Overhaul Manual

Vickers®

Flow Controls

Remote Electrically Modulated Flow Control Valve

FGE-06-30-002-(E)-10
FGE-06-60-002-(E)-10

Revised 4/1/79

I-3416-S

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Section I – Introduction

A. Purpose Of Manual

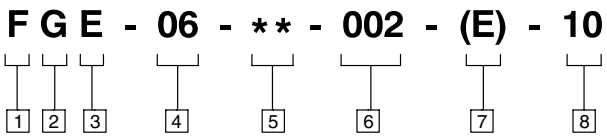
This manual describes the basic operational characteristics and provides service, overhaul and parts information for the Vickers FGE-06-*-002-(E)-10 Electrically Modulated Flow Control.

B. General Information

1. **Related Publications** – Installation dimensions are not contained in this manual. Refer to installation drawing 513870 for dimension information.

2. **Kits** – Gasket kit 919899 contains all the seals necessary to service the unit. It is recommended that O-rings and gaskets be replaced at each overhaul.

C. Model Code



1 Flow control valve	4 60 Series (3/4" nominal valve size)	7 E - external pilot supply (Omit for internal pilot supply)
2 Manifold or subplate mounted	5 Maximum flow 30 - 30 GPM 60 - 60 GPM	8 Design
3 Remote electrically modulated	6 Coil designation (Number times 10 equals coil resistance in OHMS)	

Table 1. Model Code Breakdown

Index No.	Part No.	Nomenclature	Source Code	Qty.	Usable on Code
		FGE-06-30-002-10	A		
		FGE-06-30-002-E-10	B		
		FGE-06-60-002-10	C		
		FGE-06-60-002-E-10	D		
1	253722	Screw		1	
2	▲164538	Sealing Washer		1	
3	10932	Screw		4	
4	381624	Cover		1	
5	▲381626	Gasket		1	
6	277596	Plug		2	
7	174638	Captive Screw		4	
8	351900	Nameplate		1	
9	380244	Gasket & Wire S/A		1	
10	36212	Screw		1	
11	10359	Screw		2	
12	125792	Screw		1	
13	381325	Housing		1	
14	▲381625	Gasket		1	
15	11009	Screw		4	
16	68905	Lockwasher		4	
17	381628	First Stage S/A: Consists of items noted with a bullet (●).		2	
18	●344966	Screw		1	
19	●389831	Strip		1	
20	●375121	Flapper S/A		1	
21	380250	Spring (Feedback)		1	
22	●102671	Retaining Ring		1	
23	●346773	Coil & Bushing S/A		1	
24	▲154006	O-ring		1	
25	●377012	Nozzle		1	
26	●112201	Screw		1	
27	●207886	Screw		1	
28	●352641	Nut		1	
29	●323933	Frame		1	
30	140108	Screw		1	
31	233107	Washer		1	
32	381324	Bushing Retainer		1	
33	●942309	Adapter S/A		1	
34	▲153950	O-ring		1	
35	▲154023	O-ring		1	
36	98129	Retaining Ring		1	
37	113000	Plug		1	
38	388335	Throttle & Plug S/A FGE-06-30		1	A, B
	388334	Throttle & Plug S/A FGE-06-60		1	C, D
39	380256	Retainer		1	
40	▲170441	O-ring		1	
41	327926	Retaining Ring		1	
42	▲199811	O-ring (D Port)		1	
43	▲154022	O-ring		2	
44	14925	Plug (Hollow)		1	

Figure 1. Remote Electrically Modulated Flow Control Disassembly Sequence .

Index No.	Part No.	Nomenclature	Source Code	Qty.	Usable on Code
45	281670	Filter Screen		1	
46	388338	Spacer		1	
47	■7074	Plug		1	
48	■226892	Rollpin		2	
49	▲154012	O-ring (“X” Port)		1	
50	7075	Plug		1	
51	■7075	Plug (Alternate external pilot connection)		1	
52	315932	Plug		1	
53	▲154128	O-ring		1	
54	315932	Plug		1	
55	▲154128	O-ring		1	
56	381320	Spacer		1	
57	381631	Spring		1	
58	101412	Washer		1	
59	381319	Reducing Valve Spool		1	
60	■7074	Plug		1	
61	■7078	Plug		1	
62	■113000	Plug		1	
63	■7075	Plug		1	
64	■162976	Restriction Plug		1	
65	315932	Plug		1	
66	▲154128	O-ring		1	
67	381910	Needle Valve		1	
68	■184052	Heli-Coil (Do Not Remove)		1	
69	■7075	Plug		1	
70	■7074	Plug		1	
71	■7079	Plug		1	
72	353860	Screw		1	
73	353859	Clamp		1	
74	381632	Retaining Ring		1	
75	381321	Plug		1	
76	▲197643	Back-up Ring		1	
77	▲154080	O-ring		1	
78	387113	Spring		1	
79	271434	Spring		1	
80	104998	Spring		1	
81	388123	Plug		1	
82	381630	Spacer		1	
83	▲160618	Back-up Ring		1	
84	▲154080	O-ring		1	
85	105504	Valve Hydrostat		1	
86	381322	Sleeve FGE-06-30, FGE-06-60		1	A, B, C, D
87	■7074	Plug		1	
88	■7075	Plug		1	
89	■113000	Plug		1	
90	■942308	Body & Plugs S/A (Includes items noted with (■). FGE-06-*0-002-(E)-10		1	
	▲919899	Gasket Kit (Includes items noted with (▲).		1	

NOTE

Where “Usable on Code” is blank, the part is used on all units tabulated.
When codes are shown, use with indicated units.

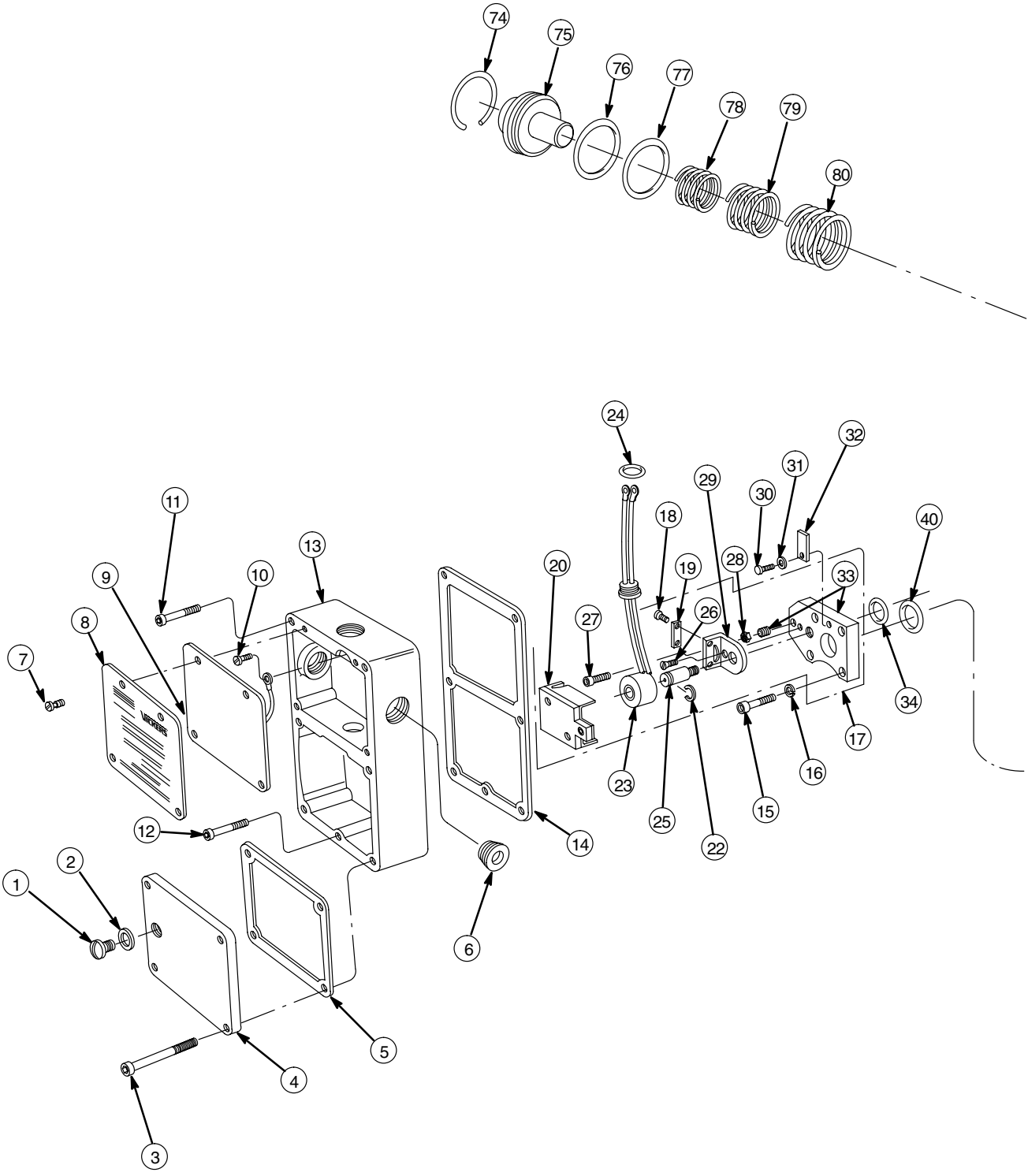
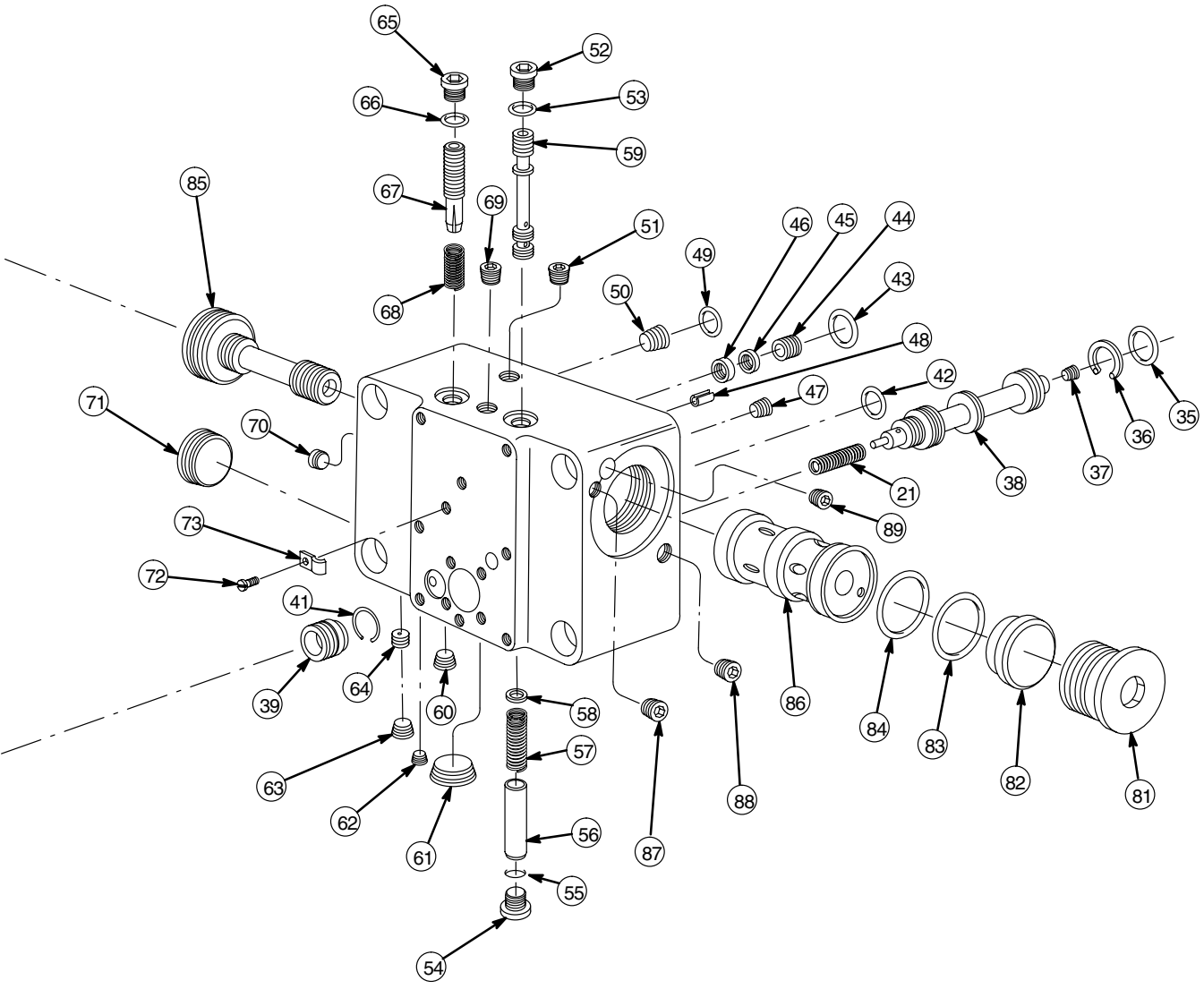


Figure 1. Remote Electrically Modulated Flow Control Exploded View.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Section II – Overhaul

A. Unit Removal

WARNING

Turn off all electrical power and relieve hydraulic pressure. Block any load that could generate pressure.

1. Remove the unit from the system.

2. Cap all system openings to prevent contamination.

B. Special Tools

The following special tools are required:

1. Test stand mounting plate Vickers model FGM-06Y-10, assembly 326101. See Figure 8 located in Section III, test procedure for dimensions.

2. Power supply rated at: Input 115AC50/60 Hz: Output 0-400 DC mA. Vickers EMCS-P-20 Power Supply part number 751946.

3. Milliampere rated at 0-500 mA.

4. Test stand capable of providing the required hydraulic flow. See Figure 9 located in Section III, Test Procedure.

5. Micrometer capable of measuring 1 to 2 inches.

C. Improvised Tools

No improvised tools are required for overhaul.

D. Disassembly

Periodic maintenance of the valve will generally not require disassembly to the extent described here. However, the sequence can also be used as a guide for partial disassembly. In general, disassembly is accomplished in the item number sequence shown in Figure 1. Special procedures are included in the following steps:

NOTE

Discard and replace all O-rings removed during disassembly.

1. Thoroughly clean the exterior of the valve.

2. The valve is full of fluid, so hold it over a container when the cover (14) is removed.

3. Remove parts (1) thru (13) according to numerical sequence.

NOTE

Remove coil feed-thru bushing from housing (13) before removal of housing from body S/A (90).

4. Remove housing (13) and gasket (14).

NOTE

First stage subassembly (17) can be removed as a unit. The parts in this subassembly include items noted with a bullet (●) next to part number. See item number listing (front of manual).

5. Remove four screws (15) and washers (16). Gently remove first stage subassembly (17). Remove feedback spring (21). It may be caught on flapper tang.

NOTE

The following steps (6.) thru (9.) contain instructions for disassembly of the first stage.

6. Remove parts (18) thru (20) and (22) according to numerical sequence.

7. Slide the coil (23) from the nozzle (25). Remove O-ring (24) from coil bushing.

8. Use a 5/16” open end wrench to remove nozzle (25). Turn nozzle counterclockwise to remove.

9. Remove screw (26), nut (28), and frame (29) by turning screw (27) from adapter subassembly (33). Screw (26) and nut (28) need not be removed from frame (29) unless screw threads show evidence of damage.

NOTE

Do not attempt to remove heli-coil from adapter subassembly (33). If heli-coil threads are damaged, order a new subassembly.

10. Remove parts (30) thru (38). Plug (37) need not be removed from throttle (38) unless evidence of dirt is found in the throttle lubrication holes.

11. Gently push retainer (39) from the valve. Use a brass rod from the mounting face side of the valve.

12. Remove O-ring (40) from the retainer. Do not remove retaining ring (41) unless visual inspection indicated a problem.

13. Remove parts (42) thru (47). Be careful not to damage filter screen (45).

NOTE

Do not remove rollpin (48) in the following step unless damaged. The mounting surface can be scored during removal. If removal is necessary, check surface for burrs and flatness before installation of a new rollpin.

14. Remove parts (48) thru (64) in item number sequence.

15. Remove parts (65), (66), and (67). Use a .156 inch hex key to remove needle valve (67).

NOTE

Do not attempt removal of heli-coil (68) if coil threads are damaged - order a new body S/A (90).

16. Remove parts (69) thru (73).

CAUTION

In the following step, use an arbor press or a ten inch "C" clamp to decompress springs slowly during removal of plug (75). The "C" clamp is preferred as you have better control of plug movement during removal.

CAUTION

Back-up ring (76) and O-ring (77) may be damaged during the following step. Be sure to have replacement seals available before attempting the removal of plug (75).

17. Press plug (75) into body (90) far enough to permit removal of retaining ring (74). Plug is under approximately one hundred ninety (190) pounds spring compression, so use care during removal. The Teflon back-up ring (76) and O-ring (77) may catch at the retaining ring groove. To help align plug (75) with the bore, gently rock plug with an oscillatory motion as it is removed.

18. Remove parts (78) thru (84). Thread a 5/16" -18 bolt into spacer (82) and gently pull spacer and seals (83) and (84) from body (90).

19. Remove hydrostat (85) from body (90). Gently tap the hydrostat past the retaining ring groove. Use a brass rod against the end of the hydrostat.

20. Remove sleeve (86) by reversing hydrostat (85) in the bore. With a soft tip hammer, drive the hydrostat and sleeve from body (90).

21. Remove plugs (87) thru (89) from body (90).

E. Cleaning

All parts must be thoroughly cleaned and kept clean during inspection and assembly. The close tolerance of the first stage portion of the valve makes this requirement more stringent than usual. Clean all removed parts, using a commercial solvent that is compatible with the system fluid. Compressed air may be used in cleaning the valve, but it must be filtered to remove water and contamination. Clean compressed air is particularly useful in cleaning the spool orifices and body passages.

CAUTION

Do not stone the sharp land edges of reducing valve spool (59), hydrostat (85), or throttle subassembly (38).

F. Inspection, Repair and Replacement

Check that all internal passages are clean and unobstructed. Examine all mating surfaces for nicks and burrs. Minor nicks and burrs can be removed with an India stone or crocus cloth. If unit has operated in a contaminated system, all internal passages of body subassembly and spools must be thoroughly flushed with clean solvent.

CAUTION

Reliable operation throughout the specified operating range is assured only if genuine Vickers parts are used. Sophisticated design processes and material are used in the manufacture of our parts. Substitutions may result in early failure.

1. Inspect nozzle (25) for damaged threads. Replace the part if threads are damaged. Inspect the orifice face of nozzle for evidence of nicks or scratches. If the orifice size is distorted, or face is eroded, replace the part.

2. Inspect all screws for evidence of damaged threads. If threads are damaged, replace the screws.

3. Inspect the flapper subassembly (20) for fractured tines, distortion, and loose rivets, If rivets are loose, replace the part. If tines are fractured, replace the part. If part is distorted, straighten and square up damaged portion. If the top of flapper is nicked or burrs are evident around the rivets, remove the nicks and burrs using an India stone. Finish the repair by polishing the top of the flapper using 500 grit paper placed on a flat surface.

4. Inspect springs (21), (57), (78), (79), and (80) for damaged coils. Replace springs if coils are damaged. Inspect springs for distortion. The ends of the springs must be parallel to each other. Replace springs if distorted.

5. Inspect frame (29) for distortion. Correct to a square condition. Inspect adapter S/A (33) for evidence of damage. Replace part if threads are damaged.

6. Perform a continuity test on coil (23). Resistance values should range from 18 to 22 ohms. This test is superficial, but a more rigorous test requires special equipment. Replace coil if it does not meet the established standard.

7. If a new throttle (38), reducing valve spool (59), or hydrostat (85) is required, use a three cornered India stone to break feather edges of balancing grooves. Use 500 grit polishing paper lightly on the outside diameter of the part. Wash in clean solvent to remove all traces of contamination.

8. Inspect mounting surfaces of housing (13) and adapter S/A (33) for evidence of nicks and scratches. Remove nicks and scratches using an India stone and/or polishing paper.

9. Inspect needle valve for damaged threads. Replace if damaged and inspect heli-coil and body passages for thread strippings. If heli-coil is damaged, replace body.

NOTE

Use polishing paper on a clean, flat surface.

G. Assembly

Replace the gaskets and O-rings removed from the unit with those supplied in the gasket kit part number 919899. Lubricate O-rings and parts, using clean system fluid to facilitate assembly. Assembly of the parts will be in the reverse numerical sequence. Special procedures are included in the following steps:

1. Install parts (89) thru (87) into body subassembly (90).

NOTE

Two types of sleeves exist: In previous models a short sleeve was used with FGE-06-30 models and a long sleeve used with the FGE-06-60 models. The sleeve presently used is directly interchangeable with both. See index number (86) page 4.

CAUTION

In the following steps, position sleeve as shown in Figures 1 and 2 with hole at 45° from the vertical centerline. Gently tap sleeve (86) into body subassembly (90) until the sleeve bottoms against the body. Use a soft tipped hammer to prevent damage to the sleeve.

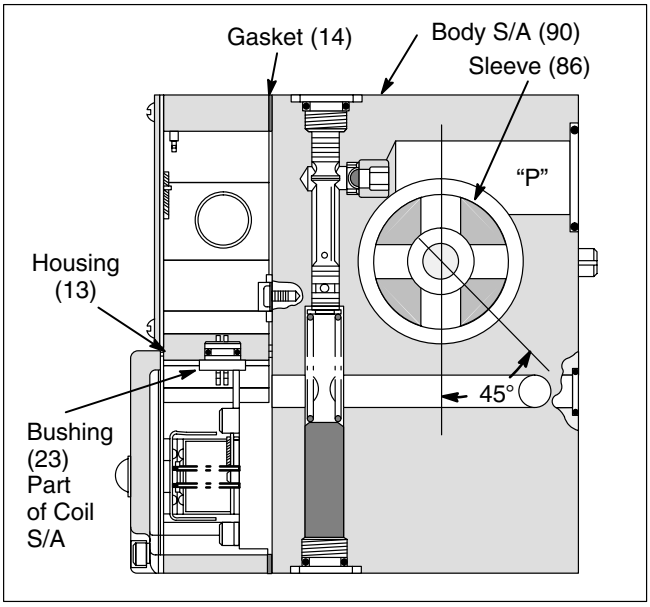


Figure 2. Sectional View Showing Hydrostat Sleeve Orientation.

2. Install hydrostat (85) into body and sleeve. Move the hydrostat in and out of the sleeve to check for bind. Rotate the hydrostat 360° while performing this check. No binding or sticking of the part can be tolerated. If a bind occurs, remove the hydrostat and use polishing paper gently against the outside surface of the hydrostat. Clean the hydrostat and bore again with solvent and compressed air to eliminate all possibility of dirt contamination. Reinstall the hydrostat and perform the preceding test for bind. If binding continues, remove the sleeve and inspect the internal passage for burrs. Reassemble sleeve and hydrostat, using the aforementioned procedures.

3. Install parts (84) thru (78) in item number sequence. See Figures 1 and 3.

CAUTION

In the following step, when plug (75) is started into body S/A (90), and the seals have moved past the retaining ring groove, continue to press the plug inward until retaining ring (74) can be installed. DO NO PERMIT PLUG (75) TO BACK OUT OF THE BORE, AS THE SEALS MAY BE CUT AND LEAKAGE WILL OCCUR.

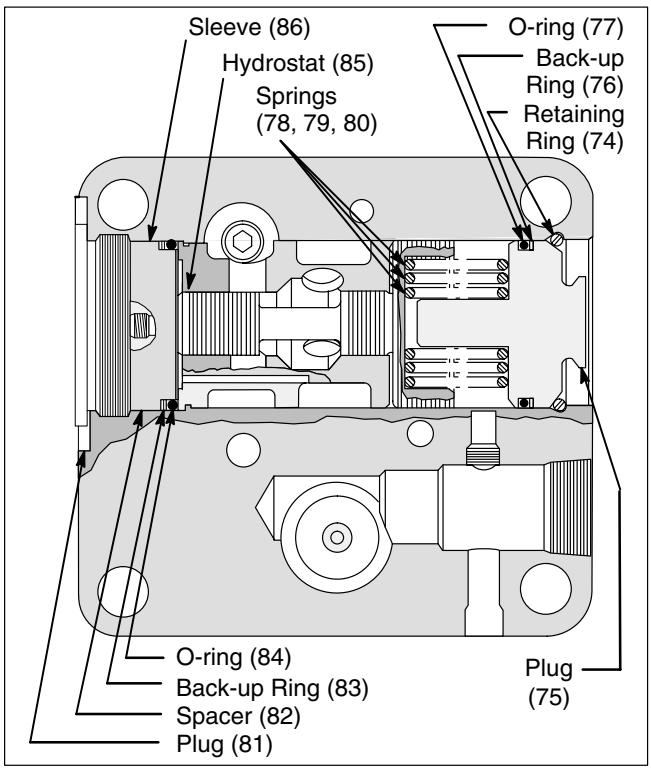


Figure 3. Sectional View of Hydrostat Arrangement.

4. Install O-ring (77) and Teflon back-up ring (76) on plug (75). Install plug (75) into body S/A (90) and insert retaining ring (74) in place. (Use an Arbor press or a ten inch "C" clamp to compress springs (80), (79), and (78). See Figure 3.

5. Install clamp (73) and screw (72). Do not tighten screw completely, at this time.

6. Install parts (71) thru (67). Thread needle valve (67) into body a depth of .60 inches. See Figure 4 for dimensional data.

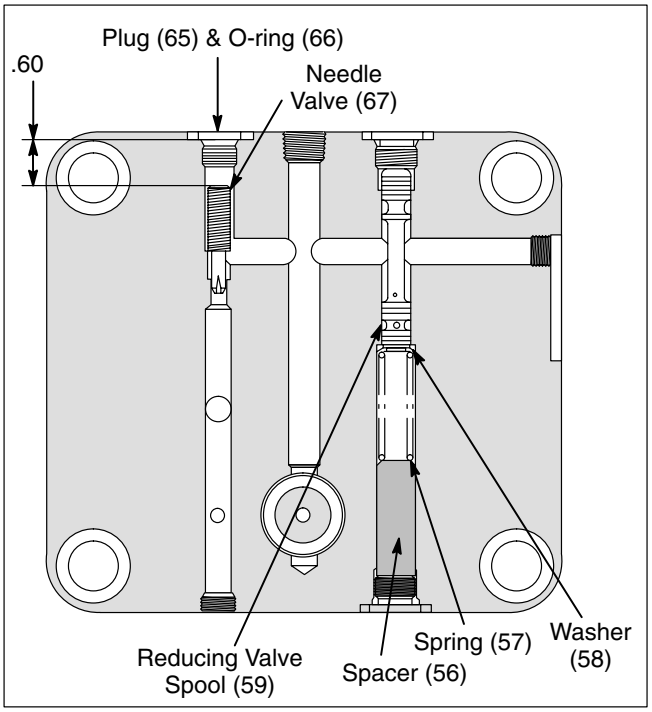


Figure 4. Needle Valve and Pressure Reducing Valve.

NOTE

In the following step, install plug (65) and O-ring (66) hand tight. Final adjustment of needle valve (67) will be accomplished at test. See Section III.

7. Install parts (66) thru (51). See Figure 4 for correct orientation of reducing valve spool (59).

NOTE

Internal pilot pressure models have plug (50) and O-ring (49) located in the “X” port; spacer (46), filter screen (45), hollow plug (44), and O-ring (43) are located in the “P” pressure port. To change the unit to an external pilot pressure “E” model, reverse location of plug (50) with spacer (46), filter screen (45) and hollow plug (44). See Figure 5.

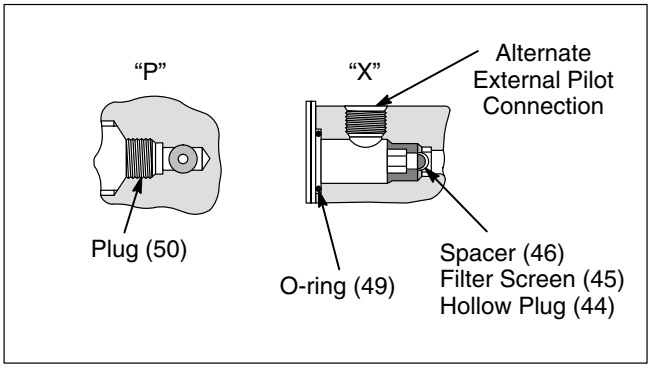


Figure 5. External Pilot Pressure “E” Plug Arrangement.

8. Install parts (50) thru (39). Use care when installing retainer (39). Do not shear O-ring (41). (See Figure 6.)

9. Install parts (38) thru (34). Move throttle (38) to check for spool bind. If binding occurs, correct the binding or sticking condition in the same way as shown in step 2-7.B. (See Figures 1 & 6).

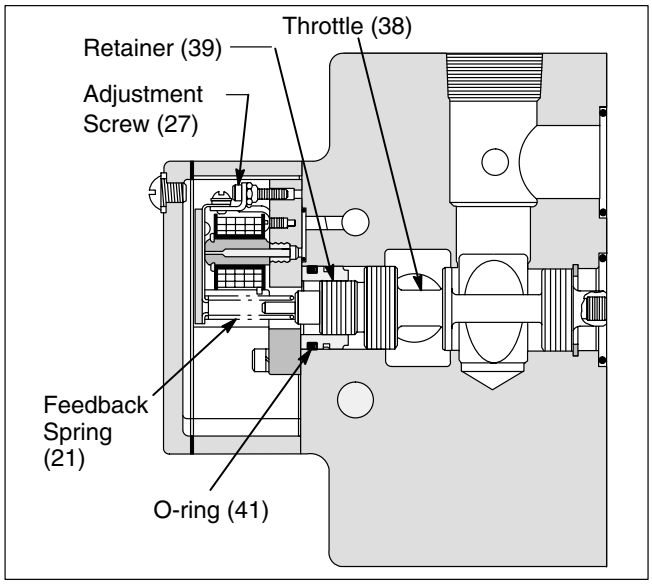


Figure 6. Sectional View of Throttle Arrangement.

10. Assemble first stage parts (33) thru (17). Refer to Figures (1) and (7) as required.

a. Check frame (29) for squareness of mounting face to arm of frame. Straighten if necessary to a square condition. A vane from a pump or motor works well for measuring squareness.

b. Assemble screw (27) thru hole in tang of frame (29). Thread nut (28) on to screw ten (10) turns. (Nut is self-locking type).

c. Thread screws (18) thru strip (19) approximately two (2) turns into frame (29).

d. Thread screws (27) loosely into adapter subassembly (33). Position frame (29) to install screw (26). Thread screw (26) into adapter. Do not tighten at this time.

e. Thread nozzle (25) thru frame (29) into adapter subassembly. Tighten nozzle with a (5/16) inch open end wrench. Do not over torque or nozzle will break at threads. Tighten screw (26).

f. Hold nut (28) and thread screw (27) into adapter until screw head touches the tang of frame (29). Hold screw and turn nut (28) until it tightens against the bottom of tang. Loosen nut 1/8 turn to allow screw (27) to turn freely with minimum clearance.

CAUTION

In the following step, do not pull on coil wires. The wires will break if abused.

g. Assemble O-ring (24) on bushing of coil (23) and install coil over nozzle (25) with wires located next to adapter (33). Orient wires as shown in Figure 1. Use retaining ring (22) to secure coil.

h. Position flapper subassembly (20) over nozzle (25) and coil (23) onto frame (29). See Figure 7. Tighten screws (18) to a snug condition.

11. Perform the following flapper subassembly (20) to nozzle (25) alignment procedure. The flapper to nozzle adjustment is very critical. When completed, the top of the flapper must be parallel to the surface of adapter S/A (33) within .001 inch and flat against the top of the nozzle.

a. Visually align the flapper for a parallel condition and tighten screws (18) just enough to keep flapper from moving.

b. Use a two inch (2") micrometer to measure the distance from the top of flapper (20) to the bottom of adapter subassembly (33). Position the flapper to a parallel condition at points **A** and **B** by tapping lightly with a plastic screwdriver handle or similar soft object. See Figure 7. Check top of flapper at point **C**. Adjust screw (27) for a parallel condition of flapper (20) in all planes.

c. Loosen screws (18) again and reposition flapper (20) to touch the top of nozzle. Repeat alignment as above (b.). Point **C** should fall within limits during this adjustment since frame (29) now has the proper setting for overall flatness of the flapper. Tighten screws (18) securely.

d. Install feedback spring (21) over end of throttle (38). See Figure 6.

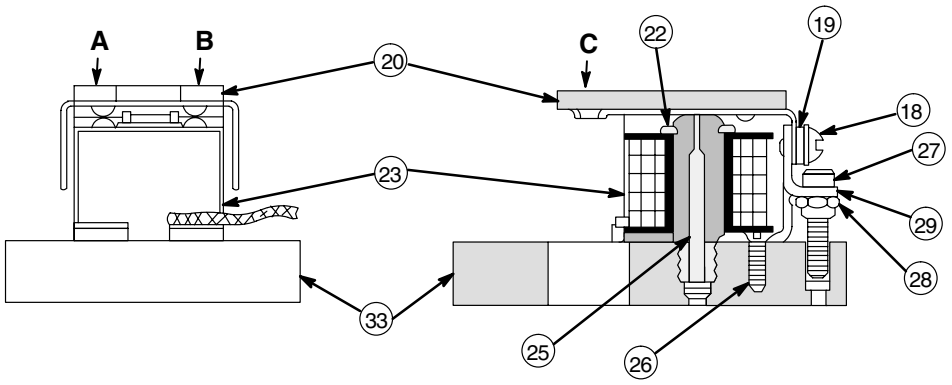
e. Assemble first stage subassembly (17) to body S/A (90). Check to be sure O-ring (34) is in place. Use screw (15) and lockwashers (16). Tighten securely. Check feedback spring (21) to be over the tang of the flapper. If not, rotate the spring until it rests over the tang, flat against the flapper.

12. Assemble gasket (14) and housing (13) use screws (12) and (11). Install the bushing and O-ring (part of coil (27) thru the hole in center section of housing (13). Press in place with a suitable tool. (See Figure 2.)

CAUTION

Do not disturb flapper alignment. Position coil wires under clamp (73) and away from flapper subassembly (20). Tighten screw (72) securely.

13. Assemble parts (10) thru (1). Screws (7) and (1) should be hand tight; they will be removed during test.



18. Screw
19. Strip
20. Flapper S/A
22. Retaining Ring
23. Coil & Bushing S/A
25. Nozzle
26. Screw
27. Screw
28. Nut
29. Frame
33. Adapter S/A

Figure 7. First Stage Subassembly.

Section III – Test Procedure

A. Test Conditions

Hydraulic

Fluid Medium: . . Oil viscosity grades: 150–315 SUS (32–68 cSt) @100° F (38°C)
Running: 70–250 SUS (13–54 cSt).
At start–up: 1000 SUS (220 cSt). Maximum

Fluid Temperature: 120° F ± 5°

Test Volume:
FGE-06-30-002-*-10 . . . . 35 GPM Minimum
FGE-06-60-002-*-10 . . . . 65 GPM Minimum

Maximum Pressure . . . . . 3000 PSI

Test Plate . . . . . FGM-06Y-10 (Assy #326101)

Pilot Pressure:
FGE-06-*-*-E-10 Models . . . . . 200 PSI Minimum

Electrical

An adjustable current source from zero (0) to 400 milliamperes (mA) is required. Vickers EMCS-P-20 power supply part number 751946 is recommended. Installation information for the EMCS is shown on drawing 521555. (Power supply wiring connections are shown on Figure 9.)

B. Test

a. Before mounting valve on subplate, manually shift throttle (38, Figure 6) fully in. Use a screw driver or similar tool. Throttle must move freely without restriction.

NOTE

Gasket mounted units require a suitable subplate. A FGM-06Y-10 (Assy 326101) properly piped is recommended. See Figure 8. If the valve is replacing a standard FG-06-**-10 on a standard subplate, the upper limits of flow may be restricted due to the smaller connecting lines.

NOTE

A sample hydraulic and electrical circuit is shown in Figure 9. Modify an existing test stand or obtain necessary components to assemblE the test circuit.

2. Connect test plate (FGM-06Y-10) to test stand and mount valve on test plate. See recommended circuit diagram (Figure 9).

3. Connect power supply (9, Figure 9) to valve as shown. The connections can be made without regard to polarity.

4. Set dither adjustment on power supply (9) to minimum.

5. Turn power supply (9) current control knob to zero (0).

6. Refer to sample test circuit Figure (9) during the following steps:

a. Close globe valve (6).

b. Close globe valve (1) and (15).

c. Open globe valve (12). (Venting the load relief valve.)

NOTE

External pilot pressure models (“E” in the model code) must have plug (51) (Figure 1) removed and the external pilot pressure source connected at the plug location. A minimum of 200 PSI external pilot pressure is required.

d. Energize electrical and hydraulic systems; adjust test stand relief valve (2) for 1000 PSI as shown on gage (5), then open globe valve (6).

NOTE

Valve may be unstable until entrained air is purged from the system. Allow at least one (1) full minute for the valve to stabilize before adjustments are performed.

e. Remove plug (65) and adjust needle valve (67) to obtain a 50-55 in ^{3}/minute flow from the drain port of valve. Use a .156 hex key to adjust needle valve and a beaker to measure flow from the drain port. See Figures 1 or 4 for needle valve location. Reinstall plug (65).

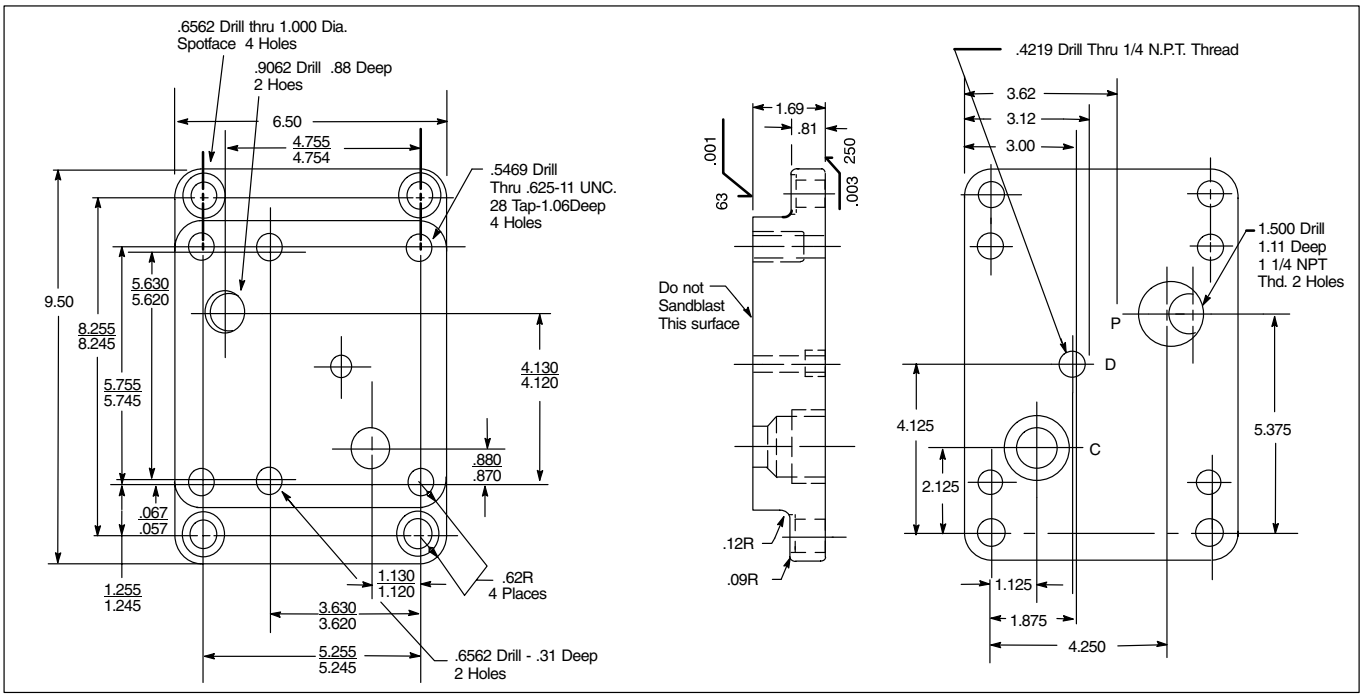
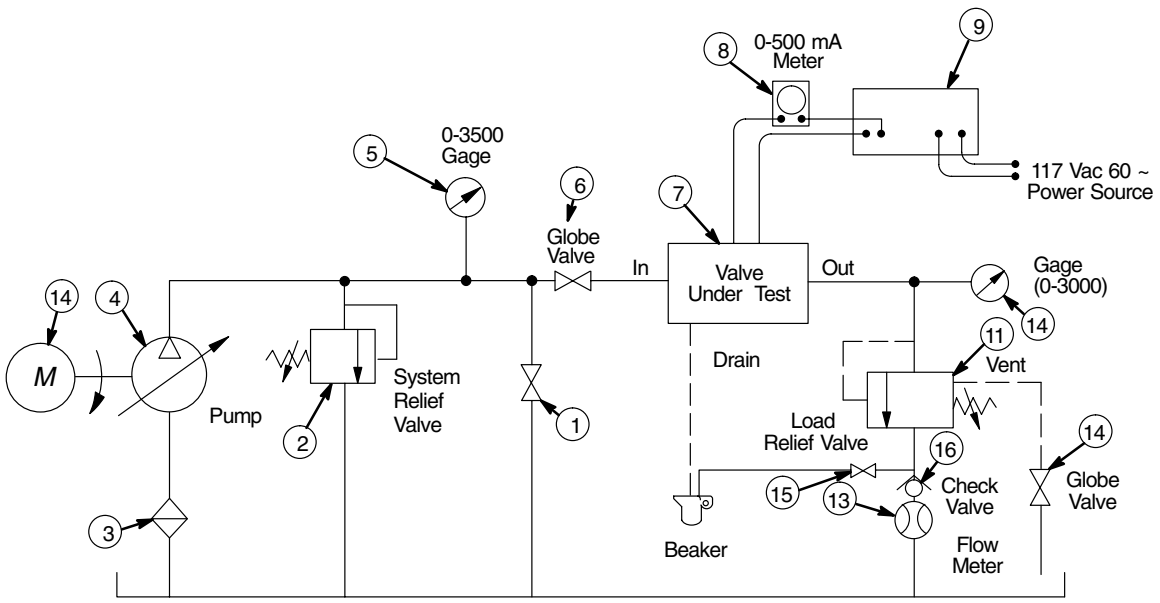


Figure 8. FGM-06Y-10 Subplate Dimensions.



1. Globe Valve
2. Test Stand Relief Valve
3. Inlet Filter - 25 Microns
4. Variable Delivery Pump
5. Pressure Gage (0-3500 PSI)
6. Globe Valve
7. Valve Under Test
8. Ammeter (0-500 mA)
9. Power supply Vickers #751946 or equivalent. Must be capable of delivering 0-400 mA DC to 20 OHM inductive load.
10. Pressure gage (0-3000 PSI)
11. Load relief valve (CT-10-F-20)
12. Globe Valve
13.. Flow Meter
14.. Electric drive motor approximately 23 Hp for 75 GPM @ 3000 PSI. Approximately 150 Hp for 65 GPM @3000 PSI.
15.. 1/2" Globe Valve -DTPG2-04-10
16.. 35 PSI Check Valve C2-830-S2

Figure 9. Test Stand for FGE-06 Flow Control Valve.

CAUTION

In the following step, oil under pressure will escape from the cover when screw and seal are removed. Use a suitable shield to deflect the flow of oil away from the test operator.

f. Remove screw and seal (1 & 2, Figure 1) from cover (4).

CAUTION

In the following step, if milliampere reads in reverse, reverse the meter connecting wires.

g. Adjust the first stage subassembly for a 30-40 in ^{3}/minute flow from the outlet port. To measure this flow, use a beaker and open globe valve (15) shown in Figure 9. Close globe valve and cycle current from 0-400 mA three times. Recheck minimum flow to be 30-40 in 3/minute. Continue adjustment and cycling until 30-40 in ^{3}/minute is obtained. Use a .094 hex key to turn adjustment screw (27, Figure 1 and 6). Replace screw and seal (1 & 2, Figure 1). Recheck drain flow to be 50-55 in ^{3}/minute.

h. Increase current to 400 ±10 mA and check for metered volume.

Model	Outlet Flow-GPM
FGE-06-30-002-*-10	30 - 35
FGE-06-60-002-*-10	60 - 65

Cycle valve 0-400 mA three times and check that outlet flow at 400 mA remains within ± 1 GPM.

C. Linearity Check

1. Set current to 400 mA as read on the 0-500 mA meter (8). Record metered volume under the following conditions:

a. Adjust test stand relief valve (2, Figure 9) for inlet pressure shown: read gage (5, Figure 9).

Inlet Pressure	Outlet Pressure
1000	Vented
3000	Vented

b. Close globe valve (12) and adjust load relief valve (11) for 2500 PSI as read on gage (10). (Inlet pressure 3000 PSI).

The maximum difference between the flows recorded must not exceed:

FGE-06-30-002-*-10	3 GPM
FGE-06-60-002-*-10	6 GPM

c. Set current control to zero (0) mA as read on milliampere (8).

2. Reduce setting of test stand relief valve (2) until 1000 PSI is read on gage (5), then open globe valve (12) to vent load relief valve (11).

Slowly increase current to 200 mA and record flow. Increase current to 400 mA then slowly reduce current until 200 mA is reached and record flow. The difference between the two flow readings must not be greater than 1.5 GPM.

3. Set current control on power supply (9) to zero mA.

a. Increase setting of test stand relief valve (2) to 3000 PSI.

b. Close globe valve (12) and adjust load relief valve (11) for 2500 PSI. Open globe valve (15). Outlet flow must not be greater than 50 in 3/minute.

4. Open globe valve (1) and close globe valve (6).

5. Remove components (10) thru (13), (15) and (16) from the outlet port of unit under test (7).

6. Install a plug into the outlet port of unit under test (7).

7. Close globe valve (1) and open globe valve (6). Check unit under test for porosity and seal leaks at 3000 PSI.

8. Remove all power from test stand. Disconnect power supply from valve and remove valve from test stand.

9. After the unit has been successfully tested, install parts (9, Figure 1) thru (7). Seal all openings to prevent dirt contamination of the tested valve.

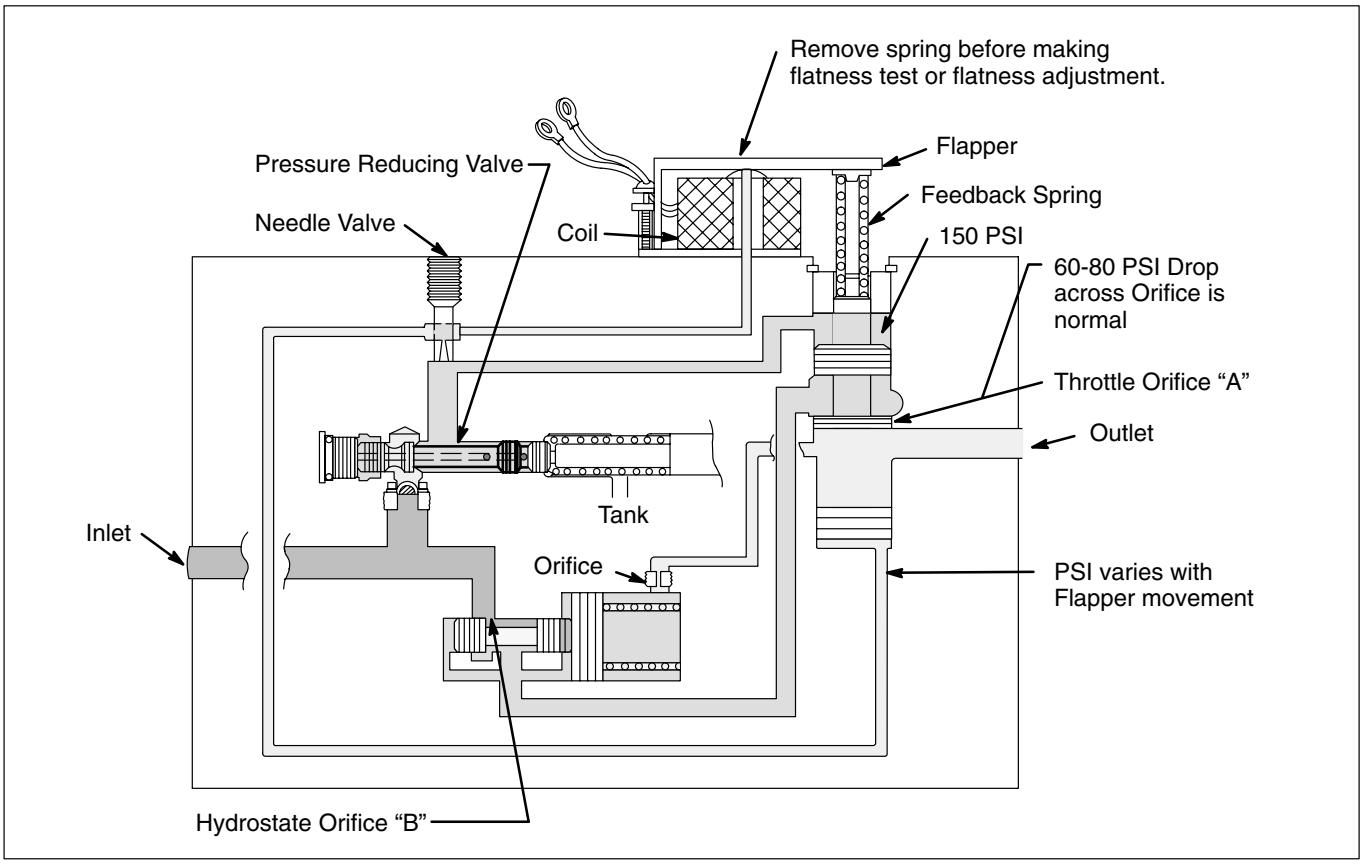


Figure 10. Pictorial Diagram of Valve Operation.

D. Theory of Operation

General:

The FGE valve is an electrically modulated flow control having the following characteristics:

a. No current through the coil - minimum outlet flow.

b. 400 mA current through the coil - rated outlet flow (See model code)

Operation:

Consider the FGE valve as being two distinct and separate systems - one a standard compensated flow control with a fixed throttle setting and secondly, an electrically modulated servo device used to vary the throttle opening. (Refer to the pictorial diagram Figure 10 during the following explanation.)

Flow Controls – Flow controls work on the principle that flow through an orifice will be constant when the pressure drop across the orifice is held constant. Flow (Q) through an orifice is directly proportional to the orifice area (A) and the square root of the pressure drop across it $(\sqrt{\Delta P})$.

$Q = A\sqrt{\Delta P/0.0325}$ Valid for short orifice
Q = USgpm A = in^2 P = PSI

Assume throttle orifice “A” is opened to allow 15 GPM flow through the valve to an external load circuit. The external load circuit develops 1000 PSI when operating the load. The inlet pressure to the valve is 2000 PSI. The total pressure drop across the valve’s two series orifices “A” and “B” must equal 1000 PSI. (The difference between inlet and outlet pressures.)

The normal drop across throttle orifice “A” is between 60 and 80 PSI. (Use 75 PSI for this explanation.) Orifice “B” will drop 925 PSI, which is the difference between the total valve drop of 1000 PSI and orifice “A”’s drop of 75 PSI.

If the work load increases, the outlet pressure increases. To keep a constant flow, the total pressure drop across orifice “A” must not change. This is accomplished as follows:

The increased outlet pressure is sensed against the spring end of the hydrostat causing it to move to the left, increasing the area of orifice “B” , and reducing the pressure drop across it. This increases the pressure available at the top side of orifice “A”. 15 GPM will continue to flow as long as a 75 PSI pressure drop is maintained across orifice “A”.

If the work load were to decrease (output PSI lower) a similar set of events will begin except in the opposite direction. The hydrostat will move to the right. Orifice “B” reduces in size, increasing the pressure drop, lowering the pressure at the top side of orifice “A”, thus keeping a constant pressure drop across orifice “A” and a constant 15 GPM flow through the valve.

Electrically Modulated Servo Device - A flapper type servo is used to position and maintain orifice opening “A” to some value. This value is governed by the coil current.

Assume the coil current is zero (0). The flapper does not close the nozzle opening and pressure cannot build up at the bottom of the throttle spool. The throttle spool is held in the closed, minimum flow position by directing pressurized oil to the top of the throttle spool. This oil is obtained from a pressure reducing (X) valve connected to the inlet pressure source. The supply pressure is reduced to approximately 150 PSI thru the “X” valve. The “X” valve also acts as a pressure stabilized source of oil for the servo valve.

The needle valve and flapper adjustments interact. If the needle valve is closed too far, the valve reaction time to input signal change will increase. Also, the range may be limited. If the valve is open too far, minimum or zero (0) flow may not occur. Adjust the needle valve clockwise (cw) to close, and counterclockwise (ccw) to open.

The flapper must be square to the adapter S/A within .001 inch and flat against the nozzle at final adjustment. This permits the flapper to be an effective orifice governed primarily by the magnetic field developed in the coil. The feedback spring must be removed during the flatness adjustment. See Figure 7. If the flapper is not square, the valves upper flow limit cannot be obtained due to oil slipping through the nozzle orifice at the maximum current setting (the flapper bottoms against the side of the nozzle and does not close off the opening). If the needle valve were opened to obtain the high flow setting, then minimum flow could not be reached. It is recommended that adjustment of the valve be attempted only after all other malfunction possibilities have been checked.

Assume a current of 200 milliamperes is applied to the coil. The following chain of events will happen:

1. Current thru the coil creates a magnetic field which attracts the flapper toward the nozzle.

2. The flapper will partially close, causing the flow of oil from the nozzle to be reduced to some low value.

3. Pressure will build up at the bottom of the throttle spool causing the throttle spool to start to move upward.

4. The feedback spring (located between the flapper and throttle spool) will start to compress, exerting force against the flapper (the spring will counteract part of the magnetic attraction developed by the coil current).

5. The feedback spring causes the flapper orifice to start to open, gradually reducing the force against the bottom of the throttle spool. Movement of the throttle spool will stop when forces above and below the spool are at equilibrium.

Movement of the throttle spool upward opens throttle orifice “A” to some intermediate value. The flow control section then starts to function to this throttle setting. If the current to the coil is changed, the throttle setting correspondingly changes. Adjustment of flow throughout the entire range of the valve is accomplished by varying the coil current.

E. Troubleshooting Hints

Symptom	Possible Cause	Remedy
Full Flow (No Control)	1. Plugged flapper orifice	Remove first stage as an assembly and clean orifice.
	2. Power supply malfunctions	Repair or replace.
No Flow (No Control)	1. Open coil	Replace
	2. Power supply malfunction	Repair or replace
	3. Needle valve orifice plugged	Remove, clean, and recalibrate.
	4. Hydrostat stuck in closed position	Remove, clean, and check for burrs.
Flow varies with inlet and outlet pressure changes.	1. Hydrostat stuck in the open position.	Remove, clean, and check for burrs.
	2. Hydrostat sensing orifice plugged.	Remove and clean orifice.
Insufficient flow range	1. Throttle restriction	Remove, check bore and throttle for possible burrs. Clean and reassemble.
	2. Feedback spring broken or distorted changing the spring rate.	Replace
	3. Power supply malfunction.	Repair or replace (Check current, look for a short circuit in the wiring)
Improper flow range. Linearity poor	1. Flapper and needle valve out of adjustment.	Perform alignment procedure
	2. Partial plugging of needle valve or flapper orifices.	Remove, clean, and perform alignment of valve.
	3. Defective coil (shorted turns)	Check resistance to be 18-22 ohms, replace if defective.
	4. Power supply - insufficient current range, poor linearity.	Repair or replace.

NOTE

If a contaminant large enough to plug needle valve or nozzle is found, valve should be removed from subplate and the pilot inlet screen checked for contamination and/or holes. If holes exist in the screen, the control stage passages of the valve should be thoroughly cleaned.

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