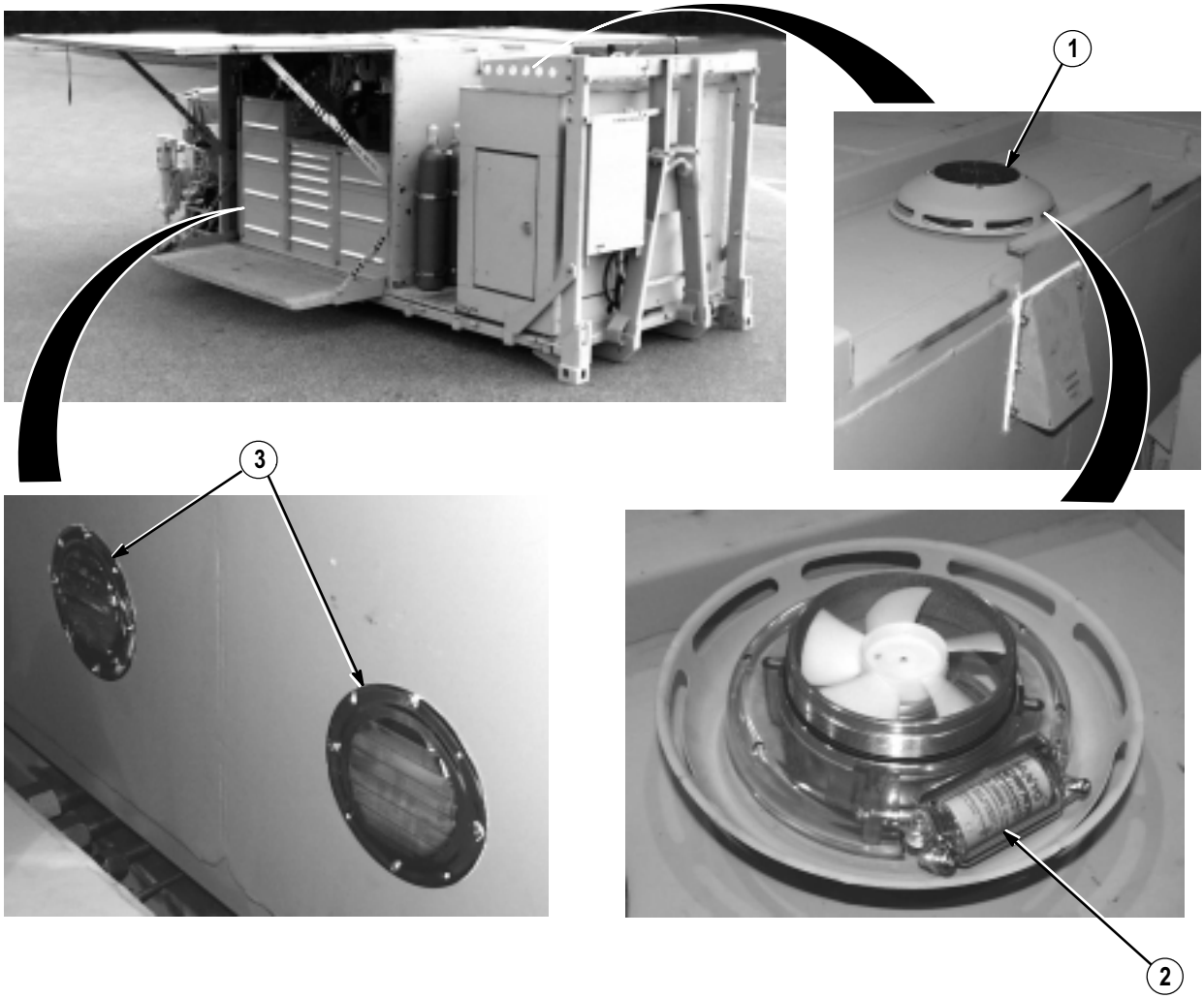
A coolant tank heater (5) is used to keep the engine coolant warm when the engine is shut down. It heats and circulates the coolant within the engine. This reduces startup time and lessens engine wear caused by cold starts. It is electrically operated and thermostatically controlled (ON at 70°F (21°C) and OFF at 100°F (38°C)). Heater operates when connected to 110 VAC.

1-17. AIR COMPRESSOR SYSTEM.



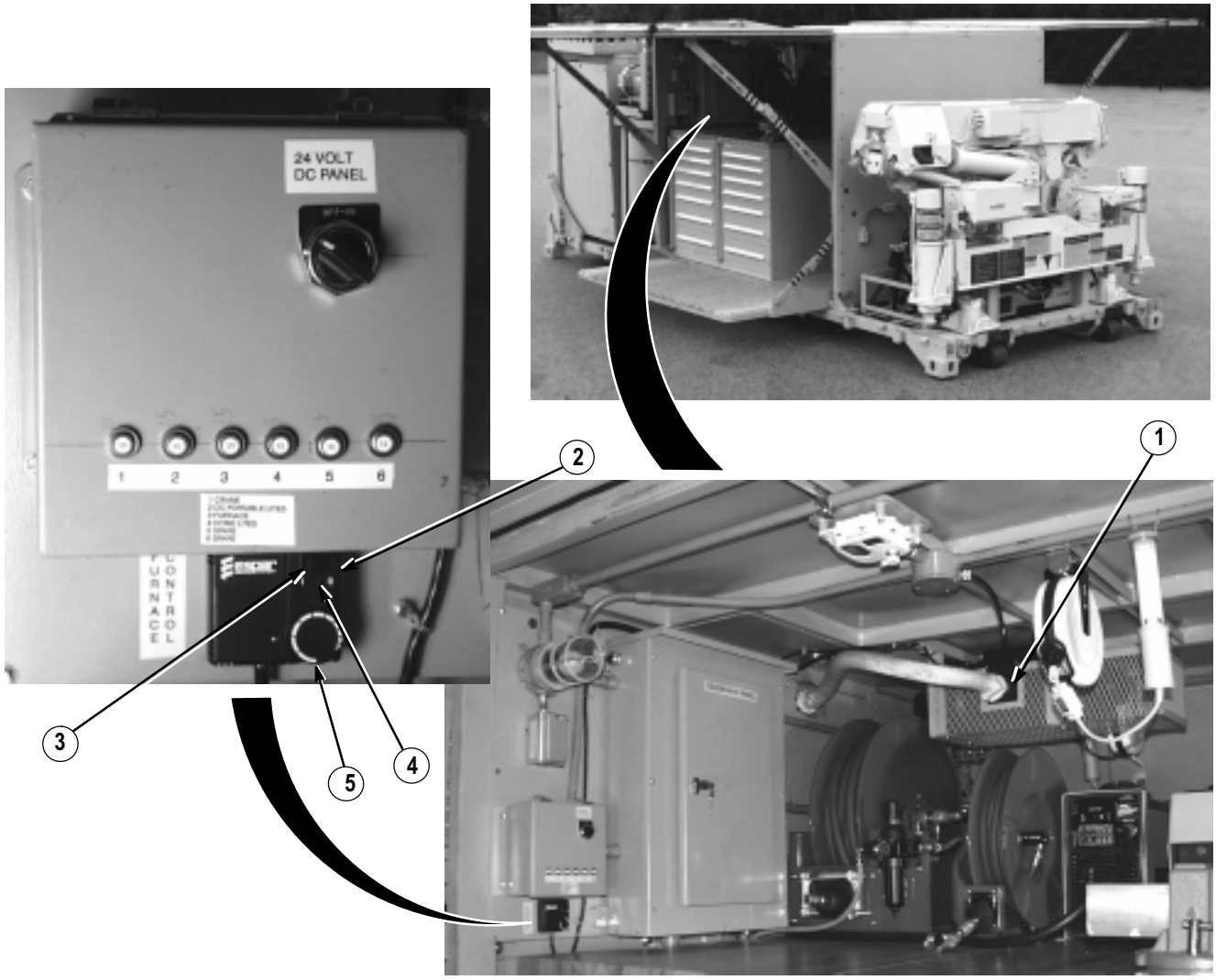
The air compressor system consists of air compressor (1) and a 80 gallon air reservoir (2). It can provide up to 175 psi of regulated compressed air to power pneumatic tools and any other operation. The air compressor is driven by 208 volt three phase electrical motor which can be manually controlled by a switch (3) located inside the shelter.

1-18. SOLAR AIR VENT.



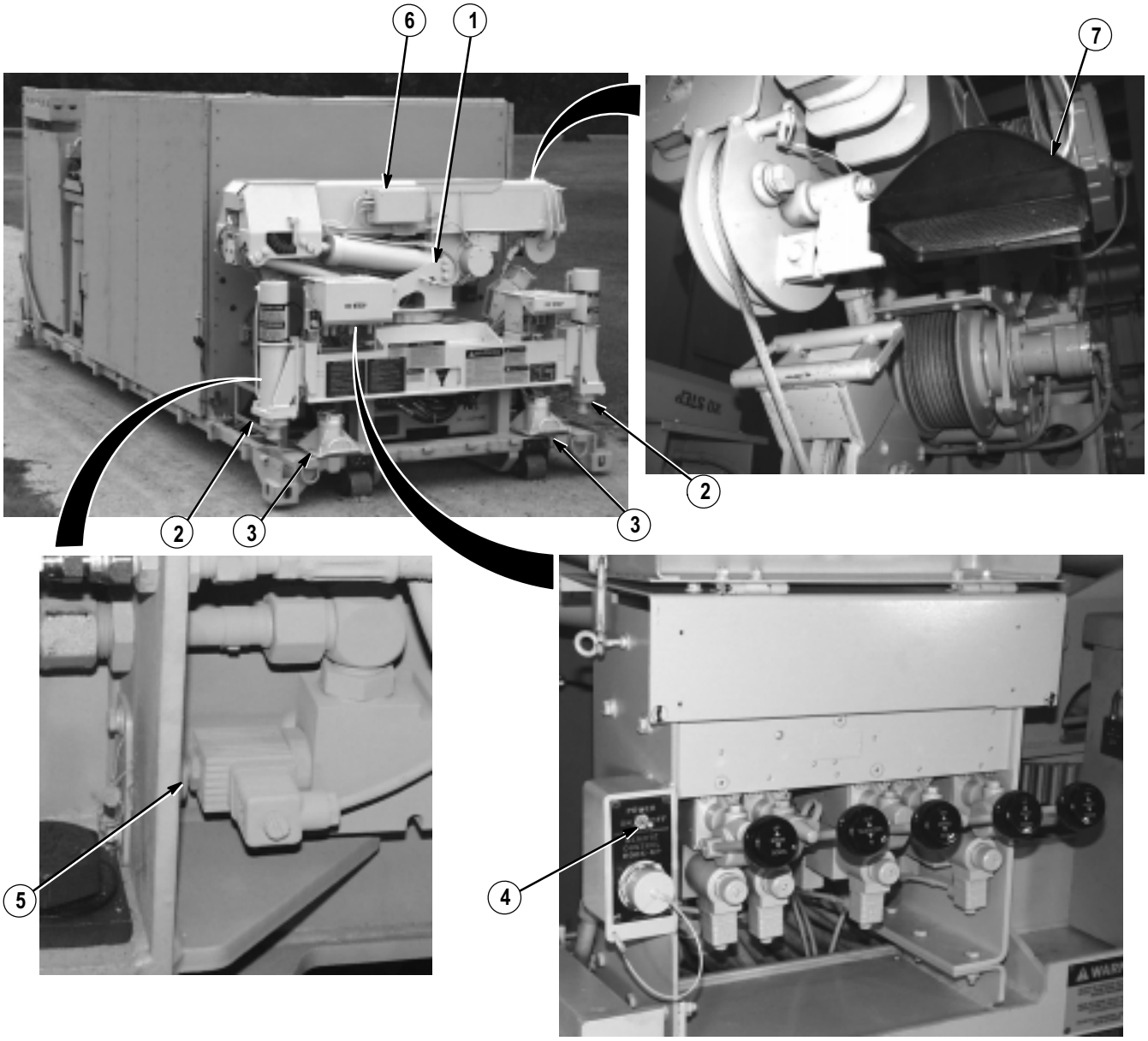
The solar air vent (1) combines solar cell technology with a standard Ni-Cad battery (2) to provide round-the clock ventilation. Air is drawn in two vents (3) on rear wall of shelter and exhausted through solar air vent. The solar air vent is used to equalize the humidity level inside and outside the shelter to reduce condensation buildup.

1-19. SHELTER HEATER.



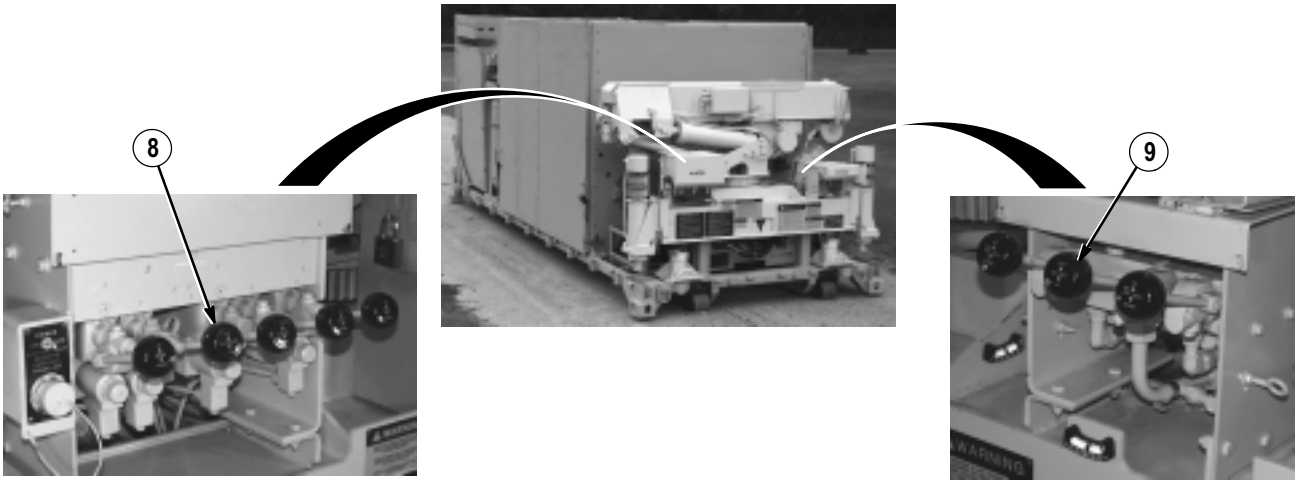
The shelter heater (1) is a diesel-fueled air heater, 24VDC system. Controlled by a thermostat with ON/OFF switch (2), red operating light (3) and green diagnostic light (4). The thermostat control dial (5) has a variable setting of approximately 50° F to approximately 85° F.

1-20. CRANE.

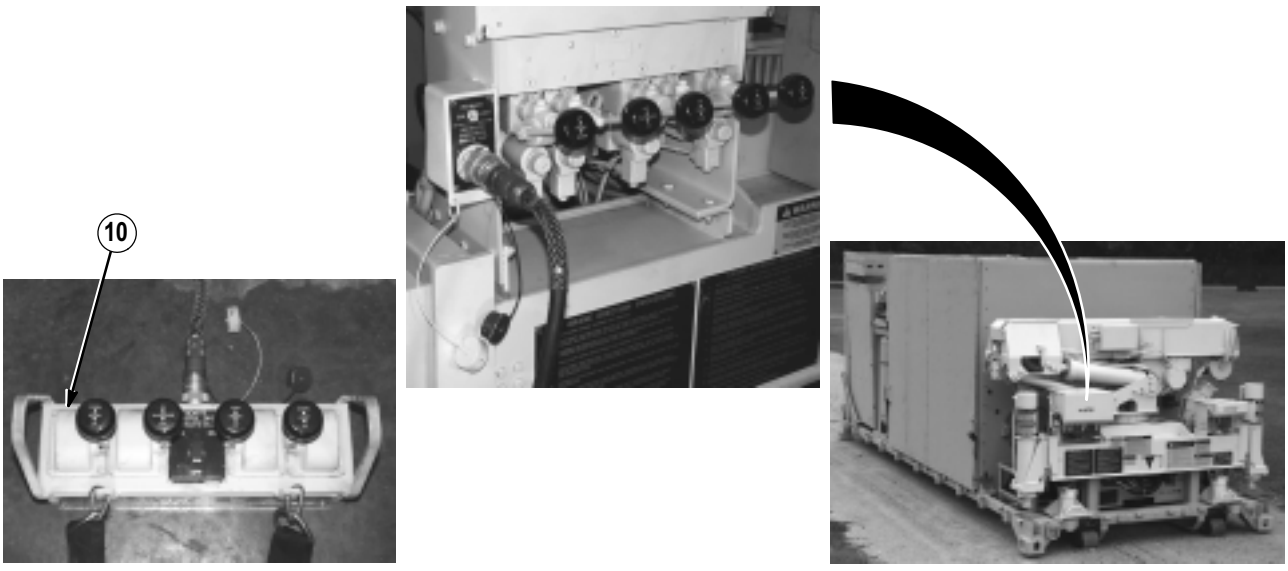


a. Crane. The FRS crane (1) is fully hydraulic and is powered by the FRS hydraulic system. The boom can rotate 300 degrees. The crane is capable of lifting up to 10,000 lbs (4,534 kg) load at a 14 ft (4.3 m). The FRS stability and leveling is accomplished with the left and right side hydraulically operated outrigger jacks (2). The outrigger pads (3) are attached to the outrigger jacks by means of retaining pins and are stowed on the crane base. The pads swivel 360 degrees when installed on the jacks. The crane is energized by turning power ON/OFF switch (4) to ON supplying electrical power to the hydraulic system solenoid (5) and the overload shutdown system (6). The boom light (7) is powered directly from the FRS unit and works independently from the crane power.

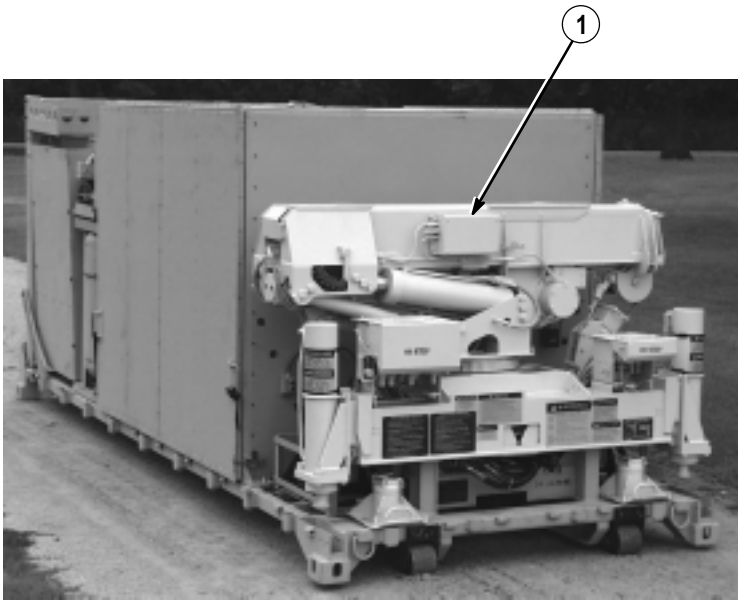
1-20. CRANE (CONT).

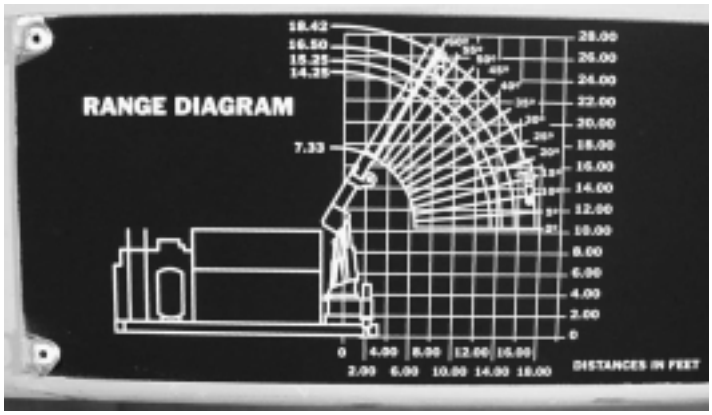


b. Fixed Controls. All crane controls and indicators are located to the rear of the crane. The crane controls (8) are to the left, the outrigger jack controls (9) are to the right and both are accessible to the operator while standing on the ground. Control valves, both crane and outrigger jack, automatically return to the neutral position should operator inadvertently or intentionally release control.



c. Remote Controls. The remote control system is designed to operate the spools of the directional control valve. Remote control is proportionally variable. Remote control (10) is provided with an emergency shutdown capability and designed so that when activated, all remote control crane functions cease. The operator can operate the remote control anywhere within 30 ft (9.2 m) of the crane base. The controller has multiple functions to match control levers on the crane controls.





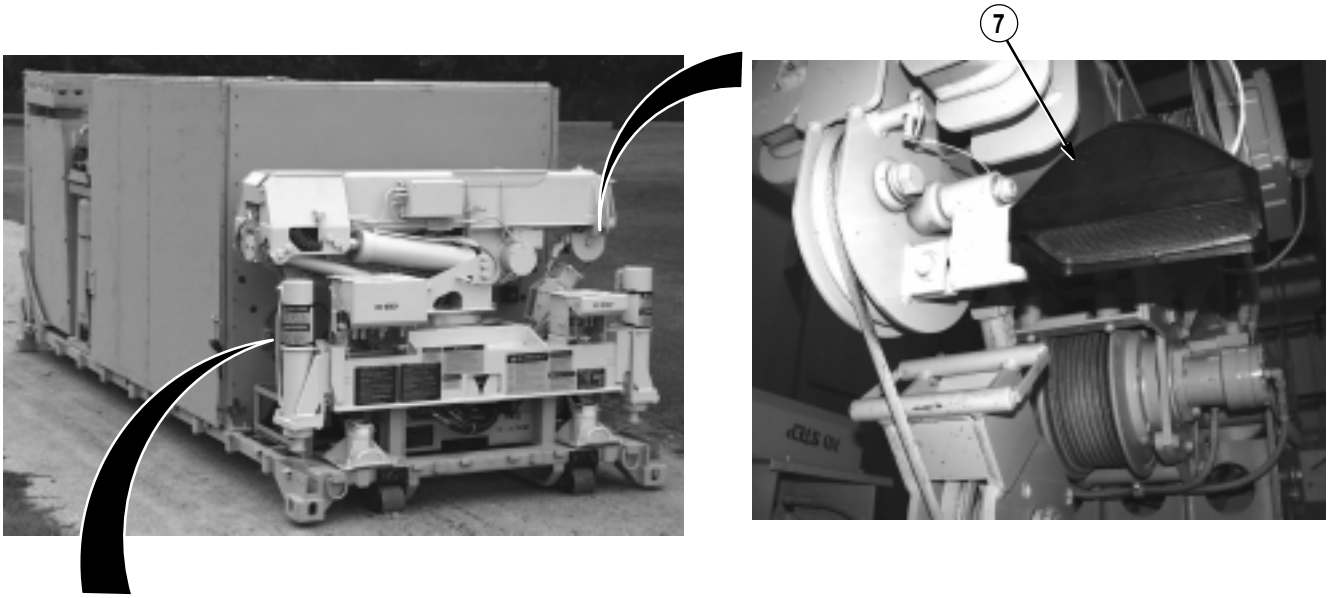
RADIUS (FT)	ON OUTRIGGERS, 300° LIFTING AREA BOOM LENGTH (FT)				
	7.33	14.25	15.25	16.50	18.42
4.00	10500				
7.00	10500				
8.00		10500	10500		
9.00		10500	10500	10000	
10.00		10500	10500	10000	9000
12.00		10000	10000	10000	9000
14.00		10000	10000	9000	8000
15.00			9000	8400	7900
16.00				8000	7500
18.20					6500

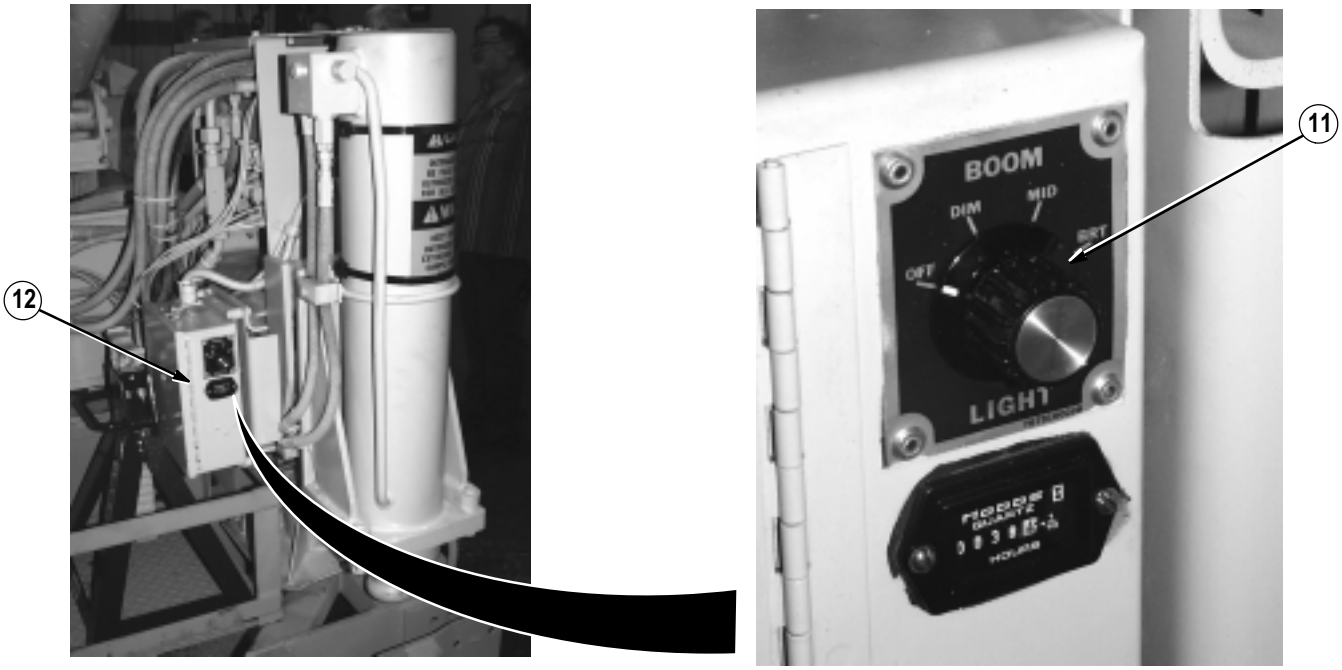
CAPACITIES ARE NET HOOK LOADS, IN LBS

7829100000

d. Overload Shutdown. The crane is provided with an overload shutdown (1) which prevents structural overloading. Two block and overload conditions are sensed through line-pull of the hoist. A preprogrammed microprocessor that is constantly comparing boom angle, boom length and hoist line pull, activates solenoid valves to prevent telescope out, lift up, lift down, and hoist up functions when unit is overloaded or two-blocked. During an overload condition the crane's functions cease except for hoist down.

1-20. CRANE (CONT).





e. Boom Light. The 24VDC boom light (7) is powered directly from the FRS unit. As long as the FRS unit has power directed to the crane the light can be utilized even when the crane is not energized. The boom light switch (11) is located on the crane electrical box (12) and can be operated at three switchable intensities (DIM, MID & BRIGHT).

CHAPTER 2

TROUBLESHOOTING PROCEDURES

Para	Contents	Page
2-1	Troubleshooting Introduction	2-1
2-2	Engine Troubleshooting	2-4
2-3	Starter Motor Troubleshooting	2-11
2-4	Crane Troubleshooting	2-14

2-1. TROUBLESHOOTING INTRODUCTION.

a. This section contains information for locating and correcting most of the troubles which may develop on the Forward Repair System (FRS). Each malfunction for an individual component, unit, or system is followed by a list of tests or inspection which will help to determine corrective actions to take.

b. This manual can not list all malfunctions that may occur, nor all tests or inspections and corrective actions. If a malfunction is not listed or is not corrected by listed corrective actions, notify supervisor.

c. Table 2-1 lists common malfunctions that you may find with your equipment. Perform the tests, inspections and corrective actions in the order they appear in the table.

Table 2-1. Troubleshooting Fault Index

Fault Number	Troubleshooting Procedure	Page Number
ENGINE SYSTEM FAULT INDEX		
1.	Engine Cranks But Will Not Start - No Smoke From Exhaust	2-5
2.	Coolant Loss	2-5
3.	Lubricating Oil Pressure Low	2-5
4.	Lubricating Oil Pressure High	2-5
5.	Lubricating Oil Consumption Excessive	2-5
6.	Lubricating Oil Contaminated	2-6
7.	Fuel Or Oil Leaking From Exhaust Manifold	2-6
8.	Compression Knocks	2-6
9.	Fuel Consumption Excessive	2-6
10.	Engine Will Not Shut Off	2-7
11.	Engine Vibration Excessive	2-7
12.	Engine Noises Excessive	2-7
13.	Engine Hard To Start Or Will Not Start - Smoke From Exhaust	2-7
14.	Engine Surging (Speed Change)	2-8
15.	Engine Idle Rough (Irregularly Firing Or Engine Shaking)	2-8
16.	Engine Runs Rough Or Is Misfiring	2-9
17.	Engine RPM Will Not Reach Rated Speed	2-9
18.	Engine Power Output Is Low	2-9
19.	Exhaust Black Smoke Excessive	2-10
20.	Exhaust White Smoke Excessive	2-10
21.	Coolant Temperature Above Normal - Gradual Overheat	2-10

Table 2-1. Troubleshooting Fault Index (CONT).

Fault Number	Troubleshooting Procedure	Page Number
STARTER MOTOR FAULT INDEX		
1.	Normal Current And Speed	2-12
2.	Current Flow With Test Circuit Switch Open	2-12
3.	Failure To Operate With Very Low Or No Current	2-12
4.	Failure To Operate With High Current	2-12
5.	Low Speed With High Current	2-13
6.	Low Speed With Normal (Or Low) Current	2-13
7.	High Speed With High Current	2-13
CRANE ELECTRIC FAULT INDEX		
1.	Overload Shutdown System (OSS) Disables Crane Functions, Boom Up, Boom Down, Telescope Out And Hoist Up	2-16
CRANE HYDRAULIC FAULT INDEX		
1.	Crane Functions Do Not Operate Or Operate Slowly	2-32
2.	Outrigger Beam Does Not Extend Or Retract	2-36
3.	Left Outrigger Jack Cylinder Does Not Raise Or Lower	2-39
4.	Right Outrigger Jack Cylinder Does Not Raise Or Lower	2-42
5.	Mast Does Not Raise Or Lower	2-45
6.	Crane Does Not Swing Or Swings Slowly	2-48
7.	Crane Does Not Swing Clockwise	2-53
8.	Crane Does Not Swing Counter Clockwise	2-57
9.	Boom Does Not Telescope Out Or In	2-61
10.	Boom Does Not Raise or Lower	2-64
11.	Boom Creeps Down	2-67
12.	Hoist Does Not Raise Or Lower Or Raises Slowly	2-69

2-2. ENGINE TROUBLESHOOTING.

This paragraph covers Engine Troubleshooting.

Table 2-2. Engine Fault Index

Fault Number	Troubleshooting Procedure	Page Number
1.	Engine Cranks But Will Not Start - No Smoke From Exhaust	2-5
2.	Coolant Loss	2-5
3.	Lubricating Oil Pressure Low	2-5
4.	Lubricating Oil Pressure High	2-5
5.	Lubricating Oil Consumption Excessive	2-5
6.	Lubricating Oil Contaminated	2-6
7.	Fuel Or Oil Leaking From Exhaust Manifold	2-6
8.	Compression Knocks	2-6
9.	Fuel Consumption Excessive	2-6
10.	Engine Will Not Shut Off	2-7
11.	Engine Vibration Excessive	2-7
12.	Engine Noises Excessive	2-7
13.	Engine Hard To Start Or Will Not Start - Smoke From Exhaust	2-7
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16.	Engine Runs Rough Or Is Misfiring	2-9
17.	Engine RPM Will Not Reach Rated Speed	2-9
18.	Engine Power Output Is Low	2-9
19.	Exhaust Black Smoke Excessive	2-10
20.	Exhaust White Smoke Excessive	2-10
21.	Coolant Temperature Above Normal - Gradual Overheat	2-10

Table 2-3. Engine Troubleshooting

Malfunction
Test or Inspection
Corrective Action

1. ENGINE CRANKS BUT WILL NOT START - NO SMOKE FROM EXHAUST.

Worn or malfunctioning fuel injection pump.

Visually check fuel delivery with an externally connected injector to one of the pump outlets. Replace fuel injection pump (Para 5-17).

Injection pump timing is incorrect.

Verify/time the pump (Para 5-19).

Engine camshaft is out of time.

Check and correct the gear train timing alignment (Para 7-7).

2. COOLANT LOSS.

Cylinder head gasket leaks.

Check and replace the head gasket (Para 5-7).

Cylinder head cracked or porous.

Check and replace the head (Para 5-7).

Cylinder block coolant passaged leaking.

Check and replace the cylinder block (Para 5-7).

3. LUBRICATING OIL PRESSURE LOW.

Pressure regulator valve is struck open.

Check and replace valve (TM 9-4940-568-20).

Cylinder block or cylinder head plugs loose or missing.

Check and replace expansion plugs (Para 7-3).

4. LUBRICATING OIL PRESSURE HIGH.

Pressure regulator valve stuck open.

Check and replace valve (TM 9-4940-568-20).

5. LUBRICATING OIL CONSUMPTION EXCESSIVE.

Valve seals worn.

Inspect and replace the valve seals (Para 7-4).

Piston rings not sealing and lubricating oil being consumed by the engine.

Perform a compression check (Para 5-8). Repair as required (Para 7-6).

Table 2-3. Engine Troubleshooting (CONT).

Malfunction Test or Inspection Corrective Action

6. LUBRICATING OIL CONTAMINATED.

Fuel injection pump seal leaking (rotary).

Remove and repair the fuel injection pump (Para 5-17).

Internal plunger seal leaking (in-line).

Remove and repair the fuel injection pump (Para 5-17).

Injector needle valves not sealing.

Locate and replace malfunctioning injector (TM 9-4940-568-20).

7. FUEL OR OIL LEAKING FROM EXHAUST MANIFOLD.

Injector needle valve is stuck open.

Locate and replace malfunctioning injector (TM 9-4940-568-20).

Blowby is excessive.

Check for excessive blowby (TM 9-4940-568-20).

Fuel injection pump timing is incorrect.

Check and time the injection pump (Para 5-19).

8. COMPRESSION KNOCKS.

Fuel injection pump timing is incorrect.

Check and time fuel injection pump (Para 5-19).

Injectors are malfunctioning.

Replace injectors (TM 9-4940-568-20).

Coolant operating temperature is incorrect.

Refer to troubleshooting logic for Low Coolant Temperature (TM 9-4940-568-20).

9. FUEL CONSUMPTION EXCESSIVE.

Injectors worn or malfunctioning.

Check and replace injectors (TM 9-4940-568-20).

Table 2-3. Engine Troubleshooting (CONT).

Malfunction Test or Inspection Corrective Action

10. ENGINE WILL NOT SHUT OFF.

Fuel injection pump malfunctioning.

Remove the fuel injection pump. Check and repair the fuel injection pump (Para 5-17).

11. ENGINE VIBRATION EXCESSIVE.

Flywheel housing is misaligned.

Check and correct flywheel alignment (Para 5-11).

Power components loose or broken.

Inspect the camshaft (Para 7-7) and rods (TM 9-4940-568-20) for damage that cause an unbalance.

12. ENGINE NOISES EXCESSIVE.

Valve lash is excessive.

Adjust valves. Make sure the push rods are not bent or the rocker levers are not severely worn (TM 9-4940-568-20).

Power function knock.

Check and replace rod and main bearings (Para 7-5).

13. ENGINE HARD TO START OR WILL NOT START - SMOKE FROM EXHAUST.

Fuel injection pump out of time.

Check top dead center (TDC) (Para 7-9).

Check and adjust fuel injection pump timing (Para 5-19).

Valves are incorrectly adjusted.

Adjust valves (TM 9-4940-568-20).

One or more injectors are worn or malfunctioning.

Check and replace injectors (TM 9-4940-568-20).

Engine compression is low.

Perform a compression check to identify the problem (Para 5-8).

Fuel injection pump is malfunctioning and delivery valves are malfunctioning.

Replace fuel injection pump (Para 5-17).

Table 2-3. Engine Troubleshooting (CONT).

Malfunction Test or Inspection Corrective Action

14. ENGINE SURGING (SPEED CHANGE).

One or more injectors are worn or malfunctioning.

Replace fuel injection pump (Para 5-17).

Fuel injection pump is malfunctioning and delivery valves are malfunctioning.

Replace fuel injection pump (Para 5-17).

15. ENGINE IDLE ROUGH (IRREGULARLY FIRING OR ENGINE SHAKING).

Injector needle valve sticking.

Check and replace the injector (TM 9-4940-568-20).

Fuel injection pump or delivery valve is malfunctioning.

Replace fuel injection pump (Para 5-17).

Valves are not sealing.

Adjust valves (TM 9-4940-568-20).

Compression in one or more cylinders is low.

Perform a compression check and repair as required (Para 5-8).

Table 2-3. Engine Troubleshooting (CONT).

Malfunction Test or Inspection Corrective Action

16. ENGINE RUNS ROUGH OR IS MISFIRING.

Valve adjustment is incorrect.

Check for a bent push rod and adjust valves (TM 9-4940-568-20).

Injection pump timing is incorrectly adjusted.

Check top dead center (TDC) (Para 7-9).

Check and adjust injection pump timing (Para 5-19).

Compression in one or more cylinders is low.

Perform a compression check and repair as required (Para 5-8).

Injectors are malfunctioning.

Check and replace injectors (TM 9-4940-568-20).

Injection pump (delivery valves) is defective.

Replace fuel injection pump (Para 5-17).

Camshaft out of time.

Check and correct gear train timing alignment (Para 7-7).

Camshaft or tappets are damaged.

Inspect camshaft and tappets (Para 7-7).

17. ENGINE RPM WILL NOT REACH RATED SPEED.

Fuel injection pump is malfunctioning.

Replace fuel injection pump (Para 5-17).

18. ENGINE POWER OUTPUT IS LOW.

Injectors worn or malfunctioning.

Check injectors (TM 9-4940-568-20).

Fuel injection pump timing incorrect.

Adjust fuel injection pump timing (Para 5-18).

Fuel injection pump malfunctioning.

Replace fuel injection pump (Para 5-16).

Engine compression low.

Replace engine (Para 5-4).

Table 2-3. Engine Troubleshooting (CONT).

Malfunction Test or Inspection Corrective Action

19. EXHAUST BLACK SMOKE EXCESSIVE.

Injectors malfunctioning.

Replace injectors (TM 9-4940-568-20).

Fuel injection pump malfunctioning or overfueled.

Replace fuel injection pump (Para 5-17).

Piston rings are not sealing (blue smoke).

Perform a compression check (Para 5-8). Correct as required (Para 7-6).

Fuel injection pump timing is incorrect.

Check and time fuel injection pump (Para 5-19).

20. EXHAUST WHITE SMOKE EXCESSIVE.

Injection pump timing is incorrectly adjusted.

Check top dead center (TDC) (Para 7-9).

Check and adjust injection pump timing (Para 5-19).

Injector is installed with more than one sealing washer.

Remove extra washer (TM 9-4940-568-20).

Injectors are malfunctioning.

Check and replace injectors (TM 9-4940-568-20).

Coolant leaking into combustion chamber.

Refer to troubleshooting logic for coolant loss (TM 9-4940-568-20).

Fuel injection pump is malfunctioning and delivery valves are malfunctioning.

Replace fuel injection pump (Para 5-17).

Cylinder head gasket leaking.

Replace cylinder head gasket (Para 5-7).

21. COOLANT TEMPERATURE ABOVE NORMAL - GRADUAL OVERHEAT.

Fuel injection pump timing is incorrect.

Verify fuel injection pump timing marks are aligned (Para 5-17).

Fuel injection pump is overfueled.

Replace fuel injection pump (Para 5-17).

2-3. STARTER MOTOR TROUBLESHOOTING.

This paragraph covers Starter Motor Troubleshooting.

Table 2-4. Starter Motor Fault Index

Fault Number	Troubleshooting Procedure	Page Number
1.	Normal Current and Speed	2-12
2.	Current Flow With Test Circuit Switch Open	2-12
3.	Failure To Operate With Very Low Or No Current	2-12
4.	Failure to Operate With High Current	2-12
5.	Low Speed With High Current	2-13
6.	Low Speed With Normal (Or Low) Current	2-13
7.	High Speed With High Current	2-13

Table 2-5. Starter Motor Troubleshooting.

Malfunction Test or Inspection Corrective Action

1. NORMAL CURRENT AND SPEED.

Cranking motor ok.

Recheck battery, switches and wiring, including battery cable loss check if cranking motor operation on engine is slow or sluggish (TM 9-4940-568-10).

2. CURRENT FLOW WITH TEST CIRCUIT SWITCH OPEN.

Solenoid switch contacts stuck closed.

Test and, if necessary, replace solenoid assembly (Para 5-23).

3. FAILURE TO OPERATE WITH VERY LOW OR NO CURRENT.

Open solenoid winding.

Inspect and test solenoid assembly (Para 5-23).

Open field circuit.

Inspect and test frame and field assembly (Para 5-23).

Open armature coil(s) or high insulation between commutator bars.

Inspect armature (Para 5-23).

Broken brush spring(s) or worn brushes.

Inspect brushes and brush springs (Para 5-23).

4. FAILURE TO OPERATE WITH HIGH CURRENT.

Frozen bearing or other damage to drive train.

Inspect bearings, armature, drive shaft and related drive parts (Para 5-23).

Direct ground in terminals or fields.

Inspect and test frame and field assembly, solenoid assembly, armature and brush installations for shorts (Para 5-23).

Table 2-5. Starter Motor Troubleshooting (CONT).

Malfunction Test or Inspection Corrective Action

5. LOW SPEED WITH HIGH CURRENT.

Excessive friction in bearing(s) or gear reduction unit, bent armature shaft or loose pole shoe, bent drive shaft.

Inspect bearings, armature, drive shaft and gear reduction gears (Para 5-23).

Shorted armature.

Inspect and test armature (Para 5-23).

Grounded armature or fields.

Inspect and test frame and field coil assembly and armature (Para 5-23).

6. LOW SPEED WITH NORMAL (OR LOW) CURRENT.

High internal electrical resistance caused by poor connections, defective leads or dirty commutator.

Inspect internal wiring, electrical connections and armature commutator (Para 5-23).

Causes listed under “Failure To Operate With Very Low Or No Current”, Malfunction 3.

Corrections listed under “Failure To Operate With Very Low Or No Current”, Malfunction 3.

7. HIGH SPEED WITH HIGH CURRENT.

Shorted fields.

Inspect and test field and frame assembly (Para 5-23).

2-4. CRANE TROUBLESHOOTING.

This paragraph covers Crane Troubleshooting.

Table 2-6. Crane System Fault Index

Fault Number	Troubleshooting Procedure	Page Number
CRANE ELECTRIC		
1.	Overload Shutdown System (OSS) Disables Crane Functions, Boom Up, Boom Down, Telescope Out and Hoist Up	2-16
CRANE HYDRAULIC		
1.	Crane Functions Do Not Operate Or Operate Slowly	2-32
2.	Outrigger Beam Does Not Extend Or Retract	2-36
3.	Left Outrigger Jack Cylinder Does Not Raise Or Lower	2-39
4.	Right Outrigger Jack Cylinder Does Not Raise Or Lower	2-42
5.	Mast Does Not Raise Or Lower	2-45
6.	Crane Does Not Swing Or Swings Slowly	2-48
7.	Crane Does Not Swing Clockwise	2-53
8.	Crane Does Not Swing Counter Clockwise	2-57
9.	Boom Does Not Telescope Out Or In	2-61
10.	Boom Does Not Raise or Lower	2-64
11.	Boom Creeps Down	2-67
12.	Hoist Does Not Raise Or Lower Or Raises Slowly	2-69

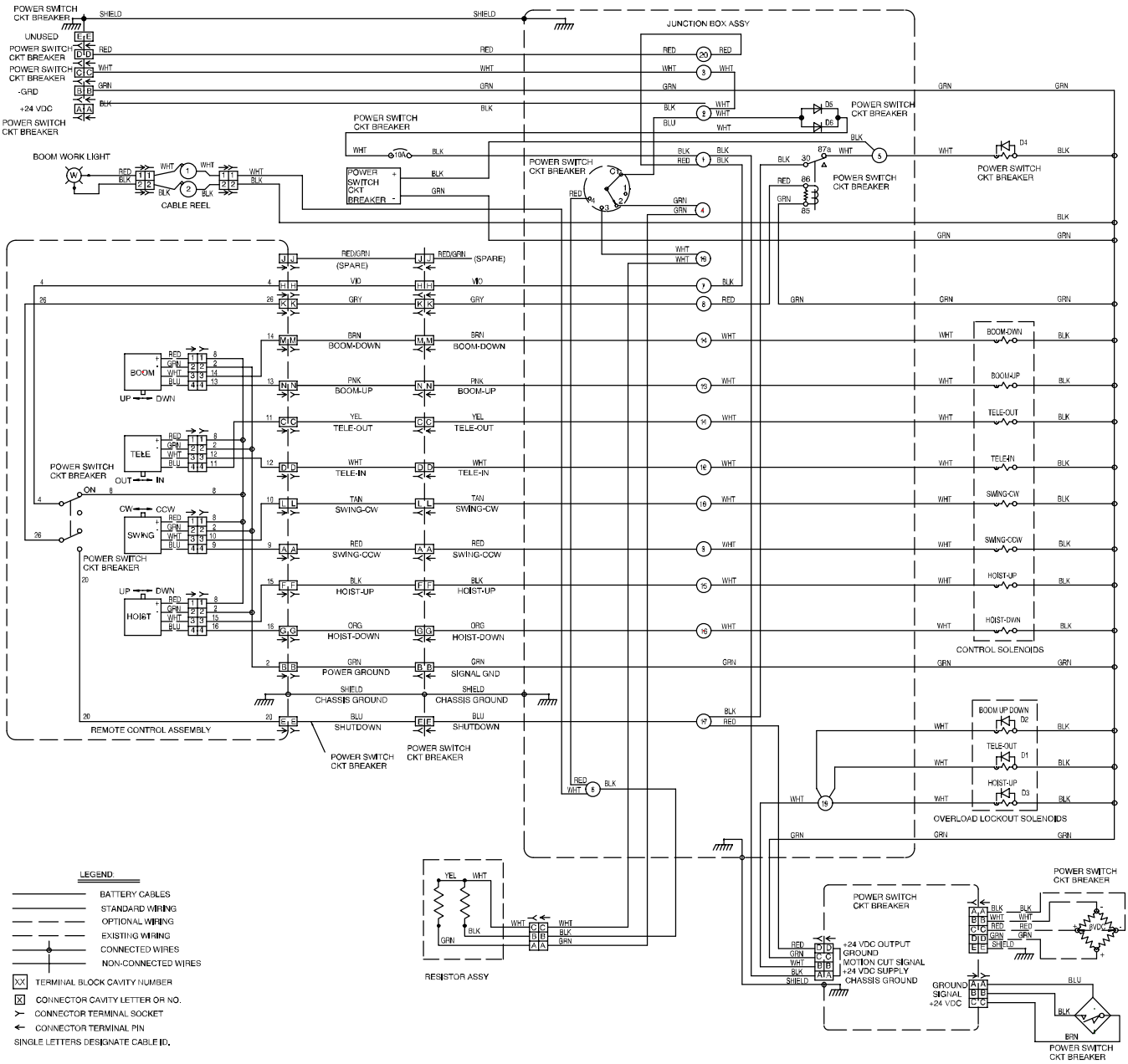


Figure 2-1. Crane Electrical Wiring Schematic

Table 2-7. Crane Troubleshooting.

1. OVERLOAD SHUTDOWN SYSTEM (OSS) DISABLES CRANE FUNCTIONS, BOOM UP, BOOM DOWN, TELESCOPE OUT AND HOIST UP.

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
OSS Tester (Item 89, Appendix F)

References
TM 9-4940-568-10

Materials/Parts
Cable Ties (2) (Item 5, Appendix B)
Sealing Compound (Item 41, Appendix B)
Wire, Nonelectrical (Item 42, Appendix B)
Packing, Preformed (4) (Item 86, Appendix E)

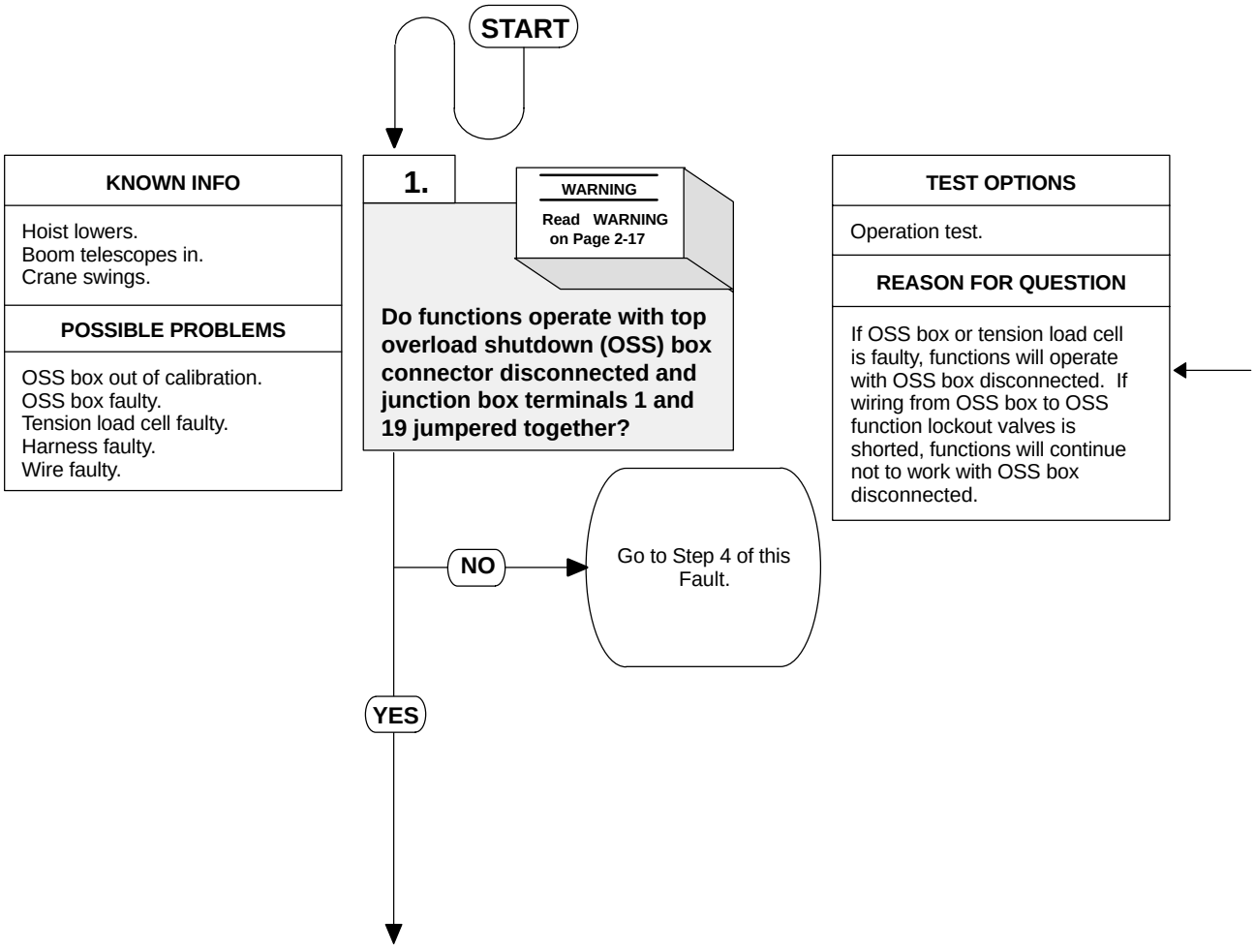
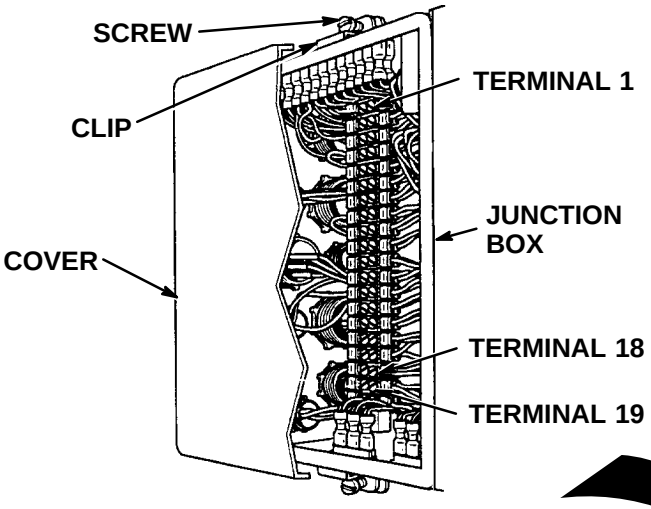
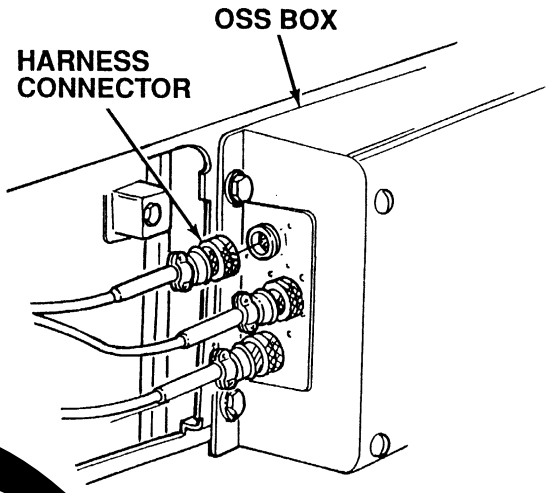


Table 2-7. Crane Troubleshooting (CONT).

WARNING

- Remove all jewelry such as rings, dog tags, bracelets, etc. If jewelry or tools contact positive electrical circuits a direct short may result. Damage to equipment, injury or death to personnel may result.
- Do not stand under crane. Mechanical failure and operator error can cause injury or death to personnel.





OPERATION TEST

(1) Loosen four screws and remove four clips from crane main junction box cover.
(2) Open cover from junction box.
(3) Connect junction box terminals 1 and 19 using jumper wire.
(4) Disconnect top connector from OSS box.
(5) Start FRS (TM 9-4940-568-10).
(6) Set crane main POWER switch to ON position.
(7) Attempt to operate boom and hoist functions using BOOM “UP & DOWN”, TELESCOPE “OUT” and HOIST “UP” control levers.
  (a) If functions do not operate, perform Steps (10) through (12) below and go to Step 4 of this Fault.
  (b) If functions operate, perform Steps (8) through (14) below and go to Step 2 of this Fault.
(8) Position boom so that OSS box is accessible for repairs.
(9) Telescope boom out completely.
(10) Set crane main POWER switch to OFF position.
(11) Shutdown FRS engine.
(12) Remove two screws and disconnect wires from crane junction box, terminal 18.
(13) Disconnect jumper wire from crane main junction box terminals 1 and 19.
(14) Connect connector to OSS box.

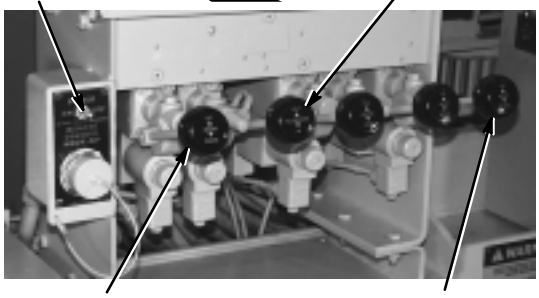


Table 2-7. Crane Troubleshooting (CONT).

1. OVERLOAD SHUTDOWN SYSTEM (OSS) DISABLES CRANE FUNCTIONS, BOOM UP, BOOM DOWN, TELESCOPE OUT AND HOIST UP (CONT).

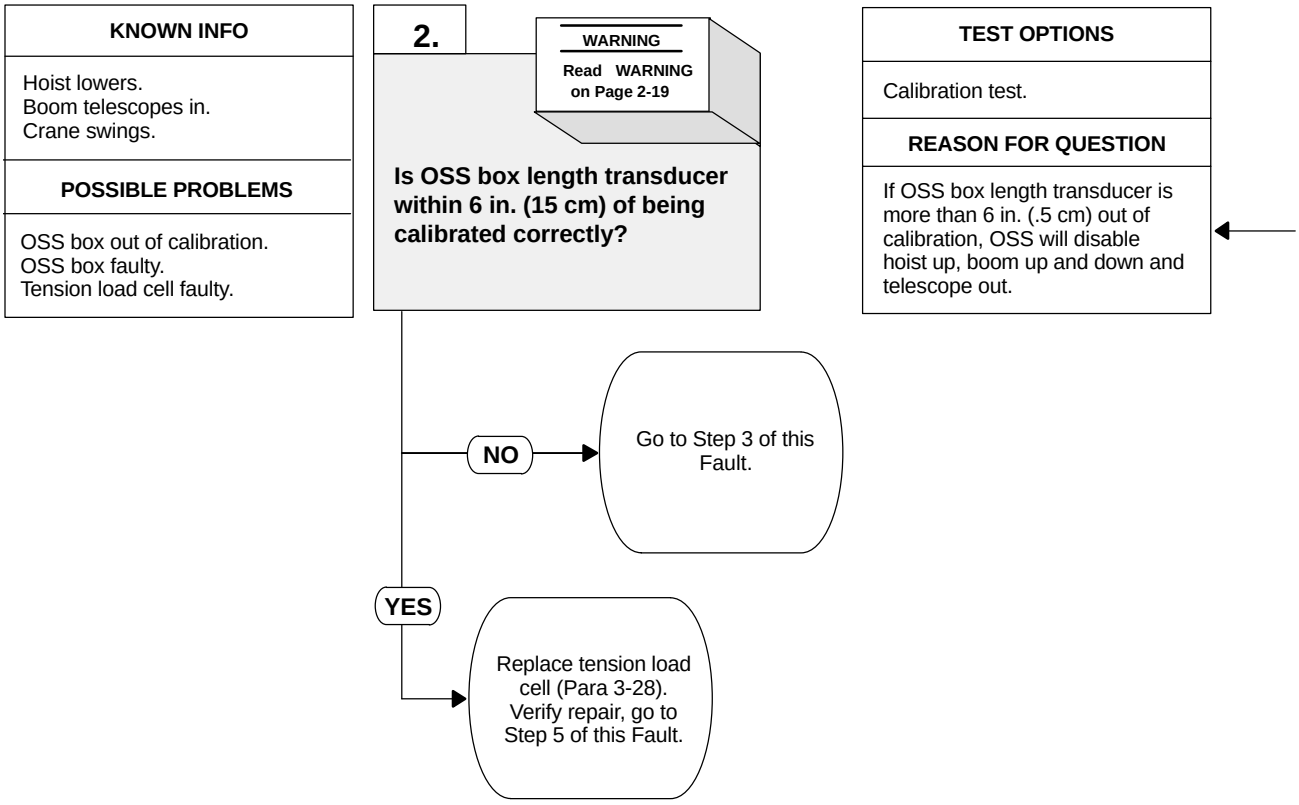


Table 2-7. Crane Troubleshooting (CONT).

WARNING

- Remove all jewelry such as rings, dog tags, bracelets, etc. If jewelry or tools contact positive electrical circuits a direct short may result. Damage to equipment, injury or death to personnel may result.
- Do not stand under crane. Mechanical failure and operator error can cause injury or death to personnel.

CAUTION

Hooked test unit connector must not contact other transistor wire or damage to OSS and test unit will result.

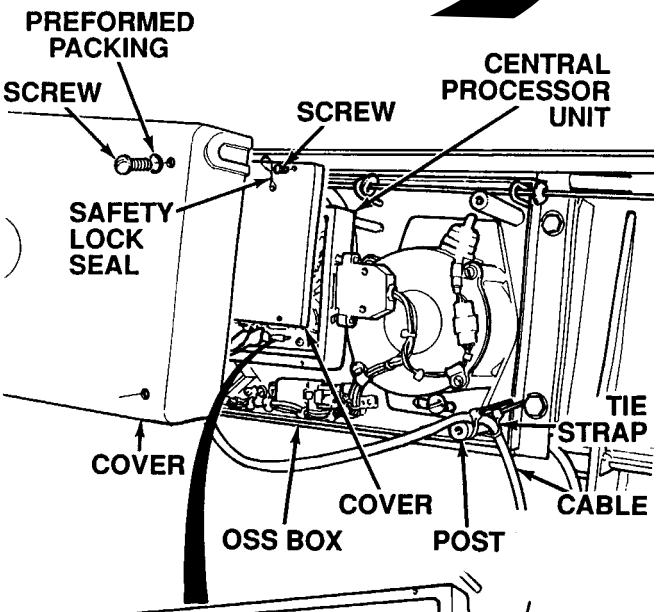
NOTE

When connecting test unit connector to display receptacle, test unit connector white wire receptacle must be engaged in the third pin from the right (fourth pin from left) of display receptacle.

CALIBRATION TEST

(1) Remove four screws, preformed packings, and cover from OSS box. Discard preformed packings.
(2) Remove safety lock seal from two screws.
(3) Remove four screws and cover from central processor unit.
(4) Connect test unit connector to display receptacle pins.
(5) Connect test unit red connector to RH inductive coil wire.
(6) Connect test unit black connector to LH inductive coil wire.
(7) Connect test unit hooked connector to transistor middle wire.

Continued on next page.



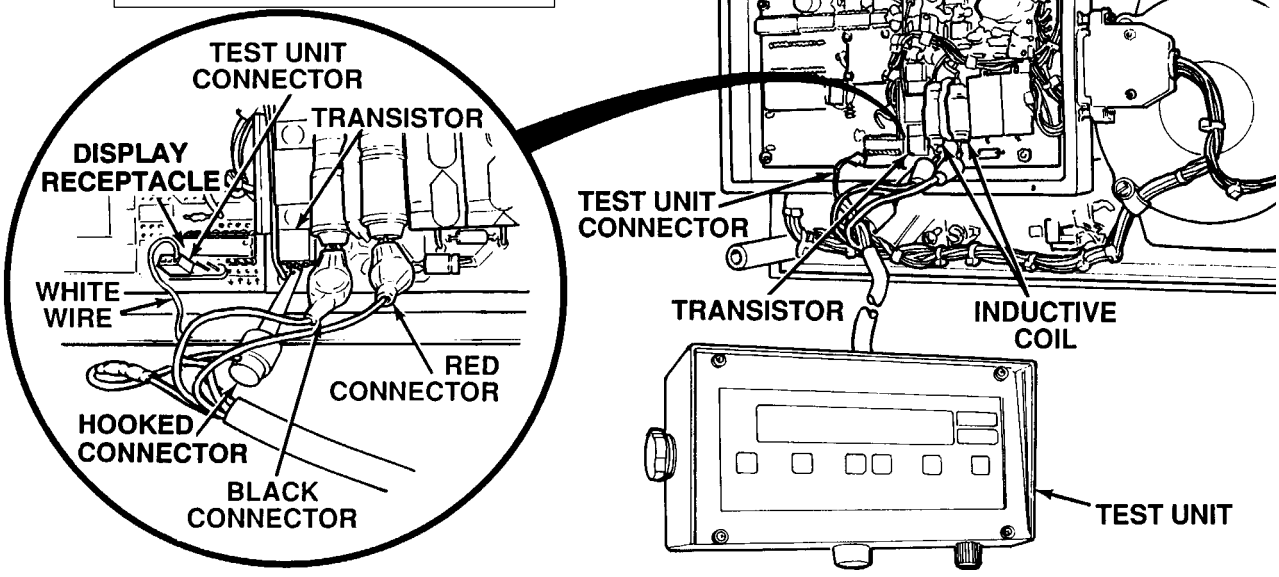


Table 2-7. Crane Troubleshooting (CONT).

1. OVERLOAD SHUTDOWN SYSTEM (OSS) DISABLES CRANE FUNCTIONS, BOOM UP, BOOM DOWN, TELESCOPE OUT AND HOIST UP (CONT).

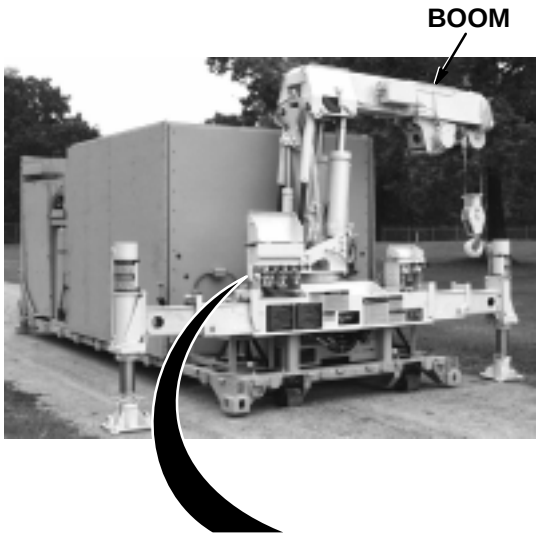
WARNING

- Remove all jewelry such as rings, dog tags, bracelets, etc. If jewelry or tools contact positive electrical circuits a direct short may result. Damage to equipment, injury or death to personnel may result.
- Do not stand under crane. Mechanical failure and operator error can cause injury or death to personnel.

CALIBRATION TEST (CONT).

(8) Start FRS (TM 9-4940-568-10).
(9) Set crane main POWER switch to ON position.
(10) Using TELE control lever, telescope boom out completely.
(11) Adjust clarity of test unit display using control knob on bottom of test unit.
  (a) If test unit does not indicate 18.4 ft (5.61 m), go to Step 3 of this Fault.
  (b) If test unit indicates 18.4 ft (5.61 m), go to Step (12) below.
(12) Using TELE control lever, retract boom completely.
  (a) If test unit does not indicate 7.3 ft (2.2 m), go to Step 3 of this Fault.
  (b) If test unit indicates 7.3 ft (2.2 m), perform Steps (13) through (19) below and replace tension load cell (Para 3-28).

Continued on next page.



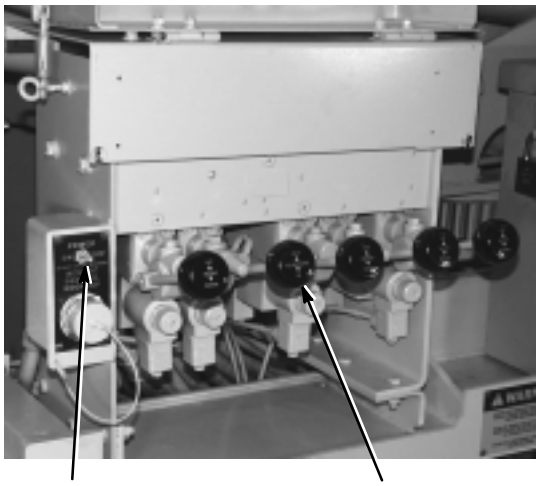


Table 2-7. Crane Troubleshooting (CONT).

WARNING

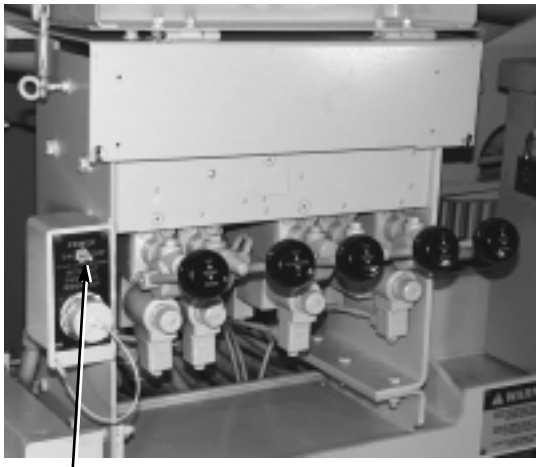
- Remove all jewelry such as rings, dog tags, bracelets, etc. If jewelry or tools contact positive electrical circuits a direct short may result. Damage to equipment, injury or death to personnel may result.
- Do not stand under crane. Mechanical failure and operator error can cause injury or death to personnel.
- Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesives, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

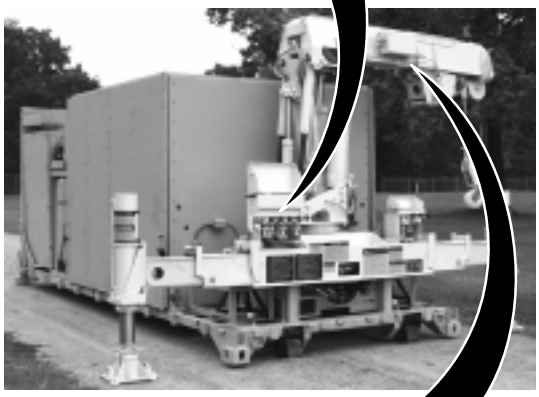
CAUTION

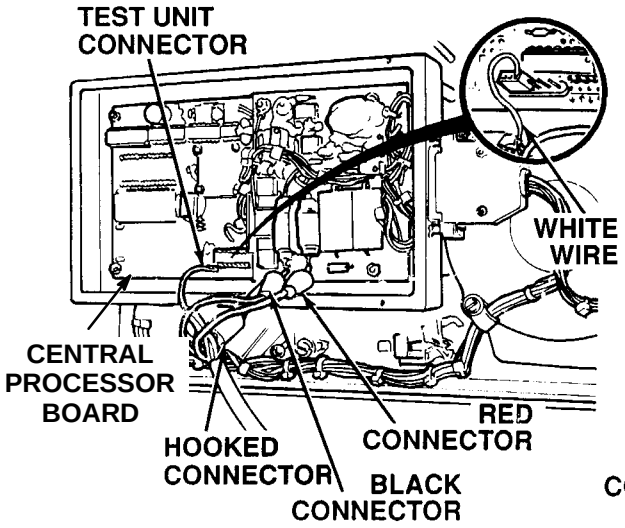
Hooked test unit connector must not contact other transistor wire or damage to OSS and test unit will result.

CALIBRATION TEST (CONT).

(13) Set crane main POWER switch to OFF position.
(14) Turn OFF engine switch.
(15) Disconnect four connectors from central processor board.
(16) Install cover on central processor unit with four screws.
(17) Install safety lock seal on two screws.
(18) Install cover on OSS box with four screws and preformed packings.
(19) Apply bead of sealant to edge of cover where it is against OSS box.







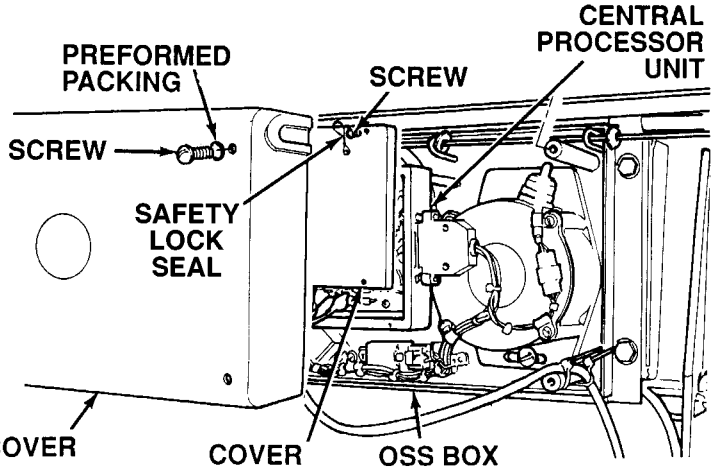


Table 2-7. Crane Troubleshooting (CONT).

1. OVERLOAD SHUTDOWN SYSTEM (OSS) DISABLES CRANE FUNCTIONS, BOOM UP, BOOM DOWN, TELESCOPE OUT AND HOIST UP (CONT).

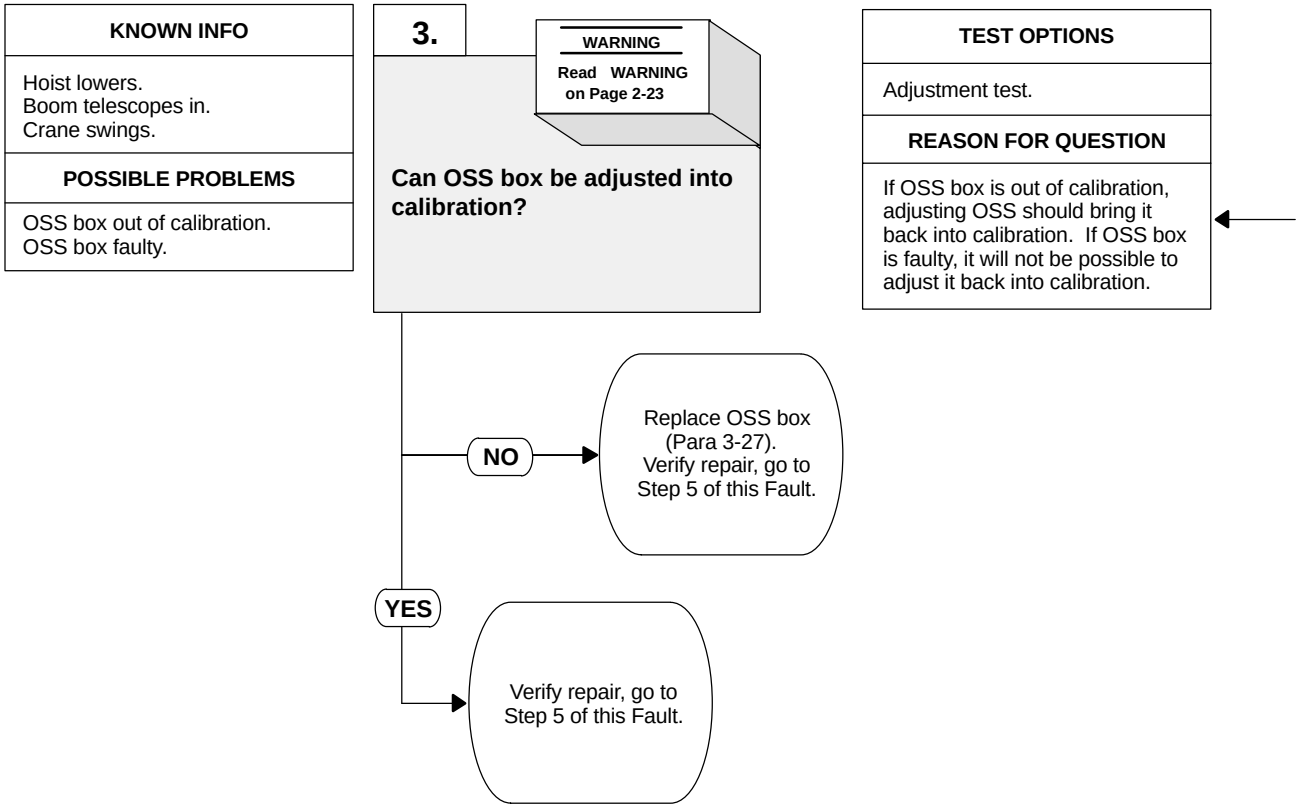


Table 2-7. Crane Troubleshooting (CONT).

WARNING

- Remove all jewelry such as rings, dog tags, bracelets, etc. If jewelry or tools contact positive electrical circuits a direct short may result. Damage to equipment, injury or death to personnel may result.
- Do not stand under crane. Mechanical failure and operator error can cause injury or death to personnel.

NOTE

- Record any adjustment made to gear assembly and length trimpot. The number of gear teeth moved or turns of trimpot screw may be necessary information for later steps.
- Adjustment made in Step (3) may be affected by adjustment made in Step (6).

ADJUSTMENT TEST
(1) Using TELE control lever, retract boom completely if not already done (TM 9-4940-568-10). (a) If test unit does not indicate 7.3 ft (2.2 m), go to Step (2) below. (b) If test unit indicates 7.3 ft (2.2 m), go to Step (5) below. (2) Loosen screw on gear assembly and slide gear assembly away from idler gear being careful not to move gears in relation to each other. (3) Rotate gear assembly gear to the right to increase test unit reading or to the left to decrease test unit reading. Moving the gear one to two teeth in a particular direction will increase or decrease test unit reading 0.1 to 0.2 ft (.03 to .06 m). (4) Mesh gear assembly gear and idler gear and tighten screw when test unit indicates 7.3 ft (2.2 m). (a) If it is not possible to adjust gear assembly enough that test unit indicates 7.3 ft (2.2 m), replace OSS box (Para 3-27). (b) If test unit indicates 7.3 ft (2.2 m), go to Step (5) below. (5) Using TELE control lever, extend boom completely. (a) If test unit does not indicate 18.4 ft (5.61 m), go to Step (6) below. (b) If test unit does indicate 18.4 ft (5.61 m) go to Step 5 of this Fault. (6) Adjust length trimpot until test unit indicates 18.4 ft (5.61 m). (a) If it is not possible to adjust length trim pot enough that test unit indicates 18.4 ft (5.61 m), replace OSS box (Para 3-27). (b) If test unit indicates 18.4 ft (5.61 m), go to Step (7) below. (7) Repeat Steps (1) through (6) a maximum of two more times to achieve a consistent reading of 7.3 ft (2.2 m) (retracted) and 18.4 ft (5.61 m) (extended) without needing adjustment. *Continued on next page.*

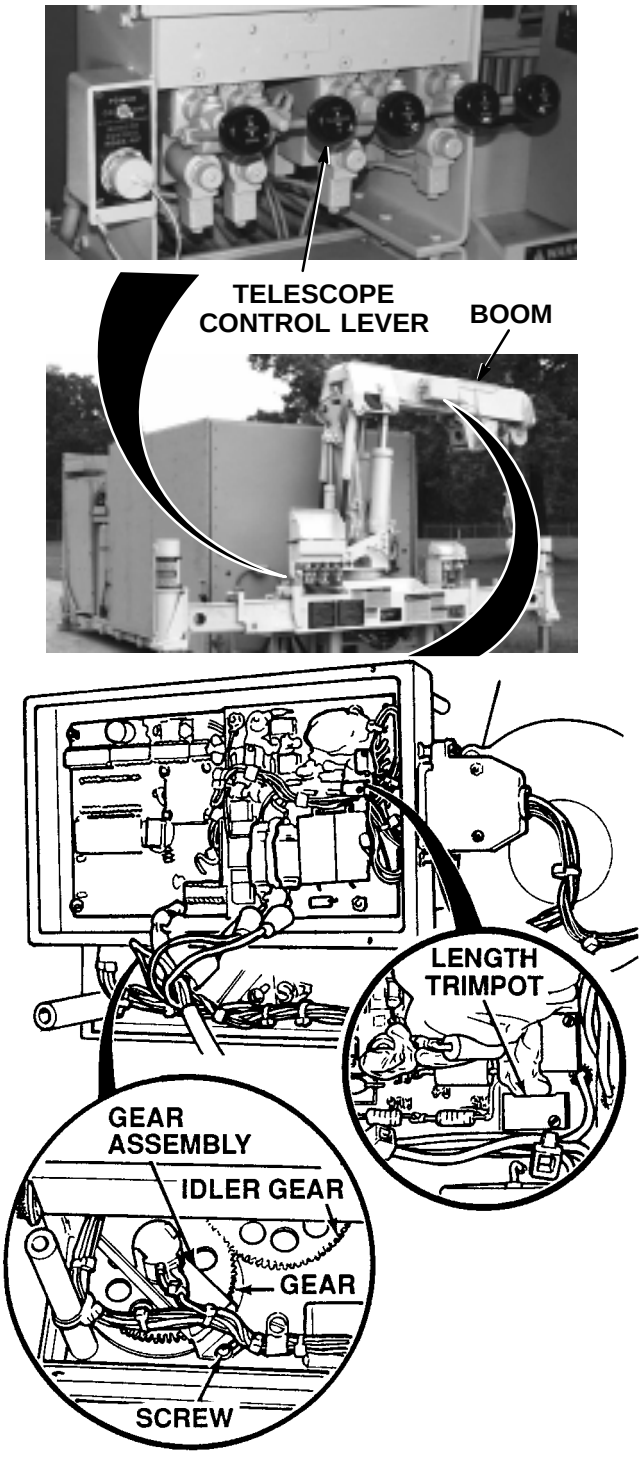
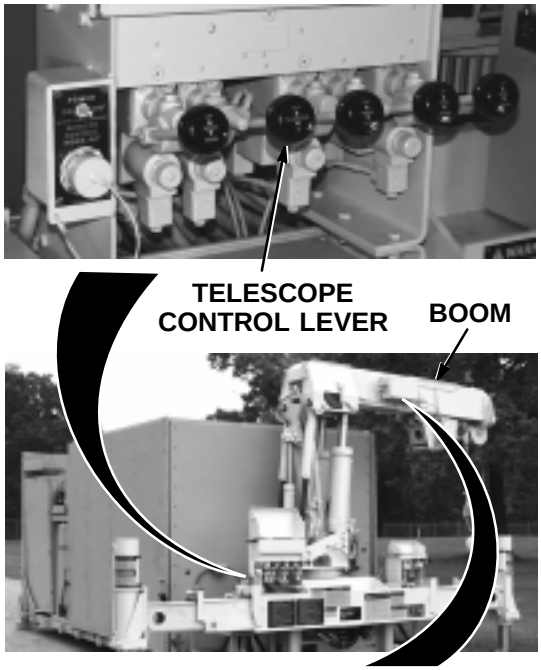


Table 2-7. Crane Troubleshooting (CONT).

1. OVERLOAD SHUTDOWN SYSTEM (OSS) DISABLES CRANE FUNCTIONS, BOOM UP, BOOM DOWN, TELESCOPE OUT AND HOIST UP (CONT).

WARNING

- Remove all jewelry such as rings, dog tags, bracelets, etc. If jewelry or tools contact positive electrical circuits a direct short may result. Damage to equipment, injury or death to personnel may result.
- Do not stand under crane. Mechanical failure and operator error can cause injury or death to personnel.



ADJUSTMENT TEST (CONT).

(a) If Steps (1) through (6) have been completed three times and it is still necessary to adjust trimpot or gear every time boom is fully extended or retracted, go to Step (8) below.
(b) If, after repeating Steps (1) through (6), the boom can be extended and retracted and test unit will indicate 18.4 ft (5.61 m) and 7.3 ft (2.2 m) without adjustment, go to Step 5 of this Fault.

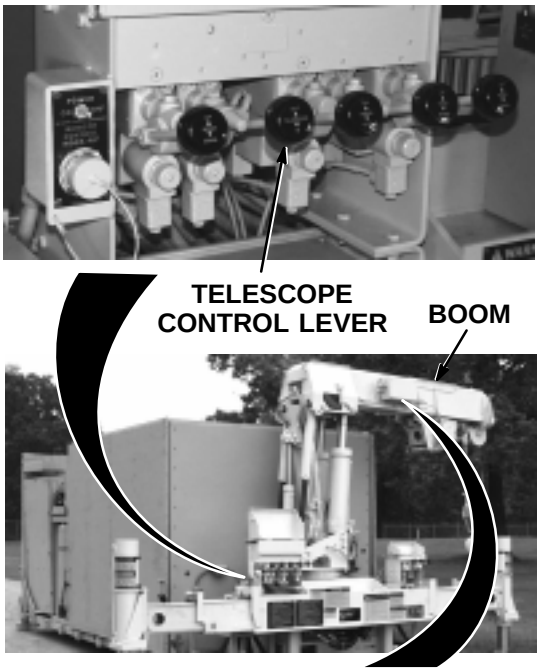
(8) Loosen screw on gear assembly and slide gear assembly away from idler gear being careful not to move gears in relation to each other.
(9) Rotate gear assembly gear back three teeth past the position it was in prior adjustment (if gear was turned seven teeth to the right during adjustment, then turn gear 10 teeth to the left).
(10) Mesh gear assembly gear and idler gear and tighten screw.
(11) Using TELE control lever, retract boom completely.

Continued on next page.

Table 2-7. Crane Troubleshooting (CONT).

WARNING

- Remove all jewelry such as rings, dog tags, bracelets, etc. If jewelry or tools contact positive electrical circuits a direct short may result. Damage to equipment, injury or death to personnel may result.
- Do not stand under crane. Mechanical failure and operator error can cause injury or death to personnel.



ADJUSTMENT TEST (CONT).

(12) Adjust length trimpot until test unit indicates 7.3 ft (2.2 m).
(13) Using TELE control lever, extend boom completely.
  (a) If test unit does not indicate 18.4 ft (5.61 m), go to Step (14) below.
  (b) If test unit does indicate 18.4 ft, (5.61 m) go to Step 5 of this Fault.
(14) Loosen screw on gear assembly and slide gear assembly away from idler gear being careful not to move gears in relation to each other.
(15) Rotate gear assembly gear to the right to increase test unit reading or to the left to decrease test unit reading. Moving the gear one to two teeth in a particular direction will increase or decrease test unit reading 0.1 to 0.2 ft (.03 to .06 m).
(16) Mesh gear assembly gear and idler gear and tighten screw when test unit indicates 18.4 ft (5.61 m).
(17) Repeat Steps (8) through (17) until boom can be extended and retracted with test unit indicating 18.4 ft (5.61 m) and 7.3 ft (2.2 m) without adjustment and then go to Step 5 of this Fault.

Table 2-7. Crane Troubleshooting (CONT).

1. OVERLOAD SHUTDOWN SYSTEM (OSS) DISABLES CRANE FUNCTIONS, BOOM UP, BOOM DOWN, TELESCOPE OUT AND HOIST UP (CONT).

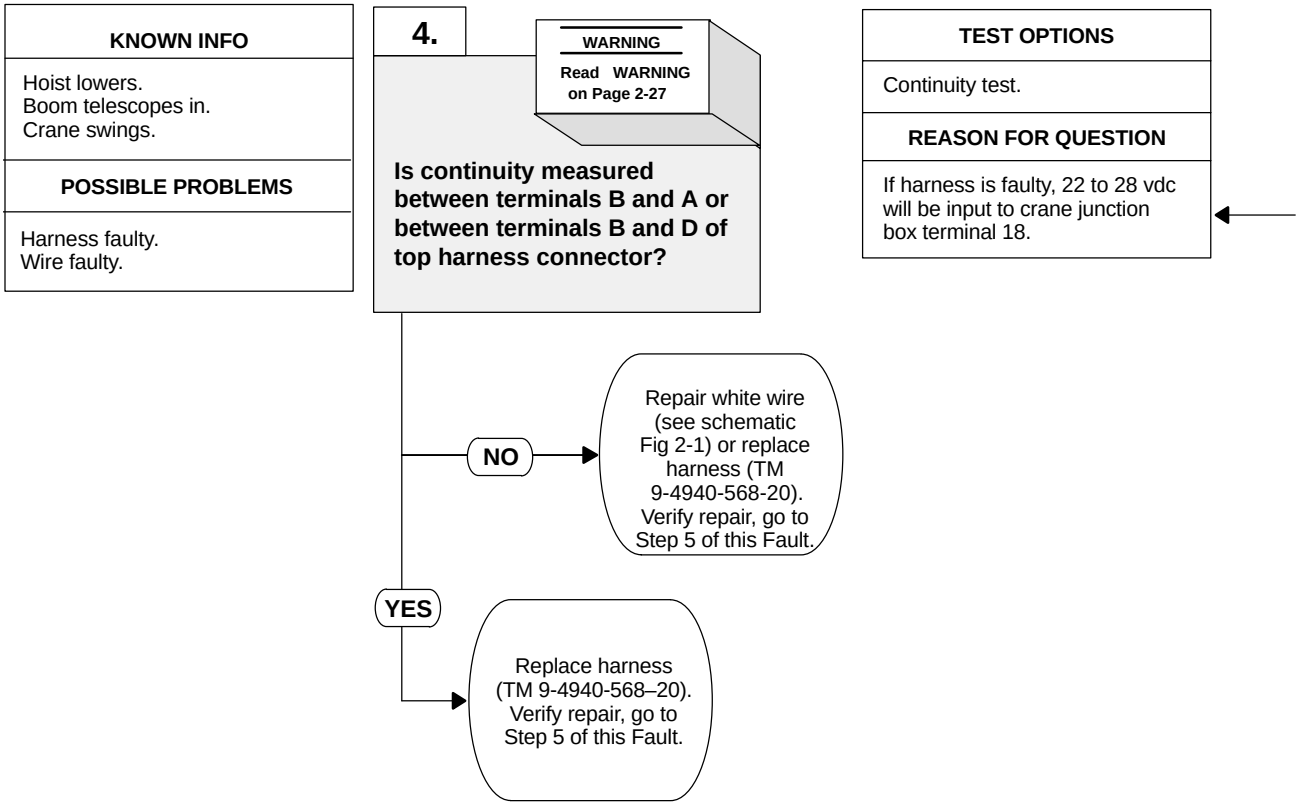


Table 2-7. Crane Troubleshooting (CONT).

WARNING

Remove all jewelry such as rings, dog tags, bracelets, etc. If jewelry or tools contact positive electrical circuits a direct short may result. Damage to equipment, injury or death to personnel may result.

NOTE

- Disconnected white wires should not be in contact.
- Steps (4) through (11) are for crane junction box.
- White wires should have 0 vdc present when OSS is not activated. Faulty wire is shorted to a wire with 22 to 28 vdc present.

CONTINUITY TEST
(1) Check disconnected harness connector for continuity between terminals B and A. (a) If continuity is present, replace harness (TM 9-4940-568-20). (b) If continuity is not present, go to Step (2) below. (2) Check disconnected harness connector for continuity between terminals B and D. (a) If continuity is present, replace harness (TM 9-4940-568-20). (b) If continuity is not present, go to Step (3) below. (3) Connect harness connector to OSS box. (4) Set multimeter to volts dc. (5) Connect multimeter negative lead to known good ground. (6) Connect multimeter positive lead to one of the four white wires disconnected from terminal 18 with ENGINE switch OFF (TM 9-4940-568-10). (7) Turn ON FRS. (8) Set crane main POWER switch to ON position. (9) Repeat Steps (6) through (8) until wire with 22 to 28 vdc present is found. Repair white wire (Fig 2-1) with 22 to 28 vdc present or replace harness after completing Steps (10) through (11) below. (10) Set crane main power switch to OFF position. (11) Turn OFF FRS.

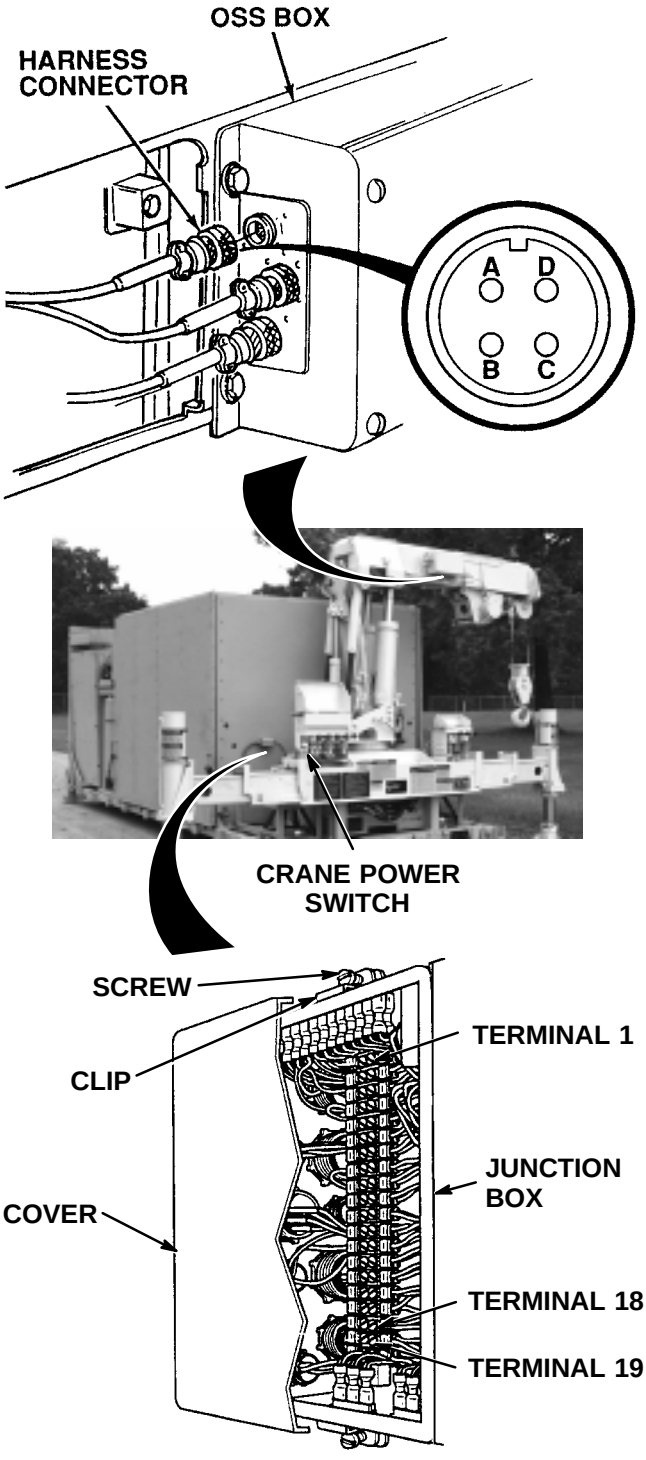


Table 2-7. Crane Troubleshooting (CONT).

1. OVERLOAD SHUTDOWN SYSTEM (OSS) DISABLES CRANE FUNCTIONS, BOOM UP, BOOM DOWN, TELESCOPE OUT AND HOIST UP (CONT).

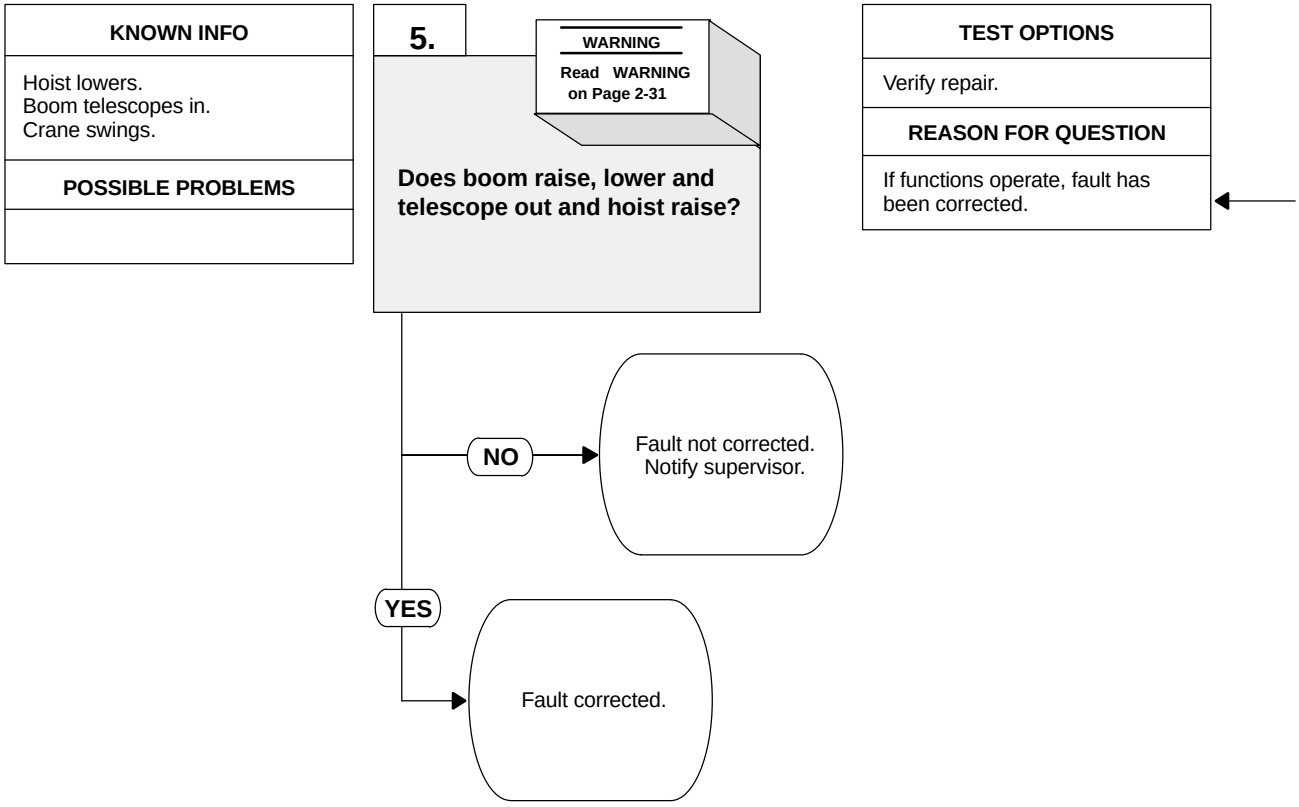


Table 2-7. Crane Troubleshooting (CONT).

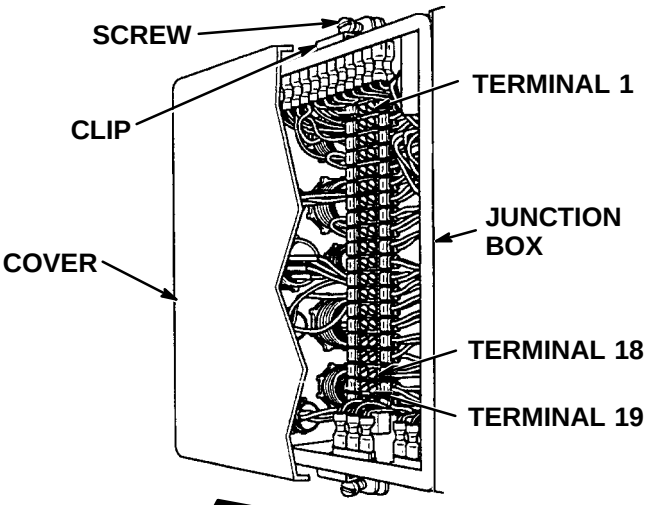
WARNING

- Remove all jewelry such as rings, dog tags, bracelets, etc. If jewelry or tools contact positive electrical circuits a direct short may result. Damage to equipment, injury or death to personnel may result.
- Do not stand under crane. Mechanical failure and operator error can cause injury or death to personnel.

VERIFY REPAIR

(1) Connect four white wires on crane junction box, terminal 18 with two screws.
(2) Disconnect jumper wire from crane junction box, terminals 1 and 19.
(3) Turn ON crane main POWER switch.
(4) Attempt to operate boom and hoist functions using BOOM, TELESCOPE and HOIST control levers.
  (a) If functions do not operate, fault not corrected. Notify Supervisor and perform Steps (5) through (13) below.
  (b) If functions operate, fault has been corrected. Perform Steps (5) through (13) below.

Continued on next page.



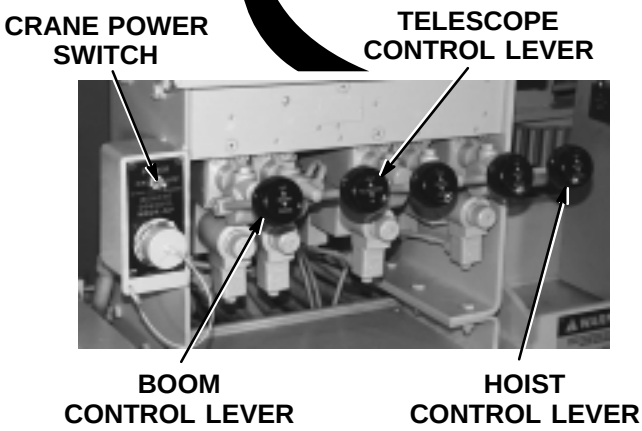


Table 2-7. Crane Troubleshooting (CONT).

1. OVERLOAD SHUTDOWN SYSTEM (OSS) DISABLES CRANE FUNCTIONS, BOOM UP, BOOM DOWN, TELESCOPE OUT AND HOIST UP (CONT).

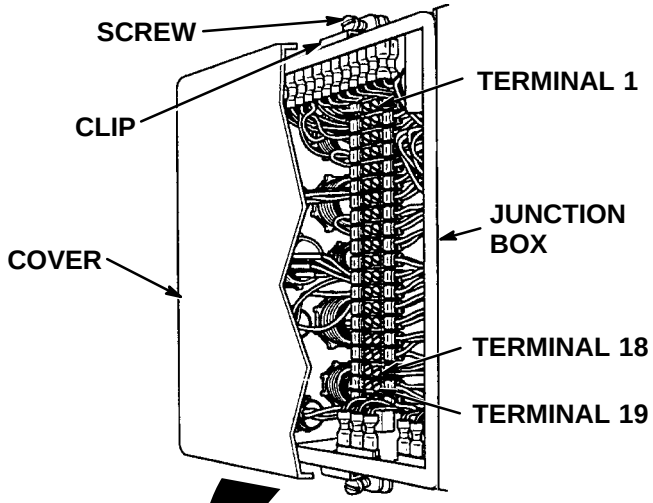
WARNING

- Remove all jewelry such as rings, dog tags, bracelets, etc. If jewelry or tools contact positive electrical circuits a direct short may result. Damage to equipment, injury or death to personnel may result.
- Do not stand under crane. Mechanical failure and operator error can cause injury or death to personnel.

VERIFY REPAIR (CONT).

(5) Set crane main POWER switch to OFF position.
(6) Turn OFF FRS.
(7) Install cover on crane main junction box.
(8) Place four clips on edge of cover and tighten four screws.

Continued on next page.



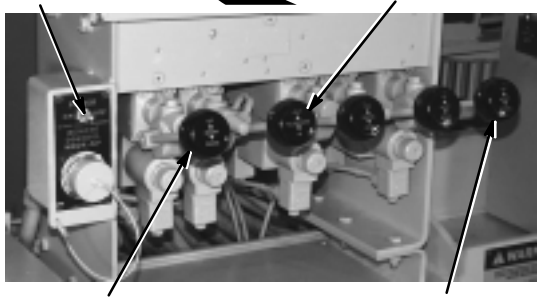


Table 2-7. Crane Troubleshooting (CONT).

WARNING

- Remove all jewelry such as rings, dog tags, bracelets, etc. If jewelry or tools contact positive electrical circuits a direct short may result. Damage to equipment, injury or death to personnel may result.
- Do not stand under crane. Mechanical failure and operator error can cause injury or death to personnel.
- Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesives, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

CAUTION

Hooked test unit connector must not contact other transistor wire or damage to OSS and test unit will result.

NOTE

If OSS box cover is installed, do not perform Steps (9) through (13) below.

VERIFY REPAIR (CONT).

(9) Disconnect four connectors from central microprocessor.
(10) Install cover on central processor unit with four screws.
(11) Install safety lock seal on two screws.
(12) Install cover on OSS box with four screws and preformed packings.
(13) Apply bead of sealant to edge of cover where it is against OSS box.

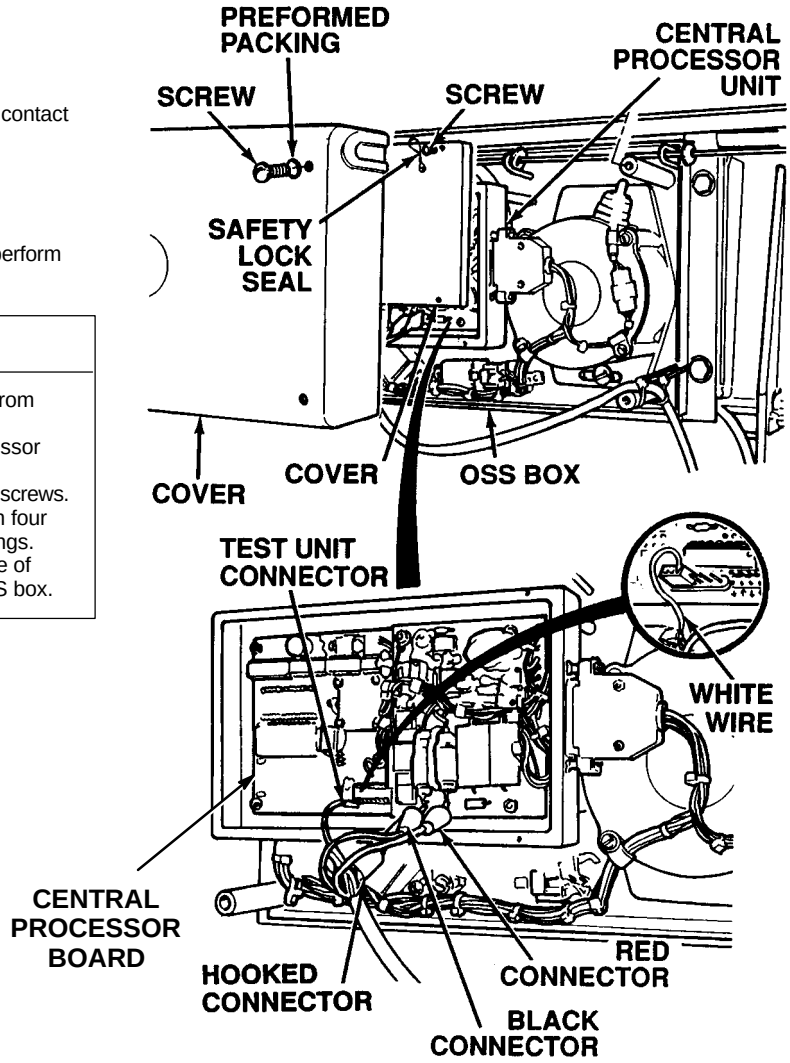


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

CRANE HYDRAULIC

1. CRANE FUNCTIONS DO NOT OPERATE OR OPERATE SLOWLY.

WARNING

Never disconnect any hydraulic hose or part while FRS is running. Allow several minutes for pressure to relieve itself. With FRS shut down, operate control valves fully in each direction to relieve trapped pressure.

Before testing hydraulic system with a flow meter, always open the pressure control valve all the way by turning the knob counter clockwise to DECREASE. Failure to do so may cause hydraulic lines to burst, causing personal injury.

When increasing hydraulic system pressure with the pressure control valve, always increase pressure slowly. If pressure is increased too fast, damage to hydraulic system or test set will result.

CAUTION

- Checking system pressure involves putting valves into relief. Relief is defined as a point when a needed system pressure is reached, causing excessive pressurized hydraulic fluid to be directed to the hydraulic reservoir.

- Relief is accomplished either by operating the system in a manner which will create relief or by using the loading valve on the flow meter, which will simulate the operating conditions. Putting valves into relief should be limited to no more than 10 seconds to prevent excessive heat buildup.

Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

NOTE

- Unless called for in the test being done, all pressure tests will be done with FRS 24 V MASTER switch in the ON position, and hydraulic oil temperature at 130-150° F (54-66° C).
- Unless advised otherwise, the crane MAIN POWER switch must be in the ON position for all checks.
- Crane manual override valve is in “normal” position (turned in and locked).
- Before performing troubleshooting procedures, make sure there are no restrictions in pressure or return lines.

Test 1. Check hydraulic pressure to crane. Refer to paragraph 4-3 in this manual.

- If hydraulic pressure is correct, go to Test 2.
- If hydraulic pressure is not correct, adjust or replace hydraulic pump. Refer to paragraph 4-2 or 4-3 in this manual.

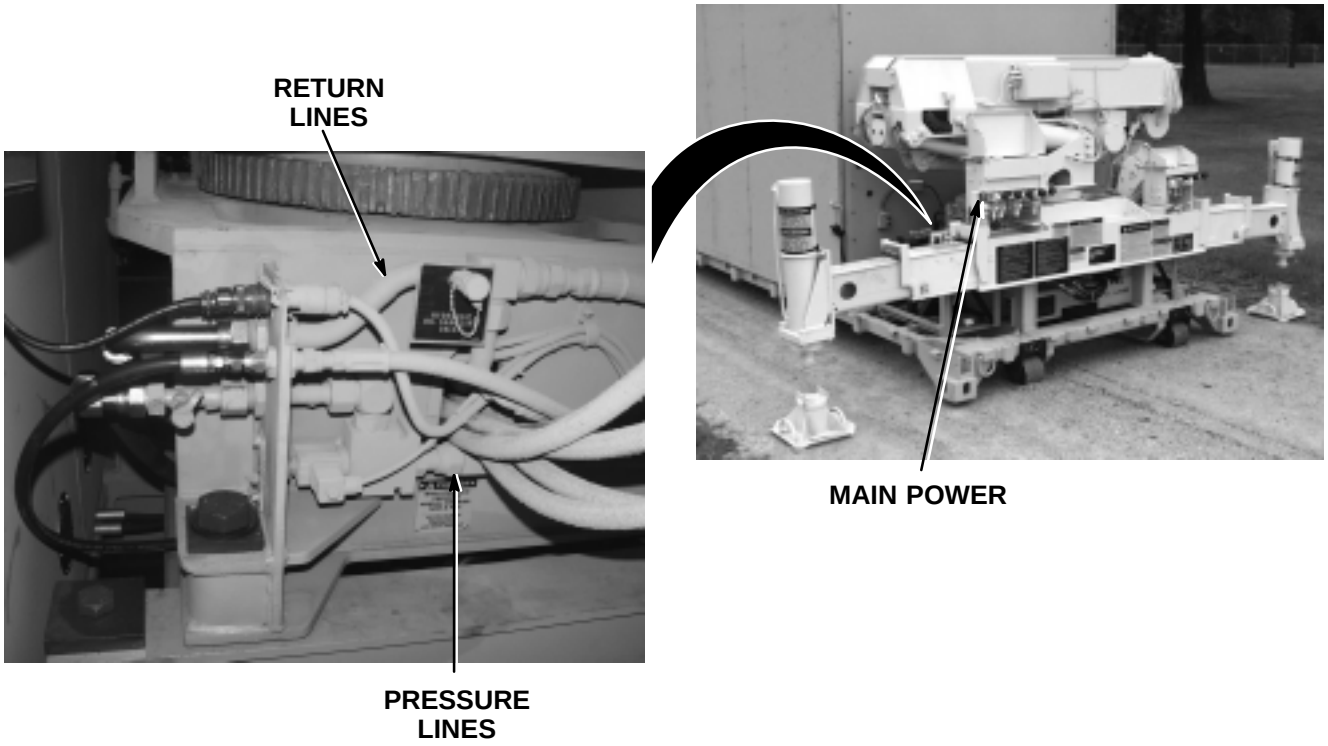


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

1. CRANE FUNCTIONS DO NOT OPERATE OR OPERATE SLOWLY (Continued).

Test 2. Install hydraulic pressure test meter on test port. Start FRS. Observe hydraulic pressure. Have assistant operate either outrigger jack control lever to attempt to raise or lower jack. Check that hydraulic pressure to five valve bank assembly is 3,000 - 3,200 psi (20,684 to 22,063 kPa).

- If hydraulic pressure is not correct, repair shuttle valve circuit(s). Refer to paragraph 3-37 in this manual.
- If hydraulic pressure is correct, go to Test 3.

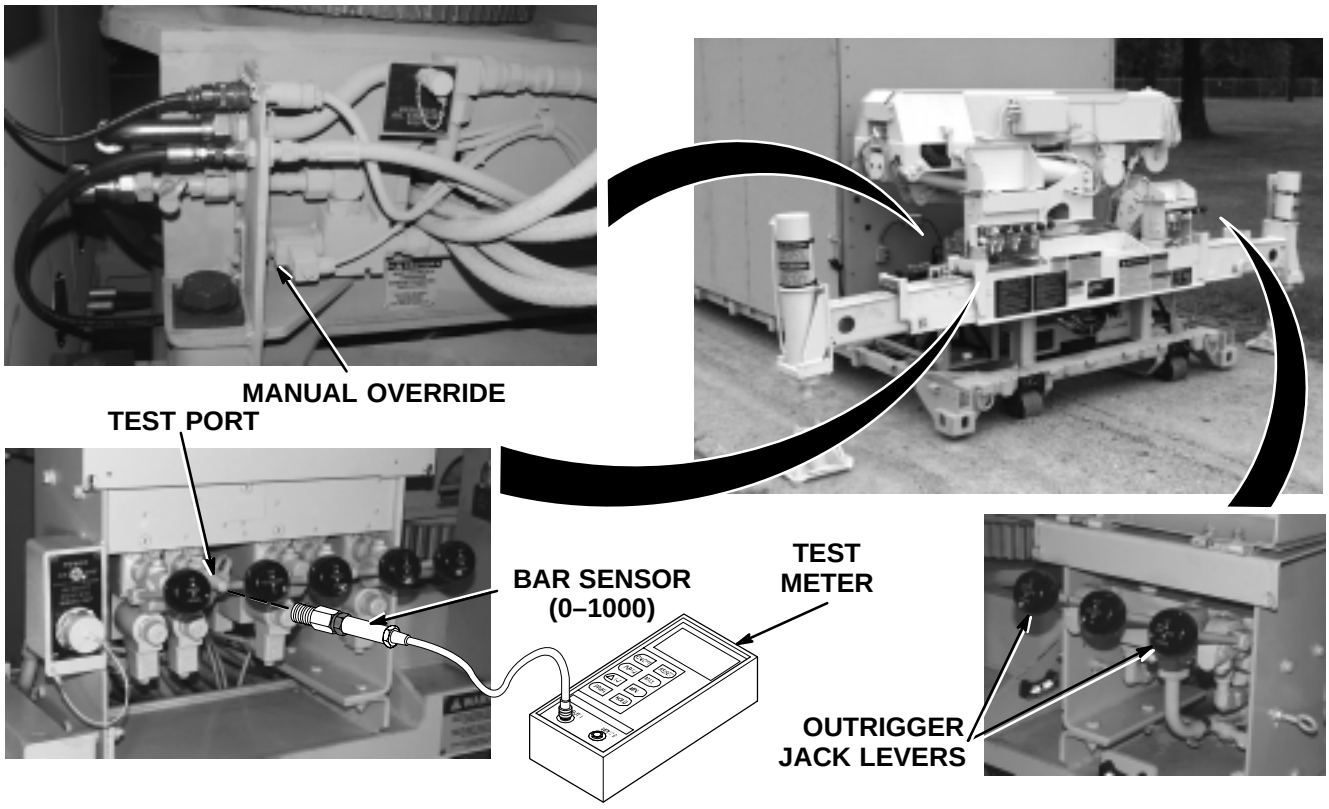


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	

Test 3. Check that hydraulic pressure to five valve bank assembly is correct with manual override valve button pulled out. Refer to TM 9-4940-568-10.

- While holding the TELESCOPE control lever in the RETRACT position, observe hydraulic pressure. If hydraulic pressure is 3,000 - 3,200 psi (20,684 to 22,063 kPa), perform Electrical Troubleshooting. Refer to CRANE ELECTRIC Troubleshooting in this manual.
- If hydraulic pressure is not 3,000 - 3,200 psi (20,684 to 22,063 kPa) or override is stuck, adjust or replace main pressure relief valve or replace manual override valve. Refer to paragraph 3-33 or 3-42 or 3-46.

END OF TEST

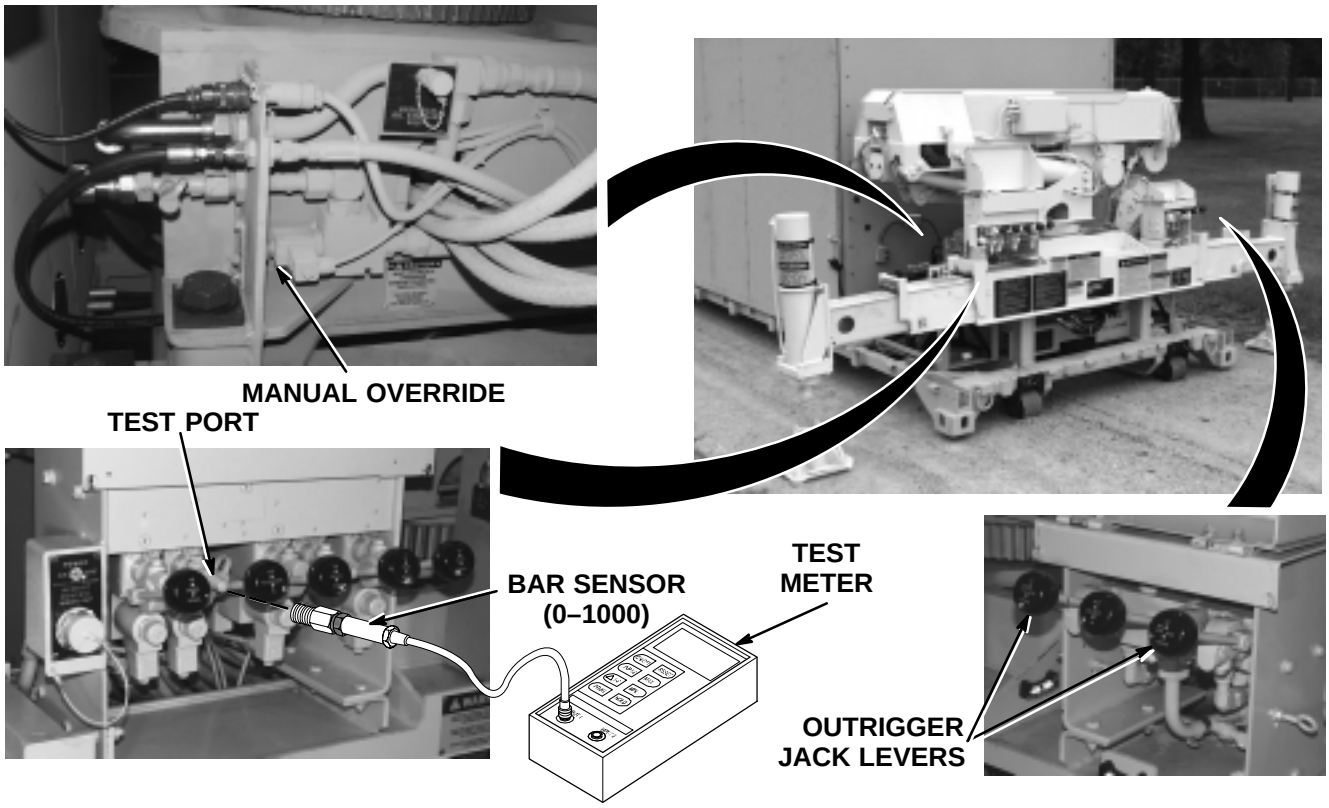


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

2. OUTRIGGER BEAM DOES NOT EXTEND OR RETRACT.

WARNING

Never disconnect any hydraulic hose or part while FRS is running. Allow several minutes for pressure to relieve itself. With FRS shut down, operate control valves fully in each direction to relieve trapped pressure.

Before testing hydraulic system with a flow meter, always open the pressure control valve all the way by turning the knob counter clockwise to DECREASE. Failure to do so may cause hydraulic lines to burst, causing personal injury.

When increasing hydraulic system pressure with the pressure control valve, always increase pressure slowly. If pressure is increased too fast, damage to hydraulic system or test set will result.

CAUTION

- Checking system pressure involves putting valves into relief. Relief is defined as a point when a needed system pressure is reached, causing excessive pressurized hydraulic fluid to be directed to the hydraulic reservoir.
- Relief is accomplished either by operating the system in a manner which will create relief or by using the loading valve on the flow meter, which will simulate the operating conditions. Putting valves into relief should be limited to no more than 10 seconds to prevent excessive heat buildup.

NOTE

- Unless called for in the test being done, all pressure tests will be done with FRS 24 V MASTER switch in the ON position, and hydraulic oil temperature at 130-150° F (54-66° C).
- Unless advised otherwise, the FRS 24V MASTER switch and the crane MAIN POWER switch must be in the ON position for all voltage checks.
- Before performing troubleshooting procedures, make sure there are no restrictions in pressure or return lines.
- If outrigger beams will not retract, go to Test 3.

Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
Test 1.	Remove the line that comes from the outrigger beam extend fitting at the middle valve of three valve bank assembly. Install a flow meter in line between control valve and line. Open pressure control valve fully by turning control knob counter clockwise to DECREASE. Start FRS. Have assistant operate O/R EXT. control lever to attempt to extend outrigger beam. Slowly close pressure control valve by turning knob clockwise to INCREASE. Create 3,000 - 3,200 psi (20,684 to 22,063 kPa) working pressure. • If pressure is within specifications, repair or replace outrigger beam extend/retract cylinder. Refer to paragraph 3-8 or 6-2. • If pressure is not within specifications, repair or replace outrigger control valve/shuttle valve circuit. Refer to paragraphs 3-34 or 3-35. If fault is not corrected, repair or replace outrigger beam extend/retract cylinder. Refer to paragraph 3-8 or 6-2.

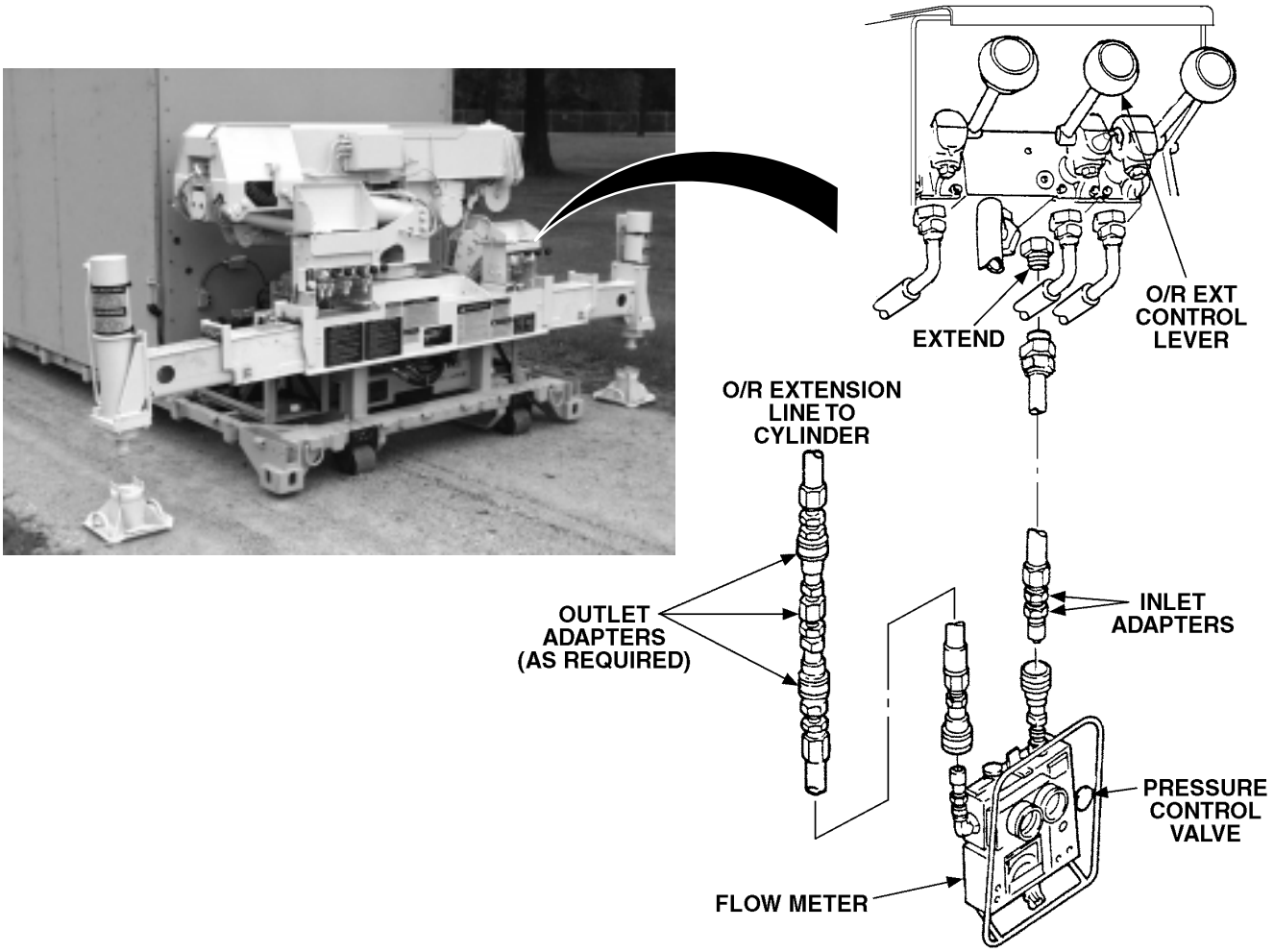


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

2. OUTRIGGER BEAM DOES NOT EXTEND OR RETRACT (Continued).

Test 2. Remove the line that comes from the outrigger beam retract fitting at middle valve of three valve bank assembly. Install a flow meter in line between control valve and line. Open pressure control valve fully by turning control knob counter clockwise to DECREASE. Start FRS. Have assistant operate O/R EXT control lever to attempt to retract outrigger beam. Slowly close pressure control valve by turning knob clockwise to INCREASE. Create 3,000 - 3,200 psi (20,684 to 22,063 kPa) working pressure.

- If pressure is within specifications, repair or replace outrigger beam extend/retract cylinder. Refer to paragraph 3-8 or 6-2.
- If pressure is not within specifications, repair or replace control valve/shuttle valve circuit. Refer to paragraphs 3-7 or 3-35. If fault is not corrected, repair or replace outrigger beam extend/retract cylinder. Refer to paragraph 3-8 or 6-2.

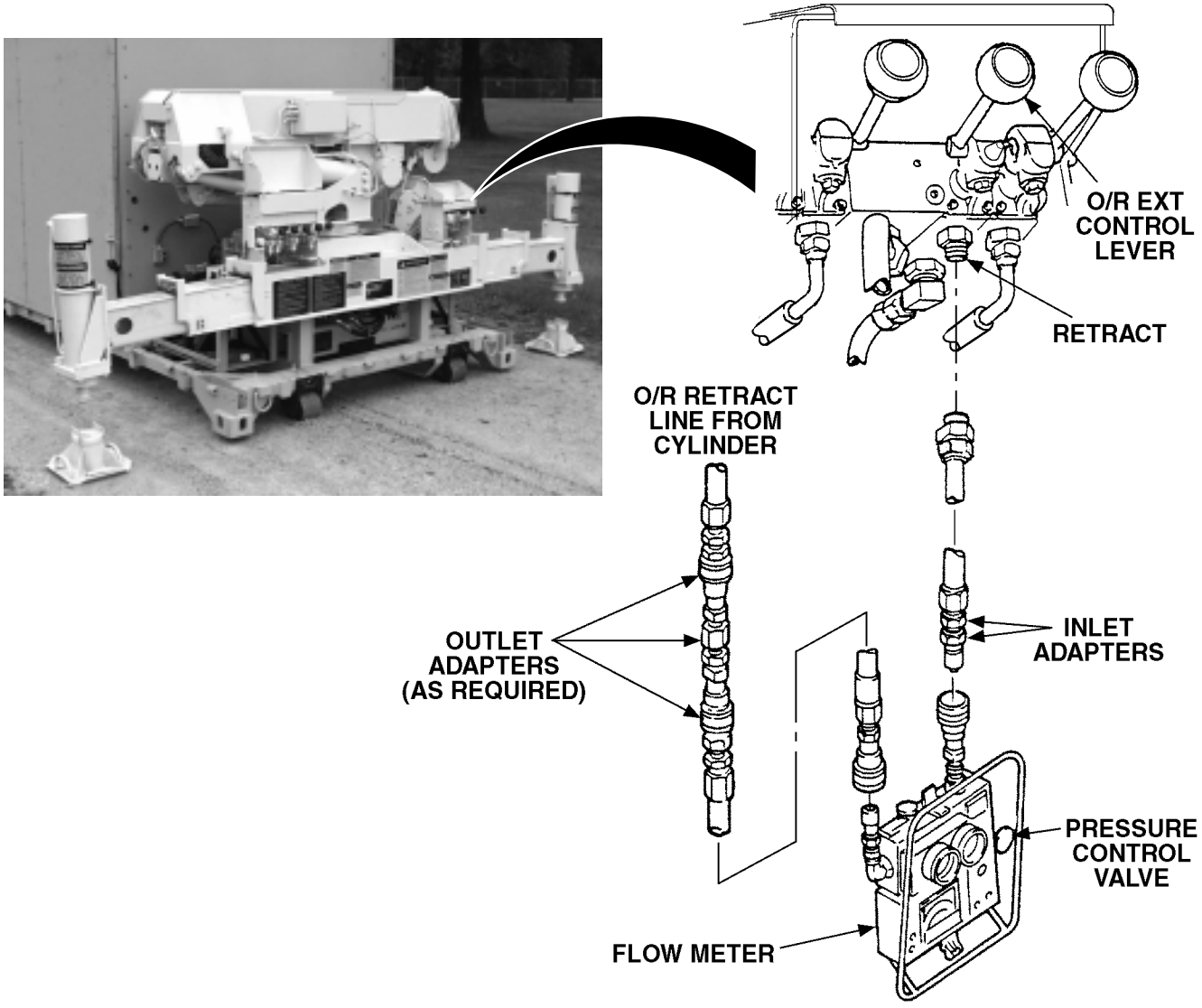


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

3. LEFT OUTRIGGER JACK CYLINDER DOES NOT RAISE OR LOWER.

WARNING

Never disconnect any hydraulic hose or part while FRS is running. Allow several minutes for pressure to relieve itself. With FRS shut down, operate control valves fully in each direction to relieve trapped pressure.

Before testing hydraulic system with a flow meter, always open the pressure control valve all the way by turning the knob counter clockwise to DECREASE. Failure to do so may cause hydraulic lines to burst, causing personal injury.

When increasing hydraulic system pressure with the pressure control valve, always increase pressure slowly. If pressure is increased too fast, damage to hydraulic system or test set will result.

CAUTION

- Checking system pressure involves putting valves into relief. Relief is defined as a point when a needed system pressure is reached, causing excessive pressurized hydraulic fluid to be directed to the hydraulic reservoir.
- Relief is accomplished either by operating the system in a manner which will create relief or by using the loading valve on the flow meter, which will simulate the operating conditions. Putting valves into relief should be limited to no more than 10 seconds to prevent excessive heat buildup.

NOTE

- Unless called for in the test being done, all pressure tests will be done with FRS 24 V MASTER switch in the ON position, and hydraulic oil temperature at 130-150° F (54-66° C).
- Unless advised otherwise, the FRS 24V MASTER switch and the crane MAIN POWER switch must be in the ON position for all voltage checks.
- Before performing troubleshooting procedures, make sure there are no restrictions in pressure or return lines.
- If outrigger jack cylinder will not raise, go to Test 2.

Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

3. LEFT OUTRIGGER JACK CYLINDER DOES NOT RAISE OR LOWER (Continued).

Test 1. Disconnect the line that comes from the outrigger jack cylinder extend fitting at left jack control valve of three valve bank assembly. Install a flow meter in line between control valve and line. Open pressure control valve fully by turning control knob counter clockwise to DECREASE. Start FRS. Have assistant operate LH O/R JACK control lever to attempt to extend outrigger jack cylinder. Slowly close pressure control valve by turning knob clockwise to INCREASE. Create 3,000 - 3,200 psi (20,684 to 22,063 kPa) working pressure.

- If pressure is within specifications, repair or replace outrigger jack cylinder. Refer to paragraph 3-9 or 6-2.
- If pressure is not within specifications, go to Test 2.

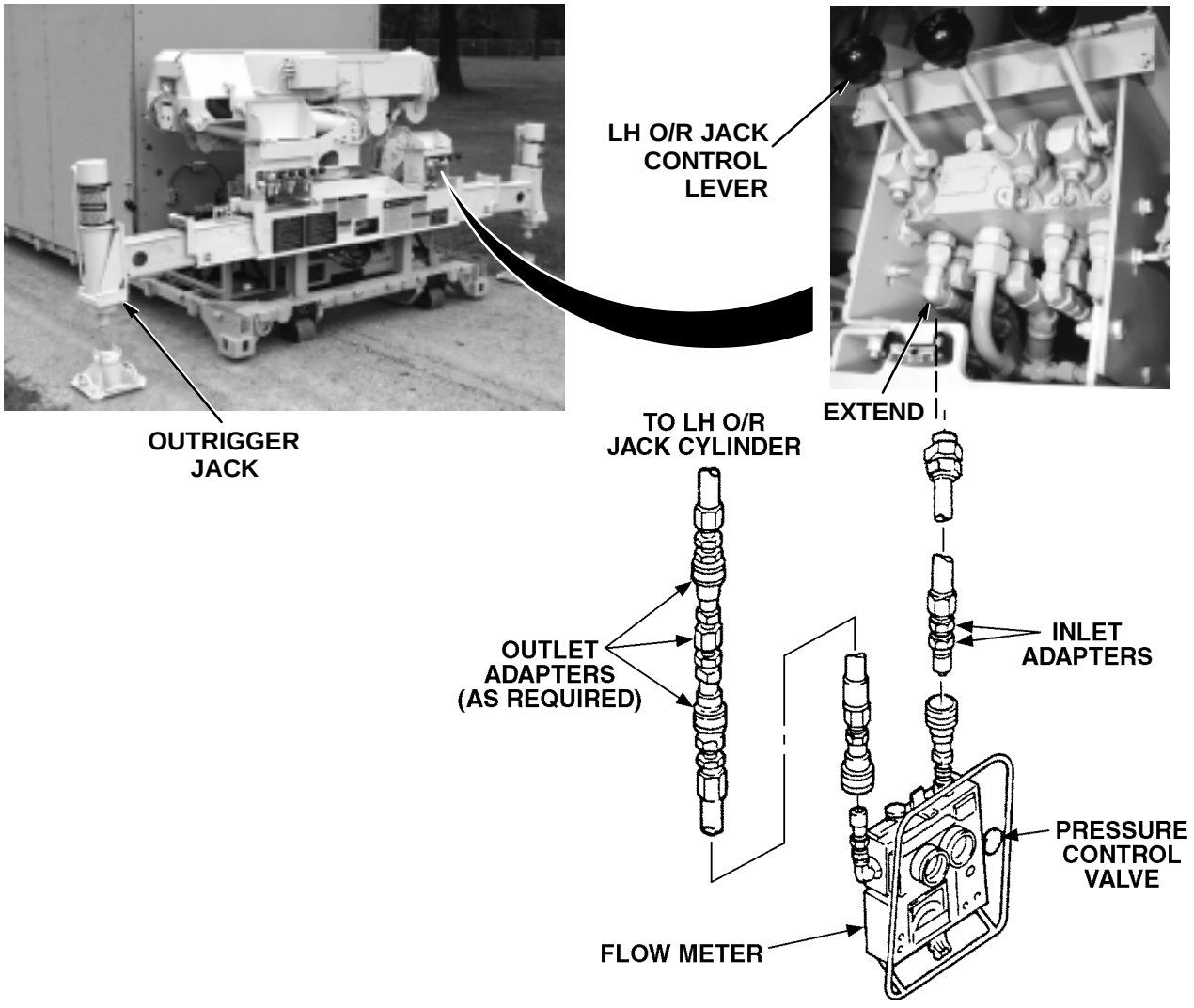


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
Test 2.	Disconnect the line that comes from the outrigger jack cylinder retract fitting at the left jack control valve of three valve bank assembly. Install a flow meter in line between control valve and line. Open pressure control valve fully by turning control knob counter clockwise to DECREASE. Start FRS. Have assistant operate LH O/R JACK control lever to attempt to retract outrigger jack cylinder. Slowly close pressure control valve by turning knob clockwise to INCREASE. Create 3,000 - 3,200 psi (20,684 to 22,063 kPa) working pressure. • If pressure is within specifications, repair or replace outrigger jack cylinder. Refer to paragraphs 3-9 or 6-3. • If pressure is not within specifications, repair or replace control valve/shuttle valve circuit. Refer to paragraphs 3-7 or 3-35. If fault is not corrected, repair or replace outrigger jack cylinder. Refer to paragraphs 3-9 or 6-3.

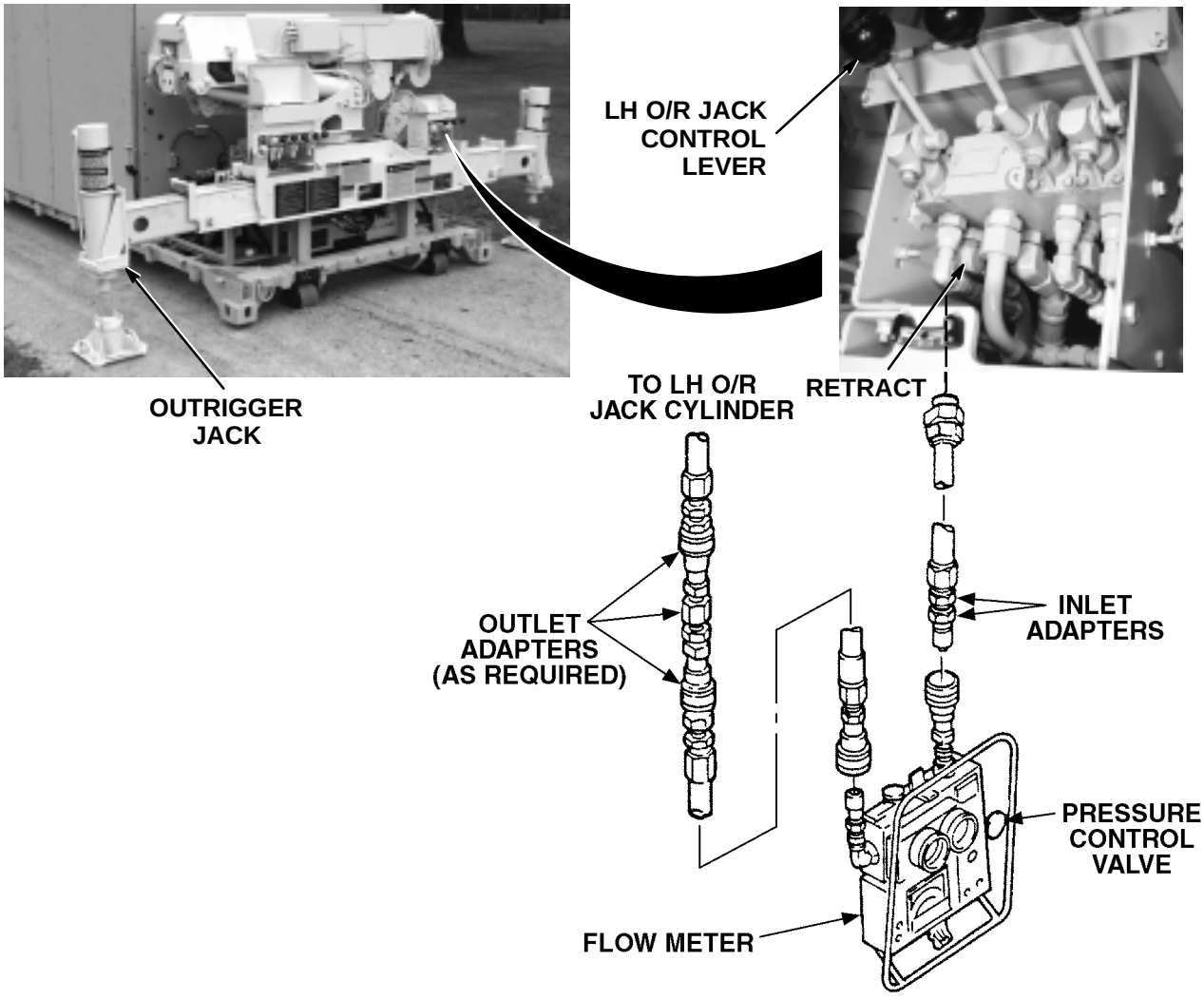


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

4. RIGHT OUTRIGGER JACK CYLINDER DOES NOT RAISE OR LOWER.

WARNING

Never disconnect any hydraulic hose or part while FRS is running. Allow several minutes for pressure to relieve itself. With FRS shut down, operate control valves fully in each direction to relieve trapped pressure.

Before testing hydraulic system with a flow meter, always open the pressure control valve all the way by turning the knob counter clockwise to DECREASE. Failure to do so may cause hydraulic lines to burst, causing personal injury.

When increasing hydraulic system pressure with the pressure control valve, always increase pressure slowly. If pressure is increased too fast, damage to hydraulic system or test set will result.

CAUTION

- Checking system pressure involves putting valves into relief. Relief is defined as a point when a needed system pressure is reached, causing excessive pressurized hydraulic fluid to be directed to the hydraulic reservoir.
- Relief is accomplished either by operating the system in a manner which will create relief or by using the loading valve on the flow meter, which will simulate the operating conditions. Putting valves into relief should be limited to no more than 10 seconds to prevent excessive heat buildup.

NOTE

- Unless called for in the test being done, all pressure tests will be done with FRS 24 V MASTER switch in the ON position, and hydraulic oil temperature at 130-150° F (54-66° C).
- Unless advised otherwise, the FRS 24V MASTER switch and the crane MAIN POWER switch must be in the ON position for all voltage checks.
- Before performing troubleshooting procedures, make sure there are no restrictions in pressure or return lines.
- If outrigger jack cylinder will not lower, go to Test 3.

Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	

Test 1. Disconnect the line that comes from the outrigger jack cylinder extend fitting at the right jack control valve of three valve bank assembly. Install a flow meter in line between control valve and line. Open pressure control valve fully by turning control knob counter clockwise to DECREASE. Start FRS. Have assistant operate RH O/R JACK control lever to attempt to extend outrigger jack cylinder. Slowly close pressure control valve by turning knob clockwise to INCREASE. Create 3,000 - 3,200 psi (20,684 to 22,063 kPa) working pressure.

- If pressure is within specifications, repair or replace outrigger jack cylinder. Refer to paragraphs 3-9 or 6-3.
- If pressure is not within specifications, go to Test 2.

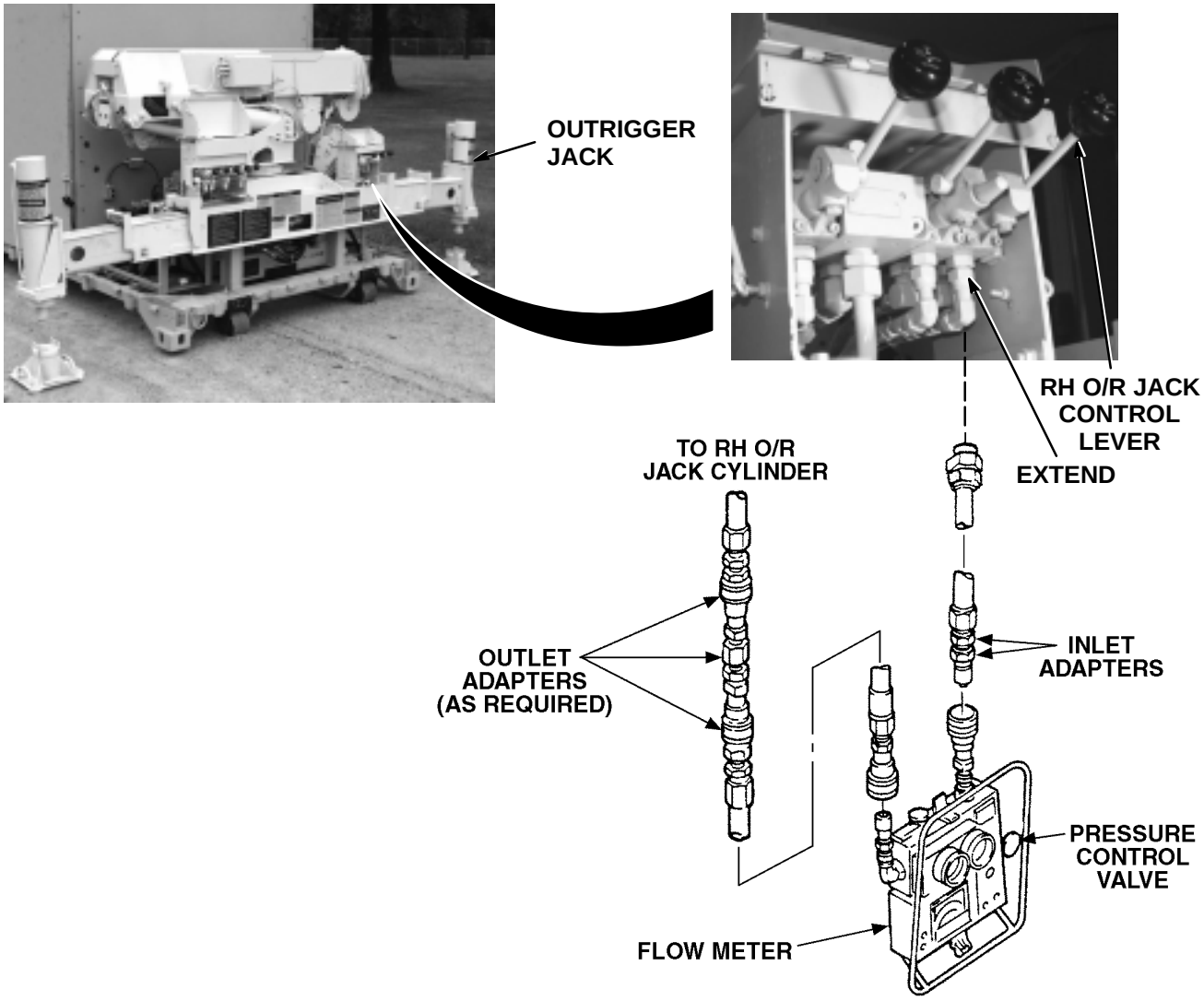


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

4. RIGHT OUTRIGGER JACK CYLINDER DOES NOT RAISE OR LOWER (Continued).

Test 2. Disconnect the line that comes from the outrigger jack cylinder retract fitting at the right jack control valve of three valve bank assembly. Install a flow meter in line between control valve and line. Open pressure control valve fully by turning control knob counter clockwise to DECREASE. Start FRS. Have assistant operate RH O/R JACK control lever to attempt to retract outrigger jack cylinder. Slowly close pressure control valve by turning knob clockwise to INCREASE. Create 3,000 - 3,200 psi (20,684 to 22,063 kPa) working pressure.

- If pressure is within specifications, repair or replace outrigger jack cylinder. Refer to paragraph 3-9 or 6-3.
- If pressure is not within specifications, repair or replace control valve/shuttle valve circuit. Refer to paragraphs 3-7 or 3-35. If fault is not corrected, repair or replace outrigger jack cylinder. Refer to paragraphs 3-9 or 6-3.

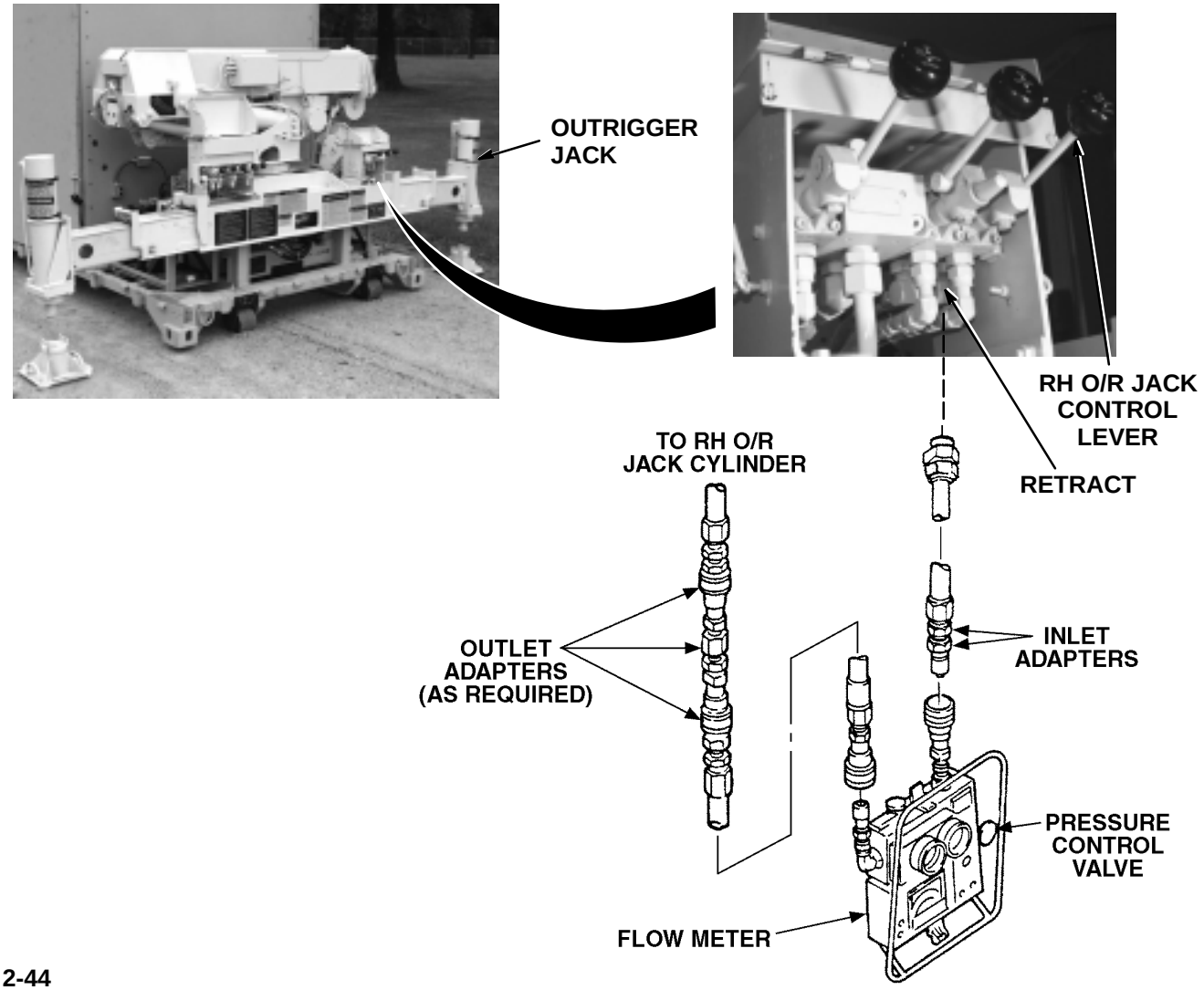


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

5. MAST DOES NOT RAISE OR LOWER.

WARNING

Never disconnect any hydraulic hose or part while FRS is running. Allow several minutes for pressure to relieve itself. With FRS shut down, operate control valves fully in each direction to relieve trapped pressure.

Before testing hydraulic system with a flow meter, always open the pressure control valve all the way by turning the knob counter clockwise to DECREASE. Failure to do so may cause hydraulic lines to burst, causing personal injury.

When increasing hydraulic system pressure with the pressure control valve, always increase pressure slowly. If pressure is increased too fast, damage to hydraulic system or test set will result.

CAUTION

- Checking system pressure involves putting valves into relief. Relief is defined as a point when a needed system pressure is reached, causing excessive pressurized hydraulic fluid to be directed to the hydraulic reservoir.
- Relief is accomplished either by operating the system in a manner which will create relief or by using the loading valve on the flow meter, which will simulate the operating conditions. Putting valves into relief should be limited to no more than 10 seconds to prevent excessive heat buildup.

NOTE

- Unless called for in the test being done, all pressure tests will be done with FRS 24 V MASTER switch in the ON position, and hydraulic oil temperature at 130-150° F (54-66° C).
- Unless advised otherwise, the FRS 24V MASTER switch and the crane MAIN POWER switch must be in the ON position for all voltage checks.
- Before performing troubleshooting procedures, make sure there are no restrictions in pressure or return lines.

Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

5. MAST DOES NOT RAISE OR LOWER (Continued).

Test 1. Check that tension links are not damaged or seized up.

- If damage is not found, and tension links are not seized up, go to Test 2.
- If damage is found, or tension links are seized up, replace tension link cylinders. Refer to paragraph 3-20.

NOTE

If mast does not lower, go to Test 3.

Test 2. Remove five function control cover. Refer to paragraph 3-31. Disconnect the line that comes from the extend fitting to the mast control valve. Install a flow meter in line between control valve and line. Open pressure control valve fully by turning control knob counter clockwise to DECREASE. Start FRS. Have assistant operate MAST control lever to attempt to raise mast. Slowly close pressure control valve by turning knob clockwise to INCREASE. Create 3,000 - 3,200 psi (20,684 to 22,063 kPa) working pressure.

- If pressure is within specifications, repair or replace erection cylinder. Refer to paragraphs 3-19 or 6-10.
- If pressure is not within specifications, repair MAST control valve/shuttle valve circuit. Refer to paragraph 3-35. If fault is not corrected, repair or replace erection cylinder. Refer to paragraphs 3-19 or 6-10.

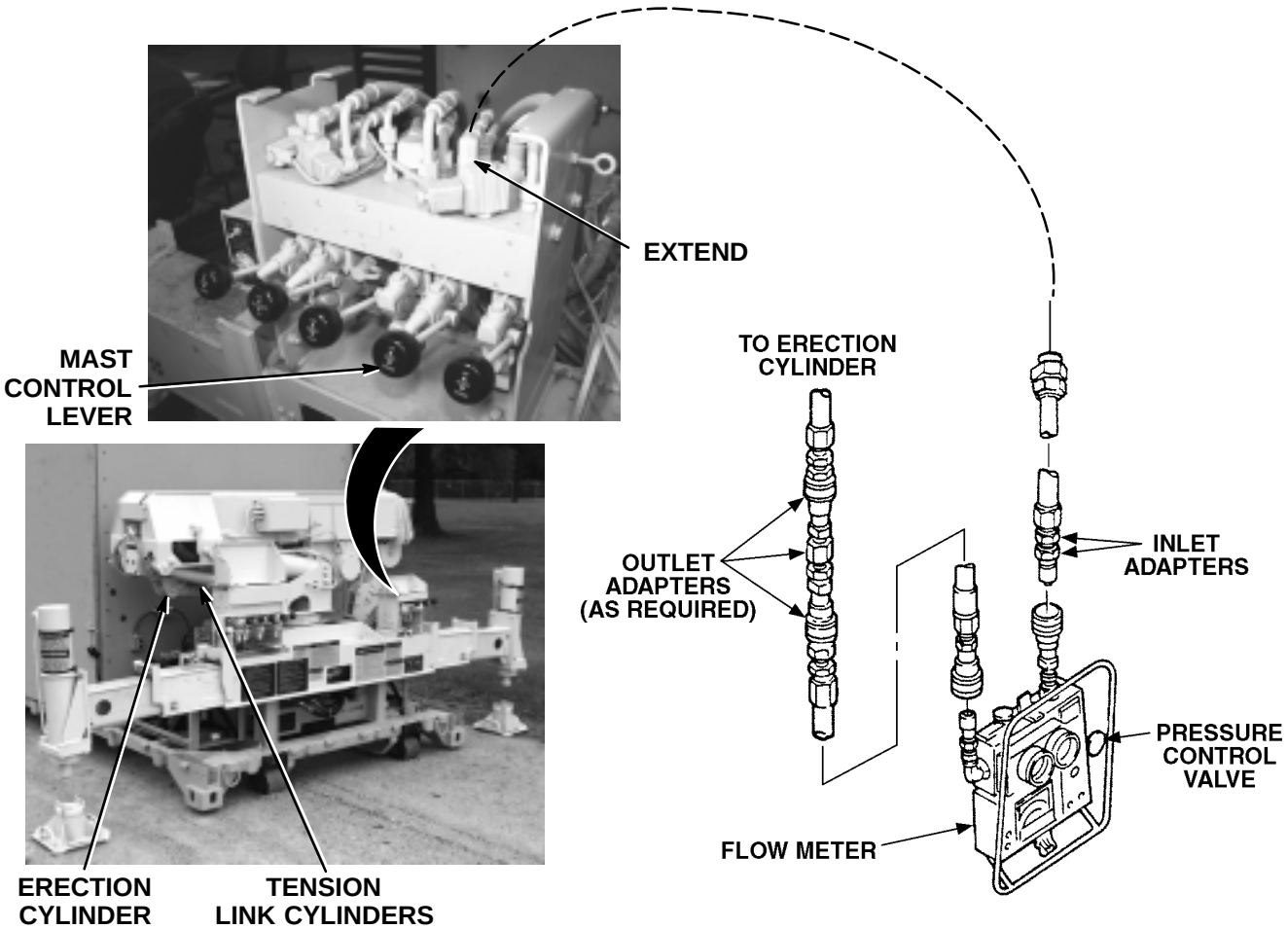


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
Test 3.	Remove five function control cover. Refer to paragraph 3-31. Disconnect the line that comes from the retract fitting to the mast control valve. Install a flow meter in line between control valve and line. Open pressure control valve fully by turning control knob counter clockwise to DECREASE. Start FRS. Have assistant operate MAST control lever to attempt to lower mast. Slowly close pressure control valve by turning knob clockwise to INCREASE. Create 3,000 - 3,200 psi (20,684 to 22,063 kPa) working pressure. • If pressure is within specifications, repair or replace erection cylinder. Refer to paragraph 3-19 or 6-10. • If pressure is not within specifications, repair MAST control valve/shuttle valve circuit. Refer to paragraph 3-35. If fault is not corrected, repair or replace erection cylinder. Refer to paragraphs 3-19 or 6-10.

END OF TEST

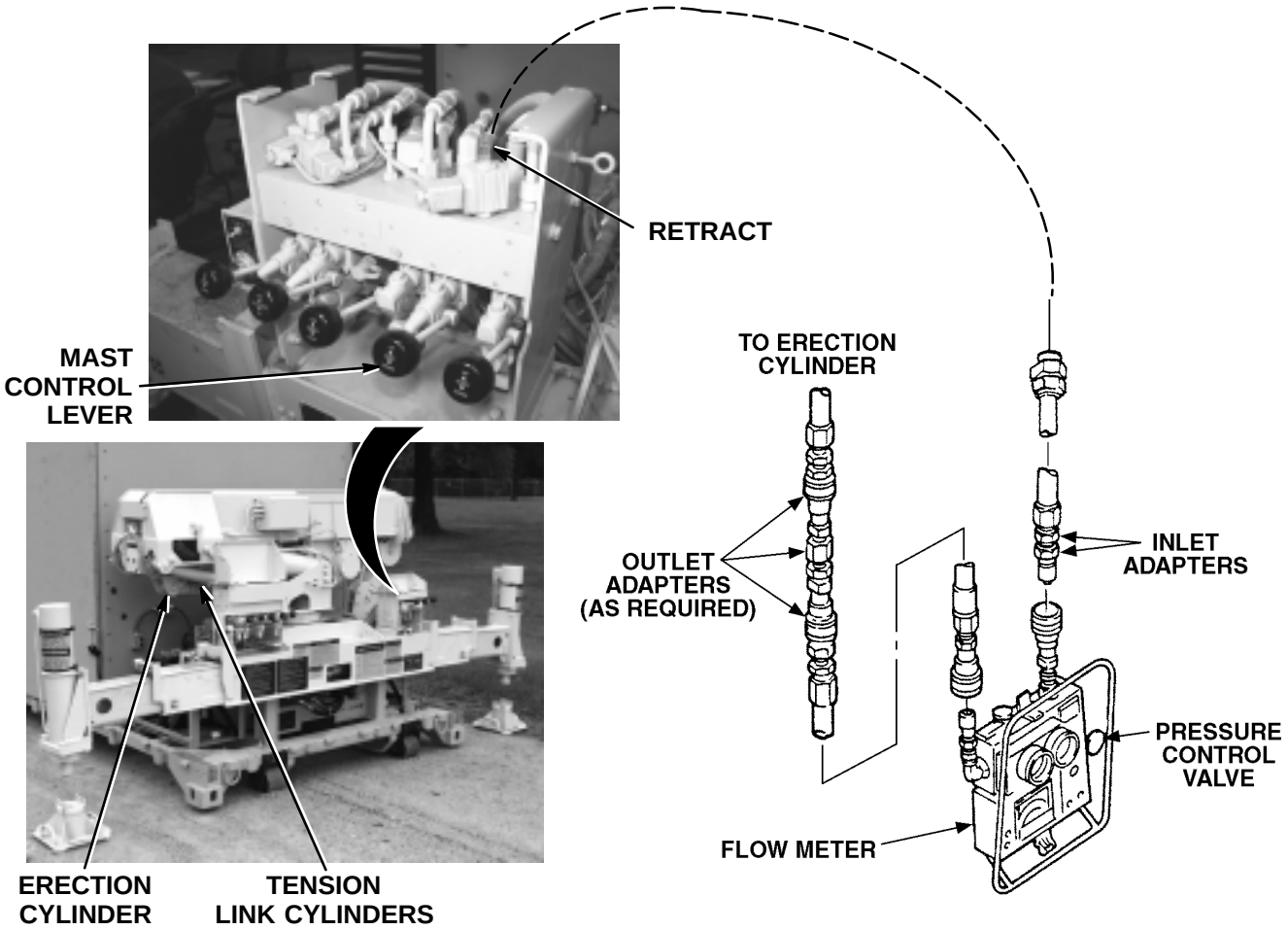


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

6. CRANE DOES NOT SWING OR SWINGS SLOWLY.

WARNING

Never disconnect any hydraulic hose or part while FRS is running. Allow several minutes for pressure to relieve itself. With FRS shut down, operate control valves fully in each direction to relieve trapped pressure.

Before testing hydraulic system with a flow meter, always open the pressure control valve all the way by turning the knob counter clockwise to DECREASE. Failure to do so may cause hydraulic lines to burst, causing personal injury.

When increasing hydraulic system pressure with the pressure control valve, always increase pressure slowly. If pressure is increased too fast, damage to hydraulic system or test set will result.

CAUTION

- Checking system pressure involves putting valves into relief. Relief is defined as a point when a needed system pressure is reached, causing excessive pressurized hydraulic fluid to be directed to the hydraulic reservoir.
- Relief is accomplished either by operating the system in a manner which will create relief or by using the loading valve on the flow meter, which will simulate the operating conditions. Putting valves into relief should be limited to no more than 10 seconds to prevent excessive heat buildup.

NOTE

- Unless called for in the test being done, all pressure tests will be done with FRS 24 V MASTER switch in the ON position, and hydraulic oil temperature at 130-150° F (54-66° C).
- Unless advised otherwise, the FRS 24V MASTER switch and the crane MAIN POWER switch must be in the ON position for all voltage checks.
- Before performing troubleshooting procedures, make sure there are no restrictions in pressure or return lines.

Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
Test 1.	Remove five function control cover. Refer to paragraph 3-31. Disconnect the lines that come from the swing clockwise and swing counterclockwise fittings on the swing control valve. Install a flow meter in line between fittings. Open pressure control valve fully by turning control knob counter clockwise to DECREASE. Start FRS. Have assistant operate SWING control lever to attempt to swing clockwise and counter clockwise. Slowly close pressure control valve by turning knob clockwise to INCREASE. Create 1,400-1,600 psi (9,653-11,032 kPa) working pressure. Check for 8-9 gpm (30-34 lpm) • If pressure and flow is within specifications, go to Test 2. • If pressure and flow is not within specifications, ensure hydraulic pump is working properly. Refer to paragraph 4-3. If fault is not corrected, repair SWING control valve/shuttle valve circuit. Refer to paragraph 3-35.

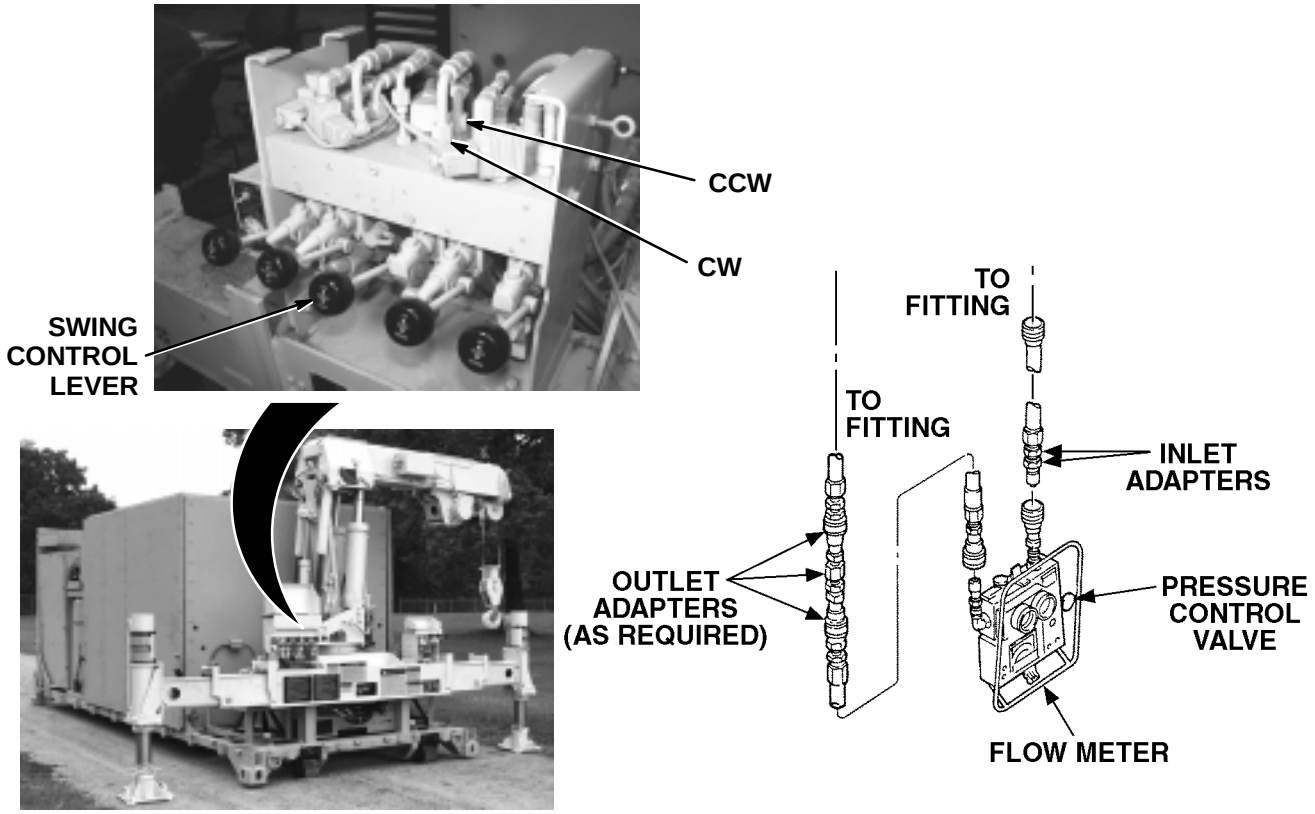


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

6. CRANE DOES NOT SWING OR SWINGS SLOWLY (Continued).

Test 2. Install test meter on test port. Start FRS. Have assistant operate SWING control lever to attempt to swing clockwise and counter clockwise. Check for 1,400-1,600 psi (9,653-11,032 kPa) swing pressure in both directions.

- If pressure is within specifications, go to Test 3.
- If pressure is not within specifications, repair or replace the cross relief valve. Refer to paragraph 3-32 or 6-12.

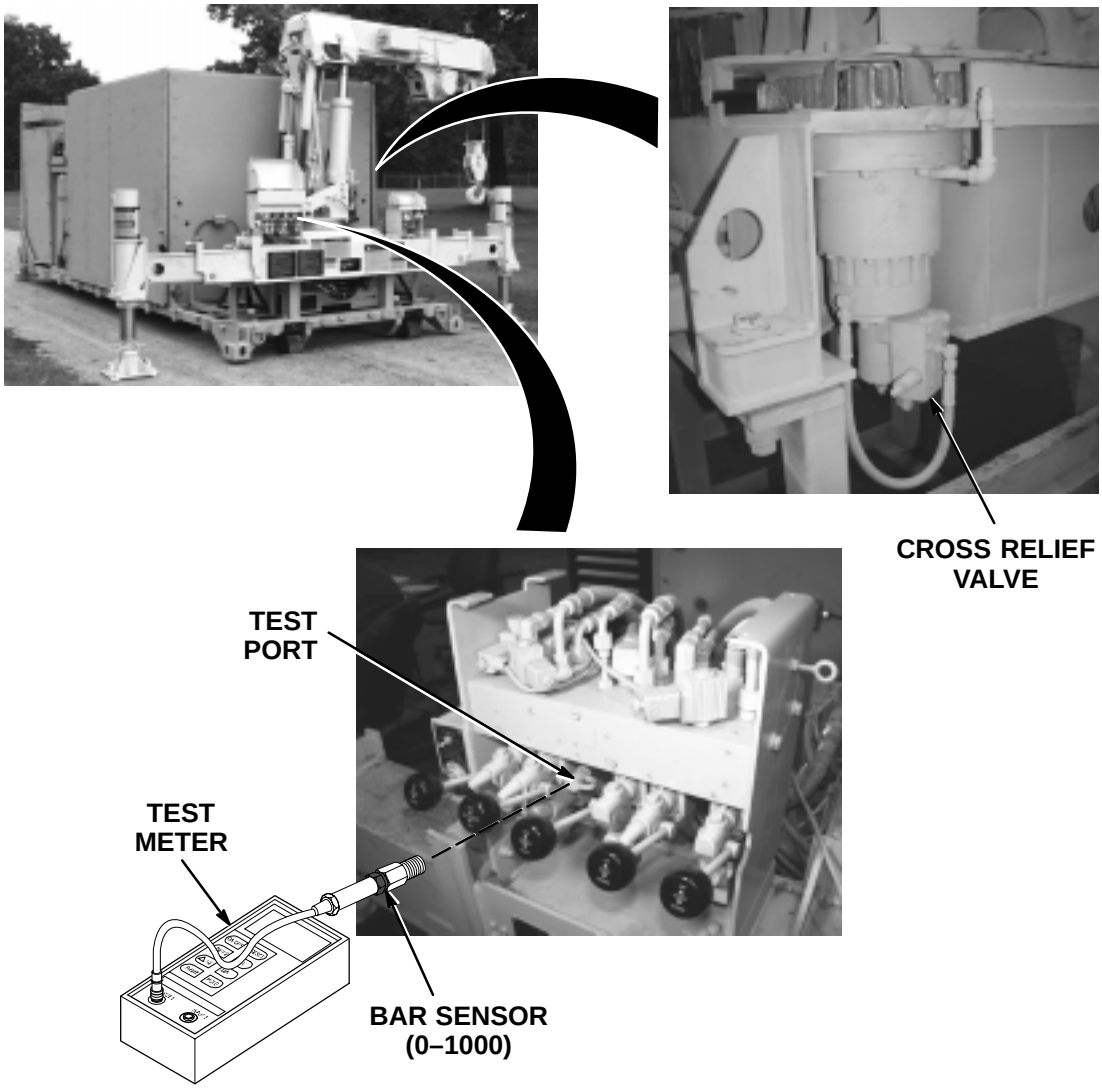


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
Test 3.	Remove two screws, lockwashers, and swing drive orbit motor from swing drive gear reducer. Start FRS. Operate swing drive orbit motor using SWING control lever. • If swing motor operates, go to Test 4. • If swing motor does not operate, replace swing drive orbit motor. Refer to paragraph 3-12 or 6-4.

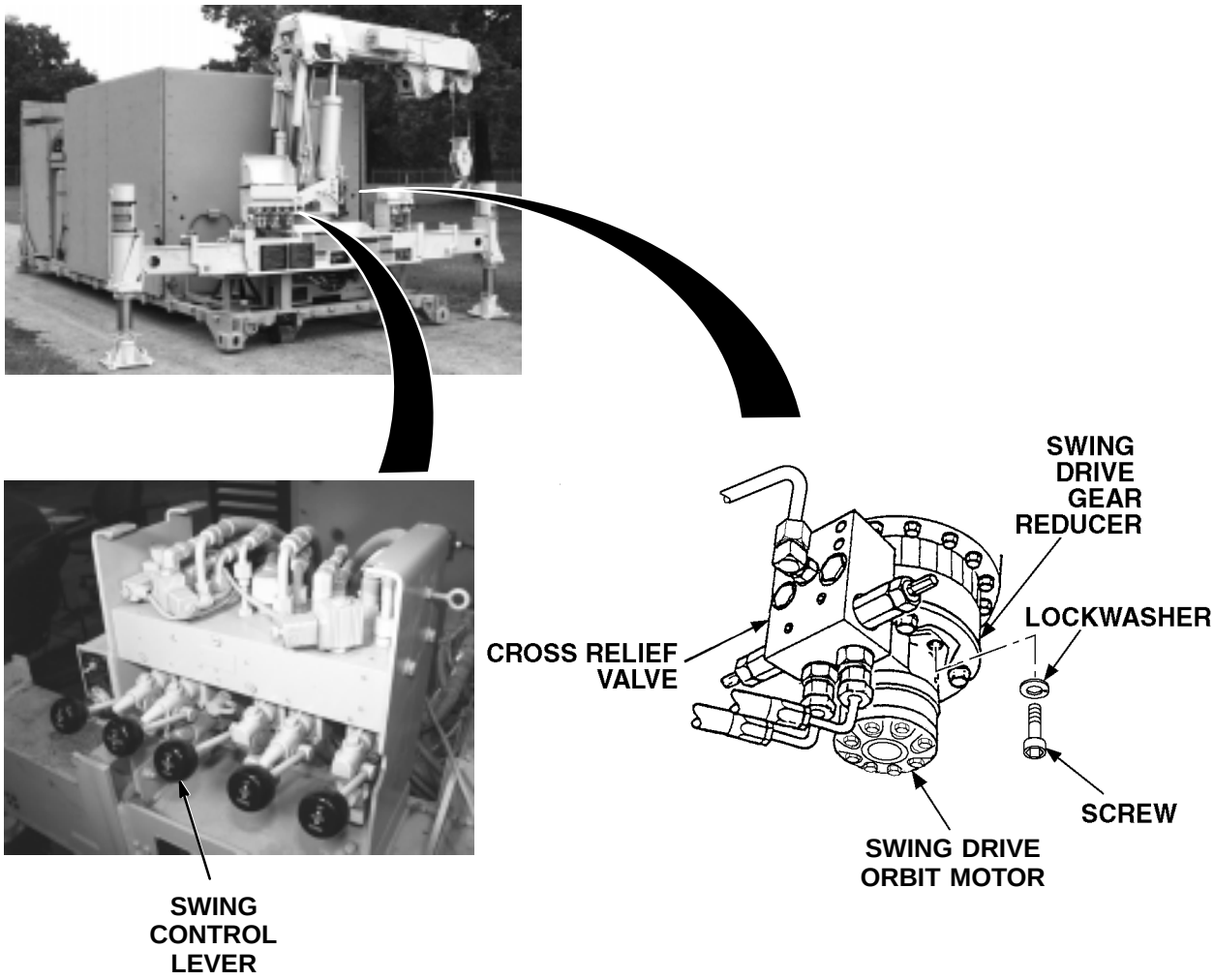


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

6. CRANE DOES NOT SWING OR SWINGS SLOWLY (Continued).

Test 4. Disconnect line and fitting from brake port on cross relief valve. Install test fitting and a 0-5,000 psi pressure gage. Start FRS. Have assistant operate SWING control lever to attempt to swing clockwise and counter clockwise. Check for a minimum of 1,300 psi (8,963 kpa) brake release pressure.

- If pressure is within specifications, replace swing drive brake or swing drive assembly. Refer to paragraphs 3-13, 6-5, 3-14, or 6-6.
- If pressure is not within specifications, repair or replace the cross relief valve. Refer to paragraph 3-32.

END OF TEST

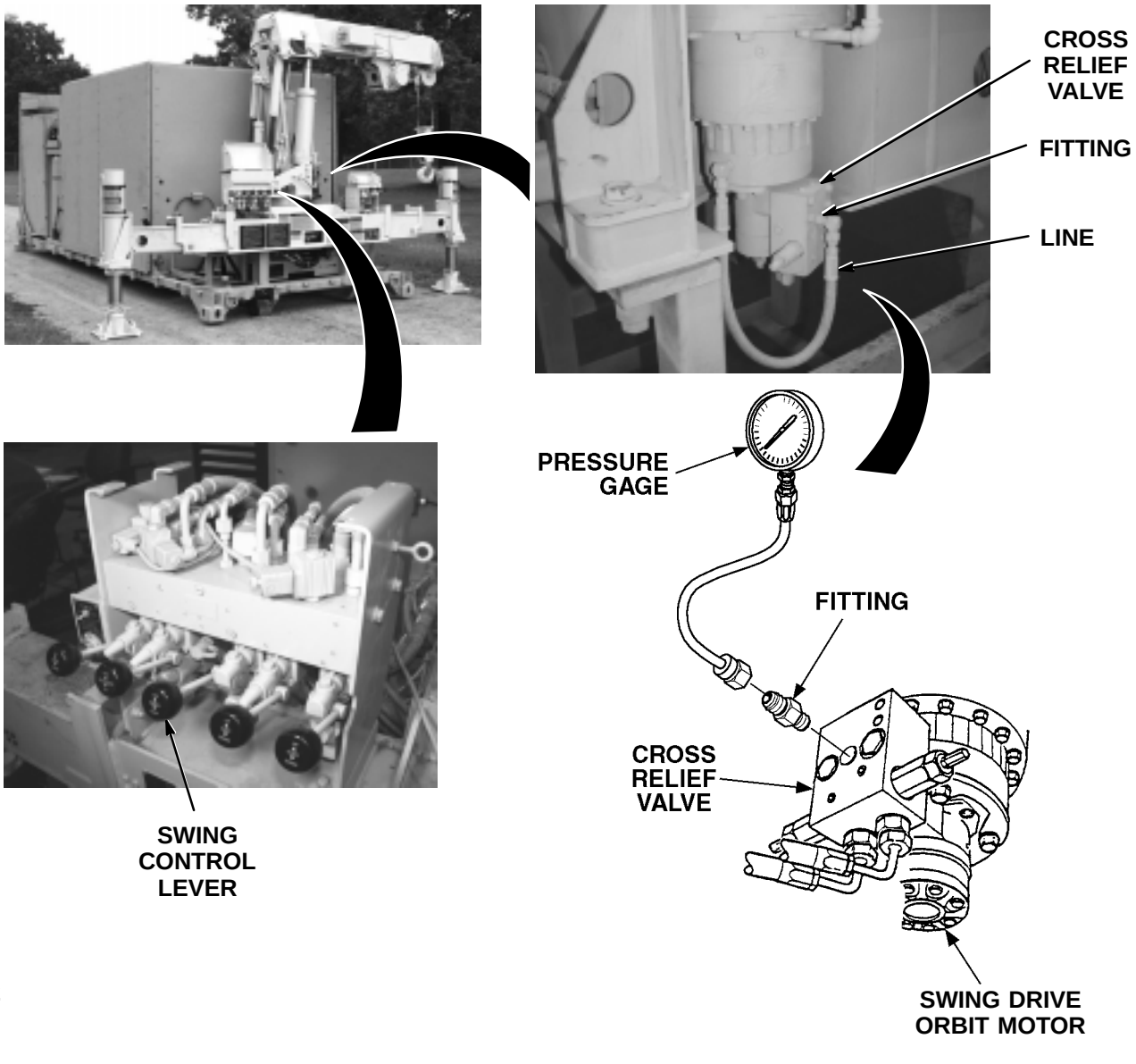


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

7. CRANE DOES NOT SWING CLOCKWISE.

WARNING

Never disconnect any hydraulic hose or part while FRS is running. Allow several minutes for pressure to relieve itself. With FRS shut down, operate control valves fully in each direction to relieve trapped pressure.

Before testing hydraulic system with a flow meter, always open the pressure control valve all the way by turning the knob counter clockwise to DECREASE. Failure to do so may cause hydraulic lines to burst, causing personal injury.

When increasing hydraulic system pressure with the pressure control valve, always increase pressure slowly. If pressure is increased too fast, damage to hydraulic system or test set will result.

CAUTION

- Checking system pressure involves putting valves into relief. Relief is defined as a point when a needed system pressure is reached, causing excessive pressurized hydraulic fluid to be directed to the hydraulic reservoir.
- Relief is accomplished either by operating the system in a manner which will create relief or by using the loading valve on the flow meter, which will simulate the operating conditions. Putting valves into relief should be limited to no more than 10 seconds to prevent excessive heat buildup.

NOTE

° Unless called for in the test being done, all pressure tests will be done with FRS 24 V MASTER switch in the ON position, and hydraulic oil temperature at 130-150° F (54-66° C).

° Unless advised otherwise, the FRS 24V MASTER switch and the crane MAIN POWER switch must be in the ON position for all voltage checks.

° Before performing troubleshooting procedures, make sure there are no restrictions in pressure or return lines.

Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

7. CRANE DOES NOT SWING CLOCKWISE (Continued).

Test 1. Remove five function control cover. Refer to paragraph 3-31. Remove and cross two outlet hoses at swing valve. Start FRS. Operate SWING control lever to swing counter clockwise.

- If crane swings clockwise, repair SWING control valve/shuttle valve circuit. Refer to paragraph 3-35.
- If crane does not swing clockwise, go to Test 2.

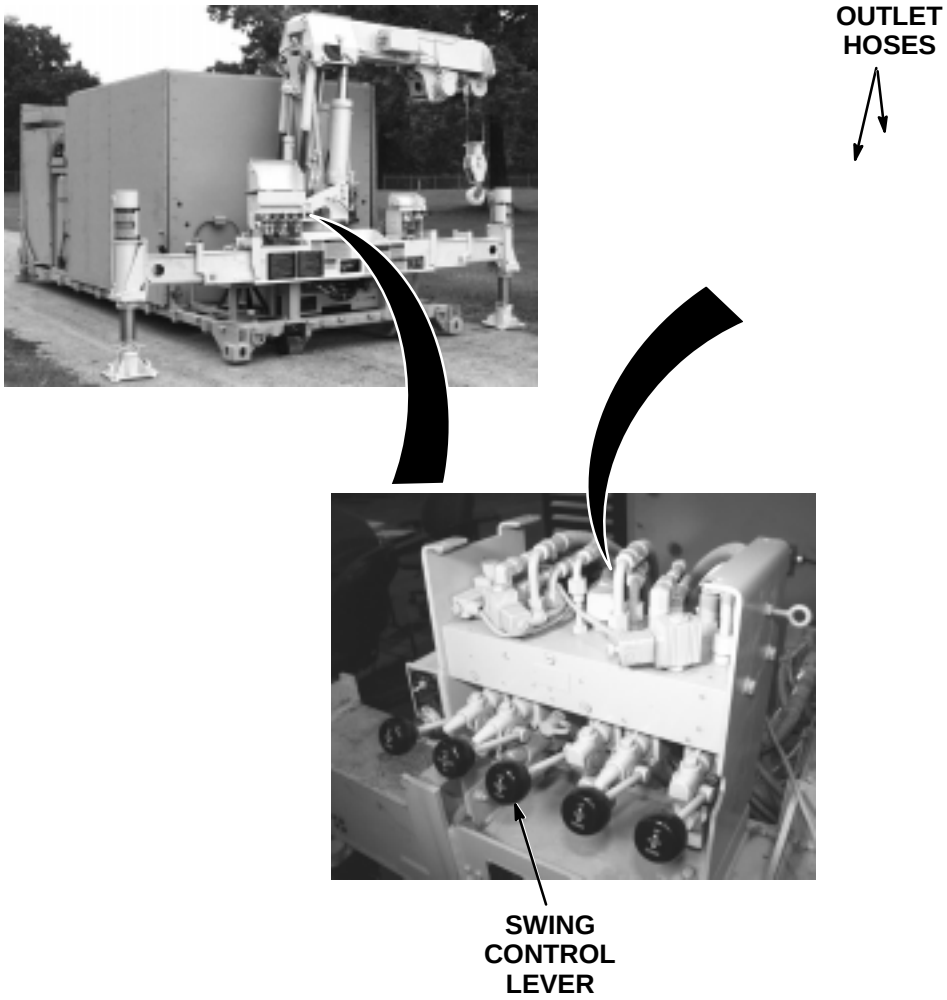


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
Test 2.	Install test meter on test port. Start FRS. Operate SWING control lever to swing clockwise. Check for 1,400-1,600 psi (9,653-11,032 kPa). • If pressure is within specification, go to Test 3. • If pressure is not within specifications, repair or replace cross relief valve. Refer to paragraph 3-32 and 6-12.

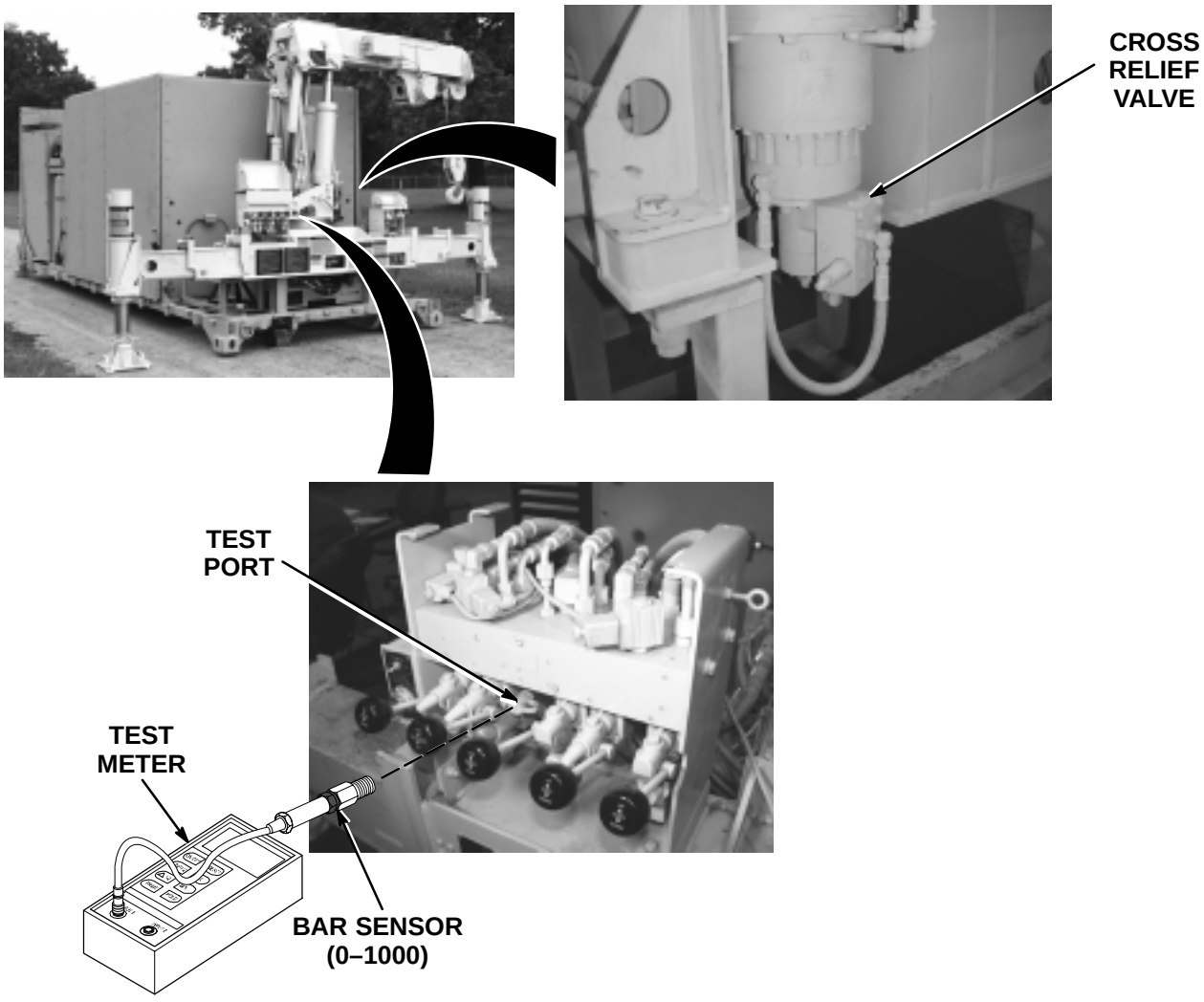


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

7. CRANE DOES NOT SWING CLOCKWISE (Continued).

Test 3. Disconnect line and fitting from brake release port on cross relief valve. Install test fitting and a 0-5,000 psi (0-34,475 kPa) pressure gage. Start FRS. Have assistant operate SWING control lever to attempt to swing clockwise. Check for a minimum of 1,300 psi (8,963 kPa).

- If pressure is not within specifications, repair or replace cross relief valve. Refer to paragraph 3-32 or 6-12.

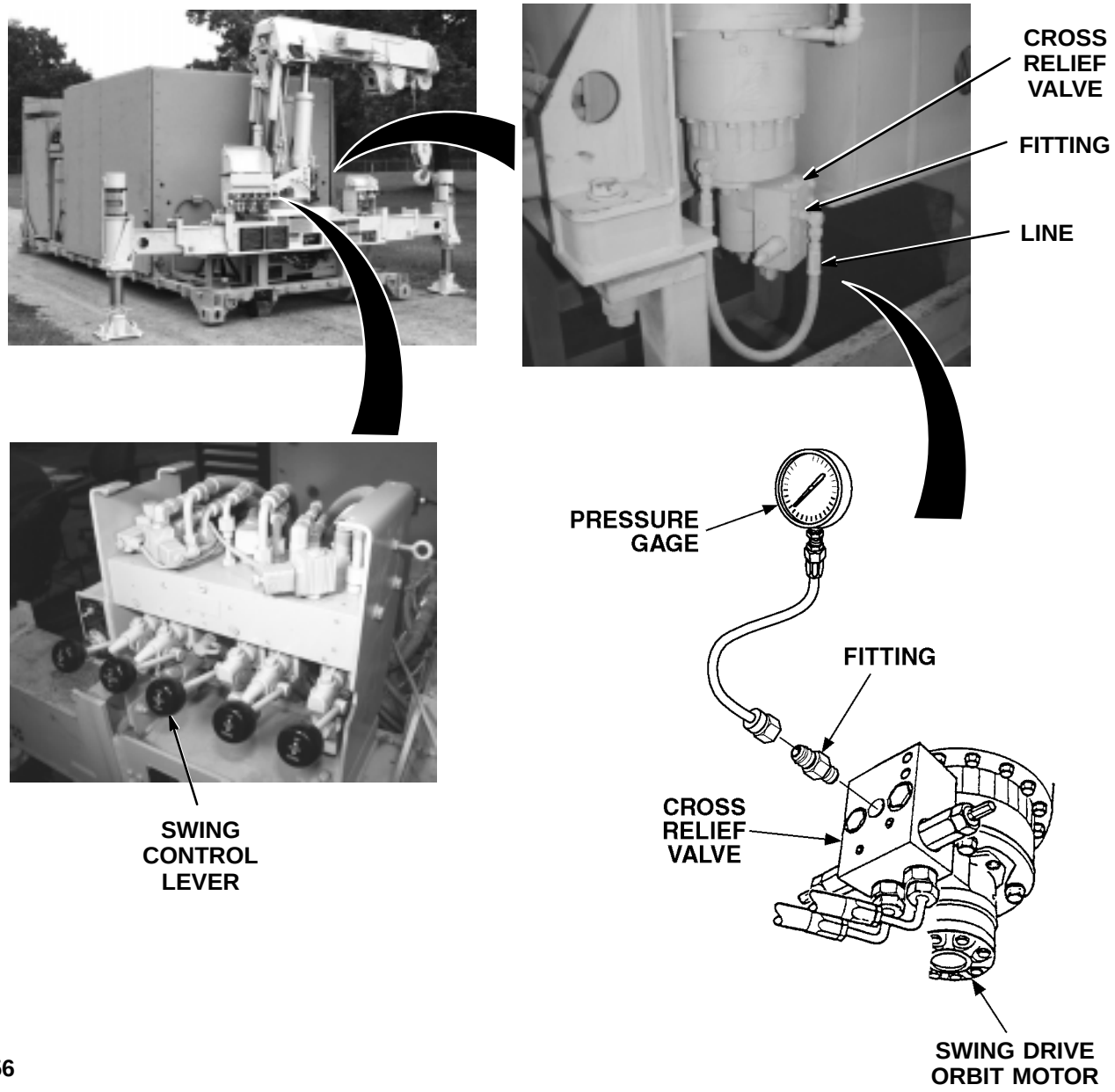


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

8. CRANE DOES NOT SWING COUNTER CLOCKWISE.

WARNING

Never disconnect any hydraulic hose or part while FRS is running. Allow several minutes for pressure to relieve itself. With FRS shut down, operate control valves fully in each direction to relieve trapped pressure.

Before testing hydraulic system with a flow meter, always open the pressure control valve all the way by turning the knob counter clockwise to DECREASE. Failure to do so may cause hydraulic lines to burst, causing personal injury.

When increasing hydraulic system pressure with the pressure control valve, always increase pressure slowly. If pressure is increased too fast, damage to hydraulic system or test set will result.

CAUTION

- Checking system pressure involves putting valves into relief. Relief is defined as a point when a needed system pressure is reached, causing excessive pressurized hydraulic fluid to be directed to the hydraulic reservoir.
- Relief is accomplished either by operating the system in a manner which will create relief or by using the loading valve on the flow meter, which will simulate the operating conditions. Putting valves into relief should be limited to no more than 10 seconds to prevent excessive heat buildup.

NOTE

° Unless called for in the test being done, all pressure tests will be done with FRS 24 V MASTER switch in the ON position, and hydraulic oil temperature at 130-150° F (54-66° C).

° Unless advised otherwise, the FRS 24V MASTER switch and the crane MAIN POWER switch must be in the ON position for all voltage checks.

° Before performing troubleshooting procedures, make sure there are no restrictions in pressure or return lines.

Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

8. CRANE DOES NOT SWING COUNTER CLOCKWISE (Continued).

Test 1. Remove five function control cover. Refer to paragraph 3-31. Remove and cross two outlet hoses at swing valve. Start FRS. Operate SWING control lever to swing clockwise.

- If crane swings counter clockwise, repair swing control valve/shuttle valve circuit. Refer to paragraph 3-35.
- If crane does not swing counter clockwise, go to Test 2.

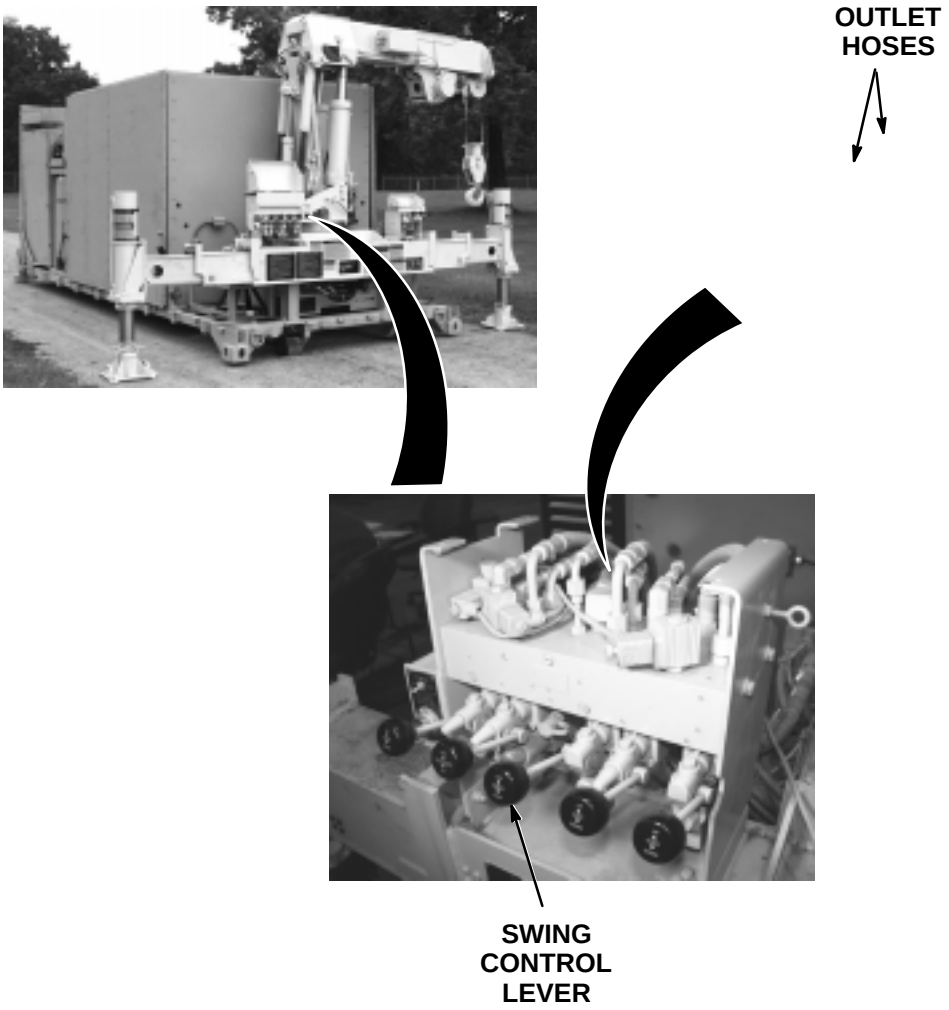


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

Test 2. Install test meter on test port. Start FRS. Operate SWING control lever to swing counter clockwise. Check for 1,400-1,600 psi (9,653-11,032 kPa).

- If pressure is within specification, go to Test 3.
- If pressure is not within specifications, repair or replace cross relief valve. Refer to paragraph 3-32 or 6-12.

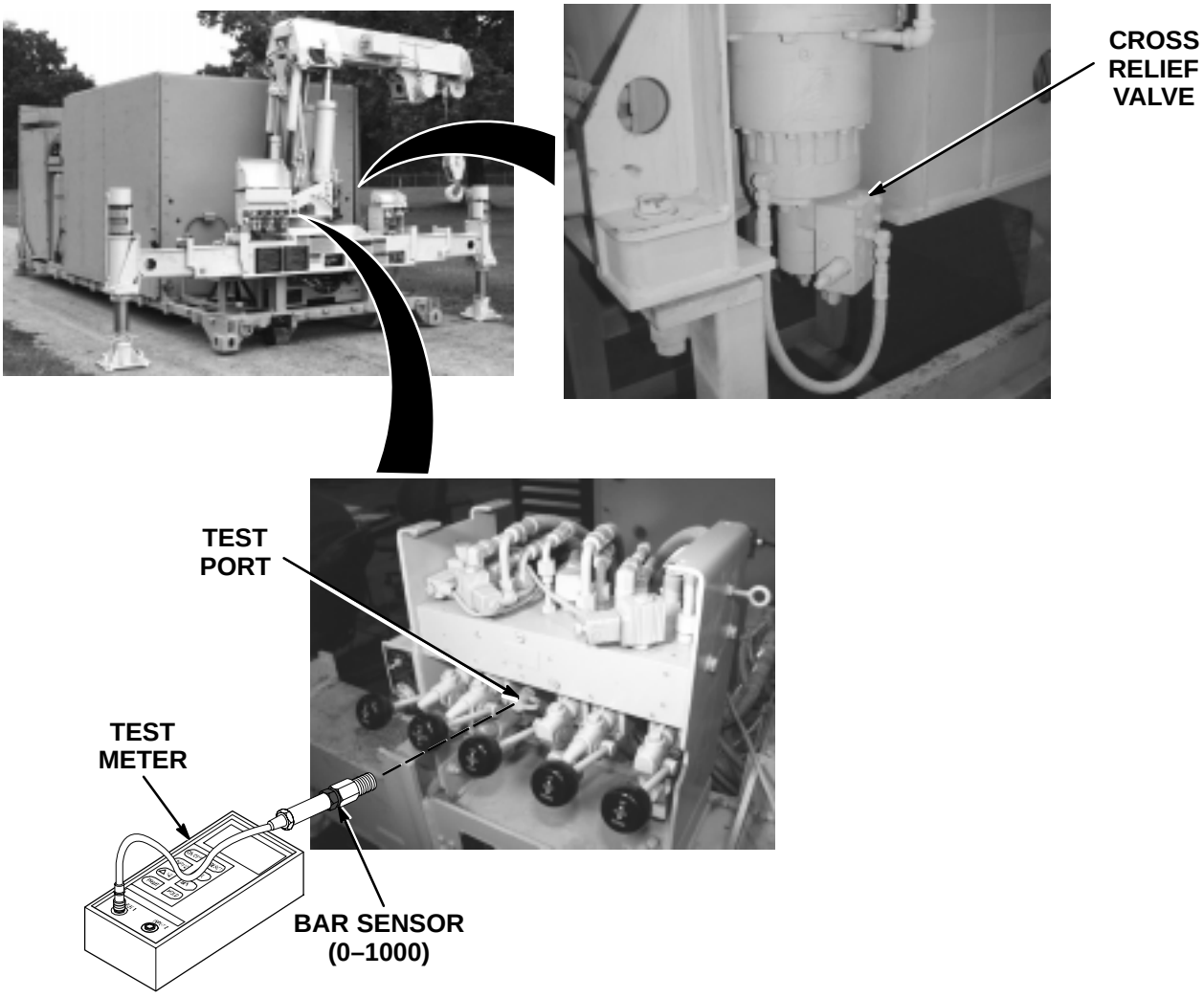


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

8. CRANE DOES NOT SWING COUNTER CLOCKWISE (Continued).

Test 3. Disconnect line and fitting from brake release port on cross relief valve. Install test fitting and a 0-5,000 psi (0-34,475 kPa) pressure gage. Start FRS. Have assistant operate SWING control lever to attempt to swing counter clockwise. Check for a minimum of 1,300 psi (8,963 kPa) brake release pressure.

- If pressure is not within specifications, repair or replace cross relief valve. Refer to paragraph 3-32 or 6-12.

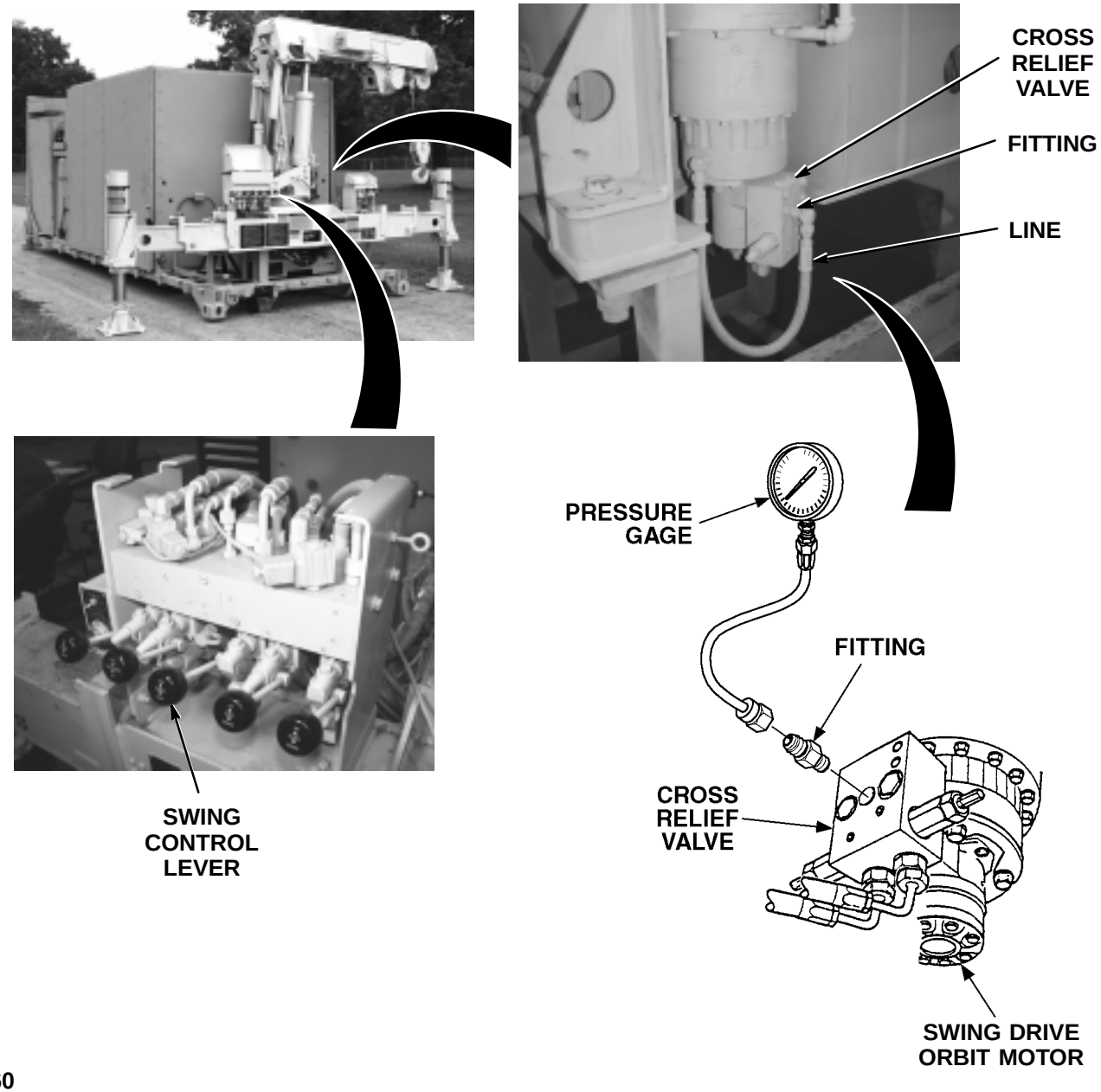


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

9. BOOM DOES NOT TELESCOPE OUT OR IN.

WARNING

Never disconnect any hydraulic hose or part while FRS is running. Allow several minutes for pressure to relieve itself. With FRS shut down, operate control valves fully in each direction to relieve trapped pressure.

Before testing hydraulic system with a flow meter, always open the pressure control valve all the way by turning the knob counter clockwise to DECREASE. Failure to do so may cause hydraulic lines to burst, causing personal injury.

When increasing hydraulic system pressure with the pressure control valve, always increase pressure slowly. If pressure is increased too fast, damage to hydraulic system or test set will result.

CAUTION

- Checking system pressure involves putting valves into relief. Relief is defined as a point when a needed system pressure is reached, causing excessive pressurized hydraulic fluid to be directed to the hydraulic reservoir.
- Relief is accomplished either by operating the system in a manner which will create relief or by using the loading valve on the flow meter, which will simulate the operating conditions. Putting valves into relief should be limited to no more than 10 seconds to prevent excessive heat buildup.

NOTE

° Unless called for in the test being done, all pressure tests will be done with FRS 24 V MASTER switch in the ON position, and hydraulic oil temperature at 130-150° F (54-66° C).

° Unless advised otherwise, the FRS 24V MASTER switch and the crane MAIN POWER switch must be in the ON position for all voltage checks.

° Before performing troubleshooting procedures, make sure there are no restrictions in pressure or return lines.

° If boom does not telescope in, go to Test 2.

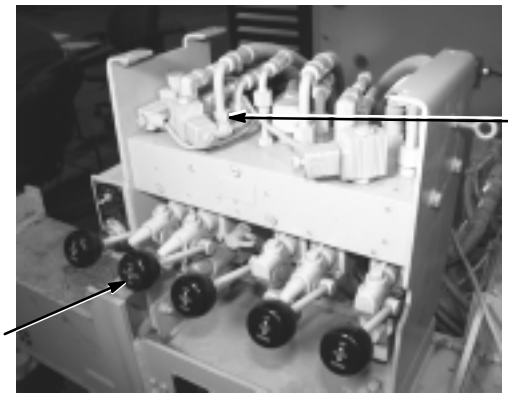
Table 2-7. Crane Troubleshooting (CONT).

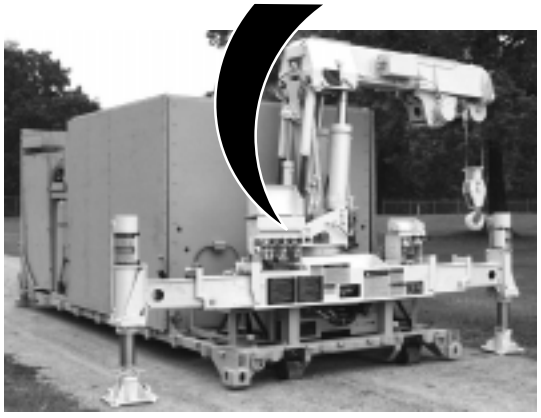
MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

9. BOOM DOES NOT TELESCOPE OUT OR IN (Continued).

Test 1. Remove five function control cover. Refer to paragraph 3-31. Disconnect the line that comes from the telescopic cylinder extend fitting on the telescopic control valve. Install a flow meter in line between control valve and line. Open pressure control valve fully by turning control knob counter clockwise to DECREASE. Start FRS. Have assistant operate TELESCOPE control lever to attempt to extend boom. Slowly close pressure control valve by turning knob clockwise to INCREASE. Create 3,000 - 3,200 psi (20,684 to 22,063 kPa) working pressure.

- If pressure is within specifications, repair or replace boom telescopic cylinder. Refer to paragraph 3-15 or 6-11.
- If pressure is not within specifications, repair telescope control valve/shuttle valve circuit. Refer to paragraph 3-35. If fault is not corrected, repair or replace boom telescopic cylinder. Refer to paragraph 3-15 or 6-11.





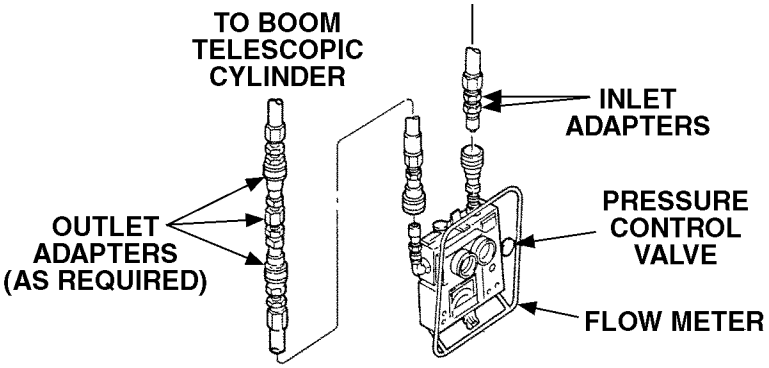


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	

Test 2. Remove five function control cover. Refer to paragraph 3-31. Disconnect the line that comes from the telescopic cylinder retract fitting on telescope control valve. Install a flow meter in line between control valve and line. Open pressure control valve fully by turning control knob counter clockwise to DECREASE. Start FRS. Have assistant operate TELESCOPE control lever to attempt to retract boom. Slowly close pressure control valve by turning knob clockwise to INCREASE. Create 3,000 - 3,200 psi (20,684 to 22,063 kPa) working pressure.

- If pressure is within specifications, repair or replace boom telescopic cylinder. Refer to paragraph 3-15 or 6-11.
- If pressure is not within specifications, repair telescopic control valve/shuttle valve circuit. Refer to paragraph 3-35**.** If fault is not corrected, repair or replace boom telescopic cylinder. Refer to paragraph 3-15 or 6-11.

END OF TEST

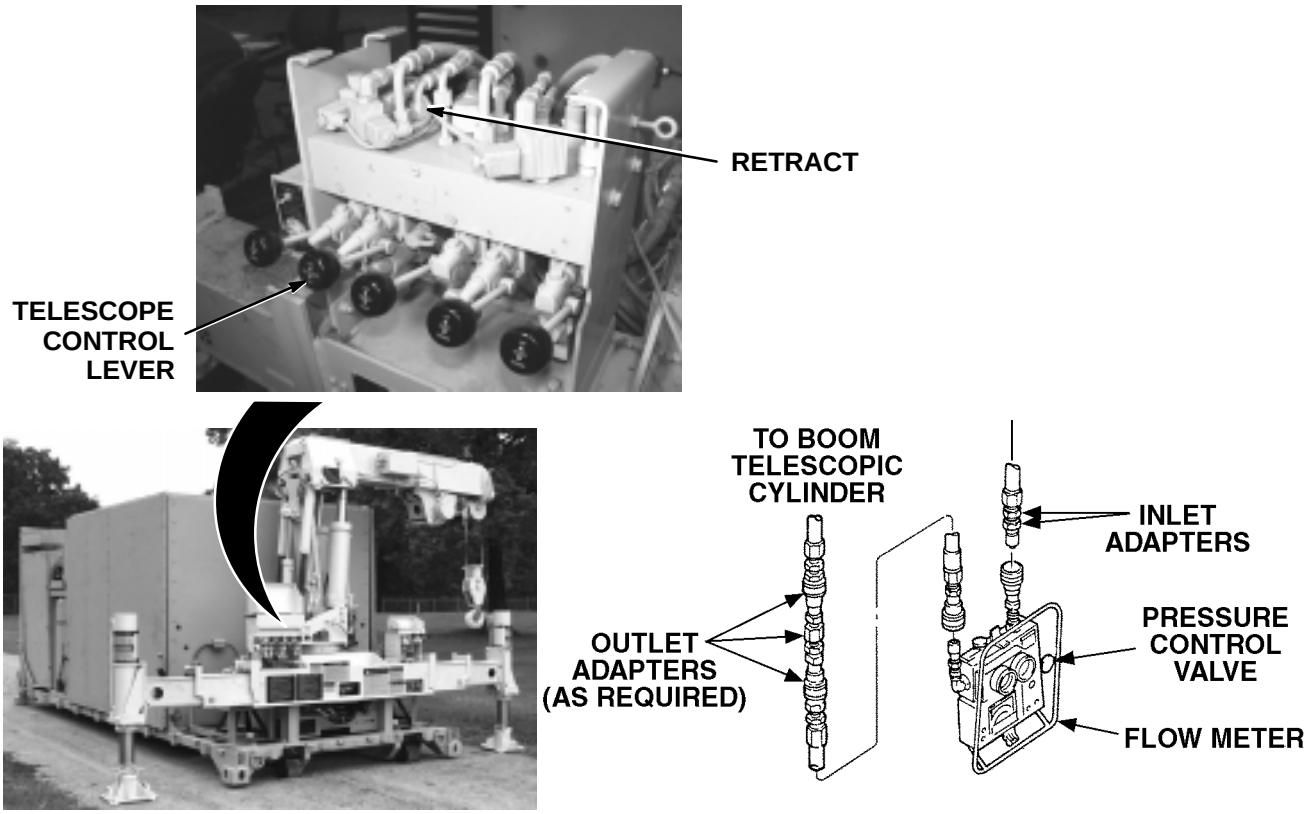


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

10. BOOM DOES NOT RAISE OR LOWER.

WARNING

Never disconnect any hydraulic hose or part while FRS is running. Allow several minutes for pressure to relieve itself. With FRS, operate control valves fully in each direction to relieve trapped pressure.

Before testing hydraulic system with a flow meter, always open the pressure control valve all the way by turning the knob counter clockwise to DECREASE. Failure to do so may cause hydraulic lines to burst, causing personal injury.

When increasing hydraulic system pressure with the pressure control valve, always increase pressure slowly. If pressure is increased too fast, damage to hydraulic system or test set will result.

CAUTION

- Checking system pressure involves putting valves into relief. Relief is defined as a point when a needed system pressure is reached, causing excessive pressurized hydraulic fluid to be directed to the hydraulic reservoir.
- Relief is accomplished either by operating the system in a manner which will create relief or by using the loading valve on the flow meter, which will simulate the operating conditions. Putting valves into relief should be limited to no more than 10 seconds to prevent excessive heat buildup.

NOTE

- Unless called for in the test being done, all pressure tests will be done with FRS 24 V MASTER switch in the ON position, and hydraulic oil temperature at 130-150° F (54-66° C).
- Unless advised otherwise, the FRS 24V MASTER switch and the crane MAIN POWER switch must be in the ON position for all voltage checks.
- Before performing troubleshooting procedures, make sure there are no restrictions in pressure or return lines.
- If a boom lift cylinder must be isolated, connect flow meter at cylinder and disconnect line between cylinders.
- If boom does not lower, go to Test 2.

Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
Test 1.	Remove five function control cover. Refer to paragraph 3-31. Disconnect the line that comes from the boom cylinder up fitting on the boom control valve. Install a flow meter in line between control valve and line. Open pressure control valve fully by turning control knob counter clockwise to DECREASE. Start FRS. Have assistant operate BOOM control lever to attempt to raise boom. Slowly close pressure control valve by turning knob clockwise to INCREASE. Create 3,000 - 3,200 psi (20,684 to 22,063 kPa) working pressure. • If pressure is within specifications, repair or replace boom lift cylinder. Refer to paragraph 3-18 or 6-9. • If pressure is not within specifications, repair boom control valve/shuttle valve circuit. Refer to paragraph 3-35. If fault is not corrected, repair or replace boom lift cylinder. Refer to paragraph 3-18 or 6-9.

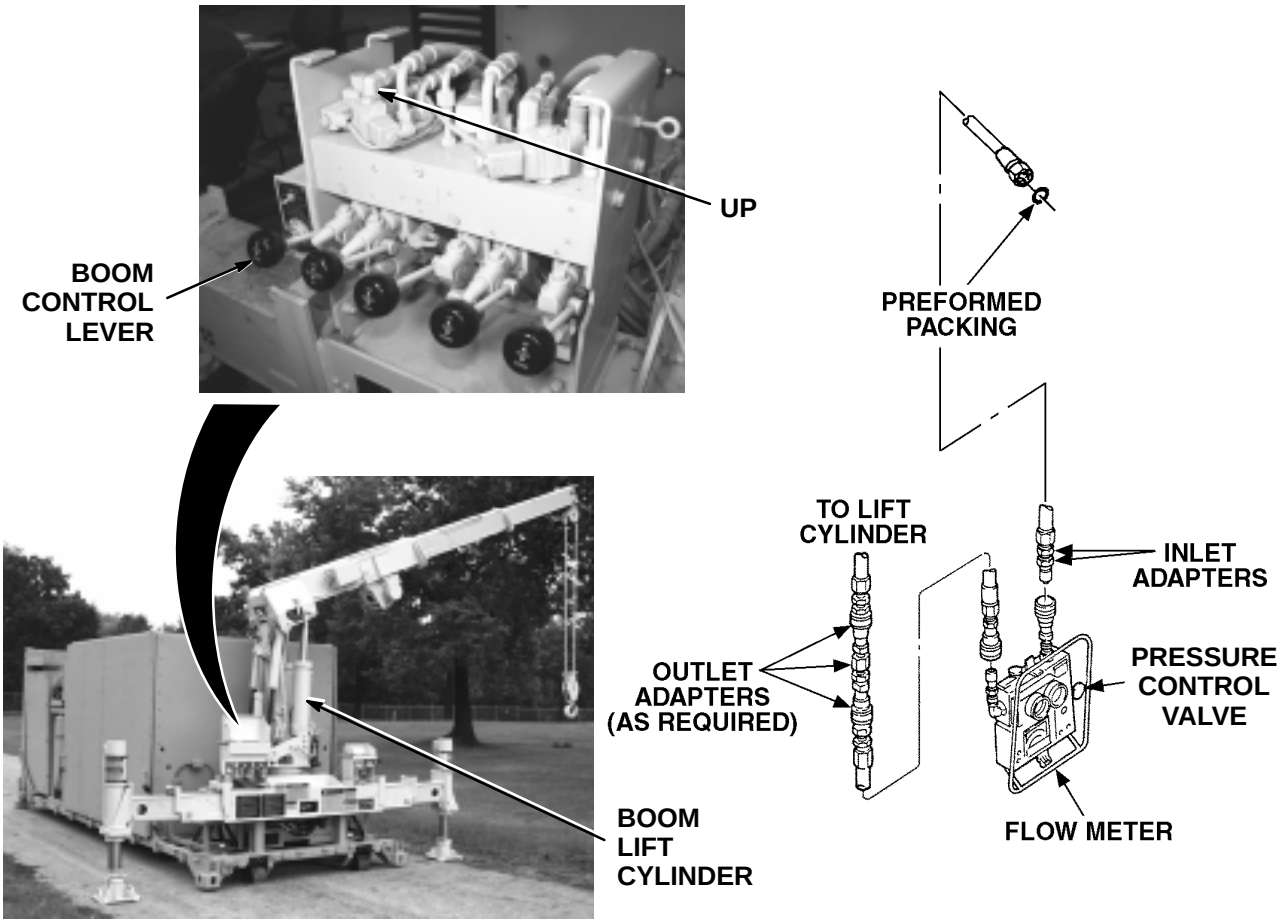


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

10. BOOM DOES NOT RAISE OR LOWER (Continued).

Test 2. Remove five function control cover. Refer to paragraph 3-31. Disconnect the line that comes from the boom cylinder lower fitting on the boom control valve. Install a flow meter in line between control valve and line. Open pressure control valve fully by turning control knob counter clockwise to DECREASE. Start FRS. Have assistant operate BOOM control lever to attempt to lower boom. Slowly close pressure control valve by turning knob clockwise to INCREASE. Create 3,000 - 3,200 psi (20,684 to 22,063 kPa) working pressure.

- If pressure is within specifications, repair or replace boom lift cylinder. Refer to paragraph 3-18 or 6-9.
- If pressure is not within specifications, repair boom control valve/shuttle valve circuit. Refer to paragraph 3-35. If fault is not corrected, repair or replace boom lift cylinder. Refer to paragraph 3-18 or 6-9.

END OF TEST

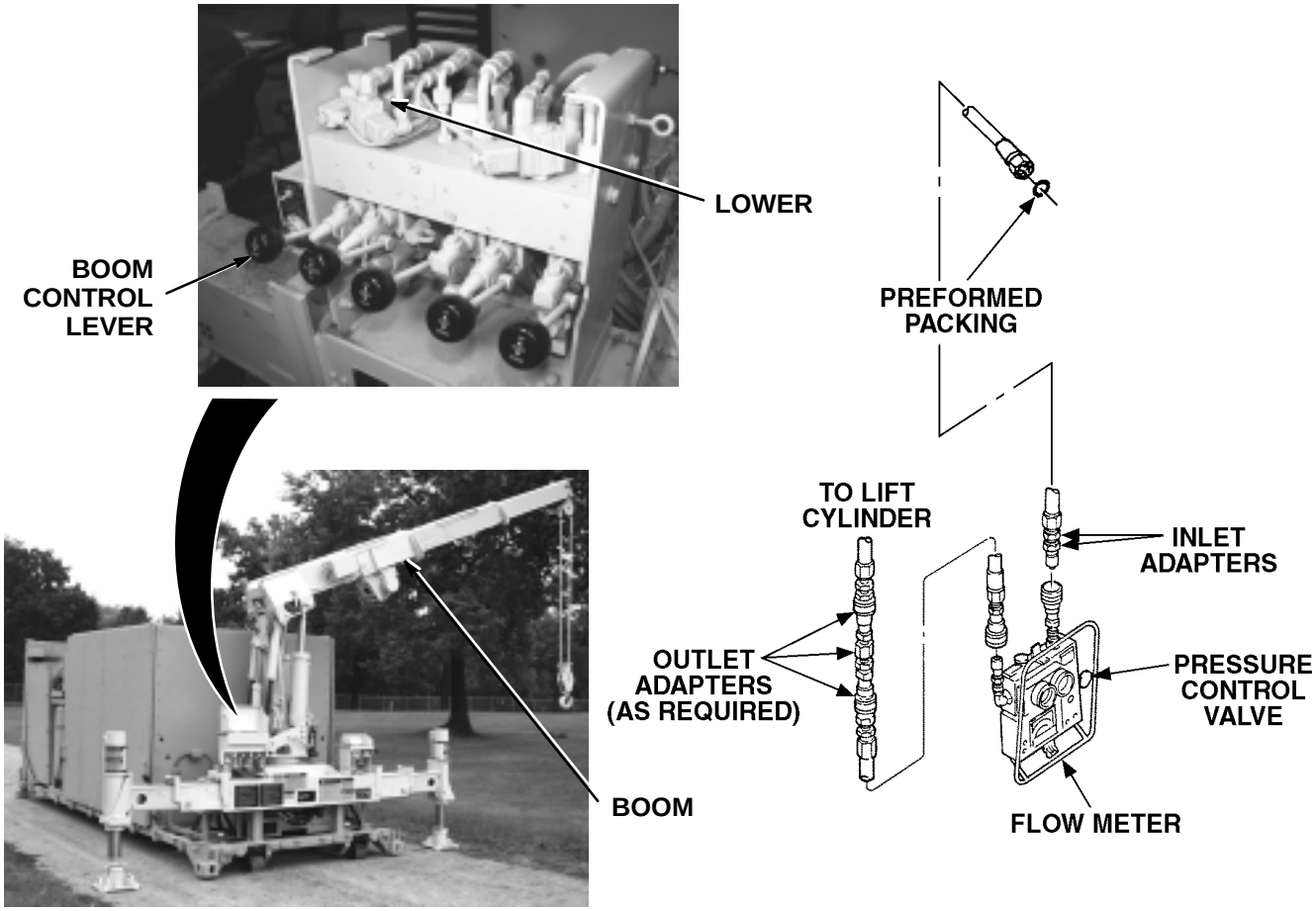


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

11. BOOM CREEPS DOWN.

WARNING

Never disconnect any hydraulic hose or part while FRS is running. Allow several minutes for pressure to relieve itself. With FRS shut down, operate control valves fully in each direction to relieve trapped pressure.

Before testing hydraulic system with a flow meter, always open the pressure control valve all the way by turning the knob counter clockwise to DECREASE. Failure to do so may cause hydraulic lines to burst, causing personal injury.

When increasing hydraulic system pressure with the pressure control valve, always increase pressure slowly. If pressure is increased too fast, damage to hydraulic system or test set will result.

CAUTION

- Checking system pressure involves putting valves into relief. Relief is defined as a point when a needed system pressure is reached, causing excessive pressurized hydraulic fluid to be directed to the hydraulic reservoir.
- Relief is accomplished either by operating the system in a manner which will create relief or by using the loading valve on the flow meter, which will simulate the operating conditions. Putting valves into relief should be limited to no more than 10 seconds to prevent excessive heat buildup.

NOTE

- Unless called for in the test being done, all pressure tests will be done with FRS 24 V MASTER switch in the ON position, and hydraulic oil temperature at 130-150° F (54-66° C).
- Unless advised otherwise, the FRS 24V MASTER switch and the crane MAIN POWER switch must be in the ON position for all voltage checks.
- Before performing troubleshooting procedures, make sure there are no restrictions in pressure or return lines.

Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

11. BOOM CREEPS DOWN (Continued).

Check for faulty boom lift cylinder or holding valve assembly. Attach lifting device to boom. Support boom with lifting device, stop FRS and disconnect hose from fitting at bottom of each boom lift cylinder. Allow fluid in fitting to drain. Lower lifting device to exert pressure on lift cylinders. No drainage should be present at fitting.

- If drainage is present, replace holding valve assembly on cylinder. Refer to paragraph 6-9.
- If drainage is not present, repair or replace boom lift cylinder. Refer to paragraph 3-18 or 6-9.

END OF TEST

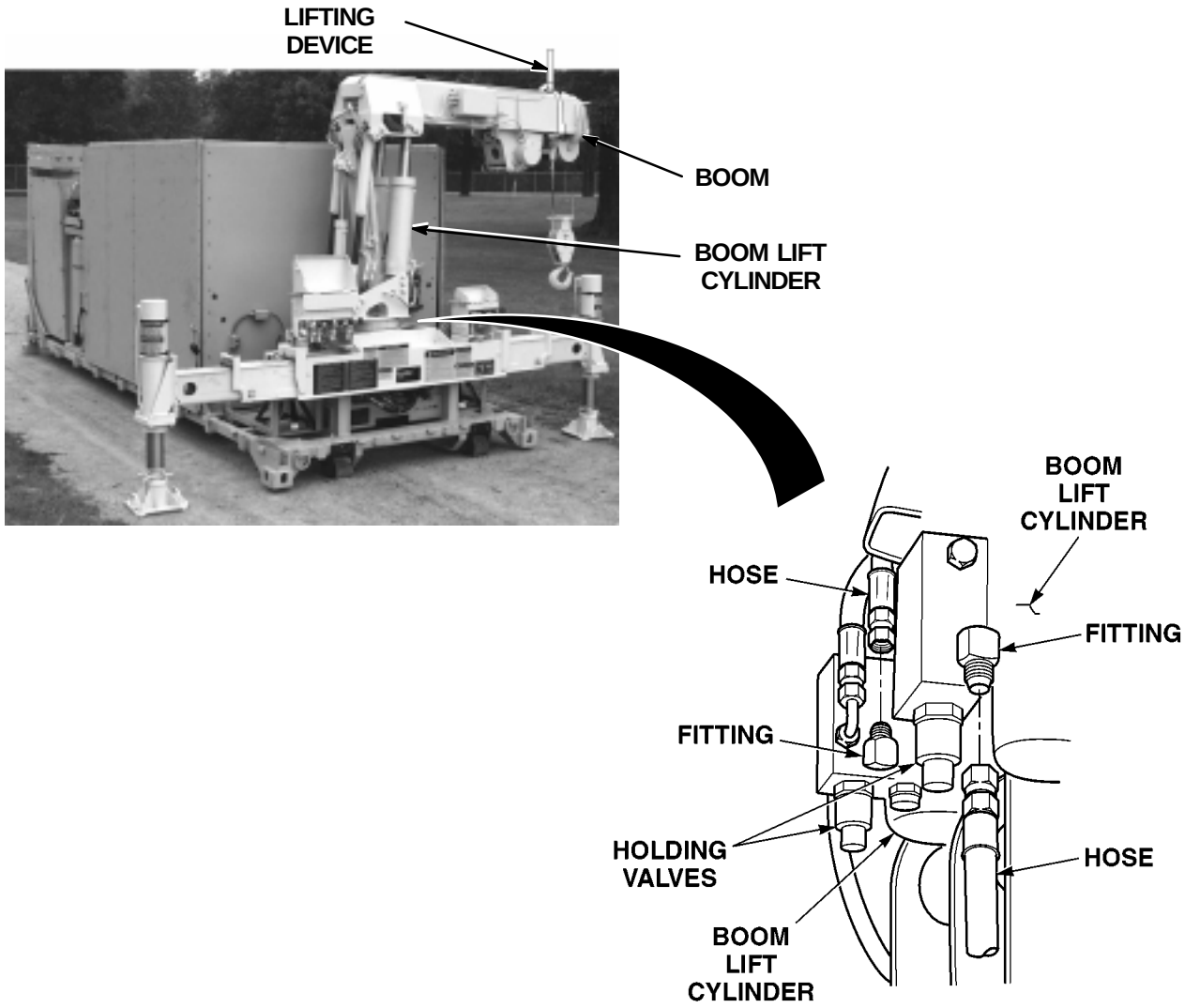


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

12. HOIST DOES NOT RAISE OR LOWER OR RAISES SLOWLY.

WARNING

Never disconnect any hydraulic hose or part while FRS is running. Allow several minutes for pressure to relieve itself. With FRS shut down, operate control valves fully in each direction to relieve trapped pressure.

Before testing hydraulic system with a flow meter, always open the pressure control valve all the way by turning the knob counter clockwise to DECREASE. Failure to do so may cause hydraulic lines to burst, causing personal injury.

When increasing hydraulic system pressure with the pressure control valve, always increase pressure slowly. If pressure is increased too fast, damage to hydraulic system or test set will result.

CAUTION

- Checking system pressure involves putting valves into relief. Relief is defined as a point when a needed system pressure is reached, causing excessive pressurized hydraulic fluid to be directed to the hydraulic reservoir.
- Relief is accomplished either by operating the system in a manner which will create relief or by using the loading valve on the flow meter, which will simulate the operating conditions. Putting valves into relief should be limited to no more than 10 seconds to prevent excessive heat buildup.

NOTE

° Unless called for in the test being done, all pressure tests will be done with FRS 24 V MASTER switch in the ON position, and hydraulic oil temperature at 130-150° F (54-66° C).

° Unless advised otherwise, the FRS 24V MASTER switch and the crane MAIN POWER switch must be in the ON position for all voltage checks.

° Before performing troubleshooting procedures, make sure there are no restrictions in pressure or return lines.

° If hoist will not lower, go to Test 2.

Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

12. HOIST DOES RAISE OR LOWER OR RAISES SLOWLY (Continued).

Test 1. Remove five function control cover. Refer to paragraph 3-31. Disconnect the line that comes from the hoist raise fitting on the hoist control valve. Install a flow meter in line between control valve and line. Open pressure control valve fully by turning control knob counter clockwise to DECREASE. Start FRS. Have assistant operate HOIST control lever to attempt to raise hoist. Slowly close pressure control valve by turning knob clockwise to INCREASE. Create 2,550-2,750 psi (17,582-18,961 kPa) working pressure. Check for 12 gpm (45 lpm) flow.

- If pressure and flow is within specifications, replace hoist assembly. Refer to paragraph 3-26.
- If pressure and flow is not within specifications, ensure hydraulic pump is working properly. Refer to paragraph 4-3. If fault is not corrected, adjust relief valve. Refer to paragraph 3-41. If adjustment will not bring into specifications, replace HOIST control valve/shuttle valve circuit. Refer to paragraph 3-35.

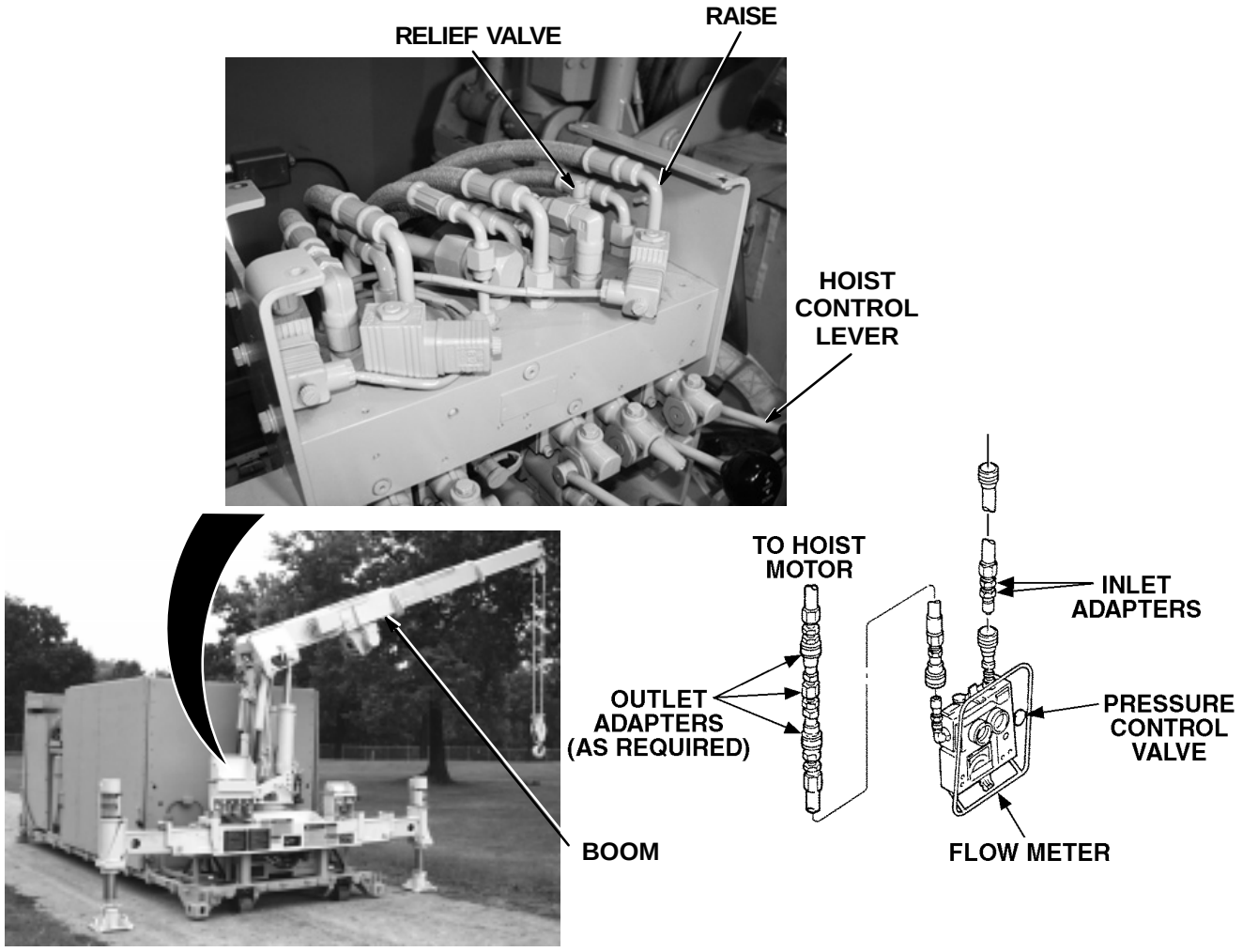


Table 2-7. Crane Troubleshooting (CONT).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
Test 2.	Remove five function control cover. Refer to paragraph 3-31. Disconnect the line that comes from the hoist lower fitting on hoist control valve. Install a flow meter in line between control valve and line. Open pressure control valve fully by turning control knob counter clockwise to DECREASE. Start FRS. Have assistant operate HOIST control lever to attempt to lower hoist. Slowly close pressure control valve by turning knob clockwise to INCREASE. Create 3,000 - 3,200 psi (20,684 to 22,063 kPa) working pressure. • If pressure is within specifications, go to Test 3. • If pressure is not within specifications, replace hoist control valve/shuttle valve circuit. Refer to paragraph 3-35.

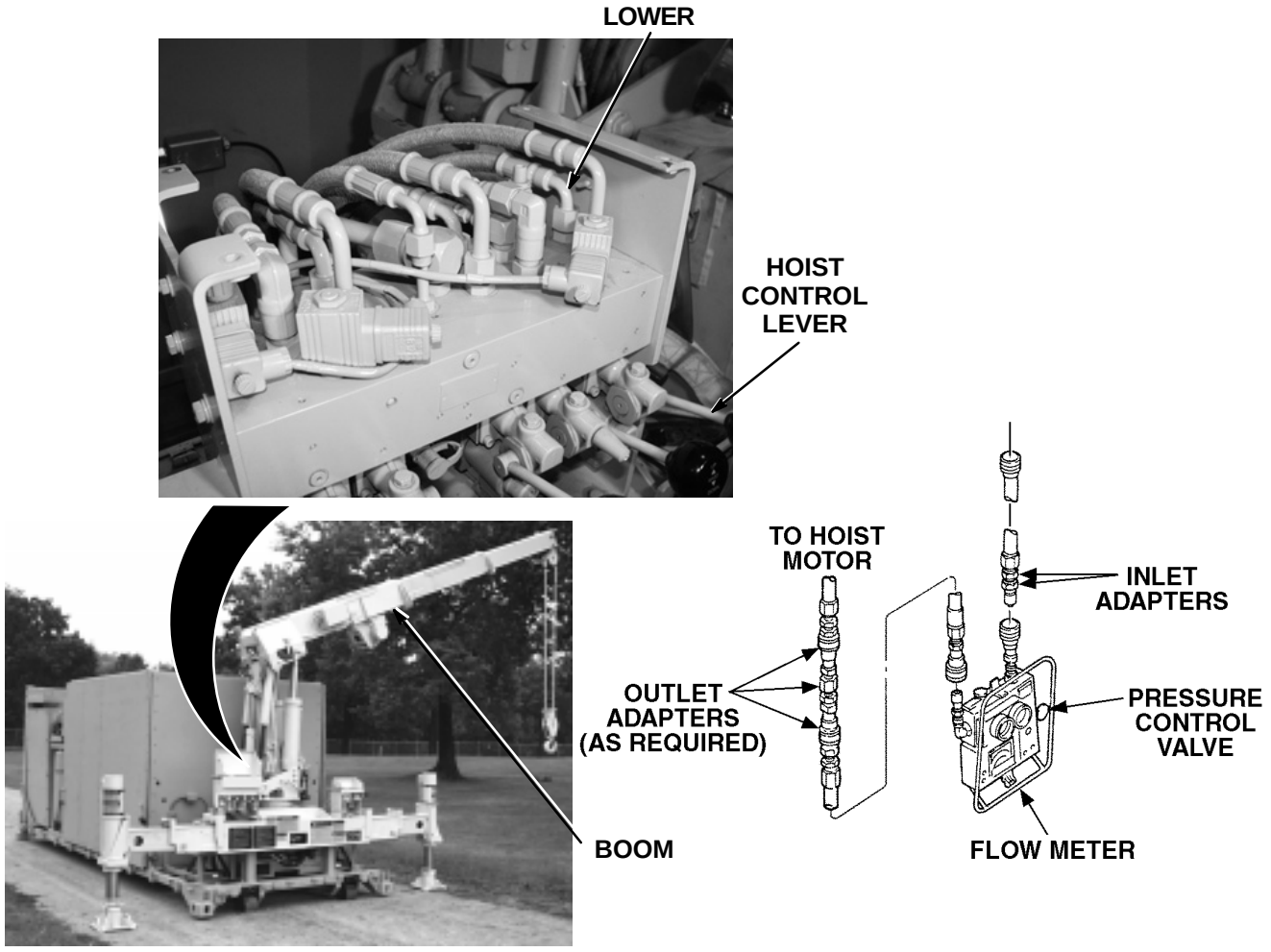


Table 2-7. Crane Troubleshooting (CONT).

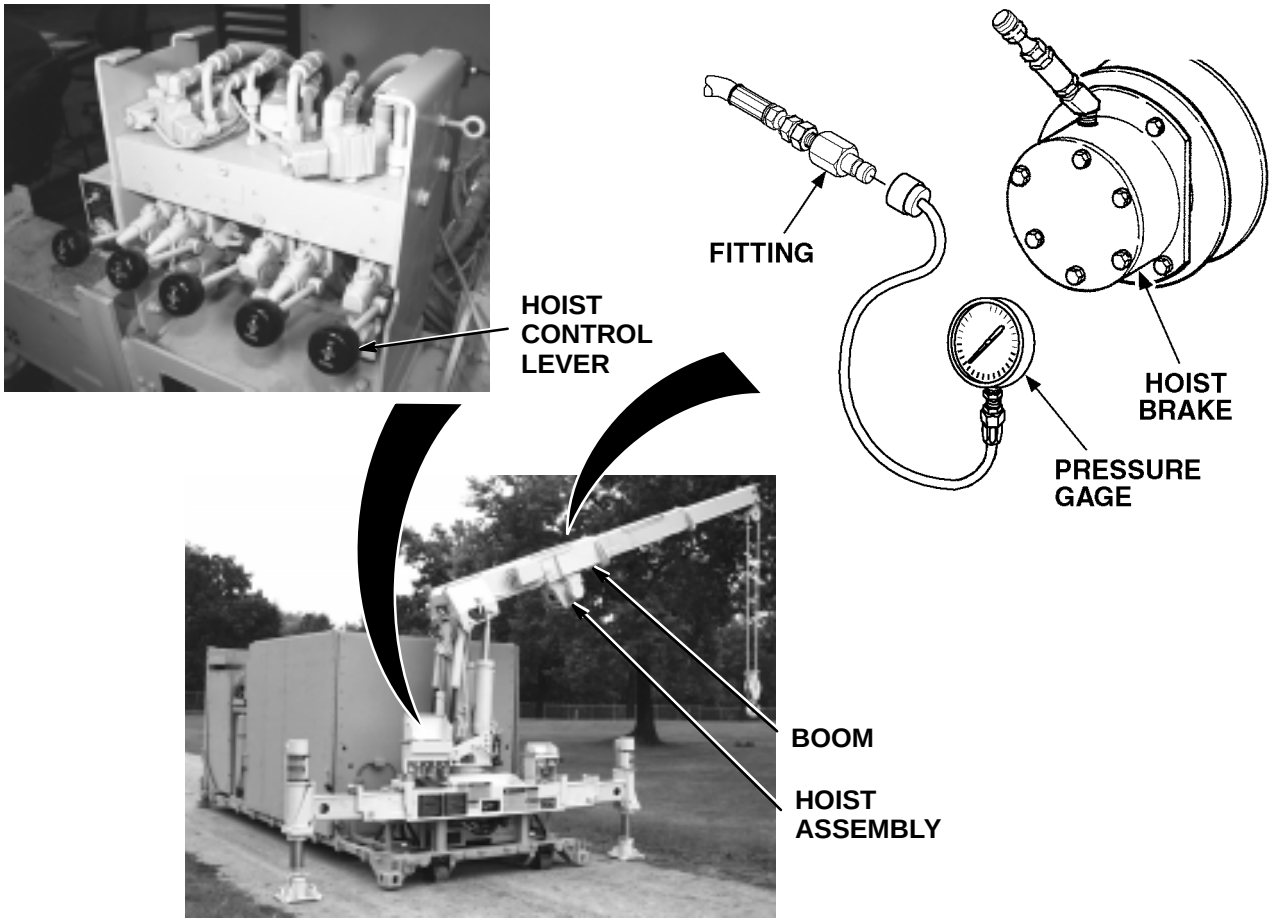
MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

12. HOIST DOES RAISE OR LOWER OR RAISES SLOWLY (Continued).

Test 3. Disconnect the brake release line at the hoist brake on the right side of boom. Install test fitting and 0-5,000 psi (34,475 kPa) gage in the brake release line. Start FRS. Have assistant operate HOIST control lever to attempt to lower hoist. Create 3,000 - 3,200 psi (20,684 to 22,063 kPa) working pressure.

- If pressure is within specifications, replace hoist assembly. Refer to paragraph 3-26.
- If pressure is not within specifications, replace hoist motor control valve. Refer to paragraph 3-38.

END OF TEST



CHAPTER 3
CRANE MAINTENANCE

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3-1. INTRODUCTION.

This chapter contains maintenance instructions for removing, replacing, repairing, installing and adjusting components authorized by the Maintenance Allocation Chart (MAC) at the Direct Support Maintenance level.

3-2. CRANE OVERVIEW

Chapter 3 contains maintenance instructions for removing, replacing, repairing, installing and adjusting components authorized by the Maintenance Allocation Chart (MAC) at the Direct Support Maintenance level.

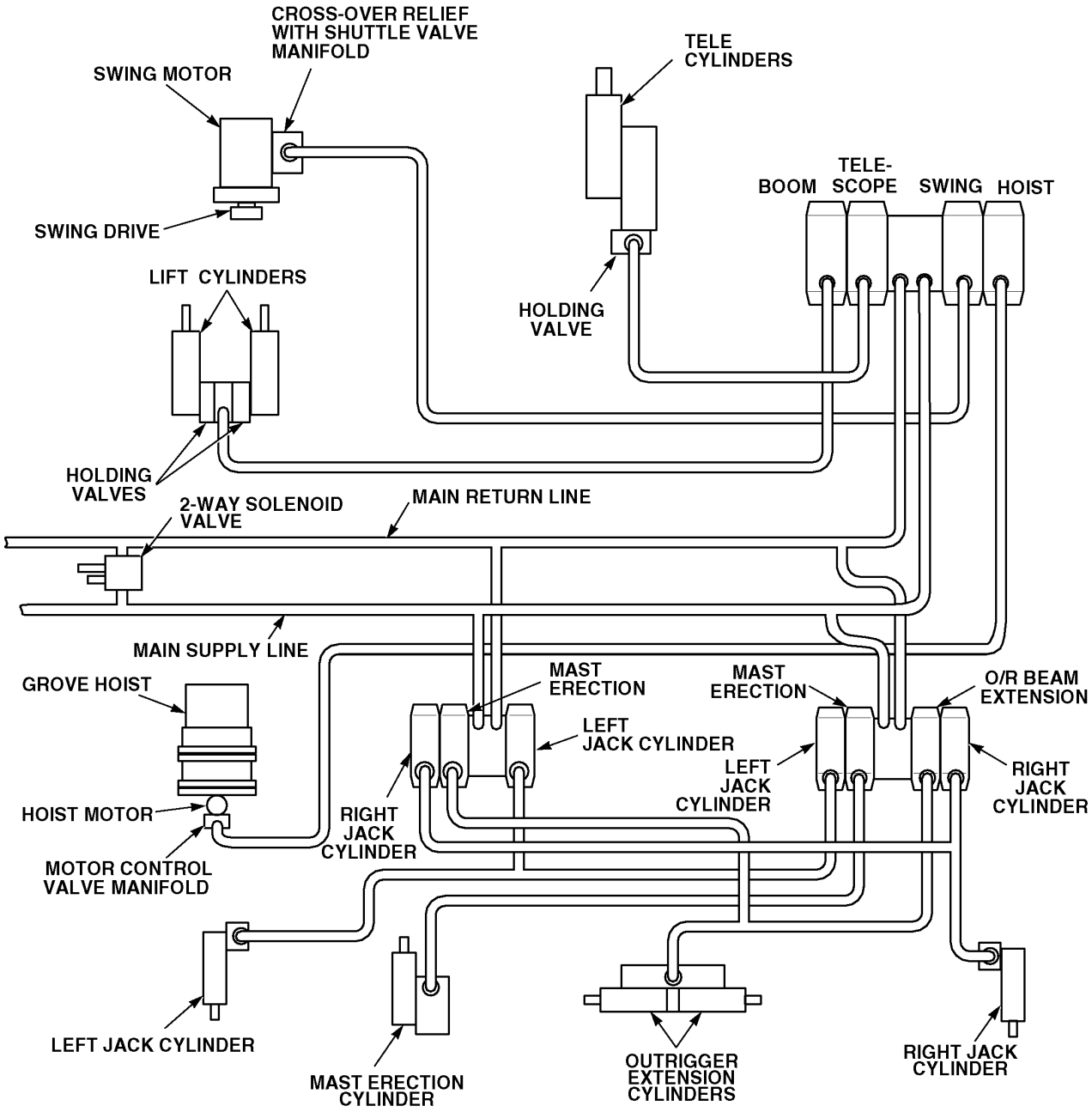
3-3. CRANE PRINCIPLES OF OPERATION

a. General. The FRS crane is (hydraulically powered, telescopic with auxiliary remote controls. The FRS crane has the following four main functions: boom, telescope, swing, and hoist. The FRS crane is laterally supported by outrigger beams and jack cylinders.

b. Hydraulic System. The main controls receive hydraulic oil supplied by the FRS hydraulic system. The two-way solenoid valve opens or blocks the passage of oil to the crane control valves. When the solenoid valve is activated by the remote control or the main switch, hydraulic oil is diverted through the main control valves. The solenoid valve incorporates a manual override in the event of electrical failure.

The main control valves are closed-center, closed-port valves. Hydraulic oil always passes through the unloader valve and returns to the reservoir, unless one or more of the control valves are activated. When a control valve is activated, the ports open to direct hydraulic oil to a function of the crane. The control valve also sends a signal to the unloader valve, regulating the return flow.

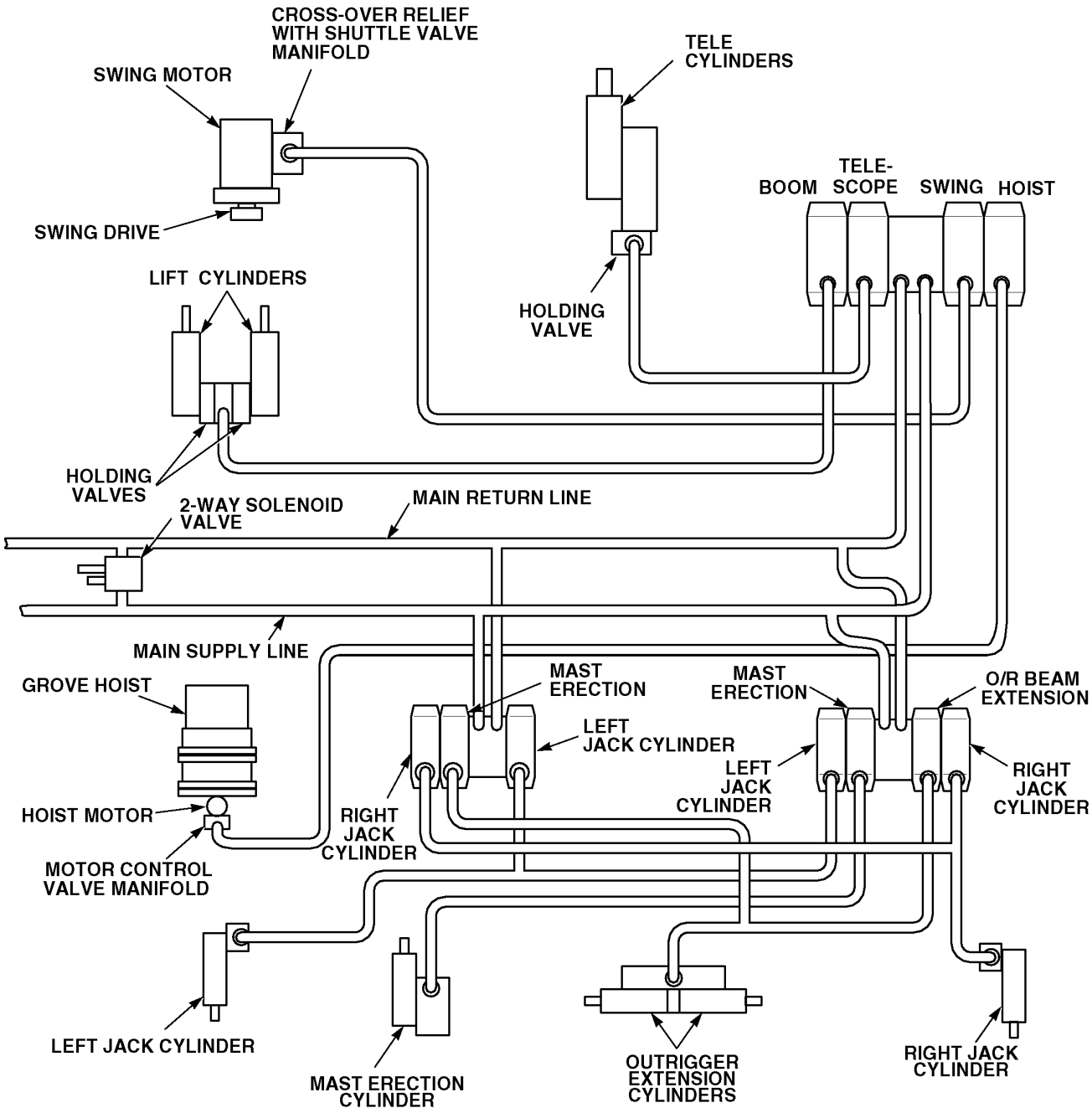
3-3. CRANE PRINCIPLES OF OPERATION (Continued)



When the main control valve is activated, the ports open. Depending on the direction that the control valve lever is moved, one port directs hydraulic oil to push its cylinder in the desired direction. The other port allows the hydraulic oil in the other end of its cylinder to return to the reservoir. When the control valve lever is moved in the opposite direction, the function of the ports is reversed.

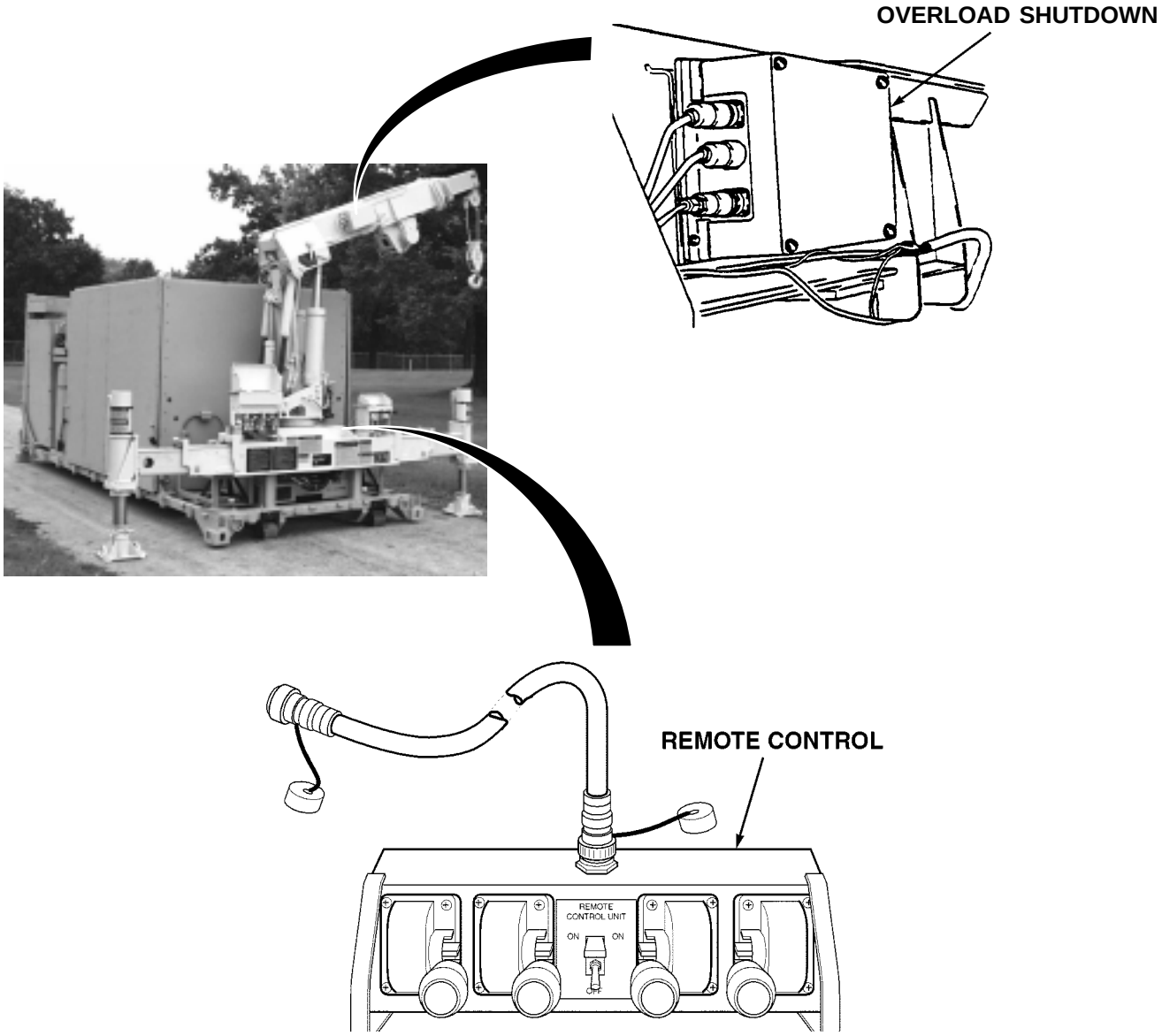
The hoist circuit has a preset relief valve that further protects its function.

The FRS also has a main relief valve in the load sense circuit, to protect all components of the hydraulic system.



Holding valves are used to lock or hold hydraulic oil in a cylinder when a load is held or suspended. This prevents suspended loads from creeping downward. Holding valves are used on all cylinders except the outrigger extensions. All other cylinders use single holding valves except the erection cylinder, it uses a double holding valve. A double holding valve prevents motion in both directions.

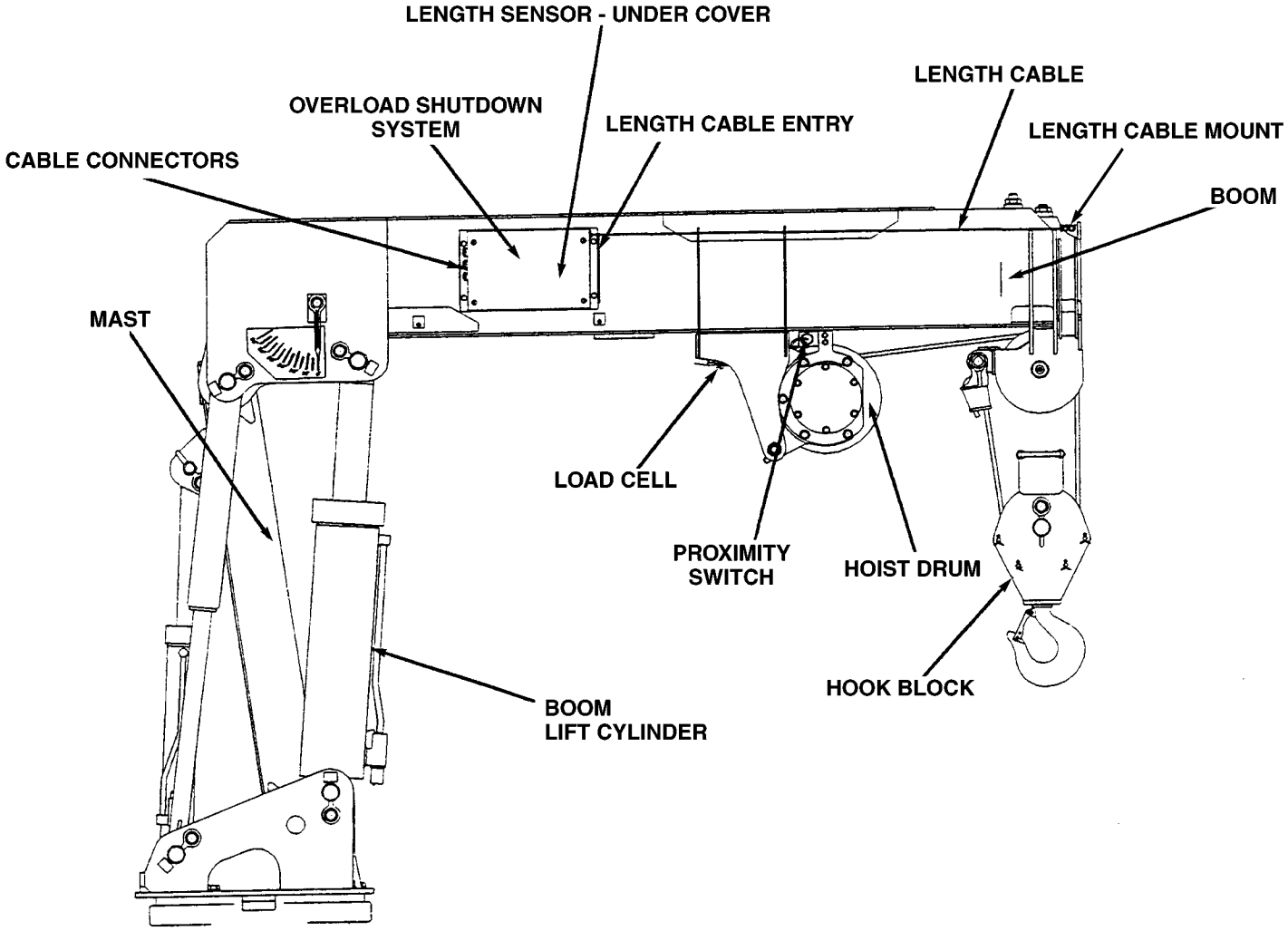
3-3. CRANE PRINCIPLES OF OPERATION (Continued)



c. Remote Control System. The remote control system for crane consists of a shoulder suspended control (remote control unit) and a remote control cable. The remote control system is inoperative without electricity. The emergency stop switch is the master power switch for the remote control system. Four control switches are used to signal electrical control valves. The remote control cable links the remote control unit to the electrical control valves.

d. Overload Shutdown System. The overload shutdown system is designed to disable all functions which may cause tipping or structural damage when the crane attempts to lift over its limits. These limits are specified in the load capacity chart. When the overload shutdown system detects an overload condition the following crane functions are disabled immediately.

Telescope out
Boom up and boom down
Hoist up



e. System Operation. The microprocessor central unit operates as the control center of the system. The length cable is connected to the boom nose. During telescoping the length cable spools off a drum which turns the length potentiometer using a gear assembly. The length potentiometer is a variable resistor which varies linearly with the boom length. An angle sensor is built into the central unit which senses the boom angle (pendulum turns a potentiometer, similiar to length sensor). The load cell provides the signal to calculate the load on hook. The proximity switch located on the hoist drum switches to a different calibration factor during spooling off the hoist rope. This will allow a steady load calculation and compensates for the difference in the lever arm. All together the signals get processed in the central microprocessor unit where actual and rated load are compared. Once the actual load exceeds the rated load, the system de-energizes a relay and disables the applicable crane functions.

3-4. CRANE REPLACEMENT.

This task covers:

a. Removal b. Installation c. Follow-On Maintenance

INITIAL SETUP

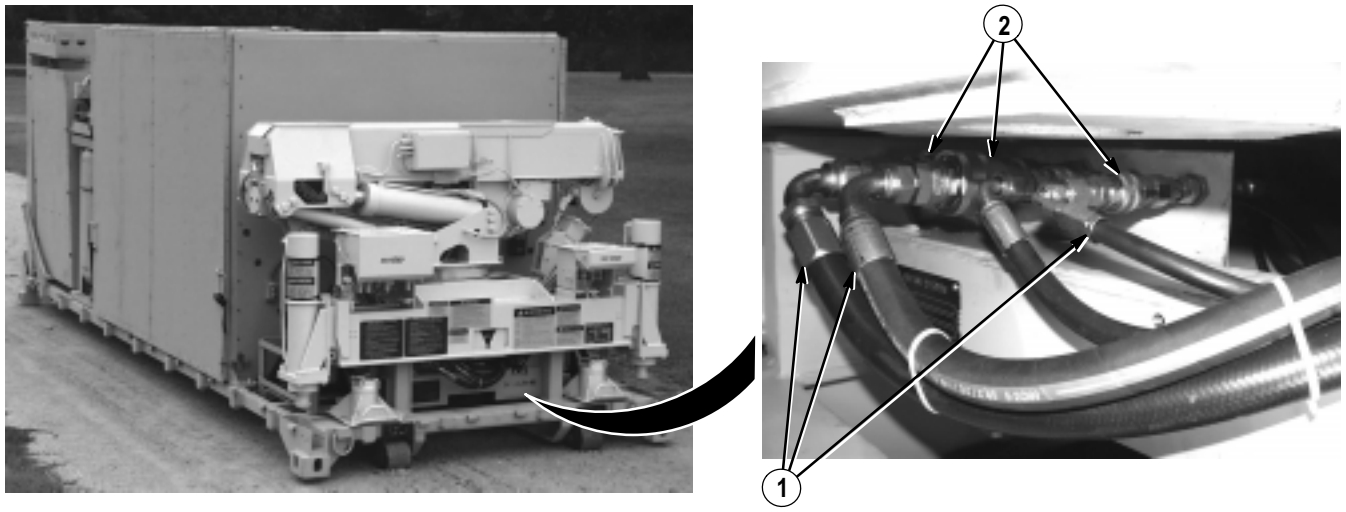
Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Cap and Plug Set (Item 6, Appendix F)
Jackstand (4) (Item 35, Appendix F)
Multiplier, Torque (Item 39, Appendix F)
Pan, Drain (Item 42, Appendix F)
Socket Set, 3/4 in. (Item 51, Appendix F)
Socket Set 2" - 1" Drive (Item 53, Appendix F)
Suitable Lifting Device 6000 lbs (2,722 kg)
Wrench, Combination, 1 -5/16 in. (Item 76, Appendix F)
Wrench, Combination, 1 -11/16 in. (Item 79, Appendix F)
Wrench, Combination, 2 in. (Item 81, Appendix F)
Wrench, Torque (0 to 300 lb-ft [0-407 N·m]) (Item 84, Appendix F)
Wrench, Torque (0 to 600 lb-ft [0-814 N·m]) (Item 86, Appendix F)
Wrench, Offset (Item 87, Appendix F)
Handle, Tubular (Item 88, Appendix F)

Materials/Parts
Cable Ties (Item 5, Appendix B)
Tags, Identification (Item 36, Appendix B)
Bolt (4) (Item 7, Appendix E)
Jam Nut (Item 31, Appendix E)
Nut (4) (Item 70, Appendix E)

Personnel Required
Three

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
Crane stowed, (TM 9-4940-568-10)
Batteries disconnected, (TM 9-4940-568-10)
Jackstand stowage boxes removed, (TM 9-4940-568-20)
Outrigger pads removed, (TM 9-4940-568-10)

a. Removal.



WARNING

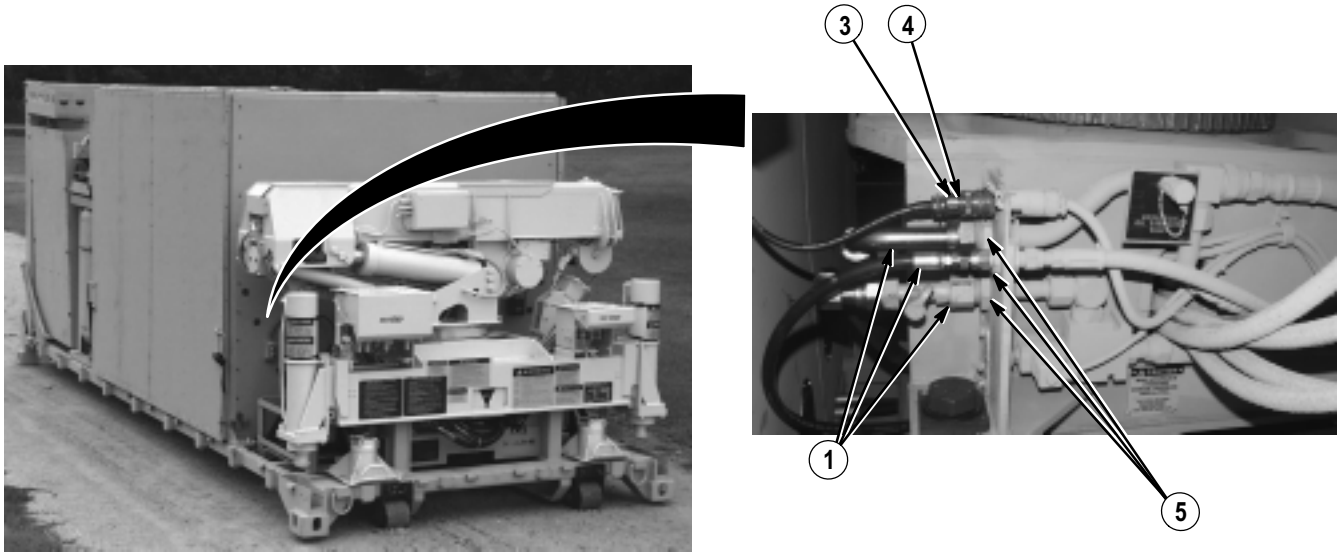
- The crane hydraulic system operates at oil pressures up to 3,500 psi (24,132 kPa). Never disconnect any hydraulic line or fitting without crane stowed with no load at zero pressure. Failure to comply may result in serious injury or death to personnel.
- Crane assembly weighs approximately 5,700 lbs (2,586 kg). Attach suitable lifting device to prevent possible injury to personnel.

NOTE

- Remove cable ties as required.
- Cap and plug all hydraulic hoses and fittings to prevent contamination.
- Note location and position of fittings and adapters as each item is removed.
- Tag and mark all hydraulic hoses prior to removal.
- Place drain pan to catch hydraulic oil during removal of hydraulic lines.

(1) Disconnect three hydraulic hoses (1) from three hydraulic quick disconnects (2).

3-4. CRANE REPLACEMENT (CONT).

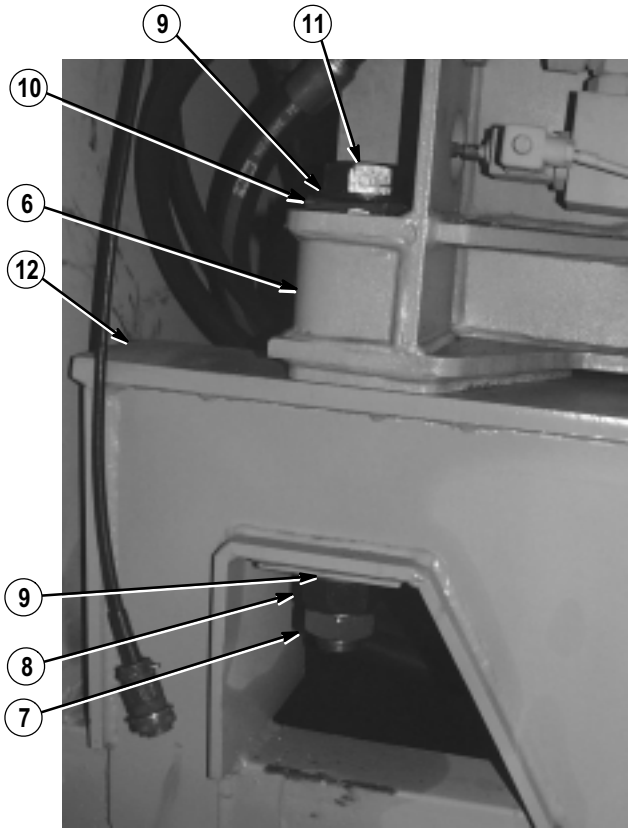


(2) Disconnect crane main power connector (3) from connector (4).

(3) Disconnect three hydraulic hoses (1) from connectors (5).

WARNING

Crane assembly weighs approximately 5,700 lbs (2,586 kg). Attach suitable lifting device to prevent possible injury to personnel.



(4) With the aid of assistants, attach lifting device to crane assembly (6).

(5) With the aid of assistants, remove jam nut (7) from bolt.

(6) Remove nut (8), two washers (9), spacer (10) and bolt (11) from crane assembly (6) and frame (12). Discard nut and bolt.

(7) Repeat Steps (5) and (6) for remaining bolts.

(8) With the aid of assistants, raise crane assembly (6) approximately 2 in. (51 mm) and ensure load is balanced.

(9) Position crane assembly (6) on jackstands.

(10) Remove lifting device from crane assembly (6).

b. Installation.

WARNING

Crane assembly weighs approximately 5,700 lbs (2,586 kg). Attach suitable lifting device to prevent possible injury to personnel.

(1) With the aid of assistants, attach lifting device to crane assembly (6).

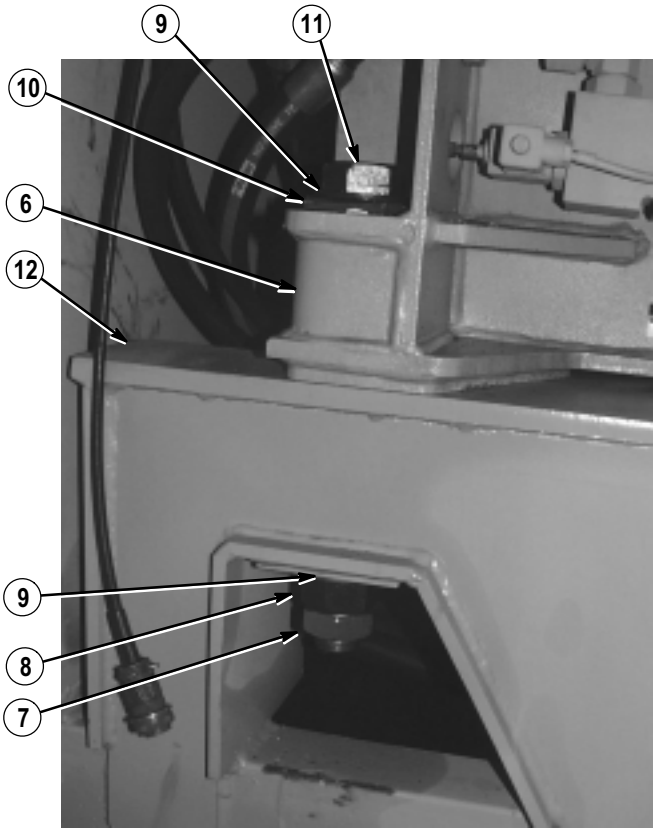
(2) With the aid of assistants, position crane assembly (6) on frame (12) using bolt (11), spacer (10), two washers (9) and nut (8).

(3) Tighten nut (8) to 2296-2496 lb-ft (3113-3385 N·m).

(4) Install jam nut (7) and tighten to 500 lb-ft (678 N·m).

(5) Repeat Steps (2) through (4) for remaining bolts.

(6) Remove lifting device from crane assembly (6).

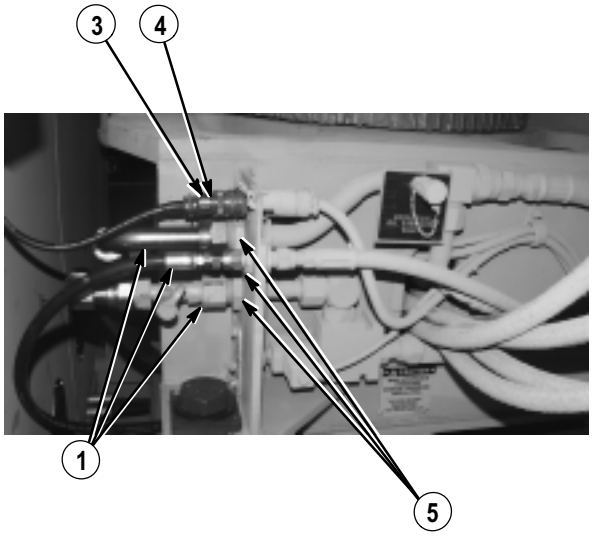


NOTE

Install hydraulic hoses as noted prior to removal.

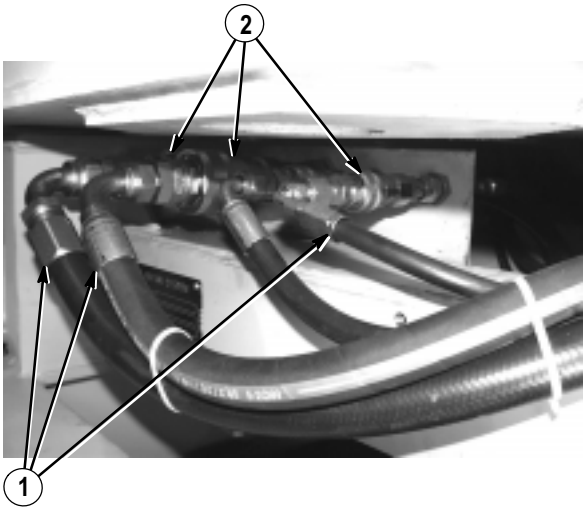
(7) Install three hydraulic hoses (1) and install on connectors (5).

(8) Connect crane main power connector (3) to connector (4).



3-4. CRANE REPLACEMENT (CONT).

(9) Connect three hydraulic hoses (1) to hydraulic quick disconnects (2).



c. Follow-On Maintenance:

- Check hydraulic fluid and fill hydraulic reservoir, if necessary, (TM 9-4940-568-20).
- Connect batteries, (TM 9-4940-568-10).
- Operate crane and check for leaks, (TM 9-4940-568-10).
- Load test crane, (Para 3-5).
- Install jackstand storage boxes, (TM 9-4940-568-20).
- Stow outrigger pads, (TM 9-4940-568-10).

END OF TASK

3-5. CRANE LOAD TEST.

This task covers:

a. Load Test

b. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Protractor, Magnetic (Item 41, Appendix F)
Test weight, 9890 to 9910 lbs. (4486-4495 kg)
Test weight, 10,280 to 10,300 lbs. (4662-4672 kg)

References
TM 9-4940-568-10

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
FRS system leveled (including cribbing if necessary) on hard, level ground, with crane erected

a. Load Test.

WARNING

Do not stand under crane. Mechanical failure and operator error can cause injury or death to personnel.

(1) Swing boom (1) so that hoist hook block (2) is on back side of FRS system.

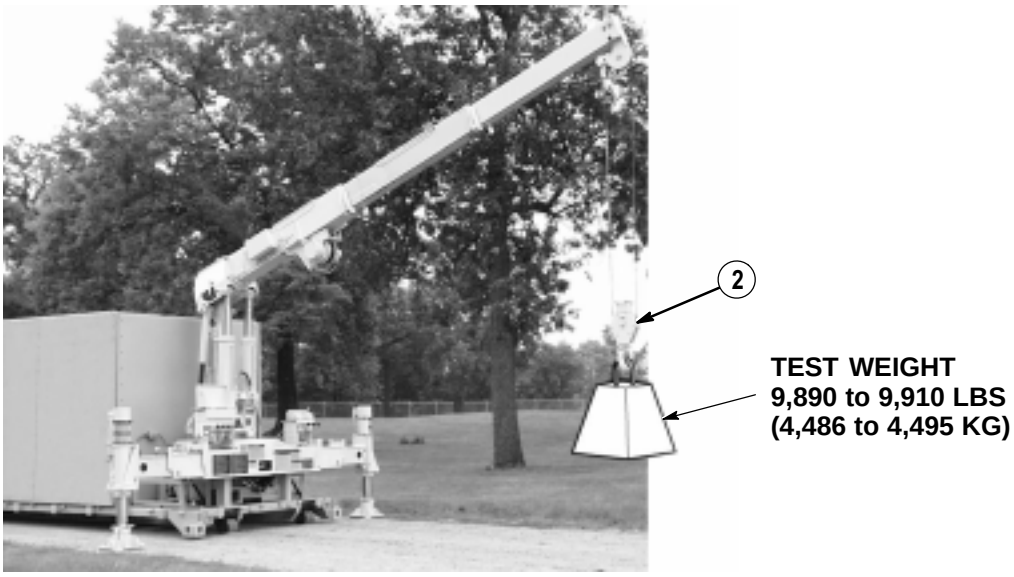
(2) Telescope boom (1) out completely.

(3) Attach inclinometer parallel to boom (1) on underside of boom.

(4) Operate boom (1) so that inclinometer indicates 0 degrees.

(5) Raise boom so that inclinometer indicates 5 degrees and remove inclinometer from boom.

3-5. CRANE LOAD TEST (CONT).



(6) Lower hook block (2) and attach hook block to test weight (9,890 to 9,910 lbs. [4,486 to 4,495 kg]).

NOTE

- Only use HOIST control lever in Steps (7) through (9). Do not use TELESCOPE or MAST control levers or test will be invalid.
- If crane will not lift test weight in Step (7), crane has failed load test. Refer to troubleshooting task.

(7) Lift test weight three to four ft. (0.92 to 1.2 m) up using hoist.

(8) Lower test weight to ground using hoist.

(9) Disconnect hook block (2) from test weight.

(10) Attach hook block (2) to test weight (10,280 to 10,300 lbs. [4,662 to 4,672 kg]).

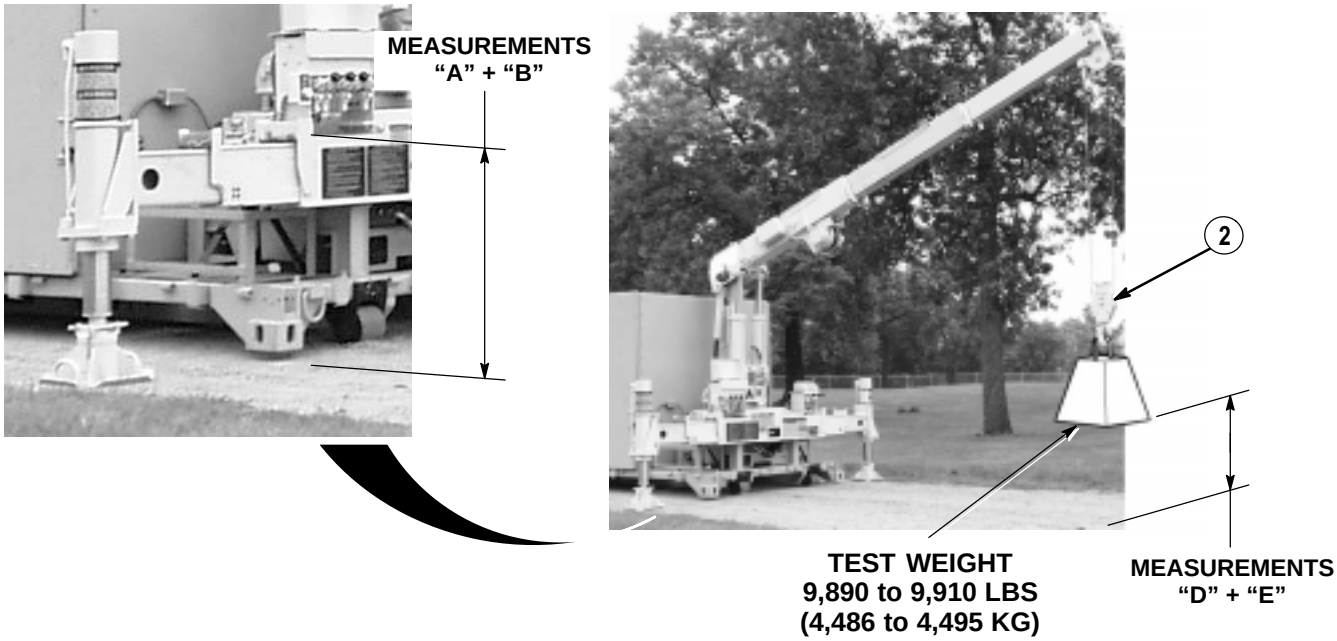
NOTE

- Only use HOIST control lever in Steps (11) and (12). Do not use TELESCOPE or MAST control levers or test will be invalid.
- Using HOIST control lever, crane should lift test weight a maximum of 1 in. (2.5 cm) before Overload Sensing System (OSS) disables hoist. If hoist lifts test load higher than 1 in. (2.5 cm), OSS is not functioning correctly and crane has failed load test. Perform Troubleshooting OSS task, TM 9-4940-568-20.
- OSS disables hoist only in the direction of raising. OSS does not effect hoist lowering.

(11) Attempt to lift test weight using hoist.

(12) Lower test weight to ground using hoist.

(13) Disconnect hoist hook block (2) from test weight.



WARNING

Do not stand under crane. Mechanical failure and operator error can cause injury or death to personnel.

(14) Lower hook block (2) and attach hook block to test weight (9,890 to 9,910 lbs [4,486 to 4,495 kg]).

(15) Lift test weight three to four ft (0.92 to 1.2 m) using hoist.

(16) Measure the distance between the top of the subframe and the ground. Record as measurement A.

NOTE

Allow thirty minutes between Step (16) and Step (17). If measurement C exceeds one-half inch, notify GS maintenance for repair.

(17) Repeat Step (16). Record as measurement B.

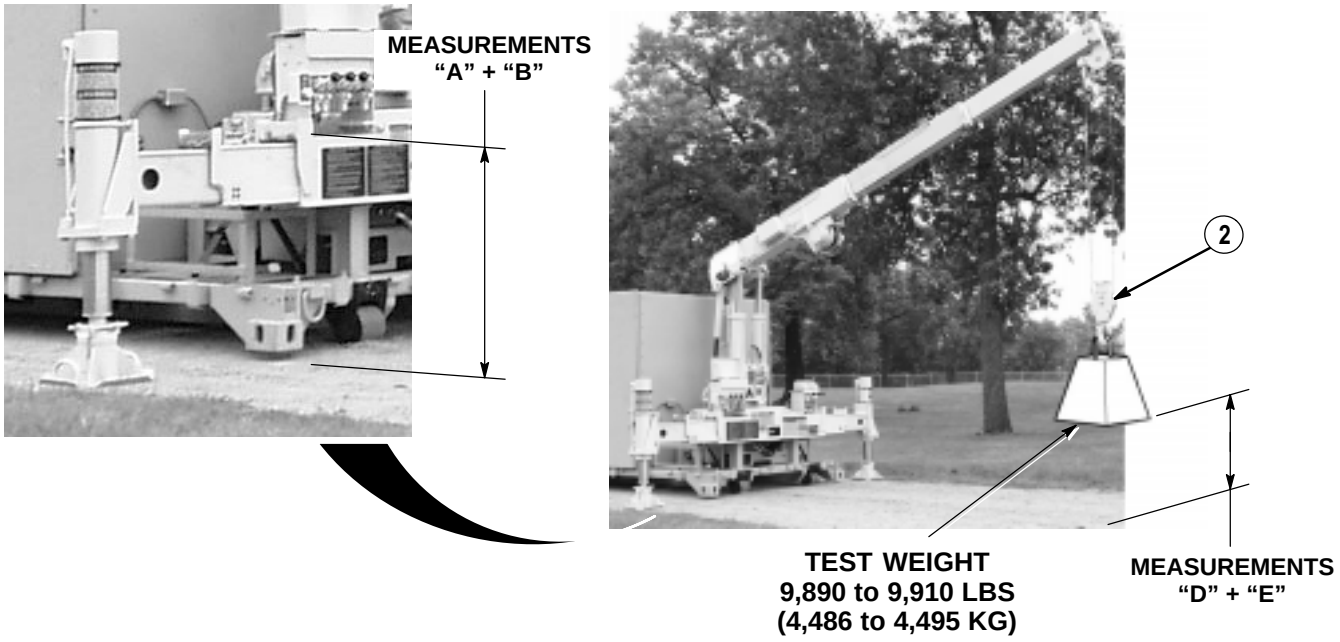
(18) Subtract measurement B, from measurement A, and record as measurement C.

NOTE

Ensure distance between top of subframe and ground (measurement B), does not change while performing Step (19).

(19) Measure the distance between the bottom outside edge of test weight and the ground. Record as measurement D.

3-5. CRANE LOAD TEST (CONT).



WARNING

Do not stand under crane. Mechanical failure and operator error can cause injury or death to personnel.

NOTE

Allow thirty minutes between Step (19) and Step (20). If measurement F exceeds one inch, notify GS maintenance for repair.

(20) Repeat Step (19). Record as measurement E.

(21) Subtract measurement E from measurement D, and record as measurement F.

(22) Lower test weight to ground using hoist.

(23) Disconnect hook block (2) from test weight.

b. Follow-On Maintenance:

- Stow crane, (TM 9-4940-568-10).

END OF TASK

3-6. TURNTABLE BEARING INSPECTION PROCEDURE.

This task covers:

a. Inspection b. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Indicator, Dial, Set (Item 33, Appendix F)
Protractor, Magnetic (Item 41, Appendix F)
Sander, Portable, Disk Electric (Item 48, Appendix F)

References
TM 9-4940-568-10

Equipment Condition
FRS unloaded (TM 9-4940-568-10)
FRS system leveled (including cribbing if necessary) on hard, level ground, with crane erected, (TM 9-4940-568-10)
Ensure turntable bearing is lubricated, (TM 9-4940-568-10)
Ensure all turntable mounting bolts have been tightened to recommended torque value, (Para 3-29)

a. Inspection.

WARNING

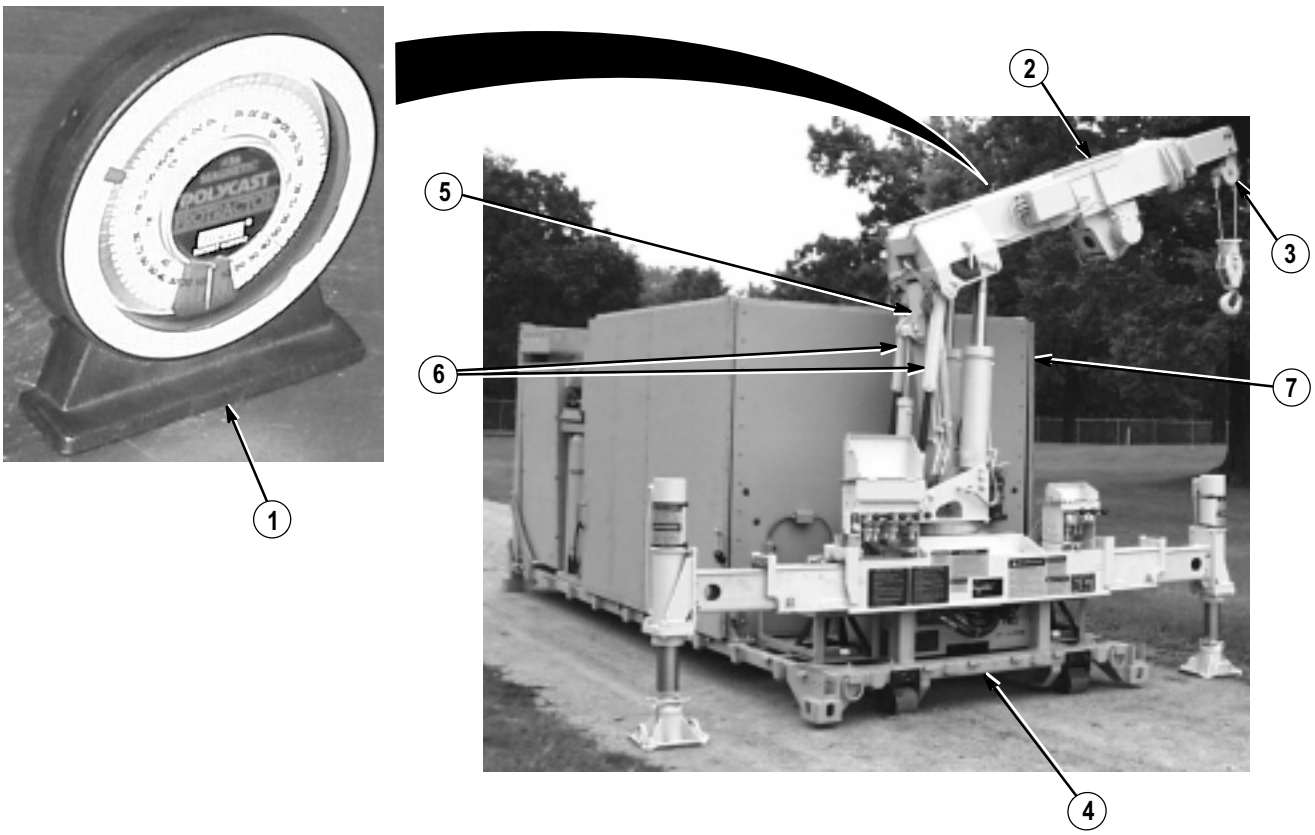
Do not stand under crane. Mechanical failure and operator error can cause injury or death to personnel.

NOTE

To obtain a true reading of bearing vertical movement, the dial indicator and magnetic base must be positioned correctly. Perform the steps below.

- Ensure that the plunger is straight up and down in all directions, front to back and side to side. It is not necessary to measure this, but try to get it as close as possible with a visual inspection from different angles.
- Ensure that the dial indicator is pre-loaded at least one turn by allowing the needle to complete one turn around the dial before zeroing the dial.
- Ensure that the magnetic base is secure at its attachment point so it will not move and contribute to a false indicator reading.
- The dial indicator must be in line with the axial centerline of the boom for all measurements.
- To give a consistent reading, the dial indicator plunger must be as close as possible to the outside diameter of the swing gear tooth tip, as the allowable bearing movement only applies at the tip of the gear tooth. The indicator reading will be magnified if the plunger contact point is off of the outer diameter of the swing gear tooth tip.
- Always verify that the dial indicator reading is correct by lowering the boom from the 60 degree boom angle to the level boom angle, then check that the dial indicator returns to the zero position. Repeat the procedure if the dial indicator does not return to the zero position.

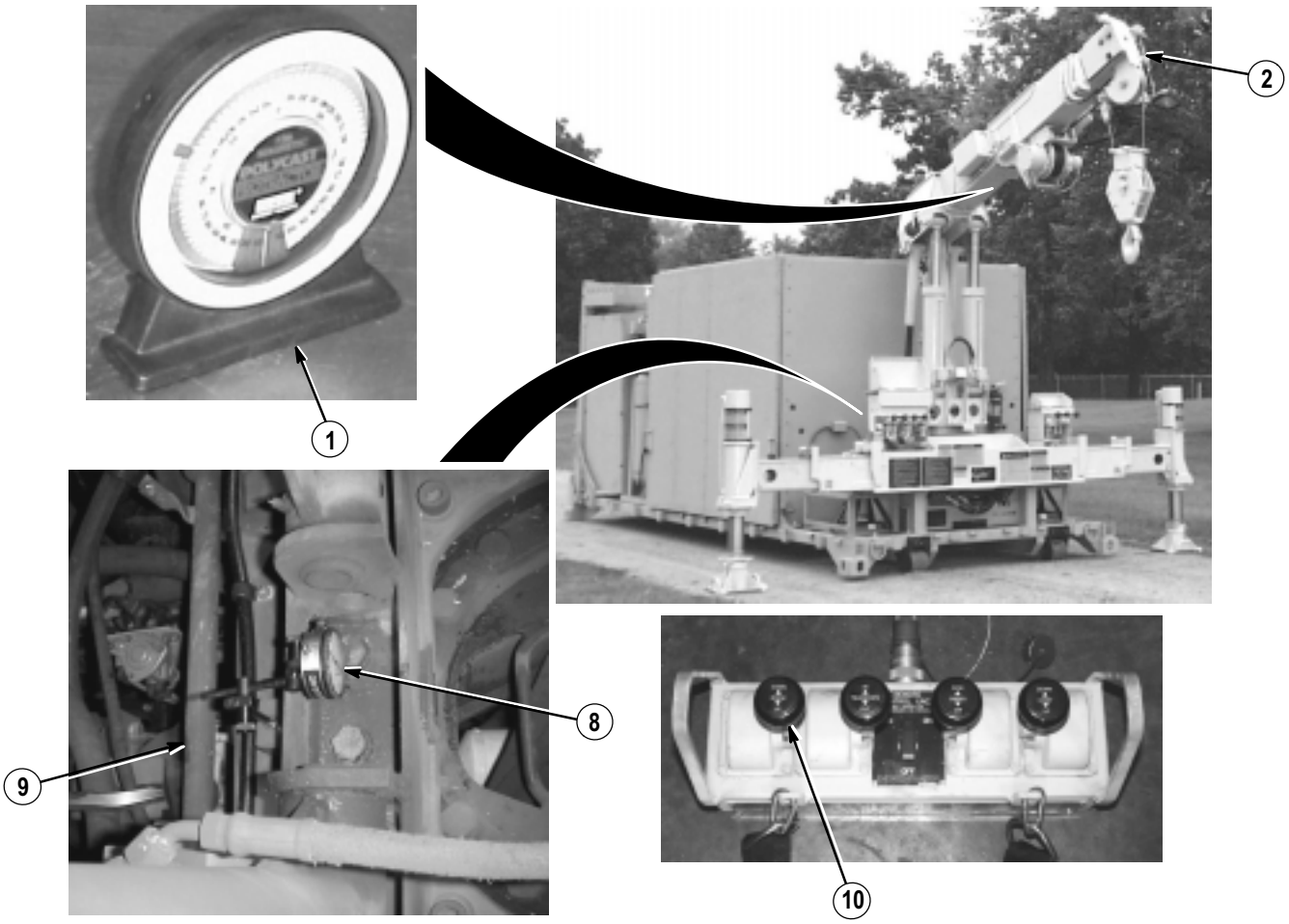
3-6. TURNTABLE BEARING INSPECTION PROCEDURE (CONT).



(1) Position magnetic protractor (1) on boom (2), ensure magnetic protractor is in line with axial centerline of boom.

(2) With the boom angle level, rotate boom (2) and position boom nose (3) towards the rear of the FRS (4).

(3) Keeping boom (1) level, lower mast (5) until approximately 1 in. (24.4 mm) clearance is present between the mast erection cylinders (6) and shelter (7).



NOTE

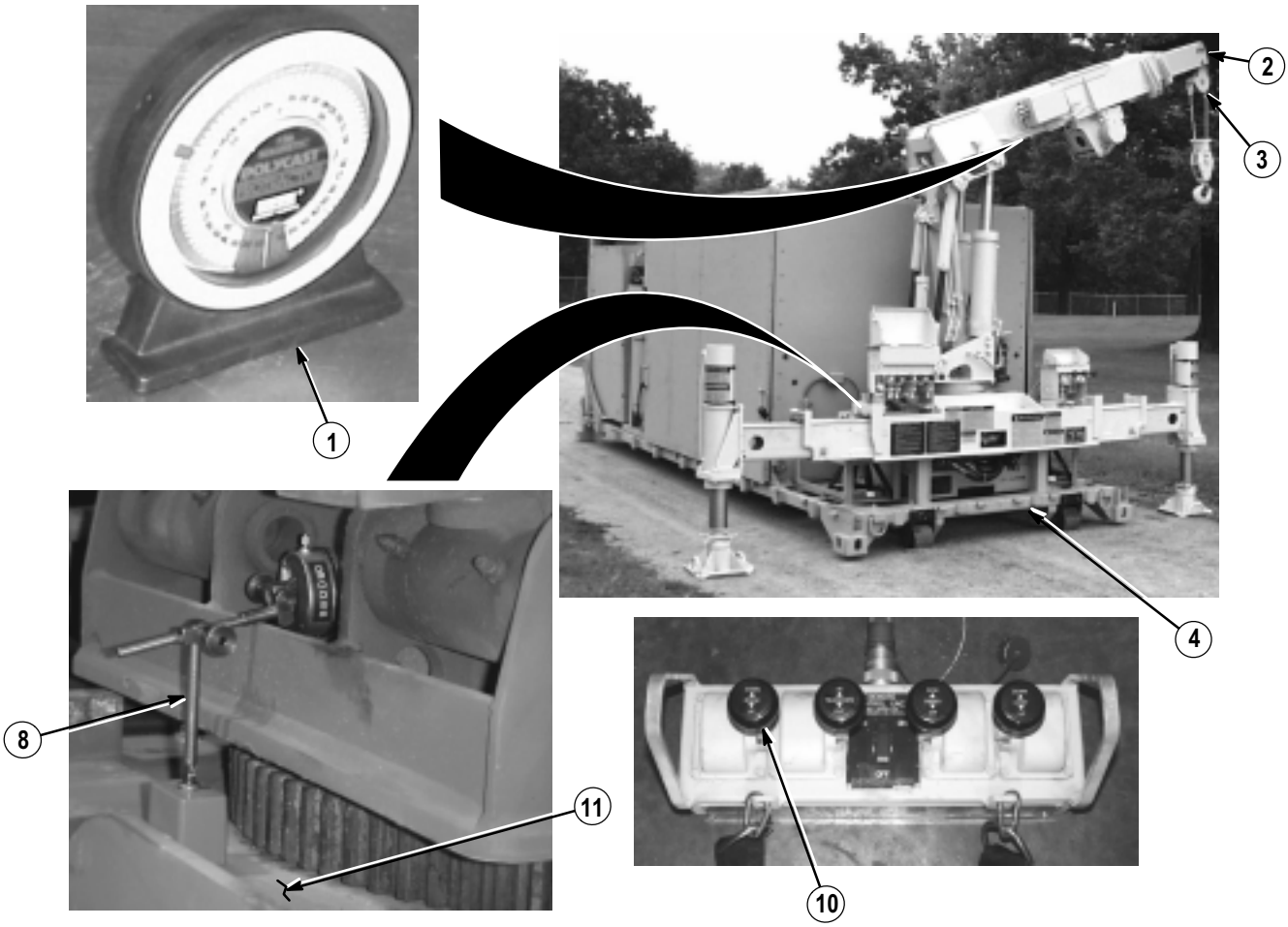
- Operate the crane controls smoothly to avoid any jerking or harsh movement that could affect the dial indicator reading.
- Surfaces where magnetic base mounts and dial indicator plunger indicates off of must be free of grease and dirt, and must be smooth. Clean surfaces as required and if needed, use sand paper to smooth out the surfaces. Surfaces that are not clean or are rough will affect the true dial indicator reading.

(4) Position dial indicator (8) with magnetic base on subframe (9). Plunger of dial indicator must be in-line with the axial centerline of the crane boom (2), with the plunger tip centered as close as possible above the tip of the swing gear tooth.

(5) Adjust dial indicator (8) to preload the dial, then zero the dial indicator.

(6) Operate boom up control (10) until boom angle is reading 60 degrees on magnetic protractor (1).

3-6. TURNTABLE BEARING INSPECTION PROCEDURE (CONT).



NOTE

Any reading equal to or over .065 in. (1.65 mm) will require a new bearing to be ordered and installed as soon as possible. If the reading occurs on the first step of the inspection, it is not necessary to continue the inspection. However, even if the first reading is within the specifications, it is still necessary to complete all of the remaining steps in the inspection procedure.

(7) Record dial indicator reading.

(8) If reading is equal to or over .065 in. (1.65 mm), perform bearing replacement procedures (Para 3-29). If reading is under .065 in. (1.65 mm) continue the inspection procedure.

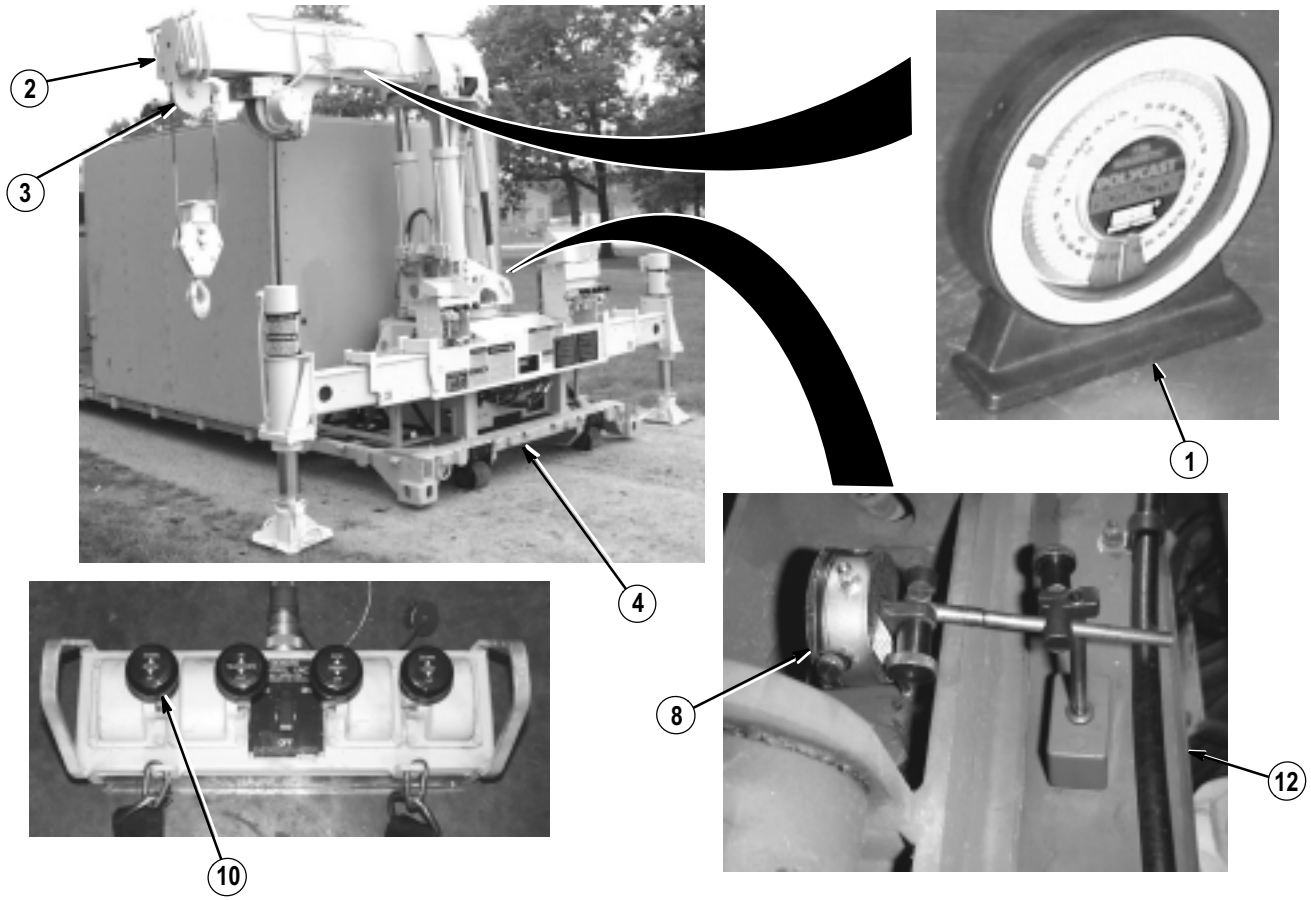
(9) Rotate boom (2) 90 degrees to position boom nose (3) over right side of the FRS (4).

(10) Lower boom (2) to obtain a level boom angle.

(11) Position dial indicator (8) with magnetic base on subframe (11). Plunger of dial indicator must be in-line with the axial centerline of the crane boom (2), with the plunger tip centered as close as possible above the tip of the swing gear tooth.

(12) Adjust dial indicator (8) to preload the dial, then zero the dial indicator.

(13) Operate boom up control (10) until boom angle is reading 60 degrees on magnetic protractor (1).



(14) Record measurement.

(15) If reading is equal to or over .065 in. (1.65 mm), perform bearing replacement procedures. If reading is under .065 in. (1.65 mm) continue the inspection procedure.

(16) Rotate the boom (2) 180 degrees to place the boom nose (3) over left side of the FRS (4).

(17) Lower boom (2) to obtain a level boom angle.

(18) Position dial indicator (8) with magnetic base on subframe (12). Plunger on dial indicator must be in-line with the axial centerline of the crane boom (2) with the plunger tip centered as close as possible above the tip of the swing gear tooth.

(19) Record measurement.

(20) Operate boom up control unit (10) until boom angle is reading 60 degrees on magnetic protractor (1).

(21) Record measurement.

(22) If reading is equal to or over .065 in. (1.65 mm), replace bearing (Para 3-29). If reading is under .065 in. (1.65 mm) the inspection procedure is complete, return crane to service.

b. Follow-On Maintenance:

- Stow crane, (TM 9-4940-568-10).

END OF TASK

3-7. THREE FUNCTION MANUAL CONTROL VALVE REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Hydraulic oil (Item 16, Appendix B)
Primer, (Item 22, Appendix B)
Sealing compound (Item 33, Appendix B)
Packing, preformed (Item 73, Appendix E)
Packing, preformed (6) (Item 74, Appendix E)
Packing, preformed (2) (Item 78, Appendix E)
Packing, preformed (Item 89, Appendix E)
Packing, preformed (8) (Item 93, Appendix E)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Three function manual control valve bracket removed, (Para 3-11).

---

a. Removal

NOTE

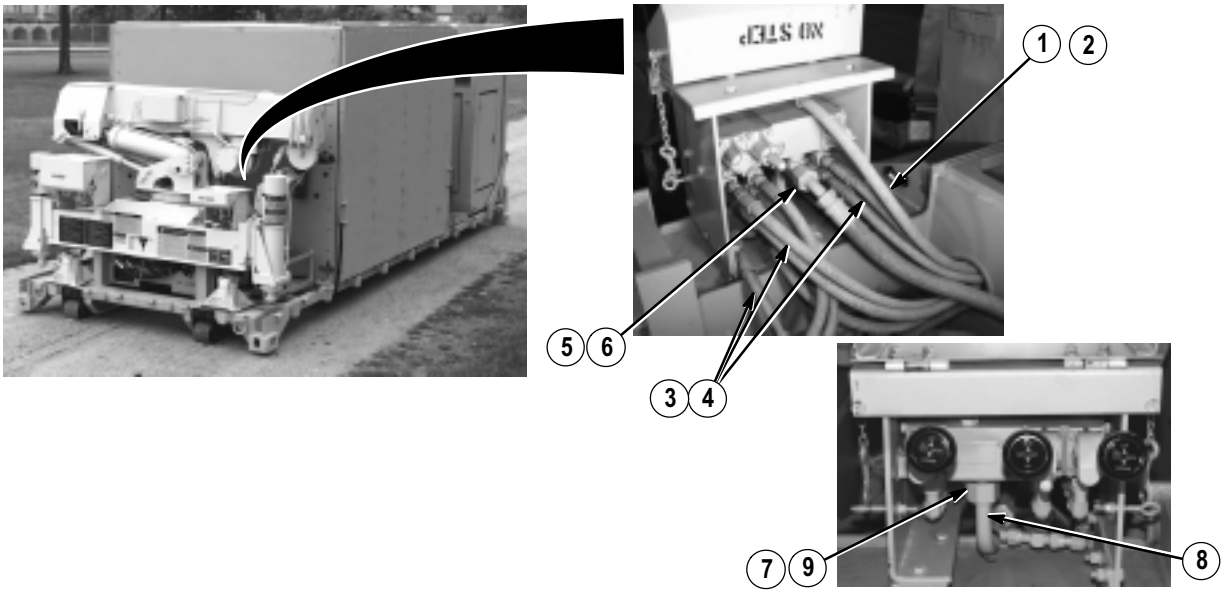
- Place a container to catch hydraulic oil during hose removal.
- Tag and mark all hoses, tubes, and connectors prior to removal.

(1) Remove hose (1) and preformed packing (2). Discard preformed packing.

(2) Remove eight hoses (3) and preformed packings (4). Discard preformed packings.

(3) Remove hose (5) and preformed packings (6). Discard preformed packings.

(4) Loosen fitting (7) and remove tube (8) and preformed packings (9). Discard preformed packings.



NOTE

Note position of elbows (10, 13, and 20) prior to removal, to ensure proper installation.

(5) Remove elbow (10) and preformed packings (11). Discard preformed packings.

(6) Loosen three fittings (12) and remove three elbows (13) and preformed packings (14). Discard preformed packings.

(7) Remove three adapters (15) and preformed packings (16). Discard preformed packings.

(8) Remove adapter (17) and preformed packings (18). Discard preformed packings.

(9) Loosen three fittings (19) and remove three elbows (20) and preformed packings (21). Discard preformed packings.

(10) Loosen three nuts (22) and remove three knobs (23) from levers (24).

b. Installation

NOTE

- Lubricate all new preformed packings with clean hydraulic oil.
- Ensure all elbows (20, 13, and 10) are installed in same position as noted during removal.

(1) Install three nuts (22) and knobs (23) on levers (24). Tighten nuts (22) against knobs (23).

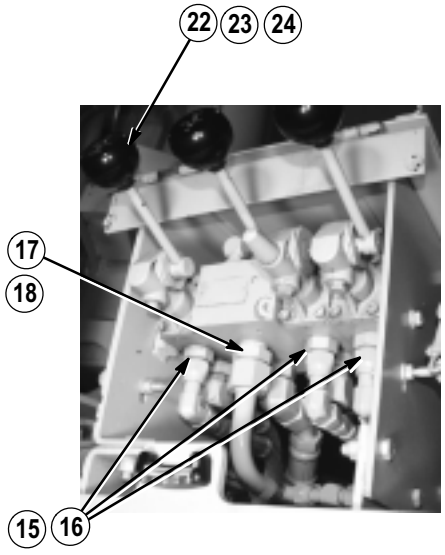
(2) Install three preformed packings (21) on three elbows (20) and tighten three fittings (19).

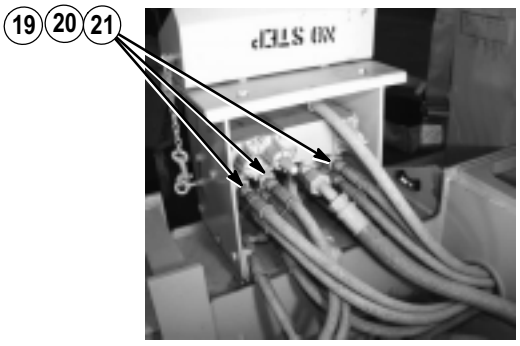
(3) Install preformed packing (18) and adapter (17).

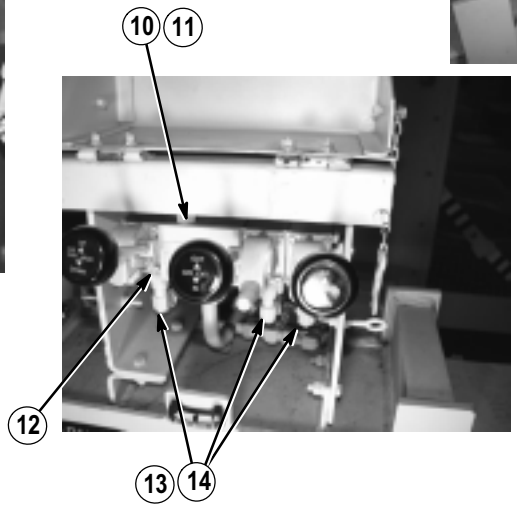
(4) Install three preformed packings (16) and adapters (15).

(5) Install three preformed packings (14), three elbows (13) and tighten three fittings (12).

(6) Install preformed packing (11) and elbow (10).







3-7. THREE FUNCTION MANUAL CONTROL VALVE REPLACEMENT (Continued)

(7) Install preformed packing (9), tube (8), and tighten fitting (7).

(8) Install preformed packing (6) and hose (5).

(9) Install eight preformed packings (4) and hoses (3).

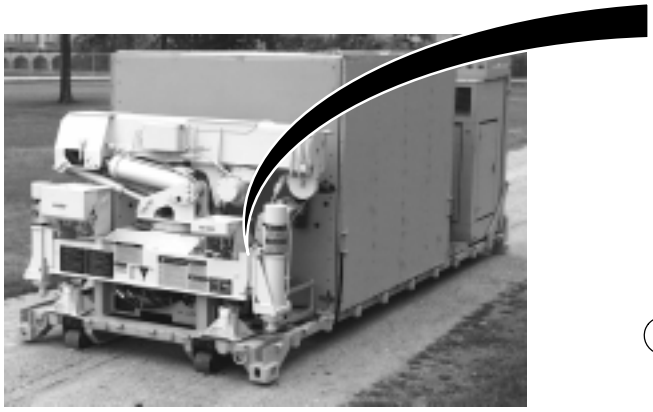
(10) Install preformed packing (2) and hose (1).

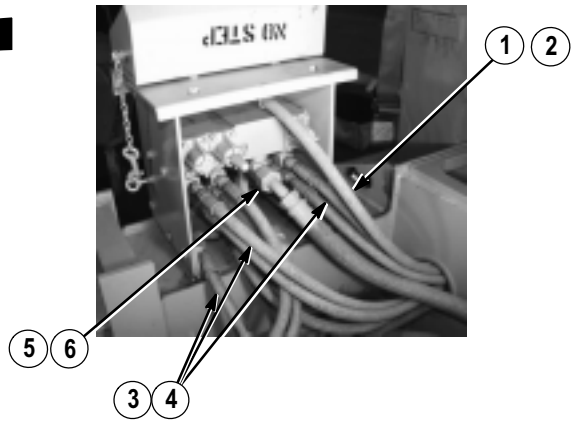
END OF TASK

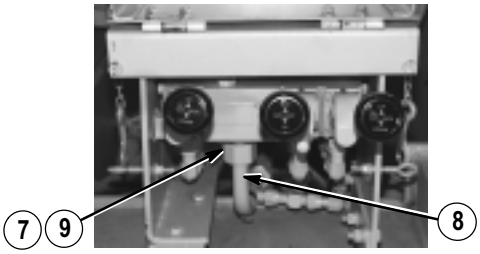
Follow-On Maintenance

Install three function manual control valve bracket (Para 3-11).

Load test crane (para 3-5)







3-8. OUTRIGGER EXTENSION CYLINDER REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Hydraulic oil (Item 16, Appendix B)
Packing, preformed (13)
(Item 75, Appendix E)

Personnel Required
Two

Equipment Condition
Outrigger beams removed (para 3-10).

Remote control storage box removed
(para 5-12).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

a. Removal

WARNING

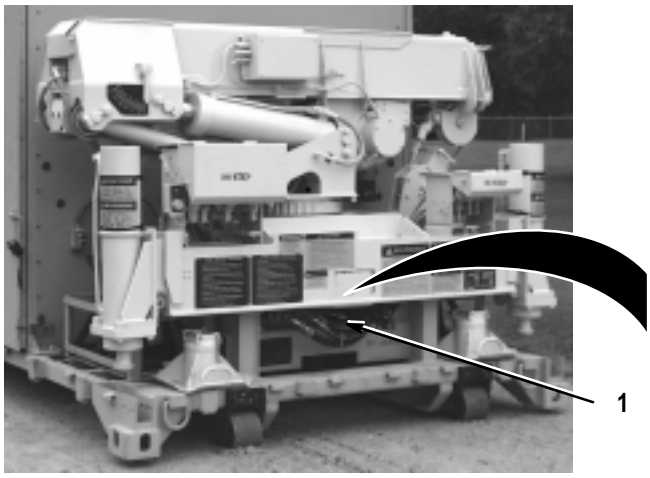
Hydraulics may be under pressure and can spurt out when lines are disconnected. Crack all lines slowly and keep your face clear of lines.

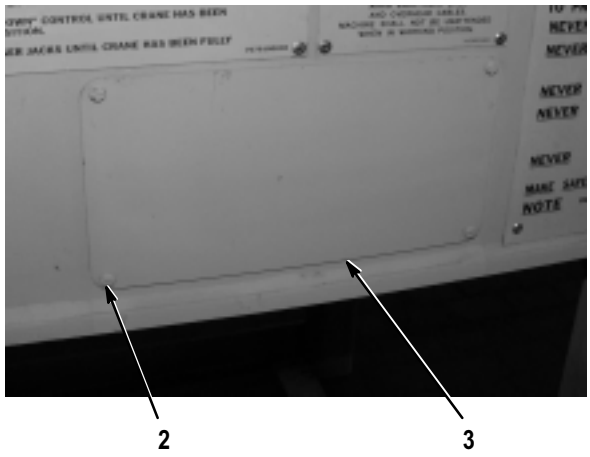
NOTE

- Tag and mark hoses and tubes prior to removal to ensure proper installation.
- Cap and plug hoses, tubes, and fittings upon removal.

(1) Place drain pan under access hole at the center of the base (1).

(2) Remove four screws (2) and cover (3).





3-8. OUTRIGGER EXTENSION CYLINDER REPLACEMENT (Continued)

(3) Disconnect seven hoses (4, 5, 6, 7, 8, 9 and 10) and remove seven preformed packings (11) from extension cylinder (12). Discard preformed packings.

(4) Remove two safety pins (13) from pins (14).

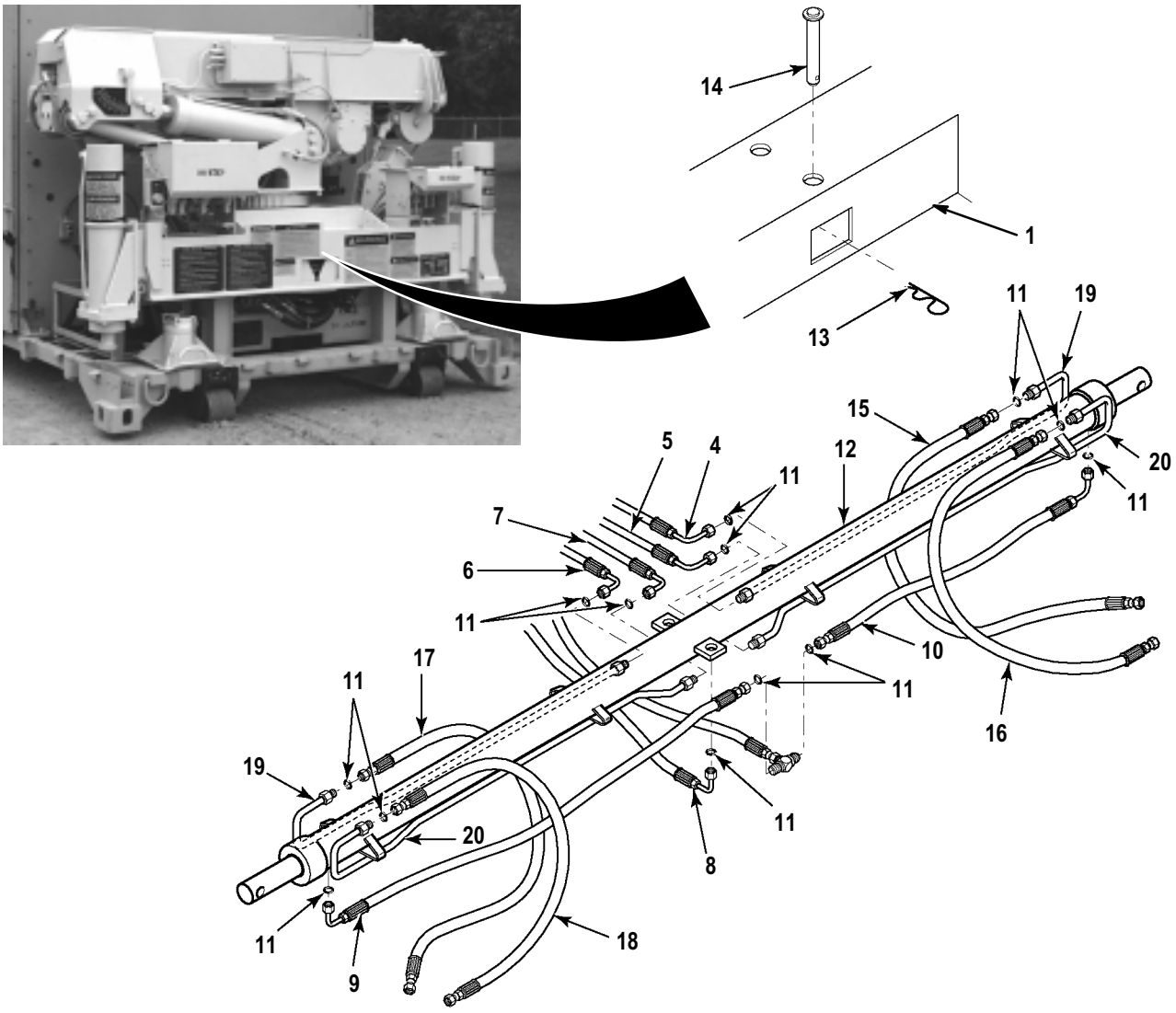
(5) Remove two pins (14) from extension cylinder (12).

(6) With help from assistant, remove extension cylinder (12) from base (1).

(7) Remove four hoses (15, 16, 17 and 18) from two tubes (19 and 20).

(8) Remove four preformed packings (11) from two tubes (19 and 20). Discard four preformed packings.

(9) Remove two hoses (9 and 10) and preformed packings (11) from extension cylinder (12). Discard preformed packings.



b. Installation

NOTE

Lubricate all preformed packings with clean hydraulic oil.

(1) Install two preformed packings (11) and hoses (9 and 10) on extension cylinder (12).

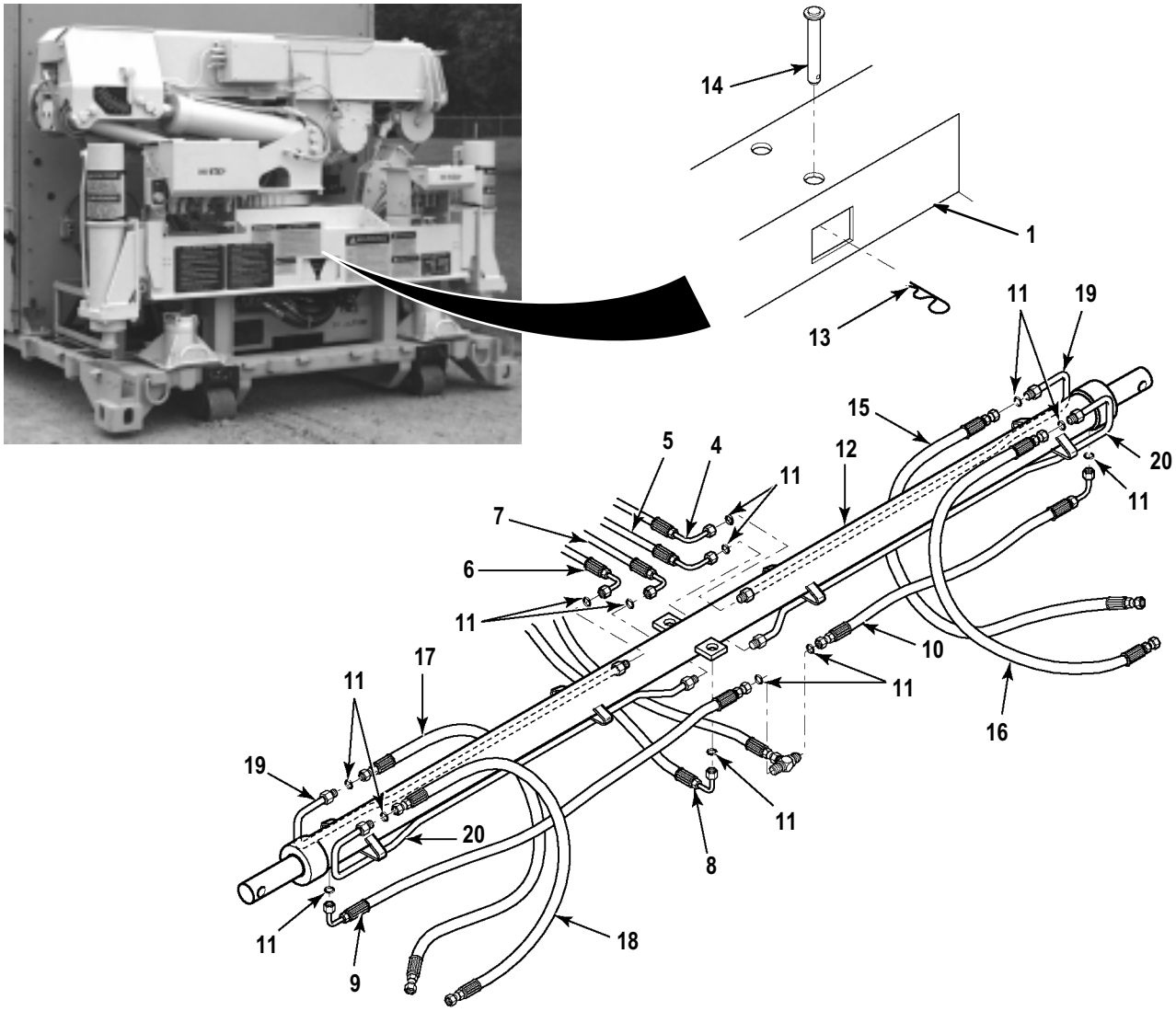
(2) Install four preformed packings (11) and hoses (15, 16, 17 and 18) on two tubes (19 and 20).

(3) With help from assistant, position extension cylinder (12) in base (1).

(4) Install two pins (14) in extension cylinder (12).

(5) Install two safety pins (13) in pins (14).

(6) Install seven preformed packings (11) and hoses (4, 5, 6, 7, 8, 9 and 10) on extension cylinder (12).



3-8. OUTRIGGER EXTENSION CYLINDER REPLACEMENT (Continued)

(7) Install cover (3) using four screws (2).

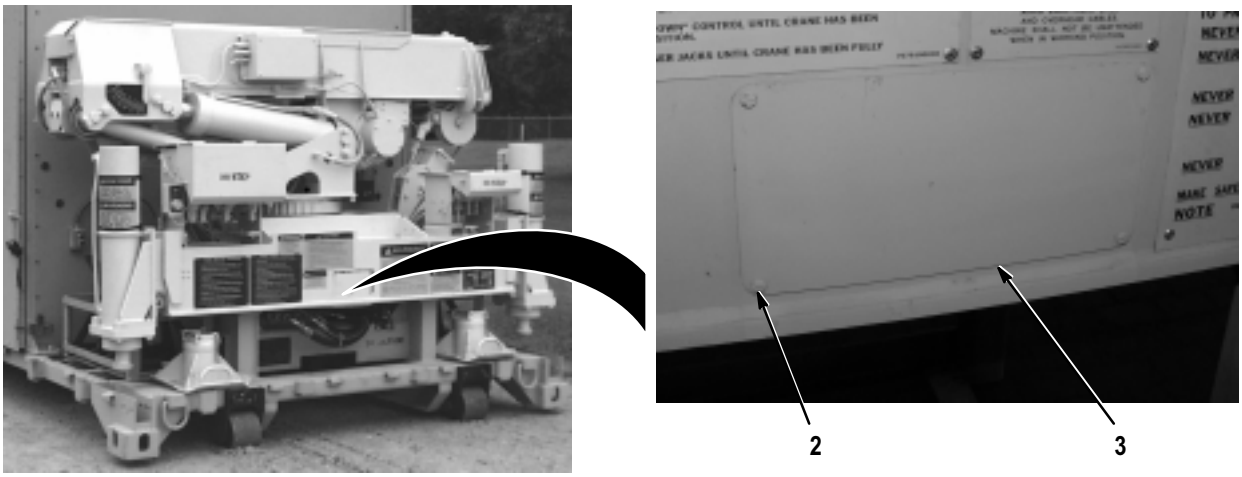
END OF TASK

Follow-On Maintenance

Install outrigger beams (para 3-10).

Install remote control box (para 5-12).

Check crane for proper operation and hydraulic leaks (TM 9-4940-568-10).



3-9. JACK CYLINDER REPLACEMENT.

THIS TASK COVERS:
a. Removal
b. Cleaning/Inspection
c. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Personal required
1 Assistant

Materials/Parts
Packing, preformed (4) (Item 74, Appendix E)
Lockwasher (4) (Item 45, Appendix E)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Special Environmental Conditions
Cleanliness is extremely important when working with hydraulic equipment. Clean all parts before disassembly, and work in a clean area.

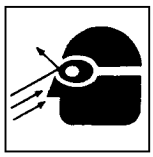
---

a. Removal

WARNING

Hydraulics may be under pressure and can spurt out when lines are disconnected. Crack all lines slowly and keep your face clear of lines.

WARNING



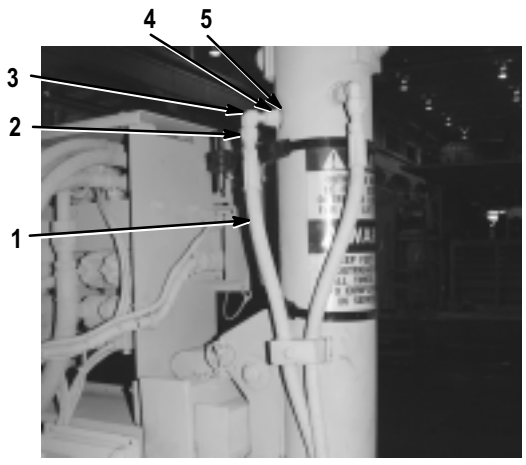
Be sure to wear safety glasses when servicing hydraulic system.

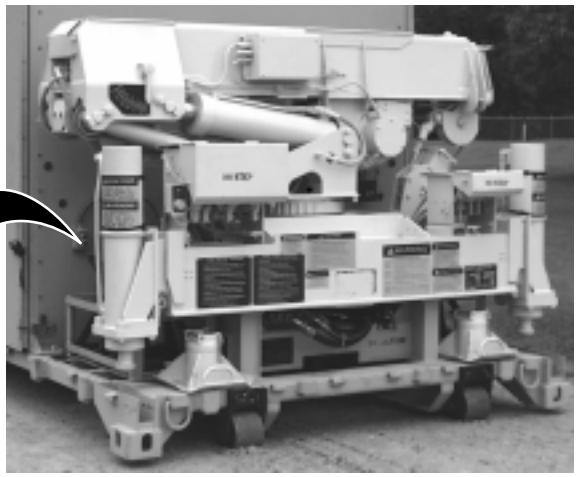
NOTE

- Steps are the same for left or right jack cylinders, left side shown.
- Tag and mark all hydraulic hoses prior to removal.
- Cap and plug all hoses and fittings upon removal.

(1) Remove hose (1) and two preformed packings (2) from elbow (3). Discard preformed packings.

(2) Remove elbow (3) and adapter (4) from cylinder (5).





3-9. JACK CYLINDER REPLACEMENT (Continued)

(3) Remove hose (6) and two preformed packings (7) from elbow (8). Discard preformed packings.

(4) Remove elbow (8) and adapter (9) from cylinder (5).

(5) Remove four screws (10), lockwashers (11), washers (12) and cover plate (13) from barrel (14).

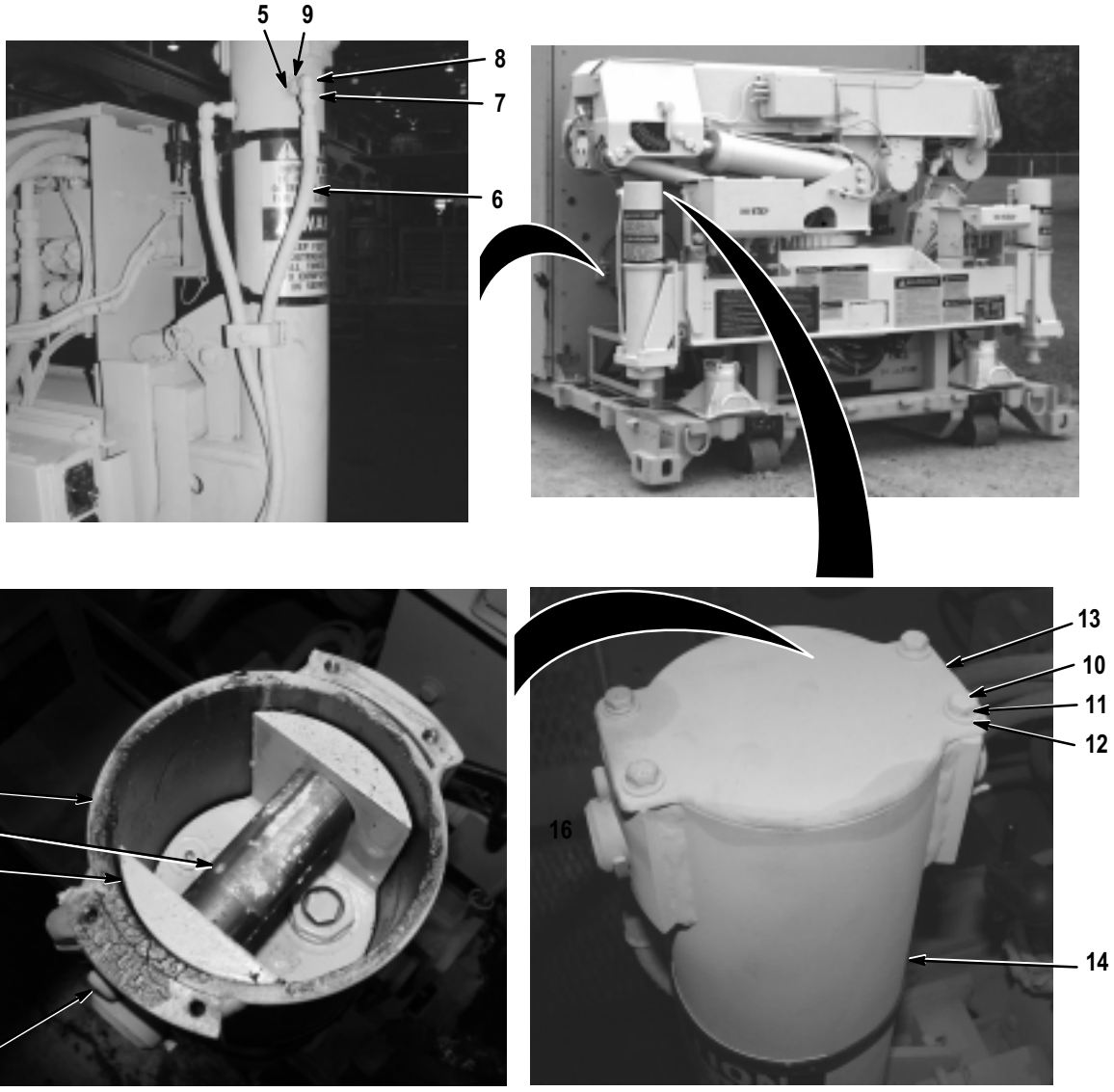
CAUTION

Bottom of cylinder must be supported prior to removal.

(6) With the aid of an assistant, support cylinder (5) and remove two cotter pins (15) and pin (16) from barrel (14) and cylinder.

(7) With the aid of an assistant, remove cylinder (5) through top of barrel (14).

(8) Repeat Steps (1) through (7) for right side.



b. Cleaning/Inspection

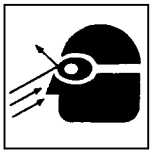
(1) Clean all parts.

(2) Inspect all parts.

(3) Replace all parts failing inspection.

c. Installation

WARNING



Be sure to wear safety glasses when servicing hydraulic system.

CAUTION

Bottom of cylinder must be supported during installation.

NOTE

Steps are the same for left or right jack cylinders, left side shown.

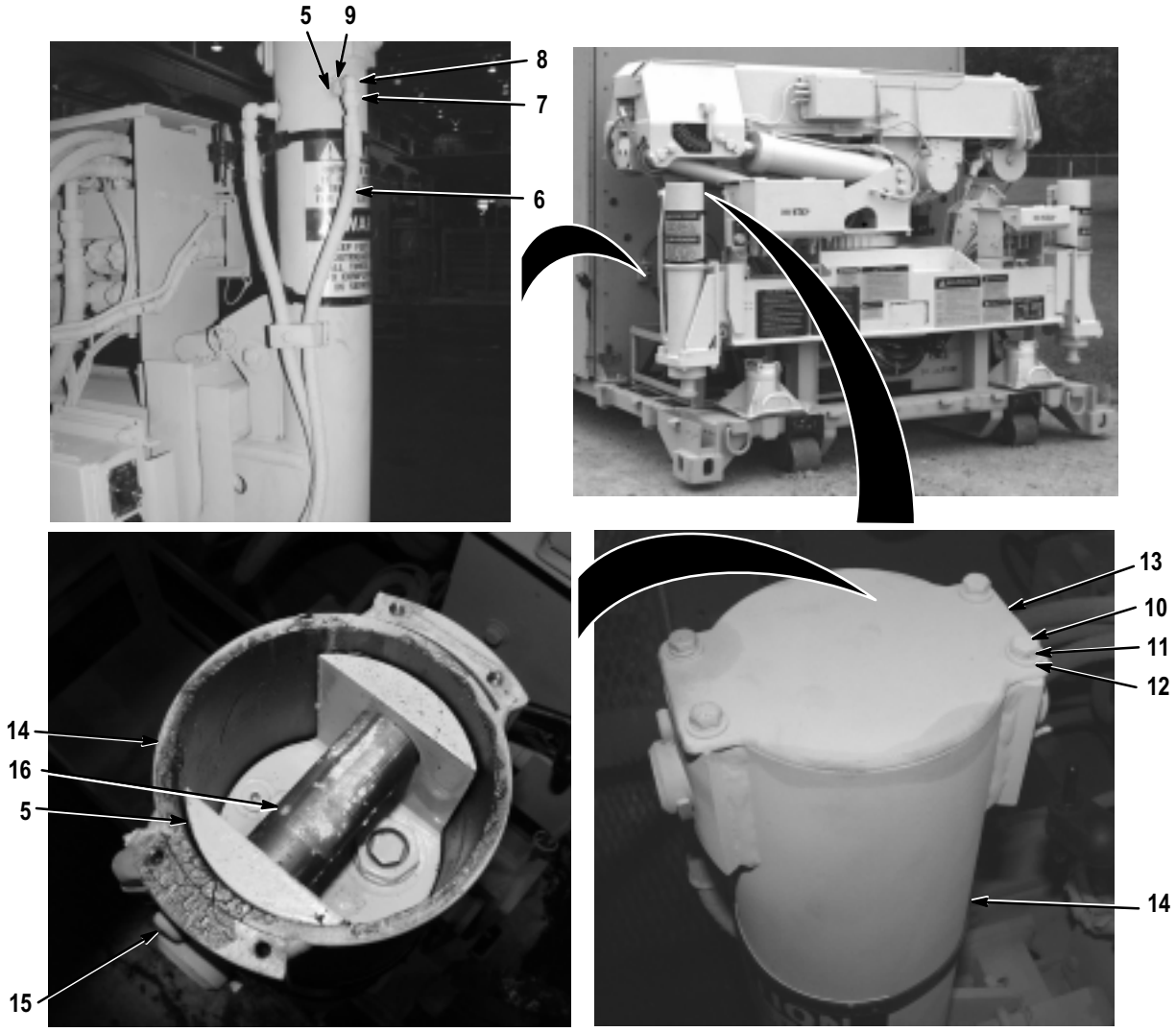
(1) With the aid of an assistant, install cylinder (5) through top of barrel (14).

(2) With the aid of an assistant, install cylinder (5) to barrel (14) using pin (16) and two cotter pins (15).

(3) Install cover plate (13) on barrel (14) using four washers (12), lockwashers (11) and screws (10).

(4) Install adapter (9) and elbow (8) on cylinder (5).

(5) Install preformed packing (7) and hose (6) on elbow (8).



3-9. JACK CYLINDER REPLACEMENT (Continued)

(6) Install adapter (4) and elbow (3) on cylinder (5).

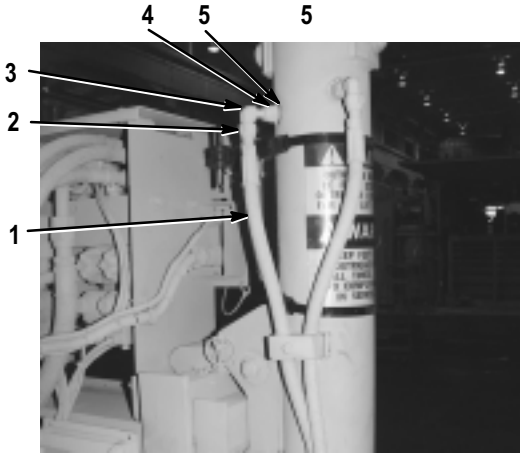
(7) Install two preformed packings (2) and hose (1) on elbow (3).

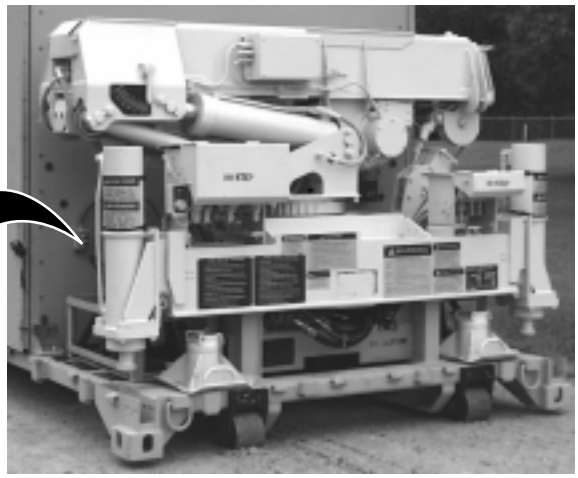
END OF TASK

Follow-On Maintenance

Check crane for proper operation (TM 9-4940-568-10).

Check hydraulic oil level (TM 9-4940-568-10).





3-10. OUTRIGGER BEAM MAINTENANCE

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Sealing compound (Item 29, Appendix B)
Packing, preformed (4) (Item 112, Appendix E)
Shim (A/R) (Item 164, Appendix E)
Shim (A/R) (Item 165, Appendix E)
Shim (A/R) (Item 166, Appendix E)
Shim (A/R) (Item 167, Appendix E)
Shim (A/R) (Item 168, Appendix E)
Shim (A/R) (Item 169, Appendix E)
Shim (A/R) (Item 170, Appendix E)

Materials/Parts Continued
Shim (A/R) (Item 171, Appendix E)
Shim (A/R) (Item 172, Appendix E)
Shim (A/R) (Item 173, Appendix E)
Shim (A/R) (Item 174, Appendix E)
Shim (A/R) (Item 175, Appendix E)

Personnel Required
1 Assistant

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Jack cylinder removed, (para 3-9).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

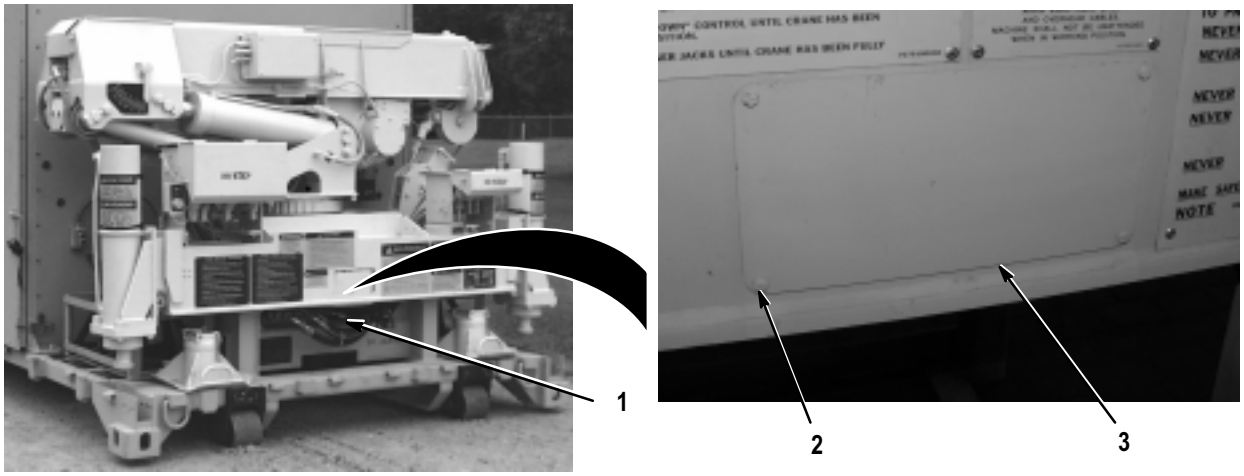
a. Removal

NOTE

This procedure applies to both right and left outrigger beams, right shown.

(1) Place drain pan under access hole at the center of the base (1).

(2) Remove four screws (2) and cover (3).



3-10. OUTRIGGER BEAM MAINTENANCE (Continued)

WARNING

Outrigger beams are heavy and coated with grease. Use extreme care to avoid personal injury.

NOTE

- This paragraph applies to both the right and the left outrigger beams.
- Tag and mark hoses and tubes prior to removal.
- Note positions of elbows prior to removal.
- Cap and plug hoses, tubes, and fittings upon removal to ensure proper installation.

(3) With help from assistant, pull inner beam (4) out of outer beam (5) to allow access to pin (6).

(4) Remove screw (7), washer (8), and pin (6) from extension cylinder (9).

(5) Remove screw (10) and washer (11) from pin (6).

(6) Pull inner beam (4) out 18 inches (46 cm).

(7) Disconnect two hoses (12 and 13) and preformed packings (14) from adapters (15 and 16). Discard preformed packings.

(8) Disconnect two hoses (17 and 18) and remove preformed packings (19) from adapters (15 and 16). Discard preformed packings.

(9) Remove two adapters (15 and 16) from inner beam (4).

(10) Remove screw (20), clamp cover (21), hoses (17 and 18) and clamp base (22).

(11) Attach lifting device to inner beam (4) and remove all slack from lifting device.

NOTE

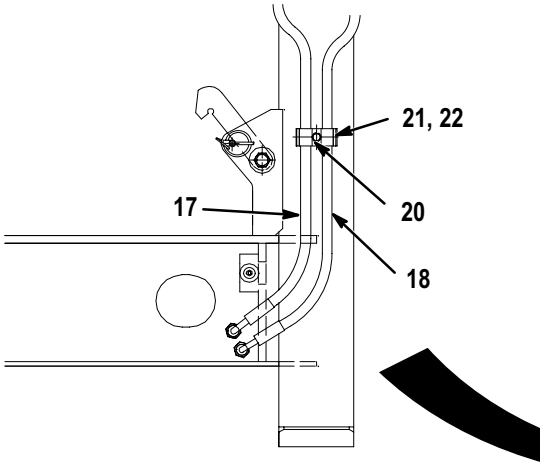
Note positions of plates. Plates differ in thickness and need to be installed in original locations.

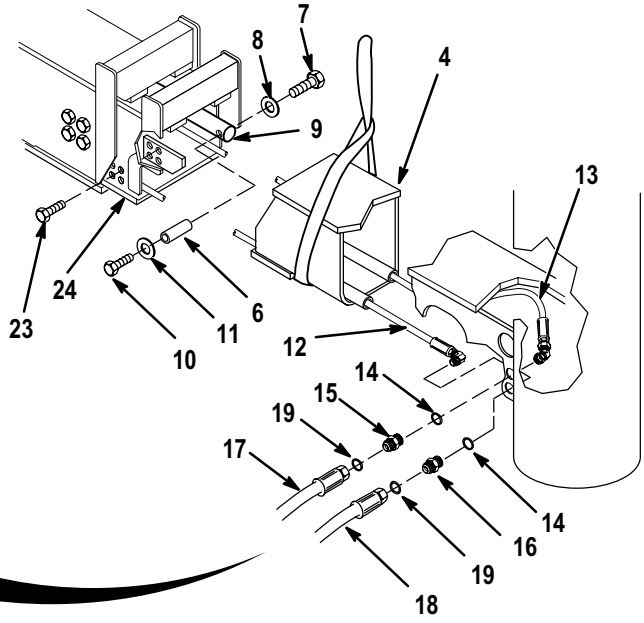
(12) Remove eight screws (23) and two plates (24) from outer beam (5).

NOTE

Ensure hoses remain with crane.

(13) With help from assistant, remove inner beam (4) from outer beam (5) and lower onto wooden block.





(14) Attach lifting device to outer beam (5) and remove all slack from lifting device.

(15) Remove eight screws (25) and two plates (26) from base (27).

(16) With help from assistant, remove outer beam (5) from base (27) and lower onto wooden block.

b. Installation

(1) Attach lifting device to outer beam (5).

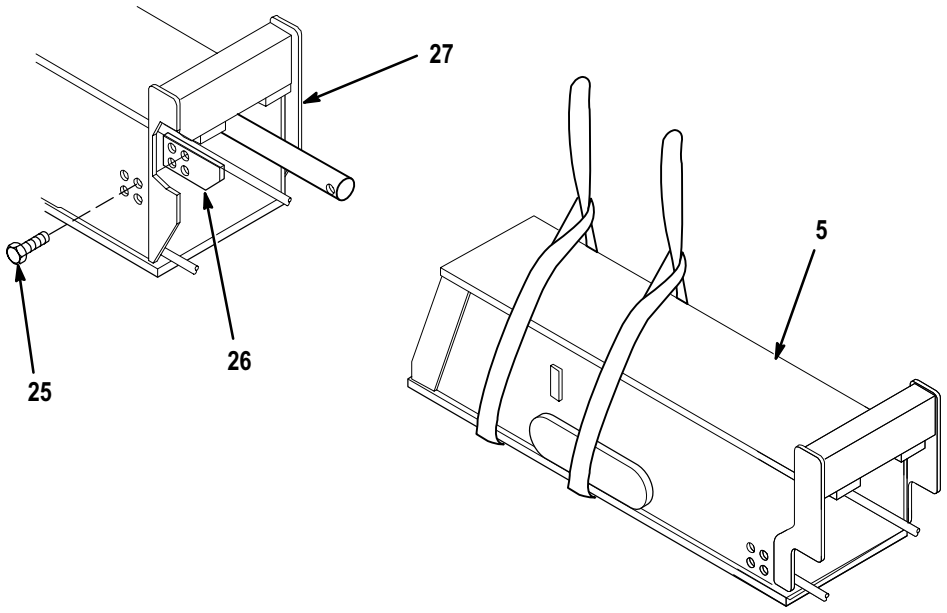
(2) Raise outer beam (5) with lifting device so that the end alines with base (27).

(3) Slide outer beam (5) into the base (27) with help from assistant as needed.

NOTE

Ensure plates are installed in their original locations.

(4) Apply sealing compound to threads of eight screws (25) and install two plates (26) in base (27) with screws (25).



3-10. OUTRIGGER BEAM MAINTENANCE (Continued)

(5) Remove lifting device from outer beam (5) and attach to inner beam (4).

(6) Raise inner beam (4) with lifting device so that the end alines with outer beam (5).

(7) Slide inner beam (4) into outer beam (5).

(8) Apply sealing compound to threads of eight screws (23) and install two plates (24) on outer beam (5) with screws (23). Remove lifting device.

NOTE

Clearance of shims must be 0.06 in. (1.52 mm) at the tightest point.

(9) Measure clearance between shims (28) and top of outer beam (5) and between shims (29) and top of inner beam (4). If proper clearance is not obtained on either or both shims, grind shims off and weld new shims in until proper clearance is obtained.

(10) Install clamp base (22), hoses (18 and 17) and clamp cover (21) using screw (20).

(11) Install two adapters (15 and 16) on inner beam (4).

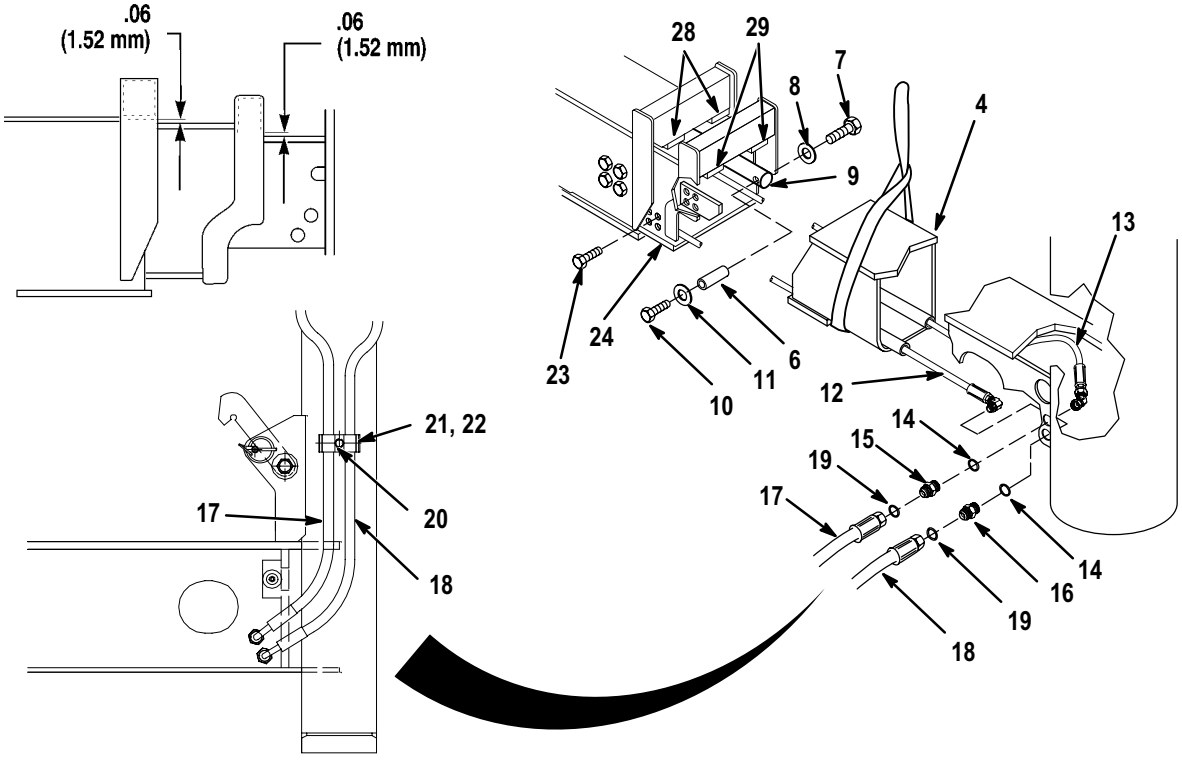
(12) Install two hoses (18 and 17) and preformed packings (19) on adapters (15 and 16).

(13) Install two preformed packings (14) in adapters (15 and 16).

(14) Install two hoses (12 and 13) and preformed packings (14) on adapters (15 and 16).

(15) Install washer (11) and screw (10) in pin (6).

(16) Install pin (6) in extension cylinder (9) using washer (8) and screw (7).



(17) Install cover (3) and four screws (2).

(18) Remove drain pan under access hole at the center of the base (1).

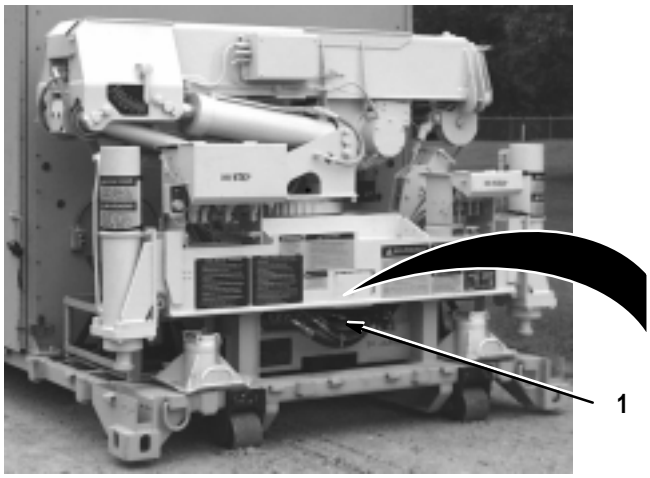
END OF TASK

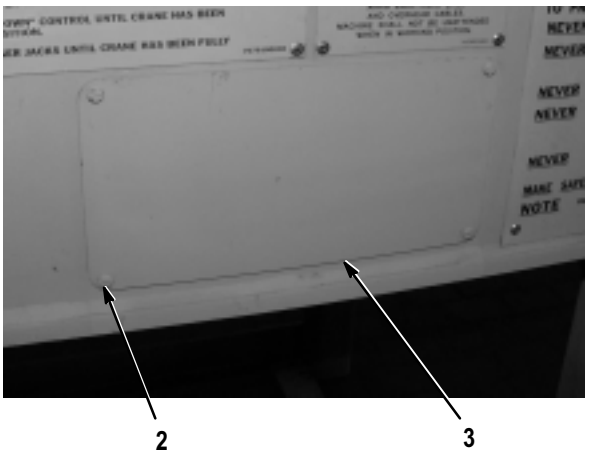
Follow-On Maintenance

Install jack cylinder (para 3-9).

Lubricate outrigger beams (TM 9-4940-568-10).

Check crane for proper operation and hydraulic leaks (TM 9-4940-568-10).





3-11. THREE FUNCTION CONTROL VALVE MOUNTING BRACKET REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Lockwasher (4) (Item 44, Appendix E)
Lockwasher (8) (Item 45, Appendix E)
Lockwasher (6) (Item 47, Appendix E)
Lockwasher (2) (Item 46, Appendix E)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

---

a. Removal

(1) Remove two nuts (1), lockwashers (2), spacer plate (3), anchor bracket (4) and screws (5) from cover (6). Discard lockwashers.

(2) Remove screw (7), lockwasher (8) and rubber latch (9) from mounting bracket (10). Discard lockwasher.

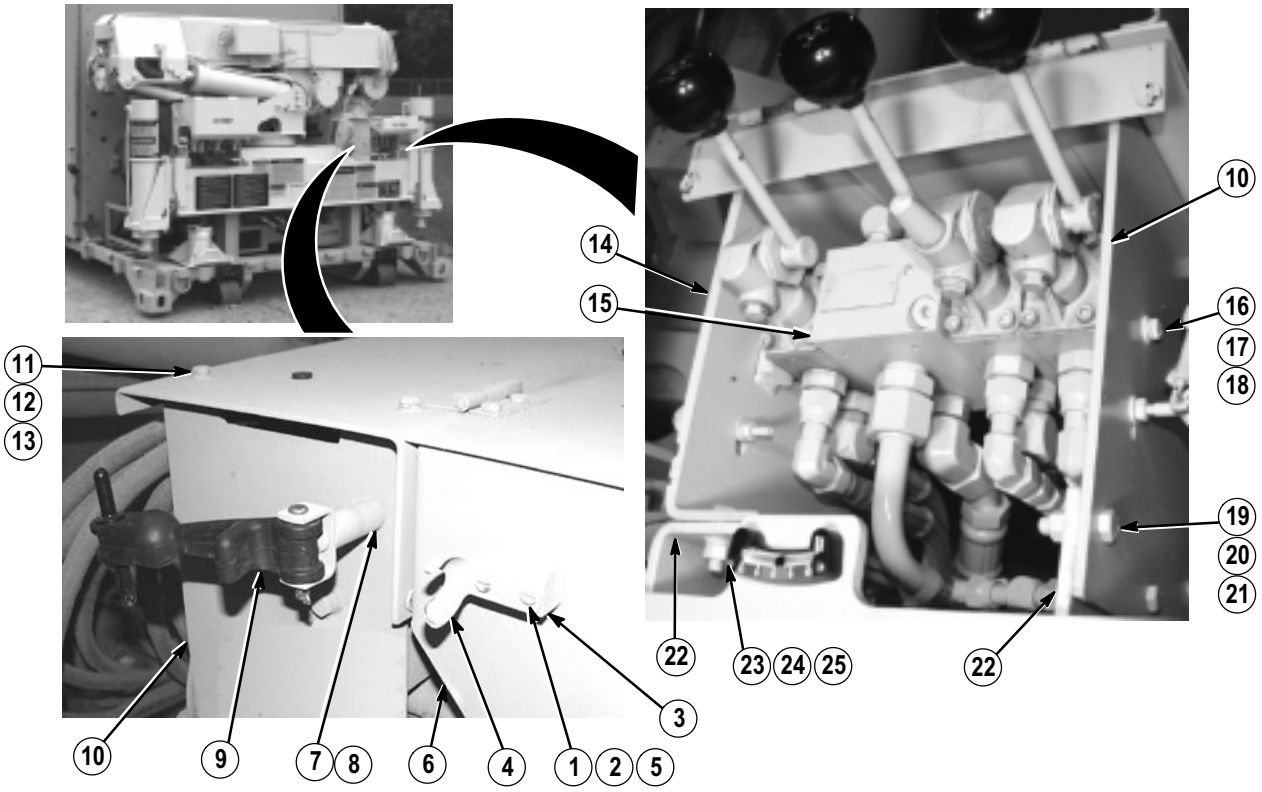
(3) Repeat Steps (1) and (2) for other side of control valve.

(4) Remove four screws (11), lockwashers (12), washers (13) and cover (6) from mounting brackets (10 and 14). Discard lockwashers.

(5) Support valve manifold (15), remove four screws (16), lockwashers (17) and washers (18) from mounting brackets (10 and 14). Discard lockwashers.

(6) Remove three screws (19), lockwashers (20), washers (21), and mounting bracket (10) from base (22). Discard lockwashers.

(6) Remove three screws (23), lockwashers (24), washers (25), and mounting bracket (14) from base (22). Discard lockwashers.



b. Installation

(1) Install mounting bracket (14) on base (22) using three screws (23), lockwashers (24), and washers (25).

(2) Install mounting bracket (10) on base (22) using three screws (19), lockwashers (20), and washers (21).

(3) Support valve manifold (15), install four screws (16), lockwashers (17) and washers (18) on mounting brackets (10 and 14).

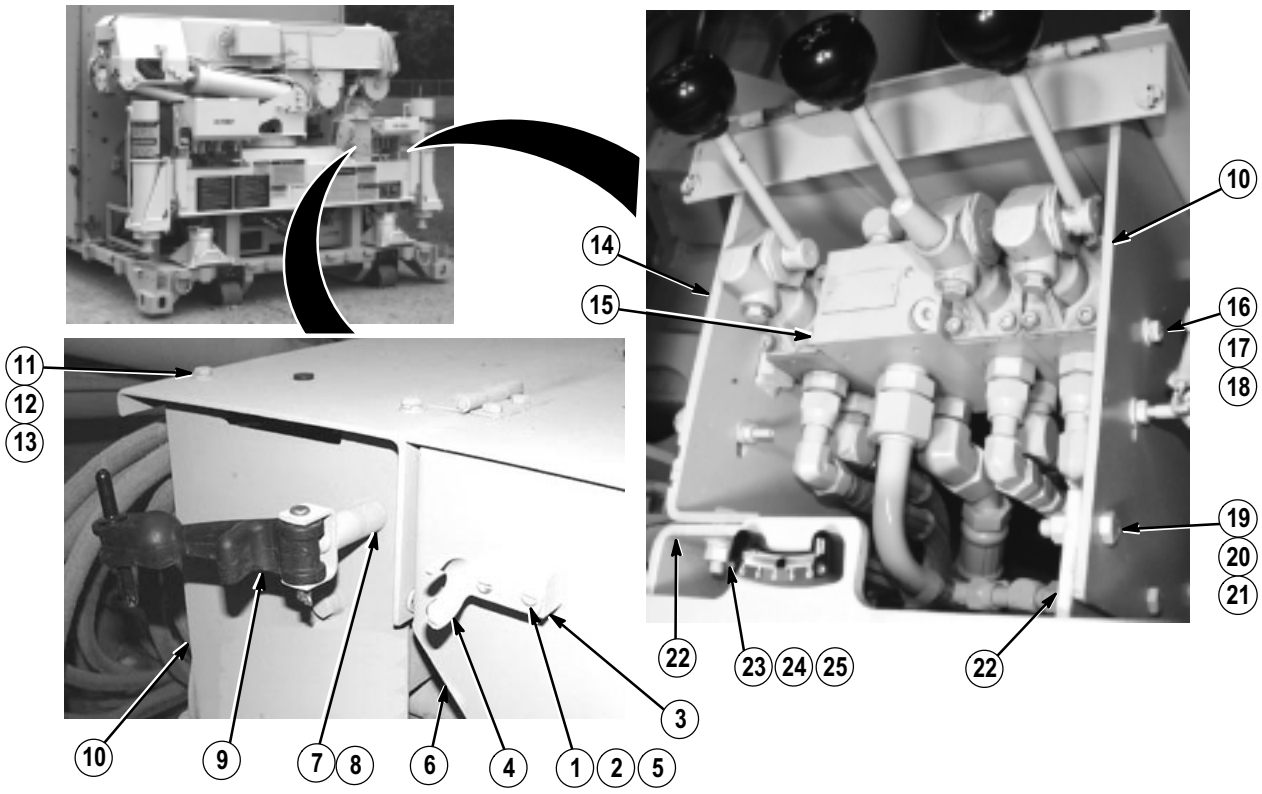
(4) Install cover (6) on mounting brackets (10 and 14) using four washers (13), lockwashers (12), and screws (11).

(5) Install rubber latch (9) on mounting bracket (10) using lockwasher (8) and screw (7).

(6) Install spacer plate (3) and anchor bracket (4) on cover (6) using two screws (5), lockwashers (2) and nuts (1).

(7) Repeat Steps (5) and (6) for other side of control valve.

END OF TASK



3-12. SWING DRIVE ORBIT MOTOR REPLACEMENT

THIS TASK COVERS:
a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Compound, antiseize (Item 8, Appendix B)
Hydraulic oil (Item 16, Appendix B)
Sealant, adhesive (Item 28, Appendix B)
Sealing compound (Item 29, Appendix B)
Lockwasher (2) (Item 42, Appendix E)
Packing, preformed (Item 73, Appendix E)
Packing, preformed (Item 125, Appendix E)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Cross-relief valve removed (para 3-32).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

General Safety Instructions
To avoid personal injury, always assume hydraulic lines have pressure. Slowly crack hydraulic lines open to allow all pressure to escape. Always wear safety glasses.

---

a. Removal

NOTE

Place a container to catch hydraulic oil during removal of hydraulic line.

(1) Remove hose (1) and preformed packing (2) from elbow (3). Discard preformed packing.

(2) Remove elbow (3) and preformed packing (4) from swing drive orbit motor (5). Discard preformed packing.

(3) Remove two allen head screws (6), lockwashers (7), and swing drive orbit motor (5) from swing drive assembly (8). Discard lockwashers.

b. Installation

NOTE

Lubricate all new preformed packing with clean hydraulic oil.

(1) Apply sealing compound to threads of two allen head screws (6).

(2) Apply adhesive sealant to mounting flange of swing drive orbit motor (5) and apply antiseize to motor splines of swing drive orbit motor (5).

(3) Install swing drive orbit motor (5) on swing drive assembly (8) with two new lockwashers (7) and allen head screws (6). Tighten allen head screws (6) to 35 lb-ft (47 N·m).

(4) Loosen four screws (9) in two stops (10) on swing drive assembly (8).

(5) Move two stops (10) firmly around swing drive orbit motor (5) and tighten four screws (9) to 35 lb-ft (47 N·m).

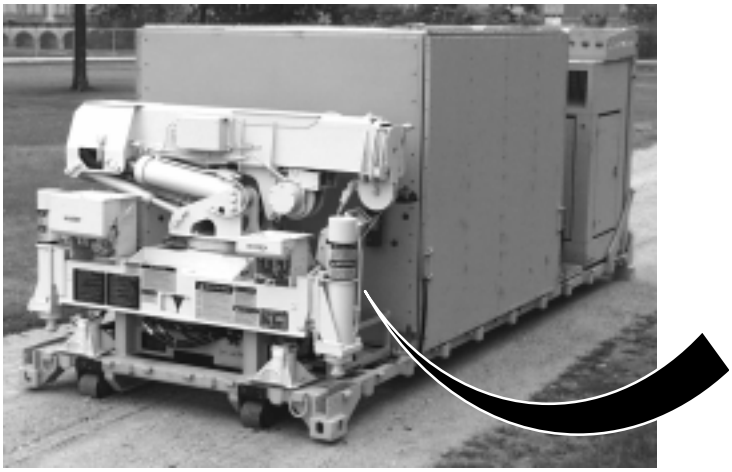
(6) Install preformed packing (4) and elbow (3) on swing drive orbit motor (5).

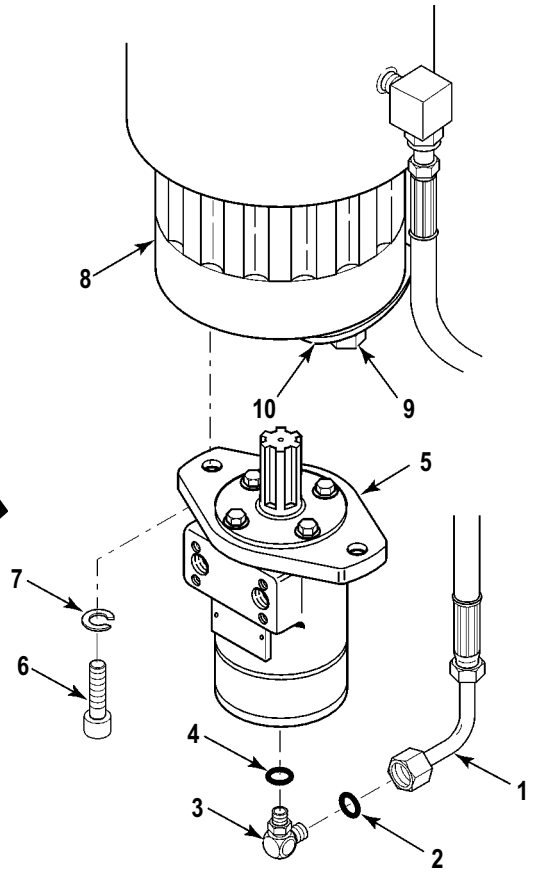
(7) Install preformed packing (2) and hose (1) on elbow (3).

END OF TASK

Follow-On Maintenance

Install cross-relief valve (para 3-32).





3-13. SWING DRIVE BRAKE REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Adhesive, Sealant, Silicone
(Item 2, Appendix B)
Sealing compound (Item 29, Appendix B)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Swing drive orbit motor removed (para 3-12).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

---

a. Removal

(1) Place a container to catch hydraulic oil during removal of brake.

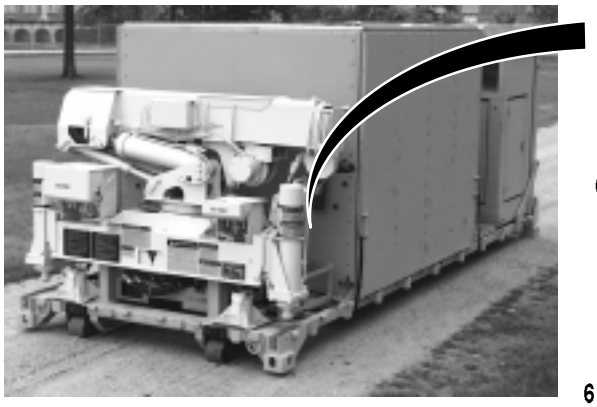
(2) Remove four screws (1), washers (2), and two stops (3) from brake cylinder housing (4).

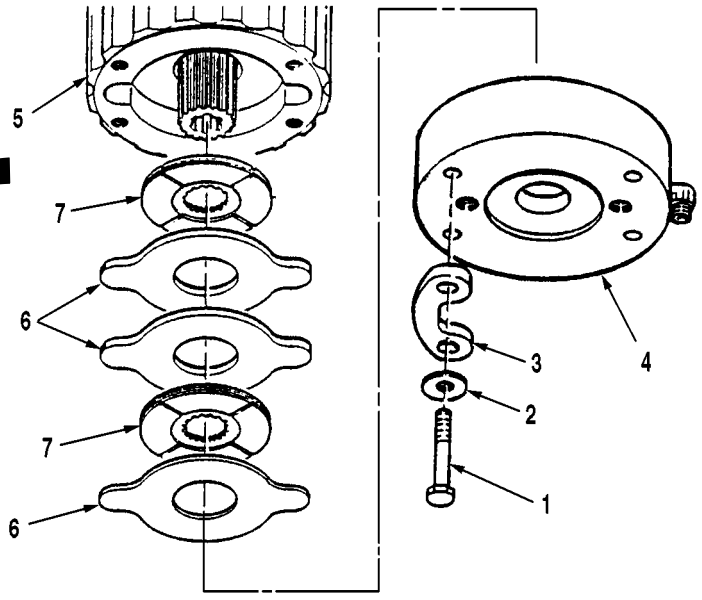
NOTE

- Brake is spring loaded.
- Disc and stators may drop when brake is removed.

(3) Remove brake cylinder housing (4) from swing drive assembly (5).

(4) Remove three stators (6) and two discs (7) from swing drive assembly (5).





b. Installation

(1) Install disc (7) in swing drive assembly (5).

(2) Install three stators (6) and two discs (7) in swing drive assembly (5).

(3) Apply adhesive to mating surface of brake cylinder housing (4).

NOTE

Brake is spring loaded.

(4) Aline and install brake cylinder housing (4) on swing drive assembly (5).

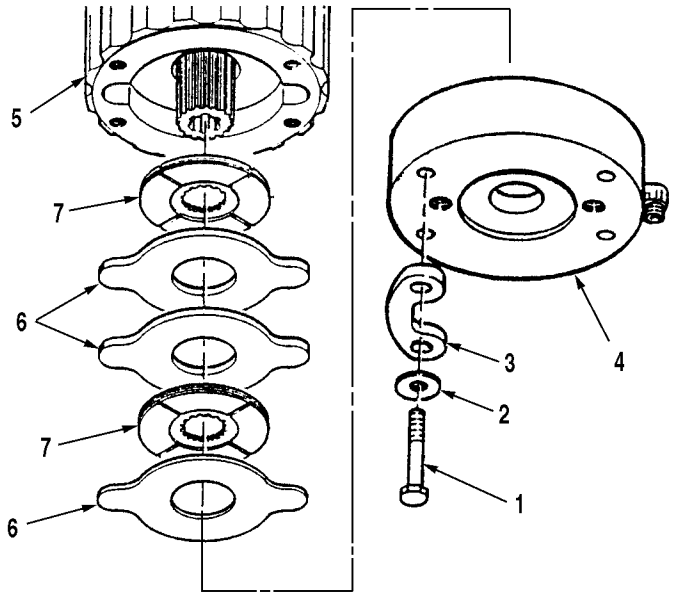
(5) Apply sealing compound to threads of four screws (1).

(6) Install two stops (3), four washers (2) and screws (1). Evenly tighten screws to 35 lb-ft (47 N·m).

END OF TASK

Follow-On Maintenance

Install swing drive orbit motor (para 3-12).



3-14. SWING DRIVE ASSEMBLY REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Sealing compound (Item 29, Appendix B)

Strip, metal (Item 179, Appendix E)

Lockwasher (2) (Item 47, Appendix E)

Personnel Required
1 Assistant

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Swing drive brake removed (para 3-13).

General Safety Instructions
To avoid personal injury, always assume hydraulic lines have pressure. Slowly crack hydraulic lines open to allow all pressure to escape. Always wear safety glasses and keep all personnel out from under swing drive assembly.

---

a. Removal

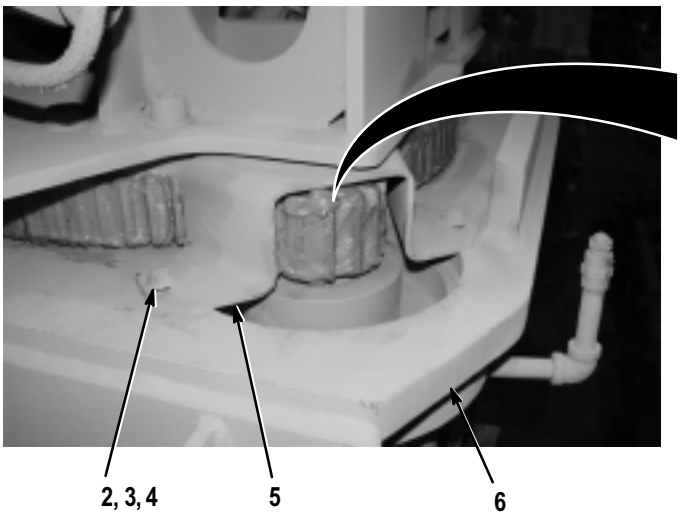
NOTE

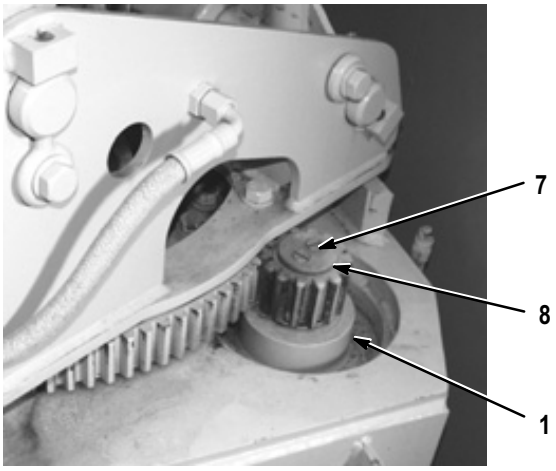
If performing only Steps (1 through 8) of this task, the turntable must be turned to access cover in Step (3). If performing Steps (1 through 11), the turntable and turntable bearing must be removed prior to beginning this task (refer to para 3-29 and 3-30).

(1) Place a container to catch hydraulic oil during removal of swing drive assembly (1).

(2) Remove two screws (2), lockwashers (3), washers (4) and swing drive cover (5) from subframe assembly (6).

(3) Remove two screws (7) and cover (8) from swing drive assembly (1).





(4) Attach a lifting device to swing drive assembly (1) using two screws (9) and washers (10) and remove all slack.

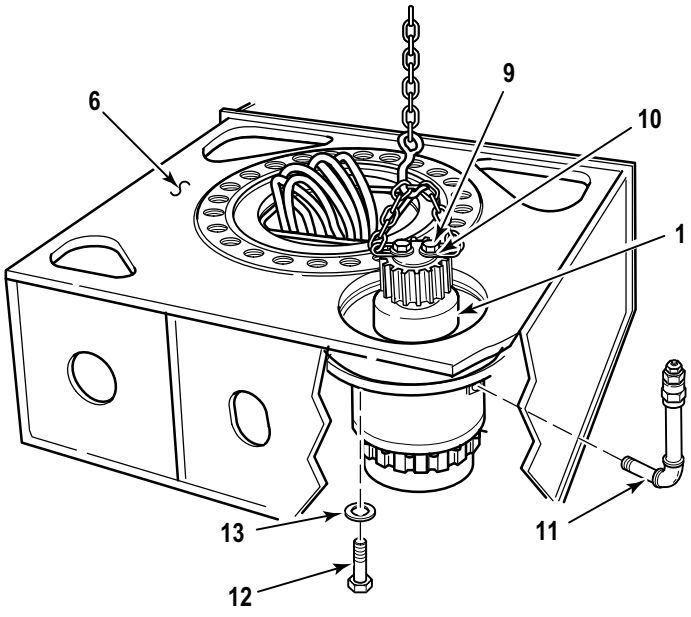
(5) Note position and remove oil fill pipe (11) from swing drive assembly (1).

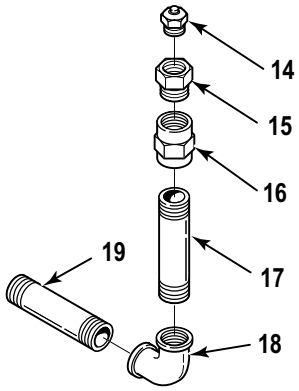
CAUTION

Use caution when lowering swing drive assembly past cables and hoses. Failure to comply may result in damage to equipment.

(6) With help from assistant, remove nine screws (12), washers (13), and swing drive assembly (1) from subframe assembly (6).

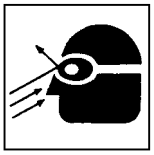
(7) Remove two screws (9), washers (10), and chain from swing drive assembly (1).





(8) Remove relief valve (14), bushing (15), coupling (16), nipple (17), and elbow (18) from nipple (19) .

WARNING



CARC paint contains isocyanate (HDI) which is highly irritating to skin and respiratory system. High concentrations of HDI can produce symptoms of itching and reddening of skin, a burning sensation in throat and nose, and watering of the eyes. In extreme concentrations, HDI can cause cough, shortness of breath, pain during respiration, increased sputum production, and chest tightness. The following precautions must be taken whenever using CARC paint:

Never weld or cut CARC-coated materials.

NOTE

Perform Steps (9) thru (12) if a new gear reducer is to be installed.

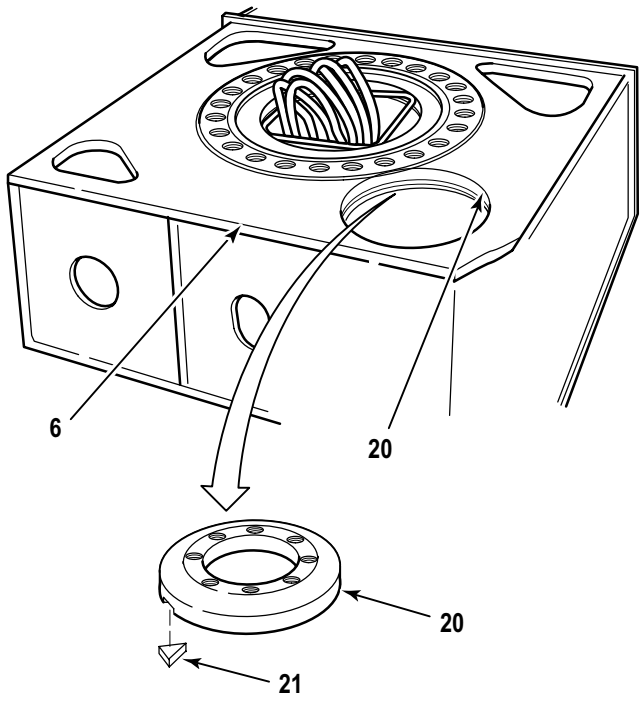
(9) Using a wire scratch brush, remove CARC paint from area four in. (102 mm) around welding/grinding points of spacer ring.

3-14. SWING DRIVE ASSEMBLY REPLACEMENT (Continued)

(10) Grind off weld from spacer ring (20) and subframe assembly (6) and remove spacer ring (20).

(11) Using a wire scratch brush, remove CARC paint from area four in. (102 mm) around welding/grinding points of wedge (21).

(12) Grind off weld from two wedges (21) and spacer ring (20) and remove two wedges (21).



b. Installation

NOTE

- Perform Steps (1) thru (20) if installing new gear reducer.
- If installing original gear reducer, go to Step (21).
- Screws used in Step (1) were removed with turntable.

(1) Attach lifting device to bearing gear (22) with three screws (23).

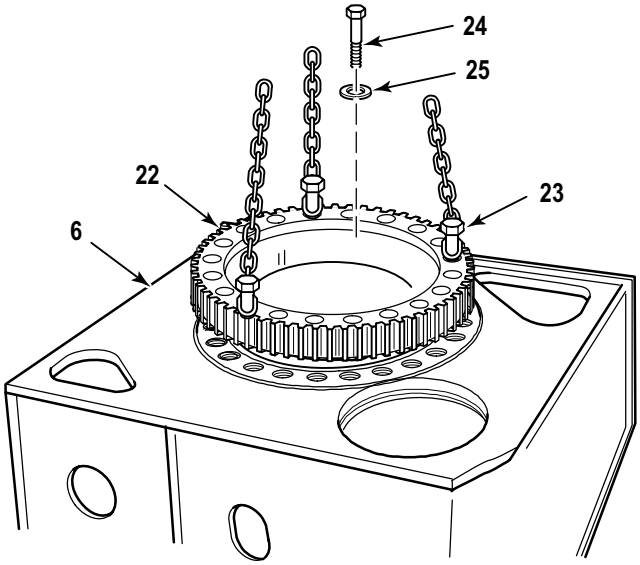
NOTE

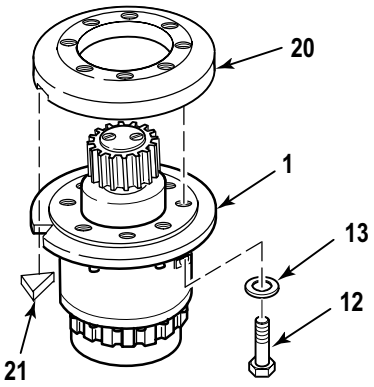
Letter G stamped on bearing faces down and centered on subframe.

(2) Position bearing gear (22) on subframe (6).

(3) Install 3 screws (24) and washers (25) in bearing gear (22). Tighten screws (24) to 333 lb-ft (452 N·m).

(4) Remove three screws (23) and lifting device from bearing gear (22).





(5) Install spacer ring (20) on swing drive assembly (1) with nine screws (12) and washers (13). Tighten screws to 99 lb-ft (134 N·m).

(6) Position two wedges (21) in "V" shaped cut-outs on swing drive assembly (1) and against spacer ring (20).

WARNING

Unsafe welding practices can cause serious injury from fire, explosions, or harmful agents. Allow only authorized personnel to weld or cut metals, and follow safety precautions in TM 9-237. Protective clothing and goggles must be worn; adequate protective equipment used, a suitable fire extinguisher kept nearby; and requirements of TM 9-237 strictly followed.

CAUTION

Do not weld wedge to swing drive assembly (1). Only weld wedge (21) to spacer ring (20) or damage to equipment will result.

(7) Weld two wedges (21) to spacer ring (20) in accordance to TM 9-237.

(8) Install lifting device on swing drive assembly (1) using two washers (10) and screws (9).

(9) With help from assistant, position swing drive assembly (1) under subframe assembly (6).

(10) Position lifting device through subframe assembly (6) and attach to chain.

(11) With help from assistant, use lifting device and position swing drive assembly (1) in subframe assembly (6).

NOTE

The .005 in. (.127 mm) metal strip must be positioned around tooth on spur gear (26) and between spur gear (26) and bearing gear (22) to obtain .010 in. (.254 mm) backlash.

(12) Position .005 in. (.127 mm) metal strip around tooth of spur gear (26) and position spur gear (26) with metal strip on bearing gear (22).

WARNING

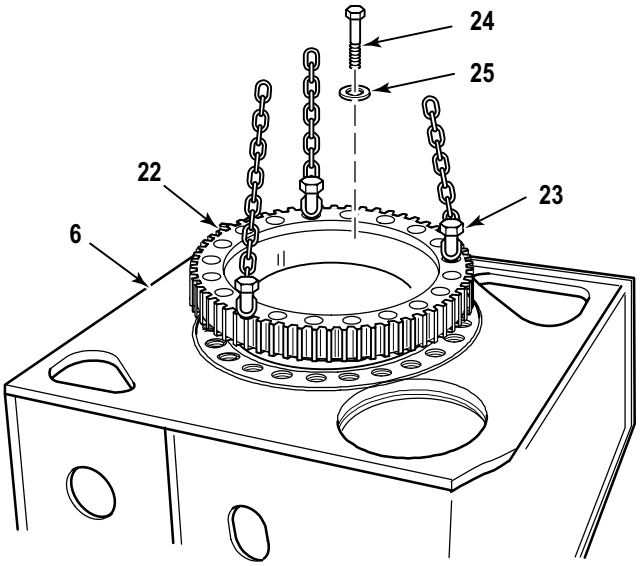
Unsafe welding practices can cause serious injury from fire, explosions, or harmful agents. Allow only authorized personnel to weld or cut metals, and follow safety precautions in TM 9-237. Protective clothing and goggles must be worn; adequate protective equipment used, a suitable fire extinguisher kept nearby; and requirements of TM 9-237 strictly followed.

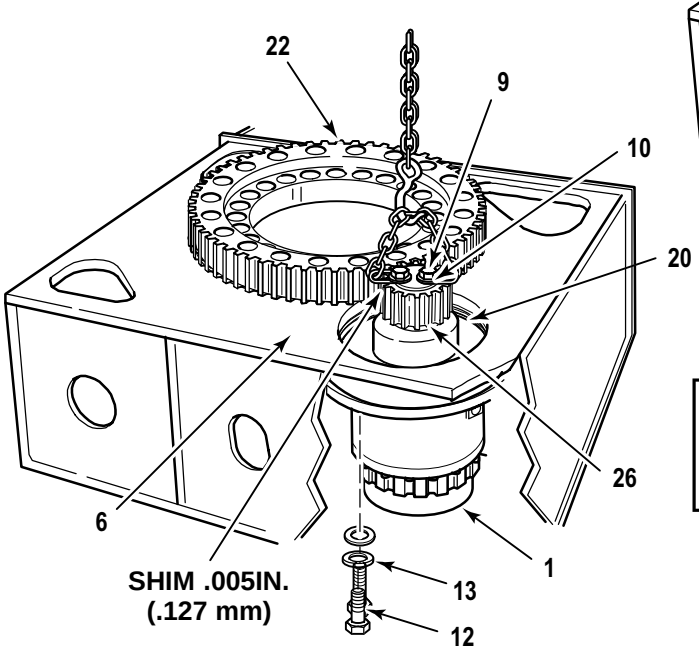
(13) Tack weld spacer ring (20) to subframe (6) in accordance with TM 9-237.

3-14. SWING DRIVE ASSEMBLY REPLACEMENT (Continued)

(14) With help from assistant and using lifting device, remove nine screws (12), washers (13), and swing drive assembly (1) from subframe assembly (6).

(15) Remove two screws (9), washers (10) and chain from swing drive assembly (1).





WARNING

Unsafe welding practices can cause serious injury from fire, explosions, or harmful agents. Allow only authorized personnel to weld or cut metals, and follow safety precautions in TM 9-237. Protective clothing and goggles must be worn; adequate protective equipment used, a suitable fire extinguisher kept nearby; and requirements of TM 9-237 strictly followed.

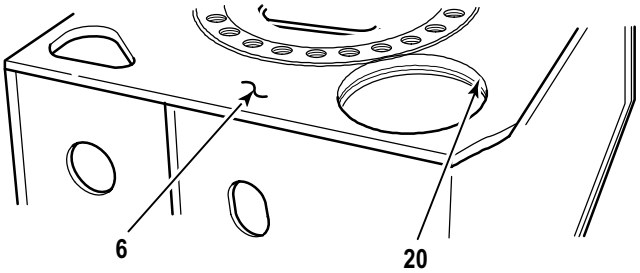
(16) Remove 33 screws (24) and washers (25) from bearing gear (22).

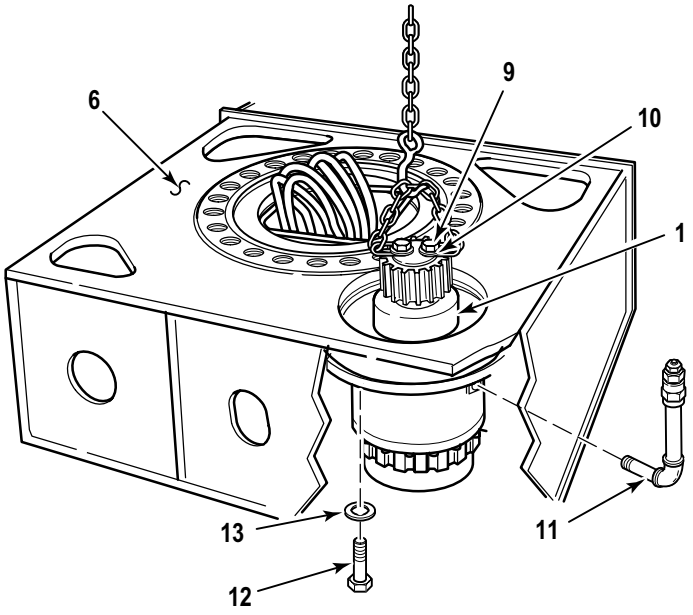
(17) Attach lifting device to bearing gear (22) with three screws (23).

(18) Remove bearing gear (22) from subframe assembly (6).

(19) Remove three screws (23) and lifting device from bearing gear (22).

(20) Weld spacer ring (20) to subframe assembly (23) in accordance to TM 9-237.





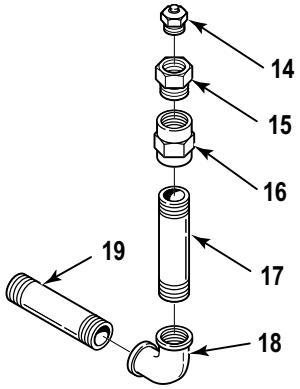
(21) Position swing drive assembly (1) under subframe assembly (6).

(22) Position lifting device through subframe assembly (6) and attach to chain.

(23) With help from assistant, using lifting device and position swing drive assembly (1) in subframe assembly (6).

(24) Install nine washers (13) and screws (12) in swing drive assembly (1) and subframe assembly (6). Tighten screws to 106-114 lb-ft (144-155 N·m).

(25) Remove lifting device, two screws (9) and washers (10) from swing drive assembly (1).



(26) Install elbow (18), nipple (17), coupling (16), bushing (15), and relief valve (14) in nipple (19).

3-14. SWING DRIVE ASSEMBLY REPLACEMENT (Continued)

(27) Apply sealing compound to threads of oil fill pipe (11) and install oil fill pipe (11) in swing drive assembly (1).

(28) Apply sealing compound to threads of two screws (7) and install cover (8) on swing drive assembly (1) using two screws (7). Tighten screws (7) to 19 lb-ft (26 N·m).

(29) Apply sealing compound to threads of two screws (2) and install swing drive cover (5) on subframe assembly (6) using two washers (4), lockwashers (3) and screws.

NOTE

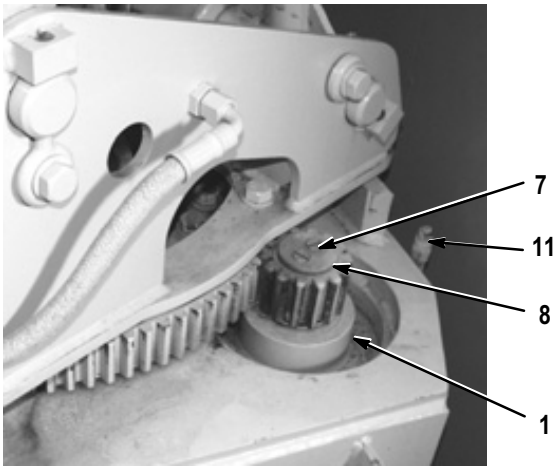
If turntable was turned during removal, return turntable to original position. If turntable and turntable bearing were removed during removal, install turntable and turntable bearing (refer to para 3-29 and 3-30).

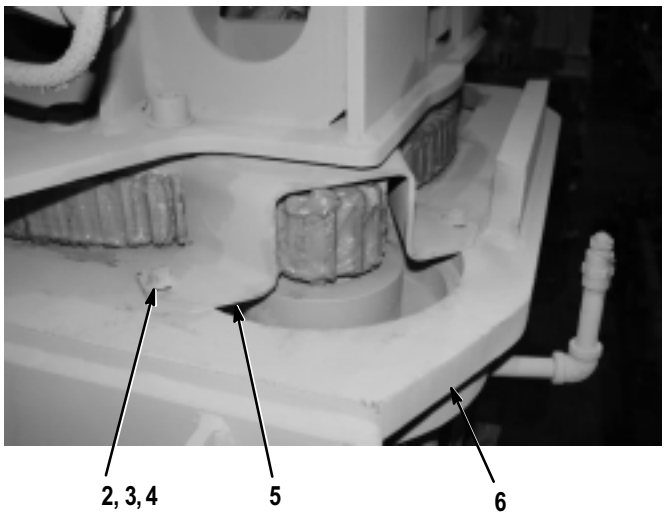
END OF TASK

Follow-On Maintenance

Install swing drive brake (para 3-13).

Fill swing drive assembly with oil (TM 9-4940-568-10).





3-15. BOOM MID SECTION AND TELESCOPIC CYLINDER REPLACEMENT/ ADJUSTMENT

THIS TASK COVERS:
a. Removal
b. Installation
c. Adjustment

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Grease (item 43, Appendix B)
Sealing compound (Item 29, Appendix B)
Packing, preformed (2)
(Item 106, Appendix E)
Packing, preformed (2)
(Item 121, Appendix E)

Personnel Required
1 Assistant

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).
Boom fly section removed (para 3-16).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

General Safety Instructions

To avoid personal injury, always assume hydraulic lines have pressure. Crack hydraulic lines open slowly to allow all pressure to escape. Always wear safety glasses.

---

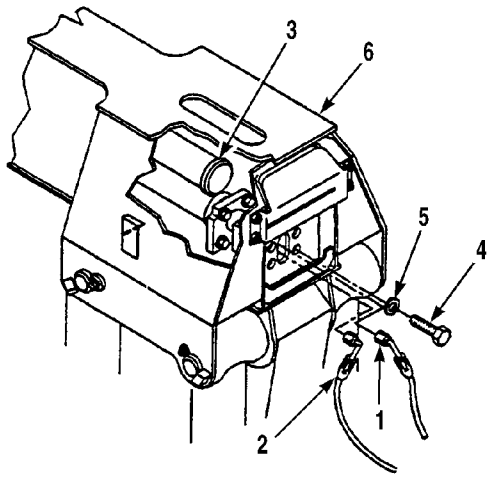
a. Removal

NOTE

- Tag and mark hoses and tubes prior to removal to ensure proper installation.
- Cap and plug hoses, tubes, and fittings upon removal.
- Place a container to catch hydraulic oil before disconnecting hydraulic lines.

(1) Disconnect hoses (1 and 2) from telescopic cylinder (3).

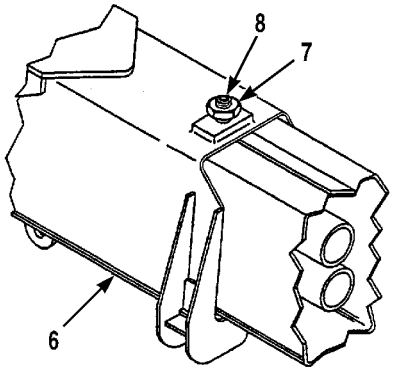
(2) Remove four screws (4) and washers (5) from boom base section (6).



3-15. BOOM MID SECTION AND TELESCOPIC CYLINDER REPLACEMENT/ ADJUSTMENT (Continued)

(3) Loosen jam nut (7) on setscrew (8).

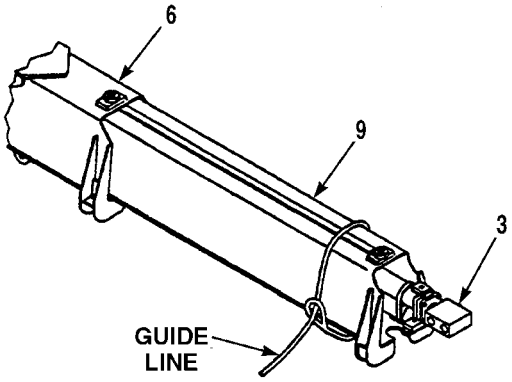
(4) Loosen setscrew (8) at outer end of boom base section (6).



WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

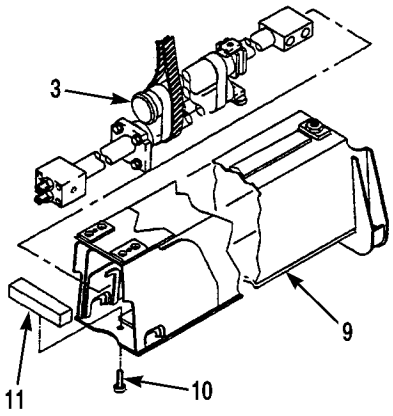
(5) Attach lifting device and guide line to boom mid section (9) and telescopic cylinder (3).



(6) With help from assistant, remove boom mid section (9) and telescopic cylinder (3) from boom base section (6).

(7) With help from assistant, remove screw (10) and cylinder retainer bar (11) from boom mid section (9).

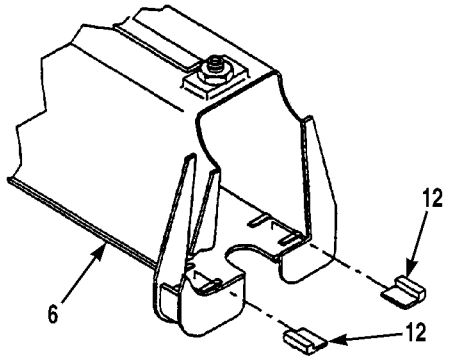
(8) Attach lifting device to telescopic cylinder (3) and remove telescopic cylinder (3) from boom mid section (9).



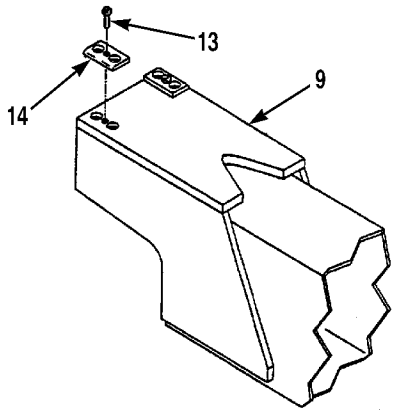
NOTE

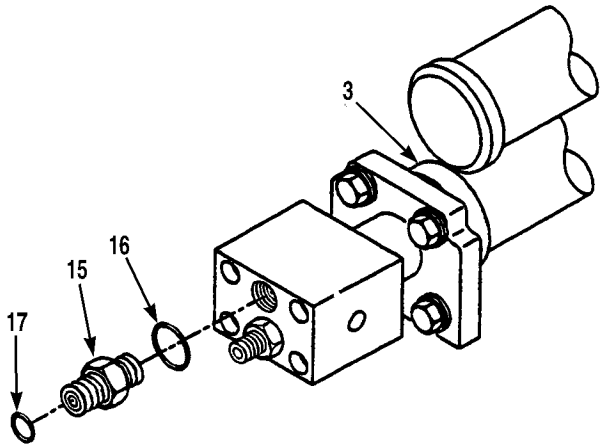
Note position of wear pads (12 and 14) prior to removal to ensure proper installation.

(9) Remove two wear pads (12) from outer end of boom base section (6).



(10) Remove two screws (13) and wear pads (14) from top of boom mid section (9).





(11) Remove two fittings (15) from telescopic cylinder (3).

(12) Remove two preformed packings (16) and preformed packings (17) from fittings (15). Discard preformed packings.

b. Installation

(1) Install two preformed packings (17) and preformed packings (16) on fittings (15).

(2) Install two fittings (15) in telescopic cylinder (3).

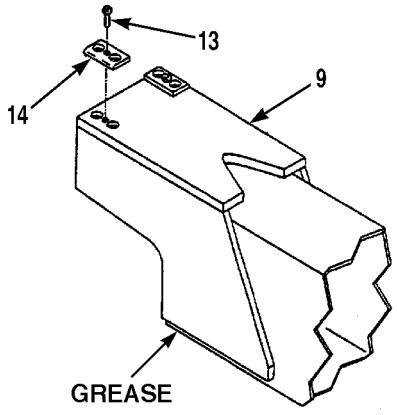
(3) Apply sealing compound to threads of two screws (13).

NOTE

Ensure wear pads (14 and 12) are installed in original locations.

(4) Install two wear pads (14) and screws (13) on top of boom mid section (9).

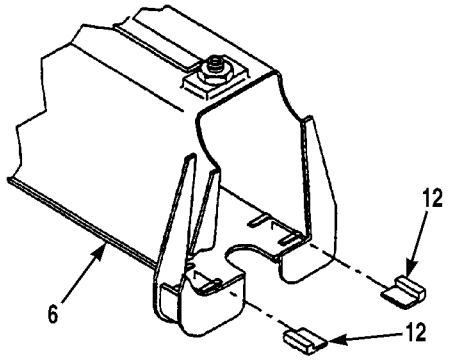
(5) Apply grease to wear pads (14) and bottom edges of boom mid section (9).



3-15. BOOM MID SECTION AND TELESCOPIC CYLINDER REPLACEMENT/ ADJUSTMENT (Continued)

(6) Install two wear pads (12) in outer end of boom base section (6).

(7) Apply grease to wear pads (12).



(8) Extend telescopic cylinder (3) base shaft fully and fly section approximately two feet.

WARNING

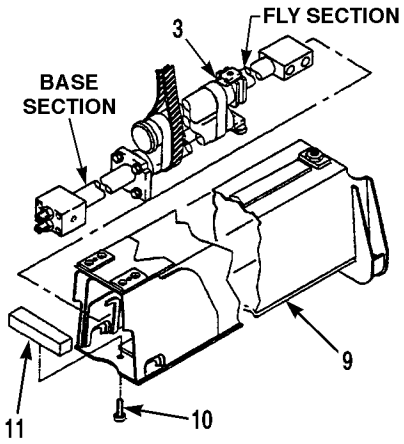
To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

(9) Attach lifting device to telescopic cylinder (3) and install in boom mid section (9).

(10) Apply sealing compound to threads of screw (10).

(11) Position cylinder retainer bar (11) in boom mid section (9) with screw (10).

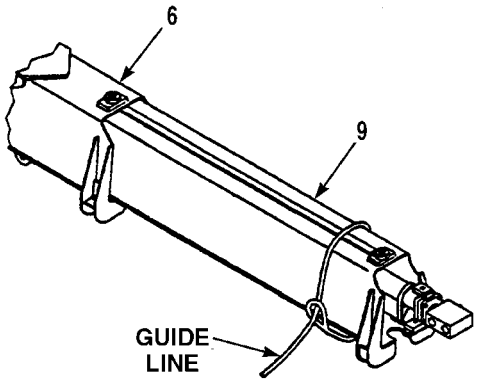
(12) Tighten screw (10) to 72-78 lb-ft (98-106 N·m).



(13) Attach lifting device and guide line to boom mid section (9) and telescopic cylinder (3).

(14) With help from assistant, install boom mid section (9) in boom base section (6) as far as possible.

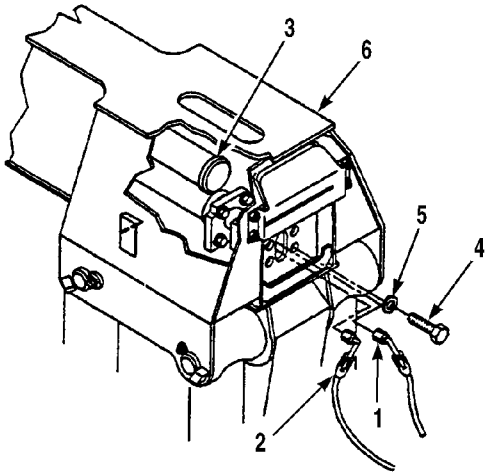
(15) Remove lifting device and guide rope.



(16) Position telescopic cylinder (3) in boom base section (6) with four washers (5) and screws (4).

(17) Tighten four screws (4) to 144-156 lb-ft (205-237 N·m).

(18) Connect hoses (2 and 1) to telescopic cylinder (3).



c. Adjustment

NOTE

This procedure requires operation of crane. Refer to (TM 9-4940-568-10).

(1) Start FRS.

(2) Place MAIN hydraulic power switch in ON position.

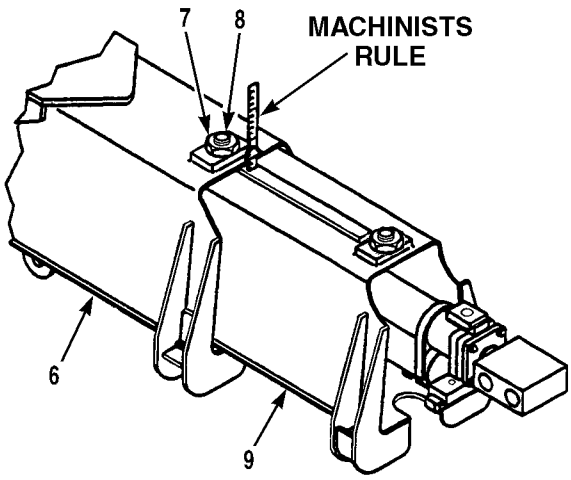
(3) With help from assistant, operate crane and extend and retract boom mid section (9).

(4) With help from assistant, hold machinists rule at outer end of boom base section (6); obtain reading to determine high spot of boom mid section (9).

(5) Operate crane to place high spot of boom mid section (9) directly under setscrew (8).

(6) Adjust setscrew (8) for 0.06 in. (0.15 cm) maximum clearance between setscrew (8) and high spot of boom mid section (9).

(7) Tighten jam nut (7) on setscrew (8).



END OF TASK

Follow-On Maintenance

Install boom fly section (para 3-16).

Check crane for proper operation and hydraulic leaks (TM 9-4940-568-10).

Load test crane (para 3-5).

3-16. BOOM FLY SECTION REPLACEMENT/ADJUSTMENT

THIS TASK COVERS:
a. Removal
b. Installation
c. Adjustment

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Grease (item 43, Appendix B)
Sealing compound (Item 29, Appendix B)
Pin, cotter (4) (Item 129, Appendix E)

Personnel Required
1 Assistant

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Boom positioned with boom mid section fully extended , (TM 9-4940-568-10).

Hook block assembly removed, (para 5-6).

Boom sheave removed, (para 5-7).

a. Removal

CAUTION

Overload shutdown cable is on a tension reel. Allow cable to rewind slowly. Failure to comply may result in damage to equipment.

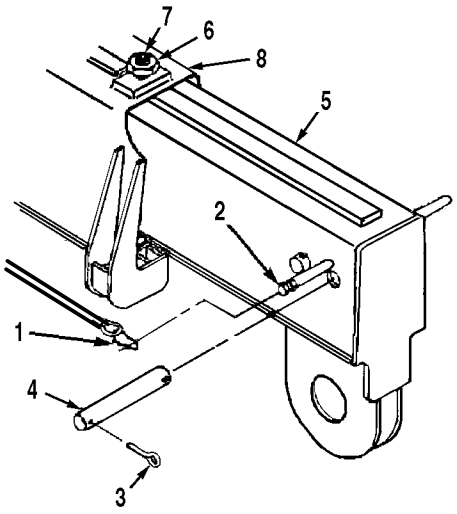
(1) Disconnect overload shutdown cable eye (1) from screw (2).

(2) Remove and discard four cotter pins (3) from two shafts (4).

(3) Remove two shafts (4) from boom fly section (5).

(4) Loosen jam nut (6) on setscrew (7).

(5) Loosen setscrew (7) at outer end of boom mid section (8).

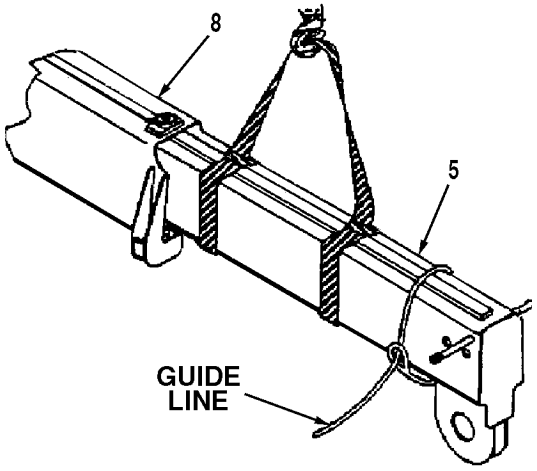


WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

(6) Attach lifting device and guide rope to boom fly section (5) and adjust lifting device to balance boom fly section (5).

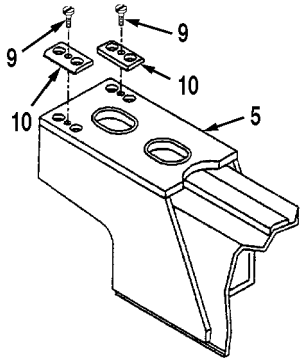
(7) With help from assistant, remove boom fly section (5) from boom mid section (8).



NOTE

Note location of wear pads (10 and 11) prior to removal to ensure proper installation.

(8) Remove two screws (9) and wear pads (10) from boom fly section (5).



(9) Remove two wear pads (11) from end of boom mid section (8).

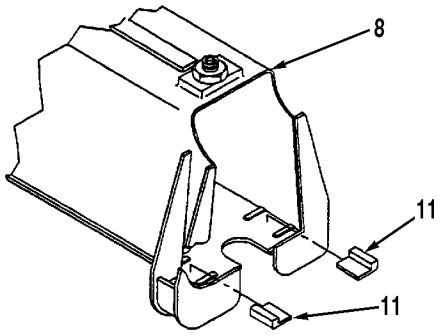
b. Installation

NOTE

Ensure wear pads (11) are installed in original locations and remain in position upon installation of boom fly section.

(1) Install two wear pads (11) in outer end of boom mid section (8).

(2) Apply grease to wear pads (11).



3-16. BOOM FLY SECTION REPLACEMENT/ADJUSTMENT (Continued)

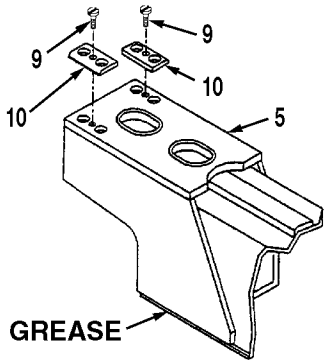
NOTE

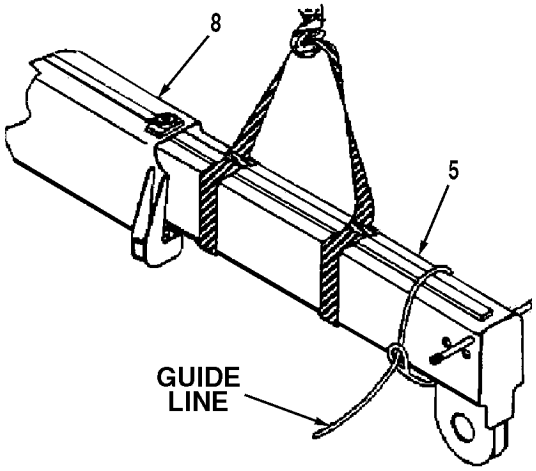
Ensure wear pads (10) are installed in original locations.

(3) Apply sealing compound to threads of two screws (9).

(4) Install two wear pads (10) on boom fly section (5) with two screws (9).

(5) Apply grease to wear pads (10) and sliding surfaces of boom fly section (5).





(9) Install boom fly section (5) on telescopic cylinder (12) with two shafts (4).

(10) Install four cotter pins (3) in two shafts (4).

(11) Connect overload shutdown cable eye (1) to screw (2).

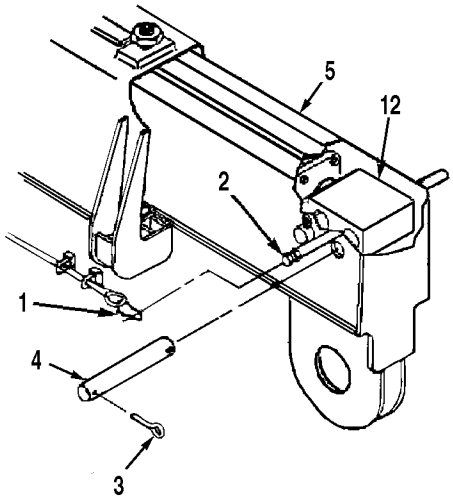
WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

(6) Attach lifting device and guide line to boom fly section (5) and, with help from assistant, position boom fly section (5) in boom mid section (8).

(7) Slide boom fly section (5) in boom mid section (8).

(8) Disconnect lifting device and guide line from boom fly section (5).



c. Adjustment

NOTE

This procedure requires operation of crane. Refer to (TM 9-4940-568-10).

(1) Start FRS.

(2) With help from assistant, operate crane and extend and retract boom fly section (5).

(3) With help from assistant, hold machinists rule at outer end of boom mid section (8); obtain reading to determine high spot of boom fly section (5).

(4) Operate crane to place high spot of boom fly section (5) directly under setscrew (7).

(5) Adjust setscrew (7) for 0.06 in. (0.15 cm) maximum clearance between setscrew (7) and high spot of boom fly section (5).

(6) Tighten jam nut (6) on setscrew (7).

(7) Shut down FRS.

END OF TASK

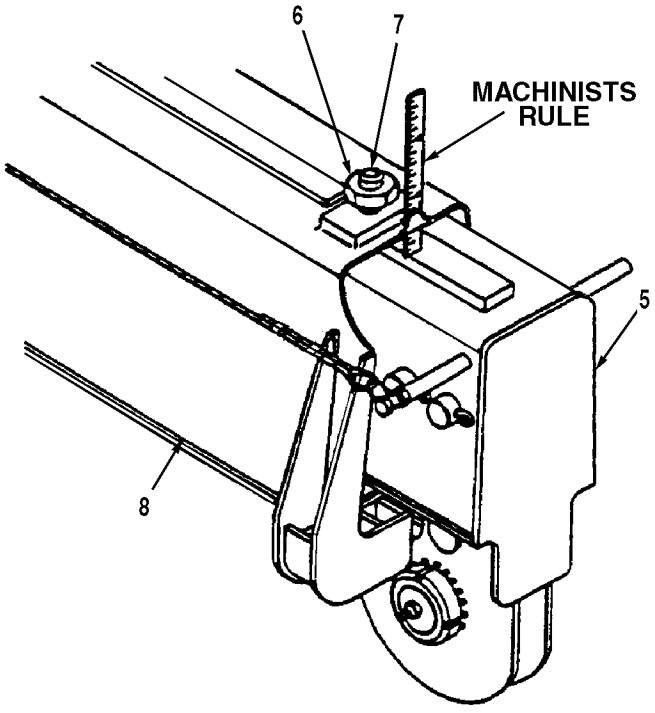
Follow-On Maintenance

Install boom sheave (para 5-7).

Install hook block assembly (para 5-6).

Check crane for proper operation and hydraulic leaks (TM 9-4940-568-10).

Load test crane (para 3-5).



3-17. BOOM BASE SECTION REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Sealing compound (Item 29, Appendix B)

Personnel Required
1 Assistant

Equipment Condition
FRS unloaded, crane in operating position (TM 9-4940-568-10).

Hoist tubing and hoses removed, (para 3-43 and 3-44).

Boom fly section removed, (para 3-16).

Boom mid section and telescopic cylinder removed, (para 3-15).

Overload shutdown removed, (para 3-27).

Hoist proximity sensor removed, (para 3-23).

Hoist assembly removed, (para 3-26).

---

a. Removal

WARNING

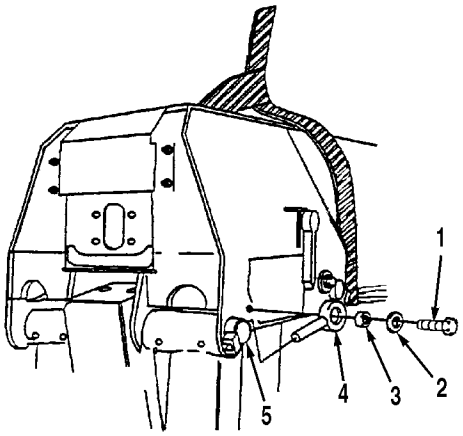
To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

NOTE

- Left and right rivet eyebolts are removed the same way. Right side shown.
- Perform Steps (1 and 2) for left and right side rivet eyebolts (4).

(1) Attach lifting device and remove screw (1), washer (2), and bushing (3) from rivet eyebolt (4).

(2) Remove rivet eyebolt (4) from pivot shaft (5).



WARNING

Remove pivot shaft only far enough to release tension link cylinder and support tension link upon removal of pivot shaft. Failure to comply may result in injury to personnel or damage to equipment.

(3) With help from assistant, remove pivot shaft (5) from RH tension link cylinder (6).

WARNING

Remove pivot shaft only far enough to release mast and support mast upon removal of pivot shaft. Failure to comply may result in injury to personnel or damage to equipment.

(4) With help from assistant, remove pivot shaft (5) from mast (7).

WARNING

Remove pivot shaft only far enough to release tension link cylinder and support tension link upon removal of pivot shaft. Failure to comply may result in injury to personnel or damage to equipment.

(5) With help from assistant, remove pivot shaft (5) from LH tension link cylinder (8).

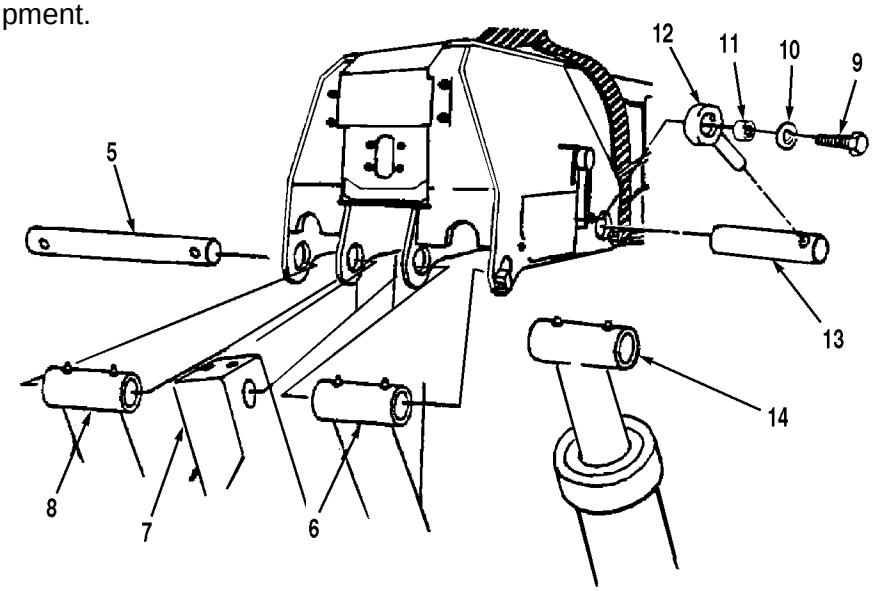
(6) Remove screw (9), washer (10), and bushing (11) from rivet eyebolt (12).

(7) Remove rivet eyebolt (12) from pivot shaft (13).

WARNING

Remove pivot shaft only far enough to release lift cylinder and support lift cylinder upon removal of pivot shaft. Failure to comply may result in injury to personnel or damage to equipment.

(8) Remove pivot shaft (13) from RH lift cylinder (14).



3-17. BOOM BASE SECTION REPLACEMENT (Continued)

(9) Remove screw (15), washer (16), and bushing (17) from rivet eyebolt (18).

(10) Remove rivet eyebolt (18) from pivot shaft (19).

(11) Remove pivot shaft (19) from LH lift cylinder (20).

(12) With help from assistant, remove boom base section (21).

b. Installation

WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

(1) Attach lifting device to boom base section (21) and position boom base section (21).

(2) With help from assistant, install LH tension link cylinder (8) with pivot shaft (5).

(3) With help from assistant, install mast (7) with pivot shaft (5).

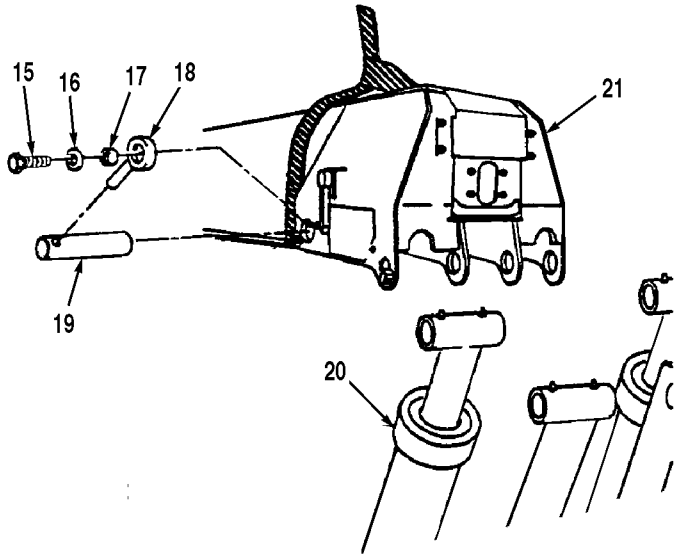
(4) With help from assistant, install RH tension link cylinder (6) with pivot shaft (5).

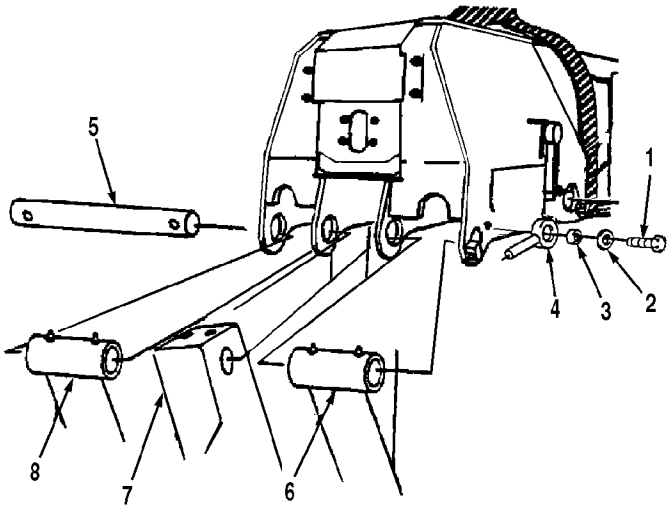
(5) Install two rivet eyebolts (4) in pivot shaft (5).

(6) Apply sealing compound to threads of two screws (1).

(7) Install two bushings (3), washers (2), and screws (1) in rivet eyebolts (4).

(8) Tighten two screws (1) to 135 lb-ft (183 N·m).





WARNING

Lift cylinders must be supported to install pivot shaft. Failure to comply may result in injury to personnel or damage to equipment.

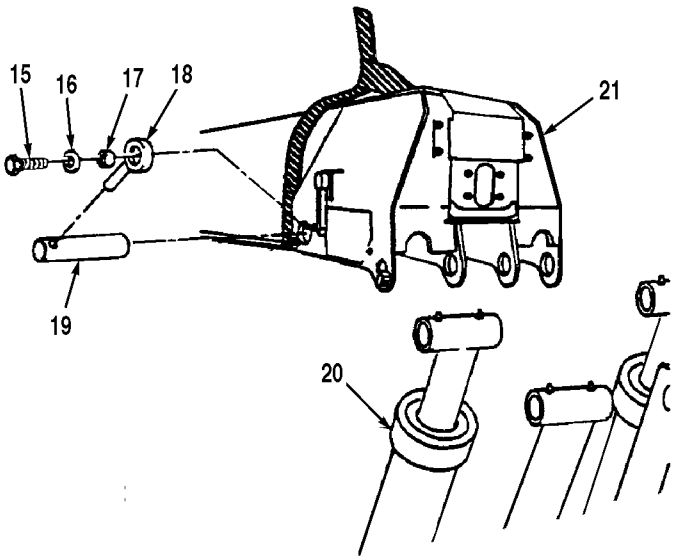
(9) With help from assistant, install LH lift cylinder (20) in boom base section (21) with pivot shaft (19).

(10) Install rivet eyebolt (18) in pivot shaft (19).

(11) Apply sealing compound to threads of screw (15).

(12) Install bushing (17), washer (16), and screw (15) in rivet eyebolt (18).

(13) Tighten screw (15) to 135 lb-ft (183 N·m).



WARNING

Lift cylinders must be supported to install pivot shaft. Failure to comply may result in injury to personnel or damage to equipment.

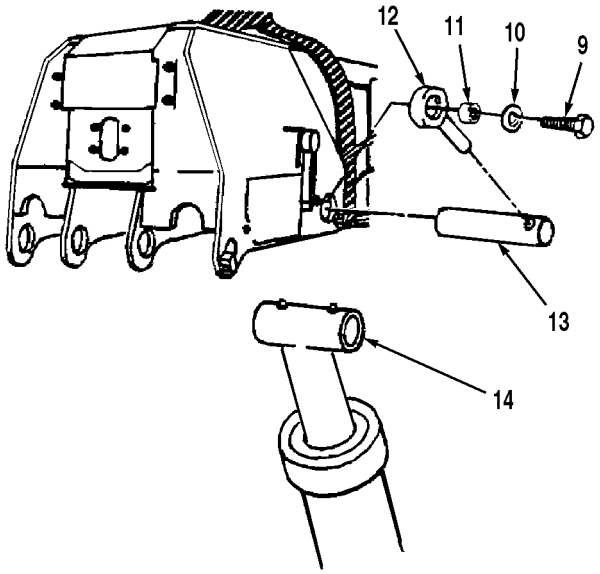
(14) With help from assistant, install RH lift cylinder (14) with pivot shaft (13).

(15) Install rivet eyebolt (12) in pivot shaft (13).

(16) Apply sealing compound to threads of screw (9).

(17) Install bushing (11), washer (10), and screw (9) in rivet eyebolt (12).

(18) Tighten screw (9) to 135 lb-ft (183 N·m).



3-17. BOOM BASE SECTION REPLACEMENT (Continued)

END OF TASK

Follow-On Maintenance

Install hoist assembly (para 3-26).

Install hoist proximity sensor (para 3-23).

Install overload shutdown (para 3-27).

Install boom mid section and telescopic cylinder (para 3-15).

Install boom fly section (para 3-16).

Install tubing and hoses (para 3-43 and para 3-44).

Lubricate pivot pins, (TM 9-4940-568-10).

Check crane for proper operation and hydraulic leaks, (TM 9-4940-568-10).

Load test crane (para 3-5).

3-18. LIFT CYLINDER REPLACEMENT

THIS TASK COVERS:
a. Removal
b. Cleaning/Inspection
c. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Grease (item 43, Appendix B)
Sealing compound (Item 29, Appendix B)
Packing, preformed (Item 113, Appendix E)
Packing, preformed (2) (Item 83, Appendix E)
Packing, preformed (Item 84, Appendix E)
Packing, preformed (2) (Item 106, Appendix E)
Packing, preformed (2) (Item 112, Appendix E)
Packing, preformed (2) (Item 125, Appendix E)
Shim (A/R) (Item 176, Appendix E)

Personnel Required
1 Assistant

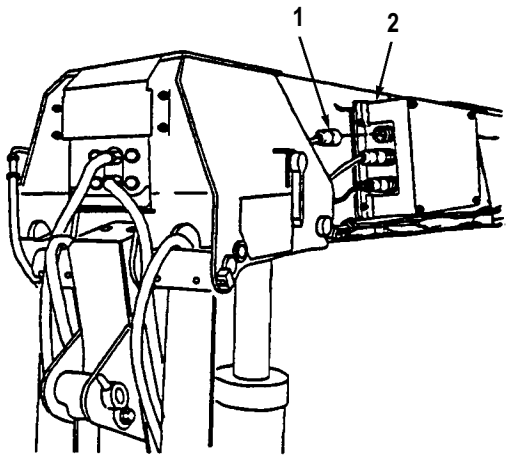
Equipment Condition
FRS unloaded, crane in operating position (TM 9-4940-568-10).

a. Removal

NOTE

- Tag and mark all hoses and connectors prior to removal.
- Plug all hoses after removal to prevent dirt from entering hydraulic system.
- Step (1) applies to RH lift cylinder only.

(1) Disconnect overload lockout connector (1) from overload shutdown assembly (2).



3-18. LIFT CYLINDER REPLACEMENT (Continued)

(2) Disconnect hose (3) from fitting (4).

(3) Remove fitting (4) from holding valve (5).

(4) Remove and discard preformed packings (6 and 7) from fitting (4).

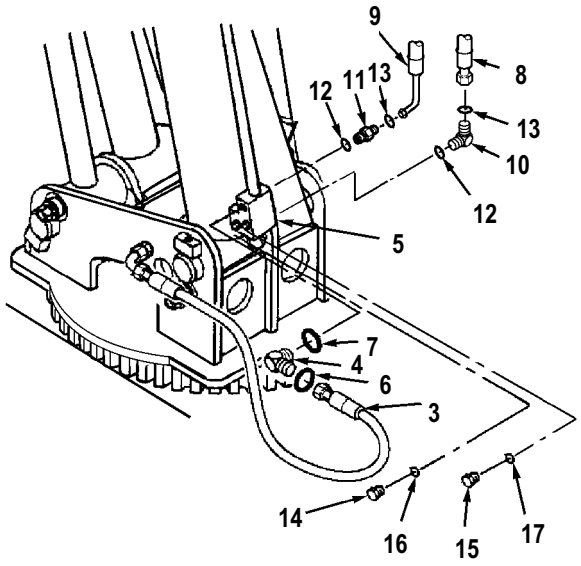
(5) Disconnect two hoses (8 and 9) from fittings (10 and 11).

(6) Remove two fittings (10 and 11) from holding valve (5).

(7) Remove and discard two preformed packings (12) and preformed packings (13) from fittings (10 and 11).

(8) Remove two plugs (14 and 15) from holding valve (5).

(9) Remove and discard preformed packings (16 and 17) from plugs (14 and 15).



WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

(10) Attach lifting device to lift cylinder (18) and remove screw (19), washer (20), and bushing (21) from rivet eyebolt (22).

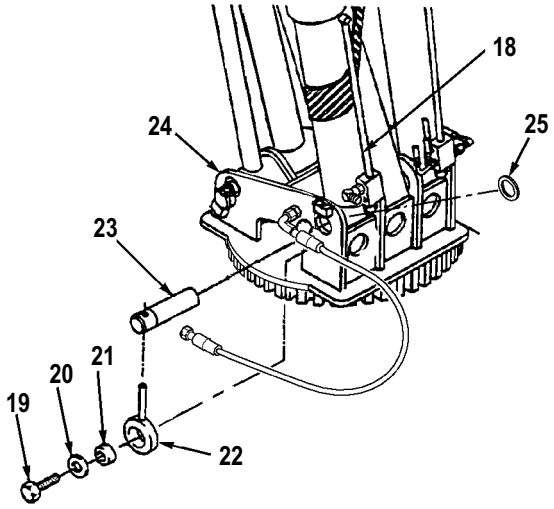
(11) Remove rivet eyebolt (22) from pivot shaft (23).

(12) With help from assistant, remove pivot shaft (23) from turntable (24).

NOTE

Lift cylinder may or may not have shims.

(13) If present, note number and location and remove shims (25).

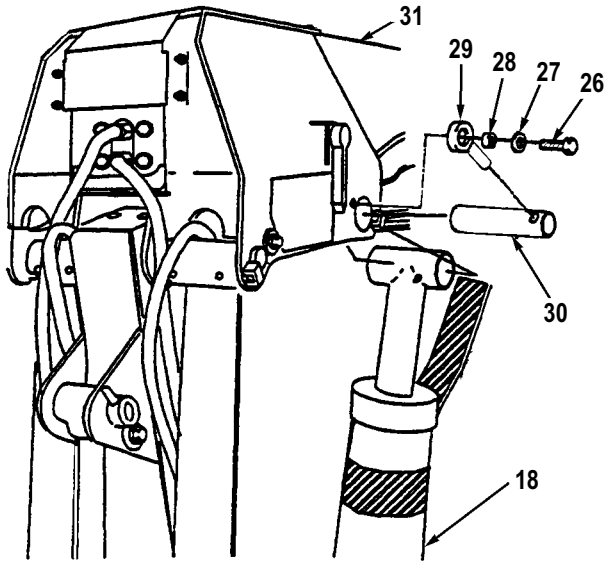


(14) Remove screw (26), washer (27), and bushing (28) from rivet eyebolt (29).

(15) Remove rivet eyebolt (29) from pivot shaft (30).

(16) With help from assistant, remove pivot shaft (30) from boom assembly (31).

(17) With help from assistant, remove lift cylinder (18) from boom assembly (31).



3-18. LIFT CYLINDER REPLACEMENT (Continued)

b. Installation

WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

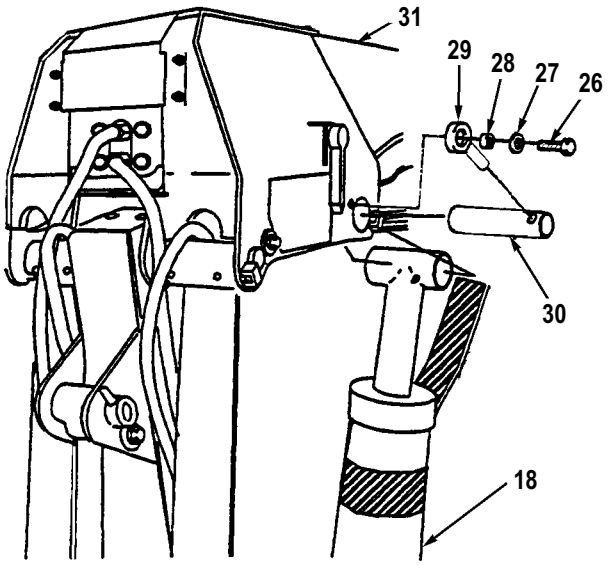
(1) With help from assistant, attach lifting device to lift cylinder (18) and install lift cylinder (18) in boom assembly (31) with pivot shaft (30).

(2) Install rivet eyebolt (29) in pivot shaft (30).

(3) Apply sealing compound to threads of screw (26).

(4) Install bushing (28), washer (27), and screw (26) in rivet eyebolt (29).

(5) Tighten screw (26) to 135 lb-ft (183 N·m).



NOTE

Perform Step (6) if installing same lift cylinder (18) and use same number of shims (25) that were removed during removal. Perform Steps (7 and 8) if installing new lift cylinder.

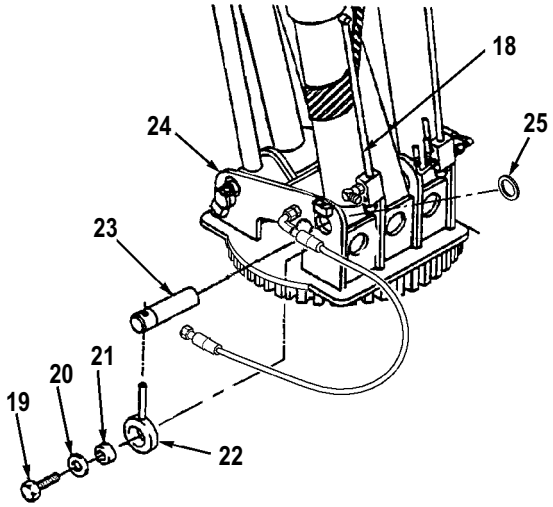
(6) With help from assistant, install lift cylinder (18) and shims (25) in turntable (24) with pivot shaft (23).

(7) With help from assistant, lower lift cylinder (18) and ensure lift cylinder (18) is not making contact with turntable (24). If lift cylinder (18) is making contact with turntable (24), remove pivot shaft (23) and install shims (25) as required to maintain clearance between lift cylinder (18) and turntable (24).

(8) Install rivet eyebolt (22) in pivot shaft (23).

(9) Apply sealing compound to threads of screw (19).

(10) Install bushing (21), washer (20), and screw (19) in rivet eyebolt (22). Tighten screw (19) to 135 lb-ft (183 N·m).



(11) Install two preformed packings (16 and 17) on plugs (14 and 15).

(12) Install two plugs (14 and 15) in holding valve (5).

(13) Install two preformed packings (13 and 12) on two fittings (10 and 11).

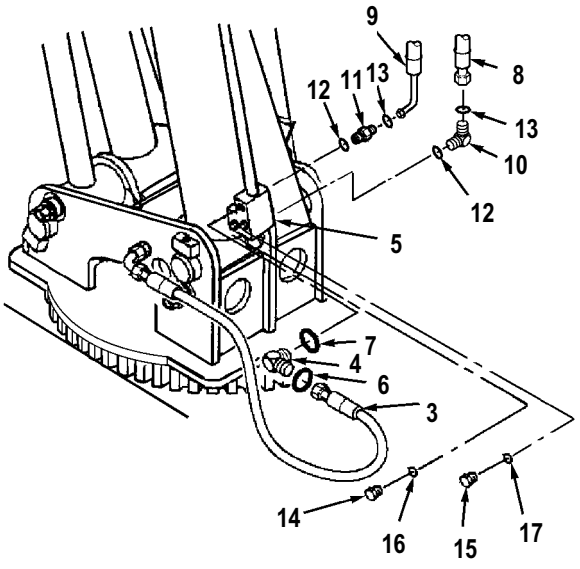
(14) Install fittings (10 and 11) in holding valve (5).

(15) Connect two hoses (8 and 9) to fittings (10 and 11).

(16) Install preformed packings (7 and 6) on fitting (4).

(17) Install fitting (4) on holding valve (5).

(18) Connect hose (3) to fitting (4).



NOTE

Step (19) applies only to RH lift cylinder.

(19) Connect overload lockout connector (1) to overload shutdown assembly (2).

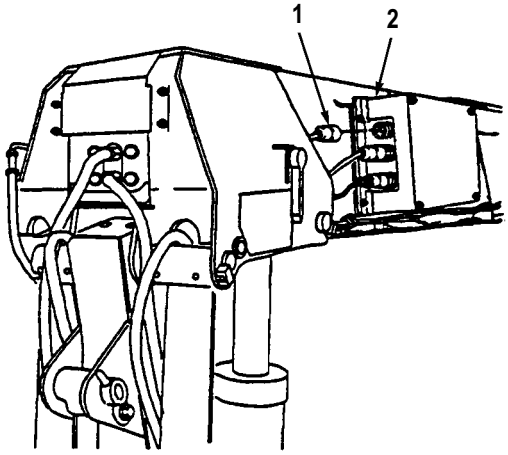
END OF TASK

Follow-On Maintenance

Lubricate lift cylinder (TM 9-4940-568-10).

Check crane for proper operation and hydraulic leak (TM 9-4940-568-10).

Load test crane (para 3-5).



3-19. ERECTION CYLINDER REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Sealing compound (Item 29, Appendix B)

Personnel Required
1 Assistant

Equipment Condition
FRS unloaded, crane in operating position (TM 9-4940-568-10).

General Safety Instructions
Ensure boom is supported during this task.

---

a. Removal

NOTE

- Place a container to catch hydraulic oil during hose removal.
- Plug all hoses after removal to prevent dirt from entering hydraulic system.

(1) Remove two screws (1), washers (2), and bushings (3) from rivet eyebolts (4).

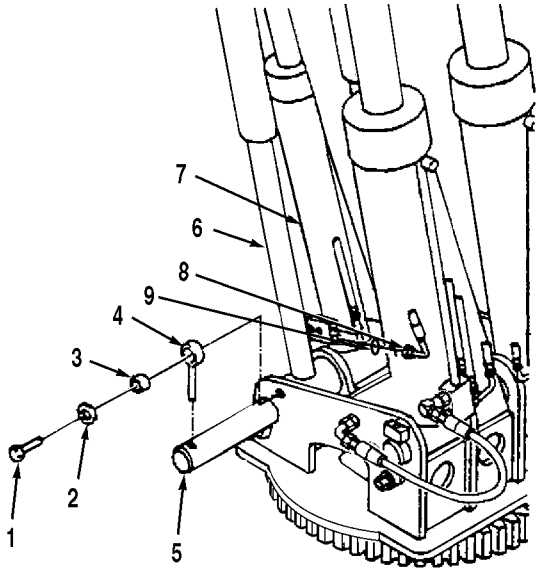
(2) Remove two rivet eyebolts (4) from pivot shaft (5).

WARNING

Remove pivot shaft only far enough to release tension link cylinder and erection cylinder. Failure to comply may result in injury to personnel or damage to equipment.

(3) Remove pivot shaft (5) from tension link cylinder (6).

(4) Disconnect two hoses (7) from erection cylinder (8). Discard preformed packings (9).



WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

(5) Attach lifting device to erection cylinder (8) and remove screw (10), washer (11), and bushing (12) from rivet eyebolt (13).

(6) Remove rivet eyebolt (13) from pivot shaft (14).

(7) Remove pivot shaft (14) from erection cylinder (8).

(8) Remove erection cylinder (8) from mast (15).

b. Installation

WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

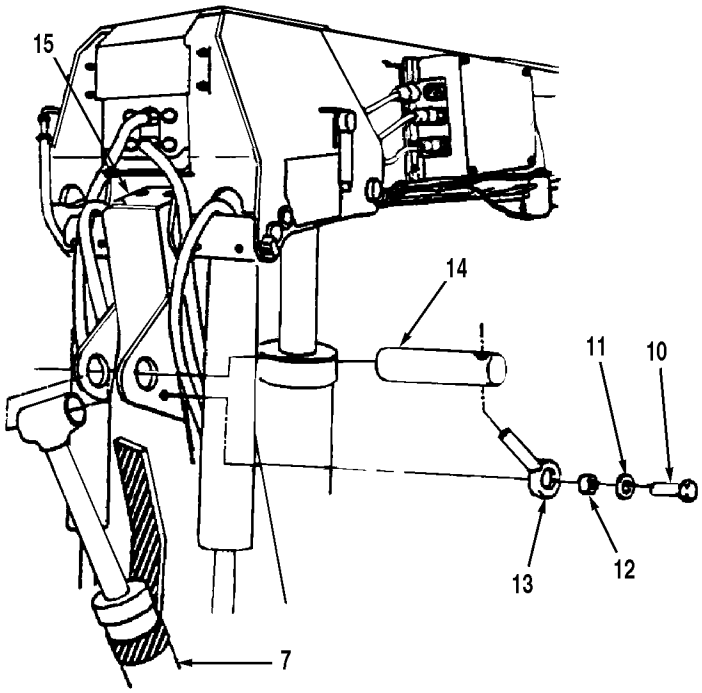
(1) With help from assistant, attach lifting device to erection cylinder (8) and install erection cylinder (8) on mast (15) with pivot shaft (14).

(2) Apply sealing compound to threads of screw (10).

(3) Install rivet eyebolt (11) in pivot shaft (14).

(4) Install bushing (12) and washer (11) in rivet eyebolt (13) with screw (10).

(5) Tighten screw (10) to 135 lb-ft (183 N·m).



3-19. ERECTION CYLINDER REPLACEMENT (Continued)

(6) With help from assistant, install erection cylinder (8) and tension link cylinder (6) with pivot shaft (5).

(7) Install two rivet eyebolts (4) in pivot shaft (5).

(8) Apply sealing compound to threads of two screws (1).

(9) Install two bushings (3), washers (2), and screws (1) in rivet eyebolts (4).

(10) Tighten screws (1) to 135 lb-ft (183 N·m).

(11) Install two preformed packings (9) and connect two hydraulic hoses (7) to erection cylinder (8).

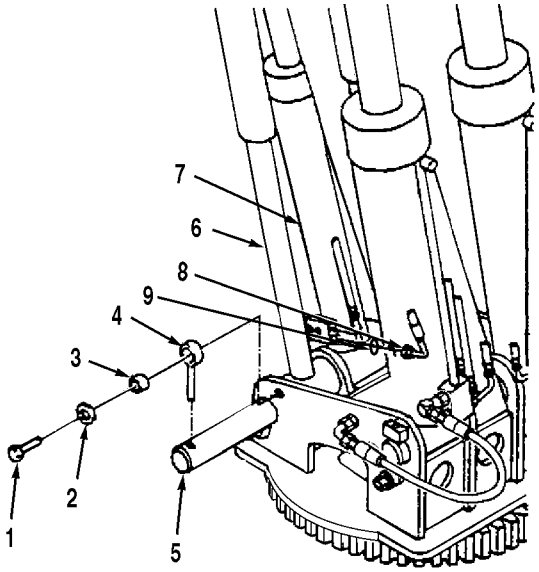
END OF TASK

Follow-On Maintenance

Check crane for proper operation and hydraulic leaks, (TM 9-4940-568-10).

Load test crane (para 3-5).

Lubricate pivot pins, (TM 9-4940-568-10).



3-20. TENSION LINK REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Sealing compound (Item 29, Appendix B)

Personnel Required
1 Assistant

Equipment Condition
FRS unloaded, crane in operating position
(TM 9-4940-568-10).

---

a. Removal

NOTE

- Left and right side tension links are removed the same way. Right side shown.
- Only remove rivet eyebolt closest to tension link to be removed.

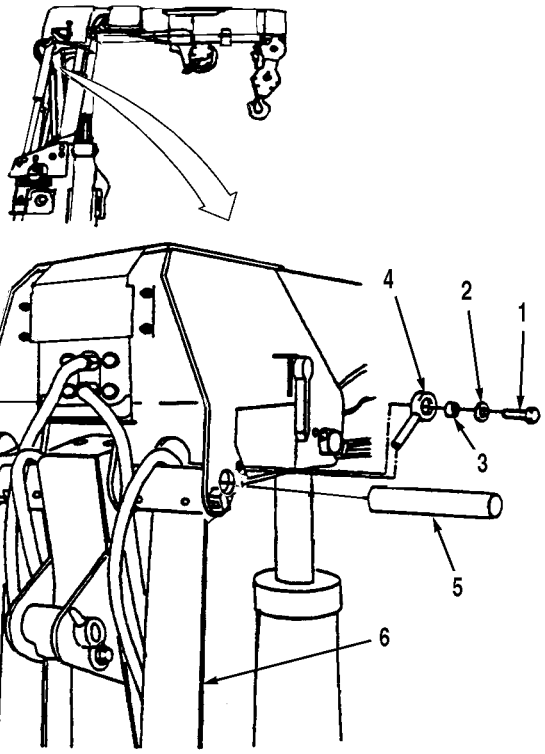
(1) Remove two screws (1), washers (2), and bushings (3) from rivet eyebolts (4).

(2) Remove two rivet eyebolts (4) from pivot shaft (5).

WARNING

Remove pivot shaft only far enough to release tension link. Failure to comply may result in injury to personnel or damage to equipment.

(3) With help from assistant, drive pivot shaft (5) out of tension link (6).



3-20. TENSION LINK REPLACEMENT (Continued)

(4) Remove two screws (7), washers (8), and bushings (9) from rivet eyebolts (10).

(5) Remove two rivet eyebolts (10) from pivot shaft (11).

WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

Remove pivot shaft only far enough to release tension link. Failure to comply may result in injury to personnel or damage to equipment.

(6) With help from assistant, attach lifting device to tension link (6) and drive pivot shaft (11) out of tension link (6).

(7) Remove tension link (6) from turntable (12).

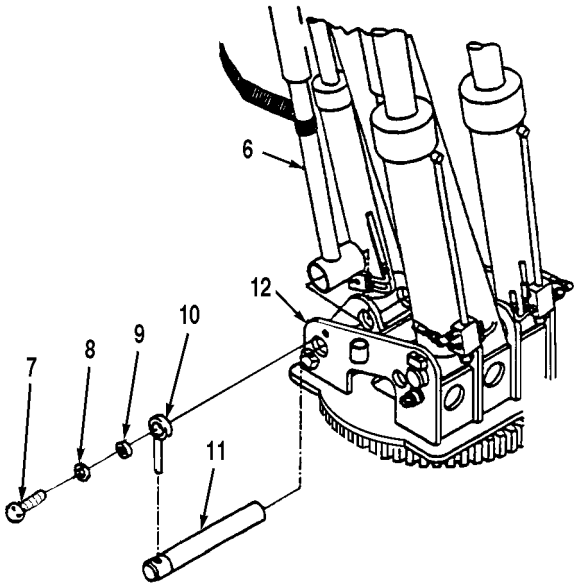
(8) Remove four grease fittings (13) from tension link (6).

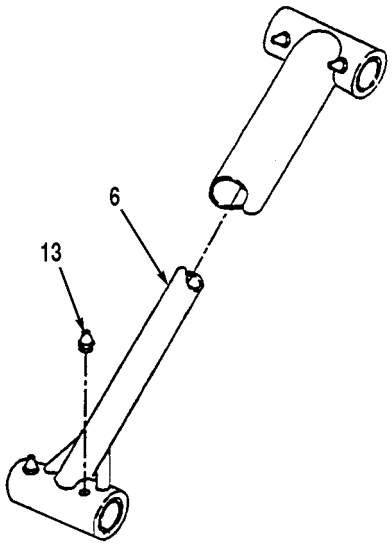
b. Installation

NOTE

Left and right side tension links are installed the same. Right side shown.

(1) Install four grease fittings (13) in tension link (6).





WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

(2) With help from assistant, attach lifting device to tension link (6) and install tension link (6) in turntable (12) with pivot shaft (11).

(3) Install two rivet eyebolts (10) in pivot shaft (11).

(4) Apply sealing compound to threads of two screws (7).

(5) With help from assistant, install two bushings (9) and washers (8) in rivet eyebolts (10) with screws (7).

(6) Tighten two screws (7) to 135 lb-ft (183 N·m).

(7) With help from assistant, install tension link (6) with pivot shaft (5).

(8) Install two rivet eyebolts (4) in pivot shaft (5).

(9) Apply sealing compound to head and threads of two screws (1).

(10) Install two bushings (3) and washers (2) in rivet eyebolts (4) with screws (1).

(11) Tighten two screws (1) to 135 lb-ft (183 N·m).

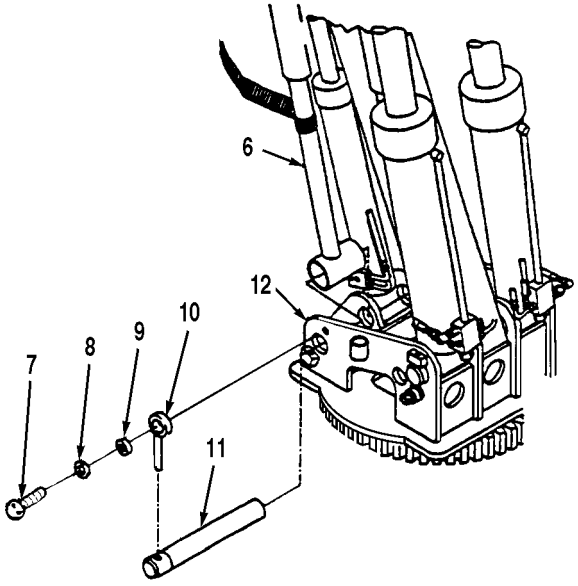
END OF TASK

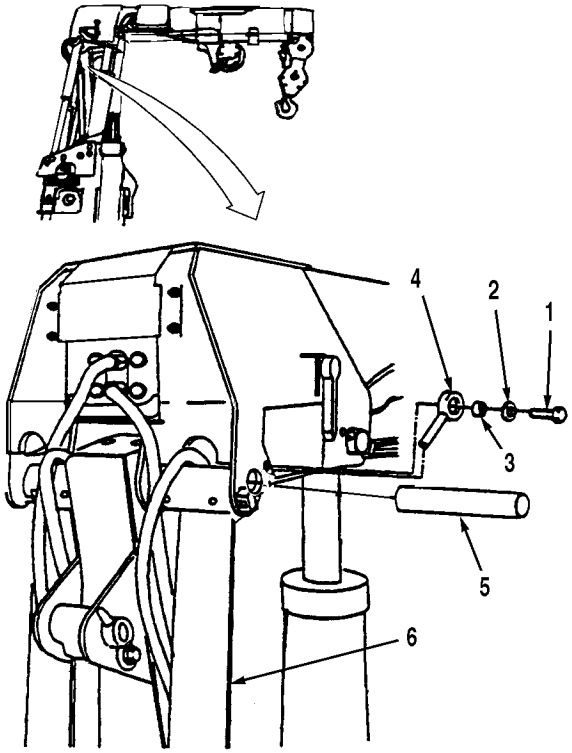
Follow-On Maintenance

Lubricate pivot shafts, (TM 9-4940-568-10).

Check crane for proper operation and hydraulic leaks, (TM 9-4940-568-10).

Load test crane (para 3-5).





3-21. MAST REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Sealing compound (Item 29, Appendix B)
Packing, preformed (4) (Item 76, Appendix E)

Personnel Required
1 Assistant

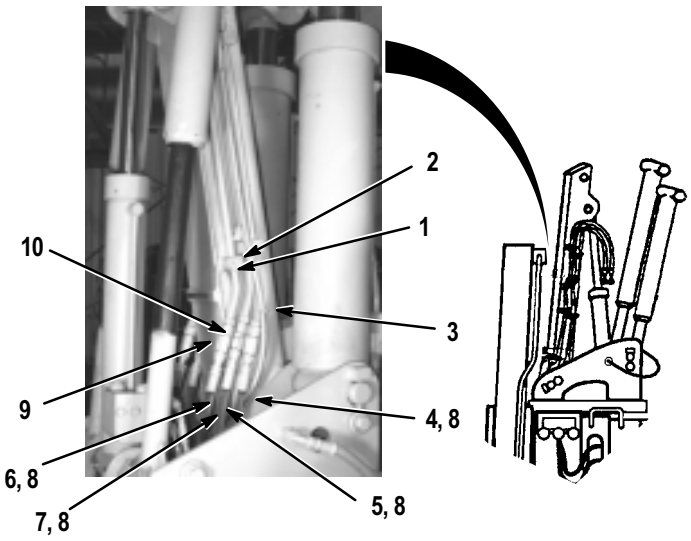
Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Boom base section removed (para 3-17).

a. Removal

NOTE

- Place a container to catch hydraulic oil during hose removal.
- Plug all hoses after removal to prevent dirt from entering hydraulic system.
- Tag and mark all hoses prior to removal to ensure proper installation.
- Left and right side hoses are removed the same way. Left side shown.
- Remove cushion clamps as required.



(1) Remove eight screws (1) and four clamps (2) from mast (3).

(2) Disconnect four hoses (4, 5, 6, and 7) and preformed packings (8) from fittings (9). Discard preformed packings.

(3) Remove two nuts (10) and fittings (9) from mast (3).

WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

(4) With help from assistant, attach lifting device to mast (3) and remove screw (11), washer (12), and bushing (13) from rivet eyebolt (14).

(5) Remove rivet eyebolt (14) from pivot shaft (15).

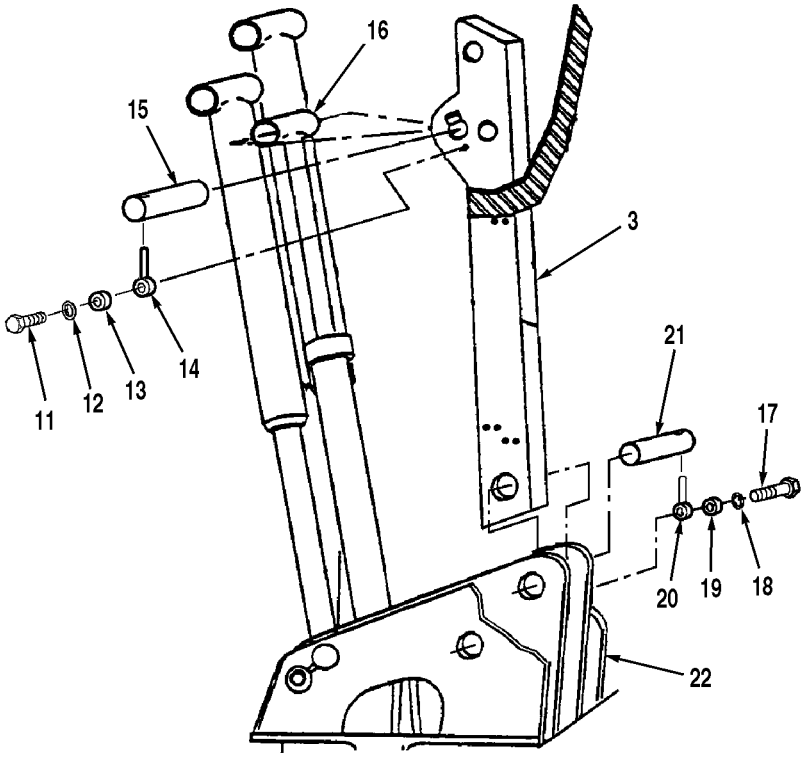
(6) Remove pivot shaft (15) from erection cylinder (16) and mast (3).

(7) Remove screw (17), washer (18), and bushing (19) from rivet eyebolt (20).

(8) Remove rivet eyebolt (20) from pivot shaft (21).

(9) With help from assistant, remove pivot shaft (21) from turntable (22).

(10) With help from assistant, remove mast (3) from turntable (22).



3-21. MAST REPLACEMENT (Continued)

b. Installation

WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

(1) With help from assistant, attach lifting device to mast (3) and install mast (3) on turntable (22) with pivot shaft (21).

(2) Install rivet eyebolt (22) in pivot shaft (21).

(3) Apply sealing compound to threads of screw (17).

(4) Install bushing (19) and washer (18) in rivet eyebolt (20) with screw (17).

(5) Tighten screw (17) to 135 lb-ft (183 N·m).

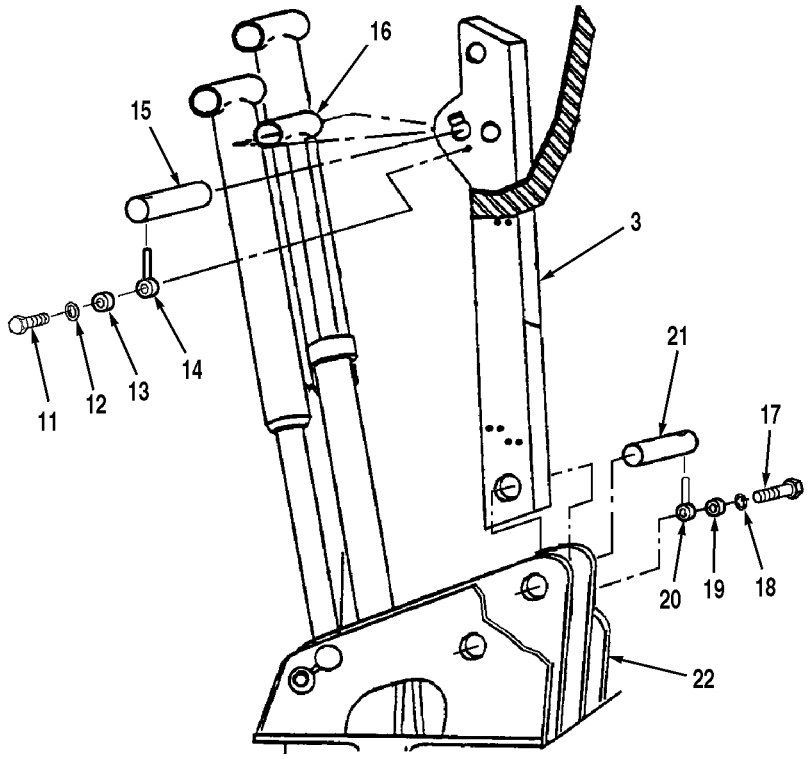
(6) Install erection cylinder (16) with pivot shaft (15).

(7) Install rivet eyebolt (14) in pivot shaft (15).

(8) Apply sealing compound to threads of screw (11).

(9) Install bushing (13) and washer (12) in rivet eyebolt (14) with screw (11).

(10) Tighten screw (11) to 135 lb-ft (183 N·m).



NOTE

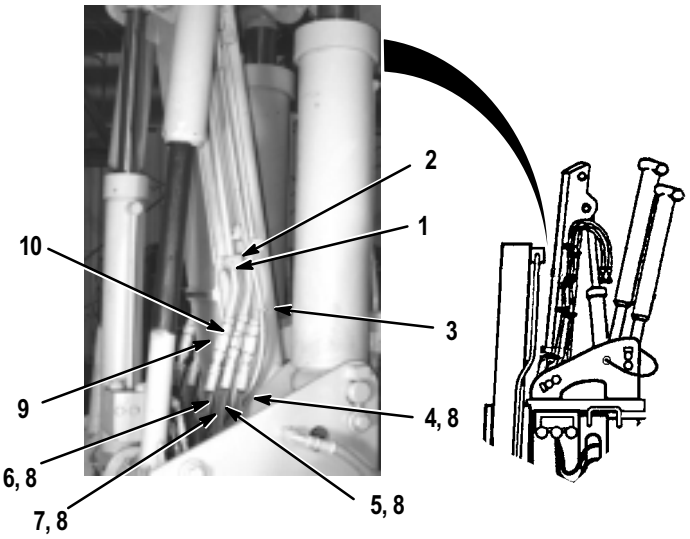
Left and right side hoses are installed the same. Left side shown.

(11) Install two fittings (9) and nuts (10) on mast (3).

(12) Install four preformed packings (8) and hoses (4 thru 7) on fittings (9).

(13) Install four clamps (2) and eight screws (1) on mast (3).

END OF TASK



Follow-On Maintenance

Install boom base section (para 3-17).

Lubricate pivot pins, (TM 9-4940-568-10).

Check crane for proper operation and hydraulic leaks, (TM 9-4940-568-10).

Load test crane (para 3-5).

3-22. CABLE FOLLOWER REPLACEMENT/REPAIR

THIS TASK COVERS:
a. Removal
b. Disassembly
c. Assembly
d. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

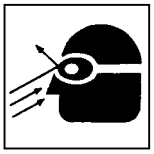
Materials/Parts
Sealing compound (Item 29, Appendix B)

Equipment Condition
FRS unloaded, crane in operating position (TM 9-4940-568-10).

Hoist assembly removed (para 3-26).

a. Removal

WARNING

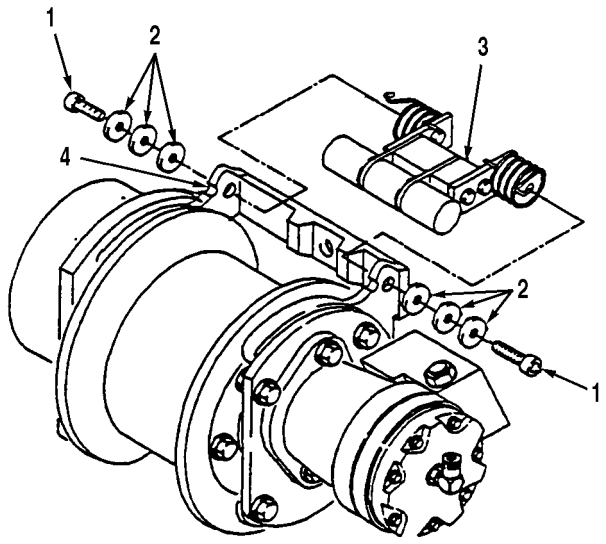


Use care when removing springs. Springs are under tension and can act as projectiles when released. Failure to comply may result in injury to personnel.

(1) Remove two screws (1), six thrust washers (2), and cable follower (3) from hoist assembly (4).

NOTE

Roller guide removed for clarity.

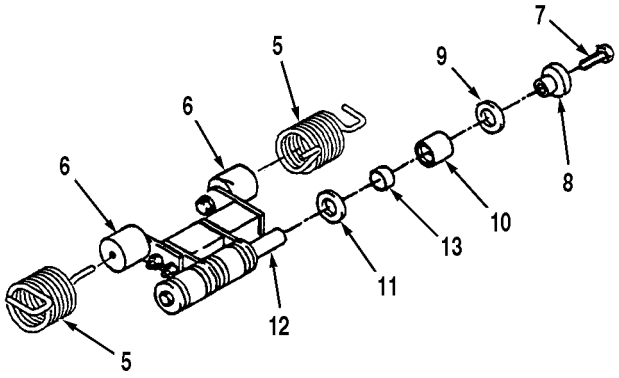


b. Disassembly

(1) Remove two springs (5) from posts (6).

(2) Remove two screws (7), washers (8), thrust washers (9), rollers (10), and washers (11) from shaft (12).

(3) Remove two bearings (13) from rollers (10).

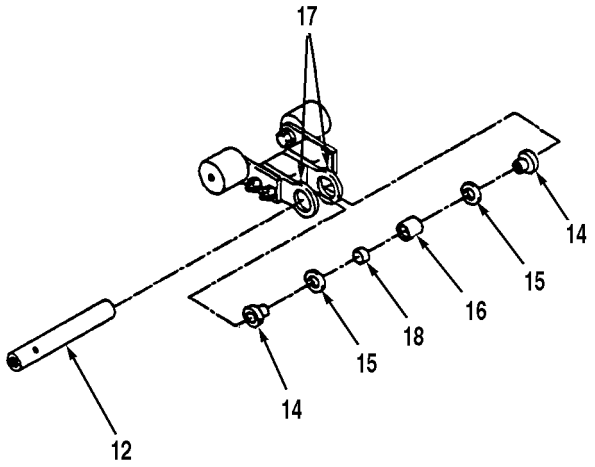


NOTE

Roller Guide shown removed for clarity.

(4) Remove shaft (12), two washers (14), washers (15), and roller (16) from control levers (17).

(5) Remove bearing (18) from roller (16).



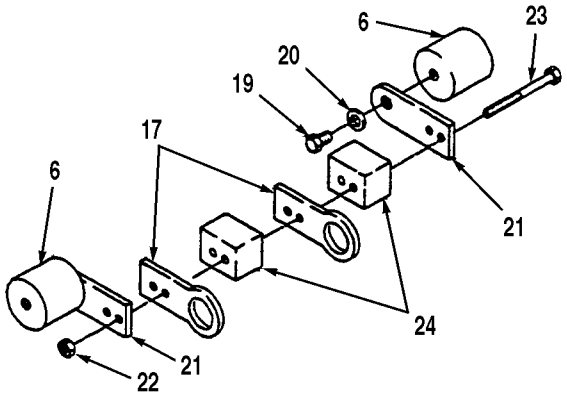
(6) Remove two screws (19), washers (20), and posts (6) from manual levers (21).

(7) Remove two nuts (22), screws (23), control levers (17), and manual levers (21) from spacers (24).

c. Assembly

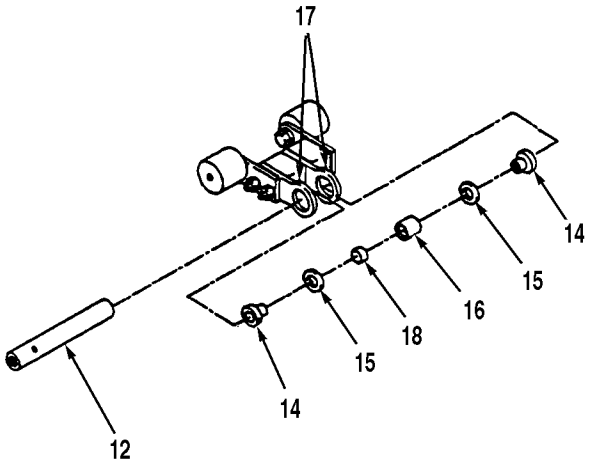
(1) Install two control levers (17) and manual levers (21) on spacers (25) with two screws (23) and nuts (22).

(2) Install two posts (6) on manual levers (21) with two washers (20) and screws (19).



(3) Install bearing (18) in roller (16).

(4) Position two washers (15), washers (14), and roller (16) in control levers (17) with shaft (12).

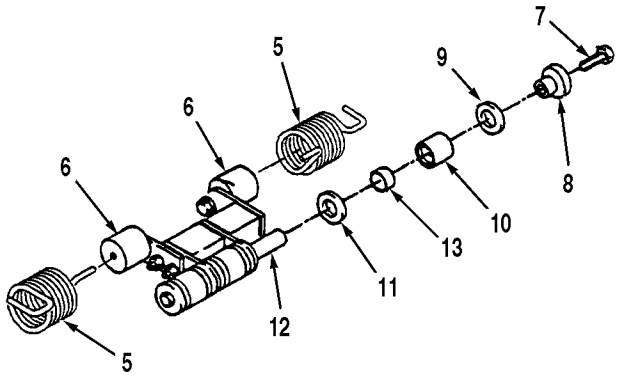


3-22. CABLE FOLLOWER REPLACEMENT/REPAIR (Continued)

(5) Install two bearings (13) in rollers (10).

(6) Install two washers (11), rollers (10), thrust washers (9), and washers (8) on shaft (12) with screws (7).

(7) Install two springs (5) on posts (6).

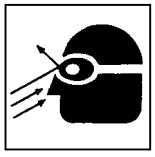


d. Installation

(1) Apply sealing compound to threads of two screws (1).

(2) Install cable follower (3) on hoist assembly (4) with six thrust washers (2) and two screws (1).

WARNING



Use care when removing springs. Springs are under tension and can act as projectiles when released. Failure to comply may result in injury to personnel.

(3) Attach springs (5) to hoist assembly (4).

END OF TASK

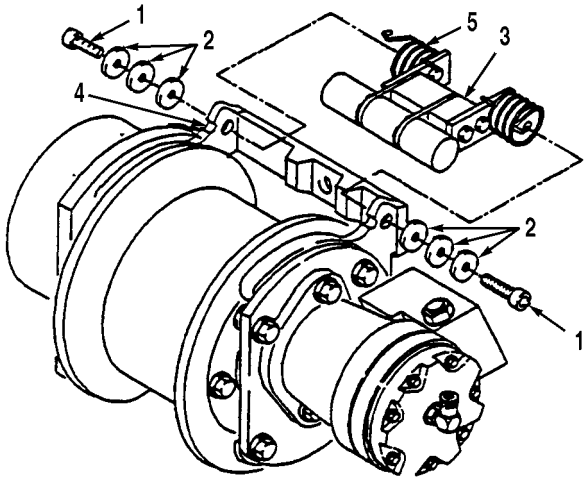
Follow-On Maintenance

Install hoist assembly, (para 3-26).

Check crane for proper operation and hydraulic leaks, (TM 9-4940-568-10).

NOTE

Roller guide removed for clarity.



3-23. PROXIMITY SENSOR REPLACEMENT

THIS TASK COVERS:
a. Removal
b. Installation
c. Adjustment

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

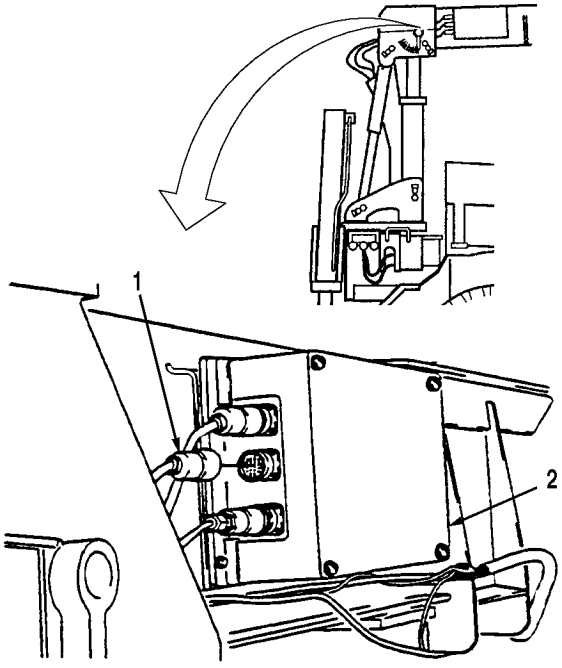
Materials/Parts
Sealing compound (Item 29, Appendix B)
Lockwasher (2) (Item 67, Appendix E)

Equipment Condition
FRS unloaded, boom extended
(TM 9-4940-568-10).

Cable follower removed (Para 3-22).

a. Removal

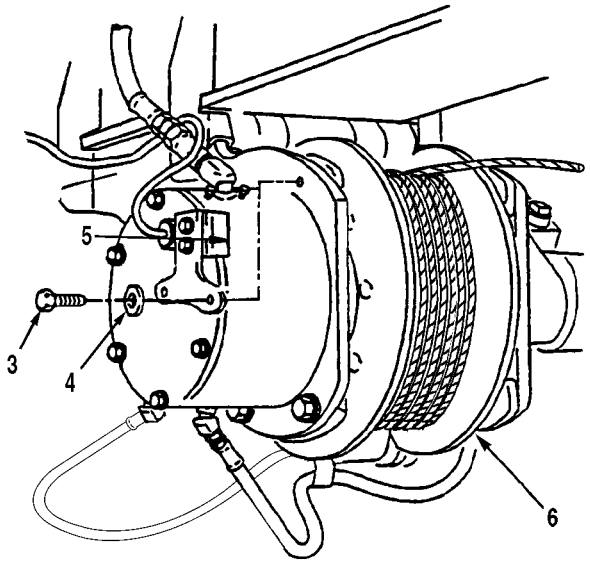
(1) Disconnect connector (1) from overload shutdown box (2).



NOTE

Remove cable ties as required.

(2) Remove two screws (3), washers (4), and bracket (5) from hoist assembly (6).



3-23. PROXIMITY SENSOR REPLACEMENT (Continued)

(3) Remove two screws (7), lockwashers (8), washers (9), and plate (10) from bracket (5). Discard lockwashers.

(4) Remove nut (11) and proximity sensor (12) from plate (10).

b. Installation

(1) Remove nut (11) from proximity sensor (12).

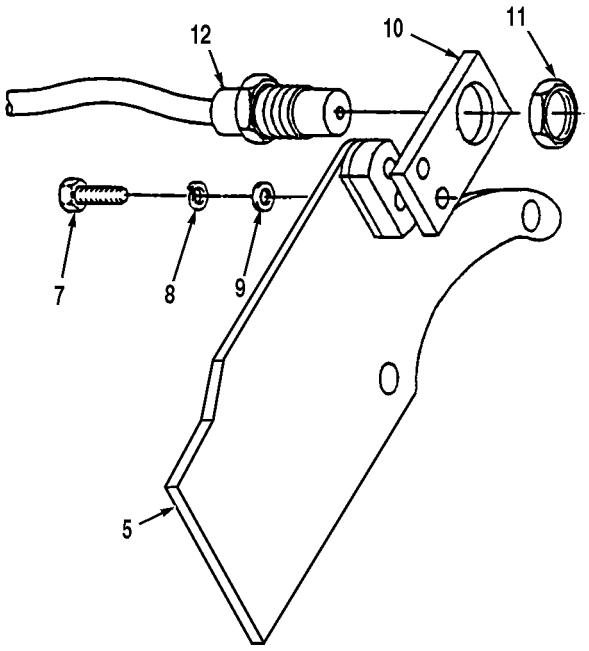
(2) Install proximity sensor (12) in plate (10) with nut (11).

(3) Apply sealing compound to threads of two screws (7).

(4) Install plate (10) on bracket (5) with two washers (9), lockwashers (8), and screws (7).

(5) Apply sealing compound to threads of two screws (3).

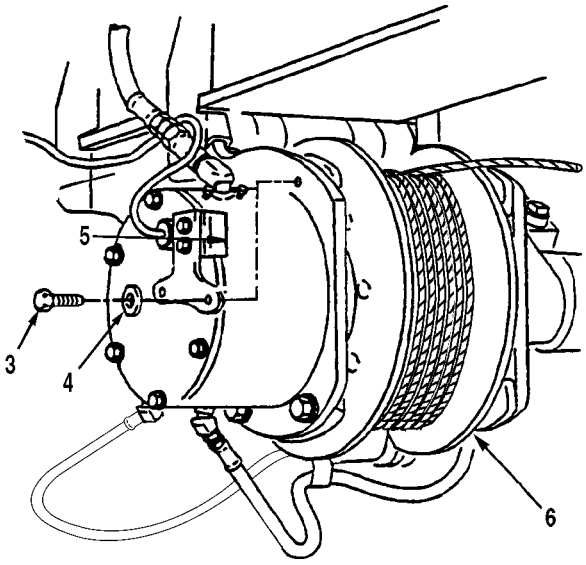
(6) Install bracket (5) on hoist assembly (6) with two washers (4) and screws (3). Tighten screws to 68 lb-ft (92 N·m).

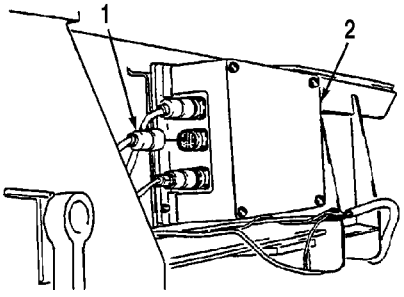


NOTE

Install cable ties as required.

(7) Connect connector (1) to overload shutdown box (2).

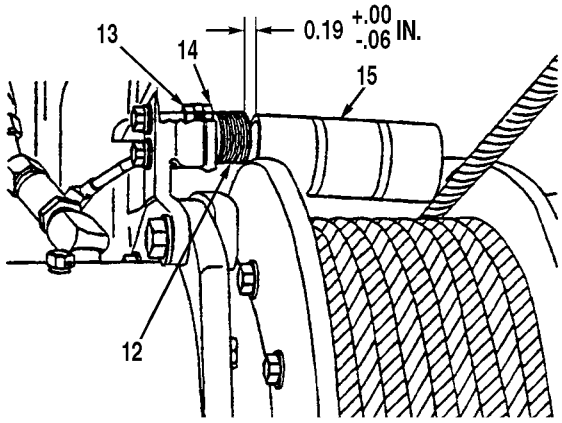




c. Adjustment

(1) Install cable follower (Para 3-22).

(2) Adjust nuts (13 and 14) to obtain a 0.19 ± .06 in. (.48 ± .15 cm) gap between proximity sensor (12) and cable follower (15).



END OF TASK

Follow-On Maintenance

Stow crane, (TM 9-4940-568-10).

Check crane for proper operation and hydraulic leaks, (TM 9-4940-568-10).

3-24. HOIST HYDRAULIC MOTOR REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Adhesive, sealant (Item 3, Appendix B)
Hydraulic oil (Item 16, Appendix B)
Sealing compound (Item 29, Appendix B)
Gasket (Item 12, Appendix E)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

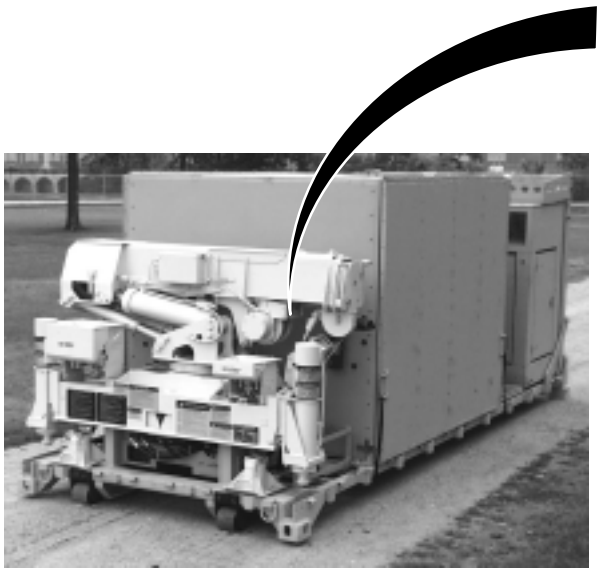
Hoist motor control valve removed, (para 3-38).

a. Removal

NOTE

- Place a container to catch hydraulic oil during hose removal.
- Plug all hoses after removal to prevent dirt from entering hydraulic system.

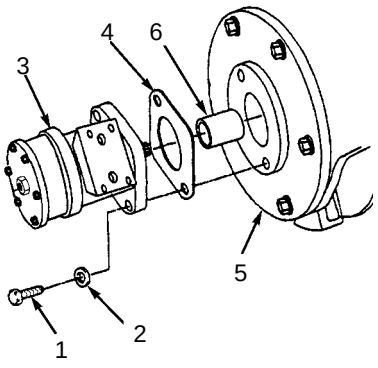
(1) Remove two screws (1), washers (2), hoist hydraulic motor (3), and gasket (4) from hoist assembly (5). Discard gasket.



NOTE

Note position of boss coupling (6) prior to removal to ensure proper installation.

(2) Remove boss coupling (6) from hoist assembly (5).



b. Installation

(1) Install unsplined end of boss coupling (6) in hoist assembly (5).

(2) Apply sealing compound to threads of two screws (1).

(3) Apply a thin even film of adhesive sealant to mating surfaces of hoist hydraulic motor (3), gasket (4), and boss coupling (6).

(4) Install gasket (4) and hoist hydraulic motor (3) on hoist assembly (5) with two washers (2) and screws (1).

(5) Tighten two screws (1) to 68 lb-ft (92 N·m).

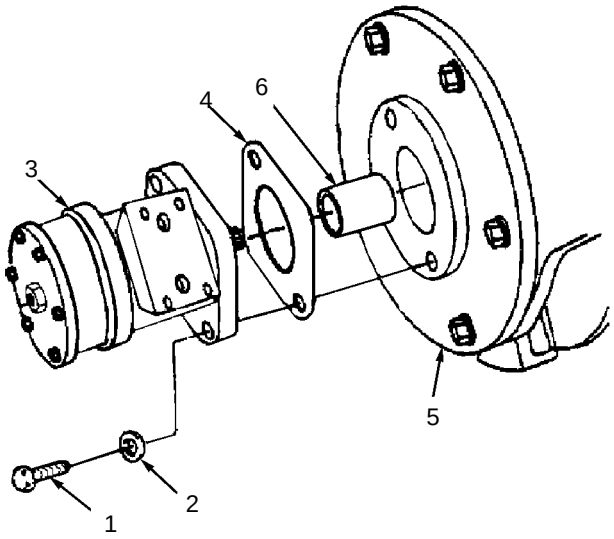
END OF TASK

Follow-On Maintenance

Install hoist control valve (para 3-38).

Check crane for proper operation and hydraulic leaks, (TM 9-4940-568-10).

Load test crane (para 3-5).



3-25. OIL FILLED DISC BRAKE ASSEMBLY REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Sealing compound (Item 29, Appendix B)
Sealing compound (Item 30, Appendix B)
Packing, preformed (3) (Item 73, Appendix E)
Packing, preformed (Item 81, Appendix E)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

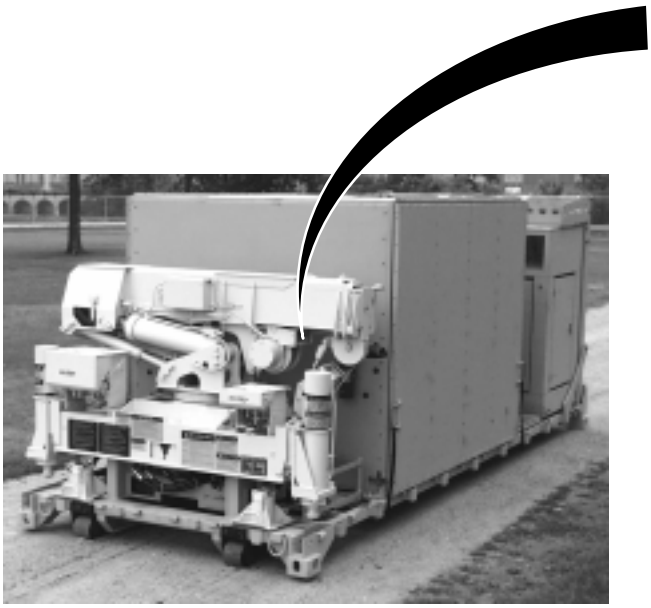
a. Removal

NOTE

- Place a container to catch hydraulic oil during hose removal.
- To aid in later installation, be sure to plug all lines as necessary, and tag all lines and their connection points.

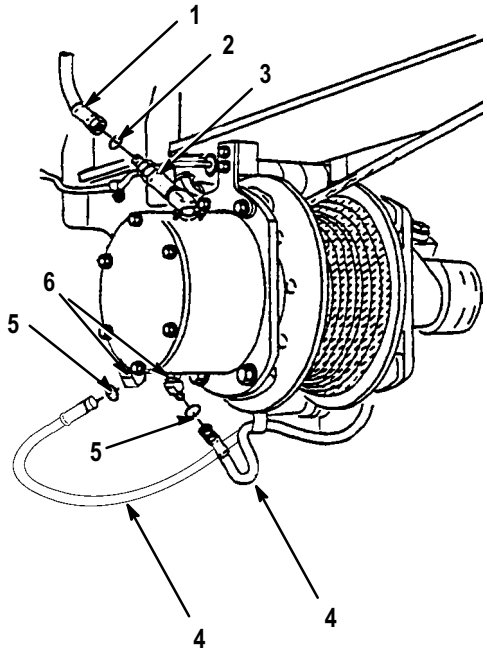
NOTE

Roller guide removed for clarity.



(1) Disconnect adapter (1) and preformed packing (2) from check valve (3). Discard preformed packing.

(2) Disconnect two hoses (4) and preformed packings (5) from fittings (6). Discard preformed packing.



(3) Remove four screws (7), washers (8), and bracket (9) from oil filled disc brake assembly (10).

(4) Remove three screws (11), washers (12), and oil filled disc brake assembly (10) from hoist (13).

(5) Remove check valve (3) from oil filled disc brake assembly (10).

(6) Remove two fittings (6) from oil filled disc brake assembly (10).

b. Installation

(1) Apply sealing compound to threads of two fittings (6).

(2) Install two fittings (6) in oil filled disc brake assembly (10).

(3) Install check valve (3) in oil filled disc brake assembly (10).

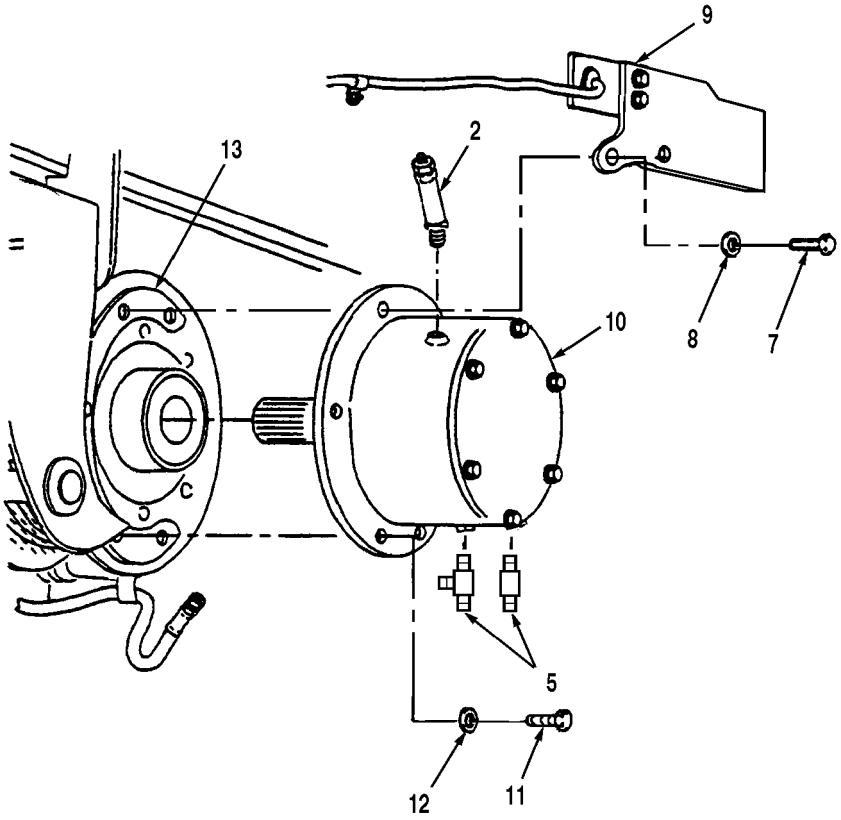
(4) Apply sealing compound to threads of three screws (11).

(5) Install oil filled disc brake assembly (10) on hoist (13) with three washers (12) and screws (11).

(6) Apply sealing compound to threads of four screws (7).

(7) Install bracket (9) on oil filled disc brake assembly (10) with four washers (8) and screws (7).

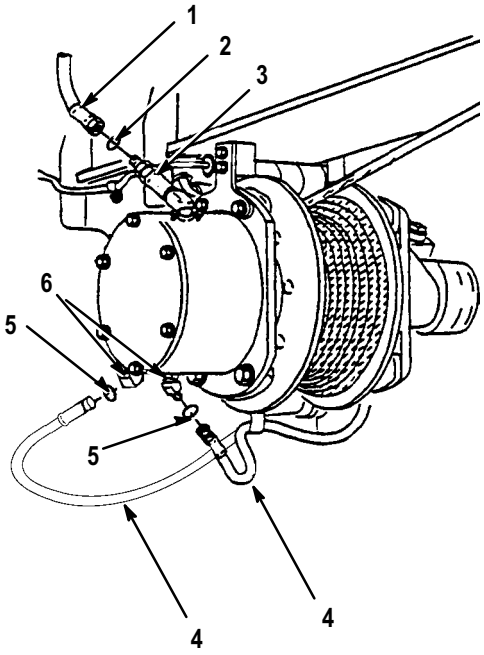
(8) Tighten screws (7 and 11) to 55 lb-ft (75 N·m).



3-25. OIL FILLED DISC BRAKE ASSEMBLY REPLACEMENT (Continued)

(9) Install preformed packings (5) and connect two hoses (4) to fittings (6).

(10) Install preformed packing (2) and connect adapter (1) to check valve (3).



NOTE

Roller guide removed for clarity.

END OF TASK

Follow-On Maintenance

Check crane for proper operation and hydraulic leaks, (TM 9-4940-568-10).

Load test crane (para 3-5).

3-26. HOIST ASSEMBLY REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Sealing compound (Item 29, Appendix B)
Packing, preformed (Item 73, Appendix E)
Packing, preformed (Item 75, Appendix E)

Personnel Required
1 Assistant

Equipment Condition
FRS unloaded, boom extended,
(TM 9-4940-568-10).

Hoist cable removed (para 5-5).

Tension load cell removed (para 3-28).

a. Removal

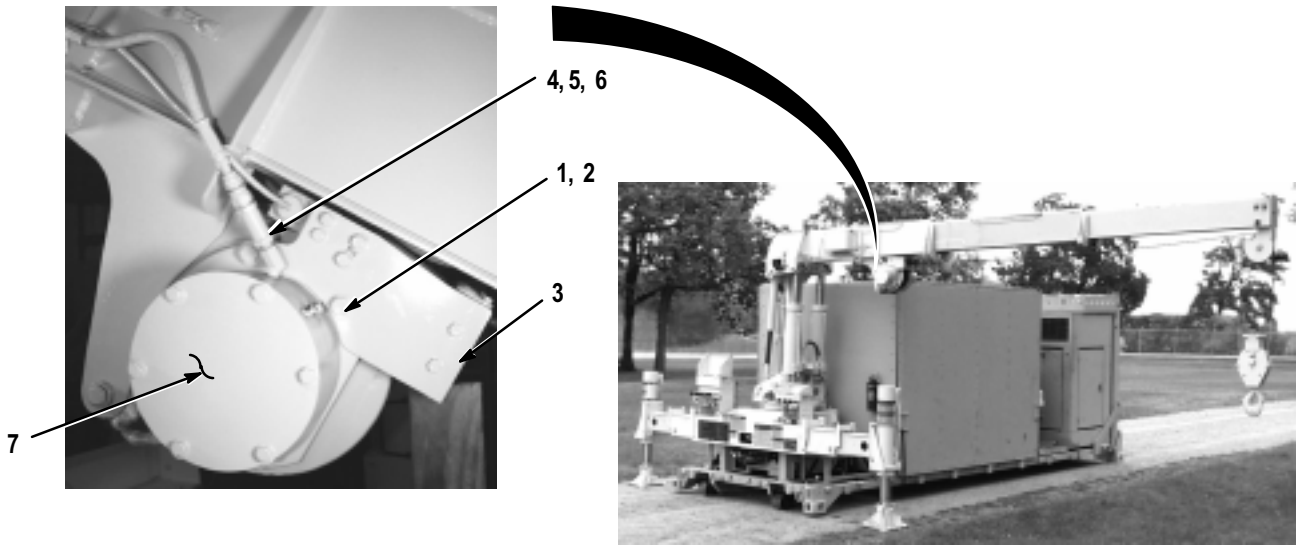
NOTE

- Place a container to catch hydraulic oil during hose removal.
- To aid in later installation, be sure to plug all lines as necessary, and tag all lines and their connection points.

(1) Remove two screws (1) and washers (2) from bracket (3).

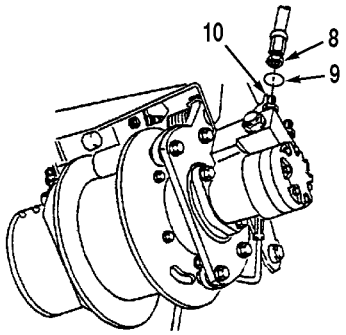
(2) Disconnect adapter (4) and remove preformed packing (5) from check valve (6). Discard preformed packing.

(3) Position adapter (4) and bracket (3) clear of hoist assembly (7).

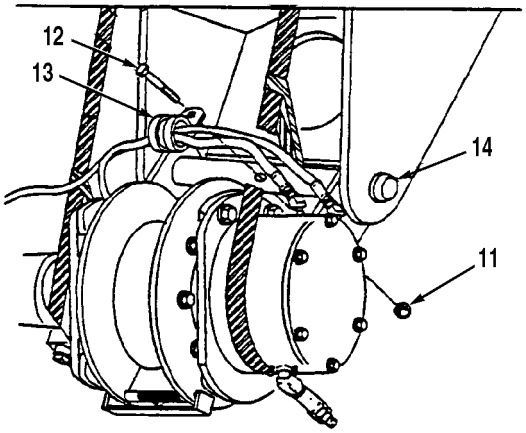


3-26. HOIST ASSEMBLY REPLACEMENT (Continued)

(4) Disconnect two adapters (8) and remove preformed packings (9) from fittings (10). Discard preformed packings.



(5) Remove locknut (11), screw (12), and clamp (13) from shaft (14). Discard locknut.



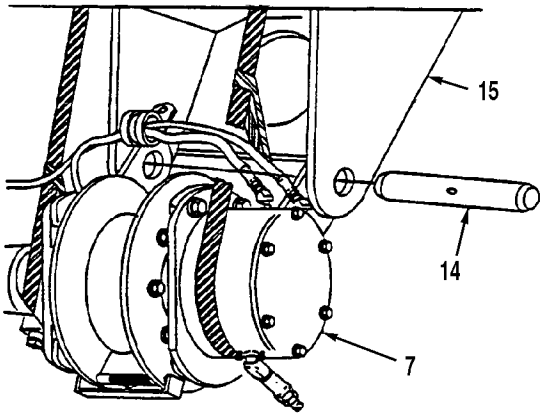
(6) Attach lifting device to hoist assembly (7), and with help from assistant, remove shaft (14) and hoist assembly (7) from boom brace (15).

b. Installation

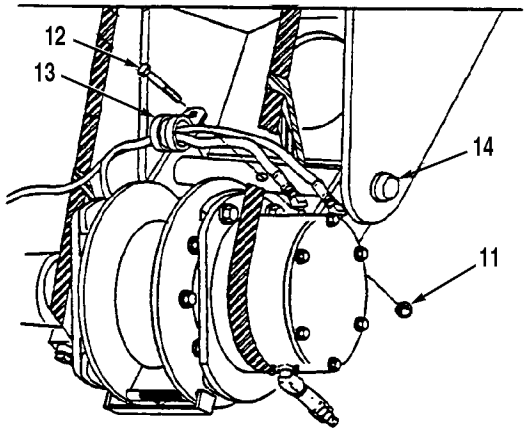
WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

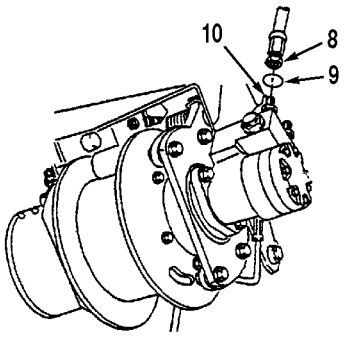
(1) With help from assistant, attach lifting device to hoist assembly (7) and install hoist assembly (7) in boom brace (15) with shaft (14).



(2) Install clamp (13), screw (12) and locknut (11) on shaft (14).



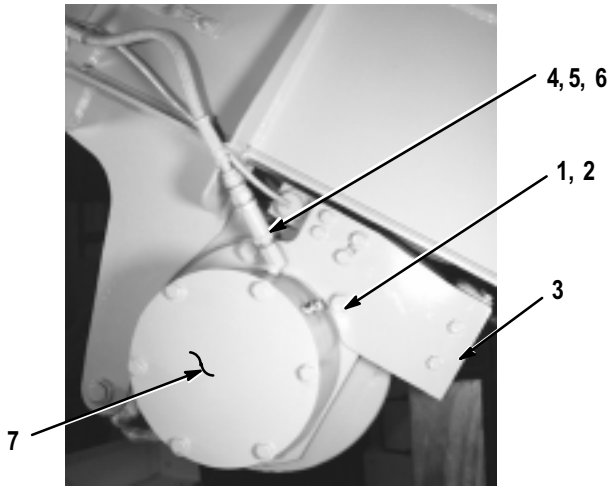
(3) Install two preformed packings (9) and connect adapters (8) to fittings (10).



(4) Apply sealing compound to threads of two screws (1).

(5) Install bracket (3) on hoist assembly (7) with two washers (2) and screws (1).

(6) Install preformed packing (5) and connect adapter (4) to check valve (6).



END OF TASK

Follow-On Maintenance

Install tension load cell (para 3-28).

Install hoist cable (para 5-5).

Check crane for proper operation and hydraulic leaks, (TM 9-4940-568-10).

Load test crane (para 3-5).

3-27. OVERLOAD SHUTDOWN REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

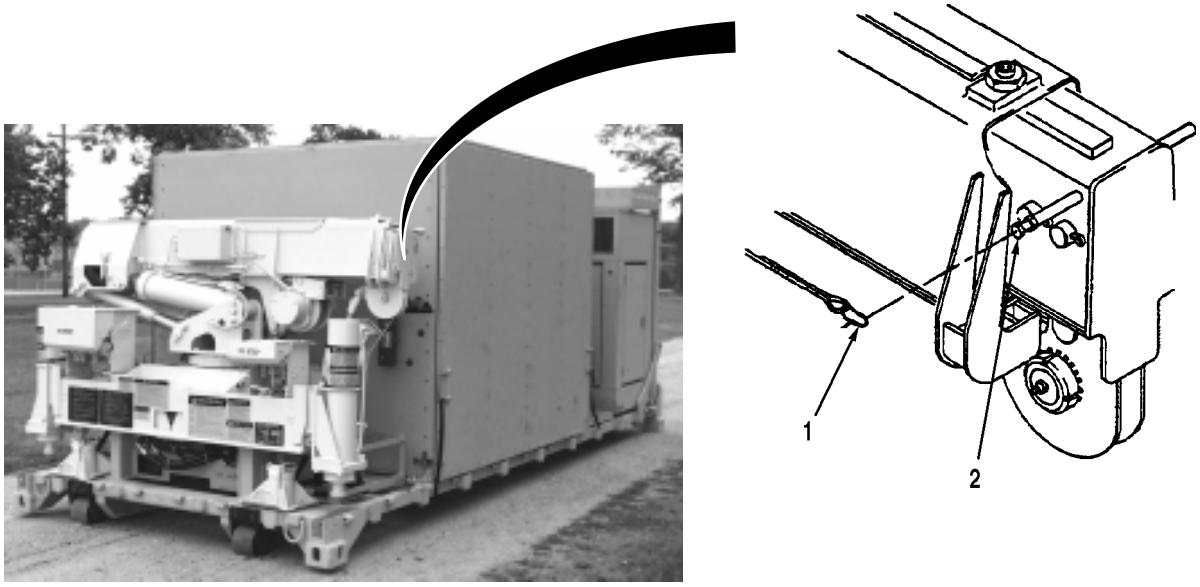
Materials/Parts
Lockwasher (Item 46, Appendix E)

a. Removal

CAUTION

Overload shutdown cable is on a tension reel. Allow cable to rewind slowly. Failure to comply may result in damage to equipment.

(1) Disconnect cable eye (1) from screw (2).



NOTE

Tag connectors and connection points prior to disconnecting.

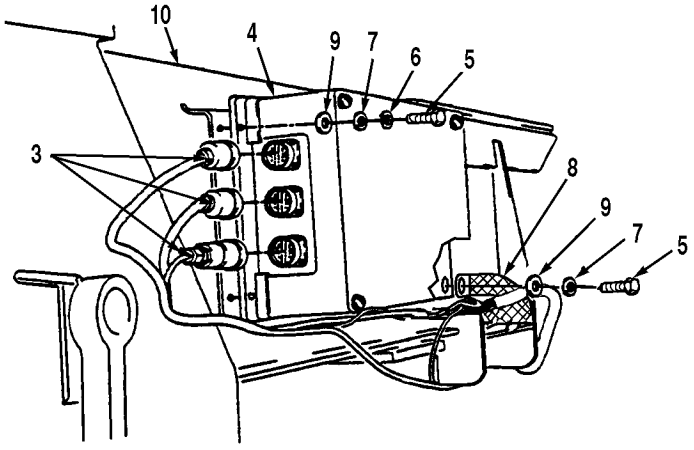
(2) Disconnect three connectors (3) from overload shutdown box (4).

(3) Remove four screws (5), lockwashers (6), flat washers (7), grounding strap (8), four nylon washers (9), and overload shutdown box (4) from boom assembly (10). Discard lockwashers.

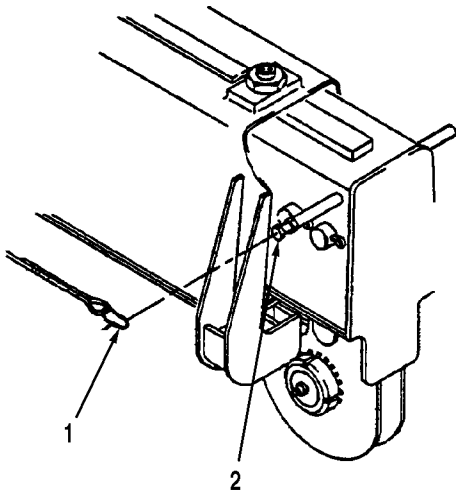
b. Installation

(1) Install overload shutdown box (4) on boom assembly (10) with four nylon washers (9), ground strap (8), four flat washers (7), lockwashers (6) and screws (5).

(2) Connect three connectors (3) to overload shutdown box (4).



(3) Connect cable eye (1) to screw (2).



END OF TASK

Follow-On Maintenance

Check crane for proper operation and hydraulic leaks.

Load test crane (para 3-5).

3-28. TENSION LOAD CELL REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Sealing compound (Item 29, Appendix B)
Lockwasher (Item 66, Appendix E)

Personnel Required
1 Assistant

Equipment Condition
FRS unloaded, mast and boom in raised position, (TM 9-4940-568-10).

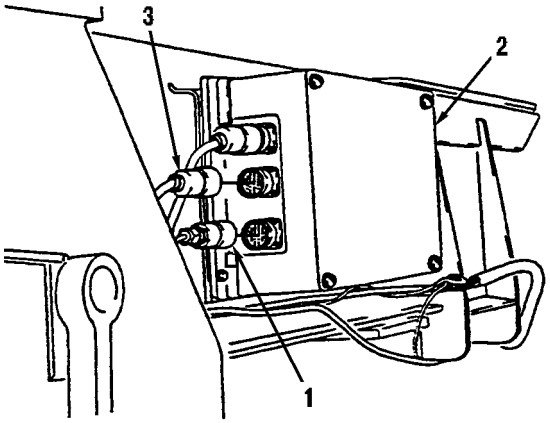
a. Removal

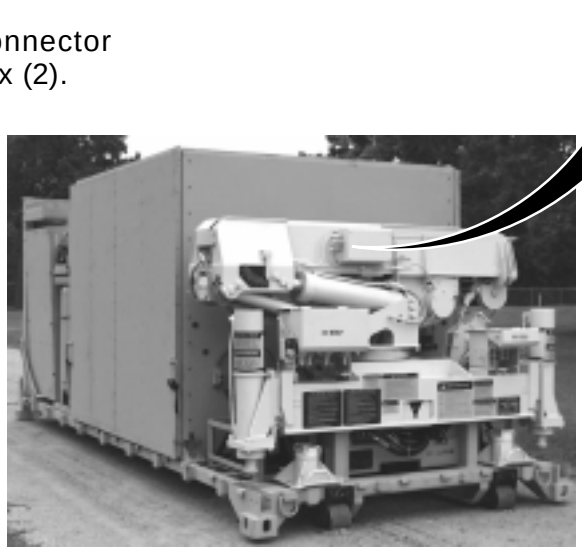
NOTE

- Tag and mark all hoses and electrical connectors prior to disconnecting.
- Plug all hoses after removal to prevent dirt from entering hydraulic system.
- Remove cable ties as required.

(1) Disconnect tension load cell connector (1) from overload shutdown box (2).

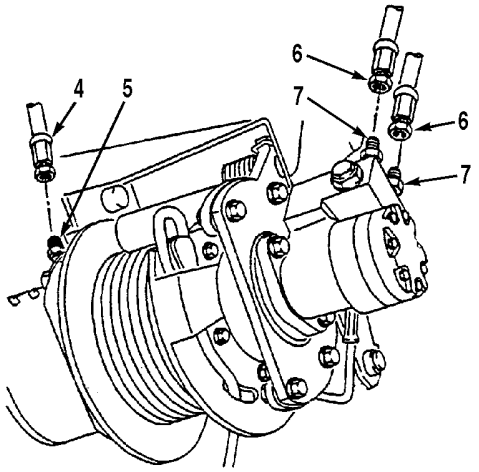
(2) Disconnect proximity sensor connector (3) from overload shutdown box (2).





(3) Disconnect hydraulic hose (4) from check valve (5).

(4) Disconnect two hydraulic hoses (6) from fittings (7).

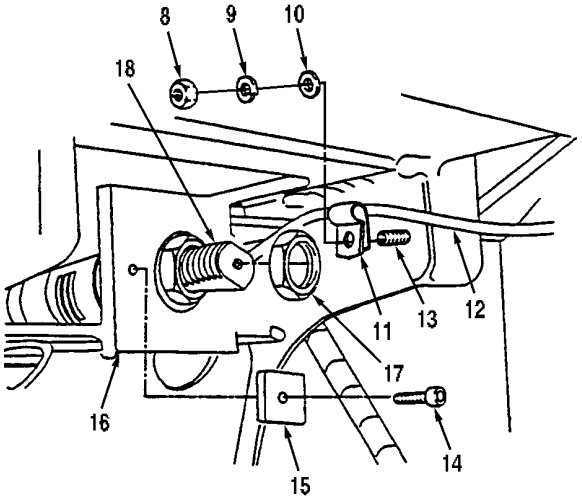


(5) Remove nut (8), lockwasher (9), washer (10), clamp (11) and tension load cell cable (12) from boom stud (13). Discard lockwasher.

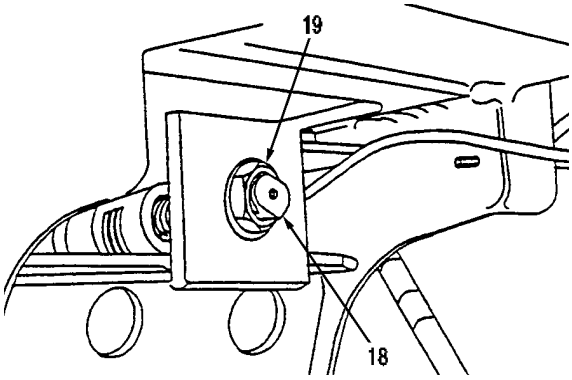
(6) Remove clamp (11) from cable (12).

(7) Remove allen head screw (14) and stop block (15) from boom brace (16).

(8) Remove jam nut (17) from tension load cell (18).



(9) Loosen rear swivel nut (19) until flush with rear end of tension load cell (18).



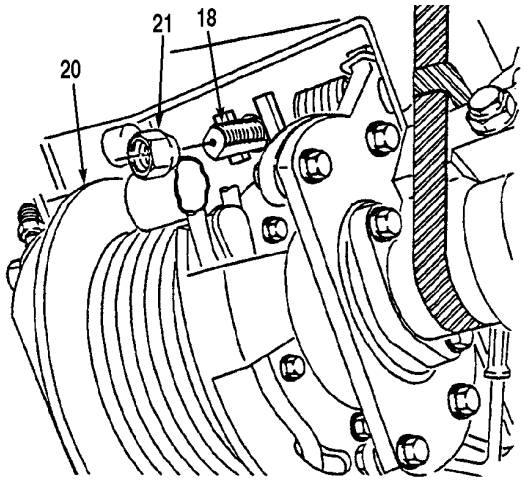
WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

(10) With help from assistant, attach lifting device to hoist assembly (20) and lift up on hoist assembly (20).

(11) With help from assistant, remove front swivel nut (21) from front of tension load cell (18).

(12) Lower hoist assembly (20) away from tension load cell (18).



3-28. TENSION LOAD CELL REPLACEMENT (Continued)

(13) Remove rear swivel nut (19) from tension load cell (18).

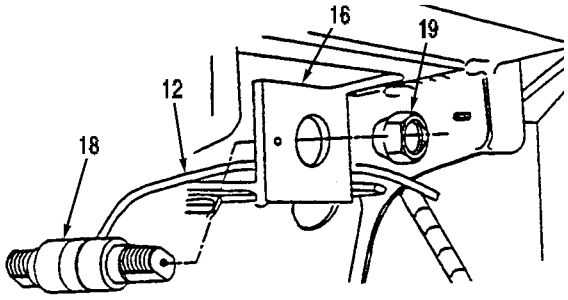
(14) Remove tension load cell (18) from boom brace (16).

b. Installation

(1) Install tension load cell (18) in boom brace (16) with rear swivel nut (19).

(2) Tighten rear swivel nut (19) until flush with end.

(3) Route tension load cell cable (12) through hole in boom brace (16).

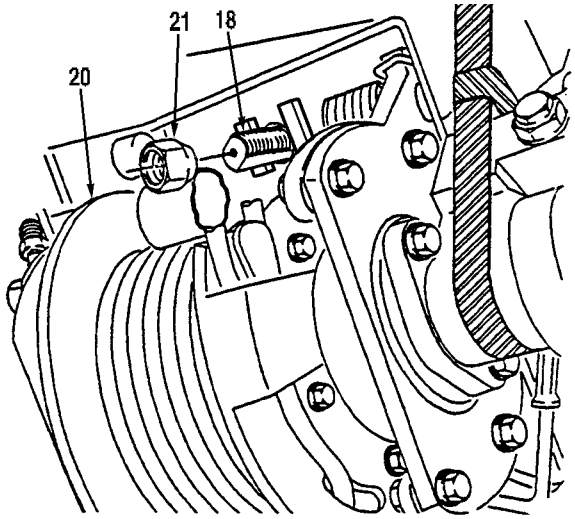


WARNING

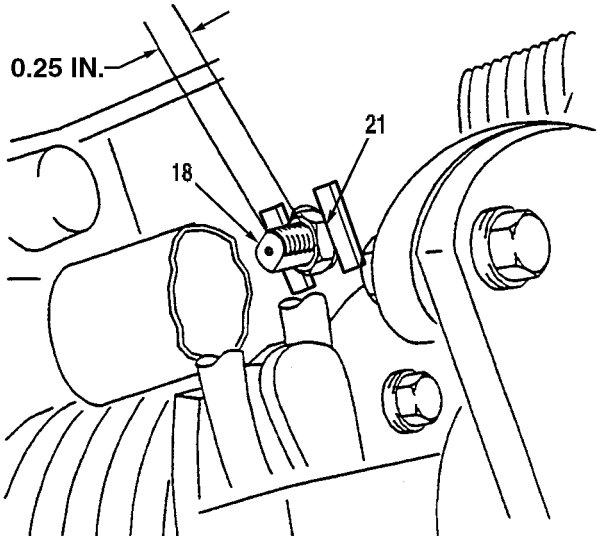
To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

(4) With help from assistant, install lifting device on hoist assembly (20) and lift up hoist assembly (20) on tension load cell (18).

(5) With help from assistant, position front swivel nut (21) on tension load cell (18).



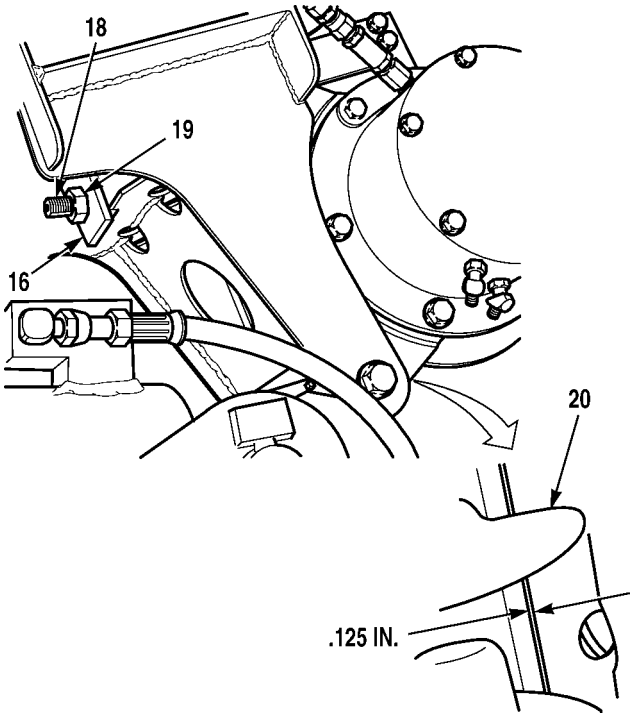
(6) Adjust front swivel nut (21) on tension load cell (18) until approximately 0.25 in. (0.64 cm) of threads are protruding past rear swivel nut (21).



NOTE

Access to measure gap can be obtained through bottom of hoist drum.

(7) Tighten rear swivel nut (19) on tension load cell (18) until gap between hoist assembly (20) and boom brace (16) is 0.125 in. (.318 cm).



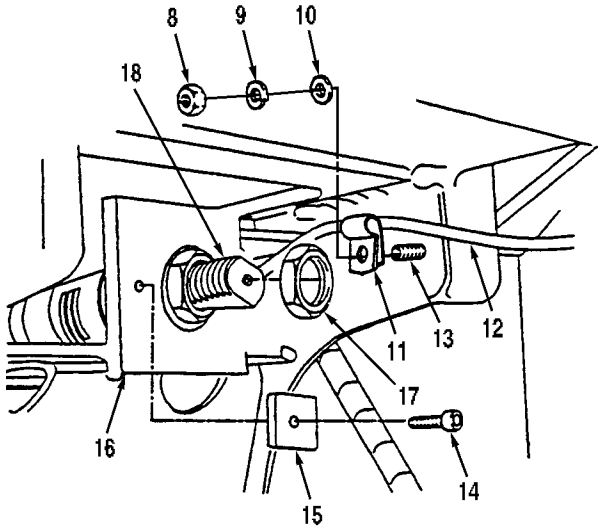
(8) Install jam nut (17) on tension load cell (18).

(9) Apply sealing compound to threads of allen head screw (14).

(10) Install stop block (15) on boom brace (16) with allen head screw (14).

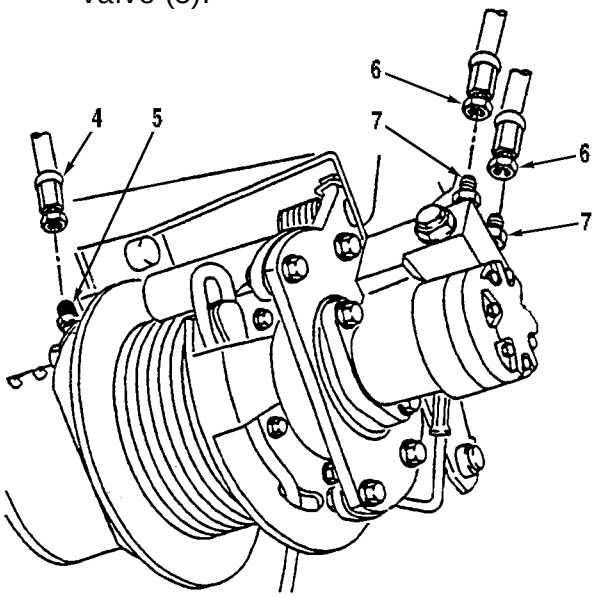
(11) Position clamp (11) on tension load cell cable (12).

(12) Install clamp (11) on boom stud (13) with washer (10), lockwasher (9) and nut (8).



(13) Connect two hydraulic hoses (6) to fittings (7).

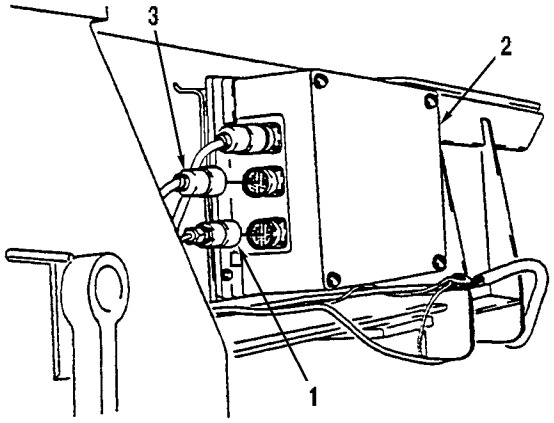
(14) Connect hydraulic hose (4) to check valve (5).



3-28. TENSION LOAD CELL REPLACEMENT (Continued)

(15) Connect tension load cell connector (1) to overload shutdown box (2).

(16) Connect proximity sensor connector (3) to overload shutdown box (2).



END OF TASK

Follow-On Maintenance

Check crane for proper operation and hydraulic leaks, (TM 9-4940-568-10).

Load test crane (para 3-5).

3-29. TURNTABLE BEARING REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Personnel Required
1 Assistant

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Turntable removed (para 3-30).

a. Removal

NOTE

Tag and mark all hoses prior to removal.

(1) Remove four hoses (1) and elbows (2) from turntable bearing (3).

(2) Remove 23 screws (4) and washers (5) from turntable bearing (3).

WARNING

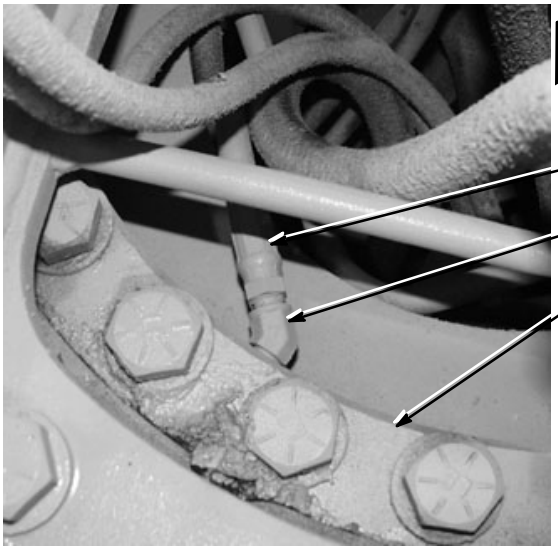
To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

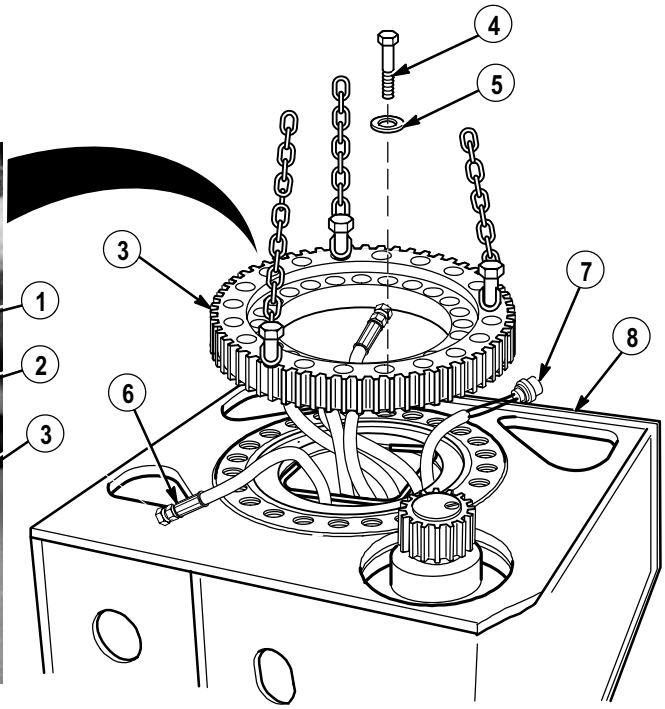
(3) Install lifting chain on turntable bearing (3) with three washers (5) and screws (4).

(4) With help from assistant, guide hoses (6) and electrical connector (7) through turntable bearing (3).

(5) Remove turntable bearing (3) from subframe (8).

(6) Remove three screws (4), washers (5), and lifting chain from turntable bearing (3).





3-29. TURNTABLE BEARING REPLACEMENT (Continued)

b. Installation

WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

(1) Install lifting chain on turntable bearing (3) with three washers (5) and screws (4).

(2) With help from assistant, lift turntable bearing (3) in position over subframe (8).

(3) With help from assistant, feed hoses (6) and electrical connector (7) through turntable bearing (3).

(4) Position turntable bearing (3) on subframe (8) with screw holes aligned.

(5) Remove three screws (4), washers (5), and lifting chain from turntable bearing (3).

(6) Install 23 washers (5) and screws (4) on turntable bearing (3).

(7) Tighten 23 screws (4) to 355-385 lb-ft (481-522 N·m).

(8) Install four elbows (2) and hoses (1) on turntable bearing (3).

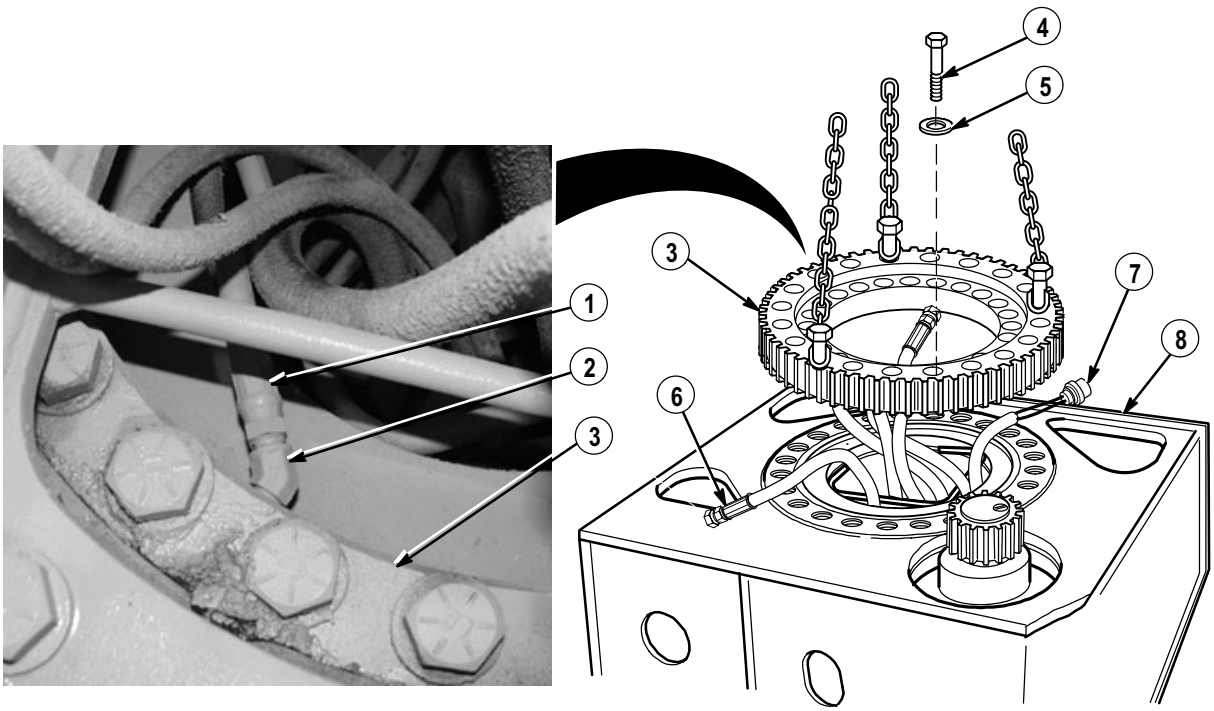
END OF TASK

Follow-On Maintenance

Install turntable (para 3-30).

Load test crane (para 3-5).

Check crane for proper operation and hydraulic leaks, (TM 9-4940-568-10).



3-30. TURNTABLE REPLACEMENT.

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Packing, preformed (Item 76, Appendix E)

Personnel Required
1 Assistant

Equipment Condition
FRS unloaded, boom extended,
(TM 9-4940-568-10).

Mast removed (para 3-21).

Tension link cylinder removed (para 3-20).

Erection cylinder removed (para 3-19).

a. Removal

(1) Remove four hoses (1), preformed packing (2) and bulkhead fittings (3) from turntable (4). Discard preformed packing.

(2) Matchmark turntable (4) to ring gear (5).

NOTE

Tag and mark washers (7 and 8) prior to removal. Washers must be installed in original locations.

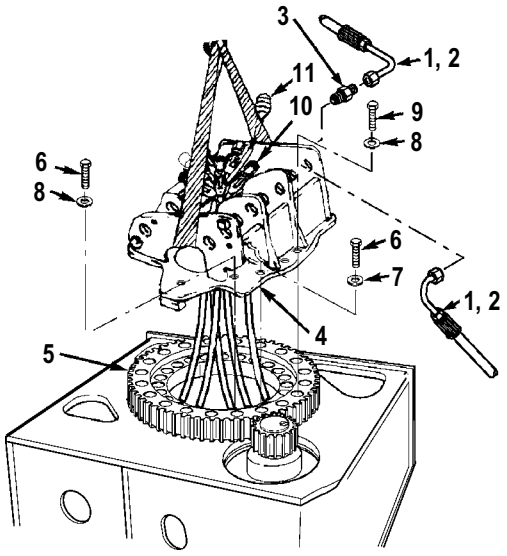
(3) Remove 12 screws (6), eight washers (7), and four washers (8) from turntable (4).

(4) Remove four socket head screws (9) and washers (8) from turntable (4).

WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

(5) With help from assistant, attach lifting device to turntable (4) and remove turntable (4) from ring gear (5) and route hydraulic hoses (10) and electrical cable (11) through center of turntable.



3-30. TURNTABLE REPLACEMENT (Continued)

b. Installation

WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

(1) With help from assistant, attach lifting device to turntable (4) and position turntable (4) over ring gear (5).

(2) Route hydraulic hoses (10) and electrical cable (11) through center of turntable (4).

(3) Lower turntable (4) on ring gear (5) with matchmarks aligned.

(4) Position four washers (8) and socket head screws (9) on turntable (4) at marked locations.

(5) Position eight washers (7), four washers (8) and 12 screws (6) in turntable (4).

(6) Tighten four socket head screws (9) and 12 screws (6) to 355-385 lb-ft (481-522 N·m).

(7) Install two bulkhead fittings (3), preformed packing (2) and connect four hoses (1).

END OF TASK

Follow-On Maintenance

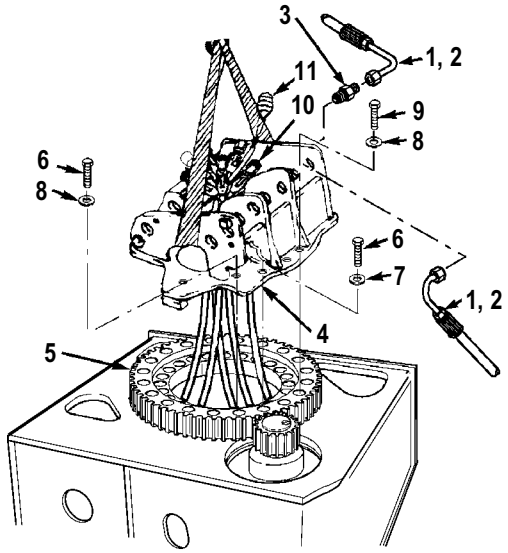
Install erection cylinder (para 3-19).

Install tension link cylinder (para 3-20).

Install mast (para 3-21).

Load test crane (para 3-5).

Check crane for proper operation and hydraulic leaks, (TM 9-4940-568-10).



3-31. FIVE FUNCTION CONTROL VALVE MOUNTING BRACKET REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Lockwasher (4) (Item 44, Appendix E)
Lockwasher (4) (Item 45, Appendix E)

Materials/Parts Continued
Lockwasher (10) (Item 47, Appendix E)
Lockwasher (2) (Item 46, Appendix E)
Lockwasher (Item 43, Appendix E)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).
Batteries disconnected (TM 9-4940-568-10).

---

a. Removal

CAUTION

When replacing brackets, replace one bracket at a time. Failure to comply may result in damage to equipment.

(1) Remove two nuts (1), lockwashers (2), spacer plate (3), anchor bracket (4) and screws (5) from cover (6). Discard lockwashers.

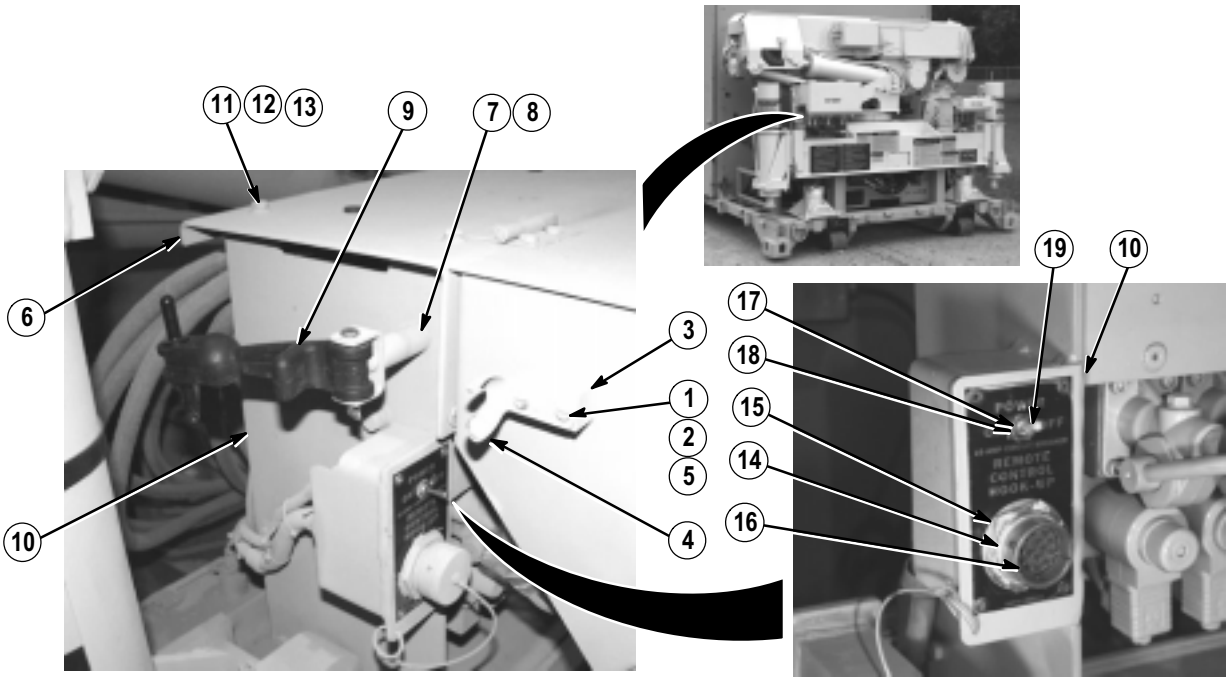
(2) Remove screw (7), lockwasher (8) and rubber latch (9) from left side bracket (10). Discard lockwasher.

(3) Repeat Steps (1) and (2) for other side of control valve.

(4) Remove four screws (11), lockwashers (12), washers (13), and cover (6). Discard lockwashers.

(5) Remove nut (14), washer (15), and remote control power cable (16) from left side bracket (10). Discard lockwasher.

(6) Remove nut (17), lockwasher (18), and crane main power switch (19) from left side bracket (10).



3-31. FIVE FUNCTION CONTROL VALVE MOUNTING BRACKET REPLACEMENT (Continued)

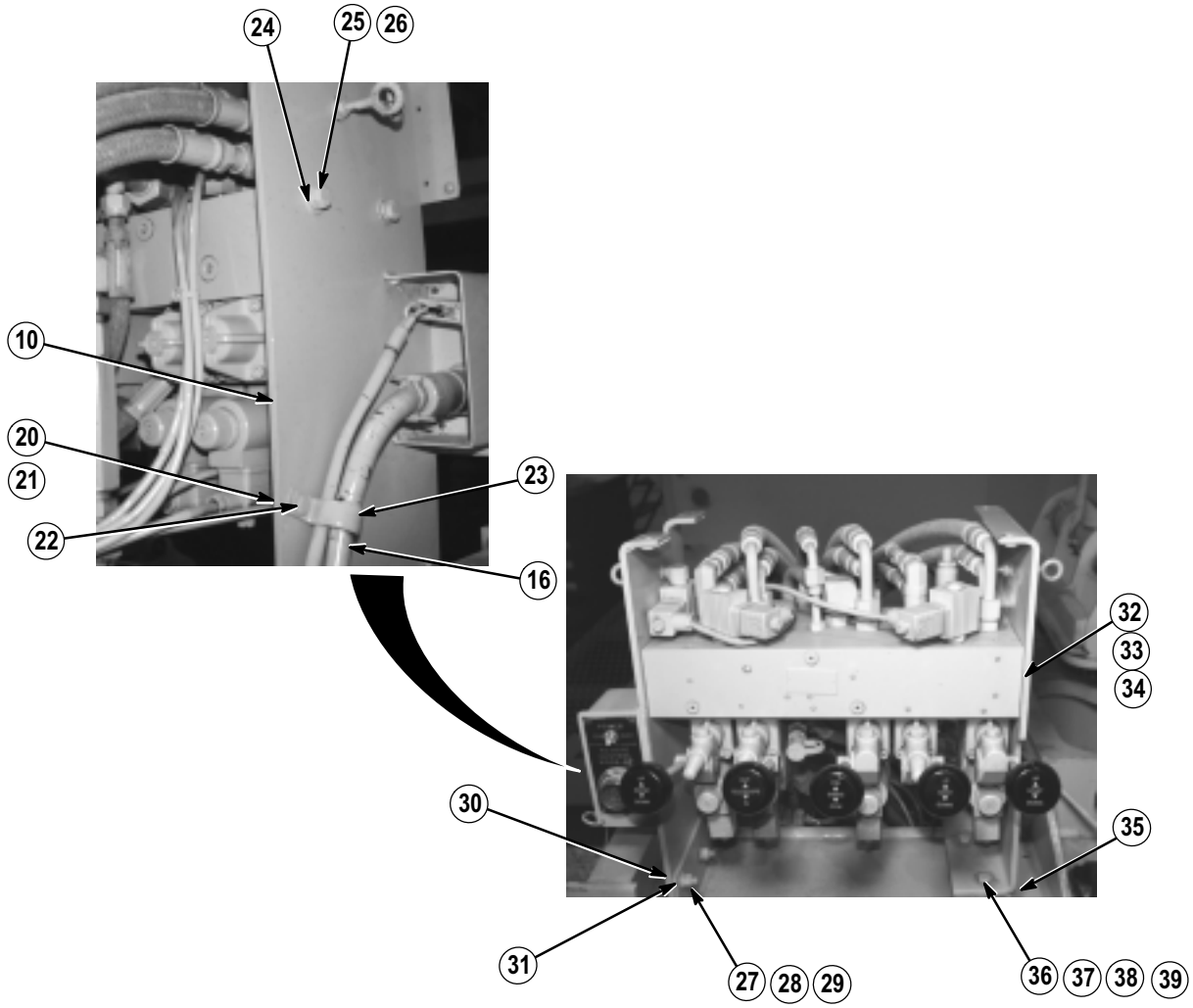
(7) Remove nut (20), washer (21), screw (22) and clamp (23) for remote control power cable (16).

(8) Remove two bolts (24), lockwashers (25), washers (26) from left side bracket (10). Discard lockwashers.

(9) Remove three nuts (27), lockwashers (28), washers (29), screws (30), and left side bracket (10) from base (31). Discard lockwashers.

(10) Remove two bolts (32), lockwashers (33), and washers (34) from right side bracket (35). Discard lockwashers.

(11) Remove three nuts (36), lockwashers (37), washers (38), screws (39) and right side bracket (35) from base (31). Discard lockwashers.



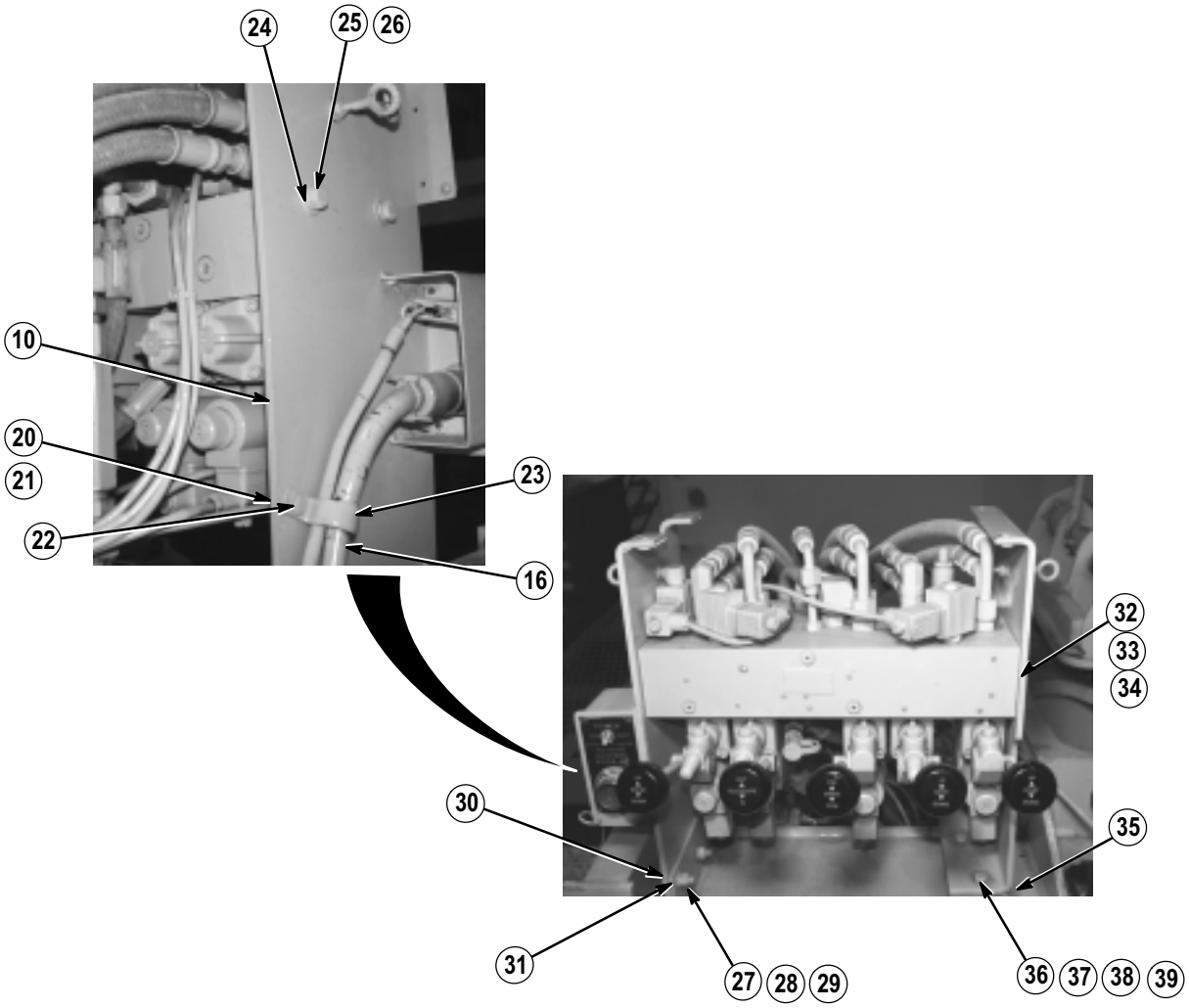
b. Installation

(1) Install right side bracket (35) on base (31) using three screws (39), washers (38), lockwashers (37), and nuts (36).

(2) Install two bolts (32), lockwashers (33), and washers (34) in right side bracket (35).

(3) Install left side bracket (10) on base (31) using three screws (30), washers (29), lockwashers (28), and nuts (27).

(4) Install two bolts (24), lockwashers (25), and washers (26) in left side bracket (10).



3-31. FIVE FUNCTION CONTROL VALVE MOUNTING BRACKET REPLACEMENT (Continued)

(5) Install remote control power cable (16) in left side bracket (10) using washer (15) and nut (14).

(6) Install clamp (23) on remote control power cable (16) using screw (22), washer (21), and nut (20).

(7) Install crane main power switch (19) in left side bracket (10) using lockwasher (18) and nut (17).

(8) Install cover (6) using four washers (13), lockwashers (12), and screws (11).

(9) Install rubber latch (9) on left side bracket (10) using lockwasher (8) and screw (7).

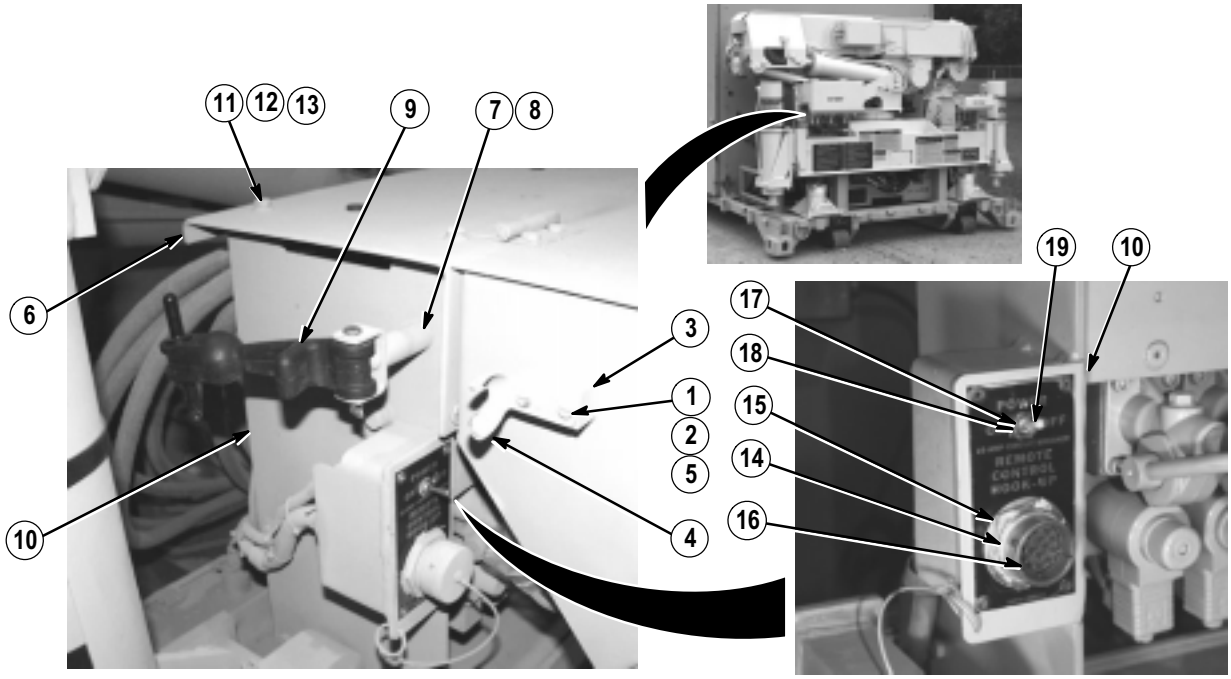
(10) Install spacer plate (3) and anchor bracket (4) on cover (6) using two screws (5), lockwashers (2) and nuts (1).

(11) Repeat Steps (9) and (10) for other side of control valve.

END OF TASK

Follow-On Maintenance

Connect batteries (TM 9-4940-568-10).



3-32. CROSS-RELIEF VALVE REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Hydraulic oil (Item 16, Appendix B)
Primer (Item 22, Appendix B)
Lockwasher (4) (Item 46, Appendix E)
Packing, preformed (Item 73, Appendix E)
Packing, preformed (2) (Item 75, Appendix E)
Packing, preformed (3) (Item 76, Appendix E)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

General Safety Instructions
To avoid personal injury, always assume hydraulic lines have pressure. Slowly crack hydraulic lines open to allow all pressure to escape. Always wear safety glasses.

a. Removal

NOTE

- To aid in later installation, be sure to plug all lines as necessary, and tag all lines and their connection points.
- Place a container to catch hydraulic oil during removal of hydraulic lines.

(1) Remove hose (1) and preformed packing (2) from elbow (3). Discard preformed packing.

(2) Remove tube (4) and preformed packing (5) from adapter (6). Discard preformed packing.

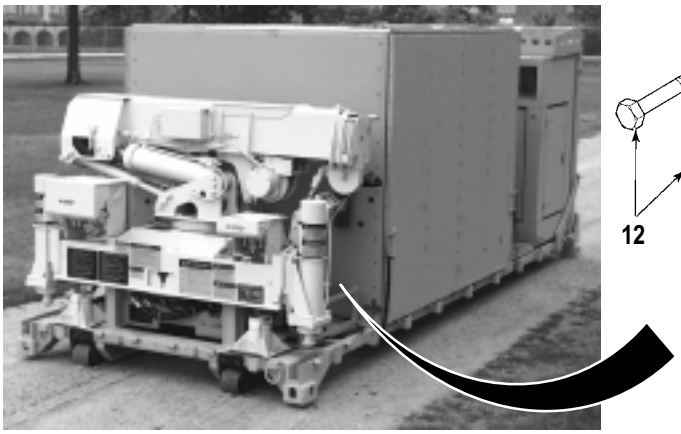
(3) Remove adapter (6) and preformed packing (7) from cross-relief valve (8). Discard preformed packing.

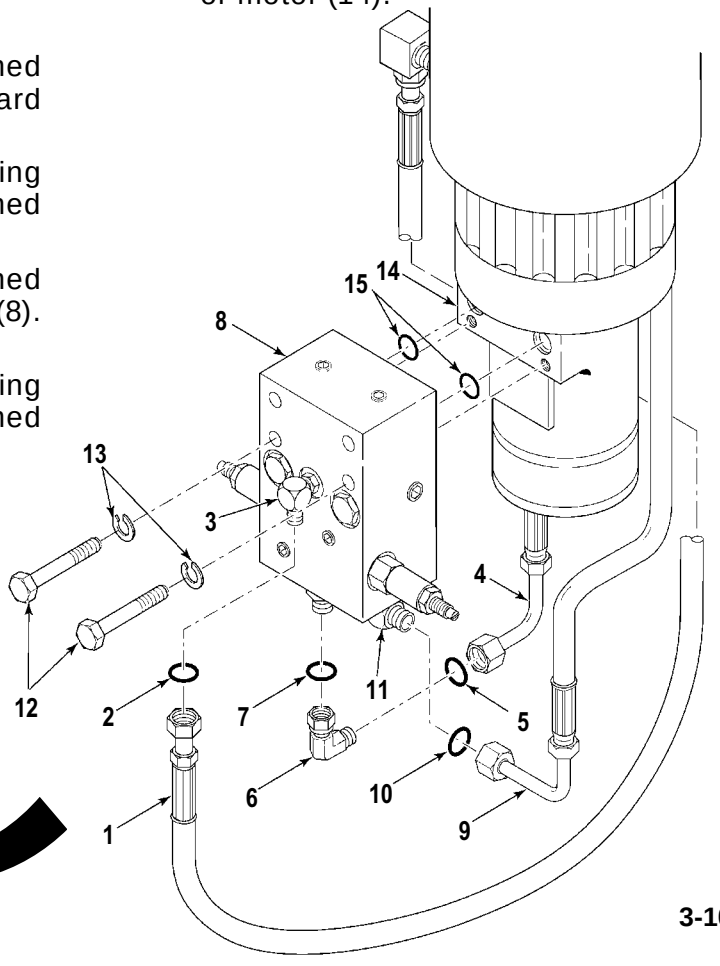
(4) Remove tube (9) and preformed packing (10) from elbow (11). Discard preformed packing.

(5) Remove four screws (12) and lockwashers (13) from cross-relief valve (8). Discard lockwashers.

(6) Remove cross-relief valve (8) from motor (14).

(7) Remove and discard two preformed packings (15) from cross-relief valve (8) or motor (14).





3-32. CROSS-RELIEF VALVE REPLACEMENT (Continued)

b. Installation

NOTE

Lubricate all preformed packings with clean hydraulic oil.

(1) Install two preformed packings (15) on motor (14).

(2) Apply primer to mounting surface of cross relief valve (8), screw heads (12) and lockwashers (13).

(3) Install cross-relief valve (8) on motor (14) with four lockwashers (13) and screws (12).

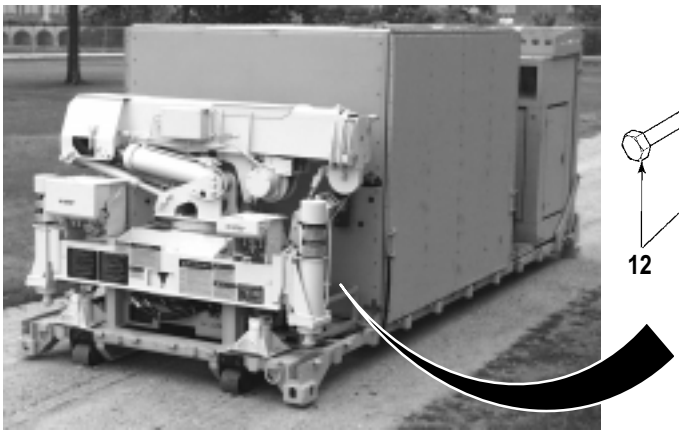
(4) Install preformed packing (10) and tube (9) on elbow (11).

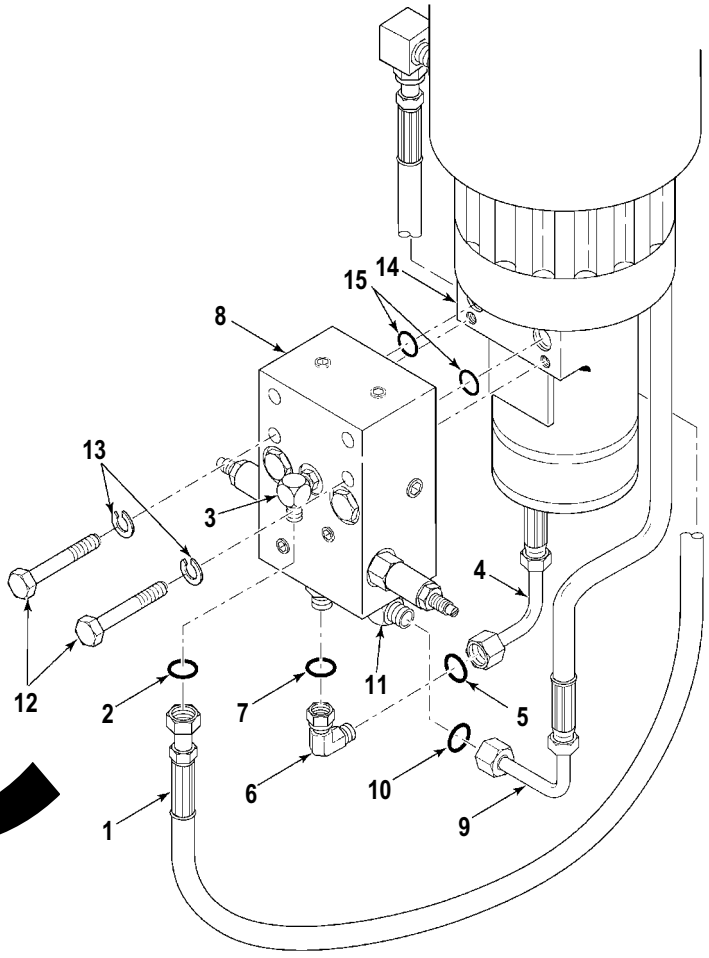
(5) Install preformed packing (7) and adapter (6) on cross-relief valve (8).

(6) Install preformed packing (5) and tube (4) on adapter (6).

(7) Install preformed packing (2) and hose (1) on elbow (3).

END OF TASK





3-33. FIVE FUNCTION CONTROL VALVE BANK REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Gasket (3) (Item 13, Appendix E)
Lockwasher (4) (Item 45, Appendix E)
Lockwasher (4) (Item 47, Appendix E)
Packing, preformed (13) (Item 76, Appendix E)
Packing, preformed (2) (Item 96, Appendix E)
Packing, preformed (5) (Item 120, Appendix E)
Packing, preformed (13)
(Item 126, Appendix E)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Batteries disconnected (TM 9-4940-568-10).

Crane electric solenoid valves disconnected (para 3-37).

a. Removal

WARNING

The hydraulic system operates at high pressures. Never disconnect any hydraulic line or fitting without first dropping pressure to zero. Failure to comply may result in serious injury or death to personnel.

(1) Remove four screws (1), lockwashers (2), washers (3), and cover (4).

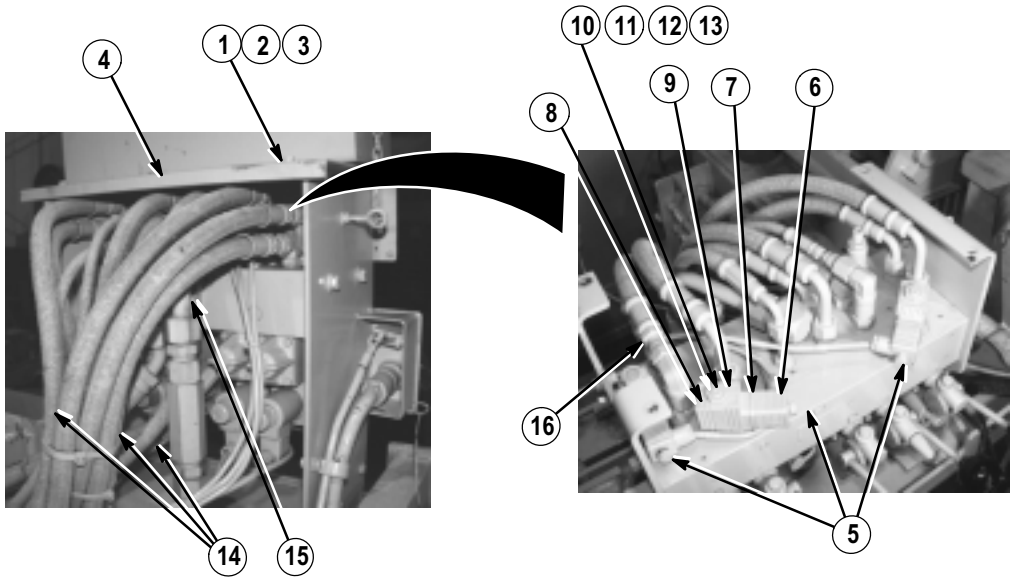
NOTE

Tag and mark all hoses and wires prior to removal.

(2) Loosen three screws (5) and remove connectors (6) and gaskets (7) from solenoids (8).

(3) Remove three nuts (9), solenoids (8), valves (10), preformed packings (11), backup rings (12), and preformed packings (13).

(4) Remove 13 hoses (14), tube (15), and nine preformed packings (16).



3-33. FIVE FUNCTION CONTROL VALVE BANK REPLACEMENT (Continued)

(5) Remove 13 fittings (17) and preformed packings (18) from the crane hydraulic valve manifold (19).

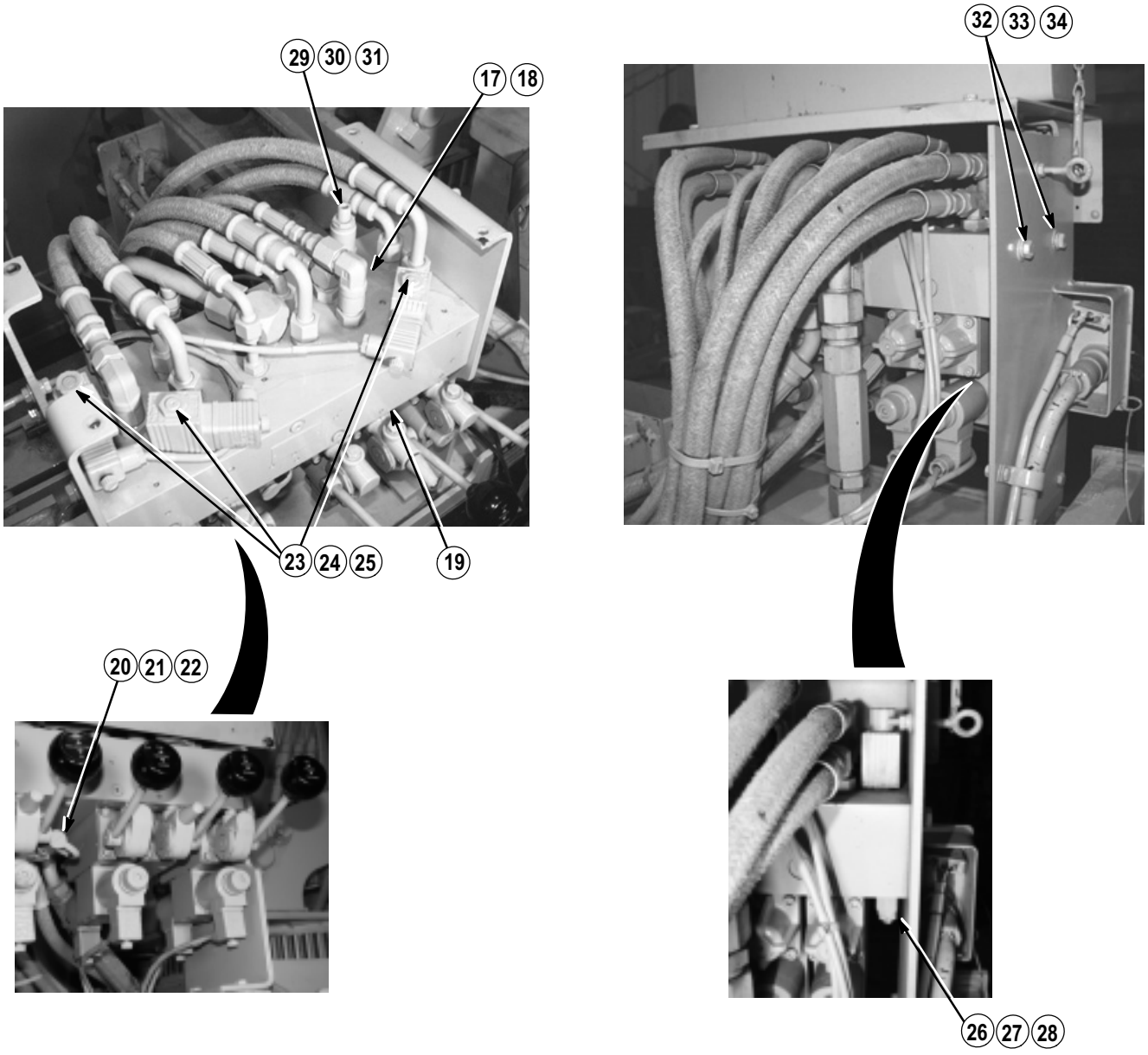
(6) Remove pressure test coupling (20), elbow (21) and preformed packing (22).

(7) Remove three solenoid valves (23), preformed packings (24) and backup rings (25).

(8) Remove relief valve (26), preformed packing (27) and backup ring (28).

(9) Remove pressure valve (29), preformed packing (30) and backup ring (31).

(10) Remove four screws (32), washers (33), lockwashers (34) and crane hydraulic valve manifold (19).



b. Installation

(1) Install crane hydraulic valve manifold (19) using four screws (32), washers (33) and lockwashers (34).

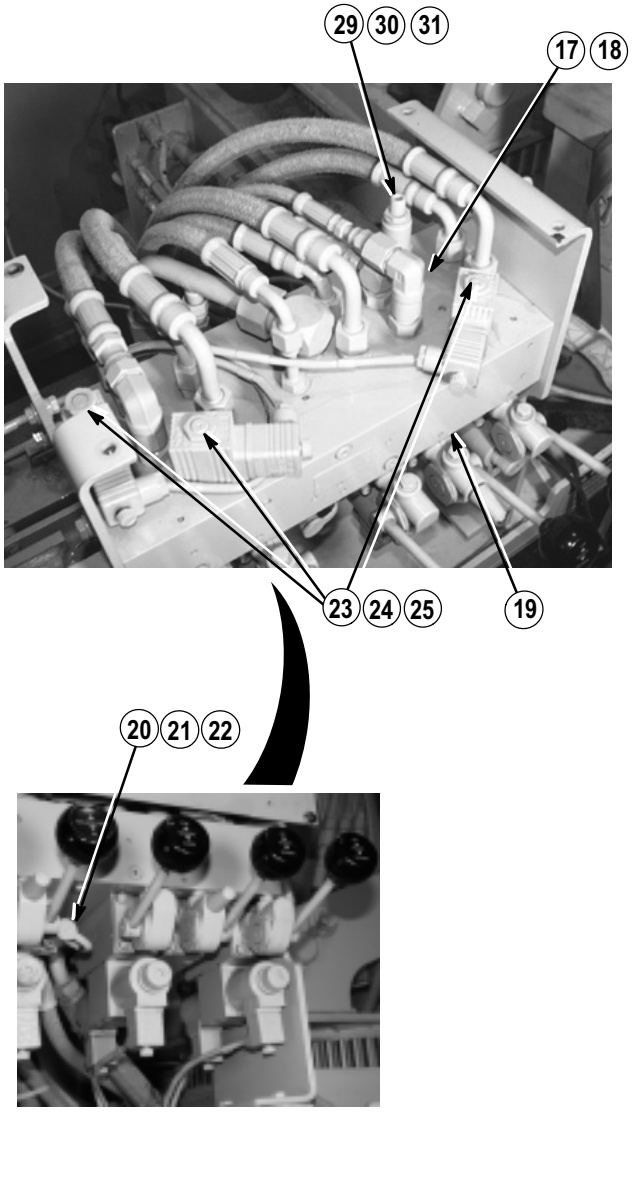
(2) Install preformed packing (30), backup ring (31) and pressure valve (29).

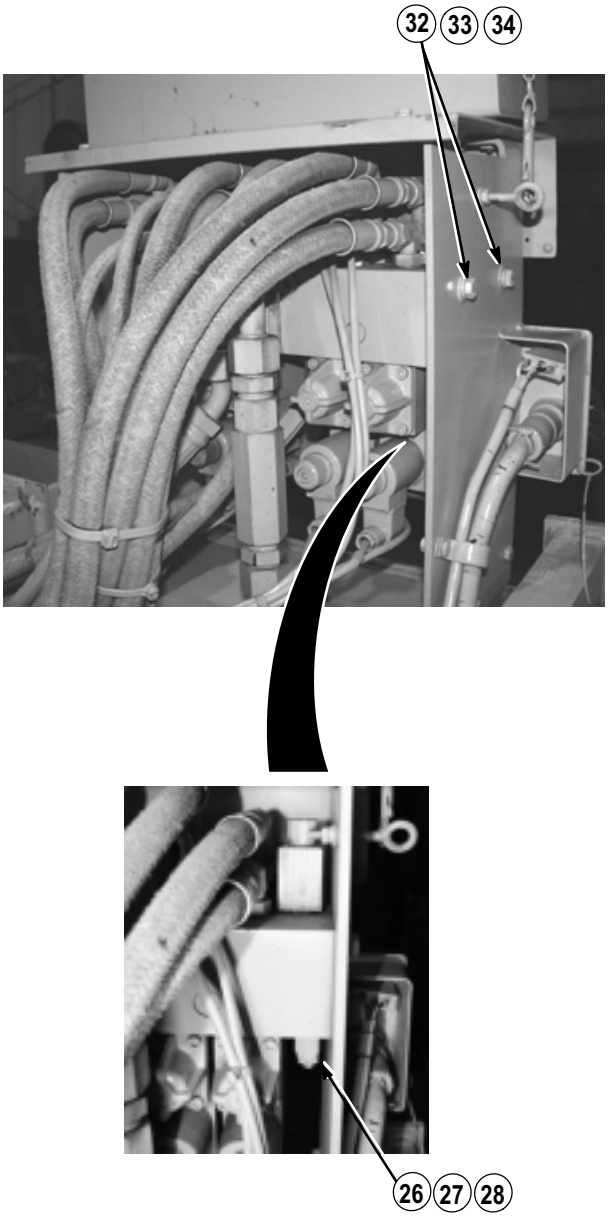
(3) Install preformed packing (27), backup ring (28) and relief valve (26).

(4) Install three preformed packings (24), backup rings (25) and solenoid valves (23).

(5) Install preformed packing (22), elbow (21) and pressure test coupling (20).

(6) Install 13 preformed packings (18) and fittings (17) in crane hydraulic manifold (19).





3-33. FIVE FUNCTION CONTROL VALVE BANK REPLACEMENT (Continued)

(7) Install nine preformed packings (16), tube (15) and 13 hoses (14).

(8) Install three preformed packings (13), backup rings (12), preformed packings (11), valves (10), solenoids (8) and nuts (9).

(9) Install three gaskets (7), position connectors (6) and tighten screws (5) on solenoids (8).

(10) Install cover (4), four washers (3), lockwashers (2) and screws (1).

END OF TASK

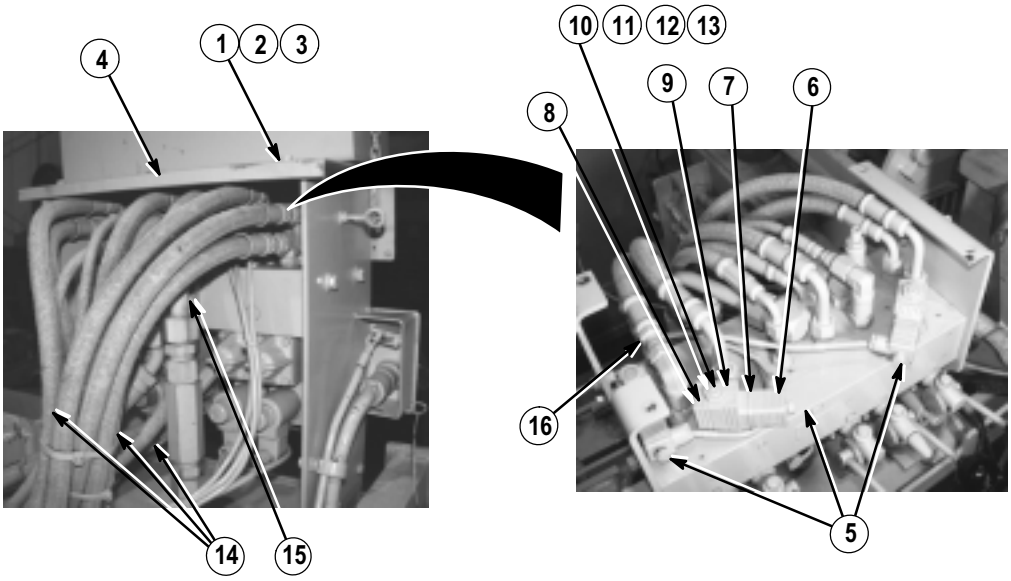
Follow-On Maintenance

Install electric solenoid valves (para 3-37).

Adjust hoist and hydraulic pressure (para 3-41 and 3-42)

Connect batteries (TM 9-4940-568-10).

Check crane for leaks and proper operation (TM 9-4940-568-10).



3-34. THREE FUNCTION MANUAL CONTROL VALVE REPAIR

THIS TASK COVERS:
a. Disassembly
b. Cleaning/Inspection
c. Assembly

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Hydraulic oil (Item 16, Appendix B)
Packing, performed (Item 87, Appendix E)
Packing, performed (2) (Item 107, Appendix E)
Packing, performed (2) (Item 90, Appendix E)
Packing, performed (3) (Item 115, Appendix E)
Packing, performed (9) (Item 118, Appendix E)
Seal kit (Item 154, Appendix E)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Three function manual control valve removed, (para 3-7).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

---

a. Disassembly

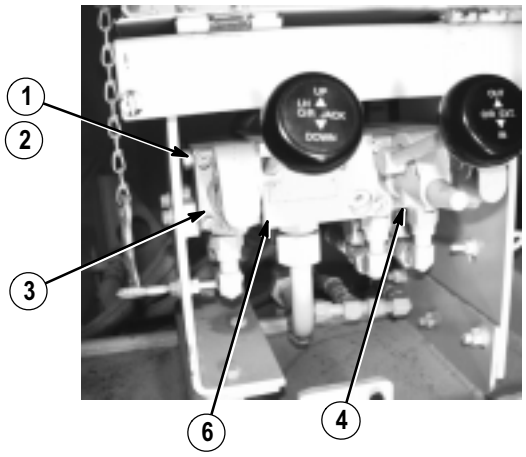
(1) Remove six nuts (1) and three studs (2).

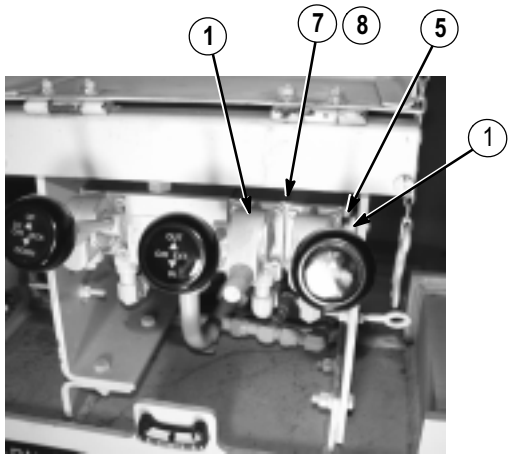
NOTE

- Valves are shown upside down.
- Tag and mark position of valves prior to disassembly.

(2) Separate right-hand outrigger valve (3), outrigger extension valve (4), left-hand outrigger valve (5) and three preformed packings (7) from manifold (6). Discard preformed packings.

(3) Remove and discard nine preformed packings (8) from right-hand outrigger valve (3), outrigger extension valve (4) and left-hand outrigger valve (5).





3-34. THREE FUNCTION MANUAL CONTROL VALVE REPAIR (Continued)

(4) Remove plug (9), preformed packing (10) and shuttle valve (11). Discard preformed packing (10).

(5) Remove and discard backup ring (12) and two preformed packings (13) from shuttle valve (11).

(6) Remove plugs (14 and 15) and preformed packings (16) from manifold (6). Discard preformed packings (16).

b. Cleaning/Inspection

(1) Clean all parts.

(2) Inspect all parts for scoring, pits, rust, gouges, or damage.

(3) Inspect all other parts. Replace all parts failing inspection.

c. Assembly

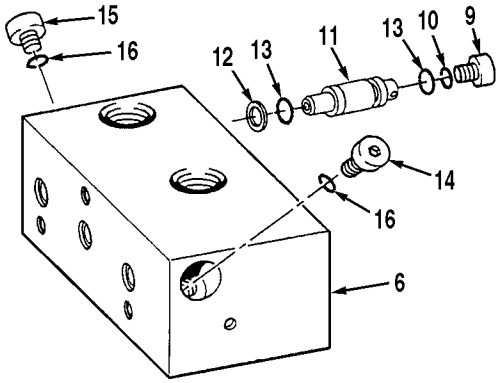
NOTE

Lubricate all preformed packings and backup ring with clean hydraulic oil.

(1) Install two preformed packings (16) and plugs (14 and 15) in manifold (6).

(2) Install two preformed packings (13) and backup ring (12) on shuttle valve (11).

(3) Install shuttle valve (11), preformed packing (10) and plug (9).



(4) Install nine preformed packings (8) on left-hand outrigger valve (5), outrigger extension valve (4) and right-hand outrigger valve (3).

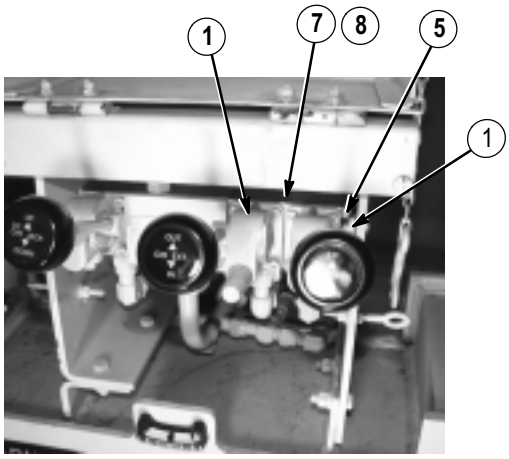
(5) Install three preformed packings (7) and position left-hand outrigger valve (5), outrigger extension valve (4) and right-hand outrigger valve (3) on manifold (6).

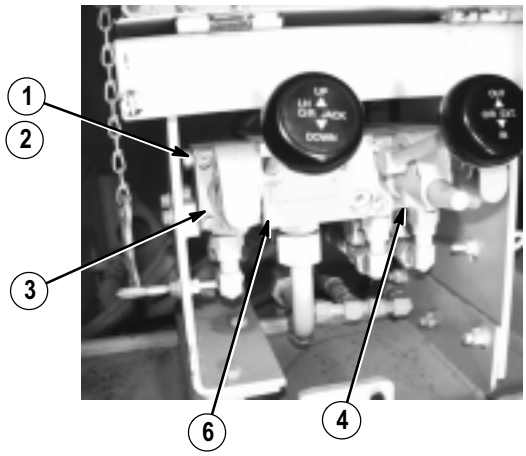
(6) Install three studs (2) through left-hand outrigger valve (5), outrigger extension valve (4) and right-hand outrigger valve (3) with six nuts (1). Tighten six nuts (1) to 11 lb-ft (15 N·m).

END OF TASK

Follow-On Maintenance

Install three function manual control valve (para 3-7).





3-35. CRANE CONTROL VALVES REPAIR

THIS TASK COVERS:
a. Disassembly
b. Cleaning/Inspection
c. Assembly
d. Adjustment

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Hydraulic oil (Item 16, Appendix B)
Sealing compound (Item 29, Appendix B)
Packing, preformed (3)
(Item 119, Appendix E)
Seal kit (Item 157, Appendix E)
Seal, washer (Item 161, Appendix E)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Three function manual control valve removed (para 3-11).

Five function electric control valve removed (para 3-31).

Electric solenoid valves removed (para 3-37).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

---

a. Disassembly

NOTE

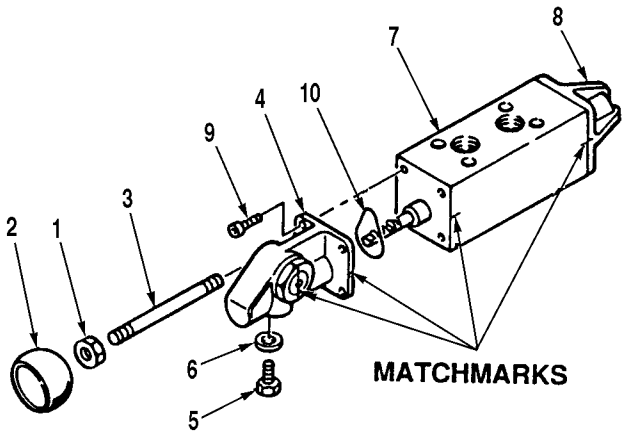
All valve assemblies are disassembled the same way.

(1) Loosen nut (1) and remove knob (2), nut (1), and lever (3) from lever end cap (4).

(2) Remove screw (5) and seal washer (6). Discard seal washer (6).

(3) Matchmark valve body (7), lever end cap (4), and end cap (8).

(4) Remove four allen head screws (9), lever end cap (4), and preformed packing (10) from valve body (7). Discard preformed packing.

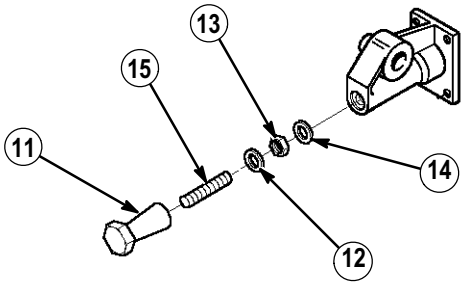


3-35. CRANE CONTROL VALVES REPAIR (Continued)

NOTE

Step 5 only applies to control valves with adjustable spools.

(5) Remove tamper proof cap (11), sealing washer (12), jam nut (13), sealing washer (14) and set screw (15).



NOTE

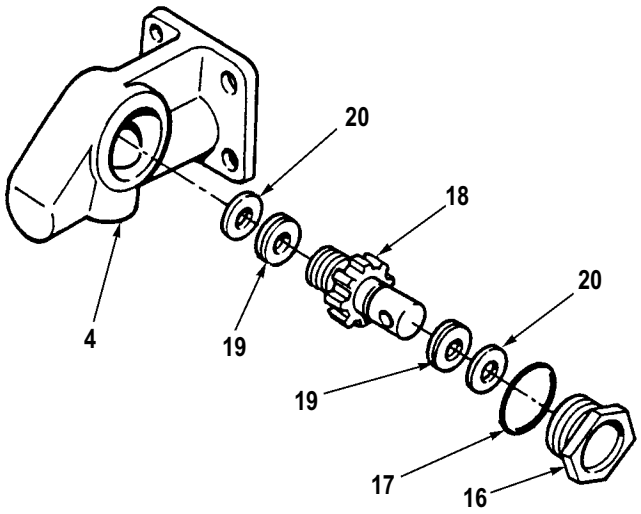
Matchmark pinion (13) before removing.

(6) Remove cap (16), preformed packing (17), and pinion (18) from lever end cap (4). Discard preformed packing.

(7) Remove and discard two quad rings (19) and backup ring (20) from pinion (18).

(8) Remove four allen head screws (21), end cap (8), and preformed packing (22) from valve body (7). Discard preformed packing.

(9) Remove spool assembly (23) from valve body (7).



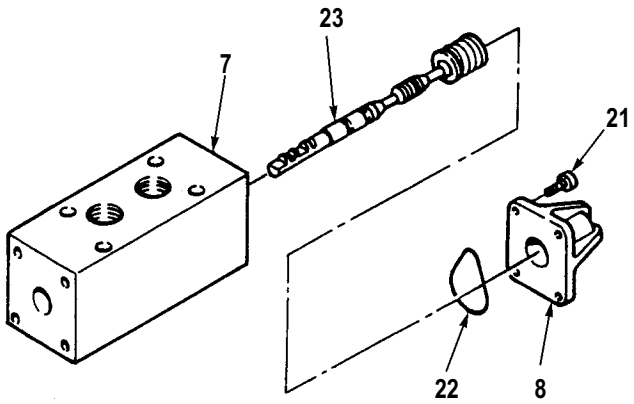
b. Cleaning/Inspection

(1) Clean all parts.

(2) Inspect all parts for scoring, pits, rust, gouges, or damage.

(3) Inspect spool assembly (23) for scoring or damage. If deeply scored or damaged, valve body (7) and spool assembly (23) must be replaced.

(4) Inspect all other parts. Replace all parts failing inspection.



c. Assembly

NOTE

- All valve assemblies are assembled the same way.
- Lubricate all new preformed packings, backup rings, and quad rings with clean hydraulic oil.

(1) Install spool assembly (8) in valve body (7).

(2) Aline matchmarks and install preformed packing (22) and end cap (8) on valve body (7) with four allen head screws (21).

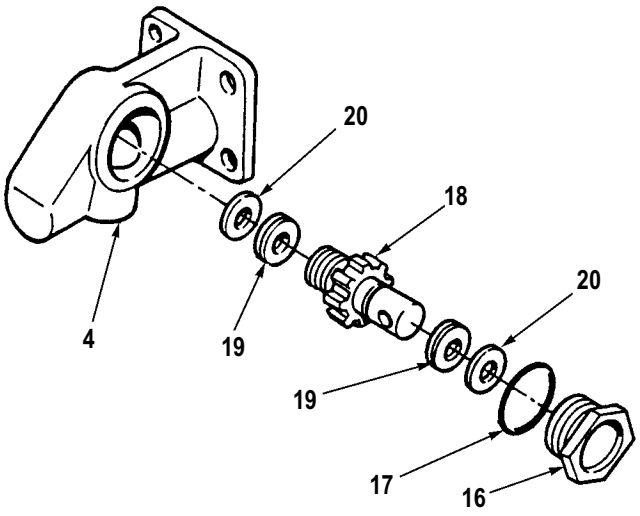
(3) Install two backup rings (20) and quad rings (19) on pinion (18).

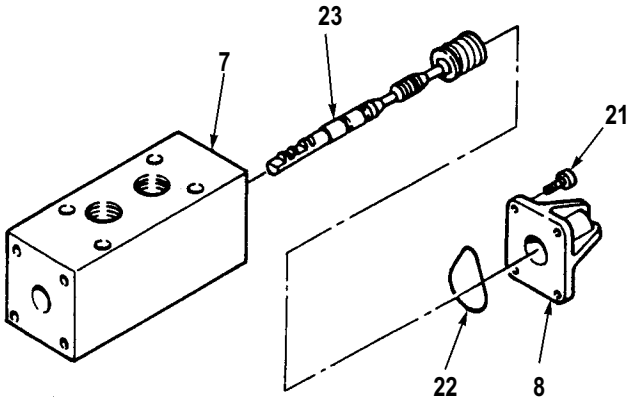
(4) Install pinion (18), preformed packing (17), and cap (16) in lever end cap (4).

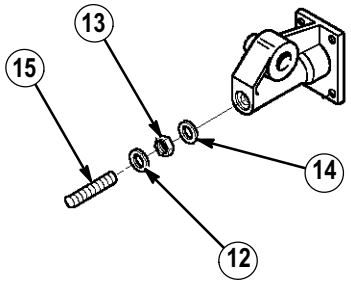
NOTE

Do not install tamper proof cap until adjustment is complete.

(5) Install set screw (15), two sealing washers (12 and 14) and jam nut (13). Do not tighten in end cap (4).







3-35. CRANE CONTROL VALVES REPAIR (Continued)

(6) Aline matchmarks and install preformed packing (10) and lever end cap (4) on valve body (7) with four allen head screws (9).

(7) Install seal washer (6) and screw (5) in lever end cap (4).

(8) Apply sealing compound to threads of lever (3).

(9) Install lever (3), nut (1), and knob (2) on lever end cap (4). Tighten nut (1) against knob (2).

d. Adustment

NOTE

- All control valves must be installed and FRS operational prior to adjustment.
- All control valves are adjusted in the same manner using the approximate time.

(1) Adjust set screw (15) while holding the control valve lever (3) fully in the prescribed direction to obtain the proper time in accordance with the chart below and tighten jam nut (13).

(2) Install tamper proof cap (11) and tighten until nut on the end of cap breaks off.

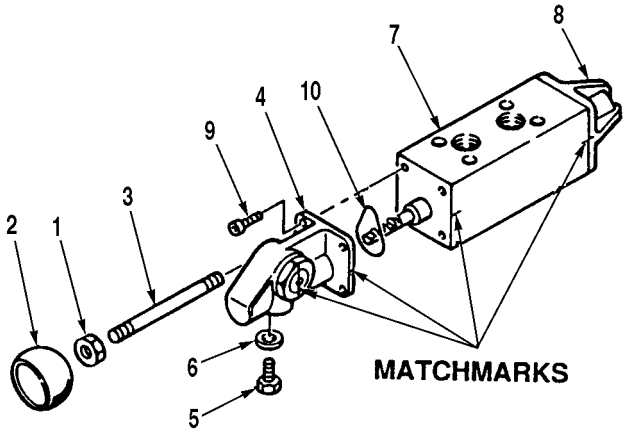
END OF TASK

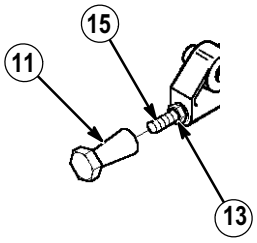
Follow-On Maintenance

Install three function manual control valve (para 3-11).

Install five function manual control valve (para 3-31).

Electric solenoid valves removed (para 3-37).





VALVE	DIRECTION	TIME
Outrigger Extension	Fully Extended	16 sec. ±1 sec.
MAST	Fully Raised	15 sec. ±1 sec.
	Fully Lowered	16 sec. ±1 sec.
Boom*	To Horizontal	26 sec. ±2 sec.
Telescope**	Fully Retracted	20 sec. ±1 sec.

* From Maximum Elevation
** From Fully Extended

3-36. CRANE CONTROL VALVE REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Gasket (5) (Item 118, Appendix E)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Batteries disconnected, (TM 9-4940-568-10).

Crane electric solenoid valve removed, (para 3-37).

---

a. Removal

WARNING

The FRS hydraulic system operates at oil pressure up to 3,500 psi (24, 132 kPa). Never disconnect any hydraulic line or fitting without first dropping the pressure to zero. Failure to comply may result in serious injury or death to personnel.

NOTE

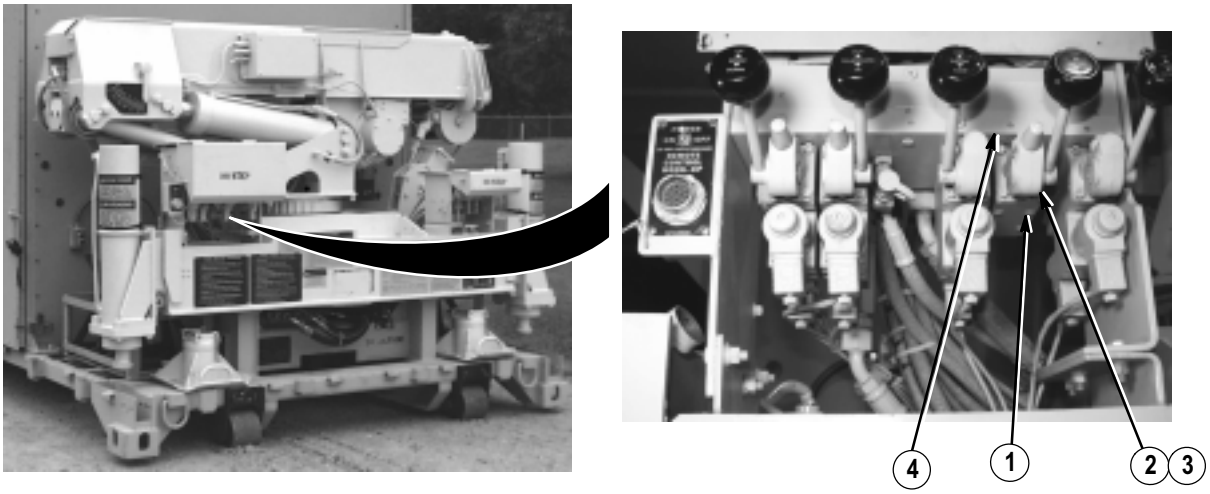
The following procedures apply to both the crane and outrigger control valves.

(1) Remove four screws (1) and control valve (2).

NOTE

Performed packing may stay with manifold or come off with valve.

(2) Remove control valve (2) and five preformed packings (3) from valve manifold (4). Discard preformed packing.



3-36. CRANE CONTROL VALVE REPLACEMENT (Continued)

b. Installation

(1) Position five preformed packings (3) and control valve (2) on valve manifold (4).

(2) Install control valve (2) using four screws (1).

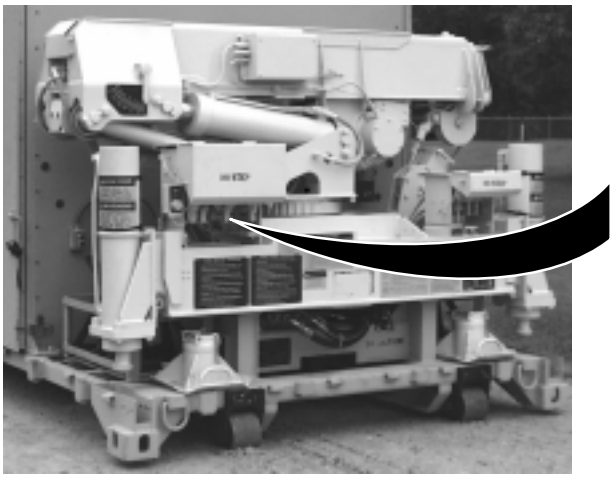
END OF TASK

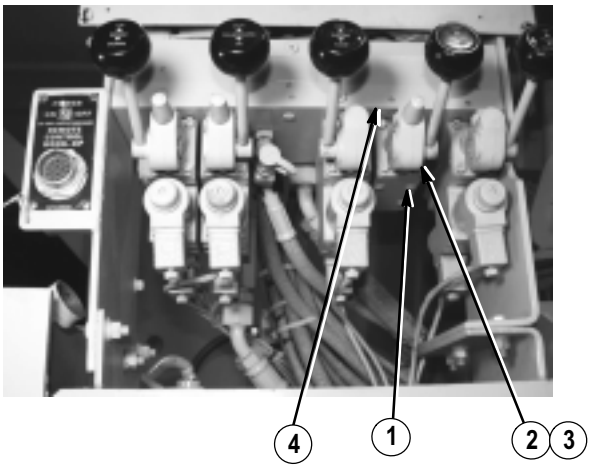
Follow-On Maintenance

Install crane electric solenoid valve (para 3-37).

Connect batteries, (TM 9-4940-568-10).

Check crane for proper operation, (TM 9-4940-568-10).





3-37. CRANE ELECTRIC SOLENOID VALVE REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Gasket (Item 9, Appendix E)
Gasket (Item 13, Appendix E)
Packing, preformed (3)
(Item 116, Appendix E)
Packing, preformed (1)
(Item 117, Appendix E)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Batteries disconnected, (TM 9-4940-568-10).

---

a. Removal

WARNING

The FRS hydraulic system operates at oil pressure up to 3,500 psi (24, 132 kPa). Never disconnect any hydraulic line or fitting without first dropping the pressure to zero. Failure to comply may result in serious injury or death to personnel.

NOTE

- Tag and mark all wires prior to removal.
- All four solenoid valves are removed and replaced the same.

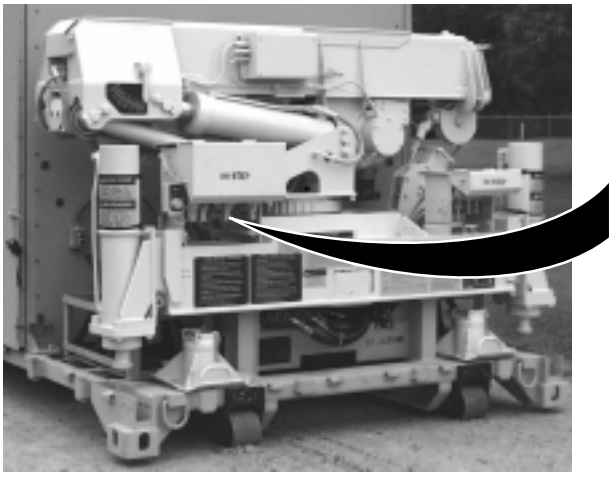
(1) Loosen two screws (1) and remove connector (2) and gaskets (3) from solenoids (4).

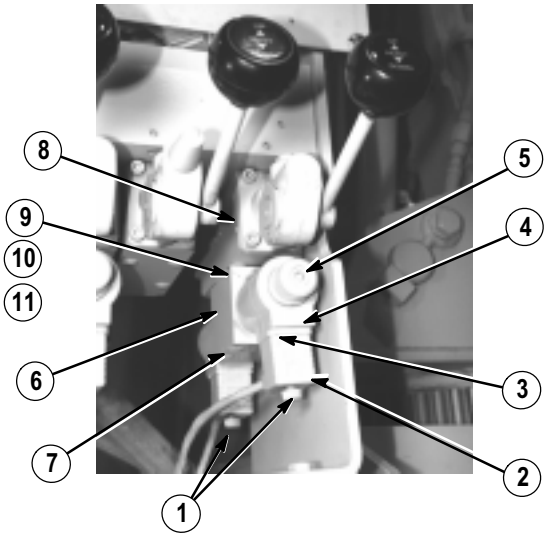
(2) Remove two threaded caps (5) and solenoids (4) from electric solenoid valve (6).

(3) Remove four screws (7) from electric solenoid valve (6).

(4) Remove electric solenoid valve (6) from crane control valve (8).

(5) Remove plate (9) and four performed packings (10 and 11) from crane control valve (8).





3-37. CRANE ELECTRIC SOLENOID VALVE REPLACEMENT (Continued)

b. Installation

(1) Install plate (9) and four new performed packings (10 and 11) on crane control valve (8).

(2) Position electric solenoid valve (6) on crane control valve (8).

(3) Install four screws (7) in electric solenoid valve (6).

(4) Install two solenoids (4) on electric solenoid valve (6) using two threaded caps (5).

(5) Install two connectors (2) and gaskets (3) using screws (1).

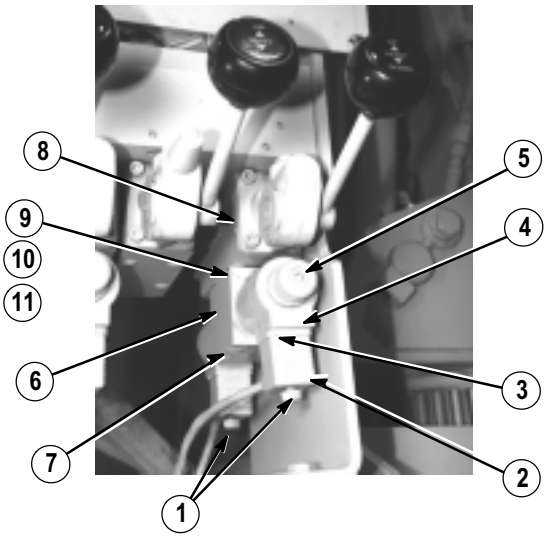
END OF TASK

NOTE

Follow-On Maintenance

Connect batteries, (TM 9-4940-568-10).

Check crane for proper operation, (TM 9-4940-568-10).



3-38. HOIST MOTOR CONTROL VALVE REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Hydraulic oil (Item 16, Appendix B)
Lockwasher (4) (Item 67, Appendix E)
Packing, preformed (2) (Item 80, Appendix E)
Packing, preformed (Item 106, Appendix E)
Packing, preformed (Item 124, Appendix E)
Packing, preformed (Item 125, Appendix E)
Packing, preformed (5) (Item 121, Appendix E)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Holding valve removed (para 3-39).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

General Safety Instructions
To avoid personal injury, always assume hydraulic lines have pressure. Slowly crack hydraulic lines open to allow all pressure to escape. Always wear safety glasses.

---

a. Removal

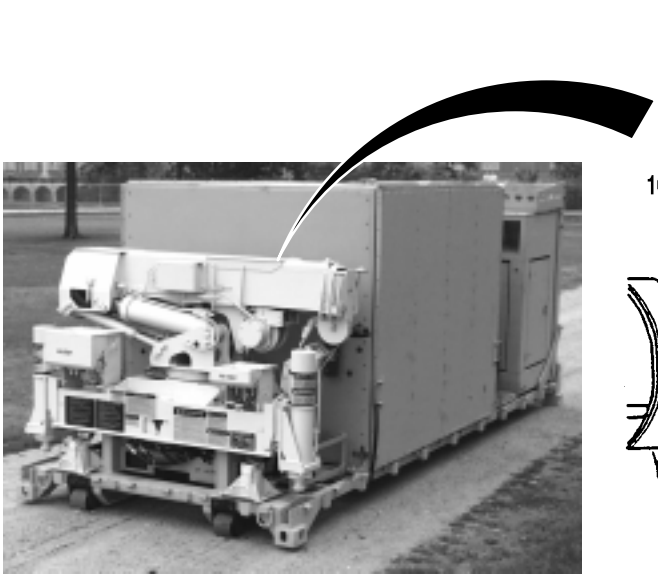
NOTE

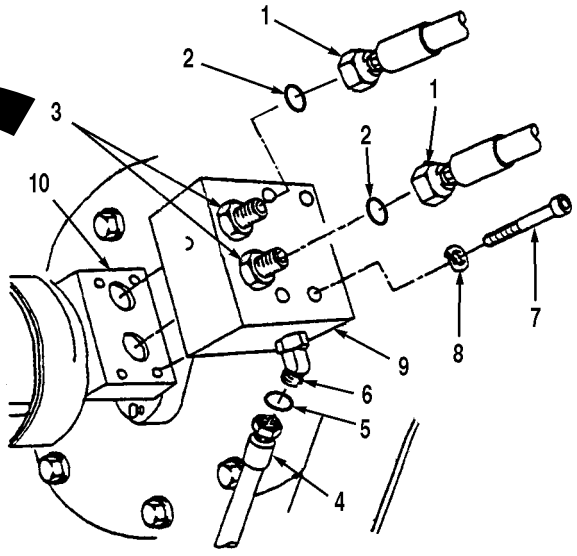
- To aid in later installation, be sure to plug all lines as necessary, and tag all lines and their connection points.
- Place a container to catch hydraulic oil during removal of hydraulic lines.

(1) Disconnect two hoses (1) and preformed packings (2) from fittings (3). Discard preformed packings.

(2) Disconnect hose (4) and preformed packing (5) from fitting (6). Discard preformed packing.

(3) Remove four screws (7), lockwashers (8), and hoist control valve (9) from hydraulic motor (10). Discard lockwashers.





3-38. HOIST MOTOR CONTROL VALVE REPLACEMENT (Continued)

(4) Remove and discard two preformed packings (11) from hoist control valve (9).

(5) Remove two fittings (3) from hoist control valve (9).

(6) Remove and discard two preformed packings (12) from fittings (3).

(7) Remove fitting (6) from hoist control valve (9).

(8) Remove and discard preformed packing (13) from fitting (6).

(9) Remove two plugs (14 and 15) and preformed packings (16 and 17) from hoist control valve (9). Discard preformed packings.

b. Installation

NOTE

Lubricate all preformed packings with clean hydraulic oil.

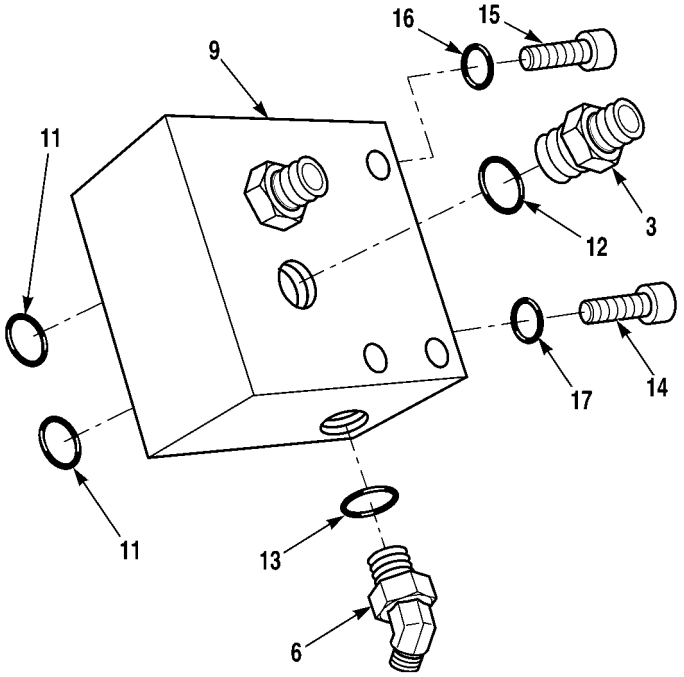
(1) Install two preformed packings (17 and 16) and plugs (15 and 14) in hoist control valve (9).

(2) Install preformed packing (13) on fitting (6).

(3) Install two preformed packings (12) on fittings (3).

(4) Install fitting (6) and two fittings (3) in hoist control valve (9).

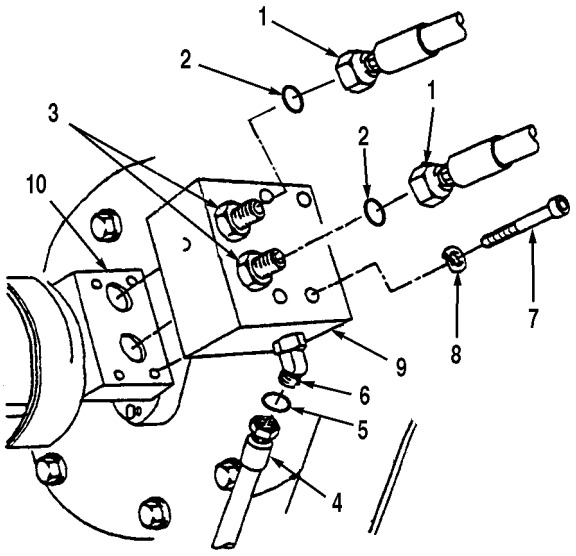
(5) Install two preformed packings (11) on hoist control valve (9).



(6) Install hoist control valve (9) on hydraulic motor (10) with four lockwashers (8) and screws (7).

(7) Install preformed packing (5) and connect hose (4) to fitting (6).

(8) Install two preformed packings (2) and connect two hoses (1) to fittings (3).



END OF TASK

Follow-On Maintenance

Install holding valve (para 3-39).

Check crane for proper operation and hydraulic leaks, (TM 9-4940-568-10).

Load test crane (para 3-5).

3-39. HOIST MOTOR HOLDING VALVE REPLACEMENT

THIS TASK COVERS:
a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Hydraulic oil (Item 16, Appendix B)
Repair kit (Item 137, Appendix E)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Holding valve removed (para 3-39).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

---

a. Removal

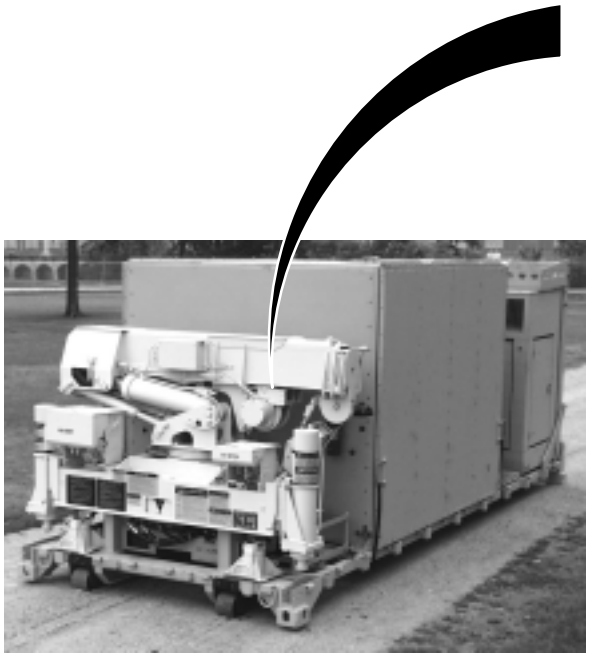
(1) Remove holding valve (1) from hoist control valve (2).

(2) Remove and discard two backup rings (3) and preformed packing (4) from holding valve (1).

(3) Remove and discard preformed packing (5) and backup ring (6) from holding valve (1).

(4) Remove and discard preformed packing (7) from holding valve (1).

(5) Remove and discard orifice (8) from hoist control valve (2).



b. Installation

NOTE

Lubricate all preformed packings and backup rings with clean hydraulic oil.

(1) Install orifice (8) in hoist control valve (2).

(2) Install preformed packing (7) on holding valve (1).

(3) Install backup ring (6) and preformed packing (5) on holding valve (1).

(4) Install two backup rings (3) and preformed packing (4) on holding valve (1).

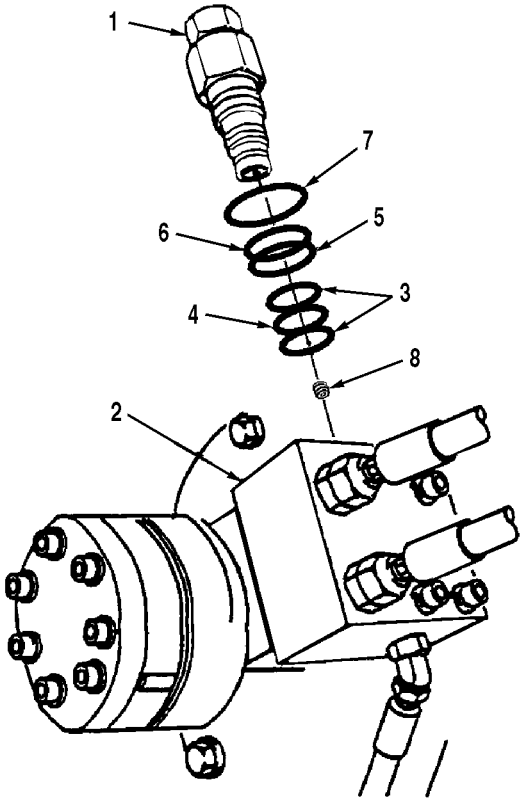
(5) Install holding valve (1) in hoist control valve (2).

END OF TASK

Follow-On Maintenance

Check crane for proper operation and hydraulic leaks, (TM 9-4940-568-10).

Load test crane (para 3-5).



3-40. BOOM ASSEMBLY REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Sealing compound (Item 29, Appendix B)
Packing, preformed (4) (Item 114, Appendix E)
Packing, preformed (Item 121, Appendix E)

Personnel Required
1 Assistant

Equipment Condition
FRS unloaded, crane unstowed
(TM 9-4940-568-10).

Hoist cable removed (para 5-5).

---

a. Removal

NOTE

- To aid in later installation, be sure to plug all lines as necessary, and tag all lines and their connection points.
- Place a container to catch hydraulic oil during removal of hydraulic lines.

(1) Disconnect top electrical connector (1) from overload shutdown box (2).

NOTE

Remove plastic cable ties and cable clamps as required.

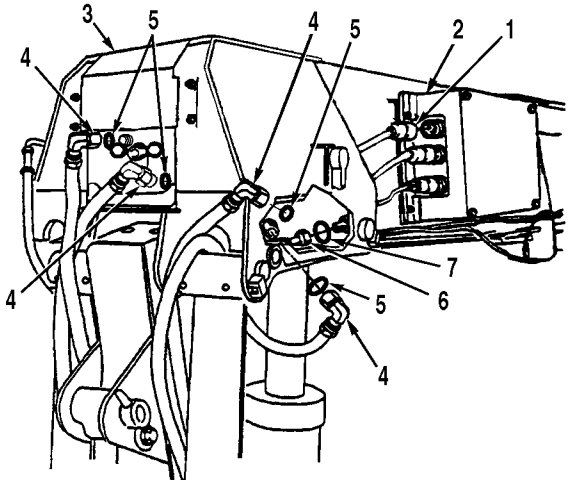
(2) Pull electrical connector (1) clear of boom assembly (3).

NOTE

Two outer hydraulic hoses are accessed from underneath boom.

(3) Disconnect four hoses (4) and preformed packings (5) from boom assembly (3). Discard preformed packings.

(4) Disconnect hose (6) and preformed packing (7) from boom assembly (3). Discard preformed packing.



WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

NOTE

Left and right rivet eyebolts are removed the same way. Right rivet eyebolt shown.

(5) Remove screw (8), washer (9) and bushing (10) from rivet eyebolt (11).

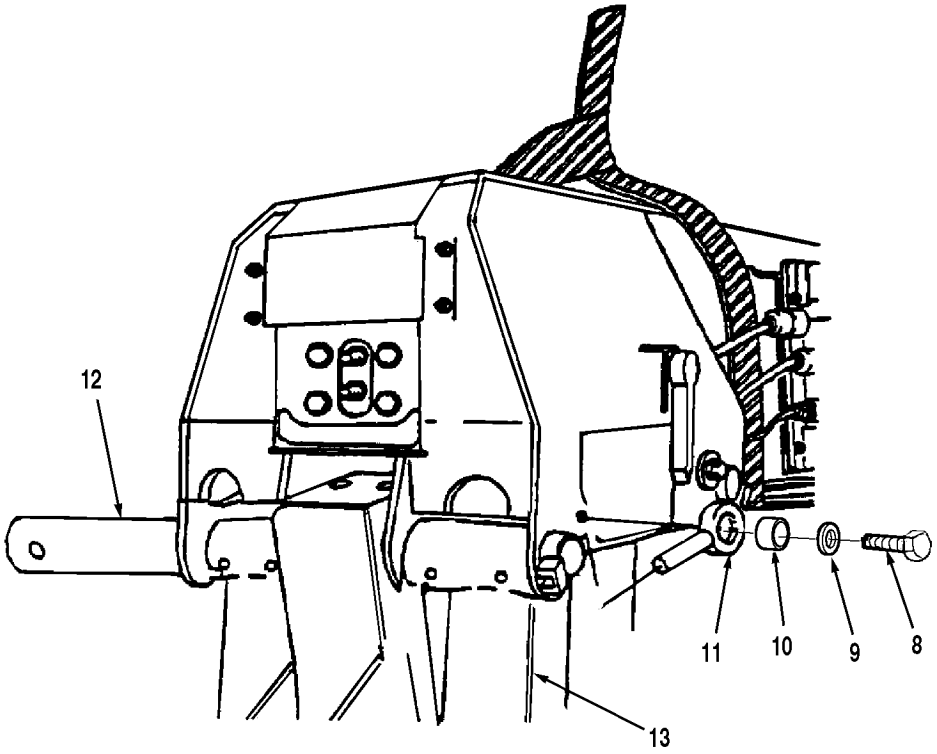
(6) Remove rivet eyebolt (11) from pivot shaft (12).

(7) Perform Steps (5 and 6) on left side rivet eyebolt (10).

WARNING

Remove pivot shaft (12) far enough to release RH tension link cylinder (13). Ensure that tension link cylinder is properly supported. Failure to comply may result in injury to personnel or damage to equipment.

(8) With help from assistant, remove pivot shaft (12) from RH tension link cylinder (13).



3-40. BOOM ASSEMBLY REPLACEMENT (Continued)

WARNING

Remove pivot shaft (12) far enough to release mast (14). Ensure that mast (14) is properly supported. Failure to comply may result in injury to personnel or damage to equipment.

(9) With help from assistant, remove pivot shaft (12) from mast (14).

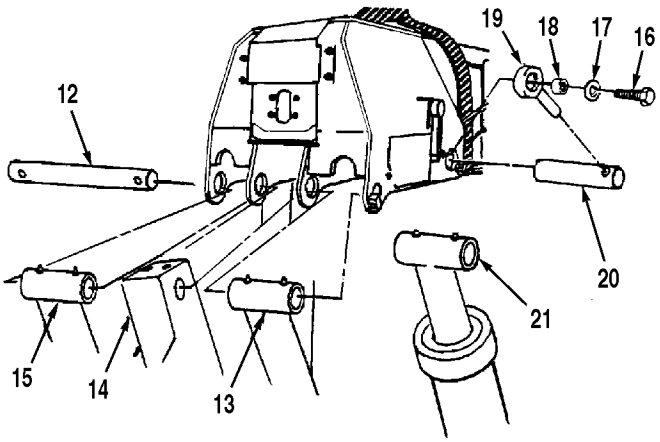
(10) With help from assistant, remove pivot shaft (12) from LH tension link cylinder (15).

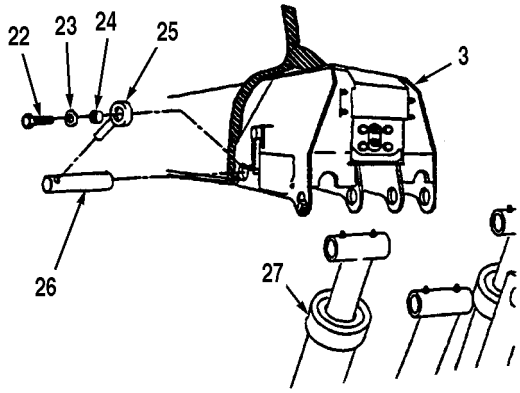
(11) Remove screw (16), washer (17), and bushing (18) from rivet eyebolt (19).

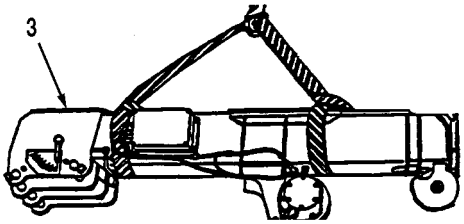
WARNING

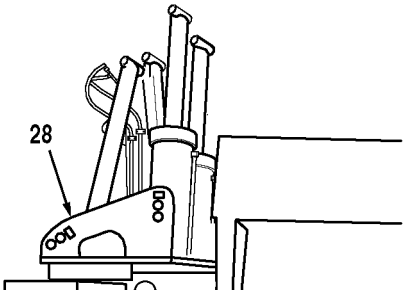
Lift cylinders must be supported to remove pivot shafts (20 and 26). Failure to comply may result in injury to personnel or damage to equipment.

(12) Remove pivot shaft (20) from RH lift cylinder (21).









(13) Remove screw (22), washer (23) and bushing (24) from rivet eyebolt (25).

(14) Remove rivet eyebolt (25) from pivot shaft (26).

(15) Remove pivot shaft (26) from LH lift cylinder (27).

(16) Remove boom assembly (3) from crane (28).

b. Installation

WARNING

To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

(1) Position boom assembly (3) on crane (28).

WARNING

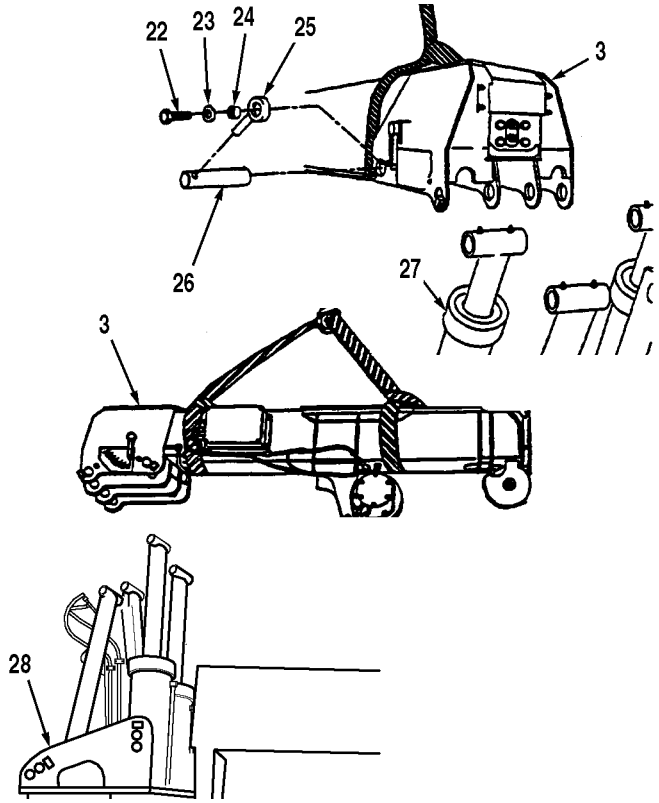
Lift cylinders must be supported to install pivot shafts. Failure to comply may result in injury to personnel or damage to equipment.

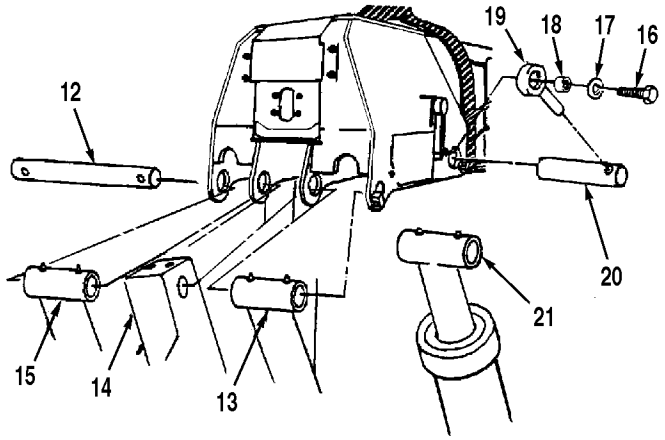
(2) With help from assistant, install LH lift cylinder (27) with pivot shaft (26).

(3) Install rivet eyebolt (25) in pivot shaft (26).

(4) Apply sealing compound to threads of screw (22).

(5) Position bushing (24), washer (23), and screw (22) in rivet eyebolt (25).





(6) Tighten screw to 135 lb-ft (183 N·m).

WARNING

Lift cylinders must be supported to install pivot shafts. Failure to comply may result in injury to personnel or damage to equipment.

(7) With help from assistant, install RH lift cylinder (21) with pivot shaft (20).

(8) Install rivet eyebolt (19) in pivot shaft (20).

(9) Apply sealing compound to threads and head of screw (16).

(10) Position bushing (18), washer (17), and screw (16) in rivet eyebolt (19).

(11) Tighten screw (16) to 135 lb-ft (183 N·m).

(12) With help from assistant, install LH tension link cylinder (15) with pivot shaft (12).

(13) With help from assistant, install mast (14) with pivot shaft (12).

3-40. BOOM ASSEMBLY REPLACEMENT (Continued)

WARNING

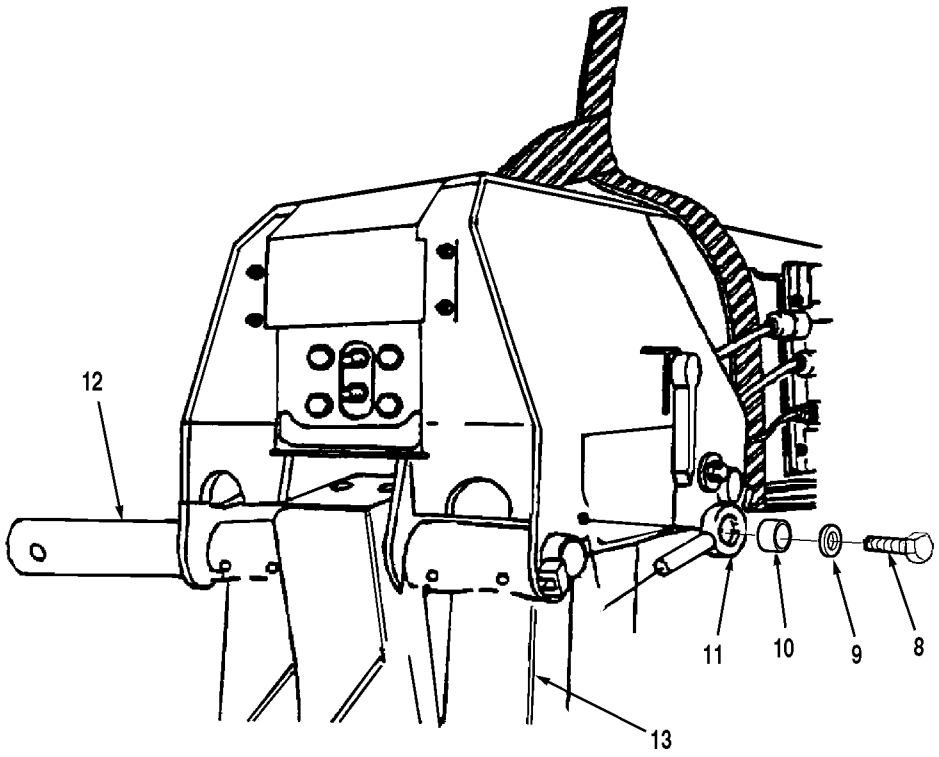
To prevent personal injury, extreme care must be taken to properly handle heavy overhead objects. Make sure all slings and straps are safe to use and are secured properly. Make sure there are no obstacles in the way. Keep clear of all suspended loads.

(14) With help from assistant, install RH tension link cylinder (13) with pivot shaft (12).

(15) Position two rivet eyebolts (11) in pivot shaft (12).

(16) Apply sealing compound to threads of two screws (8).

(17) Position two bushings (10), washers (9), and screws (8) in rivet eyebolts (11).



(18) Tighten two screws (8) to 135 lb-ft (183 N·m).

(19) Connect preformed packing (7) and hose (6) to boom assembly (3).

(20) Connect four preformed packings (5) and hoses (4) to boom assembly (3).

NOTE

Install plastic cable ties and cable clamps as required.

(21) Connect electrical connector (1) to overload shutdown box (2).

END OF TASK

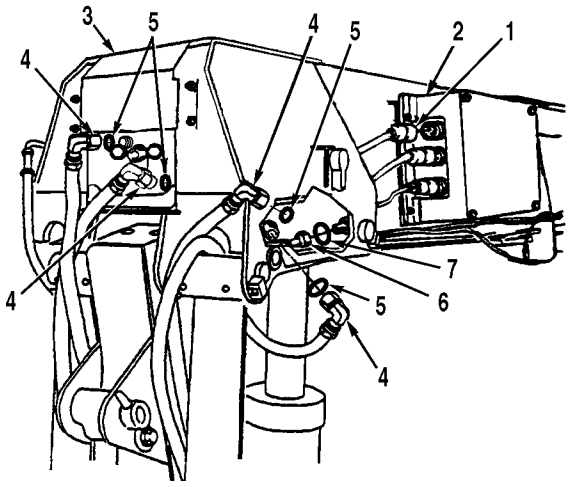
NOTE

Follow-On Maintenance

Lubricate crane, (TM 9-4940-568-10).

Install hoist cable (para 5-5).

Load test crane (para 3-5).



3-41. HOIST HYDRAULIC PRESSURE ADJUSTMENT

THIS TASK COVERS: Adjustment

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Lockwasher (4) (Item 45, Appendix E)
Digital multimeter (Item 12, Appendix F)

Adjustment

NOTE

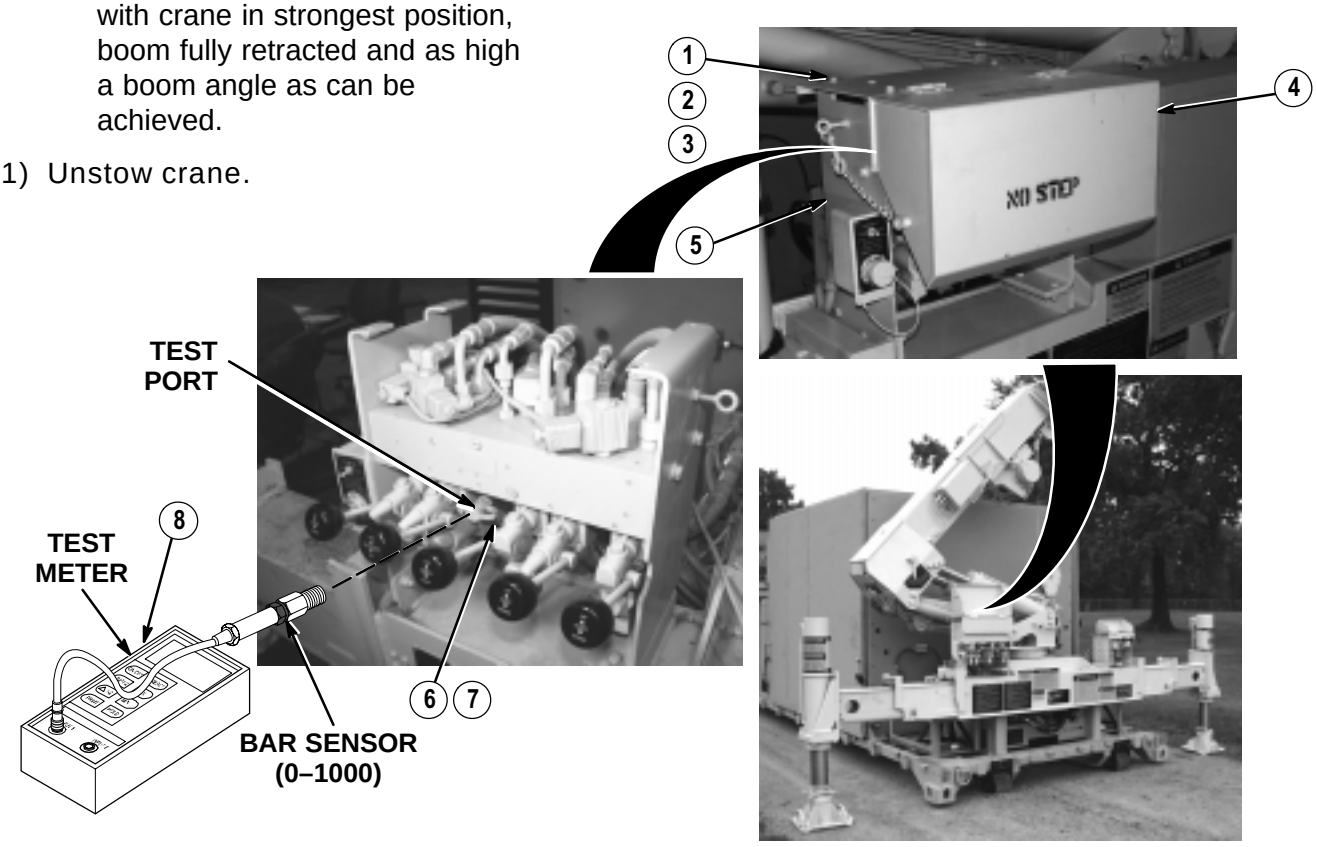
- This procedure requires operation of the crane with power disconnected and operated using manual control levers. Refer to CRANE EMERGENCY PROCEDURE (TM 9-4940-568-10).
- Adjustment should be performed with crane in strongest position, boom fully retracted and as high a boom angle as can be achieved.

(1) Unstow crane.

(2) Remove four screws (1), lockwashers (2), washers (3) and cover (4) from valve mounting brackets (5). Discard lockwashers.

(3) Remove protective cap (6) from test port (7).

(4) Install pressure test meter (8) on test port (7).



(5) Attach crane hook (9) to an immovable object (10).

(6) Loosen jam nut (11).

(7) While operating HOIST control lever in the UP position, adjust internal screw (12) until pressure test meter (8) reads 2300 - 2500 psi (15,862 - 17,241 kPa).

(8) Tighten jam nut (11).

(9) Lower HOIST control lever until crane hook (9) can be removed from immovable object (10).

(10) Remove crane hook (9) from immovable object (10).

(11) Check crane for proper operation and stow crane (TM 9-4940-568-10).

(12) Disconnect pressure test meter (8) from test port (7).

(13) Install protective cap (6) on test port (7).

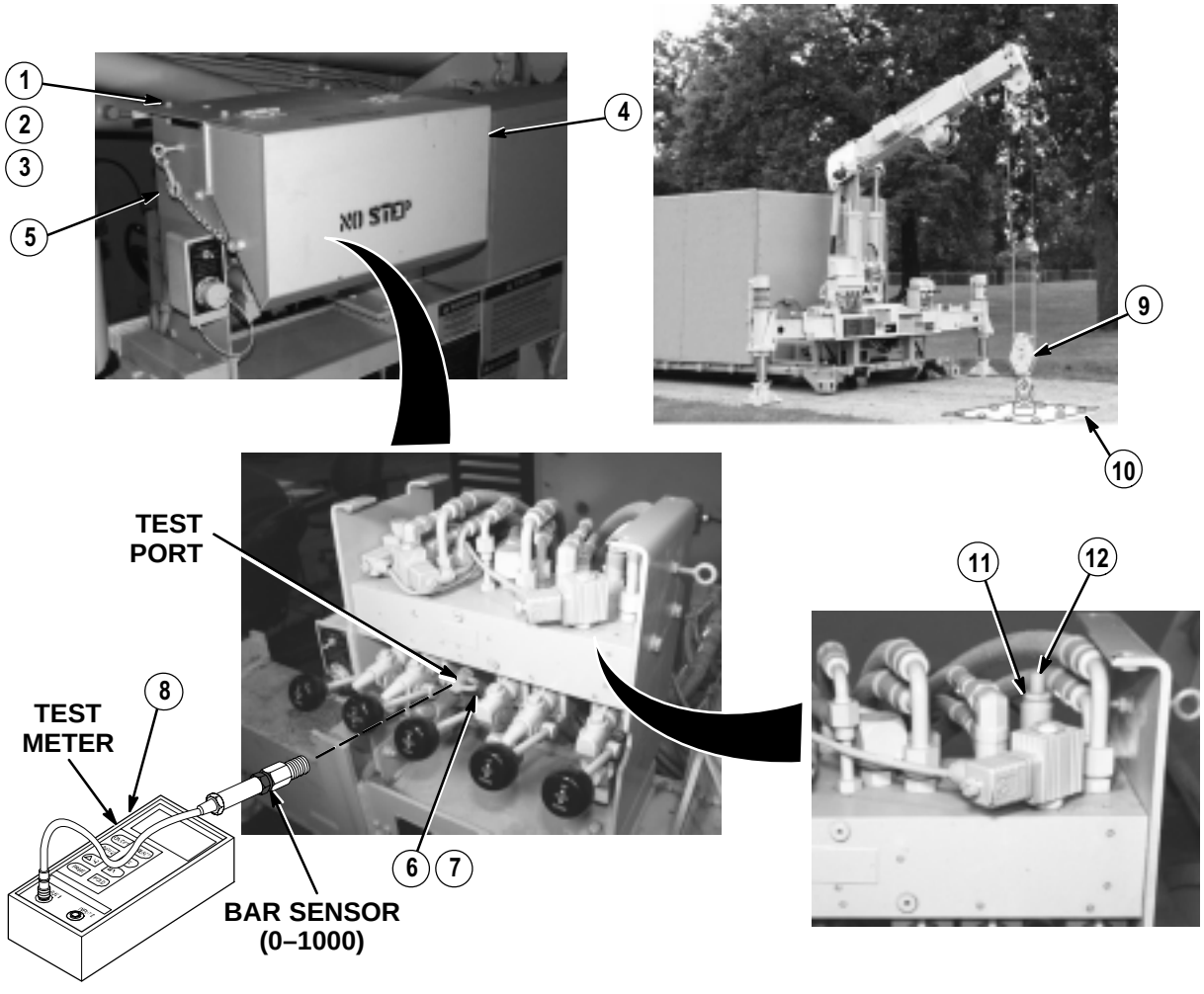
(14) Install cover (4) on valve mounting brackets (5) with four washers (3), lockwashers (2) and screws (1).

END OF TASK

Follow-On Maintenance

Install manual override guard, (Para 3-46).

Stow crane, (TM 9-4940-568-10).



3-42. MAIN HYDRAULIC PRESSURE ADJUSTMENT

THIS TASK COVERS: Adjustment

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Lockwasher (4) (Item 45, Appendix E)
Digital multimeter (Item 12, Appendix F)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Adjustment

(1) Remove four screws (1), lockwashers (2), washers (3) and cover (4) from valve mounting brackets (5). Discard lockwashers.

(2) Remove protective cap (6) and attach test meter (7) to test port (8).

NOTE

Crane must be in stowed position when performing this adjustment. Refer to (TM 9-4940-568-10).

(3) Operate BOOM control lever (9) DOWN.

NOTE

Reading should be 3000 - 3200 psi (20,685 - 22,064 kPa). If reading is not 3000 - 3200 psi (20,685 - 22,064 kPa), perform steps (4) through (7). If reading is 3000 - 3200 psi (20,685 - 22,064 kPa), perform step (8).

(4) Check pressure reading.

(5) Loosen jam nut (10) and adjust screw (11) to lower pressure while operating BOOM control lever (9) DOWN.

(6) Adjust screw (11) to bring pressure up to 3000 - 3200 psi (20,685 - 22,064 kPa).

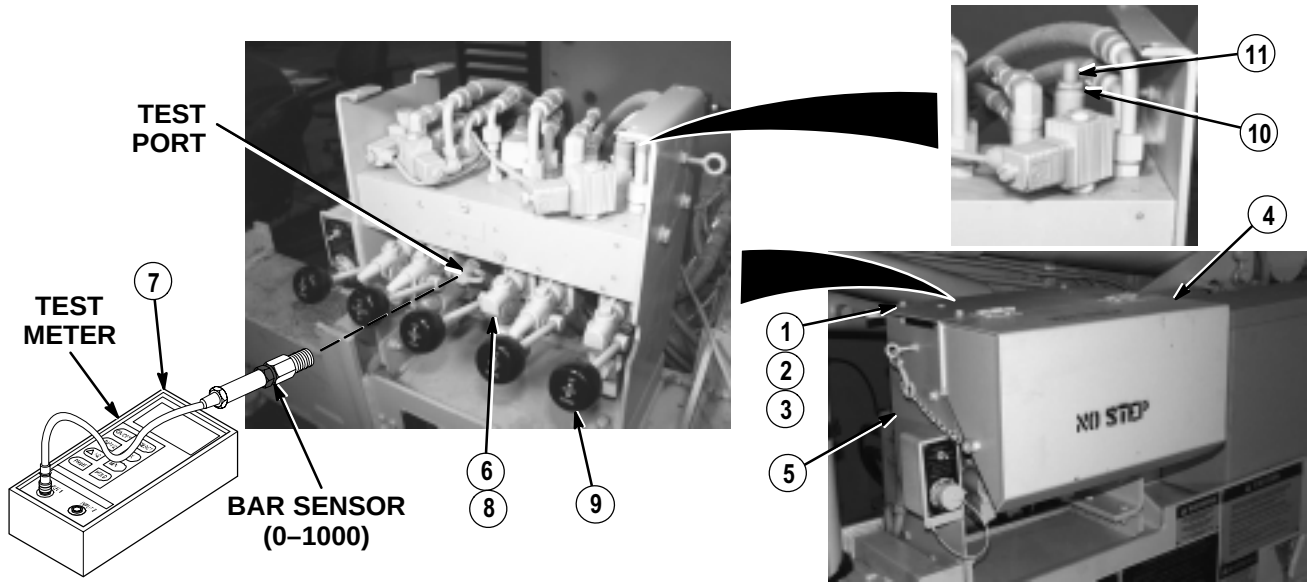
(7) Tighten jam nut (10).

(8) Check crane for proper operation and stow crane (TM 9-4940-568-10).

(8) Remove pressure gage (7) and install protective cap (6).

(9) Install cover (4) on valve mounting brackets (5) with four washers (3), lockwashers (2), and screws (1).

END OF TASK



3-43. CRANE TUBING REPLACEMENT

THIS TASK COVERS: Hydraulic Tubing Locations

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

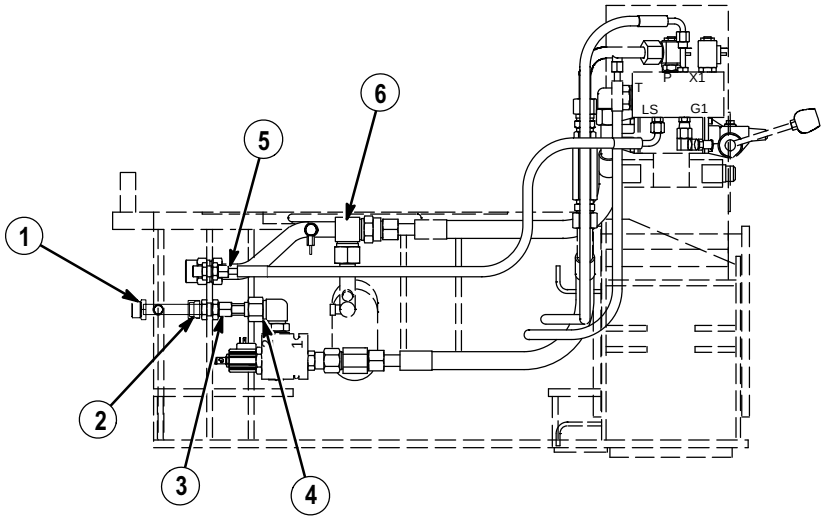
Crane quick disconnects disconnected
(Para 3-4)

General Safety Instructions
To avoid personal injury, always assume hydraulic lines have pressure. Slowly crack hydraulic lines open to allow all pressure to escape. Always wear safety glasses.

Hydraulic Tubing Locations

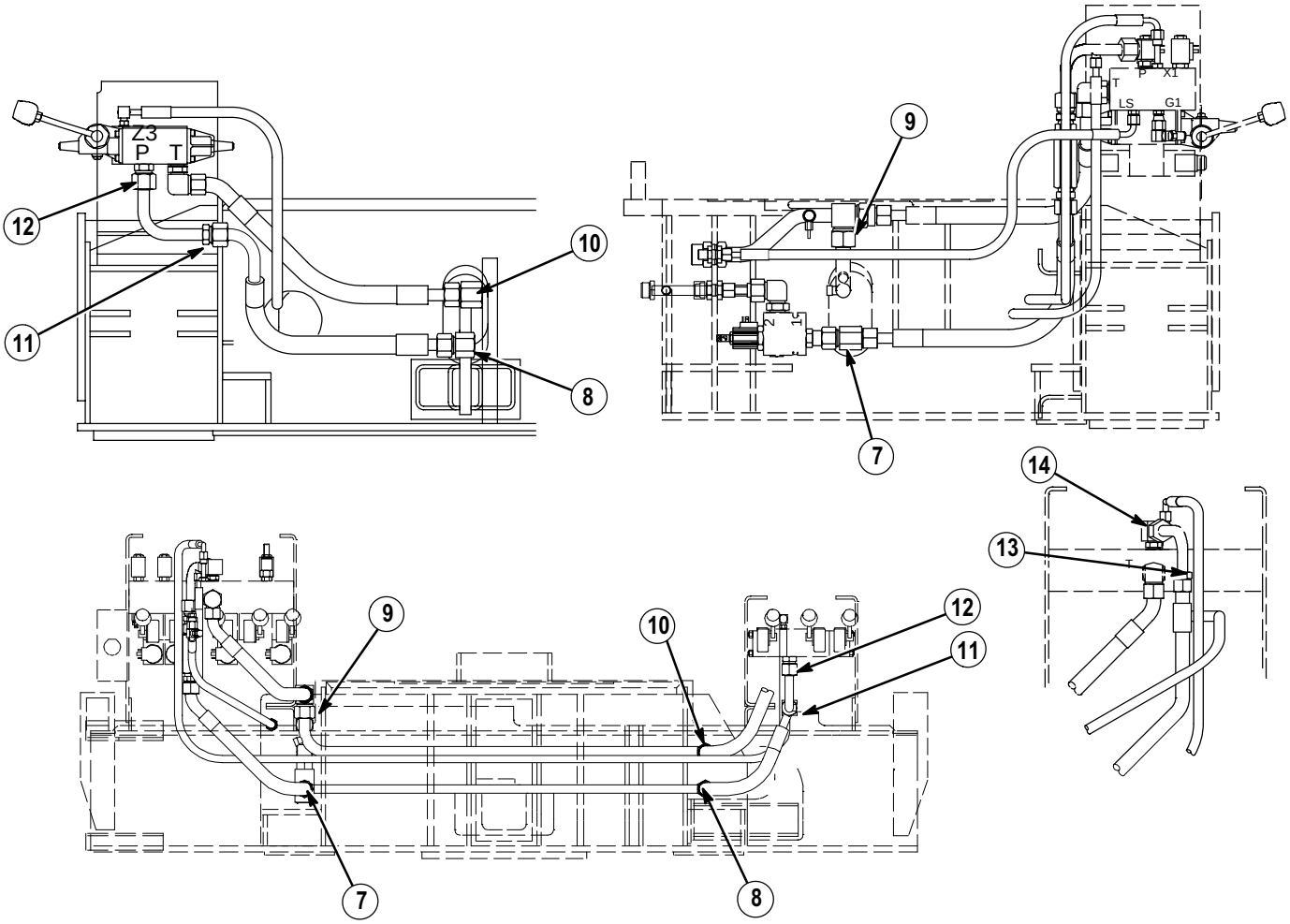
NOTE

- Place a container to catch hydraulic oil during tube removal.
- Plug all tubes after removal to prevent dirt from entering the hydraulic system.
- Tag and mark all tubes prior to removal.
- Note location of plastic cable ties prior to removal.
- Remove plastic cable ties as required.
- Remove clamps and support brackets as required.
- Inspect all tubing and fittings for cracks, kinks, nicks, dents, stripped threads, and cuts. Replace damaged parts.

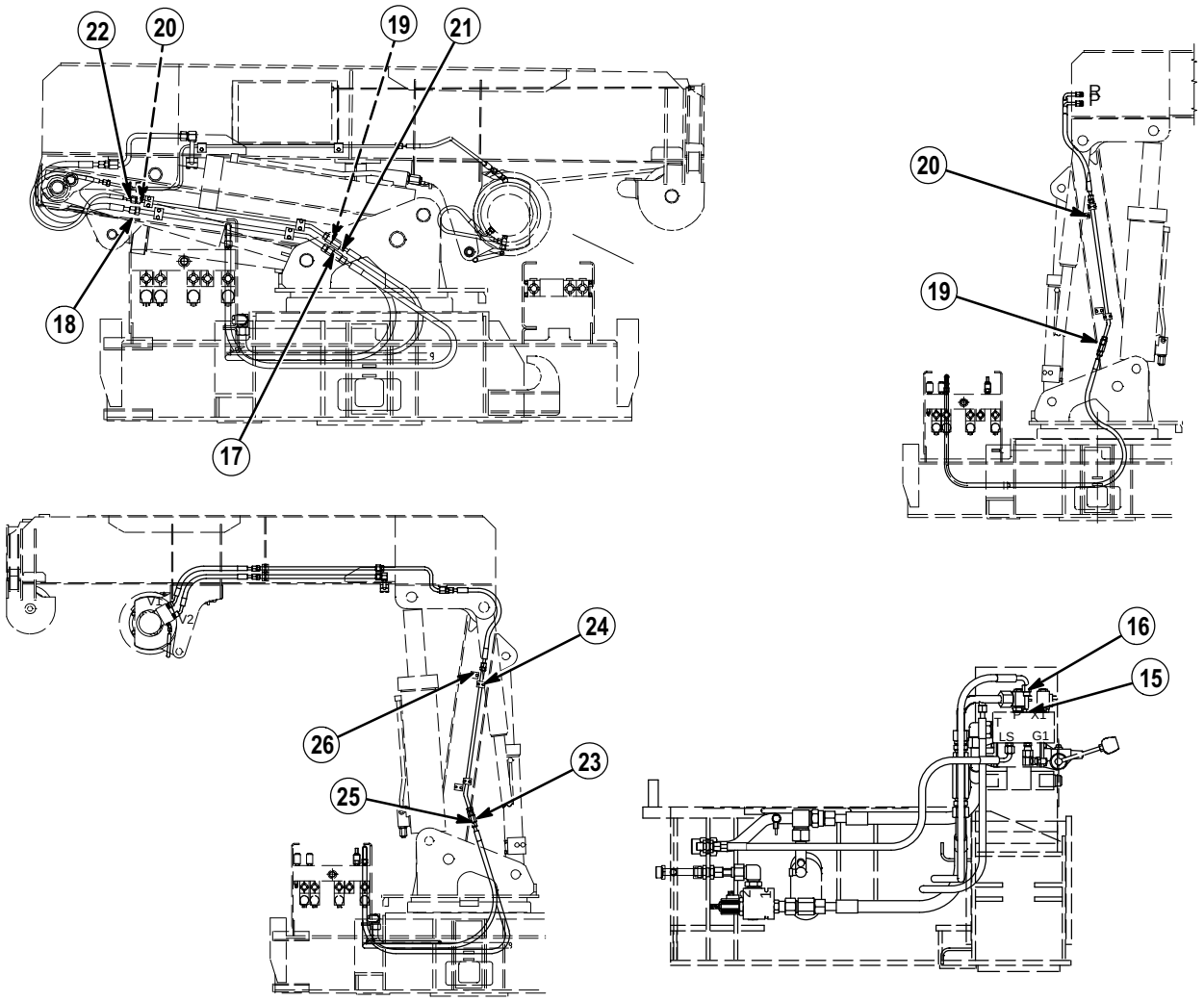


Tube Name	From	To
Main Supply Tube	Pressure inlet connection (1)	Bulkhead fitting (2)
Supply Tube	Bulkhead fitting (3)	Manual override valve fitting (4)
Main Return Tube	Bulkhead fitting (5)	Tee tube end (6)

3-43. CRANE TUBING REPLACEMENT (Continued)

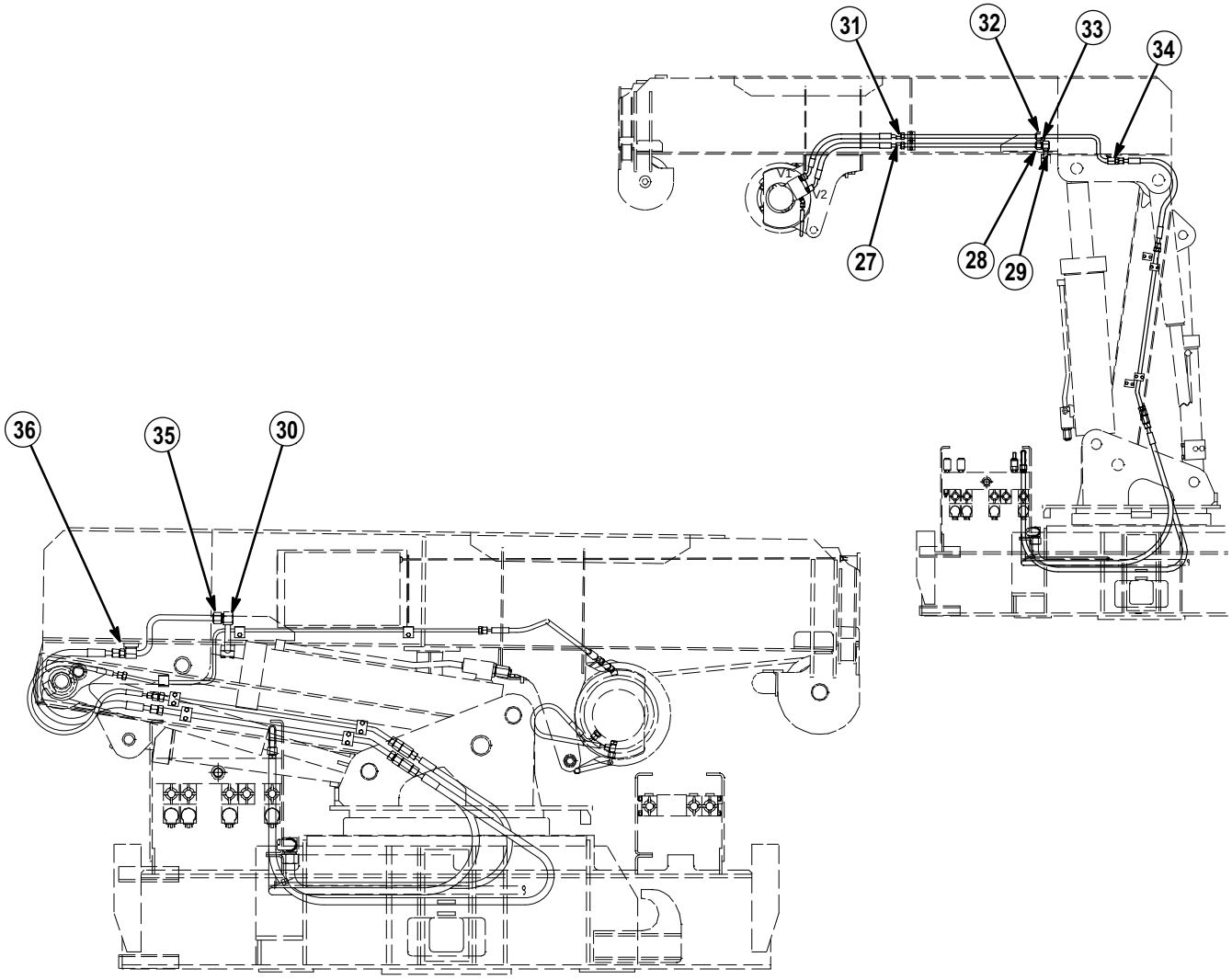


Tube Assembly	M.O. valve fitting (7)	Outrigger valve supply hose fitting (8)
Tube	Tee tube end (9)	Outrigger valve return hose fitting (10)
Tube	Outrigger valve supply hose fitting (11)	Outrigger valve inlet fitting (12)
Tube	Crane valve supply hose fitting (13)	Crane valve inlet fitting (14)



Tube	Crane valve load sense port (15)	Outrigger valve load sense hose fitting (16)
Tube	Right side mast beam bottom fitting right side inner (17)	Right side upper mast fitting right side inner (18)
Tube	Right side mast base bottom fitting inner (19)	Right side upper mast fitting inner (20)
Tube	Right side mast base bottom fitting outside (21)	Right side upper mast fitting outside (22)
Tube	Left side mast base bottom fitting lower hose (23)	Left side upper mast fitting lower hose (24)
Tube	Left side mast base bottom fitting upper hose (25)	Left side upper mast fitting upper hoser (26)

3-43. CRANE TUBING REPLACEMENT (Continued)



Tube Name	From	To
Boom Tube	Hoist boom left tube fitting (27)	Hoist boom left tube fitting (28)
Boom Tube	Hoist boom left welded elbow (29)	Hoist boom right lower welded elbow (30)
Boom Tube	Hoist boom left tube fitting (31)	Hoist boom left tube (32)
Boom Tube	Hoist boom left tube (33)	Hoist boom left tube (34)
Boom Tube	Hoist boom right upper (35)	Hoist boom right (36)

END OF TASK

3-44. CRANE HOSES REPLACEMENT

THIS TASK COVERS: Hydraulic Hose Locations

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Crane quick disconnects disconnected
(Para 3-4)

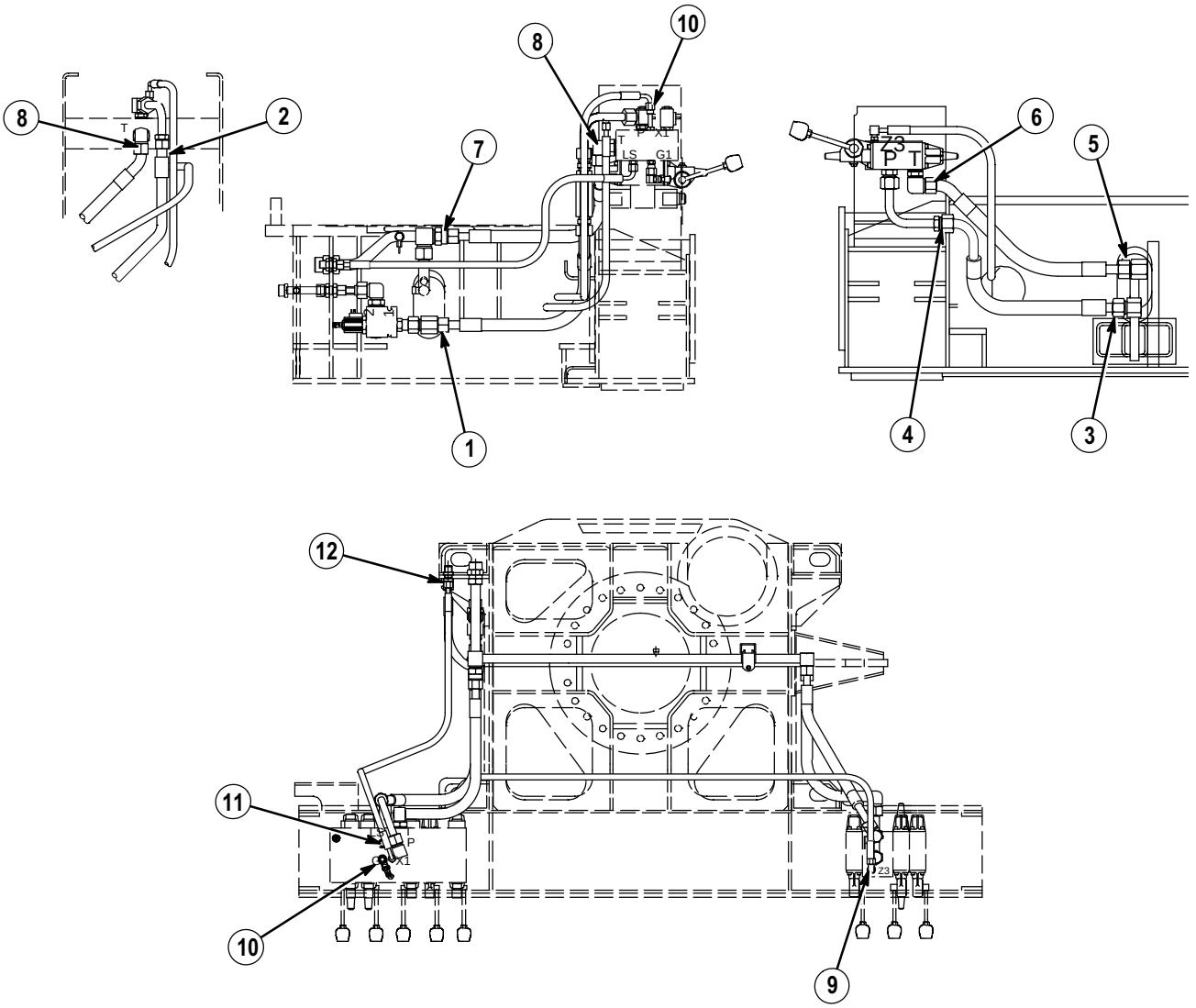
General Safety Instructions
To avoid personal injury, always assume hydraulic lines have pressure. Slowly crack hydraulic lines open to allow all pressure to escape. Always wear safety glasses.

Hydraulic Hose Locations

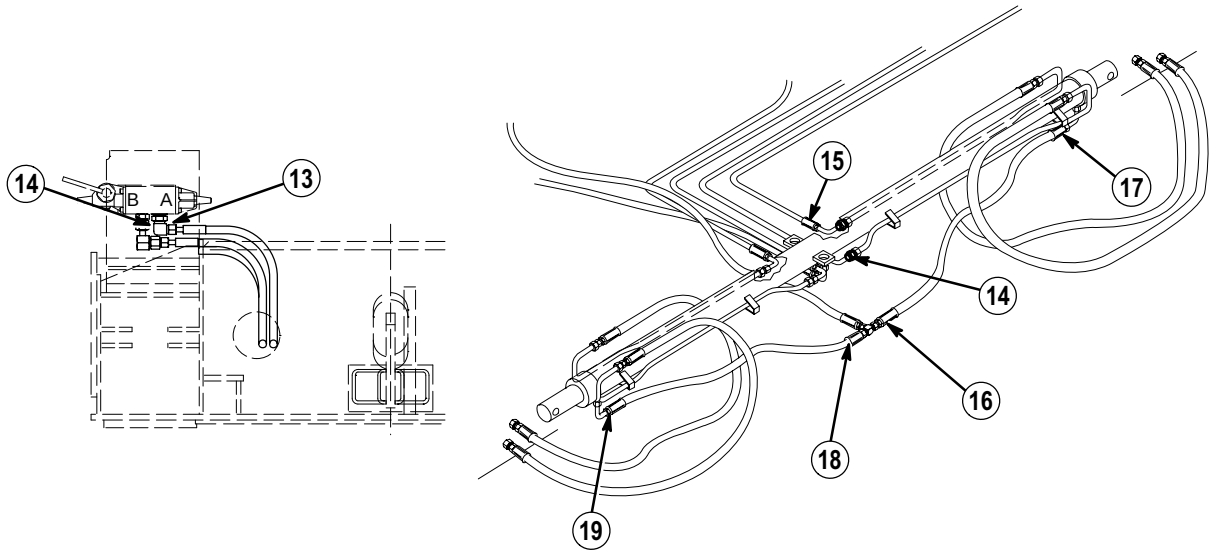
NOTE

- Place a container to catch hydraulic oil during hose removal.
- Plug all hoses after removal to prevent dirt from entering the hydraulic system.
- Tag and mark all hoses prior to removal.
- Note location of plastic cable ties prior to removal.
- Remove plastic cable ties as required.
- Remove clamps and support brackets as required.
- Inspect all hoses and fittings for cracks, kinks, nicks, dents, stripped threads, and cuts. Replace damaged parts.

3-44. CRANE HOSES REPLACEMENT (Continued)

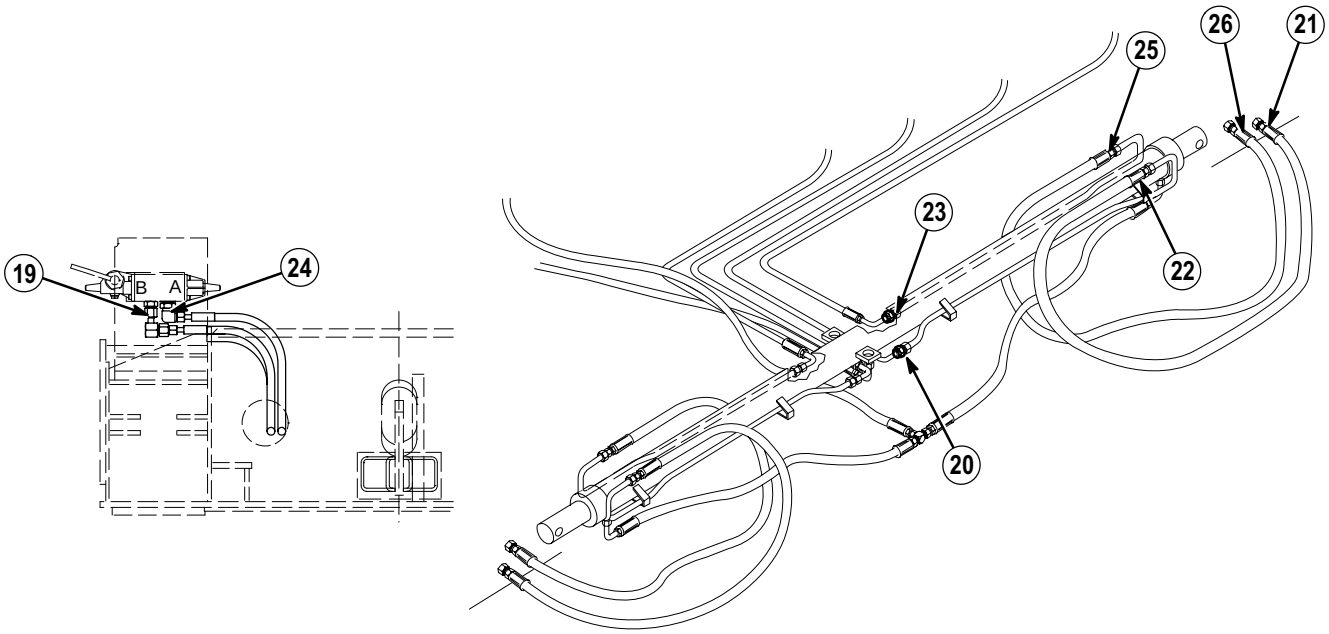


Hose Name	From	To
Crane Valve Supply Hose	Supply tee tube (1)	Crane valve supply tube fitting (2)
Outrigger Valve Supply Hose	Supply tee tube (3)	Outrigger valve supply tube fitting (4)
Outrigger Valve Return Hose	Return tee tube (5)	Outrigger valve return fitting (6)
Crane Valve Return Hose	Return tee tube (7)	Crane valve return fitting (8)
Outrigger Valve Load Sense Hose	Outrigger valve loadsense fitting (9)	Crane valve load sense tube fitting (10)
Main Load Sense Hose	Crane valve load sense fitting (11)	Bulkhead fitting (12)

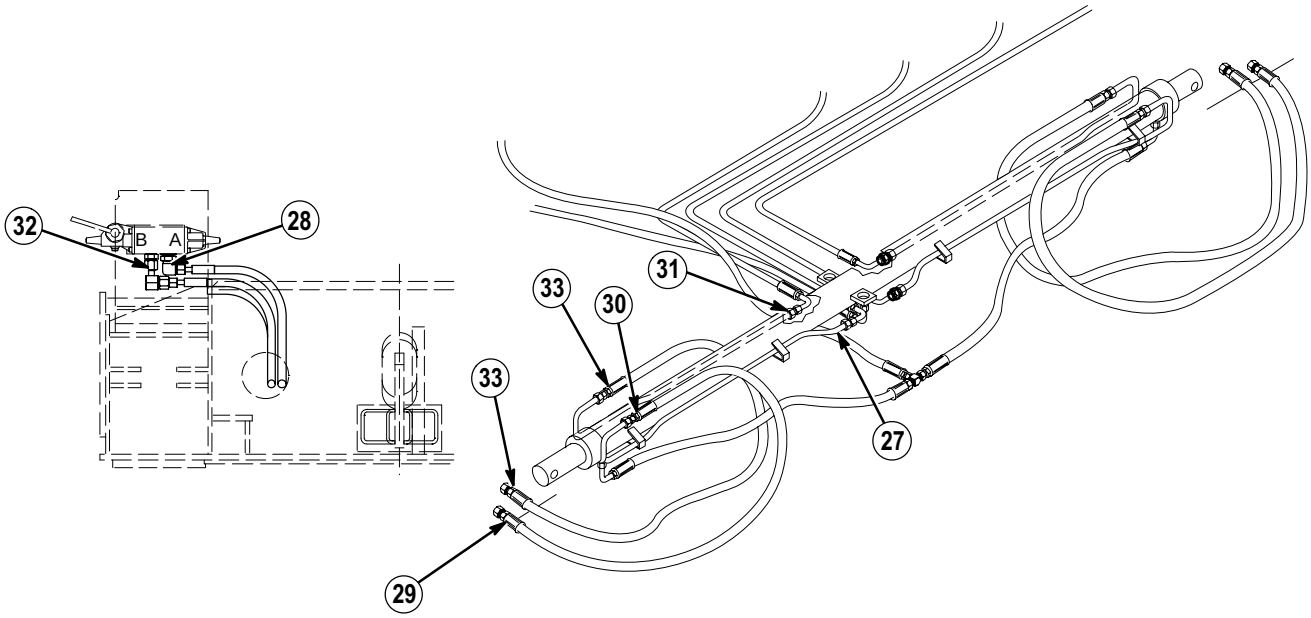


Hose Name	From	To
Outrigger Extend	Extension cylinder bottom fitting (13)	Extension cylinder supply fitting (14)
Outrigger Extend	Extension cylinder supply fitting (14)	Right and left outrigger extension manual control rear fitting “A” Port (13)
Outrigger Retract	Extension cylinder tee fitting (15)	Right and left outrigger extension manual control front fitting “B” Port (16)
Outrigger Retract Extension Cylinder	Tee fitting (15)	Extension cylinder supply fitting (17)
Outrigger Retract	Extension cylinder tee (18)	Extension cylinder supply fitting (19)

3-44. CRANE HOSES REPLACEMENT (Continued)

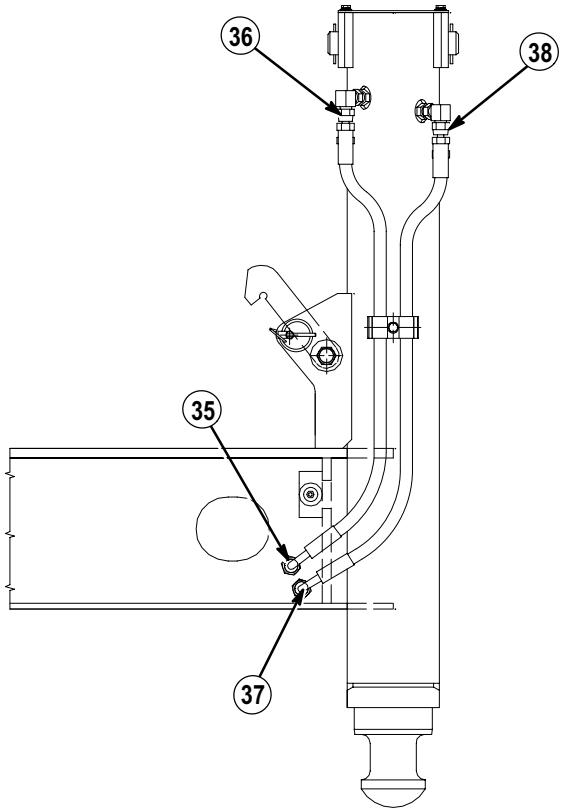


Hose Name	From	To
Right Outrigger Jack Cylinder, Down	Outrigger supply tee (20)	Right and left outrigger (up/down) jack manual control front fittings (19)
Right Outrigger Jack Cylinder, Down	Extension cylinder rear fitting (21)	Outrigger supply tee (22)
Right Outrigger Jack Cylinder, Up	Outrigger supply tee (23)	Right and left outrigger (up/down) jack manual control rear fittings (24)
Right Outrigger Jack Cylinder, Up	Extension cylinder tube (25)	Outrigger supply tee (26)
Outrigger Main	Outrigger supply tube bottom fitting	Outrigger check valve fitting and manifold
Outrigger Return	Outrigger return tube top fitting	Outrigger control valve manifold rear fitting

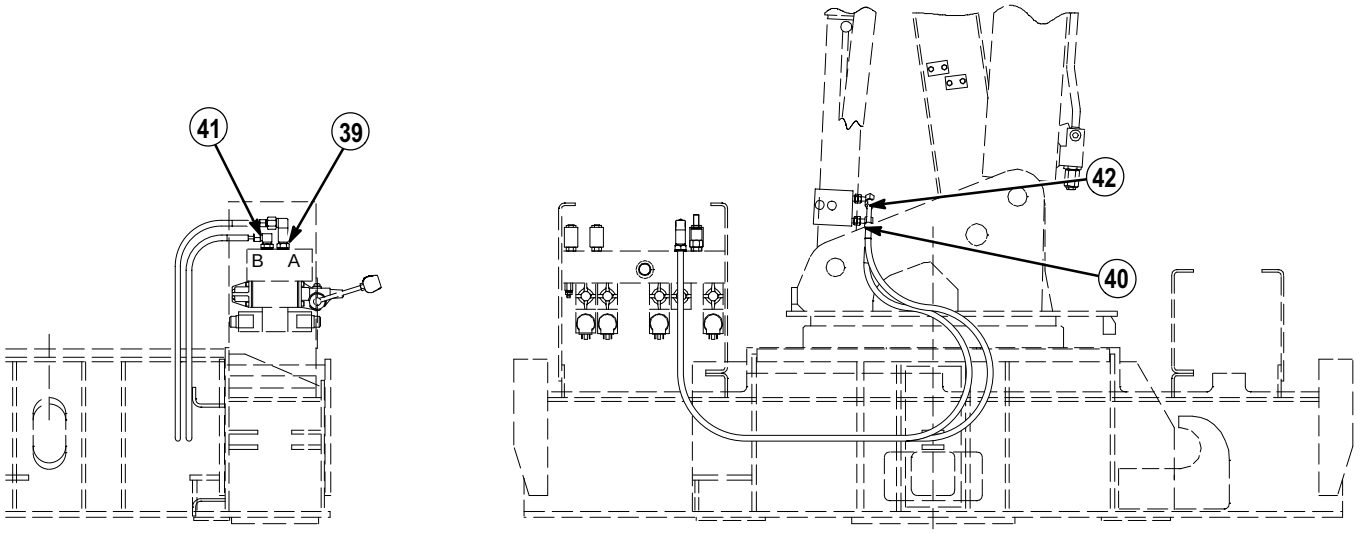


Hose Name	From	To
Left Outrigger Jack Cylinder, Down	Outrigger supply tee (27)	LH (up/down) manual control front fitting (28) “A” Port
Left Outrigger Jack Cylinder, Down	Extension cylinder tube (29)	Outrigger supply tee (30)
Left Outrigger Jack Cylinder, Up	Outrigger supply tee (31)	Right and left outrigger jack LH (up/down) manual control rear fittings (32) “B” Port
Left Outrigger Jack Cylinder, Up	Extension cylinder tube (33)	Outrigger supply tee (34)

3-44. CRANE HOSES REPLACEMENT (Continued)

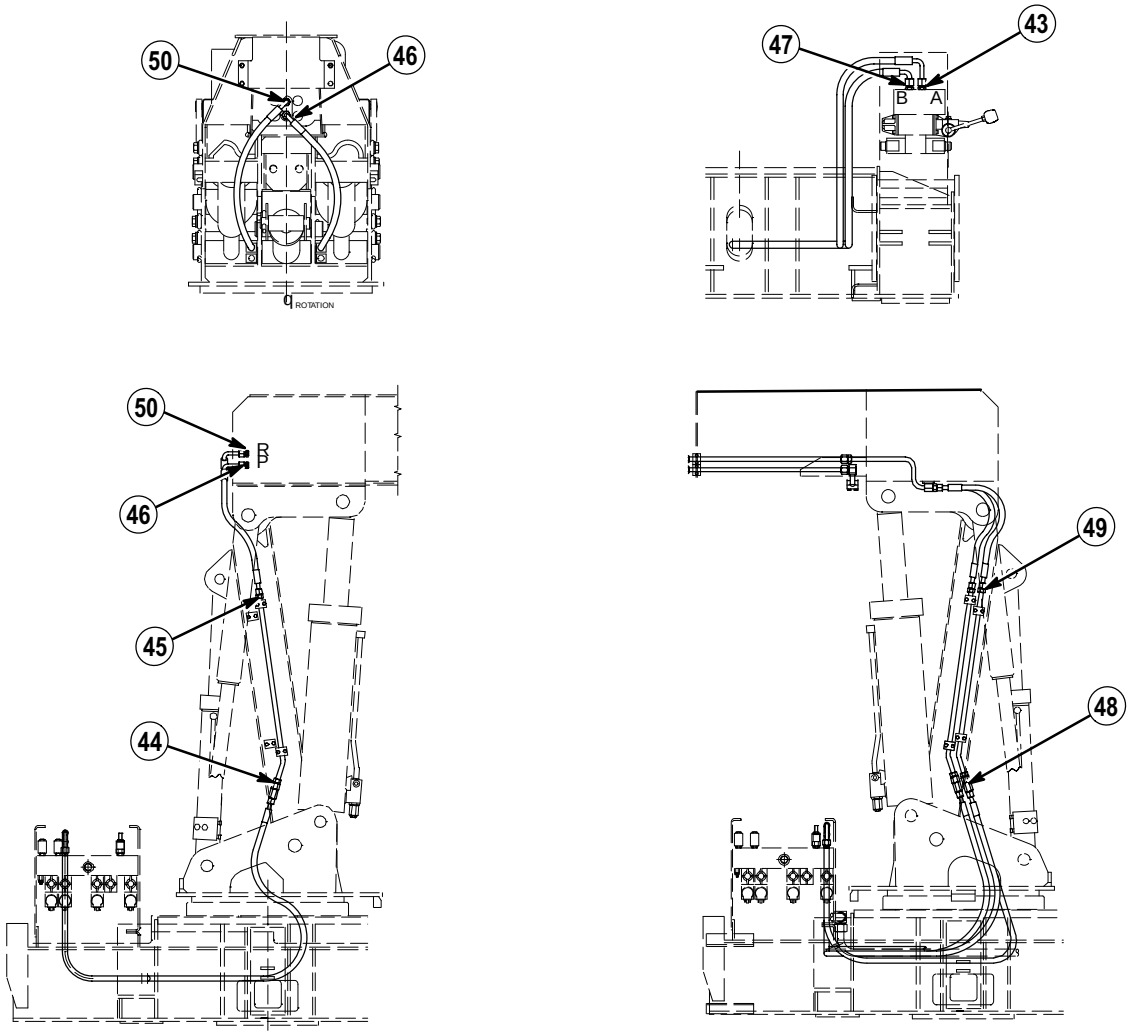


Hose Name	From	To
Left and Right Jack Cylinder, Extended	Left and right beam upper fitting (35)	Extension cylinder tube fitting (36)
Left and Right Jack Cylinder, Extended	Left and right beam lower fitting (37)	Extension Cylinder tube fitting (38)

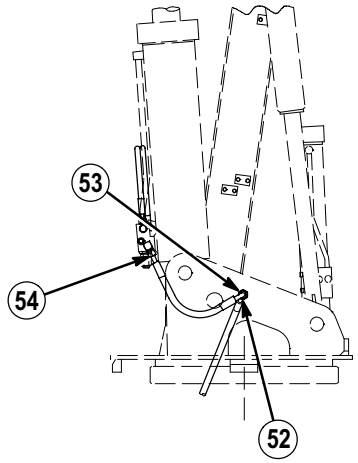


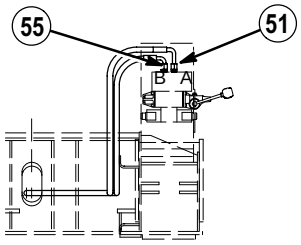
Hose Name	From	To
Mast Erection Up	Mast erection manual control valve front fitting (39)	Mast erection cylinder holding valve bottom fitting (40)
Mast Erection Down	Mast erection manual control valve rear fitting (41)	Mast erection cylinder holding valve top fitting (42)

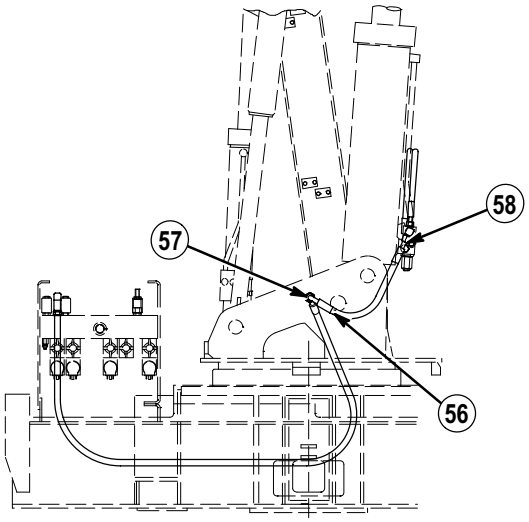
3-44. CRANE HOSES REPLACEMENT (Continued)

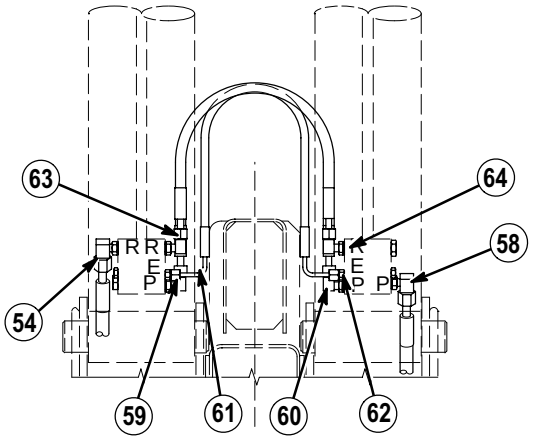


Hose Name	From	To
Telescope Out	Telescope manual control valve front fitting (43)	Bulkhead fitting on left side of crane (44)
Telescope Out	Bulkhead upper fitting on left side of crane (45)	Telescope cylinder lower fitting (46)
Telescope In	Telescope manual control valve rear fitting (47)	Bulkhead fitting on right side of crane (48)
Telescope In	Bulkhead upper fitting on right side of crane (49)	Telescope cylinder upper fitting (50)



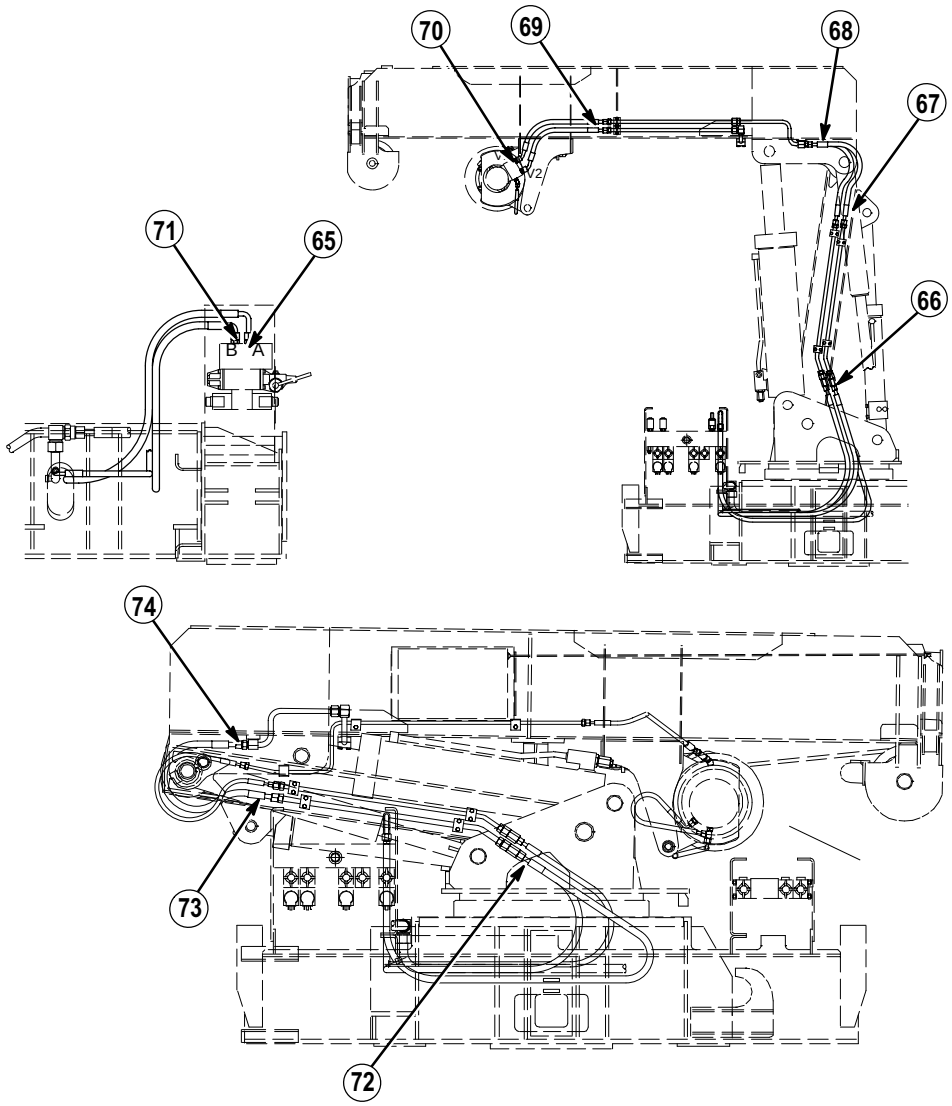




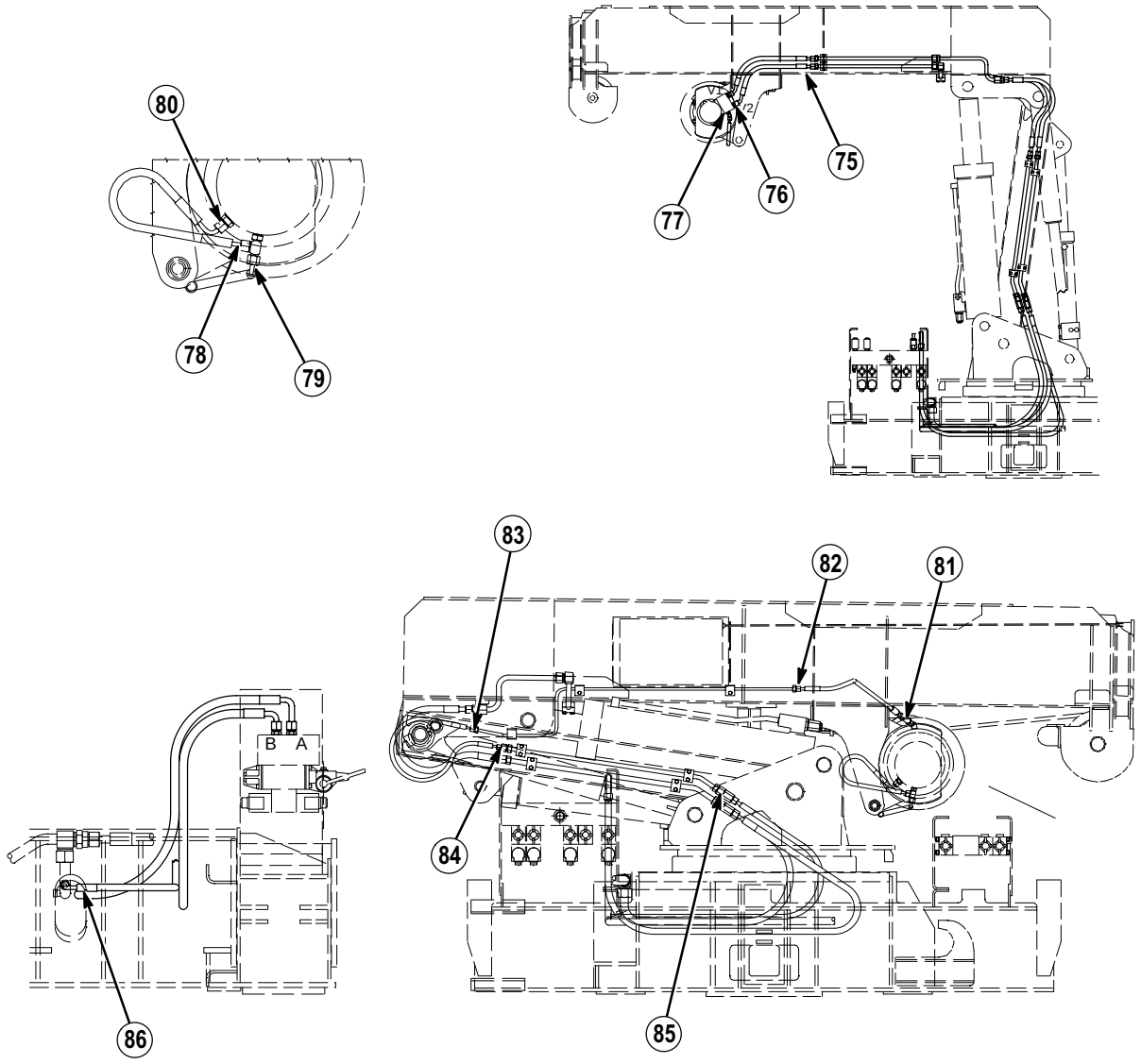


Hose Name	From	To
Boom Up	Boom manual control valve front fitting (51)	Boom holding valve left fitting (52)
Boom Up	Bulkhead on turntable outer fitting 53)	Boom holding valve lower fitting (54)
Boom Down	Boom manual control valve rear tee fitting (55)	Bulkhead on turntable (56)
Boom Down	Bulkhead on turntable (57)	Boom holding valve fitting (58)
Boom Holding Valve Inside Left	Boom holding valve inside left fitting (59)	Boom holding valve inside right fitting (60)
Boom Holding Valve Inside Center	Boom holding valve inside center fitting (61)	Boom holding valve inside center fitting (62)
Boom Holding Valve Inside Right	Boom holding valve inside right fitting (63)	Boom holding valve inside left fitting (64)

3-44. CRANE HOSES REPLACEMENT (Continued)

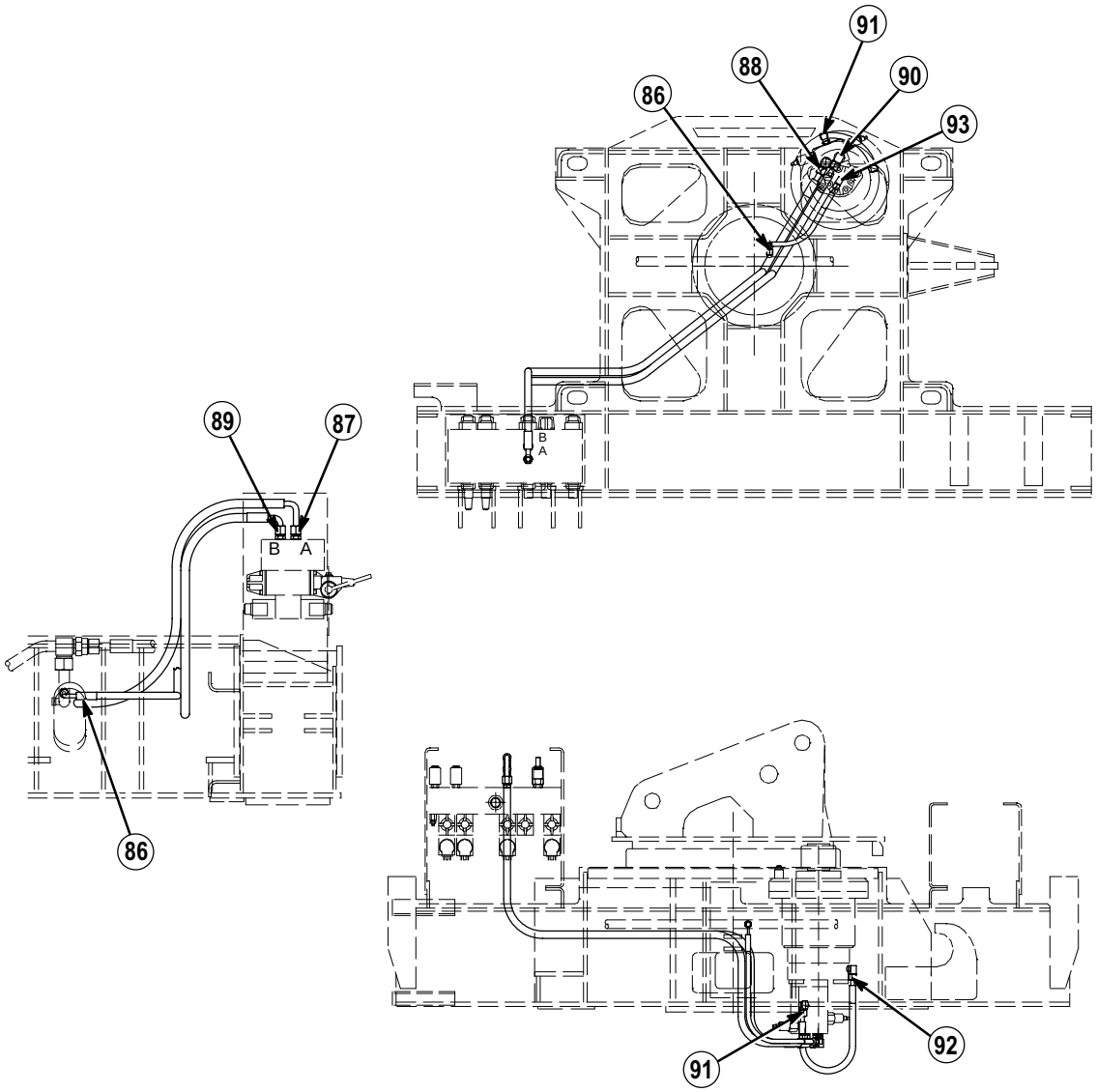


Hose Name	From	To
Hoist Up Lower	Hoist manual control valve front fitting (65)	Hoist mast hose left lower fitting (66)
Hoist Up Upper	Hoist mast hose left upper fitting (67)	Hoist boom left upper tube rear fitting (68)
Hoist Up Boom	Hoist boom left upper tube forward fitting (69)	Hoist motor control valve upper fitting (70)
Hoist Down Lower	Hoist manual control valve rear fitting (71)	Hoist mast tube right lower fitting (72)
Hoist Down Upper	Hoist mast tube right upper fitting (73)	Hoist boom tube right rear fitting (74)



Hose Name	From	To
Hoist Down Boom	Hoist boom left lower tube forward fitting (75)	Hoist motor control valve lower fitting (76)
Hoist Motor Brake Release	Hoist motor control valve bottom fitting (77)	Hoist motor right bottom forward fitting (78)
Hoist Motor Brake Engage	Hoist motor left side fitting (79)	Hoist motor right bottom rear fitting (80)
Hoist Motor Return Boom Lower Outer	Hoist motor right top fitting (81)	Hoist boom bottom lower fitting (82)
Hoist Motor Return Boom Upper Outer	Hoist boom tube fitting (83)	Hoist boom upper outer tube fitting (84)
Hoist motor return lower	Hoist boom R/S lower outer tube fitting (85)	Main return tube tee fitting (86)

3-44. CRANE HOSES REPLACEMENT (Continued)



Hose Name	From	To
Swing, Clockwise	Swing manual control valve front fitting (87)	Swing motor cross-over with shuttle valve left fitting (88)
Swing, Counterclockwise	Swing manual control valve rear fitting (89)	Swing motor cross-over with shuttle valve right fitting (90)
Swing Motor Brake Release	Swing motor cross-over with shuttle valve front fitting (91)	Swing motor fitting (92)
Swing Motor Drain	Swing orbit motor bottom fitting (93)	Main return tube tee fitting (86).

END OF TASK

3-45. BOOM LIFT HOLDING VALVE REPLACEMENT

THIS TASK COVERS: a. Removal
b. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Lubricating oil (Item 16, Appendix B)
Backup ring (Item 1, Appendix E)
Packing, preformed (Item 103, Appendix E)
Packing, preformed (Item 101, Appendix E)
Packing, preformed (Item 100, Appendix E)
Retainer, packing (Item 102, Appendix E)
Cap and plug set (Item 6, Appendix F)
Drain Pan (Item 42, Appendix F)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Crane unstowed (TM 9-4940-568-10).

General Safety Instructions
To avoid personal injury, always assume hydraulic lines have pressure. Slowly crack hydraulic lines open to allow all pressure to escape. Always wear safety glasses.

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

a. Removal

NOTE

Cap and plug all hoses and fittings upon removal.

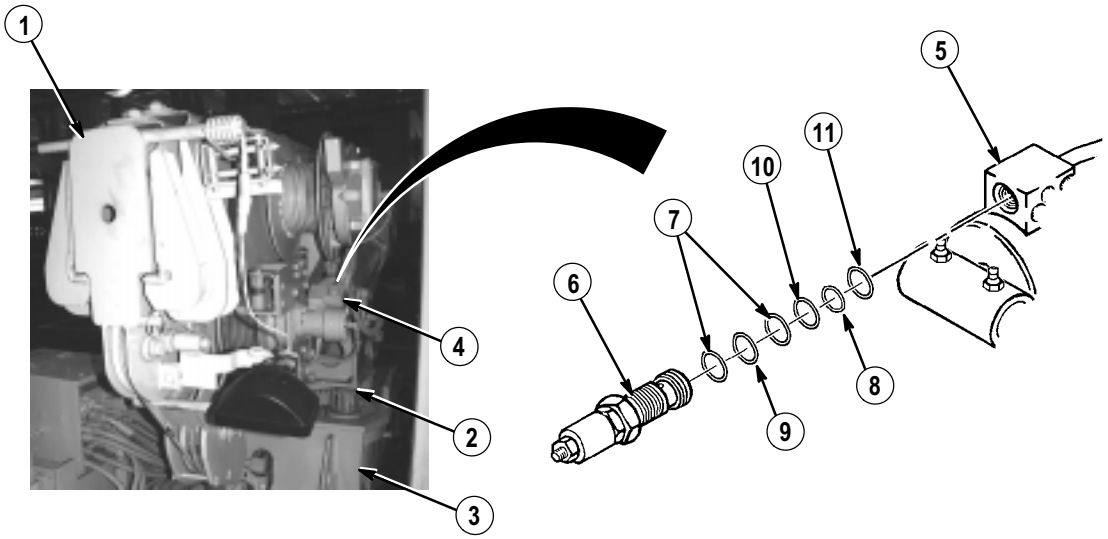
(1) Raise boom (1) and turn turntable (2) on crane (3) approximately 45° or until boom (1) clears manifold bracket (4) for holding valve manifold (5).

(2) Remove holding valve (6) from holding valve manifold (5).

NOTE

Note position of backup rings and preformed packing prior to removal.

(3) Remove two backup rings (7), packing retainer (8), and three preformed packings (9, 10 and 11) from holding valve (6). Discard preformed packings, packing retainer and backup rings.



3-45. BOOM LIFT HOLDING VALVE REPLACEMENT (Continued)

b. Installation

NOTE

- Apply lubricating oil to all preformed packings, backup rings and packing retainer prior to installation.
- Position backup rings and preformed packing as noted removal.

(1) Install three preformed packings (11, 10 and 9), packing retainer (8) and two backup rings (7) on holding valve (6).

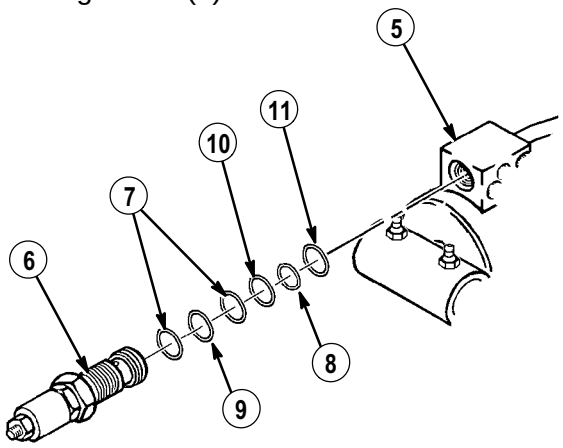
(2) Install holding valve (6) in holding valve manifold (5).

Follow-On Maintenance

Operate crane and check for leaks (TM 9-4940-568-10)

Stow crane (TM 9-4940-568-10)

END OF TASK



3-46. MANUAL OVERRIDE VALVE REPAIR

THIS TASK COVERS:
a. Removal
b. Disassembly
c. Assembly
d. Installation

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Sealing compound (Item 29, Appendix B)
Tags, Identification (Item 36, Appendix B)
Cap and plug set (Item 6, Appendix F)
Gasket (Item 9, Appendix E)

Materials/Parts - Continued
Lockwashers (2) (Item 45, Appendix E)
Packing, preformed (Item 113, Appendix E)
Packing, preformed (Item 104, Appendix E)
Seal, safety lock (Item 159, Appendix E)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10).

Batteries disconnected, (TM 9-4940-568-10).

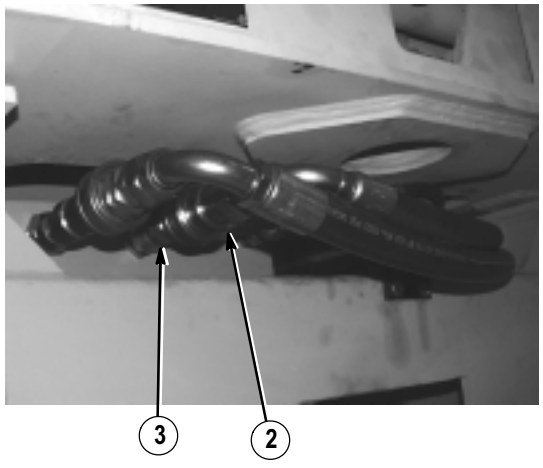
a. Removal

NOTE

- Tag and mark all hoses and connectors prior to removal.
- Cap and plug hydraulic hoses and tubes after removal.

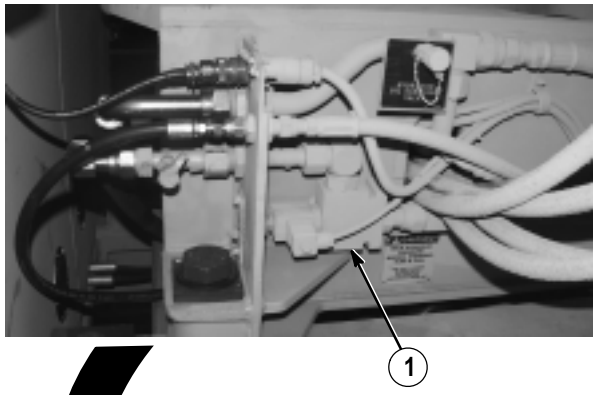
WARNING

The hydraulic system operates at high pressures. Never disconnect any hydraulic line or fitting without first dropping pressure to zero. Failure to comply may result in serious injury or death to personnel.



(1) Position drain pan under manual override valve (1).

(2) Remove hydraulic line quick disconnect (2) from crane supply line (3).



3-46. MANUAL OVERRIDE VALVE REPAIR (Continued)

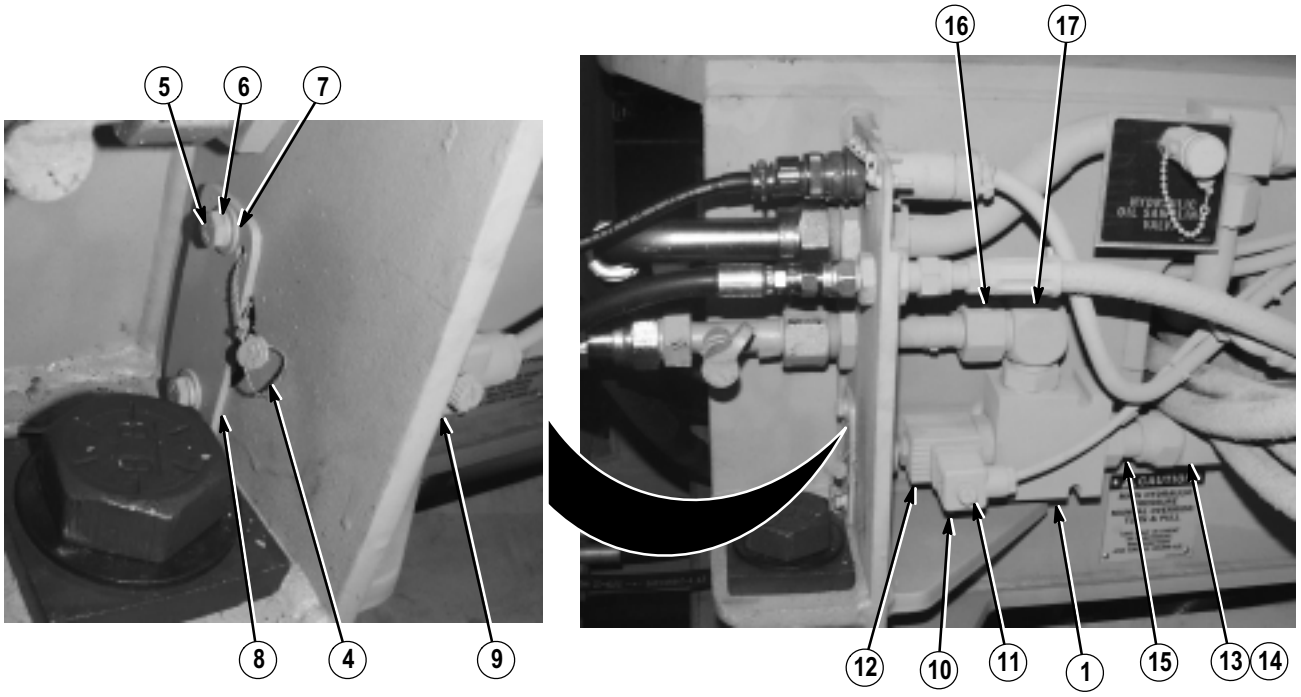
(3) Cut and remove safety lock seal (4). Discard seal.

(4) Remove two screws (5), lockwashers (6), washers (7) and manual override guard (8) from crane (9). Discard lockwashers.

(5) Loosen screw (10) and remove connector (11) and square seal (12) from manual override valve (1). Discard seal.

(6) Remove hose (13) and preformed packing (14) from tube (15).

(7) Loosen nut (16) on fitting (17) and remove manual override valve (1).



b. Disassembly

CAUTION

Do not damage electrical connector or crane will not operate properly.

(1) Position manual override valve (1) in vise with soft jaws.

NOTE

Tag and mark fittings prior to disassembly.

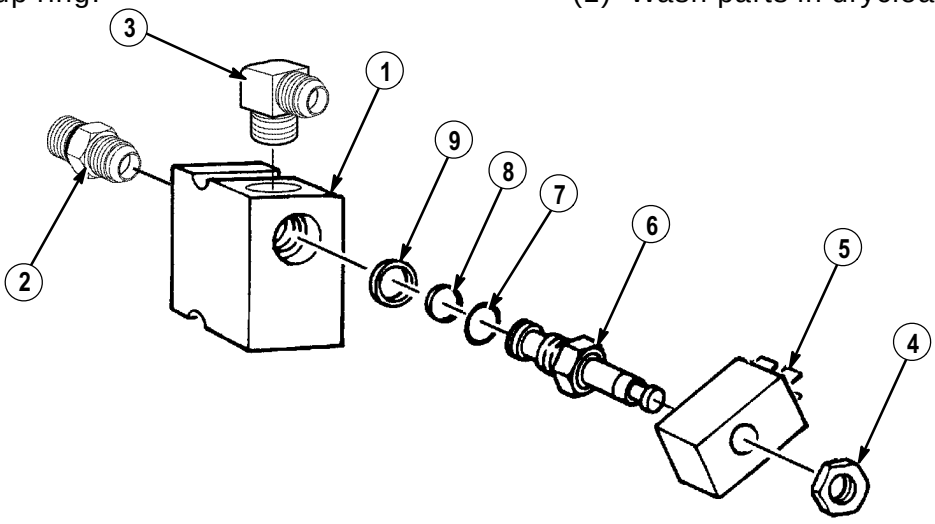
(2) Remove tube fitting (2) from manual override valve (1).

(3) Remove elbow (3) manual override valve (1).

(4) Remove nut (4) and coil (5) from valve stem (6).

(5) Remove valve stem (6) from manual override valve (1).

(6) Remove preformed packings (7) and (8) and backup ring (9) from valve stem (6). Discard preformed packings and backup ring.



c. Cleaning/Inspection.

WARNING

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles, face shield, and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes, and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent. The flashpoint for Type II Drycleaning Solvent is 140 degrees F (60 degrees C) and Type III Drycleaning Solvent is 200 degrees F (93 degrees C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.

(1) Wash parts in drycleaning solvent.

3-46. MANUAL OVERRIDE VALVE REPAIR (Continued)

(2) Dry parts with cleaning cloth.

(3) Inspect parts for cracks, broken terminals and stripped threads.

(4) Replace damaged parts.

d. Assembly

NOTE

All oil rings should have a light coat of oil applied prior to installation.

(1) Install preformed packings (7) and (8) and backup ring (9) on valve stem (6).

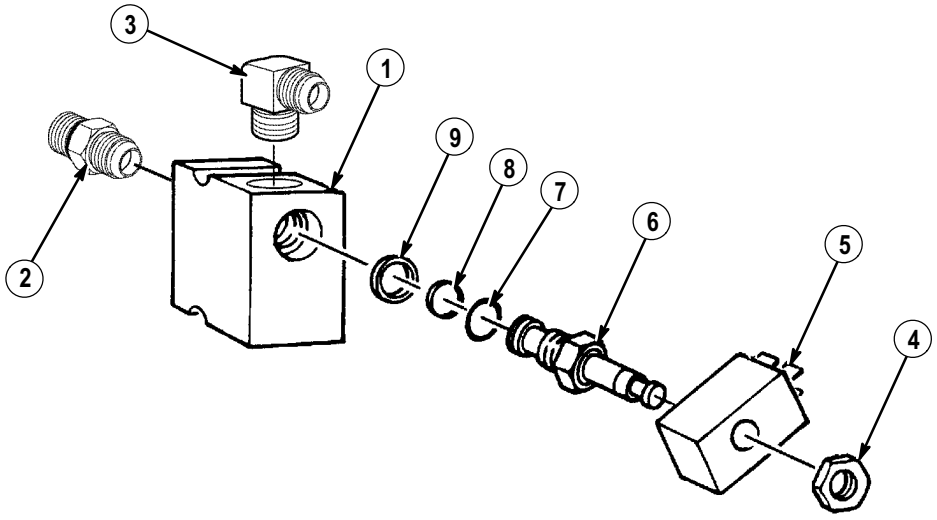
(2) Install valve stem (6) into manual override valve (6).

(3) Install coil (5) and nut (4) on valve stem (6).

(4) Apply sealer to threads and install elbow (3) into manual override valve (1).

(5) Apply sealer to threads and install tube fitting (2) into manual override valve (1).

(6) Remove manual override valve (1) from vise.



e. Installation

(1) Install manual override valve (1) and tighten nut (16) on fitting (17).

(2) Install preformed packing (14) and hose (13) on tube (15).

(3) Install square seal (12) and connector (11), tighten screw (10).

(4) Install manual override guard (8) using two washers (7), lockwashers (6) and screws (5) on crane (3).

(5) Install safety lock seal (4).

(6) Install hydraulic line quick disconnect (2) on crane supply line (3).

END OF TASK

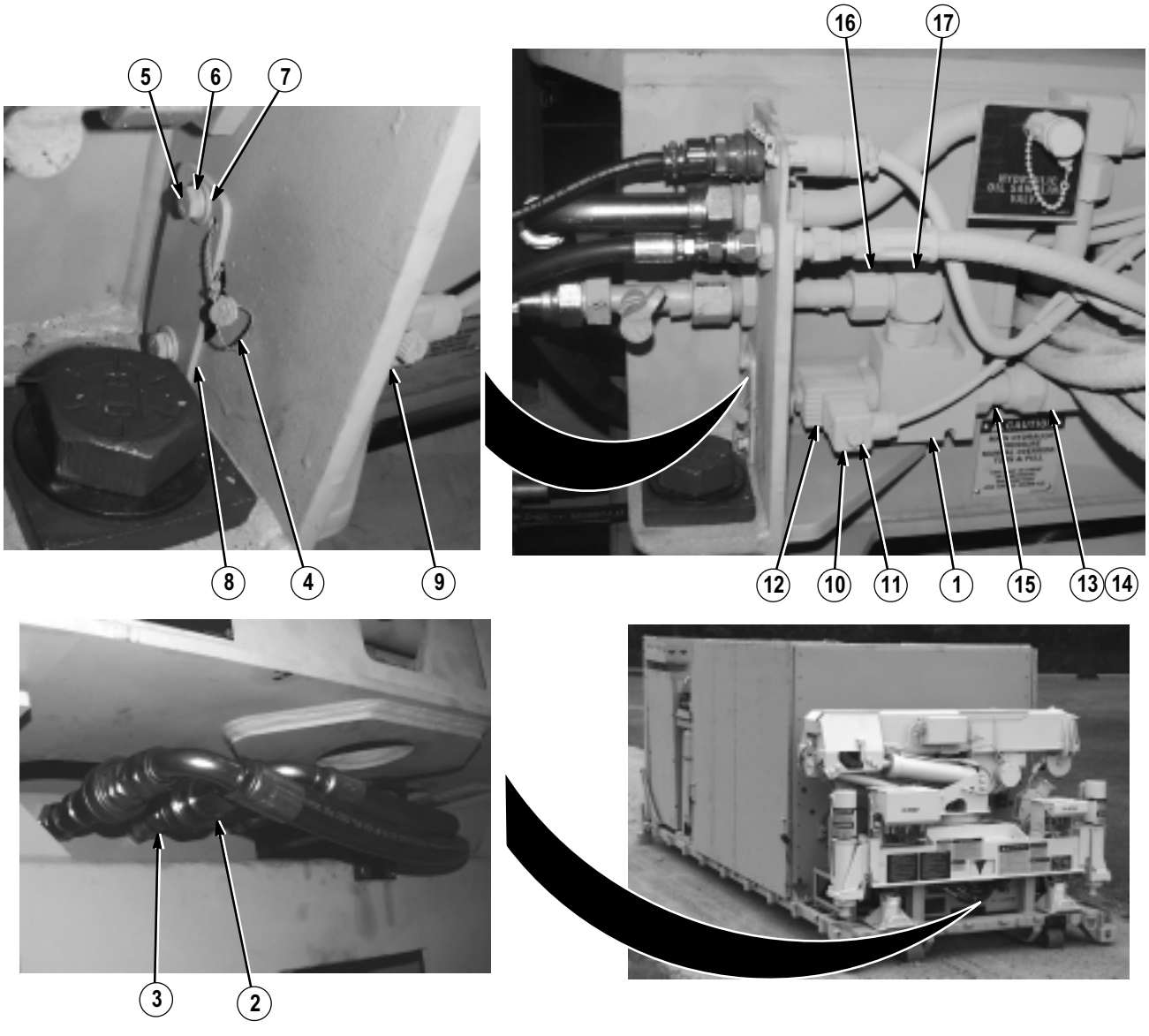
Follow-On Maintenance

Install crane control valves (para 3-35).

Install electric solenoid valves (para 3-37).

Connect batteries, (TM 9-4940-568-10).

Check crane for leaks and proper operation, (TM 9-4940-568-10).



CHAPTER 4
HYDRAULIC MAINTENANCE

Para	Contents	Page
4-1	Introduction	4-1
4-2	Hydraulic Pump Replacement	4-2
4-3	Hydraulic Pump Adjustment	4-6

4-1. INTRODUCTION.

This chapter contains maintenance instructions for removing, replacing, repairing, installing and adjusting components authorized by the Maintenance Allocation Chart (MAC) at the Direct Support Maintenance level.

4-2. HYDRAULIC PUMP REPLACEMENT.

This task covers:

a. Removal
b. Disassembly
c. Assembly
d. Installation
e. Follow-On Maintenance

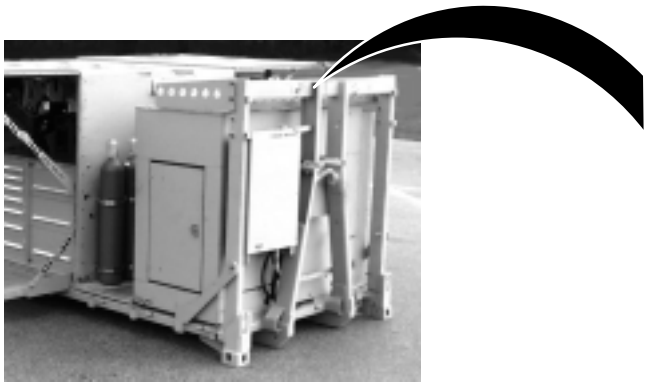
INITIAL SETUP

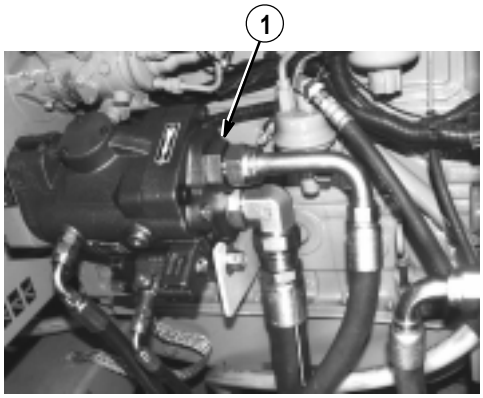
Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Pan, Drain (Item 42, Appendix F)
Socket Set, 3/8 in. (Item 52, Appendix F)
Wrench, Combination, 1-5/8 in. (Item 78, Appendix F)
Wrench, Combination, 1-7/8 in. (Item 80, Appendix F)
Wrench, Torque (0-60 N·m) (Item 85, Appendix F)

Materials/Parts
Oil, Hydraulic (Item 16, Appendix B)
Tags, Identification (Item 36, Appendix B)
Gasket (Item 14, Appendix E)
Gasket (2) (Item 15, Appendix E)
Locknut (Item 39, Appendix E)
Lockwasher (2) (Item 58, Appendix E)
Preformed Packing (Item 77, Appendix E)
Preformed Packing (Item 79, Appendix E)
Preformed Packing (Item 81, Appendix E)
Preformed Packing (Item 127, Appendix E)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
Batteries disconnected, (TM 9-4940-568-10)
Drain hydraulic reservoir, (TM 9-4940-568-20)

a. Removal.





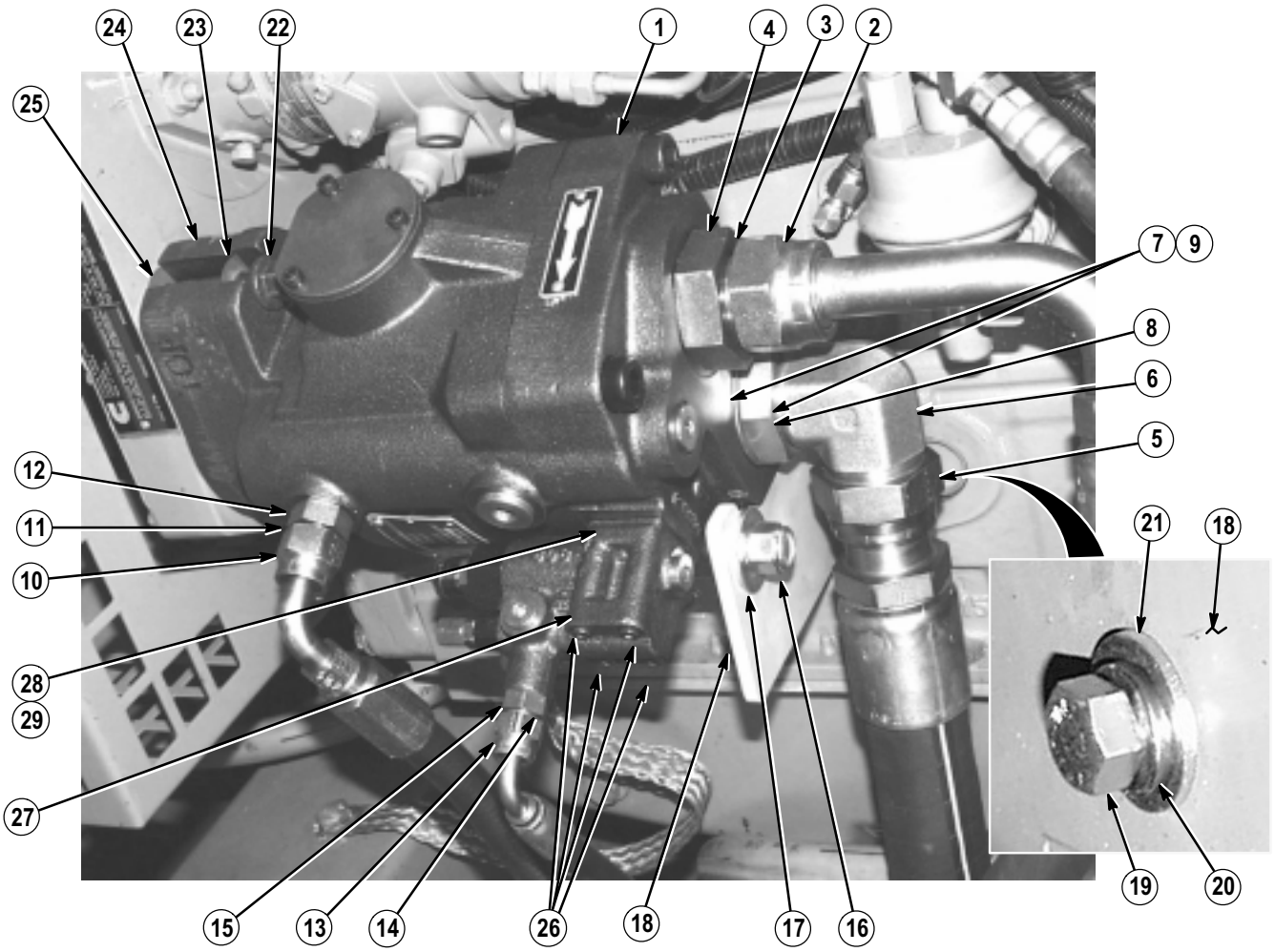
WARNING

The hydraulic system operates at high pressures. Never disconnect any hydraulic line or fitting without first, crane stowed with no load at zero pressure. Failure to comply may result in serious injury or death to personnel.

NOTE

- Tag and mark all hoses prior to removal.
- Note position of hoses prior to removal.

(1) Position drain pan under hydraulic pump (1).



(2) Remove hose (2), preformed packing (3) and adapter (4) from hydraulic pump (1).

(3) Remove hose (5), elbow (6), preformed packing (7), adapter (8) and preformed packing (9) from hydraulic pump (1).

(4) Remove hose (10), preformed packing (11) and adapter (12) from hydraulic pump (1).

(5) Remove hose (13), preformed packing (14) and adapter (15) from hydraulic pump (1).

(6) Remove locknut (16) and two washers (17) from hydraulic pump bracket (18). Discard locknut.

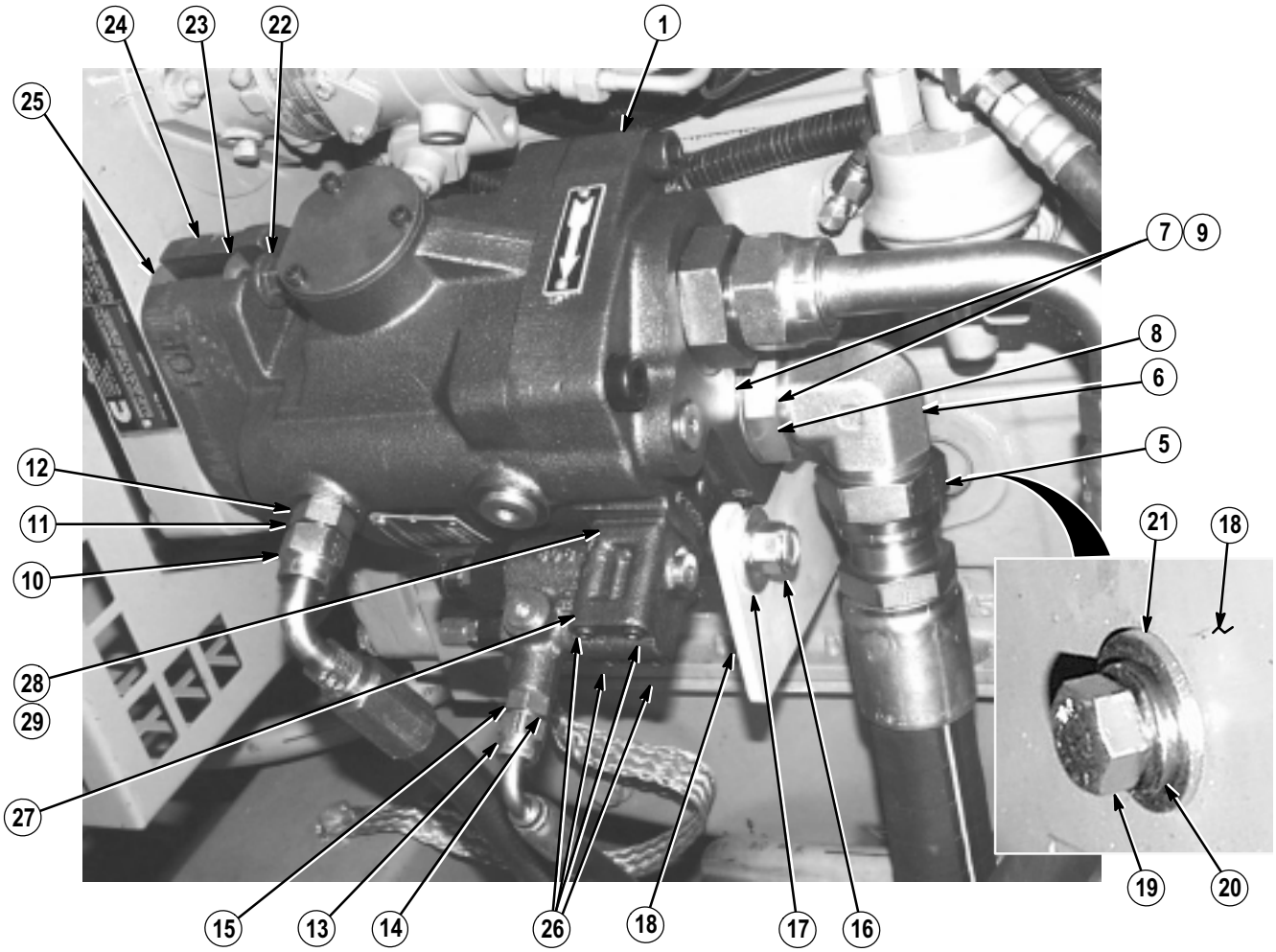
(7) Remove two screws (19), lockwashers (20), washers (21) and hydraulic pump bracket (18). Discard lockwashers.

(8) Remove two screws (22), hydraulic pump (1), gasket (23), hydraulic pump drive adapter (24) and gasket (25). Discard gaskets.

b. Disassembly.

(1) Remove four screws (26), load sense compensator assembly (27), preformed packing (28) and gasket (29) from hydraulic pump (1). Discard preformed packing and gasket.

4-2. HYDRAULIC PUMP REPLACEMENT (CONT).



c. Assembly.

(1) Install gasket (29), preformed packing (28), load sense compensator assembly (27) and four screws (26) on hydraulic pump (1). Tighten capscrews to 50 lb-in (57 N·m).

d. Installation.

NOTE

Prior to installation, hydraulic pump should be primed by adding oil to the inlet port while rotating drive gear until oil is pumped from outlet port.

(1) Install gasket (25), hydraulic pump adapter (24), gasket (23), hydraulic pump (1) and two screws (22).

(2) Install hydraulic pump bracket (18), two washers (21), lockwashers (20) and screws (19).

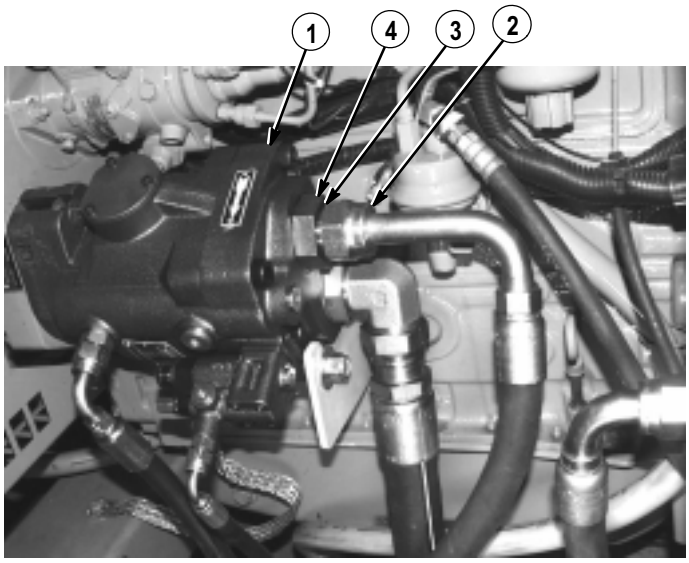
(3) Install two washers (17) and locknut (16) on hydraulic pump bracket (18).

(4) Install adapter (15), preformed packing (14) and hose (13) on hydraulic pump (1).

(5) Install adapter (12), preformed packing (11) and hose (10) on hydraulic pump (1).

(6) Install preformed packing (9), adapter (8), preformed packing (7), elbow (6) and hose (5) on hydraulic pump (1).

(7) Install adapter (4), preformed packing (3) and hose (2) on hydraulic pump (1).



e. Follow-On Maintenance:

- Fill hydraulic reservoir, (TM 9-4940-568-20).
- Connect batteries, (TM 9-4940-568-10).
- Start generator and check for leaks, (TM 9-4940-568-10).
- Shut off generator, (TM 9-4940-568-10).
- Perform hydraulic pump adjustment, (Para 4-3).
- Check hydraulic oil level, (TM 9-4940-568-10).

END OF TASK

4-3. HYDRAULIC PUMP ADJUSTMENT.

This task covers:

a. Adjustment b. Follow-On Maintenance

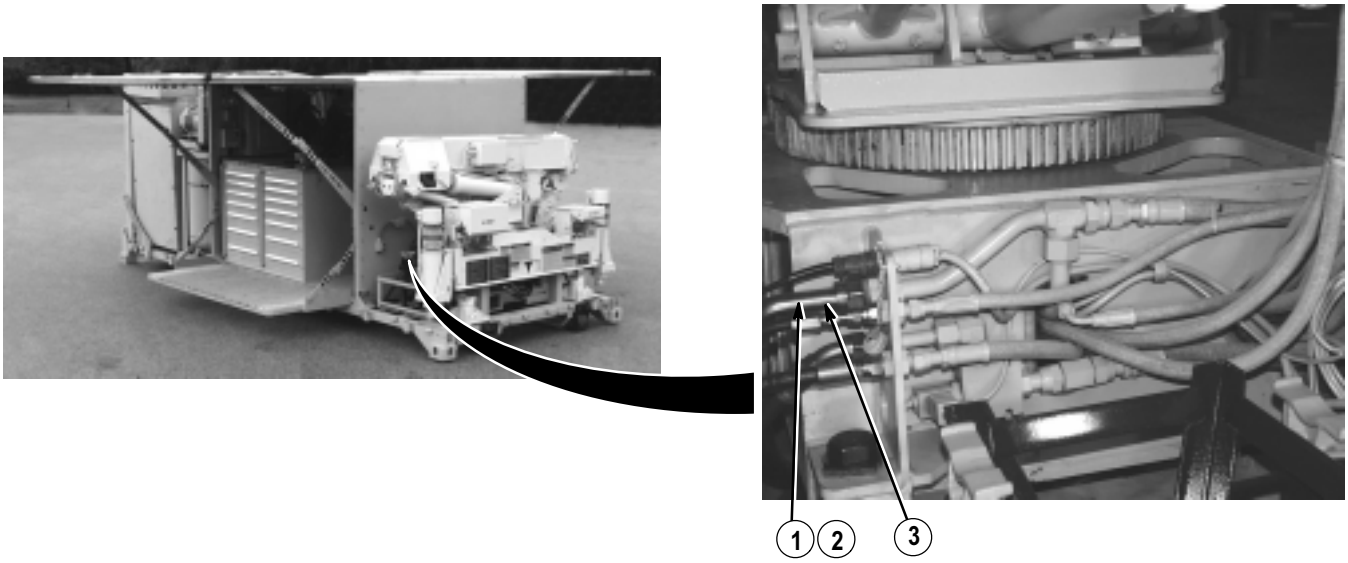
INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)
Tester, Hydraulic Pressure
(Item 64, Appendix F)

Personnel Required
Two

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
Crane and outriggers fully deployed,
(TM 9-4940-568-10)

a. Adjustment.



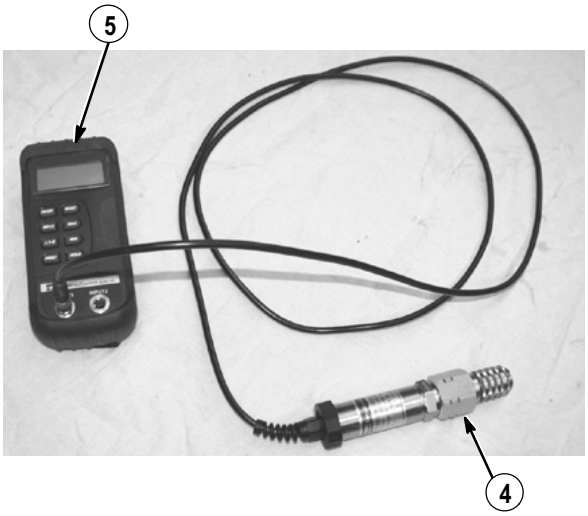
WARNING

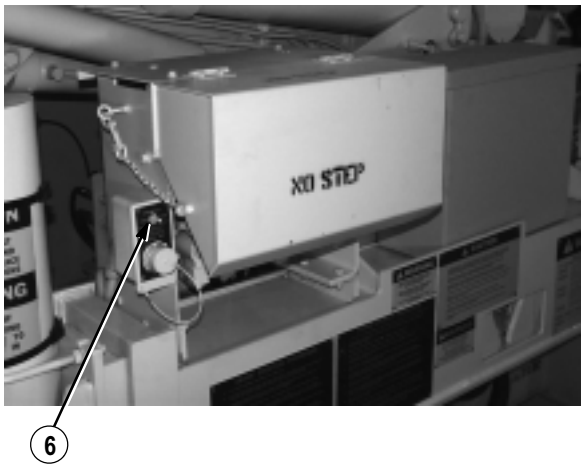
Personnel hearing can be PERMANENTLY DAMAGED if exposed to constant high noise levels of 85 DBA or greater. Wear approved hearing protection devices when working in high noise level areas. Personnel exposed to high noise levels shall participate in a hearing observation program in accordance with TB MED 501. Hearing loss occurs gradually but becomes permanent over time.

NOTE

Ensure outriggers are fully extended.

(1) Remove protective cap (1) from test port (2) on crane hydraulic pressure hose (3).





NOTE

- 0-100 bar sensor has a green band, 0-1000 bar sensor has an orange band.
- Bar sensor extension jack can be used so test meter can be read at hydraulic pump.

(2) Connect 0–100 bar sensor (4) to test port (2) and test meter (5).

(3) Start generator (TM 9-4940-568-10).

(4) Move crane power switch (6) to ON.

(5) With the aid of an assistant, monitor pressure reading on test meter (5) and loosen nut (7) on low pressure valve (8).

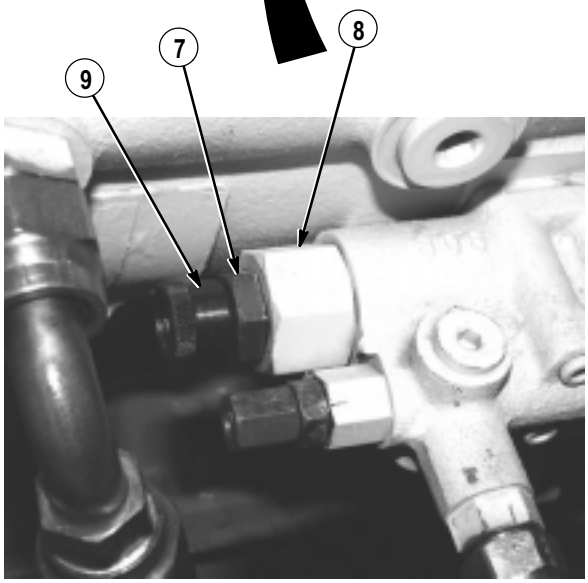
NOTE

If 325 ± 10 pressure cannot be reached, replace hydraulic pump (Para 4-2).

(6) Turn adjustment screw (9) until pressure is 325 ± 10 on test meter (5) and tighten nut (7).

(7) Move crane power switch (6) to OFF.

(8) Shut down generator.



4-3. HYDRAULIC PUMP ADJUSTMENT (CONT).

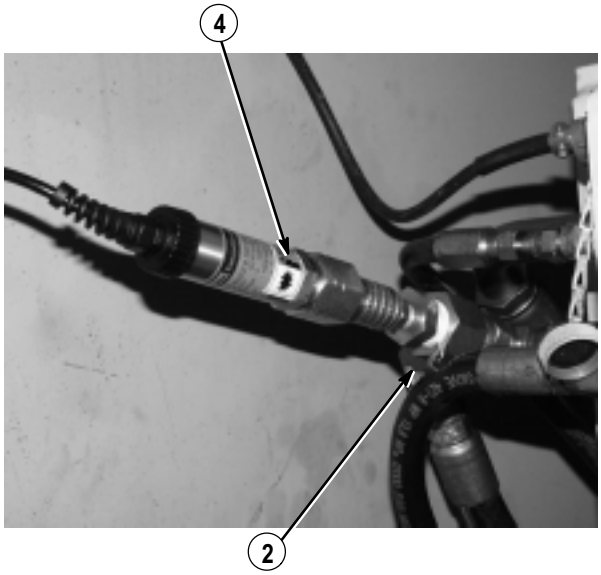
(9) Disconnect 0-100 bar sensor (4) from test port (2) and test meter (5).

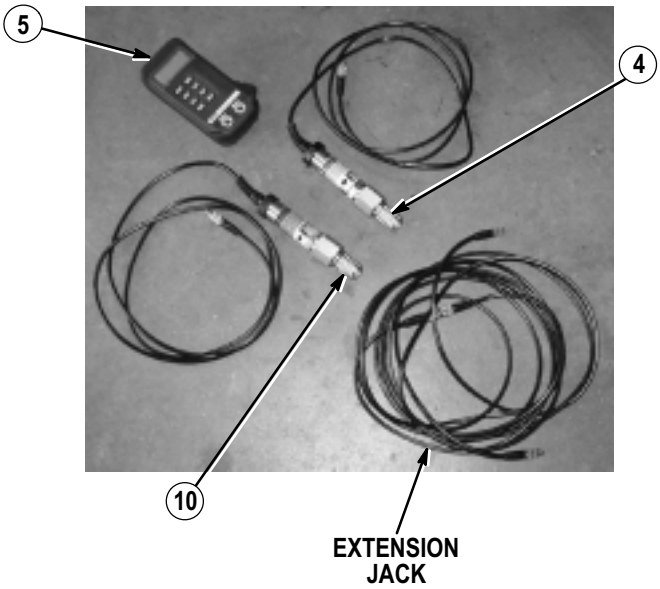
(10) Connect 0-1000 bar sensor (10) to test port (2) and test meter (5).

NOTE

Allow 3-5 minutes before restart.

(11) Start generator.





(12) Move crane power switch (6) to ON.

NOTE

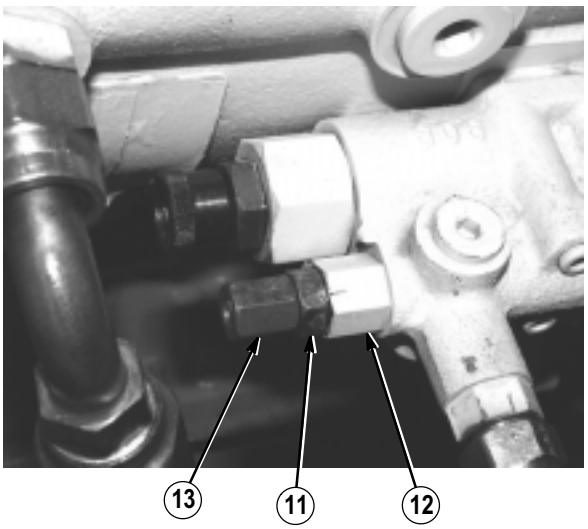
MAST UP lever must be held in the full “up” position during Step (13).

(13) With the aid of an assistant, monitor pressure reading on test meter (5) and loosen nut (11) on high pressure valve (12).

NOTE

If 3100 to 3500 pressure cannot be reached, replace hydraulic pump (Para 4-2).

(14) Turn adjustment screw (13) until pressure is between 3100 to 3500 on test meter (5) and tighten nut (11).

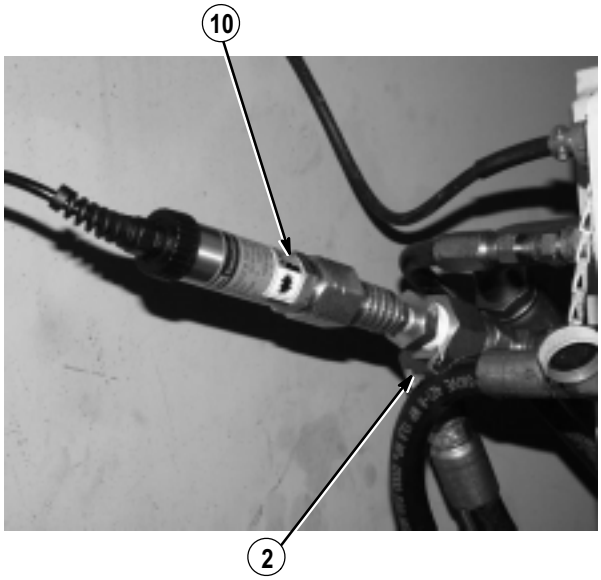


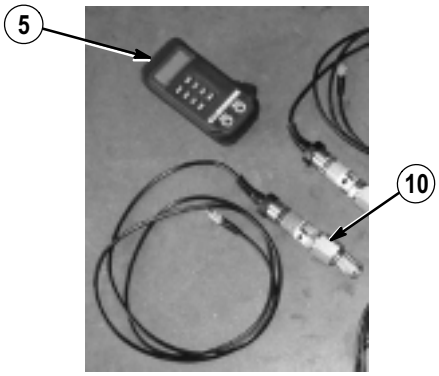
(15) Move crane power switch (6) to OFF.

(16) Shut down generator.

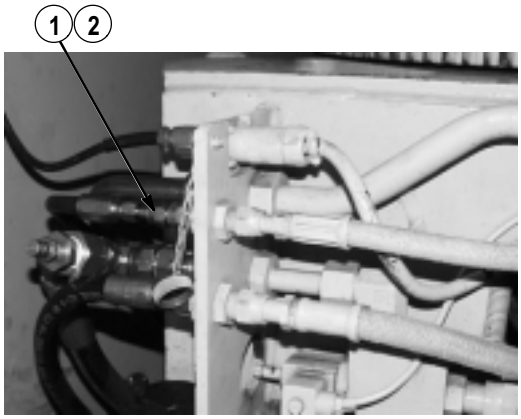
4-3. HYDRAULIC PUMP ADJUSTMENT (CONT).

(17) Disconnect 0-1000 bar sensor (10) from test port (2) and test meter (5).





(18) Install protective cap (1) on test port (2).



b. Follow-On Maintenance:

- Stow crane and outriggers, (TM 9-4940-568-10).

END OF TASK

CHAPTER 5
GENERATOR AND ENGINE MAINTENANCE

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5-1. INTRODUCTION.

This chapter contains maintenance instructions for removing, replacing, repairing, installing and adjusting components authorized by the Maintenance Allocation Chart (MAC) at the Direct Support Maintenance level.

5-2. GENERATOR HOUSING REPLACEMENT.

This task covers:

a. Removal b. Installation c. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Cap and Plug Set (Item 6, Appendix F)
Lifting Device, Minimum Capacity 500 lbs (227 kg)
Wooden Blocks (4) (Appendix C)

Materials/Parts
Gasket (Item 8, Appendix E)
Lockwasher (4) (Item 52, Appendix E)
Locknut (4) (Item 40, Appendix E)

Personnel Required
Two

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
Generator set removed (if necessary), (Para 5-3)
Batteries disconnected, (TM 9-4940-568-10)
Panels removed, (TM 9-4940-568-10)

a. Removal.

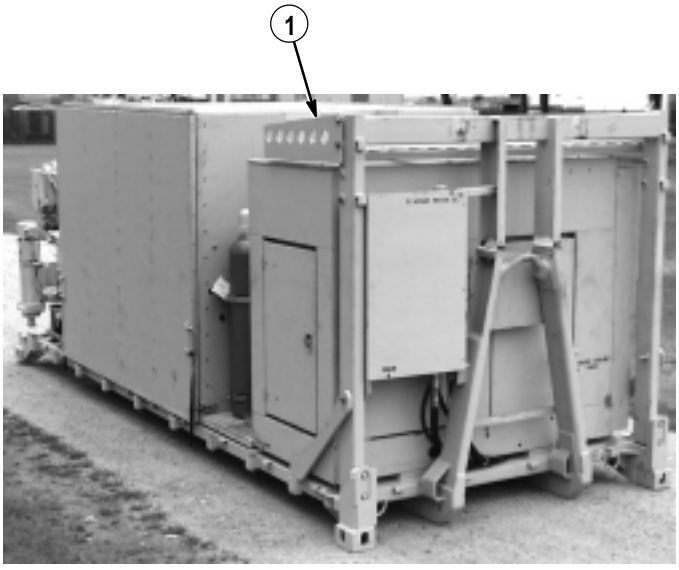
WARNING

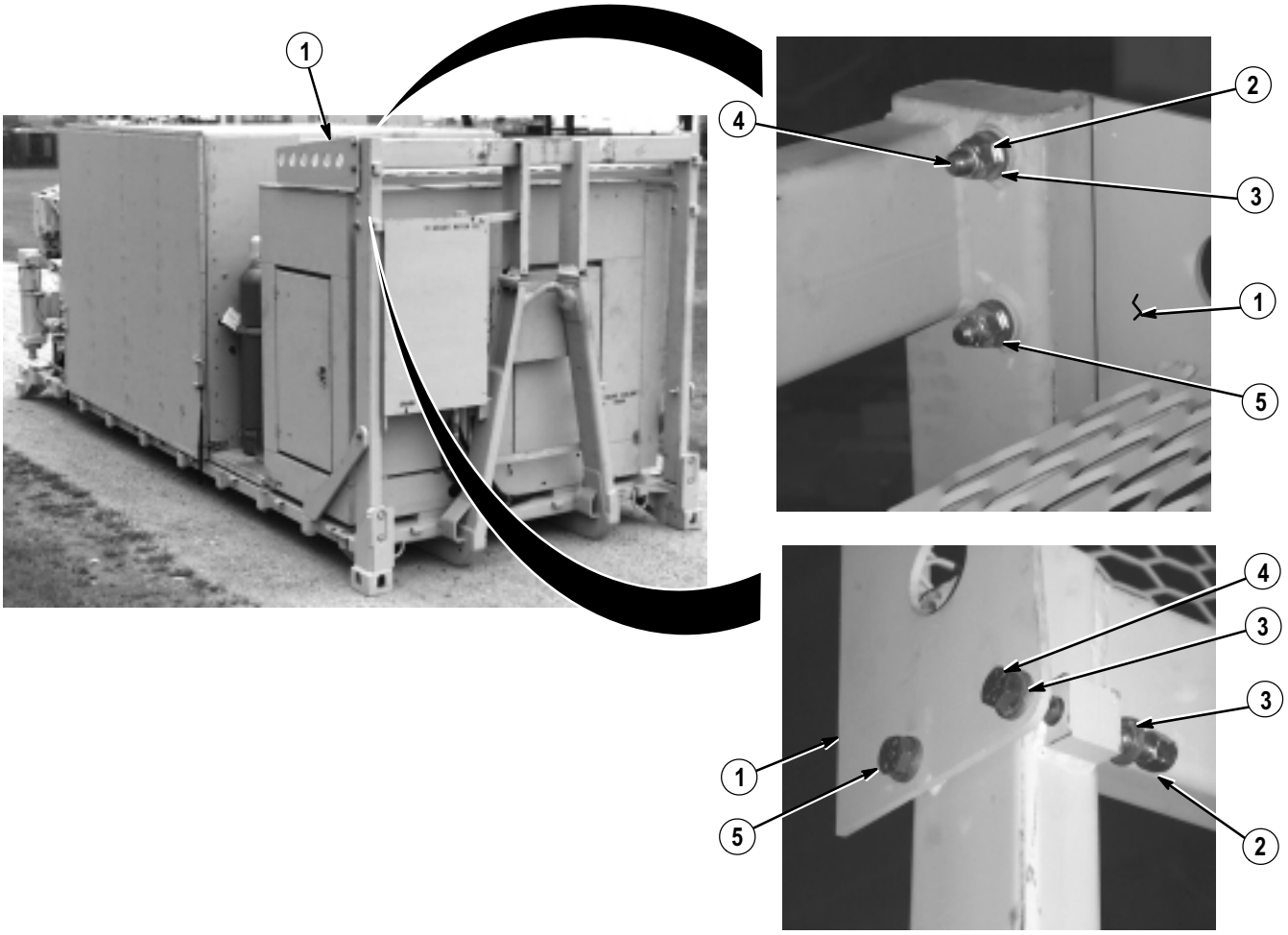
Storage rack weighs approximately 300 lbs (136 kg). Attach suitable lifting device to prevent possible injury to personnel.

NOTE

If removing generator housing with generator set on flatrack, perform Steps (1) through (5).

(1) Attach lifting device to storage rack (1).





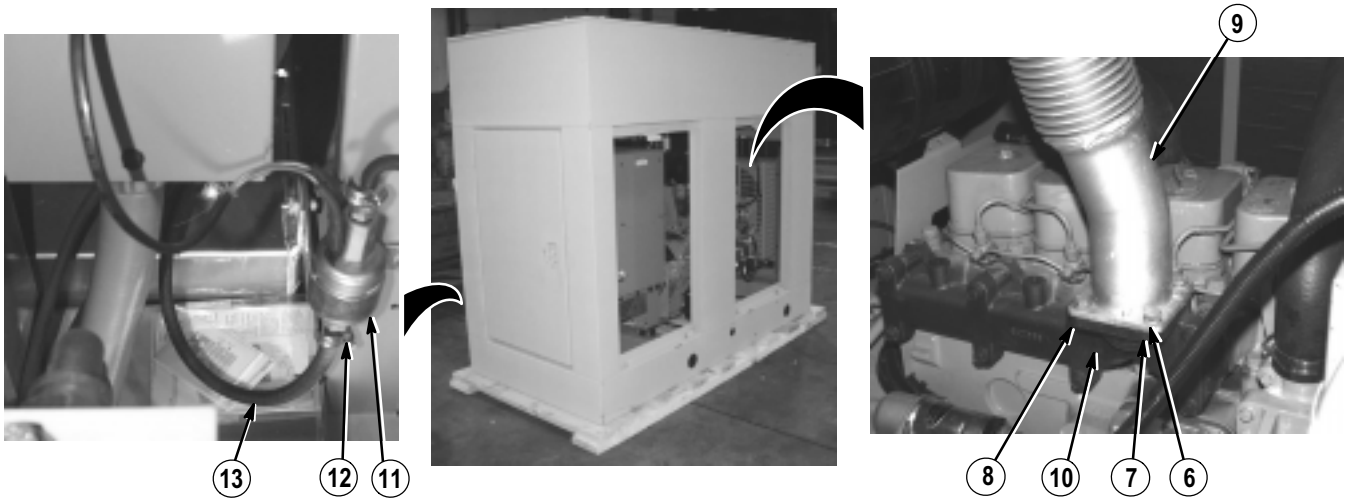
(2) Remove two top locknuts (2), washers (3) and screws (4) from storage rack (1). Retain locknuts.

(3) Loosen two bottom locknuts (5) on storage rack (1).

(4) With the aid of an assistant, pivot storage rack (1) up and place two screws (4), washers (3) and locknuts (2) in storage rack to lock in upright position.

(5) Remove lifting device from storage rack (1).

5-2. GENERATOR HOUSING REPLACEMENT (CONT).



NOTE

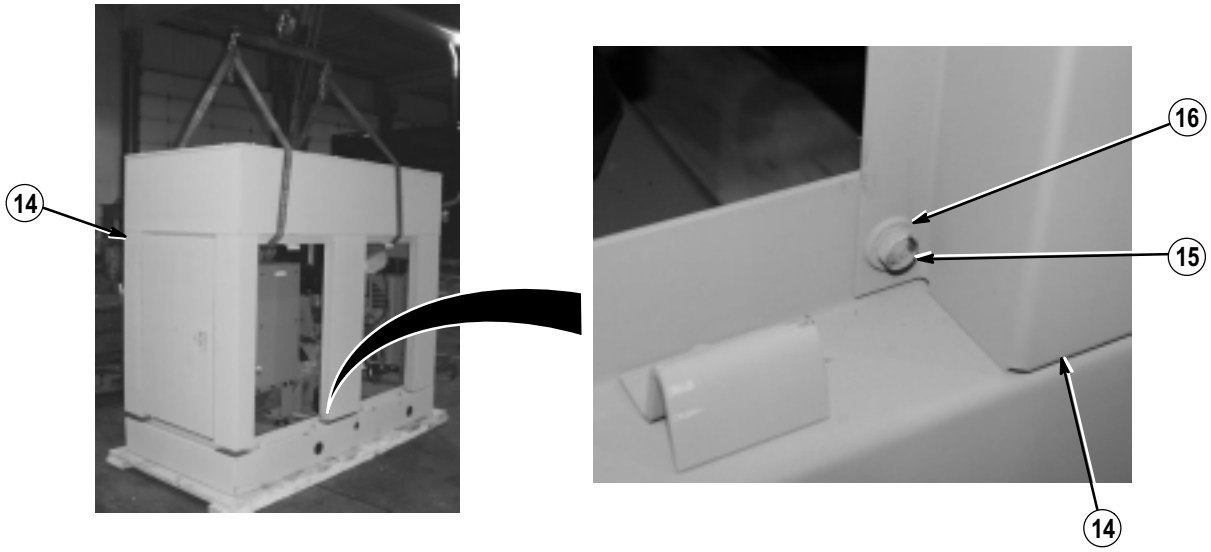
- The following procedures can be performed with generator set on or off the flatrack.
- Generator set shown off flatrack.
- Plug exhaust manifold with wiping rag or suitable material.

(6) Remove four screws (6), lockwashers (7), gasket (8), exhaust pipe (9) and exhaust manifold (10). Discard lockwashers and gasket.

(7) Loosen clamp (11) and remove hose (12) from electric fuel pump (13).

(8) Remove overflow tube from coolant surge tank (TM 9-4940-568-20).

(9) Remove fuel tank vent tube from fuel tank (TM 9-4940-568-20).



WARNING

Generator set housing weighs approximately 200 lbs (65 kg). Attach suitable lifting device to prevent possible injury to personnel.

(10) Attach lifting device to generator set housing (14).

(11) Remove 12 screws (15) and washers (16) from generator set housing (14).

(12) Remove generator set housing (14) and place on wooden blocks.

b. Installation.

WARNING

Generator set housing weighs approximately 200 lbs (65 kg). Attach suitable lifting device to prevent possible injury to personnel.

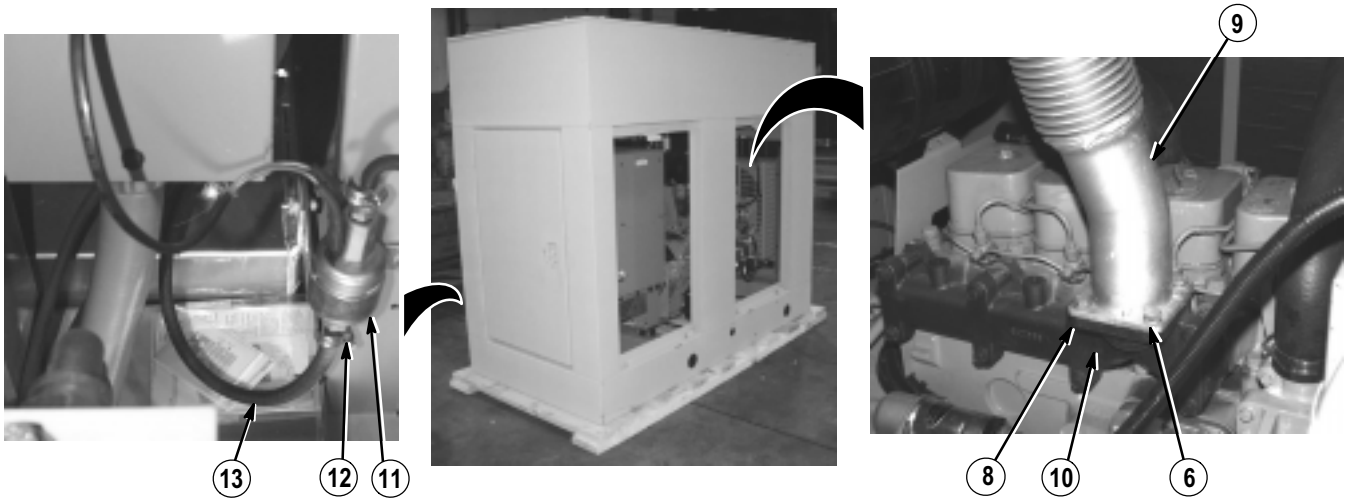
NOTE

- Remove cloth or suitable material from exhaust manifold.
- The following procedures can be performed with generator set on or off flatrack.
- Generator set shown off flatrack.

(1) Attach lifting device and install generator set housing (14) using 12 screws (15) and washers (16).

(2) Remove lifting device from generator set housing (14).

5-2. GENERATOR HOUSING REPLACEMENT (CONT).



(3) Install fuel tank vent tube on fuel tank (TM 9-4940-568-20).

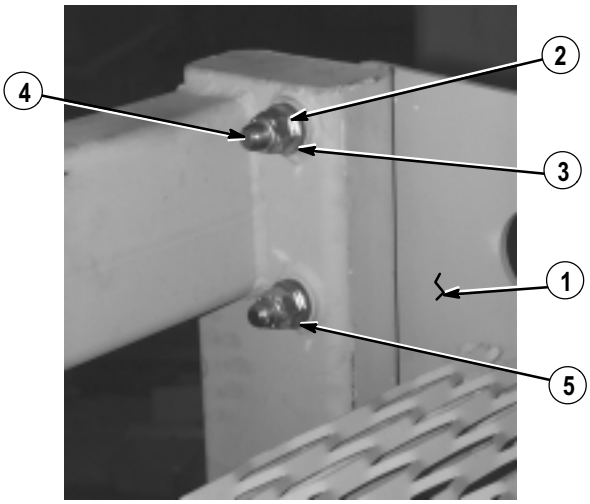
(4) Install overflow tube on coolant surge tank (TM 9-4940-568-20).

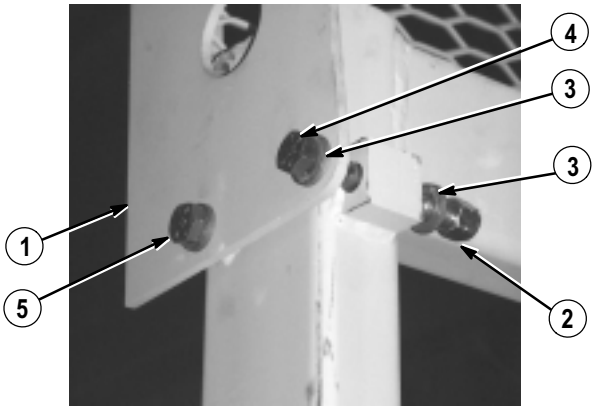
WARNING

Fuel is very flammable and can explode easily. To avoid serious injury or death, keep fuel away from open fire and keep fire extinguisher within easy reach when working with fuel. Do not work on fuel system when engine is hot. Fuel can be ignited by hot engine.

(5) Install hose (12) and clamp (11) on electric fuel pump (13).

(6) Install exhaust pipe (9), gasket (8), four lockwashers (7) and screws (6) on exhaust manifold (10).





WARNING

Storage rack weighs approximately 300 lbs (136 kg). Attach suitable lifting device to prevent possible injury to personnel.

NOTE

If installing generator housing with generator set on flatrack, perform Steps (7) through (11).

(7) With the aid of an assistant, attach lifting device to storage rack (1).

(8) With the aid of an assistant, remove two locknuts (2), washers (3) and screws (4), pivot storage rack (1) down. Discard locknuts.

(9) Install two screws (4), washers (3) and locknuts (2).

(10) Install two bottom locknuts (5) on screws (4) and storage rack (1)

(11) Remove lifting device from storage rack (1).

c. Follow-On Maintenance:

- Install generator set (if necessary), (Para 5-3).
- Connect batteries, (TM 9-4940-568-10).
- Start generator and check for proper operation, (TM 9-4940-568-10).

END OF TASK

5-3. GENERATOR SET REPLACEMENT.

This task covers:

a. Removal b. Installation c. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Cap and Plug Set (Item 6, Appendix F)
Hooks, Lifting (4) (Item 32, Appendix F)
Pan, Drain (Item 42, Appendix F)
Socket Set, 3/4 in. (Item 51, Appendix F)
Wrench, Combination, 1 -5/16 in. (Item 76, Appendix F)
Wrench, Combination, 1 -3/8 in. (Item 77, Appendix F)
Wrench, Combination 1 7/8 in. (Item 80, Appendix F)
Wrench, Torque (0 to 300 lb-ft [0-407 N·m]) (Item 84, Appendix F)
Lifting Device, Minimum Capacity 3000 lbs (2,270 kg)
Wooden Blocks (4) (Appendix C)

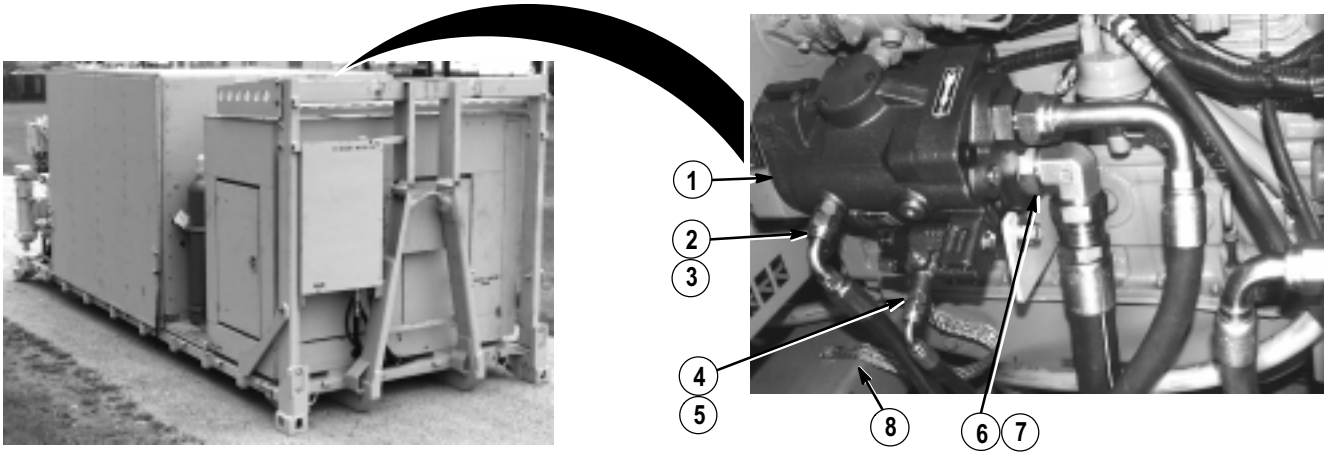
Materials/Parts
Cable Ties (Item 5, Appendix B)
Oil, Hydraulic (Item 16, Appendix B)
Sealing Compound (Item 31, Appendix B)
Tags, Identification (Item 36, Appendix B)
Locknut (4) (Item 40, Appendix E)
Lockwasher (2) (Item 61, Appendix E)
Packing, Preformed (Item 79, Appendix E)
Packing, Preformed (Item 77, Appendix E)
Packing, Preformed (Item 81, Appendix E)
Packing, Preformed (Item 98, Appendix E)
Screw, Self-Tapping (2) (Item 150, Appendix E)

Personnel Required
Three

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
Batteries disconnected, (TM 9-4940-568-10)
Brush guard support arms removed, (TM 9-4940-568-20)
Hydraulic reservoir drained, (TM 9-4940-568-20)

a. Removal.

(1) Remove air filter cover and base (TM 9-4940-568-20).



NOTE

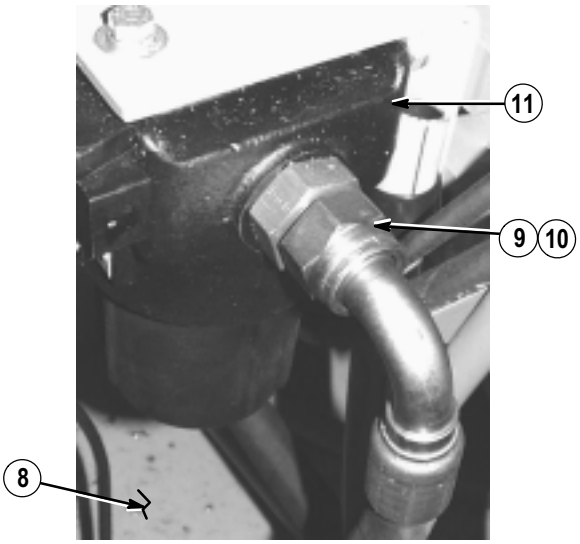
- Tag and mark all hoses and connectors before removal.
- Cap and plug hydraulic hoses and fittings after disconnecting.
- Remove cable ties as required to remove wires and hydraulic hoses.
- Place drain pan under hydraulic hoses as necessary.
- Generator set can be removed with generator set housing installed or removed. Generator set housing shown installed.

(2) Position drain pan under hydraulic pump (1).

(3) Remove hose (2) and preformed packing (3), hose (4) and preformed packing (5), hose (6) and preformed packing (7) from hydraulic pump (1) and position hoses below generator set enclosure (8).

5-3. GENERATOR SET REPLACEMENT (CONT).

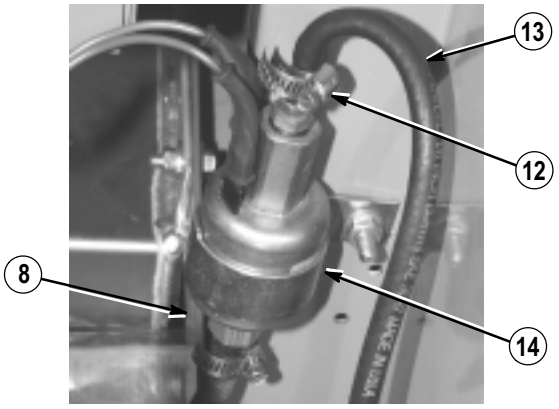
(4) Remove hose (9) and preformed packing (10) from hydraulic filter (11) and position hose below generator set enclosure (8). Discard preformed packing.



WARNING

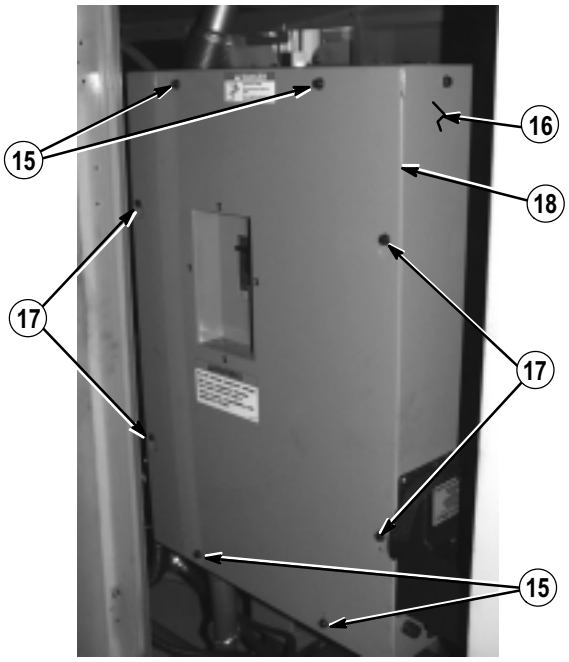
Fuel is very flammable and can explode easily. To avoid serious injury or death, keep fuel away from open fire and keep fire extinguisher within easy reach when working with fuel. Do not work on fuel system when engine is hot. Fuel can be ignited by hot engine.

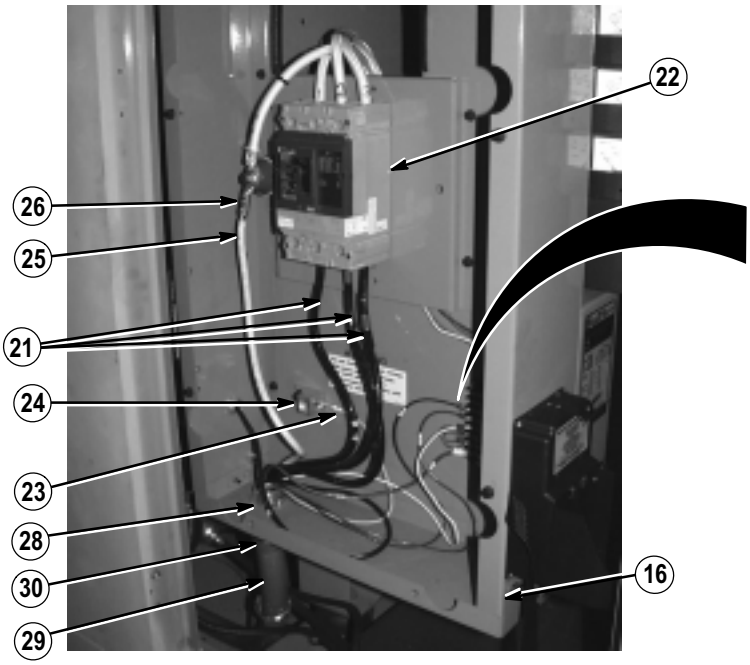
(5) Loosen clamp (12) and disconnect fuel line (13) from heater fuel pump (14). Position fuel line below generator set enclosure (8).

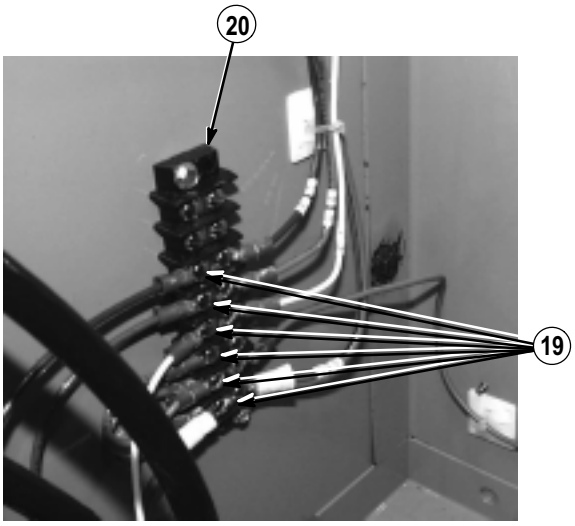


(6) Remove four screws (15) from generator circuit panel (16).

(7) Loosen four screws (17) and remove panel cover (18) from generator circuit panel (16).







NOTE

Tag and mark all wires before removal.

(8) Remove wires (19) from wire connection strip (20).

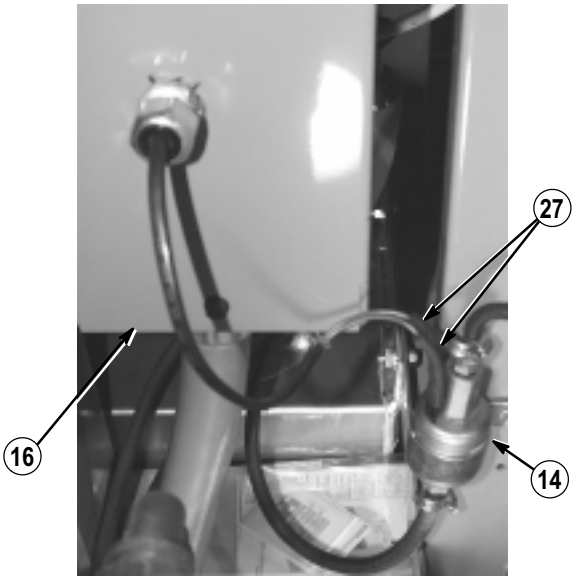
(9) Remove three wires (21) from circuit breaker (22).

(10) Remove ground wire (23) from block (24).

(11) Remove neutral wire (25) from insulator (26).

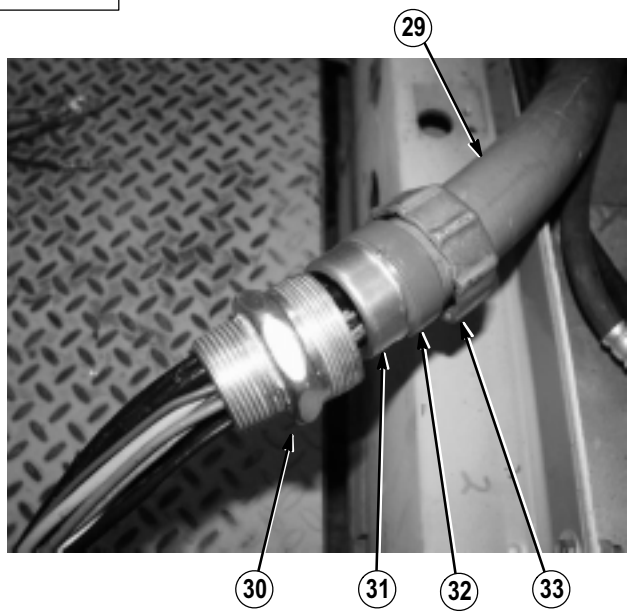
(12) Remove two wires (27) from heater fuel pump (14) and push wires in through generator circuit panel (16).

(13) Remove nut (28) and pull electrical tube (29), electrical connector (30) and wires out through generator circuit panel (16) and nut.

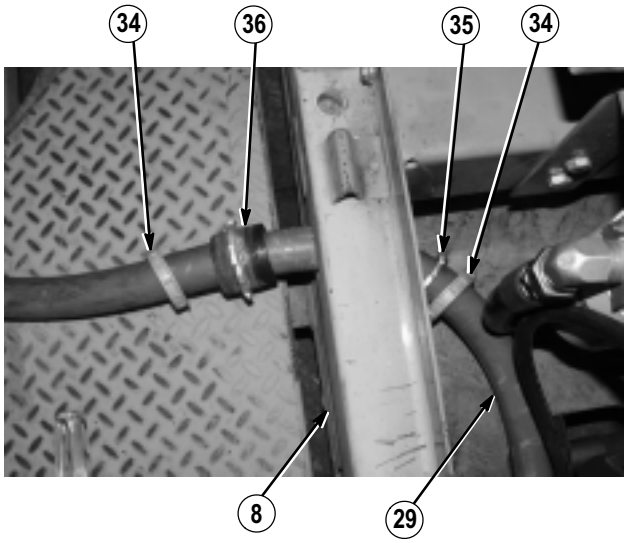


5-3. GENERATOR SET REPLACEMENT (CONT).

(14) Remove electrical connector (30), inner sleeve (31), outer sleeve (32) and nut (33) from electrical tube (29).



(15) Remove two end nuts (34), nut (35) and pull electrical connector (36) and electrical tube (29) with wires out through generator set enclosure (8).

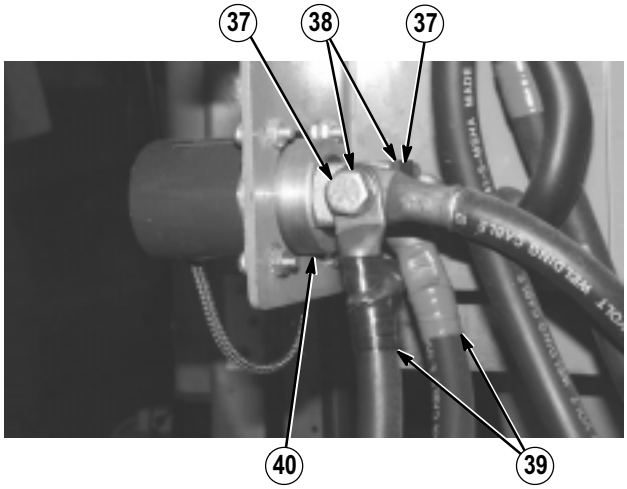


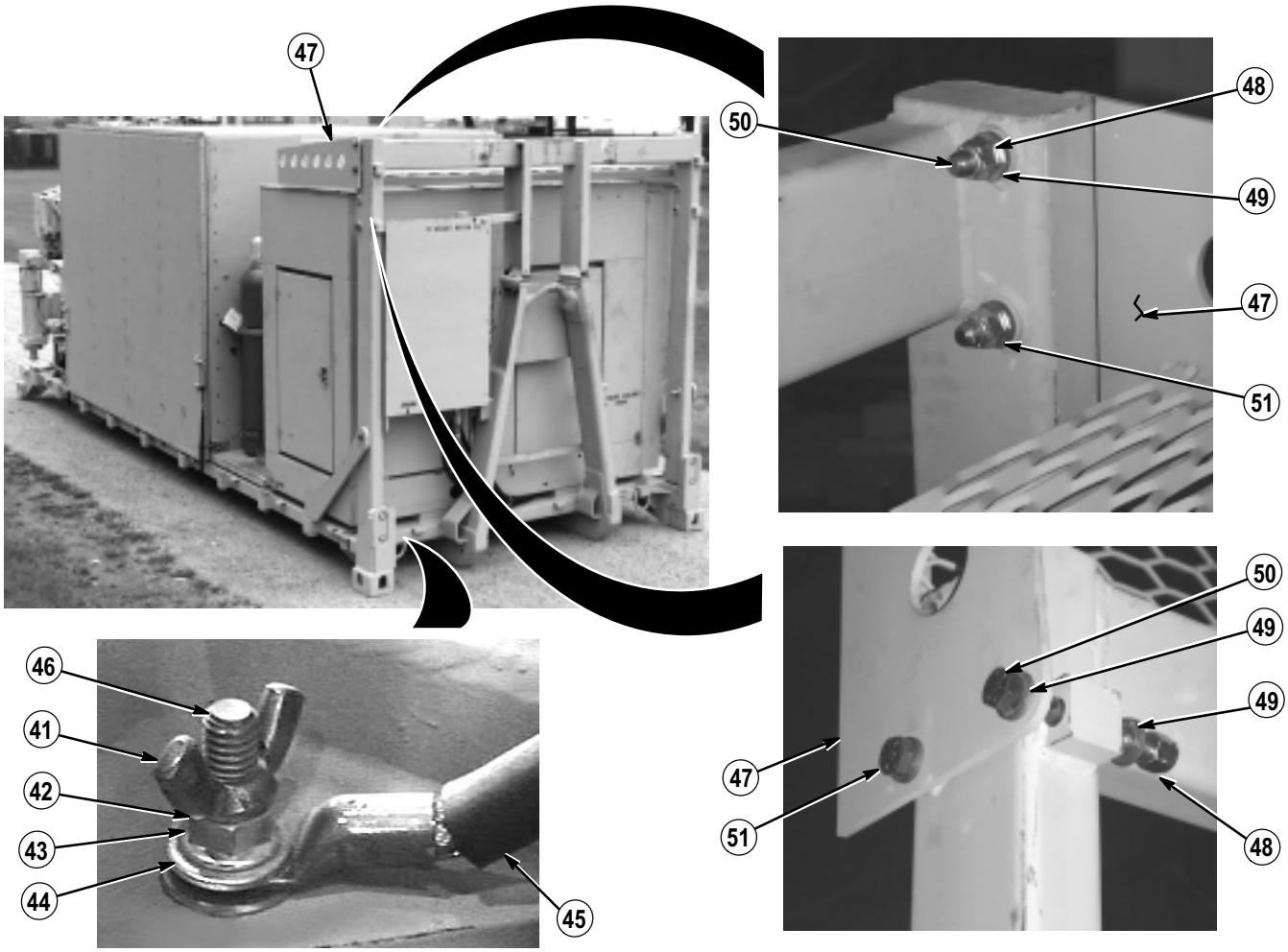
NOTE

Note position of wires prior to removal.

(16) Remove two screws (37), lockwashers (38) and wires (39) from slave receptacle (40). Discard lockwashers.

(17) Pull two wires out through generator set enclosure (8).





(18) Remove wingnut (41), starwasher (42), nut (43), starwasher (44) and grounding cable (45) from grounding stud (46).

WARNING

Storage rack weighs approximately 300 lbs (136 kg). Attach suitable lifting device to prevent possible injury to personnel.

(19) Attach lifting device to storage rack (47).

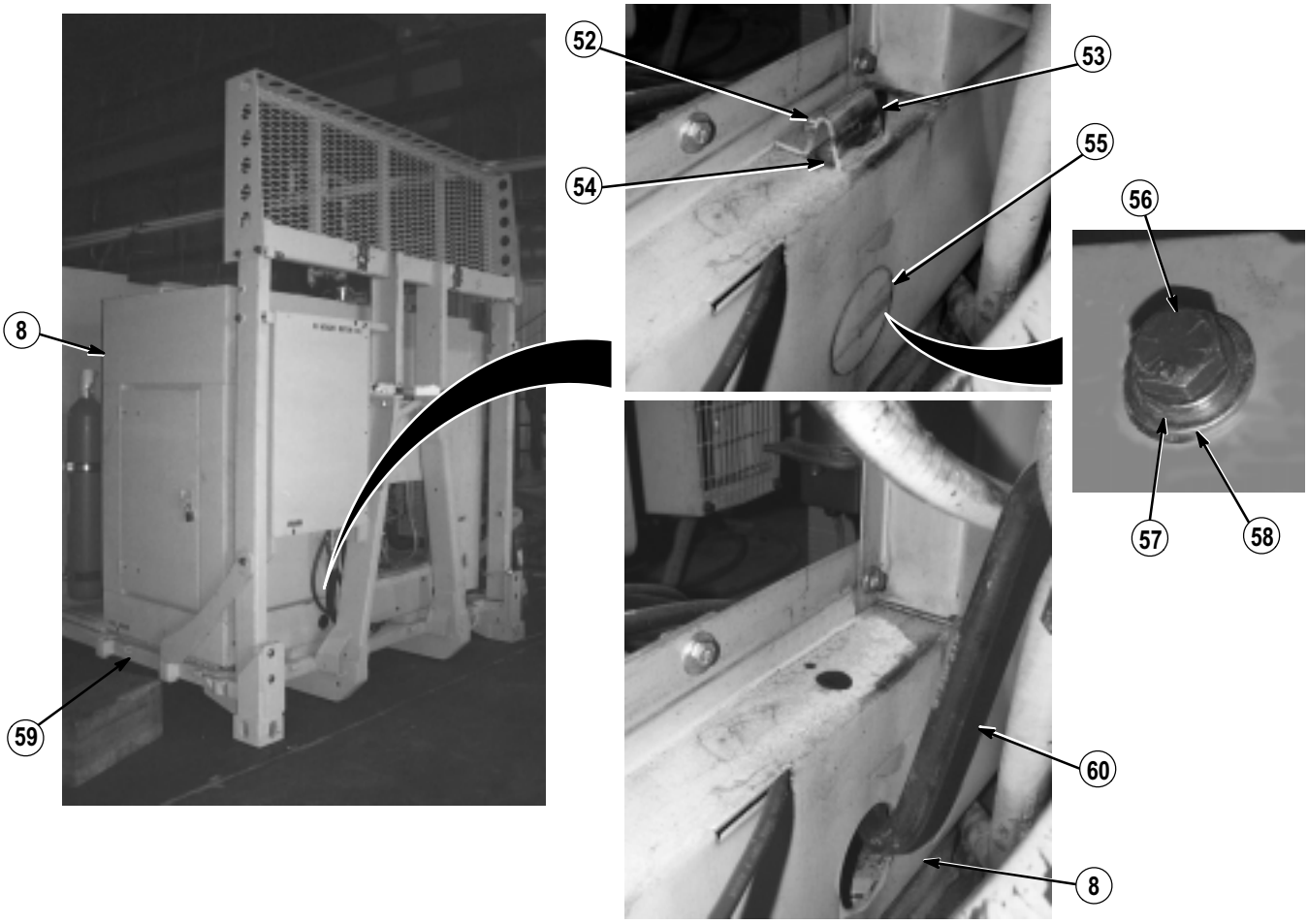
(20) Remove two top locknuts (48), washers (49) and screws (50) from storage rack (47). Retain locknuts.

(21) Loosen two bottom locknuts (51) on storage rack (47).

(22) With the aid of an assistant, pivot storage rack (47) up and place two screws (50), washers (49) and locknuts (48) in storage rack to lock in upright position.

(23) Remove lifting device from storage rack (47).

5-3. GENERATOR SET REPLACEMENT (CONT).



(24) Remove two self-tapping screws (52) and brackets (53) from generator set enclosure (8). Discard self-tapping screws.

(25) Remove four small rubber covers (54) and four large rubber covers (55) from generator set enclosure to expose screws (56).

(26) Remove four screws (56), washers (57) and washers (58) from generator set enclosure (8) and flatrack (59).

WARNING

Generator set enclosure weighs approximately 2450 lbs (1111 kg). Attach suitable lifting device to prevent possible injury to personnel.

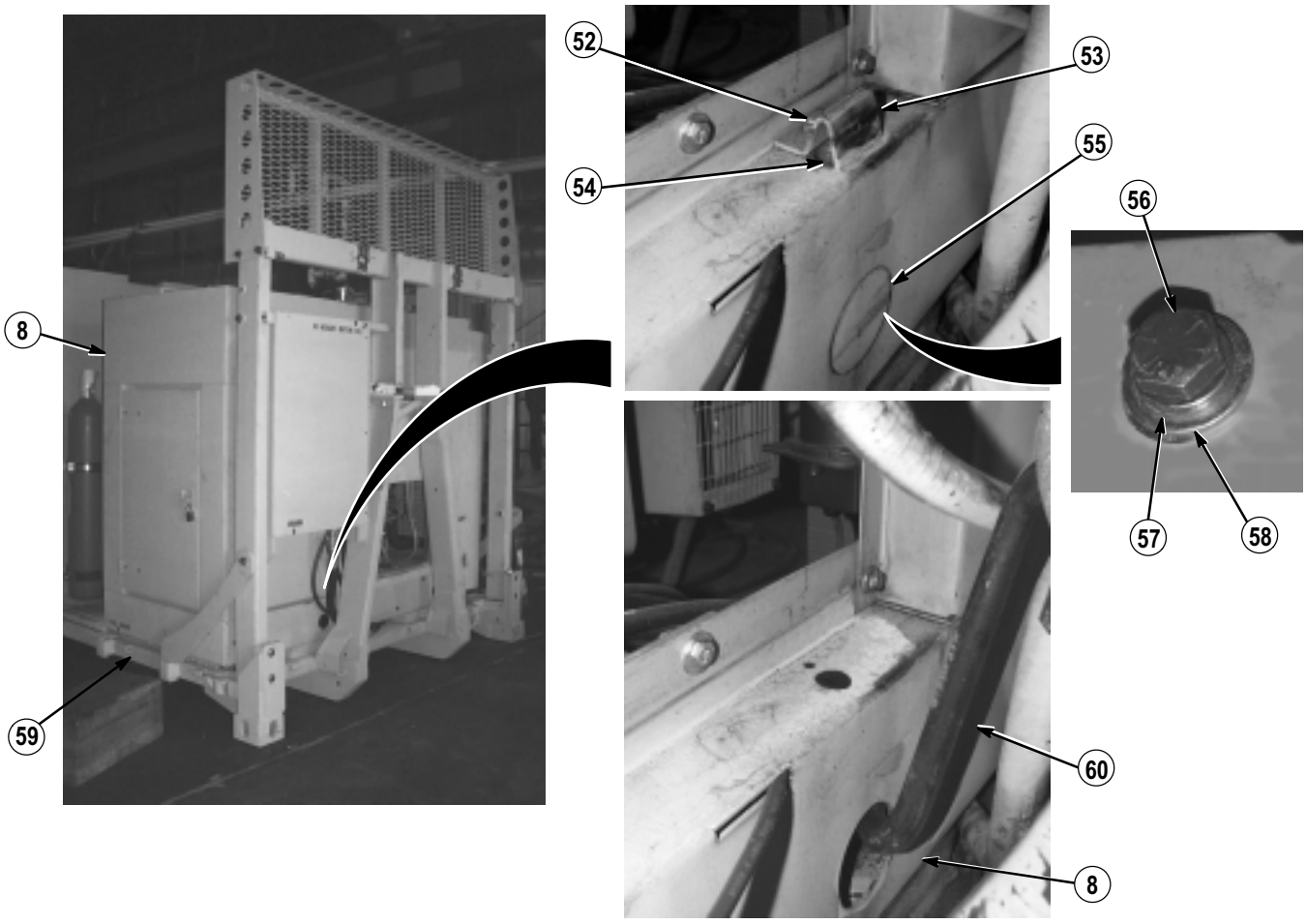
(27) With the aid of assistants, position S-hooks (60) and attach lifting device to generator set enclosure (8).

(28) With the aid of assistants, raise generator set enclosure (8) approximately 20 in. (508 mm) and ensure load is balanced.

(29) With the aid of assistants, position generator set enclosure (8) on wooden blocks.

(30) Remove lifting device and four S-hooks (60) from generator set enclosure (8).

b. Installation.



WARNING

Generator set enclosure weighs approximately 2450 lbs (1111 kg). Attach suitable lifting device to prevent possible injury to personnel.

(1) With the aid of assistants, position S-hooks (60) and attach lifting device to generator set enclosure (8).

(2) With the aid of assistants, position generator set enclosure (8) on flatrack (59).

(3) Remove lifting device and four S-hooks (60) from generator set enclosure (8).

WARNING

Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

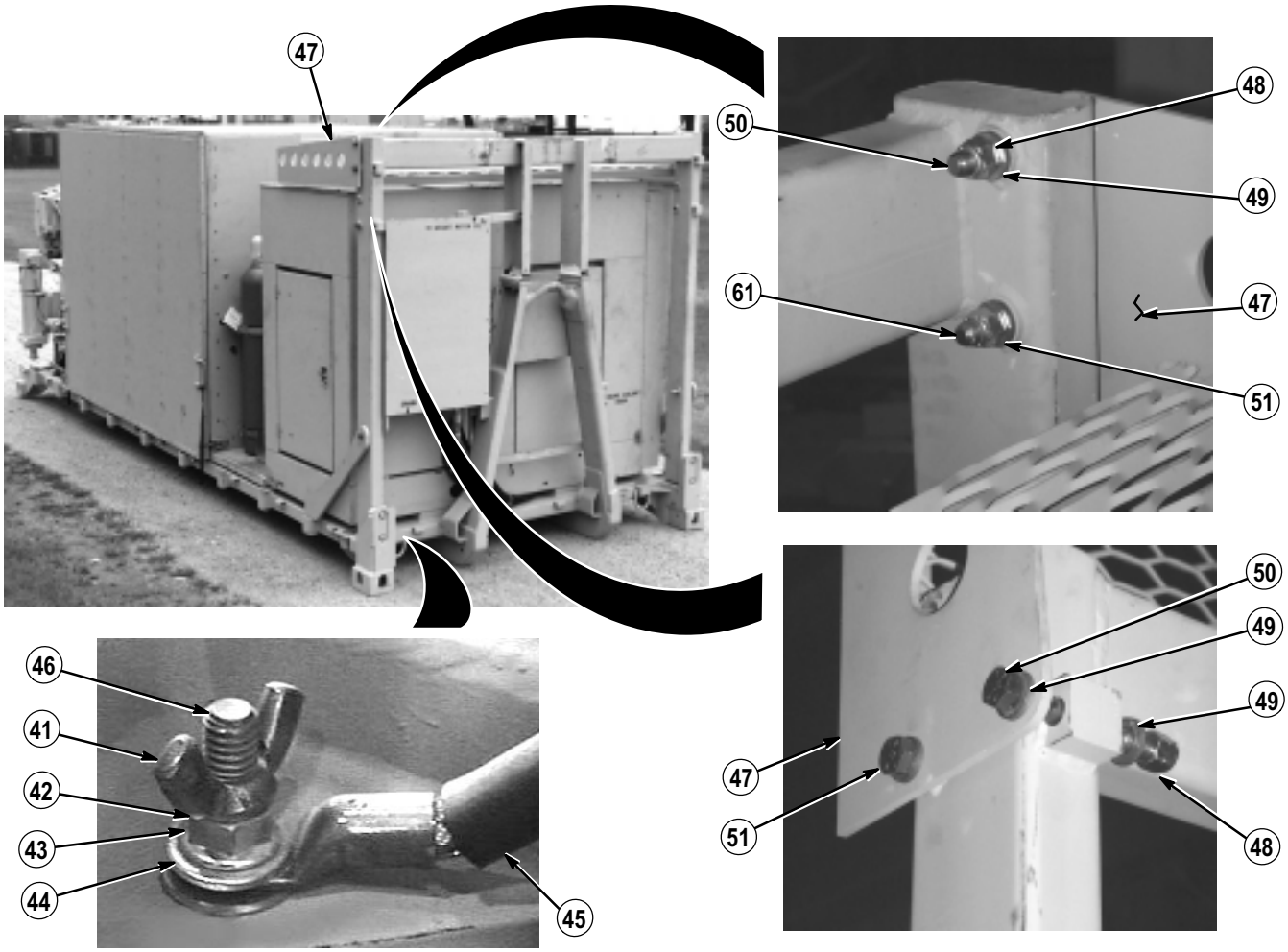
(4) Apply sealing compound to four screws (56).

(5) With the aid of assistants, install generator set enclosure (8) on flatrack (59) using four washers (58), washers (57) and screws (56). Tighten four screws (56) to 210 ft-lb (285 N·m).

(6) Install four large rubber covers (55) and four small rubber covers (54) on generator set enclosure (8).

(7) Install two brackets (53) with self-tapping screws (52) on generator set enclosure (8).

5-3. GENERATOR SET REPLACEMENT (CONT).



WARNING

Storage rack weighs approximately 300 lbs (136 kg). Attach suitable lifting device to prevent possible injury to personnel.

(8) With the aid of an assistant, attach lifting device to storage rack (47).

(9) With the aid of an assistant, remove two locknuts (48), washers (49) and screws (50), pivot storage rack (47) down. Discard locknuts.

(10) Install two screws (50), washers (49) and locknuts (48).

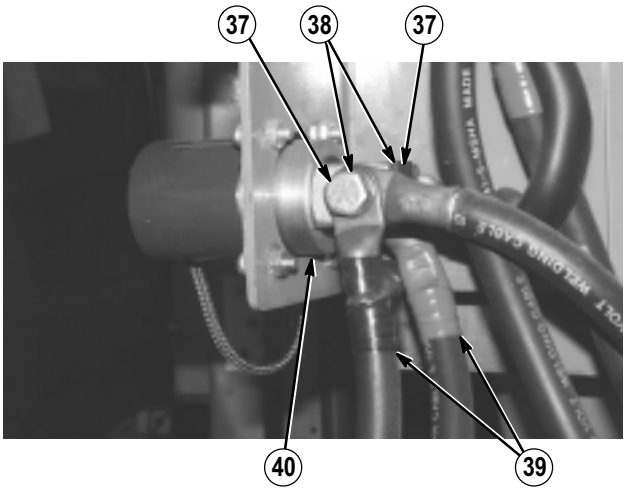
(11) Remove two bottom locknuts (51) on storage rack (47). Discard locknuts.

(12) Install two bottom locknuts (51) on screw (61) and storage rack (47).

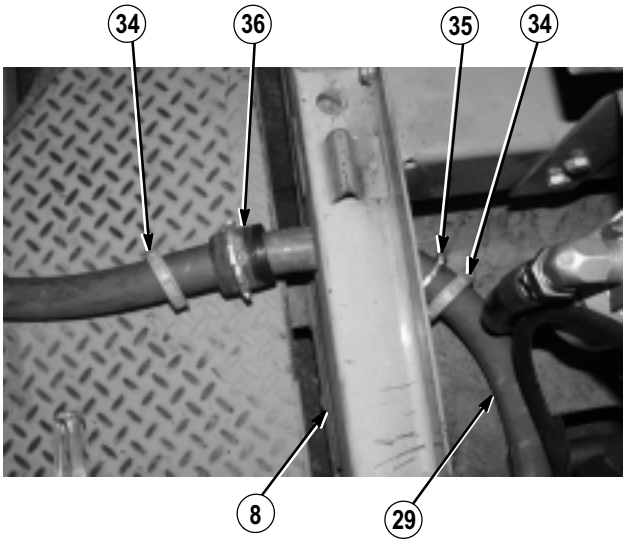
(13) Remove lifting device from storage rack (47).

(14) Install grounding cable (45), starwasher (44), nut (43), starwasher (42) and wingnut (41) on grounding stud (46).

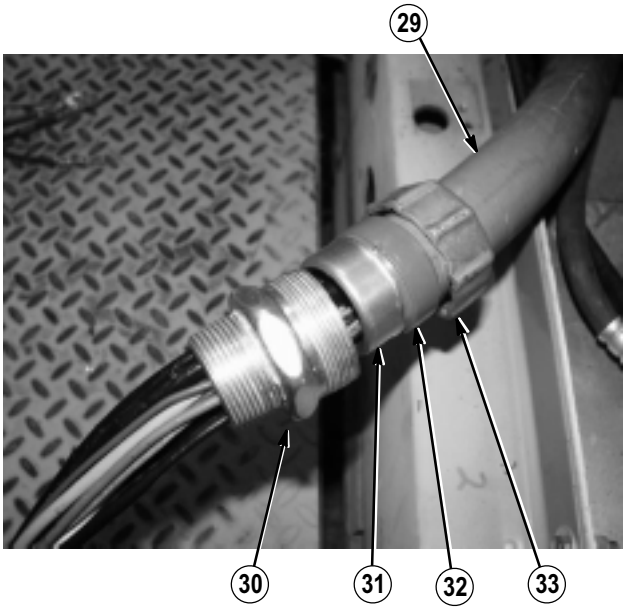
(15) Install two wires (39), lockwashers (38) and screws (37) on slave receptacle (40).



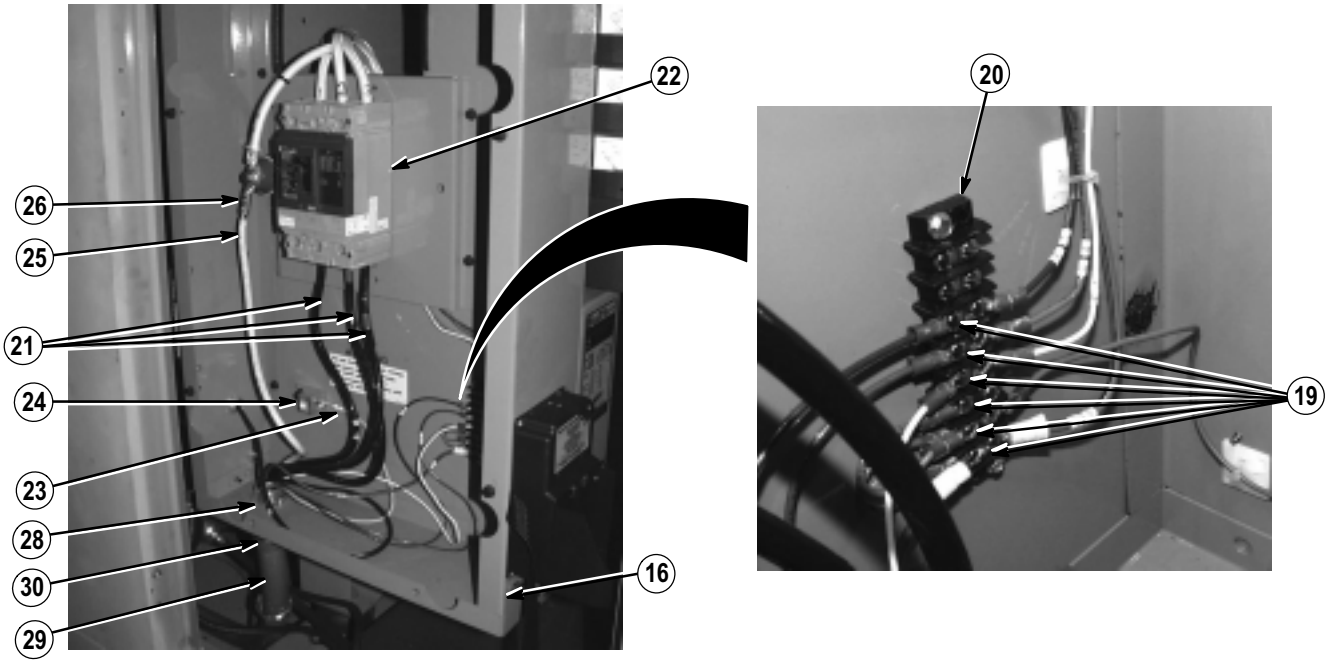
(16) Push electrical wires with electrical tube (29) and electrical connector (36) through generator set enclosure (8) and tighten nut (35) and two end nuts (34).



(17) Install electrical connector (30), inner sleeve (31), outer sleeve (32) and nut (33) on electrical tube (29).



5-3. GENERATOR SET REPLACEMENT (CONT).



(18) Push electrical wires with electrical tube (29) and electrical connector (30) through generator circuit panel (16) and nut (28) and tighten nut.

NOTE

Install hoses and connectors as noted during removal.

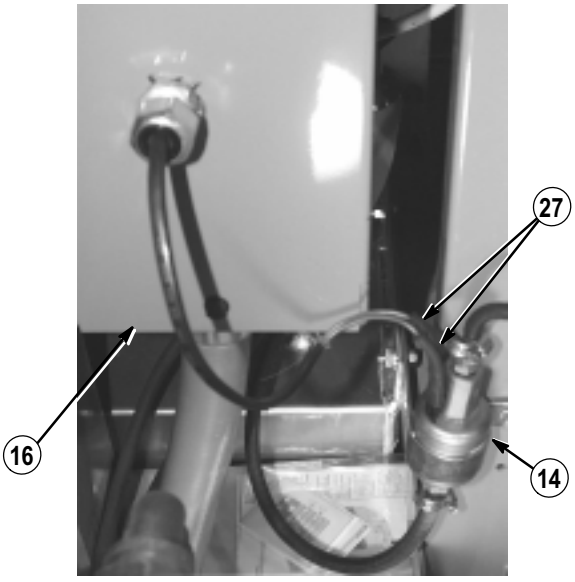
(19) Push two wires (27) out through generator circuit panel (16) and install on heater fuel pump (14).

(20) Install neutral wire (25) on insulator (26).

(21) Install ground wire (23) on block (24).

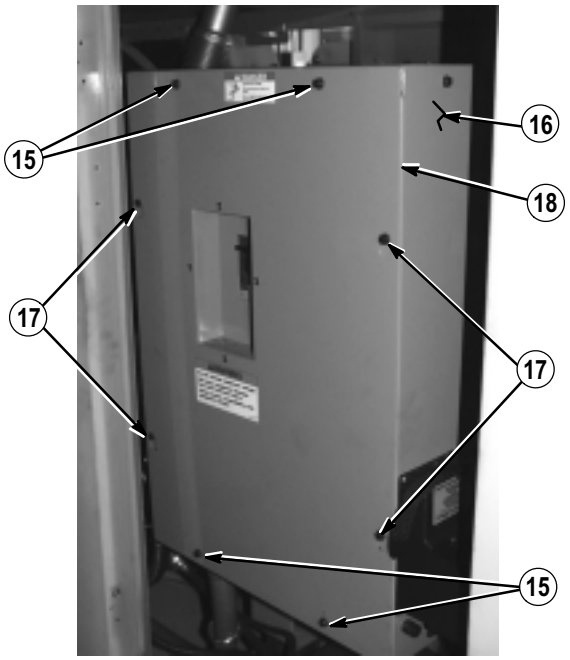
(22) Install three wires (21) on circuit breaker (22).

(23) Install wires (19) on wire connection strip (20).



(24) Position panel cover (18) on generator circuit panel (16) and install four screws (15).

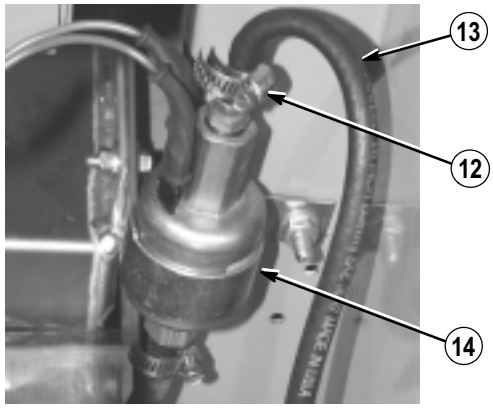
(25) Tighten four screws (17) on generator circuit panel (16).



WARNING

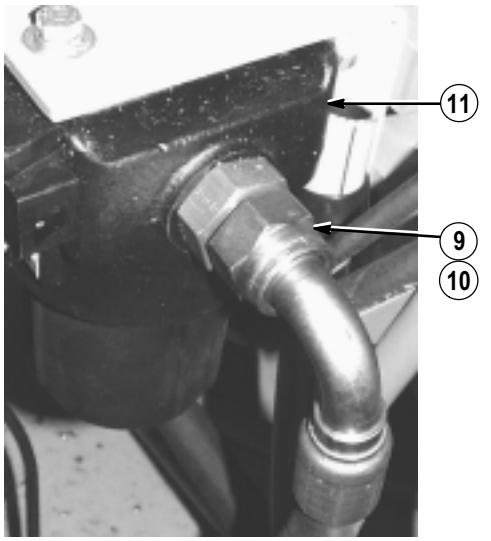
Fuel is very flammable and can explode easily. To avoid serious injury or death, keep fuel away from open fire and keep fire extinguisher within easy reach when working with fuel. Do not work on fuel system when engine is hot. Fuel can be ignited by hot engine.

(26) Install shelter heater fuel line (13) on heater fuel pump (14). Tighten clamp (12).



(27) Apply hydraulic oil to prefromed packing (10).

(28) Install supply hydraulic hose (9) and preformed packing (10) on hydraulic filter (11).

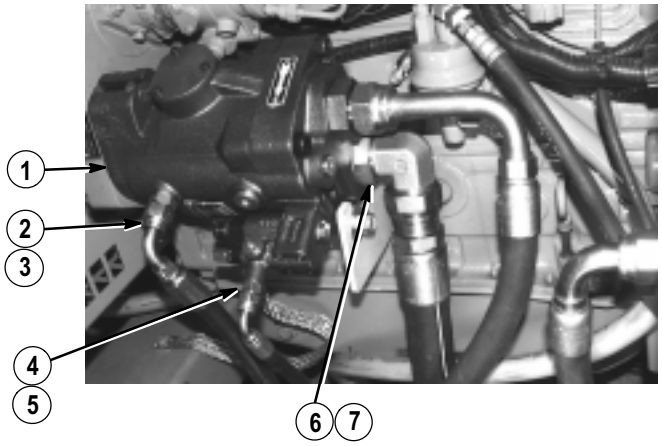


5-3. GENERATOR SET REPLACEMENT (CONT).

(29) Apply hydraulic oil to preformed packings (7), (5) and (3).

(30) Install hose (6), preformed packing (7), hose (4), preformed packing (5), hose (2) and preformed packing (3) on hydraulic pump (1).

(31) Install air filter cover and base (TM 9-4940-568-20).



c. Follow-On Maintenance:

- Install brush guard support arms, (TM 9-4940-568-20).
- Fill fuel tank, (TM 9-4940-568-10).
- Fill hydraulic reservoir, (TM 9-4940-568-20).
- Connect batteries, (TM 9-4940-568-10).
- Start engine and run for three minutes, (TM 9-4940-568-10).
- Shut down engine, (TM 9-4940-568-10).
- Check for fuel leaks, (TM 9-4940-568-10).

END OF TASK

5-4. ENGINE REPLACEMENT.

This task covers:

a. Removal b. Installation c. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Engine Turnover Tool (Item 18, Appendix F)
Jackstand (3) (Item 35, Appendix F)
Wrench, Torque (0 to 300 lb-ft [0-470 N·m]) (Item 84, Appendix F)
Pin, Alignment (Appendix C)
Lifting Device, Minimum Capacity 700 lbs (227 kg)
Wooden Blocks (4) (Appendix C)

Materials/Parts
Cable Ties (Item 5, Appendix B)
Rag, Wiping (Item 23, Appendix B)
Tags, Identification (Item 36, Appendix B)

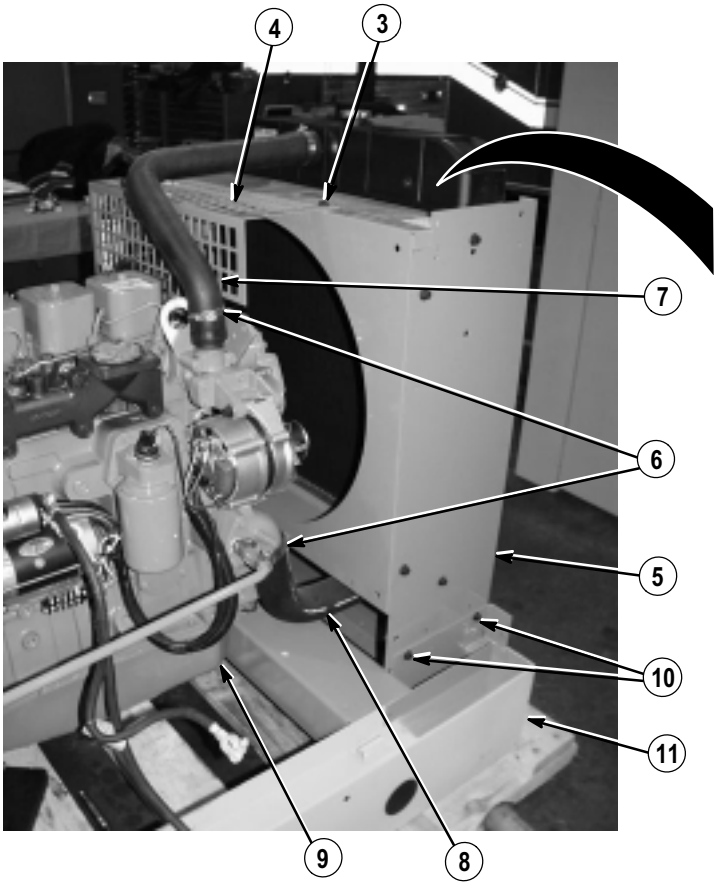
Materials/Parts – Continued
Lockwasher (Item 62, Appendix E)
Lockwasher (10) (Item 52, Appendix E)
Lockwasher (Item 53, Appendix E)

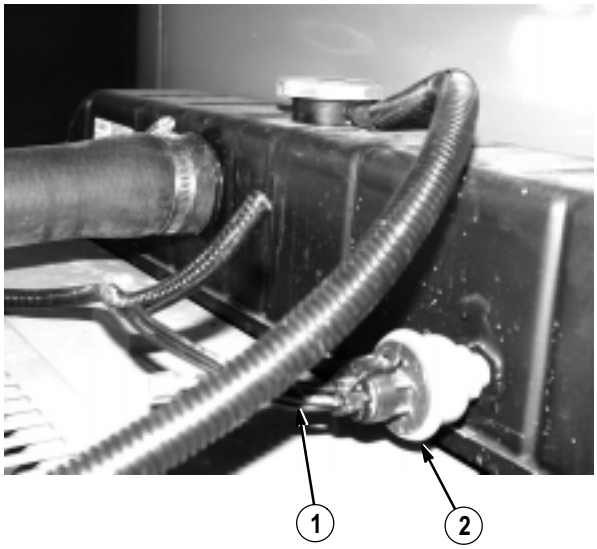
Personnel Required
Two

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
Batteries disconnected, (TM 9-4940-568-10)
Drain coolant, (TM 9-4940-568-20)
Engine block heater removed, (TM 9-4940-568-20)
Hydraulic filter removed, (TM 9-4940-568-20)
Generator set removed (if necessary), (Para 5-3)
Generator housing removed, (Para 5-2)

5-4. ENGINE REPLACEMENT (CONT).

a. Removal.





(1) Remove wires (1) from low coolant level sensor (2).

(2) Remove fan (TM 9-4940-568-20).

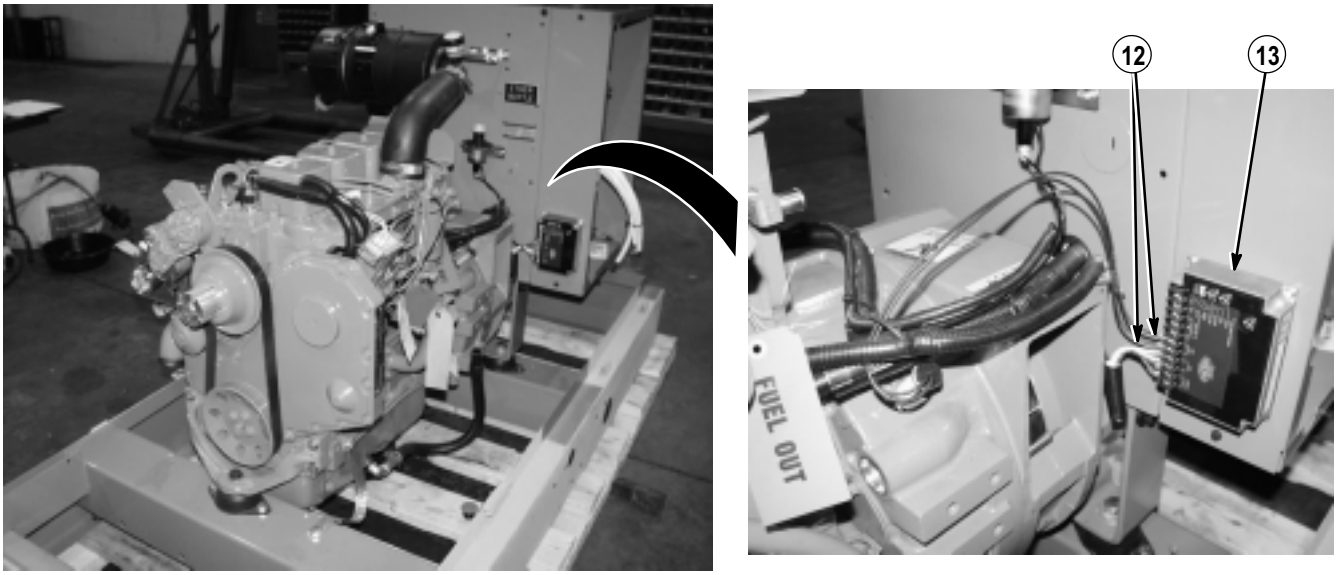
(3) Remove five screws (3) and fan shroud (4) from radiator assembly (5).

(4) Loosen two hose clamps (6) and remove radiator hoses (7) and (8) from engine (9).

WARNING

Radiator assembly weighs approximately 50 lbs (23 kg). Use an assistant to help remove radiator assembly or possible injury to personnel may result.

(5) With the aid of an assistant, remove four screws (10) and radiator assembly (5) from generator set frame (11).

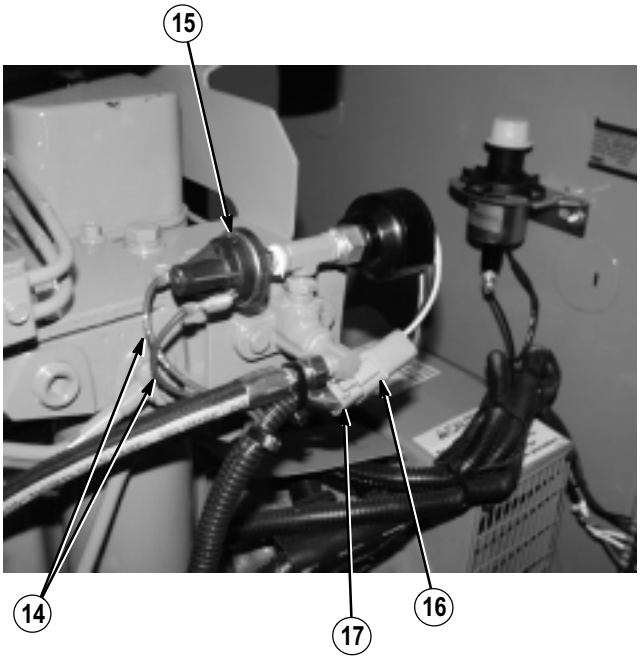


NOTE

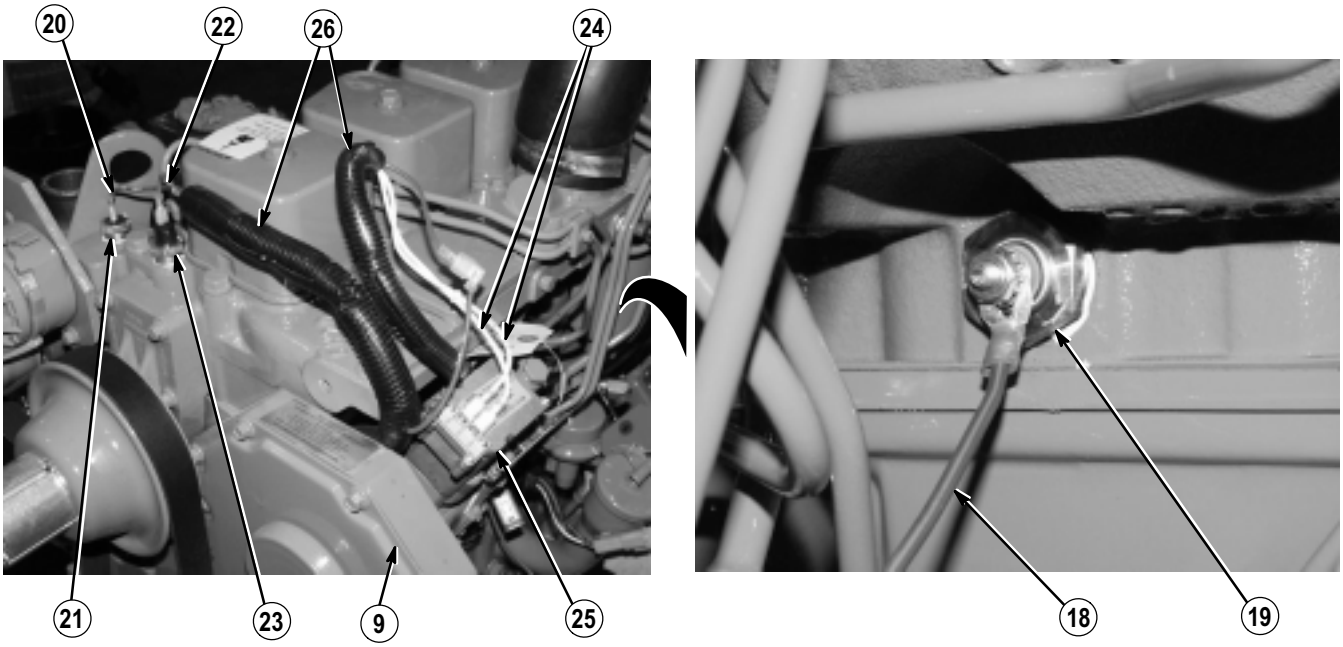
- Remove cable ties as necessary.
- Tag and mark all wires prior to removal.

(6) Disconnect two magnetic pickup wires (12) from terminal # 5 and 6 of electronic overspeed module (13).

(7) Remove wires (14) from low oil pressure sensor S5 switch (15) and disconnect oil pressure sender E1 switch (16) connector from harness connector (17).



5-4. ENGINE REPLACEMENT (CONT).



(8) Remove wire (18) from cylinder head temperature switch E2 (19).

(9) Remove wire J2-3 (20) from S6 pre-high coolant temperature sensor (21) and wire J2-5 (22) from S2 coolant temperature sensor (23).

(10) Remove two wires (24) from electronic fuel shutoff valve (25).

WARNING

Fuel is very flammable and can explode easily. To avoid serious injury or death, keep fuel away from open fire and keep fire extinguisher within easy reach when working with fuel. Do not work on fuel system when engine is hot. Fuel can be ignited by hot engine.

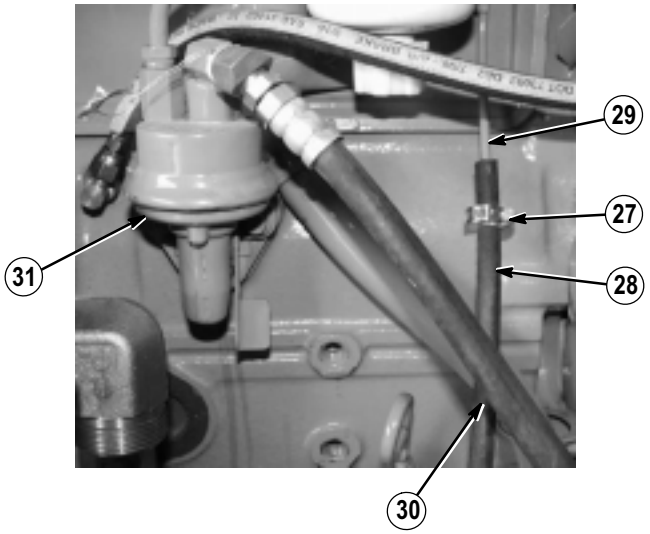
NOTE

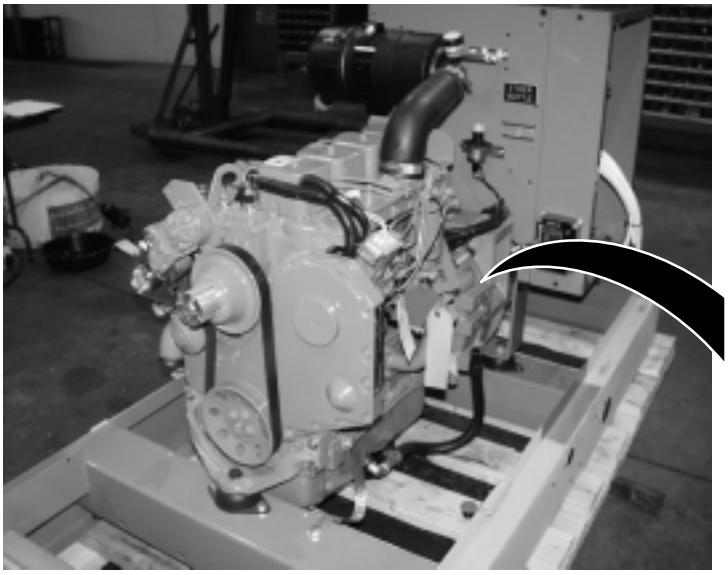
Note position of wire harness prior to removal.

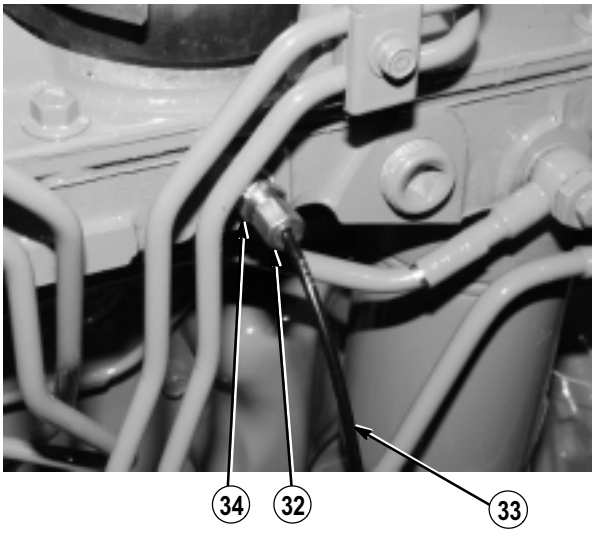
(11) Remove wire harnesses (26) from engine (9).

(12) Remove clamp (27) and fuel return hose (28) from fuel return tube (29).

(13) Remove fuel hose (30) from fuel pump (31).



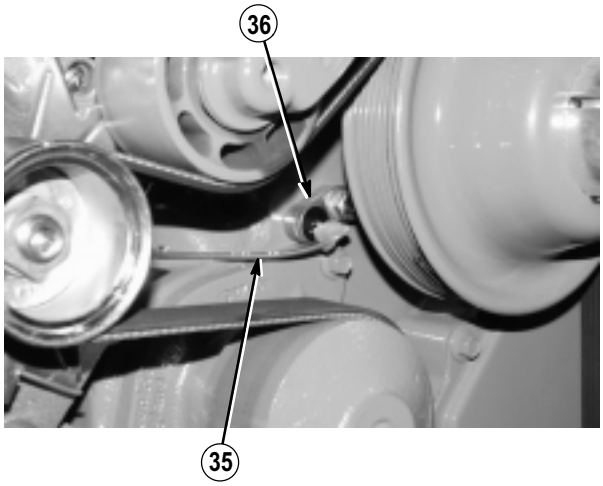




(14) Remove fitting (32) and tube (33) from ether start adapter (34).

(15) Remove wires from alternator (TM 9-4940-568-20).

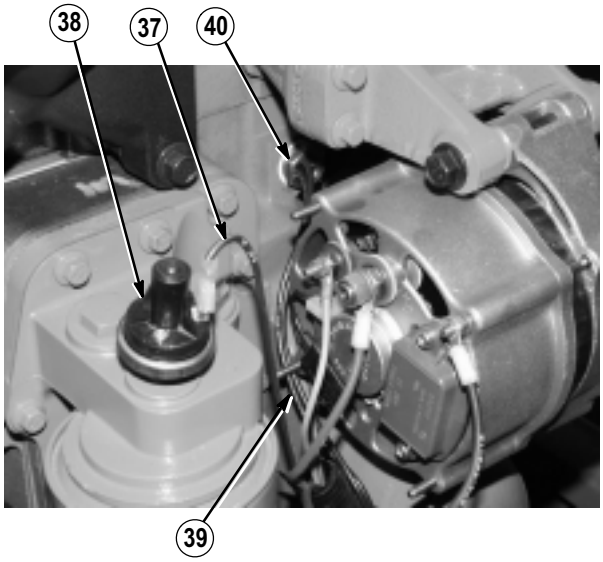
(16) Remove wire (35) from S4 low engine temperature sensor (36).



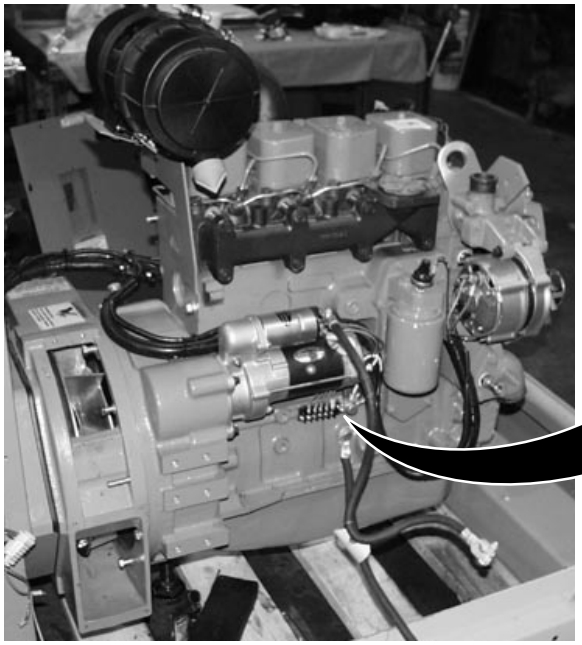
(17) Remove wire (37) from S1 pre-low oil pressure sensor (38).

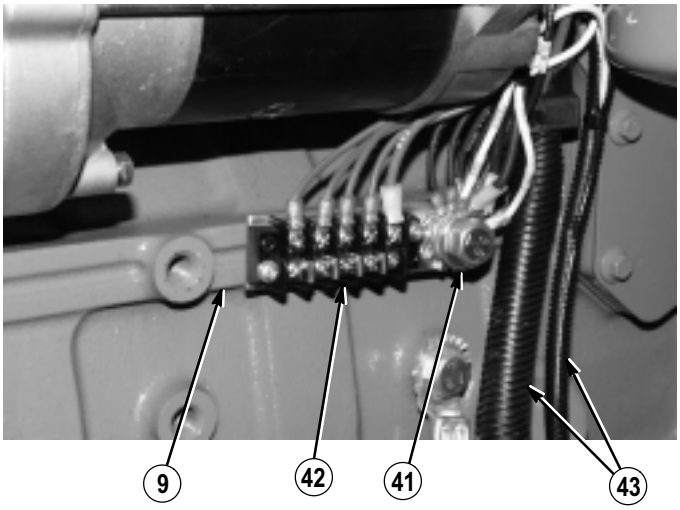
(18) Remove wires (39) from ether thermostat (40).

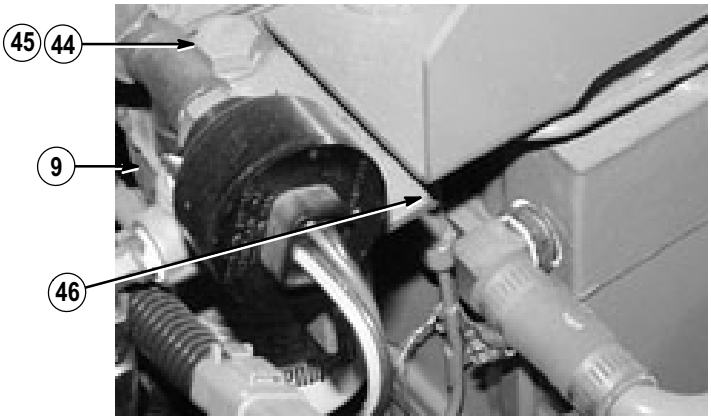
(19) Remove wires from starter (TM 9-4940-568-20).



5-4. ENGINE REPLACEMENT (CONT).







(20) Remove screw (41) and wire bar assembly (42) from engine (9).

(21) Remove engine air cleaner bracket (TM 9-4940-568-20).

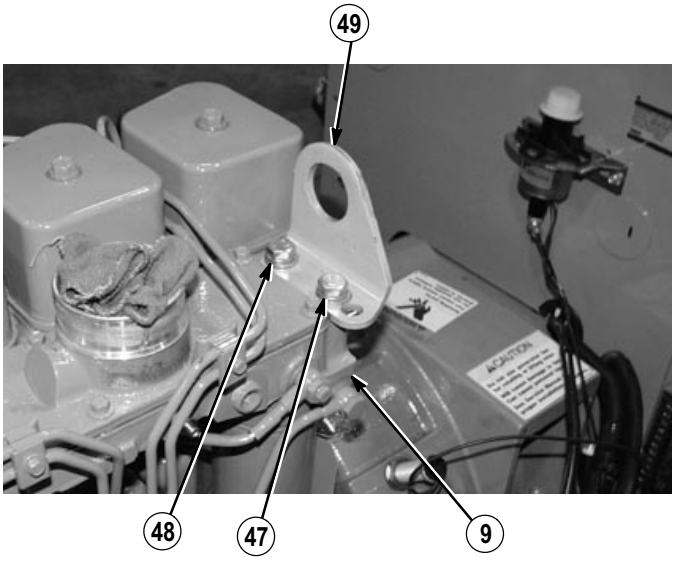
(22) Remove harness (43) from engine (9).

(23) Remove screw (44), lockwasher (45) and sensor bracket (46) from engine (9). Discard lockwasher.

NOTE

Use two screws from air cleaner removal to attach lifting bracket.

(24) Install screw (47), screw (48) and lifting bracket (49) to engine (9).

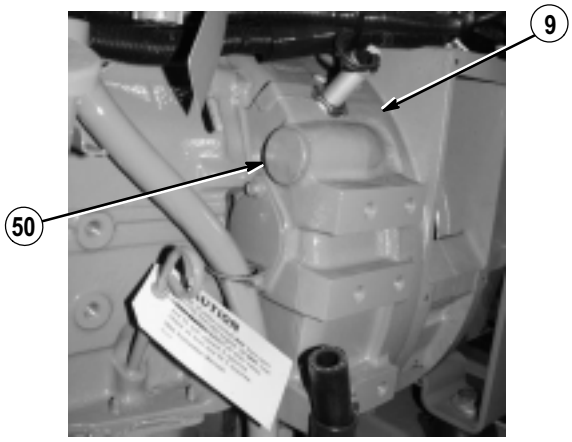


WARNING

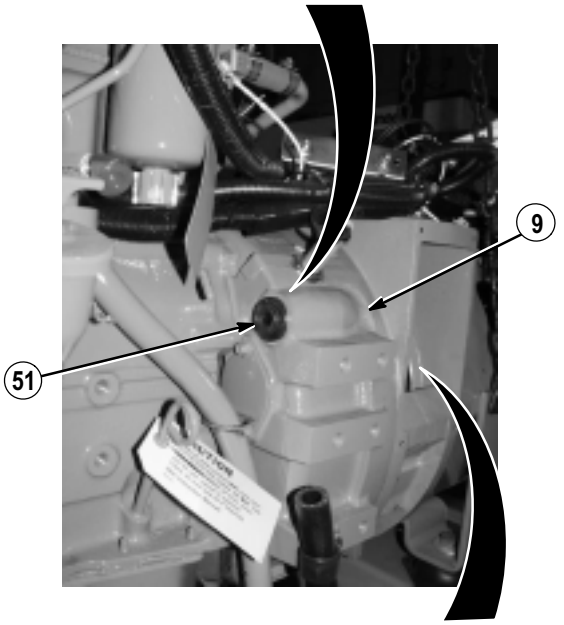
Engine weighs approximately 680 lbs (308 kg). Attach suitable lifting device to prevent possible injury to personnel.

(25) Attach lifting device to engine (9).

(26) Remove cover (50) from engine (9).



(27) Install engine turnover tool (51) on engine (9).



NOTE

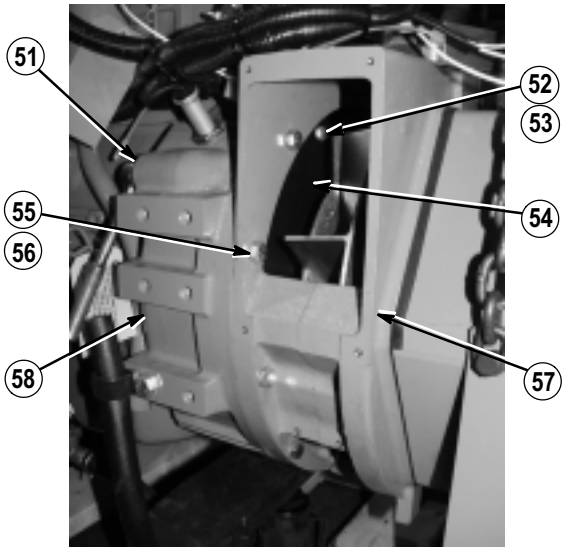
The engine should be turned over until one of the four poles of the rotor points straight down.

(28) Using engine turnover tool (51), turn engine over and remove eight screws (52) and washers (53) from drive discs (54).

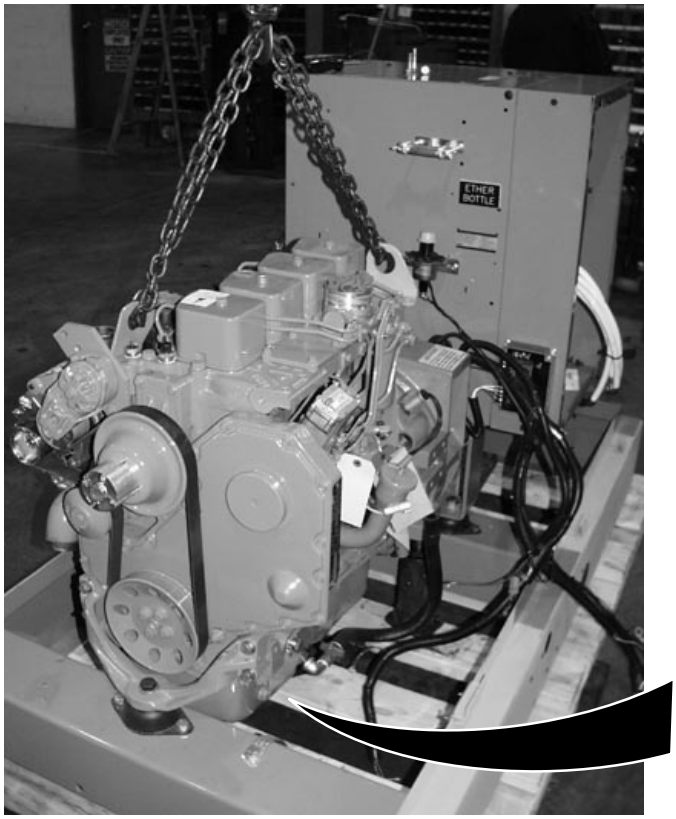
(29) Remove ten screws (55) and lockwashers (56) from generator adapter (57) and flywheel housing (58). Discard lockwashers.

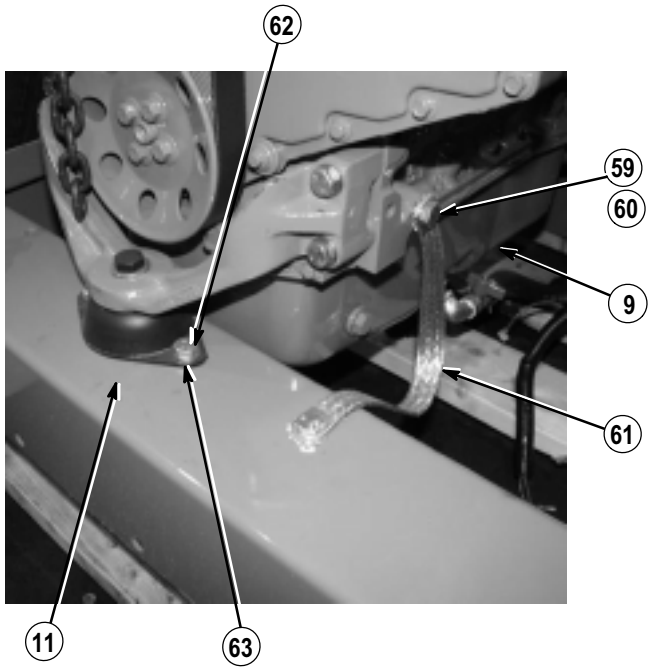
(30) Remove engine turnover tool (51).

(31) Install cover (50) on engine (9).



5-4. ENGINE REPLACEMENT (CONT).



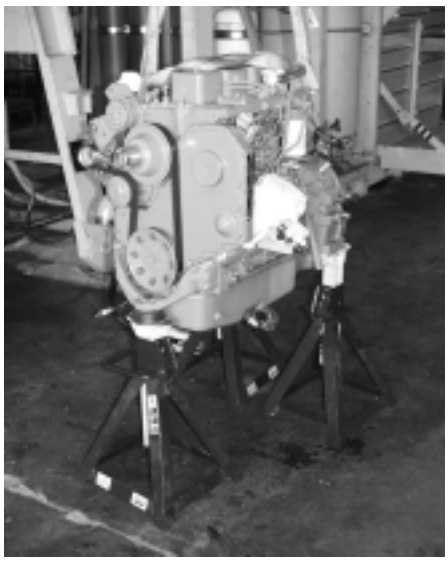


(32) Remove screw (59), lockwasher (60) and ground strap (61) from engine (9). Discard lockwasher.

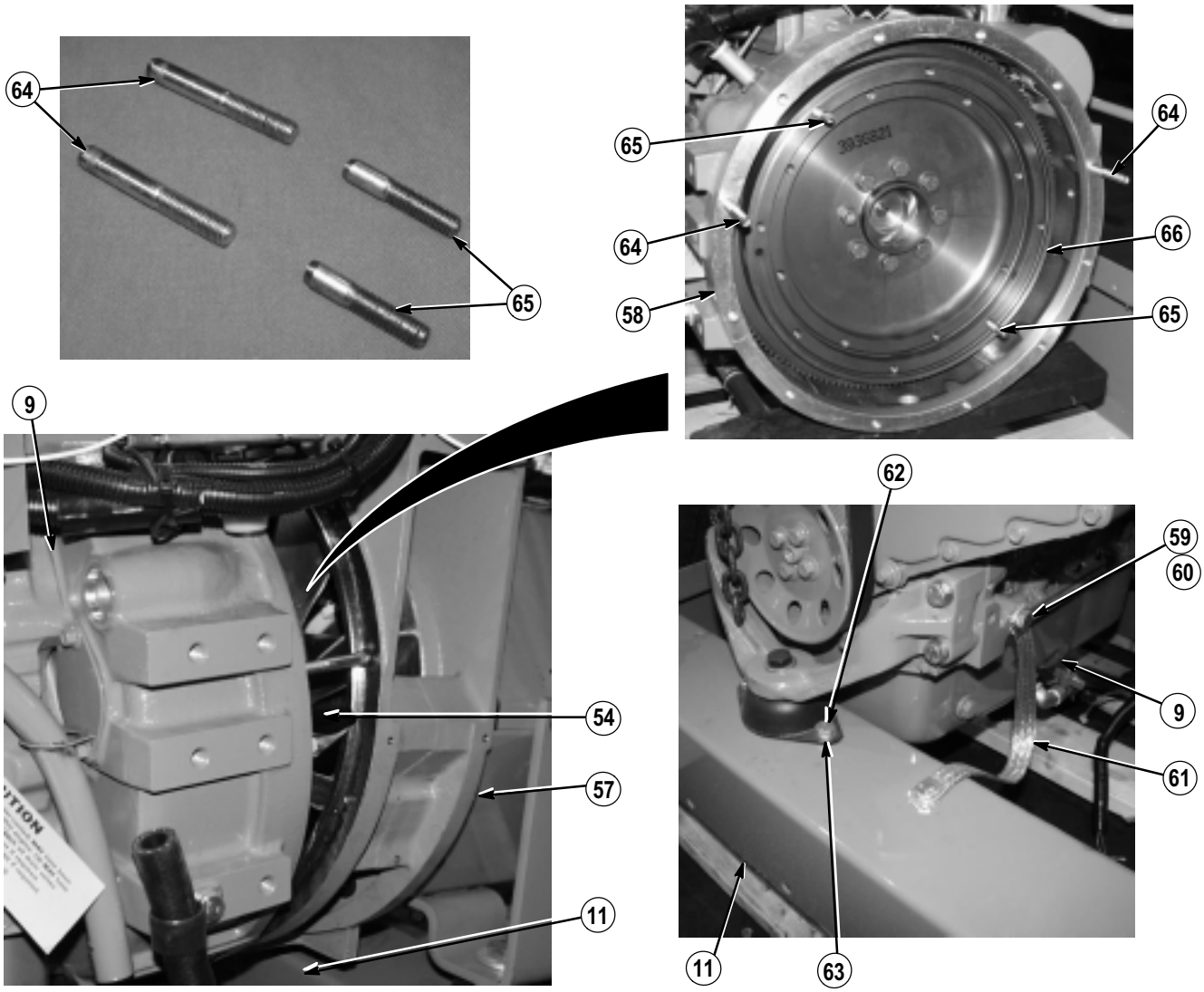
(33) Remove two engine mount bolts (62) and washers (63) from generator set frame (11).

(34) Remove engine (9) from generator set frame (11) and support on jackstands.

(35) Remove lifting device from engine (9).



b. Installation.



WARNING

Engine weighs approximately 680 lbs (308 kg). Attach suitable lifting device to prevent possible injury to personnel.

(1) Attach lifting device to engine (9).

(2) Install two alignment pins (64) in flywheel housing (58) and two alignment pins (65) in flywheel (66).

(3) Position engine (9) on generator set frame (11) and align alignment pins (64) and (65) with generator adapter (57) and drive discs (54).

(4) Install two engine mount bolts (62) and washers (63) on engine (9) and generator set frame (11).

(5) Install ground strap (61), lockwasher (60) and screw (59) on engine (9).

5-4. ENGINE REPLACEMENT (CONT).

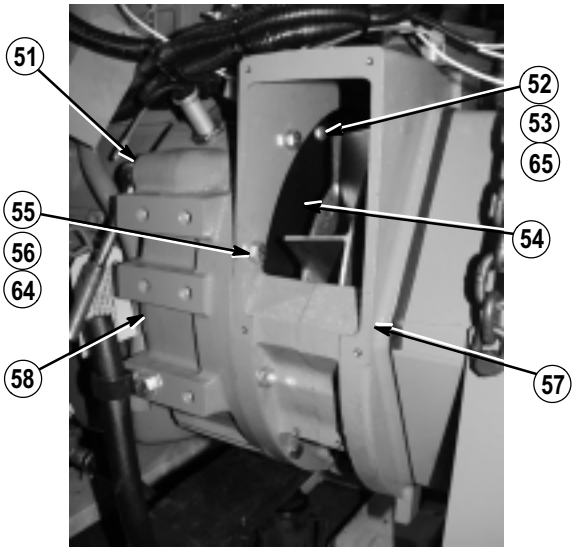
(6) Install ten screws (55) and lockwashers (56) on flywheel (57) and flywheel housing (58) and remove alignment pins (64).

(7) Tighten screws (55) to 50 lb-ft (23 N·m).

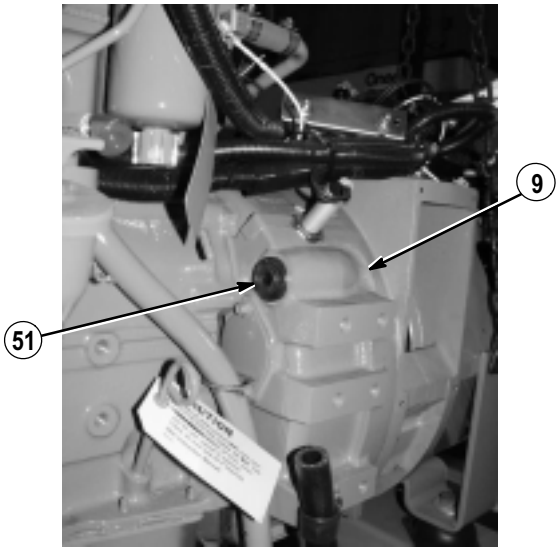
(8) Using engine turnover tool, turn engine over and install eight screws (52) and washers (53) on drive discs (54) and remove alignment pins (65).

(9) Tighten screws (52) to 35 lb-ft (16 N·m).

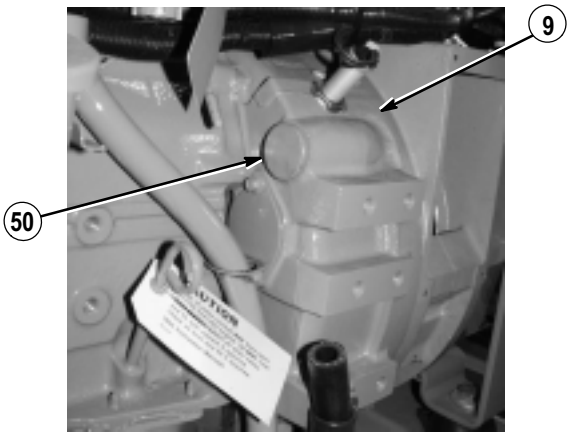
(10) Remove lifting device from engine (9).

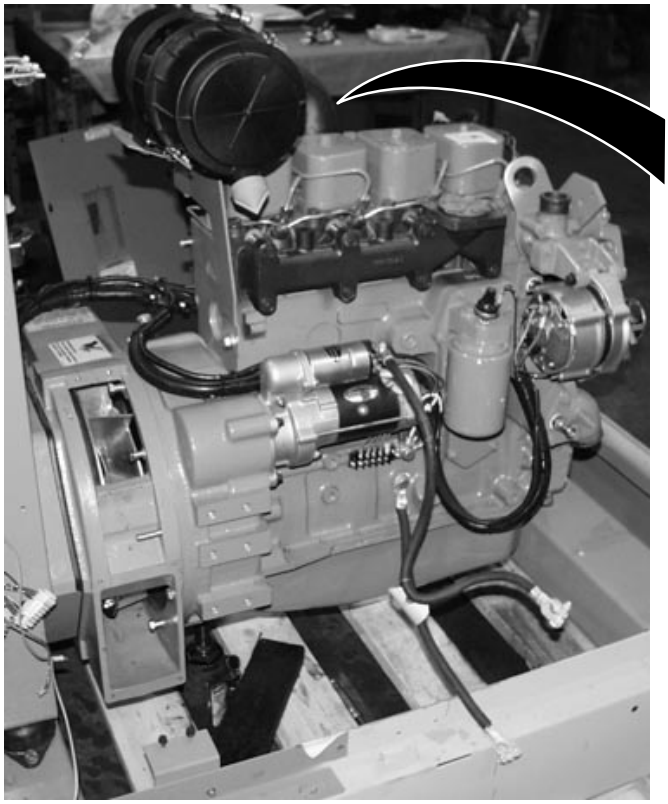


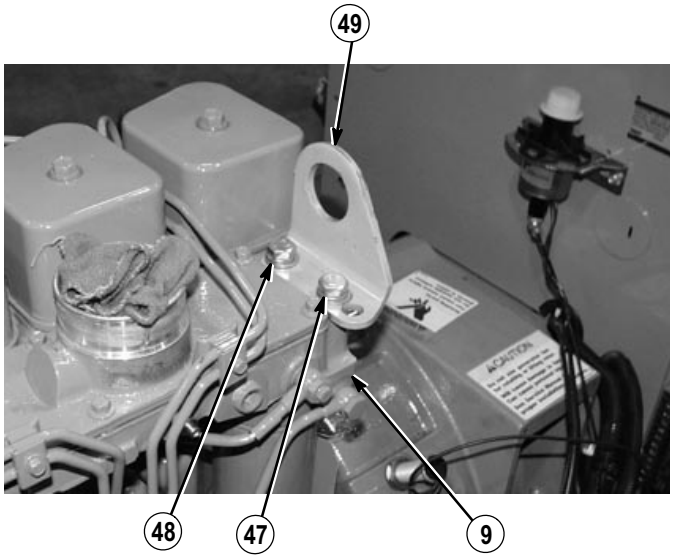
(11) Remove engine turnover tool (51) from engine (9).

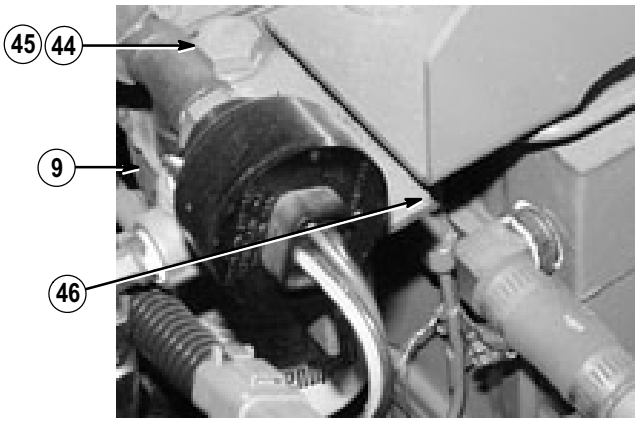


(12) Install cover (50) on engine (9).









NOTE

Screws used for lifting bracket should be retained for engine air filter bracket and sensor bracket installation.

(13) Remove screw (48), screw (47) and lifting bracket (49) from engine (9).

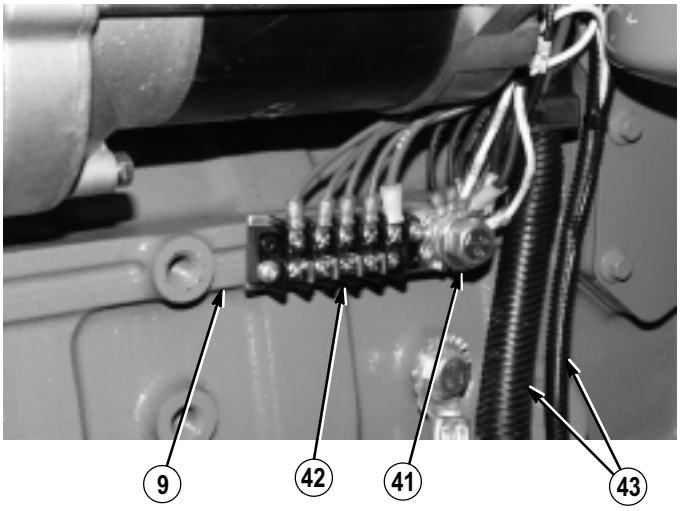
(14) Install sensor bracket (46), lockwasher (45) and screw (44) on engine (9).

(15) Install harness (43) on engine (9).

(16) Install engine air filter bracket (TM 9-4940-568-20).

(17) Install wire bar assembly (42) and screw (41) on engine (9).

(18) Install wires as outlined in starter replacement (TM 9-4940-568-20).



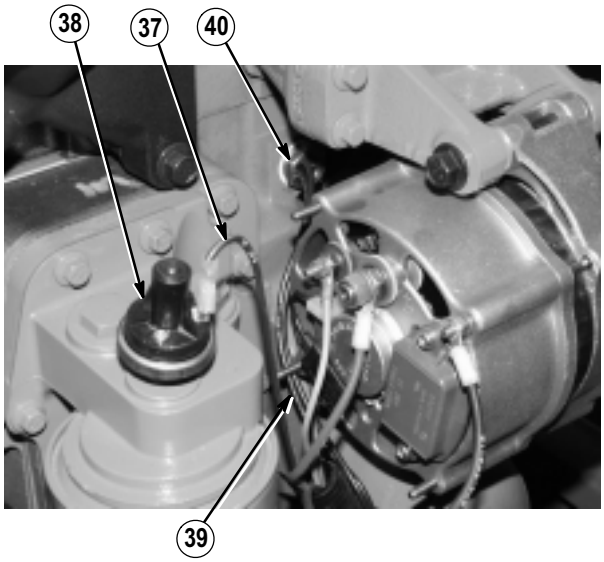
5-4. ENGINE REPLACEMENT (CONT).

NOTE

Install wires as noted prior to removal.

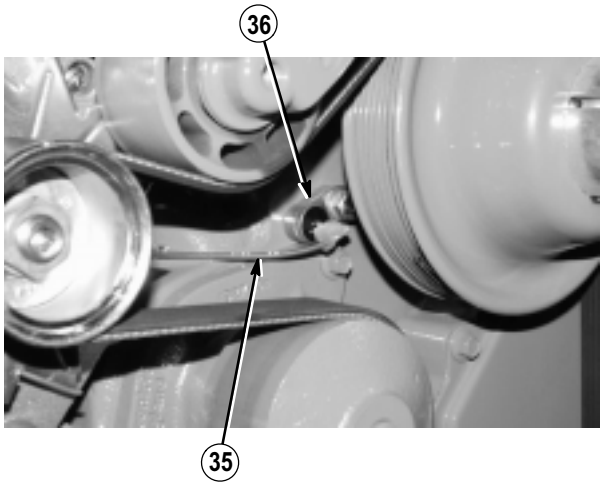
(19) Install wires (39) to ether thermostat (40).

(20) Install wire (37) on S1 pre-low engine temperature sensor (38).

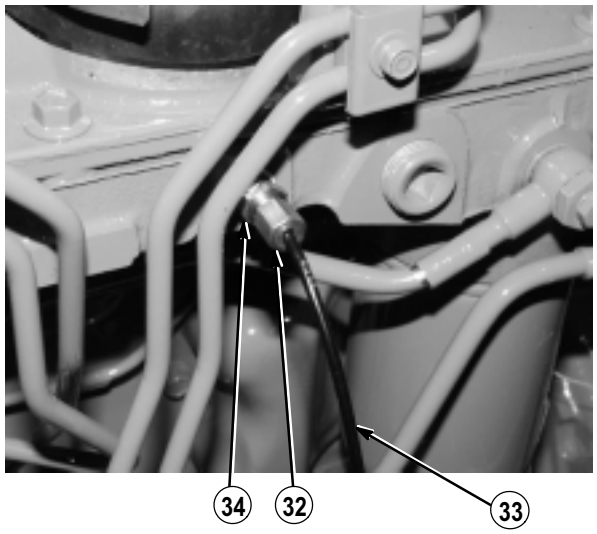


(21) Install wires (35) on S4 low engine temperature sensor (36).

(22) Install wires as outlined in alternator removal (TM 9-4940-568-20).



(23) Install tube (33) and fitting (32) on ether start adapter (34).



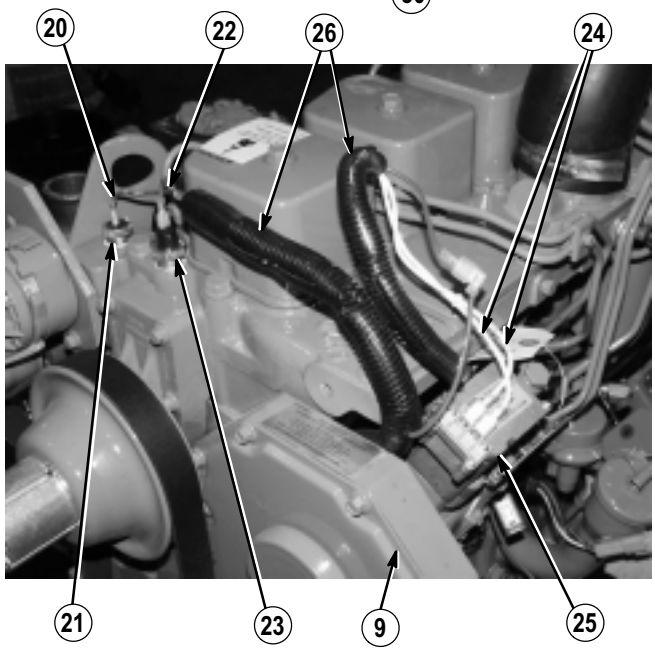
(24) Install fuel hose (30) on fuel pump (31).

(25) Install clamp (27) and fuel return hose (28) on fuel return tube (29).

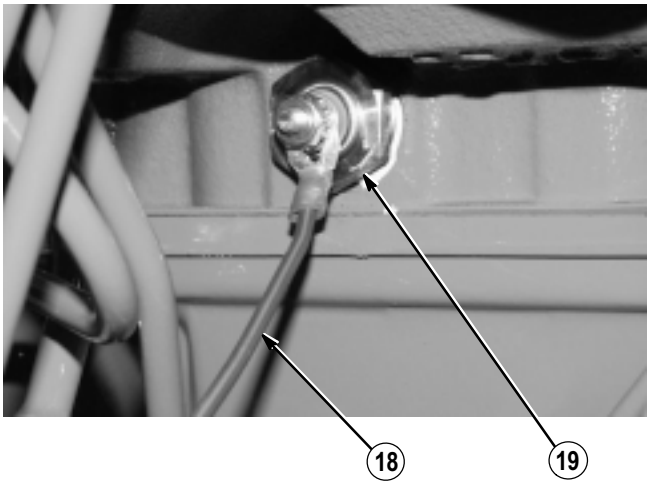
(26) Install wire harnesses (26) on engine (9) as noted in removal.

(27) Install two wires (24) on electronic fuel shut-off valve (25).

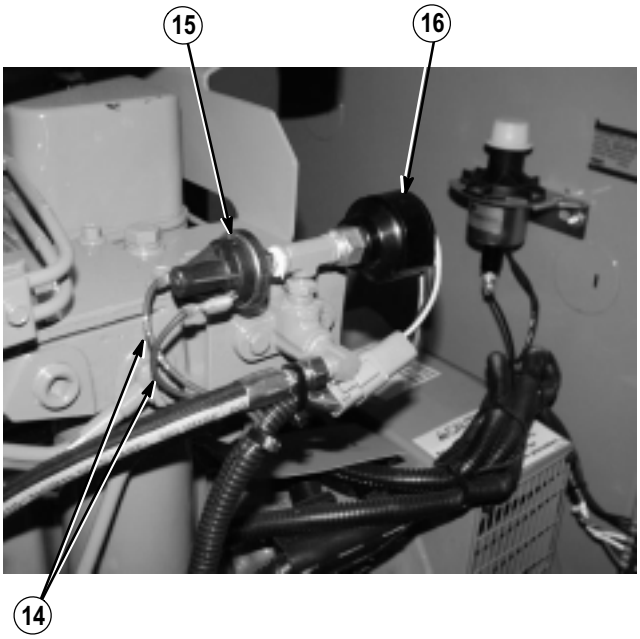
(28) Install wire J2-3 (20) on S6 pre-high coolant temperature sensor (21) and wire J2-5 (22) on S2 high coolant sensor (23).

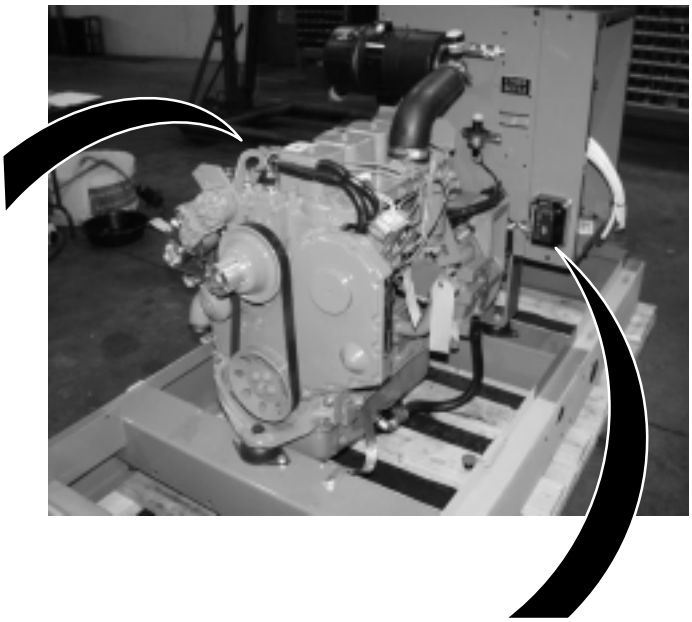


(29) Install wire (18) on cylinder head temperature switch E2 (19).



5-4. ENGINE REPLACEMENT (CONT).



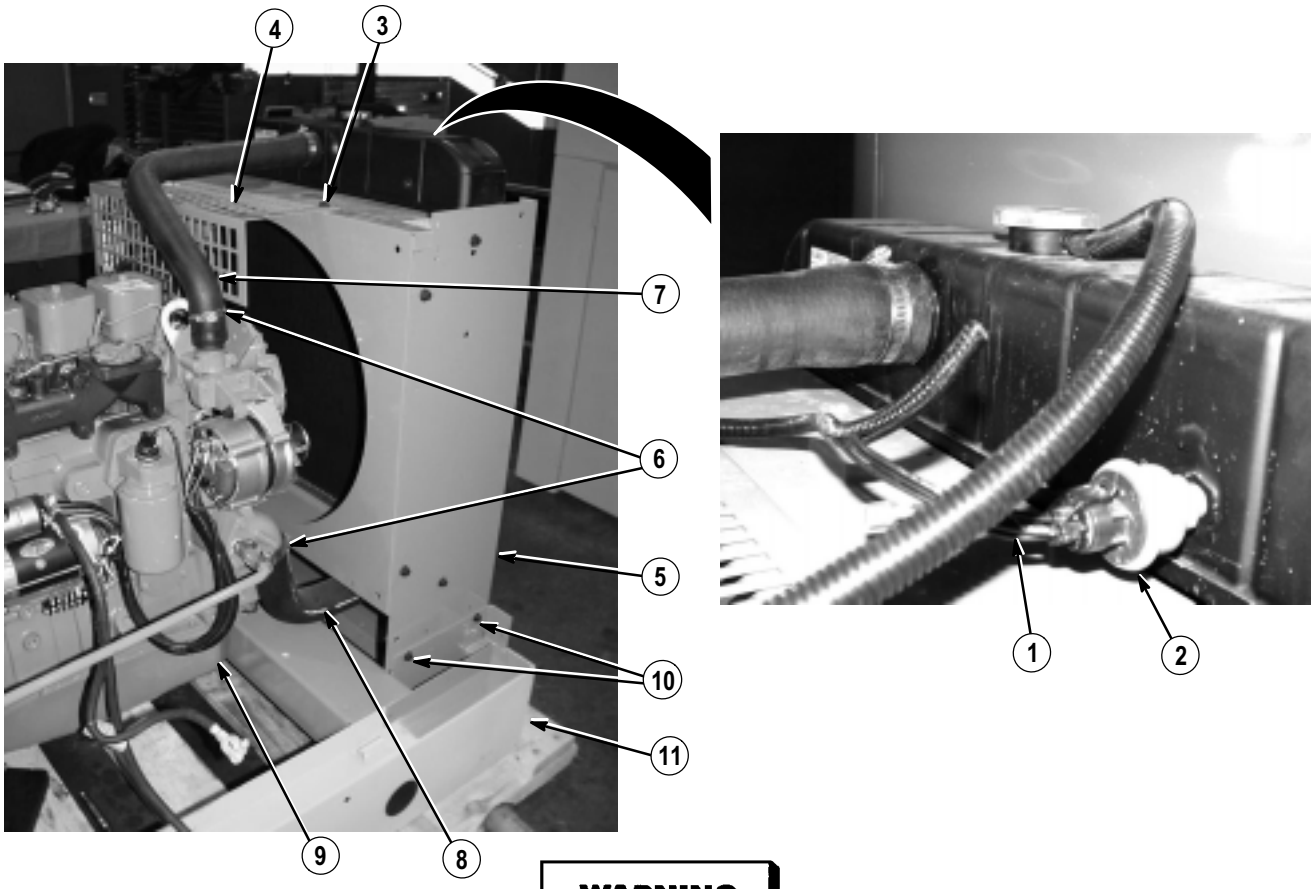


NOTE

Install cable ties as necessary.

(30) Install wires (14) on low oil pressure sensor S5 switch (15) and oil pressure sender E1 switch (16).

(31) Install two magnetic pickup wires (12) on terminal 5 and 6 of electronic overspeed module (13).



WARNING

Radiator assembly weighs approximately 50 lbs (23 kg). Use an assistant to help remove radiator assembly or possible injury to personnel may result.

(32) With the aid of an assistant, install radiator assembly (5) with four screws (10) on generator set frame (11).

(33) Install radiator hoses (7) and (8) and two hose clamps (6) on engine (9).

(34) Install fan shroud (4) and five screws (3) on radiator assembly (5).

(35) Install fan (TM 9-4940-568-20).

(36) Install wires (1) on low coolant level sensor (2).

c. Follow-On Maintenance:

- Cooling system filled, (TM 9-4940-568-20).
- Install engine block heater, (TM 9-4940-568-20).
- Install hydraulic filter, (TM 9-4940-568-20).
- Prime fuel lines, (TM 9-4940-568-10).
- Install generator set, (Para 5-3).
- Connect batteries, (TM 9-4940-568-10).
- Start generator and check for proper operation, (TM 9-4940-568-10).

END OF TASK

5-5. ENGINE MOUNT REPLACEMENT.

This task covers:

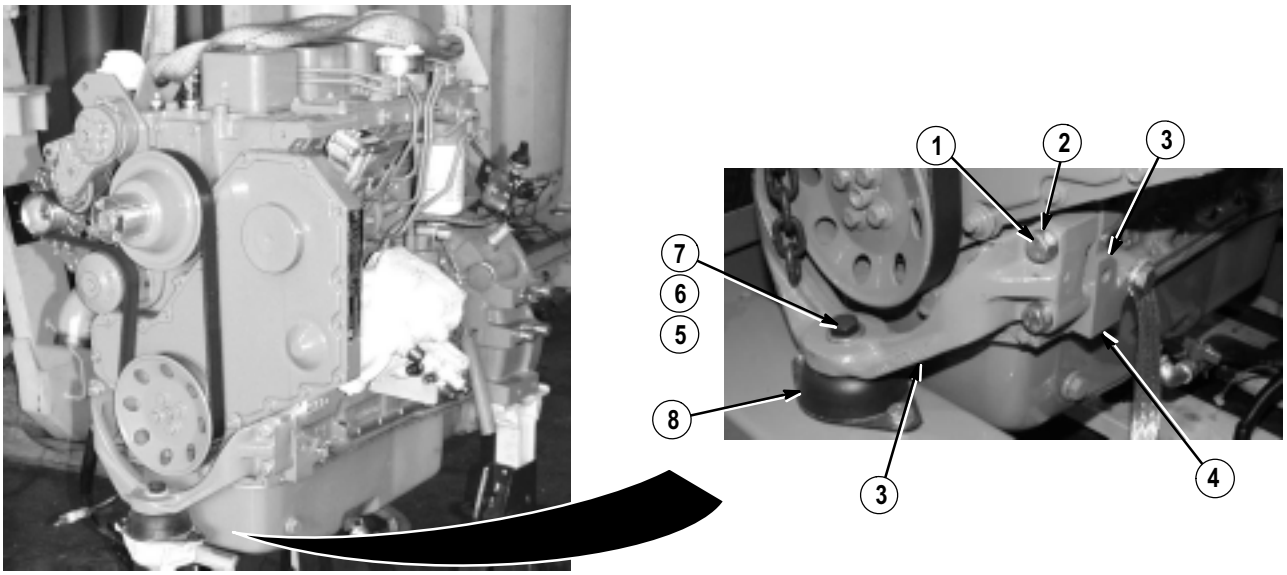
a. Removal
b. Cleaning/Inspection
c. Installation
d. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)
Wrench, Torque (0 To 300 lb-ft [0–407 N·m])
(Item 83, Appendix F)

Equipment Condition
Engine removed, (Para 5-4)

a. Removal.



(1) Remove four screws (1), washers (2) and engine mount (3) from engine (4).

CAUTION

Remove mounting cushion only if damaged.

NOTE

Note position of mounting cushion prior to removal.

(2) Remove nut (5), washer (6), screw (7) and mounting cushion (8) from engine mount (3).

b. Cleaning/Inspection.

(1) Inspect rubber-cushioned mount for cracks or damage.

NOTE

Damaged engine mounts and brackets can cause engine misalignment, drive line components damage, and result in vibration complaints.

(2) Inspect all mounting brackets for cracks or damaged bolt holes.

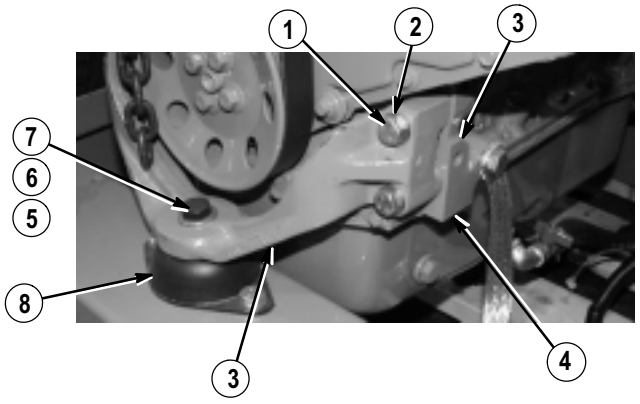
c. Installation.

NOTE

Position mounting cushion as noted during removal.

(1) Install mounting cushion (8) on engine mount (3) with screw (7), washer (6) and nut (5).

(2) Install engine mount (3) on engine (4) with four washers (2) and screws (1). Torque to 57 lb-ft (77 N·m).



d. Follow-On Maintenance:

- Install engine, (Para 5-4).

END OF TASK

5-6. TIMING PIN REPLACEMENT.

This task covers:

a. Removal b. Installation c. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Socket Set, 3/8 in. (Item 52, Appendix F)
Tool, Engine Turnover (Item 66, Appendix F)
Wrench, Torque 0 to 60 N·m (Item 85, Appendix F)

Materials/Parts
Gasket (Item 10, Appendix E)

Equipment Condition
Batteries disconnected, (TM 9-4940-568-10)
Rear panel removed, (TM 9-4940-568-10)

a. Removal.

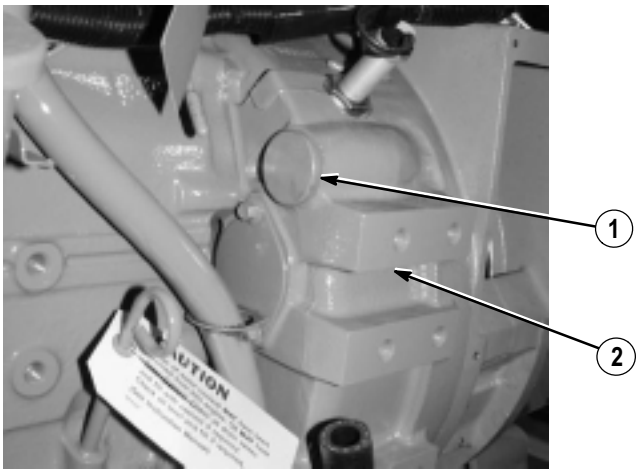
NOTE

Perform Step (1), if necessary, to gain access to timing pin.

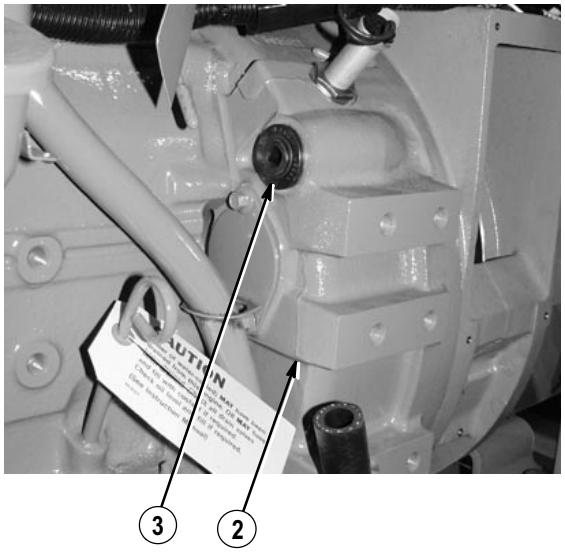
(1) If necessary remove mounting screws and support hydraulic pump assembly (Para 4-2).

(2) Remove front gear cover (Para 5-14).

(3) Remove access cover cap (1) from engine (2).

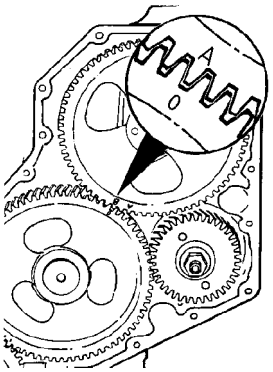


(4) Install engine turnover tool (3) in access cover on engine (2).

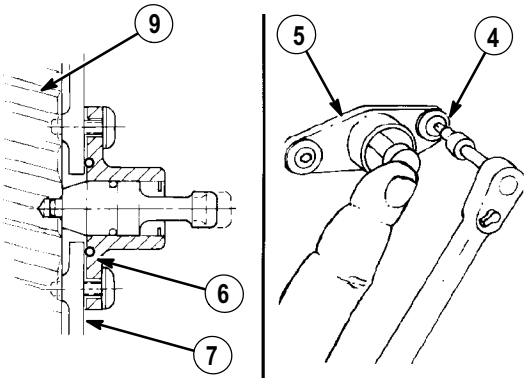


(5) Bar engine and locate TDC of compression stroke for Cylinder No. 1.

(6) The letter “A” on the gear must be aligned with the “O” mark on the camshaft gear.



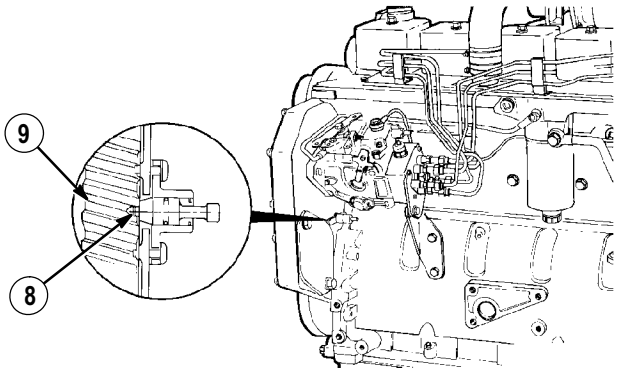
(7) Remove two screws (4), timing pin assembly (5) and gasket (6) from gear housing (7). Discard gasket.



NOTE

If timing pin assembly tip is broken perform Step (8).

(8) Remove tip (8) from camshaft gear (9).



5-6. TIMING PIN REPLACEMENT (CONT).

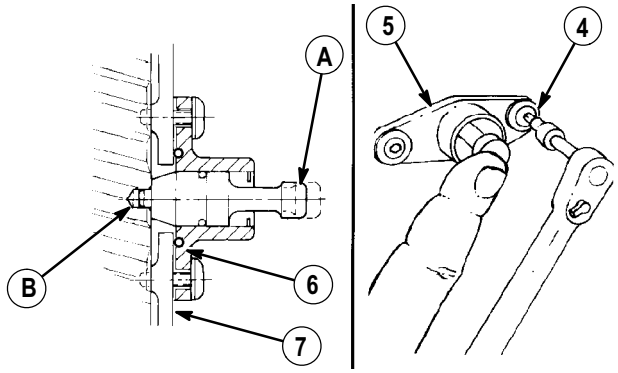
b. Installation.

NOTE

Ensure Cylinder No. 1 is at TDC and timing pin hole can be seen through Front Gear Housing.

(1) Position gasket (6), timing pin assembly (5) and two screws (4) on gear housing (7). Do not tighten screws.

(2) Hold timing pin (A) in hole (B) in camshaft gear to align timing pin with housing. Tighten two screws (4) to 48 lb-in (5 N·m).



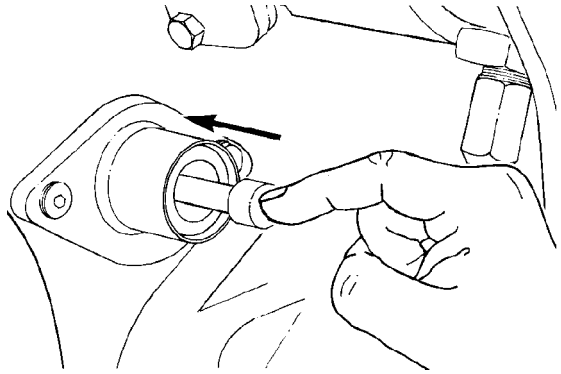
CAUTION

Ensure to disengage (pullout) timing pin to prevent damage to equipment.

(3) Disengage (pullout) timing pin (5).

(4) Install front gear cover (Para 5-14).

(5) If removed install hydraulic pump assembly (Para 4-2).



c. Follow-On Maintenance:

- Connect batteries, (TM 9-4940-568-10).
- Install rear panel, (TM 9-4940-568-10).

END OF TASK

5-7. CYLINDER HEAD REPLACEMENT.

This task covers:

a. Removal
b. Cleaning/Inspection
c. Installation
d. Follow-On Maintenance

INITIAL SETUP

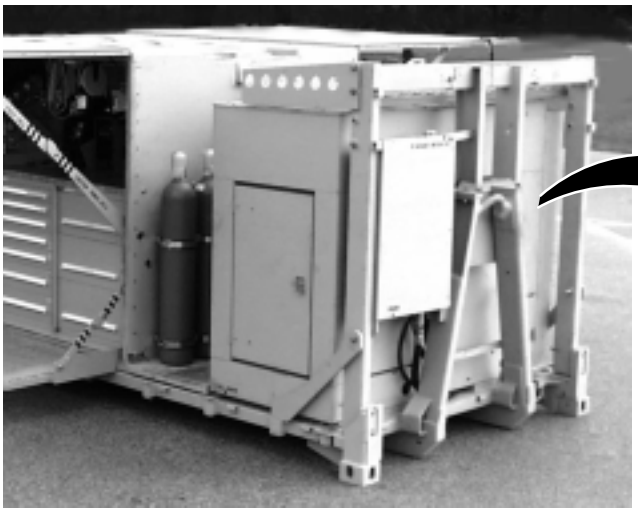
Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Straight Edge (Item 59, Appendix F)
Wrench, Torque (0 to 175 lb-ft. [0 to 237 N·m]) (Item 83, Appendix F)

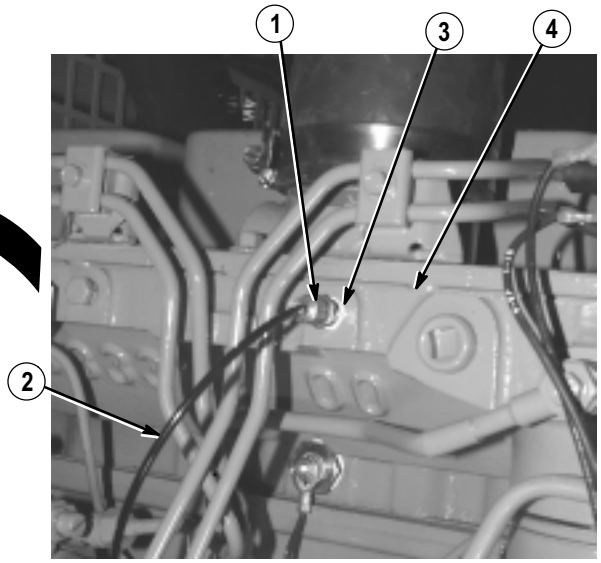
Materials/Parts
Rags, Wiping (Item 23, Appendix B)
Sealing Compound (Item 32, Appendix B)
Tags, Identification (Item 36, Appendix B)
Gasket, Cylinder Head (Item 18, Appendix E)

Personnel Required
Two

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
Batteries disconnected, (TM 9-4940-568-10)
Generator housing removed (if necessary), (Para 5-2)
Coolant drained, (TM 9-4940-568-20)
Fuel injector lines removed, (TM 9-4940-568-20)
Air intake manifold cover removed, (TM 9-4940-568-20)
Alternator removed, (TM 9-4940-568-20)
Engine drive belt removed, (TM 9-4940-568-20)
Engine drive belt tensioner removed, (TM 9-4940-568-20)
Thermostat removed, (TM 9-4940-568-20)
Engine fan removed, (TM 9-4940-568-20)
Engine rocker arm removed, (TM 9-4940-568-20)
Engine fan hub removed, (TM 9-4940-568-20)
Exhaust manifold removed, (TM 9-4940-568-20)

a. Removal.





WARNING

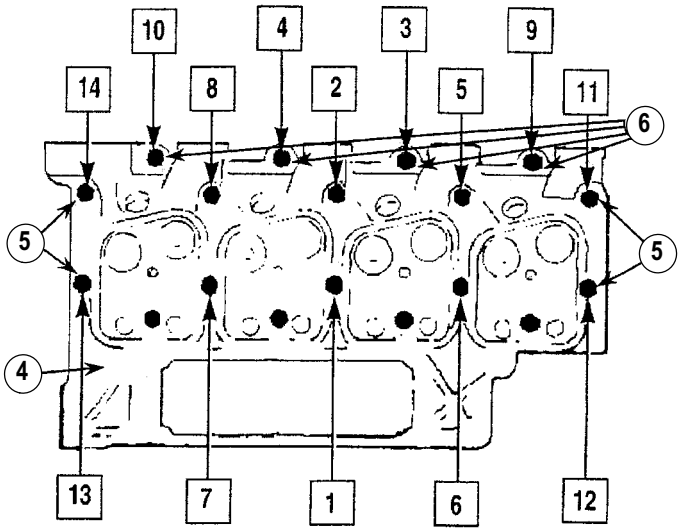
Ensure engine is cool before performing this task or injury to personnel may result.

(1) Remove fitting (1), ether tube (2) and adapter (3) from engine cylinder head (4).

5-7. CYLINDER HEAD REPLACEMENT (CONT).

NOTE

- There are two different lengths of screws.
- Tag and mark all screws.
- Note location of screws prior to removal.
- Tightening sequence is shown with numbers in boxes.

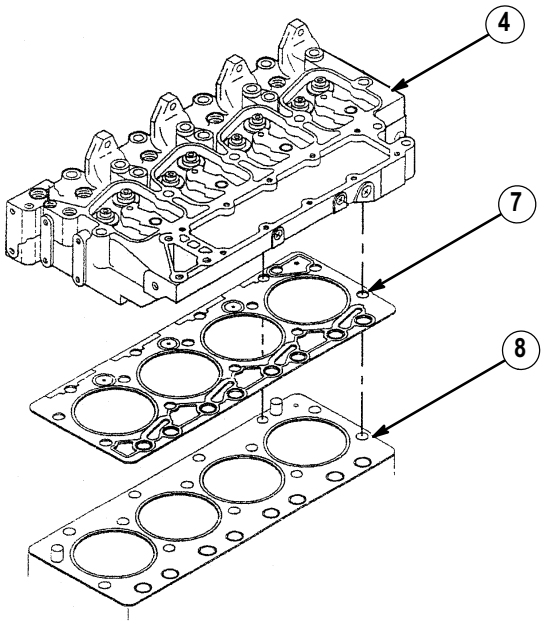


(2) Remove 10 cylinder head screws (5) and four cylinder head screws (6) from cylinder head (4) in the sequence shown.

WARNING

Cylinder head weighs 80 lbs (36 kg). Attach suitable lifting device for removal and properly support cylinder head to prevent injury to personnel.

(3) With the aid of an assistant, remove cylinder head (4) and gasket (7) from engine (8).



b. Cleaning/Inspection.

(1) Inspect the coolant passages. A large build up of rust and lime will require removal of the cylinder block for cleaning in a hot tank.

(2) Use a straight edge and feeler gage to measure the overall flatness of the cylinder block. The overall flatness, end to end and side to side, must not exceed 0.075 mm (0.003 in.).

(3) Visually inspect the combustion deck for any localized dips or imperfections. If present, the cylinder head must be replaced.

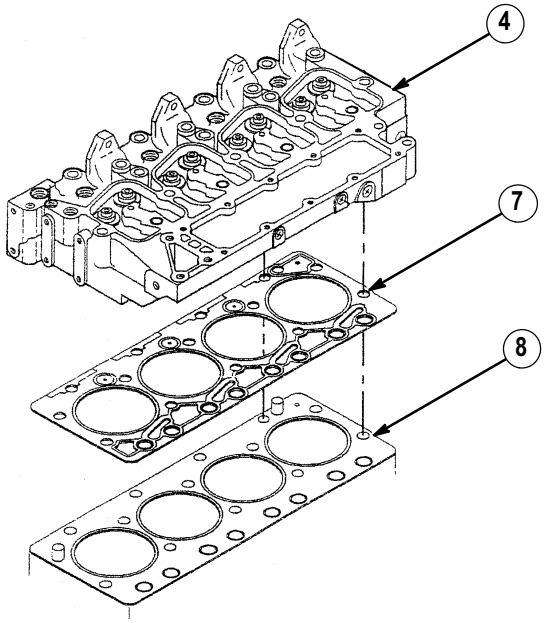
c. Installation.

WARNING

Cylinder head weighs 80 lbs (36 kg). Attach suitable lifting device for installation and properly support cylinder head to prevent injury to personnel.

CAUTION

Ensure the gasket is correctly aligned with dowels on cylinder block.



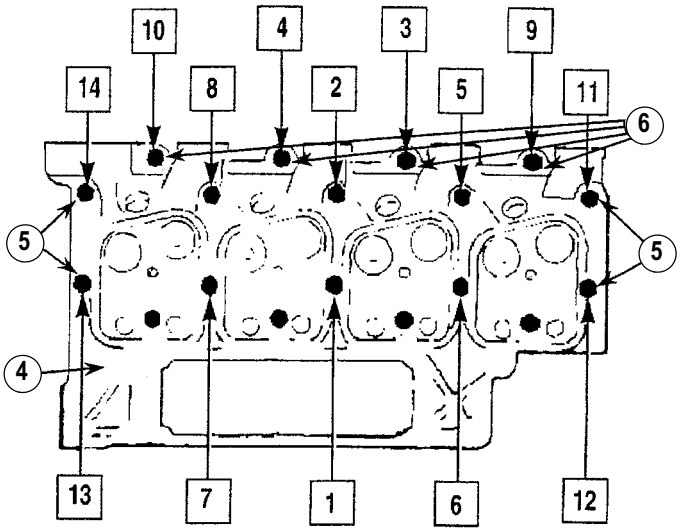
(1) Position gasket (7) and cylinder head (4) on engine (8).

NOTE

- Install screws in position noted prior to removal.
- Tightening sequence is shown with numbers in boxes

(2) Install four cylinder head screws (6) and 10 cylinder head screws (5) on cylinder head (4) and hand tighten in sequence shown.

(3) Tighten all screws (5) and (6) to 66 lb-ft (90 N·m). Recheck all screws (5) and (6) to 66 lb-ft (90 N·m). Tighten ten screws (5) to 89 lb-ft (120 N·m). Recheck ten screws (5) to 89 lb-ft (120 N·m).

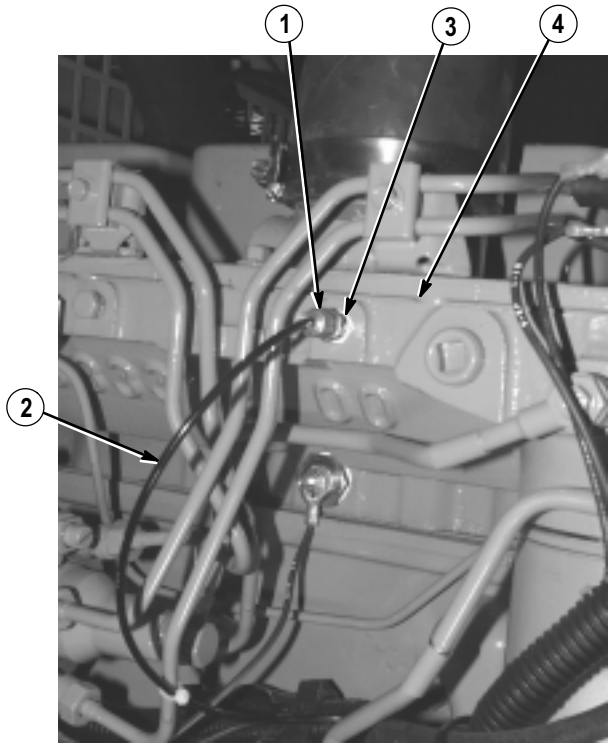


5-7. CYLINDER HEAD REPLACEMENT (CONT).

NOTE

Atomizer opening at end of fitting must point straight up when installed in cylinder head.

(4) Install adapter (3), ether tube (2) and fitting (1) on engine cylinder head (4).



d. Follow-On Maintenance:

- Install exhaust manifold, (TM 9-4940-568-20).
- Install engine rocker arm, (TM 9-4940-568-20).
- Install engine fan hub, (TM 9-4940-568-20).
- Install engine fan, (TM 9-4940-568-20).
- Install thermostat, (TM 9-4940-568-20).
- Install engine drive belt tensioner, (TM 9-4940-568-20).
- Install engine drive belt, (TM 9-4940-568-20).
- Install alternator, (TM 9-4940-568-20).
- Install air intake manifold, (TM 9-4940-568-20).
- Install fuel injector lines, (TM 9-4940-568-20).
- Fill coolant, (TM 9-4940-568-20).
- Install generator housing (if removed), (Para 5-2).
- Connect batteries, (TM 9-4940-568-10).
- Start generator and check operation, (TM 9-4940-568-10).

END OF TASK

5-8. ENGINE COMPRESSION CHECK.

This task covers:

a. Piston Ring Sealing
b. Valve Sealing
c. Head Gasket Sealing
d. Follow-On Maintenance

INITIAL SETUP

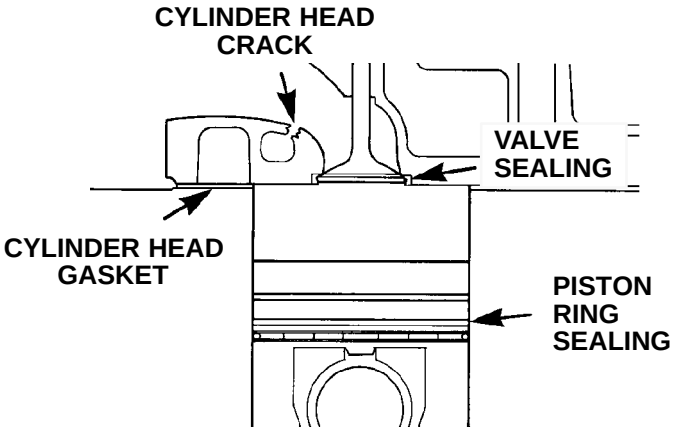
Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Tester, Cylinder Compression (Item 63, Appendix F)

Materials/Parts
Oil, Lubricating (Item 17, Appendix B)
Soap Solution (Item 33, Appendix B)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
Remove front panel, (TM 9-4940-568-10)

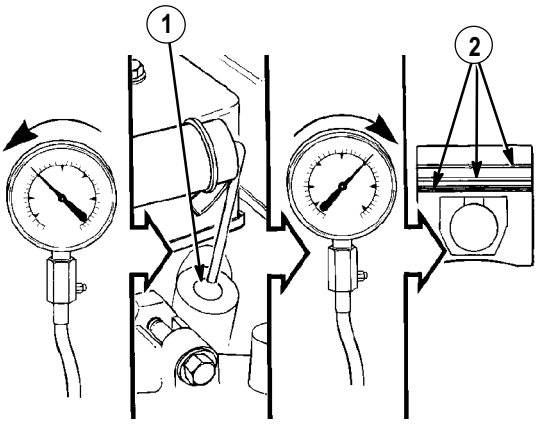
NOTE

If the air and fuel system are functioning correctly, perform a compression check to determine whether the problem is piston ring sealing, valve sealing and/or cylinder head gasket sealing or a crack in the cylinder head.



a. Piston Ring Sealing.

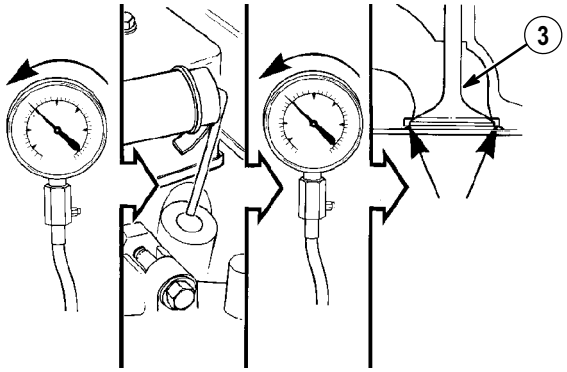
If the compression is low but can be increased significantly by squirting lubricating oil into the cylinder (1), the cause of low compression is inadequate sealing between the piston rings (2) and the cylinder walls, notify GS Maintenance.



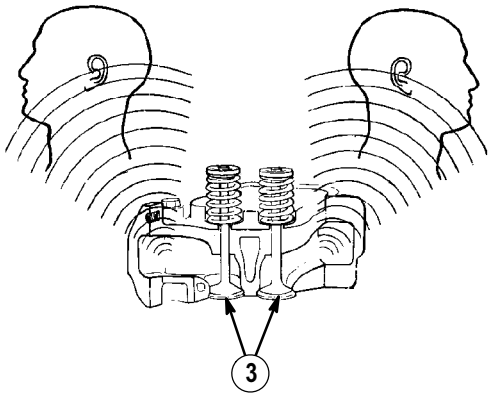
5-8. ENGINE COMPRESSION CHECK (CONT).

b. Valve Sealing.

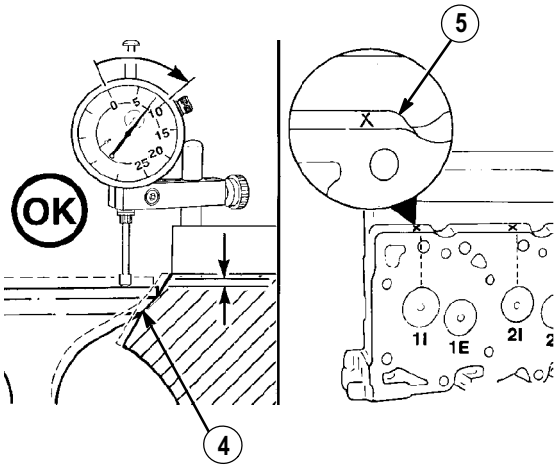
(1) If the compression is low on one or more non-adjacent cylinders and the pressure cannot be increased by oiling the rings, poor valve (3) sealing is to be suspected.



(2) Valve (3) leakage is often audible from the intake and/or exhaust manifold.

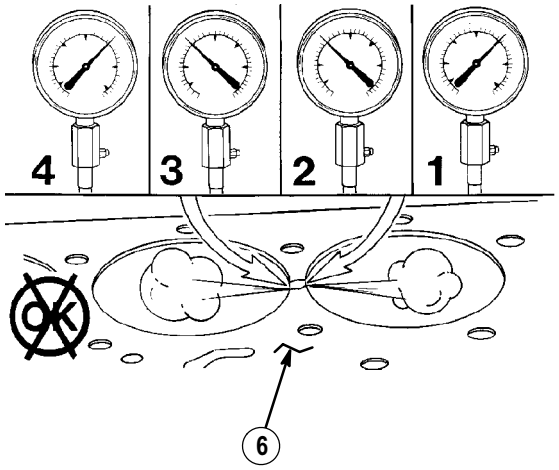


(3) The parent valve seats (4) can be re-ground to a depth of .010 in. (.254 mm). Re-ground seats are identified with a mark on the cylinder head (5). Service valve seats must be installed in previously ground valve seats, notify GS Maintenance.

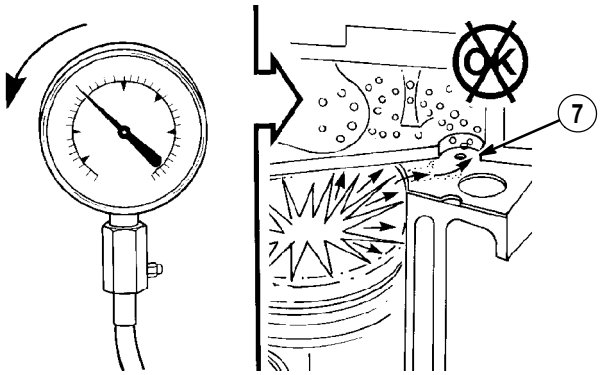


c. Head Gasket Sealing.

(1) If the compression was found low on adjacent cylinders and the pressure cannot be increased by oiling the rings (Step **a.**), the head gasket (6) is probably leaking between the cylinders (Para 5-7).

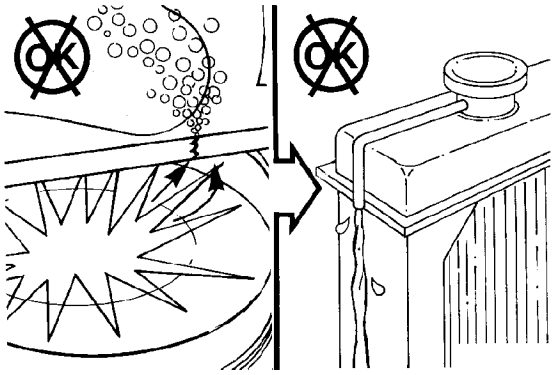


(2) Low compression on a single cylinder can be caused by an external leak or a leak to a coolant passage (7).

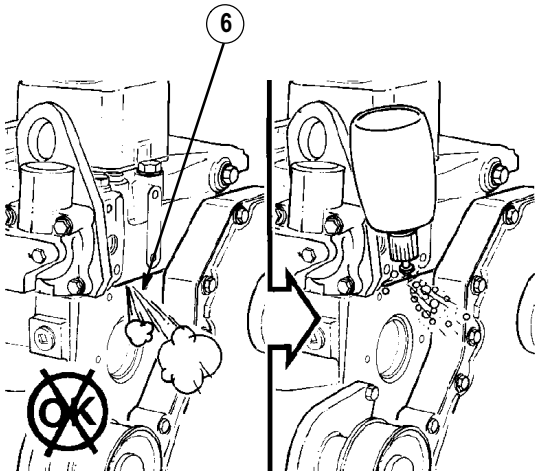


5-8. ENGINE COMPRESSION CHECK (CONT).

(3) A compression leak to the coolant will normally be detected by loss of coolant as the coolant is blown from the cooling system.



(4) External cylinder head gasket (6) leaks can be detected visually. Soap solution can be used to locate external leaks.



d. Follow-On Maintenance:

- Install front panel, (TM 9-4940-568-10).

END OF TASK

5-9. CRANKSHAFT FRONT SEAL REPLACEMENT.

This task covers:

a. Removal
b. Cleaning/Inspection
c. Installation
d. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)
Oil Seal Installer (Item 40, Appendix F)
Press, Arbor (Item 45, Appendix F)

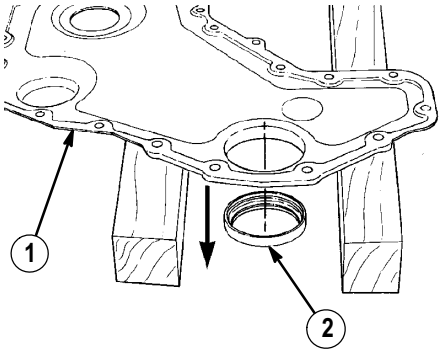
Materials/Parts
Adhesive, RTV108 (Item 2, Appendix B)

Equipment Condition
Front gear cover removed, (Para 5-14)

a. Removal.

(1) Support front gear cover (1) with front facing down.

(2) Remove front oil seal (2) from front gear cover (1) by driving from back side of front gear cover toward front side.



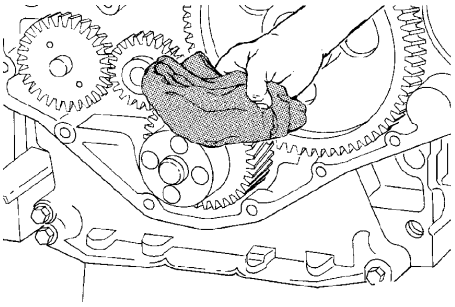
b. Cleaning/Inspection.

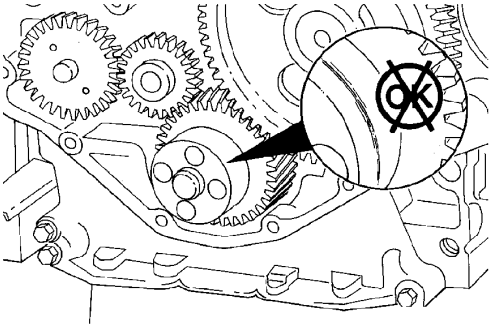
(1) Clean front gear cover seal bore and crankshaft sealing lip surface free of all oil and seal residue.

NOTE

If crankshaft sealing lip surface is worn or damaged, a service wear sleeve is available.

(2) Inspect crankshaft sealing lip surface for nicks, gouges or grooves.





5-9. CRANKSHAFT FRONT SEAL REPLACEMENT (CONT).

c. Installation.

WARNING

Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

(1) Apply a bead of adhesive to outside diameter of front oil seal (2).

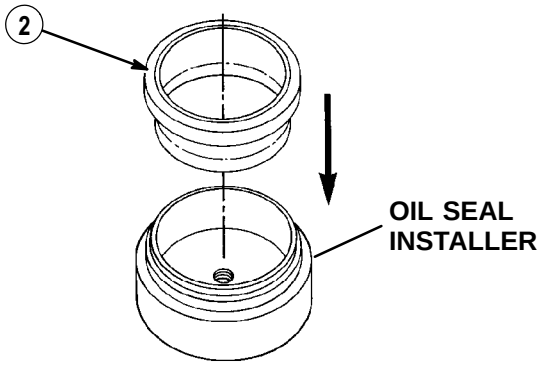
(2) Position seal on oil seal installer with front oil seal (2) dust lip facing outward.

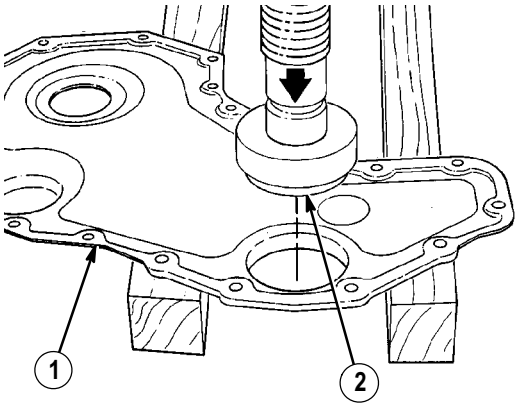
NOTE

Properly support front oil seal flange to prevent damage to front oil seal and front gear cover.

(3) Press front oil seal (2) in front gear cover (1) from back side of front gear cover toward front side of front gear cover.

(4) Press front oil seal (2) until oil seal installer bottoms against front gear cover (1).





d. Follow-On Maintenance:

- Install front gear cover, (Para 5-14).

END OF TASK

5-10. CRANKSHAFT REAR SEAL REPLACEMENT.

This task covers:

a. Removal
b. Cleaning/Inspection
c. Installation
d. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Wear Sleeve Installation Tool (Item 71, Appendix F)

Materials/Parts
Cloth, Cleaning (Item 6, Appendix B)
Crocus Cloth (Item 11, Appendix B)

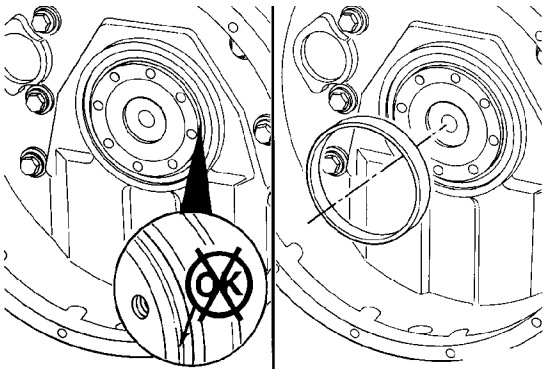
Materials/Parts – Continued
Oil, Lubricating (Item 17, Appendix B)
Gasket (Item 11, Appendix E)

Equipment Condition
Engine removed, (Para 5-4)
Flywheel housing removed, (Para 5-11)

a. Removal.

CAUTION

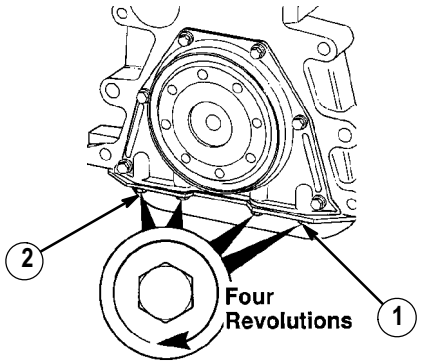
- If crankshaft seal has worn a groove in the crankshaft flange, a wear sleeve must be installed to prevent oil leakage.
- Use extreme care when releasing the oil pan gasket from rear cover to prevent damage to gasket. If gasket is damaged, the oil pan must be removed and gasket replaced.



NOTE

For clearance between rear cover and oil pan it may be necessary to loosen all oil pan mounting screws (TM 9-4940-568-20).

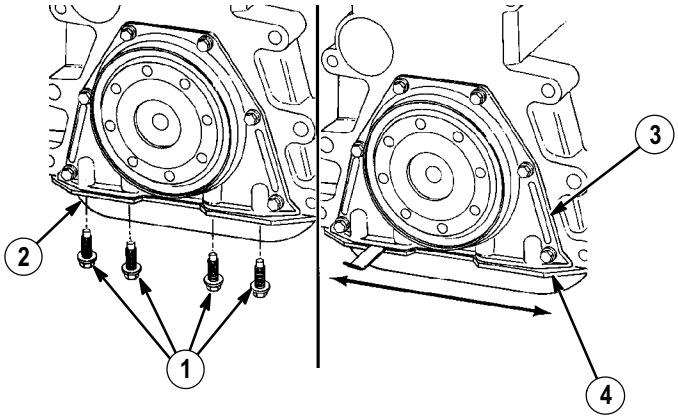
(1) Loosen four oil pan mounting screws (1) from oil pan (2) four revolutions.



5-10. CRANKSHAFT REAR SEAL REPLACEMENT (CONT).

(2) Insert feeler gage or shim stock between rear cover (3) and oil pan gasket (4). Move feeler gage or shim stock back and forth to release gasket from rear cover.

(3) Remove four oil pan mounting screws (1) from oil pan (2).

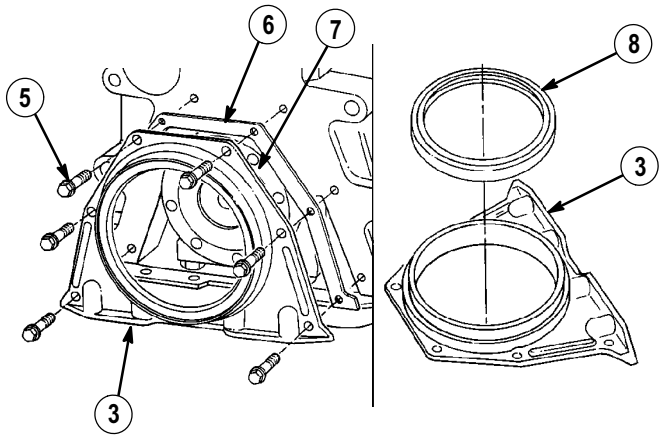


(4) Remove six screws (5), gasket (6) and rear cover (3) from crankshaft flange (7). Discard gasket.

(5) Remove oil seal (8) from rear cover (3).

CAUTION

Do not nick or gouge crankshaft with chisel. If crankshaft is damaged, it must be replaced.

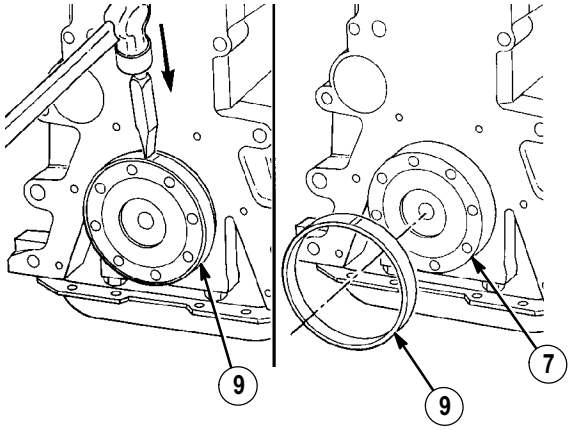


NOTE

- If crankshaft currently has a wear sleeve, it must be removed before installing a new one.
- Use a dull chisel that is only as wide as the wear sleeve.

(6) Make one or two soft blows with a hammer to make chisel marks across wear sleeve (9). This will expand wear sleeve allowing wear sleeve to be removed.

(7) Remove wear sleeve (9) from crankshaft flange (7).

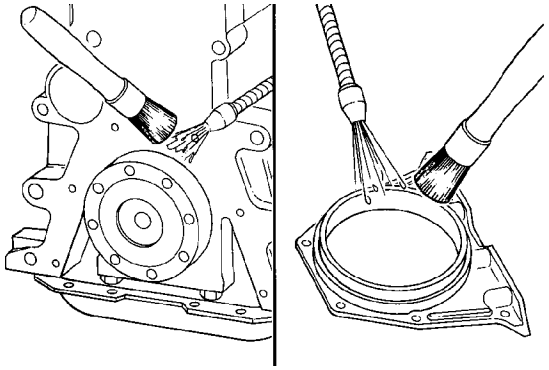


b. Cleaning/Inspection.

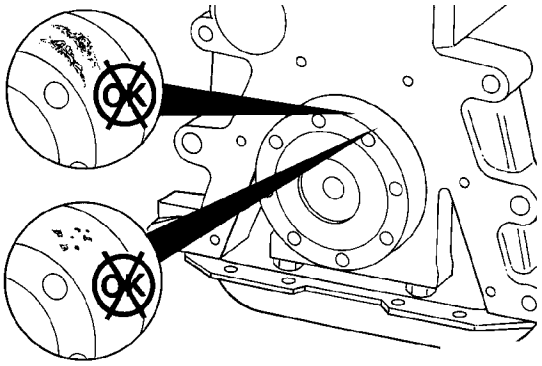
(1) Clean gasket surfaces of cylinder block and rear cover.

(2) Use a crocus cloth to remove any rust or other deposits from crankshaft flange.

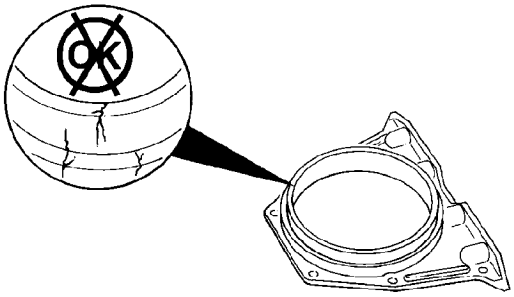
(3) Use a clean cloth to clean crankshaft flange.



(4) Inspect crankshaft flange for dirt or nicks.



(5) Inspect rear cover for cracks or other damage.



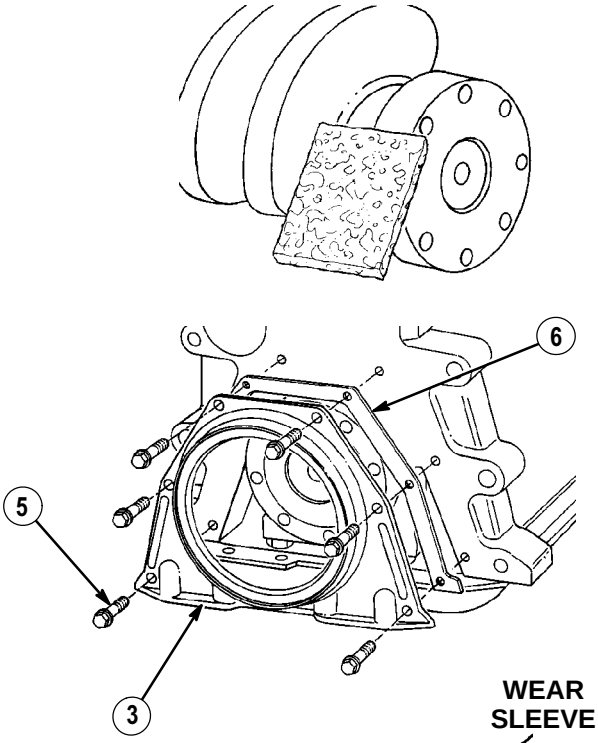
5-10. CRANKSHAFT REAR SEAL REPLACEMENT (CONT).

c. Installation.

NOTE

- Do not use any kind of lubricant to install the seal. The oil seal must be installed with lip of oil seal and crankshaft clean and dry to ensure proper oil sealing.
- For clearance between rear cover and oil pan it may be necessary to loosen all oil pan mounting screws (TM 9-4940-568-20).
- The seal installation is being used to properly align the rear cover. Do not push or force the cover in any direction to prevent irregular seal lip position after seal installation.

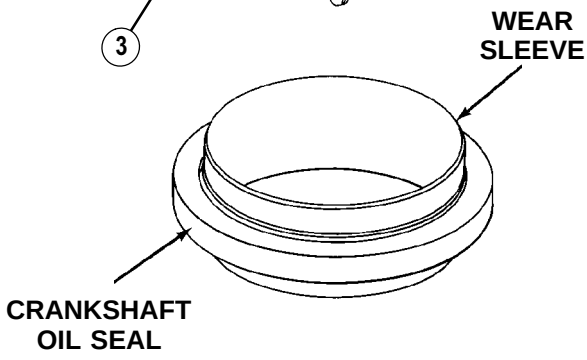
(1) Install gasket (6), rear cover (3) and six screws (5). Do not tighten screws.

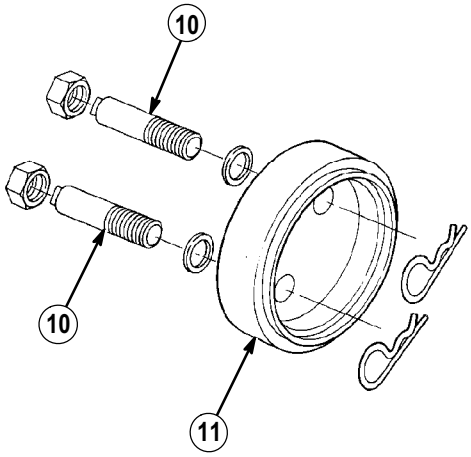


NOTE

- The combination crankshaft oil seal/wear sleeve replacement kit for service usage is installed on the crankshaft as an assembly. The crankshaft rear oil seal should not be removed from the rear seal wear sleeve.
- Use a wear sleeve installation tool to install oil seal/wear sleeve assembly.
- Apply a small amount of lubricating oil to crankshaft, threaded studs, and inside diameter of crankshaft rear seal/wear sleeve installation tool.

(2) Install two threaded studs (10) into wear sleeve installation tool (11).

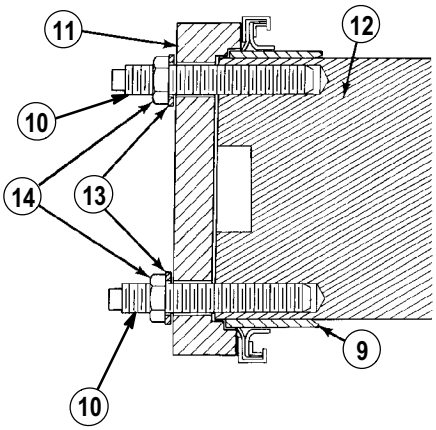




NOTE

Do not exceed 1/2 revolution of each nut to prevent wear sleeve binding and irregular stretch.

(3) Position chamfered end of wear sleeve (9) on end of crankshaft (12). Position counterbore end of wear sleeve installation tool (11) over threaded studs and align with wear sleeve, perpendicular to end of crankshaft. Install two washers (13) and nuts (14) on threaded studs (10). Alternately tighten nuts (14) until installation tool contacts end of crankshaft.

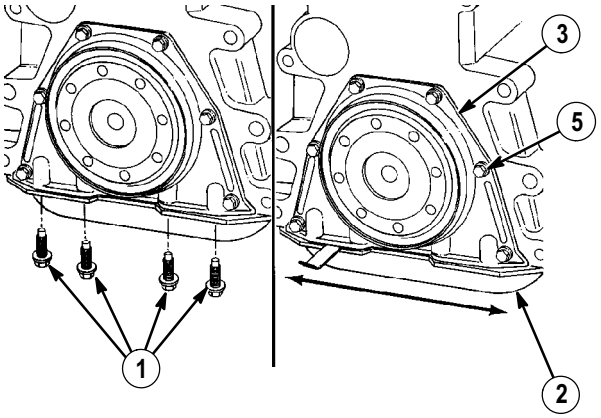


(4) Remove two nuts (14), washers (13), wear sleeve installation tool (11) and two threaded studs (10) from crankshaft (12).

(5) Align rear cover (3) even with both sides of oil pan (2).

(6) Install four oil pan mounting screws (1) on oil pan (2). Tighten screws to 18 lb-in (2 N·m).

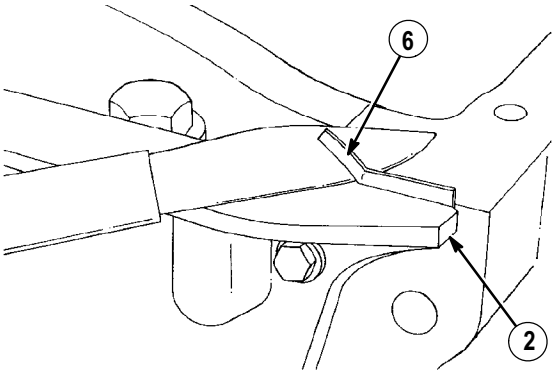
(7) Tighten six screws (5) on rear cover (3) to 80 lb-in (9 N·m).



NOTE

Ensure gasket excess does not enter engine.

(8) Trim gasket (6) even with oil pan (2) mounting surface.



d. Follow-On Maintenance:

- Install flywheel, (Para 5-11).
- Install engine, (Para 5-4).

END OF TASK

5-11. FLYWHEEL RING/GEAR AND FLYWHEEL HOUSING REPLACEMENT.

This task covers:

a. Removal
b. Disassembly
c. Cleaning/Inspection
d. Assembly
e. Installation
f. Flywheel Housing Bore Alignment Check
g. Flywheel Housing Face Alignment Check
h. Follow-On Maintenance

INITIAL SETUP

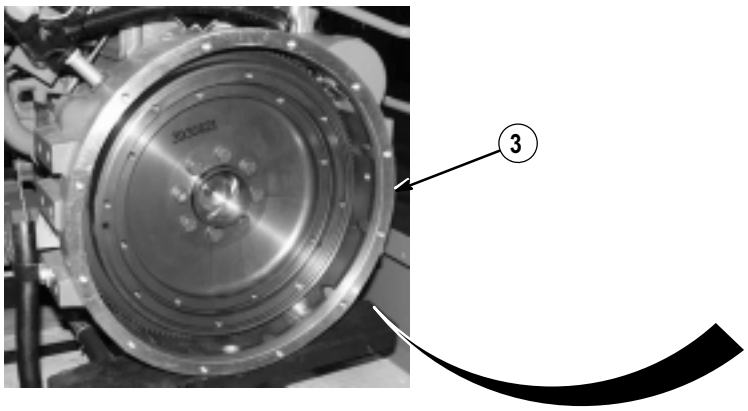
Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Compressor Unit, Air (Item 10, Appendix F)
Gloves, Chemical Oil Protective (Item 23, Appendix F)
Gloves, Heavy Duty (Item 24, Appendix F)
Goggles, Industrial (Item 25, Appendix F)
Gun, Air Blow (Item 29, Appendix F)
Hammer, Soft Plastic (Item 30, Appendix F)
Indicator, Dial (Item 34, Appendix F)
Wrench, Torque (0-175 lb-ft)(0-237 N·m) (Item 83, Appendix F)

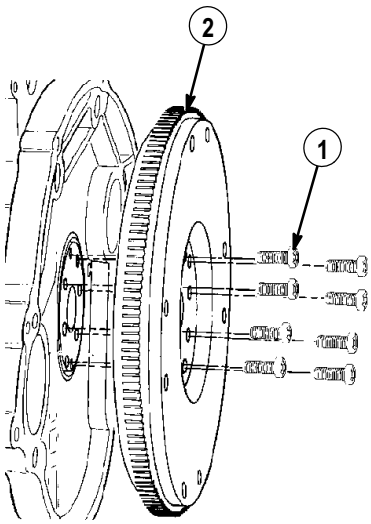
Materials/Parts
Compound, Degreaser (Item 9, Appendix B)
Crocus Cloth (Item 11, Appendix B)
Oil, Lubricating (Item 17, Appendix B)
Packing, Preformed (Item 95, Appendix E)

Personel Required
Two

Equipment Condition
Remove engine assembly, (Para 5-4)
Remove starter motor, (Para 5-23)

a. Removal.





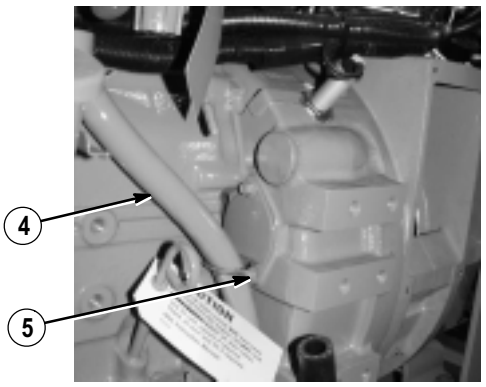
NOTE

May be necessary to hold crankshaft from turning for flywheel removal.

(1) Remove eight screws (1) and flywheel/ring gear assembly (2) from engine (3).

(2) Remove hose (4) from bracket (5).

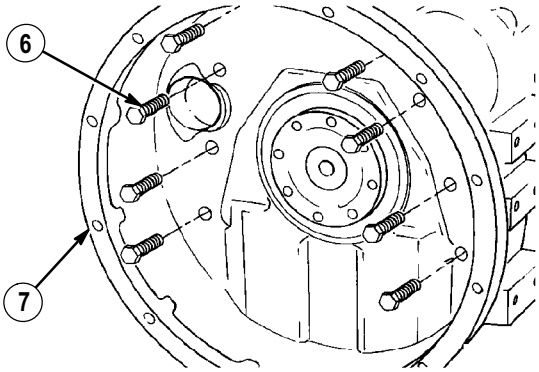
(3) Remove eight mounting screws (6).



WARNING

The flywheel housing weighs approximately 50 lbs (23 kg). Attach suitable lifting device to prevent possible injury to personnel.

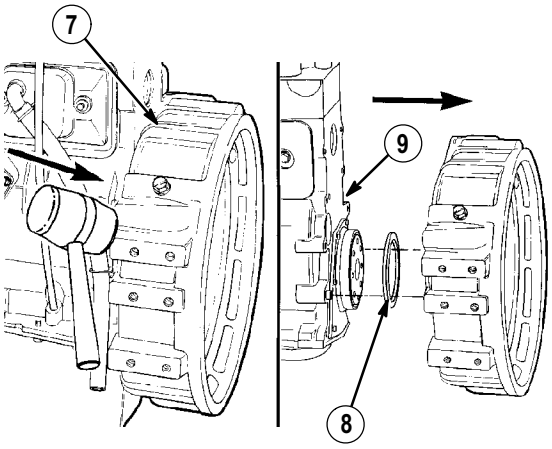
(4) With aid of an assistant attach lifting device to flywheel housing (7).



(5) With aid of an assistant using a soft plastic hammer, loosen the flywheel housing (7).

(6) Remove flywheel housing and preformed packaing (8) from cylinder block (9). Discard seal.

(7) Remove lifting device from flywheel housing (7).

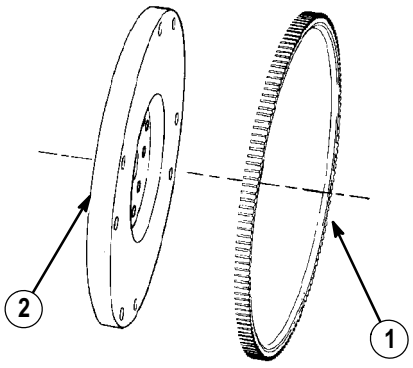


b. Disassembly.

WARNING

Wear eye protection when driving the ring gear from flywheel. Serious injury may result from flying metal fragments. Do not use a steel drift pin.

(1) Using brass drift pin, drive ring gear (1) from the flywheel (2). Discard ring gear.



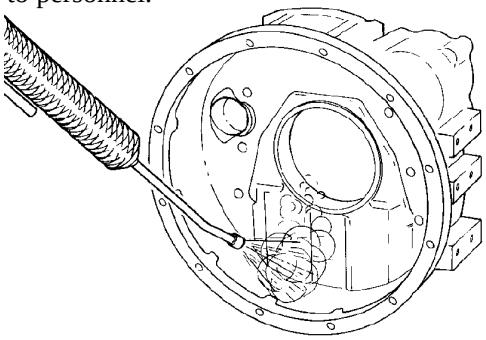
5-11. FLYWHEEL RING/GEAR AND FLYWHEEL HOUSING REPLACEMENT (CONT).

c. Cleaning/Inspection.

WARNING

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles, face shield, and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes, and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent. The flashpoint for Type II Drycleaning Solvent is 140 degrees F (60 degrees C) and Type III Drycleaning Solvent is 200 degrees F (93 degrees C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc). Failure to comply may result in injury or death to personnel.

(1) Use dry cleaning solvent to clean flywheel housing. Dry with compressed air.

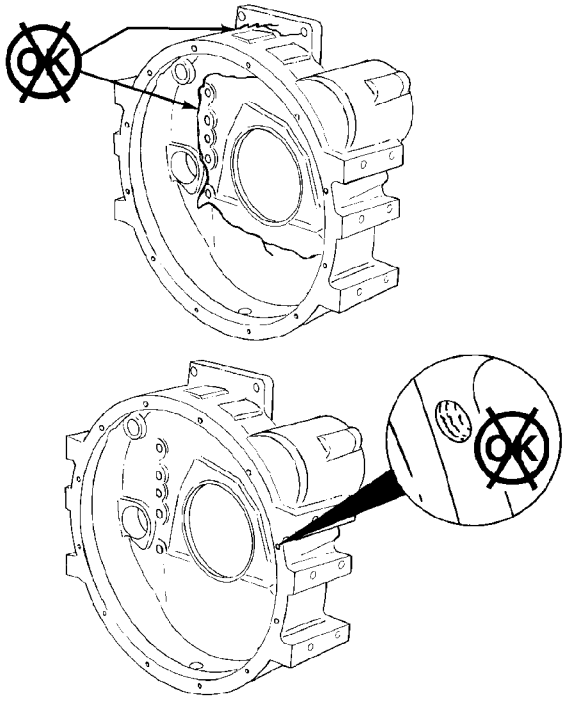


(2) Inspect flywheel housing for cracks, especially in the bolt pattern area.

(3) Visually inspect all surfaces for nicks, burrs, or cracks.

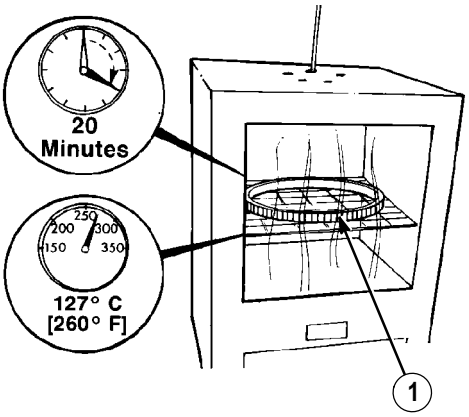
(4) Use fine crocus cloth to remove small nicks and burrs.

(5) Inspect for damage threads commonly caused by cross threaded screws or installing an incorrect screw.



d. Assembly.

(1) Heat new ring gear (1) for 20 minutes in an oven preheated to 127° C (260° F).



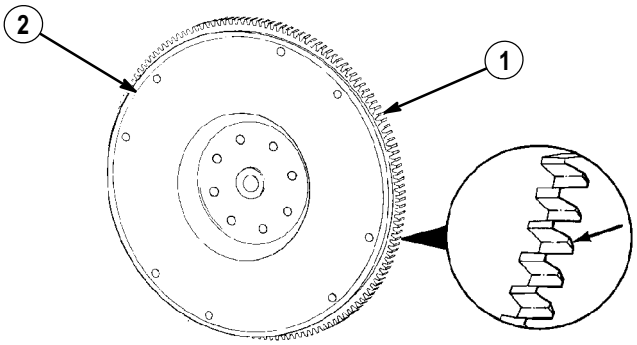
WARNING

Wear protective gloves when installing ring gear. Failure to comply may result in injury to personnel.

NOTE

Ring gear must be installed so the bevel on teeth is toward the crankshaft side of flywheel.

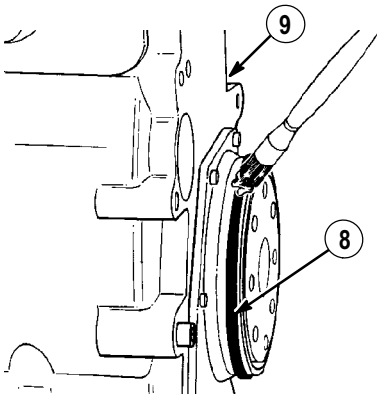
(2) Install hot ring gear (1) on flywheel (2).



e. Installation.

(1) Apply coat of lubricating oil to seal (8).

(2) Install preformed packing (8) on cylinder block (9).



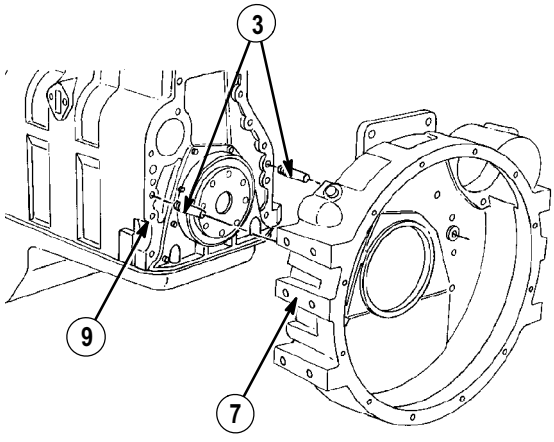
(3) Visually inspect rear face of cylinder block (9) and flywheel housing (7) mounting surface for cleanliness and raised nicks or burrs.

WARNING

The flywheel housing weighs approximately 50 lbs (23 kg). Attach suitable lifting device to prevent possible injury to personnel.

(4) With the aid of an assistant attach lifting device to flywheel housing (7).

(5) With the aid of an assistant, install flywheel housing (7) over two ring dowels (3) on cylinder block (9).

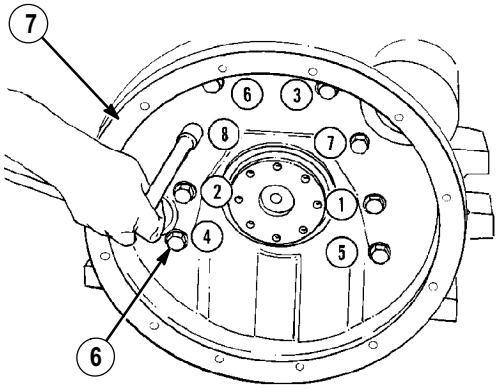


5-11. FLYWHEEL RING/GEAR AND FLYWHEEL HOUSING REPLACEMENT (CONT).

NOTE

Be sure sealing ring is not damaged during installation.

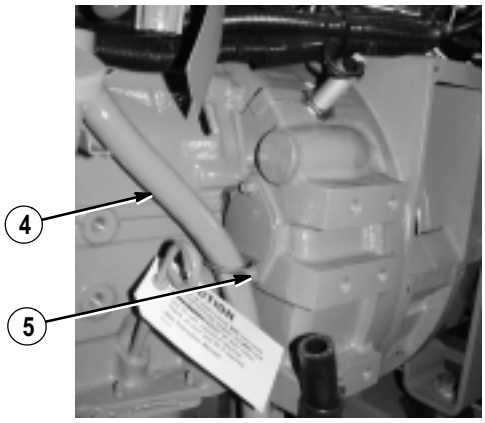
(6) Install eight screws (6) in flywheel housing (7) and tighten in sequence shown. Tighten screws 57 lb-ft (77 N·m).



CAUTION

If installing new flywheel housing perform procedure "**f**. Flywheel Housing Bore Alignment Check" and procedure "**g**. Flywheel Housing Face Alignment Check".

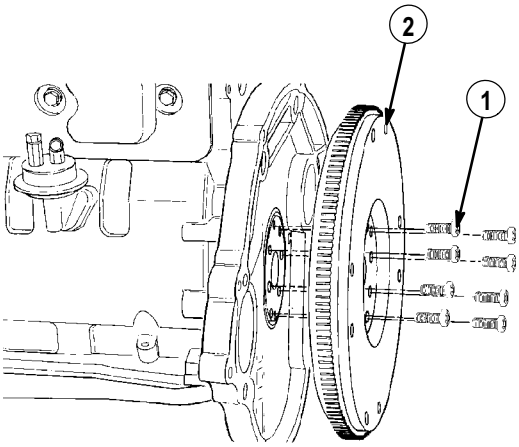
(7) Install hose (4) in bracket (5).



(8) Install two screws in front of crankshaft, or similar device, to hold crankshaft from turning.

(9) Install flywheel ring/gear assembly (2) on engine with eight screws (1). Tighten screws to 101 lb-ft (137 N·m).

(10) Perform **h**. Follow-On Maintenance.



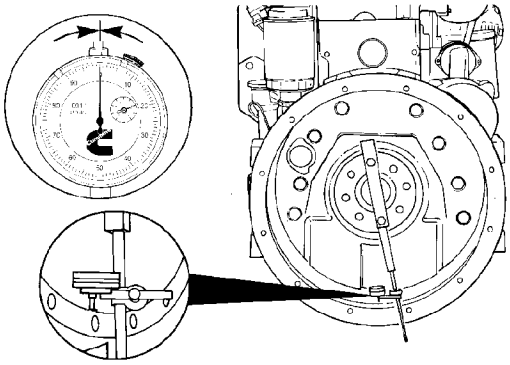
f. Flywheel Housing Bore Alignment Check.

NOTE

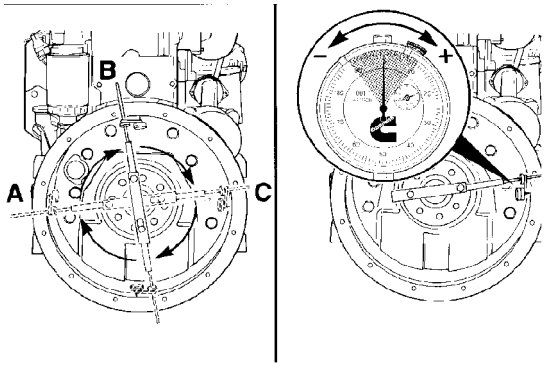
Perform Steps (1) through (18) only if installing a new flywheel housing.

(1) Attach a dial indicator to crankshaft. The dial indicator can be mounted by any method that holds extension bar of the indicator rigid so it does not sag. If bar sags or indicator slips, the readings obtained will not be accurate.

(2) Position the dial indicator at the 6 o'clock position and zero the gauge.



(3) Slowly rotate crankshaft. Record readings obtained at 9 o'clock, 12 o'clock, and 3 o'clock positions as (a), (b), and (c) in the concentricity work sheet. Recheck zero at the 6 o'clock position.



(4) The values for (a), (b), and (c) could be positive or negative. Refer to accompanying figure to determine the correct sign when recording these values.

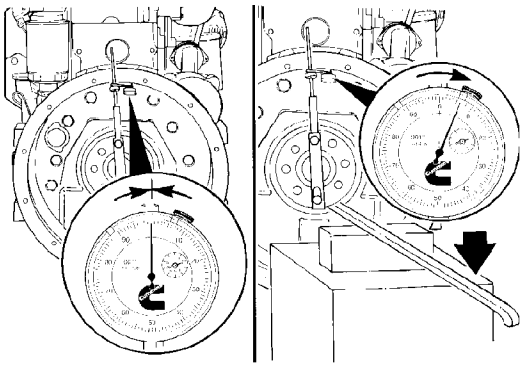
(5) Remove lifting device from flywheel housing.

Concentricity Worksheet

9 o'clock 3 o'clock	a = 0.004 c = -0.002
Total Horizontal	a – c = .006
12 o'clock Bearing Clearance	b = .003 d = .002
Total Vertical	b + d = .005

5-11. FLYWHEEL RING/GEAR AND FLYWHEEL HOUSING REPLACEMENT (CONT).

(6) Rotate crankshaft until dial indicator is at 12 o'clock position and zero the gauge.



CAUTION

Do not force the crankshaft beyond the point where bearing clearance has been removed. Do not pry against the flywheel housing. These actions could cause cause bearing clearance readings.

(7) Using a pry bar, raise rear of crankshaft to its upper limit. Record the value as (d) in the concentricity work sheet. This is the vertical bearing clearance adjustment and will always be positive.

(8) Using the concentricity work sheet, determine the values for the "total vertical" and "total horizontal" values.

(9) The "total horizontal" is equal to the 9 o'clock reading, (a), minus the 3 o'clock reading, (c).

(10) The "total vertical" is equal to the 12 o'clock reading, (b), plus the bearing clearance, (d).

Example:

6 o'clock = ref = 0

9 o'clock = ref = 0.004"

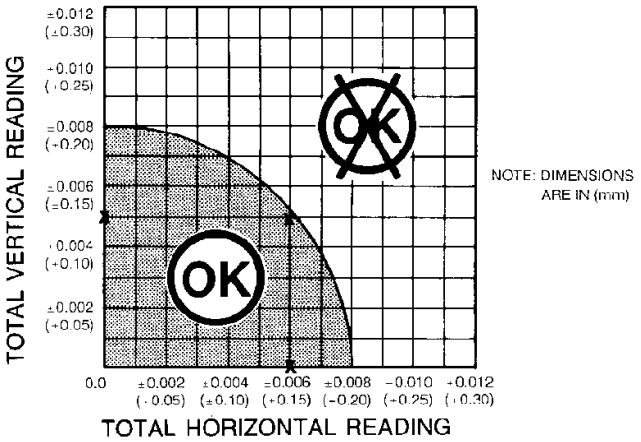
12 o'clock = ref = 0.003"

3 o'clock = ref = –0.002

(11) Using the work sheet and the numbers from the example:
"total horizontal" value = 0.006"
"total vertical" value = 0.005".

Concentricity Worksheet

9 o'clock	a = 0.004
3 o'clock	c = -0.002
Total Horizontal	a – c = .006
12 o'clock	b = .003
Bearing Clearance	d = .002
Total Vertical	b + d = .005



(12) Mark the “total horizontal” value on horizontal side of chart and the “total vertical” on vertical side of chart.

(13) Using a straight edge, find the intersection point of the “total horizontal” and “total vertical” values. The intersection point must fall within shaded area for the flywheel housing concentricity to be within specification.

(14) Using the “total horizontal” and “total vertical” values from the previous example, the intersection point falls within the shaded area. Therefor, the flywheel housing concentricity is within specification.

(15) If the intersection point falls outside the shaded area, the ring dowels must be removed and the housing repositioned.

NOTE

The ring dowels are not required to maintain concentricity of the housing; the clamping force of the screws holds the housing in place.

(16) After the ring dowels (3) are discarded, install flywheel housing (7) on engine.

NOTE

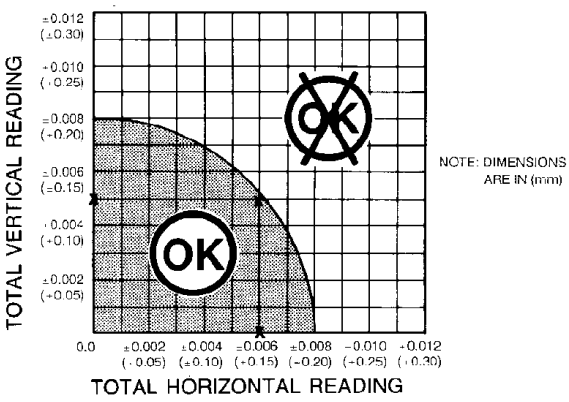
Reference Step (4) of “Installation” for installation of screws.

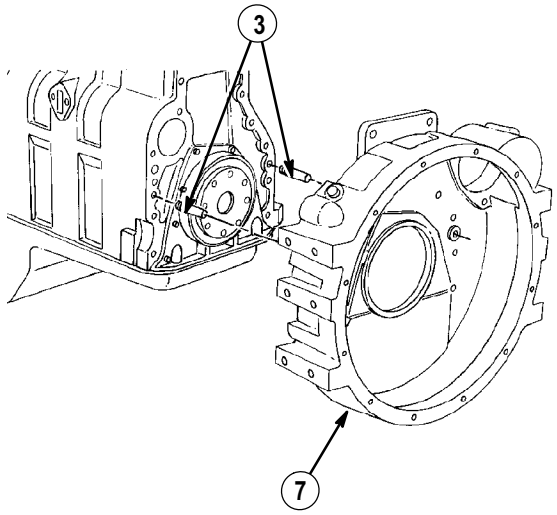
(17) To position flywheel housing, tighten eight screws enough to hold flywheel housing in place, but loose enough to enable small movement when struck lightly with a soft plastic hammer.

(18) Recheck the concentricity. When concentricity is within specification, torque the capscrews to the specified value.

Concentricity Worksheet

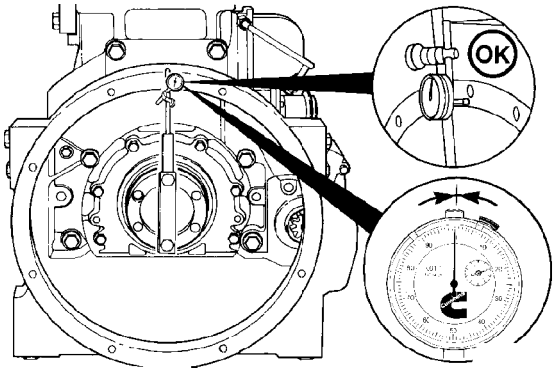
9 o’clock 3 o’clock	a = 0.004 c = -0.002
Total Horizontal	a – c = .006
12 o’clock Bearing Clearance	b = .003 d = .002
Total Vertical	b + d = .005





5-11. FLYWHEEL RING/GEAR AND FLYWHEEL HOUSING REPLACEMENT (CONT).

g. Flywheel Housing Face Alignment Check.



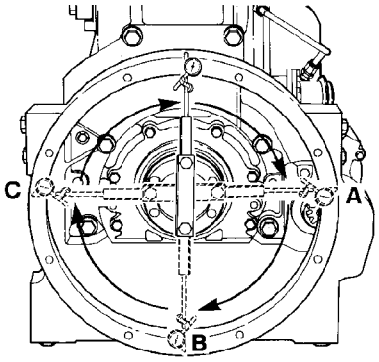
NOTE

Perform Steps (1) through (5) only if installing a new flywheel housing.

CAUTION

The dial indicator tip must not enter the screw holes or the gauge will be damaged.

(1) Install the dial indicator as shown.



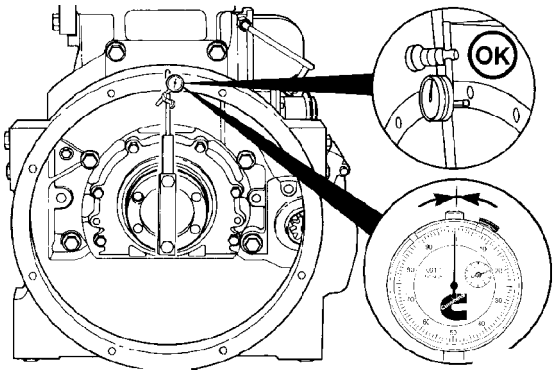
NOTE

The extension bar for dial indicator must be rigid for an accurate reading. It must not sag. Position dial indicator at the 12 o'clock position. Adjust dial indicator until the needle points to zero.

(2) Slowly rotate crankshaft. Record readings at 3 o'clock, 6 o'clock, and 9 o'clock positions.

NOTE

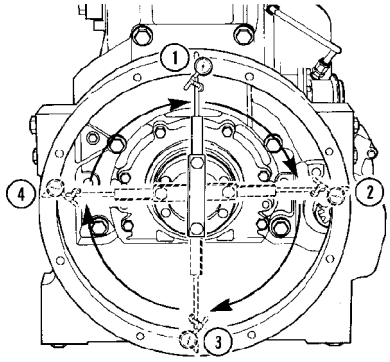
The crankshaft must be pushed toward the front of the engine to remove the crankshaft end clearance each time a position is measured.



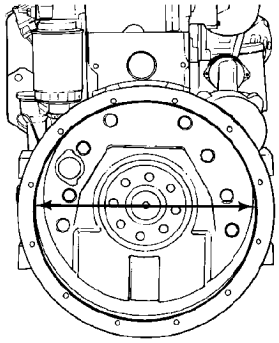
(3) Continue to rotate crankshaft until indicator is at the 12 o'clock position. Check the indicator to make sure the needle points to zero. If it does not, the readings will be incorrect.

(4) Determine the Total Indicator Reading (TIR).

Example:	inch	mm
12 o'clock	0.000	(0.00)
3 o'clock	+0.0003	(+0.08)
6 o'clock	–0.0002	(–0.05)
9 o'clock	+0.0003	(+0.08)
Equals TIR	0.005	(0.13)



(5) The maximum allowable Total Indicator Reading (TIR) is determined by the diameter of the housing bore. If out of specifications, replace the housing.



Bore Diameter

SAE No.	inchmm	mm	TIR Max inch	TIR Max mm
2	17.625 to 17.30	(447.68 to 447.80)	0.008	(0.20)
3	16.125 to 16.130	(409.58 to 409.70)	0.008	(0.20)

h. Follow-On Maintenance.

- Install starting motor, (Para 5-23).
- Install engine assembly, (Para 5-4).

END OF TASK

5-12. PUSH ROD COVER REPLACEMENT.

This task covers:

a. Removal
b. Cleaning/Inspection
c. Installation
d. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Compressor Unit, Air (Item 10, Appendix G)
Gloves, Chemical Oil Protective (Item 23, Appendix G)
Goggles, Industrial (Item 25, Appendix G)
Gun, Air Blow (Item 29, Appendix G)
Indicator, Dial (Item 33, Appendix F)
Socket Set, 3/8 In. (Item 52, Appendix F)
Wrench, Torque 0-60 N·m (Item 85, Appendix F)

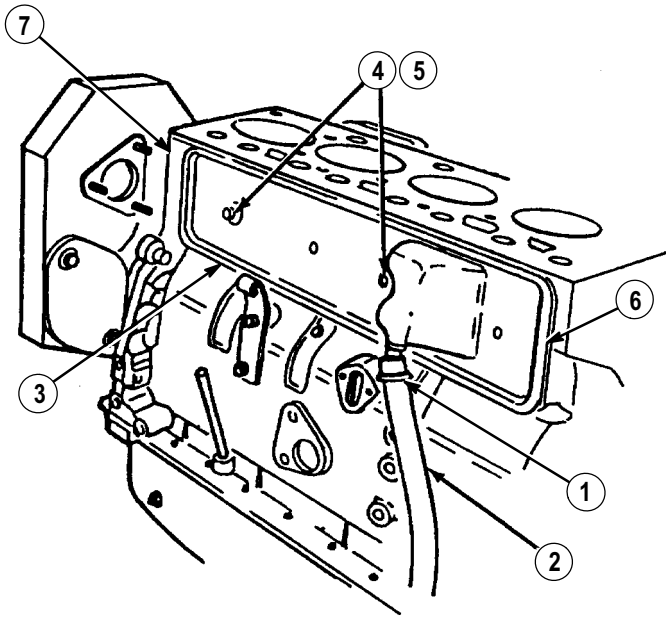
Materials/Parts
Sealing Compound (Item 25, Appendix B)
Solvent, Dry Cleaning (Item 34, Appendix B)
Gasket, Push Rod Cover (Item 26, Appendix E)
Packing, Preformed (2) (Item 99, Appendix E)

Equipment Condition
Batteries disconnected, (TM 9-4940-568-10)
Remove rear panel, (TM 9-4940-568-10)
Fuel filter removed, (TM 9-4940-568-20)
Fuel injection pump removed, (Para 5-17)
Fuel pump removed, (TM 9-4940-568-20)

a. Removal.

(1) Remove spring hose clamp (1) and hose (2) from push rod cover (3).

(2) Remove two screws (4), preformed packing (5), push rod cover (3) and push rod cover gasket (6) from engine block (7). Discard preformed packing and push rod cover gasket.



b. Cleaning/Inspection.

(1) Clean gasket material from push rod cover and engine block.

WARNING

Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

(2) Clean push rod cover with dry cleaning solvent.

(3) Dry push rod cover with compressed air and inspect for cracks or dents.

c. Installation.

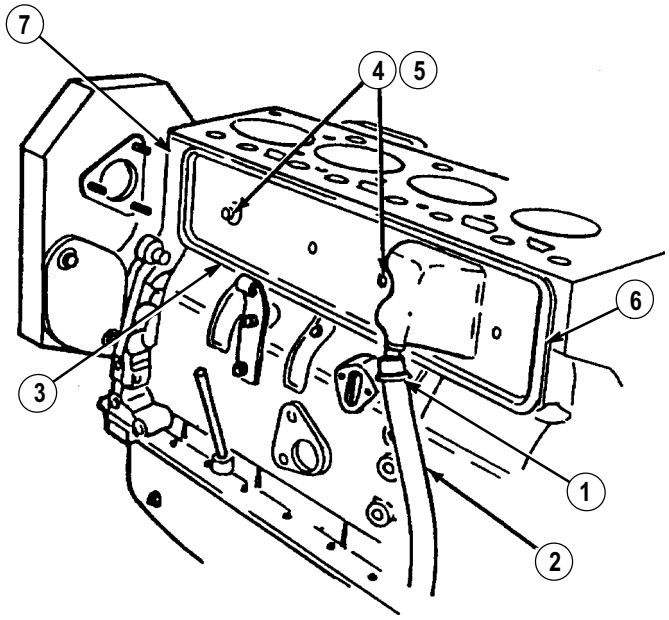
NOTE

Push rod cover gasket has an adhesive back. Pull off protective cover on gasket to expose adhesive surface.

(1) Install push rod cover gasket (6) with adhesive side down on push rod cover (3).

WARNING

Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.



(2) Apply thin coat of sealing compound to top of gasket and engine block (7).

(3) Install push rod cover (3), two preformed packings (5), and screws (4) on engine block (7). Tighten two screws to 18 lb-ft (24 N·m).

(4) Install hose (2) and spring hose clamp (1) on push rod cover (3).

d. Follow-On Maintenance:

- Install fuel pump, (TM 9-4940-568-20).
- Install fuel injection pump, (Para 5-17).
- Install fuel filter, (TM 9-4940-568-20).
- Install rear panel, (TM 9-4940-568-10).
- Connect batteries, (TM 9-4940-568-10).
- Start generator set and operate the engine at idle for 5 to 10 minutes and check for leaks, (TM 9-4940-568-10).

END OF TASK

5-13. LUBE OIL PUMP REPAIR.

This task covers:

a. Removal
b. Disassembly
c. Cleaning/Inspection
d. Assembly
e. Installation
f. Follow-On Maintenance

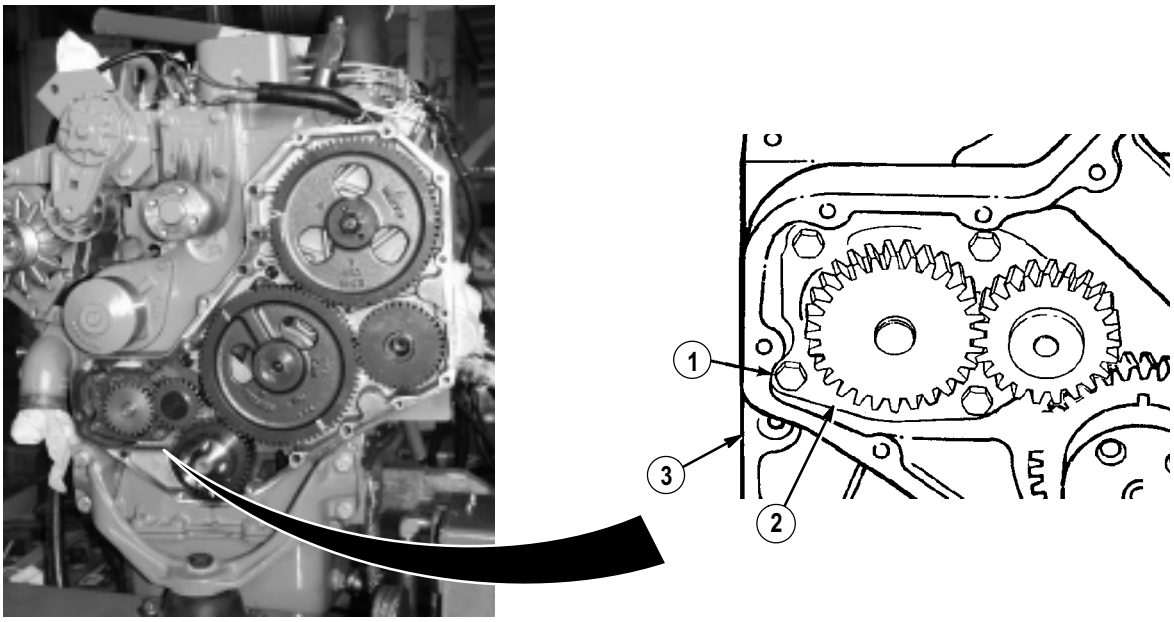
INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Compressor Unit, Air (Item 10, Appendix F)
Gloves, Chemical Oil Protective (Item 23, Appendix F)
Goggles, Industrial (Item 25, Appendix F)
Gun, Air Blow (Item 29, Appendix F)
Socket Set, 3/8 in. (Item 52, Appendix F)
Wrench, Torque 0 to 60 N·m (Item 85, Appendix F)

Materials/Parts
Oil, Engine (Item 18, Appendix B)
Solvent, Drycleaning (Item 34, Appendix B)

Equipment Condition
Batteries disconnected, (TM 9-4940-568-10)
Fan blade removed, (TM 9-4940-568-20)
Front gear cover removed, (Para 5-14)

a. Removal.

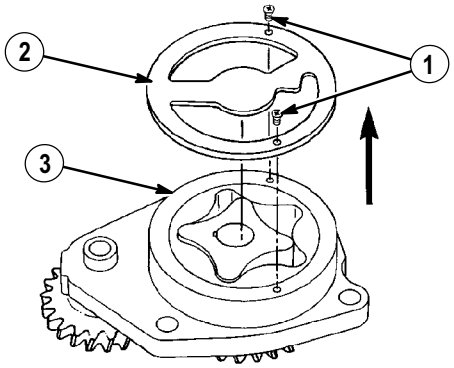


(1) Remove four mounting screws (1) from oil pump (2).

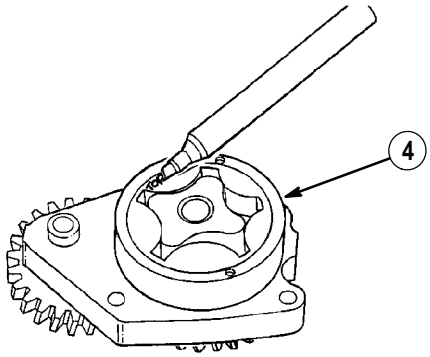
(2) Remove oil pump (2) from bore in the cylinder block (3).

b. Disassembly.

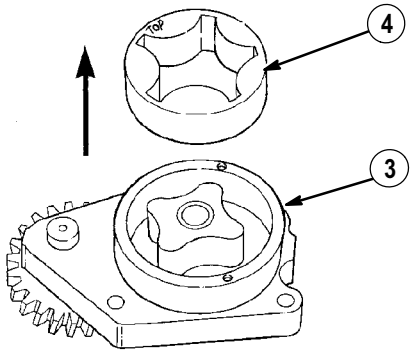
(1) Remove two screws (1) and back plate (2) from oil pump (3).



(2) Mark “TOP” on the gerotor planetary (4).

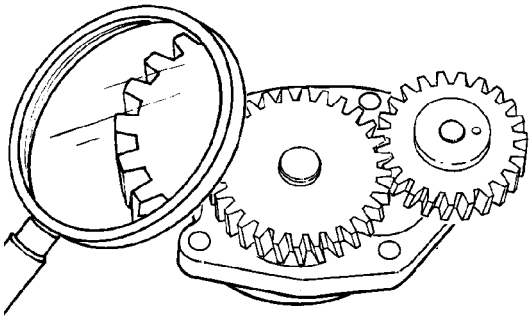


(3) Remove gerotor planetary (4) from oil pump (3).



c. Cleaning/Inspection.

(1) Visually inspect lubricating oil pump gears for chips, cracks, or excessive wear.

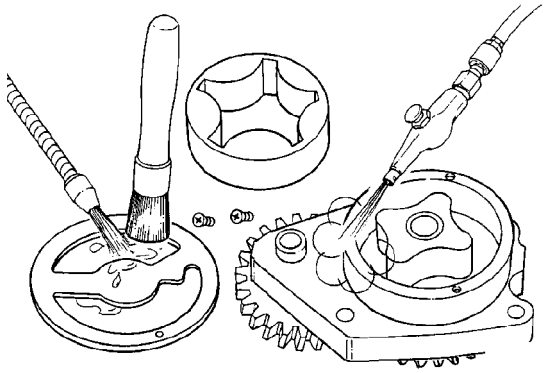


5-13. LUBE OIL PUMP REPAIR (CONT).

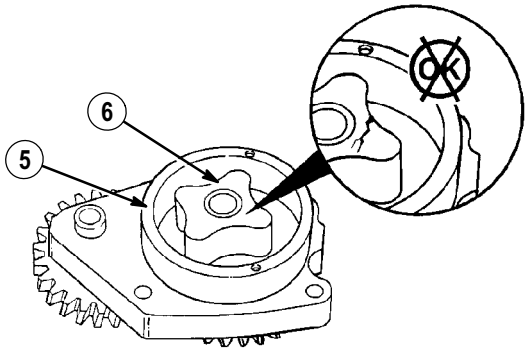
WARNING

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles, face shield, and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes, and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent. The flashpoint for Type II Drycleaning Solvent is 140 degrees F (60 degrees C) and Type III Drycleaning Solvent is 200 degrees F (93 degrees C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc). Failure to comply may result in injury to personnel.

(2) Clean all parts in solvent and dry with compressed air.



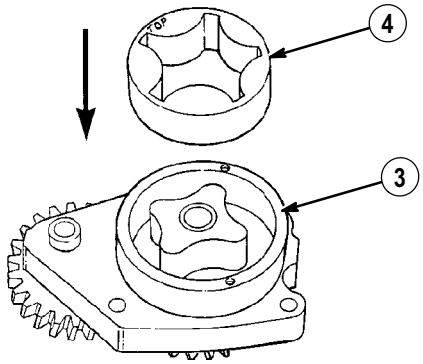
(3) Inspect lubricating oil pump housing (5) and gerotor drive (6) for cracks, chips or obvious damage.



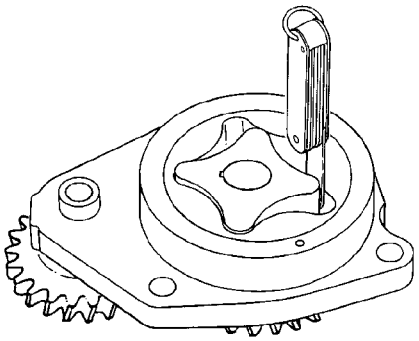
CAUTION

Install gerotor planetary as marked during disassembly.

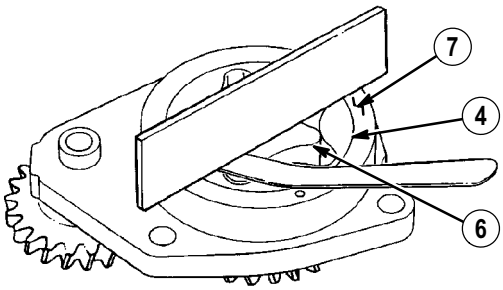
(4) Install gerotor planetary (4) in oil pump (3).



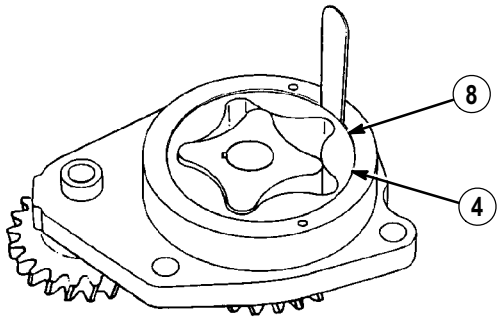
(5) Measure the tip clearance. Maximum clearance 0.007 in. (0.1778 mm).



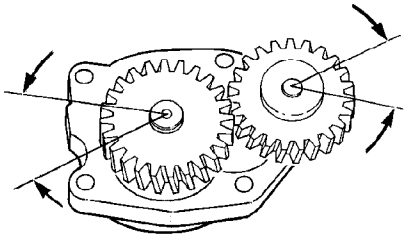
(6) Measure the clearance of gerotor drive (6) and gerotor planetary (4) to the port plate (7). Maximum clearance 0.005 in. (0.127 mm).



(7) Measure the clearance of gerotor planetary (4) to body bore (8). Maximum clearance 0.015 in. (0.381 mm).



(8) Measure the gears backlash. Minimum clearance 0.003 in. (0.076 mm). Maximum clearance 0.013 in. (0.330 mm).



5-13. LUBE OIL PUMP REPAIR (CONT).

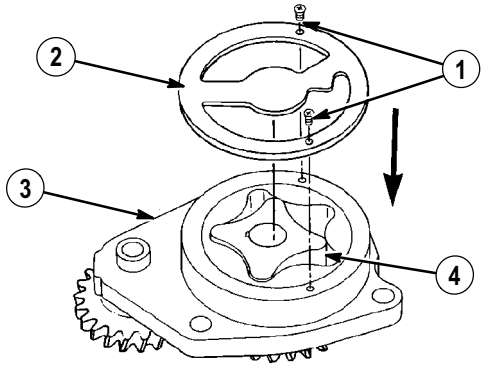
d. Assembly.

CAUTION

Install gerotor planetary as marked during disassembly.

(1) Position gerotor planetary (4) in oil pump (3).

(2) Install back plate (2) and two screws (1) on oil pump (3).

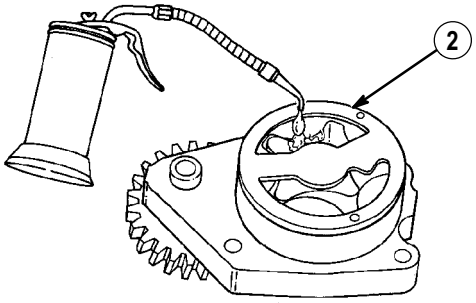


e. Installation.

CAUTION

Failure to fill the pump with oil during installation can result in a slow prime at initial engine start up, resulting in severe engine damage.

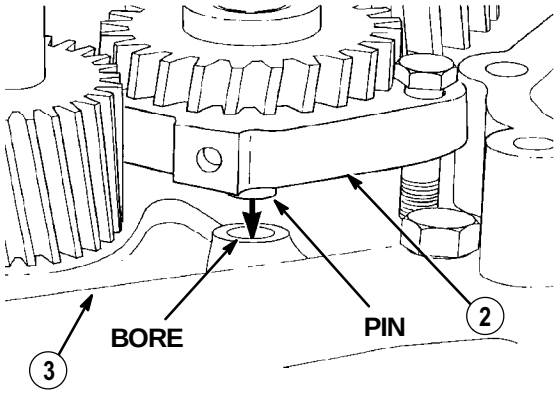
(1) Lubricate lubricating oil pump (2) with clean engine oil.



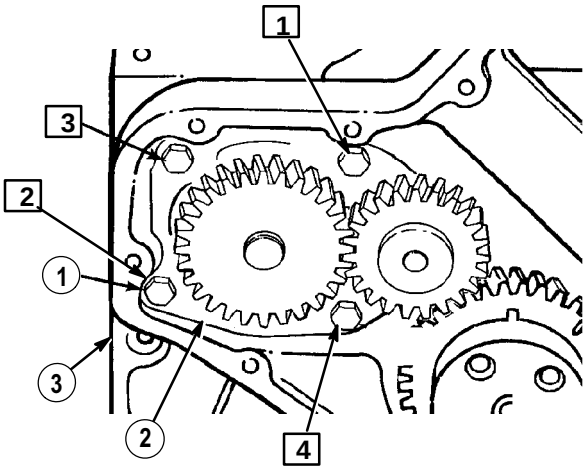
CAUTION

Ensure the idler gear pin is installed in the locating bore in the cylinder block.

(2) Install lubricating oil pump (2) on bore of cylinder block (3).



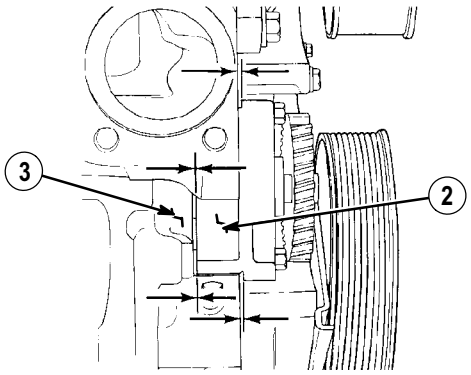
(3) Install four mounting screws (1) in sequence shown. Tighten to 18 lb-ft (24 N·m).



NOTE

The back plate on the pump seats against the bottom of the bore in the cylinder block. When the lubricating oil pump is correctly installed, the flange on the lubricating oil pump will not touch the cylinder block.

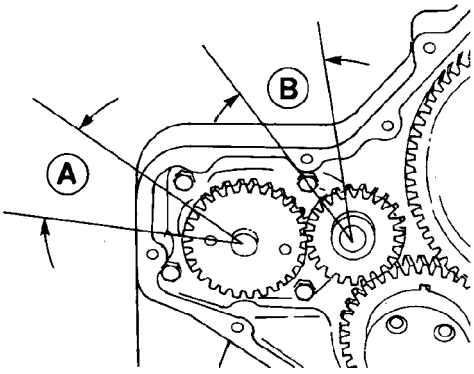
(4) Check for clearance between flange on lubricating oil pump (2) and cylinder block (3).



NOTE

- Perform Step (5) to ensure gear backlash is correct if installing a new lubricating oil pump.
- If the adjoining gear moves when you measure the backlash, the reading will be incorrect.

(5) Measure gear backlash limits.
A= .003 in. to .013 in.
(.076 mm to .330 mm)
B= .003 in. to .013 in.
(.076 mm to .330 mm)



f. Follow-On Maintenance:

- Install front gear cover, (Para 5-14).
- Install fan blade, (TM 9-4940-568-20).
- Install panels as necessary, (TM 9-4940-568-10).
- Connect batteries, (TM 9-4940-568-10).

END OF TASK

5-14. FRONT GEAR COVER REPLACEMENT.

This task covers:

a. Removal
b. Cleaning/Inspection
c. Installation
d. Follow-On Maintenance

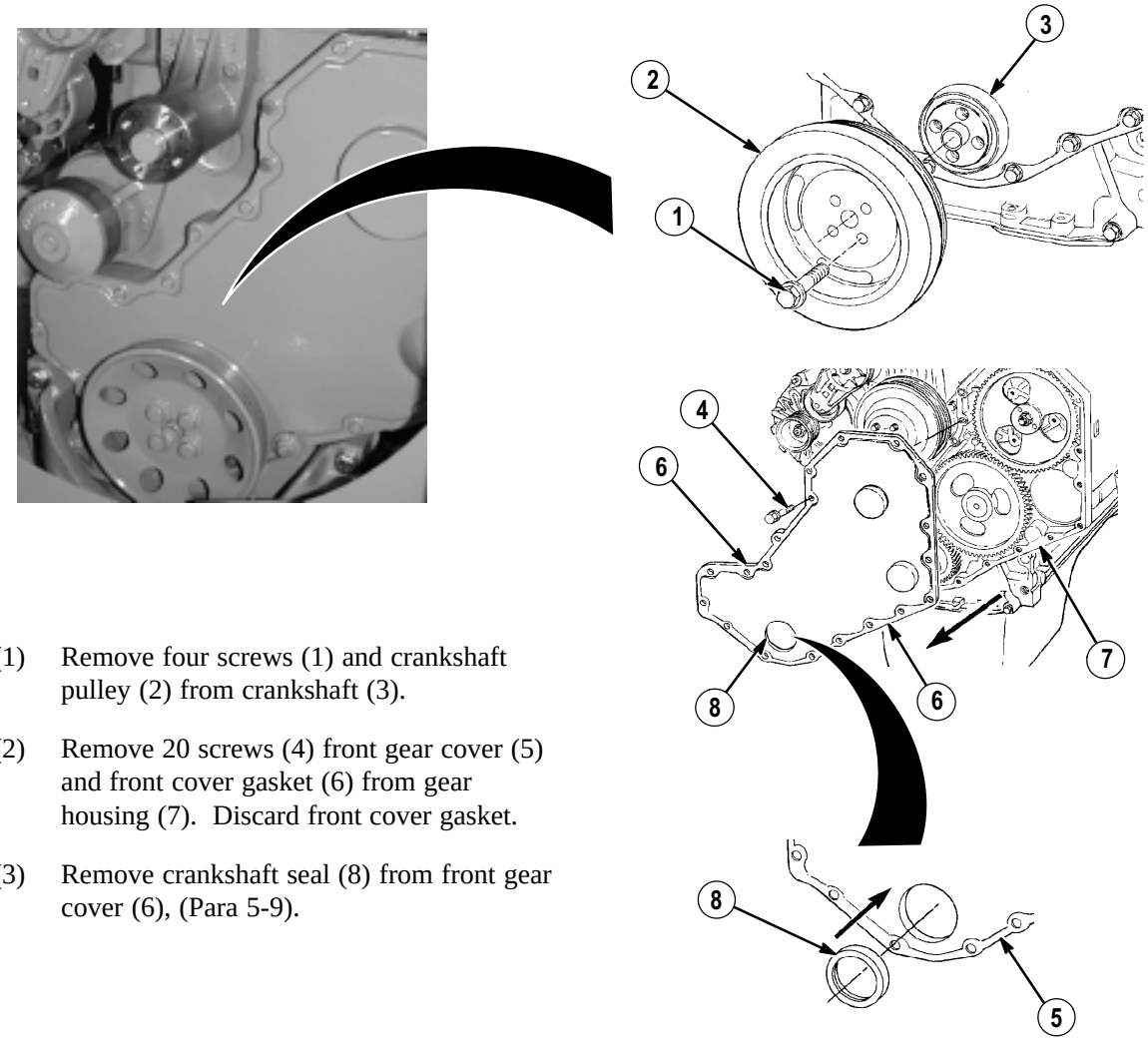
INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Wrench, Torque 0–175 (N·m) (Item 83, Appendix F)

Materials/Parts
Adhesive, RTV (Item 2, Appendix B)
Front Cover Gasket (Item 21, Appendix E)

Equipment Condition
Batteries disconnected, (TM 9-4940-568-10)
Radiator removed, (TM 9-4940-568-20)
Fan blade removed, (TM 9-4940-568-20)

a. Removal.



(1) Remove four screws (1) and crankshaft pulley (2) from crankshaft (3).

(2) Remove 20 screws (4) front gear cover (5) and front cover gasket (6) from gear housing (7). Discard front cover gasket.

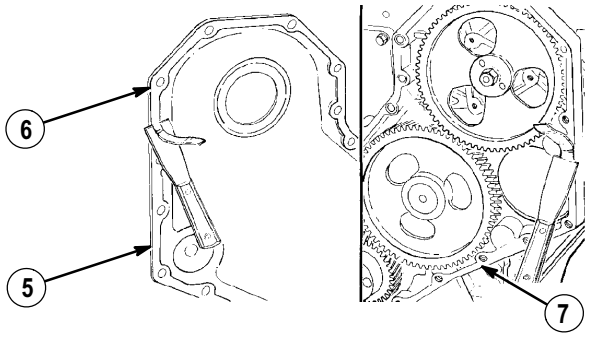
(3) Remove crankshaft seal (8) from front gear cover (6), (Para 5-9).

b. Cleaning/Inspection.

(1) Clean remaining front cover gasket (6) from gear cover (5) and gear housing (7) gasket surfaces.

(2) Inspect the front gear cover (5) for cracks or damage.

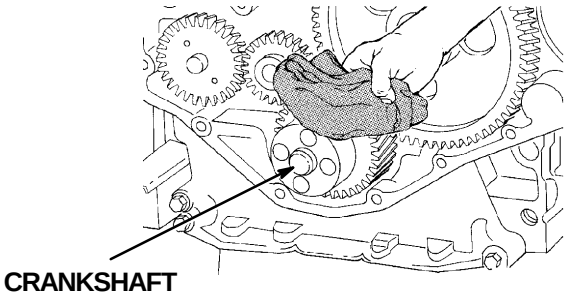
(3) Clean and dry crankshaft sealing lip surface.



c. Installation.

CAUTION

The crankshaft sealing lip surface must be clean, dry and oil free before installing the gear cover. Failure to properly clean the sealing lip surface will result in an oil leak.



(1) Install crankshaft seal (8) in the front gear cover (5), (Para 5-9).

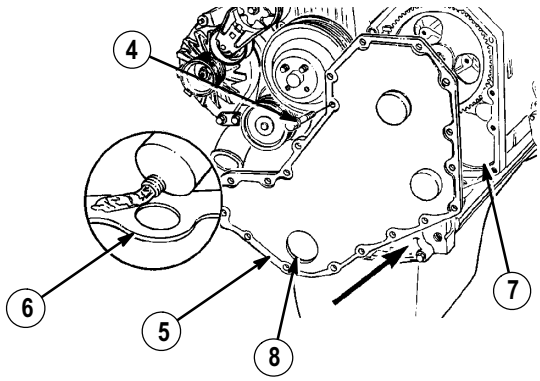
WARNING

Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

(2) Apply a thin bead of RTV to the cover side of the front cover gasket (6) only and position on front gear cover (5).

NOTE

Ensure crankshaft seal is positioned on crankshaft when front gear cover is installed.



(3) Install the front cover gasket (6) and front gear cover (5) on gear housing (7).

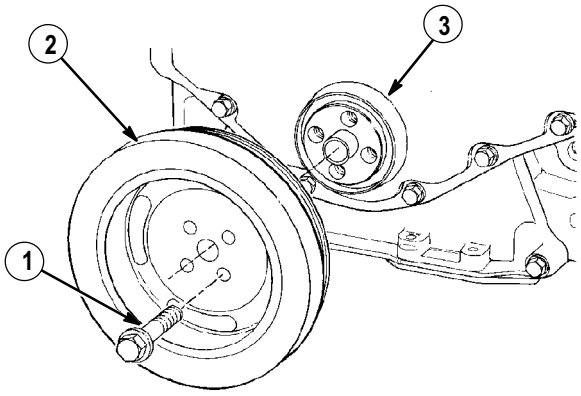
(4) Install 20 screws (4) on front gear cover (5). Tighten screws to 18 lb-ft (24 N·m).

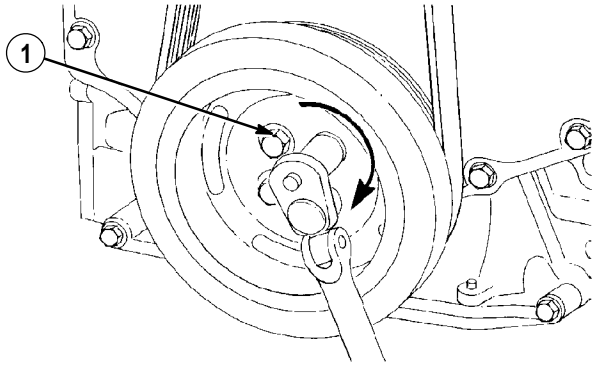
5-14. FRONT GEAR COVER REPLACEMENT (CONT).

(5) Position four screws (1) and the crankshaft pulley (2) on crankshaft (3). Do not tighten screws.

(6) Install fan blade and drive belt, (TM 9-4940-568-20).

(7) Tighten four screws (1) to 92 lb-ft (125 N·m).





d. Follow-On Maintenance.

- Install radiator, (TM 9-4940-568-20).
- Connect batteries, (TM 9-4940-568-10).

END OF TASK

5-15. FUEL TANK REPLACEMENT.

This task covers:

a. Removal
b. Cleaning/Inspection
c. Installation
d. Follow-On Maintenance

INITIAL SETUP

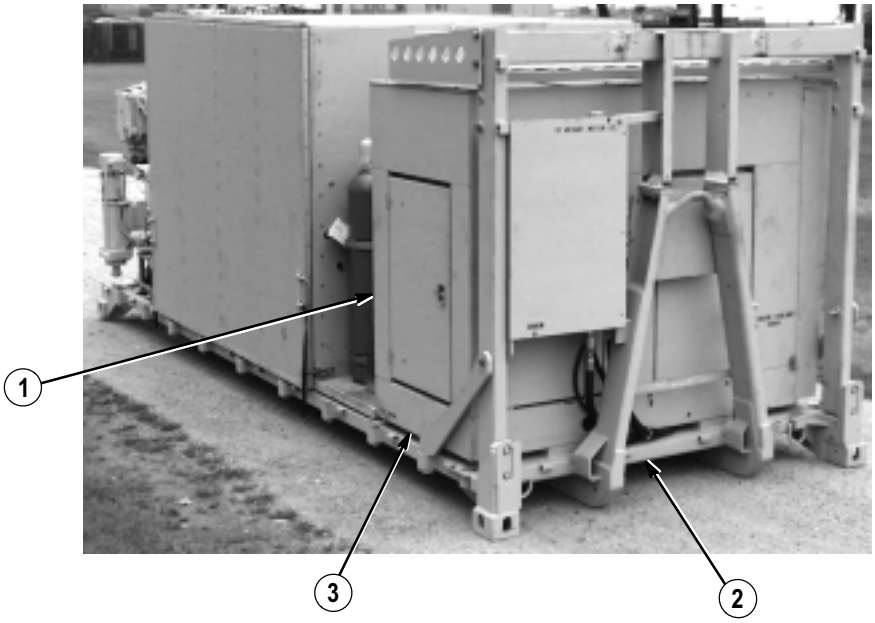
Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Dispensing Pump (Item 13, Appendix F)
Drill, Electric, Portable 1/4 in. (Item 14, Appendix F)
Drill Set, Twist (Item 15, Appendix F)
Drum, Storage 57 Gal (Item 17, Appendix F)
Gloves, Chemical Oil Protective (Item 23, Appendix F)
Goggles, Industrial (Item 25, Appendix F)
Pan, Drain 6 Gal (Item 42, Appendix F)

Material/Parts
Sealing Compound, (Item 30, Appendix B)
Locknut (9) (Item 38, Appendix E)
Rivet (26) (Item 144, Appendix E)

Personnel Required
Two

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
Batteries disconnected, (TM 9-4940-568-10)

a. Removal.

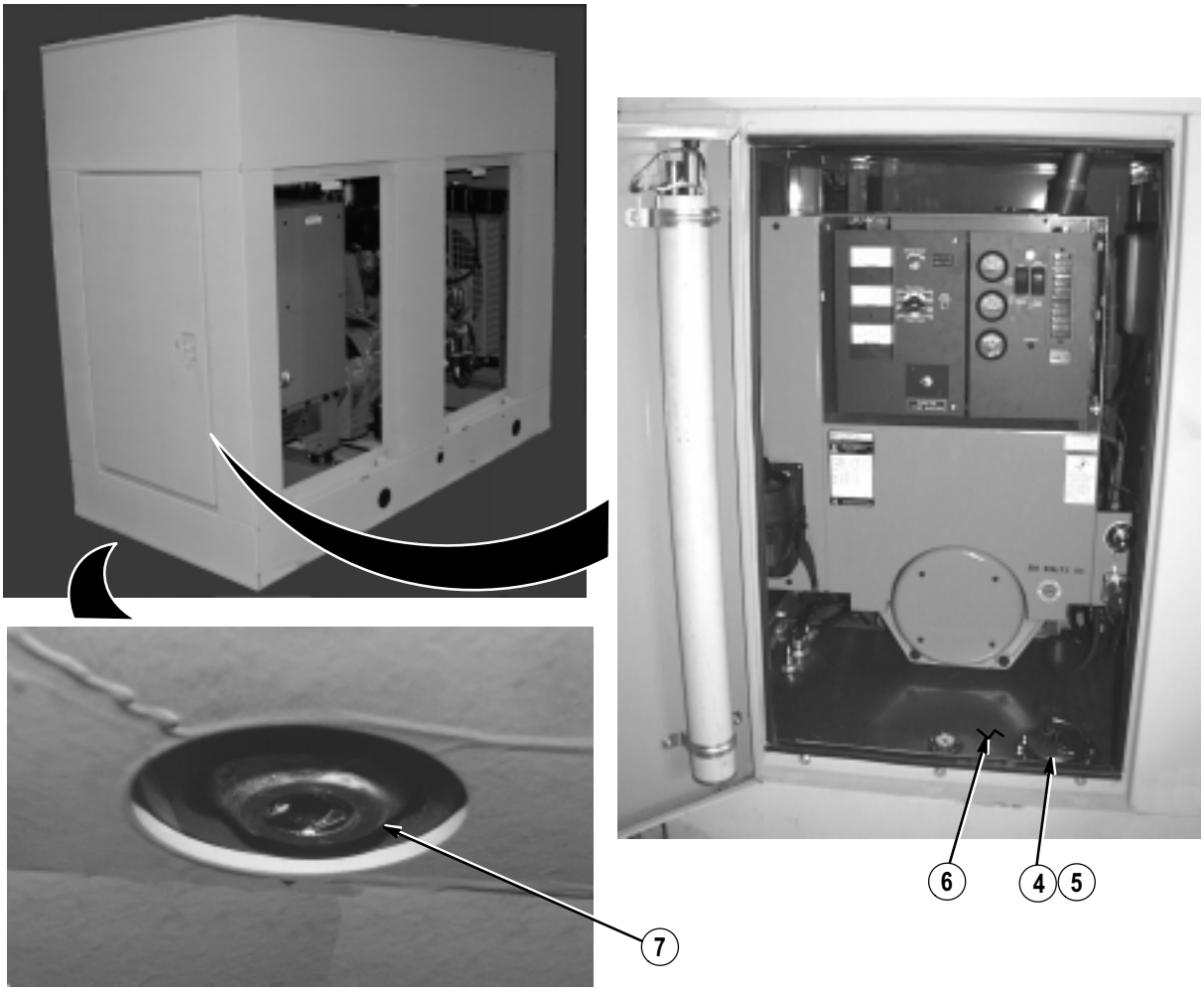


(1) Remove generator set (1) from flatrack (2) and support so their is access for removal of bottom cover (3) from bottom of generator set (Para 5-3).

(2) Remove fuel hoses and fittings from fuel tank (TM 9-4940-568-20).

(3) Remove fuel tank vent hose from fuel tank (TM 9-4940-568-20).

5-15. FUEL TANK REPLACEMENT (CONT).



WARNING

Fuel is very flammable and can explode easily. To avoid serious injury or death, keep fuel away from open fire and keep fire extinguisher within easy reach when working with fuel. Do not work on fuel system when engine is hot. Fuel can be ignited by engine.

(4) Remove cap and chain (4) and strainer (5) from fuel tank (6).

(5) Position dispensing pump in fuel tank (6).

(6) Pump fuel into storage drum.

(7) Position drain pan under drain plug (7).

(8) Remove drain plug (7) from fuel tank (6) and drain excess fuel.

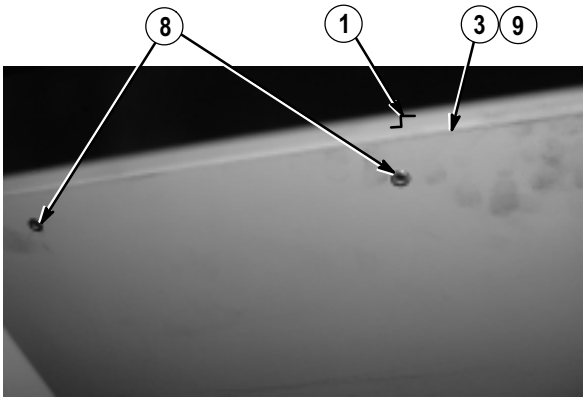
CAUTION

Ensure bottom cover is supported during removal of rivets or damage to equipment may result.

NOTE

Note position of bottom cover and fuel tank pad during removal.

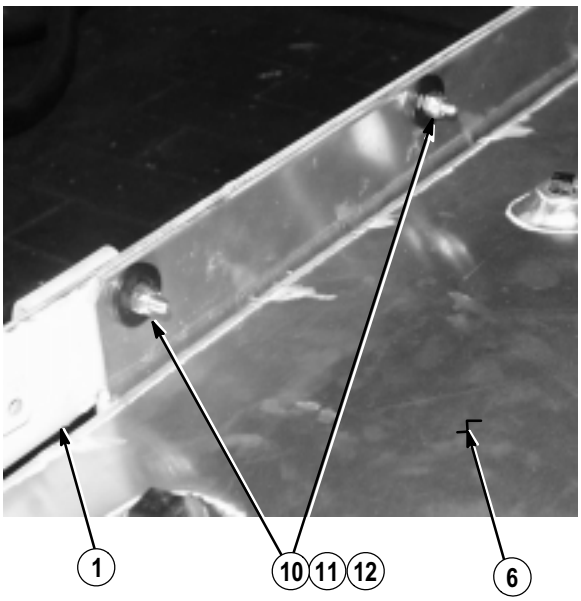
(9) With the aid of an assistant, remove 26 rivets (8), bottom cover (3) and fuel tank pad (9) from bottom of generator set (1).



CAUTION

Ensure fuel tank is supported during removal or damage to equipment may result.

(10) With the aid of an assistant, remove nine locknuts (10), washers (11), screws (12) and fuel tank (6) from bottom of generator set (1).



NOTE

If replacing fuel tank, perform Step (11).

(11) Remove fuel tank gage from fuel tank (TM 9-4940-568-20).

b. Cleaning/Inspection.

WARNING

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles, face shield, and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes, and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent. The flashpoint for Type II Drycleaning Solvent is 140 degrees F (60 degrees C) and Type III Drycleaning Solvent is 200 degrees F (93 degrees C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.

(1) Clean fuel tank brackets and generator set supports with drycleaning solvent.

(2) Clean fuel tank pad with soapy water. Rinse pad with clean water.

5-15. FUEL TANK REPLACEMENT (CONT).

(3) Inspect fuel tank brackets and generator set supports for cracks, breaks or corrosion.

(4) Inspect fuel tank pad for brittleness, cracks, or breaks.

(5) Purge and clean fuel tank as required.

(6) Inspect fuel tank for cracks or broken welds.

(7) Replace all damaged parts.

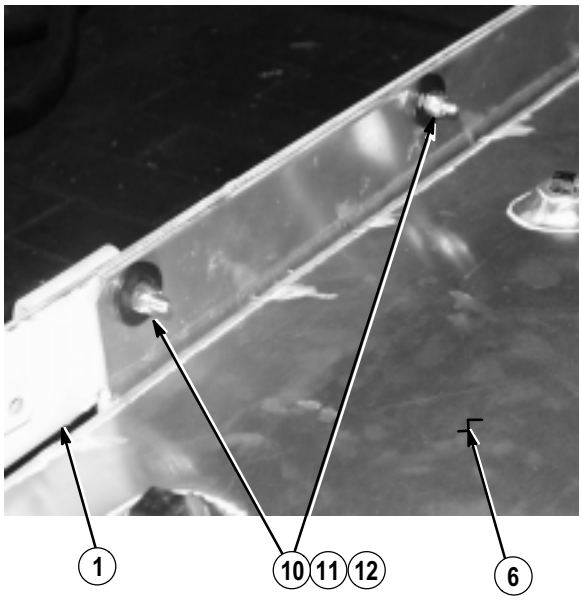
c. Installation.

NOTE

If fuel tank gage was removed, perform Step (1).

(1) Install fuel tank gage on fuel tank (TM 9-4940-568-20).

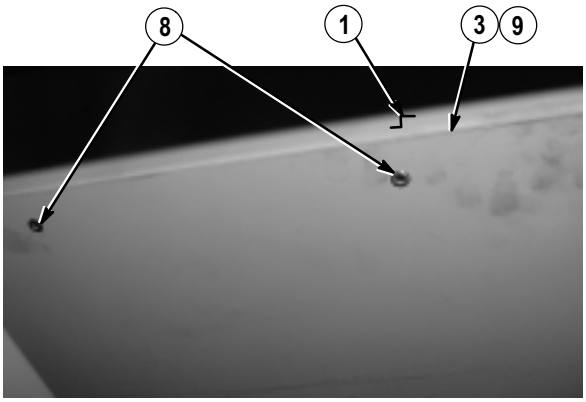
(2) With the aid of an assistant, install fuel tank (6) to generator set (1) with nine screws (12), washers (11) and locknuts (10).

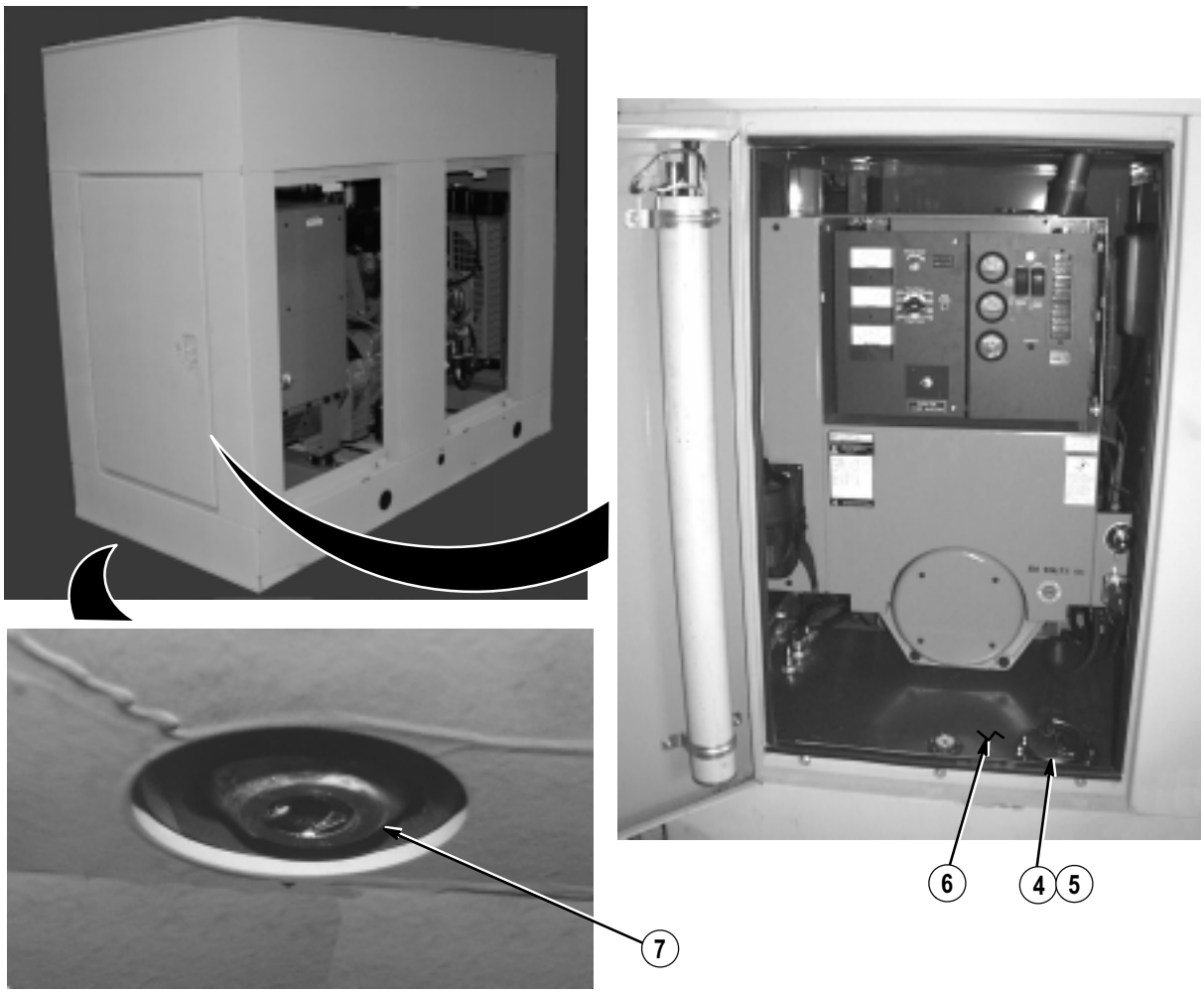


NOTE

Install fuel tank pad and bottom cover as noted during removal.

(3) With the aid of an assistant, install fuel tank pad (9) and bottom cover (3) on bottom of generator set (1) with 26 rivets (8).





WARNING

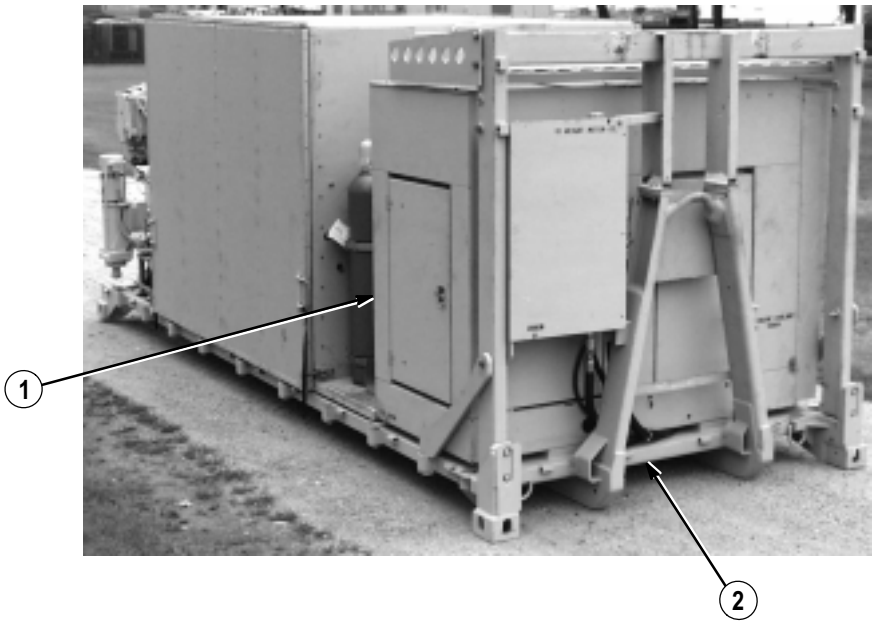
Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

(4) Apply sealing compound to threads of drain plug (7).

(5) Install drain plug (7) in fuel tank (6).

(6) Install strainer (5) and cap and chain (4) in fuel tank (6).

5-15. FUEL TANK REPLACEMENT (CONT).



(7) Install fuel tank vent hose to fuel tank (TM 9-4940-568-20).

(8) Install fuel hoses and fittings to fuel tank (TM 9-4940-568-20).

(9) Install generator set (1) on flatrack (2) (Para 5-3).

d. Follow-On Maintenance.

- Fill fuel tank, (TM 9-4940-568-10).
- Check fuel tank and connections for leaks. Tighten any connections that leak.
- Connect batteries, (TM 9-4940-568-10)

END OF TASK

5-16. FUEL INJECTOR REPLACEMENT.

This task covers:

a. Removal
b. Disassembly
c. Cleaning/Inspection
d. Testing
e. Assembly
f. Installation
g. Follow-On Maintenance

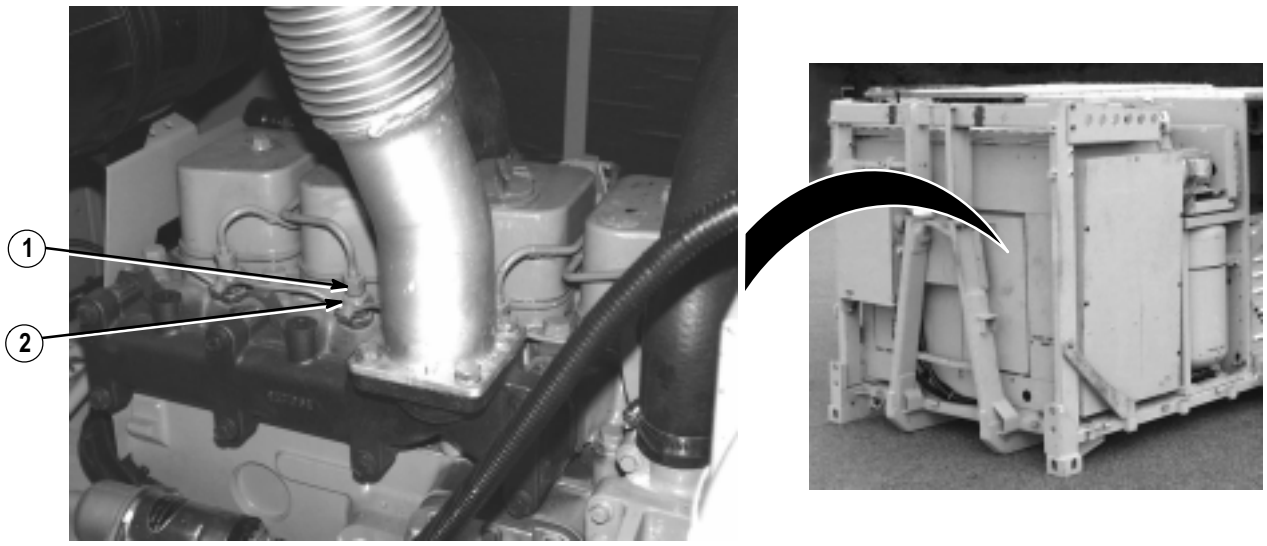
INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's: Automotive (Item 30, Appendix G)
Brush, Injector Cleaning (Item 1, Appendix G)
Gloves, Chemical Oil Protective (Item 13, Appendix G)
Goggles, Industrial (Item 14, Appendix G)
Socket Set, 3/8 in. (Item 25, Appendix G)
Testor, Injector (Item 28, Appendix G)
Wrench, Torque (0 to 60 N·m) (Item 46, Appendix G)

Material/Parts
Cleaner, Lubricant (Item 12, Appendix C)
Compound, Anti-Sieze (Item 8, Appendix C)
Solvent, Drycleaning (Item 38, Appendix C)
Seal, Banjo (Item 103, Appendix F)
Seal, Copper (Item 105, Appendix F)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
Engine OFF, (TM 9-4940-568-10)
Batteries disconnected, (TM 9-4940-568-10)

a. Removal.



WARNING

Fuel is very flammable and can explode easily. To avoid serious injury or death, keep fuel away from open fire and keep fire extinguisher within easy reach when working with fuel. Do not work on fuel system when engine is hot. Fuel can be ignited by hot engine.

NOTE

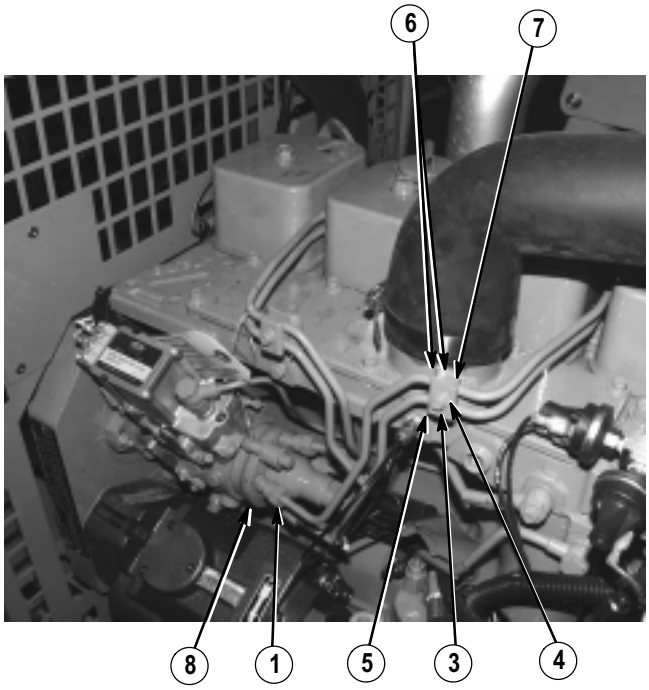
There are four fuel injectors. All fuel injectors are removed the same way.

(1) Disconnect fuel line (1) from injector (2).

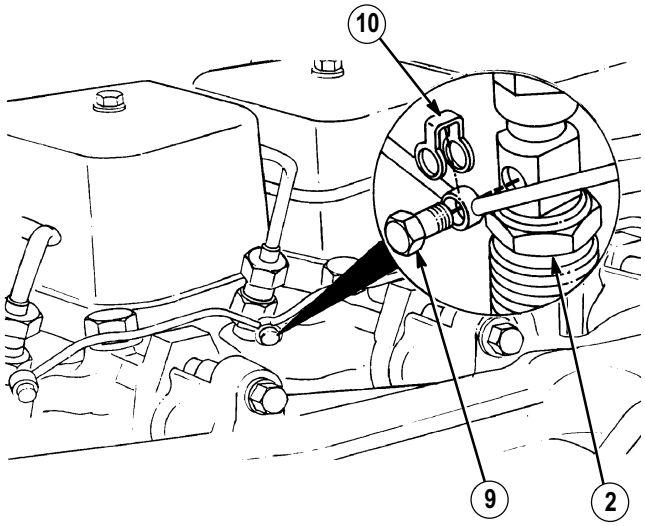
5-16. FUEL INJECTOR REPLACEMENT (CONT).

(2) Remove screw (3), washer (4), plate (5) and two clamps (6) from fuel lines (1) and bracket (7).

(3) Disconnect fuel line (1) from fuel injector pump (8).



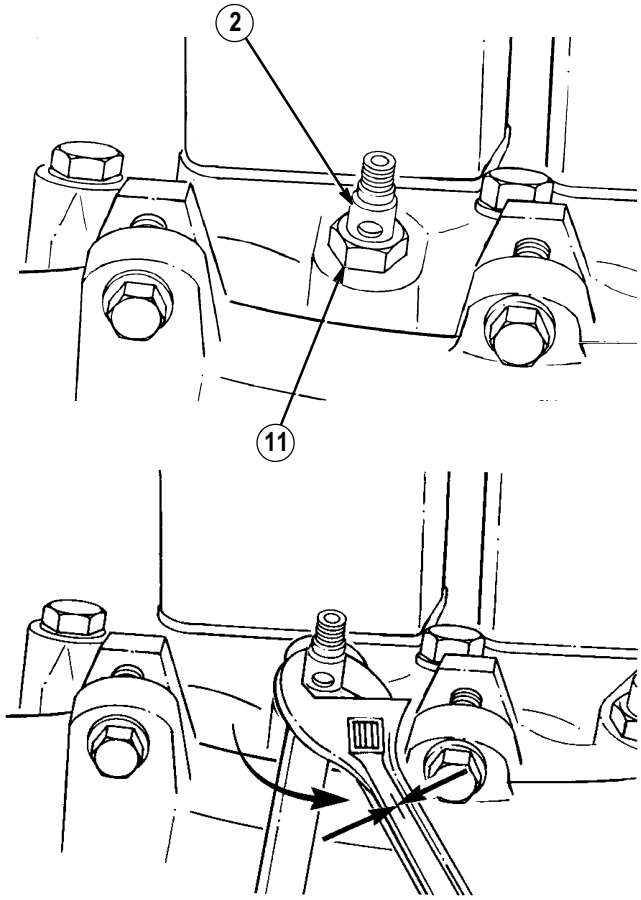
(4) Remove banjo fitting screw (9) and banjo seal (10) from injector (2). Discard banjo seal.



NOTE

Soak hold down nut with lubricant for a minimum of three minutes. If necessary tap injector body lightly with drift pin to loosen any rust.

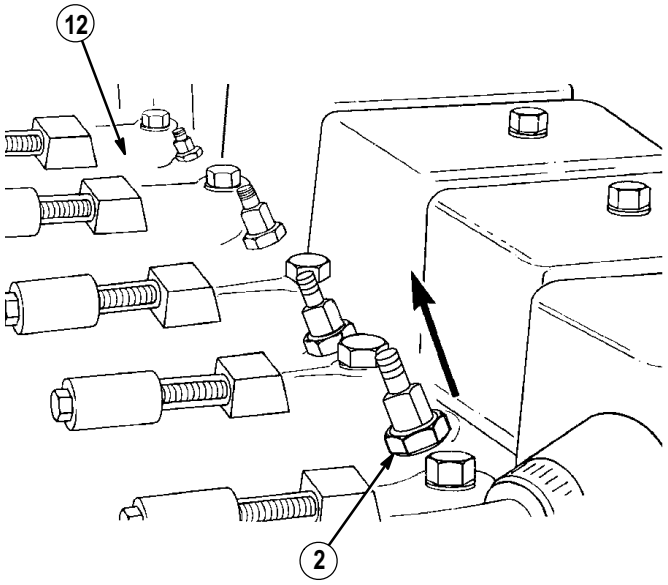
(5) Hold body of injector (2) with wrench while loosening the hold down nut (11).



NOTE

It may be necessary to tap the injector to work the injector up and down in order to remove it.

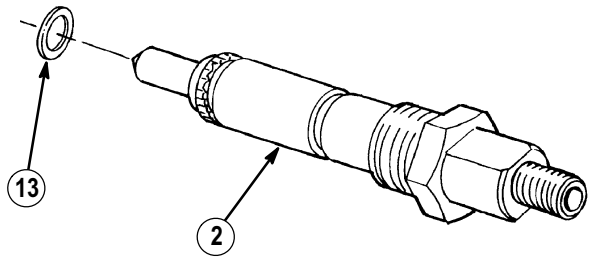
(6) Remove injector (2) from engine (12).



5-16. FUEL INJECTOR REPLACEMENT (CONT).

b. Disassembly.

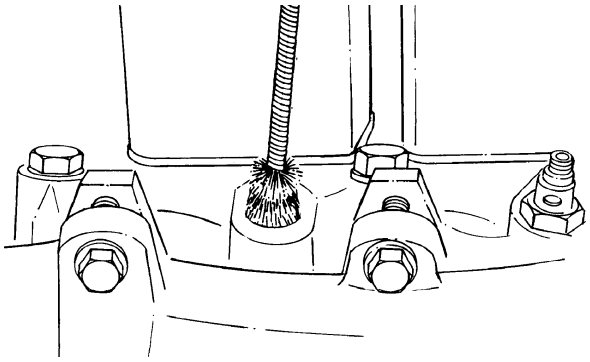
(1) Remove copper seal (13) from injector (2). Discard copper seal.



c. Cleaning/Inspection.

WARNING

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles, face shield, and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes, and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent. The flashpoint for Type II Drycleaning Solvent is 140 degrees F (60 degrees C) and Type III Drycleaning Solvent is 200 degrees F (93 degrees C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.



(1) Clean all metal parts with drycleaning solvent.

(2) Clean injector nozzle bore.

d. Testing.

WARNING

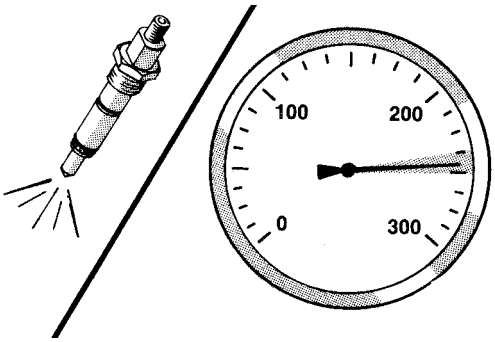
- Keep your body clear of test spray. Fluid can be injected into the blood stream causing blood poisoning and possible death.
- Always wear eye protection and protective gloves when performing fuel injector testing to prevent possible injury to personnel.
- Fuel is very flammable and can explode easily. To avoid serious injury or death, keep fuel away from open fire and keep fire extinguisher within easy reach when working with fuel. Do not work on fuel system when engine is hot. Fuel can be ignited by hot engine.

(1) Opening pressure test:

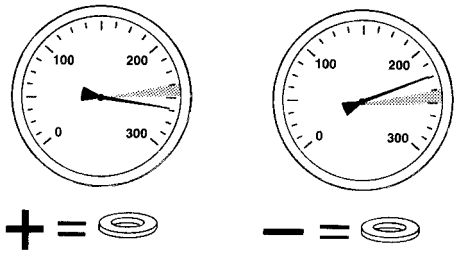
(a) Open valve.

(b) Operate lever at one stroke per second.

(c) Read pressure indicated when nozzle opens and spray begins. Nozzle opening pressure should be 220 bar (3,191 psi).



(d) If the opening pressure is out of specification, then change the shim pack. Adding shims will increase pressure.



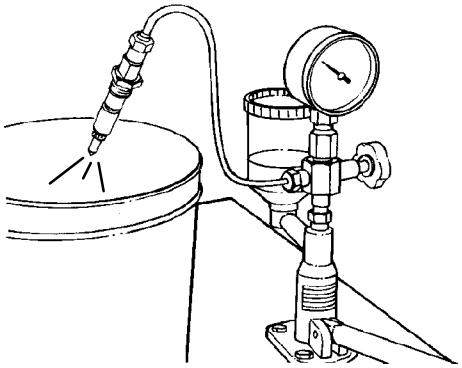
5-16. FUEL INJECTOR REPLACEMENT (CONT).

(2) Spray pattern check:

(a) Open valve.

(b) Operate lever at one stroke per second.

(c) When nozzle opens you should see a well atomized spray pattern.

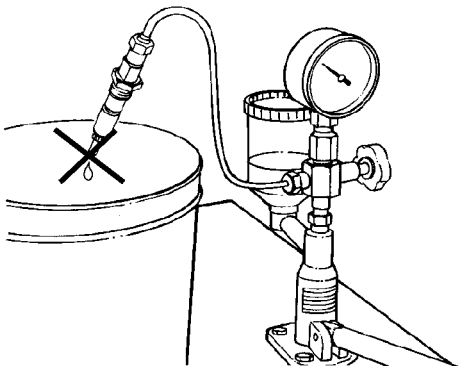


(3) Leakage test:

(a) Open valve.

(b) Operate lever to hold pressure 20 bar (290 psi) below opening pressure of 220 bar (3,191 psi).

(c) No drops should fall from the tip within 10 seconds.



(4) Chatter test:

NOTE

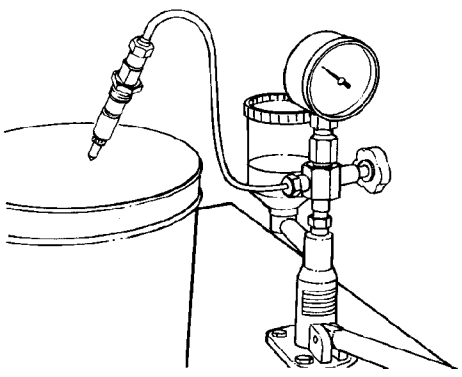
- The chatter test indicates the ability of the needle valve to move freely and correctly atomize the fuel.
- Used nozzles should not be evaluated for chatter at lower speeds. A used nozzle can generally be used if it passes the leakage test, chatters audibly at high lever speeds and uniformly atomizes the fuel.

(a) Close on\off valve.

(b) Open pump isolator valve.

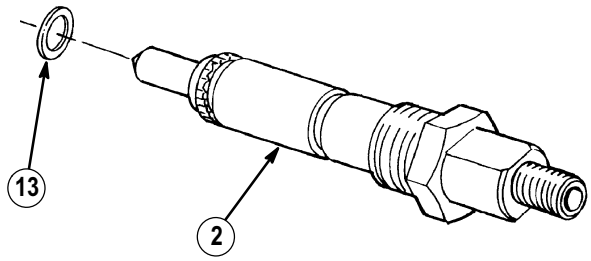
(c) Operate lever rapidly.

(d) Listen for the audible chatter of the valve opening.



e. Assembly.

(1) Apply lubricating oil to copper seal (13) and position copper seal on injector (2).

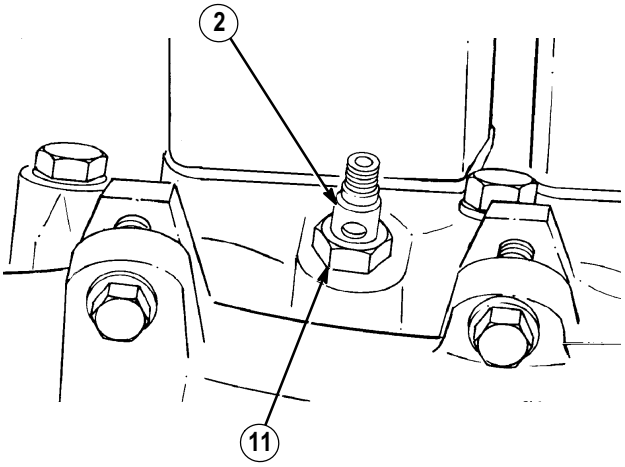


f. Installation.

WARNING

Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

(1) Apply light coat of anti-seize compound to threads of injector hold down nut (11) and between top of nut and injector body (2).



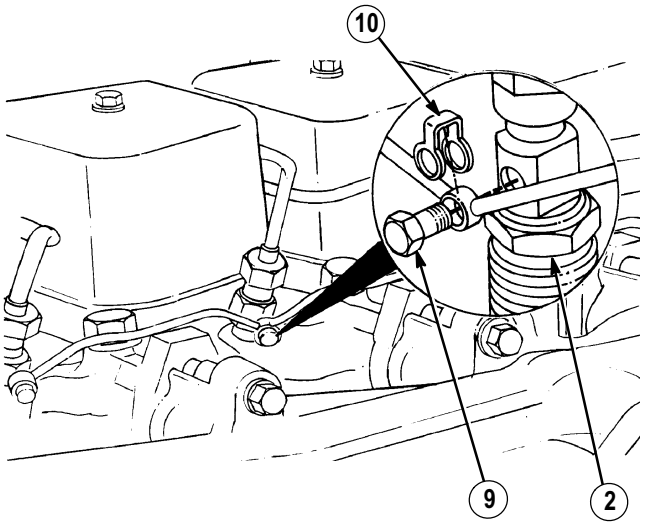
CAUTION

Align injector with notch in the bore.

(2) Position injector (2) in cylinder head and hold body of injector with wrench.

NOTE

One type of injector has a preformed packing located above the hold down nut. After tightening the injector be sure to push the preformed packing into the groove.



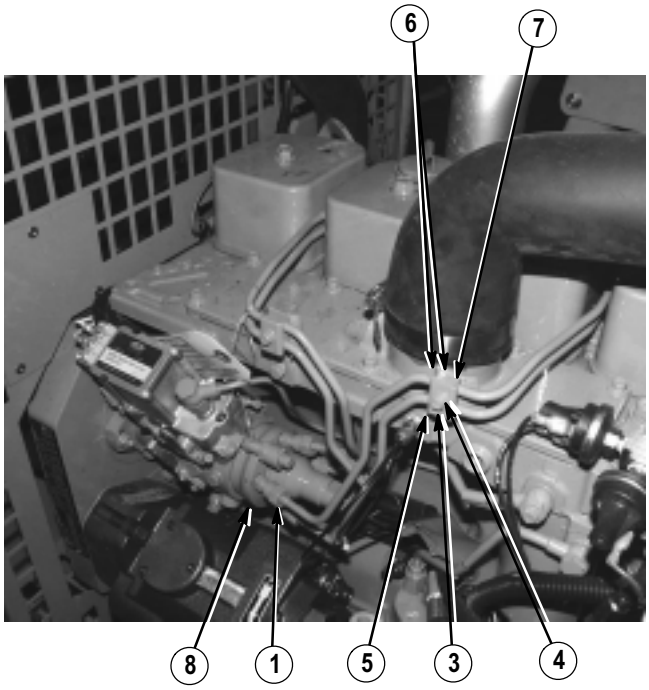
(3) Tighten injector hold down nut (11) to 44 lb-ft (60 N·m).

(4) Install banjo seal (10) and banjo fitting screw (9) on fuel injector (2).

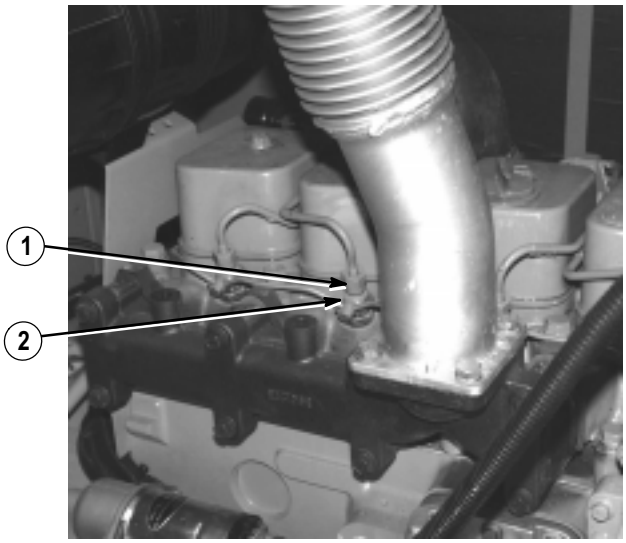
5-16. FUEL INJECTOR REPLACEMENT (CONT).

(5) Connect fuel line (1) to fuel injection pump (8)

(6) Install fuel lines (1) on bracket (7) with two clamps (6), plate (5), washer (4) and screw (3).



(7) Connect fuel line (1) on injector (2).



g. Follow-On Maintenance:

- Connect batteries, (TM 9-4940-568-10).
- Prime high pressure fuel lines, (TM 9-4940-568-10).

END OF TASK

5-17. FUEL INJECTION PUMP REPLACEMENT.

This task covers:

a. Removal b. Installation c. Follow-On Maintenance

INITIAL SETUP

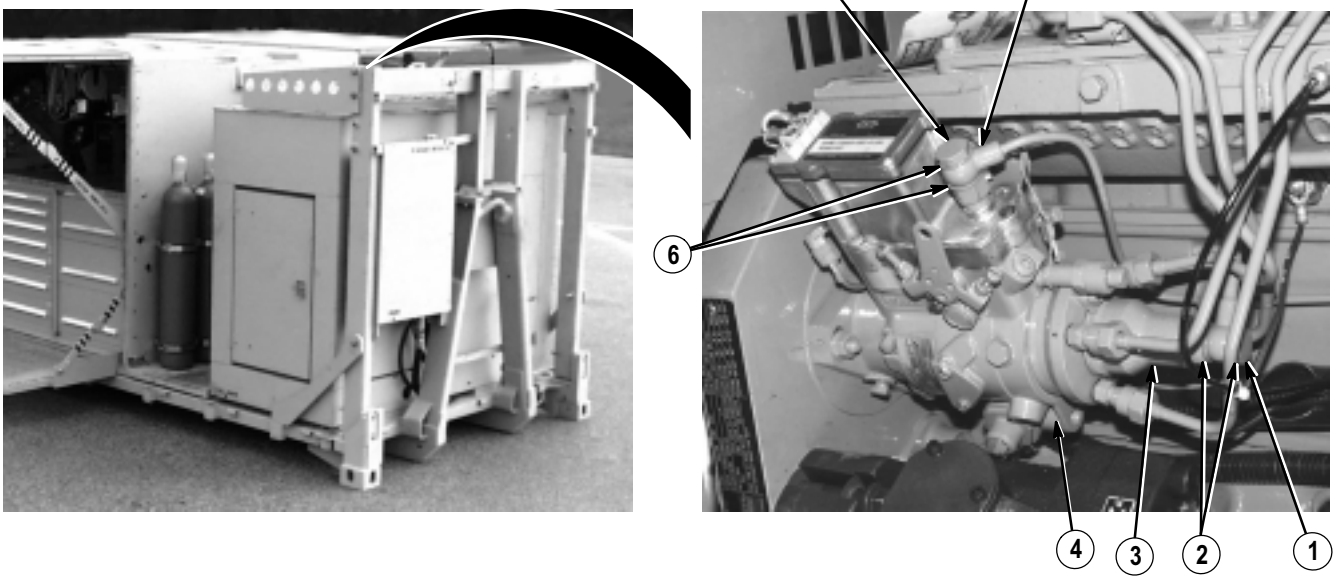
Tools and Special Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)
Puller, Mechanical (Item 47, Appendix F)
Socket Set, 3/8 in. (Item 52, Appendix F)
Tool, Engine Turnover (Item 66, Appendix F)
Wrench, Torque (0 to 175 lb-Ft [0–237 N·m])
(Item 83, Appendix F)
Wrench, Torque (0 to 60 N·m)
(Item 85, Appendix F)

Materials/Parts
Tags, Identification (Item 36, Appendix B)
Gasket, Fuel Pump (Item 22, Appendix E)
Lockwasher (Item 59, Appendix E)
Washer, Sealing (4) (Item 180, Appendix E)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
Batteries disconnected, (TM 9-4940-568-10)
Fuel injection lines removed,
(TM 9-4940-568-20)

5-17. FUEL INJECTION PUMP REPLACEMENT (CONT).

a. Removal.



WARNING

Fuel is very flammable and can explode easily. To avoid serious injury or death, keep fuel away from open fire and keep fire extinguisher within easy reach when working with fuel. Do not work on fuel system when engine is hot. Fuel can be ignited by hot engine.

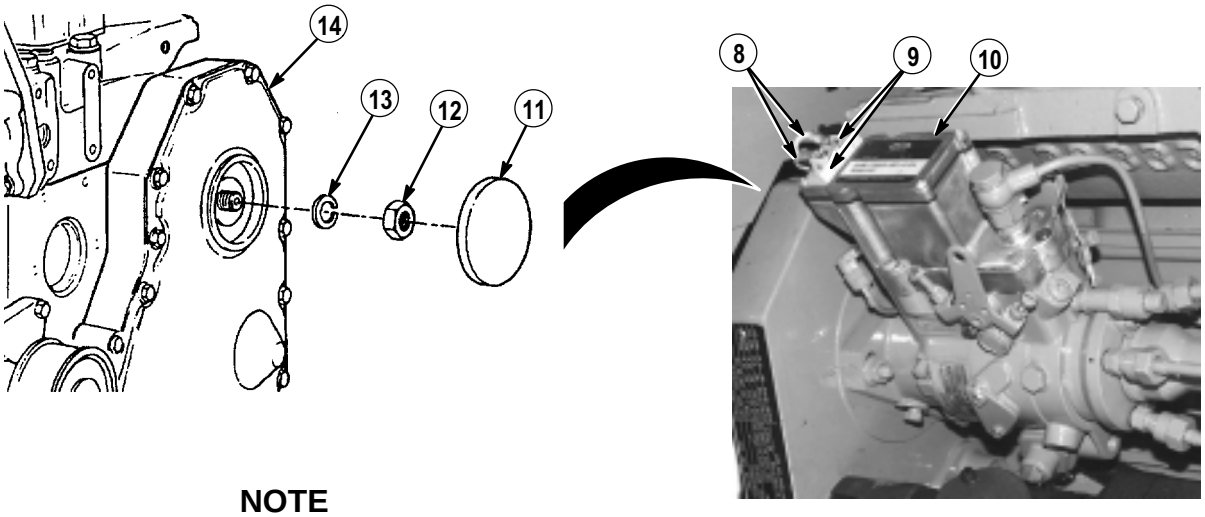
NOTE

- Tag and mark fuel lines prior to removal.
- May be necessary to remove hydraulic pump for access to fuel injection pump nuts.

(1) If necessary, remove hydraulic pump as an assembly and support (Para 4-2).

(2) Remove banjo screw (1), two sealing washers (2) and fuel injector supply line (3) from fuel injection pump (4).

(3) Disconnect banjo screw (5), two sealing washers (6) and fuel return line (7) from fuel injector pump (4).



NOTE

Tag all wires prior to removal.

(4) Remove two wires (8) and two screws (9) from fuel shut-off solenoid (10).

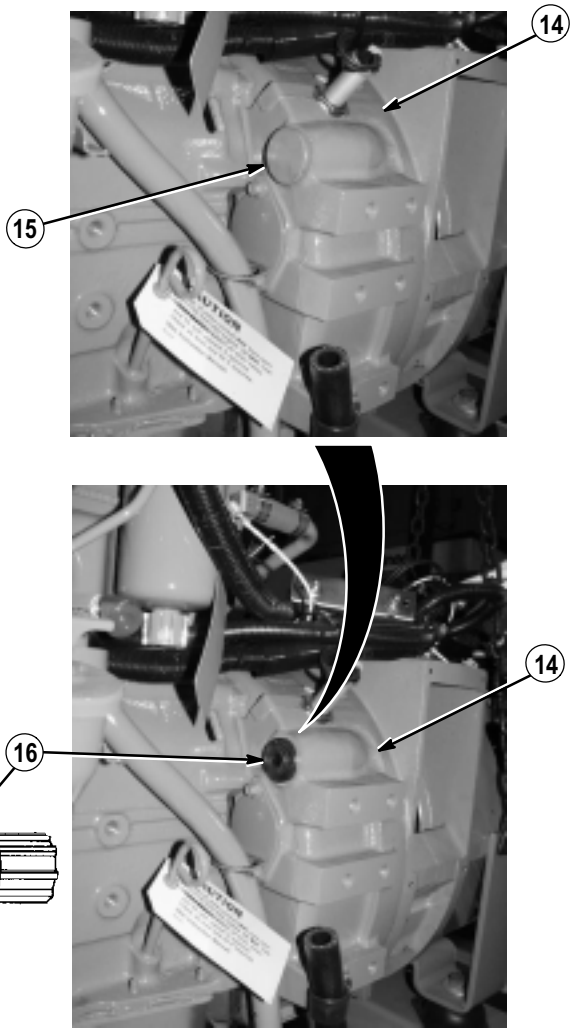
NOTE

Access cap is threaded. Turn counterclockwise to remove.

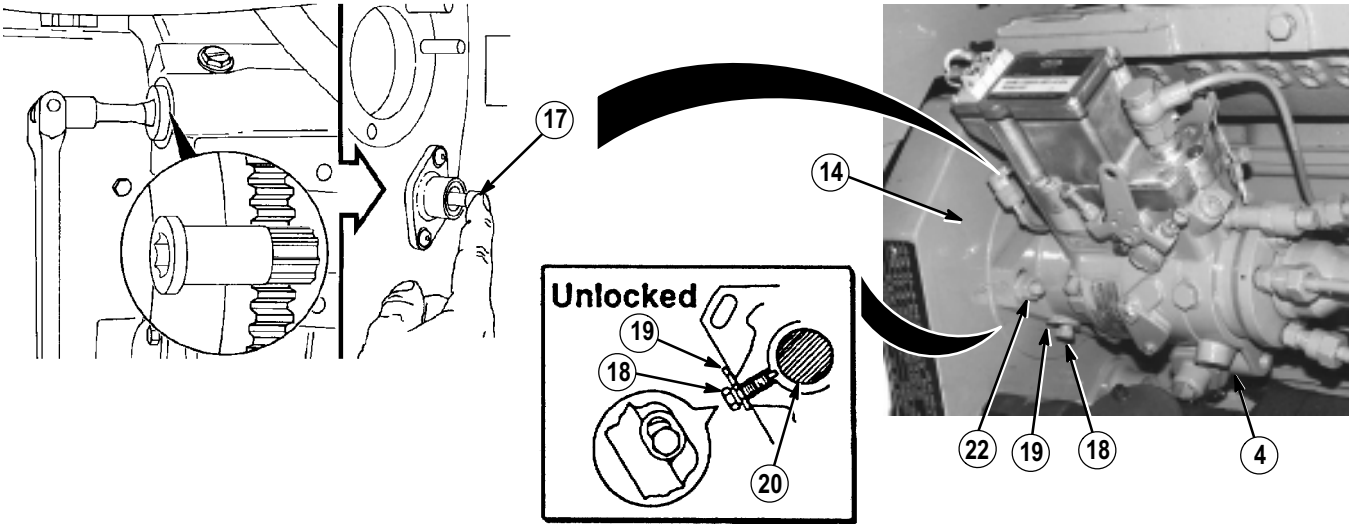
(5) Remove access cap (11), gear retaining nut (12) and lockwasher (13) from engine (14). Discard lockwasher.

(6) Remove cover (15) from engine (14).

(7) Install engine turnover tool (16) on engine (14).



5-17. FUEL INJECTION PUMP REPLACEMENT (CONT).



(8) Locate TDC for Cylinder No. 1 by barring engine slowly while pushing in on TDC pin (17).

(9) Loosen fuel injection pump lockscrew (18). Position slotted washer (19) and fuel injection pump lockscrew against pump drive shaft (20) and tighten lockscrew.

CAUTION

Ensure to disengage (pullout) the pin after locating top dead center (TDC) to prevent damage to the equipment.

(10) Disengage the TDC pin after locating TDC.

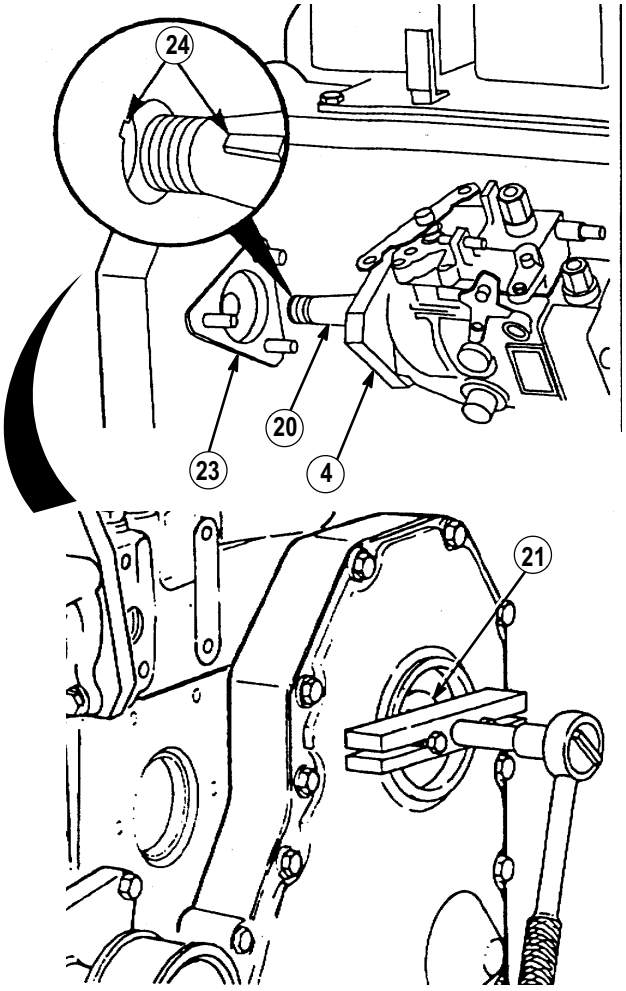
(11) Using puller, pull fuel injection pump drive gear (21) loose from pump drive shaft (20). Remove puller.

NOTE

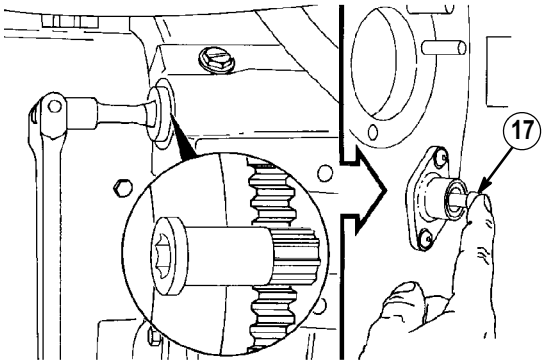
- Do not drop woodruff key when removing pump.
- Matchmark fuel injection pump and engine prior to removal.

(12) Remove three nuts (22), fuel injection pump (4) and gasket (23) from engine (14).

(13) Remove woodruff key (24) from pump drive shaft (20).

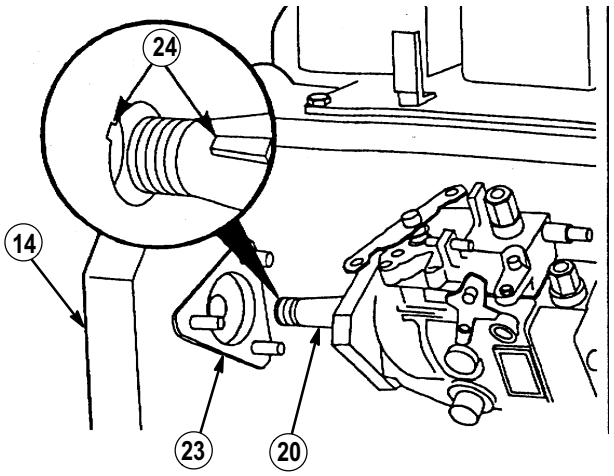


b. Installation.



WARNING

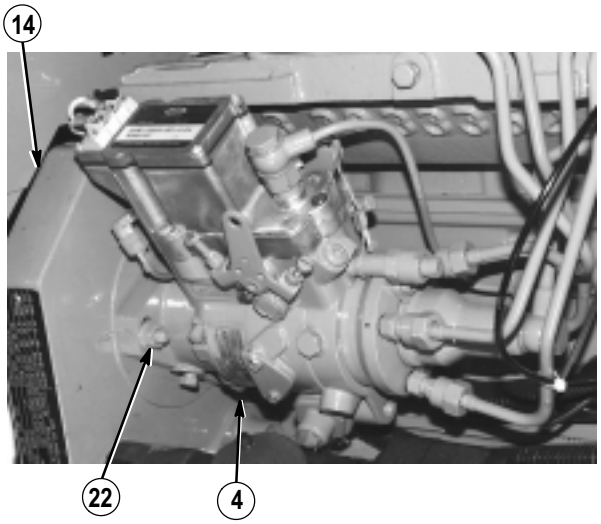
Fuel is very flammable and can explode easily. To avoid serious injury or death, keep fuel away from open fire and keep fire extinguisher within easy reach when working with fuel. Do not work on fuel system when engine is hot. Fuel can be ignited by hot engine.



(1) Verify Cylinder No. 1 is at TDC by barring engine slowly while pushing in on TDC pin (17).

(2) Install woodruff key (24) on pump drive shaft (20).

(3) Position gasket (23), fuel injection pump (4) and three nuts (22) on engine (14). Do not tighten nuts, pump must be free to move in the slots.



5-17. FUEL INJECTION PUMP REPLACEMENT (CONT).

CAUTION

Do not overtighten nut. This is not the final torque.

(4) Install lockwasher (13) and gear retaining nut (12) on pump drive shaft (20). Do not tighten nut, pump must be free to move.

NOTE

- If installing original pump, rotate pump to align the scribe marks.
- If installing a new or rebuilt pump without scribe marks, take up gear lash by rotating pump against the direction of drive rotation.

(5) Tighten three nuts (22) on fuel injection pump (4). Tighten nuts to 216 lb-in (24 N·m).

(6) Loosen fuel injection pump lockscrew (18). Position slotted washer (19) and then tighten fuel injection pump lockscrew to 180 lb-in (20 N·m).

CAUTION

Ensure to disengage (pullout) the pin after locating top dead center (TDC) to prevent damage to the equipment.

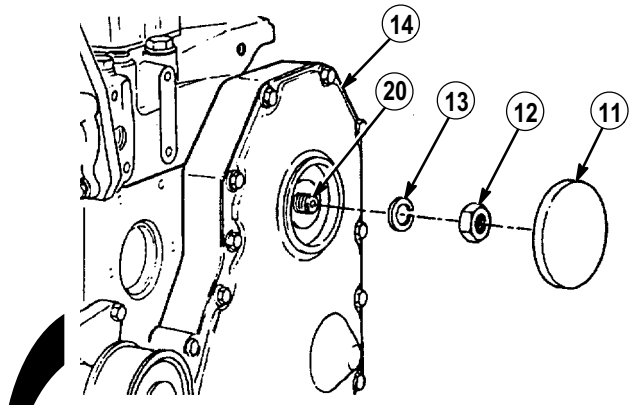
(7) Disengage TDC pin (17) before rotating crankshaft.

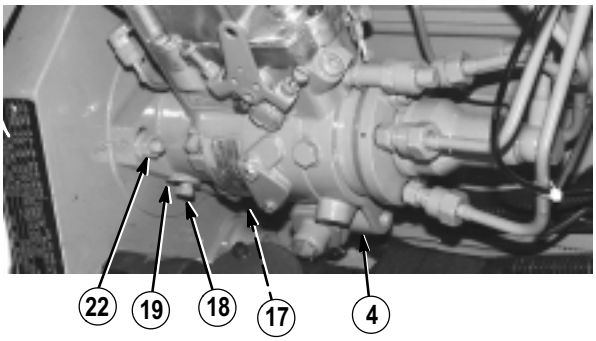
(8) Remove engine turnover tool (16) from engine (14).

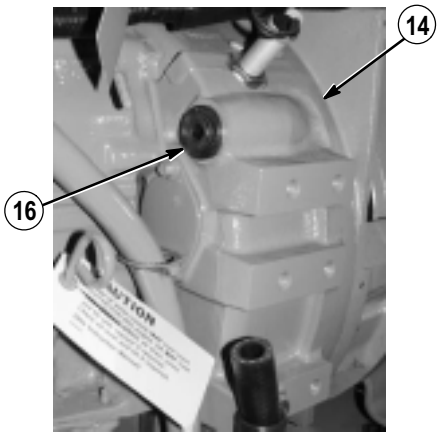
(9) Install cover (15) on engine (14).

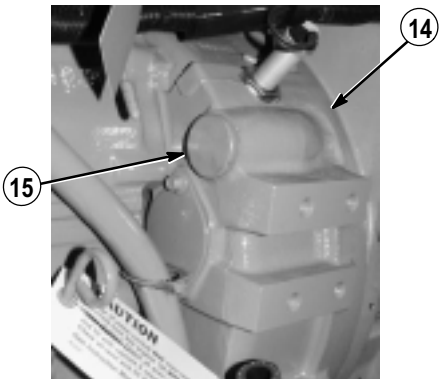
(10) Tighten gear retaining nut (12). Tighten nut to 90 lb-ft (122 N·m).

(11) Install access cap (11) on engine (14).





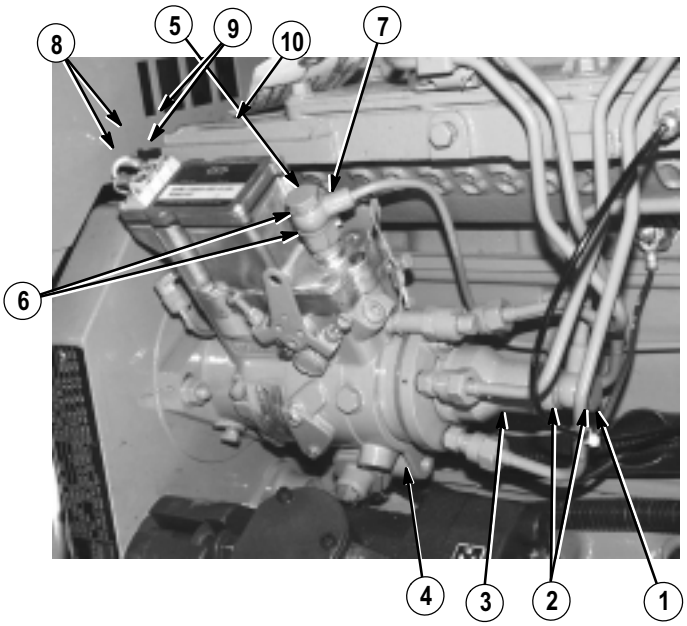




(12) Install two wires (8) and screws (9) on fuel shut-off solenoid (10).

(13) Install two sealing washers (6), banjo screw (5) and connect fuel return line (7) to fuel injection pump (4).

(14) Install two sealing washers (2), banjo screw (1) and connect fuel injector supply line (3) to fuel injection pump (4).



c. Follow-On Maintenance:

- Install fuel injector lines, (TM 9-4940-568-20).
- Connect batteries, (TM 9-4940-568-10).
- Adjust fuel injection pump, (Para 5-18).

END OF TASK

5-18. FUEL INJECTION PUMP ADJUSTMENT.

This task covers:

a. Adjustment

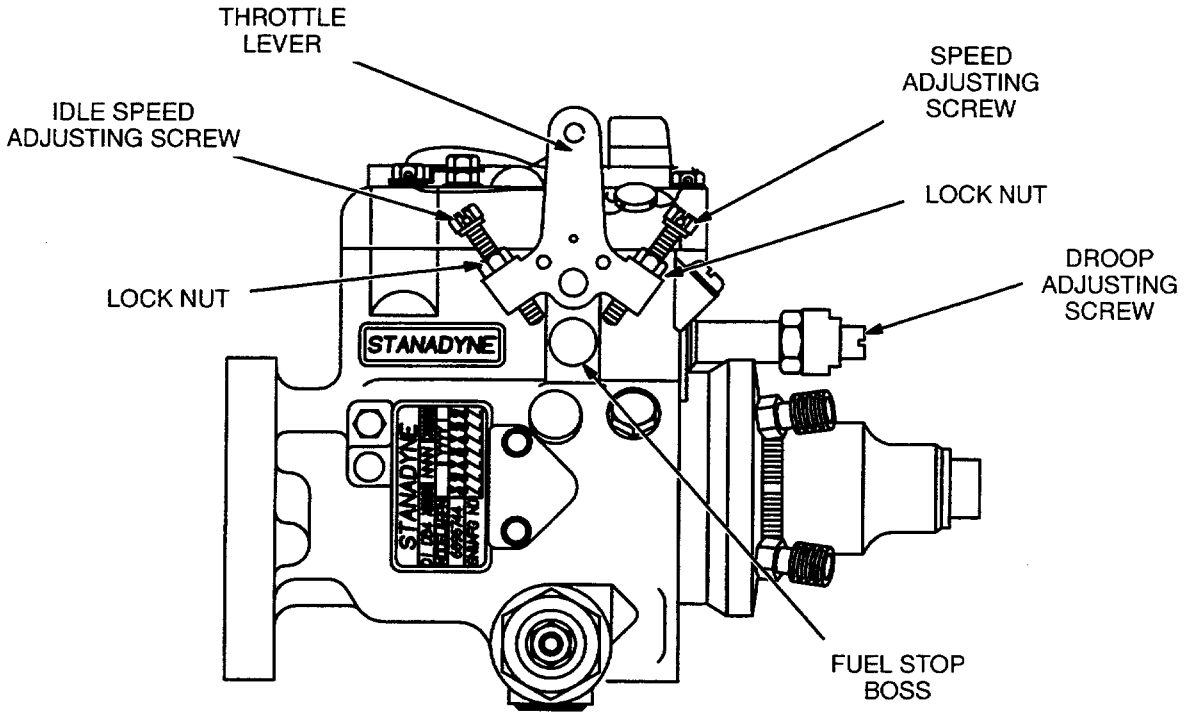
b. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
Remove front panel, (TM 9-4940-568-10)

a. Adjustment.



(1) In the mechanical governor, the output frequency (50 Hz or 60 Hz) can be adjusted by turning the governor "idle" and "speed" adjusting screws while the engine is running at its normal operating temperature under full load.

(2) Adjust droop to within five percent of nominal frequency (3 Hz for 60 Hz sets and 2.5 Hz for 50 Hz sets).

(3) Check operation under various loads and increase droop if the governor hunts.

(4) Readjust full-load frequency if droop is adjusted.

b. Follow-On Maintenance:

- Adjust electronic overspeed module, (TM 9-4940-568-20).

END OF TASK

5-19. FUEL INJECTION PUMP TIMING.

This task covers:

a. Timing

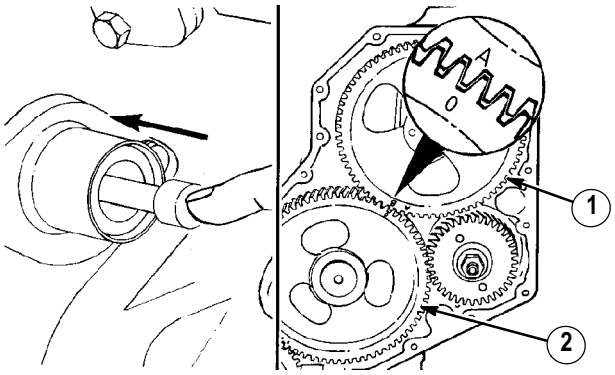
b. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Socket Set, 3/8 in. (Item 52, Appendix F)
Tool, Engine Turnover (Item 66, Appendix F)
Wrench, Torque, 3/8 in. (0 to 60 N·m) (Item 85, Appendix F)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
Disconnect batteries, (TM 9-4940-568-10)
Remove front gear cover (if necessary), (Para 5-14)
Remove fuel injection pump (if necessary), (Para 5-17)

a. Timing.



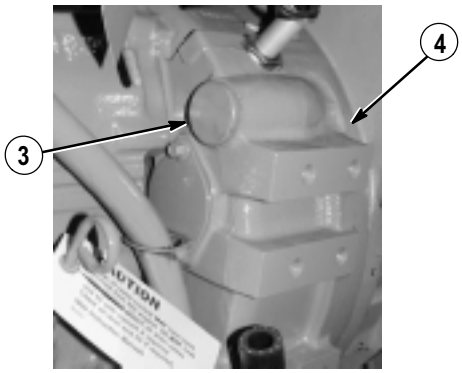
NOTE

Pump-to-pump timing is extremely critical. Pump timing that is off by only a few crankshaft degrees causes poor performance – starting, lack of power, excessive smoke, excessive emissions and poor fuel economy.

(1) Engine pump timing begins with timing of the fuel injection pump drive gear (1) to the camshaft gear (2).

(2) Locate TDC of compression stroke for Cylinder No. 1.

(3) Remove cover (3) from engine (4).

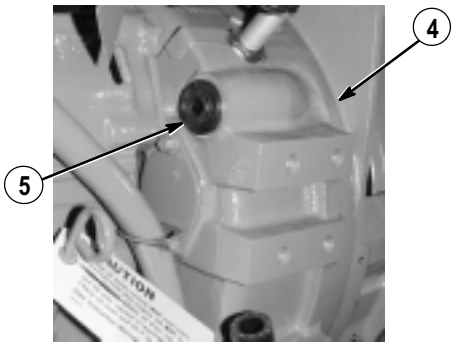


(4) Install engine turnover tool (5) on engine (4).

NOTE

Engine model 4B3.9 with Standyne injection pump will have the letter "A" on the fuel injection pump drive gear.

(5) The letter "A" on the gear must be aligned with the "O" mark on the camshaft gear.

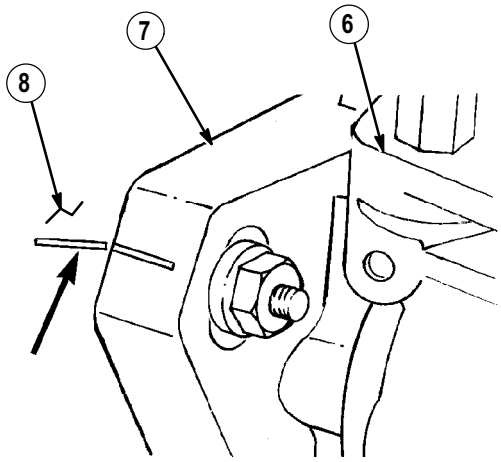


5-19. FUEL INJECTION PUMP TIMING (CONT).

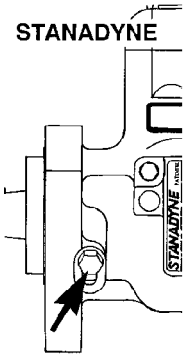
NOTE

1 mm of rotation past the timing mark will advance or retard (depending on direction of rotation) the pump timing by 1 degree.

(6) To verify fuel injection pump (6) is timed correctly, first check the alignment marks on the pump flange (7) and gear housing (8).



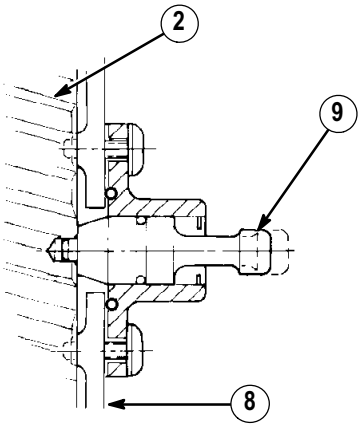
(7) Stanadyne DB4 fuel injection pumps all have a provision for locking the pump shaft at a position corresponding to top-dead-center for Cylinder No. 1. New and reconditioned fuel injection pumps should be received with the shafts located in this position.



CAUTION

If the timing pin is incorrectly located on the gear housing, the timing procedure will not ensure that the pump is timed correctly.

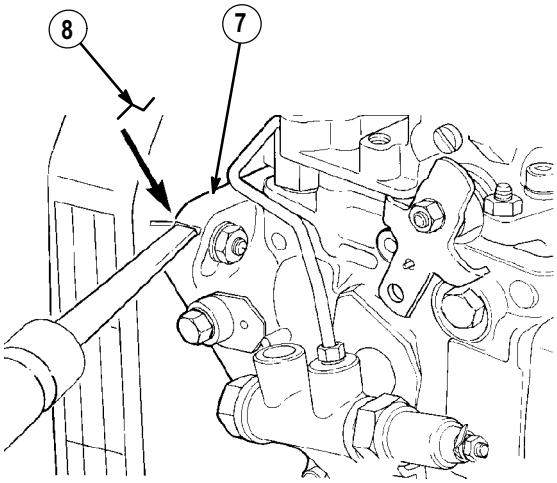
(8) After precisely locating TDC for Cylinder No. 1, the factory positions the timing pin (9) to the gear housing (8) using the timing pin and the holes in the camshaft gear (2). If the gear housing or timing pin assembly are removed, the same precision is required to relocate it. Refer to Para 5-6.



(9) If timing pin (9) is incorrectly located, reposition timing pin. Refer to Para 5-6.

NOTE

- The marks on the gear housing and the pump flange are unique to each engine.
- The flange of a replacement pump must be marked to align with the mark on the gear housing after installation.

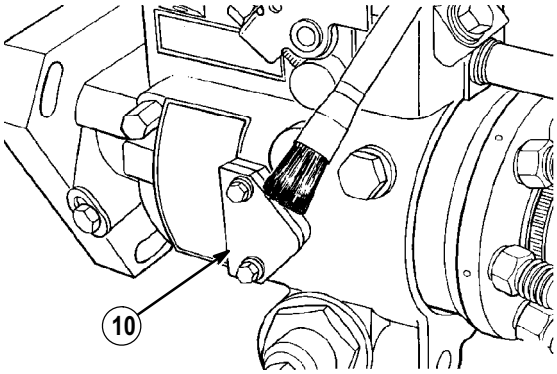


(10) During production, after the locked pump is fitted to the engine with Cylinder No. 1 at TDC, a mark is stamped on the gear housing (8) and pump flange (7). Thereafter, when these marks are aligned, the pump is correctly timed to the engine.

NOTE

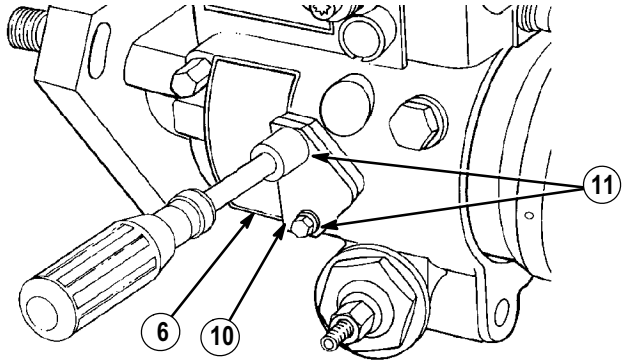
If fuel injection pump is removed from engine, perform Steps (11) through (16) for timing fuel injection pump.

(11) Clean all debris from around fuel injection pump timing window cover (10).

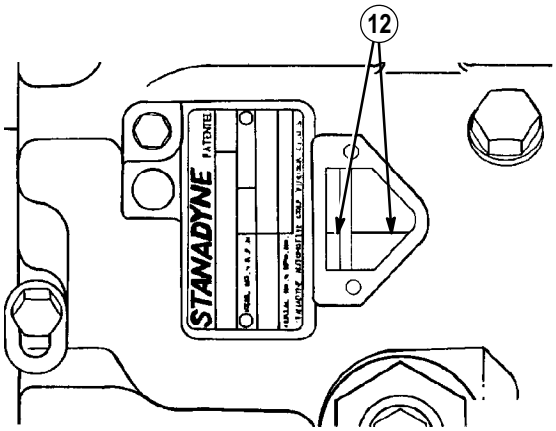


5-19. FUEL INJECTION PUMP TIMING (CONT).

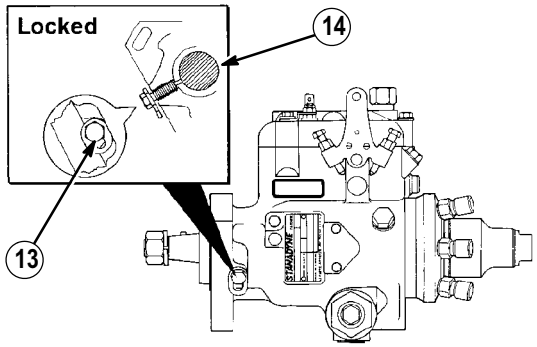
(12) Remove two screws (11) and fuel injection pump timing cover (10) from fuel injection pump (6).



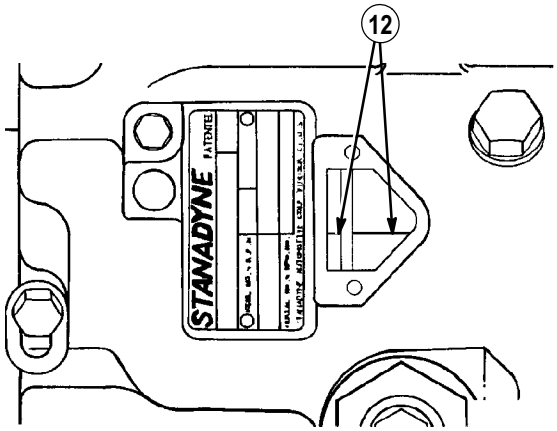
(13) Rotate fuel injection pump drive shaft in direction of pump rotation to align timing lines (12) on weight retainer hub with line on cam ring.



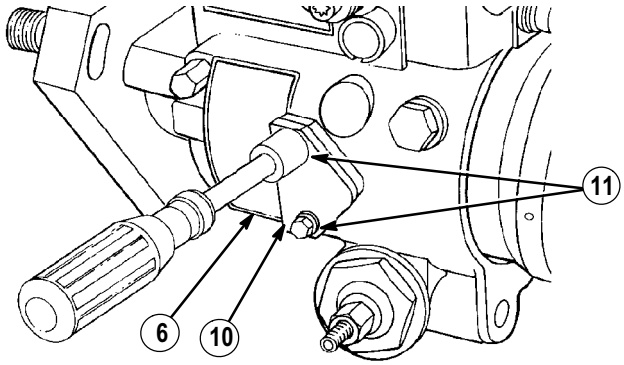
(14) Position the fuel injection drive shaft locking key plate in the locked position. Turn the locking screw (13) in until contact is made with the drive shaft (14). Tighten locking screw to 105 lb-in (11.9 N·m).



(15) Verify the timing marks (12) are aligned after lock timed.

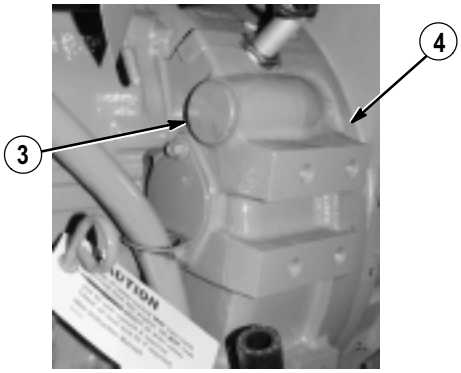


(16) Install fuel injection pump timing cover (10) and two screws (11) on fuel injection pump (6).



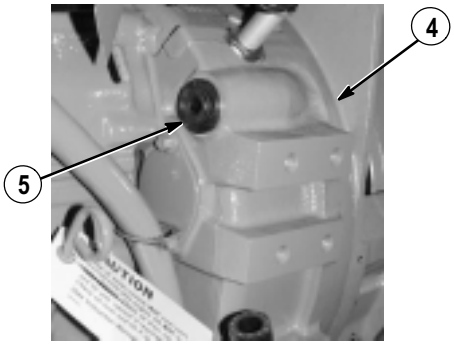
(17) Remove engine turnover tool (5) from engine (5).

(18) Install cover (3) on engine (4).



b. Follow-On Maintenance:

- Install fuel injection pump (if necessary), (Para 5-17).
- Install front gear cover (if necessary), (Para 5-14).
- Connect batteries, (TM 9-4940-568-10).
- Start generator and check for proper operation, (TM 9-4940-568-10).



END OF TASK

5-20. FUEL SHUTOFF VALVE REPLACEMENT.

This task covers:

a. Removal b. Installation c. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Wrench, Torque 0 to 60 N·m (Item 85, Appendix F)
Socket Set, 3/8 in. (Item 52, Appendix F)

Materials/Parts
Tags, Identification (Item 60, Appendix B)

Materials/Parts – Continued
Screw (3) (Item 146, Appendix E)
Washer, Sealing (2) (Item 180, Appendix E)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
Batteries disconnected, (TM 9-4940-568-10)
Remove left rear panel, (TM 9-4940-568-10)

a. Removal.

WARNING

Fuel is very flammable and can explode easily. To avoid serious injury or death, keep fuel away from open fire and keep fire extinguisher within easy reach when working with fuel. Do not work on fuel system when engine is hot. Fuel can be ignited by engine.

(1) Remove banjo connector screw (1), two sealing washers (2) and fuel drain line (3) from fuel shutoff valve (4).

NOTE

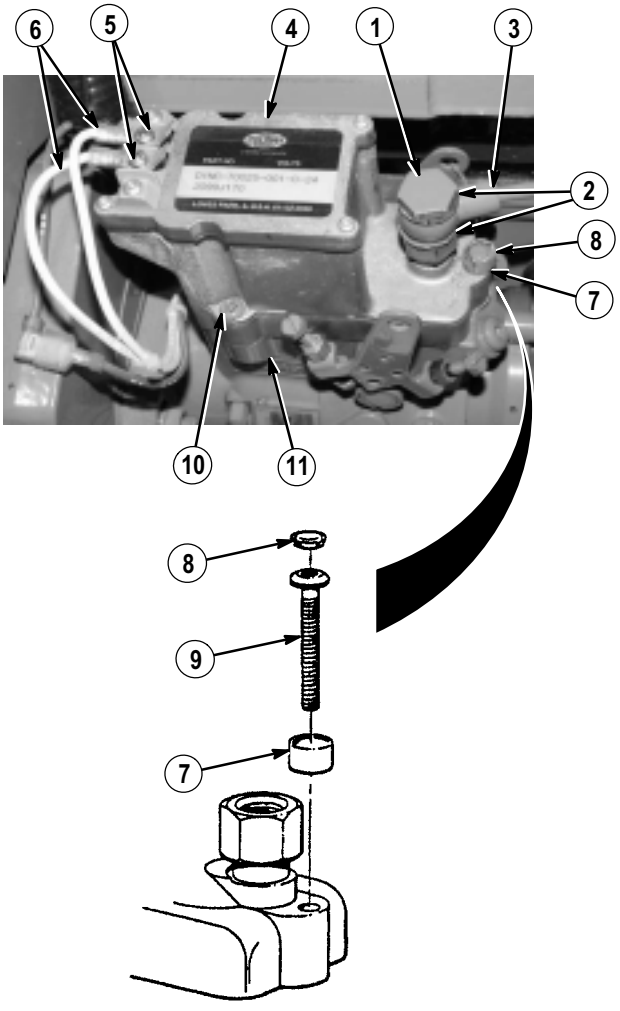
- Tag and mark all wires prior to removal.
- Screw cup and screw cover may not be present. Perform Step (3) if screw cup and screw cover are present.

(2) Remove two screws (5) and wires (6) from fuel shutoff valve (4).

(3) Using a pliers, distort screw cup (7) and remove screw cover (8). Discard cover.

(4) Remove screw (9) and screw cup (if present) (7) from fuel shutoff valve (4). Discard screw cup and screw.

(5) Remove two screws (10) and fuel shutoff valve (4) from fuel injection pump (11). Discard screws.



b. Installation.

CAUTION

Care must be taken when reinstalling actuator to the fuel injection pump. Ensure the actuator yoke is aligned with the linkage in the fuel injection pump. With linkage properly engaged, a slight amount of pressure will be required to align the actuator mounting holes.

(1) Position fuel shutoff valve (4) on fuel injection pump (11).

(2) Align fuel shutoff valve (4) with fuel injection pump (11) and install two screws (10). Do not tighten screws.

(3) Install screw (9) in fuel shutoff valve (4) and fuel injection pump (11). Tighten screw to 35-45 lb-in (4-5 N·m).

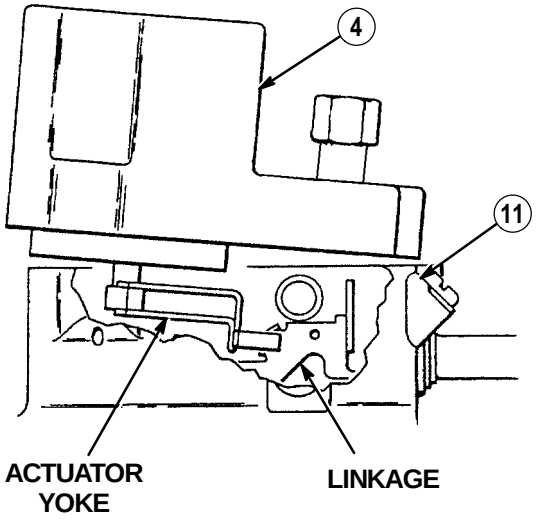
(4) Tighten two screws (10) to 35-45 lb-in (4-5 N·m).

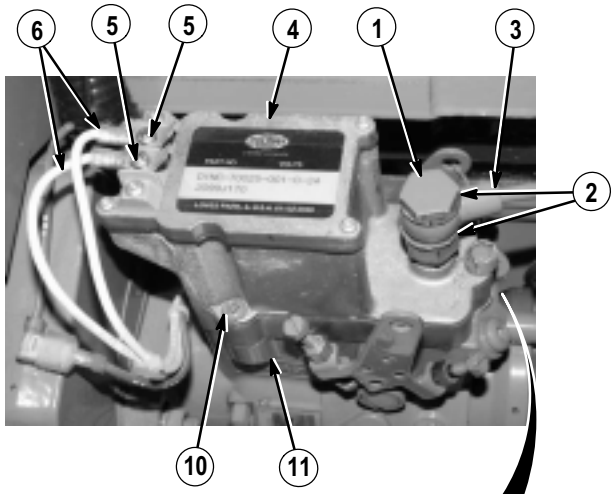
NOTE

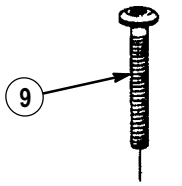
Install wires as noted during removal.

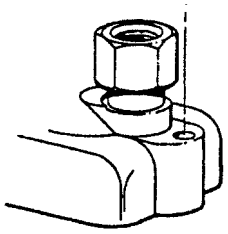
(5) Install two wires (6) and screws (5) on fuel shutoff valve (4).

(6) Install two sealing washers (2), fuel drain line (3) and banjo connector screw (1) on fuel shutoff valve (4).









c. Follow-On Maintenance:

- Install left rear panel, (TM 9-4940-568-10).
- Connect batteries, (TM 9-4940-568-10).

END OF TASK

5-21. GENERATOR REPLACEMENT.

This task covers:

a. Removal b. Installation c. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Cap and Plug Set (Item 6, Appendix F)
Engine Turnover Tool (Item 18, Appendix F)
Socket Set, 3/8 in. (Item 52, Appendix F)
Wrench, Torque 3/8 in. Drive (0 to 60 N·m) (Item 85, Appendix F)
Wrench, Torque (0 to 300 lb-ft [0-470 N·m]) (Item 84, Appendix F)
Lifting Device, Minimum Capacity 500 lbs (227 kg)
Pin, Alignment (2) (Appendix C)
Pin, Alignment (2) (Appendix C)
Wooden Blocks (4) (Appendix C)

Materials/Parts
Cable Ties (Item 5, Appendix B)
Rags, Wiping (Item 23, Appendix B)

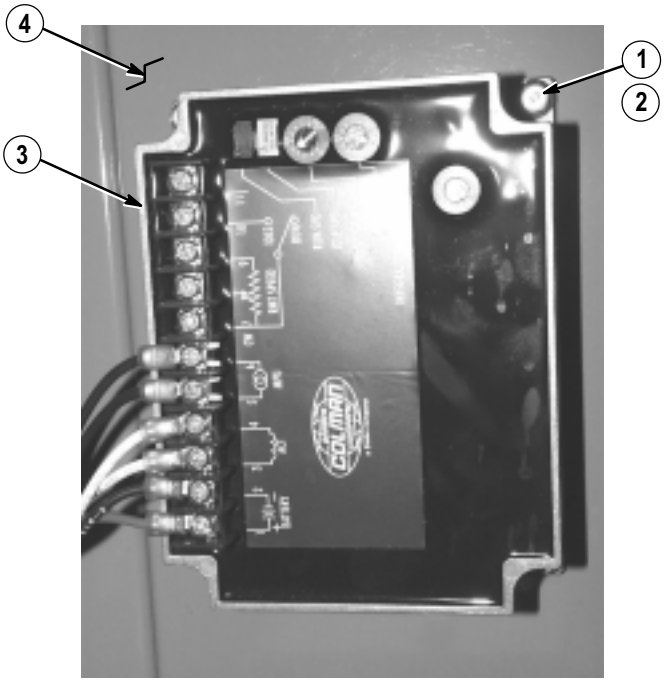
Materials/Parts – Continued
Tags, Identification (Item 36, Appendix B)
Gasket (Item 8, Appendix E)
Locknut (4) (Item 41, Appendix E)
Lockwasher (Item 48, Appendix E)
Lockwasher (8) (Item 50, Appendix E)

Personnel Required
Two

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
Generator housing removed, (Para 5-2)
Batteries disconnected, (TM 9-4940-568-10)
Generator set removed (if necessary), (Para 5-3)

a. Removal.

(1) Remove four screws (1), locknuts (2) and electronic overspeed module (3) from generator back panel (4). Discard locknuts.

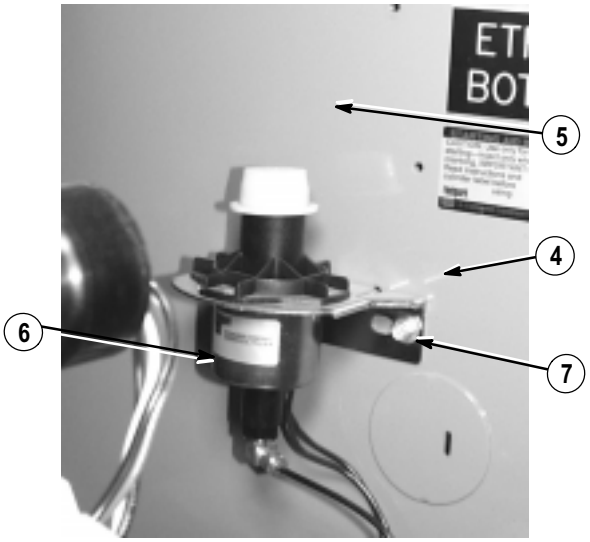


NOTE

- Tag and mark all wires prior to removal.
- Remove cable ties as necessary.

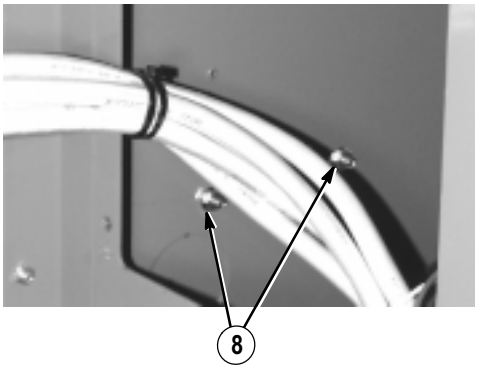
WARNING

Starting fluid is toxic and highly flammable. Container is pressurized. NEVER heat container and NEVER discharge starting fluid in confined areas or near open flame. Severe injury to personnel may result.



(2) Remove ether supply cylinder (5) by turning counterclockwise from ether start aid assembly (6).

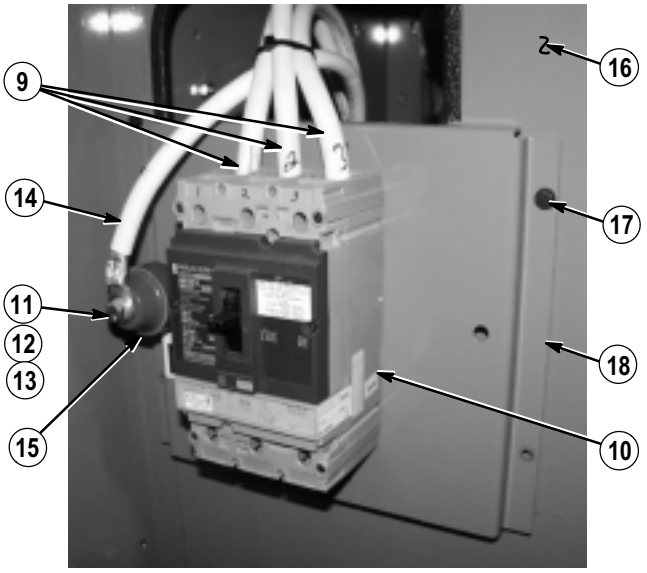
(3) Remove two screws (7), nuts (8) and ether start aid assembly (6) from generator panel (4).



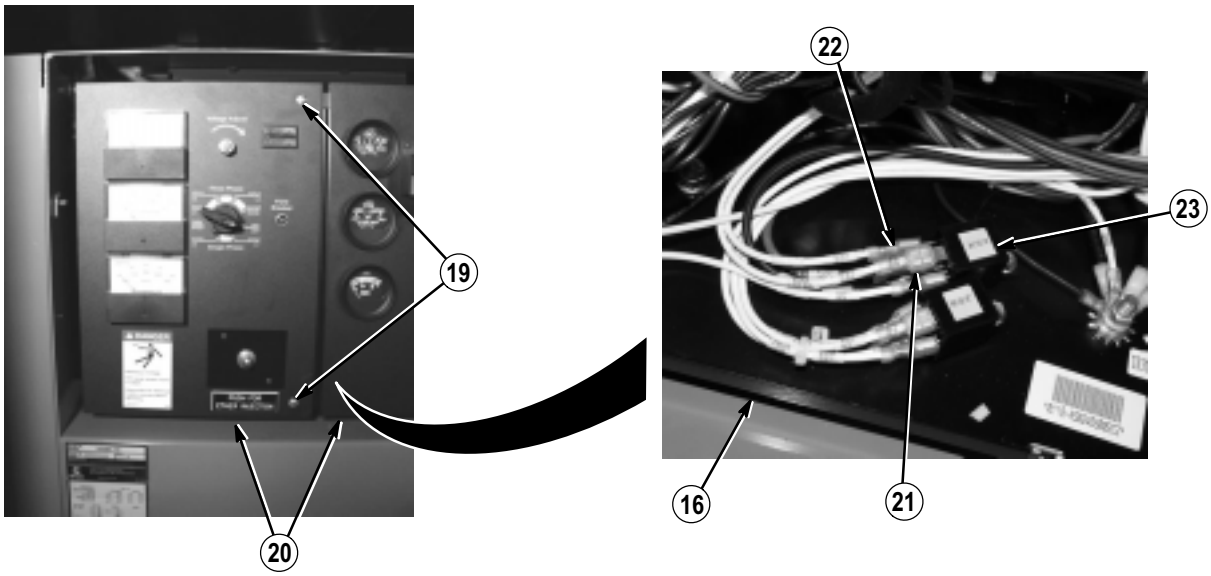
(4) Remove three wires (9) from main circuit breaker (10).

(5) Remove screw (11), lockwasher (12), washer (13), ground wire (14) and insulator (15) from generator control housing (16). Push wires in generator control housing. Discard lockwasher.

(6) Remove four screws (17) and panel (18) from generator control housing (16).



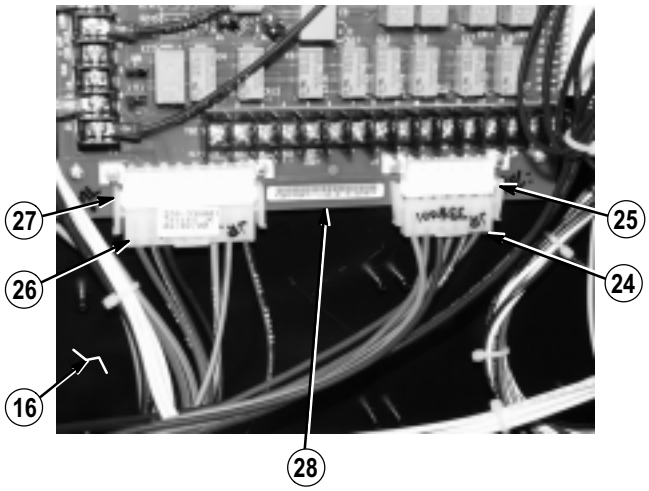
5-21. GENERATOR REPLACEMENT (CONT).



(7) Disconnect wires from master disconnect switch and slave receptacle (TM 9-4940-568-20).

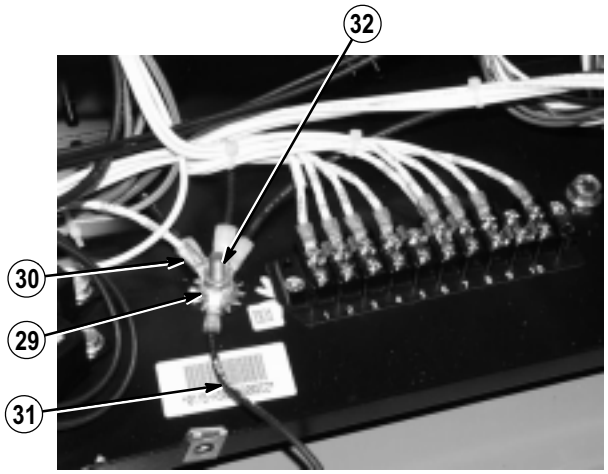
(8) Unlock panel screws (19) and open instrument panel doors (20).

(9) Disconnect wire 87 (21) and wire 86 (22) from K-33 ether start relay (23) and generator control housing (16).



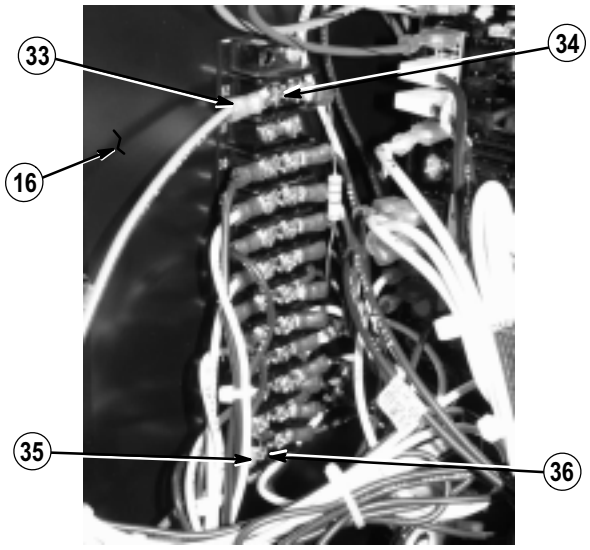
(10) Remove connector J2 (24) from connector P2 (25) and connector J1 (26) from connector P1 (27) of A11 card (28).

(11) Remove nut (29), engine ground wire (30) and J1 ground (31) from ground stud (32).



(12) Remove wire (33) from TB21 terminal 32 (34) and wire (35) from terminal 21 (36).

(13) Pull wires through back of generator control housing (16).

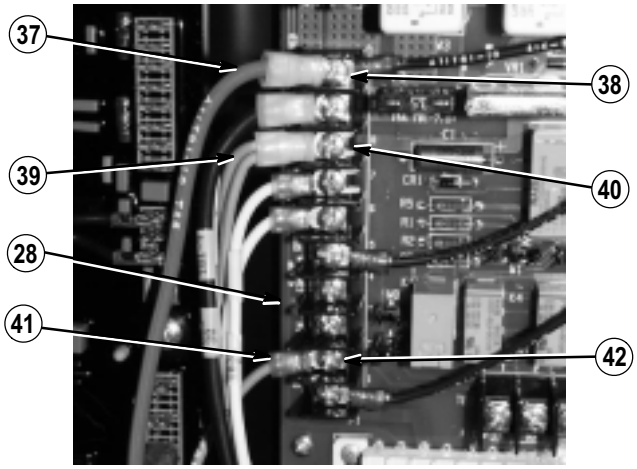


5-21. GENERATOR REPLACEMENT (CONT).

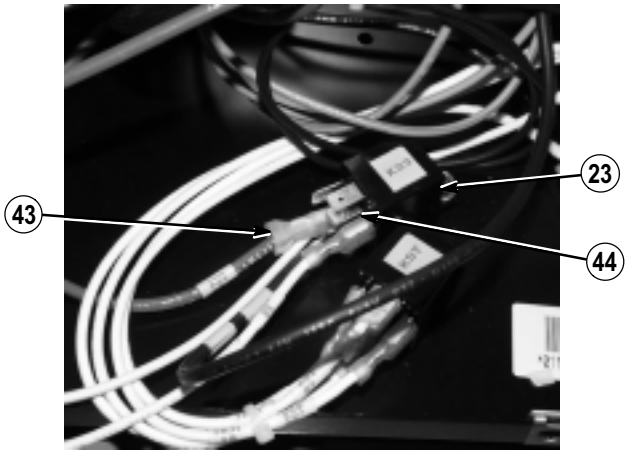
(14) Remove wire T26 (37) from TB1 terminal 10 (38) on A11 card (28).

(15) Remove wire (39) from TB1 terminal 8 (40) on A11 card (28).

(16) Remove wire (41) from TB1 terminal 2 (42) on A11 card (28).

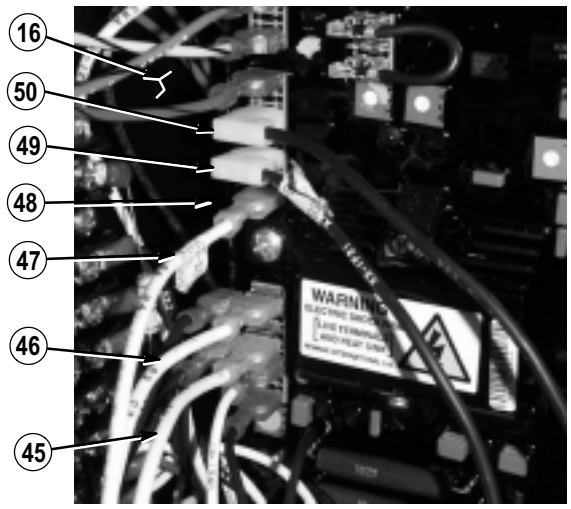


(17) Remove wire (43) from terminal 30 (44) of K33 ether start relay (23).



(18) Remove wires P2 (45), P3 (46) and P4 (47) from voltage regulator card (48) and pull wires through back of generator control housing (16).

(19) Remove bottom black wire (xx-(F2)) (49) and top black wire (x+-(F1)) (50) from voltage regulator card (48) and pull wires through back of generator control housing (16).

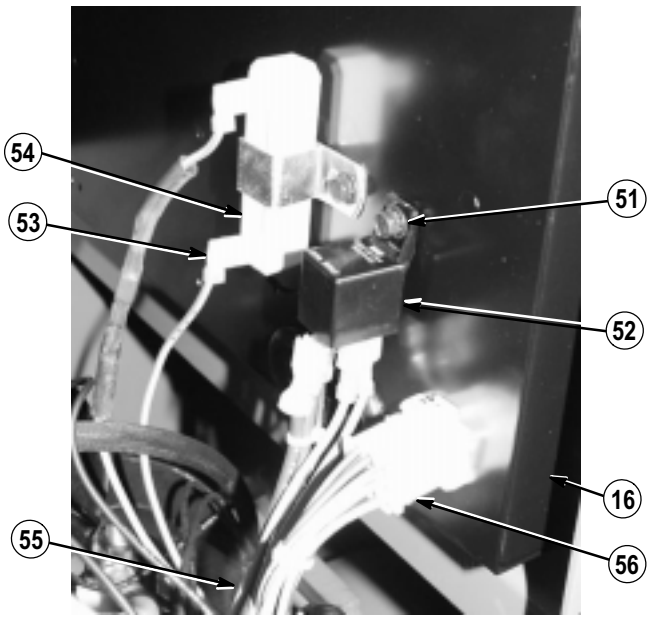


(20) Remove screw (51) and K4 relay (52) from generator control housing (16).

(21) Remove bottom wire (53) from resistor R1 (54).

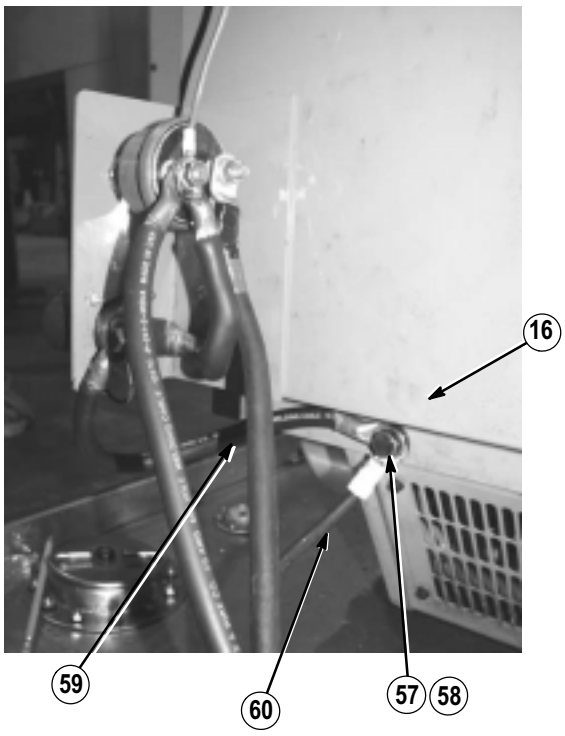
(22) Remove wire harness (55) from generator control housing (16).

(23) Remove J2 cannon plug (56) from generator control housing (16).

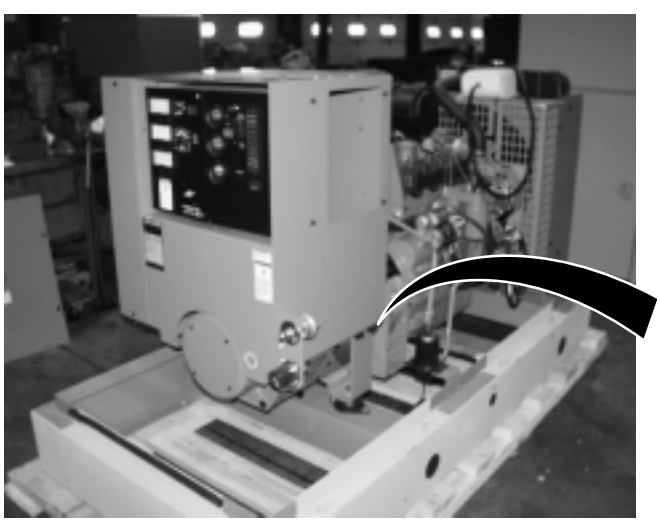


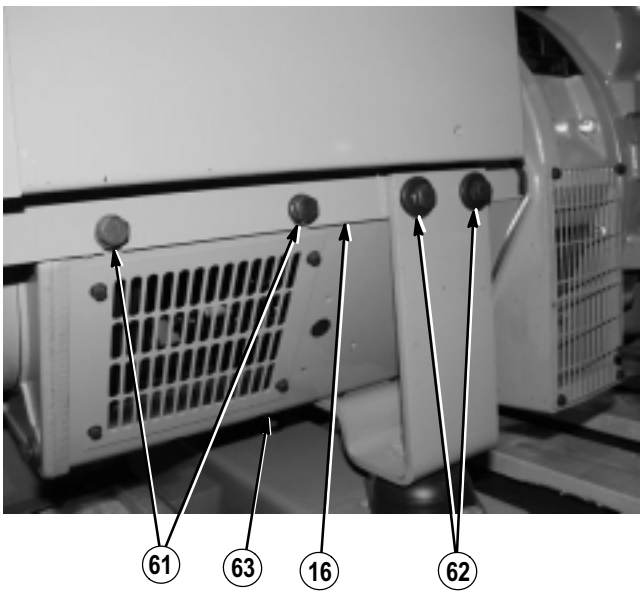
(24) Remove wires from master disconnect switch (TM 9-4940-568-20).

(25) Remove screw (57), washer (58), ground wire (59) and ground wire (60) from generator control housing (16).



5-21. GENERATOR REPLACEMENT (CONT).



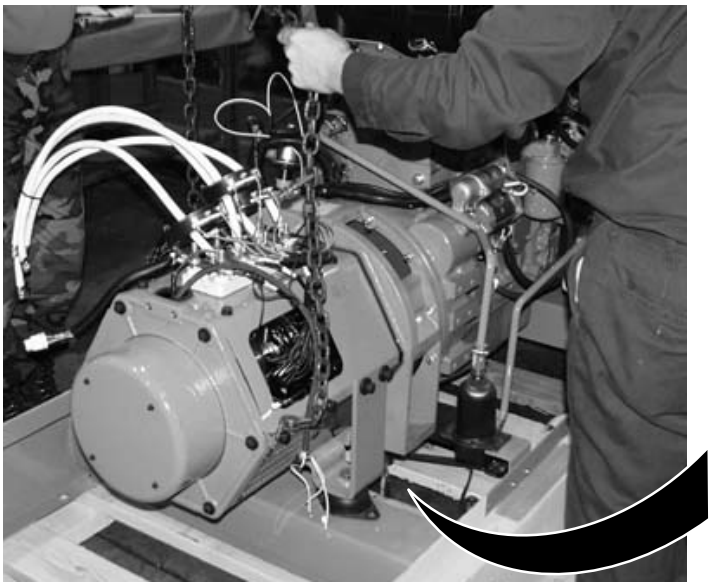


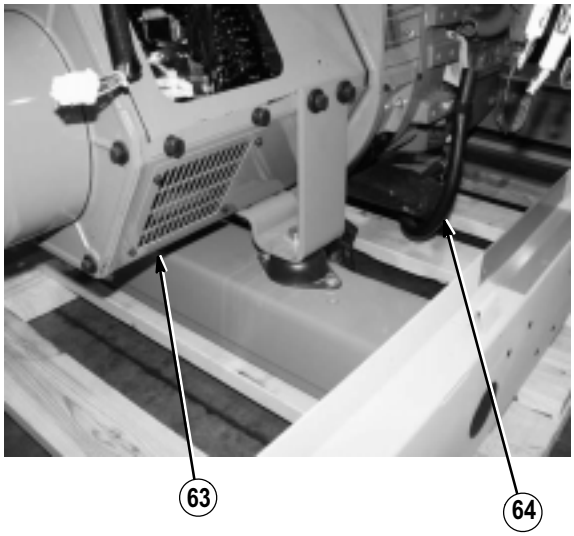
WARNING

Generator control housing weighs approximately 75 lbs (34 kg). Use an assistant to help remove generator control housing or possible injury to personnel may result.

(26) Loosen three screws (61) from generator control housing (16) and generator assembly (63).

(27) Remove four screws (62) and with the aid of an assistant, remove generator control housing (16) from generator assembly (63).





WARNING

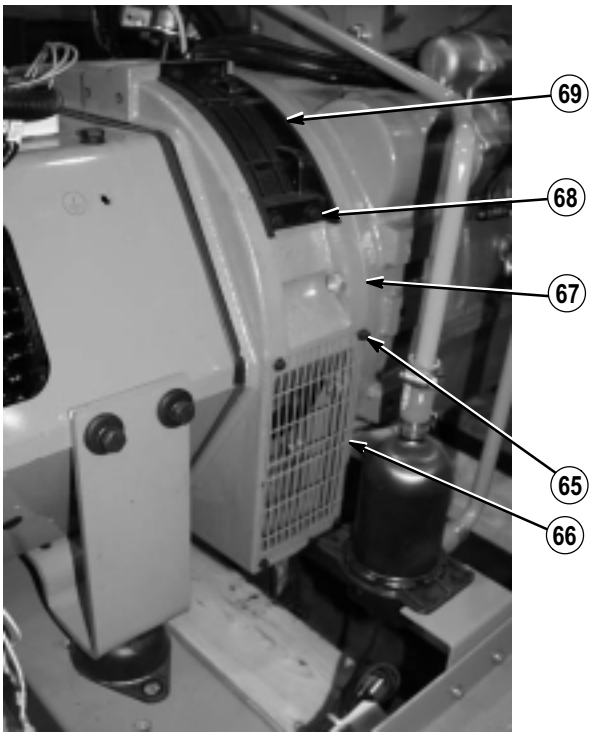
- Generator weighs 550 lbs (249 kg). Attach suitable lifting device for removal and properly support generator to prevent possible injury to personnel.
- Support engine prior to removal of generator to prevent possible injury to personnel.

(28) Attach lifting device to generator assembly (63).

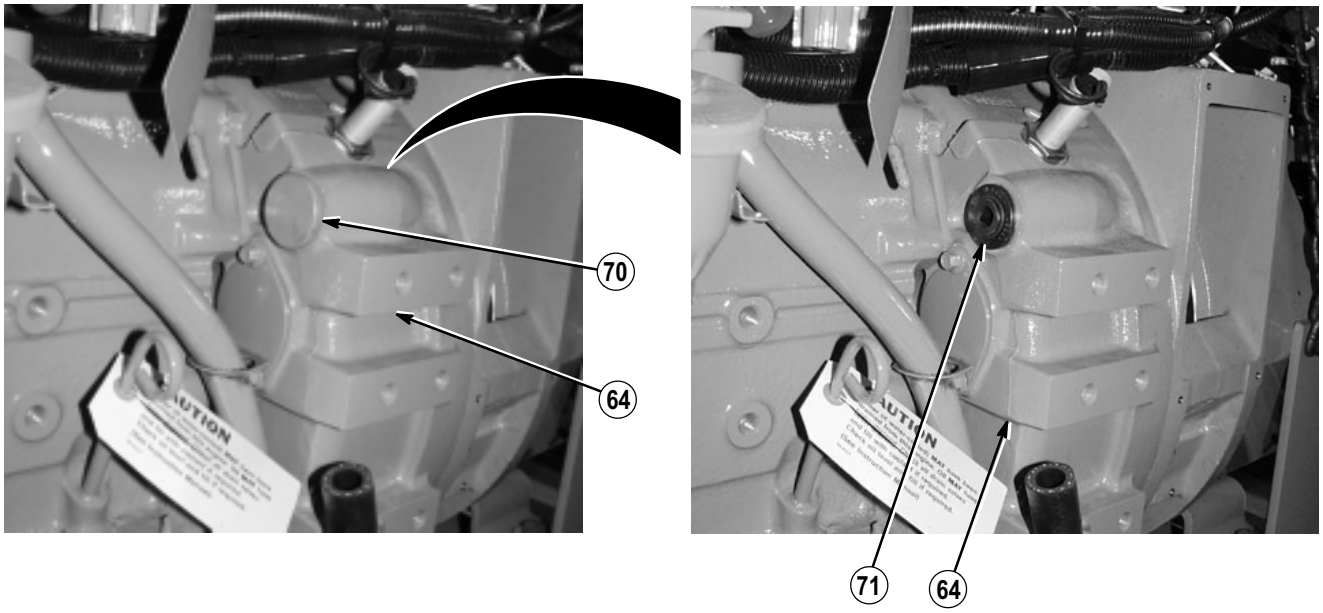
(29) Place support under engine (64).

(30) Remove eight screws (65) and two fan vents (66) from generator adapter housing (67).

(31) Remove eight screws (68) and two fan guards (69) from generator adapter housing (67).



5-21. GENERATOR REPLACEMENT (CONT).



(32) Remove access cover cap (70) from engine (64).

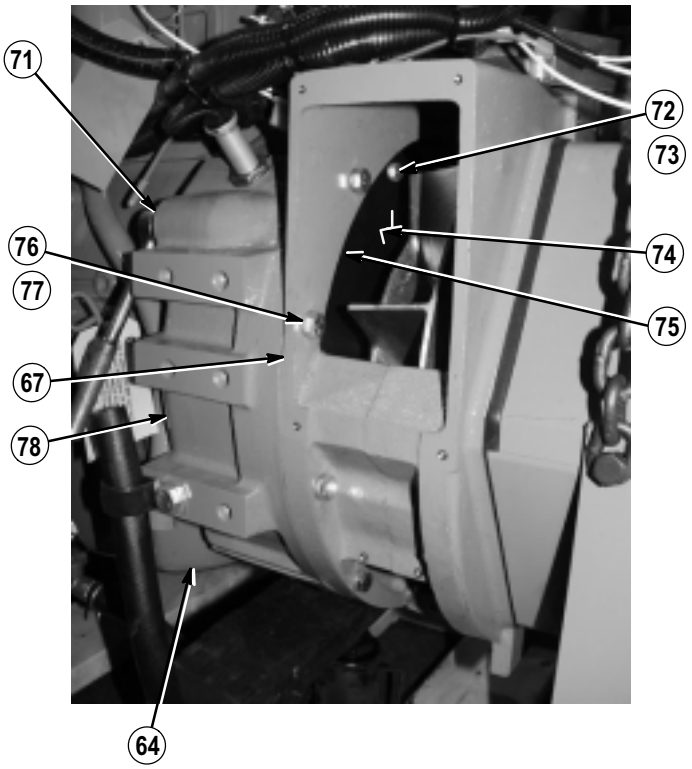
(33) Install engine turnover tool (71) in access cover on engine (64).

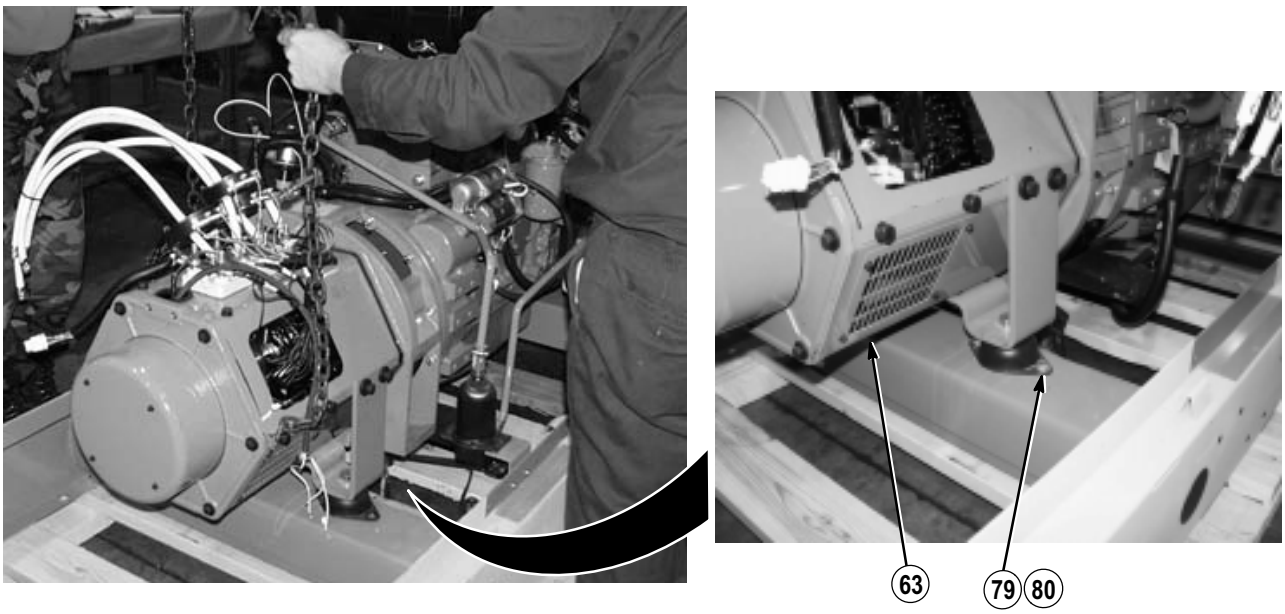
NOTE

The engine should be turned over until one of the four poles of the rotor points straight down.

(34) Using engine turnover tool (71), turn engine over and remove eight screws (72) and washers (73) from drive discs (74) and flywheel (75).

(35) Remove ten screws (76) and washers (77) from generator adapter housing (67) and flywheel housing (78).



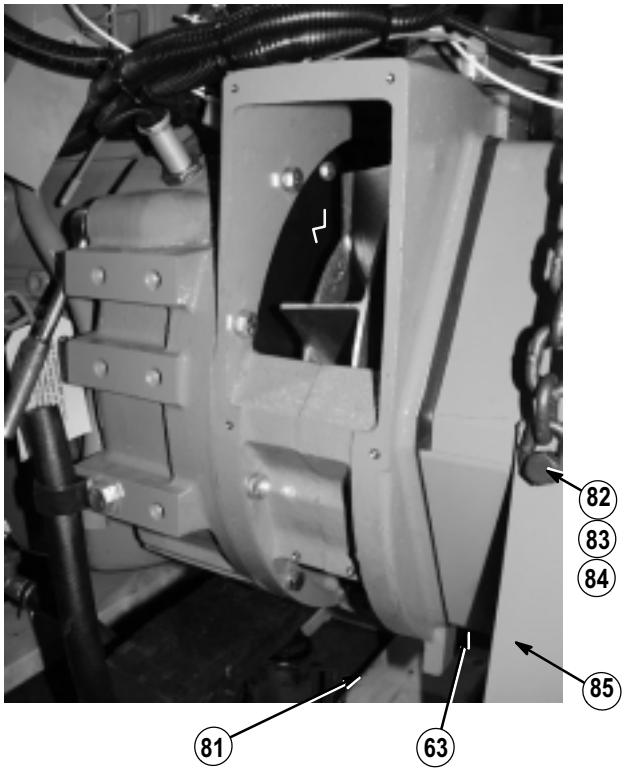


(36) Remove four rear mount bolts (79) and washers (80).

(37) Remove generator assembly (63) from generator set frame (81). Place on support blocks.

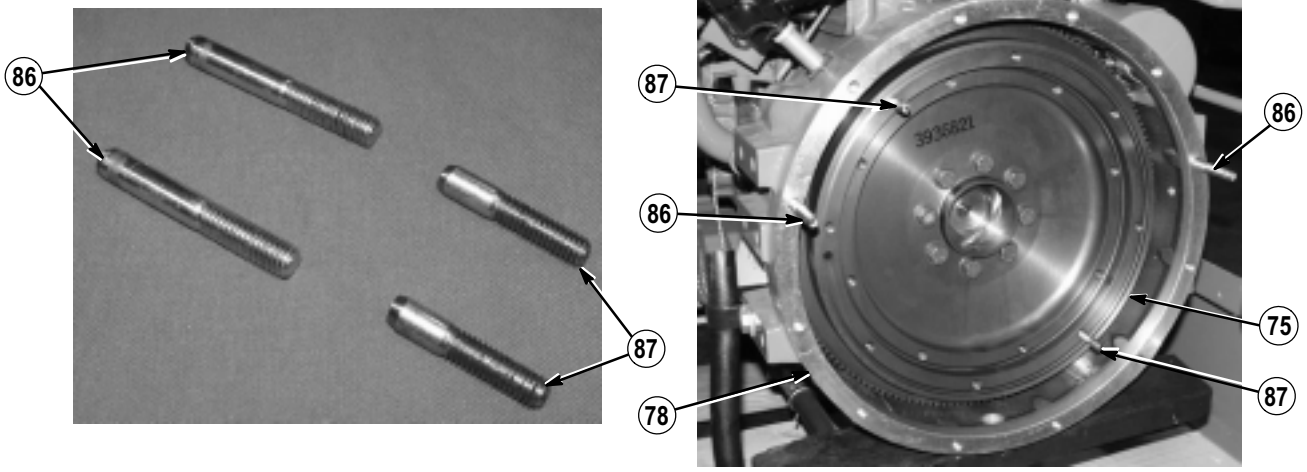
(38) Remove eight screws (82), lockwasher (83), washer (84) and two generator support brackets (85) from generator assembly (63). Discard lockwashers.

(39) Remove lifting device from generator assembly (63).



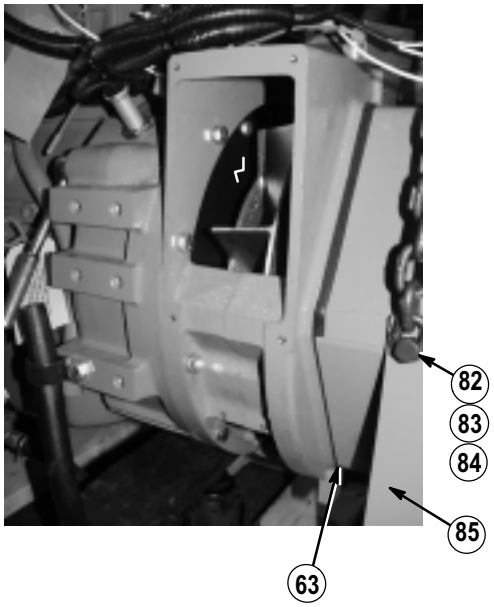
5-21. GENERATOR REPLACEMENT (CONT).

b. Installation.



WARNING

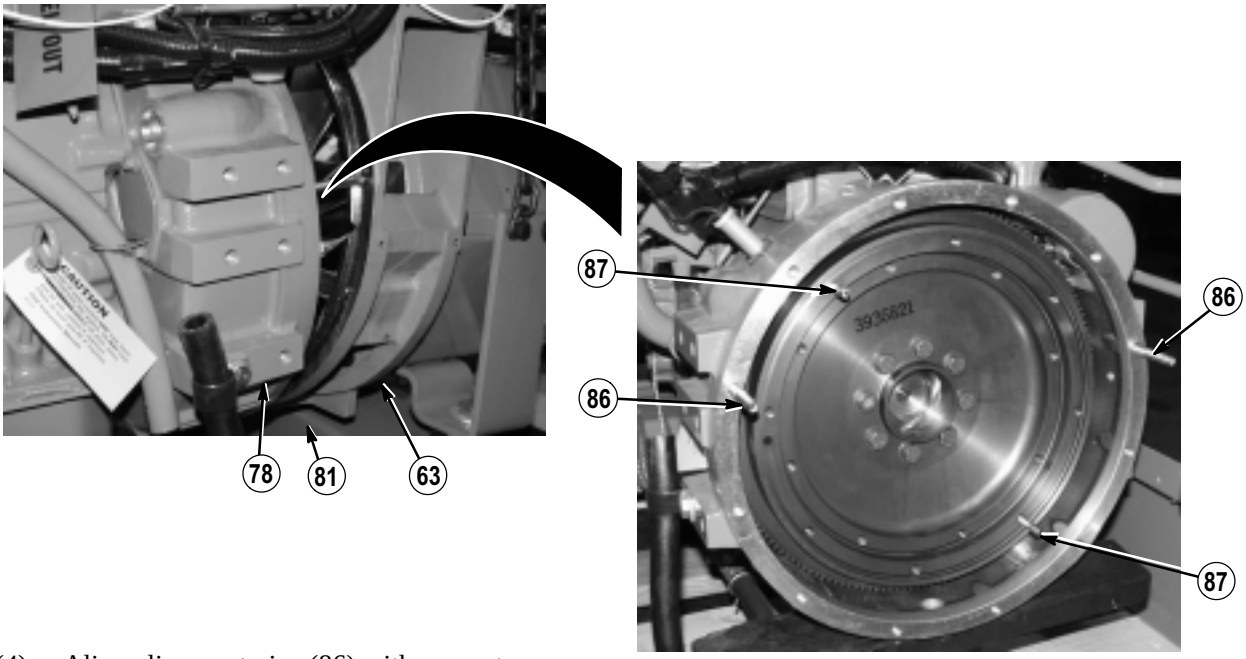
- Generator weighs 550 lbs (249 kg). Attach suitable lifting device for installation and properly support generator to prevent possible injury to personnel.
- Support engine prior to installation of generator to prevent possible injury to personnel.



(1) Attach lifting device to generator assembly (63).

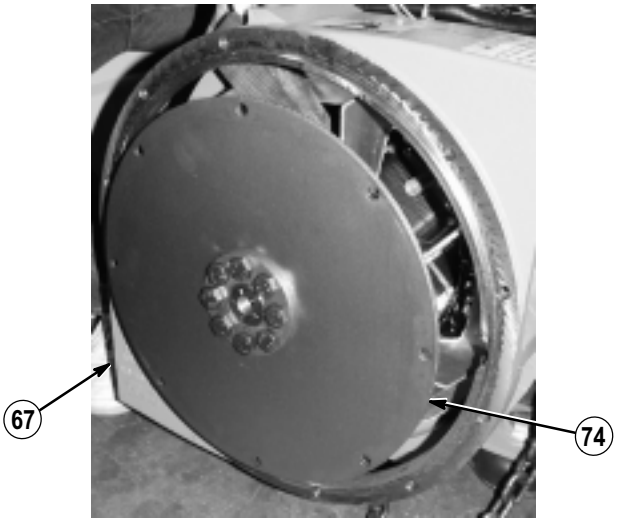
(2) Install two alignment pins (86) in flywheel housing (78) and two alignment pins (87) in flywheel (75).

(3) Install two generator support brackets (85) on generator assembly (63) with eight washers (84), lockwashers (83) and screws (82).



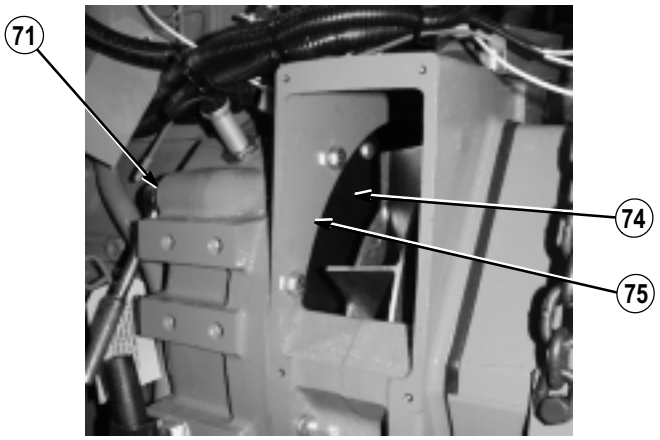
(4) Align alignment pins (86) with generator adapter housing (67) and alignment pins (87) with drive disks (74).

(5) Position generator assembly (63) on flywheel housing (78) and place generator assembly on generator set frame (81).

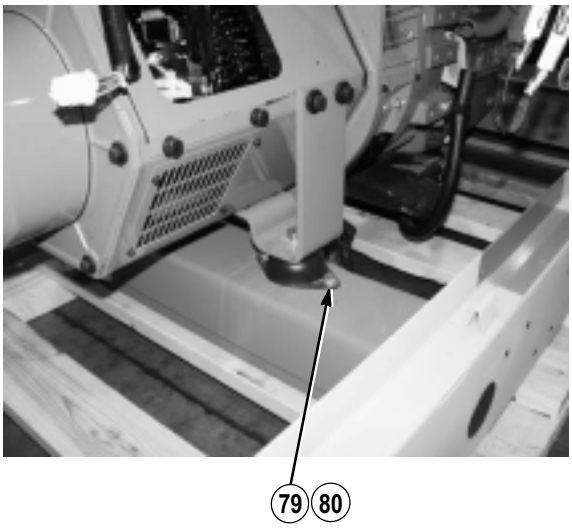


5-21. GENERATOR REPLACEMENT (CONT).

(6) Using engine turnover tool (71), turn engine over and align alignment pins on flywheel (75) with drive disks (74).

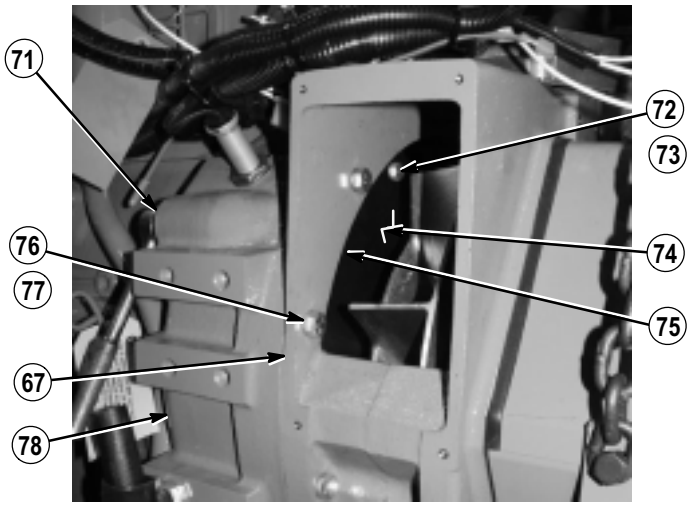


(7) Install four washers (80) and rear mount screws (79).

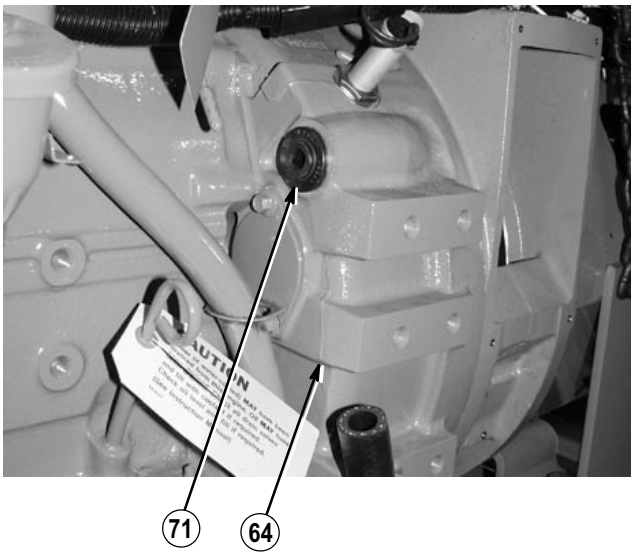


(8) Install washers (77) and ten screws (76) on generator adapter housing (67) and flywheel housing (78).

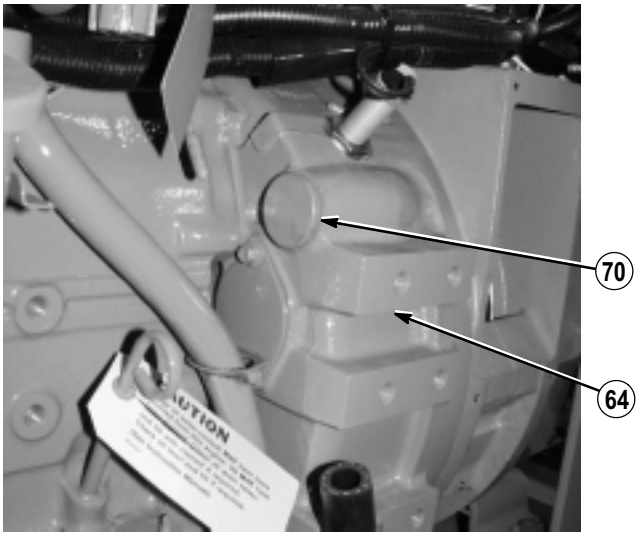
(9) Install eight washers (73) and screws (72) on drive disks (74) and flywheel (75).



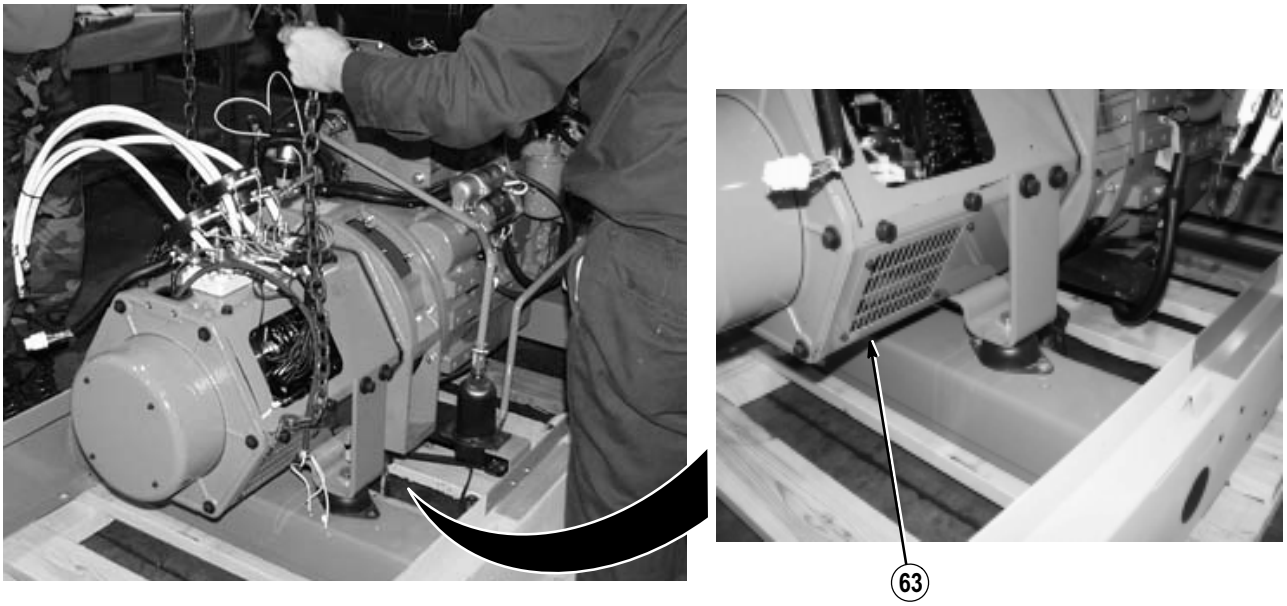
(10) Remove engine turnover tool (71) from access opening on engine (64).



(11) Install access cover cap (70) in access opening on engine (64).



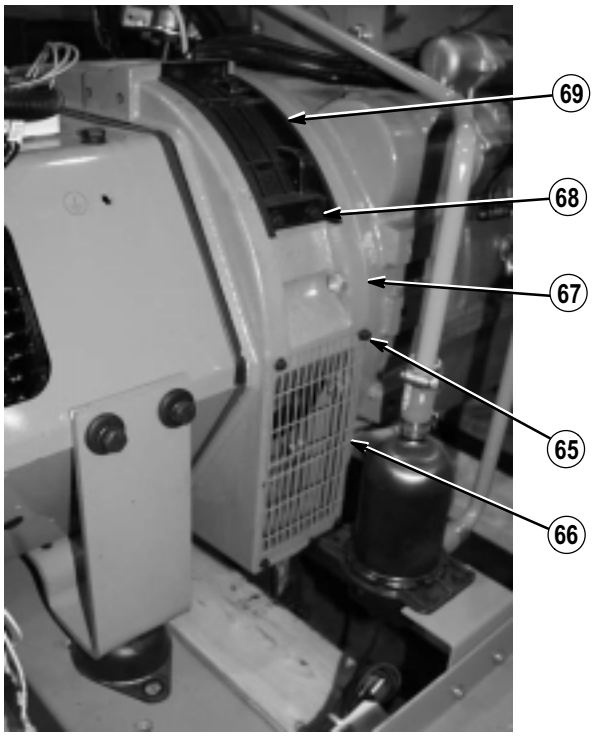
5-21. GENERATOR REPLACEMENT (CONT).



(12) Remove lifting device from generator assembly (63).

(13) Install fan guards (69) with eight screws (68) on generator adapter housing (67).

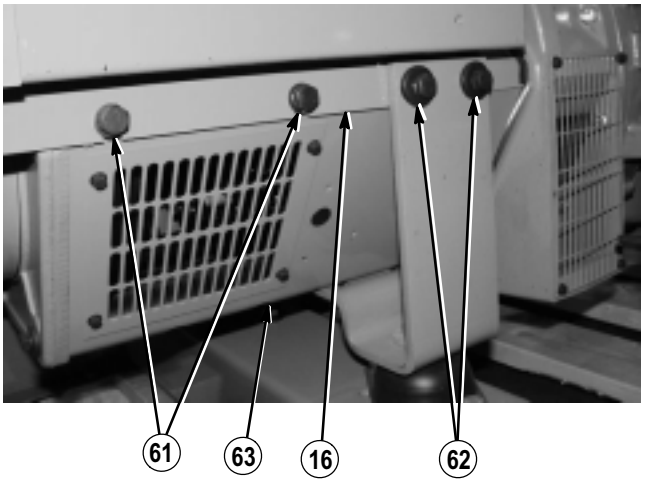
(14) Install fan vents (66) with eight screws (65) on generator adapter housing (67).



WARNING

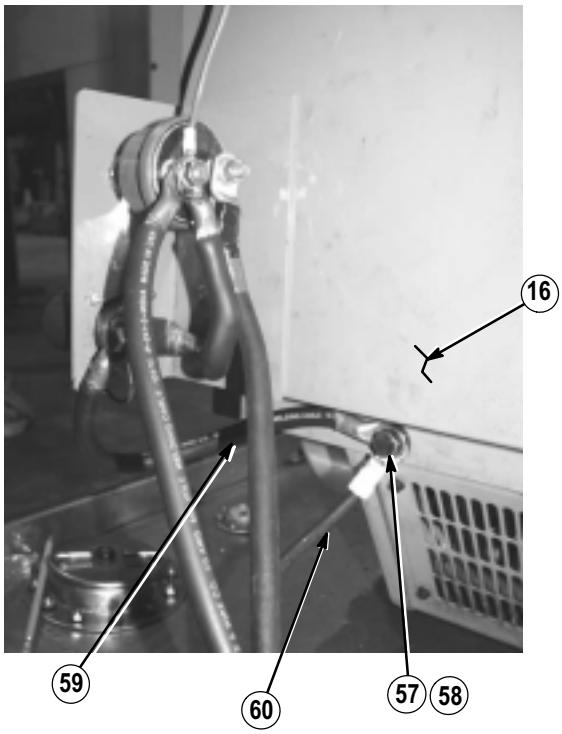
Generator control housing weighs approximately 75 (34 kg). Use an assistant to help remove generator control housing or possible injury to personnel may result.

(15) With the aid of an assistant, install generator control housing (16) on generator assembly (63) and tighten three screws (61) and four screws (62).



(16) Install ground wire (60), ground wire (59), washer (58) and screw (57) on generator housing (16).

(17) Install wires on master disconnect switch (TM 9-4940-568-20).



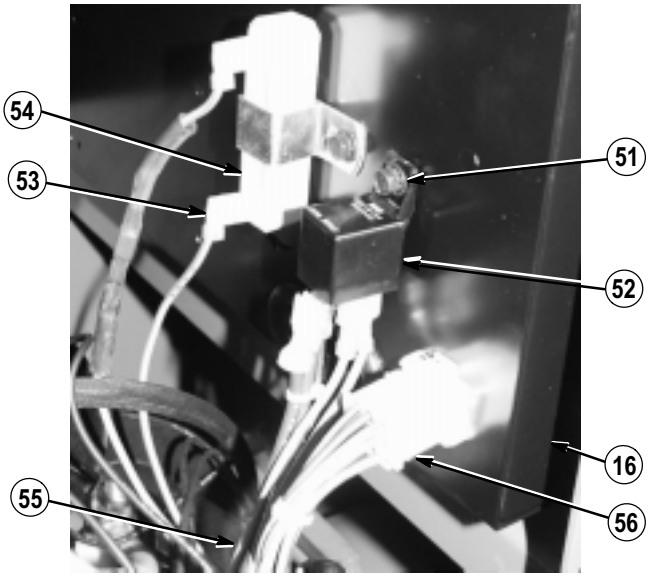
5-21. GENERATOR REPLACEMENT (CONT).

(18) Install J2 cannon plug (56) on generator control housing (16).

(19) Install wire harness (55) on generator control housing (16).

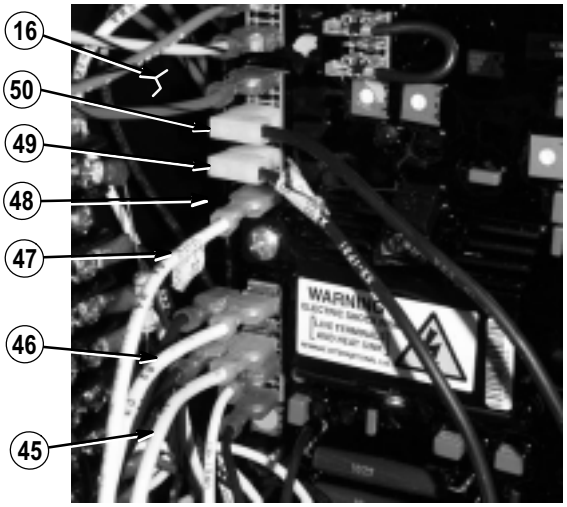
(20) Install bottom wire (53) on resistor R1 (54).

(21) Install K4 relay (52) using screw (51) on generator control housing (16).

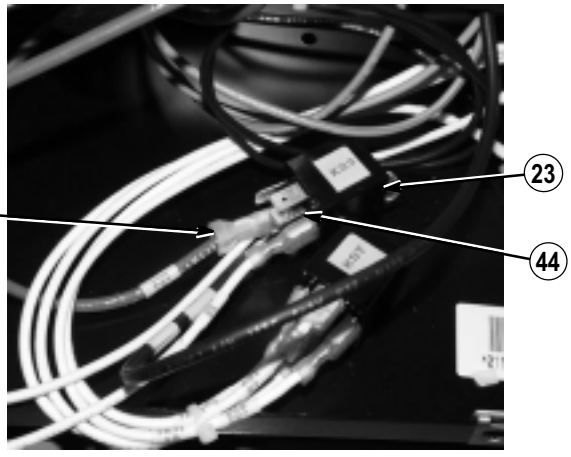


(22) Install top black wire (x+-(F1)) (50) and bottom black wire (xx-(F2)) (49) on voltage regulator card (48).

(23) Install wires P2 (45), P3 (46) and P4 (47) on voltage regulator card (48).



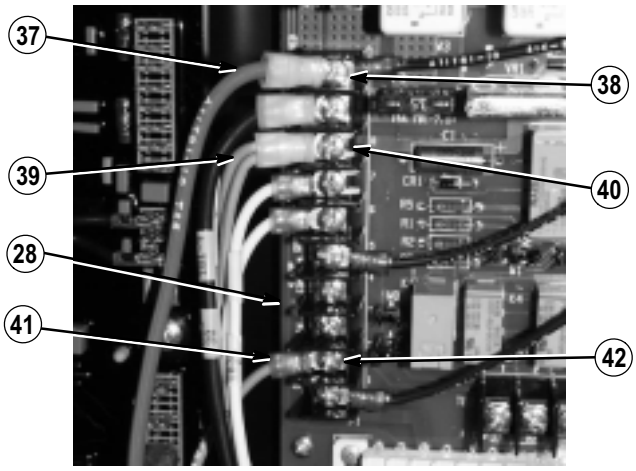
(24) Install wire (43) on terminal 30 (44) of K33 ether start relay (23).



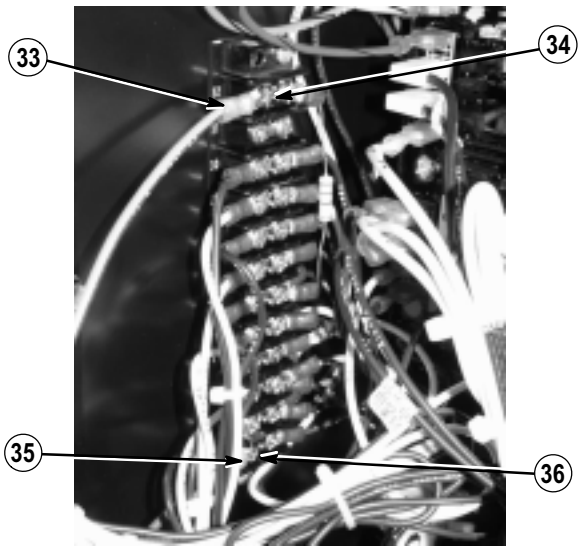
(25) Install wire (41) on TB1 terminal 2 (42) of A11 card (28).

(26) Install wire (39) on TB1 terminal 8 (40) of A11 card (28).

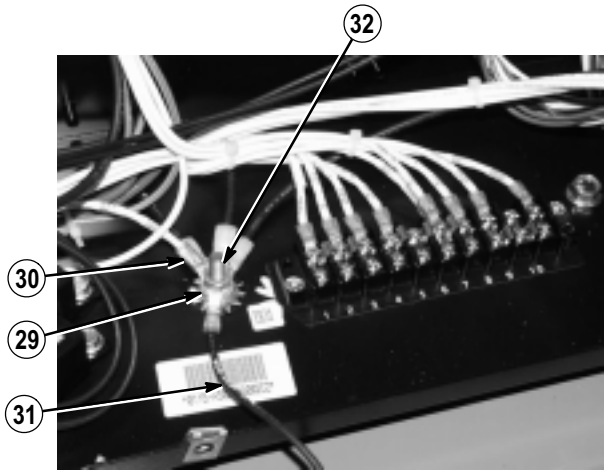
(27) Install wire T26 (37) on TB1 terminal 10 (38) of A11 card (28).



(28) Install wire (33) on TB 21 terminal 32 (34) and wire (35) on terminal 21 (36).

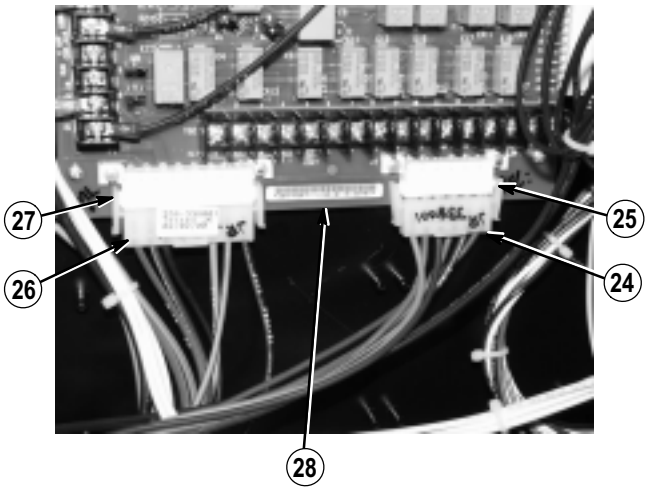


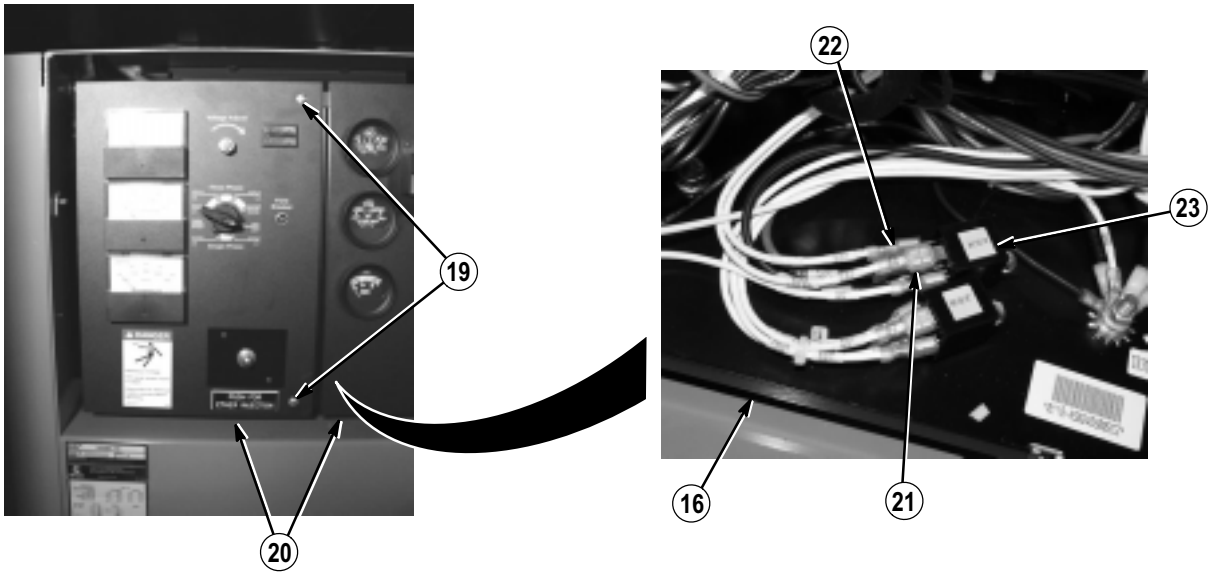
(29) Install J1 ground (31), engine ground wire (30) and nut (29) on ground stud (32).



5-21. GENERATOR REPLACEMENT (CONT).

(30) Install connector J2 (24) on connector P2 (25) and connector J1 (26) on connector P1 (27) and of A11 card (28).

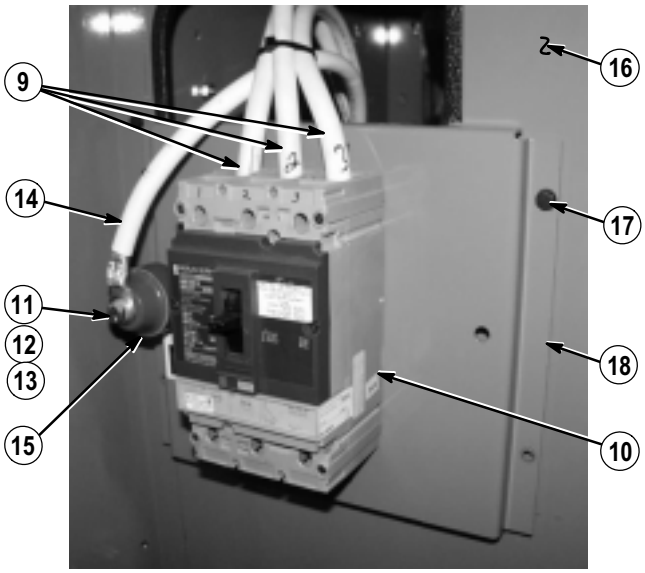




(31) Install wire 87 (21) and wire 86 (22) on K33 ether start relay (23) and generator control housing (16).

(32) Close instrument panel doors (20) and lock panel screws (19).

(33) Install panel (18) and four screws (17) on generator control housing (16).



NOTE

Pull wires through generator control housing as noted in removal and install wire ties where needed.

(34) Install insulator (15), ground wire (14), washer (13), lockwasher (12) and screw (11) on generator control housing (16).

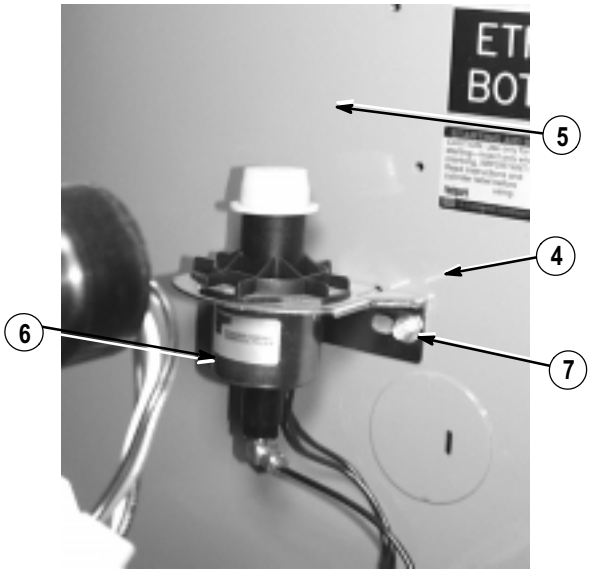
(35) Install three wires (9) on main circuit breaker (10).

NOTE

Install wires as noted prior to removal.

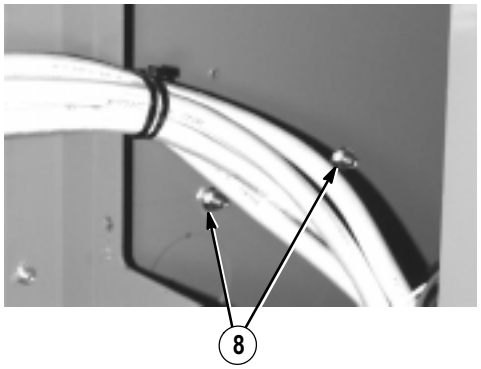
WARNING

Starting fluid is toxic and highly flammable. Container is pressurized. NEVER heat container and NEVER discharge starting fluid in confined areas or near open flame. Severe injury to personnel may result.



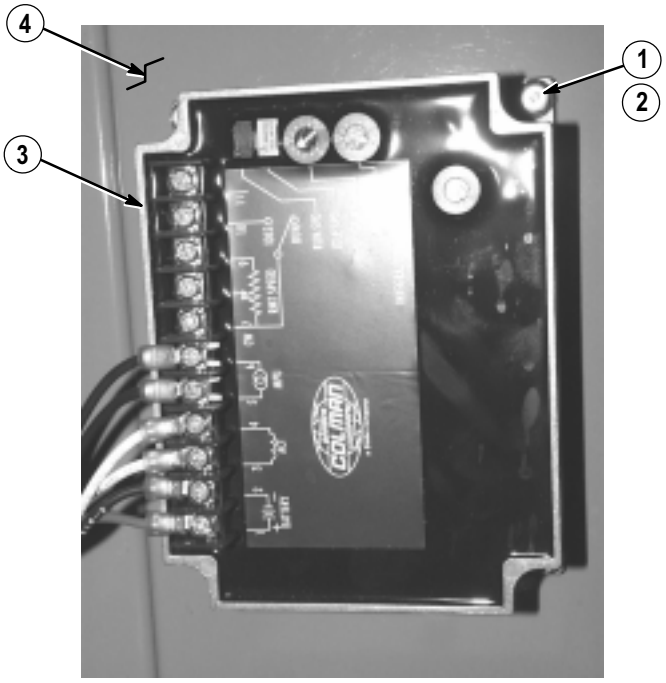
(36) Install ether start aid assembly (6) on generator panel (4) with two screws (7) and nuts (8).

(37) Install ether supply cylinder (5) on ether start aid assembly (6).



5-21. GENERATOR REPLACEMENT (CONT).

(38) Install electronic overspeed module (3) on generator back panel (4) with four screws (1) and locknuts (2).



c. Follow-On Maintenance:

- Connect batteries, (TM 9-4940-568-10).
- Install generator housing, (Para 5-3).
- Start generator and check for proper operation, (TM 9-4940-568-10).

END OF TASK

5-22. GENERATOR TESTING.

This task covers:

a. General Information
b. Testing Exciter Stator
c. Testing Exciter Rectifier Bridge (Rotating Rectifier Assembly)
d. Testing Exciter Rotor
e. Testing Main Rotor (Generator Field)
f. Testing Main Stator
g. Testing PMG Exciter

INITIAL SETUP

Tools and Special Tools
Multimeter (Item 12, Appendix F)
Socket Set, 3/8 in. (Item 52, Appendix F)
Wheatstone Bridge (Item 73, Appendix F)
Wrench, Torque 3/8 in. Drive (0 to 60 N·m) (Item 85, Appendix F)

Materials/Parts
Heat-Shrink Compound (Item 48, Appendix B)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
Batteries disconnected, (TM 9-4940-568-10)

a. General Information.

These tests can be performed without removing the generator.

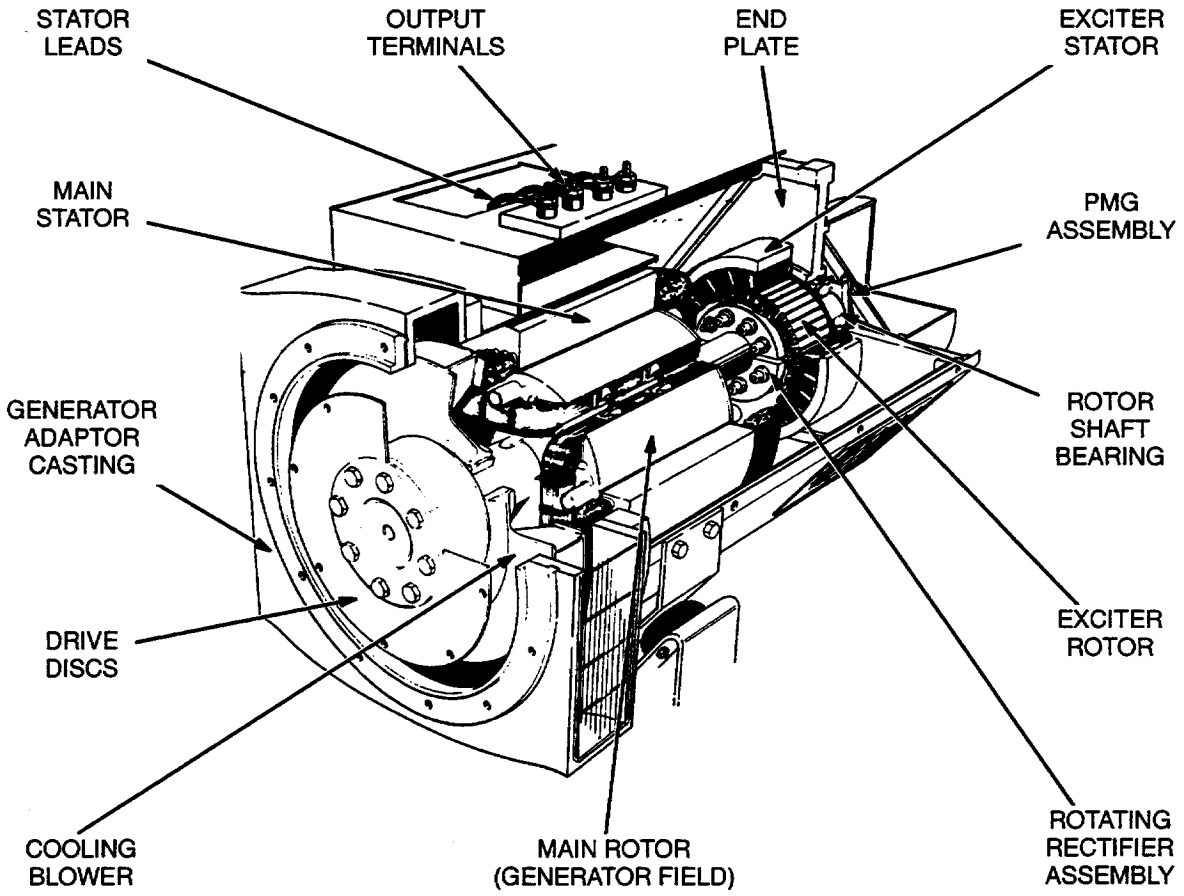
WARNING

- Accidental starting of the generator set while working on it can cause severe personal injury or death. Prevent accidental starting by disconnecting the starting battery cables (negative [–] first).
- Arcing can ignite the explosive hydrogen gas given off by batteries, causing severe personal injury. Arcing can occur if the negative (–) battery cable is connected and a tool being used to connect or disconnect the positive (+) battery cable accidentally touches the frame or other grounded metal part of the set. To prevent arcing, always remove the negative (–) cable first, and reconnect it last.

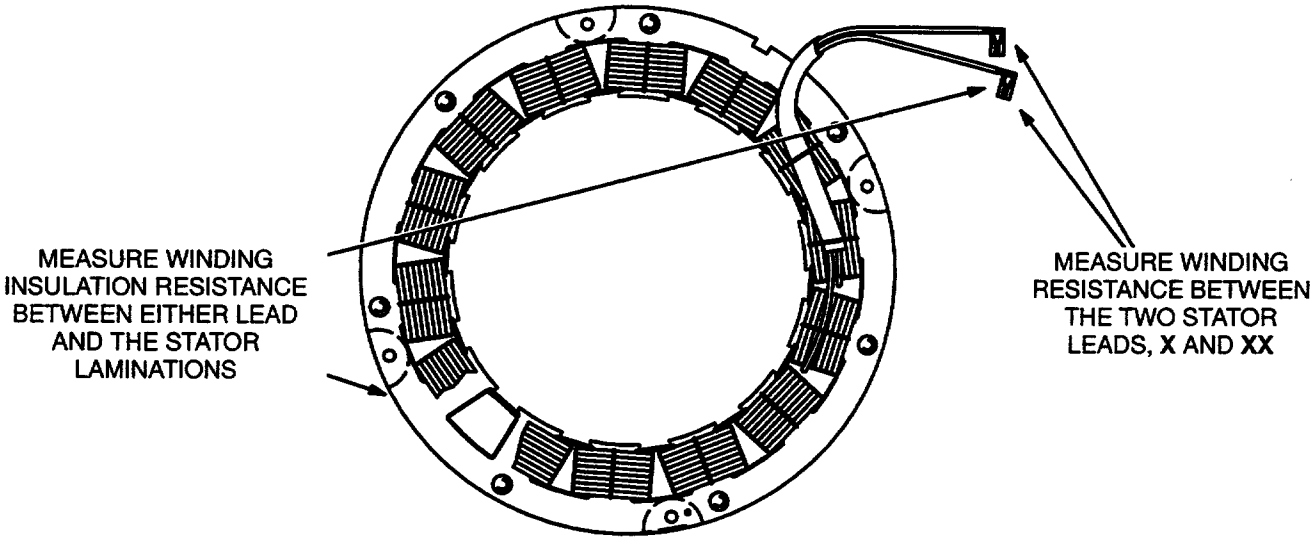
CAUTION

Always disconnect a battery charger from its AC source before disconnecting the battery cables. Otherwise, disconnecting the cables can result in voltage spikes high enough to damage the DC control circuits of the set.

5-22. GENERATOR TESTING (CONT).



b. Testing Exciter Stator.

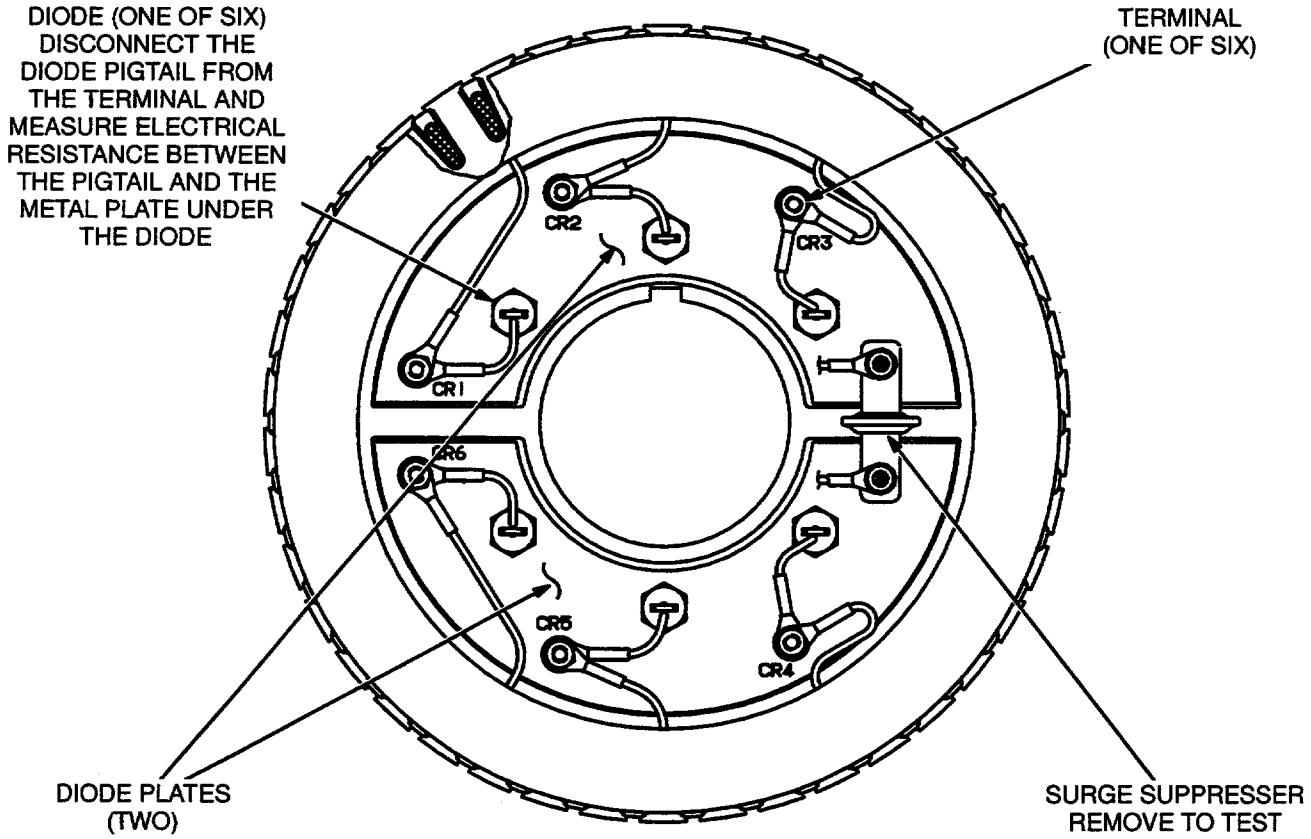


(1) Testing Winding Resistance: Measure winding resistance with a Wheatstone bridge or digital ohmmeter. Replace the stator (Para 5-21) if winding resistance is not as specified by Table 5-1.

(2) Testing Winding Insulation Resistance: Disconnect the exciter stator leads from terminals X and XX on the auxiliary terminal board in the generator output box. Using an ohmmeter, measure resistance between either lead and the stator laminations. Replace stator (notify General Support) if any reading other than infinity ∞.

5-22. GENERATOR TESTING (CONT).

c. Testing Exciter Rectifier Bridge (Rotating Rectifier Assembly).



The exciter rectifier bridge is mounted on the exciter rotor, inboard, facing the main rotor. It consists of a positive plate and a negative plate, split diametrically. Each carries three diodes, three terminal posts for connecting exciter rotor leads to the diode pigtails and a terminal for the main rotor (generator field) lead. A surge suppressor is connected across the two plates to prevent transient voltages that could damage the diodes.

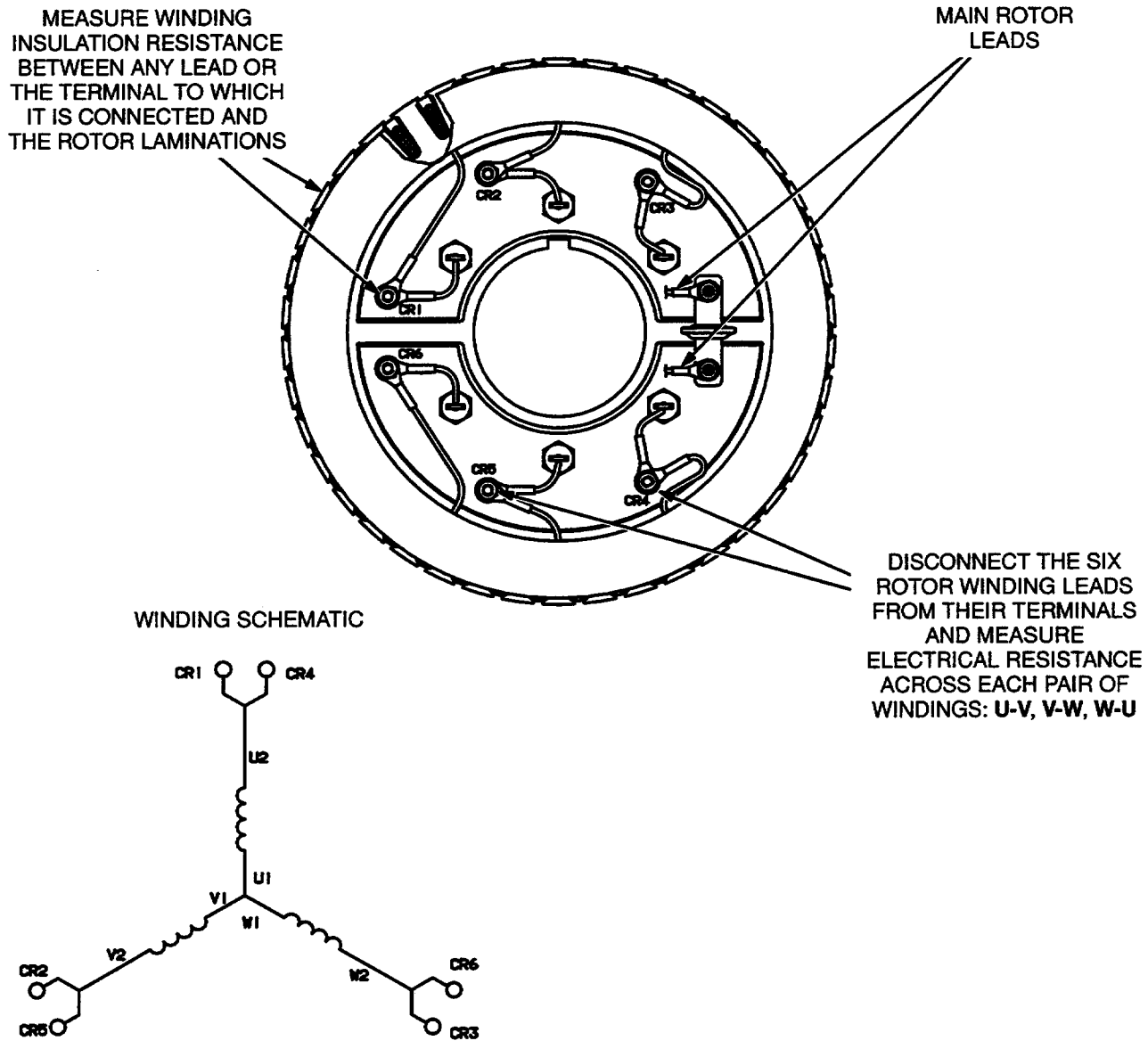
(1) Testing the Diodes: Disconnect the diode pigtails from the terminal posts. Using an ohmmeter, measure electrical resistance between each diode pigtail and the plate on which the diode is mounted. Reverse the meter test probes and repeat the tests. The electrical resistance across each diode should be high in one direction and low in the other. If the resistance is high or low in both directions, replace the diode.

(2) Replacing Diodes: Make sure the replacement diode is of the correct polarity. Disconnect the pigtail from the terminal post and unscrew the old diode. Apply heat-shrink compound under the head of the diode. Make sure the compound does not get on the threads. Tighten the diodes to 36 to 42 lb-in (4 to 4.8 N·m) and the pigtail terminals to 24 lb-in (2.7 N·m) when reassembling.

CAUTION

Layers of dust can cause diodes to overheat and fail. Brush dust off regularly.

(3) Surge Suppressor Testing and Replacement: Remove the suppressor. Replace the suppressor if it appears to have overheated or if ohmmeter readings indicate less than infinite resistance (end of scale) in both directions. Tighten the terminals to 24 lb-in (2.7 N·m) when reassembling.



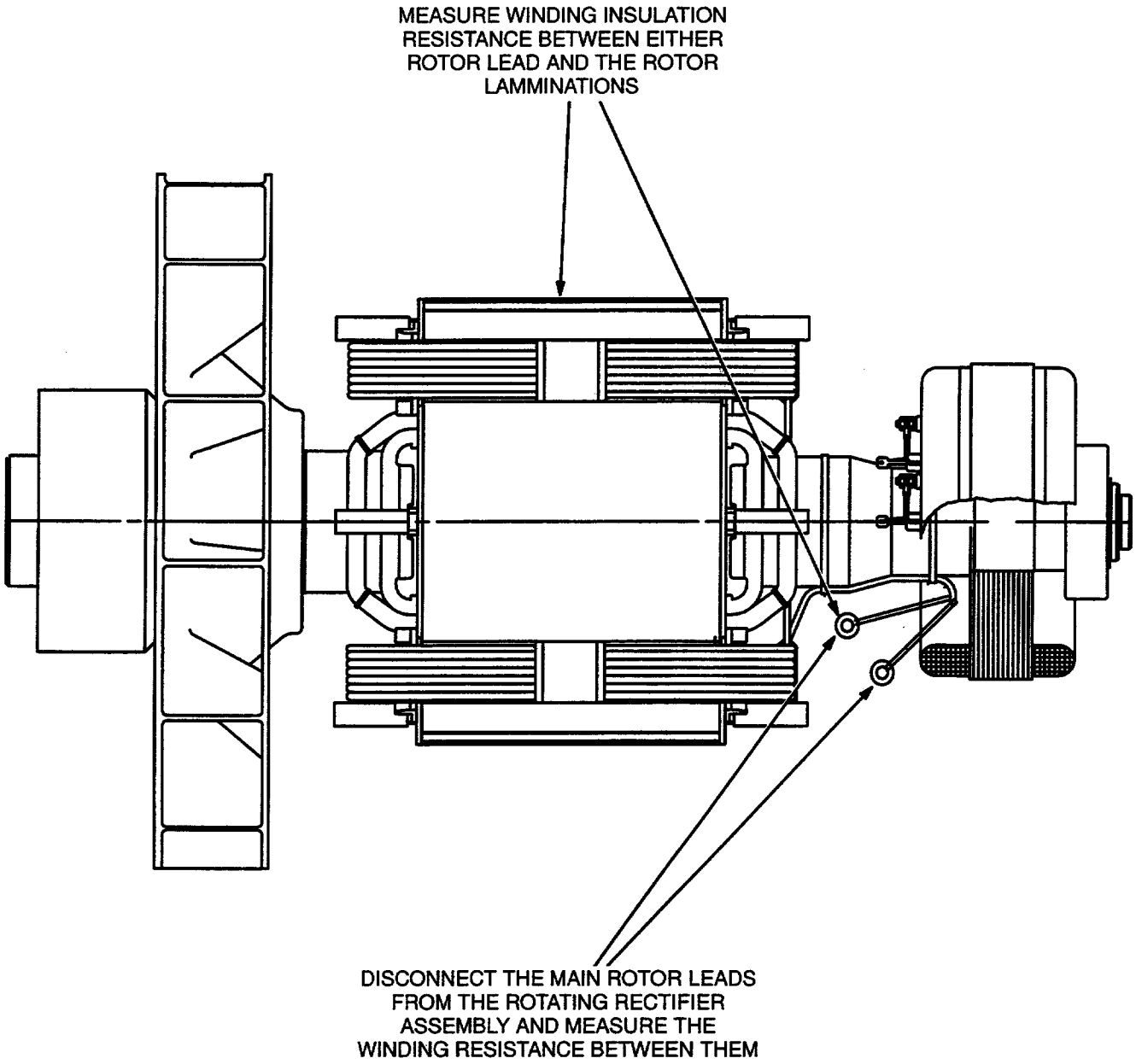
d. Testing Exciter Rotor.

(1) Testing Winding Resistance: Disconnect the six rotor winding leads from the terminal posts on the rectifier assembly. With a Wheatstone bridge, measure electrical resistance across each pair of rotor windings: U (CR1 or CR4) and V (CR2 or CR5), V (CR2 or CR5) and W (CR3 or CR6), W (CR3 or CR6) and U (CR1 or CR4). See the winding schematic. Replace the whole rotor shaft assembly (Para 5-21) if the resistance of any winding is not as specified in Table 5-1.

(2) Testing Winding Insulation Resistance: Using an ohmmeter, measure the resistance between any rotor winding lead or the terminal to which it is connected and the rotor laminations. Replace the whole rotor shaft assembly (Para 5-21) if insulation resistance is less than 1 megohm.

5-22. GENERATOR TESTING (CONT).

e. Testing Main Rotor (Generator Field).



(1) Testing Winding Resistance: Disconnect the two leads of the main rotor from the terminals on the rotating rectifier assembly. Measure electrical resistance between the two leads with at Wheatstone bridge or digital ohmmeter. Replace the rotor (Para 5-21) if the resistance is not as specified in Table 5-1. Connect the rotor leads and tighten the terminals to 24 in-lbs (2.7 N·m) when reassembling.

(2) Testing Winding Insulation Resistance: Using an ohmmeter, measure the resistance between either lead of the main rotor windings, or the terminal to which it is connected, and the main rotor laminations. Replace the rotor (Para 5-21) if insulation resistance is less than 1 megohm.

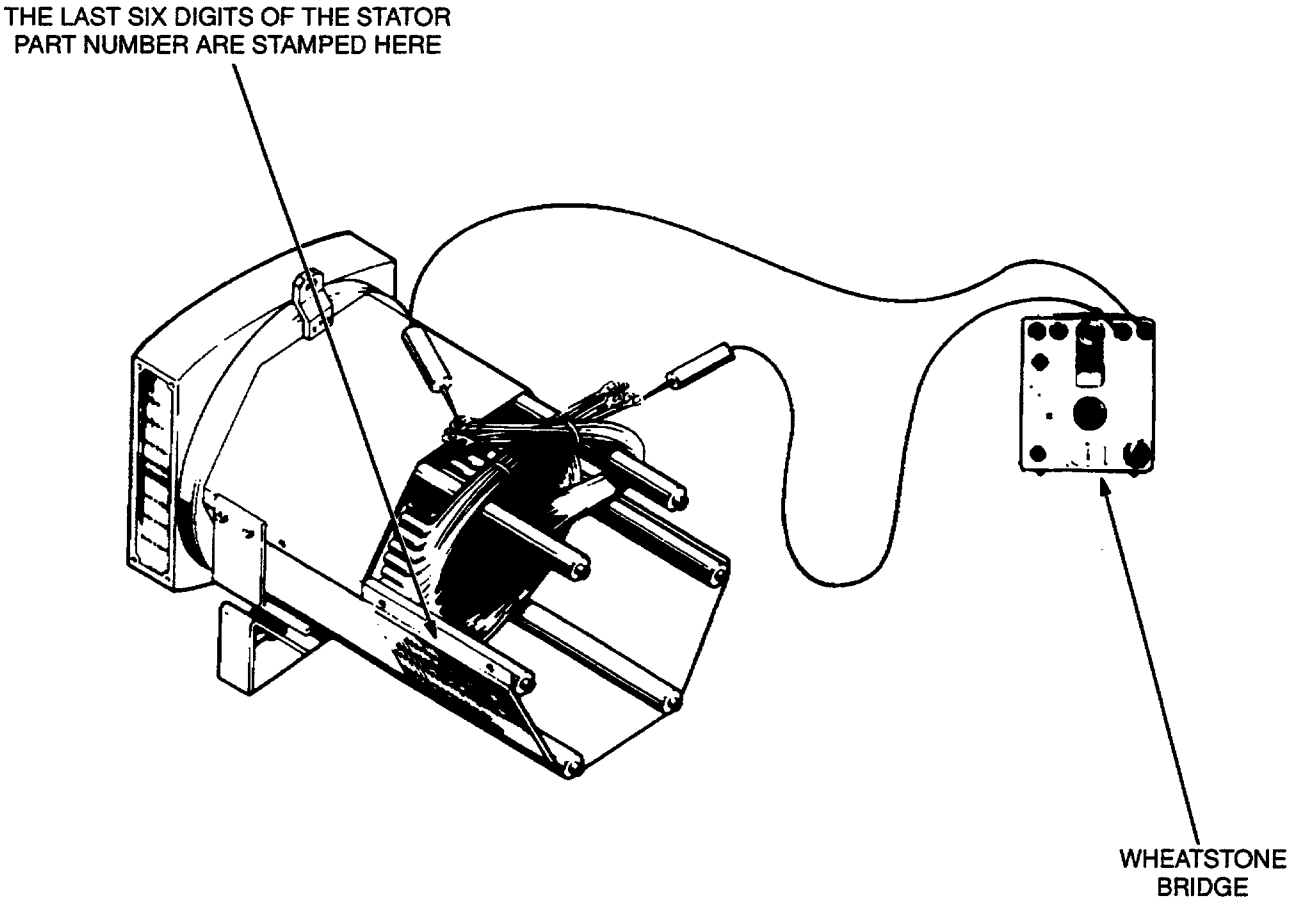
f. Testing Main Stator.

(1) Testing Winding Resistance.

(a) Measure electrical resistance across each pair of stator leads (U1-U2, U5-U6, V1-V2, V5-V6, W1-W2 and W5-W6) with a Wheatstone bridge or ohmmeter having at least 0.001 ohm precision. Replace the stator (Para 5-21) if the resistance of any winding is not as specified in Table 5-1.

(b) Alternatively, winding resistance can be measured line-to-line at the generator terminals (U-V, V-W, W-U) on "star" connected generators. On a 600 volt generator, line-to-line resistance should be twice the table value (two winding elements in series). On a "series star" connected generator, line-to-line resistance should be four times the table value (four winding elements in series). On a "parallel star" connected generator, line-to-line resistance should be the same as the table value (two sets of two winding elements in series). Single phase only windings can be measure at W-V and should be twice the table value.

(2) Testing Winding Insulation Resistance: Disconnect all stator leads and winding taps from their respective terminals and make sure the ends do not touch the generator frame. Using an ohmmeter, measure electrical resistance between any stator lead and the stator laminations. Replace the stator (Para 5-21) if insulation resistance is less than 1 megohm.



5-22. GENERATOR TESTING (CONT).

Table 5-1. Generator Winding Resistances.

MAIN STATOR PART NUMBER***	MAIN STATOR (OHMS*)	MAIN ROTOR (OHMS**)	EXCITER STATOR (OHMS**)	EXCITER ROTOR (OHMS*)
220-4447-16	0.0561–0.0620	0.57	20.3	0.167

* - These values are approximate, plus or minus 10 percent at 68° F (20° C).

** - These values are approximate, plus or minus 10 percent at 77° F (25° C).

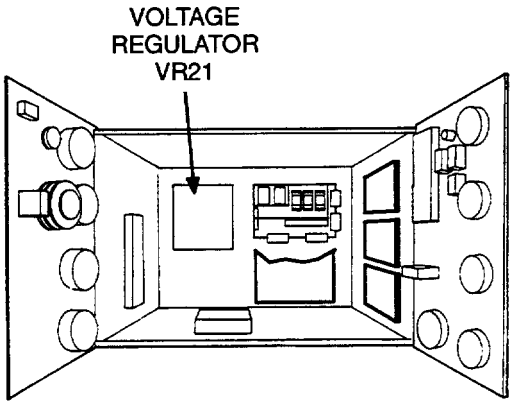
*** - See art on page 5-133 for the location of the stator part number.

g. Testing PMG Exciter.

The following information is applicable if the generator is equipped with a PMG (permanent magnet) exciter.

(1) Disconnect leads P2, P3 and P4 from the voltage regulator.

(2) Start the engine at the set and let the speed stabilize.



DETECTOR CONTROL

WARNING

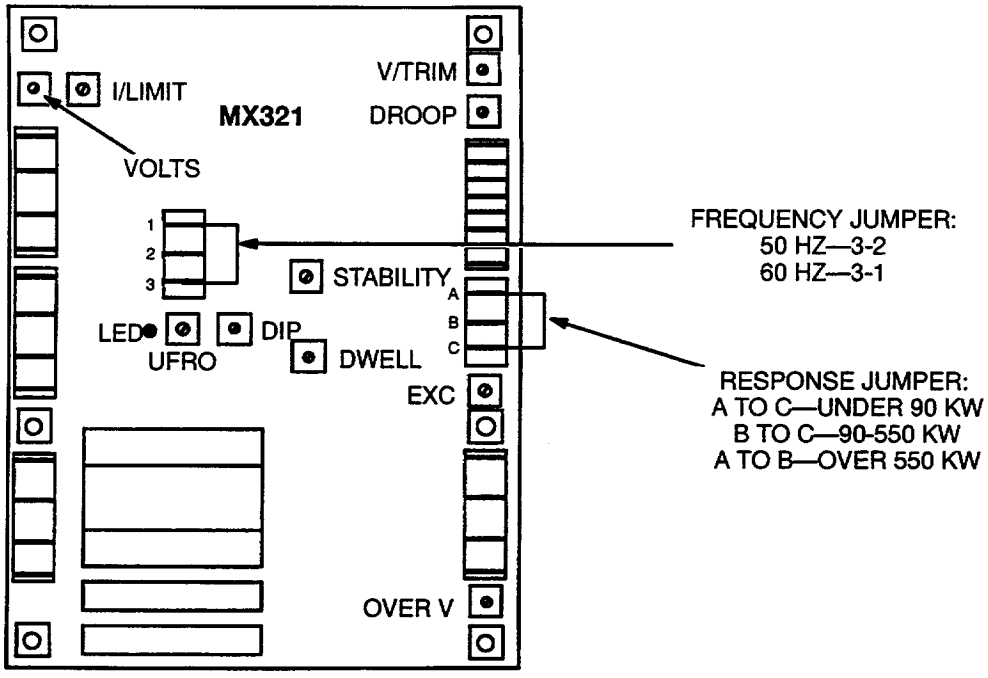
HAZARDOUS VOLTAGE

- Touching un-insulated high voltage parts inside the control and power output boxes can result in severe personal injury or death. Measurements and adjustments must be done with care to avoid touching high voltage parts.
- For your protection, stand on a dry wooden platform or rubber insulating mat, make sure your clothing and shoes are dry, remove jewelry and use tools with insulated handles.

(3) Measure voltage across lead pairs P2-P3, P3-P4, and P4-P2. Voltage should be at least 150 VAC for 50 Hz sets and at least 180 VAC for 60 Hz sets, and should be approximately the same for each set of leads. If the voltages are low or uneven, check all the leads and connections between the voltage regulator and the PMG and repair as necessary before disassembling the PMG. Note the connections at the auxiliary terminal board in the power output box.

(4) Stop the set and measure electrical resistance across lead pairs P2-P3, P3-P4, and P4-P2 with a Wheatstone bridge or digital ohmmeter. Each winding should have a resistance of approximately 4.4 ohms.

PMG-EXCITED GENERATORS (MX321)



END OF TASK

5-23. STARTER MOTOR REPAIR.

This task covers:

a. Disassembly of Frame and Field Assembly
b. Disassembly of Brush Holder Group
c. Disassembly of Gear Reduction and Drive Group
d. Disassembly of Drive Shaft and Clutch Group
e. Cleaning/Inspection
f. Component Electrical Testing
g. Assembly of Drive Shaft and Clutch Group
h. Assembly of Gear Reduction and Drive Group
i. Assembly of Brush Holder Group
j. Assembly of Frame and Field Assembly
k. Testing After Repair or Overhaul

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Multimeter (Item 38, Appendix F)
Socket Set, 3/8 in. (Item 52, Appendix F)
Vise, Mechanic's (Item 72, Appendix F)
Wrench, Torque 0 to 60 N·m (Item 85, Appendix F)
Bearing Removal Tool (Appendix C)
Block, Metal (Appendix C)
Pin, Dowel (Appendix C)

Materials/Parts
Cloth, Cleaning (Item 6, Appendix B)
Cloth, Polishing (Item 7, Appendix B)
Delco Remy Lubricant No. 196094 (Item 14, Appendix B)

Materials/Parts – Continued
Commutator End Armature Bearing (Item 6, Appendix E)
Drive End Armature Bearing (Item 5, Appendix E)
Preformed Packing (Item 72, Appendix E)
Ring, Stop (2) (Item 143, Appendix E)
Seal, Frame (Item 152, Appendix E)
Stop, Pinion (Item 178, Appendix E)

Equipment Condition
Starter motor on clean work surface.

a. Disassembly of Frame and Field Assembly.

(1) Remove nut (1) and motor lead (2) from solenoid assembly (3) and reinstall nut.

(2) Remove two thru bolts (4) from commutator end frame (5).

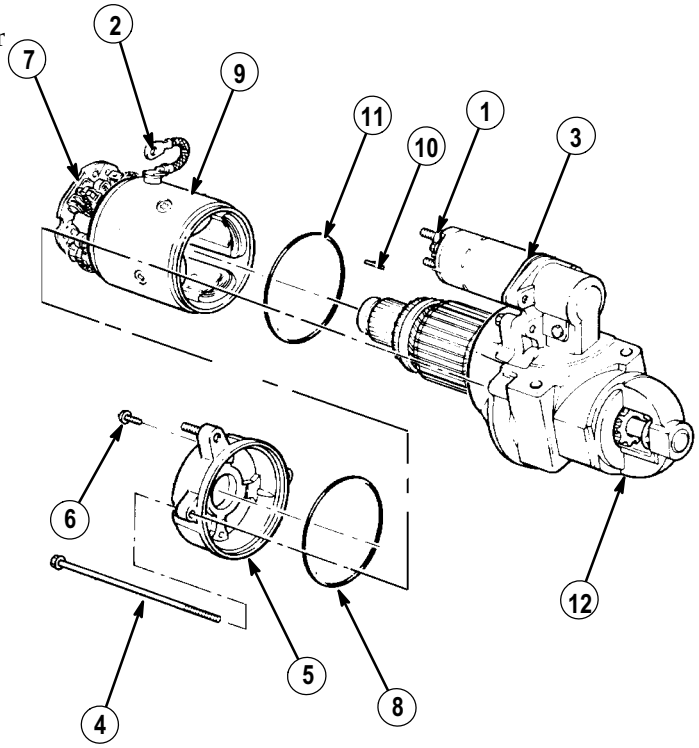
(3) Remove two brush plate screws (6) from commutator end frame (5) and brush holder assembly (7).

(4) Remove commutator end frame (5) and preformed packing (8) from brush holder assembly (7). Discard preformed packing.

NOTE

- Use care not to lose the small dowel pin installed between the frame and field assembly and the gear reduction and drive group.
- The dowel pin is required for assembly and must be saved. If the dowel pin is lost, it must be replaced (Appendix C).
- Before disassembly, mark the dowel pin location in the gear reduction and drive group and the frame and field assembly.

(5) Remove the frame and field assembly (9), dowel pin (10) and frame seal (11) from drive housing (12). Discard frame seal.



5-23. STARTER MOTOR REPAIR (CONT).

NOTE

Armature assembly may come off with the frame and field assembly, the brush holder assembly, or it may be retained by the gear reduction and drive group.

(6) Remove armature assembly (13) with drive end armature bearing (14) and commutator end armature bearing (15) installed.

NOTE

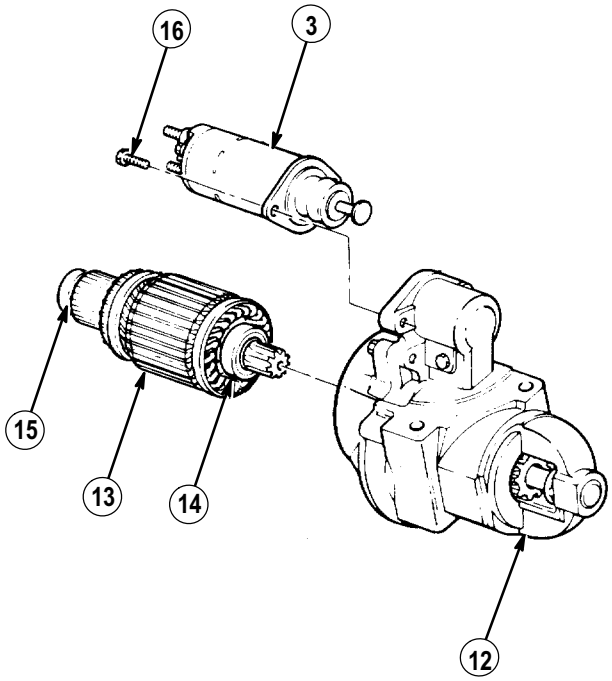
Do not remove armature bearings unless replacement is required. Removed bearings must be replaced with new armature bearings. Removal procedure causes internal damage to armature bearings.

(7) Remove drive end armature bearing (14) and commutator end armature bearing (15) from armature assembly (13). Discard bearings.

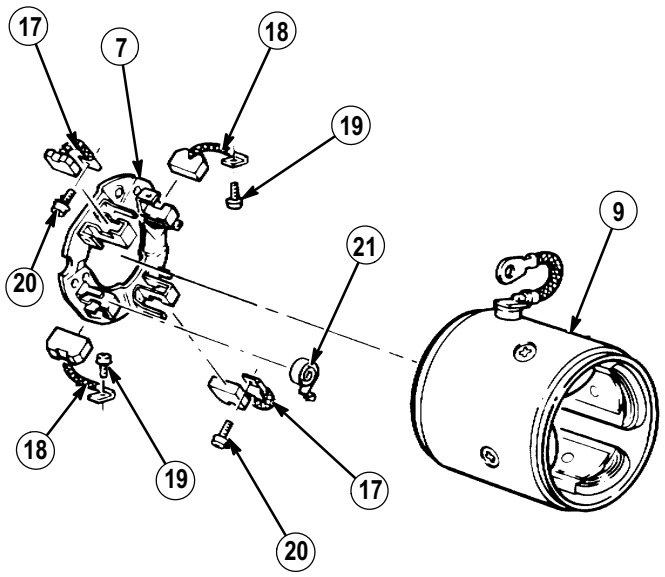
(8) Remove two solenoid screws (16) from solenoid assembly (3).

(9) Pivot inside end of solenoid assembly (3) out of engagement with shift lever and remove solenoid assembly from drive housing (12).

(10) After all items in Steps (1) through (9) have been removed, perform inspection and testing procedures.



b. Disassembly of Brush Holder Group.



(1) Move brush holder assembly (7), with two grounded brushes (17) and insulated brushes (18) still installed, away from the frame and field assembly (9) slightly to reach across with screwdriver and remove two insulated brush screws (19).

(2) Remove frame and field assembly (9) from brush holder assembly (7).

(3) Remove two grounded brush screws (20) from brush holder assembly (7).

(4) If replacement is needed, grab the brush end of brush spring (21) with needle nose pliers, twist the brush spring (21) away from the brush, and remove two grounded brushes (17) and two insulated brushes (18) from brush holder assembly (7).

(5) If replacement is needed, grab the brush end of brush spring (21) with needle nose pliers, twist brush spring away from brush socket on brush holder assembly (7) and remove four brush springs (21) from brush holder assembly (7).

(6) After all items in Steps (1) through (5) have been removed, perform inspection and testing procedures.

5-23. STARTER MOTOR REPAIR (CONT).

c. Disassembly of Gear Reduction and Drive Group.

NOTE

Before removing armature support bracket from assembled drive housing, make aligning marks on the armature support bracket and the drive housing to aid in assembly.

(1) Remove long drive housing bolt (22) and short drive housing bolt (23) from the armature support bracket (24).

(2) Remove armature support bracket (24) from the drive shaft and clutch group (25).

NOTE

Washers might stick to armature support bracket or the drive shaft and clutch group as the armature support bracket is removed. In either case, note the position and number of each of these washers.

(3) Remove fiber washer(s) (26), thin washer(s) (27), and thick washer(s) (28).

(4) Using a large screwdriver, pry out the drive housing plug (29) and plate (30) from drive housing (12).

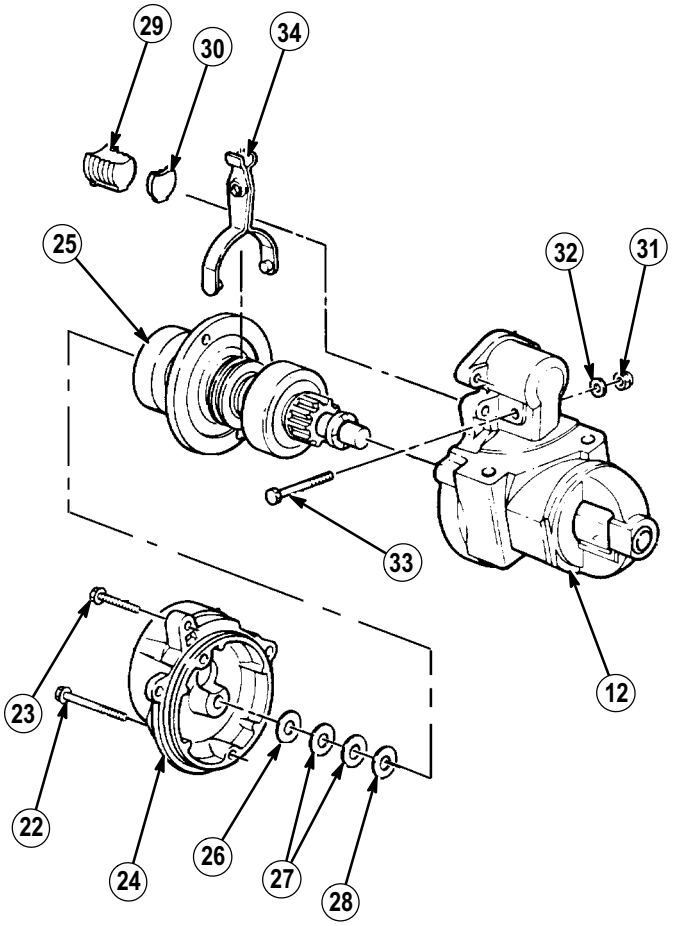
(5) Remove shift lever nut (31), shift lever washer (32), and shift lever screw (33) from shift lever (34) and assembled drive shaft and clutch group (25).

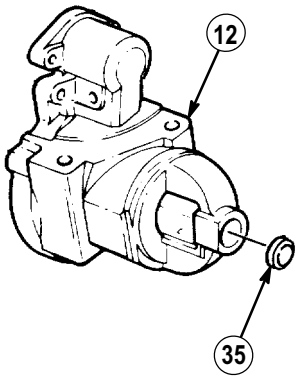
(6) Remove shift lever (34) and drive shaft and clutch group (25) from drive housing (12). Separate shift lever (34) and drive shaft and clutch group (25) from each other.

NOTE

Do not remove bushing plug or bushing from drive housing unless replacement is required.

(7) From inside of drive housing (12), drive out bushing plug (35) if present. Using a clean file, clean away remnants of old stake to allow installation of new bushing plug. Clean away any metal shavings.





(8) From inside of drive housing (12), drive out bushing (36).

(9) After all items in Step (1) through (8) have been removed, perform cleaning and inspection procedures.

d. Disassembly of Drive Shaft and Clutch Group.

NOTE

Disassembly of the drive shaft and clutch group is not required unless it is necessary to clean, inspect, or replace one or more parts of the group separately.

(1) Position drive shaft and clutch group (25) on work bench with internal gear end down.

(2) Using an open tube slightly larger than the drive shaft (37), drive pinion stop (38) toward clutch drive assembly (39) until it clears two stop rings (40).

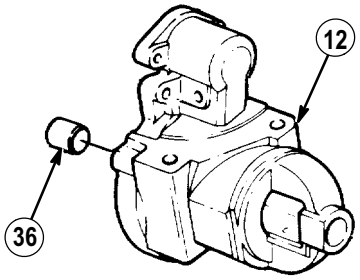
(3) Using care not to scratch drive shaft (37), pry two stop rings (40) out of shaft groove and slide off end of drive shaft (37). Discard stop rings.

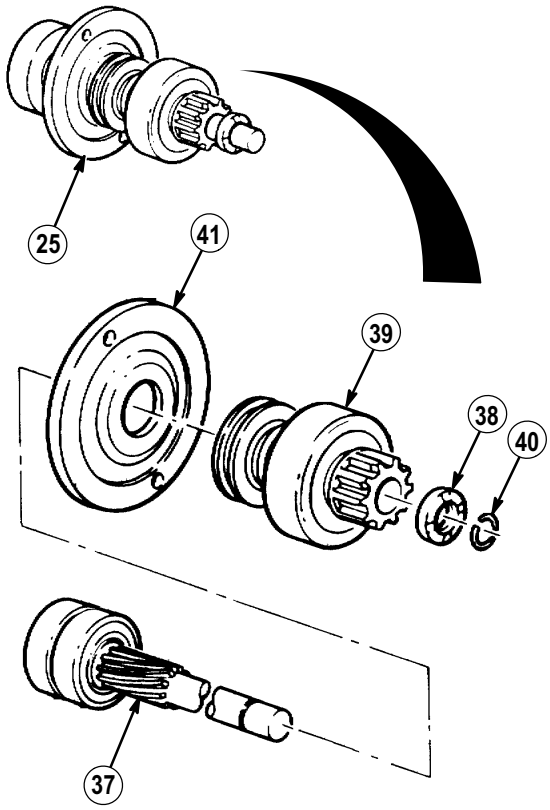
(4) Inspect edges of shaft groove for burrs that may have been formed through repeated cranking cycles. Burrs may make removal of pinion stop (38) and clutch drive assembly (39) difficult. If burrs are found, use a suitable file to carefully remove burrs only – not base metal. Thoroughly clean away metal fillings.

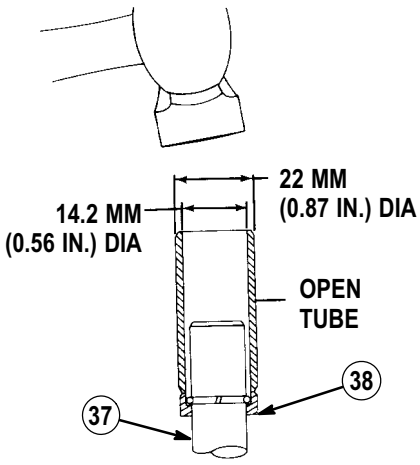
(5) Slide pinion stop (38) off drive shaft (37). Discard pinion stop.

(6) Remove clutch drive assembly (39) from drive shaft (37).

(7) Remove drive shaft support (41) from drive shaft (37).







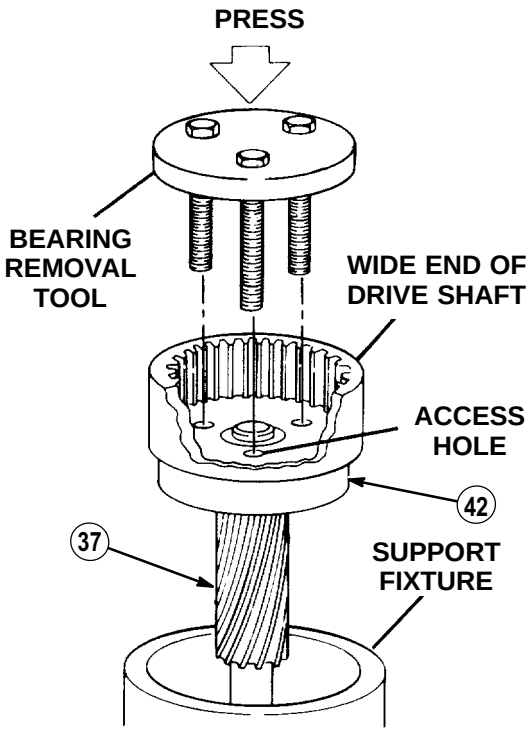
5-23. STARTER MOTOR REPAIR (CONT).

NOTE

- Do not remove bearing from drive shaft unless replacement is required.
- Ball bearings removed from drive shaft must be replaced with new bearings. Removal procedure causes internal damage to bearings.

(8) Using bearing removal tool, remove center support bearing (42) from drive shaft (37). Discard bearing.

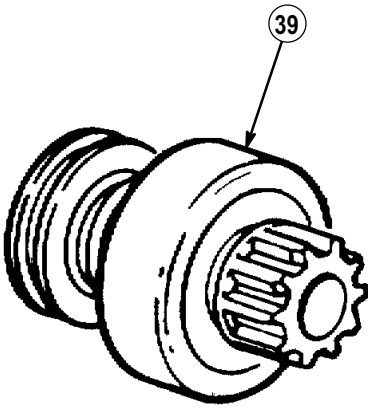
(9) After all items in Step (1) through (8) have been removed, perform cleaning and inspection procedures.



e. Cleaning/Inspection.

CAUTION

Do not clean or immerse starter motor parts in grease dissolving solvents. Solvents will dissolve grease packed in drive assembly and may damage armature or field coil insulation.



(1) Clean all motor parts with a soft cloth prior to testing.

(2) Inspect all parts for cracks, distortion or other structural damage. Replace parts or assemblies which are cracked, bent or otherwise damaged.

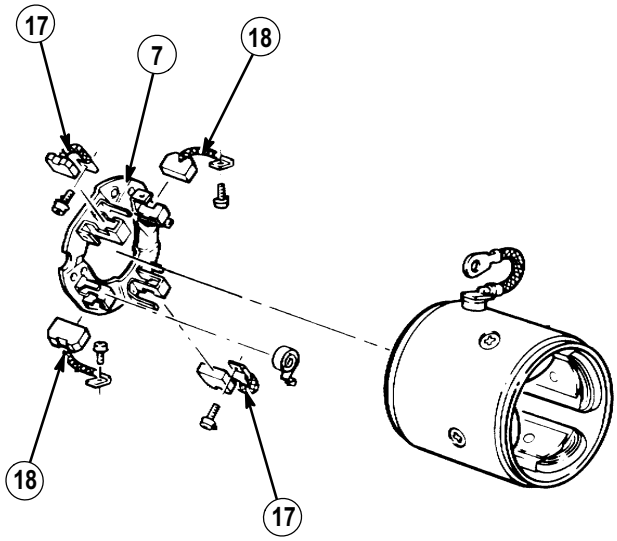
(3) Inspect threaded parts for stripped, crossed or otherwise damaged threads. Replace parts with thread damage that cannot be cleaned up. Replace any hardware items that have damaged threads.

(4) Inspect clutch drive assembly (39).

(5) Replace clutch drive assembly if pinion gear turns roughly or turns in both directions, pinion gear teeth are broken or showing evidence of step wear, and deep scoring or other damage to shift lever collar has occurred.

(6) Inspect brush holder assembly (7). Replace brush holder if loose riveted joints or cracked or broken insulation is found.

(7) Inspect brushes (17) and (18) for excessive wear. The minimum allowable brush length is 0.472 in. (12 mm). Replace excessively worn brushes in sets.



5-23. STARTER MOTOR REPAIR (CONT).

(8) Inspect drive end housing bushing (36) for scoring or other damage. Replace damaged bushing.

(9) Check solenoid assembly (3) for cut or torn boot. If boot is damaged, replace solenoid assembly.

(10) Inspect ball bearings (14), (15), and (42), as follows:

(a) Hold armature (13) and slowly rotate outer bearing race by hand. Hold outer edge of ball bearing (42) and slowly rotate drive shaft (37) by hand.

(b) Check that bearings turn freely without binding or the feel of flat spots.

(c) Replace damaged bearings.

(11) Inspect armature assembly (13) for gear teeth that are broken, or that show evidence of step wear or root interference.

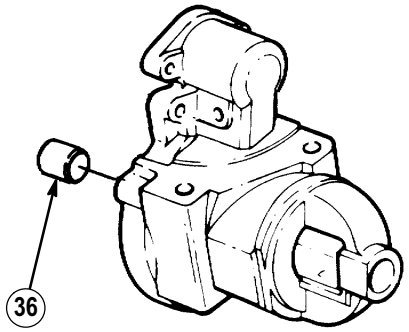
(12) Inspect armature assembly (13) for rough commutator surface. Polish with No. 400 grit polishing cloth if necessary. Thoroughly clean metal dust from between commutator bars. If commutator surface cannot be repaired in this manner, replace armature assembly. Do not turn commutator in a lathe.

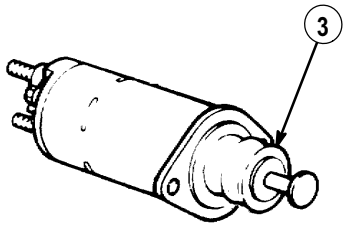
(13) Inspect armature assembly (13) for worn commutator. Replace armature assembly if commutator OD is less than 35 mm (1.378 in.) or if undercut depth at any point is less than 0.2 mm (0.008 in.). Do not undercut insulation.

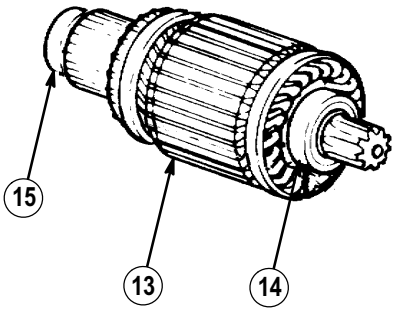
(14) Inspect drive shaft (37) for scored or damaged shaft where it turns in drive end housing bushing. Replace drive shaft if damaged.

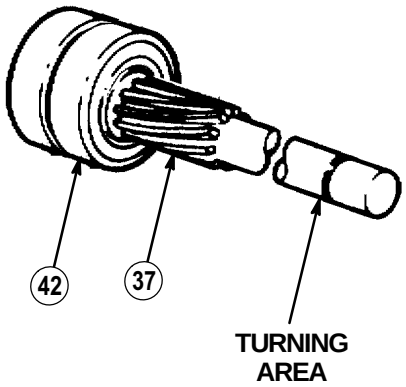
(15) Inspect drive shaft (37) for internal gear with teeth broken or showing evidence of step wear. Replace drive shaft if damaged.

(16) Inspect drive shaft (37) for damaged spline. Clutch drive assembly must slide smoothly and easily over full length of spline. Replace drive shaft if damaged.









f. Component Electrical Testing.

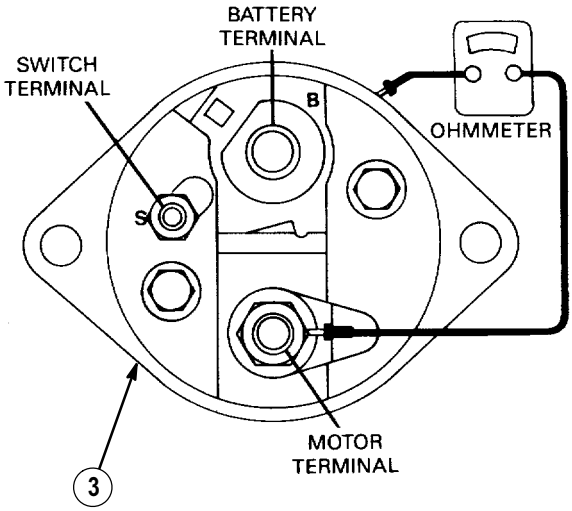
NOTE

Perform the following electrical tests on the solenoid assembly, armature assembly, and frame and field assembly to determine their serviceability.

(1) Check windings of solenoid assembly (3) for continuity as follows:

(a) Check resistance of solenoid pull-in and hold-in windings in series by measuring resistance between motor terminal and solenoid case. Resistance should be approximately 1.75 ohms for 24 volt starters.

(b) An extremely high resistance reading indicates a break or fault in winding continuity. A very low resistance reading indicates a short or ground in the winding circuit. Either condition is cause for replacement of the solenoid assembly (3).



5-23. STARTER MOTOR REPAIR (CONT).

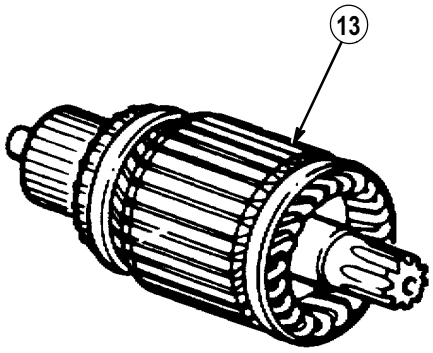
(2) Check armature assembly (13) as follows for shorts, opens or grounds.

(a) Rotate armature in a growler holding a steel strip such as a hacksaw blade against the armature. If a short circuit is present, the steel strip will vibrate in that area.

(b) Check the armature for grounds. There shall be no continuity between the armature shaft and any point on the commutator.

(c) Check for opens by visually inspecting the points where the armature conductors join the commutator. A poor connection often will be indicated by signs of arcing or burning of the commutator.

(d) Replace armatures which are shorted, grounded or show evidence of opens.

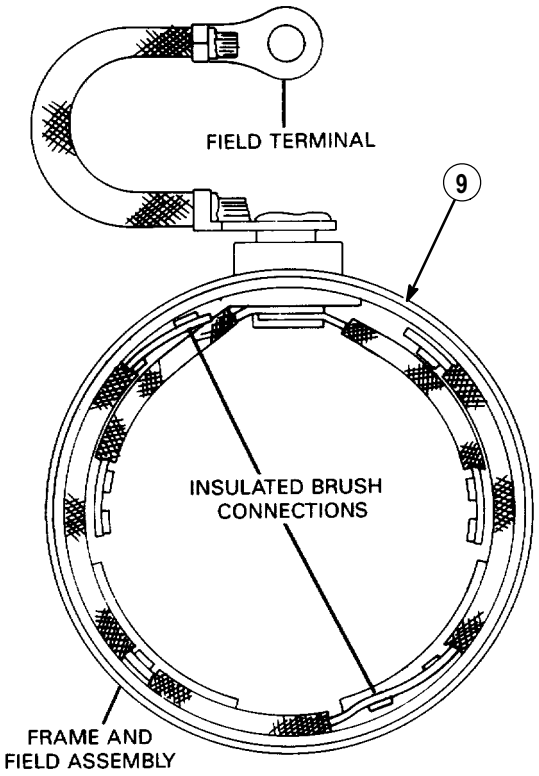


(3) Check frame and field assembly (9) for grounds or opens, as follows:

(a) Check that there is continuity (no opens) between the field terminal that connects to the solenoid, and the connection points for insulated brushes on the field coil straps.

(b) Check that there is no continuity (no grounds) between the frame and the field terminal that connects to the solenoid.

(c) Replace frame and field assemblies that have grounds or opens.



g. Assembly of Drive Shaft and Clutch Group.

(1) If disassembled, position drive shaft (37) on work surface with internal gear end down and assemble drive shaft and clutch group (25), as follows:

CAUTION

Center support bearing is permanently lubricated. Do not add lubricant to this bearing.

NOTE

If center support bearing was removed, perform Step (2) below before proceeding with assembly.

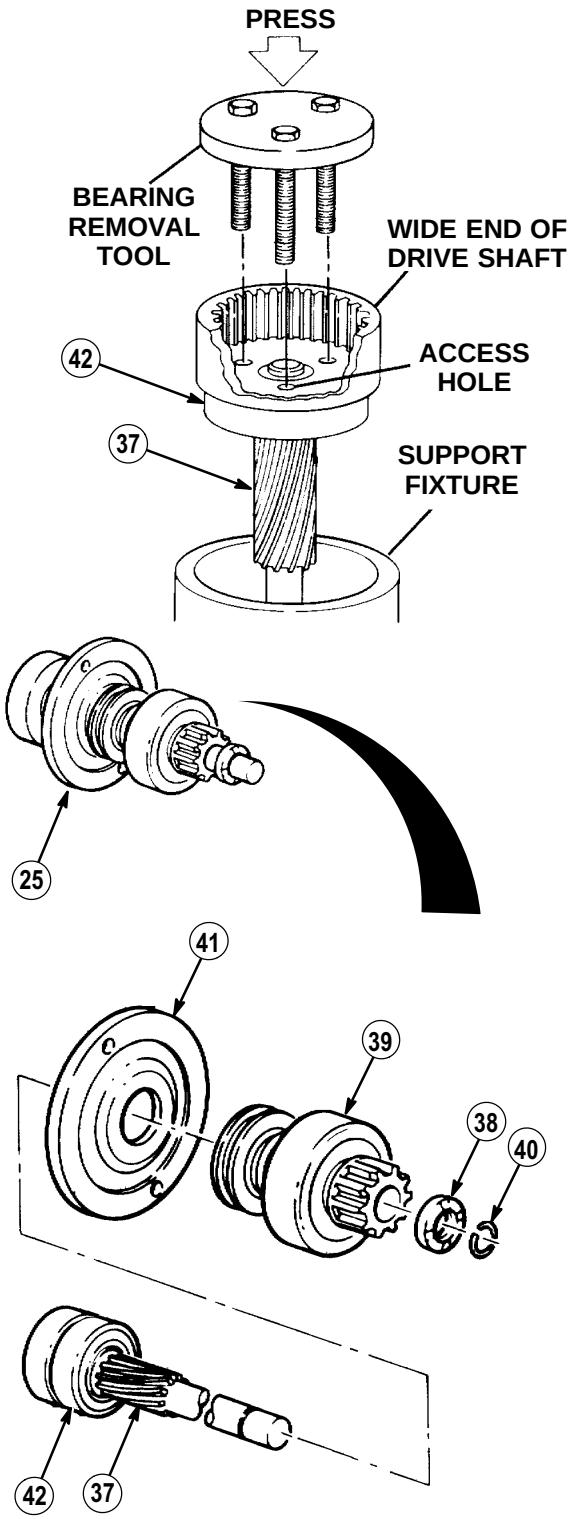
(2) With drive shaft (37) on, in a vise, place bearing removal tool ends through access holes in wide end of drive shaft and squarely press center support bearing (42) off of surface on center shaft.

(3) Install drive shaft support (41) on drive shaft (37), seating the center support bearing (42) into drive shaft support.

(4) Install clutch drive assembly (39) on drive shaft (37).

(5) Slide pinion stop (38) on drive shaft (37) end with the recess for two stop rings (40) face up.

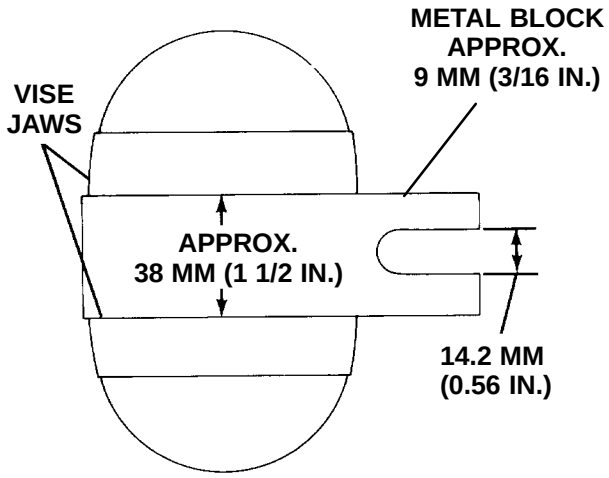
(6) Install two stop rings (40) in groove in drive shaft (37).

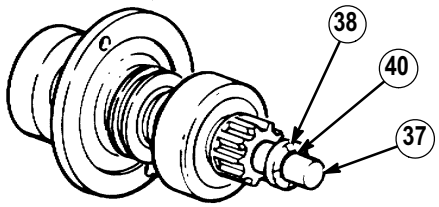


5-23. STARTER MOTOR REPAIR (CONT).

(7) Pick up and support assembly under pinion stop (38). A metal block, with a U-shaped cutout that can slide over drive shaft (37) between pinion gear and stop, can be clamped in a vise to provide support.

(8) Ensure two stop rings (40) (in the drive shaft groove) are fully seated in pinion stop recess and stake upper edge of pinion stop (38) over stop ring (40) in four places, equally spaced. Do not allow staked metal to contact drive shaft (37).





h. Assembly of Gear Reduction and Drive Group.

(1) Using a suitable open tube, press bushing (36) in drive housing (12) until end of bushing is flush with inside of drive housing.

(2) Install plug (35), if used, to drive housing (12). Stake housing material over plug at three equally spaced places.

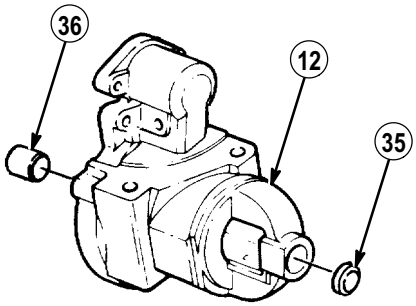
(3) Lubricate the following items before assembly:

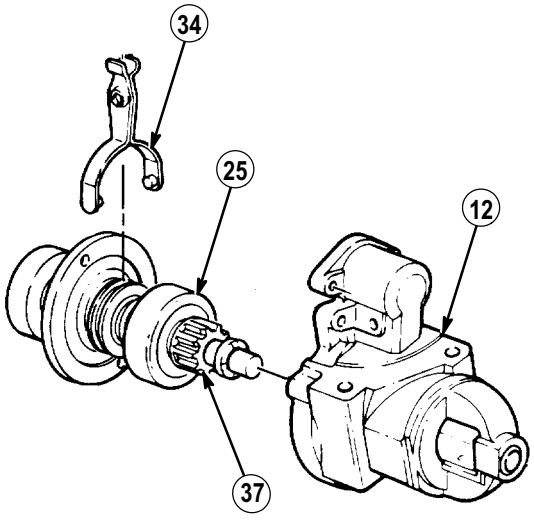
(a) The internal gear, shaft and spline on drive shaft (37). Avoid excessive grease.

(b) The drive end housing bushing (36) in the drive housing. Avoid excessive grease.

(c) The pivot hole and working surface on ends of shift lever (34). Avoid excessive grease.

(4) Install arms of shift lever (34) with shift collar on drive shaft and clutch group (25).





(5) Install assembled shift lever (34) and drive shaft and clutch group (25) in drive housing (12) and align the holes in drive shaft support (41) with those in drive housing.

(6) Ensure drive shaft support (41) is fully seated in drive housing (12) and drive shaft bearing (42) remains fully seated in drive shaft support.

(7) Install shift lever screw (33), shift lever washer (32), and shift lever nut (31). Tighten shift lever nut to 40 lb-in (4.5 N·m).

(8) If used, install plate (30) and drive housing plug (29) in drive housing (12).

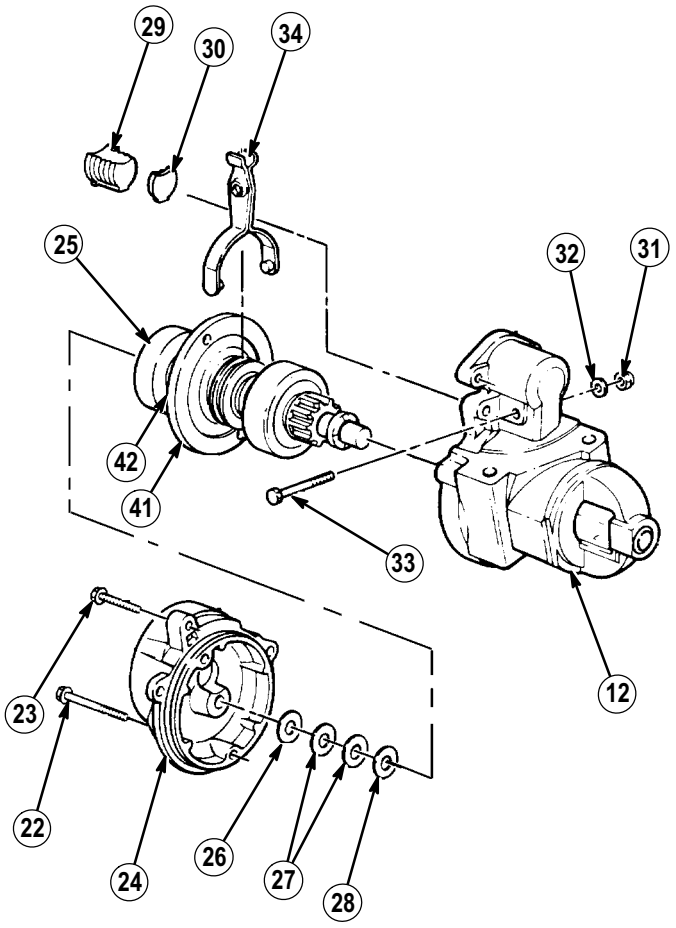
NOTE

Install washers as noted during removal.

(9) Install fiber washer(s) (26), thin washer(s) (27) and thick washer(s) (28).

(10) Install armature support bracket (24) on drive housing (12) and align together using aligning marks made during disassembly.

(11) Secure armature support bracket (24) and drive housing (12) together with long drive housing bolt (22) and short drive housing bolt (23). Tighten long drive housing bolt and short drive housing bolt to 75 lb-in (8.5 N·m).



5-23. STARTER MOTOR REPAIR (CONT).

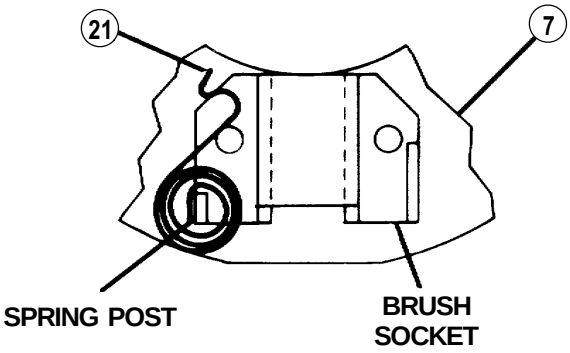
i. Assembly of Brush Holder Group.

(1) Position one brush spring (21), on post on brush holder assembly (7), just enough to hold the inside end of brush spring from turning.

(2) Using needle nose pliers, grasp free end of brush spring (21) and twist clockwise over the tops of the brush socket.

(3) Push brush spring (21) fully on the post and release the free end to engage notch in brush socket.

(4) Repeat Steps (1) through (3) for assembly of second brush spring (21).

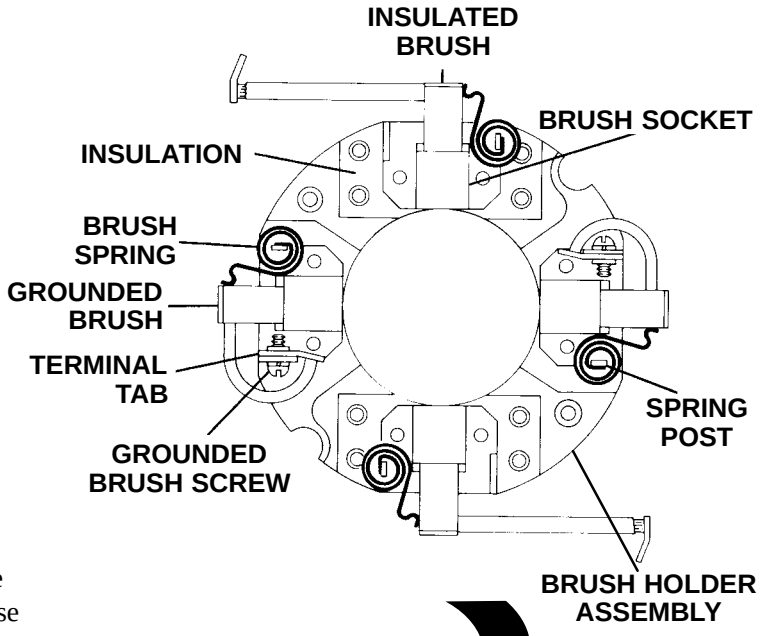


CAUTION

Brush leads may be damaged by excessive handling. Do not over-flex leads near clip welds or clips may break off.

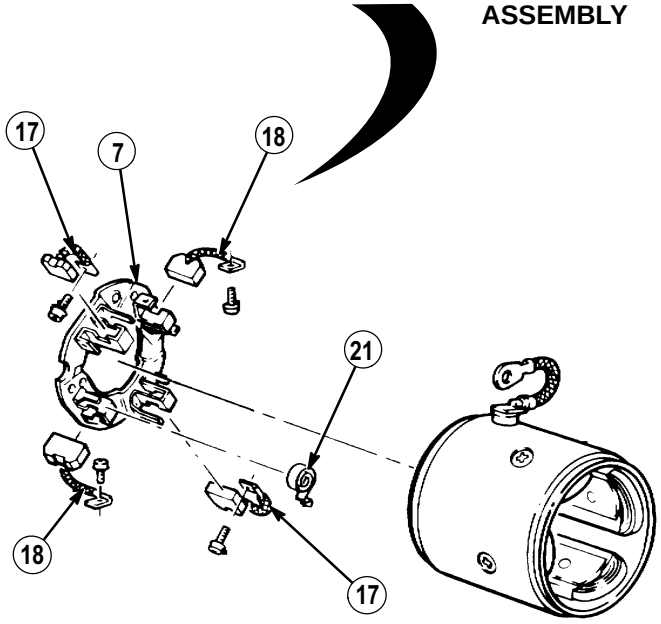
NOTE

Ensure two insulated brushes go in the brush sockets of brush holder assembly that are mounted on the insulation.



(5) Using needle nose pliers, grasp the free end of brush spring (21), twist clockwise to clear the brush socket, and insert grounded brush (17) or insulated brush (18) in brush socket.

(6) Gradually release brush spring (21) until end contacts the side (not the end) of grounded brush (17) or insulated brush (18). This will hold brush retracted until after the brush holder assembly (7) is installed over the armature commutator.



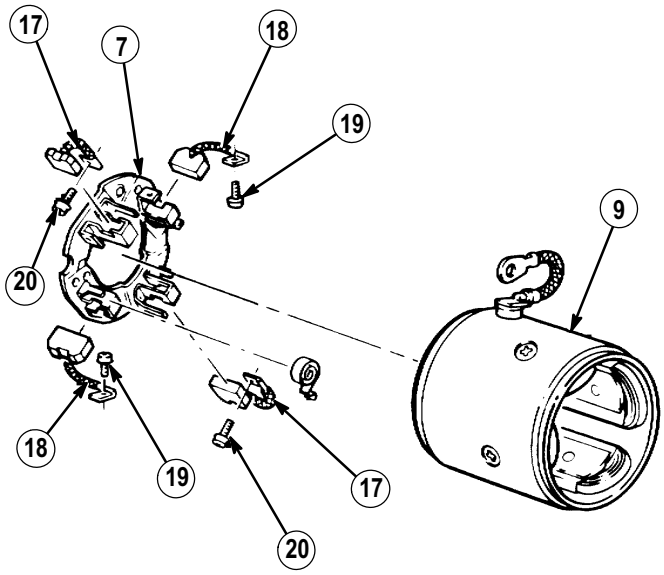
(7) Repeat Steps (5) and (6) until a total of two grounded brushes (17) and two insulated brushes (18) are installed.

(8) Position the terminals of two grounded brush (17) leads behind the terminal tabs on brush holder assembly (7).

(9) Insert two grounded brush screws (20) through the terminal tabs on brush holder assembly (7) and thread into two grounded brush (17) lead terminals. Tighten grounded brush screws to 13 lb-in (1.5 N·m).

(10) Position brush holder assembly (7) (with installed brushes) over terminal end of frame and field assembly (9).

(11) Attach terminals of two insulated brush (18) leads to conductors in frame and field assembly (9) and insert two insulated brush screws (19). Tighten insulated brush screws to 13 lb-in (1.5 N·m).



5-23. STARTER MOTOR REPAIR (CONT).

j. Assembly of Frame and Field Assembly.

NOTE

Prior to performing Step (1), position the assembled gear reduction and drive group with the pinion gear end down.

(1) Using a tube that bears on the bearing inner race only, press on commutator end armature bearing (15) and/or drive end armature bearing (14) until inner race bottoms out against the shoulder on the armature assembly (13) shaft.

(2) Repeat Step (1) until both commutator end armature bearing (15) and drive end armature bearing (14) are installed on armature assembly (13).

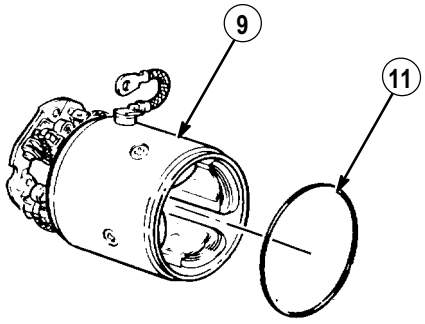
(3) Pivot plunger of solenoid assembly (3) into engagement with shift lever (34).

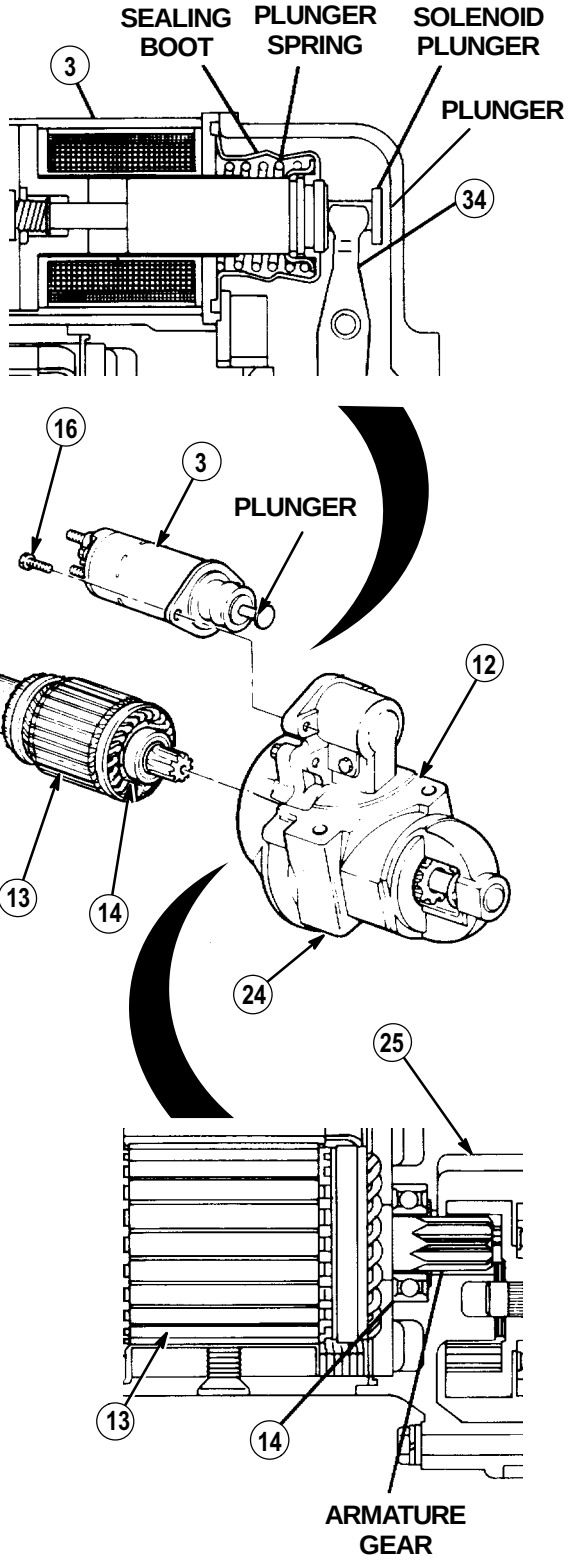
(4) Position solenoid assembly (3) mounting flange and install solenoid screws (16). Tighten solenoid screws to 25 lb-in (2.8 N·m).

(5) Position assembled armature assembly (13) into the drive shaft and clutch group (25).

(6) Align gear teeth, and then seat drive end armature bearing (14) on armature assembly (13) shaft fully in armature support bracket (24).

(7) Install frame seal (11) on front of frame and field assembly (9).



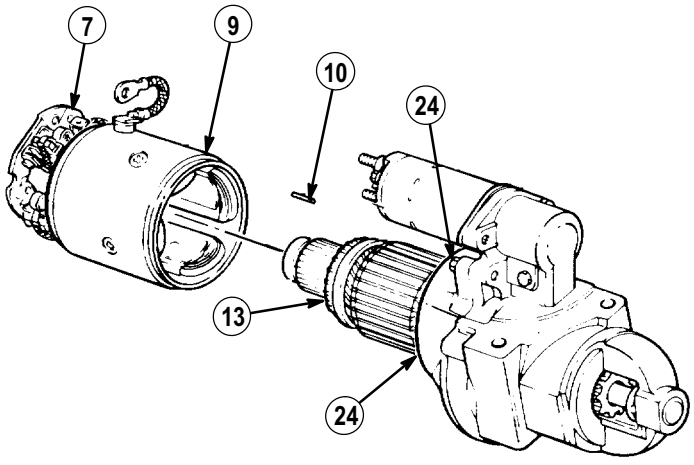


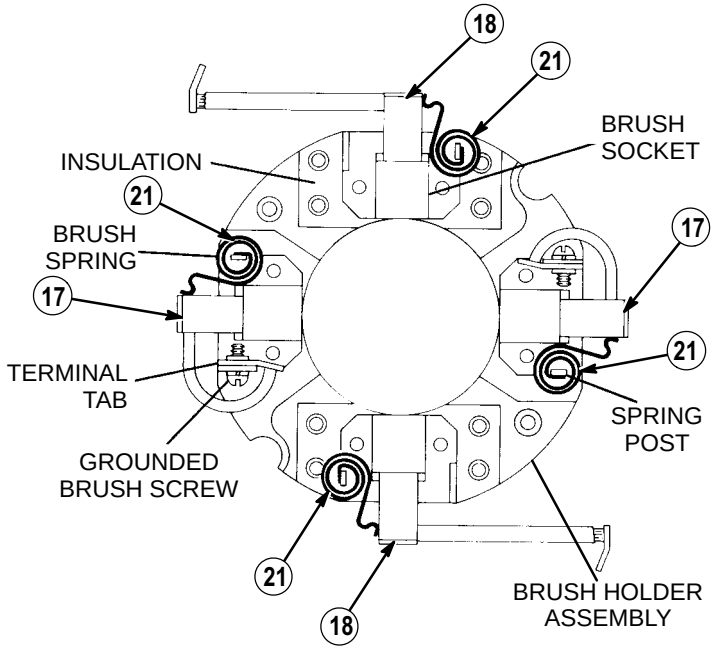
(8) Position dowel pin (10) in hole in armature support bracket (24).

(9) Position assembled frame and field assembly (9) and brush holder assembly (7) over armature assembly (13).

(10) Align hole for dowel pin (10) with marks made prior to disassembly, and seat frame and field assembly (9) and brush holder assembly (7) in armature support bracket (24).

(11) Twist four brush springs (21) away from two grounded brushes (17) and two insulated brushes (18). Slide brushes in until brushes contact commutator on armature assembly (13) and release brush springs to contact ends of brushes.





5-23. STARTER MOTOR REPAIR (CONT).

CAUTION

The preformed packing can easily be damaged during installation of the commutator end frame. To prevent such damage, install preformed packing as described in the following steps.

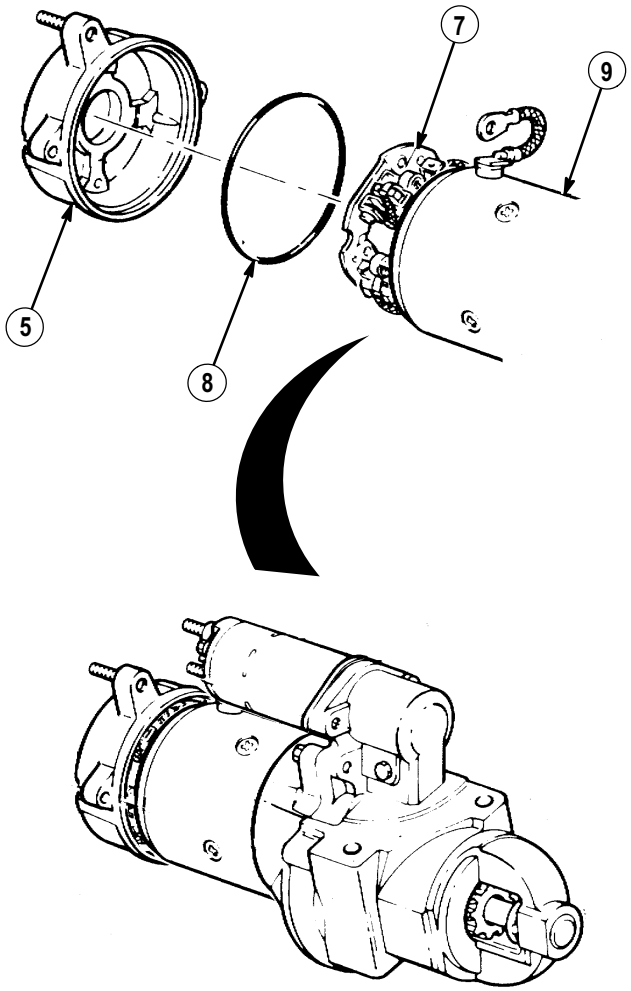
(12) Install preformed packing (8) on frame and field assembly (9).

(13) Carefully roll preformed packing (8) out of its normal installed position up on the major OD of the frame and field assembly (9). Allow preformed packing to remain in this position until commutator end frame (5) is partially installed.

(14) Align marks on commutator end frame (5) and field and frame assembly (9) made prior to disassembly.

(15) Start commutator end frame (5) on frame and field assembly, leaving a gap just slightly larger than the thickness of preformed packing (8).

(16) Using a scribe or similar tool, align tapped holes in brush holder assembly (7) with screw holes in commutator end frame (5).



(17) Install two brush plate screws (6) in commutator end frame (5) and brush holder group (7). Torque two brush plate screws to 25 lb-in (2.8 N·m).

(18) Install two thru bolts (4) in commutator end frame (5). Tighten thru bolts by hand but do not close gap between commutator end frame and frame and field assembly (9) where preformed packing (8) goes.

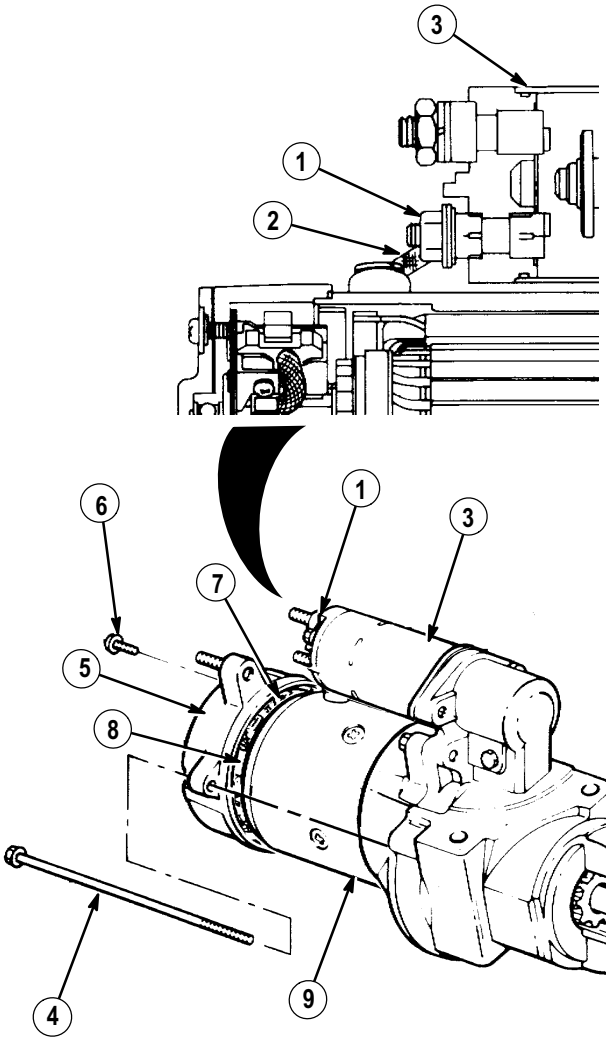
(19) Roll preformed packing (8) back down in its installed position between commutator end frame (5) and the frame and field assembly (9).

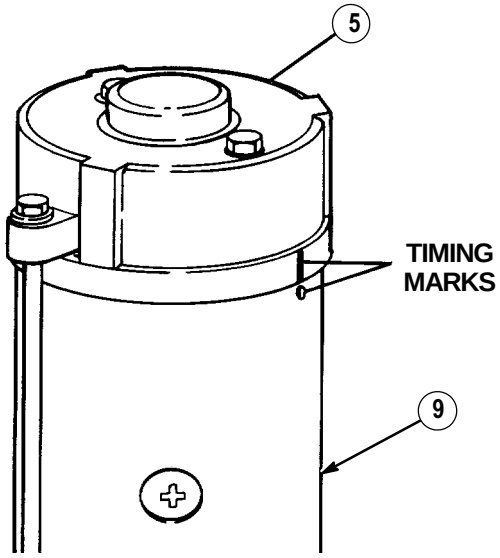
(20) Align timing ribs on edge of commutator end frame (5) with timing spots on frame and field assembly (9) to assure proper brush alignment. Marks are located in two places on motor but will match only one way.

(21) Tighten two thru bolts (4) to 75 lb-in (8.5 N·m).

(22) Remove nut (1) from solenoid assembly (3), install motor lead (2), and reinstall nut (1) onto solenoid assembly (3).

(23) Tighten nut (1) on terminal of solenoid assembly (3) to 100 lb-in (11 N·m).





5-23. STARTER MOTOR REPAIR (CONT).

k. Testing After Repair Or Overhaul.

(1) Connect starter motor for no-load test using suitable instruments, battery cables and connecting wiring as illustrated. Note the following:

(a) Secure starter motor in suitable test stand to check operation.

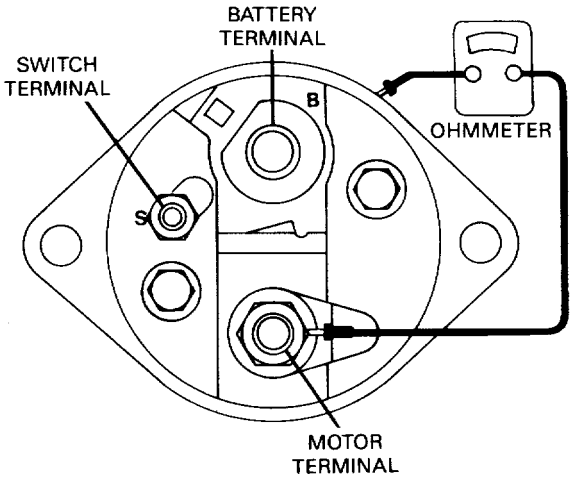
(b) Use a momentary contact, pushbutton switch in test circuit for quick release if very high current surges are encountered.

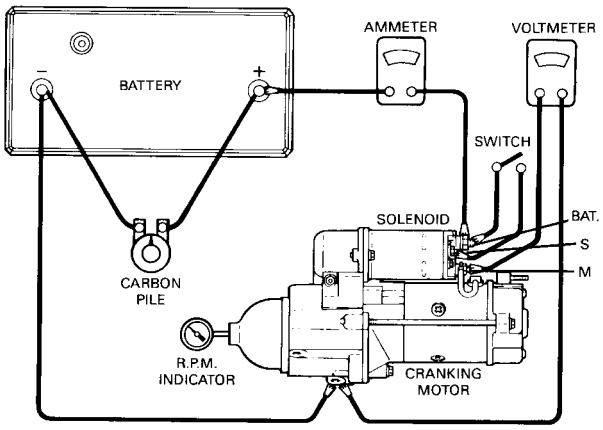
(c) Make all connections or disconnections with switch open and carbon pile load turned off.

(d) If sparking or current flow in the battery circuit is noted when making connections, the starter motor solenoid switch contacts may be frozen shut (refer to Troubleshooting).

(e) As the last step in making the test connection, ground the negative battery cable securely to a clean metal ground on starter motor frame

(f) The carbon pile load is used to adjust operating voltage for comparison with specifications. It may not be necessary in all cases but should be used to eliminate the need for interpolation of test data.





NO LOAD TEST (INCLUDES SOLENOID CURRENT) SPECIFICATIONS				
VOLTS	MIN AMPS	MAX. AMPS	MIN. RPM	MAX. RPM
20	75	90	360	5400

SOLENOID (CURRENT CONSUMPTION)					
PULL-IN WINDING			HOLD-IN WINDING		
AMPS	VOLTS	OHMS	AMPS	VOLTS	OHMS
100-125	20	0.16-0.20	12-14	20	1.45-1.65

WARNING

Keep fingers and tools away from opening in drive end housing while testing. The strong shifting action of the solenoid could cause personal injury as the drive pinion moves into the cranking position and spins. Failure to comply may cause injury to personnel.

CAUTION

During no-load test, close switch and operate starter motor for cycles of 30 seconds maximum. Between cycles, allow starter motor to cool for at least two minutes. Otherwise, overheating and damage to the starter motor may result.

(2) Momentarily close switch.

(a) If there is high current flow and starter motor fails to operate (zero rpm), release switch immediately. Internal mechanical damage is indicated. Discontinue test and refer to Troubleshooting.

(b) If there is no current flow and starter motor fails to operate (zero rpm), release switch immediately. An open circuit is indicated. Discontinue test and refer to Troubleshooting.

(c) If there is current flow and starter motor operates, release switch and proceed with the next step of the no-load test.

(3) Close switch and observe voltmeter. Adjust carbon pile load to obtain 10 volt reading (20 volts on 24-volt starter motor). Observe and record ammeter and RPM readings. Release switch.

(4) Compare ammeter and RPM readings to those listed under “Specifications” at the end of this manual. If the readings are outside the limits shown, refer to Troubleshooting to determine the most likely causes. If the readings are within the limits, the starter motor is operating normally.

END OF TASK

5-24. GENERATOR ELECTRONIC CIRCUIT CARD (ECC) REPLACEMENT.

This task covers:

a. Removal b. Installation c. Follow-On Maintenance

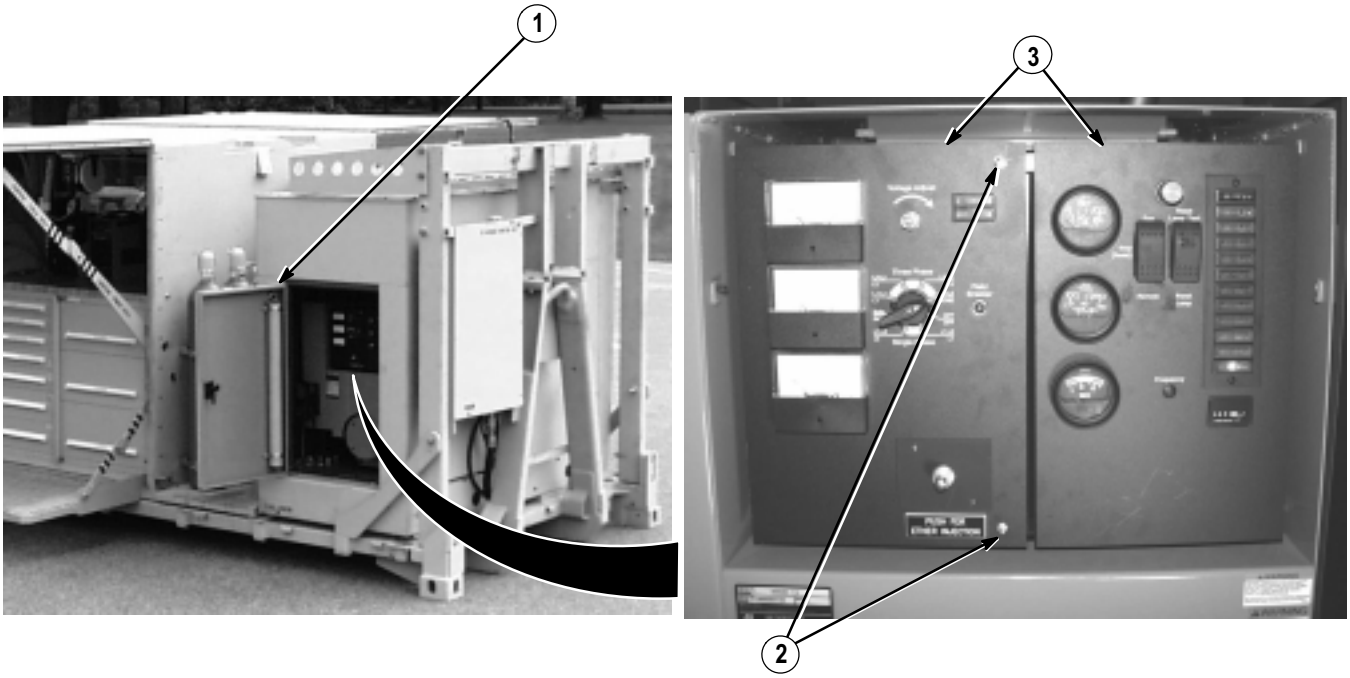
INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Tags, Identification (Item 36, Appendix B)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
Batteries disconnected, (TM 9-4940-568-10)

a. Removal.



NOTE

This procedure applies to the DC panel circuit card and the AC panel circuit card. The DC panel circuit card is shown.

(1) Open generator panel door (1).

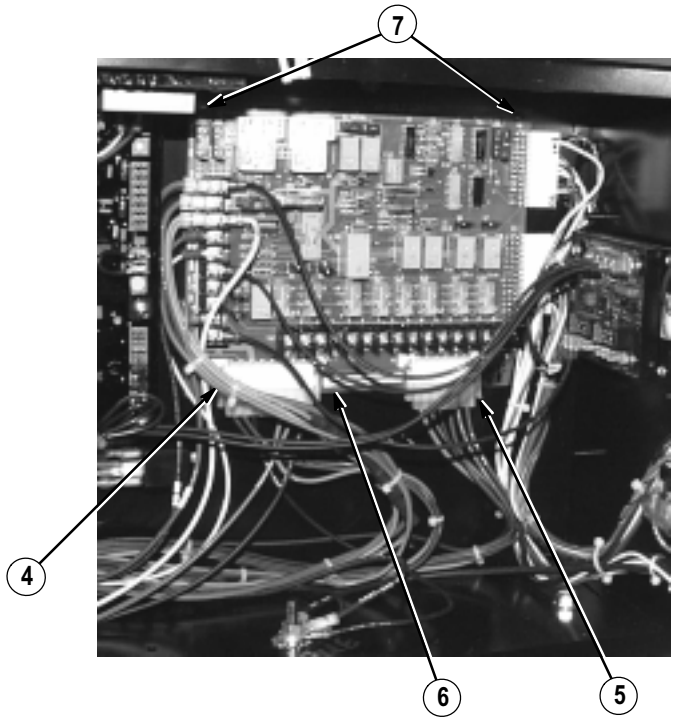
(2) Unlock panel screws (2) and open instrument panel doors (3).

NOTE

Tag and mark all wires and connectors prior to removal.

(3) Remove all wires (4) and connectors (5) from circuit card (6).

(4) Remove four screws (7) and circuit card (6).



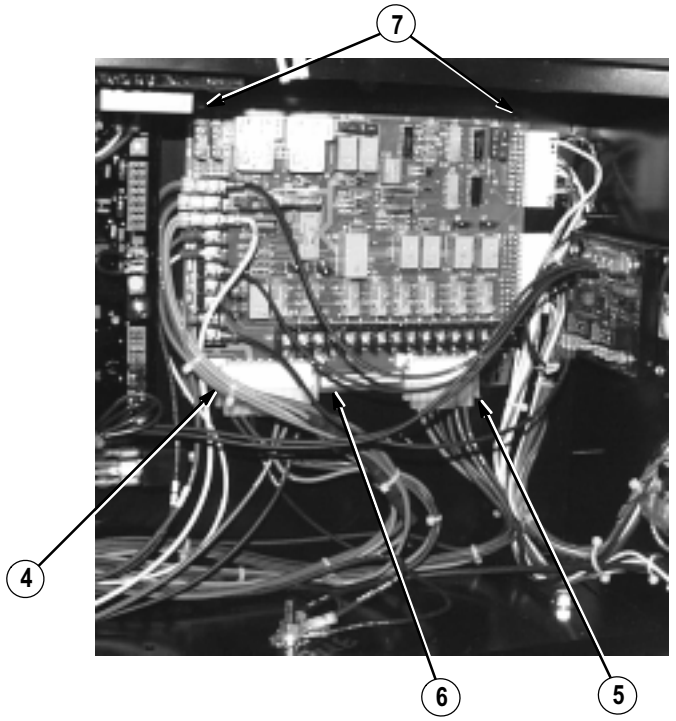
b. Installation.

(1) Install circuit card (6) and four screws (7).

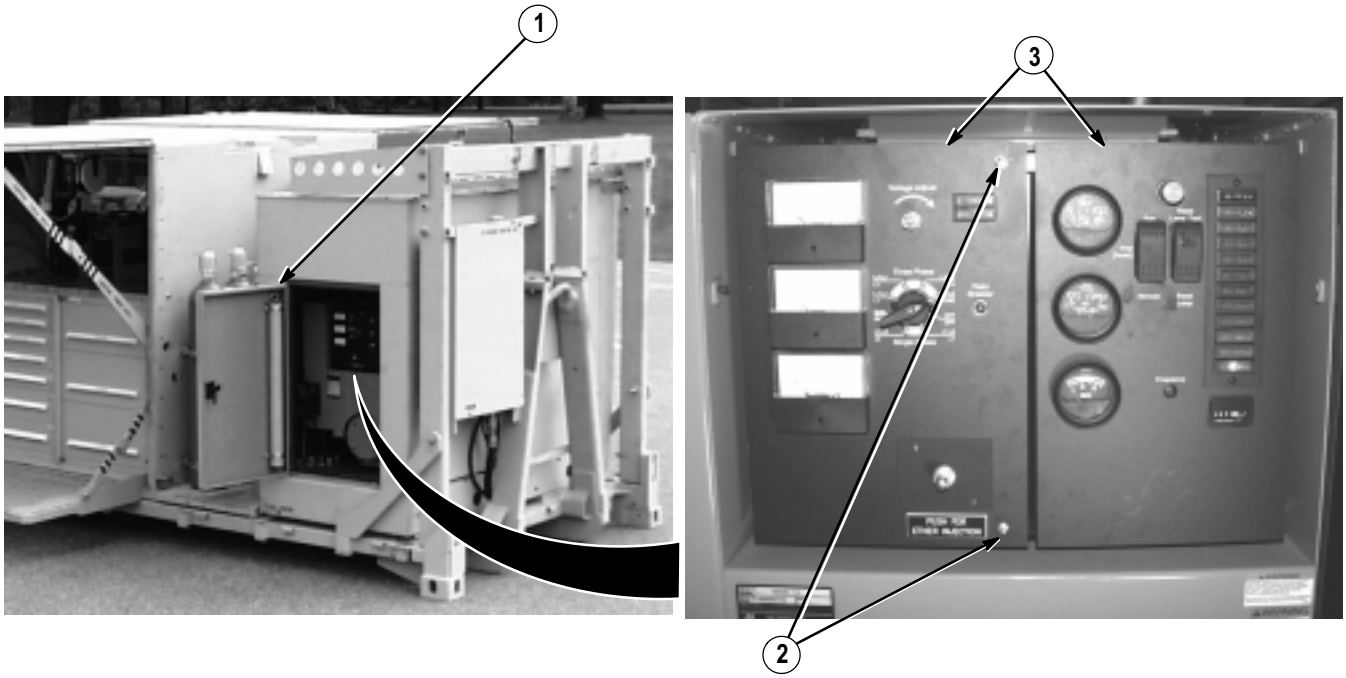
NOTE

Ensure all wires and connectors are connected as noted during removal.

(2) Connect all wires (4) and connectors (5) to circuit card (6).



5-24. GENERATOR ELECTRONIC CIRCUIT CARD (ECC) REPLACEMENT (CONT).



(3) Close instrument panel doors (3) and lock panel screws (2).

(4) Close generator control panel (1).

c. Follow-On Maintenance:

- Connect batteries, (TM 9-4940-568-10).
- Start generator and check for proper operation, (TM 9-4940-568-10).

END OF TASK

5-25. GENERATOR VOLTAGE REGULATOR CARD (VR21) REPLACEMENT.

This task covers:

a. Removal b. Installation c. Follow-On Maintenance

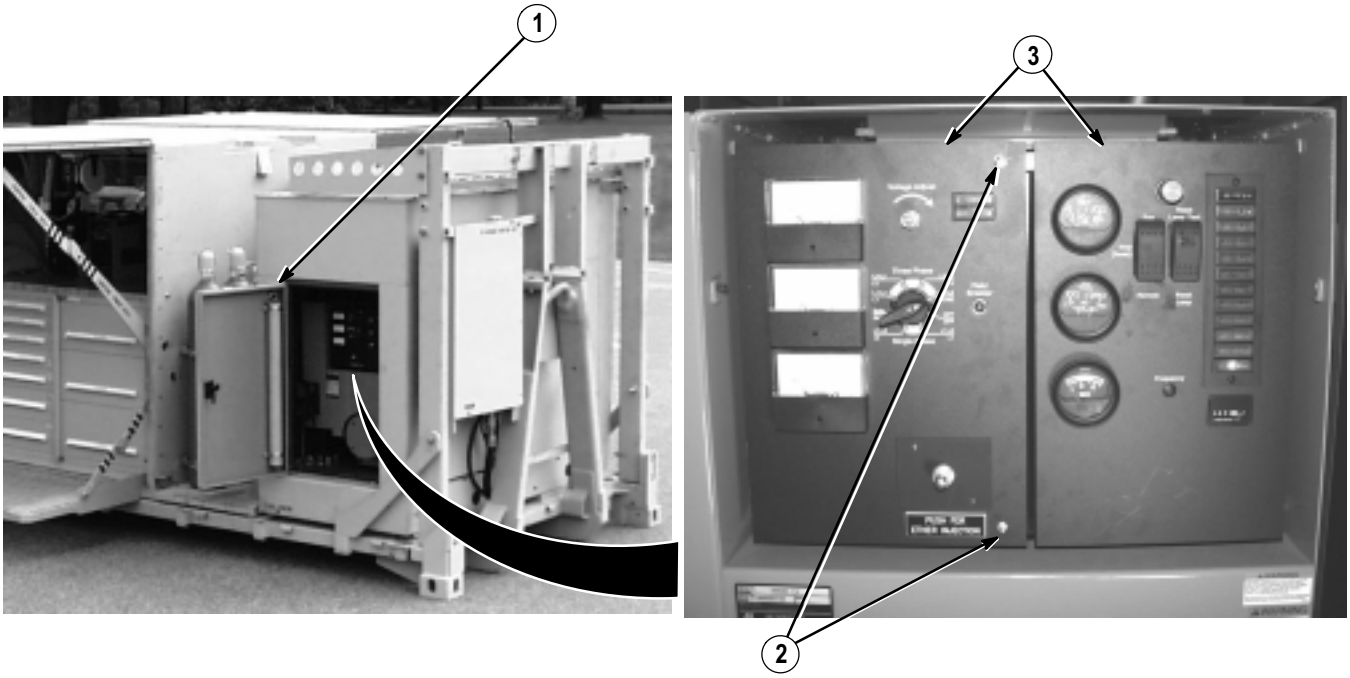
INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Tags, Identification (Item 36, Appendix B)

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
Batteries disconnected, (TM 9-4940-568-10)

a. Removal.



(1) Open generator panel door (1).

(2) Unlock panel screws (2) and open instrument panel doors (3).

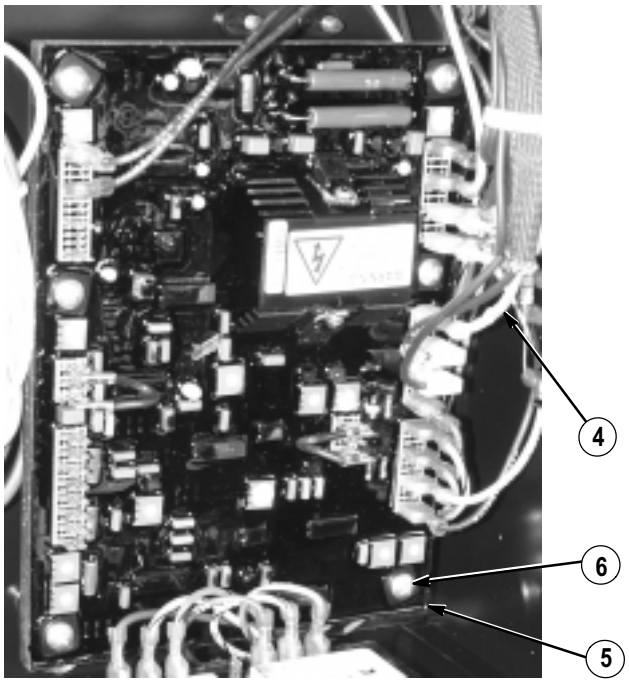
5-24. GENERATOR VOLTAGE REGULATOR CARD (VR21) REPLACEMENT (CONT).

NOTE

Tag and mark all wires and connectors prior to removal.

(3) Remove all wires (4) from circuit card (5).

(4) Remove six screws (6) and circuit card (5).



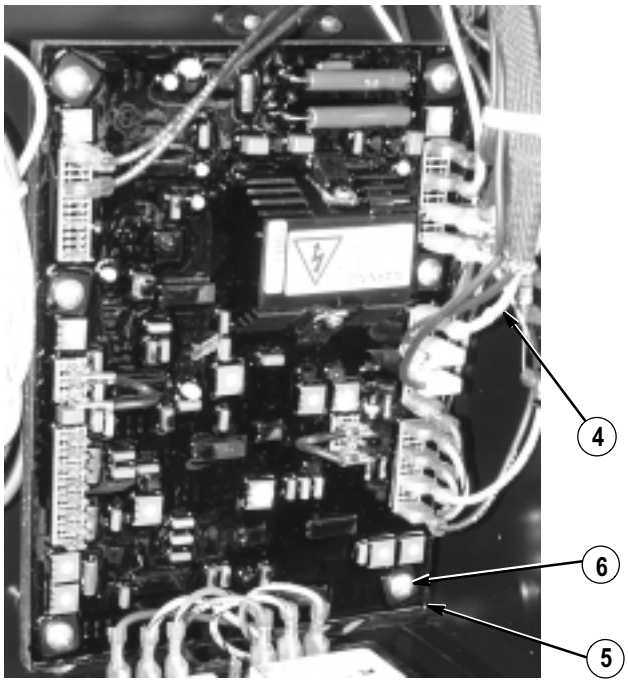
b. Installation.

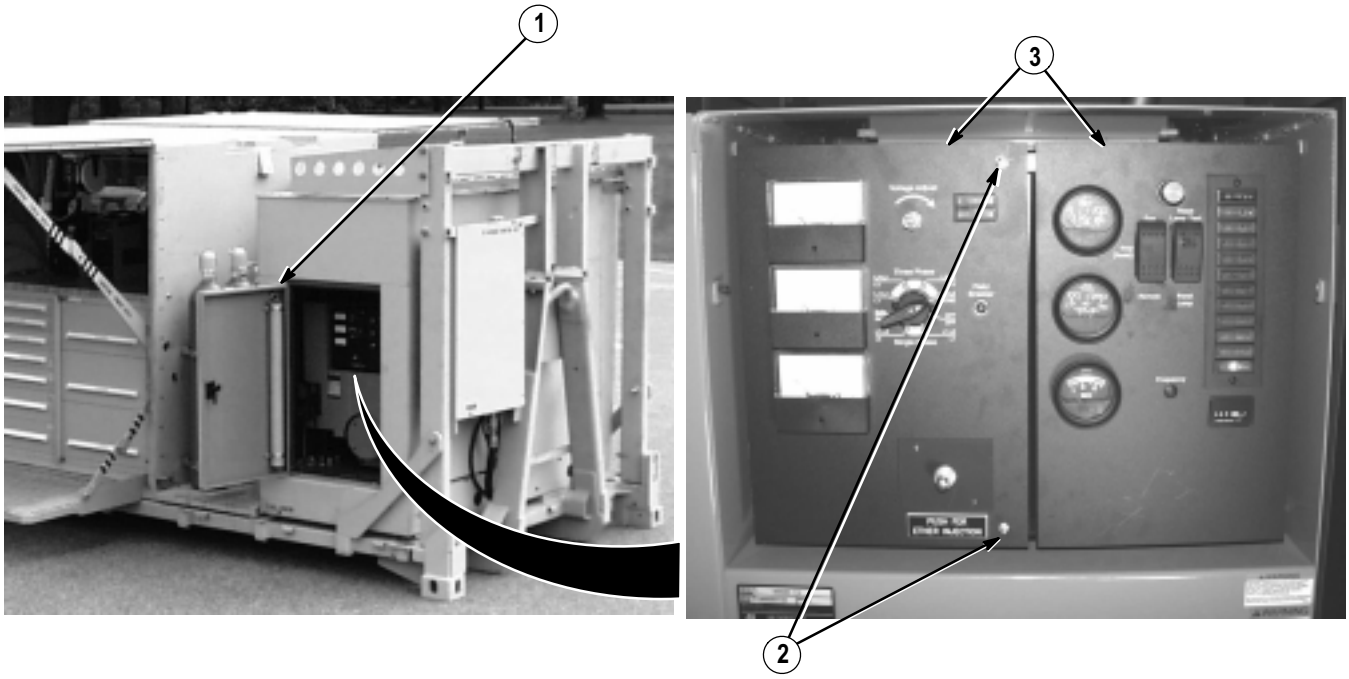
(1) Install circuit card (5) and six screws (6).

NOTE

Ensure all wires and connectors are connected as noted during removal.

(2) Connect all wires (4) to circuit card (5).





(3) Close instrument panel doors (3) and lock panel screws (2).

(4) Close generator control panel (1).

c. Follow-On Maintenance:

- Connect batteries, (TM 9-4940-568-10).
- Start generator and check for proper operation, (TM 9-4940-568-10).

END OF TASK

CHAPTER 6
GENERAL SUPPORT CRANE MAINTENANCE

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6-5	Swing Drive Brake Repair	6-20
6-6	Swing Drive Assembly Repair	6-22
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6-1. INTRODUCTION.

This chapter contains maintenance instructions for removing, replacing, repairing, installing and adjusting components authorized by the Maintenance Allocation Chart (MAC) at the General Support Maintenance level.

6-2. OUTRIGGER EXTENSION CYLINDER REPAIR

THIS TASK COVERS:
a. Disassembly
b. Cleaning/Inspection
c. Assembly

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)
Pan, drain (Item 42, Appendix F)
Spanner wrench set (Item 82, Appendix F)

Materials/Parts
Crocus cloth (Item 11, Appendix B)
Emery cloth (Item 12, Appendix B)
Grease, lithium (Item 13, Appendix B)
Hydraulic oil (Item 16, Appendix B)
Sealing compound (Item 29, Appendix B)
Seal kit (Item 156, Appendix E)
Setscrew (Item 162, Appendix E)

Equipment Condition
Outrigger extension cylinder beam removed (para 3-8).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

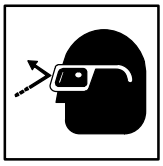
---

a. Disassembly

(1) With help from assistant, position extension cylinder (1) in soft jawed vise using rubber stripping to protect cylinder surface.

(2) Position drain pan under extension cylinder (1).

WARNING



Oil will spray from cylinder manifold ports when rod is moved in or out. Cover ports with two cloths to prevent oil from spraying. Failure to comply may result in injury to personnel.

CAUTION

Do not allow threaded or machined surfaces to come in contact with other metal surfaces. Clearances between cylinder components are very small. Any minor damage done during disassembly could require component replacement or make assembly difficult.

(3) Remove setscrew (2) from retaining head (3). Discard setscrew.

WARNING

Use extreme care to avoid being scalded or burned when heating retaining head (3). Use heavy rag or gloves to protect hands.

(4) Heat retaining head (3) to loosen sealing compound and, using a spanner wrench, remove retaining head (3) from extension cylinder (1).

(5) Remove wiper ring (4) from retaining head (3). Discard wiper ring.

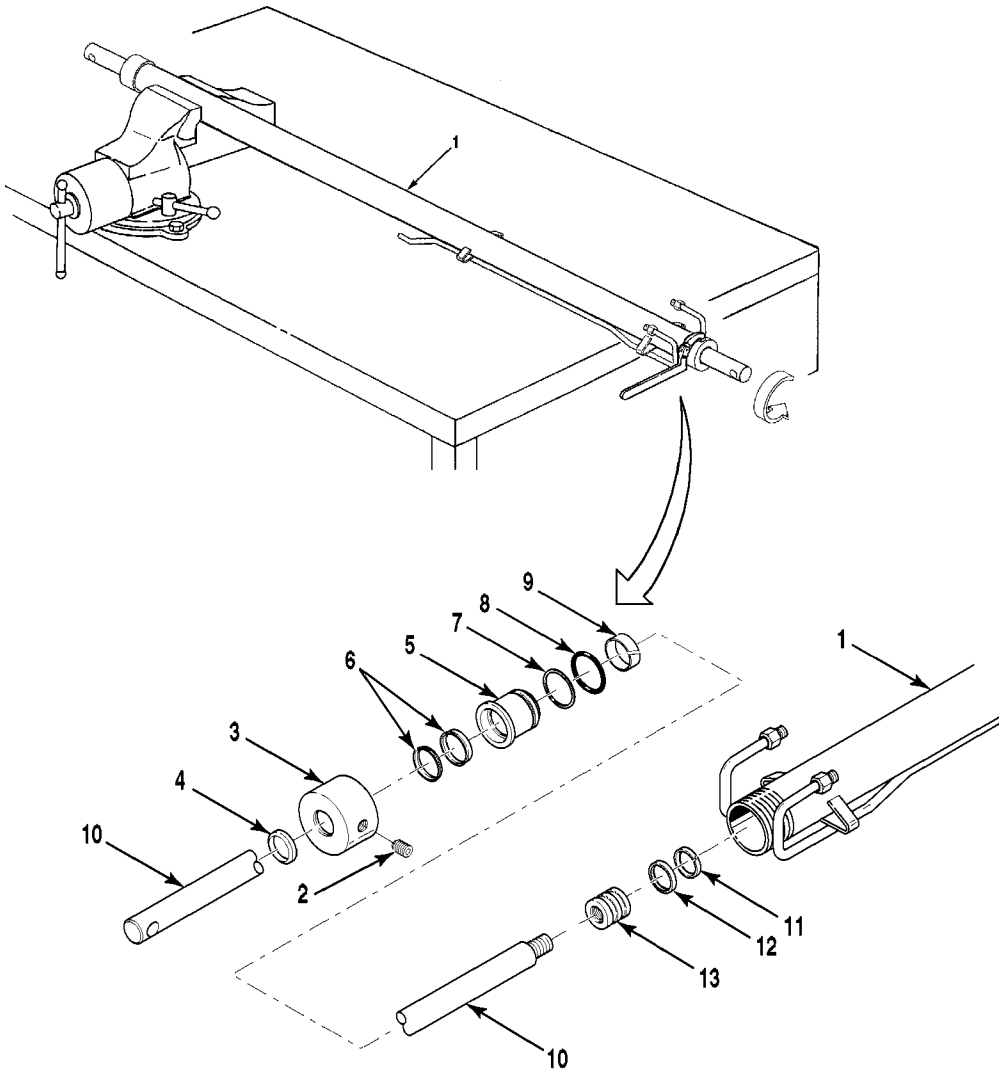
(6) Remove cylinder head (5) from extension cylinder (1).

(7) Remove rod seal (6), backup ring (7), preformed packing (8), and wear ring (9) from cylinder head (5). Discard rod seal, backup ring, preformed packing and wear ring.

(8) Remove cylinder rod (10) from extension cylinder (1).

(9) Remove seal (11) and wear ring (12) from cylinder rod (10). Discard seal and wear ring.

(10) Repeat steps (3 thru 9) for other end of extension cylinder.



6-2. OUTRIGGER EXTENSION CYLINDER REPAIR (Continued)

b. Cleaning/Inspection

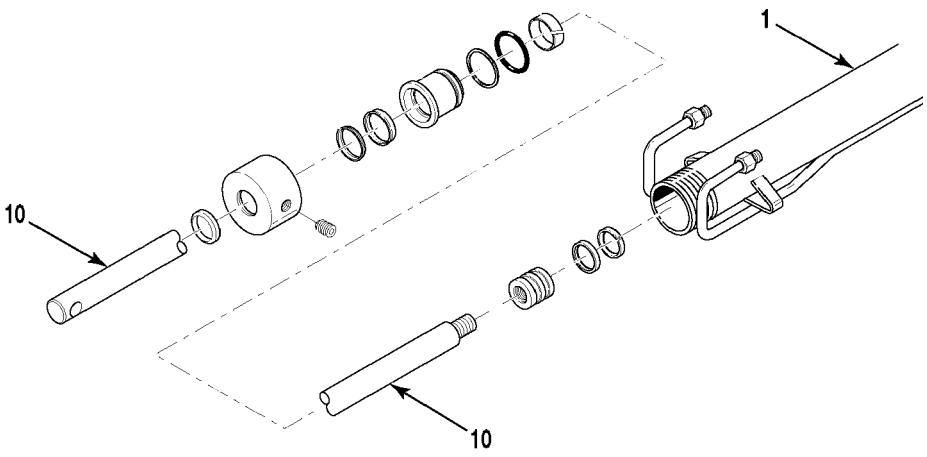
(1) Clean all parts.

(2) Inspect cylinder rod (10) and inner surface of extension cylinder (1) for nicks, scratches, gouging, pits, rust, or corrosion. Clean any minor nicks, scratches, gouges, pits, rust, or corrosion with crocus cloth and fine emery cloth.

(3) Nicks, scratches, gouges, pits, rust, or corrosion that are too deep to be cleaned with crocus cloth will limit or prevent use of cylinder.

(4) Inspect cylinder rod (10) and extension cylinder barrel (1) for trueness.

(5) Replace all parts failing inspection.



c. Assembly

NOTE

Lubricate seal with clean hydraulic oil.

(1) Install wear ring (12) and seal (11) on cylinder rod (10).

(2) Apply grease to seal (12).

(3) Install cylinder rod (10) in extension cylinder (1).

(4) Install wear ring (9), backup ring (7), and preformed packing (8) on cylinder head (5).

(5) Apply grease to wear ring (9), backup ring (7), and preformed packing (8).

(6) Apply grease to rod seal (6).

(7) Install cylinder head (5) and rod seal (6) on extension cylinder (1).

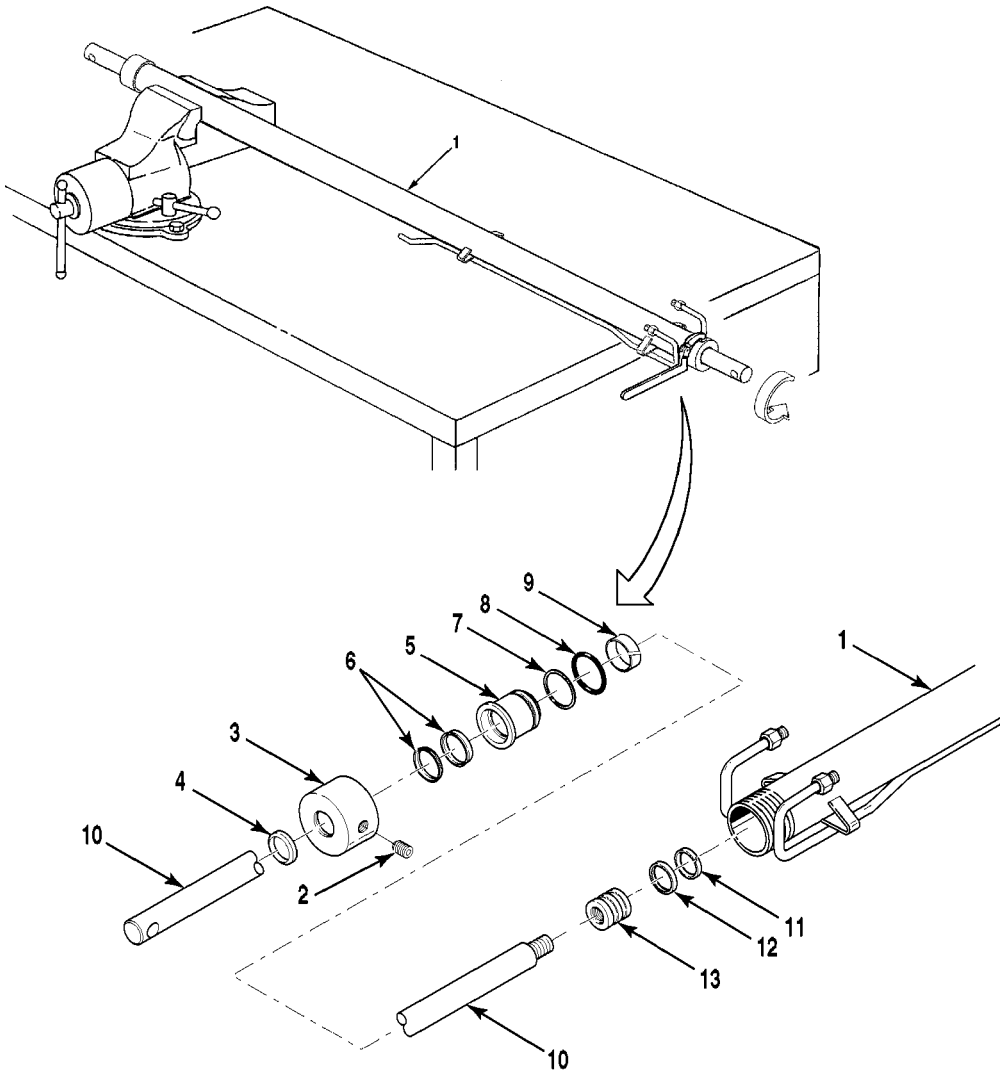
(8) Install wiper ring (4) in retaining head (3).

(9) Apply grease to wiper ring (4).

(10) Apply sealing compound to threads of extension cylinder (1) and install retaining head (3). Use a spanner wrench to tighten retaining head (3).

(11) Install setscrew (2) in retaining head (3).

(12) Repeat steps (1 thru 11) for other end of extension cylinder (1).



6-2. OUTRIGGER EXTENSION CYLINDER REPAIR (Continued)

Follow-On Maintenance

Install extension cylinder (para 3-8).

Check crane for proper operation and hydraulic leaks, (TM 9-4940-568-10).

END OF TASK

6-3. JACK CYLINDER REPAIR

THIS TASK COVERS:
a. Disassembly
b. Cleaning/Inspection
c. Assembly

INITIAL SETUP

Special Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)
Caps, vise jaw (Item 90, Appendix F)
Compressor unit, air (Item 10, Appendix F)
Gloves, chemical oil protective
(Item 23, Appendix F)
Goggles, industrial (Item 25, Appendix F)
Gun, airblow (Item 29, Appendix F)
Pan, drain 6 gal (Item 42, Appendix F)
Tags, identification (Item 60, Appendix F)
Vise, machinist's (Item 72, Appendix F)
Vise, pipe, chain (Item 91, Appendix F)
Wrench, torque (0-175 lb-ft [0-237 N·m])
(Item 83, Appendix F)
Wooden blocks (2) (Appendix C)

Materials/Parts
Oil, hydraulic (Item 16, Appendix B)
Sealing compound (Item 29, Appendix B)
Setscrew (Item 163, Appendix E)
Solvent, drycleaning (Item 34, Appendix B)
Repair kit (Item 33, Appendix E)
Repair kit (Item 35, Appendix E)

Personnel Required
1 Assistant

Equipment Condition
Jack cylinder removed (Para 3-9).

Jack cylinder on clean work surface.

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

6-3. JACK CYLINDER REPAIR (Continued)

a. Disassembly

NOTE

- Left and right hand outrigger cylinders are disassembled the same way.
- Position drain pan under cylinder.

(1) Remove plug (1) and preformed packing (2) from cylinder rod (3). Discard preformed packing.

NOTE

Tag and mark all valves prior to removal.

(2) Remove check valve (4) and preformed packing (5) from cylinder rod (3). Discard preformed packing.

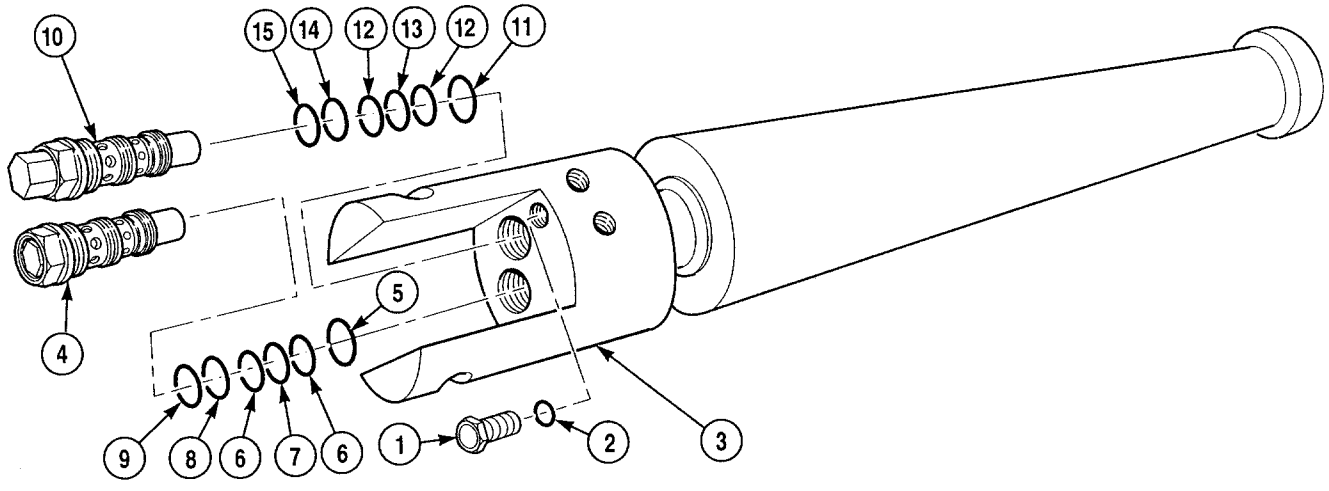
(3) Remove two backup rings (6) and preformed packing (7) from check valve (4). Discard preformed packing and backup rings.

(4) Remove backup ring (8) and preformed packing (9) from check valve (4). Discard preformed packing and backup ring.

(5) Remove cartridge holding valve (10) and preformed packing (11) from cylinder rod (3). Discard preformed packing.

(6) Remove two backup rings (12) and preformed packing (13) from cartridge holding valve (10). Discard preformed packing and backup rings.

(7) Remove preformed packing (14) and backup ring (15) from cartridge holding valve (10). Discard preformed packing and backup ring.



(8) Remove setscrew (16) from cylinder barrel (17).

CAUTION

Cylinder must not be dented when held in vise, or leakage and improper operation may result.

(9) Place cylinder barrel (17) in chain vise with wooden blocks.

(10) Remove wear ring (18) from cylinder head (19). Discard split ring.

NOTE

Cylinder head is threaded.

(11) With the aid of an assistant, pull cylinder rod (3) out of cylinder barrel (17). Allow hydraulic fluid to drain into drain pan.

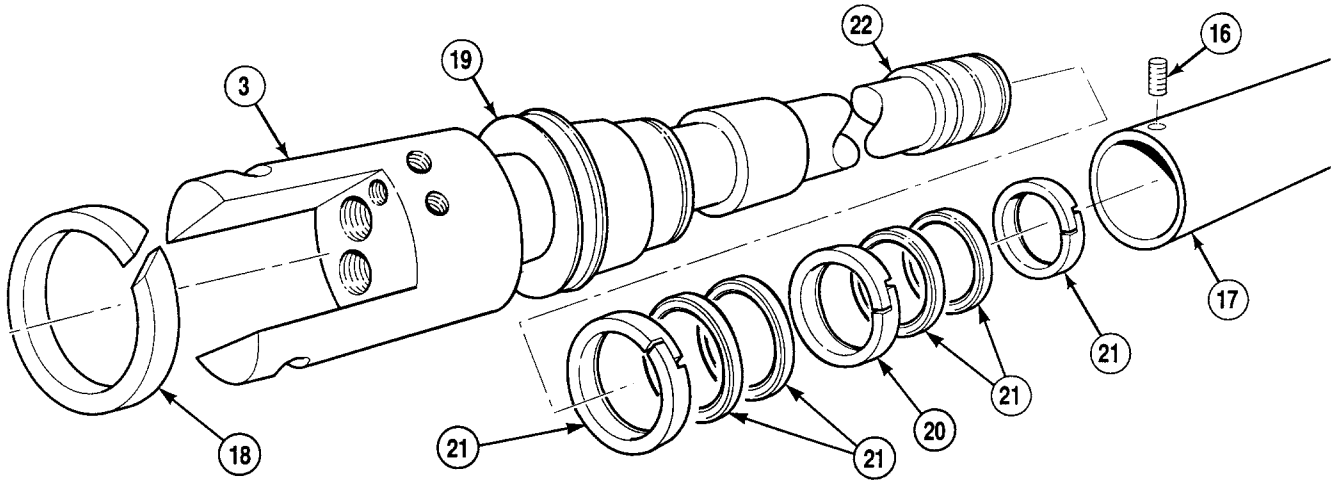
(12) Remove cylinder head (19) and cylinder rod (3) from cylinder barrel (17).

(13) Remove cylinder head (19) from cylinder rod (3).

NOTE

Note position of seal assemblies and ring.

(14) Turn cylinder rod (3) around and remove two seal assemblies (21) and ring (20) from piston (22). Discard seal assemblies and ring.



6-3. JACK CYLINDER REPAIR (Continued)

(15) Remove setscrew (23), and piston (22) from cylinder rod (3).

(16) Remove backup ring (29), preformed packing (30) and backup ring (29) from piston (22). Discard preformed packing and backup rings.

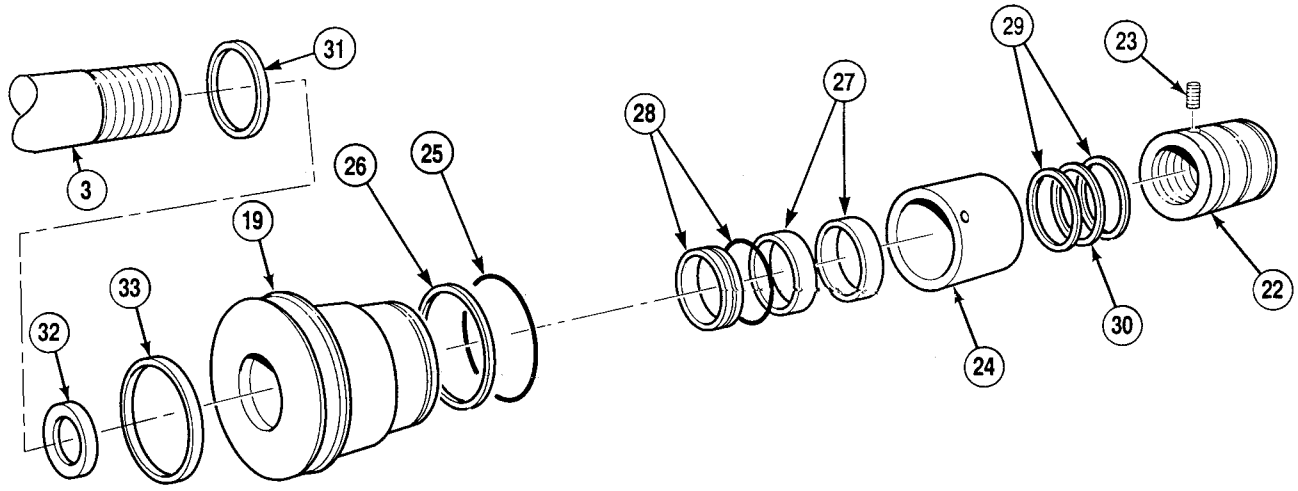
(17) Remove spacer (24) from cylinder rod (3).

(18) Remove cylinder head (19) from cylinder rod (3).

(19) Remove preformed packing (25) and backup ring (26) from outside of cylinder head (19). Discard preformed packing and backup ring.

(20) Remove two wear rings (27) and buffer seal assembly (28) from inside cylinder head (19). Discard seal and wear rings.

(21) Remove wiper ring (31), seal (32) and ring (33) from inside cylinder head (19).



b. Cleaning/Inspection

WARNING

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles, face shield, and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes, and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent. The flashpoint for Type II Drycleaning Solvent is 140 degrees F (60 degrees C) and Type III Drycleaning Solvent is 200 degrees F (93 degrees C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc). Failure to comply may result in injury to personnel.

(1) Clean all metal parts in drycleaning solvent.

(2) Dry all metal parts with compressed air.

(3) Inspect each part for cracks, bends, gouges and stripped threads.

(4) Replace damaged parts.

6-3. JACK CYLINDER REPAIR (Continued)

c. Assembly

NOTE

Both outrigger cylinders are assembled the same way.

(1) Apply hydraulic oil to buffer seal assembly (28) and two wear rings (27) and install in cylinder head (19).

(2) Apply hydraulic oil to backup ring (26) and preformed packing (25) and install on outside of cylinder head (19).

(3) Install cylinder head (19) on cylinder rod (3).

(4) Install spacer (24) with drilled hole facing threaded end of cylinder rod (3).

(5) Install piston (22) on cylinder rod (3).

(6) Install cylinder rod (3) in vise with soft jaws.

(7) Tighten piston (22) on cylinder rod (3) until setscrew holes are aligned.

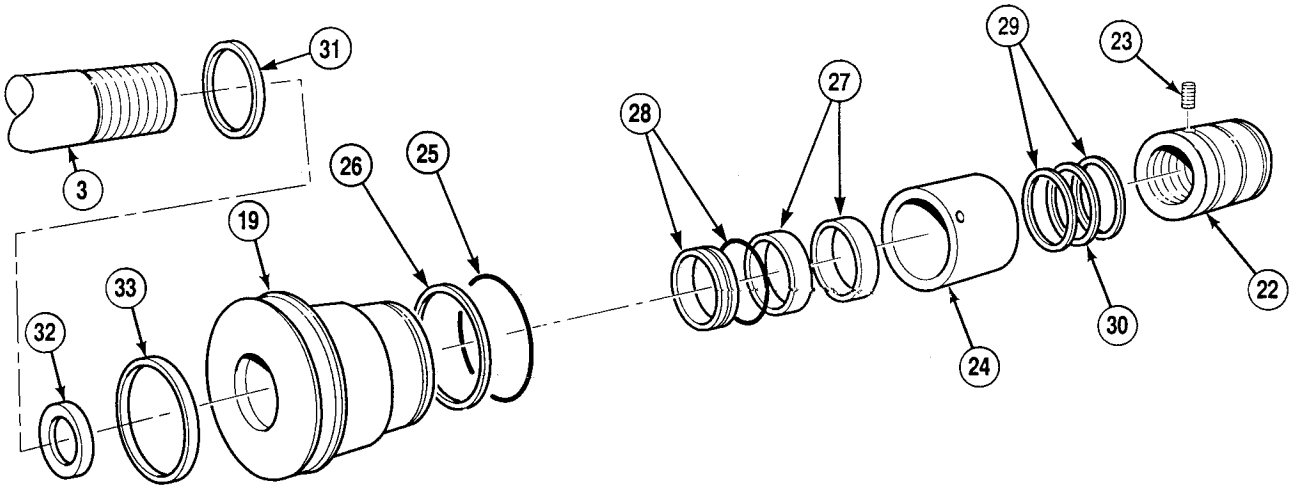
WARNING

Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

(8) Apply sealing compound on threads of setscrew (23).

(9) Install setscrew (23) in piston (22).

(10) Apply hydraulic oil to backup ring (29), preformed packing (30) and backup ring (29) and install on piston (22).



NOTE

Install seal assemblies and ring as noted prior to removal.

(11) Apply hydraulic oil to seal assemblies (21) and ring (20) and install on piston (22).

(12) Place cylinder barrel (17) in chain vise with wooden blocks.

(13) Install cylinder rod (3) in cylinder barrel (17).

(14) Turn cylinder head (19) on cylinder rod (3) until setscrew holes are aligned.

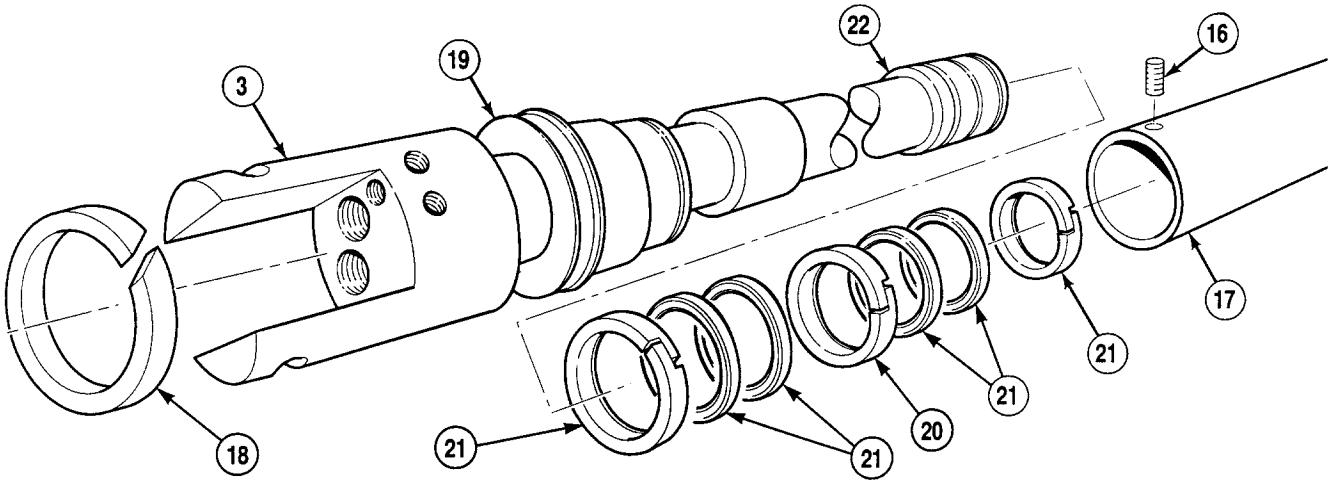
WARNING

Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

(15) Apply sealing compound on threads of setscrew (16).

(16) Install setscrew (16) in cylinder barrel (17).

(17) Install wear ring (18) on cylinder barrel (17).



6-3. JACK CYLINDER REPAIR (Continued)

(18) Apply hydraulic oil to backup ring (15) and preformed packing (14) and install on holding valve (10).

(19) Apply hydraulic oil to preformed packing (13) and two backup rings (12) and install on holding valve (10).

(20) Apply hydraulic oil to preformed packing (11) and holding valve (10) and install on cylinder rod (3) side marked “P”.

(21) Tighten holding valve (10) to 50 to 55 lb-ft (68 to 75 N·m).

(22) Apply hydraulic oil to preformed packing (9) and backup ring (8) and install on check valve (4).

(23) Apply hydraulic oil to preformed packing (7) and two backup rings (6) and install on check valve (4).

(24) Apply hydraulic oil to preformed packing (5) and check valve (4) and install on cylinder rod (3).

(25) Apply hydraulic oil to preformed packing (2).

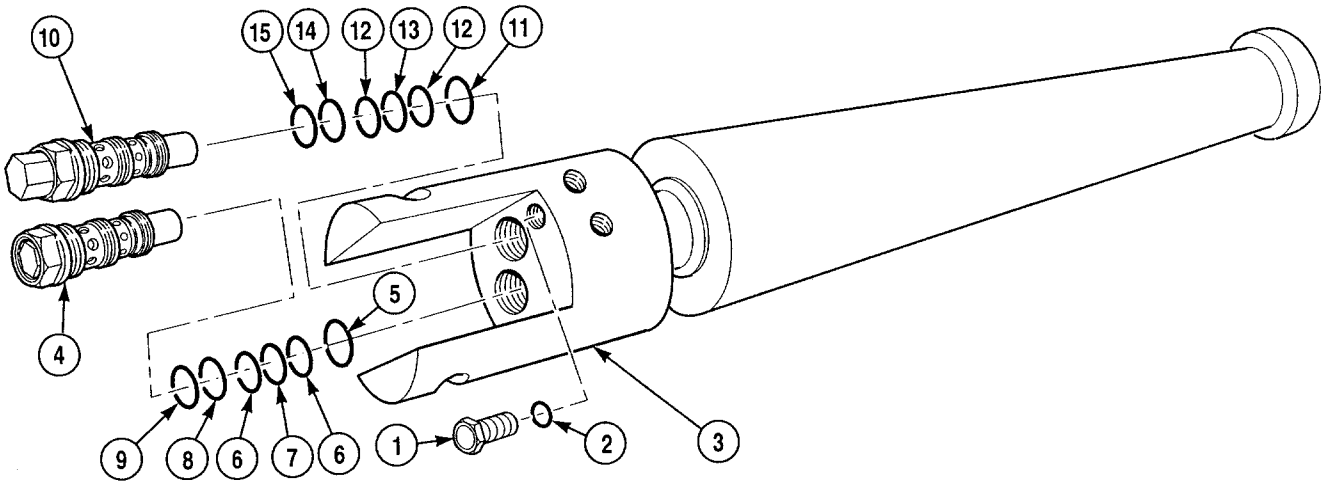
(26) Install preformed packing (2) and plug (1) on cylinder rod (3).

END OF TASK

Follow-On Maintenance

Jack cylinder installed (Para 3-9).

Check crane for proper operation and hydraulic leaks, (TM 9-4940-568-10).



6-4. SWING DRIVE ORBIT MOTOR REPAIR

THIS TASK COVERS:
a. Disassembly
b. Cleaning/Inspection
c. Assembly

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Hydraulic oil (Item 16, Appendix B)
Sealing compound (Item 29, Appendix B)
Screw (7) (Item 145, Appendix E)
Packing, preformed (3) (Item 108, Appendix E)
Packing, preformed (Item 110, Appendix E)
Repair kit (Item 136, Appendix E)
Seal kit (Item 155, Appendix E)

Equipment Condition
Swing drive orbit motor removed.
(para 3-12).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

---

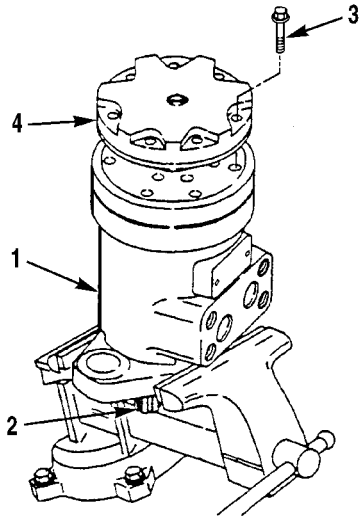
a. Disassembly

CAUTION

Use vise jaw caps to protect edge of motor housing flange when placed in vise. Failure to comply may result in damage to equipment.

(1) Place motor housing (1) in vise with output shaft (2) down.

(2) Remove seven screws (3) and end cap (4) from motor housing (1). Discard screws.



6-4. SWING DRIVE ORBIT MOTOR REPAIR (Continued)

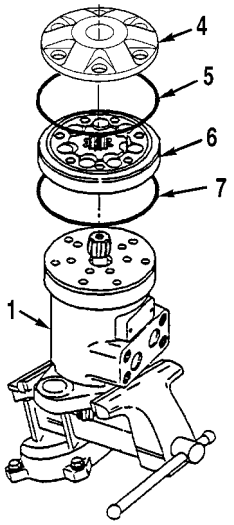
(3) Remove seal (5) from end cap (4). Discard seal.

CAUTION

Geroter is a two piece assembly. Use care when removing geroter. Do not allow parts to separate. Failure to comply may result in damage to equipment.

(4) Remove geroter (6) from motor housing (1).

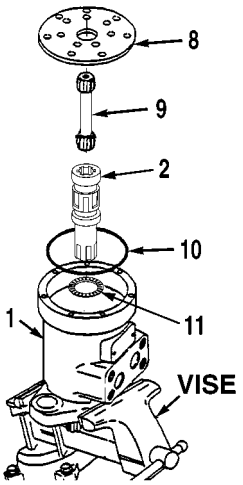
(5) Remove seal (7) from geroter (6). Discard seal.



(6) Remove spacer plate (8) from motor housing (1).

(7) Remove drive gear shaft (9) from motor housing (1).

(8) Remove preformed packing (10) from motor housing (1). Discard preformed packing.



(9) Remove output shaft (2) from motor housing (1).

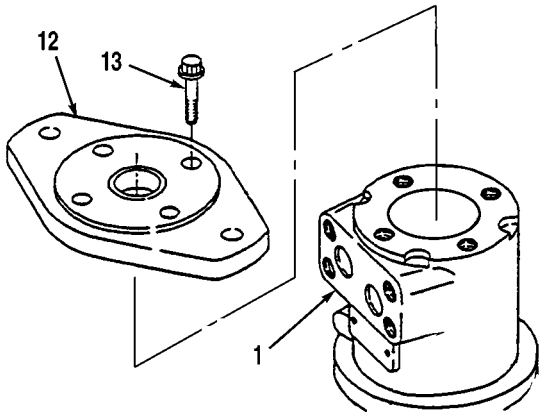
(10) Remove needle thrust bearing (11) from motor housing (1).

(11) Reposition motor housing (1) in vise with flange (12) facing up.

(12) Heat up four screws (13) to loosen sealing compound.

(13) Remove four screws (13) from motor housing flange (12).

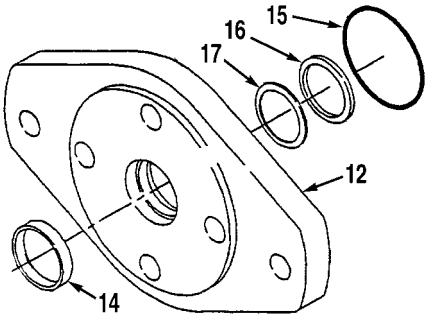
(14) Remove motor housing flange (12) from motor housing (1).



NOTE

Note position of seals prior to removal.

(15) Remove seal (14), seal (15), seal (16), and backup washer (17) from motor housing flange (12). Discard seals and backup washer.



(16) Remove bearing race (18) from motor housing (1).

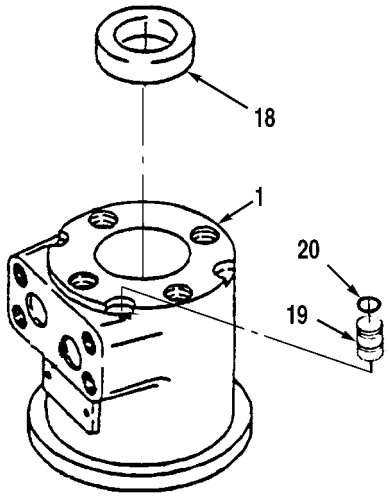
NOTE

Plug (19) may be pushed out from oil port hole.

(17) Remove plug (19) from motor housing (1).

(18) Remove preformed packing (20) from plug (19). Discard preformed packing.

(19) Remove motor housing (1) from vise.



b. Cleaning/Inspection

(1) Clean all parts.

(2) Inspect motor housing (1) and motor housing flange (12) for cracks or damage.

(3) Inspect all other parts. Replace all parts failing inspection.

c. Assembly

NOTE

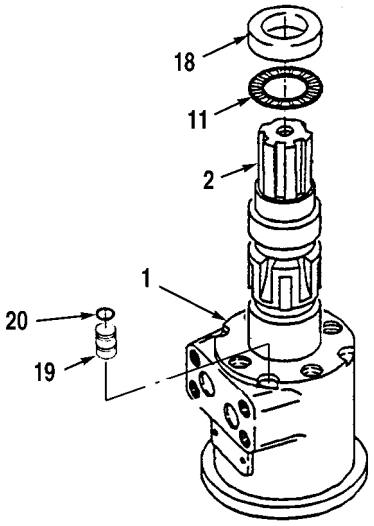
Lubricate all parts with clean hydraulic oil.

(1) Install output shaft (2) in motor housing (1).

(2) Install needle thrust bearing (11), then bearing race (18) on shaft (2). Pull shaft (2) partially out of housing (1). Push all three parts in housing (1) together.

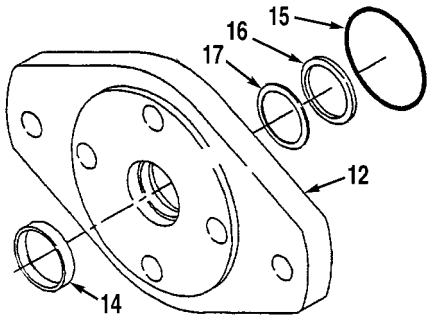
(3) Install preformed packing (20) on plug (19).

(4) Install plug (19) in motor housing (1).



(5) Install backup washer (17), seal (16), and seal (15) in motor housing flange (12).

(6) Install seal (14) in motor housing flange (12).



6-4. SWING DRIVE ORBIT MOTOR REPAIR (Continued)

(7) Install motor housing (1) in vise with output shaft (2) up.

(8) Apply tape over splined area of output shaft (2).

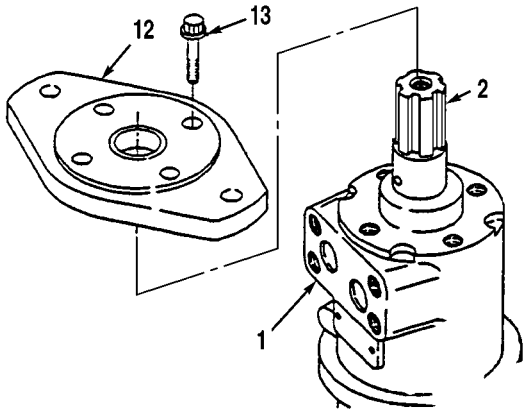
(9) Apply sealing compound to four screws (13).

(10) Position motor housing flange (12) on output shaft (2) with four screws (13).

CAUTION

Tighten screws in a crisscross pattern to properly seat motor housing flange. Failure to comply may result in damage to equipment.

(11) Tighten four screws (13) to 21 lb-ft (28 N·m).



(12) Reposition motor housing (1) in vise with output shaft (2) down.

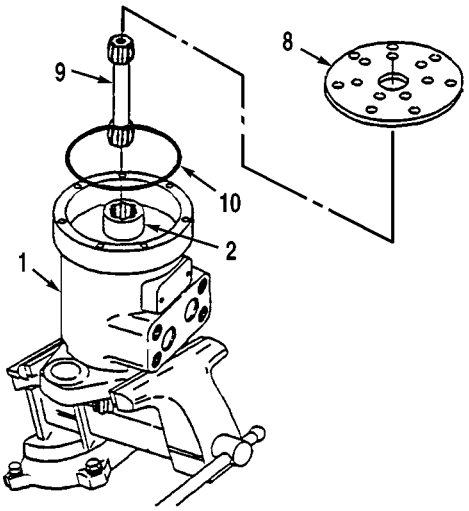
(13) Fill output shaft cavity with clean hydraulic oil.

(14) Install seal (10) on motor housing (1).

(15) Position drive gear shaft (9) in output shaft (2).

(16) Use felt tip marker to mark one drive tooth and drive gear shaft (9). Aline this tooth with timing dot on output shaft (2).

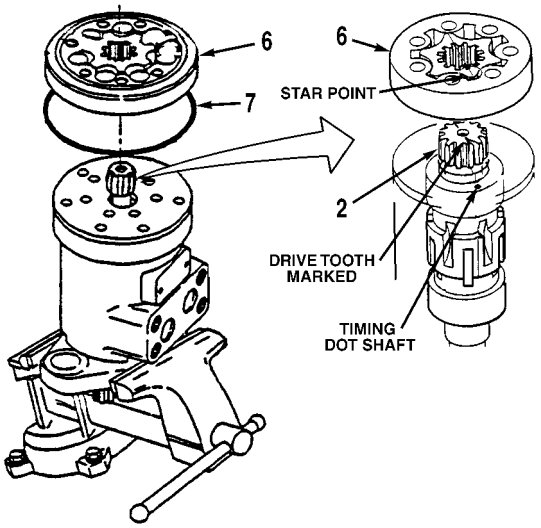
(17) Install spacer plate (8) on motor housing (1).



(18) Install preformed packing (7) on geroter (6).

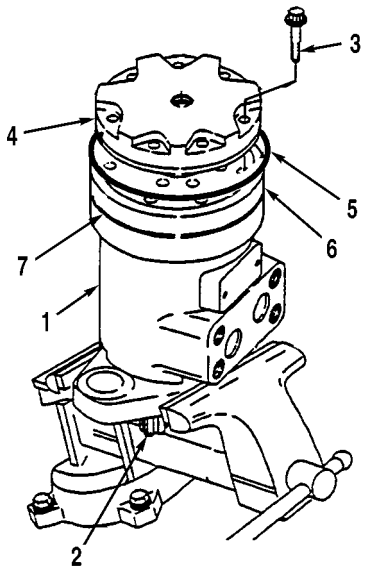
(19) Install geroter (6) on output shaft (2) alining any star point to tooth marked in step (16).

(20) Rotate geroter (6) to line up with bolt holes. Be careful not to disengage star from drive or disturb geroter seal.



(21) Install seal (5) on end cap (4).

(22) Position end cap (4) on geroter (6) with seven screws (3).



CAUTION

Tighten screws in a crisscross pattern to properly seat end cap. Failure to comply may result in damage to equipment.

(23) Tighten seven screws (3) to 40 lb-in (5 N·m).

(24) Verify geroter (6) and seals (5 and 7) are properly seated.

(25) Retighten screws (3) to 20-30 lb-ft (27-41 N·m).

(26) Remove housing (1) from vise.

(27) Remove tape from output shaft (2).

END OF TASK

Follow-On Maintenance

Install swing drive orbit motor (para 3-12).

6-5. SWING DRIVE BRAKE REPAIR

THIS TASK COVERS:
a. Disassembly
b. Cleaning/Inspection
c. Assembly

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Hydraulic oil (Item 16, Appendix B)
Sealing compound (Item 29, Appendix B)
Backup ring (2) (Item 3, Appendix E)
Backup ring (Item 4, Appendix E)
Packing, preformed (2) (Item 122, Appendix E)
Packing, preformed (Item 123, Appendix E)
Spring (6) (Item 177, Appendix E)

Equipment Condition
Swing drive brake removed.
(para 3-13).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

a. Disassembly

NOTE

Note position of elbow (1) prior to removal to ensure proper installation.

(1) Remove elbow (1).

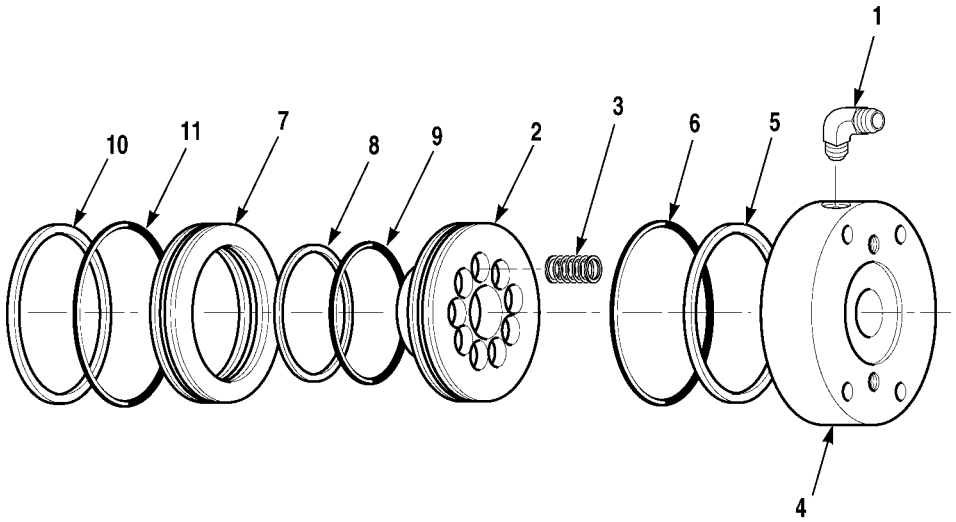
(2) Remove piston assembly (2) and six springs (3) from cylinder housing (4). Discard springs (3).

(3) Remove backup ring (5) and preformed packing (6) from piston (2). Discard backup ring and preformed packing.

(4) Remove piston (2) from spacer (7).

(5) Remove backup ring (8) and preformed packing (9) from spacer (7). Discard backup ring and preformed packing.

(6) Remove backup ring (10) and preformed packing (11) from spacer (7). Discard backup ring and preformed packing.



b. Cleaning/Inspection

(1) Clean all parts.

(2) Inspect cylinder housing and piston assembly for cracks or damage.

(3) Inspect all other parts. Replace all parts failing inspection.

c. Assembly

NOTE

Lubricate all preformed packings and backup rings with clean hydraulic oil.

(1) Install preformed packing (9) and backup ring (8) in spacer (7).

(2) Install piston (2) on spacer (7).

(3) Install preformed packing (11) and backup ring (10) on spacer (7).

(4) Install preformed packing (6) and backup ring (5) on piston (2).

NOTE

Leave one hole empty between every two springs.

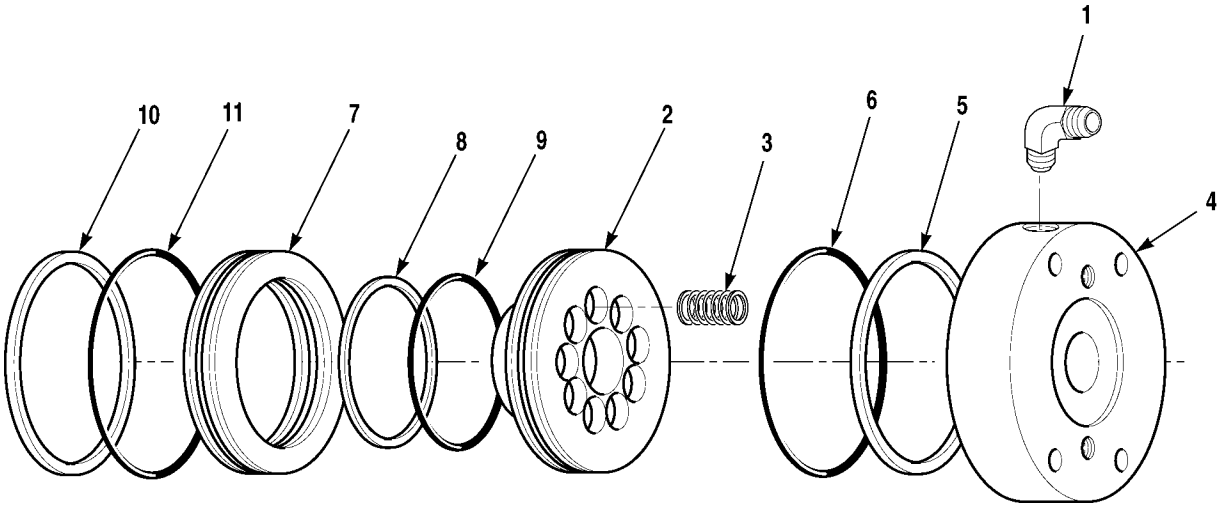
(5) Install piston assembly (2) and six springs (3) in cylinder housing (4).

(6) Apply sealing compound to threads of elbow (1) and install elbow (1) in cylinder housing (4).

END OF TASK

Follow-On Maintenance

Install swing drive brake (para 3-13).



6-6. SWING DRIVE ASSEMBLY REPAIR

THIS TASK COVERS:
a. Disassembly
b. Cleaning/Inspection
c. Assembly

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)
Pan, drain (Item 42, Appendix F)
Wooden blocks (2) (Appendix C)

Materials/Parts
Grease, lithium (Item 16, Appendix B)
Hydraulic oil (Item 16, Appendix B)
Sealing compound (Item 29, Appendix B)
Lockwasher (16) (Item 47, Appendix E)
Oil seal (Item 71, Appendix E)
Packing, preformed (2) (Item 105, Appendix E)
Nut (Item 69, Appendix E)
Lockwasher (Item 65, Appendix E)

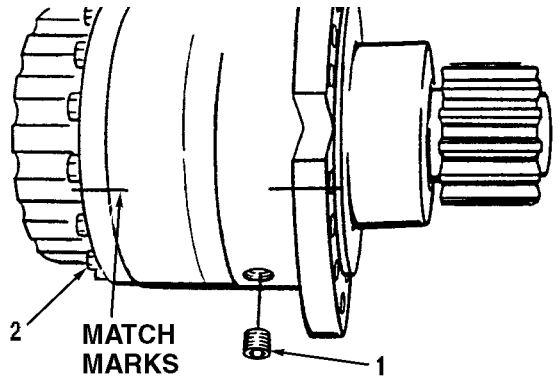
Equipment Condition
Swing drive assembly removed.
(para 3-14).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

a. Disassembly

(1) Remove two plugs (1) from swing drive assembly (2) and drain oil in drain pan.

(2) Matchmark length of swing drive assembly (2) and place gear side down on wooden blocks.



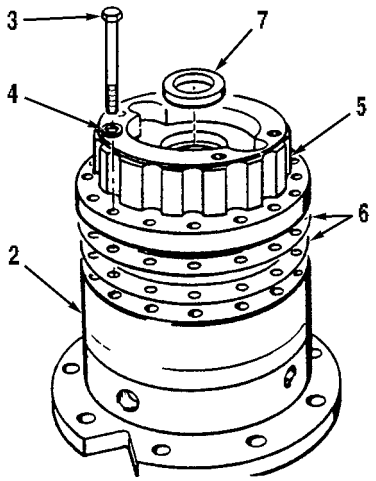
(3) Remove 16 screws (3) and lockwashers (4) from end cover (5). Discard lockwashers (4).

NOTE

Number of shims may vary.

(4) Remove end cover (5) and shims (6) from swing drive assembly (2).

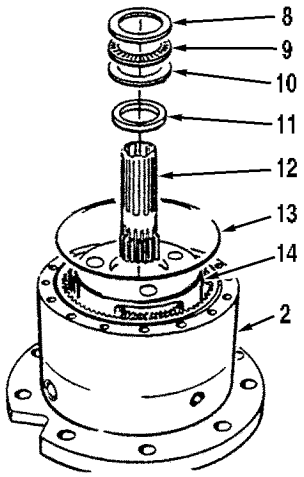
(5) Remove oil seal (7) from end cover (5). Discard oil seal.



(6) Remove race (8), bearing (9), race (10), and spacer (11) from sun gear (12).

(7) Remove sun gear (12) and preformed packing (13) from swing drive assembly (2). Discard preformed packing.

(8) Remove planetary assembly (14) from swing drive assembly (2).



(9) Drive roll pin (15) into pin (16).

(10) Remove pin (16), gear (17) and two spacers (18).

(11) Remove roll pin (15) from pin (16). Discard roll pin.

CAUTION

Handle bearing with care or individual needles may be lost.

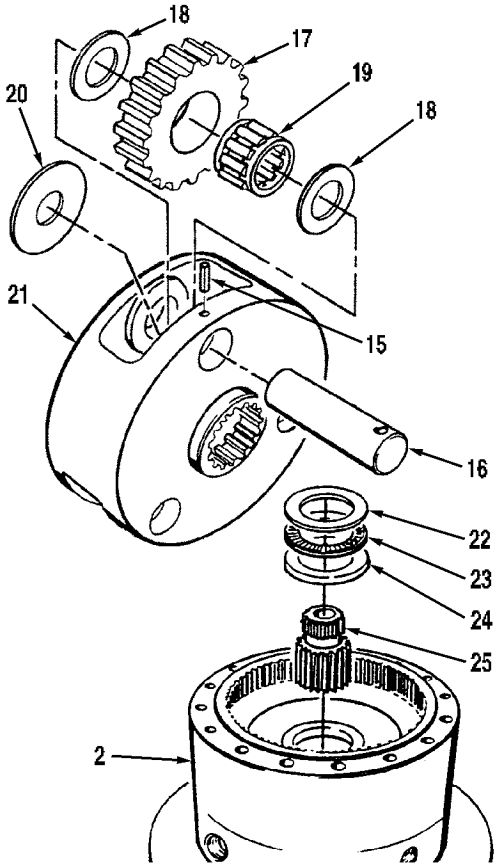
(12) Remove bearing (19) from gear (17).

(13) Repeat steps (9 thru 12) for other two gear assemblies.

(14) Remove center spacer (20) from carrier (21).

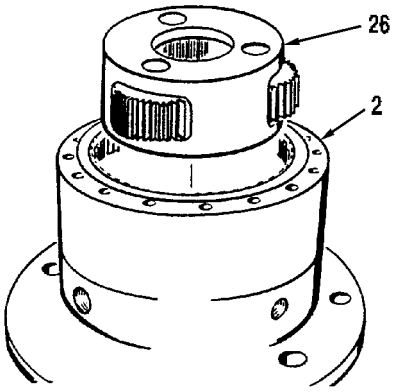
(15) Remove race (22), bearing (23), and race (24) from swing drive assy (2).

(16) Remove secondary sun gear (25) from swing drive assembly (2).



6-6. SWING DRIVE ASSEMBLY REPAIR (Continued)

(17) Remove inner planetary assembly (26) from swing drive assembly (2).



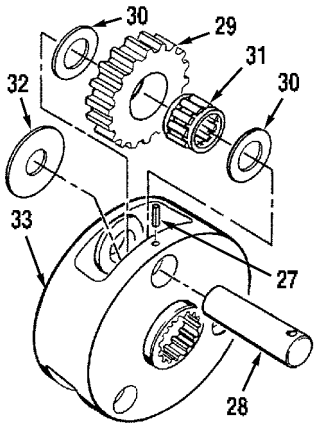
(18) Drive roll pin (27) into pin (28).

(19) Remove pin (28), gear (29), and two spacers (30).

(20) Remove roll pin (27) from pin (28). Discard roll pin.

CAUTION

Handle bearing with care or individual needles may be lost.



(21) Remove bearing (31) from gear (29).

(22) Repeat steps (18 thru 21) for other two assemblies.

(23) Remove center spacer (32) from carrier (33).

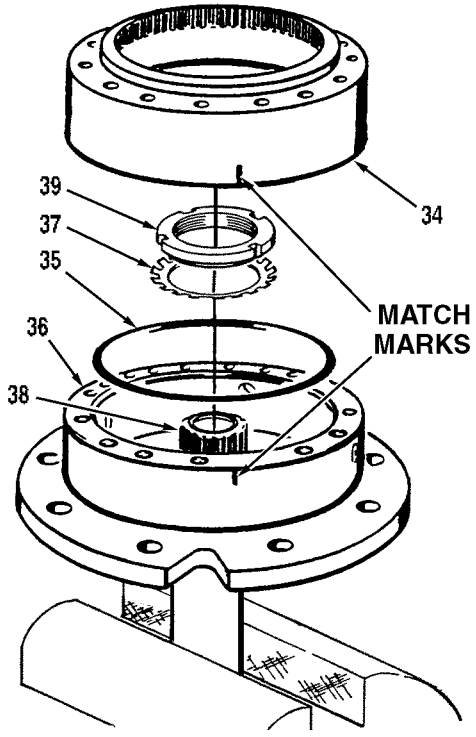
(24) Matchmark and remove ring gear (34) and preformed packing (35) from hub (36). Discard preformed packing (35).

(25) Bend down tine of lockwasher (37).

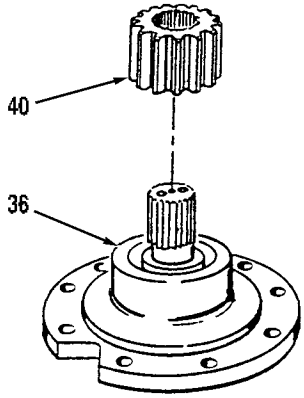
(26) Position shaft (38) in soft jawed vise.

(27) Remove nut (39) and lockwasher (37). Discard nut and lockwasher.

(28) Remove shaft (38) from vise.



(29) Turn hub (36) over and remove gear (40).



(30) Remove seal (41) from hub (36). Discard seal.

(31) Position hub (36) in press.

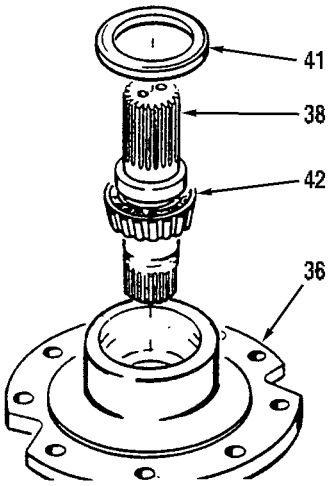
(32) Press shaft (38) and bearing (42) from hub (36).

(33) Remove hub (36) from press.

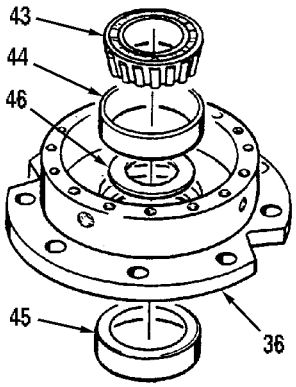
(34) Position shaft (38) in press.

(35) Press bearing (42) from shaft (38).

(36) Remove shaft (38) from press.



(37) Remove bearing (43), race (44) and (45), and spacer (46) from hub (36).



b. Cleaning/Inspection

(1) Clean all parts.

(2) Inspect all parts.

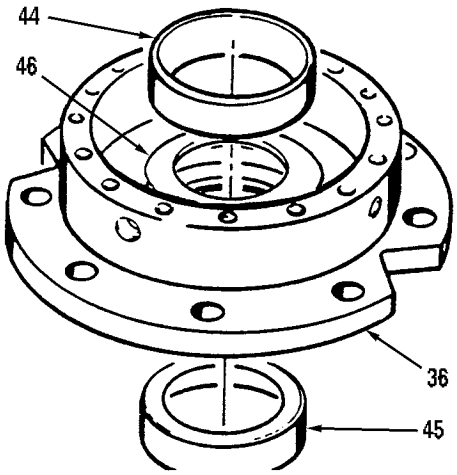
(3) Replace all parts failing inspection.

c. Assembly

NOTE

Lubricate all preformed packings and seal with clean hydraulic oil.

(1) Apply thin coat of grease to race (45) and install race (45 and 44) and spacer (46) in hub (36).



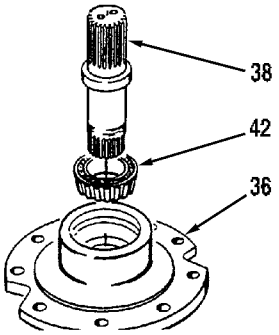
6-6. SWING DRIVE ASSEMBLY REPAIR (Continued)

(2) Position shaft (38) in press.

(3) Pack bearing (42) with grease and press bearing onto shaft (38).

(4) Remove shaft (38) from press.

(5) Install shaft (38) in hub (36).



(6) Pack bearing (43) with grease and install bearing on shaft (38).

(7) Install lockwasher (37) and nut (39) on shaft (38).

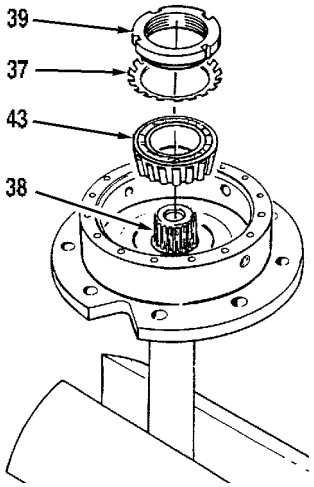
(8) Tighten nut (39) until shaft (38) starts to turn.

(9) Position shaft (38) in soft jaw vise.

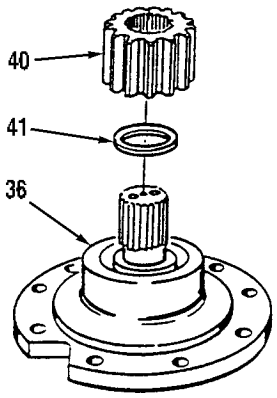
(10) Hold shaft (38) and tighten nut (39) until one tine on lockwasher (37) alines with slot in nut.

(11) Bend tine of lockwasher (37) up in slot of nut (39).

(12) Remove shaft (38) from vise.

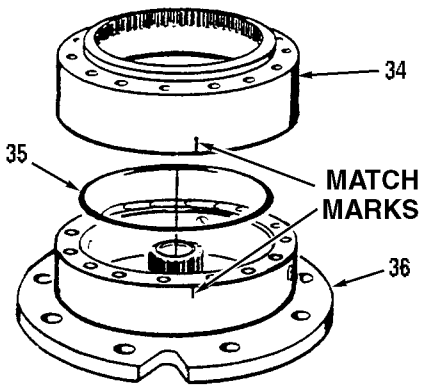


(13) Turn hub (36) over and install seal (41) and gear (40) on hub.



(14) Apply adhesive on mating surface of hub (36) and install preformed packing (35) on hub.

(15) Aline matchmarks and install ring gear (34) on hub (36).



(16) Position center spacer (32) in carrier (33).

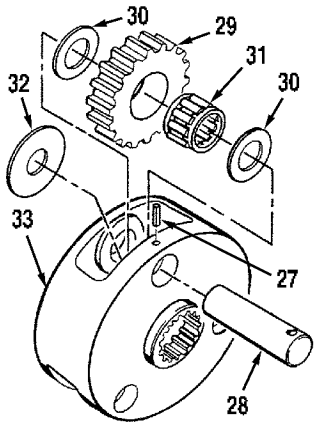
CAUTION

Handle bearing with care or individual needles may be lost.

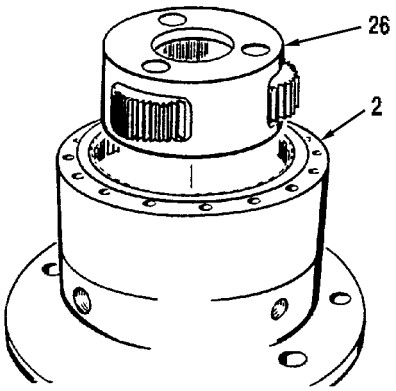
(17) Pack bearing (31) with grease and install bearing in gear (29).

(18) Install gear (29) and two spacers (30) with pin (28) and roll pin (27).

(19) Repeat steps (17 and 18) for other two assemblies.



(20) Install inner planetary assembly (26) in swing drive assembly (2).



NOTE

Install thick race first.

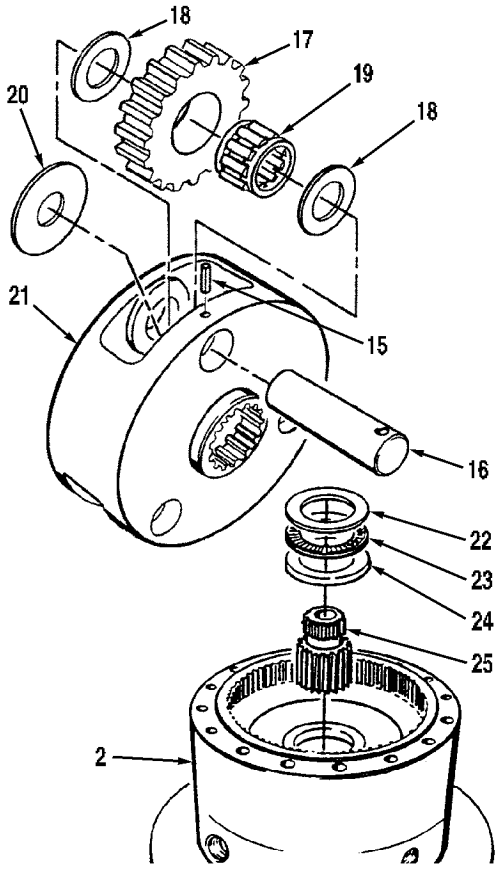
(21) Install sun gear (25), race (24), bearing (23), and race (22) in swing drive assembly (2).

(22) Position center spacer (20) in carrier (21).

(23) Pack bearing (19) with grease and install in bearing in gear (17).

(24) Install gear (17) and two spacers (18) with pin (16) and roll pin (15).

(25) Repeat steps (22, 23, and 24) for other two assemblies.



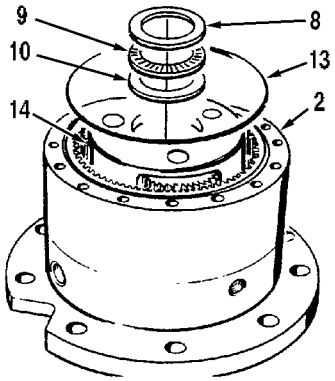
6-6. SWING DRIVE ASSEMBLY REPAIR (Continued)

(26) Install planetary assembly (14) in swing drive assembly (2).

(27) Apply adhesive on mating surface of swing drive assembly (2).

(28) Install preformed packing (13) on swing drive assembly (2).

(29) Install race (10), bearing (9), and race (8) in swing drive assembly (2).



(30) Install oil seal (7) in end cover (5).

(31) Install sun gear (12) and race (8) in swing drive assembly (2).

(32) Aline matchmarks and position end cover (5) on swing drive assembly (2).

NOTE

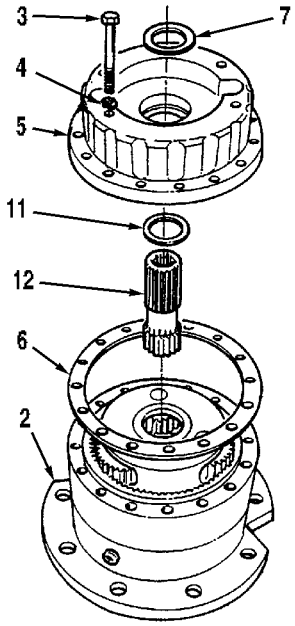
Movement is checked through hole in end cover.

(33) Check for free movement by moving planetary assembly up and down with sun gear (12).

(34) If no movement is felt, install shims (6) in progressions of 0.002 in. (0.05 mm) until movement is felt.

(35) Apply sealing compound to threads of 16 screws (3).

(36) Install end cover (5) with 16 lockwashers (4) and screws (3). Tighten screws to 35 lb-ft (47 N·m).

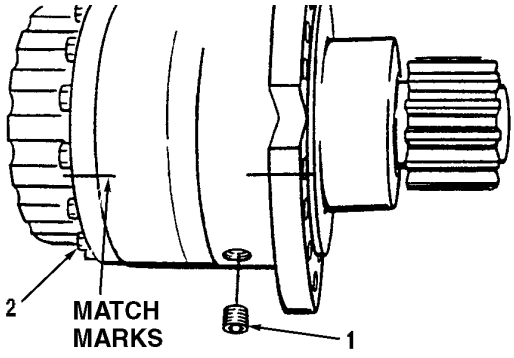


(37) Apply sealing compound to threads of two plugs (1) and install two plugs in swing drive assembly (2).

END OF TASK

Follow-On Maintenance

Install swing drive assembly (para 3-14).



6-7. GEAR SET REPAIR

THIS TASK COVERS:
a. Disassembly
b. Cleaning/Inspection
c. Assembly

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Sealing compound (Item 29, Appendix B)
Sealing compound (Item 3, Appendix B)
Packing, preformed (2) (Item 82, Appendix E)
Seal, plain encased (2) (Item 158, Appendix E)

Equipment Condition
Hoist motor control valve removed (para 3-38).

Hoist hydraulic motor removed (para 3-24).

Oil filled disc brake assembly removed (para 3-25).

Hoist assembly removed (para 3-26).

Cable follower removed (para 3-22).

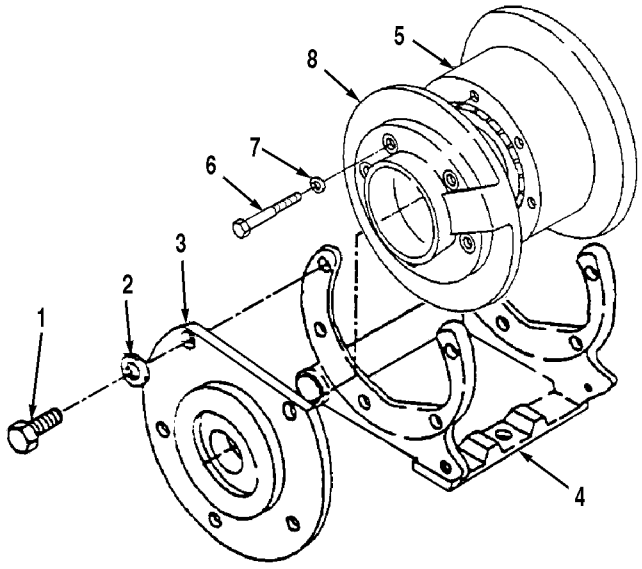
a. Disassembly

(1) Remove five screws (1), washers (2), and retaining plate (3) from housing (4).

(2) Remove ring gear (5) from housing (4).

(3) Remove six screws (6) and washers (7) from RH drum end (8).

(4) Remove RH drum end (8) from ring gear (5).



6-7. GEAR SET REPAIR (Continued)

(5) Remove preformed packing (9) from RH drum end (8). Discard preformed packing.

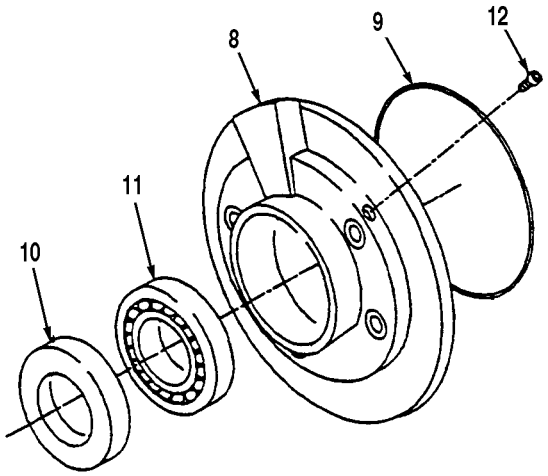
(6) Remove seal (10) from RH drum end (8). Discard seal.

NOTE

Note position of bearing (11) prior to removal to ensure proper installation.

(7) Remove bearing (11) from RH drum end (8).

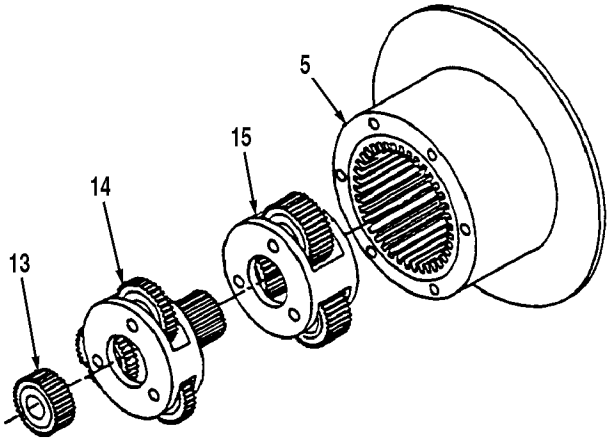
(8) Remove two plugs (12) from RH drum end (8).



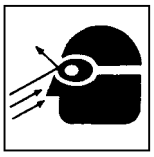
(9) Remove sun gear (13) from carrier (14).

(10) Remove carrier (14) from ring gear (15).

(11) Remove ring gear (15) from carrier (5).



WARNING



Use care when removing retaining rings. Retaining rings are under tension and can act as projectiles when released. Failure to comply may result in injury to personnel.

NOTE

All three gears are disassembled the same way. Only one shown.

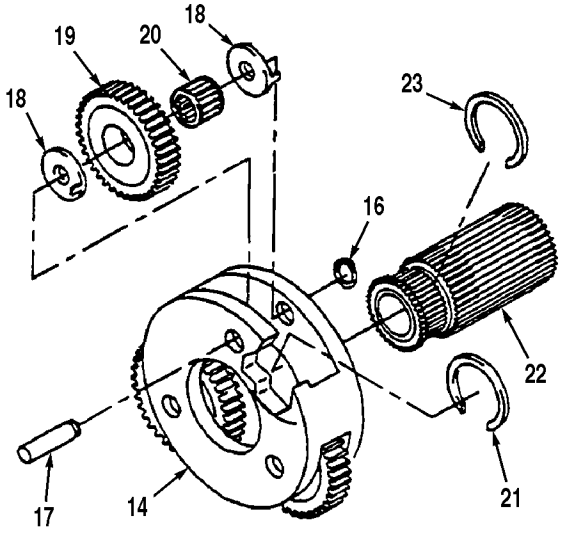
(12) Remove retaining ring (16), pin (17), two washers (18), gear (19), and roller set (20) from carrier (14).

(13) Perform step (12) for remaining gears (19).

(14) Remove retaining ring (21) from drive gear (22).

(15) Remove drive gear (22) from carrier (14).

(16) Remove retaining ring (23) from drive gear (22).



NOTE

All three gears are disassembled the same way. Only one shown.

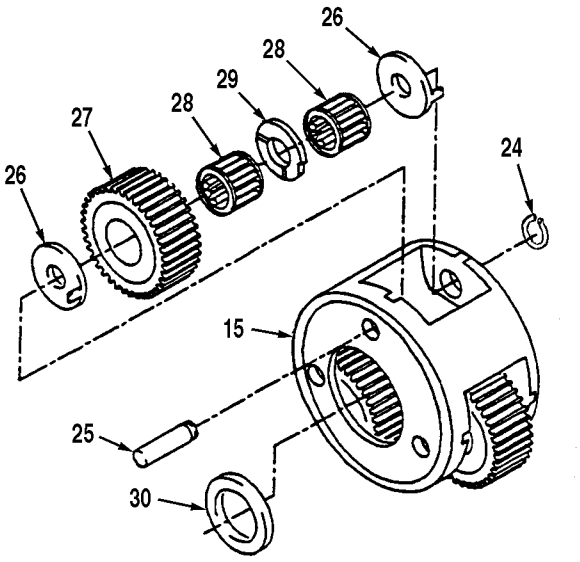
(17) Remove retaining ring (24) from pin (25).

(18) Remove pin (25), two washers (26), and gear (27) from carrier (15).

(19) Remove two roller sets (28) and separator (29) from gear (27).

(20) Perform steps (17 through 19) for remaining gears (27).

(21) Remove washer (30) from carrier (15).

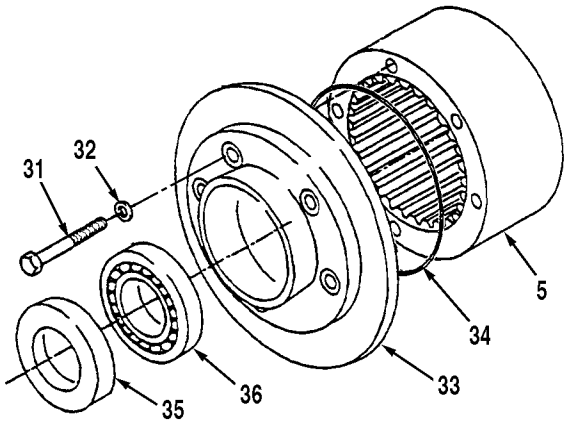


(22) Remove eight screws (31), washers (32), and LH drum end (33) from ring gear (5).

(23) Remove preformed packing (34) from LH drum end (33). Discard preformed packing.

(24) Remove seal (35) from LH drum end (33). Discard seal.

(25) Remove bearing (36) from LH drum end (33).



6-7. GEAR SET REPAIR (Continued)

b. Cleaning/Inspection

(1) Clean all parts.

(2) Inspect all parts for burrs, cracks, crossed, or peened threads.

(3) Repair or replace all parts failing inspection.

c. Assembly

(1) Install bearing (36) in LH drum end (33).

(2) Install seal (35) in LH drum end (33).

(3) Install preformed packing (34) on LH drum end (33).

(4) Apply sealing compound to threads of eight screws (31) and silicone sealant to mating surface of ring gear (5).

(5) Position LH drum end (33) on ring gear (5) with eight washers (32) and screws (31).

(6) Tighten screws (31) to 16 lb-ft (22 N·m).

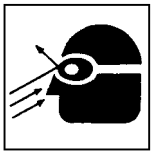
NOTE

All three gears are assembled the same way. Only one shown.

(7) Install two roller sets (28) and separator (29) in gear (27).

(8) Install gear (27) and two washers (26) in carrier (15) with pin (25).

WARNING

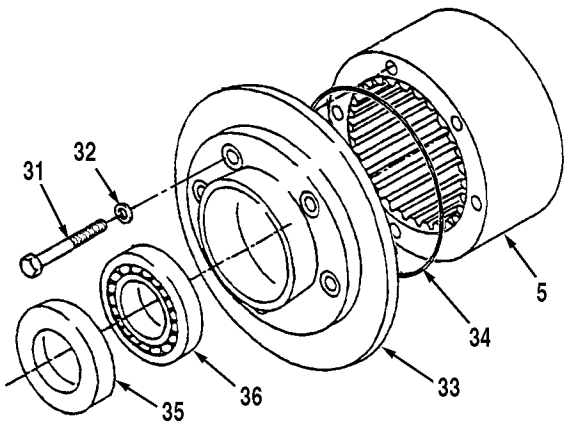


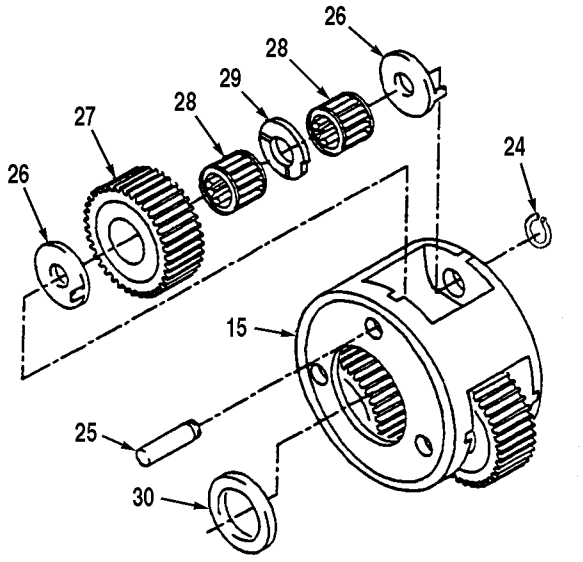
Use care when installing retaining rings. Retaining rings are under tension and can act as projectiles when released. Failure to comply may result in injury to personnel.

(9) Install retaining ring (24) on pin (25).

(10) Perform steps (7 through 9) on remaining gears (10).

(11) Install washer (30) in carrier (15).





NOTE

All three gears are assembled the same. Only one shown.

(12) Install retaining ring (23) on drive gear (22).

(13) Install drive gear (22) in carrier (14).

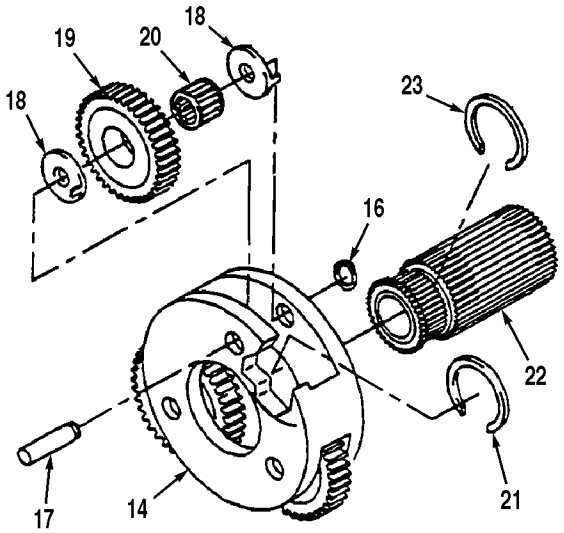
(14) Install retaining ring (21) on drive gear (22).

(15) Install roller set (20) in gear (19).

(16) Install two washers (18) and gear (19) in carrier (14) with pin (17).

(17) Install retaining ring (16) on pin (17).

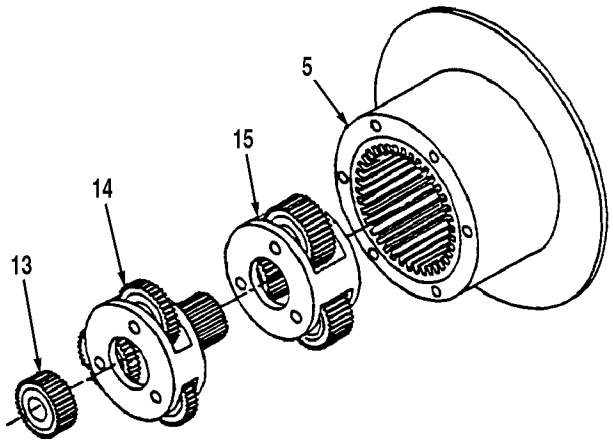
(18) Perform steps (12 through 17) on remaining gears (19).



(19) Install carrier (5) in ring gear (15).

(20) Install carrier (14) in ring gear (15).

(21) Install sun gear (13) in carrier (14).

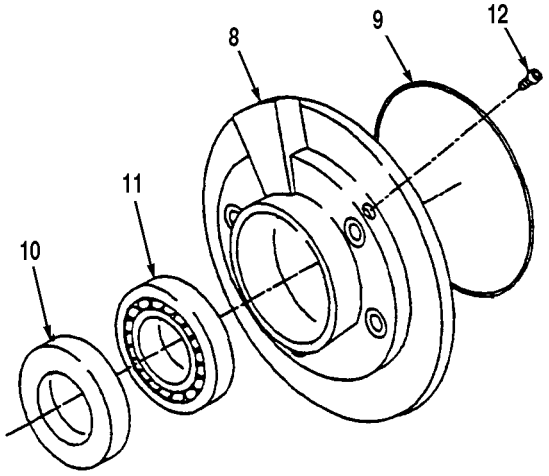


(22) Install bearing (11) in RH drum end (8).

(23) Install seal (10) in RH drum end (8).

(24) Install preformed packing (9) on RH drum end (8).

(25) Install two plugs (12) in RH drum end (8).



6-7. GEAR SET REPAIR (Continued)

(26) Apply sealing compound to threads of six screws (6) and silicone sealant to mating surface of ring gear (5).

(27) Install RH drum end (8) on ring gear (5) with six washers (7) and screws (6).

(28) Tighten six screws (6) to 28 lb-ft (38 N·m).

(29) Install ring gear (5) in housing (4).

(30) Apply sealing compound to threads of five screws (1).

(31) Install retaining plate (3) on housing (4) with five washers (2) and screws (1).

(32) Tighten five screws (1) to 68 lb-ft (92 N·m).

END OF TASK

Follow-On Maintenance

Install cable follower (para 3-22).

Install hoist assembly (para 3-26)

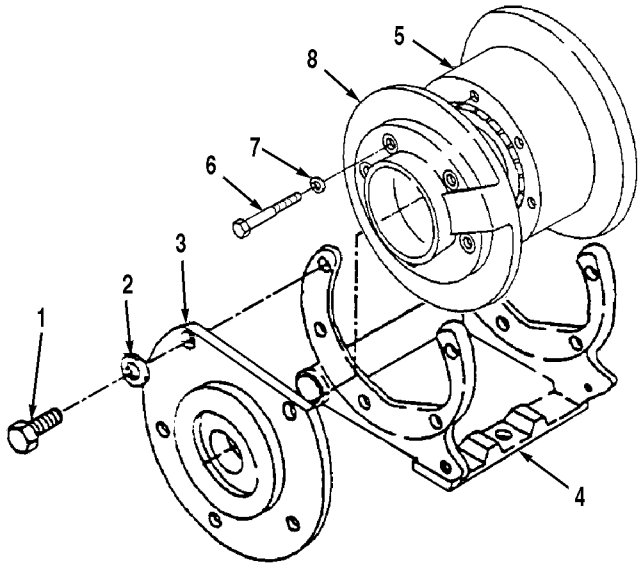
Install oil filled disc brake assembly (para 3-25).

Install hoist hydraulic motor (para 3-24).

Install hoist motor control valve (para 3-38).

Check crane for proper operation and hydraulic leaks (TM 9-4940-568-10).

Load test crane (para 3-5).



6-8. OIL FILLED DISC BRAKE ASSEMBLY REPAIR

THIS TASK COVERS:
a. Disassembly
b. Cleaning/Inspection
c. Assembly

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Hydraulic oil (Item 16, Appendix B)
Sealing compound (Item 29, Appendix B)
Packing, preformed (4) (Item 85, Appendix E)
Seal (2) (Item 151, Appendix E)

Equipment Condition
Oil filled disc brake assembly removed.
(para 3-25).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

---

a. Disassembly

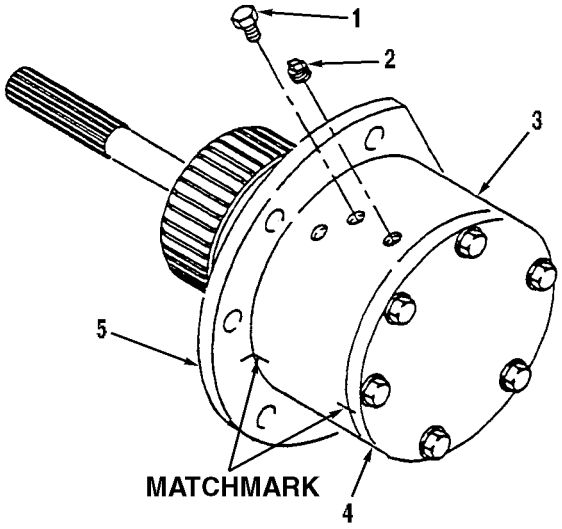
(1) Remove plug (1) and bleeder valve (2) from ring gear (3).

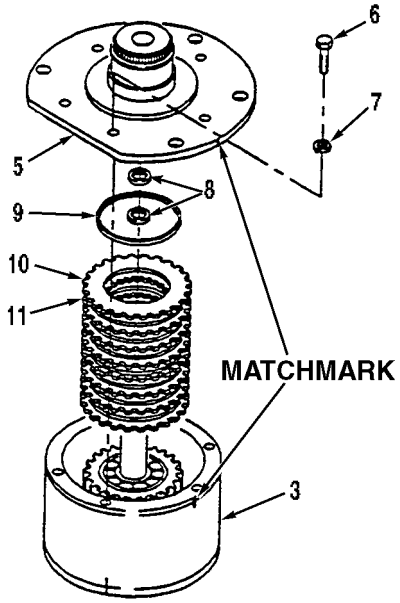
(2) Matchmark ring gear (3) to cover (4) and end cap (5).

(3) Remove six screws (6), washers (7), and end cap (5) from ring gear (3).

(4) Remove and discard two oil seals (8) and preformed packing (9) from end cap (5).

(5) Remove eight stators (10) and seven discs (11) from ring gear (3).



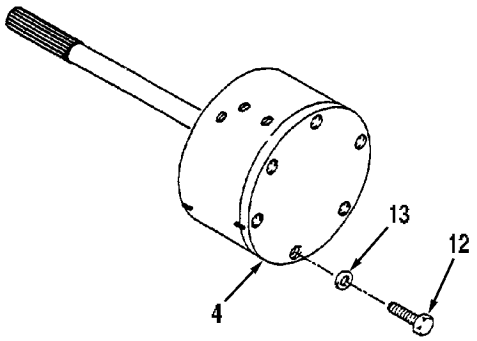


6-8. OIL FILLED DISC BRAKE ASSEMBLY REPAIR (Continued)

WARNING

Cover is under pressure. Loosen screws equally when removing cover. Failure to comply may result in injury to personnel.

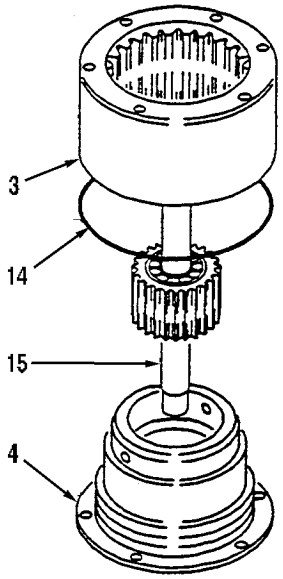
(6) Remove six screws (12) and washers (13) from cover (4).



(7) Remove ring gear (3) from cover (4).

(8) Remove and discard preformed packing (14) from ring gear (3).

(9) Remove shaft (15) from cover (4).



(10) Remove retaining ring (16) from shaft (15).

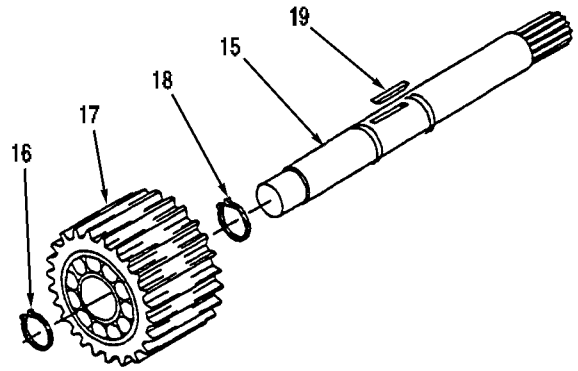
NOTE

Note direction of holes in gear face prior to removing.

(11) Remove gear (17) from shaft (15).

(12) Remove retaining ring (18) from shaft (15).

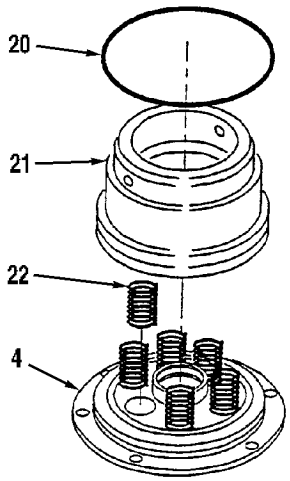
(13) Remove key (19) from shaft (15).



(14) Remove and discard preformed packing (20) from piston (21).

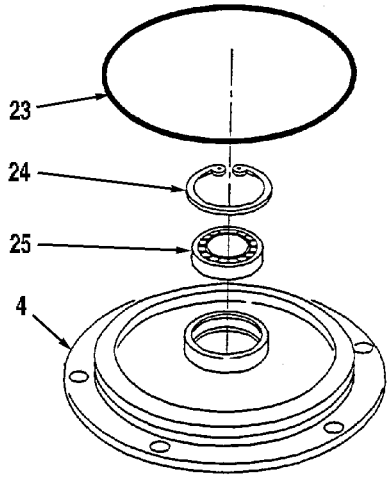
(15) Remove piston (21) from cover (4).

(16) Remove six springs (22) from cover (4).



(17) Remove and discard preformed packing (23) from cover (4).

(18) Remove retaining ring (24) and bearing (25) from cover (4).



b. Cleaning/Inspection

(1) Clean all parts.

NOTE

Replace any part that fails visual inspection or size measurement requirements.

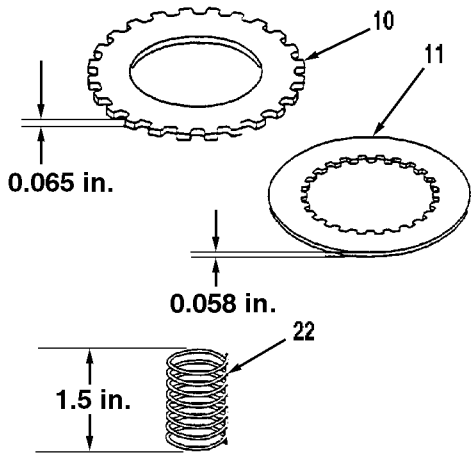
(2) Inspect all parts for pitting, corrosion, scoring, damaged splines, damaged teeth, or indications of binding.

(3) Check eight stators (10) for wear, minimum thickness 0.065 in. (0.162 cm).

(4) Check seven discs (11) for wear, minimum thickness 0.058 in. (0.144 cm).

(5) Check six springs (22) for length, minimum length 1.5 in. (3.8 cm).

(6) Inspect all other parts. Replace all parts failing inspection.



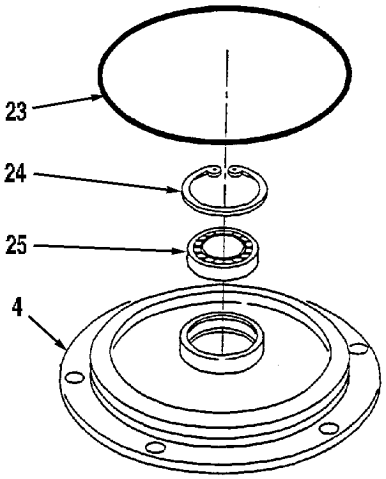
c. Assembly

NOTE

Lubricate all preformed packings and seal with clean hydraulic oil.

(1) Install bearing (25) in cover (4).

(2) Install retaining ring (24) and preformed packing (23) on cover (4).

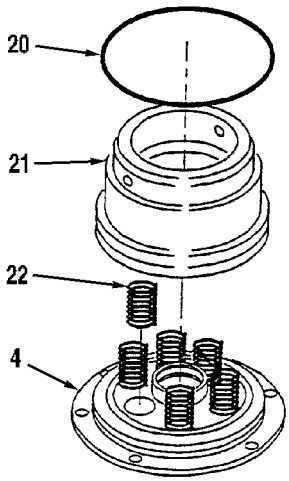


6-8. OIL FILLED DISC BRAKE ASSEMBLY REPAIR (Continued)

(3) Install preformed packing (20) on piston (21).

(4) Install six springs (22) in cover (4).

(5) Install piston (21) on cover (4).



(6) Install retaining ring (18) on shaft (15).

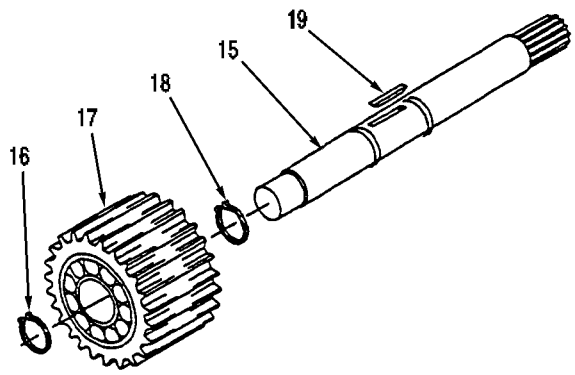
(7) Install key (19) on shaft (15).

CAUTION

Install gear (17) with holes in direction noted during disassembly. Failure to comply may result in damage to equipment.

(8) Install gear (17) on shaft (15).

(9) Install retaining ring (16) on shaft (15).



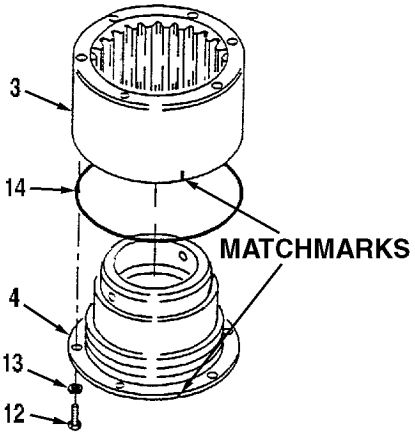
(10) Install preformed packing (14) on ring gear (3).

(11) Install ring gear (3) on cover (4) with matchmarks aligned.

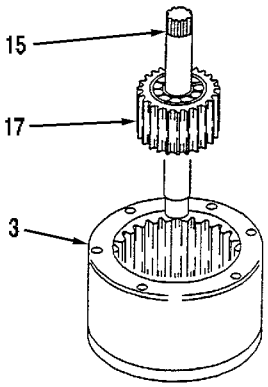
(12) Apply sealing compound to threads of six screws (12).

(13) Position six screws (12) and washers (13) on cover (4).

(14) Tighten six screws (12) to 28 lb-ft (38 N·m).



(15) Position shaft (15) in ring gear (3) with gear (17) resting slightly above ring gear (3).



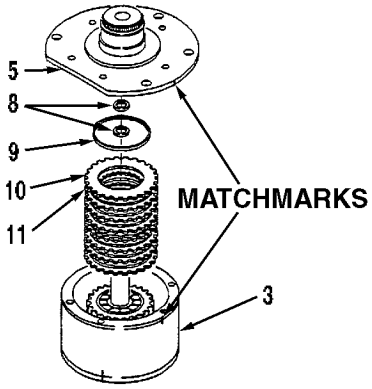
(16) Alternately install eight stators (10) and seven discs (11) in ring gear (3).

(17) Install two oil seals (8) in end cap (5).

(18) Install preformed packing (9) in end cap (5).

(19) Fill ring gear (3) with oil.

(20) Install end cap (5) on ring gear (3) with matchmarks aligned.

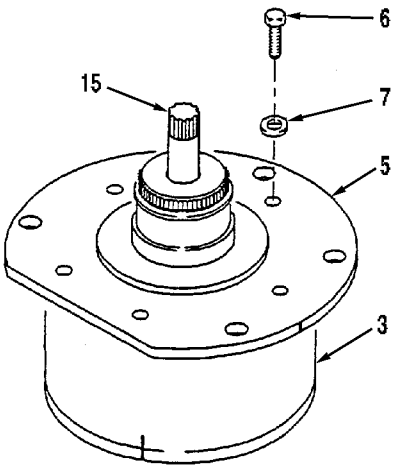


(21) Apply sealing compound to threads of six screws (6).

(22) Position six washers (7) and screws (6) in end cap (5).

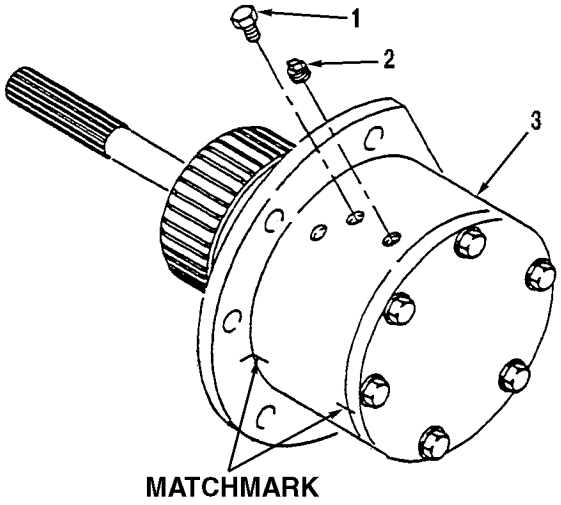
(23) Tighten six screws (6) to 28 lb-ft (38 N·m).

(24) Install shaft (15) in ring gear (3).



(25) Apply sealing compound to threads of plug (1) and bleeder valve (2).

(26) Install plug (1) and bleeder valve (2) in ring gear (3).



END OF TASK

Follow-On Maintenance

Install oil filled disc brake assembly (para 3-25).

6-9. LIFT CYLINDER REPAIR

THIS TASK COVERS:
a. Disassembly
b. Cleaning/Inspection
c. Assembly

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Hydraulic oil (Item 16, Appendix B)
Kit, repair (Item 34, Appendix E)

Personnel Required
2 Assistants

Equipment Condition
Lift cylinder removed (para 3-18).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

---

a. Disassembly

NOTE

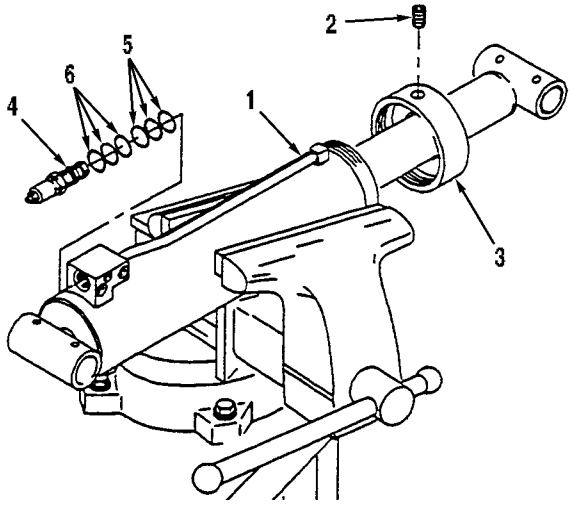
Place a container to catch hydraulic oil during disassembly.

(1) With help from assistant, place cylinder barrel (1) in vise.

(2) Remove setscrew (2) and retaining ring (3) from cylinder barrel (1).

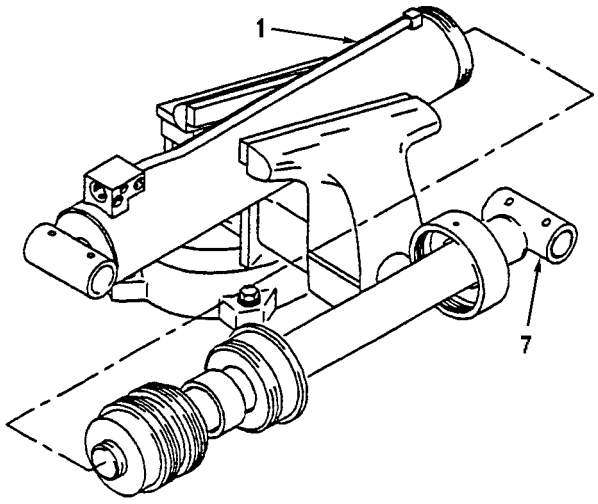
(3) Remove cartridge holding valve (4) from cylinder barrel (1).

(4) Remove three backup rings (5) and preformed packings (6) from cartridge holding valve (4). Discard backup rings and preformed packings.



(5) With help from assistant, remove rod (7) from cylinder barrel (1).

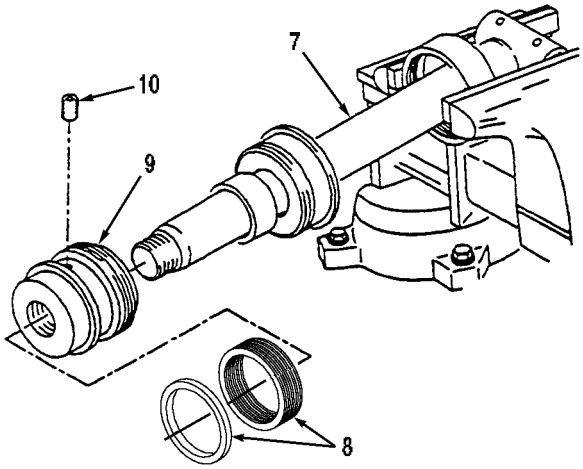
(6) With help from assistant, remove cylinder barrel (1) from vise.



(7) With help from assistant, place rod (7) in vise.

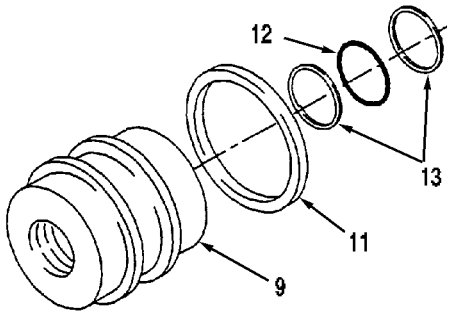
(8) Note position and remove and discard seal assembly (8) from piston (9).

(9) Remove setscrew (10) and piston (9) from rod (7).



(10) Note position and remove guide lock ring (11) from piston (9).

(11) Note position and remove two backup rings (12) and preformed packings (13) from piston (9). Discard backup rings and preformed packings.



(12) Remove spacer (14) from rod (7).

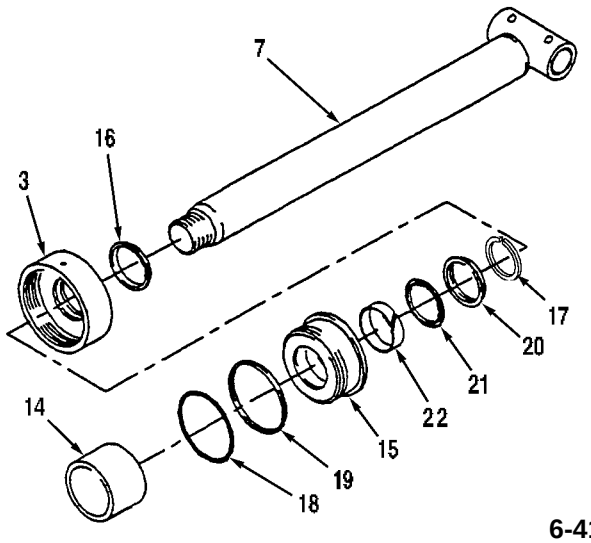
(13) Remove cylinder head (15) and retaining ring (3) from rod (7).

(14) Remove wiper ring (16) from retaining ring (3).

(15) Remove and discard seal (17) from cylinder head (15).

(16) Remove and discard preformed packing (18) and backup ring (19) from cylinder head (15).

(17) Remove and discard rod seal (20), buffer seal (21), and wiper ring (22) from cylinder head (15).



6-9. LIFT CYLINDER REPAIR (Continued)

b. Cleaning/Inspection

(1) Clean all parts.

(2) Inspect all parts for pitting, corrosion, scoring, damaged splines, damaged teeth, or indications of binding.

(3) Inspect all other parts. Replace all parts failing inspection.

c. Assembly

NOTE

Lubricate all preformed packings, backup rings and seals with clean hydraulic oil.

(1) Install wiper seal (22), buffer seal (21), and rod seal (20) in cylinder head (15).

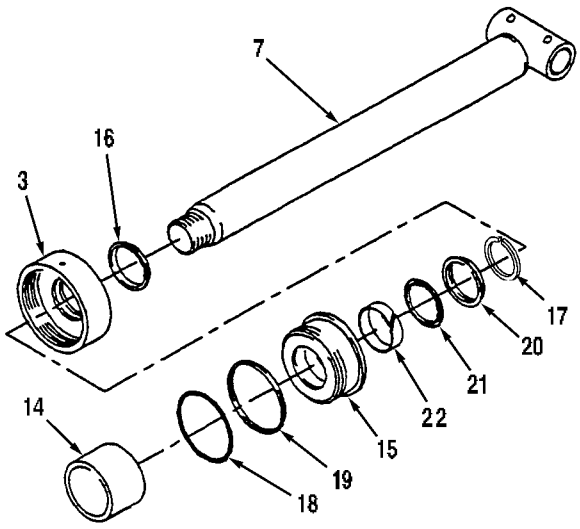
(2) Install backup ring (19) and preformed packing (18) on cylinder head (15).

(3) Install seal (17) on cylinder head (15).

(4) Install wiper ring (16) in retaining ring (3).

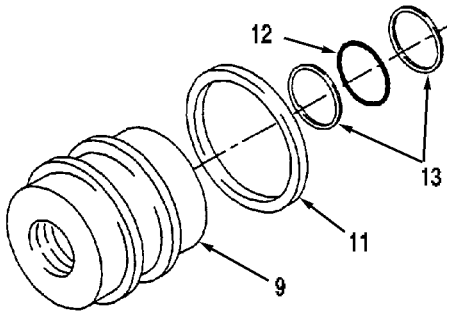
(5) Install retaining ring (3) and cylinder head (15) on rod (7).

(6) Install spacer (14) on rod (7).



(7) Install preformed packing (13) and two backup rings (12) on piston (9).

(8) Install guide lock ring (11) on piston (9).

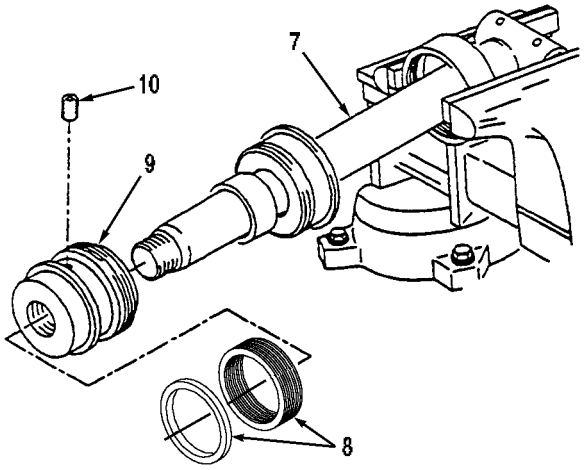


(9) With help from assistant, place rod (7) in vise.

(10) Install piston (9) on rod (7) with setscrew (10).

(11) Install seal assembly (8) on piston (9).

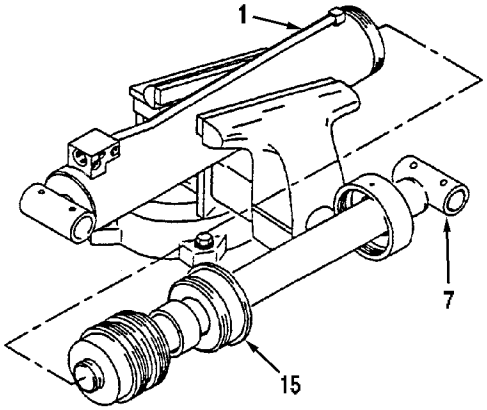
(12) With help from assistant, remove rod (7) from vise.



(13) With help from assistant, place cylinder barrel (1) in vise.

(14) With help from assistant, position rod (7) in cylinder barrel (1).

(15) Install cylinder head (15) in cylinder barrel (1).

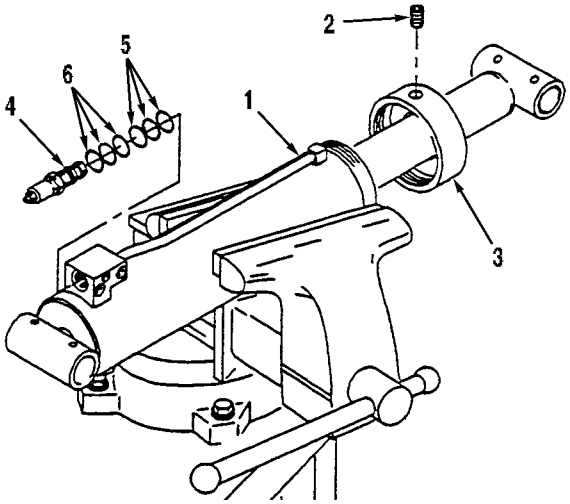


(16) Install three preformed packings (6) and backup rings (5) on cartridge holding valve (4).

(17) Position cartridge holding valve (4) in cylinder barrel (1).

(18) Install retaining ring (3) on cylinder barrel (1) with setscrew (2).

(19) Tighten cartridge holding valve (4) to 75-80 lb-ft (102-108 N·m).



(20) With help from assistant, remove cylinder barrel (1) from vise.

END OF TASK

Follow-On Maintenance

Install lift cylinder (para 3-18).

6-10. ERECTION CYLINDER REPAIR

THIS TASK COVERS:
a. Disassembly
b. Cleaning/Inspection
c. Assembly

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Hydraulic oil (Item 16, Appendix B)
Kit, repair (Item 33, Appendix E)
Kit, repair (Item 35, Appendix E)
Packing, preformed (2) (Item 88, Appendix E)

Personnel Required
2 Assistants

Equipment Condition
Erection cylinder removed (para 3-19).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

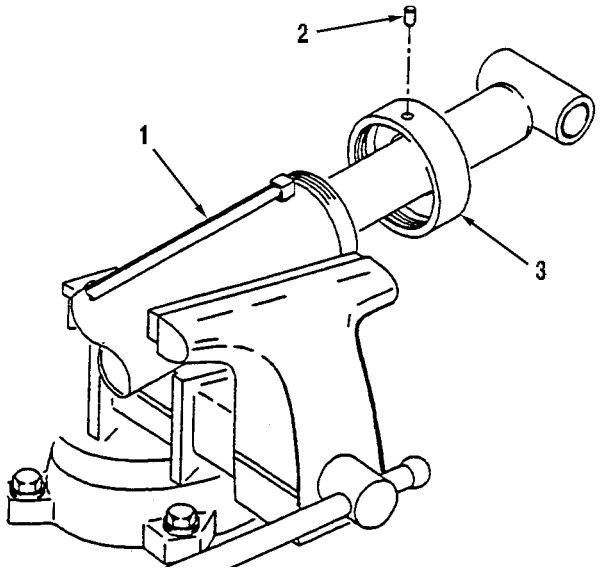
a. Disassembly

NOTE

Place a container to catch hydraulic oil during disassembly.

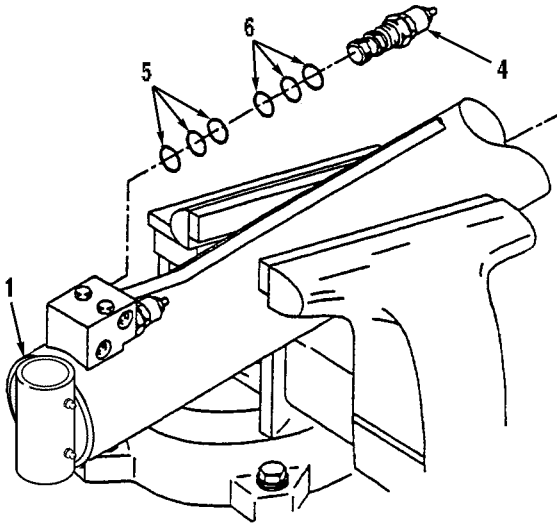
(1) With help from assistant, place cylinder barrel (1) in vise.

(2) Remove setscrew (2) and retaining ring (3) from cylinder barrel (1).



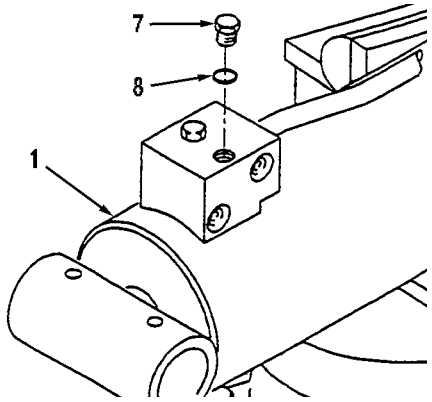
(3) Remove cartridge holding valve (4) from cylinder barrel (1).

(4) Remove three backup rings (5) and preformed packings (6) from cartridge holding valve (4). Discard backup rings and preformed packing.



(5) Remove two plugs (7) from cylinder barrel (1).

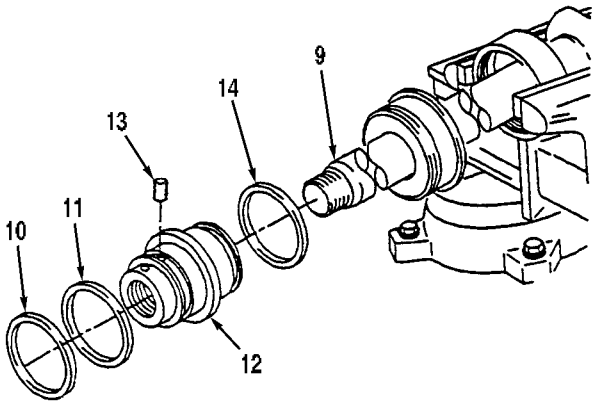
(6) Remove two preformed packings (8) from plugs (7). Discard preformed packings.



(9) Place rod (9) in vise.

(10) Remove guide lock ring (10) and seal (11) from piston (12). Discard seal.

(11) Remove setscrew (13), piston (12), and spacer (14) from rod (9).

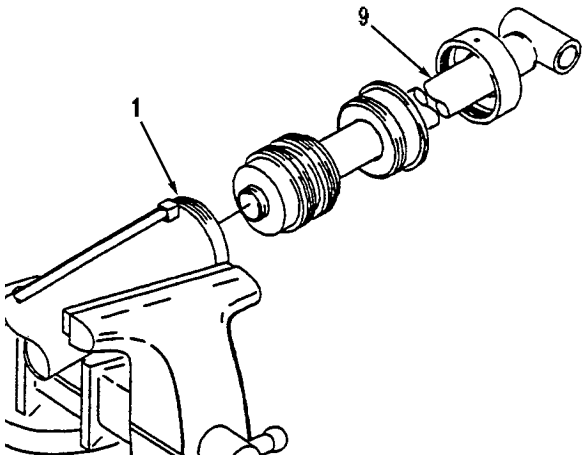


CAUTION

Do not pry cylinder head from cylinder barrel. Failure to comply will result in damage to equipment.

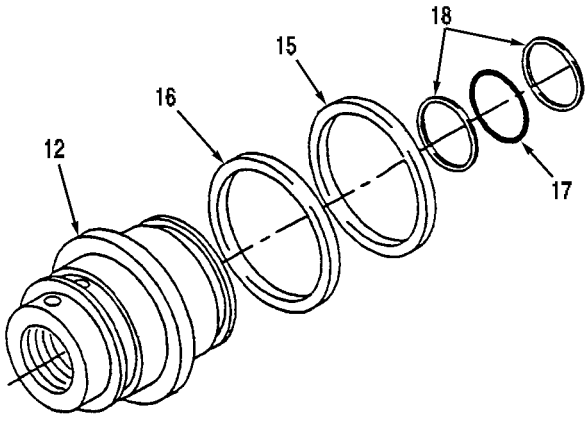
(7) Remove rod (9) from cylinder barrel (1).

(8) Remove cylinder barrel (1) from vise.



(12) Remove guide lock ring (15) and seal (16) from piston (12). Discard seal.

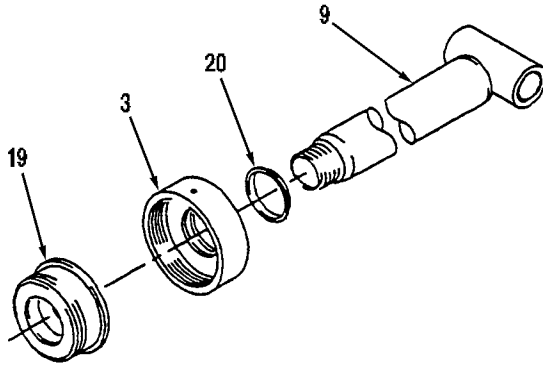
(13) Remove preformed packing (17) and two backup rings (18) from piston (12). Discard preformed packing and backup rings.



6-10. ERECTION CYLINDER REPAIR (Continued)

(14) Remove cylinder head (19) and retaining ring (3) from rod (9).

(15) Remove wiper ring (20) from retaining ring (3). Discard wiper ring.



(16) Remove preformed packing (21) and backup ring (22) from cylinder head (19). Discard preformed packing and backup ring.

(17) Remove rod seal (23), buffer seal (24), and wear ring (25) from cylinder head (19). Discard rod seal, buffer seal and wear ring.

b. Cleaning/Inspection

(1) Clean all parts.

(2) Inspect all parts for pitting, corrosion, scoring, damaged splines, damaged teeth, or indications of binding.

(3) Inspect all other parts. Replace all parts failing inspection.

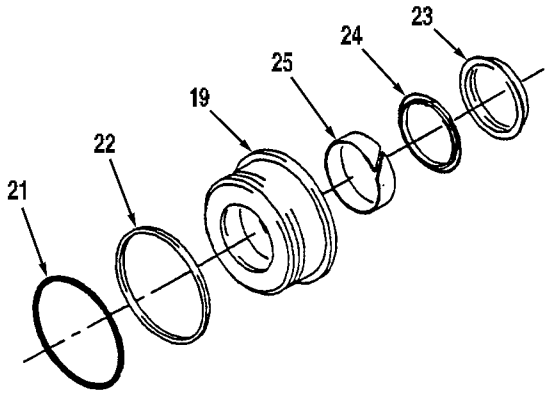
c. Assembly

NOTE

Lubricate all preformed packings, backup rings and seals with clean hydraulic oil.

(1) Install wear ring (25), buffer seal (24), and rod seal (23) in cylinder head (19).

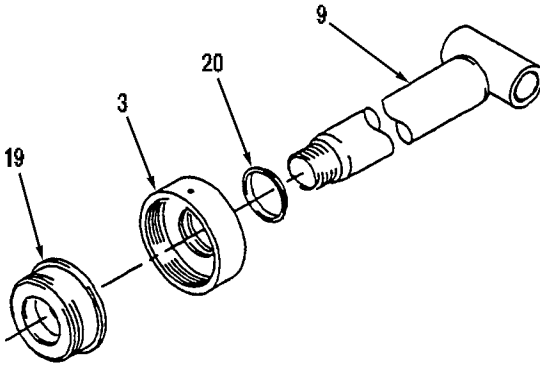
(2) Install backup ring (22) and preformed packing (21) on cylinder head (19).



(3) Install wiper ring (20) in retaining ring (3).

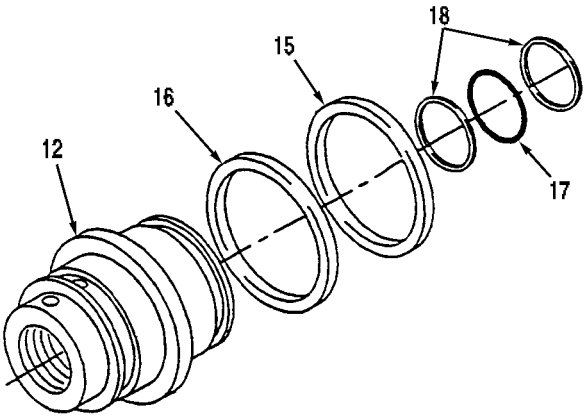
(4) Install retaining ring (3) on rod (9).

(5) Install cylinder head (19) on rod (9).



(6) Install two backup rings (18) and preformed packing (17) in piston (12).

(7) Install seal (16) and guide lock ring (15) on piston (12).

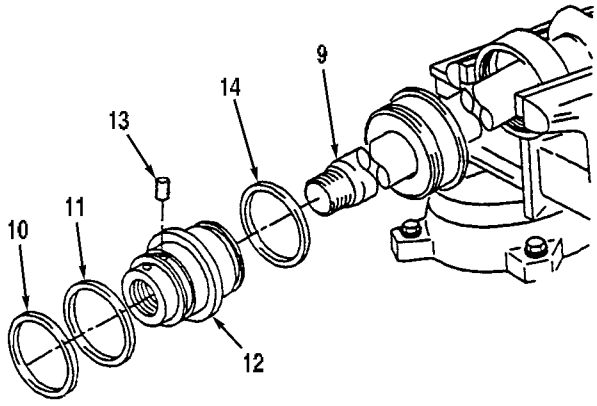


(8) Place rod (9) in vise.

(9) Install spacer (14) and piston (12) on rod (9) with setscrew (13).

(10) Install seal (11) and guide lock ring (10) on piston (12).

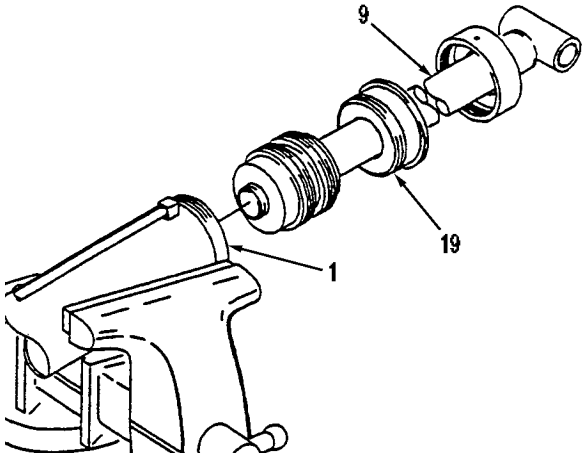
(11) Remove rod (9) from vise.



(12) With help from assistant, place cylinder barrel (1) in vise.

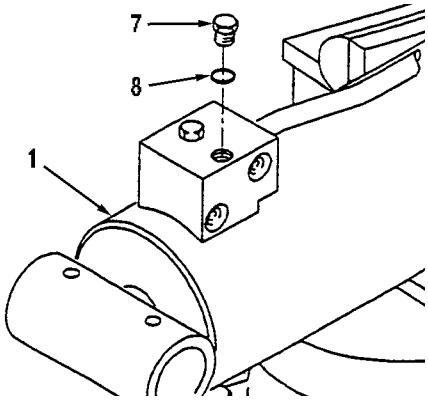
(13) Install rod (9) in cylinder barrel (1).

(14) Install cylinder head (19) in cylinder barrel (1).



(15) Install two preformed packings (8) on plugs (7).

(16) Install two plugs (7) in cylinder barrel (1).

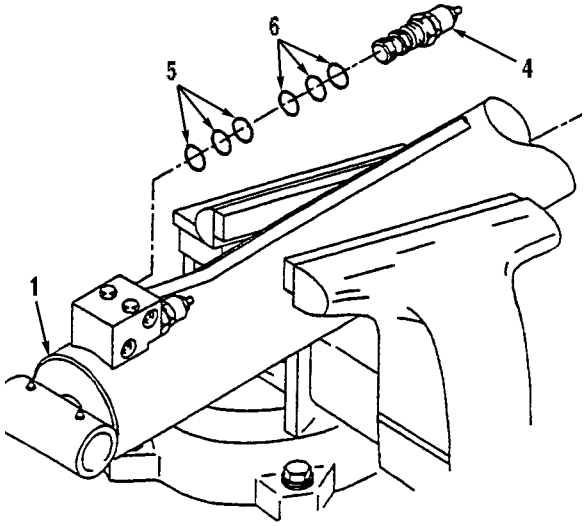


6-10. ERECTION CYLINDER REPAIR (Continued)

(17) Install three preformed packings (6) and backup rings (5) on cartridge holding valve (4).

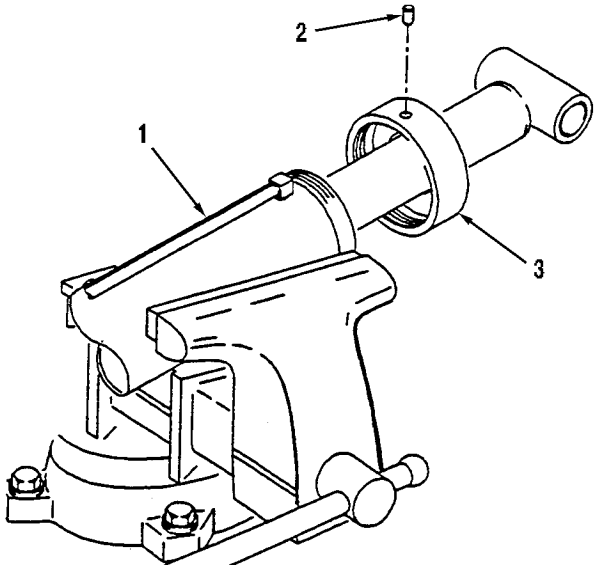
(18) Position cartridge holding valve (4) in cylinder barrel (1).

(19) Tighten cartridge holding valve (4) to 50-55 lb-ft (68-75 N·m).



(20) Install retaining ring (3) on cylinder barrel (1) with setscrew (2).

(21) With help from assistant, remove cylinder barrel (1) from vise.



END OF TASK

Follow-On Maintenance

Install erection cylinder (para 3-19).

6-11. BOOM TELESCOPIC CYLINDER REPAIR

THIS TASK COVERS:
a. Disassembly
b. Cleaning/Inspection
c. Assembly

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)
Pan, drain (Item 42, Appendix F)

Materials/Parts
Hydraulic oil (Item 16, Appendix B)
Kit, repair (Item 32, Appendix E)
Kit, repair (Item 36, Appendix E)
Kit, repair (Item 37, Appendix E)

Personnel Required
2 Assistants

Equipment Condition
Boom telescopic cylinder removed (para 3-15).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

---

a. Disassembly

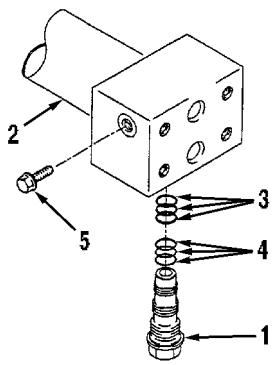
NOTE

- Place a container to catch hydraulic oil during disassembly.
- Disassemble lower cylinder first.

(1) Remove cartridge holding valve (1) from rod (2).

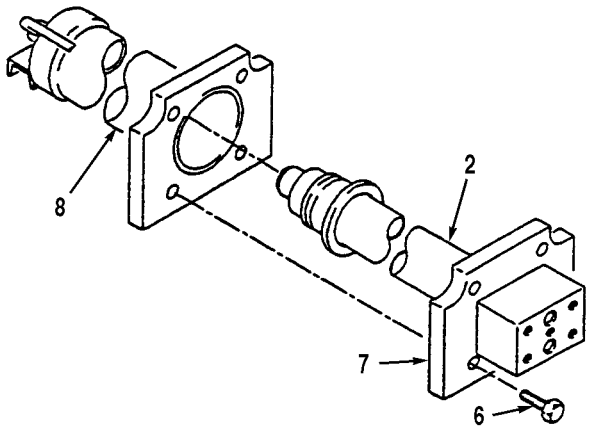
(2) Remove three backup rings (3) and preformed packings (4) from cartridge holding valve (1). Discard backup rings and preformed packings.

(3) Remove plug (5) from rod (2).



(4) With help from assistant, remove four screws (6) from retaining plate (7).

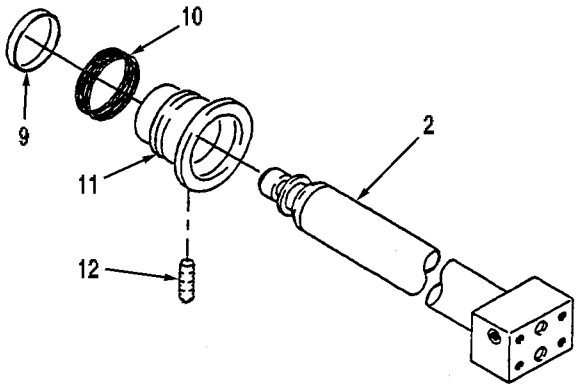
(5) Remove rod (2) from telescopic cylinder (8).



6-11. BOOM TELESCOPIC CYLINDER REPAIR (Continued)

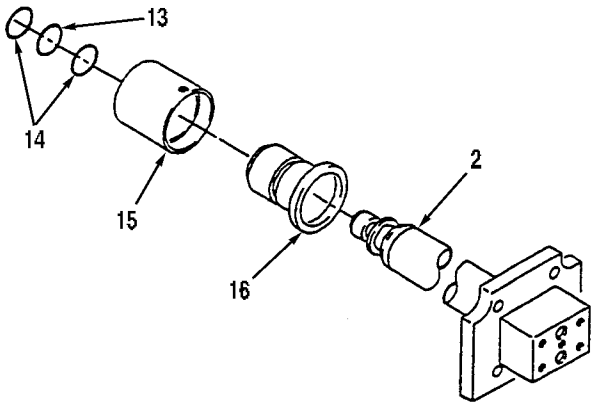
(6) Remove guide lock ring (9) and seal (10) from piston (11). Discard seal.

(7) Remove setscrew (12) and piston (11) from rod (2).



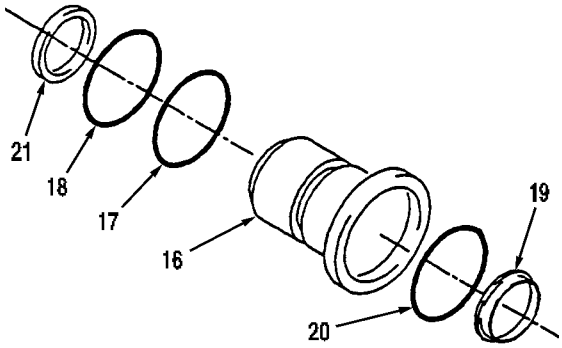
(8) Remove preformed packing (13) and two backup rings (14) from rod (2). Discard preformed packing and backup rings.

(9) Remove spacer (15) and cylinder head (16) from rod (2).



(10) Remove preformed packing (17) and backup ring (18) from cylinder head (16). Discard preformed packing and backup rings.

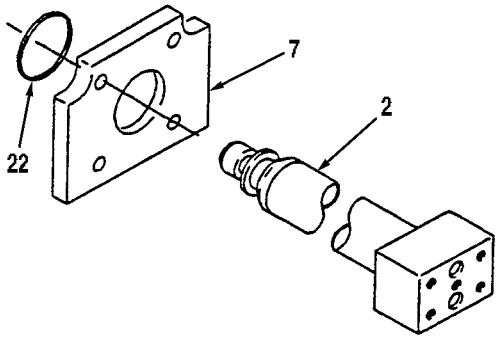
(11) Remove rod seal (19), buffer seal (20), and wear ring (21) from cylinder head (16). Discard rod seal, buffer seal and wear ring.



(12) Remove wiper ring (22) from rod (2). Discard wiper ring.

(13) Remove retaining plate (7) from rod (2).

(14) Perform steps (4 through 13) on upper cylinder.



b. Cleaning/Inspection

(1) Clean all parts.

(2) Inspect all parts for pitting, corrosion, scoring, damaged splines, damaged teeth, or indications of binding.

(3) Inspect all other parts. Replace all parts failing inspection.

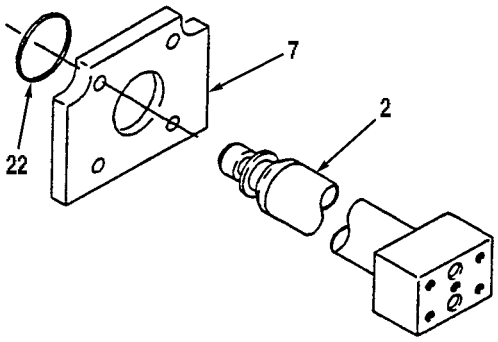
c. Assembly

NOTE

- Lubricate all preformed packings, backup rings and seals with clean hydraulic oil.
- Assemble upper cylinder first.

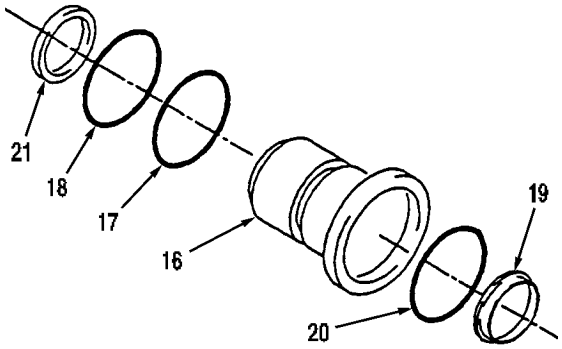
(1) Install retaining plate (7) on rod (2).

(2) Install wiper ring (22) on rod (2).



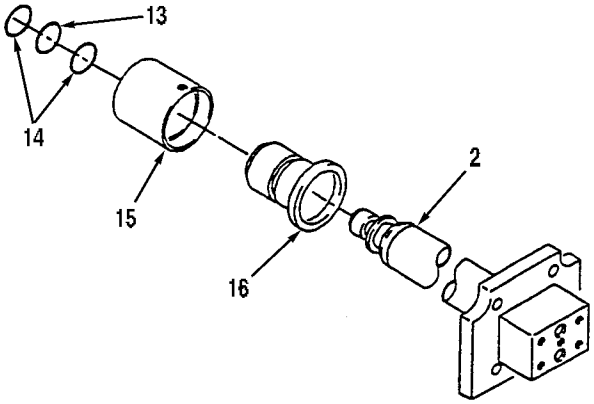
(3) Install wear ring (21), buffer seal (20), and rod seal (19) in cylinder head (16).

(4) Install backup ring (18) and preformed packing (17) on cylinder head (16).



(5) Install cylinder head (16) and spacer (15) on rod (2).

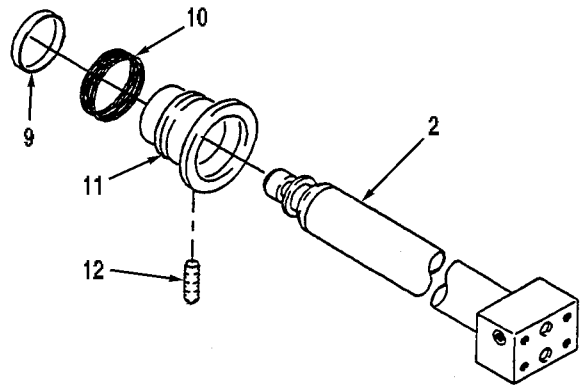
(6) Install two backup rings (14) and preformed packing (13) on rod (2).



6-11. BOOM TELESCOPIC CYLINDER REPAIR (Continued)

(7) Install piston (11) on rod (2) with setscrew (12).

(8) Install seal (10) and guide lock ring (9) on piston (11).

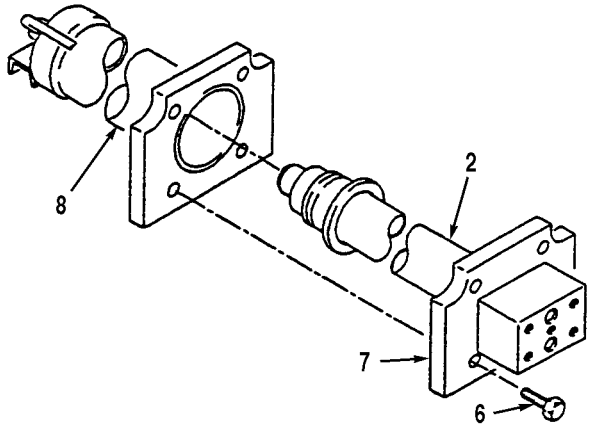


(9) With help from assistant, install rod (2) in telescopic cylinder (8).

(10) With help from assistant, position head retaining plate (7) to telescopic cylinder (8) with four screws (6).

(11) Tighten four screws (6) to 68 lb-ft (92 N·m).

(12) Repeat steps (1 through 11) on lower cylinder.



NOTE

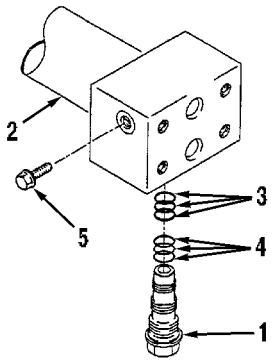
Perform steps (13) thru (16) for lower cylinder only.

(13) Install three preformed packings (4) and backup rings (3) on cartridge holding valve (1).

(14) Position cartridge holding valve (1) on rod (2).

(15) Tighten cartridge holding valve (1) to 50-55 lb-ft (68-75 N·m).

(16) Install plug (5) in rod (2).



END OF TASK

Follow-On Maintenance

Install boom telescopic cylinder (para 3-15).

6-12. CROSS-RELIEF VALVE REPAIR

THIS TASK COVERS:
a. Disassembly
b. Cleaning/Inspection
c. Assembly

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Hydraulic oil (Item 16, Appendix B)
Sealant, pipe (Item 27, Appendix B)
Packing, preformed (Item 89, Appendix E)
Packing, preformed (2) (Item 91, Appendix E)
Packing, preformed (2) (Item 109, Appendix E)
Repair kit (Item 138, Appendix E)

Equipment Condition
Cross-relief valve removed (para 3-32).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

a. Disassembly

(1) Remove two relief valves (1) from valve body (2).

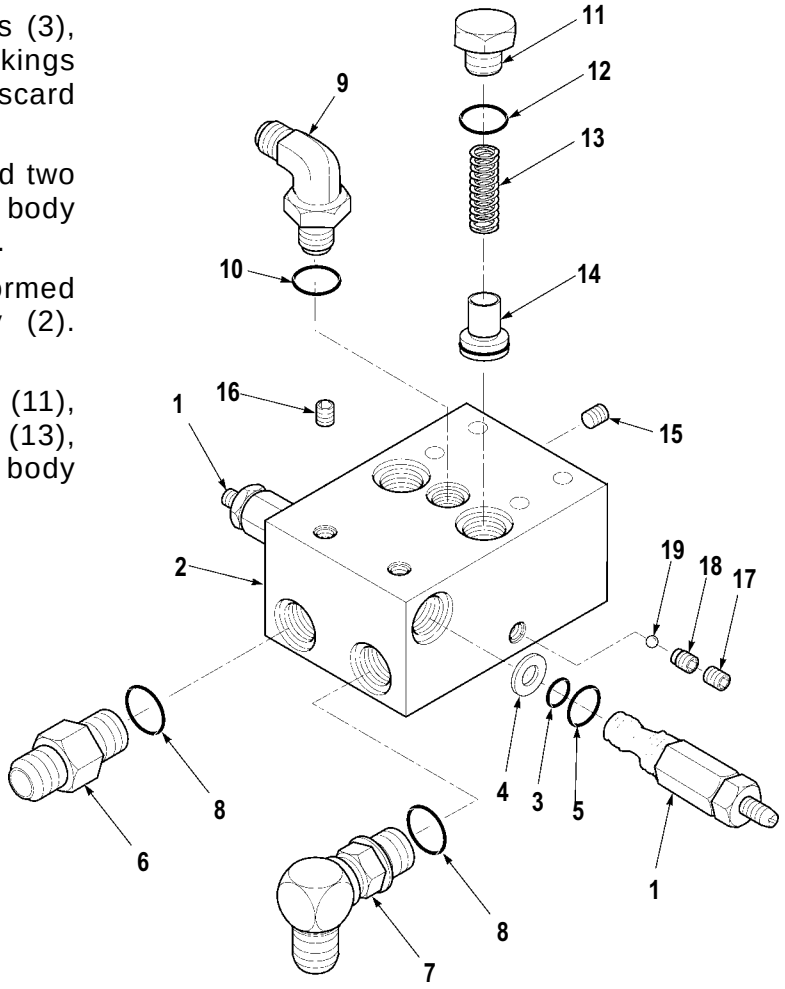
(2) Remove two preformed packings (3), retainers (4), and preformed packings (5) from relief valves (1). Discard preformed packings.

(3) Remove fitting (6), elbow (7), and two preformed packings (8) from valve body (2). Discard preformed packings.

(4) Remove elbow (9) and preformed packing (10) from valve body (2). Discard preformed packing.

(5) Remove two check valves (11), preformed packings (12), springs (13), and valve seats (14) from valve body (2). Discard preformed packing.

(6) Remove two plugs (15), two plugs (16), two plugs (17), ball seat (18), and ball bearing (19) from valve body (2).



6-12. CROSS-RELIEF VALVE REPAIR (Continued)

b. Cleaning/Inspection

(1) Clean all parts.

(2) Inspect all parts.

(3) Replace all parts failing inspection.

c. Assembly

NOTE

Lubricate all preformed packings with clean hydraulic oil.

(1) Apply sealing compound to plugs and install ball bearing (19), ball seat (18), two plugs (17), two plugs (16), and two plugs (15) in valve body (2).

(2) Install two valve seats (14), springs (13), preformed packings (12), and check valves (11) in valve body (2).

(3) Install preformed packing (10) and elbow (9) in valve body (2).

(4) Install two preformed packings (8), elbow (7), and fitting (6) in valve body (2).

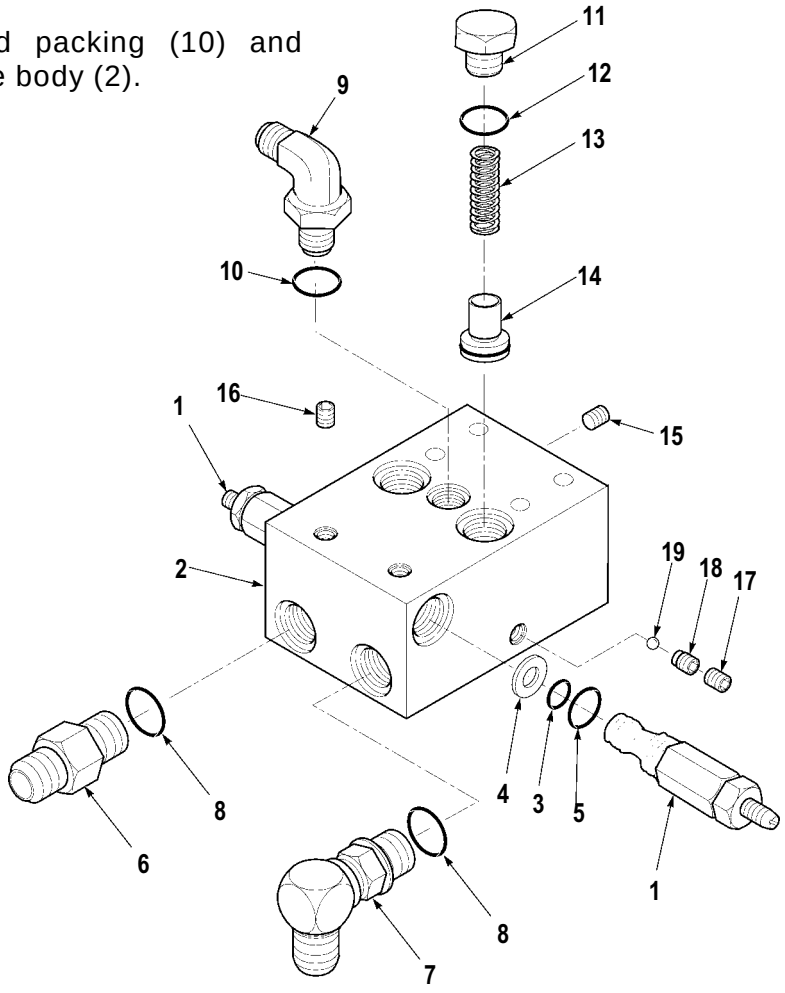
(5) Install two preformed packings (5), preformed packings (3), and retainers (4) on relief valves (1).

(6) Install two relief valves (1) in valve body (2).

END OF TASK

Follow-On Maintenance

Install cross relief valve (para 3-32).



6-13. FIVE FUNCTION CONTROL VALVE MANIFOLD REPAIR

THIS TASK COVERS: a. Disassembly
b. Assembly

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)
Shuttle valve tool (Appendix C)

Materials/Parts
Hydraulic oil (Item 16, Appendix B)
Packing, preformed (5) (Item 87, Appendix E)
Packing, preformed (4) (Item 90, Appendix E)
Packing, preformed (3) (Item 92, Appendix E)
Packing, preformed (10) (Item 115, Appendix E)
Backup ring (5) (Item 2, Appendix E)

Equipment Condition
Five function control valve removed (para 3-33).

Electric solenoid valves removed (para 3-37).

Crane control valves removed (para 3-36).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

---

a. Disassembly

NOTE

When disassembling manifold, tag all parts for location to ensure correct assembly.

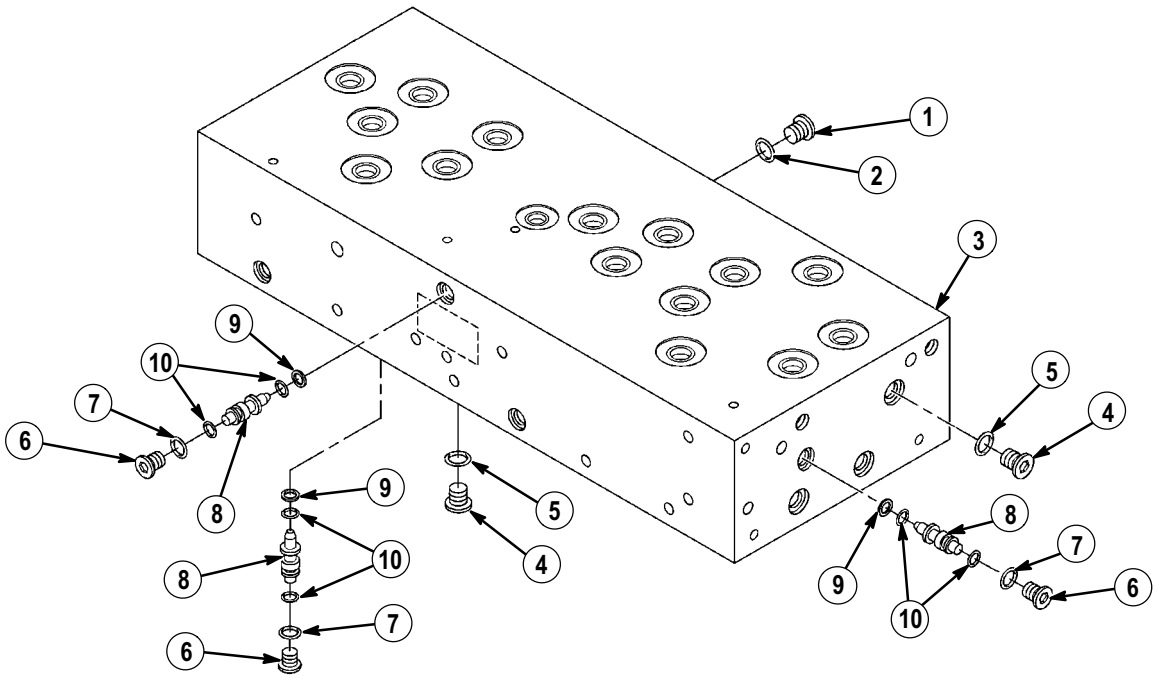
(1) Remove four plugs (1) and preformed packings (2) from manifold (3). Discard preformed packings.

(2) Remove three plugs (4) and preformed packings (5) from manifold (3). Discard preformed packings.

(3) Remove five plugs (6) and preformed packings (7) from manifold (3). Discard preformed packings.

(4) Using shuttle valve tool, remove five shuttle valves (8) from manifold (3).

(5) Remove backup ring (9), and two preformed packings (10) from five shuttle valves (8). Discard backup rings and preformed packings.



6-13. FIVE FUNCTION CONTROL VALVE MANIFOLD REPAIR (Continued)

b. Assembly

NOTE

Lubricate all new preformed packings and backup rings with clean hydraulic oil.

(1) Install two preformed packings (10) and backup ring (9) on five shuttle valves (8).

(2) Using shuttle valve tool, install five shuttle valves (8) in manifold (3).

(3) Install five preformed packings (7) and plugs (6) on manifold (3).

(4) Install three preformed packings (5) and plugs (4) on manifold (3).

(5) Install three preformed packings (2) and plugs (1) on manifold (3).

END OF TASK

Follow-On Maintenance

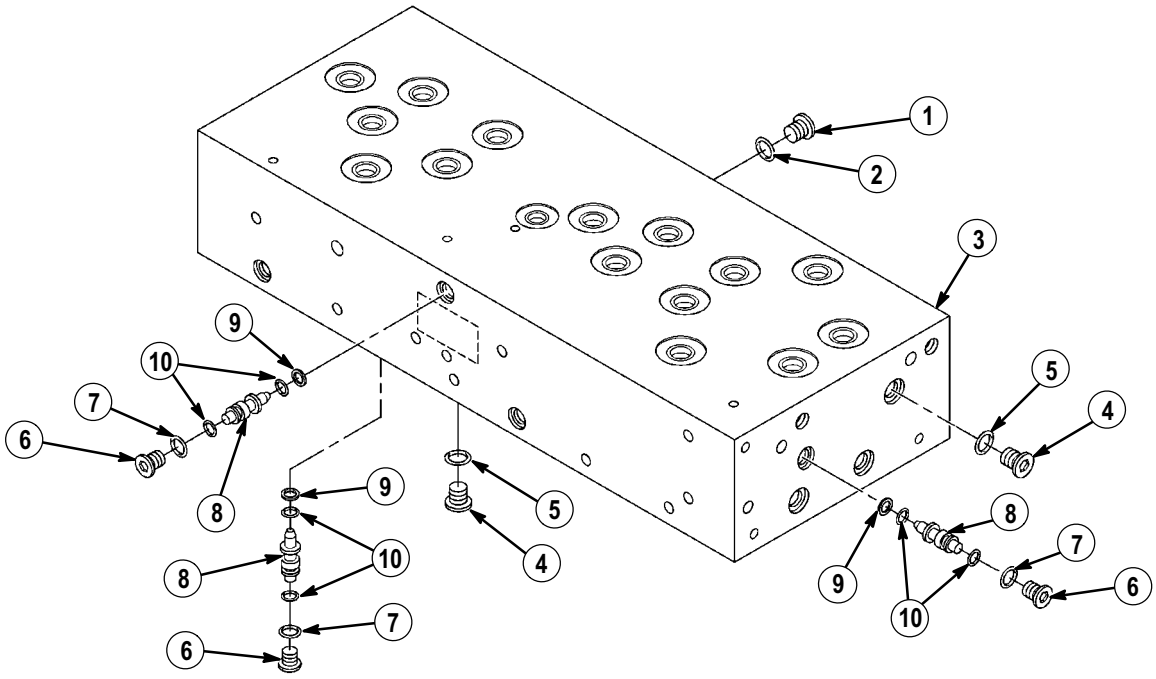
Install crane control valves (para 3-36).

Electric solenoid valves installed (para 3-37).

Install five function electric control valve (para 3-33).

Check crane for proper operation (TM 9-4940-568-10).

Load test crane (para 3-5).



6-14. HOIST, BOOM, TELESCOPE, SWING SOLENOID PILOT VALVE REPAIR

THIS TASK COVERS:
a. Disassembly
b. Cleaning/Inspection
c. Assembly

INITIAL SETUP

Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)

Materials/Parts
Hydraulic oil (Item 16, Appendix B)
Packing, preformed (4) (Item 97, Appendix E)
Packing, preformed (2) (Item 94, Appendix E)

Equipment Condition
Hoist, boom, telescope, and swing valves removed (para 3-37).

Special Environmental Conditions
Cleanliness is extremely important when working on hydraulic equipment. Clean all parts before disassembly and work in a clean area.

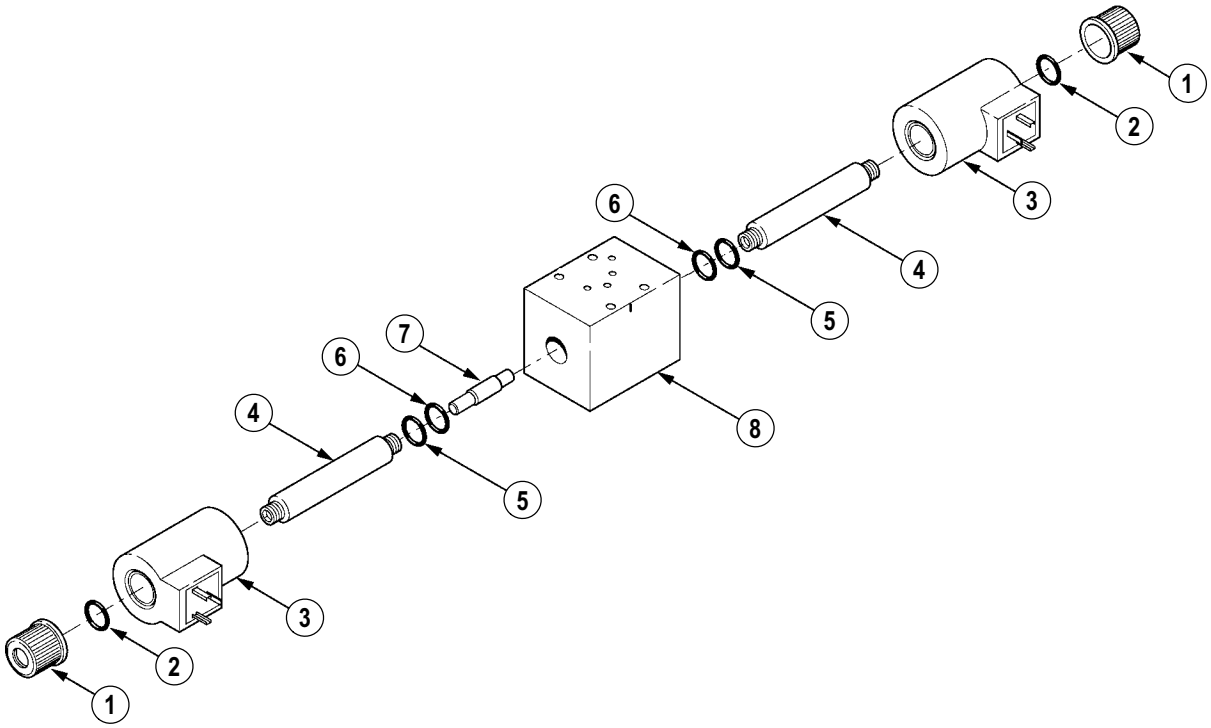
a. Disassembly

NOTE

- All four pilot valves are disassembled the same way.
- Matchmark position of two solenoids prior to removal.

(1) Remove two caps (1), preformed packings (2) and solenoids (3) from directional valves (4). Discard preformed packings.

(2) Remove two directional valves (4), preformed packings (5), preformed packings (6) and valve slide (7) from solenoid valve (8). Discard preformed packings.



6-14. HOIST, BOOM, TELESCOPE, SWING SOLENOID PILOT VALVE REPAIR (Continued)

b. Cleaning/Inspection

(1) Clean all parts.

(2) Inspect all parts for scoring, pits, rust, gouges, or damage.

(3) Inspect all other parts. Replace all parts failing inspection.

c. Assembly

NOTE

- Lubricate all preformed packings with clean hydraulic oil.
- All four valves are assembled the same way.

(1) Install valve slide (7) in solenoid valve (8).

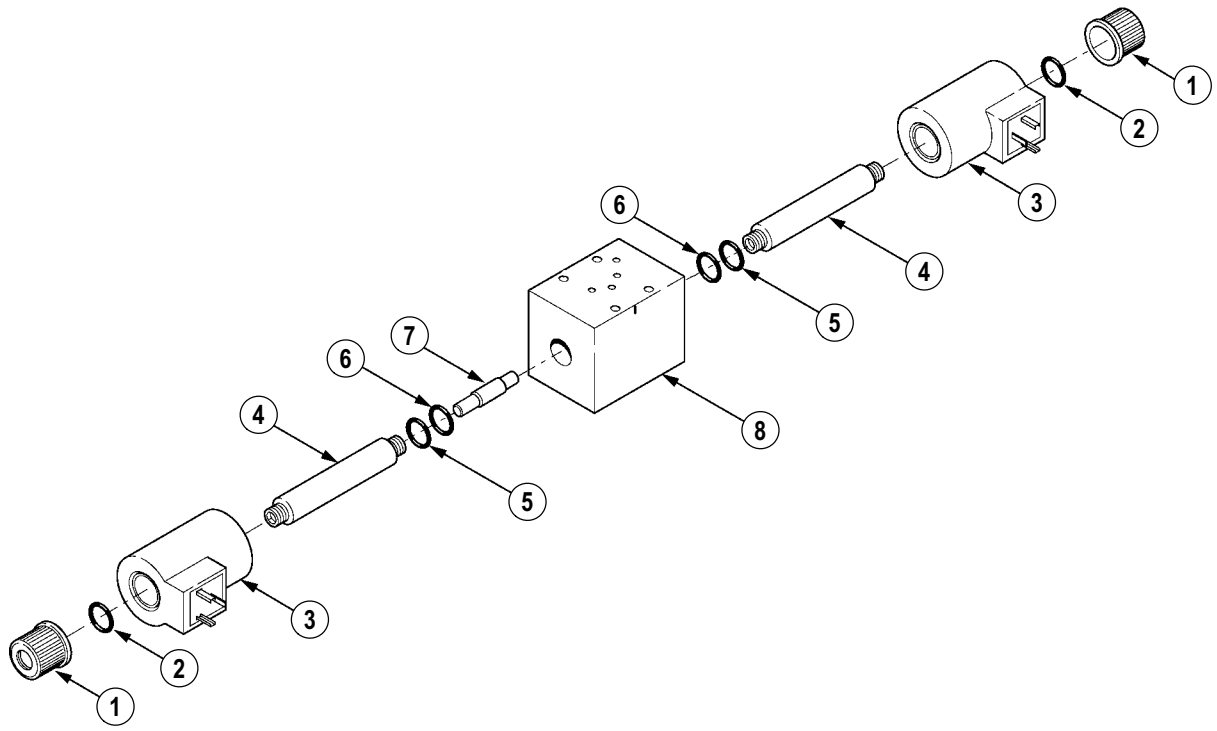
(2) Install two preformed packings (6), preformed packings (5) and directional valves (4) in solenoid valve (8).

(3) Aline matchmarks and install two solenoids (3), preformed packings (2) and caps (1) on directional valves (4).

END OF TASK

Follow-On Maintenance

Install hoist, boom telescope, and swing valves (para 3-37).



CHAPTER 7
GENERAL SUPPORT ENGINE AND GENERATOR MAINTENANCE

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7-1. INTRODUCTION.

This chapter contains maintenance instructions for removing, replacing, repairing, installing and adjusting components authorized by the Maintenance Allocation Chart (MAC) at the General Support Maintenance level.

7-2. INSTALLING/REMOVING ENGINE FROM STAND.

This task covers:

a. Installing Engine On Engine Stand
b. Removing Engine From Engine Stand
c. Follow-On Maintenance

INITIAL SETUP

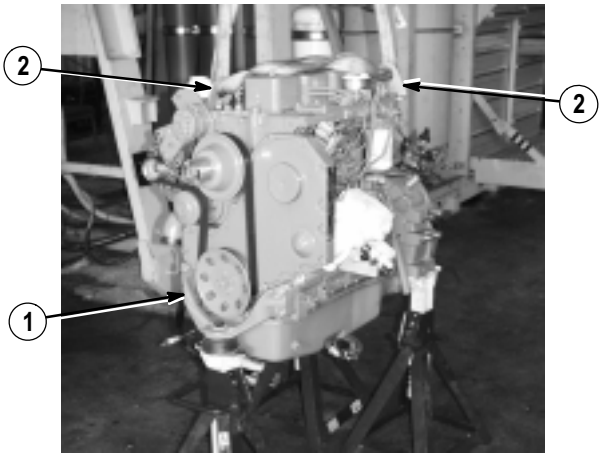
Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Jackstand, Trestle (3) (Item 35, Appendix F)
Plate, Adapter, Engine (Item 43, Appendix F)
Stand, Maintenance, Engine (Item 55, Appendix F)
Wrench, Torque (0-175 lb-ft [0-237 N·m]) (Item 83, Appendix F)
Lifting Device, Minimum Capacity 700 lbs (227 kg)

Materials/Parts
Screw (4) (Item 147, Appendix E)

Personnel Required
Two

Equipment Condition
Engine removed, (Para 5-4)
Starter removed, (TM 9-4940-568-20)
Drain oil from engine, (TM 9-4940-568-20)
Oil filter removed, (TM 9-4940-568-20)

a. Installing Engine On Engine Stand.



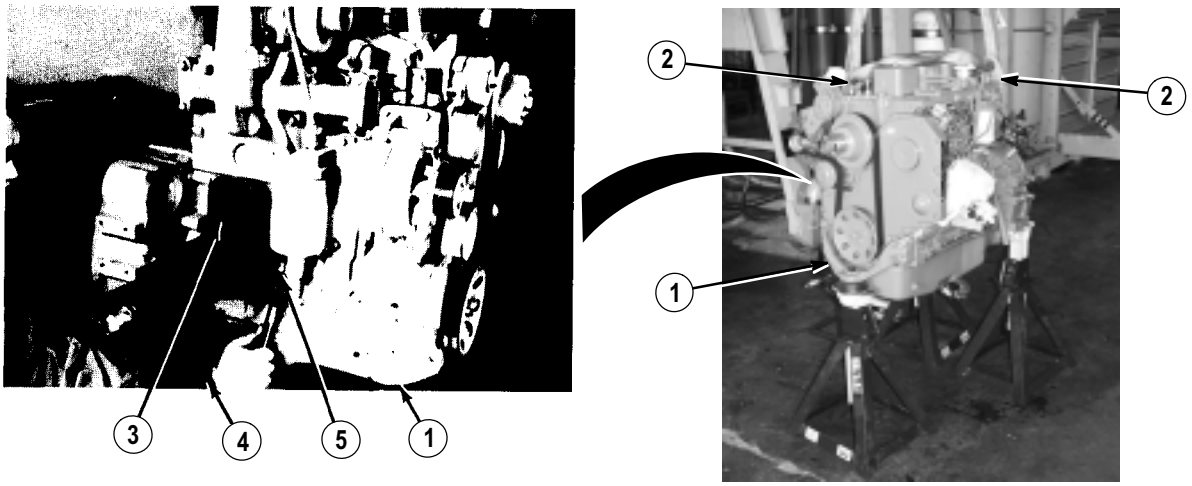
WARNING

- Engine weighs approximately 680 lbs (308 kg). Attach suitable lifting device to prevent possible injury to personnel.
- Keep out from under engine when lifting. If engine slips, sideways, or falls, serious injury or death may result.

CAUTION

- Ensure loose wires and hoses are secure and moved out of the way so they do not snag and cause damage when engine is lifted.
- Before lifting engine completely off support, test by lifting slightly to see if balanced. If engine starts to tilt, lower and adjust. Unbalanced engine can swing causing damage.

(1) Install lifting device on engine (1) at lifting points (2).



(2) With the aid of an assistant, align side of engine (1) to mounting bracket (3) of stand (4).

(3) Install four screws (5) and secure engine (1) to stand (4). Tighten screws to 57 lb-ft (77 N·m).

b. Removing Engine From Engine Stand.

WARNING

- Engine weighs approximately 680 lbs (308 kg). Attach suitable lifting device to prevent possible injury to personnel.
- Keep out from under engine when lifting. If engine slips, sideways, or falls, serious injury or death may result.

CAUTION

- Ensure loose wires and hoses are secure and moved out of the way so they do not snag and cause damage when engine is lifted.
- Before lifting engine completely off support, test by lifting slightly to see if balanced. If engine starts to tilt, lower and adjust. Unbalanced engine can swing causing damage.

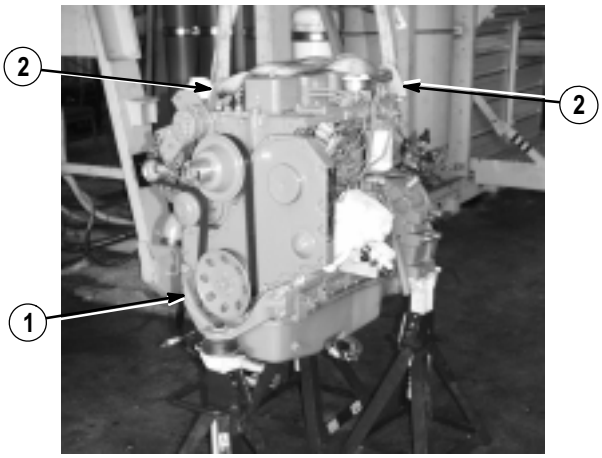
(1) Install lifting device on engine (1) at lifting points (2) and support engine.

(2) With the aid of an assistant, remove four screws (5) from engine (1) and stand (4).

7-2. INSTALLING/REMOVING ENGINE FROM STAND (CONT).

(3) Position engine (1) on jackstands.

(4) Remove lifting device from engine (1).



c. Follow-On Maintenance:

- Install oil filter, (TM 9-4940-568-20).
- Fill engine with oil, (TM 9-4940-568-20).
- Install starter, (TM 9-4940-568-20).
- Install engine, (Para 5-4).

END OF TASK

7-3. CYLINDER BLOCK REPAIR AND DE-GLAZING INSTRUCTIONS.

This task covers:

a. Removal
b. Cleaning/Inspection
c. De-Glazing and Honing
d. Installation
e. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Compressor Unit, Air (Item 10, Appendix F)
Drill, Electric, Portable (Item 14, Appendix F)
Gloves, Chemical Oil Protective (Item 23, Appendix F)
Goggles, Industrial (Item 25, Appendix F)
Gun, Air Blow (Item 29, Appendix F)
Honing Unit, Cylinder Bore, Portable (Item 31, Appendix F)
Sander, Portable, Disc Electric (Item 48, Appendix F)
Steam Cleaner (Item 56, Appendix F)
Straight Edge (Item 59, Appendix F)

Materials/Parts
Cloth, Cleaning (Item 6, Appendix B)
Oil, Lubricating (Item 17, Appendix B)
Pad, Sanding (Item 20, Appendix B)
Paper, 400Grit (Item 21, Appendix B)
Sealant (Item 26, Appendix B)
Sealing Compound (Item 31, Appendix B)
Solvent, Drycleaning (Item 34, Appendix B)
Spirits, Mineral (Item 35, Appendix B)

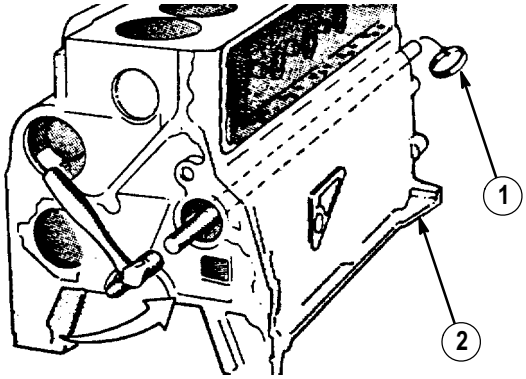
Materials/Parts – Continued
Tape, Protective (Item 37, Appendix B)
Waterproof Tape (Item 38, Appendix B)
Plug, Camshaft Expansion (Item 130, Appendix E)
Plug, Expansion (2) (Item 133, Appendix E)
Plug, Expansion (3) (Item 135, Appendix E)
Plug, Expansion (3) (Item 134, Appendix E)
Plug, Expansion (3) (Item 131, Appendix E)
Plug, Expansion (Item 132, Appendix E)

Equipment Condition
Engine installed on stand, (Para 7-2)
Remove cylinder head, (Para 7-4)
Piston and connecting rod assemblies removed, (Para 7-6)
Engine oil pan and suction tube removed, TM 9-4940-568-20)
Camshaft removed, (Para 7-7)
Front gear housing removed, (Para 7-9)
Crankshaft removed, (Para 7-5)
Crankshaft rear seal removed, (Para 5-10)
Lube oil pump removed, (Para 5-13)

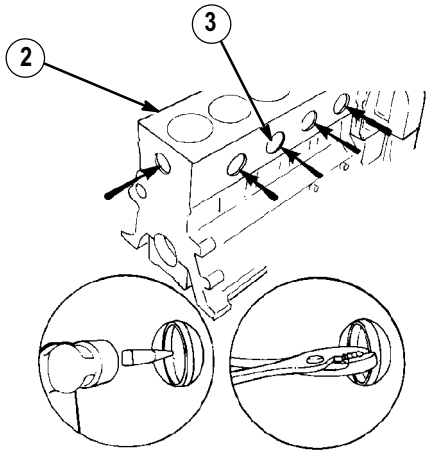
7-3. CYLINDER BLOCK REPAIR AND DE-GLAZING INSTRUCTIONS (CONT).

a. Removal.

(1) Drive camshaft expansion plug (1) from cylinder block (2). Discard expansion plug.



(2) Remove expansion plugs (3) from cylinder block (2). Discard expansion plugs.

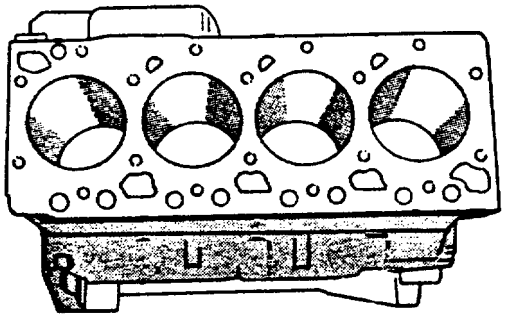


b. Cleaning/Inspection.

CAUTION

Clean the cylinder bores immediately after de-glazing.

(1) Scrape gasket material and sealant off cylinder block surfaces.



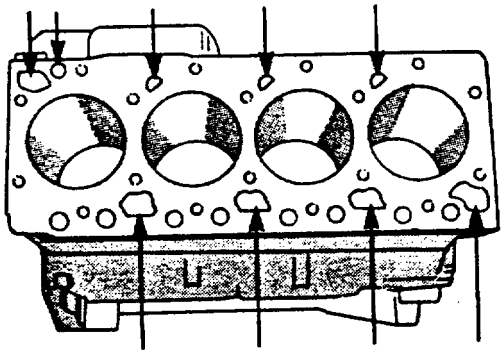
WARNING

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles, face shield, and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes, and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent. The flashpoint for Type II Drycleaning Solvent is 140 degrees F (60 degrees C) and Type III Drycleaning Solvent is 200 degrees F (93 degrees C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.

(2) Wash the cylinder bores with drycleaning solvent. Use a nylon brush to clean all oil passages.

CAUTION

Build up of deposits in coolant passages can cause engine overheating. Excessive deposits can be cleaned in an acid tank, but the cam bushing must be removed first (Para 7-7). Failure to follow this procedure could cause damage to the equipment.

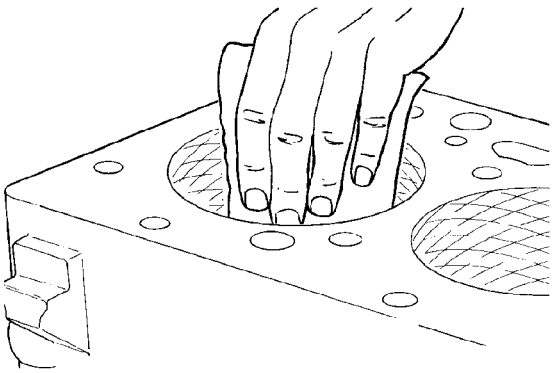


(3) Make sure coolant passages are clean.

WARNING

High pressure steam can blow particles into eyes, can cause severe burns, and creates hazardous noise levels. Eye, skin, and hearing protection is required.

(4) Steam clean cylinder block. Ensure oil and water galleries are cleaned thoroughly.

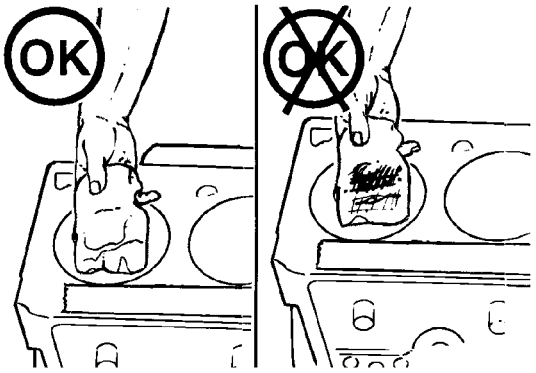


7-3. CYLINDER BLOCK REPAIR AND DE-GLAZING INSTRUCTIONS (CONT).

NOTE

Cam bushing does not have to be removed for Step (5).

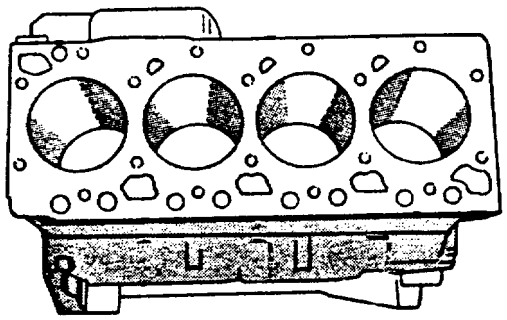
(5) Check the cylinder bore cleanliness by wiping with a white, lint-free, lightly oiled cloth. If grit residue is still present, repeat the cleaning process until all residue is removed.



WARNING

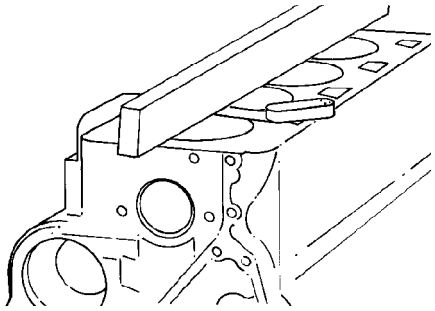
Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc). Failure to comply may result in injury to personnel.

(6) Dry the cylinder block with compressed air.



(7) Using a straight edge and feeler gauge, measure the overall flatness of the cylinder block. The overall flatness must not exceed 0.003 in. (.076 mm) end-to-end, and .002 in. (.051 mm) side-to-side. Replace cylinder block if not within limits.

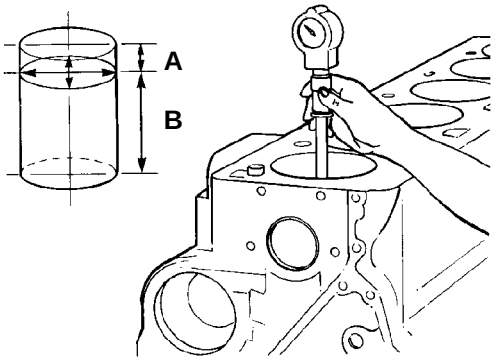
(8) Visually inspect for any localized dips or imperfections. If present, replace cylinder block.



NOTE

- Do not proceed with in-chassis overhaul if cylinder bores are worn beyond specifications.
- Oversize pistons and rings are available for re-bored cylinder blocks.

(9) Check for out-of-roundness and taper of bore. Tolerance for out-of-roundness is 0.0015 in. (0.038 mm) measured in 1.00 in (25.4 mm) distance. Tolerance for taper is 0.003 in. (0.76 mm) measured in 4.50 in. (144.3 mm) distance.



Bore I.D. Min. – 4.0157 in. (101.99 mm)

Bore I.D. Max – 4.0203 in. (102.116 mm)

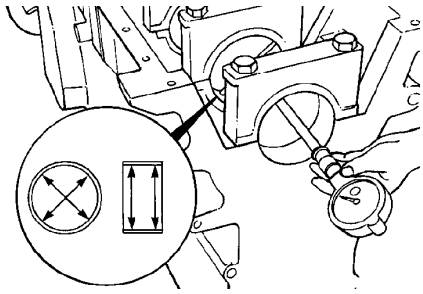
Bore Out of Round Max. – .0015 in. (.035 mm)

Bore Taper Max. – .003 in. (.076 mm)

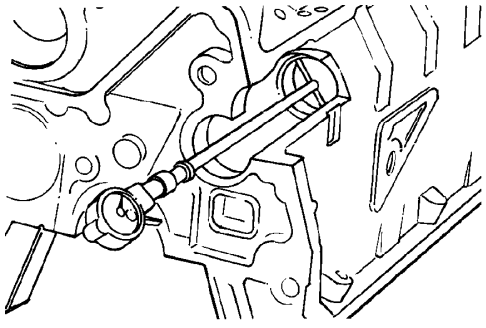
(10) If tolerances exceed limits block must be bored or replaced. Refer to de-glazing and honing section.

(11) Inspect tappet bores for scoring or excessive wear. Minimum diameter should be 0.630 in. (16.00 mm) and maximum diameter should be 0.632 in. (16.05 mm).

(12) Measure the main bearing bore diameter. The maximum diameter with bearing installed is 3.272 in. (83.106 mm) (Para 7-5).



(13) Measure the camshaft bore diameter. The maximum measurements are listed below.



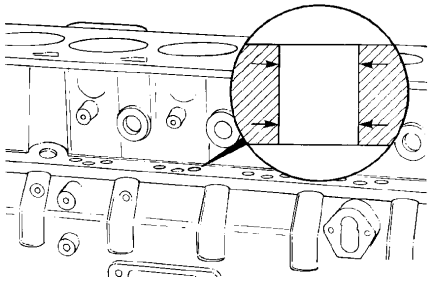
2.2543 in. (57.258 mm) (without bushing) No. 1 only

2.1317 in. (54.146 mm) No. 1 with bushing

2.1324 in. (54.164 mm) No. 2 through No. 7

7-3. CYLINDER BLOCK REPAIR AND DE-GLAZING INSTRUCTIONS (CONT).

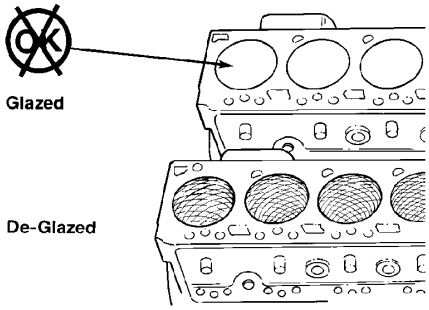
c. De-Glazing and Honing.



NOTE

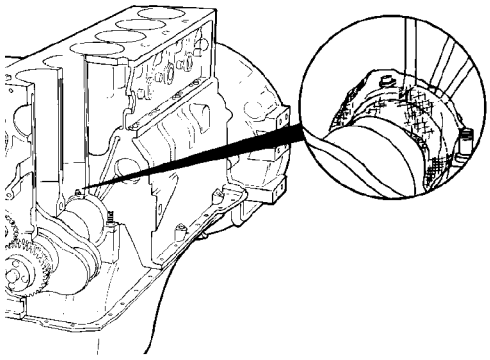
- New piston rings may not seal in glazed cylinder bores.
- De-glazing gives cylinder bore the correct surface finish required to seat the rings.

(1) If necessary wrap connecting rod journals with a clean cloth and cover cloth with waterproof tape.



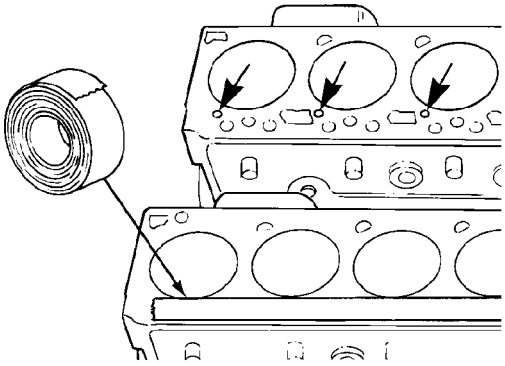
(2) Place a clean shop towel around top main bearing saddle to deflect water and residue from piston cooling nozzles.

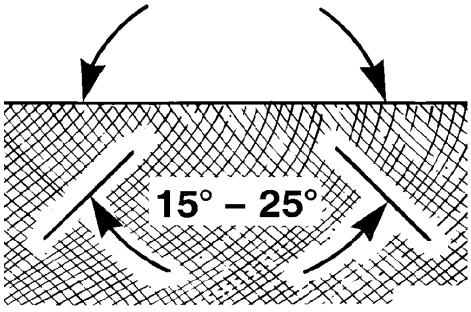
(3) Also cover lubricating holes and tappet holes in top of cylinder block with waterproof tape.

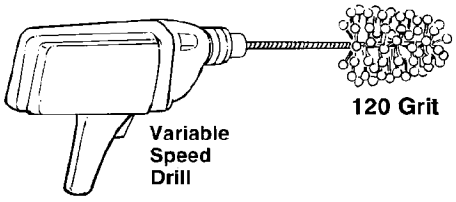


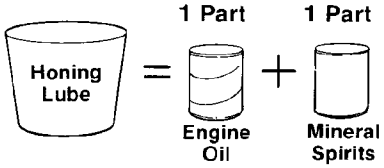
(4) A correctly de-glazed surface will have a crosshatched appearance with lines at 15-to-25 degree angles with top of cylinder block.

(5) Using a drill, fine grit flex-hone and a mixture of equal parts of mineral spirits and engine lubricating oil, de-glaze the cylinder bores.







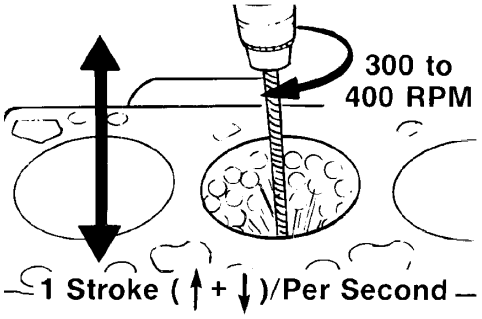


CAUTION

Crosshatch angle is a function of the drill speed and how fast the hone is moved vertically. Drill speed should be 300 to 400 rpm. Failure to follow this procedure could cause damage to equipment.

NOTE

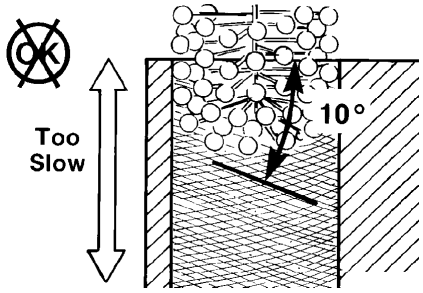
Vertical strokes must be smooth, continuous passes along the full length of the bore.

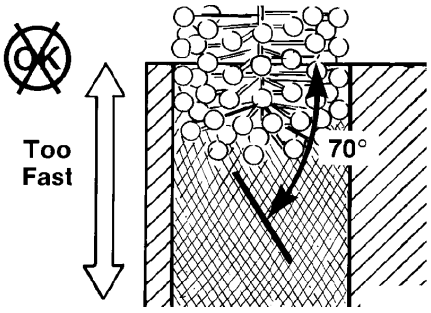


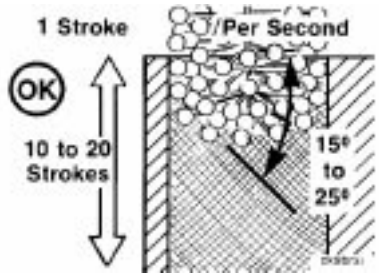
(6) Inspect cylinder bore after 10 strokes.

(7) If drill speed is too slow or vertical stroke is too fast, crosshatch angle lines will show a 70-degree angle.

(8) If drill speed is too fast or vertical stroke is too slow, crosshatch angle lines will show a 10 degree angle.



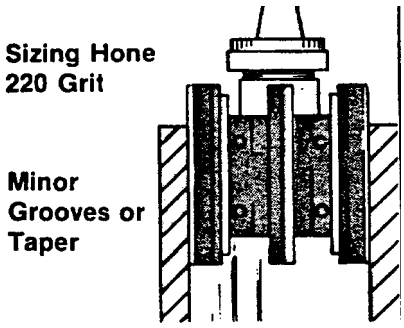




CAUTION

Be extremely careful not to hone the bore out of specification. Refer to Step (9) of cleaning/inspection for proper specifications. Failure to follow this procedure could cause damage to the equipment.

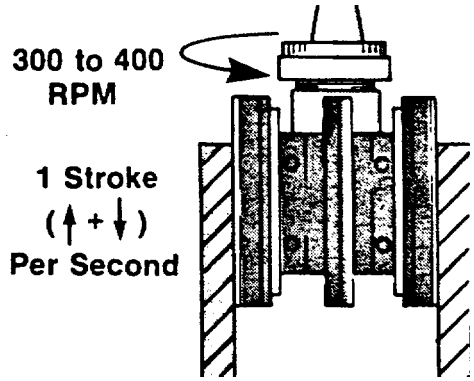
(9) A sizing hone can be used to remove minor grooves or to correct minor out of taper.



7-3. CYLINDER BLOCK REPAIR AND DE-GLAZING INSTRUCTIONS (CONT).

(10) Operate sizing hone similar to Flexi-Hone. Inspect bore after 10 strokes.

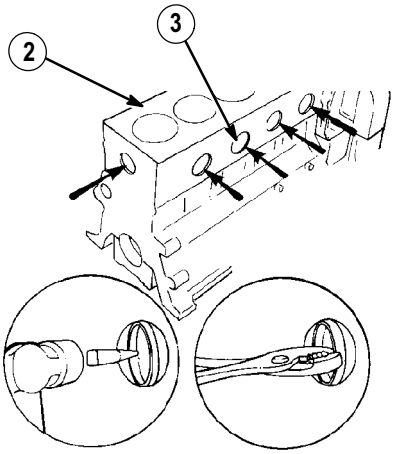
(11) Remove tape from lubricating holes and tappet holes.



d. Installation.

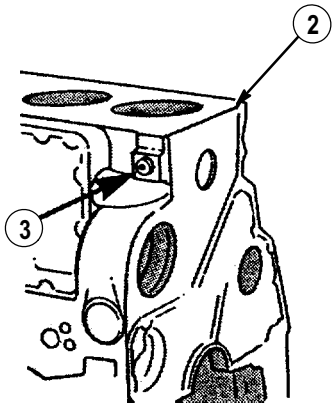
WARNING

Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

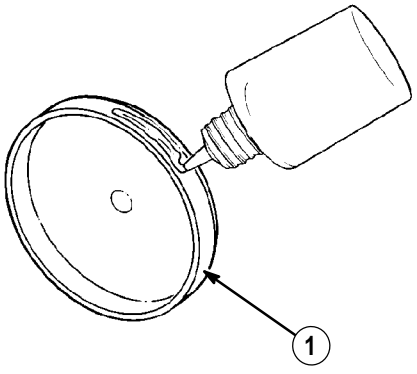


(1) Apply sealant to expansion plugs (3).

(2) Install expansion plugs (3) into passages until flush with countersink in cylinder block (2).



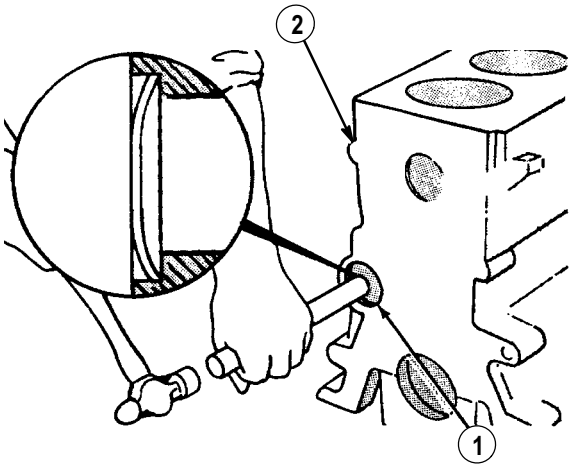
(3) Apply sealant around outside diameter of camshaft expansion plug (1).



CAUTION

Make sure oil holes are clean. A 0.128 in. (3.25 mm) diameter rod must be able to pass through oil holes. Failure to follow this procedure could cause damage to equipment.

(4) Using a large drift and hammer, expand camshaft expansion plug (1) and drive it flush with cylinder block (2).



e. Follow-On Maintenance:

- Install engine oil pan and suction tube, (TM 9-4940-568-20).
- Install piston and connecting rod assemblies, (Para 7-6).
- Install cylinder head and gaskets, (Para 7-4).
- Install camshaft, (Para 7-7).
- Install front gear housing, (Para 7-9).
- Install crankshaft, (Para 7-5).
- Install crankshaft rear seal, (Para 5-20).
- Install lube oil pump, (Para 5-13).
- Remove engine from stand, (Para 7-2).

END OF TASK

7-4. CYLINDER HEAD REPAIR.

This task covers:

a. Disassembly
b. Cleaning/Inspection
c. Valve Springs Inspection
d. Assembly
e. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Brush, Bore (Item 3, Appendix F)
Compressor, Spring, Valve (Item 9, Appendix F)
Compressor Unit, Air (Item 10, Appendix F)
Gage, Depth, Micrometer (Item 20, Appendix F)
Gloves, Chemical Oil (Item 23, Appendix F)
Goggles, Industrial (Item 25, Appendix F)
Grinding Wheel (Item 27, Appendix F)
Gun, Air Blow (Item 29, Appendix F)
Micrometer, Outside, Caliper Set (Item 37, Appendix F)
Sander, Portable, Disk Electric (Item 48, Appendix F)
Soft Wire Wheel (Item 54, Appendix F)
15-Degree Stone (Item 57, Appendix F)
60-Degree Stone (Item 58, Appendix F)

Tools and Special Tools - Continued
Straight Edge (Item 59, Appendix F)
Lifting Device, Minimum Capacity 80 lbs (36kg)

Materials/Parts
Crocus Cloth (Item 11, Appendix B)
Oil, Lubricating (Item 17, Appendix B)
Paper, 400-Grit (Item 21, Appendix B)
Pad, Sanding (Item 20, Appendix B)
Solution, Soap (Item 33, Appendix B)
Valve Lapping Compound (Item 40, Appendix B)

Personnel Required
Two

Equipment Condition
Cylinder head removed, (Para 5-7)

a. Disassembly.

NOTE

- Cylinder head has integral valve guides and valve seats. The seats can be re-ground. Service valve guides are also available to replace worn guides.
- The following is a maintenance procedure for one valve spring, two valve collets and valve. The maintenance procedure for the remaining seven valve springs, valve collets and valve is identical.

(1) Mark valve (1) to identify position and to aid in assembly.

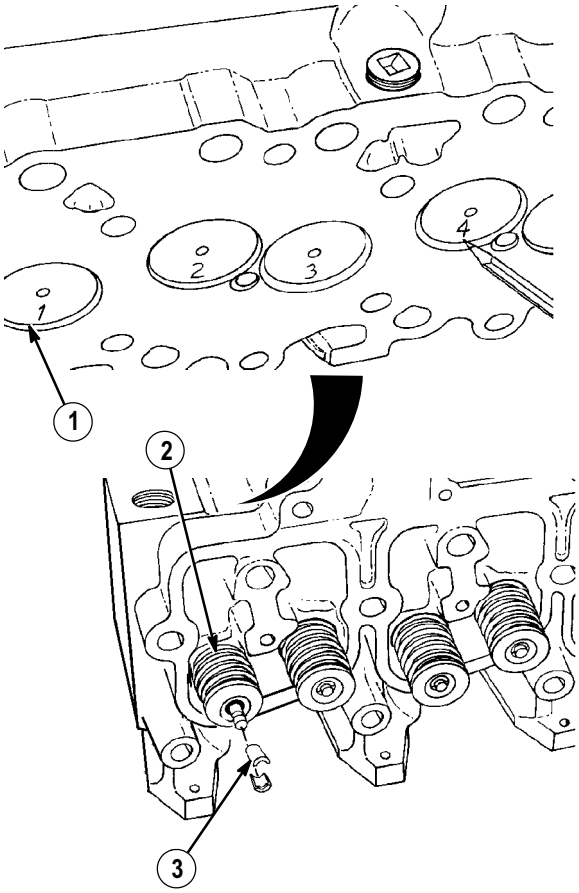
WARNING

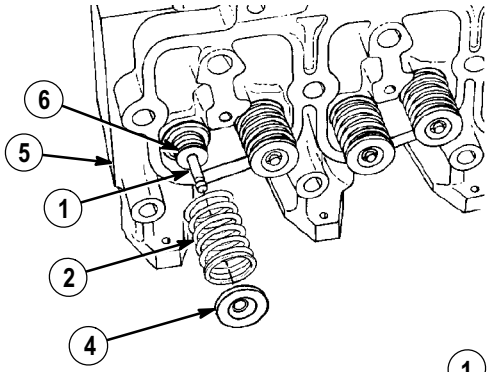
Use care when removing springs. Springs are under tension and can act as projectiles when released. Failure to comply may result in injury to personnel.

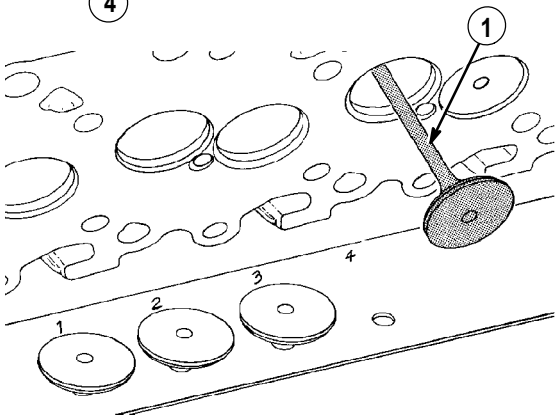
(2) Using spring compressor, compress valve spring (2) and remove valve collets (3).

(3) Release valve spring (2) slowly and remove retainer (4), valve spring (2) and valve (1) from cylinder head (5).

(4) Remove valve seal (6) from cylinder head (5).



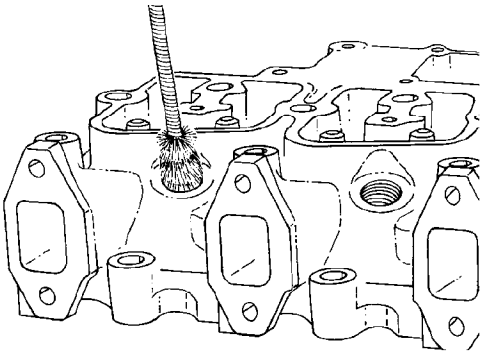




7-4. CYLINDER HEAD REPAIR (CONT).

b. Cleaning/Inspection.

(1) Clean carbon from injector nozzle seat with bore brush.



WARNING

Compressed air used for cleaning purposes must not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc) or injury to personnel may result.

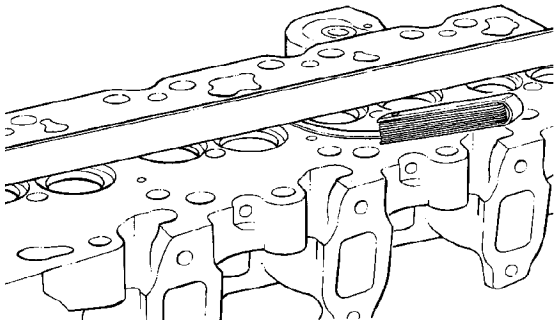
(2) Wash cylinder head in hot soapy water solution and dry with compressed air.

(3) Polish gasket surfaces with 400-grit paper. Use sander or sanding block to maintain a flat surface.

(4) Inspect valve guides for scuffing or scoring.

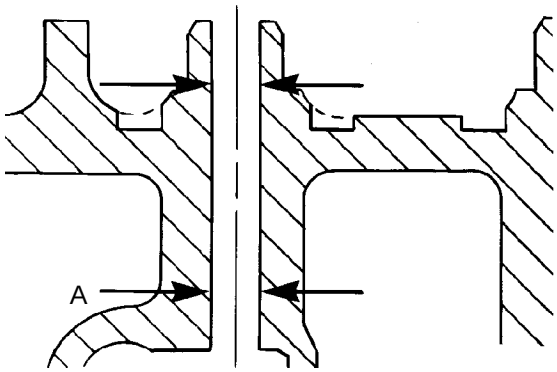
(5) Inspect cylinder head surface for nicks and erosion.

(6) Using a feeler gage and straight edge, check cylinder head for distortion.



The overall flatness, side to side, must not exceed 0.003 in. (0.075 mm).
The overall flatness, end to end, must not exceed 0.008 in. (0.203 mm).

(7) Measure valve guide bore. Minimum diameter is 0.3157 in. (8.019 mm) and maximum diameter is 0.3185 in. (8.090 mm).



(8) If valve guide bores are found to be worn during inspection, cylinder head must be machined for service valve guides. Valve guides must be finished-reamed after installation into head.

NOTE

If, after inspection, it is determined that service valve guides and valve inserts are required, install service valve guides first.

Valve Guide Part No.

3904408 – Intake (Thick wall)

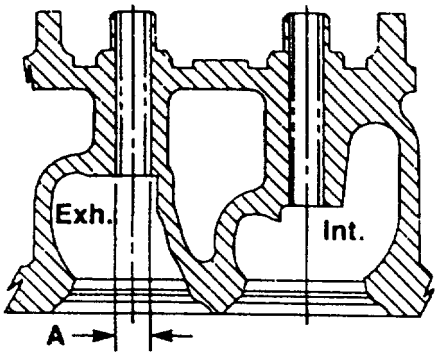
3904409 – Exhaust (Thick wall)

3906206 – Intake and Exhaust (Thin wall)

NOTE

The following dimensions are for (Thin wall) valve guides.

(9) Machine cylinder head parent metal valve guide bores to dimension “A”.



A = 0.4380 ± 0.0005 in. (11.125 ± 0.013 mm) diameter.

Bore is to be centered with valve seats within 0.01378 in. (0.3500 mm) diameter and square with combustion face within 0.004 in. (0.10 mm) at 1.9685 in. (49.999 mm) radius.

7-4. CYLINDER HEAD REPAIR (CONT).

(10) Install valve guides to dimension A thru D.

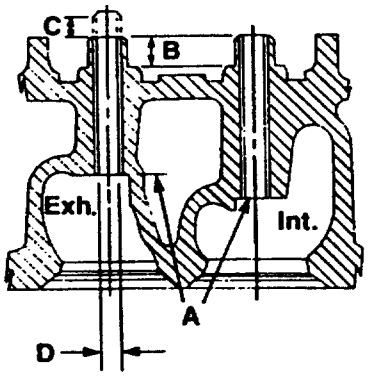
A = Lubricate with oil and press guides flush to bottom of bosses.

B = 0.4724 ± 0.0295 in. (12.00 ± 0.75 mm) diameter.

C = Trim off flush to top of guide bosses, if necessary.

D = 0.3161 ± 0.0004 in. (8.029 ± 0.010 mm).

Final bore after assembly is to be centered with valve seats within 0.01378 in. (0.3500 mm) diameter and square with combustion face within 0.004 in. (0.10 mm) at 1.9685 in. (49.999 mm) radius.



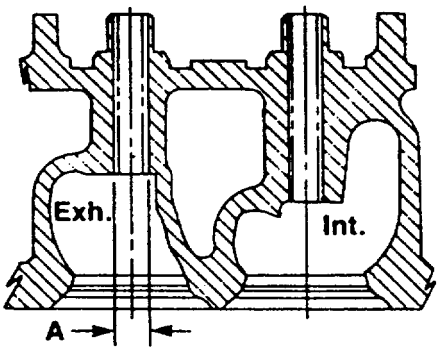
NOTE

The following dimensions are for (Thick wall) valve guides.

(11) Machine cylinder head parent metal valve guide bores to dimension "A".

A = 0.5512 ± 0.0005 in. (14.000 + 0.013 mm).

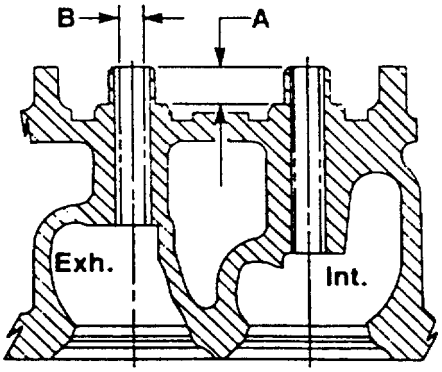
Bore is to be centered with valve seats within (0.01378 in. (0.3500 mm) diameter and square with combustion face within 0.004 in. (0.10 mm) at 1.9685 in. (49.999 mm) radius.



(12) Install valve guides. Lubricate with oil and press guides to dimension A protrusion above cylinder head. Finish ream bores to dimension "B".

A = 0.4823 ± 0.020 in. (12.250 ± 0.51 mm).

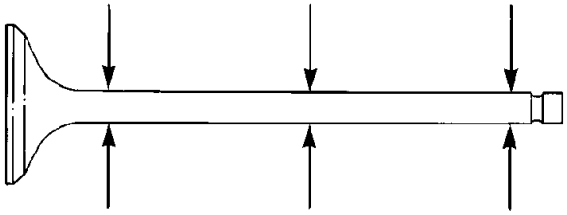
B = 0.3161 ± 0.0004 in. (8.029 ± 0.010 mm).



(13) Clean valve heads with soft wire wheel.

(14) Polish valve stem with crocus cloth.

(15) Using a 0–1 in. (0–25 mm) micrometer, inspect valve heads and stems for abnormal wear.

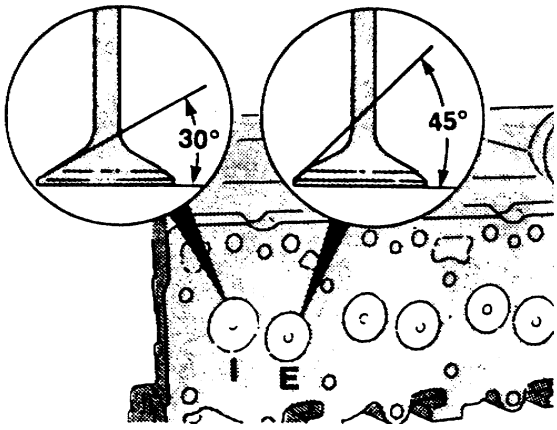


(16) Measure valve stem diameter. Minimum diameter is 0.3126 in. (7.940 mm) and maximum is 0.3142 in. (7.981 mm).

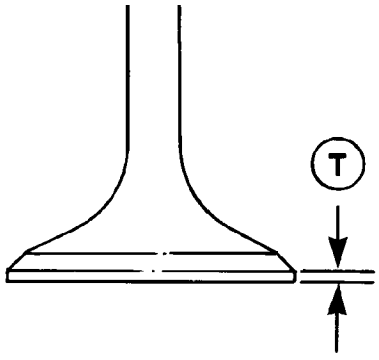
(17) Mark new valves, if required, for replacement location.

(18) Grind face of valves being reused. Check and replace bent valves.

(19) Check seat angle of valves. Intake is 30 degrees and exhaust is 45 degrees.



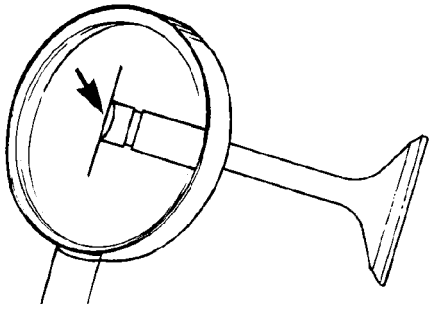
(20) Measure thickness of rim. The minimum (T) is 0.031 in. (0.79 mm).



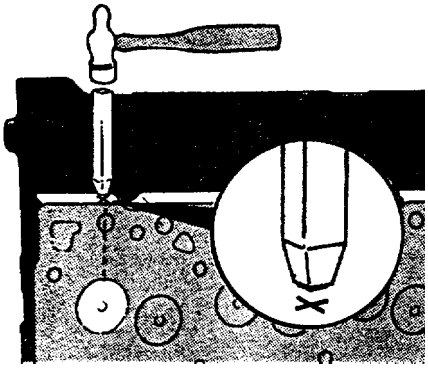
7-4. CYLINDER HEAD REPAIR (CONT).

(21) Check valve stem tip for flatness.

(22) Using grinding wheel, re-surface valve tip if inspection indicates it is necessary.

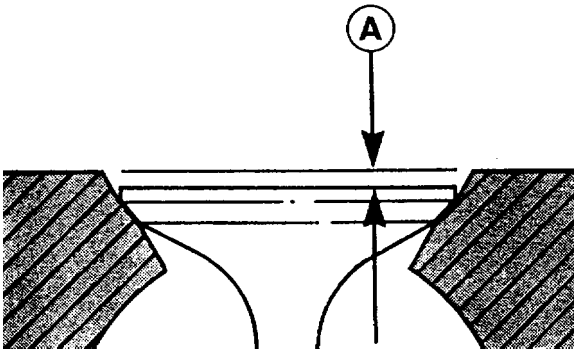


(23) The illustrated marks indicate valve seats have been ground previously. Previously re-ground seats can be replaced with service seats.



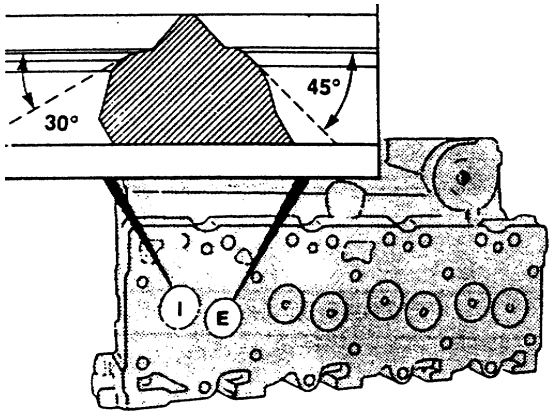
(24) Install valves in their designated location and measure valve depth.

(25) The valve depth is the distance from valve face to head deck. Record depth of each valve as A. The valve depth minimum is 0.039 in. (0.99 mm) and maximum is 0.060 in. (1.52 mm).



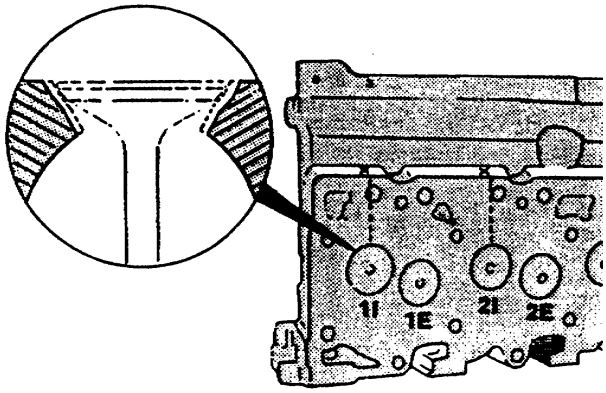
(26) Grind valve seats to remove scores, scratches and burns.

(27) Check seat angle of cylinder head. Intake is 30 degrees and exhaust is 45 degrees.



(28) Install valves in their respective bores and measure depth again.

(29) Record depth of each valve as B, and calculate grinding depth GD = B – A. The grinding depth limit is 0.010 in. (0.25 mm).



NOTE

The service valve seats are available for over the limit seats.

(30) Mark cylinder head to identify re-ground valve seats.

(31) If removed, install valves in their designated location and measure depth again. Refer to Step (25) for correct valve depth. Replace valve if depth is over limit.

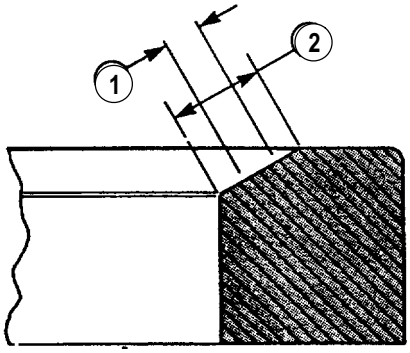
(32) Apply a light coat of valve lapping compound to each valve and lap each valve to its companion seat.

CAUTION

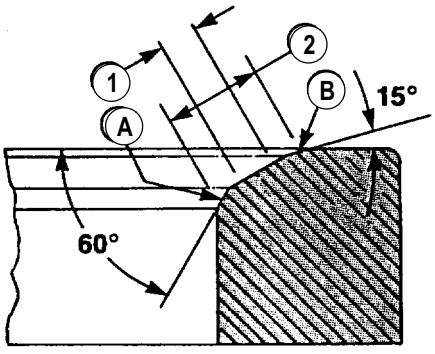
Ensure all lapping compound is cleaned from valves and seats. Failure to do so will cause serious damage to cylinder head and valves.

(33) Remove valves and clean lapping compound from valves and seats.

(34) Measure valve seat width indicated by lapped surface. Valve seat minimum width (1) limit is 0.060 in. (1.5 mm) and maximum width (2) is 0.080 in. (2.03 mm).



(35) If required, grind area (A) with a 60-degree stone and (B) with a 15-degree stone to center seat on valve face. Maintain valve seat width limits referred to in Step (34).

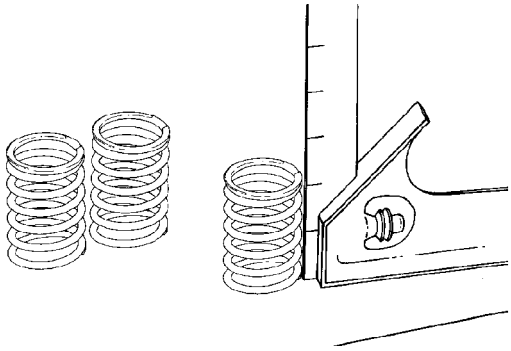


7-4. CYLINDER HEAD REPAIR (CONT).

c. Valve Springs Inspection.

(1) Measure valve springs. The approximate limit for free length is 2.190 in. (55.63 mm). The maximum inclination is 0.039 in. (0.99 mm).

(2) Inspect valve spring tension. A minimum load of 65.0 to 72.2 lb (289 to 321 N·m) is required to compress spring to a height of 1.94 in. (49.3 mm).



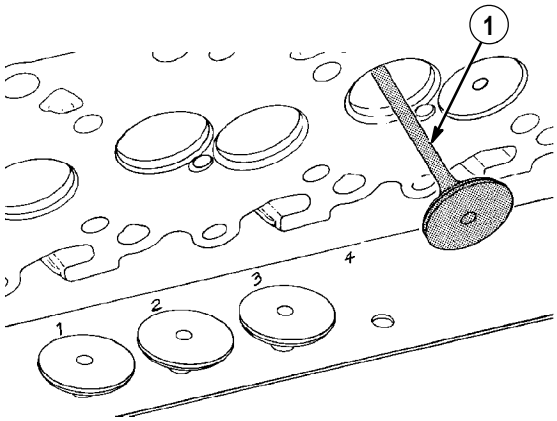
d. Assembly.

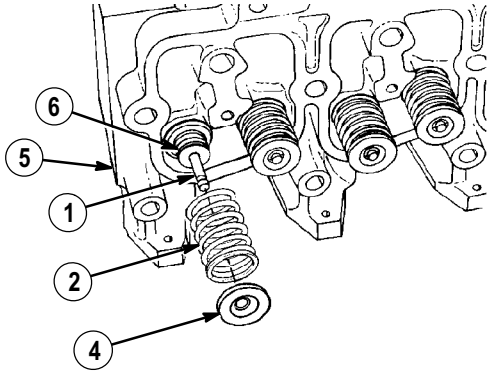
(1) Install valve seal (6).

NOTE

Make sure marks made on valves match up with marks on cylinder head during disassembly.

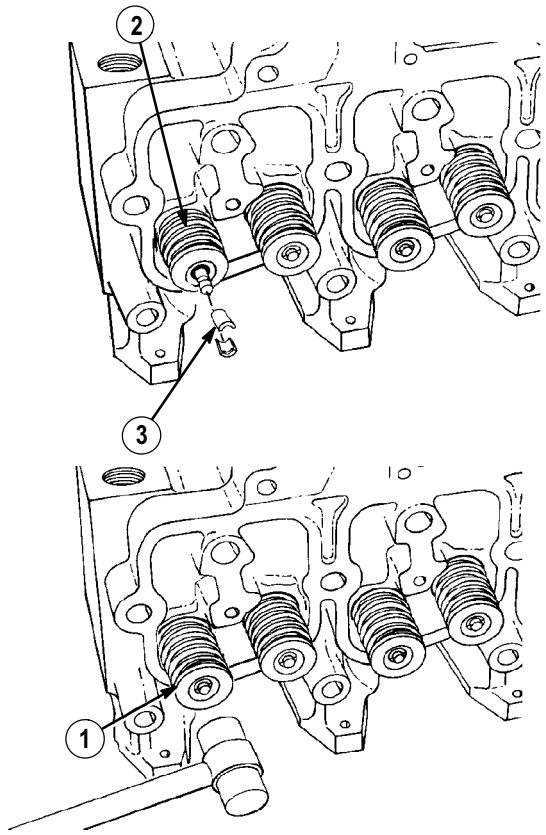
(2) Lubricate valve (1) with lubricating oil and install valve, valve spring (2) and retainer (4) on cylinder head (5).





(3) Compress valve spring (2), install valve collets (3) and release spring tension.

(4) After assembly, tap valve stems (1) to verify collets (3) are seated.



e. Follow-On Maintenance:

- Install cylinder head, (Para 5-7).

END OF TASK

7-5. CRANKSHAFT AND BEARINGS REPLACEMENT.

This task covers:

a. Removal
b. Disassembly
c. Cleaning/Inspection
d. Assembly
e. Installation
f. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Gloves, Chemical (Item 23, Appendix F)
Indicator, Dial, Set W/Magnetic Base (Item 33, Appendix F)
Micrometer, Outside, Caliper, Set (Item 37, Appendix F)
Nylon Brush (Item 4, Appendix F)
Puller Kit (Item 46, Appendix F)

Materials/Parts
Oil, Lubricating (Item 17, Appendix B)

Personnel Required
Two

Equipment Condition
Engine installed on stand, (Para 7-2)
Flywheel and housing removed, (Para 5-11)
Front gear cover removed, (Para 5-14)
Pistons, connecting rods and bearings removed, (Para 7-6)
Oil pan removed, (TM 9-4940-568-20)

a. Removal.

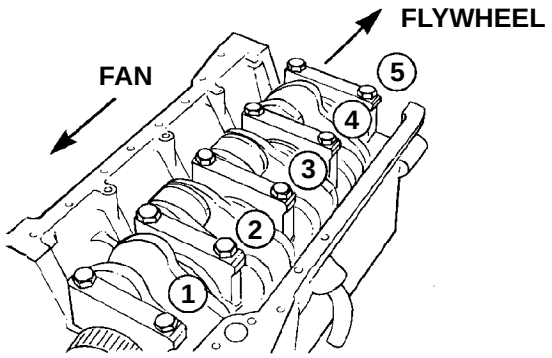
CAUTION

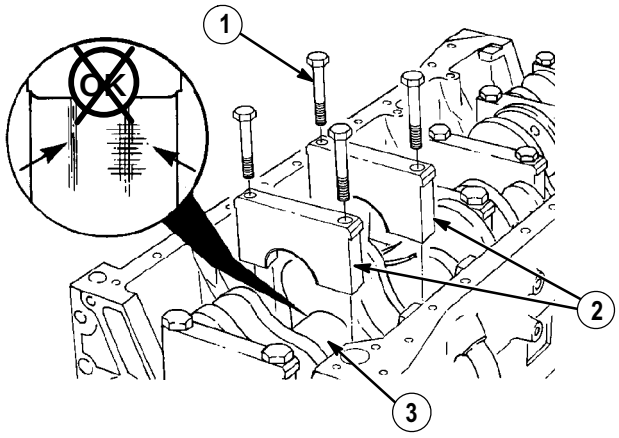
Do not pry on main bearing caps to free them. Failure to follow procedure could cause damage to equipment.

NOTE

Before removing five main bearing caps, ensure caps are clearly marked for their location on lubricating oil cooler side of main bearing cap.

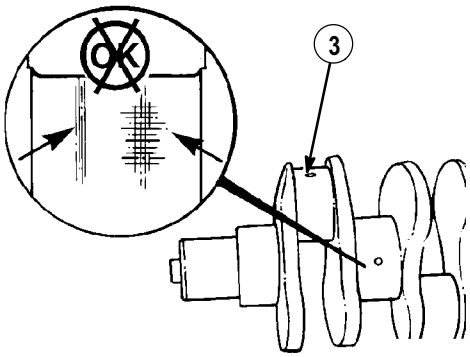
(1) Perform a visual inspection of five main bearings and crankshaft journals. Remove four screws (1) No. 2 and 3 main bearing caps (2) and check crankshaft (3) journals for signs of overheating, deep scratches or other damage.





(2) Inspect five main bearing caps (2) for dents, cracks, or other damage.

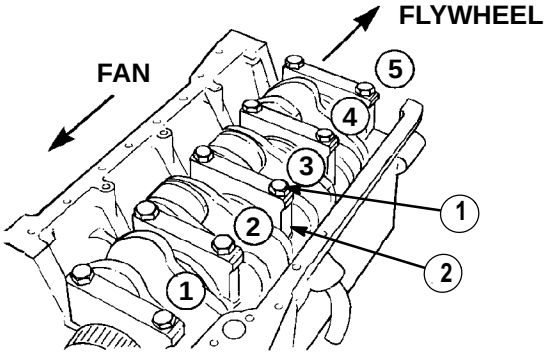
(3) Inspect crankshaft (3) journals for deep scratches, indications of overheating and other damage.



CAUTION

Do not pry on main bearing caps to free them. Failure to follow procedure could cause damage to equipment.

(4) Remove remaining six screws (1) and three main bearing caps (2).

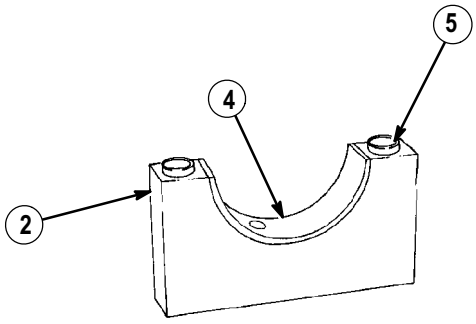


(5) Remove five lower main bearings (4) from five main bearing caps (2).

NOTE

Perform Step (6) if ring dowels are damaged.

(6) Remove ten ring dowels (5) from five main bearing caps (2).



7-5. CRANKSHAFT AND BEARINGS REPLACEMENT (CONT).

WARNING

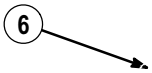
Crankshaft weighs 80 lbs (36 kg). Attach a suitable lifting device prior to removal to prevent possible injury to personnel.

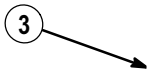
(7) Attach lifting device to crankshaft (3).

(8) Remove crankshaft (3).

(9) Remove lifting device from crankshaft (3).

(10) Remove five upper main bearings (6).

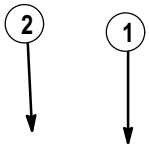


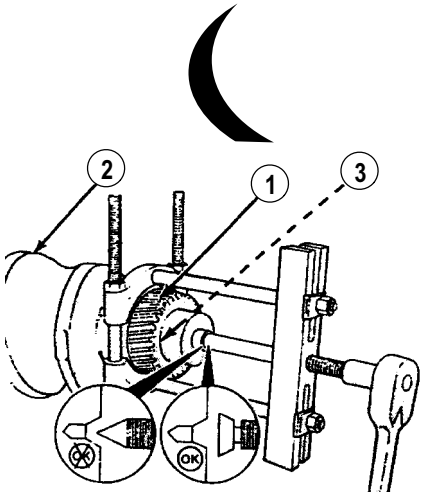


b. Disassembly.

(1) Using puller, remove gear (1) from crankshaft (2).

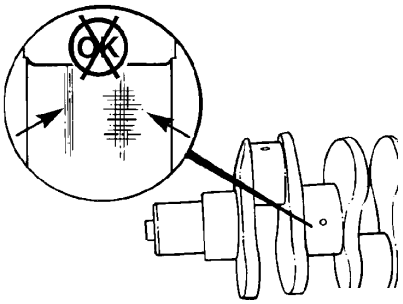
(2) Using locking pliers, remove dowel pin (3).





c. Cleaning/Inspection.

(1) Clean crankshaft oil holes with a nylon brush.



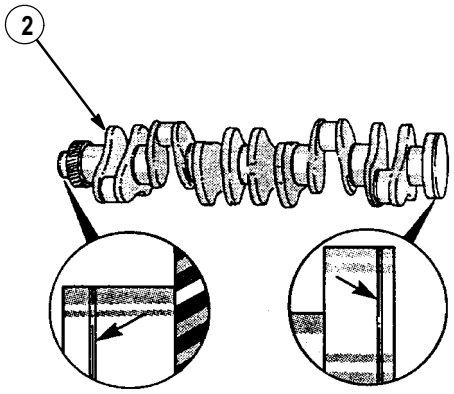
WARNING

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles, face shield, and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes, and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent. The flashpoint for Type II Drycleaning Solvent is 140 degrees F (60 degrees C) and Type III Drycleaning Solvent is 200 degrees F (93 degrees C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.

(2) Use dry cleaning solvent and clean all other parts.

(3) Check crankshaft (2) seal surfaces for scratches and grooves.

(4) Check connecting rod and main bearing journals for deep scoring and overheating.

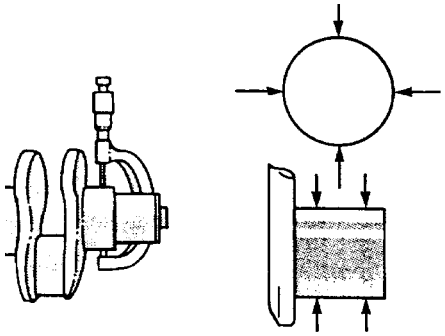


7-5. CRANKSHAFT AND BEARINGS REPLACEMENT (CONT).

NOTE

Step (5) determines main bearing clearance.

(5) Measure crankshaft main journal diameters at locations shown by arrows.



DIAMETER

MIN. 3.2662 in. (82.961 mm)

MAX. 3.2682 in. (83.012 mm)

OUT-OF-ROUNDNESS

0.002 in. (0.05 mm)

TAPER

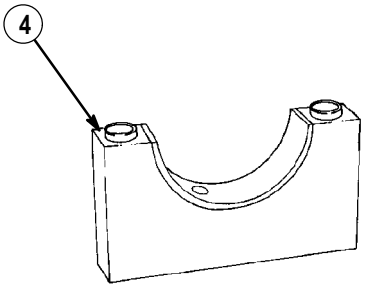
0.0005 in. (0.013 mm)

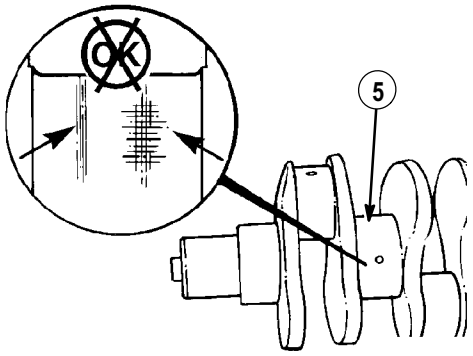
Main bearing clearance =

Main bore diameter with bearing installed minus crankshaft main journal diameter.

MAIN BEARING CLEARANCE MAX.

0.00475 in. (0.1206 mm)

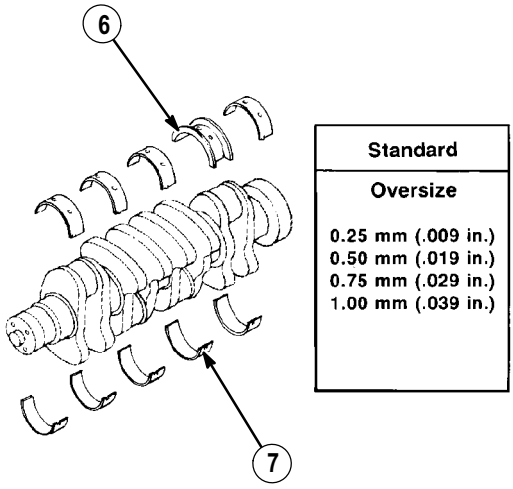




(6) Inspect all main bearing caps (4) and main bearing crankshaft journals (5).

(7) Determine the size of the upper main bearing (6) and lower main bearing (7) removed and obtain same size for installation.

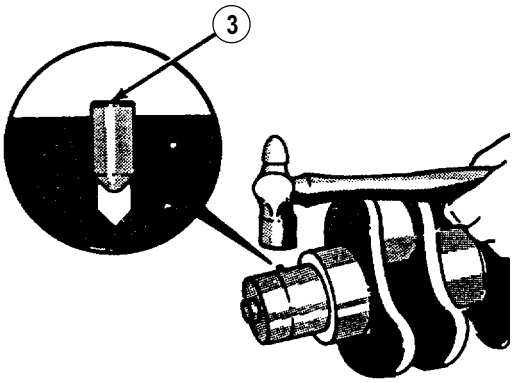
(8) Refer to chart for dimensions of the standard and undersize main bearing crankshaft journals (5).



Standard
Oversize
0.25 mm (.009 in.)
0.50 mm (.019 in.)
0.75 mm (.029 in.)
1.00 mm (.039 in.)

d. Assembly.

(1) Using a hammer, install dowel pin (3) until it bottoms out.



WARNING

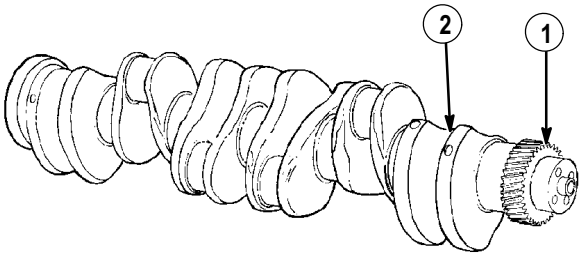
Wear protective gloves when handling hot gear. SERIOUS INJURY may result if skin contacts hot gear.

CAUTION

Gear will be permanently distorted if heated for longer than 45 minutes. Failure to follow this procedure could cause damage to the equipment.

(2) Heat gear (1) for 45 minutes at 250° F (121° C).

(3) Apply a thin coat of lubricant to nose of crankshaft (2).



NOTE

Gear should be installed with timing mark facing out.

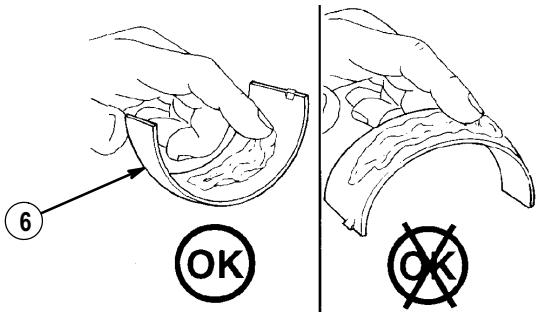
(4) Install gear (1) up to the shoulder of crankshaft (2) with timing mark facing out.

e. Installation.

CAUTION

Do not lubricate the side that is against the cylinder block.

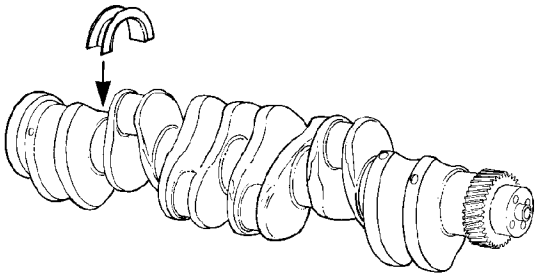
(1) Apply a coat of lubricating oil to one upper main bearing (6).

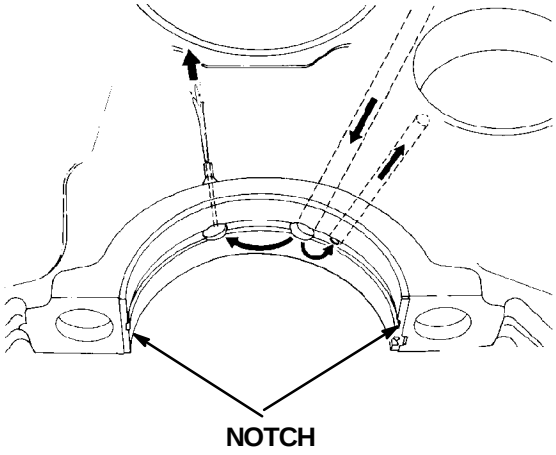


7-5. CRANKSHAFT AND BEARINGS REPLACEMENT (CONT).

NOTE

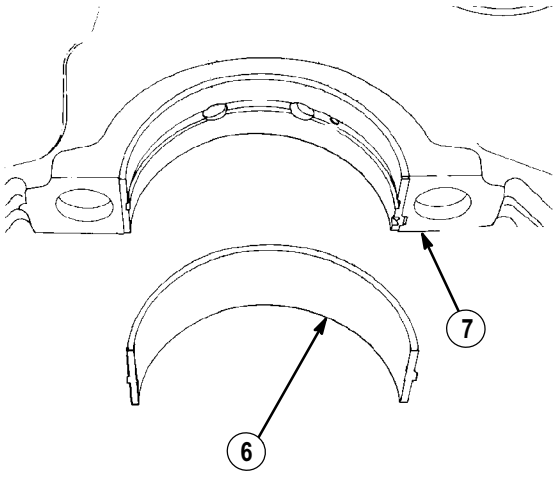
- Crankshaft is a balanced, forged steel unit with five main bearings. Lower bearing shells are all the same. All upper bearing shells are also the same with the exception of journal adjacent to the rear one. The next to last journal is fitted with a flanged upper bearing shell. Flanges control end thrust of the crankshaft.
- Upper bearings have three holes in them. Middle hole receives lubricating oil from main oil rifle. One of the adjacent holes is aligned with a drilling to camshaft journal and serves as an orifice for lubrication flow to the journal. Other adjacent hole supplies lubricating oil for piston cooling. The hole does not align perfectly with cooling nozzle. The hole is off-set to keep it away from highly loaded bearing area. Make sure the tang on the upper main bearing sets into the notch.





(2) Position upper main bearing (6) on engine block bearing surface (7).

(3) Repeat Step (2) for remaining upper bearings.



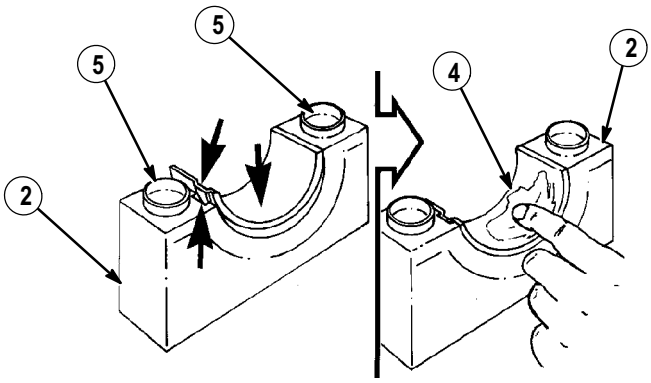
NOTE

Perform Step (4) if ring dowels were removed.

(4) Install two ring dowels (5) in one main bearing cap (2).

(5) Install the lower main bearings (4) in main bearing cap (2). Apply a coat of lubricating oil to the assembled lower main bearing.

(6) Repeat Steps (4) and (5) for remaining main bearing caps.



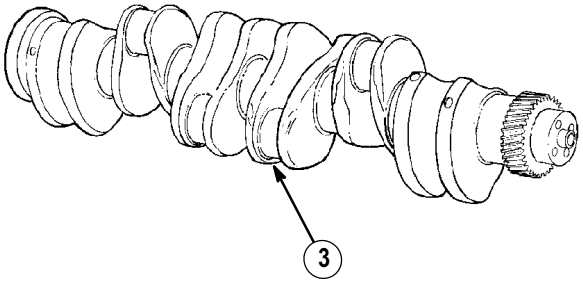
WARNING

Crankshaft weighs 80 lbs (36 kg). Attach a suitable lifting device prior to removal to prevent possible injury to personnel.

(7) Attach lifting device to crankshaft (3).

(8) With the aid of an assistant, install crankshaft (3).

(9) Remove lifting device from crankshaft (3).



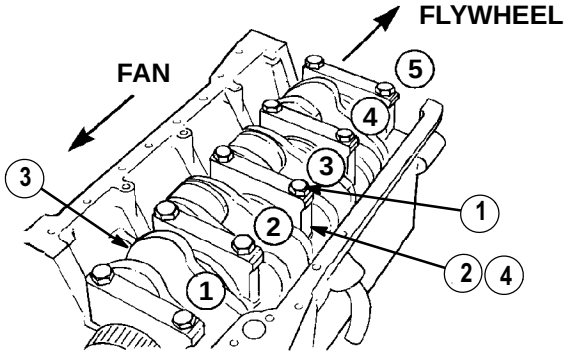
CAUTION

Ensure caps are correctly installed with number towards oil cooler side of the engine.

(10) Position five main bearing caps (2) with lower main bearings (4) on crankshaft (3) with ten screws (1).

(11) Tighten the ten screws (1) to 37 lb-ft (50 N·m). Do not tighten to the final torque value at this time.

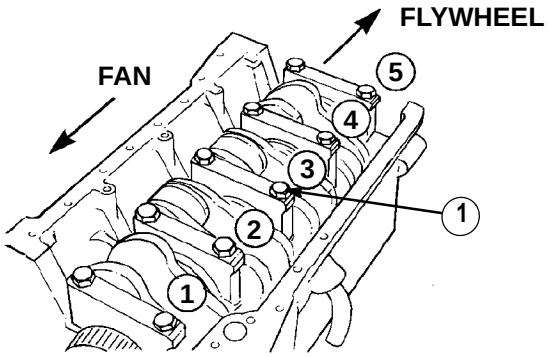
(12) Ensure crankshaft (3) rotates freely.



7-5. CRANKSHAFT AND BEARINGS REPLACEMENT (CONT).

(13) Tighten 10 screws (1) evenly and in sequence below.

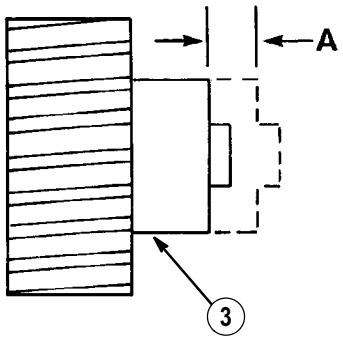
Step	Torque Value
1	44 lb-ft (60 N·m)
2	88 lb-ft (119 N·m)
3	129 lb-ft (176 N·m)



(14) Check the main bearing installation and the size of the main bearings if crankshaft (3) does not rotate freely.

NOTE

The dimensions of the thrust bearing and crankshaft journal determine end play.



(15) Measure crankshaft (3) end play.

Dim. (A) End Play Limits

MIN.	MAX.
0.004 in.	0.017 in.
(0.102 mm)	(0.432 mm)

f. Follow-On Maintenance:

- Install pistons, connecting rods and bearings, (Para 7-6).
- Install front gear cover, (Para 5-14).
- Install flywheel and housing, (Para 5-11).
- Install oil pan, (TM 9-4940-568-20).
- Remove engine from stand, (Para 7-2).
- Install engine, (Para 5-4).
- Operate engine at idle for 5 to ten minutes and check for leaks, (TM 9-4940-568-10).

END OF TASK

7-6. PISTONS, CONNECTING RODS, AND BEARINGS REPLACEMENT.

This task covers:

a. Removal
b. Cleaning/Inspection
c. Installation
d. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Compressor, Unit Air (Item 10, Appendix F)
Die Grinder (Item 26, Appendix F)
Drill, Electric Portable 1/4 in. (Item 14, Appendix F)
Engine Turnover Tool (Item 66, Appendix F)
Feeler Gage (Item 21, Appendix F)
Gage Set, Telescoping (Item 22, Appendix F)
Gloves, Chemical Oil Protective (Item 23, Appendix F)
Goggles, Industrial (Item 25, Appendix F)
Gun, Air Blow (Item 29, Appendix F)
Micrometer, Outside, Caliper, Set (Item 37, Appendix F)
Oil Ring Expander (Item 68, Appendix F)
Piston Ring Expander Tool, (Item 69, Appendix F)
Pliers, Retaining Ring, (Item 44, Appendix F)
Ring Compressor, 75-125 mm (3-5 in.) (Item 8, Appendix F)
Steel Wire Wheel (Item 74, Appendix F)

Tools and Special Tools - Continued
Tags, Identification (Item 60, Appendix F)
Wrench, Torque 0-300 lb-ft (N·m) (Item 84, Appendix F)

Materials/Parts
Oil, Diesel, Fuel (Item 15, Appendix B)
Oil, Lubricating (Item 17, Appendix B)
Pad, Abrasive (Item 19, Appendix B)
Solvent, Dry Cleaning (Item 34, Appendix B)
Ring, Piston (Item 139, Appendix E)
Ring, Piston (Item 140, Appendix E)
Ring, Piston (Item 141, Appendix E)
Ring, Retaining (Item 142, Appendix E)

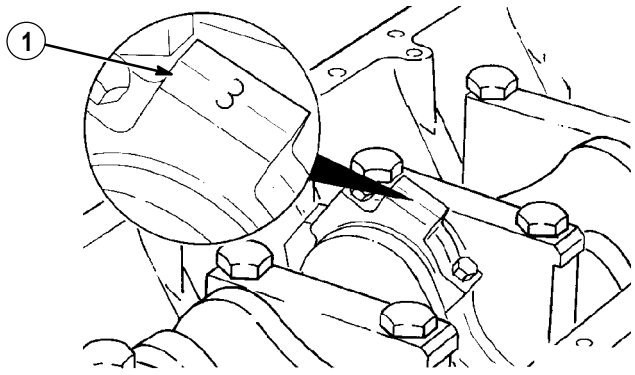
Equipment Condition
Engine installed on stand, (Para 7-2)
Engine oil pan and suction tube removed, (TM 9-4940-568-20)
Cylinder head removed, (Para 7-4)

a. Removal.

NOTE

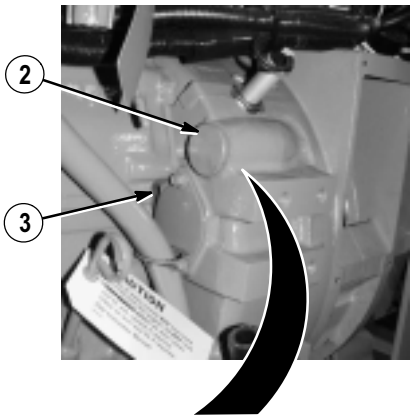
Tag and mark position and location of each connecting rod and piston prior to removal.

(1) Mark each connecting rod cap (1) according to the cylinder.

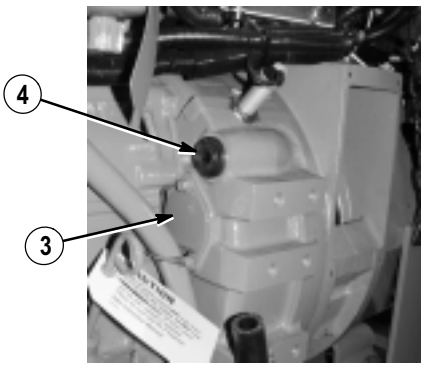


7-6. PISTONS, CONNECTING RODS, AND BEARINGS REPLACEMENT (CONT).

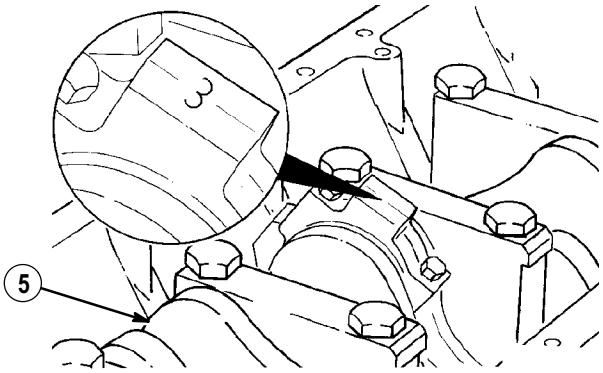
(2) Remove access cover (2) from engine (3).

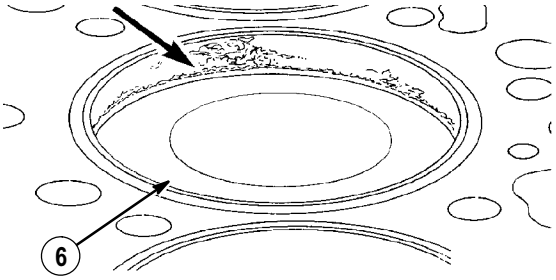


(3) Install engine turnover tool (4) in access cover on engine (3).



(4) Rotate crankshaft (5) until pistons (6) are below carbon deposits which are found above ring travel area.





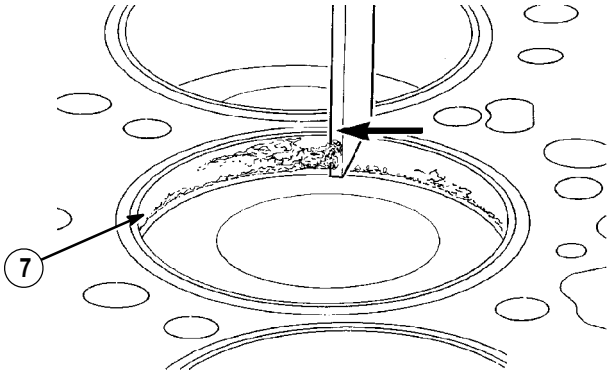
CAUTION

Be careful not to gouge cylinder bore during cleaning. Failure to follow this procedure could cause damage to equipment.

NOTE

The following is a maintenance procedure for one piston and connecting rod. The maintenance procedure for remaining pistons and connecting rods is identical.

(5) Scrape ridge from top of cylinder bore (7).

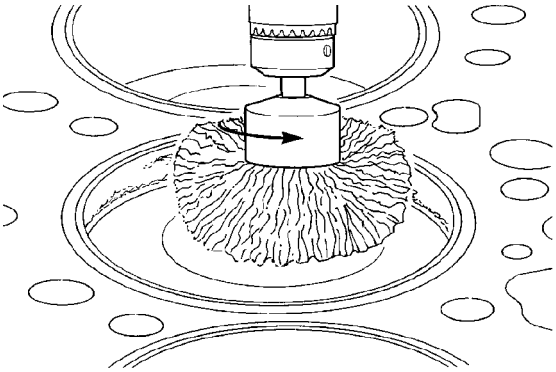


WARNING

To prevent serious eye damage, wear eye protection during this operation.

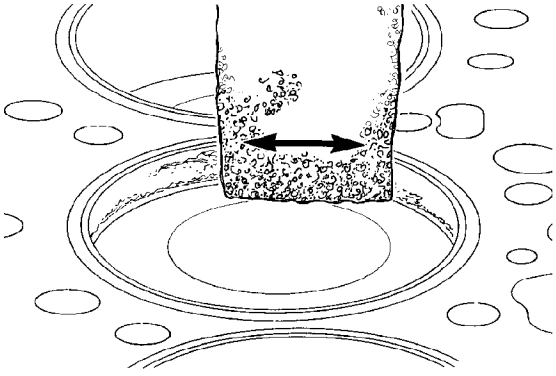
CAUTION

- Do not use steel wire wheel in piston travel area. Operate wheel in a circular motion to remove deposits.
- Do not damage cylinder when scraping carbon deposits.



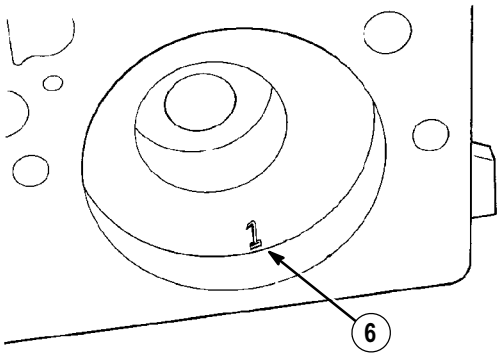
(6) Using a blunt edged instrument or a high quality steel wire wheel installed in a drill or die grinder, loosen carbon deposits from cylinder bore (7).

(7) Remove remaining carbon with a cleaning pad or equivalent.

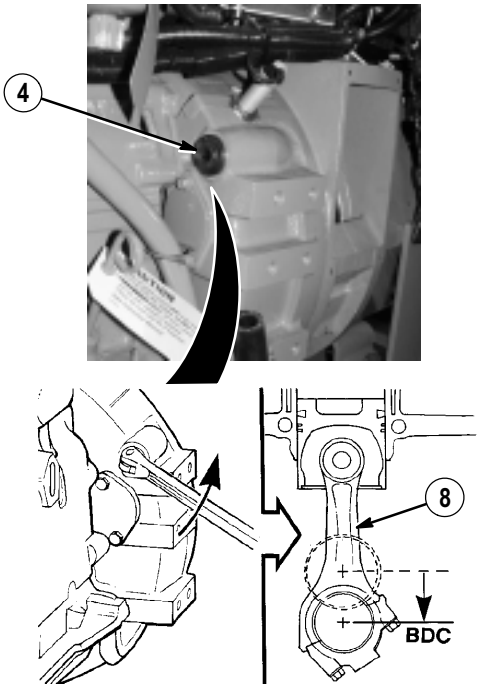


7-6. PISTONS, CONNECTING RODS, AND BEARINGS REPLACEMENT (CONT).

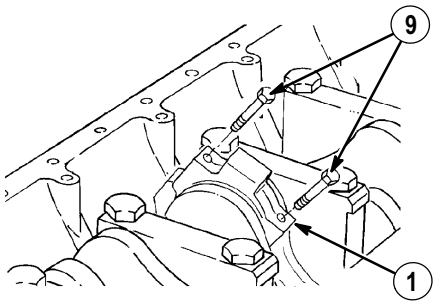
(8) Mark each piston (6) according to the cylinder.



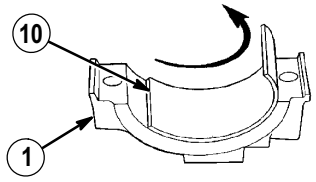
(9) Using engine turnover tool (4), turn engine and position two of the connecting rods (8) at “BDC” (Bottom Dead Center).



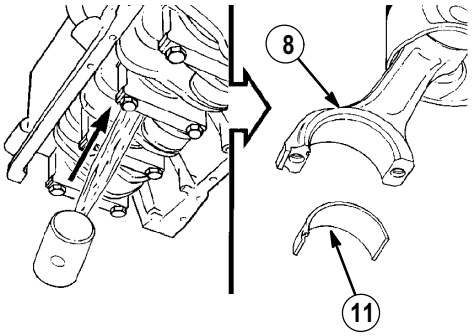
(10) Remove two connecting rod screws (9) and connecting rod cap (1) from engine.



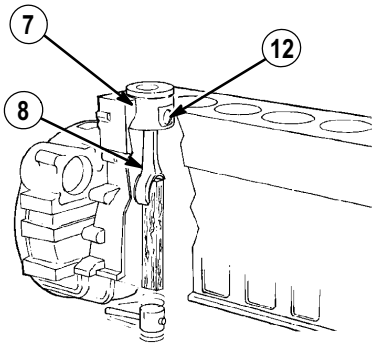
(11) Remove and discard lower bearing shell (10) from connecting rod cap (1).



(12) Push connecting rod (8) away from crankshaft to allow upper bearing shell (11) to be removed. Discard upper bearing shell.



(13) Push connecting rod and piston assembly (12) out of cylinder bore (7). Care must be taken not to damage connecting rod (8) or cylinder bore.

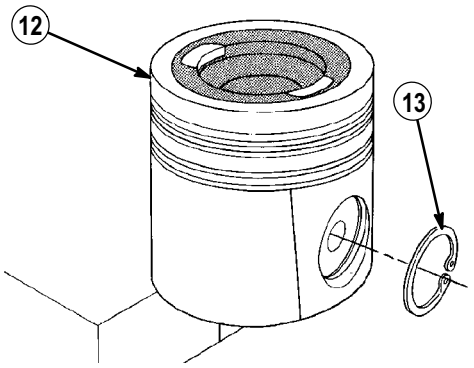


7-6. PISTONS, CONNECTING RODS, AND BEARINGS REPLACEMENT (CONT).

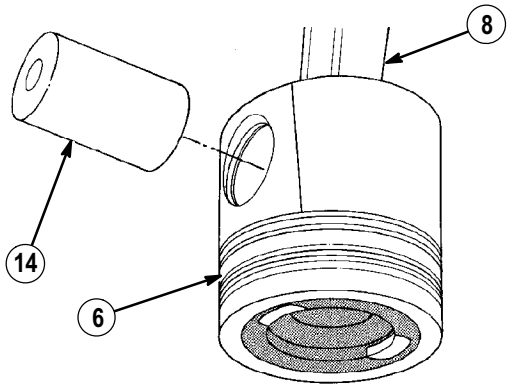
WARNING

Use care when removing or installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released and could cause eye injury.

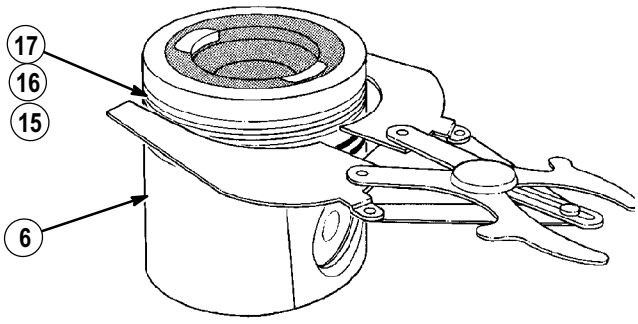
(14) Remove two retaining rings (13) from connecting rod and piston assembly (12).



(15) Remove piston pin (14) and connecting rod (8) from piston (6).



(16) Using piston ring expander, remove oil control ring (15), intermediate ring (16) and top ring (17) from piston (6). Discard rings.



b. Cleaning/Inspection.

WARNING

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles, face shield, and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes, and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent. The flashpoint for Type II Drycleaning Solvent is 140 degrees F (60 degrees C) and Type III Drycleaning Solvent is 200 degrees F (93 degrees C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.

CAUTION

Do not sandblast or use wire brush to clean carbon deposits from piston skirt. Damage to parts may occur.

(1) Clean carbon deposits from all ring grooves using soft bristle brush and drycleaning solvent.

(2) Clean oil drain holes in piston skirt using brush and drycleaning solvent.

(3) Clean all metal parts, except connecting rod and piston pin with drycleaning solvent.

WARNING

Fuel is very flammable and can explode easily. To avoid serious injury or death, keep fuel away from open fire and keep fire extinguisher within easy reach when working with fuel. Do not work on fuel system when engine is hot. Fuel can be ignited by hot engine.

(4) Clean connecting rod and piston pin with diesel fuel.

(5) Using a nylon bristle brush, clean oil drillings on the connecting rods.

WARNING

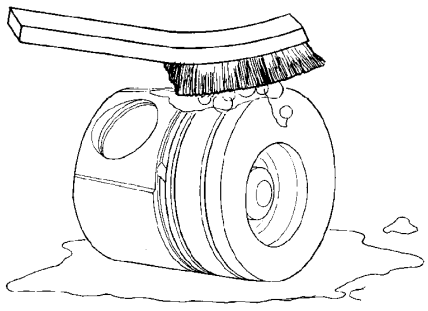
Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc). Failure to comply may result in injury or death to personnel.

(6) Dry all parts with compressed air.

(7) Inspect all parts for nicks, burrs or scratches. Replace all damaged parts.

(8) Inspect piston skirt and piston crown for score marks, cracks, or damaged ring grooves.

(9) Using a nylon bristle brush, clean oil drillings on connecting rods.

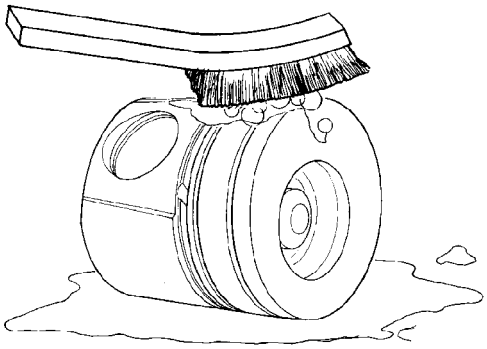


7-6. PISTONS, CONNECTING RODS, AND BEARINGS REPLACEMENT (CONT).

WARNING

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles, face shield, and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes, and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent. The flashpoint for Type II Drycleaning Solvent is 140 degrees F (60 degrees C) and Type III Drycleaning Solvent is 200 degrees F (93 degrees C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc). Failure to comply may result in injury or death to personnel.

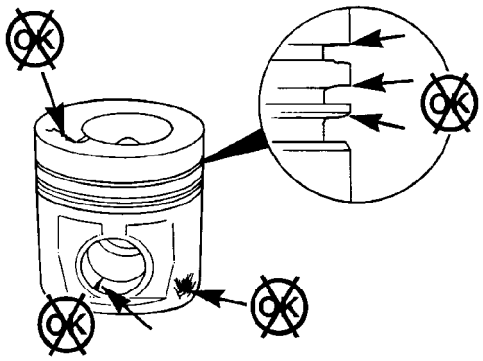
(10) Wash pistons again in a drycleaning solvent. Rinse and dry with compressed air.



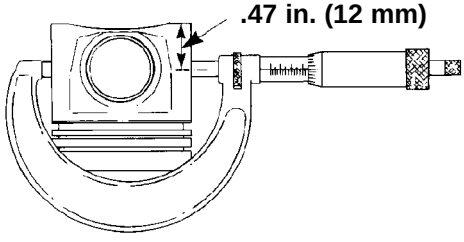
NOTE

If severe piston damage has occurred, check the exhaust components for damage from debris.

(11) Inspect piston for damage and excessive wear. Check the top, ring, grooves, skirt and pin bore.

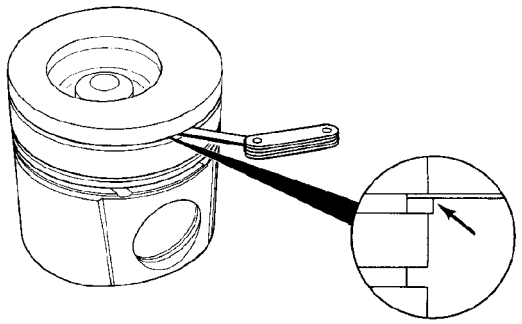


(12) Measure piston skirt diameter as illustrated.



Diameter		
in.		mm
4.0088	MIN.	(101.823)
4.0107	MAX.	(101.887)

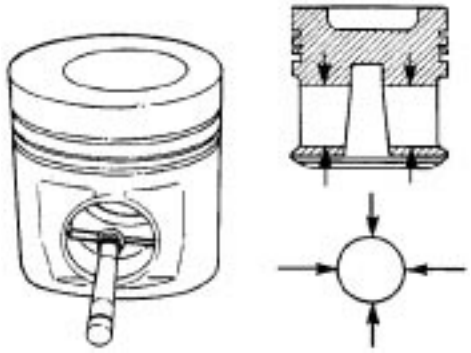
(13) Using one of three new piston rings and feeler gage, measure clearance in ring groove.



Ring Clearance

	in.		mm
Top	0.003	MIN.	(0.075)
	0.0059	MAX.	(0.150)
Intermediate	0.003	MIN.	(0.075)
	0.0059	MAX.	(0.150)
Oil Control	0.0016	MIN.	(0.040)
	0.0051	MAX.	(0.130)

(14) Using an inside micrometer, measure piston pin bore at illustrated locations.

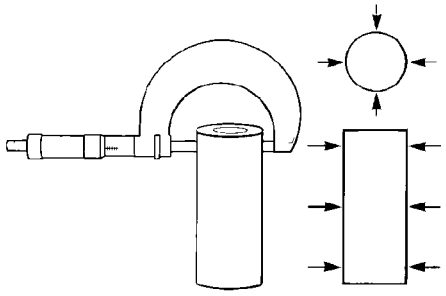


Diameter

in.		mm
1.5750	MIN.	(40.006)
1.5758	MAX.	(40.025)

(15) Inspect piston pin for nicks, gouges and excessive wear.

(16) Using a micrometer, measure pin diameter at locations illustrated.

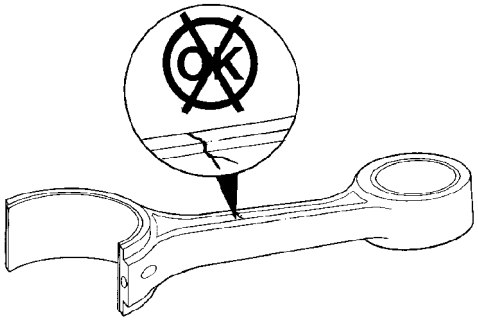


Diameter

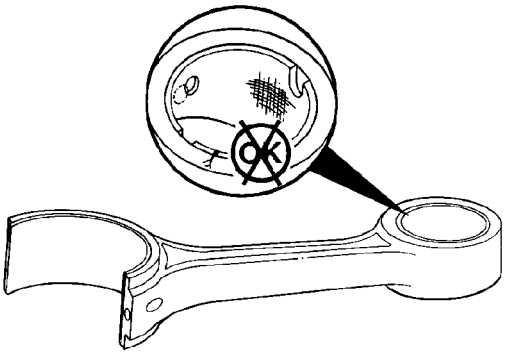
in.		mm
1.5744	MIN.	(39.990)
1.5749	MAX.	(40.003)

7-6. PISTONS, CONNECTING RODS, AND BEARINGS REPLACEMENT (CONT).

(17) Inspect connecting rods and connecting rod caps for damage. Replace connecting rod if "I-beam" is nicked or damaged.



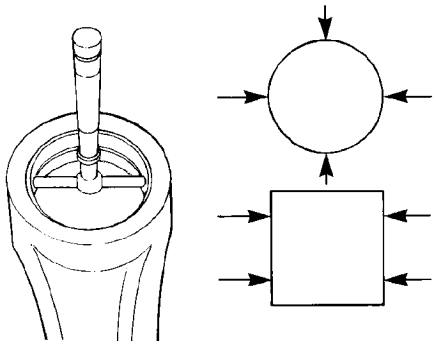
(18) Visually inspect piston pin bore for damage or mis-alignment of the oil passage and bushing.



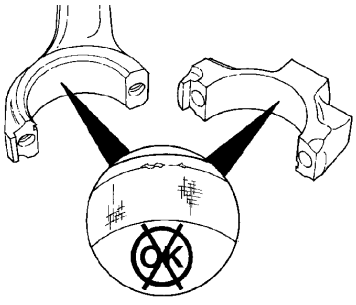
(19) Measure connecting rod piston pin bushing I.D.

Piston Pin Bushing Diameter

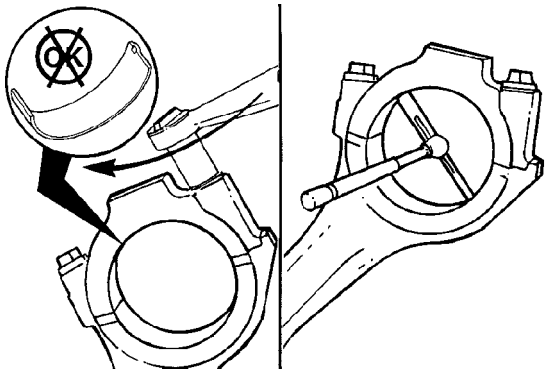
in.		mm
1.5755	MIN.	(40.019)
1.5765	MAX.	(40.042)



(20) Visually inspect connecting rod bearing saddles and screws for nicks, cracks, burrs, scratches or fretting.



(21) Measure the connecting rod crank bore with the bearing shells removed. Tighten screws to 73 lb-ft (100 N·m).



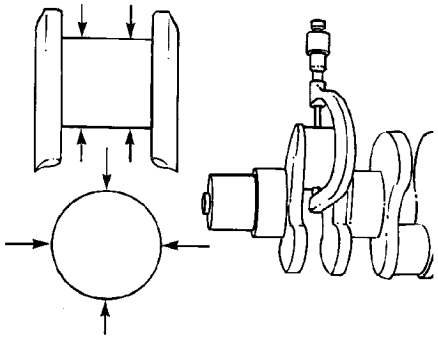
Connecting Rod Diameter (Bearings Removed)

in.		mm
2.8735	MIN.	(72.987)
2.8745	MAX.	(73.013)

NOTE

If crankshaft rod journals are not within the given specifications, crankshaft must be replaced.

(22) Measure diameter of the rod journal on crankshaft.



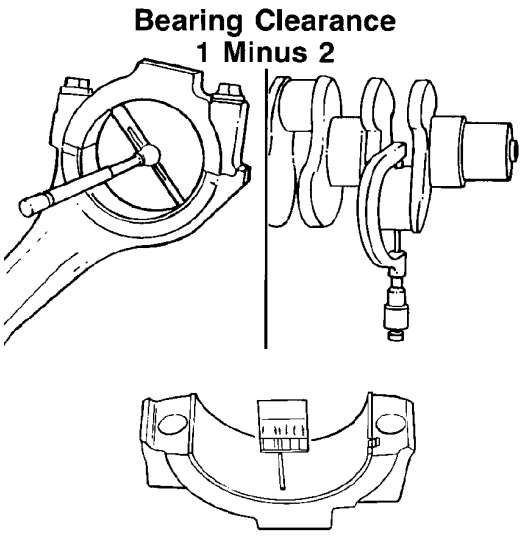
Connecting Rod Journal Diameter

Standard	2.7150-2.7170 in.	(68.962-69.012 mm)
.25 mm O/S	2.7052-2.7072 in.	(68.712-68.762 mm)
.50 mm O/S	2.6953-2.6973 in.	(68.462-68.512 mm)
.75 mm O/S	2.6855-2.6875 in.	(68.212-68.262 mm)
1.00 mm O/S	2.6757-2.6777 in.	(68.962-69.012 mm)

NOTE

Step (23) will determine thickness of connecting rod bearing required.

(23) Bearing clearance = rod inside diameter (with bearing) minus crankshaft journal diameter.



Bearing Clearance

in.		mm
.0015	MIN.	(.038)
.0045	MAX.	(.116)

7-6. PISTONS, CONNECTING RODS, AND BEARINGS REPLACEMENT (CONT).

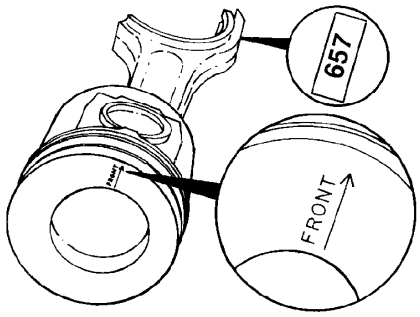
c. Installation.

WARNING

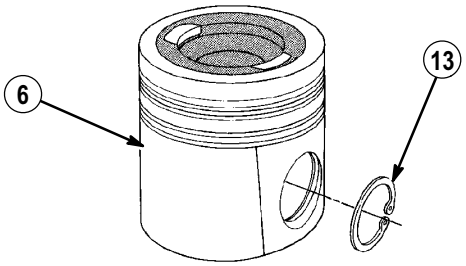
Use care when removing or installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released and could cause eye injury.

NOTE

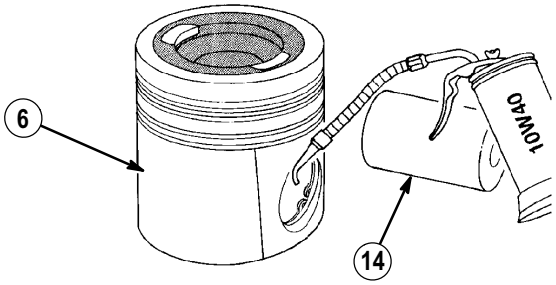
- Ensure “FRONT” marking on piston and numbers on connecting rod and cap are positioned as illustrated.
- All four piston assemblies are installed the same way.



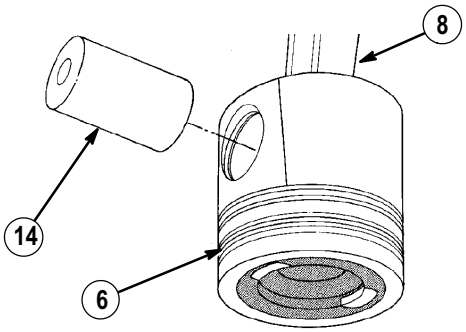
(1) Install first retaining ring (13) in pin groove on “FRONT” side of piston (6).



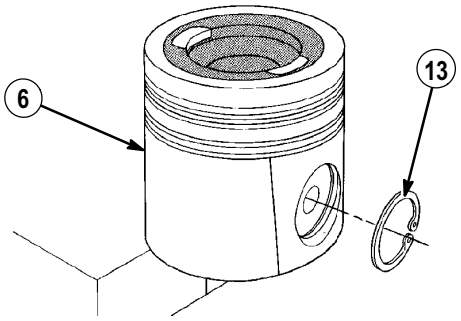
(2) Lubricate piston pin (14) and pin bores on piston (6) with engine lubricating oil.



(3) Install piston pin (14) and piston (6) on connecting rod (8), positioning FRONT marking on piston with numbers on connecting rod.

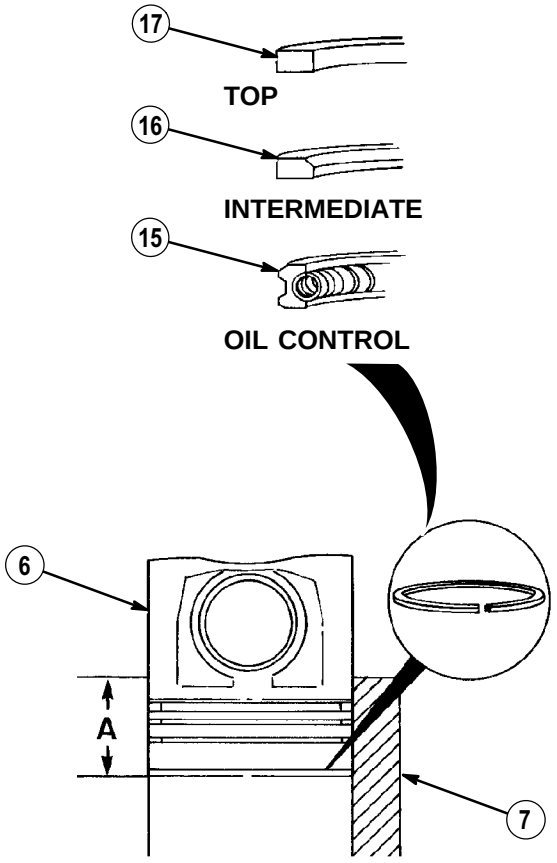


(4) Install second retaining ring (13) on piston (6).



(5) Install one of three piston rings (15, 16, or 17) in the cylinder bore (7) and use a piston (6) to square it with cylinder bore.

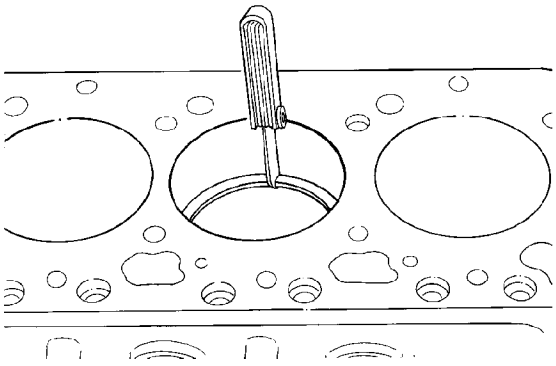
A = 3.5 in. (89 mm)



(6) Using a feeler gage, measure the gap.

Ring Gap

	in.		mm
Top	0.0100	MIN.	(0.25)
Intermediate	0.0100	MIN.	(0.25)
	0.0215	MAX.	(0.55)
Oil Control	0.0100	MIN.	(0.25)
	0.0215	MAX.	(0.55)



(7) Repeat Steps (5) and (6) for remaining two piston rings.

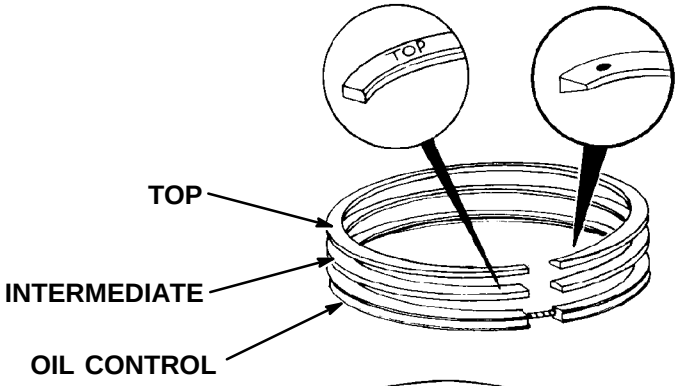
7-6. PISTONS, CONNECTING RODS, AND BEARINGS REPLACEMENT (CONT).

CAUTION

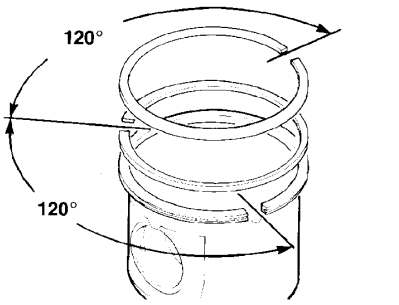
- Top surfaces of all piston rings are marked with the word TOP. Piston rings must be assembled with the word TOP facing up. Failure to follow this procedure could cause damage to equipment.
- If a ring expander tool is being used, be careful not to over expand the ring.

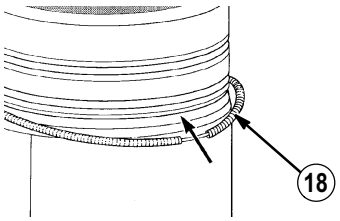
NOTE

The top surface of the top and intermediate rings are identified as illustrated. The oil control ring can be assembled with either side up.

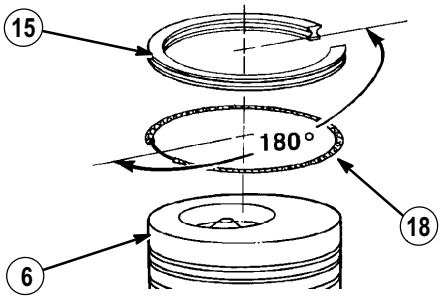


(8) Position oil ring expander (18) in control ring groove of one of three piston rings.

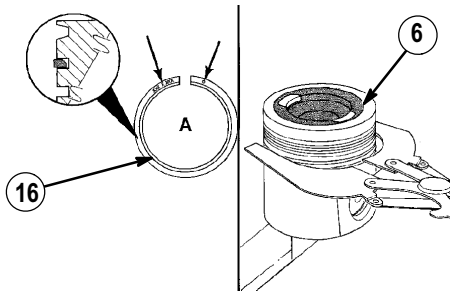




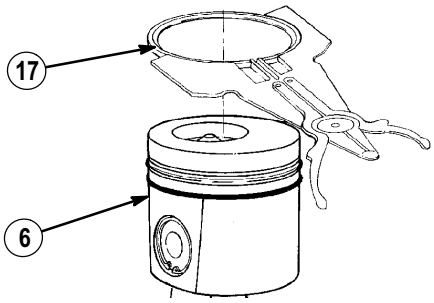
(9) Install oil control ring (15) on piston (6) with end gap 180° from ends of expander (18).



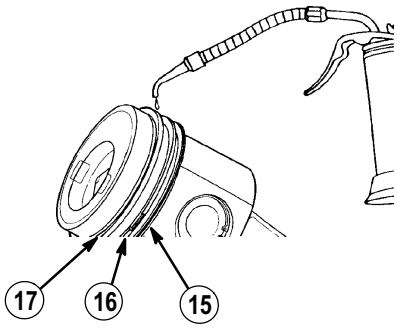
(10) Using piston ring expander tool, install intermediate ring (16) on piston (6).



(11) Using piston ring expander tool, install top ring (17) on piston (6).



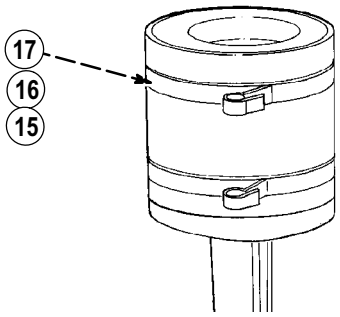
(12) Lubricate piston rings (15), (16) and (17) and the piston skirt with clean engine lubricating oil before installation.



CAUTION

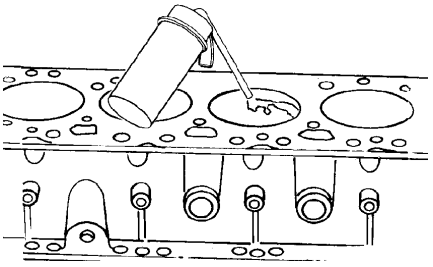
If using a strap type ring compressor, ensure inside end of strap does not hook on a ring gap and break the ring.

(13) Using ring compressor, compress three piston rings (15), (16), and (17).

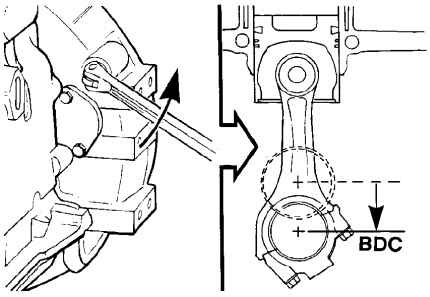


7-6. PISTONS, CONNECTING RODS, AND BEARINGS REPLACEMENT (CONT).

(14) Lubricate cylinder bore with clean engine lubricating oil.



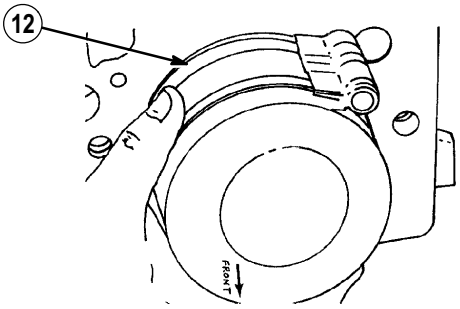
(15) Position crankshaft journal so piston, when installed, will be at bottom dead center (BDC).



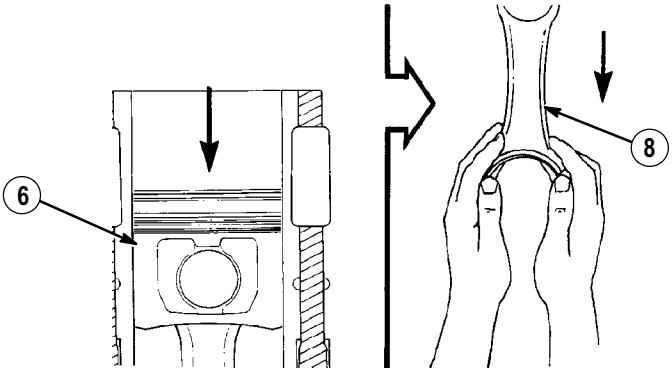
CAUTION

Take care not to damage cylinder wall when inserting connecting rod and piston assembly.

(16) Position connecting rod and piston assembly (12) in cylinder bore with word “front” on piston towards front of the cylinder block.

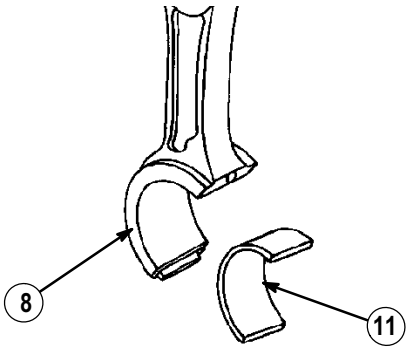


(17) Carefully push piston (6) in bore while guiding connecting rod (8) to the crankshaft journal.

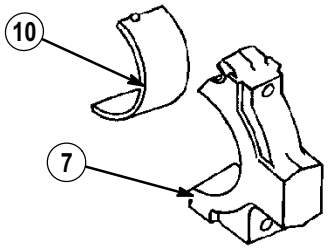


(18) Use lubricating oil to coat the inside diameter of upper bearing shell (11).

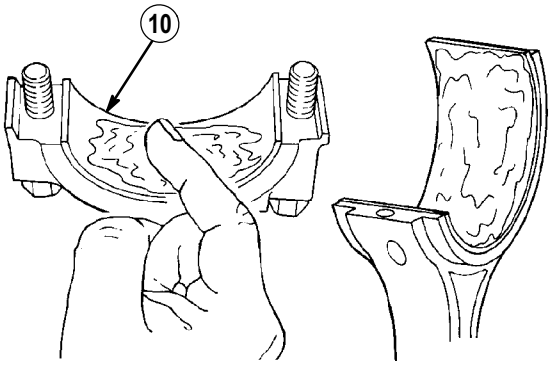
(19) Install upper bearing shell (11) in connecting rod (8) with tang of bearing in slot of connecting rod.



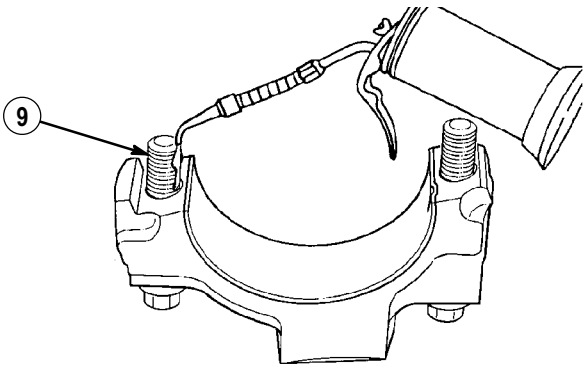
(20) Install lower bearing shell (10) in connecting rod cap (7) with tang of bearing in slot of connecting rod cap.



(21) Use lubricating oil to coat inside diameter of lower bearing shell (10).



(22) Use lubricating oil to lubricate threads and underside of connecting rod screw (9) head.

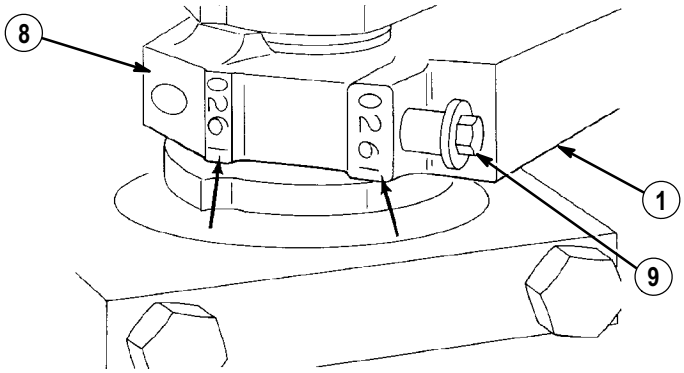


7-6. PISTONS, CONNECTING RODS, AND BEARINGS REPLACEMENT (CONT).

CAUTION

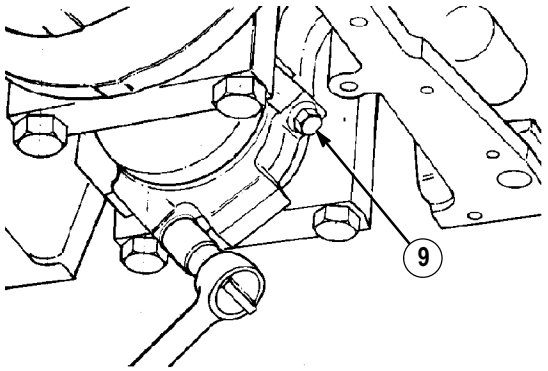
The four digit number stamped on connecting rod (8) and connecting rod cap (1) at parting line must match and be installed on lubricating oil cooler side of engine.

(23) Install connecting rod cap (1) and two connecting rod screws (9) to connecting rod (8).



(24) Alternately tighten two connecting rod screws (9) per instructions below.

Step	Torque Value
1	26 lb-ft (35 N·m)
2	51 lb-ft (70 N·m)
3	73 lb-ft (100 N·m)

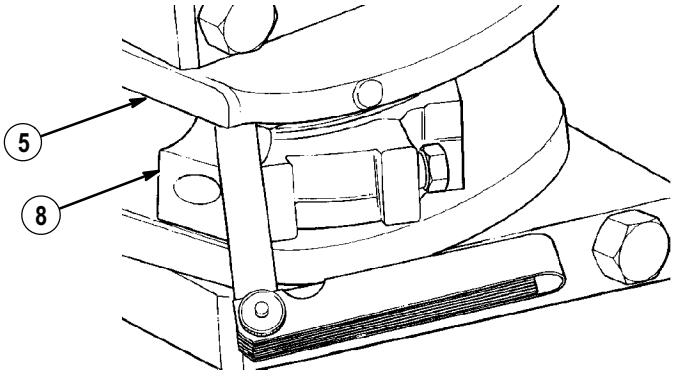


NOTE

Do not measure clearance between connecting rod cap and crankshaft.

(25) Measure side clearance between connecting rod (8) and crankshaft (5).

Side Clearance Limits	
.004 to .013 in.	(0.10 to 0.33 mm)



CAUTION

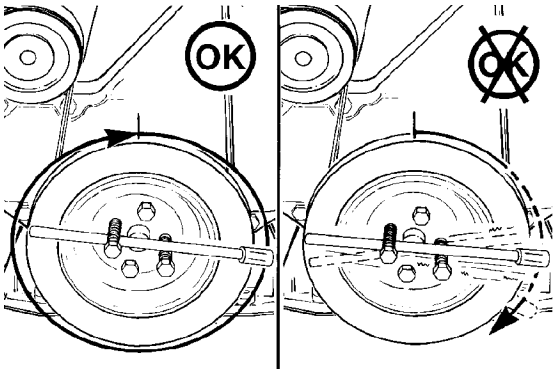
The crankshaft must rotate freely.

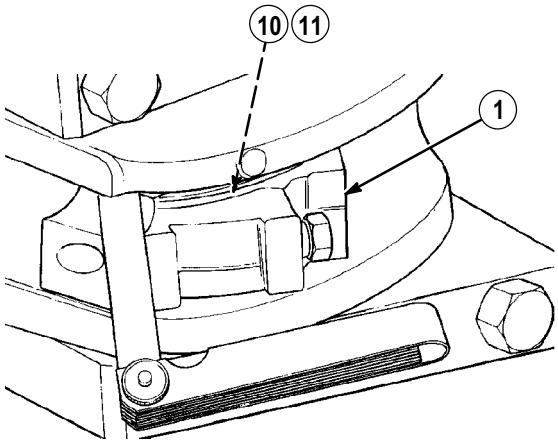
NOTE

If connecting rod is not properly orientated (tang opposite camshaft), it will contact the camshaft and lock the engine.

(26) Check for freedom of rotation as the connecting rod caps (1) are installed. If crankshaft does not rotate freely, check installation of connecting rod bearings (10) and (11) and bearing size.

(27) Repeat Steps (1) through (26) for installation of remaining three piston assemblies.





d. Follow-On Maintenance:

- Install cylinder head, (Para 7-4).
- Install engine oil pan and suction tube, (TM 9-4940-568-20).
- Remove engine from stand, (Para 7-2).

END OF TASK

7-7. CAMSHAFT AND VALVE TAPPETS REPLACEMENT.

This task covers:

a. Removal
b. Cleaning/Inspection
c. Pitting Reuse and Edge Deterioration (Breakdown) Criteria
d. Camshaft Bore Inspection
e. Installation
f. Follow-On Maintenance

INITIAL SETUP

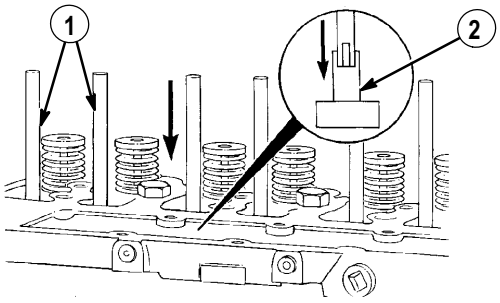
Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Camshaft Bushing Tool (Item 1, Appendix F)
Compressor Unit, Air (Item 10, Appendix F)
Gage Set, Telescoping (Item 22, Appendix F)
Gloves, Chemical Oil Protective (Item 23, Appendix F)
Goggles, Industrial (Item 25, Appendix F)
Gun, Air Blow (Item 29, Appendix F)
Micrometer, Outside, Caliper, Set (Item 37, Appendix F)
Tappet Kit (Item 62, Appendex F)
Tool, Engine Turnover (Item 66, Appendix F)
Dowel, Wooden (Appendix C)

Materials/Parts
Grease, Lithium (Item 13, Appendix B)
Oil, Lubricating (Item 17, Appendix B)

Equipment Condition
Engine installed on stand, (Para 7-2)
Rocker arms removed, (TM 9-4940-568-20)
Drive belt removed, (TM 9-4940-568-20)
Front gear cover removed, (Para 5-14)
Fuel pump removed, (TM 9-4940-568-20)

a. Removal.

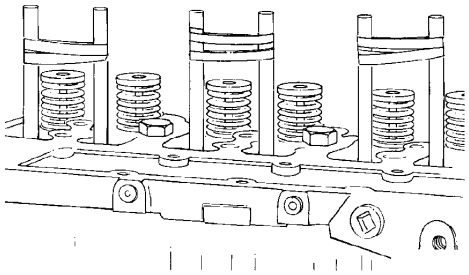
(1) Insert two dowels (1) through the push rod holes and into the top of each tappet (2) securely.



NOTE

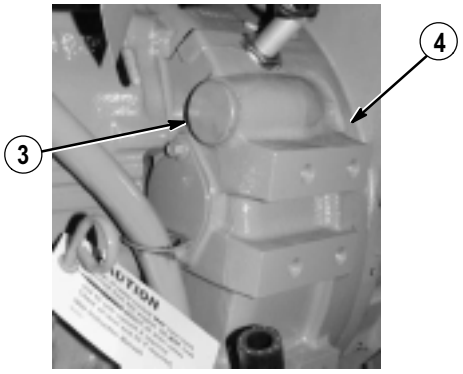
When properly installed, the dowels can each be used to pull the tappets up and should not be able to be pulled out without considerable effort.

(2) Pull two tappets (2) up and wrap a rubber band around the top of two dowel rods (1). This will prevent the tappets from dropping down.

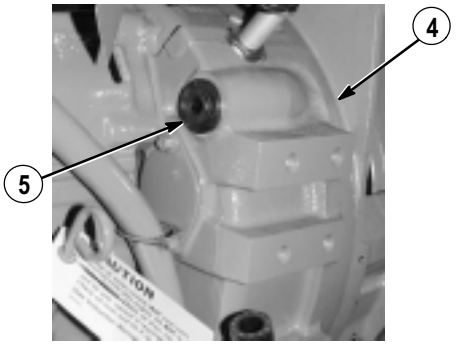


(3) Repeat Step (1) and (2) for remaining six tappets.

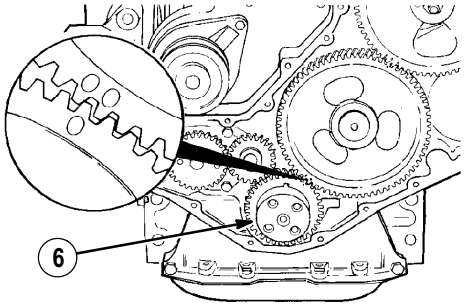
(4) Remove cover (3) from engine (4).



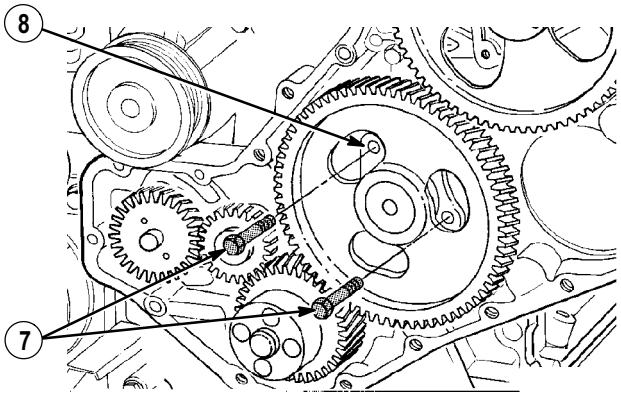
(5) Install engine turnover tool (5) on engine (4).



(6) Rotate the crankshaft gear (6) to align the crankshaft to camshaft timing marks.

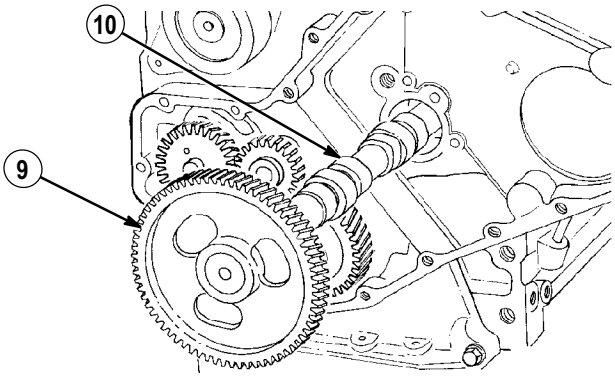


(7) Remove two screws (7) from the thrust plate (8).

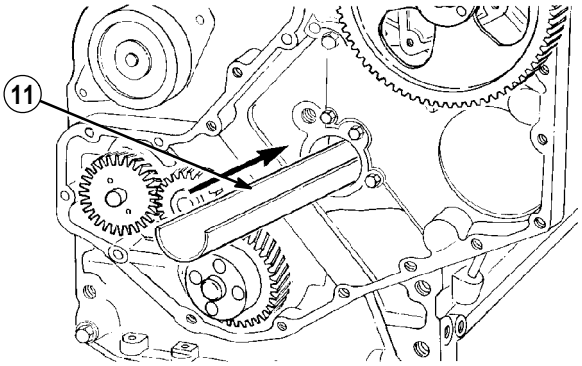


7-7. CAMSHAFT AND VALVE TAPPETS REPLACEMENT (CONT).

(8) Remove the camshaft gear (9) and camshaft (10).

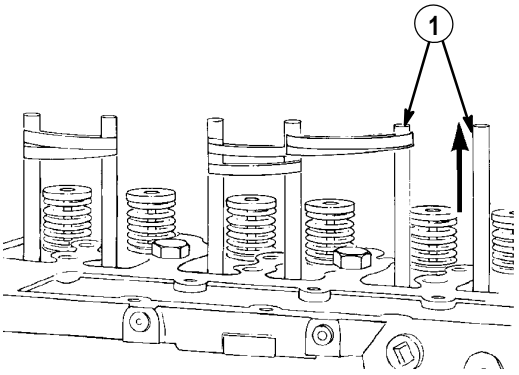


(9) Insert the plastic trough (11) to the full length of the cam bore.



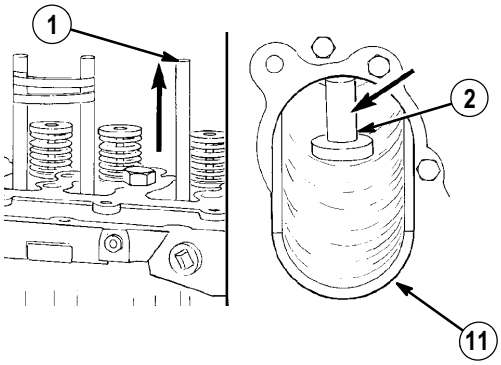
NOTE

- Make sure the plastic trough is positioned so it will catch the tappet when the wooden dowel is removed.
- Only remove one tappet at a time.



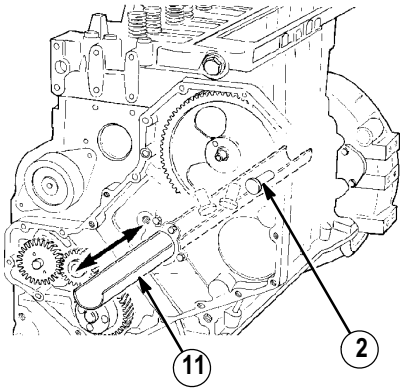
(10) Remove rubber band from two wooden dowels (1) and secure the tappet not to be removed with the rubber band.

(11) Pull the wooden dowel (1) from tappet bore allowing tappet (2) to fall into the plastic trough (11).



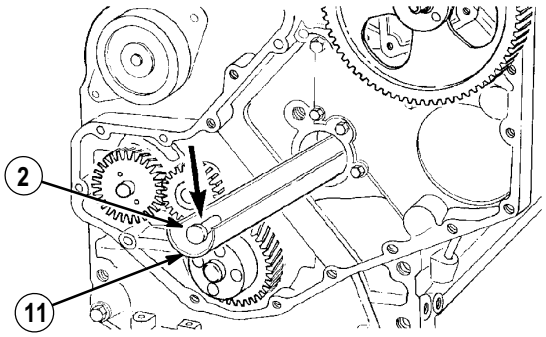
NOTE

When the tappet is dropped into the plastic trough, most of the time it will fall over. However, if it doesn't, gently shake the plastic trough just enough to allow the tappet to fall over before removing. When removing tappets from number four cylinder ensure tappet does not fall off end of trough.

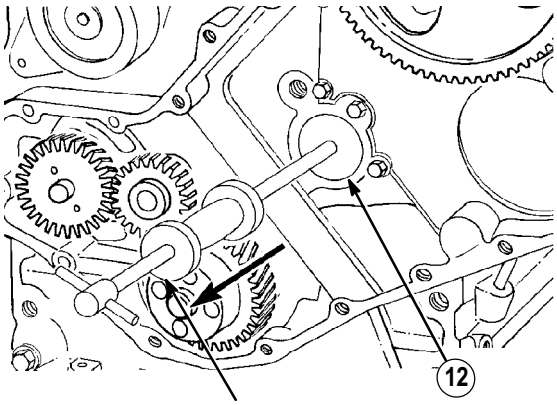


(12) Carefully pull the plastic trough (11) and tappet (2) from cam bore and remove tappet.

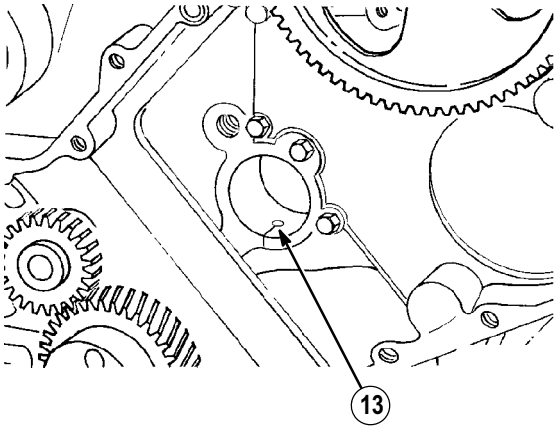
(13) Repeat Steps (9) through (11) until all tappets (2) are removed.



(14) Using camshaft bushing tool, remove camshaft bushing (12) from the No. 1 bore.



(15) Mark the camshaft bushing (12) and cylinder block (13) to align the lubricating oil hole in the cylinder block with the lubricating oil hole in the bushing.



7-7. CAMSHAFT AND VALVE TAPPETS REPLACEMENT (CONT).

b. Cleaning/Inspection.

WARNING

Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

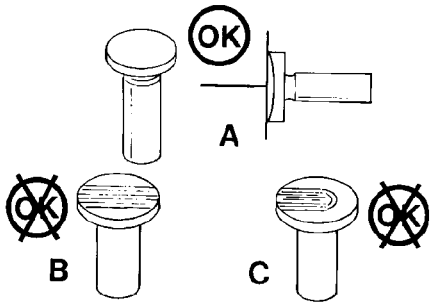
(1) Clean camshaft and camshaft gear with drycleaning solvent.

WARNING

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.) or injury to personnel may result.

(2) Dry camshaft and camshaft gear with compressed air.

(3) Inspect the socket, stern and tappet face for excessive wear, cracks and other damage.



(A) = Normal Contact (exaggerated).

(B) and (C) = Irregular Contact: Do not reuse.

(4) Pit marks on the tappet face are acceptable.

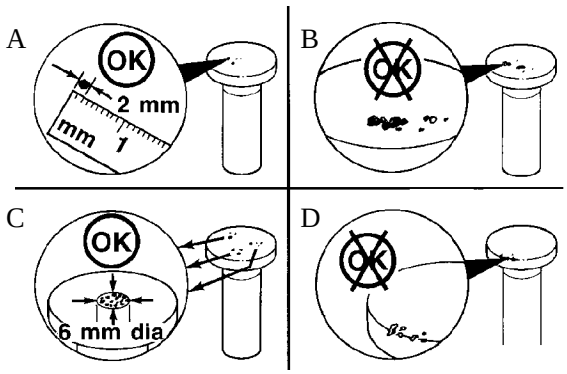
(5) The following criteria defines the size of the pits allowed.

(a) A single pit cannot be greater than 0.078 in. (2 mm).

(b) Interconnection of pits is not allowed.

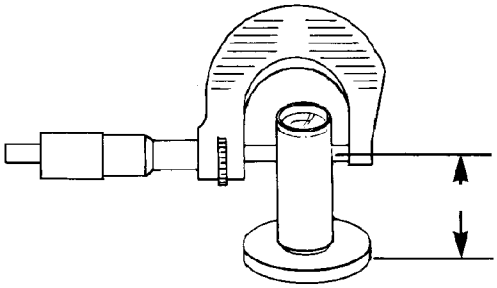
(c) Total pits when added together should not exceed 0.236 in. (6 mm) diameter or a total of 4 percent of the tappet face.

(d) No pitting is allowable on the edges of the wear face of the tappet.

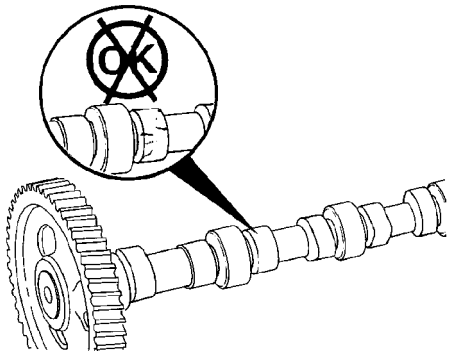


(6) Measure the valve tappet stem.

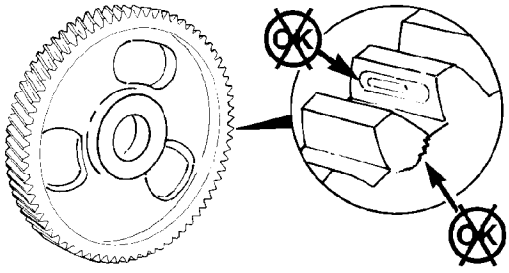
in.		mm
0.627	MIN.	(15.936)
0.629	MAX.	(15.977)



(7) Inspect the fuel transfer pump lobe, valve lobes and bearing journals for cracking, pitting or scoring.

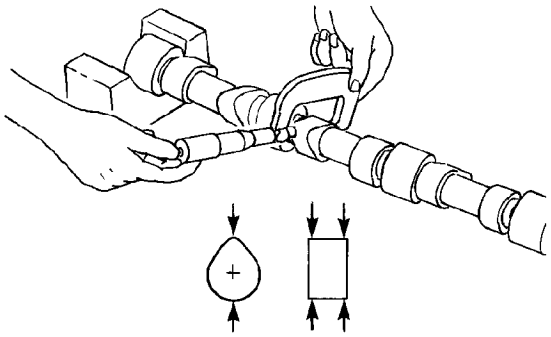


(8) Inspect the camshaft gear teeth for pitting; look for cracks at the root of the teeth.



7-7. CAMSHAFT AND VALVE TAPPETS REPLACEMENT (CONT).

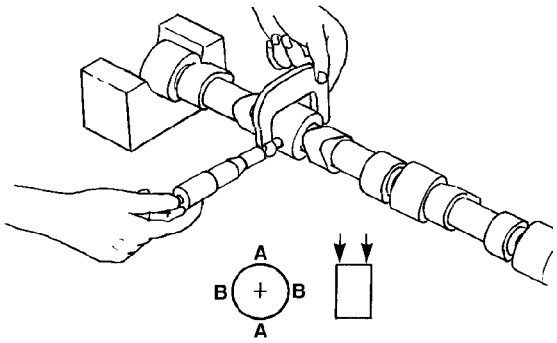
(9) Measure the fuel transfer pump and valve lobes.



Diameter at Peak of Lobe

	in.		mm
Intake	1.852	MIN.	(47.040)
	1.870	MAX.	(47.492)
Exhaust	1.841	MIN.	(46.770)
	1.859	MAX.	(47.222)
Lift Pump	1.398	MIN.	(35.50)
	1.428	MAX.	(36.26)

(10) Measure the bearing journals.

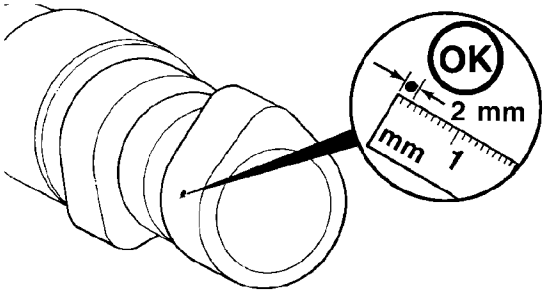


Journal Diameter

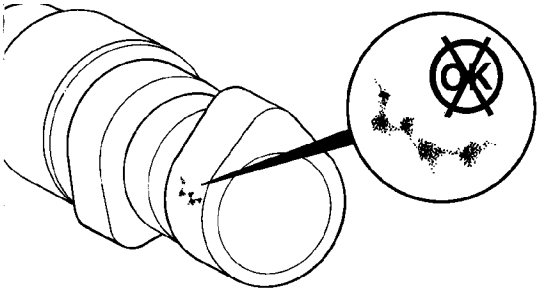
in.		mm
2.1245	MIN.	(53.962)
2.1265	MAX.	(54.013)

c. Pitting Reuse and Edge Deterioration (Breakdown) Criteria.

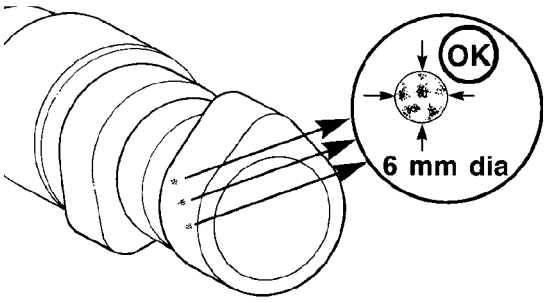
(1) A single pit should not be greater than an area of a 0.079 in. (2 mm) diameter circle.



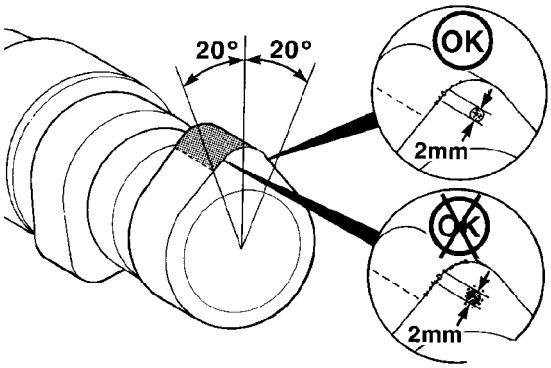
(2) Interconnection of pits is not allowable and is treated as one pit.



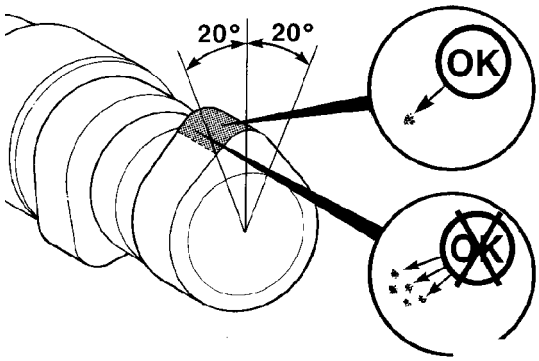
(3) The total pits, when added together, should not exceed a circle of 0.236 in. (6 mm).



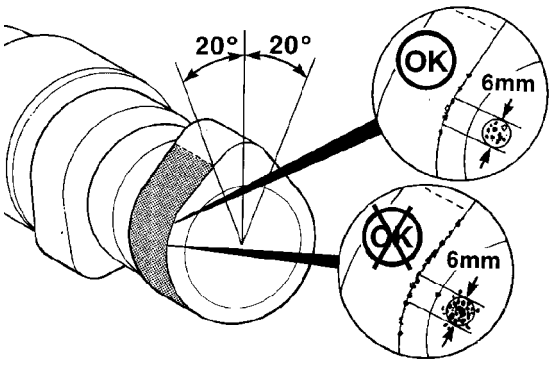
(4) Only one pit is allowed within + or -20 degrees of nose of cam lobe.



(5) The area of edge deterioration should not be greater than the equivalent area of a 0.079 in. (2 mm) circle within + or -20 degrees of the nose of the cam lobe.

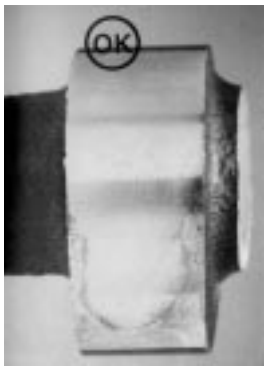


(6) Outside of the + or -20 degrees of the nose of the cam lobe, the areas of edge deterioration should not be greater than equivalent area of a 0.236 in. (6 mm) circle.

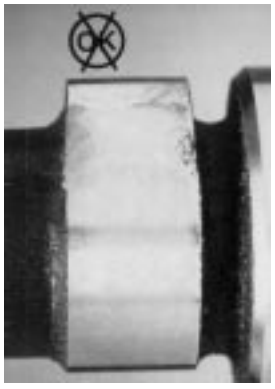


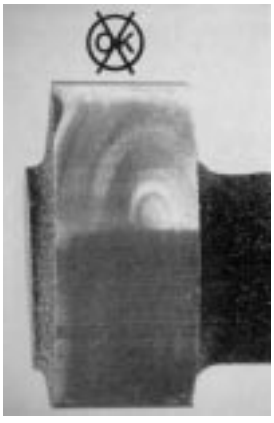
7-7. CAMSHAFT AND VALVE TAPPETS REPLACEMENT (CONT).

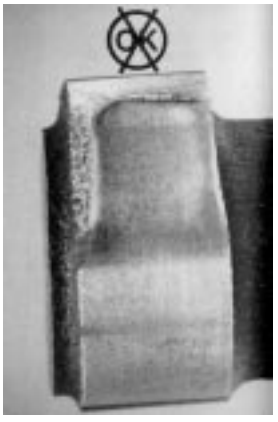
(7) The first of the following illustrations shows normal grain pattern and a casting flaw within nose area. Both of these conditions are acceptable for reuse.



(8) The following three illustrations show wear patterns that are not acceptable for reuse.

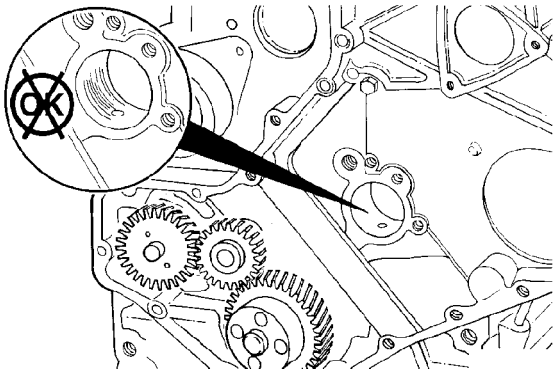






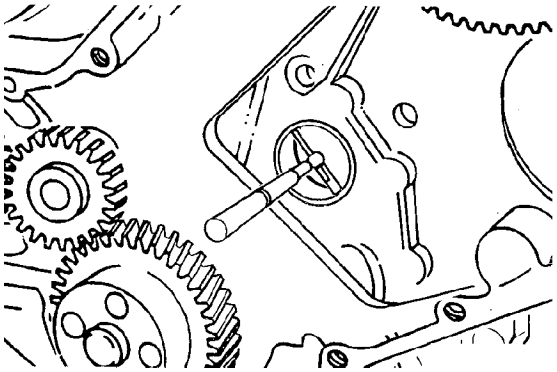
d. Camshaft Bore Inspection.

(1) Inspect camshaft bore for obvious damage and excessive wear.



NOTE

If the bores without a bushing are worn beyond the limit, the engine must be removed for machining and installation of service bushings or replacement of cylinder block.

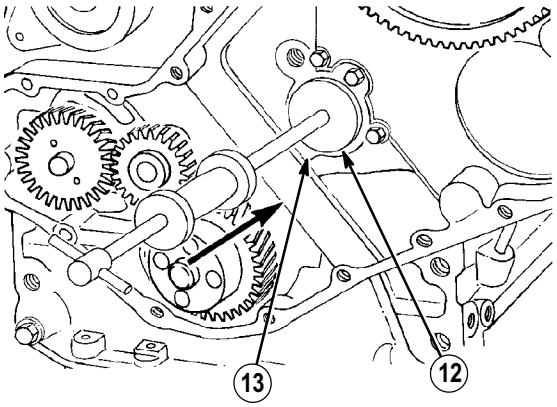


(2) Measure camshaft bore inside diameter:

No. 1 bushing	2.1317 in.	MAX.	(54.146 mm)
All except No. 1	2.1324 in.	MAX.	(54.164 mm)

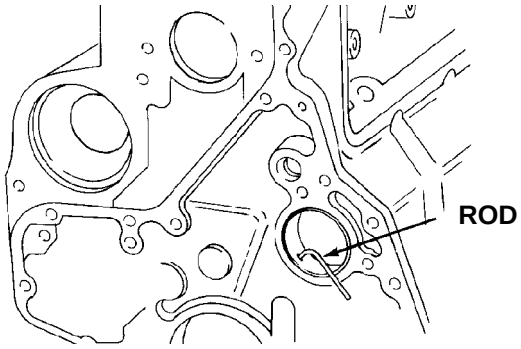
e. Installation.

(1) Using camshaft bushing tool, install camshaft bushing (12) so that it is even with front face of cylinder block (13).



7-7. CAMSHAFT AND VALVE TAPPETS REPLACEMENT (CONT).

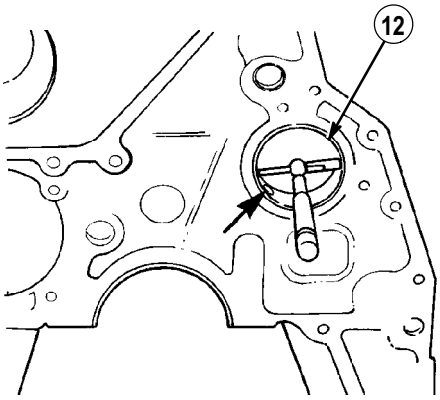
(2) Ensure lubricating oil hole is aligned. A 0.128 in. (3.2 mm) diameter rod must be able to pass through lubricating oil hole.



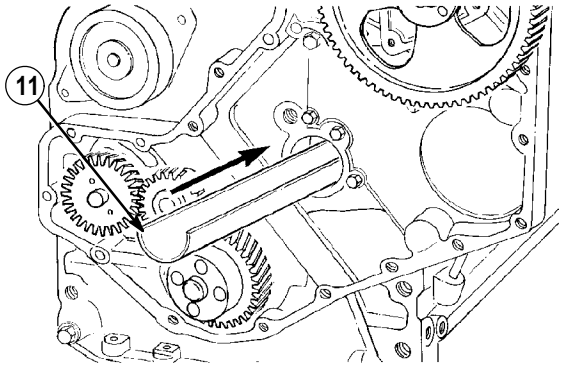
(3) Measure installed camshaft bushing (12).

Camshaft Bushing Bore

in.		mm
2.1302	MIN.	(54.107)
2.1317	MAX.	(54.146)

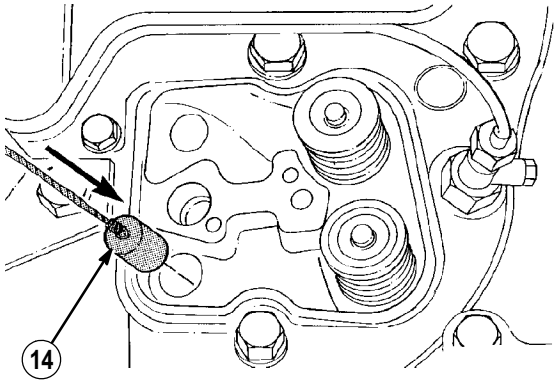


(4) Insert plastic trough (11) full length of cam bore.



(5) Lower tappet installation tool (14) down push tube hole, through tappet bore, and into plastic trough (11).

(6) Feed installation tool (14) through cam bores by carefully pulling plastic trough/installation tool out the front. The barrier at rear of plastic trough will pull tool out most of the time.

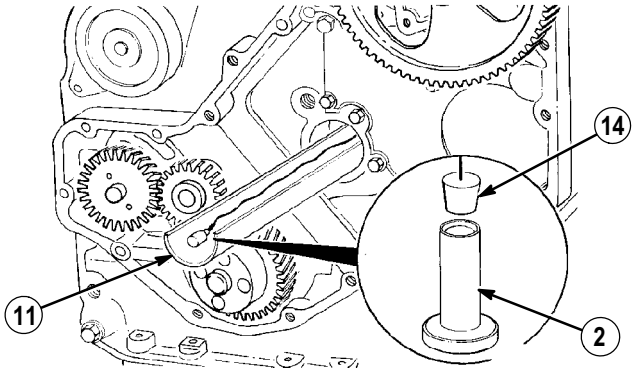


(7) Lubricate tappets (2) with lubricating oil.

NOTE

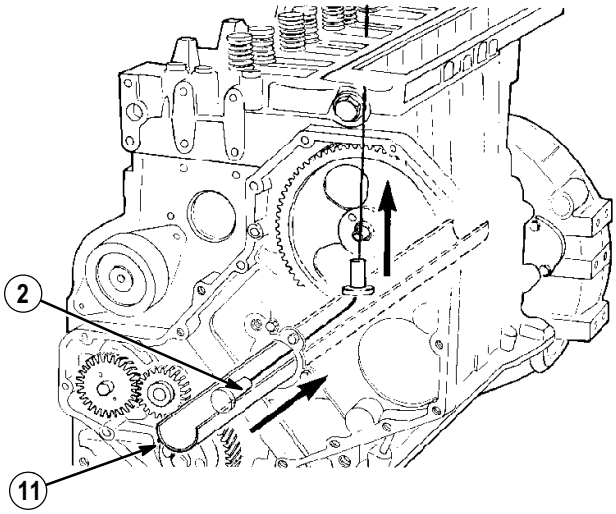
To aid in removing the installation tool after the tappet is installed, work the tool in and out of the tappet several times before installing the tappets.

(8) Insert installation tool (14) into tappet (2).

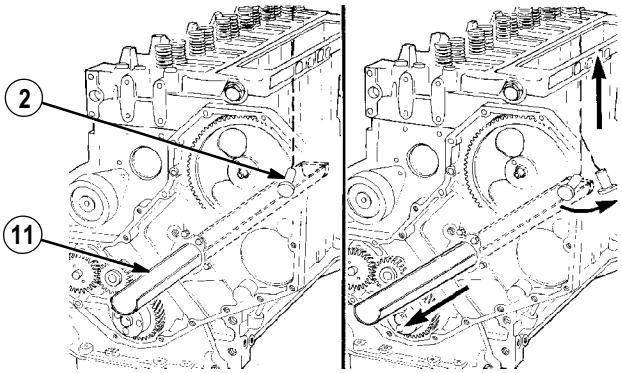


(9) Slide plastic trough (11) into cam bore.

(10) Pull tappet (2) through cam bore and up into tappet bore.

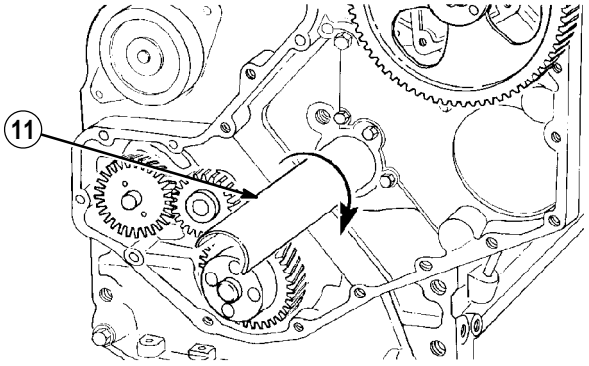


(11) If difficulty is experienced in getting tappet (2) to make the bend from plastic trough (11) up to tappet bore, pull trough out enough to allow tappet to drop down and align itself, then pull tappet up into bore.

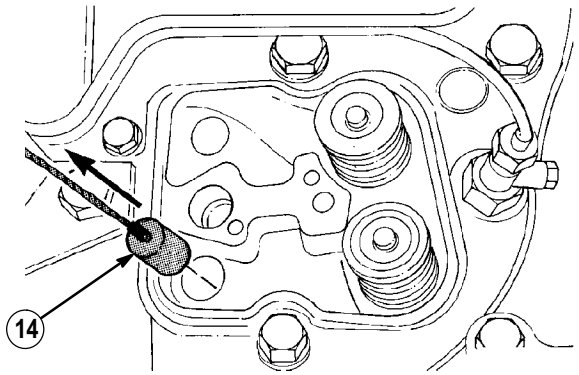


7-7. CAMSHAFT AND VALVE TAPPETS REPLACEMENT (CONT).

(12) After tappet has been pulled up into position, slide plastic trough (11) back into cam bore and rotate it 1/2 turn. This will position round side of plastic trough up, which will hold tappet in place.

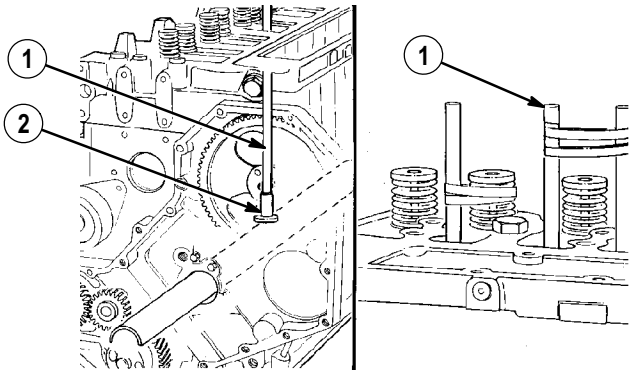


(13) Remove installation tool (14) from tappet.

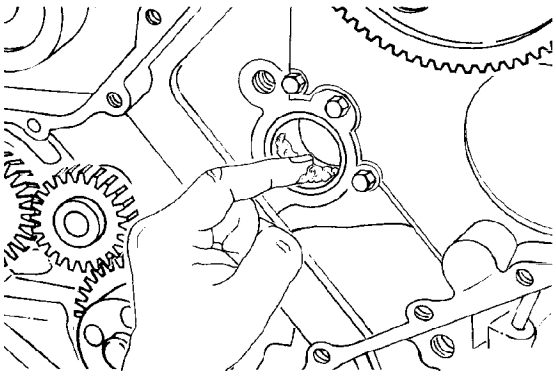


(14) Install a wooden dowel (1) into top of tappet (2). Wrap rubber band around wooden dowels to secure tappets.

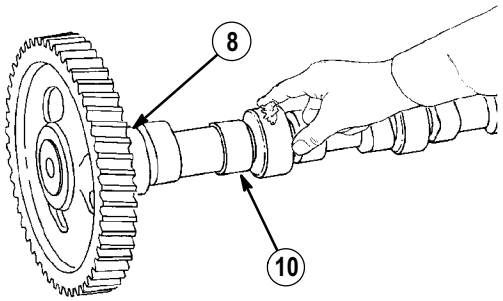
(15) Repeat Steps (4) through (14) until all tappets have been installed.



(16) Apply a coat of lubricating oil to front of camshaft bore.



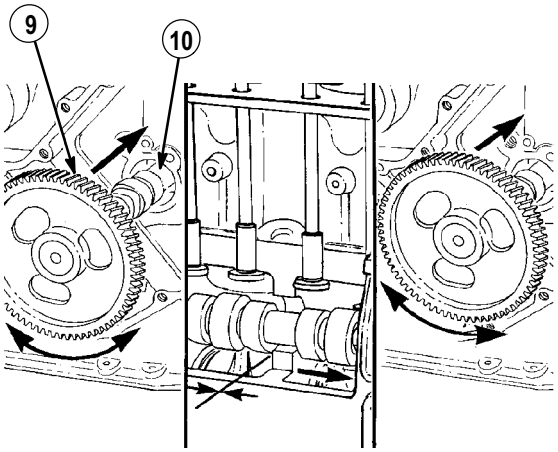
(17) Lubricate camshaft lobes and journals of camshaft (10) and thrust plate (8) with grease.



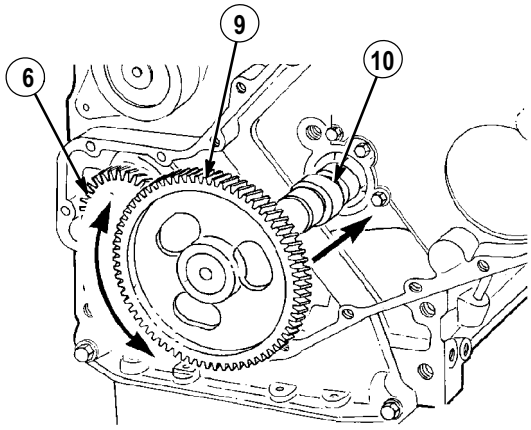
CAUTION

Do not try to force the camshaft in the camshaft bore as damage to the camshaft bushing can result.

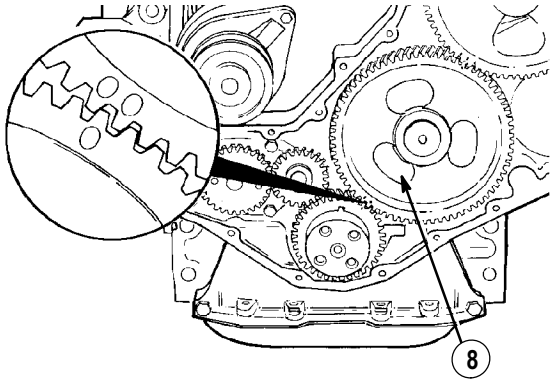
(18) Install camshaft (10) and camshaft gear (9). While pushing in slightly, rotate camshaft gear and carefully work camshaft through camshaft bushings. As each camshaft journal passes through a bushing, camshaft will drop slightly and camshaft lobes will catch on bushings. Rotating camshaft gear will free the lobe from bushing and allow camshaft to be installed.



(19) Before camshaft gear (9) engages crankshaft gear (6), check camshaft (10) for ease of rotation. When installed properly, camshaft should rotate freely.

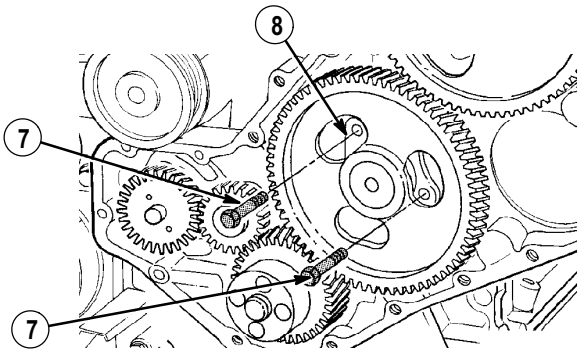


(20) Position thrust plate (8) and align timing marks as illustrated.

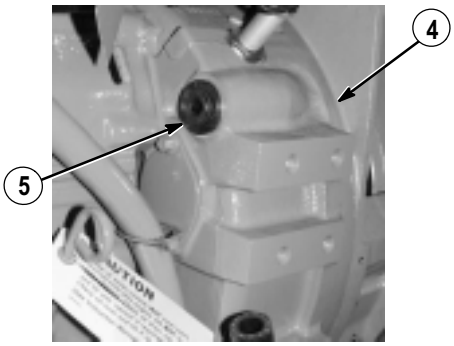


7-7. CAMSHAFT AND VALVE TAPPETS REPLACEMENT (CONT).

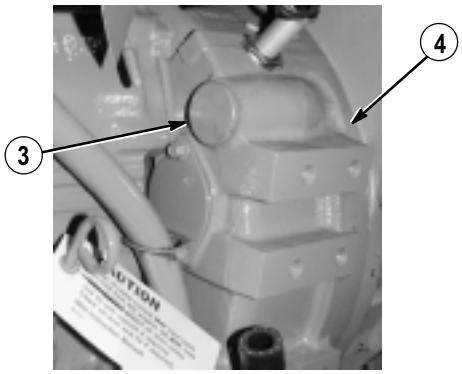
(21) Install two screws (7) and thrust plate (8). Tighten screws to 18 lb-ft (24 N·m).



(22) Remove engine turnover tool (5) from engine (4).



(23) Install cover (3) on engine (4).



f. Follow-On Maintenance:

- Install fuel pump, (TM 9-4940-568-20).
- Install front gear cover, (Para 5-14).
- Install drive belt, (TM 9-4940-568-20).
- Install rocker arms, (TM 9-4940-568-20).
- Remove engine from stand, (Para 7-2).
- Install engine, (Para 5-4).
- Start generator set and operate the engine at idle for 5 to 10 minutes and check for leaks, (TM 9-4940-568-10).

END OF TASK

7-8. CAMSHAFT GEAR REPLACEMENT.

This task covers:

a. Removal
b. Cleaning/Inspection
c. Installation
d. Follow-On Maintenance

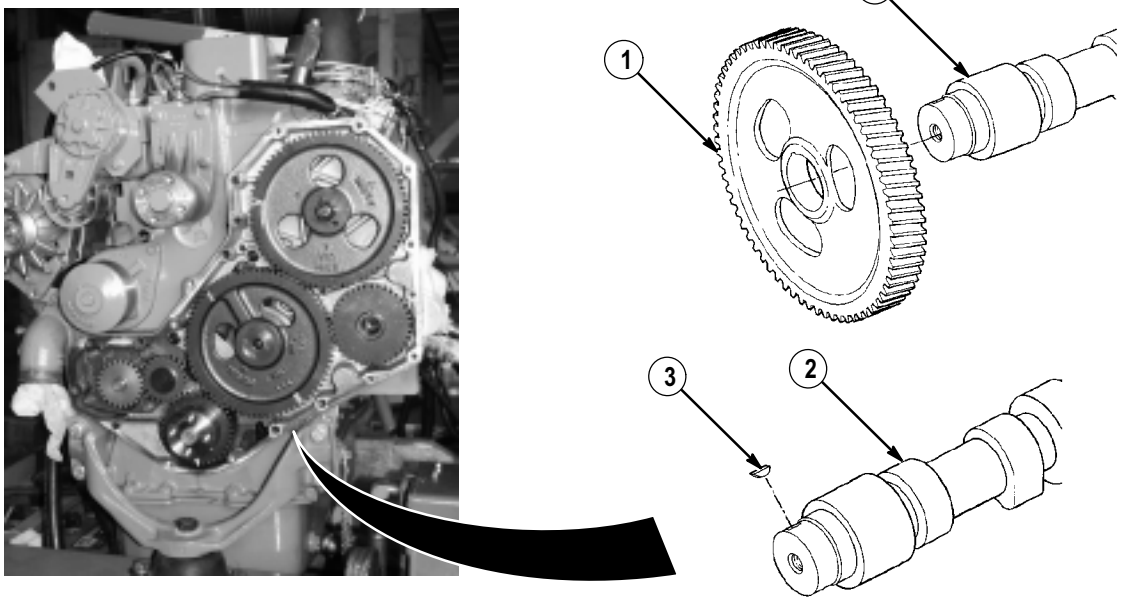
INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's
(Item 67, Appendix F)
Gage, Feeler, .001 (Item 21, Appendix F)

Materials/Parts
Grease, Lithium (Item 13, Appendix B)
Pad, Abrasive (Item 19, Appendix B)

Equipment Condition
Engine installed on stand, (Para 7-2)
Front gear cover removed, (Para 5-14)
Camshaft removed (if necessary),
(Para 7-7)

a. Removal.



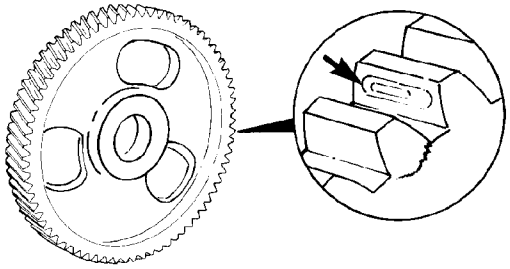
(1) Remove camshaft gear (1) from camshaft (2).

(2) Remove camshaft key (3) from camshaft (2).

7-8. CAMSHAFT GEAR REPLACEMENT (CONT).

b. Cleaning/Inspection.

(1) Visually inspect camshaft gear for cracks, chipped or broken teeth.



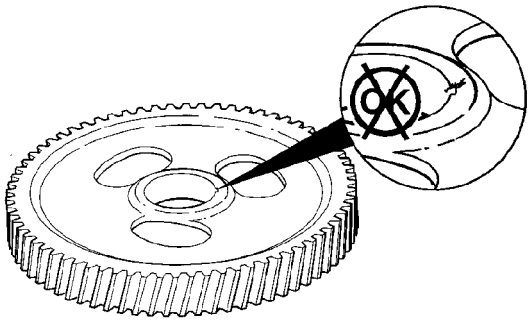
NOTE

If fretting, burrs or raised material cannot be removed with abrasive pad or equivalent, replace camshaft gear.

(2) Inspect camshaft bore for fretting or burrs.

NOTE

If the keyway is damaged or burrs cannot be removed, camshaft gear must be replaced.

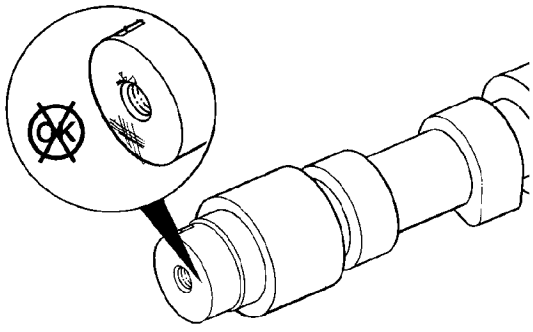


(3) Inspect camshaft gear keyway for burrs.

(4) Remove burrs with abrasive pad, or equivalent.

NOTE

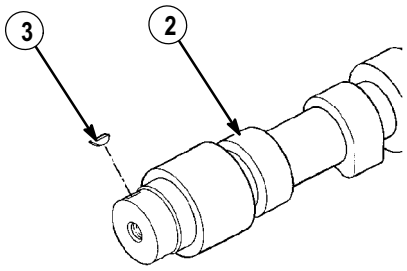
If fretting, burrs or raised material cannot be removed with abrasive pad or equivalent, replace camshaft gear.



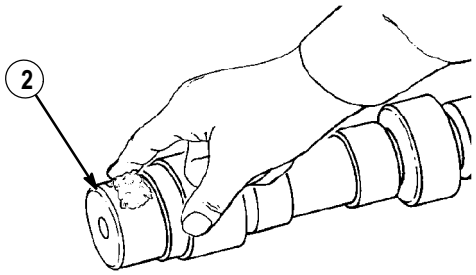
(5) Visually inspect camshaft nose for fretting or burrs.

c. Installation.

(1) Install camshaft key (3) into camshaft (2).



(2) Lubricate camshaft (2) surfaces with grease or equivalent.

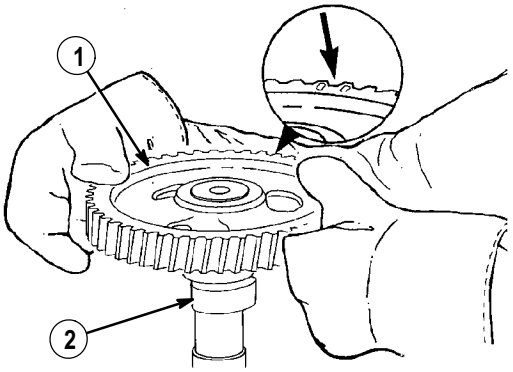


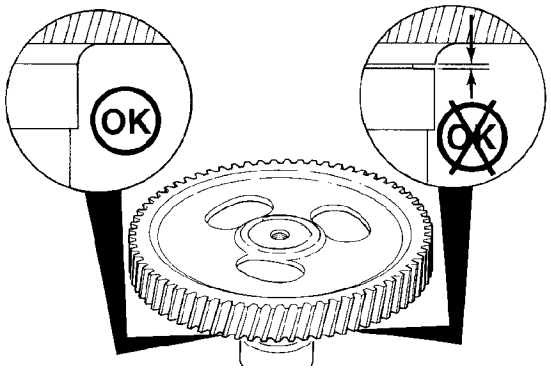
(3) Install camshaft gear (1) with timing marks away from camshaft (2).

NOTE

Be sure camshaft gear is seated against camshaft shoulder.

(4) Using a .001 inch feeler gage, check to see if feeler gage can be inserted between camshaft gear (1) and shoulder of camshaft (2). If feeler gage can be inserted, camshaft gear is not properly seated.





d. Follow-On Maintenance:

- Install camshaft (if necessary), (Para 7-7).
- Install front gear cover, (Para 5-14).
- Remove engine from stand, (Para 7-2).

END OF TASK

7-9. FRONT GEAR HOUSING REPLACEMENT.

This task covers:

a. Removal
b. Cleaning/Inspection
c. Installation
d. Relocating The Timing Pin
e. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Feeler Gage (Item 21, Appendix F)
Hammer, Plastic (Item 30, Appendix F)
Indicator, Dial, Set W/Magnetic Base (Item 33, Appendix F)
Wooden Dowels (Appendix C)

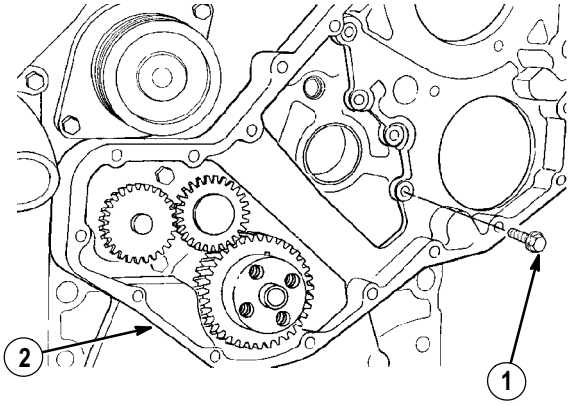
Materials/Parts
Adhesive, RTV 108 (Item 2, Appendix B)
Compound, Sealing (242) (Item 29, Appendix B)

Materials/Parts - Continued
Grease (Item 13, Appendix B)
Oil, Lubricating (Item 17, Appendix B)
Gasket (Item 23, Appendix E)

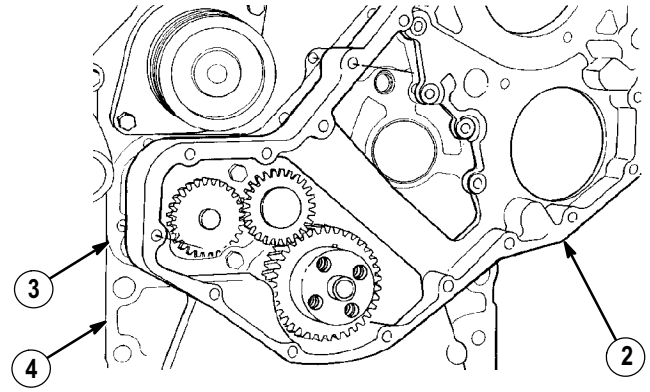
Equipment Condition
Engine installed on stand, (Para 7-2)
Valve cover rocker levers and push rods removed, (TM 9-4940-568-20)
Camshaft removed, (Para 7-7)
Fuel injection pump removed, (Para 5-17)
Oil pan removed, (TM 9-4940-568-20)

a. Removal.

(1) Remove 11 gear housing screws (1) from gear housing (2).

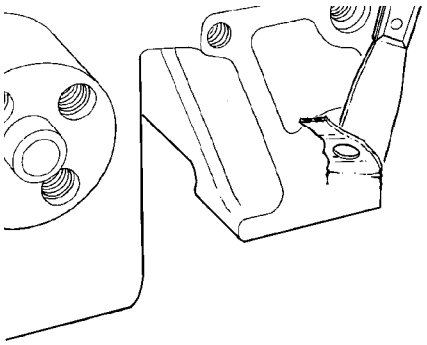


(2) Using a plastic hammer, remove the gear housing (2) and gasket (3) from cylinder block (4). Discard gasket.



b. Cleaning/Inspection.

Clean the gasket material from the cylinder block.

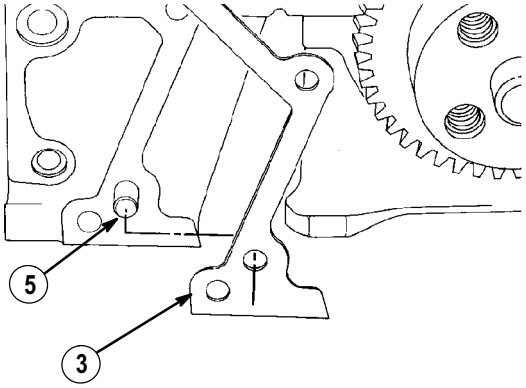


c. Installation.

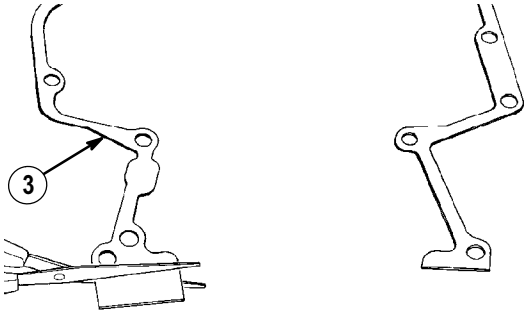
NOTE

When properly trimmed, the gear housing gasket should be even with the lubricating oil pan gasket when installed.

(1) Position the gasket (3) on the alignment dowels (5).



(2) Trim off excess gear housing gasket (3).

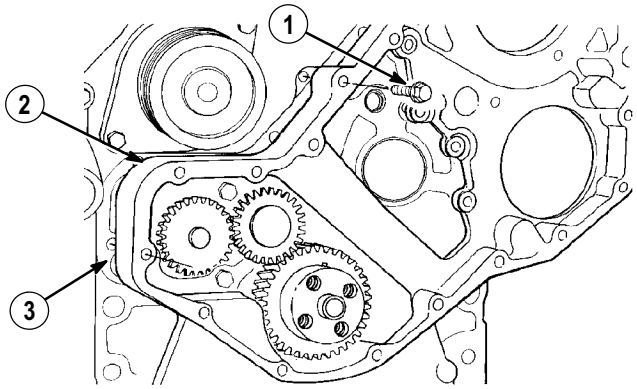


7-9. FRONT GEAR HOUSING REPLACEMENT (CONT).

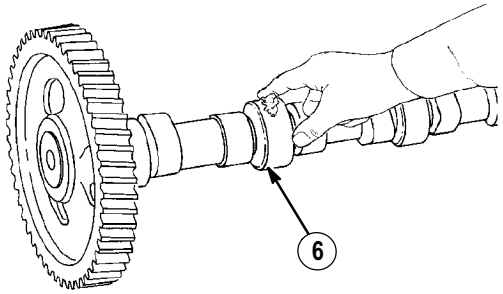
CAUTION

If a housing or other than the original housing is installed, the timing pin assembly must be accurately located. Refer to (Para 5-6).

(3) Carefully position the gear housing (2) and ensure gasket (3) is in place and install 11 gear housing screws (1). Tighten screws to 18 lb-ft (24 N·m).



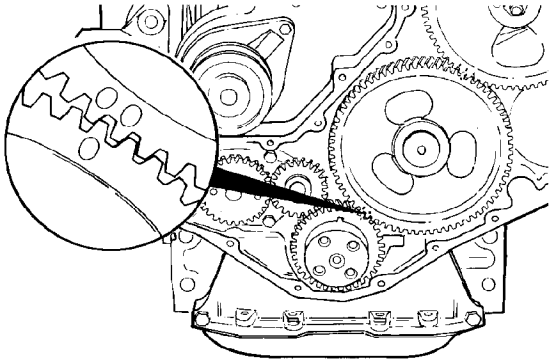
(4) Lubricate the camshaft and thrust washer (6) with grease.



NOTE

Ensure the alignment marks on the camshaft and camshaft gears are aligned.

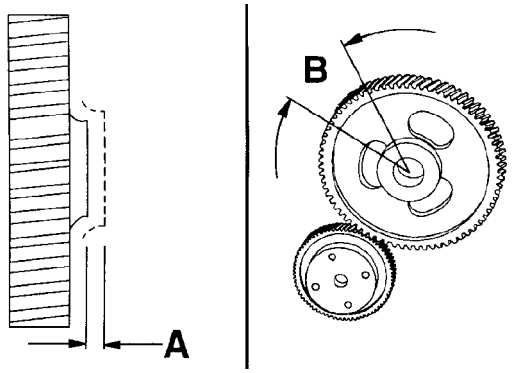
(5) Install the camshaft and thrust washer (Para 7-7).



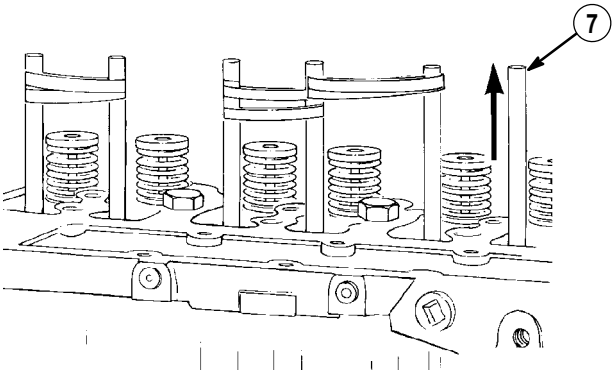
(6) Using dial indicator, verify the camshaft has proper backlash and end play.

A = 0.005 to 0.018 in. (0.12 to 0.47 mm)

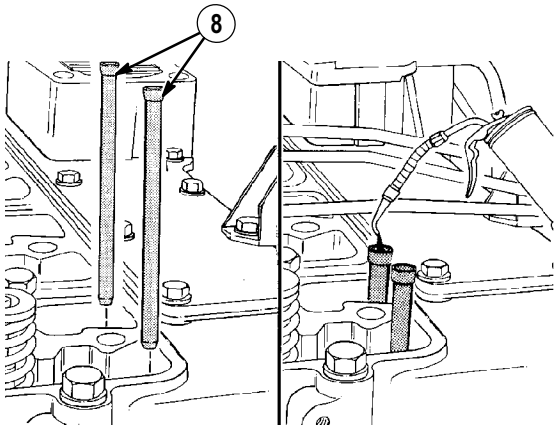
B = 0.003 to 0.013 in. (0.076 to 0.330 mm)



(7) Remove the wooden dowels (7) from the tappets.



(8) Install two push rods (8) and lubricate with lubricating oil.

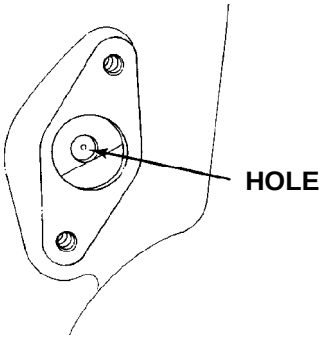


7-9. FRONT GEAR HOUSING REPLACEMENT (CONT).

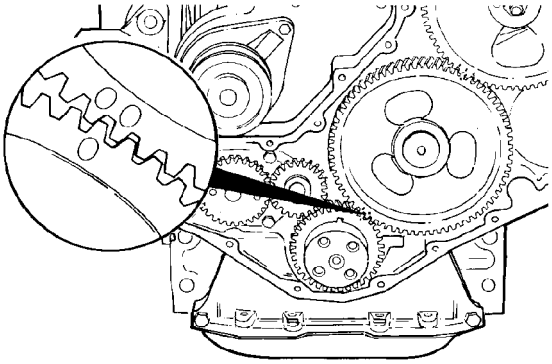
d. Relocating The Timing Pin.

NOTE

- If gear housing removed during removal was reinstalled proceed to Follow-On Maintenance.
- If new gear housing was installed perform Steps (3) through (14).
- The location of the timing pin assembly on the gear housing is critical for correct engine adjustments. Follow this procedure to install the assembly so that it corresponds to Top Dead Center (TDC), for Cylinder Number 1.



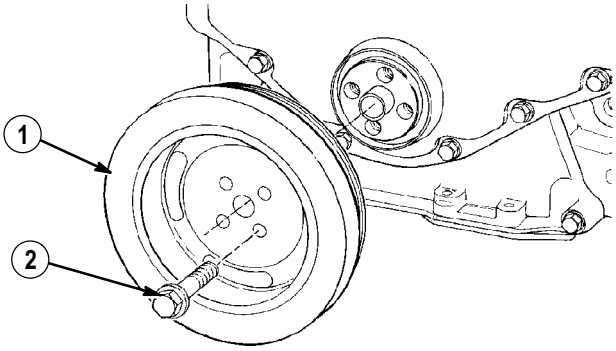
(1) Remove the injector nozzles from all of the cylinders (TM 9-4940-568-20). This step is important to vent the cylinders so the crankshaft can be rotated smoothly to located TDC for Cylinder Number 1.



(2) Temporarily install crankshaft pulley (1) and four screws (2).

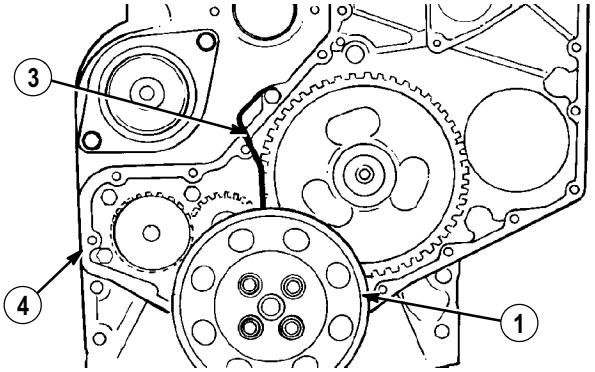
(3) Verify that the No. 1 cylinder is at or near TDC on the compression stroke by rotating the crankshaft until the engine timing pin hole is visible through the gear housing.

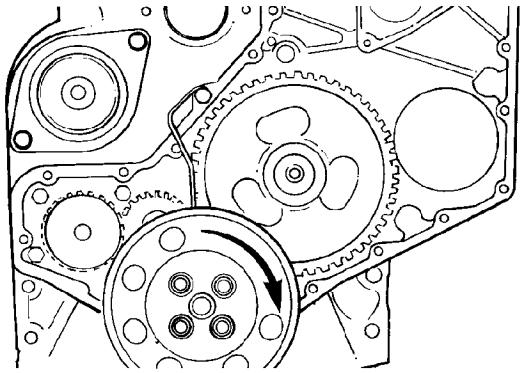
(4) Install the rocker lever, pedestal assembly for Cylinder Number 1 (TM 9-4940-568-20).



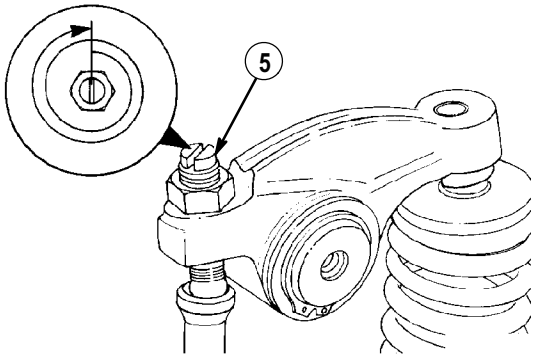
(5) Fabricate and install a wire pointer (3) for the front of the engine (4). This can be done by forming a piece of wire that can be tightened under one of the gear housing screws. The wire should extend from the gear cover to a place on the crankshaft pulley that is easily seen.

(6) Rotate crankshaft pulley (1) one-quarter revolution in the direction of normal engine rotation.





(7) Tighten the adjusting screw (5) for the No. 1 intake valve to zero “0” lash plus 5 turns.

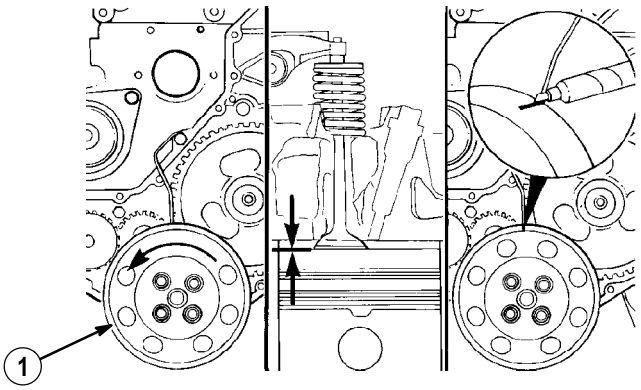


CAUTION

Use extreme care when rotating the crankshaft pulley. Use of too much force from crankshaft could damage the valve or push rod.

(8) Rotate crankshaft pulley (1) slowly in the opposite direction of normal engine rotation until the piston touches the intake valve.

(9) Mark crankshaft pulley (1) at the wire pointer.



7-9. FRONT GEAR HOUSING REPLACEMENT (CONT).

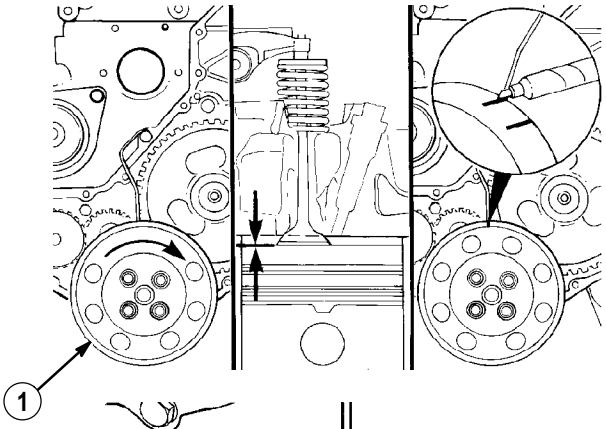
CAUTION

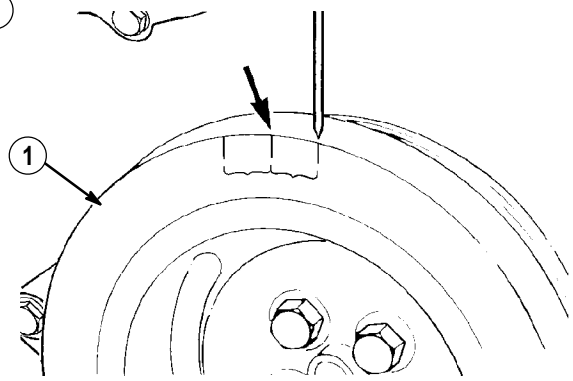
Make sure that the piston touches the intake valve with approximately the same amount of force as in the previous step.

(10) Rotate crankshaft pulley (1) in the direction of normal engine rotation until the piston touches the intake valve.

(11) Mark crankshaft pulley (1) at the wire pointer.

(12) Measure the distance and mark the crankshaft pulley (1) at one-half the distance between the two marks. This mark is the TDC mark.

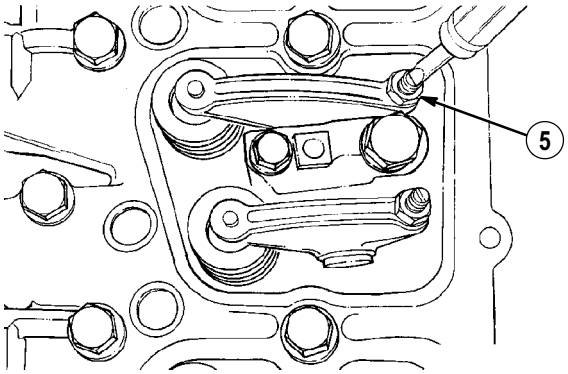




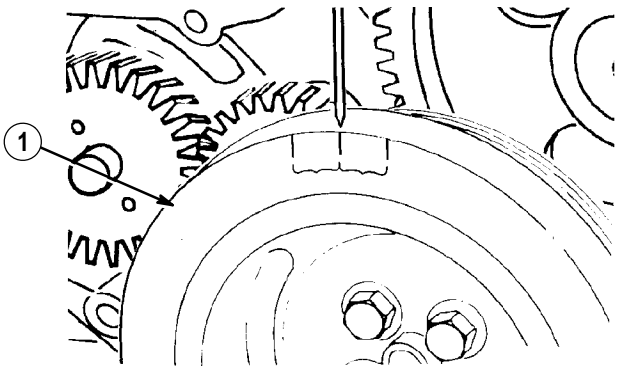
CAUTION

Completely loosen the intake valve adjusting screw. Failure to do so will result in damage to the intake valve or push rod when the crankshaft is rotated.

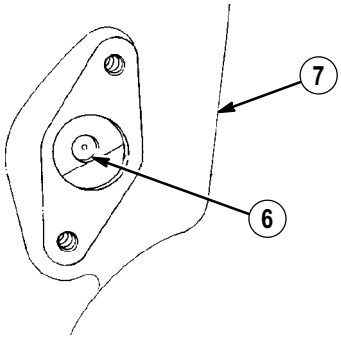
(13) Completely loosen intake valve adjustment screw (5).



(14) Rotate crankshaft pulley (1) in the direction of normal engine rotation until the pointer is aligned with the TDC mark, then rotate the crankshaft pulley one additional revolution.



(15) The timing pin hole (6) in the cam gear should be visible or felt through the back side of the gear housing (7). If not, the crankshaft must be rotated on revolution in the direction of engine rotation.

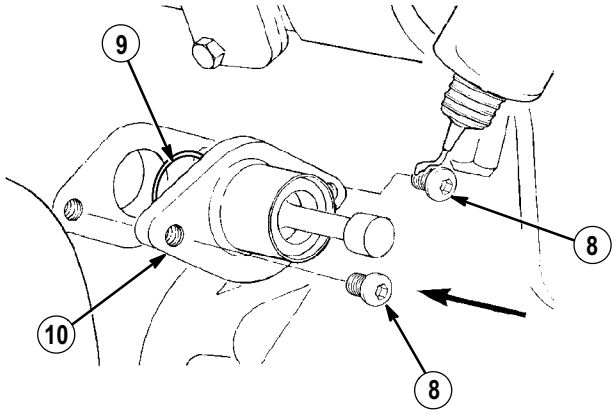


WARNING

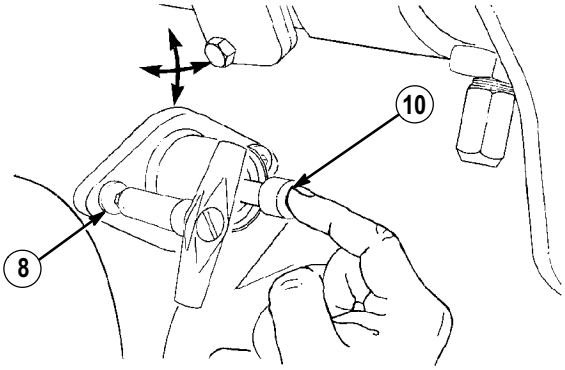
Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

(16) Remove timing pin from old gear housing (Para 5-6).

(17) Apply a coat of sealing compound to the threads of two screws (8) and install gasket (9) and timing pin (10) on gear housing (7).

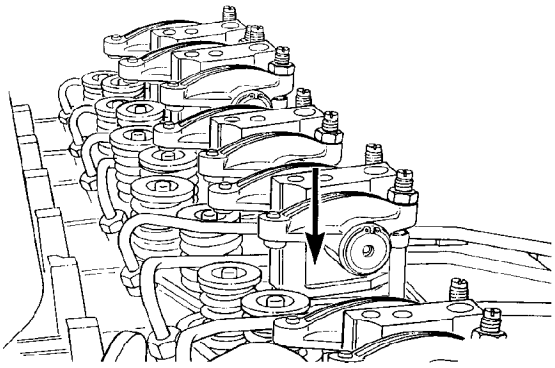


(18) Hold the timing pin (10) in the hole to align the housing. Tighten two screws (8) to 4 lb-ft (5 N·m).



7-9. FRONT GEAR HOUSING REPLACEMENT (CONT).

(19) Install the remaining rocker lever pedestal assemblies (TM 9-4940-568-20).



e. Follow-On Maintenance:

- Install valve cover rocker levers and push rods (as necessary), (TM 9-4940-568-20).
- Adjust the valves, (TM 9-4940-568-20).
- Install fuel injection pump, (Para 5-17).
- Remove engine from stand, (Para 7-2).
- Install engine, (Para 5-4).
- Operate the engine at idle for 5 to 10 minutes and check for leaks, (TM 9-4940-568-10).

END OF TASK

7-10. GENERATOR REPAIR.

This task covers:

a. Disassembly b. Assembly c. Follow-On Maintenance

INITIAL SETUP

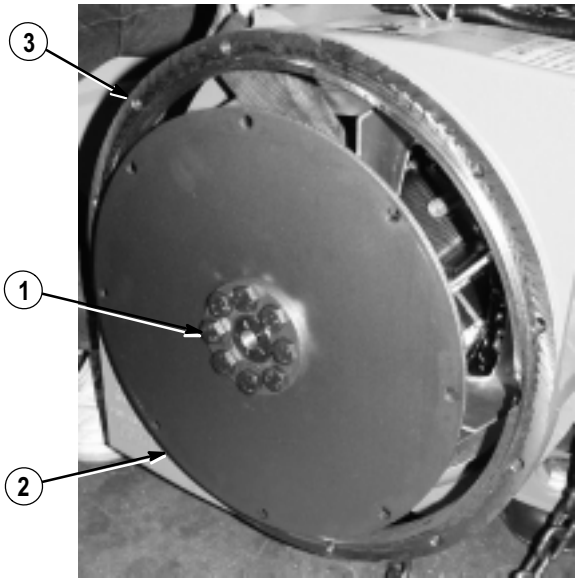
Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Cap and Plug Set (Item 6, Appendix F)
Wrench, Torque (0 to 300 lb-ft [0-470 N·m]) (Item 84, Appendix F)
Lifting Device, Minimum Capacity 500 lbs (227 kg)
Wooden Blocks (4) (Appendix C)

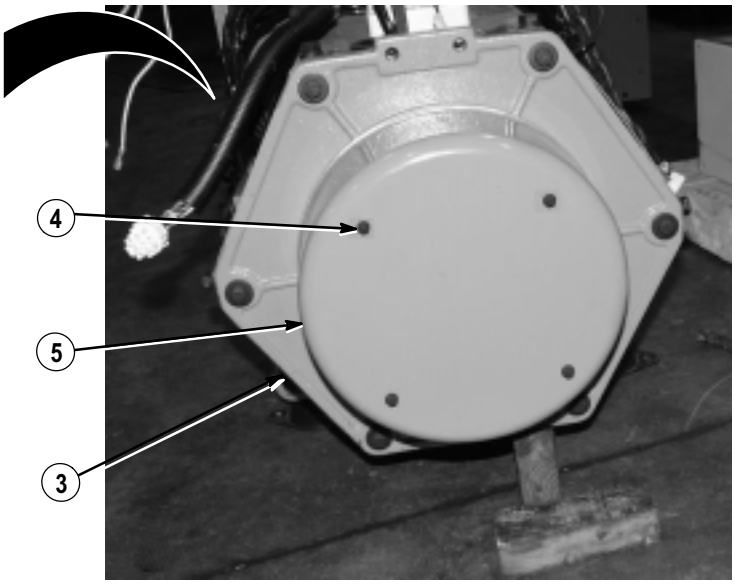
Materials/Parts
Cable Ties (Item 5, Appendix B)
Lockwasher (Item 52, Appendix E)
Lockwashers (4) (Item 51, Appendix E)
Lockwashers (6) (Item 49, Appendix E)

Personnel Required
Two

Equipment Condition
FRS unloaded, (TM 9-4940-568-10)
Generator set removed, (Para 5-3)
Batteries disconnected, (TM 9-4940-568-10)

a. Disassembly.





NOTE

Use wooden block to hold fan in position.

(1) Remove eight screws (1) and three drive disks (2) from generator (3).

(2) Remove four screws (4) and end bell cover (5) from generator (3).

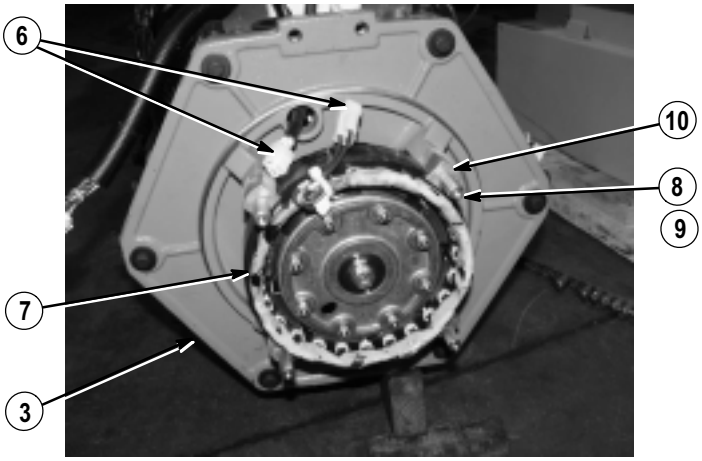
7-10. GENERATOR REPAIR (CONT).

(3) Disconnect lead (6) from PMG stator (7).

NOTE

Note position of PMG stator before removal.

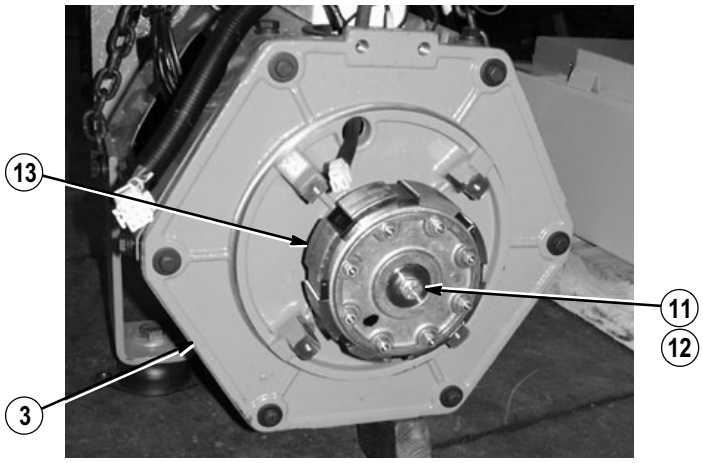
(4) Remove four spacers (8), lockwashers (9), clamps (10) and PMG stator (7) from generator (3). Discard lockwashers.



NOTE

Use wooden block to hold fan in position.

(5) Remove PMG mount screw (11), lockwasher (12) and PMG rotor (13) from generator (3). Discard lockwasher.

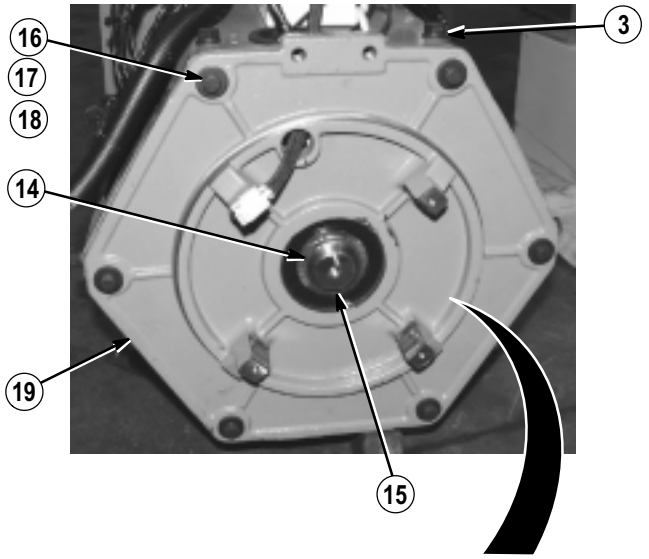


WARNING

Use extreme care when removing or installing spring retaining rings. Spring retaining rings are under tension and can act as projectiles when released suddenly. Ensure proper eye protection is worn to prevent injury to personnel.

(6) Remove retaining ring (14) from shaft (15).

(7) Remove six screws (16), lockwashers (17) and washers (18) from end bell (19) and generator (3). Discard lockwashers.



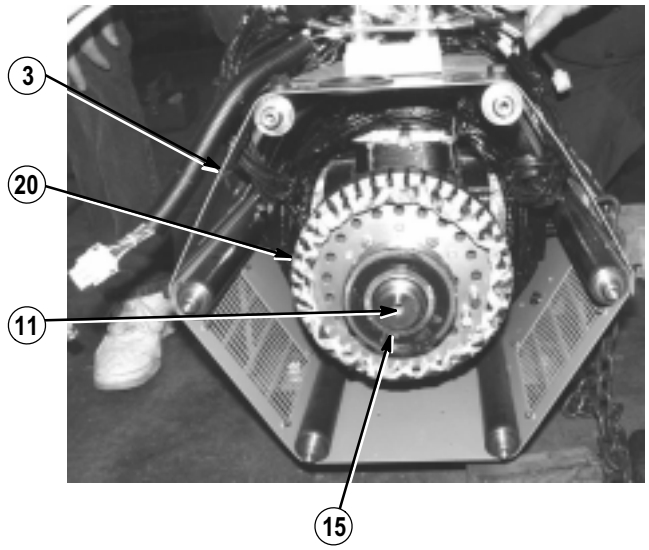
NOTE

Note position of wire lead prior to removal.

(8) Remove end bell (19) from generator (3).

(9) Install PMG mount screw (11) into shaft (15).

(10) Remove rotor assembly (20) from generator (3) from fan.



NOTE

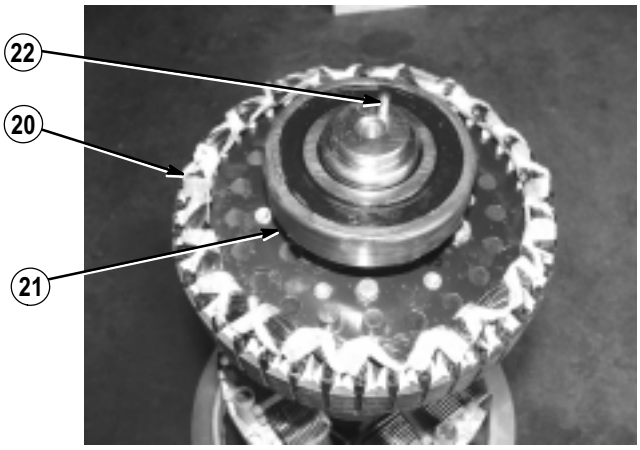
Bearing may need to be pressed out for removal.

(11) Remove bearing (21) from rotor assembly (20).

NOTE

If pin is damaged, perform Step (12).

(12) Remove pin (22) from rotor assembly (20).



7-10. GENERATOR REPAIR (CONT).

b. Assembly.

NOTE

Pin may need to be pressed in for installation.

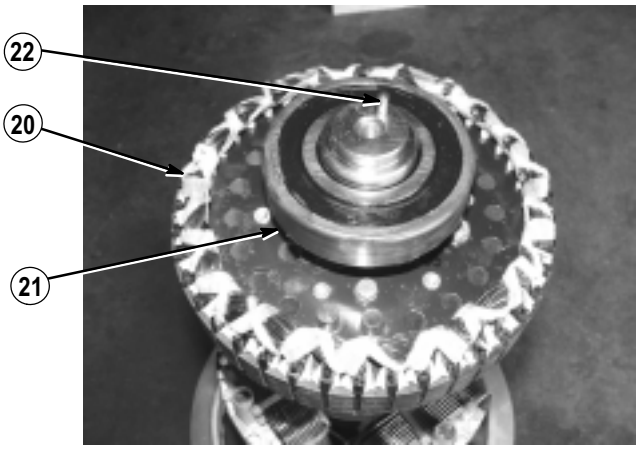
(1) If necessary, install pin (22) on rotor assembly (20).

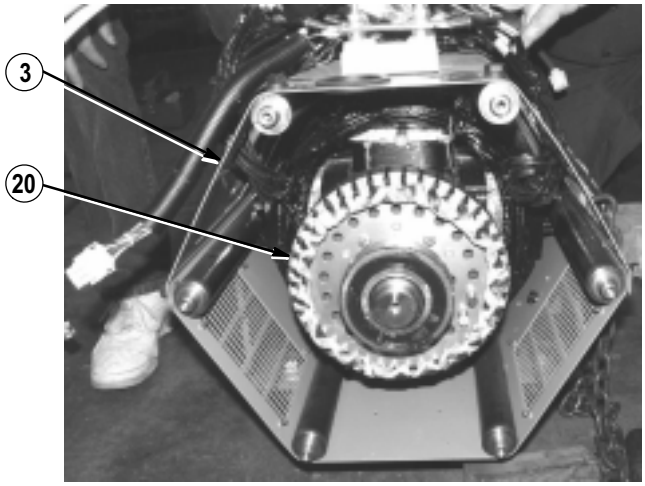
NOTE

Bearing may need to be pressed in for assembly.

(2) Install bearing (21) on rotor assembly (20).

(3) Install rotor assembly (20) into generator (3).





NOTE

Position wire lead as noted prior to removal.

(4) Install end bell (19) on generator (3).

(5) Install six washers (18), lockwashers (17) and screws (16) on end bell (19) and generator (3).

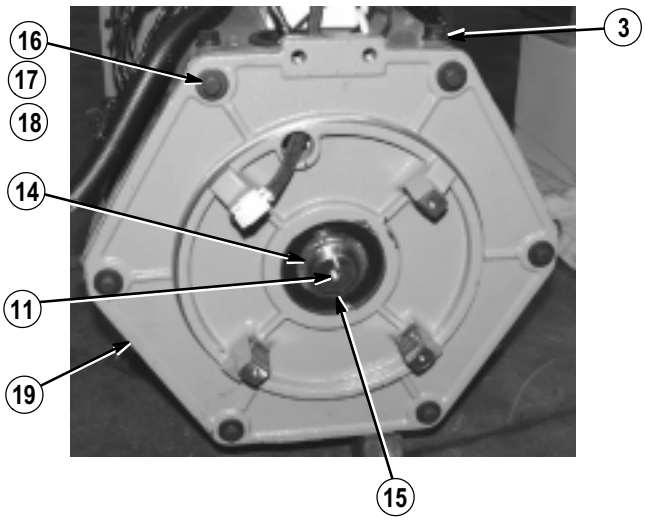
(6) Tighten screws (16) to 25 lb-ft (11 N·m).

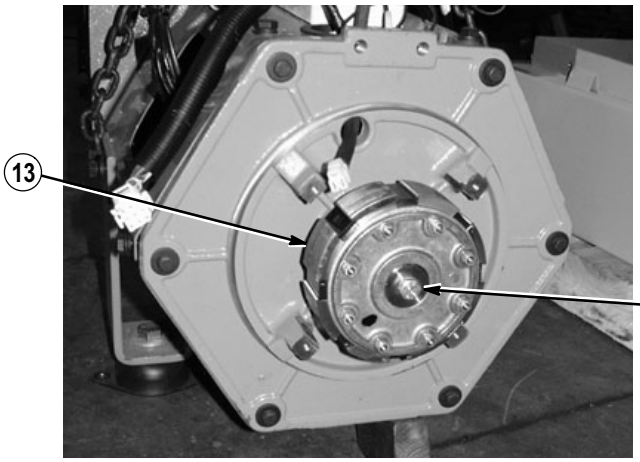
WARNING

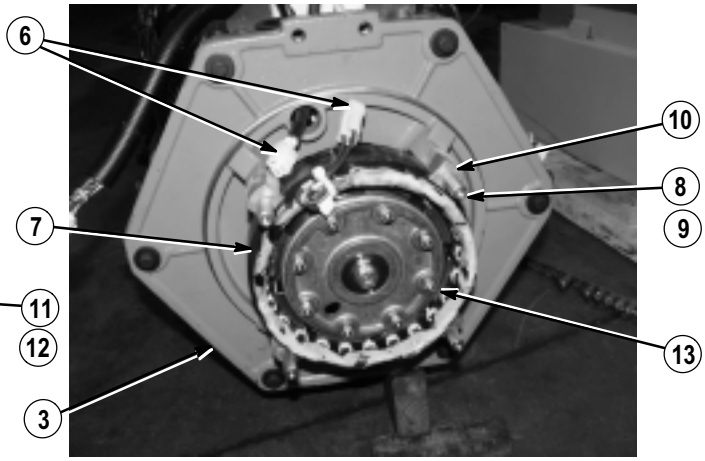
Use extreme care when removing or installing spring retaining rings. Spring retaining rings are under tension and can act as projectiles when released suddenly. Ensure proper eye protection is worn to prevent injury to personnel.

(7) Install retaining ring (14) on shaft (15).

(8) Remove PMG mount screw (11) from shaft (15).







(9) Install PMG rotor (13), lockwasher (12) and PMG mount screw (11).

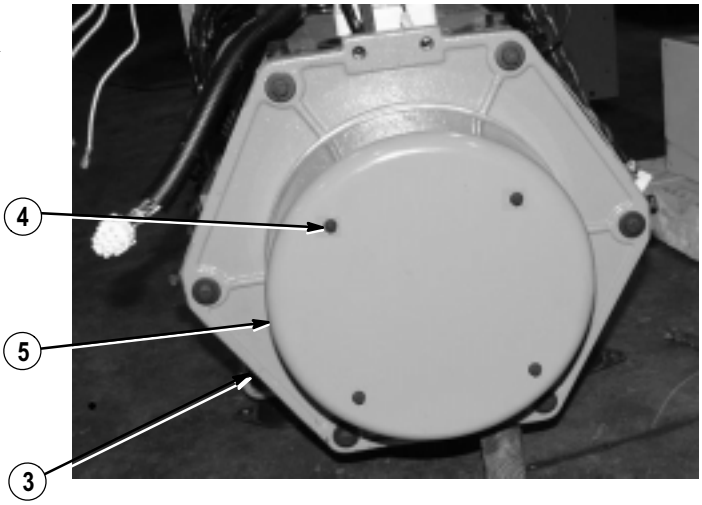
(10) Tighten PMG mount screw (11) to 40 lb-ft (19 N·m).

NOTE

Position PMG stator as noted during removal.

(11) Install PMG stator (7) on PMG rotor (13).

(12) Install four clamps (10), lockwashers (9) and four spacers (8) on PMG stator (7) and generator (3).



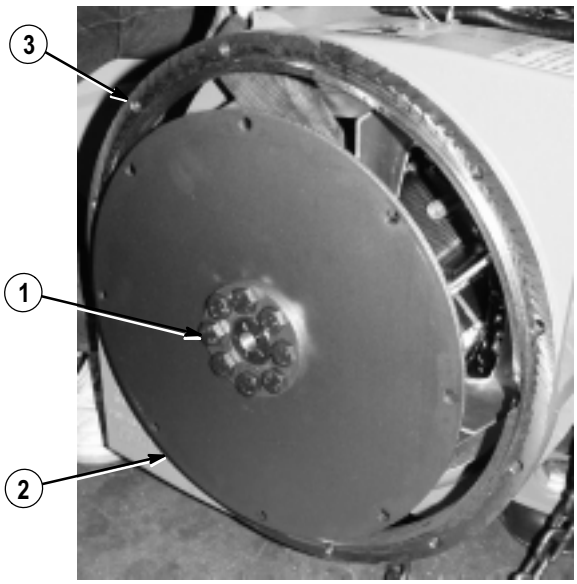
(13) Tighten spacers (8) to 7 lb-ft (3 N·m)

(14) Install lead (6) to PMG stator (7).

(15) Install four screws (4) and end bell cover (5) on generator (3).

(16) Install eight screws (1) and three drive disks (2) on generator (3).

(17) Tighten screws (1) to 95 lb-ft (43 N·m).



c. Follow-On Maintenance:

- Install generator set, (Para 5-3).
- Connect batteries, (TM 9-4940-568-10).
- Start generator and check for proper operation, (TM 9-4940-568-10).

END OF TASK

CHAPTER 8
GENERAL SUPPORT PNEUMATIC SYSTEM MAINTENANCE

Para	Contents	Page
8-1	Introduction	8-1
8-2	Air Compressor Repair	8-2

8-1. INTRODUCTION.

This chapter contains maintenance instructions for removing, replacing, repairing, installing and adjusting components authorized by the Maintenance Allocation Chart (MAC) at the General Support Maintenance level.

8-2. AIR COMPRESSOR REPAIR.

This task covers:

a. Disassembly b. Assembly c. Follow-On Maintenance

INITIAL SETUP

Tools and Special Tools
Tool Kit, General Mechanic's (Item 67, Appendix F)
Hammer, Hand, Soft Plastic (Item 30, Appendix F)
Pliers, Retaining Ring Compressor (Item 44, Appendix F)
Wrench 1 1/16 (Item 75, Appendix F)
Wrench 1 11/16 (Item 79, Appendix F)
Wrench, Torque (0 to 300 lb-ft [0-470 N·m]) (Item 84, Appendix F)

Materials/Parts
Air Compressor Maintenance Kit (Item 1, Appendix E)
Gasket (Item 16, Appendix E)
Gasket (Item 17, Appendix E)
Gasket (2) (Item 19, Appendix E)
Gasket (Item 20, Appendix E)
Gasket (Item 24, Appendix E)
Gasket (Item 25, Appendix E)
Gasket (Item 27, Appendix E)
Gasket (2) (Item 28, Appendix E)

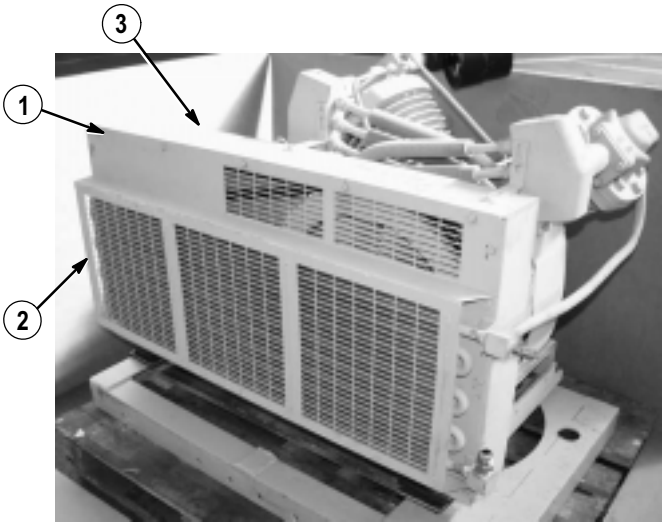
Materials/Parts – Continued
Gasket (Item 29, Appendix E)
Gasket (Item 30, Appendix E)
Lockwasher (4) (Item 63, Appendix E)
Lockwasher (4) (Item 64, Appendix E)
Lockwasher (2) (Item 54, Appendix E)
Lockwasher (4) (Item 55, Appendix E)
Lockwasher (Item 56, Appendix E)
Lockwasher (10) (Item 57, Appendix E)
Lockwire (Item 68, Appendix E)
Preformed Packing (Item 111, Appendix E)
Preformed Packing (Item 128, Appendix E)
Seal (Item 160, Appendix E)
Screw, Self-Tapping (19) (Item 149, Appendix E)
Screw, Self-Tapping (4) (Item 148, Appendix E)

Personnel Required
Two

Equipment Condition
Air compressor and platform removed (TM 9-4940-568-20)
Air compressor in a clean work area

a. Disassembly.

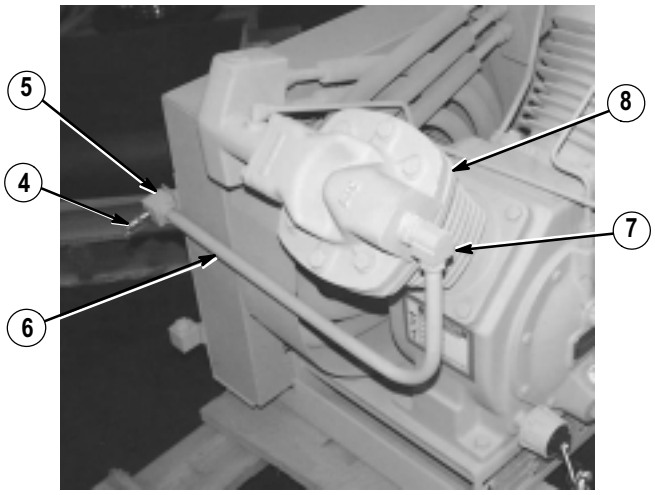
(1) Remove nine self-tapping screws (1) and belt guard cover (2) from belt guard shroud (3).



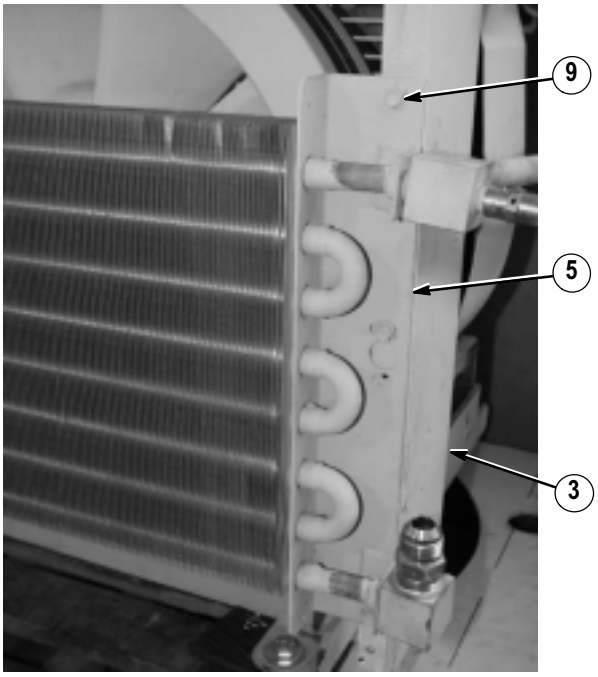
(2) Remove safety valve (4) from aftercooler coil (5).

(3) Remove tube assembly (6) from aftercooler coil (5).

(4) Remove elbow (7) and tube assembly (6) from airhead (8).

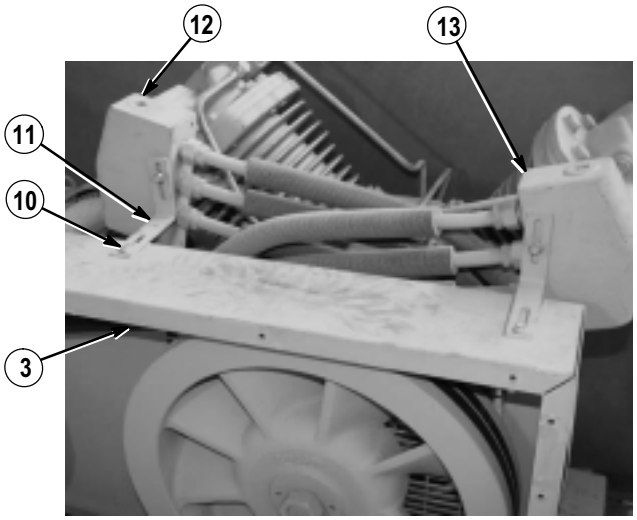


(5) Remove six self-tapping screws (9) and aftercooler coil (5) from belt guard shroud (3).



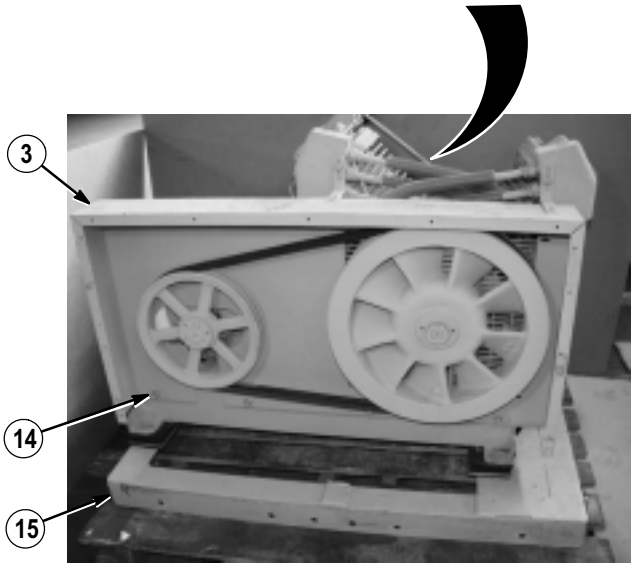
8-2. AIR COMPRESSOR REPAIR (CONT).

(6) Remove four self-tapping screws (10) and two brackets (11) from belt guard shroud (3) and high pressure intercooler manifold (12) and low pressure intercooler manifold (13).



(7) Remove four self-tapping screws (14) and belt guard back (3) from air compressor subbase (15).

(8) Remove two belts (TM 9-4940-568-20).



NOTE

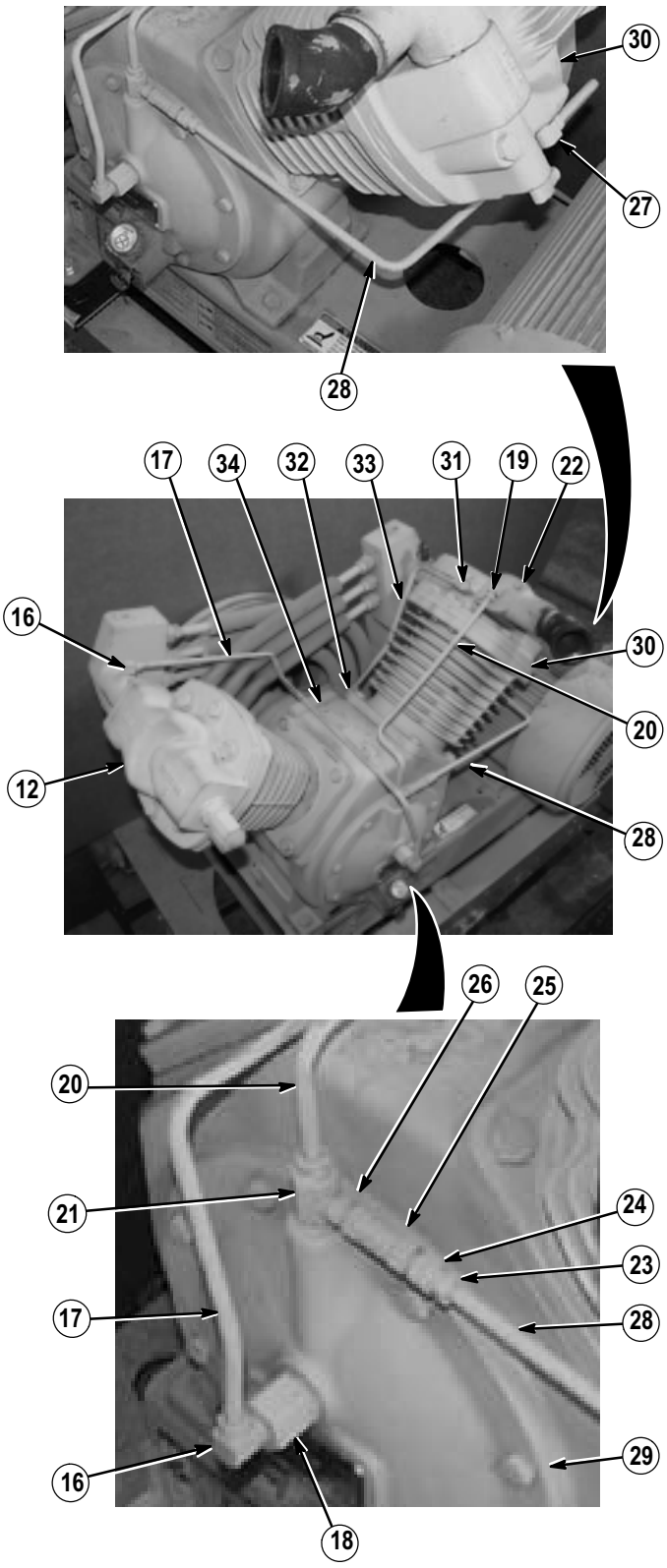
- Tag and mark all tubes prior to removal.
- Note position of tubes prior to removal.

(9) Remove two elbows (16) and pilot valve manifold tube assembly (17) from pilot valve (18) and high pressure intercooler manifold (12).

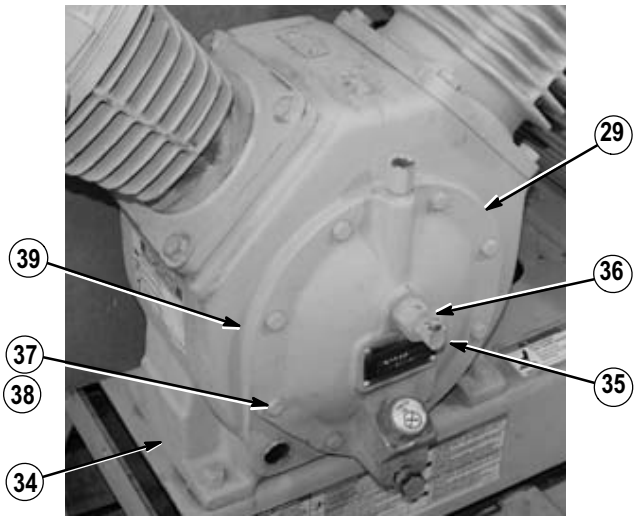
(10) Remove elbow (19) and frame end cover tube assembly (20) from tube connector (21) and unloader cover (22).

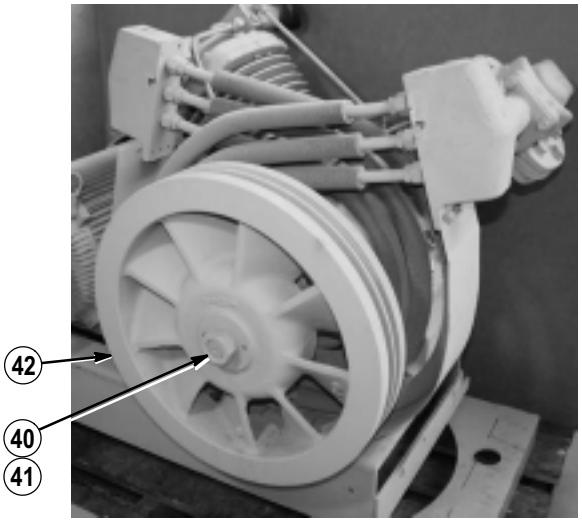
(11) Remove tube connector (23), nipple (24), check valve (25), tube connector (26), elbow (27) and check valve tube assembly (28) from frame end cover (29) and low pressure airhead (30).

(12) Remove elbow (31), connector (32) and breather tube assembly (33) from low pressure airhead (30) and air compressor frame (34).



8-2. AIR COMPRESSOR REPAIR (CONT).





(13) Remove pilot valve (35) and spacer(s) (36) from frame end cover (29).

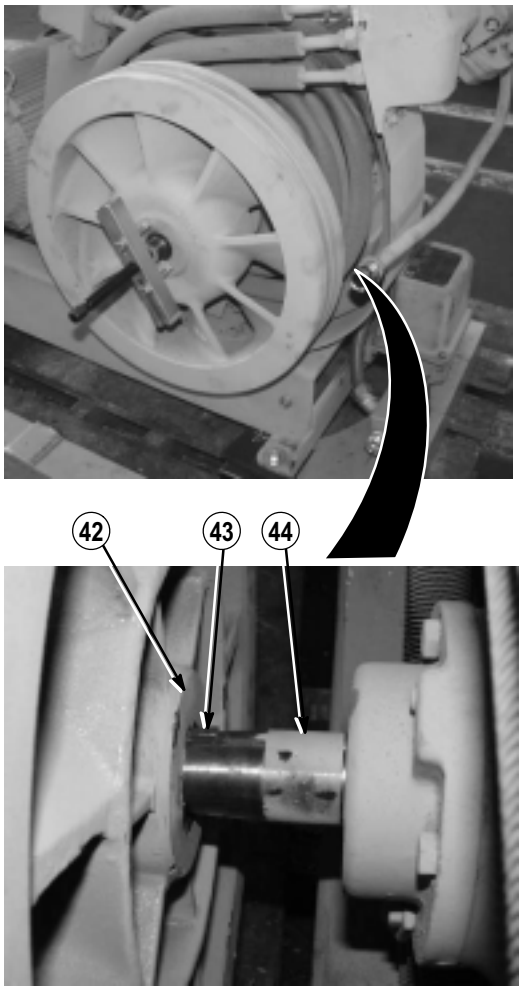
(14) Remove eight screws (37), washers (38), gasket (39) and frame end cover (29) from air compressor frame (34). Discard lockwashers and gasket.

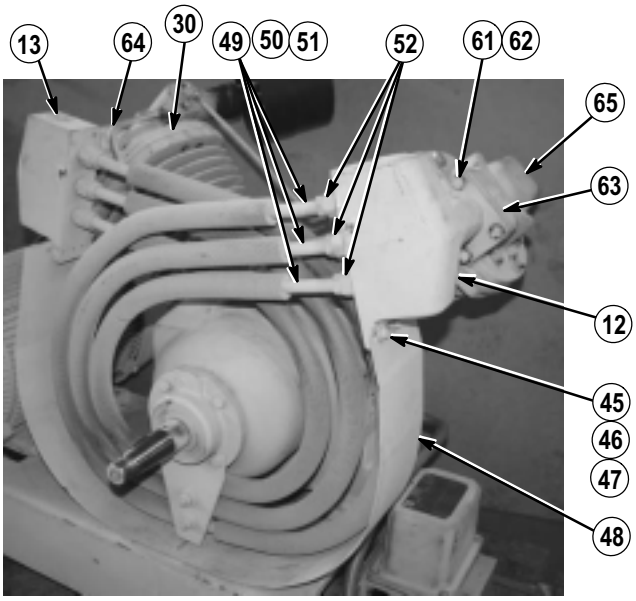
(15) Remove nut (40) and lockwasher (41) from air compressor pulley (42). Discard lockwasher.

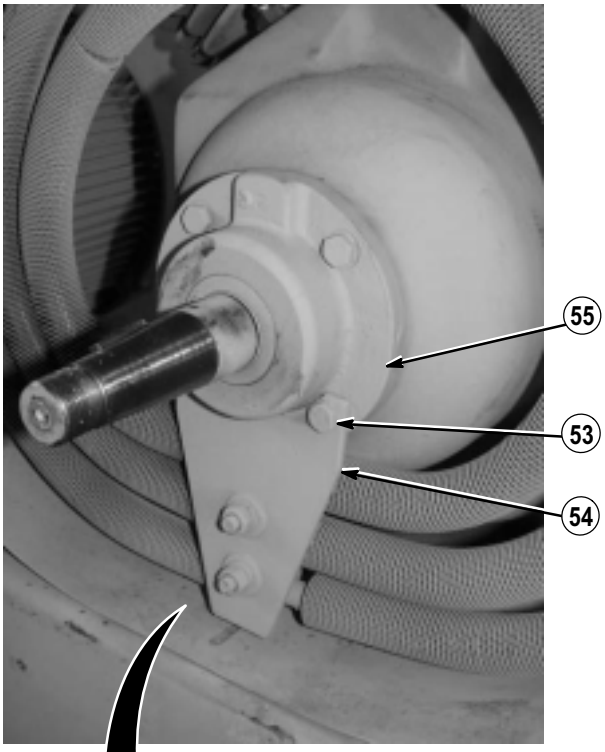
NOTE

- Note position of air compressor pulley prior to removal.
- Attach pulley tool prior to removal of air compressor pulley.

(16) Remove air compressor pulley (42) and key (43) from air compressor crankshaft (44).







(17) Remove four screws (45), lockwashers (46), washers (47) and intercooler shroud (48) from high pressure intercooler manifold (12) and low pressure intercooler manifold (13). Discard lockwashers.

NOTE

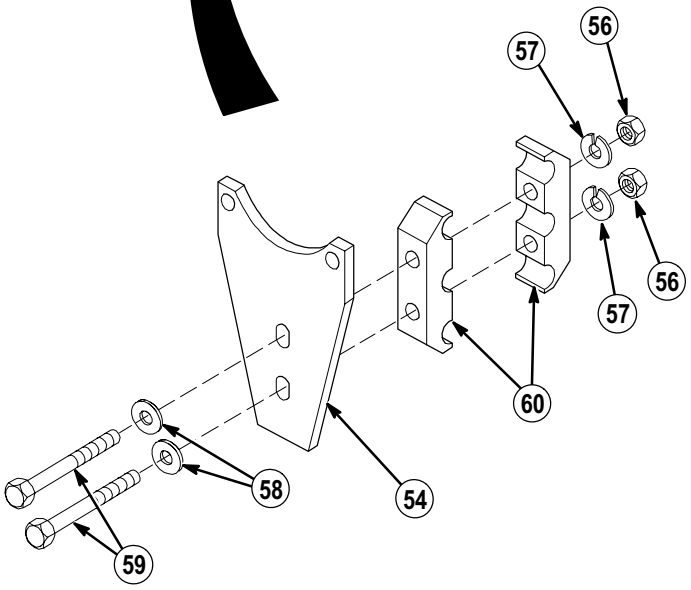
Note position of intercooler tubes prior to removal.

(18) Remove intercooler tube #1 (49), intercooler tube #2 (50), intercooler tube #3 (51) and six tube connectors (52) from high pressure intercooler manifold (12) and low pressure intercooler manifold (13).

(19) Remove two screws (53) and bracket (54) from end cover (55).

(20) Remove two nuts (56), lockwashers (57), washers (58), screws (59), bracket (54) and clamp (60) from intercooler tube #1 (49), intercooler tube #2 (50) and intercooler tube #3 (51). Discard lockwashers.

(21) Remove eight screws (61), lockwashers (62), high pressure intercooler manifold (12), low pressure intercooler manifold (13), gasket (63) and gasket (64) from low pressure airhead (30) and high pressure airhead (65). Discard lockwashers and gaskets.

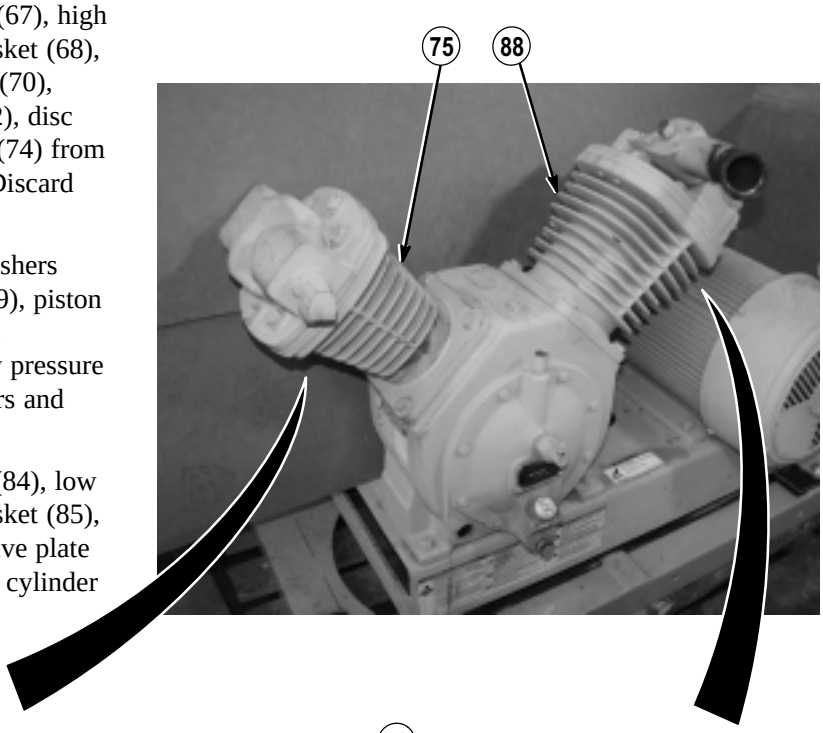


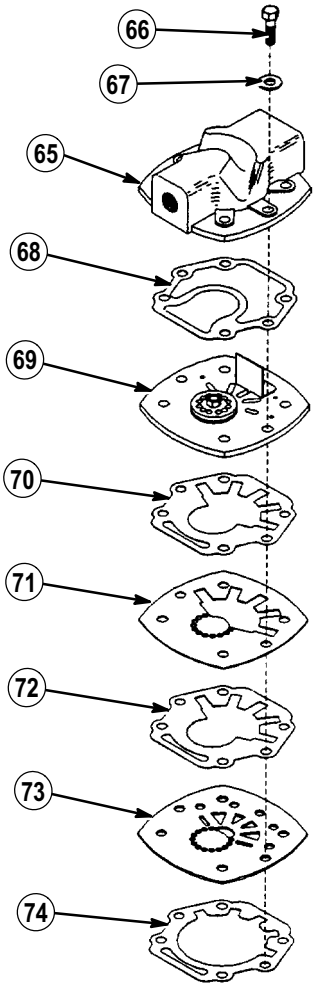
8-2. AIR COMPRESSOR REPAIR (CONT).

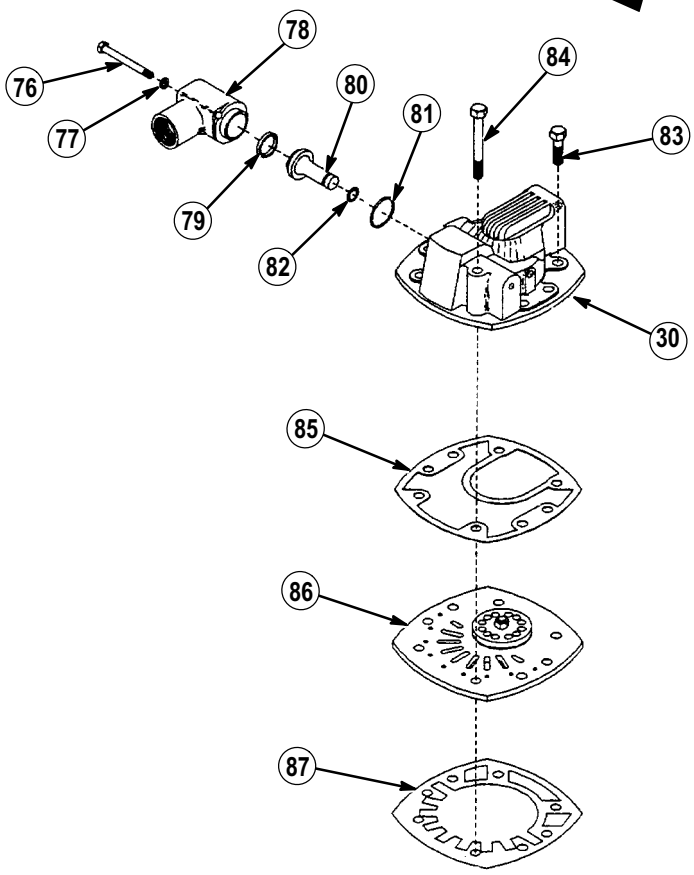
(22) Remove six screws (66), washer (67), high pressure airhead (65), airhead gasket (68), plate assembly (69), plate gasket (70), spacer plate (71), plate gasket (72), disc plate (73) and valve plate gasket (74) from high pressure air cylinder (75). Discard gaskets.

(23) Remove two screws (76), lockwashers (77), unloader cover (78), seal (79), piston (80), preformed packing (81) and preformed packing (82) from low pressure airhead (30). Discard lockwashers and preformed packing.

(24) Remove five screws (83), screw (84), low pressure airhead (30), airhead gasket (85), valve plate assembly (86) and valve plate gasket (87) from low pressure air cylinder (88). Discard gaskets.





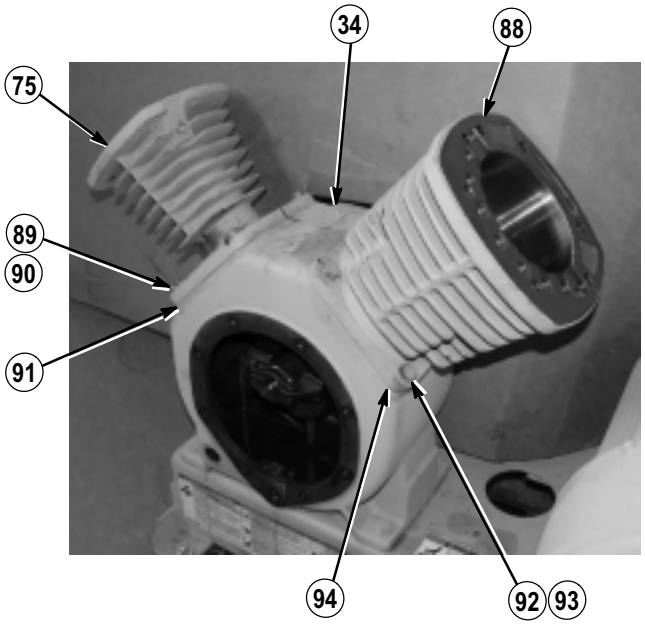


NOTE

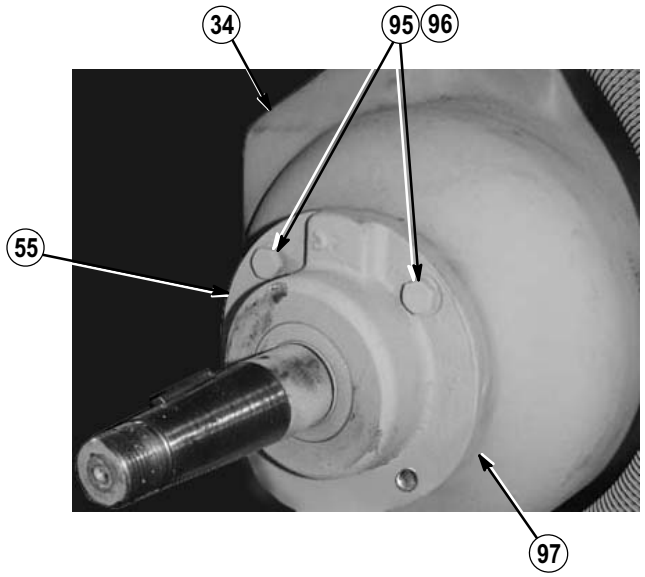
Support pistons during air cylinder removal.

(25) Remove four screws (89), washers (90), high pressure air cylinder (75) and gasket (91) from air compressor frame (34). Discard gasket.

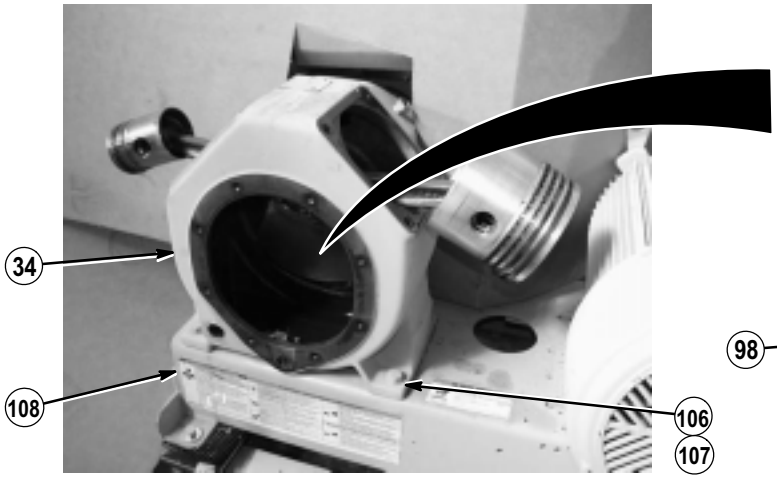
(26) Remove four screws (92), washers (93), low pressure air cylinder (88) and gasket (94) from air compressor frame (34). Discard gasket.

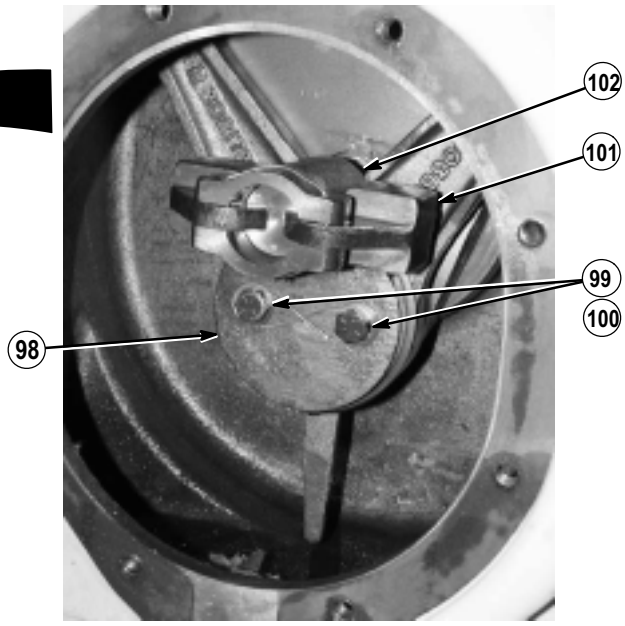


(27) Remove remaining two screws (95), washers (96), end cover (55) and gasket (97) from air compressor frame (34). Discard gasket.



8-2. AIR COMPRESSOR REPAIR (CONT).





(28) Remove lockwire (98), two screws (99), washers (100) and centrifugal unloader (101) from crankshaft (102).

NOTE

Note position of connecting rods and bushing prior to removal.

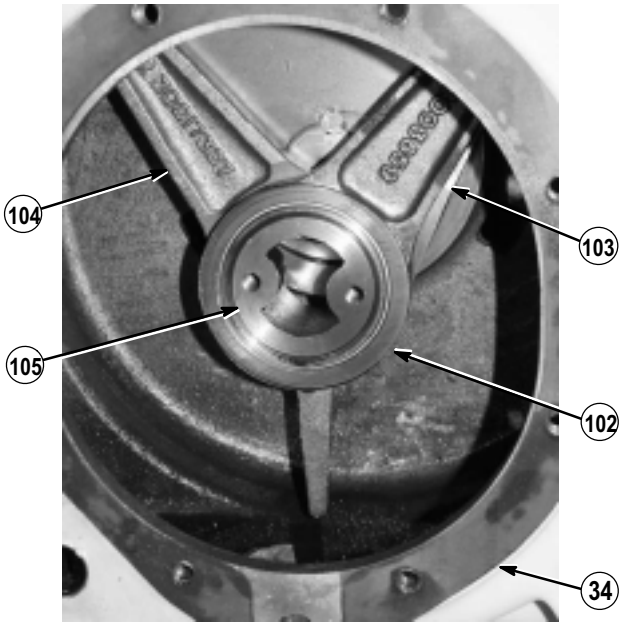
(29) Remove low pressure connecting rod (103), high pressure connecting rod (104) and bushing (105) from crankshaft (102).

NOTE

- Crankshaft must be pressed out of air compressor frame.
- Note position of crankshaft prior to removal.

(30) Remove crankshaft (102) from air compressor frame (34).

(31) Remove four screws (106), lockwashers (107) and compressor frame (34) from air compressor subbase (108). Discard lockwashers.



NOTE

Low pressure air piston assembly and high pressure air piston assembly are disassembled identically.

(32) Remove two lock rings (109), piston pin (110) and high pressure connecting rod (104) from high pressure air piston (111).

NOTE

- High pressure air piston has four ring design, with a compression ring in the first groove, scraper ring in second groove and two oil control ring assemblies (expander and reel) in the third groove.
- Rings should be removed using an expander tool.
- Remove rings beginning with the first groove.

(33) Remove compression ring (112) from first groove on high pressure air piston (111). Discard compression ring.

(34) Remove scraper ring (113) from second groove on high pressure air piston (111). Discard scraper ring.

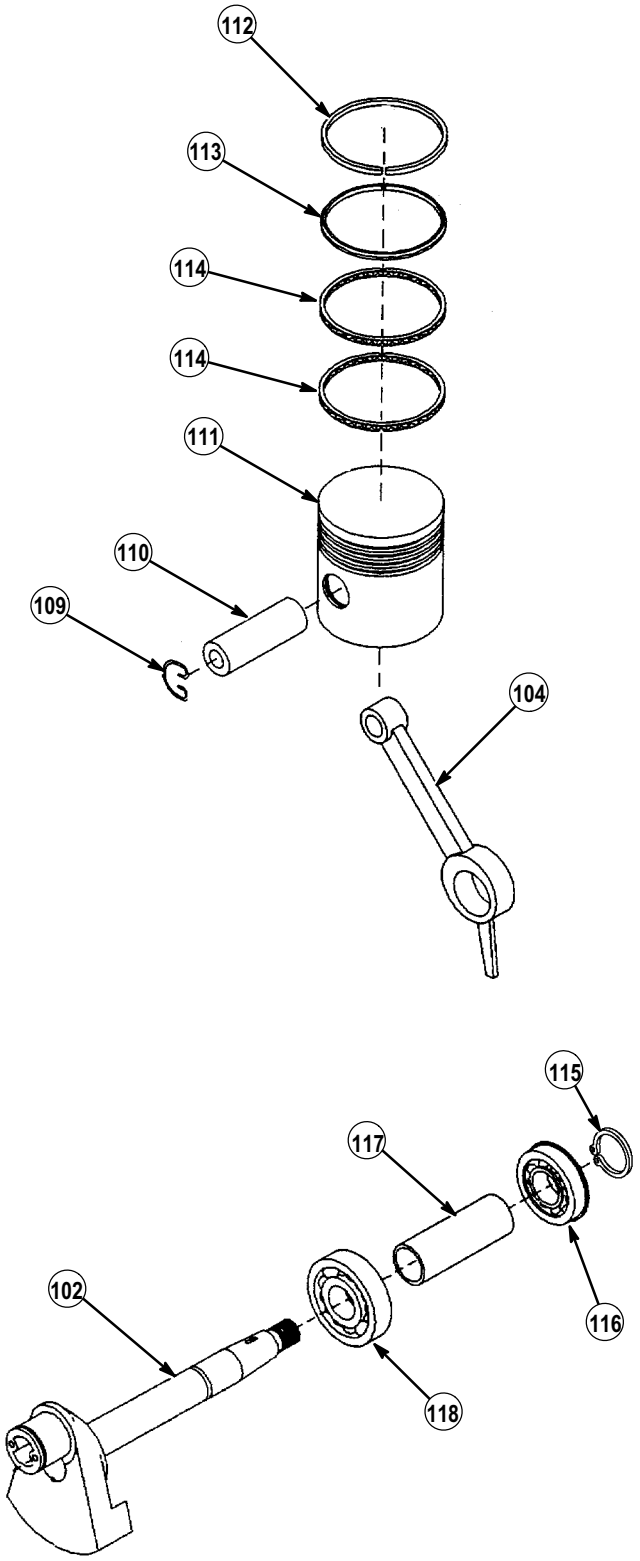
(35) Remove two oil control rings (114) from third groove on high pressure air piston (111). Discard oil control rings.

(36) Repeat Steps (32) through (35) for low pressure air piston assembly.

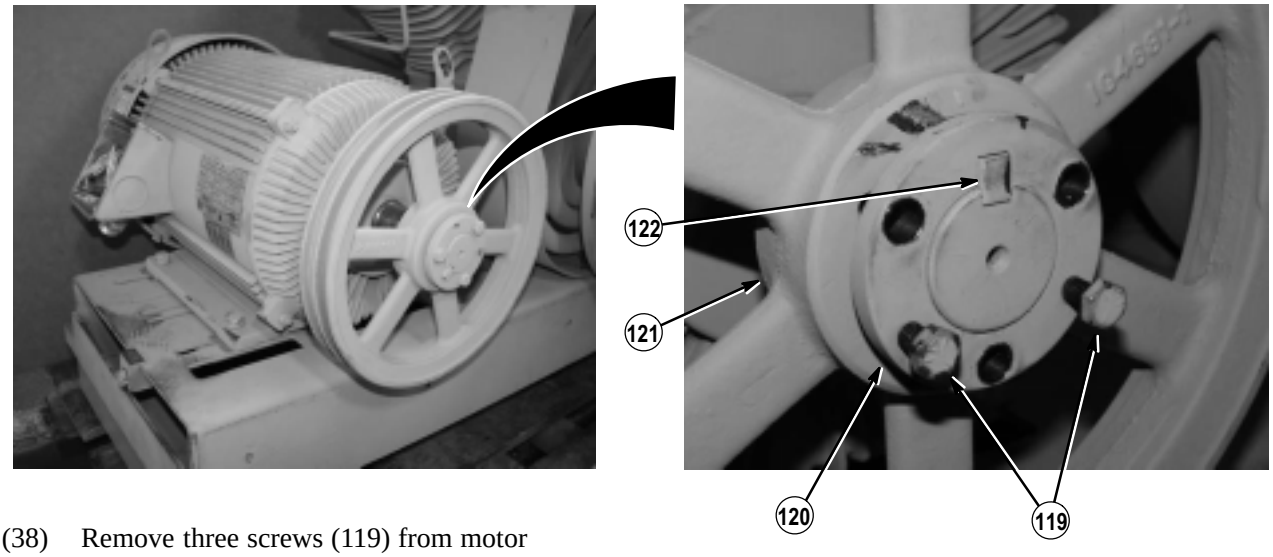
NOTE

Bearings will need to be pressed off for removal.

(37) Remove snapring (115), bearing (116), spacer (117) and bearing (118) from crankshaft (102).



8-2. AIR COMPRESSOR REPAIR (CONT).



(38) Remove three screws (119) from motor pulley collar (120) and motor pulley wheel (121).

NOTE

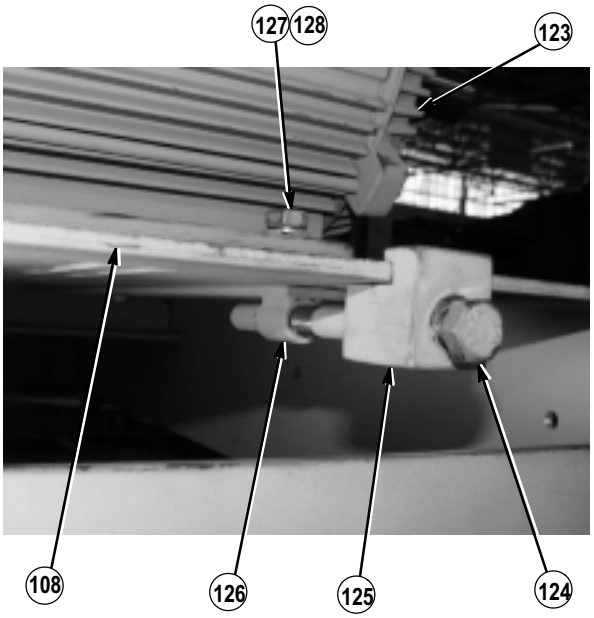
- Motor pulley collar will be used as a puller tool.
- Note position of motor pulley wheel prior to removal.

(39) Install two screws (119), in taped holes of pulley collar (120) and tighten till motor pulley wheel (121) loosens.

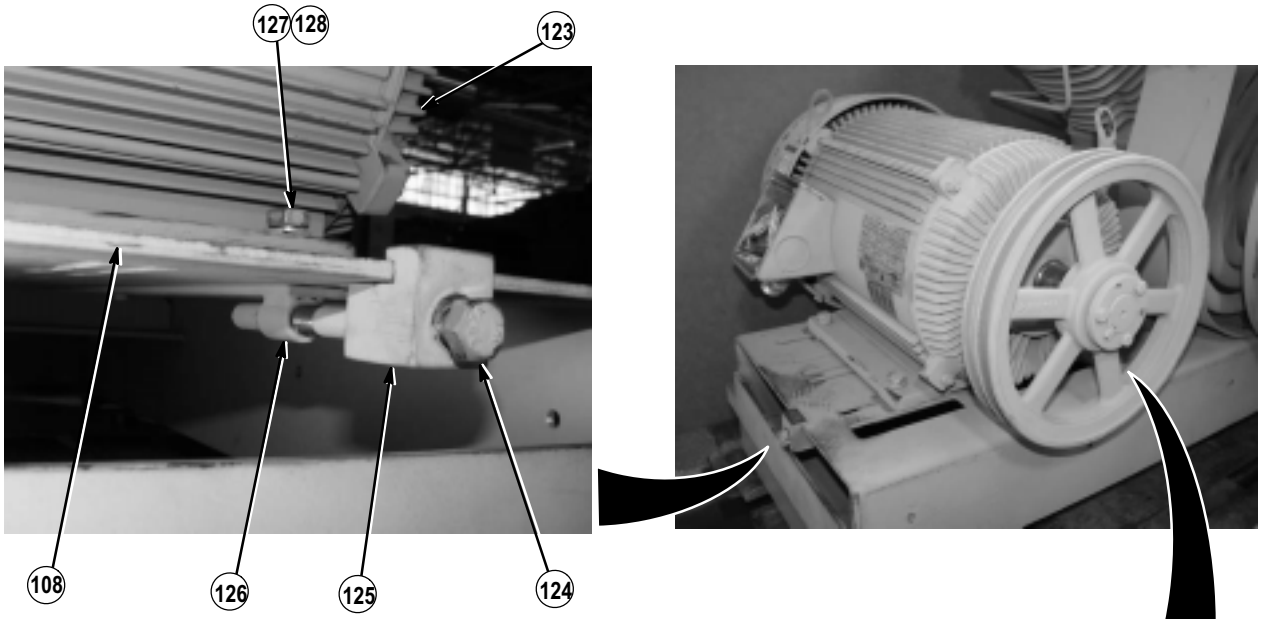
(40) Remove two screws (119), motor pulley collar (120), key (122) and motor pulley wheel (121) from motor (123).

(41) Remove screw (124) and stop (125) from motor guide (126) and air compressor subbase (108).

(42) Remove four screws (127), lockwashers (128), two motor guides (126) and motor (123) from air compressor subbase (108). Discard lockwashers.



b. Assembly.



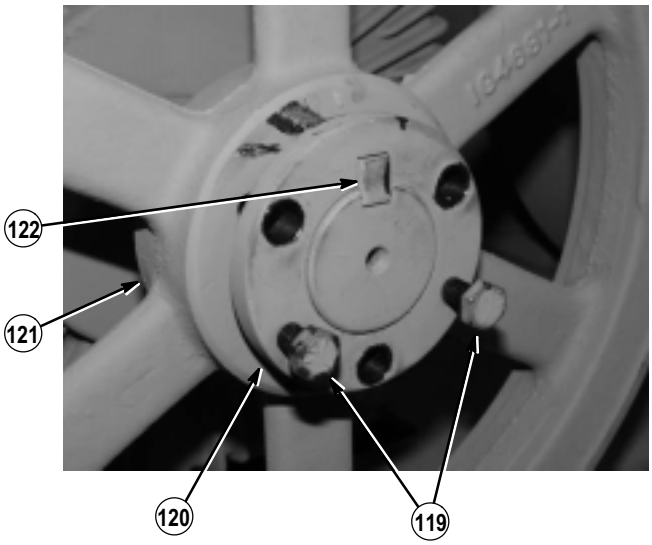
(1) Position four screws (127), lockwashers (128), two motor guides (126) and motor (123) on air compressor subbase (108). Do not tighten screws.

(2) Position screw (124) and stop (125) on motor guide (126) and air compressor subbase (108). Do not tighten screw.

NOTE

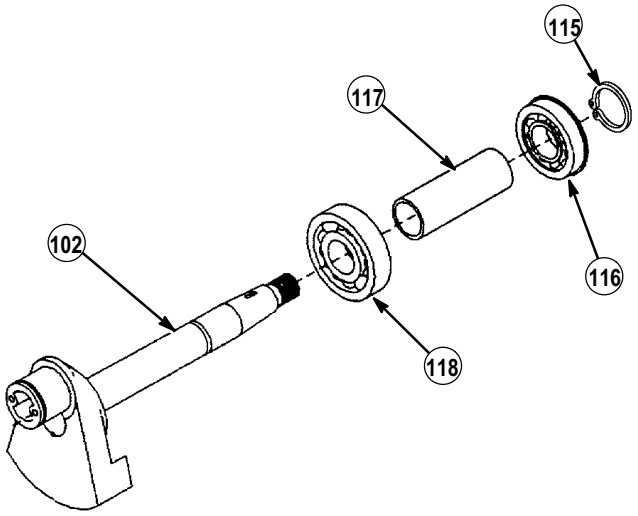
Position motor pulley wheel as noted during removal.

(3) Install key (122), motor pulley wheel (121), motor pulley collar (120) and three screws (119) on motor (123).



8-2. AIR COMPRESSOR REPAIR (CONT).

(4) Install bearing (118), spacer (117), bearing (116) and snap ring (115) on crankshaft (102).



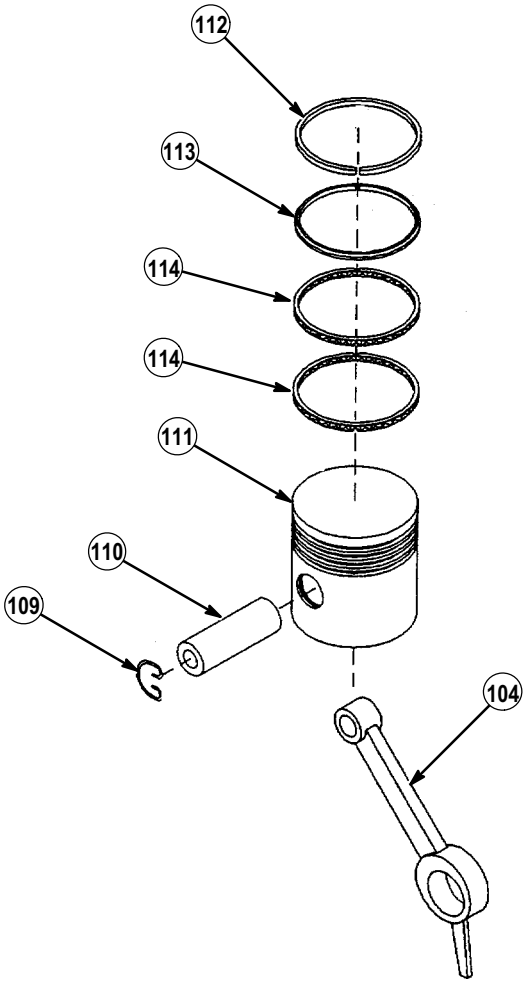
NOTE

- High pressure air piston has four ring design, with a compression ring in the first groove, scraper ring in second groove and two oil control ring assemblies (expander and reel) in the third groove.
- Rings should be installed using an expander tool.
- Install rings beginning with the third groove.

(5) Install two oil control rings assemblies (114) on third groove on high pressure air piston (111).

(6) Install scraper ring (113) on second groove on high pressure air piston (111).

(7) Install compression ring (112) on first groove on high pressure air piston (111).

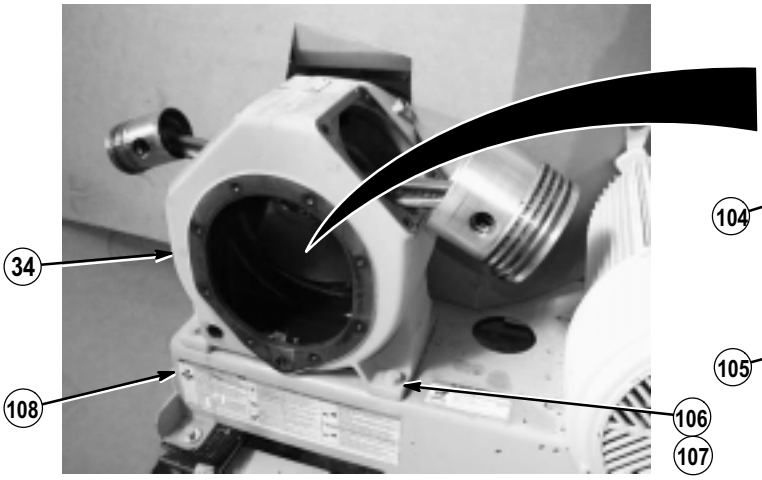


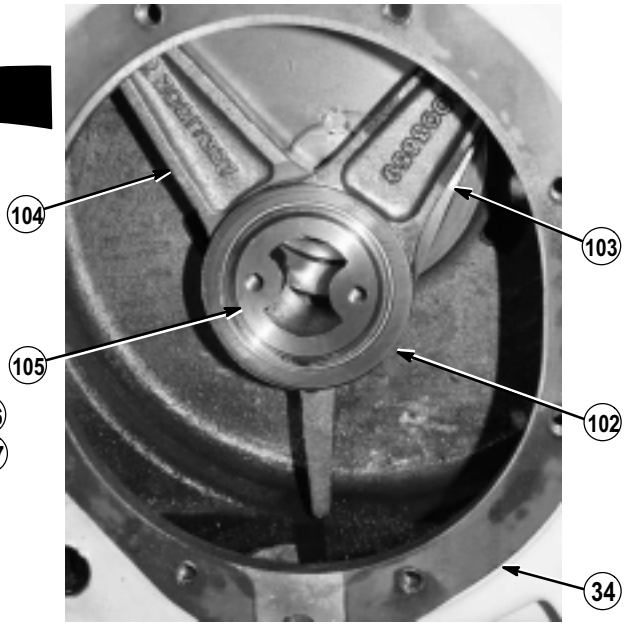
NOTE

Low pressure air piston assembly and high pressure air piston assembly are installed identically.

(8) Install high pressure connecting rod (104), piston pin (110) and two lock rings (109) on high pressure air piston (111).

(9) Repeat Steps (5) through (8) for low pressure air piston assembly.





(10) Install compressor frame (34), four lockwashers (107) and four screws (106) on air compressor subbase (108). Torque screws to 131 lb-ft (177 N·m).

NOTE

- Crankshaft must be driven into air compressor frame.
- Install crankshaft in position noted during removal.

(11) Install crankshaft (102) on air compressor frame (34).

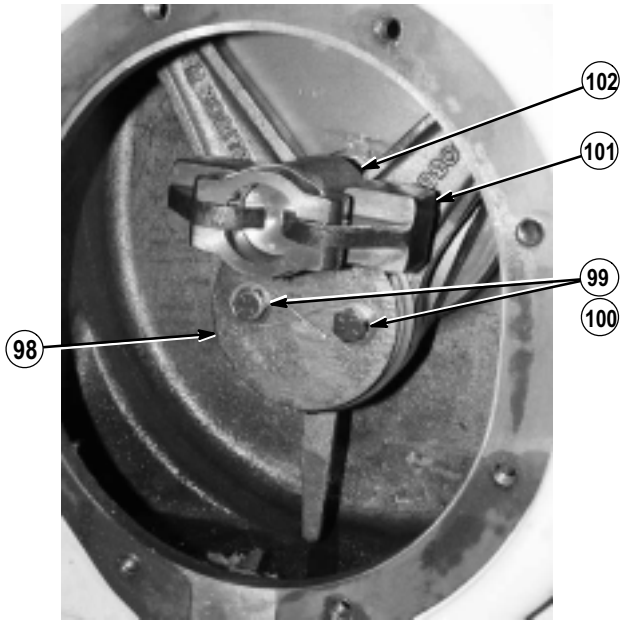
NOTE

Install bushing and connecting rods in position noted during removal.

(12) Install bushing (105), high pressure connecting rod (104) and low pressure connecting rod (103) on crankshaft (102).

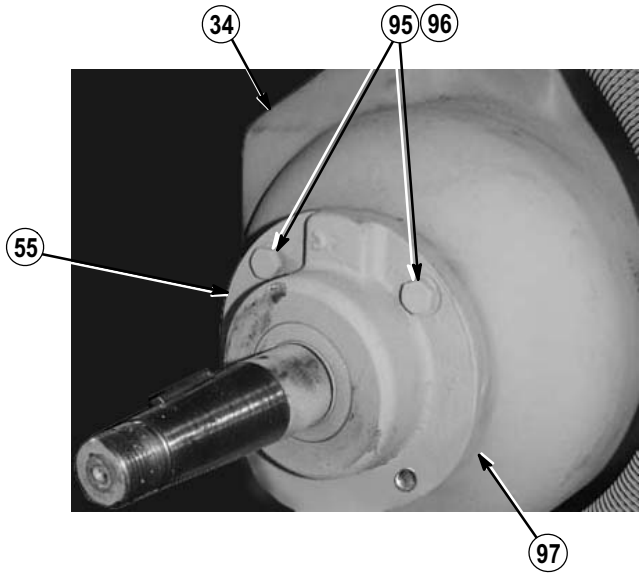
(13) Install centrifugal unloader (101), two washers (100) and screws (99) on crankshaft (102). Tighten screws to 286 lb-ft (388 N·m).

(14) Install lockwire (98) on two screws (99).



8-2. AIR COMPRESSOR REPAIR (CONT).

(15) Install gasket (97), cover (55), two washers (96) and two screws (95) on air compressor frame (34).

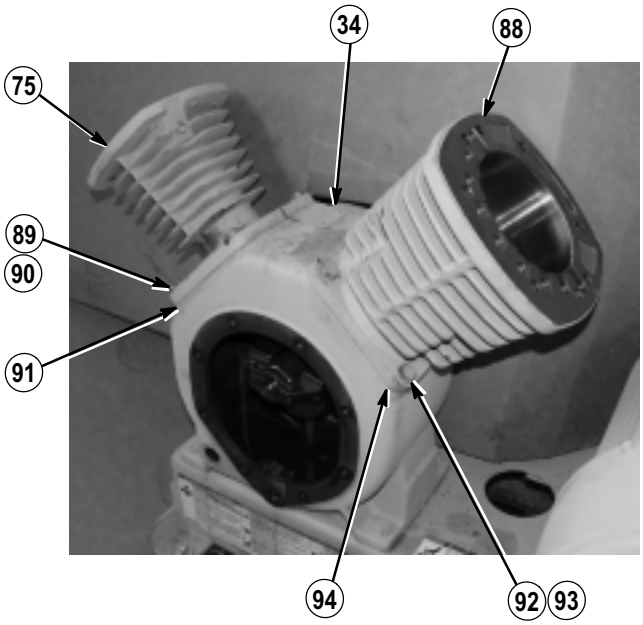


NOTE

Support pistons during air cylinder installation.

(16) Install gasket (94), low pressure air cylinder (88), four washers (93) and four screws (92) on piston and air compressor frame (34). Torque screws to 131 lb-ft (177 N·m).

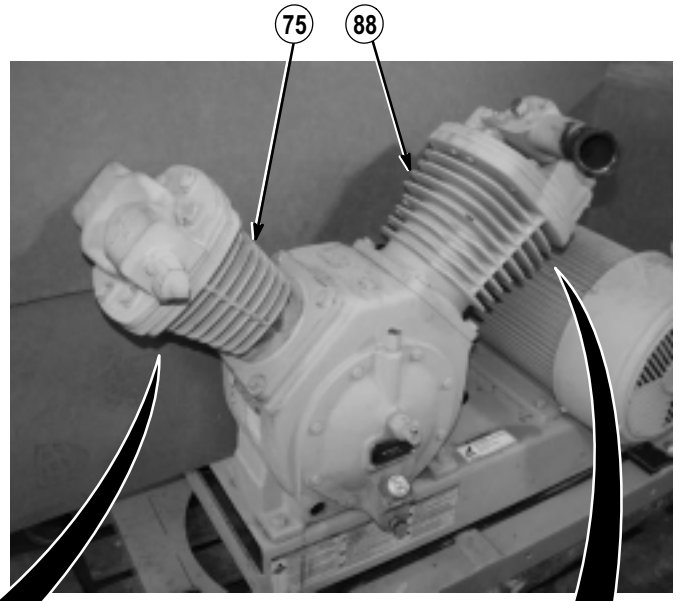
(17) Install gasket (91), high pressure air cylinder (75), four washers (90) and four screws (89) on piston and air compressor frame (34). Tighten screws to 131 lb-ft (177 N·m).

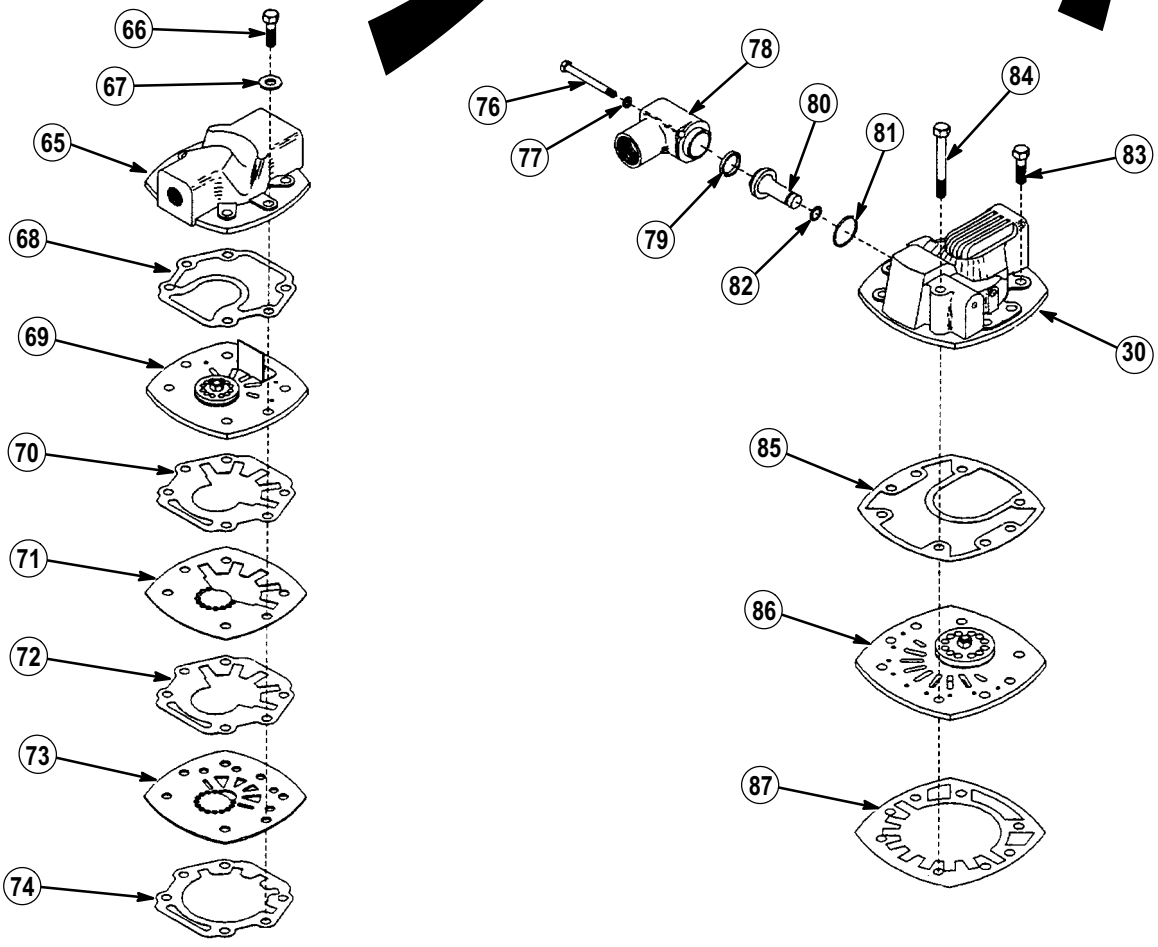


(18) Install valve plate assembly (87), valve plate assembly (86), airhead gasket (85), low air pressure head (30), screw (84) and five screws (83) on low pressure air cylinder (88). Tighten both screws to 75 lb-ft (102 N·m).

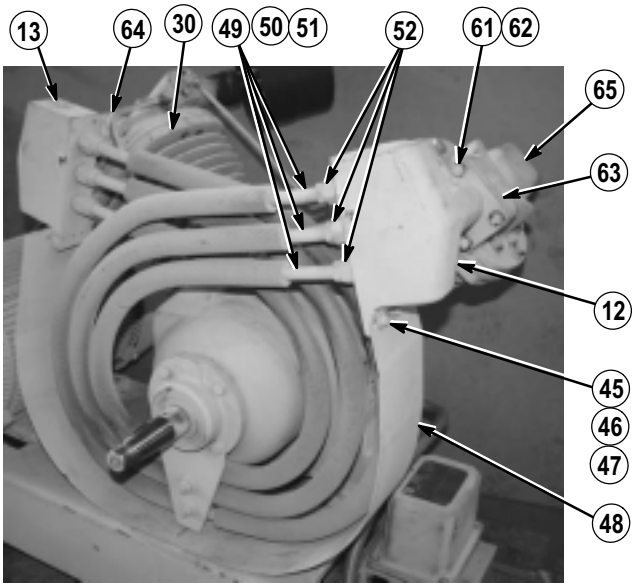
(19) Install preformed packing (81), preformed packing (82), piston (80), seal (79), unloader cover (78), two lockwashers (77) and two screws (76) on low pressure airhead (30). Tighten screws to 120-144 lb-in (13 - 16 N·m).

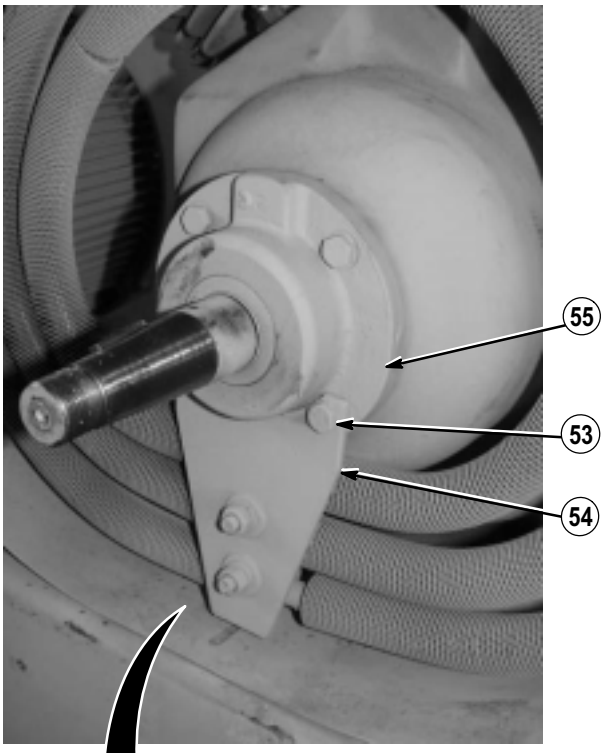
(20) Install valve plate gasket (74), discplate (73), plate gasket (72), spacer plate (71), plate gasket (70), plate assembly (69), airhead gasket (68), high pressure airhead (65), washer (67) and six screws (66) on high pressure air cylinder (75). Tighten screws to 203 lb-ft (275 N·m).





8-2. AIR COMPRESSOR REPAIR (CONT).





(21) Install gasket (64), gasket (63), low pressure intercooler manifold (13), high pressure intercooler manifold (12), eight lockwashers (62) and eight screws (61) on high pressure airhead (65) and low pressure airhead (30). Tighten screws to 116 lb-ft (157 N·m).

(22) Install clamp (60), bracket (54), two screws (59), washers (58), lockwashers (57) and nuts (56) on intercooler tube # 3 (51), intercooler tube #2 (50) and intercooler tube #1 (49).

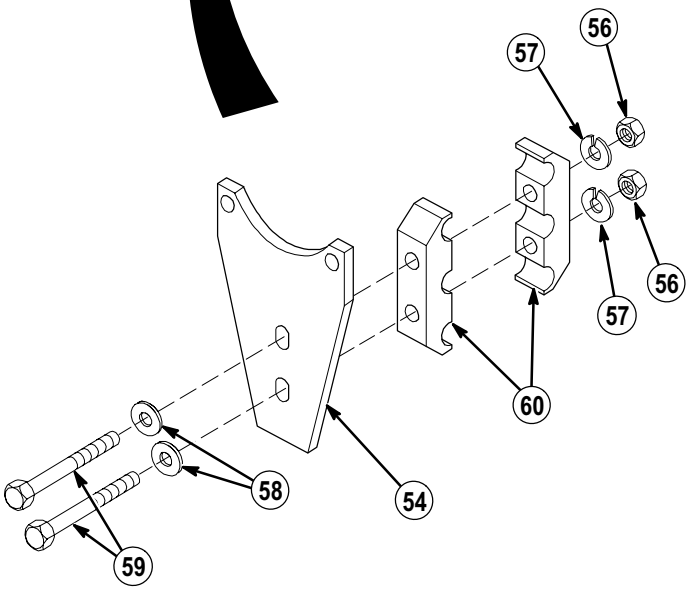
(23) Install bracket (54) and two screws (53) on end cover (55).

NOTE

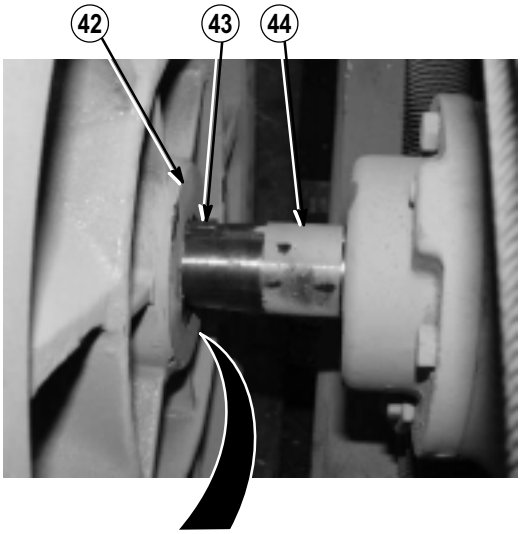
Install intercooler tubes into positions noted during removal.

(24) Install six tube connectors (52), intercooler tube # 3 (51), intercooler tube #2 (50) and intercooler tube # 1 (49) on low pressure intercooler manifold (13) and high pressure intercooler manifold (12).

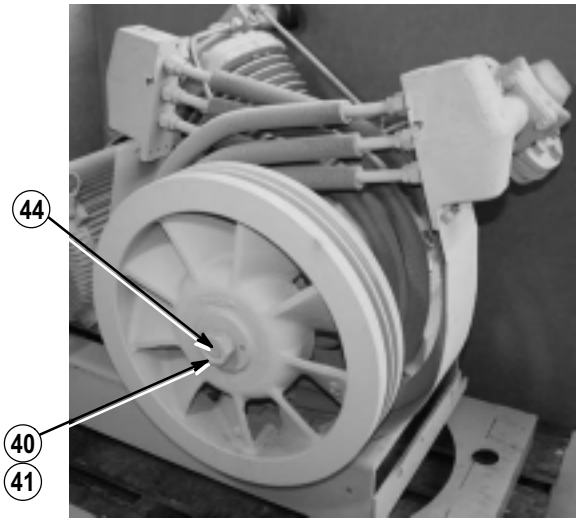
(25) Install intercooler shroud (48), four washers (47), four lockwashers (46) and screws (45) on low pressure intercooler manifold (13) and high pressure intercooler manifold (12).



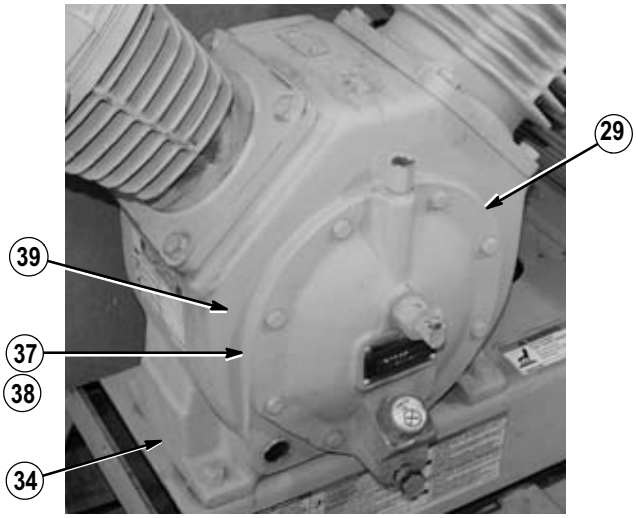
(26) Install key (43) and air compressor pulley (42) on air compressor crankshaft (44).



(27) Install lockwasher (41) and nut (40) on air compressor crankshaft (44).



(28) Install frame end cover (29), gasket (39), eight washers (38) and eight screws (37) on air compressor frame (34). Tighten screw to 116 lb-ft (157 N·m).



8-2. AIR COMPRESSOR REPAIR (CONT).

NOTE

To adjust pilot valve, preform the following procedures.

(29) Remove the pilot valve tube and the tube fittings.

(30) Remove the pilot valve body and all existing shims.

(31) Screw the pilot valve body back into the frame end cover (without any shims) until contact with the thrust pin is felt. Advance the pilot valve body 1/4 to 1/2 turn more.

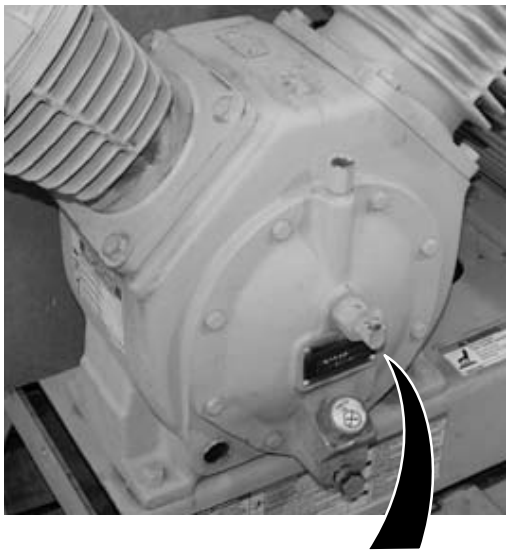
NOTE

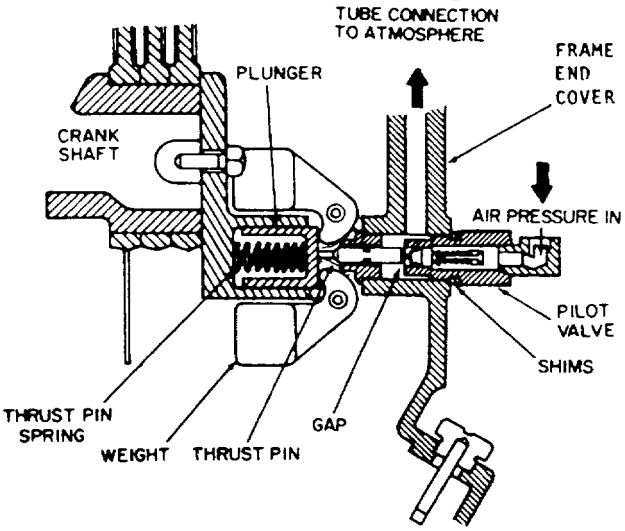
If contact with the thrust pin cannot be felt, the following steps may be necessary to locate the contact pin.

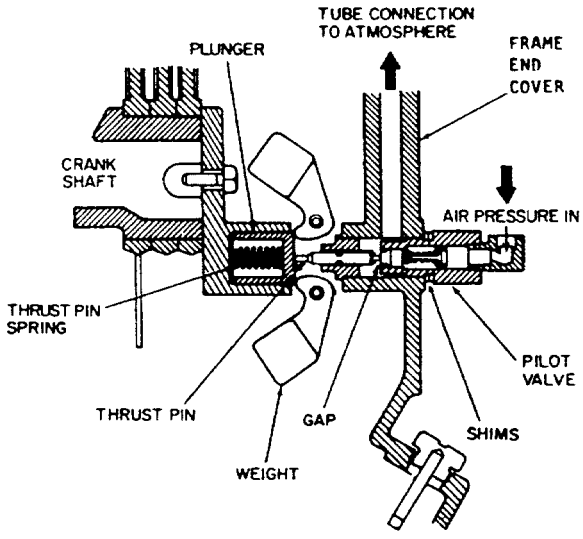
(32) Insert a small instrument (Punch, rod, nail, etc.) into the end of the pilot valve until it contacts the valve stem.

(33) While inserted in the pilot valve, make a mark on the instrument even with the outside edge of the pilot valve body.

(34) Keeping the instrument pressed lightly against the valve stem, screw the pilot valve body into the frame end cover. When the mark on the instrument starts moving out away from the edge of the pilot valve body, contact has been made with the thrust pin.







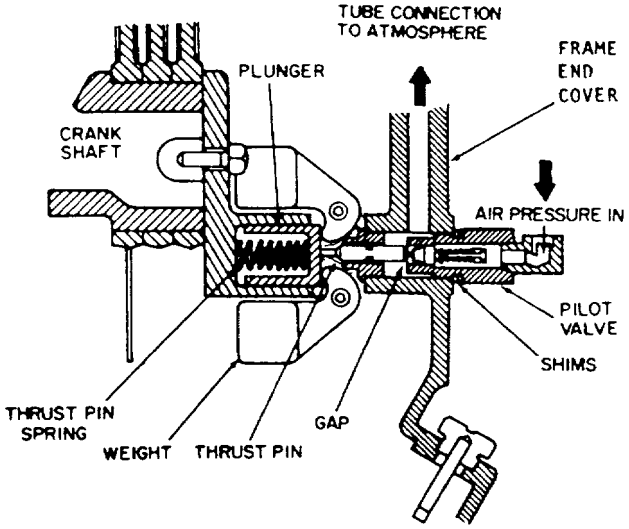
(35) Advance the pilot valve body 1/4 to 1/2 turn more and proceed with Step (36).

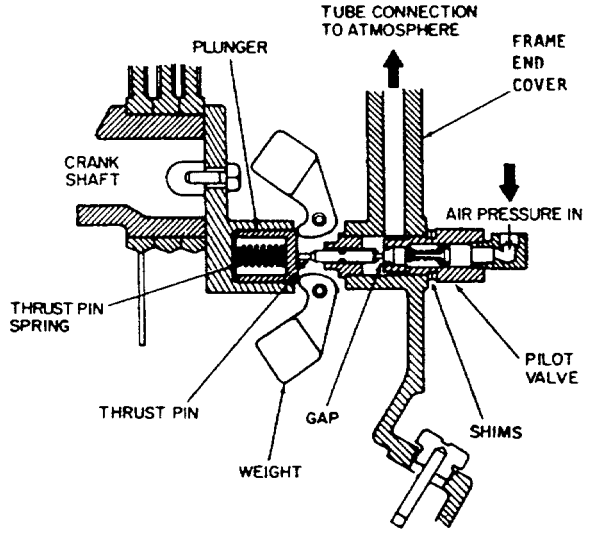
(36) Measure the gap between the pilot valve body and the frame end cover.

(37) Remove the pilot valve body and enough shims to fill the gap measured in Step (36).

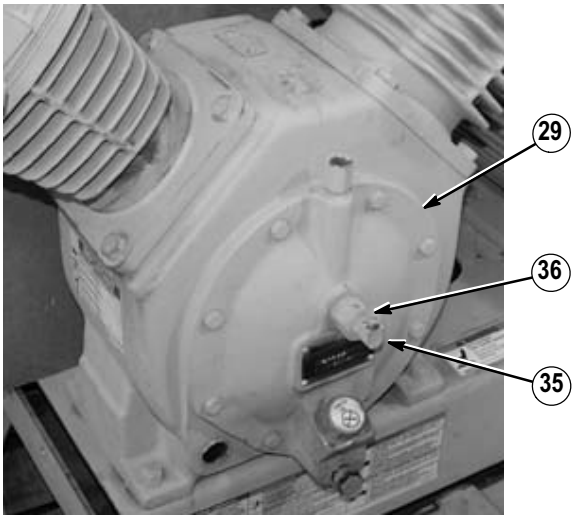
(38) Screw the pilot valve body back into the frame end cover until the body is tight on the shims.

(39) Reconnect the pilot valve tube and tube fittings.





(40) Install spacer(s) (36) and pilot valve (35) on frame end cover (29).



8-2. AIR COMPRESSOR REPAIR (CONT).

(41) Install breather tube assembly (33), connector (32) and elbow (31) on air compressor frame (34) and low pressure airhead (30).

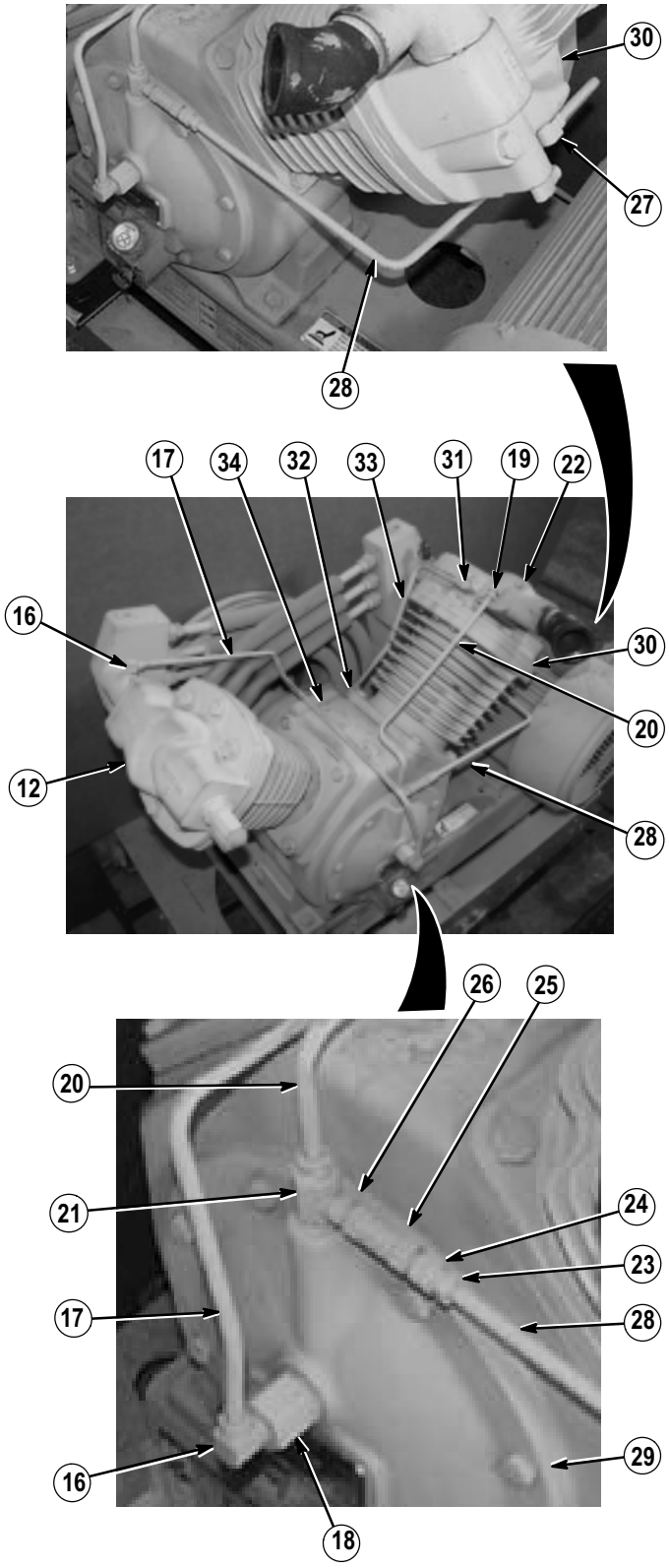
(42) Install check valve tube assembly (28), elbow (27), tube connector (26), check valve (25), nipple (24) and tube connector (23) on low pressure airhead (30) and frame end cover (29).

(43) Install frame end cover tube assembly (20) and elbow (19) on unloader cover (22) and tube connector (21).

NOTE

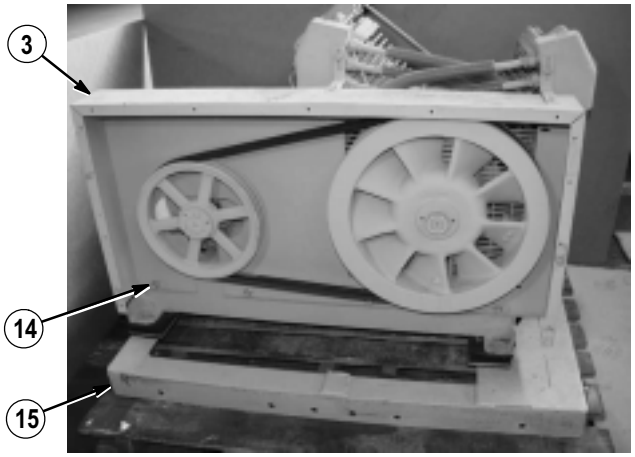
Install tubes in positions noted during removal.

(44) Install pilot valve manifold tube assembly (17) and two elbows (16) on high pressure intercooler manifold (12) and pilot valve (18).

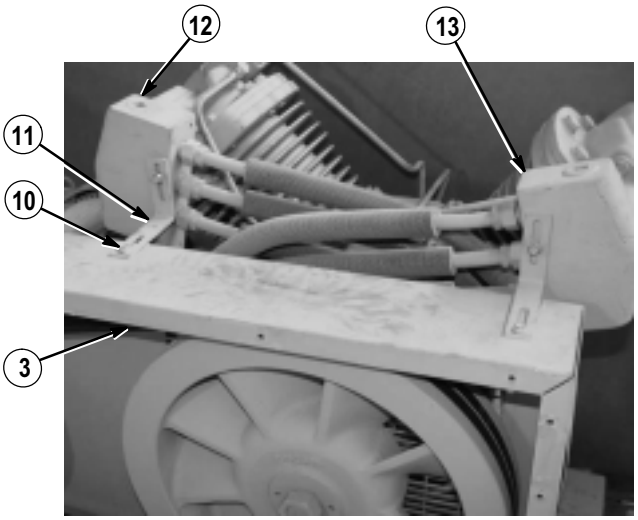


(45) Install two belts (TM 9-4940-568-20).

(46) Install belt guard shroud (3) and four self-tapping screws (14) on air compressor subbase (15).

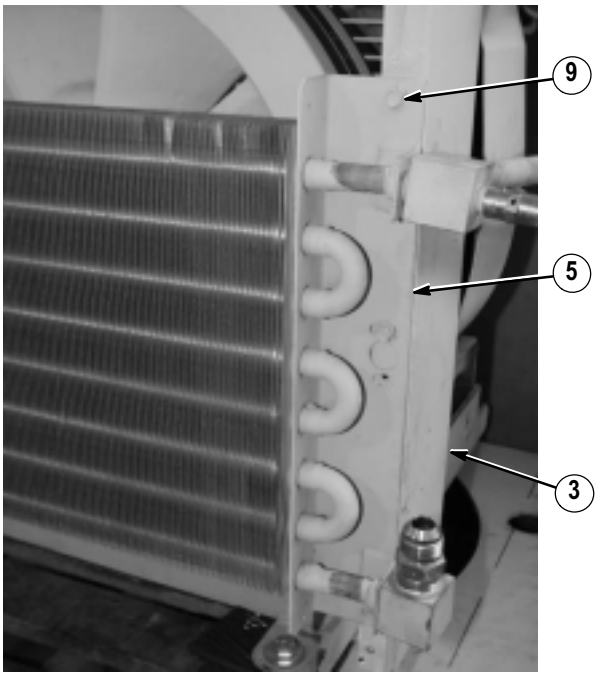


(47) Install low pressure intercooler manifold (13), high pressure intercooler manifold (12), two brackets (11) and four self-tapping screws (10) on belt guard shroud (3).



8-2. AIR COMPRESSOR REPAIR (CONT).

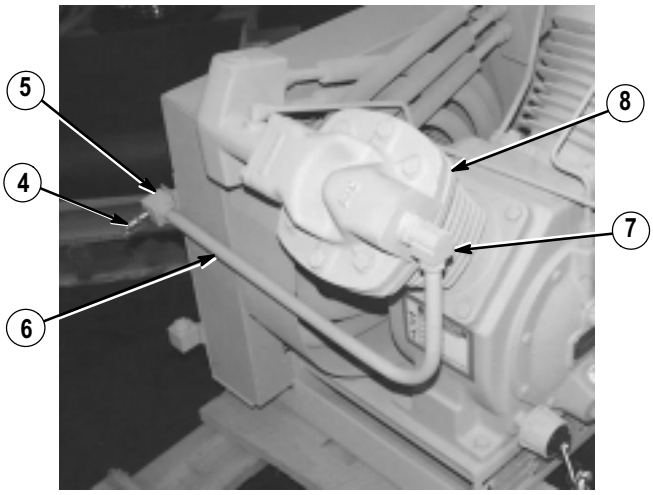
(48) Install aftercooler coil (5) and six self-tapping screws (9) on belt guard (3).



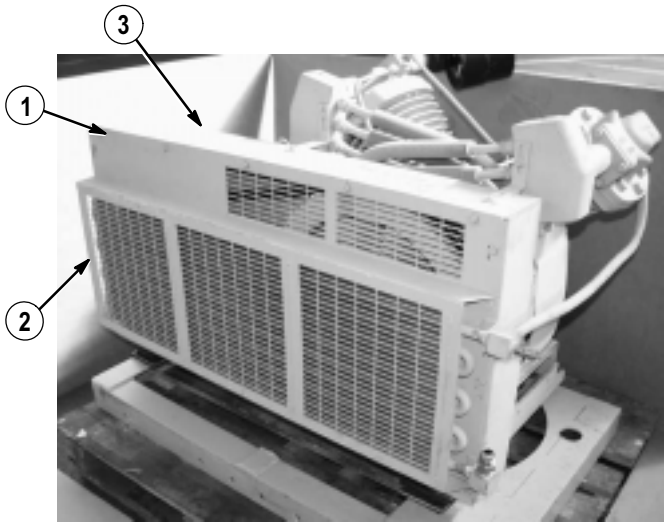
(49) Install tube assembly (6) and elbow (7) on airhead (8).

(50) Install tube assembly (6) on aftercooler coil (5).

(51) Install safety valve (4) on aftercooler coil (5).



(52) Install belt guard cover (2) and nine self-tapping screws (1) on belt guard shroud (3).



c. Follow-On Maintenance:

- Install air compressor and platform, (TM 9-4940-568-20).
- Start generator and air compressor and check for proper operation, (TM 9-4940-568-10).

END OF TASK

APPENDIX A

REFERENCES

A-1. FORMS.

The following forms pertain to this manual. See DA PAM 310-1 for index of blank forms. See DA PAM 738-750, The Army Maintenance Management System (TAMMS), for instructions on the use of maintenance forms pertaining to this manual.

The Army Maintenance Management System (TAMMS) ..... DA PAM 738-750
Equipment Inspection and Maintenance Worksheet ..... DA Form 2404/5988E
Product Quality Deficiency Report ..... SF 368
Recommended Changes to DA Publications and Blank Form ..... DA Form 2028
Recommended Changes to Equipment and Technical Publications ..... DA Form 2028-2
TACOM Major End Item and Product Assurance Managers ..... SF 2407

A-2. TECHNICAL MANUALS.

Procedures for Destruction of Tank-Automotive Equipment to Prevent Enemy Use ..... TM 750-244-6
Operator's Circular for Welding Theory and Application ..... TM 9-237
..... TM 9-2320-10/11, TM 9-2320-297-10
Organizational Maintenance for Truck, 8 x 8 Logistics Vehicle System (Diesel) ..... TM 9-2320-297-20

A-3. MISCELLANEOUS PUBLICATIONS.

Hearing Conservation Program ..... TB MED 501
B Series Engine Shop Manual, Bulletin No. 3810206
Alternative Repair Manual, Bulletin No. 3810234

APPENDIX B

EXPENDABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

B-1. SCOPE.

This appendix lists expendable supplies and materials you will need to operate and maintain the Forward Repair System (FRS). These items are authorized to you by CTA50-970, Expendable Items (Except Medical, Class V, Repair parts and Heraldic Items) or CTA8-100, Army Medical Department Expendable/Durable Items.

B-2. EXPLANATION OF COLUMNS.

a. Column (1) - Item Number. This number is assigned to the entry in the listing and is referenced in the narrative task box to identify the material (e.g., “Cloth, Cleaning, Item 6, Appendix B”).

b. Column (2) - Level. This is the maintenance level approved to use the item listed.

c. Column (3) - National Stock Number. This is the National Stock Number assigned to the item; use it to request or requisition the item.

d. Column (4) - Description. Indicates the Federal item name and, if required, a description to identify the item. The last line for each item indicates the Commercial and Government Entity (CAGE) code in parentheses followed by the part number.

e. Column (5) - Unit of Measure. Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in. or pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

Section II. EXPENDABLE SUPPLIES AND MATERIALS LIST

(1) Item No.	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
1	F	8030-01-135-0685	Adhesive (Loctite 242) (65270AX)	50 ml
2	F	8040-00-843-0802 8040-00-225-4548	Adhesive, RTV 108 (80244) MIL-A-46106 GP1TY1 3 ounce kit 12 ounce tube	TBD
3	F	TBD	Adhesive-Sealant, Silicone. RTV General MIL-A–46106-A (24758FX)	
4	F	5110-00-277-4591	Blade, Hacksaw	ea
5	F	5975-01-273-8133	Cable Ties (96906) MS3367-3 12 inches long, 100 per package	hd
6	F	7920-00-165-7195 7920-00-044-9281	Cloth, Cleaning (81349) MIL-C-85043 Type 1 - 10 lb box Type 2 - 10 lb box	lb lb
7	F	5350-01-024-8333	Cloth, No. 400 Grit Polishing	lb
8	F	8030-00-616-7694	Compound, Antiseize, High Temperature MIL-A-907D (OTC P/N 1302130)	lb
9	F	TBD	Compound, Degreaser	TBD
10	F	TBD	Compound, Heat Shrink	TBD
11	F	5350-00-221-0872	Crocus Cloth (81348)	roll
12		5350-00-186-8813	Emery Cloth	TBD
13	F	9150-00-076-1587	Grease, Lithium (07748) 5555	oz
14	F	TBD	Lubricant, Delco Remy No. 196094	TBD
15	F	9140-00286-5294	Oil, Diesel, Fuel BULK (81348) VVF800GRADEDF2RE	gl
16	F	9150-00-189-6727 9150-00-183-7807	Oil, Hydraulic OE/HDDO 10 (81349) MIL-L-2104 1 quart can 55 gallon drum	gt hl
17	F	9150-00-186-6681 9150-00-189-6729	Oil, Lubricating OE/HDO 30 (81349) MIL-L-2104 1 quart can 55 gallon drum	gt gl
18	F	9150-00-186-6699 9150-00-186-6703	Oil,Lubricating, Engine OE/HDO 10W/30 (81349) MIL-L-46152 1 quart can 55 gallon drum	gt gl

Section II. EXPENDABLE SUPPLIES AND MATERIALS LIST (CONT)

(1) Item No.	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
19	F	5130-01-079-8392	Pad, Abrasive	TBD
20	F	5345-01-445-5784	Pad, Sanding	TBD
21	F	5350-01-024-8333	Paper, 400 Grit	TBD
22	F	TBD	Primer, VCI 373 (44695)	gal
23	F	7920-00-205-1711	Rags, Wiping (58536) A-A-531 50 pound bale	lb
24	F	TBD	Rubber Bands	TBD
25	F	TBD	Sealant MIL-S-7916	TBD
26		8030-00-111-2762 8030-01-253-2319	Sealant, Adhesive (81349) MIL-S-46163 50 cc bottle 12 ounce tube	bt tu
27	F	8030-01-054-0740	Sealant, Pipe (Loctite 592) (45152) 46642AX	50 ml
28	F	TBD	Sealant, Ultra Blue 587 (TBD)	TBD
29	F	8030-01-104-5392 8030-01-025-1692	Sealing Compound (05972) Loctite #242 (80244) MIL-S-46163A Type 2 Grade N 10 milliliter bottle 250 milliliter bottle	bt bt
30	F	8030-01-054-0740 8030-00-204-9149 8030-01-166-0675	Sealing Compound (05972) Loctite #567 50 ml bottle 250 ml tube (05972) Loctite #567-47 50 ml tube	ml ml ml
31	F	8030-00-148-9833 8030-01-158-6070	Sealing Compound (05972) Loctite #271 (80244) MIL-S-46163 Type 1 Grade K 10 ml bottle 50 ml bottle	ml ml
32	F	TBD	Sealing Compound	TBD
33		6810-00-252-1345	Solution, Soap (81349) MIL-W-15000 Class C	bt
34	F	6850-00-664-5685 6850-00-264-9038 6850-01-378-0679	Solvent, Drycleaning (81348) P-D-680 1 quart can 5 gallon can (Environmentally Compliant Solvent) (0K209) Breakthrough 5 gallon can	qt gl gl

Section II. EXPENDABLE SUPPLIES AND MATERIALS LIST (CONT)

(1) Item No.	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
35	F	8010-00-440-4224	Spirits, Mineral (83992) 3526	gl
36	F	9905-00-720-3577	Tag, Identification (16956) 12-105 white	ea
37		4390-01-359-7367	Tape, Protective	roll
38		TBD	Tape, Waterproof	roll
39		TBD	Tube, Open	TBD
40		TBD	Valve Lapping Compound	TBD
41	F	8040-01-260-1939	Sealing Compound (71984) RTV 738	oz
42	H	9505-00-331-3275	Wire, Nonelectrical (96906 MS20995C41	lb
43	O	9150-01-197-7688 9150-01-197-7690 9150-00-197-7689	Grease, Automotive and Artillery (70878) 5542P (81349) MIL-G-10924 2.25 oz tube 1.75 lb can 6.5 lb can	oz lb lb

APPENDIX C

ILLUSTRATED LIST OF MANUFACTURED ITEMS

Section I. INTRODUCTION

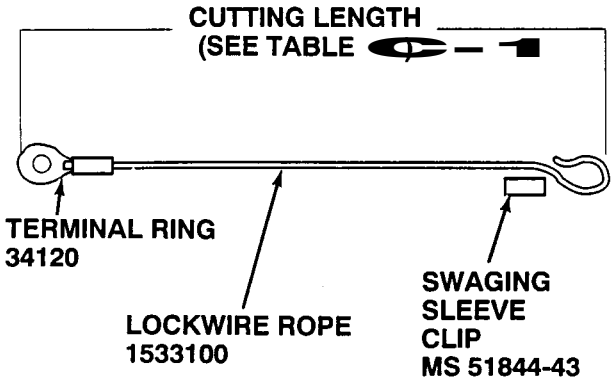
C-1. SCOPE.

This appendix includes complete instructions for manufacturing or fabricating authorized items locally. All bulk materials needed to manufacture an item are listed by part number or specification number in a tabular list with an illustration, as needed.

Section II. MANUFACTURED ITEMS

C-2. LOCKWIRE ROPE FABRICATION.

The lockwire length is shown in Table C-1. Crimped button stop caps are used to attach the lockwire to other components. Each application requires two swaging sleeve clips.



NOTES:

1. OBTAIN ALL COMPONENTS REQUIRED TO FABRICATE LOCKWIRE.
2. USE A FINE TOOTHED HACKSAW OR SUITABLE CUTTING DEVICE, AND CUT LOCKWIRE TO LENGTH REQUIRED.
3. SLIDE WIRE THROUGH HOLE IN COMPONENT, UNTIL LOCKWIRE COMES THROUGH OTHER SIDE.
4. SLIDE CAP ONTO LOCKWIRE, UNTIL CAP BOTTOMS AGAINST COMPONENT AND WIRE COMES THROUGH CAP.
5. CRIMP CAP TO LOCKWIRE.
6. SLIDE OPPOSITE END OF WIRE THROUGH ASSEMBLY, AND SLIDE OTHER CAP OVER END OF WIRE.
7. SLIDE WIRE THROUGH HOLE IN COMPONENT, UNTIL LOCKWIRE COMES THROUGH OTHER SIDE.
8. SLIDE CAP ONTO LOCKWIRE, UNTIL CAP BOTTOMS AGAINST COMPONENT AND WIRE COMES THROUGH CAP.
9. CRIMP CAP TO LOCKWIRE.

The following wire rope is cut from bulk stock. Refer to Table C-1 for cutting lengths.

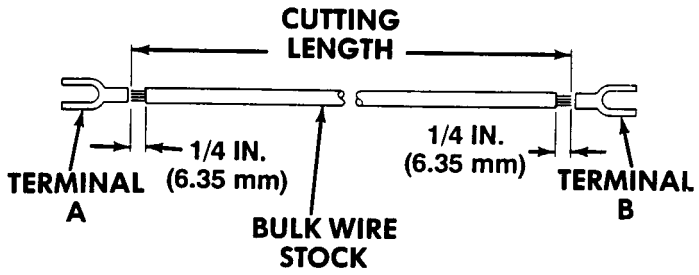
Table C-1. Lockwire Rope

Lockwire Rope Part Number	Lockwire Rope Part Number	Cutoff Length	
		Inches	cm
1533100-010	1533100	10	25
1533100-015	1533100	15	38
1533100-020	1533100	20	51
1533100-024	1533100	24	61

C-3. WIRE AND WIRE ASSEMBLIES FABRICATION.

Fabricate from bulk wire stock listed in Table C-2. Use wire cutters to cut wire to required length, then strip ends of wire ¼ in. (6.35 mm). Crimp the required lugs or terminals onto wire ends.

Table C-2. Wire And Wire Assemblies

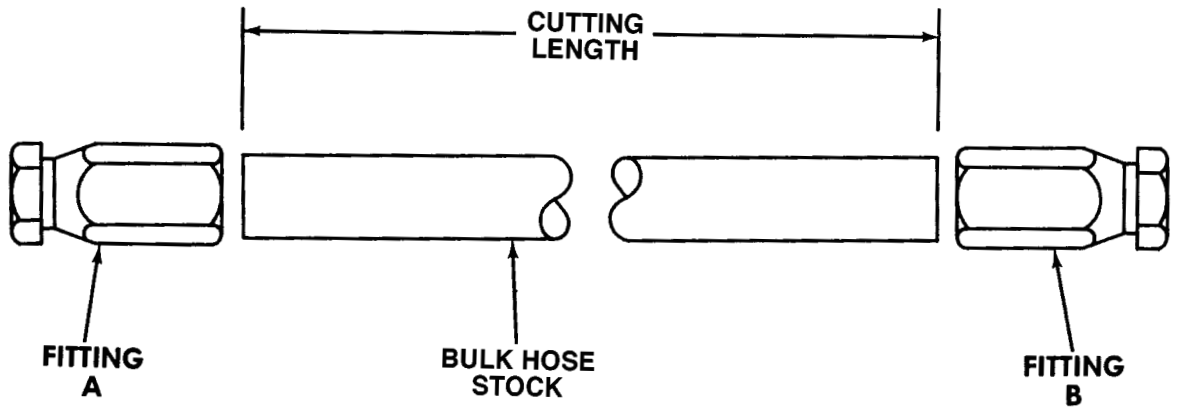


Wire/Assembly Part Number	Bulk Wire Part Number	Cutoff Length	
		Inches	cm
1884540W-012	121782A	12	31
1947560W-012	121782A	12	31
1959390W-012	121782A	12	31
1969600W-012	121782A	12	31
1977300W-010	4127FX	10	25
1974580-013	R-64951	13	33
1974590-005	R-64951	5	13
1978470W-005	R-64951	5	13

C-4. HOSES AND TUBES.

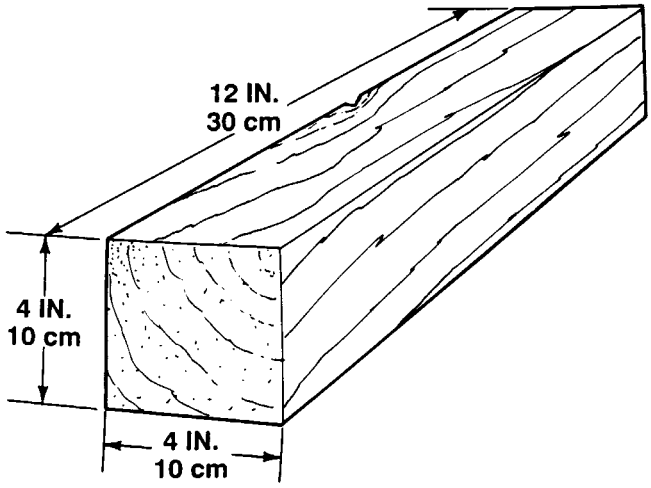
Fabricate hoses and tubes from bulk hose or tube stock listed in Table C-3. Use a fine toothed hacksaw or suitable cutting device and cut hose/tube to desired length. Place fitting A in vise and screw hose/tube counterclockwise until hose/tube bottoms out in fitting. Back off ¼ turn. Repeat for fitting B.

Table C-3. Hoses and Tubes



Hose/Tube Part Number	Bulk Hose Part Number	Cutoff Length	
		Inches	cm

C-5. WOODEN BLOCKS.



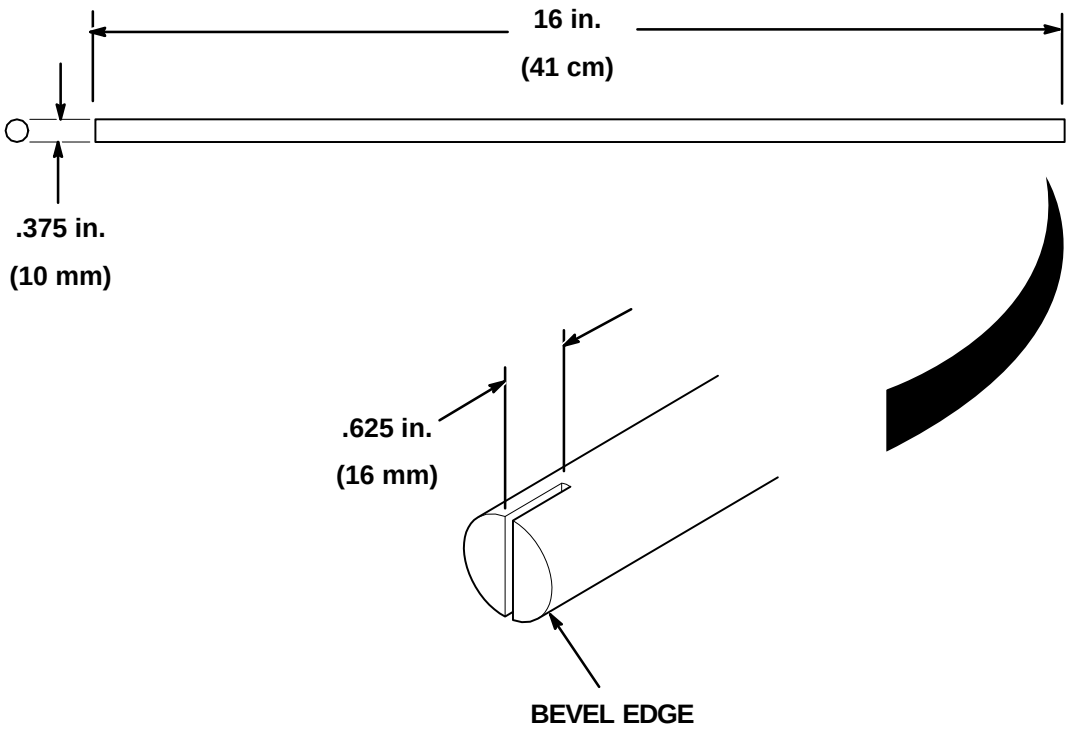
a. Fabricate from MML751 lumber stock.

b. Using saw and standard planing machine, cut stock to size required in Table C-4.

Table C-4. Wooden Blocks

Para Number	Finished Dimensions of Block In. (cm)

C-6. WOODEN DOWEL ROD.



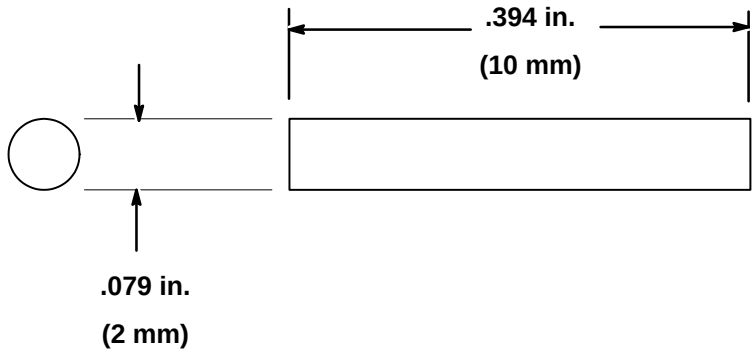
a. Fabricate wooden dowel rod from .375 in. (10 mm) diameter wooden dowel.

b. Using a saw, cut to dimensions shown.

c. Using a hacksaw, cut a slot .625 in. (16 mm) long to one end of wooden dowel.

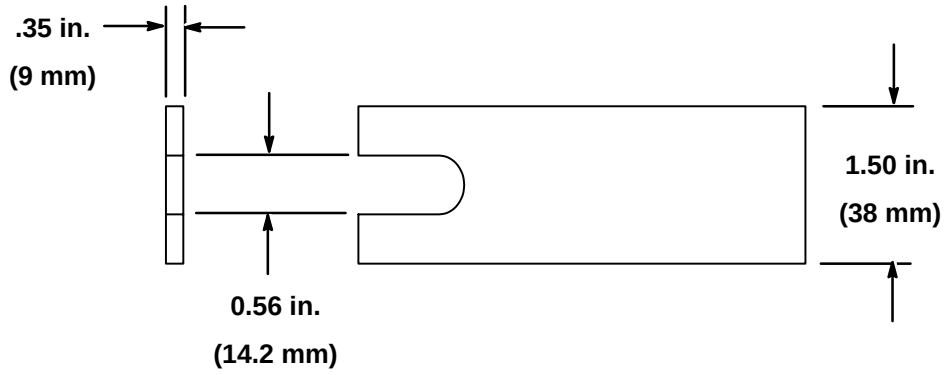
d. Using a file, bevel edge of wooden dowel at sloted end and remove all roughe edges.

C-7. WOODEN DOWEL PIN.



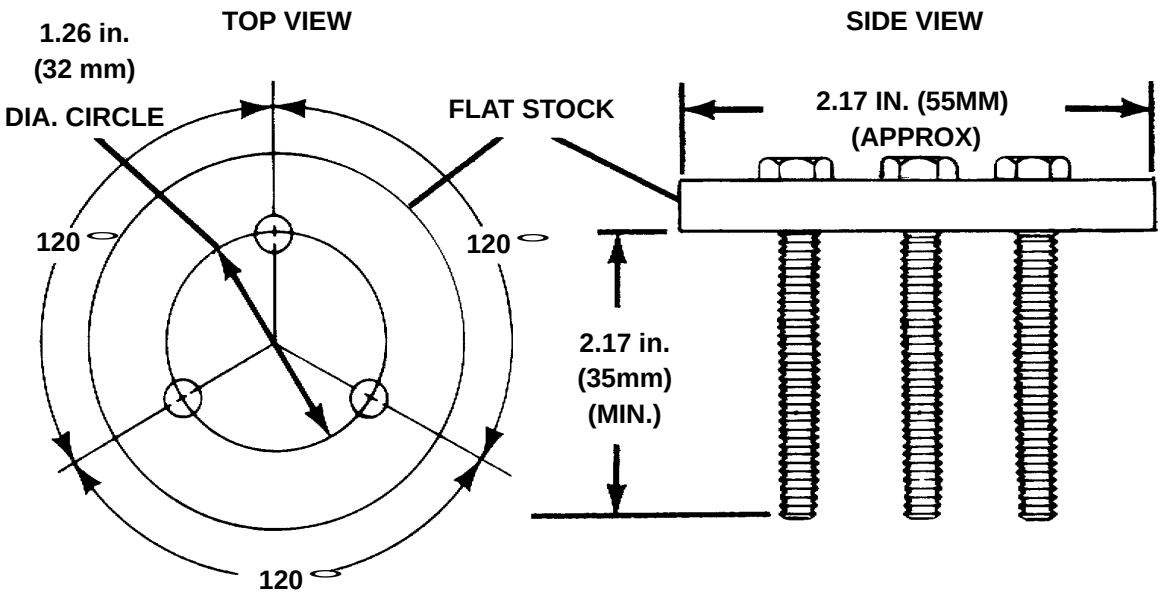
Fabricate wooden dowel pin from .079 in. (2 mm) diameter wooden dowel. Using a saw, cut to dimensions shown. Using a file, remove all rough edges.

C-8. METAL BLOCK.



Fabricate metal block from .35 in. (9 mm) thick mild steel stock. Cut to dimensions shown. File off rough edges.

C-9. BEARING REMOVAL TOOL.

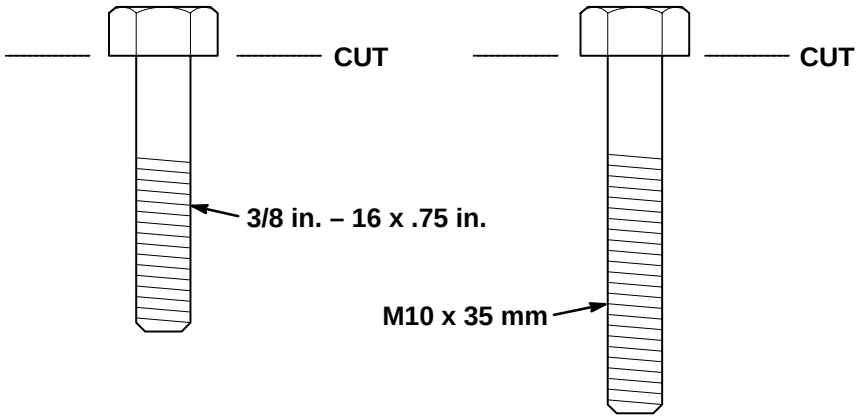


Piece of flat metal stock about .20 in. (5 mm) thick, and 2.17 in. (55 mm) square or round. Three .22 in. (6 mm) bolts of equal length to extend at least 1.38 in. (35 mm) below the flat stock when installed through it. To use nuts instead of tapped holes, use longer bolts to compensate for nut thickness.

a. Locate three holes equally around a 1.26 in. (32 mm) circle on flat stock. Drill and tap holes as needed to match bolt threads.

b. Install bolts in flat stock and tighten. Ends of installed bolts should pass through access holes in end of drive shaft without binding.

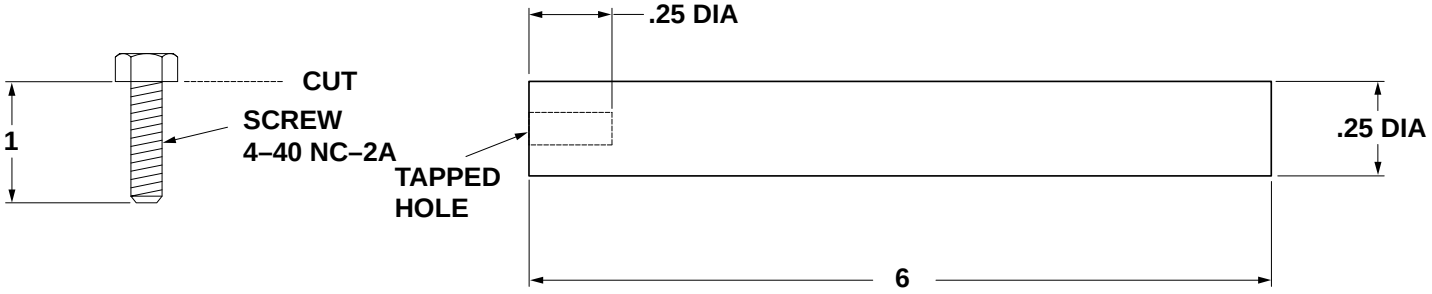
C-10. ALIGNMENT PIN.

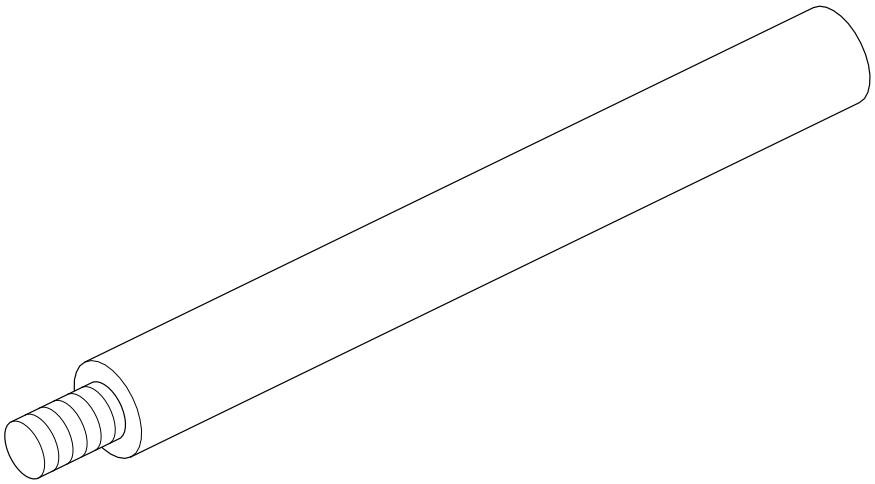


Fabricate two alinement pins from 3/8 in. – 16 x .75 in. screws and two alinement pins from M10 x 35 mm screws.

a. Using a hacksaw, cut the head of the screw off. File off rough edges.

C-11. SHUTTLE VALVE INSTALLATION/REMOVAL TOOL.





Fabricate threaded tip from 4-40NC-2A screw and handle from .25 in. (6.35 mm) steel rod.

a. Using a hacksaw, cut head off of screw. File off rough edges.

b. Using a hacksaw, cut steel rod to dimension shown.

c. Drill and tap hole at end of steel rod as needed to match bolt threads.

WARNING

Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

d. Apply a thin bead of sealing compound (Item 29, Appendix B) to threads of one end of threaded tip and install in steel rod.

APPENDIX D

TORQUE LIMITS

D-1. SCOPE.

This section provides general torque limits for the screws, hoses and fittings used on the truck. Special torque limits are listed in the maintenance procedures for applicable components. The general torque limits given in this appendix shall be used when specific torque limits are not indicated in the maintenance procedure. These general torque limits cannot be applied to screws that retain rubber components. The rubber components will be damaged before the torque limit is reached. If a special torque limit is not given in the maintenance instructions, tighten the screw or nut until it touches the metal bracket then tighten it one more turn.

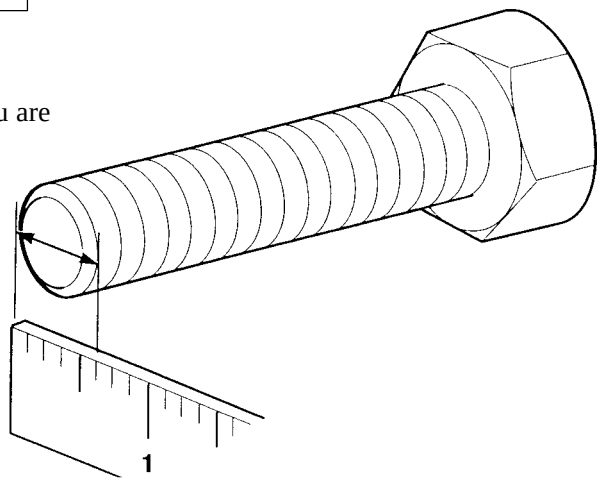
D-2. TORQUE LIMITS.

Table D-1 lists the torque limits for wet flange nuts. Table D-2 lists the torque limits for wet socket head capscrews. Table D-3 lists dry torque limits for capscrews. Dry torque limits are used on screws that do not have high pressure lubricants applied to the threads. Table D-4 lists wet torque limits for capscrews. Wet torque limits are used on screws that have high pressure lubricants applied to the threads. Table D-5 lists the torque limits for SAE 37 degree flare hose connections. Table D-6 lists the torque limits for SAE 45 degree flare hose connections. Table D-7 lists the torque limits for ORS preformed packing face seal hose connections. Table D-8 lists the torque limits for NPSM swivel connections.

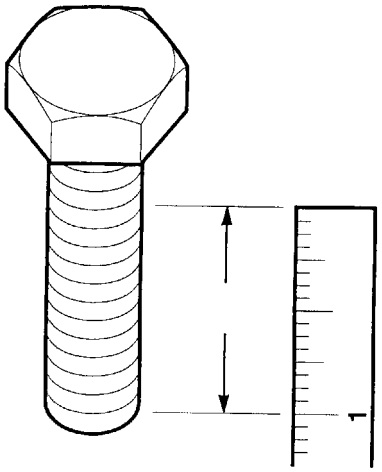
D-3. HOW TO USE TORQUE TABLE.

a. Screws and Nuts.

(1) Measure the diameter of the screw you are installing with a ruler.



D-3. HOW TO USE TORQUE TABLE (CONT).



(2) Measure out one inch with a ruler and count the number of threads per inch.

(3) Under the heading SIZE, look down the left hand column until you find the diameter of the screw you are installing (there will usually be two lines beginning with the same size).

(4) In the second column under SIZE, find the number of threads per inch that matches the number of threads per inch you counted in Step 2. (Not required for metric screws).

(5) To find the grade screw you are installing, match the markings on the head to the correct picture of CAPSCREW HEAD MARKINGS on the torque table.

(6) Look down the column under the picture you found in Step 5. until you find the torque limit (lb-ft or N·m) for the diameter and threads per inch of the screw you are installing.

(7) Use wet torque values.

CAPSCREW HEAD MARKINGS

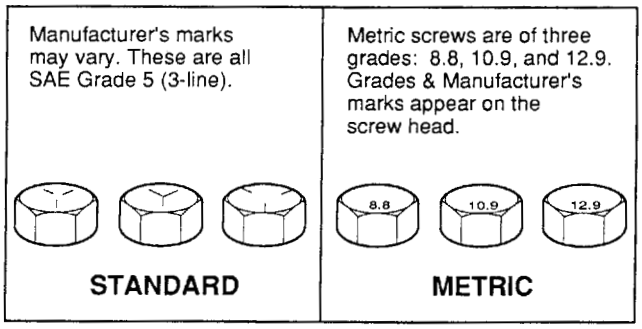


Table D-1. Torque Limits For Wet Flange Nuts

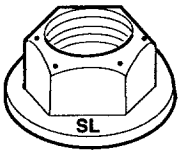
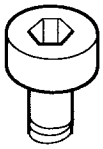
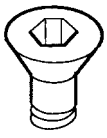
SPIRALOCK FLANGE NUT MARKINGS GRADE 8	DIAMETER		THREADS PER INCH	TORQUE	
	IN.	MM		LB-FT	N·m
	1/4	6.35	20	15	20
	5/16	7.94	18	25	34
	3/8	9.65	16	45	61
	1/2	12.70	13	110	149
	5/8	15.87	11	210	285
	3/4	19.05	10	375	508

Table D-2. Torque Limits For Wet Socket Head Cap Screws

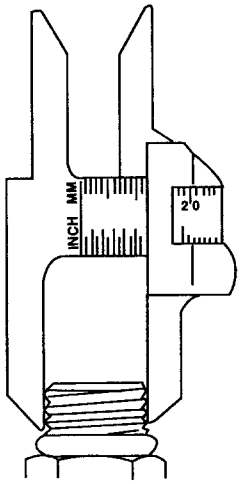
SOC HEAD/12 PT.	TORQUE IN FT. LBS. (CAP SCREWS) LUBED		
	SIZE	SOC HD OR 12 PT	SOC FLAT HD
	.10-24	5	2.5
	.25-20	12	6
	.31-18	25	12
	.38-16	44	22
SOC FLAT HEAD	.50-13	70	36
	.56-12	106	53
	.62-11	212	106
	.75-10	375	187
	1.00-8	781	

b. Hoses and Fittings.

NOTE

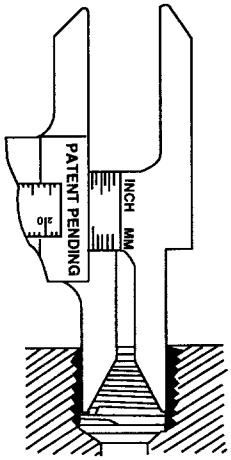
Most fluid piping system sizes are measured by dash numbers. These are universally used abbreviations for the size of the component expressed as the numerator of the fraction with the denominator always being 16. For example, a -04 port is 4/16 or 1/4-inch. Dash numbers are usually nominal (in name only) and are abbreviations that make ordering of components easier.

(1) Measure the I.D./O.D. diameter with a caliper as shown.



O.D.
(MALE THREADS)

(2) Under the heading MALE THREAD O.D. and FEMALE THREAD I.D., match the measurements with the row in table to determine proper torque.



I.D.
(FEMALE THREADS)

(3) To find the sealing surface angle, use a protractor and measure the sealing surface parallel to the center line of the fitting.

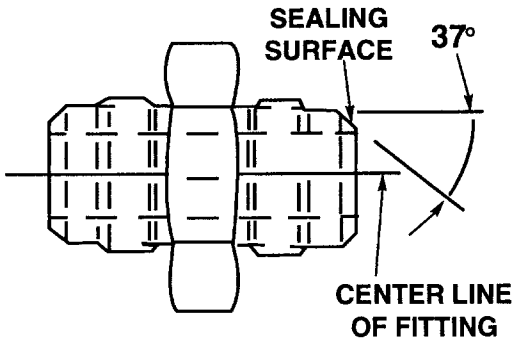
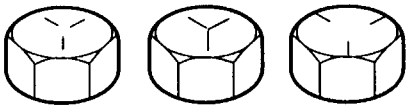
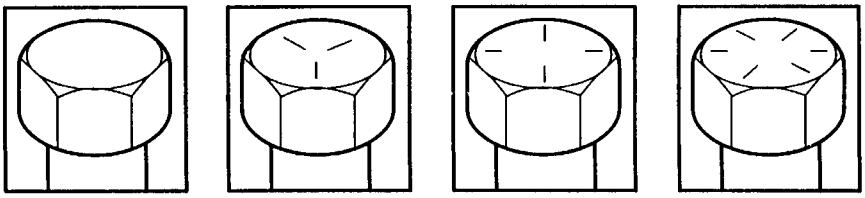


Table D-3. Torque Limits For Dry Fasteners

CAPSCREW HEAD MARKINGS



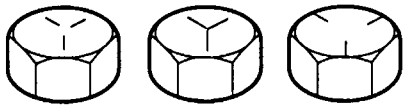
Manufacturer's marks may vary.
These are all SAE Grade 5 (3-line).



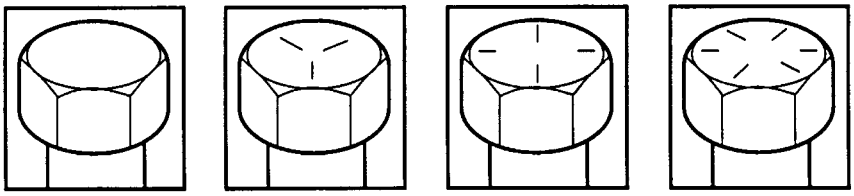
SIZE			TORQUE							
			SAE GRADE NO. 2		SAE GRADE NO. 5		SAE GRADE NO. 6 or 7		SAE GRADE NO. 8	
DIA. INCHES	THREADS PER INCH	MILLIMETERS	POUNDS FEET	NEWTON METERS	POUNDS FEET	NEWTON METERS	POUNDS FEET	NEWTON METERS	POUNDS FEET	NEWTON METERS
1/4	20	6.35	5	7	8	11	10	14	12	16
1/4	28	6.35	6	9	10	14	12	16	14	19
5/16	18	7.94	11	15	17	23	21	28	25	34
5/16	24	7.94	12	16	19	26	24	33	25	34
3/8	16	9.53	20	27	30	41	40	54	45	61
3/8	24	9.53	23	31	35	47	45	61	50	68
7/16	14	11.11	30	41	50	68	60	81	70	95
7/16	20		35	47	55	75	70	95	80	108
1/2	13	12.70	50	68	75	102	95	129	110	149
1/2	20		55	75	90	122	100	136	120	163
9/16	12	14.29	65	88	110	149	135	183	150	203
9/16	18		75	102	120	163	150	203	170	231
5/8	11	15.88	90	122	150	203	190	258	220	298
5/8	18		100	136	180	244	210	285	240	325
3/4	10	19.05	160	217	260	353	320	434	380	515
3/4	16		180	244	300	407	360	488	420	569
7/8	9	22.23	140	190	400	542	520	705	600	814
7/8	14		155	210	440	597	580	786	660	895
1	8	25.40	220	298	580	786	800	1085	900	1220
1	12		240	325	640	868	860	1166	1000	1356
1-1/8	7	25.58	300	407	800	1085	1120	1519	1280	1736
1-1/8	12		340	461	880	1193	1260	1709	1440	1953
1-1/4	7	31.75	420	597	1120	1519	1580	2142	1820	2468
1-1/4	12		460	624	1240	1681	1760	2387	2000	2712
1-3/8	6	34.93	560	759	1460	1980	2080	2820	2380	3227
1-3/8	12		640	868	1680	2278	2380	3227	2720	3688
1-1/2	6	38.10	740	1003	1940	2631	2780	3770	3160	4285
1-1/2	12		840	1139	2200	2983	3100	4204	3560	4827

Table D-4. Torque Limits For Wet Fasteners

CAPSCREW HEAD MARKINGS

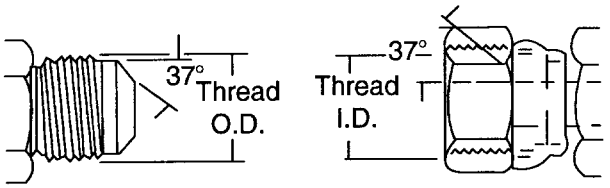


Manufacturer's marks may vary.
These are all SAE Grade 5 (3-line).



SIZE			TORQUE							
			SAE GRADE NO. 2		SAE GRADE NO. 5		SAE GRADE NO. 6 or 7		SAE GRADE NO. 8	
DIA. INCHES	THREADS PER INCH	MILLIMETERS	POUNDS FEET	NEWTON METERS	POUNDS FEET	NEWTON METERS	POUNDS FEET	NEWTON METERS	POUNDS FEET	NEWTON METERS
1/4	20	6.35	4	6	6	8	8	11	9	12
1/4	28	6.35	5	7	7	9	9	12	10	14
5/16	18	7.94	8	11	13	18	16	22	18	24
5/16	24	7.94	9	12	14	19	18	24	20	27
3/8	16	9.53	15	20	23	31	30	41	35	47
3/8	24	9.53	17	23	25	34	30	41	35	47
7/16	14	11.11	24	33	35	47	45	61	55	75
7/16	20		25	34	40	54	50	68	60	81
1/2	13	12.70	35	47	55	75	70	95	80	108
1/2	20		40	54	65	88	80	108	90	122
9/16	12	14.29	50	68	80	108	100	136	110	149
9/16	18		55	75	90	122	110	149	130	176
5/8	11	15.88	70	95	110	149	140	190	170	231
5/8	18		80	108	130	176	160	217	180	244
3/4	10	19.05	120	163	200	271	240	325	280	380
3/4	16		140	190	220	298	280	380	320	434
7/8	9	22.23	110	149	300	407	400	542	460	624
7/8	14		120	163	320	434	440	597	500	678
1	8	25.40	160	217	440	597	600	814	680	922
1	12		170	231	480	651	660	895	740	1003
1-1/8	7	25.58	220	298	600	814	840	1139	960	1320
1-1/8	12		260	353	660	895	940	1275	1080	1464
1-1/4	7	31.75	320	434	840	1139	1100	1492	1360	1844
1-1/4	12		360	488	920	1248	1320	1790	1500	2034
1-3/8	6	34.93	420	570	1100	1492	1560	2115	1780	2414
1-3/8	12		460	624	1260	1709	1780	2414	2040	2776
1-1/2	6	38.10	560	760	1460	1980	2080	2820	2360	3200
1-1/2	12		620	841	1640	2224	2320	3146	2660	3607

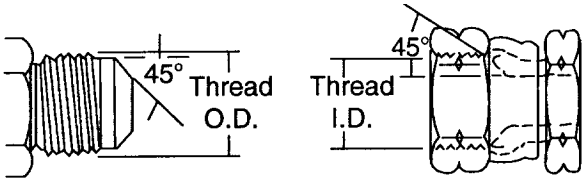
Table D-5. Torque Limits For 37 Degree Flare Hose Connections



Male Half **Female Half**

INCH SIZE	DASH NO.	THREAD SIZE	TORQUE LB.FT.	TORQUE N·m
1/4	04	7/16-20	11-12	15-16
3/8	06	9/16-18	18-21	24-28
1/2	08	3/4-16	36-39	49-53
5/8	10	7/8-14	57-62	77-84
3/4	12	1 1/16-12	79-87	107-118
7/8	14	1 3/16-12	83-91	113-123
1	16	1 5/16-12	108-113	146-153
1 1/4	20	1 5/8-12	127-133	172-180
1 1/2	24	1 7/8-12	158-167	214-224
2	32	2 1/2-12	245-258	332-350

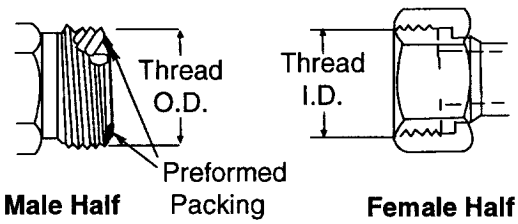
Table D-6. Torque Limits For 45 Degree Flare Hose Connections



Male Half **Female Half**

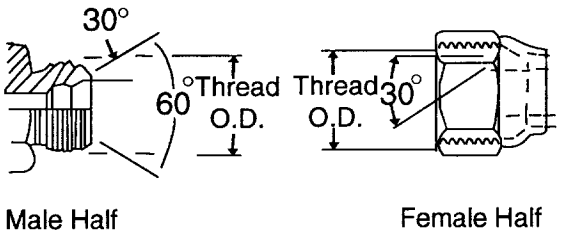
INCH SIZE	DASH NO.	THREAD SIZE	TORQUE LB.FT.	TORQUE N·m
1/4	04	7/16-20	8-9	11-12
3/8	06	5/8-18	18-20	24-27
1/2	08	3/4-16	36-38	49-51
5/8	10	7/8-14	52-54	70-73
3/4	12	1 1/16-14	71-74	97-100

Table D-7. Torque Limits For ORS Preformed Packing Face Seal Hose Connections



INCH SIZE	DASH NO.	THREAD SIZE	TORQUE LB.FT.	TORQUE N·m
1/4	04	9/16-18	10-12	14-16
3/8	06	11/16-16	18-20	24-27
1/2	08	13/16-16	32-35	43-47
5/8	10	1-14	46-50	62-68
3/4	12	1 3/16-12	65-70	88-95
1	16	1 7/16-12	108-113	146-153
1 1/4	20	1 11/16-12	127-133	172-180
1 1/2	24	2-12	158-167	214-226

Table D-8. Torque Limits For NPSM Swivel Connections



INCH SIZE	DASH NO.	THREAD SIZE	TORQUE LB.FT.	TORQUE N·m
1/8	02	1/8-27	3-4	4-5
1/4	04	1/4-18	10-11	14-15
3/8	06	3/8-18	16-18	22-24
1/2	08	1/2-14	25-27	34-37
3/4	12	3/4-14	46-48	62-65
1	16	1-1 1/2	80-83	108-113
1 1/4	20	1 1/4-11/2	130-134	176-182
1 1/2	24	1 1/2-11/2	160-164	217-222
2	32	2-11/2	170-174	231-240

APPENDIX E

MANDATORY REPLACEMENT PARTS

Section I. INTRODUCTION

E-1. SCOPE.

This appendix lists all mandatory replacement parts required for performance of Unit Support Maintenance of the Forward Repair System (FRS). It authorizes the requisitioning, issue, and disposition of consumable repair parts. All consumable repair parts listed in the maintenance tasks are listed here for ease of reference.

E-2. EXPLANATION OF COLUMNS (SECTION II).

a. Column (1) - Replacement Part Reference Code. This number is assigned to the entry in the listing and is referenced in the narrative task box to identify the part e.g., Gasket (Item 8, Appendix E).

b. Column (2) - Nomenclature. Indicates the federal item name and, if required, a description to identify the item.

c. Column (3) - Part Number. This is the vendor number assigned to the item.

d. Column (4) - National Stock Number. This is the National Stock Number assigned to the item; use it to request or requisition the item.

Section II. MANDATORY REPLACEMENT PARTS LIST

(1) Index No.	(2) Nomenclature	(3) Part Number	(4) National Stock Number
1	Backup Ring	363602	TBD
2	Backup Ring	8-008N300-90	5330-00-225-3266
3	Backup Ring	MS28783-16	5330-00-171-5910
4	Backup Ring	MS28783-26	5330-00-944-9577
5	Bearing, C.E. Armature	10456461	3110-01-368-7234
6	Bearing, D.E. Armature	10456462	3110-01-368-7235
7	Bolt	2229490	5306-01-466-1063
8	Gasket	154-2708	TBD
9	Gasket	25029-02	5330-01-372-3832
10	Gasket	3915772	5330-01-263-6179
11	Gasket	3928493	5330-01-304-7807
12	Gasket	6-794-000557	5330-01-196-6757
13	Gasket	731740-002	TBD
14	Gasket	TBD	TBD
15	Gasket	TBD	TBD
16	Gasket, Airhead - First Stage	32172926	TBD
17	Gasket, Airhead - Second Stage	32252801	5330-01-469-8277
18	Gasket, Cylinder Head	3283333	TBD
19	Gasket, Flange	30294235	5330-01-218-0715
20	Gasket, Frame End Cover	30439277	5330-01-219-5993
21	Gasket, Front Cover	3914385	5330-01-191-7322
22	Gasket, Fuel Pump	3931059	5330-01-306-8642
23	Gasket, Gear Housing	3931351	5330-01-453-7142
24	Gasket, Manifold - High Pressure	32153827	TBD
25	Gasket, Manifold - Low Pressure	32153801	TBD
26	Gasket, Push Rod Cover	3283767	5330-01-266-3297
27	Gasket, Shaft End Cover	30295166	5330-01-218-1498
28	Gasket, Spacerplate, Second Stage	32252819	4310-01-466-4961
29	Gasket, Valveplate - First Stage	32172942	TBD
30	Gasket, Valveplate - Second Stage	32252827	TBD
31	Jam Nut	7-659-190009	TBD
32	Kit, Repair	9-752-101100	TBD
33	Kit, Repair	711992	TBD
34	Kit, Repair	9-752-100820	TBD

Section II. MANDATORY REPLACEMENT PARTS LIST (CONT)

(1) Index No.	(2) Nomenclature	(3) Part Number	(4) National Stock Number
35	Kit, Repair	9-752-101052	TBD
36	Kit, Repair	TBD	5330-01-353-9513
37	Kit, Repair	TBD	5330-01-353-9623
38	Locknut	M45913/1-4CG8N	TBD
39	Locknut	M45913/1-8CG8C	TBD
40	Locknut	MS17830-12C	5310-00-241-6609
41	Locknut	TBD	TBD
42	Lockwasher	004-003005-024	5310-00-933-8778
43	Lockwasher	114021	5310-01-081-0798
44	Lockwasher	7-950-100050	TBD
45	Lockwasher	7-950-140050	5310-01-292-7273
46	Lockwasher	7-950-150050	5310-00-407-9566
47	Lockwasher	7-950-160050	5310-01-212-9285
48	Lockwasher	850-0050	TBD
49	Lockwasher	850-0114-54	TBD
50	Lockwasher	10589	5310-01-259-3595
51	Lockwasher	850-2006	TBD
52	Lockwasher	850-2010	5310-01-473-0398
53	Lockwasher	856-0013	TBD
54	Lockwasher	95043188	TBD
55	Lockwasher	95043196	TBD
56	Lockwasher	MS35338-75	5310-00-274-8728
57	Lockwasher	MS35338-46	5310-00-637-9541
58	Lockwasher	926001-0086	5310-00-933-8778
59	Lockwasher	TBD	TBD
60	Lockwasher	TBD	TBD
61	Lockwasher	TBD	TBD
62	Lockwasher	TBD	TBD
63	Lockwasher	95674677	TBD
64	Lockwasher	TBD	TBD
65	Lockwasher	MS19070-101	5310-00-186-0969
66	Lockwasher	MS35338-44	5310-00-582-5965
67	Lockwasher	MS35338-45	5310-00-184-9562
68	Lockwire	95799289	TBD
69	Nut	MS19068-101	5310-00-185-6462

Section II. MANDATORY REPLACEMENT PARTS LIST (CONT)

(1) Index No.	(2) Nomenclature	(3) Part Number	(4) National Stock Number
70	Nut	7-659-190008	TBD
71	Oil Seal	26284	5330-01-208-7006
72	Packing, Preformed	10456474	5331-01-373-6247
73	Packing, Preformed	2-011-N507-90	5331-01-265-8308
74	Packing, Preformed	22012-10	5331-00-996-8620
75	Packing, Preformed	2-012N507-90	5331-00-092-5502
76	Packing, Preformed	2-014N507-90	5330-01-366-5377
77	Packing, Preformed	2-014N552-90	5331-00-612-6148
78	Packing, Preformed	2-018N552–90	5331-01-299-0062
79	Packing, Preformed	2-025N0552	TBD
80	Packing, Preformed	2-112N507-90	5331-01-093-3504
81	Packing, Preformed	2-11N552-9	5330-01-047-6305
82	Packing, Preformed	2-165-N507-90	5331-01-369-3591
83	Packing, Preformed	22012-6	5331-00-200-8125
84	Packing, Preformed	22012-12	5331-00-966-8621
85	Packing, Preformed	2-256 N507-90	5331-01-460-5394
86	Packing, Preformed	23045075	5330-01-341-6763
87	Packing, Preformed	3-903N304-75	5330-00-593-6181
88	Packing, Preformed	3-904N507-90	5331-00-805-2966
89	Packing, Preformed	3-906	TBD
90	Packing, Preformed	3-906N304-75	5331-01-154-3998
91	Packing, Preformed	3-908N552-90	5331-00-929-8171
92	Packing, Preformed	3-908N304-75	5331-01-472-2930
93	Packing, Preformed	3-910	TBD
94	Packing, Preformed	3-910N552-90	5331-01-115-8223
95	Packing, Preformed	3912473	5330-01-271-9375
96	Packing, Preformed	TBD	TBD
97	Packing, Preformed	3-916N304-75	TBD
98	Packing, Preformed	3-916N552-90	5331-01-125-6268
99	Packing, Preformed	3928759	5330-01-450-6038
100	Packing, Preformed	405862	5331-00-490-1899
101	Packing, Preformed	408569	5331-00-556-8268
102	Retainer, Packing	491001	5330-01-203-3061
103	Packing, Preformed	490309	5331-01-152-3138
104	Packing, Preformed	7-755-018003	TBD
105	Packing, Preformed	7-755-166003	5331-01-353-9544

Section II. MANDATORY REPLACEMENT PARTS LIST (CONT)

(1) Index No.	(2) Nomenclature	(3) Part Number	(4) National Stock Number
106	Packing, Preformed	7-755-906003	5331-01-431-6558
107	Packing, Preformed	8-008N300-90	5330-00-225-3266
108	Packing, Preformed	9086-002	5331-01-336-6718
109	Packing, Preformed	908-77-00-00	5331-01-361-1181
110	Packing, Preformed	9091-001	TBD
111	Packing, Preformed	95026183	5331-01-469-8276
112	Packing, Preformed	FF9855-12	5331-01-376-9629
113	Packing, Preformed	FF9855-18	5330-01-363-7073
114	Packing, Preformed	FF9855-14	5331-01-371-2035
115	Packing, Preformed	MS28775-008	5331-00-579-3158
116	Packing, Preformed	MS28775-009	5331-00-542-1365
117	Packing, Preformed	MS28775-014	5331-00-584-1840
118	Packing, Preformed	MS28775-015	5331-00-618-5361
119	Packing, Preformed	MS28775-36	TBD
120	Packing, Preformed	MS28775-910	5331-00-448-6753
121	Packing, Preformed	MS28778-14	5331-00-472-2786
122	Packing, Preformed	MS28778-238	5331-01-352-7742
123	Packing, Preformed	MS28778-246	5330-01-354-0235
124	Packing, Preformed	MS28778-3	5331-00-835-7485
125	Packing, Preformed	MS28778-4	5331-00-805-2966
126	Packing, Preformed	MS28778-8	5331-01-808-0794
127	Packing, Preformed	2-021N552-90	5331-01-469-1835
128	Packing, Preformed, Unloader Piston	32188385	TBD
129	Pin, Cotter	MS24665-360	5315-00-298-1499
130	Plug, Camshaft Expansion	3900687	5340-01-194-4667
131	Plug, Expansion	3900956	5340-01-190-7424
132	Plug, Expansion	3900958	5340-01-190-7425
133	Plug, Expansion	3910435	TBD
134	Plug, Expansion	3920706	5340-01-431-8752
135	Plug, Expansion	3922072	5340-01-431-8753
136	Repair Kit	6547	TBD
137	Repair Kit	711939T	4820-01-354-0290
138	Repair Kit	SK85002126	5330-01-228-1466
139	Ring, Piston	3802040	2815-01-237-1754

Section II. MANDATORY REPLACEMENT PARTS LIST (CONT)

(1) Index No.	(2) Nomenclature	(3) Part Number	(4) National Stock Number
140	Ring, Piston	3802042	2815-01-243-6299
141	Ring, Piston	3802044	2815-01-242-2875
142	Ring, Retaining	3920691	5325-01-412-6320
143	Ring, Stop	10456465-1	TBD
144	Rivet	RIA149036	TBD
145	Screw	16294-212	5306-01-463-9552
146	Screw	22351	TBD
147	Screw	B18231B12035N	5305-01-438-0369
148	Screw, Self-Tapping	32000705	TBD
149	Screw, Self-Tapping	32187056	TBD
150	Screw, Self-Tapping	TBD	TBD
151	Seal	8694-CRWA5	5330-01-263-8267
152	Seal, Frame	1113276-6	TBD
153	Seal Kit	75209-01P	TBD
154	Seal Kit	75252-08SK	5330-01-392-8534
155	Seal Kit	60540	5330-01-316-1440
156	Seal Kit	7-373-000154	5330-01-479-8449
157	Seal Kit	SKMEH-4	5330-01-372-5296
158	Seal, Plain Encased	31333CRWH1	5330-01-204-5486
159	Seal, Safety Lock	7-850-000781	5340-01-352-8127
160	Seal, Unloader Piston	32254740	TBD
161	Seal Washer	25008-36	5310-01-406-8407
162	Setscrew	7-099-000378	5305-01-230-8348
163	Setscrew	7-785-160802	5305-01-236-7095
164	Shim	6-705-010516	5365-01-203-0300
165	Shim	6-705-010517	5335-01-230-0298
166	Shim	6-705-010518	5365-01-203-0299
167	Shim	6-705-010519	5365-01-211-1521
168	Shim	6-705-010520	5365-01-203-0301
169	Shim	6-705-010521	5365-01-203-0302
170	Shim	6-705-010522	5365-01-203-6465
171	Shim	6-705-010523	5365-01-203-0303
172	Shim	6-705-010524	TBD

Section II. MANDATORY REPLACEMENT PARTS LIST (CONT)

(1) Index No.	(2) Nomenclature	(3) Part Number	(4) National Stock Number
173	Shim	6-705-010525	5365-01-206-2346
174	Shim	6-705-010526	5365-01-204-8899
175	Shim	6-705-010527	5365-01-205-2884
176	Shim	6949001179	5365-01-460-3387
177	Spring	3-4X1MD	5360-01-143-4761
178	Stop, Pinion	10456465	3120-01-374-4440
179	Strip, Metal	9500K18	9515-01-268-9500
180	Washer, Sealing	3918191	5310-01-340-8469

APPENDIX F

TOOL IDENTIFICATION LIST

Section I. INTRODUCTION

F-1. SCOPE.

This appendix lists all of the tools needed to repair the Forward Repair System (FRS).

F-2. GENERAL.

This appendix is a list of tools, both common and special, test equipment and tool kits used at unit level to repair the truck. This list is arranged alphabetically and shows the nomenclature, part number (P/N), National Stock Number (NSN) and references when applicable. The index number corresponds to the index number found in the task box of maintenance procedures.

Section II. COMMON TOOLS, TEST EQUIPMENT AND TOOL KITS

Item No.	Description	Part No.	NSN	Reference
1	Camshaft Bushing Tool	3823509	5120-01-389-8449	
2	Bracket, Lifting	3908118	TBD	
3	Brush, Bore, Injector	3822509	7920-01-381-6132	
4	Brush, Nylon	7920-00-685-3980	7920-00-685-3980	
5	Caliper, Outside	TBD	TBD	
6	Cap and Plug Set	10935405	5340-00-450-5718	
7	Cleaner, Cold Parts	TBD	TBD	
8	Compressor, Ring, 75-125mm (3-5 in.)	HC 686	5120-00-322-8848	SC 4910-95-A63
9	Compressor, Spring, Valve	J7455-A	5120-01-297-2347	
10	Compressor Unit, Air	MIL-C-13874	4130-00-752-9633	
11	Dent Puller, Slide Hammer, No. 10 Sheet Metal Screw	TBD	TBD	
12	Digital Multimeter	TBD	TBD	
13	Dispensing Pump	FEDXXD370	4930-00-287-8293	SC 4910-95-A72-HR
14	Drill, Electric, Portable 1/4 in.	1070	5130-00-889-8993	SC 4910-95-A31
15	Dril Set, Twist	GGG-D-751	5133-00-449-6775	SC 3470-95-A02
16	Driver	TBD	TBD	
17	Drum, Storage 57 Gal	MIL-D6054	8110-00-082-2626	
18	Engine Turnover Tool	3824591	5120-01-285-5193	
19	File	TBD	TBD	
20	Gage, Depth, Micrometer	GGG-C-105	5210-00-619-4045	SC 3470-95-A02
21	Gage, Feeler	2070A70	5210-01-131-8151	
22	Gage Set, Telescoping	559-590	5210-00-473-9350	SC 4910-95-A63

Section II. COMMON TOOLS, TEST EQUIPMENT AND TOOL KITS (CONT)

Item No.	Description	Part No.	NSN	Reference
23	Gloves, Chemical Oil Protective	ZZ-G-381	8415-00-641-4601	SC 4910-95-A31
24	Gloves, Heavy Duty	A-A-50022	8415-00-268-7859	SC 4910-95-A31
25	Goggles, Industrial	GGG-G-513	4240-00-269-7912	SC 4910-95-A31
26	Grinder, Die	TBD	TBD	
27	Grinding Wheel	TBD	3460-00-529-2105	SC 4910-95-A31
28	Growler	TBD	TBD	
29	Gun, Air Blow	GGG-G-770	4940-00-333-5541	SC 4910-95-A31
30	Hammer, Hand, Soft Plastic	3-HD	5120-01-065-9037	SC 4910-95-A72-HR
31	Honing Unit, Cylindrical	MIL-C-82609	5130-00-991-0699	SC 4910-95-A02
32	Hooks, Lifting	3784T24	4030-01-478-1098	
33	Indicator, Dial, Set W/Magnetic Base	J7872	5120-00-402-9619	
34	Indicator, Dial, Set	TBD	5210-00-794-9178	SC 4910-95-A31
35	Jackstand, Trestle	306	4910-00-251-8013	SC 4910-95-A74
36	Lamp, Test	TBD	TBD	
37	Micrometer, Outside, Caliper, Set	GGG-C-105	5210-00-554-7134	SC 3470-95-A02
38	Multimeter	ANURM105C	6625-00-999-6282	SC 4910-95-A31
39	Multiplier, Torque	YA393	5120-01-348-9484	
40	Oil Seal Installer, Front Crankshaft	38242298	5120-01-476-1516	
41	Protractor, Magnetic	2150A25	5210-00-415-0075	
42	Pan, Drain 6 Gal	TBD	4910-00-287-2944	MIL-P-45819
43	Plate, Adapter, Engine	J39898	TBD	
44	Pliers, Retaining Ring	S6800	5120-00-595-9552	SC 4910-95-A31
45	Press, Arbor, Hand Operated	MIL-P-80261	3444-00-163-4338	SC 4910-95-A31
46	Puller Kit, Universal	1677	5180-00-423-1596	SC 4910-95-A31
47	Puller, Mechanical	3823276	5720-01-389-5917	
48	Sander, Portable, Disk Electric	OOS90	5130-00-596-9728	SC 4910-95-A31
49	Scraper	TBD	TBD	
50	Scribe	TBD	TBD	
51	Socket Set, 3/4 in.	GGG-W-641	5120-00-204-1999	SC 4910-95-A72-HR
52	Socket Set, 3/8 in.	221FSMY	5120-01-117-3876	SC 4910-95-A72-HR
53	Socket Set, 2 in. – 1 in. Drive	TBD	5120-00-081-2390	
54	Soft Wire Wheel	TBD	TBD	
55	Stand, Maintenance, Engine	J29109	4910-00-808-3372	
56	Steam Cleaner	PRO 12-5	7910-01-157-8272	
57	Stone, 15 Degree	TBD	4940-00-473-6437	SC 4910-95-A31
58	Stone, 60 Degree	TBD	4910-00-540-4679	SC 4910-95-A31
59	Straight Edge	11-1480	4920-00-442-1030	SC 3470-95-A02
60	Tag, Identification	PDS-400-05-10	TBD	
61	Tap or Die	TBD	TBD	

Section II. COMMON TOOLS, TEST EQUIPMENT AND TOOL KITS (CONT)

Item No.	Description	Part No.	NSN	Reference
62	Tappet Kit	3822513	TBD	
63	Tester, Cylinder Compression	TBD	4910-00-250-2423	SC 4910-95-A31
64	Tester, Hydraulic Oil Flow Pressure	PDS1-400-05-10	TBD	
65	Test Kit, Pressure	TBD	6685-01-265-5105	
66	Tool, Engine Turnover	3824591	5120-01-285-5193	
67	Tool Kit, General Mechanic's	TBD	5180-00-699-5273	SC 5180-90-CL-N05
68	Tool, Oil Ring Expander	TBD	TBD	
69	Tool, Piston Ring Expander	3823137	5120-01-387-8935	
70	Tool, Universal Bushing Installation	TBD	TBD	
71	Tool, Wear Sleeve Installation	3824078	4920-01-476-0297	
72	Vice, Mechanics	504M2	5120-00-293-1439	
73	Wheatstone Bridge	TBD	TBD	
74	Wheel, Steel Wire	TBD	TBD	
75	Wrench, Combination 1 1/16 in.	1234	5120-00-228-9515	SC 4910-95-A74
76	Wrench, Combination 1 5/16 in.	1174	5120-00-228-9518	SC 4910-95-A74
77	Wrench, Combination 1 3/8 in.	1176A	5120-01-367-0103	SC 4910-95-A74
78	Wrench, Combination 1 5/8 in.	1180	5120-01-016-7144	
79	Wrench, Combination 1 11/16 in.	1254	5120-01-399-8795	
80	Wrench, Combination 1 7/8 in.	1260	5120-01-399-8806	
81	Wrench, Combination 2 in.	1264	5120-01-399-8813	
82	Wrench Set, Spanner	304AHSK	(PARA 6-2)	
83	Wrench, Torque (0 to 175 lb-ft [0–237 N·m])	1753LDF	5120-01-396-5751	SC 4910-95-A74
84	Wrench, Torque (0 to 300 lb-ft [0–407 N·m])	5120-00-555-1523	5120-00-555-1523	SC 4910-95-A72-HR
85	Wrench, Torque, 3/8 in. Drive (0 to 60 N·m)	TESI60	5120-01-112-9531	SC 4910-95-A72-HR
86	Wrench, Torque (0 to 600 lb-ft [0 to 814 N·m])	TE602LA	5120-01-355-1797	
87	Wrench, Offset 2 in.	TBD	TBD	
88	Handle, Tubular	54555A82	TBD	
89	OSS Tester	13189	4910-00-370-4908	
90	Caps, Vise Jaw	GGG-C-137	5120-00-246-4747	
91	Vise, Pipe, Chain	CV12	5120-00-078-6662	

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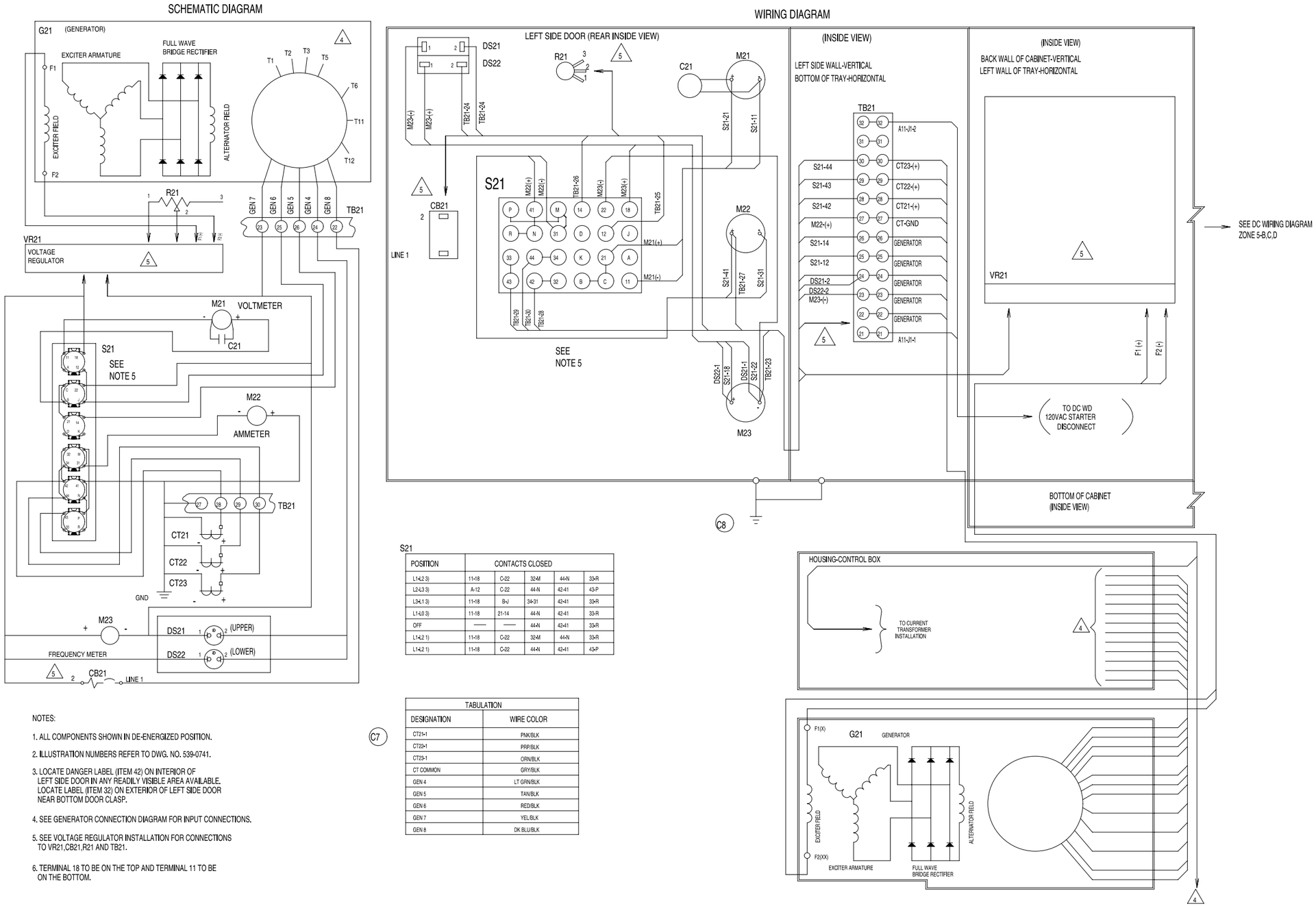
SCHEMATICS

The following section contain the schematics which are the same in TM 9-4940-568-20 and TM 9-4940-568-34.



S21

POSITION	CONTACTS CLOSED				
L1-L2 3)	11-18	C-22	32-M	44-N	33-R
L2-L3 3)	A-12	C-22	44-N	42-41	43-P
L3-L1 3)	11-18	B-J	34-31	42-41	33-R
L1-L0 3)	11-18	21-14	44-N	42-41	33-R
OFF	——	——	44-N	42-41	33-R
L1-L2 1)	11-18	C-22	32-M	44-N	33-R
L1-L2 1)	11-18	C-22	44-N	42-41	43-P

NOTES:

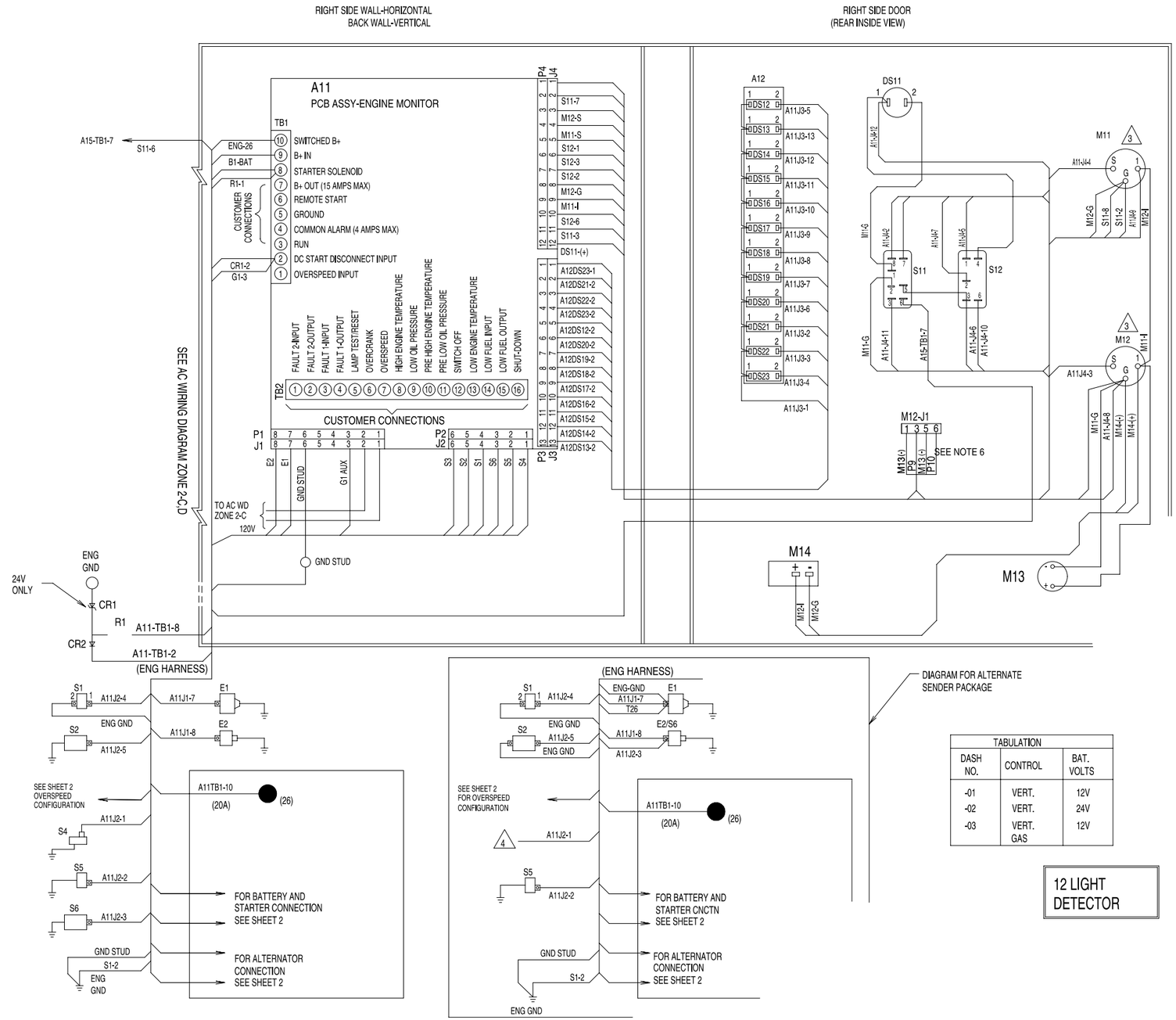
1. ALL COMPONENTS SHOWN IN DE-ENERGIZED POSITION.
2. ILLUSTRATION NUMBERS REFER TO DWG. NO. 539-0741.
3. LOCATE DANGER LABEL (ITEM 42) ON INTERIOR OF LEFT SIDE DOOR IN ANY READILY VISIBLE AREA AVAILABLE. LOCATE LABEL (ITEM 32) ON EXTERIOR OF LEFT SIDE DOOR NEAR BOTTOM DOOR CLASP.
4. SEE GENERATOR CONNECTION DIAGRAM FOR INPUT CONNECTIONS.
5. SEE VOLTAGE REGULATOR INSTALLATION FOR CONNECTIONS TO VR21,CB21,R21 AND TB21.
6. TERMINAL 18 TO BE ON THE TOP AND TERMINAL 11 TO BE ON THE BOTTOM.

C7

TABULATION	
DESIGNATION	WIRE COLOR
CT21-1	PNK/BLK
CT22-1	PPR/BLK
CT23-1	ORN/BLK
CT COMMON	GRY/BLK
GEN 4	LT GRN/BLK
GEN 5	TAN/BLK
GEN 6	RED/BLK
GEN 7	YEL/BLK
GEN 8	DK BLU/BLK

GENERATOR SET CONTROL BOX (AC) WIRING SCHEMATIC

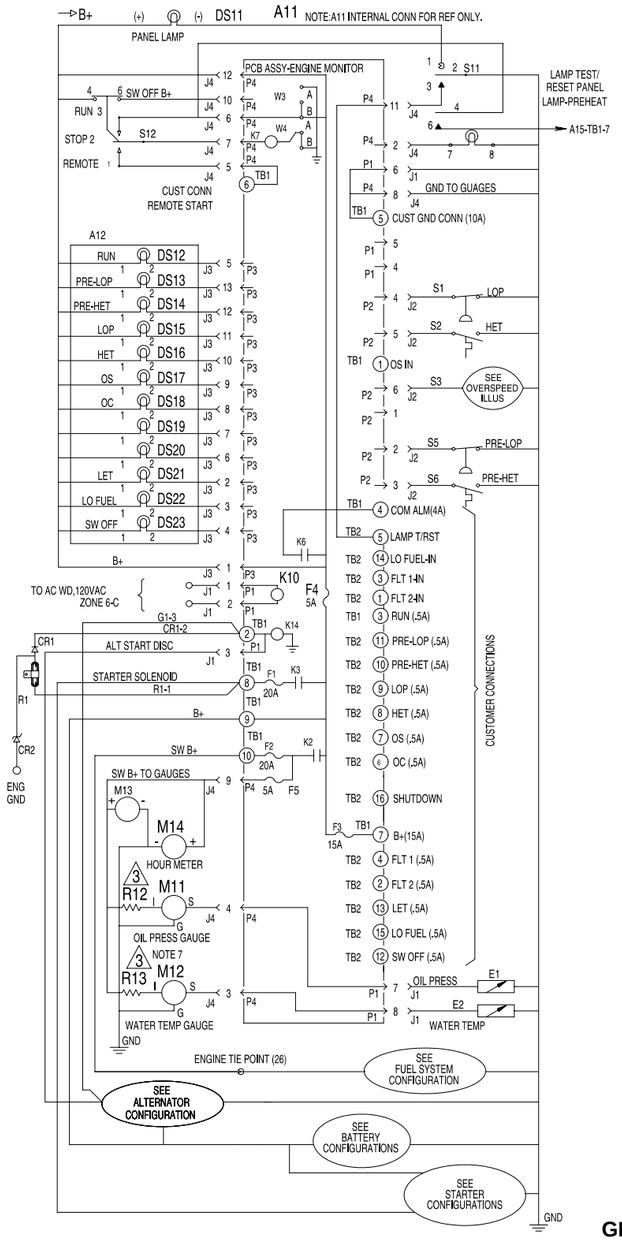
FIGURE FO-1. ELECTRICAL SYSTEM SCHEMATIC
FOLDOUT 1 OF 19
FP– 1 /FP– 2 BLANK



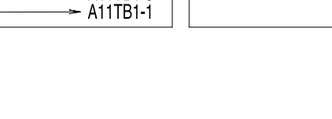
GENERATOR SET CONTROL BOX INDICATOR LAMP (DC) WIRING SCHEMATIC (1 OF 2)

FIGURE FO-1. ELECTRICAL SYSTEM SCHEMATIC
FOLDOUT 2 OF 19
FP– 3 /FP– 4 BLANK

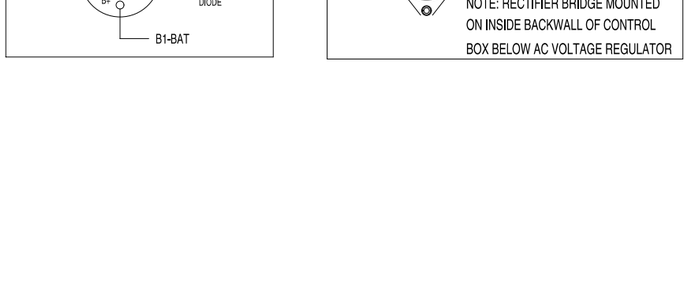
SCHEMATIC DIAGRAM



IGNITION FUEL SYSTEMS CONFIGURATIONS



STARTER CONFIGURATIONS



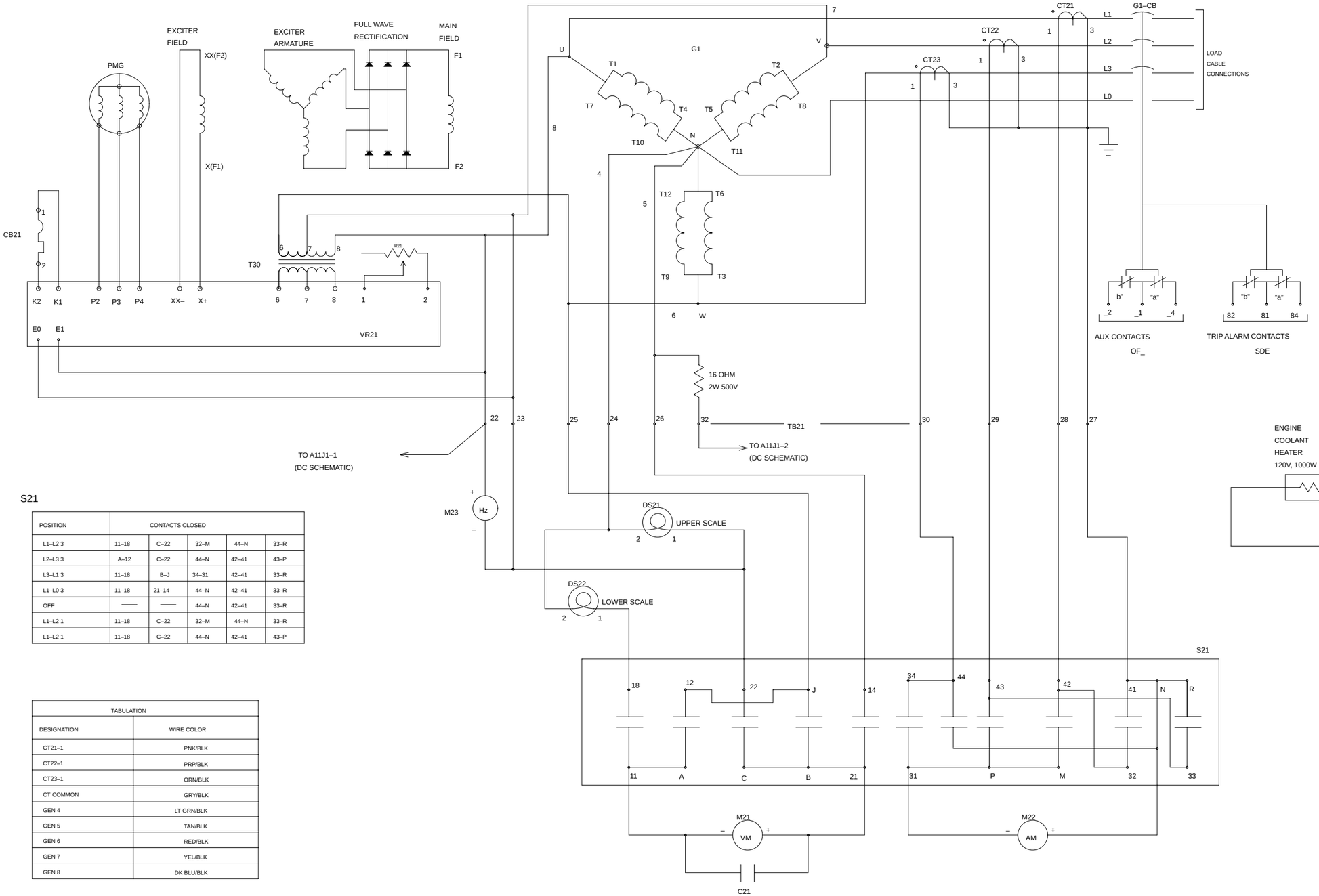
BATTERY CONFIGURATIONS

OVERSPEED CONFIGURATION

ALTERNATOR CONFIGURATIONS

GENERATOR SET CONTROL BOX INDICATOR LAMP (DC) WIRING SCHEMATIC (2 OF 2)

FIGURE FO-1. ELECTRICAL SYSTEM SCHEMATIC
FOLDOUT 3 OF 19



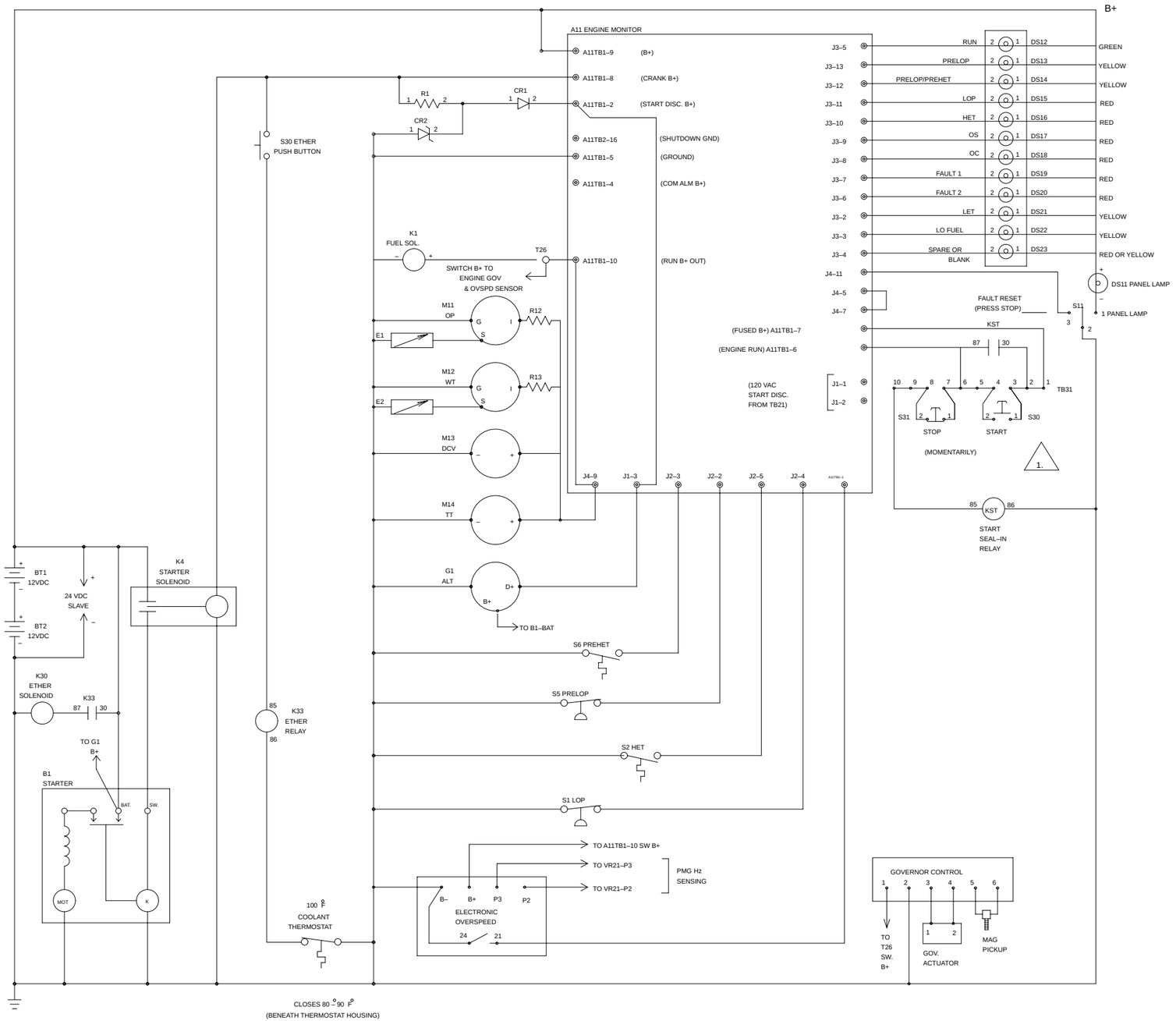
S21

POSITION	CONTACTS CLOSED				
L1–L2 3	11–18	C–22	32–M	44–N	33–R
L2–L3 3	A–12	C–22	44–N	42–41	43–P
L3–L1 3	11–18	B–J	34–31	42–41	33–R
L1–L0 3	11–18	21–14	44–N	42–41	33–R
OFF	——	——	44–N	42–41	33–R
L1–L2 1	11–18	C–22	32–M	44–N	33–R
L1–L2 1	11–18	C–22	44–N	42–41	43–P

TABULATION	
DESIGNATION	WIRE COLOR
CT21–1	PNK/BLK
CT22–1	PRP/BLK
CT23–1	ORN/BLK
CT COMMON	GRY/BLK
GEN 4	LT GRN/BLK
GEN 5	TAN/BLK
GEN 6	RED/BLK
GEN 7	YEL/BLK
GEN 8	DK BLU/BLK

GENERATOR SET (AC) WIRING SCHEMATIC

FIGURE FO-1. ELECTRICAL SYSTEM SCHEMATIC
FOLDOUT 4 OF 19
FP– 7 /FP– 8 BLANK

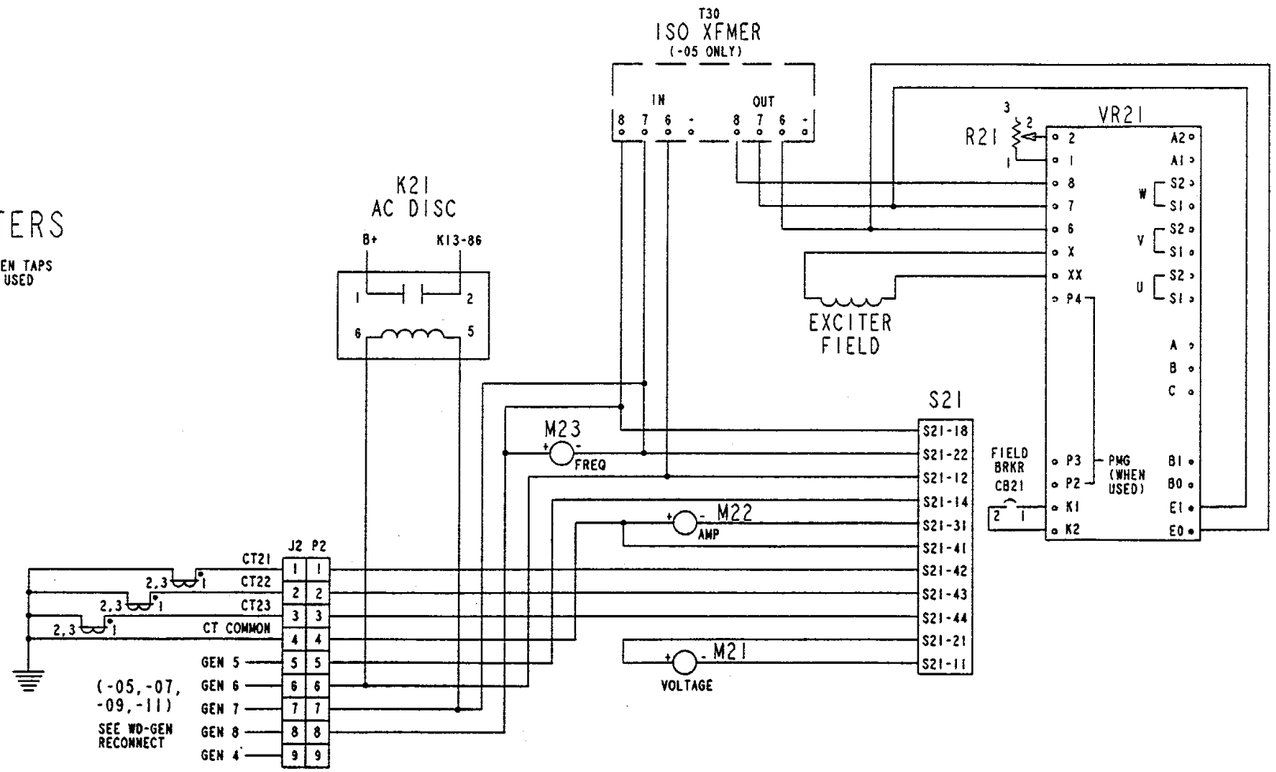


GENERATOR SET (DC) WIRING SCHEMATIC

FIGURE FO-1. ELECTRICAL SYSTEM SCHEMATIC
FOLDOUT 5 OF 19
FP– 9 /FP– 10 BLANK

METERS

600V GEN TAPS
NOT USED



SCHEMATIC-MX321 & SX421 REGULATOR

S21 JUMPERS

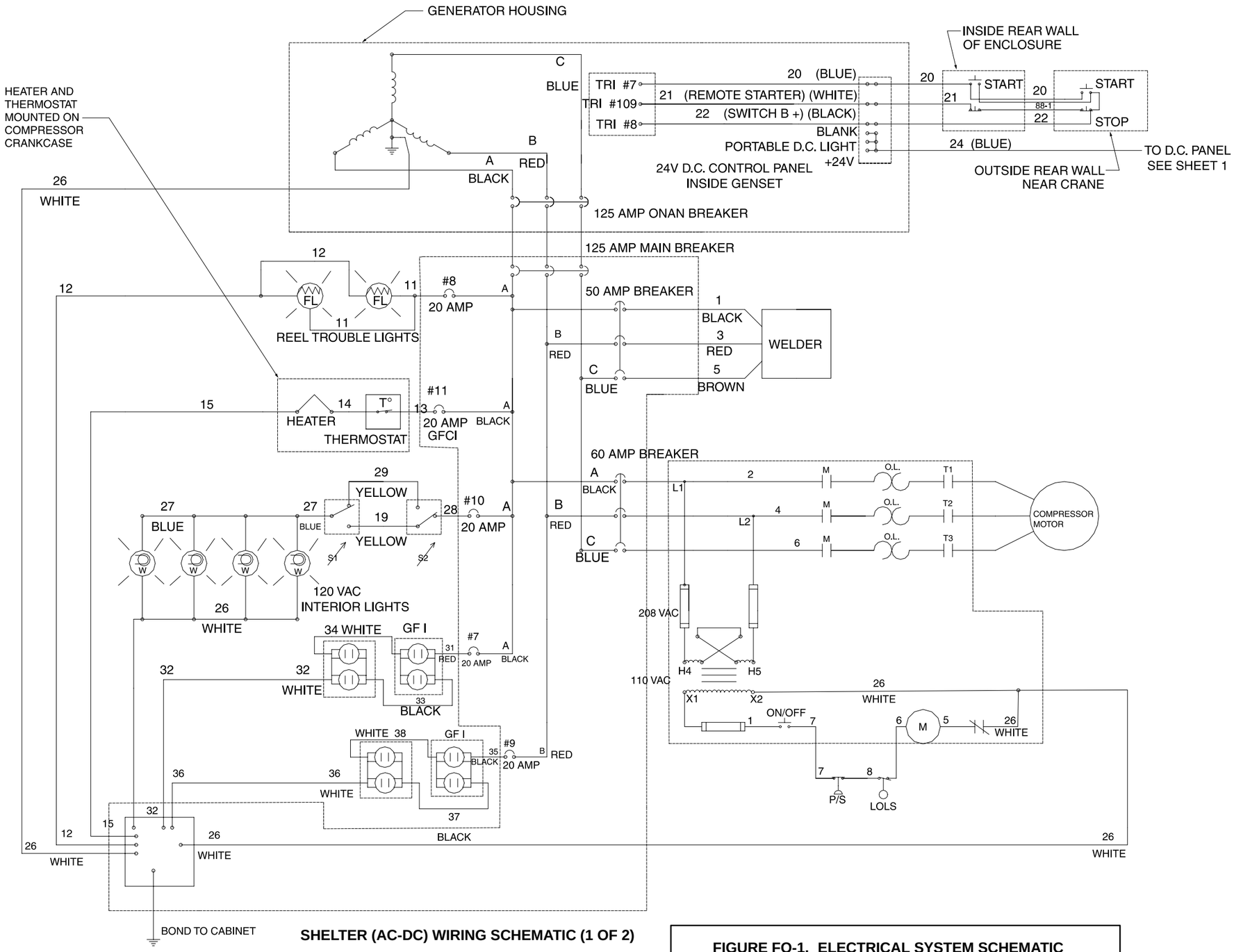
EXTERNAL	INTERNAL
M-P	N-41
34-44	M-31
C-21	A-11
32-42	B-C
12-J	33-43
N-R	

S21 SWITCH LOGIC

	18-11	22-C	14-21	M-32	41-42	P-43	12-A	J-B	31-34	N-44	R-33
L1-L2 3Ø	X	X		X						X	X
L2-L3 3Ø		X			X	X	X			X	
L3-L1 3Ø	X				X			X	X		X
L1-L0 3Ø	X		X		X					X	X
OFF					X					X	X
L1-L2 1ØA	X	X		X						X	X
L1-L2 1ØB	X	X			X	X				X	

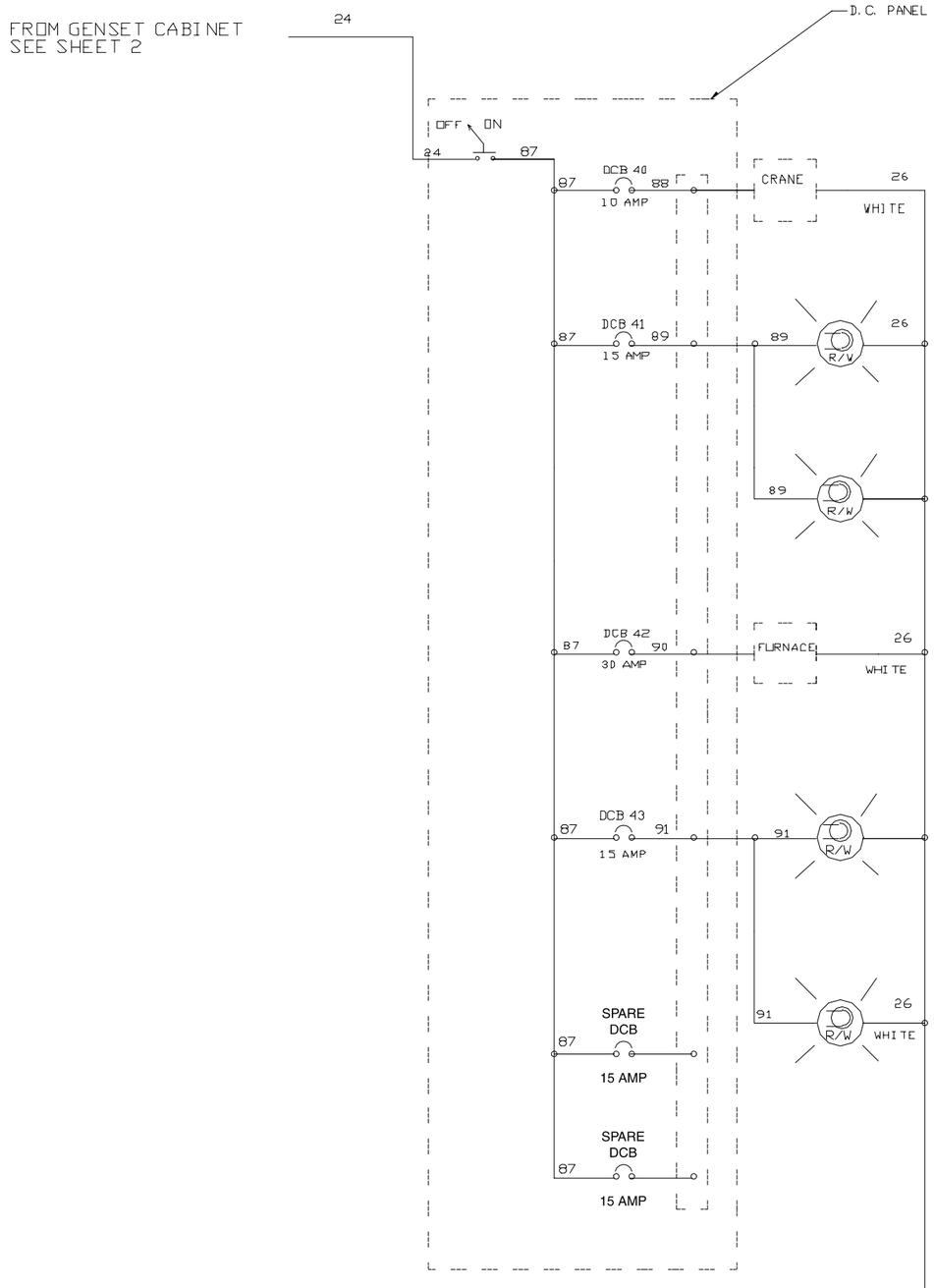
GENERATOR SET VOLTAGE REGULATOR WIRING SCHEMATIC

FIGURE FO-1. ELECTRICAL SYSTEM SCHEMATIC
FOLDOUT 6 OF 19
FP– 11 /FP– 12 BLANK



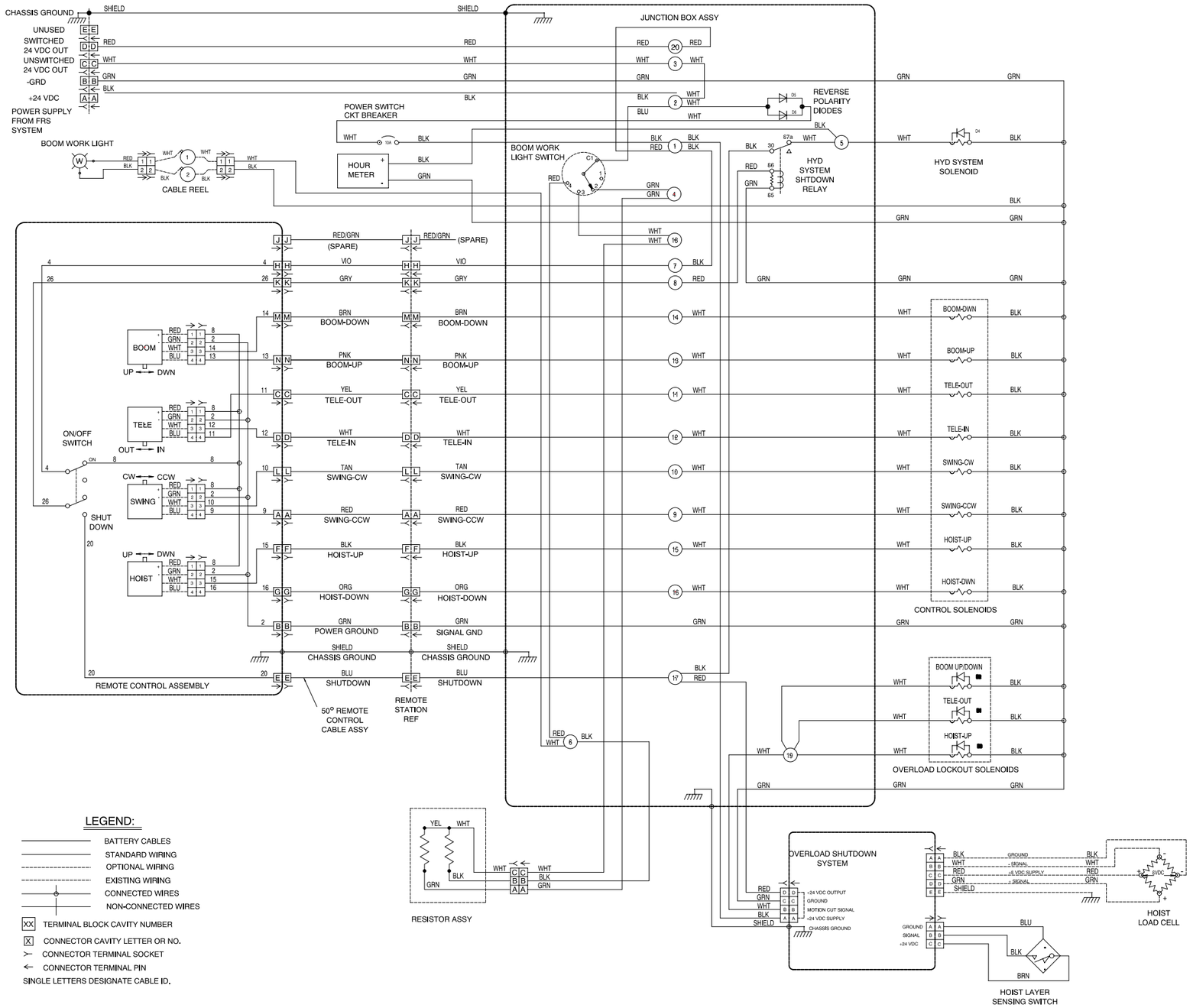
SHELTER (AC-DC) WIRING SCHEMATIC (1 OF 2)

FIGURE FO-1. ELECTRICAL SYSTEM SCHEMATIC
FOLDOUT 7 OF 19
FP– 13 /FP– 14 BLANK



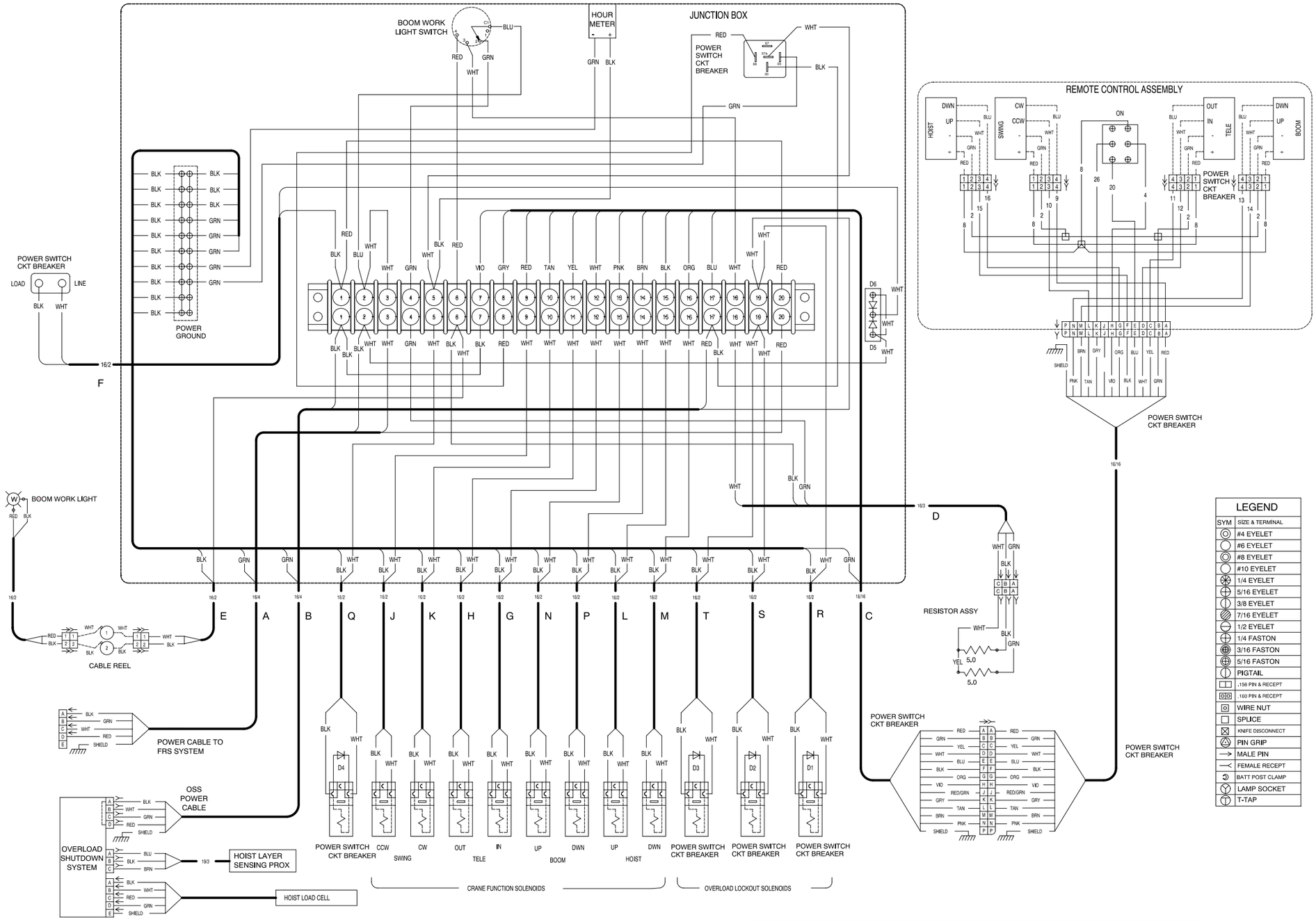
SHELTER (AC-DC) WIRING SCHEMATIC (2 OF 2)

FIGURE FO-1. ELECTRICAL SYSTEM SCHEMATIC
FOLDOUT 8 OF 19



CRANE ELECTRICAL WIRING SCHEMATIC (1 OF 3)

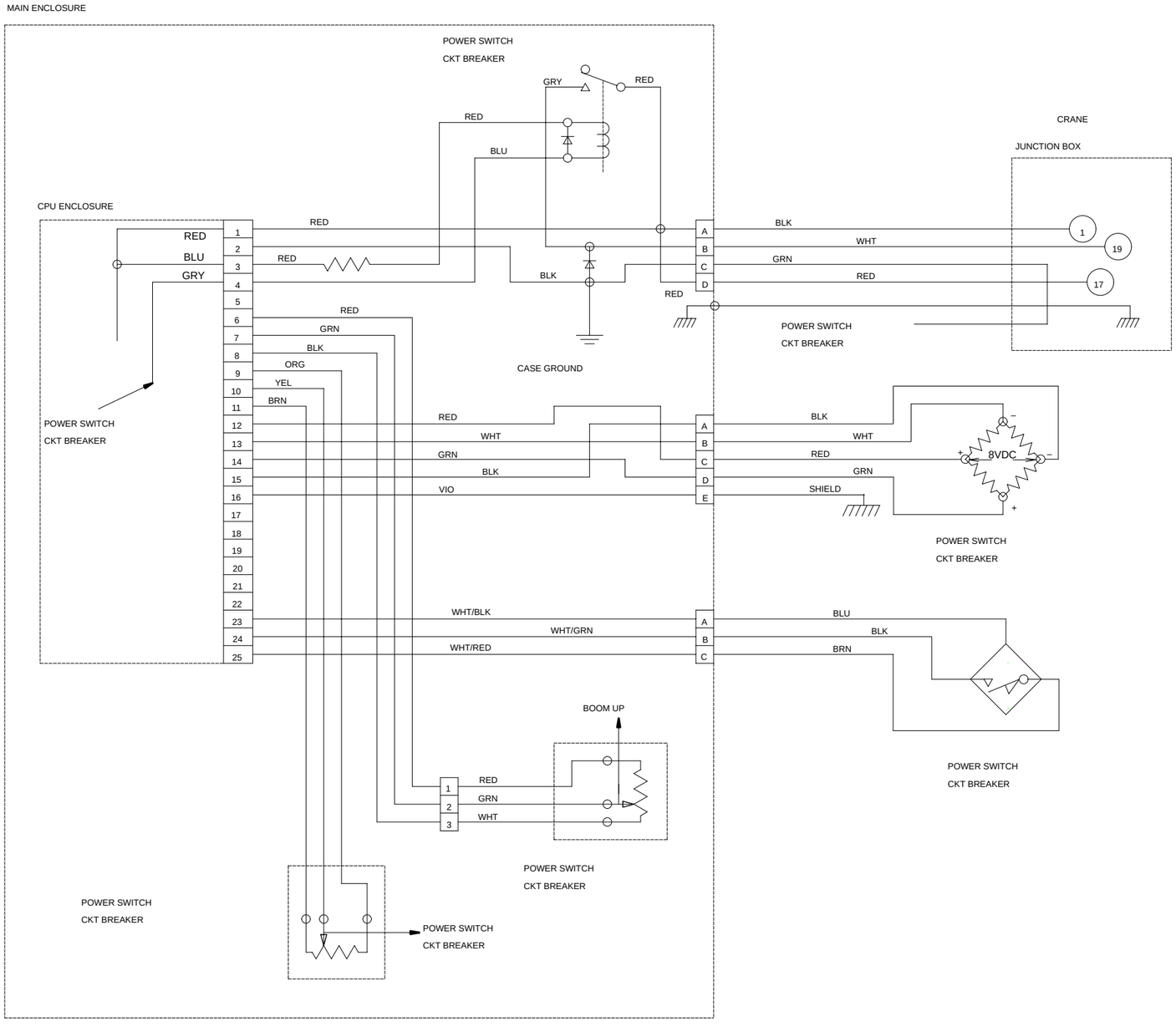
FIGURE FO-1. ELECTRICAL SYSTEM SCHEMATIC
FOLDOUT 9 OF 19
FP– 17 /FP– 18 BLANK



LEGEND	
SYM	SIZE & TERMINAL
	#4 EYELET
	#6 EYELET
	#8 EYELET
	#10 EYELET
	1/4 EYELET
	5/16 EYELET
	3/8 EYELET
	7/16 EYELET
	1/2 EYELET
	1/4 FASTON
	3/16 FASTON
	5/16 FASTON
	PIGTAIL
	.156 PIN & RECEPT
	.160 PIN & RECEPT
	WIRE NUT
	SPLICE
	KNIFE DISCONNECT
	PIN GRIP
	MALE PIN
	FEMALE RECEPT
	BATT POST CLAMP
	LAMP SOCKET
	T-TAP

CRANE ELECTRICAL WIRING SCHEMATIC (2 OF 3)

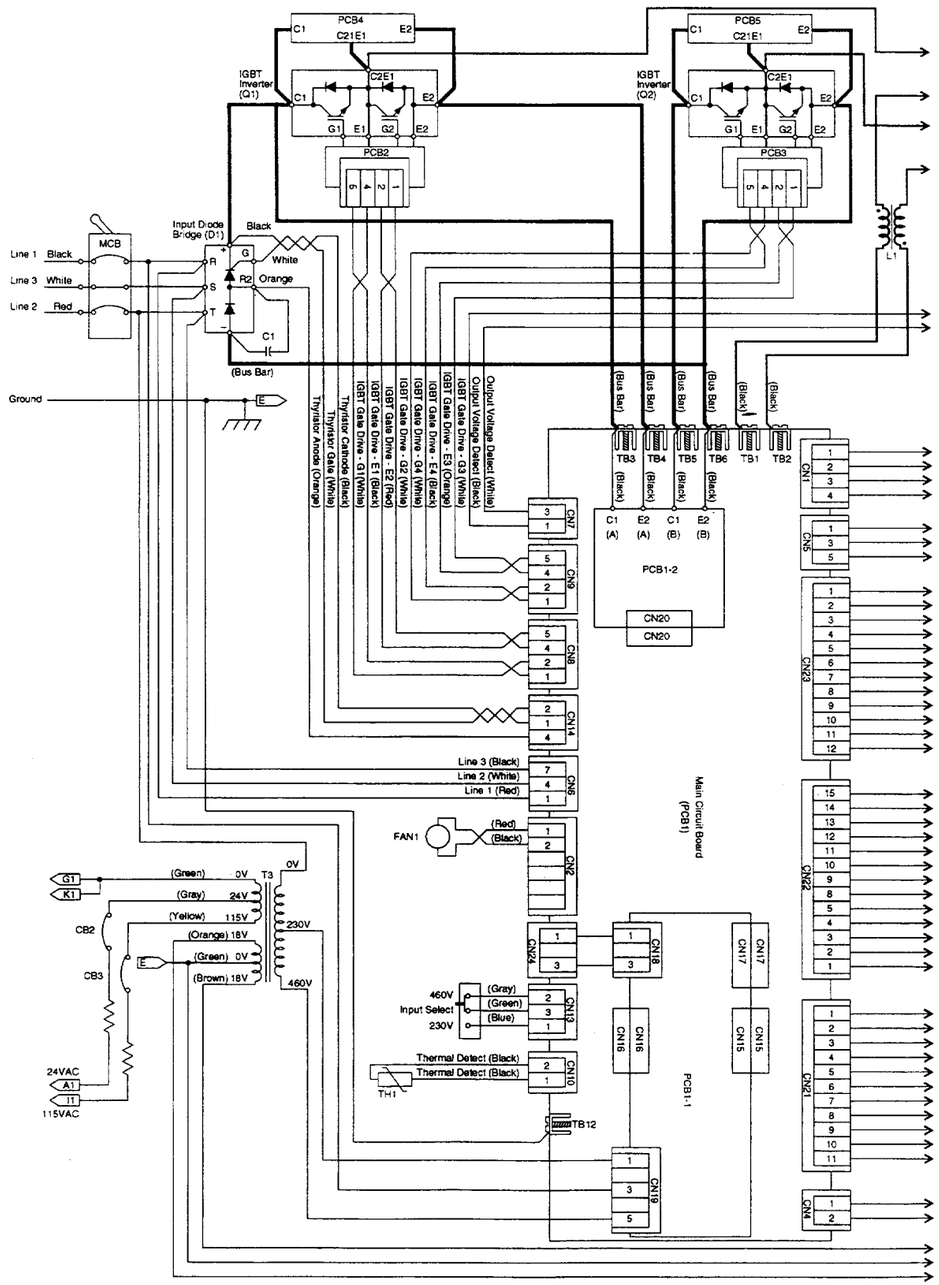
FIGURE FO-1. ELECTRICAL SYSTEM SCHEMATIC
FOLDOUT 10 OF 19
FP– 19 /FP– 20 BLANK



CPU CONNECTOR PIN DESIGNATIONS	
PIN	DESIGNATION
1	24 VDC POWER INPUT FROM CRANE AND VEHICLE
2	GROUND TO CRANE AND VEHICLE
3	24 VDC OUTPUT, UNSWITCHED, TO MOTION CUT RELAY COIL
4	GROUND FROM MOTION CUT RELAY COIL, SWITCHED IN CPU
5	
6	POWER TO BOOM ANGLE POTENTIOMETER (8.0 VDC)
7	BOOM ANGLE POTENTIOMETER OUTPUT SIGNAL
8	BOOM ANGLE POTENTIOMETER GROUND
9	POWER TO BOOM LENGTH POTENTIOMETER (8.0 VDC)
10	BOOM LENGTH POTENTIOMETER OUTPUT SIGNAL
11	BOOM LENGTH POTENTIOMETER GROUND
12	POWER TO HOIST LOAD CELL (8.0 VDC)
13	HOIST LOAD CELL OUTPUT SIGNAL, –VE
14	HOIST LOAD CELL OUTPUT SIGNAL, +VE
15	HOIST LOAD CELL GROUND
16	HOIST LOAD CELL SHIELD (GROUND)
17	
18	
19	
20	
21	
22	
23	HOIST LAYER SENSING SWITCH GROUND
24	HOIST LAYER SENSING SWITCH OUTPUT SIGNAL
25	POWER TO HOIST LAYER SENSING SWITCH (24 VDC)

CRANE ELECTRICAL WIRING SCHEMATIC (3 OF 3)

FIGURE FO-1. ELECTRICAL SYSTEM SCHEMATIC
FOLDOUT 11 OF 19
FP– 21 /FP– 22 BLANK



STICK WELDER WIRING SCHEMATIC

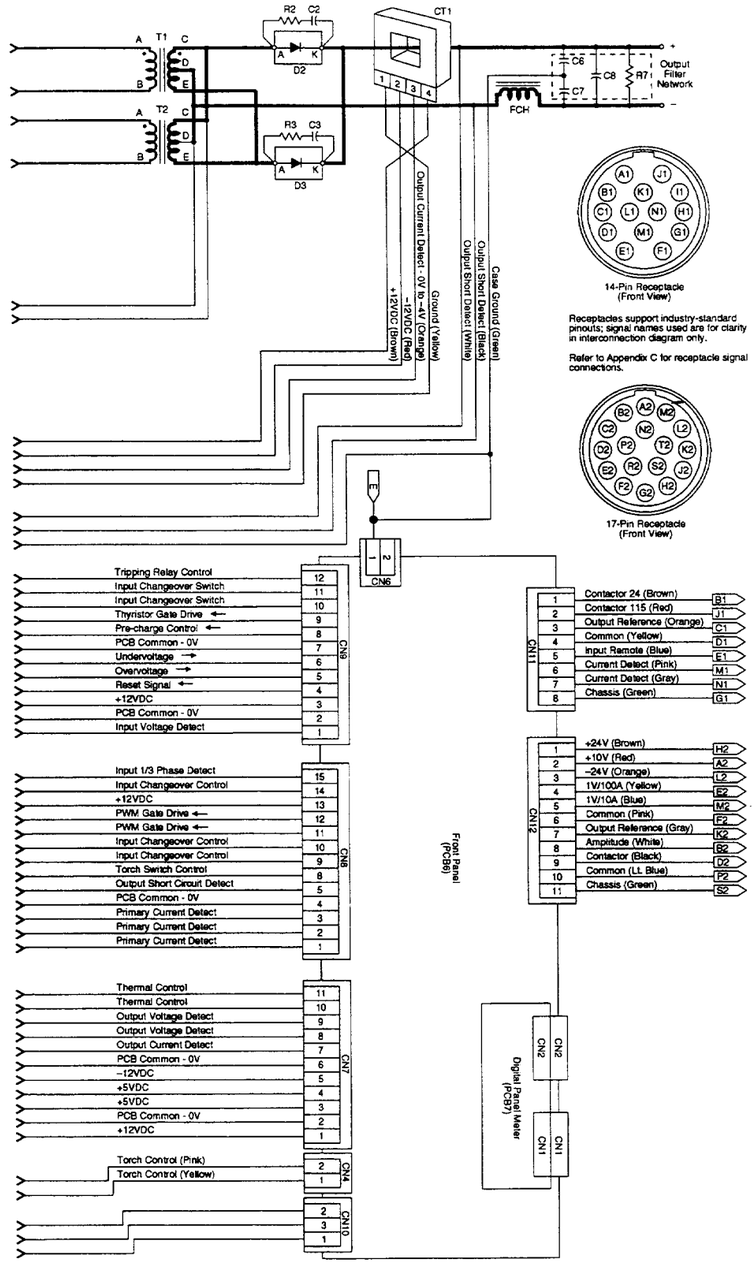
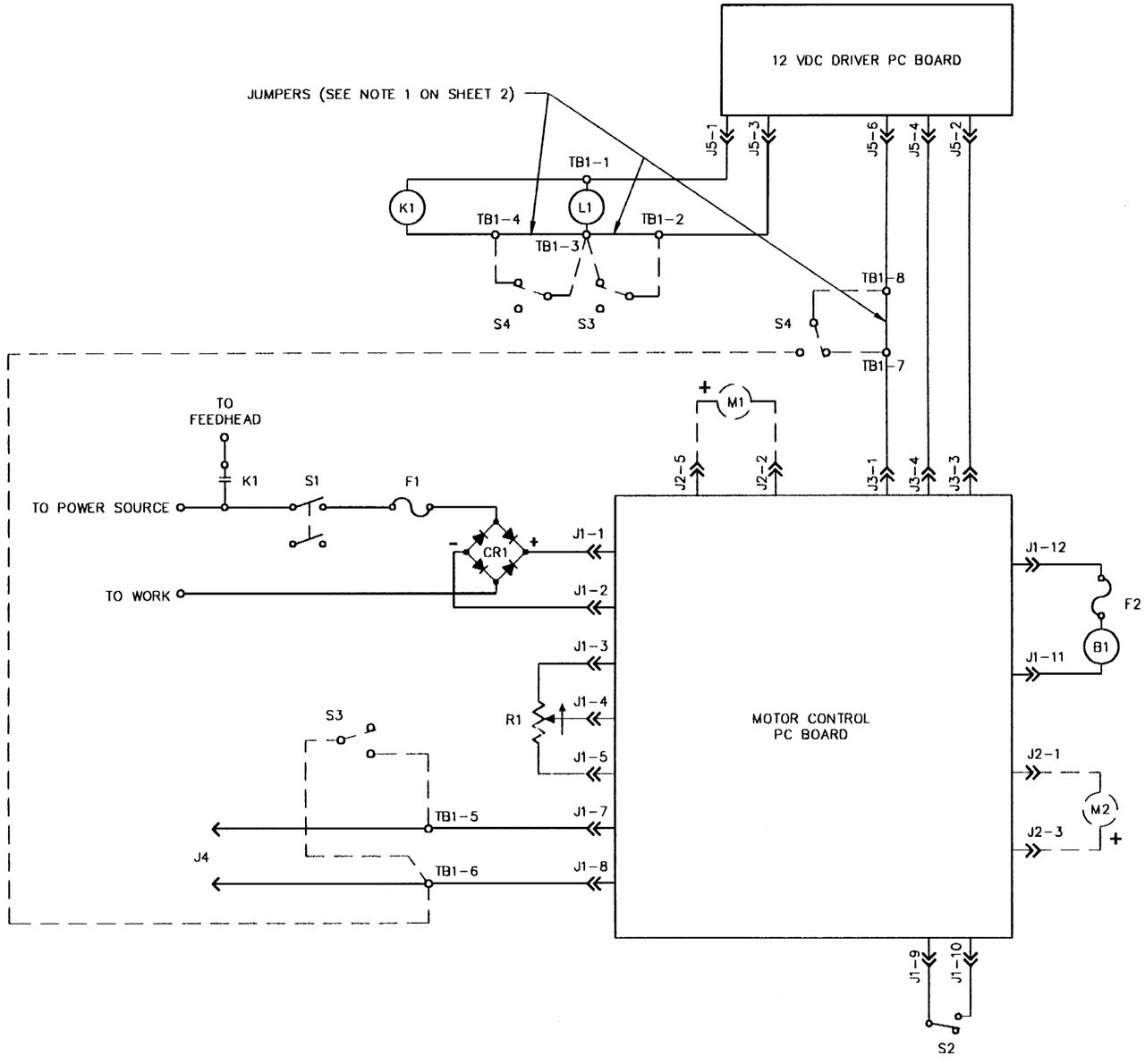


FIGURE FO-1. ELECTRICAL SYSTEM SCHEMATIC
FOLDOUT 12 OF 19
FP– 23 /FP– 24 BLANK

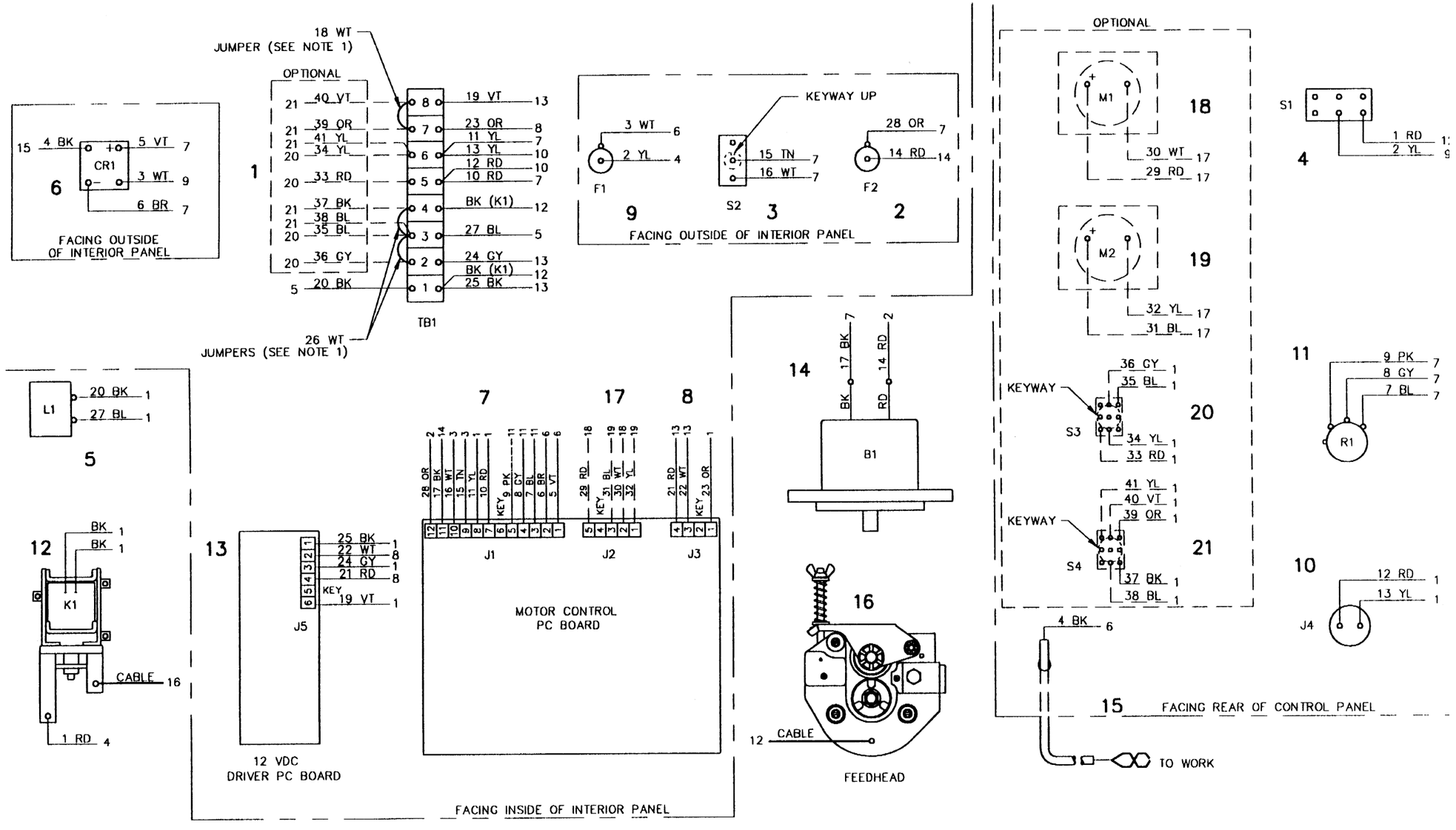


LEGEND

B1	MOTOR, WIRE FEED
CR1	RECTIFIER, BRIDGE
F1	FUSE, SLOW BLOW, 6A
F2	FUSE, SLOW BLOW, 5A
J1	RECEPTACLE, MOTOR CONTROL BOARD
J2	RECEPTACLE, METER OPTION
J3	RECEPTACLE, MOTOR CONTROL BOARD
J4	RECEPTACLE, GUN SWITCH
J5	RECEPTACLE, 12 VDC DRIVER BOARD
K1	CONTACTOR, 300 AMP
L1	GAS VALVE, 12 VDC
M1	VOLTMETER (OPTIONAL)
M2	WIRE FEED SPEED METER (OPTIONAL)
R1	POTENTIOMETER, 10 KOHMS, 2W
S1	SWITCH, ON/OFF
S2	SWITCH, CC/CV
S3	INCH SWITCH (OPTIONAL)
S4	PURGE SWITCH (OPTIONAL)
TB1	TERMINAL BLOCK

WIRE FEED MIG WELDER WIRING SCHEMATIC (1 OF 2)

FIGURE FO-1. ELECTRICAL SYSTEM SCHEMATIC
FOLDOUT 13 OF 19
FP– 25 /FP– 26 BLANK

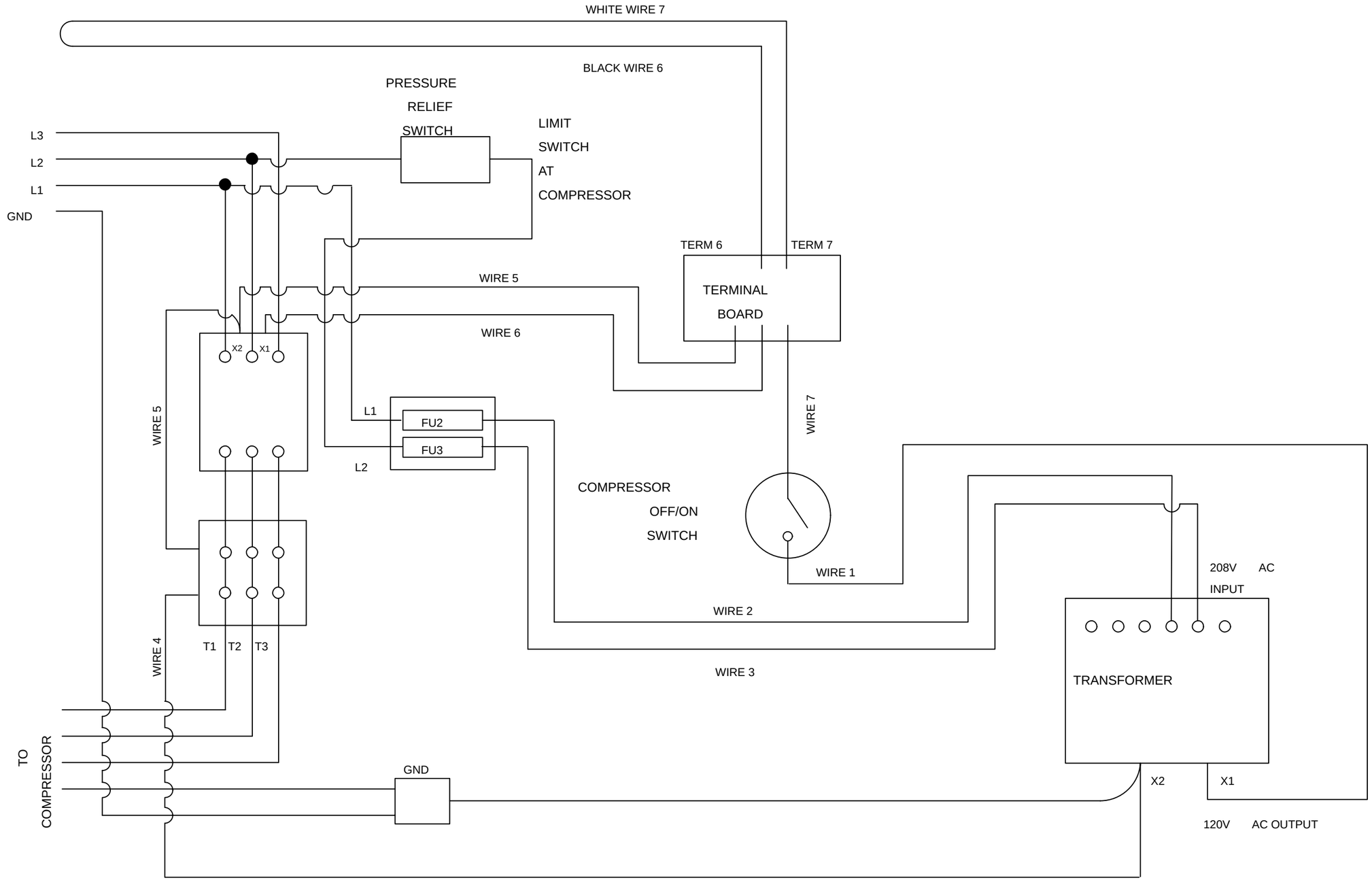


NOTES:

1) REMOVE (3) JUMPERS (WIRES 18 WT, 26 WT, & 26 WT) FROM TB1 IF INCH/PURGE SWITCHES (S3 AND S4) ARE INSTALLED.

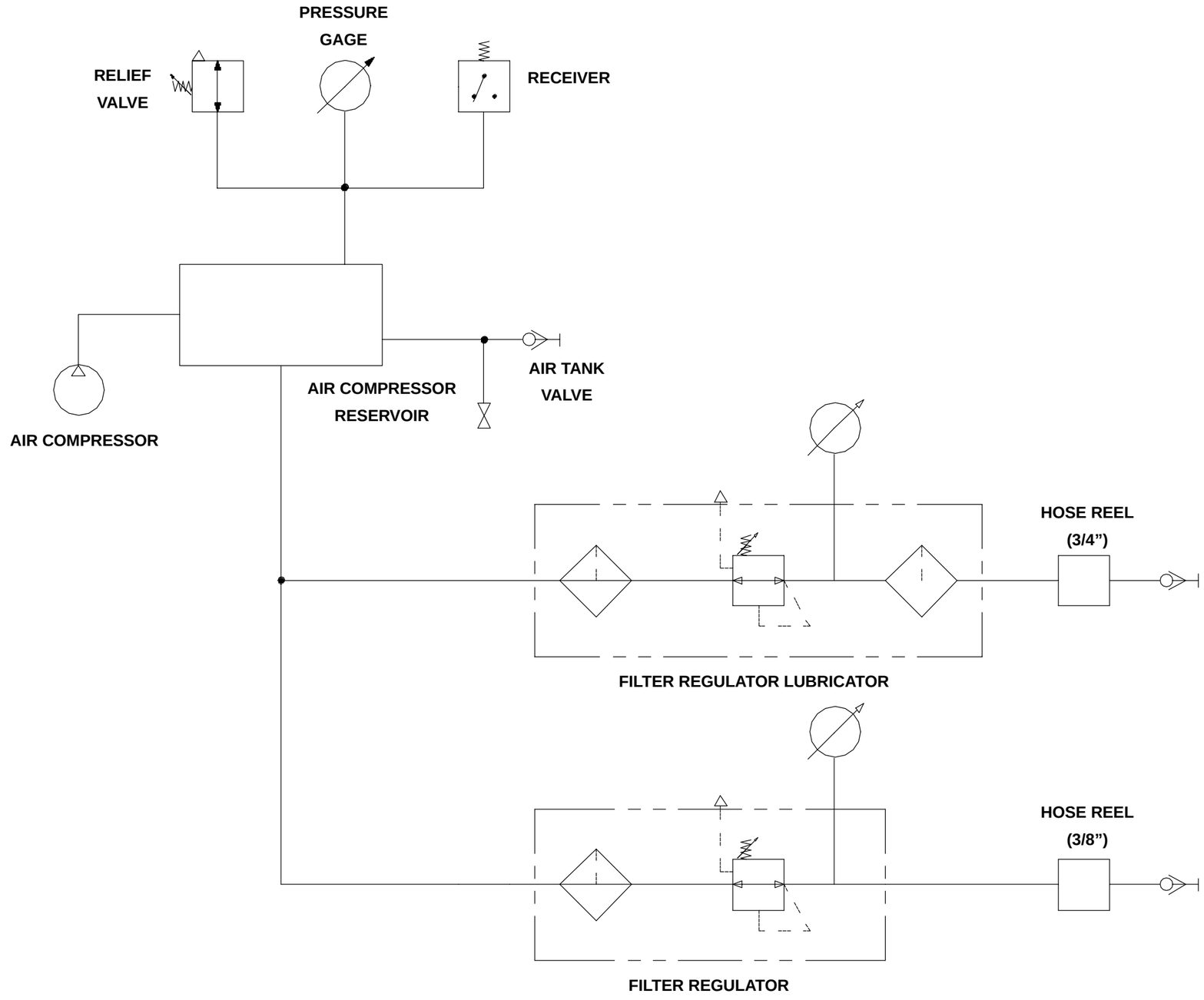
WIRE FEED MIG WELDER WIRING SCHEMATIC (2 OF 2)

FIGURE FO-1. ELECTRICAL SYSTEM SCHEMATIC
FOLDOUT 14 OF 19
FP– 27 /FP– 28 BLANK



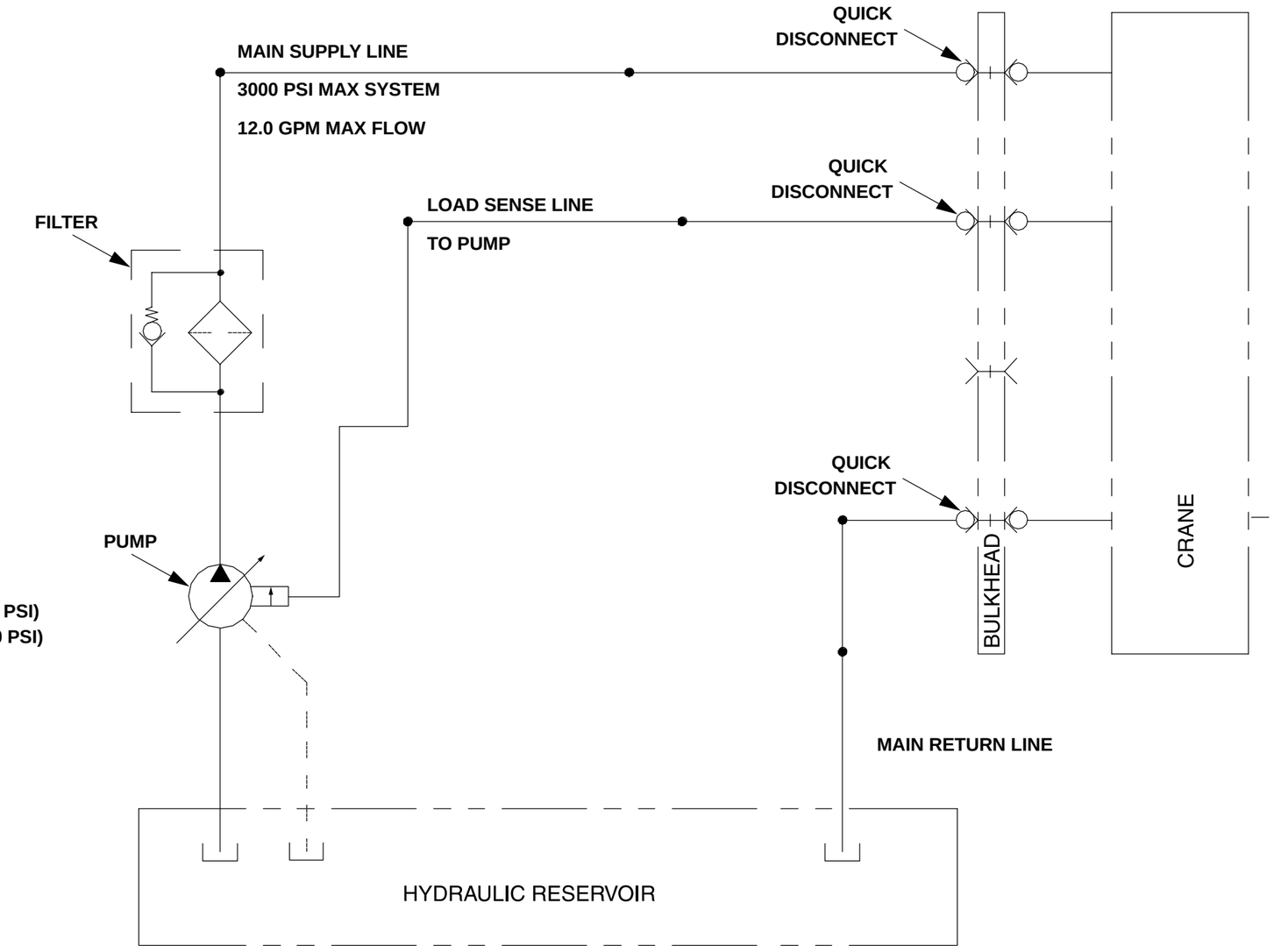
AIR COMMPRESSOR WIRING SCHEMATIC

FIGURE FO-1. ELECTRICAL SYSTEM SCHEMATIC
FOLDOUT 15 OF 19
FP– 29 /FP– 30 BLANK



AIR COMPRESSOR HOSE SCHEMATIC

FIGURE FO-2. AIR COMPRESSOR HOSE SCHEMATIC
FOLDOUT 16 OF 19
FP– 31 /FP– 32 BLANK

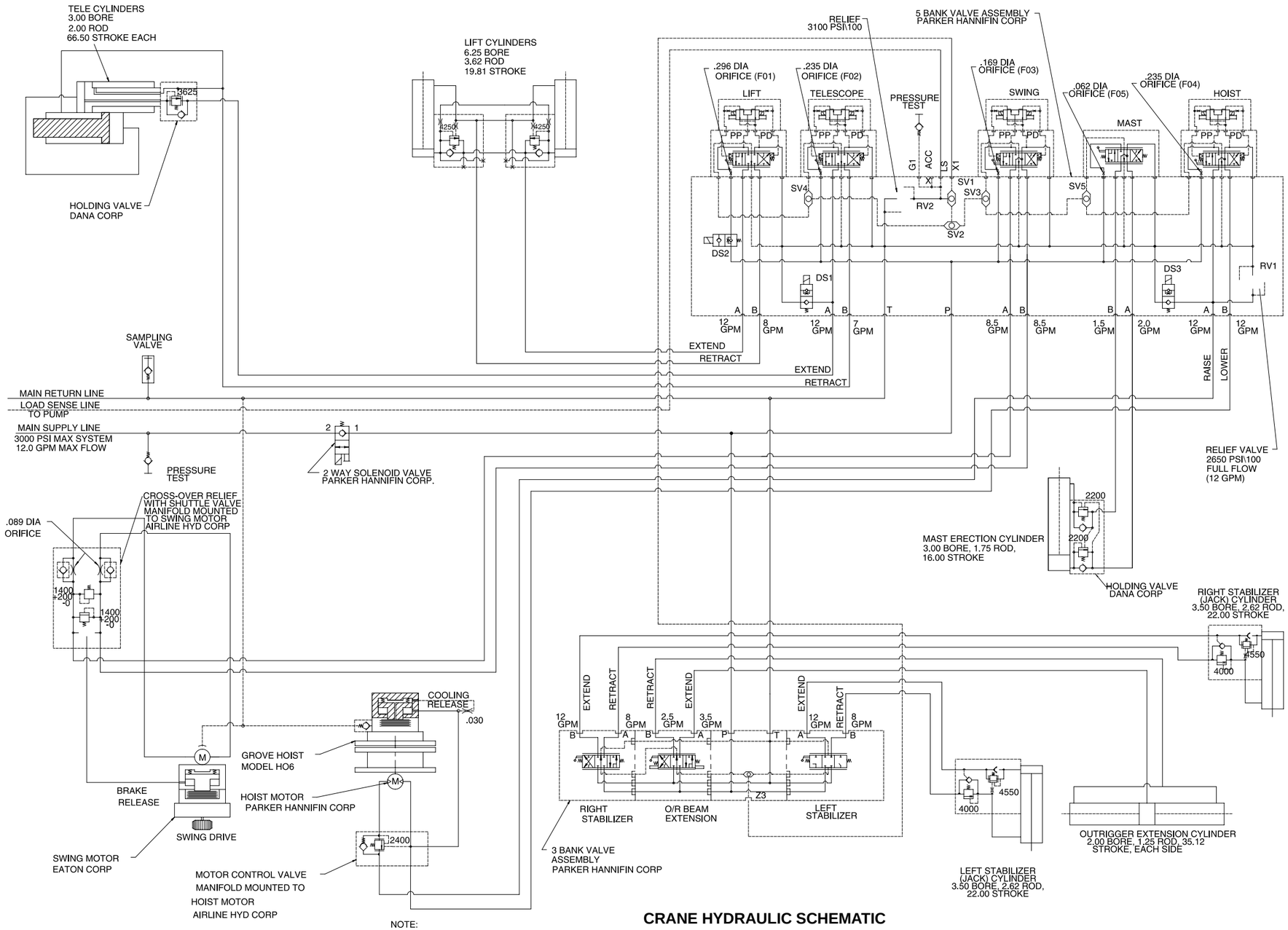


NOTE:
VERIFY HYDRAULIC PRESSURE SETTINGS UNDER THE FOLLOWING CONDITIONS:

1. **LOADSENSE PUMP STAND–BY PRESSURE: 325 PSI (\10 PSI)**
2. **LOADSENSE PUMP LIMITING PRESSURE: 3500 PSI (\100 PSI)**
3. **HYDRAULIC OIL TEMPERATURE: 140 (\10PSI)**

FRS HYDRAULIC SCHEMATIC

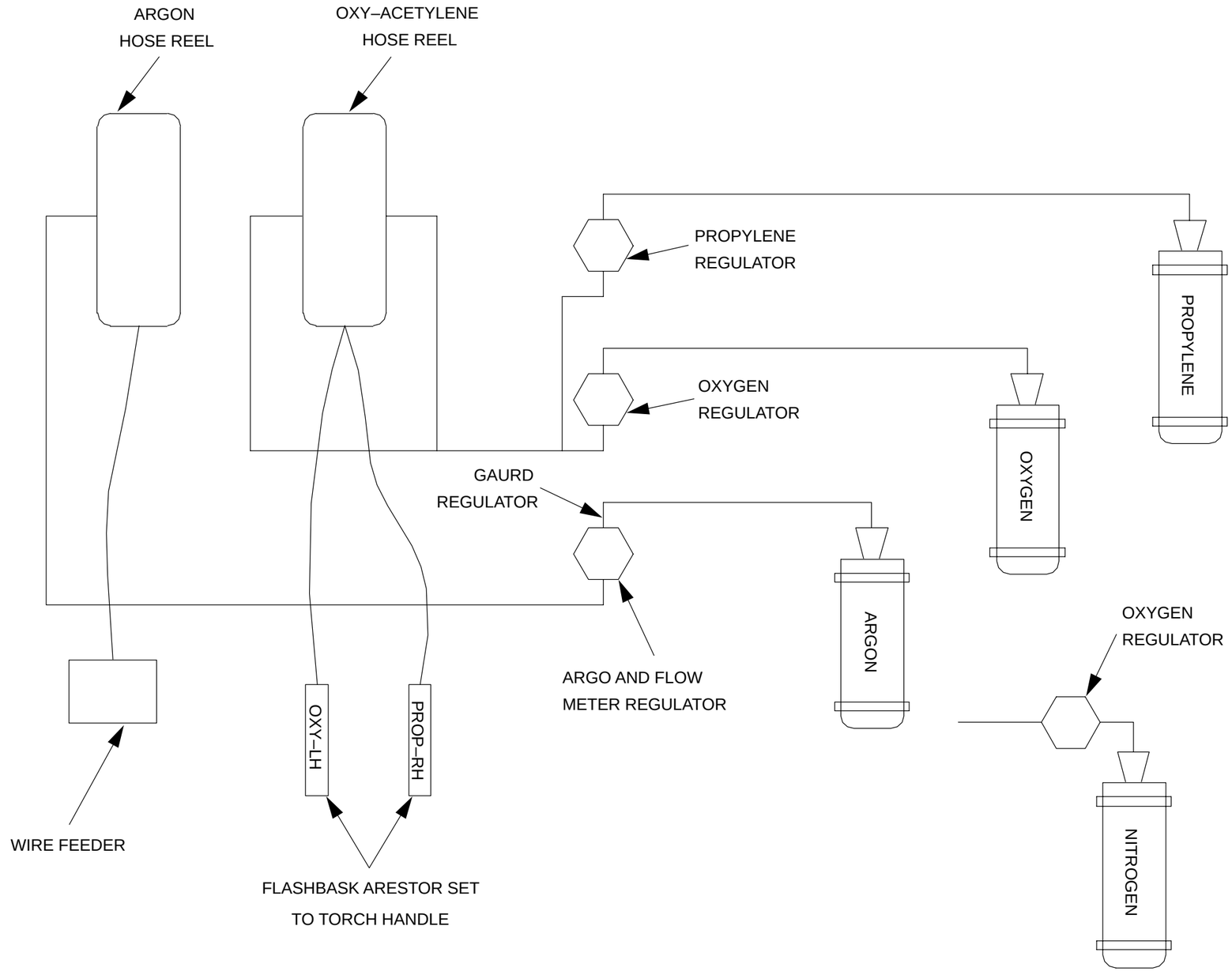
FIGURE FO-3. HYDRAULIC SYSTEM SCHEMATIC
FOLDOUT 17 OF 19



CRANE HYDRAULIC SCHEMATIC

NOTE:
VERIFY HYDRAULIC PRESSURE SETTINGS
UNDER THE FOLLOWING CONDITIONS:
1. LOADSENSE PUMP STAND-BY PRESSURE:325 PSI(\10PSI)
2. LOADSENSE PUMP LIMITING PRESSURE:3500 PSI(\100PSI)
3. HYDRAULIC OIL TEMPERATURE: 140˚F (\10˚F)

FIGURE FO-3. HYDRAULIC SYSTEM SCHEMATIC
FOLDOUT 18 OF 19



WELDING HOSE SCHEMATIC

FIGURE FO-4. WELDING HOSE SCHEMATIC
FOLDOUT 19 OF 19
FP– 37 /FP– 38 BLANK

By Order of the Secretary of the Army:

ERIC K. SHINSEKI
General, United States Army
Chief of Staff

Official:

JOEL B. HUDSON
Administrative Assistant to the
Secretary of the Army
0030712

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THE METRIC SYSTEM AND EQUIVALENTS

LINEAR MEASURE
1 Centimeter=10 Millimeters=0.01 Meters=0.3937 Inches
1 Meter=100 Centimeters=1000 Millimeters=39.37 Inches
1 Kilometer=1000 Meters=0.621 Miles

WEIGHTS
1 Gram=0.001 Kilograms=1000 Milligrams=0.035 Ounces
1 Kilogram=1000 Grams=2.2 Lb
1 Metric Ton=1000 Kilograms=1 Megagram=1.1 Short Tons

LIQUID MEASURE
1 Milliliter=0.001 Liters=0.0338 Fluid Ounces
1 Liter=1000 Milliliters=33.82 Fluid Ounces

SQUARE MEASURE
1 Sq Centimeter=100 Sq Millimeters=0.155 Sq Inches
1 Sq Meter=10,000 Sq Centimeters=10.76 Sq Feet
1 Sq Kilometer=1,000,000 Sq Meters=0.386 Sq Miles

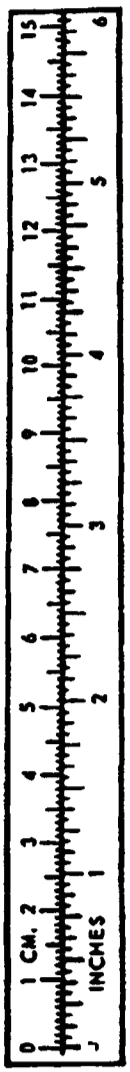
CUBIC MEASURE
1 Cu Centimeter=1000 Cu Millimeters=0.06 Cu Inches
1 Cu Meter=1,000,000 Cu Centimeters=35.31 Cu Feet

TEMPERATURE
5/9 (°F − 32) = °C
212° Fahrenheit is equivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
9/5 C° + 32 = F°

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
Pints	Liters	0.473
Quarts	Liters	0.946
Gallons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds/Sq Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Sq Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Sq Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
Liters	Gallons	0.264
Grams	Ounces	0.035
Kilograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pound-Feet	0.738
Kilopascals	Pounds per Sq Inch	0.145
Km per Liter	Miles per Gallon	2.354
Km per Hour	Miles per Hour	0.621



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