



Worcester Controls

# ***1/2"–2" Series 94 and FZ94 Three-Piece Ball Valves, 1/2"–6" Series 94 and FZ94 150/300, 1"–2" Series 94 600, and 4"–6" Series AF94 150/300 Flanged One-Piece Ball Valves Installation, Operation and Maintenance Instructions***

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**CAUTION:** Flowserve recommends that all product which must be stored prior to installation be stored indoors, in an environment suitable for human occupancy. Do not store product in areas where exposure to relative humidity above 85%, acid or alkali fumes, radiation above normal background, ultraviolet light, or temperatures above 120°F or below 40°F may occur. Do not store within 50 feet of any source of ozone.

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## **I. INSTALLATION**

- A. Standard 94 Series three-piece and flanged one-piece valves may be installed for flow or vacuum in either direction. Use care to exclude pipe sealants from the valve cavity. Valves with upstream relief hole in ball (V3 option) are one-way valves.
- B. When installing 94, AF94 or FZ94 flanged one-piece valves, use standard gaskets suitable for the specific service. Tighten flange bolts or studs evenly. Follow ANSI standards for flange bolt torque.
- C. For Weld End Valves (SW, BW):

**NOTES:** Prior to welding, **THOROUGHLY CLEAN ALL JOINT SURFACES** to prevent contamination.

Valves with "PG", "RG", "XG", "AG" and "GG" seat/body seal combinations and V67 option code are compatible with welding temperatures. Therefore, these valves are weld-as-is and do not have to be disassembled to be welded in line. A red welding tag will be attached to the valve. If these valves are disassembled, the

graphite-coated stainless steel gasket body seals (code "G") and the seat back seals (used with "A" or "G" seats only) must be replaced. When welding these valves, the ball must be open to prevent adhesion of weld spatter to the ball. Use STICK or MIG welding and allow valve and joint to cool to the touch between passes.

For All Other Weld End Valves:

1. Tack weld the valve in place.
2. Remove three body bolts, loosen the fourth and swing out the body with valve open. Close the valve and remove the seats, ball and body seals.  
**NOTE:** FZ94 valves can not be swung out. Remove fourth bolt and spread pipe ends to clear centering ring (Revision R3 FZ94 valves with "G" seats, and all Revision R4 and later FZ94 valves do not have centering rings). Close valve, remove ball, seats, body seals.
3. Swing body in and secure it with one additional body bolt diagonally from first.
4. Weld pipe ends. When gas welding, DO NOT play flame on the valve body.
5. Allow valve to cool. Reassemble valve. Install new body seals, or coated stainless steel "S" gaskets (code M or G), if they were shipped separately from the valve, discarding the temporary Buna body seals found in the valve as received. See I.D.3.

- Tighten and torque the body bolts of the valve evenly and diagonally opposite each other, alternating in a criss-cross pattern. Use the torque figures shown:

Carbon Steel Bolts			Stainless Steel & Alloy 20 Bolts		
Bolt Dia.	In.-Lbs.	Ft.-Lbs.	Bolt Dia.	In.-Lbs.	Ft.-Lbs.
1/4"	96-120	8-10	1/4"	72-94	6-8
5/16"	156-204	13-17	5/16"	120-144	10-12
3/8"	216-264	18-22	3/8"	192-216	16-18
7/16"	480-540	40-45	7/16"	336-384	28-32
1/2"	720-780	60-65	1/2"	504-552	42-46

**NOTE:** Stainless steel bolts and nuts are used in all three-piece valves with stainless steel bodies and also valves with "GG" seats and body seals.

**D. CAUTION: The fluoropolymer body seals (code T) and the coated stainless steel stainless steel gaskets (codes M & G) make excellent seals. However, some points of caution in their use need emphasizing:**

- No coated stainless steel gasket body seal, graphite seat back seal or fluoropolymer part (except a seat) is reusable. Upon disassembly of the valve, they should be discarded and replaced with new parts.
- Avoid scratching or damaging the fluoropolymer seals or the coating of the "S" gaskets during installation. Light lubrication of these seals can help to prevent damage.
- "S" gaskets are installed with the wide flange against the valve body (see View A-A on page 7).
- Care must also be taken when handling graphite seat back seals, stem seals, thrust bearings, and body seals. These parts can be easily damaged by squeezing the O.D. Parts should be handled on the flat surfaces rather than the O.D. These parts will not work if they are cracked or broken. Light flaking of the material is acceptable.
- The ball used in "A" or "G" (filled metal) seated valves is round to special tolerances. To ensure proper contact with the seat, do not drop, dent or scratch the ball during handling. These balls also have an anti-galling coating; DO NOT use uncoated balls with filled metal seats.

## II. OPERATION

- The operation of the valve consists of turning the stem (by manual or automated means) 1/4 turn clockwise to close and 1/4 turn counter-clockwise to open. When the handle (if used) and/or stem flats or groove are in-line with the pipeline, the valve is open.

- 94 Series valves will provide bubble-tight shutoff when used in accordance with Worcester's published pressure/temperature chart, with the exception of "G" seated valves. Valves with "G" seats meet the leakage rates of ANSI B16.104 Class VI.
- Do not leave the ball partly open (throttling operation) without having first determined whether the pressure drop and/or flow rate are detrimental to the valve seats. These conditions should be checked with Worcester's Control Valve Manual or the factory.
- As shipped from the factory, valves (except oxygen prepared (prefix code "X"), and valves with V38 or V46 options) contain a silicone-based lubricant. This is for break-in purposes and may be removed if it is objectionable for a particular application by disassembling and solvent washing. Lacquer thinner will remove the lubricant. "A" or "G" (filled metal) seated valves should not be operated without a break-in lubricant.
- Media that can solidify, crystallize or polymerize should not be allowed to stand in ball valve cavities.
- Torque Requirements: Operating torque requirements will vary depending on the length of time between cycles, media in the system, line pressure and type of valve seats. The figures in the following table are based on laboratory tests with clean tap water as the media. They are measured at WOG rated pressure, 70°F, after 24 hours. For a more detailed analysis of valve torque requirements, see Worcester's Actuator Sizing Manual.

**Maximum Expected Breakaway Torque (In.-Lbs.)**

Valve Size	All Seats	
	Except A, G, X	A, G, X Seats Only
1/2"	125	225
3/4"	150	275
1"	250	360
1 1/4"	400	550
1 1/2"	600	750
2"	750	850
3"	1800	2100
4"	2500	3600
6"	6500	7500

**NOTE:** Media that contain fine powders (25 microns or less) will significantly raise ball valve torque requirements.

## III. MAINTENANCE

For maximum stem seal life, proper packing adjustment procedure must be followed.

- Tighten packing gland bolts to the torque values in the table below. Alternate between the two gland bolts when tightening to maintain the alignment of the gland plate with the top of the valve body. Some rocking of the gland plate can be tolerated; however, excessive misalignment may cause premature failure of the stem packing.

Gland Bolt Torque (In.-Lbs.)		
Valve Size	"T" Packing	"G" Packing
½"-¾"	40-45	90-110
1"-1¼"	65-70	120-140
1½"-2"	85-95	210-230
3"-4"	175-200	270-295
6"	240-265	340-365

**NOTE:** After adjustments, packing creep will occur over several hours. Bolt torque measured then will be less.

## IV. REBUILDING

This manual contains exploded views of the valves covered by the text. They have been included to aid in the rebuilding of the valves. Please refer to them when following the written instructions.

**▲ WARNING: BALL VALVES CAN TRAP PRESSURIZED FLUIDS IN THE BALL CAVITY WHEN CLOSED.**

Special handling and cleaning procedures are necessary for oxygen and vacuum service valves. Refer to industry practices when overhauling these units.

If the valve has been used to handle hazardous media, it must be decontaminated before disassembly. It is recommended that the following steps be taken for safe removal and disassembly:

- Relieve the line pressure. Operate the valve prior to attempting removal from line.
  - Place the valve in half-open position and flush the line to remove any hazardous material from the valve body.
  - All persons involved in the removal and disassembly of the valve should wear the proper protective clothing such as a face shield, gloves, apron, etc.
- A. A standard repair kit can be ordered for the 94 Series valve containing all the necessary parts for standard valve rebuilding; seats, seat back seals (used with "A" and "G" filled metal seats only), body seals, split thrust bearing, split ring, all non-metallic stem packing parts, and Belleville washers. To order, specify the valve size and series, the material of the ball, seats and body seals, and the "R" number (Revision Number) or for non-standard valve, the "P" number, "T" number, "C" number, or similar number. This information is found on the nameplate on the valve body. If valve body is stainless steel, place a "6" after valve size in repair kit ordering code.

**Repair Kit Ordering Examples:**

1" RK94 6PM R0      3" RK94 PT R0      2" 6 RK94 6PM R1  
 1" FZRK94 PM R1      3" FZRK94 RZ R0      2" RK94 AG T0726

**CAUTION:** If the seats and seals installed differ from those removed, the valve nameplate **MUST** be replaced or re-marked to indicate the altered materials and ratings or valve tagged to so indicate.

**B. TO DISASSEMBLE ½"-2" THREE-PIECE 94 VALVES:**

1. Place valve in open position. Remove three body bolts and nuts and loosen fourth to swing the center section out from between the pipe ends, or remove all four bolts to remove the valve from the line; whichever is more convenient. FZ94 valves require spreading the pipe ends to clear the centering rings (Note: Revision R3 FZ94 valves with "G" seats, and all Revision R4 and later FZ94 valves do not have centering rings).
2. Close the valve. Remove the seats, seat back seals (if any), ball and body seals.
3. Remove the handle (if any), gland bolts, Bellevilles, gland plate and follower(s) (1 or 2 pcs.) from the top of the valve.
4. Remove the stem and packing from the valve:
  - a. Push the stem down into the body cavity.
  - b. Remove the split ring and split thrust bearing from the recessed diameter above the stem tang.
  - c. Remove the stem from the top of the body. This may require considerable force. The flats on the stem can be clamped in a vise or other fixture to aid in removal. Avoid damaging the stem flats. The packing will be removed with the stem by the shoulder on the end of the stem.

**CAUTION:** Use care to avoid scratching the surface of the stem and packing chamber.

- d. Remove the packing from the stem.

**TO DISASSEMBLE ½"-2" FLANGED ONE-PIECE VALVES:**

5. Place valve in closed position.
6. Unscrew end plug and remove. If required, end plug disassembly tools are available from your supplier or from Flowserve Corporation.
7. Remove body seal, ball, seats and seat back seals (if any).
8. Remove the handle (if any), gland bolts, Belleville washers, gland plate and follower(s) (1 or 2 pieces) from the top of the valve.
9. Remove the stem and packing from the valve:
  - a. Push the stem down into the body cavity.
  - b. Remove the split ring and split thrust bearing from the recessed diameter above the stem tang.

- c. Remove the stem from the top of the body. This may require considerable force. The flats on the stem can be clamped in a vise or other fixture to aid in removal. Avoid damaging the stem flats. The packing will be removed with the stem by the shoulder on the end of the stem.

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**CAUTION: Use care to avoid scratching the surface of the stem and packing chamber.**

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- d. Remove the packing from the stem.

**TO DISASSEMBLE 3"-6" FLANGED ONE-PIECE VALVES:**

- 10. Place valve in closed position. Remove end plug retaining screws.
- 11. Remove end plug. If necessary, drive end plug from valve, using wooden drift applied to face of ball. Be certain the ball is fully closed.
- 12. Remove body seal, ball, seats, and seat back seals (if any).
- 13. Remove the handle assembly, spacer, and stop (if any), gland bolts, Belleville washers, gland plate and follower(s) (1 or 2 pieces) from the top of the valve.
- 14. Push the stem down into the body cavity and remove.
- 15. Remove the thrust bearing and stem packing from the body.

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**CAUTION: Use care to avoid scratching the surface of the stem and packing chamber.**

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**C. VISUAL INSPECTION**

- 1. The ball and surfaces against which the seats and seals are installed should be undamaged, clean, and free of pit marks and scratches. Light marring from the action of the ball against the seats is normal and will not affect the operation of the valve. Flaws that can be seen, but barely detected with fingertips, are acceptable.
- 2. The stem and body surfaces that the stem seals and thrust bearing contact must be undamaged, clean and free of pit marks and scratches.

**D. REASSEMBLY**

**NOTE:** Valves with a pressure relief hole in the ball (V3) must be assembled with the hole upstream when valve is closed. Any valve with this V3 option will have an arrow indicating downstream. This arrow is stamped on the body or on a metal tag welded to the body.

Clean all sealing surfaces of the valve including the ball.

Lightly lubricate the ball, seats, seat back seals (if used), body seal(s), split thrust bearing and split ring or one-piece thrust bearing, and stem seals with a lubricant compatible with the media being handled (except for valves with V38 option, which are assembled dry) as the parts are used. White petroleum jelly is a good general purpose lubricant. For oxygen prepared valves (prefix code "X"), use a PTFE-based lubricant such as Fluorolube

S-30 or equivalent. Filled metal seats will be lubricated at the factory. If they are not, they should be lubricated as previously stated. The seat back seals will be preassembled to the seat backs. Do not operate a newly rebuilt valve with filled metal seats without lubricant.

If graphite parts are used, they should be handled on the flat surfaces rather than the O.D. These parts can be damaged by squeezing the O.D. and will not work if they are cracked or broken. Light flaking of the material is acceptable.

**TO REASSEMBLE ½"-2" THREE-PIECE VALVES:**

- 1. Insert the stem down through the bonnet and into the body.
- 2. Place the split thrust bearing in the recessed diameter above the stem tang. Place the split ring in the same recessed diameter, under the split thrust bearing (refer to exploded view).
- 3. Pull the stem up so that the split thrust bearing and split ring are drawn into the stem hole recess in the ball cavity. See instructions 21 through 26 for stem packing and gland plate assembly.
- 4. With the valve in the closed position (stem flats going across pipeline), replace the ball, seats and seat back seals (with "A" or "G" seats only). Open the ball and add the body seals. For "S" gaskets, see cautions I.D.1 - I.D.5. If seat back seals are used, be certain that they are correctly located on the seat back face before putting the center section between the pipe ends. Damage may occur and leaks or high operating torque may result if the seat back seals are not located correctly.
- 5. Place the center section between the pipe ends and replace the four body bolts and nuts. Tighten finger-tight. For FZ94 valves, insert the centering rings (if any) into the pipe ends before installing the center section of the valve.

**TO REASSEMBLE ½"-2" FLANGED ONE-PIECE VALVES:**

- 6. On all sizes except the ½", place the far seat and seat back seal (used with "A" or "G" seats only) in the body cavity. If seat back seals are used, be certain that they are correctly located on the seat back face before installing the ball and end plug. Damage may occur and leaks or high operating torque may result if the seat back seals are not located correctly.
- 7. Insert the stem down through the bonnet and into the body.
- 8. Place the split thrust bearing in the recessed diameter above the stem tang. Place the split ring in the same recessed diameter, under the split thrust bearing (refer to exploded view).
- 9. Pull the stem up so that the split thrust bearing and split ring are drawn into the stem hole recess in the ball cavity. See instructions 21 through 26 for stem packing and gland plate assembly.
- 10. Install far seat (½" valves only). With the valve in closed position (stem flats going across pipeline), insert the ball into the body so that the stem slot engages the tang on the stem.

11. Install the body seal. Be certain that the body seal rests squarely on the sealing surface in the body. For "S" gaskets, see cautions I.D.1 - I.D.5.
12. Insert the seat and seat back seal (if used) in the cavity in the end plug.
13. Install the end plug into the body and tighten until the body and end plug make metal-to-metal contact. The end plug may project up to .009" beyond the surrounding serrated surface. End plug must be fully tightened against machined step in body. If in doubt, assemble end plug without seat and seal, make a witness mark, then reassemble the full assembly.
14. For "G" Packing - Two graphite packing rings, lantern ring-G, two graphite packing rings, two followers-G or one-piece follower-G.
22. Install gland plate over stem.
23. Valves with "T" and "G" packing both use twelve Belleville washers. The arrangement of the washers is different for each type of packing (refer to packing assembly drawings Figures 1 and 2):
  - a. For "T" Packing - Use three sets of two washers on each bolt. Each set consists of two Bellevilles opposing each other with their O.D.s touching.
  - b. For "G" Packing - Use three nested Bellevilles opposing three nested Bellevilles on each bolt. The middle two will have their O.D.s touching.

**TO REASSEMBLE 3"-6" FLANGED ONE-PIECE VALVES:**

14. Place the thrust bearing on the stem.
15. Insert the stem and thrust bearing into the body through the ball cavity. See instructions 21 through 26 for stem packing and gland plate assembly.
16. Place one of the seats and seat back seal (used with "A" or "G" seats only) in the body. If seat back seals are used, be certain that they are correctly located on the seat back face before installing the ball and end plug. Damage may occur and leaks or high operating torque may result if the seat back seals are not located correctly.
17. With the valve in closed position (stem groove going across pipeline), insert the ball into the body so that the stem slot engages the tang on the stem.
18. Install the body seal. Be certain that the body seal rests squarely on the sealing surface in the body. CAUTION: If the body seal is installed on the end plug, it will be damaged.
19. Insert the seat and seat back seal (used with "A" or "G" filled metal seats only) in the cavity in the end plug.
20. Assemble the end plug into the body as far as it will go. Secure with end plug retaining screws, tightening each one firmly. The end plug screws only retain the end plug. Flange bolt force is required to compress the body seal and seat the end plug. Proper installation will allow not more than .010" protrusion of the end plug beyond the valve body.

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**CAUTION: Tightening the gland bolts can cause the stem to be pushed into the ball cavity. The stem must either be fixtured to prevent this, or be worked back into position when assembling the ball and seats into the body.**

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Upon reinstallation of the valve in the line, retighten the end plug retaining screws after the flange bolts are fully torqued.

**THE FOLLOWING INSTRUCTIONS ARE FOR ALL 94 VALVES:**

21. *NOTE: Be certain that the stem seals are lubricated per Section IV.D. prior to assembly.*

Install the following parts over the stem and into the packing chamber in this order (refer to packing assembly drawings Figures 1 and 2):

  - a. For "T" Packing - Filler ring, 629 seal, lantern ring-T, three Chevron packing rings (for 1/2"-2" 94 three-piece and one-piece valves only, one Chevron ring is of carbon filled fluoropolymer material and black in color and must be positioned as the top ring), follower-T, follower-G or one-piece follower-T.

24. Lubricate the gland bolt threads with an anti-galling agent, such as Christo-Lube MCG-111. Install gland bolt/Bellevilles through the gland plate and thread them into the body. Tighten the gland bolts per Section III.A. Be certain that the bolts do not bind - this can result in improper packing loading.
25. Tighten the body bolts per Section I.C.6. (1/2"-2" three-piece valves only).
26. Add handle (if any) and tighten the handle set screws.

For 3"-6" flanged one-piece valves add stop, spacer and handle assembly (if used) and tighten handle retaining bolt. Note: The spacer is to be used only if one was removed with the handle assembly and stop.

## V. RECOMMENDED SPARES

When ordering parts, please provide the part name and all the valve code information found on the nameplate on the body: valve size, style, materials, ends and "R" number (Revision Number).

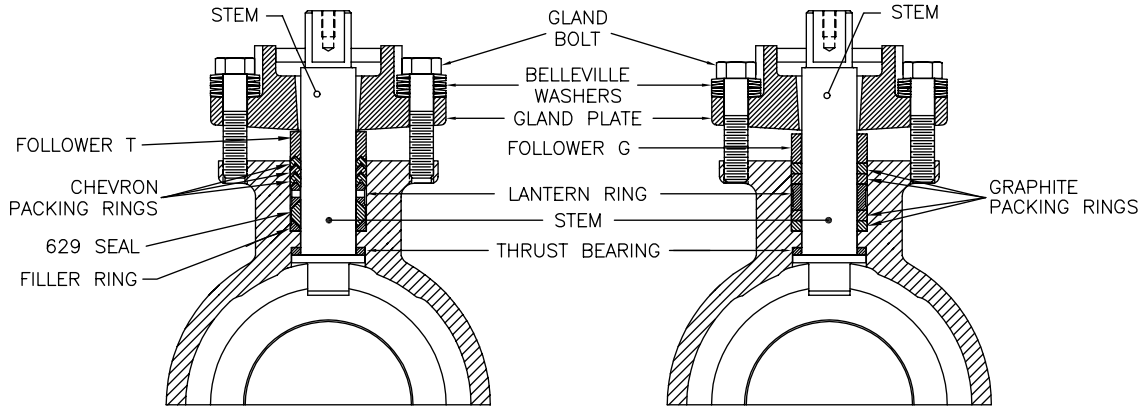
Example: 1" 94 66 RV SE R0 Ball or 3" 94 46 GZ150 R0 Stem

Valves may also be marked with an additional "P", "T", "C", or similar number. These numbers designate non-standard products and must be specified along with the valve code.

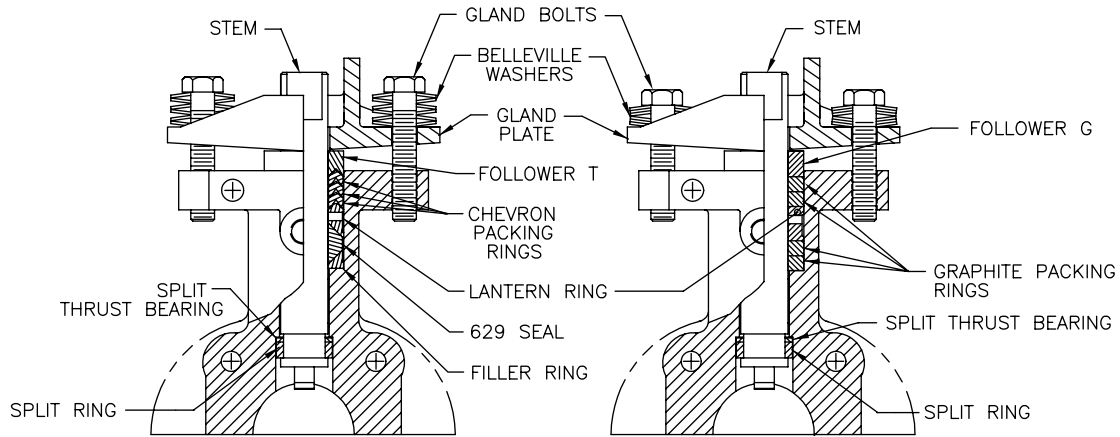
Example:

1" 94 66 RV SE P-2933 Ball or 1/2" 94 66 GZ300 T-1340 Stem





**3"-6" Flanged One-Piece Valves**



$\frac{1}{2}$ " - 2" 3-PIECE AND FLANGED ONE-PIECE VALVES

**"T" Packing Detail**

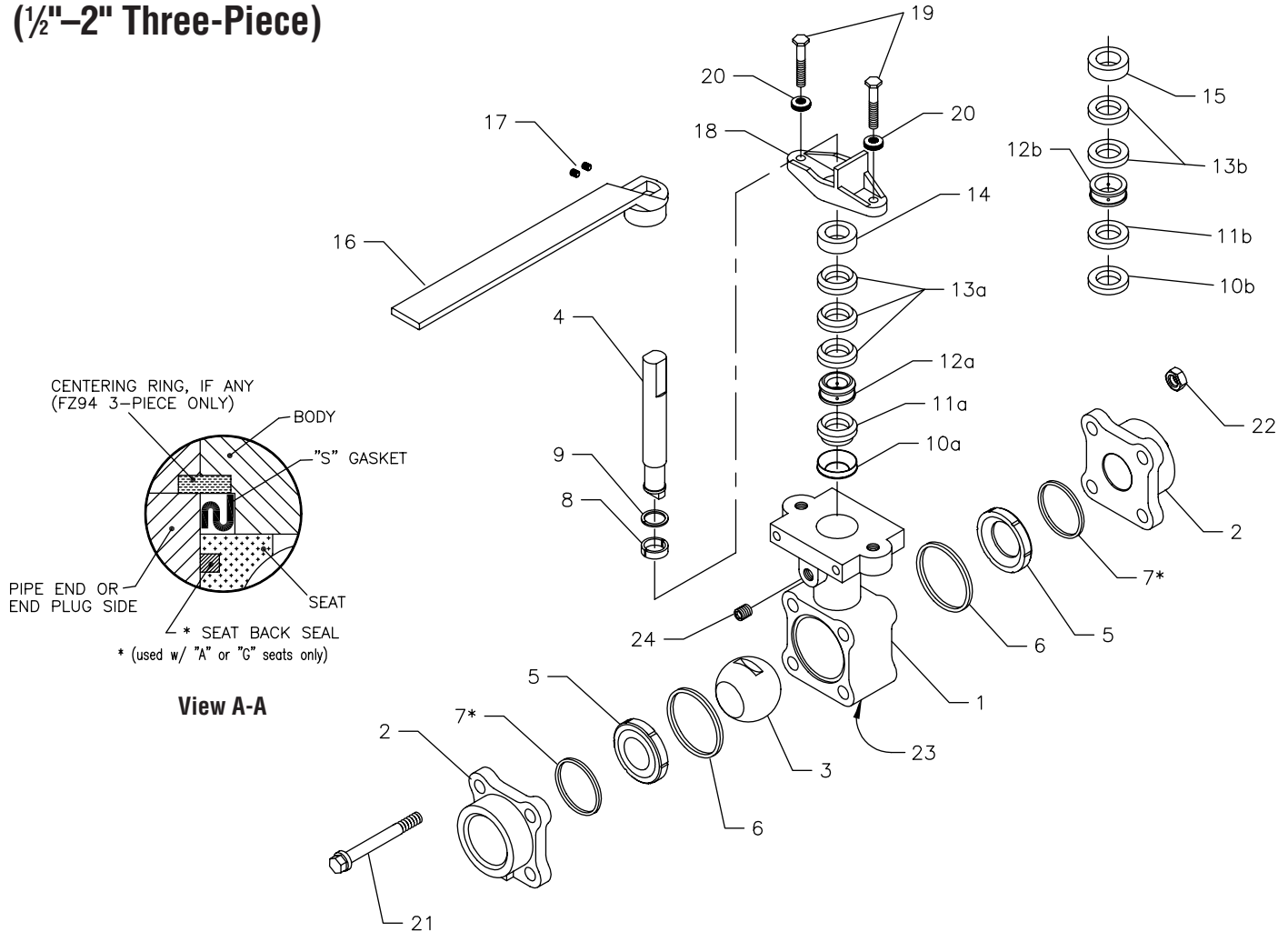
**"G" Packing Detail**

Figure 1

Figure 2

**Series 94**

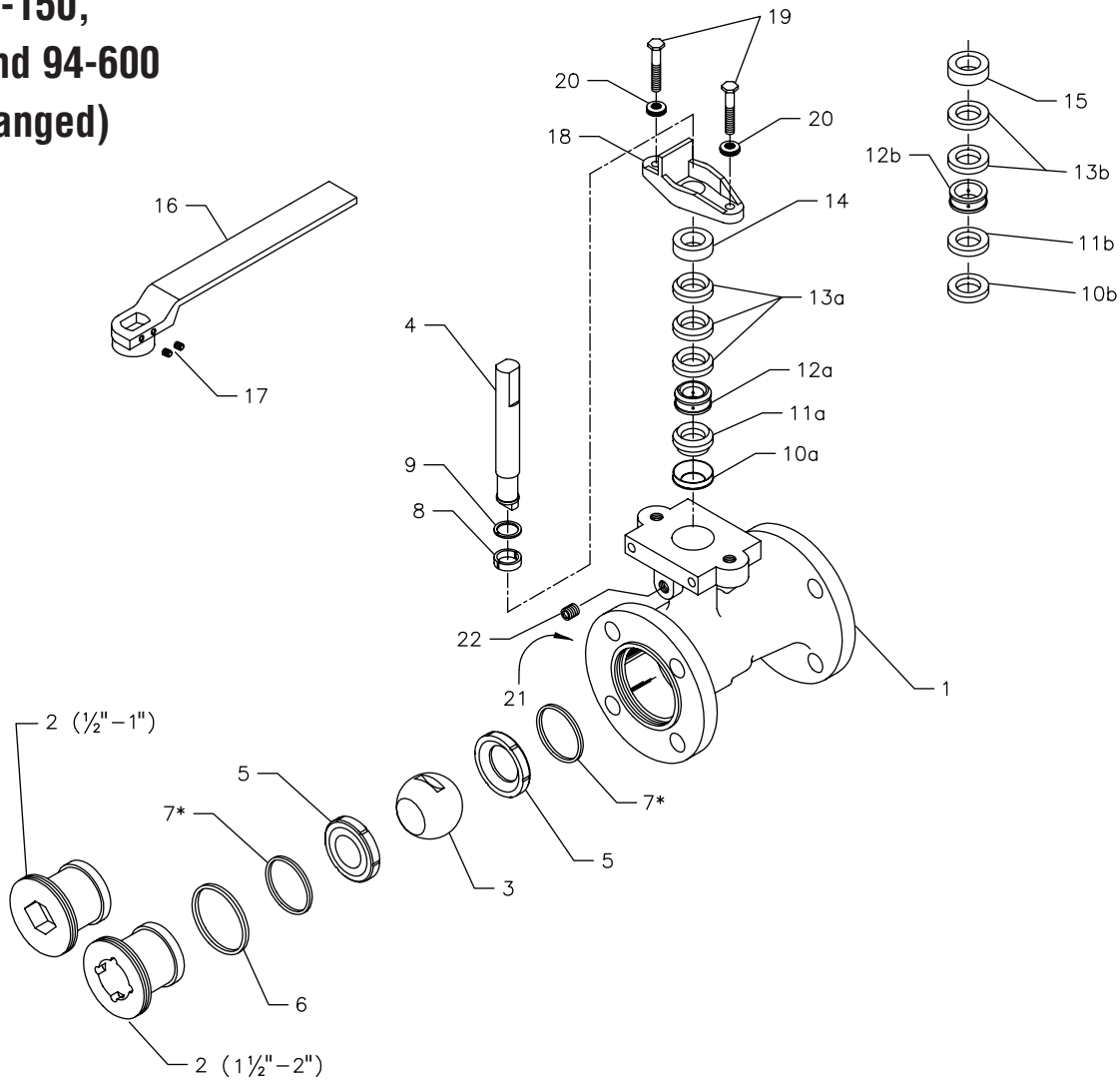
**(1/2"-2" Three-Piece)**



Part	Name	Qty
1	Body	1
2	Pipe End	2
3	Ball	1
4	Stem	1
5	Seat	2
6	Body Seal	2
*7	Seat Back Seal (Metal Seats Only)	2
8	Split Ring	1
9	Thrust bearing	1
10a	Filler Ring	1
10b	Graphite Ring	1
11a	629 Seal	1
11b	Graphite Ring	1
12a	Lantern Ring T	1

Part	Name	Qty
12b	Lantern Ring G	1
13a	Chevron Ring	3
13b	Graphite Ring	2
14	Follower T	1
15	Follower G	1
16	Handle (Optional, ordered separately)	1
17	Set Screw (Handle)	2
18	Gland Plate	1
19	Gland Bolt	2
20	Belleville Washer	12
21	Body Bolt	4
22	Body Nut	4
23	Name Plate	1
24	1/2" NPT Pipe Plug	1

**Series 94-150,  
94-300 and 94-600  
(1/2"-2" Flanged)**

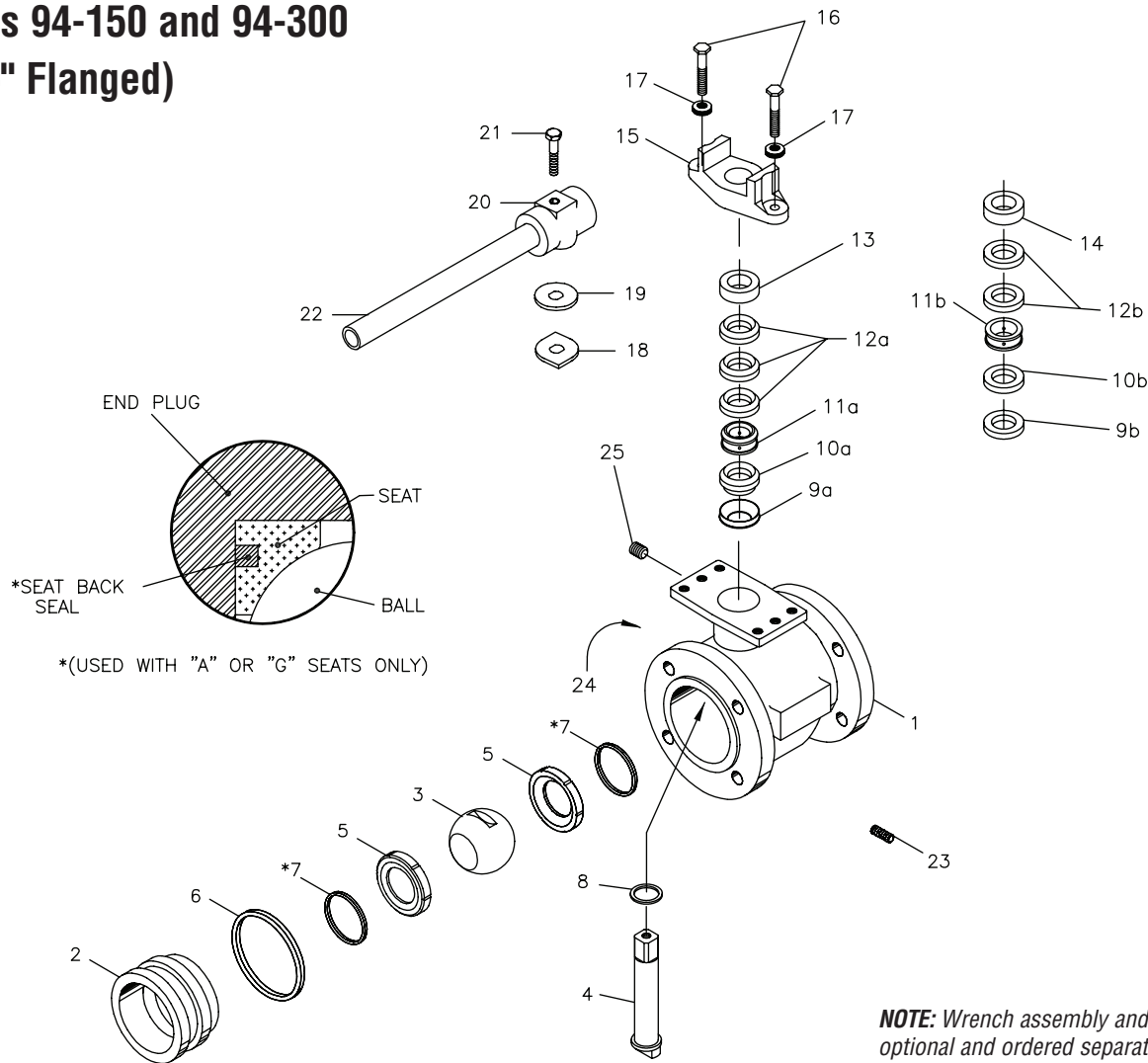


Part	Name	Qty
1	Body	1
2	End Plug	1
3	Ball	1
4	Stem	1
5	Seat	2
6	Body Seal	1
*7	Seat Back Seals (Metal Seats Only)	2
8	Split Ring	1
9	Thrust bearing	1
10a	Filler Ring	1
10b	Graphite Ring	1
11a	629 Seal	1
11b	Graphite Ring	1

Part	Name	Qty
12a	Lantern Ring T	1
12b	Lantern Ring G	1
13a	Chevron Ring	3
13b	Graphite Ring	2
14	Follower T	1
15	Follower G	1
16	Handle (Optional, ordered separately)	1
17	Set Screw (Handle)	2
18	Gland Plate	1
19	Gland Bolt	2
20	Belleville Washer	12
21	Name Plate	1
22	1/8" NPT Pipe Plug	1



**Series 94-150 and 94-300  
(3"-6" Flanged)**



**NOTE:** Wrench assembly and stop are optional and ordered separately.

Part	Name	Qty
1	Body	1
2	End Plug	1
3	Ball	1
4	Stem	1
5	Seat	2
6	Body Seal	1
*7	Seat Back Seals (Metal Seats Only)	2
8	Thrust bearing	1
9a	Filler Ring	1
9b	Graphite Ring	1
10a	629 Seal	1
10b	Graphite Ring	1
11a	Lantern Ring T	1
11b	Lantern Ring G	1
12a	Chevron Ring	3

Part	Name	Qty
12b	Graphite Ring	2
13	Follower T	1
14	Follower G	1
15	Gland Plate	1
16	Gland Bolt	2
17	Belleville Washer	12
18	Stop	1
19	Spacer (not always present)	1
20	Wrench Block	1
21	Hex Head Bolt	1
22	Wrench Extension	1
23	End Plug Screw	4-8
24	Name Plate	1
25	1/8" NPT Pipe Plug	1





Flowserve Corporation has established industry leadership in the design and manufacture of its products. When properly selected, this Flowserve product is designed to perform its intended function safely during its useful life. However, the purchaser or user of Flowserve products should be aware that Flowserve products might be used in numerous applications under a wide variety of industrial service conditions. Although Flowserve can (and often does) provide general guidelines, it cannot provide specific data and warnings for all possible applications. The purchaser/user must therefore assume the ultimate responsibility for the proper sizing and selection, installation, operation, and maintenance of Flowserve products. The purchaser/user should read and understand the Installation Operation Maintenance (IOM) instructions included with the product, and train its employees and contractors in the safe use of Flowserve products in connection with the specific application.

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