

TECHNICAL MANUAL

INTERMEDIATE DIRECT SUPPORT AND

INTERMEDIATE GENERAL SUPPORT

MAINTENANCE MANUAL

**LOCOMOTIVE, DIESEL-ELECTRIC,
56-1/2-INCH GAGE, 60 TON, 500 HP,
0-4-4-0 WHEEL, MODEL RS-4-TC-1A
NSN 2210-01-158-2978**

Approved for public release; distribution is unlimited.

HEADQUARTERS, DEPARTMENTS OF THE ARMY AND THE AIR FORCE

8 JANUARY 1987

WARNING

EXHAUST GASES CAN BE DEADLY

Exhaust gases can produce symptoms of headache, dizziness, loss of muscular control, or coma. Permanent brain damage or death can result from severe exposure. You can ensure your safety by following this rule:

DON'T operate the engine in an enclosed area unless it is properly ventilated.

If you notice exhaust odors or exposure symptoms, **IMMEDIATELY VENTILATE** the cab. If the symptoms persist, remove the affected personnel and treat them as follows:

1. Expose them to fresh air.
2. Keep them warm.
3. **DON'T PERMIT PHYSICAL EXERCISE.** If necessary give artificial respiration. Refer to FM 21-11, First Aid to Soldiers.

WARNING

A blue signal flag shall be placed on one or both ends of the locomotive while doing maintenance on, under, or around it. The locomotive shall not be moved or coupled while the blue signal flag is displayed. Only the maintenance personnel who placed the blue signal flag(s) have authority to remove it. Failure to observe these warnings may result in injury or death to personnel.

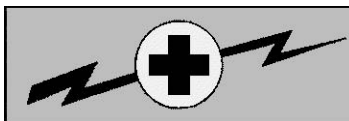
WARNING

High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.

WARNING

Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.

WARNING



WARNING

HIGH VOLTAGE

is used in the operation of this equipment.

DEATH ON CONTACT

may result if personnel fail to observe safety precautions.

Never work on electrical equipment unless there is at least one other person nearby who is familiar with the operation and hazards of that equipment. That person should also be competent in giving first aid. When an operator helps a technician, he must be warned about dangerous areas.

Whenever possible, shut off the power supply to equipment before beginning work. When working inside the equipment with power off, take special care to ground every capacitor. Electrical shock may occur if personnel fail to observe safety precautions.

Be careful not to contact high-voltage connections when installing or operating this equipment. Whenever possible, keep one hand away from the equipment to reduce the hazard of current flowing through vital organs of the body.

WARNING

When traction motor or under-locomotive equipment must be inspected while the engine is running, turn GF switch to OFF and set air brakes. Move reverser to center position and remove from the controller. This will prevent accidental movement of the locomotive.

WARNING

Should a fire develop on the locomotive and carbon dioxide is used to extinguish the flame, do not breathe the fumes. These fumes are toxic.

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. Shut off engine and do not smoke while refueling.

WARNING

Fuel and oil are slippery and can cause falls. To avoid injury, wipe up spilled fuel or oil with rags.

WARNING

Never remove the engine cooling system cap when the engine is hot. This is a high-pressure cooling system, and escaping steam or hot water can cause serious burns.

WARNING

Operation of this locomotive presents a noise hazard to personnel in the area. The noise level exceeds the allowable limits for unprotected personnel. Wear aural protectors or earplugs.

WARNING

Water/rain make catwalk and steps slippery and may cause injury or death. Be careful when using wet catwalks and steps.

WARNING

Dry-cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 1380F (38 59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.

WARNING

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

WARNING

When machining parts of locomotive, be careful of hot, sharp chips. Wear adequate eye protection. Use leather welding gloves. Cover exposed skin areas. Do not use hands to remove shavings, even with leather gloves; use a hook or welding rod.

WARNING

Be careful not to short out battery terminals. Do not smoke or use open flame near batteries. Batteries may explode from a spark. Battery acid is harmful to skin and eyes.

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

WARNING

Procedures specify the heating and cooling of parts to aid in disassembly and assembly. Heated and cooled parts may cause injury to personnel if hand protection is not worn when handling. Wear protective gloves for maximum protection.

WARNING

Pressurized steam is specified in cleaning operations, which may cause injury to personnel if safety precautions are not followed. Use rubberized gloves, boots, suit, hood, and face shield for protection against burns and scalding.

WARNING

Valve assemblies may be under a spring load. Use caution during disassembly and assembly procedures so that no parts fly out, causing bodily injury.

WARNING

Prior to performing engine maintenance, be sure that battery switch is in open position and tagged and that battery fuse is removed. This is to prevent engine from being started while personnel are working on engine components.

WARNING

Flash fire may result in injury to personnel if crankcase covers are removed within 15 minutes after emergency shutdown. Do not restart engine until cause for shutdown has been corrected.

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TECHNICAL MANUAL

HEADQUARTERS
DEPARTMENTS OF THE ARMY AND AIR FORCE
WASHINGTON, D.C., 8 January 1987

NO. 55-2210-223-34

INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT MAINTENANCE MANUAL

**LOCOMOTIVE, DIESEL-ELECTRIC
56-1/2-INCH GAGE, 60-TON, 500 HP,
0-4-4-0 WHEEL, MODEL RS74-TC-1A
NSN 2210-01-158-2978**

REPORTING OF ERRORS AND RECOMMENDING IMPROVEMENTS

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

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CHAPTER 1

INTRODUCTION

Section I. GENERAL INFORMATION

1-1. SCOPE

MODEL NUMBER AND NAME: RS-4-TC-1A, 60-ton diesel-electric locomotive.

PURPOSE OF EQUIPMENT: Used for general yard switching. Can be used as a single unit or connected in multiple unit operation under one operator.

TYPE OF MANUAL: Intermediate Direct Support and Intermediate General Support Maintenance.

- a. This manual is published for the use of personnel engaged in the operation, inspection, and maintenance of the 60-ton diesel-electric locomotive. It shall be used as a guide for regulations, standards, and procedures governing such work assignments.
- b. Maintenance portion of this manual provides guidance to intermediate direct support and intermediate general support level maintenance personnel. The purpose of each assembly, subassembly, and general overall locomotive maintenance procedure is given. Also included is a general troubleshooting guide to aid in removal, disassembly, cleaning, inspection, repair, assembly, and installation of components. General functions of the main features are given as an aid to provide a concise understanding of major and minor components.

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).

1-3. PREPARATION FOR STORAGE OR SHIPMENT

Refer to TM 55-2210-223-12, Operator and Unit Maintenance Manual for Locomotive, for information pertaining to the preparation for storage or shipment.

1-4. QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

- a. Refer to Federal Railroad Administration (FRA) Form 6180-49A to document 92-day Locomotive Inspection and Repair Record in accordance with Locomotive Inspection Act, 36 State, 913. The form must be completed and signed by the personnel conducting the inspection. The completed form shall be placed in the card holder in the locomotive cab. A copy shall be retained for a period of 2 years. Refer to TB 55-2200-207-15/1, Inspection and Maintenance Checklist for Diesel-Electric Locomotive, for unit maintenance's 92-day inspection of the locomotive. The checklist and DA Form 2407, Maintenance Request, will be used as prescribed in DA PAM 738-750.

- b. Refer to TB 55-2200-207-15/1 for intermediate direct support maintenance inspection of the locomotive. The checklist in TB 55-2200-207-15/1 and DA Form 2407 will be used as prescribed in DA PAM 738-750.

1-5. CALIBRATION

Measuring and test equipment used to determine equipment conformance shall be calibrated in accordance with MIL-STD-120, MIL-STD-45662, and MIL-I-45607.

1-6. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR)

If your locomotive needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you do not like about your equipment. Let us know why you do not like the design or performance. Tell us why a procedure is hard to perform. Put it on an SF 368 (Quality Deficiency Report). Mail it to: Commander, US Army Troop Support Command, ATTN: AMSTR-QX, 4300 Goodfellow Blvd., St. Louis, MO. 63120-1798. We'll send you a reply.

1-7. WARRANTY INFORMATION

The 3508 diesel engine is warranted by Caterpillar Tractor Company for 12 months or 1000 hours of operation, whichever comes first. Warranty starts on the date found on DA Form 2408, Equipment Log Assembly, or DA Form 2410, Component Removal and Repair/Overhaul Record, in the logbook. Report defects in material or workmanship to your supervisor, who will take appropriate action.

Section II. EQUIPMENT DESCRIPTION AND DATA

1-8. EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES

CHARACTERISTICS

An eight-wheel, four-traction-motor driven, 60-ton diesel-electric locomotive.

CAPABILITIES

Used as a yard switching locomotive and includes features listed below. Description of major components and system is listed in the applicable maintenance paragraphs. Can also be operated as a single unit or connected with other units of the same type for multiple-unit operation.

FEATURES

Include the following:

- Diesel engine
- Main generator
- Exciter-auxiliary generator
- Traction motors
- Traction motor blower
- Air compressor
- Airbrake system
- Sanding system

1-9. LOCATION AND DESCRIPTION OF MAJOR COMPONENTS

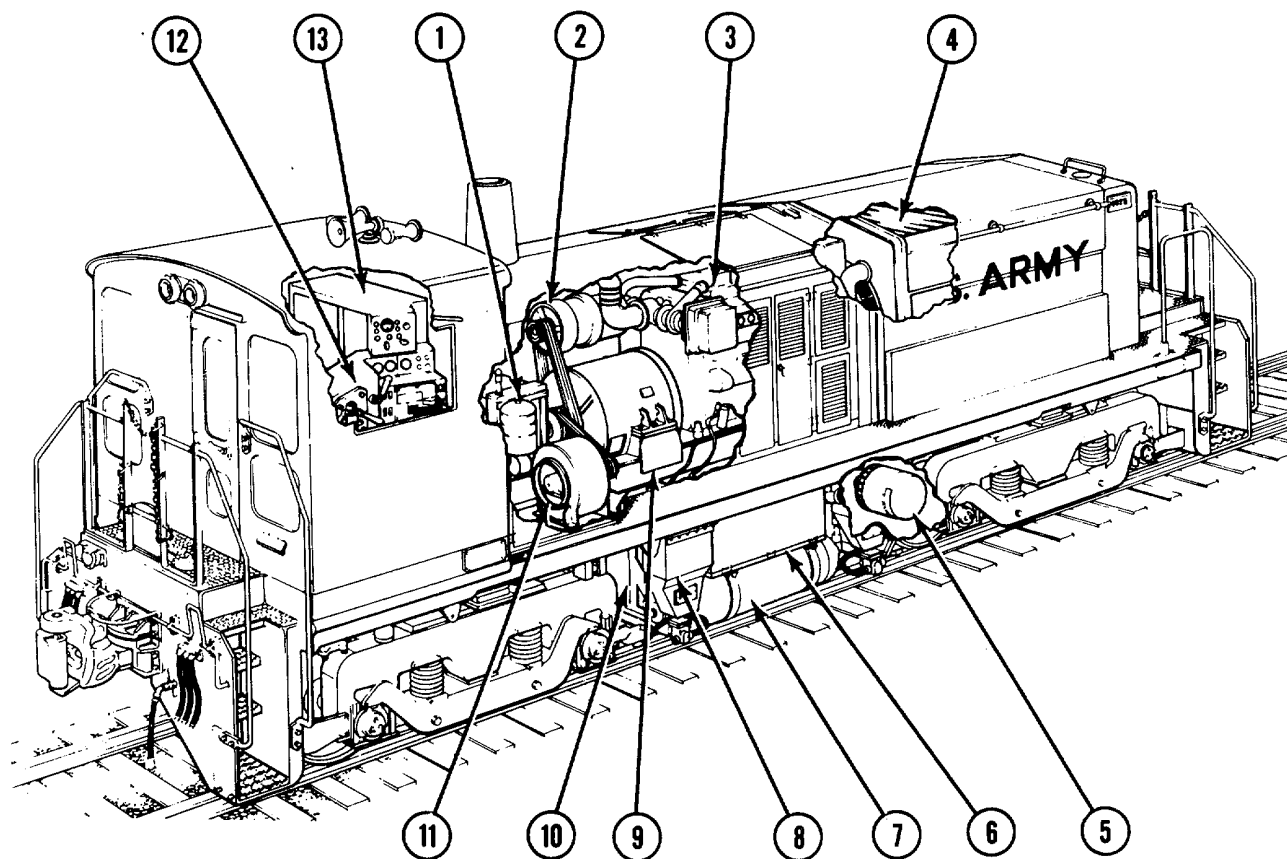


Figure 1-1. Major components - location.

- ① AIR COMPRESSOR. The air compressor is a compound, vertical, two-cylinder compressor and is directly connected to the main generator by a flexible coupling.
- ② EXCITER-AUXILIARY GENERATOR. The exciter-auxiliary generator consists of two separate armatures mounted on a common shaft, and two separate frames bolted together back-to-back. It is belt driven from the main generator shaft.
 - a. The auxiliary generator section is regulated for constant voltage over the normal speed and load range. It supplies power for charging the batteries and operating the electrical auxiliaries.
 - b. The exciter section furnishes excitation for the main generator, which is of the differential control type for automatic engine loading.
- ③ DIESEL ENGINE. The diesel engine is an eight-cylinder, turbocharged, water-cooled, four-cycle, V-type engine used to provide power. It is directly connected to the main generator.

- ④ ENGINE RADIATOR. The radiator keeps engine at proper operating temperature between 100 and 1980F (37.7 and 92.2°C).
- ⑤ TRACTION MOTORS. The traction motors are axle hung and supported on the truck transoms by spring-loaded suspension. One motor is geared to each axle through a single set of gears with a ratio of 14:72.
- ⑥ BATTERY BOX. Two externally mounted battery boxes, one on each side of the locomotive, provide ventilated compartments to house the eight batteries.
- ⑦ MAIN RESERVOIR AIR TANK. Two main reservoir tanks, one on each side of the locomotive, provide a means of storing air for the air system.
- ⑧ SANDBOX AND SAND CONTROLLER. There are eight sandboxes and sand controllers, one for each wheel. The sand controllers are mounted underneath the sandboxes and deliver a metered amount of sand to the driving wheels. The sand controller is controlled by the sander control valve.
- ⑨ MAIN GENERATOR. The main generator furnishes direct-current power over a wide range of voltage at various speeds up to 1200 rpm. It is separately excited by the exciter generator mounted on the generator frame. The generator also acts as a starting motor when the start button is pushed and the battery switch is closed.
- ⑩ FUEL TANK. The fuel tank can hold 500 gallons (1892 liters) of diesel fuel for engine operation. Two fill pipes and two sight glasses, one on each side of the locomotive, provide a means of filling the tank and monitoring the level of fuel.
- ⑪ TRACTION MOTOR BLOWER. The blower provides forced ventilation for the traction motors which require adequate cooling. It is belt driven from the main generator shaft.
- ⑫ MASTER CONTROLLER. The master controller contains the throttle, reverser, brake controls, and other controls and indicators used by operator to operate and monitor the locomotive and is located in the cab of the locomotive.
- ⑬ ELECTRICAL EQUIPMENT CABINET. The equipment cabinet contains the automatic switching relays and contactors and is located in the cab of the locomotive. Both high and low voltage are present in the electrical equipment cabinet when the locomotive is in operation.

1-10. DIFFERENCES BETWEEN MODELS

This manual covers 60-ton, diesel-electric locomotives. Minor differences may exist in components and component location and in the electrical conduit and air piping layouts. There are no known differences between locomotives.

1-11. PRINCIPLES OF OPERATION

Refer to TM 55-2210-223-12 for principles of operation.

CHAPTER 2

LOCOMOTIVE MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS, SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

2-1. COMMON TOOLS AND EQUIPMENT

For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

2-2. SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

Special tools, TMDE, and support equipment are listed and illustrated in TM 55-2210223-24P, Unit, Intermediate Direct Support, and Intermediate General Support Maintenance Repair Parts and Special Tool List, for the locomotive and in TM 5-2815232-24P, Unit, Intermediate Direct Support, and Intermediate General Support Maintenance Repair Parts and Special Tool List, Engine, for the engine.

2-3. REPAIR PARTS

Repair parts are listed and illustrated in the repair parts and special tools list, TM 55-2210-223-24P, for the locomotive and in TM 5-2815-232-24P for the engine.

2-4. SERVICE UPON RECEIPT

Refer to TM 55-2210-223-12 for service upon receipt instructions.

Section II. QUARTERLY AND ANNUAL CHECKS AND SERVICES

- a. Quarterly and Annual Inspection Worksheet for Diesel-Electric Locomotives. The quarterly and annual inspections will be performed by qualified maintenance personnel of using organizations. The inspections are divided into five sections from A to E denoting the specific items to be checked.
 - (1) Section A, mechanical, requires inspection of wheels and truck details, couplers and draft gear, and the condition of the horn, bell, window wiper, sander, heater, handbrakes, fan, fan drive, etc.
 - (2) Section B, engine, requires a complete inspection of engine lubricating oil, fuel oil intake, and cooling systems in conjunction with all bearings, piston assemblies, and governor and throttle linkage.
 - (3) Section C, airbrakes, requires a complete inspection of the compressor and its operation, air gages, brake details, and air reservoirs.

- (4) Section D, electrical, requires a complete inspection of the lighting system, battery, rotating electrical equipment, and control circuits.
- (5) Section E requires the inspection of fire extinguishers and lubrication system and a test run of the locomotive.

b. Form FRA F6180-49A, Locomotive Inspection and Repair Record.

- (1) Purpose. This form shows the condition of locomotives and also shows whether the equipment complies with Federal Railroad Administration (FRA) and Department of Transportation (DOT) regulations.
- (2) Use. This form has two uses. It is used to show whether the equipment complies with regulations, and it is also used as a record of maintenance and repairs required by FRA and DOT.
- (3) General Instructions.
 - (a) A Quarterly Report will be made by qualified personnel.
 - (b) The Annual Report will be made in three copies by qualified intermediate direct support and intermediate general support or depot-level personnel. The Annual Report is also completed after each depot overhaul.
 - (c) The qualified person making the inspection also signs the form.
 - (d) The form is countersigned by the officer in charge. If a non-Army organization does the work, the supervisor will countersign.
 - (e) Form FRA F6180-49A may be obtained from the local Mobile Rail Repair Shop (MRRS).

(4) Disposition.

- (a) The original copy of the report remains in the cab of the Locomotive. Protect the form with a clear cover.
- (b) Keep one copy at the user level.
- (c) Send the third copy to: Commander, USATROSCOM, ATTN: AMSTR-MCFR, 4300 Goodfellow Blvd, St. Louis, MO 63120-1798.
- (d) Retain copies only until a new report is made. Then destroy the old form.

NOTE

Maintenance procedures for the following tables will be found in the applicable maintenance chapters.

Table 2-1. Quarterly and Annual Inspection Worksheet

Item	Quarterly	Annual
<u>A - MECHANICAL</u>		
1. Inspect for wheel and truck details:		
a. Bearings and wheels	X	X
b. Thrust plate and bolts	X	X
c. Wheel flanges	X	X
2. Inspect couplers and draft gears:		
a. Coupler mechanism	X	X
b. Gage knuckle		X
c. Draft gear, carrier, etc.		X
3. Inspect foot boards, hand rails, steps, and safety appliances.	X	X
4. Inspect cab, hood, doors, windows, platform, etc.	X	X
5. Check operation or condition of:		
a. Horn	X	X
b. Bell	X	X
c. Window wiper	X	X
d. Sander equipment	X	X
e. Cab heater	X	X
f. Shutters and shutter mechanism	X	X
g. Fan and fan drive	X	X
h. Handbrake	X	X
i. Hose and hose clamps	X	X
j. Belts and pulleys	X	X
k. Traction motor blowers and ducts	X	X
6. Drain water and sludge from fuel tanks.	X	X
<u>B - ENGINE</u>		
7. Inspect the following for leaks:		
a. Fuel system	X	X
b. Lube system	X	X
c. Cooling system	X	X
d. Cylinder heads, crankcase inspection plates, and covers	X	X
e. Exhaust and intake systems	X	X
8. Check cooling water level.		
a. Test antifreeze	X	X
b. Comparator test water treatment	X	X

Table 2-1. Quarterly and Annual Inspection Worksheet (continued)

Item	Quarterly		Annual
9. Clean and check: a. Fuel strainers and filters b. Lube oil strainers and filters c. Air intake filters d. Crankcase breathers e. Turbo-filters f. Air boxes	 X X X X X		 X X X X X X
10. Check pressures: a. Lube oil b. Fuel oil	 X X		 X X
11. Check the following: a. Engine speeds (Idle: 900 Full: 1800) b. Turbocharger c. Fuel injection, pump timing, and rack setting d. Intake and exhaust valves and mechanism (1) Tappet or lash adjuster clearance (2) Lubrication, leaks, sticking valves, and broken springs e. Governor and throttle linkage	 X X X X		 X X X
12. Check main and connecting rod bearings (when accessible).			X
13. Check tightness of engine base bolts.			X
14. Visually inspect piston rings and cylinders (when accessible).			X
<u>C - AIRBRAKES</u>			
15. Inspect compressor: a. Check coupling. b. Clean air intake filters.	 X X		 X X
16. Check compressor operation. a. Unloading valves: (1) Cuts in: 130 lb (2) Cuts out: 140 lb b. Orifice test	 X X X X		 X X X
17. Check air pressure settings and operation of air gages.	X		X
18. Check air system for leaks.	X		X
19. Drain moisture from reservoirs and intercoolers.	X		X

Table 2-1. Quarterly and Annual Inspection Worksheet (continued)

Item	Quarterly	Annual
20. Check brake details:		
a. Rods, levers, and pins	X	X
b. Air hoses and couplings	X	X
c. Handbrake and chain	X	X
d. Brakeshoes and keys	X	X
e. Brake cylinders and piston travel	X	X
f. Centrifugal filters, strainer, etc. (clean items)		X
<u>D - ELECTRICAL</u>		
21. Check lights and lighting system.	X	X
22. Check battery.		
a. Check level of electrolyte.	X	X
b. Check specific gravity.	X	X
c. Wash off battery.	X	X
d. Clean and lubricate terminals.	X	X
23. Inspect rotating electrical equipment.		
a. Visually check condition; clean and blow out:		
(1) Commutators and armatures	X	X
(2) String bands	X	X
(3) Brushes and pigtails	X	X
(4) Brush holders	X	X
(5) Insulators, field coils, and insulation	X	X
b. Inspect and check:		
(1) For proper drive gear lubrication	X	X
(2) Inspection covers (tight and clean)	X	X
(3) Motor nose suspension	X	
(4) For proper traction motor support bearing lubrication	X	X
24. Inspect control circuits.		
a. Check condition and operation and clean contact surfaces:	X	X
(1) Throttle contacts	X	X
(2) Electrical contactors	X	X
(3) Reverser	X	X
(4) Relays	X	X
(5) Resistors	X	
b. Check connections for tightness.	X	
c. Check fuses and knife switch.	X	X
<u>E - GENERAL</u>		
25. Check fire extinguishers.	X	X
26. Clean engine and compartment.	X	X
27. Lubricate locomotive in accordance with LO 55-2210-223-12.	X	X
28. Test run locomotive.	X	X
29. Replace cab card.	X	X

Section IV. GENERAL MAINTENANCE INSTRUCTIONS

2-6. GENERAL

- a. This section provides instructions for performing the stationary vehicle airbrake test, welding, and painting.
- b. Publications which provide additional information on general shop practice techniques, preservation, sheet metal work, etc., are listed in appendix A of this manual.

2-7. PAINTING

Painting on the locomotive shall be done in accordance with TM 43-0139, Painting Instructions for Field Use.

2-8. WELDING

Welding on the locomotive shall be done in accordance with TM 9-237, Welding Theory and Application.

2-9. STATIONARY VEHICLE AIRBRAKE TEST

WARNING

Before beginning stationary vehicle airbrake test, ensure handbrake has been set, wheels are blocked, reverser is in NEUTRAL position, and GF switch is in OFF position. Failure to do so may result in injury to personnel.

NOTE

Brake preventive maintenance checks and services (PMCS) will be performed in accordance with TM 55-2210-223-12.

Before beginning stationary locomotive airbrake test, brake system must be fully charged.

- a. Set handbrake and block wheels.
- b. Set automatic and independent brake valve handles in RELEASE position.
- c. Observe gages. Gages shall indicate the following:
 - (1) Main reservoir pressure 120 to 130 psi.
 - 2) Equalizing reservoir and brake pipe pressure 80 to 90 psi.
 - (3) Brake cylinder pressure - 0 psi.

d. Use the automatic brake valve and make a 10-psi (70 kPa) brake pipe reduction. e. After brake pipe exhaust ceases to blow, move cutoff pilot valve to OUT position and perform the following:

- (1) Make a visual inspection of each brake cylinder and ensure brakes are applied.
- (2) Observe brake pipe and brake cylinder gage for 1 minute. Brake pipe pressure leakage must not exceed 5 psi (35 kPa) in one minute. Brake cylinder pressure should indicate between 10 and 25 psi (70 and 175 kPa).
- (3) Observe equalizing reservoir gage for 1 minute. No drop in equalizing reservoir pressure is allowed.
- (4) Press independent brake valve handle down for 7 seconds. Ensure brakes release.
- (5) Move automatic brake valve cutoff valves to IN position and make a 15-psi (85 kPa) brake pipe reduction. Ensure brakes apply and brake cylinder pressure indicates between 10 to 25 psi.
- (6) Move automatic brake valve handle halfway toward RELEASE position. Observe equalizing pointer in main reservoir/equalizing gage. Ensure there is no rise in pressure. Any rise in pressure shall require repair of automatic brake valve, distributing valve, and/or associated piping up to the angle cock.
- (7) Move isolation switch to RUN position.
- (8) Move power throttle to No. 3 position and move automatic brake valve to EMERGENCY position. Observe the following:
 - (a) Brake pipe pressure reduces rapidly to zero.
 - (b) Equalizer reservoir pressure falls to zero in 3 to 5 seconds.
 - (c) Brake cylinder pressure builds up at a rapid rate to no more than 68-72 psi .
 - (d) PC switch contacts have disengaged and PC light is on.
 - (e) Engine rpm reduces to IDLE.
 - (f) Sanders are actuated.
 - (9) Press independent brake valve handle down. Ensure brakes release.
 - (10) Release independent brake valve handle. Ensure brakes apply.

- (11) Move automatic brake valve handle to EMERGENCY position and wait 2 minutes. Move throttle to IDLE position and move automatic brake valve handle to RELEASE position to charge the brake system. Ensure pressure is restored to normal. Set isolation switch to IDLE. Ensure PCS switch has reset, and PCS light is extinguished.
- (12) Open and close fireman's emergency brake valve. Ensure proper operation.
- (13) Move independent brake valve handle to FULL APPLICATION position. Ensure brakes apply. Brake cylinder pressure shall be 45 psi.
- (14) Move independent brake valve handle to RELEASE position. Ensure brakes release.
- (15) With independent brake valve in RELEASE position, make a 15-psi (85 kPa) brake pipe reduction with automatic brake valve. Ensure brakes apply. Brake cylinder pressure shall be 10 to 25 psi.
- (16) Move automatic brake valve handle to RELEASE position. Visually ensure brakes release. Brake cylinder pressure shall be 0 psi.

Section IV. PREPARATION FOR STORAGE AND RETURN TO SERVICE

2-10. LONG-TERM STORAGE

Refer to TM 55-2210-223-12 for preparation for storage and return to service instructions.

CHAPTER 3

INTERMEDIATE DIRECT SUPPORT MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS, SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

3-1. COMMON TOOLS AND EQUIPMENT

For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

3-2. SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

Special tools, TMDE, and support equipment are listed and illustrated in TM 55-2210223-24P for the locomotive and TM 5-2815-232-24P for the engine.

3-3. REPAIR PARTS

Repair parts are listed and illustrated in the Repair Parts and Special Tools List TM 55-2210-223-24P for the locomotive and TM 5-2815-232-24P for the engine.

Section II. INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT TROUBLESHOOTING

3-4. GENERAL

a. The table lists the common malfunctions which you may find during the operation or maintenance of the locomotive or its components. You should perform the tests/inspections and corrective actions in the order listed. These procedures supplement the following troubleshooting procedures for the 60-ton locomotive.

- (1) Operator/crew level - TM 55-2210-223-12.
- (2) Organizational level - TM 55-2210-223-12.
- (3) Engine Intermediate Direct Support and Intermediate General Support level - TM 5-2815-232-14.

3-4. GENERAL (cont)

b. This manual cannot 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 your supervisor.

WARNING

Operation of a deadlined locomotive without inspection and repair will cause further damage to a disabled component and possible injury to personnel.

- c. Check the easiest and most obvious things first. This simple rule saves
- d. Doublecheck before disassembly. The source of most problems can be traced to more than one part in a system.
- e. Check tags, service request forms, and vehicle log book for repair history. This may help lead to source of problems.
- f. Before correcting a problem, diagnose the cause of the problem. Do not allow the same failure to occur again.

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MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

AIRBRAKE SYSTEM

1. AIR PRESSURE DOES NOT BUILD UP.

Step 1. Check to see if main reservoir cutout cock is open.

Close cutout cock.

Step 2. Check to see if the main reservoir drain valve is open.

Close main reservoir drain valve.

Step 3. Check to see if train line angle cock is open.

Close train line angle cock.

Step 4. Check to see if the unloader valve is stuck open.

Disassemble and clean unloader valve (para 4-8).

Step 5. Check to see if main reservoir safety valve is stuck open.

Replace or rebuild safety valve (para 4-8).

Step 6. Check to see-if the air compressor governor is stuck open.

Disassemble and clean governor (para 4-34).

Step 7. Check to see if high or low air pressure discharge and suction valves are stuck open.

Replace or rebuild valve (para 4-8).

2. AIR PRESSURE BUILDS UP SLOWLY.

Step 1. Check to see if fittings are loose.

Locate and tighten loose fittings.

Step 2. Check to see if any cocks are partially open.

Close all cocks fully.

Step 3. Check to see if the air compressor unloader valve or compressor-head valve is leaking slightly.

Disassemble and clean unloader valve or compressor-head valve (para 4-8).

<p>MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION</p>
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3. MAIN RESERVOIR AIR PRESSURE NOT PROPERLY CONTROLLED.

Step 1. Check to see if cutout cock in governor pipe is closed.

Open cutout cock in governor pipe.

Step 2. Check to see if air compressor valves are leaking.

Disassemble and lap valves and valve seats (para 4-8).

Step 3. Check to see if air compressor governor is sticking.

Disassemble and clean governor (para 3-45).

Step 4. Check to see if air compressor unloader pipe is leaking.

Repair or replace air compressor unloader pipe (para 4-8).

Step 5. Check to see if air compressor unloader valves are sticking.

Disassemble and clean air compressor unloader valves (para 4-8).

4. EQUALIZING RESERVOIR AIR GAGE INDICATES NO PRESSURE OR A LEAK.

Step 1. Check to see if the equalizing reservoir gage or fittings are leaking.

Locate leakage and tighten fittings and/or repair or replace gage (para 3-8).

Step 2. Check to see if gage mounting bracket O-ring is leaking.

Locate leakage and tighten or replace mounting bracket O-ring (para 3-8).

Step 3. Check to see if piping or fittings on pipes 5 and 15 are leaking (para 3-8).

Locate leakage and tighten or replace piping and/or fittings (para 3-8).

Step 4. Check to see if the equalizing reservoir piping or fittings are leaking.

Locate leakage and tighten or replace reservoir, piping, and/or fittings.

<p>MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION</p>
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4. EQUALIZING RESERVOIR AIR GAGE INDICATES NO PRESSURE OR A LEAK. (cont)

Step 5. Check to see if automatic brake valve is defective. (Refer to malfunctions 21 and 22.)

Disassemble, clean, and repair or replace automatic brake valve (para 4-11).

Step 6. Check to see if equalizing reservoir is leaking.

Repair or replace equalizing reservoir.

5. BRAKE PIPE AIR GAGE INDICATES NO PRESSURE OR MORE THAN A 5-PSI LEAKAGE IN 1 MINUTE. (Refer to para 2-9e(2).)

Step 1. Check to see if the brake pipe angle cocks on front and rear of locomotive are open.

Close angle cocks.

Step 2. Check to see if brake pipe gage or fittings are leaking.

Locate leakage and tighten fittings and/or repair or replace gage (para 3-8).

Step 3. Check to see if piping or fittings on pipe 53 are leaking.

Locate leakage and tighten or replace piping and/or fittings.

Step 4. Check to see if A-1 charging cutoff pilot valve is defective. (Refer to malfunction 24.)

Disassemble, clean, and repair or replace A-1 charging cutoff pilot valve (para 4-15).

6. EQUALIZING RESERVOIR DOES NOT REDUCE WITH SERVICE APPLICATION.

Step 1. Check to see if automatic brake valve is defective. (Refer to malfunctions 21 and 22.)

Disassemble, clean, and repair or replace brake valve (para 4-11).

Step 2. Check to see if regulating valve is defective.

Disassemble, clean, and repair or replace brake valve (para 4-11).

<p>MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION</p>
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7. EQUALIZING RESERVOIR REDUCTION IS TOO FAST OR TOO SLOW WITH SERVICE APPLICATION.

Step 1. Check to see if equalizing reservoir piping or fittings are leaking.

Locate leakage and tighten or replace piping and/or fittings.

Step 2. Check to see if automatic brake valve is defective. (Refer to malfunctions 21 and 22.)

Disassemble, clean, and repair or replace automatic brake valve (para 4-11).

8. BRAKE PIPE REDUCTION IS TOO SLOW.

Step 1. Check to see if the exhaust orifice in automatic brake valve is dirty or defective.

Clean or replace exhaust orifice (para 4-11).

Step 2. Check to see if automatic brake valve is defective. (Refer to malfunctions 21 and 22.)

Disassemble, clean, and repair or replace automatic brake valve (para 4-11).

9. AUTOMATIC BRAKE DOES NOT APPLY FOLLOWING A BRAKE PIPE REDUCTION.

Step 1. Check to see if brake pipe is fully charged.

Charge brake pipe.

Step 2. Check to see if the brake pipe cutout cock is closed.

Open brake pipe cutout cock.

Step 3. Check to see if main reservoir cock is partially open.

Close cock.

Step 4. Check to see if there is a leak in pipe 16.

Locate leakage and repair or replace pipe 16 (para 4-11).

Step 5. Check to see if pipe 16 and 20 double check valve is defective.

Disassemble and repair or replace double check valve (para 3-54).

<p>MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION</p>
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9. AUTOMATIC BRAKE DOES NOT APPLY FOLLOWING A BRAKE PIPE REDUCTION. (cont)

Step 6. Check to see if the brake cylinder cutout cocks are open.

Close brake cylinder cutout cocks.

Step 7. Check to see if brake cylinders are defective.

Disassemble, clean, and repair or replace brake cylinders (para 3-58).

Step 8. Check to see if 6-NFR distributing valve is defective. (Refer to malfunctions 25 thru 28.)

Disassemble, clean, and repair or replace 6-NFR distributing valve (para 4-13).

10. UNDESIRED RELEASE OF AN AUTOMATIC BRAKE APPLICATION BY AN INCREASE IN EITHER EQUALIZING RESERVOIR OR BRAKE PIPE PRESSURE.

Step 1. Check to see if pipe 16 is leaking.

Locate leakage and repair or replace pipe 16.

Step 2. Check to see if automatic brake valve is defective. (Refer to malfunctions 21 and 22.)

Disassemble, clean, and repair or replace automatic brake valve (para 4-11).

11. BRAKE PIPE PRESSURE DOES NOT REDUCE AT EMERGENCY RATE.

Step 1. Check to see if pipe 53 is leaking.

Locate leakage and repair or replace pipe 53 (para 4-11).

Step 2. Check to see if the front and/or rear #8 vent valve is defective.

Disassemble, clean, and repair or replace #8 vent valve (para 4-14).

Step 3. Check to see if the A-1 charging cutoff pilot valve is defective. (Refer to malfunction 24.)

Disassemble, clean, and repair or replace A-1 charging cutoff pilot valve (para 4-15).

<p>MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION</p>
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11. BRAKE PIPE PRESSURE DOES NOT REDUCE AT EMERGENCY RATE. (cont)

Step 4. Check to see if automatic brake valve is defective. (Refer to malfunctions 21 and 22.)

Disassemble, clean, and repair or replace automatic brake valve (para 4-11).

12. UNABLE TO RECOVER FROM AN EMERGENCY APPLICATION.

Step 1. Brake is open to atmosphere.

Repair or replace piping.

Step 2. Check to see if double check valve in pipes 9 and 35 is defective.

Disassemble, clean, and repair or replace double check valve (para 3-54).

Step 3. Check to see if A-1 charging cutoff pilot valve is defective. (Refer to malfunction 24.)

Disassemble, clean, and repair or replace A-1 charging cutoff pilot valve (para 4-15).

Step 4. Check to see if automatic brake valve is defective.

Repair automatic brake valve (para 4-11).

Step 5. Check to see if #8 vent valve is stuck open.

Disassemble, clean, and repair #8 vent valve (para 4-14).

13. EMERGENCY APPLICATION OCCURS DURING SERVICE APPLICATION.

Step 1. Check to see if front or rear #8 vent valve is defective.

Disassemble, clean, and repair or replace #8 vent valve (para 4-14).

Step 2. Check to see if brake pipe piping and fittings are leaking.

Locate leakage and tighten or replace piping and/or fittings.

Step 3. Check to see if brake pipe exhaust orifice in automatic brake valve is defective.

Replace exhaust orifice (para 4-11).

<p>MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION</p>
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14. INDEPENDENT BRAKE DOES NOT APPLY OR IS TOO WEAK.

Step 1. Check to see if there is a leak in piping system.

Locate leakage and repair or replace piping.

Step 2. Check to see if double check valve in pipes 16 and 20 is defective.

Disassemble, clean, and repair or replace double check valve (para 3-54).

Step 3. Check to see if independent brake valve is defective. (Refer to malfunction 23.)

Disassemble, clean, and repair or replace independent brake valve (para 4-12).

15. INDEPENDENT BRAKE DOES NOT FULLY RELEASE.

Step 1. Check to see if automatic brake valve is set.

Set automatic brake valve.

Step 2. Check to see if double check valve in pipes 16 and 20 is defective.

Disassemble, clean, and repair or replace double check valve (para 3-54).

Step 3. Check to see if independent brake valve is defective. (Refer to malfunction 23.)

Disassemble, clean, and repair or replace independent brake valve (para 4-12).

16. AUTOMATIC BRAKE CYLINDER PRESSURE FAILS TO APPLY OR APPLIES AND RELEASES.

Step 1. Check to see if piping or fittings between 6-NFR distributing valve and No. 24 double check valve are leaking.

Locate leakage and tighten or replace piping and/or fittings.

<p>MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION</p>
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16. AUTOMATIC BRAKE CYLINDER PRESSURE FAILS TO APPLY OR APPLIES AND RELEASES. (cont)

Step 2. Check to see if piping or fittings between 6-NFR distributing valve and port 2 of H-5 relay air valve are leaking.

Locate leakage and tighten or replace piping and/or fittings.

Step 3. Check to see if piping or fittings between 6-NFR distributing valve port 2 and 12 pipe check valve are leaking.

Locate leakage and tighten or replace piping and/or fittings.

17. BRAKE PIPE PRESSURE DOES NOT RECOVER AFTER AN EMERGENCY BRAKE APPLICATION.

Check to see piping or fittings of pipe 12 from A-1 charging cutoff pilot valve is leaking.

Locate leakage and tighten or replace piping and/or fittings.

18. THERE IS LOSS OF MAIN RESERVOIR PRESSURE FROM BRAKE PIPE-INITIATED EMERGENCY.

Check to see if piping or fittings of pipe 53 from A-i charging cutoff pilot valve are leaking.

Locate leakage and tighten or replace piping and/or fittings.

19. THERE IS NO INDEPENDENT BRAKE APPLICATION.

Check to see if piping or fittings of pipe 20 from independent brake valve are leaking.

Locate leakage and tighten or replace piping and/or fittings.

20. THERE IS NO INDEPENDENT RELEASE OF AN AUTOMATIC BRAKE APPLICATION.

Check to see if piping or fittings of pipe 13 from independent brake valve are leaking.

Locate leakage and tighten or replace piping and/or fittings.

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

AUTOMATIC BRAKE VALVE

21. LARGE CAVITY EXHAUST OF THE BRAKE VALVE LEAKS WITH HANDLE IN RELEASE POSITION.

Step 1. Check to see if there is a light blow of air at the brake valve housing exhaust.

Replace O-ring on emergency valve of automatic brake valve (last O-ring) or replace O-rings on suppression valve of automatic brake valve (1st, 2nd, or 5th O-ring) (para 4-11).

Step 2. Check to see if there is a heavy blow of air at brake valve cavity exhaust and no brake pipe pressure.

Replace O-ring on cutoff portion of the A-1 charging cutoff pilot valve (bottom O-ring) (para 4-15).

22. REGULATING VALVE EXHAUST (LOCATED IN SPRING HOUSING NEAR REGULATING VALVE HANDLE) OF THE AUTOMATIC BRAKE VALVE LEAKS.

Step 1. Check to see if the equalizing reservoir pressure approaches main reservoir pressure.

Replace regulating valve diaphragm of automatic brake valve (para 4-11).

Step 2. Check to see if the equalizing reservoir does not register full pressure, and brake pipe charges slowly; during an automatic brake application, brake pipe exhaust is at the regulating valve.

Replace relay valve diaphragm of the automatic brake valve (para 4-11).

Step 3. Check for a continuous blow at exhaust port on top of the automatic brake valve.

Replace supply valve in the relay valve portion of the automatic brake valve (para 4-11).

INDEPENDENT BRAKE VALVE

23. THERE IS CONTINUOUS BLOW FROM THE EXHAUST WITH THE HANDLE IN RELEASE POSITION.

Step 1. Check to see if there is a heavy blow of air from exhaust.

Replace O-ring on spool valve separating main reservoir supply and line 20 of the independent brake valve (center O-ring) (para 4-12).

<p>MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION</p>
--

23. THERE IS CONTINUOUS BLOW FROM THE EXHAUST WITH THE HANDLE IN RELEASE POSITION. (cont)

Step 2. Check to see if the brake cylinder pressure will approach main reservoir pressure in APPLICATION position of the independent brake valve.

Replace O-ring in the independent brake valve (center O-ring) (para 4-12).

A-1 CHARGING CUT-OFF PILOT VALVE

24. THERE IS CONTINUOUS SANDING.

Check to see if there is air leaking from the sanding choke.

Replace O-ring on the actuating piston of the A-1 charging cutoff pilot valve (2nd O-ring from top) (para 4-15).

6-NFR DISTRIBUTING VALVE

25. AUTOMATIC BRAKE CYLINDER PRESSURE FAILS TO DEVELOP OR APPLIES AND REDUCES TO ZERO.

Step 1. Check to see if there is a blow of air at port 9 of H-5 relay air valve.

Repair or replace H-5 relay air valve seat that is leaking (port 11 to port 9) (para 4-16).

Step 2. Check to see if there is a blow of air at brake valve exhaust cavity.

Repair or replace pipe 12 check valve seat that is leaking.

Step 3. Check to see if there is a blow of air at safety valve.

Repair or replace safety valve seat that is leaking, (para 4-13).

Step 4. Check to see if there is a blow of air at application piston exhaust during application.

Repair or replace leak in application valve diaphragm (para 4-13).

Step 5. Check to see if there is a blow of air at independent brake valve exhaust.

Repair or replace No. 24 double check valve (port 20) (para 3-54).

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

26. THERE IS A STEADY BLOW OF AIR AT APPLICATION VALVE EXHAUST WITH BRAKES APPLIED OR RELEASED.

Check to see if the blow of air stops while brakes are applying.

Repair or replace application valve supply seat (para 4-13).

27. THERE IS A STEADY BLOW OF AIR AT APPLICATION VALVE EXHAUST.

Check to see if air blows only when brakes are applied.

Repair or replace application valve seat or repair application piston O-ring (top or middle O-ring) (para 4-13).

28. BRAKES FAIL TO RELEASE.

Check to see if brakes do not release after emergency application.

Adjust safety valve setting to proper pressure.

AIR COMPRESSOR GOVERNOR

29. AIR COMPRESSOR GOVERNOR NOT LOADING AND UNLOADING.

With locomotive running, observe air pressure gages. Bleed air slowly from system to see if governor controls the air compressor unloading and loading.

Remove air compressor governor and repair and test (para 3-45).

BATTERIES

30. BATTERIES FAIL TO CHARGE.

Step 1. Check to see if water level in batteries is low.

Fill batteries to proper level and test (TM 55-2210-223-12).

Step 2. Check to see if connections on batteries are clean and secure.

Clean and tighten connections.

Step 3. Check to see if voltage regulator is working properly.

Test and repair voltage regulator (para 3-34).

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

30. BATTERIES FAIL TO CHARGE. (cont)

Step 4. Check to see if the battery charging resistors RE70 are working properly.

Test and replace resistors RE70 (para 3-31).

Step 5. Check to see if battery fuse F3 is blown.

Test and replace fuse F3 (TM 55-2210-223-12).

Step 6. Check to see if the auxiliary generator fuse F2 is blown.

Test and replace auxiliary generator fuse F2 (TM 55-2210-223-12).

Step 7. Check to see if start switch S2 contacts transfer.

Test and replace start switch S2 (TM 55-2210-223-12).

COOLING SYSTEM

31. COOLANT TEMPERATURE IS EXCESSIVE.

Step 1. Check for broken coolant pump shaft or impeller.

Repair or replace pump (TM 5-2815-232-14).

Step 2. Check for faulty shutter operation.

Repair for proper operation (para 3-40).

Step 3. Check for faulty water pump operation.

Repair or replace water pump (TM 5-2815-232-14).

Step 4. Check for faulty fan operation.

Repair or replace fan (para 3-41).

Step 5. Check to see if thermostat (water temperature regulator) is stuck.

Repair or replace thermostat (water temperature regulator) (TM 5-2815-232-14).

Step 6. Check to see if oil cooler is plugged.

Unplug oil cooler (TM 5-2815-232-14).

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

32. SYSTEM LOSES COOLANT.

Step 1. Check for cracked or clogged radiator core or tank.

Replace radiator core or tank (para 4-6).

Step 2. Check for leaking hoses and pipes.

Tighten hose clamps. Repair or replace leaking hoses or pipes.

EMERGENCY SHUTDOWN SYSTEM

33. EMERGENCY SHUTDOWN SYSTEM FAILS TO OPERATE WHEN BUTTONS ARE PUSHED.

Step 1. Check for faulty switches S60, S70, or S71.

Replace switches S60, S70, or S71 (TM 55-2210-223-12).

Step 2. Check for problem in engine governor.

Replace engine governor (TM 5-2815-232-14).

ENGINE FUEL SYSTEM

34. LOCOMOTIVE ENGINE SHUTS DOWN DUE TO MALFUNCTIONING FUEL SYSTEM.

Step 1. Check for malfunctioning fuel pump.

Repair or replace fuel pump (TM 5-2815-232-14).

Step 2. Check for plugged injector lines.

Unplug injector lines (TM 5-2815-232-14).

Step 3. Check for defective injectors.

Repair or replace injectors (TM 5-2815-232-14).

EXCITER-AUXILIARY GENERATOR

35. EXCITER-AUXILIARY GENERATOR ARMATURE OR FIELD COILS ARE GROUNDED.

Step 1. Check for dirty, oily, water-soaked, or frayed insulation.

Remove exciter-auxiliary generator for repair (para 3-35).

**Table 3-1. INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT
TROUBLESHOOTING (continued)**

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

35. EXCITER-AUXILIARY GENERATOR ARMATURE OR FIELD COILS ARE GROUNDED. (cont)

Step 2. Check for defective field coils.

Remove exciter-auxiliary generator for repair (para 3-35).

Step 3. Check for broken insulators.

Replace insulators (para 3-35).

Step 4. Check to see if commutator bars are dirty or broken.

Remove exciter-auxiliary generator for repair (para 3-35).

Step 5. Check for broken high-voltage leads.

Remove exciter-auxiliary generator for repair (para 3-35).

36. EXCITER-AUXILIARY BEARINGS FAIL.

Step 1. Check for unbalanced armature.

Replace armature (para 3-35).

Step 2. Check for no lubrication or contaminated grease.

Lubricate in accordance with LO 55-2210-223-12.

Step 3. Check for proper alinement.

Aline exciter-auxiliary generator (para 3-35).

Step 4. Check for improper installation of bearings.

Remove exciter-auxiliary generator for repair (para 3-35).

37. EXCITER-AUXILIARY GENERATOR BRUSHES ARE BROKEN.

Step 1. Check for rough commutator, burned spots, flat spots, or high bars.

Resurface commutator (para 3-35).

Step 2. Check for low brush spring tension.

Adjust spring tension (TM 55-2210-223-12).

**Table 3-1. INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT
TROUBLESHOOTING (continued)**

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

37. EXCITER-AUXILIARY GENERATOR BRUSHES ARE BROKEN. (cont.)

Step 3. Check for vibration caused by defective bearing.

Replace bearings (para 3-35).

Step 4. Check for out-of-round commutator.

Resurface commutator (para 3-35).

Step 5. Check for high bar on commutator.

Repair or replace commutator (para 3-35).

Step 6. Check for dirty or sticking brushes.

Clean brush holders and blow out generator.

38. THERE IS EXCITER-AUXILIARY GENERATOR FLASHOVER.

Step 1. With engine stopped, check to see if insulating (mica) spaces between commutator segments contain dirt or foreign particles.

Undercut or clean out spaces to 3/64 inch (1.2 mm) (para 3-35).

Step 2. Check to see if brushes are broken or worn beyond condemning limits.

Replace brushes (TM 55-2210-223-12).

Step 3. Check for low brush spring tension or sticking brushes.

Adjust spring tension and clean brush holders (1M 55-2210-223-12).

Step 4. Check to see if commutator bars have slagged over.

Undercut mica bars (para 3-35).

Step 5. Check for high bar on commutator.

Repair or replace commutator (para 3-35).

Step 6. Check for exciter-auxiliary broken insulators, insulation, or brush shunt wires.

Remove generator for repair (para 3-35).

**Table 3-1. INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT
TROUBLESHOOTING (continued)**

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

HORN

39. HORN WILL NOT SOUND.

Step 1. Check to see if the auxiliary air cutout is open.

Open auxiliary air cutout.

Step 2. Check for a defective horn valve.

Repair or replace horn valve (TM 55-2210-223-12).

LIGHTS

40. HEADLIGHTS WILL NOT FUNCTION PROPERLY.

Step 1. Check for broken or burned out headlamps.

Replace headlamps (TM 55-2210-223-12).

Step 2. Check for tripped circuit breakers CB7, CB60, or CB61.

Reset tripped circuit breakers CB7, CB60, or CB61.

Step 3. Check for defective headlight switch S68.

Replace headlight switch S68 (TM 55-2210-223-12).

Step 4. Check for defective train line switch S4.

Replace train line switch S4 (TM 55-2210-223-12).

Step 5. Check for defective headlight resistors.

Replace headlight resistors (para 3-32).

41. CAB LIGHTS WILL NOT FUNCTION PROPERLY.

Step 1. Check for burned out light bulbs.

Replace light bulbs (TM 55-2210-223-12).

Step 2. Check that circuit breaker CB4 has been tripped.

Reset circuit breaker CB4.

Step 3. Check that circuit breaker CB50 has been tripped.

Reset circuit breaker CB50.

**Table 3-1. INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT
TROUBLESHOOTING (continued)**

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
--------------------	---------------------------	--------------------------

42. ENGINE HOUSING LIGHTS WILL NOT FUNCTION PROPERLY.

Step 1. Check for burned out light bulbs.

Replace light bulbs (TM 55-2210-223-12).

Step 2. Check that circuit breaker CB4 has been tripped.

Reset circuit breaker CB4.

Step 3. Check to see if engine room light switch S7 is defective.

Replace engine room light switch S7.

43. STEP AND NUMBER LIGHTS WILL NOT FUNCTION PROPERLY.

Step 1. Check for light bulbs.

Replace burned out light bulbs (TM 55-2210-223-12).

Step 2. Check that circuit breakers CB51 and CB4 have been tripped.

Reset circuit breakers CB51 and CB4.

MAIN AIR SYSTEM

44. MAIN AIR SYSTEM IS SLOW TO BUILD UP PRESSURE.

Check to see if centrifugal air filters are restricted.

Remove and replace centrifugal air filter canisters (para 3-60).

45. MOISTURE IS OBSERVED IN AIR SYSTEM.

Step 1. Check to see if the automatic drain valve is cycling properly.

Test, repair, or replace automatic drain valve.

Step 2. Check for proper operation of timer.

Test, repair, or replace timer (para 3-21).

MAIN GENERATOR

46. MAIN GENERATOR ARMATURE OR FIELD COILS ARE GROUNDED.

Step 1. Check for dirty, oily, water-soaked, or frayed insulation.

Remove main generator for repair (para 3-36).

**Table 3-1. INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT
TROUBLESHOOTING (continued)**

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

46. MAIN GENERATOR ARMATURE OR FIELD COILS ARE GROUNDED. (cont.)

Step 2. Check for defective field coils.

Remove main generator for repair (para 3-36).

Step 3. Check for broken insulators.

Replace insulators (para 3-36).

Step 4. Check to see if commutator bars are dirty or broken.

Remove main generator for repair (para 3-36).

Step 5. Check for broken high-voltage leads.

Remove main generator for repair (para 3-36).

Step 6. Check for broken power contactors.

Replace power contactors.

47. MAIN GENERATOR BEARING FAILS.

Step 1. Check for unbalanced armature.

Replace armature (para 3-36).

Step 2. Check for no lubrication or contaminated grease.

Lubricate in accordance with LO 55-2210-223-12.

Step 3. Check for proper alinement.

Aline main generator (para 3-36).

Step 4. Check for improper installation of bearings.

Remove main generator for repair (para 3-36).

48. MAIN GENERATOR BRUSHES ARE BROKEN.

Step 1. Check for rough commutator, burned spots, flat spots, or high bars.

Resurface commutator (para 3-36).

Step 2. Check for low brush spring tension.

Adjust spring tension (TM 55-2210-223-12).

Table 3-1. INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT
TROUBLESHOOTING (continued)

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

48. MAIN GENERATOR BRUSHES ARE BROKEN. (cont)

Step 3. Check for vibration caused by defective bearing.

Replace bearings (para 3-36).

Step 4. Check for out-of-round commutator.

Resurface commutator (para 3-36).

Step 5. Check for high bar on commutator.

Repair or replace commutator (para 3-36).

49. THERE IS MAIN GENERATOR FLASHOVER.

Step 1. With generator running, check to see if commutator is eccentric.

Aline main generator (para 3-36).

Step 2. With engine stopped, check to see if insulating (mica) spacers between commutator segments contain dirt or foreign particles.

Undercut or clean out spacers to 3/64 inch (1.2 mm) (para 3-36).

Step 3. Check to see if brushes are broken or worn beyond condemning limits.

Replace brushes (TM 55-2210-223-12).

Step 4. Check for low brush spring tension or sticking brushes.

Adjust spring tension and clean brush holders and brushes (TM 55-2210-223-12).

Step 5. Check to see if commutator bars have slagged over.

Undercut mica bars (para 3-36).

Step 6. Check for high bar on commutator.

Repair or replace commutator (para 3-36).

Table 3-1. INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT
TROUBLESHOOTING (continued)

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

49. THERE IS MAIN GENERATOR FLASHOVER. (cont)

Step 7. Check for broken insulators, insulation, or brush shunt wires.

Remove main generator for repair (para 3-36).

Step 8. Check to see if there are sudden surges of power from main generator.

With brakes applied, reduce to idle before complete stop is made.

Remove main generator for repair (para 3-36).

ENGINE WARNING SYSTEM

50. ENGINE OIL PRESSURE GAGE DROPS BELOW SAFE OPERATING RANGE, BUT THERE IS NO WARNING INDICATION.

Step 1. Check for defective oil pressure gage.

Replace oil pressure gage (para 3-9).

Step 2. Check for plugged oil pressure gage line.

Replace or clean oil pressure gage line.

Step 3. Check for wrong oil pressure at engine.

Refer to TM 5-2815-232-14 and correct oil pressure problem.

Step 4. Check for defective warning bell.

Replace warning bell (TM 55-2210-223-12).

Step 5. Check for a burned out low oil warning light.

Replace low oil warning light (TM 55-2210-223-12).

51. ENGINE TEMPERATURE RISES ABOVE SAFE OPERATING RANGE AND NO HIGH TEMPERATURE WARNING OCCURS.

Step 1. Check for defective water temperature gage.

Replace temperature gage (para 3-10).

Step 2. Check for defective temperature safety switch.

Replace temperature safety switch.

**Table 3-1. INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT
TROUBLESHOOTING (continued)**

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

51. ENGINE TEMPERATURE RISES ABOVE SAFE OPERATING RANGE AND NO HIGH TEMPERATURE WARNING OCCURS. (cont)

Step 3. Check for defective warning bell.

Replace warning bell (TM 55-2210-223-12).

Step 4. Check for a burned out temperature warning light.

Replace temperature warning light (TM 55-2210-223-12).

SANDING SYSTEM

52. SANDING SYSTEM WILL NOT FUNCTION.

Step 1. Check for obstructions in sandboxes, sander hoses, and sander control valves.

Clear obstructions in sandboxes, sander hoses, and sander control valves.

Step 2. Check for a defective sander control valve.

Repair or replace sander control valve (para 3-16).

Step 3. Check for defective sander switch S61.

Replace sander switch S61 (TM 55-2210-223-12).

SHUTTERS

53. ENGINE OVERHEATS DUE TO SHUTTERS NOT OPENING.

Step 1. Check for a bent or damaged shutter louver.

Replace shutter louver (para 3-40).

Step 2. Check that the shutter control ball cock valve is open.

Open ball cock valve.

Step 3. Check for improper operation of the shutter control sensing switch.

Replace shutter control sensing switch.

Step 4. Check for improper operation of the shutter control valve.

Replace shutter control valve.

Table 3-1. INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT
TROUBLESHOOTING (continued)

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

TRACTION MOTOR

54. TRACTION MOTOR ARMATURE OR FIELD COILS ARE GROUNDED.

Step 1. Check for dirty, oily, water-soaked, or frayed insulation.

Remove traction motor for repair (para 3-62).

Step 2. Check for defective field coils.

Remove traction motor for repair (para 3-62).

Step 3. Check for broken insulators.

Replace insulators (para 3-62).

Step 4. Check for dirty or broken commutator bars.

Remove traction motor for repair (para 3-62).

Step 5. Check for broken high voltage leads.

Remove traction motor for repair (para 3-62).

Step 6. Check for broken power contactors.

Replace power contactors.

Step 7. Check for broken brush shunt wires.

Remove traction motor for repair (para 3-62).

55. THERE IS TRACTION MOTOR FLASHOVER.

Refer to main generator flashover (malfunction 49).

56. TRACTION MOTOR BEARING FAILS.

Step 1. Check for unbalanced armature.

Replace armature (para 3-62).

Step 2. Check for no lubrication or contaminated grease.

Lubricate in accordance with LO 55-2210-223-12.

**Table 3-1. INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT
TROUBLESHOOTING (continued)**

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

56. TRACTION MOTOR BEARING FAILS. (cont)

Step 3. Check for improper traction motor alinement.

Aline traction motor (para 3-62).

Step 4. Check for improper installation of bearings.

Remove traction motor for repair (para 3-62).

57. TRACTION MOTOR BRUSHES ARE BROKEN.

Step 1. Check for rough commutator, burned spots, flat spots, or high bars.

Resurface commutator (para 3-62).

Step 2. Check for low brush spring tension.

Adjust spring tension (TM 55-2210-223-12).

Step 3. Check for motor vibration caused by weak or broken nose suspension springs.

Replace springs (para 3-62).

Step 4. Check for motor vibration caused by defective bearings.

Replace bearings (para 3-62).

Step 5. Check for out-of-round commutator.

Resurface commutator (para 3-62).

Step 6. Check for high bar on commutator.

Repair or replace commutator (para 3-62).

Step 7. Check for dirty or sticking brushes.

Clean brush holder and blow out generator.

**Table 3-1. INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT
TROUBLESHOOTING (continued)**

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

58. TRACTION MOTOR SUSPENSION IS LOOSE.

Step 1. Check for broken or weak nose suspension springs.

Replace spring (para 3-61).

Step 2. Check for worn motor support axle bearings (3-62).

Replace motor support axle bearings.

THROTTLE CONTROLLER MECHANISM

59. THROTTLE CONTROLLER MECHANISM DOES NOT RESPOND.

Step 1. Check for improper operation of throttle control valves.

Repair or replace control valves (TM 5-2815-232-14).

Step 2. Check for defective controller mechanism.

Repair or replace defective controller mechanism (para 3-33).

60. LOCOMOTIVE WILL NOT MOVE WHEN SHIFTED FORWARD OR REVERSE.

Step 1. Check for defective reverser relays.

Repair or replace reverser relay (para 3-28).

Step 2. Check for defective controller mechanism.

Repair or replace controller mechanism (para 3-33).

TRUCK ASSEMBLY

61. LOCOMOTIVE TILTS OR SWAYS BACK AND FORTH WHILE MAKING TURNS OR IF TRACK IS ON AN ANGLE.

Step 1. Check for excessive side bearing clearance.

Replace side bearings (para 3-61).

Step 2. Check for defective or broken springs.

Replace springs (para 3-61).

Step 3. Check center casting ear plate for excessive wear.

Replace center casting ear plate (para 3-61).

Table 3-1. INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT
TROUBLESHOOTING (continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

62. TRUCKS BIND AND WILL NOT PIVOT WHEN LOCOMOTIVE IS MAKING A TURN.

Check for zero side bearing clearance.

Replace center casting ear plates (para 3-61).

WARNING BELL

63. WARNING BELL WILL NOT SOUND.

Step 1. Check for a defective bell valve.

Repair or replace bell valve (TM 55-2210-223-12).

Step 2. Check for a defective bell ringer assembly.

Repair or replace bell ringer assembly (TM 55-2210-223-12).

WHEELS

64. A ROUGH RIDE OR THUMPING IS FELT WHILE OPERATING LOCOMOTIVE.

Check wheels for flat spots.

Turn wheels down (para 3-63).

65. LOCOMOTIVE CONTINUALLY SPLITS SWITCHES.

Check wheels for thin flanges.

Turn wheels down (para 3-63).

66. LOCOMOTIVE CLIMBS RAIL.

Check wheel for a vertical flange.

Turn wheel down (para 3-63).

Section III. INTERMEDIATE DIRECT SUPPORT MAINTENANCE INSTRUCTIONS

3-5. GENERAL

This section contains maintenance procedures authorized at the intermediate direct support maintenance category.

3-6. TASK SUMMARY

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TASK PARA	PROCEDURE	PAGE NO.
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3-7. ENGINE HOOD AND HANDRAIL ASSEMBLIES

This task covers:

- a. Removal b. Installation
-

INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12

Personnel Required

3

Equipment Condition

Reference

TM 55-2210-223-12

Condition Description

Muffler removed

REMOVAL

1. Remove engine hood by the following:
 - a. Remove eight screws (1) and clamps (2) and disconnect PCS air supply tubing and temperature gage wiring conduit from hood.
 - b. Remove six screws (3), nuts (4), and clamps (5) and disconnect hood lamp wiring conduit.
 - c. Remove 29 bolts (6) and lockwashers (7).
 - d. Remove 26 bolts (8) and lockwashers (9).
 - e. Remove 26 nuts (10), lockwashers (11), and flat washers (12).
 - f. Remove bolts (13) and (14), nuts (15) and (16), and ground strap (17).
 - g. Install lifting eyes and cables at four corners of handrail (22).

WARNING

Components of this engine hood and door assembly are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

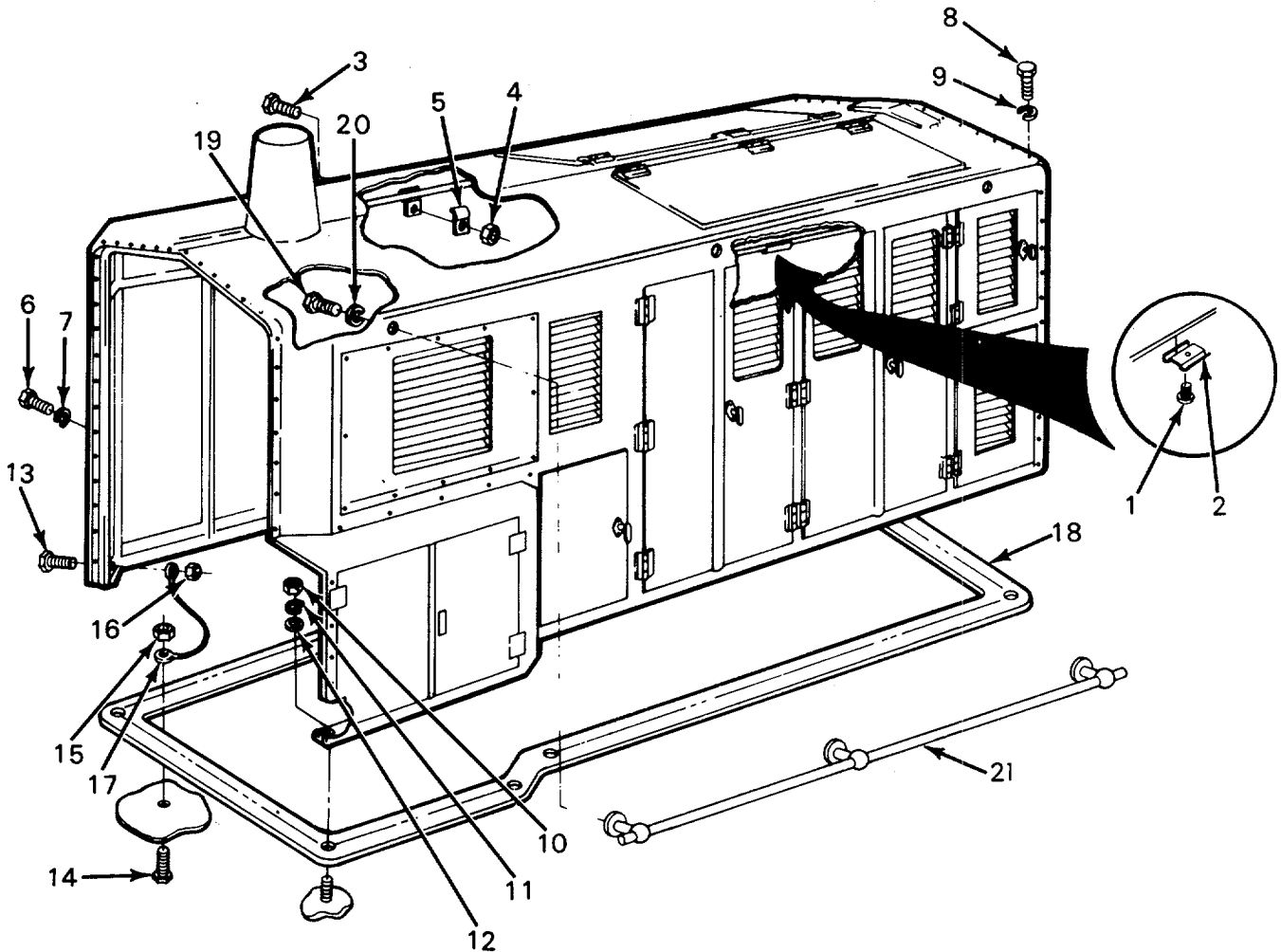
NOTE

- Check that hood is free of interference.
- Taglines may be used to steady hood when lifting.

- h. Position a person on each side of locomotive to guide lifting operation.

3-7. HOOD AND HANDRAIL ASSEMBLIES (cont)

REMOVAL (cont)



CAUTION

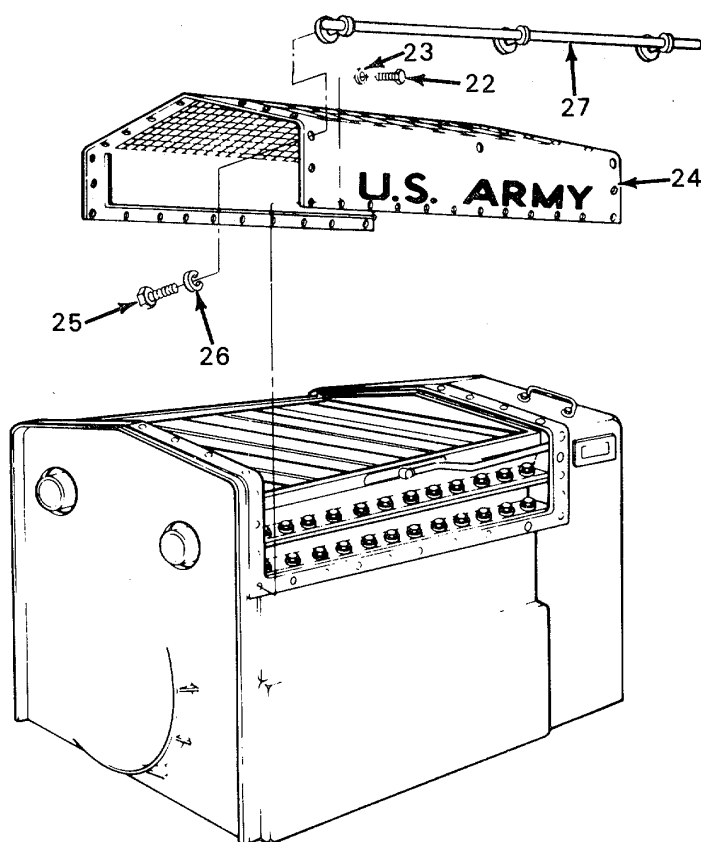
Care should be taken when lifting engine hood and door assembly to prevent binding, uneven balance, or damage to engine components.

- i. Use a suitable lifting device and slowly lift engine hood and door assembly from locomotive.
- j. Lower engine hood and door assembly and place on a suitable support device.
- k. Remove gasket (18).
- l. Remove eight bolts (19) and lockwashers (20) and remove handrail (21).

3-7. HOOD AND HANDRAIL ASSEMBLIES (cont)

REMOVAL (cont)

2. Remove radiator hood by the following:
 - a. Remove 40 bolts (22) and lockwashers (23) and install lifting eyes at four corners of handrail (27).



WARNING

Components of this hood assembly are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

- b. Use a suitable lifting device and slowly lift radiator hood (24) from locomotive. Set radiator hood on a suitable support device.
 - c. Remove eight bolts (25) and lockwashers (26) and remove handrail (27).
3. Refer to TM 55-2210-223-12 for repair of hood and handrail assemblies.

3-7. HOOD AND HANDRAIL ASSEMBLIES (cont)

INSTALLATION

4. Install radiator hood by the following:
 - a. Install handrail (27) and secure with eight lockwashers (26) and bolts (25). Install lifting eyes on four corners of hood.
 - b. Position a person on each side of locomotive to guide installation procedures.

WARNING

Components of this hood assembly are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

- c. Use a suitable lifting device and slowly lift radiator hood (24) over locomotive. Slowly lower radiator hood on locomotive and secure with 40 lockwashers (23) and bolts (22).
5. Install engine hood by the following:
 - a. Install handrail (21) and secure with eight lockwashers (20) and bolts (19).
 - b. Install gasket (18).
 - c. Install lifting eyes and cables at four corners of handrail (21).

WARNING

Components of this hood assembly are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

CAUTION

Care should be taken when lifting engine hood and door assembly to prevent binding, uneven balance, or damage to engine components.

- d. Use a suitable lifting device and raise hood and door assembly over locomotive. Slowly lower hood to deck.
 - e. Install 26 flat washers (12), lockwashers (11), and nuts (10).
 - f. Install 26 lockwashers (9) and bolts (8).

3-7. HOOD AND HANDRAIL ASSEMBLIES (cont)

INSTALLATION (cont)

- g. Install 29 lockwashers (7) and bolts (6).
- h. Install hood lamp wiring conduit and secure with six clamps (5), nuts (4), and screws (3).
- i. Use eight clamps (2) and screws (1) and connect PCS air supply tubing and temperature gage wiring conduit to hood.
- j. Install ground strap (17) and secure with nuts (15) and (16) and bolts (13) and (14).

3-8. DUPLEX AIR GAGE

This task covers:

- | | | | |
|----------------|---------------|-----------|-----------------|
| a. Removal | c. Cleaning | e. Repair | g. Assembly |
| b. Disassembly | d. Inspection | f. Test | h. Installation |
-

INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12
Pointer puller

Material/Parts

Glass cleaner (Item 3, Appendix B)

Test Equipment

Portable air gage tester P/N 700-1

REMOVAL

NOTE

- Federal Railroad Administration requires annual testing of duplex air gages or when gage is not operating properly.
- Duplex air gage can be tested while installed in control stand using a self-contained, portable air gage tester. Refer to step 13 below for testing instructions.

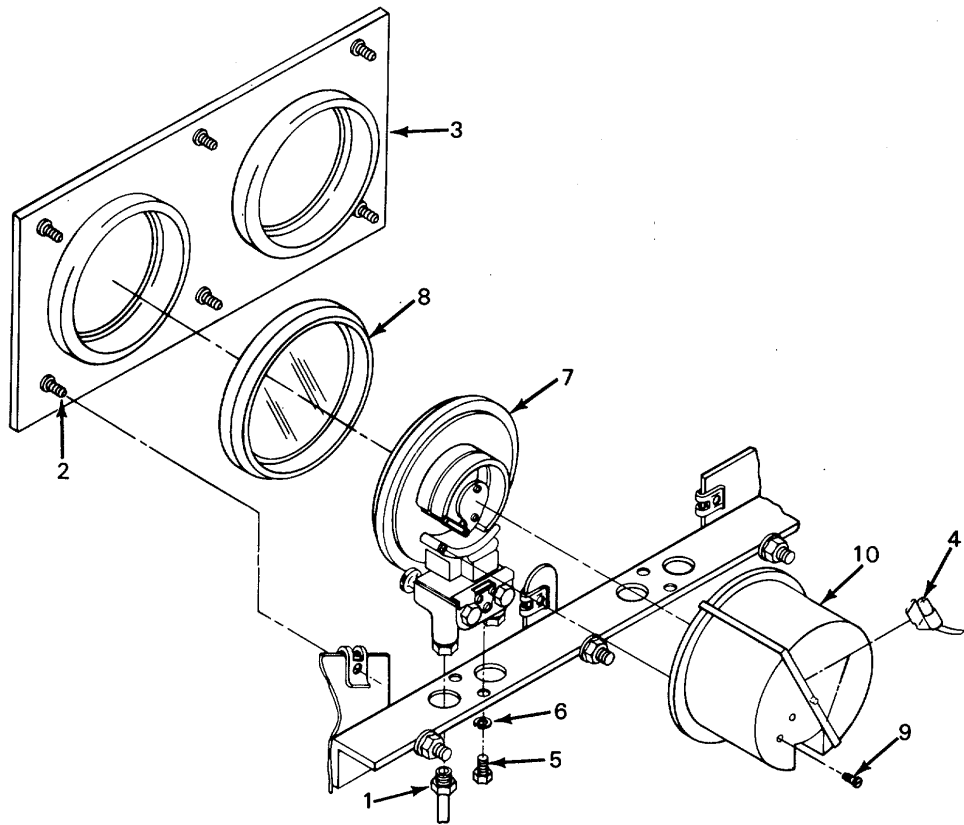
1. Disconnect four air line connections (1) from duplex air gage (7).
2. Remove six thumbscrews (2) and remove cover (3).
3. Remove two light sockets (4).
4. Remove two bolts (5), lockwashers (6), and duplex air gage (7).

DISASSEMBLY

6. Pry copper clasp from face of gage and remove front glass cover (8) and expose inner front of dial.
7. Remove two screws (9) and remove duplex air gage (7) from glass housing (10).

3-8. DUPLEX AIR GAGE (cont)

DISASSEMBLY (cont)



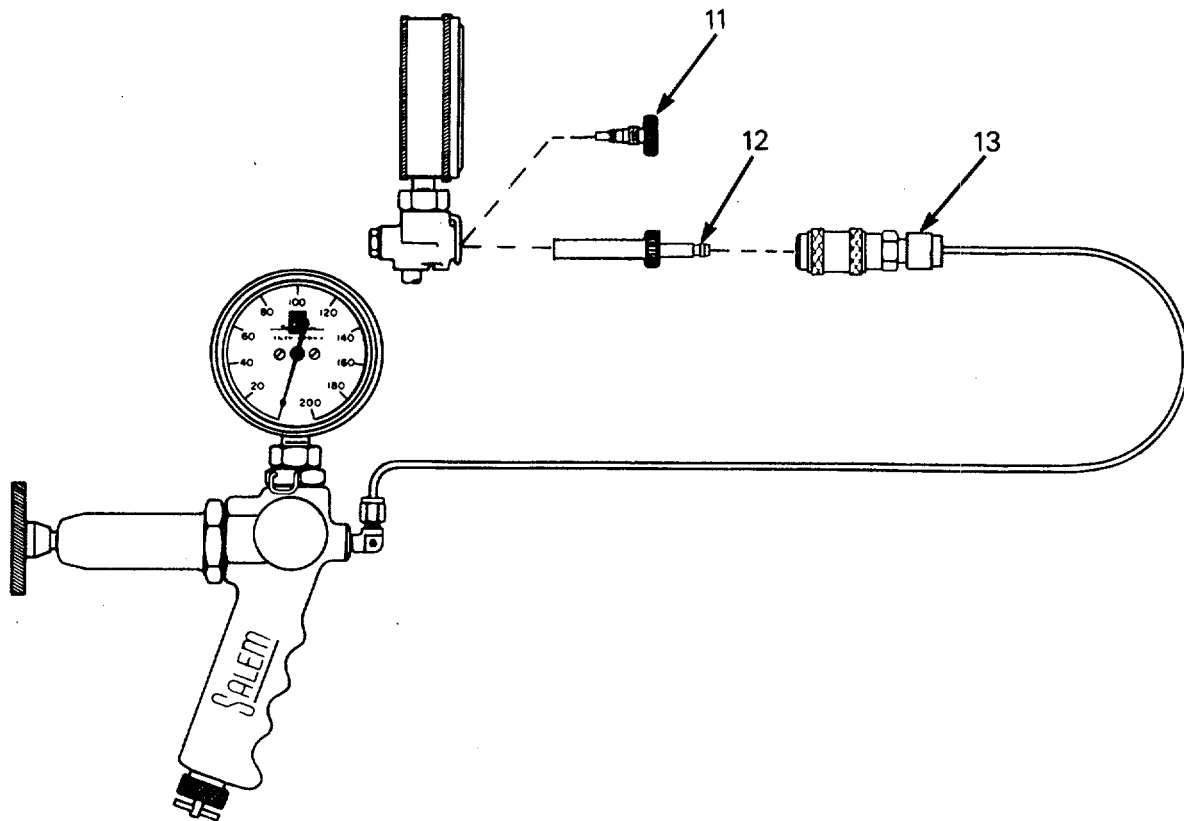
CLEANING, INSPECTION, AND REPAIR

8. Use glass cleaner and clean front glass cover (8) and glass housing (10).
9. Check that front glass cover (8) and glass housing (10) are not cracked or broken. Replace damaged front glass cover or glass housing.
10. Inspect face of duplex air gage (7) for damage. Replace if components appear damaged.
11. Repair is limited to the adjustment of pointers. If pointer hand does not set at zero, use pointer puller and remove pointer. Set pointer on zero.

3-8. DUPLEX AIR GAGE (cont)

TEST

12. If duplex air gage (7) is removed from the locomotive, test by the following:
 - a. Use a deadweight tester and test duplex air gage (7) at half scale and full scale. Compare amount of weight applied to the reading shown on gage.
 - b. Adjust pointer as follows:
 - (1) Use a puller and remove pointer.
 - (2) Apply 30 psi (207 kPa) test pressure and install pointer.
 - (3) Set pointer on the 30-psi (207 kPa) mark on the dial. Check calibration over the entire scale.
 - (4) Recheck duplex air gage (7) for accuracy.
 - c. If duplex air gage is not accurate, further repair is required. Send duplex air gage to a calibration facility.



3-8. DUPLEX AIR GAGE (cont)

TEST (cont)

13. If duplex air gage (7) is not removed from locomotive, use a portable air gage tester and test by the following:
 - a. Remove probe plug (11).
 - b. Install tester probe (12) and female hose connector (13).
 - c. Test at half scale and full scale and compare amount of pressure applied to the reading shown on gage as indicated:
 - (1) Brake cylinder - 20 and 45 psi (183 and 310 kPa)
 - (2) Brake pipe and equalizer - 40 and 80 psi (276 and 552 kPa)
 - (3) Main reservoir - 70 and 130 psi (483 and 896 kPa)
 - d. Adjust pointer as needed. Refer to step 12b above.
 - e. If duplex air gage (7) is not accurate, further repair is required. Send duplex air gauge to a calibration facility.
 - f. Disconnect female hose connector (13), and remove tester probe (12).
 - g. Install probe plug (11).

ASSEMBLY

14. Install duplex air gage (7) into glass housing (10) and secure with two screws (9).
15. Install front glass cover (8) on dial and secure with copper clasp.

INSTALLATION

16. Install duplex air gage (7) on control stand.
17. Install two lockwashers (6) and bolts (5).
18. Install two light sockets (4).
19. Connect four air line connections (1) to duplex air gage (7).
20. Install cover (3) and secure with six thumbscrews (2).

3-9. OIL AND FUEL PRESSURE GAGES

This task covers:

- a. Removal b. Test c. Installation
-

INITIAL SETUP

Tools

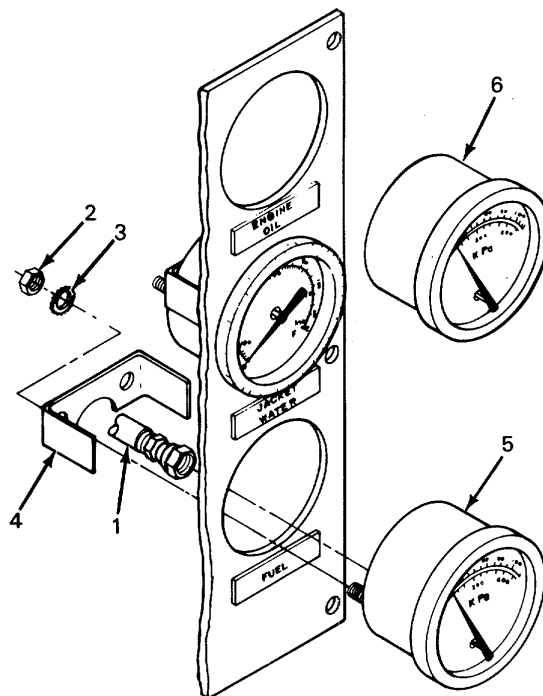
Tool kit SC 4940-97-CL-E12

REMOVAL

NOTE

- Federal Railroad Administration requires annual testing of fuel and oil pressure gages or when gage is not operating properly.
- Oil and fuel pressure gages are removed and installed in the same manner.

1. Disconnect oil pressure line (1) from oil pressure gage (5).
2. Remove two nuts (2), lockwashers (3), and retainer bracket (4). Remove oil pressure gage (5).
3. Repeat steps 1 and 2 and remove fuel pressure line from fuel pressure gage (6) and remove gage.



3-9. OIL AND FUEL PRESSURE GAGES (cont)

TEST

4. If it is suspected the gage is defective, remove and test with a dead weight tester.

INSTALLATION

5. Install oil pressure gage (5) on control stand and secure with retainer bracket (4), two lockwashers (3), and nuts (2).
6. Connect oil pressure line (1) to oil pressure gage (5).
7. Repeat step 5 and install fuel pressure gage (6). Connect fuel pressure line to gage.

3-10. TEMPERATURE GAGE

This task covers:

- a. Removal
- b. Test
- c. Installation

INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12

REMOVAL

1. Disconnect capillary tubing (1) from engine block.
2. Remove two nuts (2), lockwashers (3), and retainer bracket (4). Remove temperature gage (5).

TEST

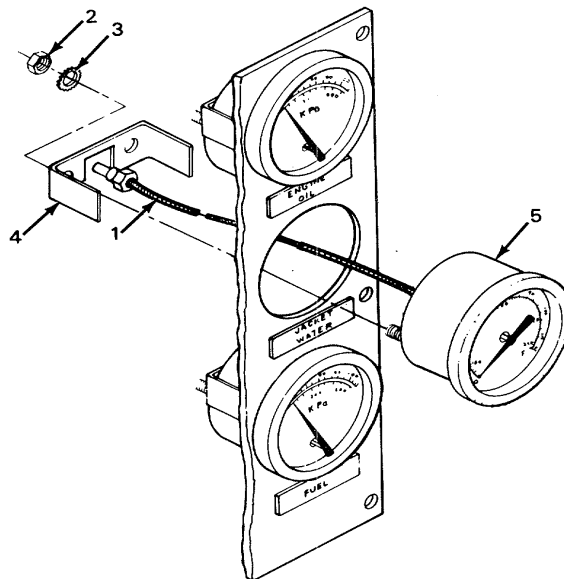
NOTE

If it is suspected that gage is defective remove and test gage.

3. Heat water vat to 180°F (82°C). Check with thermometer.
4. Place bulb in vat. If gage does not indicate 180°F (82°C), replace gage.

INSTALLATION

5. Install temperature gage (5) on control stand and secure with retainer bracket (4), two lockwashers (3), and nuts (2).
6. Connect capillary tubing (1) to engine water manifold on left top of engine.



3-11. LOAD METER GAGE

This task covers:

- a. Removal b. Test c. Installation
-

INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12

Test Equipment

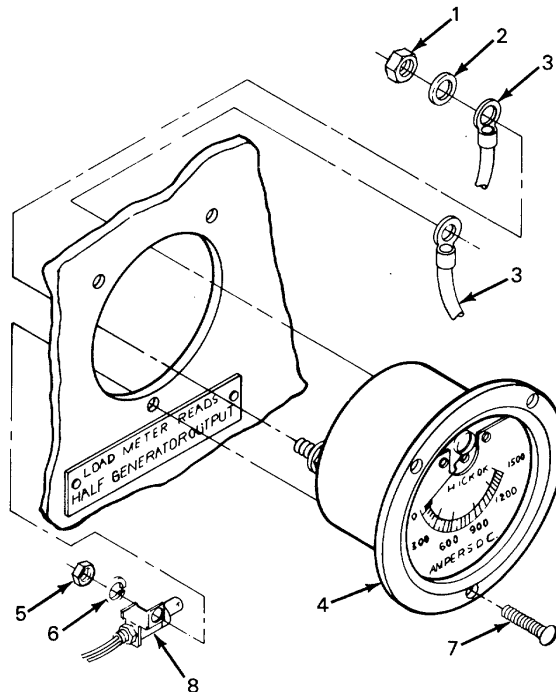
Variable dc voltage supply tester 6125-00-B06-6715

WARNING

- Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.
- High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.

REMOVAL

1. Set battery switch to OPEN position.
2. Tag electrical leads (3) and remove two nuts (1), four flat washers (2), and electrical leads from load meter gage (4).
3. Remove three nuts (5), lockwashers (6), screws (7), and lamp socket (8). Remove load meter gage (4).



3-11. LOAD METER GAGE (cont)

TEST

NOTE

The load meter gage can be tested while installed in the locomotive.
Attach lead of variable dc voltage tester to rear of gage.

4. Test load meter by the following:
 - a. Use a variable millivolt dc voltage supply and a multimeter and test load meter gage. Test at half scale and full scale and compare amount of power supplied to the reading shown on load meter gage.
 - b. If gage is not accurate, further repair is required. Send load meter gage to a calibration facility.

INSTALLATION

5. Install load meter gage (4) on control stand. Install lamp socket (8) and secure with three lockwashers (6), screws (7), and nuts (5).
6. Connect two electrical leads (3) and install four flat washers (2) and two nuts (1) to load meter gage (4). Remove tags.

3-13. SERVICE METER GAGE

This task covers:

- a. Removal b. Test c. Installation
-

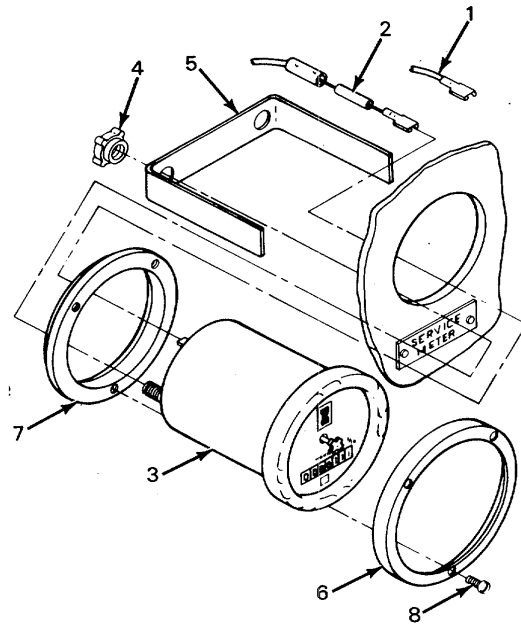
INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12

REMOVAL

1. Set battery switch to OPEN position.
2. Tag and disconnect wire (1) and resistor (2) from meter (3).
3. Remove two plastic nuts (4) and remove clamp (5).
4. Remove meter (3) from front of meter panel.
5. Remove chrome ring (6), spacer (7), and three screws (8) from meter (3) as one assembly.
6. Remove three screws (8) and remove chrome ring (6) from spacer (7).



TEST

7. Connect a variable DC power supply to + and - side of the service meter and apply 40 VDC to meter. Check that time advances on meter face.

INSTALLATION

8. Install chrome ring (6) on spacer (7).
9. Install three screws (8) into chrome ring (6).
10. Install assembled chrome ring (6) and spacer (7) on meter (3).
11. Install meter (3) into meter panel.
12. Install clamp (5) and two plastic nuts (4) on back of meter (3).
13. Connect resistor (2) and wire (1) to proper terminals. Remove tags.

3-14. AIR COMPRESSOR OIL PRESSURE GAGE

This task covers:

- a. Removal b. Test c. Installation
-

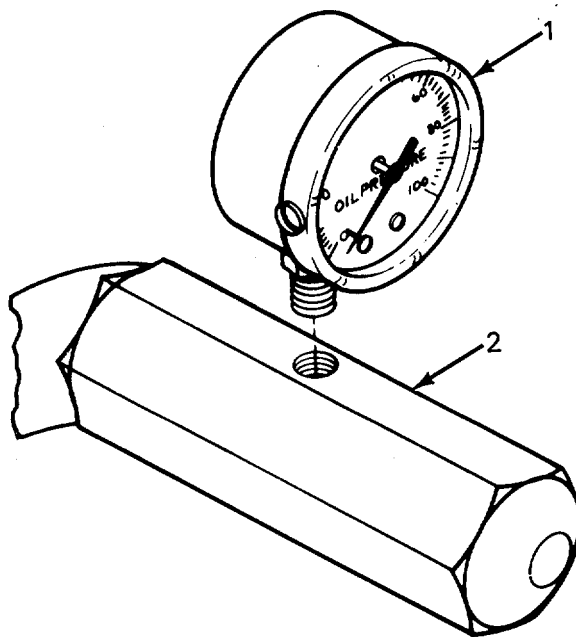
INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12

REMOVAL

1. Remove air compressor oil pressure gage (1) from air compressor oil pressure mounting bracket (2).



TEST

2. Use deadweight tester and test air compressor oil pressure gage.

INSTALLATION

3. Install air compressor oil pressure gage (1) into air compressor oil pressure mounting bracket (2).

3-15. OIL FILTER DIFFERENTIAL GAGE

This task covers:

- a. Removal b. Test c. Installation
-

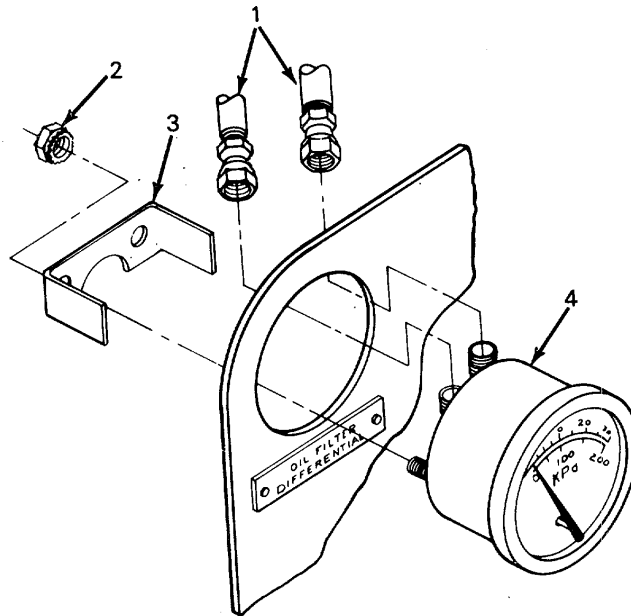
INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12

REMOVAL

1. Disconnect oil pressure lines (1).
2. Remove two locknuts (2) and clamp (3).
3. Remove gage (4) from bracket.



TEST

4. Use dead weight tester and test oil filter differential gage.

INSTALLATION

5. Install gage (4) into bracket.
6. Install clamp (3) and two locknuts (2) on back of gage (4).
7. Connect oil pressure lines (1).

3-16. SANDER CONTROL VALVE

This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Repair
- e. Assembly

INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12
Pneumatic grease (Item 16, Appendix B)

Material/Parts

Dry-cleaning solvent (Item 30, Appendix B)

Test Equipment

Multimeter 6625-01-139-2512

Equipment Condition

Reference

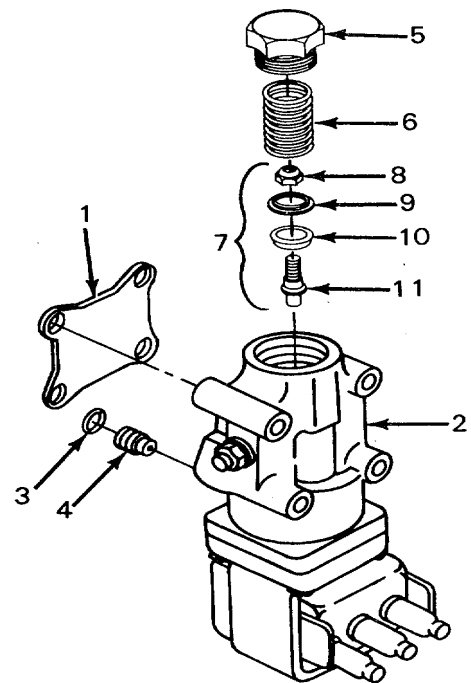
TM 55-2210-223-12

Condition Description

Sander control valve removed from locomotive

DISASSEMBLY

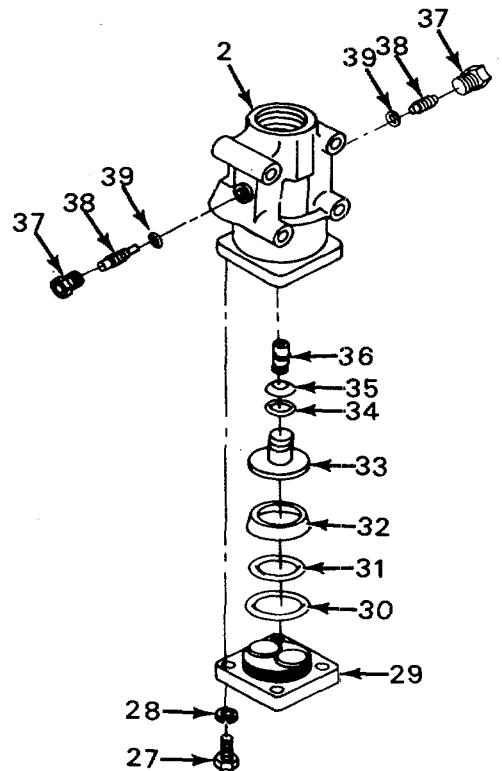
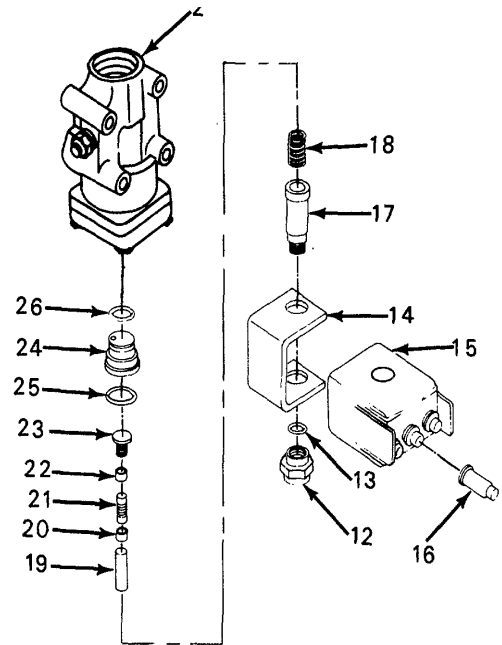
1. Remove gasket (1) from valve body (2). Discard gasket.
2. Remove O-ring (3) and strainer plug (4). Discard seal O-ring.
3. Remove spring cap (5) and spring (6).
4. Remove valve assembly (7).
5. Remove locknut (8), seat washer (9), and neoprene valve seat (10) from valve stem (11). Discard valve seat.



3-16. SANDER CONTROL VALVE (cont)

DISASSEMBLY (cont)

6. Remove exhaust nut (12), O-ring (13), field yoke (14), and coil (15).
7. Remove three terminal insulators (16).
8. Remove coil pole (17), spring (18), plunger body (19), and plunger seat (20). Discard plunger seat.
9. Remove plunger spacer (21), plunger seat (22), and plunger cap (23) from solenoid valve body (24). Discard plunger seat.
10. Remove and discard O-rings (25) and (26).
11. Remove four screws (27) and lockwashers (28).
12. Remove actuating cap (29), O-rings (30) and (31), and rubber cup (32). Discard O-rings and rubber cup.
13. Remove actuating piston (33), O-ring (34), neoprene valve seat (35), and piston stem (36). Discard O-rings.
14. Remove two plunger bodies (37), two plungers (38), and two O-rings (39). Discard O-rings.



3-16. SANDER CONTROL VALVE (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Dry-cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 138°F (38 59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
15. Use a cloth dampened in dry-cleaning solvent and remove grease and oil from exterior and interior of valve body (2).
 16. Use dry-cleaning solvent and clean metal parts. Dry with compressed air.
 17. Inspect metal parts for cracks, breaks, cuts, or other damage. Replace damaged parts.
 18. Check that springs are not rusted or distorted or have taken a permanent set. Replace damaged springs.
 19. Measure free height of spring (6). Minimum free height is 1-7/16 inch (36.5 mm). Replace damaged spring.
 20. Measure free height of spring (18). Minimum free height is 31/32 inch (24.6 mm). Replace damaged spring.
 21. Use repair kit and replace the following:
 - a. Gasket (1)
 - b. O-rings (3), (25), (26), (30), (31), (34), and (39)
 - c. Valve seat (10)
 - d. Plunger seats (20) and (22)
 - e. Rubber cup (32)
 22. Use a multimeter and measure resistance of coil case (15). Resistance should be 330 ±5% ohms. If this reading is not obtained, replace defective coil.
 23. Use silicone grease and lubricate O-rings (3), (13), (25), (26), (30), (31), (34), and (39), actuating piston (33), and rubber cup (32). Use a clean cloth and remove excess grease.

3-16. SANDER CONTROL VALVE (cont)

ASSEMBLY

26. Install two new O-rings (39), three plungers (38), and two plunger bodies (37).

NOTE

Dowels must be alined on actuating cup.

27. Install piston stem (36), neoprene valve seat (35), new O-ring (34), actuating piston (33), new rubber cup (32), new O-rings (31) and (30), and actuating cap (29). Secure with lockwashers (28) and screws (27).
28. Install new O-rings (26) and (25) on solenoid valve body (24).
29. Install new plunger seat (22) in plunger cap (23).
30. Install plunger seat (20) and plunger spacer (21) into plunger body (19).
Install plunger cap (23) on plunger body.
31. Install spring (18) on plunger body (19).
32. Install spring (18) and plunger body (19) in coil pole (17).
33. Install solenoid valve body (24).
34. Install terminal insulators (16) on coil case (15).
35. Install coil case (15) in field yoke (14).
36. Install field yoke (14) and coil case (15) and secure with O-ring (13) and exhaust nut (12).
37. Assemble valve assembly (7) by the following:
- a. Install new neoprene valve seat (10) and seat washer (9) on valve stem (11).
 - b. Secure with locknut (8).
38. Install valve assembly (7) and spring (6). Secure with spring cap (5).
39. Install O-ring (3) and strainer plug (4) in valve body (2).
40. Install gasket (1).

NOTE

If a repair kit is installed in sander control valve, check that gasket (1) remains with repaired valve for installation procedures.

3-17. BATTERY BOX

This task covers:

- a. Removal
 - b. Installation
-

INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12

Equipment Condition

Reference

TM 55-2210-223-12

Condition Description

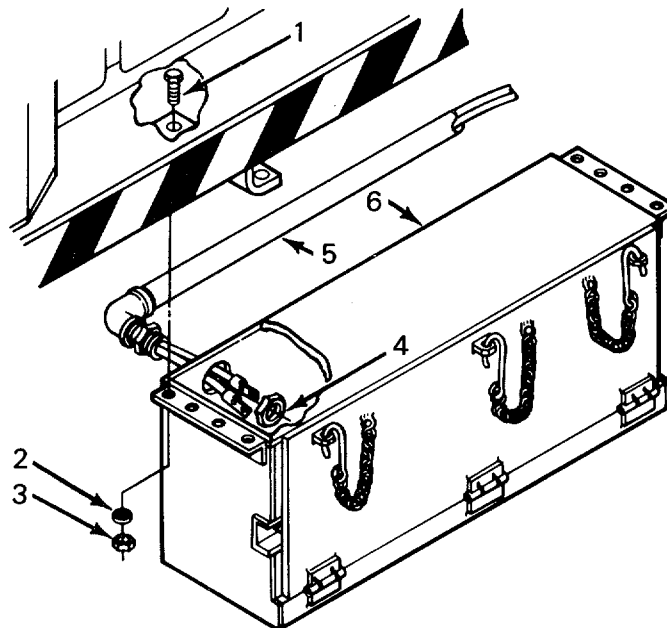
Batteries Removed

REMOVAL

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

1. Place suitable supports under battery box (6).
2. Remove eight bolts (1), lockwashers (2), and nuts (3).
3. Remove conduit nut (4) and conduit (5) from battery box (6).
4. Use a suitable lifting devise and remove battery box (6).



3-17. BATTERY BOX (cont)

INSTALLATION

5. Use a suitable lifting device and install battery box (6).
6. Install eight bolts (1), lockwashers (2), and nuts (3).
7. Install conduit (5) and conduit nut (4).
8. Refer to TM 55-2210-223-12 and install batteries.

3-18. BATTERY CHARGING RECEPTACLE

This task covers:

- | | | |
|----------------|---------------|-----------------|
| a. Test | d. Cleaning | g. Test |
| b. Removal | e. Inspection | h. Assembly |
| c. Disassembly | f. Repair | i. Installation |
-

INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12

Test Equipment

Multimeter 6625-01-139-2512

Megohmmeter 6625-00-456-7442

TEST

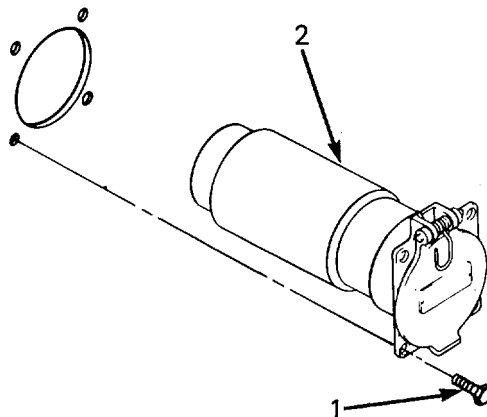
WARNING

- High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.
- Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.

1. Set battery switch to OPEN position.
2. Disconnect battery leads.
3. Use a multimeter and perform a continuity test on the battery charging receptacle.
4. Use a megohmmeter and perform a resistance test on the battery charging receptacle.

REMOVAL

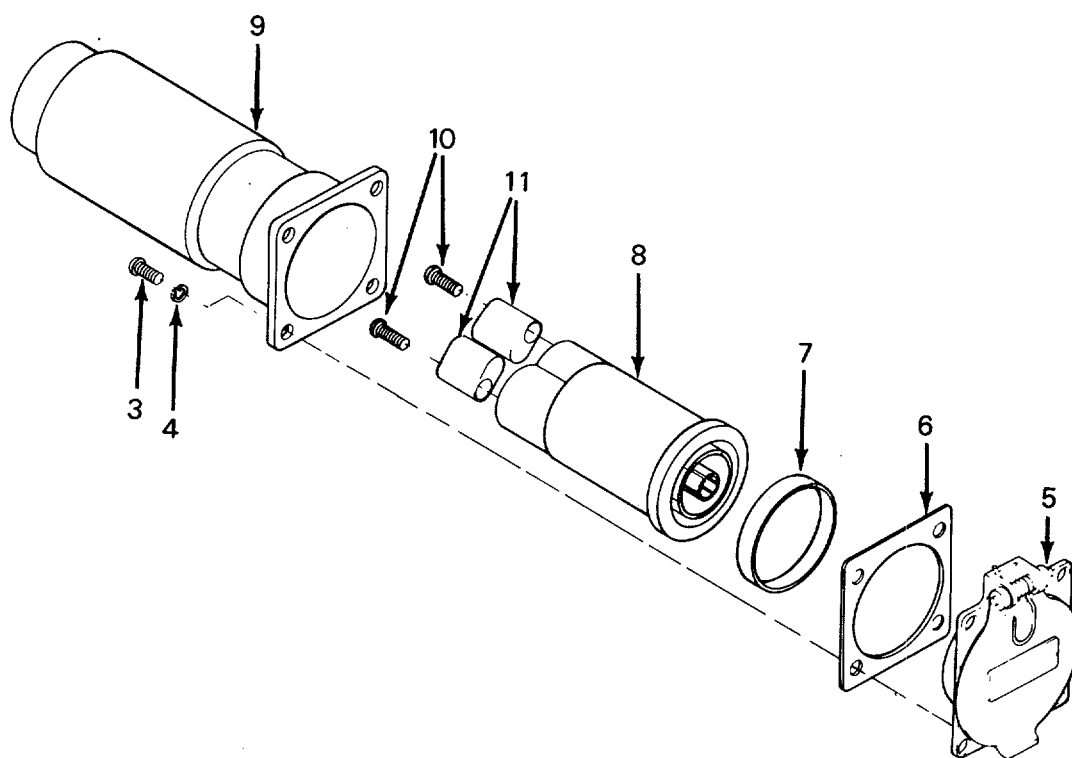
5. Disconnect positive lead from battery.
6. Remove four bolts (1) and remove receptacle assembly (2) from firewall.



3-18. BATTERY CHARGING RECEPTACLE

DISASSEMBLY

7. Remove four screws (3), lockwashers (4), receptacle cap (5), gasket (6), and insulation sleeve (7).
8. Remove receptacle (8) from receptacle housing (9).
9. Remove two screws (10) and gently pry two terminal lugs (11) from receptacle (8).
10. Tag and disconnect wires from terminal lugs (11).
11. Disconnect receptacle housing (9) from wires.



3-18. BATTERY CHARGING RECEPTACLE (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Dry-cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air and get medical aid, immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

12. Use a cloth dampened with solvent and clean parts. Dry with compressed air.
13. Inspect contacts for pitted or burned areas. Replace damaged contacts.
14. Inspect housing for bends or dents. Replace damaged housing.
15. Inspect for broken or frayed wiring. Replace damaged wires.

TEST

16. Use a multimeter and perform a continuity test on the battery charging receptacle. Replace defective parts.
17. Use a megohmmeter and perform a resistance test on the battery charging receptacle. Replace defective parts.

ASSEMBLY

18. Install wire through receptacle housing (9).
19. Connect wires to two terminal lugs (11). Remove tags.
20. Install two terminal lugs (11) on receptacle (8) and secure with two screws (10).
21. Install receptacle (8) into receptacle housing (9).
22. Install gasket (6), insulation sleeve (7), and receptacle cap (5) on receptacle housing (9) and secure with four lockwashers (4) and screws (3).

INSTALLATION

23. Install receptacle assembly (2) and secure with four bolts (1).
24. Connect positive lead to batteries.

3-19. MULTIPLE-UNIT RECEPTACLE

This task covers:

- | | | |
|----------------|---------------|-----------------|
| a. Removal | d. Inspection | g. Assembly |
| b. Disassembly | e. Repair | h. Installation |
| c. Cleaning | f. Test | |

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

Test Equipment

Multimeter 6625-01-139-2512

Megohmmeter 6625-00-456-7442

Personnel

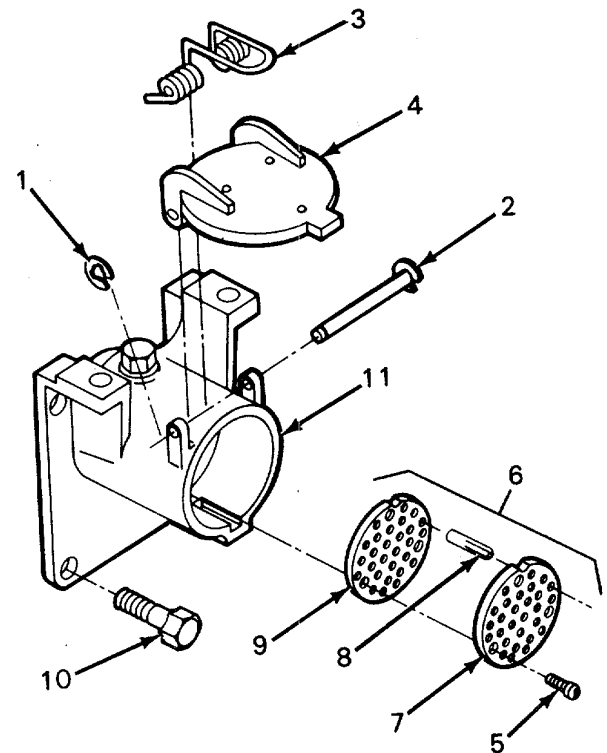
2

REMOVAL AND DISASSEMBLY

WARNING

- High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.
- Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.
- Use caution when removing cover hinge shaft. Spring is under pressure and may cause injury to personnel when released from cover hinge shaft.

1. Set battery switch to OPEN position.
2. Remove external snapping (1), cover hinge shaft (2), spring (3), and housing cover (4).
3. Remove three screws (5) securing pin assembly (6) to receptacle housing (11).
4. Remove pin assembly (6) from receptacle housing (11).
5. Remove insulator plate (7).
6. Tag and disconnect wires from 32 pins (8) as required.
7. Remove insulator plate (9) if required.
8. Remove four bolts (10) and receptacle housing (11).



3-19. MULTIPLE-UNIT RECEPTACLE (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Dry-cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air and get medical aid, immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
9. Use a cloth dampened with dry-cleaning solvent and clean parts. Dry with compressed air.
 10. Inspect pins for pitted or burned areas. Replace damaged pins.
 11. Inspect housing for bends or dents. Replace damaged housing.
 12. Inspect for broken or frayed wiring. Replace damaged wires.
 13. Inspect for broken or cracked insulation plates. Replace damaged insulator plates.

TEST

14. Use a multimeter and perform a continuity test on the multiple-unit receptacle. Replace defective part.
16. Use a megohmmeter and perform a resistance test on the multiple-unit receptacle. Replace defective part.

ASSEMBLY AND INSTALLATION

16. Install insulator plate (9), if removed.
17. Connect wires to pins (8). Remove tags.
18. Install insulator plate (7).
19. Position pin assembly (6) on receptacle housing (11) and secure with screws (5).
20. Install housing cover (4), spring (3), cover hinge shaft (2), and snapping (1).
21. Install receptacle housing (11) and secure with four bolts (10).

3-20. ENGINE HEATER RECEPTACLE

This task covers:

- | | | | |
|------------|----------------|---------------|-----------------|
| a. Test | c. Disassembly | e. Inspection | g. Installation |
| b. Removal | d. Cleaning | f. Repair | h. Test |
-

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

Test Equipment

Multimeter 6625-01-139-2512

Megohmmeter 6625-00-456-7442

Material/Parts

Dry-cleaning solvent
(Item 30, Appendix B)

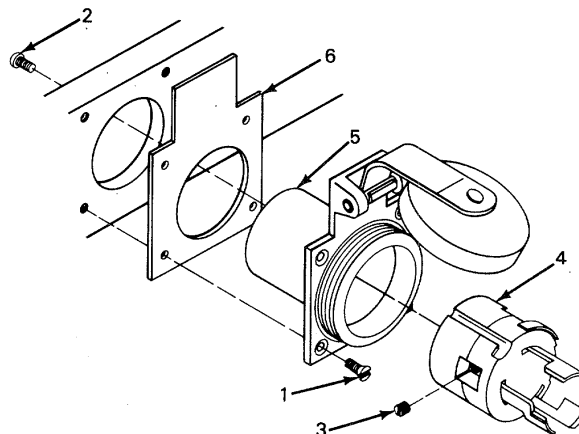
TEST

1. Remove electrical connections from jacket water heater.
2. Use a multimeter and perform a continuity test on the engine heater receptacle.
3. Use a megohmmeter and perform a resistance test on the engine heater receptacle.

REMOVAL

WARNING

- High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.
 - Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.
4. Set battery switch to OPEN position.
 5. Remove four screws (1) and pull engine heater receptacle away from firewall.



DISASSEMBLY

6. Remove three screws (2).
7. Turn receptacle housing (5) counterclockwise until slots on receptacle housing align with grooves on receptacle (4). Push receptacle through receptacle housing.
8. Remove three setscrews (3).

3-20. ENGINE HEATER RECEPTACLE (cont)

DISASSEMBLY (cont)

9. Tag and disconnect wiring. Remove receptacle (4).
10. Remove receptacle housing (5) and gasket (6).

CLEANING, INSPECTION, AND REPAIR

WARNING

- Dry-cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air and get medical aid, immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
11. Use a cloth dampened with dry-cleaning solvent and remove dirt. Dry with compressed air.
 12. Inspect contacts for pitted or burned areas. If damaged, replace receptacle.
 13. Inspect receptacle housing for bends or dents. If damaged, replace receptacle.
 14. Inspect for broken or frayed wiring. Replace damaged wires.

INSTALLATION

15. Install gasket (6) and receptacle housing (5).
16. Insert wiring into terminals of receptacle (4) and install three setscrews (3).
17. Align grooves on receptacle (4) with slots in receptacle housing (5) and push receptacle into receptacle housing. Turn receptacle housing clockwise to lock into place.
18. Install three screws (2).
19. Install engine heater receptacle to fire wall and secure with four screws (1).

TEST

20. Use a multimeter and perform a continuity test on the engine heater receptacle.
21. Use a megohmmeter and perform a resistance test on the engine heater receptacle.

3-22. BATTERY FIELD AND SHUNT FIELD CONTACTOR

This task covers:

- | | | | |
|----------------|---------------|-------------|-----------------|
| a. Removal | c. Cleaning | e. Repair | g. Installation |
| b. Disassembly | d. Inspection | f. Assembly | h. Test |
-

INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12

Material/Parts

Dry-cleaning solvent (Item 30, Appendix B)

Test Equipment

Multimeter 6625-01-139-2512

Variable dc voltage supply 6125-00-B06-6715

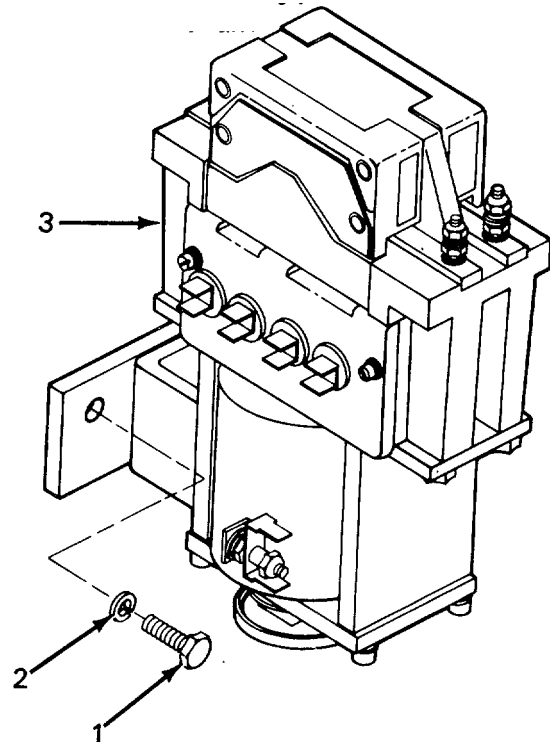
REMOVAL

WARNING

- High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.
- Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.

NOTE

- Battery field and shunt field relays are removed, disassembled, assembled, and installed identically.
 - Check that electrical wires are labeled with wire numbers or polarity signs.
1. Set battery switch to OPEN position. Disconnect wires from relay assembly.
 2. Remove two mounting screws (1), lockwashers (2), and relay assembly (3).

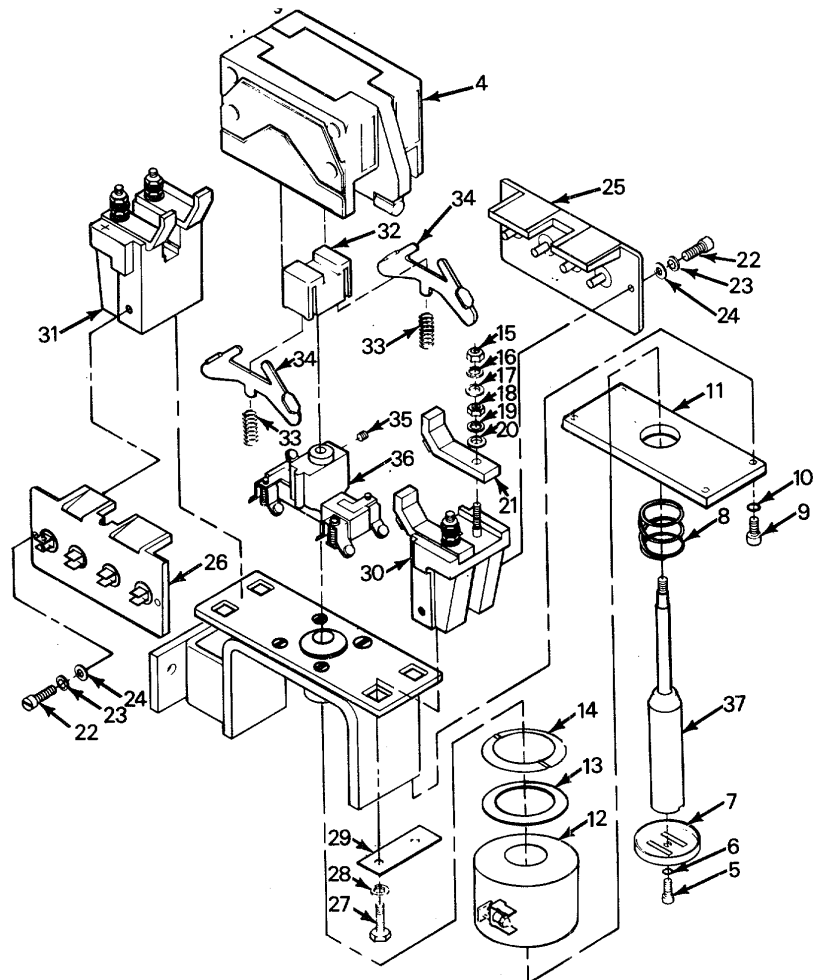


3-22. BATTERY FIELD AND SHUNT FIELD CONTACTOR (cont)

DISASSEMBLY

3. Remove chute (4), allen-head screw (5), lockwasher (6), cup washer (7), and compression spring (8).
4. Remove four allen-head screws (9), lockwashers (10), and plate assembly (11).
5. Remove coil (12), insulator gasket (13), and copper tension washer (14).
6. Remove four locknuts (15), lockwashers (16), flat washers (17), nuts (18), lockwashers (19), flat washers (20), and contact bars (21) from contact housings (30) and (31).

7. Remove four screws (22), lockwashers (23), flat washers (24), and contact plates (25) and (26).
8. Remove four bolts (27), lockwashers (28), two plates (29), and contact housings (30) and (31).



9. Remove carrier (32) by twisting counterclockwise. Remove two springs (33) and contacts (34).
10. Loosen setscrews (35) and remove contact set (36) from plunger (37).
11. Remove plunger (37) from mounting bracket (38).

3-22. BATTERY FIELD AND SHUNT FIELD CONTACTOR (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Dry-cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

NOTE

Do not file or attempt to clean contacts (34) and (36). Silver alloy surfaces on contacts may become blackened, pitted, or eroded. Always replace contacts.

12. Use dry-cleaning solvent and clean metal parts. Dry with compressed air.
13. Inspect molded parts for warpage, breaks, and cracks. Replace damaged parts.
14. Inspect contacts (34) and (36). If alloy material is worn through to base metal, replace contacts.
15. Inspect coil (12) for damaged insulation. Replace damaged coil.
16. Use a multimeter and measure resistance of coil (12). If resistance is not between 445 and 545 ohms, replace coil.
17. Inspect chute (4) for cracks and breaks. Replace damaged chute.

3-22. BATTERY FIELD AND SHUNT FIELD CONTACTOR (cont)

ASSEMBLY

18. Install plunger (37) into mounting bracket (38).
19. Install contact set (36). Tighten setscrews (35).
18. Install two contacts (34) and springs (33) into carrier (32).
19. Install assembled carrier (32), contacts (34), and springs (33) on plunger (37) by turning clockwise.
20. Install contact housings (30) and (31), two plates (29), four lockwashers (28) and bolts (27).
21. Install four contact bars (21), flat washers (20), lockwashers (19), nuts (18), flat washers (17), lockwashers (16), and locknuts (15) on contact housings (30) and (31).

NOTE

With mounting bracket (37) holes facing to the left, contact plate (25) marked DCBA will be installed on this side.

22. Install contact plates (26) and (25), four flat washers (24), lockwashers (23), and screws (22).
23. Install copper tension washer (14), insulation gasket (13), coil (12), plate assembly (11), four lockwashers (10), and allen-head screws (9).
24. Install compression spring (8), cup washer (7), lockwasher (6), and allen-head screw (5).
25. Install chute (4).

INSTALLATION

26. Install relay assembly (3) and secure with two lockwashers (2) and screws (1).

CAUTION

Check that electrical connections to terminals are correct. Incorrect electrical connections to terminals will result in damage to contacts (34) and (36). The arc suppression feature will be nullified.

27. Connect electrical wires.

3-22. BATTERY FIELD AND SHUNT FIELD CONTACTOR (cont)

TEST

28. Connect a variable dc voltage supply to coil (12). Use a multimeter and measure voltage. Check that pickup voltage is 48 V dc maximum and dropout voltage is 5 to 28 V dc.
29. Energize and deenergize relay and check that there is no hesitation during pickup or dropout.
30. Check that battery switch is in open position. Manually operate interlock contacts. Use a multimeter and check resistance of contacts for infinity while open and continuity while closed.

3-23. STARTING CONTACTOR

This task covers:

- | | | | |
|----------------|---------------|-------------|-----------------|
| a. Removal | c. Cleaning | e. Repair | g. Installation |
| b. Disassembly | d. Inspection | f. Assembly | h. Test |
-

INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12

Material/Parts

Dry-cleaning solvent (Item 30, Appendix B)

Test Equipment

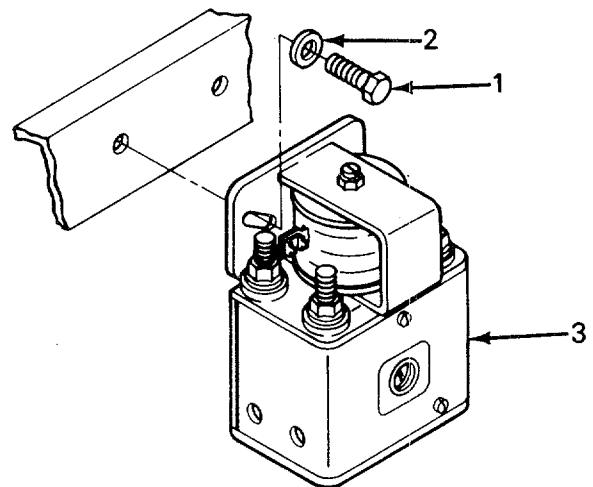
Multimeter 6625-01-139-2512

Variable dc voltage supply 6125-00-B06-6715

REMOVAL

WARNING

- High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.
 - Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.
1. Set battery switch to OPEN position. Tag and disconnect wires from relay assembly.
 2. Remove two bolts (1), flat washers (2), and relay assembly (3).

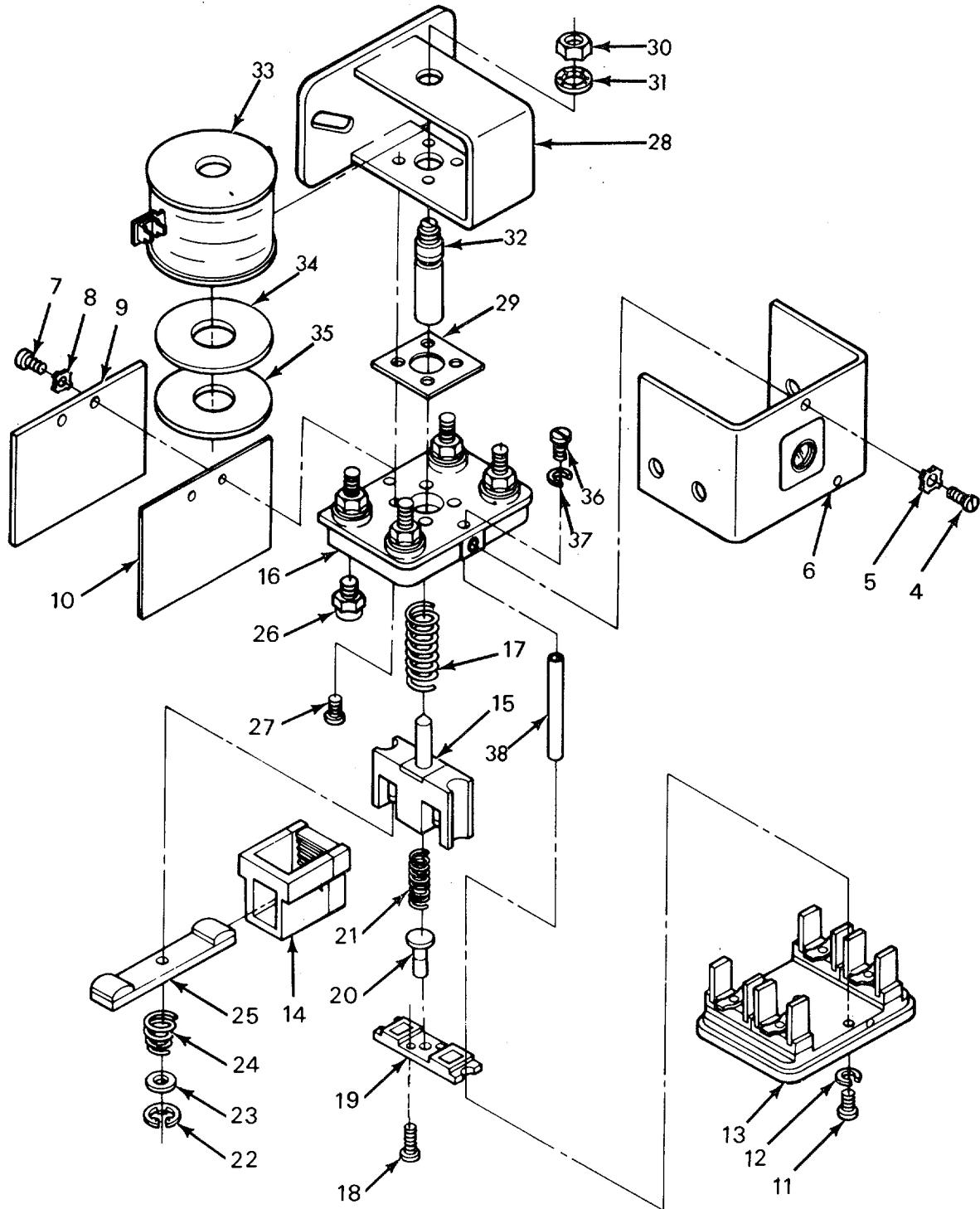


DISASSEMBLY

3. Remove two screws (4), lockwashers (5), and front cover (6).
4. Remove four screws (7), lockwashers (8), rear cover (9), and insulator (10).
5. Remove two screws (11) and lockwashers (12) and remove lower contact base (13).

3-23. STARTING CONTACTOR (cont)

DISASSEMBLY (cont)



3-23. STARTING CONTACTOR (cont)

DISASSEMBLY (cont)

6. Remove four arc boxes (14).
7. Remove plunger (15) from stationary contact assembly (16).
8. Remove main spring (17), two screws (18), plunger guide (19), plunger (20), and spring (21).
9. Remove two snaprings (22), washer (23), spring (24), and movable contacts (25) from plunger (20).
10. Remove four stationary contacts (26).
11. Remove four screws (27) and stationary contact assembly (16) from coil assembly (28).
12. Remove insulating plate (29) from stationary contact assembly (16).
13. Remove jamnut (30), lockwasher (31), and stop core (32) from coil assembly (28).
14. Remove coil (33), insulating washer (34), and spring washer (35) from coil assembly (28).
15. Remove two screws (36), lockwashers (37), and guide pins (38).

3-23. STARTING CONTACTOR (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Dry-cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

NOTE

Do not file or attempt to clean movable contacts (25) and stationary contacts (26). Silver alloy surfaces on contacts may become blackened, pitted, or eroded. These conditions will not hamper the operation of the contactor.

16. Use dry-cleaning solvent and clean parts. Dry with compressed air.
17. Inspect molded parts for warpage, breaks, and cracks. Replace damaged parts.
18. Inspect two movable contacts (25) and four stationary contacts (26). If alloy material is worn through to base metal, replace contacts.
19. Inspect coil (33) for damaged insulation. Replace damaged coil.
20. Use a multimeter and measure resistance of coil (33). If resistance is not 23.3 ohms ($\pm 10\%$), replace coil.
21. Inspect for damaged and loose terminals.
22. Repair consists of replacing defective parts.

3-23. STARTING CONTACTOR (cont)

ASSEMBLY

23. Install two guide pins (38) and secure with two lockwashers (37) and screws (36).
24. Install spring washer (35), insulating washer (34), and coil (33) in coil assembly (28).
25. Install stop core (32), lockwasher (31), and jamnut (30).
26. Install insulating plate (29) on stationary contact assembly (16).
27. Install stationary contact assembly (16) on coil assembly (28) and secure with four screws (27).
28. Install four stationary contacts (26).
29. Install movable contacts (25) in plunger (20) and secure with two springs (24), washers (23), and snaprings (22).
30. Install spring (21) on plunger (20) and secure with plunger guide (19) and two screws (18).
31. Install main spring (17) on plunger and main contact assembly (15).
32. Install four arc boxes (14).
33. Install lower contact base (13) and secure with two lockwashers (12), screws (11).
34. Install insulator (10) and rear cover (9) and secure with four lockwashers (8) and screws (7).
35. Install front cover (6), two lockwashers (5), and screws (4).

INSTALLATION

36. Install relay assembly (3) and secure with two flat washers (2) and two bolts (1).
37. Connect electrical wires to relay and remove tags.

3-23. STARTING CONTACTOR (cont)

TEST (cont)

CAUTION

To avoid excessive heating, do not energize coil for more than 2 minutes at a time.

38. Connect a variable dc voltage supply to coil (33). Use a multimeter and measure voltage. Check that pickup voltage is 36 V dc maximum and dropout voltage is 3 to 16 V dc. If voltage values are not as specified loosen jamnut (30) and adjust core stop (32) at top of coil frame (28). Tighten jamnut.
39. Energize and deenergize relay and check that there is no hesitation during pickup or dropout.
40. Set battery switch to open position. Manually operate interlock contacts. Use a multimeter and check resistance of contacts for infinity while open and continuity while closed.

3-24. POWER CONTACTOR

This task covers:

- | | | |
|----------------|---------------|-----------------|
| a. Removal | d. Inspection | g. Installation |
| b. Disassembly | e. Repair | h. Test |
| c. Cleaning | f. Assembly | |
-

INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12

Material/Parts

Dry-cleaning solvent (Item 30, Appendix B)
Silicone adhesive (Item 1, Appendix B)

Test Equipment

Multimeter 6625-01-139-2512
Variable dc voltage supply 6125-00-B06-6715

REMOVAL

WARNING

- High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.
- Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.

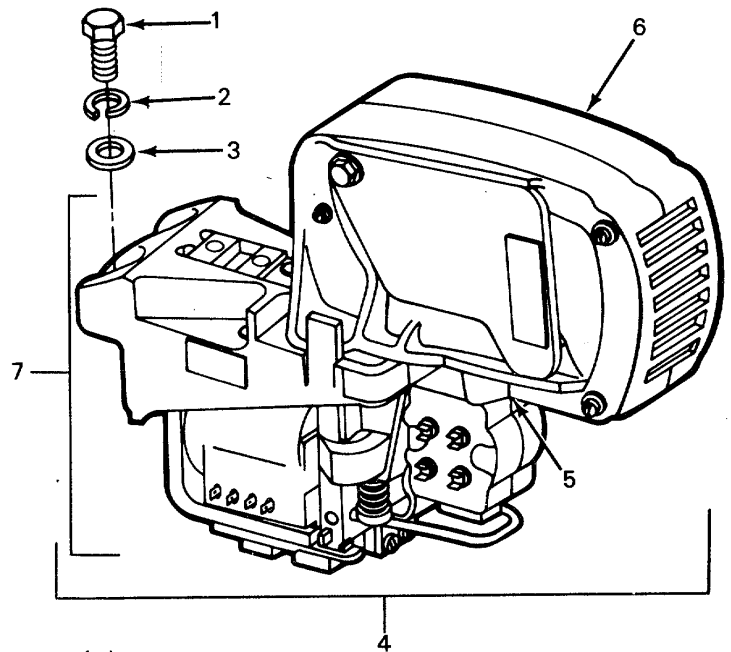
NOTE

- If power contactor is suspected of being defective perform steps 24, 25, and 26 before removing.
 - Check that electrical wires are labeled with wire numbers or polarity signs.
1. Set battery switch to OPEN position. Tag and disconnect wires from power contactor assembly.

3-24. POWER CONTACTOR (cont)

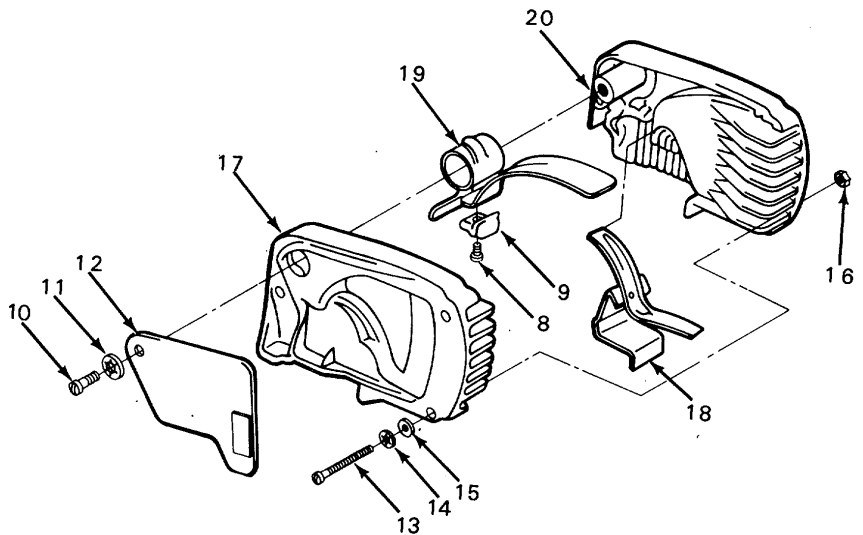
REMOVAL (cont)

2. Remove two capscrews (1), lockwashers (2), flat washers (3), and power contactor assembly (4).
3. Pull latch spring (5) forward and remove arc chute assembly (6) from contactor assembly (7).



DISASSEMBLY

4. Disassemble arc chute assembly (6) by the following:
 - a. Remove two screws (8) and arcing contact assembly (9).
 - b. Remove capscrew (10), lockwasher (11), and pole plate (12) from left side.
 - c. Remove three screws (13), lockwashers (14), flat washers (15), nuts (16), and arc chute (17).
 - d. Remove latch spring and arc runner assembly (18).
 - e. Remove blowout coil and arc runner assembly (19) from arc chute (20).

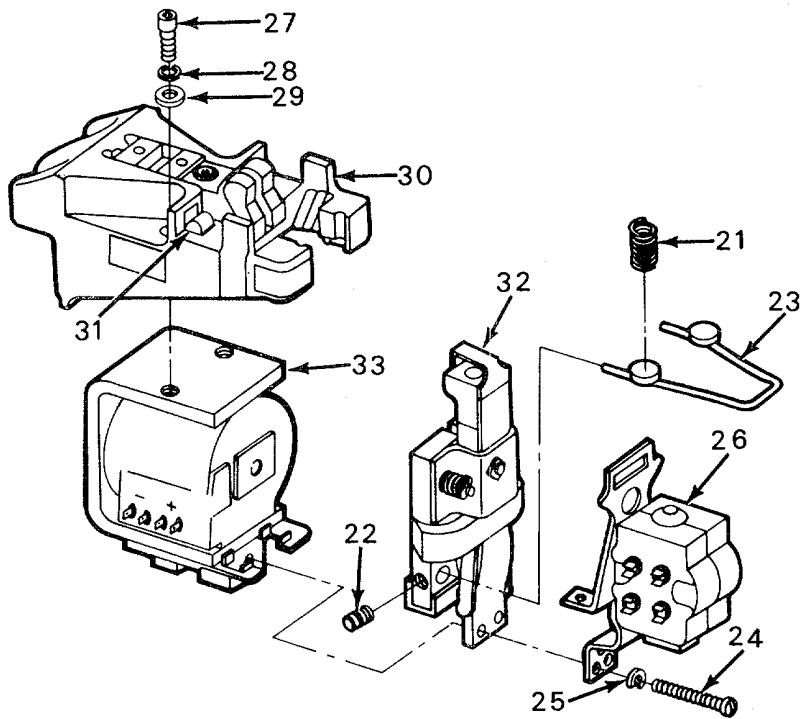


3-24. POWER CONTACTOR (cont)

DISASSEMBLY (cont)

5. Disassemble contactor assembly (7) by the following:

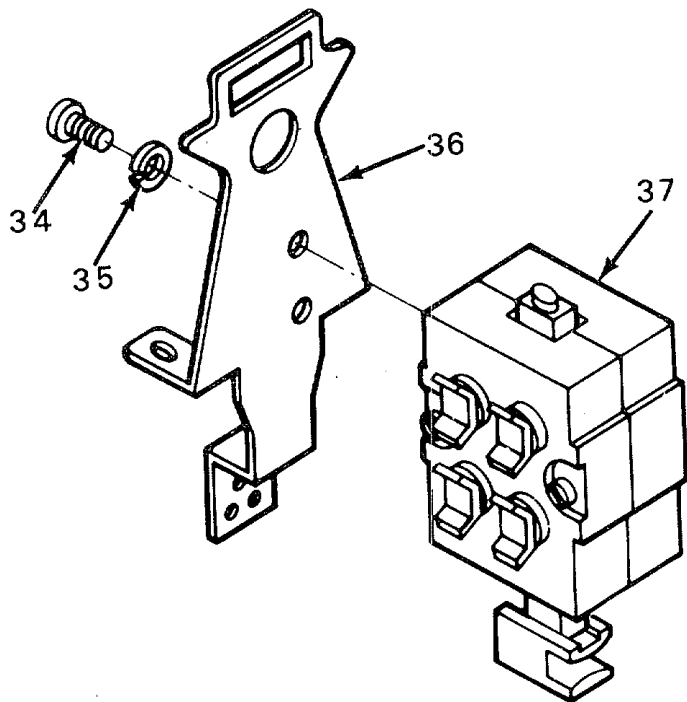
- a. Remove two return springs (21), set-screw (22), and operating lever (23).
- b. Remove two screws (24), lockwashers (25), and interlock assembly (26).
- c. Remove two allen head screws (27), lockwashers (28), flat washers (29), stationary contact assembly (30), and plastic safety lock (31).



d. Remove movable contact assembly (32) from magnet assembly (33).

6. Disassemble interlock assembly (26) by the following:

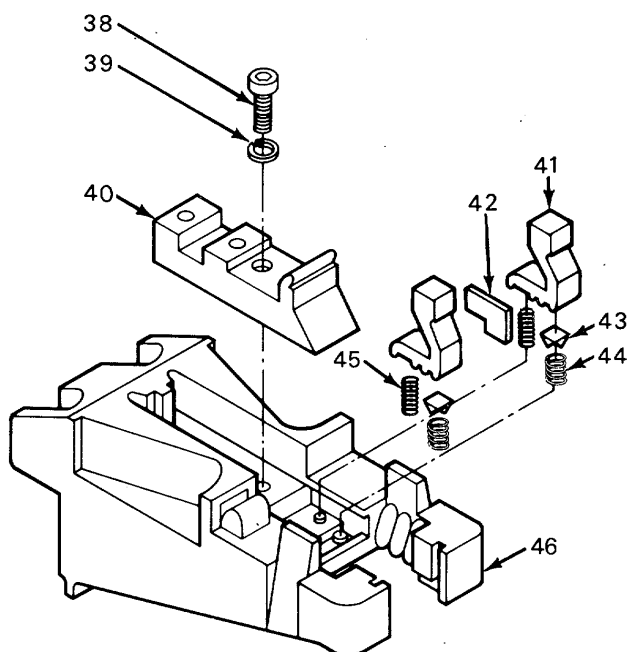
- a. Remove two screws (34), lockwasher (35), and support bracket (36).
- b. Remove interlock housing (37).



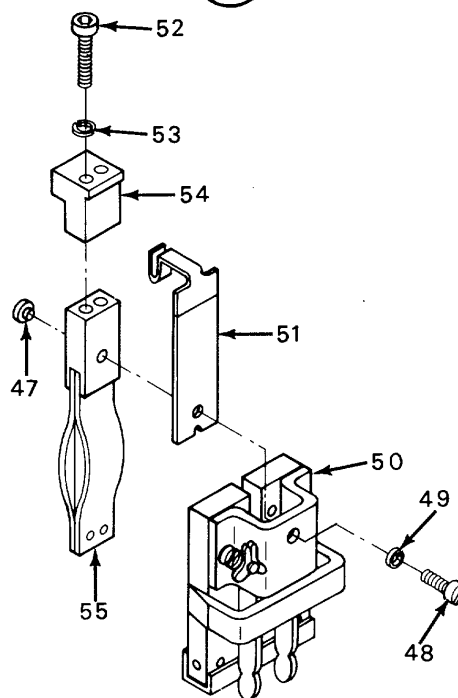
3-24. POWER CONTACTOR (cont)

DISASSEMBLY (cont)

7. Disassemble stationary contact assembly (30) by the following:
 - a. Remove two allen-head screws (38), lockwashers (39), and top stationary contact (40).
 - b. Remove two stationary contacts (41) and spacer (42).
 - c. Remove two pivot spring caps (43), pivot springs (44), and wipe springs (45) from top terminal bracket (46).



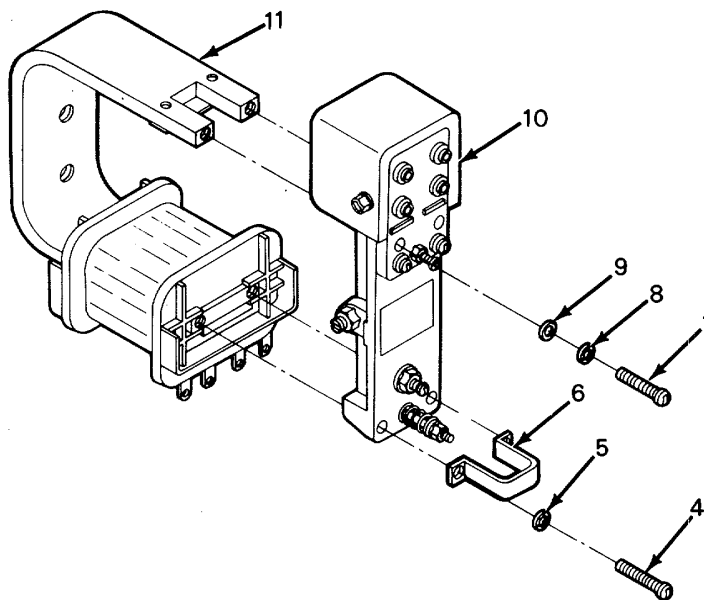
8. Disassemble movable contact assembly (32) by the following:
 - a. Remove open-stop (47), screw (48), and lockwasher (49); pull back hold-on iron (50); and remove movable arcing tip (51).
 - b. Remove two allen-head screws (52), lockwashers (53), and movable contact (54) from movable contact support (55).



3-24. POWER CONTACTOR (cont)

DISASSEMBLY (cont)

9. Remove screw (56), lock-washer (57), pole plate (58), magnet coil (59), and spring washer (60) from magnet bracket (61).



CLEANING, INSPECTION, AND REPAIR

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash you eyes and get medical aid immediately.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
- Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.

NOTE

Do not file or attempt to clean stationary contacts (41) or movable contact (54). Silver alloy surfaces on contacts may become blackened, pitted, or eroded. These conditions will not hamper the operation of the contactor.

10. Use dry-cleaning solvent and clean metal parts. Dry with compressed air.

3-24. POWER CONTACTOR (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

11. Inspect molded parts for warpage, breaks, and cracks. Replace damaged parts.
12. Inspect two stationary contacts (41) and movable contact (54) for wear. If alloy material is worn through to base metal, replace stationary and movable contacts together.
13. Inspect interlock housing (37) for wear. If contacts are burned or broken, replace interlock housing.
14. Inspect magnet coil (59) for damaged insulation. Use a multimeter and measure resistance of magnet coil. If resistance is not 120.0 ohms ($\pm 10\%$) or insulation is damaged replace coil.
15. Replace damaged or loose terminals.

ASSEMBLY

16. Assemble magnet assembly (33) by the following:
 - a. Install spring washer (60) and magnet coil (59) on magnet bracket (61).
 - b. Install pole plate (58) on magnet assembly (61). Secure with lockwasher (57) and screw (56).
17. Assemble movable contact assembly (32) by the following:
 - a. Install movable contact (54) on movable contact support (55). Secure with two lockwashers (53) and allen-head screws (52).
 - b. Install movable arcing tip (51) and hold-on iron (50) on movable contact support (55). Secure with lockwasher (49) and screw (48).
 - c. Install open-stop (47) in movable contact support (48).
18. Assemble stationary contact assembly (30) by the following:
 - a. Install two wipe springs (45) into tapered holes in top terminal (46).
 - b. Install two pivot springs (44) over cone-shaped pins on top terminal (46), and install two pivot spring caps (43) on pivot springs.
 - c. Install spacer (42) with short leg of L between two pivot springs (44) and long leg between two wipe springs (45).
 - d. Install two stationary contacts (41) over two pivot springs (44) and two wipe springs (45).
 - e. Install top stationary contact (40) and secure with two lockwashers (39) and allen-head screws (38).

3-24. POWER CONTACTOR (cont)

ASSEMBLY (cont)

19. Assemble interlock assembly (26) by the following:
 - a. Position support bracket (36) on interlock housing (37).
 - b. Install two lockwashers (35) and screws (34).
20. Assemble contactor assembly (7) by the following:
 - a. Install movable contact assembly (32) on magnet assembly (33).
 - b. Install plastic safety lock (31) in stationary contact assembly (30). Position over magnet assembly (33) and movable contact assembly (32).

NOTE

Do not tighten screws (27) until interlock assembly has been installed.

- c. Install two flat washers (29), lockwashers (28), and allen-head screws (27).
 - d. Install top end of interlock assembly (26) under front end of stationary contact assembly (30).
 - e. Center movable contact assembly (32) in opening of stationary contact assembly (30) and install two lockwashers (25) and allen-head screws (24).
 - f. Install operating lever (23), setscrew (22), and two return springs (21).
20. Assemble arc chute assembly (6) by the following:
 - a. Install blowout coil and arc runner assembly (19), magnetic core (19) and latch spring and arc runner assembly (18) on arc chute (20).
 - b. Install arc chute (17) and secure with three nuts (16), flat washers (15), lockwashers (14), and screws (13).
 - c. Apply silicone rubber between pole plate (12) and arc chute (17). Install pole plate (12) and secure with lockwasher (11) and capscrew (10).
 - d. Install arcing contact assembly (9) and two screws (8).
 21. Install latch spring (5) in notch of contactor assembly (7). Pull latch spring forward and press arc chute assembly (6) down. Release latch spring.

3-24. POWER CONTACTOR (cont)

INSTALLATION

22. Install power contactor assembly (4) and secure with two flat washers (3), lockwashers (2), and capscrews (1).
23. Connect electrical wires in accordance with wiring diagram.

TEST

WARNING

- High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.
 - Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.
24. Connect a variable dc voltage to magnetic coil (74). Use a multimeter and attach leads of variable dc voltage source. While applying voltage, check that the maximum pickup is 48 V dc. While decreasing voltage, note the dropout point; it should be between 28 and 5 V dc.
 25. Energize and deenergize relay and check that there is no hesitation during pickup or dropout.
 26. Set battery switch to open position. Manually operate interlock contacts. Use a multimeter and check resistance of contacts for infinity while open and continuity while closed.

3-25. GENERAL-PURPOSE RELAY

This task covers:

- a. Removal b. Installation c. Test

INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12

REMOVAL

WARNING

- High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.
- Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.

NOTE

If general purpose relay is suspected of being defective perform step 5.

1. Set battery switch to OPEN position. Tag and disconnect wires from relay assembly.

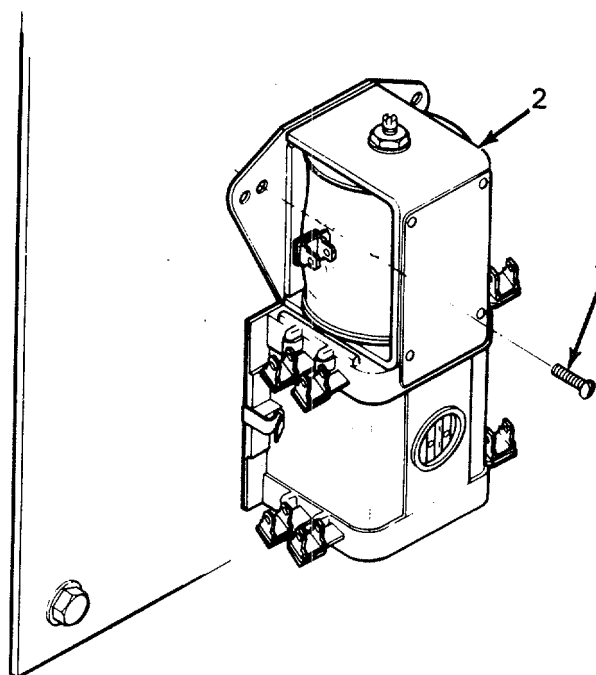
2. Remove two screws (1) and relay assembly (2).

INSTALLATION

3. Install relay assembly (2) and secure with two screws (1).
4. Connect electrical wires and remove tags.

TEST

5. Energize and deenergize relay and check that there is no hesitation during pickup or dropout.



3-26. GROUND RELAY

This task covers:

- | | | | |
|----------------|---------------|-------------|-----------------|
| a. Removal | c. Cleaning | e. Repair | g. Installation |
| b. Disassembly | d. Inspection | f. Assembly | f. Test |

INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12

Material/Parts

Dry-cleaning solvent (Item 30, Appendix B)

Test Equipment

Multimeter 6625-01-139-2512

Variable dc voltage supply

REMOVAL

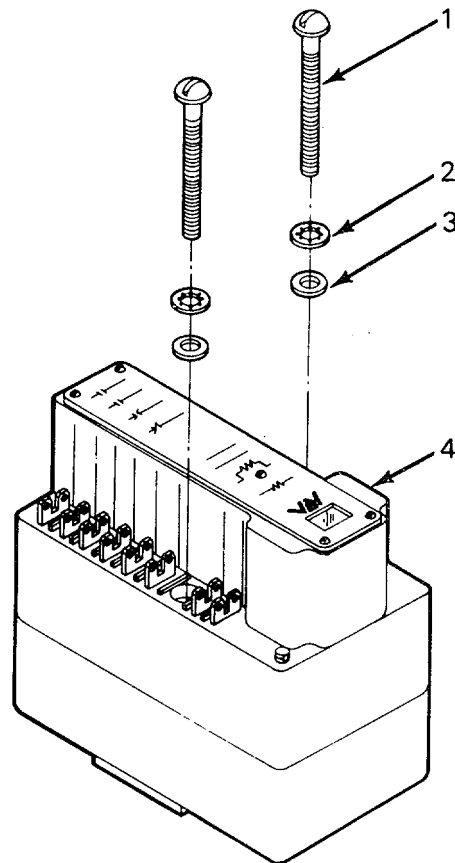
WARNING

- High voltage is used in the operation of equipment. Do not be misled by the term **LOW VOLTAGE**. Potentials as low as 50 volts may cause death.
- Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.

NOTE

If ground relay is suspected of being defective perform steps 19 and 20 before removal.

1. Set battery switch to **OPEN** position. Tag and disconnect wires from relay assembly.
2. Remove two screws (1), lockwashers (2), flat washers (3), and ground relay (4).



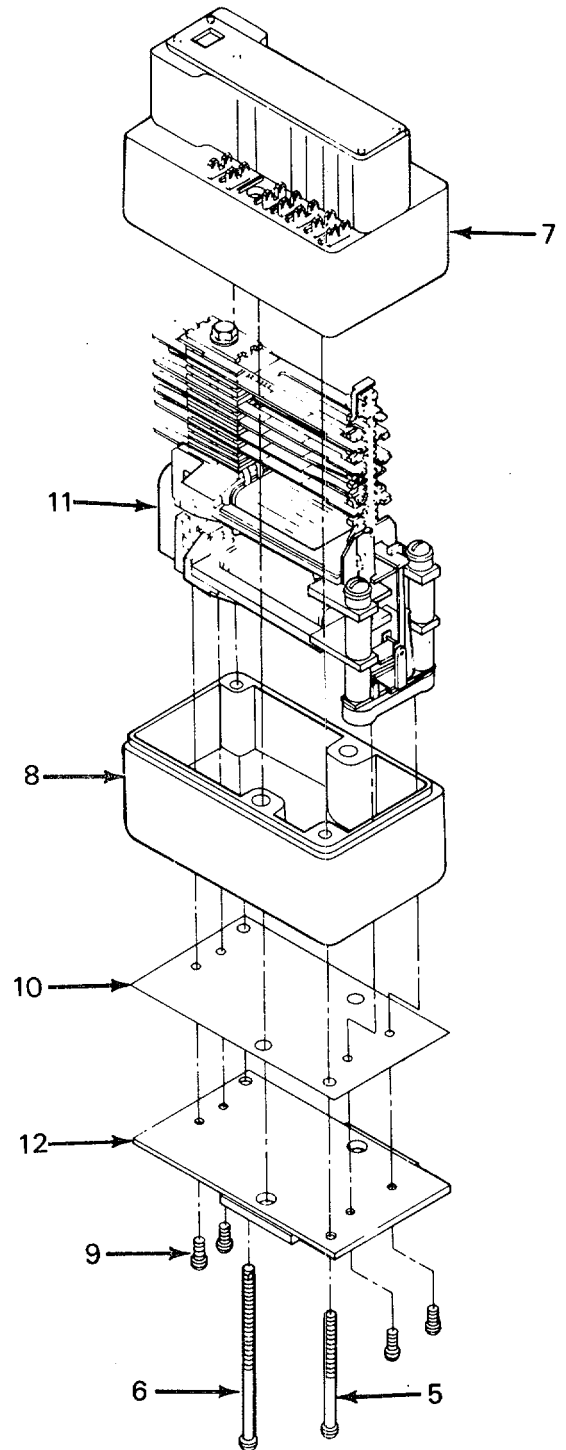
3-26. GROUND RELAY (cont)

DISASSEMBLY

CAUTION

Coil and contact assembly (11) must be repaired at depot maintenance level.

3. Remove two screws (5) and (6) and separate cover assembly (7) from spacer (8).
4. Remove four screws (9), insulator (10), and coil and contact assembly (11) from base (12).
5. Tag and disconnect electrical wires inside cover assembly (7).
6. Remove cover assembly (7) and spacer (8).



3-26. GROUND RELAY (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Dry-cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
7. Use dry-cleaning solvent and clean metal parts. Dry with compressed air.
 8. Inspect molded parts for warpage, breaks, and cracks. Replace damaged parts.
 9. Inspect cover assembly (7) for loose or corroded terminals. Replace damaged cover assembly.
 10. Use a multimeter and measure coil resistance on operator portion of coil and contact assembly (11). If resistance is not 0.86 ohms ($\pm 10\%$), replace coil.
 11. Use a multimeter and measure coil resistance on unlatching portion of coil and contact assembly (11). If resistance is not 250 ohms ($\pm 10\%$), replace coil.

ASSEMBLY

12. Install insulator (10) and coil and contact assembly (11) on base (12). Install screws (9).
13. Connect wires to inside terminals of cover assembly (7).
14. Install cover assembly (7) on spacer (8).
15. Install assembled base (12) on spacer (8).
16. Install screws (6) and (5).

3-26. GROUND RELAY (cont)

INSTALLATION

17. Install ground relay (4) and install two flat washers (3), lockwashers (2), and screws (1).
18. Connect wires to relay assembly and remove tags.

TEST

19. Connect a variable dc voltage supply and multimeter to operator portion of coil and contact assembly (10). Check that operating coil maximum pickup current is 0.825 amps, minimum pickup current is 0.750 amps, and drop away current is 0.075 amps.
20. Connect a variable dc voltage supply to unlatching portion of coil and contact assembly (10). Use a multimeter and measure voltage. Check that pickup voltage is 48 V dc maximum and dropout voltage is 2 to 18 V dc.

3-27. WHEEL SLIP RELAY

This task covers:

- | | | | |
|----------------|---------------|-------------|-----------------|
| a. Removal | c. Cleaning | e. Repair | g. Installation |
| b. Disassembly | d. Inspection | f. Assembly | h. Test |
-

INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12

Material/Parts

Dry-cleaning solvent (Item 30, Appendix B)

Test Equipment

Multimeter 6625-01-139-2512
Variable dc voltage supply

REMOVAL

WARNING

- High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.
- Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.

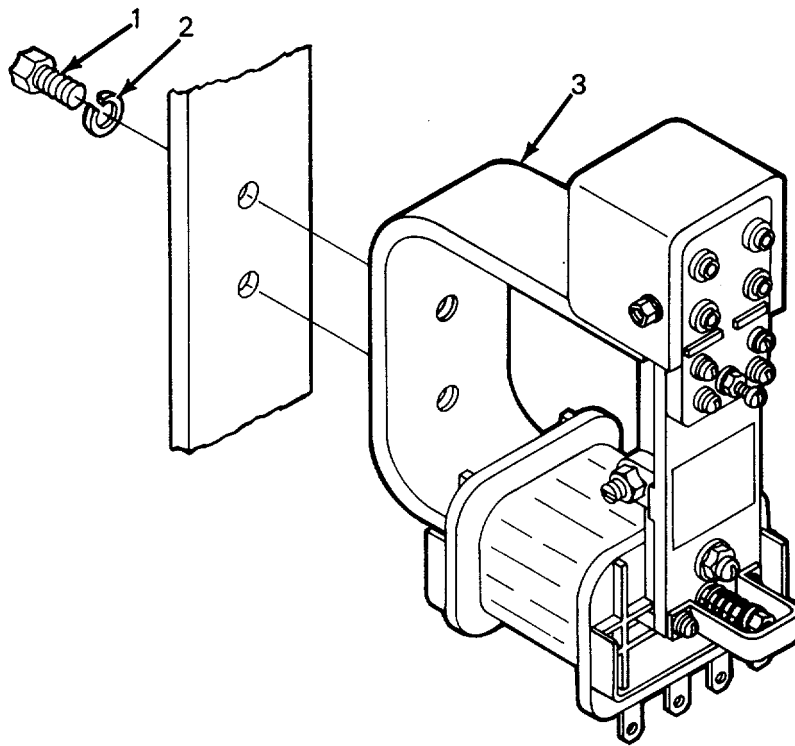
NOTE

If wheel slip relay is suspected of being defective perform steps 24, 25, and 26 before removal.

1. Set battery switch to OPEN position. Disconnect wires from relay assembly.
2. Disconnect and remove power cables running through center of relay assembly.
3. Remove two bolts (1), lockwashers (2), and wheel slip relay (3).

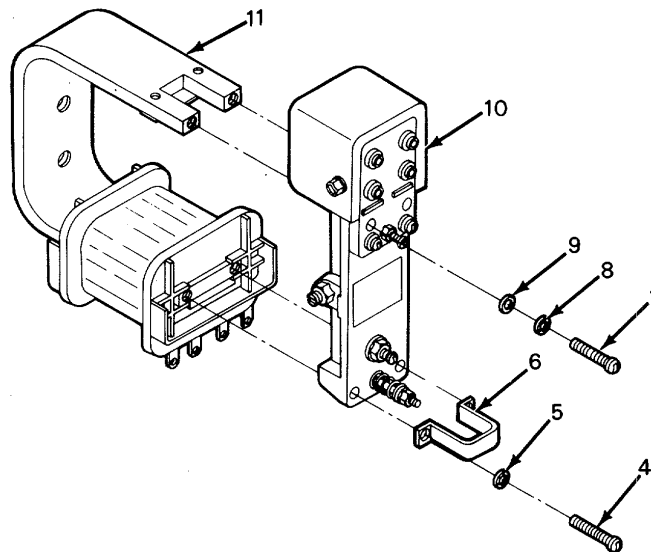
3-27. WHEEL SLIP RELAY (cont)

REMOVAL (cont)



DISASSEMBLY

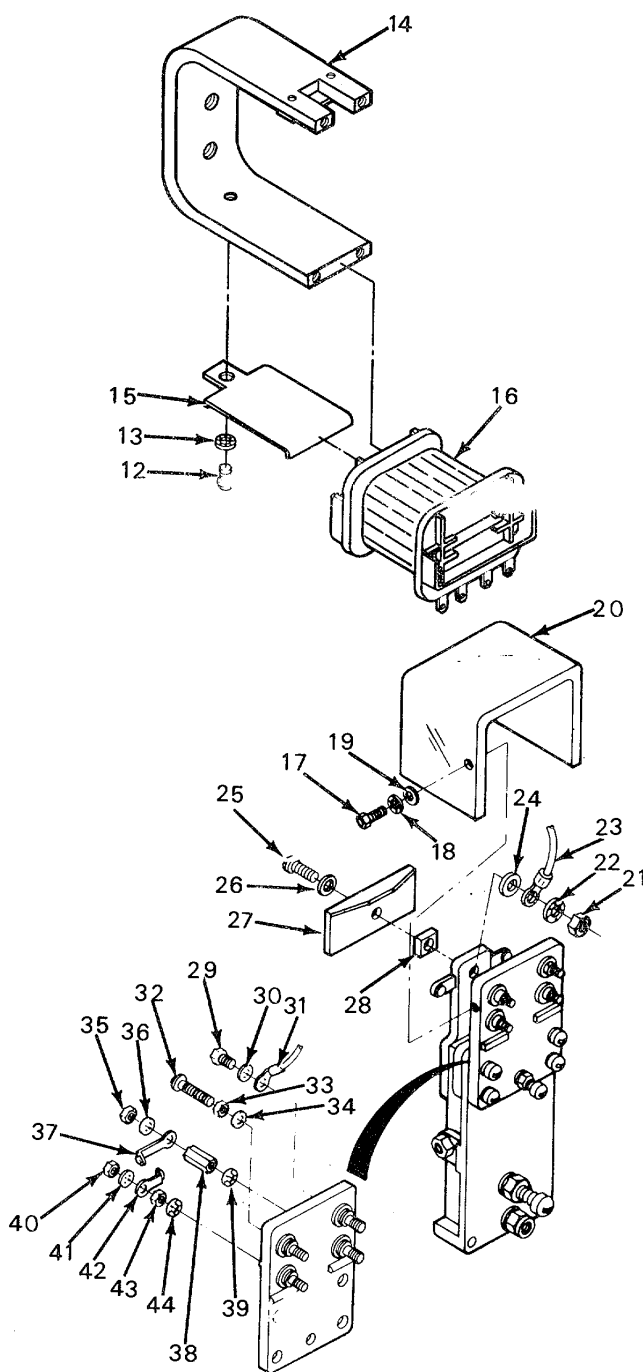
4. Remove two screws (4), lockwashers (5), and bracket (6).
5. Remove two screws (7), lockwashers (8), flat washers (9), and armature and board assembly (10) from coil assembly (11).



3-27. WHEEL SLIP RELAY (cont)

DISASSEMBLY (cont)

6. Disassemble coil assembly (11) by the following:
 - a. Remove screw (12) and lockwasher (13).
 - b. Remove yoke (14) and bracket (15) from coil (16).
7. Disassemble armature and board assembly (10) by the following:
 - a. Remove two screws (17), lockwashers (18), flat washers (19), and cover (20).
 - b. Remove nut (21), flat washer (22), lead assembly (23), and flat washer (24).
 - c. Remove screw (25), flat washer (26), shield (27), and nut (28).
 - d. Remove screw (29), flat washer (30), and lead assembly (31).
 - e. Remove screw (32), nut (33), and flat washer (34).
 - f. Remove nut (35), flat washer (36), contact (37), stud (38), and lockwasher (39).
 - g. Remove nut (40), flat washer (41), contact (42), nut (43), and lockwasher (44) from board assembly (45).



3-27. WHEEL SLIP RELAY (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Dry-cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
8. Use dry-cleaning solvent and clean metal parts. Dry with compressed air.
 9. Inspect molded parts for warpage, breaks, and cracks. Replace damaged parts.
 10. Use a multimeter and measure resistance of coil (16). If resistance is not 542 ohms ($\pm 10\%$), replace coil.

ASSEMBLY

11. Assemble board assembly (45) by the following:
 - a. Install lockwasher (44), nut (43), contact (42), flat washer (41), and nut (40).
 - b. Install lockwasher (39), stud (38), contact (37), flat washer (36), and nut (35).
 - c. Install flat washer (34), nut (33), and screw (32).
 - d. Install lead assembly (31) and flat washer (30) on board assembly (45). Secure with screw (29).
12. Assemble armature and board assembly (10) by the following:
 - a. Install nut (28), shield (27), flat washer (26), and screw (25).
 - b. Install flat washer (2A), lead assembly (23), and flat washer (22). Secure with nut (21).

3-27. WHEEL SLIP RELAY (cont)

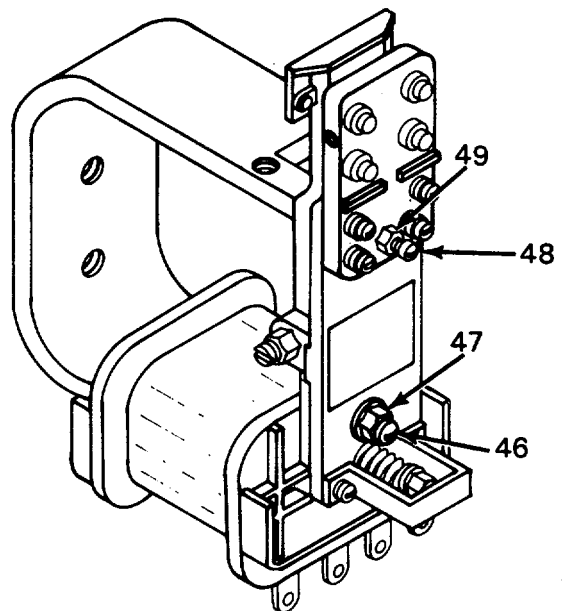
ASSEMBLY (cont)

13. Assemble coil assembly (11) by the following:
 - a. Place bracket (15) inside coil (16).
 - b. Slide coil (16) and bracket (15) onto yoke (14). Install lockwasher (13) and screw (12).
14. Install armature and board assembly (10) on coil assembly (11). Install two flat washers (9), lockwashers (8), and screws (7).
15. Install bracket (6), two lockwashers (5), and screws (4).

NOTE

Air gap settings should be made with relay at workbench. Measurements are to be made with feeler gage between armature and board assembly (10) and coil assembly (11).

16. Adjust open air gap to 0.073 to 0.075 inch (1.85 to 1.90 mm) by adjusting screw (46). Tighten nut (47).
17. Adjust closed air gap to 0.005 to 0.015 inch (0.13 to 0.38 mm) by adjusting screw (48). Tighten nut (49).
18. Adjust normally closed contacts to open at 0.030 to 0.034 inch (0.76 to 0.86 mm).
19. Adjust normally open contacts to close at 0.041 to 0.045 inch (1.041 to 1.14 mm).
20. Install cover (20), two flat washers (19), lockwashers (18), and screws (17).



3-27. WHEEL SLIP RELAY (cont)

INSTALLATION

21. Install wheel slip relay (3) and install two lockwashers (2) and bolts (1).

CAUTION

Improper routing of power cables through center of wheel slip relay will result in improper operation of relay.

22. Install power cables through center of wheel slip relay and connect in accordance with wiring diagram.
23. Connect electrical wires in accordance with wiring diagram.

TEST

24. Connect a variable dc voltage supply and multimeter to coil (16). Check that pickup current is 17 to 19 milliamps. If not in tolerance, adjust nut (21).
25. Connect a variable dc voltage supply and multimeter to coil (16). Check that dropout current is 9 to 12 milliamps. If not, readjust closed air gap in accordance with step 19.
26. Energize and deenergize relay and check that there is no hesitation during pickup or dropout.

3-28. MAGNETIC REVERSER SWITCH

This task covers:

- | | | | |
|----------------|---------------|-------------|-----------------|
| a. Removal | c. Cleaning | e. Repair | g. Installation |
| b. Disassembly | d. Inspection | f. Assembly | h. Test |

INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12

Test Equipment

Multimeter 6625-01-139-2512

Variable dc voltage supply

Material/Parts

Dry-cleaning solvent (Item 30, Appendix B)

Sealing compound (Item 8, Appendix B)

REMOVAL

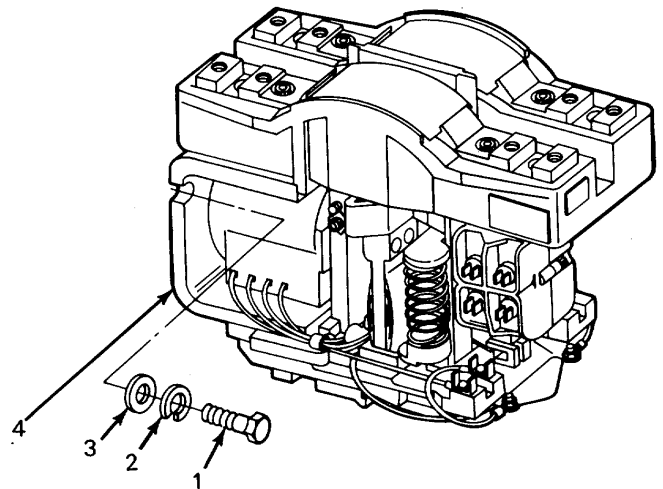
WARNING

- High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.
- Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.

NOTE

If magnetic reverse switch is suspected of being defective perform steps 37, 38, and 39 before removal.

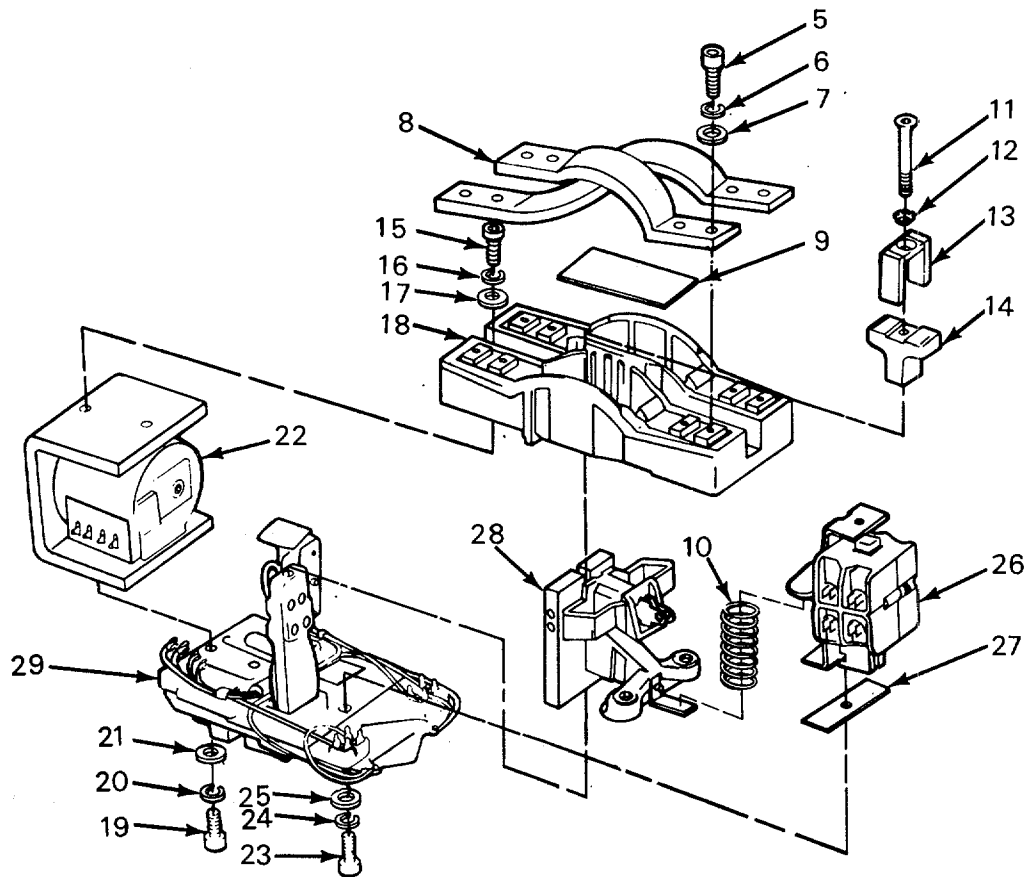
1. Set battery switch to OPEN position. Disconnect wires from relay assembly and tag wires.
2. Remove two socket-head screws (1), lockwashers (2), flat washers (3), and magnetic reverser switch (4).



3-28. MAGNETIC REVERSER SWITCH (cont)

DISASSEMBLY

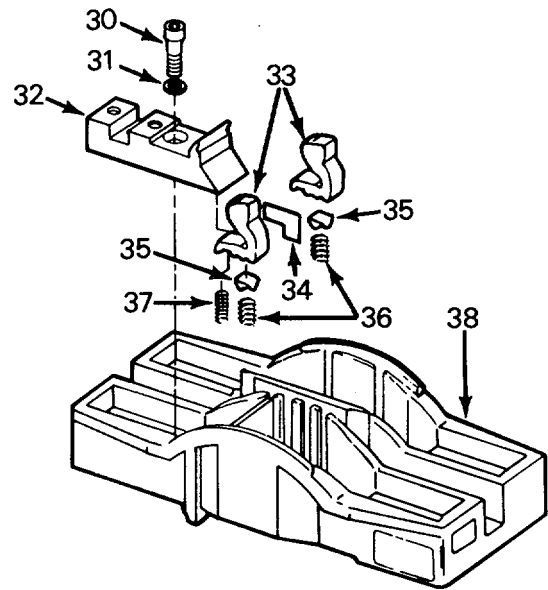
3. Remove eight screws (5), lockwashers (6), flat washers (7), and two transfer bars (8).
4. Push ends of two plastic covers (9) and remove.
5. Remove two return springs (10).
6. Remove two allen-head screws (11), lockwashers (12), movable hold-on irons (13), and movable contacts (14).
7. Remove three allen-head screws (15), lockwashers (16), flat washers (17), and top terminal assembly (18).
8. Tag and remove wires from magnetic assembly (22).
9. Remove two allen-head screws (19), lockwashers (20), flat washers (21), and magnet assembly (22).
10. Remove allen-head screws (23), lockwashers (24), and flat washer (25).
11. Remove interlock assembly (26), insulator (27), and armature and operator assembly (28) from bottom terminal and limit switch assembly (29).



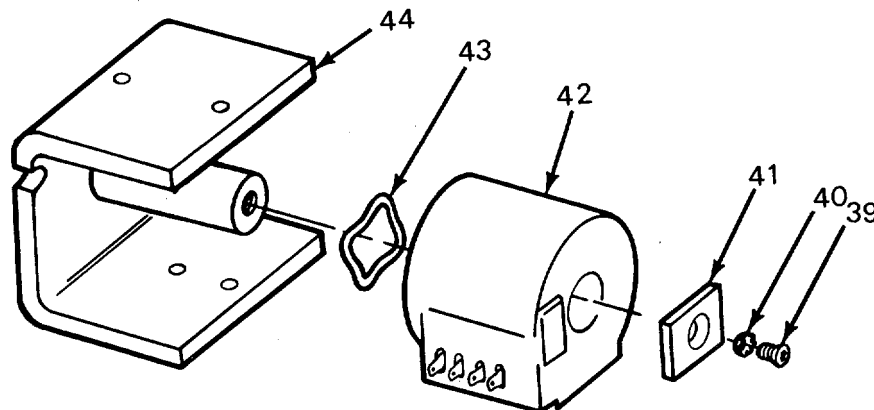
3-28. MAGNETIC REVERSER SWITCH (cont)

DISASSEMBLY (cont)

12. Disassemble top terminal assembly (18) by the following:
 - a. Remove eight allen-head screws (30), lockwashers (31), and four contact assemblies (32).
 - b. Remove eight stationary contacts (33) and four spacers (34).
 - c. Remove eight caps (35), pivot springs (36), and wipe springs (37) from top terminal (38).



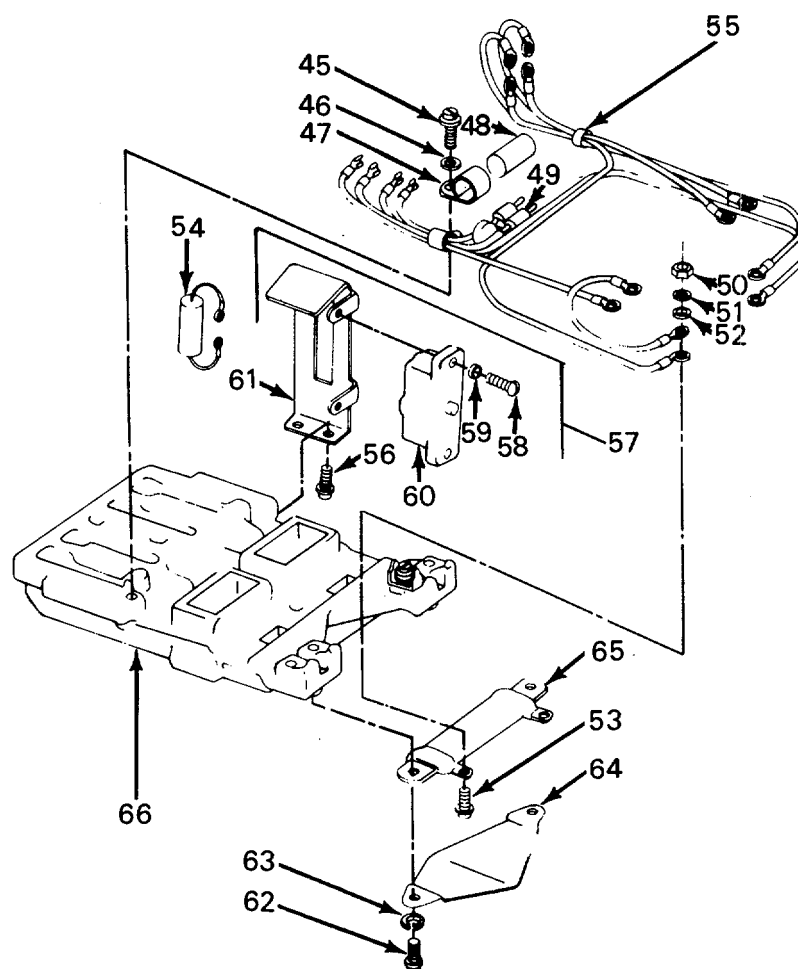
13. Disassemble magnet assembly (22) by the following:
 - a. Remove allen head screw (39), lockwasher (40), and pole plate (41).
 - b. Remove magnet coil (42) and spring washer (43) from magnet yoke (44).



14. Disassemble bottom terminal and limit switch assembly (29) by the following:
 - a. Remove screw (45), flat washer (46), clamp (47), sleeve (29), and rectifier assembly (49).
 - b. Remove two nuts (50), lockwashers (51), flat washers (52), and screws (53).
 - c. Tag and disconnect wires from back of limit switch (60). Remove capacitor (54) and wiring harness (55).

3-28. MAGNETIC REVERSER SWITCH (cont)

DISASSEMBLY (cont)



- d. Remove two screws (56) and limit switch assembly (57).
- e. Remove two screws (58), lockwashers (59), and limit switch (60) from switch bracket (61).
- f. Remove two screws (62), lockwashers (63), resistor guard (64), and resistor (65) from bottom terminal (66).

3-28. MAGNETIC REVERSER SWITCH (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 138°F (38 - 59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

NOTE

Do not file or attempt to clean movable contacts (14) and stationary contacts (33). Silver alloy surfaces on contacts may become blackened, pitted, or eroded. These conditions will not hamper the operation of the contactor.

15. Use drycleaning solvent and clean metal parts. Dry with compressed air.
16. Inspect molded parts for warpage, breaks, and cracks. Replace damaged parts.
17. Inspect movable contacts (14) and stationary contacts (33). If alloy material is worn through to base metal, replace contacts.
18. Inspect magnet coil (42) for damaged insulation. Replace damaged coil.
19. Use a multimeter and measure resistance of magnet coil (42). If resistance is not 19.8 ohms ($\pm 10\%$), replace coil.
20. Use a multimeter and measure resistance of resistor (65). If resistance is not 75 ohms ($\pm 5\%$), replace resistor.

3-28. MAGNETIC REVERSER SWITCH (cont)

ASSEMBLY

21. Assemble bottom terminal and limit switch assembly (29) by the following:
 - a. Install resistor (65) and resistor guard (64) on bottom terminal (66). Coat two screws (62) with sealant and install screws and lockwashers (63).
 - b. Install limit switch (60) on switch bracket (61). Secure with two lockwashers (59) and screws (58).
 - c. Install limit switch assembly (57) on bottom terminal (66). Coat two screws (56) with sealant and install.
 - d. Install wiring harness (55) on bottom terminal (66). Install capacitor (54) on back of limit switch assembly (57) and connect wires.
 - e. Install two screws (53), flat washers (52), lockwashers (51), and nuts (50).
 - f. Install rectifier assembly (49), sleeve (48), clamp (47), flat washer (46), and screw (45).
23. Assemble magnet assembly (22) by the following:
 - a. Install spring washer (43) and magnet coil (42).
 - b. Install pole plate (41) and secure with lockwasher (40) and screw (39).
24. Assemble top terminal assembly (18) by the following:
 - a. Install eight wipe springs (37), pivot springs (36), and caps (35) on top terminal (38).
 - b. Install eight stationary contacts (33), four spacers (34), and four contact assemblies (32) on top terminal (38). Secure with eight lockwashers (31) and allen-head screws (30).
25. Install armature and operator assembly (28) over movable contact assembly on limit switch assembly (29).
26. Install insulator (27) and interlock assembly (26) on limit switch assembly (29), with armature and operator assembly (28) in slot of interlock assembly.
27. Install flat washer (25), lockwasher (24), and allen-head screw (23).
28. Install magnet assembly (22) on limit switch assembly (29). Secure with two flat washers (21), lockwashers (20), and allen-head screws (19).
29. Connect wires and remove tags.

3-28. MAGNETIC REVERSER SWITCH (cont)

ASSEMBLY (cont)

30. Install top terminal assembly (18) on magnet assembly (22) and interlock assembly (26). Secure with three flat washers (17), lockwashers (16), and allen-head screws (15).
31. Install two movable contacts (14) and two movable hold-on irons (13). Secure with two lockwashers (12) and allen-head screws (11).
32. Install two return springs (10) between armature and operator assembly (28) and interlock assembly (26).
33. Install two plastic covers (.9).
34. Install two transfer bars (8) on top terminal assembly (18). Secure with eight flat washers (7), lockwashers (6), and screws (5).

INSTALLATION

35. Install magnetic reverser switch (4) and secure with two flat washers (3), lockwashers (2), and socket-head screws (1).
36. Install electrical wires in accordance with wiring diagram.

TEST

37. Connect a variable dc voltage supply to magnet coil (42). Use a multimeter and measure voltage. Check that pickup voltage is 48 V dc maximum and dropout voltage is 5 to 28 V dc.
38. Energize and deenergize relay and check that there is no hesitation during pickup or dropout.
39. Check that that battery switch is in OPEN position. Manually operate interlock contacts. Use a multimeter and check resistance of contacts for infinity while open and continuity while closed.

3-29. LOAD AMMETER SHUNT

This task covers:

a. Removal

b. Test

d. Installation

INITIAL SETUP:

Tools

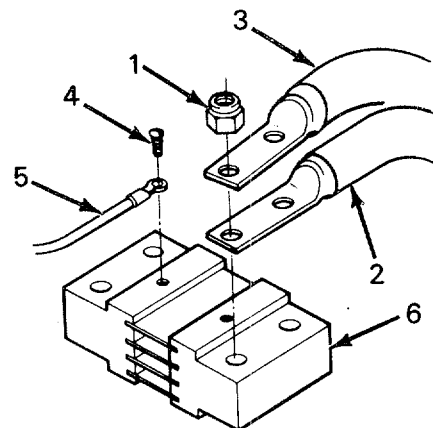
Tool kit SC 4940-97-CL-E12
Multimeter 6625-01-139-2512

REMOVAL

WARNING

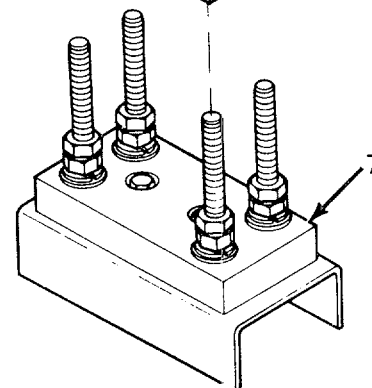
- High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.
- Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.

1. Place battery switch in OPEN position.
2. Remove four nuts (1).
3. Tag and disconnect two wires (2) and two wires (3).
4. Remove two screws (4).
5. Tag and disconnect two wires (5).
6. Remove shunt (6).



TEST

7. Use a multimeter and perform a continuity test on the load ammeter shunt. Replace if defective.



3-29. LOAD AMMETER SHUNT (cont)

INSTALLATION

8. Install shunt (6) to shunt base (7).
9. Connect two wires (3) and two wires (2) to shunt (6) and secure with four nuts (1).
10. Connect two wires (5) and secure with two screws (4).

3-30. BATTERY CHARGING AMMETER SHUNT

This task covers:

a. Removal

b. Test

c. Installation

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12
Multimeter 6625-01-139-2512

REMOVAL

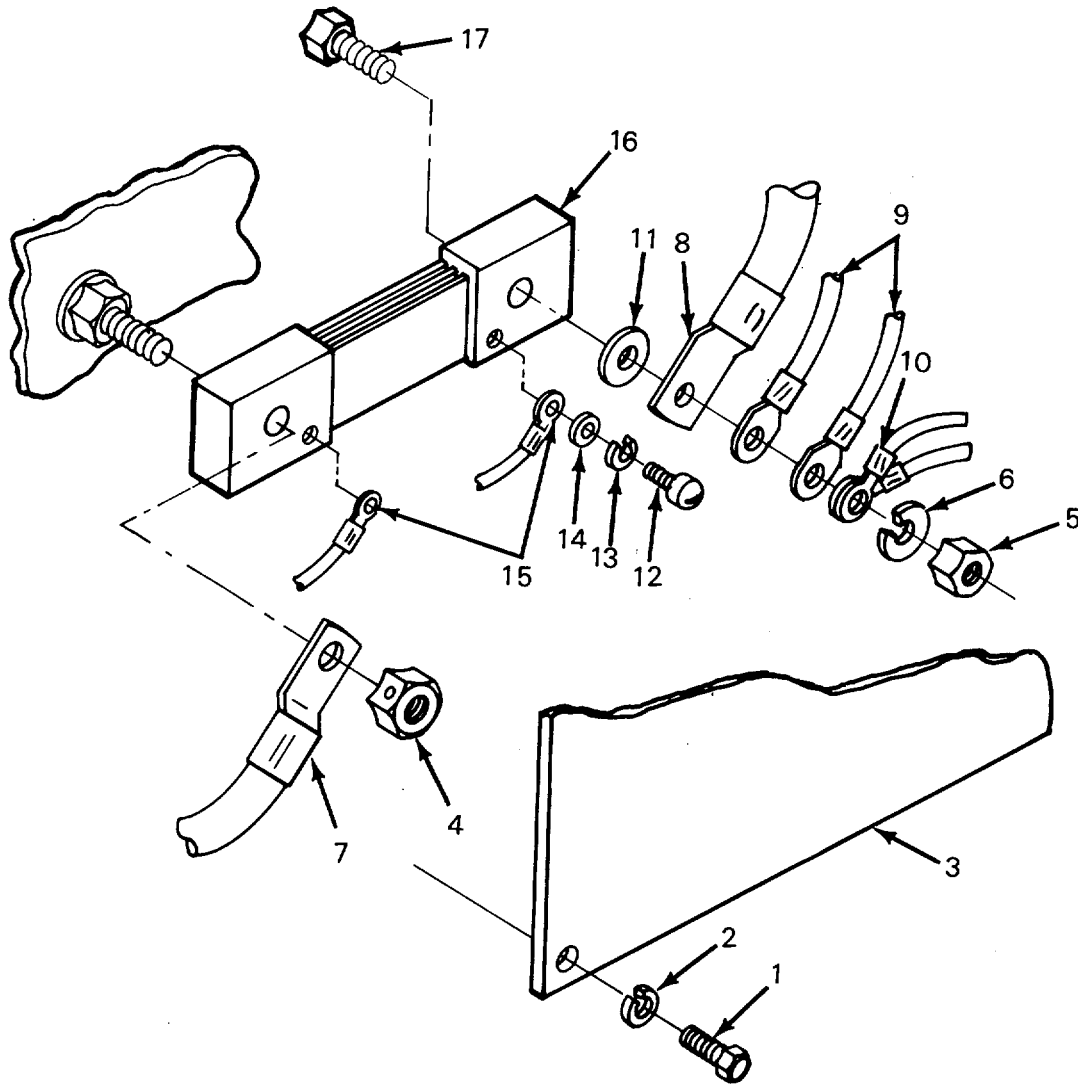
WARNING

- High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.
- Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.

1. Place battery switch in OPEN position.
2. Tag and disconnect positive lead from battery.
3. Remove eight bolts (1) and lockwashers (2) and lower rear access panel (3).
4. Remove locknut (4), nut (5), and lockwasher (6).
5. Tag and disconnect wires (7), (8), (9), and (10).
6. Remove flat washer (11).
7. Remove two screws (12), lockwashers (13), and flat washers (14). Remove wires (15).
8. Remove shunt (16).
9. Remove bolt (17).

3-30. BATTERY CHARGING AMMETER SHUNT (cont)

REMOVAL (cont)



TEST

10. Use a multimeter and perform a continuity test on the battery charging ammeter shunt. Replace defective unit.

3-30. BATTERY CHARGING AMMETER SHUNT (cont)

INSTALLATION

11. Install bolt (17).
12. Install shunt (16) on stud.
13. Install wires (15) and secure with two flat washers (14), lockwashers (13), and screws (12).
14. Install flat washer (11).
15. Install wires (10), (9), (8), and (7) and secure with lockwasher (6), nut (5), and locknut (4).
16. Install lower rear access panel (3) and secure with eight lockwashers (2) and bolts (3).
17. Connect positive lead to battery and remove tag.

3-31. BATTERY CHARGING RESISTOR

This task covers:

a. Removal

b. Test

c. Installation

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12
Multimeter 6625-01-139-2512

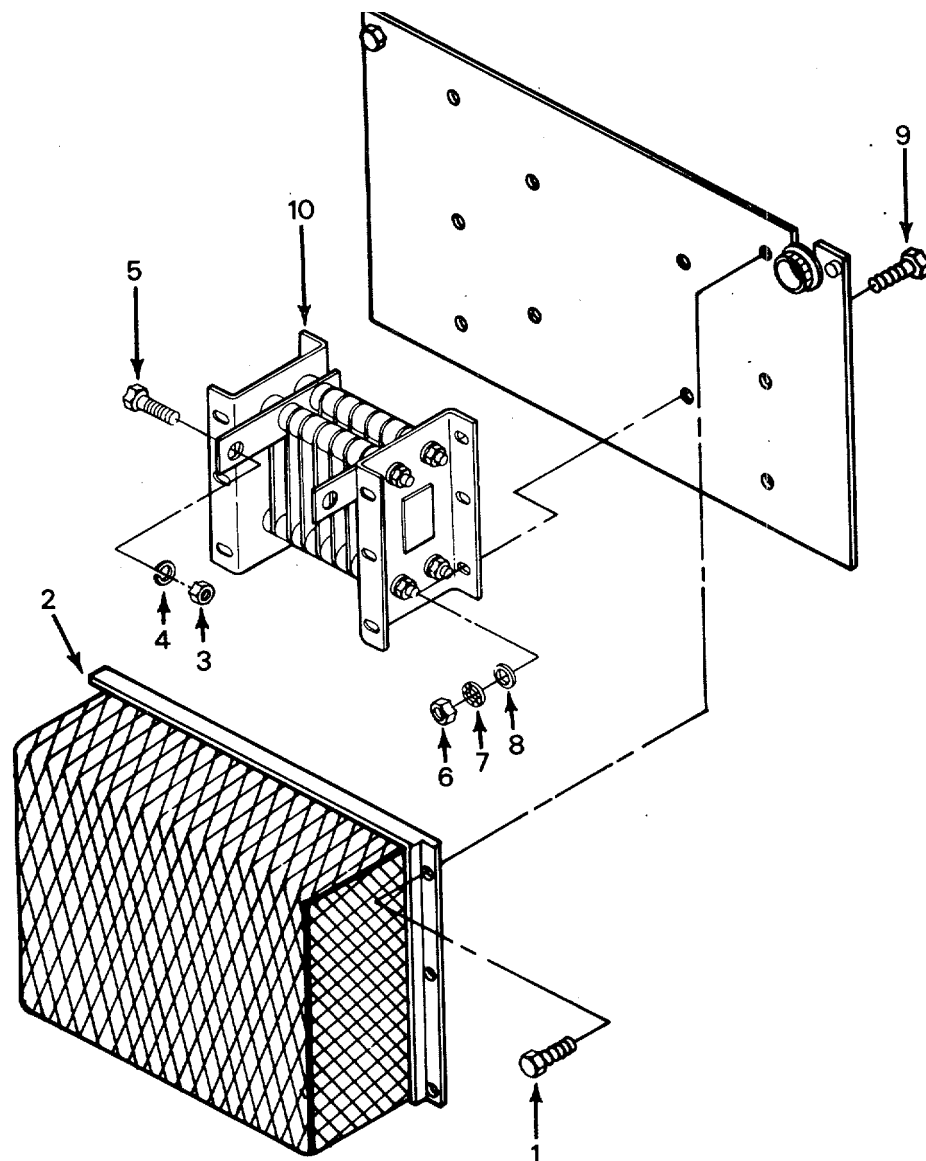
REMOVAL

WARNING

- High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.
 - Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.
1. Place battery switch in OPEN position. Remove six screws (1) and resistor cage (2).
 2. Remove two nuts (3), lockwashers (4), and bolts (5). Tag and disconnect wiring.
 3. Remove four nuts (6), star washers (7), flat washers (8), capscrews (9), and resistor assembly (10).

3-31. BATTERY CHARGING RESISTOR (cont)

REMOVAL (cont)



TEST

4. Use a multimeter and perform a resistance test on the battery charging resistor. The resistor value should be 0.05 ohms. If this reading is not obtained, replace defective resistor.

INSTALLATION

5. Install resistor assembly (10) and secure with four cap screws (9), flat washers (8), star washers (7), and nuts (6).
6. Connect wiring to resistor assembly (10) and secure with two bolts (5), lockwashers (4), and nuts (3).
7. Install resistor cage (2) and secure with six screws (1).

3-32. HEADLIGHT RESISTORS

This task covers:

a. Removal

b. Test

d. Installation

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

Test Equipment

Multimeter 6625-01-139-2512

REMOVAL

WARNING

- High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.
- Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.

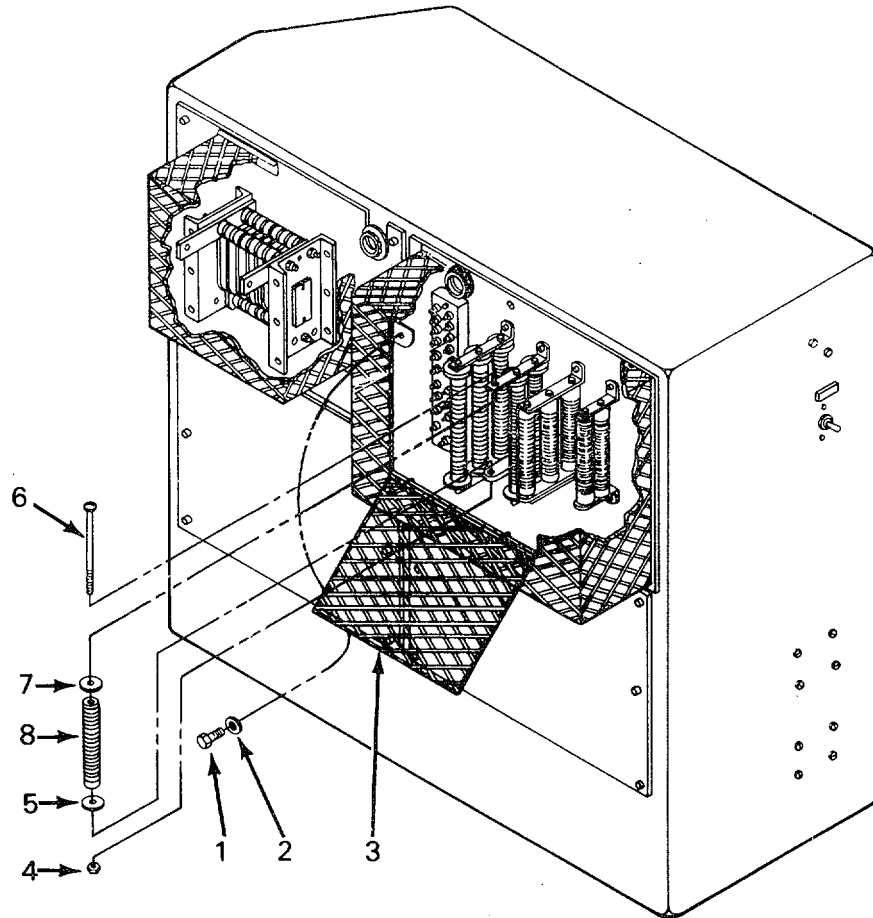
NOTE

All resistors in the locomotive, excluding the battery charger resistor, will be removed and installed in a manner similar to the headlight resistors.

1. Set battery switch to OPEN position.
2. Remove two screws (1) and flat washers (2) and lower resistor cage door (3).
3. Tag and disconnect wiring.
4. Remove locknut (4), mica washer (5), screw (6), mica washer (7), and resistor (8).
5. Repeat step 4 and remove five more headlight resistors.

3-32. HEADLIGHT RESISTORS (cont)

REMOVAL (cont)



TEST

6. Use a multimeter and perform a resistance test on the headlight resistors. The six 12-inch (305 mm) resistors are 8 ohms. If these readings are not obtained, replace defective resistors.

INSTALLATION

7. Install resistor (8) and mica washers (7) and (5). Secure with screw (6) and locknut (4).
8. Repeat step 7 and install five more headlight resistors.
9. Connect wiring.
10. Close resistor cage door (3) and secure with two flat washers (2), screws (1).

3-33. CONTROLLER MECHANISM

This task covers:

a.	Removal	c.	Cleaning	e.	Repair	g.	Assembly
b.	Test	d.	Inspection	f.	Disassembly	h.	Installation

INITIAL SETUP:

Tools

Tool kit No. SC 4940-97-CL-E12

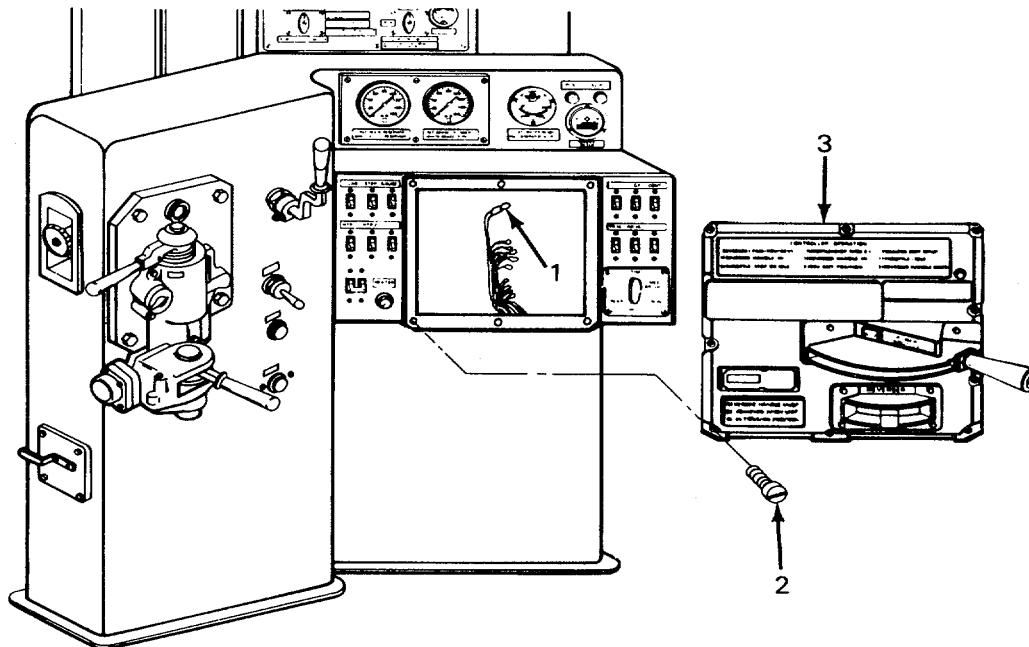
Material/Parts

Drycleaning solvent (Item 30, Appendix B)

REMOVAL

WARNING

- High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.
 - Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.
1. Set battery switch to OPEN position.
 2. Gain access to rear of controller through high-voltage cabinet door.
 3. Tag and disconnect wire harness leads from controller mechanism (3).



3-33. CONTROLLER MECHANISM (cont)

REMOVAL (cont)

4. Remove panel light (1) from top of controller mechanism (3).
5. Remove eight mounting screws (2) from top and sides of controller mechanism (3).
6. Remove controller mechanism (3).

TEST

7. Use multimeter and check the switches individually. Make a resistance test to check that the switches open and close while moving the throttle from STOP to THROTTLE 8 position.
8. Use a voltmeter and test resistor (7). Make a resistance test to check that the resistance is 300 ohms $\pm 5\%$.
9. Use a voltmeter and test resistor (16). Make a resistance test to check that the resistance is 75 ohms $\pm 5\%$.

CLEANING, INSPECTION, AND REPAIR

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 - 138°F (38 - 59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.
- 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.).

NOTE

Repair consists of replacing defective switches and/or replacing resistors.

10. Use drycleaning solvent and clean parts. Dry with compressed air.

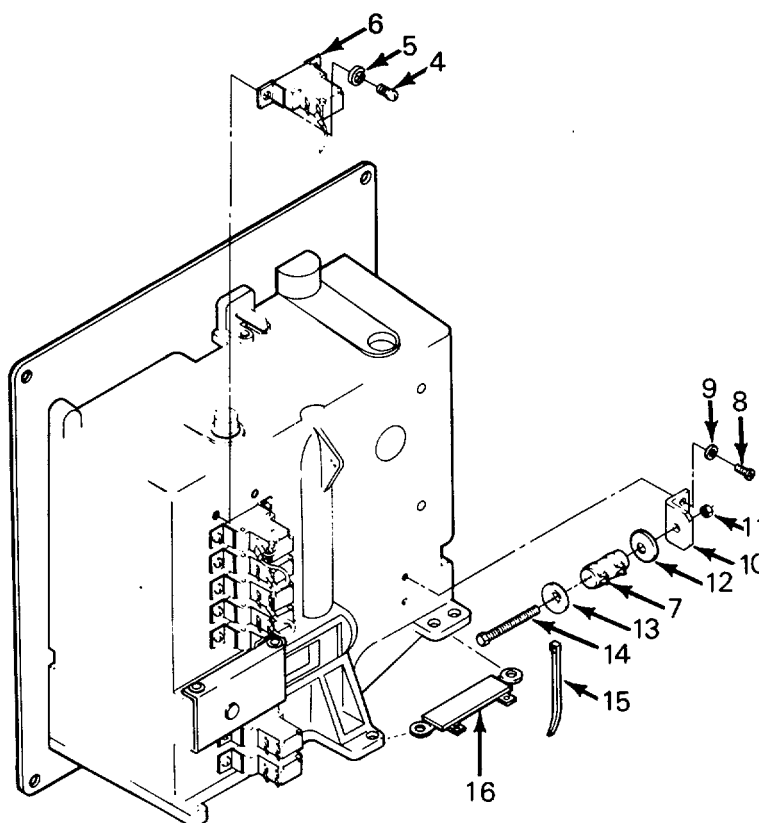
3-33. CONTROLLER MECHANISM (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

11. Inspect parts for cracks, breaks, or other damage.
12. Replace defective parts.

DISASSEMBLY

13. Remove two screws (4) and lockwashers (5).
14. Tag and disconnect wire jumpers between RE50 (7) and RE53 (16).
15. Remove switch (6).
16. Tag and disconnect wires from resistor RE50 (7) and resistor RE53 (16).
17. Remove two screws (8), lockwashers (9), and bracket (10).
18. Remove nut (11), mica washer (12), resistor RE50 (7), mica washer (13), and screw (14).
19. Remove two tie straps (15) and resistor RE53 (16).



3-33. CONTROLLER MECHANISM (cont)

ASSEMBLY

20. Install resistor RE53 (16) and secure with two tie straps (15).
21. Install screw (14), mica washer (13), resistor RE50 (7), mica washer (12) into bracket (10) and secure with nut (11).
22. Connect wires from resistor RE50 and RE53 and remove tags.
23. Install bracket (10), two lockwashers (9), and screws (8).
24. Install switch (6), two lockwashers (5), and screws (4).

INSTALLATION

25. Install controller mechanism (3) into control stand and secure with eight screws (2).
26. Connect wire jumpers between RE50 (7) and RE53 (16) and remove tags.
27. Install panel light (1).
28. Connect wiring harness to controller mechanism (3) and remove tags.

3-34. VOLTAGE REGULATOR

This task covers:

a. Test

b. Removal

c. Repair

d. Installation

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

Material/Parts

Drycleaning solvent (Item 30, Appendix B)

Test Equipment

Multimeter 6625-01-139-2512

WARNING

- High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.
- Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.

TEST

1. With engine running and throttle in No. 8 position, use a multimeter and measure voltage between terminal (1) of voltage regulator (positive) and negative side of battery switch. Multimeter reading should be 74 ± 1 volt in all throttle positions. It may be necessary to loosen locking nut (2) and adjust rheostat (3) to obtain correct reading. Shut down engine.

NOTE

If regulator is defective, attempt to correct fault by replacing panel control board. If correct test measurement cannot be obtained after replacing panel control board, replace entire voltage regulator.

REMOVAL

2. Set battery switch to OPEN position. Tag and disconnect voltage regulator wires.

3-34. VOLTAGE REGULATOR (cont)

REMOVAL (cont)

- Remove four screws (4), lockwashers (5), flat washers (6), and voltage regulator (7).

REPAIR

- Remove four screws (8), lockwashers (9), flat washers (10), panel control board (11), and four grommets (12). Tag and disconnect wires from panel control board.

INSTALLATION

- Connect wires to panel control board and remove tags.

- Install four grommet (12). Position panel control board (11) and secure with four flat washers (10), lockwashers (9), and screws (8).

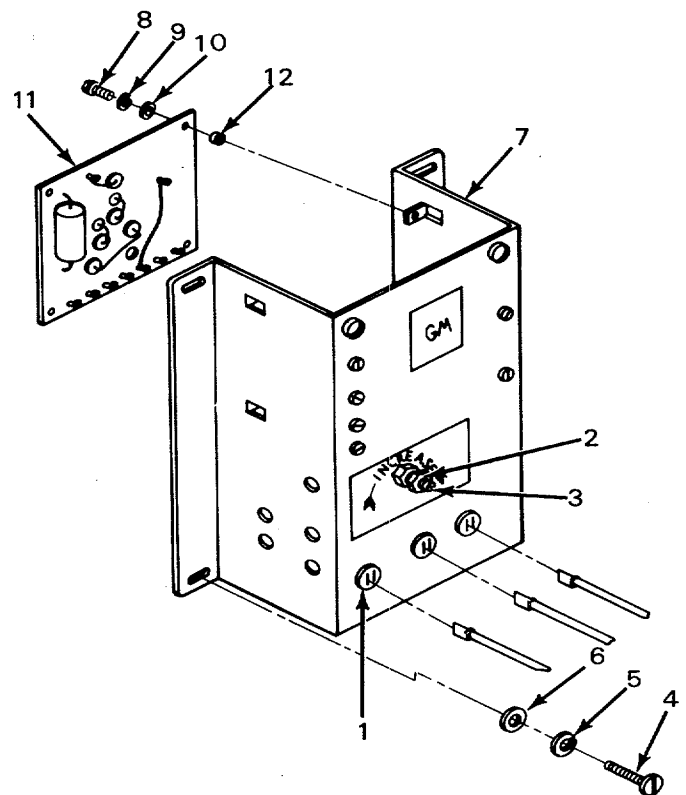
- Connect voltage regulator wires and perform voltage test in step 1 above. If reading of 74 ± 1 volt is not obtained, remove control board, return board to stock, and perform step 8. If 74 volts ± 1 is obtained proceed to step 9-and continue with installation procedures.

- Tag and disconnect voltage regulator wires, and replace entire voltage regulator.

- Install voltage regulator (7) and secure with four flat washers (6), lockwasher (5), and screws (4).

- Connect voltage regulator wires in accordance with wiring diagram and remove tags.

- Loosen locking nut (2) and turn rheostat (3) to minimum reading.



- Connect multimeter leads between positive side of charge fuse and negative side of battery switch.

- With engine running the multimeter reading should indicate between 62 and 70 volts.

- Place throttle in No. 8 position and adjust rheostat to maintain 74 volts. Allow components to warm up, and adjust voltage as necessary until constant 74-volt reading is attained. Lock rheostat (3) in place by tightening locking nut (2).

- Shut down engine. (TM 55-2210-223-12)

3-35. EXCITER-AUXILIARY GENERATOR ASSEMBLY

This task covers:

a.	Removal	c.	Cleaning	e.	Repair	g.	Assembly
b.	Disassembly	d.	Inspection	f.	Test	h.	Installation

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12
Dial indicator 5210-00-640-0953
Portable propane torch 3439-00-542-0531
Induction heater 2815-00-366-1432

Material/Parts

Drycleaning solvent (Item 30, Appendix B)
Grease BB (Item 12, Appendix B)
Clear acrylic lacquer (Item 17,
Appendix B)
Red insulating varnish (Item 33,
Appendix B)
Gray gloss enamel (Item 9, Appendix B)
Electrical tape (Item 32, Appendix B)
Wiping rags (Item 28, Appendix B)

Test Equipment

Multimeter 6625-01-139-2512
Megohmmeter 6625-00-456-7442

REMOVAL

WARNING

- Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.
 - High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.
1. Set battery switch to OPEN position. Tag and disconnect wiring (1) from terminals.
 2. Loosen four bolts (2).
 3. Refer to TM 55-2210-223-12 and remove drive belts.
 4. Remove four bolts (2) and flat washers (3) and (4).
 5. Turn adjusting nut (5) and free adjusting screw (6) from mounting bracket (7).

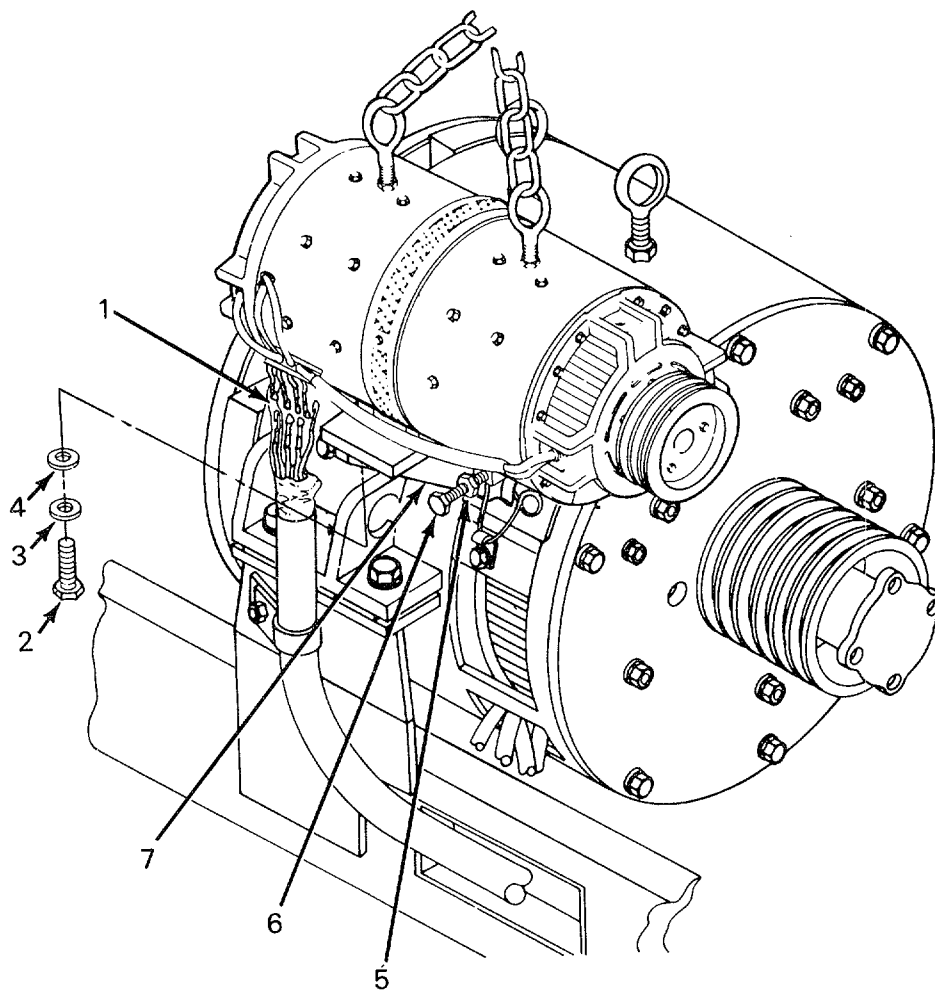
3-35. EXCITER-AUXILIARY GENERATOR ASSEMBLY (cont)

REMOVAL (cont)

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

6. Use a suitable lifting device and slowly lift exciter-auxiliary generator from main generator mounting bracket. Set upright on auxiliary generator end.



3-35. EXCITER-AUXILIARY GENERATOR ASSEMBLY (cont)

DISASSEMBLY

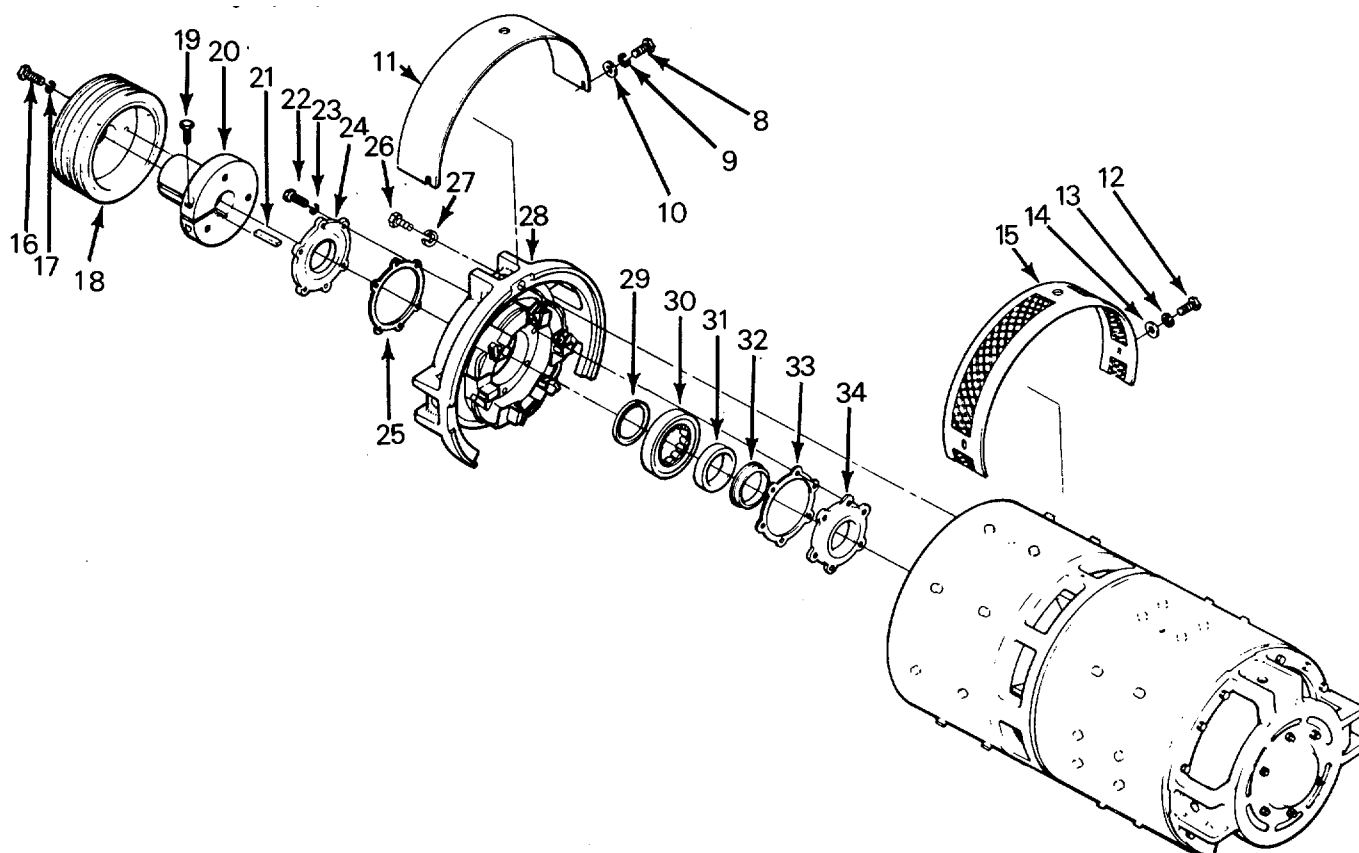
WARNING

Procedures specify the heating of parts to aid in disassembly. Heated parts may cause injury to personnel if hand protection is not worn when handling. Wear protective gloves for maximum protection.

NOTE

Some parts may have to be heated to release them from their shrink fit. When this becomes necessary, the use of a portable propane torch and a puller tool set is recommended for disassembly.

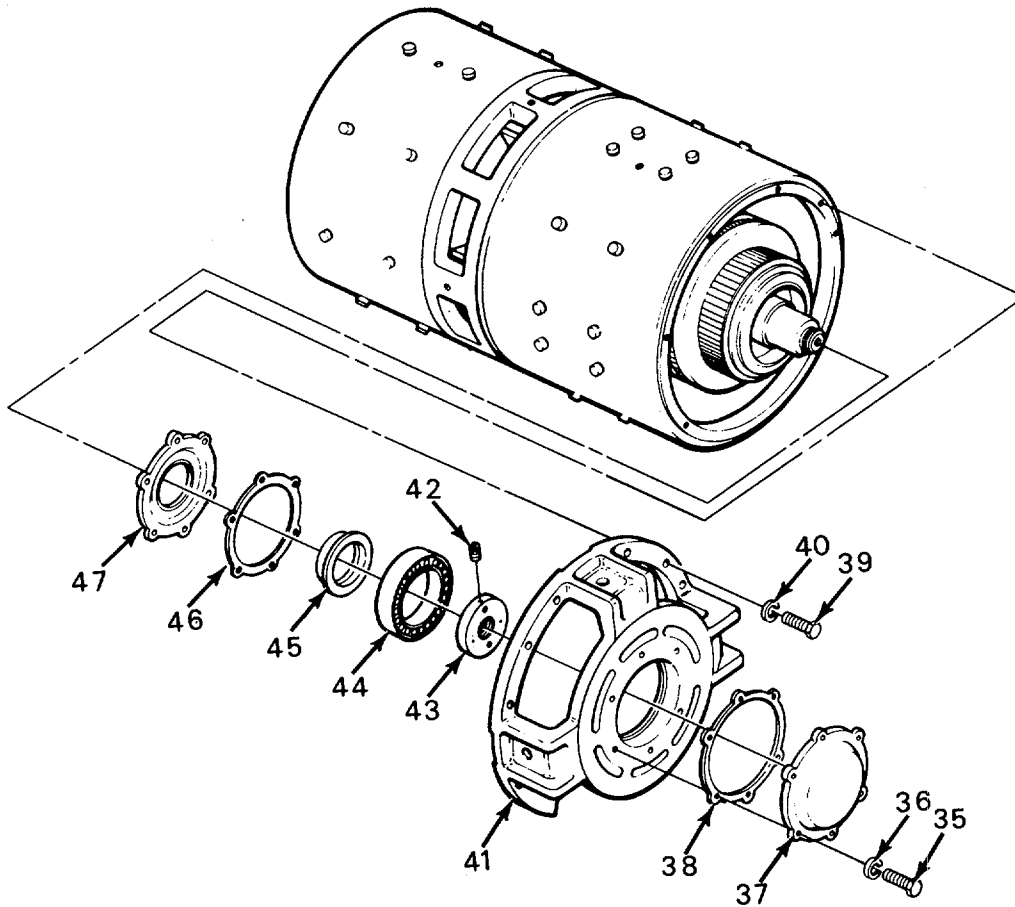
7. Remove six bolts (8), lockwashers (9), flat washers (10), and two covers (11).
8. Remove three bolts (12), lockwashers (13), flat washers (14), and screen (15).
9. Remove three bolts (16) and lockwashers (17) from pulley (18) and remove pulley.
10. Remove three bolts (19) and inner pulley (20).
11. Remove key (21).



3-35. EXCITER-AUXILIARY GENERATOR ASSEMBLY (cont)

DISASSEMBLY (cont)

12. Remove six bolts (22), lockwashers (23), outer bearing housing (24), and gasket (25). Remove eight bolts (26) and lockwashers (27). Rotate exciter end housing (28) and remove exciter end housing from generator.
13. Install puller in inner bearing housing (34) and remove oil slinger (29), bearing assembly (30), inner race (31), bearing spacer (32), gasket (33), and inner bearing housing.
14. Remove six bolts (35), lockwashers (36), auxiliary end cap (37), and gasket (38).

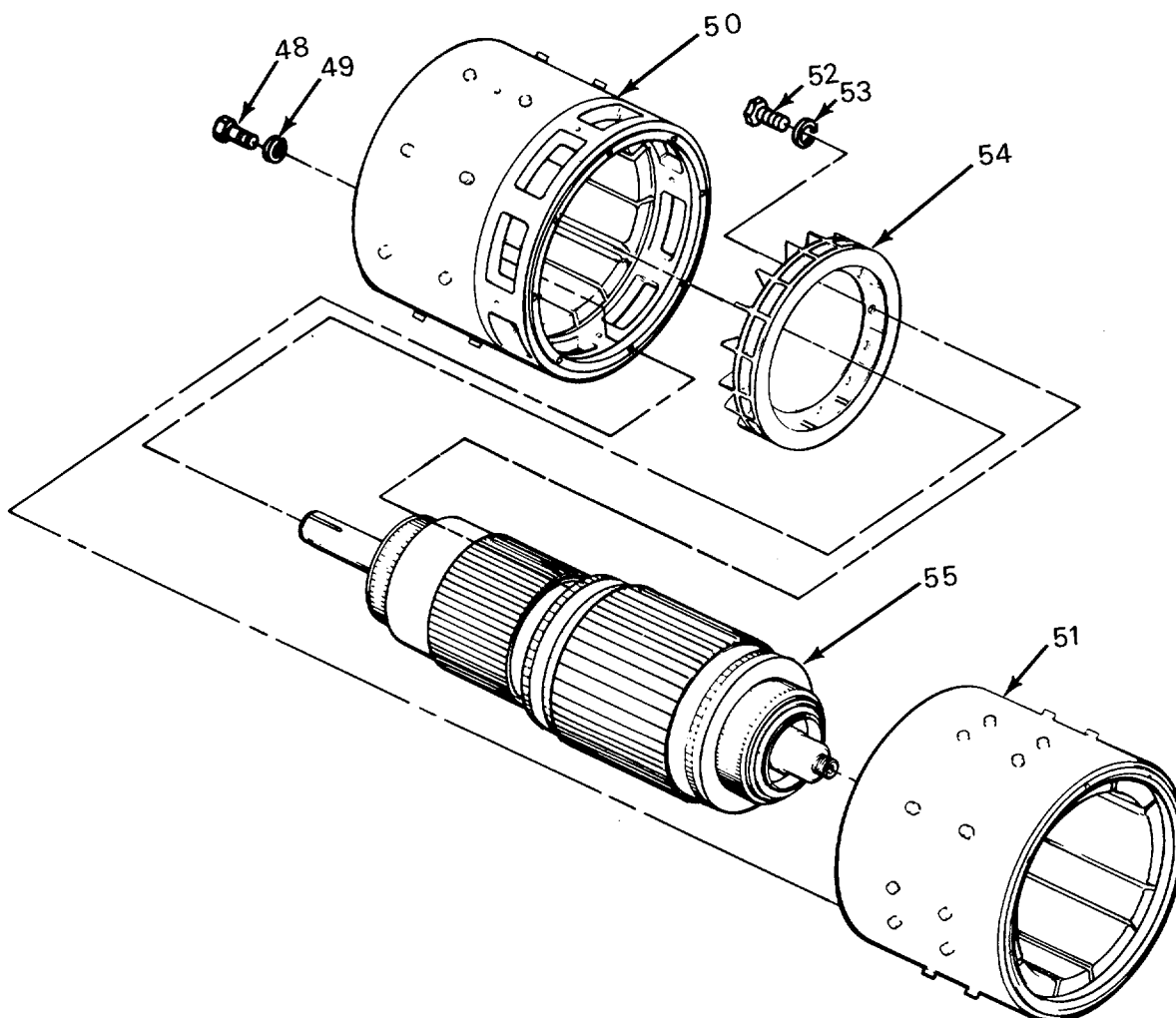


15. Remove eight bolts (39), lockwashers (40), and auxiliary end housing (41).
16. Remove two setscrews (42) and locknut (43).
17. Install puller in inner bearing housing (47) and remove bearing assembly (44), inner race (45), gasket (46), and inner bearing housing.

3-35. EXCITER-AUXILIARY GENERATOR ASSEMBLY (cont)

DISASSEMBLY (cont)

18. Remove eight bolts (48) and eight lockwashers (49) and separate exciter frame (50) from auxiliary frame (51).
19. Remove eight bolts (52) and lockwashers (53).



20. Remove cooling fan (54) and armature (55).
21. Refer to TM 55-2210-223-12 for brush holder and brush removal.

3-35. EXCITER-AUXILIARY GENERATOR ASSEMBLY (cont)

CLEANING, INSPECTION, AND REPAIR

22. Clean, inspect, and repair bearing assembly by the following:

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 - 138°F (38 - 59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
- a. Use drycleaning solvent and remove grease from bearing, outer bearing caps, outer bearing stops, oil slingers, and bearing cartridges. Dry with compressed air.
 - b. Inspect parts for wear, cracks, or breaks.
 - c. Inspect rollers for cracks or pits.
 - d. Inspect parts for overheating.
 - e. Replace parts that are damaged.

CAUTION

Do not coat gasket seats with insulating varnish.

- f. Paint bearing housings with red insulating varnish.
- g. Replace outer bearing cap gaskets.

3-35. EXCITER-AUXILIARY GENERATOR ASSEMBLY (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

23. Clean, inspect, and repair armature assembly by the following:

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 - 138°F (38 - 59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

CAUTION

Check that drycleaning solvent does not get on commutator, copper parts, coils, and windings. Damage to equipment will result.

NOTE

Armature must be repaired at depot maintenance level.

- a. Blow carbon dust from armature assembly with compressed air. Direct air into the pockets and through the openings of the armature to remove internal accumulations of dirt.
- b. Use a cloth dampened with drycleaning solvent and wipe armature surface to remove external grease and dirt. Dry with compressed air.
- c. Inspect for journal damage. If journal shows signs of bearing slippage, have armature repaired.

CAUTION

Do not coat commutator surfaces with insulating varnish.

NOTE

If varnished surfaces of coil insulation are damaged, repair at depot level maintenance facility.

- d. Inspect varnished surfaces of coil insulation.

3-35. EXCITER-AUXILIARY GENERATOR ASSEMBLY (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

NOTE

If bands are loose, repair at depot level maintenance facility.

- e. Check that bands are tight and secure and soldering is intact.
- f. Use a dial indicator and check commutator for roughness or out-of-roundness. Commutator is out-of-round if there is a 0.002-inch (0.05 mm) variance within a six bar span. Inspect surface for wear, burns, or pitting. If these conditions exist perform the following:
 - (1) Use fine grinding stone and give commutator a smooth finish.
 - (2) Check that mica is undercut to a depth of 1/16 to 3/32 inch (1.6 to 2.4 mm). If mica depth is not within these limits, use a mica undercutter saw and regroove mica.

CAUTION

Do not damage commutator bars during cleaning process.

- (3) Clean slots between copper bars to remove burrs.

WARNING

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

- (4) Use dry compressed air and remove loose mica and copper from commutator.

CAUTION

Do not coat commutator surfaces with insulating varnish.

- g. Paint surfaces of coil insulation with red insulating varnish.

3-35. EXCITER-AUXILIARY GENERATOR ASSEMBLY (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

24. Clean, inspect, and repair exciter-auxiliary generator frame assembly by the following:

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 - 138°F (38 - 59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

NOTE

The exciter-auxiliary generator frame assembly must be repaired at depot level maintenance facility.

- a. Use a cloth dampened with drycleaning solvent and remove dirt and foreign material from exciter-auxiliary generator frame and field assembly. Dry with compressed air.
- b. Check that field coils, leads, and cable connections are secure.
- c. Check that shunt and interpole fields are tight.

CAUTION

Do not coat gasket seats with insulating varnish.

- d. Paint insulation surfaces with red insulating varnish.
- e. Paint outside surface with gray gloss enamel.

3-35. EXCITER-AUXILIARY GENERATOR ASSEMBLY (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

25. Clean, inspect, and repair brush holder assembly by the following:

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 - 138°F (38 - 59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
- a. Use drycleaning solvent and clean brush holder assemblies. Dry with compressed air.
 - b. Inspect connecting rods for nicks and breaks.
 - c. Inspect brush holder for wear, cracks, or breaks. Replace defective brush holder. To replace defective brush holder and brushes refer to TM-55-2210-223-12.
 - d. Check that fiberglass ring is not cracked or broken.
 - e. Inspect spring assemblies for tension and check that exciter end braiding is not frayed. Replace defective spring assemblies.

CAUTION

Do not paint inside surfaces of brush holders.

- f. Paint brush holders and fiberglass ring with clear acrylic spray.
- g. Paint connecting rods between brush holders with red insulating varnish.

3-35. EXCITER-AUXILIARY GENERATOR ASSEMBLY (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

26. Clean, inspect, and repair remaining parts by the following:

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 - 138°F (38 - 59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
- a. Use drycleaning solvent and clean parts. Dry with compressed air.
 - b. Inspect parts for cracks or breaks.
 - c. Replace defective parts.

CAUTION

Do not paint gasket surfaces. Check that machined surfaces are not painted.

- d. Paint inside surface of covers with red insulating varnish and outside surface with gray gloss enamel.

TEST

27. Refer to table 3-2 for exciter-auxiliary generator data.

3-35. EXCITER-AUXILIARY GENERATOR ASSEMBLY (cont)

TEST (cont)

Table 3-2. Exciter-Auxiliary Generator

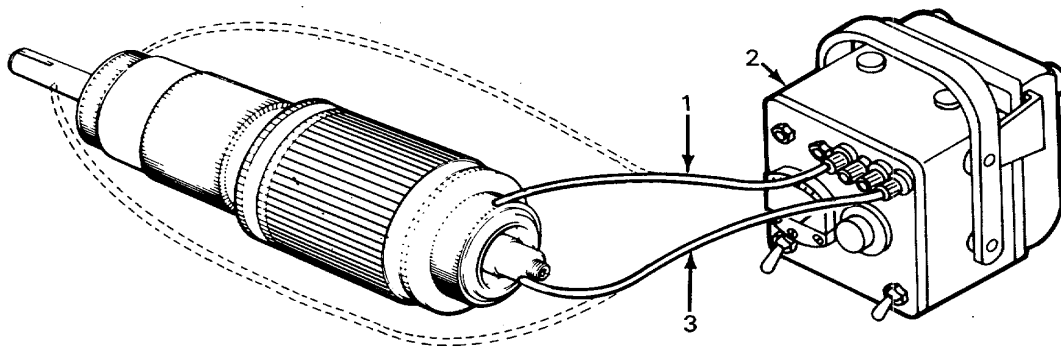
ITEM	SPECIFICATION
Auxiliary Generator:	
Safe speed	2345 rpm maximum
Voltage	75 dc
Armature amperes	150 amps
Main field amperes	8 amps
Number of brush arms	6
Brushes per arm	1
Brush size	1/2 x 1-1/2 inches (12.7 x 38.1 mm)
Brush pressure	2-1/4 to 2-1/2 pounds (1.02 to 1.13 kg)
Brush-to-holder thickness clearance	0.004 to 0.010 inch (0.10 to 0.25 mm)
Brush-to-holder width clearance	1/16 inch (1.6 mm) maximum
Exciter:	
Safe speed	2345 rpm maximum
Voltage	75 dc
Armature amperes	110 amps
Main field amperes	3.2 amps
Number of brush arms	6
Brushes per arm	1
Brush size	3/8 x 1 inch (9.5 x 25.4 mm)
Brush pressure	1-1/4 to 1-1/2 pounds (0.5 to 0.68 kg)
Brush-to-holder thickness clearance	0.004 to 0.010 inch (0.10 to 0.25 mm)
Brush-to-holder width clearance	1/16 inch (1.6 mm) maximum

28. Perform the armature and stator megohmmeter test by the following:

NOTE

A minimum of 500 V at 1 megohm is required for this test.

- a. Place lead (1) of megohmmeter (2) on shaft or core of the armature.



3-35. EXCITER-AUXILIARY GENERATOR ASSEMBLY (cont)

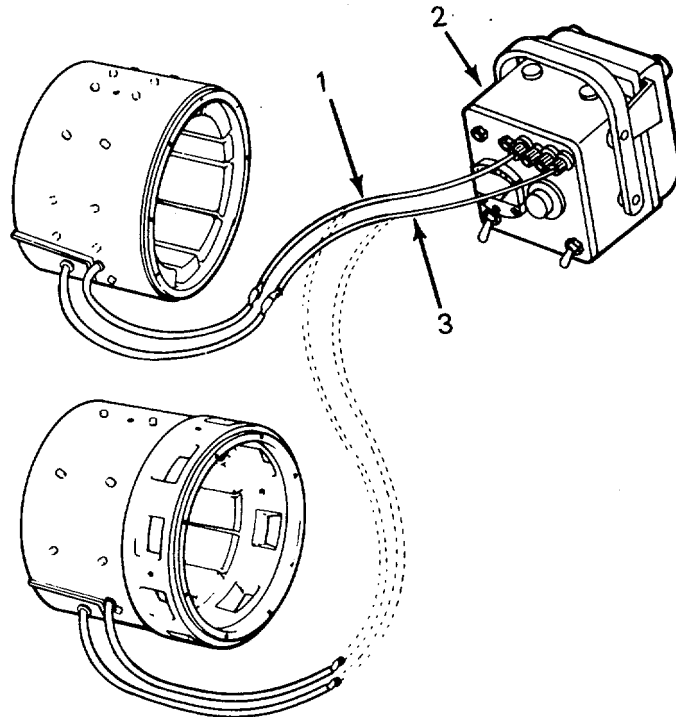
TEST (cont)

- b. Place lead (3) of megohmmeter (2) on one of the commutator bars. Note reading on megohmmeter. Contact each successive bar around the commutator.
- c. If a reading of less than three megohms is obtained, bake armature for 4 hours at 230°F in a convection oven. Recheck megohm reading after cooling armature to room temperature. If the reading is still low, replace the armature.

NOTE

This test must be accomplished on both the exciter stator and the auxiliary stator.

- d. Attach lead (1) of megohmmeter (2) to lead AA- on stator housing.

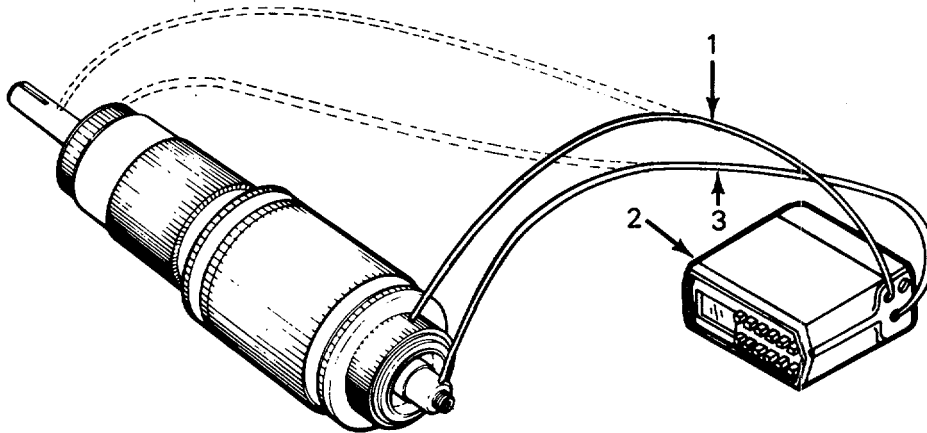


- e. Attach lead (3) of megohmmeter (2) to lead A+ on stator housing and note reading on megohmmeter.
- f. Attach lead (1) of megohmmeter (2) to lead FF+ on stator housing.
- g. Attach lead (3) of megohmmeter (2) to lead F- on stator housing and note reading on megohmmeter.
- h. If a reading of less than 3 megohms is obtained on the two sets of leads, bake stator for 4 hours at 230°F (110°C) in a convection oven. Recheck megohm readings after cooling stator to room temperature. If the readings are still low, replace stator.

3-35. EXCITER-AUXILIARY GENERATOR ASSEMBLY (cont)

TEST (cont)

29. Perform the bar-to-bar resistance test by the following:
- Place lead (1) of multimeter (2) on the shaft or core of the armature.



- Place lead (3) of multimeter (2) on one of the commutator bars. Record reading on multimeter. Contact each successive bar around the commutator and record each reading.
- If the test indicates resistance readings of 10 percent or more above the average recorded readings on 20 or more connections, tig weld all coil leads to commutator neck connections. If test indicates resistance readings of 1/2 percent below the average or a full-scale meter deflection of the multimeter, there is a shorted coil to the armature.
- Below average readings could indicate the presence of water in the coils. If below average readings are obtained bake armature in a convection oven for 4 hours at 230° (110°C).
- Cool at room temperature and repeat step (b).
- If readings are still low, replace armature.

ASSEMBLY

- Install cooling fan (54), eight lockwashers (53), and bolts (52) on armature (55).
- Install armature (55) in auxiliary frame (51).
- Install exciter frame (50) on armature (55) and secure with eight lockwashers (49) and bolts (48).
- Fill inner bearing housing (47) and bearing assembly (44) with grease.
- Install inner bearing housing (47) and gasket (46).

3-35. EXCITER-AUXILIARY GENERATOR ASSEMBLY (cont)

ASSEMBLY (cont)

CAUTION

Procedures specify the heating of parts to aid in disassembly and assembly. Heated parts may cause injury to personnel if hand protection is not worn when handling. Wear protective gloves for maximum protection.

35. Heat inner race (45) on an induction heater to 230°F (110°C) and install on shaft.
36. Install bearing assembly (44).
37. Fill inner bearing housing (34) and bearing assembly (30) with grease.
38. Install inner bearing housing (34), gasket (33), bearing spacer (32), inner race (31), and bearing assembly (30) on shaft.
39. Install brushes and brush holders. Refer to TM 55-2210-223-12 for brushes and brush holder installation.
40. Install locknut (43) and secure with two setscrews (42).
41. Install auxiliary end housing (41), eight lockwashers (40), and bolts (39).
42. Install gasket (38) and auxiliary end cap (37). Secure with six lockwashers (36) and bolts (35).
43. Install oil slinger (29).
44. Install exciter end housing (28) and secure with eight lockwashers (27) and bolts (26).
45. Install gasket (25) outer bearing housing (24), and secure with six lockwashers (23) and bolts (22).
46. Install key (21) and inner pulley (20) on shaft and secure with three bolts (19).
47. Install pulley (18) and secure with three lockwashers (17) and bolts (16).
48. Install screen (15) and secure with three flat washers (14), lockwashers (13), and bolts (12).
49. Adjust brush holders and brushes. Refer to TM 55-2210-223-12 and adjust brushes.
50. Install two covers (11) and secure with six flat washers (10), lockwashers (9) and bolts (8).

3-35. EXCITER-AUXILIARY GENERATOR ASSEMBLY (cont)

INSTALLATION

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

51. Use a suitable lifting device and set exciter-auxiliary generator on main generator mounting bracket (7).
52. Install flat washers (4) and (3) and four bolts (2).
53. Turn adjusting nut (5) and secure free adjusting screw (6) into mounting bracket.
54. Refer to TM 55-2210-223-12 and install and adjust drive belts.
55. Tighten four bolts (2).
56. Connect wiring (1) to terminals.

3-36. MAIN GENERATOR

This task covers:

- | | | | | | | | |
|----|-------------|----|------------|----|--------|----|--------------|
| a. | Removal | c. | Cleaning | e. | Repair | g. | Assembly |
| b. | Disassembly | d. | Inspection | f. | Test | h. | Installation |
-

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12
Mica undercutter
Dial indicator 5210-00-640-0953
Crankshaft deflection strain gauge
Model #696 5210-00-494-1776
Portable propane torch
3439-00-542-0531
Induction heater 2815-00-366-1432
Puller set

Material/Parts

Drycleaning solvent (Item 30, Appendix B)
Grease (Item 12, Appendix B)
Clear acrylic lacquer (Item 17, Appendix B)
Red insulating varnish (Item 33, Appendix B)
Gray gloss enamel (Item 9, Appendix B)
Electrical tape (Item 32, Appendix B)
Insulating paper (Item 26, Appendix B)
Wiping Rags (Item 28, Appendix B)

Test Equipment

Multimeter 6625-01-139-2512
Megohmmeter 6625-00-456-7442

Personnel Required

3

Equipment Condition Reference

Para 3-7
TM 55-2210-223-12
TM 55-2210-223-12
Para 3-35

Condition Description

Hood removed
Blower motor belts removed
Drive belts removed
Exciter-auxiliary generator removed

REMOVAL

WARNING

- Remove rings, bracelets, wristwatches, and neck chains before working around the locomotive. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.
- High voltage is used in the operation of equipment. Do not be misled by the term LOW VOLTAGE. Potentials as low as 50 volts may cause death.

1. Set battery switch to open position.

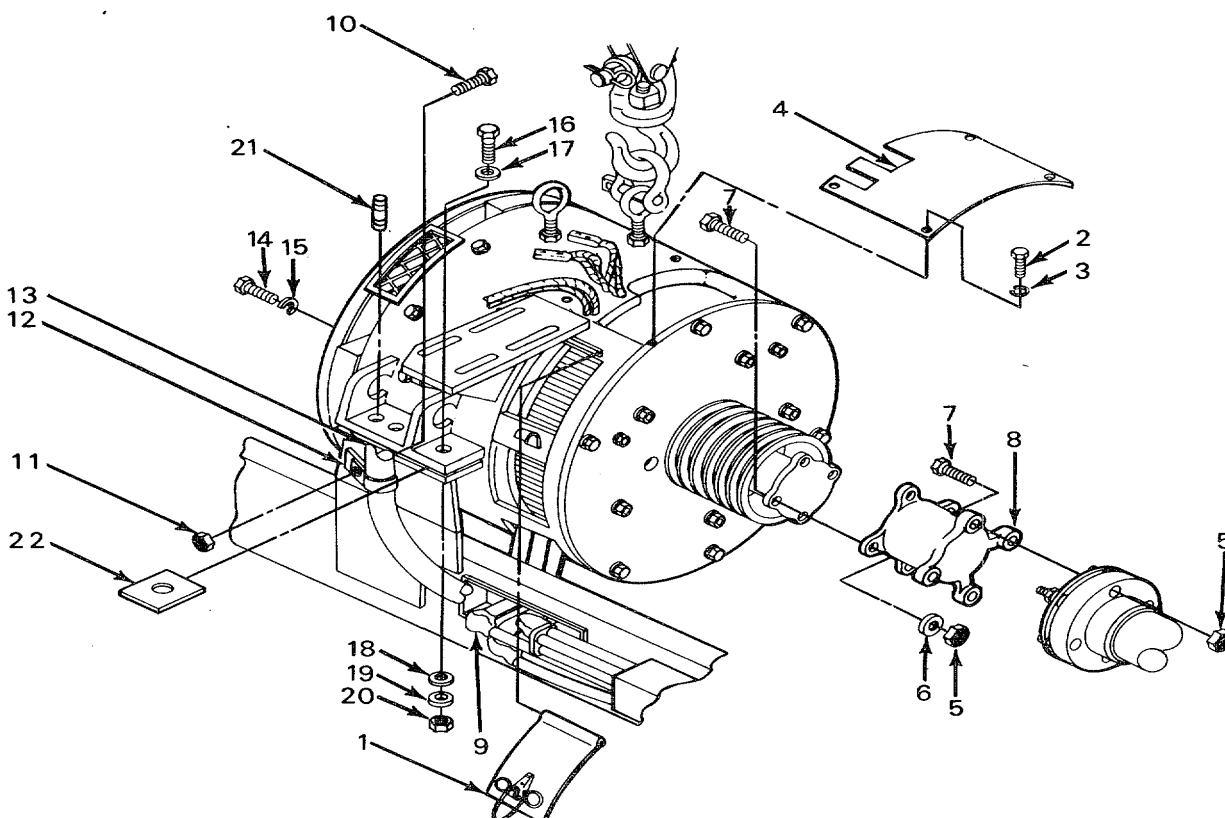
3-36. MAIN GENERATOR (cont)

REMOVAL (cont)

NOTE

If repair of main generator is limited to resurfacing commutator, refer to step 54f(l) below.

2. Remove two covers (1).
3. Remove four bolts (2), lockwashers (3), and cover (4).
4. Remove eight locknuts (5), four spacers (6), and eight bolts (7) and remove flexible coupling (8).
5. Tag and disconnect terminals (9).
6. Remove two screws (10), nuts (11), clamp (12), and conduit (13).
7. Use a punch and punch-mark main generator to engine flywheel. Remove 16 bolts (14) and lockwashers (15).
8. Remove four base mounting bolts (16), washers (17), (18), and (19), four nuts (20), and two dowel pins (21).



3-36. MAIN GENERATOR (cont)

REMOVAL (cont)

9. Refer to TM 55-2210-233-12 and remove exhaust flex pipe.
10. Install lifting eye and a suitable lifting device.

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

CAUTION

Use extreme care to prevent main generator from damaging emergency fuel shutoff assembly.

11. Move main generator toward air compressor.
12. Slowly lift main generator from base and set on a suitable support device in horizontal position.
13. Mark locations of shims for installation.
14. Remove shims (22) from base. Retain shims for installation.

DISASSEMBLY

WARNING

- Components of the main generator are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.
- Heated parts may cause injury to personnel if hand protection is not worn when handling. Wear protective gloves for maximum protection.

NOTE

Some parts may have to be heated to release them from their shrink fit. When this becomes necessary, the use of a portable propane torch, a portable hydraulic press, and a puller set is recommended for disassembly.

15. Remove two capscrews (23), two washers (24), clamp (25), tubing (26), and two pipe elbows (27).

3-36. MAIN GENERATOR (cont)

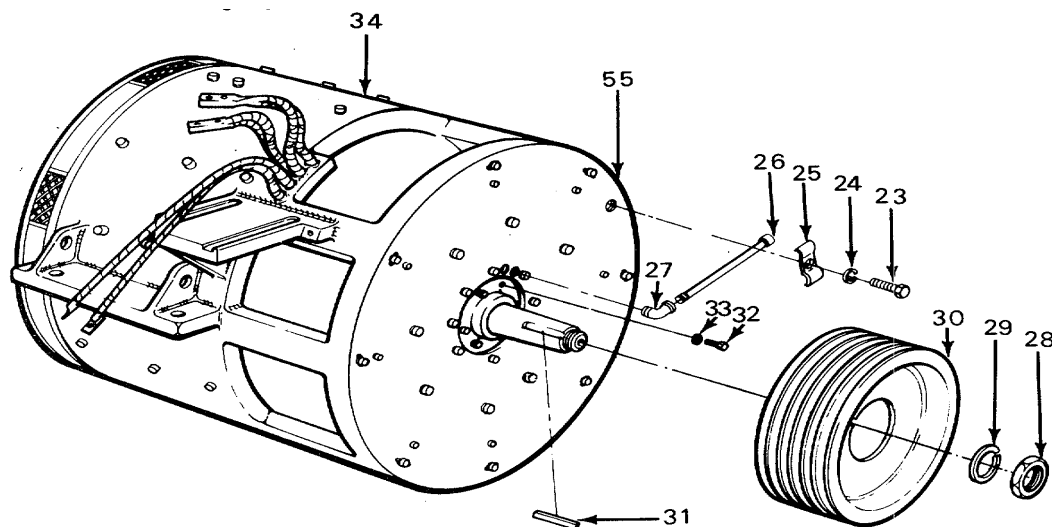
DISASSEMBLY (cont)

16. Remove nut (28) and lockwasher (29). Reinstall nut to serve as a stop when pulley (30) is removed.
17. Install pry bars between stator frame cover (55) and pulley (30).
18. Use a torch and heat pulley (30). Apply pressure to pulley and loosen pulley.
19. Remove nut (28) and pulley (30).
20. Remove keyway (31) from armature shaft.
21. Install lifting eye near fan end of main generator.
22. Install a heavy-duty strap (7000-lb (3175 kg) minimum capacity) through cover hole on each side of main generator.

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

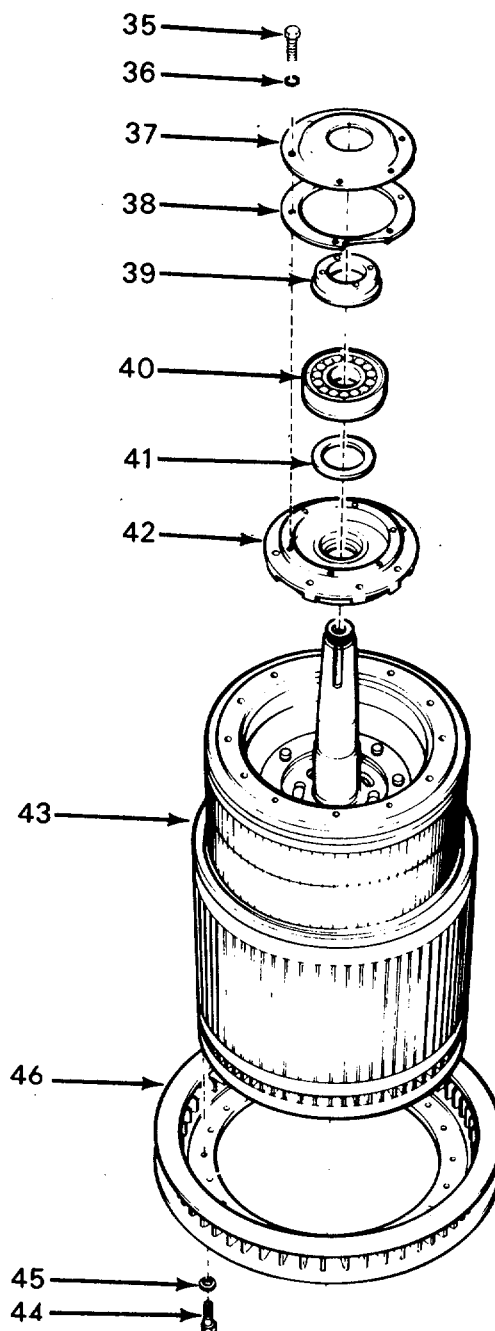
23. Use suitable lifting devices and simultaneously lower fan end and raise pulley end until main generator is in a vertical position with pulley end facing up. Slowly lower main generator to ground.
24. Remove eight bolts (32) and washers (33).
25. Use spring to hold brushes from holder and lift brushes far enough out of brush box to prevent them from sliding back against the commutator.
26. Wrap a piece of insulating paper around the commutator to protect it while handling.
27. Install lifting eyes on each side of stator frame cover (55).



3-36. MAIN GENERATOR (cont)

DISASSEMBLY (cont)

28. Use a suitable lifting device and slowly lift stator frame assembly (34) from armature (43). Lower stator frame assembly to ground and rest on suitable support device.
29. Install wooden blocks under bearing cartridge (42) to prevent bearing cartridge from sliding down on shaft.
30. Remove six bolts (35) and washers (36).
31. Remove outer bearing cap (37) and gasket (38).
32. Install puller in tapped holes of outer bearing stop (39) and remove outer bearing stop.
33. Install puller in bearing cartridge (42) and remove bearing (40), oil slinger (41), and bearing cartridge.
34. Install lifting eye in pulley end of armature (43).
35. Use a hoist and lift armature (43) high enough to install lifting eye under fan end.
36. Use two hoists and simultaneously lower pulley end and raise fan end of main generator. Set armature (43) on suitable supporting device in horizontal position.
37. Remove 16 bolts (44) and washers (45).
38. Use a punch and punch-mark fan (46) to armature (43) for assembly.
39. Separate fan (46) from armature (43).

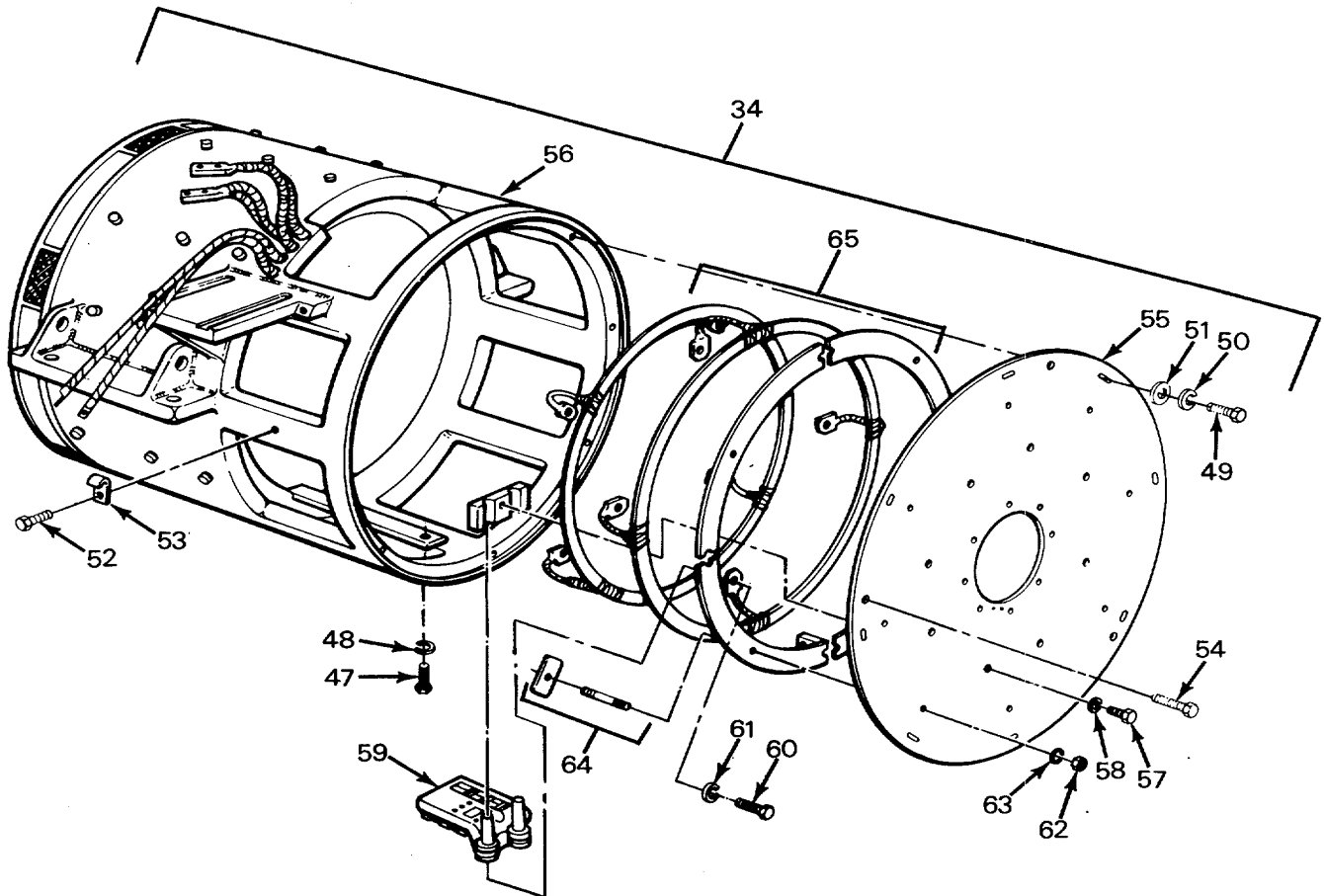


40. Use a punch and punch-mark ring assembly (65) to stator frame cover (55) for assembly.
41. Use a punch and punch-mark stator frame cover (55) to stator frame (56) for assembly.

3-36. MAIN GENERATOR (cont)

DISASSEMBLY (cont)

42. Remove eight bolts (47) and lockwashers (48).
43. Remove eight bolts (49), eight lockwashers (50), and washers (51).
44. Remove 2 bolts (52) and clips (53).



45. Remove lifting eyes.
46. Install three jacking bolts (54) into stator frame cover (55) and separate stator frame cover from stator frame (56).
47. Remove jacking bolts (54) and install lifting eyes.
48. Remove eight bolts (57), lockwashers (58), and brush holders (59).
49. Remove eight bolts (60), washers (61), and disconnect brush holders (59) from ring assembly (65).
50. Remove eight nuts (62), lockwashers (63), and T-bars (64).

3-36. MAIN GENERATOR (cont)

DISASSEMBLY (cont)

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

51. Use a suitable lifting device and separate stator frame cover (55) from ring assembly (65).
52. Use a punch and punch-mark three places where the field connects to ring assembly (65) for assembly.

CLEANING, INSPECTION, AND REPAIR

53. Clean, inspect, and repair bearing assembly by the following:

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
- a. Use drycleaning solvent and remove grease from bearing, outer bearing cap, outer bearing stop, oil slinger, and bearing cartridge. Dry with compressed air.
 - b. Inspect parts for wear, cracks, or breaks.
 - c. Inspect rollers for cracks or pits.
 - d. Inspect parts for overheating.
 - e. Replace parts that are damaged.

3-36. MAIN GENERATOR (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

CAUTION

Do not paint gasket surfaces.

- f. Paint bearing housing with red insulating varnish.

NOTE

Armature must be repaired at depot maintenance level facility.

54. Clean, inspect, and repair armature assembly by the following:

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

CAUTION

Check that drycleaning solvent does not get on commutator, copper parts, coils, and windings. Damage to equipment will result.

- a. Blow carbon dust from armature assembly with compressed air. Direct air into the pockets and through the openings of the armature to remove internal accumulations of dirt.
- b. Use a cloth dampened with drycleaning solvent and wipe armature surface to remove external grease and dirt. Dry with compressed air.
- c. Inspect for journal damage. If journal shows signs of bearing slippage, replace armature.

3-36. MAIN GENERATOR (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

NOTE

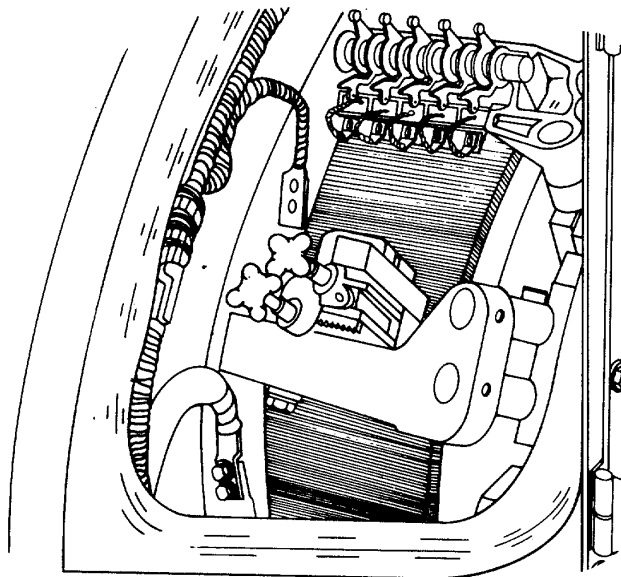
If varnished surfaces of coil insulation are damaged, repair at depot level maintenance facility.

- d. Inspect varnished surfaces of coil insulation.

NOTE

If bands are loose, repair at depot level maintenance facility.

- e. Check that bands are tight and secure and soldering is intact.
- f. Use a dial indicator and check commutator for roughness or out-of-roundness. Commutator is out-of-round if there is a 0.002-inch (0.05 mm) variance within a six bar span. Inspect surface for wear, burns, or pitting. If these conditions exist, resurface commutator by the following:
 - (1) Grind commutator by the following method:
 - (a) Remove brush holder and install grinding equipment.
 - (b) Start diesel engine and run at idle speed. (TM 55-2210-223-12)
 - (c) Slowly feed grinding stones into commutator until light contact is made.
 - (d) Run stones across commutator enough to give a uniform surface.
 - (e) Stop diesel engine. (TM 55-2210-223-12)



3-36. MAIN GENERATOR (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

- (2) Check that mica is undercut to a depth of 1/16 to 3/32 inch (1.6 to 2.4 mm). If mica depth is not within these limits, use a mica undercutter and regroove mica.
- (3) Clean slots between copper bars to remove burrs.

WARNING

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

- (4) Use dry compressed air and remove loose mica and copper from commutator.

CAUTION

Do not paint gasket surfaces.

- g. Paint surfaces of coil insulation with red insulating varnish.

55. Clean, inspect, and repair stator frame assembly by the following:

WARNING

Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.

- a. Use a cloth dampened with drycleaning solvent and remove dirt and foreign material from stator frame and field assembly. Dry with compressed air.
- b. Check that field coils, leads, and cable connections are secure.
- c. Check that shunt and interpole fields are tight.

3-36. MAIN GENERATOR (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

CAUTION

Do not paint gasket surfaces.

- d. Paint insulation surfaces with red insulating varnish.
 - e. Paint outside surface with gray gloss enamel.
56. Clean, inspect, and repair brush holder assembly by the following:

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
- a. Use drycleaning solvent and clean brush holder assemblies. Dry with compressed air.
 - b. Inspect brush holder for wear, cracks, or breaks. Replace defective brush holder.
 - c. Inspect insulators for breaks, cracks, burns, or dull surface. Replace defective insulators by pressing off stud and pressing new one on.
 - d. Inspect studs for cracks or breaks. Replace defective studs by pressing out of brush holder and pressing new one in.
 - e. Inspect spring assemblies for tension and check that braiding is not frayed. Replace defective spring assemblies.

CAUTION

Do not spray brush contact areas.

- f. Paint brush holders with clear acrylic spray.

3-36. MAIN GENERATOR (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

57. Clean, inspect, and repair ring assembly by the following:

- a. Check that insulation is not cracked or blistered. Replace damaged insulation.
- b. Check that fiberglass rings are not cracked or broken. Replace damaged fiberglass rings.

CAUTION

Do not paint gasket surfaces.

- c. Paint assembly with red insulating varnish.

58. Clean, inspect, and repair remaining parts by the following:

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

- a. Use drycleaning solvent and clean parts. Dry with compressed air.
- b. Inspect parts for cracks or breaks.
- c. Replace defective parts.
- d. Paint the following with red insulating varnish:

CAUTION

Do not paint machined surfaces.

- (1) Fan
- (2) Inside surface of stator frame cover
- (3) Inside surface of main generator covers

3-36. MAIN GENERATOR (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

CAUTION

Do not paint gasket surfaces.

- e. Paint the following with gray gloss enamel:
 - (1) Coupler assembly
 - (2) Inside surface of pulley
 - (3) Outside surface of main generator covers
 - (4) Outside surface of stator frame cover

59. Refer to table 3-3 for main generator data.

Table 3-3. Main Generator

ITEM	SPECIFICATION
Safe speed	1325 rpm maximum
Voltage	600 dc
Armature amperes	2600 amps
Main field amperes	100 amps
Number of brush arms	8
Brushes per arm	4
Brush size	1 x 1-1/2 x 2-3/4 inches (25.4 x 38.1 x 69.9 mm)
Brush pressure	7 to 8 pounds (3.2 to 3.6 kg)
Brush-to-holder thickness clearance	0.004 to 0.010 inch (0.10 to 0.25 mm)
Brush-to-holder width clearance	1/16 inch (1.5875 mm) maximum

TEST

60. Perform the armature and stator megohmmeter test by the following:

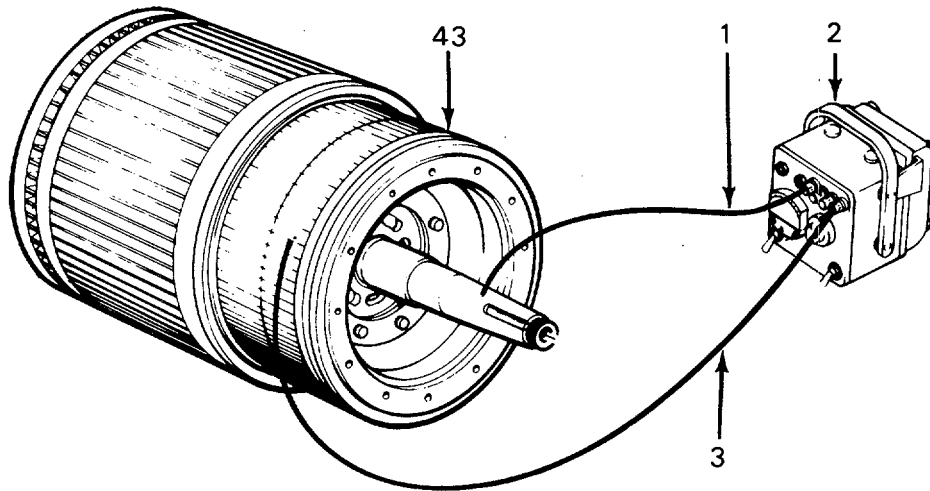
NOTE

A minimum of 500 V at 1 megohm is required for this test.

- a. Place lead (1) of megohmmeter (2) on shaft or core of armature (43).
- b. Place lead (3) of megohmmeter (2) on one of the commutator bars. Note reading on megohmmeter. Contact each successive bar around the commutator.

3-36. MAIN GENERATOR (cont)

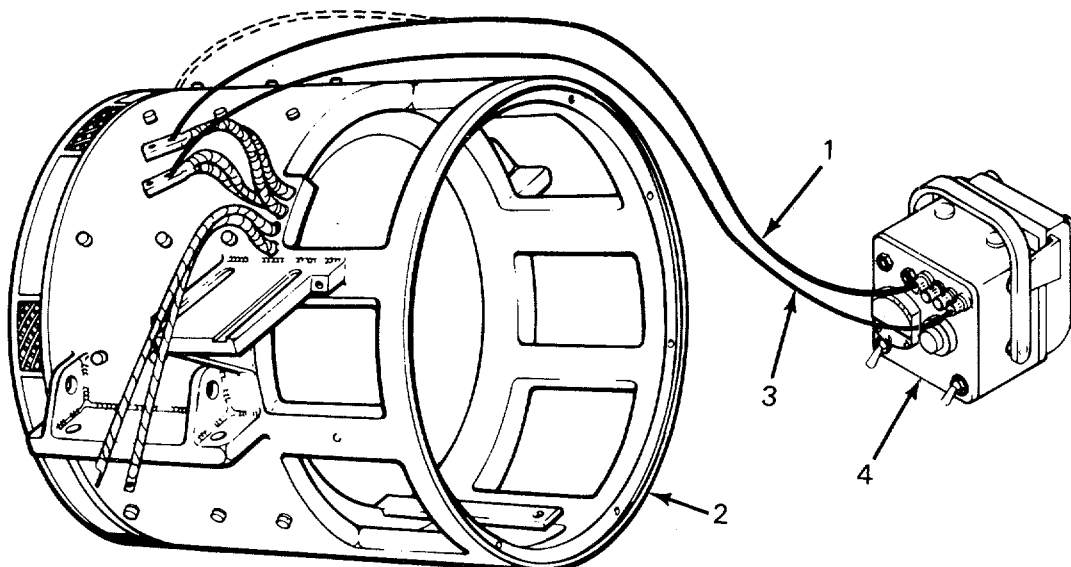
TEST (cont)



WARNING

Procedures specify the heating and cooling of parts to aid in disassembly and assembly. Heated and cooled parts may cause injury to personnel if hand protection is not worn when handling. Wear protective gloves for maximum protection.

- c. If a reading of less than three megohms is obtained, bake armature for 4 hours at 230°F (110°C) in a convection oven. Recheck megohm reading after cooling armature to room temperature. If the reading is still low, replace the armature.
- d. Attach lead (1) of megohmmeter (2) to one exciter lead.
- e. Attach lead (2) of megohmmeter (2) to other exciter lead.



3-36. MAIN GENERATOR (cont)

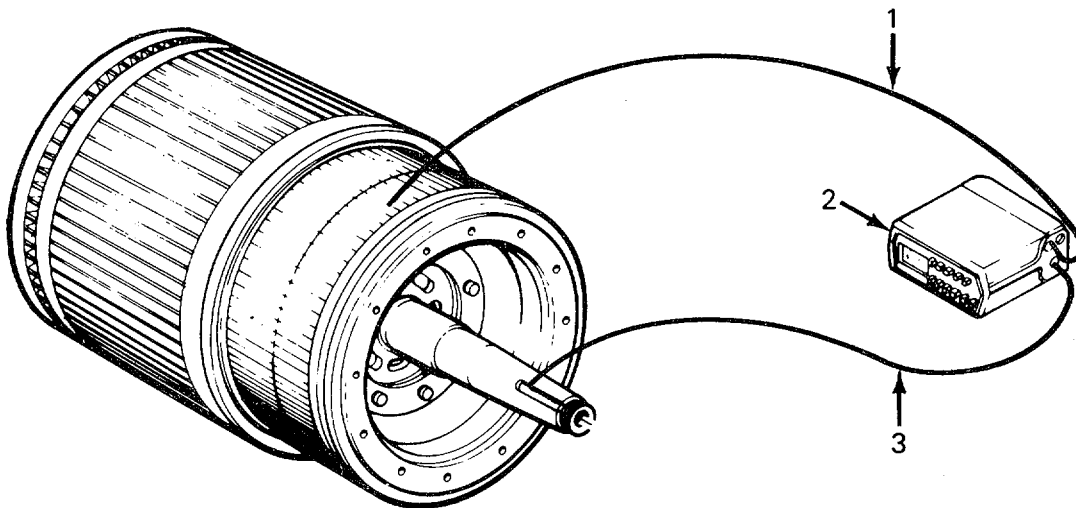
TEST (cont)

- f. Attach megohmmeter lead (1) to stator housing (2) and to each exciter lead.
- g. Attach lead (1) of megohmmeter (4) to lead GF+ on stator housing.
- h. Attach lead (3) of megohmmeter (4) to lead GF-on stator housing and note reading on megohmmeter.
- i. Attach megohmmeter lead to each GF+ and GF-and stator housing.
- j. Repeat steps g thru h for GS, GP, and GN leads.

WARNING

Procedures specify the heating and cooling of parts to aid in disassembly and assembly. Heated and cooled parts may cause injury to personnel if hand protection is not worn when handling. Wear protective gloves for maximum protection.

- k. If a reading of less than 3 megohms is obtained on two sets of leads, bake stator for 4 hours at 230°F (110°C) in a convection oven. Recheck megohm readings after cooling stator to room temperature. If the readings are still low, replace stator.
61. Perform a bar-to-bar resistance test by the following:
- a. Place lead (1) of multimeter (2) on the shaft or core of the armature.



3-36. MAIN GENERATOR (cont)

TEST (cont)

- b. Place lead (3) of multimeter (2) on one of the commutator bars. Record reading on multimeter. Contact each successive bar around the commutator and record each reading.
- c. If the test indicates resistance readings of 10 percent or more above the average recorded readings on 20 or more connections, tig weld all coil leads to commutator neck connections. If test indicates resistance readings of 1/2 percent below the average or a full-scale meter deflection of the multimeter, there is a shorted coil to the armature.

WARNING

Procedures specify the heating and cooling of parts to aid in disassembly and assembly. Heated and cooled parts may cause injury to personnel if hand protection is not worn when handling. Wear protective gloves for maximum protection.

- d. Below average average readings could indicate the presence of water in the coils. If below average readings are obtained, bake armature in a convection oven for 4 hours at 230° (110°C).
- e. Cool at room temperature and repeat steps (b).
- f. If readings are still low, replace armature.

ASSEMBLY

WARNING

Components of the main generator are heavy and may be awkward to handle. Use correct lifting procedure, indicated lifting devices, and/or assistance from other personnel to avoid injury.

- 62. Install ring assembly (65) on stator frame cover (55). Check that punch marks line up. Secure with eight T-bars (64), lockwashers (63), and nuts (62).
- 63. Install eight brush holders (59) on stator frame cover (55) and secure with eight washers (61) and bolts (60).

3-36. MAIN GENERATOR (cont)

ASSEMBLY (cont)

64. Install stator frame cover (55) by the following:

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

- a. Use a suitable lifting device and install stator frame cover (55) on stator frame (56).
 - b. Line up punch marks on stator frame cover (55) to stator frame (56).
 - c. Secure with eight washers (51), lockwashers (50), and bolts (49).
65. Use eight bolts (57) and lockwashers (58) and secure fields to eight brush holders (59).
66. Use two clips (53) and bolts (52) and secure stator frame (56).
67. Install fan (46) on armature (43). Line up punch marks of fan to armature. Secure with 16 lockwashers (45) and bolts (44).

WARNING

Heated parts may cause injury to personnel if hand protection is not worn when handling. Wear protective gloves for maximum protection.

NOTE

When installing new bearing, check that outer race does not stick in the cartridge. If the outer race is tight, the housing must be lapped to give a loose fit. Clearance should be 0.001 to 0.002 inch (0.03 to 0.05 mm).

68. Place outer bearing stop (39), bearing (40), oil slinger (41), and bearing cartridge (42) on an induction heater. Heat parts to 212°F (100°C).
69. Install bearing cartridges (42), (41), and (40) on heater. Install on armature shaft and hold in place until cooled.
70. Fill bearing cartridge (42) half full of grease. Fill space between bearing rollers with grease.

3-36. MAIN GENERATOR (cont)

ASSEMBLY (cont)

71. Remove outer bearing stop (39) from heater. Install on armature shaft against bearing (40) and hold firmly in place until cooled.
72. Fill grease pocket in outer bearing cap (37) half full of grease.
73. Install gasket (38) and outer bearing cap (37) and secure with six lockwashers (36) and bolts (35).

CAUTION

When stator frame assembly is being lowered on armature, check that parts are aligned and no binding occurs. Binding of parts will cause damage of equipment.

74. Install three lifting eyes on stator frame cover (55), one on each side.
75. Use a hoist and slowly lower stator frame assembly (34) over armature assembly (43). Secure with eight bolts (33) and lockwashers (32).
76. Install two pipe elbows (27) and tubing (26) clamp (25) and secure with two washers (24) and capscrews (23).

WARNING

Procedures specify the heating of parts to aid in assembly. Heated parts may cause injury to personnel if hand protection is not worn when handling. Wear protective gloves for maximum protection.

77. Put keyway (31) on armature shaft.
78. Place pulley (30) on an induction heater. Heat part to 212°F (100°C).
79. Remove pulley (30) from heater and install on armature shaft. Hold firmly until cooled.
80. Install lockwasher (29) and nut (28).
81. Install brushes. Refer to TM 55-2210-223-12 for brush adjustment data.

3-36. MAIN GENERATOR (cont)

INSTALLATION

WARNING

- Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.
- Unbalanced generator may cause injury to personnel and damage to equipment.

CAUTION

Use extreme caution to prevent main generator from damaging emergency fuel shutoff assembly.

82. Install lifting eye and hoist to main generator and lift main generator over mounting base.

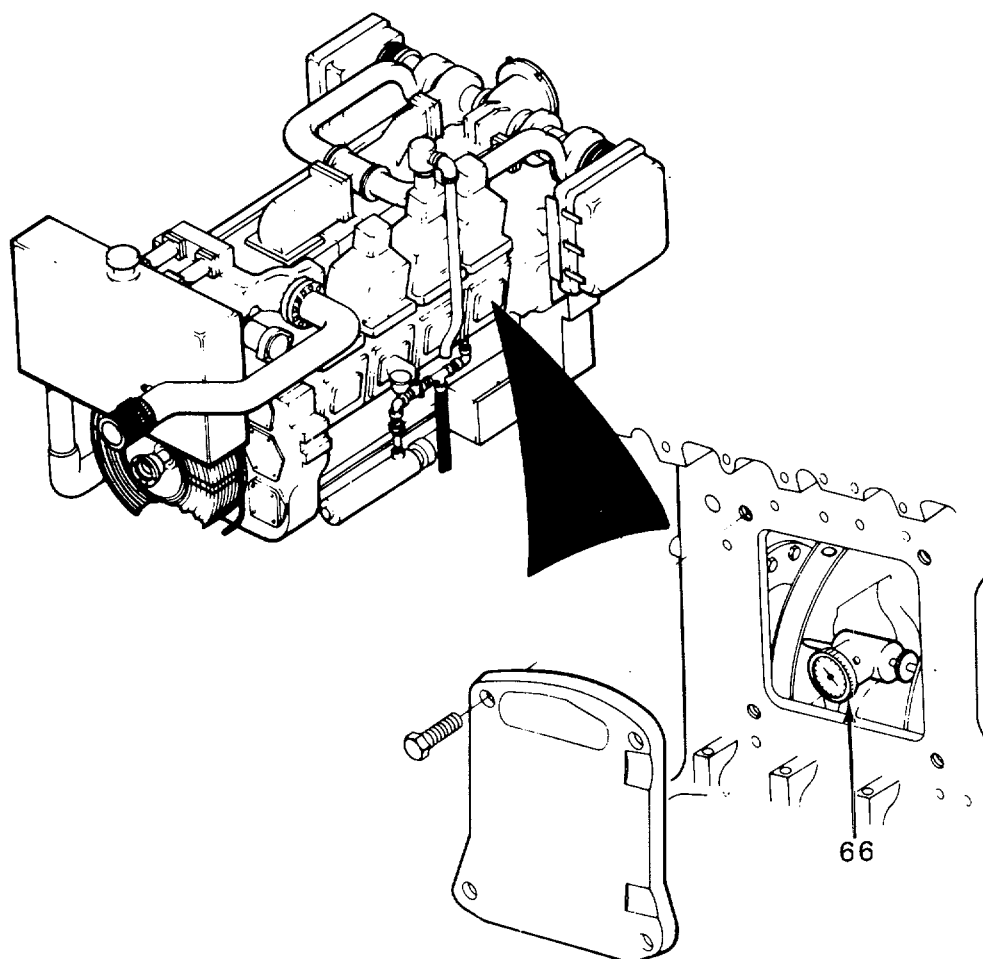
NOTE

Check that shims are placed in original positions as marked.

83. Install shims (22) retained from removal and slowly lower main generator, moving it toward engine.
84. Check that punch marks on engine flywheel and main generator line up.
85. Install 16 bolts (14) and lockwashers (15) opposite each other and tighten, pulling main generator and engine flywheel together.
86. Install main generator on base and secure with four base mounting bolts (16), lockwashers (19) and (18), flat washer (17), four nuts (20), and two dowel pins (21).
87. Check alinement of main generator and engine by deflection of engine crankshaft as follows:
- a. Use a crankshaft deflection strain gage (66) and center between the crankshaft cheeks of number six throw.
 - b. Record readings at top and bottom dead center.
 - c. If reading exceeds 0.002 inch (0.05 mm) add or subtract shims as necessary and install shims.
88. Install conduit (13). Secure with clamp (12), two nuts (11), and screws (10).
89. Connect terminals (9).

3-36. MAIN GENERATOR (cont)

INSTALLATION (cont)



90. Install flexible coupling (8) and secure with eight bolts (7), four spacers (6), and eight locknuts (5).
91. Install cover (4), lockwashers (3), and bolts (2).
92. Install two covers (1).

3-37. EMERGENCY FUEL CUTOFF SWITCH

This task covers:

- | | | |
|----------------|---------------|-----------------|
| a. Removal | d. Inspection | g. Installation |
| b. Disassembly | e. Repair | |
| c. Cleaning | f. Assembly | |
-

INITIAL SETUP:

Tools

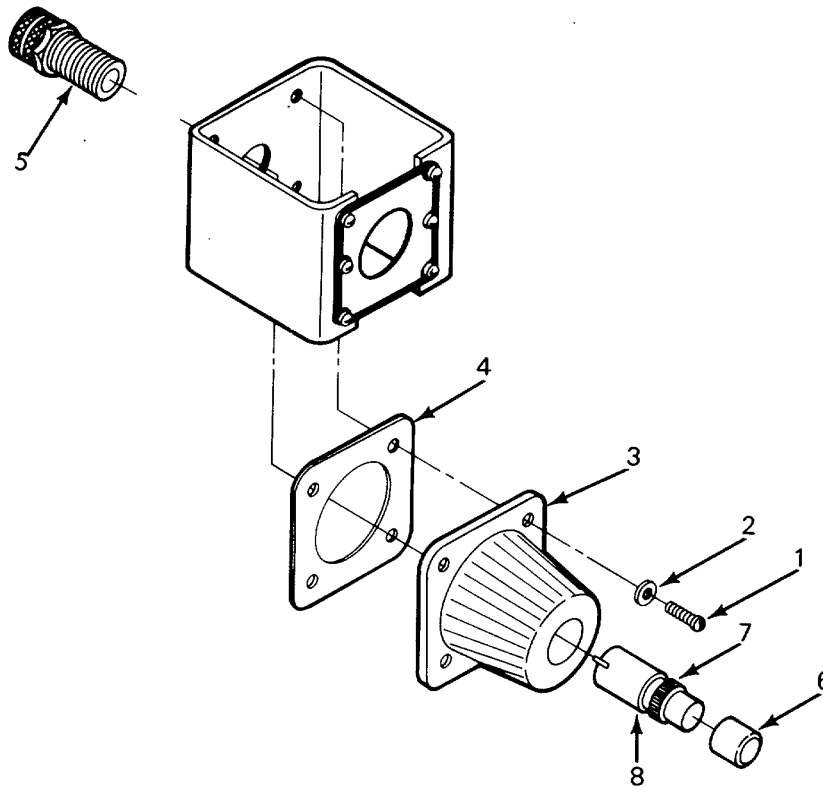
Tool kit SC 4940-97-CL-E12

Material/Parts

Drycleaning solvent (Item 30, Appendix B)
Switch 8230431 (72915)

REMOVAL

1. Remove four screws (1), washers (2), housing (3), and gasket (4).
2. Disconnect wire coupling nut (5).



DISASSEMBLY

3. Remove rubber cover (6) and nut (7).
4. Remove switch (8).

3-37. EMERGENCY FUEL CUTOFF SWITCH (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

5. Use a cloth dampened with drycleaning solvent and remove dirt and grease from housing (3) and gasket (4).
6. Replace switch (8) if defective.

ASSEMBLY

7. Install switch (8) in housing (3) and secure with nut (7) and rubber cover (6).

INSTALLATION

8. Install gasket (4) and housing (3) and secure with four washers (2) and screws (1).
9. Connect wire coupling (5).
10. Turn wire coupling nut (5) and tighten wire connection.

3-38. EMERGENCY FUEL SOLENOID

This task covers:

- | | | |
|----------------|---------------|-----------------|
| a. Removal | d. Inspection | g. Installation |
| b. Disassembly | e. Repair | h. Test |
| c. Cleaning | f. Assembly | |

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

Material/Parts

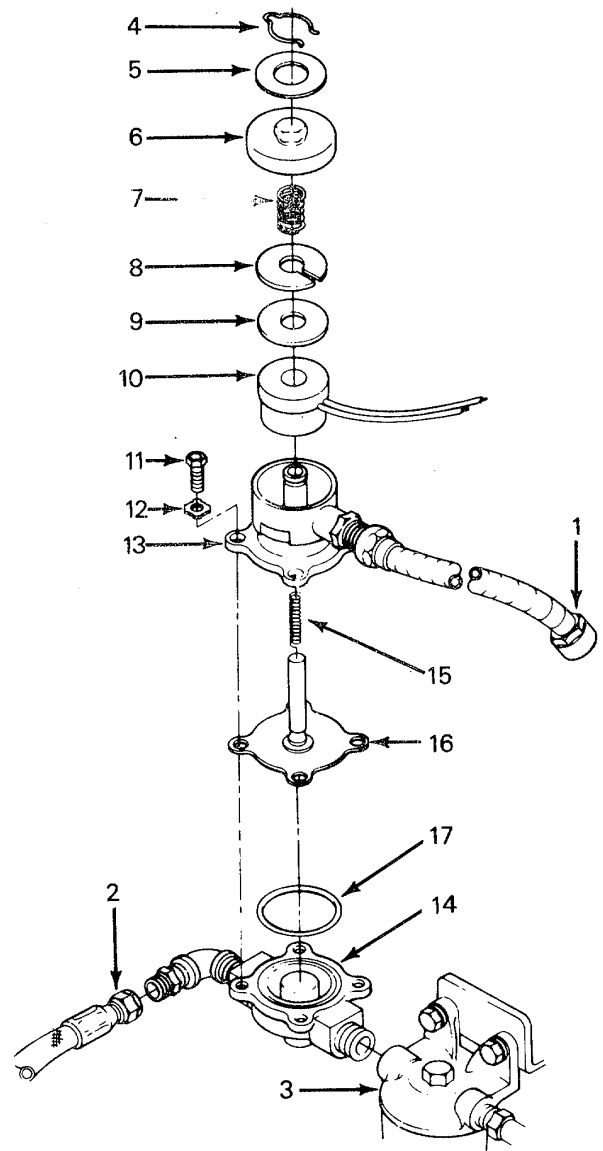
Drycleaning solvent (Item 30, Appendix B)

REMOVAL

1. Disconnect plug (1).
2. Disconnect hose (2) from fuel solenoid and remove solenoid from fuel filter bracket (3).

DISASSEMBLY

3. Remove retainer clip (4) and data plate (5).
4. Remove solenoid housing cap (6).
5. Remove takeup spring (7), flux washer (8), fiber washer (9), and coil (10).
6. Remove four capscrews (11) and washers (12) and carefully remove solenoid housing (13) from valve body (14).
7. Remove spring (15), valve plunger assembly (16) and O-ring (17).



3-38. EMERGENCY FUEL SOLENOID (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air and get medical aid, immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
8. Clean the inside of solenoid housing (13), valve body (14), springs (7) and (15), and seats with drycleaning solvent and dry with compressed air.
 9. Inspect the solenoid and chamber to check that that it moves freely.
 10. Inspect both male and female parts of the seat and mating surfaces to check that they are clean and without pits or damage.
 11. Check rubber diaphragm (17) for cracks, tears, and deterioration. Replace if damaged.
 12. Check O-ring (18) and replace if damaged.
 13. Inspect the coil for burns, shorts, overheating, or physical damage.

ASSEMBLY

14. Install O-ring (17), valve plunger assembly (16), and spring (15) into valve body (14).
15. Install solenoid housing (13) onto valve body (14) and secure with four lockwashers (12) and bolts (11).
16. Install coil (10), fiber washer (9), flux washer (8), and takeup spring (7).
17. Install solenoid housing cap (6) on solenoid housing (13).
18. Install data plate (5) and retainer clip (4).

3-38. EMERGENCY FUEL SOLENOID (cont)

INSTALLATION

19. Install assembled solenoid into fuel filter bracket (3) and connect hose (2).
20. Connect plug (1).

TEST

21. Test by feeling the valve snap open or closed when the control-fuel pump breaker is ON or when the emergency fuel cut-off pushbutton is pressed.

3-39. FUEL TANK AND SIGHT GLASS

This task covers:

- | | | |
|-------------|---------------|-----------------|
| a. Removal | c. Inspection | e. Installation |
| b. Cleaning | d. Repair | |
-

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

Material/Parts

Drycleaning solvent (Item 30, Appendix B)

Equipment Condition Reference

Para 3-52
Para 3-17
TM 55-2210-223-12

Condition Description

Main air reservoir removed
Battery box removed
Sand box removed

REMOVAL

NOTE

- Removal procedures must be performed from the fireman's side.
 - Check that fuel tank has been drained.
1. Disconnect fuel supply line (1) and fuel return line (2).
 2. Disconnect vent pipe (3).
 3. Disconnect relief valve (4).
 4. Remove fuel filler neck (5) on engineers side.
 5. Place a suitable lifting device under fuel tank (6) for support.
 6. Remove 12 bolts (7), flat washers (8), lockwashers, (9), and nuts (10).

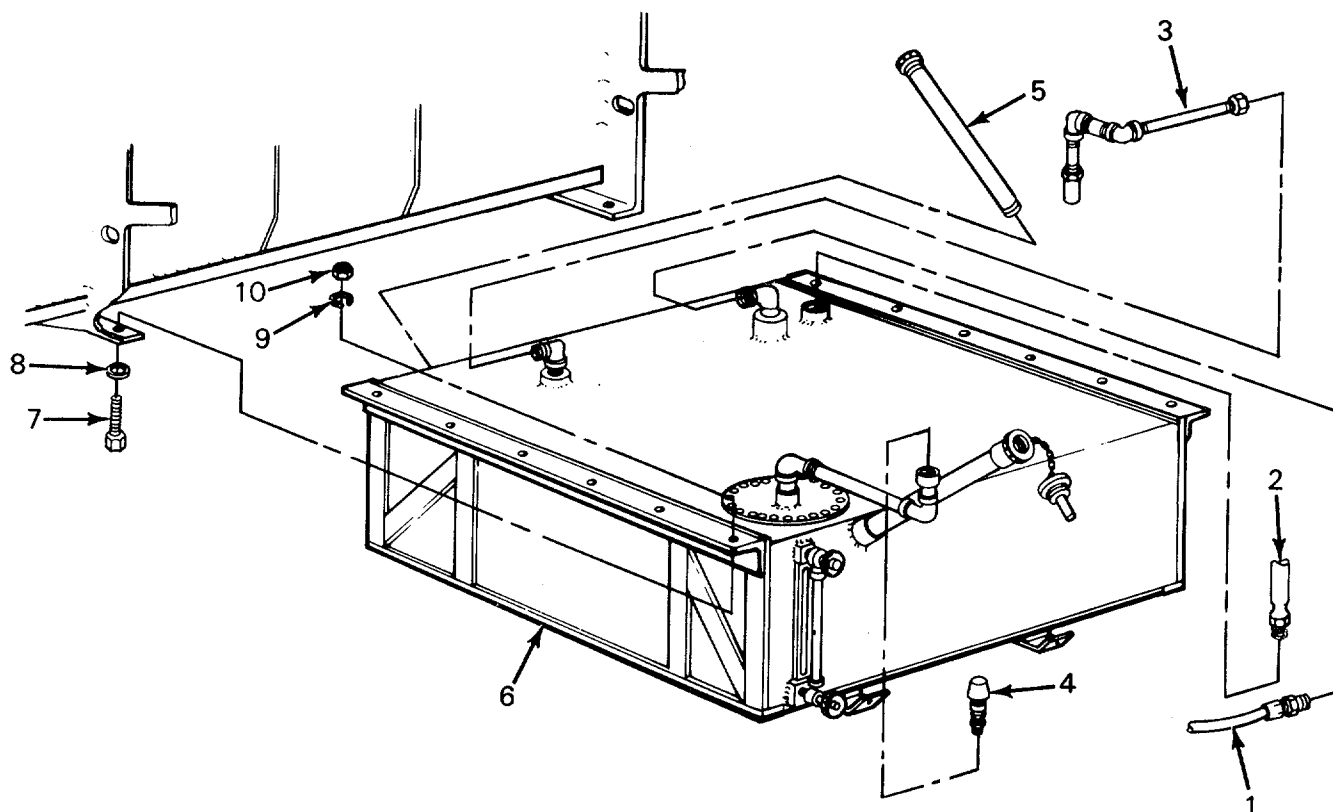
WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

7. Use a suitable lifting device and remove fuel tank (6).

3-39. FUEL TANK AND SIGHT GLASS (cont)

REMOVAL (cont)



CLEANING, INSPECTION, AND REPAIR

8. Steam clean exterior of fuel tank (6) and remove dirt and grease.
9. Purge Interior of fuel tank.
10. Check that pipes, connections, and vent valves are tight and do not leak.
11. Repair leaks by welding, sanding and painting as required.
12. Check that sight glass is not cracked or broken.
13. Replace damaged parts as required.

3-39. FUEL TANK AND SIGHT GLASS (cont)

INSTALLATION

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

13. Use a suitable lifting device and install fuel tank (6). Secure with 12 nuts (10), lockwashers (9), flat washers (8), and bolts (7).
14. Connect fuel return line (2) and fuel supply line (1).
15. Connect vent pipe (3).
16. Connect relief valve (4).
17. Install fuel filler neck (5).

3-40. SHUTTER ASSEMBLY

This task covers:

- | | | |
|-----------------|---------------|-------------|
| a. Removal | c. Cleaning | e. Repair |
| b. Disassembly | d. Inspection | f. Assembly |
| g. Installation | | |
-

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12
Lubricating Oil (Item 19, Appendix B)

Material/Parts

Drycleaning solvent (Item 30, Appendix B)

Equipment Condition Reference

Para 3-7

Condition Description

Radiator hood removed

REMOVAL AND DISASSEMBLY

1. Remove bolt (1), flat washer (2), and locknut (3) and disconnect shutter actuator linkage (4).
2. Remove 10 bolts (5) and lockwashers (6).

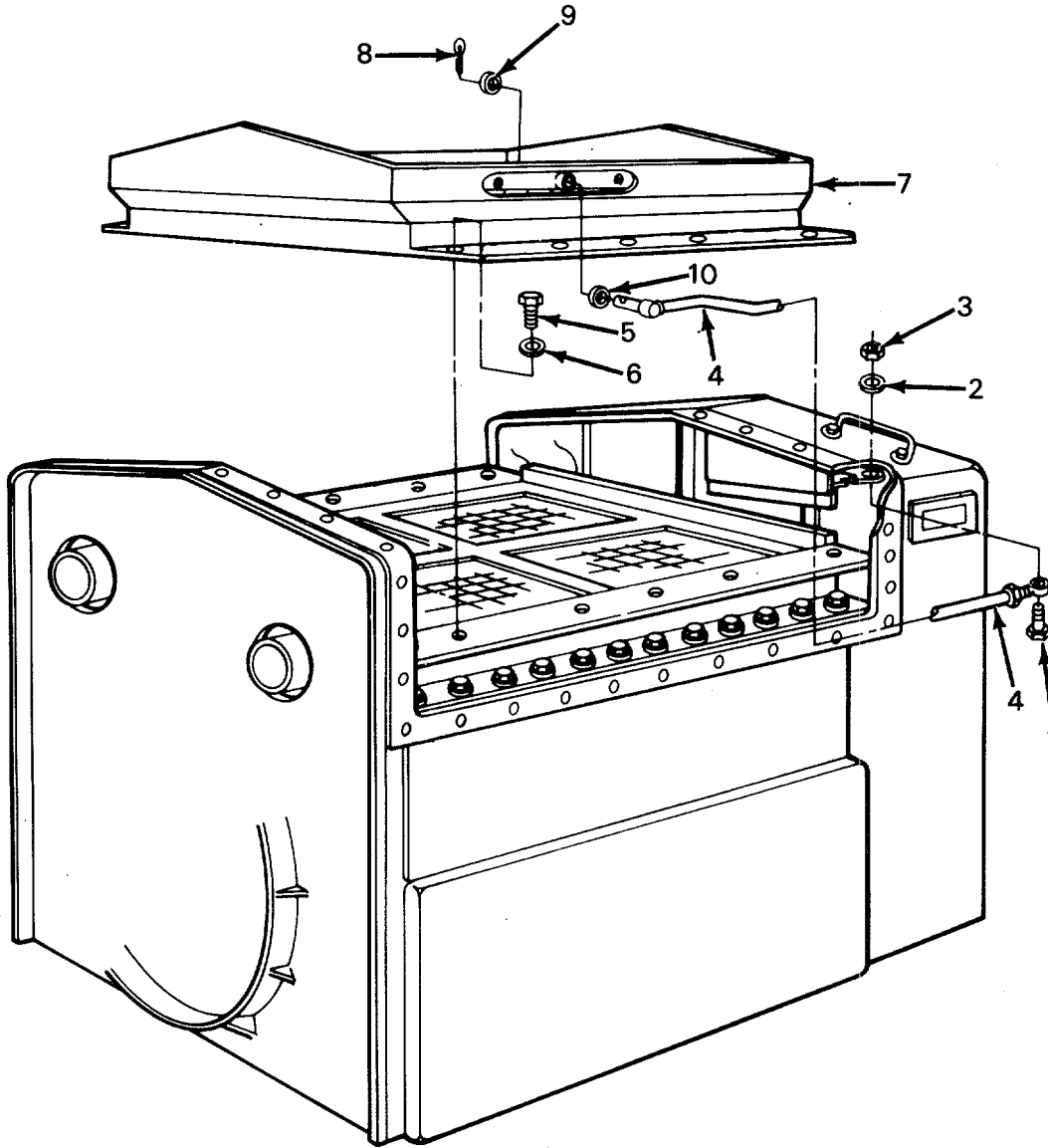
WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

3. Use a suitable lifting device and lift shutter assembly (7) from locomotive. Slowly lower shutter assembly to ground and set on a suitable support device.
4. Remove cotter pin (8), flat washers (9) and (10), and shutter actuator linkage (4).

3-40. SHUTTER ASSEMBLY (cont)

REMOVAL AND DISASSEMBLY (cont)



3-40. SHUTTER ASSEMBLY (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
5. Use drycleaning solvent and remove dirt and grease from shutter assembly (10). Dry with compressed air.
 6. Operate shutters by hand and check that shutters open and close freely.
 7. Check that blades are not bent.
 8. Apply a few drops of oil to shutter linkage.
 9. Repair or replace damaged parts as required.

ASSEMBLY AND INSTALLATION

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

10. Use a suitable lifting device and lift shutter assembly (7) over locomotive. Slowly lower shutter assembly on locomotive and secure with 10 lockwashers (6) and bolts (5).
11. Install shutter actuator linkage (4) and secure with flat washers (10) and (9) and cotter pin (8).
12. Install shutter actuator linkage (4), bolt (1), flat washer (2), and locknut (3).

3-41. COOLING FAN ASSEMBLY

This task covers:

a. Removal

b. Repair

c. Installation

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

Equipment Condition
Reference

Para 3-7

Material/Parts

Grease (Item 12, Appendix B)

Condition Description

Engine hood removed

REMOVAL

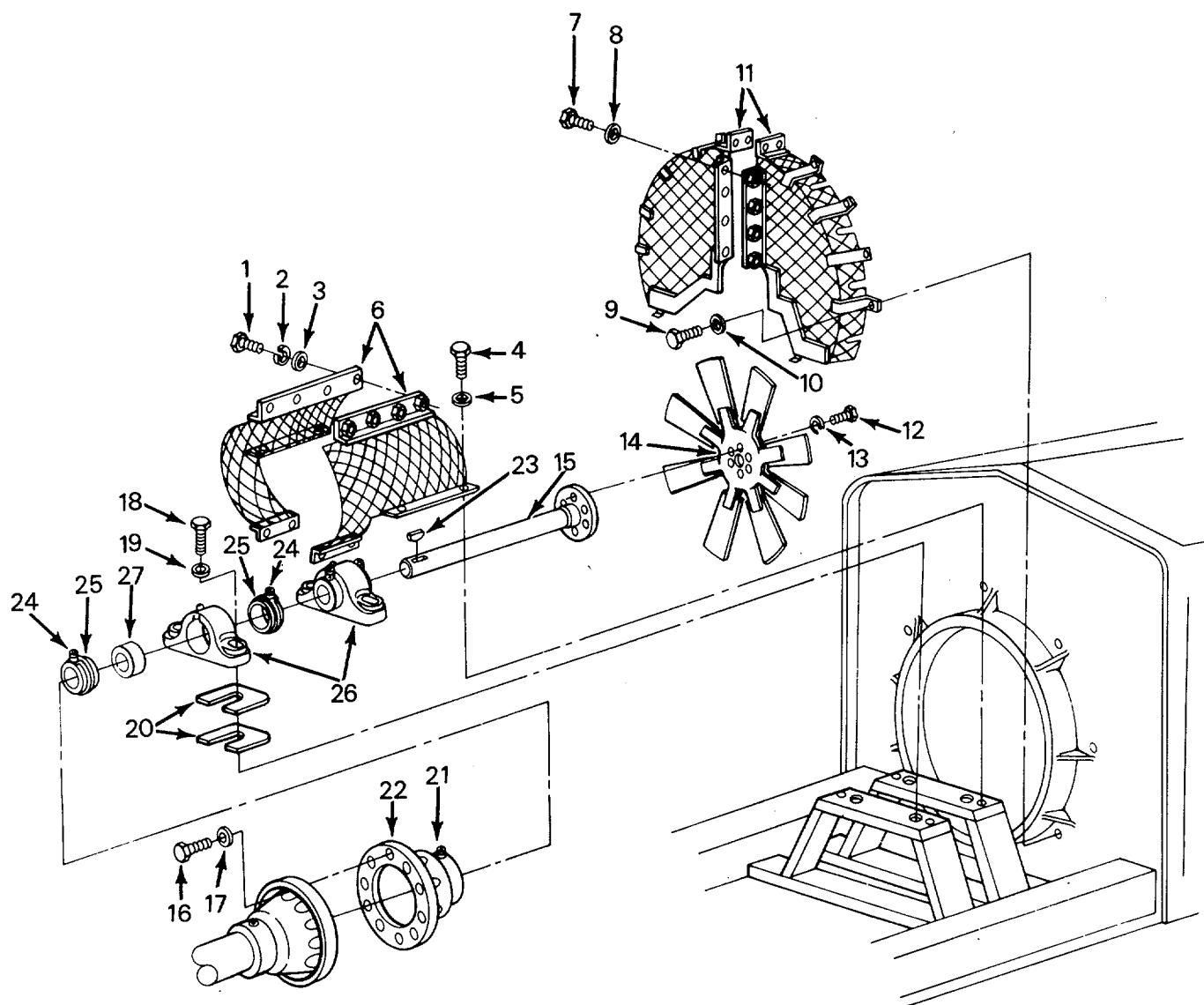
WARNING

Prior to performing cooling fan maintenance, be sure battery switch is in open position and tagged, and battery fuse removed. This is to prevent engine from being started while personnel are working on engine components.

1. Place battery switch in OPEN position and remove battery fuse.
2. Remove four bolts (1), lockwashers (2), and flat washers (3).
3. Remove four bolts (4) and lockwashers (5).
4. Remove flexible fan drive coupler shroud halves (6).
5. Remove eight bolts (7) and flat washers (8).
6. Remove 10 bolts (9) and flat washers (10).
7. Remove engine fan shrouds (11).
8. Remove six bolts (12) and lockwashers (13) from fan (14).
9. Remove fan (14) from drive shaft (15).
10. Remove 10 bolts (16) and flat washers (17).
11. Remove four bolts (18) and flat washers (19).
12. Remove drive shaft (15) from mounting brackets.
13. Remove bearing shims (20). Record thickness of shims taken from each mounting bracket.

3-41. COOLING FAN ASSEMBLY (cont)

REMOVAL (cont)



14. Loosen setscrew (21) and press flexible fan drive coupler (22) from drive shaft (15).
15. Remove key (23) from drive shaft (15).
16. Loosen four setscrews (24) on bearing retainers (25), and press pillow blocks (26) and bearings (27) from fan drive shaft (15).

REPAIR

17. Lubricate bearings (27) with grease.
18. Replace or repair damaged items as required.

3-41. COOLING FAN ASSEMBLY (cont)

INSTALLATION

19. Press assembled pillow blocks (26) and bearings (27) on drive shaft (15). Tighten four setscrews (24) on bearing retainers (25).
20. Install key (23) and flexible fan drive coupler (22) on drive shaft (15).
21. Refer to step 12 for thickness of four bearing shims (20) and install shims in each side of the mounting brackets.
22. Install assembled drive shaft (15) on mounting brackets.
23. Install four washers (19) and bolts (18).
24. Press flexible fan drive coupler (22) on drive shaft (15). Tighten setscrew (21).
25. Install 10 washers (17) and bolts (16) through engine coupler.
26. Install fan (14) on drive shaft (15).
27. Install six lockwashers (13) and bolts (12) in fan (14).
28. Install engine fan shroud (11), 10 flat washers (10), and bolts (9).
29. Install eight flat washers (8) and bolts (7).
30. Install flexible fan drive coupling shroud halves (6), four lockwashers (5), and bolts (4).
31. Install four lockwashers (3), flat washers (2), and bolts (1).

3-42. RADIATOR

This task covers:

a. Removal

b. Test

c. Installation

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12
Antifreeze (Item 2, Appendix B)

Material/Parts

Drycleaning solvent (Item 30, Appendix B)

Equipment Condition Reference

Para 3-40
Para 3-7

Condition Description

Shutters removed
Hood removed

REMOVAL

NOTE

Check that radiator is drained.

1. Remove 10 locknuts (1), flat washers (2), bolts (3).
2. Remove eight clamps (4) and two 6-inch (152 mm) hoses (5).
3. Disconnect vent tube (6) from radiator assembly (7).

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

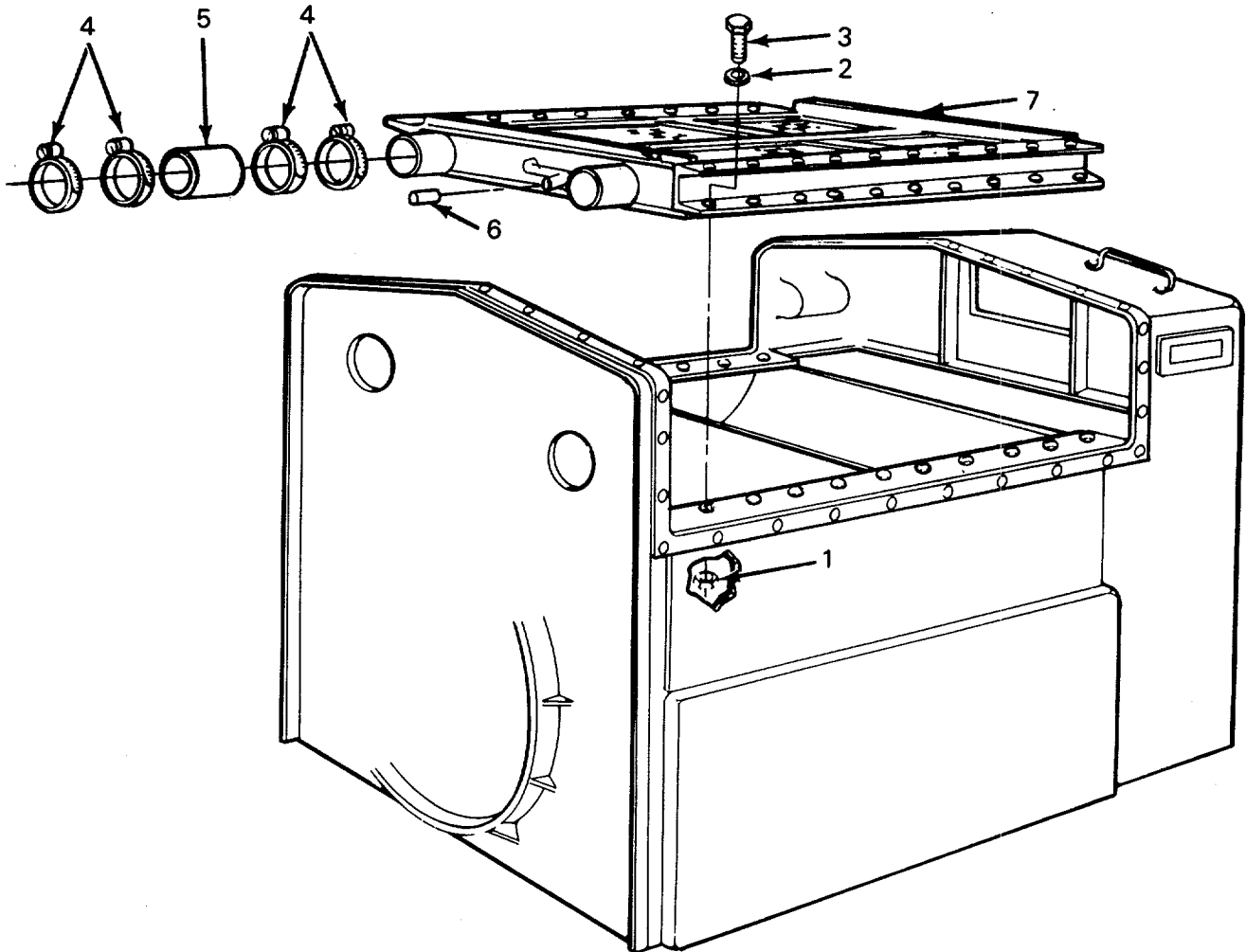
CAUTION

Use extreme caution in selection and installation of chains/ straps, etc. for Removal/ Installation of radiator. Careless selection and installation of lifting devices may result in damage to radiator assembly.

4. Use a suitable lifting device and lift radiator assembly (7) from locomotive. Slowly lower radiator assembly to ground and set on a suitable support device.

3-42. RADIATOR (cont)

REMOVAL (cont)



TEST

5. Apply 10 psi (69 kPa) air pressure to radiator and submerge radiator in a water tank. Check for air leaks. Straighten bent fins as required.

3-42. RADIATOR (cont)

INSTALLATION

NOTE

Leaking radiator must be repaired at intermediate general support level maintenance facility.

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

6. Use a suitable lifting device and lift radiator assembly (7) over locomotive. Slowly lower radiator assembly on locomotive and secure with 10 flat washers (2), bolts (3) and locknuts (1).
7. Install two 6-inch (152 mm) hoses (5) and eight clamps (4).
8. Connect vent tube (6) to radiator (7).
9. Fill radiator with a 50/50 mix of antifreeze and water.

3-43. TRACTION MOTOR BLOWER

This task covers:

a. Removal

b. Installation

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

Equipment Condition Reference

TM 55-2210-223-12

Condition Description

Belts removed

REMOVAL

NOTE

Traction motor blower must be repaired at intermediate general support level maintenance facility.

1. Remove 22 bolts (1), lockwashers (2), and flat washers (3) from base of blower (4).

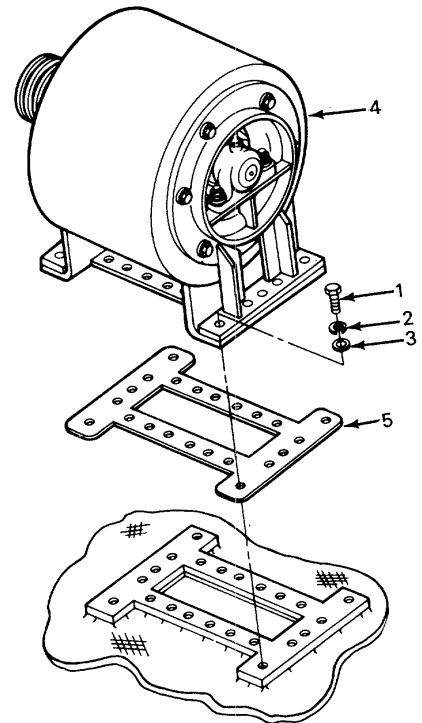
WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

2. Use a suitable lifting device and lift blower (4) from locomotive and set on a suitable support device.
3. Remove gasket (5).

INSTALLATION

4. Install gasket (5).
5. Use a suitable lifting device and slowly raise blower (4) and install on locomotive.
6. Secure blower (4) to deck with 22 washers (3), lockwashers (2), and bolts (1).



3-44. AIR COMPRESSOR ASSEMBLY

This task covers:

a. Removal

b. Installation

c. Test

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

Equipment Condition Reference

Condition Description

Para 3-7
TM 55-2210-223-12

Engine hood removed
Belt removed

REMOVAL

WARNING

Check that air has been completely drained from the compressor before removal. Residual air may escape and cause injury to personnel.

1. Disconnect air line (1).
2. Remove air compressor governor line (2).
3. Drain air compressor oil.
4. Disconnect oil drain flange (3).
5. Use a punch and punch-mark flange coupling (7) to flexible coupling (8).
6. Remove eight bolts (4), lockwashers (5), and locknuts (6) and remove flange coupling (7) and flexible coupling (8).
7. Remove four base mounting bolts (9) and lockwashers (10).

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

8. Connect a suitable lifting device around air intake flange (low-pressure side) and around intercooler connection on high side.

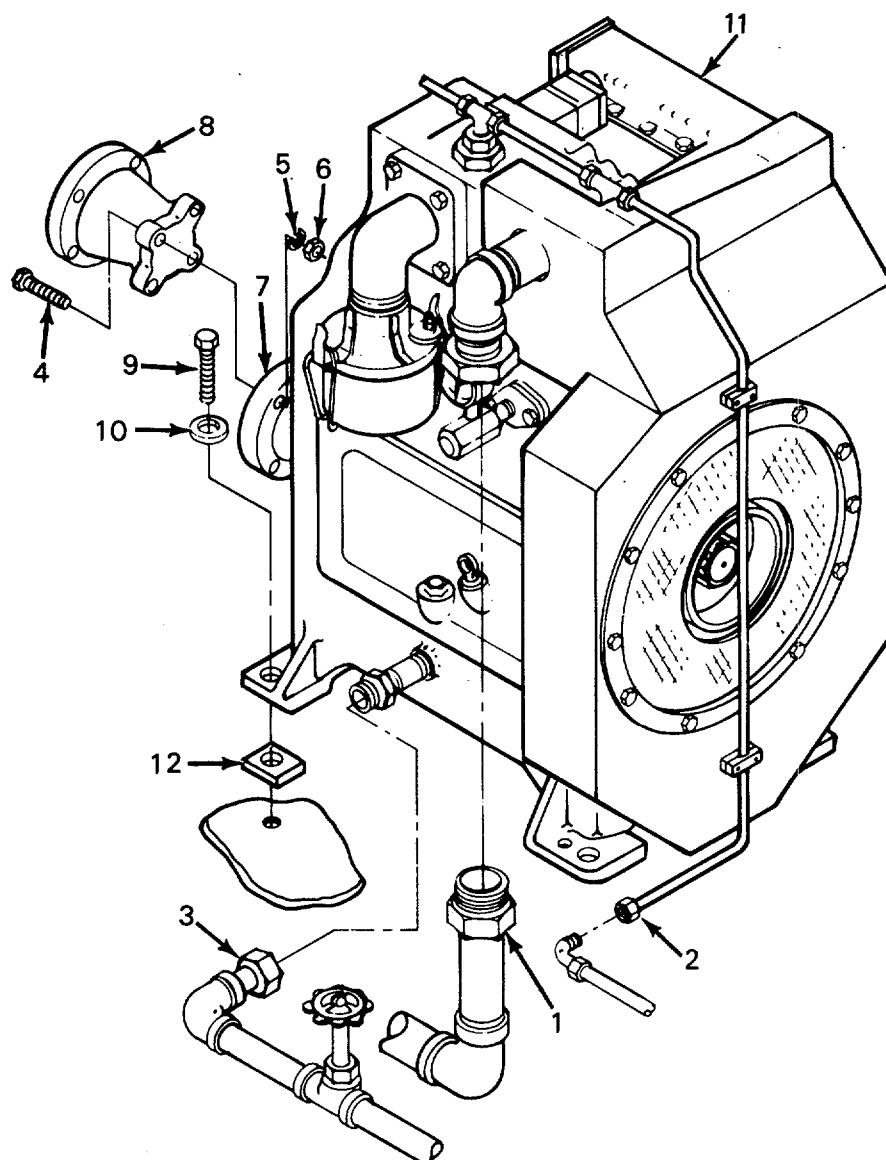
3-44. AIR COMPRESSOR ASSEMBLY (cont)

REMOVAL (cont)

9. Use a suitable lifting device and lift air compressor (11) from locomotive deck and set on a suitable support device.
10. Remove shims (12) and record thickness of shims taken from each mounting bracket.

NOTE

Air compressor must be repaired at intermediate general support level maintenance facility.



3-44. AIR COMPRESSOR ASSEMBLY (cont)

INSTALLATION

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

NOTE

If new compressor is to be installed, alinement dowels must be relocated if compressor does not align with engine.

11. Use a suitable lifting device and lift air compressor (11) and install on locomotive deck.

NOTE

Check that marked shims retained from removal are in original positions.

12. Install shims (12).
13. Install four lockwashers (10) and base mounting bolts (9).
14. Check that punch marks on flexible coupling (8) and flange coupling (7) are lined up. Secure couplings with eight locknuts (6), lockwashers (5), and bolts (4).
15. Refer to TM 5-2815-232-14 and align air compressor to engine.
16. Connect oil drain flange (3).
17. Connect air compressor governor line (2).
18. Connect air line (1).
19. Refer to LO 55-2210-223-12 and fill air compressor with oil.

3-44. AIR COMPRESSOR ASSEMBLY (cont)

TEST

CAUTION

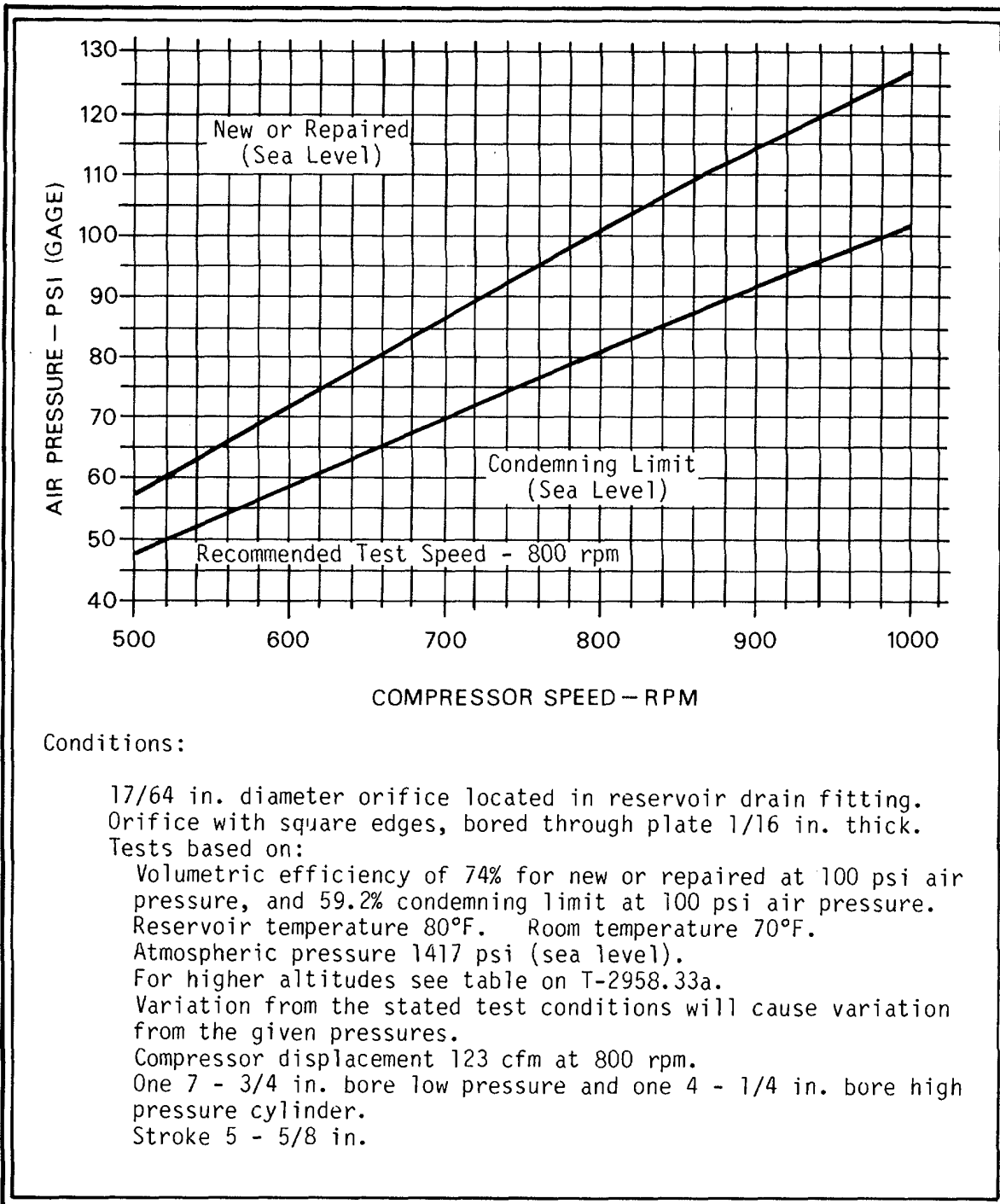
When performing orifice test, check that oil pressure is never less than 15 psi (103 kPa). Damage to air compressor can result.

20. Perform an orifice test by the following:
 - a. Connect an orifice holder with 17/64-inch (6.7 mm) orifice in air reservoir drain cock. Use orifice with square edges bored through plate 1/16 inch (1.6 mm) thick.
 - b. Start engine and run until it is at normal operating temperature.
 - c. Close outlet valve from reservoirs, open drain cock, and leave open for all tests.
 - d. Run air compressor at least 2 minutes at low speed (table 3-4) and take a pressure reading. Record air compressor speed (rpm) and corresponding pressure.
 - e. Run air compressor at least 2 minutes at high speed (table 3-4) and take a pressure reading. Record air compressor speed (rpm) and corresponding pressure.
 - f. Run air compressor 15 minutes (drain cock open) and repeat steps d and e.
 - g. Use table 3-5 and compare speed-pressure readings.
 - h. Safety valve and check that intercooler safety valve opens at 60 psi (414 kPa). Replace damaged intercooler safety valve.
21. Apply air to unloading valves and check that unloading valves open at 130 psi (896 kPa) and close at 140 psi (965 kPa). If unloading valves do not open and close at specified psi, refer to paragraph 3-45 and adjust air compressor governor.
22. Apply air pressure to main reservoir safety valve and check that main reservoir safety valve opens at 150 psi (1034 kPa). Adjust main reservoir safety valve by turning regulating nut. Replace damaged main reservoir safety valve.

3-44. AIR COMPRESSOR ASSEMBLY (cont)

TEST (cont)

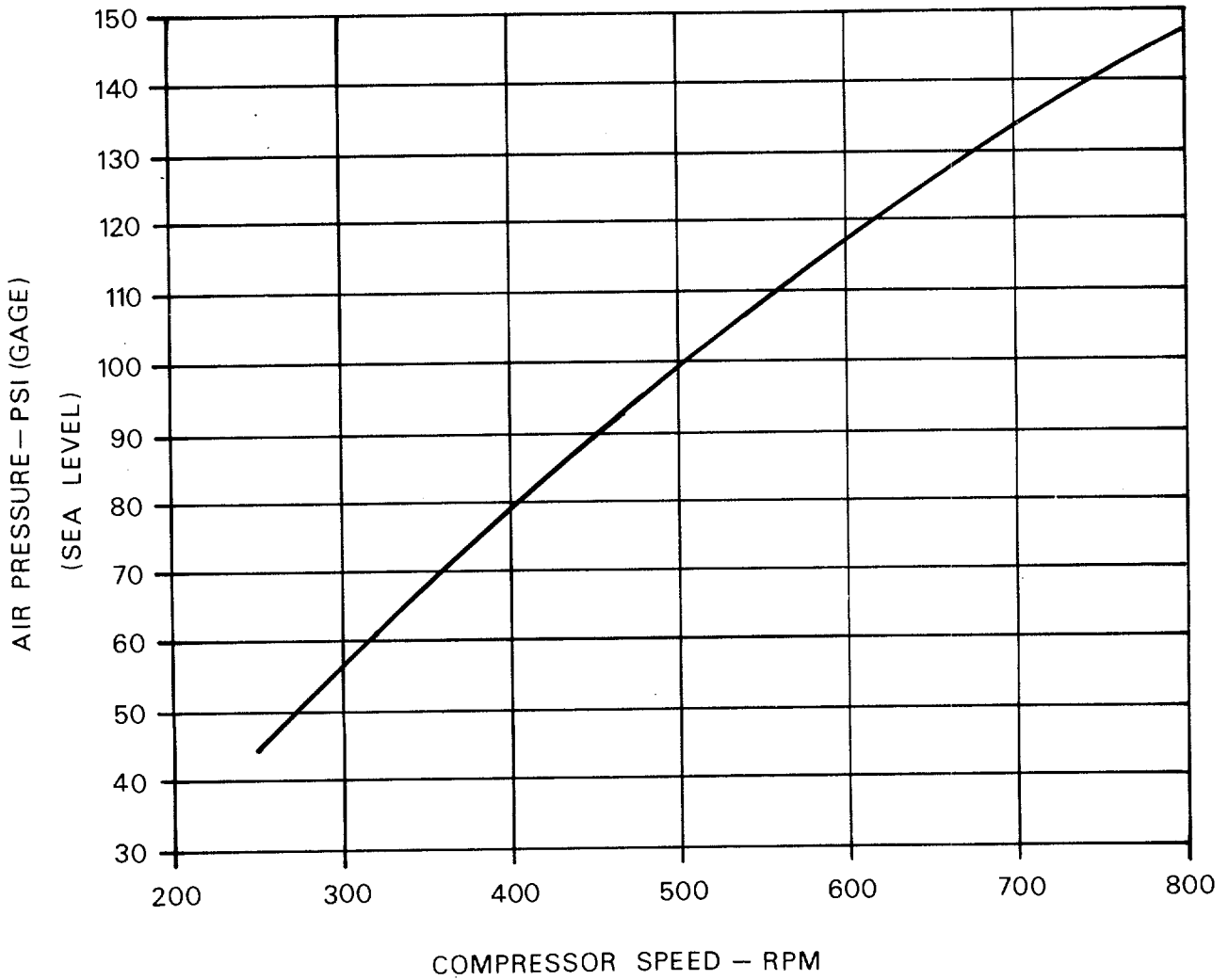
Table 3-4. Compressor Passing and Condemning Limit



3-44. AIR COMPRESSOR ASSMEBLY (cont)

TEST (cont)

Table 3-5. Speed Versus Pressure Curve



3-45. AIR COMPRESSOR GOVERNOR ASSEMBLY

This task covers:

- | | | |
|----------------|---------------|-----------------|
| a. Removal | d. Inspection | g. Installation |
| b. Disassembly | e. Repair | h. Adjustment |
| c. Cleaning | f. Assembly | |
-

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

Personnel Required

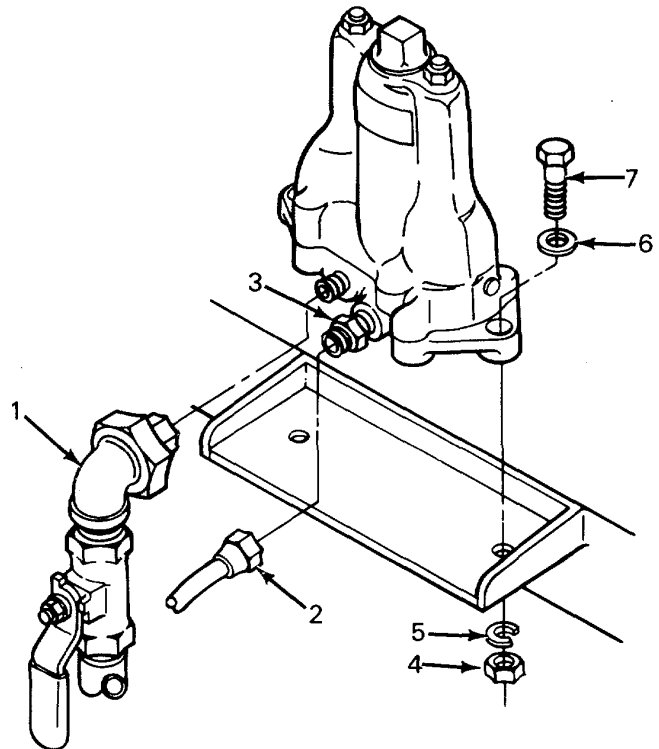
2

Material/Parts

1000-grit lapping compound (Item 7, Appendix B)
Drycleaning solvent (Item 30, Appendix B)
Triple valve oil (Item 23, Appendix B)
Air filter 579738 (82722)

REMOVAL

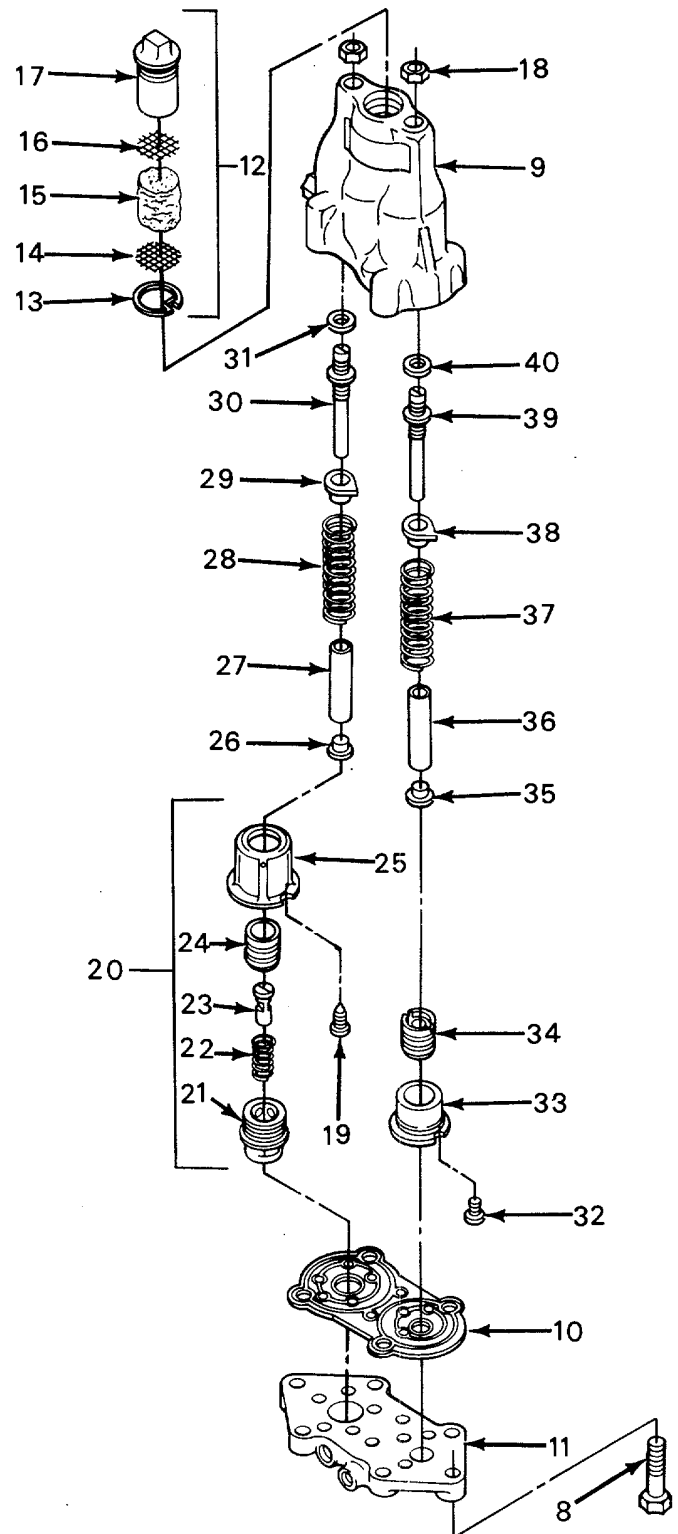
1. Close vent cutoff cock valve (1).
2. Disconnect union elbow (2).
3. Remove copper compressor line (3).
4. Remove two nuts (4), lockwashers (5), flat washers (6), and bolts (7).



3-45. AIR COMPRESSOR GOVERNOR ASSEMBLY (cont)

DISASSEMBLY

5. Remove four bolts (8), governor body (9), and gasket (10) from pipe bracket (11).
6. Remove strainer assembly (12) from governor body (9).
7. Disassemble strainer assembly (12) by removing retainer (13), strainer plate (14), air filter (15), and strainer plate (16) from strainer case (17).
8. Remove two locknuts (18).
9. Remove tension from adjusting stems (39) and (30).
10. Remove two screws (19) and cut-in valve assembly (20).
11. Disassemble cut-in valve assembly (20) by removing cut-in tail valve seat (21), spring (22), cut-in tail valve (23), and cut-in valve (24) from cut-in valve seat (25).
12. Remove spring seat (26), adjusting stem sleeve (27), spring (28), adjusting stem nut (29), adjusting stem (30), and washer (31).
13. Remove two screws (32), cutout valve seat (33), and cutout valve (34).
14. Remove spring seat (35), adjusting stem sleeve (36), spring (37), adjusting stem nut (38), adjusting stem (39), and washer (40).



3-45. AIR COMPRESSOR GOVERNOR ASSEMBLY (cont.)

CLEANING, INSPECTION, AND REPAIR

WARNING

● Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 - 138°F (38 - 59C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.

● Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

15. Use a cloth dampened with dry-cleaning solvent and remove dirt, grease, and oil from body. Dry with compressed air.

16. Use dry-cleaning solvent and remove dirt, grease, and oil from metal parts. Dry with compressed air.

NOTE

If it is necessary to replace a valve or valve seat, it must be replaced as a combination valve and valve seat assembly because of required close tolerances.

17. Inspect metal parts for cracks, breaks, cuts, or other damage. Replace damaged parts.

18. Check that springs are not rusted or distorted or have taken a permanent set. Replace damaged springs.

19. Replace air filter (15).

20. Apply oil to cut-in valve, cutout valve, and tail valves.

3-45. AIR COMPRESSOR GOVERNOR ASSEMBLY (cont.)

ASSEMBLY

NOTE

Lap all brass surfaces as required.

21. Install washer (40), adjusting stem (39), adjusting stem nut (38), spring (37), adjusting stem sleeve (36), spring seat (35), cutout valve (34), and cutout valve seat (33). Secure with two screws (32).
22. Install washer (31), adjusting stem (30), adjusting stem nut (29), spring (28), adjusting stem sleeve (27), and spring seat (26).
23. Assemble cut-in valve assembly (20) by installing cut-in valve (24), cut-in tail valve (23), spring (22), and cut-in tail valve seat (21) in cut-in valve seat (25).
24. Install cut-in valve assembly (20) and secure with two screws (19).
25. Install two locknuts (18).
26. Assemble strainer assembly (12) by installing strainer plate (16), new air filter (15), and strainer plate (14) in strainer case (17). Secure with retainer (13).
27. Install strainer assembly (12) in governor body (9).
28. Install gasket (10) and governor body (9) on pipe bracket (11) and secure with four bolts (8).

INSTALLATION

29. Install governor on pipe mounting bracket and secure with two flat washers (6), bolts (7), lockwashers (5), and nuts (4).
30. Install copper line (3).
31. Install union elbow (2).
32. Open vent cutoff cock valve (1).

ADJUSTMENT

33. Loosen two locknuts (18).
34. Apply air and turn adjusting stem (39) until the 130 psi (896 kPa) cutout point is reached. At the same time, turn adjusting stem (30) down to the same tension.
35. If 120 psi (827 kPa) cutout point is not reached, turn adjusting stem (30) down to raise cut-in point to decrease the range, or turn adjusting stem up to lower cut-in point to increase the range.

3-46. AUTOMATIC BRAKE VALVE

This task covers:

- a. REMOVAL b. INSTALLATION c. TEST
-

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

REMOVAL

WARNING

- Whenever the automatic brake valve is removed and installed for any reason, a stationary vehicle airbrake test must be performed to check that the automatic brake valve functions properly in the brake equipment arrangement. Failure to perform test may result in injury to personnel.

- Make sure air is drained before removal of the automatic brake valve. Residual air may escape and cause injury to personnel.

NOTE

When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P.

1. Remove eight screws (1) and panel (2).

2. Remove four locknuts (3), flat washers (4), and bolts (5).

3. Remove four bolts (6).

4. Remove regulating valve handle (7).

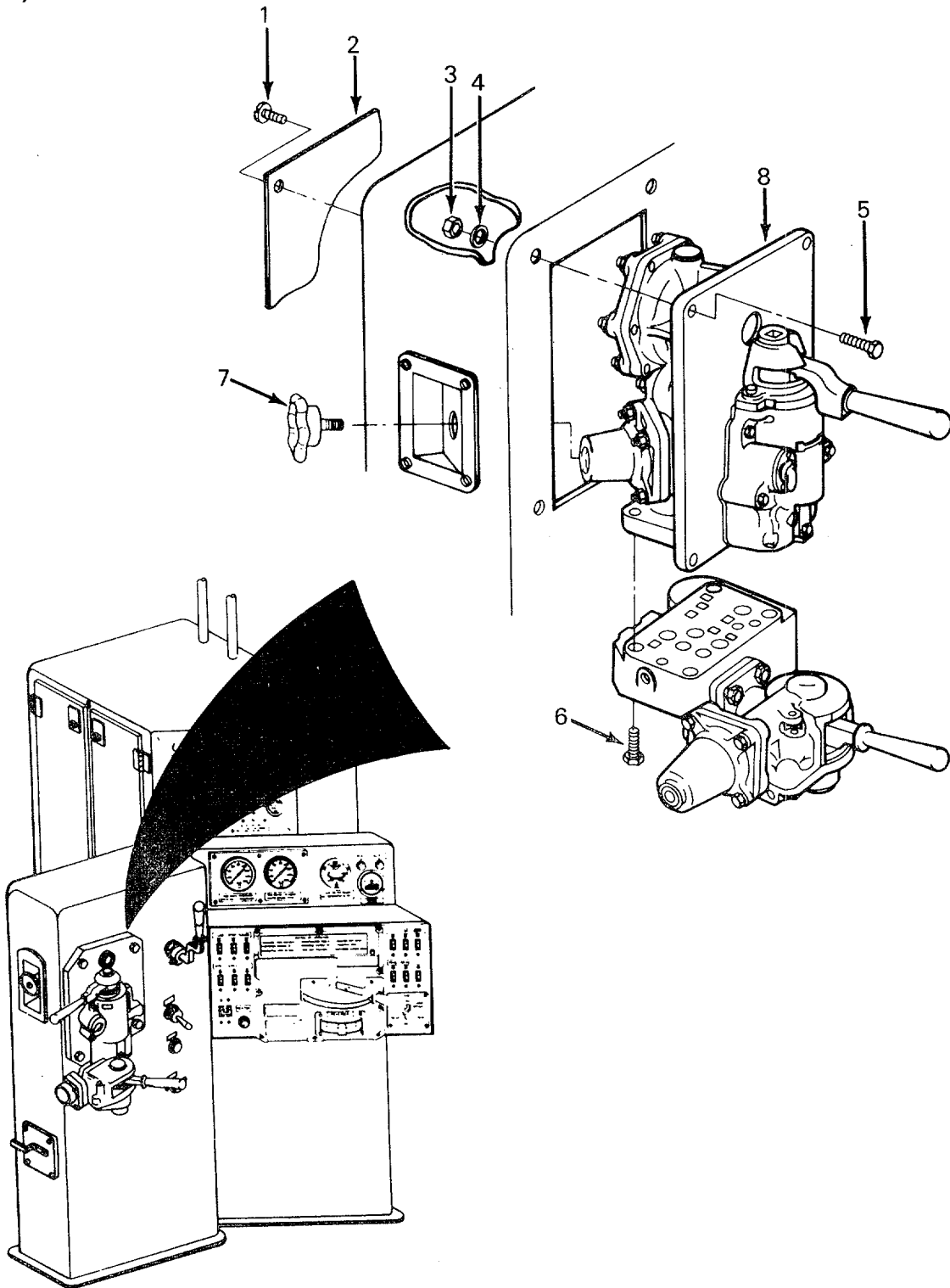
5. Remove automatic brake valve (8).

NOTE

Automatic brake valve must be repaired at intermediate general support level facility.

3-46. AUTOMATIC BRAKE VALVE (cont.)

REMOVAL (cont.)



3-46. AUTOMATIC BRAKE VALVE (cont.)

INSTALLATION

7. Install automatic brake valve (8).
8. Install regulating valve handle (7).
9. Install four bolts (6).
10. Install four locknuts (3), flat washers (4), and bolts (5).
11. Install panel (2) and eight screws (1).

TEST

12. Refer to paragraph 2-9 and perform a stationary vehicle airbrake test.

3-47. INDEPENDENT BRAKE VALVE

This task covers:

- a. REMOVAL b. INSTALLATION c. TEST
-

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

REMOVAL

WARNING

● Whenever the independent brake valve is removed and installed for any reason, a stationary vehicle airbrake test must be performed to check that the independent brake valve functions properly in the brake equipment arrangement. Failure to perform test may result in injury to personnel.

● Make sure air is drained before removal of the independent brake valve. Residual air may escape and cause injury to personnel.

NOTE

Independent brake valve must be repaired at intermediate general support level maintenance facility.

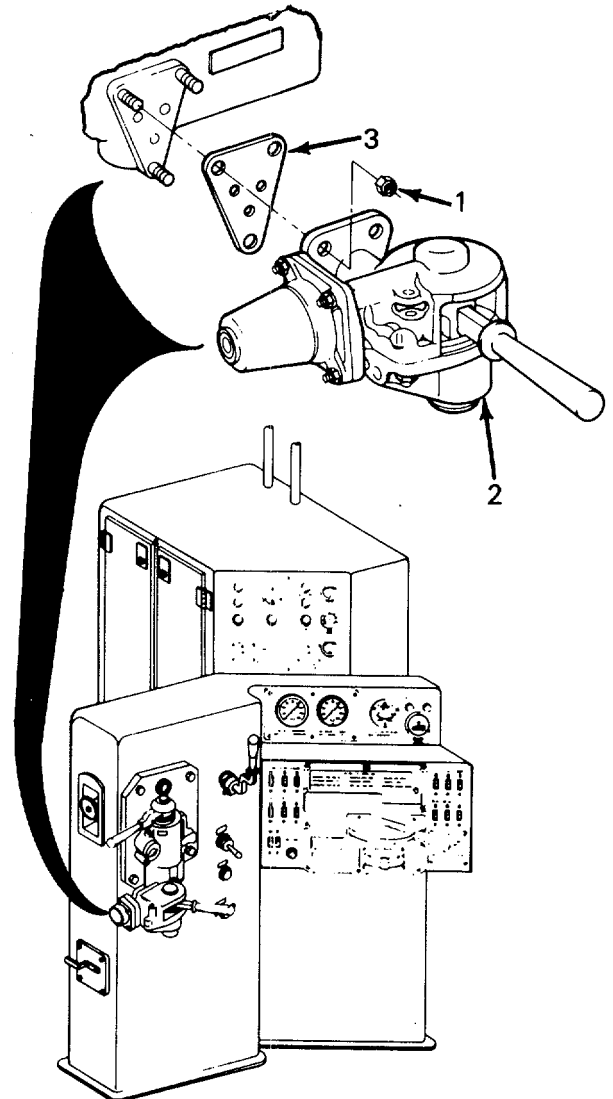
1. Remove three nuts (1).
2. Remove independent brake valve (2) and gasket (3).

INSTALLATION

3. Install gasket (3) and independent brake valve (2) and secure with three nuts (1).

TEST

4. Refer to paragraph 2-9 and perform a stationary vehicle airbrake test.



3-48. 6-NFR DISTRIBUTING VALVE

This task covers:

a. Removal

b. Installation

c. Test

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

REMOVAL

WARNING

- Whenever the 6-NFR distributing valve is removed and installed for any reason, a stationary vehicle airbrake test must be performed to check that the 6-NFR distributing valve functions properly in the brake equipment arrangement. Failure to perform test may result in injury to personnel.
- Make sure air is drained before removal of the 6-NFR distributing valve. Residual air may escape and cause injury to personnel.

NOTE

When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

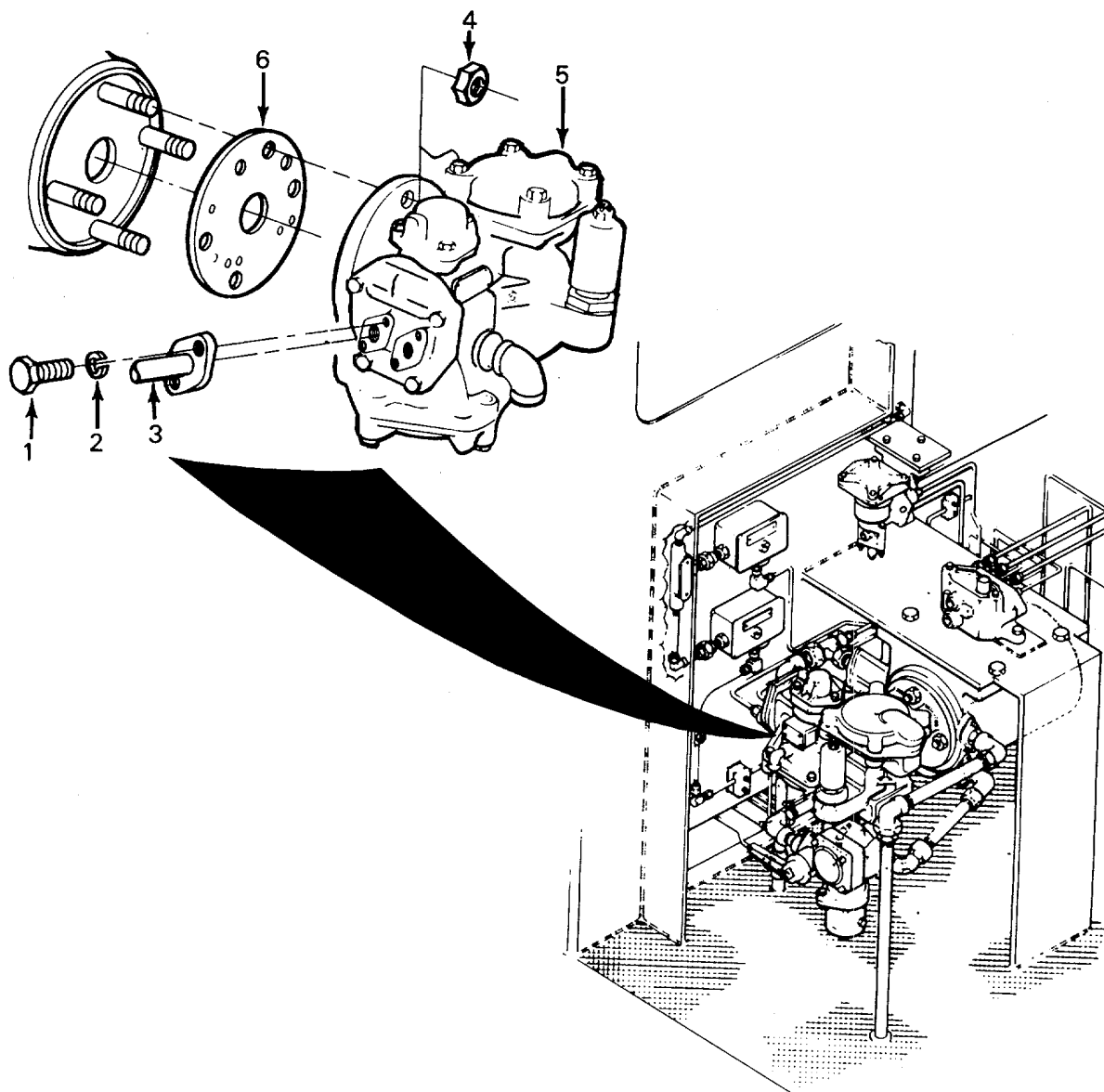
1. Remove four bolts (1) and lockwashers (2) and disconnect two air lines (3).
2. Remove four nuts (4).
3. Remove 6-NFR distributing valve (5).
4. Remove rubber gasket (6).

NOTE

The 6-NFR distributing valve must be repaired at intermediate general support level maintenance facility.

3-48. 6-NFR DISTRIBUTING VALVE (cont.)

REMOVAL (cont.)



INSTALLATION

5. Install rubber gasket (6).
6. Install 6-NFR distributing valve (5) and secure with four nuts (4).
7. Connect two air lines (3) and secure with two lockwashers (2) and bolts (1).

TEST

8. Refer to paragraph 2-9 and perform a stationary vehicle airbrake test.

3-49. NO. 8 VENT VALVE

This task covers:

a. Removal

b. Installation

c. Test

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

REMOVAL

WARNING

- Whenever the No. 8 vent valve is removed and installed for any reason, a stationary vehicle airbrake test (para 2-9) must be performed to check that the No. 8 vent valve functions properly in the brake equipment arrangement. Failure to perform test may result in injury to personnel.
- Make sure air is drained before removal of the No. 8 vent brake valve. Residual air may escape and cause injury to personnel.

NOTE

When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

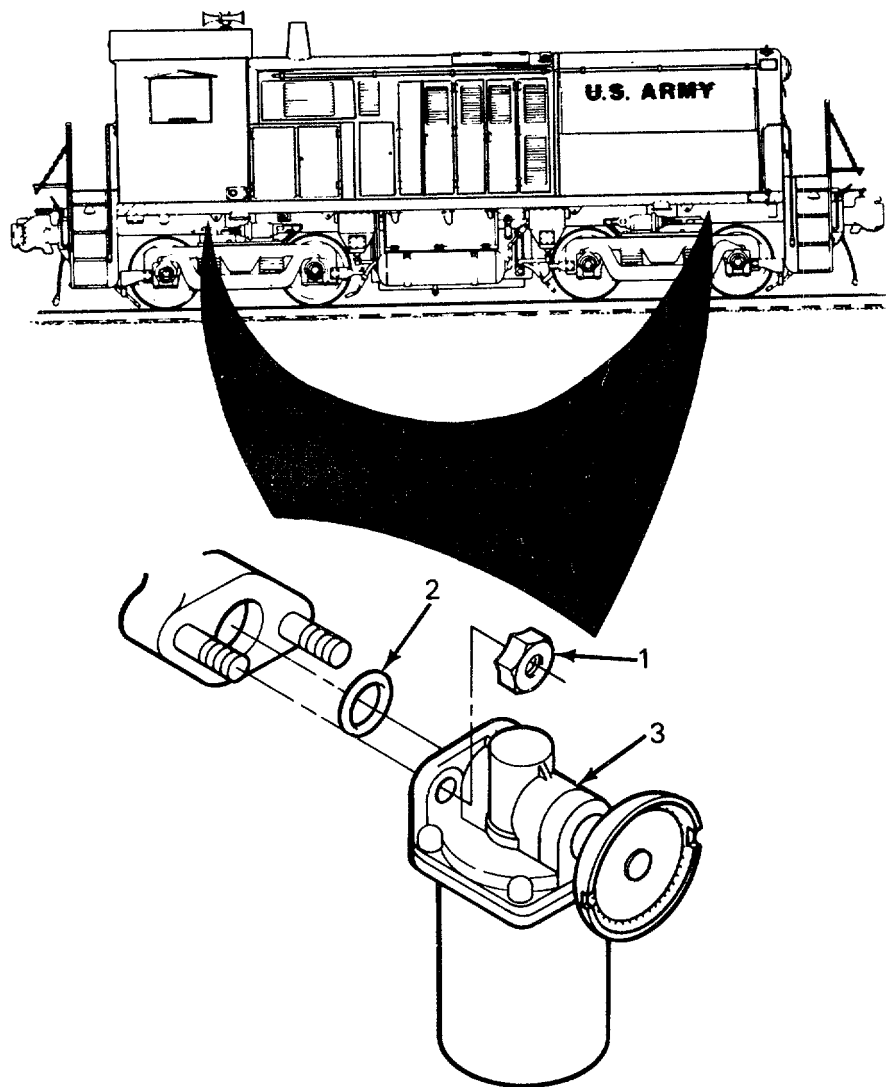
1. Remove two nuts (1).
2. Remove No. 8 vent valve (3).
3. Remove rubber gasket (2).
4. Repeat steps (1) thru (3) and remove remaining No. 8 vent valve.

NOTE

The No. 8 vent valve must be repaired at an intermediate general support level maintenance facility.

3-49. NO. 8 VENT VALVE (cont.)

REMOVAL (cont.)



INSTALLATION

5. Install rubber gasket (2).
6. Install No. 8 vent valve (3) and secure with two nuts (1).
7. Repeat steps 3 and 4 and install remaining No. 8 vent valve.

TEST

8. Refer to paragraph 2-9 and perform a stationary vehicle airbrake test.

3-50. A-1 CHARGING CUTOFF PILOT VALVE

This task covers:

a. Removal

b. Installation

c. Test

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

REMOVAL

WARNING

- Whenever the A-1 charging cutoff pilot valve is removed and installed for any reason, a stationary vehicle airbrake test (para 2-9) must be performed to check that the A-1 charging cutoff pilot valve functions properly in the brake equipment arrangement. Failure to perform test may result in injury to personnel.
- Make sure air is drained before removal of the A-1 charging cutoff pilot valve. Residual air may escape and cause injury to personnel.

NOTE

When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

1. Remove two bolts (1).
2. Remove A-1 charging cutoff pilot valve (2) and gasket (3).

3-50. A-1 CHARGING CUTOFF PILOT VALVE (cont.)

REMOVAL (cont.)

NOTE

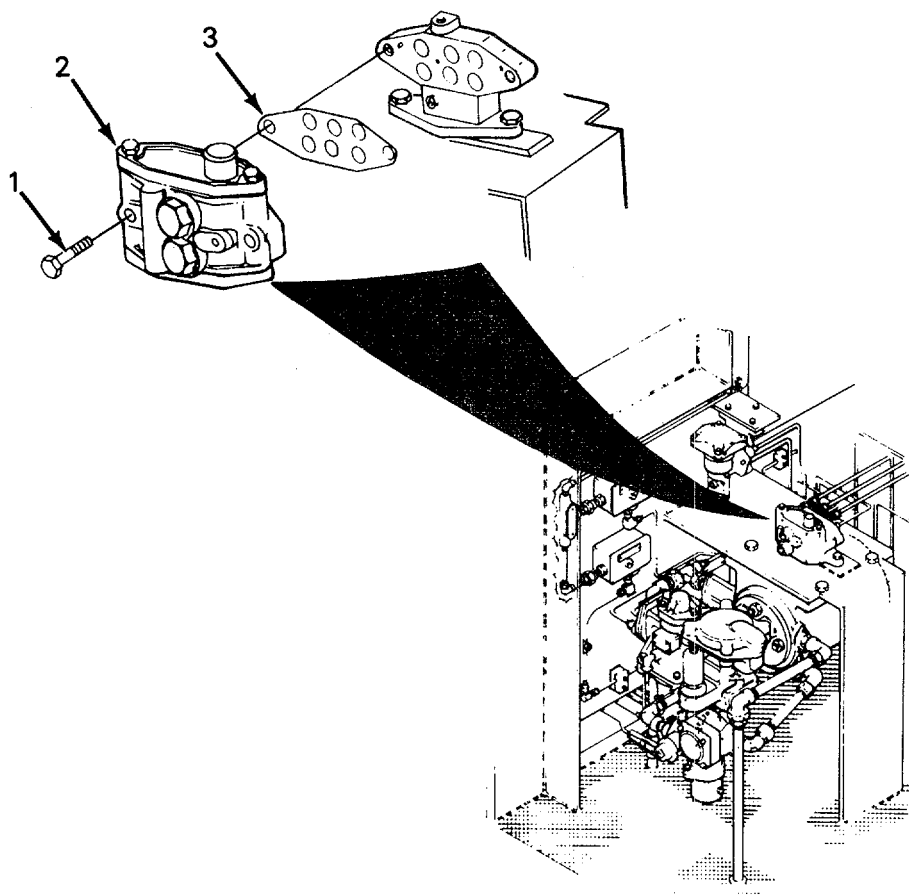
A-1 charging cutoff valve must be repaired at intermediate general support maintenance facility.

INSTALLATION

3. Install gasket (3) and A-1 charging cutoff pilot valve (2) and secure with two bolts (1).

TEST

4. Refer to paragraph 2-9 and perform a stationary vehicle airbrake test.



3-51. H-5 RELAY AIR VALVE

This task covers:

a. Removal

b. Installation

c. Test

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

REMOVAL

WARNING

- Whenever the H-5 relay air valve is removed and installed for any reason, a stationary vehicle airbrake test (para 2-9) must be performed to check that the H-5 relay air valve functions properly in the brake equipment arrangement.. Failure to perform test may result in injury to personnel.
- Make sure air is drained before removal of the H-5 relay air valve. Residual air may escape and cause injury to personnel.

NOTE

When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

1. Remove three nuts (1).
2. Remove H-5 relay air valve (3).
3. Remove three rubber gaskets (2).

NOTE

The H-5 relay valve must be repaired at intermediate general support level maintenance facility.

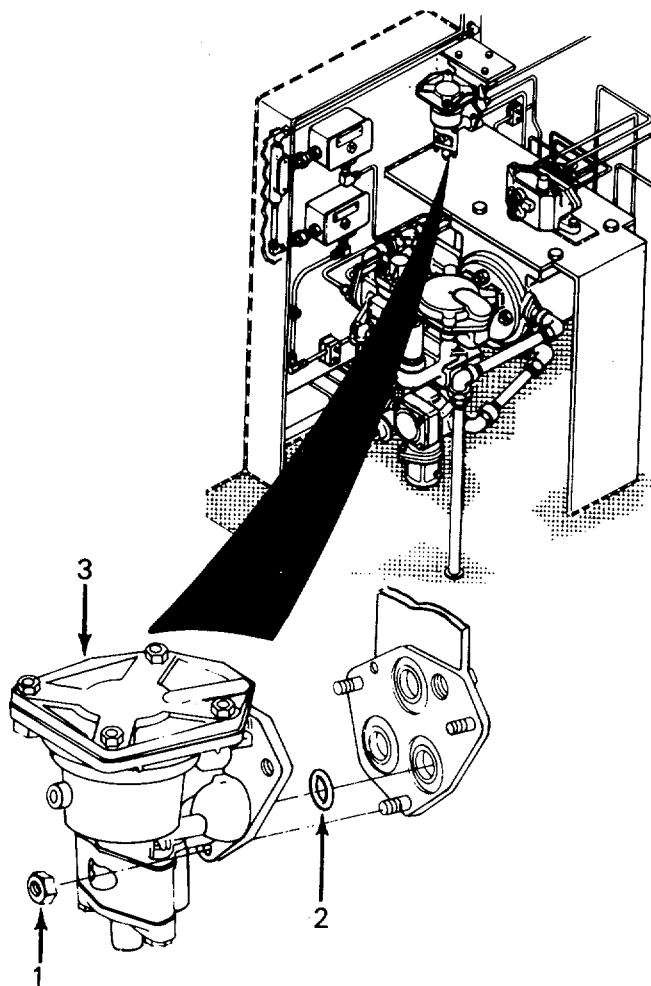
3-51. H-5 RELAY AIR VALVE (cont.)

INSTALLATION

4. Install three rubber gaskets (2).
5. Install H-5 relay air valve (3) and secure with three nuts (1).

TEST

6. Refer to paragraph 2-9 and perform a stationary vehicle airbrake test.



3-52. EMERGENCY BRAKE VALVE

This task covers:

a. Removal

b. Installation

c. Test

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

REMOVAL

WARNING

- Whenever the emergency brake valve is removed and installed for any reason, a stationary vehicle airbrake test (para 2-9) must be performed to check that the emergency brake valve functions properly in the brake equipment arrangement. Failure to perform test may result in injury to personnel.
- Make sure air is drained before removal of the emergency brake valve. Residual air may escape and cause injury to personnel.

NOTE

When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210- 223-24P for identification of piping.

1. Disconnect air fitting.

3-52. EMERGENCY BRAKE VALVE (cont.)

REMOVAL (cont.)

2. Remove two bolts (1), nuts(2).
3. Remove cotter key (3), pin (4), and handle (5).
4. Rotate pipe elbow toward engineer's side.
5. Remove emergency brake valve (6) from pipe (7).

NOTE

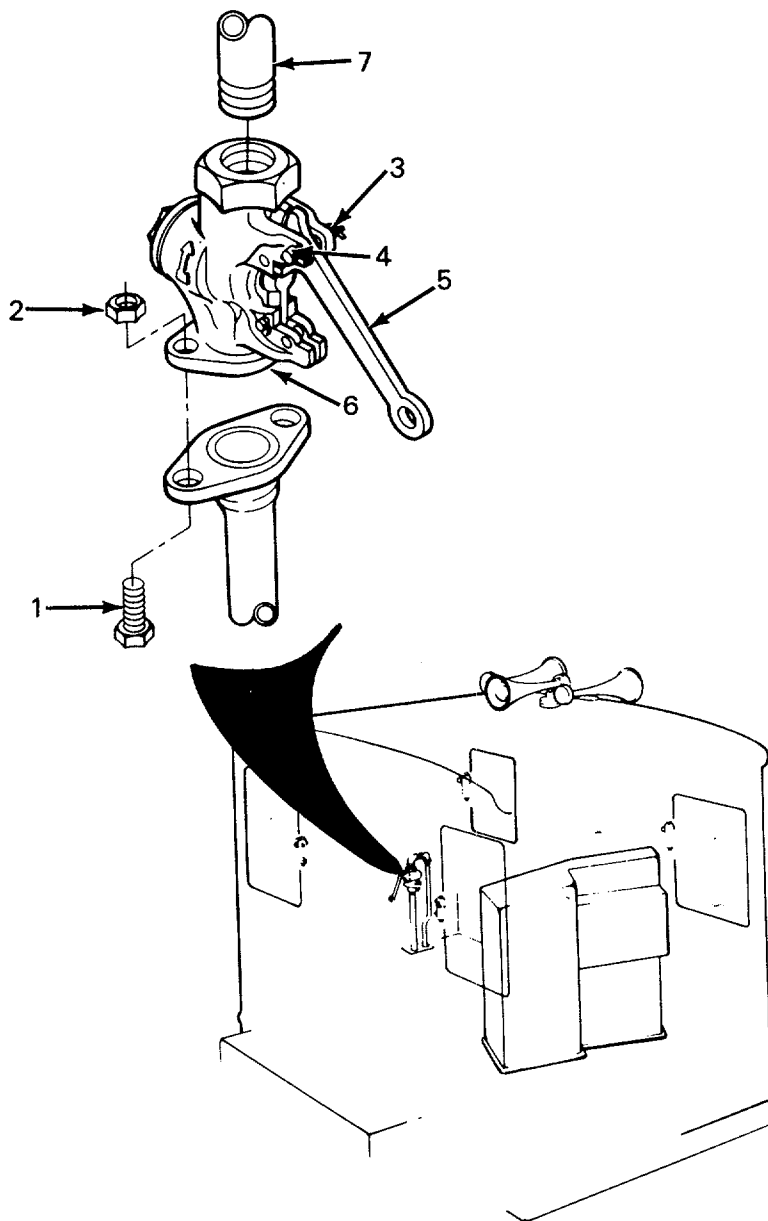
Emergency brake valve must be repaired at intermediate general support level maintenance facility.

INSTALLATION

6. Install emergency brake valve (6) on pipe (7).
7. Rotate pipe elbow toward fireman's side.
8. Install handle (5), pin (4), and cotter key (3).
9. Install two bolts (1), and nuts (2).

TEST

10. Refer to paragraph 2-9 and perform a stationary vehicle airbrake test.



3-53. STRAINER AND CHECK VALVE

This task covers:

a. Removal

b. Installation

c. Test

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

REMOVAL

WARNING

- Whenever the strainer and check valve is removed and installed for any reason, a stationary vehicle airbrake test (para 2-9) must be performed to check that the strainer and check valve functions properly in the brake equipment arrangement. Failure to perform test may result in injury to personnel.
- Make sure air is drained before removal of the strainer and check valve. Residual air may escape and cause injury to personnel.

NOTE

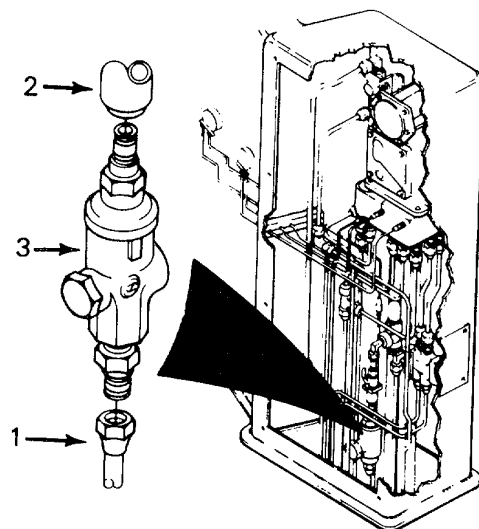
- When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.
 - Strainer and check valve must be repaired at intermediate general support level maintenance facility.
1. Disconnect air fitting (1).
 2. Remove strainer and check valve (3) from air fitting (2).

INSTALLATION

3. Install strainer and check valve (3) in air fitting (2) and connect air fitting (1).

TEST

4. Refer to paragraph 2-9 and perform a stationary vehicle airbrake test.



3-54. NO. 24 DOUBLE CHECK VALVE

This task covers:

a. Removal

b. Installation

c. Test

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

REMOVAL

WARNING

- Whenever the No. 24 double check valve is removed and installed for any reason, a stationary vehicle airbrake test (para 2-9) must be performed to check that the No. 24 double check valve functions properly in the brake equipment arrangement. Failure to perform test may result in injury to personnel.
- Make sure air is drained before removal of the No. 24 double check valve. Residual air may escape and cause injury to personnel.

NOTE

When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

1. Disconnect three air fittings (1), (2) and (3).
2. Remove No. 24 double check valve (4).

NOTE

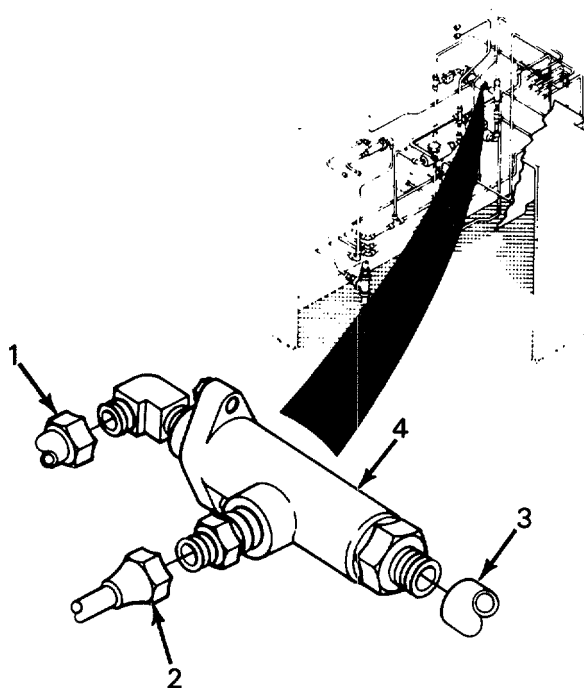
No. 24 double check valve must be repaired at intermediate general support level facility.

INSTALLATION

3. Install No. 24 double check valve (4) and connect three air fittings (1), (2) and (3).

TEST

4. Refer to paragraph 2-9 and perform a stationary vehicle airbrake test.



3-55. CUTOUT COCK AND STRAINER

This task covers:

a. Removal

b. Installation

c. Test

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

REMOVAL

WARNING

- Whenever the cutout cock and strainer is removed and installed for any reason, a stationary vehicle airbrake test (para 2-9) must be performed to check that the cutout cock and strainer function properly in the brake equipment arrangement. Failure to perform test may result in injury to personnel.
- Make sure air is drained before removal of the cutout cock and strainer. Residual air may escape and cause injury to personnel.

NOTE

When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

1. Remove two bolts (1) and (2) and two nuts (3).

3-55. CUTOUT COCK AND STRAINER (cont.)

REMOVAL (cont.)

2. Remove gaskets (4) and (5).
3. Remove cutout cock and strainer (6).

INSTALLATION

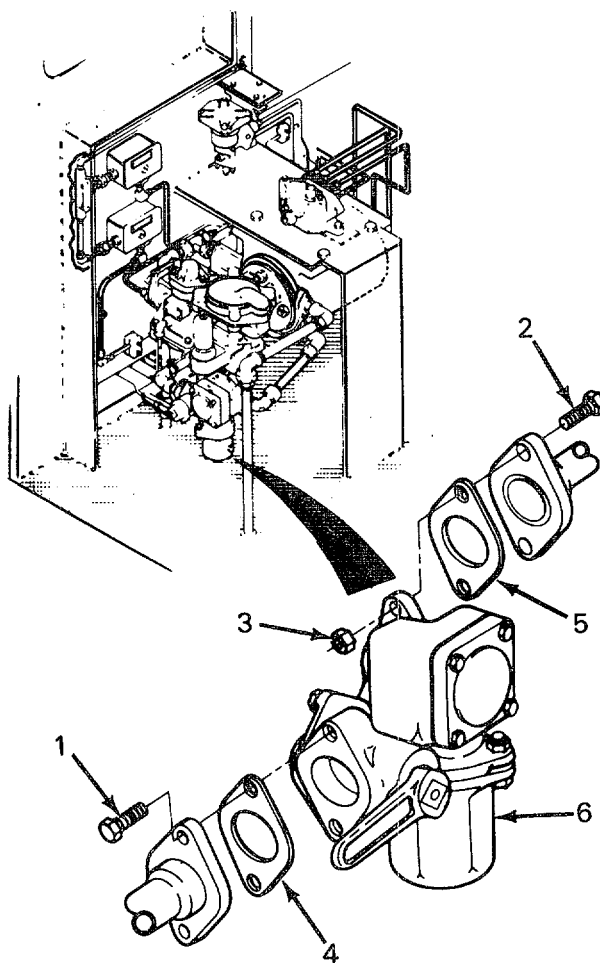
4. Install cutout cock and strainer (6) and gaskets (5) and (4) and secure with two nuts (3) and four bolts (2) and (1).

TEST

5. Refer to paragraph 2-9 and perform a stationary vehicle airbrake test.

NOTE

Cutout cock and strainer must be repaired at intermediate general support level maintenance facility.



3-56. RUBBER SEATED CHECK VALVE

This task covers:

a. Removal

b. Installation

c. Test

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

REMOVAL

WARNING

- Whenever the rubber seated check valve is removed and installed for any reason, a stationary vehicle airbrake test (para 2-9) must be performed to check that the rubber seated check valve functions properly in the brake equipment arrangement. Failure to perform test may result in injury to personnel.
- Make sure air is drained before removal of the rubber seated check valve. Residual air may escape and cause injury to personnel.

NOTE

- This is a one-way valve. Note direction of air flow.
 - When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.
1. Disconnect two air connections (1) and (2).
 2. Remove rubber seated check valve (3).

3-56. RUBBER SEATED CHECK VALVE (cont.)

INSTALLATION

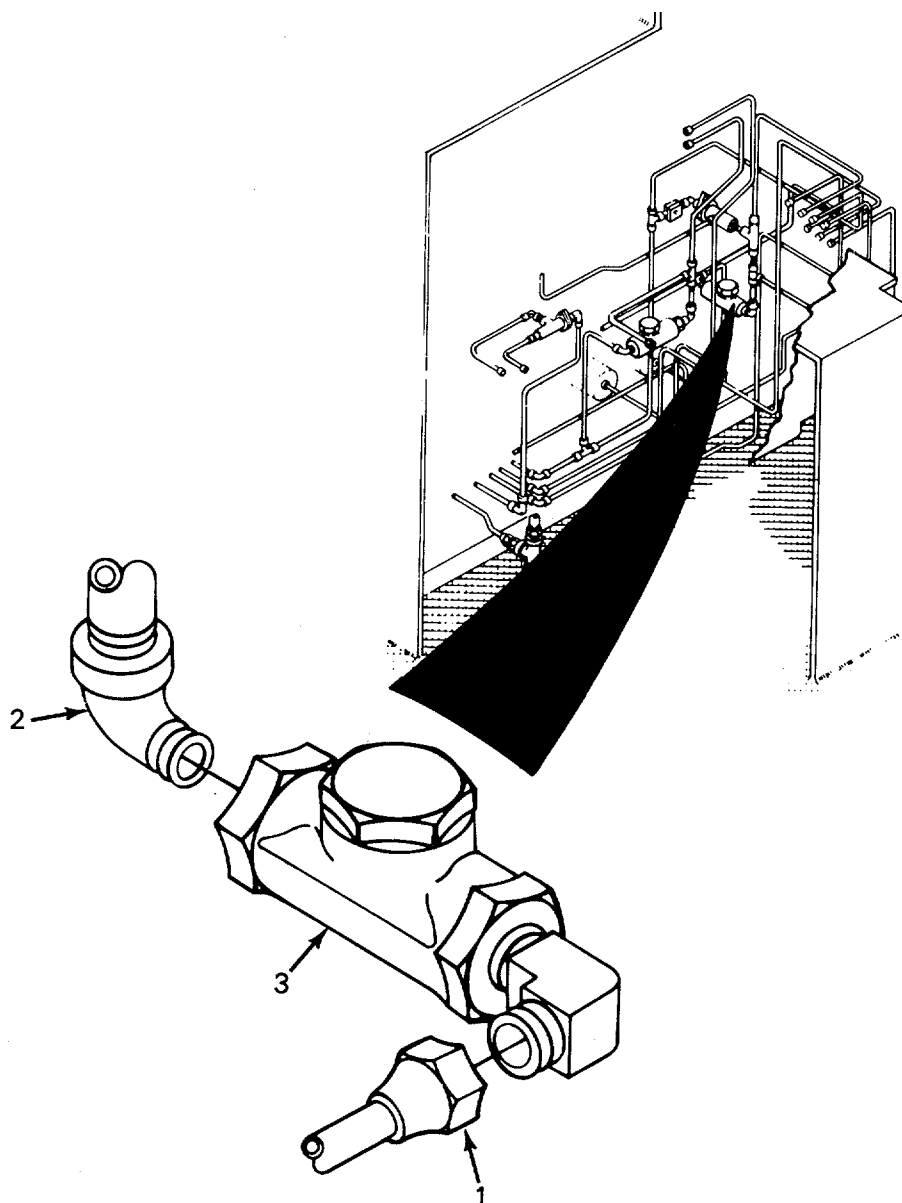
NOTE

Note direction of air flow.

3. Install rubber seated check valve (3) and connect two air connections (1) and (2).

TEST

4. Refer to paragraph 2-9 and perform a stationary vehicle airbrake test.



3-57. BALL CUTOUT COCK

This task covers:

a. Removal

b. Installation

c. Test

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

REMOVAL

WARNING

- Whenever the ball cutout cock is removed and installed for any reason, a stationary vehicle airbrake test (para 2-9) must be performed to check that the ball cutout cock functions properly in the brake equipment arrangement. Failure to perform test may result in injury to personnel.
- Make sure air is drained before removal of the ball cutout cock. Residual air may escape and cause injury to personnel.

NOTE

- Note direction of air flow and direction of valve before removal.
 - When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.
1. Disconnect two air connections (1) and (2).
 2. Remove ball cutout cock (3).

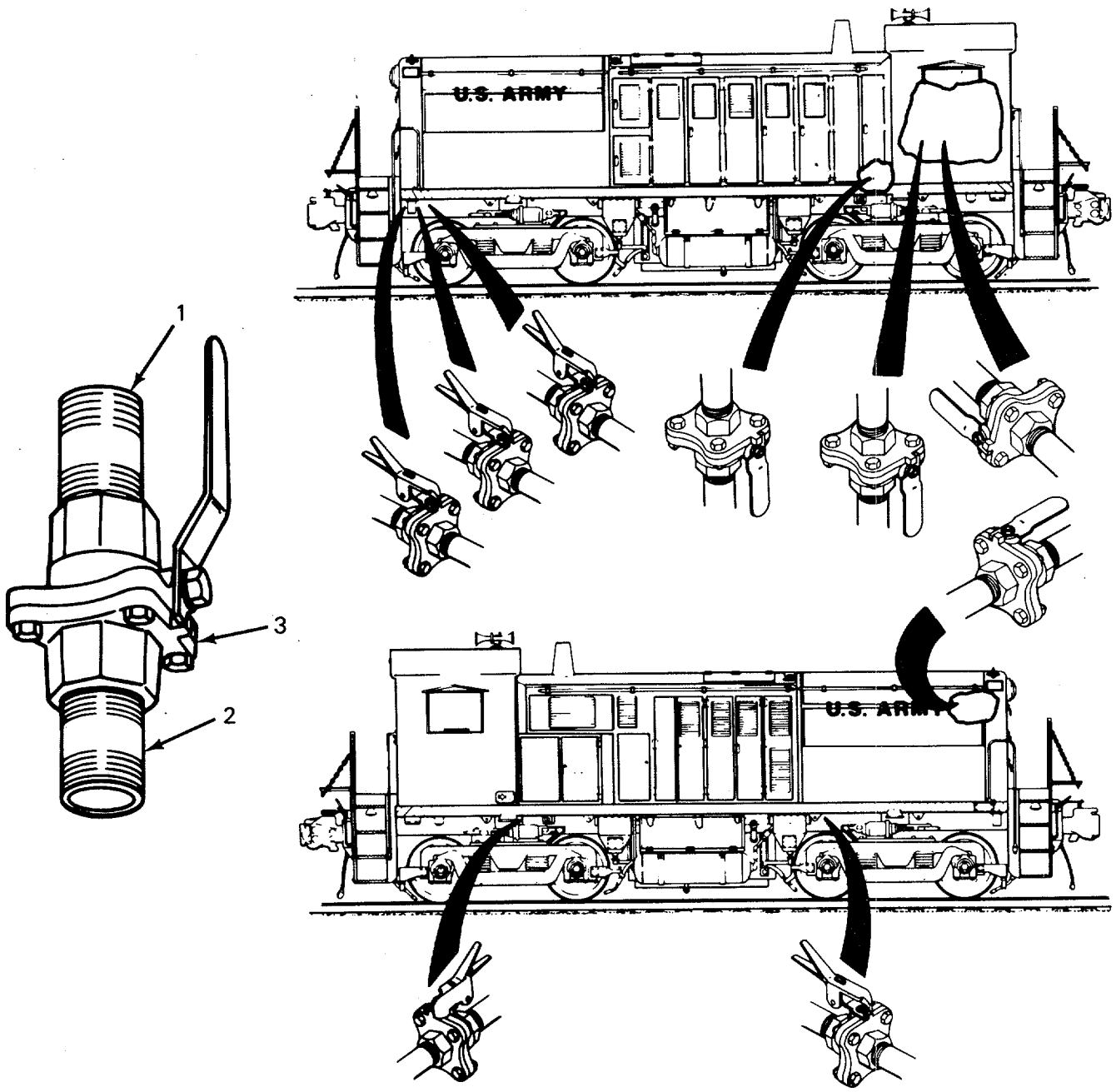
INSTALLATION

3. Install ball cutout cock (3) and connect two air connections (1) and (2).

TEST

4. Refer to paragraph 2-9 and perform a stationary vehicle airbrake test.

3-57. BALL CUTOUT COCK (cont.)



3-58. BRAKE CYLINDER

This task covers:

- | | | | |
|----------------|---------------|-------------|-----------------|
| a. Removal | c. Cleaning | e. Repair | g. Installation |
| b. Disassembly | d. Inspection | f. Assembly | h. Test |
-

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12
Micrometer 5210-00-267-3093
Inside micrometer
5210-00-221-1921

Material/Parts

Drycleaning solvent (Item 30, Appendix B)
Brake cylinder grease (Item 13, Appendix B)

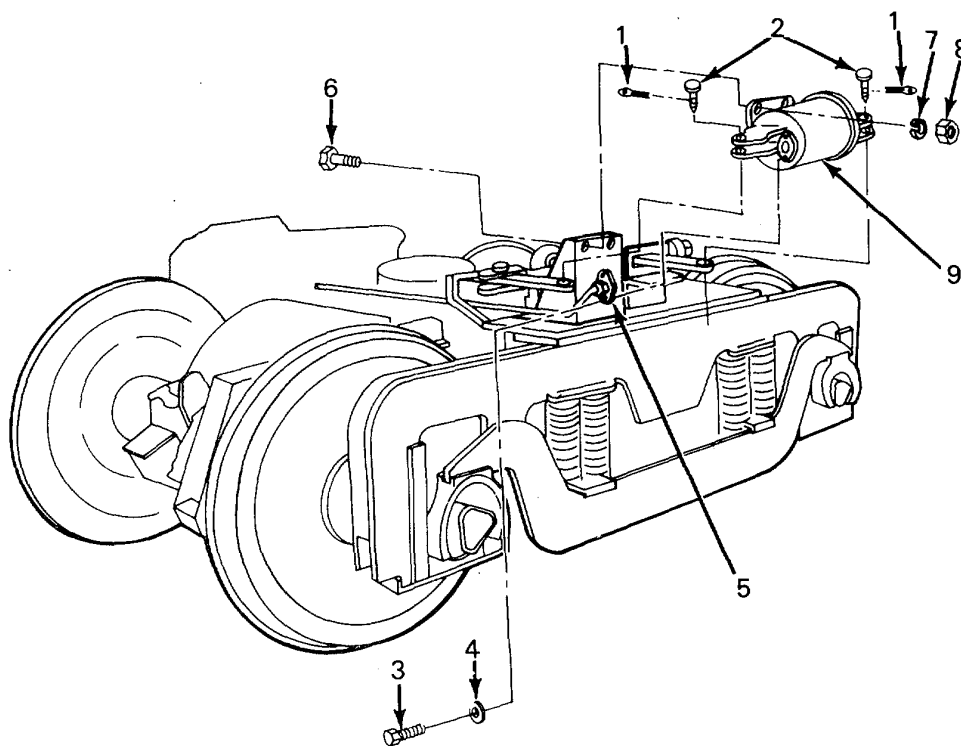
Personnel Required

2

REMOVAL

NOTE

- Stationary airbrake test (para 2-9) should be performed before removal.
 - When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.
1. Remove two cotter pins (1) and two pins (2).



3-203

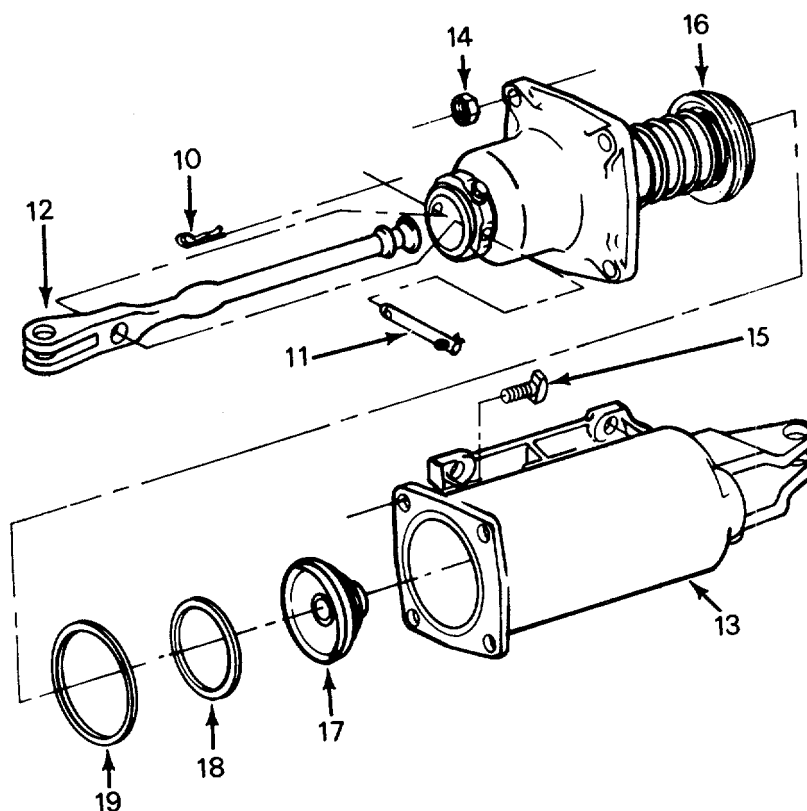
3-58. BRAKE CYLINDER (cont.)

REMOVAL (cont.)

2. Remove two bolts (3) and flat washers (4) and disconnect air line (5).
3. Remove four bolts (6), lockwashers (7), nuts (8), and brake cylinder (9).

DISASSEMBLY

4. Remove cotter pin (10), push rod holder pin (11), and push rod (12), from cylinder (13).



5. Remove four nuts (14), bolts (15), and piston assembly (16).
6. Disassemble piston assembly (16) by the following:
 - a. Separate packing cup (17) and felt wiper (18) from piston assembly (16).
 - b. Remove gasket (19).

NOTE

Piston assembly must be repaired at depot level maintenance facility.

3-58. BRAKE CYLINDER (cont.)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 138°F (38 59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.

- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

7. Use dry-cleaning solvent and remove dirt and grease from metal parts. Dry with compressed air.
8. Inspect metal parts for cracks and breaks. Replace damaged parts.
9. Inspect rubber parts for cracks, breaks, or flattened beads. Replace damaged rubber parts.
10. Use brake cylinder lubricant and coat push rod (12), packing cup (17), and walls of cylinder.

ASSEMBLY

NOTE

Beveled side of felt wiper should be facing piston assembly. Be sure that packing cup (17) is free of air bubbles.

11. Install felt wiper (18) and packing cup (17) on piston (16). Install gasket (19) on cylinder (13).

NOTE

- Before installation of piston assembly (16), be sure that packing is greased and that cylinders are coated with grease.

- When strainer cylinder head is installed, be sure strainer is at bottom.

12. Install piston assembly (16) into cylinder (13). Secure with four bolts (15) and nuts (14).

3-58. BRAKE CYLINDER (cont.)

ASSEMBLY (cont.)

13. Install push rod (12) holder pin (11) and secure with cotter pin (10). INSTALLATION
14. Install brake cylinder (9) and secure with four nuts (8), lockwashers (7), and bolts (6).
15. Connect air line (5) and secure with two bolts (3) and washers (4).
16. Install two pins (2) and secure with two cotter pins (1).

TEST

- 17 Test brake cylinder by the following:
 - a. Use an air supply source with a cutout cock and a gauge located between cutout cock and brake cylinder and connect brake cylinder.
 - b. Charge brake cylinder to 45 psi (310 kPa) and hold for 15 seconds.
 - c. Use cutout cock and turn off air supply.
 - d. Check that there is no pressure drop in 5 seconds.

3-59. AIR RESERVOIR

This task covers:

- a. Removal
- b. Cleaning

c. Inspection

e. Installation

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12
Enamel gloss gray (Item 9, Appendix B)

Material/Parts

Drycleaning solvent (Item 30, Appendix B)

REMOVAL

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

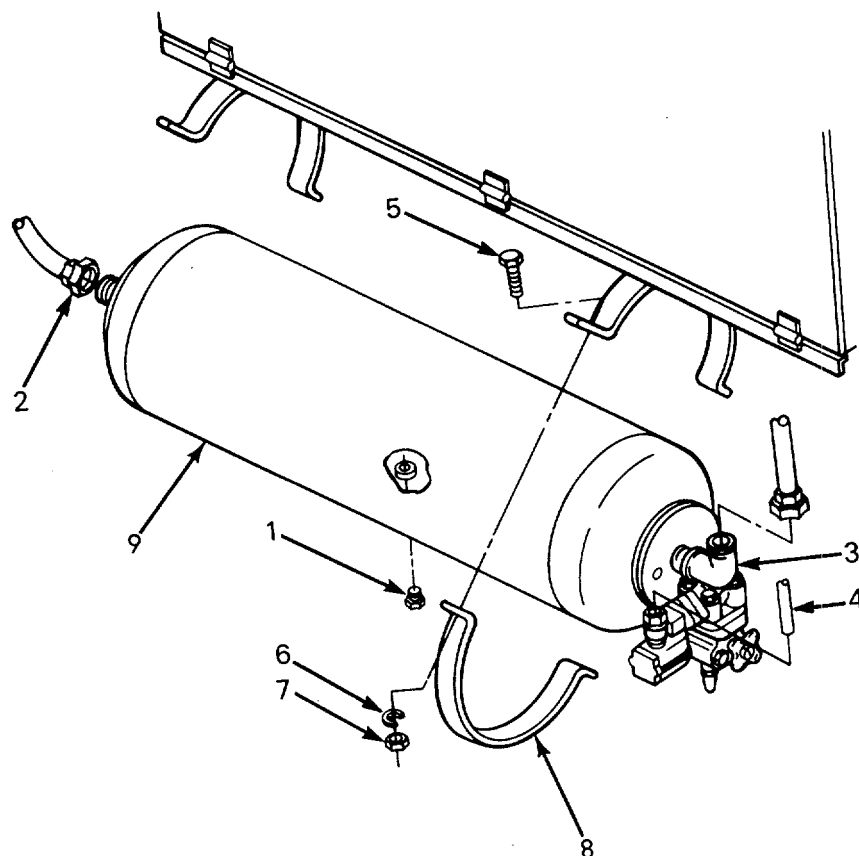
NOTE

- Before removing air reservoirs, check that air system is drained.
- Smaller air reservoirs within the air system are removed following the same procedures as those used for main air reservoir.
- When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

1. Place a suitable support device under air reservoir.
2. Remove drain plug (1) and drain air reservoir (8).
3. Disconnect two air lines (2) and (3).
4. Tag and disconnect electrical line (4).
5. Remove four bolts (5), lockwashers (6), nuts (7) and two support braces (8).
6. Use a suitable lifting device and slowly lower air reservoir (9) and set on a suitable support device.
7. Repeat steps 1 thru 6 and remove remaining air reservoirs.

3-59. AIR RESERVOIR (cont.)

REMOVAL (cont.)



CLEANING

WARNING

● Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 138°F (38 590C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.

● Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

8. Use dry-cleaning solvent and remove dirt and grease from exterior of air reservoirs. Dry with compressed air.

3-59. AIR RESERVOIR (cont.)

INSPECTION

9. Inspect reservoir for cracks, breaks, or other damage. Replace if severe damage or cracks are apparent.

TEST

10. Test air reservoir by the following:
 - a. Seal one end of reservoir and apply a source of air to other end of air reservoir.
 - b. Inspect exterior of air reservoir for leaks. If there are air leaks replace main air reservoir.
 - c. Test in accordance with FRA 229.31.
 - d. Stencil date of test on air reservoir surface with gray gloss enamel.

INSTALLATION

NOTE

Smaller air reservoirs within the air system are installed following the same procedures as those used for main air reservoir.

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

11. Use a suitable lifting device and raise air reservoir (9) to locomotive.
12. Secure with two braces (8), four nuts (7), lockwashers (6), and bolts (5). Do not tighten.
13. Connect air lines (2) and (3).
14. Connect electrical line (4).
15. Tighten four nuts (7), lockwashers (6), and bolts (5).
16. Install drain plug (1) in air reservoir (8).
17. Repeat steps 12 thru 16 and install remaining air reservoir.

3-60. CENTRIFUGAL AIR FILTERS

This task covers:

- | | | | |
|----------------|---------------|-------------|-----------------|
| a. Removal | c. Cleaning | e. Repair | g. Installation |
| b. Disassembly | d. Inspection | f. Assembly | h. Test |

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12
Filter element

Test Equipment

Wiping rags (Item 28, Appendix B)
Multimeter 6625-01-139-2512

Material/Parts

Drycleaning solvent (Item 30, Appendix B)

GPS grease (Item 16, Appendix B)

REMOVAL

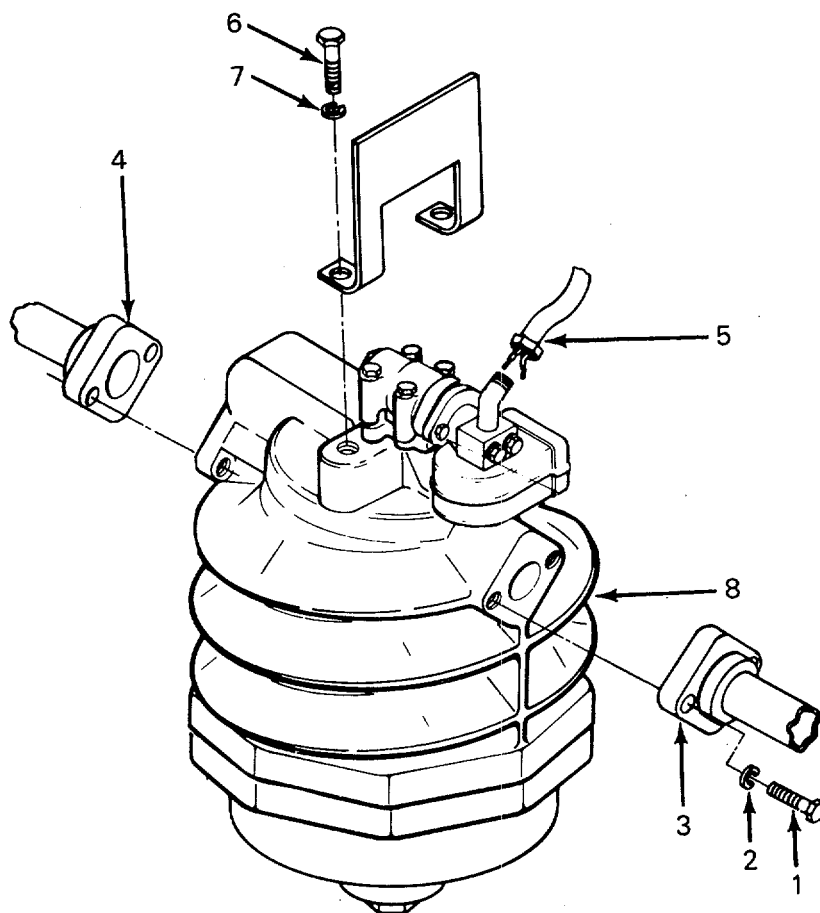
NOTE

● Repair procedures are similar for the main air reservoir centrifugal air filter and the secondary centrifugal air filter.

● If repair of centrifugal filter is limited to the replacement of the filter element, perform steps 3, 4, 20, and 21.

● When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

1. Remove the main centrifugal air filter by the following:
 - a. Remove four bolts (1) and lockwashers (2) and disconnect air connections (3) and (4).
 - b. Tag and disconnect electrical connection (5).
 - c. Remove two bolts (6), lockwashers (7), and centrifugal air filter (8).

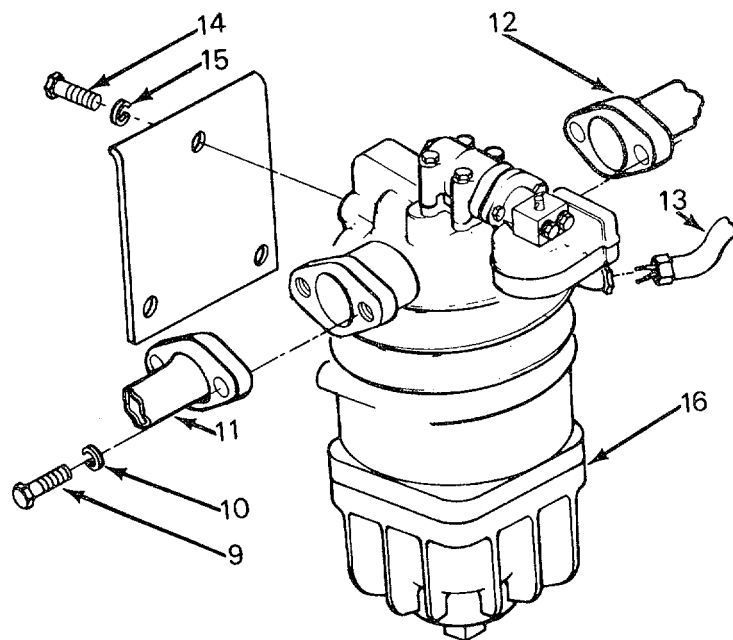


3-60. CENTRIFUGAL AIR FILTERS (cont.)

REMOVAL (cont.)

2. Remove secondary centrifugal air filter by the following:

- a. Remove four bolts (9) and lockwashers (10) and disconnect air connections (11) and (12).
- b. Tag and disconnect electrical connection (13).
- c. Remove three bolts (14) and lockwashers (15).
- d. Remove secondary centrifugal air filter (16).



DISASSEMBLY

NOTE

For secondary centrifugal air filter remove six nuts (17) and lockwashers (18).

3. Remove eight nuts (17), lockwashers (18), sump bowl (19), and gasket (20) from filter body (21).
4. Remove wing nut (22) and filter element (23).

NOTE

If drain and solenoid valves show obvious defects, replace entire component.

5. Remove two bolts (24), solenoid valve body (25), and O-ring (26).
6. Remove four nuts (27), flat washers (28), and valve body (29).
7. Remove three screws (30) and seal (31).
8. Remove drain valve adapter (32).
9. Remove exhaust tube assembly (33), two seals (34), and O-ring (35).
10. Remove elbow (36).

3-60. CENTRIFUGAL AIR FILTERS (cont.)

CLEANING, INSPECTION, AND REPAIR

WARNING

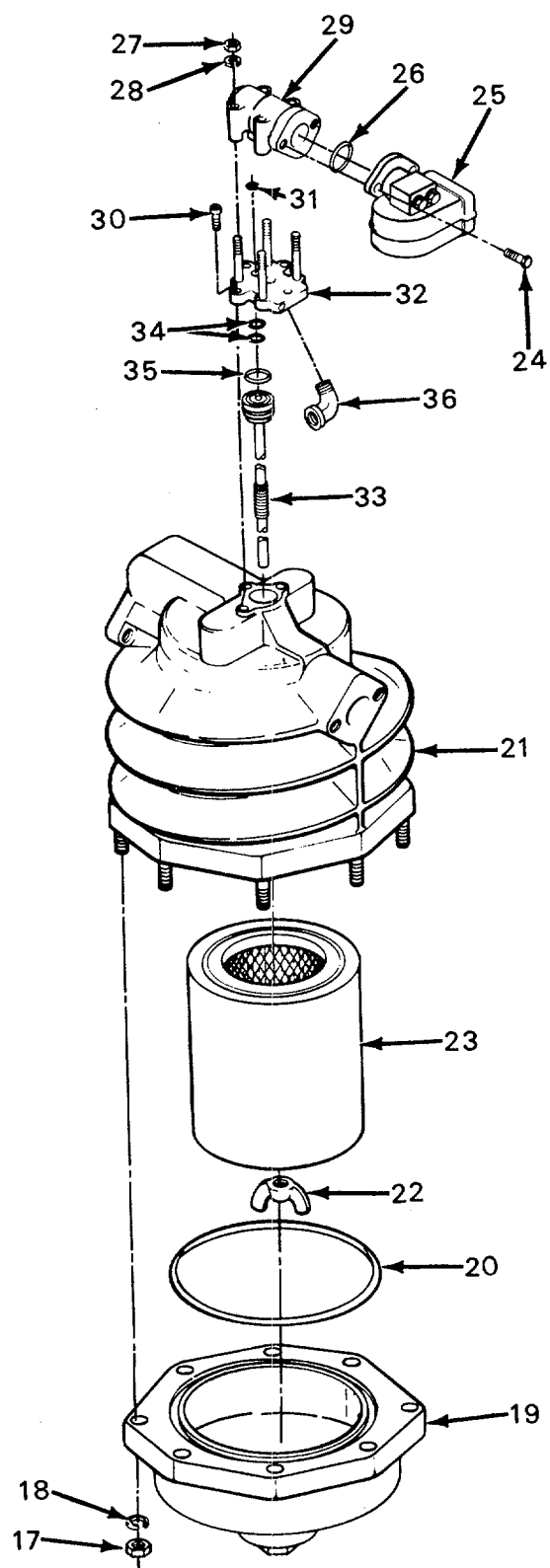
● Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 1380F (38 590C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.

● Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

NOTE

When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

11. Use dry-cleaning solvent and clean metal parts. Dry with compressed air.
12. Inspect parts for cracks, breaks, or wear. Replace damaged parts.
13. Replace air filter.
14. Use a multimeter and check coil at 75 V dc. Resistance of coil should be 330 +5% at 680F (200C). Replace defective coil if readings are not obtained.
15. Use GPS grease and apply a small amount to seals and seal grooves. Use a clean, lint-free cloth and remove excess grease.



3-60. CENTRIFUGAL AIR FILTERS (cont.)

ASSEMBLY

16. Install O-ring (35) and elbow (36) on exhaust tube assembly (33). Install exhaust tube assembly in filter body (21).
17. Install two seals (34) and seal (31) on drain valve adapter (32). Install drain valve adapter and secure with three screws (30).
18. Install valve body (29) on drain valve adapter (32) and secure with four washers (28) and nuts (27).
19. Install O-ring (26) and solenoid valve body (25) and secure with 2 bolts (24).
20. Install new filter element (23) in filter body (2) and secure with wing nut (22).

NOTE

For secondary centrifugal air filter, secure sump bowl with six nuts and lockwashers.

21. Install gasket (20) and sump bowl (19). Secure with eight lockwashers (18) and nuts (17).

INSTALLATION

22. Install main centrifugal air filter by the following:
 - a. Install air filter (8) on bracket and secure with two lockwashers (7) and bolts (6).
 - b. Connect air connection (3) and (4) and install four lockwashers (2) and bolts (1).
 - c. Connect electrical connection (5) and remove tags.
23. Install secondary centrifugal air filter by the following:
 - a. Install air filter (16) on bracket and secure with three lockwashers (15), and bolts (14).
 - b. Connect air connections (11) and (12) and install four lockwashers (10) and bolts (9).
 - c. Connect electrical connection (13) and remove tags.

3-61. TRUCK ASSEMBLY

This task covers:

- | | | | |
|-----------------------|----------------------|--------------------|------------------------|
| a. Removal | c. Cleaning | e. Repair | g. Installation |
| b. Disassembly | d. Inspection | f. Assembly | h. Test |
-

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12
Grease GAA (Item 11, Appendix B)
Personnel Required
Graphite/lubricant (Item 18, Appendix B)

Materials/Parts

Drycleaning solvent (Item 30, Appendix B)
Electrical tape (Item 32, Appendix B)

3

REMOVAL

1. Tag and disconnect eight traction motor electrical leads (1).
2. Remove cotter pin (2) and pin (3) and disconnect handbrake connecting chain (4).
3. Remove 16 nuts (5) and 8 U-bolts (6) and move 4 sander hoses (7) out of the way.
4. Remove bolt (8), lockwasher (9), and clamp (10) and disconnect air hose from brake cylinder line connection (11).

WARNING

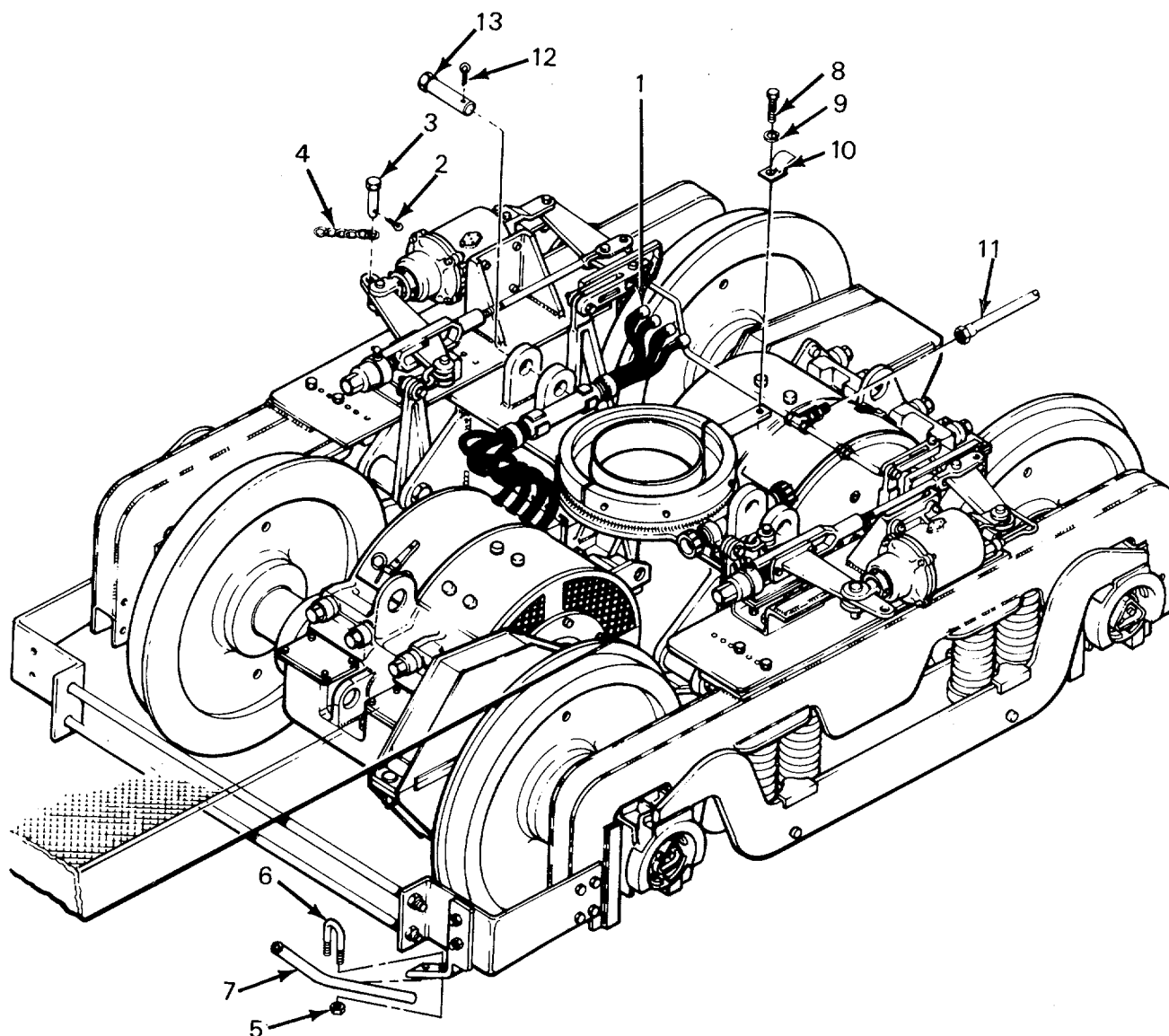
Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

NOTE

- To remove swing bracket pins, locomotive must be raised slowly with a suitable lifting device so that pins may be worked out of the swing brackets.
 - When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.
5. Remove four cotter pins (12) and two swing bracket pins (13).
 6. Check to see that steps 1 thru 5 above have been completed.

3-61. TRUCK ASSEMBLY (cont.)

REMOVAL (cont.)



7. Attach a suitable lifting device under each corner of locomotive. Check that the location will not interfere with the removal of truck assembly.
8. Use the suitable lifting device and raise locomotive until it is high enough (approximately 4 feet (1.2 m)) to clear truck assembly.

WARNING

Once truck assembly is removed, suitable support devices must be installed under locomotive frame to prevent injury to personnel.

CAUTION

Be careful to avoid damage to pipes and wiring.

9. Roll truck from under locomotive.

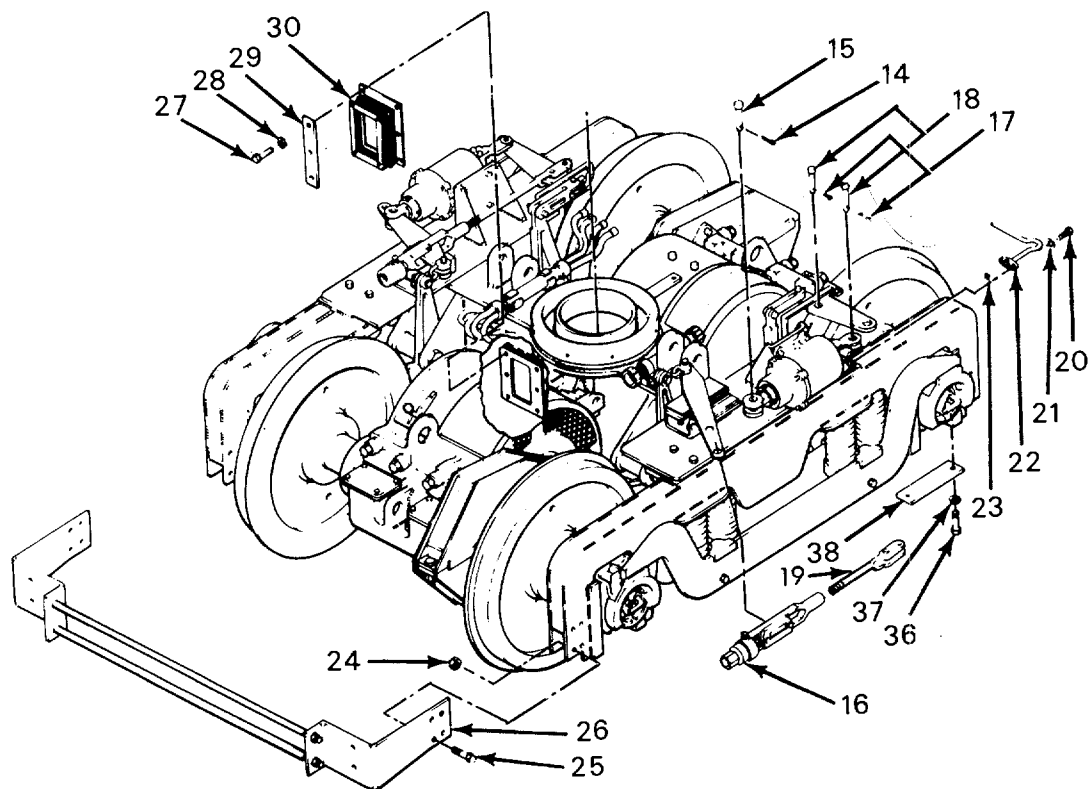
3-61. TRUCK ASSEMBLY (cont.)

DISASSEMBLY

WARNING

Components of the truck assembly are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

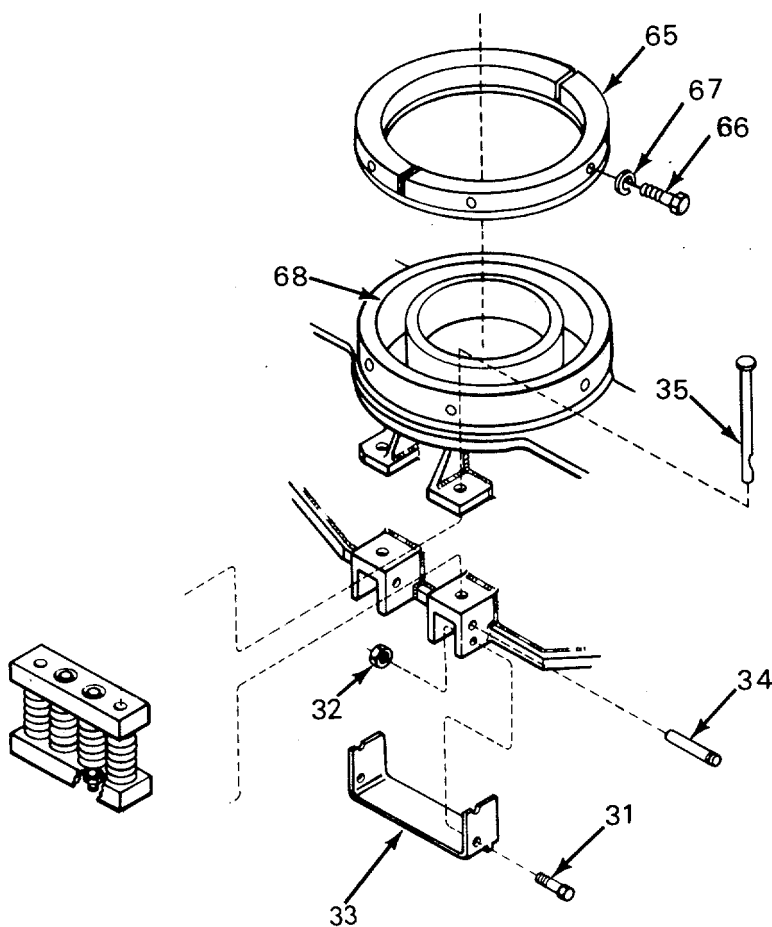
10. Remove two cotter pins (14), pins (15) and slack adjuster heads (16). Remove 16 cotter pins (17), 8 pins (18), and 4 equalizer rods (19).
11. Remove two bolts (20) and lockwashers (21). Disconnect two air lines (22) and remove gasket (23).
12. Remove 16 lock nuts (24), bolts (25), and 2 sander brackets (26).
13. Remove 12 bolts (27), lockwashers (28), 2 retainers (29), and 2 bellows (30).
14. Remove four bolts (31), self-locking nuts (32), and two suspension safety hangers (33).



3-61. TRUCK ASSEMBLY (cont.)

DISASSEMBLY (cont.)

15. Remove four pin retainers (34) and suspension guide pins (35) so traction motor can be removed.
16. Remove eight bolts (36), lockwashers (37), and four pedestal binders (38).



17. Check that brake rigging has been disconnected so that frame (39) can be lifted from wheels.

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury. 18. Place a suitable support device under traction motor jaw to support traction motor when frame is lifted.

3-61. TRUCK ASSEMBLY (cont.)

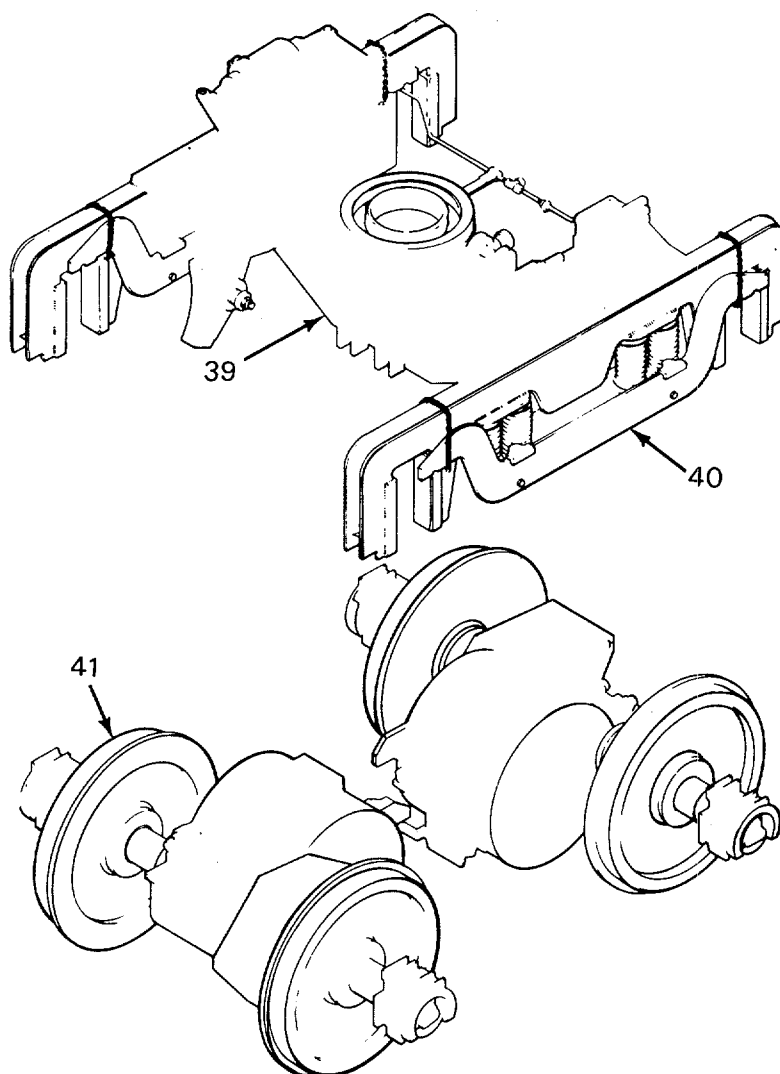
DISASSEMBLY (cont.)

19. Use 1/2-inch heavy chain and secure equalizers (40) to frame (39) at four corners of truck assembly.

NOTE

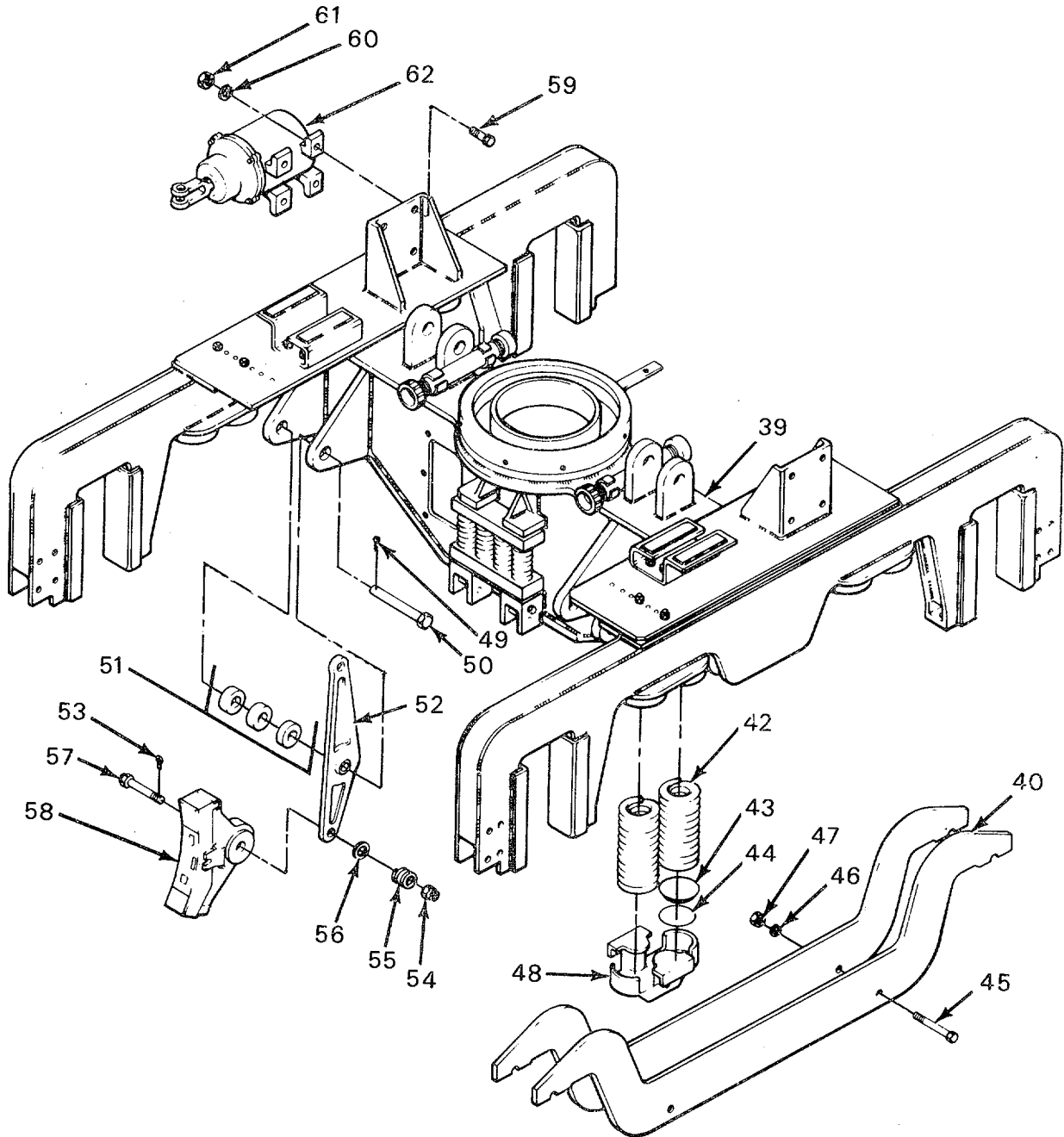
Truck assembly may be lifted by swing bracket pins on corners of frame.

20. Attach a suitable lifting device to four corners of frame (39) and lift frame from traction-motor-wheel-axle assembly (41).



3-61. TRUCK ASSEMBLY (cont)

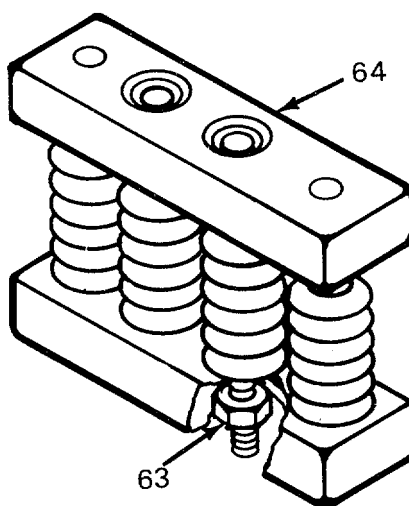
DISASSEMBLY (cont)



3-61. TRUCK ASSEMBLY (cont)

DISASSEMBLY (cont)

21. Lower frame (39) onto a suitable support device.
22. Remove chains securing four equalizers (40) to frame (39) and remove equalizers.
23. Remove eight coil springs (42), four snubber spacers (43), and shims (44).
24. Remove four bolts (45), lockwashers (46), nuts (47), and spring seats (48) and separate four equalizers (40).
25. Remove 4 cotter pins (49), pins (50), 12 metal spacers (51), and 4 vertical brake levers (52).
26. Remove four cotter pins (53), castle nuts (54), springs (55), washer (56), brake head pins (57), and brake heads (58).
27. Remove eight bolts (59), lockwashers (60), nuts (61), and two brake cylinders (62).
28. Tighten four nuts (63) until suspension assembly is compressed to 10 inches (254 mm) and remove suspension assemblies (64).



NOTE

Make sure center plate rings are marked before removal.

29. Remove eight bolts (66) and lockwashers (67) and felt dust cover (65) from center plate ring (68).

3-61. TRUCK ASSEMBLY (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
30. Use drycleaning solvent and clean metal parts. Dry with compressed air.
 31. Inspect pedestal liners for cracks and excessive wear. Use table 3-6 and check wear limits. Replace damaged pedestal liners if these measurements are not obtained.
 32. Inspect side bearing. Use table 3-6 and check wear limits. Replace damaged side bearing wear plates if damaged or if these measurements are not obtained.
 33. Inspect center casting and wear plate for excessive wear. Use table 3-6 and check wear limits. Replace damaged wear plates and oiler fittings. If these measurements are not obtained.
 34. Inspect brake rods, levers, pins, and other rigging for wear, cracks, and breaks. Replace defective parts.
 35. Inspect springs and suspension bars for cracks, breaks, or other damage. Replace defective parts.
 36. Inspect frame, bolster, and equalizers for cracks. Repair cracks by grooving, welding, and grinding smooth.
 37. Inspect bellows for cracks or damage. Replace if damaged.
 38. Inspect dust cover for cracks or damage. Replace if damaged.
 39. Inspect remaining parts for damage and replace as necessary.
 40. Refer to table 3-6 for truck assembly data.

3-61. TRUCK ASSEMBLY (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

Table 3-6. Truck Assembly

ITEM	SPECIFICATION
Pedestal Liner:	
Total nominal pedestal liner clearance	1/8 inch (3.2 mm)
Total maximum pedestal liner clearance	3/8 inch (9.5 mm)
Total nominal lateral clearance	1/8 inch (3.2 mm)
Total maximum lateral clearance	3/8 inch (9.5 mm)
Side Bearing:	
Normal side bearing clearance	1/4 inch (6.4 mm)
Side bearing wear plate thickness	1/4 inch (6.4 mm)
Side bearing wear plate thickness	1/8 inch (3.2 mm) minimum
Axle Lateral:	
Normal axle lateral	3/8 inch (9.5 mm)
Maximum axle lateral	5/8 inch (15.9 mm)

ASSEMBLY

WARNING

Components of the truck assembly are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

41. Tighten four nuts (63) until suspension assembly (64) is compressed to the maximum and place suspension assembly against bolster between lugs.
42. Release tension of suspension assembly (63) and install four suspension guide pins (35) and four pin retainers (34).
43. Install two brake cylinders (62) and secure with eight bolts (59), lockwashers (60), and nuts (61).
44. Install four brake heads (58), brake head pins (57), washer (56), spring (55), castle nuts (54), and cotter pins (53).
45. Install 4 vertical brake levers (52) and 12 metal spacers (51) and secure with 4 pins (50) and cotter pins (49).
46. Install four springs seats (48) into four equalizers (40) and secure with four lockwashers (46), nuts (47), and bolts (45).

3-61. TRUCK ASSEMBLY (cont)

ASSEMBLY (cont)

NOTE

Snubber springs must be installed in a zigzag pattern, starting with the one nearest the bolster.

47. Install four snubber spacers (43) in spring seats (48) and add shims (44).
48. Install eight coil springs (42). Coil springs must be shimmed to be of equal height.
49. Use 1/2-inch heavy chain and secure four equalizers (40) to frame (39) at four corners of truck assembly.

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

50. Attach a suitable lifting device hoist to four corners of frame (39) and lift frame over traction-motor-wheel-axle assembly.
51. Slowly lower frame (39). Check that pedestal frames enter jaws of roller bearing journal boxes on axles.

NOTE

When installing traction motors on suspension assembly, traction motor must be tilted up so traction motor jaws start on spring assembly from the bottom.

52. Check that traction motor jaws line up with suspension assembly (64).
53. Install two suspension safety hangers (33) and secure with four self-locking nuts (32) and bolts (31).
54. Install 2 bellows (30) and retainer (29) and secure with 12 bolts (27) and lockwasher (28).
55. Install four pedestal binders (38) and secure with eight lockwashers (37) and bolts (36).
56. Install 2 sander brackets (26) and secure with 16 bolts (25) and self-locking nuts (24).

3-61. TRUCK ASSEMBLY (cont)

ASSEMBLY (cont)

57. Install two slack adjuster heads (16) and secure with two pins (15) and cotter pins (14). Install four equalizer rods (19) and secure with eight pins (18) and eight cotter pins (17).
58. Connect two air lines (22) to brake cylinders (62). Install gasket (23) and secure with lockwashers (21) and four bolts (20).
59. Refer to TM 55-2210-223-12 and adjust brakes.
60. Install dust cover (65), eight bolts (66), and lockwashers (67) on center plate ring (68).

INSTALLATION

61. Apply graphite pancakes to center plate ring (68) and cover entire wear surface.
62. Roll truck assembly into position under locomotive.

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

63. Use a suitable lifting device and lower locomotive. Check that male center ring enters center plate ring (68) without binding.

NOTE

To install swing bracket pins, locomotive must be raised slowly with a suitable lifting device so that pins may be worked into swing brackets.

64. Install two swing bracket pins (13) and secure with four cotter pins (12).
65. Connect air hose to brake cylinder line connection (11) and secure with clamp (10), lockwashers (9), and bolt (8).
66. Install 4 sander hoses (7) and secure with 8 U-bolts (6) and 16 nuts (5).
67. Install handbrake connecting chain (4) and secure with pin (3) and cotter pin (2).
68. Connect eight traction motor electrical leads (1) to terminals and remove tags. Wrap connections with insulating tape.
69. Check side bearing clearance in accordance with table 3-6.

3-62. TRACTION MOTOR ASSEMBLY

This task covers:

- | | | | | | | | |
|----|-------------|----|------------|----|--------|----|--------------|
| a. | Removal | c. | Cleaning | e. | Repair | g. | Assembly |
| b. | Disassembly | d. | Inspection | f. | Test | h. | Installation |
-

INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12
Magnaflux 6635-01-131-0730
Undercutter
Dial indicator 5210-00-640-0953
Portable propane torch 3439-00-542-0531
Induction heater 2815-00-366-1432
Large hydraulic press
Puller set

Materials/Parts

Emery cloth (Item 4, Appendix B)
Drycleaning solvent (Item 30, Appendix B)
Grease GAA (Item 11, Appendix B)
Clear acrylic lacquer (Item 17, Appendix B)
Red insulating varnish (Item 33, Appendix B)
Gray gloss enamel (Item 9, Appendix B)
Electrical tape (Item 32, Appendix B)
Paint insulating (Item 25, Appendix B)
Lubricating oil (Item 22, Appendix B)
Pigment iron bluing (Item 27, Appendix B)
Gear lubricating oil (Item 20, Appendix B)
Insulating paper (Item 26, Appendix B)

Test Equipment

Multimeter 6625-01-139-2512
Megohmmeter 6625-00-456-7442

Personnel Required

3

Equipment Condition Paragraph

Para 3-61

Condition Description

Truck assembly removed

3-62. TRACTION MOTOR ASSEMBLY (cont)

REMOVAL

WARNING

When traction motor or under-locomotive equipment must be inspected while the engine is running, remove excitation from the main generator and set airbrakes. Move reverser to center position and remove from the controller. This will prevent accidental movement of the locomotive and possible injury to personnel.

NOTE

- If repair of traction motor is limited to resurfacing commutator, refer to step 32g below.
- If it is necessary to remove axle bearings while traction motor is under locomotive, procedures below will apply with the exception of step 5. The upper axle bearing halves can be removed by jacking the traction motor frame up just enough to relieve the weight on the bearing, revolving the bearing around the axle, and slipping it off below.

1. Remove drain plug (1) and drain axle bearing oil reservoirs.
2. Remove five bolts (2) and lockwashers (3) and remove upper and lower gear case (4).

NOTE

- Traction motor must be blocked with wheels up or supported. Wheels must be removed from the traction motor.
- If axle bearing caps (7) sticks, a flat cold chisel may be used to loosen cap. Place chisel in the crack between cap and motor frame. Tap cold chisel on one side and then the other until cap is loose.

3. Remove eight bolts (5), lockwashers (6), and axle bearing cap (7).
4. Remove two traction motor lower support axle bearing halves (8).
5. Remove eight bolts (9), lockwashers (10), two covers (11), and gaskets (12).

3-62. TRACTION MOTOR ASSEMBLY (cont)

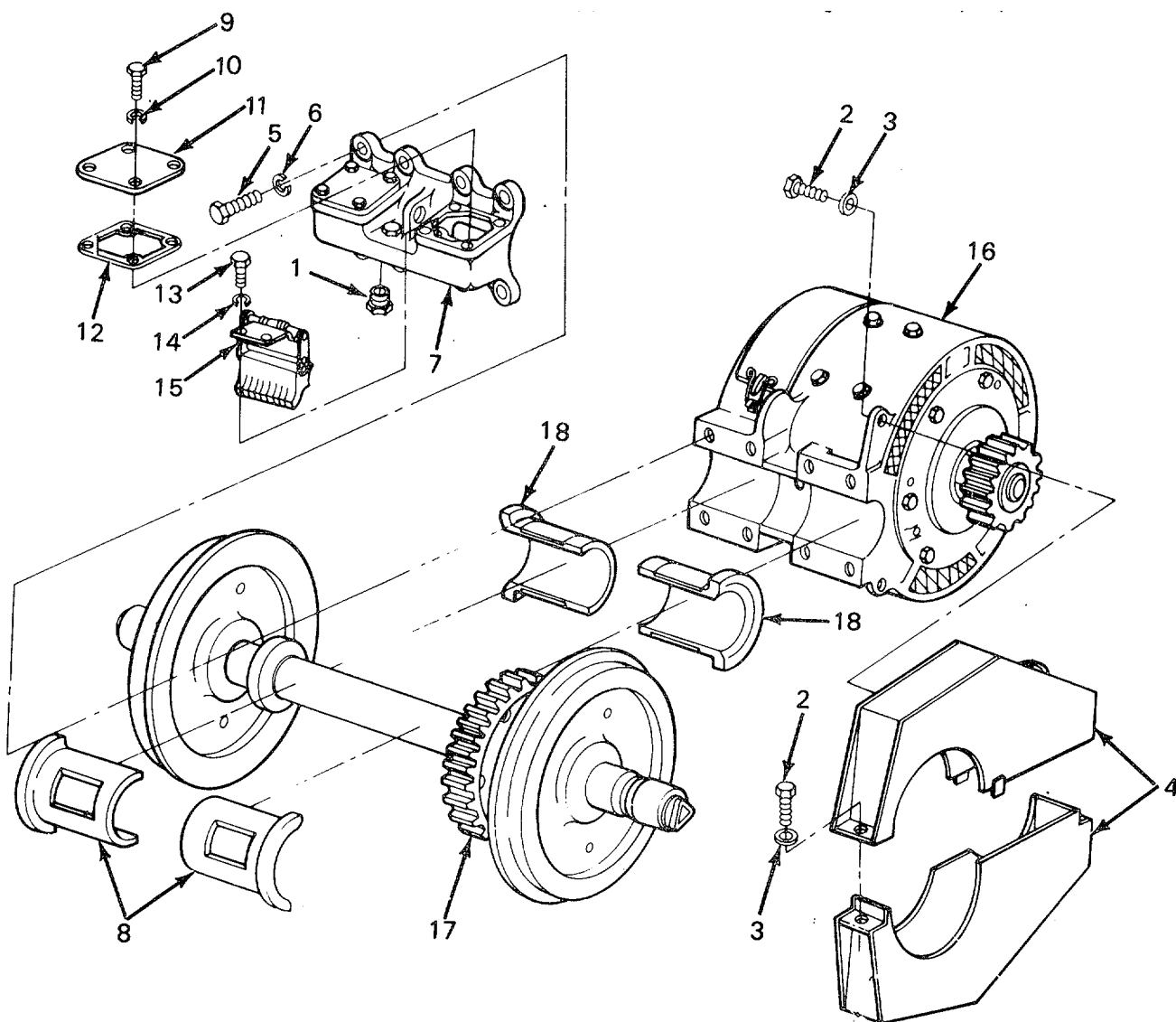
REMOVAL (cont)

6. Remove four bolts (13), lockwashers (14), and two felt wick lubricators (15).

WARNING

Components of this locomotive are heavy and may be awkward to handles Use correct lifting procedures, indicted lifting devices, and/or assistance from other personnel to avoid injury.

7. Use a suitable lifting device and slowly lift traction motor (16) from wheel and axle (17).
8. Remove two traction motor upper support axle bearing halves (18).



3-62. TRACTION MOTOR ASSEMBLY (cont)

DISASSEMBLY

WARNING

Components of the traction motor are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury,

9. Remove spanner (19) and lockring (20).

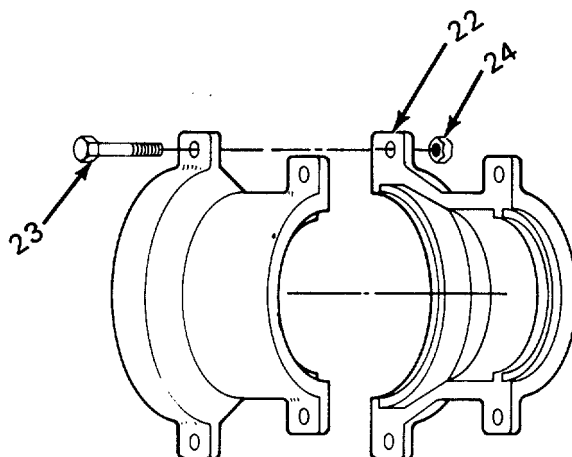
WARNING

Heated parts may cause injury to personnel if hand protection is not worn when handling. Wear protective gloves for maximum protection.

CAUTION

Do not remove a pinion by driving a wedge between pinion and traction motor frame. Avoid blows with a hammer on pinion or pinion puller. Damage to bearings will result. Never apply heat to a pinion that is to be put back in service. Destruction of the original heat treatment will result. If it becomes necessary to remove a pinion that is to be scrapped and is very hard to pull, it may be necessary to apply heat to the pinion for a very short time. Pinion shaft and traction motor frame must not be heated. Damage to parts will result.

10. Use a pinion puller and remove pinion gear (21) as follows:

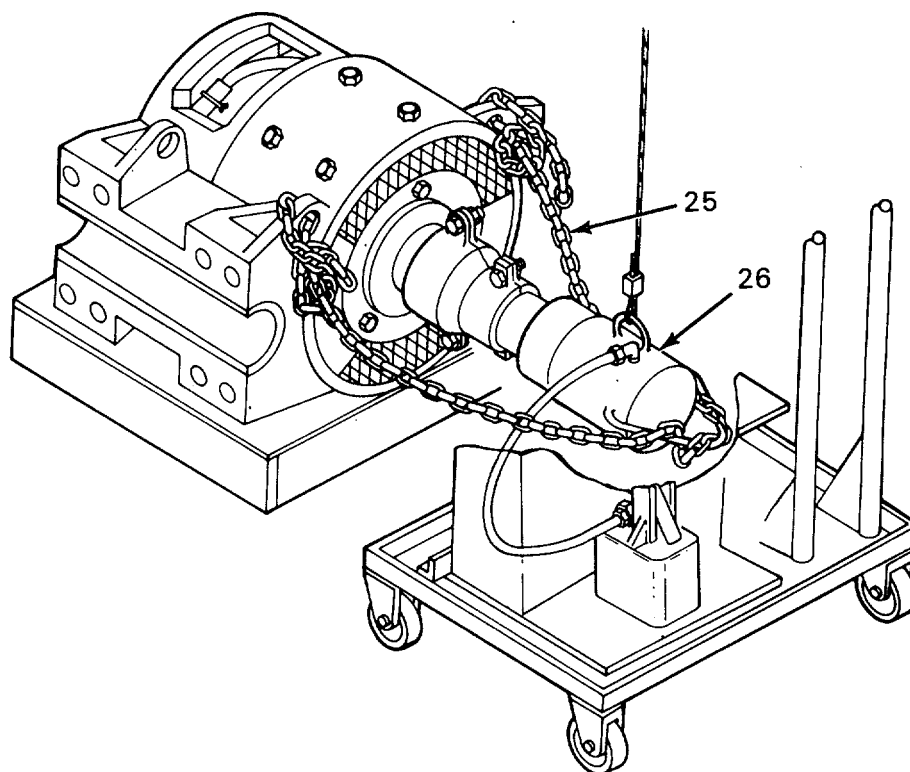


3-62. TRACTION MOTOR ASSEMBLY (cont)

DISASSEMBLY (cont)

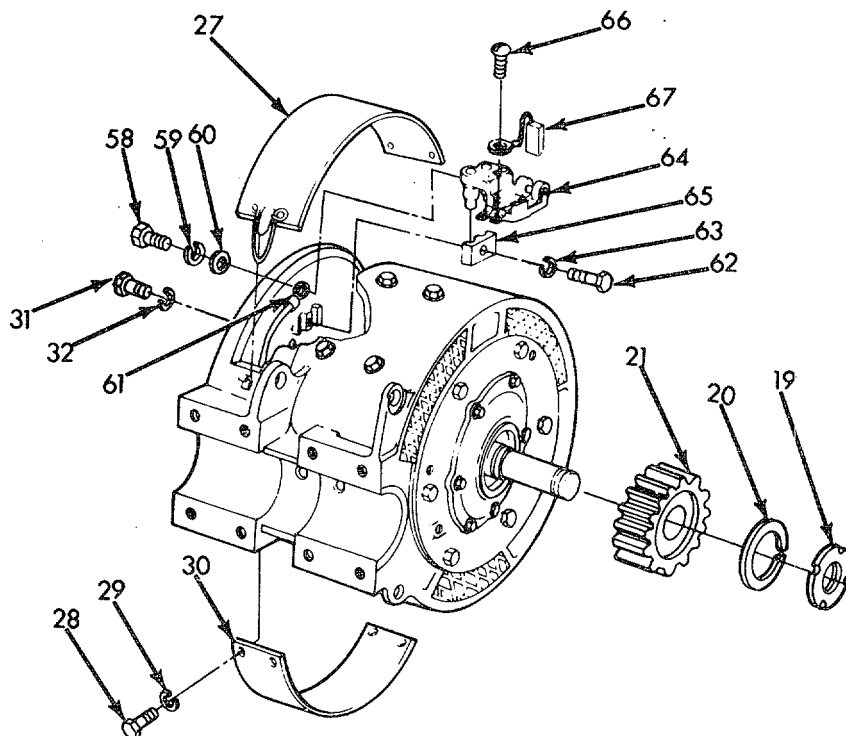
WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
- a. Use drycleaning solvent and remove grease from pinion gear. Dry with compressed air.
 - b. Line up press (26) with pinion gear shaft.
 - c. Install pinion puller (22) around pinion gear (21) and press (26).



3-62. TRACTION MOTOR ASSEMBLY (cont)

DISASSEMBLY (cont)



- d. Tighten four bolts (23) and nut (24) and secure pinion puller (22).
- e. Route safety chain (25) through two lifting eyes, on both sides of traction motor (16), and through hydraulic press safety loop (26) and secure.

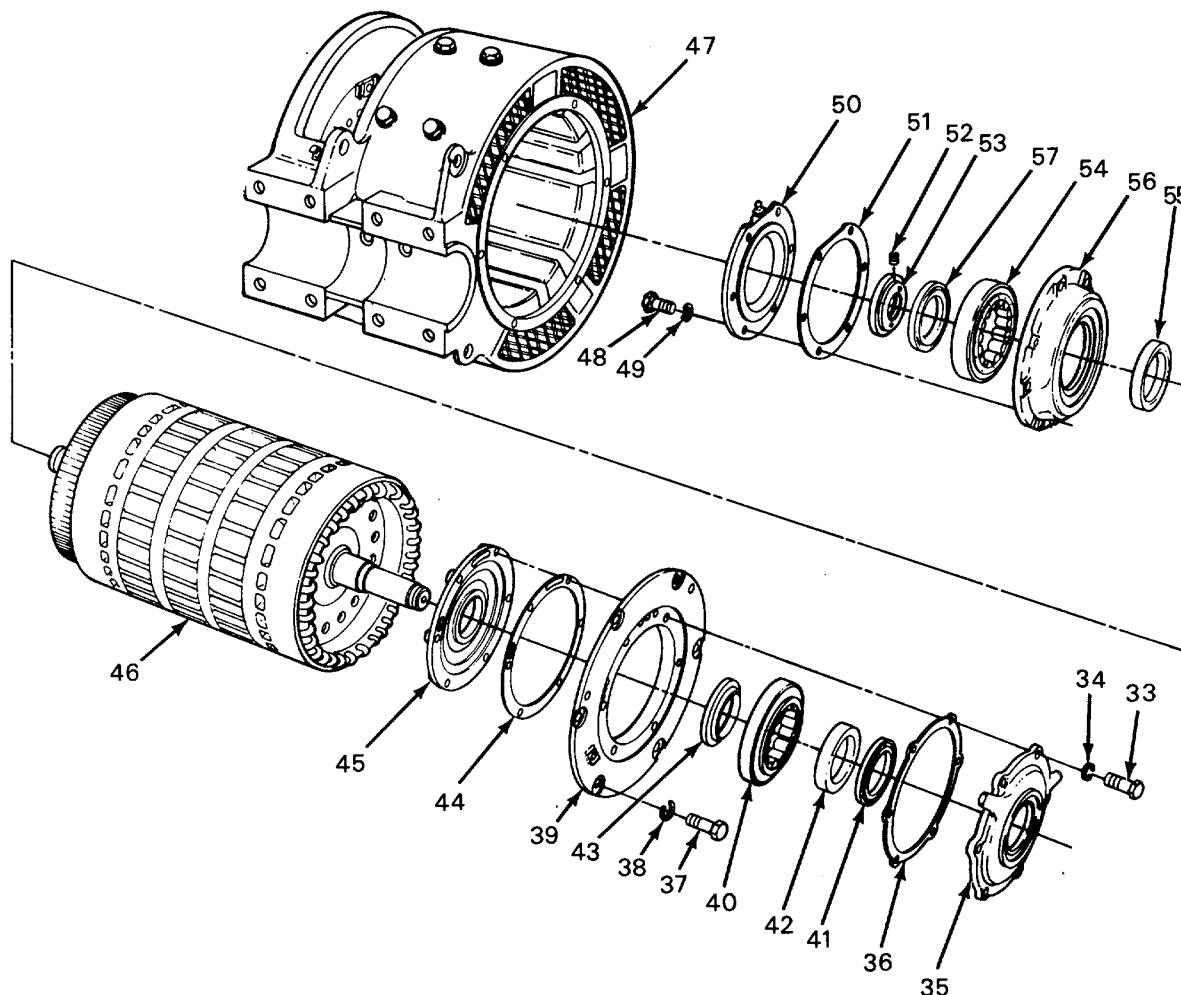
WARNING

Pinion gear will snap off suddenly under approximately 50 to 90 tons (45.3 to 81.6 metric tons) of pressure. Personnel must stand to either side of motor when pulling pinion gear. Area behind press must be clear. Injury or death could result if safety precautions are not followed.

- f. Apply 50 to 90 tons (45.3 to 81.6 metric tons) pressure with hydraulic press and remove pinion gear (21).
- g. When pinion gear (21) is removed, mark it to the traction motor from which it was removed.

3-62. TRACTION MOTOR ASSEMBLY (cont)

DISASSEMBLY (cont)



WARNING

Procedures specify the heating of parts to aid in disassembly. Heated parts may cause injury to personnel if hand protection is not worn when handling. Wear protective gloves for maximum protection.

NOTE

Some parts may have to be heated to release them from their shrink fit. When this becomes necessary, the use of a portable propane torch, a portable hydraulic press, and puller tools are recommended for disassembly.

11. Remove two traction motor covers (27).

3-62. TRACTION MOTOR ASSEMBLY (cont)

DISASSEMBLY (cont)

12. Remove four bolts (28), lockwashers (29), and inspection cover (30).
13. Lift brushes far enough out of brush holder box to prevent them from slipping back against commutator.

CAUTION

Take care to avoid damage to the commutator surfaces.

14. Protect commutator by wrapping it with heavy insulating paper.
15. Remove eight bolts (31) and lockwashers (32) from commutator end bearing cap.

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

16. Install lifting eye on pinion end. Use a suitable lifting device and set traction motor in a vertical position.
17. Remove six bolts (33), washers (34), bearing cap (35), and gasket (36).
18. Remove six bolts (37) and lockwashers (38). Use a punch and punch-mark cover (39) to traction motor frame (47).
19. Install three bolts into jacking holes of cover (39) and tighten until cover is free.
20. Remove cover (39) and outer race and bearing assembly (40).
21. Install puller to inner bearing housing (45) and remove outer oil slinger (41), inner race (42), inner oil slinger (43), gasket (44), and inner bearing housing.

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

22. Use a suitable lifting device and slowly pull armature (46) out of traction motor frame (47). Set armature in a horizontal position on suitable supporting device.

3-62. TRACTION MOTOR ASSEMBLY (cont)

DISASSEMBLY (cont)

23. Remove six bolts (48) and lockwashers (49) and remove bearing cap (50) and gasket (51) from commutator end.
24. Remove two setscrews (52) and retainer ring (53).
25. Remove bearing and race assembly (54), oil slinger (55), and bearing housing (56).
26. Remove inner race (57).
27. Remove bolt (58), lockwasher (59), and flat washer (60), and disconnect electrical lead (61).
28. Remove four bolts (62) and lockwashers (63) and remove four brush holders (64) and blocks (65).
29. Loosen eight screws (66) and remove brushes (67).

CLEANING, INSPECTION, AND REPAIR

30. Clean, inspect, and repair pinion assembly by the following:

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
- a. Use drycleaning solvent and clean pinion gear. Dry with compressed air.
 - b. Magnaflux pinion gear and inspect for cracks. No cracks allowed.
 - c. Visually inspect pinion gear for broken, chipped, spalled, or pitted teeth. Maximum allowable pitting and spallation is 20% of total working surface of teeth.

3-62. TRACTION MOTOR ASSEMBLY (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

- d. Inspect inside bore of pinion gear. Surface must be smooth. Use a fine grade of sandpaper and polish surface.
- e. Replace pinion gear if damaged beyond repair. 31. Clean, inspect, and repair bearing assembly by the following:

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
- a. Use drycleaning solvent and remove grease from bearings, outer bearing caps, outer bearing stops, oil slingers, and bearing cartridges. Dry with compressed air.
 - b. Inspect parts for wear, cracks, or breaks.
 - c. Inspect rollers for cracks or pits.
 - d. Inspect parts for discoloration indicating overheating.
 - e. Replace parts that are damaged.

NOTE

Do not paint machined surfaces.

- f. Paint bearing housings with red insulating varnish.

3-62. TRACTION MOTOR ASSEMBLY (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

32. Clean, inspect, and repair armature assembly by the following:

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

CAUTION

Check that drycleaning solvent does not get on commutator, copper parts, coils, and windings. Damage to equipment will result.

- a. Blow carbon dust from armature assembly with compressed air. Direct air into the pockets and through the openings of the armature to remove internal accumulation of dirt.
- b. Use a cloth dampened with drycleaning solvent and wipe armature surface to remove external grease and dirt. Dry with compressed air.
- c. Inspect for shaft damage. If shaft shows signs of bearing slippage, replace armature.
- d. Inspect pinion end of shaft. Check that threads are not damaged. Check that surface where pinion gear mates is smooth. Use a fine grade of sandpaper and polish surface.

NOTE

Check insulation bands for blisters, cracks, or breaks. Armature must be repaired at depot level maintenance facility.

- e. Inspect varnished surfaces of coil insulation.
- f. Check that bands are tight and secure and soldering is intact.

3-62. TRACTION MOTOR ASSEMBLY (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

- g. Use a dial indicator and check commutator for roughness or out-of-roundness. Commutator is out-of-round if there is a 0.002 inch (0.05 mm) variance within a six bar span. Inspect surface for wear, burns, or pitting. If these conditions exist, use fine grinding stones and resurface commutator.

WARNING

When traction motor or under-locomotive equipment must be inspected while the engine is running, remove excitation from the main generator and set airbrakes. Move reverser to center position and remove from the controller. This will prevent accidental movement of the locomotive and possible injury to personnel.

- (4) Check that mica is undercut to a depth of 1/16 to 3/32 inch (1.6 to 2.4 mm). If mica depth is not within these limits, use an undercutter and regroove mica.
- (5) Clean slots between copper bars to remove burrs.

WARNING

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield to prevent injury to personnel.

- (6) Use dry compressed air and remove loose mica and copper from commutator.
- (7) Paint surfaces of coil insulation with red enamel insulating varnish. 33. Clean, inspect, and repair stator frame assembly by the following:

WARNING

Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.

- a. Use a cloth dampened with drycleaning solvent and remove dirt and foreign material from traction motor frame and field assembly. Dry with compressed air.
- b. Check that field coils, leads, and cable commutator are secure.

3-62. TRACTION MOTOR ASSEMBLY (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

- c. Check that shunt and interpole fields are tight.
 - d. Paint insulation surfaces with red insulating vanish.
34. Clean, inspect, and repair brush holder assembly by the following:

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
- a. Use drycleaning solvent and clean brush holder assemblies. Dry with compressed air.
 - b. Inspect brush holder for wear, cracks, or breaks. Replace defective brush holder.
 - c. Inspect insulators for breaks, cracks, burns, or dull surface. Replace defective insulators by pressing off stud and pressing on new one.
 - d. Inspect studs for cracks or breaks. Replace defective studs by pressing out of brush holder and pressing in new one.
 - e. Inspect spring assemblies for tension and check that braiding is not frayed. Replace defective spring assemblies.

CAUTION

Do not spray inside of brushed holder.

- f. Paint brush holders with clear acrylic spray.

3-62. TRACTION MOTOR ASSEMBLY (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

35. Inspect gear case by the following:

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
- a. Use drycleaning solvent and clean gear case. Dry with compressed air.
 - b. Check that gears have not been rubbing against gear case by inspecting the inside metal band. Metal band should be intact and undamaged. Replace gear case that is damaged.

CAUTION

Do not paint machined surface.

- c. Paint outside surface of gear case with black air drying insulating paint.
36. During installation, use a feeler gage and check traction motor axle bearing lateral. Maximum total lateral is 5/16 inch (7.9 mm).
37. Use a feeler gage and check axle bearing clearance and wear. Radial clearance between axle and bearings is 0.010 inch (0.25 mm). Check that 0.014 inch (0.36 mm) shims are in place between axle cap and traction motor frame.
38. Use drycleaning solvent and clean felt wick lubricators. Dry with compressed air. Check that felt wick lubricators are not glazed or charred. Replace damaged felt wick lubricators. Saturate felt wick lubricators with oil before installation.

3-62. TRACTION MOTOR ASSEMBLY (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

39. Check that traction motor leads to stator housing are tight and secure. Replace insulation that is cracked or brittle with three layers of friction tape using 1/2 inch (12.7 mm) lap. Paint with black air drying insulation paint.
40. Clean, inspect, and repair remaining parts by the following:

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
- a. Use drycleaning solvent and clean parts. Dry with compressed air.
 - b. Inspect parts for cracks or breaks.
 - c. Replace defective parts.

CAUTION

Do not paint machined surfaces.

- d. Paint inside surface of traction motor covers with red enamel insulating varnish.
- e. Paint outside surface of traction motor frame with black air drying insulating paint.

3-62. TRACTION MOTOR ASSEMBLY (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

41. Refer to table 3-7 for traction motor data.

Table 3-7. Traction Motor Data

ITEM	SPECIFICATION
Maximum Operating Limits:	
Volts	640 dc
Amperes	600 amps
Safe speed	2200 rpm
Brushes:	
Number of brush arms	4
Brushes per arm	2
Size of brush	3/4 x 1-1/2 x 2-1/4 inches (19.1 x 38.1 x 57.2 mm)
Brush pressure with full-length brush	7 to 9 pounds (3.2 to 4.1 kg)
Weights:	
Motors with lubricators, pinions, and axle bearings	3400 pounds (1542.2 kg)
Armature complete	805 pounds (365.1 kg)
Resistance of Windings:	
Armature	0.0370 ohms
Commutating fields	0.0145 ohms
Series fields	0.0210 ohms
Armature Bearings:	
Pinion end	Free roller
Commutator end	Thrust roller
Traction Motor Support Axle Bearings:	
Type	Sleeve
Oil level	2-1/4 inches (57.2 mm) maximum
Pinion Application:	
Teeth in pinion	14
Application temperature	273.2°F (134°C) above shaft temperature
Advance limits	0.046 to 0.056 inch (1.17 to 1.42 mm)

3-62. TRACTION MOTOR ASSEMBLY (cont)

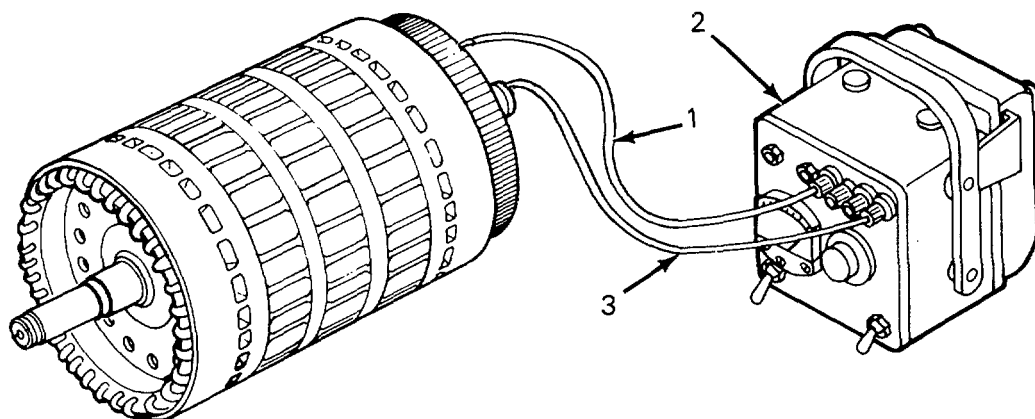
TEST

42. Perform armature and stator megohmmeter test by the following: Armature Test

NOTE

A minimum of 500 V at 1 megohm is required for this test.

- a. Place lead (1) of megohmmeter (2) on shaft or core of the armature.



- b. Place lead (3) of megohmmeter (2) on one of the commutator bars. Note reading on megohmmeter. Contact each successive bar around the commutator.

WARNING

Procedures specify the heating and cooling of parts to aid in disassembly and assembly. Heated and cooled parts may cause injury to personnel if hand protection is not worn when handling. Wear protective gloves for maximum protection.

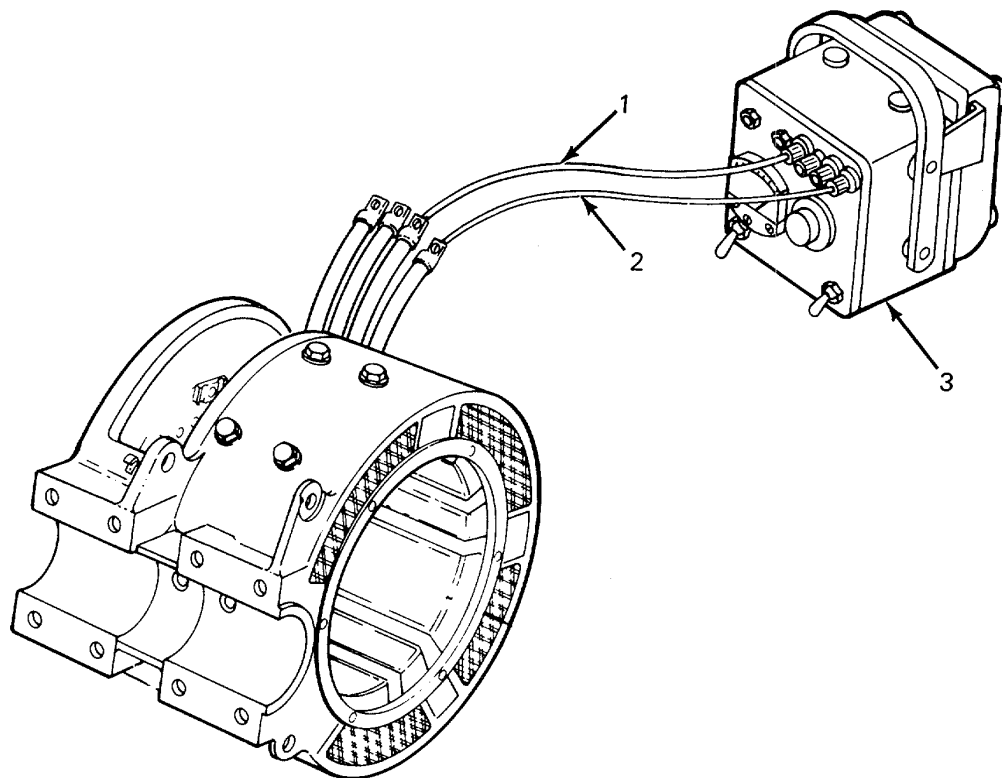
- c. If a reading of less than three megohms is obtained, bake armature for 4 hours at 230°F (110°C) in a convection oven. Recheck megohm reading after cooling armature to room temperature. If the reading is still low, replace the armature.

3-62. TRACTION MOTOR ASSEMBLY (cont)

TEST (cont)

Stator Test

- a. Attach lead (1) of megohmmeter (3) to lead AA- on stator housing.



- b. Attach lead (2) of megohmmeter (3) to lead A on stator housing and note reading on megohmmeter.
- c. Attach lead (1) of megohmmeter (3) to lead FF on stator housing.
- d. Attach lead (2) of megohmmeter (3) to lead F on stator housing and note reading on megohmmeter.

WARNING

Procedures specify the heating and cooling of parts to aid in disassembly and assembly. Heated and cooled parts may cause injury to personnel if hand protection is not worn when handling. Wear protective gloves for maximum protection.

- e. If a reading of less than 3 megohms is obtained on the two sets of leads, bake stator for 4 hours at 230°F (110°C) in a convection oven. Recheck megohm readings after cooling stator to room temperature. If the readings are still low, replace stator.

3-62. TRACTION MOTOR ASSEMBLY (cont)

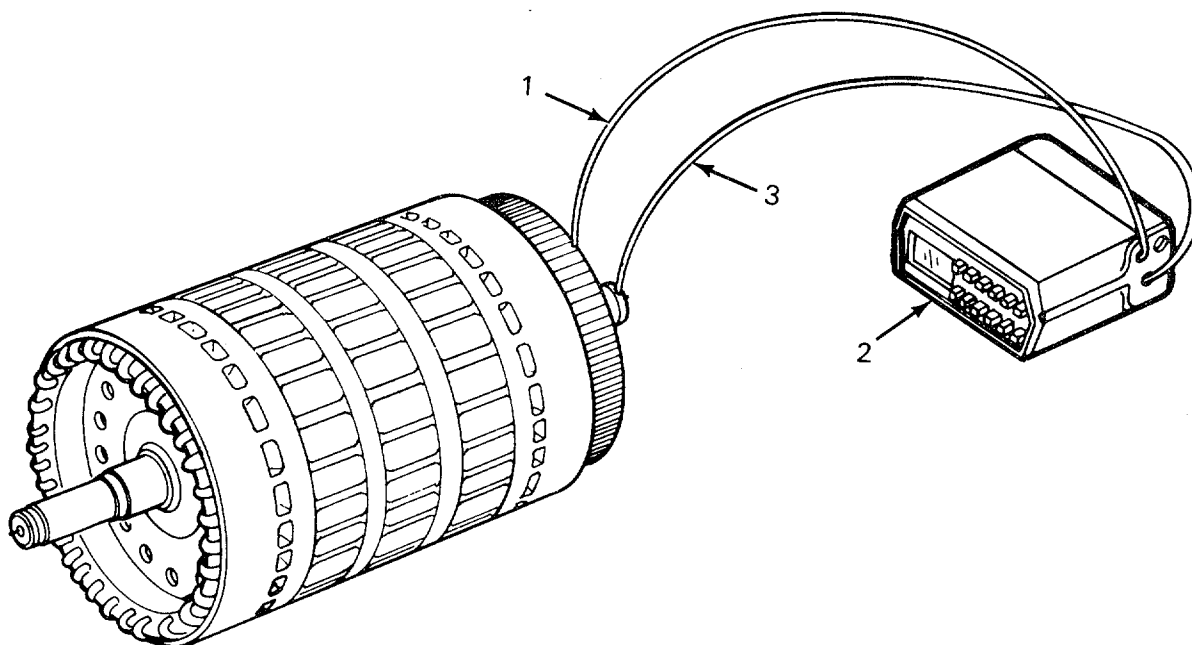
TEST (cont)

43. Perform a bar-to-bar resistance test by the following:
- Place lead (1) of multimeter (2) on the shaft or core of the armature.
 - Place lead (3) of multimeter (2) on one of the commutator bars. Record reading on multimeter. Contact each successive bar around the commutator and record each reading.
 - If the test indicates resistance readings of 10 percent or more above the average recorded readings on 20 or more connections, tig weld all coil leads to commutator neck convections. If test indicates resistance readings of 1/2 percent below the average or a full-scale meter deflection of the multimeter, there is a shorted coil to the armature.

WARNING

Procedures specify the heating and cooling of parts to aid in disassembly and assembly. Heated and cooled parts may cause injury to personnel if hand protection is not worn when handling. Wear protective gloves for maximum protection.

- Below average readings could indicate the presence of water in the coils. If below average readings are obtained bake armature in a convection oven for 4 hours at 230° (110°C).
- Cool at room temperature and repeat step (b).
- If readings are still low, replace armature.



3-62. TRACTION MOTOR ASSEMBLY (cont)

ASSEMBLY

WARNING

Components of the traction motor are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

44. Install four blocks (65) and brush holders (64) on traction motor frame and secure with four bolts (62) and lockwashers (63).
45. Attach brush holder electrical leads (61) and secure with four flat washers (60), lockwashers (59) and bolts (58).

WARNING

Heated parts may cause injury to personnel if hand protection is not worn when handling. Wear protective gloves for maximum protection.

46. Place inner race (57) on an induction heater. Heat parts to 212°F (100°C).
47. Remove inner race (57) from heater and install on armature shaft. Hold in place until cooled.
48. Place oil slinger (55) on induction heater and heat to 212°F (100°C).
49. Remove oil slinger (55) from heater and install on armature shaft against shoulder. Hold in place until cooled.
50. Fill grooves of oil slinger (55) with grease.
51. Fill spaces between rollers of bearing and outer race assembly (54) with grease.
52. Fill lower half of grease chamber in bearing housing (56) with grease.
53. Install bearing and outer race assembly (54) in bearing housing (56) and install assembly onto armature shaft.
54. Use a feeler gauge and check internal radial clearance of bearing. Pass feeler gauge between bearing rollers and inner race. Maximum clearance is 0.0015 inch (0.038 mm).

3-62. TRACTION MOTOR ASSEMBLY (cont)

ASSEMBLY (cont)

55. Install retainer ring (53) and secure with two setscrews (52).
56. Fill lower half of grease pocket in bearing cap (50) and install gasket (51) and bearing cap. Secure with six lockwashers (49) and bolts (48).

WARNING

Heated parts may cause injury to personnel if hand protection is not worn when handling. Wear protective gloves for maximum protection.

NOTE

Parts must be heated and installed individually.

57. Place inner oil slinger (43), outer oil slinger (41), and inner race (42) on an induction heater. Heat parts to 212°F (100°C).
58. Fill lower half of grease chamber in inner bearing housing (45) with grease and install on armature shaft. Install gasket (44).

WARNING

Procedures specify the heating and cooling of parts to aid in disassembly and assembly. Heated and cooled parts may cause injury to personnel if hand protection is not worn when handling. Wear protective gloves for maximum protection.

59. Remove inner oil slinger (43) from heater and install on armature shaft. Hold in place until cooled. Fill sealing grooves with grease.
60. Remove inner race (42) from heater. Install on armature shaft and hold in place until cooled.
61. Remove outer oil slinger (41) from heater. Install on armature shaft and hold in place until cooled. Fill sealing grooves with grease.
62. Fill spaces between bearing (40) rollers with grease.
63. Install outer race and bearing assembly (40) in cover (39) and install cover on shaft. Check that drain holes of cover and inner bearing housing are aligned.

3-62. TRACTION MOTOR ASSEMBLY (cont)

ASSEMBLY (cont)

64. Install two guide bolts into inner bearing housing (45) to aid in lining up bearing housing and commutator end cover (39).
65. Use a feeler gauge and check internal radial clearance of bearing. Pass feeler gauge between rollers and inner race. Maximum radial clearance is 0.003 inch (0.08 mm).
66. Fill lower half of grease chamber in bearing cap (35) with grease.
67. Install gasket (36) and bearing cap (35) on shaft and secure with six lockwashers (34) and bolts (33).
68. Install lifting eye on pinion end of shaft.

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

69. Use a suitable lifting device and slowly lower armature assembly (46) into traction motor frame (47). Check that guide bolts line up holes in gasket (44) and commutator end cover (39). Check that punch marks on commutator end cover (39) line up with punch marks on traction motor frame (47).
70. Install six lockwashers (38) and bolts (37).
71. Remove guide bolts and secure armature (46) to traction motor frame (47) with eight lockwashers (32) and bolts (31).
72. Turn armature (46) by hand and check that it is free.
73. Install two screws (66) and brushes (67). Refer to TM 55-2210-223-12 for brush adjustment.
74. Install traction motor cover (30), four lockwashers (29), and bolts (28).
75. Install two traction motor covers (27).
76. Install pinion gear (21) as follows:
 - a. Cover shaft with a light coat of Prussian blue.
 - b. Install pinion gear on armature shaft and give it a quick push to set it against the traction motor cover.
 - c. Lightly drive a wedge between pinion gear and traction motor cover and remove pinion gear.

3-62. TRACTION MOTOR ASSEMBLY (cont)

ASSEMBLY (cont)

- d. Observe the contact area of pinion gear bore. If inspection shows bluing to cover less than 75 percent of total contact surface, use a fine grade of sandpaper and sand armature shaft and pinion gear bore. Repeat steps a thru d.

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
- e. Use drycleaning solvent and remove bluing from armature shaft and pinion gear bore. Dry with compressed air.
- f. Install pinion gear on armature shaft and give it a push against traction motor cover.
- g. Use a depth gauge and measure pinion gear position in respect to the shaft. Record reading.
- h. Use chalk and mark points of contact between depth gauge, pinion gear, and armature shaft so that pinion gear can be remounted in exactly the same position.
- i. Lightly drive a wedge between pinion gear and traction motor cover and remove pinion gear.
- j. Set pinion gear on an induction heater and heat to 273.2°F (134°C) above shaft.

WARNING

Heated parts may cause injury to personnel if hand protection is not worn when handling. Wear protective gloves for maximum protection.

- k. Remove pinion gear from heater and install on armature shaft. Line up chalk marks on pinion gear and armature shaft. Push pinion gear towards traction motor cover.

3-62. TRACTION MOTOR ASSEMBLY (cont)

ASSEMBLY (cont)

1. Use a depth gauge and check the advance of pinion gear. The advance will be 0.046 to 0.056 inch (1.17 to 1.42 mm) greater than reading recorded in step g above. If this advance is not obtained, pinion gear must be pulled and reinstalled.
 - m. Install lockring (20) and spanner nut (19).

INSTALLATION

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

77. Use a suitable lifting device and position traction motor with bearing housing facing wheel and axle assembly.
78. Install upper traction motor axle support bearing halves (8) to traction motor frame. Apply a light film of oil to bearing surfaces.
79. Use a suitable lifting device and slowly lower wheel and axle assembly into traction motor frame.
80. Apply a light film of oil to bearing surfaces and install two lower traction motor axle support bearing halves (8).
81. Install two felt wick lubricators (15) to two axle caps (7).
82. Install two axle caps (7) and secure with eight lockwashers (6) and bolts (5).
83. Install two gaskets (12) covers (11) and secure with eight lockwashers (10), and bolts (9).
84. Install gear case (4) and secure with five bolts (2) and lockwashers (3).
85. Install drain plug (1).
86. Fill axle bearing oil reservoirs with lubricating oil. Fill reservoir to an oil depth of 3/4 inch to 2-1/4 inches (19.1 to 57.2 mm).
87. Fill gear case with 8 pounds (3.6 kg) crater lube grease.
88. Hook up traction motor leads to a test stand and test run traction motor at 1500 rpm for 2 hours before installing.

3-63. WHEELS

This task covers:

Repair

INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12
Wheel turning machine 3416-00-X84-2519
Model 2012, Type A
DC welder 3431-00-276-0397

REPAIR

NOTE

Before wheel turning and recontouring are performed, wheel rim thickness and flange thickness must be measured to determine if the results will meet Association of American Railroad (AAR) Rule 41 specification requirements.

1. Refer to TM 55-2210-223-12 for inspection procedures. Inspect wheels for wear, sharp flanges, shelling, cracks, and flat spots. Use a steel fish tape and measure wheels. Maximum variance of wheel circumference between wheels on same axle is two tapes (1/4 inch (6.4 mm)). Maximum variance of wheel diameter is 0.080 inch (2 mm). Wheel size between different axles can vary up to 3/4 inch (19.1 mm) in diameter. Defects greater than those outlined above will require replacement of wheel sets on truck assembly.

WARNING

When machining wheels of locomotive, be careful of hot, sharp chips. Wear adequate eye protection. Use leather welding gloves. Cover exposed skin areas. Do not use hand to remove shavings, even with leather gloves. Use a hook or welding rod.

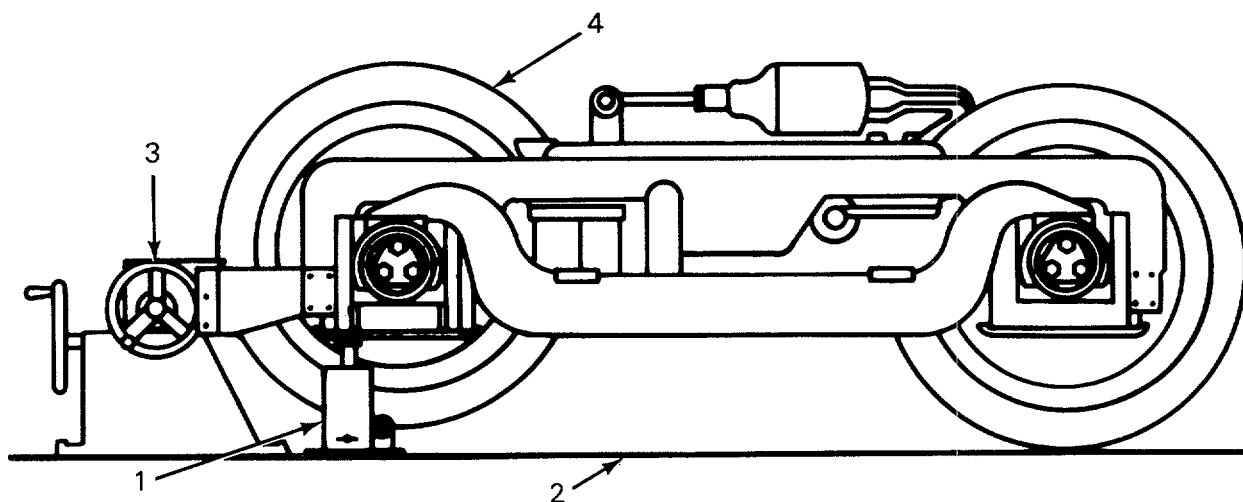
2. Use a wheel turning machine and turn wheel as follows:
 - a. Refer to paragraph 3-61 and remove vertical brake lever with brake assembly.

NOTE

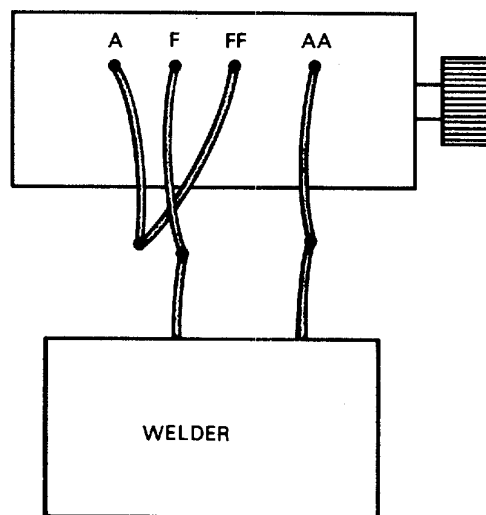
- Lift must be accomplished with a 20-ton (18.1 metric tons) (minimum) jack.
 - To be certain that axle is raised by pedestal assembly, two blocks approximately 3-1/2 inches (88.9 mm) high must be used on each wheel.
- b. Install two blocks between bearing and pedestal binder on each side.

3-63. WHEELS (cont)

REPAIR (cont)



- c. Install 20-ton (18.1 metric ton) jack on each side (1) under roller bearing axle assembly and raise axle until wheels clear rail (2) by 1 inch (25.4 mm).
- d. Disconnect traction motor leads from locomotive.
- e. Connect traction motor leads to welder as shown below.
- f. Install wheel turning machine (3) on rail in front of wheel (4) and lock in place.
- g. Start rotation of wheel and engage wheel turning machine tool to wheel.



3. After wheels are turned, disconnect traction motor leads from welder.
4. Connect traction motor leads to locomotive.
5. Remove wheel turning machine (3) from rail (2).
6. Lower two jacks (1) and remove from locomotive.
7. Remove two blocks from between bearings and pedestal binders.
8. Refer to paragraph 3-61 and replace vertical brake lever with brake assembly.
9. Inspect wheels in accordance with TM 55-2210-223-12.

3-64. COUPLER AND DRAFT GEAR

This task covers:

- | | | | |
|----------------|---------------|-------------|-----------------|
| a. Removal | c. Cleaning | e. Repair | g. installation |
| b. Disassembly | d. Inspection | f. Assembly | |
-

INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12
Magnaflux 6635-01-131-0730
Grease GAA (Item 11, Appendix B)

Materials/Parts

Graphite grease (Item 14, Appendix B)
Drycleaning solvent (Item 30, Appendix B)

REMOVAL

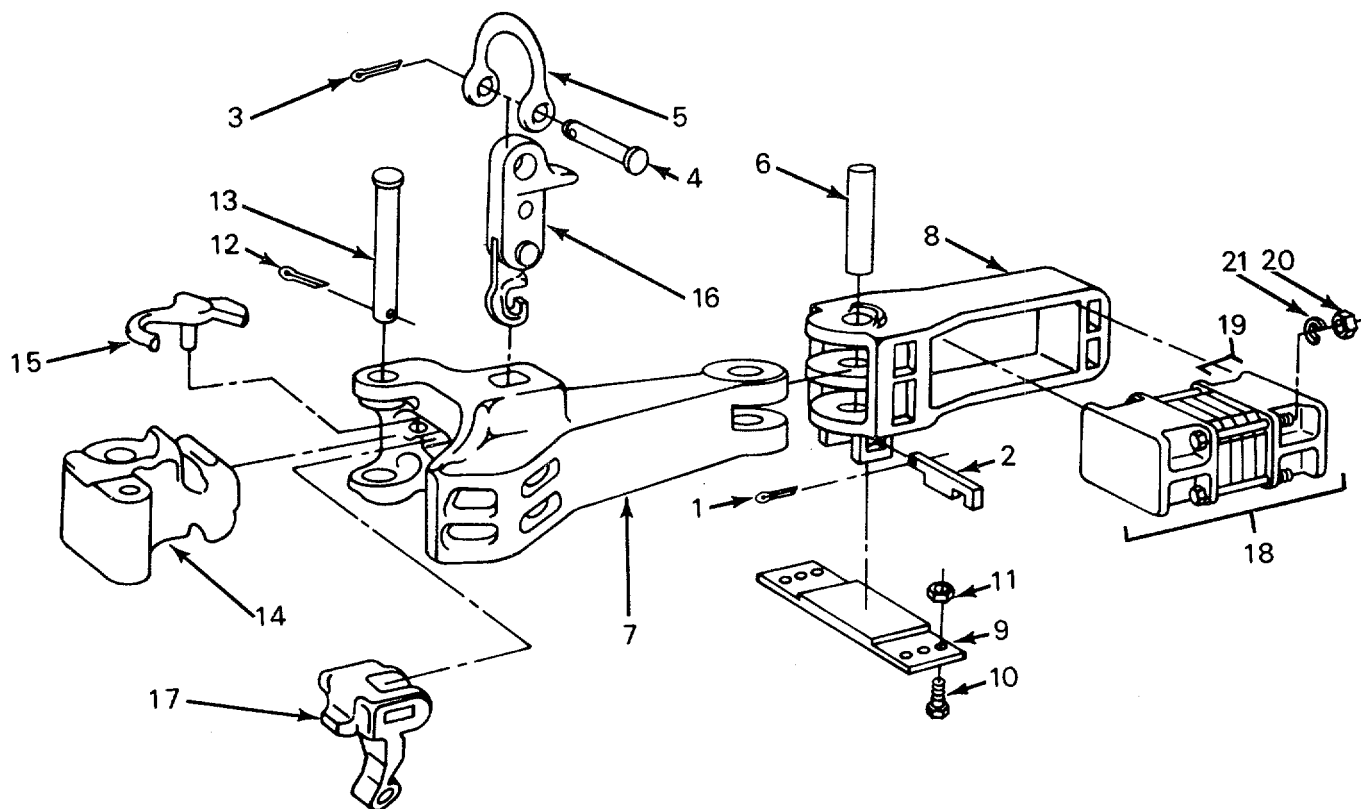
WARNING

Components of the coupler and draft gear are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

1. Remove cotter key (1) and lockpin (2).
2. Remove cotter key (3) and pin (4) from lock lifter connector (5).
3. Use a suitable lifting device and remove pivot pin (6) and coupler (7) from yoke (8).
4. Refer to paragraph 3-61 and disconnect sander hoses and sander bracket.
5. Install a suitable lifting device under yoke (8) and lift weight of yoke off carrier plate (9).
6. Remove six bolts (10) and locknuts (11).

3-64. COUPLER AND DRAFT GEAR (cont)

REMOVAL (cont)



NOTE

Yoke and draft gear may become wedged in place. This may require a suitable jack or some other device to force the yoke out of position.

7. Slowly lower lifting device and remove carrier plate (9) and yoke (8).

DISASSEMBLY

8. Disassemble coupler (7) as follows:
 - a. Remove cotter key (12), knuckle pin (13), and knuckle (14).
 - b. Remove knuckle thrower (15), lock lifter assembly (16), and knuckle lock (17).
9. Remove draft gear assembly (18) from yoke (8). If phenolic block is damaged, replace draft gear assembly.

3-64. COUPLER AND DRAFT GEAR (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes and get medical aid immediately.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

10. Use a brush and remove dirt from draft gear assembly.
11. Use drycleaning solvent and clean metal parts. Dry with compressed air.
12. Clean, inspect, and repair draft gear assembly by the following:
 - a. Inspect blocks. Check that phenolic material is bonded to plate. Check that location tabs are intact. Replace damaged blocks as a complete set. Do not use new and old blocks together.
 - b. Inspect follower plates for roughness or gouging. Remove roughness or gouging as required.
 - c. Check that draft gear assembly in free state is 1/2 to 3/4 inch (12.7 to 19.1 mm) larger than yoke pocket. If draft gear assembly is smaller than yoke pocket, tack weld 1/8 inch (3.2 mm) shims to vertical edge of follower.
 - d. Magnaflux follower plates and bolts. Check that there are no cracks, breaks, or damaged threads. Replace damaged parts.
13. Inspect yoke by the following:
 - a. Inspect yoke pocket for rough surfaces. Remove roughness as required.
 - b. Inspect pin hole in yoke for wear. Diameter of pin hole is 1-13/16 inches (46 mm) minimum and 2 inches (50.8 mm) maximum. Replace yoke if hole exceeds maximum diameter.
 - c. Magnaflux yoke. Replace cracked yoke.

3-64. COUPLER AND DRAFT GEAR (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

14. Inspect coupler assembly by the following:
 - a. Magnaflux pivot pin. Replace pin if cracked or if diameter is worn below 1-11/16 inches (42.9 mm).
 - b. Inspect remaining parts of coupler assembly for cracks, breaks, or other damage. Replace defective parts.
15. Inspect draft gear pocket on locomotive underframe for cracks or rough surfaces. Remove cracks by grooving, welding, and grinding smooth.

ASSEMBLY

16. Assemble yoke (8) by the following:
 - a. Use a press and compress plates of draft gear assembly (18) to 1/2 inch (12.7 mm) less than yoke pocket.
 - b. Install draft gear assembly (18) in yoke (8).
 - c. Install 1/2-inch (12.7 mm) metal spacers between inside yoke (8) surface and follower plates (19). Remove 1/2-inch (12.7 mm) metal spacers between two follower plates and four nuts (20) and lockwashers (21).
17. Assemble coupler (7) by the following:
 - a. Install knuckle lock (17), lock lifter assembly (16), and knuckle thrower (15).
 - b. Install knuckle (14) and secure with knuckle pin (13) and cotter key (12).

INSTALLATION

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

18. Position yoke (8) on carrier plate (9).
19. Use suitable lifting device and raise yoke (8) and carrier plate (9) to underframe draft gear pocket. Secure with six bolts (10) and locknuts (11).

3-64. COUPLER AND DRAFT GEAR (cont)

INSTALLATION (cont)

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

20. Use a suitable lifting device and install coupler (7) in yoke (8) and secure with pivot pin (6), lockpin (2), and cotter key (1).
21. Install pin (4) into lock lifter connector (5) and secure with cotter key (3).
22. Refer to paragraph 3-61 and connect sander hoses and sander bracket.
23. Refer to TM 55-2210-223-12 and adjust free slack and coupler height.
24. Use automotive and graphite grease in accordance with LO 55-2210-223-12.

CHAPTER 4

INTERMEDIATE GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS, SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

4-1. COMMON TOOLS AND EQUIPMENT

For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

4-2. SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

Special tools, TMDE, and support equipment are listed and illustrated in TM 55-2210-223-24P for the locomotive and TM 5-2815-232-24P for the engine.

4-3. REPAIR PARTS

Repair parts are listed and illustrated in the Repair Parts and Special Tools List, TM 55-2210-223-24P for the locomotive and TM 5-2815-232-24P for the engine.

Section II. INTERMEDIATE GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

4-4. SCOPE

This chapter contains maintenance procedures authorized at the intermediate general support maintenance category.

4-5. TASK SUMMARY

TASK PARA	PROCEDURES	PAGE NO.
4-6	Radiator	4-2
4-7	Traction Motor Blower	4-5
4-8	Air Compressor	4-8
4-9	Engine Assembly	4-27
4-10	Motor Mounting Frame	4-33
4-11	Automatic Brake Valve	4-35
4-12	Independent Brake Valve	4-51
4-13	6-NFR Distributing Valve	4-58
4-14	No. 8 Vent Valve	4-68
4-15	A-1 Charging Cutoff Pilot Valve	4-72
4-16	H-5 Relay Air Valve	4-79
4-17	Emergency Brake Valve	4-83
4-18	Strainer and Check Valve	4-87
4-19	Cutout Cock and Strainer	4-91

4-6. RADIATOR

This task covers:

- | | | |
|----------------|---------------|-------------|
| a. Disassembly | c. Inspection | e. Assembly |
| b. Cleaning | d. Repair | |

INITIAL SETUP

Tools

Tool kit SC 4940-97-CL-E12
Tin alloy solder (Item 29, Appendix B)

Material/Parts

Alkali cleaning compound (Item 6, Appendix B)

Equipment Condition Reference

Para 3-42

Condition Description

Radiator removed

DISASSEMBLY

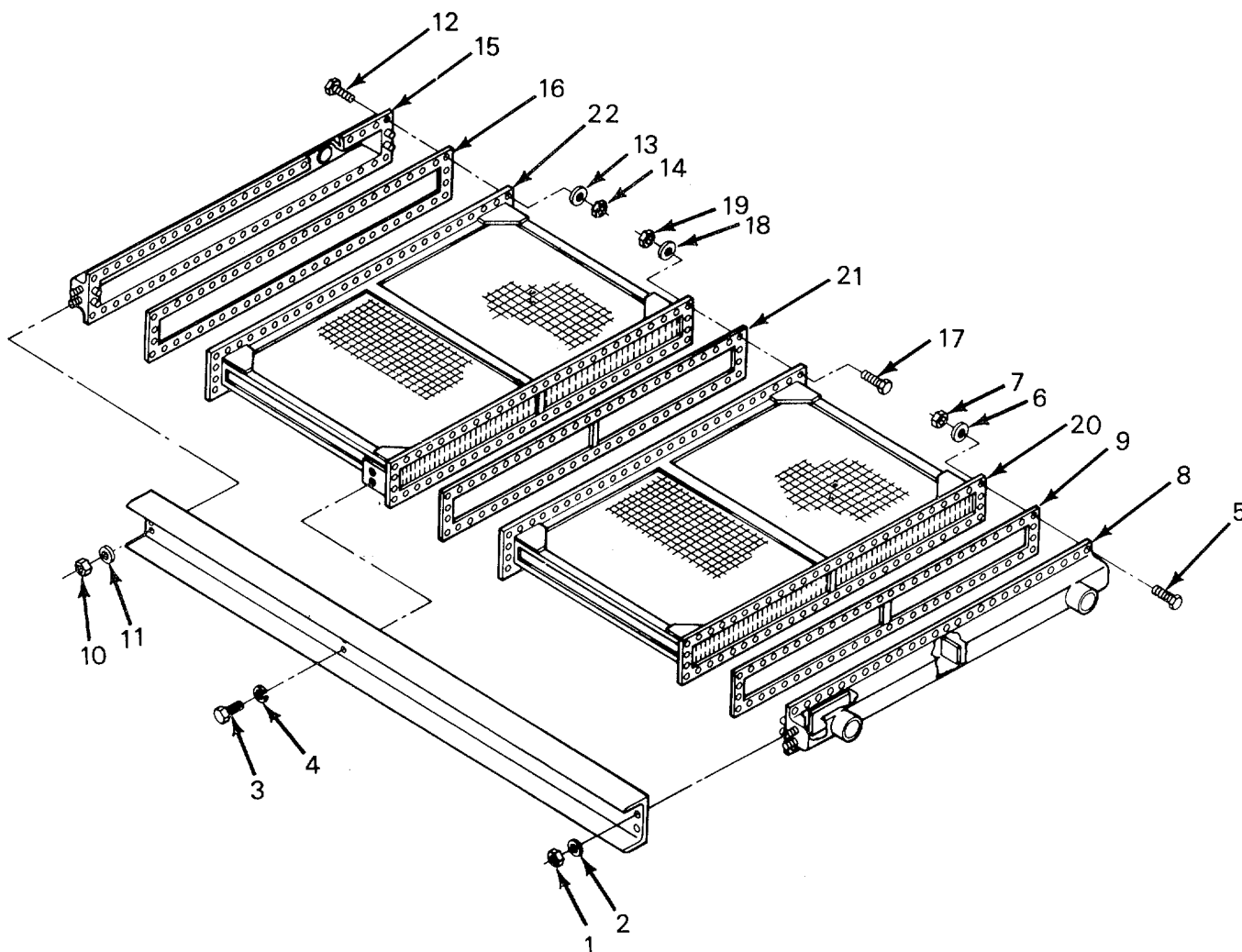
NOTE

Check that cooling system is drained.

1. Remove four nuts (1) and lockwashers (2).
2. Remove four bolts (3) and lockwashers (4).
3. Remove 70 bolts (5), washers (6), and nuts (7).
4. Remove top header (8) and gasket (9).
5. Remove four nuts (10) and washers (11).
6. Remove 70 bolts (12), washers (13), and nuts (14).
7. Remove bottom header (15) and gasket (16).
8. Remove 70 bolts (17), washers (18), and nuts (19).
9. Remove top core (20), gasket (21), and bottom core (22).

4-6. RADIATOR (cont)

DISSASSEMBLY (cont)



CLEANING, INSPECTION, AND REPAIR

10. Remove old gasket material from top and bottom header gasket surfaces.
11. Place top and bottom cores in a tank of hot alkaline soap solution and soak for 4 hours.
12. Remove top and bottom cores and steam clean. Rinse with clean water.
13. Remove old gasket material from top and bottom core gasket surfaces.
14. Ream each core with a stainless steel rod.

4-6. RADIATOR (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

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.).

15. Use compressed air and blow out each tube. Rinse with clean water.
16. Visually examine top and bottom cores for cracks, breaks, or other damage.
17. Refer to paragraph 3-42 and perform a leak test.
18. Repair cracks, breaks, and leaks as required. Use duckbill pliers and straighten bent fins.

NOTE

Refer to appendix C for modification procedures.

ASSEMBLY

NOTE

Check to see if radiator has been modified. Refer to appendix C for modification and modification procedures. Modify radiator prior to assembly.

19. Install bottom core (22), gasket (21), and top core (20). Secure with 70 nuts (19), washers (18), and bolts (17).
20. Install gasket (16) and bottom header (15). Secure with 70 nuts (14), washers (13), and bolts (12).
21. Install four nuts (10) and washers (11).
22. Install gasket (9) and top header (8). Secure with 70 nuts (7), washers (6), and bolts (5).
23. Install four bolts (3) and lockwashers (4).
24. Install four nuts (1) and washers (2).

4-7. TRACTION MOTOR BLOWER

This task covers:

a. Disassembly
b. Cleaning

c.leaning
d. Repair

e. Assembly

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

Equipment Condition
Reference

Para 3-43

Material/Parts

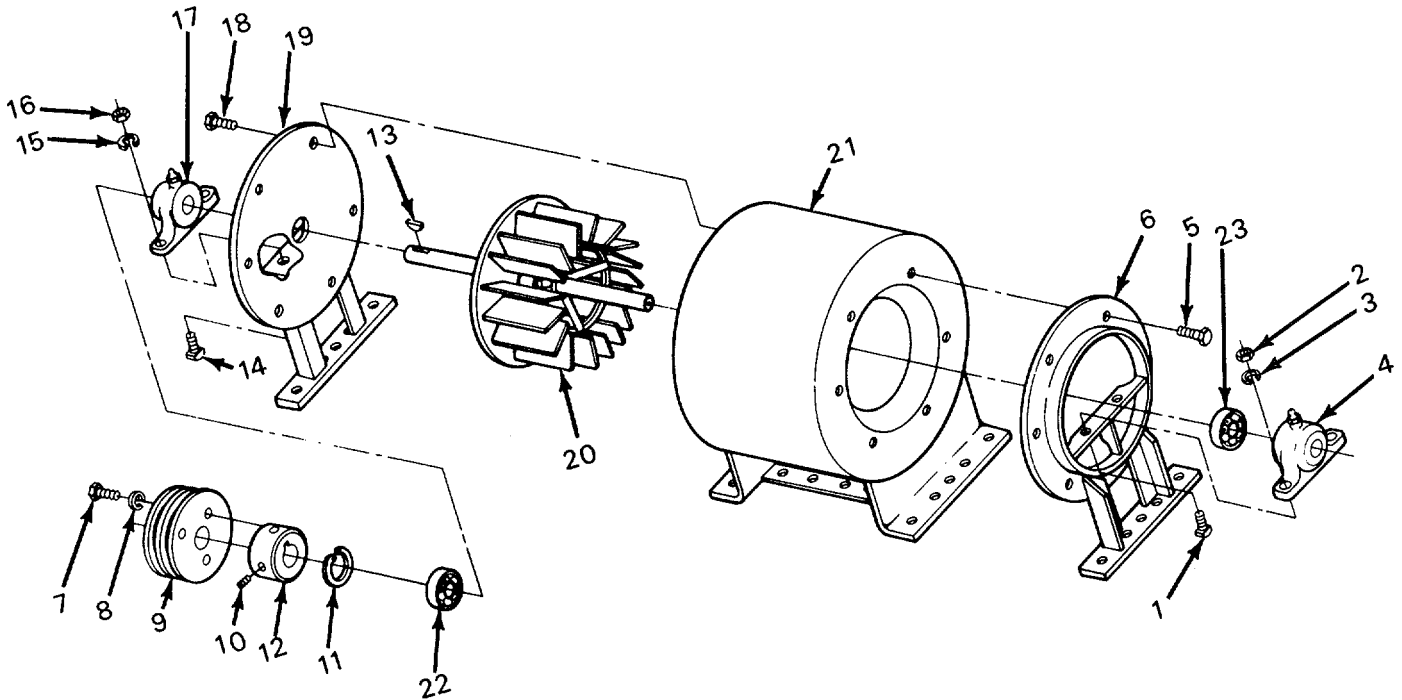
Drycleaning solvent (Item 30, Appendix B)

Condition Description

Traction motor blower removed

DISASSEMBLY

1. Remove two bolts (1), nuts (2), lockwashers (3), and rear pillow block (4).
2. Remove eight bolts (5) and rear cover (6).



4-7. TRACTION MOTOR BLOWER (cont)

DISASSEMBLY (cont)

3. Remove three bolts (7), lockwashers (8), and pulley (9).
4. Loosen two allen-head setscrews (10) and remove lockring (11), spacer (12), and key (13).
5. Remove two bolts (14), lockwashers (15), nuts (16), and front pillow block (17).
6. Remove eight bolts (18) and front cover (19).
7. Remove shaft and fan assembly (20) from housing (21).
8. Remove bearings (22) and (23).

CLEANING, INSPECTION, AND REPAIR

WARNING

* Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 138°F (38 59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.

* Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

9. Use drycleaning solvent and clean metal parts. Dry with compressed air.
10. Inspect fan, pulley, and shaft for cracks, breaks, or scoring. Replace damaged parts.
11. Check bearings for free rotation. Replace damaged bearings.

4-7. TRACTION MOTOR BLOWER (cont)

ASSEMBLY

12. Install bearing (22) in front pillow block (17).
13. Install bearing (23) in rear pillow block (4).
14. Install shaft and fan assembly (20) in housing (21).
15. Install front cover (19) and secure with eight bolts (18).
16. Install front pillow block (17) and secure with two nuts (16), lockwashers (15), and bolts (14).
17. Install key (13), spacer (12), and lockring (11) and tighten two allen-head screws (10).
18. Install pulley (9) on shaft and secure with three bolts (7) and lockwashers (8).
19. Install rear cover (6) and secure with eight bolts (5).
20. Install rear pillow block (4) and secure with two nuts (2), lockwashers (3), and bolts (1).

4-8. AIR COMPRESSOR

This task covers:

- | | | |
|----------------|---------------|-------------|
| a. Disassembly | c. Inspection | e. Assembly |
| b. Cleaning | d. Repair | f. Test |

INITIAL SETUP:

<u>Tools</u>	<u>Test Equipment</u>	<u>Material/Parts</u>
Tool kit SC 4940-97-CL-E12	Orifice holder	Drycleaning solvent (Item 30, Appendix B)
Magnetic particle tester 6635-01-131-0730		Lubrication oil (Item 19, Appendix B)
Feeler gage		Grease BB (Item 11, Appendix B)
Micrometer 5210-00-267-3093		
Honing drill		
Dial indicator 5210-00-640-0953	<u>Equipment Condition Reference</u>	<u>Condition Description</u>
Torque wrench	Para 3-44	Air compressor removed

DISASSEMBLY

WARNING

- * Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 138°F (38 59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
- * Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

NOTE

* Thoroughly clean exterior to prevent dirt from entering internal parts.

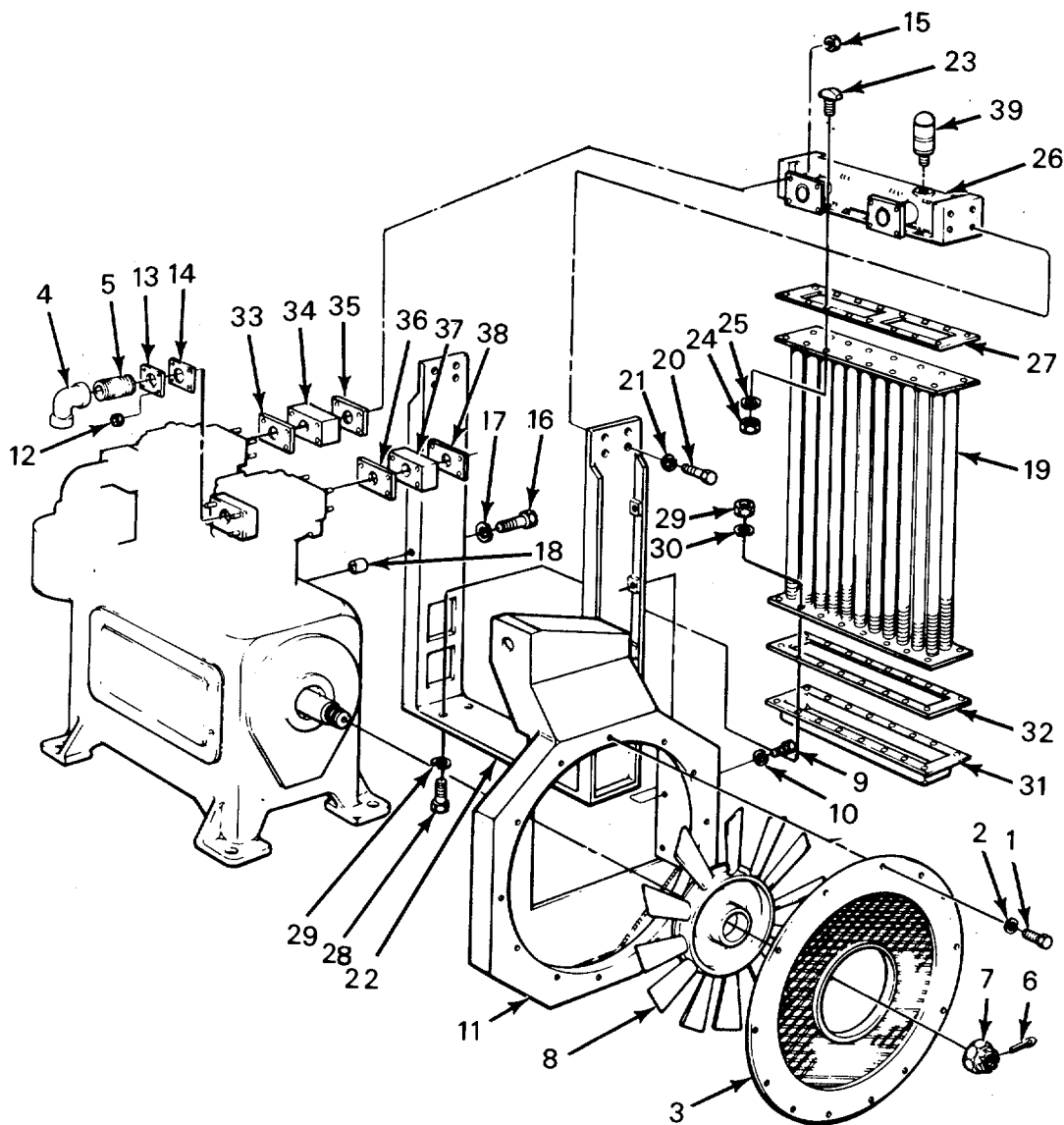
- * When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

1. Use drycleaning solvent and remove dirt from exterior of air compressor. Dry with compressed air.

4-8. AIR COMPRESSOR (cont)

DISASSEMBLY (cont)

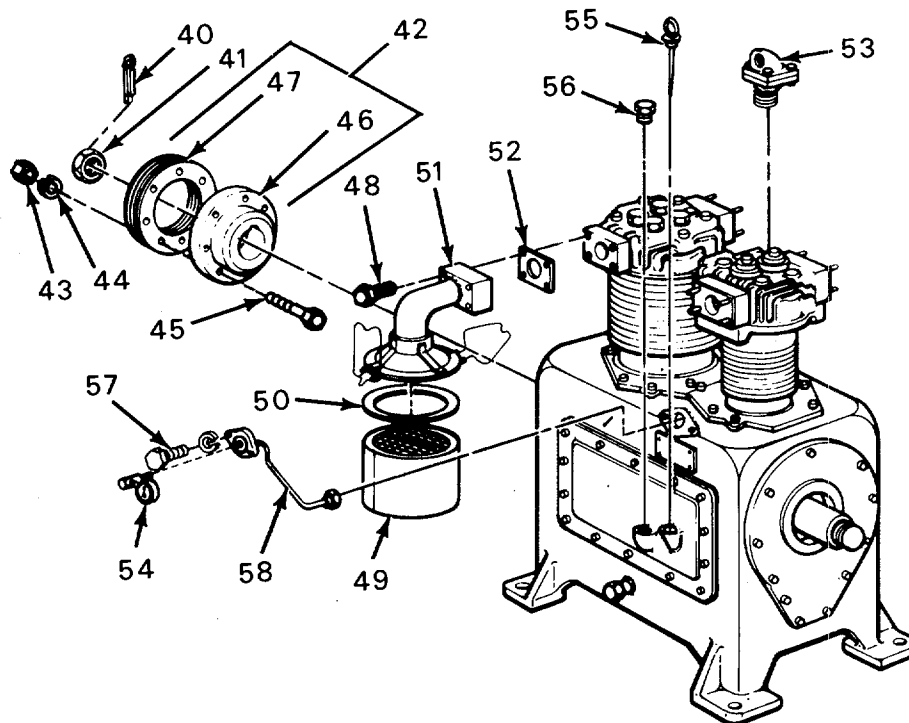
2. Remove 12 capscrews (1) and lockwashers (2). Remove fan guard (3).
3. Remove discharge elbow (4) and extension (5).
4. Remove cotter pin (6), nut (7), and cooling fan (8).
5. Remove eight bolts (9), lockwashers (10), and air baffle (11).
6. Remove four locknuts (12), discharge flange (13), and gasket flange (14).



4-8. AIR COMPRESSOR (cont)

DISASSEMBLY (cont)

7. Remove eight nuts (15).
8. Remove two bolts (16), lockwashers (17), and two spacers (18). Remove items (19) thru (32).
9. Remove 12 bolts (20) and lockwashers (21) from outer core assembly (22).
10. Remove 16 bolts (23), nuts (24), lockwashers (25), top flange assembly (26), and gasket (27).
11. Remove 16 bolts (28), nuts (29), lockwashers (30), bottom flange assembly (31), and gasket (32) from tube assembly (19).
12. Remove gasket flange (33), spacer (34), and gasket flange (35).
13. Remove gasket flange (36), spacer (37), and gasket flange (38).
14. Remove EI safety valve (39).

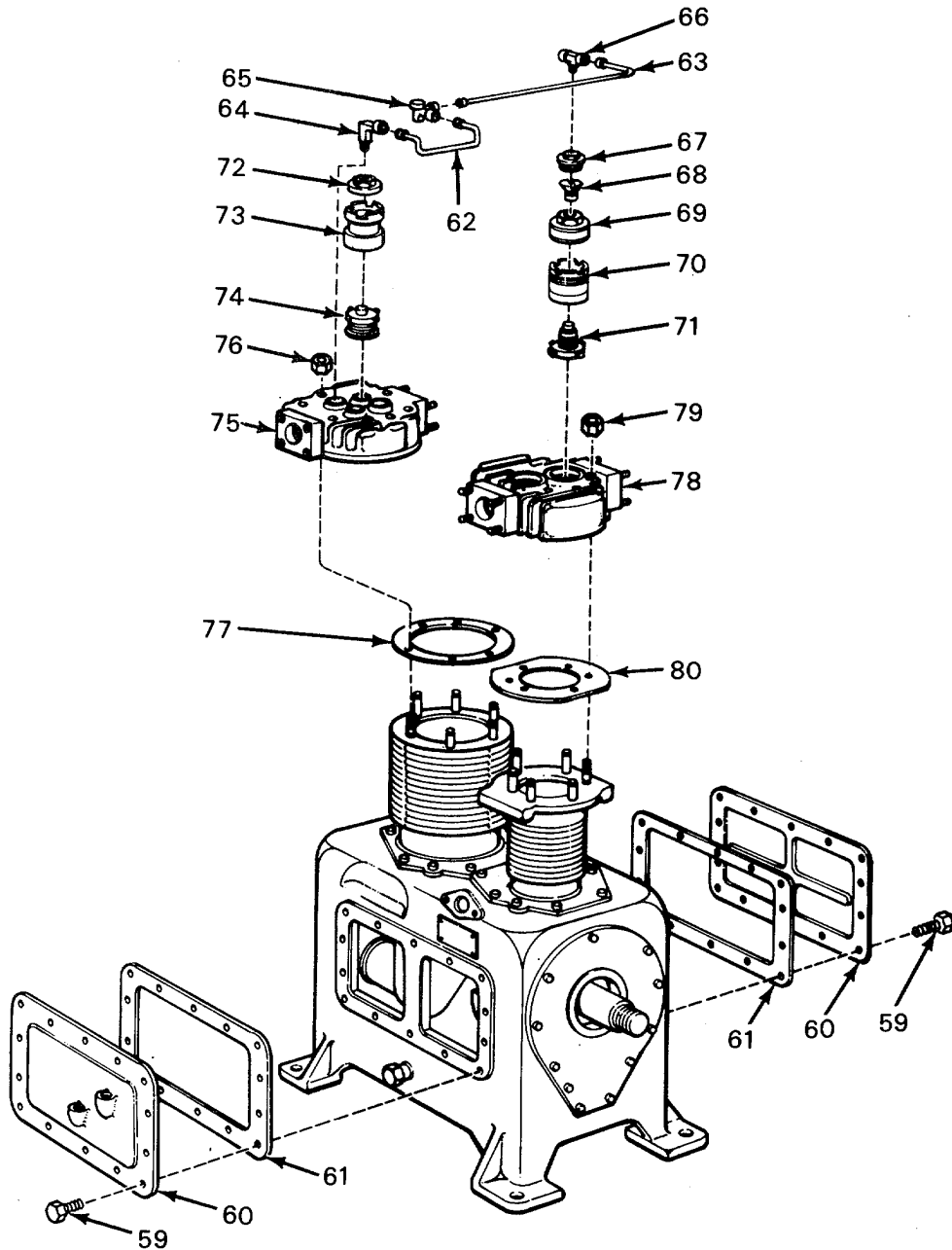


15. Remove cotter pin (40), nut (41), and coupling flange assembly (42).
16. Remove four nuts (43), spacers (44), and bolts (45) and separate flange (46) from pulley (47).
17. Remove two bolts (48), intake strainer (49), rubber gasket (50), intake tube (51), and gasket flange (52).
18. Remove crankcase breather (53), oil pressure gauge (54), dipstick (55), and filler plug (56).
19. Remove two capscrews (57) and oil pressure tubing (58).

4-8. AIR COMPRESSOR (cont)

DISASSEMBLY (cont)

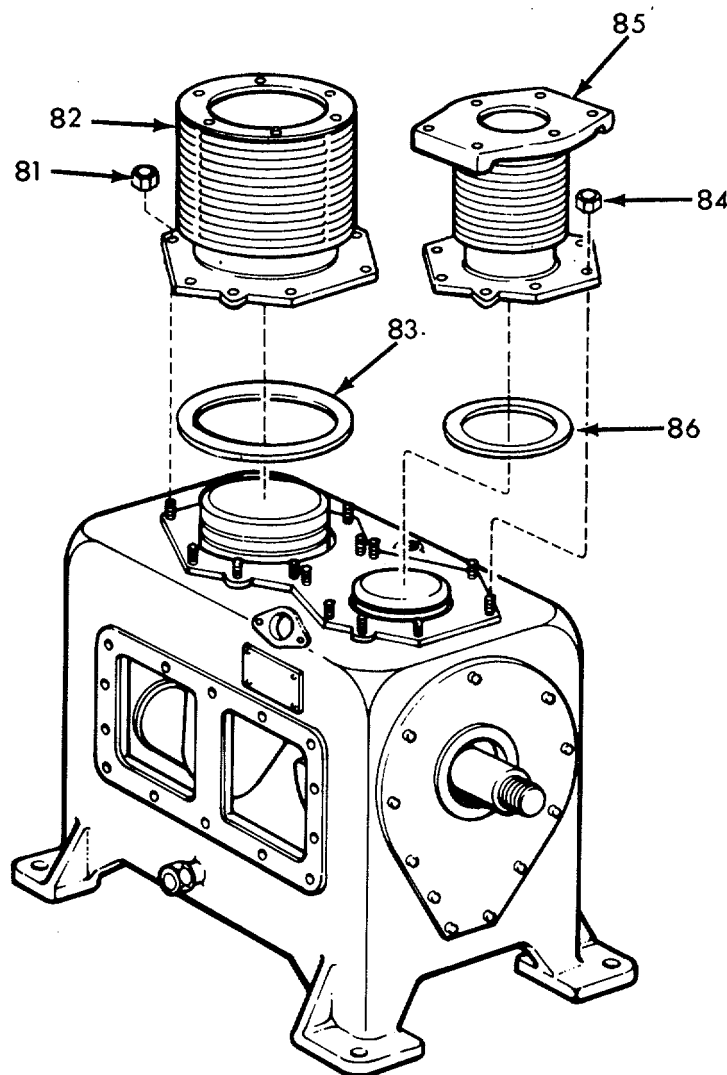
20. Remove 26 capscrews (59). Remove two side covers (60) and gaskets (61).
21. Remove unloader tubes (62) and (63).
22. Remove unloader pipe fittings (64), (65), and (66).
23. Remove three capnuts (67).
24. Remove three brass spacers (68), unloaders (69), unloader valve plugs (70), and inlet valves (71).



4-8. AIR COMPRESSOR (cont)

DISASSEMBLY (cont)

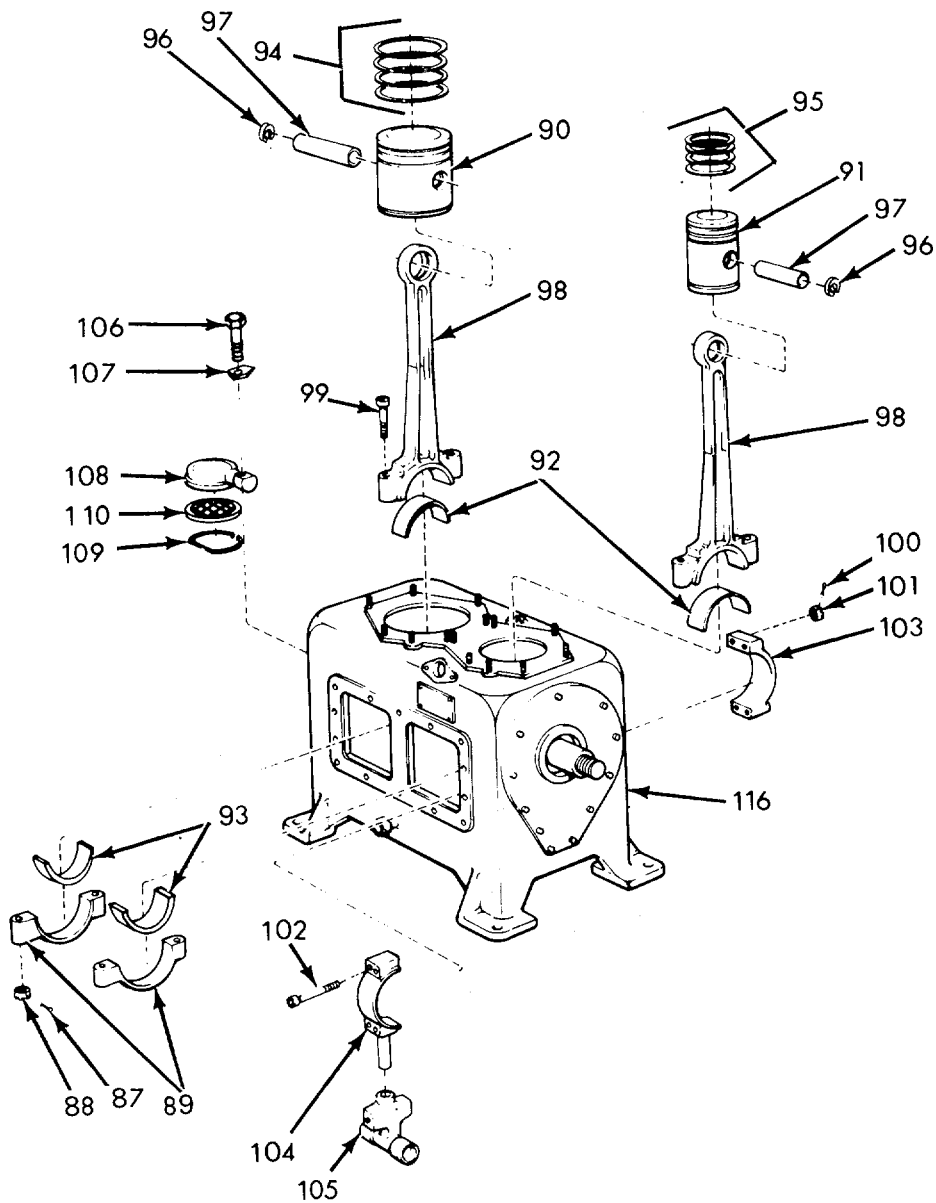
25. Remove three unloader capnuts (72).
26. Remove three valve plugs (73) and discharge valves (74).
27. Use a punch and punch-mark low-pressure cylinder head (75) to cylinder (83). Remove six nuts (76), low-pressure cylinder head, and gasket (77).
28. Use a punch and punch-mark high-pressure cylinder head (78) to cylinder (86). Remove six nuts (79), high-pressure cylinder head, and gasket (80).
29. Remove six nuts (81), low-pressure cylinder (82), and gasket (83).
30. Remove six nuts (84), high-pressure cylinder (85), and gasket (86).



4-8. AIR COMPRESSOR (cont)

DISASSEMBLY (cont)

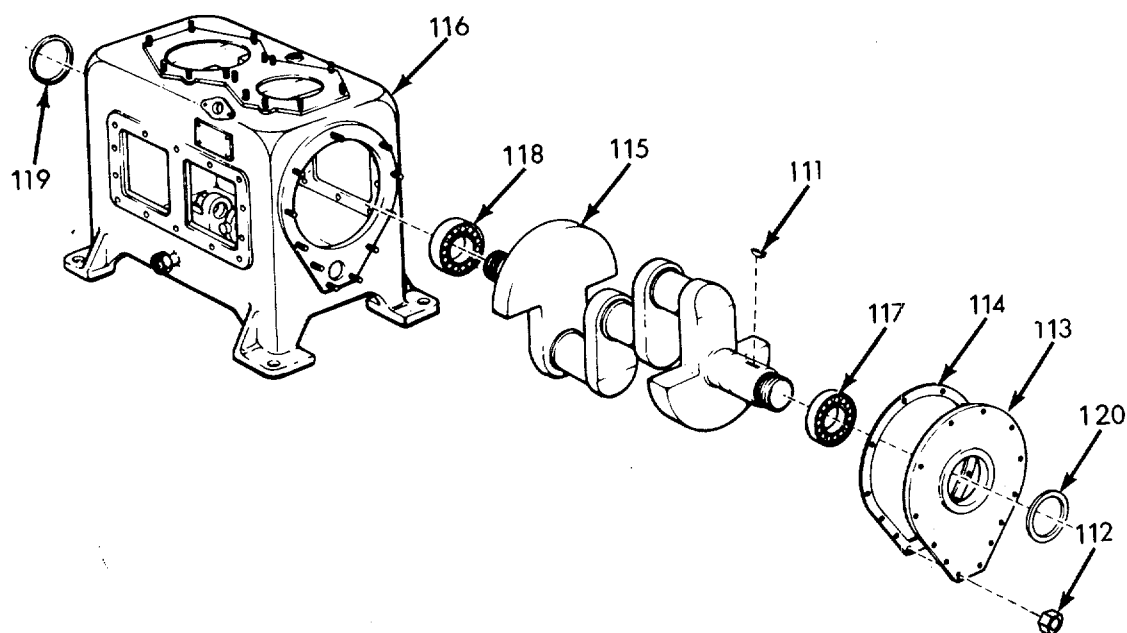
31. Remove four cotter pins (87), castle nuts (88), and two connecting rod caps (89).
32. Remove piston assemblies (90) and (91).
33. Remove two upper bearings (92) and lower bearings (93).
34. Remove four piston rings (94) and (95).



4-8. AIR COMPRESSOR (cont)

DISASSEMBLY (cont)

35. Remove four piston pin snap rings (96), two piston pins (97), two connecting rods (98), and four bolts (99).
36. Remove four cotter pins (100), nuts (101), bolts (102), and cap (103).
37. Remove oil pump plunger (104) from oil pump housing (105).
38. Remove capscrew (106), washer (107), oil strainer body (108), retainer ring (109), and oil strainer screen (110).
39. Remove key (111).



40. Remove 11 nuts (112), main bearing housing (113), and gasket (114).

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

CAUTION

Be careful not to damage crankshaft during removal.

41. Use a suitable lifting device and slowly remove crankshaft (115) from crankcase (116).
42. Remove main ball bearings (117) and (118) and oil seals (119) and (120).

4-8. AIR COMPRESSOR (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

* Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 138°F (38 59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.

* Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

43. Use drycleaning solvent and remove dirt, grease, and oil from cylinder heads, cylinders, side covers, discharge elbow, piston pins, and discharge flange. Dry with compressed air.
44. Magnaflux cylinder heads, cylinders, side covers, discharge elbow, piston pins, and discharge flange and check that there are no cracks. Replace damaged parts.
45. Clean, inspect, and repair crankshaft (115) by the following:
 - a. Use drycleaning solvent and remove grease, dirt, and oil from crankshaft (115). Check that oil passages are free of obstruction. Dry with compressed air.
 - b. Magnaflux crankshaft (115) and check that there are no cracks. Check that crankshaft is not bent or broken.

NOTE

Check that oil seal surfaces are not grooved, ball bearing seats are not worn, and oil relay valve seat is not scored.

- c. Inspect ends of crankshaft (115). Check that there is no damage to surfaces, threads, or keyway.
- d. Use a micrometer and measure crankshaft (115) journal diameter. Refer to table 4-1 for dimensions.

4-8. AIR COMPRESSOR (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

- e. Use a feeler gauge and measure radial clearance between oil pump plunger (104) collar and crankshaft eccentric. Refer to table 4-1 for dimensions.

NOTE

Maximum runout of 0.001 inch (0.03 mm) must be checked at depot level maintenance facility.

- f. Replace damaged crankshaft (115).

46. Clean, inspect, and repair cylinders (82) and (85) by the following:

- a. Use drycleaning solvent and remove dirt, grease, and oil from cylinders (74) and (78). Dry with compressed air.

NOTE

Ring travel surface should not be scored and should not have ridges.

- b. Use a honing drill and hone cylinder walls to a bright, smooth finish.

NOTE

If cylinder flanges are machined, check that cylinder length is not shortened beyond the minimum limit. This is determined by installing piston in top dead center position and ensuring piston is flush or below top face of cylinder.

- c. Use a dial indicator and true both ends of bore and flange face. Inspect perpendicularity of low-pressure cylinder (82) and high-pressure cylinder (85) to flange face. Maximum variance is 0.002 inch (0.05 mm) If variance exceeds maximum, machine cylinder flanges.
- d. Use a feeler gage and measure cylinder-to-piston clearance. Refer to table 4-1 for clearance dimensions. If cylinder-to-piston clearance is not within limits, replace piston with a new, standard size piston. Recheck cylinder-to-piston clearance. If not within limits, replace cylinder with a new, standard size cylinder.
- e. Replace damaged low-pressure cylinder (82) and high-pressure cylinder (85).

4-8. AIR COMPRESSOR (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

47. Clean, inspect, and repair pistons (90) and (91) by the following:
- a. Use drycleaning solvent and remove dirt, grease, and oil. Dry with compressed air.
 - b. Magnaflux pistons (90) and (91) and check that there are no cracks.

NOTE

Check that piston ring grooves are square and do not have ridges.

- c. Use a feeler gage and measure clearance between ring sides and grooves. Clearance is 0.002 to 0.004 inch (0.05 to 0.10 mm).
- d. Use a micrometer and measure skirts of pistons (90) and (91). Refer to table 4-1 for diameter limits.

CAUTION

Do not use a stone or emery cloth to remove minor scuff marks or scratches from pistons. Damage to pistons will result.

- e. Use a file and remove minor scuff marks and scratches from pistons (90) and (91).
 - f. Replace damaged pistons (90) and (91).
48. Clean, inspect, and repair connecting rods (98) by the following:
- a. Use drycleaning solvent and remove dirt, grease, and oil from connecting rods (98). Check that oil passages are free of obstruction. Dry with compressed air.
 - b. Magnaflux connecting rods (98) and check that there are no cracks.
 - c. Inspect bolts and nuts and check that threads are not damaged. Check that bolts turn freely on nuts.
 - d. Fit connecting rods (98) to crankshaft journals by the following:
 - (1) Apply a film of light oil on crankshaft (115) journal.
 - (2) Install connecting rod (98) and torque bolts to 125 ± 25 lb-ft (170 ± 34 N.m). Check that castle nut is lined up to meet-cotter pin hole in bolt.

4-8. AIR COMPRESSOR (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

- (3) Use feeler gage between connecting rod cap (93) and journal of crankshaft (115) and check for a measurement of 0.0015 inch (0.038 mm) maximum clearance.
 - (4) Turn connecting rod (90) 1 inch (25.4 mm) at piston pin end and check that connecting rod turns freely.
 - (5) Check for maximum clearance in same manner as in step (3) above. Clearance between connecting rod cap (93) and crankshaft journal (115) must be 0.003 inch (0.076 mm) maximum.
 - (6) Turn connecting rod (98) 1 inch (25.4 mm) at piston pin end and check that connecting rod turns tightly.
- e. Use a feeler gage and measure side clearance of connecting rod (98). Side clearance limits are 0.002 inch (0.05 mm) minimum and 0.031 inch (0.79 mm) condemnable.
 - f. Remove connecting rods (98), bearings (93), and caps (89) from crankshaft (115).
 - g. Replace damaged connecting rods (98).
49. Clean, inspect, and repair oil pump plunger (104) by the following:
- a. Use drycleaning solvent and remove dirt and oil from oil strainer screen (110). Dry with compressed air.
 - b. Check that oil strainer screen (110) is not frayed or damaged. Replace damaged screen.
 - c. Use a feeler gauge and measure radial clearance between oil pump plunger collar and crankshaft eccentric journal. Clearance limits are 0.003 inch (0.08 mm) minimum and 0.005 inch (0.13 mm) condemnable. If clearance limits are exceeded, replace oil pump plunger (104).
 - d. Check that ball and ball seat of oil plunger (104) are not worn or damaged by the following:
 - (1) Use a micrometer and measure from end of oil pump plunger (104) to bottom of ball. Wear limits are 0.271 to 0.225 inch (6.88 to 5.72 mm). If wear limits are exceeded, replace plunger.
 - (2) If ball inside oil pump housing (105) is damaged, replace with new stainless steel ball.

4-8. AIR COMPRESSOR (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

- e. Use a feeler gauge and measure clearance between oil pump plunger (104) and oil pump housing (105). Clearance limits are 0.002 inch (0.05 mm) minimum and 0.006 inch (0.15 mm) condemnable. Replace damaged oil pump plunger and oil pump housing.
 - f. Check that crankcase journal supporting oil pump housing (105) is not cracked or broken.
 - g. Replace damaged parts.
50. Magnaflux crankcase (116) and check that crankcase is not cracked or broken. Replace damaged crankcase.
51. Use a dial indicator and measure bearing bore in main bearing housing (113). Maximum allowable wear or eccentricity is 0.002 inch (0.05 mm). Replace damaged main bearing housing.
52. Clean, inspect, and repair intercooler (19) by the following:
- a. Use drycleaning solvent and remove dirt and loose paint from intercooler (19). Dry with compressed air.
 - b. Use duckbill pliers and straighten bent fins.
53. Clean, inspect, and repair intake strainer (49) by the following:
- a. Use drycleaning solvent and remove dirt and oil from intake strainer (49). Dry with compressed air.
 - b. Apply a thin coat of oil to intake strainer (49).
54. Replace damaged oil lines.
55. Tighten fittings.
56. Replace metallic filter material in crankcase breather (53).
57. Replace seals, rings, bearings, and gaskets.
58. Refer to table 4-1 for air compressor data. Measure parts and check that parts do not exceed condemnable limits. Replace damaged parts.

4-8. AIR COMPRESSOR (cont)

Table 4-1. AIR COMPRESSOR DATA

Displacement	73 cfm (2.07 cu m) at 480 rpm
Displacement	92 cfm (2.61 cu m) at 600 rpm
Displacement	123 cfm (3.48 cu m) at 800 rpm
Displacement	153 cfm (4.33 cu m) at 1000 rpm
Compressor bhp (rated speed - 140 psi (965 kPa))	28.5 at 800 rpm
Compressor bhp (rated speed - 140 psi (965 kPa))	40 at 1000 rpm
Number of low pressure cylinders	1
Low-pressure cylinder bore	7.750 to 7.751 inches (196.85 to 196.88 mm)
Low-pressure piston outside diameter	7.744 to 7.743 inches (196.70 to 196.67 mm)
Number of compression rings (low-pressure piston)	2
Number of oil rings (low-pressure piston)	2
Number of high-pressure cylinders	1
High-pressure cylinder bore	4.250 to 4.251 inches (107.95 to 107.98 mm)
High-pressure piston outside diameter	4.246 to 4.245 inches (107.85 to 107.82 mm)
Number of compression rings (high-pressure piston)	2
Number of oil rings (high-pressure piston)	2
Stroke (all pistons)	5.625 inches (142.88 mm)
Number of main bearings	2
Type of main bearings	Ball
Crankshaft journal diameter	3.624 to 3.623 inches (92.05 to 92.02 mm)
Crankshaft journal lubrication	Forced
Oil pump type	Uniflow

4-8. AIR COMPRESSOR (cont)

Table 4-1. AIR COMPRESSOR DATA (continue d)

Oil capacity	14-3/4 quarts (13.954 liters)
Compressor cooling	Air (fan)
Intercooling	Air (fan)
Intercooling pressure	50 psi (345 kPa)
Low-pressure piston-to-cylinder clearance	Minimum 0.006 inch (0.15 mm); Maximum 0.008 inch (0.20 mm); Condemnable 0.0105 inch (0.267 mm)
Low-pressure cylinder ring side clearance	Minimum 0.002 inch (0.05 mm)
Low-pressure cylinder ring gap	Minimum 0.025 inch (0.64 mm)
High-pressure piston-to-cylinder clearance	Minimum 0.004 inch (0.10 mm); Maximum 0.006 inch (0.15 mm); Condemnable 0.009 inch (0.23 mm)
High-pressure cylinder ring side clearance	Minimum 0.002 inch (0.05 mm)
High-pressure cylinder ring gap	Minimum 0.015 inch (0.38 mm)
Main bearing end clearance	No adjustment
Connecting rod to crankshaft clearance	Minimum 0.0015 inch (0.038 mm) Condemnable 0.006 inch (0.15 mm)
Piston pin-to-connecting rod clearance	Minimum 0.003 inch (0.08 mm) Condemnable 0.007 inch (0.18 mm)
Oil pump bearing end clearance	Minimum 0.010 inch (0.25 mm)
Oil pump body clearance in crankcase	Minimum 0.002 inch (0.05 mm) Condemnable 0.006 inch (0.15 mm)
Valve lift	Maximum 0.081 inch (2.06 mm) Minimum 0.072 inch (1.83 mm)
Valve thickness	Minimum 0.046 inch (1.17 mm) Condemnable 0.038 inch (0.97 mm)

4-8. AIR COMPRESSOR (cont)

ASSEMBLY

WARNING

Heated parts may cause injury to personnel if hand protection is not worn when handling. Wear protective gloves for maximum protection.

59. Install main ball bearing (118) on an induction heater and heat to 250°F (121°C).
60. Remove main ball bearing (118) from induction heater and install on crankshaft (115).

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

61. Use a suitable lifting device and slowly lower crankshaft (115) into crankcase (116). Check that main ball bearing (118) is firmly seated.
62. Install main ball bearing (117) on an induction heater and heat to 250°F (121 °C).
63. Remove main ball bearing (117) from induction heater and install on crankshaft (115).
64. Coat gasket (114) with grease and install on main bearing housing (113).
65. Install main bearing housing (113) and nuts (112). Tighten nuts evenly and pull main bearing housing in place.
66. Turn crankshaft (115) and check that main ball bearings (118) and (117) turn freely. If crankshaft does not turn freely, use a hammer and lightly tap main bearing housing (113) near oil seal bore to relieve tension.

NOTE

Oil seals are presoaked and wrapped in an airtight paper when received from the manufacturer. However, if the oil seals have been stored for a considerable length of time, they may be dry and should be resoaked in oil for a period of 12 hours before installation.

67. Install oil seals (120) and (119).

4-8. AIR COMPRESSOR (cont)

ASSEMBLY (cont)

68. Install oil strainer screen (110) into oil strainer body (108) and secure with retainer ring (109).
69. Install oil pump housing (105) into crankcase (116).
70. Install assembled oil strainer body (108) and secure with capscrew (106).
71. Install oil pump plunger (104) in oil pump housing (105) and around crankshaft (115).
72. Install cap (103) on crankshaft (115) and secure with four bolts (101), nuts (102), and cotter pins (100). Refer to table D-1 for torque values.
73. Install key (111).
74. Install two upper bearings (92) on connecting rods (98).
75. Install pistons (90), and (91) on connecting rods (98).
76. Install two piston pins (97) into connecting rods (98) and pistons (90) and (91) and secure with four snap rings (96).
77. Install four piston rings (94) on piston (90) and four piston rings (95) on piston (91).

NOTE

Check that punch marks are aligned when installing heads and cylinders.

78. Install gasket (86), high-pressure cylinder (85), and six nuts (84). Tighten nuts evenly and pull high-pressure cylinder in place.
79. Install gasket (83), low-pressure cylinder (82), and six nuts (81). Tighten nuts evenly and pull low-pressure cylinder in place.
80. Use oil and lubricate crankshaft journal throw, cylinder walls, connecting rod bearings, piston rings, and piston pins.
81. Stagger piston ring gap and install piston (91) in high-pressure cylinder (85).
82. Stagger piston ring gap and install piston (90) in low-pressure cylinder (82).
83. Install two upper bearings (92) and lower bearings (93).
84. Install four bolts (99), two connecting rod caps (89), and four castle nuts (88). Tighten nuts to 125 ± 50 lb-ft (170 ± 68 N.m) and align castle nut with holes in bolts, and secure with four cotter pins (87). Refer to table 4-1 and check ring gap and cylinder-to-piston clearance.

4-8. AIR COMPRESSOR (cont)

ASSEMBLY (cont)

85. Install gasket (80) and high-pressure cylinder head (78). Install high-pressure cylinder head and secure with six nuts (79). Tighten nuts evenly and pull high-pressure cylinder head in place. Refer to table D-1 for torque specifications.
86. Install gasket (77) on low-pressure cylinder head (75). Install low-pressure cylinder head and secure with nuts (76). Tighten nuts evenly and pull low-pressure cylinder head in place. Refer to table D-1 for torque specifications.
87. Install three discharge valves (74), valve plugs (73), and unloader capnuts (72).
88. Install three inlet valves (71), unloader valve plugs (70), unloaders (69), brass spacers (68), and unloader capnuts (67).
89. Install unloader pipe fittings (64), (65), and (66).
90. Install unloader tubes (62) and (63).
91. Install oil pressure tubing (58) and secure with two capscrews (57).
92. Install pulley (47) on flange (46) and secure with four bolts (45), spacers (44), and nuts (43).
93. Install coupling flange assembly (42), nut (41), and cotter pin (40).
94. Install EI safety valve (39).
95. Install gasket flange (38), spacer (37), and gasket flange (36).
96. Install gasket flange (35), spacer (34), and gasket flange (33).
97. Install two gaskets (61) and two side covers (60). Secure with 26 bolts (59).
98. Perform a leak test and check that intercooler (19) does not leak. Replace damaged intercooler.
99. Install bottom flange assembly (31), gasket (32), 16 lockwashers (30), nuts (29), and bolts (28).
100. Install top flange assembly (26), gasket (27), 16 lockwashers (25), nuts (24), and bolts (23).
101. Install 12 lockwashers (21), bolts (20), and outer core assembly (22).
102. Install items (19) thru (32) and secure with two lockwashers (17), bolts (16), two spacers (18), and eight nuts (15).

4-8. AIR COMPRESSOR (cont)

ASSEMBLY (cont)

103. Install dipstick (55), oil pressure gauge (54), and crankcase breather (53).
104. Install gasket flange (52), intake tube (51), rubber gasket (50), and intake strainer (49) and secure with two bolts (48).
105. Install gasket flange (14), discharge flange (13), and four locknuts (12).
106. Install air baffle (11), cooling fan (8), nut (7), and cotter pin (6) and secure with eight lockwashers (10) and bolts (9).
107. Install extension (5) and discharge elbow (4).
108. Install fan guard (3) and secure with 12 lockwashers (2) and capscrews (1).
109. Refer to paragraph 3-44 and install and align air compressor.
110. Fill crankcase with oil and install filler plug (43).

TEST

CAUTION

When performing orifice test, check that oil pressure is never less than 15 psi (103 kPa). Damage to air compressor can result.

111. Perform an orifice test by the following:
 - a. Connect an orifice holder with 17/64-inch (6.7 mm) orifice in air reservoir drain cock. Use orifice with square edges bored through plate 1/16 inch (1.6 mm) thick.
 - b. Start engine and run until it is at normal operating temperature.
 - c. Close outlet valve from reservoirs and open drain cock. Leave drain cock open for all tests.
 - d. Run air compressor at least 2 minutes at low speed (table 4-2) and take a pressure reading. Record air compressor speed (rpm) and corresponding pressure.
 - e. Run air compressor at least 2 minutes at high speed (table 4-2) and take a pressure reading. Record air compressor speed (rpm) and corresponding pressure.
 - f. Run air compressor 15 minutes (drain cock open) and repeat steps d and e.
 - g. Use table 4-3 and compare speed-pressure readings.

4-8. AIR COMPRESSOR (cont)

TEST (cont)

112. Apply air pressure to EI safety valve (39) of intercooler (19) and check that intercooler safety valve opens at 60 psi (414 kPa). Replace damaged intercooler safety valve.
113. Apply air to unloading valves (69) and (74) and check that unloading valves open at 130 psi (910 kPa) and close at 140 psi (896 kPa). If unloading valves do not open and close at specified psi, refer to paragraph 3-45 and adjust air compressor governor.
114. Apply air pressure to main reservoir safety valve and check that main reservoir safety valve opens at 150 psi (1034 kPa). Adjust main reservoir safety valve by turning regulating nut. Replace damaged main reservoir safety valve.
115. Inspect tested air compressor by the following:
- a. Check that oil has not escaped through crankcase breather or dipstick opening. If oil has spilled out, replace oil seals or crankcase breather.
 - b. Remove valve assemblies and check that there are no broken springs or cut or broken valves. Check that there is no scoring.

NOTE

If pistons, cylinders, rings, piston pins, connecting rods, or bearings are replaced, orifice test must be repeated.

- c. Remove cylinder heads and inspect cylinder walls. Check that there is no scoring.

4-9. ENGINE ASSEMBLY

This task covers:

a. Removal

b. Installation

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

Material/Parts

Drycleaning solvent (Item 30, Appendix B)

Personnel Required

3

Equipment Condition

Reference

Para 3-7

Condition Description

Engine hood removed

REMOVAL

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury.

NOTE

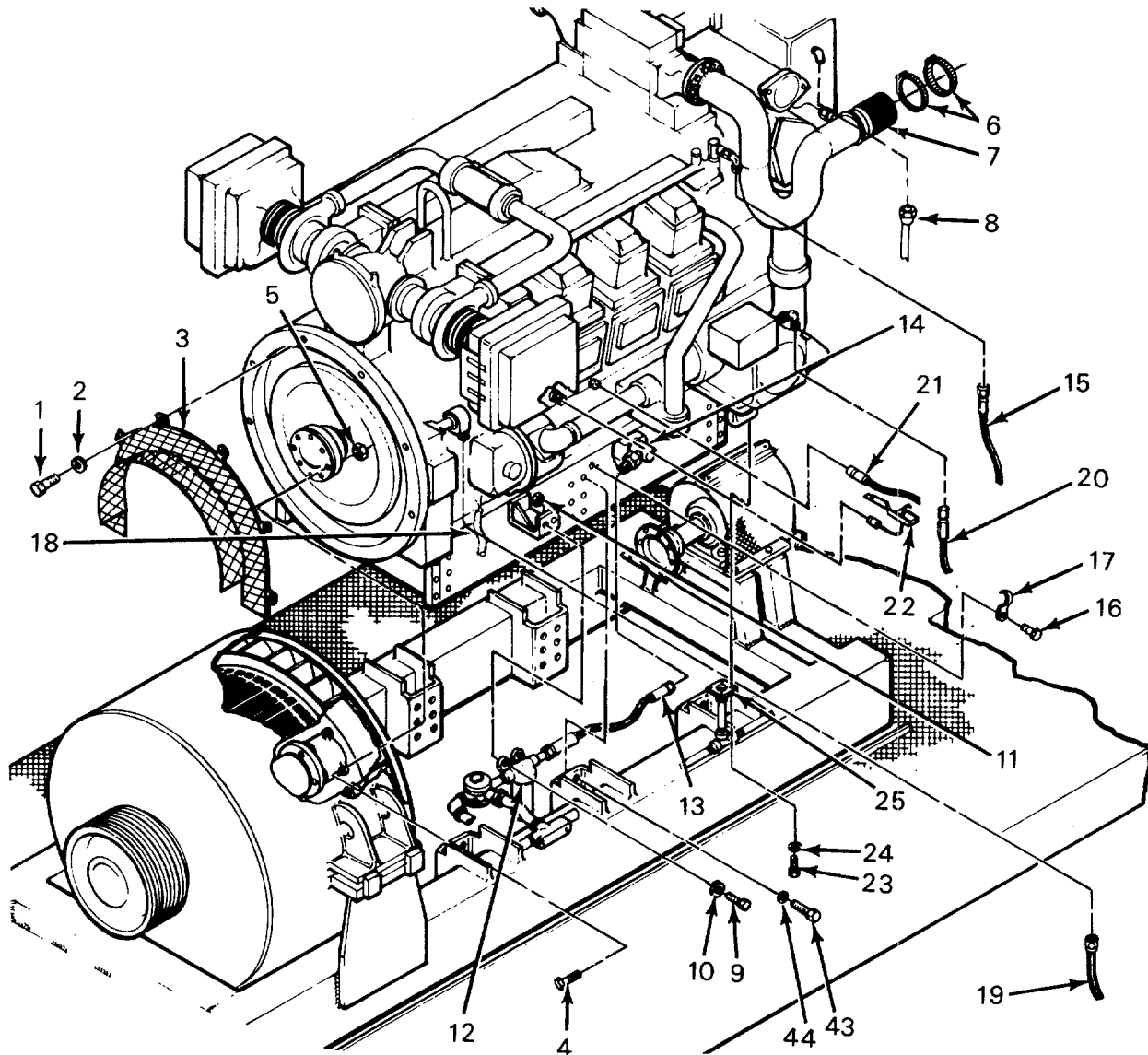
- Before removing diesel engine, check that water and oil have been drained and battery switch is in the OPEN position.
- When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

1. Prepare right side (engineer side) of diesel engine for removal by the following:
 - a. Remove six bolts (1), lockwashers (2), and engine coupling shroud (3).
 - b. Use a punch and punch-mark main generator to flywheel. Remove four bolts (4) and nuts (5).
 - c. Remove two radiator pipe clamps (6) and hose (7).
 - d. Remove radiator vent line (8).

4-9. ENGINE ASSEMBLY (cont)

REMOVAL (cont)

- e. Remove two bolts (9), lockwashers (10), nuts (11), and fuel filter canister (12).

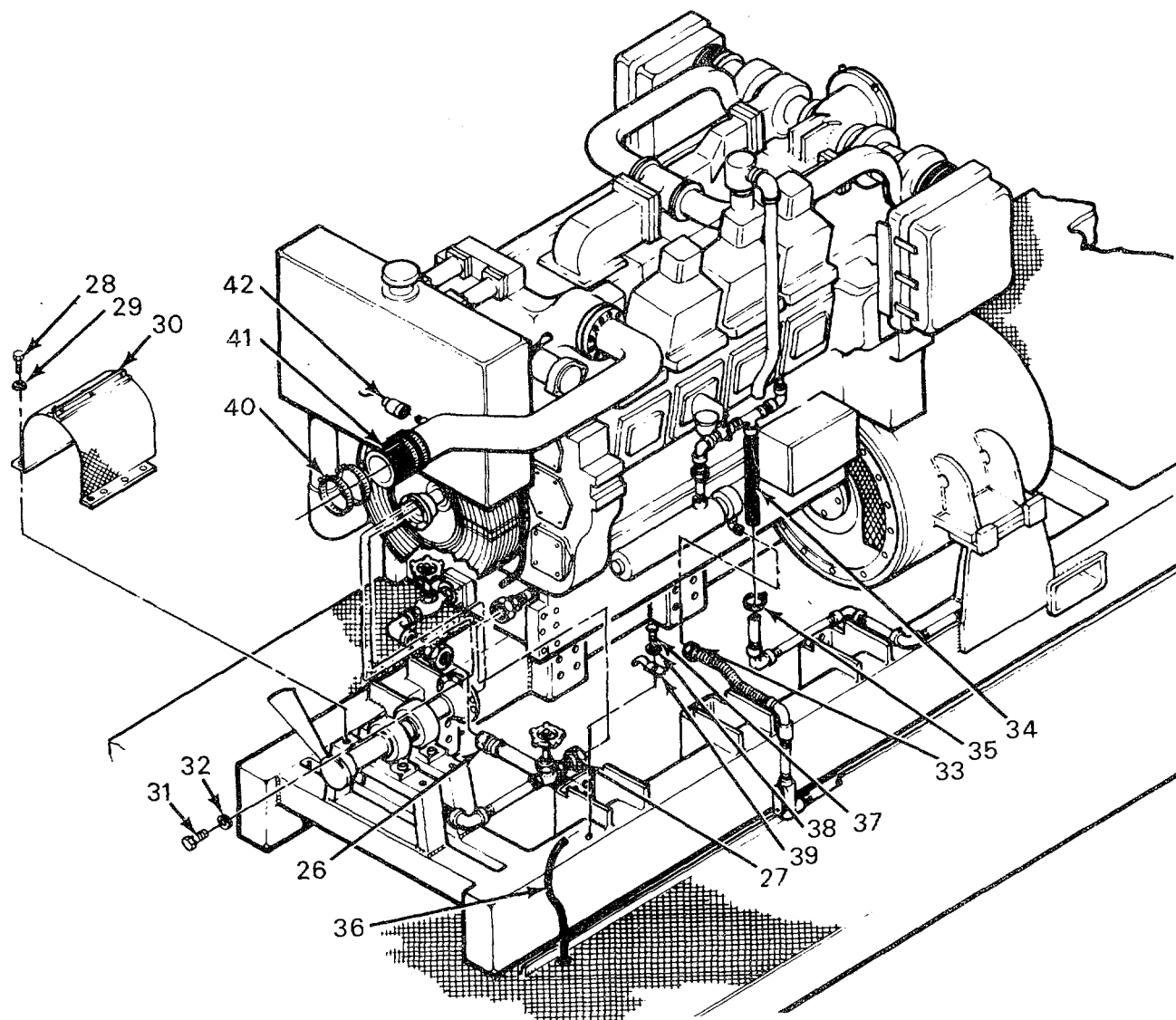


- f. Disconnect fuel line (13) from fuel transfer pump (14).
- g. Disconnect injector fuel return line hose (15). Remove bolt (16) and clamp (17).
- h. Tag and disconnect emergency fuel shutdown harness (18).
- i. Disconnect water pump drain pipe (19).
- j. Disconnect air control line (20).
- k. Disconnect oil pressure safety switch (21).

4-9. ENGINE ASSEMBLY (cont)

REMOVAL (cont)

- I. Disconnect oil pressure warning switch (22).
- m. Remove four bolts (23) and washers (24) from pump housing (25).
2. Prepare left side (fireman side) of diesel engine for removal by the following:
 - a. Disconnect oil pan drain hose (26).
 - b. Disconnect engine heater drain valve (27).
 - c. Remove four shroud mount bolts (28) and lockwashers (29). Remove shroud (30).
 - d. Remove eight coupler bolts (31) and lockwashers (32).



4-9. ENGINE ASSEMBLY (cont)

REMOVAL (cont)

- e. Disconnect engine heater harness (33).
 - f. Remove clamp (35) and disconnect cab heater hose (34).
 - g. Disconnect radiator overflow hose (36). Remove bolt (37), lockwasher (38), and clamp (39).
 - h. Remove two clamps (40) and radiator hose (41).
 - i. Disconnect two temperature sending units (42).
3. Remove 28 engine mount bolts (43) and washers (44) from left and right sides of engine skid.
 4. Station a person on each side of locomotive to observe lifting operation and to check that no binding occurs. Use taglines to steady engine.

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures indicated lifting devices, and/or assistance from other personnel to avoid injury.

NOTE

The engine has its own lifting eyes.

5. Use a suitable lifting device and lift diesel engine from locomotive. Lower to ground and set on a suitable support device.
6. Refer to TM 5-2815-232-14 for disassembly, repair, and assembly of diesel engine.

INSTALLATION

7. Station a person on each side of locomotive to observe installation operation and to check that no binding occurs, use taglines to steady engine.

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures indicated lifting devices, and/or assistance from other personnel to avoid injury.

CAUTION

Care should be taken when lifting engine to prevent damage to other components.

8. Use a suitable lifting device and lift diesel engine above locomotive. Slowly lower to deck.

4-9. ENGINE ASSEMBLY (cont)

INSTALLATION (cont)

9. Install 28 engine mount bolts (43) and washers (44) to left and right sides of engine skid.
10. Install left side (fireman side) of diesel engine by the following:
 - a. Install radiator hose (41) and two clamps (40).
 - b. Connect two temperature sending units (42).
 - c. Install clamp (35) and secure cab heater hose (34).
 - d. Connect engine heater harness (33).
 - e. Install eight coupler bolts (31) and lockwashers (32).
 - f. Install shroud (30), four lockwashers (29), and shroud mount bolts (28).
 - g. Connect radiator overflow hose (36). Install clamp (39), lockwasher (38), and bolt (37).
 - h. Connect engine heater drain valve (27).
 - i. Connect oil pan drain hose (26).
11. Install right side (engineer's side) of diesel engine by the following:
 - a. Install four washers (24) and bolts (23) on pump housing (25).
 - b. Connect oil pressure warning switch (22).
 - c. Connect oil pressure safety switch (21).
 - d. Connect air control line (20).
 - e. Connect water pump drain pipe (19).
 - f. Connect emergency fuel shutdown harness (18) and remove tags.
 - g. Connect injector fuel return line hose (15) and install bolt (16) and clamp (17).
 - h. Connect fuel line (13) to fuel transfer pump (14).
 - i. Install fuel filter canister (12), two lockwashers (10), bolts (9), and nuts (11).

4-9. ENGINE ASSEMBLY (cont)

INSTALLATION (cont)

- j. Install radiator vent line (8).
- k. Install hose (7) and two radiator pipe clamps (6).
- l. Aline punch-marks on main generator to flywheel. Install 16 lockwashers (5) and bolts (4).
- m. Install engine coupling shroud (3), six bolts (1), and lockwashers (2).

NOTE

Refer to paragraph 3-36 for alinement procedures for main generator.

INSERT SUBTITLE HERE!

This task covers:

a. Removal

b. Inspection

c. Installation

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

Personnel Required

2

Equipment Condition Reference

Para 3-33
Para 3-40
Para 4-9

Condition Description

Main generator removed
Air compressor removed
Engine removed

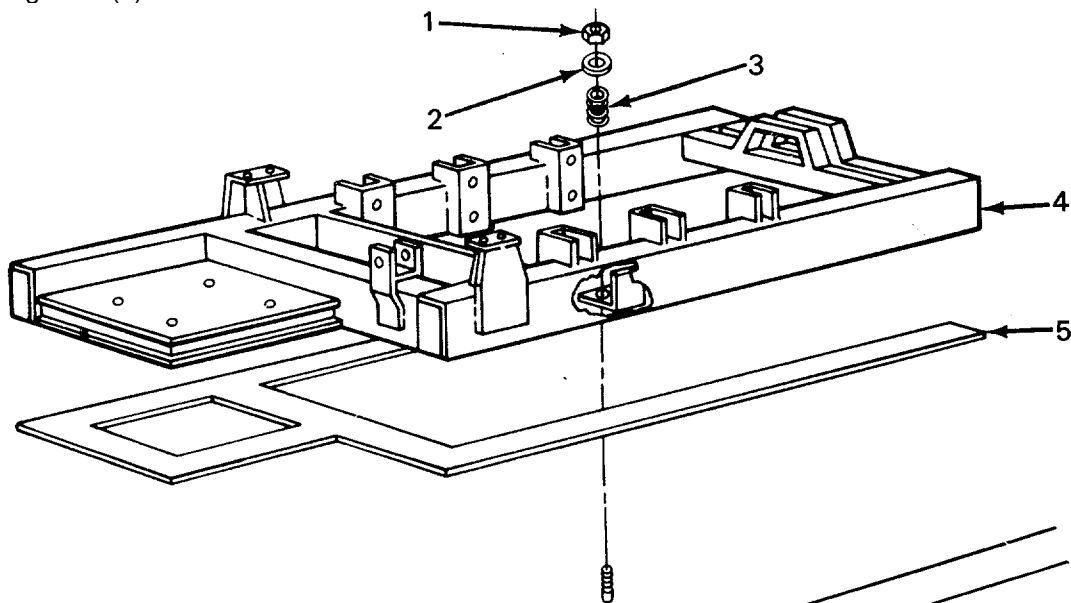
REMOVAL

1. Remove 10 nuts (1), flat washers (2), and springs (3).

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures indicated lifting devices, and/or assistance from other personnel to avoid injury.

2. Check that tie straps and electrical conduit have been disconnected.
3. Attach suitable lifting device to motor mounting frame (4) and remove from locomotive deck.
4. Remove cork gasket (5) from locomotive deck.



4-10. MOTOR MOUNTING FRAME (cont)

INSPECTION

5. Check that springs have not rusted, become distorted, or taken a permanent set. Replace damaged springs.
6. Inspect motor mounting frame (4) for cracks and breaks, and that mounting bolt holes are not out of round.

INSTALLATION

7. Install cork gasket (5) onto locomotive deck.

WARNING

Components of this locomotive are heavy and may be awkward to handle. Use correct lifting procedures indicated lifting devices, and/or assistance from other personnel to avoid injury.

8. Attach a suitable lifting device to motor mounting frame (4) and install motor mounting frame onto deck.
9. Install 10 springs (3) and flat washers (2). Secure with 10 nuts (1).
10. Tighten nuts (1) until spring is compressed to 3/4 inch (19.05 mm).

4-11. AUTOMATIC BRAKE VALVE

This task covers:

- | | | |
|----------------|---------------|-------------|
| a. Disassembly | c. Inspection | e. Assembly |
| b. Cleaning | d. Repair | f. Test |
-

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

Material/Parts

Drycleaning solvent (Item 30, Appendix B)
Pneumatic grease (Item 16, Appendix B)
Emery cloth (Item 4, Appendix B)
Powder graphite (Item 10, Appendix B)
Lubricating oil (Item 19, Appendix B)
Lime-base grease (Item 15, Appendix B)

Equipment Condition Reference

Para 3-46

Condition Description

Automatic brake valve removed

DISASSEMBLY

WARNING

Valve assemblies are under a spring load. Use caution during disassembly procedures so that no parts fly out, causing injury to personnel.

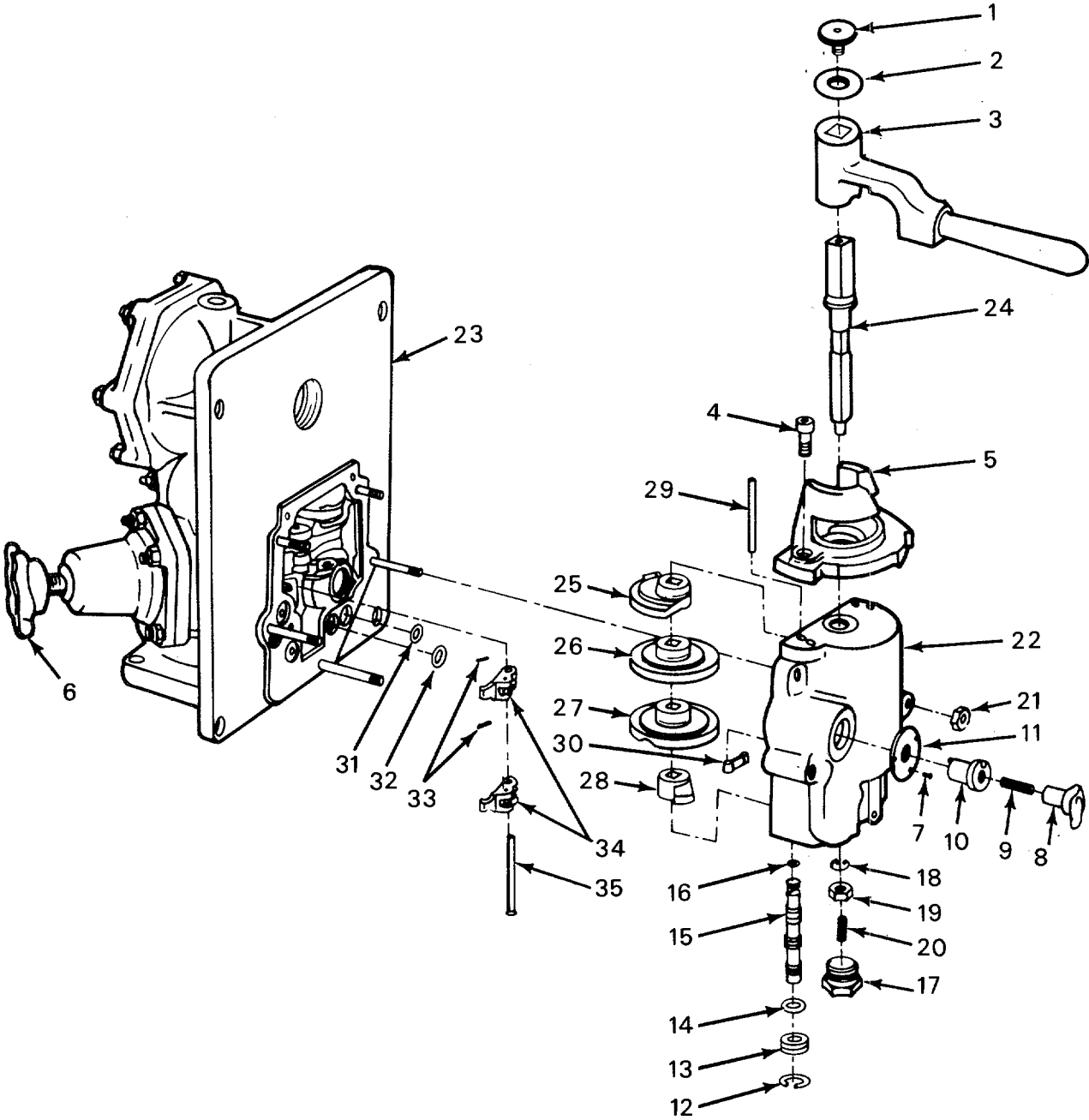
NOTE

When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

1. Place handle (3) in HANDLE-OFF position. Remove retaining socket-head screw (1) and washer (2) and remove handle.
2. Remove two socket-head screws (4) and quadrant (5) from cam housing (22).
3. Turn regulating valve adjusting handle (6) and release tension on adjusting spring (68).

4-11. AUTOMATIC BRAKE VALVE (cont)

DISASSEMBLY (cont)



4. Press cutoff valve control knob (8) to CUT-OUT position and then turn 45 degrees.
5. Remove three screws (7) and return cutoff valve control knob (8) to CUT-OUT position. Remove spring (9), insignia plate (11), and cutoff valve operating shaft (10).
6. Remove retaining ring (12) and remove cutoff pilot valve position selector plug (13). Remove O-ring (14) from plug.

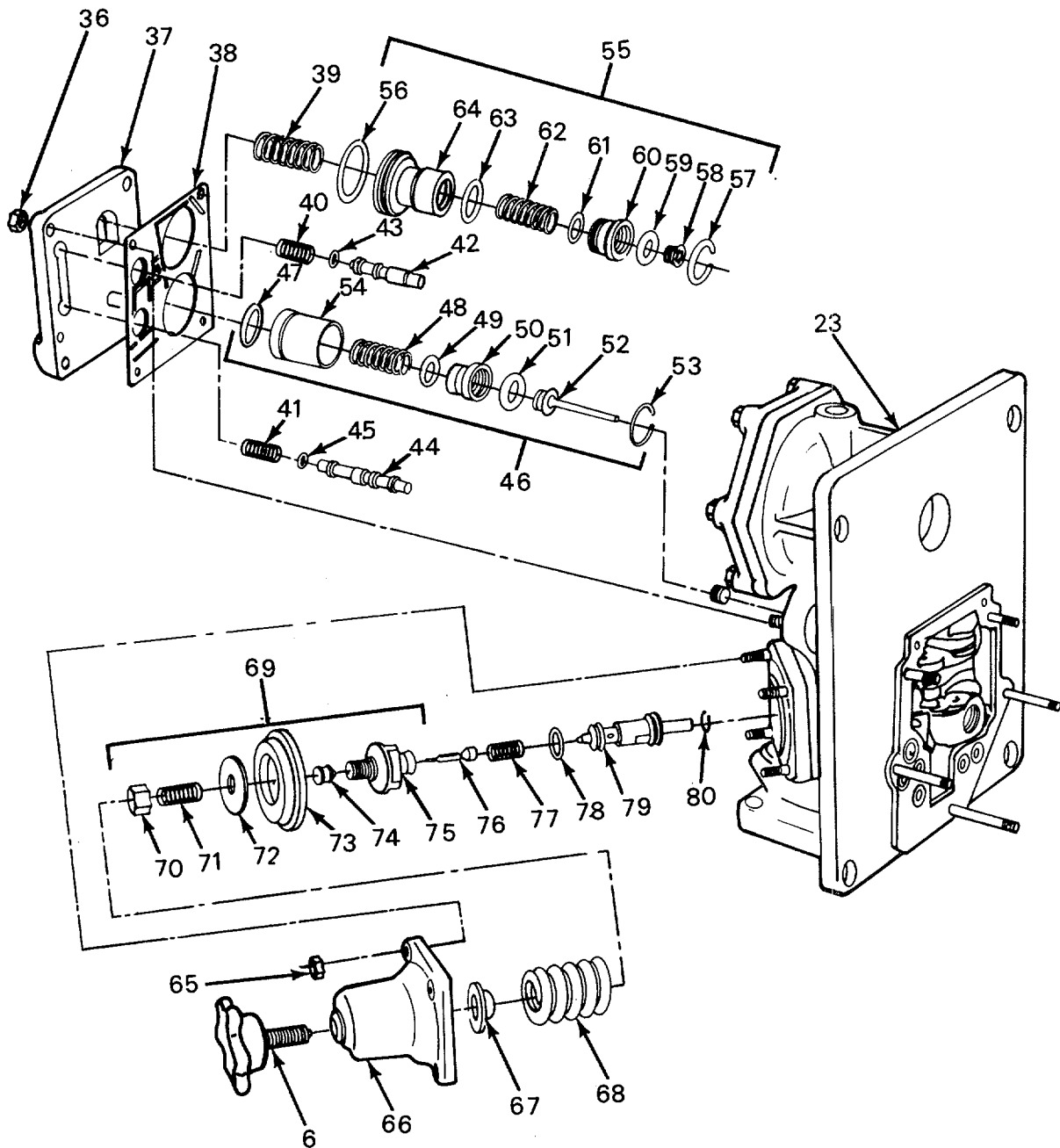
4-11. AUTOMATIC BRAKE VALVE (cont)

DISASSEMBLY (cont)

7. Remove cutoff valve (15). Remove five O-rings (16) from valve.
8. Remove two spillover check valve capnuts (17).
9. Remove two retaining rings (18) by inserting a 1/16-inch (1.6 mm) rod into hole at side of spillover check valve capnuts (17). Press inward on retaining ring and remove retaining rings.
10. Remove two check valves (19) and two springs (20).
11. Remove five nuts (21) and separate cam housing (22) from brake valve body (23).
12. Remove cam shaft (24).
13. Remove emergency valve cam (25), regulating valve cam (26), suppression valve cam (27), and vent valve cam (28).
14. Remove pin (29) and cam dog (30).
15. Remove ring gaskets (31) and (32) from mounting face of brake valve body (23).
16. Remove two cylindrical spring pins (33) and two cam dogs (34) from cam pin (35).
17. Remove four nuts (36), cover (37), and gasket (38).
18. Remove cutoff valve spring (39), emergency valve spring (40), and suppression valve spring (41).
19. Remove emergency valve (42). Remove four O-rings (43) from emergency valve.
20. Remove suppression valve (44). Remove five O-rings (45) from suppression valve.
21. Remove vent valve assembly (46).
22. Disassemble vent valve assembly (46) by removing O-ring (47), retaining ring (53), spring (48), O-ring (49), housing (50), seal (51), and retainer (52) from vent valve cage (54).
23. Remove cutoff valve assembly (55).
24. Disassemble cutoff valve assembly (55) by removing O-ring (56), retaining ring (57), retainer (58), seal (59), housing (60), O-ring (61), spring (62), and O-ring (63) from cutoff valve cage (64).
25. Remove four nuts (65) and regulating valve spring housing (66).
26. Remove spring seat (67) and adjusting spring (68).

4-11. AUTOMATIC BRAKE VALVE (cont)

DISASSEMBLY (cont)

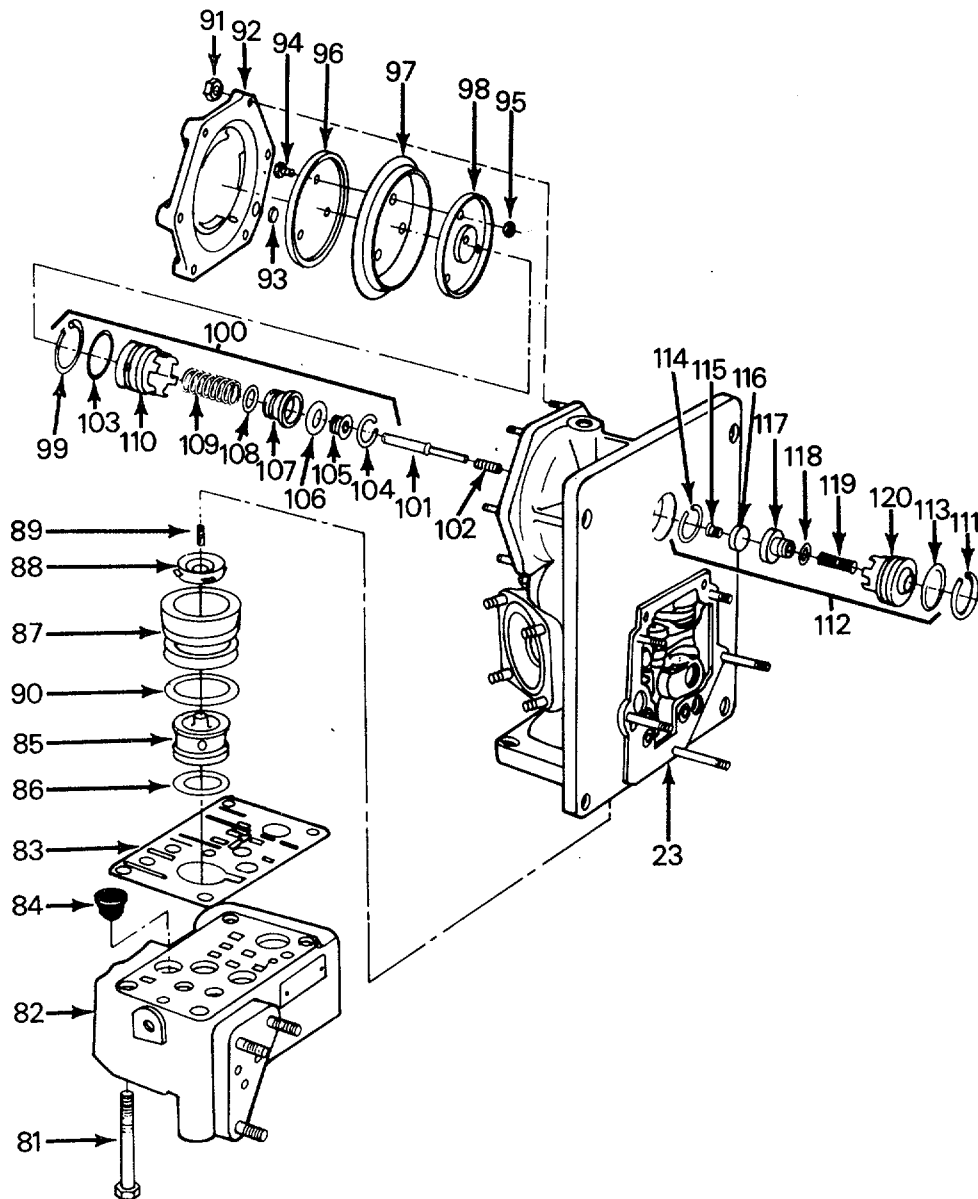


27. Remove exhaust valve assembly (69).
28. Disassemble exhaust valve assembly (69) by removing exhaust valve spring seat (70), spring (71), follower (72), diaphragm (73), spring seat (74), and exhaust valve seat (75).

4-11. AUTOMATIC BRAKE VALVE (cont)

DISASSEMBLY (cont)

29. Remove inlet valve (76) and spring (77). Remove regulating valve inlet valve (78). Remove two O-rings (79) from regulating valve inlet valve.
30. Remove retaining ring (80) from bushing in brake valve body (23).
31. Remove four bolts (81) and separate pipe bracket (82) and gasket (83) from brake valve body (23). Remove two strainers (84).
32. Insert a 10-24 machine screw into equalizer reservoir cutoff valve piston (85) and remove equalizer reservoir cutoff valve piston from brake valve body (23). Remove O-ring (86) from piston.
33. Remove cutoff valve seat (87), check valve (88), and spring (89). Remove two O-rings (90) from cutoff valve seat.



4-11. AUTOMATIC BRAKE VALVE (cont)

DISASSEMBLY (cont)

34. Remove six nuts (91), relay valve cover (92), and gasket (93).

NOTE

Use elongated slot to remove diaphragm.

35. Remove three retaining bolts (94), three nuts (95), upper follower (96), diaphragm (97), and lower follower (98).
36. Remove retaining ring (99), exhaust valve assembly (100), diaphragm stem (101), and spring (102).
37. Disassemble exhaust valve assembly (100) by removing O-ring (103), retaining ring (104), retainer (105), valve seal (106), housing (107), O-ring (108), and spring (109) from exhaust valve cage (110).
38. Remove retaining ring (111).
39. Remove supply valve assembly (112).
40. Disassemble supply valve assembly (112) by removing O-ring (113), retaining ring (114), retainer (115), seal (116), housing (117), O-ring (118), and spring cage (119) from supply valve cage (120).

CLEANING, INSPECTION AND REPAIR

WARNING

Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 138°F (38 59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.

41. Use a cloth dampened with drycleaning solvent and remove grease and oil from exterior of brake valve body and cam housing.

WARNING

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

42. Use drycleaning solvent and clean metal parts. Dry with compressed air.

4-11. AUTOMATIC BRAKE VALVE (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

43. Inspect metal parts for cracks, breaks, cuts, or other damage. Replace damaged parts.
44. Check that springs have not rusted, become distorted, or taken a permanent set. Replace damaged springs.
45. Refinish faces of rubber check valves by lapping on a piece of medium weight emery paper.

WARNING

* Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 138°F (38 59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.

* Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

CAUTION

Do not use metallic tools to clean chokes. The use of metallic tools will change size of chokes, resulting in failure of brake valve system.

NOTE

To avoid misplacement of chokes, remove and replace one choke plug at a time.

46. Clean, inspect, and repair choke plugs by the following:
 - a. Remove choke plugs and place in drycleaning solvent.
 - b. Inspect choke plug passage for cleanliness. Use compressed air and remove foreign matter.
 - c. Remove choke plug from drycleaning solvent and dry with compressed air. Check that choke plug is clean and unrestricted.
 - d. Lightly coat threads of choke plug with compound consisting of one part graphite and two parts oil. Install choke plug.

4-11. AUTOMATICBRAKE VALVE (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

47. Use silicone grease and lubricate O-rings, O-ring grooves in spool valves (15), (44), (54), (64), (76), (78), (88), (110), (120), and bushings into which spool valves enter. Use a clean, lint-free cloth and remove excess lubricant.
48. Lubricate rubber check valves by placing them in a box with dry graphite and shaking the box. Remove check valves. Wipe excess graphite off on a piece of chamois.

CAUTION

Do not lubricate new style emergency and suppression cams and cam dog rollers which have sandblasted surfaces. These must remain clean and dry to retain rolling friction.

49. Lubricate cams and cam dogs with lime base grease.

ASSEMBLY

WARNING

Valve assemblies are under a spring load. Use caution during assembly procedures so that no parts fly out, causing injury to personnel.

50. Assemble supply valve assembly (112) by the following:
 - (a) Install seal (116) into housing (117) and secure with retainer (115).
 - (b) Install O-ring (118) on housing (117).
 - (c) Install housing (117) and spring cage (119) in supply valve cage (120) and secure with retaining ring (114).
 - (d) Install O-ring (113) on supply valve cage (120).
51. Install supply valve assembly (112) in brake valve body (23) and secure with retaining ring (111).
52. Assemble exhaust valve assembly (100) by the following:
 - (a) Install valve seal (106) in housing (107) and secure with retainer (105).
 - (b) Install O-ring (108) on housing (107).
 - (c) Install spring (109) and housing (107) in exhaust valve cage (110) and secure with retaining ring (104).
 - (d) Install O-ring (103) on exhaust valve cage (110).

4-11. AUTOMATIC BRAKE VALVE (cont)

ASSEMBLY (cont)

53. Install diaphragm stem (101) in exhaust valve assembly (100). Install spring (102) on diaphragm stem.
54. Install spring (102), diaphragm stem (101), and exhaust valve assembly (100) in brake valve body (23) and secure with retaining ring (99).
55. Assemble lower follower (98), diaphragm (97), and upper follower (96) and secure with three nuts (95) and three retaining bolts (94). Install into brake valve body (23). Check that ball socket joint of diaphragm stem (101) is in elongated slot of upper follower.
56. Install gasket (93) and relay valve cover (92) and secure with six nuts (91).
57. Install two O-rings (90) on cutoff valve seat (87).
58. Place a small amount of grease on end of spring (89) and install spring in brake valve body (23).
59. Install check valve (88) in cutoff valve seat (87) and install cutoff valve seat in brake valve body (23). Check that spring (89) is in place.
60. Install O-ring (86) on equalizer reservoir cutoff valve piston (85) and install equalizer reservoir cutoff valve piston in cutoff valve seat (87).
61. Place two strainers (84) in pipe bracket (82).
62. Install gasket (83) and pipe bracket (82) on brake valve body (23) and secure with four bolts (81).
63. Install retaining ring (80) in bushing of brake valve body (23).
64. Install two O-rings (79) on regulating valve inlet valve (78).
65. Install regulating valve inlet valve (78), spring (77), and inlet valve (76) in brake valve body (23).
66. Assemble exhaust valve assembly (69) by the following:
 - (a) Install spring seat (74) and spring (71) in exhaust valve seat (75).
 - (b) Install diaphragm (73) and follower (72) on exhaust valve seat (75) and secure with exhaust valve spring seat (70). Tighten exhaust valve spring seat to 40 ± 5 lb-ft (54 ± 7 N.m).
67. Install exhaust valve assembly (69), spring seat (67), and adjusting spring (68) into regulating valve spring housing (66) and secure to brake valve body (23) with four nuts (65).

4-11. AUTOMATIC BRAKE VALVE (cont)

ASSEMBLY (cont)

68. Assemble cutoff valve assembly (55) by the following:
 - (a) Install seal (59) in housing (60) and secure with retainer (58).
 - (b) Install O-ring (61) on housing (60).
 - (c) Install spring (62) and housing (60) in cutoff valve cage (64) and secure with retaining ring (57).
 - (d) Install O-rings (63) and (56) on cutoff valve cage (64).
69. Install cutoff valve assembly (55) in brake valve body (23).
70. Assemble vent valve assembly (46) by the following:
 - (a) Install seal (51) in housing (50) and secure with retainer (52).
 - (b) Install O-ring (49) on housing (50).
 - (c) Install spring (48) and housing (50) in vent valve cage (54) and secure with retaining ring (53).
 - (d) Install O-ring (47) on vent valve cage (54).
71. Install vent valve assembly (46) in brake valve body (23).
72. Install four O-rings (43) on emergency valve (42).
73. Install hardened tip end of emergency valve (42) in brake valve body (23) and press into place.
74. Install five O-rings (45) on suppression valve (44).
75. Install hardened tip end of suppression valve (44) in brake valve body (23) and press into place.
76. Install gasket (38) on brake valve body (23).
77. Install suppression valve spring (41), emergency valve spring (40), and cutoff valve spring (39) on their respective valves.
78. Install cover (37) on brake valve body (23) and secure with four nuts (36).
79. Install one cam dog (34) on cam pin (35) and install cam pin into cam pinhole in brake valve body (23). Press cam pin in until pin extends from upper end of pinhole. Install other cam dog in brake valve body and press cam pin through cam dog. Secure with two cylindrical spring pins (33).
80. Position cam shaft (24) 1 inch (25.4 mm) into cam housing (22).

4-11. AUTOMATIC BRAKE VALVE (cont)

ASSEMBLY (cont)

81. Install emergency valve cam (25), regulating valve cam (26), suppression valve cam (27), and vent valve cam (28) in brake valve body (23). Press cam shaft (24) through cams.
82. Install pin (29) in cam housing (22).
83. Install cam dog (30) in cam housing (22). Press pin (29) through cam dog.
84. Install ring gaskets (32) and (31) into grooves in brake valve body (23).
85. Install quadrant (5) on cam housing (22) and secure with two socket-head screws (4).
86. With brake valve body (23) in vertical position, turn cam shaft (24) in cam housing (22) to HANDLE OFF position. This will permit cam dog (30) to drop into indent in regulating valve cam (26).
87. Secure brake valve body (23) to cam housing (22) with five nuts (21).
88. Install two springs (20) and two check valves (19) into two spillover check valve capnuts (17) and secure with two retaining rings (18).
89. Install two spillover check valve capnuts (17) into cam housing (22).
90. Install five O-rings (16) on cutoff valve (15).
91. With milled slot in cutoff valve (15) facing upward, insert cutoff valve into bottom of cam housing (22) until milled slot is in center of bushing.
92. Install cutoff valve operating shaft (10) into cam housing (22). The eccentric cam of cutoff valve operating shaft must go into milled slot in cutoff valve (15) so that top of cutoff valve operating shaft is flush with insignia plate mounting face of cam housing.
93. Turn slot of cutoff valve operating shaft (10) to line up with any notch on insignia plate mounting face of cam housing (22).
94. Install spring (9) in cutoff valve operating shaft (10).
95. Install insignia plate (11) on cutoff valve control knob (8) and install cutoff valve control knob in cutoff valve operating shaft. Check that cutoff valve control knob locks in position.
96. Secure insignia plate (11) with three screws (7).
97. Check that cutoff valve control knob (8) moves freely. Leave cutoff valve (15) in OUT position.
98. Install O-ring (14) on cutoff pilot valve position selector plug (13).

4-11. AUTOMATIC BRAKE VALVE (cont)

ASSEMBLY (cont)

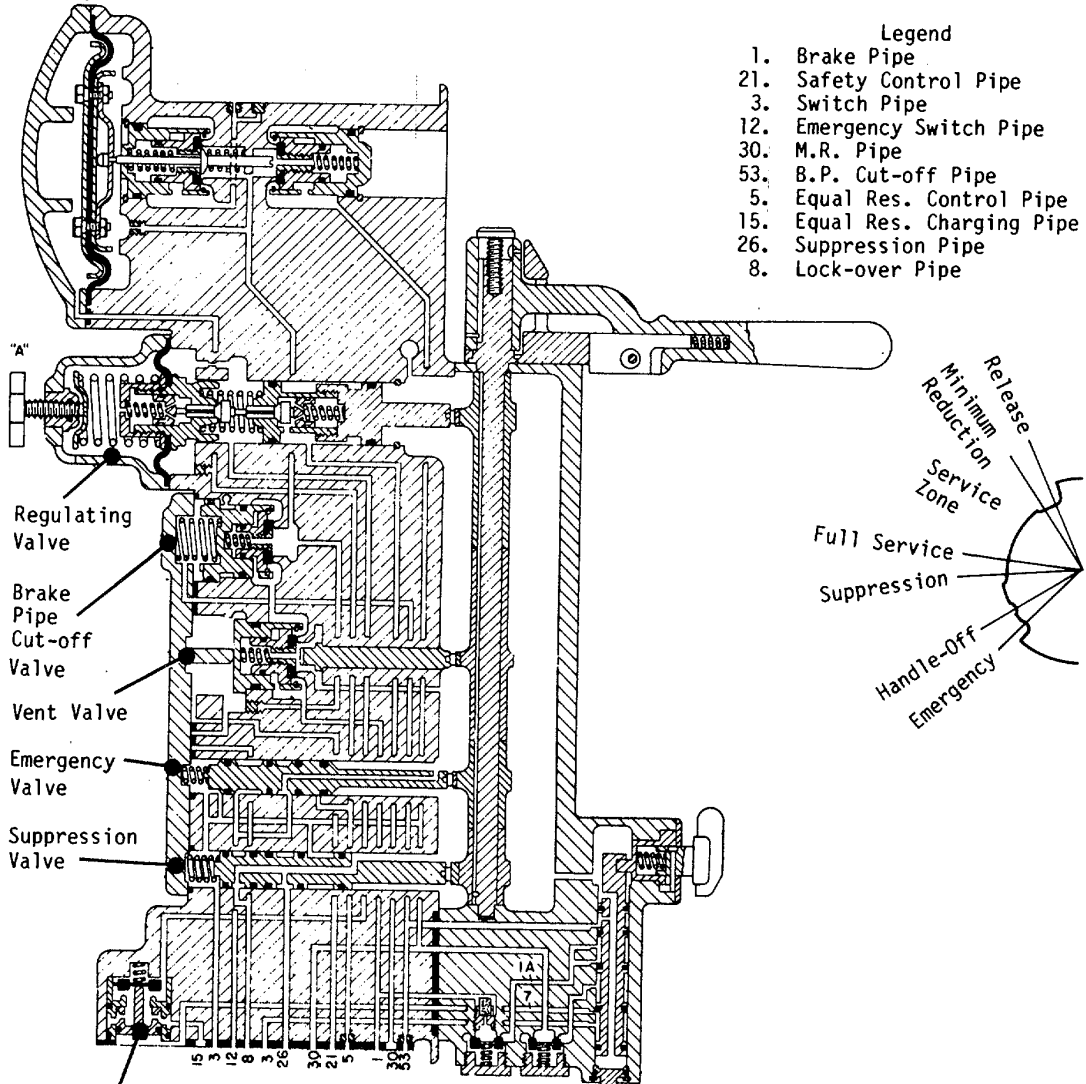
99. Install cutoff pilot valve position selector plug (13) and secure with retaining ring (12). Check that circular projection on one face of cutoff pilot valve position selector plug extends into spool valve chamber.
100. Turn in regulating valve adjusting handle (6).
101. Install handle (3) on cam shaft (24) in HANDLE OFF position and secure with washer (2) and retaining socket-head screw (1) move handle (3) to RELEASE POSITION.

TEST

102. Test the automatic brake valve in accordance with Test Specification T-2646. The automatic brake valve functions as follows:
 - a. RELEASE Position. This is the position of the automatic brake valve for charging the brake pipe and brake system and for releasing an automatic brake application. In this position the valve functions as follows:
 - (1) Main reservoir air enters port 30 and flows as follows:
 - (a) To the supply portion in the relay valve.
 - (b) To the supply portion in the regulating valve.
 - (c) To the spool of the suppression valve, where it is trapped.
 - (d) To the spring chamber of both the emergency valve spool and the suppression valve spool. Air pressure is trapped in the spring chamber of the emergency valve spool.
 - (e) Through the suppression valve spool to passage 3, where it is directed to the spool of the cutoff pilot valve; through the valve to passage 7; and to the underside of the emergency reservoir cutoff pilot valve. Air pressure raises the piston of the valve and unseats it.
 - (f) To spillover check valve A, through the valve, to the spool of the cutoff pilot valve, where it is trapped.
 - (2) Equalizing reservoir air pressure is developed as follows:
 - (a) Regulating valve pressure setting is adjusted by turning adjustment handle A. This opens the supply seat of the valve, and main reservoir air pressure enters the equalizing reservoir charging passage and flows to the equalizing reservoir cutoff valve.
 - (b) Equalizing reservoir air pressure flows through the equalizing reservoir cutoff valve and out port 15.
 - (c) From port 15, equalizing reservoir air pressure flows to the equalizing reservoir, to the air gauges, and to port 5.

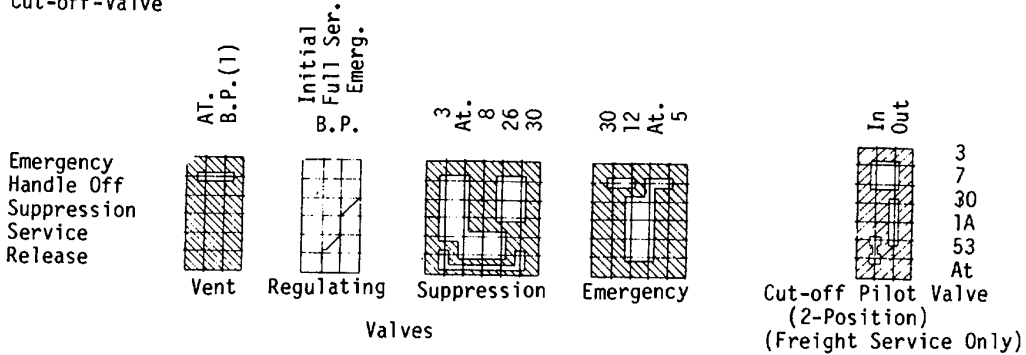
4-11. AUTOMATIC BRAKE VALVE (cont)

TEST (cont)



Equalizing Reservoir Cut-off-Valve

Regulating Valve-Set By Adjustment "A"



4-11. AUTOMATIC BRAKE VALVE (cont)

TEST (cont)

- (d) Equalizing reservoir air pressure is directed through an orifice from the charging passage to the diaphragm of the regulating valve.
 - (e) Through port 5, the equalizing reservoir air pressure is directed to the outer side of the relay valve diaphragm.
- (3) Brake pipe air pressure is developed as follows:
- (a) Equalizing reservoir air pressure on the outer side of the relay valve diaphragm forces the diaphragm and valve stem inward. Inward movement of the valve stem opens the supply valve seat, and main reservoir air enters the brake pipe charging passage.
 - (b) The brake pipe charging pressure flows to the brake pipe cutoff valve, which opens when the charging air pressure is about 25 psi (172 kPa). Air then flows around the sealed vent valve, into the brake pipe passage, and out port 1.
 - (c) Brake pipe charging air pressure is also directed through an orifice to the inner face of the relay valve diaphragm, where it develops a counteracting force to the equalizing reservoir force on the outer face of the diaphragm. When these forces are equal, brake pipe charging cuts off.
 - (d) Brake pipe air pressure is also connected through a passage in the brake valve to spillover check valve B on the bottom of the handle portion, where it is made available to the spool of the cutoff pilot valve in passage 1A.
- (4) Lap position is maintained as follows:
- (a) When the equalizing reservoir charging air pressure in pipe 15 and on the inner face of the regulating valve diaphragm are equal to the adjustment spring tension of the regulator valve, the valve spool moves toward the adjustment spring. This moves the supply valve against its seat and stops charging of the equalizing reservoir. This is self-flapping. If a leak in the equalizing reservoir occurs, the diaphragm pressure weakens and the regulator valve moves to supply and the equalizing reservoir pressure is brought back up to make the adjustment spring tension. This is equalizing reservoir pressure maintaining.
 - (b) Brake pipe charging continues until pressure on the inner face of the relay valve diaphragm matches the pressure of equalizing reservoir control pipe 5 on the outer face of the diaphragm, The valve stem is then drawn back, away from the supply seat, allowing it to close and stop brake pipe charging. The valve self-laps. If a leak in the brake pipe occurs, the pressure on the inner face of the diaphragm weakens and the equalizing reservoir pressure on the outer face of the diaphragm moves the relay valve to supply until the brake pipe pressure once again matches the equalizing reservoir pressure. This is brake pipe pressure maintaining.

4-11. AUTOMATIC BRAKE VALVE (cont)

TEST (cont)

- b. SERVICE Position. As the handle is moved from RELEASE position toward SERVICE position, the brake pipe pressure reduction is gradually increased until in FULL SERVICE position a full service brake pipe reduction is obtained.
 - (1) Equalizing reservoir air pressure reduces as follows:
 - (a) When handle is moved into the SERVICE zone, the regulating valve cam rotates to a lower grind and allows the regulating valve spool to move toward the handle shaft. This action opens the exhaust seat of the regulating valve and weakens the adjustment spring tension.
 - (b) Equalizing reservoir air flows from the equalizing reservoir to the regulating valve exhaust port, through pipe 15 and the equalizing reservoir cutoff valve in the brake valve. The equalizing reservoir pressure will be reduced at a controlled rate as the regulating valve vents. Air pressure on the regulating valve diaphragm will also be reduced at the same rate.
 - (c) Handle movement into the service zone will also rotate suppression valve cam to move suppression valve spool inward to an intermediate position. In this position, passage and port 3 air pressure will be vented through the valve spool. Venting of passage 3 air pressure will result in venting of passage 7, through cutoff pilot valve. Air pressure holding up the check of the equalizing reservoir cutoff valve will be removed and the check will seal. Air pressure from the equalizing reservoir can pass toward the regulating valve to exhaust, allowing graduated exhaust of equalizing reservoir pressure as the brake valve handle is advanced through the service zone. The equalizing reservoir cutoff valve will not allow an increase in equalizing reservoir pressure as the brake valve handle is moved toward release until the handle is returned fully to RELEASE position.
 - (2) Brake pipe air pressure reduces as follows:
 - (a) Pressure reduction in the equalizing reservoir will be felt on the outer side of the relay valve diaphragm. With the inner face of the diaphragm at brake pipe pressure, the pressure difference will force the diaphragm outward, pulling the valve stem with it.
 - (b) The valve stem will open the exhaust seat of the relay valve. Brake pipe air pressure will be vented out relay valve exhaust port, causing a brake pipe pressure reduction at service rate.
 - (c) Brake pipe air pressure will continue to vent until pressure on the inner face of relay valve diaphragm and in the brake pipe balances with the pressure of the equalizing reservoir. Relay valve will then assume lap position.
 - (d) Equalizing reservoir air pressure can be reduced in steps, by handle movement, in about 2-psi (14 kPa) increments until a pressure reduction of 23 to 26 psi (159 to 179 kPa) is attained at FULL SERVICE position.

4-11. AUTOMATIC BRAKE VALVE (cont)

TEST (cont)

- (3) Lap position will be maintained as follows:
 - (a) Reduction of equalizing reservoir air pressure through regulating valve exhaust will continue until pressure on the valve diaphragm balances with the adjusting spring tension which has been weakened by handle cam movement.
 - (b) The valve will then move to close the exhaust seat and assume lap position.
- (4) Release of service brake application functions as follows:
 - (a) Movement of brake handle toward RELEASE position will cause regulating valve cam on the handle to move the regulating valve assembly toward the adjustment spring, increasing the spring tension and opening the supply seat of the valve.
 - (b) Equalizing reservoir charging air pressure will increase at the regulating valve; however, it will not increase in equalizing reservoir charging pipe 15 because the check on the equalizing reservoir cutoff valve remains seated until the brake valve handle is placed in RELEASE position.
- c. SUPPRESSION Position. This portion of the brake handle is provided for reset of a safety control penalty brake application. Although this position is to the right of FULL SERVICE position, no further reduction of equalizing reservoir pressure will be made beyond that already attained at FULL SERVICE.
 - (1) When brake handle is placed in SUPPRESSION position, suppression valve spool will be displaced fully inward by the handle cam.
 - (2) Main reservoir air pressure will be trapped in the spring chamber of the spool and port 3 will continue to be vented.
 - (3) Main reservoir air pressure will be directed to port 26 and suppression pipe port 8; the lock-over pipe will be blocked by the valve spool in suppression position.
 - (4) Air pressure on port 26 is used to suppress the safety control brake application valve, and blocking of port 8 will reset the safety control brake application valve.
- d. HANDLE-OFF Position. This position is provided to allow the brake valve to be cut out when the locomotive is trailing.
 - (1) In HANDLE-OFF position, suppression valve is positioned as it is in SUPPRESSION position. The regulating valve cam, however, is moved to allow the regulating valve spool to move fully away from its adjustment spring tension.
 - (2) If the brake valve handle is placed in HANDLE-OFF position and removed, equalizing reservoir air pressure will be reduced to atmosphere and safety control will be suppressed, allowing the brake valve to be cut out and left unattended.

4-12. INDEPENDENT BRAKE VALVE

This task covers:

- | | | |
|----------------|---------------|-------------|
| a. Disassembly | b. Inspection | e. Assembly |
| b. Cleaning | d. Repair | f. Test |
-

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

Material/Parts

Drycleaning solvent (Item 30, Appendix B)

Equipment Condition

Reference

Para 3-47

Condition Description

Independent brake valve removed

DISASSEMBLY

WARNING

- Valve assemblies are under a spring load. Use caution during disassembly procedures so that no parts fly out, causing injury to personnel.
- Before proceeding to remove the independent brake valve handle, the automatic brake valve handle must be placed in full service position (approximately a 25 psi (172 kPa) brake pipe reduction). Brake cylinder pressure must be applied to the locomotive, and proper procedures followed for cutting out brake operation control on this locomotive. Failure to comply with these instructions may result in locomotive movement which could possibly cause equipment damage and/or injury to personnel.

NOTE

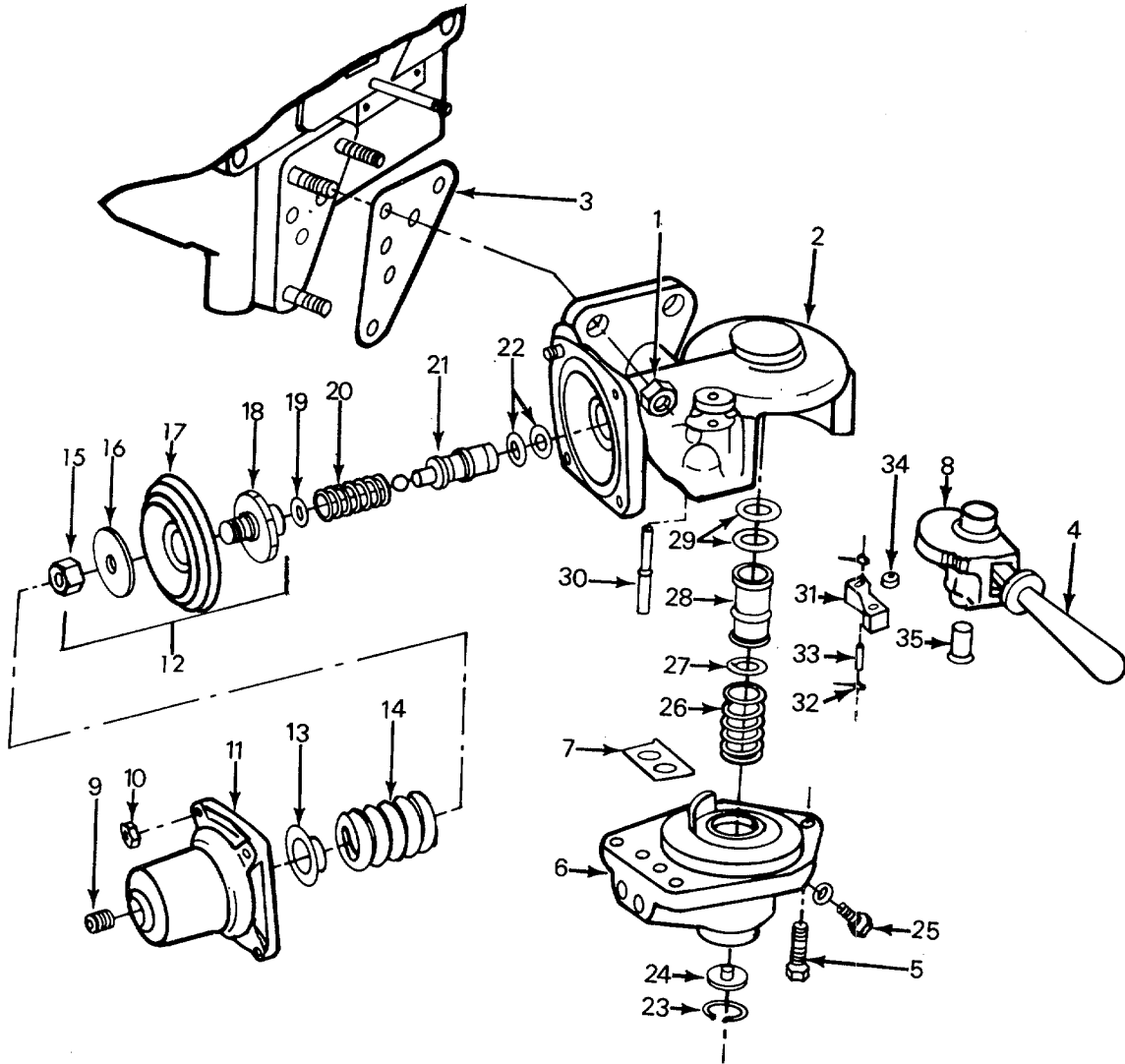
- Before disassembly, check that handle is in RELEASE position.
- When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

1. Remove three nuts (1), valve body (2) and gasket (3).

4-12. INDEPENDENT BRAKE VALVE (cont)

DISASSEMBLY (cont)

- 2. Pull handle retaining pin assembly (25) straight out and remove handle assembly (4).



4-12. INDEPENDENT BRAKE VALVE (cont)

DISASSEMBLY (cont)

3. Remove three screws (5) and separate quick-release valve body (6) from valve body (2). Remove gasket (7).
4. Remove cam (8).
5. Turn adjusting screw (9) counterclockwise and relieve tension on regulating valve spring (14).

WARNING

Valve assemblies are under a spring load. Use caution during disassembly procedures so that no parts fly out, causing injury to personnel.

6. Remove four nuts (10), spring housing (11), exhaust valve seat assembly (12), spring seat (13), and regulating valve spring (14).
7. Disassemble exhaust valve seat assembly (12) by removing nut (15), follower (16), diaphragm (17), exhaust valve seat (18), and O-ring (19).
8. Remove exhaust valve spring (20) from valve body (2).
9. Remove inlet-exhaust valve (21) from valve body (2). Remove two O-rings (22) from inlet-exhaust valve.
10. Remove retainer ring (23), spring seat (24), and handle retaining pin assembly (25) from quick-release valve body (6).
11. Remove quick release spring (26), O-ring (27), and quick-release valve (28). Remove two O-rings (29) from quick release valve.
12. Remove cam dog pin (30) and remove cam dog (31).
13. Remove two cotter pins (32), roller pin (33), and roller (34) from cam dog (31).
14. Remove brake valve push pin (35) from cam (8).

4-12. INDEPENDENT BRAKE VALVE (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 138°F (38 590C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.

15. Use a cloth dampened with drycleaning solvent and remove grease and oil from exterior and interior of body.

WARNING

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

16. Use drycleaning solvent and clean metal parts. Dry with compressed air.
17. Inspect metal parts for cracks, breaks, cuts, or other damage. Replace damaged parts.
18. Check that springs have not rusted, become distorted, or taken a permanent set. Replace damaged springs.
19. Inspect roller (34) and roller pin (33) for flat spots. Replace damaged parts.
20. Inspect handle retaining pin assembly (25) for a broken spring or flat spot on end of pin. Replace damaged parts.
21. Check that roller contact surface on cam (8) and cam contact surface on roller (34) are clean and dry to maintain rolling friction between the two surfaces.
22. Use silicone grease and lubricate O-rings, O-ring grooves in spool valves, and bushings into which spool valves enter. Use a clean, lint-free cloth and remove excess lubricant.

4-12. INDEPENDENT BRAKE VALVE (cont)

ASSEMBLY

WARNING

Valve assemblies are under a spring load. Use caution during assembly procedures so that no parts fly out, causing injury to personnel.

23. Install brake valve push pin (35) in cam (8).
24. Install roller (34) and roller pin (33) in cam dog (31) and secure with two cotter pins (32).
25. Install cam (8) and cam dog (31) in valve body (2) and secure with cam dog pin (30).
26. Install two O-rings (29) and O-ring (27) on quick-release valve (28).
27. Install handle retaining pin assembly (25), spring seat (24), and retainer ring (23) in quick-release valve body (6).
28. Install gasket (7) on valve body (2).
29. Install quick-release valve (28) and quick-release spring (26) on quick-release valve body (6).
30. Install quick-release valve body (6) on valve body (2) and secure with three screws (5).
31. Install two O-rings (22) on inlet-exhaust valve (21).
32. Install inlet-exhaust valve (21) in valve body (2).
33. Install exhaust valve spring (20) over ball end of inlet-exhaust valve (21).
34. Assemble exhaust valve seat assembly (12) by the following:
 - (a) Install O-ring (19) on exhaust valve seat (18).
 - (b) Install exhaust valve seat (18) on diaphragm (17) and follower (16). Secure with nut (15).
35. Install exhaust valve seat assembly (12) in valve body (2). Check that exhaust valve spring (20) is positioned in bore of exhaust valve seat (18).
36. Install regulating valve spring (14) over nut (16).
37. Install spring seat (13) on end of regulating valve spring (14).

4-12. INDEPENDENT BRAKE VALVE (cont)

ASSEMBLY (cont)

38. Install spring housing (11) on valve body (2) and secure with four nuts (10). Turn adjusting screw (9) clockwise.
39. Check that cam (8) is in RELEASE position. Install handle (4) into slot of cam.
40. Pull back on handle retaining pin assembly (25) and check that full travel of handle is into cam. Release handle retaining pin assembly.
41. Install valve body (2) and gasket (3) and secure with three nuts (1).

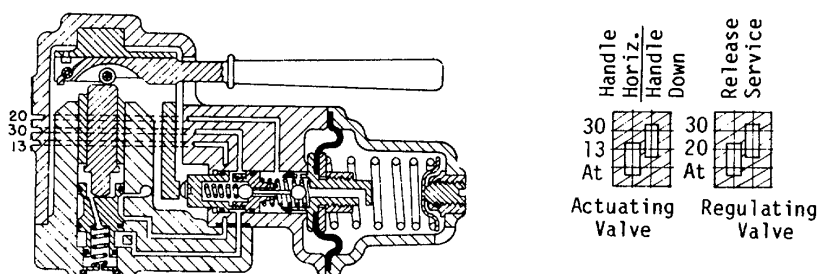
TEST

42. Test the independent brake valve in accordance with Test Specification T-2403. The independent brake valve functions as follows:
 - a. Make adjustment of delivery pressure at the adjusting screw on the control spring housing. If a higher pressure is desired, increase the compression on the spring so that a higher delivery pressure will be required to lap the valve portion. If a lower pressure is desired, decrease the compression on the spring so that a lower delivery pressure will be required to lap the valve portion.
 - b. The independent brake valve shall function as follows:
 - (1) The independent brake valve has two positions: RELEASE and FULL APPLICATION.
 - (2) When the handle is moved from RELEASE position toward FULL APPLICATION position, the valve functions as follows:
 - (a) The valve handle actuates a cam which, in turn, positions a supply and exhaust valve assembly, first to seat the exhaust valve and then to unseat the supply seat.
 - (b) Main reservoir air will flow past the unseated supply valve from port 30 to port 20. Port 20 from the brake valve is connected to port No. 2a on the 6-NFR distributing valve via the No. 24-A double check valve.
 - (c) Pressure developed in port 20 will actuate the relay valve to develop pressure in the brake cylinders. As air pressure develops in port 20, it also develops on the inner face of the diaphragm in the independent brake valve.
 - (d) The buildup of pressure on the diaphragm is opposed by spring pressure on the opposite side; and when the air pressure and spring become balanced, the valve assembly will move to its lap position in which the supply valve becomes seated to terminate further flow of main reservoir air to port 20.

4-12. INDEPENDENT BRAKE VALVE (cont)

TEST (cont)

- (3) Pressing the independent brake handle when the handle is in RELEASE position will cause release of any automatic brake application existing on the locomotive. The valve functions as follows:
- (a) Main reservoir air will flow into port 13 which, in turn, is connected to port 10 of the H-5 relay air valve.
 - (b) When air pressure in port 10 exceeds the strength of the valve return spring, port 11 is connected to 9 and atmosphere.
 - (c) Air in application chamber port 2A is exhausted through port 2 at H-5 relay air valve port 9.
 - (d) Air in the brake cylinder will, in turn, be vented at the 6-NFR distributing valve BC exhaust.
 - (e) Pressing of the independent brake handle with it somewhere in the application zone will release the automatic application only to the value corresponding to the position of the handle in the application zone.



4-13. 6-NFR DISTRIBUTING VALVE

This task covers:

- | | | |
|----------------|---------------|-------------|
| a. Disassembly | b. Inspection | e. Assembly |
| b. Cleaning | d. Repair | f. Test |
-

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12
 Plug gage 56204
 Gage block 5210-00-264-6403
 Micrometer 5120-00-267-3093
 Depth gage 5210-00-619-4045
 Flat gage 5210-00-221-1986
 Marking Pigment (Item 27, Appendix B)
 Lapping compound 1000 grit (Item 7, Appendix B)

Material/Parts

Drycleaning solvent (Item 30, Appendix B)
 Pneumatic grease (Item 16, Appendix B)
 Emery cloth (Item 4, Appendix B)
 Powder graphite (Item 10, Appendix B)
 Lubricating oil (Item 19, Appendix B)
 Triple valve oil (Item 23, Appendix B)

Equipment Condition Reference

Para 3-48

Condition Description

6-NFR distributing valve removed

DISASSEMBLY

WARNING

Valve assemblies are under a spring load. Use caution during disassembly procedures so that no parts fly out, causing injury to personnel.

NOTE

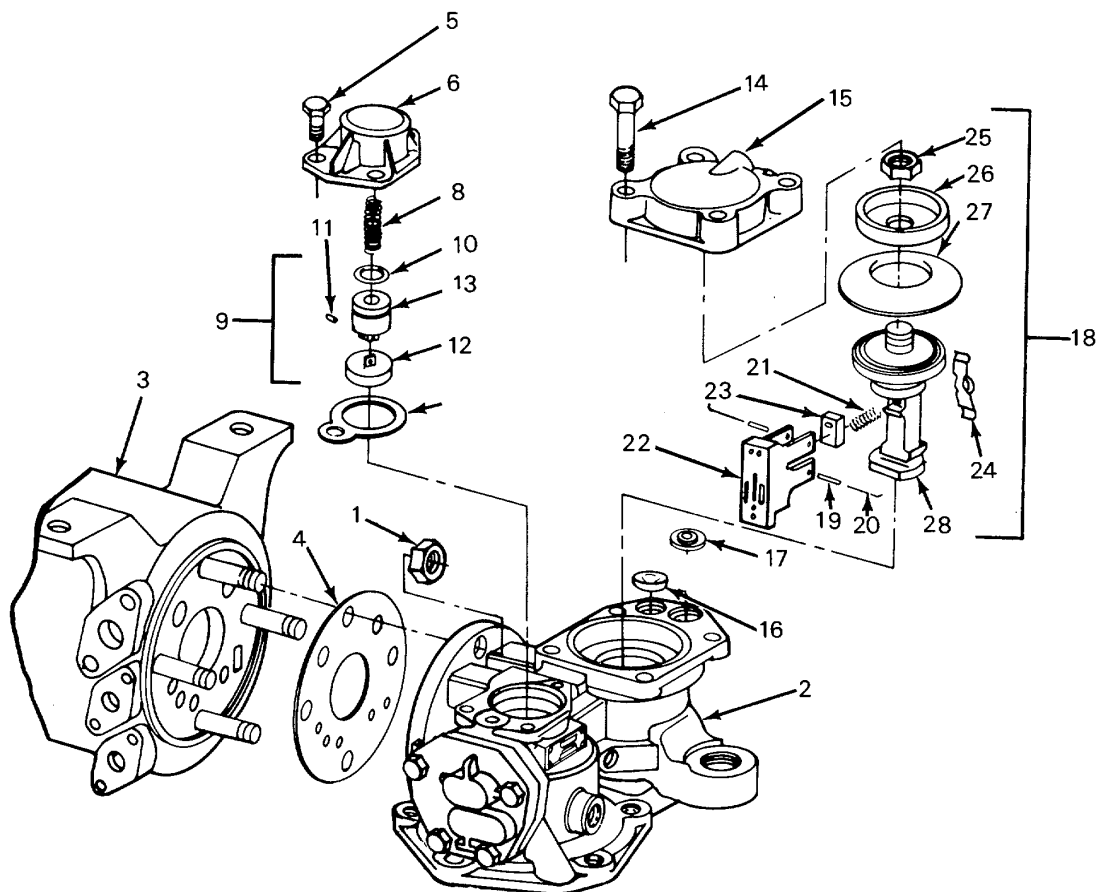
- The 26-NFR distributing valve provides increased sensitivity of brake application and release, ensuring reliability of operation in long, multiple-unit consists, and also acts as a safety valve to limit brake cylinder pressure to required standards, regardless of brake pipe pressure employed.
- When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

1. Remove four nuts (1) and separate body (2) from reservoir (3). Remove gasket (4).
2. Remove three bolts (5), top cover (6), and gasket (7).

4-13. 6-NFR DISTRIBUTING VALVE (cont)

DISASSEMBLY (cont)

3. Remove spring (8).
4. Remove check valve and carrier assembly (9).
5. Disassemble check valve and carrier assembly (9) by removing O-ring (10), pin (11), and check valve (12) from carrier (13).
6. Remove four bolts (14) and remove equalizing piston cover (15) and gaskets (16) and (17).
7. Remove equalizing piston assembly (18).

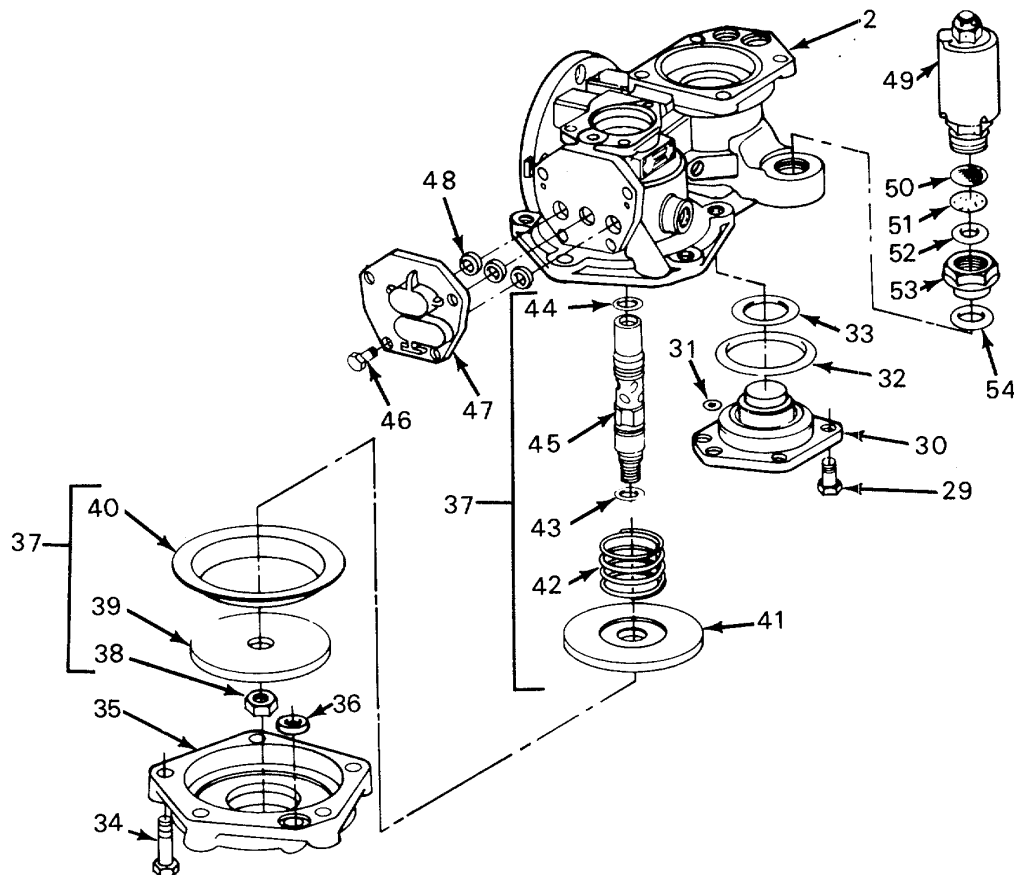


8. Disassemble equalizing piston assembly (18) by the following:
 - a. Remove two lock pins (19), two spring pins (20), spring (21), slide valve (22), graduating valve (23), and spring (24).
 - b. Remove nut (25), follower (26), and diaphragm (27) from piston (28).

4-13. 6-NFR DISTRIBUTING VALVE (cont)

DISASSEMBLY (cont)

9. Remove four bolts (29), slide valve stop (30), gasket (31), O-ring (32), and gasket (33).



10. Remove five bolts (34), bottom cover (35), and gasket (36).

11. Remove large diaphragm piston assembly (37).

12. Disassemble large diaphragm piston assembly (37) by the following:

- a. Remove nut (38), follower (39), diaphragm (40), piston head (41), and piston spring (42).
- b. Remove O-rings (43) and (44) from piston stem (45).

13. Remove four bolts (46), cover (47), and three gaskets (48).

14. Remove safety valve (49), screen (50), strainer (51), gasket (52), adapter (53), and O-ring (54).

4-13. 6-NFR DISTRIBUTING VALVE (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 138°F (38 59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

15. Use a cloth dampened with drycleaning solvent and remove grease and oil from exterior and interior of body.

16. Use drycleaning solvent and clean metal parts. Dry with compressed air.

17. Inspect metal parts for cracks, breaks, cuts, or other damage. Replace damaged parts.

18. Check that springs have not rusted, become distorted, or taken on permanent set. Replace damaged springs.

19. Refinish faces of rubber check valves by lapping on a piece of medium-weight emery paper.

CAUTION

Do not use metallic tools to clean chokes. The use of metallic tools will change size of chokes, resulting in failure of brake valve system.

NOTE

To avoid misplacement of chokes, remove and replace one choke plug at a time.

20. Clean, inspect, and repair choke plugs by the following:

- a. Remove choke plug and place in drycleaning solvent.
- b. Inspect choke plug passage for cleanliness. Use compressed air and remove foreign matter.

4-13. 6-NFR DISTRIBUTING VALVE (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

- c. Remove choke plug from drycleaning solvent and dry with compressed air. Check that choke plug is clean and unrestricted.
 - d. Lightly coat threads of choke plug with compound consisting of one part graphite and two parts oil and install.
21. Clean, inspect, and repair slide valve bushing by the following:
- a. Check that slide valve bushing is not scratched or scored.
 - b. Use plug gage and check depth of seat.
 - c. If slide valve seat is scratched or scored, use lapping compound and recondition.
 - d. Use Prussian blue and gage blocks and inspect for low spots on bearing surface.
 - e. Remove burrs from slide valve seat and regage.
 - f. Use a depth gage and measure clearance groove. If it is less than 0.005 inch (0.13 mm) deep, use a hacksaw blade and recut. Do not cut deeper than 0.020 inch (0.51 mm).
22. Clean, inspect, and repair slide valve and graduating valve by the following:
- a. Check that valves are not scratched, scored, or damaged. Replace damaged valves.
 - b. Use a micrometer and measure slide valve thickness from the bottom of the graduating valve seat. Replace slide valve if thickness is less than 0.549 inch (13.94 mm).
 - c. Use a depth gage and measure depth of 1/8-inch (3.2 mm) slots in slide valve. Replace slide valve if depth of slots is greater than 0.093 inch (2.36 mm).
 - d. Use flat gage and gauge thickness of graduating valve.
 - e. If graduating valve is within gage limits, use lapping compound and lap slide valves to slide valve seat by the following:
 - (1) Condition the valve by rubbing slide valve against seat several times with lapping compound. Remove burrs and rough surface marks.

4-13. 6-NFR DISTRIBUTING VALVE (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

WARNING

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

(2) Use compressed air and remove foreign particles from cavities.

(3) Regage graduating valve.

23. Check that piston is not bent. Use a micrometer and measure diameter of two guides on piston. Replace piston if diameter is greater than 1.733 inches (44.02 mm).
24. Use triple valve oil and lubricate slide valve bushing.
25. Use silicone grease and lubricate O-rings, O-ring grooves in piston valves, and bushings into which piston valves enter. Use a clean, lint-free cloth and remove excess lubricant.
26. Lubricate rubber check valves by placing them in a box with dry graphite and shaking the box. Remove check valves. Wipe excess graphite off on a piece of chamois.

ASSEMBLY

WARNING

Valve assemblies are under a spring load. Use caution during assembly procedures so that no parts fly out, causing injury to personnel.

27. Install O-ring (54) on adapter (53).
28. Install adapter (53), gasket (52), strainer (51), screen (50), and safety valve (49) in body (2).
29. Install three gaskets (48) and cover (47) and secure with four bolts (46).
30. Assemble large diaphragm piston assembly (37) by the following:
 - a. Install O-rings (44) and (43) on piston stem (45).
 - b. Install piston spring (42) and piston head (41) on piston stem (45).
 - c. Install diaphragm (40) and follower (39) on piston head (41) and secure with nut (38).

4-13. 6-NFR DISTRIBUTING VALVE (cont)

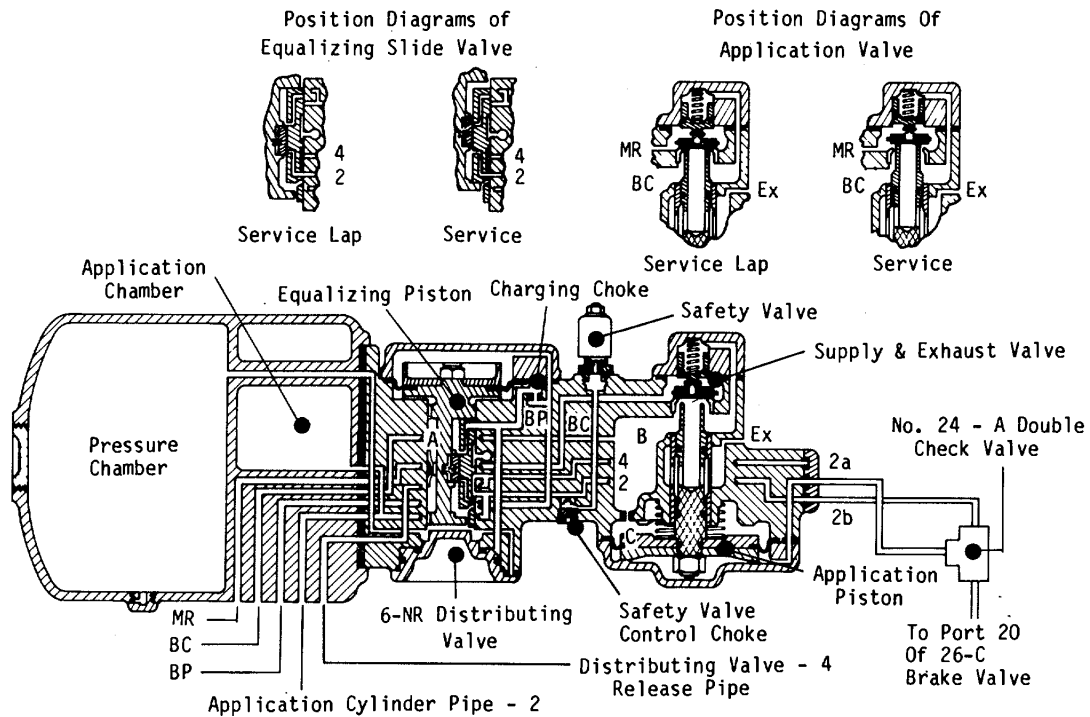
ASSEMBLY (cont)

31. Install large diaphragm piston assembly (37) in body (2).
32. Install gasket (36) and bottom cover (35) and secure with five bolts (34).
33. Install gasket (33), O-ring (32), and gasket (31) on slide valve stop (30).
34. Position slide valve top (30) on body (2) and secure with four bolts (29).
35. Assemble equalizing piston assembly (18) by the following:
 - a. Install diaphragm (27) and follower (26) on piston (28) and secure with nut (25). Tighten nut to 30 lb-ft (40 N.m) of torque.
 - b. Install graduating valve (23) on slide valve (22) and install spring (24) in recess of graduating valve.
 - c. Install piston (28) on slide valve (22). Check that spring (24) enters recess of piston stem.
 - d. While holding slide valve (22) in position on piston (28), install spring (21) on stem of piston. Secure with two spring pins (20) and lock pins (19).
36. Apply one drop triple valve oil to slide valve seat in bushing and one drop to face of slide valve (22). Coat over entire surface with oil.
37. Install equalizing piston assembly (18) into body (2). Check that bead of diaphragm (27) is positioned in recess of body.
38. Install gaskets (17) and (16) and equalizing piston cover (15) and secure with four bolts (14).
39. Assemble check valve and carrier assembly (9) by the following:
 - a. Install check valve (12) on carrier (13) and secure with pin (11).
 - b. Install O-ring (10) on carrier (13).
40. Install check valve and carrier assembly (9) in body (2). Install spring (8) in carrier (13).
41. Install gasket (7) and top cover (6) and secure with three bolts (5),
42. Install body (2) and gasket (4) on reservoir (3) and secure with four nuts (1).

4-13. 6-NFR DISTRIBUTING VALVE (cont)

TEST

43. Test the 6-NFR distributing valve in accordance with Test Specification NYT-460. The 6-NFR distributing valve functions as follows:



- a. During charging and release, the 6-FNR distributing valve functions as follows:
- (1) Brake pipe air flows first to the outer face of the equalizing piston diaphragm, forcing the piston and slide valve to release position.
 - (2) Air in brake pipe flows through charging choke and equalizing slide valve to the pressure chamber, charging it to brake pipe pressure.
 - (3) In this position, equalizing slide valve connects application chamber through release port No. 4 to exhaust.

4-13. 6-NFR DISTRIBUTING VALVE (cont)

TEST (cont)

- (4) Application cylinder on the outer face of application piston is exhausted via passage 2a, through No. 24-A double check valve, passages 26, 2, then 4 in the distributing valve, to exhaust.
 - (5) The release spring holds application piston in release position against application cylinder cover.
 - (6) The inner end of application piston, which is machined to form the exhaust valve seat, is moved away from the rubber supply and exhaust valve to vent the brake cylinder passage.
 - (7) Main reservoir air is constantly present in the chamber and to application cylinder on the outer face of application piston via passage No. 2, 26, No. 24-A double check valve, and passage 2a.
- b. During a service brake application, the 6-NFR distributing valve functions as follows:
- (1) Brake pipe pressure reduces, causing a difference in pressure between brake pipe and pressure chamber.
 - (2) The higher pressure in the pressure chamber and equalizing slide valve chamber causes the equalizing piston and slide valve to move upward to service position where slide valve port connections are made.
 - (3) Upon the first movement toward service position, the graduating valve severs communication between brake pipe and pressure chamber.
 - (4) Communication between pressure chamber and passage 2 is then made, allowing pressure chamber air to flow to application chamber and to application cylinder on outer face of application piston via passages 2 and 26, 24-A double check valve, and passage 2a.
 - (5) Flow of pressure chamber air is continued until pressure has been reduced to slightly below brake pipe pressure on the opposite side of the equalizing piston, at which time the piston and graduating valve are moved to service lap position, terminating further flow of pressure chamber air to passage 2. Maximum pressure in passage 2 is limited by the safety valve, which is connected to passage 2 by the safety valve control choke.
 - (6) Pressure that is developed in passage 2 and the application cylinder on the outer face of the application piston causes the piston to move upward against the force of the release spring, first to seal the exhaust seat against the underside of the supply and exhaust valve, and then to raise this valve from its supply seat to allow main reservoir air to flow to brake cylinder cavity B and passage BC.
 - (7) Brake cylinder air pressure also builds up in chamber C on the inner face of application piston and diaphragm via the stabilizing choke.

4-13. 6-NFR DISTRIBUTING VALVE (cont)

TEST (cont)

- (8) As brake cylinder pressure in chamber C approaches application cylinder pressure on the opposite side of the diaphragm and piston, the application piston is moved downward to allow the supply and exhaust valve to be seated on its supply valve seat to terminate further flow of main reservoir air to the brake cylinder.
- c. During brake release the 6-FNR brake valve functions as follows:
 - (1) An increase in brake pipe pressure moves the equalizing piston and slide valve to release position to connect passage 2 and the application chamber to exhaust at port 4.
 - (2) Reduction of pressure in passage 2 and the application cylinder permits the higher brake cylinder pressure in chamber C to move the piston out of contact with the exhaust valve seat, allowing brake cylinder air to flow through chamber B, past the exhaust valve seat, to atmosphere through the brake cylinder exhaust passage.
 - d. During an emergency application, the 6-NFR distributing valve functions in the same manner as during a service application, with the addition of the following:
 - (1) Main reservoir is connected to port 12 via the brake valve emergency valve.
 - (2) From port 12, main reservoir air flows through check valve and choke fitting to passage 2, past equalizing piston, to the outer face of the application piston via passages 2 and 2b, 24-A double check valve, and passage 2a.
 - (3) Main reservoir pressure will increase to the value of the safety valve setting, where it is maintained by the safety valve control choke and blowdown of the safety valve.
 - (4) Should the brake valve handle be moved out of EMERGENCY position, control pressure in passage 2 is prevented from escaping from vent pipe No. 12 by a check valve. The pipe 12 choke ensures a positive brake release when an emergency brake application is bailed off.
 - e. During the independent brake application, air pressure from passage 20 of the 26-C brake valve flows directly to the outer face of the application piston via 24-A double check valve and passage 2a.

4-14. NO. 8 VENT VALVE

This task covers:

- | | | |
|----------------|---------------|-------------|
| a. Disassembly | b. Inspection | e. Assembly |
| b. Cleaning | d. Repair | f. Test |
-

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12
Pneumatic grease (Item 16, Appendix B)
Triple valve oil (Item 23, Appendix B)
Lapping compound 1000-grit (Item 7, Appendix B)

Material/Parts

Drycleaning solvent (Item 30, Appendix B)

Equipment Condition

Reference

Para 3-49

Condition Description

No. 8 vent valve removed

DISASSEMBLY

WARNING

Valve assemblies are under a spring load. Use caution during disassembly procedures so that no parts fly out, causing injury to personnel.

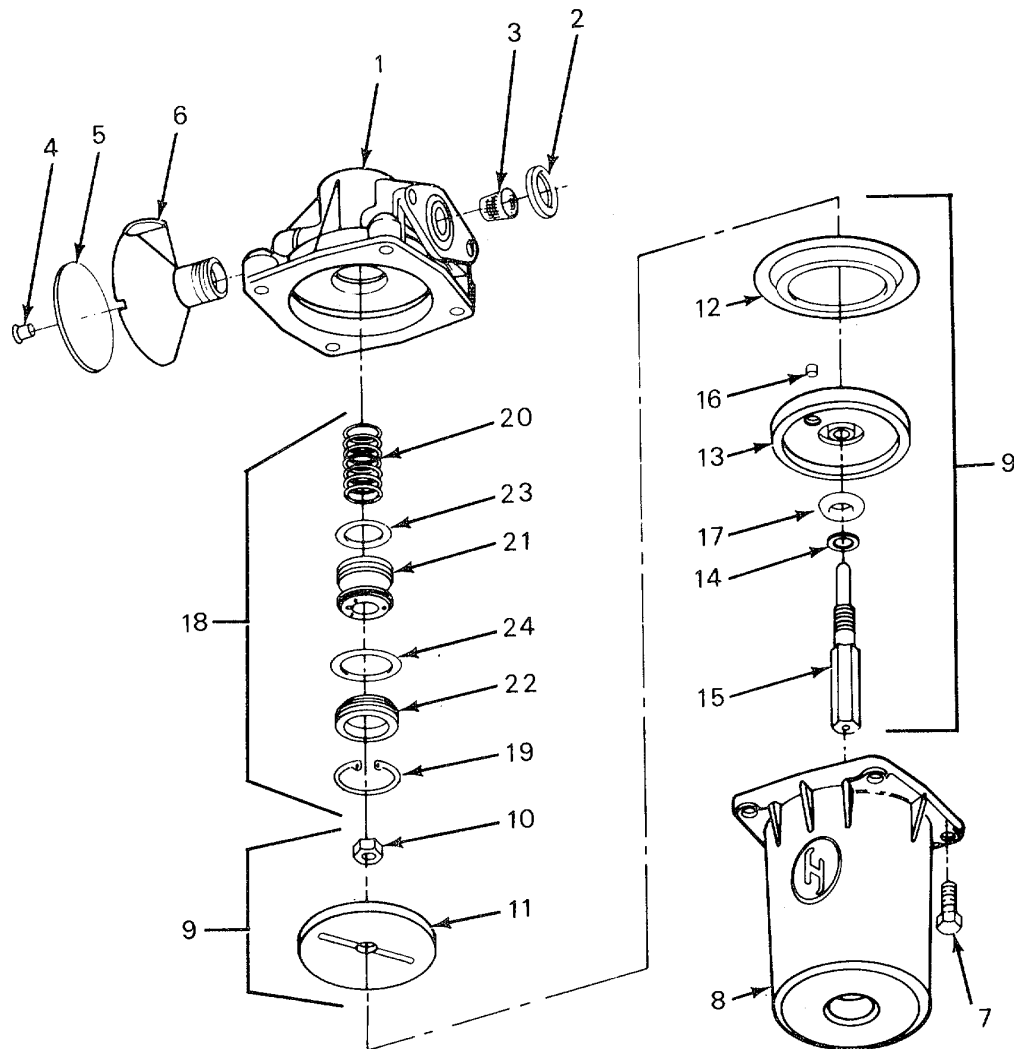
NOTE

When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

1. Remove gasket (2) and strainer (3) from body (1).
2. Remove pop rivet (4), seal (5), and vent protector body (6).
3. Remove four bolts (7) and diaphragm housing (8).
4. Remove piston diaphragm assembly (9).
5. Disassemble piston diaphragm assembly (9) by the following:
 - a. Remove locknut (10), follower (11), diaphragm (12), piston (13), and flat washer (14) from piston stem (15).
 - b. Remove felt (16) and seal (17) from piston (13).
6. Remove exhaust valve assembly (18).

4-14. NO. 8 VENT VALVE (cont)

DISASSEMBLY (cont)



7. Disassemble exhaust valve assembly (18) by the following:
 - a. Compress exhaust valve assembly (18) and remove retaining ring (19).
 - b. Remove spring (20), exhaust valve (21), and exhaust valve seat (22).
 - c. Remove O-ring (23) from exhaust valve (21).
 - d. Remove O-ring (24) from exhaust valve seat (22).

4-14. NO. 8 VENT VALVE (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 138°F (38 59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
8. Use a cloth dampened with drycleaning solvent and remove grease and oil from exterior and interior of body.
 9. Use drycleaning solvent and clean metal parts. Dry with compressed air.
 10. Inspect metal parts for cracks, breaks, cuts, or other damage. Replace damaged parts.
 11. Check that spring is not rusted or distorted or has taken a permanent set. Replace damaged spring.
 12. Check that exhaust valve seat is not scratched or scored. If exhaust valve seat is damaged, recondition by the following:
 - a. Lap exhaust valve seat with lapping compound using a front-to-back motion.
 - b. Use compressed air and remove foreign matter from exhaust valve seat.
 - c. Use a cloth dampened with drycleaning solvent and clean exhaust valve seat.
 13. Check that exhaust valve seal is not cracked or cut. Replace damaged exhaust valve seal.
 14. Use silicone grease and lubricate O-rings, O-ring grooves in spool valves, and bushings into which piston valves enter. Use a clean lint-free cloth and remove excess lubricant.
 15. Use triple valve oil and lubricate piston stem guides.

4-14. NO. 8 VENT VALVE (cont)

ASSEMBLY

WARNING

Valve assemblies are under a spring load. Use caution during assembly procedures so that no parts fly out, causing injury to personnel.

16. Assemble exhaust valve assembly (18) by the following:
 - a. Install O-ring (24) on exhaust valve seat (22).
 - b. Install O-ring (23) on exhaust valve (21).
 - c. Assemble exhaust valve seat (22), exhaust valve (21), and spring (20) and secure with retaining ring (19).
17. Assemble piston diaphragm assembly (9) by the following:
 - a. Install seal (17) and felt (16) in piston (13).
 - b. Install flat washer (14) and piston (13) on piston stem (15). Check that felt (16) is toward threaded end of piston stem.
 - c. Install diaphragm (12) on piston (13). Check that bead of diaphragm is in groove of piston.
 - d. Install follower (11) on diaphragm (12). Check that ribbed side of follower is toward threaded side of piston stem (15).
 - e. Secure with locknut (10).
18. Install exhaust valve assembly (18) in body (1).
19. Install piston diaphragm assembly (9) in diaphragm housing (8). Check that bead of diaphragm is in groove of diaphragm housing.
20. Install body (1) on diaphragm housing (8) and secure with four bolts (7).
21. Install vent protector body (6) and seal (5) and secure with pop rivet (4).
22. Install strainer (3) and gasket (2) in body (1).

TEST

23. Test No. 8 vent valve in accordance with Test Specification T-2720.

4-15. A-1 CHARGING CUTOFF PILOT VALVE

This task covers:

- | | | |
|-----------------------|----------------------|--------------------|
| a. Disassembly | b. Inspection | e. Assembly |
| b. Cleaning | d. Repair | f. Test |
-

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12
Pneumatic grease (Item 16, Appendix B)
Emery cloth (Item 4, Appendix B)
Powder graphite (Item 10, Appendix B)
Lubricating oil (Item 19, Appendix B)

Material/Parts

Drycleaning solvent (Item 30, Appendix B)

Equipment Condition
Reference

Para 3-50

Condition Description

A-1 charging cutoff pilot valve removed

DISASSEMBLY

WARNING

Valve assemblies are under a spring load. Use caution during disassembly procedures so that no parts fly out, causing injury to personnel.

NOTE

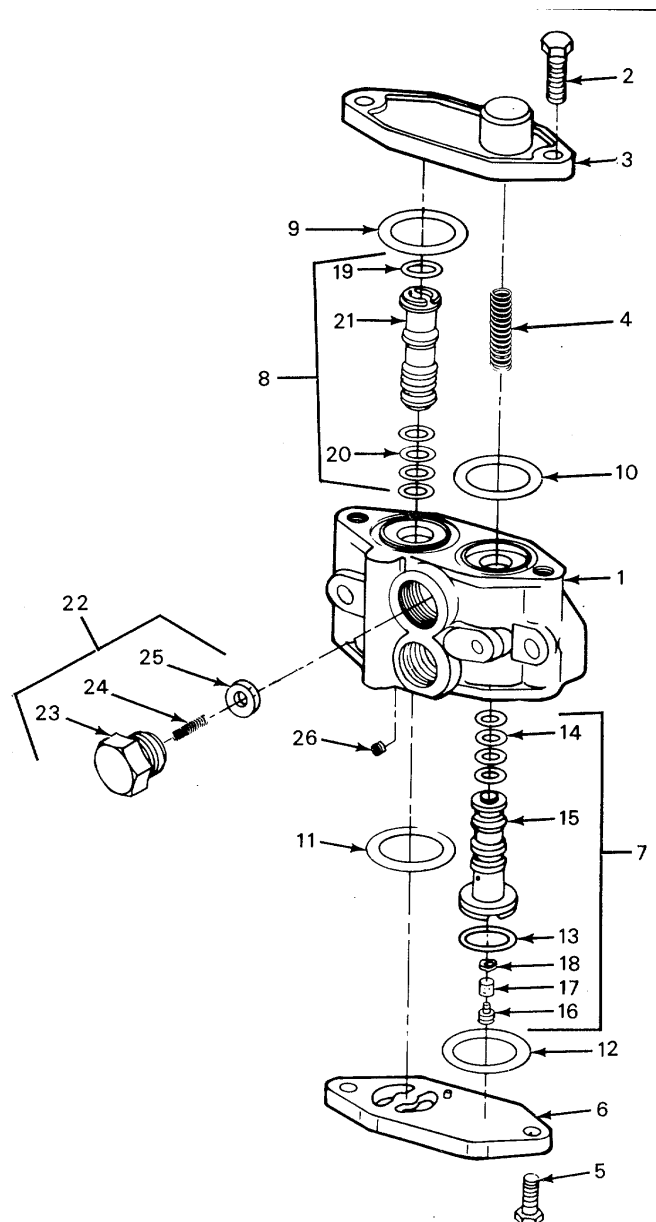
- charging cutoff pilot valve provides break-in-two protection.
- When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

1. Remove two bolts (2) and remove top cover (3) and spring (4) from body (1).

4-15. A-1 CHARGING CUTOFF PILOT VALVE (cont)

DISASSEMBLY (cont)

2. Remove two bolts (5) and bottom cover (6).
3. Remove actuating piston assembly (7).
4. Remove cutoff piston assembly (8).
5. Remove gaskets (9), (10), (11), and (12).
6. Disassemble actuating piston assembly (7) by the following:
 - a. Remove O-ring (13) and four O-rings (14) from actuating piston (15).
 - b. Remove plug (16), felt strainer (17), and strainer retainer (18).
7. Disassemble cutoff piston assembly (8) by removing O-ring (19) and four O-rings (20) from cutoff valve (21).
8. Remove two check valve assemblies (22).
9. Disassemble two check valve assemblies (22) by removing two capnuts (23), springs (24), and check valves (25).
10. Remove choke plug (26).



4-15. A-1 CHARGING CUTOFF PILOT VALVE (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 138°F (38 59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

11. Use a cloth dampened with drycleaning solvent and remove grease and oil from exterior and interior of body.
12. Use drycleaning solvent and clean metal parts. Dry with compressed air.
13. Inspect metal parts for cracks, breaks, cuts, or other damage. Replace damaged parts.
14. Check that springs have not rusted, become distorted, or taken a permanent set. Replace damaged springs.
15. Refinish faces of rubber check valves by lapping on a piece of medium-weight emery paper.

CAUTION

Do not use metallic tools to clean chokes. The use of metallic tools will change size of chokes, resulting in failure of brake valve system.

NOTE

To avoid misplacement of chokes, remove and replace one choke plug at a time.

16. Clean, inspect, and repair choke plugs by the following:
 - a. Remove choke plug and place in drycleaning solvent.
 - b. Inspect choke plug passage for cleanness. Use compressed air and remove foreign matter.

4-15. A-1 CHARGING CUTOFF PILOT VALVE (cont)

CLEANING, INSPECTION, AND REPAIR (cont)

- c. Remove choke plug from drycleaning solvent and dry with compressed air. Check that choke plug is clean and unrestricted.
 - d. Lightly coat threads of choke plug with compound consisting of one part graphite and two parts oil. Install choke plug.
17. Use silicone grease and lubricate O-rings, O-ring grooves in spool valves, and bushings into which spool valves enter. Use a clean, lint-free cloth and remove excess lubricant.

ASSEMBLY

WARNING

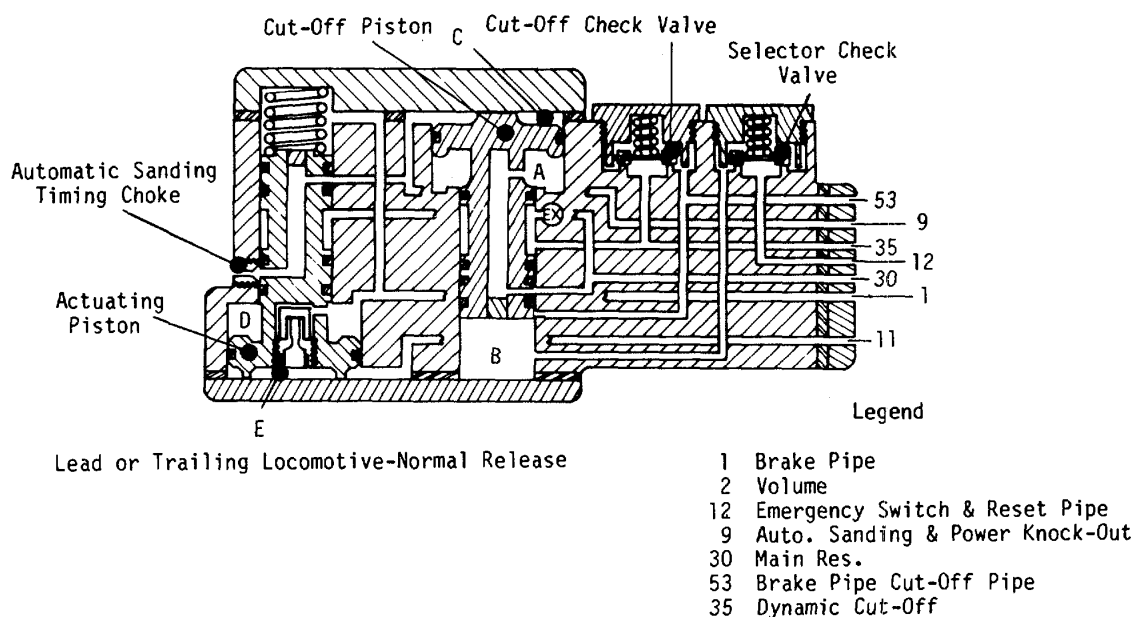
Valve assemblies are under a spring load. Use caution during assembly procedures so that no parts fly out, causing injury to personnel.

- 18. Install choke plug (26) in body (1).
- 19. Install two springs (24) and check valves (25) into two capnuts (23).
- 20. Install two check valve assemblies (22) and tighten.
- 21. Install four O-rings (20) and O-ring (19) on cutoff valve (21).
- 22. Assemble actuating piston assembly (7) by the following:
 - a. Install four O-rings (14) and O-ring (13) on actuating piston (15).
 - b. Install felt strainer (17) on plug (16) and secure with strainer retainer (18).
 - c. Install plug (16) in actuating piston (15) and tighten.
- 23. Install gaskets (12), (11), (10), and (9).
- 24. Install actuating piston assembly (7).
- 25. Install bottom cover (6) and secure with two bolts (5).
- 26. Install cutoff piston assembly (8).
- 27. Install spring (4) and top cover (3) and secure with two bolts (2).

4-15. A-1 CHARGING CUTOFF PILOT VALVE (cont)

TEST

28. Test the A-1 charging cutoff valve in accordance with Test Specification T-2617. The A-1 charging cutoff pilot valve functions as follows:

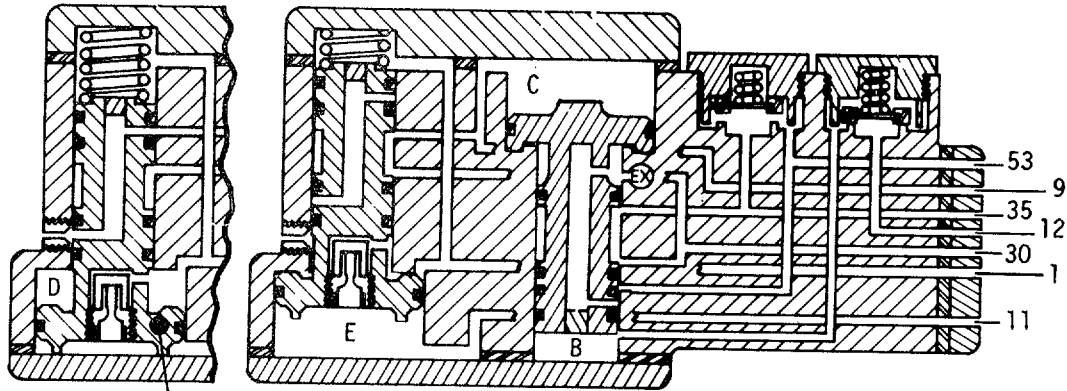


- a. During normal brake operation, the A-1 charging cutoff pilot valve will be in its normal position as follows:
 - (1) Main reservoir air will be present in chamber A, beneath the cutoff piston head to hold it in its upper position. Chamber B beneath the cutoff piston spool valve will be connected to exhaust via port 53 and the cutoff pilot valve exhaust in the 26-C brake valve on leading units.
 - (2) Chamber C, above the cutoff piston and port 9, is connected to exhaust via the actuating piston spool valve and automatic sanding timing choke.
 - (3) Brake pipe flows through port 1 to chamber D surrounding the back side of the actuating piston, through the choke in the piston to chamber E at the outer face of the piston, and through port 11 to the 90-cubic-inch (1475 cc) volume reservoir, charging the volume reservoir and both sides of the actuating piston to brake pipe pressure.
 - (4) Port 35 and the chamber beneath the dynamic cutout switch are exhausted through the cutoff piston spool valve.

4-15. A-1 CHARGING CUTOFF PILOT VALVE (cont)

TEST (cont)

b. When a break-in-two occurs, the A-i charging cutoff pilot valve functions as follows:



Actuating Piston Position After
#11 Pipe Volume Reservoir Exhausts
Through Timing Choke

Lead Locomotive-Break-In-Two Emergency

- (1) Brake pipe pressure drops faster from chamber D than it can from chamber E via the choke. The resultant pressure differential across the actuating piston causes it and its spool valve to be moved upward against spring loading.
- (2) Main reservoir air is connected through the actuating piston spool valve to chamber C at the outer face of the cutoff piston and also to port 9 and the power cutoff (PCO) switch and sanding reservoir.
- (3) With chamber B beneath the cutoff spool valve normally exhausted, the presence of main reservoir pressure in chamber C at the outer face of the cutoff piston will cause the piston and its spool valve to be forced inward to its lowest position, where chamber A beneath the cutoff piston head is exhausted.
- (4) Main reservoir air is connected through the cutoff piston spool valve 35 and past the unseated cutoff check valve to port 53 and to the brake pipe cutoff valve in the 26-C brake valve.
- (5) Air pressure in the 90-cubic-inch (1475 cc) volume reservoir, port 11, and chamber E beneath the actuating chamber continue to reduce to zero through the piston choke and port 1 to brake pipe exhaust.

4-15. A-1 CHARGING CUTOFF PILOT VALVE (cont)

TEST (cont)

- (6) When the pressure has been reduced to a predetermined value, spring tension will move the actuating piston and its spool valve to the lowest position.
 - (7) Air pressure in the sanding reservoir will then exhaust through the automatic sanding timing choke via port 9 and the actuating piston spool valve. Air pressure likewise exhausts from chamber C at the outer face of the cutoff piston.
- c. When the 26-C brake valve handle is moved to EMERGENCY position to reset, the A-1 charging cutoff pilot valve functions as follows:
- (1) Main reservoir air is connected to port 12 from the brake valve and flows past the unseated selector check valve to chamber B beneath the cutoff piston to force the cutoff piston and its spool valve upward to their normal release position.
 - (2) Pipe 53 pressure, supplied with air flow from port 12,, cannot be dissipated through the cutoff pilot valve at the brake valve.
 - (3) The brake valve handle must be moved to RELEASE position before the pipe 53 air pressure can be drained and the brakes release. A slight inherent delay in releasing the brakes has been introduced with the use of this arrangement of break-in-two protection.

4-16. H-5 RELAY AIR VALVE

This task covers:

- | | | |
|-----------------------|----------------------|--------------------|
| a. Disassembly | b. Inspection | e. Assembly |
| b. Cleaning | d. Repair | f. Test |
-

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12
Pneumatic grease (Item 16, Appendix B)

Material/Parts

Drycleaning solvent (Item 30, Appendix B)

Equipment Condition

Reference

Para 3-51

Condition Description

H-5 relay air valve removed

DISASSEMBLY

WARNING

Valve assemblies are under a spring load. Use caution during disassembly procedures so that no parts fly out, causing injury to personnel.

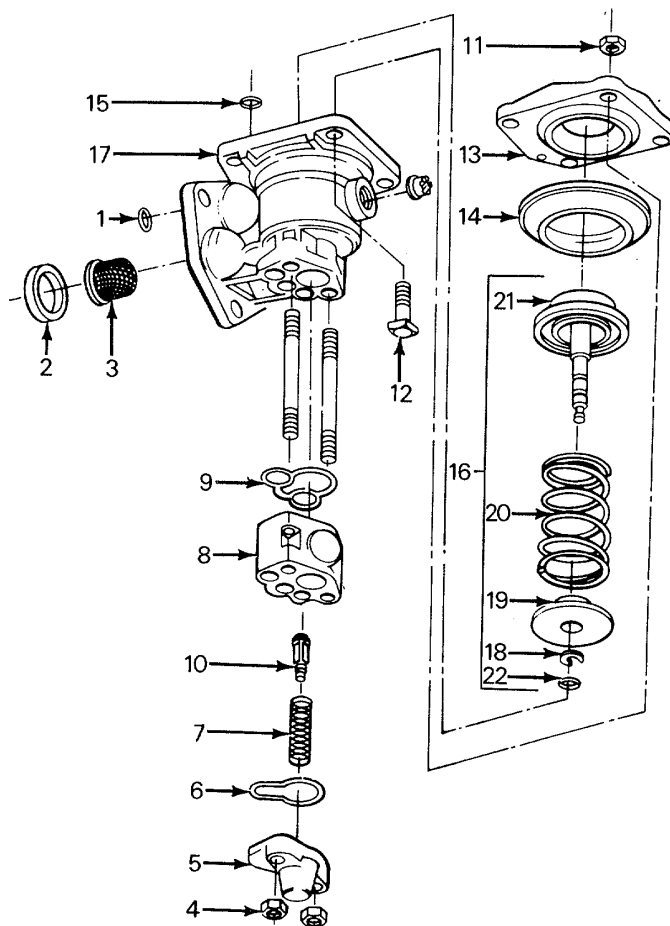
NOTE

- The H-5 relay air valve provides for an automatic brake release on the locomotive, independent of the train brakes.
- When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

1. Remove gaskets (1) and (2) and three strainers (3).
2. Remove two nuts (4) and remove cover (5), gasket (6), spring (7), check valve body (8), and gasket (9).
3. Remove supply valve (10) from check valve body (8).
4. Remove four nuts (11) and bolts (12) and remove cover (13), diaphragm (14), and gasket (15).
5. Remove diaphragm follower unit assembly (16) from body (17).

4-16. H-5 RELAY AIR VALVE (cont)

DISASSEMBLY (cont)



6. Disassemble diaphragm follower unit assembly (16) by the following:
 - a. Use a vise and compress diaphragm follower unit assembly (16).
 - b. Remove retainer (18), seat (19), spring (20), and follower (21).
 - c. Remove O-ring (22) from follower (21).

4-16. H-5 RELAY AIR VALVE (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 138°F (38 590C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
7. Use a cloth dampened with drycleaning solvent and remove grease and oil from exterior and interior of bodies.
 8. Use drycleaning solvent and clean metal parts. Dry with compressed air.
 9. Inspect metal parts for cracks, breaks, cuts, or other damage. Replace damaged parts.
 10. Check that springs have not rusted, become distorted, or taken a permanent set. Replace damaged springs.
 11. Use silicone grease and lubricate O-rings, O-ring grooves in spool valves, and bushings into which spool valves enter. Use a clean, lint-free cloth and remove excess lubricant.

ASSEMBLY

WARNING

Valve assemblies are under a spring load. Use caution during assembly procedures so that no parts fly out, causing injury to personnel.

12. Assemble diaphragm follower unit assembly (16) by the following:
 - a. Install spring (20) and seat (19) on follower (21). Secure with retainer (18).
 - b. Install O-ring (22) on stem of follower (21).
13. Install diaphragm follower unit assembly (16) in body (17).

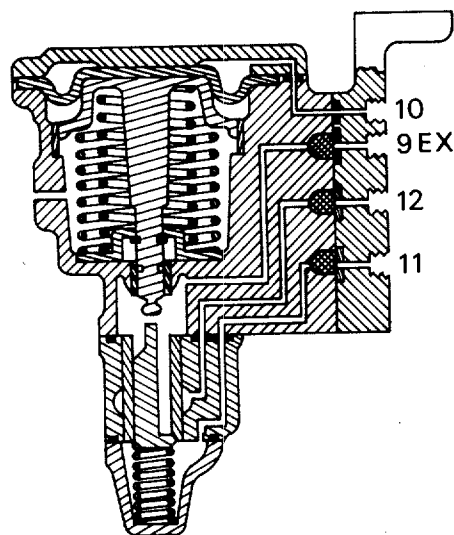
4-16. H-5 RELAY AIR VALVE (cont)

ASSEMBLY (cont)

14. Install gasket (15).
15. Install diaphragm (14) on follower (21) with its heavy bead up. Check that bead of diaphragm is in bead groove of body (17).
16. Install cover (13) and secure with four bolts (12) and nuts (11).
17. Install gasket (9) on check valve body (8) and install gasket (6) on cover (5).
18. Install check valve body (8) on body (17).
19. Install supply valve (10) in check valve body (8).
20. Install spring (7) on supply valve (10).
21. Install cover (5) and secure with two nuts (4)
22. Install strainers (3) and gaskets (2) and (1).

TEST

23. Test the H-5 relay air valve in accordance with Test Specification T-1462. The H-5 relay air valve functions as follows:
 - a. When control port 10 is not pressurized, the diaphragm and spool valve are held in the upper position by a return spring. None of the ports are in communication at this time.
 - b. When control port 10 is pressurized sufficiently to move the spool against the force of the return spring, port 11 is in communication with port 9, which is exhausted. Port 12 is still blocked off.



4-17. EMERGENCY BRAKE VALVE

This task covers:

- | | | |
|----------------|---------------|-------------|
| a. Disassembly | c. Inspection | e. Assembly |
| b. Cleaning | d. Repair | f. Test |
-

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

Material/Parts

Drycleaning solvent (Item 30, Appendix B)
Brake cylinder grease (Item 13, Appendix B)
Valve set 5330-00-366-2420; P/N 92273 (82772)

Equipment Condition Reference

Para 3-52

Condition Description

Emergency brake valve removed

DISASSEMBLY

WARNING

Valve assemblies are under a spring load. Use caution during disassembly procedures so that no parts fly out, causing injury to personnel.

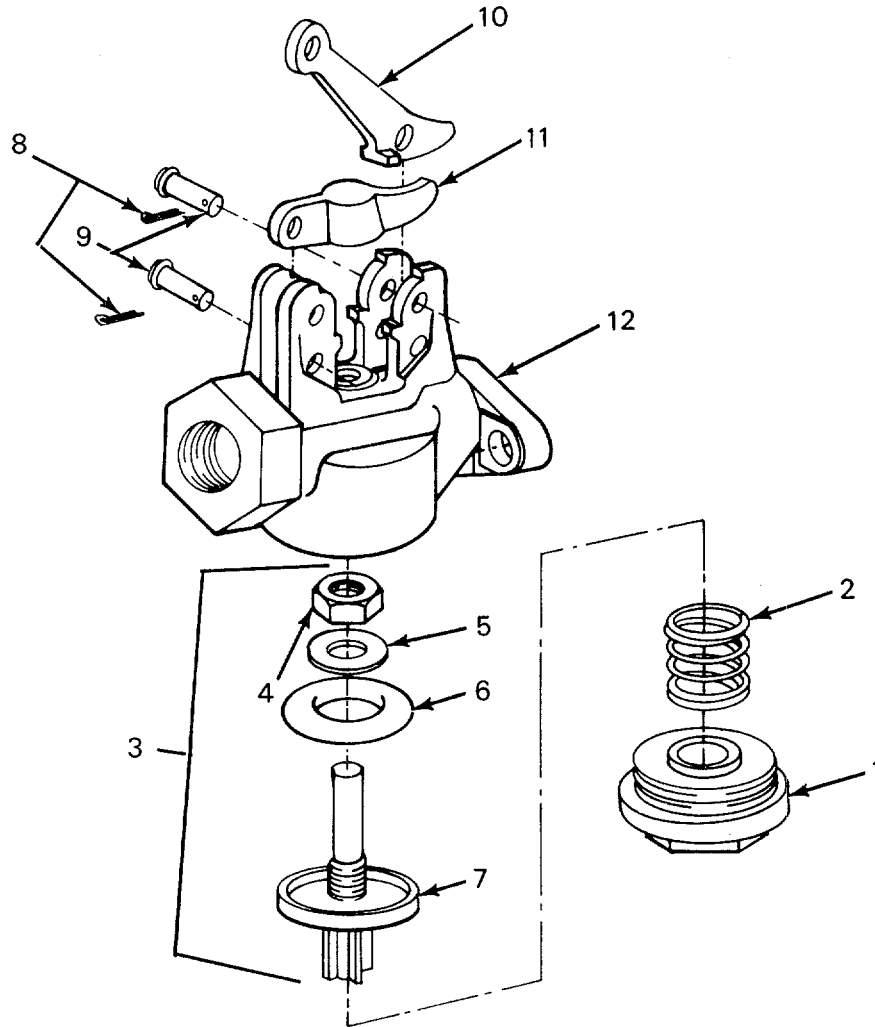
NOTE

When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

1. Remove capnut (1) spring (2), and vent valve assembly (3).
2. Remove nut (4), flat washer (5), and valve seat (6) from valve (7).
3. Remove two cotter pins (8) and two pins (9).
4. Remove operating lever (10) and valve lever (11) from body (12).

4-17 EMERGENCY BRAKE VALVE (cont)

DISASSEMBLY (cont)



4-17. EMERGENCY BRAKE VALVE (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.

5. Use a cloth dampened with drycleaning solvent and remove grease and oil from exterior and interior of body.
6. Use drycleaning solvent and clean metal parts. Dry with compressed air.
7. Inspect metal parts for cracks, breaks, cuts, or other damage. Replace damaged parts.
8. Check that spring (2) has not rusted, become distorted, or taken a permanent set. Replace damaged spring.
9. Discard valve seat (6) and cotter pins (8) and replace with new valve seat and cotter pins.
10. Check that valve (7) and valve stem are not bent. Replace damaged valve.
11. Use brake cylinder lubricant and lubricate pins (9), upper and lower parts of valve stem, and spring (2).

ASSEMBLY

WARNING

- Valve assemblies are under a spring load. Use caution during assembly procedures so that no parts fly out, causing injury to personnel.
12. Install valve lever (11) and operating lever (10) on body (12). Secure with two pins (9) and two cotter pins (8).

4-17. EMERGENCY BRAKE VALVE)

ASSEMBLY (cont)

13. Assemble vent valve assembly (3) by the following:

- a. Install valve seat (6) on valve (7).
- b. Secure with flat washer (5) and nut (4).

14. Install vent valve assembly (3) in body (12).

15. Install spring (2). Secure with capnut (1).

TEST

16. Test the emergency brake valve in accordance with Test Specification T-1063.

4-18. STRAINER AND CHECK VALVE

This task covers:

- | | | |
|----------------|---------------|-------------|
| a. Disassembly | c. Inspection | e. Assembly |
| b. Cleaning | d. Repair | f. Test |
-

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

Equipment Condition Reference

Para 3-53

Material/Parts

Drycleaning solvent (Item 30, Appendix B)
Filter curled hair (734877)

Condition Description

Strainer and check valve removed

DISASSEMBLY

WARNING

Valve assemblies are under a spring load. Use caution during disassembly procedures so that no parts fly out, causing injury to personnel.

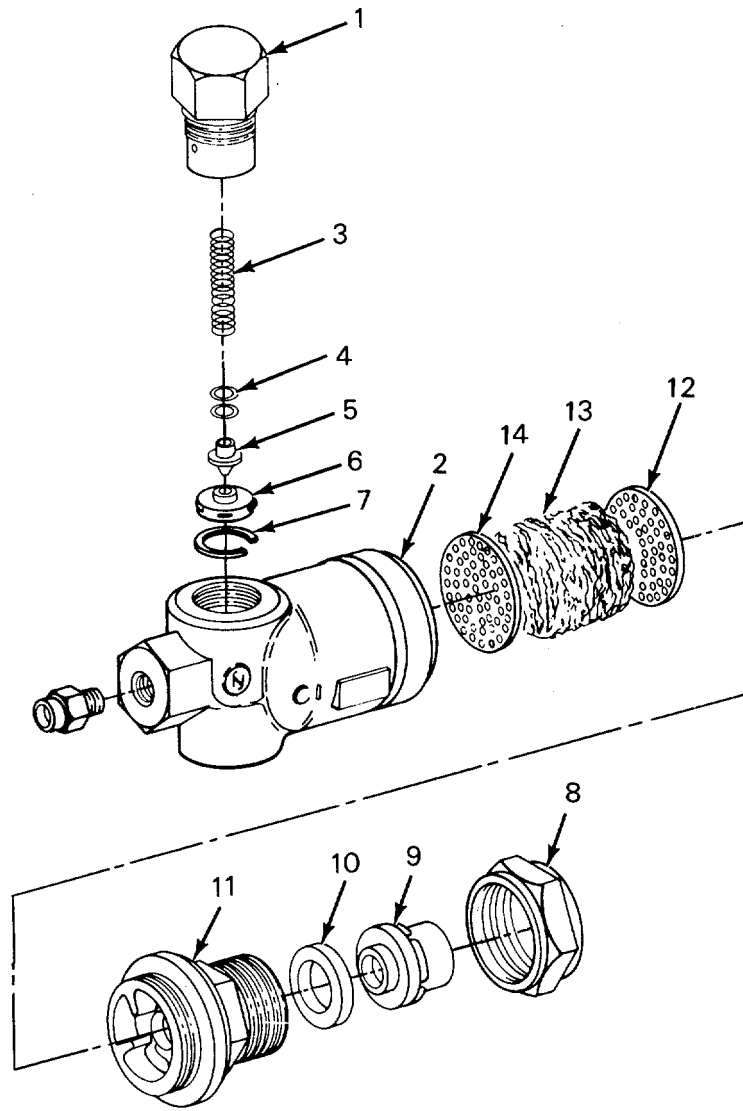
NOTE

When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

1. Remove capnut (1) from body (2).
2. Remove spring (3), two shims (4), spring seat (5), check valve (6), and snapping (7) from capnut (1).
3. Remove nut (8), swivel (9), and gasket (10).
4. Remove capnut (11), strainer (12), air filter (13), and strainer (14).
5. Remove fitting (15).

4-18. STRAINER AND CHECK VALVE (cont)

DISASSEMBLY (cont)



4-18. STRAINER AND CHECK VALVE (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100 138°F (38 59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
6. Use a cloth dampened with drycleaning solvent and remove grease and oil from exterior and interior of body.
 7. Use drycleaning solvent and clean metal parts. Dry with compressed air.
 8. Inspect metal parts for cracks, breaks, cuts, or other damage. Inspect for damaged threads. Replace damaged parts.
 9. Check that spring (3) has not rusted, become distorted, or taken a permanent set. Replace damaged spring.
 10. Replace air filter (13).

ASSEMBLY

WARNING

Valves assemblies are under a spring load. Use caution during assembly procedures so that no parts fly out, causing injury to personnel.

11. Install fitting (15).
12. Install strainer (14), air filter (13), and strainer (12) and secure with capnut (11).
13. Install gasket (10) on swivel (9) and secure without (8).

4-18. STRAINER AND CHECK VALVE (cont)

ASSEMBLY (cont)

14. Install spring (3), two shims (4), spring seat (5), check valve (6), and snapping (7) into capnut (1).
15. Install assembled capnut (1) in valve body (2).

TEST

16. Test strainer and check valve in accordance with Test Specification T-1660.

4-18. CUTOUT COCK AND STRAINER

This task covers:

- | | | |
|----------------|---------------|-------------|
| a. Disassembly | c. Inspection | e. Assembly |
| b. Cleaning | d. Repair | |
-

INITIAL SETUP:

Tools

Tool kit SC 4940-97-CL-E12

Material/Parts

Drycleaning solvent (Item 30, Appendix B)
Filter 569146

Equipment Condition Reference

Para 3-55

Condition Description

Cutout cock and strainer removed

DISASSEMBLY

1. Remove four bolts (1), strainer cover (2), gasket (3), and filter (4).
2. Remove pin (5) and handle (6).

WARNING

Valve assemblies may be under a spring load. Use caution during disassembly procedures so that no parts fly out, causing injury to personnel.

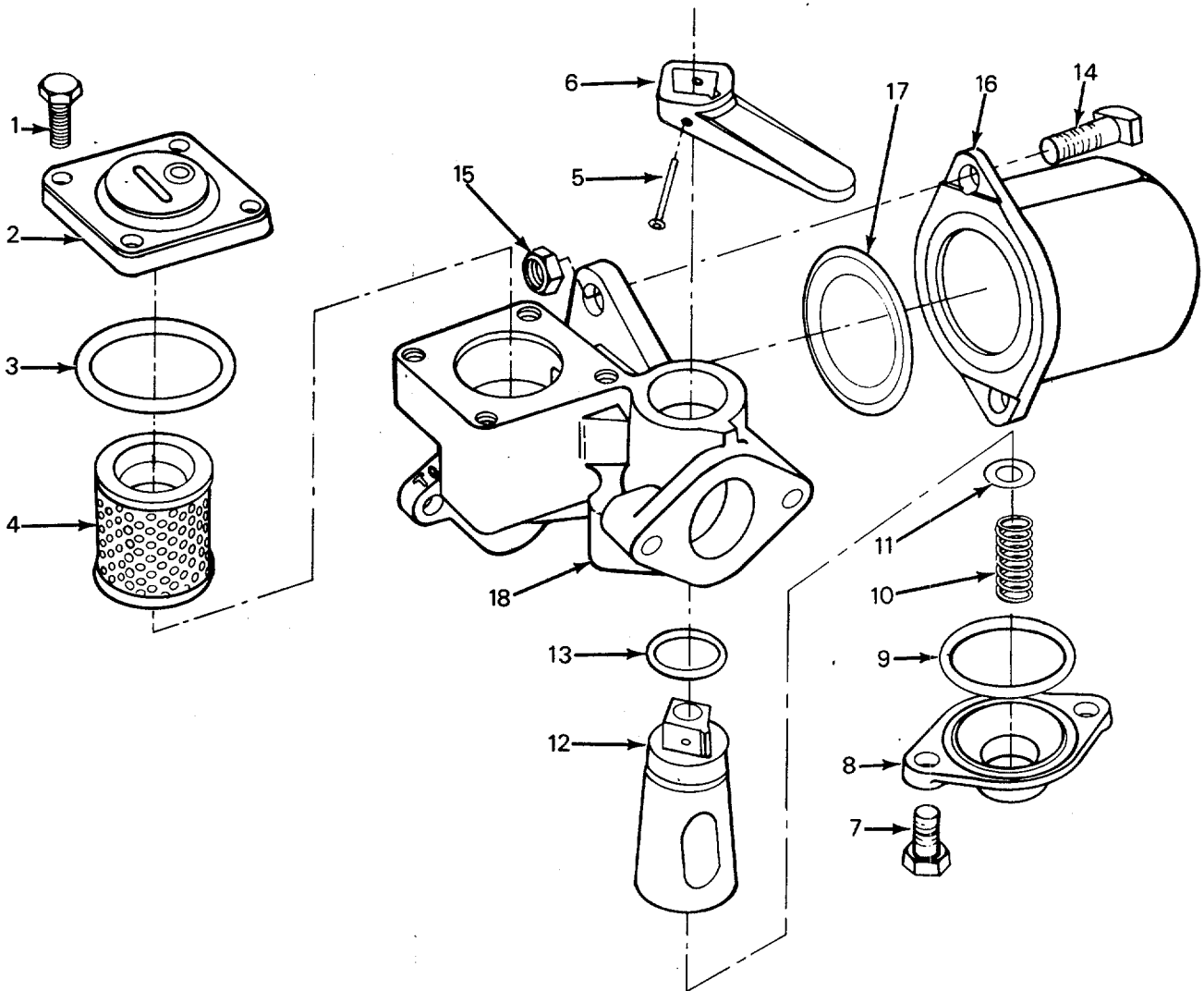
NOTE

When removing or repairing brake valves or components, check air lines and pipes for corrosion, breaks, splits, or loose connections. Repair of air lines and piping consists of replacing defective pipes, lines, and connections. Refer to TM 55-2210-223-24P for identification of piping.

3. Remove two bolts (7), cover (8), gasket (9), spring (10), washer (11), key (12), and O-ring (13).
4. Remove two bolts (14), nuts (15), sump cover (16), and gasket (17) from body (18).

4-19. CUTOUT COCK AND STRAINER (cont)

DISASSEMBLY (cont)



4-19. CUTOUT COCK AND STRAINER (cont)

CLEANING, INSPECTION, AND REPAIR

WARNING

- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy, get fresh air and medical aid immediately. If contact with eyes is made, wash your eyes and get medical aid immediately.
 - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Do not direct compressed air against skin. Use goggles or full face shield.
5. Use a cloth dampened in drycleaning solvent and remove grease and oil from exterior and interior of body.
 6. Use drycleaning solvent and clean metal parts. Dry with compressed air.
 7. Inspect metal parts for cracks, breaks, cuts, or other damage. Replace damaged parts.
 8. Check that spring (10) has not rusted, become distorted, or taken a permanent set. Replace damaged spring. Replace air filter.

ASSEMBLY

WARNING

Valve assemblies may be under a spring load. Use caution during assembly procedures so that no parts fly out, causing injury to personnel.

9. Install gasket (17) on sump cover (16) and secure to body (18) with two nuts (15) and bolts (14).
10. Install O-ring (13) on key (12) and install key in body (18).
11. Install washer (11) and spring (10) on key (12).
12. Install gasket (9) on cover (8) and secure with two bolts (7).
13. Install handle (6) and secure with pin (5).
14. Install new filter (4) in body (18).
15. Install gasket (3) on strainer cover (2) and secure with four bolts (1).

APPENDIX A

REFERENCES

A-1. SCOPE

This appendix lists all forms, field manuals, technical bulletins, technical manuals and miscellaneous publications referenced in this manual.

A-2. ADMINISTRATIVE PUBLICATIONS

a. Pamphlets.

DA PAM 738-750

The Army Maintenance Management System (TAMMS)

b. Forms.

DA Form 2028

Recommended Changes to Publications and Blank Forms

DA Form 2028-2

Recommended Changes to Equipment Technical Publications

DA Form 2404

Equipment Inspection and Maintenance Worksheet

DA Form 2407

Maintenance Request

DA Form 2408

Equipment Log Assembly

DA Form 2410

Component Removal and Repair/Overhaul Record

SF 364

Report of Discrepancy (ROD)

FRA Form 6180-49A

Locomotive Inspection and Repair Record

SF 368

Quality Deficiency Report

A-3. SPECIFICATIONS AND STANDARDS

a. Military Specifications

MIL-I-45607

Acquisition, Maintenance, and Disposition of Inspection Equipment

b. Military Standards.

MIL-STD-120

Gage Inspection

MIL-STD-45662

Calibration Systems Requirements

A-3. TECHNICAL PUBLICATIONS

a. Bulletins.

TB 55-2200-207-15/1

Inspection and Maintenance Checklist for
Diesel-Electric Locomotives

b. Manuals.

CFR-49

Code of Federal Regulations

FM 21-11

First Aid for Soldiers

TM 5-2815-232-24P

Unit, Intermediate Direct Support, and
Intermediate General Support Maintenance
Repair Parts and Special Tools List,
Diesel Engine, 500 HP, Model 3508,
Caterpillar Tractor Company

TM 9-237

Welding Theory and Application

TM 43-0139

Painting Instructions for Field Use

TM 55-2210-223-12

Operator and Unit Maintenance Manual,
Locomotive, Diesel-Electric, 56-1/2-inch
gage, 60-Ton, 500-HP, 0-4-4-0 Wheel,
Baldwin-Lima-Hamilton, Model RS-4-TC-1A
NSN 2210-01-158-2978

TM 55-2210-223-24P

Unit, Intermediate Direct Support, and
Intermediate General Support Maintenance
Repair Parts and Special Tools Lists,
Locomotive, Diesel-Electric, 56-1/2-inch
gage, 60-Ton, 500-HP, 0-4-4-0 Wheel,
Baldwin-Lima-Hamilton, Model RS-4-TC-1A
NSN 2210-01-158-2978

c. Lubrication Order.

LO 55-2210-223-12

Locomotive, Diesel-electric, 56-1/2-inch
gage, 60-Ton, 500-HP, 0-4-4-0 Wheel,
Baldwin-Lima-Hamilton, Model RS-4-TC-1A
NSN 2210-01-158-2978

APPENDIX B

EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

B-1. SCOPE

This listing is for information purposes only and is not authority to requisition the listed items. These items are authorized to you by CTA 50-970 or CTA 8-100, Expendable/Durable Items (Except Medical, Class V, Repair Parts, and Heraldic 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 instructions to identify the material, e.g., Use drycleaning solvent (item 32, app E).

b. Column 2 - Category. This column identifies the lowest category of maintenance that requires the listed item.

F - Intermediate Direct Support Maintenance

H - Intermediate General Support Maintenance

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 of each item indicates the Federal Supply Code for Manufacturer (FSCM) in parentheses, followed by the part number.

e. Column 5 - Unit of Measure (U/M). Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in., pr). A V in this column indicates that the amount used will vary. 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) Category	(3) National Stock Number	(4) Description	(5) U/M
1	F	8040-00-144-9774	Adhesive, Silicone, Rubber (81349) MIL-A-46146	oz
2	F	6850-00-181-7940	Antifreeze, Ethylene Glycol, Inhibited (81349) MIL-A-46153 55-gal (208.2 L) drum	gl
3	F	7930-00-664-6910	Cleaner, Glass (81349) A-A-40	bx
4	H	5350-00-174-0992	Cloth, Abrasive, Emery (58536) A-A-1200	ea
5	H	8030-00-753-4953	Compound, Antisieze, Mica Base (81349) MIL-A-13881	lb
6	F	6850-00-664-7530	Compound, Cleaning, Alkali (81349) P-C-436	dr
7	F	5350-00-197-9461 (87742) 1000	Compound, Lapping, 1000 Grit	cn
8	F	8030-01-025-1692	Compound, Sealing (81349) MIL-S-46163	cc
9	F	8010-00-852-9034	Enamel, Alkyd, Gloss Gray (81348) TI-E-489	pt
10	H		Graphite, Powder	
11	F	9150-00-190-0904	Grease, Automotive and Artillery GAA (81349) MIL-G-10924 1.75-lb (0.795 kg) can	lb
12	F		Grease, Ball and Roller Bearing, BB (93508) RA-71005	
13	F		Grease, Brake Cylinder,, CC (59595) AAR-M-914-70	
14	F	9510-00-272-7652	Grease, Graphite, GG-1 (81348) VV-G-671 35-lb (15.89 kg) can	lb
15	H		Grease, Lime Base	

Section II. EXPENDABLE SUPPLIES AND MATERIALS LIST (continued)

(1) Item No.	(2) Category	(3) National Stock Number	(4) Description	(5) U/M
16	F	9150-00-269-8255	Grease, Pneumatic System GPS 1.75-lb (0.79 kg) pail (81349) MIL-G-4343	lb
17	F	8010-00-873-9315	Lacquer, Clear Acrylic (87187) TT-L-50 TV2	oz
18	F		Lubricant, Graphite, DD (93508) 72777	ea
19	H		Lubricating Oil, Engine OE/HDO (81349) MIL-L-2104 Grade 10	
		9150-00-189-6727	1-qt (0.95 L) can Grade 30	qt
20	F	9150-00-189-6729	55-gal (208.2 L) drum Lubricating Oil, Gear, Multi- purpose, GO (81349) MIL-L-2105 Grade 90	gl
		9150-01-035-5393	5-gal (18.93 L) can Grade 140	gl
		9150-01-035-5395	5-gal (18.93 L) can	gl
21	F	9150-00-252-6174	Oil, Lubricating, General-Purpose (81348) VV-L-820	qt
22	F		Lubricating Oil, Railway Car and Locomotive AA (59595) 57-40W	gl
23	F		Oil, Triple Valve	qt
24	F		Paint	
		8010-00-297-0591	Black, Polyurethane (09869) 48A-27038-66	gl
		8010-00-664-4761	White, Enamel (81348) TT-E-489	gl
		8010-00-286-7758	Yellow, Enamel (81348) TT-E-489	gl

Section II. EXPENDABLE SUPPLIES AND MATERIALS LIST (continued)

(1) Item No.	(2) Category	(3) National Stock Number	(4) Description	(5) U/M
25	0	8010-00-297-0591	Paint, Rubberized Insulating Epoxy (09861)	gl
26	F		Paper, Insulating	
27	F	8110-00-551-0128	Pigment, Iron Blue Marking (81348) TT-P-381	oz
28		7920-00-205-3570	Rags, Wiping, Cotton, General- Purpose, class 2, grade 2 50-lb (22.69 kg) bale	be be
29	F	3439-01-026-1084	Solder, Tin Alloy (81348) QQ-S-571	lb
30	F	6850-00-281-1985	Solvent, Drycleaning, SD.-II	
		6850-00-664-5685	(81348) P-D-680 1-gal (3.8 L) can 1-qt (0.95 L) can	gl qt
31	H	8030-00-889-3534	Tape, Antiseize, Polytetra- fluoroethylene, Class 1 (81349) MIL-T-27730	yd
32	F	5970-00-955-9976	Tape, Electrical Pressure Sensitive (07099) MS70T09-S	
33	F	5970-00-785-4098	Varnish, Insulating Electrical (red) (81349) MIL-I-204092	oz

APPENDIX C

ILLUSTRATED LIST OF MANUFACTURED ITEMS

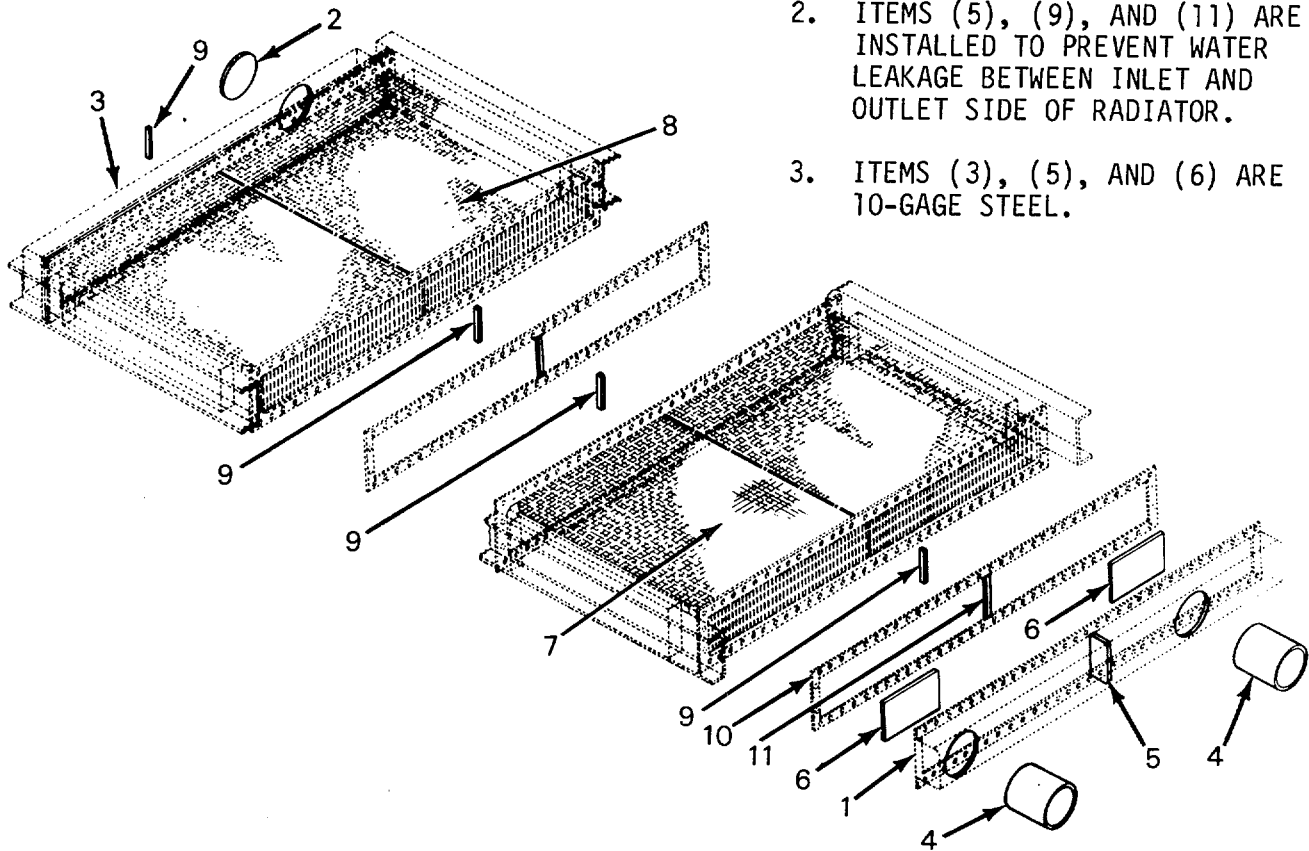
C-1. INTRODUCTION

This appendix includes complete instructions for making items authorized to be manufactured or fabricated at intermediate direct support and intermediate general support maintenance.

C-2. RADIATOR MODIFICATION

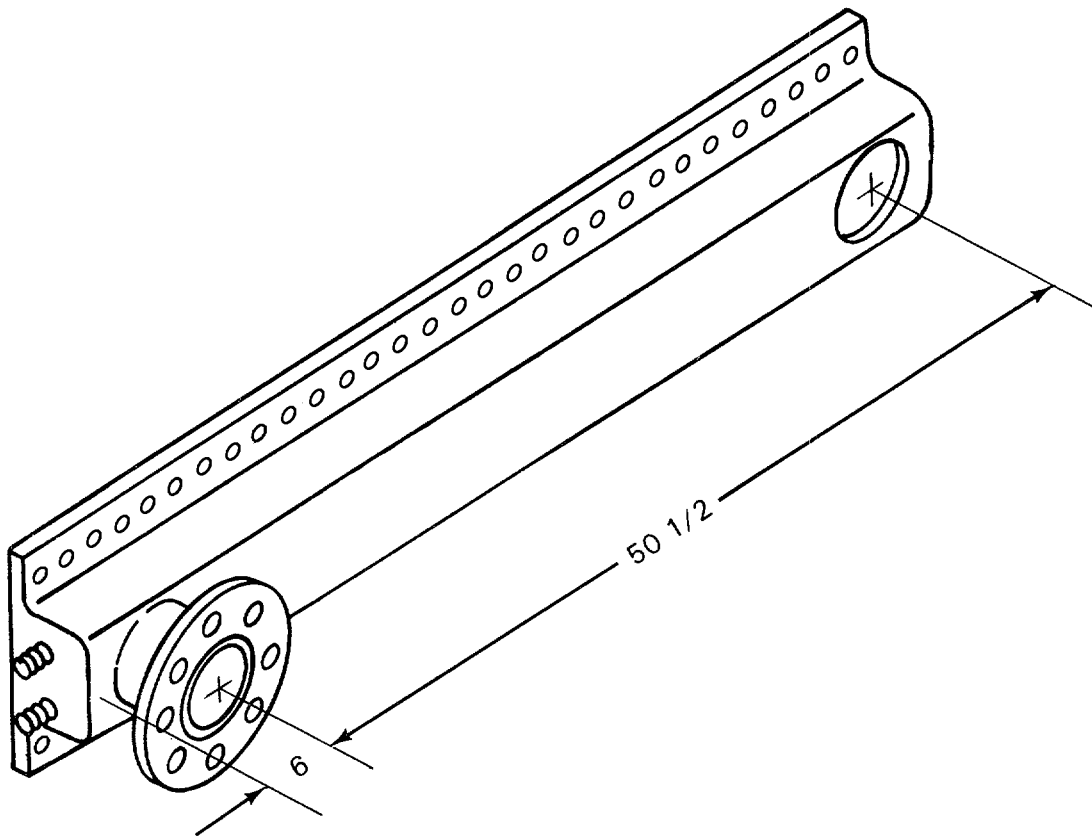
NOTES:

1. PIPES (4) ARE 5-1/2 INCHES O.D. 1/8 INCH WALL X 8 INCH.
2. ITEMS (5), (9), AND (11) ARE INSTALLED TO PREVENT WATER LEAKAGE BETWEEN INLET AND OUTLET SIDE OF RADIATOR.
3. ITEMS (3), (5), AND (6) ARE 10-GAGE STEEL.



C-2. RADIATOR MODIFICATION (cont)

- a. Remove top tank (1) and bottom tank (2) from radiator assembly.
- b. Cut flange, pipe, and baffle assembly from top and bottom tanks (1) and (2).
- c. Weld steel plugs (3) in top and bottom tanks.
- d. Cut two holes in top tank as shown below.
- e. Weld inlet and outlet pipes (4), tank dividers (5), and baffle plates (6) into top tank.
- f. Separate top header core assembly (7) from bottom header core assembly (8).
- g. Modified header core assemblies (7) and (8) will be cleaned and overhauled before assembly.
- h. Use tin alloy solder (Item 29, Appendix B) and solder copper bar (9) into both ends of top header core assembly (7) and into the end of bottom header core assembly (8) mating with top header core assembly.
- i. Use new gasket (70) and fabricated gasket divider (11) and connect top header core assembly (7) to bottom header core assembly (8).
- j. Use new gasket (10) and fabricated gasket (71) and connect top and bottom tanks to top and bottom header core assemblies.
- k. Air leak test radiator to 10 lbs psi.



APPENDIX D

TORQUE LIMITS

D-1. GENERAL

This section provides general torque limits for screws used on the locomotive. Special torque limits are indicated 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 secure rubber components. The rubber components will be damaged before the correct torque limit is reached. If a special torque limit is not given in the maintenance instructions, tighten screw or nut until it touches the metal bracket then tighten it one more turn.

D-2. TORQUE LIMITS

Table D-1 lists dry torque limits. Dry torque limits are used on screws that do not have lubricants applied to the threads. Table D-2 lists wet torque limits. Wet torque limits are used on screws that have high-pressure lubricants applied to the threads.

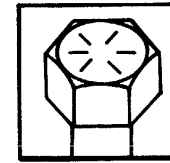
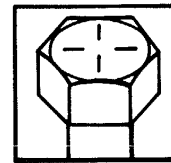
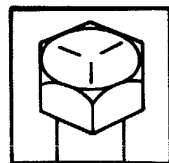
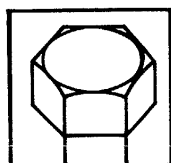
D-3. HOW TO USE TORQUE TABLE

- a. Measure the diameter of the screw you are installing.
- b. Count the number of threads per inch.
- c. 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).
- d. In the second column under SIZE, find the number of threads per inch that matches the number of threads you counted in step (2).
- e. 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.
- f. Look down the column under the picture you found in step (5) until you find the torque limit (in lb-ft or N.m) for the diameter and threads per inch of the screw you are installing.

Table D-1. Torque Limits for Dry Fasteners

CAPSCREW HEAD MARKINGS

Manufacturer's marks may vary.
These are all SAE Grade 5
(3-line).



TORQUE

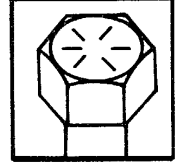
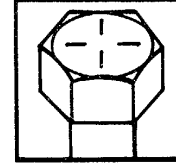
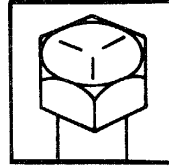
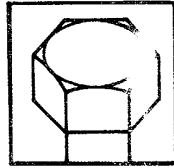
SIZE			SAE GRADE NO. 1 or 2		SAE GRADE No. 5		SAE GRADE No. 6 or 7		SAE GRADE No. 8	
DIA INCHES	THREADS PER INCH	MILLIMETERS	POUNDS FEET	NEWTON METERS	POUNDS FEET	NEWTON METERS	POUNDS FEET	NEWTON METERS	POUNDS FEET	NEWTON METERS
1/4	20	6.35	5	6.78	8	10.85	10	13.56	12	16.27
1/4	28	6.35	6	8.14	10	13.56	-	-	14	18.98
5/16	18	7.94	11	14.92	17	23.05	19	25.76	24	32.52
5/16	24	7.94	13	17.63	19	25.76	-	-	27	36.61
3/8	16	9.53	18	24.41	31	42.04	34	46.10	44	59.66
3/8	24	9.53	20	27.12	35	47.46	-	-	49	66.44
7/16	14	11.11	28	37.97	49	66.44	55	74.58	70	94.92
7/16	20		30	40.68	55	74.58	-	-	78	105.77
1/2	13	12.70	39	52.88	75	101.70	85	115.26	105	142.38
1/2	20		41	55.60	85	115.26	-	-	120	162.78
9/16	12	14.29	51	69.16	110	149.16	120	162.72	155	210.18
9/16	18		55	74.58	120	162.72	-	-	170	230.52
5/8	11	15.88	63	85.43	150	203.40	167	226.45	210	284.76

Table D-1. Torque Limits for Dry Fasteners (continued)

D-3

CAPSCREW HEAD MARKINGS

Manufacturer's marks may vary.
These are all SAE Grade 5
(3-line).



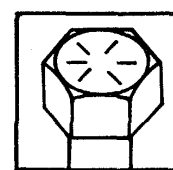
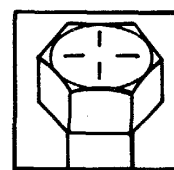
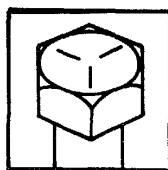
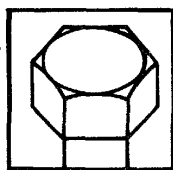
TORQUE

SIZE			SAE GRADE NO. 1 or 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
5/8	18		95	128.82	170	230.52	-	-	240	325.44
3/4	10	19.05	105	142.38	270	366.12	280	379.68	375	508.50
3/4	16		115	155.94	295	400.02	-	-	420	596.52
7/8	9	22.23	160	216.96	395	535.62	440	596.64	605	820.38
7/8	14		175	237.30	435	589.86	-	-	675	915.30
1	8	25.40	235	318.66	590	800.04	660	894.96	910	1233.96
1	14		250	339.00	660	894.96	-	-	990	1342.44
1-1/8	-	25.58	-	-	800- 874	1092.0- 1193.3	-	-	1280- 1440	1735.7- 1952.8
1-1/4	-	31.75	-	-			-	-	1820- 2000	2467.9- 2712.0
1-3/8	-	34.93	-	-	1460- 1680	1979.8- 2278.1	-	-	2380- 2720	3227.3- 3688.3
1-1/2	-	38.10	-	-	1940- 2200	2630.6- 2983.2	-	-	3160- 3560	4285.0- 4827.4

Table D-2. Torque Limits for Wet Fasteners

CAPSCREW HEAD MARKINGS

Manufacturer's marks may vary.
These are all SAE Grade 5
(3-line).



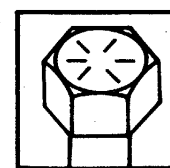
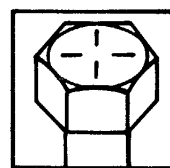
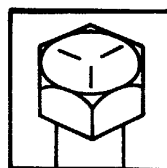
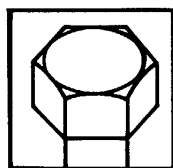
TORQUE

SIZE			SAE GRADE NO. 1 or 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	4.9	6.10	7.2	9.76	9.0	12.20	10.8	14.64
1/4	28	6.35	5.4	7.33	9.0	12.20	-	-	12.6	17.08
5/16	18	7.94	9.9	13.34	15.3	22.54	17.1	23.18	21.6	29.27
5/16	24	7.94	11.7	15.87	17.1	23.18	-	-	24.3	32.95
3/8	16	9.53	16.2	21.97	27.9	37.84	30.6	41.49	39.6	53.69
3/8	24	9.53	18.0	24.41	31.5	42.71	-	-	44.1	59.80
7/16	14	11.11	25.2	34.17	44.1	59.80	49.5	67.12	63.0	85.42
7/16	20		27.0	36.61	49.5	67.12	-	-	70.2	95.19
1/2	13	12.70	35.1	47.59	67.5	91.53	76.5	103.73	94.5	128.14
1/2	20		36.9	50.04	76.5	103.73	-	-	108.0	146.50
9/16	12	14.29	45.9	62.24	99.0	134.24	108.0	146.45	139.5	189.16
9/16	18		49.5	67.12	108.0	146.45	-	-	153.0	207.47
5/8	11	15.88	56.7	76.89	135.0	183.06	150.3	203.80	189.0	256.28

Table D-2. Torque Limits for Wet Fasteners (continued)

CAPSCREW HEAD MARKINGS

Manufacturer's marks may vary.
These are all SAE Grade 5
(3-line).



TORQUE

SIZE			SAE GRADE NO. 1 or 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
5/8	18		85.5	115.94	153.0	207.47	-	-	216.0	296.90
3/4	10	19.05	94.5	128.14	243.0	329.51	252.0	341.71	337.5	457.65
3/4	16		103.5	140.35	265.5	360.02	-	-	378.0	536.87
7/8	9	22.23	144.0	195.26	355.5	482.06	396.0	536.98	544.5	738.34
7/8	14		157.5	213.57	391.5	530.87	-	-	607.5	823.77
1	8	25.40	211.5	286.79	531.0	720.04	594.0	805.46	819.0	1110.56
1	14		225.0	305.10	594.0	805.46	-	-	891.0	1208.20
1-1/8	-	25.58	-	-	720.0- 792.0	976.32- 1073.97	-	-	1152- 1296	1562.13- 1757.52
1-1/4	-	31.75	-	-	-	-	-	-	-	2221.11- 2440.80
1-3/8	-	34.93	-	-	1314.0- 1512.0	1781.82- 2050.29	-	-	2142- 2448	2904.57- 3319.47
1-1/2	-	38.10	-	-	1746.0- 1980.0	2367.54- 2684.88	-	-	2844- 3204	3856.5- 4344.66

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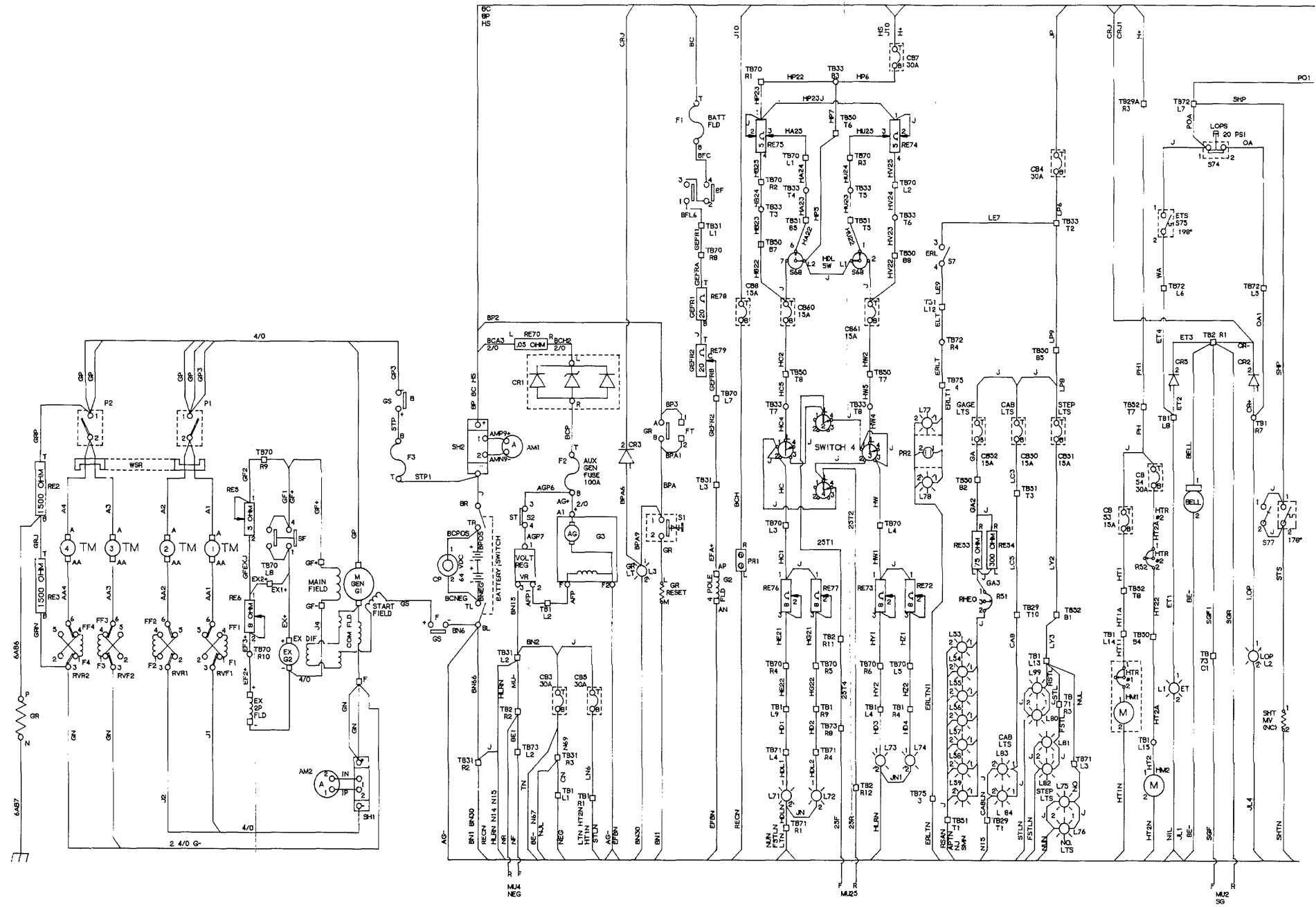
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- A, AM AMMETER
- AG AUXILIARY GENERATOR
- AUX AUXILIARY
- B BOTTOM POSITION
- BAT, BATT BATTERY
- BF BATTERY FIELD
- CB CIRCUIT BREAKER
- COM COMMUTATOR
- CP CHARGE PLUG
- CR CURRENT RECTIFIER, DIODE
- ERL ENGINE ROOM LIGHT
- ET ENGINE TEMPERATURE
- ETS ENGINE TEMPERATURE SWITCH
- EX EXCITER
- F1,2,3 FUSES
- FLD FIELD
- FT FUSE TEST
- G GENERATOR
- GEFR GENERATOR EXCITER FIELD RESISTOR
- GEN GENERATOR
- GF GENERATOR FIELD
- GR, GRN GROUND, GROUND RELAY
- GS GENERATOR SWITCH OR CONTACTOR
- HDL HEADLIGHT
- HM HEATER MOTOR
- HTR HEATER
- J JUMPER
- LOP LOW OIL PRESSURE
- LOPS LOW OIL PRESSURE SWITCH
- LT LIGHT
- LTS LIGHTS
- M MAIN, MOTOR
- MU MULTIPLE UNIT PLUG
- MV MAGNETIC VALVE
- NEG NEGATIVE
- P1 AND P2 POWER CONTACTOR
- POS POSITIVE
- PR CONVENIENCE RECEPTACLE
- R, RHEO RHEOSTAT
- RE RESISTOR
- REG REGULATOR
- RVR RVF REVERSER SWITCH
- S, SW SWITCH
- SF SHUNT FIELD CONTACTOR
- SH SHUNT
- SHT SHUTTER
- ST START
- SW SWITCH
- T TOP POSITION
- TB TERMINAL BOARD
- TM TRACTION MOTOR
- VOLT VOLTAGE
- VR VOLTAGE REGULATOR
- WSR WHEEL SLIP RELAY



BATTERY, RECTIFIER,
START,
GROUND RELAY

HEADLIGHTS

HEATERS

ENGINE
WARNING

FO-1 SCHEMATIC (1 of 2)

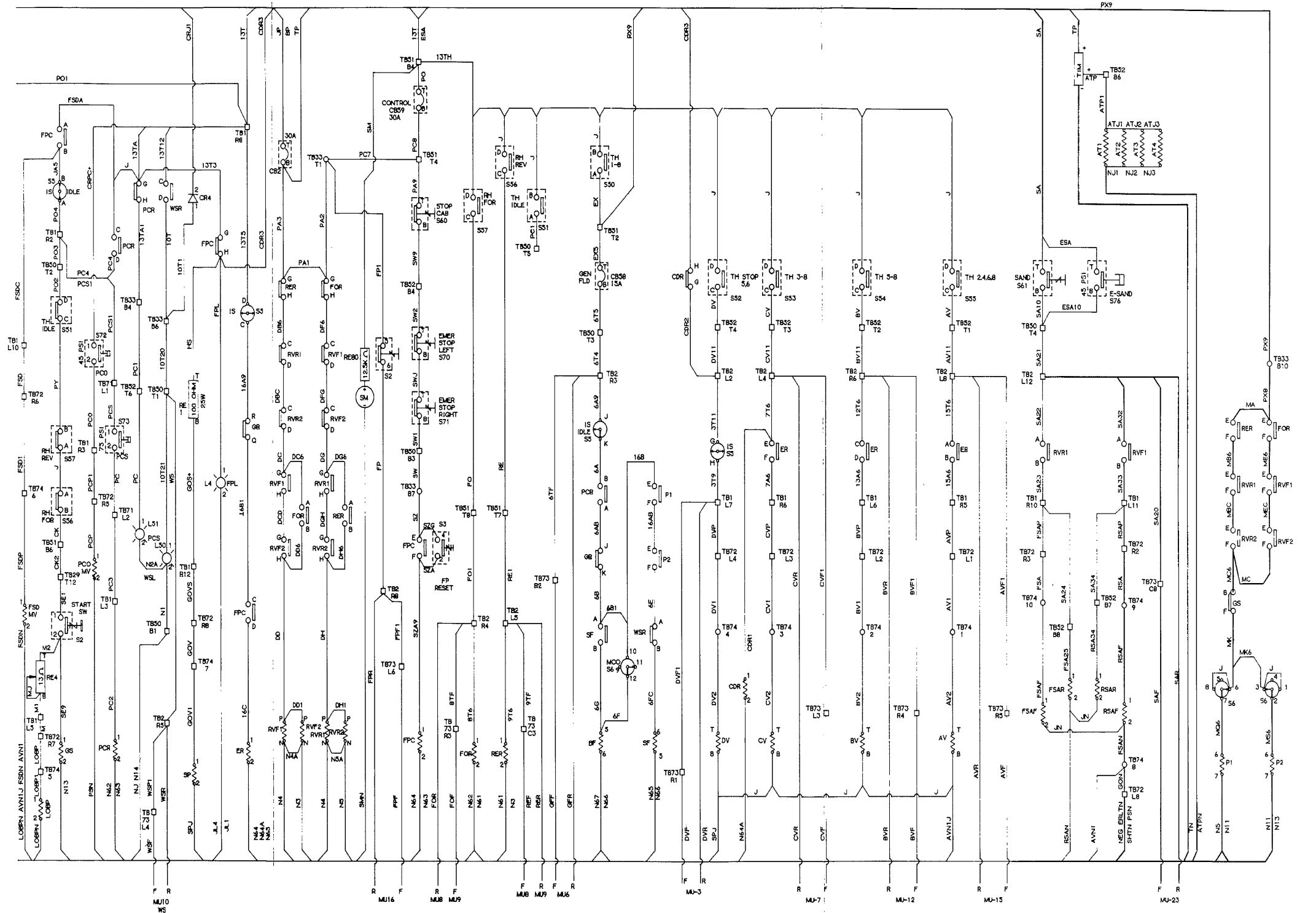
FP-1/(FP-2 blank)

FO-1 SCHEMATIC (1 of 2)

FP-1/(FP-2 blank)

- AT1,2,3,4 AUTOMATIC TIMER RESISTOR
- AV A-VALVE
- BF BATTERY FIELD
- BV B-VALVE
- CB CIRCUIT BREAKER
- CR CLOSE DOWN RELAY
- CV CURRENT RECTIFIER, DIODE
- DV C-VALVE
- EMER,E D-VALVE
- ER EMERGENCY
- FLD ENGINE RUN RELAY
- FOR FIELD
- FP FORWARD RELAY
- FP FUEL PRESSURE
- FPC FUEL PRESSURE CONTROL
- FPL FUEL PRESSURE LIGHT
- FSAF FRONT SAND FORWARD
- FSAR FRONT SAND REVERSE
- FSD FUEL SHUT DOWN
- GEN GENERATOR
- GR, GRN GROUND, GROUND RELAY
- GS GENERATOR SWITCH OR CONTACTOR
- IS, ISO ISOLATION SWITCH
- J JUMPER
- L, LT LIGHT
- LOBP LOW OIL BY PASS
- MCO MOTOR CUT OUT
- MU MULTIPLE UNIT PLUG
- MV MAGNETIC VALVE
- P1 AND P2 POWER CONTACTOR
- PCO PRESSURE CUTOUT
- PCR PRESSURE CONTROL RELAY
- PCS PRESSURE CONTROL SWITCH
- RE RESISTOR
- RER REVERSE RELAY
- REV REVERSE
- RH REVERSER HANDLE
- RSAR REAR SAND FORWARD
- RSAR REAR SAND REVERSE
- RVR RVF REVERSER SWITCH
- S, SW SWITCH
- SAND SAND
- SF SHUNT FIELD CONTACTOR
- SM SERVICE METER
- SP STOP
- ST START
- TB TERMINAL BOARD
- TH THROTTLE
- TIM TIMER
- WSL WHEEL SLIP LIGHT
- WSR WHEEL SLIP RELAY

Schematic Legend for F02.



START/
SHUTDOWN

FORWARD-REVERSE
RELAYS

THROTTLE,
ENGINE RUN
RELAYS

SANDERS MOTOR
CUTOUT

FO-1 SCHEMATIC (2 of 2)
FP-3/(FP-4 blank)

FO-1 SCHEMATIC (2 of 2)

FP-3/(FP-4 blank)

From	Wire ID	To	From	Wire ID	To	From	Wire ID	To	From	Wire ID	To
AM1+	AMP9+	SH2-1	CB7-T	HS	SH2-+	ER-1	16C	FPC-D	FPC-H	HS	RE1-T
AM1-	AMN9-	SH2-2	CB8-B	BCH	PR1-R	ER-2	N64	FPC-2	FSAF-1	FSAF	TB74-10
AM2-1	IP	SH1-2	CB8-T	J10	CB7-T	ER-2	N64A	CDR-2	FSAF-2	JN	RSAF-2
AM2-2	IN	SH1-1	CB50-B	LC3	TB51-T3	ER-2	N65	SF-5	FSAR-1	FSA25	TB52-B8
AT1-B	ATPN	TB51-T1	CB50-T	J	CB51-T	ER-A	15T6	TB2-L8	FSAR-2	RSAN	TB51-T1
AT1-B	NJ1	AT2-B	CB51-B	LY2	TB52-B1	ER-B	15A6	TB1-R5	FSAR-2	JN	RSAR-2
AT1-T	ATJ1	AT2-T	CB51-T	J	CB50-T	ER-C	12T6	TB2-R6	FSDMV-1	FSDP	TB74-6
AT1-T	ATP1	TB52-B6	CB51-T	J	CB52-T	ER-D	13A6	TB1-L6	FSDMV-2	FSDN	TB74-8
AT2-B	NJ1	AT1-B	CB51-T	LP8	TB50-B5	ER-E	CDR1	CDR-1	FSDMV-2	AVNI	TB74-8
AT2-B	NJ2	AT3-B	CB52-B	GA	TB50-B2	ER-E	7T6	TB2-L4	FSDMV-2	LOBPN	LOBP2
AT2-T	ATJ2	AT3-T	CB52-T	J	CB51-T	ER-F	7A6	TB1-R6	FSDMV2	AVNIJ	AV-B
AT2-T	ATJ1	AT1-T	CB53-B	HT1	TB52-T8	EX2PFLD-+	EF2+	TB70-R10	FT-1	BP3	GR-A
AT3-B	NJ2	AT2-B	CB53-T	J	CB54-T	EXG2-	J4	MAIN FLD-GF-	FT-2	BPA1	GR-B
AT3-B	NJ3	AT4-B	CB54-B	HT2A	R52-1	EXG2-+	EX+	SF-1	G1	GN	RVF2-3
AT3-T	ATJ3	AT4-T	CB54-T	J	CB53-T	F1-B	BFC	BF-2	G1	GN	RVF2-3
AT3-T	ATJ2	AT2-T	CB54-T	PH	TB52-T7	F1-T	BC	SH2-T	G1	GP	P1-1
AT4-B	NJ3	AT3-B	CB58-B	6T5	TB50-T3	F2-B	AG+	G3-A1	G1	GP	P1-1
AT4-T	ATJ3	AT3-T	CB58-T	EX5	TB51-T2	F2-B	AGP6	ST-3	G1	GP	P2-2
AV-B	AVNIJ	FSDMV2	CB59-B	PC8	TB51-T4	F2-T	BCP	CR1-R	G1	GP	P2-2
AV-B	J	BV-B	CB59-T	PO	TB51-B4	F3-B	STP	GS+	G2-AN	EFBN	G3-F2
AV-T	AV2	TB74-1	CB60-B	HC2	TB50-T8	F3-T	STP1	SH2	G2-AP	EFA+	TB31-L3
BELL-1	BELL	TB2-R1	CB60-T	J	S68-7	FF1-6	AA1	TM1-AA	G3-A1	AG+	F2-B
BELL2	BE-	TB31-R3	CB60-T	HB22	TB50-B7	FF2-6	AA2	TM2-AA	G3-F2	AG-	BS-BL
BF-1	BFL6	TB31-L1	CB61-B	HW2	TB50-T7	FF3-6	AA3	TM3-AA	G3-F2	EFBN	G2-AN
BF-2	BFC	F1-B	CB61-T	HV22	TB50-B8	FF4-6	AA4	TM4-AA	GR-A	BP3	FT-1
BF-5	6F	S6-12	CB61-T	J	S68-2	FOR-1	8T6	TB2-R4	GR-A	BP2	SH2-+
BF-5	6G	SF-B	CDR-1	CDR1	ER-E	FOR-2	N62	PCR-2	GR-B	BPA	S1-1
BF-6	N66	SF-5	CDR-2	N64A	ER-2	FOR-2	N61	RER-2	GR-B	BPA1	FT-2
BF-6	N67	TB31-R3	CDR-G	CDR2	TB2-L2	FOR-A	DC6	RVF1-G	GR-J	6AB	PCR-A
BS-BL	AG-	G3-F2	CDR-H	CDR3	FPC-H	FOR-B	DD6	RVF2-H	GR-K	6B	SF-A
BS-TL	BCNEG	CP-2	COM FLD-F	GN	SH1-T	FOR-E	MA	RER-E	GR-M	BN1	TB31-R2
BS-TR	BCPOS	CP-1	CP-1	BCPOS	BS-TR	FOR-E	PX8	TB33-B10	GR-N	6AB7	GROUND
BTRY SWTCH-BL	BN6	GS-	CP-2	BCNEG	BS-TL	FOR-F	ME6	RVF1-E	GR-P	6AB6	RE2-B
BTRY SWTCH-BL	BN66	TB31-R2	CR1-L	BCH2	RE70-R	FOR-G	PA2	TB33-T1	GR-Q	16B1	FPC-C
BV-B	J	CV-B	CR1-R	BCP	F2-T	FOR-G	PA1	RER-G	GR-R	16A9	S5-C
BV-B	J	AV-B	CR2-1	CR+	TB1-R7	FOR-H	DF6	RVF1-C	GROUND	6AB7	GR-N
BV-T	BV2	TB74-2	CR2-2	CRJ1	CR4-2	FPC-1	SZA9	FPC-F	GS+	STP	F3-B
CB2-B	TP	TIM+	CR2-2	CR-	TB2-R1	FPC-2	N64	ER-2	GS-	BN6	BTRY SWTCH-BL
CB2-B	PA3	RER-G	CR2-2	CRJ	CR3-2	FPC-2	N63	PCR-2	GS-+	GS	START FLD
CB2-T	BP	SH2-+	CR3-1	BPA6	L3-1	FPC-A	FSDA	PCR-C	GS-1	SE9	S2-2
CB2-T	JP	CB4-T	CR3-2	CRJ	CR2-2	FPC-B	FSDC	TB1-L10	GS-2	N13	P2-7
CB3-B	N69	TB31-R3	CR4-1	10T1	TB33-B6	FPC-B	JA5	S5-B	GS-B	MK	S6-6
CB3-B	TN	TIM-	CR4-2	CRJ1	CR2-2	FPC-C	16B1	GR-Q	GS-B	MC6	RVR2-F
CB3-T	J	CB5-T	CR5-1	ET2	TB1-L8	FPC-D	16C	ER-1	GS-B-	GP3	P1-1
CB3-T	BN2	TB31-L2	CR5-2	ET3	TB2-R1	FPC-E	SZG	S3-4	HM1-1	HM1	HTR1-2
CB4-B	LP6	TB33-T2	CV-B	J	DV-B	FPC-E	SZ	TB33-B7	HM2-1	HT2	TB1-L15
CB4-T	JP	CB2-T	CV-B	J	BV-B	FPC-F	SZA9	FPC-1	HM2-2	HT2N	TB1-R1
CB5-B	LN6	TB1-R1	CV-T	CV2	TB74-3	FPC-F	SZA	S3-2	HN1-2	HT1N	TB1-R1
CB5-T	J	CB3-T	DV-B	SPJ	SP-2	FPC-G	13T3	PCR-G	HTR1-1	HT11	TB1-L14
CB7-B	HP6	TB33-B3	DV-B	J	CV-B	FPC-H	CDR3	CDR-H	HTR1-2	HM1	HM1-1
CB7-T	H+	TB29A-R3	DV-T	DV2	TB74-4	FPC-H	FPL	L4-1	L1-1	ET1	TB1-L8
CB7-T	J10	CB3-T									

From	Wire ID	To	From	Wire ID	To	From	Wire ID	To	From	Wire ID	To
L1-2	JL1	L4-2	L75-1	J	L76-1	MUR-12	BVR	TB2-R6	RE2-B	6AB6	GR-P
L1-2	NIL	TB31-R3	L75-1	NO	TB7-L3	MUR-15	AVR	TB2-L8	RE2-B	GRJ	RE3-B
L2-1	LOP	TB1-R7	L75-2	J	L76-2	MUR-16	FPR	TB2-R8	RE2-T	GRP	P2-1
L2-2	JL4	L4-2	L76-1	J	L75-1	MUR-23	SAR	TB2-L12	RE3-B	GRJ	RE2-B
L3-1	BPA6	CR3-1	L76-2	NUN	TB71-R1	MUR-25	25R	TB2-R12	RE4-B	MJ	RE4-C
L3-1	BPA9	S1-1	L76-2	J	L75-2	P1-1	GP3	GS-B-	RE4-B	M1	TB1-L5
L3-2	BN30	TB31-R2	L77-1	J	PR2-1	P1-1	GP	G1	RE4-C	MJ	RE4-B
L4-1	FPL	FPC-H	L77-1	ERLT1	TB75-4	P1-1	GP	G1	RE4-T	M2	S2-2
L4-2	JL1	L1-2	L77-2	J	PR2-2	P1-2	A1	TM1-A	RE5-1	EX2+	TB70-L8
L4-2	JL4	L2-2	L78-1	J	PR2-1	P1-2	A2	TM2-A	RE5-2	GFEXJ	RE6-T
L50-1	10T21	TB50-T1	L78-2	J	PR2-2	P1-6	MQ6	S6-7	RE5-B	GF2	TB70-R9
L50-2	N1	TB50-B1	L78-2	ERLTN1	TB75-3	P1-7	N11	P2-7	RE6-B	EF3+	TB70-R10
L50-2	N2A	L51-2	L80-2	STLN	TB1-R1	P1-7	N5	RVR2-N	RE6-T	GFEXJ	RE5-2
L51-1	PC	TB52-T6	L80-2	J	L99-2	P1-E	16B	S6-10	RE53-L	J	RE54-L
L51-2	N2A	L50-2	L81-1	J	L82-1	P1-F	16AB	P2-E	RE53-L	GA3	R51-1
L53-1	J	L54-1	L81-1	FSTL	TB71-R3	P2-1	GRP	RE2-T	RE53-R	J	RE54-R
L53-1	J	R51-2	L81-2	J	L82-2	P2-2	GP	G1	RE53-R	GA2	TB50-B2
L53-2	J	L54-2	L82-1	J	L81-1	P2-2	GP	G1	RE54-L	J	RE53-L
L54-1	J	L55-1	L82-2	FSTLN	TB71-R1	P2-2	A3	TM3-A	RE54-R	J	RE53-R
L54-1	J	L53-1	L82-2	J	L81-2	P2-2	A4	TM4-A	RE70-L	BCA3	SH2-T
L54-2	J	L55-2	L83-1	J	L84-1	P2-6	MS6	S6-2	RE70-R	BCH2	CR1-L
L54-2	J	L53-2	L83-1	CAB	TB29-T10	P2-7	N13	GS-2	RE72-1	J	RE73-1
L55-1	J	L56-1	L83-2	J	L84-2	P2-7	N11	P1-7	RE72-2	J	RE72-3
L55-1	J	L54-1	L84-1	J	L83-1	P2-E	16AB	P1-F	RE72-3	J	RE72-2
L55-2	J	L56-2	L84-2	J	L83-2	P2-F	6E	WSR-A	RE72-3	HZ1	TB70-L5
L55-2	J	L54-2	L84-2	CABLN	TB29-T1	PCOMV-1	PCP	TB72-R5	RE73-1	J	RE72-1
L56-1	J	L57-1	L88-1	J	L99-1	PCOMV-2	PSN	TB72-L8	RE73-1	HW1	TB70-L4
L56-1	J	L55-1	L99-1	J	L88-1	PCR-1	PC2	TB1-L3	RE73-2	J	RE73-3
L56-2	J	L57-2	L99-1	RSTL	TB1-L13	PCR-2	N62	FOR-2	RE73-3	J	RE73-2
L56-2	J	L55-2	L99-2	J	L80-2	PCR-2	N63	FPC-2	RE73-3	HY1	TB70-R6
L57-1	J	L58-1	LOBP-1	LOBP1	TB74-5	PCR-A	6AB	GR-J	RE74-1	J	RE74-2
L57-1	J	L56-1	LOBP2	LOBPN	FSDMV-2	PCR-B	6A	S5-K	RE74-1	HP23J	RE75-1
L57-2	J	L58-2	MAIN FLD-GF+	GF+	SF-4	PCR-C	FSDA	FPC-A	RE74-2	J	RE74-1
L57-2	J	L56-2	MAIN FLD-GF-	J4	EXG2-	PCR-C	J	PCR-G	RE74-3	HU25	TB70-R3
L58-1	J	L59-1	MUF-3	DVF	TB73-R1	PCR-D	PC4	TB1-R2	RE74-4	HV25	TB70-L2
L58-1	J	L57-1	MUR-3	DVR	TB1-L7	PCR-G	13T3	FPC-G	RE75-1	J	RE75-2
L58-2	J	L59-2	MUF-6	GFF	TB73-R2	PCR-G	J	PCR-C	RE75-1	HP23J	RE74-1
L58-2	J	L57-2	MUR-6	GFR	TB2-R3	PCR-G	13TA	TB1-R8	RE75-1	HP23	TB70-R1
L59-1	J	L58-1	MUF-7	CVF	TB73-L3	PCR-H	13TA1	TB33-B4	RE75-2	J	RE75-1
L59-2	J	TB51-T1	MUR-7	CVR	TB2-L4	PR1-L	RECN	TB31-R2	RE75-3	HA25	TB70-L1
L59-2	J	L58-2	MUF-8	REF	TB73-C3	PR1-R	BCH	CB8-B	RE75-4	HB25	TB70-R2
L71-1	HDL1	TB71-L4	MUR-8	FOR	TB2-R4	PR2-1	J	L78-1	RE76-1	J	RE77-1
L71-2	HDLN	TB71-R1	MUF-9	FOF	TB73-R3	PR2-1	J	L77-1	RE76-1	HC1	TB70-L3
L71-2	JN	L72-2	MUR-9	RER	TB2-L5	PR2-2	J	L77-2	RE76-2	J	RE76-3
L72-1	HDL2	TB71-R4	MUF-10	WSF	TB73-L4	PR2-2	J	L78-2	RE76-3	J	RE76-2
L72-2	JN	L71-2	MUF-12	BVF	TB73-R4	R51-1	GA3	RE53-L	RE76-3	HE21	TB70-R4
L73-1	HD3	TB1-L4	MUF-15	AVF	TB73-R5	R51-2	J	L53-1	RE77-1	J	RE76-1
L73-2	HLRN	TB31-L2	MUF-16	FPF	TB73-L6	R52-1	HT2A	CB54-B	RE77-2	J	RE77-3
L73-2	JN1	L74-2	MUF-23	SAF	TB73-C8	R52-2	HT22	TB50-B4	RE77-3	J	RE77-2
L74-1	HD4	TB1-R4	MUF-25	25F	TB73-R8	RE1-B	GOS+	TB1-R12	RE77-3	HG21	TB70-R5
L74-2	JN1	L73-2	MUR-10	WSR	TB2-R5	RE1-T	HS	FPC-H	RE78-B	J	RE79-B

From	Wire ID	To	From	Wire ID	To	From	Wire ID	To	From	Wire ID	To
RE78-T	GEFRA	TB70-R8	RVR1-G	DG6	RER-A	S5-J	6A9	TB2-R3	S68-6	HA22	TB51-B5
RE79-B	J	RE78-B	RVR1-G	DG	RVF2-D	S5-K	6A	PCR-B	S68-7	J	CB60-T
RE79-C	GEFRB	TB70-L7	RVR1-H	DGH	RVR2-G	S6-1	J	S6-3	S68-L1	J	S68-L2
RE80+	SM	TB51-B4	RVR1-N	N4	RVF1-N	S6-2	MS6	P2-6	S68-L2	HP5	TB50-T6
RER-1	9T6	TB2-L5	RVR1-N	N5A	RVR2-N	S6-3	MK6	S6-6	S68-L2	J	S68-L1
RER-2	N61	FOR-2	RVR1-P	DH1	RVR2-P	S6-3	J	S6-1	S70-B	SWJ	S71-T
RER-2	N3	RVF2-N	RVR1-P	DH	RVR2-H	S6-6	J	S6-8	S70-T	SW2	TB52-B4
RER-A	DG6	RVR1-G	RVR2-3	GN	G1	S6-6	MK	GS-B	S71-B	SW1	TB50-B3
RER-B	DH6	RVR2-H	RVR2-C	DBC	RVR1-D	S6-6	MK6	S6-3	S71-T	SWJ	S70-B
RER-E	MA	FOR-E	RVR2-D	DC	RVF1-G	S6-7	MQ6	P1-6	S72-1	CRPC+	TB1-R8
RER-F	MB6	RVR1-E	RVR2-E	MBC	RVR1-F	S6-8	J	S6-6	S72-2	PCO	TB1-R3
RER-G	PA1	FOR-G	RVR2-F	MC6	GS-B	S6-10	6B1	SF-A	S73-1	PCS	TB71-L1
RER-G	PA3	CB2-B	RVR2-F	MC	RVF2-F	S6-10	16B	P1-E	S73-2	PC	TB71-L2
RER-H	DB6	RVR1-C	RVR2-G	DGH	RVR1-H	S6-12	6F	BF-5	S74-1	J	S75-1
RSAF-1	RSFAF	TB74-9	RVR2-H	DH	RVR1-P	S7-3	LE7	TB33-T2	S74-1	POA	TB72-L7
RSAF-2	JN	FSAF-2	RVR2-H	DH6	RER-B	S7-4	LE9	TB1-L12	S74-2	OA	TB72-L5
RSAF-2	FSAN	TB74-8	RVR2-N	N5A	RVR1-N	S50-A	EX	TB51-T2	S75-1	J	S74-1
RSAR-2	JN	FSAF-2	RVR2-N	N5	P1-7	S50-B	J	S51-B	S75-2	WA	TB72-L6
RSAR-2	RSA34	TB52-B7	RVR2-P	DH1	RVR1-P	S50-B	J	S52-D	S76-B	ESA 10	TB50-T4
RVF1-3	J1	SH1	S1-1	BPA9	L3-1	S51-A	PC1	TB50-T5	S76-T	ESA	TB51-B4
RVF1-A	SA32	TB2-L12	S1-1	BPA	GR-B	S51-B	J	S50-B	S77-1	SHP	TB72-L7
RVF1-B	SA33	TB1-L11	S2-1	SE1	TB29-T12	S51-B	J	S56-D	S77-2	STS	SHTMV-2
RVF1-C	DF6	FOR-H	S2-2	SE9	GS-1	S51-C	PY	S57-B	SF-1	EX1+	TB70-L8
RVF1-D	DFG	RVF2-C	S2-2	M2	RE4-T	S51-D	PO2	TB50-T2	SF-1	EX+	EXG2-+
RVF1-E	ME6	FOR-F	S2-4	AGP7	VR-1	S52-C	DV	TB52-T4	SF-4	GF+	MAIN FLD-GF+
RVF1-F	MEC	RVF2-E	S2-5	FP1	TB33-T1	S52-D	J	S50-B	SF-4	GF1	TB70-R9
RVF1-G	DC6	FOR-A	S2-6	FP	TB2-R8	S52-D	J	S53-D	SF-5	N65	ER-2
RVF1-G	DC	RVR2-D	S3-2	SZA	FPC-F	S53-C	CV	TB52-T3	SF-5	N66	BF-6
RVF1-H	DCD	RVF2-G	S3-4	SZG	FPC-E	S53-D	J	S54-D	SF-6	6FC	WSR-B
RVF1-N	N4A	RVF2-N	S4/W1-1	HC	TB70-L3	S53-D	J	S52-D	SF-A	6B1	S6-10
RVF1-N	N4	RVR1-N	S4/W1-1	J	S4/W4-4	S54-C	BV	TB52-T2	SF-A	6B	GR-K
RVF1-P	DD1	RVF2-P	S4/W1-3	J	S4/W2-L	S54-D	J	S55-D	SF-B	6G	BF-5
RVF1-P	DD	RVF2-H	S4/W1-L	HC4	TB33-T7	S54-D	J	S53-D	SH1	J2	RVR1-3
RVF2-3	GN	G1	S4/W2-4	J	S4/W3-1	S55-C	AV	TB52-T1	SH1	J1	RVF1-3
RVF2-C	DFG	RVF1-D	S4/W2-L	25T1	TB2-R11	S55-D	J	S54-D	SH1-1	IN	AM2-2
RVF2-D	DG	RVR1-G	S4/W2-L	J	S4/W1-3	S56-A	J	S57-A	SH1-2	IP	AM2-1
RVF2-E	MEC	RVF1-F	S4/W3-1	J	S4/W3-3	S56-B	CK	TB51-B6	SH1-T	GN	COM FLD-F
RVF2-E	MC	RVR2-F	S4/W3-1	J	S4/W2-4	S56-C	RE	TB51-T7	SH1-T	GN	COM FLD-F
RVF2-F	DCD	RVF1-H	S4/W3-2	J	S4/W4-L	S56-D	J	S51-B	SH2	STP1	F3-T
RVF2-H	DD	RVF1-P	S4/W3-3	HW	TB70-L4	S56-D	J	S57-D	SH2-+	BP2	GR-A
RVF2-H	DD6	FOR-B	S4/W3-3	J	S4/W3-1	S57-A	J	S56-A	SH2-+	HS	CB7-T
RVF2-N	N3	RER-2	S4/W3-L	HW4	TB33-T8	S57-B	PY	S51-C	SH2-+	BP	CB2-T
RVF2-N	N4A	RVF1-N	S4/W4-4	J	S4/W1-1	S57-C	FO	TB51-T8	SH2-1	AMP9+	AM1+
RVF2-P	DD1	RVF1-P	S4/W4-L	25T2	TB2-R12	S57-D	J	S56-D	SH2-2	AMN9-	AM1-
RVR1-3	J2	SH1	S4/W4-L	J	S4/W3-2	S57-D	13TH	TB51-B4	SH2-T	BC	F1-T
RVR1-A	SA22	TB2-L12	S5-A	PO4	TB1-R2	S60-B	SW9	TB52-B4	SH2-T	BCA3	RE70-L
RVR1-B	SA23	TB1-R10	S5-B	JA5	FPC-B	S60-T	PA9	TB51-T4	SHTMV-2	SHTN	TB72-L8
RVR1-C	DB6	RER-H	S5-C	16A9	GR-R	S61-B	SA10	TB50-T4	SHTMV-2	STS	S77-2
RVR1-D	DBC	RVR2-C	S5-D	13T5	TB1-R8	S61-T	SA	TB51-B4	SM+	SM	TB51-B4
RVR1-E	MB6	RER-F	S5-G	3T11	TB2-L2	S68-1	HU22	TB51-T5	SM-	SMN	TB51-T1
RVR1-F	MBC	RVR2-E	S5-H	3T9	TB1-L7	S68-2	J	CB61-T	SP-1	GOV1	TB74-7

From	Wire ID	To	From	Wire ID	To	From	Wire ID	To	From	Wire ID	To
SP-2	SPJ	DV-B	TB1-R5	AVP	TB72-L1	TB2-R4	F01	TB51-T8	TB33-B6	10T20	TB50-T1
ST-3	AGP6	F2-B	TB1-R5	15A6	ER-B	TB2-R5	WSR	MUR-10	TB33-B6	10T1	CR4-1
START FLD	GS	GS+	TB1-R6	CVP	TB72-L3	TB2-R5	WSF1	TB73-L4	TB33-B6	10T	WSR-D
TB1-L1	NEG	TB72-L8	TB1-R6	7A6	ER-F	TB2-R5	WS	TB50-T1	TB33-B7	SZ	FPC-E
TB1-L1	CN	TB31-R3	TB1-R7	LOP	L2-1	TB2-R6	BVF1	TB73-R4	TB33-B7	SW	TB50-B3
TB1-L2	AFP1	VR-2	TB1-R7	OA1	TB72-L5	TB2-R6	BVR	MUR-12	TB33-B10	PX8	FOR-E
TB1-L3	PC3	TB71-L2	TB1-R7	CR+	CR2-1	TB2-R6	12T6	ER-C	TB33-T1	FP1	S2-5
TB1-L3	PC2	PCR-1	TB1-R8	PO1	TB72-L7	TB2-R6	BV11	TB52-T2	TB33-T1	PC7	TB51-T4
TB1-L4	HD3	L73-1	TB1-R8	13T12	WSR-C	TB2-R8	FPR	MUR-16	TB33-T1	PA2	FOR-G
TB1-L4	HY2	TB70-R6	TB1-R8	13TA	PCR-G	TB2-R8	FPF1	TB73-L6	TB33-T2	LE7	S7-3
TB1-L5	M	TB72-R7	TB1-R8	13T5	S5-D	TB2-R8	FP	S2-6	TB33-T2	LP9	TB50-B5
TB1-L5	M1	RE4-B	TB1-R8	13T	TB51-B4	TB2-R11	25T4	TB73-R8	TB33-T2	LP6	CB4-B
TB1-L6	BVP	TB72-L2	TB1-R8	CRPC+	S72-1	TB2-R11	25T1	S4/W2-L	TB33-T3	HB23	TB50-B7
TB1-L6	13A6	ER-D	TB1-R9	HD2	TB71-R4	TB2-R12	25R	MUR-25	TB33-T3	HB24	TB70-R2
TB1-L7	DVR	MUR-3	TB1-R9	HG22	TB70-R5	TB2-R12	25T2	S4/W4-L	TB33-T4	HA24	TB70-L1
TB1-L7	DVF1	TB73-R1	TB1-R10	FSAP	TB72-R3	TB7-L3	NO	L75-1	TB33-T4	HA23	TB51-B5
TB1-L7	DVP	TB72-L4	TB1-R10	SA24	TB52-B8	TB29-T1	CABLN	L84-2	TB33-T5	HU24	TB70-R3
TB1-L7	3T9	S5-H	TB1-R10	SA23	RVR1-B	TB29-T1	N15	TB31-L2	TB33-T5	HU23	TB51-T5
TB1-L8	ET1	L1-1	TB1-R12	GOVS	TB72-R8	TB29-T1	LC5	TB51-T3	TB33-T6	HV23	TB50-B8
TB1-L8	ETH	TB72-L6	TB1-R12	GOS+	RE1-B	TB29-T1	CK2	TB51-B6	TB33-T6	HV24	TB70-L2
TB1-L8	ET2	CR5-1	TB2-L2	3T11	S5-G	TB29-T10	CAB	L83-1	TB33-T7	HC4	S4/W1-L
TB1-L9	HD1	TB71-L4	TB2-L2	DV11	TB52-T4	TB29-T12	SE1	S2-1	TB33-T7	HC5	TB50-T8
TB1-L9	HE22	TB70-R4	TB2-L2	CDR2	CDR-G	TB29A-R3	PH1	TB52-T7	TB33-T8	HW4	S4/W3-L
TB1-L10	FSD	TB72-R6	TB2-L4	CVF1	TB73-L3	TB29A-R3	H+	CB7-T	TB33-T8	HW5	TB50-T7
TB1-L10	FSDC	FPC-B	TB2-L4	CVR	MUR-7	TB31-L1	GEFR1	7B70-R8	TB50-B1	NJ	TB51-T1
TB1-L11	RASP	TB72-R2	TB2-L4	7T6	ER-E	TB31-L1	BFL6	BF-1	TB50-B1	N1	L50-2
TB1-L11	SA34	TB52-B7	TB2-L4	CV11	TB52-T3	TB31-L2	J	TB31-R2	TB50-B1	N14	TB31-L2
TB1-L11	SA33	RVF1-B	TB2-L5	RER	MUR-9	TB31-L2	N15	TB29-T1	TB50-B2	GA2	RE53-R
TB1-L12	ELT	TB72-R4	TB2-L5	ITF	TB73-C3	TB31-L2	MU-	TB2-R2	TB50-B2	GA	CB52-B
TB1-L12	LE9	S7-4	TB2-L5	9T6	RER-1	TB31-L2	BN2	CB3-T	TB50-B3	SW1	S71-B
TB1-L13	RSTL	L99-1	TB2-L5	RE1	TB51-T7	TB31-L2	N14	TB50-B1	TB50-B3	SW	TB33-B7
TB1-L13	STL	TB71-R3	TB2-L8	AVF1	TB73-R5	TB31-L2	HLRN	L73-2	TB50-B4	HT2A	TB1-L15
TB1-L13	NUL	TB71-L3	TB2-L8	AVR	MUR-15	TB31-L2	BN15	VR-3	TB50-B4	HT22	R52-2
TB1-L13	LY3	TB52-B1	TB2-L8	15T6	ER-A	TB31-L3	EFA+	G2-AP	TB50-B5	LP8	CB51-T
TB1-L14	HT11	HTR1-1	TB2-L8	AV11	TB52-T1	TB31-L3	GEFR2	TB70-L7	TB50-B5	LP9	TB33-T2
TB1-L14	HT1A	TB52-T8	TB2-L12	SAR	MUR-23	TB31-R2	BN1	GR-M	TB50-B7	HB22	CB60-T
TB1-L15	HT2	HM2-1	TB2-L12	SA20	TB73-C8	TB31-R2	RECN	PR1-L	TB50-B7	HB23	TB33-T3
TB1-L15	HT2A	TB50-B4	TB2-L12	SA32	RVF1-A	TB31-R2	BN30	L3-2	TB50-B8	HV22	CB61-T
TB1-R1	HT2N	HM2-2	TB2-L12	SA22	RVR1-A	TB31-R2	J	TB31-L2	TB50-B8	HV23	TB33-T6
TB1-R1	HT1N	HN1-2	TB2-L12	SA21	TB50-T4	TB31-R2	BN66	BTRY SWITCH-BL	TB50-T1	WS	TB2-R5
TB1-R1	STLN	L80-2	TB2-R1	BELL	BELL-1	TB31-R3	CN	TB1-L1	TB50-T1	10T21	L50-1
TB1-R1	LTN	TB71-R1	TB2-R1	ET3	CR5-2	TB31-R3	BE-	BELL2	TB50-T1	10T20	TB33-B6
TB1-R1	LN6	CB5-B	TB2-R1	CR-	CR2-2	TB31-R3	N67	BF-6	TB50-T2	P02	S51-D
TB1-R2	P04	S5-A	TB2-R2	MU-	TB31-L2	TB31-R3	NIL	L1-2	TB50-T2	P03	TB1-R2
TB1-R2	P03	TB50-T2	TB2-R3	GFR	MUR-6	TB31-R3	N69	CB3-B	TB50-T3	6T4	TB2-R3
TB1-R2	PCS1	TB71-L1	TB2-R3	6TF	TB73-R2	TB33-B1	PX9	TB51-T2	TB50-T3	6T5	CB58-B
TB1-R2	PC4	PCR-D	TB2-R3	6A9	S5-J	TB33-B3	HP22	TB70-R1	TB50-T4	SA21	TB2-L12
TB1-R3	PC0	S72-2	TB2-R3	6T4	TB50-T3	TB33-B3	HP6	CB7-B	TB50-T4	ESA 10	S76-B
TB1-R3	PCP1	TB72-R5	TB2-R4	FOR	MUR-8	TB33-B3	HP7	TB50-T6	TB50-T4	SA10	S61-B
TB1-R4	HD4	L74-1	TB2-R4	8TF	TB73-R3	TB33-B4	PC1	TB52-T6	TB50-T5	PC1	S51-A
TB1-R4	HZZ	TB70-L5	TB2-R4	8T6	FOR-1	TB33-B4	13TA1	PCR-H	TB50-T6	HP7	TB33-B3

From	Wire ID	To	From	Wire ID	To	From	Wire ID	To	From	Wire ID	To
TB50-T6	HP5	S68-L2	TB52-T4	DV	S52-C	TB71-R3	STL	TB1-L13	TB73-R3	8TF	TB2-R4
TB50-T7	HW5	TB33-T8	TB52-T4	DV11	TB2-L2	TB71-R4	HDL2	L72-1	TB73-R4	BVF	MUF-12
TB50-T7	HW2	CB61-B	TB52-T6	PC	L51-1	TB71-R4	HD2	TB1-R9	TB73-R4	BVF1	TB2-R6
TB50-T8	HC5	TB33-T7	TB52-T6	PC1	TB33-B4	TB72-L1	AV1	TB74-1	TB73-R5	AVF	MUF-15
TB50-T8	HC2	CB60-B	TB52-T7	PH	CB54-T	TB72-L1	AVP	TB1-R5	TB73-R5	AVF1	TB2-L8
TB51-B4	ESA	S76-T	TB52-T7	PH1	TB29A-R3	TB72-L2	BV1	TB74-2	TB73-R8	25F	MUF-25
TB51-B4	SM	SM+	TB52-T8	HT1A	TB1-L14	TB72-L2	BVP	TB1-L6	TB73-R8	25T4	TB2-R11
TB51-B4	SM	RE80+	TB52-T8	HT1	CB53-B	TB72-L3	CV1	TB74-3	TB74-1	AV2	AV-T
TB51-B4	SA	S61-T	TB70-L1	HA25	RE75-3	TB72-L3	CVP	TB1-R6	TB74-1	AV1	TB72-L1
TB51-B4	13TH	S57-D	TB70-L1	HA24	TB33-T4	TB72-L4	DVP	TB1-L7	TB74-2	BV2	BV-T
TB51-B4	PO	CB59-T	TB70-L2	HV24	TB33-T6	TB72-L4	DV1	TB74-4	TB74-2	BV1	TB72-L2
TB51-B4	13T	TB1-R8	TB70-L2	HV25	RE74-4	TB72-L5	OA1	TB1-R7	TB74-3	CV2	CV-T
TB51-B5	HA23	TB33-T4	TB70-L3	HC1	RE76-1	TB72-L5	OA	S74-2	TB74-3	CV1	TB72-L3
TB51-B5	HA22	S68-6	TB70-L3	HC	S4/W1-1	TB72-L6	ETH	TB1-L8	TB74-4	DV1	TB72-L4
TB51-B6	CK2	TB29-T1	TB70-L4	HW1	RE73-1	TB72-L6	WA	S75-2	TB74-4	DV2	DV-T
TB51-B6	CK	S56-B	TB70-L4	HW	S4/W3-3	TB72-L7	SHP	S77-1	TB74-5	LOBP1	LOBP-1
TB51-T1	NJ	TB50-B1	TB70-L5	HZ2	TB1-R4	TB72-L7	POA	S74-1	TB74-5	LOBP	TB72-R7
TB51-T1	SMN	SM-	TB70-L5	HZ1	RE72-3	TB72-L7	PO1	TB1-R8	TB74-6	FSD1	TB72-R6
TB51-T1	ATPN	AT1-B	TB70-L7	GEFR2	TB31-L3	TB72-L8	NEG	TB1-L1	TB74-6	FSDP	FSDMV-1
TB51-T1	RSAN	FSAR-2	TB70-L7	GEFRB	RE79-C	TB72-L8	ERLTN	TB75-3	TB74-7	GOV1	SP-1
TB51-T1	J	L59-2	TB70-L8	EX2+	RE5-1	TB72-L8	SHTN	SHTMV-2	TB74-7	GOV	TB72-R8
TB51-T2	EX5	CB58-T	TB70-L8	EX1+	SF-1	TB72-L8	PSN	PCOMV-2	TB74-8	AVNI	FSDMV-2
TB51-T2	PX9	TB33-B1	TB70-R1	HP23	RE75-1	TB72-L8	GON	TB74-8	TB74-8	GON	TB72-L8
TB51-T2	EX	S50-A	TB70-R1	HP22	TB33-B3	TB72-R2	RSA	TB74-9	TB74-8	FSAN	RSAF-2
TB51-T3	LC5	TB29-T1	TB70-R2	HB24	TB33-T3	TB72-R2	RASP	TB1-L11	TB74-8	FSDN	FSDMV-2
TB51-T3	LC3	CB50-B	TB70-R2	HB25	RE75-4	TB72-R3	FSA	TB74-10	TB74-9	RSAF	RSAF-1
TB51-T4	PC8	CB59-B	TB70-R3	HU25	RE74-3	TB72-R3	FSAP	TB1-R10	TB74-9	RSA	TB72-R2
TB51-T4	PA9	S60-T	TB70-R3	HU24	TB33-T5	TB72-R4	ERLT	TB75-4	TB74-10	FSAF	FSAF-1
TB51-T4	PC7	TB33-T1	TB70-R4	HE22	TB1-L9	TB72-R4	ELT	TB1-L12	TB74-10	FSA	TB72-R3
TB51-T5	HU23	TB33-T5	TB70-R4	HE21	RE76-3	TB72-R5	PCP1	TB1-R3	TB75-3	ERLTN1	L78-2
TB51-T5	HU22	S68-1	TB70-R5	HG22	TB1-R9	TB72-R5	PCP	PCOMV-1	TB75-3	ERLTN	TB72-L8
TB51-T7	RE1	TB2-L5	TB70-R5	HG21	RE77-3	TB72-R6	FSD	TB1-L10	TB75-4	ERLT1	L77-1
TB51-T7	RE	S56-C	TB70-R6	HY2	TB1-L4	TB72-R6	FSD1	TB74-6	TB75-4	ERLT	TB72-R4
TB51-T8	FO1	TB2-R4	TB70-R6	HY1	RE73-3	TB72-R7	LOBP	TB74-5	TIM+	ATP	TB52-B6
TB51-T8	FO	S57-C	TB70-R8	GEFRA	RE78-T	TB72-R7	M	TB1-L5	TIM+	TP	CB2-B
TB52-B1	LY3	TB1-L13	TB70-R9	GF1	SF-4	TB72-R8	GOV	TB74-7	TIM-	TN	CB3-B
TB52-B1	LY2	CB51-B	TB70-R9	GF2	RE5-B	TB72-R8	GOVS	TB1-R12	TM1-A	A1	P1-2
TB52-B4	SW2	S70-T	TB70-R10	EF2+	EX2PFLD-+	TB73-C3	REF	MUF-8	TM1-AA	AA1	FF1-6
TB52-B4	SW9	S60-B	TB70-R10	EF3+	RE6-B	TB73-C3	ITF	TB2-L5	TM2-A	A2	P1-2
TB52-B6	ATP1	AT1-T	TB71-L1	PCS1	TB1-R2	TB73-C8	SAF	MUF-23	TM2-AA	AA2	FF2-6
TB52-B6	ATP	TIM+	TB71-L1	PCS	S73-1	TB73-C8	SA20	TB2-L12	TM3-A	A3	P2-2
TB52-B7	RSA34	RSAR-2	TB71-L2	PC	S73-2	TB73-L3	CVF	MUF-7	TM3-AA	AA3	FF3-6
TB52-B7	SA34	TB1-L11	TB71-L2	PC3	TB1-L3	TB73-L3	CVF1	TB2-L4	TM4-A	A4	P2-2
TB52-B8	FSA25	FSAR-1	TB71-L3	NUL	TB1-L13	TB73-L4	WSF	MUF-10	TM4-AA	AA4	FF4-6
TB52-B8	SA24	TB1-R10	TB71-L4	HD1	TB1-L9	TB73-L4	WSF1	TB2-R5	VR-1	AGP7	S2-4
TB52-T1	AV11	TB2-L8	TB71-L4	HDL1	L71-1	TB73-L6	FPF	MUF-16	VR-2	AFP1	TB1-L2
TB52-T1	AV	S55-C	TB71-R1	LTN	TB1-R1	TB73-L6	FPF1	TB2-R8	VR-3	BN15	TB31-L2
TB52-T2	BV11	TB2-R6	TB71-R1	FSTLN	L82-2	TB73-R1	DVF	MUF-3	WSR-A	6E	P2-F
TB52-T2	BV	S54-C	TB71-R1	NUN	L76-2	TB73-R1	DVF1	TB1-L7	WSR-B	6FC	SF-6
TB52-T3	CV11	TB2-L4	TB71-R1	HDLN	L71-2	TB73-R2	6TF	TB2-R3	WSR-C	13T12	TB1-R8
TB52-T3	CV	S53-C	TB71-R3	FSTL	L81-1	TB73-R2	GFF	MUF-6	WSR-D	10T	TB33-B6
						TB73-R3	FOF	MUF-9	7B70-R8	GEFR1	TB31-L1

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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
 1 decimeter = 10 centimeters = 3.94 inches
 1 meter = 10 decimeters = 39.37 inches
 1 dekameter = 10 meters = 32.8 feet
 1 hectometer = 10 dekameters = 328.08 feet
 1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
 1 decigram = 10 centigrams = 1.54 grains
 1 gram = 10 decigram = .035 ounce
 1 decagram = 10 grams = .35 ounce
 1 hectogram = 10 decagrams = 3.52 ounces
 1 kilogram = 10 hectograms = 2.2 pounds
 1 quintal = 100 kilograms = 220.46 pounds
 1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliliters = .34 fl. ounce
 1 deciliter = 10 centiliters = 3.38 fl. ounces
 1 liter = 10 deciliters = 33.81 fl. ounces
 1 dekaliter = 10 liters = 2.64 gallons
 1 hectoliter = 10 dekaliters = 26.42 gallons
 1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
 1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
 1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
 1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
 1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
 1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
 1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
 1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

<i>To change</i>	<i>To</i>	<i>Multiply by</i>	<i>To change</i>	<i>To</i>	<i>Multiply by</i>
inches	centimeters	2.540	ounce-inches	Newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	Newton-meters	1.356	metric tons	short tons	1.102
pound-inches	Newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C
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