

Bendix® AR-2™ AntiLock Relay Valve

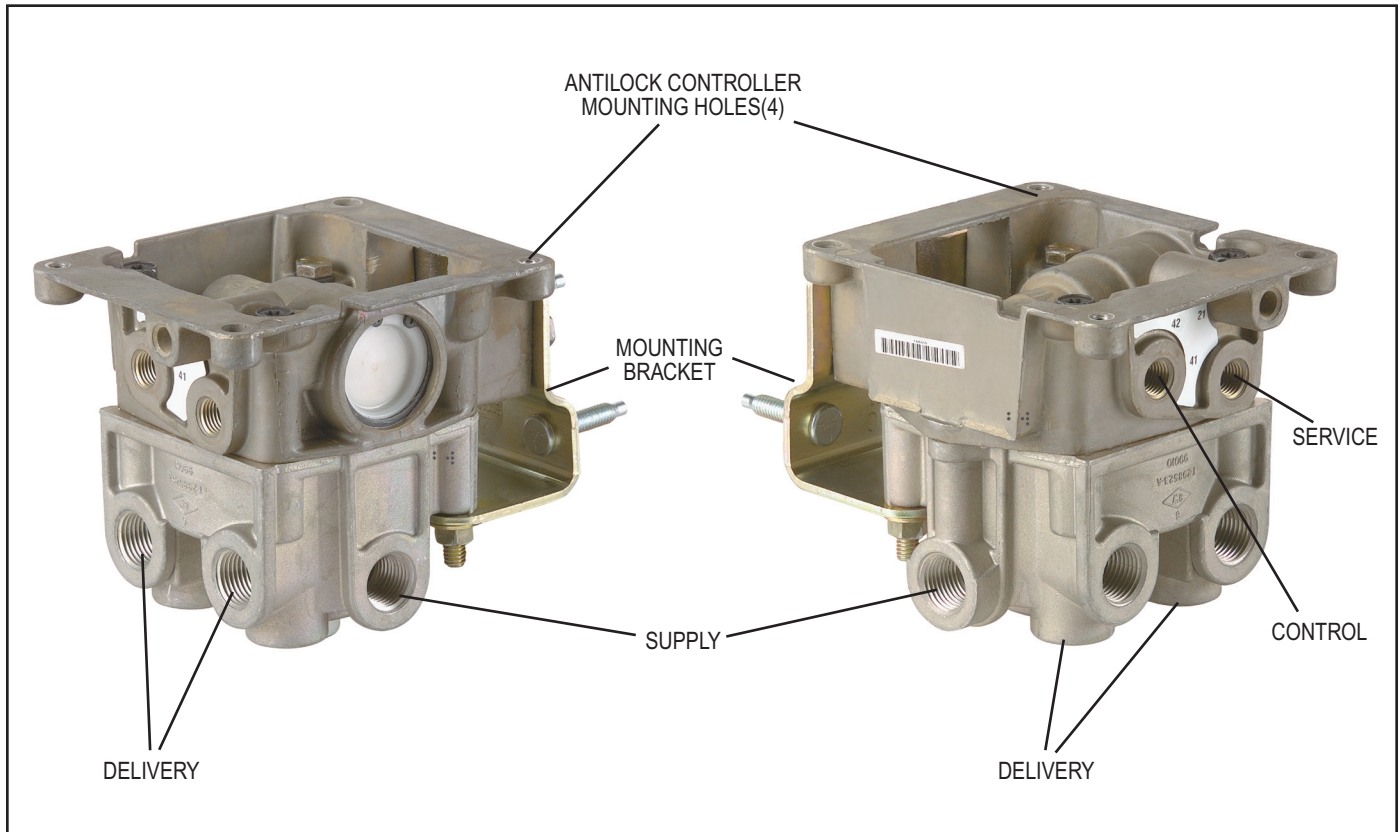


FIGURE 1 - AR-2™ ANTILOCK RELAY VALVE ASSEMBLY

DESCRIPTION

The Bendix® AR-2™ antilock relay is a specialized air brake valve developed for use on antilock equipped tractors only. It is essentially a BP-R1® “bobtail” brake proportioning relay valve (Bendix Service Data Sheet SD-03-1067) with a modified cover that permits direct attachment of a Bendix® antilock controller such as the EC-15™. When combined with an antilock controller the resulting assembly is referred to as a antilock controller relay assembly. For example when the AR-2™ valve is combined with the EC-15™ electronic controller, the resulting assembly is referred to as a CR-16™ controller relay assembly.

While it is intended for use on antilock equipped tractors, the AR-2™ valve functions solely as an air brake relay and contains no electronics of its own.

The AR-2™ valve replaces the standard relay valve used to control the rear axle service brakes and performs the standard relay function during tractor-trailer operation. During tractor bobtail operation, the AR-2™ valve reduces brake application pressure to the lighter rear axle(s) brakes to improve vehicle controllability and minimize rear axle(s) wheel skid before antilock is required. The AR-2™ valve provides added vehicle braking control and reduces the number of times antilock is actually needed.

Like the standard relay valve it replaces, the AR-2™ valve and its attached antilock controller is normally mounted near the service brakes it serves. A mounting bracket, furnished with the valve, permits either frame or cross member mounting. All air connections on the AR-2™ valve are identified with cast, embossed letters for ease of identification and installation.

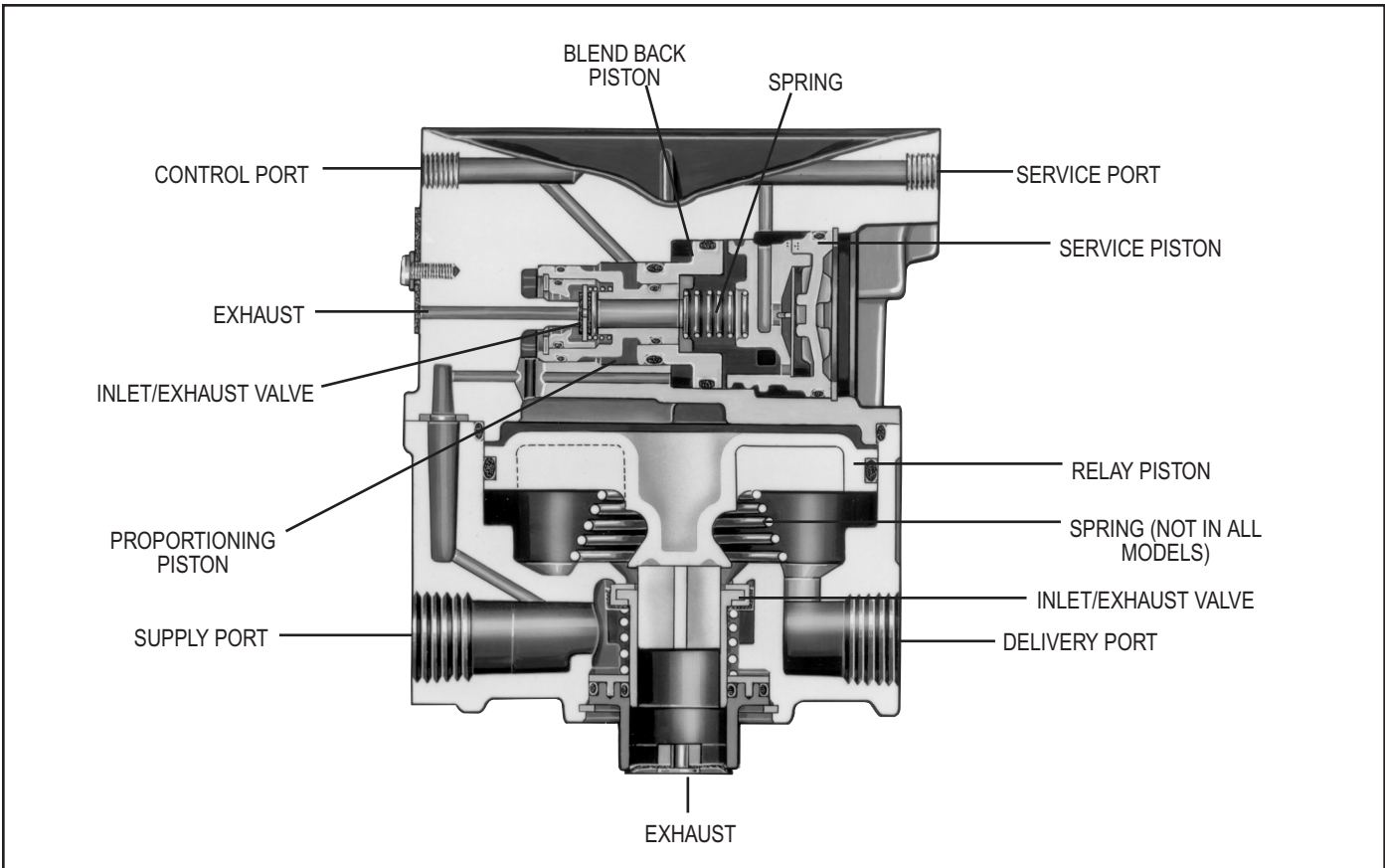


FIGURE 2 - SECTIONAL VIEW BENDIX® AR-2™ ANTILOCK RELAY VALVE

The letter identification and air hose connections are shown below for reference.

Bendix® AR-2™ VALVE

AIR CONNECTION	EMBOSSED IDENT.
Supply (to reservoir)	SUP
Delivery (to brake chamber)	DEL
Service (to brake valve rear service delivery)	SER
Control (to delivery of trailer supply valve)	CON

The AR-2™ valve is part of the R-12® family of relay valves which includes the R-12®, R-14®, BP-R1®, and AR-1™ valves. The internal components of the relay portion of all of these valves are interchangeable with the R-12® valve and therefore the same basic components are used to service all of them.

The AR-2™ valve incorporates various crack pressures to accommodate specific applications, the standard is 4 psi.

OPERATION

GENERAL

Because the AR-2™ valve is actually a relay valve, the following description of operation refers to its function in the vehicle's air brake system and does not address the separate antilock components and their operation. For a description of antilock operation, refer to the appropriate

Service Data Sheet covering the electronic controller used with the AR-2™ valve (SD-13-4785 covering the EC-15™ electronic controller). Other useful information regarding antilock system components used in conjunction with the AR-2™ valve are contained in publications: SD-13-4793 (Bendix® M-21™ antilock modulator); SD-13-4870 (Bendix® M-32™ and M-32QR™ antilock modulators); SD-13-4860 (Bendix® WS-24™ wheel speed sensors); and SD-13-4754 (Bendix® WS-20™ wheel speed sensors).

INITIAL CHARGING

During the initial build up of tractor system air pressure, reservoir air flows into the supply port and through internal body and cover passages to the blend back piston. When sufficient air pressure is applied to the blend back piston, it moves against the resistance of its spring until it comes to rest against the service piston.

Activating the trailer supply valve (dash control with red octagonal button), simultaneously charges the trailer and the AR-2™ valve control port. Air entering the AR-2™ valve control 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 seat. With the tractor and trailer air system fully charged the vehicle may be operated.

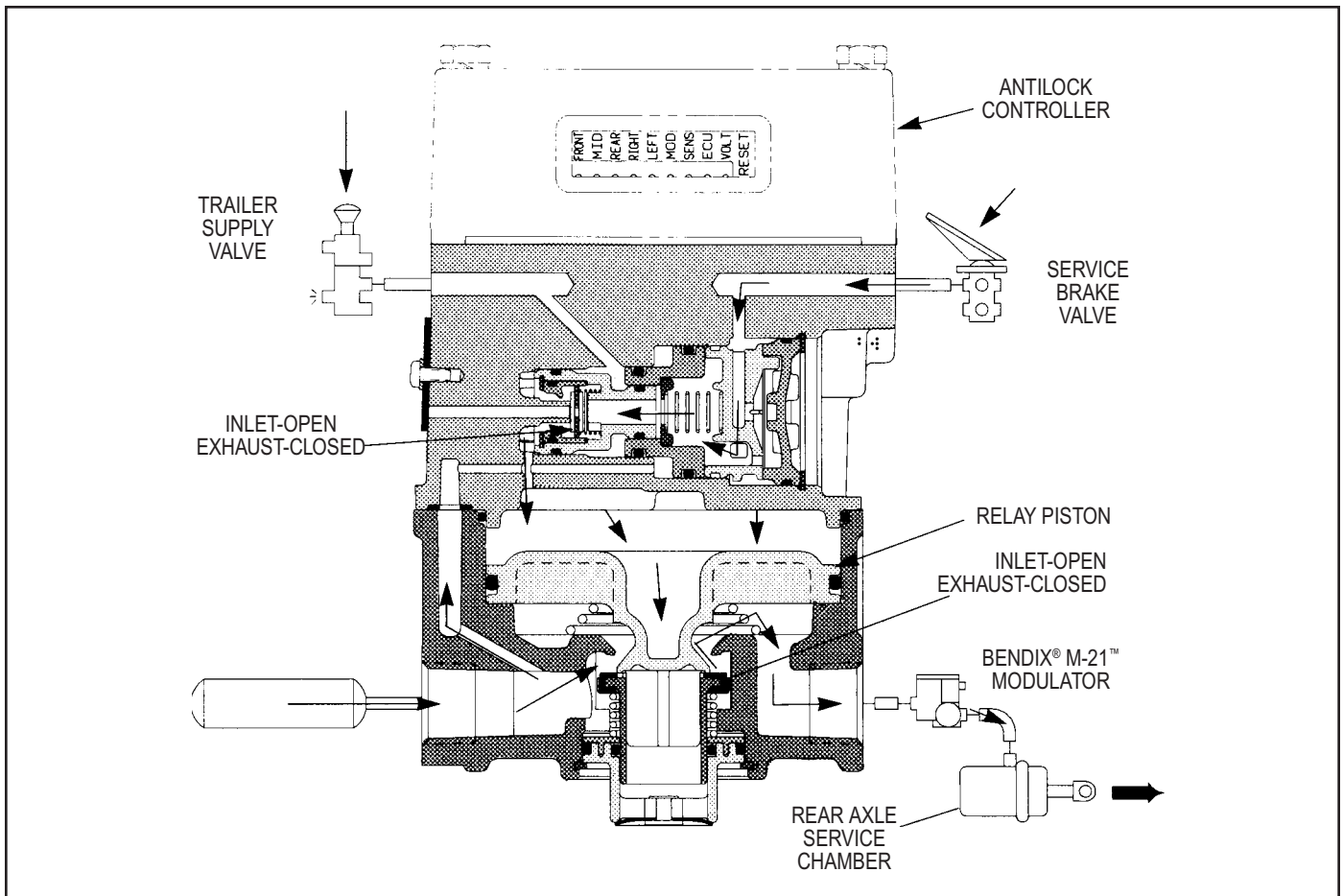


FIGURE 3 - TRACTOR SERVICE BRAKES APPLYING - TRACTOR TRAILER COMBINATION

SERVICE BRAKES APPLYING - TRACTOR/TRAILER COMBINATION

Brake application air enters the Bendix® AR-2™ valve service port and is conducted through the service piston 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 of its 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 AR-2™ valve delivery ports to the brake chambers.

SERVICE BRAKES HOLDING - TRACTOR/TRAILER COMBINATION

The air pressure being delivered to the brake chambers is also present beneath the relay piston. When the air pressure above and below the 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 chambers is held stable and neither increases nor decreases.

SERVICE BRAKES RELEASING - TRACTOR/TRAILER COMBINATION

When the brake application is released, air from above the relay piston flows back through the proportioning, blend back and service pistons, to the foot brake valve and is exhausted. 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 chambers returns to the AR-2™ valve and flows out the open exhaust.

SERVICE APPLICATION - BOBTAIL TRACTOR

When the trailer supply valve (dash control with red octagonal button) is activated to disconnect the trailer, air in the AR-2™ valve control port and trailer supply line is exhausted to atmosphere. During bobtail tractor operation, service application air enters the AR-2™ valve service port and as it passes through the blend back piston, air 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.

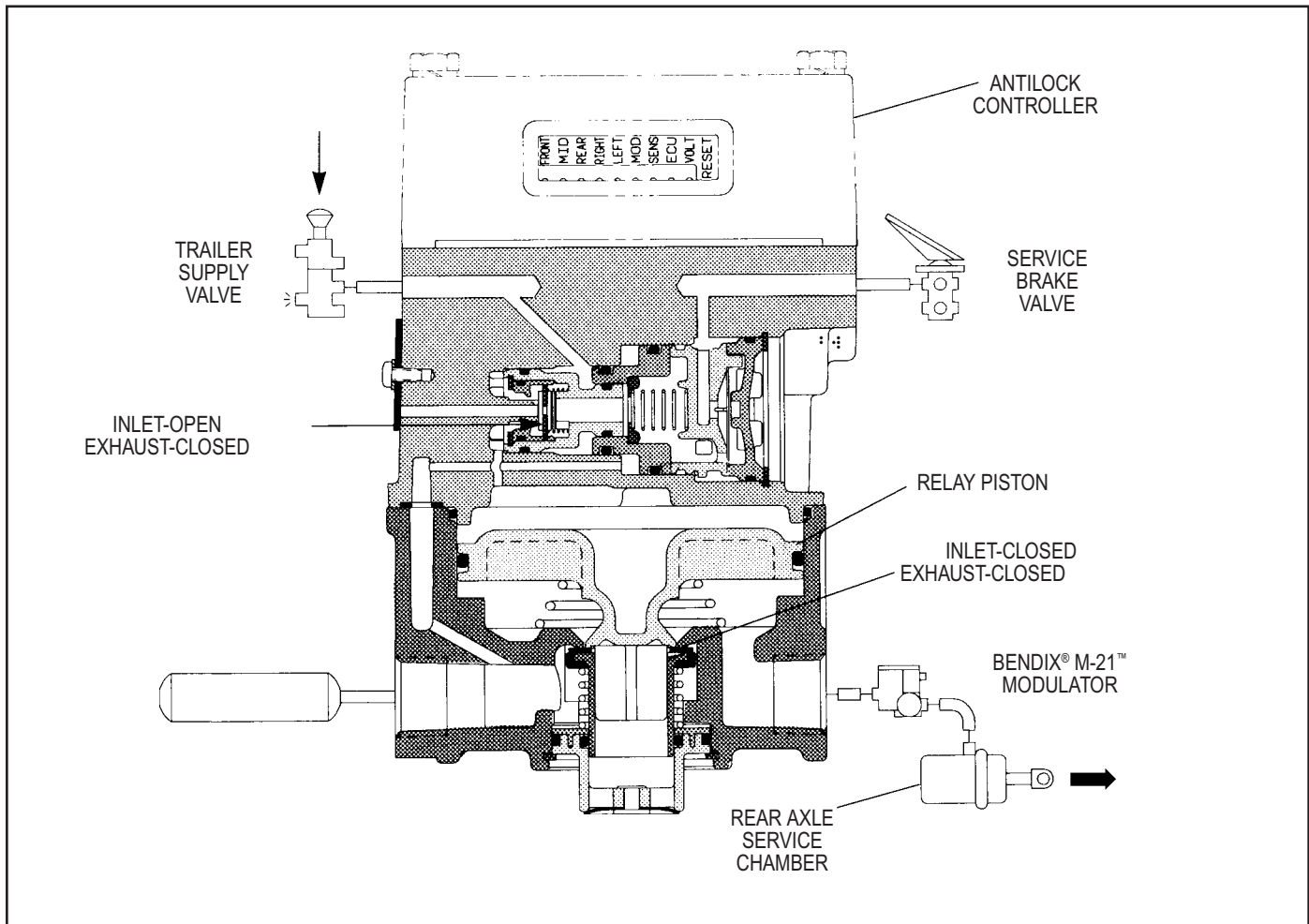


FIGURE 4 - TRACTOR SERVICE BRAKES HOLDING - TRACTOR TRAILER COMBINATION

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 have moved sufficiently to close its inlet valve without opening the exhaust.

The inlet remains closed, preventing additional air delivery to the relay piston and a subsequent increase in brake chamber pressure, until service application pressure exceeds approximately 30 psi. Service applications above this pressure will result in a proportioned increase of the preset initial brake application to the tractor's rear brakes. Proportioning occurs due to the difference in effective area on each end of the proportioning piston. Tractor rear axle brake proportioning will occur for all service applications between approximately 30 and 80 psi.

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 over comes the resistance of reservoir pressure acting on the large diameter of the other side. Above 80 psi the ratio between control and delivered air pressure is reduced and "blends back" from a proportioned delivery to a full 1 to 1 delivery. Complete "blend back" to a 1 for 1 delivery is achieved when a full brake application is made.

SERVICE BRAKES RELEASING - BOBTAIL TRACTOR

When the brake application is released, all air pressure from between the closed proportioning piston inlet valve and the Bendix® AR-2™ valve service port returns to the brake valve and is exhausted. 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 chambers returns to the AR-2™ valve and flows out the open exhaust.

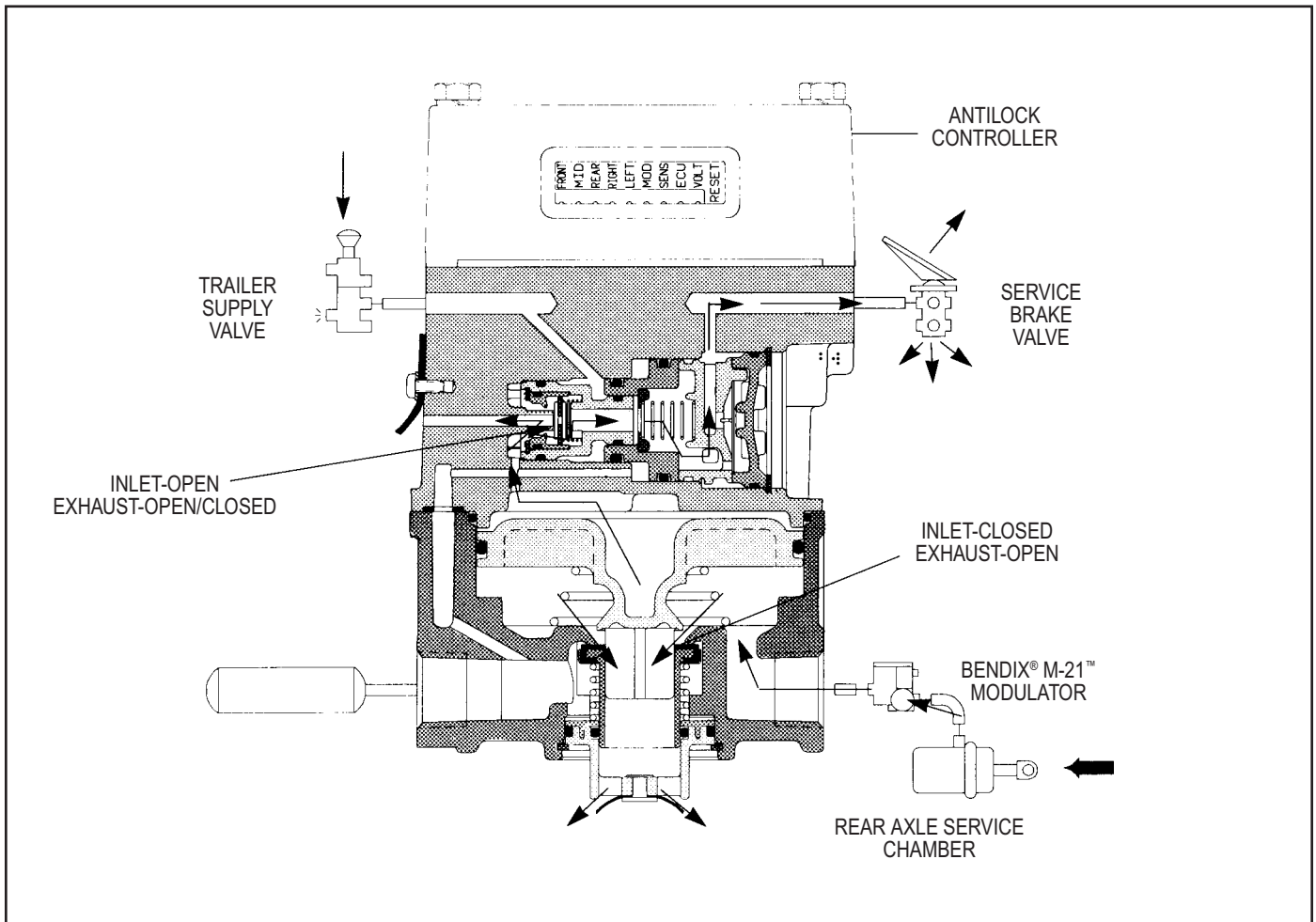


FIGURE 5 - TRACTOR SERVICE BRAKES RELEASING - TRACTOR TRAILER COMBINATION

PREVENTIVE MAINTENANCE

GENERAL

Perform the tests and inspections presented at the prescribed intervals. If the Bendix® AR-2™ 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, 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 AR-2™ 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.

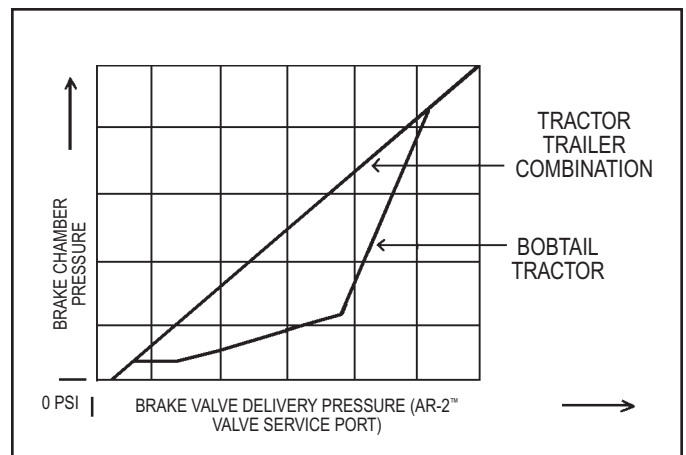


FIGURE 6 - AR-2™ VALVE BRAKE PRESSURE DELIVERY

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.

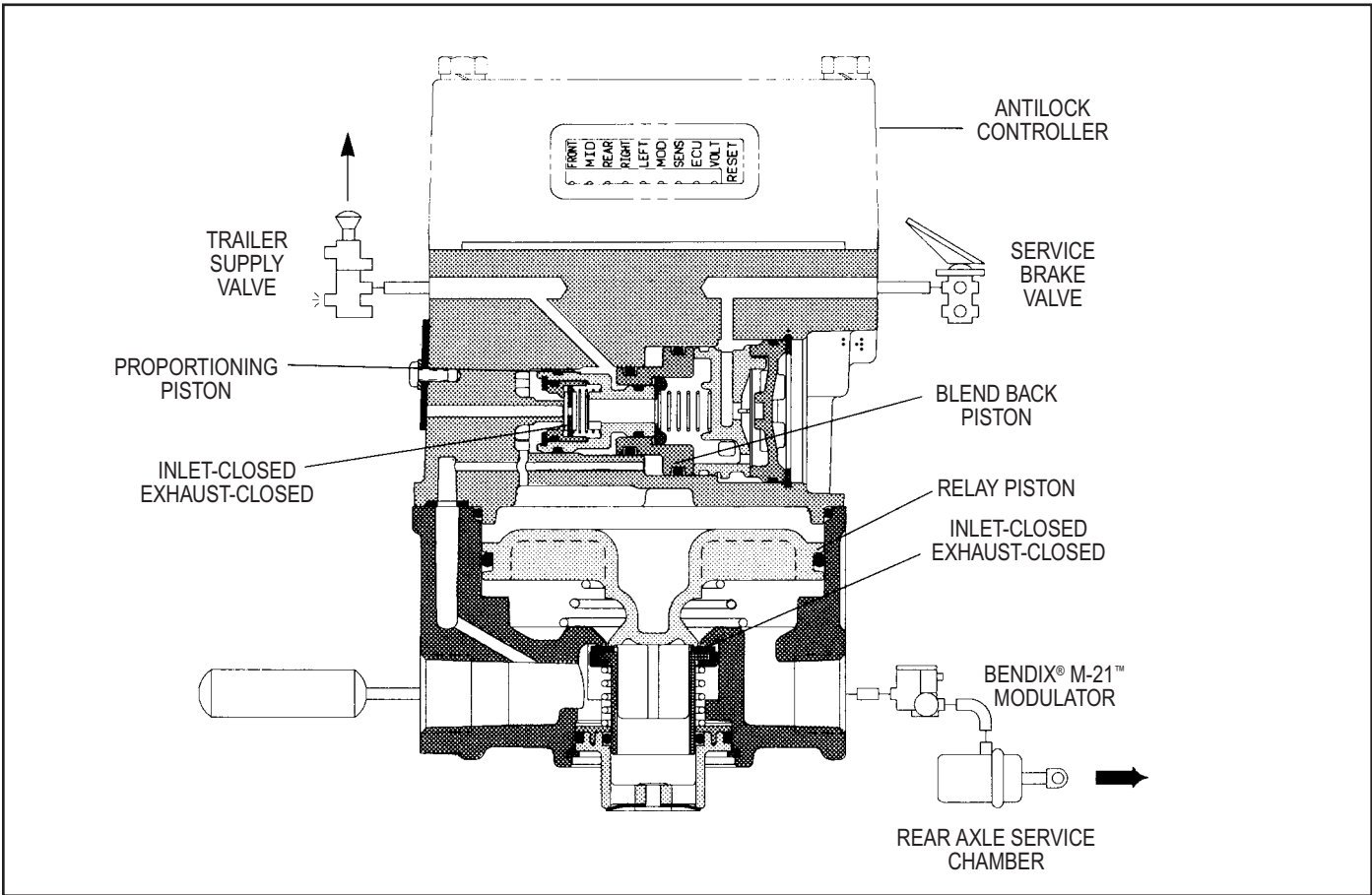


FIGURE 7 - SERVICE APPLICATION HOLDING - BOBTAIL TRACTOR

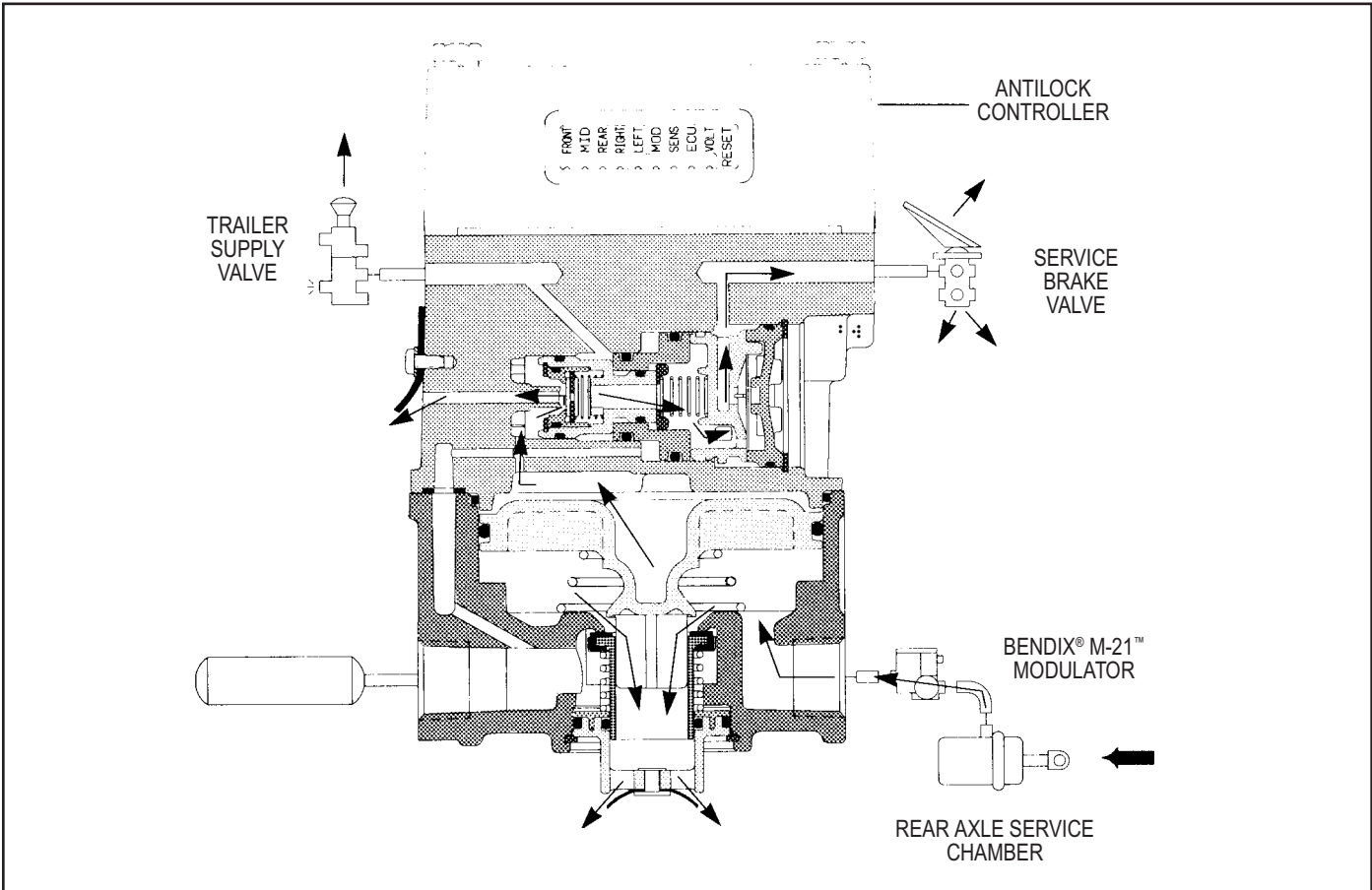


FIGURE 8 - TRACTOR SERVICE BRAKES RELEASING - BOBTAIL TRACTOR

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 a Bendix® 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® brand 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 Automatic 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.
2. Connect the tractor service and emergency "glad hands" (hose couplings) to dummy connectors, 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 AR-2™ valve for leakage. Tighten as needed.
3. With the trailer supply valve (dash control with a red octagonal button) and system park control (dash control with a yellow diamond button) activated for tractor/trailer operation, apply and release the brakes several times and check for prompt application and release at each wheel. If prompt reaction is noted at some, but not all wheels, test the Bendix® M-21™ antilock modulator between the AR-2™ valve and the brake chamber for proper operation. If a "sluggish" response is noted at all wheels, inspect for a kinked or obstructed air line leading to or from the AR-2™ valve. If a complete release of the brakes is noted at some, but not all wheels, test the M-21™ antilock modulator between the AR-2™ valve and the brake chamber for proper operation. If an incomplete release is noted at all wheels, inspect for a kinked or obstructed air line leading to or from the AR-2™ valve.
4. Check the AR-2™ valve's 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 AR-2™ valve part number. NOTE: For AR-2™ valves not incorporating a relay piston return spring the measured differential should be approximately 4 psi. When a spring is in use, the differential will be higher.
5. Make and hold a full (100 psi or greater) brake application and note that full pressure is delivered to the brake chambers.
6. Activate the dash mounted trailer supply valve for bobtail tractor operation. Then make a slow brake application, increasing the pressure at the AR-2™ 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.
7. Make another brake application and **slowly** increase the pressure at the AR-2™ 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 to 1. For example: Each 3 psi increase at the service port results in a delivery pressure increase of 1 psi. At 70 psi service port pressure, brake chamber pressure should be 15 to 25 psi.

OPERATION & LEAKAGE TESTS

Operation

To properly test the function of the Bendix® AR-2™ valve, a pair of test gauges or gauges of known accuracy must be used.

1. Install a "tee" at the AR-2™ valve's service port and at one of the delivery ports, then install a gauge in each.

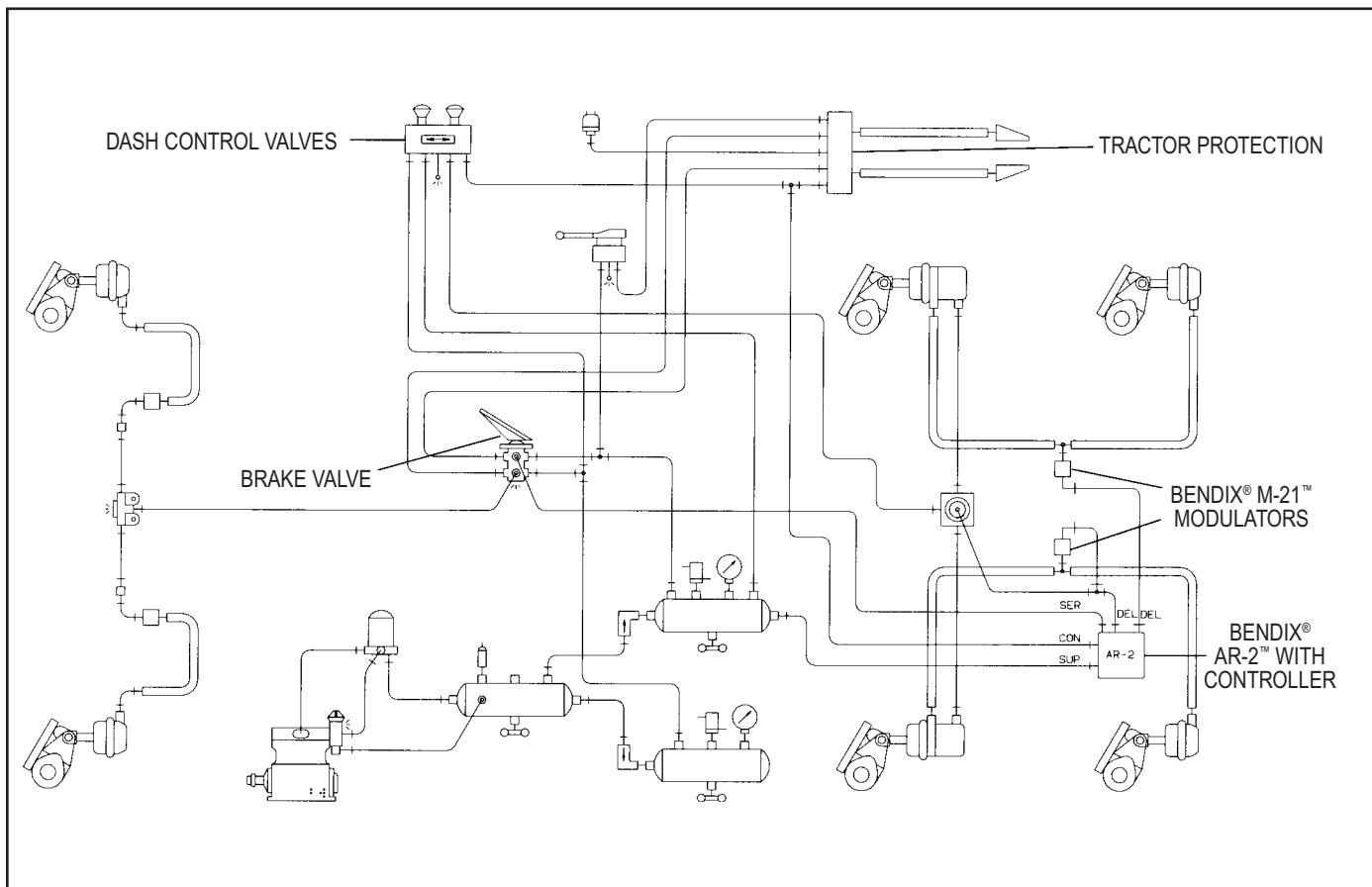


FIGURE 9 - TYPICAL BENDIX® CR-16™ AIR BRAKE SYSTEM

8. Make a full brake application and note that both test gauges register the same pressure. **IMPORTANT:** If during testing the service port pressure is **SLOWLY increased** from approximately 70 psi to a full (100 psi or greater) brake application, the Bendix® AR-2™ valve MAY begin to cycle between an apply and exhaust mode. This condition is normal while the AR-2™ valve is transitioning from the proportioning mode to the full delivery mode and will only occur if the service application is **SLOWLY** increased as described. Cycling will not occur or can be stopped by increasing or decreasing service port pressure.
9. Remove the test gauges from the AR-2™ valve.
10. If the AR-2™ valve fails to perform as described it should be replaced or repaired using genuine Bendix replacement parts or kits.

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 either 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 with no leakage detected between the cover and body.

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, mark or label all air lines and wiring cables and their respective connections on the valve or antilock controller to facilitate ease of installation.
4. Disconnect all air lines and wiring.
5. Remove the AR-2™ valve and controller assembly 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 and wiring cables to the valve and controller assembly using the identification made during VALVE REMOVAL step 3.
4. After installing the valve and controller assembly, test all air fittings for excessive leakage and tighten as needed.

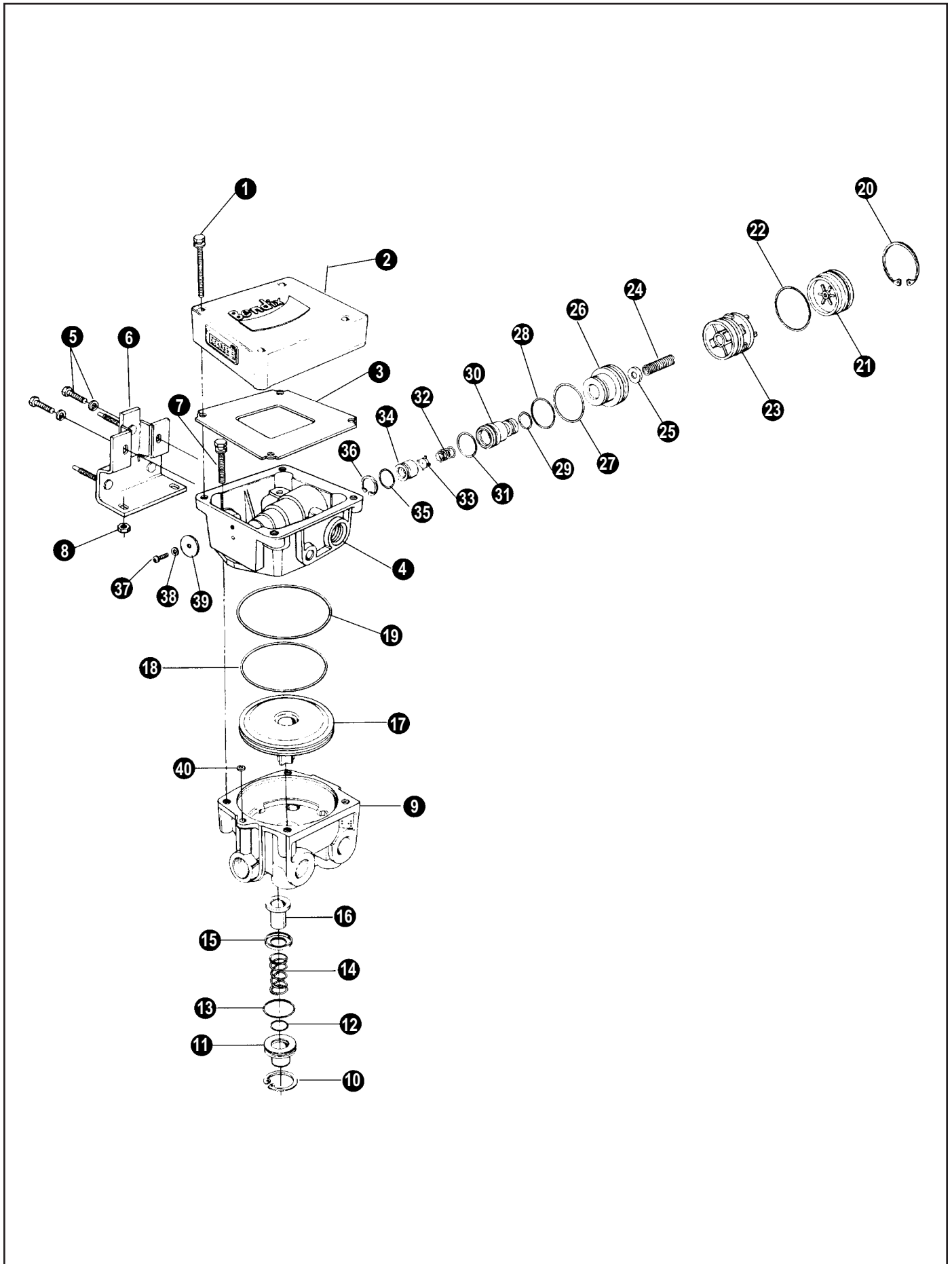


FIGURE 10 - BENDIX® AR-2™ ANTILOCK RELAY VALVE

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 Bendix® AR-2™ valve may be lightly clamped in a bench vise during disassembly, however, over clamping 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 AR-2™ valve.
2. Mark the relationship of the antilock electronic controller (2) and valve cover (4) to the body (9). Note the position of the mounting bracket (6) and mark the relationship of the bracket to the valve body (9), cover (4), and antilock controller (2). Remove and retain the four cap screws and lock washers (1) that secure the controller to the cover (4), then carefully remove the electronic controller without damaging its gasket (3).
3. While holding the exhaust cover (11), remove the retaining ring (10) that secures it to the body (9).
4. Remove the exhaust cover (11) along with both o-rings (12 & 13).
5. Remove the valve spring (14), valve retainer (15), and the valve assembly (16) from the body (9).
6. Remove and retain the two cap screws and lock washers (5) that secure the bracket (6) to the cover (4). Remove and retain the two bolts with lock washers (7), and nuts (8) that secure the cover (4) and mounting bracket to the valve body (9). Then remove the remaining two cap screws (7) that secure the cover (4) to the body (9).
7. Separate the cover (4) and mounting bracket (6) from the body (9), then remove the large and small sealing rings (19 & 40).
8. Remove and retain the relay piston (17) and relay piston spring (if present) from the body (9). NOTE: The relay piston spring is not used in all AR-2™ valves.
9. Remove the o-ring (18) from the relay piston (17).
10. Remove the retaining ring (20) from the cover (4), then remove the exhaust piston (21).
11. Remove the exhaust piston o-ring (22).
12. Remove the service piston (23) from the cover (4).
13. Remove the spring (24) and spring cage (25) from the cover (4).
14. Remove the blend back piston (26) from the valve cover (4), then remove both o-rings (27 & 28).

15. Remove the proportioning piston (30) from the valve cover (4), then remove both o-rings (29 & 31).
16. While holding the inlet valve seat (34) in place, remove the retaining ring (36) from the proportioning piston (30).
17. Remove the inlet valve seat (34), the inlet valve (33), and the valve spring (32) from the proportioning piston (30), then remove the o-ring (35) from the valve seat (34).
18. Remove the exhaust diaphragm screw (37), washer (38) and exhaust diaphragm (39) from the cover (4).

CLEANING & INSPECTION

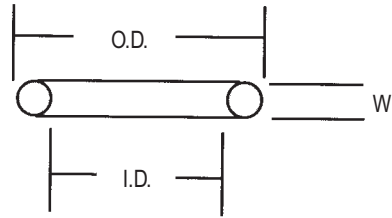
1. Using mineral spirits or an equivalent solvent, clean and thoroughly dry all metal parts.
2. Inspect the interior and exterior of all metal parts that will be reused for severe corrosion, pitting and cracks. Superficial corrosion and/or pitting on the exterior portion of the body (9) and cover (4) is acceptable. Replace the entire valve if the interior of the body or cover exhibit signs of corrosion or pitting.
3. Inspect the bores of both the body (9) and cover (4) for deep scuffing or gouges. Replace the entire valve if either are found.
4. Make certain all air channels and exhaust passages in the valve cover (4) are clear and free of obstruction.
5. Inspect the pipe threads in the body (9). Make certain they are clean and free of thread sealant.
6. Wash all non-metallic components in a soap and water solution making certain to rinse and dry thoroughly. Inspect each non-metallic component for cracks, wear or distortion. Replace the entire valve if these conditions are found.
7. If the valve was equipped with a relay piston spring, inspect it for signs of corrosion, pitting and cracks. Replace as necessary.
8. 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, seals, and pistons, as well as body and cover bores, using the lubricant provided with the Bendix maintenance kit.
2. Install the o-ring (35) on the inlet valve seat (34).
3. Insert the inlet and exhaust valve spring (32), LARGE END FIRST, into the proportioning piston (30).
4. Install the inlet and exhaust valve (33) inside the inlet valve seat (34) making certain that the four tabs are within the bore of the seat.

5. Carefully insert the assembled valve (33) and seat (34) into the proportioning piston (30), making certain that the coils of the valve spring (32) rest on the four tabs of the valve (33). While holding the seat (34) in place, install the retaining ring (36) to secure it in the piston (30). Make certain the retaining ring is fully seated in its groove.
6. Install both the large and small diameter o-rings (31 & 29) on the proportioning piston (30).
7. Install both the large and small diameter o-rings (27 & 28) on the blend back piston (26), then insert the small diameter of the proportioning piston (30) into the small diameter end of the blend back piston (26).
8. Carefully insert the assembled proportioning and blend back pistons (30 & 26) into the cover (4).
9. Install the spring cage (25) in the blend back piston (26) so that its flat side rests against the blend back piston.
10. Install the spring (24) in the cage (25) so that its coils are within the I.D. of the cage.
11. Insert the service piston (23) in the cover (4) so that the coils of the spring (24) are contained within the piston and the six protruding posts of the piston are visible after the piston is in the cover.
12. Install the o-ring (22) on the exhaust piston (21) then install the exhaust piston (21) in the cover (4). Refer to the figure and make certain that the exhaust piston (21) is installed with its concave surface away from the service piston (23).
13. While holding the exhaust piston (21) in the cover (4), install the retaining ring (20), making certain it is fully seated in its groove.
14. Install the exhaust diaphragm (39) using its screw (37) and washer (38) to retain it. Torque the screw to 8-15 pound inches.
15. Install the valve retainer (15) on the inlet and exhaust valve (16) so that the flange of the retainer (15) surrounds the rubber portion of the valve. Install the inlet and exhaust valve in the body (9).
16. Install the inlet and exhaust valve return spring (14) in the body (9).
17. Install the large and small diameter o-rings (13 & 12) in the cover (11), then install the exhaust cover in the body (9) taking care not to damage the o-rings. Hold the exhaust cover in place.
18. While depressing the exhaust cover (11), install the retaining ring (10) in the body (9). Make certain the retainer (10) is fully seated in its groove in the body.
19. If the Bendix® AR-2™ valve was equipped with a relay piston return spring, install the spring in the body, large diameter first.

O-RING IDENTIFICATION CHART



KEY NO.	I.D.	O.D.	W
12	.862"	1.068"	.103"
13	1.424"	1.630"	.103"
19	3.487"	3.693"	.103"
18	3.234"	3.512"	.139"
22	1.356"	1.496"	.070"
27	1.112"	1.318"	.103"
28	.737"	.943"	.103"
29	.412"	.552"	.070"
31	.739"	.879"	.070"
35	.489"	.629"	.070"

20. Using lubricant to hold them in place, install the large diameter sealing ring (19) on the cover (4) and the small diameter sealing ring (40) on the body (9).
21. Install the o-ring (18) on the relay piston (17), then install the piston in the body (9).
22. After noting the relationship marks made prior to disassembly, install the cover (4) on the body (9). Secure the cover to the body using the two shortest cap screws and lock washers (7). Make certain the sealing rings (19 & 40) remain in place. Torque the cap screws to 120-150 pound inches.
23. Secure the mounting bracket (6) to the cover (4) using the cap screws and lock washers (5), and torque the cap screws to 180-220 pound inches. Then secure the mounting bracket (6) to the body (9) and cover (4) using the two longest cap screws and lock washers (7) and nuts (8) and torque the cap screws to 120-150 pound inches.
24. Install all air line fittings and plugs making certain thread sealing material does not enter the valve.
25. Install the AR-2™ valve on the vehicle and perform the Operation and Leakage Tests before returning the vehicle to service.

