YARWAY ARC AUTOMATIC RECIRCULATION CONTROL VALVE SERIES 5300

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS

Before installation, these instructions must be carefully read and understood.

Designed expressly for protection of centrifugal pumps against overheating during critical low-load periods, Yarway's ARC Automatic Recirculation Control Valve functions as a:

1. Check Valve—to prevent reverse flow through the pump
2. Recirculation Control Valve—to provide cooling flow through the pump

HOW IT OPERATES

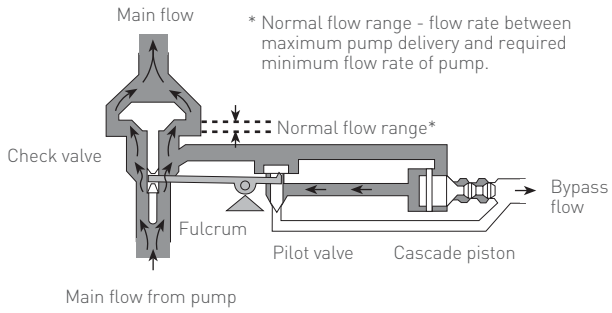
Normal Main Flow—Normal flow through the check valve overcomes the spring force and supports the main check valve disc in positions determined by the normal flow range. In these positions, the lever is kept free of the pilot valve nut. The pump pressure, directed to the closing side of the cascade piston, holds the recirculation valve firmly closed to prevent recirculation flow.
Note that design of the control head exposes both opening and closing faces of the cascade piston to pump pressure. The pressure acting on the differential piston area keeps the valve closed during normal pump flow conditions

Low Main Flow—As flow decreases, the check valve disc moves toward its seat. At a flow rate determined by the minimum flow requirement of the pump, the disc forces the lever to lift the pilot from its seat. This vents the pressure from the closing side of the cascade piston; pump pressure acting on the opposite side of the piston forces the recirculation valve open establishing the recirculation flow.

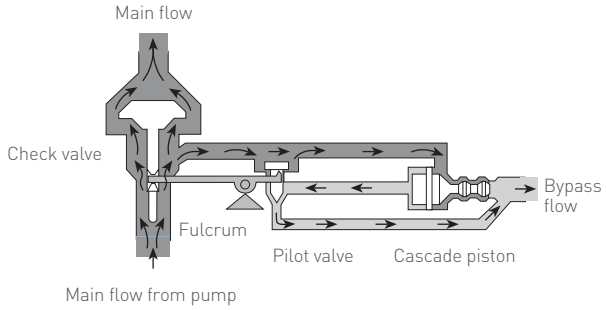
No Main Flow—The recirculation valve remains in the open position as long as the pilot valve is open, a condition which is maintained by the low main flow rate, described above. At the condition of no main flow, when the check valve disc is seated, all flow from the pump passes through the recirculation valve.

MAIN FLOW

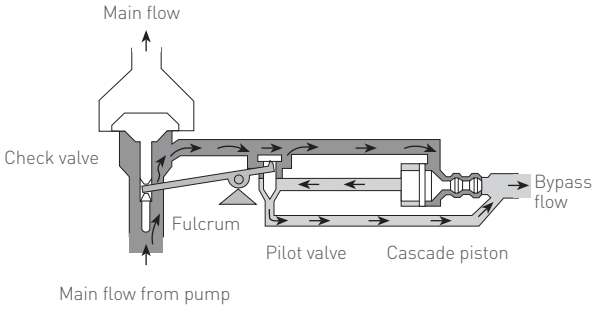
Normal main flow
Check valve - open
Pilot valve - closed
Cascade valve - closed



Low main flow
Check valve - at switch point
Pilot valve - partially open
Cascade valve - opening



No main flow
Check valve - closed
Pilot valve - open
Cascade valve - open



Increasing Main Flow—Closing of the recirculation valve occurs at the main flow at which the check valve disc, acting through the lever, allows the pilot valve to seat The closing side of the cascade piston receives the full pump pressure and closes the recirculation valve.
Understanding the self-actuating, automatic operation of the Yarway ARC Valve reveals the importance of maintaining the specifications originally used in sizing the valve. The sizing is dependent upon pump data, such as minimum and normal flow rates, pressures, temperatures, and the recirculation discharge pressure under flow conditions. The sizing is also based on the position of the valve in the line; main flow horizontal or vertical with flow upward. If the original specifications for the pump and ARC Valve are revised, consult Emerson to insure protection of the pump.

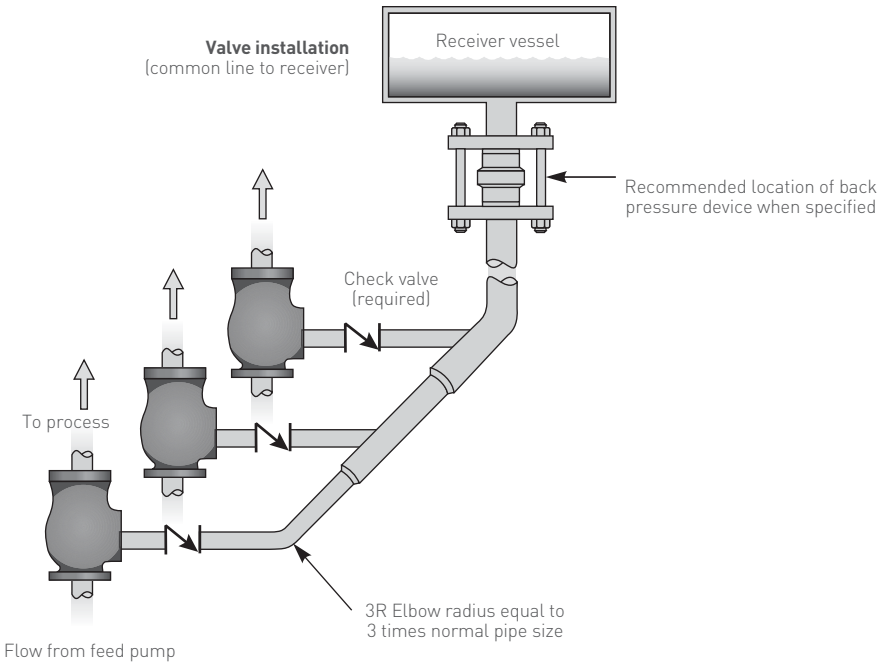
SPECIFICATIONS

Attached to each ARC valve is a data plate upon which are stamped the specifications for the valve. Data include the size, pressure class, types of ends, main flow rate, maximum temperature, bypass C_V. and serial number. Cast letters on the body and bonnet give materials and pressure class of the castings. Pressure ratings are in accordance with ANSI B16 34 "Steel Valves, Flanged and Buttwelding Ends." Table 1 gives typical valve dimensions and weights.
Always refer to the size, figure number, and serial number on the data plate when contacting Emerson for information or ordering spare parts.

STORAGE

Inspect the valve as received prior to storage. Store the valve in the original shipping container In a clean, dry location.

PARALLEL APPLICATIONS OF ARC VALVES



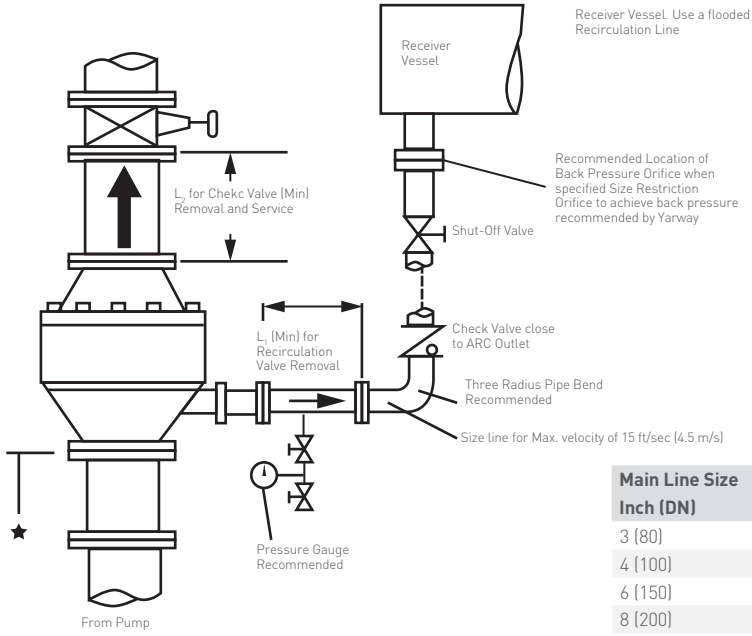
★Recommended locations of back pressure orifices for manifold connections. Pressure drop in the common line to the receiver will change the number of valves recirculation; significant increases in the line pressure drop may reduce recirculation flows below the required rates. An orifice in the common header, located at the receiver vessel, may also be required to minimize problems attendant with vapor formation at the individual orifices. Pressure losses under all conditions of operation must be considered in the sizing of the recirculation valves.

PLANNING THE INSTALLATION

In planning the piping, the installation practices recommended for control valves should be followed. A summary of those practices is contained in the ISA Handbook of Control Valves, Chapter 12. Recommendations for straight piping runs at the body Inlet and outlet are: Allow the maximum length of straight inlet piping consistent with other piping requirements; 10 to 20 pipe diameters is given as a rule of thumb for inlet piping, with a straight length of 3 to 5 pipe diameters for the outlet connection. The straight run allows the flow to establish a stable pattern before the entrance of the valve and extends the service life.
The direction of the main flow must be as originally specified (horizontal or vertical flow upward). The direction of recirculation flow may be selected to suit the installation without affecting the valve operation. Supply a flanged elbow of a flanged 24" (610 mm) length of pipe next to the bypass flange for convenient withdrawal of all bypass elements. Use L_1 shown on the typical installation diagram as a minimum length.

Typical installations are shown on page 3.
Provision for connection of a pressure gauge and/or pressure switch to sense pressure near the outlet of the recirculation valve to facilitate operational checking is recommended. For selection purposes, the gauge and/or switch must be capable of withstanding a pressure of at least 120% of the recirculation valve design inlet pressure, usually the maximum pump pressure. It is desirable that a gauge be provided with a snubber to reduce wear under flow vibration conditions.
Provide a shut-off valve between the pressure tap and the gauge and/or pressure switch.
Clearance dimensions for maintenance of the check valve and recirculation valve are given by valve size with the typical installation diagrams on page 3.
Horizontally installed valves larger than 8 inches (DN 200) should be removed from the pipe line for operations that involve removal and assembly of the main check valve. This is necessary for supporting and aligning the parts of the assembly during these operations.

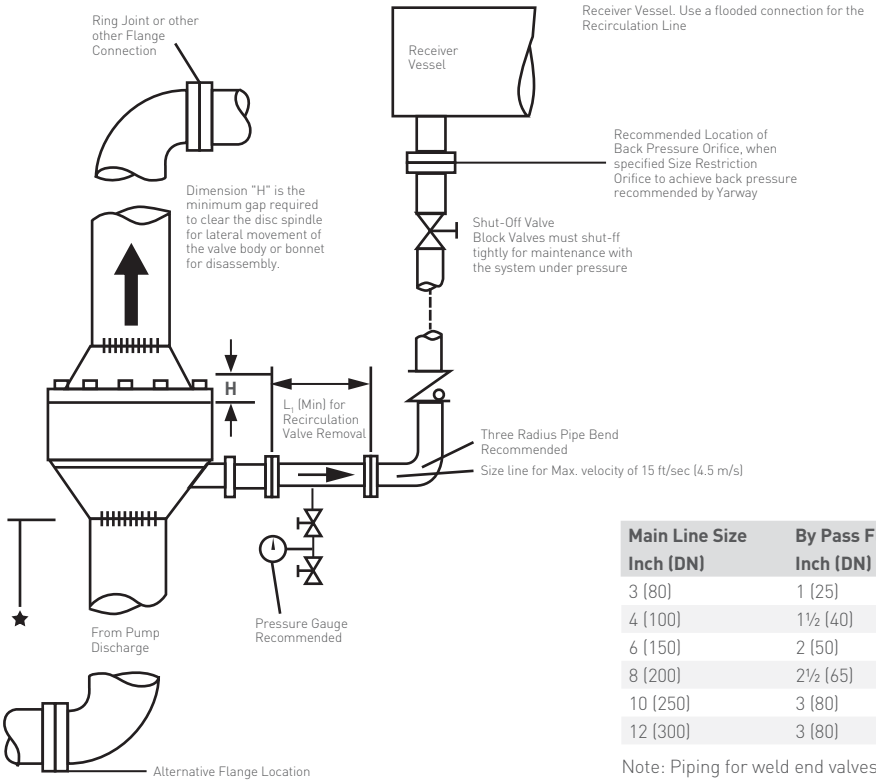
TYPICAL INSTALLATION
Flanged connections, vertical or horizontal mounting



Main Line Size Inch (DN)	By Pass Flange Inch (DN)	L1 Inch (mm)	L2 Inch (mm)
3 (80)	1 (25)	8 (203)	7 (178)
4 (100)	1½ (40)	11½ (291)	9 (229)
6 (150)	2 (50)	12½ (318)	12 (305)
8 (200)	2½ (65)	14 (356)	7 (178)
10 (250)	3 (80)	18½ (470)	9 (229)
12 (300)	3 (80)	21½ (545)	13 (330)

★See inlet piping recommendations

TYPICAL INSTALLATION FOR ARC VALVE
Welded connections vertical or horizontal mounting



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Note: Piping for weld end valves requires consideration of inspection and maintenance of Main Flow Check Valve.

★See inlet piping recommendations

INSTALLATION PROCEDURE

Do not install the valve until this section has been read and understood

Pre-Installation Check

Prior to installation, clean the line leading to the valve inlet of any debris that may have accumulated. Use of a strainer ahead of the pump is STRONGLY recommended during startup operations.
All elements of the ARC Valve are chosen in accordance with the original engineering and installation specifications supplied to Yarway. Make certain these specifications are still applicable to the valve. Changes in valve position, flow direction, flow, pressures or temperatures, maximum main flow or minimum required recirculation flow can cause unsatisfactory operation. When specification changes are apparent, contact Yarway. The accessibility of the ARC Valve will permit certain adjustments prior to installation, if required. Do not make any adjustments before consulting Emerson.

Do not use the recirculation flange connection as a lifting grip. Lifting lugs are provided on large valves. Remove all packaging material and shipping restraints, both interior and exterior. Use wooden support blocks to protect buttweld or flange surfaces from damage. Place the valve vertically upside-down on the wooden blocks with the disc weight supported by the spring. Push the disc from its seat and flush away any packaging debris with compressed air or high pressure water.

A threaded hole is provided at the exposed end of the cascade piston. Insert a matching ¼" -20 UNC (3" (DN 80) through 10" (DN 250) size valve) or ½"-13 UNC (above 10" (DN 250) size valve) threaded rod to check free movement of cascade piston. A force of 10 to 36 pounds (44.5 to 160 N) will move the ¼"-20 UNC threaded rod, while 36 to 65 pounds (160 to 289 N) will move the ½"-13 UNC threaded rod. Excessive forces indicate lodged debris or damage during transit. Excessive force cannot correct such conditions. The bypass elements must be removed to determine actual cause of resistance.

Welding

Valve body material is carbon steel ASME SA216 Grade WCB or stainless steel ASME SA351 Grade CF8M. Select compatible welding rod when installing ARC Valves with buttweld end connections and follow appropriate codes and regulations.
Protect the several O-ring seals during pre-heating, welding and post weld heat treatment procedures. See the cross-section drawing on page 7 for the location of the O-ring seals. The valves have a distinctive warning label that calls attention to the seals and a temperature limit of 400°F (204°C).
Full disassembly of the valve may be avoided if cooling can be provided to keep the seals below 350°F (177°C) while localized heat treatment of the weld is employed. Use of a temperature indicator applied to the valve surface near the body seal is strongly recommended during welding and heat treating.
Protect any exposed machined surtaces from weld spatter.
Use care to prevent piping strains at the valve inlet, outlet and recirculation connections.

OPERATIONAL CHECK

When the ARC Valve is properly installed, the recirculation flow should equal that of the design specification or exceed it by not more than 20%.
During start-up and original testing of the pump, the procedure outlined below is recommended to check the operation of the recirculation valve. A pressure gauge attached to the outlet flange of the recirculation valve is useful during operational checks. During such checks, however, downstream and upstream conditions should remain constant to insure reliable readings.
Proceed as outlined below to determine the recirculation valve opening and closing reference pressures.

Opening

1. Fully open the pump block and control valves. Open the recirculation shut-off valve; close the gauge valve.
2. Start the pump and establish main flow.
3. Throttle the main control valve until the recirculation valve opens; noticeable by an audible "tap" and hissing at the recirculation flange.
4. Open the gauge valve. Note gauge pressure at the recirculation outlet flange and main line pump pressure. This pressure differential is indicative of the recirculation flow rate.
5. Close the main conlrol valve. Again, note the pressures at the outlet flange and pump pressure.

The pressures recorded under the conditions above are reference indications of the recirculation valve in its open position. Condition (4) represents the "switch point" and (5) represents the zero main flow/full recirculation flow condition.

Closing

When the "opening" checks are completed, slowly open the main control valve until the automatic recirculation valve closes. An audible "tap" will be heard as the valve closes and the gauge at the outlet flange will show a normal static head. Note the pressure for future reference.
From the above noted pressures, the operation of the automatic recirculation is known. Maximum pressure at the outlet indicates maximum recirculation flow (valve open); minimum or static head pressure indicates zero recirculation flow (valve closed).
The pressure references above were observed under specific downstream and upstream conditions; if these conditions are changed, new references may be necessary.
The ARC valve was factory-adjusted to your specifications. Field adjustments are not normally required if operational checks indicate performance different from the original specifications and field adjustment appears necessary, contact Emerson for additional information.

VALVE MAINTENANCE

Except for periodic operational checks, the valve requires little maintenance. Yarway recommends that the check valve, spring and guides be inspected in 3 to 4 year cycles, and that the recirculation valve mechanism be inspected in 1 to 2 year cycles. This mechanism is easily removed whenever the system is secured with the ARC valve valved out.
Make certain that all line pressure is relieved and the piping is secured against pressurization before attempting disassembly for inspection purposes.

Disassembly

1. Dismantle the flanged elbow or short length of flanged pipe connected to the recirculation flange.
2. Remove the pressure gauge to prevent instrument damage.
   Never operate the ARC valve without the pilot valve. Serious pump damage can result.
3. Remove the bolts attaching the recirculation body to the main body; carefully slide out the recirculation body and cascade seat bushing to expose the cascade piston.
4. Except In 8" (DN 200) and some 4" (DN 100) and 6" (DN 150) valves, rotation of the cascade piston is prevented by a piston guide pin. Do not twist the piston for removal; never use a pipe wrench on the cascade piston surface or any other part of the bypass mechanism. The piston must slide freely from the control head. It necessary, a tee shaped threaded rod (¼"-20 UNC or ½" 13 UNC) can be inserted in the hole at the end of the valve. Light bumping of the tee-shaped rod is permissible.
5. Angular position of the control head is fixed by the guide pin. Do not damage the guide pin when pulling the control head from the main body.
6. Remove the pivot pin and lever. Note that the pivot pin is not on the centerline. It is important that this relation be properly set during reassembly to give correct operation. Note also that the lever has a small radius for contact with the pilot valve nut.

Repair and Inspection Seals—Inspect the condition of all elastomer seals and mating sealing surfaces. Seals should be flexible and free of cuts or gouges. Sealing surfaces must be free of burrs. Replace doubtful seals and carefully deburr any sealing surface with very fine emery cloth. Deep scratches will not seal when exposed to pressure.

Control Head/Cascade Piston—Examine the condition of the cascade seat bushing, cascade piston, piston guide pin, pivot pin and the guide pin for the control head. Replace any Items that are damaged or show evidence of severe wear or erosion.
Examine the sealing surfaces on the cascade piston and the cascade seat bushing. When there is evidence of gouges, grooving, (wire drawing) or a discontinuous wear pattern indicating seat eccentricity, the surface may be reconditioned by lapping. Use a very fine lapping compound just sufficient to obtain smooth, continuous seating surfaces. Thoroughly flush away all compound when lapping is completed.
Inspect the pressure passageways in the control head to be sure they are free of obstacles to flow. Clean out any deposils with a stiff wire and compressed air.

Pilot valve—The setting of the pilot valve was factory set and pinned through the pilot valve nut. The control head design prevents removal of the pilot valve without first removing the pin and pilot valve nut. Before attempting disassembly of the pilot valve, use a feeler gauge to measure the height from the control head to the underside of the pilot valve nut, when the pilot valve is firmly pressed against its seat. Feeler gauge measurement must be accurate within 005" (Q 1 mm). **Retain this measurement for future reference**

NOTE:
This measurement has been recorded on the valve performance curve supplied with every valve. If the actual measurement is in question and the performance curve is not available, please contact Emerson with the valve serial number to obtain correct measurement

1. Remove cotter pin to remove pilot valve nut.
2. Choose a small screwdriver that bottoms in the pilot valve slot to prevent slot distortion. Rotate pilot valve to back off pilot valve nut
3. Remove nut and pilot valve and inspect seating surfaces.

Reconditioning of Seating Surfaces by Lapping Seating

Seating surfaces of valves having integral and removable seats may be reconditioned by lightly lapping with a very fine lapping compound and rotating the pilot valve against the seat with a small screwdriver until a smooth, continuous, 360° seating surface at least 1/64" (0.4 mm) wide is obtained. All lapping compound should be flushed away when completed.
If the pilot valve seats cannot be reconditioned by lapping, machining of the seats or replacement of the pilot valve plug and seat may be necessary.

Reconditioning of Seating Surfaces by Machining

Resurfacing of the seat on the pilot valve plug, and the seat on the control head, are possible on valves which do not have removable seats. The amount of metal that can be removed from the seating surfaces is limited by the adjustment of the pilot valve nut and the requirement that the pilot valve must remain in its guide hole in lhe control head extension when the pilot valve is seated.

The male and female seating surfaces have a slight (0° to 1°) angular mismatch with the male surface being the smaller angle.

1. Measure the included angle of the pilot valve tip. Grind the tip to clean up to new condition with a tip angle 0° to ½° smaller than the nominal angle with a minimum of material removal.
2. The seat may be recut using a carbide tipped or high speed drill. Measure the diameter of the pilot valve hole in the control head. Select a drill that is the same nominal size as the measured diameter; no material is to be removed from the side of the hole during the seat repair. Grind the included angle on the tip of the drill to be 0° to ½° larger than the pilot tip, Hold the control head in a secure holding fixture and carefully align the drill to be exactly in line and centered in the pilot valve hole. A milling machine or other accurate drilling machine is recommended for this operation. Use a low turning speed (100 to 150 rpm) and recondition the seat to clean up with a minimum of material removal.
3. Clean the pilot valve hole and vent hole of all cutting oil and chips.
4. Carefully lap the pilot valve and seat together using a very fine lapping compound to develop a continuous seating surface at least 1/64" (0.4 mm) wide. Flush away all compound when completed.

Replacement of Removable Pilot Valve Seats

Detail A shows the design of the removable pilot valve. The plug and seat, items 34, 35 and 36, are supplied as a matched set. No further conditioning of the seating surfaces is required. The seat should be torqued to 75-100 inch-pounds (8.5-113 N•m). The pilot valve plug and nut can then be reassembled with the pilot valve nut being adjusted to the previous feeler gauge measurement. Be sure the pilot valve is pressed firmly against its seat when final adjustment is made If slots in the pilot valve nut are not aligned with the pilot valve hole, rotate the pilot valve counterclockwise to expose the next opening. Insert a cotter pin to secure the pilot valve nut to the pilot valve. The cotter pin must not prevent 360° rotation of the pilot valve assembly in its seat.

Reassembly

Apply a light coating of liquid soap or clean water on sealing surfaces and moving perts to aid in reassembly and prevent damage to elastomer seals. Do not use petroleum base lubricants on E.P.R. O-ring seals, since such lubricants can alter the seal effectiveness. Choose lubricants which are compatible with the process fluid.

1. Replace the pivot pin and lever with the parts properly oriented. Slide the control head in the main valve body, guiding the lever into the lever bushing on disc and aligning the guide pin with the hole in the control head.
2. Assemble the cascade piston in the control head, engaged with the piston guide pin, if a guide pin is incorporated.
3. Place the cascade seat bushing on the cascade piston and secure in place with the recirculation body and cap screws which have been lubricated with an anti-seize compound, Evenly torque the cap screws to the values listed in the following table

Cap Screw Size, Inch	Torque, Ft-Lb (N•m)
3/8	15/18 (20.3/24.4)
7/16	25/30 (33.9/40.7)
1/2	38/45 (51.5/61)
5/8	75/90 (101.7/122)
3/4	135/160 (183/217)
7/8	215/225 (292/305)
1	325/385 (441/522)
1 1/8	450/500 (610/678)
1 1/4	600/660 (814/895)
1 3/8	840/925 (1139/1254)
1 1/2	1125/1225 (1526/1661)

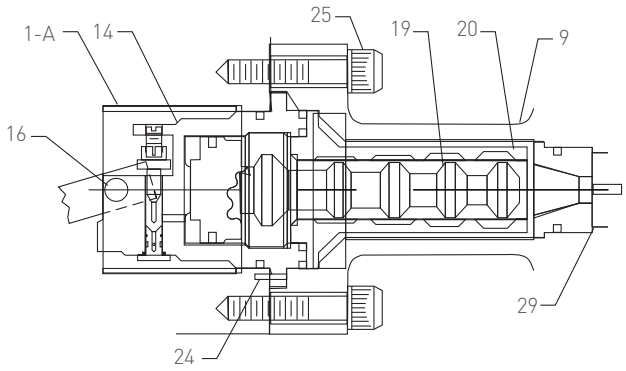
Use threaded rod (1/4 -20 UNC or 1/2 -13 UNC) inserted in the hole at the end of the piston to check for movement. Drag due to piston sealing friction should be:

Nominal Valve Size, In. (DN)	Approximate Drag, Lbs (N)
3 (80)	10 (44.5)
4 (100)	15 (67)
6 (150)	18 (80)
8 (200)	25 (111)
10 (250)	36 (160)
12 (300)	40 (177)

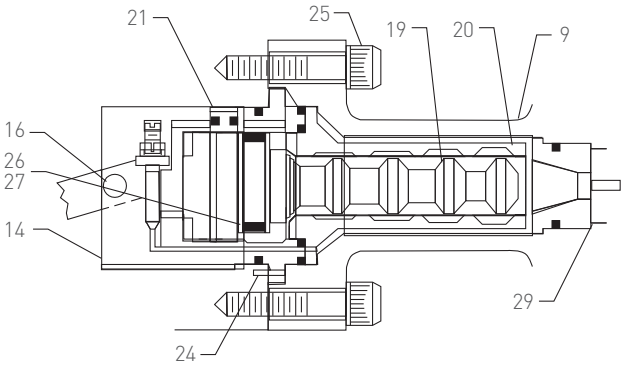
Excessive drag, indicating pinched seals or foreign debris, must be corrected.

4. Perform "Operational Checks" to re-confirm pressure references for opening and closing.

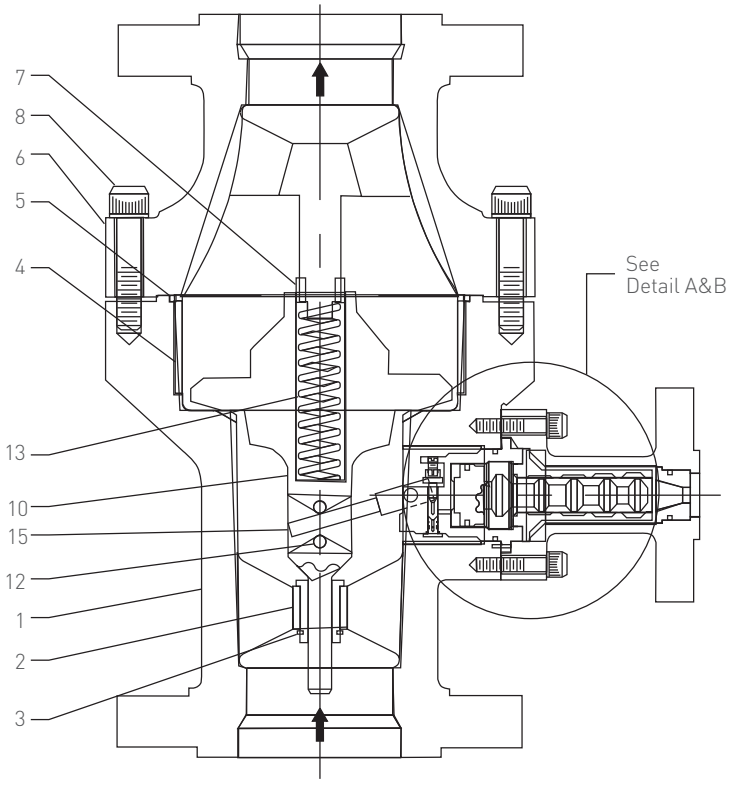
DETAIL A—4" (DN 100) to B" (DN 200) (6000 Series Serial Numbers) (DN 400) Valves having removable seats



DETAIL B—Valves with integral seats



ARC VALVE CROSS SECTION



Item	Name of Part	Material
1	Body	Cast Steel
2	Body Bushing	Stainless Steel
3	Retaining Ring	Stainless Steel
4	Liner	Stainless Steel
5	O-ring	Elastomer
6	Bonnet	Cast Steel
7	Guide Ring	Stainless Steel
8	Cap Screw	Alloy Steel
9	Bypass Body	Cast Steel
10	Disc	Cast Steel
12	Disc Pins	Stainless Steel
13	Spring	Stainless Steel
14	Control Head	Stainless Steel
15	Lever	Stainless Steel
16	Pivot Pin	Stainless Steel
17	Pilot Valve	Stainless Steel
18	Pilot Valve Nut	Stainless Steel
19	Cascade Piston	Stainless Steel
20	Cascade Seat Bushing	Stainless Steel
21[1]	Piston Guide Pin	Stainless Steel
22[3]	O-ring	Elastomer
22A[3]	O-ring	Elastomer
23	O-ring	Elastomer
24	Guide Pin	Stainless Steel
25	Cap Screw	Alloy Steel
26	Seal Ring	Teflon
27	O-ring	Elastomer
28	O-ring	Elastomer
29	Bypass Orifice	Stainless Steel
30	O-ring	Elastomer
34[2]	Pilol Valve Seat	Stainless Steel
35[2]	O-ring	Elastomer
36[2]	O-ring	Elastomer

1. Not used on Valves with 6000 Series Serial Numbers.
2. Used only on Valves with 6000 Series Serial Numbers.
3. 4" and 6" valves require one 22 and one 22A
   3", 8" end target Valves require two 22 (22A replaced by 22).

TROUBLE-SHOOTING GUIDE

Symptom	Probable cause	Corrective action
Pump overheats	• Insufficient pump flow	• Check pump suction head, piping and valving for closed valves. • Check recirculation line and valves for blockage. • Check pressure in recirculation line at ARC valve outlet for high back pressure. • Check freedom of recirculation valve and pilot valve in opening. Compare flows and pressures with those obtained during operational tests
Loss of pump head	• Piping system restrictions. • Pump flow higher than normal. • Recirculation valve remains open	• Check main flow system piping and valving. • Compare flows/pressures with operational tests • Check freedom of recirculation valve to close • Check pilot valve seat for wear; recondition.
Piping noise and/or vibration develops during recirculation.	• Restricted line • Vaporizing or cavitation in outlet line	• Check recirculation line and valving • Check recirculation line pressure versus design specification. Compare pressure with fluid vapor pressure; increase recirculation line pressure if operating within 20 to 30 psi (14 to 21 MPa) of vapor pressure; check effect on recirculation flow rate. • Correct "water hammer" by use of accumulator or other means • Operate with higher or lower flow than at switch point
Indication of reverse flow through check valve .	• Disc held off seat • Foreign object lodged between main check valve and seat	• Flushing may remove small objects. • Disassemble valve at body/bonnet joint. Clear any foreign objects; inspect freedom of disc motion; relap seat and disc . If necessary.
Recirculation flow too high or too low	• Error in switch point or recirculation valve flow coefficient	• On original installation, contact Emerson. • After "Maintenance", review assembly operation in "Maintenance" section of manual and repeat assembly as described.
Recirculation valve stays open	• Pilot valve not closing tight . • Pilot seat seal ring omitted or damaged	• Lap seat and valve tip. Repair or replace as necessary. • Inspect and replace as necessary
Valve develops leak between body-bonnet or body-bypass connection.	• Internal seal deterioration or damage .	• Disassemble and inspect to determine location of leak. O-ring seals require smooth surfaces for sealing; increasing bolt torques will not seal leaks. Repair surfaces and replace seals.