AP105D-1309-16

SERVO VALVE
FAIREY HYDRAULICS
SERIES FHS 722

GENERAL AND TECHNICAL INFORMATION
REPAIR AND RECONDITIONING INSTRUCTIONS

BY COMMAND OF THE DEFENCE COUNCIL

Frank Cooper.

Ministry of Defence

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A P (N) 140 Chap 1 Annex A (RN)
A P 100B–01 Order 0504 (RAF)

MODIFICATIONS

This publication is technically up to date in respect of the modifications listed below.

FHB 90

FHB 129

FHB 131

FHB 162

CAUTIONARY NOTICE

Acid damage

The cleaning fluid for many hydraulic components is trichloroethane or some other form of chlorinated solvent. If traces of solvent are left in components they can combine with minute amounts of water, present in operational hydraulic systems, to form hydrochloric acid. It is essential that when hydraulic components are cleaned with a chlorinated solvent all traces of the solvent must be removed from internal surfaces and passages, before assembly, using the air blast method or other effective means.

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SERVO VALVES, SERIES FHS 722

(Completely revised)

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ILLUSTRATIONS

Leading Particulars

Servo valve FHS 722	Ref. No. 27KF/ –
Fluid OM–15, DTD 585	Ref. No. 34B/9100572
Overall dimensions (approx) –	
Length	4.2 in
Width	3.0 in
Height	3.2 in
Weight (approx)	2.2 lb

INTRODUCTION

1. The purpose of the valve is to regulate the supply of hydraulic fluid to a jack in response to movements of the control column of an aircraft. Variations between valves are indicated by suffixes to the part number (para. 7).

DESCRIPTION

2. The valve body is divided into two chambers, one containing the hydraulic fluid control mechanism and the other the damper piston. The piston chamber is closed by an end cap which is retained by a circlip, and the chamber wall is tapped to accept two bleed screws. Alternative positions for the bleed screws and for the control chamber fluid ports are given in Table 1 and Figure 2; positions V, W and X are alternative pressure connections and Y and Z return.

3. The valve control chamber contains a top and bottom platen, the two being separated by a platen spacer. Two concentric sleeves, termed the inner sleeve and the outer sleeve, fit between the platens and within the platen spacer. The mating surfaces of the sleeves and platens are kept in contact by a compression spring between the two sleeves. The outer sleeve is encircled by an operating ring which is slotted to fit a groove in the piston spindle. A similar slot in the opposite side of the ring fits in the balancing spindle which locates in a hole in the valve body.

4. The inner end of the piston spindle passes through the wall separating the two valve chambers, and its outer end protrudes through the end cap to provide the valve external control connection. The piston head is tapped to accept an orifice screw and a duct from the spindle inner end leads to a spring-loaded ball valve; the valve is retained in the head by a pin, the pin being secured by light peening. Stop collars fitted on the spindle either side of the piston, control the valve stroke.

5. Seals are fitted between the end cap and the body and between the end cap and the piston spindle, they are also fitted between the two sleeves and between the valve body and top platen, bottom platen and balancing spindle. There is no seal fitted around the piston spindle in the chamber separating wall and whether a seal is fitted to the piston head is dependent on the valve part number suffix (fig. 1).

6. A tabwasher is fitted under the head of each of the four valve attachment bolts and a platen retaining washer locates in each of the four recesses in the valve base. These coned washers are flattened into the recesses when the bolts are tightened and are retained by the bolts; in turn they retain the bottom platen.

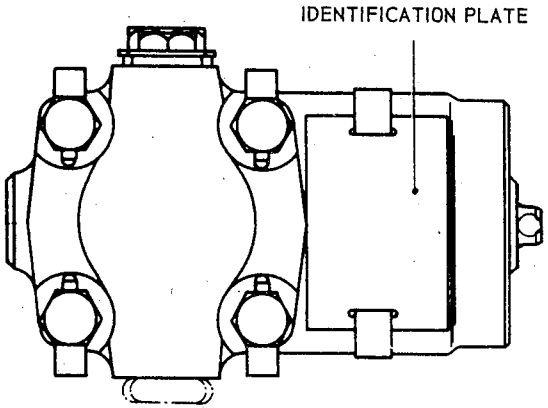
7. The type of body, spindle stroke, and piston orifice of a particular valve are indicated in the part number of the valve, which consists of the basic part number and three suffix numbers, for example:–

FHS 722/3/140/0

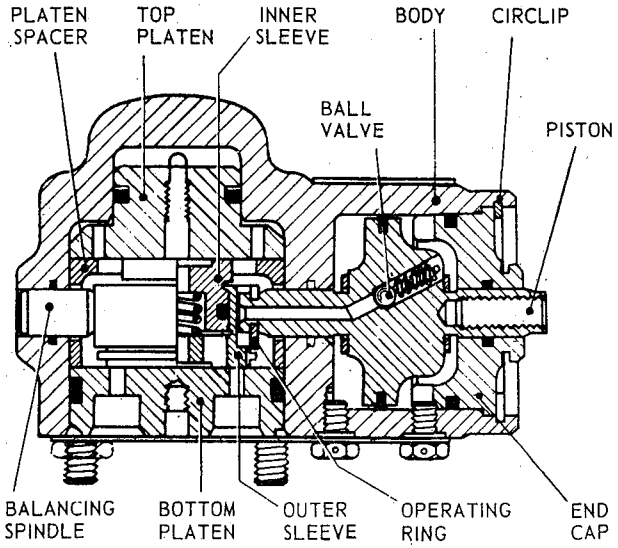
FHS 722	Basic part number
/3	Valve body number (Table 1)
/140	Piston stroke in thousandths of an inch.
/0	Diameter of orifice in orifice screw, in thousandths of an inch. (see detail fig. 1).

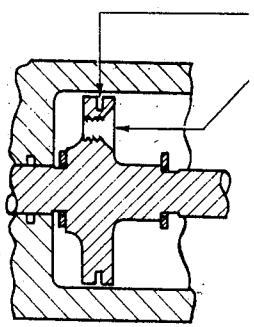
OPERATION

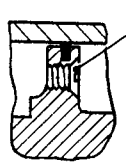
8. The principle of operation is illustrated in figure 3. Movement of the piston spindle is transmitted by the operating ring to the inner and outer sleeve assembly. When the piston is

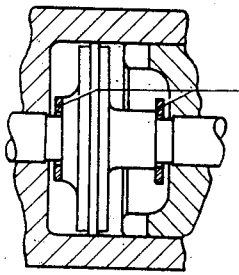


DISPOSITION OF CONNECTIONS, BLANKING PLUGS AND BLEED SCREWS, IS GIVEN BY THE FIRST SUFFIX TO THE VALVE PART NUMBER.
ILLUSTRATION SHOWS BODY NUMBER 3 (TABLE 1)









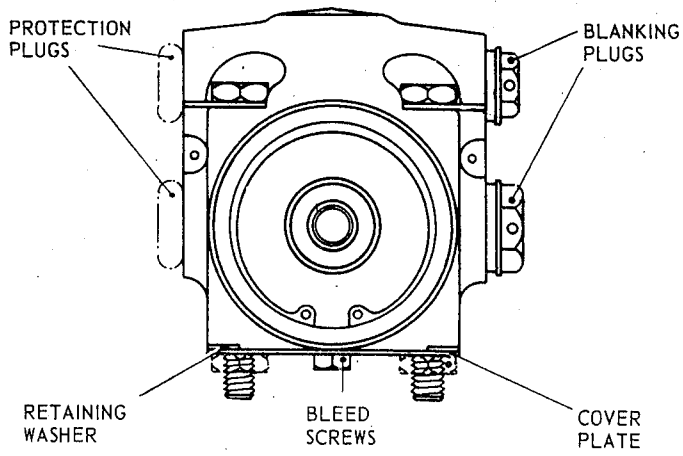


Fig. 1 General assembly

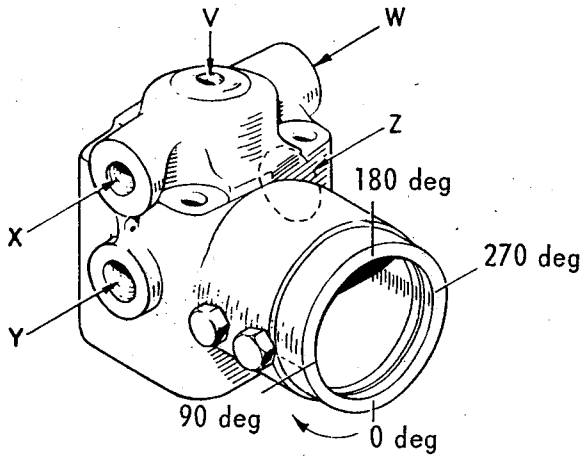


Fig. 2 Connection and bleed screw positions

TABLE 1 Valve body numbers *(fig. 2 and para. 7)*

Valve body number and bleed screw position				Connection bosses			
0 deg	90 deg	180 deg	270 deg	Tapped $\frac{1}{4}$ in B.S.P.	Tapped $\frac{1}{8}$ in B.S.P.	Removed during manufacture	Fitted with blanking plugs
1	20	40	60	Y and Z	V	W and X	Z
2	21	41	61	Y and Z	W and X	–	Z and X
3	22	42	62	Y and Z	W and X	–	Z and W
4	23	43	63	Y and Z	V	W and X	Y
5	24	44	64	Y and Z	W and X	–	Y and X
6	25	45	65	Y and Z	W and X	–	Y and W
7	26	46	66	Y	V	W, X and Z	–
8	27	47	67	Y	W	X and Z	–
9	28	48	68	Y	X	W and Z	–
10	29	49	69	Z	V	W, X and Y	–
11	30	50	70	Z	W	X and Y	–
12	31	51	71	Z	X	W and Y	–

moved in one direction, pressure fluid supplied to the inside of the sleeves is directed to one of the ports through the bottom platen; fluid returning through the other port in the platen passes to the outside of the sleeves and so to the exhaust connection. When the piston is moved in the opposite direction, flow through the ports in the bottom platen is reversed. In the neutral position, both ports through the platen are closed by the sleeve assembly.

9. Piston movement in both directions is damped by fluid transmitted from one side of the piston to the other. When an orifice screw is fitted the flow is restricted by the limited opening in the screw. The ball valve in the piston ensures that the piston chamber is kept filled with fluid.

SERVICING

SPECIAL TOOLS

10. In addition to the following special tools and test equipment, a locknut and eye end will be needed to attach to the piston spindle when the valve is being tested:–

Description	Part No.	Ref. No.
		5120-99-
Seal manipulating tools (set of three)	FHQ 100	~~27KF~~/4542618
Universal test fixture	FHQ 103	27KF/695
Back-lash checking rig	FHQ 163	27KF/696
Platen tool	FHQ 165	27KF/692
End cap extractor	FHQ 231	27KF/693
Vice blocks	FHQ 264	27KF/976
Stroke centring fixture	FHQ 1878	27KF/3102

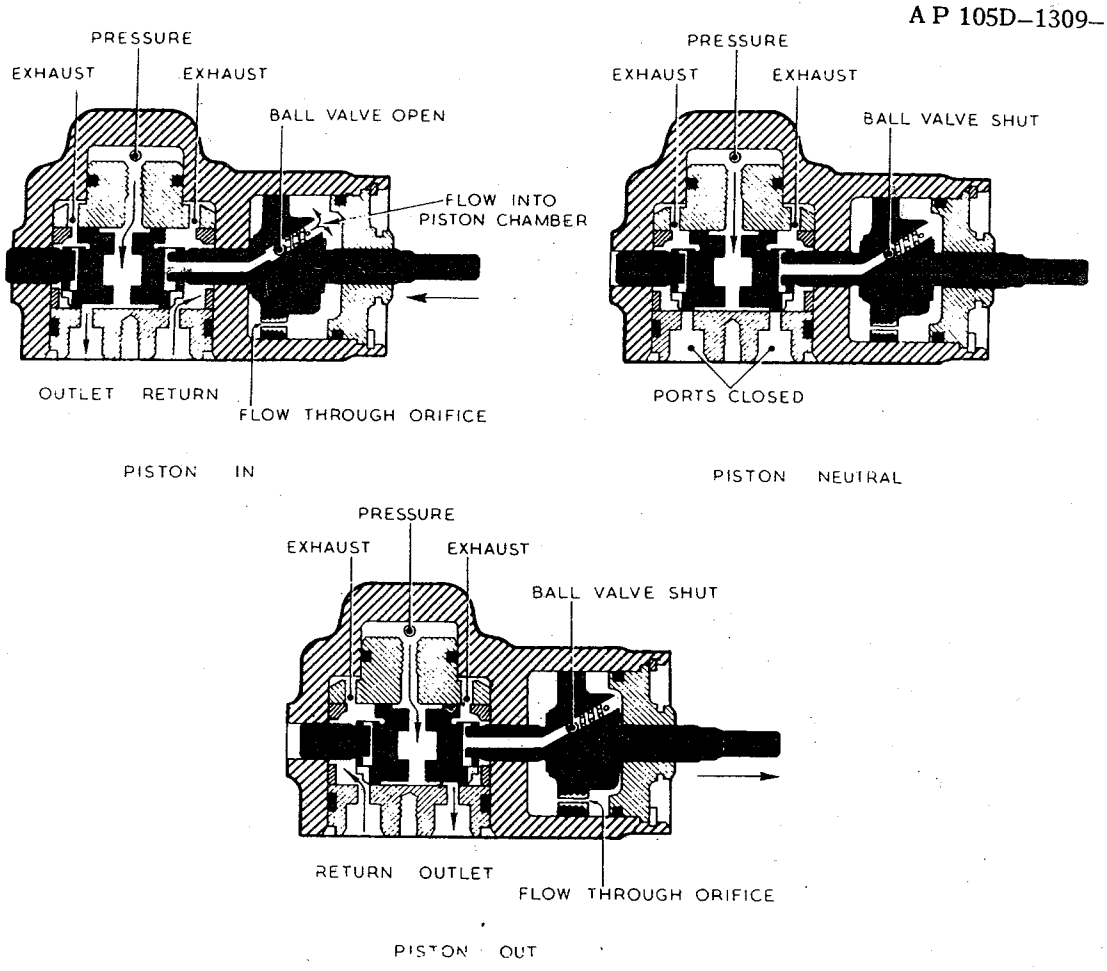


Fig. 3 Principle of operation

DISMANTLING

11. To ensure correct re-assembly it is important, during dismantling, to note the relative positions of the bottom platen, outer sleeve and operating ring. Marks in the form of a letter 'S' will be found on many of these parts already in use and on all of them when supplied as spares; these marks must be towards the piston when the valve is assembled. It is also advisable to note the position of the end cap before removal to ensure that the original piston spindle alignment is maintained at assembly. Support the valve as necessary, using vice blocks FHQ 264 and dismantle as follows:–

(1) Remove the blanking and the protection plugs from the body fluid orifices, and the bleed screws from the damper chamber.

(2) Remove the base cover plate and the platen retaining washers from the valve attachment bolts; withdraw the bolts.

(3) Withdraw the bottom platen, using tool FHQ 165.

(4) Remove the inner and outer sleeves complete with spring; separate the parts.

(5) Remove the operating ring and withdraw the balancing spindle.

(6) Remove the end cap retaining circlip and extract the end cap, using tool FHQ 231.

(7) Withdraw the piston and remove the platen spacer.

Note ...

The stop collars should not be removed from the piston unless stroke adjustment is necessary; neither should the spring-loaded ball valve be removed unless defective or it is intended to check the spring load (Table 4).

(8) Withdraw the top platen, using tool FHQ 165.

(9) Remove the seals from all parts, using tool FHQ 100.

Note ...

The following are matched parts; keep each group together:–

(1) The top platen and the inner sleeve.

(2) The bottom platen and the outer sleeve.

(3) The piston, operating ring and the balancing spindle.

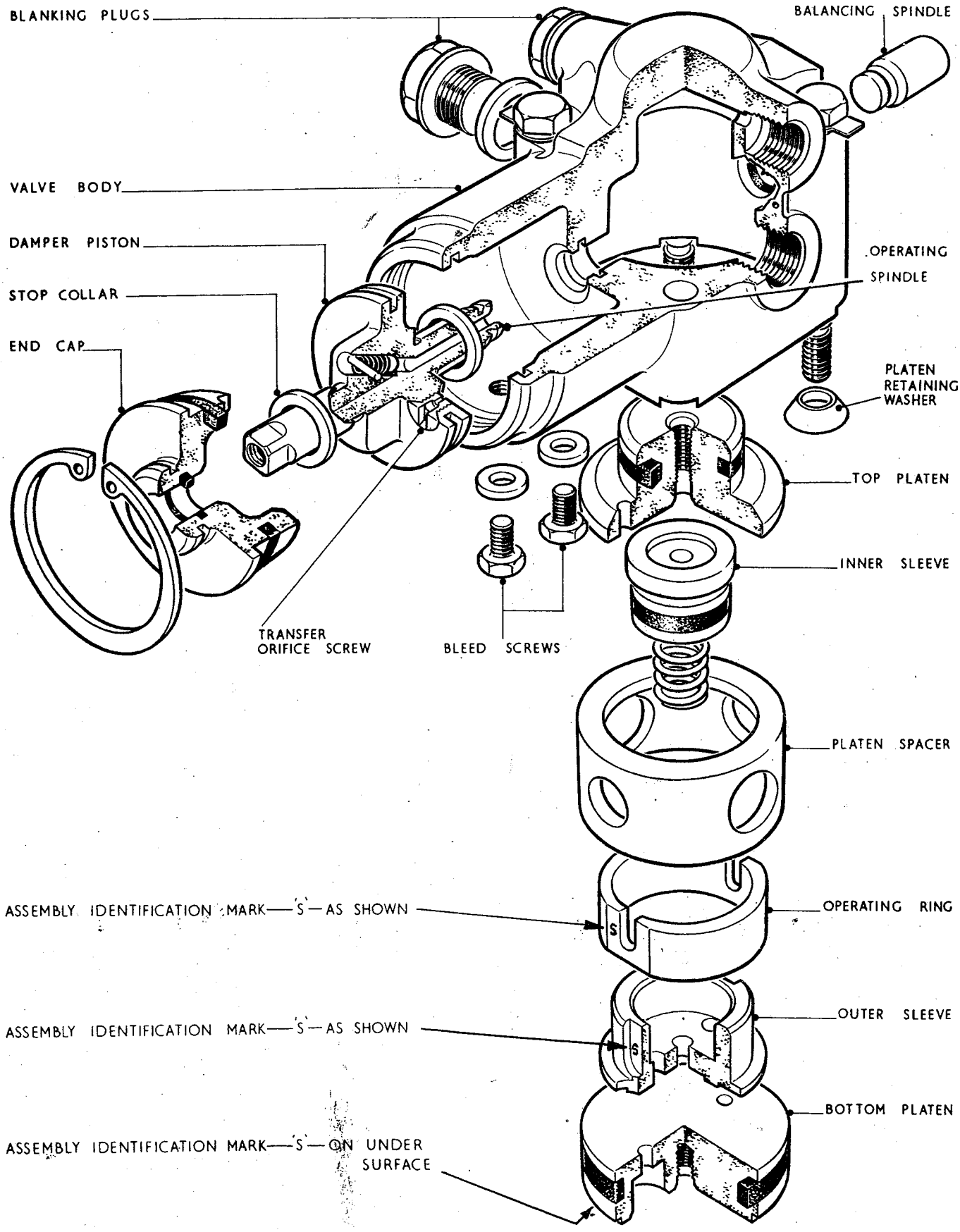


Fig. 4 Exploded view of valve FHS 722

EXAMINATION AND REPAIR

12. Discard the seals, gaskets and tabwashers. Wash all parts in trichloroethane and examine them for serviceability. Wear limits are shown in Table 4. Renew or repair all unserviceable parts. Fairey hydraulic standard repairs (FHSR) and general repair instructions appear in AP 105B–0001–1F. The points of application for FHSR are shown in fig. 6.

13. The accuracy of the fits between the outer sleeve and the bottom platen, and between the inner sleeve and the top platen cannot be checked dimensionally. If the parts appear to be serviceable they should be accepted for assembly; the accuracy of the fits will be revealed during testing.

ASSEMBLING AND ASSEMBLY CHECKS

Note ...

Throughout assembly and checking, matched parts (para. 11) must be kept together and relative assembly strictly observed.

Back-lash check

14. Dry assemble the outer sleeve, operating ring and piston, on rig FHQ 163. Back-lash between these parts must not exceed 0.001 in. The changing of a matched part (para. 11) will necessitate the changing of the other parts in that group.

Piston stroke and concentricity check

15. Partially dry assemble the valve as follows:-

(1) Fit the balancing spindle seal into the valve body and the piston spindle seal into the end cap.

(2) Position the piston, complete with stop collars, in the piston chamber and fit the end cap and circlip.

(3) Insert the balancing spindle.

(4) Position the operating ring to engage both piston and balancing spindle, and mount the valve in the stroke centring fixture FHQ 1878.

(5) Fit an eye end and locknut to the piston spindle.

(6) Check that the load required to slowly stroke the piston in each direction over all parts of stroke, does not exceed 1 lb; rotate the piston between readings.

(7) Remove the eye end and locknut and fit the appropriate rig end pad to the piston spindle.

(8) Insert the stroke centring mandrel and mount a dial indicator to bear on the pad, set the indicator to zero and then disengage the mandrel.

(9) Check that the stroke obtained is as indicated by the appropriate valve part number suffix (para. 7), within the limits +0.020 in −0.000 in, and that it is matched either side of the indicated centre to within 0.010 in. Stroke adjustment is made by changing the piston stop collars. The suffix to the collar part number gives the collar thickness to the limit +0.003 in e.g., FHS 696/60 indicates a collar between 0.060 and 0.063 in thick. A maximum of two collars may be used on each side of the piston if required, and when fitted, the chamfer on the washer inner diameter must be towards the piston.

(10) Dismantle in preparation for final assembly.

Final assembly

16. During final assembly fit new seals throughout, ensure that each part is scrupulously clean and dip it in clean hydraulic fluid immediately before fitting. Where bonded seals are used, ensure that the correct torque load is applied (AP 105B–0001–1F). The damping chamber should be primed (para. 17) at some convenient stage of assembly.

(1) Fit blanking plugs complete with new sealing washers to the body fluid orifices (Table 1). Fit protection plugs to the alternative orifices.

(2) Fit a seal to the top platen and insert the platen into the body.

(3) Insert the platen spacer, smaller inner diameter towards the top platen, and align the two smaller holes with the spindle openings in the body.

(4) If they have been removed, fit the piston ball valve, spring and retaining pin; secure the pin by light peening.

(5) Refer to para. 7 and fig. 1 and, dependent on the valve part number, check that, if an orifice screw is fitted, it is the correct one and, where called for, fit the piston seal.

(6) Insert the piston complete with stop collars into the piston chamber.

(7) Insert the two chamber bleed screws complete with new sealing washers.

(8) Fit the end cap inner and outer seals, and insert the end cap ensuring that one of the cap slots aligns with the bleed screws; fit the cap retaining circlip.

(9) Fit the balancing spindle seal into the valve body and insert the spindle.

(10) Position the operating ring, engaging the slots in the ring with the piston and balancing spindle.

(11) Fit the inner sleeve seal, place the spring in the bore of the inner sleeve and press the outer sleeve over the inner sleeve; insert the assembly into the valve with the inner sleeve towards the top platen.

(12) Fit the bottom platen seal and insert the platen.

(13) Fit protection plugs to the platen fluid orifices, insert the four valve attach-

ment bolts complete with new tabwashers and secure the valve base cover plate using ¼ in B.S.F. nuts.

PRIMING THE DAMPER CHAMBER

17. First method –

(1) Remove the damper chamber bleed screws.

(2) Immerse the valve in clean hydraulic fluid (i.e., fluid that has been subjected to 5 micron filtration), with the bleed orifices uppermost, and pump the piston until all air is expelled.

(3) Replace the bleed screws.

18. Second method – Only to be used when the valve is mounted on a platform so that the bottom platen is adequately supported:–

(1) Slacken the bleed screws and, with the bleed points uppermost, apply slight fluid pressure at the valve return connection.

(2) Pump the piston and when fluid free of air bubbles issues from the bleed points, tighten each screw in turn.

TESTING

19. The test rig used must include in the pressure line a filter capable of 5 micron filtration, and the tests should be carried out at normal room temperatures (50 to 68°F.), using the fluid specified in Leading Particulars. Fit a locknut and eye end to the piston spindle and mount the valve on test fixture FHQ 103. Test in accordance with Table 2. Fault diagnosis is given in Table 3.

AFTER TESTING

20. When the tests have been satisfactorily completed:–

(1) Disconnect the rig fluid lines and fit protection plugs, with seals, to the valve fluid orifices.

(2) Remove the valve from the fixture and, leaving the valve full of fluid, fit protection plugs to the bottom platen fluid orifices.

(3) Position a coned washer on each of the valve attachment bolts, top of cone to the valve base, and temporarily bolt the valve to the fixture platform to flatten the washers.

(4) Remove the valve from the platform and fit the valve base cover plate.

(5) Remove the locknut and eye end from the piston spindle.

(6) Wire-lock the bleed screws together.

(7) Wire-lock the body fluid orifice blanking plugs to the body.

(8) Check that the correct data is recorded on the valve identification plate and, if it has been removed, re-attach the plate.

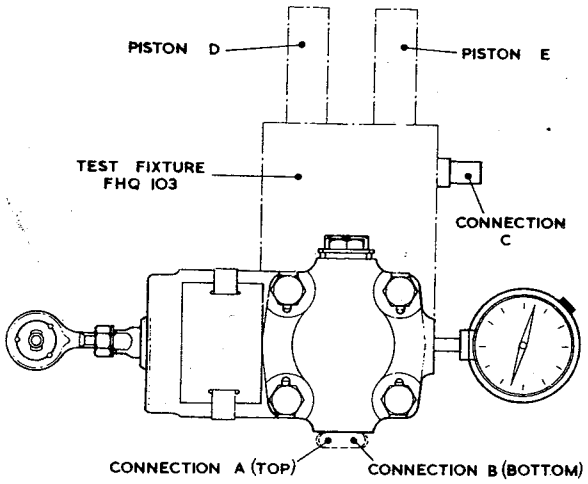


Fig- 5 Test connections

TABLE 2 Test schedule

Test No.	Minimum and maximum pressures in lbf/in² at connection A and C	B	Valve Selection	Procedure	Requirements
Note...	Connect A and C to form a common pressure line, and before commencing the tests ensure that all air has been expelled from the unit.				
1	3840 4160	Reservoir	Out	Maintain pressure for 3 minutes	No external seepage
2	3840 4160	Reservoir	In	Maintain pressure for 3 minutes	No external seepage
3	2880 3120	Atmosphere	Neutral	Maintain pressure with rig pump ON, check seepage at connection B in the fourth minute	Maximum: 35 cm³
4	2880 3120	Atmosphere	In	As for Test No. 3	As for Test No. 3
5	2880 3120	Atmosphere	Out	As for Test No. 3	As for Test No. 3
6	1920 2080	380 420	Neutral	Maintain pressure for 3 minutes	No external seepage
7	Blank	1 10	In or Out	Maintain pressure for 6 hours	No external seepage

TABLE 2 Test schedule (continued)

Test No.	Minimum and maximum pressures in lbf/in² at connections A and C	B	Valve Selection	Procedure	Requirements
	DRAIN THE DAMPER CHAMBER ONLY				
8	Atmosphere	Atmosphere	Alternate	Check valve stroke	According to valve part number within + 0.020 in.
9	Atmosphere	Atmosphere	Alternate	Move spindle slowly to keep load to a minimum and check operating load over all parts of stroke	Maximum: 7 lb.
	REFILL THE DAMPER CHAMBER AND EXPEL ALL AIR				
10	2880 3120	Reservoir	Alternate	Check load required to move spindle :— (a) Over full valve stroke in both directions (b) From neutral, in both directions	 (a) Maximum: 6 lb. matched to within 2½ lb. (b) Maximum: 2½ lb.
11	2880 3120	380 420	Alternate	Check load required to move spindle from neutral, in both directions	Maximum: 3½ lb.
12	960 1040	Reservoir	As required	(1) Centralize the valve with the two test fixture pistons in their approximate mid-positions. (2) Move the valve spindle in one direction until one of the pistons starts to extend; set the dial indicator to zero. (3) Move the spindle in the opposite direction until the other piston starts to extend; the indicator reading is the 'pressure overlap' and must be between 0.001 and 0.006 in.	
13	960 1040	Reservoir	As required	(1) As for Test No. 12 (1) (2) Move the spindle out until piston 'E' starts to retract; set the indicator to zero (3) Move the spindle in until piston 'D' starts to retract; the indicator reading is the 'return overlap' and must be between 0.002 and 0.006 in.	
14	960 1040	Reservoir	As required	(1) As for Test No. 12 (1) (2) Move the spindle in until piston 'E' starts to extend; set the indicator to zero. (3) Continue to move the spindle in until piston 'D' starts to retract; the indicator reading is the amount that pressure is selected before return and must be between 0.000 and 0.003 in.	

TABLE 2 Test schedule (continued)

Test No.	Minimum and maximum pressures in lbf/in² at connections A and C	B	Valve Selection	Procedure	Requirements
15	960 1040	Reservoir	As required	(1) As for Test No. 12 (1) (2) Move the spindle out until piston 'D' starts to extend; set indicator to zero (3) Continue to move the spindle out until piston 'E' starts to retract; the indicator reading is the amount that pressure is selected before return and must be between 0.000 and 0.003 in.	
16	2880 3120	Reservoir	Neutral	Maintain pressure with rig pump ON, check valve 'stiction' (load required to move spindle) after a 5 minute stand. Repeat after second 5 minute stand, from neutral in opposite direction	Maximum: 10 lb.

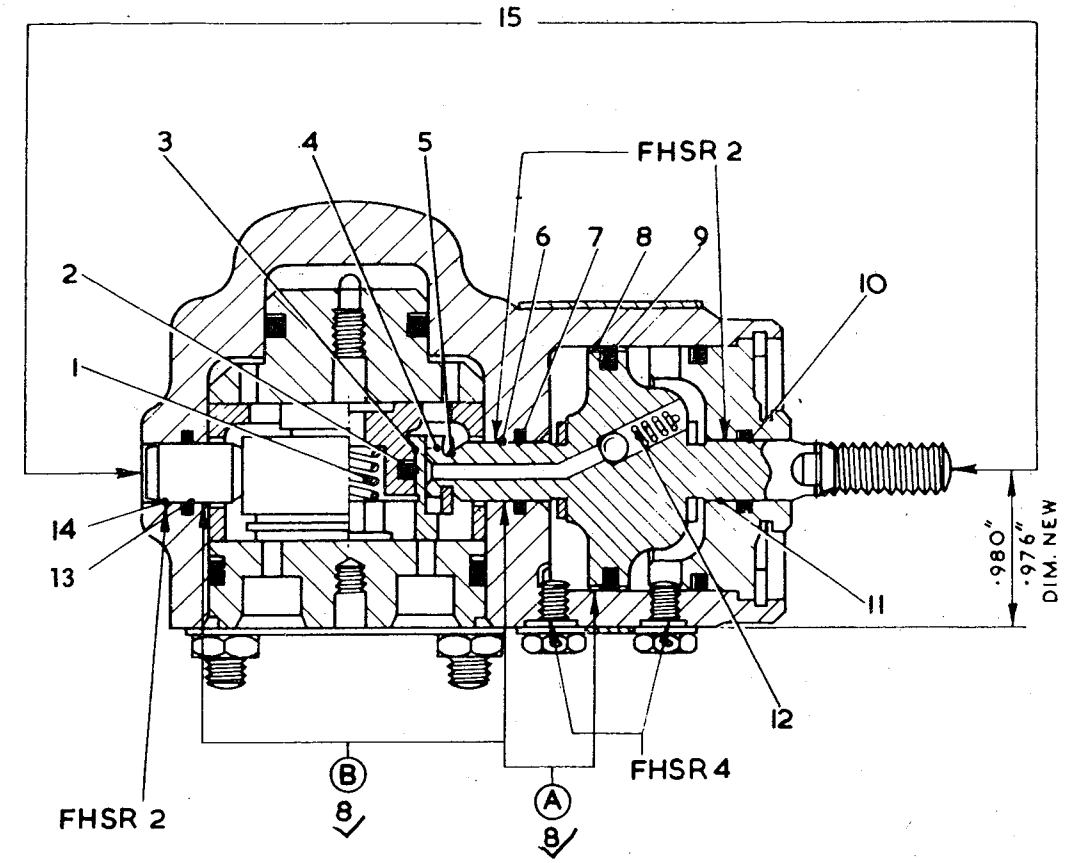
TABLE 3 Fault diagnosis

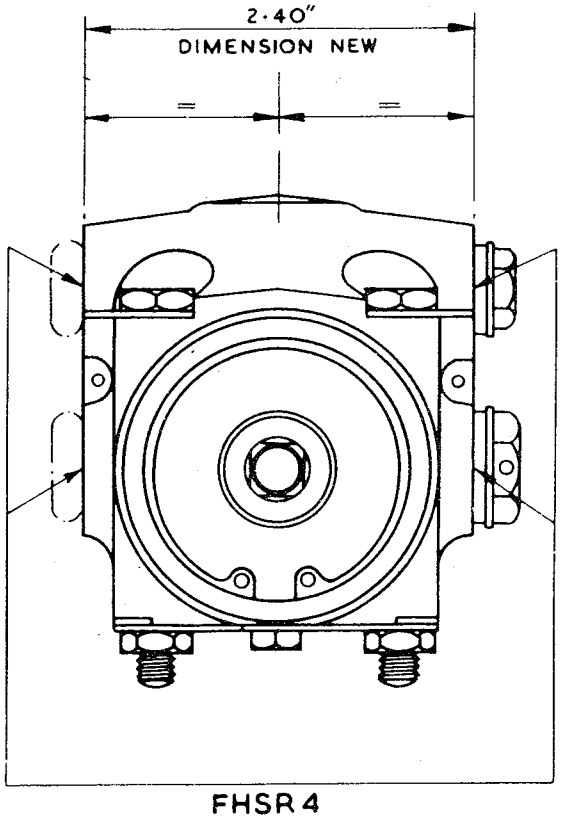
	Fault		Diagnosis
1	Excessive seepage from connection B during tests 3, 4 and 5 of Table 2	1	(1) Defective top platen seal or sleeve seal (2) Damaged platen or sleeve faces (3) Defective sleeve spring
2	Leakage between the balancing spindle and the valve body	2	Defective seal in the balancing spindle orifice
3	Leakage between the piston spindle and the end cap	3	Defective cap inner seal.
4	Leakage between the end cap and valve body	4	Defective cap outer seal
5	Leakage between valve and fixture platform	5	Defective bottom platen seal or connecting piece seal(s)
6	Valve tends to select without assistance	6	Foreign matter between the faces of the bottom platen and fixture platform, or between platen spacer and top platen
7	Test fixture pistons 'creep' when valve is at neutral	7	Foreign matter between the faces of the outer sleeve and the bottom platen

TABLE 4 Fits, clearances and repair tolerances

(All dimensions are in inches)

Ref. No. in Fig. 6	Parts and Description	Dimension New	Permissible Worn Dimension		Clearance New	Permissible Worn Clearance
			Inter-changeable Assembly	Selective Assembly		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	SPRING	Effort when compressed 0.34 in. = 7 – 9 lb				
2	SEAL IN OUTER SLEEVE					
	Sleeve i/d	0.8080 0.8070	0.8085	0.8100	-0.0090 -0.0240	-0.0050 minimum
	Seal (fitted) o/d	0.8310 0.8170	–	–		
3	INNER SLEEVE IN OUTER SLEEVE					
	Outer sleeve i/d	0.8080 0.8070	0.8085	0.8100	0.0040 0.0020	0.0050
	Inner sleeve o/d	0.8050 0.8040	0.8035	0.8020		
4	PISTON IN OPERATING RING					
	Ring slot i/d	0.1940 0.1900	0.1950	0.1980	0.0100 0.0040	0.0120
	Piston o/d	0.1860 0.1840	0.1830	0.1780		
5	OPERATING RING IN PISTON					
	Piston groove width	See Ref. No. 15				
	Ring thickness					
6	PISTON IN VALVE BODY					
	Body i/d	0.37525 0.37475	0.3765	0.3775	0.00225 0.00075	0.0035
	Piston o/d	0.3740 0.3730	0.3730	0.37125		
7	PISTON IN SEAL					
	Seal (fitted) i/d	0.3710 0.3630	–	–	-0.0020 -0.0110	-0.0010 minimum
	Piston o/d	0.3740 0.3730	0.3730	0.37125		
8	PISTON IN VALVE BODY					
	Body i/d	1.5010 1.4995	1.5030	1.5060	0.0080 0.0035	0.0100
	Piston o/d	1.4960 1.4930	1.4930	1.4895		





LIMITS OF ECCENTRICITY

A 0.004 in

B 0.002 in

TOTAL D.T.I. READING

Fig. 6 Key diagram for repairs and clearances

TABLE 4 (continued)

Ref. No. in Fig.6	Parts and Description	Dimension New	Permissible Worn Dimension		Clearance New	Permissible Worn Clearance
			Inter-changeable Assembly	Selective Assembly		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
9	SEAL IN VALVE BODY					
	Body i/d	1.5010 1.4995	1.5030	1.5060	−0.00600 −0.02750	−0.0050 minimum
	Seal (fitted) o/d	1.5270 1.5070	–	–		
10	PISTON IN SEAL					
	Seal (fitted) i/d	0.3710 0.3630	–	–	−0.0020 −0.0110	−0.0010 minimum
	Piston o/d	0.3740 0.3730	0.3730	0.37125		
11	PISTON IN END CAP					
	Eng cap i/d	0.3755 0.3745	0.3765	0.3775	0.0025 0.0005	0.0035
	Piston o/d	0.3740 0.3730	0.3730	0.37125		
12	SPRING	Effort when compressed 0.25 in. = 2 lb Effort when compressed 0.28 in. = 0.53 lb				
13	BALANCING SPINDLE IN SEAL					
	Seal (fitted) i/d	0.3710 0.3630	–	–	−0.0020 −0.0110	−0.0010 minimum
	Spindle o/d	0.3740 0.3730	0.3730	0.37125		
14	BALANCING SPINDLE IN VALVE BODY					
	Body i/d	0.37525 0.37475	0.3765	0.3775	0.00225 0.00075	0.0035
	Spindle o/d	0.3740 0.3730	0.3730	0.37125		
15	ASSEMBLY OF:– Piston, Operating ring, Outer sleeve, Balancing spindle	Total backlash over these items must not exceed 0.0010 in.				

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