



# Service Data

SD-03-1067

## Bendix® BP-R1™ Bobtail Proportioning Relay Valve

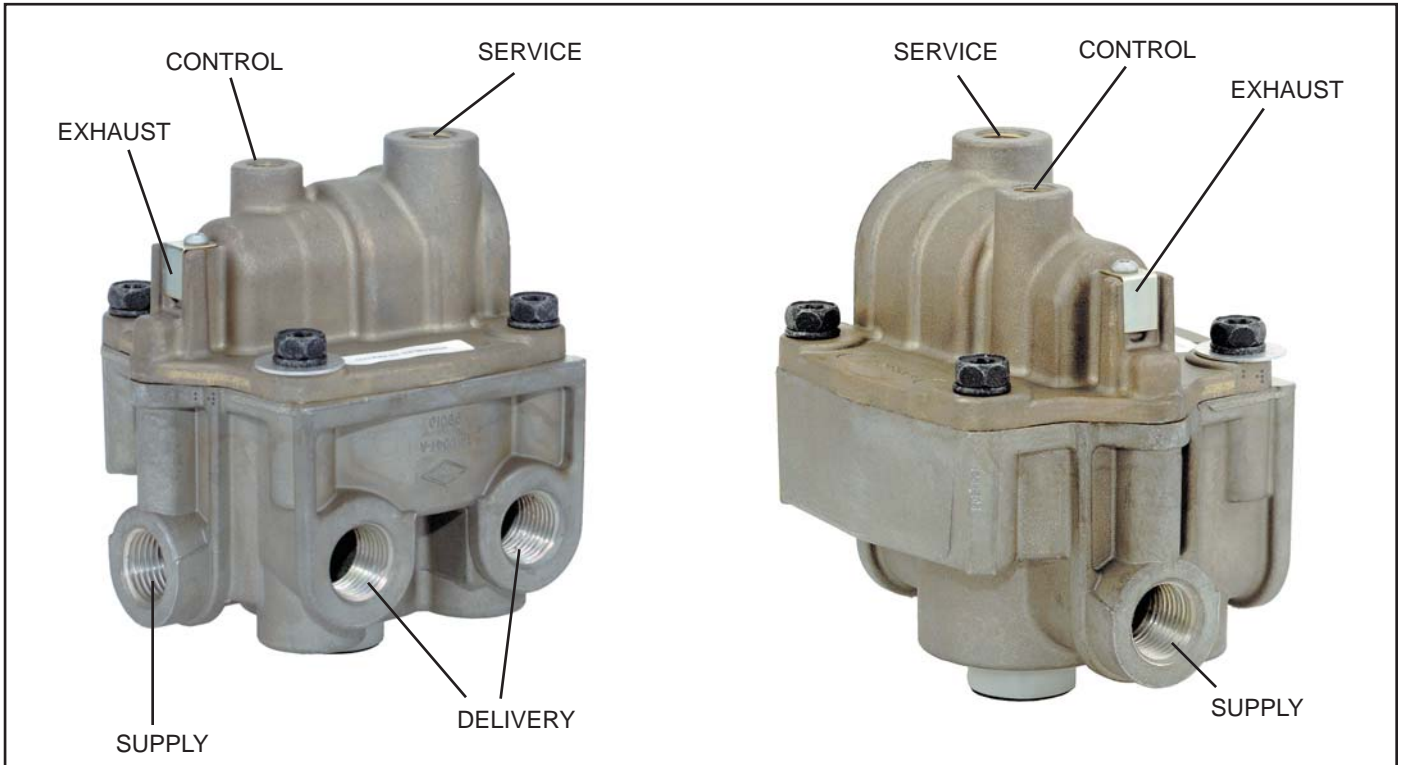


FIGURE 1 - BP-R1™ BOBTAIL PROPORTIONING RELAY VALVE

### DESCRIPTION

The BP-R1™ bobtail proportioning relay valve is a combination of two individual valves in a single housing. The lower portion, or body, of the BP-R1™ valve contains a “standard” service brake relay valve, which functions as a relay station to speed up brake application and release. The upper portion, or cover, houses a brake proportioning valve, which reduces normal service brake application pressure when the tractor is not towing a trailer.

Used in tractor air brake systems only, the BP-R1™ valve is installed in place of a standard relay valve. It functions as a standard service relay during operation of a tractor-trailer combination. During bobtail tractor operation, the BP-R1™ valve improves controllability and reduces stopping distances by reducing air pressure to the rear actuators/chambers, whose axle load has been greatly reduced.

While the BP-R1™ valve can incorporate various crack pressures to accommodate specific applications, the standard is 4 psi.

Designed for frame or cross member mounting, the BP-R1™ valve is furnished with a mounting bracket which is attached to two of the four cover cap screws. Replacement valves are furnished with a universal mounting bracket, which allows the BP-R1™ valve to replace most standard relays.

All air connections on the BP-R1™ valve are identified with cast, embossed letters for ease of installation. The letter identification and air line connections are shown below for reference.

BP-R1™ Valve Air Connection	Embossed Identification
Supply (to reservoir)	SUP
Delivery (to brake actuator)	DEL
Service (brake valve rear axle service delivery)	SER
Control (to delivery of trailer supply valve)	CON

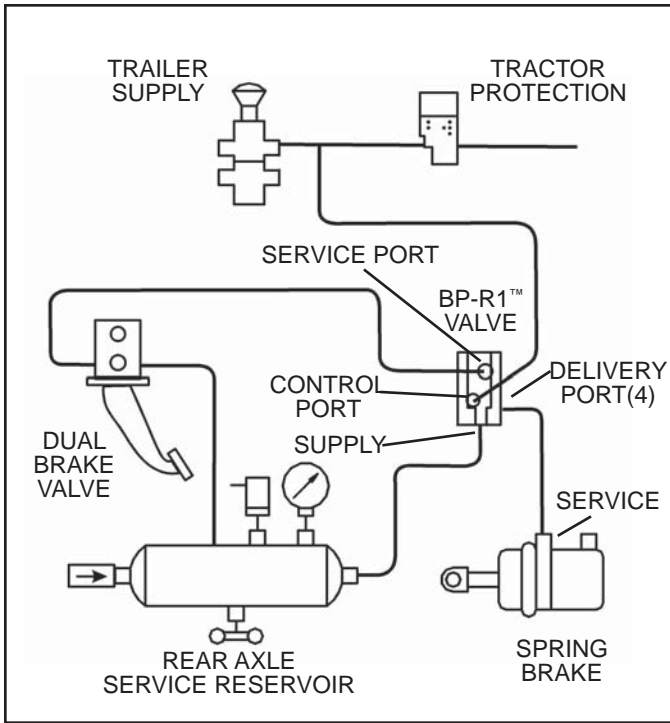


FIGURE 2 - BP-R1™ TRACTOR AIR SYSTEM

## OPERATION

### INITIAL CHARGING

During the initial build up of tractor system air pressure, supply air flows through internal body and cover passages in the BP-R1™ valve to the blend back piston.

Activating the trailer supply valve (dash control with red octagonal button), simultaneously charges the trailer and the BP-R1™ valve control port. Air entering the BP-R1™ valve control port causes the proportioning piston to move toward its stop in the cover. The integral inlet and exhaust valve is carried along with the piston until it seats and seals the exhaust passage. Continued movement of the proportioning piston opens the inlet valve. With the tractor and trailer air system fully charged, the vehicle may be operated.

### SERVICE BRAKES APPLYING — TRACTOR/TRAILER COMBINATION

Brake application air enters the BP-R1™ valve service port and is conducted through the service piston to the exhaust diaphragm which flexes in response to the incoming air and seals the exhaust passage in the exhaust piston. Air flows around the exhaust diaphragm then through the center of both the blend back and proportioning pistons to the inlet and exhaust valve. Flowing around the inlet valve, application air moves through a passage in the cover to the top of the service relay piston. In response to air pressure, the relay piston moves into contact with the exhaust portion

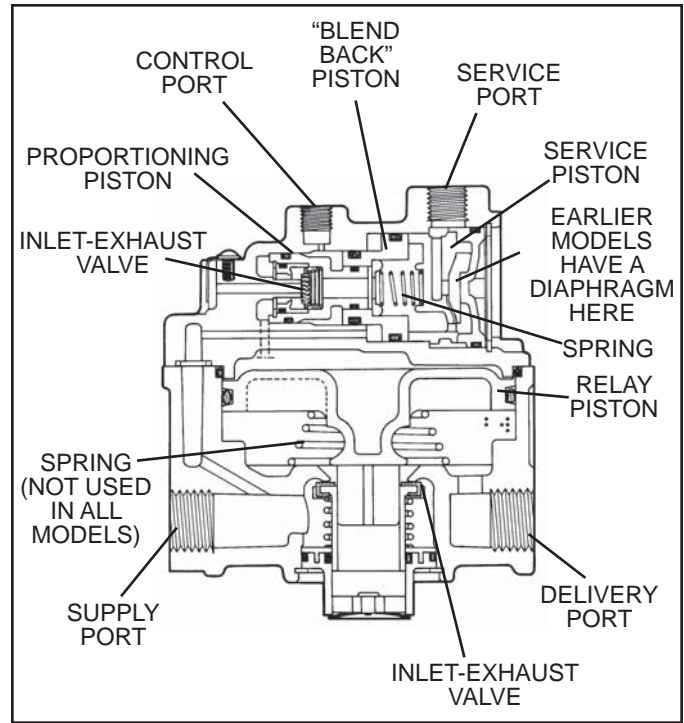


FIGURE 3 - BP-R1™ BOBTAIL PROPORTIONING RELAY VALVE

of the inlet and exhaust valve. With the exhaust passage sealed, continued movement of the piston unseats the inlet portion of the inlet and exhaust valve, allowing supply air from the reservoir to flow out the BP-R1™ valve delivery ports to the brake actuators. (See Figure 4.)

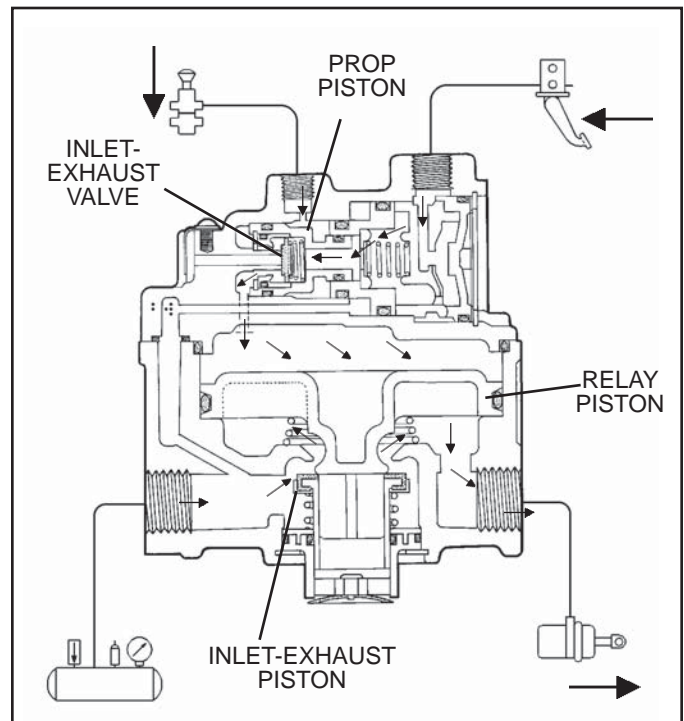


FIGURE 4 - BP-R1™ APPLYING - TRACTOR/TRAILER COMBINATION

## SERVICE BRAKES HOLDING — TRACTOR/ TRAILER COMBINATION

The air pressure being delivered to the brake actuators is also present beneath the relay piston.

When the air pressure above and below relay piston is equal, the piston moves slightly allowing the inlet valve to return to its seat. The exhaust valve remains closed. With both the inlet and exhaust valves closed, air pressure in the brake actuators is held stable and neither increases nor decreases. (See Figure 5.)

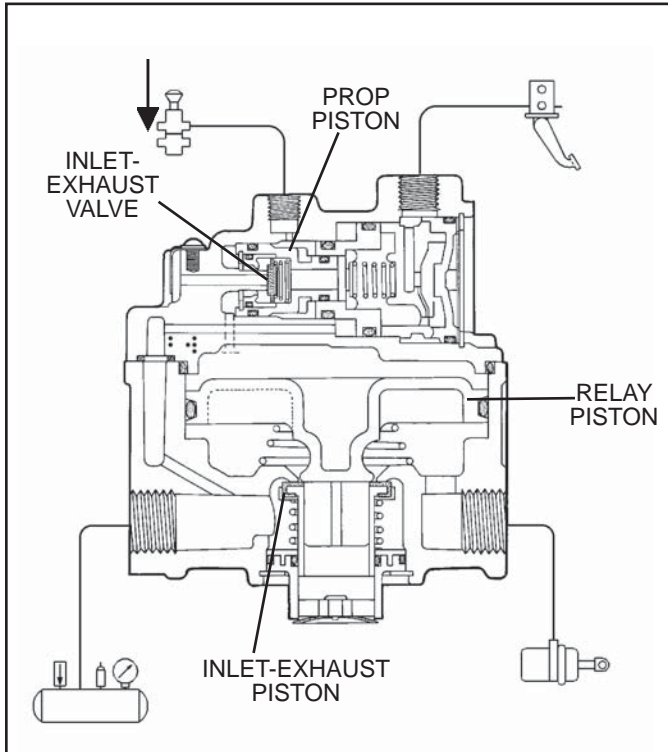


FIGURE 5 - BP-R1™ HOLDING - TRACTOR/TRAILER COMBINATION

## SERVICE BRAKES RELEASING — TRACTOR/ TRAILER COMBINATION

When the brake application is released, air pressure in the service port of the BP-R1™ valve returns to the foot brake valve and is exhausted. Air from above the relay piston flows back through the proportioning, blend back and service pistons to the exhaust diaphragm. If the service brakes are rapidly released, the diaphragm flexes in response to the returning air and opens the exhaust.

If the brakes are slowly released, service air pressure will flow through the slot behind the diaphragm and back to the brake valve. As air pressure is reduced above the relay piston, pressure beneath it lifts the piston away from the exhaust valve and opens the exhaust passage. Air from the service brake actuators returns to the BP-R1™ valve and flows out the open exhaust. (See Figure 6.)

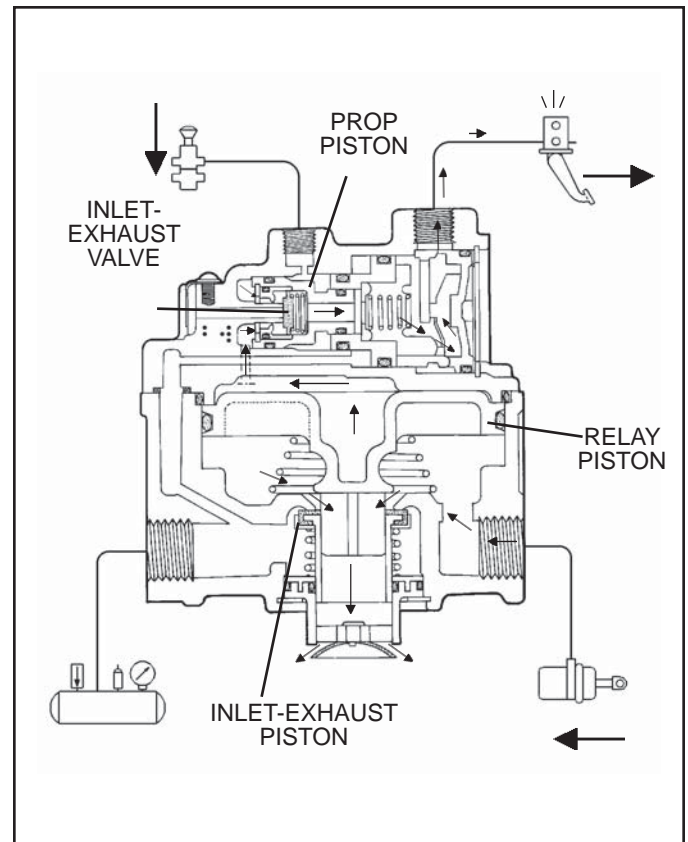


FIGURE 6 - BP-R1™ RELEASING - TRACTOR/TRAILER COMBINATION

## SERVICE APPLICATION BOBTAIL TRACTOR

When the trailer supply valve (dash control with red octagonal button) is activated to disconnect the trailer, air in the BP-R1™ valve control port and trailer supply line is exhausted to atmosphere. During bobtail tractor operation, service application air enters the BP-R1™ valve service port causing the exhaust diaphragm to seal the exhaust port. Service application air passing through the blend back piston exerts a force on the full effective diameter of the piston. The blend back piston remains stationary at application pressures below approximately 80 psi because of opposing reservoir air acting on the large diameter. Application air flowing through the blend back piston also exerts a force on the small diameter of the proportioning piston while simultaneously flowing through the center of it on its way to the inlet and exhaust valve. Once past the inlet and exhaust valve, service air pressure exerts a force on the larger diameter end of the proportioning piston, which opposes the air pressure and spring force exerted on the other end. The proportioning piston inlet valve remains open until a preset, initial application pressure has reached the relay piston assuring that the foundation brake shoes are brought into contact with the drum. As service pressure begins to exceed the preset initial application, the proportioning piston will move sufficiently to close its inlet valve without opening the exhaust.

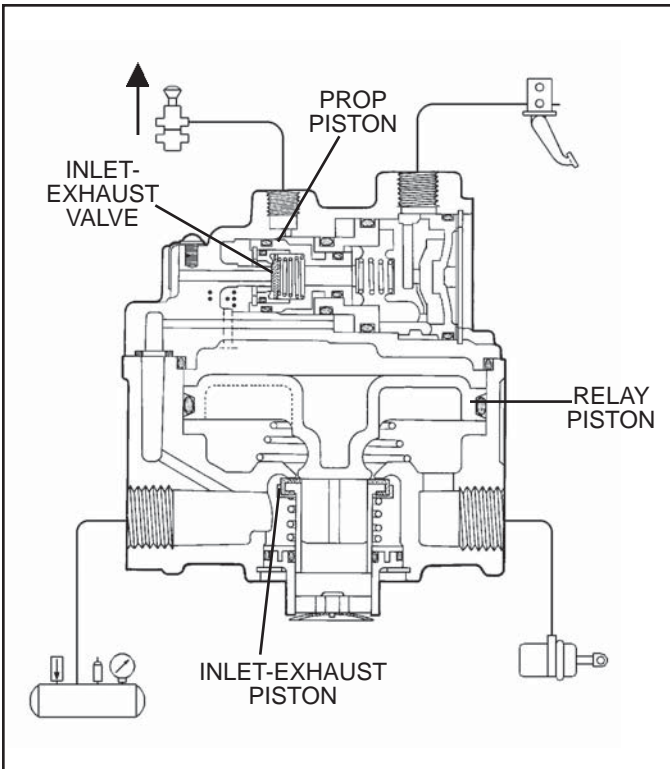


FIGURE 7 - BP-R1™ HOLDING - BOBTAIL TRACTOR

As service air pressure continues to increase, the inlet valve opens as necessary to deliver additional but reduced air pressure to the relay piston, thus to the rear axle brakes. Proportioning occurs due to the difference in effective area on each end of the proportioning piston.

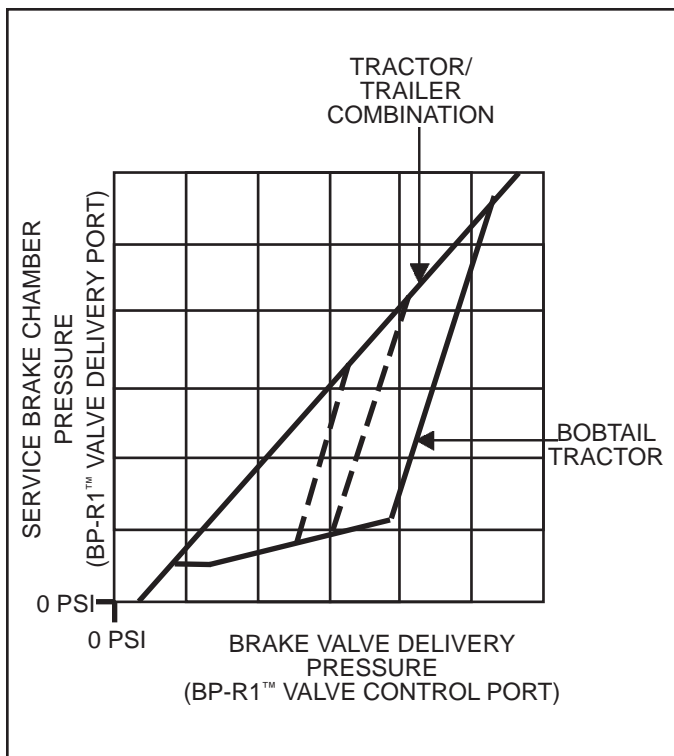


FIGURE 8 - BP-R1™ CONTROL VS. DELIVERY PRESSURE

Service applications of more than 80 psi cause the blend back piston to begin to move. Service air pressure acting on the full diameter of the blend back piston overcomes the resistance of reservoir pressure acting on the large diameter of the other side. Above 80 psi the difference between control and delivered air pressure is reduced and “blends back” from a proportioned delivery to a full 1:1 delivery. Complete “blend back” to a 1:1 delivery is achieved when a full brake application is made, and it will occur regardless of reservoir pressure level.

### SERVICE BRAKES RELEASING — BOBTAIL TRACTOR

When the brake application is released, air pressure in the service port of the BP-R1™ valve returns to the foot brake valve and is exhausted. Air between the closed proportioning piston inlet valve and the service piston returns to the exhaust diaphragm. If the release is rapid, the diaphragm flexes in response to the returning air and opens the exhaust.

Air from above the relay piston, flows back to the proportioning piston causing it to move. As it moves, the proportioning piston unseats the exhaust valve allowing air from above the relay piston to escape to atmosphere. Reducing the air pressure above the relay piston causes pressure beneath it to lift the piston away from the exhaust valve. Air from the service brake actuators returns to the BP-R1™ valve and flows out the open exhaust.

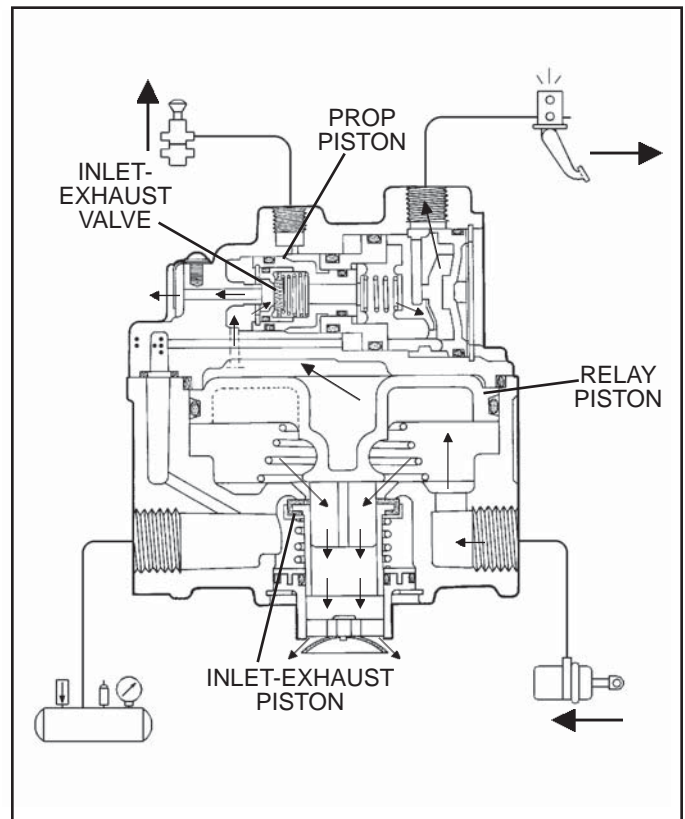


FIGURE 9 - BP-R1™ RELEASING - BOBTAIL TRACTOR



## PREVENTIVE MAINTENANCE

### GENERAL

**Important:** Review the Bendix Warranty Policy before performing any intrusive maintenance procedures. A warranty may be voided if intrusive maintenance is performed during the warranty period.

No two vehicles operate under identical conditions, as a result, maintenance intervals may vary. Experience is a valuable guide in determining the best maintenance interval for air brake system components. At a minimum, the valve should be inspected every 6 months or 1500 operating hours, whichever comes first, for proper operation. Should the valve not meet the elements of the operational tests noted in this document, further investigation and service of the valve may be required.

Perform the tests and inspections presented at the prescribed intervals. If the BP-R1™ valve fails to function as described or leakage is excessive, it should be repaired or replaced with a new or genuine Bendix remanufactured unit, available at any authorized parts outlet.

#### **Every 3 months, or 25,000 miles or 900 operating hours:**

1. Remove any accumulated contaminants and visually inspect the exterior for excessive corrosion and physical damage.
2. Inspect all air lines connected to the BP-R1™ valve for signs of wear or physical damage. Replace as necessary.
3. Test air line fittings for excessive leakage and tighten or replace as necessary.
4. Perform the Leakage Test described in this manual.

#### **Every year, 100,000 miles, or 3,600 operating hours:**

1. Perform the Operation and Leakage Tests described in this manual.

### **WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:**

**When working on or around a vehicle, the following general precautions should be observed at all times.**

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.**
2. **Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.**

3. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
4. **If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.**
5. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
6. **Never exceed manufacturer's recommended pressures.**
7. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
8. **Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.**
9. **Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.**
10. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**
11. **For vehicles with Antilock Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.**

## OPERATION & LEAKAGE TESTS

### OPERATING TEST

To properly test the function of the BP-R1™ valve, a pair of test gauges or gauges of known accuracy must be used.

1. Park the vehicle on a level surface and block the wheels and/or hold the vehicle by means other than the air brakes.
2. Drain air pressure from all vehicle reservoirs.
3. Install a "tee" at the BP-R1™ valve service port and at one of the delivery ports, then install a gauge in each.

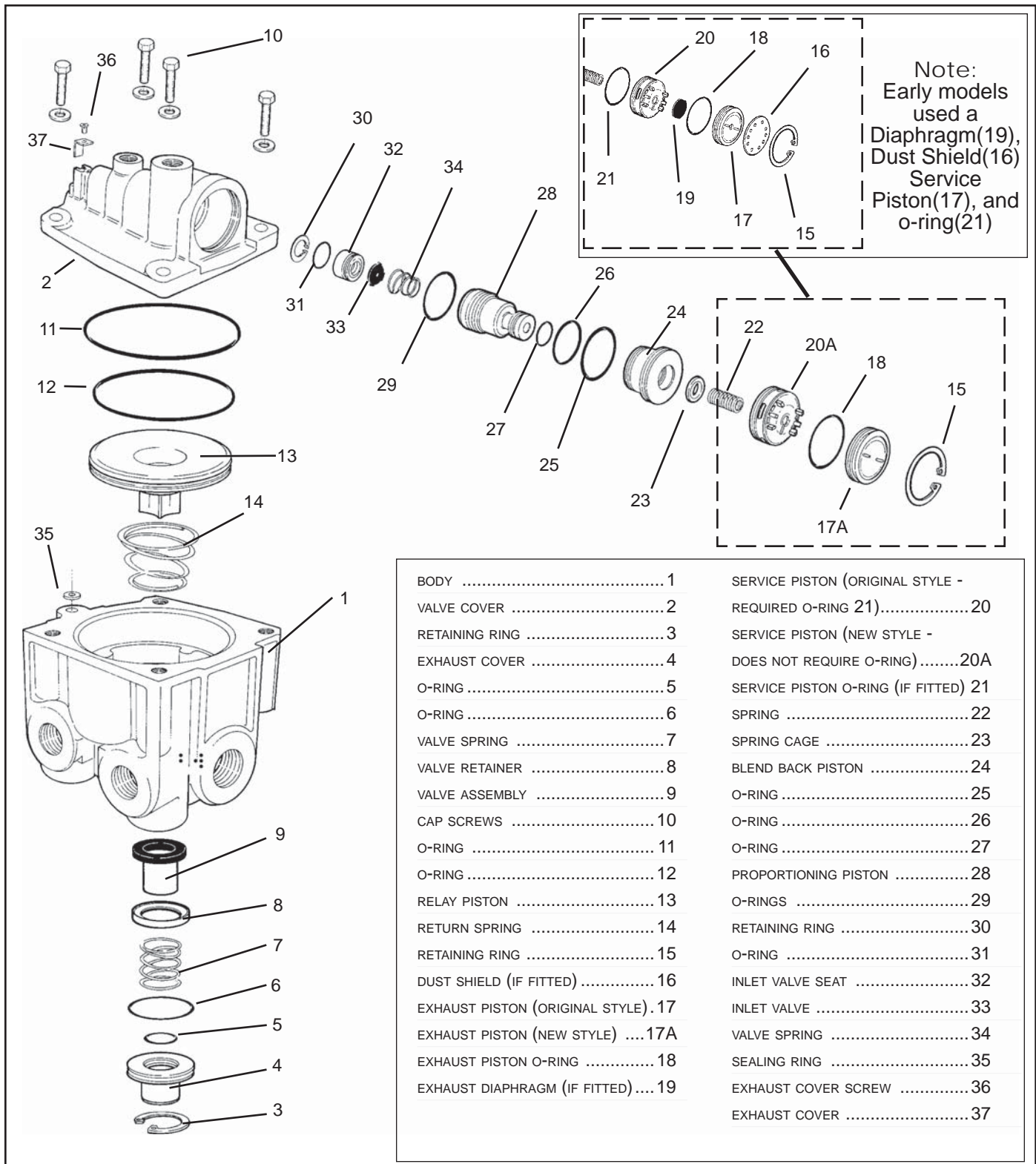


FIGURE 10 - BP-R1™ BOBTAIL BRAKE PROPORTIONING RELAY VALVE

4. Connect the tractor service and emergency “glad hands” (hose couplings) to hose couplings that have been plugged, or alternatively, to a trailer. Build the tractor system air pressure to governor cut-out and make 4 to 5 full brake applications. Check the air fittings at the BP-R1™ valve for leakage. Tighten as needed.
5. With the trailer supply valve (dash control w/red octagonal button) and system park control (dash control with yellow diamond button) activated for tractor/trailer operation, apply, **hold**, then release the brakes several times varying the application pressures while watching the reaction of the gauges installed on the BP-R1™ valve. Check that a prompt application occurs and that it can be held then promptly released.

6. Check the BP-R1™ valve differential pressure by applying 10 psi to the service port and noting the pressure registered at the delivery port. Subtract delivery port pressure from the 10 psi service pressure to obtain the differential. Compare the measured differential with the pressure specified for the BP-R1™ valve part number. **Note:** For BP-R1™ valves **not incorporating a relay piston return spring** (14), the measured differential should be approximately 4 psi. When a spring is in use, the differential will be higher (see the I.D. washer also for the differential).
7. Make and hold a full (100 psi or greater) brake application and note that full pressure is delivered to the chambers.
8. Activate the dash mounted trailer supply valve for bobtail tractor operation. Then make a **slow** brake application, increasing the pressure at the BP-R1™ valve service port to 20 psi while watching the reaction at the delivery port gauge. Note that delivery pressure rises to approximately 5 to 10 psi and remains constant while service pressure continues to rise to 20 psi. Release the application.
9. Make another brake application and **slowly** increase the pressure at the BP-R1™ valve service port to between 60 and 70 psi while observing the gauge installed at the delivery port. Note that when service port pressure rises to between 20 and 30 psi, delivery pressure begins to rise above the initial pressure noted in step 6. The rise of delivery pressure should be at a proportioned rate of **approximately** 3:1. At 70 psi service pressure, delivered pressure should be 15 to 25 psi.
10. Make a full brake application and note that both test gauges register the same pressure.
11. Drain air pressure from all vehicle reservoirs and remove the test gauges from the BP-R1™ valve.

## LEAKAGE TESTS

1. Build the air system pressure to governor cut-out. With the dash mounted trailer supply valve activated for tractor/trailer operation, apply a soap solution to both exhaust ports (one in the cover and one in the body). The leakage noted should not exceed a 1" bubble in less than 3 seconds at any exhaust port.
2. Make and hold a full brake application and apply a soap solution to both exhaust ports and around the cover where it joins the body. The leakage noted should not exceed a 1" bubble in less than 3 seconds at any exhaust port.

## VALVE REMOVAL

1. Park the vehicle on a level surface and block the wheels and/or hold the vehicle by means other than the air brakes.

2. Drain the air pressure from all vehicle reservoirs.
3. Identify and mark or label all air lines and their respective connections on the valve to facilitate ease of installation.
4. Disconnect all air lines.
5. Remove the valve from the vehicle.

## VALVE INSTALLATION

1. Install all air line fittings and plugs making certain thread sealing material does not enter the valve.
2. Install the assembled valve on the vehicle.
3. Reconnect all air lines to the valve using the identification made during *VALVE REMOVAL* (step 3).
4. After installing the valve, test all air fittings for excessive leakage and tighten as needed.

## DISASSEMBLY

### GENERAL

The following disassembly and assembly procedure is presented for reference purposes only and presupposes that the appropriate maintenance kit is on hand at the time of disassembly. The instructions provided with the maintenance kit should always be used in lieu of those presented here. Refer to Figure 10 throughout the disassembly and assembly procedure.

**Caution: The BP-R1™ valve may be lightly clamped in a bench vise during disassembly, however, overclamping will cause damage to the valve and result in leakage and/or malfunction.** If a vise is to be used, position the valve so that the jaws bear on the supply ports on opposing sides of the valve's body.

1. Remove all air fittings and plugs from the valve.
2. Mark the relationship of the valve cover to the body and if the valve is equipped with a mounting bracket, mark the relationship of the bracket to the cover.
3. While holding the exhaust cover (4), remove and discard the retaining ring (3) that secures it to the body (1).
4. Remove and discard the exhaust cover (4) along with both o-rings (5 & 6).
5. Remove and discard the valve spring (7), valve retainer (8), and the valve assembly (9) from the body (1).
6. Remove and retain the four cap screws (10) that secure the cover (2) to the body (1).
7. Separate the cover (2) from the body (1), then remove and discard the sealing ring (35) and o-ring (11).
8. Remove and retain the relay piston (13) and relay piston spring (14) from the body (1).

**Note:** The relay piston spring, item 14 is **not used in all valves.**

9. Remove and discard the o-ring (12) from the relay piston (13).
10. Remove and discard dust shield (16), if fitted, and the retaining ring (15) from the valve cover (2), then remove and discard the exhaust piston (17 or 17A).
11. Remove and discard the exhaust piston o-ring (18) and the exhaust diaphragm (19), if fitted.
12. Remove and discard the service piston (20) and its o-ring (21) from the valve cover (2).
13. Remove the spring (22) and spring cage (23) from the valve cover (2). Discard the spring and retain the spring cage.
14. Use shop air at the control port to extract the blend back piston from the valve cover (2). Retain the blend back piston (24), then remove and discard both o-rings (25 & 26).
15. Remove and retain the proportioning piston (28) from the valve cover (2), then remove and discard both o-rings (27 & 29).
16. While holding the inlet valve seat (32) in place, remove and discard the retaining ring (30) from the proportioning piston (28).
17. Remove the inlet valve seat (32), the inlet valve (33), and the valve spring (34) from the proportioning piston (28), then remove and discard the o-ring (31) from the valve seat (32). Discard the valve and spring (33 & 34) also.
18. Remove and discard the exhaust cover screw (36) and exhaust cover (37).

## CLEANING & INSPECTION

1. Using mineral spirits or an equivalent solvent, clean and thoroughly dry all metal parts. Do not damage bores with metal tools.
2. Wash all non-metallic components (key nos. 4, 12, 17, 20, 23, 24, 28, 32) in a soap and water solution making certain to rinse and dry thoroughly.
3. 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 body (1) and cover (2) is acceptable. Replace the entire valve if the interior of the body or cover exhibit signs of corrosion or pitting.
4. Inspect each non-metallic component for cracks, wear or distortion. Replace the entire valve if these conditions are found.
5. Inspect the bores of both the body (1) and cover (2) for deep scuffing or gouges. Replace the entire valve if either are found.

6. Make certain the air channel running between the top surface of the body (1) and its supply port is clear and free of obstruction.
7. Make certain all air channels and exhaust passages in the valve cover (2) are clear and free of obstruction.
8. Inspect the pipe threads in the body (1) and valve cover (2). Make certain they are clean and free of thread sealant.
9. If the valve was equipped with a relay piston spring (14), inspect it for signs of corrosion, pitting and cracks. Replace as necessary.
10. Inspect all air line fittings for corrosion and replace as necessary. Make certain to remove all old thread sealant before reuse.

## ASSEMBLY

1. Prior to assembly, lubricate all o-rings (identify by using Figure 11), seals, and pistons as well as body and cover bores, using the lubricant provided with the Bendix maintenance kit. Use all of the lubricant and spread it evenly on the rubbing surfaces.
2. Install the o-ring (31) on the inlet valve seat (32).

The diagram shows a cross-section of an O-ring. The inner diameter is labeled 'I.D.' with a double-headed arrow. The outer diameter is labeled 'O.D.' with a double-headed arrow. The width is labeled 'W' with a vertical double-headed arrow.

O-RING IDENTIFICATION			
KEY NO.	I.D.	O.D.	W
5	.8620	1.068	.103
6	1.424	1.630	.103
11	3.487	3.693	.103
13	3.234	3.512	.139
18	1.356	1.496	.070
21	1.176	1.316	.070
25	1.112	1.318	.103
26	.7370	.9430	.103
27	.4120	.5520	.070
29	.7390	.8790	.070
31	.4890	.6290	.070

FIGURE 11 - O-RING IDENTIFICATION



3. Install the small end of the inlet/exhaust valve spring (34) over the rubber of the valve (33), making sure the spring coils rest on the valve's four tabs. **Note:** Both ends of spring (34) are the same diameter on valves manufactured after June 1990.
4. Insert the spring and valve into the valve seat (32), making sure the four tabs are within the seat's bore.
5. Insert the valve, seat and spring assembly into the proportioning piston (28).
6. While holding the seat (32) in place, install the retaining ring (30) to secure it in the piston (28). Make certain the retaining ring is fully seated in its groove. Make sure the valve is straight against the exhaust seat and free to move.
7. Install both the large and small diameter o-rings (27 & 29) on the proportioning piston (28).
8. Install both the large and small diameter o-rings (25 & 26) on the blend back piston (24), then insert the small diameter of the proportioning piston (28) into the small diameter end of the blend back piston (24).
9. Carefully insert the assembled proportioning and blend back pistons (24 & 28) to the edge of the bore in the cover (2). Do not cut or pinch the o-rings.
10. With the bore of the cover facing up, install the spring cage (23) in the blend back piston (24) so that its flat side rests against the blend back piston (its depressed side out towards spring (22)).
11. Install the service piston (20) over the spring (22) in the cage (23) so that its coils are within the I.D. of the cage.
12. Install o-ring (18) on exhaust piston (17A).
13. Place exhaust piston on service piston with its six ribbed side facing the service piston. Then install both pistons while pushing the proportioning and blend back pistons (28 & 24) all the way into the cover.
14. Install the retaining ring (15), making certain it is fully seated in its groove.
15. Install the exhaust cover (37) using screw (36) to retain it. Torque the screw to 8 to 15 lb. in.
16. Install the valve retainer (8) on the inlet and exhaust valve (9) so that the flange of the retainer (8) surrounds the rubber portion of the valve. Install the inlet and exhaust valve in the body (1).
17. Install the inlet and exhaust valve return spring (7) in the body (1).
18. Install the large and small diameter o-rings (5 & 6) in the exhaust cover (4), then install the exhaust cover in the body (1), taking care not to damage the o-rings. Hold the exhaust cover in place.
19. While depressing the exhaust cover (4), install the retaining ring (3) in the body (1). Make certain the retainer (3) is fully seated in its groove in the body.
20. If the BP-R1™ valve was equipped with a relay piston return spring (15), install the spring in the body, large diameter first.
21. Using lubricant to hold them in place, install the large and small sealing rings (11 & 35) on the cover (2).
22. Install the o-ring (12) on the relay piston (13), then install the piston in the body (1).
23. After noting the relationship marks made prior to disassembly, install the mounting bracket (not illustrated) on the cover (2) then secure the cover (2) and mounting bracket on the body (1) using the four cap screws (10). Torque the cap screws to 120 to 150 lb. in.
24. Install all air line fittings and plugs making certain thread sealing material does not enter the valve.
25. Install the BP-R1™ valve on the vehicle and perform the *Operation and Leakage Tests* before returning the vehicle to service.





