SERVICE MANUAL SECTION

BRAKE COMPONENTS: This Service Manual Section should be used for reference only. For more current service information on all components go to the Bendix website from the ISIS Suppliers menu and refer to the Service Data Sheets.

s04002r, Formerly CTS-5020R

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Table of Contents

1. GENERAL INFORMATION

Air brake equipment on trucks and truck-tractors provides a means of controlling brakes through the medium of compressed air. Air brakes consist of a group of devices: some maintain a supply of compressed air, some direct and control the flow of compressed air, and others transfer the energy of compressed air into the mechanical force and motion necessary to apply the brakes. Different types and sizes of devices are in use on different types of vehicles to meet operating requirements.

Refer to GROUP 04 - AIR BRAKES in the CTS-5000 Master Service Manual for description of the split air system used on the particular vehicles covered by Federal Motor Vehicle Safety Standard 121 (FMVSS 121).

The components used to make up a typical dual air system on a chassis are listed in this section with a brief description, operation, service checks and maintenance procedures. Disassembly and reassembly instructions are provided for some components.

WARNING – Whenever any component is serviced or removed from the air system, be sure to set the parking brake and/or block the wheels to prevent the vehicle from moving while the service is being performed.

2. RESERVOIR

2.1. DESCRIPTION

The air reservoir (air tank) provides the volume of compressed air required during brake system function.

There are at least three reservoirs on trucks with the FMVSS 121 brake system: supply, secondary and primary. The primary reservoir is the air source for the rear brakes. The front brakes are supplied by the secondary air tank. In some instances, the supply reservoir and secondary reservoir may be the same tank with a separation inside (Figure 1).

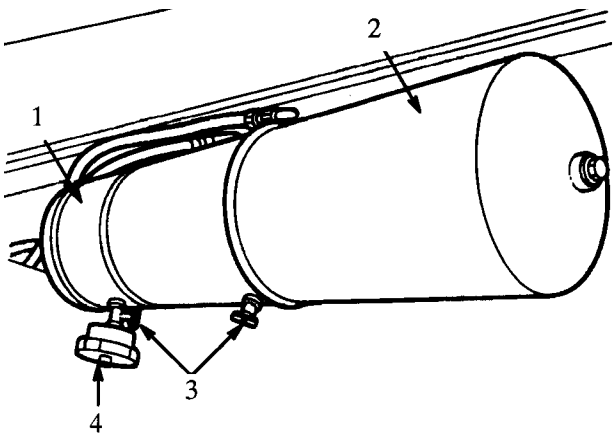

Figure 1 Reservoir

1. SUPPLY RESERVOIR
2. SECONDARY RESERVOIR
3. DRAIN COCK
4. AUTOMATIC DRAIN VALVE

Another function of a reservoir is to provide a place where the air, heated during compression, may cool and cause the oil and water vapors to condense.

The combined volume of all service reservoirs and supply reservoirs is 12 times the combined volume of all service brake chambers at maximum travel of the pistons or diaphragms.

CAUTION – Do not change the size of the air tank(s). Alterations to production air brake systems must be approved by International Engineering prior to alteration or operation.

2.2. SERVICE CHECKS

Leakage Test

With the air brake system charged, check for leakage on outside surfaces of reservoirs. If any leakage attributed to structural weakness is found, replace the reservoir.

2.3. INSPECTION

Inspect inside and outside surfaces for damage or corrosion. Shine a small flashlight through open tank ports when inspecting the interior. If damage or corrosion is evident that would weaken the reservoir, replace the reservoir.

Drain air reservoirs regularly. Local conditions govern frequency. In dry climates, for example, once a month may be sufficient, while in humid areas it may be necessary to drain reservoirs daily.

When draining the air reservoirs, open the drain cock and let the air bleed off. Be sure to leave the cock open until all drainage stops, then close the drain cock. Automatic drain valves should be inspected periodically to assure effective draining.

3. DRAIN COCK

3.1. DESCRIPTION

Drain cocks have a brass body fitted with a tapered brass key. The drain cock is open when the handle is parallel to the drain cock body and closed when the handle is at right angles to the body. Drain cocks are installed in the bottom of each reservoir in the air brake system (Figure 1) to provide a convenient means of draining condensation.

CAUTION – Always open a drain cock by hand. Never strike the handle with a hammer or any other instrument, as the cock will be damaged and leakage will develop.

3.2. SERVICE CHECKS

1. With air brake system charged and the drain cock closed, test with soap suds for leakage at the drain cock. Also check for leakage through the body by coating the outside of the drain cock with soap solution. Leakage in excess of a 3 inch diameter soap bubble in 3 seconds is not serviceable.

2. Leakage is caused by dirty or scored key or body. Leakage due to dirt is corrected by cleaning parts and lubricating. Lubricate with Fleetrite EP2 Moly grease or equivalent to NLGI #2 multi-purpose lithium grease. Leakage due to a scored key or body cannot be repaired and the drain cock must be replaced.

4. PRESSURE RELIEF VALVE

4.1. DESCRIPTION

The system pressure relief valve protects the air brake system against excessive air pressure. Should the air pressure in the air brake system rise above 150 psi, the valve opens and permits excess pressure to be exhausted. It is located on the supply reservoir.

The pressure relief valve is a piston type valve (Figure 2) incorporating an O-ring seal which seats in the body of the valve.

4.2. MAINTENANCE

Once each year or every 100,000 miles (160,000 km), the pressure relief valve should be removed and thoroughly cleaned or replaced if necessary.

WARNING – When replacing the pressure relief valve, be sure to drain all air from the supply reservoir to prevent bodily injury. Draining of the primary and secondary reservoirs is not required since they are protected by check valves.

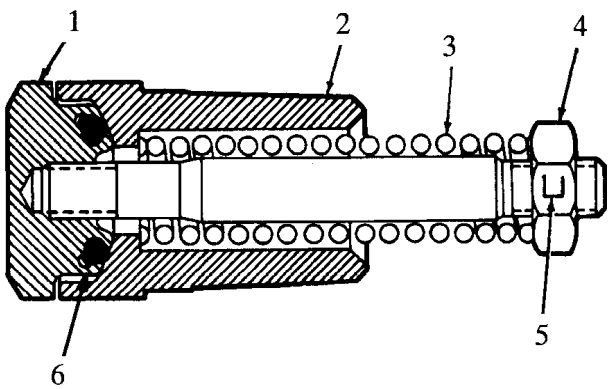

Figure 2 Pressure Relief Valve

1. PISTON AND SHAFT ASSEMBLY
2. BODY
3. SPRING
4. NUT
5. STAKE LOCK
6. O-RING

5. AIR PRESSURE GAUGES

5.1. DESCRIPTION

An air pressure gauge registers the amount of reservoir air pressure in the air system. The system has two gauges. Figure 3 shows a gauge with the figure 1 in a circle on the face of the gauge. Gauge number 1 is for the primary air reservoir system. Gauge number 2 (not shown) is identical and used for the secondary and reservoir system.

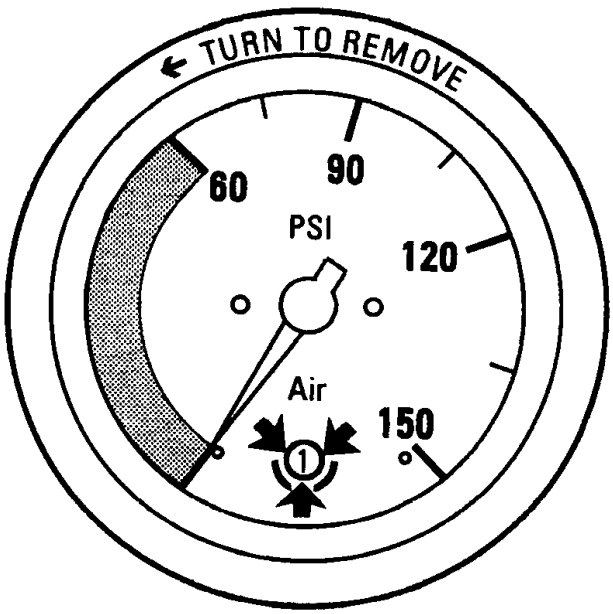

Figure 3 Air Pressure Gauges

Both the primary and secondary brake systems incorporate gauges so that the actual air pressure in each system is indicated to the operator.

5.2. SERVICE CHECKS

1. Inspect connections to assure no air leakage at gauge or in the system.

2. It is not compulsory but it is advisable that vehicles be inspected to be sure that the air gauges are properly installed. The primary system should be the gauge with number 1 on the gauge face. The secondary system is the gauge with number 2 on the gauge face.

3. To check for correct gauge installation, charge the air system (full), bleeding off the primary system (rear brake reservoir). Gauge number 1 should drop.

4. Check the air gauge for accuracy. The simplest way to do this is to compare the pressures registered by the gauge over its normal pressure range with the pressure registered by a test gauge known to be accurate.

CAUTION – Only test gauges known to be accurate are to be used for checking brake valve delivery pressures, governor pressure settings and other tests.

5. A gauge which loses its accuracy must be replaced. The continued use of a dash gauge showing an error of more than 5 psi is not recommended.

6. LOW PRESSURE INDICATOR

6.1. DESCRIPTION

The low pressure indicator (Figure 4) is a safety device designed to give an automatic warning whenever the air pressure in the primary or secondary air brake system is below approximately 65 to 70 psi.

Operating as an air-controlled switch of an electrical circuit, the low pressure indicator automatically sounds a buzzer when the air pressure drops to approximately 65 to 70 psi. The warning will be both visible (light) and audible (buzzer).

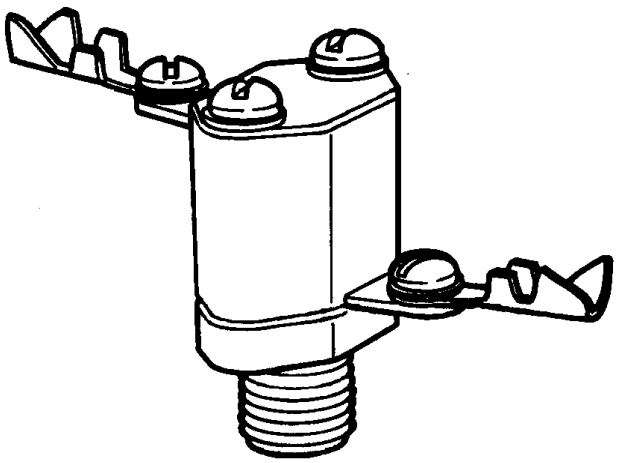

Figure 4 Low Pressure Indicator

The nominal pressure setting of 70 psi is subject to a tolerance of plus or minus 6 psi so that the actual operating pressure of the low pressure indicator may vary between 76 psi maximum to 64 psi minimum.

6.2. OPERATION

To describe the operation, assume the pressure switch is set for 70 psi. Setting of the indicator is marked on a label on the valve body. When air pressure at the supply port and under the O-ring diaphragm is above 70 psi, electrical contacts remain open because the force exerted by air pressure underneath the diaphragm overcomes force exerted by the spring above the diaphragm.

When air pressure below the diaphragm drops below 70 psi, the spring exerts a force which is greater than the force exerted by the air pressure below the diaphragm. This causes the piston to move and allows the electrical contacts to close. This completes or closes electrical circuit to the warning device, warning driver of low air pressure in the system.

6.3. MAINTENANCE

Every three months or after 25,000 miles (40,000 km), check electrical connections.

Every year or 100,000 miles (160,000 km), perform the following SERVICE CHECKS.

6.4. SERVICE CHECKS

Operation Test

Operation of the pressure switch may be checked with ignition switch on, then by reducing the reservoir pressure and being sure that the contacts close when the reservoir pressure is between 76 psi maximum and 64 psi minimum. The contacts will be closed when warning light or electrical buzzer operates.

Leakage Test

A small vent hole is provided in the cover of the low pressure switch housing to check the condition of the diaphragm. Cover the vent hole with soap solution. If a leak is indicated, replace pressure switch.

6.5. REMOVE

1. Block vehicle wheels.
2. The ignition switch must be in the “off” position.
3. Drain the air from the system.
4. Disconnect the electrical connections at the pressure switch.
5. Disconnect air line and remove pressure switch.

6.6. INSTALL

1. Install new pressure switch in fitting where faulty switch was removed.
2. Complete appropriate electrical connections.
3. Charge air system and perform leakage test as described in Leakage Test on this page.

7. STOP LIGHT SWITCH

7.1. DESCRIPTION

The stop light switch (Figure 5) is an electro-pneumatic switch which operates in conjunction with the brake valve and stop lights by completing the electrical circuit when a brake application of 5 psi or more is made.

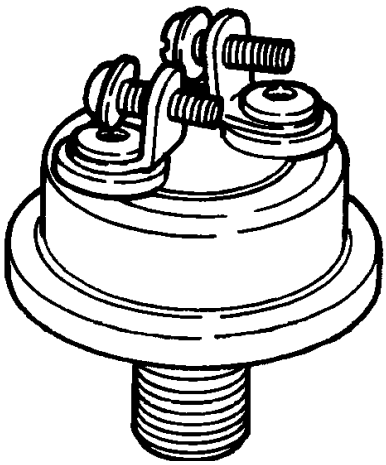

Figure 5 Stop Light Switch

Tractors have one switch located on the tractor protection valve. On trucks, both the primary and secondary brake systems are equipped with a stop light switch. If a failure should occur in either system, the system that continues to function will provide stop lights when the brakes are applied.

7.2. MAINTENANCE

Every three months or every 25,000 miles (40,000 km), check all electrical connections.

Every year or 100,000 miles (160,000 km), the stop light switches should be replaced.

7.3. SERVICE CHECKS

Operation Test

1. Both stop light switches must be checked independently to be sure they are functioning. Disconnect one switch.

2. Apply the brake and note that with first downward movement of pedal or treadle, the stop lights come on.

3. Release the brakes and note that stop lights go off.

   NOTE – Before going any further with your diagnosis, be sure that the bulb is in working order.

4. If stop lights do not go on, use a test light at stop light connections. Test both terminals to determine if an electrical supply is available at switch; then“by-pass”switch with test light or jumper wire. Lights should go on. If not, a failure in the electrical circuit is the problem. However, if lights work, replace stop light switch.

5. Repeat Step 4 to check second light switch.

Leakage Test

With brakes applied, there should be no air leakage at stop light switch.

Cover the switch with soap solution. If a leak is indicated, replace switch.

7.4. REMOVE

1. Disconnect electrical connections. Be sure to tape electrical connections to prevent inadvertent grounding.

2. Remove switch from air fitting.

7.5. INSTALL

1. Install new stop light switch in air fitting.

2. Install electrical connections.

3. After the stop light switch is reinstalled, perform the (See SERVICE CHECKS, page 7)SERVICE CHECKS.

8. AUTOMATIC DRAIN VALVE (DV-2)

8.1. DESCRIPTION

The DV-2 automatic drain valve (Figure 6) ejects moisture and contaminants from the reservoir to which it is connected. It operates automatically and requires no manual assistance or control lines.

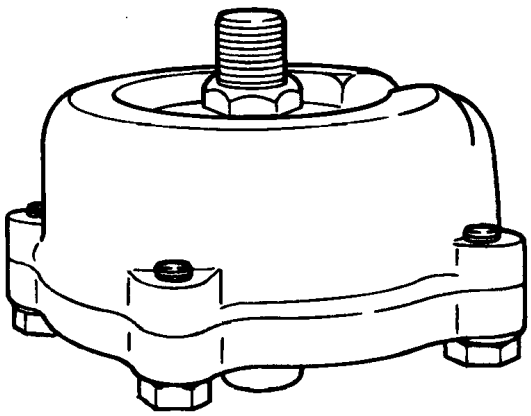

Figure 6 Automatic Drain Valve

The automatic drain valve mounts either in the bottom of the reservoir, using the top port of the drain valve, or in the end of an end drain reservoir, using the side port of the valve.

For vehicles operating in subfreezing temperatures, the valve may include an integral heater and thermostat.

8.2. OPERATION

With no pressure in the air system, the inlet and exhaust valves are closed (Figure 7).

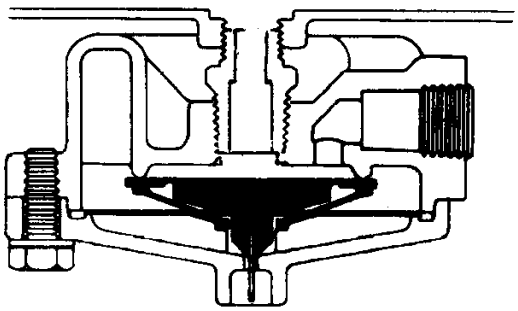

Figure 7 Inlet and Exhaust Valve Closed

When charging the air system, a slight pressure opens the inlet valve which permits air and contaminants to collect in sump (Figure 8).

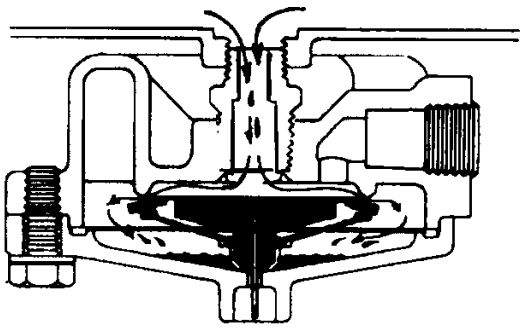

Figure 8 Contaminants Collect in Sump

The inlet valve remains open while pressure rises in the system until maximum governor cut-out pressure is reached. The spring action of the valve guide in the sump cavity closes the inlet valve. The inlet valve and exhaust valve are now closed (Figure 9).

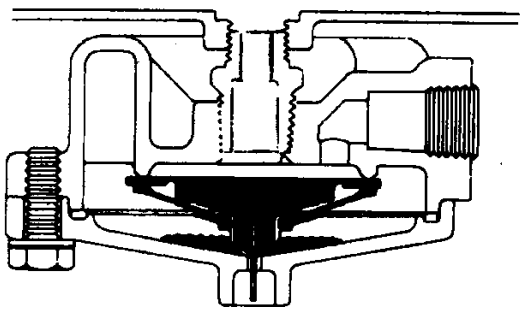

Figure 9 Inlet and Exhaust Valve Closed

When reservoir pressure drops slightly (approximately 2 psi), air pressure in the sump cavity opens the exhaust valve allowing moisture and contaminants to be ejected until pressure in sump cavity drops sufficiently to close the exhaust valve (Figure 10). The length of time the exhaust valve remains open and the amount of moisture and contaminants ejected depends upon the sump pressure and reservoir pressure drop that occurs each time air is used from the system.

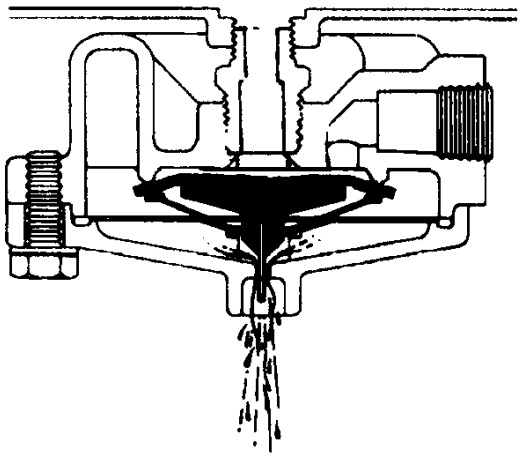

Figure 10 Contaminants Ejected

Manual draining can be accomplished by inserting a tool in the exhaust port so that the wire in the port may be moved up and held until draining is completed.

The heated automatic drain valve will activate the heating element when the valve body is warmed to 85°F (30°C).

8.3. MAINTENANCE

Every six months or every 50,000 miles (80,000 km), the automatic drain valve should be removed, disassembled, cleaned and lubricated. Parts showing signs of wear or deterioration should be replaced.

Lubricate with Fleetrite EP2 Moly grease or equivalent to NLGI #2 multi-purpose lithium grease.

8.4. SERVICE CHECKS

Operation Test

With system charged, make several brake applications and note each time if an exhaust of air occurs at exhaust port of the drain valve. If no air comes out, push the wire stem. If no air comes out, the filter is plugged and valve should be removed and cleaned.

Lubricate with Fleetrite EP2 Moly grease or equivalent to NLGI #2 multi-purpose lithium grease.

Leakage Test

With system charged and pressure stabilized in system, there should be no leaks at the drain valve exhaust. A constant slight exhaust of air at the drain valve exhaust could be caused by excessive leakage in the air brake system.

If the automatic drain valve does not function as described or if leakage is excessive, it is recommended that it be removed and repaired or replaced.

8.5. REMOVE

1. Set parking brake and block wheels.

2. Drain air system.

3. Disconnect heater wire if valve is so equipped.

4. Remove automatic drain valve.

8.6. INSTALL

1. Thoroughly flush and clean tank before installing drain valve.

2. Use compressed air to dry tank thoroughly if solvents were used to flush inside of tank.

3. Install automatic drain valve to tank.

When installing an automatic drain valve equipped with a heater and thermostat, first determine if the vehicle electrical system is a 12-volt or 24-volt and that the heater/ thermostat unit is of the same voltage. The No. 14 gauge lead wire on the valve should be connected to the“on”position of the engine control or ignition switch. Use an 8-amp fuse for one valve, a 15-amp fuse for two valves and a 20-amp fuse for three valves. All electrical connections must be waterproof.

Before returning the vehicle back to service, perform (See SERVICE CHECKS, page 10)SERVICE CHECKS.

9. CHECK VALVES

9.1. ONE WAY CHECK VALVE

Description

The one-way check valve (Figures 11 and 12) permits one-way passage of air pressure as indicated by the arrow on the side of the valve. Valves are installed at both the primary and secondary reservoirs to maintain the air supply if an air loss should occur ahead of the valve.

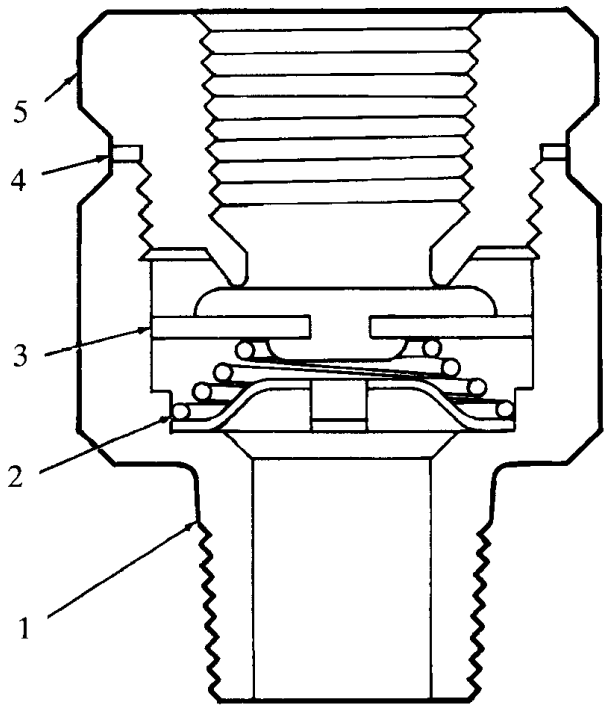

Figure 11 One Way Check Valve

1. VALVE BODY
2. SPRING
3. ASSEMBLY SEAL
4. CAP-TO-BODY WASHER
5. VALVE CAP

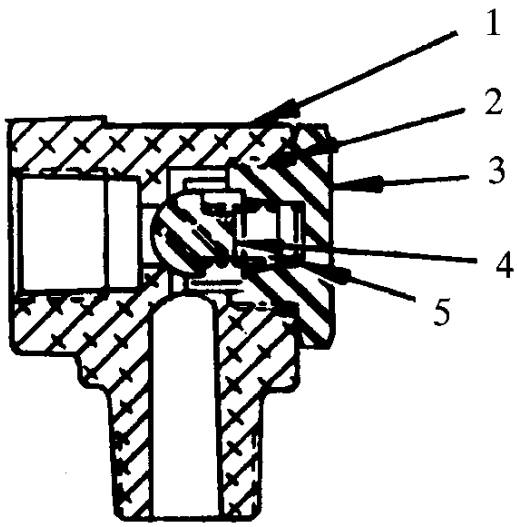

Figure 12 One Way Check Valve - Clearance Limitation

1. BODY
2. O-RING
3. CAP
4. VALVE
5. SPRING

The 90°angle check valve shown in Figure 12 is used in applications where clearance limitations exist.

Operation

Air flow through the valve moves the seal from its seat. This allows an unobstructed passage. Air flow in the reverse direction is prevented by the seal which reseats, blocking passage. An assistance spring provides additional back-pressure against the seal.

Maintenance

Once each year or every 100,000 miles (160,000 km), check valve operation.

Service Checks

It may be necessary to remove the check valve to check operation. When inspecting valves at primary and secondary reservoirs, bleed air supply reservoir and disconnect the air inlet to valve, then proceed.

With air pressure present at outlet side of check valve and inlet open to atmosphere, test for leakage. Leakage should not exceed 1 inch (25 mm) diameter soap bubble in 5 seconds. If valve leaks excessively, the valve should be repaired or replaced.

Remove

1. Apply parking brake and block wheels.

2. Drain all air reservoirs.

3. Disconnect air lines. Note direction of arrow on side of valve; remove valve.

Install

1. Inspect and clean or replace air line to valve.
2. Install valve, making certain that arrow is pointing in the same direction as when it was removed.
3. Charge air system.
4. Check valve for leakage.

9.2. DOUBLE CHECK VALVE

Description

Double check valves or two-way check valves (Figure 13) are used in an air brake system where it is necessary to automatically direct the flow of air pressure into a common line from either of two other lines.

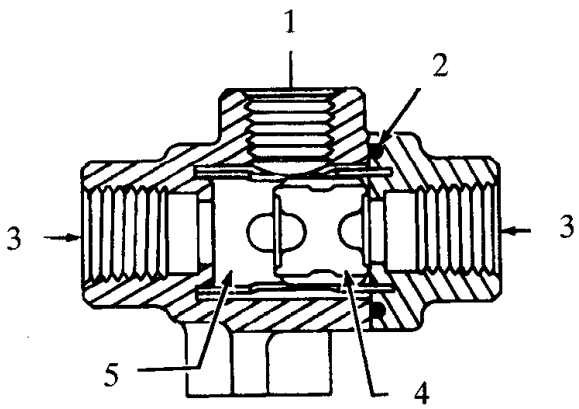

Figure 13 Double Check Valve

1. DELIVERY
2. O-RING
3. SUPPLY
4. SHUTTLE VALVE
5. SHUTTLE GUIDE

Operation

As air pressure enters either end of the double check valve (inlet port), the movable shuttle responds to the air pressure and seals the line on opposite inlet port, but permits air pressure to flow out the delivery (outlet) port. The same action takes place if air pressure on one side of shuttle is higher than that on the other side. It is not necessary for the cavity of one side of the shuttle to be exhausted for the valve to operate. Double check valves are designed so it is impossible for shuttle to block outlet port.

Maintenance

Once each year or every 100,000 miles (160,000 km), remove, disassemble, clean and inspect all parts. Install new parts if signs of wear or deterioration are apparent.

Service Checks

Due to the various applications of double check valves, it is best to bench test the valve using two separately controlled air supplies connected to inlet ports.

1. Install an accurate test gauge in outlet port or in a line from the outlet port.
2. Apply and release air to one inlet port and note that the gauge registers application and release.
3. Repeat application and release of air to the other inlet port.
4. Leakage check is performed at inlet ports by:
   a. Disconnecting line from one inlet port.
   b. Applying air to other inlet port. If soap solution is used to check leakage, leakage should not exceed 1 inch (25 mm) diameter bubble in 5 seconds.
   c. Repeat step“B”by applying air to other inlet port while checking opposite inlet port for leakage.
5. If check valve does not meet requirements, it should be repaired or replaced.

Disassemble

1. Remove valve from vehicle.
2. Remove end cap from valve.
3. Remove O-ring.
4. Remove shuttle (piston) and guide.

Clean and Inspect

1. Clean all metal parts in cleaning solvent.
2. Inspect all parts for signs of wear or deterioration. Replace all parts that are not serviceable.
3. Replace all rubber parts.

Reassemble

1. Install shuttle guide and shuttle.
2. Position new O-ring in end cap.
3. Install end cap.
4. Perform (See Service Checks, page 14)SERVICE CHECKS.
5. Reinstall on vehicle.

10. PRESSURE PROTECTION VALVE

10.1. DESCRIPTION

The pressure protection valve (Figure 14) is designed to close off air supply to any air operated device as long as the air supply is below a specified rating.

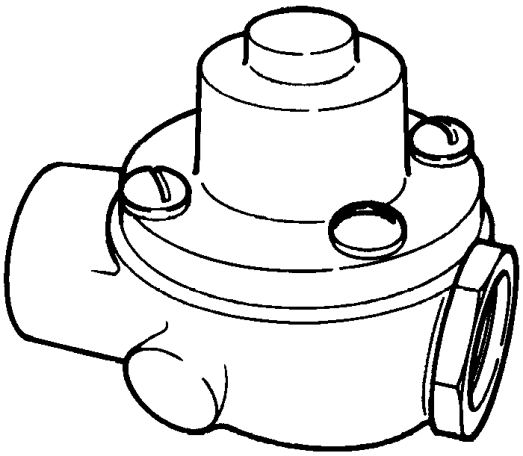

Figure 14 Pressure Protection Valve

The rating of the valve used in the FMVSS-121 air system is 65 to 75 psi.

It is important that this valve be installed when any auxiliary attachments are installed on a vehicle to avoid complete loss of air in the event of an air leak in any of the air operated attachments.

10.2. OPERATION

As long as the air supply pressure is below 65 to 75 psi, the spring will hold the diaphragm on its seat restricting the air flow through the valve.

When the air supply pressure overcomes the spring force, the diaphragm will move off the seat and allow air to flow through the valve and to the auxiliary equipment used on the vehicle.

If air pressure should fall approximately 20 psi below the opening pressure, the spring force will overcome the air pressure and force the diaphragm on its seat, closing off the air supply, protecting the air system from a complete loss of air through usage of the auxiliary equipment.

10.3. MAINTENANCE

Once each year or 100,000 miles (160,000 km), remove the pressure protection valve (Figure 15), disassemble it and clean all parts.

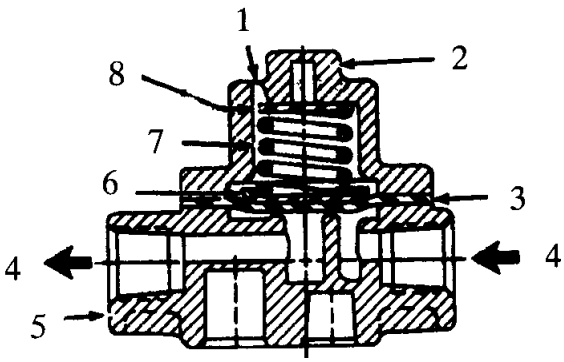

Figure 15 Pressure Protection Valve - Cross Section

1. VENT HOLE
2. UPPER BODY
3. DIAPHRAGM
4. AIR FLOW
5. LOWER BODY
6. SPRING CAP
7. SPRING
8. SHIM

Replace the diaphragm if it is worn or deteriorated.

10.4. SERVICE CHECKS

1. Block vehicle wheels.

2. Be sure the vent hole is not obstructed.

3. Bleed off main air supply.

4. Disconnect the air outlet side of valve. Install an accurate air pressure gauge with a shut-off valve. Start engine and allow air pressure to build up. Observe gauge on instrument panel and at valve outlet.

CAUTION – Only test gauges known to be accurate are to be used for checking brake valve delivery pressures, gover- nor pressure settings and other tests.

You should not have air pressure at test gauge until main air reservoir pressure reaches 65 to 75 psi. Then the pressure protection valve opens and both test gauge and gauge on vehicle should record approximately the same.

5. Stop engine and open the shut-off valve at test gauge. Air should exhaust until air pressure on vehicle reaches a pressure of approximately 20 psi below opening pressure, then close shut-off valve. If the valve performs as described, the valve is functioning properly.

Bleed off main air reservoir pressure and remove shut-off valve and test gauge. Reconnect line to the auxiliary equipment.

10.5. REMOVE

1. Set parking brake and block wheels.
2. Be sure to bleed off air reservoir pressure.
3. Disconnect air line(s) from valve.
4. Remove pressure protection valve from connector.

10.6. DISASSEMBLE

Component removed from vehicle.

1. Remove the four screws that join the upper and lower body sections.

   IMPORTANT – Care must be taken while removing screws as the internal spring force will separate the upper and lower bodies.

   WARNING – Special attention should be exercised when working with retaining rings. Always wear safety goggles when working with spring or tension loaded fasteners or devices as serious personal injury can result if not properly protected.

2. Remove diaphragm spring cap or diaphragm protector, spring and shim from upper body. Be sure to retain shim which is used to adjust the pressure regulation of the valve.

10.7. CLEAN AND INSPECT

1. Clean all parts in cleaning solvent. Make sure vent hole in upper valve body is not obstructed.
2. Inspect diaphragm, especially at lower contact area.
3. Replace any parts that show wear or spring if distorted.
4. Inspect the diaphragm seat for pitting or nicks. The seat should be smooth; if not, it may be dressed with emery cloth. Replace complete valve assembly if excessive pitting is found.

10.8. REASSEMBLE

1. Position the shim, if used, in the upper body. The same number of shims should be used to obtain proper pressure adjustment.
2. Position spring, spring cap and diaphragm on upper body.
3. Place lower body over the assembly and force the two body halves together.
4. Turn assembly over and install screws.
5. Test repaired valve assembly.

10.9. TEST REPAIRED VALVE

Prior to installing the repaired valve assembly in the vehicle, the valve should be tested for leakage and proper adjustment.

CAUTION – Only test gauges known to be accurate are to be used for checking brake valve delivery pressures, gover- nor pressure settings and other tests.

Assemble air gauge and shut-off valve at inlet and outlet of pressure protection valve, then connect to shop air source. Open shut-off valve at outlet of pressure protection valve and slowly open shut-off valve at air source until air pressure reaches 55 psi.

Check for air leakage with soap solution at outlet. Leakage must not exceed a 1 inch (25 mm) diameter soap bubble in 5 seconds.

Close the shut-off valve at outlet and increase air pressure at inlet side of pressure protection valve. Pressure at outlet air gauge should not be present until pressure at this inlet reaches 65 to 75 psi. Then both gauges should equalize.

If pressure protection valve opens prior to 65 psi, add shim to valve and if valve remains closed after 75 psi is obtained, remove shim.

After valve has been tested and meets requirements, it is ready to be installed on vehicle.

10.10. INSTALL

1. Install the pressure protection valve.

2. Connect air line(s) to valve.

3. Build up air supply and check connections for air leaks.

11. PRESSURE LIMITING VALVE

11.1. DESCRIPTION

The pressure limiting valve (Figure 16) is used to reduce air pressure and maintain it at a constant specified pre-set pressure below that of the supply pressure.

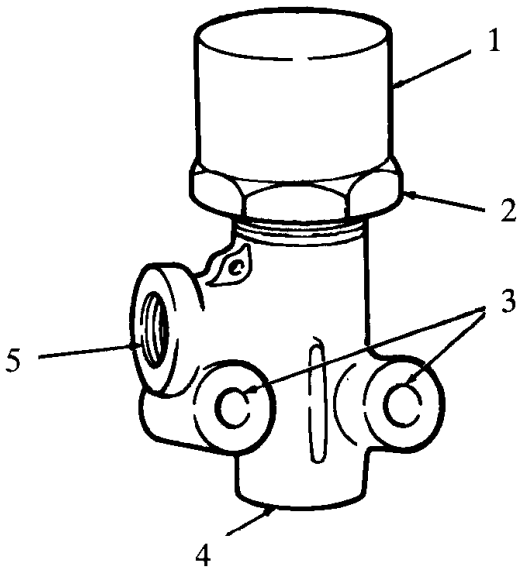

Figure 16 Pressure Limiting Valve

1. ADJUSTING CAP
2. LOCK NUT
3. MOUNTING HOLES
4. SUPPLY PORT
5. DELIVERY PORT

The pressure limiting valve has a delivery port on the side and a supply port on the bottom. Two mounting holes are cast into the body. A locking wire and seal are optional for a tamper proof setting.

11.2. OPERATION

The pressure setting of the pressure limiting valve is determined by the setting of the adjusting cap, which exerts a force on the spring on top of the piston. Compressed air enters the supply port and passes out the delivery port. When the air pressure on the bottom of the piston overcomes the force of the spring on top of the piston, the piston moves upward and the inlet valve spring forces the inlet valve on its seat, closing off the supply of air. As the pressure in the delivery line drops, the force of the spring above the piston becomes greater than the air pressure below the piston, allowing the piston to move downward, moving the inlet valve off its seat and allowing air to pass out the delivery port (Figure 17).

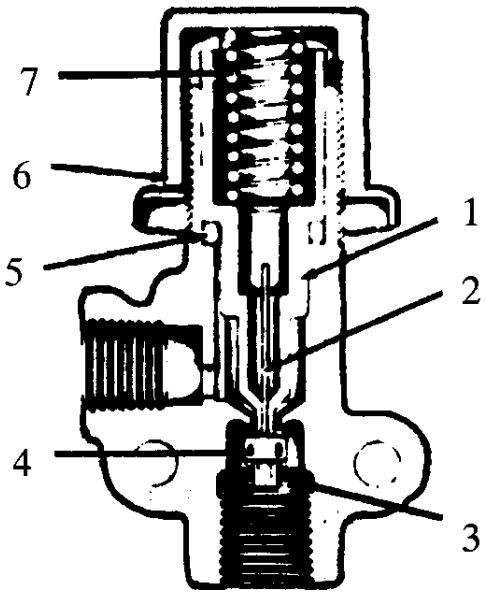

Figure 17 Pressure Limiting Valve - Cross Section

1. PISTON
2. VALVE GUIDE WIRE
3. INLET VALVE SPRING
4. INLET AND EXHAUST VALVE
5. PISTON O-RING
6. EXHAUST VENT
7. PRESSURE REGULATING SPRING

If pressure in the delivery line exceeds the pressure setting of the pressure limiting valve, the force exerted by the air pressure below the piston will be greater than the spring force above the piston. The piston will move up from the exhaust valve, permitting air to pass by the exhaust valve, through the hollow piston and valve guide and escape through the slot in the adjusting cap. When the force of the spring above the piston overcomes that of the air pressure below the piston, the exhaust valve is seated, and the pressure in the delivery line is the same as the setting of the pressure limiting valve.

11.3. MAINTENANCE

Every 6 months or 50,000 miles (80,000 km), connect a test gauge to the delivery line and observe at what pressure the inlet valves close, which is the delivery pressure. If the pressure delivered by the pressure limiting valve varies more than plus or minus 5 psi from the pressure setting of the pressure limiting valve, the valve should be adjusted. The lock nut should be tightened after each adjustment and locking wire seal replaced if used. Every year or every 100,000 miles (160,000 km), perform Operating and Leakage Tests as follows.

11.4. SERVICE CHECKS

Operating Test

CAUTION – Only test gauges known to be accurate are to be used for checking brake valve delivery pressures, governor pressure settings and other tests. Connect an accurate test gauge to the delivery line and observe what pressure the inlet valve opens, which is the delivery pressure. If delivery pressure varies more than 5 psi, adjust the valve to the specified setting. To raise the delivery pressure, the adjusting cap should be turned clockwise. Tighten lock nut after each adjustment and replace locking wire and seal if used.

Leakage Test

No leakage is permitted at the exhaust vent in the slot of the adjusting cap when making the operating check. Leakage at this point would indicate a leaking piston O-ring or a leaking exhaust valve seat.

If the pressure limiting valve does not function as described or leakage is excessive, it is recommended that it be replaced.

11.5. REMOVE

1. Set parking brake and block wheels.
2. Drain all reservoirs.
3. Disconnect air lines from the pressure limiting valve.
4. Remove valve mounting bolts and valve.

11.6. INSTALL

1. Check and clean air lines to valve.
2. Mount valve securely with bolts and lockwashers.
3. Reconnect lines to the valve.

   NOTE – Disassembly and reassembly of pressure limiting valve is not recommended as it is serviced as a complete assembly.

4. Perform (See SERVICE CHECKS, page 22)SERVICE CHECKS.

12. BENDIX E6-TREADLE AND E7-SUSPENDED PEDAL TYPE (FOOT) BRAKE VALVES

12.1. DESCRIPTION

The (foot) brake valve is the control unit of the air brake system. It provides the operator of the vehicle a means of applying or releasing the vehicle brakes.

The two types of Bendix (foot) brake valves used are E6 treadle type (Figure 18) and E7 suspended type (Figure 19).

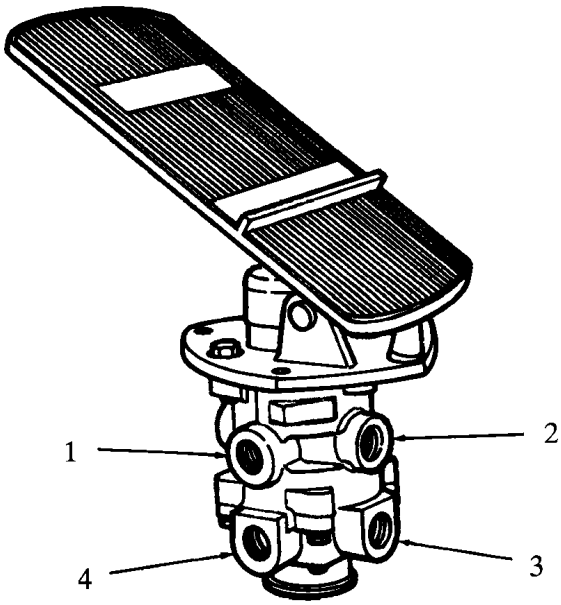

Figure 18 Bendix E6-Treadle (Foot) Brake Valve

1. PRIMARY SUPPLY
2. PRIMARY DELIVERY
3. SECONDARY DELIVERY
4. SECONDARY SUPPLY

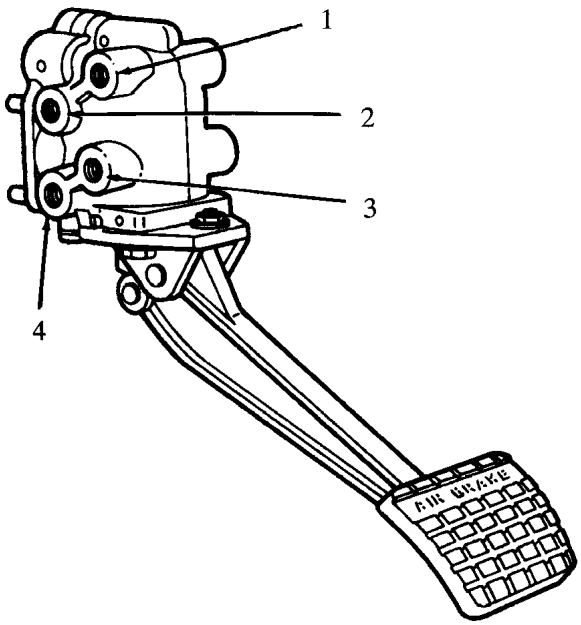

Figure 19 Bendix E7-Suspended Pedal Type (Foot) Brake Valve

1. SECONDARY SUPPLY
2. SECONDARY DELIVERY
3. PRIMARY SUPPLY
4. PRIMARY DELIVERY

Both the treadle and suspended (foot) brake valves are equipped with two separate supply and delivery circuits for service and emergency braking, each providing the driver with a graduated control for applying and releasing the vehicle brakes.

The primary circuit is that portion of the valve between the spring seats which contacts the plunger and the relay piston. The secondary circuit is that portion between the relay piston and exhaust cavity.

The primary circuit is similar in operation to a standard single circuit air brake valve. Under normal operating conditions, the secondary circuit is similar to a quick release valve.

Both the primary and secondary circuits of the (foot) brake valve use a common exhaust check valve.

12.2. OPERATION

The text and illustrations contained in this section pertain to the treadle type (foot) brake valve. The treadle and suspended type valves differ in that the suspended pedal valve is turned over and the valve body is equipped with an exhaust port at a 90 degree angle at the top.

Applying Normal Operations — Primary Circuit Portion of (Foot) Brake Valve

When the brake pedal is depressed, the plunger exerts force on the spring seat, rubber graduating spring and primary piston (Figure 20). The primary piston, which contains the exhaust valve seat, closes the primary exhaust valve. As the exhaust valve closes, the primary inlet valve is moved off its seat allowing primary air pressure to flow out the primary delivery port.

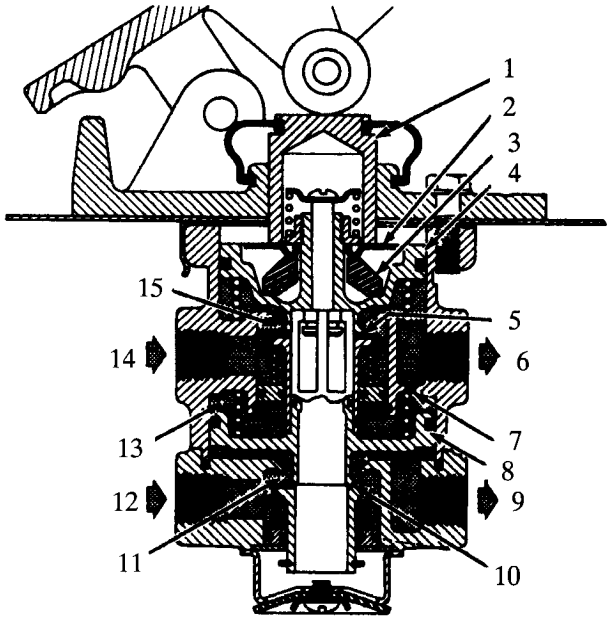

Figure 20 Treadle Type Brake Valve - Pedal Depressed

1. PLUNGER
2. SPRING SEAT
3. RUBBER GRADUATING SPRING
4. PRIMARY PISTON
5. PRIMARY EXHAUST VALVE CLOSED
6. PRIMARY DELIVERY PORT
7. TWO BLEED PASSAGES
8. RELAY PISTON
9. SECONDARY DELIVERY PORT
10. SECONDARY EXHAUST VALVE CLOSED
11. SECONDARY INLET VALVE OPEN
12. SECONDARY SUPPLY PORT
13. RELAY CAVITY
14. PRIMARY SUPPLY PORT
15. PRIMARY INLET VALVE OPEN

Applying Normal Operations — Secondary Circuit Portion of (Foot) Brake Valve

When the primary inlet valve is moved off its seat, air is permitted to pass through the bleed passage and enters the relay cavity. Air pressure moves the relay piston. The relay piston, which contains the exhaust seat, closes the secondary exhaust valve. As the secondary exhaust valve closes, the secondary inlet valve is moved off its seat, allowing secondary air pressure to flow out the secondary delivery port. Because of the small volume of air required to move the relay piston, action of the secondary circuit portion of the valve is almost simultaneous with the primary circuit.

Application — Loss of Air in Secondary Circuit

Should air be lost in the secondary circuit, the primary circuit portion will continue to function as described under (Figure 21).

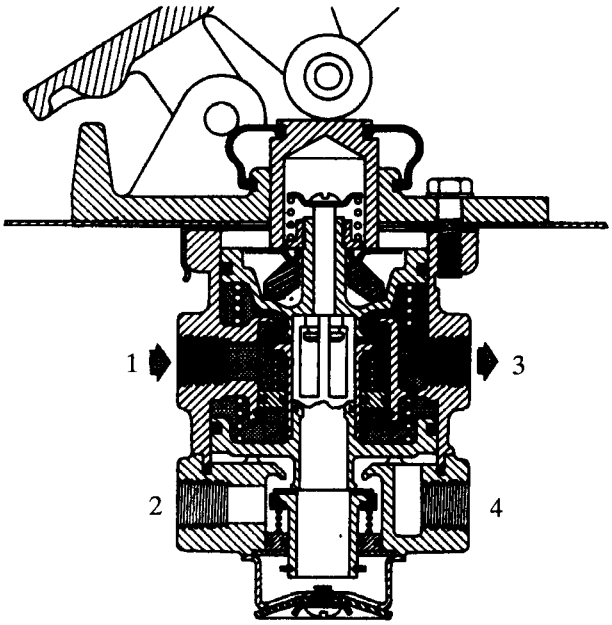

Figure 21 Loss of Air in Secondary Circuit

1. PRIMARY SUPPLY PORT
2. NO AIR IN SECONDARY CIRCUIT
3. PRIMARY DELIVERY PORT
4. SECONDARY DELIVERY PORT

Application — Loss of Air in Primary Circuit

Should air be lost in the primary circuit, the function will be as follows. As the brake pedal is depressed and no air pressure is present in the primary circuit supply and delivery ports, the primary piston will mechanically move the relay piston, allowing the piston to close the secondary exhaust valve, open the secondary inlet valve, and allow air pressure to flow out the secondary delivery port (Figure 22).

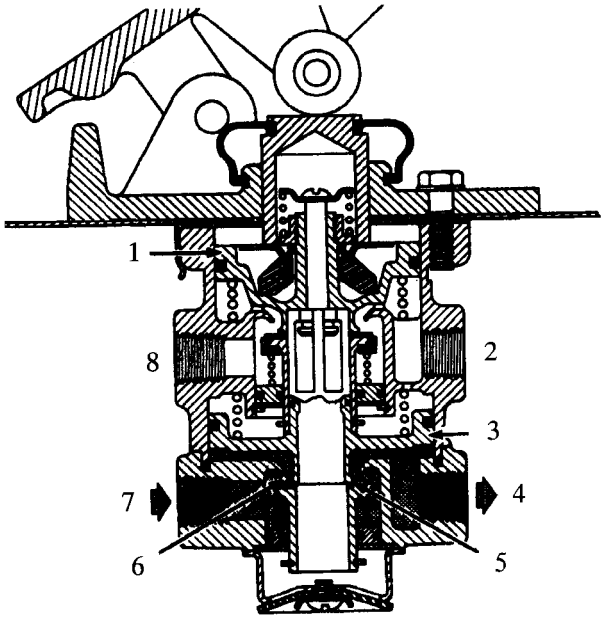

Figure 22 Loss of Air in Primary Circuit

1. PRIMARY PISTON
2. PRIMARY DELIVERY PORT
3. RELAY PISTON
4. SECONDARY DELIVERY PORT
5. SECONDARY EXHAUST VALVE CLOSED
6. SECONDARY INLET VALVE OPEN
7. SECONDARY SUPPLY PORT
8. NO AIR IN PRIMARY CIRCUIT

Balanced — Primary Circuit of (Foot) Brake Valve

When air pressure delivered to the brake actuators and air pressure in the cavity of the delivery side of the primary piston equals the mechanical force of the brake pedal application, the primary piston will move and the primary inlet valve will close, stopping the further flow of air from the primary supply line through the valve. The exhaust valve remains closed preventing any escape of air through the exhaust port (Figure 23).

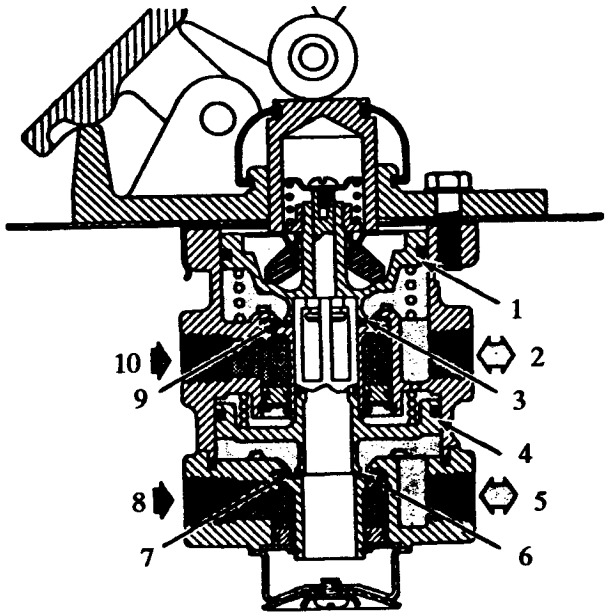

Figure 23 Primary Circuit of (Foot) Brake Valve

1. PRIMARY PISTON
2. PRIMARY DELIVERY PORT
3. PRIMARY EXHAUST VALVE CLOSED
4. RELAY PISTON
5. SECONDARY DELIVERY PORT
6. SECONDARY EXHAUST VALVE CLOSED
7. SECONDARY INLET VALVE CLOSED
8. SECONDARY SUPPLY PORT
9. PRIMARY INLET VALVE CLOSED
10. PRIMARY SUPPLY PORT

Balanced — Secondary Circuit of (Foot) Brake Valve

When the air pressure on the secondary side of the relay piston approaches that being delivered on the primary side of the relay piston, the relay piston moves, closing the secondary inlet valve and stopping further flow of air pressure from the supply line through the valve. The exhaust remains closed as the secondary supply pressure balances the secondary delivery pressure (Figure 23).

When applications in the graduating range are made, a balanced position in the primary portion is reached as the air pressure on the delivery side of the primary piston equals the effort exerted by the driver’s foot on the brake pedal or treadle.

A balanced position in the secondary portion is reached when air pressure on the secondary side of the relay piston closely approaches the air pressure on the primary side of the relay piston.

When the brake pedal or treadle is fully depressed, both primary and secondary inlet valves remain open and full reservoir pressure is delivered to the actuators.

Releasing -Primary Circuit of (Foot) Brake Valve

With the brake pedal released, mechanical force is removed from the spring seat, rubber graduating spring and primary piston. Air pressure and spring load move the primary piston, opening the primary exhaust valve, allowing air pressure in the primary delivery line to exhaust out the exhaust port (Figure 24).

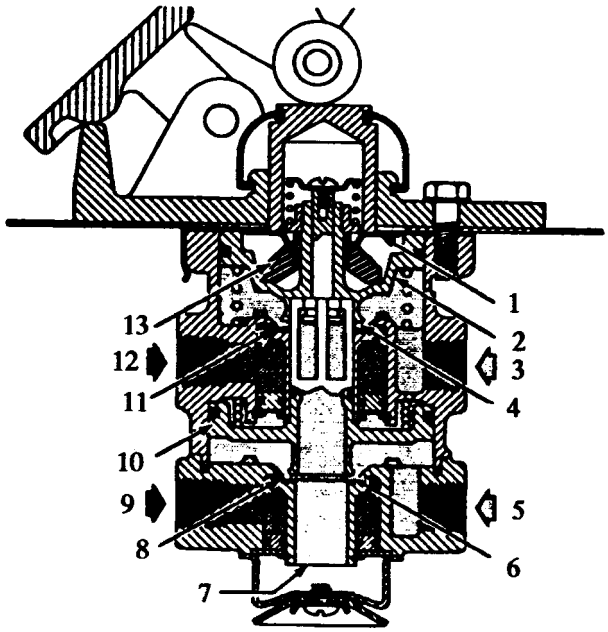

Figure 24 Releasing -Primary Circuit of (Foot) Brake Valve

1. SPRING SEAT
2. PRIMARY PISTON
3. PRIMARY DELIVERY PORT
4. PRIMARY EXHAUST VALVE OPEN
5. SECONDARY DELIVERY PORT
6. SECONDARY EXHAUST VALVE OPEN
7. EXHAUST PORT
8. SECONDARY INLET VALVE CLOSED
9. SECONDARY SUPPLY PORT
10. RELAY PISTON
11. PRIMARY INLET VALVE CLOSED
12. PRIMARY SUPPLY PORT
13. RUBBER GRADUATING SPRING

Releasing - Secondary Circuit of (Foot) Brake Valve

With the brake pedal released, air is exhausted from the primary side of the relay piston. Air pressure and spring load move the relay piston, opening the secondary exhaust valve, allowing air pressure in the secondary delivery line to exhaust out the exhaust port (Figure 24).

12.3. MAINTENANCE

Every 3 months or 20,000 miles (32,000 km):

1. Clean any accumulated dirt, gravel or foreign matter away from heel of treadle valve, plunger boot and mounting plate.

2. Lubricate plunger, roller, roller pin and hinge pin with Fleetrite EP2 Moly grease or equivalent to NLGI #2 multi-purpose lithium grease. Check rubber plunger boot for cracks, holes or deterioration and replace if required.

3. Free pedal travel should be checked to be sure plunger is in contact with spring seat, and adjust the stop button so that the roller and plunger just contact.

4. Clean exhaust port.

5. Every year or 100,000 miles (160,000 km) disassemble the brake valve. Clean and inspect all parts; install new parts where they are found to be worn or damaged.

12.4. SERVICE CHECKS

Operation Test

CAUTION – Only test gauges known to be accurate are to be used for checking brake valve delivery pressures, gover- nor pressure settings and other tests.

1. With a fully charged air system, check delivery pressure of both primary and secondary systems using test gauges known to be accurate. Depress pedal or treadle valve to several positions between the fully released and fully applied positions and check the delivered pressure on the test gauges to see that it varies proportionately with the movement of the brake pedal.

2. After a full application is released, the reading on test gauges should fall off to zero promptly. It should be noted that the primary system delivery pressure will be about 2 psi greater than the secondary system delivery pressure with both supply reservoirs at the same pressure. This is normal for these valves.

WARNING – A change in vehicle braking characteristics or a low pressure warning may indicate a malfunction in one or the other brake systems or components. Vehicle should not be operated until necessary repairs have been made and both braking systems, including pneumatic and mechanical devices, are operating properly. After performing brake work, always check vehicle brakes before returning the vehicle to service.

Leakage Test

1. Make and hold a high pressure application. Check the exhaust port for leakage. Using a soap solution, a 1 inch (25 mm) diameter soap bubble in 5 seconds is permitted.

2. If the brake valve does not function as described, the valve should either be replaced or repaired.

12.5. SERVICING TREADLE TYPE VALVE

Remove

1. Apply parking brake and block wheels.

2. Drain all air from all reservoirs.

3. Disconnect all supply and delivery lines at (foot) brake valve. Mark all air lines in relation to valve to assist when reconnecting lines.

4. Remove fittings from valve. Mark these fittings also in relation to location and position on the valve.

5. Remove (foot) brake valve and treadle assembly by removing three capscrews on outer bolt circle of mounting plate. Basic valve alone may be removed by removing three capscrews on inner bolt circle.

Disassemble

Refer to Figure 25 for all items in parentheses.

1. If the entire brake valve and treadle assembly was removed from the vehicle, remove the capscrews securing treadle assembly to the basic brake valve.

2. Remove screw (Item 19) securing the exhaust diaphragm (Item 17) and washer (Item 20) to exhaust cover (Item 16).

3. Remove four screws that secure exhaust cover (Item 16) to lower valve body (Item 23).

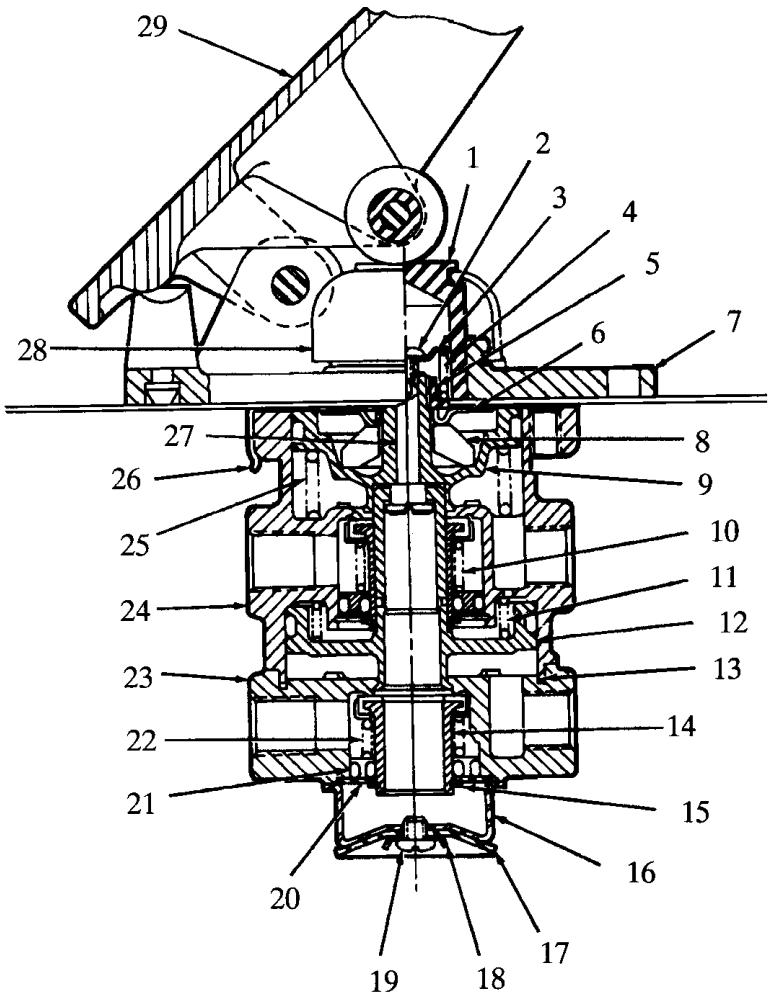

Figure 25 Treadle Type Valve - Disassemble

1. PLUNGER
2. SPRING GUIDE SCREW (NOT USED)
3. STEM SPRING GUIDE
4. STEM SPRING
5. SPRING SEAT NUT
6. SPRING SEAT
7. MOUNTING PLATE
8. RUBBER SPRING
9. PRIMARY PISTON
10. PRIMARY INLET AND EXHAUST VALVE
11. RELAY PISTON SPRING
12. RELAY PISTON
13. SEAL RING
14. SECONDARY INLET AND EXHAUST VALVE
15. RETAINING RING
16. EXHAUST COVER
17. EXHAUST DIAPHRAGM
18. DIAPHRAGM WASHER
19. SCREW
20. WASHER
21. O-RING RETAINER
22. RETURN SPRING
23. LOWER VALVE BODY
24. UPPER VALVE BODY
25. PRIMARY PISTON RETURN SPRING
26. PRIMARY PISTON RETAINER
27. STEM
28. BOOT
29. TREADLE

4. Remove secondary inlet and exhaust valve assembly (Item 14) from lower valve body (Item 23). Disassembly of secondary inlet and exhaust valve assembly is not required since it is only serviced as an assembly.

5. Remove four hex head capscrews securing the lower valve body (Item 23) to upper valve body (Item 24) and separate the bodies.

6. Remove the rubber seal ring (Item 13) from the lower body.

7. Apply thumb pressure to primary piston (Item 9), lift out and up on the three lock tabs of primary piston retainer (Item 26).

8. Use a 3/8 inch (10 mm) wrench to hold the nut on threaded end of stem on top of primary piston. Insert a screwdriver in exhaust passage through center of valve and engage slotted head of the stem (Item 27).

WARNING – Before proceeding, note the nut and stem are used to contain primary piston return spring (Item 25), stem spring (Item 4) and relay piston spring (Item 11). Combined force of these springs is approximately 50 ft-lbs. (68 Nm). Care must be taken to prevent personal injury when removing the nut as the spring forces will be released. It is recommended that primary piston and relay piston be contained while nut and stem are being removed.

9. Rotate the screwdriver counterclockwise and remove stem (Item 27), stem spring (Item 4), spring guide (Item 3) and nut.

10. Remove relay piston (Item 12), relay piston spring (Item 11), primary piston (Item 9) and primary piston return spring (Item 25) from the upper body.

11. Disassemble primary piston (Item 9) by separating spring seat nut, spring seat (Item 6), rubber spring (Item 8) and removing piston O-ring.

12. Remove large and small O-rings from relay piston.

13. Remove retaining ring securing primary inlet and exhaust valve assembly (Item 10) in upper body and remove valve assembly. Do not disassemble primary inlet as it is only serviced as an assembly.

Clean and Inspect

Wash all metal parts in cleaning solvent. Use compressed air to dry parts. Inspect all parts for excessive wear or deterioration. Inspect valve seats for nicks or burrs. Check springs for cracks or corrosion. Replace all rubber parts and any part not found to be serviceable during inspection.

Reassemble

Refer to Figure 25 for all items in parentheses.

Prior to reassembling brake valve, lubricate all O-rings, O-ring grooves, piston bores and metal-to-metal moving surfaces. Lubricate with Fleetrite EP2 Moly grease or equivalent to NLGI #2 multi-purpose lithium grease.

All torques specified are assembly torques and can be expected to differ after assembly is accomplished. Do not re-tighten nuts after initial torque is applied.

1. Position primary inlet and exhaust assembly in the upper body; then install retaining ring to secure it. Be sure the retaining ring is seated completely in its groove.

2. Install large and small O-rings on relay piston.

3. Replace primary piston O-ring in piston O-ring groove.

4. Position rubber spring (Item 8), concave side down, in primary piston (Item 9) and place spring seat (Item 6), flat side up, over rubber spring.

5. Install primary piston spring seat nut (Item 5) with its hex closest to spring seat and rotate clockwise until top surface of spring seat is even with top surface of piston (Item 9).

6. Position primary piston return spring (Item 25) in the upper body piston bore.

7. Install primary piston, spring seat out, over return spring and press piston into body bore.

8. Place relay piston return spring (Item 11) in the upper body and position relay piston (Item 12) over spring so that the concave side of the piston is against the spring.

9. Compress both primary piston and relay piston into the upper body and hold them compressed, either manually or mechanically (see **WARNING** under step 8 in (See Disassemble, page 31)Disassemble,).

10. Place stem (Item 27) through exhaust passage of the lower body so that threaded portion is visible at primary piston.

11. Use a screwdriver to engage and hold the slotted head of stem; then position stem spring (Item 4) and spring guide (Item 3) over primary piston (Item 9).

12. Install nut on stem and rotate clockwise. Tighten to 20 to 30 in-lbs. (2.3 to 3.4 N· m).

13. Install primary piston retainer (Item 26) over piston making certain all three lock tabs have engaged the outer lip of body.

14. Install secondary inlet and exhaust valve assembly in lower body.

15. Place exhaust cover (Item 16) on lower body and install four machine screws with lockwashers; tighten to 70 to 100 in-lbs. (7.9 to 11.3 N • m).

16. Install exhaust diaphragm (Item 17) and diaphragm washer (Item 18) to exhaust cover (Item 16) using Phillips head screw and lockwasher.

17. Install seal ring (Item 13) in lower body and secure lower body to upper body using four hex head capscrews and lockwashers; tighten capscrews to 70 to 100 in-lbs. (7.9 to 11.3 N • m).

18. Install treadle valve assembly to basic brake valve. Secure with capscrews and lockwashers and tighten to 80 to 100 in-lbs. (9 to 11.3 N • m).

19. Test the rebuilt brake valve by performing (See SERVICE CHECKS, page 30)SERVICE CHECKS .

12.6. SERVICING SUSPENDED TYPE VALVE

Remove

1. Apply parking brake and block wheels.

   NOTE – On some models, it may be necessary to remove the coolant reservoir tank to have access to the valve air lines and mounting bolts, or the air filter assembly may have to be removed.

2. Remove the strap securing the wiring harness to the coolant reservoir or air filter assembly.

3. Drain coolant reservoir if applicable.

4. Remove bolts/nuts securing coolant reservoir or air filter to mounting bracket.

5. Mark air lines (hoses) in relation to (foot) brake valve.

6. Disconnect all lines (hoses) connected to the valve.

7. Remove bolts securing valve from exterior side of dash panel. Remove valve.

Disassemble

Refer to Figure 26 for all items in parentheses.

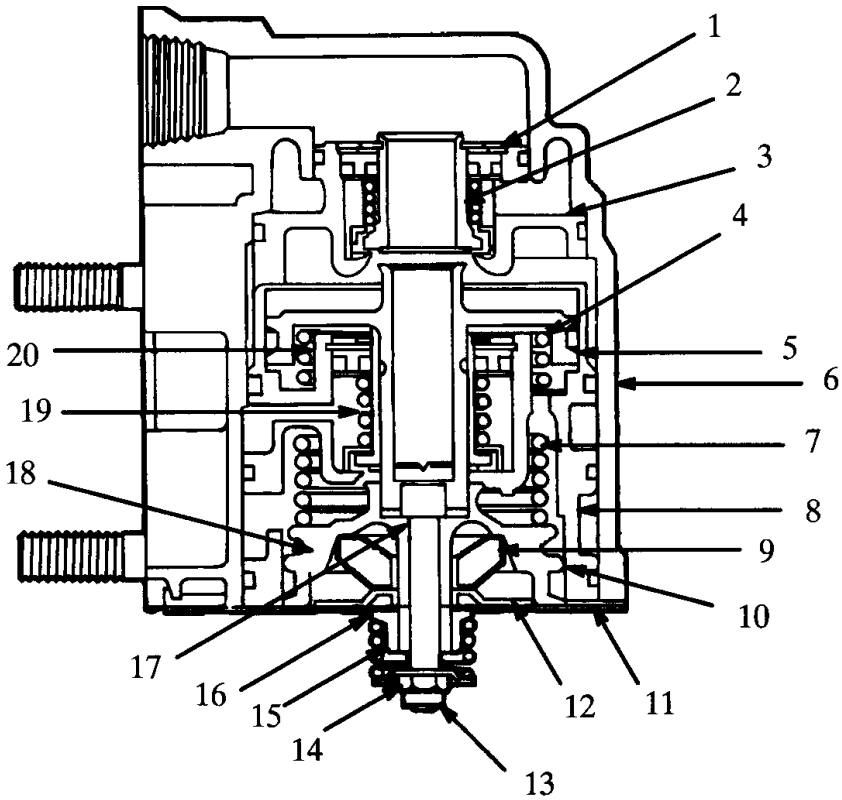

Figure 26 Suspended Type Valve - Disassemble

1. RETAINING RING
2. SECONDARY INLET AND EXHAUST VALVE
3. UPPER STATIC PISTON
4. RELAY SPRING PISTON RETURN
5. RELAY PISTON
6. BODY
7. PRIMARY SPRING PISTON RETURN
8. LOWER STATIC PISTON
9. RUBBER SPRING
10. PRIMARY PISTON
11. RETAINER
12. SPRING SEAT
13. LOCK NUT
14. STEM SPRING GUIDE
15. STEM SPRING
16. SPRING SEAT NUT
17. STEM
18. LOCKING GROOVE
19. PRIMARY VALVE INLET AND EXHAUST
20. RETAINING RING

1. Remove three capscrews and pedal assembly.

2. Apply force on retainer, disengage locking tabs from body and remove retainer (Item 11).

3. Grasp lock nut (Item 13) of lower static piston assembly (Item 8) with pliers and pull piston assembly from body (Item 6).

4. Fabricate a hook from a 6 inch (152 mm) piece of 1/8 inch (3 mm) diameter wire (approx.), bending one end 90 degrees at a length 1/2 inch to 3/4 inch (12.7 to 19 mm) from end of wire. Insert hook end in bore of body and through secondary inlet valve exhaust bore hooking onto valve. Pull firmly and remove upper static piston (Item 3) assembly with secondary inlet and exhaust valve (Item 2).

5. Apply firm pressure on spring seat (Item 12) which will compress primary piston spring (Item 9). Locking groove (Item 18) in piston is now accessible through rectangular opening in body. Insert wire on screwdriver into locking groove, thus holding primary piston spring in compressed position.

6. Insert blade of screwdriver through exhaust passage of secondary and primary pistons (Item 10) and into slot of stem (Item 17). Back off locking nut (Item 13).

7. Remove locking nut (Item 13), spring stem guide (Item 14) and stem spring (Item 15).

8. Remove spring seat nut (Item 16), spring seat (Item 12) and rubber spring (Item 9).

9. Removal of screwdriver or wire from locking groove will permit spring load to push out primary piston (Item 10) and relay piston (Item 5).

WARNING – Care should be used when removing tool from locking ring because of spring load.

10. Remove primary piston (Item 10) and return spring, and then relay piston (Item 5) and return spring.

11. Remove stem (Item 17) and O-rings from relay and primary pistons.

12. Remove O-rings from upper static piston (Item 3) and lower static piston (Item 8).

13. Remove large retaining ring from lower static piston (Item 8) and remove primary inlet/exhaust valve assembly (Item 19). Disassembly of inlet and exhaust valve is not required since it is only serviced as an assembly.

14. Remove large retaining ring from upper static piston assembly (Item 3) and remove secondary inlet/exhaust valve assembly (Item 2).

Clean and Inspect

Wash all metal parts in cleaning solvent. Use compressed air to dry parts. Inspect all parts for excessive wear or deterioration. Inspect valve seats for nicks or burrs. Check springs for cracks or corrosion. Replace all rubber parts and any part not considered to be serviceable.

Reassemble

Refer to Figure 26 for all items in parentheses.

Prior to reassembling brake valve, lubricate all O-rings, O-ring grooves, piston bores and metal-to-metal moving surfaces. Lubricate with Fleetrite EP2 Moly grease or equivalent to NLGI #2 multi-purpose lithium grease.

1. Install new secondary inlet/exhaust valve assembly (Item 2) in upper static piston (Item 3) and secure with retaining ring (Item 1) making certain retaining ring is engaged in groove of upper static piston bore.

2. Install O-ring on upper static piston assembly (Item 3) and install in body of valve.

3. Install primary inlet/exhaust valve assembly (Item 19) in lower static piston (Item 8) and secure with retaining ring (Item 20) making certain retaining ring is engaged in groove in lower static piston (Item 8).

4. Install three O-rings in grooves of lower static piston assembly (Item 8).

   The larger diameter O-ring is installed in groove nearest to bottom of piston assembly.

5. Install O-rings on relay piston (Item 5) and primary piston (Item 10).

6. Position rubber spring (Item 9), concave side down, in primary piston (Item 10) and place spring seat (Item 12), flat side up, over rubber spring.

7. Install spring seat nut (Item 16) on primary piston (Item 10) with hex head closest to spring seat and rotate nut clockwise until top surface of spring seat is even with top surface of piston.

8. Position relay piston spring, which is the lighter of the two piston return springs, relay piston (Item 5), primary piston spring and primary piston (Item 10) in lower static piston (Item 8). Compress both primary and secondary pistons in lower static piston. Hold them manually or mechanically.

   NOTE – A screwdriver may be used by inserting it through a rectangular opening in static piston into locking groove (Item 18) in primary piston (Item 10).

9. Insert stem (Item 17) through exhaust passage of relay (Item 5) and primary pistons (Item 10) and engage a screwdriver with slot in head of stem; then position stem spring (Item 15), spring guide (Item 14) on spring seat nut (Item 16).

10. Compress guide spring assembly and install lock nut (Item 13) on stem. Tighten nut to 20 to 30 in-lbs. (2.3 to 3.4 N• m).

    NOTE – Torque is a specified value for assembly; after assembly, torque value will fall off. Do not retighten nut.

11. Remove screwdriver from lower static piston assembly (Item 8).

12. Install lower static piston assembly (Item 8) in valve body. Then install retainer (Item 11) making certain locking tabs engage on valve body bosses.

13. Install pedal assembly using three capscrews. Check to be certain plunger is in contact with spring seat. The stop button should be adjusted so that the roller and plunger contact after adjustment; roller should be able to be turned freely by thumb.

14. Test rebuilt brake valve by performing (See SERVICE CHECKS, page 30)SERVICE CHECKS .

12.7. INSTALL

Treadle Type Valve

1. Start all air lines into the (foot) brake valve. Be sure the lines are in the same fitting location from which the line was removed.

2. Position (foot) brake valve onto mounting plate, and secure with screws.

3. Tighten all air lines that are attached to the brake (foot) valve.

4. Before putting vehicle back into service, check all air connections that were removed for leaks. Use a soap solution on connections and check for leaks (bubbles). No leaks on air line connections are acceptable.

Suspended Type Valve

1. Position valve into mounting plate. Install mounting bolts, but do not tighten.

2. Start all air lines. Be sure that the lines are on the same connections from which the lines were removed. After all lines have been started, tighten all lines.

3. Tighten foot valve mounting bolts.

4. Install coolant reservoir or air filter if applicable.

5. Secure wiring harness.

6. Fill coolant reservoir if applicable.

7. Before putting vehicle back into service, check all air connections that were removed for leaks. Use a soap solution on connections and check for leaks (bubbles). No leaks on air line connections are acceptable.

12.8. TORQUE CHART

Table 1 Torque Chart - Bendix E6 & E7

Location	In-Lbs.	Nm
Nut	20 to 30	2.3 to 3.4
Exhaust Cover	20 to 30	2.3 to 3.4
Lower Body	70 to 100	7.9 to 11.3
Treadle Assembly	80 to 100	9 to 11.3
Guide Spring Assembly	20 to 30	2.3 to 3.4

13. QR-N QUICK RELEASE VALVE

13.1. DESCRIPTION

The function of the Quick Release Valve is to “speed up” the exhaust of air from the brake chambers. It is generally mounted on the vehicle axle midway between the two brake chambers connected to it.

In the standard QR-N (Figure 27), a flat circular diaphragm is installed between the non-metallic upper body and stamped steel lower body. An O-ring seals the two body halves, which are held together with four 1/4" machine screws and flange nuts. The steel lower body also serves as the valve mounting bracket. In its standard configuration (Figure 28), the QR-N is supplied with a 1 psi maximum differential.

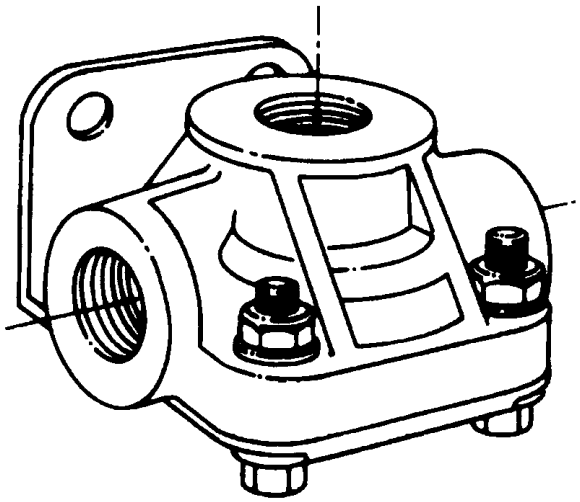

Figure 27 QR-N Quick Release Valve

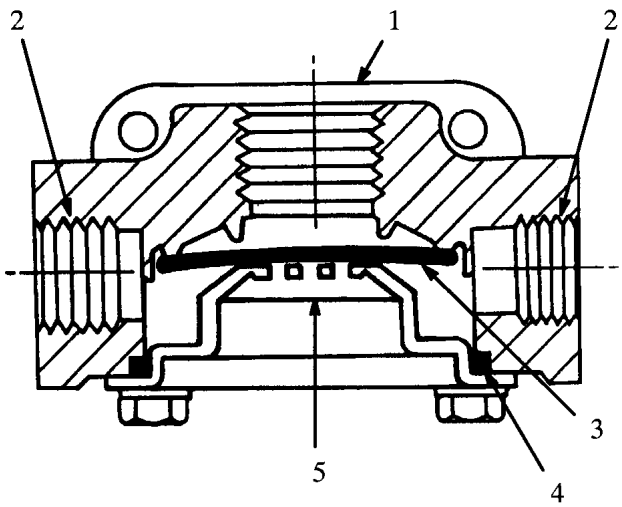

Figure 28 QR-N Quick Release Valve - Cross Section

1. SUPPLY PORT
2. DELIVERY PORT
3. DIAPHRAGM
4. O-RING
5. EXHAUST PORT

A higher differential pressure valve (3 psi) is available for special applications. The higher differential pressure is obtained by the addition of a spring and diaphragm follower to the standard QR-N. Refer to Figure 29 .

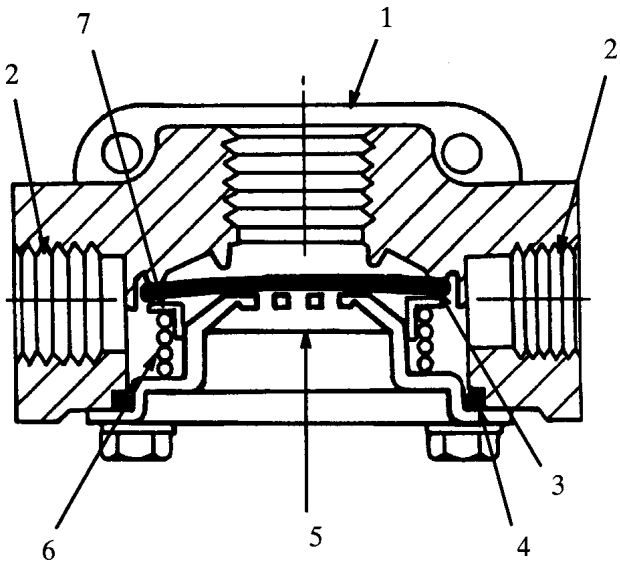

Figure 29 Addition of a Spring and Diaphragm

1. SUPPLY PORT
2. DELIVERY PORT
3. DIAPHRAGM
4. O-RING
5. EXHAUST PORT
6. SPRING
7. DIAPHRAGM FOLLOWER

The difference between a standard QR-N or differential QR-N valve can be determined by following one or more of the steps listed below:

1. Scrape paint from the valve surface. If the color of the plastic is gray, it is a differential valve.

2. Remove the fitting from the outlet port. If there is a spring inside the port, it is a differential valve.

3. Remove the valve from the crossmember. The part number tag on the cross- member side of the valve lists the valve operating pressure.

13.2. OPERATION

With no air pressure applied to the QR-N (Figure 28), the diaphragm is slightly flexed by the upper and lower body. In this condition, the center portion of the diaphragm rests on the exhaust port in the lower body while the outer edge and opposite side of the diaphragm rests against the sealing lip of the upper body.

Applying Air

Air entering the supply port of the QR-N causes the center portion of the diaphragm to seal the exhaust port. Simultaneously, the outer edge of the diaphragm moves away from the sealing lip of the upper body, allowing air to flow from the supply port out the delivery port to the brake chambers, applying the brakes.

Balance

When air pressure on both sides of the diaphragm is approximately equal (1 psi differential), the natural resiliency of the diaphragm material causes the outer edge of the diaphragm to move into contact with the

upper body sealing lip. The QR-N exhaust remains sealed because air pressure bears against the center portion of the diaphragm from one side only, allowing air to continue to flow out of the delivery ports to the brake chambers.

Release

When air pressure is reduced or removed from the QR-N supply port, the air pressure on the delivery side of the diaphragm is greater than that on the supply side. The higher delivery side pressure holds the outer edge of the diaphragm against the upper body sealing lip while simultaneously moving the center portion away from the exhaust port. Air from the delivery ports flows out the exhaust. When air pressure on the delivery side of the diaphragm equals the pressure on the supply side, the center portion of the diaphragm moves into contact with the exhaust port, shutting off the exhaust port, releasing the brakes.

13.3. SERVICE CHECKS

Operating Test

Apply 100 psi air pressure to the supply port of the QR-N and note that the brake chambers connected to the QR-N respond promptly.

Leakage Test

1. With 100 psi air pressure applied to the QR-N supply port, apply a soap solution to the exhaust port and around the junction of the upper and lower body halves.

2. Apply a soap solution to test for leakage at the exhaust port and between the 2 halves of the valve.
   a. No leakage is permitted between the body halves.
   b. Leakage of greater than a 1 inch (25 mm) diameter bubble in 3 seconds at the exhaust port is unacceptable.

3. Release the air pressure at the supply port and note that the brake chambers connected to the QR-N respond promptly and return to a zero air pressure condition.

4. If the QR-N does not function as described or if leakage is excessive, it is recommended that it be replaced with a new unit.

Balance Test

If slow brake release is experienced, the valve balance should be checked to determine if the QR-N should be replaced.

1. Block the wheels of the vehicle.

2. Drain all brake system reservoirs.

3. Remove the QR-N supply line from the valve.

4. Install a “T” in the supply line fitting.

5. Reconnect the supply line along with a shut-off valve and 125 psi gauge into the “T.”

6. Remove both delivery lines.

7. Install a plug in one delivery port.

In the other delivery port, install a hose long enough to extend into a container of water.

8. Start the engine and build up air pressure to a minimum of 80 psi.

9. Start to open the shut off valve and watch for air bubbles in the container of water. A standard QR-N should show bubbles at 1 psi. A differential QR-N (spring and spring follower installed) should have bubbles at 3 psi ±1 psi.

   If bubbles appear at pressures other than stated above, the valve is unacceptable and should be replaced.

13.4. REMOVE

1. Park the vehicle on a level surface. Block the wheels.

2. Drain all air brake system reservoirs.

3. Identify, mark and disconnect all air lines from the valve.

4. Remove all tubing or hose fittings from the valve.

5. Remove the valve mounting hardware and the valve.

13.5. INSTALL

1. Mount the QR-N on the vehicle.

2. Install the tubing or hose fittings in the upper body of the QR-N. If a thread sealant is used, make certain that this material will not enter the valve during use. Tighten all fittings to values specified in the TORQUE CHART .

CAUTION – When installing fittings, do not over-tighten or damage to the upper body may result.

3. Connect the air lines to the QR-N as identified in Step 3 of Remove.

4. Perform the (See SERVICE CHECKS, page 42)SERVICE CHECKS as described before placing the vehicle in service.

13.6. TORQUE CHART

Table 2 Torque Chart - QR-N Release Valve

Location	In-Lbs.	Nm
Supply Port Fitting	12	1.4
Delivery Port Fitting	10	1.1

14. INVERSION VALVE (BENDIX SR-1)

14.1. DESCRIPTION

This type inversion valve (Figure 30) is used only on a straight truck with dual air brake system. Its purpose is to allow a modulated spring brake application if air loss should occur in the primary (rear) portion of the air system.

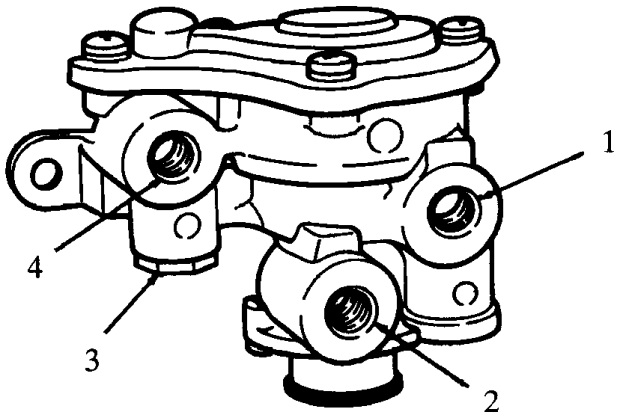

Figure 30 Inversion Valve (Bendix SR-1)

1. DELIVERY PORT
2. SUPPLY PORT
3. CONTROL PORT
4. RESERVOIR PORT

The secondary (front) brakes cannot supply enough braking effort alone to stop the vehicle quickly to meet the FMVSS 121 requirements for emergency stopping.

The inversion valve senses the loss of air in the primary system, allowing the spring brakes on the rear axle to be applied or released in a modulated manner at the same time the front service brakes are applied or released by the operator. The inversion valve also permits air pressure to enter the parking brake chamber, releasing the spring brakes.

The inversion valve (Figure 31) is not required on tractor applications due to the fact that the trailer brakes, being supplied with air from both the primary and secondary tractor systems, provide necessary braking required to meet FMVSS 121 emergency stopping requirements.

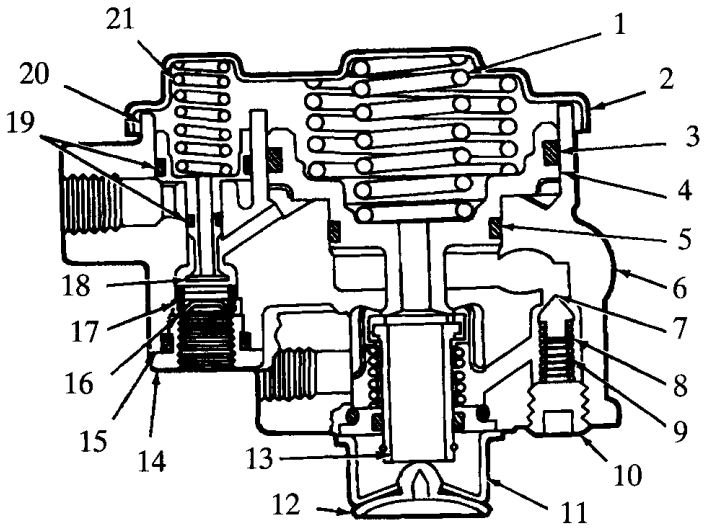

Figure 31 Inversion Valve - Cross Section

1. PISTON SPRING
2. COVER
3. LARGE O-RING
4. PISTON
5. SMALL O-RING
6. BODY
7. CHECK VALVE
8. CHECK VALVE SPRING GUIDE
9. CHECK VALVE SPRING
10. PIPE PLUG
11. EXHAUST COVER
12. DIAPHRAGM
13. INLET AND EXHAUST VALVE
14. CAP NUT
15. O-RING
16. VALVE STOP
17. VALVE SPRING
18. VALVE
19. O-RINGS
20. PISTON
21. PISTON SPRING

14.2. OPERATION

Initial Air Charge

Refer to Figure 32 for all items in parentheses.

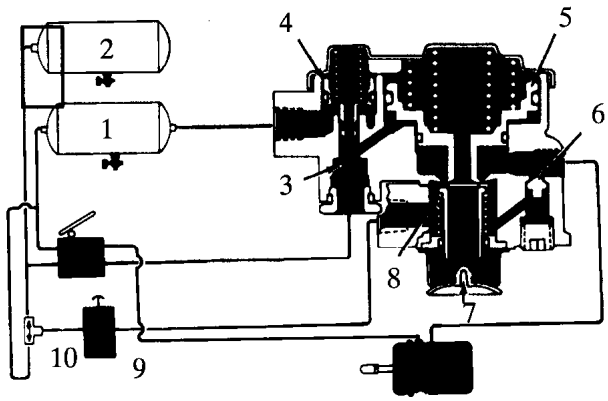

Figure 32 Initial Air Charge - Inversion Valve

1. PRIMARY RESERVOIR
2. SECONDARY RESERVOIR
3. INLET AND EXHAUST A
4. PISTON A
5. PISTON B
6. CHECK VALVE
7. EXHAUST
8. INLET AND EXHAUST B
9. SPRING BRAKE CONTROL VALVE
10. DOUBLE CHECK VALVE

Initial air charge (Figure 32) from the primary and secondary reservoirs flows through the spring brake control valve and enters the supply port of the inversion valve. Air entering the support port flows past inlet and exhaust valve “B” (Item 8), to the underside of piston “B” (Item 5) and out the delivery port to the emergency air connection on the spring brake chamber. Note that the springs above piston “B” (Item 5) force it into contact with inlet and exhaust valve “B”(Item 8). In the position shown, the exhaust is closed and the inlet is open.

Only air flowing from the primary reservoir enters the reservoir port on the inversion valve. This air remains under piston “A” (Item 4) as system pressure builds up. With primary reservoir pressure below approximately 55 psi, the spring above piston “A” (Item 4) forces it into contact with inlet exhaust valve “A” (Item 3), causing the exhaust to seal and inlet to open.

System Fully Charged

When the air pressure builds up past the approximate 55 psi in both the primary and secondary reservoirs, piston “A” (Item 4) has moved against the force of the spring above it permitting the inlet of valve “A” (Item 3) to close and open the hollow exhaust passage through piston “A” (Item 4).

When air pressure under piston “B” (Item 5) is about 95 psi, piston “B” (Item 5) rises slightly against the force of springs above it, allowing the inlet of valve “B” (Item 8) to close. The exhaust through valve “B” (Item 8) remains closed.

The closing of inlet portion of valve “B” traps about 95 psi in the hold-off cavity of the spring brake actuators while allowing full air system pressure to build elsewhere.

Normal Brake Application With Primary and Secondary Reservoirs Charged

When the service brakes are applied by actuating the dual brake valve, air from the secondary system is delivered from the brake valve to the control port where it is stopped at the closed inlet valve “A” (Figure 33,

Item 3). No further movement of internal components of the inversion valve takes place. Air from the primary delivery system of the brake valve actuates the service brakes of the spring brake chambers.

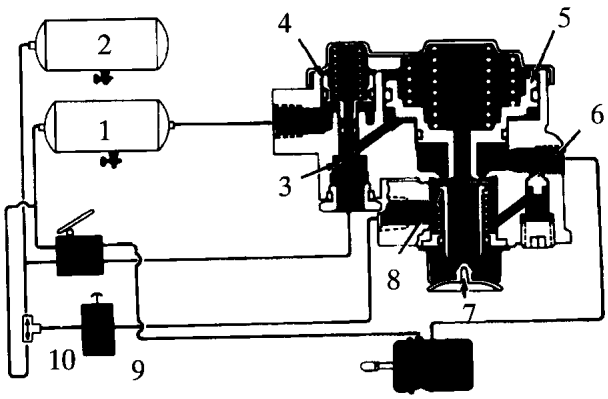

Figure 33 Normal Brake Application - Primary and Secondary Reservoirs

1. PRIMARY RESERVOIR
2. SECONDARY RESERVOIR
3. INLET AND EXHAUST A
4. PISTON A
5. PISTON B
6. CHECK VALVE
7. EXHAUST
8. INLET AND EXHAUST B
9. SPRING BRAKE CONTROL VALVE
10. DOUBLE CHECK VALVE

Brake Application With Loss of Air in Secondary System

Refer to Figure 33 for all items in parentheses.

If air pressure is lost in the secondary reservoir (Item 2), the primary reservoir (Item 1) as well as the spring brake control valve (Item 9) is protected against air loss through action of single check valve (air source to primary reservoir) and double check valve (Item 10). A brake application at brake valve in this situation results in little or no air being delivered from the secondary system to the control port of inversion valve. No movement of the internal components of the valve takes place. Braking is assured since the primary reservoir is protected and the primary delivery system of the brake valve will apply the service brake portion of the spring brake chambers.

Brake Application With Loss of Air in Primary System

Refer to Figure 34 for all items in parentheses.

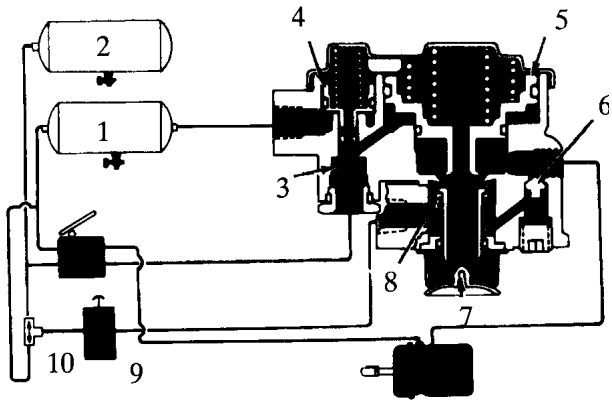

Figure 34 Brake Application With Loss of Air in Primary System

1. PRIMARY RESERVOIR
2. SECONDARY RESERVOIR
3. INLET AND EXHAUST A
4. PISTON A
5. PISTON B
6. CHECK VALVE
7. EXHAUST
8. INLET AND EXHAUST B
9. SPRING BRAKE CONTROL VALVE
10. DOUBLE CHECK VALVE

If air pressure in the primary reservoir (Item 1) should fall below approximately 55 psi, the pressure below piston “A” (Item 4) is insufficient to resist spring force above and piston “A” moves into contact with valve “A” (Item 3). Initial contact between piston “A” (Item 4) and valve “A” (Item 3) closes the hollow exhaust passage of piston “A”. Continued movement of piston opens the inlet valve “A” (Item 3).

The secondary reservoir and spring brake control valve are protected from air pressure loss by action of the check valve.

When brake application is made through the brake valve, air delivered from the secondary system of the brake valve enters the inversion valve control port. Air enters control port, moves past the inlet of valve “A” (Item 3) and is conducted through a passage in the body to the underside of piston “B” (Item 5). The added force of air pressure below piston “B” (Item 5) moves up, opening the exhaust valve “B” (Item 8). When exhaust of valve “B” (Item 8) opens, air pressure trapped in the emergency section of the spring brake chamber is allowed to escape, resulting in a brake application by emergency section. The amount of air pressure released from the spring brake is proportional to the amount of air pressure delivered to the control port of the inversion valve by delivery of brake valve secondary system.

Parking (Spring) Brake Application

Refer to Figure 35 for all items in parentheses.

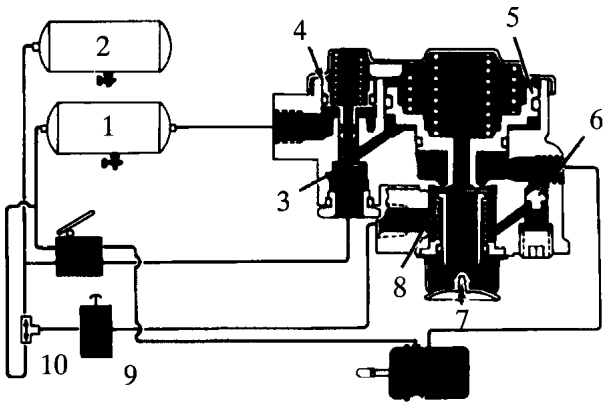

Figure 35 Parking (Spring) Brake Application

1. PRIMARY RESERVOIR
2. SECONDARY RESERVOIR
3. INLET AND EXHAUST A
4. PISTON A
5. PISTON B
6. CHECK VALVE
7. EXHAUST
8. INLET AND EXHAUST B
9. SPRING BRAKE CONTROL VALVE
10. DOUBLE CHECK VALVE

When both primary and secondary systems are charged with air and the spring brake control valve (Item 9) is placed in “apply” or exhaust position, the inversion valve air supply and air pressure in the spring brake chambers will be exhausted. The single check valve in the inversion valve assists the exhaust of air from the spring brake by allowing air below piston “B” (Item 5) to flow back out the open exhaust of the spring brake control valve (Item 9). When air pressure below piston “B” (Item 5) has dropped enough, piston “B” (Item 5) moves down, opening the inlet of valve “B” (Item 8), thus providing an additional exhaust passage for air exhausting through the inversion valve from spring brakes.

14.3. MAINTENANCE

Every 100,000 miles (160,000 km) or every year, remove, disassemble, clean and inspect all parts. If signs of wear or deterioration are found, install new parts. Replace all rubber parts.

14.4. SERVICE CHECKS

Operation Test

Block vehicle wheels; brake system will be inoperative. Charge air brake system to governor cut-out pressure.

1. Place parking control valve in the “apply” position. Observe that the spring brake actuators apply promptly. In the delivery port of the inversion valve, install a test gauge known to be accurate. Place the parking control valve in the “release” position. Observe that the spring brake actuators release fully.

2. With the parking control valve in the “release” position, note the gauge pressure reading (should be approximately the same as gauge on instrument panel). If the pressure reading is incorrect, the valve must be repaired or replaced.

3. Place the parking control valve in the “apply” position. The gauge reading should drop to zero promptly. A slow release of pressure could indicate faulty operation of the single check valve (within the modulating valve). At approximately 7 to 35 psi, the spring parking brakes should be fully applied.

4. Place the parking control valve in the “release” position. Locate the number one service reservoir and drain it completely.

5. Apply the foot brake valve several times and note that the pressure reading on the gauge decreases each time the foot brake valve is applied. After the foot brake valve has been applied several times, pressure on the gauge will drop to the point where release of the spring brake actuators will no longer occur.

Leakage Test

With air system fully charged and parking brake control valve in “release” position, check exhaust port for leakage. Slight leakage is permitted.

If inversion valve does not function as described above or leakage is excessive, repair or replace valve.

14.5. REMOVE

1. Apply parking brakes and block wheels.

2. Drain all air reservoirs of air.

3. Mark or identify all air lines before disconnecting from inversion valve. Then disconnect air lines.

4. Remove the two mounting bolts from valve and remove valve.

14.6. DISASSEMBLE

Refer to Figure 31 for all items in parentheses.

1. Remove socket head pipe plug (Item 10) at check valve (Item 7).

2. Remove check valve spring (Item 9), spring guide (Item 8) and check valve (Item 7).

3. Remove two screws, then remove exhaust cover (Item 2).

4. Separate exhaust diaphragm (Item 12) from cover (Item 2).

5. Remove inlet and exhaust valve assembly (Item 13).

6. Remove inlet and exhaust valve cap nut (Item 14) and separate cap nut O-ring (Item 15).

7. Remove valve stop (Item 16), valve spring (Item 17) and inlet and exhaust valve (Item 13).

8. Remove four screws and lockwashers that secure cover to the body.

9. Remove cover (Item 2) and three piston springs (Item 21).

WARNING – Cover is under a spring load and should be held while removing screws to avoid personal injury.

10. Remove small piston and small and large O-rings (Items 5 and 3).

11. Remove large piston and large and small O-rings (Items 3 and 5).

14.7. CLEAN AND INSPECT

Wash all metal parts in cleaning solvent. Use compressed air to dry parts. Inspect all parts for serviceability. Inspect the valve seats for nicks or burrs. Check the springs for cracks or corrosion. Replace all rubber parts and all unserviceable parts.

14.8. REASSEMBLE

Prior to reassembly of the SR-1 inversion valve, lubricate all O-rings, O-ring grooves, piston bores and metal-to-metal moving surfaces with the silicone base lubricant packaged in the repair kit or Item 3 in (See LUBRICANT SPECIFICATIONS, page 187)LUBRICANT SPECIFICATIONS .

The torque values listed in the assembly procedure are assembly torque values and can be expected to lighten following assembly. Do not retighten following initial assembly.

1. Assemble check valve, valve spring guide and valve spring, and insert them in body.

2. Apply pipe sealant to socket head pipe plug and install it in the body. Tighten to 130 to 170 in-lbs. (15 to 19 N• m).

3. Place inlet and exhaust valve assembly into valve body.

4. Install exhaust diaphragm in exhaust cover.

5. Position exhaust cover on body and secure cover with two screws. Tighten screws to 20 to 30 in-lbs. (2.3 to 3.4 N• m).

6. Place inlet exhaust valve in body and install valve spring and valve stop.

7. Install O-ring on the cap nut and install the cap nut in body. Tighten to 100 to 125 in-lbs. (11 to 14 N• m).

8. Position small and large O-rings on small diameter piston and insert piston in body.

9. Install large and small O-rings on large diameter piston and insert the piston in body.

10. Position piston springs in their respective pistons.

11. Secure cover to body with four screws and lockwashers. Tighten four screws to 50 to 80 in-lbs. (5.7 to 9 N·m).

14.9. INSTALL

1. Install inversion valve using the two mounting bolts.

2. Connect air lines. Make sure they are installed at the same ports.

3. Before releasing vehicle for service, perform (See SERVICE CHECKS, page 49)SERVICE CHECKS ,

14.10. TORQUE CHART

Table 3 Torque Chart - Inversion Valve

Location	In-Lbs.	Nm
Socket Head Pipe Plug	130 to 170	15 to 19
Exhaust Cover	20 to 30	2.3 to 3.4
Cap Nut	100 to 125	11 to 14
Body Cover	50 to 80	5.7 to 9

15. SPRING BRAKE CONTROL VALVE (MIDLAND ROSS)

15.1. DESCRIPTION

The spring brake control valve (Figure 36) is a manually operated valve of push-pull type.

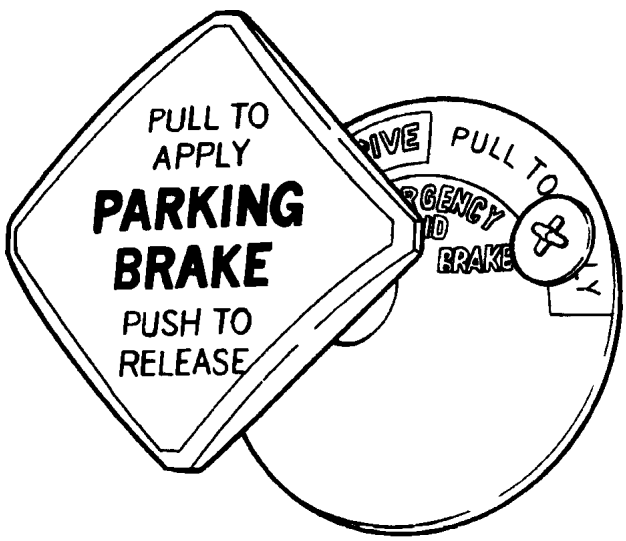

Figure 36 Spring Brake Control Valve (Midland Ross) - Lever

15.2. OPERATION

The spring brake control valve serves to apply and release the spring actuated parking brakes. The valve is in the “in” position under normal operation on either a straight truck or bus. Air supply passes through the valve, delivering system pressure to retract and hold parking brakes in the released position. Manual pull “out” closes off air supply and vents delivered air to the atmosphere, applying the parking brakes.

When valve is pushed IN, it will remain in as long as the air supply is above 7 to 17 psi on straight trucks and buses built before April 3, 1992, and above 25 to 35 psi on straight trucks and buses built after April 3, 1992. During normal operation, the air valve will automatically apply, moving OUT if air pressure should

drop below 7 to 17 psi on straight trucks and buses built before April 3, 1992, and 25 to 35 psi on straight trucks and buses built after April 3, 1992.

Pushing the piston in moves the valve assembly off the body seat until contacting end cap seat. Air pressure at the inlet has free passage to the outlet and is blocked from exhausting to atmosphere.

Pulling the piston out moves the valve assembly away from end cap seat and contacts body seat. Air pressure at inlet is blocked from entering either outlet or exhaust passages. Air pressure in outlet has free passage to exhaust to atmosphere.

The spring in the valve assists to move piston out automatically if inlet pressure drops and effective opposing force across the valve seat is overcome.

15.3. MAINTENANCE

Once each year or every 100,000 miles (160,000 km) the valve should be removed, disassembled and a repair kit installed.

15.4. SERVICE CHECKS

Leakage Test

CAUTION – Only test gauges known to be accurate are to be used for checking brake valve delivery pressures, gover- nor pressure settings and other tests.

Use air pressure source equipped with in-line manual shut-off valve, an air gauge known to be accurate and a connection adaptor. Connect air source to inlet port. Also connect a manifold with an air gauge and close manual shut off valve to outlet. With air control valve in “out” position, open manual valve to build up 100 to 125 psi to inlet port. Shut off manual valve. No air leakage is allowed around piston or through casting surfaces. Permissible leakage at exhaust port is a 1 inch (25 mm) diameter soap bubble in six seconds.

Push control valve in and build up 100 to 125 psi pressure at both inlet and outlet. Shut off manual valve and repeat above leakage test.

Pull control valve out. Outlet port pressure should exhaust to zero through valve.

Operation Test

Begin with zero pressure at inlet and outlet. Hold control valve IN and open manual valve to allow 7 to 17 psi on straight trucks and buses built before April 3, 1992, and 25 to 35 psi on straight trucks and buses built after April 3, 1992 to build up at both the inlet and outlet. The control valve should remain IN at pressures above 7 to 17 psi on straight trucks and buses built before April 3, 1992, and 25 to 35 psi on straight trucks and buses built after April 3, 1992.

Second check is accomplished with 100 to 125 psi in both inlet and outlet ports and both manual shut-off valves closed. Slowly open manual valve at outlet to bleed down pressure. The spring brake control should automatically move “out” when air pressure at inlet port reaches 7 to 17 psi on straight trucks and buses built before April 3, 1992 and 25 to 35 psi on straight trucks and buses built after April 3, 1992.

If spring brake control valve does not perform as described, it should be repaired or replaced.

15.5. REMOVE

1. Apply parking brake and block wheels.
2. Drain air supply from system.
3. Remove dash panel for access if applicable.
4. Mark air lines in relation to valve and disconnect air lines from valve.
5. Remove valve from dash panel.

15.6. DISASSEMBLE

Refer to Figure 37 for all items in parentheses.

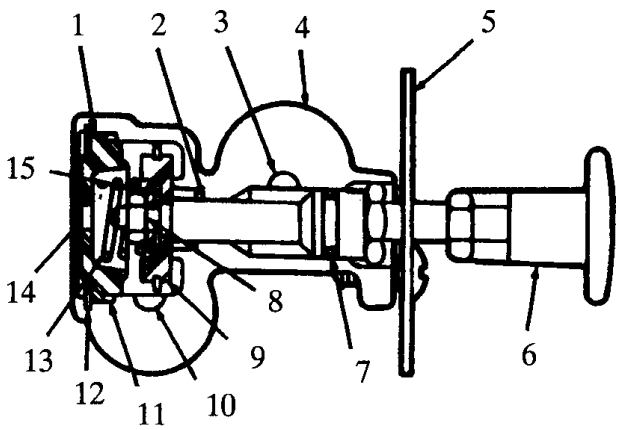

Figure 37 Spring Brake Control Valve - Disassemble

1. END CAP
2. PISTON
3. INLET
4. BODY
5. NAME PLATE
6. KNOB
7. O-RING
8. TIGHTEN NUT TO 12 - 17 IN-LBS. (1.4 - 1.9 N S M)
9. VALVE ASSEMBLY
10. OUTLET
11. O-RING
12. SNAP RING
13. SPRING
14. EXHAUST
15. WASHER

1. Inspect valve for damage. If casting is broken or shows fractures, replace valve assembly.
2. Carefully remove end cap snap ring (Item 12).
3. End cap (Item 1), O-ring (Item 11) and spring (Item 13) can be removed now.

4. Remove nut, washer and valve assembly (Item 9).

5. Remove piston (Item 2) with knob end of the body and remove O-ring (Item 7) from piston.

15.7. CLEAN AND INSPECT

Wash all metal parts in cleaning solvent. Use compressed air to dry parts. Inspect body and end cap seats. Face of seats must be flat and smooth with no cracks or nicks. If any of these conditions exists, replace valve.

15.8. REASSEMBLE

Use new parts supplied in repair kit.

Lubricate O-rings, O-ring sealing surfaces and all internal parts. Refer to Item 3 of (See LUBRICANT SPECIFICATIONS, page 187)LUBRICANT SPECIFICATIONS .

Refer to Figure 37 for all items in parentheses.

1. Install O-ring (Item 7) on piston (Item 2) and insert piston into body (Item 4), aligning hex on piston to hex on body.

2. Position valve assembly (Item 9) over end of piston (Item 2), then position washer (Item 15) over piston stud end against metal face of valve.

3. Install nut and tighten to 10 ft-lbs.

   (14 N• m). Piston should move smoothly back and forth in body.

4. Install spring (Item 13) with small end against valve disc.

5. Position O-ring (Item 11) over end cap (Item 1). Align end cap over spring and push end cap into body. Hold end cap to prevent spring pushing end cap out.

6. Install snap ring (Item 12) in valve body groove.

When applying force to move plunger in and releasing it, plunger should move freely.

7. Install new O-rings on stem and piston (Item 2).

8. Insert stem in valve body; then position piston in valve body over stem.

9. Install stem nut.

10. Install valve end cap (Item 1) and new gasket.

15.9. INSTALL

1. Install valve to dash panel.

2. Connect air lines to the connections that the lines were removed from.

3. Before vehicle is returned to service, perform (See SERVICE CHECKS, page 53)SERVICE CHECKS

16. TWO WAY CONTROL VALVE (BENDIX TYPE TW-1)

16.1. DESCRIPTION

The two-way control valve (Figure 38), which is an off-on valve, is mounted on the instrument panel and is primarily used in conjunction with various other air devices in vehicle air systems.

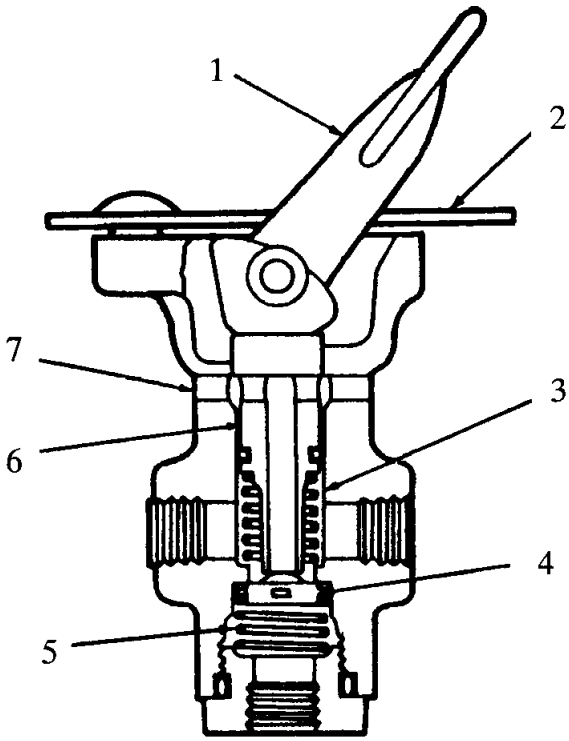

Figure 38 Two Way Control Valve (Bendix Type TW-1)

1. LEVER
2. DIAL
3. PLUNGER RETURN SPRING
4. INLET AND EXHAUST VALVE
5. INLET VALVE SPRING
6. PLUNGER
7. EXHAUST PORT

The systems in which these valves may be used are: transmission air control valve, quick release valve, two-speed shift cylinders, manually operated tractor protection valve and power divider lock-out system.

16.2. OPERATION

Applying

When the lever is actuated in the delivery position, the hollow plunger of the valve is depressed and makes contact with the inlet valve and unseats it. In this position, the exhaust passage through the hollow plunger is closed and air from the inlet port has free passage through the two-way valve and out the delivery port to the device being operated.

Releasing

When the lever is released, the plunger is raised by the plunger spring and the inlet valve removed to its seat and is held closed by the inlet valve spring and inlet air pressure. Any air pressure in line or lines connecting the two-way valve with the device being operated will be exhausted through the hollow plunger and exhaust opening near the top of the valve.

16.3. MAINTENANCE

Once each year or every 100,000 miles (160,000 km), the two-way valve should be disassembled and thoroughly cleaned. Replace all parts worn or damaged in any way.

16.4. SERVICE CHECKS

Operation Test

CAUTION – Only test gauges known to be accurate are to be used for checking brake valve delivery pressures, gover- nor pressure settings and other tests.

Plug one delivery port and install an air pressure test gauge in remaining port. Install second air pressure gauge in the air inlet line. With air connected to the inlet port, place the lever in applied position. The air gauge in the delivery port should read the same as the gauge installed in air inlet line.

Leakage Test

With air supplied to the inlet port of the two-way valve and the lever in released position, apply soap solution at exhaust opening at top of the valve (where lever enters valve) to determine leakage.

Move lever or button to “applied” position and check exhaust opening with soap solution to determine leakage past exhaust plunger.

16.5. REMOVE

1. Disconnect air lines at two-way valve.

2. Remove machine screws securing control valve and remove valve.

16.6. DISASSEMBLE

Refer to Figure 38 for all items in parentheses.

1. Press out lever roll pin.

2. If valve is of the push-pull type, loosen jam nut at control button, then remove button and jam nut.

3. Remove plunger (Item 6) and plunger return spring (Item 3) from body.

4. Unscrew cap nut at inlet port and remove valve spring (Item 5) and valve from body.

5. Remove grommets from plunger (Item 6) and cap nut.

16.7. CLEAN AND INSPECT

1. Wash all metal parts in cleaning solvent. Use compressed air to dry parts.
2. Check plunger (Item 6) for damage. Hollow hole plunger must be clean and free of all foreign material.
3. Inspect small end (exhaust seat) of plunger (Item 6) carefully; if chipped, worn or distorted, replace.
4. Check plunger return spring (Item 3) and valve spring (Item 5) for damage.
5. Valve body must be replaced if seat is worn excessively or damaged.

16.8. REASSEMBLE

Refer to Figure 38 for all item numbers in parentheses.

1. Install new grommet on plunger (Item 6).
2. Apply a small amount of Fleetrite EP2 Moly grease or equivalent to NLGI #2 multi-purpose lithium grease on the plunger (Item 6) and insert plunger return spring (Item 3) and plunger into the valve body. Plunger must move freely with only a slight drag due to grommet. Depress plunger and then release; plunger spring (Item 3) must return plunger.
3. Apply Fleetrite EP2 Moly grease or equivalent to NLGI #2 multi-purpose lithium grease to cap nut grommet and position grommet on cap nut.
4. Position valve and valve spring in valve body.
5. Install cap nut in valve body.
6. Position lever (Item 1) on top of plunger (Item 6) and align hole in lever with hole in body.
7. Install lever pin and stake edge of hole.
8. Install jam nut and button on push-pull type valve. Install bracket on remote control (cable-operated) type valve.

16.9. INSTALL

1. Install valve and secure with screws. Position lever-operated or push button-operated two-way valve on instrument panel with body of valve against rear face of instrument panel.
2. Connect all air lines and perform (See SERVICE CHECKS, page 57)SERVICE CHECKS .

17. MODULAR CONTROL VALVE (MV-3)

17.1. DESCRIPTION

The modular control valve (Figure 39) is a two-button, push-pull control valve housed in a single body which includes a dual circuit supply valve and a check valve. The valve body, plungers and spools are made of a non-metallic, non-corrosive material. All connections are at the back of the valve except for the auxiliary port as illustrated in Figure 40 .

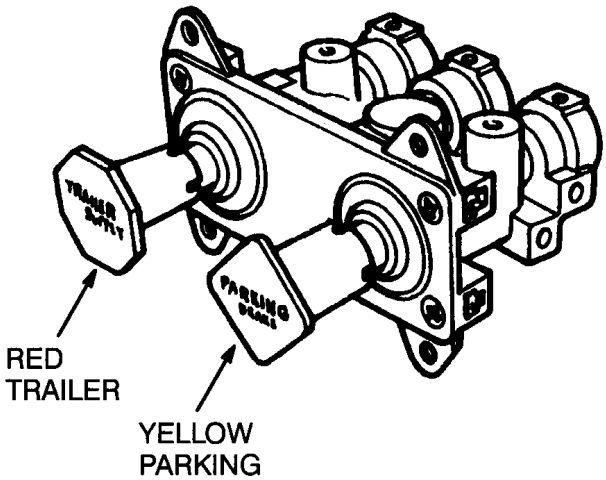

Figure 39 Modular Control Valve (MV-3)

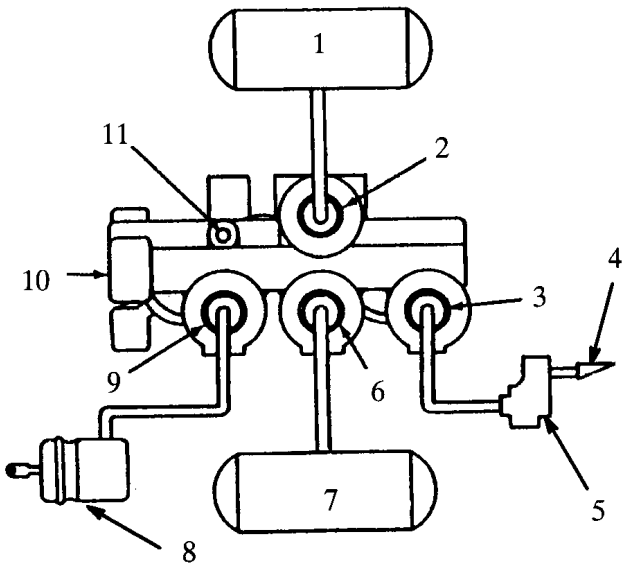

Figure 40 Modular Control Valve (MV-3) - Back

1. PRIMARY RESERVOIR
2. #1 SUPPLY PORT
3. DELIVERY - TRAILER PORT
4. TRAILER SUPPLY LINE
5. TRACTOR PROTECTION VALVE
6. #2 SUPPLY PORT
7. SECONDARY RESERVOIR
8. SPRING BRAKE CHAMBER
9. DELIVERY-TRACTOR PORT
10. AUXILIARY DELIVERY PORT
11. EXHAUST

The control valve provides the following functions:

1. Tractor protection

2. Trailer service air control

3. System park

4. Trailer park only

5. Trailer charge with tractor spring brakes applied (tractor park only)

6. Supply reservoir selection

7. Primary and secondary reservoir connection (two-way check valve).

The valve includes a spring loaded dual circuit supply double check valve. The valve selects the air source for both control valve circuits. The primary reservoir is selected at all times unless the pressure in the primary reservoir falls more than 30 psi below the pressure of the secondary reservoir.

If the pressure in the primary reservoir falls more than 30 psi below the pressure of the secondary reservoir, the dual circuit supply valve will shuttle and establish the secondary reservoir as the supply.

The trailer air supply valve or tractor protection control (red knob), Figure 39 , delivers air to the trailer supply line and also will trip (pop out) automatically and shut off the trailer supply if pressure decreases to 40 ± 5 psi.

IMPORTANT – Reservoir No. 1 must be the reservoir that supplies the primary brake system. Reservoir No. 2 must be the reservoir that supplies the secondary brake system.

The parking brake valve (yellow knob), Figure 39 , controls the spring brakes on the tractor and when exhausted, simultaneously causes the trailer supply valve to trip and exhaust, thus applying both tractor and trailer parking brakes as required by Federal Regulations. The trailer brakes may be independently released by pushing only the trailer air supply valve (red knob) in.

17.2. OPERATION

Initial Charge

With the system completely discharged, both knobs are out (Figure 41).

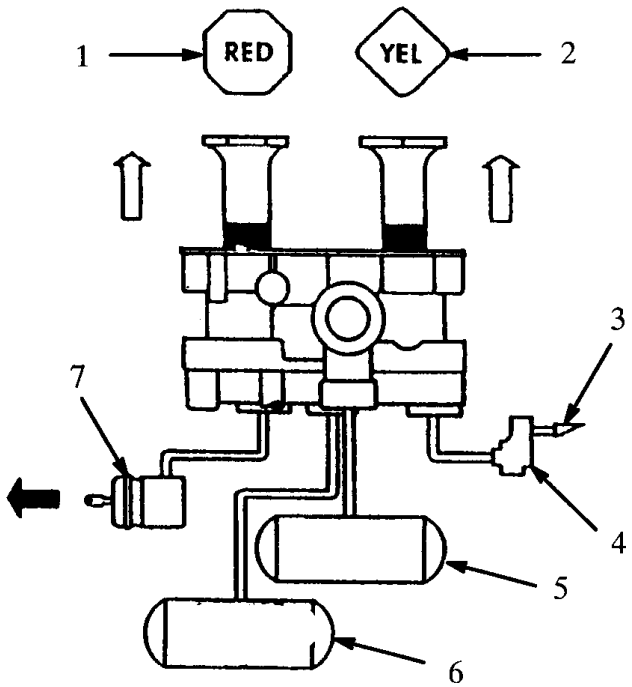

Figure 41 Modular Control Valve (MV-3) - System Discharged

1. TRAILER SUPPLY KNOB
2. PARKING BRAKE KNOB
3. TRAILER SUPPLY LINE
4. TRACTOR PROTECTION VALVE
5. PRIMARY RESERVOIR
6. SECONDARY RESERVOIR
7. TRACTOR SPRING BRAKES

When system pressure reaches 65 psi, the red knob (trailer supply) may be pushed in (Figure 42) and should stay in, charging the trailer system and releasing the trailer brakes. The yellow knob (system park) may now be pushed in (Figure 43) which will supply air to the tractor spring brakes, releasing them.

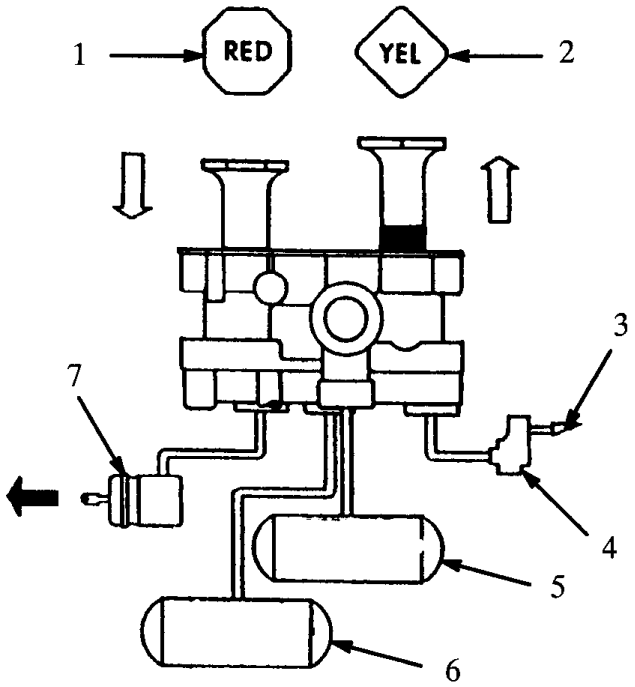

Figure 42 Red Knob Pushed In

1. TRAILER SUPPLY KNOB
2. PARKING BRAKE KNOB
3. TRAILER SUPPLY LINE
4. TRACTOR PROTECTION VALVE
5. PRIMARY RESERVOIR
6. SECONDARY RESERVOIR
7. TRACTOR SPRING BRAKE

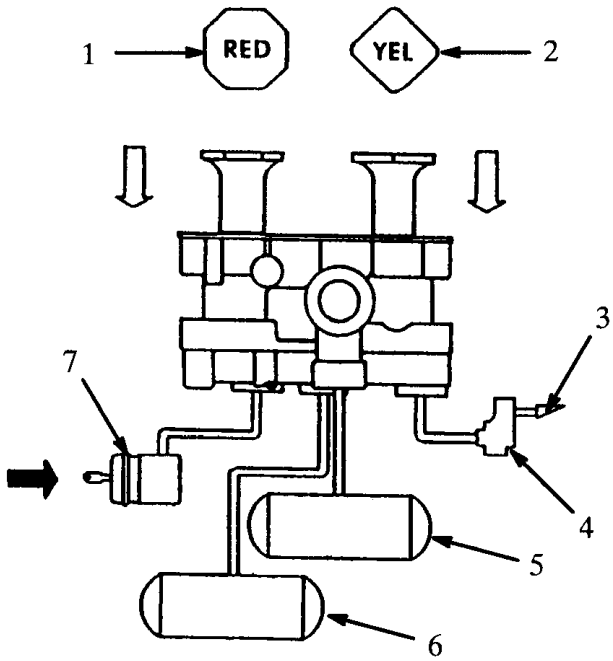

Figure 43 Yellow Knob Pushed In

1. TRAILER SUPPLY KNOB
2. PARKING BRAKE KNOB
3. TRAILER SUPPLY LINE
4. TRACTOR PROTECTION VALVE
5. PRIMARY RESERVOIR
6. SECONDARY RESERVOIR
7. TRACTOR SPRING BRAKE

System Park

With both knobs in for normal tractor-trailer run modes, the parking brakes on both tractor and trailer may be actuated by pulling the yellow knob out, which exhausts the air from the tractor spring brakes and simultaneously causes the trailer supply valve to pop out, applying the trailer brakes (Figure 41). This complies with Federal Regulations that one control must actuate all the parking brakes on a vehicle.

Trailer Charge

If both valves are out, parking the combination vehicle, and it is desired to recharge the trailer while leaving the tractor spring brakes applied, the red knob may be pushed in (Figure 42) re-pressurizing the trailer supply line. This mode may also be used to park a combination vehicle with tractor spring brakes only.

Automatic Application

With both knobs in, as in the normal run position (Figure 43) , and supply pressure to the push-pull valves reduced to 40 ± 5 psi, the red knob (trailer supply valve) must pop out, applying the emergency or parking brakes on the trailer. If the red knob is held in manually and the pressure decreases to 30 ± 5 psi, a tripper piston within the trailer control spool will move upward, exhausting the trailer air supply, thus applying the trailer brakes.

Normal Run Position

With both knobs pushed in (Figure 43) , air is now being supplied to the trailer and to the tractor spring brakes; all brakes are released.

Actuating The Trailer Brakes

To actuate the trailer brakes, only the red knob is pulled out (Figure 44), exhausting the trailer supply line. The trailer brakes are now applied either by emergency air or spring brakes, depending on the type of trailer system. This mode would be used during trailer drop and during bobtail operation.

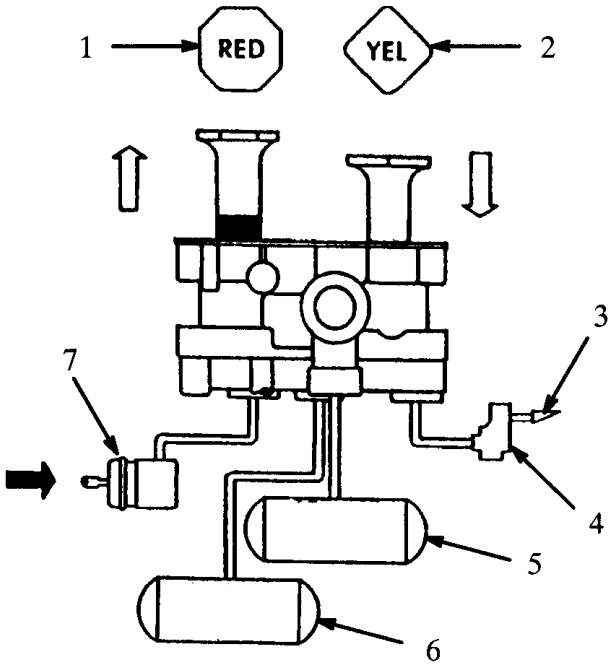

Figure 44 Red Knob Pulled Out

1. TRAILER SUPPLY KNOB
2. PARKING BRAKE KNOB
3. TRAILER SUPPLY LINE
4. TRACTOR PROTECTION VALVE
5. PRIMARY RESERVOIR
6. SECONDARY RESERVOIR
7. TRACTOR SPRING BRAKE

17.3. MAINTENANCE

Once each year or every 100,000 miles (160,000 km), the modular control valve should be disassembled and thoroughly cleaned. Replace all unserviceable components with those supplied with the repair kit.

Lubricate all components with Fleetrite EP2 Moly grease or equivalent to NLGI #2 multi-purpose lithium grease.

17.4. SERVICE CHECKS

Operation Test

Perform the Operation Test after rebuilding valve assembly.

CAUTION – Only test gauges known to be accurate are to be used for checking brake valve delivery pressures, gover- nor pressure settings and other tests.

When the Operation Test on the modular control valve is performed on the vehicle, both the Leakage and Operation checks will be accomplished simultaneously.

In some instances it will be necessary to remove the instrument panel bezel and the access panel on the instrument panel to gain access to the valve. Block wheels of vehicle while performing the Operation Test.

1. With both control knobs out, charge the air brake system to 65 psi and check for leakage. No leakage is permitted.

2. With supply pressure still at 65 psi, push the red knob in. The knob must stay in. Leakage at the exhaust port must not exceed a 1 inch (25 mm) diameter bubble in 5 seconds.

3. Push the yellow knob in. With the engine off, actuate the foot valve several times to deplete the air supply. The red knob must pop out when the reservoir with the highest pressure reaches 40 ± 5 psi. If air is depleted quickly, the red knob could pop immediately. Leakage at exhaust port must not exceed a 1 inch (25 mm) diameter bubble in 5 seconds.

4. .With the engine off, actuate foot valve, depleting additional air. Air must start to escape from the exhaust port when the air pressure in the reservoir with the higher pressure reaches 30 ± 5 psi. The yellow knob must pop out at this time.

5. With the engine off, deplete the air system further by activating the foot valve. At 25 ± 5 psi, the yellow knob must pop out and maintain supply pressure. Leakage at exhaust port should not exceed 1 inch (25 mm) diameter bubble in 5 seconds.

6. Rebuild the supply pressure to at least 40 psi. Push in the yellow knob; the yellow knob must remain in. Leakage at the exhaust port should not exceed a 1 inch (25 mm) bubble in 5 seconds.

7. Charge the system to 120 psi and push both knobs in. Pull the red knob out. The yellow knob must remain in.

8. Push the red knob in and pull the yellow knob out. The red knob must pop out almost instantaneously.

9. Install a gauge to monitor tractor spring brake delivery pressure. Apply 120 psi to both primary and secondary reservoirs. Push in the yellow knob. Delivery pressure should equal the pressure in the primary reservoir. Reduce the pressure in the primary reservoir. Delivery pressure and primary reservoir pressure should descend together to 105 to 90 psi, at which point the dual circuit supply (double check) valve shuttle should switch to the secondary reservoir and delivery pressure should increase to the secondary reservoir pressure. After the primary reservoir pressure is reduced to zero, a leakage of a 1/2 inch (12.7 mm) diameter bubble in 5 seconds is permitted at the primary reservoir opening. Close the leak which had been created at the primary reservoir.

10. Leaving the yellow knob in, recharge the secondary reservoir to 120 psi. The delivery pressure should also read 120 psi. Recharge the primary reservoir to 100 psi. Slowly vent the secondary reservoir. As the secondary reservoir pressure and the delivery line pressure descend between 115 and 105 psi, the dual circuit supply (double check) valve shuttle should switch to the primary reservoir, causing the delivery line pressure to adjust to the primary reservoir pressure.

11. Close all vents or leakage points and charge both reservoirs to 120 psi. Position the red knob out and the yellow knob in. Develop a leak in the spring brake delivery line and hold the yellow knob in. The primary reservoir pressure must reduce to zero and the secondary reservoir pressure to 20 to 30 psi. The dual circuit supply valve shuttle should cycle several times during this leak-down period.

17.5. REMOVE

1. Apply parking brake and block vehicle wheels.
2. Completely bleed air system.
3. Remove instrument panel access cover to expose valve body cover plate.
4. Mark or identify all air lines connected to valve. Then disconnect air lines.
5. Remove valve assembly from instrument panel.
6. Remove all fittings from the rear of the valve. Note the direction of all fittings.

17.6. DISASSEMBLE

Refer to Figure 45 for all items in parentheses.

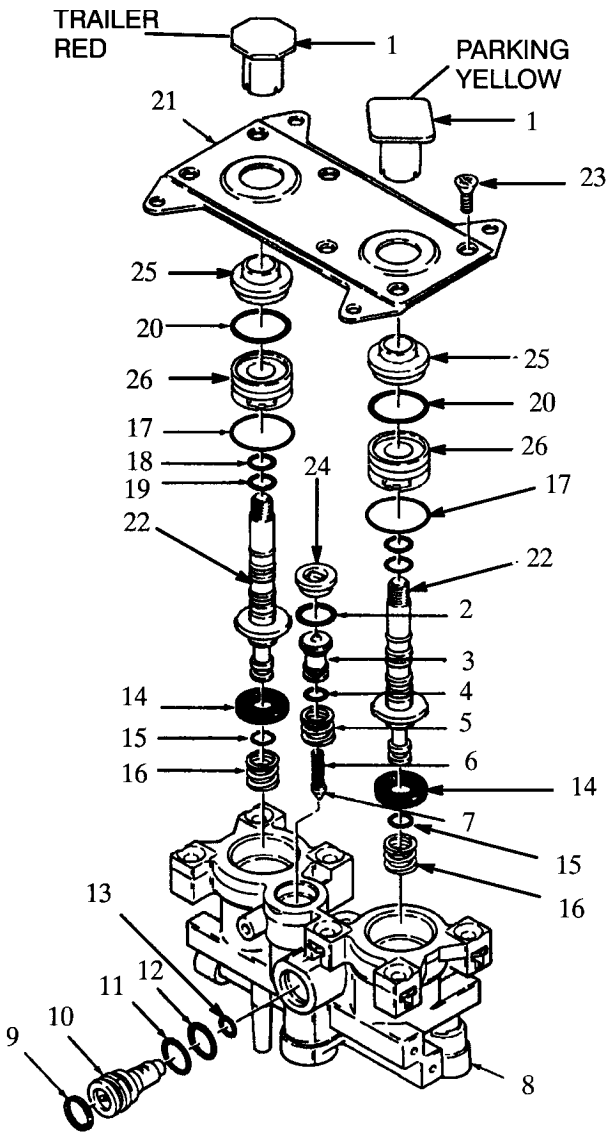

Figure 45 Modular Control Valve (MV-3) - Disassembly

1. KNOB
2. O-RING
3. PISTON
4. O-RING
5. OVERRIDE SPRING
6. SPRING
7. CHECK VALVE
8. BODY
9. RETAINING RING
10. SHUTTLE VALVE
11. O-RING
12. O-RING
13. O-RING
14. PLUNGER SPRING
15. O-RING
16. EXHAUST SEAL
17. O-RING
18. O-RING
19. O-RING
20. O-RING
21. COVER
22. VALVE SPOOLS
23. SCREWS
24. RETAINER CAP
25. GUIDE CAP
26. GUIDE SPOOL

1. Remove red and yellow knobs (Item 1), from the stems of the spools by turning in a counterclockwise direction.

CAUTION – Note the orientation of these knobs in relation to the valve to be sure they will be reinstalled correctly.

2. Remove screws (Item 23) from the cover plate (Item 21) and carefully remove the cover from the valve.

3. Remove the cap (Item 24) and O-ring from the bore of the tripper valve. Remove piston (Item 3), springs (Item 5 and 6) and check valve (Item 7). These items will all fall out of the cavity of the valve by tilting the valve forward. Remove the O-ring (Item 2) from its groove on the piston (Item 3).

4. .Remove the two main spools (Item 22) from the body of the valve by grasping the stem and pulling firmly. Remove the two springs from the bottom of the spool cavity.

5. Pull the guide cap (Item 25) and guide spool (Item 26) over the threaded end of the main spool (Item 22). Remove the O-ring (Item 20) from the guide cap (Item 25) and the O-ring (Item 17) from the guide spool (Item 26). Remove O-rings (Item 15, 18 and 19) and the exhaust seal (Item 16) from the main spool.

6. Repeat step 5 on the remaining spool.

7. Remove the retaining ring (Item 9) from the shuttle valve cavity.

8. Grasp the bar in the center of the shuttle valve piston (Item 10) with a pair of needle nose pliers and remove the dual circuit valve assembly. Remove the three O-rings (Item 11, 12 and 13) from the valve or from the cavity of the body, if some have remained there. Other than the three external O-rings, do not disassemble the piston assembly any further.

NOTE – If, during removal of this assembly from the valve body, the cap of the piston dislodges from the rest of the assembly, the balance of the parts can be removed by the use of a bent wire. Care should be taken not to scratch the valve bore with the wire. The spring, piston and O-ring that are internal parts of the dual circuit valve assembly are non-serviceable.

17.7. CLEAN AND INSPECT

The non-metallic components which comprise most of the parts of the valve**should not be immersed in any solvent type cleaner**. Old lubricant should be wiped off parts prior to reassembly and the bores of the body wiped out with a clean, dry cloth.

17.8. REASSEMBLE

Refer to Figure 45 for all items in parentheses.

1. Install O-rings (Item 11, 12 and 13) onto the shuttle valve (Item 10). Then install the assembly (small end first) into the MV-3 valve body.

2. Install the retaining ring (Item 9) making sure it's fully seated in its groove.

Refer to Figure 46 for all items in parentheses.

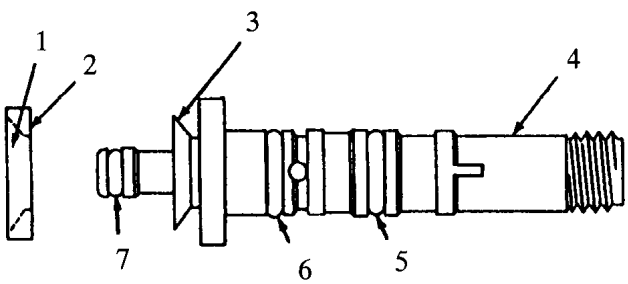

Figure 46 O-Rings

1. I.D. BEVEL
2. EXHAUST SEAL
3. MATING EXHAUST SEAL BEVEL
4. MAIN SPOOL
5. O-RING
6. O-RING
7. O-RING

3. Install O-rings (Items 5, 6, and 7) and the exhaust seal (Item 2) onto the main spool (Item 4).

NOTE – The exhaust seal (Item 2) must be installed so that its beveled surface mates with the beveled surface of the main spool (Item 4).

NOTE – The spools in the MV-3 are the same length and are interchangeable.

Refer to Figure 45 for all items in parentheses.

4. Install O-ring (Item 17) onto the guide spool (Item 26) and O-ring (Item 20) onto the guide cap (Item 25). Place the guide cap on top of the guide spool and install entire assembly over the threaded end of the main spool (Item 22) and press down firmly until it snaps into place.

5. Install spring (Item 14) over the boss in the bottom of the main spool cavity in the body of the valve. Place the main spool assembly into the valve body, keeping the spool square to the body. Press and turn the stem until the spool is fully seated in its cavity. The assembly is keyed and may only be installed one way.

6. Repeat steps 3, 4 and 5 with the opposite main spool.

7. Install O-ring (Item 4) into its groove on the piston (Item 3) and O-ring (Item 2) onto the retainer cap (Item 24).

8. Install spring (Item 5) on the piston (Item 3) and spring (Item 6) on the boss of the check valve (Item 7).

9. Install the spring and check valve into its cavity in the valve body (tapered end of check valve to enter cavity first). Make sure the spring (Item 6) is centered in the bore.

10. Install the piston assembly into the cavity making sure the spring (Item 6) mates with the bore of the piston.

11. Install the retainer cap (Item 24) with O-ring (Item 2).

12. Fasten the cover (Item 21) to the valve with six screws (Item 23). Tighten the screw to 25 in-lbs. (2.83 N · m).

13. Attach the red and yellow knobs (Item 1) onto the threaded spools, making sure that they are installed on the proper spool as noted in step 1 of (See DISASSEMBLE, page 66)DISASSEMBLE .

17.9. INSTALL

1. Apply a non-hardening sealing compound to fittings. Assemble fittings in rear of valve. Do not assume that the fittings will seal themselves to the body. Tighten to 120 in-lbs. (14 N·m).

2. Assemble valve to instrument panel.

3. Connect air lines to their respective fittings (refer to Figure 40 for porting designation).

4. Remove the identification tags.

5. After installing the valve in the vehicle, repeat the (See SERVICE CHECKS, page 64)SERVICE CHECKS . Test drive the vehicle at slow speed in a safe area prior to placing back into service.

6. After checking the serviceability of valve, reinstall instrument panel access cover (if applicable).

Table 4 Torque Chart - Modular Control Valve (MV-3)

Location	In-Lbs.	Nm
Fitting to Valve Body	120	14
Cover Plate	25	2.83

18. TRACTOR PROTECTION VALVE

18.1. BENDIX TP-5

Description

The Bendix TP-5 is a panel or crossmember mounted tractor protection valve. It has two additional double check valve and quick release functions. It contains a service line shut-off valve with exhaust function, a service line QRV (quick release valve) and two double check valves.

Operation

The function of the TP-5 is to receive all pneumatic signals pertinent to the operation of the trailer braking system, transmit same to the trailer and also to protect the tractor air supply in case of separation of the connecting lines to the trailer (Figure 47).

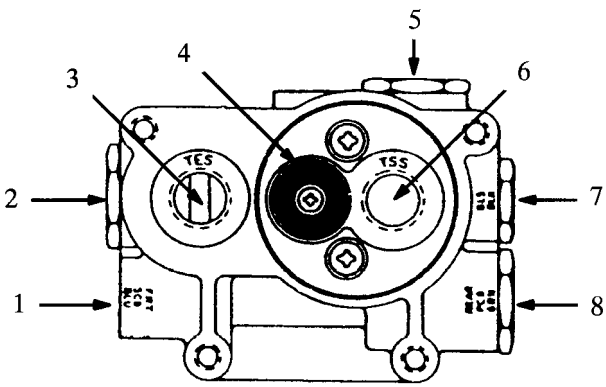

Figure 47 Tractor Protection Valve (Bendix TP-5)

1. FRONT SERVICE
2. TRACTOR PROTECTION CONTROL VALVE
3. TRAILER EMERGENCY SUPPLY
4. EXHAUST
5. TRAILER CONTROL VALVE
6. TRAILER SERVICE SUPPLY
7. STOP LIGHT SWITCH
8. REAR SERVICE

Tractor Protection Portion

Refer to Figure 48 for items in parentheses.

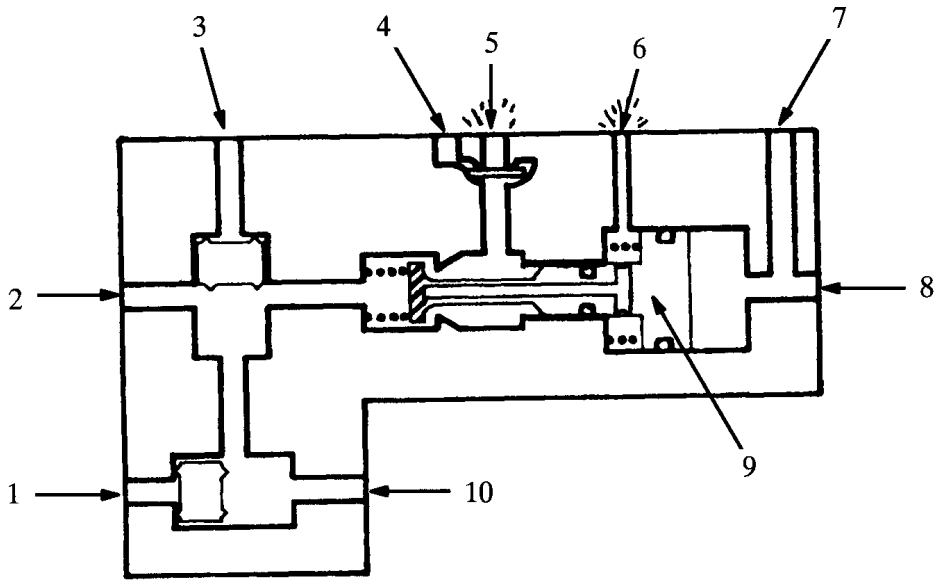

Figure 48 Tractor Protection Portion

1. FROM REAR SERVICE (PRIMARY)
2. TO STOP LIGHT SWITCH
3. FROM TRAILER CONTROL VALVE
4. TO TRAILER SERVICE
5. SERVICE LINE QUICK RELEASE VALVE
6. VENT
7. TO TRAILER EMERGENCY SUPPLY
8. FROM TRACTOR PROTECTION CONTROL VALVE
9. SERVICE LINE SHUT-OFF VALVE
10. FROM FRONT SERVICE (SECONDARY)

Air from the tractor protection control valve in the cab enters at the tractor protection delivery port (Item 8) and passes out the trailer supply port (Item 7) and simultaneously acts upon the service line shut off plunger (Item 9) moving the service line inlet valve off its seat and opening the service line passage. With common air to the supply side and service side of the manifold, the valve should open at approximately 45 psi. If the Tractor Protection Control Valve is manually or automatically moved to the exhaust position, the service line shut-off valve will close at approximately 10 psi and the exhaust passage in the plunger will vent the trailer service line (Item 5).

Double Check Valves

The two double check valves in the TP-5 serve to pick up the highest pressure service signal from either the tractor front brake circuit (secondary) (Item 10), rear brake circuit (primary) (Item 1) or trailer control valve signal (Item 3), operating the trailer brakes accordingly. The stop light switch port also picks up this signal and actuates the stop light switch (Item 2).

Service Line Quick Release Valve

The trailer service line port is in the cover as illustrated in Figure 49 This cover also houses a quick release valve. The diaphragm seals off the exhaust port on application and upon release of service line application, permits the trailer service line air to exhaust through the exhaust port, thus permitting faster release times for trailer brake release.

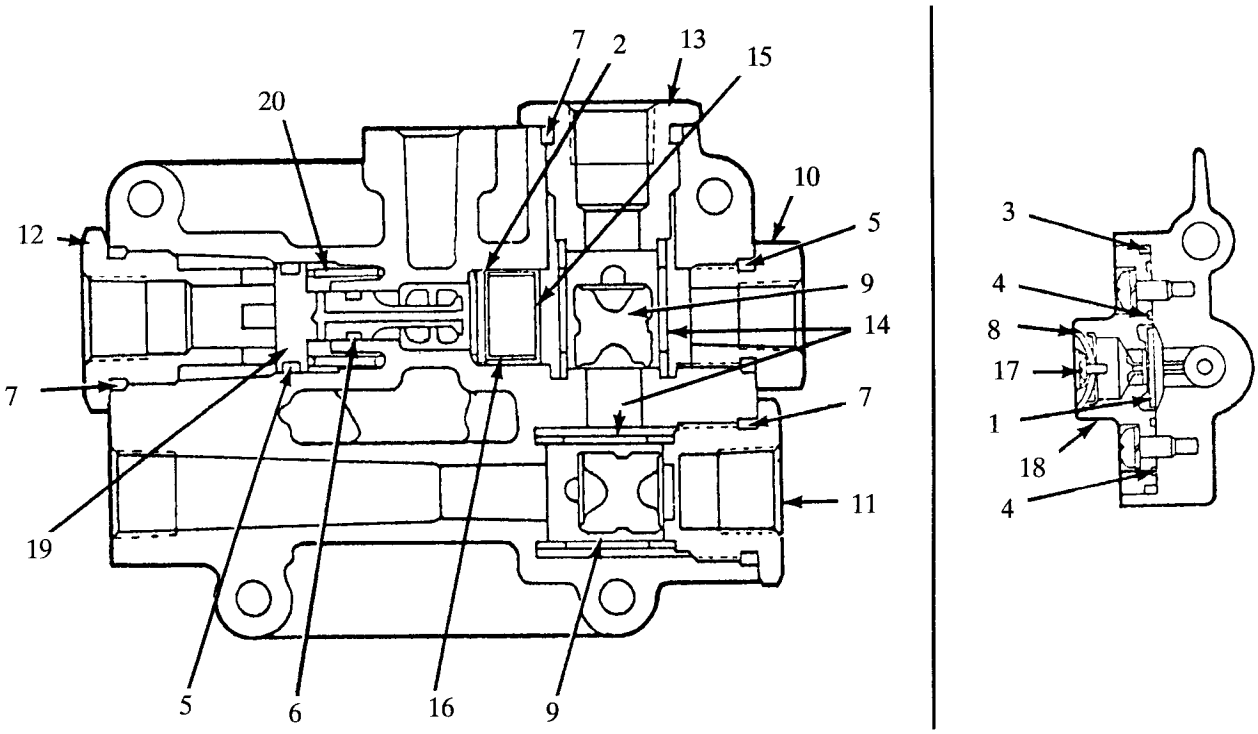

Figure 49 Tractor Protection Valve - Service Checks

1. QRV DIAPHRAGM
2. INLET VALVE
3. O-RING
4. O-RING (2)
5. O-RING (LARGE)
6. O-RING (SMALL)
7. O-RING (3)
8. EXHAUST CHECK VALVE DIAPHRAGM
9. DOUBLE CHECK SHUTTLES
10. CAP NUT
11. CAP NUT
12. CAP NUT
13. CAP NUT
14. DOUBLE CHECK GUIDES
15. SNAP RING
16. SPRING
17. PAN HD SCREW
18. COVER
19. CONTROL PISTON
20. SPRING

Maintenance

Every 3600 operating hours or after 100,000 miles (160,000 km) or yearly, disassemble, clean and inspect all parts. Install new parts if they show signs of wear or deterioration. A maintenance kit is available to service the valve.

Service Checks

Operating and Leakage Checks

Refer to Figure 49 for items in parentheses.

1. Block the wheels, charge air brake system to governor cut-out, and pull out the tractor protection control valve knob (emergency position).

2. Disconnect the trailer service line hose coupling. Make a trailer hand control valve application. Hold a finger over the 1/16 inch vent hole in the service line shut-off valve area of the TP-5 casting. Check for leakage at hose coupling and at exhaust port at the TP-5. Leakage of a one inch (25 mm) soap bubble every 3 seconds at either port indicates a faulty inlet valve (Item 2).

3. With hand control valve still applied, turn on ignition and check for stop light function.

4. .Release hand control valve application and place tractor protection valve in normal position.

> **CAUTION – Only test gauges known to be accurate are to be used for checking brake valve delivery pressures, gover- nor pressure settings and other tests.**

5. Connect the tractor service hose coupling to a test gauge, re-apply the hand control valve and note that there is pressure at the service hose coupling.

6. Check for leakage at the service line QRV. Leakage of a one inch (25 mm) soap bubble every 3 seconds indicates a defective diaphragm (Item 1).

7. With service line pressure still applied through the hand control valve, check for leakage at the brake valve exhaust. Leakage of a one inch (25 mm) soap bubble every 3 seconds indicates a defective double check valve shuttle.

8. Check for leakage at 1/16 inch vent hole. Leakage indicates either O-ring (Item 6) or O-ring (Item 5) is defective. [O-ring (Item 5) referred to is on the control piston (Item 19); the same O-ring is also used on a cap nut (Item 10).]

9. Release the hand control valve application and re-check for leakage at the vent hole. If the leakage continues, it is the large O-ring (Item 5) which is leaking. If the leakage stops, it was the smaller O-ring (Item 6) which was leaking.

10. Make and hold a foot brake application. Check for leakage at exhaust of hand control valve. Leakage of a one inch (25 mm) soap bubble every 3 seconds indicates a faulty double check valve shuttle.

11. Release foot brake application, disconnect line from primary service brake circuit at TP-5 delivery port (PCD) and block off the end of the line from the brake valve. Make a foot brake application and observe for leakage at the PCD delivery port.

12. Reconnect the primary circuit line and reverse the procedure with the secondary circuit line (SCD). Leakage of a one inch (25 mm) soap bubble every 3 seconds in either (11) or (12) indicates a faulty double check valve shuttle. Restore the secondary circuit connection to the TP-5.

If the valve does not function as described above or leakage is a one inch (25 mm) soap bubble every 3 seconds, the valve should be repaired or replaced.

Disassembly

Refer to Figure 49 for items in parentheses.

1. Block the wheels and drain the air brake systems.
2. Remove all air lines and stop light switch from the manifold and remove the unit from the vehicle.
3. Remove the four cap nuts (Items 10, 11, 12 and 13) from the body. Identify the cap nuts to their respective ports before removing. Remove the O-rings (3 of Item 7 and 1 of Item 5).
4. Remove the double check guides (Item 14) and double check shuttles (Item 9).
5. Reach into the port marked BLK-SLS with a set of snap ring pliers and remove the snap ring (Item 15), spring (Item 16), and valve (Item 2).
6. Remove the two screws which hold the cover (Item 18) to the body. Remove the two small O-rings (Item 4) and one large O-ring (Item 3). Remove the quick release valve diaphragm (Item 1).
7. Remove the 6-32 pan head screw (Item 17) and remove the exhaust check valve diaphragm (Item 8).
8. Clean all parts, bores, and passages with a solvent equivalent to mineral spirits.

Assembly

NOTE – Before assembly, lubricate all O-rings, bores, pistons, etc. with lubricant.

Refer to Figure 49 for items in parentheses.

1. Reinstall inlet valve (Item 2), spring (Item 16) and snap ring (Item 15) in body.
2. Install shuttle guides (Item 14) and shuttles (Item 9) and their respective cap nuts (Item 10 and 11).
3. Install the O-rings (Item 5 and 6) on the service line shut off plunger, and install spring (Item 20), plunger and corresponding cap nut (Item 12) with O-ring (Item 7).
4. Position the quick release valve diaphragm in the body and the O-rings (Items 3 and 4) on the cover and install the cover in its cavity in the body using the two screws to secure it.
5. Replace the exhaust seal diaphragm (Item 8) in the cover.
6. Reinstall unit into vehicle. Install all air lines and stop light switch.

Testing

Test the reassembled valve as described under (See Service Checks, page 74)SERVICE CHECKS .

18.2. MIDLAND-ROSS

Description

The tractor protection valve (Figure 50) can be referred to as a modular tractor protection valve, since it is one valve that incorporates several different functions.

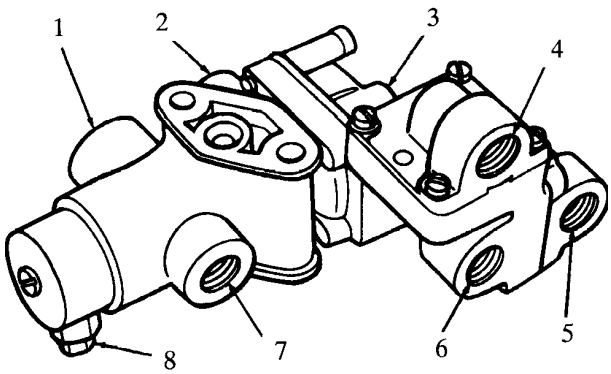

Figure 50 Tractor Protection Valve (Midland Ross)

1. TRAILER EMERGENCY
2. TRAILER SERVICE
3. STOP LIGHT SWITCH
4. BRAKE VALVE SECONDARY
5. HAND CONTROL VALVE
6. BRAKE VALVE PRIMARY
7. TRACTOR EMERGENCY
8. EXHAUST

The valve incorporates a manifold that accommodates two brake valve or foot valve ports plus a hand control port through two built-in, two-way check valves for service brake application. It also incorporates a quick release feature, automatic shut off on loss of emergency trailer air, and an automatic bleed back of any trapped service air.

The valve determines whether the service air brake line that connects the tractor and trailer systems is open or closed. The emergency passage through the valve is always open. The opening and closing of the service air brake lines is established by shuttling a spring loaded tapered piston working against piston forces developed by air pressure levels in the emergency passage.

Manual activation of the valve is performed by the operator through the use of the trailer supply (red) knob at the instrument panel.

When the trailer supply control is opened (red knob pushed in), air pressure is supplied to the emergency port to open the tractor protection valve. Pulling the red trailer supply control knob “out” exhausts the emergency line at the air control valve, allowing the tractor protection valve to close.

A quick release feature incorporated in the service passage serves to improve brake release time response. During service brake release, the service line air pressure in the trailer system is exhausted to the atmosphere at the tractor protection valve as compared to exhausting at the foot valve or hand control valve.

The automatic shut-off bleed back feature allows the valve to automatically shut off under a full service brake application. When the trailer supply control is pulled out while the service brakes are applied, the bleed back feature allows the trapped air in the trailer service line to bleed to 0 psi pressure.

During tractor operation without trailer, the trailer supply control knob is “out” and the “service” passage at the tractor protection valve is closed. The trailer supply control valve blocks the air pressure to the emergency passage to the tractor protection valve. Air passages leading from the tractor system to the trailer couplings are blocked.

When coupling the tractor to the trailer, the trailer supply control (red) knob is pushed “in.” Air flows through the tractor protection valve emergency line to charge trailer brake system reservoirs. Trailer brakes are released simultaneously if trailer brakes are holding prior to coupling. When the air pressure in the emergency line reaches approximately 40 to 50 psi, the tractor protection valve service passage will open.

During normal tractor-trailer operation, the tractor protection valve remains open, allowing air to flow in either direction between tractor and trailer air brake system. Trailer service brakes are applied and released by operation of either the foot brake valve or hand control valve, when air flows through the service passage of the tractor protection valve. Trailer air reservoirs and brake system are replenished by air flow through the emergency passage.

Operation

Refer to Figure 51 for all numbers and letters in parentheses throughout this text.

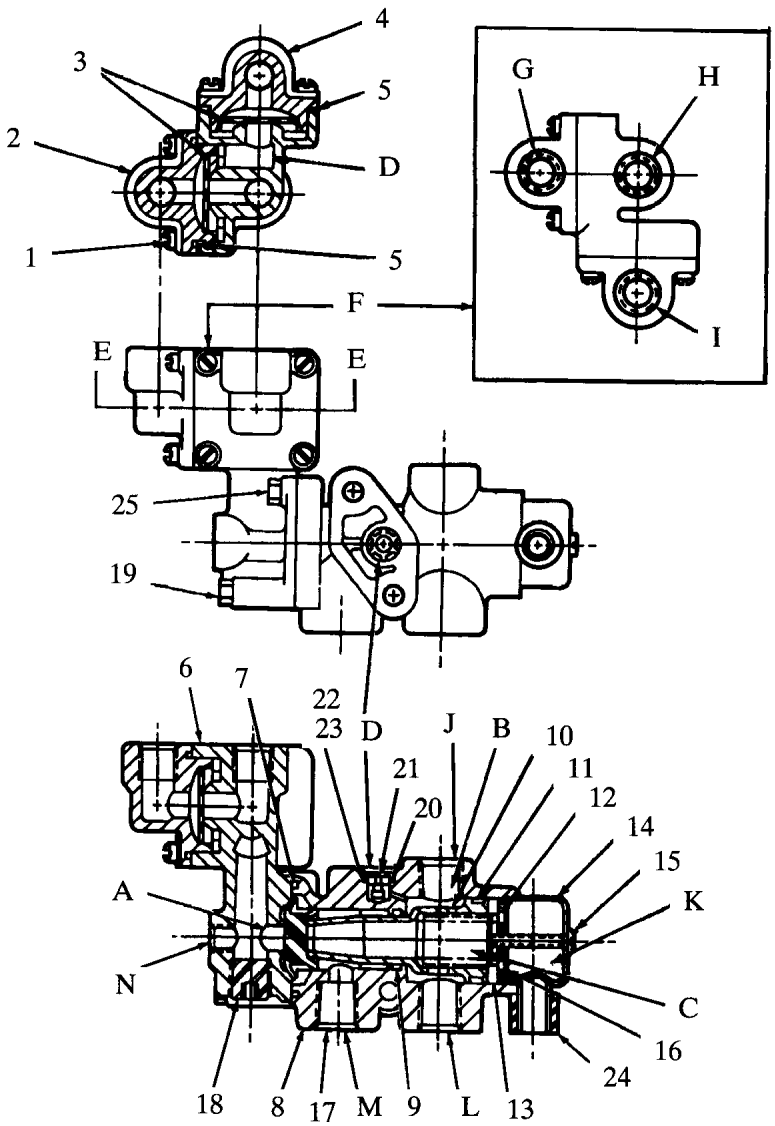

Figure 51 Tractor Protection Valve (Midland Ross) - Cross Section

A. CAVITY A
B. CAVITY B
C. CAVITY C
D. CAVITY D
E. VIEW E-E
F. VIEW F
G. CONTROL PORT
H. SERVICE PORT
I. SERVICE PORT
J. TRACTOR EMERGENCY PORT
K. EXHAUST PORT
L. TRAILER EMERGENCY PORT
M. TRAILER SERVICE PORT
1. SCREW
2. COVER (HAND CONTROL)
3. VALVE DISC
4. COVER (FOOT VALVE NO.2)
5. O-RING
6. CHECK VALVE BODY
7. O-RING
8. VALVE
9. O-RING
10. PISTON
11. O-RING
12. SPRING
13. EXHAUST DISC
14. END CAP ASSEMBLY
15. SCREW
16. SNAP RING
17. BODY
18. PIPE PLUG
19. SCREW
20. O-RING
21. VALVE DISC
22. PLUG
23. STAR WASHER
24. FOAM SEAL
25. SCREW

Figure 51 illustrates the tractor protection valve in the normally closed position for operating the tractor without a trailer.

The rubber valve (Item 8) is seated against the check valve body (Item 6) by the piston (Item 10) closing off passage of air through the valve from tractor service ports (H and I) to trailer service port (M). Cavity (B) is vented to the exhaust through the trailer emergency control (not shown) located in the cab dash panel. The trailer service port (M) and cavity (A) are vented to atmosphere.

After connecting the trailer and pushing the trailer emergency control valve knob “in,” air pressure is supplied from the tractor system through cavity (B) from tractor emergency port (J) to trailer emergency port (L). Air pressure above 40 to 50 psi against the piston (Item 10) causes it to move toward the spring (Item 12). The piston bottoms out on the exhaust disc (Item 13) which is held securely in place by the snap ring (Item 16). Service air passage from tractor to trailer is open.

During normal service brake application, the controlled air supplied by the foot valve enters the service ports marked foot valve #1 (primary) and foot valve #2 (secondary). The air pressure moves the valve disc (Item 3) against the cover (Item 2), closing off the hand control port (G). Air is allowed to enter cavity (A).

The air pressure moves the valve (Item 8) down to seat on the piston (Item 10) blocking off cavity (C). Air then flows around the diaphragm and out the trailer service port (M) to the trailer brakes. The air supplied by the hand control valve enters the service port (G) marked “hand control.” The air pressure moves the valve disc (Item 3) under the cover (Item 2) against the seat on the check valve body (Item 6) blocking the air passage to the foot valve port #1 (H). The air flows around the valve disc (Item 3) and enters cavity (D). The air pressure pushes the valve disc (Item 3) against the cover (Item 4) blocking the air passage to the foot valve port #2 (Item I). The air pressure enters cavity (A) and continues the same function as previously stated in service brake application above.

When the service brakes are released, the controlled air supplied through and downstream of the tractor protection valve acts to unseat the valve (Item 8) from the exhaust seat on the piston (Item 10). The exhaust air enters cavity (C) and out exhaust port (K). Air upstream from the tractor protection valve is exhausted through the foot valve or hand control valve.

If service brake system pressure on the tractor drops to 30 to 40 psi, spring (Item 12) force moves the piston (Item 10) towards the inlet seat on the check valve body (Item 6) and closes the tractor to trailer service port (M).

The automatic shut-off and bleed back feature functions when the service brakes or hand control valve is applied. When the trailer emergency dash control valve is pulled out, pressure in cavity (B) will be reduced to 0 psi, trapping applied service brake pressure in the trailer service port (M). At this time, the trapped air will bleed by the one-way check disc (Item 21) into cavity (B), which is exhausted to the atmosphere through the trailer emergency valve at the instrument panel.

Maintenance

Once each year or every 100,000 miles (160,000 km), remove, disassemble and clean all parts. Replace all rubber parts.

When the service checks of the tractor protection valve are made on the vehicle, both the leakage and performance checks will be accomplished simultaneously.

To obtain access to the tractor protection valve on some vehicles, removal of the floor panel directly ahead of the driver’s seat will be required.

Unless otherwise instructed, all disconnect points in the following instructions will be made at the tractor protection valve.

Service Checks - Leakage Test

1. Disconnect hand control (G) and trailer service air (M) lines with the trailer emergency control valve pulled out (no air to trailer emergency).

2. With 100 to 125 psi in both primary and secondary air systems, apply brake (foot) valve. Total leakage measured at hand control port (G), trailer service port (M) and exhaust port (K) should not exceed 5 cu. in. (82 cm^3) per minute or a 1" (25 mm) soap bubble in 12 seconds.

3. Connect hand control valve line to tractor protection valve and disconnect brake (foot) valve lines (H and I).

4. Apply hand control valve. Total leakage measured at foot valve ports (H and I), trailer service port (M) and exhaust port must not exceed 5 cu. in. (82 cm^3) per minute or a total of a 1 inch (25 mm) soap bubble in 12 seconds.

5. Disconnect lines at hand control port (G) and trailer emergency port (L).

6. Install a pipe plug in trailer emergency port (L).

7. With 100 to 125 psi in both primary and secondary air systems, push trailer emergency control “in.” Leakage through valve and at trailer service (M) and exhaust (K) ports should not exceed 5 cu. in. (82 cm^3) per minute or a total of 1 inch (25 mm) soap bubble in 12 seconds.

8. Pull trailer emergency control valve knob out and remove pipe plug from trailer emergency port (L). If valve passes leakage check, the Operation Test should be made.

Service Checks - Operation Test

1. Install a duplex gauge or two single air gauges at trailer service and emergency ports (M and L).

CAUTION – Only test gauges known to be accurate are to be used for checking brake valve delivery pressures, gover- nor pressure settings and other tests.

2. With 55 psi in both primary and secondary air systems, push the trailer emergency control “in.” Air pressure at instrument panel gauge and trailer emergency port should read approximately the same. The air gauge connected at trailer service port (M) must not show pressure. Permissible leakage at exhaust port is a 1 inch (25 mm) soap bubble in 3 seconds.

3. Replenish air to 100 to 125 psi in both primary and secondary systems.

4. Bleed off secondary air reservoir.

5. With the trailer emergency control valve knob at the instrument panel pushed in, apply the hand control valve. There should be a minimum of 85 psi at the trailer service port (M).

6. Release hand control valve and apply brake (foot) valve. Pressure at trailer service port (M) should be within 5 psi of air gauge at instrument panel.

7. Replenish air systems to 100 to 125 psi and bleed off the primary air reservoir.

8. With the trailer emergency control valve knob at instrument panel pushed in and hand control valve released, apply brake (foot) valve. Pressure at trailer service (M) should be within 5 psi of air gauge at instrument panel.

9. Replenish complete air system to 100 to 125 psi.

10. Apply brake (foot) valve and pull trailer emergency (red) knob out. The duplex gauge connected to trailer service port (M) should record the same valve 100 to 125 psi as gauge at instrument panel. Gauge connected at trailer emergency (L) should be 0 psi.

If valve passes Leakage Test and Operation Test, it is considered a serviceable valve. Remove duplex air gauge and reassemble trailer service and emergency air lines.

Remove

1. Pull out the park brake control knob to set parking brake. Be sure Trailer Emergency Control Valve Knob is pulled out.
2. Bleeding the air system is not required since there will be no air supplied to the Tractor Protection Valve while the brake (foot) valve and Hand Control Valve are released.
3. Mark all air lines to assist in re-connecting.
4. Disconnect air lines at valve. Disconnect stop light switch wires.
5. Remove mounting bolts.
6. If the Tractor Protection Valve is being replaced, remove stop light switch.

Install

1. Install stop light switch.
2. Mount valve.
3. Connect air lines as marked during removal.
4. Connect stop light switch wire.
5. Perform Operation Test.

Disassemble

Refer to Figure 51 for all items in parentheses.

1. Inspect the valve for visual damage. If casting is broken or shows fractures, replace the complete valve assembly. Remove stop light switch assembly if it was not removed during the removal of the valve assembly.
2. Remove exhaust end cap assembly (Item 14) by removing the screw (Item 15).
3. Press exhaust disc (Item 13) in and remove snap ring (Item 16). Then remove exhaust disc.

WARNING – The end cap is under spring tension which may cause it to come out of the housing quickly.

4. Remove the piston (Item 10) from the body (Item 17).
5. Remove the O-ring (Item 11) from the piston and the O-ring (Item 9) from the body.
6. Remove the star washer (Item 23) from the body by prying it out from bore. Then remove plug (Item 22), O-ring (Item 20) and valve disc (Item 21) from the body.

7. Remove the eight cover screws (Item 1) so that the hand control cover (Item 2) and foot valve cover #2 (Item 4) can be separated from the check valve body (Item 6).

8. Remove both check valve discs (Item 3).

9. Scribe alignment marks on check valve body (Item 6) and body (Item 17) for reassembly purposes. Remove the four screws (Items 19 and 25) so the check valve body (Item 6) can be separated from the body (Item 17).

10. Remove O-ring (Item 7) and valve seal (Item 8) from the body (Item 17).

Clean and Inspect

Wash all metal parts in cleaning solvent, then dry. Replace all rubber parts.

Examine covers, check valve body, piston and body. All contacting surfaces for O-rings must be smooth, round and free of deep scratches, dents or gouges. Valve seat at end of piston and in the check valve body must be smooth, showing no dents or distortion. The sealing surfaces in the cover must be smooth and free of dents and gouges. The snap ring groove in the valve body must not be distorted and must be free of corrosion.

Replace unserviceable parts.

Reassemble

Lubricate all seals and sliding surfaces with Fleetrite EP2 Moly grease or equivalent to NLGI #2 multi-purpose lithium grease.

Refer to Figure 51 for all items in parentheses.

1. Position valve (Item 8) in the body (Item 17) so that the valve lays flat on the flutes of the body.

2. Position the O-ring (Item 7) in the groove of the flange of valve body.

3. Position check valve body (Item 6) on body (Item 17), aligning scribed alignment marks. Install screws (Items 19 and 25). Tighten screws to 120 to 140 in-lbs. (13.56 to 15.8 N· m).

4. Position O-rings (Item 5) in the grooves in both covers (Items 2 and 4).

5. Position check valve discs (Item 3) on valve seats in the check valve body.

6. Position hand control cover (Item 2) on check valve body adjacent to foot valve port (H), then install foot valve cover (Item 4) adjacent to foot valve port (Item I). Tighten screws to 12 to 16 in-lbs. (1.36 to 1.81 N· m).

7. Position O-ring (Item 9) in valve body (Item 17) and O-ring on piston (Item 10). Insert piston assembly with tapered end toward check valve body.

8. Position spring (Item 12) in piston and place exhaust disc (Item 13) on spring. Align and push exhaust disc firmly into valve body. While holding spring in valve body, install snap ring (Item 16), making sure it seats properly in valve body.

9. Position valve disc (Item 21), O-ring (Item 20) and plug (Item 22) in bleed back opening (D). Then install star washer (Item 23).

When re-installing tractor protection valve on vehicle, be sure to perform the (See Service Checks - Leakage Test, page 80)SERVICE CHECKS , before releasing the vehicle for service.

Torque Chart

Table 5 Torque Chart - Tractor Protection Valve - Midland Ross

Location	In-Lbs.	Nm
Screws	120-140	13.56-15.8
Foot Valve Port Screws	12-16	1.36-1.81

19. RELAY VALVE (BENDIX R-12 AND R-14)

19.1. DESCRIPTION

The Relay Valve (R-12 is shown in Figure 52 and R-14 is shown in Figure 53) in an air brake system functions as a relay station to speed up the application and release of the brakes. The valve is normally mounted close to the chamber it serves. The valve operates as a remote controlled brake valve that delivers or releases air to the chambers in response to the control air delivered to it from the brake valve or other source.

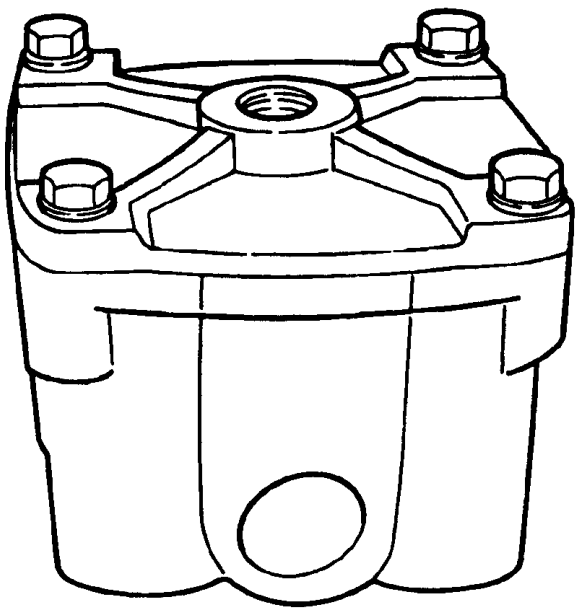

Figure 52 Relay Valve (Bendix R-12)

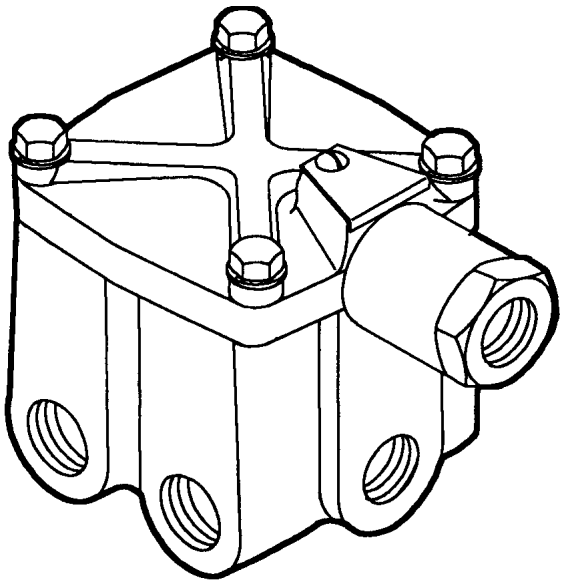

Figure 53 Relay Valve (Bendix R-14)

The R-14 incorporates an anti- compounding feature located in the valve cover (Figure 53). An exhaust cover is installed over the quick exhaust port when it is not used.

All parts are interchangeable between the two valves except for components in the R-14 cover. The inlet/exhaust valve on both valves can be replaced without removing the valve.

19.2. OPERATION

Application

Refer to Figure 54 for all items in parentheses.

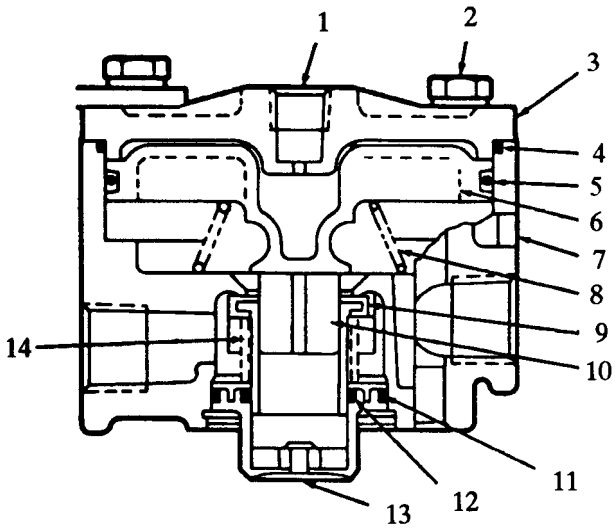

Figure 54 Bendix R-12 and R-14 Operation

1. SERVICE PORT
2. COVER CAPSCREW
3. COVER
4. COVER SEALING RING
5. PISTON O-RING
6. PISTON
7. SUPPLY PORT
8. SPRING
9. EXHAUST SEAT
10. INLET/EXHAUST VALVE
11. OUTER EXHAUST VALVE O-RING
12. INNER EXHAUST VALVE O-RING
13. EXHAUST PORT
14. EXHAUST RETURN SPRING

Air pressure delivered to the service port (Item 1) enters the small cavity above the piston and moves the piston (Item 6) down. The exhaust seat (Item 9) moves down with the piston and seats on the inner or exhaust portion of the inlet/exhaust valve (Item 10) sealing off the exhaust passage. At the same time, the outer or inlet portion of the inlet/exhaust valve (Item 10) moves off its seat, permitting supply air to flow from the reservoir, past the open inlet valve and into the brake chambers.

Balance

The air pressure being delivered by the open inlet valve also is effective on the bottom area of the relay piston (Item 6). When air pressure beneath the piston equals the service air pressure above, the piston lifts slightly and the inlet spring (Item 8) returns the inlet valve to its seat. The exhaust remains closed as the service line pressure balances the delivery pressure. As delivered air pressure is changed, the valve reacts instantly to the change, holding the brake application at that level.

Exhaust or Release

When air pressure is released from the service port and air pressure in the cavity above the relay piston (Item 6) is exhausted, air pressure beneath the piston lifts the relay piston and the exhaust seat (Item 9) moves away from the exhaust valve (Item 10), opening the exhaust passage. With the exhaust passage open, the air pressure in the brake chambers is then permitted to exhaust through the exhaust port, releasing the brakes.

Anti-Compounding (Simultaneous Service and Park Application)

Where the R-14 relay valve is used to control spring brake chambers, a line is connected from the balance/quick exhaust (anti-compound) port in the cover of the valve (Figure 55) to the delivery of the service brake valve or relay valve. With no air at the balance/quick exhaust port of the R-14, the parking brakes are applied. If a service brake application is made, air from the service brake valve enters the balance/quick exhaust port of the R-14 and moves the diaphragm, blocking the service port. Air then enters the cavity above the relay piston, forces the piston down, closing the exhaust and opening the inlet to deliver air to the spring brake cavity as described under (See Application, page 85)APPLICATION.

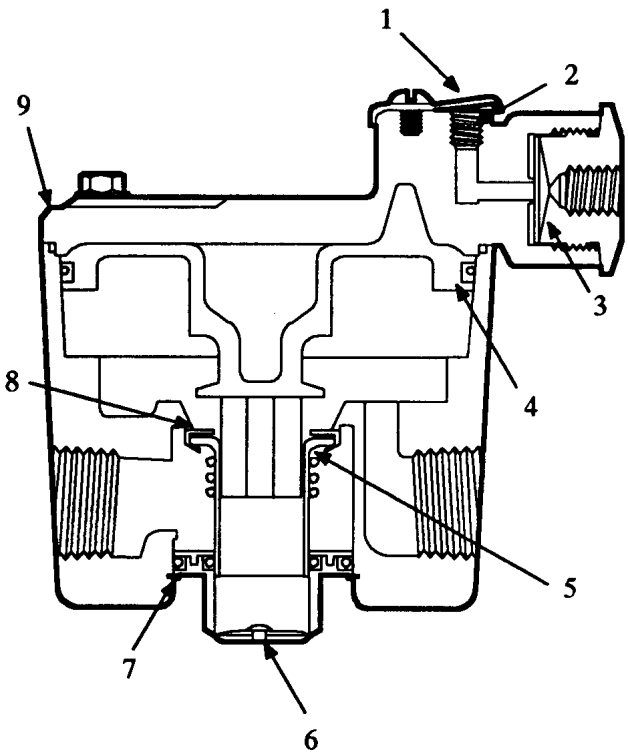

Figure 55 Simultaneous Service and Park Application

1. EXHAUST COVER
2. BALANCE/QUICK EXHAUST PORT
3. DIAPHRAGM
4. RELAY PISTON
5. INLET/EXHAUST VALVE ASSEMBLY
6. EXHAUST PORT
7. RETAINING RING
8. EXHAUST SEAT
9. COVER

19.3. MAINTENANCE

1. Every three months, 25,000 miles (40,000 km) or 900 operating hours, check for proper operation.

2. Every twelve months, 100,000 miles (160,000 km) or 3600 operating hours, disassemble valve and clean parts with mineral spirits. Replace all rubber parts and any part worn or damaged. Check for proper operation before placing vehicle in service.

19.4. SERVICE CHECKS

Operation and Leakage Tests

1. Block the wheels; fully charge air brake system.
2. Make several brake applications and check for prompt application and release at each wheel.
3. Check for inlet valve and O-ring leakage.
   a. Make this check with the service brakes released when the R-12 is used.
   b. Make the check with the spring brakes applied (PARK) when the R-14 is used to control the spring brakes.

Coat the exhaust port and the area around the retaining ring with a soap solution; 1 inch (25 mm) bubble in 3 seconds leakage is permitted.

4. Check for exhaust valve leakage.
   a. Make this check with the service brakes fully applied with the R-12 relay valve.
   b. Make this check with the spring brakes fully released if the R-14 relay valve is used to control the spring brakes.
   c. Coat the exhaust port with a soap solution; 1 inch (25 mm) bubble in 3 seconds leakage is permitted.
5. Coat the outside of the valve where the cover joins the body to check for seal ring leakage; no leakage is permitted.
6. If the R-14 relay valve is used to control the spring brakes, place the park control in the released position and coat the balance/quick exhaust port with a soap solution to check the diaphragm and its seat. Leakage equivalent to a 1 inch (25 mm) bubble in 3 seconds is permitted.

NOTE – The air line attached to the balance/quick exhaust port must be disconnected to perform this test.

19.5. REMOVE

1. Block wheels.
2. Drain air brake system.

WARNING – To avoid personal injury, drain all reservoirs before attempting to remove the relay valve.

3. If entire valve is to be removed, identify air lines to facilitate installation.
4. Disconnect air lines from valve. It is generally not necessary to remove entire valve to service the inlet/exhaust valve. The inlet/exhaust valve insert can be removed by removing the snap ring, exhaust cover assembly and then inlet/exhaust valve.
5. Remove valve from reservoir or if remotely mounted, remove mounting bolts and then valve.

19.6. DISASSEMBLE

NOTE – Prior to disassembly, mark the location of the mounting bracket to the cover and the cover to the body.

Refer to Figure 54 for all items in parentheses.

1. Remove the four (4) cover capscrews (Item 2) and lockwashers securing the cover (Item 3) to the body.
2. Remove the cover, sealing ring (Item 4) and mounting bracket.
3. Remove the piston (Item 6) and piston O-ring (Item 5) from the body.
4. While depressing the exhaust cover, remove the retaining ring and slowly relax the spring beneath the exhaust cover.
5. Remove the exhaust cover assembly and O-rings.
6. Remove the inlet/exhaust valve return spring (Item 14) from the body.
7. Remove the inlet/exhaust valve (Item 10) from the body.
8. Remove the valve retainer from the inlet/exhaust valve.
9. Remove the service port cap nut and O-ring from the R-14.
10. Remove the diaphragm from the R-14 cover.

19.7. CLEAN AND INSPECT

1. Wash all metal parts in mineral spirits and dry them thoroughly.

NOTE – When rebuilding, all springs and all rubber parts should be replaced.

2. Inspect all metal parts for deterioration and wear, as evidenced by scratches, scoring and corrosion.
3. Inspect the exhaust valve seat on the relay piston for nicks and scratches which could cause excessive leakage.
4. Inspect the inlet valve seat in the body for scratches and nicks, which could cause excessive leakage.
5. Inspect the exhaust seat of the quick release diaphragm in the R-14 cover and make sure all internal passages in this area are open, clean, and free of nicks and scratches.
6. Replace all parts considered serviceable during these inspections and all springs and rubber parts.

19.8. ASSEMBLE

Prior to assembly, lubricate all O-rings, O-ring bores and any sliding surface with a silicone lubricant equivalent to Dow Corning #10.

Refer to Figure 53 for all items in parentheses.

1. Install large piston O-ring (Item 5) on piston.

2. Install inner and outer O-rings (Items 11 and 12) in the exhaust cover assembly.

3. Install the sealing ring (Item 4) on the cover.

4. Install piston (Item 6) in body, taking care not to damage the piston O-ring (Item 5).

5. Noting the reference marks made during disassembly, install the cover on the valve body and the mounting bracket on the cover.

6. Secure the mounting bracket and cover to the body using the four (4) capscrews and lockwashers. Tighten to 80 to 120 in-lbs. (9 to 13.3 N· m).

Refer to Figure 56 for all items in parentheses.

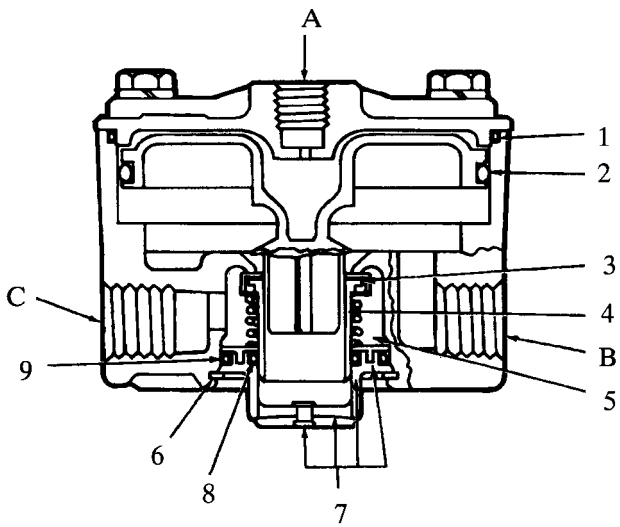

Figure 56 Bendix R-12 and R-14 Assembly

1. O-RING
2. O-RING
3. VALVE RETAINER
4. INLET AND EXHAUST VALVE
5. VALVE SPRING
6. RETAINING RING
7. EXHAUST COVER COMPLETE
8. O-RING
9. O-RING A. 1/4 I P.T. CONTROL B. 1/2 I P.T. DELIVERY C. A SUPPLY

7. Install the valve retainer (Item 3) on the inlet/exhaust valve (Item 4) and install in the body.

8. Install the inlet/exhaust valve (Item 4) return spring (Item 5) in the body.

9. Install the exhaust cover assembly (Item 7) in the body, taking care not to damage the O-ring (Item 8).

10. While depressing the exhaust cover, install the retaining ring (Item 6). Make certain the retainer is completely seated in its groove in the body.

11. Install the diaphragm in the R-14 cover, making certain it is positioned between the guide ribs in the cover.

12. Install the service port cap nut and tighten to 150 in-lbs. (16.6 N· m).

13. Test valve as outlined in (See SERVICE CHECKS, page 88)SERVICE CHECKS.

19.9. INSTALL

1. Clean air lines.

2. Inspect all lines and/or hoses for damage and replace as necessary.

3. Install valve and tighten mounting bolts.

4. Connect air lines to valve (plug and unused ports).

5. Test the valves as outlined in (See SERVICE CHECKS, page 88)SERVICE CHECKS , before returning the valve to service.

19.10. TORQUE CHART

Table 6 Torque Chart - Bendix Relay Valve R-12 and R-14

Description	In-Lbs.	Nm
Capscrews and Lockwashers	80-120	9-13.3
Cap Nut	150	16.6

20. HAND CONTROL VALVE

20.1. MIDLAND-ROSS

Description

The hand control valve is used for controlling the brakes on a trailer independently of the brakes on the towing vehicle. The valve is usually mounted on the steering column or on the dash and provides the operator with a graduated means of applying and releasing the brakes. The distance the brake handle is moved in a clockwise direction toward applied position determines the severity of the brake application.

WARNING – Do not use the hand control valve to hold the brakes applied when the chassis is parked and unattended. Air may leak from system and vehicle will move.

Operation

Refer to Figure 57 for all item numbers and letters in parentheses.

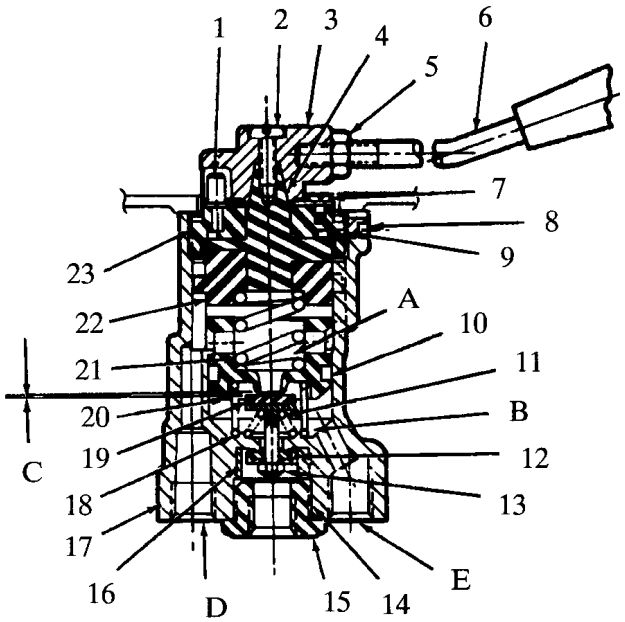

Figure 57 Hand Control Valve - Midland-Ross

A. MAIN CAVITY
B. LOWER CAVITY
C. ADJUSTMENT
D. EXHAUST PORT
E. DELIVERY PORT
1. LOCK ASSEMBLY
2. SCREW
3. COVER
4. CAM SHAFT
5. NUT
6. HANDLE ASSEMBLY
7. SCREW
8. SET SCREW
9. O-RING
10. O-RING
11. SPRING
12. VALVE DISC ASSEMBLY
13. LOCK NUT
14. O-RING
15. END CAP
16. VALVE
17. BODY
18. SPRING
19. DISCHARGE VALVE ASSEMBLY
20. PISTON
21. SPRING
22. CAM
23. BEARING

Apply

When the handle (Item 6) is moved in a clockwise direction from the released position, a rotary force is applied to a spiral cam (Item 22) which in turn converts rotary motion to axial thrust that forces the compensator spring (Item 21) into compression. The spring (Item 21) acting on the piston (Item 20), moves the piston along the centerline of the valve to close the gap between itself and the discharge valve assembly (Item 19) which closes off air passage between cavities (A) and (B). Further piston movement opens the inlet valve (Item 16) by moving it away from the valve seat of body (Item 17).

Reservoir air pressure at the supply inlet port enters cavity (A) and passes through to the delivery port (E) and out to the trailer service brake line. The delivery port (E) is common to cavity (A). Air is blocked from exhausting through (B).

Hold

Air pressure in cavity (A) acts against the piston (Item 20) to move it axially against the spring (Item 21). When the resultant forces above and below the piston (Item 20) approach a balance, it moves to allow the inlet valve to seat against the body (Item 17). Providing that spring forces and air pressure forces maintain equilibrium by virtue of holding the cam position and air pressures at the resultant condition, the valve attains a “lap” position. It is instantly responsive to any change in lever movement to increase or decrease the delivery pressure. This controlled modulating characteristic occurs from 0 to about 80 psi. When the handle is traveled fully clockwise, the valve will deliver full inlet supply pressure.

Release

Returning the handle (Item 6) towards the “off” position reduces the forces of the spring (Item 21) acting against the piston (Item 10). The “lap” position whereby both exhaust valve and inlet valve are seated simultaneously is instantaneously traversed. Force from air pressure in main cavity (A) continues to move piston (Item 20) away from discharge valve (Item 19). Air pressure feeding back from the delivery port (E) enters cavity (B) and exhausts to the atmosphere through the exhaust port (D).

Maintenance

The hand control valve is designed for maintenance free operation for the life of the vehicle. Should disassembly be necessary, follow (See Disassemble, page 94)DISASSEMBLY INSTRUCTIONS.

Service Checks

Refer to Figure 57 for all item numbers and letters in parentheses.

Testing and Adjustment

1. Connect 100 to 125 psi air supply (full reservoir pressure) to the inlet port and a gauge to the delivery port.

2. Check for exhaust port leakage. A 1 inch (25 mm) diameter bubble in 6 seconds is permissible.

3. Apply the valve by moving the handle clockwise. Delivery pressure should start to build up after 10 to 15 degrees of handle motion and full supply pressure should be delivered after 60 degrees of handle rotation. Seventy (70) degrees of handle travel is available between full application and full release.

If handle travel is excessive before delivery begins, or if full supply pressure is not delivered, bearing (Item 23) must be threaded further into the valve body.

If air is delivered with the handle in the fully released position, bearing (Item 23) should be turned counterclockwise to back it further out of the valve body.

Proper adjustment will result by screwing bearing (Item 23) into the body (without air pressure connected) until valve disc assembly (Item 12) is held open and then connecting the air supply and backing bearing (Item 23) out of the valve body to the point where delivery pressure is zero and then continuing 1/2 turn. Bearing (Item 23) can be rotated slightly in either direction as required to allow lock assembly (Item 1) to be installed in its proper position.

4. Check valve exhaust port for leakage with low pressure delivery of 15 psi and with full pressure delivery. A 1 inch (25 mm) diameter bubble in 6 seconds is allowable.

5. Rotate the valve handle to a position giving 70 psi delivery pressure. The valve should retain 60 psi delivery pressure minimum when the handle is released.

Remove

1. Apply parking brake and block wheels.

2. Drain air brake system.

3. Disconnect air lines at bottom of valve, including exhaust carry-off line if used.

4. Remove mounting clamp bolts, clamp and valve.

Disassemble

Refer to Figure 57 for all item numbers and letters in parentheses.

Rotate handle to the release position. Mark location of cover (Item 3) and lock assembly (Item 1) in relation to body (Item 17).

1. Loosen nut (Item 5) and unscrew handle (Item 6) from cover (Item 3).

2. Remove screw (Item 2) and remove cover (Item 3).

3. Remove screw (Item 7) and remove lock assembly (Item 1).

4. Loosen set screw (Item 8), remove bearing (Item 23), O-ring (Item 9), cam shaft (Item 4), cam (Item 22) and spring (Item 11).

5. Carefully remove piston (Item 20), O-ring (Item 14) and spring (Item 21).

Turn valve upside down for further disassembly:

6. Carefully remove end cap (Item 15), O-ring (Item 14) and valve guide (Item 19).

7. Reach down through large bores and grip discharge valve assembly carefully (so as to prevent damage) to stop its rotating while removing lock nut (Item 13). Remove discharge valve assembly (Item 19) and valve disc assembly (Item 12) and spring (Item 11).

Clean and Inspect

1. Wash all metal parts in mineral spirits and dry.

2. Wipe all plastic parts. **Do not use solvents.**

3. Replace all rubber parts and springs with new parts provided in repair kit.

4. Lubricate all seals except O-ring (Item 9) with lubricant comparable to that listed in Item 3 in LUBRICANT SPECIFICATIONS . Do not lubricate cam (Item 22) or cam shaft (Item 4).

5. Inspect all metal and plastic parts for nicks, scratches, or excessive wear. Replace as required.

Reassemble

Refer to Figure 57 for all item numbers and letters in parentheses.

Hold valve in horizontal position.

1. Slip spring (Item 18) on discharge valve assembly (Item 19) with small diameter end against discharge valve and place stem first through seat from large bore end of valve.

2. Holding discharge valve assembly (Item 19) with spring (Item 18) securely and from opposite end, assemble valve disc assembly (Item 12) over stem of discharge valve assembly and assemble lock nut (Item 13). Tighten lock nut to 5 to 7 in-lbs. (.6 to .8 N· m).

3. Install valve guide.

4. Slip O-ring (Item 14) on end cap (Item 15) and install end cap (Item 15) in body (Item 17). Securely position valve with large bore up and complete assembly.

5. Install spring (Item 18) in proper groove in body (Item 17).

6. Slip O-ring (Item 10) on piston (Item 20), making sure that the O-ring and piston are well lubricated.

7. Install piston (Item 20) in body (Item 17), making sure spring (Item 18) is not cocked.

8. Install spring (Item 21) on top of piston (Item 20) and place cam (Item 22) in grooves provided in body (Item 17).

9. Install cam shaft (Item 4) in cam (Item 22).

10. Place O-ring (Item 9) in bearing (Item 23) and slip bearing (Item 23) over cam shaft (Item 4) and tighten until a gap of .040 to .030 inch (1.016 to .762 mm) is obtained.

11. Place lock assembly (Item 1) in bearing (Item 23) so as to line up previously scribed lines marked on lock assembly (Item 1) and body (Item 17). Retain, using screw (Item 2) in first hole clockwise of lock pin. Tighten set screw (Item 8) until contact is made with bearing (Item 23) and then go one additional turn to lock the bearing in place.

12. Assemble nut (Item 5) on handle assembly (Item 6). Screw handle assembly (Item 6) into cover (Item 3). Rotate handle assembly (Item 6) to desired position and lock in place with nut (Item 5).

13. Install cover (Item 3) and handle assembly (Item 6), making sure previously scribed locating marks line up.

14. Secure cover (Item 3) and handle assembly (Item 6) with screw (Item 7). Tighten to 12 to 14 in-lbs. (1.4 to 1.6 N· m).

Install

1. Mount the valve to the steering column. Tighten the mounting screw to 30 to 60 in-lbs. (3.39 to 6.78 N· m).
2. Reconnect the air lines.
3. Perform the (See Service Checks, page 93)SERVICE CHECKS.

20.2. BENDIX TC-7

Description

The hand control valve is used for controlling the brakes on a trailer independently of the brakes on the towing vehicle. The valve is usually mounted on the steering column or on the dash and provides the operator with a graduated means of applying and releasing the brakes. The distance the brake handle is moved in a clockwise direction toward applied position determines the severity of the brake application.

⚠ WARNING – Do not use the hand control valve to hold the brakes applied when the chassis is parked and unattended. Air may leak from system and vehicle will move.

Operation

When the handle is moved in a clockwise direction from the released position, force is exerted on top of the pressure regulating spring through the action of the cam and cam follower. The force on top of the spring causes the piston to move down. The exhaust seat in the center of the piston contacts the exhaust valve and closes the exhaust passage in the piston. At the same time the exhaust closes, the continued downward movement of piston moves the inlet valve off its seat. Air pressure from the reservoir then flows by the open inlet and out the delivery port, through the service line and applies the brakes (Figure 58).

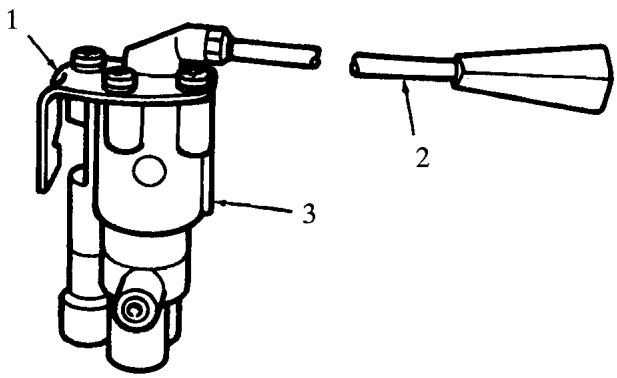

Figure 58 TC 7 Bendix Hand Control Valve

1. BRACKET
2. HANDLE
3. VALVE

Hold

The air pressure that flows by the open inlet valve also becomes effective on the bottom area of the piston. As the force of the air pressure beneath the piston balances the force of the depressed graduating spring above,

the piston lifts slightly and the inlet valve returns to its seat. The exhaust valve remains seated so the flow of air through the valve is stopped and air pressure in the service line is held.

Release

When the handle or operating lever is moved in a counterclockwise direction, the force above the piston is decreased. The air pressure beneath will then lift the piston, moving it away from the exhaust valve. With the exhaust passage open, air pressure in the service line will exhaust out the exhaust port of the valve.

Maintenance

Every three months or 25,000 miles (40,000 km), the hand control valve should be checked for graduation and proper operation. The linkage or lever connections to the remote operated type valve should be checked and lubricated if required.

Once each year or 100,000 miles (160,000 km), disassemble the hand control valve. Clean and inspect all parts. Disassemble and clean parts in mineral spirits. Replace all rubber parts and any part that is worn or damaged. Perform the (See Service Checks - Operations Test, page 97)SERVICE CHECKS before placing vehicle in service.

Service Checks - Operations Test

1. Park the vehicle on a level surface and block the wheels.

CAUTION – Only test gauges known to be accurate are to be used for checking brake valve delivery pressures, gover- nor pressure settings and other tests.

2. Connect an accurate test gauge to the delivery port or connect the gauge to the service hose coupling of the tractor. When the gauge is connected to the service hose coupling, install a dummy hose coupling on the supply (emergency) hose coupling and place tractor protection control in the trailer charging position. When the handle is moved to the fully applied position, the test gauge should register full reservoir pressure.

3. Move the handle between the released and fully applied positions and note that the air pressure registered on the test gauge varies accordingly. Upon release, the test gauge should immediately register zero.

Service Checks - Leakage Test

1. Locate the exhaust port and exhaust line fitting and apply a soap solution. With the valve in released position, exhaust leakage should not exceed a 1 inch (25 mm) diameter soap bubble in 5 seconds. With the valve fully applied, leakage at the exhaust should not exceed a 1 inch (25 mm) diameter soap bubble in 3 seconds.

2. Repair or replace valve if it does not function as described or leakage is excessive.

Remove

1. Apply parking brake and block wheels.

2. Drain air brake system.

3. Disconnect air lines at bottom of valve, including exhaust carry-off line if used.

4. Remove mounting clamp bolts, clamp and valve.

Disassemble

Refer to Figure 59 for all items in parentheses.

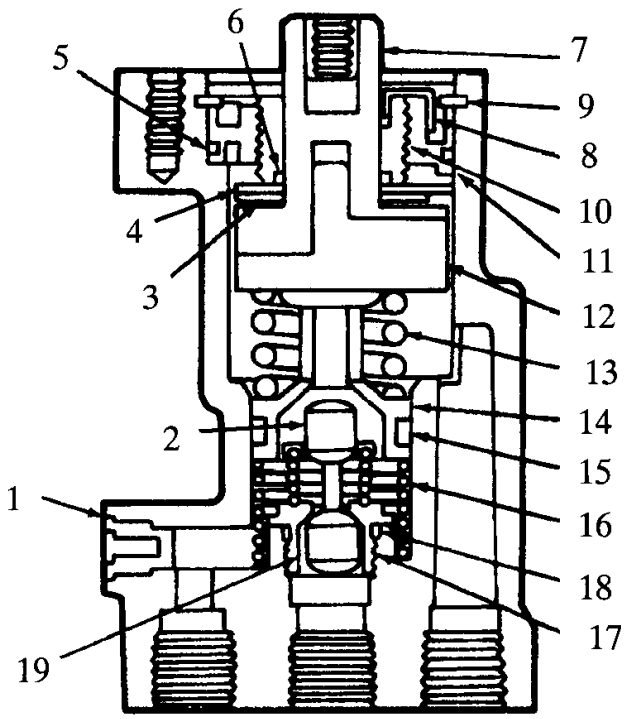

Figure 59 Midland-Ross Hand Control Valve - Disassembly

1. VALVE BODY
2. EXHAUST VALVE
3. SEALING RING
4. FRICTION WASHER
5. O-RING
6. O-RING
7. CAM FOLLOWER
8. SPECIAL LOCKWASHER
9. RETAINING RING
10. ADJUSTING RING
11. ADJUSTING RING ADAPTER
12. CAM
13. GRADUATING SPRING
14. PISTON
15. O-RING
16. SPRING
17. INLET SEAT
18. O-RING
19. INLET VALVE

If the valve is disassembled in a vise, be sure the vise is not over-tightened as the valve and internal parts can be distorted.

1. Remove the adjusting ring lockwasher (Item 8).

2. Remove the adjusting ring (Item 10).

NOTE – A spanner wrench should be used to rotate the adjusting ring. If a spanner wrench is not available, the adjusting ring can be turned with a small screwdriver inserted in one of the inner notches of the ring.

3. Remove the retaining ring (Item 9).

4. Remove adjusting ring adapter (Item 11), cam follower (Item 7), sealing ring (Item 3), and friction washer (Item 4).

NOTE – It is important to note whether the friction washer is installed with the ribs against or away from the sealing ring, as it must be re-installed the same way.

5. Remove cam (Item 12) and graduating spring (Item 13), piston (Item 14), and piston return spring (Item 16).

6. Use a deep well 11/16 inch socket and remove the inlet and exhaust valve assemblies.

Clean and Inspect

1. Wash all metal parts in mineral spirits and dry. **Do not use cleaning solvent.**

2. Replace all rubber parts.

3. Inspect all parts for excessive wear or deterioration.

4. Check springs for cracks, corrosion or distortion.

5. Inspect valve seats and piston bore for nicks and burrs.

6. Replace all unserviceable parts.

Reassemble

Prior to reassembly, lubricate the body cores, cam, cam followers, O-rings and O-ring grooves with a lubricant comparable to that listed in Item 3 of (See LUBRICANT SPECIFICATIONS, page 187)LUBRICATION SPECIFICATIONS . Do not lubricate sealing ring, friction washer or cam follower serrations.

Refer to Figure 59 for all items in parentheses.

1. Install O-ring (Item 18) on inlet and exhaust valve assembly.

2. Using a 11/16 inch deep well socket wrench, install the inlet and exhaust valve assemblies and tighten to 15 in-lbs. (1.7 N· m).

3. Install piston return spring (Item 16).

4. Install O-ring (Item 15) on piston (Item 14) and install piston in valve body.

5. Install graduating spring (Item 13).

6. Install cam (Item 12) in valve body with flat side toward graduating spring (Item 13). Line up cam “ears” to corresponding slots in valve body.

7. Install rubber sealing ring (Item 3) on cam follower (Item 7).

8. Install the friction washer (Item 4) on cam follower in the same direction as noted in Step 4 of Disassemble.

9. Install cam follower (Item 7).

NOTE – Stop “ear” on cam follower (Item 7) will not permit improper assembly of cam follower. Make certain that the positioning “ear” of the friction washer (Item 4) fits in the wide slot in the valve body.

10. Install O-ring (Item 5) in adjusting ring adapter (Item 11) and adjusting ring (Item 10).

11. Install adjusting ring (Item 10) in adapter (Item 11) until it is flush with the underside of the adapter.

    NOTE – There are two indexing lugs on the adapter that fit into slots in the valve body when the adapter is installed. Be sure to install the adjusting ring (Item 10) with its wrench slots accessible (up) after the valve is assembled.

12. Position the adapter and adjusting ring assembly (Item 11) over the cam follower (Item 7), making certain the adapter lugs fit into the body slots.

13. Push down on cam follower (Item 7) and install snap ring. Be certain the retaining ring (Item 9) is completely seated in its groove.

NOTE – If lugs on adapter are not in their body slots, the retaining ring (Item 9) cannot be installed completely.

14. Before installing the lockwasher (Item 8), adjust the valve.

Adjustment

Generally, the TC-7 Brake Hand Control Valve should deliver full reservoir pressure.

1. If the delivered pressure is below 125 psi, it can be adjusted by removing the handle, loosening ring lockwasher and rotating the adjusting ring clockwise.

2. If the delivered pressure is above 125 psi, it can be lowered by turning the adjusting ring counterclockwise.

3. After adjustment is completed, tighten the lockwasher and install the valve handle.

NOTE – Handle position is not adjustable.

Install

1. Reconnect the air lines to the TC-7.

2. Mount the valve to the steering column. Tighten the mounting screws to 30 to 60 in-lbs. (3.39 to 6.78 N· m).**Do not over-tighten.**

3. Perform as outlined on page 90.

Torque Chart

Table 7 Torque Chart - Midland-Ross Hand Control Valve

Location	In-Lbs.	Nm
Inlet and Exhaust Assemblies	15	1.7
Valve Mounting Screws	30 to 60	3.39 to 6.78
Value handle Screw	30 to 60	3.39 to 6.78
Discharge Value Stem Locknut	5 to 7	.6 to .8
Cover Screws	12 to 14	1.4 to 1.6

21. AIR DRYER

21.1. CR BRAKEMASTER MODEL 62

Description

The CR Brakemaster (Figure 60) functions as a heat exchanger, cooling air from the compressor.

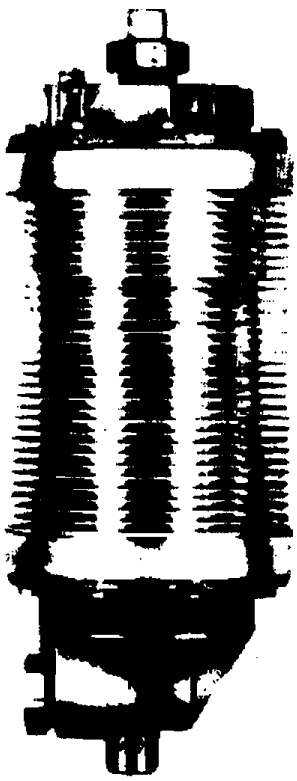

Figure 60 CR Brakemaster Model 62

When the compressed air leaves the air compressor, it is approximately 300°F (149°C), and by the time it reaches the Brakemaster unit, it has cooled to 140°F (60°C).

The hot, compressed air enters the expansion chamber where the sudden drop in pressure provides additional cooling. Heat is dissipated through the external fins on the one-piece aluminum body.

As the air cools in the expansion chamber, both water and oil vapors are condensed. This condensation collects on the walls of the expansion chamber and runs down into the collection area where it is automatically discharged through an unloader valve.

The heat exchanger has a permanent air filter element which traps carbon particles harmful to other components in the air system. Each time the unloader operates (each time the compressor completes a cycle), there is a back-rush of air through the filter, so that any carbon trapped in the filter element is flushed out and ejected through the unloader valve.

If the air compressor is working properly, the filter will require little or no maintenance. If the filter should require servicing, flush it with cleaning solvent and air dry.

Maintenance

Periodic or scheduled maintenance is not required. However, for trouble-free operation, the following items should be checked.

1. Cooling fins should be free of dirt build-up or paint.

2. Check air lines to be sure they have not become kinked, cracked, broken or chafed.

3. Build up pressure in air system, then bleed off air to cause the compressor to cycle. Repeat several times.

4. Compare heat level inlet and outlet ports by holding your hands on each of the ports.

WARNING – The inlet port may be hot; a burn could result if touched.

Service Checks

The inlet port should be warmer than the outlet port; the outlet port should be at or slightly above ambient temperature. Since the vehicle is stationary, the unit will become warmer than normally experienced during over the road operation. If both inlet and outlet temperatures seem high (too hot to touch), the deflector will need servicing.

1. Hold a clean shop towel under the unloader (exhaust) port and make the air compressor go through several “unload” cycles. Catch water from the unloader port. If water is oily, the compressor should be checked. If water is “brownish” or if brown particles are expelled, the deflector requires servicing.

2. After the heat exchanger has “exhausted” and while air compressor is in “stand-by” mode, hold your hand under the unloader port. If air flows out the port, the check valve at the top (outlet port) of the heat exchanger is stuck open and requires service, or the compressor inlet is connected to the outlet side of the turbocharger.

3. If air leaks past the exhaust port while the compressor is building up pressure, the unloader valve is stuck open and requires attention.

4. While the air compressor is building up pressure, it is normal for the check valve to produce a rattling sound through rapid opening and closing.

5. When the air compressor is rebuilt or replaced or if the heat exchanger is moved from one vehicle to another, it is recommended that the heat exchanger unit be completely disassembled and cleaned.

If the unloader valve should stick in the open position while the vehicle is on the road, the air system can be restored by threading a 1/2 inch pipe plug into the exhaust port. By doing this, the air system pressure can be restored but moisture cannot be exhausted from the air dryer. The unit should be serviced as soon as possible by repairing the unloader valve.

Before any work is accomplished, it is important to check the following:

6. The area surrounding the unit, and the unit itself, should be thoroughly cleaned to remove dirt, oil and other road grime.

7. Set parking brake and block wheels.

8. Drain all air from vehicle's air system.

9. Relieve pressure in line from "UNL" port of compressor governor to unloader port in the center of the large nut on the bottom of the air dryer.

Each part of the heat exchanger can be serviced by means of using the various service and replacement kits available.

Unloader Valve Service

There are several indications which may mean that the unloader valve of your heat exchanger unit needs servicing:

1. The compressor goes into "stand-by" mode but cycles rapidly.

2. Air flows from the exhaust port when the compressor is attempting to build up pressure in the air system.

3. The unit does not "unload" when the compressor goes into stand-by mode.

These situations can be caused by several conditions. Check the (See Table 8, page 111)TROUBLESHOOTING CHART , to make sure that the probable cause is a malfunctioning unloader valve on the CR BRAKEMASTER unit. If the probable cause is the unloader valve, it could mean that a piece of debris is clogging this valve, and it only needs to be cleaned, or that the valve assembly itself has been worn and needs to be replaced. In either case, the following steps should be taken:

Disassemble

Refer to Figure 61 for all items in parentheses.

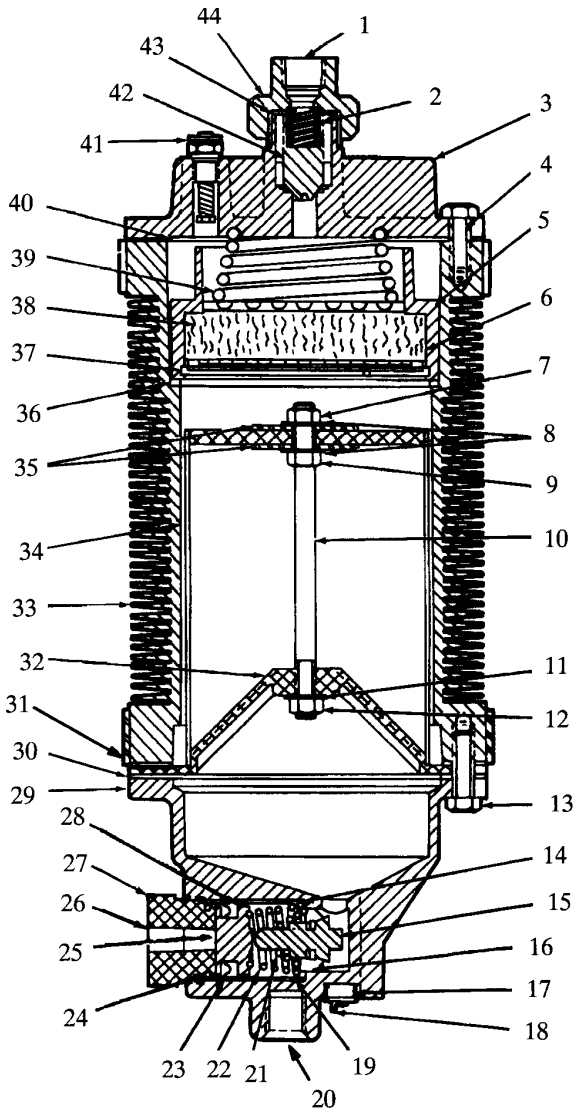

Figure 61 Air Dryer - CR Brakemaster Model 62

1. OUTLET PORT
2. V-SPRING
3. TOP CAP
4. CAPSCREW
5. FILTER CUP
6. STRAINER
7. NUT
8. LOCKWASHER
9. NUT
10. SUPPORT ROD
11. LOCKWASHER
12. NUT
13. CAPSCREW
14. GASKET
15. SPINDLE
16. RING SEAT
17. HEATER
18. THERMOSTAT
19. SPRING
20. EXHAUST PORT
21. RETAINING RING
22. SPRING
23. U-CUP
24. O-RING
25. PISTON
26. UNLOADER PORT
27. UNLOADER NUT
28. SLEEVE
29. BOTTOM CAP
30. GASKET
31. GASKET
32. SUPPORT PLATE
33. BODY
34. DEFLECTOR
35. WASHER
36. PACKING RING
37. V-SPRING
38. FILTER
39. SPRING
40. GASKET
41. SAFETY VALVE
42. SPINDLE
43. GASKET
44. NUT

1. Disconnect electrical wire to heater.

2. Disconnect inlet air line from bottom cap (Item 29).

3. Remove governor control line from UNL port (Item 26).

4. Remove large unloader nut (Item 27) from UNL port (Item 26).

WARNING – Use care in removing the nut to prevent bodily injury since nut is spring loaded.

Refer to Figure 62 for items in parentheses unless otherwise noted.

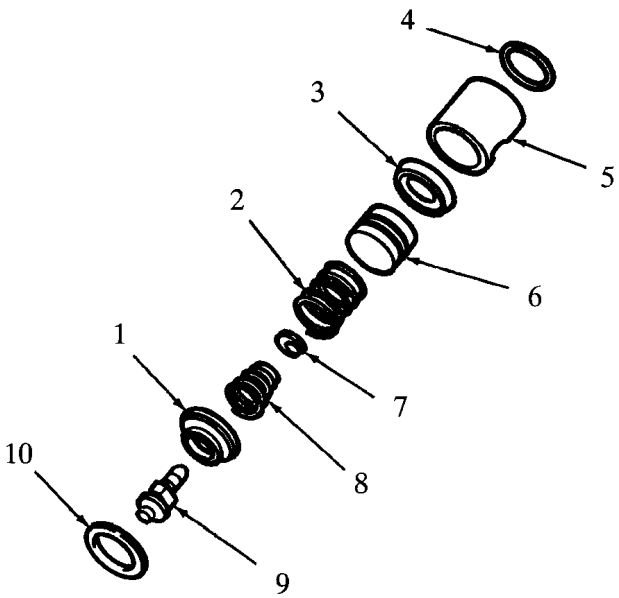

Figure 62 Air Dryer - Reassembly

1. RING SEAT
2. LARGE SPRING
3. U-CUP
4. O-RING
5. SLEEVE
6. PISTON
7. RETAINING RING
8. SMALL SPRING
9. UNLOADER SPINDLE
10. COPPER GASKET (2)

5. Remove complete unloader valve assembly, including copper gaskets (Item 10).

Excessive accumulation of oil in the unloader assembly indicates that the air compressor requires attention.

6. Examine unloader valve assembly. If the unloader sleeve (Item 5) is nicked, wrinkled or has axial scratches, the unloader valve assembly should be replaced. If clogged, the unloader valve assembly should be cleaned with a good cleansing solvent.

7. Do not remove retaining ring (Item 7) from unloader spindle (Item 9) since they are serviced as an assembly with spring (Item 8) and ring seat (Item 1).

Reassemble

Refer to Figure 62 for items in parentheses unless otherwise noted.

1. Install new “U” cup (Item 3) in groove of unloader piston (Item 6). Lips of “U” cup should face away from spring seat. Do not use sharp tools that may mar or score parts.

2. Apply a light film of Fleetrite EP2 Moly grease or equivalent to NLGI#2 multi-purpose lithium grease to O-ring (Item 4) and position on unloader nut.

3. Position the two copper gaskets (Item 10) together and lightly coat exposed surfaces with Fleetrite EP2 Moly grease or equivalent to NLGI#2 multi-purpose lithium grease. Then position lubricated gaskets on shoulder of ring seat (Item 1). Gaskets should be on face opposite the spring (Item 8).

4. Place gaskets (Item 10) followed by ring seat assembly into bottom cap (Item 29, Figure 61).

5. Install unloader sleeve (Item 5) in unloader port against the ring seat. Be sure the 1/2 inch (12.7 mm) diameter cross hole is next to the ring seat (Item 1).

6. Position large spring (Item 2) in the sleeve (Item 5) with large diameter coil against ring seat (Item 1).

7. Insert unloader piston (Item 6) into unloader sleeve. Lips of U-cup (Item 3) must face out with spring seat toward spring. The unloader spindle (Item 9) and ring seat (Item 1) is a mated assembly and should not be disassembled. If either the ring seat or spindle is nicked, the entire mated assembly must be replaced as an assembly.

8. Insert a 1/2 inch (12.7 mm) diameter rod or equivalent through the exhaust port in the bottom cap (Item 29, Figure 61) and into the cross hole of sleeve (Item 28, Figure 61) to maintain alignment. If the cross holes are not aligned, the unit will not operate.

9. Apply a non-hardening sealing compound to threads in the unloader valve nut (Item 27, Figure 61) and install nut. Tighten nut to 60 ft-lbs. (81 N· m) —**DO NOT OVER-TIGHTEN**— maintaining the alignment of the cross holes of sleeve (Item 28, Figure 61).

> **CAUTION – Over-tightening of the unloader nut will result in damage to the unloader assembly.**

10. Remove the alignment rod inserted in Step 8.

11. Reinstall the governor control line to UNL port (Item 26, Figure 61) in center of unloader nut.

12. Reinstall air inlet line from the compressor.

13. Connect electrical lead for the heater.

14. Test unit using the instructions listed in (See Maintenance, page 102)MAINTENANCE .

Deflector Assembly Service

There are several indications which may mean that the deflector assembly needs servicing:

1. Compressed air is not sufficiently cooled.

2. Water exhausted by the CR BRAKEMASTER is brownish or brown particles are exhausted.

3. A piece of the deflector is caught in the unloader valve assembly, causing it not to operate properly.

These situations can be caused by several conditions. Check the (See Table 8, page 111)TROUBLESHOOTING CHART , to make sure that the probable cause is a malfunctioning deflector assembly. If it is a malfunctioning deflector assembly, the following are the instructions for replacing this deflector assembly.

Disassemble

Refer to Figure 61 for all items in parentheses.

1. Disconnect air compressor inlet line at UNL port (Item 26).
2. Disconnect wire from heater assembly.
3. Remove the eight capscrews (Item 13) retaining bottom cap (Item 29) to body (Item 33).
4. Remove bottom cap (Item 29) and deflector assembly (Item 34).
5. Remove all traces of old gasket(s) material from gasket surfaces of bottom cap (Item 29) and body. Discard old gaskets. Be careful not to scratch or mar new gasket surfaces.
6. Wash bottom cap (Item 29) and inside of unit with cleaning solvent.

Reassemble

1. Position new gasket (Item 31) on top of the surface of the deflector support plate (Item 32).
2. Position second new gasket (Item 30) on gasket surface of bottom cap.
3. Align bolt holes and position assembly against bottom gasket surface of body (Item 33). Use of gasket sealant is NOT recommended.
4. Insert eight capscrews (Item 13) to attach bottom cap to body and deflector assembly (Item 34). Tighten alternately to 15 ft-lbs. (20.3 N· m).
5. Reconnect the air line to the inlet port (this line leads from the compressor service port).
6. Reconnect the wire to the heater.

Check Valve Assembly Service

There are several indications which may mean that the check valve needs servicing:

1. Air is exhausted from the exhaust port when compressor is in stand-by mode.
2. System air pressure bleeds off rapidly when air-using equipment is not being operated.
3. Compressor goes into stand-by mode but cycles rapidly.
4. Compressor attempts to build pressure but system pressure will not build up.
5. Safety valve opens.

These situations can be caused by several conditions. Check the (See Table 8, page 111)TROUBLESHOOTING CHART , to make sure that the probable cause is a defective assembly. The following is the procedure for servicing and replacing the check valve assembly.

Disassemble

Refer to Figure 63 for all items in parentheses.

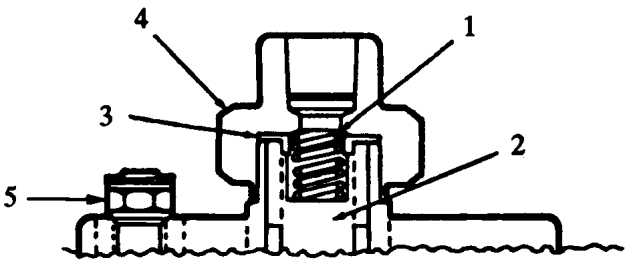

Figure 63 Air Dryer CR Brakemaster Model 62 - Disconnect Air Line

1. SPRING
2. SPINDLE
3. GASKETS
4. TOP NUT
5. NUTS

1. Disconnect air line at outlet port at top of unit.
2. Remove top nut (Item 4). This nut is spring loaded.
3. Remove copper gaskets (Item 3), spring (Item 1), and check valve spindle (Item 2).
4. Clean and dry entire check valve area and top nut (Item 4).

Reassemble

Refer to Figure 63 for all items in parentheses.

1. Position new check valve spindle (Item 2) in top cap with tapered end down.
2. Install spring (Item 1) in check valve spindle.
3. Position new copper gaskets (Item 3) in nut (Item 4) and rub a small quantity of grease on the gaskets to help them keep their position in the top nut.
4. Thread nut (Item 5) onto top cap studs and tighten to 15 ft-lbs. (20.3 N· m). Top nut (Item 4) is not included in check valve replacement kit.
5. Reconnect the air line to the outlet port. The safety valve cannot be serviced and it is recommended that it not be removed from the top cap. If the safety valve has been removed, apply non-hardening sealant to threads of top cap.

Filter Assembly Service

Although the filter assembly of the unit is designed to require little or no servicing, it is a good practice to service the filter assembly when performing service on other filters located on the vehicle. This servicing can be accomplished in one of two ways, either replacing entire filter assembly, or by servicing filter assembly. In most cases, only servicing will be necessary. The following are the steps for servicing the filter assembly.

Disassemble

Refer to Figure 61 for all items in parentheses.

1. Remove air line at outlet port (Item 1).
2. Remove eight capscrews holding top cap (Item 3) in body.

> **WARNING – The top cap is spring loaded to approximately 40 ft-lbs. (54 N S m). Use care in removing the top cap bolts to prevent possible bodily injury.**

3. Remove spring (Item 39).
4. Remove all traces of gasket material from top cap and body gasket surfaces (Items 40 and 43). Discard gasket. Be careful not to scratch or score gasket surfaces. Wash top cap in cleaning solvent.
5. Remove complete filter assembly.
6. Remove rubber packing ring (Item 36) and discard.
7. Discard old stainless steel filter (Item 38). If you are replacing the entire filter assembly, discard the entire filter assembly including filter cup (Item 5), strainer (Item 6) and V-spring (Item 2).
8. Wash strainer (Item 6) and filter cup (Item 5) in cleaning solvent.

Reassemble

1. Assemble stainless steel filter (Item 38) in filter cup (Item 5). Filter should be stretched slightly to fill the space in filter cup.
2. Reinstall strainer (Item 6) with flat face of strainer towards stainless steel filter.
3. Install V-spring (Item 2) holding the filter assembly together.
4. Install new packing ring (Item 36) on ledge of body.
5. Position filter assembly into body with large end down. The filter must set on packing ring.
6. Install heavy spring (Item 39) with larger diameter coil against top of filter assembly.
7. Position new gasket (Item 40) on body. Do not use gasket cement.
8. Position top cap (Item 3) and V-spring (Item 2) so that the small diameter coil on spring fits groove in top cap.
9. Compress spring and install four 3/8 capscrews (Item 4) into body. Each of these four screws should be engaged at least three full turns before load on cap is removed. Capscrews should be equally spaced. Then thread remaining screws into place.
10. Alternately tighten top cap bolts to 15 ft-lbs. (20.3 N· m).

11. Reconnect air line to outlet port.

Thermostatically Controlled Cartridge Type Heater Service

The current heat exchanger units contain a 15 volt 50 watt heater as standard equipment. This heater requires a newly designed bottom cap which is completely interchangeable with those in use previously. Use of this new cap may, however, necessitate a change of the deflector assembly if your present bottom cap has the deflector attached by screws.

There are two kits used in servicing the thermostatically controlled cartridge type heater assembly. Both heaters are 50 watt; however, one is 12 volt and the other is a 24 volt.

Remove

1. Disconnect the electrical line from the heater.

2. Remove old cartridge type heater by loosening set screw for heater on bottom cap.

3. Remove old thermostat from bottom cap by removing the two small screws which retain the thermostat to the bottom cap. Discard entire heater/thermostat assembly.

Install

1. Install new heater by inserting it into hole from which old heater was removed and tighten set screw.

2. Install new thermostat by inserting it into the hole from which old thermostat was removed and attach by means of the two screws provided.

3. Attach the lead from the thermostat to the electrical system. Even though the heater is thermostatically controlled, it is recommended that the heater be hooked up through a control switch.

4. Be sure the unit is grounded to the chassis.

Troubleshooting Chart

Table 8 Troubleshooting Chart - CR Brakemaster Model 62

Condition	Possible Cause	Remedy
Air is exhausted from exhaust port when compressor is in the stand-by mode.	Inlet side of compressor connected to outlet side of turbocharger. 2. Check valve at outlet port stuck open.	1. Change compressor inlet connection. 2. Clean or replace check valve assembly.
System air pressure bleeds off rapidly when air-using equipment is not operating.	1. Leak in air line connection(s). 2. Leak in air line or reservoir. 3. Check valve at outlet port stuck open.	1. Tighten or replace fittings. 2. Repair or replace faulty item(s). 3. Clean or replace check valve assembly.

Table 8 Troubleshooting Chart - CR Brakemaster Model 62 (cont.)

Condition	Possible Cause	Remedy
Compressor runs continuously (will not go into stand-by mode).	1. Leak in air line connections. 2. Leak in air line or reservoir. 3. Compressor defective. 4. Unloader valve stuck open. 5. Compressor capacity too low for vehicle.	1. Tighten or replace fittings. 2. Repair or replace faulty item(s). 3. Rebuild or replace compressor. 4. Clean or replace unloader valve assembly. 5. Install larger compressor.
Compressor goes into stand-by mode but cycles rapidly.	1. Leak in air system. 2. Check valve in CR Brakemaster outlet port stuck open. 3. Defective seal in unloader. 4. Unloader sleeve defective.	1. Correct leak. 2. Clean or replace check valve assembly. 3. Repair unloader valve. 4. Replace sleeve.
Air flows from exhaust port when compressor builds up pressure in air system.	1. Unloader valve stuck open. 2. Seat of unloader valve chipped or nicked. 3. Piece of dirt or foreign material stuck in unloader valve.	1. Rebuild unloader valve. 2. Replace seat assembly. 3. Replace seat assembly.
Compressor attempts to build pressure but system pressure will not build up.	1. Line between compressor and exchanger blocked. 2. Check valve in outlet port stuck closed.	1. Replace line or remove blockage. 2. Clean outlet and replace check.
Compressor attempts to build pressure but system pressure will not build up (Cont.).	3. Pressure sensing device defective. 4. Blockage in air line between compressor and sensing device (Note: If safety valve of exchanger opens, blockage is after unit).	3. Replace. 4. Remove blockage.

Table 8 Troubleshooting Chart - CR Brakemaster Model 62 (cont.)

Condition	Possible Cause	Remedy
Does not cool air (initial installation).	1. Mounted in location where it cannot be cooled by ambient air. 2. Mounted too near heat producing equipment or too near other heat dissipating equipment. 3. Copper tubing from compressor to inlet too short.	1. Relocate unit. 2. Relocate unit. 3. Increase length of copper tubing.
Does not “unload” when compressor goes into stand-by mode.	1. UNL port of governor not connected to unloader port or line broken. 2. Components of unloader valve worn. 3. Ice formed in area of unloader valve. 4. Heater inoperative.	1. Connect or repair valve. 2. Rebuild unloader valve. 3. Shorten line (24" minimum allowable length) and/or install heater. 4. Replace heater or check electrical connections.
Safety valve opens.	1. Check valve in outlet stuck closed. 2. Obstruction in air line beyond heat exchanger. 3. Compressor governor valve defective. 4. Safety valve defective.	1. Clean outlet and replace check valve assembly. 2. Remove obstruction. 3. Replace. 4. Replace.
Water exhausted by unit contains excessive oil and/or soot.	Compressor rings defective.	Rebuild or replace compressor.
No water exhausted during unloading cycle.	1. Insufficient water in ambient (inlet) air. 2. Not cooling air sufficiently to condense water.	1,2. Lengthen copper line from compressor to heat exchanger (36" max. length allowable). Relocate heat exchanger to area of greater ambient air flow.
Compressed air was cooled by unit but no longer is cooled properly.	1. Covered with dirt or paint. 2. Deflector damaged or broken.	1. Steam clean and/or remove paint. 2. Replace deflector assembly.
Water exhausted is brownish or brown particles are exhausted.	Broken or damaged deflector.	Replace deflector assembly.

Torque Chart

Table 9 Torque Chart - CR Brakemaster Model 62

Location	Ft-Lbs.	Nm
Unloader Value Nut Cap	60	81
Capscrews	15	20.3
Top Cap Bolts	15	20.3

21.2. AD-9 AIR DRYER

Description

The function of the AD-9 Air Dryer (Figure 64) is to collect and remove air system contaminants in solid, liquid and vapor form before they enter the brake system. It provides clean, dry air to the components of the brake system, which increases the life of the system and reduces maintenance costs.

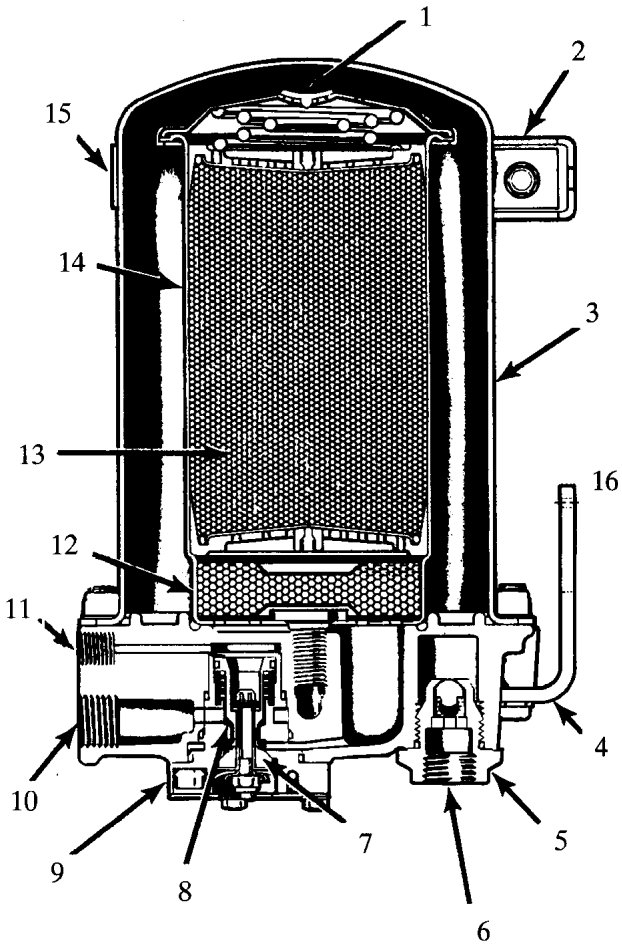

Figure 64 AD-9 Air Dryer

1. CHECK VALVE
2. UPPER MOUNTING BRACKET
3. HOUSING
4. LOWER BRACKET
5. CHECK VALVE ASSEMBLY
6. DISCHARGE PORT
7. PURGE VALVE
8. TURBO CUTOFF PISTON
9. PURGE VALVE HOUSING ASSEMBLY
10. SUPPLY PORT
11. CONTROL PORT
12. OIL SEPARATOR
13. DESICCANT BED
14. DESICCANT CARTRIDGE
15. UPPER BRACKET STRAP
16. END COVER

The AD-9 Air Dryer consists of the desiccant cartridge and a die cast aluminum end cover secured to a cylindrical steel outer shell with eight capscrews and nuts. The end cover contains a check valve assembly, a safety valve, three threaded air connections and the purge valve housing assembly. The removable purge valve housing assembly incorporates a purge valve mechanism and a turbocharger cutoff feature that is designed to

prevent loss of engine “turbo” boost pressure during the purge cycle of the air dryer. The desiccant cartridge and discharger check valve assembly are screw-in type. The purge valve housing assembly, which includes the heater and thermostat assembly, and the discharge check valve assembly, are serviceable from the exterior of the air dryer. The screw-in desiccant cartridge requires removal of the air dryer assembly from the vehicle.

Operation

The AD-9 Air Dryer alternates between two operational “cycles” during operation: the CHARGE CYCLE and the PURGE CYCLE. The following description of operation is separated into these “cycles” of operation.

Charge Cycle

Refer to Figure 65 for all items in parentheses.

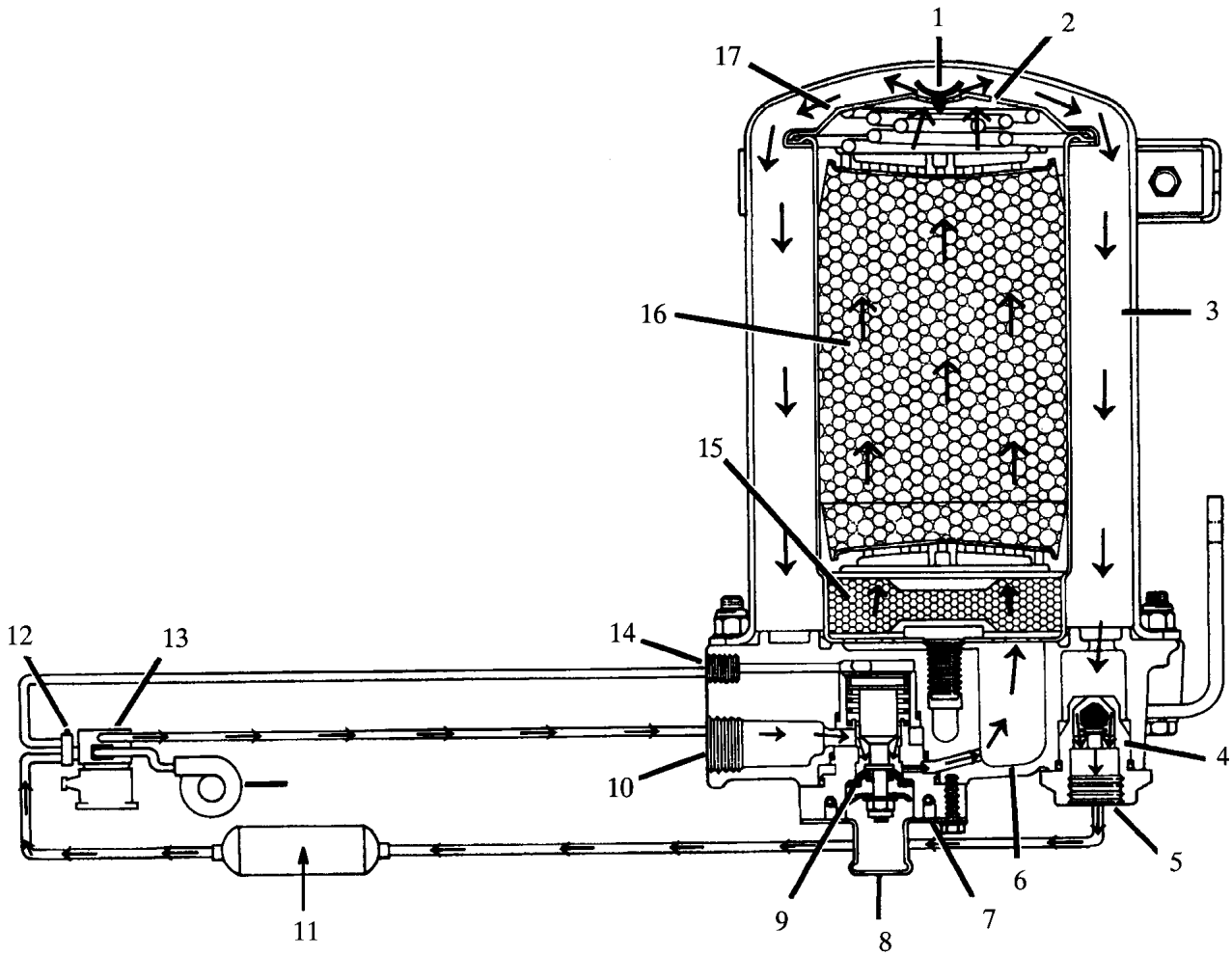

Figure 65 AD-9 Air Dryer - Charge Cycle

1. CHECK VALVE
2. ORIFICE
3. PURGE VOLUME
4. CHECK VALVE ASSEMBLY
5. DELIVERY PORT
6. SUMP
7. HEATER ELEMENT
8. EXHAUST
9. PURGE VALVE
10. SUPPLY PORT
11. RESERVOIR
12. GOVERNOR
13. COMPRESSOR
14. CONTROL PORT
15. OIL SEPARATOR
16. DESICCANT BED
17. DESICCANT CARTRIDGE

When the compressor is loaded (compressing air), compressed air, along with oil, oil vapor, water and water vapor flows through the compressor discharge line to the supply port (Item 10) of the air dryer end cover. As air

travels through the end cover assembly, its direction of flow changes several times, reducing the temperature, causing contaminants to condense and drop to the bottom or sump of the air dryer end cover.

After exiting the end cover, the air flows into the desiccant cartridge (Item 17). Once in the desiccant cartridge, air first flows through an oil separator (Item 15), which removes water in liquid form as well as oil, oil vapor and solid contaminants.

Air exits the oil separator and enters the desiccant drying bed (Item 16). Air flowing through the column of desiccant becomes progressively dryer as water vapor adheres to the desiccant material in a process known as ADSORPTION. The desiccant cartridge using the adsorption process removes water vapor from the pressurized air.

Dry air flows out of the purge volume through the single check valve assembly (Item 4) and out the delivery port (Item 5) to the first (supply) reservoir (Item 11) of the air system.

The air dryer will remain in the charge cycle until air brake system pressure builds to the governor cutout setting.

Purge Cycle

Refer to Figure 66 for all items in parentheses.

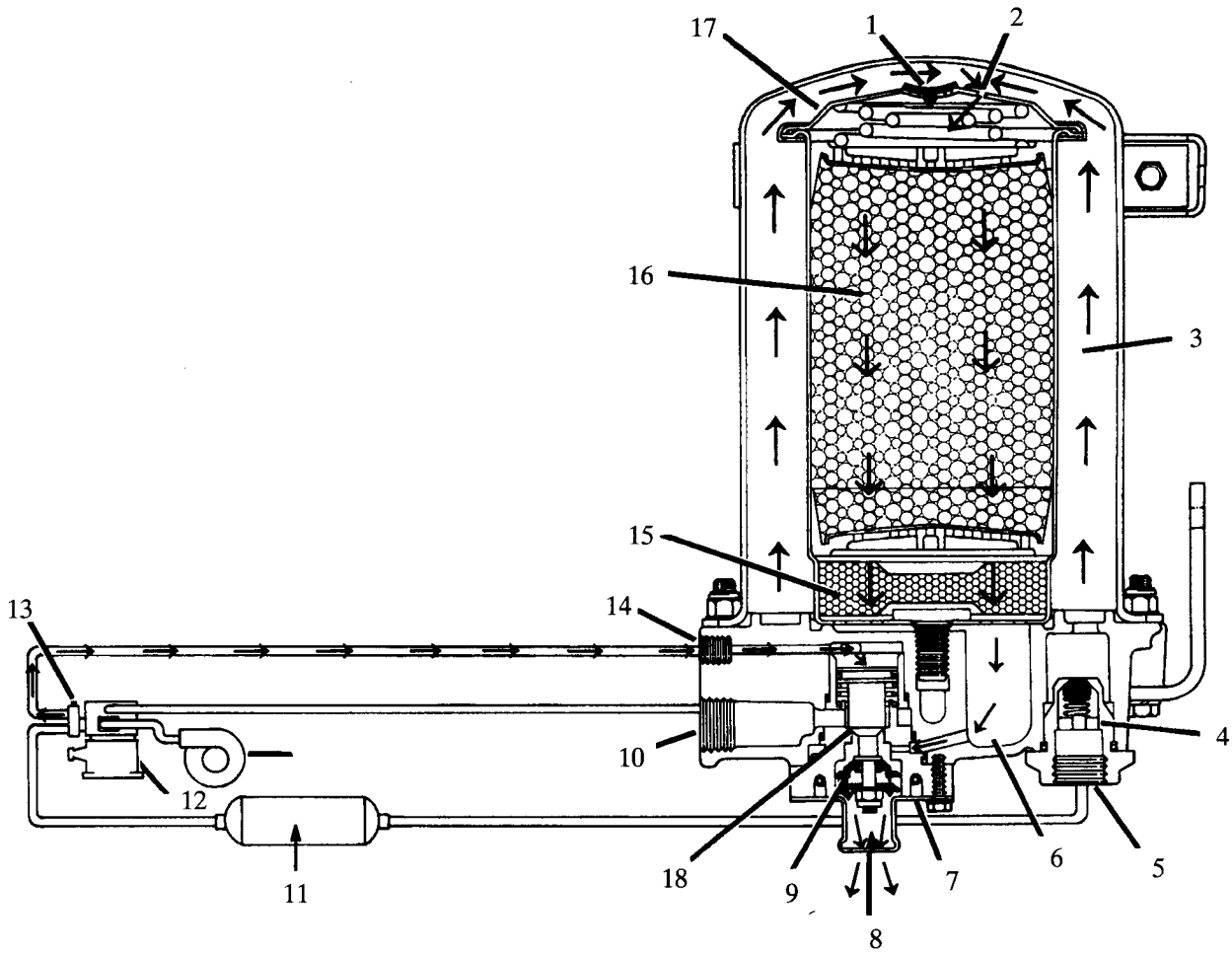

Figure 66 AD-9 Air Dryer - Purge Cycle

1. CHECK VALVE
2. ORIFICE
3. PURGE VOLUME
4. CHECK VALVE ASSEMBLY
5. DELIVERY PORT
6. SUMP
7. HEATER ELEMENT
8. EXHAUST
9. PURGE VALVE
10. SUPPLY PORT
11. RESERVOIR
12. COMPRESSOR
13. GOVERNOR
14. CONTROL PORT
15. OIL SEPARATOR
16. DESICCANT BED
17. DESICCANT CARTRIDGE
18. PURGE PISTON

When air brake system pressure reaches the cutout setting of the governor (Item 13), the compressor unloads (air compression stopped) and the purge cycle of the air dryer begins. When the governor unloads the

compressor, it pressurizes the compressor unloader mechanism line connecting the governor unloader port to the dryer end cover control port (Item 14). The purge piston (Item 18) moves in response to air pressure, causing the purge valve (Item 9) to open to atmosphere and (partially) closing off the supply of air from the compressor. Contaminants in the end cover sump (Item 6) are expelled immediately when the purge valve (Item 9) opens. Also, air which was flowing through the desiccant cartridge (Item 17) changes direction and begins to flow toward the open purge valve (Item 9). Oil and solid contaminants collected by the oil separator (Item 15) are removed by air flowing from the desiccant drying bed (Item 16) to the open purge valve (Item 9).

The initial purge and desiccant cartridge decompression lasts only a few seconds and is evidenced by an audible burst of air at the exhaust (Item 8). The reactivation of the desiccant drying bed begins as dry air flows from purge volume (Item 3) through the desiccant cartridge purge orifice (Item 2); its pressure is lowered and its volume increased. The flow of dry air through the drying bed (Item 16) reactivates desiccant material by removing the water vapor adhering to it. Fifteen to 30 seconds are required for the entire purge volume to flow through the desiccant drying bed (Item 16).

The end cover single check valve assembly (Item 4) prevents air pressure in the brake system from returning to the air dryer during the purge cycle. After the 30 second purge cycle is complete, the air dryer is ready for the next charge cycle to begin.

The purge valve will remain open after the purge cycle is complete and will not close until air brake system pressure is reduced and the governor signals the compressor to charge.

Turbo Cutoff (Figure 67)

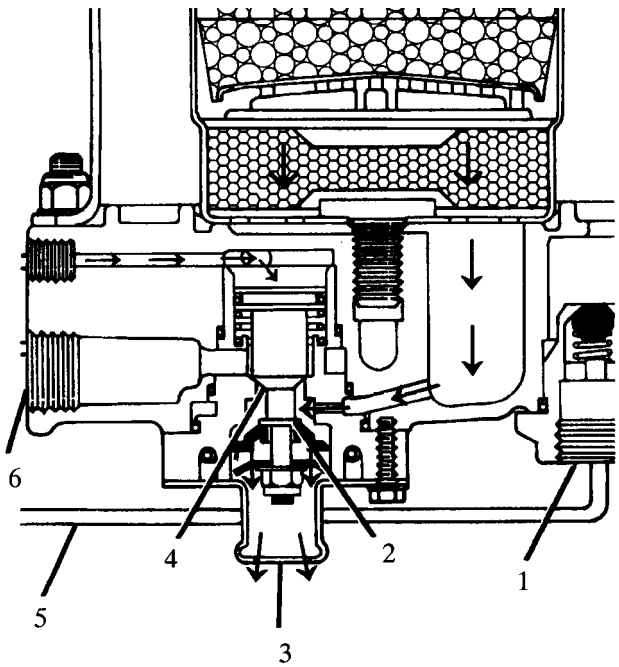

Figure 67 AD-9 Air Dryer - Turbo Cutoff

1. CHECK VALVE ASSEMBLY
2. PURGE VALVE
3. EXHAUST
4. TURBO CUTOFF PISTON
5. DISCHARGE LINE
6. SUPPLY PORT

The function of the turbo cutoff valve is to prevent loss of engine turbocharger air pressure through the air dryer in systems where the compressor intake is connected to the engine turbocharger. The turbo cutoff valve also reduces the “puffing” of air out the open exhaust when a naturally aspirated, single cylinder compressor equipped with an inlet check valve is used on the vehicle.

At the beginning of the purge cycle, the downward travel of the purge piston is stopped when the turbo cutoff valve (tapered portion of purge piston) contacts its mating metal seat in the purge valve housing. With the turbo cutoff valve seated (closed position), air in the discharge line and inlet port is restricted from entering the air dryer. While the turbo cutoff effectively prevents loss of turbocharger boost pressure to the engine, some “seepage” of air may be detected under certain conditions of compressor engine and turbocharger operation, even though there will be low pressure air trapped in the discharge line.

Maintenance

Every 900 operating hours or 25,000 miles (40,000 km) or every three (3) months:

1. Check for moisture in the air brake system by opening reservoirs, drain cocks, or valves and check for presence of water. If moisture is present, the desiccant may require replacement; however, the following conditions can also cause water accumulation and should be considered before replacing the desiccant:
   a. An outside air source has been used to charge the system. This air did not pass through the drying bed.
   b. Air usage is exceptionally high and not normal for a highway vehicle. This may be due to accessory air demands or some unusual air requirement that does not allow the compressor to load and unload (compressing and non-compressing cycle) in a normal fashion. Check for high air system leakage.
   c. In areas where more than a 30 degree range of temperature occurs in one day, small amounts of water can accumulate in the air brake system due to condensation. Under these conditions, the presence of small amounts of moisture is normal and should not be considered as an indication that the dryer is not performing properly.

   NOTE – A small amount of oil in the system may be normal and should not, in itself, be considered a reason to replace the desiccant; oil stained desiccant can function adequately.

2. Check mounting bolts for tightness. Tighten to 80 to 120 in-lbs. (9.03 to 13.55 N· m).

3. Perform the on this page.

Every 10,800 hours, 300,000 miles (480,000 km) or 36 months:

4. Rebuild the air dryer including the desiccant cartridge.

   NOTE – The desiccant change interval may vary from vehicle to vehicle. Although typical desiccant cartridge life is three years, many will perform adequately for a longer period of time. To take maximum advantage of desiccant life and assure that replacement occurs only when necessary, it is important that the followingService Checks be performed.

Service Checks - Operation and Leakage Tests

CAUTION – Only test gauges known to be accurate are to be used for checking brake valve delivery pressures, gover- nor pressure settings and other tests.

1. Test the outlet port check valve assembly by building the air system to governor cut-out and observing a test air gauge installed in the #1 reservoir. Check all lines and fittings leading to and from the air dryer for leakage and integrity. A rapid loss of pressure could indicate a failed outlet port check valve. This can be confirmed by bleeding the system down, removing the check valve assembly from the end cover, subjecting air pressure to the unit and applying a soap solution to the check valve side. Leakage should not exceed a 1 inch (25 mm) diameter bubble in 1 second.

2. Check for excessive leakage around the purge valve. With the compressor in loaded mode (compressing air), apply a soap solution to the purge valve housing assembly exhaust port and observe that leakage does not exceed a 1 inch (25 mm) diameter bubble in 1 second. If the leakage exceeds the maximum specified, service the purge valve housing assembly.

3. Close all reservoir drain cocks. Build up system pressure to governor cut-out and note that the AD-9 purges with an audible escape of air. The system once again builds to full pressure and is followed by a purge.

4. Check the operation of the safety valve by pulling the exposed stem while the compressor is loaded (compressing air). There must be an exhaust of air while the stem is held and the valve should reseat when the stem is released.

5. Check the operation of the end cover heater and thermostat assembly during cold weather operation as follows:

   a. Electric Power to the Dryer — With the ignition or engine kill switch in the ON position, check for voltage to the heater and thermostat assembly using a voltmeter or test light. Unplug the electrical connector at the air dryer and place the test leads on each of the pins of the male connector. If there is no voltage, look for a blown fuse, broken wires, or corrosion in the vehicle wiring harness. Check to see if a good ground path exists.

   b. Thermostat and Heater Operation — Turn off the ignition switch and cool the end cover assembly to below 40° F (4°C). Using an ohmmeter, check the resistance between the electrical pins in the female connector. The resistance should be 1.5 to 3.0 ohms for the 12 volt heater assembly and 6.8 to 9.0 ohms for the 24 volt heater assembly.

      NOTE – Some early models of the AD-9 will have resistance readings of 1.0 to 2.5 ohms for the 12 volt heater assembly and 4.8 to 7.2 ohms for the 24 volt heater assembly. If the resistance is higher than the maximum stated, replace the purge valve housing assembly, which includes the heater and thermostat assembly.

      Warm the end cover assembly to over 90°F (32°C) and again check the resistance. The resistance should exceed 1000 ohms. If the resistance values obtained are within the stated limits, the thermostat and heater assembly is operating properly. If the resistance values obtained are outside the stated limits, replace the purge valve housing assembly, which includes the heater and thermostat assembly.

Remove

1. Park the vehicle on a level surface and block the wheels.

2. Completely drain**all** reservoirs.

WARNING – Compressor discharge line may still contain residual pressure.

3. Identify and disconnect the three air lines from the end cover and note the position of end cover ports relative to the vehicle.

4. Unplug the vehicle wiring harness from the heater and thermostat assembly connector (Figure 68) on the purge valve housing assembly.

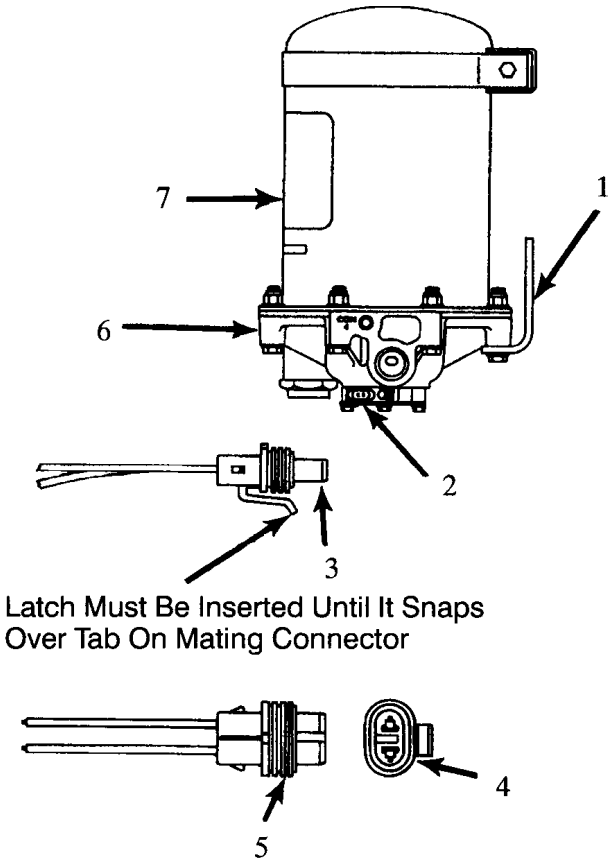

Figure 68 AD-9 Air Dryer - Thermostat and Heater Assembly

1. LOWER MOUNTING BRACKET
2. FEMALE ELECTRICAL CONNECTOR
3. MALE ELECTRICAL CONNECTOR
4. MALE CONNECTOR END VIEW
5. MALE CONNECTOR SIDE VIEW
6. END COVER
7. AIR DRYER LATCH MUST BE INSERTED UNTIL IT SNAPS OVER TAB ON MATING CONNECTOR

5. Loosen the bolt securing the upper mounting strap.

6. Remove, retain andmark the two end cover capscrews, lock nuts and four special washers that retain the lower mounting bracket to the end cover; also mark these two holes of the end cover. (These bolts are longer than the other 6 bolts.

7. Remove the air dryer from its mounting brackets on the vehicle.

Disassemble

CAUTION – While performing service on AD-9 air dryer, it is not recommended that a clamping device (vise, C-clamp, etc.) be used to hold any die cast aluminum component as damage may result. To hold the end cover, install a pipe nipple in the supply port and clamp the nipple into a vise.

Refer to Figure 69 for all items in parentheses.

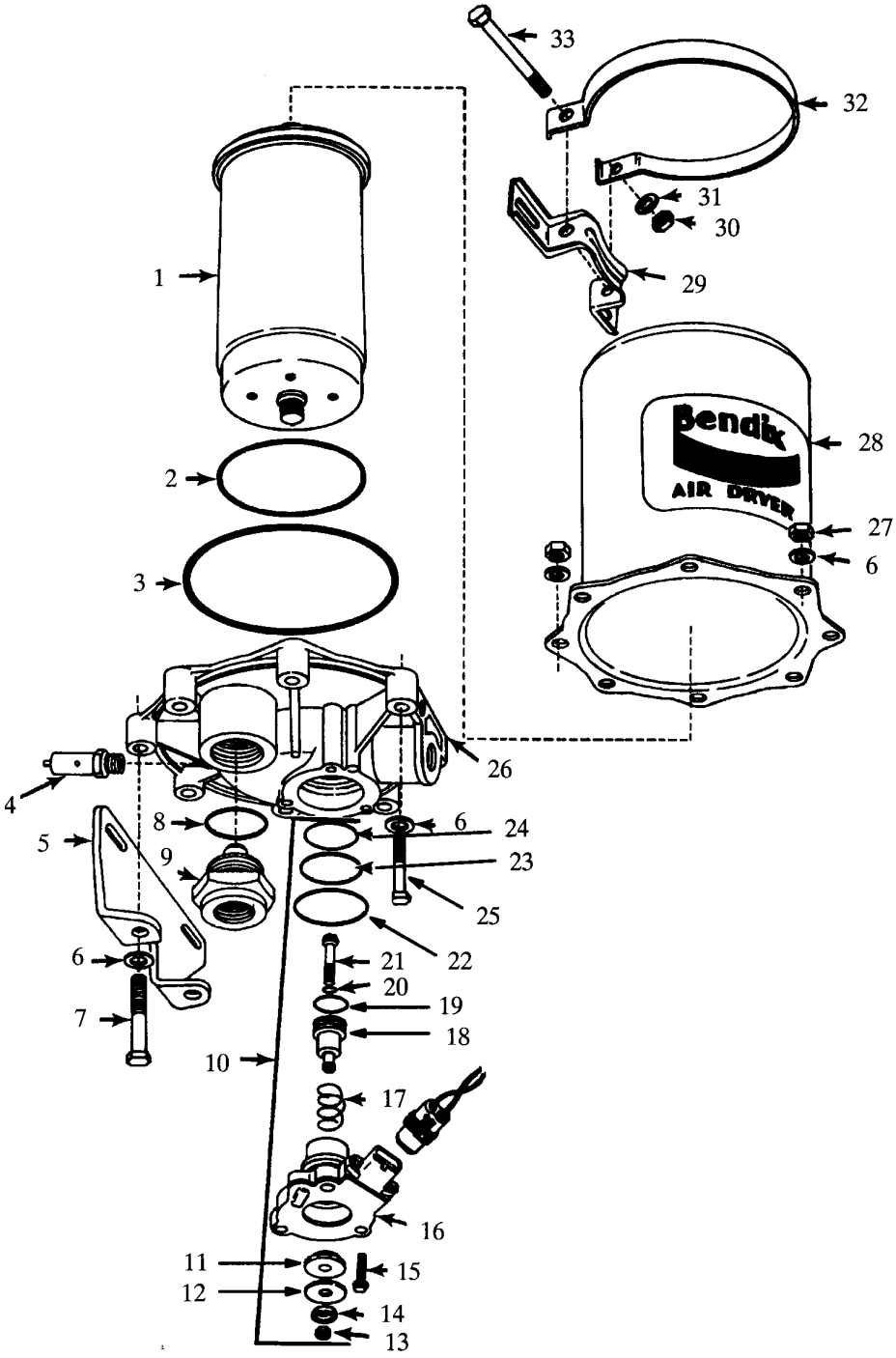

Figure 69 Ad-9 Air Dryer - Disassembly

1. COMPLETE DESICCANT CARTRIDGE
2. O-RING
3. O-RING
4. SAFETY VALVE
5. LOWER MOUNTING BRACKET
6. 3/8 I SPECIAL WASHER
7. 3/8 I CAPSCREW (LONG)
8. O-RING
9. CHECK VALVE ASSEMBLY
10. PURGE VALVE ASSEMBLY
11. PURGE VALVE
12. EXHAUST DIAPHRAGM
13. PURGE VALVE LOCK NUT
14. EXHAUST DIAPHRAGM WASHER
15. 1/4 I TAPPING SCREW
16. EXHAUST COVER
17. SPRING
18. PURGE PISTON
19. O-RING
20. O-RING
21. TORX HEAD BOLT
22. O-RING
23. O-RING
24. O-RING
25. 3/8 I CAPSCREW
26. END COVER
27. LOCK NUT
28. HOUSING
29. UPPER MOUNTING BRACKET
30. 5/16 I LOCK NUT
31. 5/16 I LOCKWASHER
32. UPPER BRACKET STRAP
33. 5/16 X 4-1/2 I UPPER BRACKET CAPSCREW

1. Remove the delivery, check valve assembly (Item 9) and O-ring (Item 8). Remove the O-ring from the check valve assembly.

2. Remove the three self tapping screws (Item 15) that secure the purge valve housing assembly to the end cover assembly. Pull the purge valve housing assembly out of the end cover assembly. Remove the three O-rings (Items 22, 23 and 24) from the exterior of the purge valve housing assembly.

   NOTE – O-rings (Items 22 and 23) may be lodged in the end cover bores; if so, they must be removed.

3. Removal of the piston from the purge valve housing assembly requires a special Torx head socket or a twelve point 1/4 in. socket to hold the head of the purge valve bolt (Item 21).

   a. Remove the nut (Item 13) from the bottom of the purge valve housing assembly using a 9/16 inch socket wrench and a Torx head socket to hold the head of the bolt (Item 21). Remove the diaphragm washer (Item 14) (if present), and the diaphragm (Item 12) (if present), and the purge valve (Item 11) from the purge valve housing.

   b. Remove the Torx head bolt (Item 21) from the opposite end, then the purge piston (Item 18), the return spring (Item 17) and two O-rings (19 and 20); one on the O.D. and the other in the inside of the purge piston.

CAUTION – Do not attempt to remove the heater and thermostat assembly, as it will be damaged during the removal process. If the heater and thermostat are defective, replace the en tire purge valve housing assembly which includes these items.

4. Remove the remaining six capscrews (Item 25), lock nuts (Item 27) and twelve special washers (Item 6) that secure the end cover to the housing. Separate the end cover and desiccant cartridge (Item 1) from the housing (Item 28).

5. Remove the end cover to outer housing O-ring (Item 3).

6. Do not remove the safety valve from the end cover unless it has been proven defective. If replacement is required, apply thread sealant or Teflon tape on the threads of the replacement valve and tighten to 120 to 400 in-lbs. (13.50 to 45.19 N· m), making sure the drain hole (slot) is facing down.

7. Place a strap or chain wrench around the desiccant cartridge (Item 1) so that it is approximately 2 to 3 inches (51 to 76 mm) away from the end cover. Rotate the cartridge counterclockwise until it completely separates from the end cover.

   NOTE – A substantial torque [up to 50 ft-lbs. (68 N· m)] may be required to perform this disassembly.

8. Remove the desiccant cartridge O-ring (Item 2) from the end cover.

Clean and Inspect

1. Using mineral spirits or an equivalent solvent, clean and**thoroughly dry** all metal parts.

2. Inspect the interior and exterior of all metal parts that will be reused for severe corrosion, pitting and cracks. Superficial corrosion and/or pitting on the exterior portion of the upper and lower body halves is acceptable.

3. Inspect the bores of both the end cover and the purge valve housing for deep scuffing or gouges.

4. Make certain that all purge valve housing and end cover passages are open and free of obstructions.

5. Inspect the pipe threads in the end cover. Make certain they are clean and free of thread sealant.

6. Inspect the purge valve housing bore and seats for excessive wear and scuffing.

7. Inspect the purge valve piston seat for excessive wear.

8. Inspect all air line fittings for corrosion. Clean all old thread sealant from the pipe threads.

9. All O-rings removed should be discarded and replaced with new O-rings.

Assemble

Prior to assembly, coat all O-rings, O-ring grooves and bores with a generous amount of barium base lubricant.

Refer to Figure 69 for all items in parentheses.

1. Purge Valve Housing Assembly

a. Install the O-ring (Item 19) in its groove on the O.D. of the purge piston. Place the return spring (Item 17) in the bore of the purge valve housing. Place the O-ring (Item 20) into its recess in the bore of the purge piston. Install the Torx head bolt (Item 21) into the I.D. of the purge piston. Insert the purge piston (Item 18) into the I.D. of the spring (Item 17). Using a Torx head wrench engaged on head of Torx head bolt, push the piston into the purge valve housing until it bottoms.

b. While depressing the purge piston with the Torx head wrench, install the following parts over the purge valve bolt (Item 21) from the opposite end of the purge valve housing; the purge valve (Item 11) with its rubber side first, followed by the diaphragm (Item 12) (if present) or the flat washer and finally the hex nut (Item 13). Tighten the purge valve nut and bolt to 60 to 80 in-lbs. (6.77 to 9.03 N· m).

c. Install the three O-rings (Items 22, 23 and 24) on the purge valve housing, placing each in its appropriate location. If the exhaust cover (Item 16) was removed during disassembly, install it on the purge valve housing assembly, making certain the “bubble” portion is positioned over the thermostat. Install the assembled purge valve housing in the end cover, making certain to orient both parts so that the connector is approximately 10 degrees clockwise from the supply port, while also making certain the purge valve housing is fully seated against the end cover. Secure the purge valve housing to the end cover using the three self-tapping screws (Item 15). Start all three screws by hand, then tighten to 85 to 125 in-lbs. (9.6 to 14.12 N· m).

2. Install the O-ring (Item 8) on the check valve assembly (Item 9), and install the assembly in the end cover using a 1-3/4 inch socket. Tighten to 200 to 250 in-lbs. (22.39 to 28.24 N· m).

3. Install the desiccant O-ring (Item 2) in its groove in the end cover. Using a light coat of barium grease, lubricate the bottom of the desiccant cartridge in the area that will contact the O-ring (Item 2) and end cover. Screw the desiccant cartridge into the end cover until contact is made between it and the O-ring. Using a strap or chain wrench positioned 2 to 3 inches (51 to 76 mm) from the bottom of the cartridge, turn the desiccant cartridge clockwise 180 to 225 degrees beyond the position where initial contact was made between the cartridge and end cover O-ring. Torque should not exceed 50 ft-lbs. (68 N· m).

4. Install the end cover outer housing O-ring (Item 3) on the shoulder in the end cover.

   Place the housing (Item 28) over the desiccant cartridge and align the holes. Install the six capscrews (Item 25), lock nuts (Item 27) and twelve special washers (Item 6), making certain they are in the proper position as marked during disassembly. The two long capscrews (Item 7) will be used to secure the dryer to its mounting bracket. Tighten the six capscrews and nuts in a star pattern as shown in Figure 70 depending on lower bracket location. Tighten to 270 to 385 in-lbs. (30.7 to 43.5 N· m).

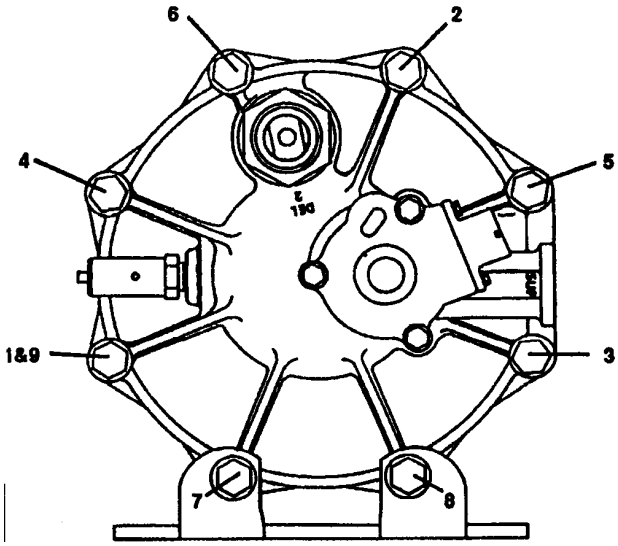

Figure 70 AD-9 Air Dryer - Tightening Capscrews

NOTE – The two remaining bolt holes in end cover and two 3/8" capscrews MUST be the ones marked during disassembly to assure proper orientation of the ports and adequate length of the capscrews.

Install

1. Install the assembled air dryer back onto the vehicle by slipping it into the upper mounting bracket. Align the two unused holes in the end cover with the bottom mounting bracket so that the bottom bracket supports the air dryer. The end cover should rest on the bracket. Using the remaining two capscrews (Item 7), four special washers (Item 6), and two lock nuts (Item 27), fasten the air dryer to the lower bracket. Tighten to 270 to 385 in-lbs. (30.7 to 43.5 N· m).

2. Tighten the bolt and nut on the upper mounting bracket. Tighten to 80 to 120 in-lbs. (9.03 to 13.55 N· m).

3. Reconnect the three air lines to the proper ports on the end cover (identified during disassembly).

4. Reconnect vehicle wiring harness to heater and thermostat assembly connector by plugging it into the air dryer connector until its lock tab snaps in place.

Troubleshooting

Table 10 Troubleshooting Chart - AD-9 Air Dryer

Condition	Cause	Remedy
1. Dryer is constantly “cycling” or purging.	1. Excessive system leakage. 2. Excessive leakage in fittings, hoses and tubing connected to the compressor, air dryer and first reservoir. 3. Defective check valve assembly in air dryer end cover. 4. Defective governor. 5. Leaking purge valve housing assembly and/or O-rings in end cover. 6. Compressor unloader mechanism leaking excessively.	1. Test for excessive system leakage. Allowable leakage: Truck - 2 psi/minute. Tractor trailer - 3 psi/minute. Truck - 1 psi/minute per service reservoir. Tractor trailer - 3 psi/minute per service reservoir. 2. Using soap solution, test for leakage at fittings, drain valve (if any) and safety valve in first reservoir. Repair or replace as necessary. 3. Remove check valve assembly from end cover. Subject air pressure to delivery side of valve. Apply soap solution at opposite end and check for leakage. (Permissible leakage: 1" bubble in five seconds). If excessive leakage, replace check valve assembly. 4. Test governor for proper cut-in and cut-out pressures and excessive leakage in both positions. 5. With the supply port open to atmosphere, apply 120 psi at the control port. Apply a soap solution to the supply port and exhaust port (purge valve seat area). Permissible leakage: 1" bubble in five seconds. 6. Remove air strainer or fitting from compressor inlet cavity. With compressor unloaded, check for unloader piston leakage. Slight leakage permissible.

Table 10 Troubleshooting Chart - AD-9 Air Dryer (cont.)

Condition	Cause	Remedy
2. Water in vehicle.	1. Desiccant requires replacement, excessive contaminants in desiccant cartridge assembly. 2. Improper discharge line length or improper line material. Maximum air dryer inlet temperature is exceeded. 3. Air dryer not purging (see Condition #5). 4. Purge (air exhaust) time insufficient due to excessive system leakage (see causes for Condition #1). 5. Air bypasses desiccant cartridge assembly. 6. Purge time is significantly less than minimum allowable.	1. Replace desiccant cartridge. 2. Minimum of six feet of discharge line must be used between the port of the compressor and the supply port. 3. See Cause and Remedy for Condition #5. 4. Check Cause and Remedy for Condition #1. 5. Replace desiccant cartridge/end cover O-ring. Check to make sure desiccant cartridge assembly is properly installed. 6. Replace desiccant cartridge/end cover O-ring. Check to make sure desiccant cartridge assembly is properly installed. Replace desiccant cartridge assembly.

Table 10 Troubleshooting Chart - AD-9 Air Dryer (cont.)

Condition	Cause	Remedy
3. Safety valve on air dryer “popping off” or exhausting air.	1. Desiccant cartridge plugged. 2. Defective discharge check valve in end cover. 3. Defective fittings, hose or tubing between air dryer and first reservoir.	1. Check compressor for excessive oil passing. Repair or replace compressor as necessary. Rebuild or replace cartridge. 2. Test to determine if air is passing through check valve. Repair or replace. 3. Check to determine if air is reaching first reservoir. Inspect for kinked tubing or hose. Check for undrilled or restricted hose or tubing fittings.

Table 10 Troubleshooting Chart - AD-9 Air Dryer (cont.)

Condition	Cause	Remedy
4. Constant exhaust of air at air dryer purge valve exhaust or unable to build system pressure. (Charge mode.)	1. Air dryer purge valve leaking excessively. 2. Defective governor. 3. Purge control line connected to reservoir or exhaust port of governor. 4. Purge valve frozen open - faulty heater and thermostat, wiring, blown fuse. 5. Inlet and outlet air connections reversed. 6. Kinked or blocked (plugged) discharge line. 7. Excessive bends in discharge line (water collects and freezes). 8. Excessive system leakage. 9. Purge valve stays open - supply air leaks to control side.	1. With compressor loaded, apply soap solution on purge valve exhaust to test for excessive leakage. Repair purge valve as necessary. 2. Check governor for proper “cut-in,” “cut-out” pressure and excessive leakage in both positions. Repair or replace as necessary. 3. Purge control line must be connected to unloader port of governor. 4. Test heater and thermostat as described in (See Service Checks - Operation and Leakage Tests, page 121)SERVICE CHECKS . 5. Compressor discharge to inlet port. Reconnect lines properly. 6. Check to determine if air passes through discharge line. Check for kinks, bends, excessive carbon deposits. 7. Discharge line should be constantly sloping from compressor to air dryer with as few bends as possible. 8. See Cause and Remedy for Condition #1. 9. Replace purge valve housing assembly O-rings.
5. Air dryer does not purge or exhaust air.	1. Broken, kinked, frozen, plugged or disconnected purge control line. 2. See Causes, 2, 5, 7 of Condition #4.	1. Test to determine air flows through purge control line when compressor unloaded. Check for undrilled fittings (See Condition #4, Remedy 3.) 2. Refer to Remedies 2, 5, 7 of Condition #4.

Table 10 Troubleshooting Chart - AD-9 Air Dryer (cont.)

Condition	Cause	Remedy
6. Desiccant material being expelled from air dryer purge valve exhaust (Many look like whitish liquid or paste or small beads). OR Unsatisfactory desiccant life.	1. Defective cloth covered perforated plate in air dryer. 2. Compressor passing excessive oil. 3. Desiccant cartridge not assembled properly to end cover (loose attachment).	1. Replace desiccant cartridge assembly. 2. Check for proper compressor installation; if symptoms persist, replace compressor. 3. Check the torque on the desiccant cartridge to end cover attachment.
7.“Pinging” noise excessive during compressor loaded cycle.	Single cylinder compressor with high pulse cycles.	A slight “pinging” sound may be heard during system build up when a single cylinder compressor is used.
8. Constant seepage of air at air dryer purge valve exhaust (non-charging mode).	1. Inlet of air compressor pressurized by turbocharger from engine. 2. Defective check valve assembly in air dryer end cover.	1. Some leakage of pressure past the metal seat of the turbo feature of the AD-9 is to be expected, also may be audible. This slight loss of air will not affect the engine or turbo performance. 2. Refer to Remedy 3, Condition #1.

Torque Chart

Table 11 Torque Chart - AD-9 Air Dryer

Description	In-Lbs.	Nm
Purge Valve Nut & Bolt	60 to 80	6.77 to 9.03
1/4 Inch Self Tapping Screw	85 to 125	9.6 to 14.12
Check Valve to End Cover	200 to 250	22.39 to 28.24
End Cap Capscrews	270 to 385	30.7 to 43.5
3/8 Inch Capscrews	270 to 385	30.7 to 43.5
Upper Mounting Bolt	80 to 120	9.03 to 13.55
Safety Valve	120 to 400	13.50 to 45.19

21.3. SYSTEM SAVER 1000 AIR DRYER

Description

The primary purpose of the System Saver 1000 Air Dryer (Figure 71) is to collect and remove air system contaminants in solid, liquid and vapor form before the air enters the brake system. It provides clean dry air to the components of the brake system.

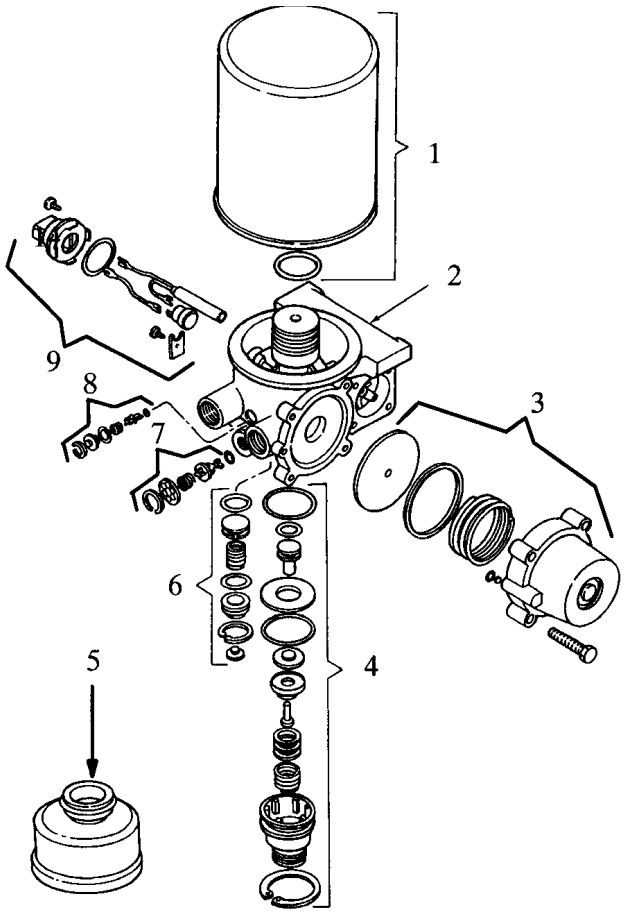

Figure 71 System Saver 1000 Air Dryer

1. DESICCANT CARTRIDGE ASSEMBLY
2. AIR DRYER BASE
3. REGENERATION VALVE ASSEMBLY
4. PURGE VALVE ASSEMBLY
5. SILENCER ASSEMBLY (OPTIONAL)
6. TURBO CUT-OFF VALVE ASSEMBLY
7. OUTLET CHECK VALVE ASSEMBLY
8. BYPASS VALVE ASSEMBLY
9. HEATER ASSEMBLY

The System Saver 1000 Air Dryer consists of an Air Dryer base, the aluminum casting to which all air dryer components are assembled and in which the threaded mounting holes are incorporated. The Bypass Valve is located between the inlet and outlet ports. This valve allows the air flow into the air dryer to bypass the desiccant cartridge and go directly to the outlet port of the air dryer. The Desiccant Cartridge is a steel housing that contains the filter elements and the desiccant necessary to filter and dry the air that passes through it. It has a spin-on and spin-off design (like an oil filter) that allows for quick and easy maintenance.

The Heater Assembly is a device that is located in the air dryer base to prevent freezing of the water that is collected in the air dryer. This assembly consists of a cylindrical resistive-type heating element and a small circular thermostat. The thermostat controls the operation of the heater element and maintains the temperature of the air dryer base above freezing (32 degrees F).

The Outlet Check Valve is located in the outlet port of the air dryer. This valve prevents air in the air system from flowing back through the air dryer and escaping out the purge valve during the compressor unload cycle. The Purge Valve is located on the bottom of the air dryer base. This valve allows the collected moisture, condensation and contamination to be expelled from the air dryer during the purge cycle.

The Regeneration Valve controls regeneration by allowing air from the supply and secondary tanks to bypass the outlet check valve, flow into the regeneration valve, and then through an orifice where air expands and “backflushes” moisture off the desiccant and then out through the purge valve.

The Silencer (an optional feature) is attached to the purge valve. When installed, this device eliminates most of the noise associated with the air dryer purge.

The Turbo Cut-Off Valve is located in the inlet port of the air dryer. This device closes the path between the air compressor and the air dryer purge valve during the compressor unload cycle.

Operation (Figure 72)

The System Saver 1000 Air Dryer alternates between two operational “cycles” during operation: the DRYING CYCLE and the PURGE CYCLE. The following description is separated into these “cycles” of operation.

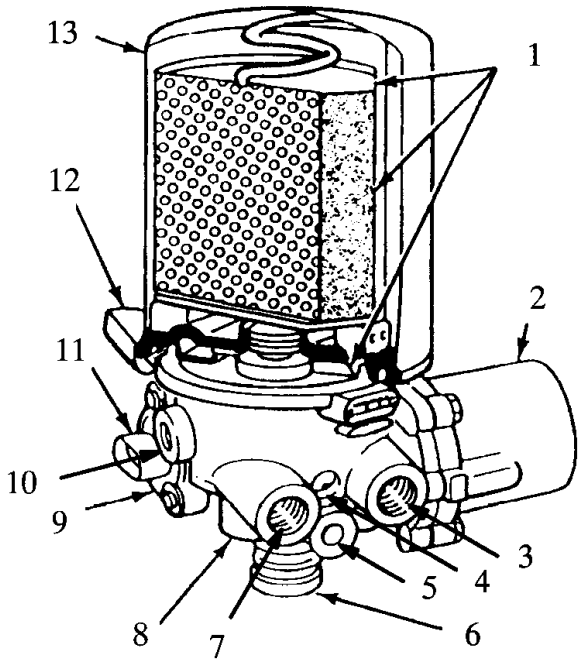

Figure 72 System Saver 1000 Air Dryer - Operation

1. MULTI-FILTER SYSTEM
2. REGENERATION VALVE
3. DRYER OUTLET
4. BYPASS VALVE
5. OUTLET CHECK VALVE
6. PURGE VALVE
7. DRYER INLET
8. TURBO CUT-OFF VALVE
9. INTEGRAL 100 WATT HEATER
10. GOVERNOR PORT
11. SEALED ELECTRICAL CONNECTOR (FOR HEATER)
12. INTEGRAL MOUNTING BRACKET
13. DESICCANT CARTRIDGE

Drying Cycle

During system pressure build-up (compressing air), compressed air passes into the air dryer where the filter system removes contaminants and passes the air into the drying cycle. Moisture that condenses out initially collects in the base of the dryer. The moisture laden air passes through the desiccant bed, where the remaining moisture is retained by the desiccant. The drying cycle begins and ends the same as the compressor load cycle.

The air dryer will remain in the drying cycle until the air brake system pressure builds to the governor cut-out setting.

Purge Cycle

When the air brake system pressure reaches the cut-out setting of the governor, the compressor unloads (air compression stopped), the purge valve opens allowing the initial decompression of the dryer (purge) and expels the water collected in the base of the dryer. The purge valve remains open during the compressor unload cycle. The regeneration valve then allows a mild back flow of air through the air dryer and out the purge

valve that begins immediately after the purge and lasts normally 8 to 15 seconds. This back flow of air from the air system and through the air dryer removes moisture from the desiccant cartridge and readies the air dryer for the next compressor load cycle.

Regeneration continues until the regeneration valve senses that the pressure of the back flow air entering the regeneration valve has dropped 10 psi from the initial pressure of the back flow air when regeneration began. Therefore, when regeneration is complete, the pressure in the supply tank and secondary tank is 10 psi less than cut-out pressure. This is normal and unique to the System Saver 1000 Air Dryer. This cycle starts at the beginning of the compressor unload cycle and normally ends well before the beginning of the compressor load cycle.

The bypass valve allows the air flow into the air dryer to bypass the desiccant cartridge and go directly to the outlet port of the air dryer. This will occur whenever the air passages in the desiccant cartridge and/or purge valve area become plugged due to contamination and/or freezing. Obviously, the air does not get dried in this mode, but the air compressor, air dryer and the air compressor discharge line are protected from damage due to an over-pressure condition.

Turbo Cut-Off Valve

The function of the turbo cut-off valve is to close the path between the air compressor and the air dryer purge valve during the compressor unload cycle. This prevents the portion of turbocharger boost pressure which passes by the air compressor during the compressor unload cycle from leaking out of the purge valve, thereby maintaining boost pressure for maximum engine horsepower during the compressor unload cycle.

Maintenance

NOTE – Before replacing any air dryer component, make sure that the air compressor and air governor are in good working order. Repair or replace these parts if needed. Check the entire air system for leaks and repair as needed. Also, when draining air tanks before servicing the air dryer, check for water and/or oil that may have accumulated in the tanks.

Table 12 Replacement Requirements - System Saver 1000 Air Dryer

Component	When	Why
Desiccant Cartridge	A. Every 2 to 3 years.	A. Preventive maintenance.
	B. Air compressor replacement.	B. Contaminated cartridge.
	C. Water in wet tank.	C. Contaminated cartridge, worn out cartridge, high duty cycle (wrong application of air dryer).
Bypass Valve	A. Air dryer cartridge or cartridge gasket ruptures due to high internal pressure.	A. Valve is stuck closed or the assembly has failed.
	B. Valve is leaking inlet to outlet.	B. Cut O-ring, bad seat.
Heater Assembly	Water collecting in air dryer is freezing and electrical power to dryer is okay.	Heater assembly not working.

Table 12 Replacement Requirements - System Saver 1000 Air Dryer (cont.)

Component	When	Why
Outlet Check Valve	A. Air continues to flow out of purge valve after the purge cycle is completed, but stops flowing when the compressor load cycle begins. B. No pressure build-up in system and everything else checks okay.	A. Valve is stuck in the open position or the valve assembly is otherwise not working. B. Valve stuck closed.
Purge Valve	A. Purge cycle does not occur when the compressor unloads and there is normal pressure at the dryer control port. B. Air flows out of purge valve during compressor load cycle and there is no pressure at the dryer control port.	A. Valve is stuck closed or the valve assembly is otherwise not working. B. Valve is stuck open or the valve assembly is otherwise not working.
Turbo Cut-Off Valve	A. Air flows out of the purge valve during the compressor unload cycle after the purge cycle has completed, and the flow is noticeably stronger at high engine rpm, especially under load. B. No pressure build-up in system and everything else checks okay.	A. Turbo cut-off valve not working. B. Valve stuck closed.
Regeneration Valve	A. Purge cycle is too long (30+ seconds) and secondary tank pressure drops 15 psi or more. B. Purge cycle is too short (5 seconds or less) and the pressure-controlled check valve checks okay and the governor control line is not leaking. C. Air dryer purges, but there is no regeneration at all, and there is no check valve installed between the air dryer and the supply tank, and the purge valve has not closed.	A. Regeneration valve not working. B. Regeneration valve not working. C. Regeneration valve not working.

Service Checks - Testing For Proper Operation

1. Begin the inspection when the compressor is in the load cycle, building up air pressure to cut-out pressure (approximately 120 psi).

2. When the air compressor reaches the unload cycle, the air dryer purges, initiating regeneration of the air dryer.

3. During the purge cycle, which lasts about 10 to 15 seconds, the wet tank and secondary tank will drop in pressure approximately 10 psi. The secondary air gauge in the cab dash panel should indicate this

drop in pressure. The 10 psi decrease in air pressure during the purge cycle is normal and unique to the System Saver 1000 air dryer.

4. If the secondary gauge needle does not show a pressure drop during the purge cycle, then check for one of the following possibilities:
   a. The pressure-control check valve is not installed on the vehicle.
   b. The pressure-control check valve is installed on the wrong air tank.
   c. The pressure-control check valve is installed to a one-way check valve, instead of in place of the one-way check valve.
   d. There is an additional check valve of some type located somewhere between the air dryer and the secondary air tank, usually at the supply (wet) tank.
   e. The secondary air gauge is not plumbed to the secondary air system.
5. If the secondary pressure drops 15 or more psi during the purge cycle and there are no other air-operated components using air during this cycle, then there are air leaks or other air system problems that need to be found and corrected.

Remove (Figure 73).

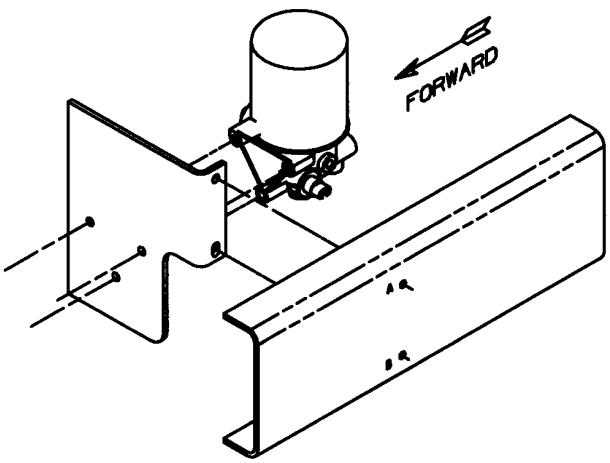

Figure 73 System Saver 1000 Air Dryer - Removal

1. Park the vehicle on a level surface and block the wheels to prevent the vehicle from moving.

⚠ WARNING – Do not work under a vehicle supported only by jacks. Jacks can slip or fall over and cause serious personal injury. Support the vehicle with safety stands.

Wear eye protection to prevent serious personal injury when servicing the vehicle.

Remove all pressure from the air system before you disconnect any component, including the desiccant cartridge. Pressurized air can cause serious personal injury.

2. Disconnect all air lines. Label them for correct installation later and plug them to prevent contamination.

3. Disconnect the heater electrical plug from the heater receptacle.

4. Remove the three mounting fasteners and remove the air dryer.

Disassemble/Clean and Inspect/Assemble

WARNING – Remove all pressure from the the air system before you disconnect any component including the desiccant cartridge. Pressurized air can cause serious personal injury.

1. Desiccant Cartridge (Figure 74).

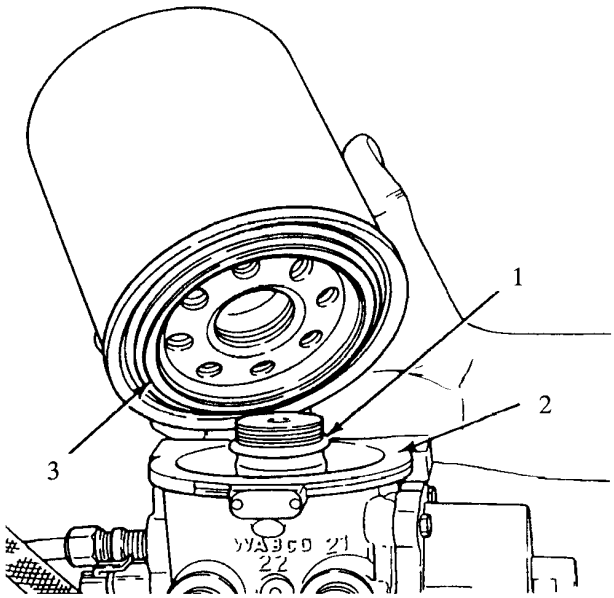

Figure 74 System Saver 1000 Air Dryer - Clean and Inspect

1. O-RING
2. SEAL SEAT
3. SEAL

a. Use a strap wrench, if necessary, to loosen and remove the cartridge.

b. Remove the O-ring.

c. Clean and inspect the surfaces where the O-ring and seal are seated. Repair any damage as required. If the seats are damaged so that a tight seal cannot be maintained, then replace the air dryer.

d. Apply a thin layer of grease to the O-ring and seal.

e. Install the new O-ring.

f. Thread the new cartridge onto the base until the seal touches the base. Then, tighten the cartridge one more complete turn.

2. Outlet Check Valve (Figure 75).

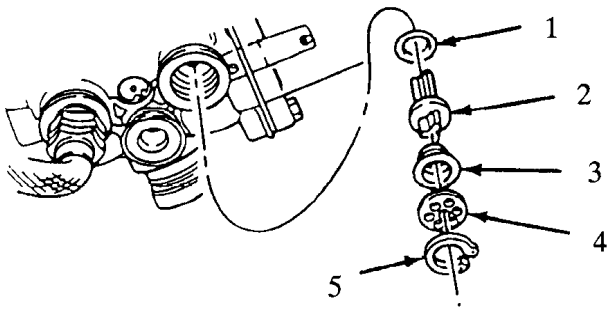

Figure 75 Outlet Check Valve

1. O-RING
2. VALVE BODY
3. SPRING
4. WASHER
5. SNAP RING

a. Remove the snap ring, washer, spring, valve body and O-ring.

b. Clean and inspect the valve bore. Repair any damage as required. If the bore is damaged so that a tight seal cannot be maintained, then replace the air dryer.

c. Install the new O-ring on the valve body.

d. Apply a thin layer of grease to the valve bore and the O-ring.

e. Install the new valve body with its long end in the bore.

f. Install the new spring with its small end around the “Y” shaped fins on the valve body.

g. Install the new washer and the new snap ring to hold the components in place.

3. Heater Assembly (Figure 76).

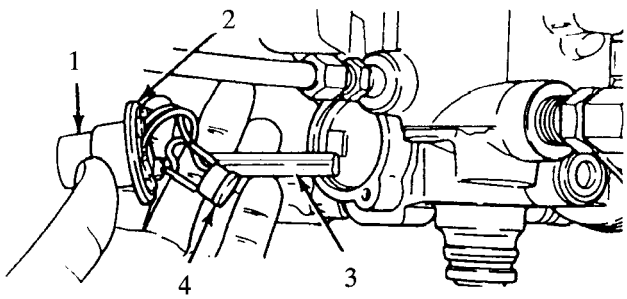

Figure 76 Heater Assembly

1. RECEPTACLE
2. O-RING
3. ELEMENT
4. THERMOSTAT

a. Disconnect the plug.

b. Remove the screws, receptacle and O-ring from the base to get access to the retainer screw.

c. Remove the retainer screw and then remove the entire heater assembly.

d. Install the new element and thermostat in their cavities.

e. Install the new retainer and screw to hold the element and thermostat in place.

f. Install the new O-ring and receptacle and fasten them in place with the screws.

g. Reconnect the plug.

4. Turbo Cut-Off Valve (Figure 77).

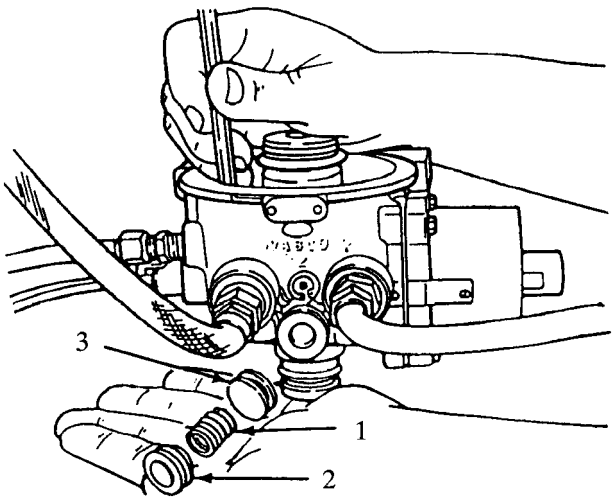

Figure 77 Turbo Cut-Off Valve

1. SPRING
2. COVER
3. PISTON

a. Remove the snap ring. The cover and spring may fall out of the bore when the snap ring is removed.

b. Remove the desiccant cartridge as described above and then use a wooden stick to push the piston, spring and cover out of the bore.

c. Clean and inspect the valve bore. Repair any damage as required. If the bore is damaged so that a tight seal cannot be maintained, then replace the air dryer.

d. Install the new O-rings on the piston and the cover.

e. Apply a thin layer of grease to the valve bore and the O-rings.

f. Install the new piston with its hollow side facing out.

g. Install the new spring, cover and snap ring to hold the components in place.

5. Regeneration Valve (Figure 78).

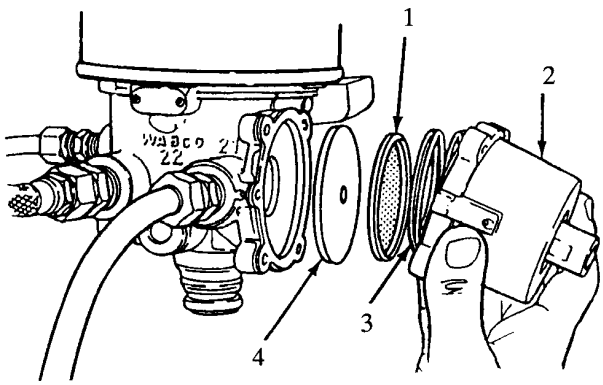

Figure 78 Regeneration Valve

1. RETAINER
2. VALVE HOUSING ASSEMBLY
3. SPRING
4. DIAPHRAGM

a. Remove the four mounting bolts and the valve housing assembly. When you remove the housing, the spring and retainer will fall out.

b. Remove the rubber diaphragm.

c. Clean and inspect the groove where the diaphragm lip fits. Repair any damage as required. If the groove is damaged so that a tight seal cannot be maintained, then replace the air dryer.

d. Install the new diaphragm with its lip in the groove.

e. Install the new spring and retainer with the retainer lip facing out. Install the valve housing assembly with the new O-ring and filter over the orifice. Install the new mounting bolts and tighten to 53 in-lbs. (6 N· m).

6. Purge Valve (Figure 79).

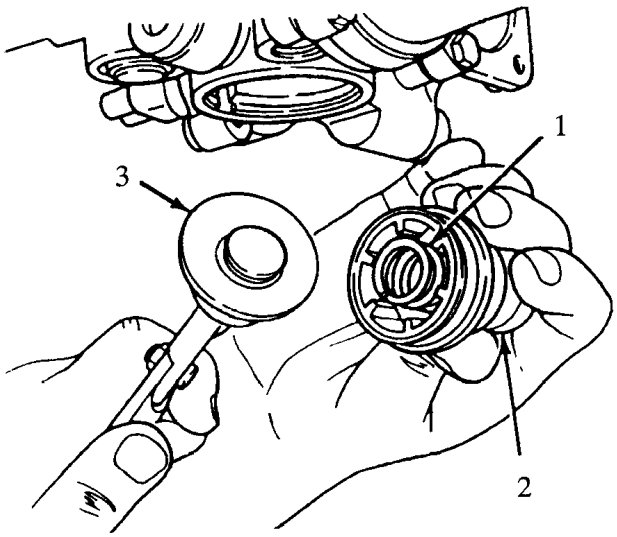

Figure 79 Purge Valve

1. SPRING
2. VALVE HEAD
3. VALVE ASSEMBLY

a. Remove the snap ring, valve head and spring.

b. Pull the valve assembly out of the base.

c. Remove the O-ring from the base.

d. Clean and inspect the valve bore. Repair any damage as required. If the bore is damaged so that a tight seal cannot be maintained, then replace the air dryer.

e. Apply a thin layer of grease to the valve bore and to all the O-rings.

f. Install new O-rings in the base and on the valve head.

g. Install the valve assembly into its bore.

h. Install the spring in the valve head, and fit them into the bore.

i. Install the snap ring to hold the valve head in place.

7. Bypass (Relief) Valve (Figure 80).

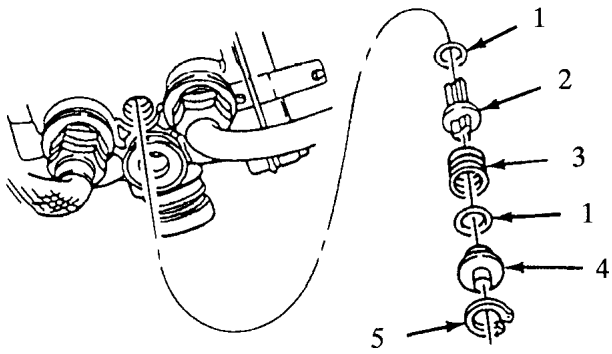

Figure 80 Bypass (Relief) Valve

1. O-RING
2. VALVE BODY
3. SPRING
4. COVER
5. SNAP RING

a. Remove the snap ring, cover, spring and valve body.

b. Clean and inspect the valve bore. Repair any damage as required. If the bore is damaged so that a tight seal cannot be maintained, then replace the air dryer.

c. Install the new O-ring on the new valve body and cover.

d. Apply a thin layer of grease to the valve bore and the O-rings.

e. Install the new valve body with its long end in the bore.

f. Install the new spring so it fits around the “Y” shaped fins on the valve body.

g. Install the new cover and the new snap ring to hold the components in place.

8. Silencer (Muffler) (Optional feature) (Figure 81).

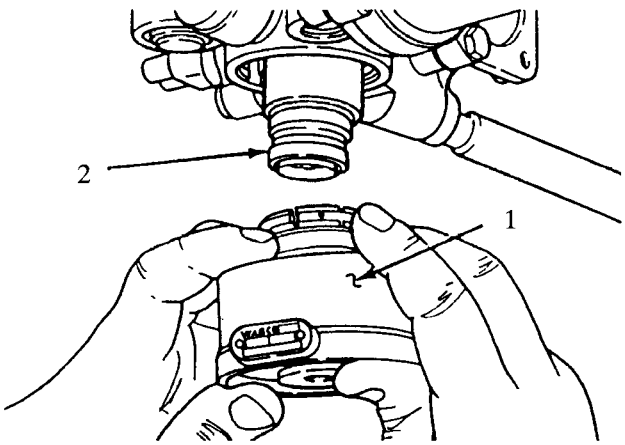

Figure 81 Silencer (Muffler)

1. SILENCER
2. PURGE VALVE HEAD

a. Use snap ring pliers to expand the snap ring and pull the silencer off the purge valve head.

b. When installing the silencer, push the silencer onto the purge valve head until the silencer snaps into place.

Install (Figure 82).

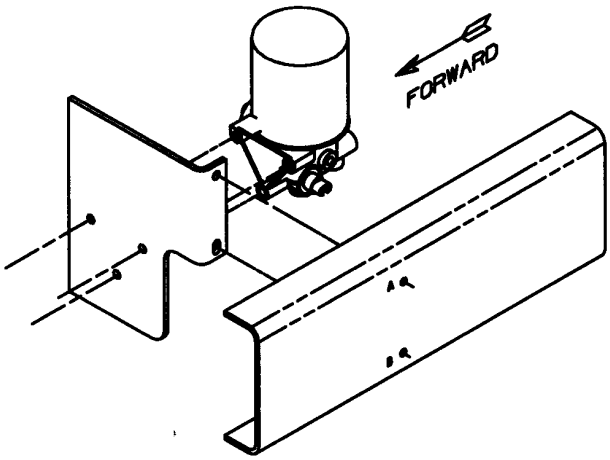

Figure 82 System Saver 1000 Air Dryer - Install

1. Fasten the unit to the frame or mounting bracket. Tighten the bolts to 65 to 90 ft-lbs. (88 to 122 N· m).
2. Connect the heater electrical plug to the heater receptacle.
3. Apply pipe sealant or teflon tape to all air fittings and re-connect the air lines to the proper ports.
4. If the vehicle is equipped with Quality Connect fittings, refer to (See QUALITY CONNECT AIR SYSTEMS, page 177)HOSES, TUBING AND CONNECTORS for service information.

Troubleshooting Chart

Table 13 Troubleshooting Chart - System Saver 1000 Air Dryer

Condition	Possible Cause	Remedy
Purge cycle is too long (more than 30 seconds)	1. Outlet check valve stuck open.	1. Replace check valve.
	2. Turbo cut-off valve leaking.	2. Replace turbo cut-off valve.
	3. Regeneration valve not working correctly.	3. Replace regeneration valve.
Air flows out of purge valve during compressor build up	1. Purge valve stuck open.	1. Replace purge valve.
	2. Wrong air line connected to the dryer port 4.	2. Connect air line correctly.

Table 13 Troubleshooting Chart - System Saver 1000 Air Dryer (cont.)

Condition	Possible Cause	Remedy
Purge cycle is too short (less than 8 seconds)	1. High demand for air during compressor unload cycle. 2. Pressure-controlled check valve not working correctly. 3. Regeneration valve not working. 4. Air governor not working.	1. Increase air system capacity or reduce air demand. 2. Replace pressure controlled check valve. 3. Replace regeneration valve. 4. Replace governor.
No purge	1. Wrong air line or no air line connected to dryer port 4. 2. Purge valve stuck closed. 3. Air governor not working correctly. 4. Cut-out pressure is never reached by air compressor.	1. Connect air lines correctly. 2. Replace purge valve. 3. Replace governor. 4. Repair system air leaks and/or repair or replace the air compressor.
No regeneration air flow	1. Air dryer not connected to supply tank. 2. Regeneration valve not working correctly. 3. Check valve installed in supply tank.	1. Connect air dryer to supply tank. 2. Replace regeneration valve. 3. Remove check valve.
Excessive cycling of air dryer	1. Outlet check valve is leaking or stuck open. 2. Air governor has narrow range setting (less than 16 psi) or otherwise not working correctly. 3. Excessive air system leaks. 4. Excessive demand for air. 5. Leak in air line to dryer port 4. 6. Leak in air line from air governor to supply tank. 7. Air compressor not working correctly.	1. Replace outlet check valve. 2. Replace with a governor that has a range of 20-30 psi. 3. Repair leaks or replace components. 4. Increase air system capacity or reduce air demand. 5. Repair leaks or replace air line and fittings. 6. Repair leaks or replace air line and fittings. 7. Repair or replace air compressor.

Table 13 Troubleshooting Chart - System Saver 1000 Air Dryer (cont.)

Condition	Possible Cause	Remedy
No build up of pressure in system	1. Air compressor discharge line not plumbed correctly.	1. Connect discharge line to air dryer inlet.
	2. Wrong air line connected to dryer port 4.	2. Connect air line correctly.
	3. Air dryer outlet not plumbed correctly.	3. Connect dryer outlet to supply tank.
	4. Large leak in air compressor discharge line.	4. Repair leak or replace discharge line and fittings.
	5. Excessive air system leaks.	5. Repair leaks or replace components.
	6. Air governor not working.	6. Replace governor.
	7. Air compressor not working.	7. Repair or replace compressor.
	8. Purge valve stuck open.	8. Replace purge valve.
	9. Turbo cut-off valve stuck closed.	9. Replace turbo cut-off valve.
	10. Outlet check valve stuck closed.	10. Replace check valve.
	11. Leak at cartridge or cartridge seal.	11. Tighten or replace cartridge.
	12. Cracked air dryer base.	12. Replace air dryer.

Table 13 Troubleshooting Chart - System Saver 1000 Air Dryer (cont.)

Condition	Possible Cause	Remedy
Air dryer is frozen (water collecting in air dryer is freezing)	1. Heater plug not installed correctly. 2. Wiring harness damaged or short circuited. 3. Heater assembly not working. 4. Power supply to heater interrupted or short circuited. 5. Low voltage output to heater unit. 6. 24-volt air dryer used in 12-volt system or vice-versa.	1. Install plug correctly. 2. Replace harness. 3. Replace heater assembly. 4. Repair or replace power supply circuit. Check fuse and replace, if needed. 5. Correct cause of low voltage. 6. Use correct air dryer for electrical system.
Water and/or oil in air tanks.	1. Desiccant cartridge is contaminated. 2. Excessive oil pumped out of air compressor. 3. Purge cycle is too short. 4. No purge. 5. No regeneration air flow. 6. Temperature of air entering the dryer is too high. 7. Shop air input connection is downstream from air dryer. 8. Air dryer mounted too close to heat source. 9. Leaking bypass valve.	1. Replace desiccant cartridge. 2. Repair or replace compressor, and replace desiccant cartridge. 3. Refer to “Purge cycle is too short” Condition. 4. Refer to “No purge” Condition. 5. Refer to “No regeneration air flow” Condition. 6. Delivery line must be a minimum 5/8 inch stainless steel braided teflon hose or steel tubing and long enough to limit temperature to 150 degrees F entering air dryer. 7. Install shop air connection upstream of air dryer. 8. Locate air dryer away from heat sources and where air can flow around it. 9. Replace bypass valve.

Torque Chart

Table 14 Torque Chart - System Saver 1000 Air Dryer

Description	In- or Ft-Lbs.	Nm
Regeneration Valve Mounting Bolts	53 In-lbs.	6
Air Dryer Mounting Bolts	65 to 90 Ft-lbs.	88 to 122

21.4. CYCLO-GARD

Description

The Cyclo-Gard air dryer is a heat transfer type air dryer that cools compressed air pumped from the compressor to ambient temperature before it enters the supply reservoir. It is also designed to prevent water, oil, carbon and sludge from entering the braking system air supply.

A thermostatically controlled heater is provided to keep moisture from freezing inside the dryer or drain valve during cold weather operation.

A check valve is provided in the discharge port of the dryer to permit depressurizing the dryer without draining the air system.

Operation

Air Flow - Pressure Cycle (Figure 83)

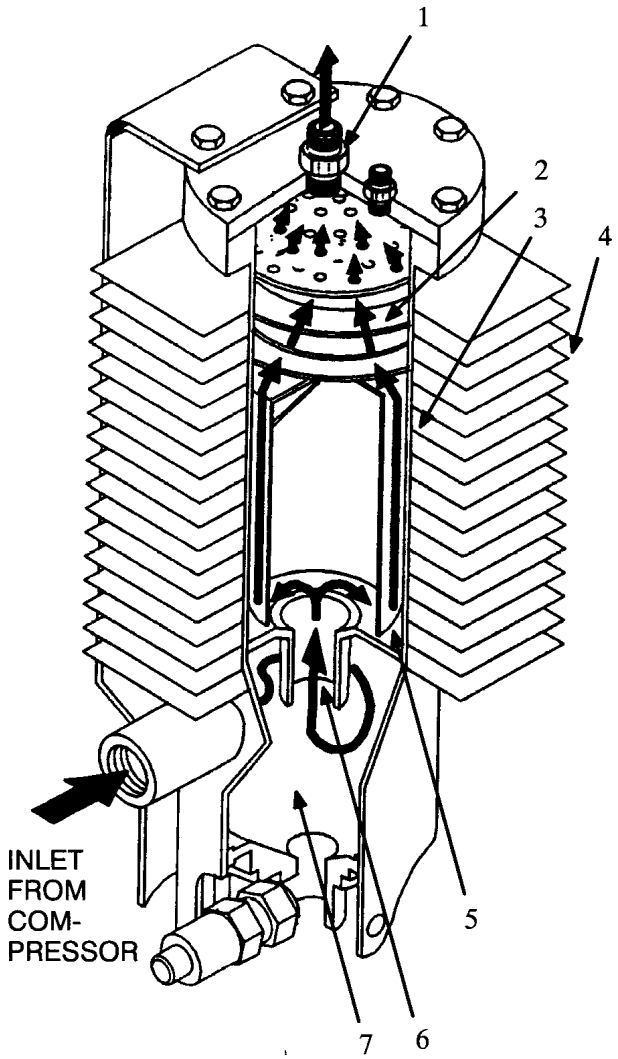

Figure 83 Cyclo-Gard Air Dryer - Air Flow

1. CHECK VALVE
2. WIRE MESH FILTER
3. TUBE WALL
4. COOLING FINS
5. BAFFLE
6. EXIT TUBE
7. SUMP

Hot air from the compressor enters the dryer at the inlet and is diverted at a right angle around the sump (Figure 83), creating a spinning action. Centrifugal force removes oil and other contaminants.

Air leaves the sump through the exit tube and is directed by the baffle to flow against the tube wall. The heat of compression is dissipated through the tube and the cooling fins, and the air temperature drops rapidly from as high as 500 degrees F to about 10 degrees above ambient temperature.

Condensed moisture runs down the tube wall and settles at the bottom of the dryer.

The cooled air then passes through a wire mesh filter which collects any minute droplets of moisture that may remain. Clean, dry air then leaves the dryer through the check valve to the supply reservoir.

Air Flow - Unload Cycle (Figure 84)

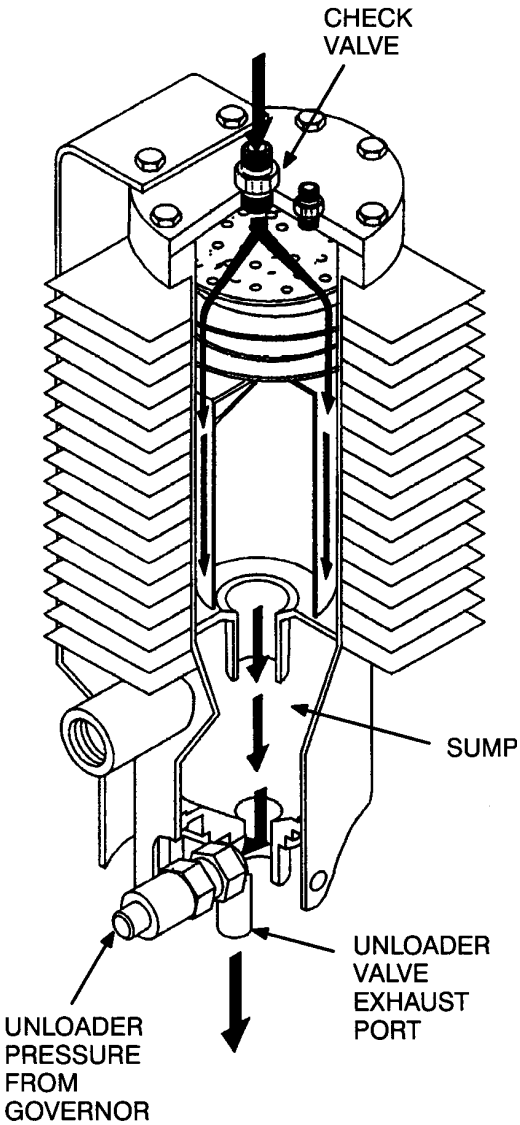

Figure 84 Cyclo-Gard Air Dryer - Unload Cycle

When system air pressure builds to governed pressure, the air compressor governor will unload the compressor and, at the same time, the governor directs system air pressure to the air dryer unloading valve which causes the valve to open. When the unloading valve opens, the check valve in the dryer discharge port will close, and air in the dryer will escape out the unloader valve (Figure 84). Moisture and other contaminants will be carried out the exhaust port of the unloader valve by the escaping air.

Maintenance

The dryer should be inspected and cleaned every 200,000 miles. Wipe out the inside and check for any damage to the baffle or other parts. Remove the mesh filter and soak in solvent to remove accumulated oil. Refer to (See Disassemble - Unloader Valve, page 158)DISASSEMBLE - AIR DRYER for the procedure to remove the filter from the air dryer.

NOTE – Be sure the filter is completely dry before it is reinstalled in the dryer.

The only moving parts in the air dryer are the check valve and the unloader valve. No maintenance is required other than the 200,000 mile cleaning as long as the unloader valve and check valve operate properly when the compressor is running in the unload cycle.

Service Checks

Heater

The heater keeps the sump from freezing in cold weather operation. The heater will automatically turn ON when the thermostatic temperature falls below 35 degrees F and automatically turn OFF when the thermostatic temperature rises above 75 degrees F. To test the heater, disconnect the unit and place it in a cup of ice water for five minutes. Reconnect the heater. The heater should heat up and continue heating until the thermostat reaches 75 degrees F. At 75 degrees F, the heater should turn itself OFF. A heater unit that fails to perform as described above should be replaced.

Unloader Valve

With the engine running, pump the brakes until the compressor cuts in (starts pumping). Verify that the unloader valve discharge port does not leak any air while the compressor is cut in (pumping).

When the compressor cuts out (stops pumping), listen for a 2 second high pressure discharge at the unloader valve discharge port. This is normal. The unloader valve will remain in the open position until the compressor cuts in again.

If the unloader valve leaks air while the compressor is cut in, or does not open (discharge air) when the compressor cuts out, then the valve is not working properly. A non-functioning valve should be cleaned, rebuilt or replaced.

Unloader Valve Test (Figure 85)

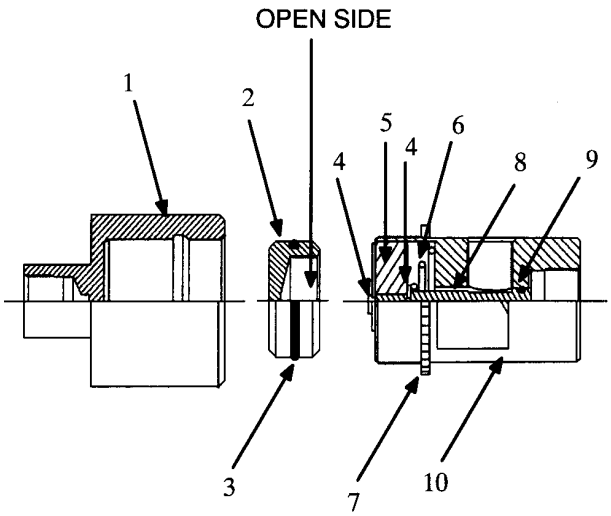

Figure 85 Cyclo-Gard Air Dryer - Unloader Valve Test

1. CAP
2. PISTON
3. O-RING
4. SNAP RING
5. WASHER
6. SPRING
7. LOCK NUT
8. PLUNGER
9. QUAD RING
10. BODY OPEN SIDE

Turn the engine off and perform the following test. It is not necessary to remove the unloader valve for this test.

1. Drain all air from the air system.

> **WARNING – Do not attempt to remove any component from the air dryer or disassemble any component on the air dryer while the air system is under pressure. High pressure air can cause personal injury or death.**

2. Disconnect the sensing line from the air compressor to the unloader valve and drain any water in the line.

3. Loosen the unloader valve lock nut and unscrew the cap from the body and dry out any water in the cap. Remove the piston. Clean and relube the piston with low temperature grease (DOW 55 or equivalent) before reinstalling.

4. Push the washer (Item 5, Figure 85) into the plunger body with your thumb. It should depress with very little effort. Travel should be approximately 1/4 inch and the washer should return flush with the end of the body when released. If the plunger does not function as described above, remove the valve and disassemble the plunger. Determine the reason for the failure and repair the assembly. Unloader valve repair kits are available from your Parts Department.

5. If the plunger travel is normal, reassemble the valve with the **open side of the piston** toward the plunger washer (Figure 85). Tighten cap fully onto the body. Tighten lock nut.

Remove - Air Dryer

WARNING – Do not attempt to remove the air dryer or any component from the air dryer while the air system is under pressure. High pressure air can cause personal injury or death.

1. Block wheels of the vehicle.
2. Drain all air from the air system.
3. Disconnect the compressor discharge and sensor lines at the dryer.
4. Disconnect the discharge line at the check valve.
5. Unplug the heater electrical connector from the heater on the dryer.
6. Remove the dryer mounting bolts and remove the dryer from the vehicle.

Remove - Unloader Valve

WARNING – Do not attempt to remove the air dryer or any component from the air dryer while the air system is under pressure. High pressure air can cause personal injury or death.

1. Block wheels of the vehicle.
2. Drain all air from the air system.
3. Disconnect the sensor line from the compressor at the unloader valve.
4. Unthread the unloader valve from the nipple in the side of the dryer base (Figure 86).

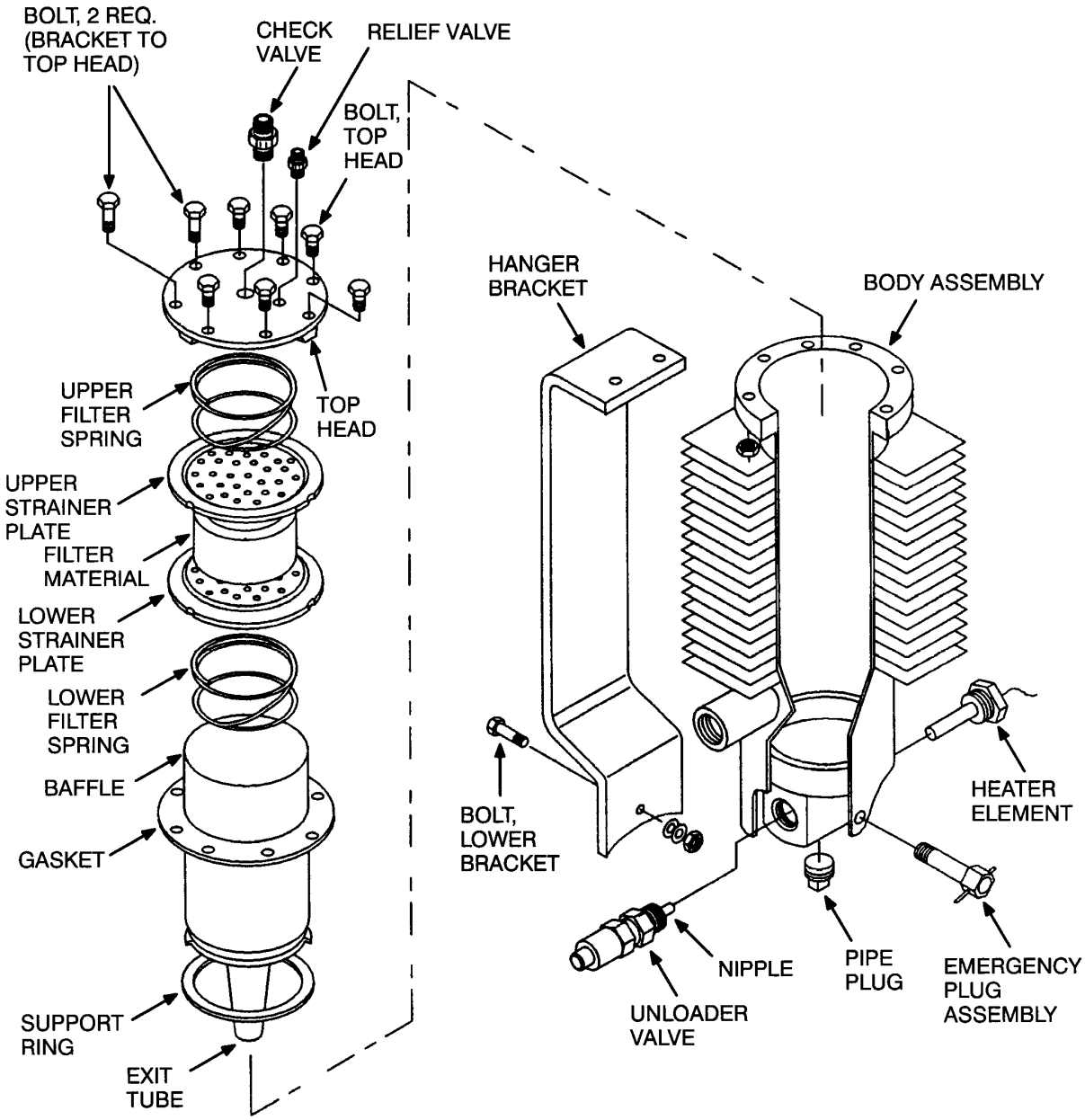

Figure 86 Air Dryer Exploded View

Remove - Check Valve

WARNING – Do not attempt to remove the air dryer or any component from the air dryer while the air system is under pressure. High pressure air can cause personal injury or death.

1. Block wheels of the vehicle.
2. Drain all air from the air system.

3. Disconnect the air dryer discharge line from the check valve.

4. Unthread the check valve from the dryer.

Remove - Heater

1. Unplug the heater electrical connector.

2. Unthread the heater from the base of the dryer.

Disassemble (Figure 86) - Air Dryer

1. Remove the bolt that secures the bottom of the dryer mounting bracket to the dryer.

2. Remove the two bolts that secure the mounting bracket to the top head (Figure 86). Mark the two bolts that secure the dryer mounting bracket to the top head to insure they are reinstalled in the same location.

3. Remove the remaining six bolts that secure the top head to the body assembly (Figure 86). Care should be taken while removing these bolts. The components held inside the dryer by these bolts are under spring tension.

4. Carefully lift the top head off the dryer and remove the upper filter spring, upper strainer plate, filter material, lower strainer plate, lower filter spring, baffle, exit tube and gasket.

5. Remove the support ring from inside the dryer cavity.

6. Unthread the unloader valve, heater and emergency plug assembly from the base of the dryer.

Disassemble - Unloader Valve

Refer to Figure 85 for all item numbers in parentheses.

1. Loosen the lock nut (Item 7) and unscrew the cap (Item 1) from the valve body.

2. Remove the piston (Item 2) from the valve body.

3. Remove the O-ring (Item 3) from the piston.

4. On the piston end of the plunger assembly, remove the snap ring (Item 4) on the outside of the washer (Item 5).

5. Lightly tap the washer end of the plunger assembly against the palm of your hand to remove the washer (Item 5).

6. Remove the inner snap ring (Item 4).

7. Remove the spring (Item 6).

8. Push the plunger (Item 8) out the opposite end of the housing from the washer end.

9. Remove the quad ring (Item 9) from the plunger.

Clean and Inspect

1. Wipe out the inside of the air dryer housing and check for damage to the baffle.

2. If the baffle is damaged, if must be replaced to insure proper cooling of the air.

3. Soak the mesh filter in solvent to remove accumulated oil.

   NOTE – The filter must be completely dry before it is reinstalled in the dryer.

4. Wipe the piston, washer, plunger and inside of the unloader valve body clean. Check for wear. If the piston and/or bore of the plunger body are damaged or worn, the complete valve must be replaced.

Assemble - Unloader Valve

Refer to Figure 85 for all items in parentheses.

1. As each part is installed, lubricate with low temperature grease (DOW 55 or equal).

2. Install new quad ring (Item 9) on the plunger (Item 8).

3. Install the plunger into the plunger body (Item 10) so the quad ring end of the plunger is on the pipe nipple end of the plunger body.

4. From the washer end, install a new spring (Item 6).

5. Install a new snap ring (Item 4) on the inner groove of the plunger shaft.

6. Install a new washer (Item 5).

7. Install a new snap ring (Item 4) on the plunger shaft to hold the washer in place.

8. Push the washer (Item 5) into the plunger body with your thumb. It should depress with very little effort. Travel should be approximately 1/4 inch and the washer should return flush with the end of the body when released. If the plunger does not function as described above, disassemble the plunger assembly, determine the reason for the failure and repair the assembly.

9. Install a new O-ring (Item 3) on the piston (Item 2).

10. Install the piston (Item 2) with the open end toward the washer (Item 5) in the plunger body (Item 10).

11. Install and tighten the cap (Item 1) fully onto the plunger body. Tighten the lock nut (Item 7) to hold the cap in place.

Assemble - Air Dryer

Refer to Figure 86 for all items referenced in the following text.

1. Install a new gasket on the upper flange of the body assembly. The gasket is installed by the manufacturer without a sealer.

2. Install the support ring in the dryer housing cavity so that it rest completely on the indentations inside the lower end of the cavity.

3. Install the exit tube so it rests completely on the support ring.

4. Install the baffle.

5. Install lower filter spring, lower strainer plate, filter material, upper strainer plate and upper filter spring in this order.

6. Position the top head over the assembly so the upper filter spring is centered on the bottom side of the top head.

7. Push the top head down (against the spring tension) so it rests against the gasket. Install two top head bolts (not the bolts that secure the hanger bracket to the assembly). Tighten finger tight. Install the remaining bolts and the mounting bracket. Use the bolts that were marked during disassembly to hold the mounting bracket in place. Tighten all bolts to 25 to 30 ft-lbs. (34 to 41 N· m).

8. Install the bolt that secures the bottom of the hanger bracket to the dryer. Tighten to 25 to 30 ft-lbs. (34 to 41 N· m).

9. Install the unloader valve, check valve, heater and emergency plug assembly.

Install

1. Mount the air dryer assembly to the vehicle. Tighten all mounting bolts to 30 to 38 ft-lbs. (41 to 51 N· m).

2. Connect and tighten the governor sensing line to the unloader valve, the compressor discharge line to the air dryer and the air dryer discharge line to the check valve.

3. Connect the electrical connector to the heater.

4. Build air pressure in the system and check the air dryer and all fittings for air leaks. Repair as required.

Troubleshooting

1. The discharge cycle should last for only a few seconds. A faulty check valve will allow a longer discharge period and cause constant cycling, probably from 30 to 50 seconds apart.

2. The unloader valve should open only when pressure is applied from the governor during the governor unload cycle. If the valve stays open during the pumping cycle, the air system cannot be brought up to operating pressure since air intended for the system will be escaping through the unloader valve exhaust port. To determine the source of the condition, disconnect the air line at the unloader valve cap. If the valve does not close, it should be repaired or replaced. If it does close, it is functioning properly and the governor may be faulty.

3. If there is no blow down when the compressor is in the unload cycle, the unloader valve should be repaired or replaced as soon as possible. Continued operation over a period of time can allow the water level to build up in the sump of the unit. If the water level reaches a point higher than the inlet port, the air pressure can lift the water with sufficient force to damage the baffle. A damaged baffle will not allow the unit to cool the air flow and will result in high moisture content in the reservoirs.

Torque Chart

Table 15 Torque Chart - Cyclo-Gard

Component	Ft-Lbs.	Nm
Mounting Bolts	30-38	41-51

Table 15 Torque Chart - Cyclo-Gard (cont.)

Component	Ft-Lbs.	Nm
Top Head Bolts	25-30	34-41
Lower Mounting Bracket Bolt	25-30	34-41

22. AIR COMPRESSOR GOVERNOR (TYPE D-2)

22.1. DESCRIPTION

The air compressor governor, along with the compressor unloader mechanism, automatically limits system pressure to a predetermined range by opening unloading valves and stopping compression when system pressure has been built up to maximum pressure limit, and by closing unloading valves and starting compression when system pressure has dropped to minimum pressure limit.

The D-2 governor (Figure 87) has a piston upon which air pressure acts to overcome the pressure setting spring and control the inlet and exhaust valve to either admit or exhaust air to or from the compressor unloader mechanism.

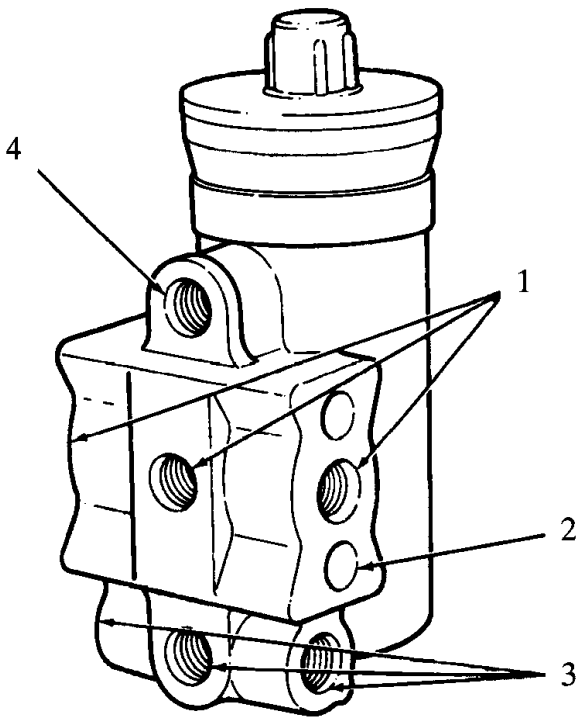

Figure 87 D-2 Governor

1. UNLOADER PORTS
2. MOUNTING HOLES
3. RESERVOIR PORTS
4. EXHAUST PORT

The governor can be attached to the compressor or mounted remotely. It is adaptable to either mounting. Connections in this system are to the reservoir and compressor unloader ports. It also has an exhaust port.

22.2. OPERATION

Refer to Figure 88 for all items in parentheses.

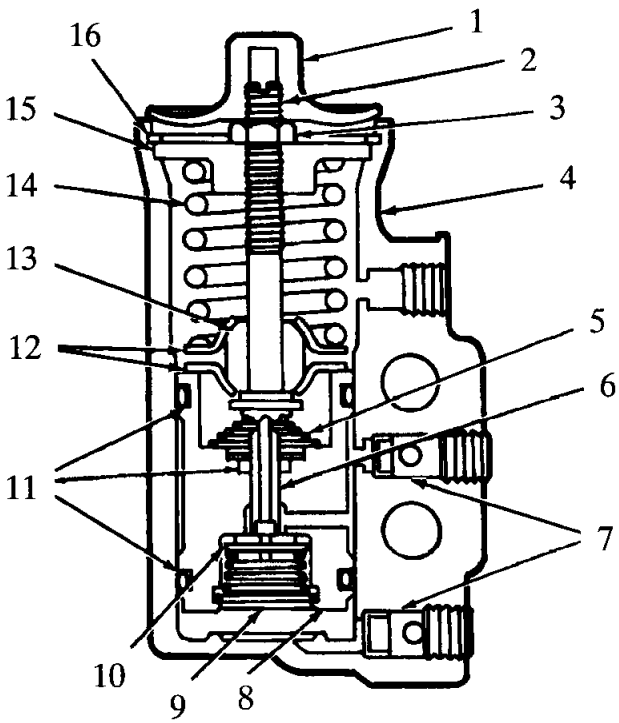

Figure 88 D-2 Governor Operation

1. COVER
2. ADJUSTING SCREW
3. LOCK NUT
4. BODY
5. EXHAUST STEM SPRING
6. EXHAUST STEM
7. FILTERS
8. PISTON
9. INLET-EXHAUST VALVE SPRING
10. INLET AND EXHAUST VALVE
11. GROMMETS
12. LOWER SPRING SEATS
13. SPRING GUIDE
14. PRESSURE SETTING SPRING
15. UPPER SPRING SEAT
16. RETAINING RING

Reservoir air pressure enters the governor at one of its reservoir ports and acts on the area of the piston and beneath the inlet and exhaust valve. As the air pressure builds up, the piston moves against the resistance of the pressure setting spring (Item 14) and the inlet and exhaust valve (Item 10) moves up when the reservoir air pressure reaches the cut-out setting of the governor (Figure 88).

The exhaust stem (Item 6) seats on the inlet and exhaust valve (Item 10) and then the inlet passage opens. Reservoir air pressure then flows by the open inlet valve, through the passage in the piston and out the

unloader port to the compressor unloader mechanism. The air, besides flowing to the compressor unloader mechanism, also flows around the piston (Item 8) and acts on the additional area of the piston, assuring positive action and fully opening the inlet valve.

As the system reservoir air pressure drops to the cut-in setting of the governor, the force exerted by the air pressure on the piston (Item 8) will be reduced so that the pressure setting spring (Item 14) will move the piston down. The inlet valve will close and the exhaust will open. With the exhaust open, the air in the unloader line will escape back through the piston, through the exhaust stem (Item 6) and out the exhaust port.

22.3. MAINTENANCE

Every 100,000 miles (160,000 km), disassemble the governor, clean and inspect all parts and replace as necessary.

Every 25,000 miles (40,000 km), clean or replace governor filters. When cleaning, use a solvent known to have no detrimental effect on metal or rubber material.

22.4. SERVICE CHECKS

Operating Test

CAUTION – Only test gauges known to be accurate are to be used for checking brake valve delivery pressures, gover- nor pressure settings and other tests.

Start the vehicle engine, build up air pressure in the air brake system, and check the pressure registered by a dash or test gauge at the time the governor cuts out, stopping the compression of air by the compressor. The cut-out pressure should be in accordance with the piece number of the governor. The more common cut-out pressure is 125 5 psi.

With the engine still running, make a series of brake applications to reduce the air pressure and observe at which pressure the governor cuts in the compressor. As in the case of the cut-out pressure, the cut-in pressure should be in accordance with the specifications of the governor part number. Common cut-in pressure is 100 to 105 psi. Governor pressure settings should be checked with an accurate test or dash gauge. If the pressure settings of the governor are inaccurate or it is necessary that they be changed, procedure is as follows.

To adjust the governor, first unscrew the cover at the top of the governor. Next, loosen the adjusting screw lock nut. Turn the adjusting screw counterclockwise to raise the pressure setting, and turn the screw clockwise to lower the pressure setting. After the adjustment is completed, the adjusting screw lock nut should be tightened to lock this adjustment. Screw cover securely onto governor.

NOTE – 1/4 turn will change the setting approximately 4 psi. Any governor requiring more than a full turn adjustment should be cleaned and inspected.

Leakage Test

Leakage checks on the governor are made at its exhaust port in both cut-in and cut-out positions.

1. In the cut-in position, check exhaust port for inlet valve leakage by applying a soap solution at the port.

2. Leakage could also be going past the bottom piston grommet. In the cut-out position, check the exhaust port to determine leakage at the exhaust valve seat or stem grommet. In this position, leakage could also be going past the upper piston grommet.

Leakage in excess of 1 inch (25 mm) diameter soap bubble in 3 seconds is not permissible in either of the foregoing tests. If excess leakage is found, the governor must be repaired or replaced.

22.5. REMOVE

1. Apply parking brakes and block wheels.

2. Drain air from brake system.

3. If governor is compressor-mounted type, disconnect reservoir air line. If remote-mounted governor, disconnect both the unloader and reservoir air lines.

4. Remove governor mounting bolts, then governor.

22.6. DISASSEMBLE

Governor removed from vehicle engine.

1. Clean governor exterior with cleaning solvent and brush.

2. Unscrew the top cover. Measure the amount of adjustment screw (rod) protruding from the top of the adjusting lock nut. This measurement will help on reassembly.

3. Using a pair of retaining ring pliers, remove the spring assembly retaining ring.

4. Remove the adjusting screw and spring assembly.

5. Remove the lock nut, then the hex-shaped upper spring seat from the adjusting screw.

6. Remove the pressure setting spring, lower spring seat, spring guide and the second lower spring seat.

7. Remove the exhaust stem and its spring from the top of the piston.

8. With the body in the inverted position, tap it lightly. The piston should fall out.

9. Remove the inlet and exhaust valve spring and the valve from the piston.

10. Remove the two piston grommets, and with a hooked wire, remove the exhaust stem grommet.

11. Clean or remove the unloader and reservoir port filters.

22.7. CLEAN AND INSPECT

1. Clean metal parts in cleaning solvent. Dry parts with compressed air.

2. Wipe rubber parts with a clean, dry cloth.

3. Inspect body for cracks or other damage. Be particularly careful that the body air passages, the filters, exhaust stem and piston are not obstructed.

4. Check springs for cracks, distortion or corrosion.

5. Replace all parts not considered serviceable.

22.8. REASSEMBLE

Prior to assembly, lubricate the lower body bore, the top of the piston, the piston grooves, piston grommets, and piston setting spring guide with Fleetrite EP2 Moly grease or equivalent to NLGI #2 multi-purpose lithium grease. Adjust screw.

1. Install the exhaust stem grommet in its groove in the stem bore of the piston.

2. Drop the inlet and exhaust valve into place at the bottom of the piston.

3. Install the inlet valve spring with its narrow end against the valve. Press the spring down until the large coiled end snaps into the groove inside the piston.

4. Position the exhaust stem spring over the exhaust stem. Then carefully press the stem into the stem bore of the piston.

5. Install the piston in the body.

6. Install in the following order: one lower spring seat, spring guide, the other lower spring seat, pressure setting spring and the hex-shaped upper spring seat on the adjusting screw. Screw the upper spring seat down until the dimension from the top of the seat to the bottom of the stem head is approximately 1-7/8 inches (47.6 mm).

7. Install the lock nut.

8. Before placing the adjusting screw and stem assembly in the governor body, check to be sure the exhaust stem and its spring are in place in the piston.

9. Install the adjusting screw and spring assembly retaining ring. Adjust adjusting screw to the measurement that was taken in step 2 in page.

10. If necessary, install new filters in the reservoir and unloader ports.

22.9. INSTALL

If compressor-mounted type governor, clean mounting pad on both compressor and governor block. Clean connecting line or lines. Also be sure compressor unloader port is clear and clean.

If the governor is being mounted remotely, it should be positioned so that its exhaust port points down. It should be mounted higher than the compressor so that its connecting lines will drain away from the governor.

1. If compressor-mounted type, use a new governor mounting gasket. Install governor and mounting bolts. Tighten bolts.

2. Connect air lines to governor. Test governor as outlined under (See SERVICE CHECKS, page 163)SERVICE CHECKS .

3. After the adjustment is made, be sure the governor cover is securely installed.

23. ALCOHOL EVAPORATOR (BENDIX AE-1)

23.1. DESCRIPTION

The alcohol evaporator (Figure 89) is designed to permit vaporized alcohol to be drawn into the air brake system to prevent possible freezing of any moisture in the air brake system.

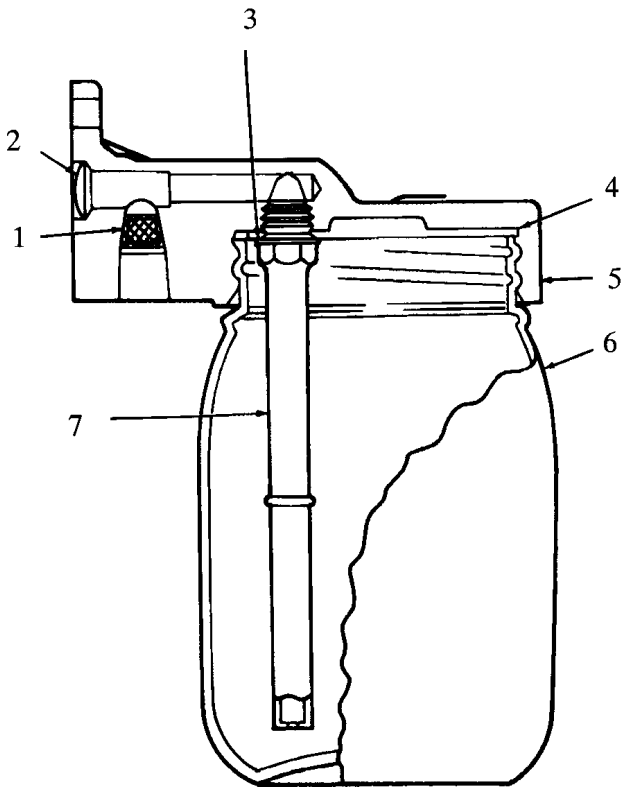

Figure 89 Bendix AE-1 Alcohol Evaporator

1. FILTER
2. WELCH PLUG
3. SEALING RING
4. GASKET
5. BODY
6. CONTAINER
7. EVAPORATOR TUBE

NOTE – Installation of an alcohol evaporator does not mean that daily draining of all air reservoirs is not required. In a moisture-laden atmospheric air system, a properly installed and maintained alcohol evaporator and daily draining of all reservoirs will be very effective in preventing air system freeze-ups.

The AE-1 alcohol evaporator has a die cast body which houses the filter, filter cap and evaporator tube. The die cast body also serves as a mounting bracket. The container can either be glass, plastic or metal and be either a pint or quart.

Some installations require the use of a check valve to prevent alcohol entering the engine induction system.

23.2. OPERATION

When the air compressor is in the compressing cycle, a partial vacuum is present at the compressor intake. A line from the evaporator is connected to the compressor intake, therefore a vacuum is created above the alcohol in the alcohol reservoir. Air at atmospheric pressure or greater, depending upon the type of installation, enters the evaporator and passes through the tube which is immersed in the alcohol.

This air passing through the alcohol causes the alcohol to bubble and the vapor formed by the bubbling is induced into the compressor intake and into the air system.

23.3. CONSUMPTION OF ALCOHOL

Complaints of inoperative alcohol evaporator or excessive use of alcohol can be traced to either a wrong kit being installed or an incorrect installation of a kit. For that reason, the correct selection of a kit is very important.

The consumption of alcohol will vary for different vehicles. The main determining factor on properly installed and maintained units is the percentage of time the air compressor is in its loaded (compressing) cycle. Since the alcohol is only used when the compressor is compressing air, good maintenance practice should be followed by keeping air leakage in the system to a minimum and keeping the brakes adjusted.

It is difficult to estimate the amount of alcohol a vehicle will use. A guide to determine if the alcohol evaporator is working properly is:

Alcohol Usage:1 to 2 ozs. per hour if compressor is continuously pumping.

Example: If a compressor on a tractor-trailer will be loaded (compressing air) 20% of the total operating time of 12 hours (or roughly 2-1/2 hours), consumption of alcohol can be calculated by multiplying 1 to 2 ozs. x 2.5 hrs. (20% of the 12 hour compressor running time) equals approximately 1/3 to 1/2 pint of alcohol in 12 hours. Additional calculations reveal that if a compressor operates a greater percentage of time, more alcohol will be used.

23.4. TYPE OF ALCOHOL

It is recommended that only pure alcohol be used in the air brake system. Certain types of alcohol and antifreeze solutions contain ingredients which leave residue or deteriorate parts in the air system.

23.5. MAINTENANCE

Every 25,000 miles (40,000 km), make sure all fittings are tight and bubbles are present in alcohol when compressor is compressing air. Refer to the (See Table 16, page 170)TROUBLESHOOTING CHART , if evaporator assembly is not operating properly.

Every 50,000 miles (80,000 km), if a strainer is present, check to be sure it is clear. Clean or replace if necessary.

Every 100,000 miles (160,000 km), disassemble evaporator and check valve (if equipped); clean all parts, replacing all gaskets and rubber parts.

Filling

1. Always use the filler plug on AE-1 evaporator. Frequent removal of alcohol reservoir will cause possible deterioration of gasket which will allow leakage and affect performance.

2. Fill reservoir 2/3 full. Be certain alcohol is used.

23.6. SERVICE CHECKS

Proof that evaporator is functioning can be determined by:

1. If a glass jar is being used, alcohol should bubble when engine is revved (compressor loaded).

2. If a plastic jar or metal can is used, check exhaust or reservoir drain for odor of alcohol.

23.7. DISASSEMBLE

1. Carefully disassemble, noting order of removed parts. Refer to Figure 89 .

23.8. CLEAN AND INSPECT

1. Wash all metal parts in solvent.

2. Inspect all parts and replace parts not considered serviceable.

23.9. REASSEMBLE

Assemble parts, making sure new gaskets and rubber parts are properly installed. Refer to Figure 89 .

23.10. TEST

With compressor in compressing cycle, bubbles should be evident in alcohol. If air bubbles are not present, refer to the (See Table 16, page 170)TROUBLESHOOTING CHART .

23.11. INSTALLATION OF ALCOHOL EVAPORATOR KITS

Installation of alcohol evaporator on vehicles in the field is a common practice and is easily accomplished. However, complaints of inoperative alcohol evaporators or excessive use of alcohol can usually be traced to either the wrong kit being installed or an incorrect installation of the proper kit. Therefore, the selection and installation of the correct kit is important. All field installation kits have installation instructions; however, the following information may be helpful.

23.12. ENGINE AIR CLEANER INDUCTION

This kit is used when the compressor inlet is connected to the engine air cleaner on the engine intake manifold and the engine is naturally aspirated (not supercharged or turbocharged). A single check valve “A” is employed in this installation and depending on evaporator used may be connected directly to the evaporator, or connected to the governor (Figure 90).

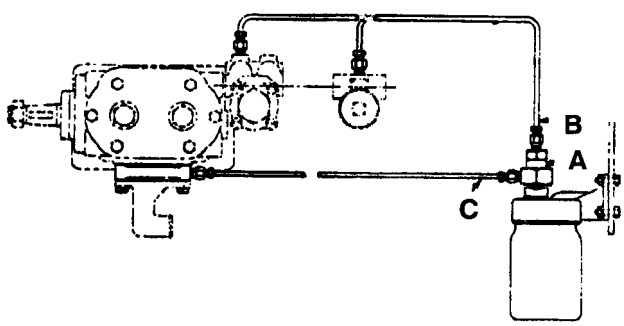

Figure 90 Engine Air Cleaner Induction

NOTE – Line “B” is connected to the unloader port of the governor.

When the compressor is unloaded (not compressing air), the air pressure in line “B” holds the check valve “A” closed and prohibits alcohol from being drawn into line “C” thus stopping any possible flow of alcohol from the jar into the engine intake.

23.13. SUPERCHARGED COMPRESSOR INDUCTION

This kit is used when the compressor inlet receives its air supply from the engine supercharger.

This kit employs two adapters “A” with a gasket “B” between them (Figure 91). Through the orifice in the gasket, a differential is created. (The pressure on the compressor side of the gasket “B” is less than the pressure on the inlet fitting side of gasket “B.”) The alcohol will be induced through line “C” into the compressor inlet and thus into the air brake system. The choke filling “D” (Figure 91) prohibits a quick change of pressure in the alcohol jar when a momentary vacuum is created in the compressor air induction line by the engine and prohibits evacuation of alcohol from the jar. Maximum safe operating pressure is 5 psi.

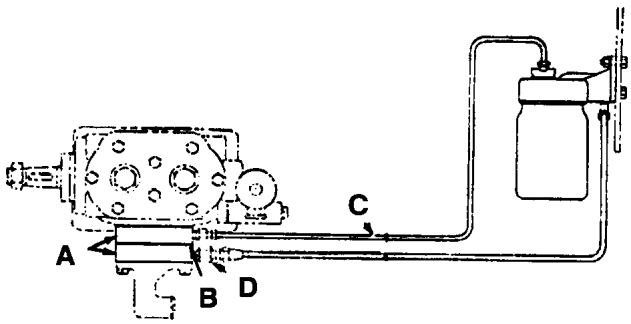

Figure 91 Supercharged Compressor Induction

23.14. TURBOCHARGED COMPRESSOR INDUCTION

This kit (Figure 92) is used when the compressor inlet receives its air supply from the blower propelled by the turbocharger and operates identically the same as the supercharged compressor induction kit described above, except the maximum safe-operating pressure is 20 psi, which necessitates the use of a metal can.

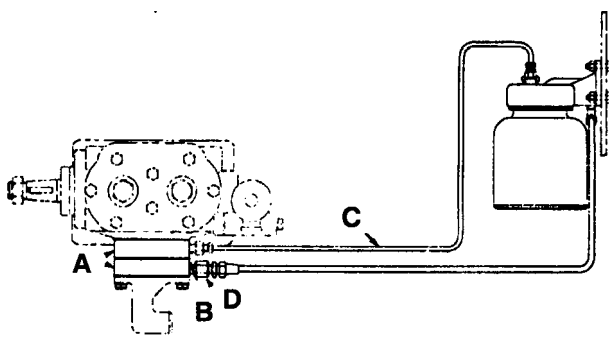

Figure 92 Turbocharged Compressor Induction

23.15. TROUBLESHOOTING CHART

Table 16 Troubleshooting Chart - Bendix AE-1 Alcohol Evaporator

Condition	Possible Cause	Remedy
Alcohol	Wrong kit installed.	Install proper kit.
evaporator does	Kit is piped incorrectly.	Check diagram for correct piping.
not operate.	Lines restricted (foreign material, kinked, etc.).	Clean or replace lines.
	Alcohol evaporator filter clogged (Standard Engine Air Cleaner Induction Kit).	Clean or replace filter material.
	Leaky fittings, lines, jar cover gasket or filler cap gasket.	Tighten or replace necessary parts.
	3/16" line from compressor to alcohol evaporator longer than five (5) feet (1.5 m) (Standard Kit and Engine Air Cleaner Induction Kit only).	Line from compressor to alcohol evaporator should not be longer than 5 feet (1.5 m) (Standard Kit and Engine Air Cleaner Induction Kit only).
	Compressor not in loaded (compressing air) cycle.	By observing dash gauge, make certain compressor is in loaded (compressing air) cycle.
	Check valve stuck in closed position (Engine Air Cleaner Induction Kit only).	Replace necessary parts or complete check valve.
Excessive use of alcohol.	Wrong kit installed; i.e., if a compressor receives its air through the engine air cleaner and a standard kit is installed without check valve, it is possible for alcohol to be drawn into the engine.	Install proper kit.
	Leaky compressor unloader (Supercharger and Turbocharger Induction Kits only). Leaky unloaders can cause alcohol to be “blown” into the engine intake.	Replace compressor unloader.
	Evaporator is subjected to excessive temperature (greater than 120°F (49°C).	Relocate alcohol evaporator.
	Check valve leaking or inoperative (Engine Air Cleaner Induction Kit only).	Replace necessary parts or complete check valve.
	Excessive system leakage (causing compressor to be in loaded compressing air cycle in excess of normal).	Check system leakage. Leakage should not be greater than 2 psi in one minute for single vehicles or 3 psi in one minute for tractor-trailer combinations (with brakes released).
	Choke fitting not used (Supercharger and Turbocharger Induction Kits only).	Install choke fitting at compressor inlet.

Table 16 Troubleshooting Chart - Bendix AE-1 Alcohol Evaporator (cont.)

Condition	Possible Cause	Remedy
	Clogged air strainer (will cause excessive intake vacuum) (Standard Kit only).	Clean or replace air strainer element.
Deposit of residue in valves from alcohol.	Wrong alcohol being used.	Use only pure methanol alcohol, Bendix-Westinghouse “Air-Guard” or equivalent.

24. HOSES, TUBING AND CONNECTIONS

24.1. FLEXIBLE HOSE

Description

Any air system hose can be made locally. Hose is stocked bulk by size.

The hose is constructed of a seamless synthetic rubber lining or tube reinforced with one fabric braid of high tensile steel wire which is covered with a synthetic rubber-impregnated, oil-resistant fabric braid.

These hoses can be used for air systems and air brake systems, except the air line from air compressor to air reservoir, where the temperature will exceed 300°F (149°C.

The fittings used at the ends of the flexible hose are of the swivel type, such as that shown in Figure 93 . The swivel end permits one end of the hose to be disconnected without disturbing the complete hose.

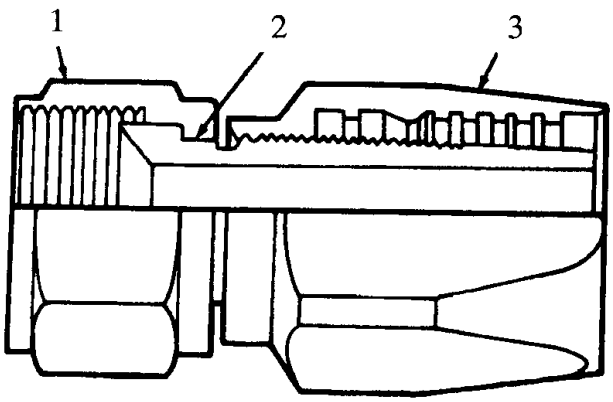

Figure 93 Flexible Hose Fittings

1. NUT
2. FITTING
3. HOSE SOCKET

Do not try to mix different type hoses and hose fittings. In some cases the hose and hose fittings may seem to fit, but the ends may not hold up under pressure which could result in loss of air while vehicle is being operated. If in doubt as to the identification of the hose, and/or fittings which are being repaired, use new components to make up a new hose assembly.

Hose Assembly Instructions

When making up a length of hose, each step should be finished carefully to assure proper connections at the hose ends (Figure 93).

1. Remove the hose fitting and nut from socket and hose. Figure 93 illustrates the swivel hose fitting. So that the swivel nut and fitting can be removed from the hose and socket assembly, install a male fitting in the swivel nut and tighten it. That locks the swivel joint assembly (nut and fitting). The swivel nut and fitting can now be turned out of the hose using a wrench.

2. Separate the hose from the socket.

3. Repeat steps 1 and 2 for the removal of second end.

4. Lightly clamp the hose in a vise.

5. Use a fine-tooth hacksaw to cut hose to desired length (Figure 94).

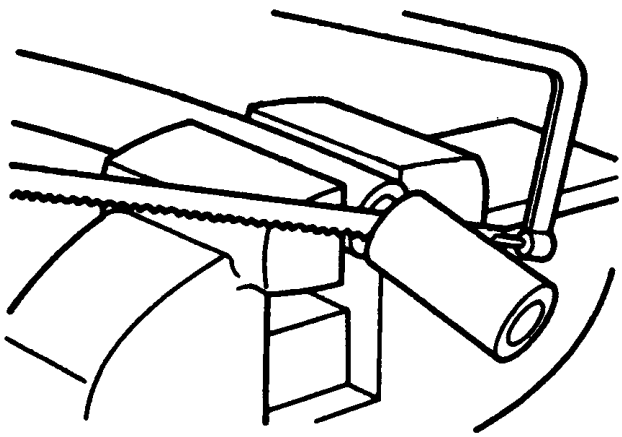

Figure 94 Hacksaw to Cut Hose

6. Lightly clamp the hose socket in a vise with the hose end facing out (Figure 95).

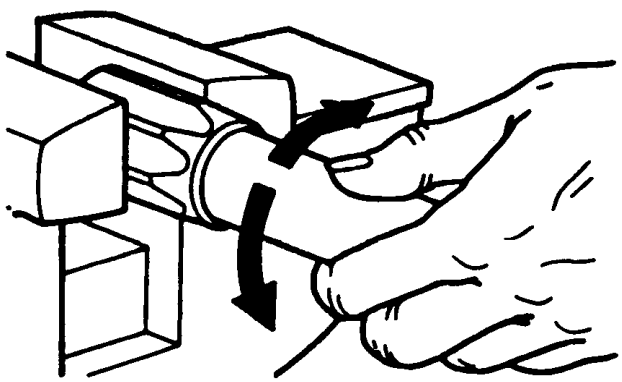

Figure 95 Hose Bottoms in Fitting

7. Screw end of new hose into socket (turn counterclockwise) until hose bottoms in fitting, then back off 1/4 turn (Figure 95) .

8. Reposition hose and socket in the vise as shown in Figure 96 . Lubricate hose socket and fitting threads. Use light weight engine oil sparingly.

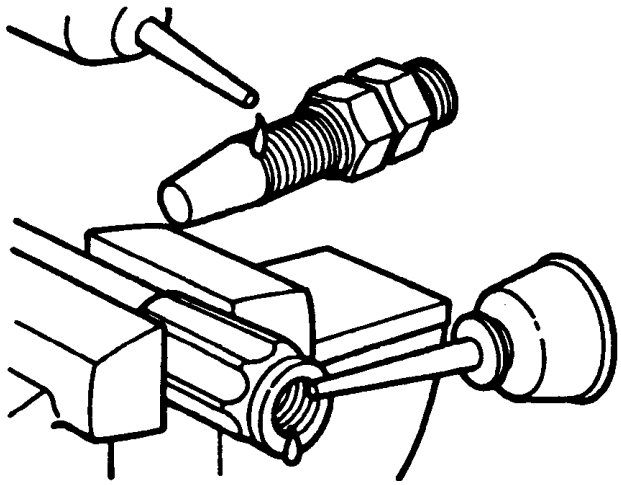

Figure 96 Lubricate Socket and Fitting Threads

9. Position hose socket in swivel nut and reassemble male fitting (if removed) to lock swivel nut on the fitting. Thread the fitting and swivel nut (with male adapter) assembly into the hose as shown in Figure 97 , leaving 1/32 inch to 1/16 inch (.793-1.59 mm) clearance between nut and socket so that the nut can swivel freely.

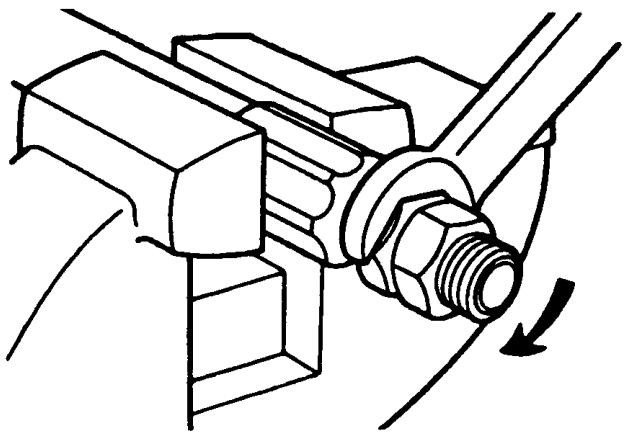

Figure 97 Thread Fitting

10. Repeat steps 5, 6, 7 and 8 on opposite end of hose to install the remaining nut and fitting.

11. Lubricate the threads of the hose assembly when connecting the lines (use light engine oil sparingly).

12. When installing the new hose assembly on the vehicle, be sure to check for leakage and correct any leaks if leaks are present.

Hose Assembly Special Instructions

Installation and routing of these hoses is just as important as special attention given to the installation of the ends. Common problems encountered with installation and routing which will result in short service life of these hoses are:

1. High external temperatures will shorten the life of a hose. Route hoses away from hot manifolds and exhaust systems.

2. Abrasion of hoses will cause outer surfaces to wear and weaken the hose. When installing these flexible hoses, avoid contact or crisscrossing sharp surfaces and with interference of moving parts (shift levers and pedals). Clamp or plastic/tie hoses in place to prevent vibration, chaffing; route hoses together and parallel. If the hose cannot be clamped adequately, the hose must be equipped with a protective conduit (cover). If the hose being replaced has a protective conduit, be sure to use a cover on the new hose.

3. Flexing of short hoses should not be allowed, since this will tend to wear the hoses at the fittings. If the hose must move, do not permit the hose to twist; keep the bend in the hose in the same plane as the movement where the hose is connected. Provide enough hose to permit any movement which may be required. Avoid sharp bends or turns in the hoses.

24.2. NYLON TUBING

Nylon tubing of varying construction has been used in the trucking industry for a period of time.

Nylon tubing as a replacement for certain copper tubing in chassis air brake system applications is acceptable. A superior color coded nylon tubing which is suitable for many applications as well as air brake system applications is being used for field service use.

Table 17 Color Coded Tubing Chart - Air Brake System

COLOR CODEDTUBING VEHICLES WITH COLOR CODED AIR BRAKE SYSTEM TUBING	
GREEN	Primary Supply and Delivery System
ORANGE	Secondary Supply and Delivery System
YELLOW	Spring Brake System
RED	Trailer Emergency
GRAY	Power Divider Lockout
BLUE	Tractor Protection Valve Service
BLACK	Other Systems

Nylon Tubing Assembly Instructions

For the most part, nylon tubing in air brake systems is assembled much like copper tubing. The same fittings, sleeves and nuts used with copper tubing can be used with nylon tubing. Long or short tube nuts may be found on chassis in service with nylon tubing (Figure 98). Either nut may be satisfactorily used on the nylon lines.

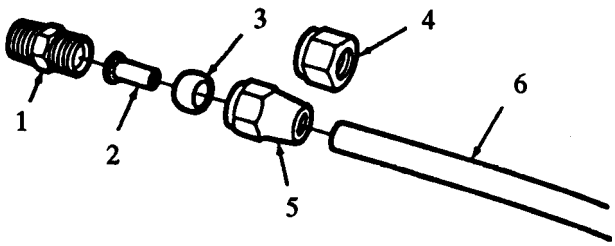

Figure 98 Nylon Tubing Assembly

1. FITTING
2. TUBE SUPPORT OR INSERT
3. SLEEVE
4. SHORT NUT
5. LONG NUT
6. NYLON TUBING

If copper tubing is being substituted for nylon tubing, the short tube nut**must not** be used. Either the short tube nut or the long tube nut may be used satisfactorily with nylon tubing.

A tube support or insert will be used in all applications of the nylon or copper tubing in air brake systems. The insert provides a stiff or rigid area for the sleeve to be crimped or compressed on the tubing and prevents collapsing the tubing when the nut is tightened. The parts listing notes that there are some sizes of tubing used only in accessory piping systems. In repairing accessory piping systems, tube supports are needed with all sizes of tubing except 1/8" O.D. if compression-type fittings are used.

Once the tubing has been connected and tightened, the sleeve has been crimped on the tubing and insert. Since the sleeve has been compressed and distortion of the insert may have resulted,**the sleeve and inserts should never be used a second time.**

The sleeve used with fittings has been changed from a barrel type to a flanged sleeve to reduce air leaks (Figure 99). The nut and insert have not been changed. Use of the flanged sleeve (ferrule) is preferred.

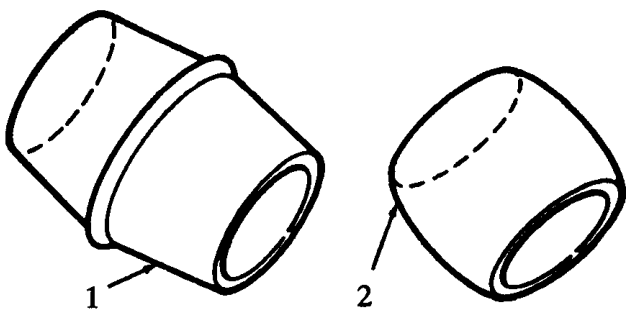

Figure 99 Sleeve Types

1. FLANGE TYPE SLEEVE
2. BARREL TYPE SLEEVE

To assemble tubing ends for use with compression-type fittings, the following steps should be followed carefully:

1. Loosen and remove nut from fitting.

2. Pull tubing from fitting.

3. Repeat the same operations at other end of tubing. If only one end of line needs repairing, the second end need not be disconnected if line is long enough to permit repairing.

4. Cut the selected size of tubing to length. Be sure to make smooth, square cuts. Either a sharp knife or hacksaw may be used.

5. Position nut on tube.

6. Position compression sleeve on tube.

7. Insert tube support into tube.*

8. Position the tube, support and sleeve in the fitting. Push fitting into tube until it bottoms.*

NOTE – * No tube support is used with 1/8" O.D. tubing. Certain fittings used in accessory piping systems have the tube support as an integral part of the fitting body. These fittings may be reused if no distortion of the tube support has occurred.

9. Install and tighten tube nut to secure sleeve on tubing. Tighten tube nut so that no more than two threads are showing between the nut and fitting (Figure 100). Do not overtighten nut.

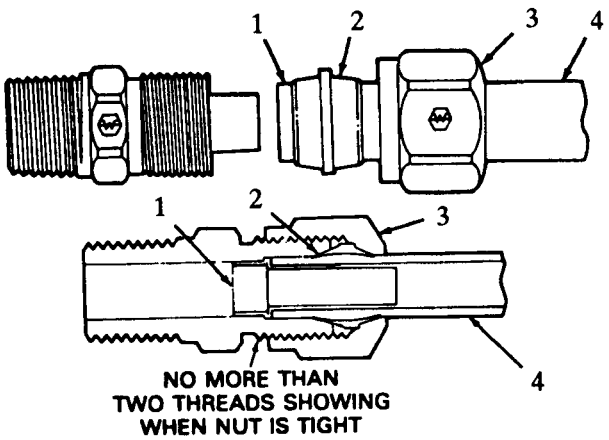

Figure 100 Tightening Tube Nut

1. TUBING SUPPORT OR INSERT
2. FLANGED SLEEVE (FERRULE)
3. NUT
4. TUBING

10. Inspect tubing connections for air leakage. With the tubing and associated fittings charged to full system air pressure, coat tubing lines and fittings with soap suds to check for leakage. No leakage is permissible.

11. Leakage at a tubing fitting is sometimes corrected by tightening the tubing fitting nut. If this fails to correct the leakage, replace the tubing fitting, tubing, or both.

The service nylon tubing will be marked at regular intervals with name, number, type, size and manufacturing code designations.

Nylon Tubing Special Instructions

Nylon tubing should not be substituted in the field for any metallic tubing. In addition, the following precautions must be taken with the use of nylon tubing.

1. Do not use nylon tubing for any application which would cause it to be exposed to temperatures below -40°F or above +200°F (-40°C or +93°C).

2. Do not subject nylon tubing to working pressure in excess of 150 psi.

3. Do not use nylon tubing for frame-to-axle, tractor-to-trailer or any similar line where a high degree of flexibility is required.

4. Observe extreme care when welding near nylon tubing. Hot slag or spark will damage the tubing.

5. Protect nylon tubing from battery acid.

24.3. QUALITY CONNECT AIR SYSTEMS

Description

The Quality Connect system is being used on some International vehicles. The Quality Connect fittings are threadless. A collet in the fitting (Figure 101) bites into the tube to hold it firmly in place. The fitting O-ring (Figure 101) seals the tube to the valve, manifold or tee body to prevent leakage. To aid in service, a kit is available with tools for each port and tube size used by International.

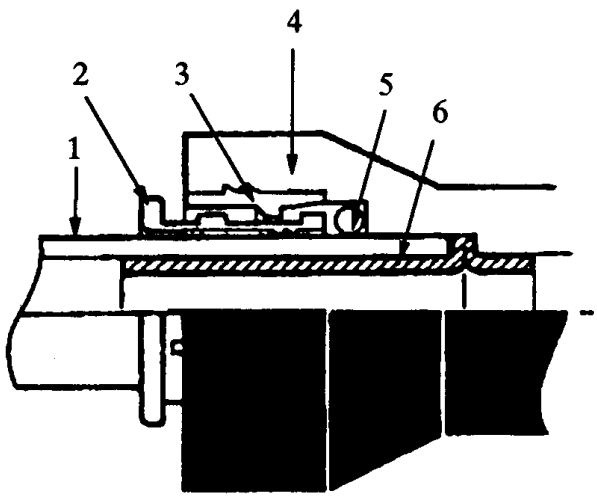

Figure 101 Quality Connect Air System

1. TUBING
2. COLLET
3. SLEEVE
4. TEE OR VALVE BODY (MANIFOLD)
5. O-RING
6. TUBE SUPPORT

To assure standardization of Quality Connect tubing used on International vehicles, the following table illustrates tubing colors, abbreviations and where that color tubing is used.

Table 18 Quality Connect Where Used Table

Color	Abbreviation	Where Used
Black	BK	MV-3 Exhaust PDL Control Supply Air Application Gauge
Blue	BL	5th Wheel Control Delivery
Brown	BN	Air Suspension Dump Control Delivery
Green	GN	Primary Brake system
Orange	OR	Secondary Brake System
Purple	PL	5th Wheel Control Supply
Red	RD	MV-3 Trailer Supply Air Suspension Dump Control Valve Bobtail Control
Silver	SIL	PDL Control Delivery
Yellow	YL	Spring Brake System

Service Procedure

1. Check to be sure where air is leaking. Soapy water can be used for this purpose. When performing a bubble test, leakage should not exceed a soap bubble of 1/2 inch (12 mm) in 3 seconds with system air pressure of 100 to 130 psi. If the leakage exceeds these specifications, the quality connect fitting(s) should be serviced.

Do not attempt to disassemble Quality Connect fittings with air pressure in the system. Failure to drain system of air pressure before removing components may cause personal injury or death.

2. If a leak has been discovered and service is necessary, drain the air off the system and push the tube into the port to make sure it is fully seated.

3. Pressurize the system. If the leak still exceeds specifications, it will be necessary to disassemble the fitting to determine the cause of the excessive air leak. Select the appropriate repair tools and parts for the tube size being serviced.

4. Use the tube release tool (Figure 102) to remove the tube. Do this by placing it around the tube.

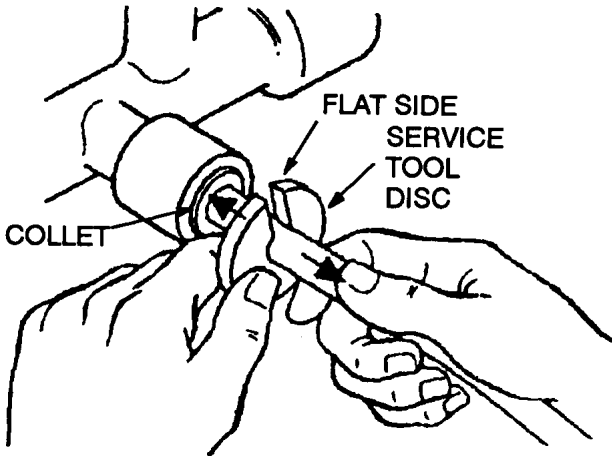

Figure 102 Tube Release Tool

5. Push down on the release tool, then pull on the tube. Pushing the tool depresses the fitting collet, allowing it to release the tube. Sometimes the brass tube support (Figure 101) will be pulled out of the fitting when the tube is removed. Be sure to reinstall a tube support when installing the tube.

6. If the brass tube support remains in the fitting and is undamaged, leave it in place. If it remains in the fitting but looks damaged, remove it with needle nose pliers (Figure 103). Discard the brass tube support. If your fitting is equipped with a black molded tube support, it cannot be removed.

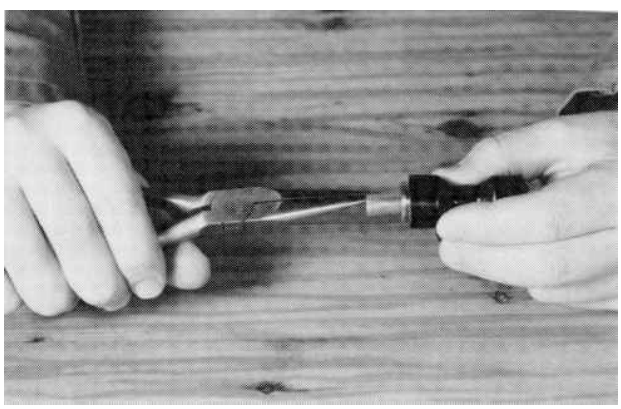

Figure 103 Remove Brass Tube Support

7. Inspect the port for any debris or contaminants. Remove any that are found.

8. Inspect the tube end for external scratches, burrs, or cracks. If it is damaged, trim the damaged portion off at an insertion depth mark (Figure 104) or replace the tube.**do not** reuse a damaged end.

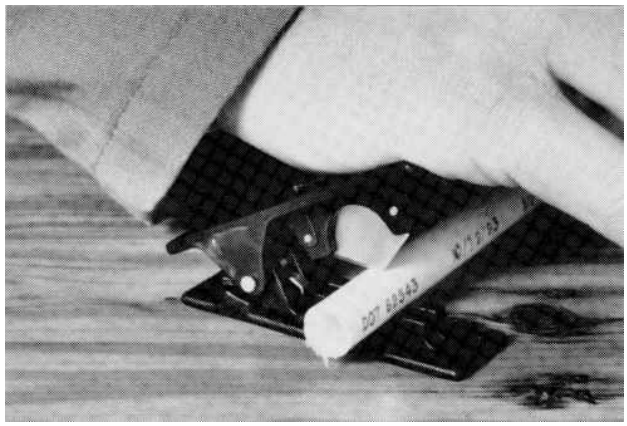

Figure 104 Trim Damaged Tube

NOTE – Use the tube cutter (supplied in the tool kit) to ensure that the cut is square within 15° to help prevent leakage (Figure 105). Do not use a dull or heavy cutting tool such as side cutters, pocket knife or hack saw which could collapse (flatten) the tube or create O-ring damaging burrs. Do not use the tube cutter to cut anything other than nylon air line tubing. Replace the blade or cutter if the cutting edge becomes dull.

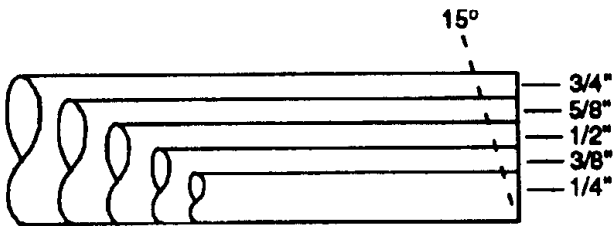

Figure 105 Figure 105

9. Use the forked end of the repair tool to remove the collet (Figure 106). Discard the collet.

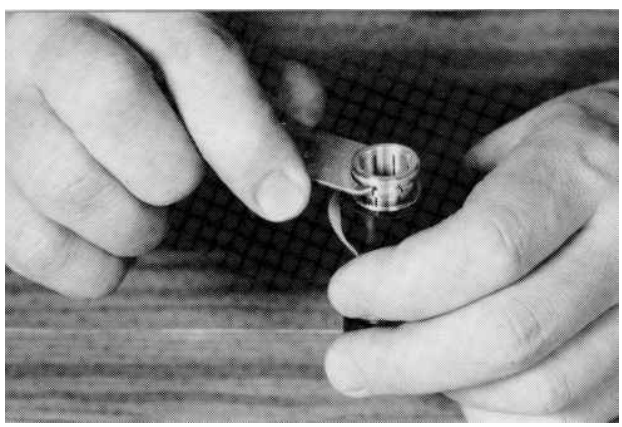

Figure 106 Remove Collet

10. Remove the O-ring using the repair tool O-ring remover (Figure 107). Discard the O-ring. Avoid scratching the O-ring cavity during removal of the O-ring.

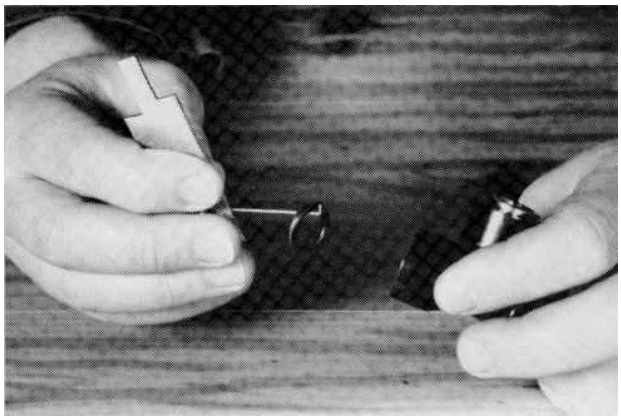

Figure 107 Remove O-ring

> **CAUTION – If the O-ring cavity is scratched during removal of the O-ring, the scratch may cause the fitting to leak.**

11. If the tube support was removed, place it or a new one into a shipping plug (supplied in the parts kit). Press the tube support into the port until it bottoms out (Figure 108). Remove the shipping plug with the plug removal tool.

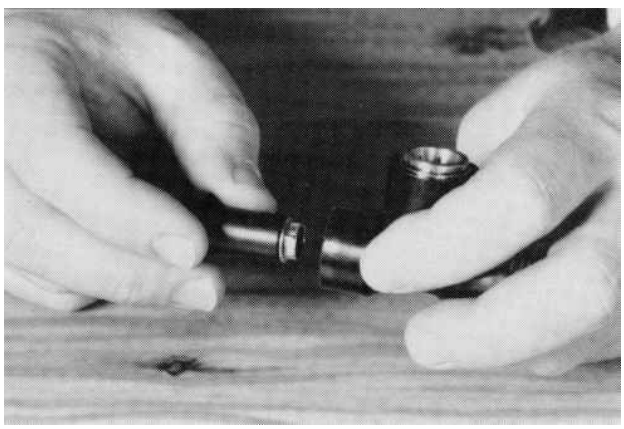

Figure 108 Press Tube Support Into Port

12. Use an approved lubricant (preferably liquid detergent in water) and lubricate the new O-ring. Place the O-ring inside the top of the Quality Connect fitting sleeve as shown in Figure 109 .

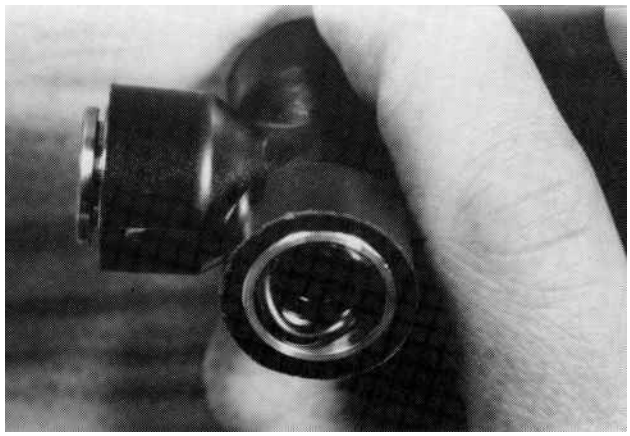

Figure 109 Use Approved Lubricant

13. Install a new collet. Hand pressure alone is enough. It will click when it is seated properly (Figure 110). In addition, the collet will push the O-ring into its fully seated position (Figure 101).

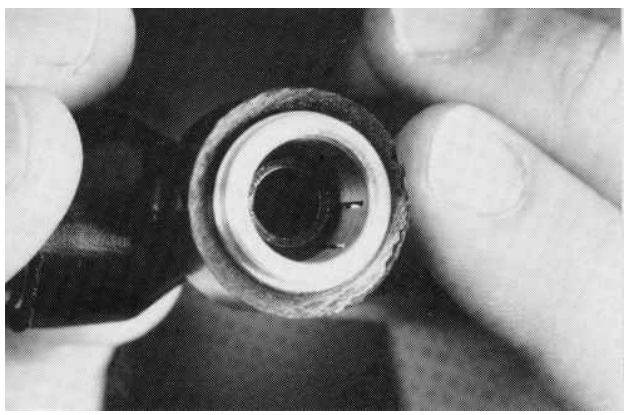

Figure 110 Install New Collet

14. If the tubing does not have an insertion depth mark, perform the following: Use the repair tool (Figure 111) to identify the correct insertion depth for the size tubing being used. Mark the correct insertion depth on the tube.

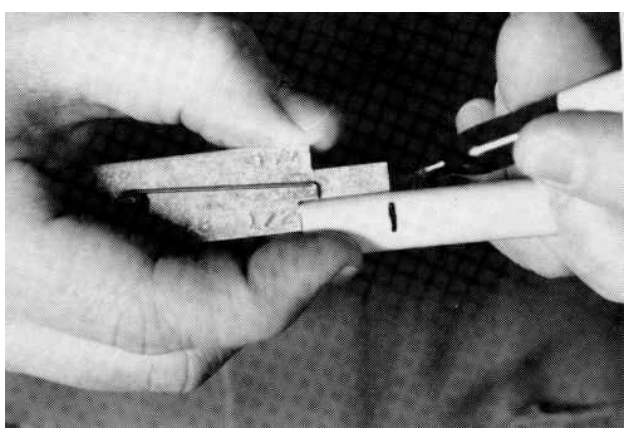

Figure 111 Identify Correct Insertion Depth

15. Lubricate the tube end and install it to the correct insertion depth (Figure 112). Install the tube by pushing it straight into the fitting. The insertion depth mark should be flush with the face of the fitting (Figure 112). Gently tug on the tube to make sure it is secured in the fitting.

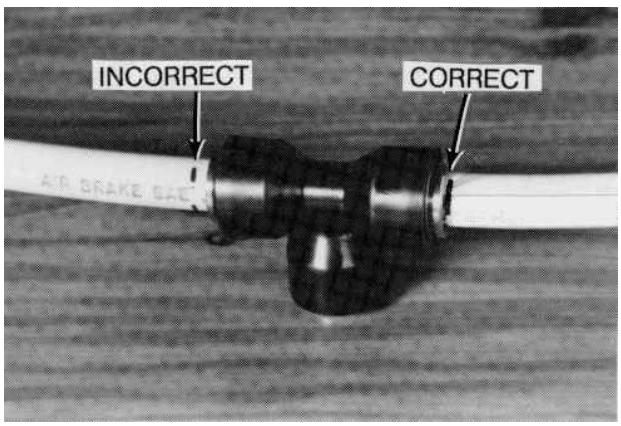

Figure 112 A Secure Fitting

16. Test to make sure the assembly is free from leaks using a soap solution and clean, dry air at system pressure. If a leak exceeding specifications (refer to (See Service Procedure, page 178)step 1) is still present, remove and replace the valve, manifold or tee.

Tube Installation into New or Optional Ports

1. To use an unused port, first remove the shipping plug with the plug removal tool. This can be done by depressing the collet, then pulling out the plug (Figure 113).

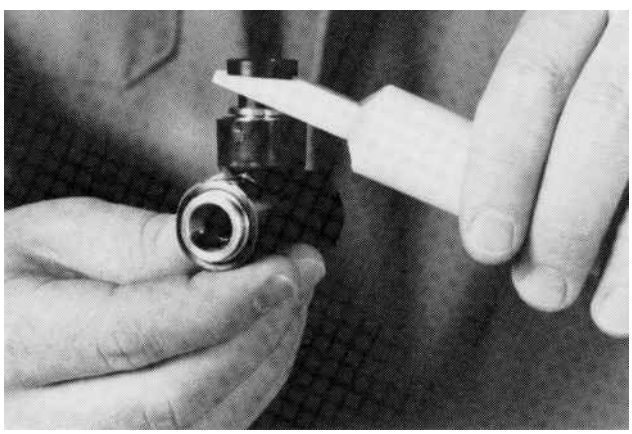

Figure 113 Remove Shipping Plug

2. Use the repair tool (Figure 114) to identify the correct insertion depth for the size tubing being used. Mark the correct insertion depth on the tube. If tubing with insertion depth marks is being used, trim the end of the tubing at an insertion mark using a recommended tube cutter. Refer to step 8(See Service Procedure, page 178) for tube cutting information.

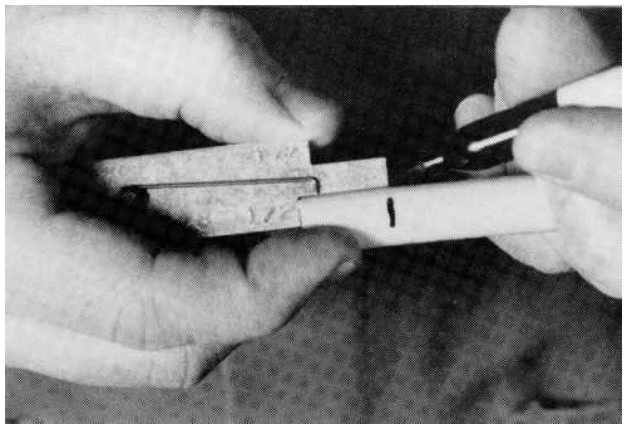

Figure 114 Identify Correct Insertion Depth

3. Lubricate the tube and install it to the correct insertion depth. Install the tube by pushing it straight into the fitting. The insertion depth mark should be flush with the face of the fitting (Figure 115). Gently tug on the tube to make sure it is secured in the fitting.

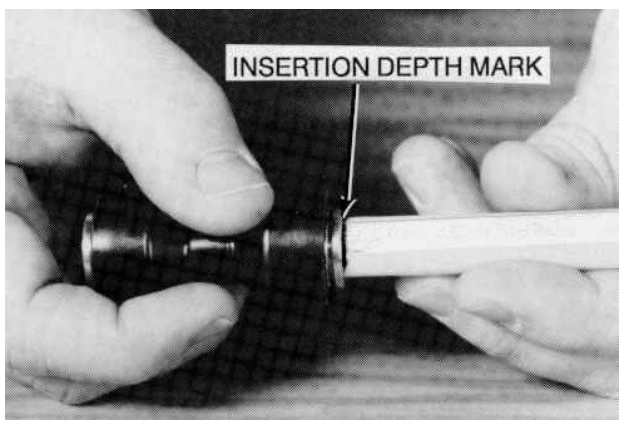

Figure 115 A Secure Fitting

4. Test to make sure the assembly is free from leaks using a soap solution and clean, dry air at system pressure. If the fitting leaks, perform the (See Service Procedure, page 178)Service Procedure.

24.4. TRAILER BRAKE HOSE COUPLING AND DUMMY COUPLING

Hose couplings provide a convenient means for connecting and disconnecting air lines between tractors and trailers. When two couplings are joined, their packing rings are forced together under pressure to form an air tight seal.

Dummy coupling is the term given to those couplings which are used to keep dirt or foreign matter out of the air lines when they are not being used. Dummy couplings are either rigidly mounted to the truck or fastened by a chain.

Service Checks

With hose couplings connected and brakes applied, coat hose couplings with soap suds to check for leaks. There should be no leakage. Leakage results from worn, dam- aged, or improperly installed packing rings.

Maintenance

1. At least once a year or when leakage is detected, the hose coupling should be disassembled, cleaned and serviced.

2. Remove old packing ring with a screwdriver. Be sure packing ring groove is thoroughly cleaned.

3. Install new packing ring by partially collapsing it with the fingers (Figure 116) and entering one side of flange in groove in coupling.

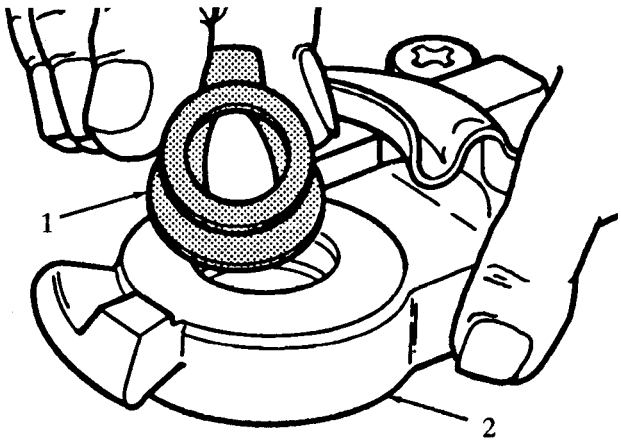

Figure 116 Install New Packing Ring

1. PACKING RING
2. HOSE COUPLING

4. Work the remaining part of the packing ring into place with a blunt nosed (not sharp) screwdriver or similar tool (Figure 117). Exposed face of packing ring will be flat and free of any bulges when properly installed.

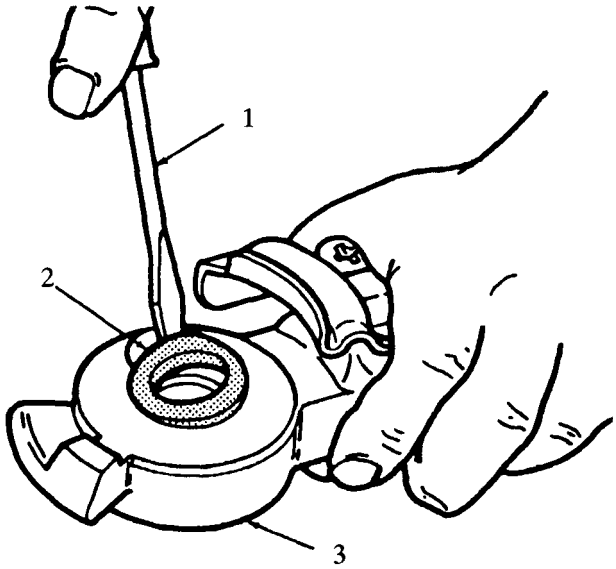

Figure 117 Packing Ring Properly Installed

1. BLUNT NOSED SCREWDRIVER
2. PACKING RING
3. HOSE COUPLING

24.5. TRAILER BRAKE HOSE ASSEMBLIES AND CONNECTORS

Trailer brake hose assemblies are used for making flexible connections between components which change position in relation to each other, or for making flexible connections between the tractor and trailer. Hose lines or couplings at the rear of tractor are marked by tags identifying them as “SERVICE” or “EMERGENCY.”

Maintenance

Every six months, all air connections should be checked and tightened if leaking (refer to on this page). Once each year, all tubing and hoses should be inspected for cuts, dents, kinks, swelling, chafing or crimping. Replace tubing if these conditions are found.

Be sure to inspect trailer brake hoses and hose coupling packing rings and replace if necessary.

Service Checks

If any evidence is found that an air line is restricted, remove and blow through it in both directions to be sure the passage is not obstructed. Inspect piping restrictions caused by dents or kinks. Damaged pipes should be replaced.

Leakage Test

With the air system fully charged, the governor cut out and brakes applied, use a soap solution at air lines, hoses and fittings to check for leakage. There should be no leakage. Leakage at a tubing fitting is sometimes corrected by tightening the fitting nut. If this fails to correct the leakage, replace the tubing, sleeve or fitting, the tubing or hose. Leakage at hose connections is sometimes corrected by tightening the connector nut. If this fails, replace the connector, hose or both.

25. LUBRICANT SPECIFICATIONS

- **Item 1**

  Fleetrite EP2 Moly grease or equivalent to NLGI #2 multi-purpose lithium grease (same as BW 226M and 204M lubricant).

- **Item 2**

  Bendix 239277 2 oz (57g) molybdenum disulfide lubricant in liquid carrier. A lubricant suited for O-ring powder suspended in synthetic lubricant (polyalkylene glycol derivative) and rubber parts as well as metal lubrication, especially at low temperatures.

- **Item 3**

  Bendix 291126 1/4 oz (7.08 g) BW291127 2 oz (57 g) silicone grease intended primarily for dynamic lubrication between oil resistant rubber seals and metal parts. Meets MIL-L-4343A requirements. Can be used in serviceable range of -65°F (-54°C) to +800°F (+426°C). Causes less swelling and hardness change of rubber parts than normally encountered with petroleum based lubricants (approved source: Dow Corning Corporation, DC-55 pneumatic grease).